9S08Badge

Demonstration Board for Motorola MC9S08GB60

CONTENTS

Cautionary Notes

1) Electrostatic Discharge (ESD) prevention measures should be applied whenever 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 9S08Badge board:

   a) This product as shipped from the factory with associated 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 also cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

Terminology

This development board applies option selection jumpers. Terminology for application of the option jumpers is as follows:

> 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 idled by installing on 1 pin so they will not be lost.

This development board applies hardwired option selection for JP2 (VREFL). This option selection applies a circuit trace between the option pads to complete a default connection. This type connection places an equivalent Jumper Installed type option. The circuit trace between the option pads may be cut with a razor blade or similar type knife to isolate the default connection provided. Applying the default connection again can be performed by installing the option post pins and shunt jumper, or by applying a wire between the option pads.

FEATURES

The 9S08Badge is an evaluation or demonstration board for the MC9S08GB60 microcontroller. Development of applications is quick and easy with the included DB9 serial cable, sample software tools, examples, and debug monitor. The prototyping area provides space to apply the MCU I/O to your needs. The DEBUG port is provided for development tool application and is compatible with HCS08 BDM interface cables and software.

Features:
♦   MC9S08GB60 CPU
        * 60K Byte Flash
        * 4K Bytes Ram
        * 56 I/O lines (64 pins)
        * 5 channel TPM 2 Timer
        * 3 channel TPM 1 Timer
        * 8 Channel 10 BIT A/D
        * SPI and IIC Serial Ports
        * 2 x SCI Serial Ports
        * Key Board Wake-up Ports
        * BDM DEBUG Port
        * Clock generator w/ FLL
        * up to 40Mhz operation
♦   32Khz Crystal
♦   Regulated +3.3V power supply
♦   SCI1 Serial Port w/ RS232 DB9-S Connector
        * SCI1 Serial Port
♦   SCI2 Serial Port w/ RS232 DB9-S Connector
        * SCI2 Serial Port
♦   Power ON/OFF switch
♦   User Components Provided
        * 5 LED Indicators (PTF0-3, PTD0)
        * 4 Push Switches (PTA6-7, IRQ, RESET)
        * Digital to Analog   (PTD2, PTB1)
        * 1.8Volt reference
♦   MCU I/O Port connector provides all digital I/O
♦   Analog or PTB I/O Port connector provides analog inputs or PTB I/O
♦   2 x AA Battery Holder
♦   Supplied with DB9 Serial Cable, Documentation (CD),
        and Batteries.
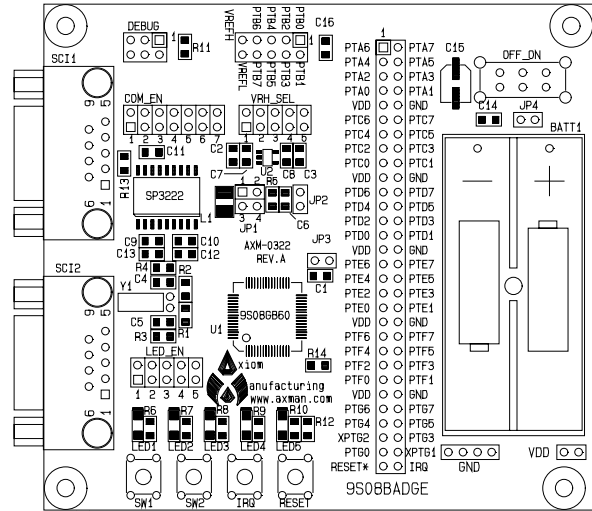
9S08Badge

Specifications:
Board Size 3.0" x 3.8"

GETTING STARTED

The 9S08Badge single board computer is a fully assembled, fully functional development board for the Motorola MC9S08GB60 microcontroller. Provided with 2 AA batteries and serial cable. Support software for this development board is provided for Windows 95/98/NT/2000/XP operating systems.

Development board users should also be familiar with the hardware and software operation of the target HCS08 device, refer to the provided Motorola User Manual for the device and the HCS08 Reference Manual for details. The demonstration board purpose is to promote the features of the 9S08GB60 device or to assist the user in quickly developing an application with a known working environment. Users should be familiar with memory mapping, memory types, and embedded software design for the quickest successful application development.

