DEMO9S08QA4

Demonstration Board for the Freescale MC9S08QA4

USER GUIDE

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FIGURES

TABLES

REVISION

Date	Rev	Comments
January 3, 2008	A	Initial Release
January 16, 2008	B	Added notes to Feature page
April 30, 2008	C	Corrected board name errors
May 12, 2008	D	Modified Table 3 to correctly show MCU pin numbers. Minor verbiage error corrections

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) EMC Information on the DEMO9S08QA4 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

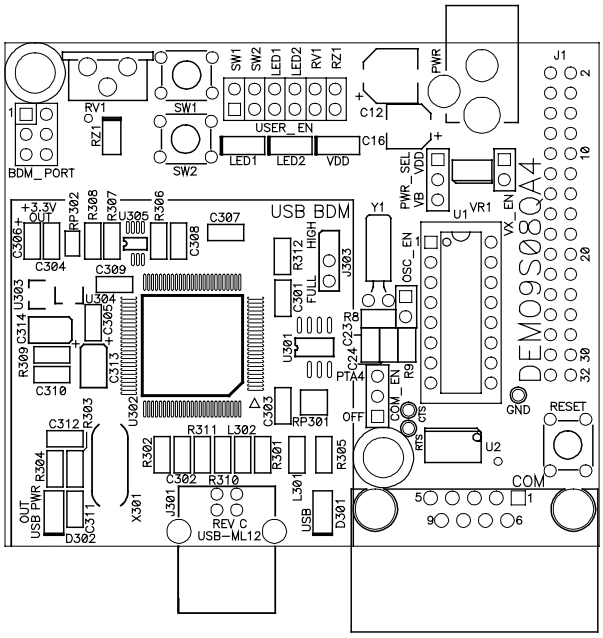
This development board uses option selection jumpers. A jumper is a plastic shunt that connects 2 terminals electrically. Terminology for application of the option jumpers is as follows:

Jumper on, in, or installed - jumper is installed such that 2 pins are connected together.

Jumper off, out, or idle - jumper is installed on 1 pin only. It is recommended that jumpers be idled by installing on 1 pin so they will not be lost.

FEATURES

The DEMO9S08QA4 is an evaluation or demonstration board for the MC9S08QA4 microcontroller. Development of applications 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 connector allows connecting the DEMO9S08QA4 board to an expanded evaluation environment.



- MC9S08QA4 CPU, 8-pin DIP, Socketed
  - 4K Byte Flash
  - 256 Bytes RAM
  - Internal 32 kHz Oscillator, trimmable to ±0.2%
  - 4 GPIO, 1 Input Only, 1 Output only
  - Timer Interface Module
  - 4 KBI inputs
  - 1-Ch, 16-bit, Timer Interface
  - 4-Ch, 10-bit Analog to Digital Converter (ADC)
  - Analog Comparator w/ internal compare
- Integrated USB-BDM
- RS-232 Serial Port w/ DB9 Connector (non-functional)
- IIC ports available on Connector J1
- External 32.768 kHz Clock Oscillator (not installed)
- Power Input Selection Jumper
  - Power input from USB-BDM
  - Power input from on-board regulator
  - Power input from Connector J1
  - Power output through Connector J1
- User Components Provided
  - 3 Push Switches; 2 User, 1 Reset
  - 3 LED Indicators; 2 BDM, 1 VDD
- Jumpers
  - USER_EN
  - PWR_SEL
  - COM_SEL
  - VX_EN
  - OSC_EN (not installed)
- Connectors
  - 32-pin MCU I/O Connector
  - 2.0mm Barrel Connector
  - BDM_PORT Pin Header (not installed)
  - DB9 Serial Connector

- **Specifications:**
  - Board Size 2.9” x 2.5”
  - Power Input:
    - USB Cable – 500mA max
    - PWR Connector - 9VDC typical, +7VDC to +18VDC

Neither the LED nor the COM circuits are connected to the target MCU. However, functionality for these circuits is available on the expansion header J1. Refer to the DEMO9S08QA4 Schematic for further details.

