DEMO9S08RG60

Demonstration Module for Freescale MC9S08RG60

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REVISION HISTORY

Date	Rev	Comments
July 12 , 2005	A	Initial Release
March 10, 2005	B	Change Power section to barrel connector. Updated top silk in Feature section. Updated PWR_SEL selection header to show silkscreen changes
August 22, 2005	C	Corrected pin-out on connector J1. Applied standard formatting. Added Table of Figures and Table of Tables.
June 21, 2007	D	Updated Reference Documentation information. Deleted BOM listing in Appendix B.

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 DEMO9S08RG60 module:

   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 B** 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 other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

TERMINOLOGY

This development module 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:

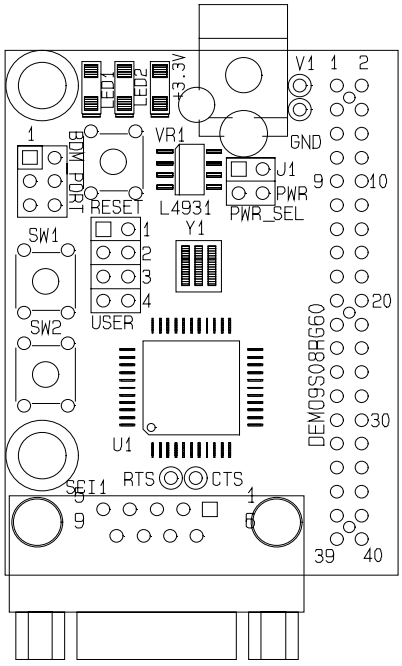
Jumper on, in, or installed - jumper is installed such that 2 pins are connected together.

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.

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.

FEATURES

The DEMO9S08RG60 is an evaluation or demonstration module for the MC9S08RG60 microcontroller. Development of applications is quick and easy with the included wall plug, DB9 serial cable, sample software tools, examples, and debug monitor. The DEBUG port is provided for development tool application and is compatible with HCS08BDM interface cables and software. A 40-pin connector allows connecting the DEMO9S08RG60 module to an expanded evaluation environment.



Features:

- MC9S08RG60 CPU
  - 60K Byte Flash
  - 2K Bytes Ram
  - 40 I/O lines (44-pin package)
  - Timer/PWM
  - SCI and SPI Communications Ports
  - 12 Key Board Wake-up Ports
  - BDM DEBUG Port
  - Analog Comparator
  - 8Mhz Internal Bus Operation
  - 8 High Current Pins
- Power Input Selection Jumper
- 16 MHz Ceramic Resonator
- Regulated +3.3V power supply
- Optional power input from Connector J1
- Optional power output through Connector J1
- RS-232 Serial Port w/ DB9 Connector
- 2 Channel, 16 bit, Timer/Pulse Width Modulator (TPM) with Input Capture, Output Compare, and PWM capability
- On-Chip Analog Comparator with internal reference and full rail-to-rail operation
- User Components Provided
  - 2 Push Switches
  - 2 LED Indicators
- Jumpers
  - Disable User Functions
  - Power Select
- Connectors
  - 40-pin MCU I/O Connector
  - 2.0mm Barrel Connector Power Input
  - DEBUG BDM Connector
  - DB9 Communications Connector
- Supplied with DB9 Serial Cable, Documentation (CD), Manual, and Wall plug type power supply.

Specifications:
Module Size 2.2” x 1.6”
Power Input: +5 to +16VDC, 9VDC typical

GETTING STARTED

The DEMO9S08RG60 is a fully assembled, fully functional development module for the Freescale MC9S08RG60 microcontroller. The module is provided with a serial cable for stand-alone operation. Support software for this development module is provided for Windows 95/98/NT/2000/XP operating systems.

The user should also be familiar with the hardware and software operation of the target HCS08. Refer to the MC9S08RG60 User Manual and Reference Manual for details. The demonstration module's purpose is to promote the features of the MC9S08RG60 and 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 quick, successful, application development.

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

A serial debug monitor is provided in the MC9S08RG60 internal flash memory that uses some HCS08 resources for operation. See application note, AN2140, from Freescale for complete details. User application may be executed by loading the program start address into the Reset Vector (0xFBFE, 0xFBFF) and loading the program into device Flash Memory. The monitor remains in protected flash memory for future use if needed.

REFERENCE DOCUMENTATION

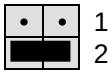
Reference documents are provided on the support CD in Acrobat Reader format.

DEMO9S08RG60_SCH_F.pdf	DEMO9S08RG60 Module Schematic Rev. F
DEMOS08RG60_MAN_D.pdf	DEMO9S08RG60 User Guide Rev. D (this document)
MC9S08RG60/D.pdf	MC9S08RG60 Device User Guide
GetStartDEMO9S08RG60.pdf	DEMO9S08RG60 Quick Start
AN-2140	HCS08 Serial Monitor Application Note
AN-2493	HCS08 Low-Power Modes Application Note
AN-2596	Using the HCS08 On-Chip Debug System Application Note
AN-2616	Getting Started with HCS08 and CodeWarrior Application Note
2616SW.zip	CodeWarrior software zip file.
MON_PLUS_DEMO_RG60.s19	Object Code for installed demo programs

STARTUP

To start the DEMO programs, install the PWR_SEL jumper as show in the figure below, then apply power to the module through the barrel connector power input.