Application development may be performed by applying the embedded serial interface monitor, or by applying a compatible HCS08 BDM cable with supporting host software. The monitor provides an effective and low cost debug method. Note that when a BDM cable is applied to the DEBUG Port for debugging, the BDM pod should be powered from an external supply.

The serial debug monitor is provided in the development board HCS08 device internal flash memory and applies some HCS08 resources for operation. See the AN2140 application note from Motorola for complete details. User applications operated under monitor control may be configured for dedicated operation by applying the User Reset Vector (0xFBFE/F) and programming the application into the device flash. The monitor will remain in protected flash memory for future use if needed.

Reference Documentation

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

AN2140 – HCS08 Serial Monitor application note.
9S08GB_GT60UM.pdf – 9S08GB60 user manual
HCS08RM.pdf – HCS08 core user manual with instruction set
9S08Badge_SCH_A.pdf – 9S08Badge board schematics

9S08Badge STARTUP

If the BADGE board is supplied with batteries pre-installed, option jumper JP4 must be installed on both pins to enable battery power.

Default example applications are programmed into the 9S08Badge board. Updated examples and additional information is provided at the www.futureerc.com/s08badge web site. The default programs are:

1) **Debug monitor**

2) **Low-power stop3 demo**

3) **ATD/timer demo**

The **Debug Monitor** is the most important program loaded into the MCU residing on the Badge board. In conjunction with a program running on a host personal computer (PC), the debug monitor enables users to program FLASH and debug their programs.

The remainder of the demo programs offer examples of some simple uses of the Badge board.

The **Low-power stop3 demo** illustrates the low-power capability of the MC9S08GB60 microcontroller operating in stop3 mode.

The **ATD/timer demo** shows two timers set up as pulse-width modulators (PWM). One of the PWM outputs drives an integrator (DAC). The other PWM output drives an LED. The ATD reads the voltage output from the integrator and modulates the intensity of the LED.

What Do the Demo Programs Do?

The **Stop3 demo** program is the default program executed at power up if no pushbuttons are held down. This program demonstrates operation of the microcontroller in low-power stop3 mode. The program uses the real time interrupt (RTI) to recover from stop3 mode.

In stop3 mode, clocks are halted and only IRQ, KBI, LVI and RTI interrupts can occur. For this reason when using the serial debugger you can not trace through the demo code once you have reached a stop instruction.

If you are using the serial debugger and you press the go button on the debugger, and test 1 is entered (No buttons pressed) you will no longer be able to halt or trace the demo code. This is because there are no clocks to the serial communications module.

If you observe LED1, located at the bottom left corner of the Badge board, it will quickly flash once approximately twice a second. The LED is on for about 600 microseconds. While the LED is off, the MCU is in low-power stop3 mode and will remain in stop3, for approximately one half second, until the next RTI.

The **ATD/timer demo** program is executed when SW1 is held down at power up or Reset. Timer 1, channel 2, is set up as a PWM output and is connected to a resistor-capacitor filter network, composing a digital-to-analog converter (DAC). The output from the DAC is fed into the input to the ATD, channel 1. Timer 1, channel 0, is connected to LED5. Timer 1, channel 0, is also set up as a PWM output.

The **Debug Monitor** program is executed when SW2 is held down at power up or Reset. The serial debugger, when applied with a host PC and associated debug interface program, enables a user to erase device FLASH memory, program FLASH memory, load application programs, and debug the application programs. The debug monitor dedicates SCI1 as its connection to the host PC and does not use the traditional background debug mode, thus eliminating the necessity for a background debug mode cable. Free software is available for execution on a PC as an interface to the monitor. Refer to application note AN2140 for a full explanation for using the debugger. The debugger is enabled when SW2 is held down at system power-up.

Applying the Demo Programs

Before you can run the demo programs, jumpers must be installed on the Badge board. Depending on which programs you plan to run, jumpers will be installed in a different configuration. Demo programs are selected at powerup from the state of two of the pushbutton switches: SW1 and SW2, located on the bottom left-edge of the Badge board.

