DEMO9S08EL32

Demonstration Board for Freescale MC9S08SE8 Microcontroller

USER GUIDE

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REVISION

Date	Rev	Comments
January 15, 2007	A	Initial Release
August 7, 2008	B	Update format, minor corrections. Removed Operating Modes section

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 DEMO9S08EL32 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.
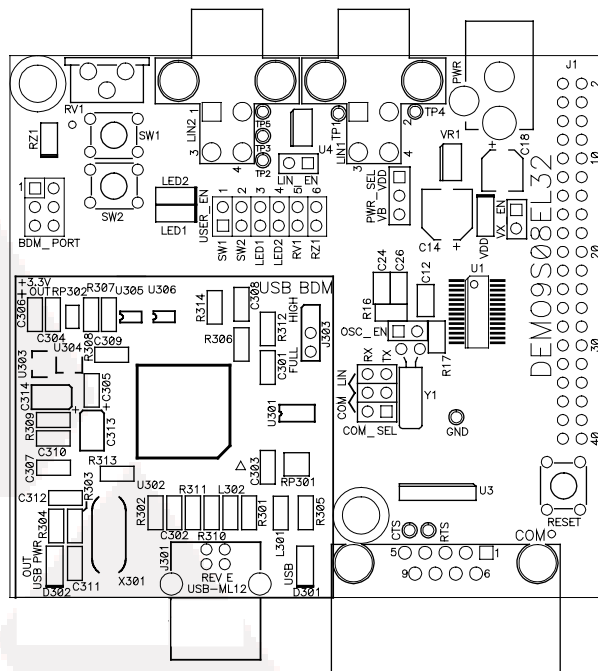
Cut-Trace – a circuit trace connection between component pads. The circuit trace may be cut using a knife to break the default connection. To reconnect the circuit, simply install a suitably sized 0-ohm resistor or attach a wire across the pads.

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

FEATURES

The DEMO9S08EL32 is a demonstration board for the MC9S08EL32 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 40-pin connector provide access to all IO signals on the target MCU.

- MC9S08EL32, 28 TSSOP
    - 32K Bytes Flash
    - 1K Bytes RAM
    - 512K Bytes EEPROM
    - Internal Oscillator
- Integrated USB-BDM
- BDM_PORT header for BDM cable support (not installed)
- LIN PHY w/ 2, 4-pos Molex connectors
- MCU_PORT socket headers for access to MCU IO signals
- 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
    - 7 LED Indicators; 2 User, VDD, USB Power, USB Power Out
    - 5K ohm POTs w /LP Filter
    - Light Sensor w/ LP Filter and Op Amp
- Jumpers
    - PWR_SEL
    - VX_EN
    - USER_EN
    - COM_SEL
- 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: +6VDC to +18VDC

> **NOTE:** LIN functionality only supported when powered from PWR connector with input voltage greater than +12V or when powered from the LIN bus.

REFERENCES

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

DEMO9S08EL32_UG.pdf   DEMO9S08EL32 User Guide (this document)
DEMO9S08EL32_QSG.pdf   DEMO9S08EL32 Quick Start Guide
DEMO9S08EL32 _SCH_A.pdf   DEMO9S08EL32 Schematic Rev. A
DEMO9S08EL32_Silk_A.pdf   DEMO9S08EL32 Top Silk, Rev A
EL32DEMO.zip   Demo Program Source Code

GETTING STARTED

To get started quickly, please refer to the DEMO9S08EL32 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

Table 1 below shows the default memory map for the MC9S08EL32 immediately out of reset. Access to unimplemented sections of memory forces a device reset. Refer to the MC9S08EL32 Data Sheet (DS) for further information.

Table 1: Memory Map

$0000 - $007F	REGISTERS	128 bytes
$0080 - $047F	RAM	1024 bytes
$0480 - $16FF	Unimplemented	4736 bytes
$1700 - $17FF	EEPROM	2 x 256 bytes
$1800 - $18FF	High Page Registers	256 bytes
$1900 - $7FFF	Unimplemented	26368 bytes
$8000 - $FFFF	FLASH	32768 bytes

SOFTWARE DEVELOPMENT

Software development requires the use of a compiler or assembler supporting the HCS08 instruction set and a host PC operating a debug interface. CodeWarrior Development Studio and Axiom IDE for Windows are supplied with this board.