REFERENCES

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

DEMO9S08QA4_UG.pdf	DEMO9S08QA4 User Guide (this document)
DEMO9S08QA4_SCH_A.pdf	DEMO9S08QA4 Board Schematic, Rev. A
DEMO9S08QA4_QSG.pdf	DEMO9S08QA4 Quick Start Guide
AN2627.pdf	Cycle-by-Cycle Instruction Details for HC(S)08 MCU's

GETTING STARTED

To get started quickly, please refer to the DEMO9S08QA4 Quick Start Guide included with the development kit. This quick start shows how to connect the board to the PC, install the correct version of CodeWarrior Development Studio, and run an LED test program.

SOFTWARE DEVELOPMENT

Software development requires the use of an HCS08 assembler or compiler and a host PC running a BDM interface. CodeWarrior Development Studio for HC(S)08 is supplied with this board for application development and debugging and for flash programming.

MEMORY MAP

The table below shows the MC9S08QA4 memory map. Accessing unimplemented memory locations causes an illegal-address reset. The memory map is grouped into 3 broad categories; Registers, RAM, and Flash. In the memory map below, the non-volatile registers and vector table are located at the top of the Flash block.

Table 1: Memory Map

0x0000 – 0x005F	Direct Page Registers	96 bytes
0x0060 – 0x015F	RAM	256 bytes
0x0160 – 0x17FF	Unimplemented	
0x 1800 – 0x184F	High Page Registers	80 bytes
0x1850 – 0xDFFF	Unimplemented	51,120 bytes
0xE000 – 0xEFFF	Reserved	
0xF000 – 0xFFFF	Flash / Vectors	

NOTE: Accessing unimplemented memory locations causes an illegal-address reset.

DEVELOPMENT SUPPORT

Application development and debug for the target MC9S08QA4 is supported through the BDM interface. The debug interface consists of an integrated USB-BDM debugger and an optional 6-pin header (BDM_PORT). The BDM_PORT header is not installed in default configuration and may be installed by the user if needed.

Integrated BDM_PORT

The DEMO9S08QA4 board features an integrated USB-BDM debugger from P&E Microcomputer Systems. The integrated debugger supports application development and debugging via the background debug mode. A USB, type B, connector provides connectivity between the target board to the host PC.

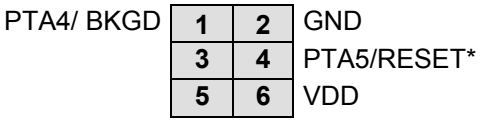
The integrated debugger provides power and ground to the target, thereby eliminating the need to power the board externally. When used, power from the USB-BDM circuit is derived from the USB bus; therefore, total current consumption for the target board, and all connected circuitry, must not exceed **500mA**. Excessive current drain will violate the USB specification causing the USB bus to disconnect; power is removed from the target forcing a POR.

CAUTION: Violating the USB specification will cause the USB bus to disconnect forcing the target to reset.

BDM_PORT Header

An HCS08/HC(S)12 BDM cable may be attached to a 6-pin BDM_PORT port header. However, this header is not installed in default configuration. Use of this port requires the user to install a 2x3, 0.1” center, pin header. Refer to the BDM cable documentation for details on the use of the BDM cable. The BDM_PORT header pin-out is shown below.

Figure 1: BDM Port



See the HCS08 Device User Guide for complete BDM_PORT documentation

NOTE: This header is not installed in default configuration.

POWER

The DEMO9S08QA4 is designed to be powered from the USB_BDM during application development. A 2.0mm barrel connector has been applied to support stand-alone operation. In addition, the board may be powered through connector J1. The board may also be configured to supply power through connector J1 to external circuitry.

When using the integrated USB-BDM, the board draws power from the USB bus. Total current consumption of the board and connected circuitry, therefore, must be limited to less than **500mA**. Excessive current drain will violate the USB specification causing the USB bus to disconnect. This will force a power-on-reset (POR).