If you want to test the **stop3 mode** for lowest power consumption, refer to Table 2 and install the option jumpers on the Badge board per Column A. In this configuration, no power is applied to the RS-232 level shifter. The other demo program applies the option jumper configuration of Column B.

If it is not important how much current the Badge board draws from the batteries during the stop3 mode demo program, install the option jumpers per Column B of Table 1. Installing jumpers as per Column B, extra current will be consumed by the RS-232 level shifter circuit.

To use the monitor program, connect a straight through DB-9 serial cable between the COM port on the PC and the SCI1 connector on the Badge board.

Selecting the Demo Programs

Two pushbutton switches are used by the Badge board's software to select the demo programs. The switches are SW1 and SW2. The switches are read at power-on or Reset. Hold down the pushbutton of choice while applying power. Apply power to the Badge PC board by sliding the ON_OFF switch, located on the top center of the Badge board, toward the top of the board. After the ON_OFF switch is moved to the on position, you can release the pushbutton SWx. The actions of the switches are shown in Table 1.

TABLE 1: Demo Program Selection

Switch (SWx)	Demo Program
No Switch held down	Stop3 demo
SW1	ATD/timer demo
SW2	Debug monitor

NOTES:
1) When power is applied to the Badge board, if none of the switches are held down, the low-power stop3 demo program will execute as the default.
2) When power is applied to the Badge board and SW3 is held down, the ATD/timer demo program will execute.
3) When power is applied to the Badge board and SW4 is held down, the serial Debug Monitor program will execute. A host serial debug program must be executed on your PC to use the monitor program. To use the monitor program, connect a straight through DB-9 serial cable between COM port on the personal computer and SCI1 on the Badge board.

TABLE2: Demo Program Option Selections

Jumper Name		Column A Stop3 Low-Power Mode Only	Column B All Other Modes
JP3		IN	IN
JP4		IN	IN
COM_EN 1	(pins 1-2)	Out	In
COM_EN 2	(pins 3-4)	Out	In
COM_EN 3	(pins 5-6)	Out	In
COM_EN 4	(pins 7-8)	Out	In
COM_EN 5	(pins 9-10)	Out	In
COM_EN 6	(pins 11-12)	Out	In
COM_EN 7	(pins 13-14)	Out	In
VRH_SEL 1	(pins 1-2)	Out	Out
VRH_SEL 2	(pins 3-4)	Out	Out
VRH_SEL 3	(pins 5-6)	Out	Out
VRH_SEL 4	(pins 7-8)	Out	Out
VRH_SEL 5	(pins 9-10)	In	In
JP1	(pins 1-2, 3-4)	In	In
LED_EN 1	(pins 1-2)	In	In
LED_EN 2	(pins 3-4)	In	In
LED_EN 3	(pins 5-6)	In	In
LED_EN 4	(pins 7-8)	In	In
LED_EN 5	(pins 9-10)	In	In

DEBUG MONITOR OPERATION

See the AN2140 application note on the monitor for complete details of operation. Basic operation is provided in this manual. The monitor occupies 1K bytes of flash memory and about to 50 bytes of stack space. It provides a binary command set via the SCI1 port.

COMMUNICATION:

The monitor provides 115.2K baud serial communication on the SCI1 interface port.

POWER ON or RESET PROMPT:

The monitor will provide a binary prompt to the Badge board serial SCI1 port.

COMMANDS:

No user commands can be applied with a keyboard with software such as HyperTerminal or AxIDE. The monitor commands are binary and not compatible with keyboard (ASCII) entry or display. Host based software should interface with the monitor on the serial communication port to provide development support.

INTERRUPT SERVICE SUPPORT:

 The monitor enables automatic hardware vector relocation in the 9S08GB60 so user interrupt vectors appear from 0xFBCC to 0xFBFF. User will not have access to the SCI1, SWI, and RESET vectors while the monitor is operating. Programming the user Reset vector will cause the monitor to execute the user program on Reset. See the AN2140 application note for user interrupt application.