DEVELOPMENT SUPPORT

Application development and debug for the target MC9S08EL32 is supported through a background debug mode (BDM) interface. The BDM interface consists of an integrated USB BDM and a 6-pin interface header (BDM_PORT). The BDM_PORT header allows connecting a HCS12/HCS08 BDM cable.

Integrated BDM

The DEMO9S08EL32 board features an integrated USB BDM. The integrated USB BDM supports application development and debugging via background debug mode. All necessary signals are provided by the integrated USB BDM. A USB, type B, connector provides connection from the target board to the host PC.

The integrated USB BDM provides +5V power and ground to target board eliminating the need to power the board externally. Power from the USB 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_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. Figure 1 below shows the pin-out for the BDM_PORT header. This information is included for completeness.

Figure 1: BDM_PORT Header

BKGD	1	2	GND	See the MC9S08EL32 Data Sheet for complete
	3	4	RESET*	DEBUG documentation
	5	6	VDD	

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

POWER

The DEMO9S08EL32 is designed to allow the user to power the board through the USB BDM during application development. A 2.0-mm barrel connector has been applied to support stand-alone operation and to support LIN functionality. The board may also be powered through connector J1. This connection may also be used to supply power from the board to external circuitry. Optionally, the board may be powered from the LIN connectors.

During application development, the board may be powered from either the USB-BDM or the PWR connector. To utilize LIN functionality, however, the board must be powered from the LIN bus or from PWR connector with an input voltage greater than +12VDC.
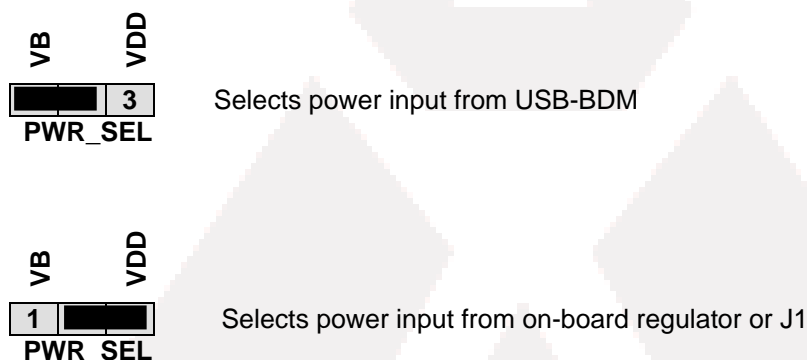
POWER SELECT

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

PWR_SEL

The PWR_SEL option header selects power input either from the integrated USB BDM circuitry or from the on-board voltage regulator. Figure 2 below details the PWR_SEL header connections.

Figure 2: PWR_SEL Option Header

VB   VDD

| | | 3 | Selects power input from USB-BDM

PWR_SEL

VB   VDD

| 1 | | | Selects power input from on-board regulator or J1

PWR_SEL

> **NOTE:** Set PWR_SEL jumper to VB during application development. Use barrel connector input (PWR) to support LIN functionality if needed.

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 +6V to +18V. The voltage regulator (VR1) provides a +5V fixed output limited to 250mA. 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.
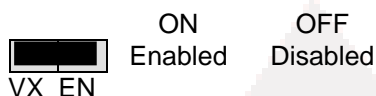
If powered from the PWR connector, the integrated BDM may still be used to develop and debug application code. Alternately, the board may be powered from the integrated BDM while the LIN bus is powered from the PWR connector.

VX_EN

The VX_EN option header is a 2-pin jumper that connects or disconnects input J1-1 directly to the target board, +5V voltage rail. J1-3 is directly connected to the ground plane. Use of this feature requires a regulated +5V 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 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. Figure 3 below details the VX_EN header connections.