CAUTION: Violating the USB specification will cause the USB bus to disconnect, forcing the target to reset.

A 2.0mm barrel connector input has been provided to allow stand-alone operation. Voltage input at this connector must be limited to between +5V and +18V. An LDO voltage regulator at VR1 converts the input voltage to the +3.3V rail on the target board. VR1 will shut down if the connected circuit draws excessive current. Stand-alone operation is also supported through connector J1.

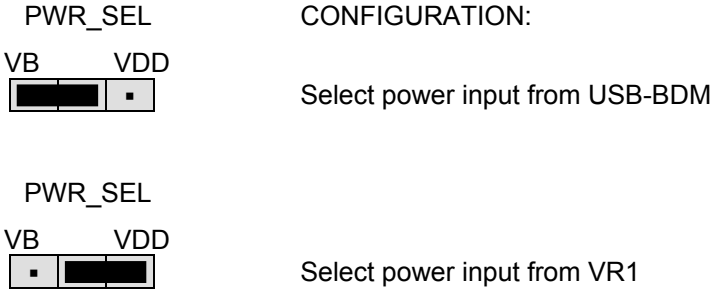
POWER SELECT

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 by using 2 option headers: PWR_SEL option header and the VX_EN option header.

The PWR_SEL option header selects power input either from the integrated USB-BDM circuitry or from the on-board voltage regulator. Power input selection, from the USB-BDM or the on-board power supply, is mutually exclusive. This prevents power-input contention from damaging the board. The figure below details the PWR_SEL header connections.

PWR_SEL

Figure 2: PWR_SEL Option Header



Power from the integrated BDM is drawn from the USB bus and is limited to **500mA**. Excessive current drain will violate the USB specification will cause the USB bus to disconnect.

CAUTION: Violating the USB specification will cause the USB bus to disconnect. This will cause the board to reset.

The on-board voltage regulator (VR1) accepts power input through a 2.0mm barrel connector (PWR). Input voltage may range from +5V to +18V. The voltage regulator (VR1) provides a +3.3V fixed output limited to 250mA. Over-temperature and over-current limits built into the voltage regulator protects the device from excessive stresses.

The user should consider the maximum output current limit of the selected power source when attempting to power off-board circuitry through connector J1.

VX_EN

The VX_EN option header is a 2-pin jumper that connects the target board voltage rail to J1-1. J1-3 is connected directly to the ground plane. Use of this feature requires a regulated +3.3V input power source. This power input is decoupled to minimize noise input 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 be sourced to off-board circuitry through the J1 connector. The current limitation of the USB bus or the on-board regulator must be considered when attempting to source power 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 option header connections.

Figure 3. VX_EN Option Header

ON Enable power connection to connector J1

VX_EN

OFF Disable power connection to connector J1

VX_EN

CAUTION: Do not apply power to connector J1 while also sourcing power from either the PWR connector or the USB-BDM circuit. Damage to the board may result.

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

RESET SWITCH

The RESET switch provides a method to apply an asynchronous reset to the MCU and is connected directly to the PTA5/RESET* input on the MCU. Pressing the RESET switch forces the MCU RESET* input low. The MC9S08QA4 MCU applies an internal pull-up on the RESET* line to prevent spurious resets and allow normal operation.

LOW VOLTAGE DETECT

The MC9S08QA4 utilizes an internal Low Voltage Detect (LVD) to protect against undervoltage conditions. The LVD is enabled out of RESET. Consult the MC9S08QA4 Device User Guide for details on configuring LVD operation.

STOP MODES

The MC9S08QA4 can be configured for three different low power stop modes. If stop1 or stop2 modes are entered, an external pull-up resistor must be placed between the PTA5/RESET*/IRQ*/TCLK pin and VDD. This pull-up resistor is not included on the DEMO9S08QA4 board. If these modes will be used with this board, a 10K – 50K ohm resistor can be placed between pins J1-1 and J1-2 to ensure proper operation of the MCU. The jumper for the VX_EN header must also be in place in this case. Consult the MC9S08QA4 Device User Guide for more details on configuring the low power stop modes.