MONITOR MEMORY MAP:

0x0000 - 0x007F	9S08GB60 Direct Page Register Space. See the 9S08GB60 User Manual for details
0x0080 - 0x107F	9S08GB60 ram memory space Initial Monitor Stack Pointer = 0x107F
0x1080 - 0x17FF	Lower flash block – User application memory
0x1800 - 0x182B	9S08GB60 High Page Register block
0x182C - 0xFBCB	User Application Flash Memory
0xFBCC - 0xFBFF	User Interrupt Vectors See AN2140 for details on application
0xFC00 - 0xFFFF	Monitor Flash Memory Space (**Protected**)

9S08Badge Board Operation

The 9S08Badge board provides input and output features to assist in application development. These features may be isolated from the applied HCS08 I/O ports by the option jumpers. This allows alternate use of the HCS08 I/O ports for other application and connection on the I/O port connectors. Caution should be observed so that the HCS08 I/O port pin applied to an on board feature is not also applied to external components by the user.

POWER SUPPLY

Input power is supplied directly from the on-board batteries. The input supply is enabled with option jumper JP4. ON_OFF switch operation will enable battery supply to the badge board circuits.

ON_OFF Switch

The ON_OFF slide switch provides board power on and off control. With the switch in the ON position, battery supply is enabled to the Badge board circuits.

Batteries

The Badge board provides for two AAA type batteries to be installed. Note the polarity indications in the battery holder when installing batteries. The batteries will provide a nominal 3V supply when applied.

JP4 Option

The JP4 option enables the input supply to the Badge board circuits prior to the ON_OFF switch. The JP4 option pins can be applied to measure total battery current consumption to the Badge board circuits.

Y1 Crystal

Crystal Y1 provides a 32.768Khz base operating frequency to the HCS08 device. The user should refer to the HCS08 device user manual for information on frequency selection. User should also note that the HCS08 PTG1 and PTG2 I/O pins provide the oscillator connection and these I/O pins are not provided to the MCU_PORT by default. See the R3 and R4 option for changing this configuration.

R3 (XPG2) and R4 (XPG1) Options

R3 and R4 component locations are open by default to isolate the sensitive crystal oscillator connections from the MCU_PORT XPG2 and XPG1 locations. The user may connect the PTG1/PTG2 to the XPG1/XPG2 locations by installing a 0805 size 0 ohm resistor or wire jumper across the R4/ R3 component locations respectfully.

SCI1 and SCI2 Ports

The COM_EN option jumper block provides HCS08 SCI I/O ports to the SCI1 and SCI2 communication port connections on the Badge board. This allows the user to apply the provided communication transceiver, or to apply the associated I/O to other purposes. Options are also provided to power off or low power the RS232 transceiver. The option jumper positions should be reviewed first if any operational problems are encountered with the SCI1 or SCI2 ports.

COM_EN

COM_EN Position		HCS08 Port	COM Signal	I/O PORT Connector
1	(pins 1-2)		RS232 Transceiver VDD Enable (U3)	
2	(pins 3-4)	PTE0/TxD1	SCI1 TxD OUT	37
3	(pins 5-6)	PTE1/RxD1	SCI1 RxD IN	38
4	(pins 7-8)	PTC0/TxD2	SCI2 TxD OUT	17
5	(pins 9-10)	PTC1/RxD2	SCI2 RxD IN	18
6	(pins 11-12)	IRQ	SCI2 RxD IN, Wake on receive option	60
7	(pins 13-14)	PTF6	RS232 Transceiver Shutdown (low)	41

Notes:

1) COM_EN position 1 will power off the RS232 transceiver (U3) when open.
2) COM_EN position 6 allows IRQ interrupt wake-up from a HCS08 low power mode when a character is received.
3) COM_EN position 7 allows shutdown control of the RS232 transceiver. A serial character may be received during shutdown to allow wake-up. No RS232 transmission is possible in shutdown mode. Shut down is active with a low level signal.