Figure 3: VX_EN Option Header


```
                    ON        OFF
                  Enabled    Disabled
 ██████
 VX_EN
```

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 MC9S08EL32 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 MC9S08EL32 reference manual for details LVD operation.

TIMING

The DEMO9S08EL32 is configured to use the target MCU's internal clock source by default. Space is provided for an external, 32 kHz XTAL oscillator; however, the external timing source is not populated. The internal timing source is active out of RESET. Default configuration sets the internal bus to run at 8.4MHz. The internal clock source is trimmable to ± 0.2%. Refer to the MC9S08EL32 Data Sheet for further details.

COMMUNICATIONS

The DEMO9S08EL32 board applies a single Serial Communications Interface (SCI) port configurable between either SCI or LIN functionality. RS-232 communications are supported through a DB9 connector. LIN communications are supported through a pair of 4-pin Molex connectors. A 2x3 option header selects the desired communications protocol.

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 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 below details the SCI connections to the target MCU.

Table 2: COM Connections

MCU Port	COM Signal	I/O PORT CONNECTOR
PTB1/PIB1/SLTXD/TXD/ADP5	TXD	J1-5
PTB0/PIB0/SLRXD/RXD/ADP4	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. Figure 4 below details the DB9 connector pin-out.

Figure 4: COM Connector

4, 6 **1** 　**6** 1, 4 TXD **2** 　**7** RTS RXD **3** 　**8** CTS 1, 6 **4** 　**9** NC GND **5**	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.**

LIN Communications

The DEMO9S08EL32 applies a fault tolerant, Local Interconnect Interface (LIN) physical layer (PHY) for use in developing automotive control applications. The PHY supports LIN bus functionality for input voltages between +12V and +18V. Only power applied to the PWR connector or through the LIN bus enable LIN functionality. Two, 4-pin, Molex connectors provide off-board connectivity. Figure 5 below shows the pin-out of the LIN connector looking into the connector.

Figure 5: LIN Connector

LIN I/O	4	3	V_{SUP}	REF: Mating Connector, Molex P/N,
GND	2	1	GND	39-01-2040, Housing
				39-00-0039, Socket

   NOTE: +12V must be applied to the PWR connector when using the LIN functionality.

LIN_EN

The LIN_EN option header can be used to disable the LIN PHY under MCU control. The LIN PHY is enabled by default if this header is removed. Figure 6 shows the LIN_EN shunt positions.
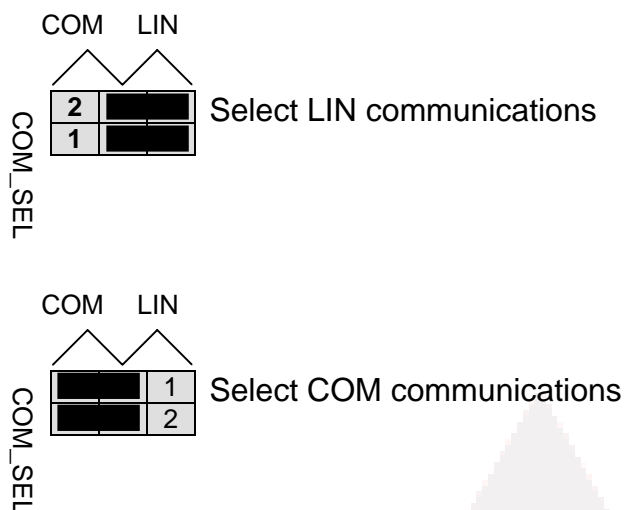
Figure 6: LIN_EN Option Header

	ON	OFF
	Enabled	Disabled

VX_EN

COM_SEL

The COM_SEL option header connects the MCU SCI port to either the SCI PHY or the LIN PHY. Figure 7 below shows jumper setting selecting between SCI or LIN signalling.

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Figure 7: COM_SEL Option

Select LIN communications

Select COM communications

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. Table 3 and Figure 8 below show the USER enable position and associated signals for each USER option.