TIMING

By default, the DEMO9S08QA4 uses timing provided from an internal 32 kHz frequency reference and an internal frequency-locked loop (FLL). The FLL output is trimmable to ± 0.2% of nominal. Refer to the MC9S08QA4 Device User Guide for further details on clock operation.

Component pads for an optional 32.768 kHz crystal oscillator circuit have also been provided to support external timing input. The external crystal is connected to the PTB6/XTAL and PTB7/EXTAL MCU inputs. This alternate timing source is configured for Pierce mode operation.

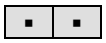
NOTE: The external oscillator pads are not connected to the MC9S08QA4 socket. This section is provided for completeness.

The alternate timing source components are not installed in default configurations. Refer to the board schematic to populate this option and associated support components.

Figure 4: OSC_EN Option Header

ON Enables Crystal Oscillator Input to MCU

OSC_EN



OFF

OSC_EN

NOTE: This option header is not installed in default configuration.
NOTE: This option header is not connected to the MC9S08QA4 socket

COMMUNICATIONS

SCI Port

NOTE: Although populated on the board, the COM circuitry is not connected to the MC9S08QA4 socket. This section is included for completeness only.

NOTE: To reduce power consumption, the COM_EN jumper should be set to OFF at all times.

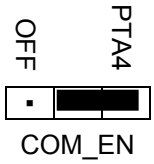
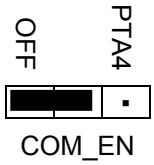
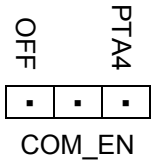
An RS-232 transceiver provides RS-232 to TTL/CMOS logic level translation between the COM connector and the MCU. The COM connector is a 9-pin Dsub, right-angle connector. A ferrite bead on shield ground provides conducted immunity protection. Communication signals TXD and RXD are routed from the transceiver to the MCU. These signals are also available on connector J1. Hardware flow control signals RTS and CTS are available on the logic side of U3 and are routed to test point vias located near the transceiver (U4). RTS has been biased properly to provide handshaking if required.

Communications signals TXD and RXD connect to general purpose Port B signals. The RS-232 transceiver should be disabled via the COM_EN option header if these signals are used as GPIO. The transceiver should also be disabled if the TXD and RXD signal inputs at connector J1 are used.

COM_EN

The COM_EN option header determines the operational status of the RS-232 transceiver. In the OFF position, the transceiver is disabled and all outputs are tri-stated. In the PTA4 position, the transceiver may be turned on or off using MCU GPIO signal PTA4. With the option jumper removed, the transceiver is always on. When the transceiver is ON, the AutoShutoff feature of the device is disabled.

Table 2: COM_EN Option Header

1		MCU controls RS-232 Transceiver. This allows the user to disable the device if needed or desired. The COM_EN jumper should not be set to this position during power-up.
2		RS-232 Transceiver disabled
3		RS-232 Transceiver always ON. AutoShutoff disabled

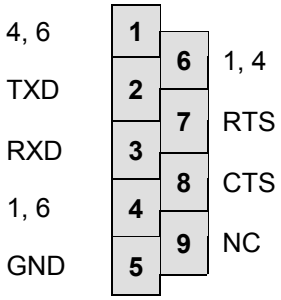
NOTE: Do not set COM_EN jumper to PTA4 position during power-on. This may cause the board to power-cycle on the USB bus. This may also lead to damage to the target board or the host PC.

NOTE: To reduce power consumption, the COM_EN jumper should be set to OFF

COM Connector

A standard 9-pin Dsub connector provides external connections for the SCI 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 DB9 connector pin-out is shown below.

Figure 5: COM Connector



Female DB9 connector that interfaces to the HC(S)08 internal SCI1 serial port via the U2 RS232 transceiver. It provides simple 2-wire asynchronous serial communications without flow control. Flow control is provided at test points on the board.

Pins 1, 4, and 6 are connected together.