SCI1 and SCI2 Connection

The SCI1 and SCI2 ports provide standard 9 pin connection with RS232 type interface to the HCS08 SCI1 and SCI2 peripherals. Refer to the COM_EN options for enabling the HCS08 signals applied to these ports. The SCI1 port is applied by default with the Debug Monitor. The HCS08 TxD1/2 and RxD1/2 signals are converted to RS232 levels by U3 and provided to the DB9 serial connectors. Following is the DB9S connection reference.

SCI1 and SCI2

```
    1 | 1 |   X     Female DB9 connector that interfaces to the HCS08 internal
TXD1 | 2  6 | 6     SCI1 serial port via the U3 RS232 transceiver.  It applies simple
RXD1 | 3  7 | 7     2 wire asynchronous serial without flow controls.
    4 | 4  8 | 8     1,4,6 connected and 7,8 connected
 GND | 5  9 | 9
```

LED 1-5 Indicators

LED Indicators 1–5 are enabled to HCS08 I/O ports by the LED_EN option bank. The LED indicators will light with a logic low signal applied from the respective HCS08 I/O port if the option is installed. The Badge board user should be familiar with the input and output application so that port conflicts do not occur. Following is the LED connection reference table:

LED_EN Position		LED INDICATOR	HCS08 PORT	I/O PORT CONNECTOR
1	(pins 1-2)	LED 1	PTF0	47
2	(pins 3-4)	LED 2	PTF1	48
3	(pins 5-6)	LED 3	PTF2	45
4	(pins 7-8)	LED 4	PTF3	46
5	(pins 9-10)	LED 5	PTD0/TPM1CH0	27

Note: LED indicators are active logic low.

VRH_SEL and 1.8V Reference

A 1.8 Volt reference circuit (U2) is provided for demonstration program application and user application if wanted. The VRH_SEL option bank selects the input and output configuration of the 1.8V reference circuit. Caution should be applied when selecting the VRH_SEL options so that supply or port conflicts do not occur.

VRH_SEL

VRH_SEL POSITION		INPUT SIGNAL	OUTPUT SIGNAL	I/O PORT Connection	OPERATION
1	(pins 1-2)	VDDAD (3.3V)	U2 Input Supply		U2 is powered on
2	(pins 3-4)	HCS08 PTF7	U2 Input Supply	MCU I/O pin 42	PTF7 = 1 for U2 powered On.
3	(pins 5-6)	1.8V reference (U2 out)	PTB0 / ATD0	Analog I/O pin 1	1.8V ref to ATD0 channel
4	(pins 7-8)	1.8V reference (U2 out)	VREFH	Analog I/O pin 9	VREFH = 1.8V Reference
5	(pins 9-10)	VDDAD	VREFH	Analog I/O pin 9	VREFH = VDDAD (3.3V)

Notes:
1) VRH_SEL jumper positions **1** (pins 1-2) and **2** (pins 3-4) must not be installed at the same time.
2) VRH_SEL jumper positions **4** (pins 7-8) and **5** (pins 9-10) must not be installed at the same time.

JP2 – VREFL

JP2 is default closed by circuit trace jumper that provides a VREFL connection to Ground potential. The user should not need to modify this connection.

JP3 – U1 / 9S08GB60 VDD

JP3 is default installed at all times. JP3 is provided to allow the actual current being consumed by the GB60 device to be measured.

SW1 and SW2 Push Switches

The push switches provide momentary active low input for user applications. The switches provide input to HCS08 ports PTA6 and PTA7. Input ports PTA6 and PTA7 provide KBD6 and KBD7 interrupt input capability also. The switches also provide the Demo program selection during Reset or power on condition if the demo program is installed in the flash memory. (Refer to 9S08Badge STARTUP).

SW2 on HCS08 PTA7 also provides the force debug monitor active operation. Holding SW2 down during power up will force the debug monitor active if it is still resident in the flash memory.

IRQ Switch

Pressing the IRQ switch provides an IRQ active signal to the GB60 device.

RESET Switch

Pressing the RESET switch provides a RESET active signal to the GB60 device.

JP1 – PWM / DAC

JP1 options enable a PWM signal filter on HCS08 port PTD2/TPM1CH2 to provide a digital to analog conversion into HCS08 PTB1/ATD1 analog input. This circuit is for demonstration of analog signal generation with a PWM timer output. The PTB1/ATD1 connection provides for measuring the analog signal value generated in the circuit.