Switches

The DEMO9S08EL32 provides 2 push button switches for user input. Each push button switch provides an active low input with a pull-up resistor bias to prevent indeterminate input conditions. Pressing a push-button switch causes a low logic input on the associated input. Refer to Table 3 below.

LED's

The DEMO9S08EL32 target board provides 2 green LEDs for output indication. Each LED is an active low output. Writing a low logic level to an LED output causes the associated LED to turn on. A series, current-limit resistor prevents excessive diode current. Refer to Table 3 below.

Potentiometer

The DEMO9S08EL32 target board provides a 5K ohm potentiometer (POT) to simulate analog input. The POT is decoupled to minimize noise during adjustment. Potentiometer RV1 connects to analog input PTA0. Refer to Table 3 below.

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. Refer to Table 3 below.

User Signals

Table 3 shows the connections for each user I/O device.

Table 3: User I/O

USER	Ref Des	Signal	Device
1	SW1	PTA2/PIA/ADP2	Push Button Switch
2	SW2	PTA3/PIA3/ADP3	Push Button Switch
3	LED1	PTC0/PIC0/TPM1CH0	Green LED
4	LED2	PTC1/PIC1/TPM1CH1	Green LED
5	RV1	PTA0/PIA0/ACMP1+	Potentiometer
6	RZ1	PTA1/PIA1/ACMP1-	Sensor

User Enable

The User option header block enables or disables each User I/O device individually. User I/O includes 4 green LEDs, 2 push button switches, one 4-position DIP switch, a Light Sensor, and a potentiometer. Installing a shunt enables the associated option. Removing a shunt disables the associated option. Figure 8 below shows the configuration option for each USER I/O.

Figure 8: USER Option Header

		Shunt		
	USER	Installed	Removed	Description
1	▮▮▮	Enable	Disable	Push Button Switch 1
2	▮▮▮	Enable	Disable	Push Button Switch 2
3	▮▮▮	Enable	Disable	LED 1
4	▮▮▮	Enable	Disable	LED 2
5	▮▮▮	Enable	Disable	Potentiometer
6	▮▮▮	Enable	Disable	Sensor

MCU I/O PORT

The MCU I/O PORT connectors (J1 and J2) provide access to the MC9S08EL32 I/O signals. Figure 9 below show the pin-out for each MCU I/O connector.

Figure 9: MCU I/O PORT – J1

VDD	1	2	RESET*
VSS	3	4	RESET*
PTB1/PIB1/SLTXD/TXD/ADP5	5	6	BKGD/MS
PTB0/PIB0/SLRXD/RXD/ADP4	7	8	PTB7/SCL/EXTAL
PTA2/PIA2/SDA/RXD/ACMP1O/ADP2	9	10	
PTA3/PIA3/SCL/TXD/ADP3	11	12	
PTA0/PIA0/TMP1CH0/TCLK/ACMP1+	13	14	
PTB6/SDA/XTAL	15	16	
PTB3/PIB3/SCL/MOSI/ADP7	17	18	PTA1/PIA1/TMP2CH0/ACMP1-/ADP1
PTB4/TMP2CH1/MISO	19	20	PTA0/PIA0/TMP1CH0/TCLK/ACMP1+
PTB2/PIB2/SDA/SPSCK/ADP6	21	22	
PTB5/TPM1CH1/SS*	23	24	
PTC0/PIC0/TPM1CH0/ADP8	25	26	PTB1/PIB1/SLTXD/TXD/ADP5
PTC1/PIC1/TPM1CH1/ADP9	27	28	PTB0/PIB0/SLRXD/RXD/ADP4
PTC2/PIC2/TPM1CH2/ADP10	29	30	PTA6/TPM2CH0
PTC3/PIC3/TMP1CH3/ADP11	31	32	PTA7/TPM2CH1
PTC4/PIC4/ADP12	33	34	PTC6/PIC6/ACMP2+/ADP14
PTC5/PIC5/ACMP2O/ADP13	35	36	PTC7/PIC7/ACMP2-/ADP15
NC	37	38	NC
NC	39	40	NC