IIC Port

IIC signaling connects directly between connector J1 and the MCU. Refer to the MC9S08QA4 Device User Guide for details on using the IIC interface.

IIC signals are available on both Port A and Port B. Configuration pull-ups have been applied to Port A, IIC signals. Refer to the schematic for details.

USER OPTIONS

The DEMO9S08QA4 includes various input and output devices to aid application development. User I/O devices include 2 momentary pushbutton switches, 2 green LEDs, 1 potentiometer, and 1 phototransistor. Each device may be enabled or disabled individually by the USER_EN option header. Each user enable is clearly marked as to functionality.

Pushbutton Switches

Two push button switches provide momentary, active-low input, for user applications. Pull-ups internal to the MCU must be enabled to provide error free switch operation. Pushbutton switches SW1 and SW2 are enabled to the MCU I/O ports by the USER option bank. SW1 and SW2 connect to input ports PTA2 and PTA3 respectively. Table 3 below details the user jumper settings.

LED Indicators

NOTE: Although populated on the board, the LED circuitry is not connected to the MC9S08QA4 socket. This section is included for completeness only.

Indicators LED1 and LED2 are enabled from HC(S)08 I/O ports by the USER option bank. Each LED is active-low and illuminates when a logic low signal is driven from the respective MCU I/O port. MCU ports PTB6 and PTB7 drive LED1 and LED2 respectively. Table 3 below details the user jumper settings.

Potentiometer

A 5k ohm, thumb-wheel type, potentiometer at RV1 provides variable resistance input for user applications. The output is the result of a voltage divider that changes as the thumb-wheel is turned. The potentiometer is connected between VDD and GND with the center tap providing the divider output. This center tap is connected to the MCU on signal PTA0. Table 3 below details the user jumper settings.

Photocell

A surface-mount phototransistor 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 U2 boosts the photocell output to useable levels. This signal is available to the MCU on signal PTA1. Table 3 below details the user jumper settings.

Table 3: User Option Jumper Settings

Jumper	On	Off	MCU PORT	MCU PIN	SU1 Pin
SW1	Enable SW1	Disable SW1	PTA2	6	14
SW2	Enable SW2	Disable SW2	PTA3	5	13
LED1	Not Connected				
LED2	Not Connected				
RV1	Enable RV1	Disable RV1	PTA0	8	16
RZ1	Enable RZ1	Disable RZ1	PTA1	7	15

I/O PORT CONNECTOR

This port connector provides access to DEMO9S08QA4 I/O signals. Signal positions not shown listed are not connected on the board.

Figure 6: MCU I/O Port Connector

VDD	1	2	PTA5/RESET*/IRQ*/TCLK
VSS	3	4	PTA5/ RESET*/IRQ*/TCLK
PTB1/KBI1P5/ADC1P5/TXD1	5	6	PTA4/BKGD/MS/ACMP10
PTB0/KBI1P4/ADC1P4/RXD1	7	8	PTB7/SCL1/EXTAL
PTA2/KBI1P2/ADC1P2/SDA1	9	10	PTB6/SDA1/XTAL
PTA3/KBI1P3/ADC1P3/SCL1	11	12	
PTA5/ RESET*/IRQ*/TCLK	13	14	
PTA0/KBI1P0/ADC1P0/TPM1CH0/AMCP+	15	16	
PTB3/KBI1P7/ADC1P7/MOSI1	17	18	PTA1/KBI1P1/ADC1P1/ACMP1-
PTB4/MISO1	19	20	PTA0/KBI1P0/ADC1P0/TPM1CH0/AMCP+
PTB2/KBI1P6/ADC1P6/SPSCK1	21	22	
PTB5/TPM1CH1/SS1	23	24	
PTA1/KBI1P1/ADC1P1/ACMP1-	25	26	
PTB6/SDA1/XTAL	27	28	
PTB7/SCL1/EXTAL	29	30	
PTA4/BKGD/MS/ACMP10	31	32	

NOTE: PTBx signals are not connected to the MC9S08QA4 socket. The signal names are included here for completeness.