JP1 Jumper Installation

```
 1   2
┌───────┐
│ ████  │
├───────┤
│ ████  │
└───────┘
 3   4
```
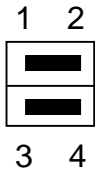
Notes:
1)   JP1 position 1-2 connects PTD2/TPM1CH2 to the R-C filter input.
2)   JP1 position 3-4 connects PTB1/ATD1 to the R-C filter output.

9S08Badge I/O PORT CONNECTORS

ANALOG and PTB I/O Port Connector

This port connector provides access to the Port B I/O or Analog input signals.

PTB0/AD0	**1 2**	PTB1/AD1
PTB2/AD2	**3 4**	PTB3/AD3
PTB4/AD4	**5 6**	PTB5/AD5
PTB6/AD6	**7 8**	PTB7/AD7
VREFH	**9 10**	VREFL

Notes:

1)   PTB0 provides 1.8V reference input if enabled. (VRH_SEL)

2)   PTB1 provides DAC filter input if enabled. (JP1)

3)   VREFH is optioned by VRH_SEL.

DEBUG PORT

The Debug or BDM port is a 6 pin header compatible with a Motorola Background Debug Mode (BDM) Pod. This allows the connection of a background debugger for software development, programming and debugging in real-time without using HCS08 I/O resources.

BGND/PTG0	**1 2**	GND
	3 4	/RESET
	5 6	+3.3V

See the HCS08 Reference Manual for complete documentation of the BDM.

MCU I/O Port Connector

This port connector provides access to all the 9S08GB60 I/O ports except PTB.

PTA6/KBD6	**1**	**2**	PTA7/KBD7
PTA4/KBD4	**3**	**4**	PTA5/KBD5
PTA2/KBD2	**5**	**6**	PTA3/KBD3
PTA0/KBD0	**7**	**8**	PTA1/KBD1
VDD	**9**	**10**	GND
PTC6	**11**	**12**	PTC7
PTC4/CLKOUT	**13**	**14**	PTC4
PTC2/SDA	**15**	**16**	PTC3/SCL
PTC0/TXD2	**17**	**18**	PTC1/RXD2
VDD	**19**	**20**	GND
PTD6/TPM2CH3	**21**	**22**	PTD7/TPM2CH4
PTD4/TPM2CH1	**23**	**24**	PTD5/TPM2CH2
PTD2/TPM1CH2	**25**	**26**	PTD3/TPM2CH0
PTD0/TPM1CH0	**27**	**28**	PTD1/TPM1CH1
VDD	**29**	**30**	GND
PTE6	**31**	**32**	PTE7
PTE4/MOSI	**33**	**34**	PTE5/SPSCK
PTE2/SS*	**35**	**36**	PTE3/MISO
PTE0/TXD1	**37**	**38**	PTE1/RXD1
VDD	**39**	**40**	GND
PTF6	**41**	**42**	PTF7
PTF4	**43**	**44**	PTF5
PTF2	**45**	**46**	PTF3
PTF0	**47**	**48**	PTF1
VDD	**49**	**50**	GND
PTG6	**51**	**52**	PTG7
PTG4	**53**	**54**	PTG5
PTG2/EXTAL	**55**	**56**	PTG3
PTG0/BGND/MS	**57**	**58**	PTG1/XTAL
RESET*	**59**	**60**	IRQ

Notes:
1) PTA6-7 also provide Push Switch SW1-2
2) PTE0 –1 provide SCI1 I/O to SCI1 Port if enabled.
3) PTC0-1 provide SCI2 I/O to SCI2 port if enabled.
4) PTD0 provides LED5 output if enabled.
5) PTG1-2 are the Y1 XTAL and EXTAL signals by default. R3 and R4 isolate the MCU PORT XPG1 and XPG2 pins to prevent crystal operation interference.
6) PTG0 is the BGND signal if a BDM is connected.
7) PTF0-F3 provide LED1 – 4 output if enabled.