Figure 1: PWR_SEL Jumper - Demo



PWR_SEL

There are three examples programmed into the DEMO9S08RG60 module. The programs are:

1) **Debug monitor**

2) **Stop3 demo**

3) **Paced-loop demo**

The **Debug Monitor** is the most important program loaded into the MCU residing on the Demo module. In conjunction with software running on a host personal computer (PC), the debug monitor enables users to program FLASH and debug their programs. This Demo requires CodeWarrior to be installed on the development PC.

The other demo programs offer examples of some simple uses of the Demo module.

The **Stop3 Demo** illustrates the low-power capability of the MC9S08RG60 microcontroller operating in stop3 mode.

The **Paced-Loop Demo** demonstrates a framework that users can implement in their system to periodically execute user routines.

Demo Programs

The **Stop3 demo** program executes by default at power up if no pushbuttons are held down. This program demonstrates operation of the microcontroller in both low power, and stop3 modes. 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, you press the go button in the debugger program, and test 1 is entered (No user switches pressed) you can no longer halt or trace the demo code. This is because there are no clocks to the serial communications module.

With the Stop3 Demo running, LED1 flashes approximately twice a second. While the LED is off, the MCU is in low-power, stop3 mode, and remains in stop3 mode until the next RTI. RTI is generated periodically by an MCU timer. During Stop3 Demo execution, press and hold SW1 for at least 0.5sec. LED1 turns on for approximately 3 seconds. Pressing SW2, for at least 0.5sec, causes LED2 to turn-on.

The **Software-paced loop demo** program executes when SW2 is held down at power-up. The software-paced loop program blinks LED1 and LED2. LED1 blinks on and off every second. LED2 blinks on and off every two seconds. Both LEDs blink at a 50% duty cycle.

The **Debug Monitor** program is executed when SW1 is held down at power-up. The serial debugger, when used with a host PC and CodeWarrior software, 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.

Executing the Demo Programs

Before you can run the demo programs, configuration jumpers must be installed. To run the Demo programs install all 4 User Interface jumpers (User-1 through User-4). Install the PWR_SEL jumper as shown above to select the applied voltage source.

If neither push-button switch is depressed during RESET or at power-on, the Stop3 Demo executes automatically. As noted above, this demo highlights the low-power feature of the MC9S08RG60 MCU.

To execute the Paced Loop Demo, press and hold SW2 then press and release the RESET switch.

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 Demo module. CodeWarrior software must be installed on the host PC to support the serial monitor.

Selecting the Demo Programs

Pushbutton switches are used to select between installed demo programs. The switches are read at the rising edge of RESET. Hold down the chosen pushbutton while applying power or while pressing the RESET switch. The actions of the switches are shown in the table below.

Table 1: Demo Program Selection

Switch (SWx)	Demo Program Executed
No Switch held down	Stop3 Demo
SW2	Paced-Loop Demo
SW1	Debug Monitor

NOTES:
1) When power is applied to the Demo module, if none of the switches is held down, the low-power, stop3, demo program executes by default.
2) When power is applied to the Demo module and SW2 is held down, the paced-loop demo program executes.
3) When power is applied to the Demo module and SW1 is held down, the serial Debug Monitor program executes. CodeWarrior must be running on the host PC to use the monitor program. Connect a straight through DB-9 serial cable between COM port on the PC and SCI1 on the Demo module to allow communications.

SERIAL MONITOR OPERATION

MEMORY MAP

Table 2: Monitor Memory Map

0x0000 - 0x0045	Direct Page Register Space. See the 9S08RG60 User Manual for details
0x0046 - 0x0845	RAM memory space Initial Monitor Stack Pointer = 0x107F
0x 0846 - 0x17FF	Lower flash block – User application memory
0x1800 - 0x182B	9S08RG60 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**)

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 MCU supports a maximum 38.4K bps serial communication rate on the SCI1 interface port.

POWER ON or RESET PROMPT:

The monitor provides a binary prompt to the Demo module serial SCI1 port.

COMMANDS:

No user commands can be applied via the 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 MC9S08RG60 so user interrupt vectors appear from 0xFBCC to 0xFBFF. Users do not have access to the SCI1, SWI, and RESET vectors while the monitor is operating. Programming the user Reset vector (0XFBFE:0xFBFF) causes the monitor to execute the user program on Reset. See the AN2140 application note for user interrupt application.

BDM PORT

The Debug or BDM port is a 6-pin header compatible with a Freescale Background Debug Mode (BDM) Pod. This allows the connection of a background debugger for software development, programming, and debugging in real-time without using HCS08I/O resources.

Figure 2: BDM Port Header

BGND/PTG0	**1**	**2**	GND
N/C	**3**	**4**	RESET*
N/C	**5**	**6**	VDD

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

OPERATION

The DEMO9S08RG60 module provides input and output features to assist in application development. Access to MCU ports is available through module the MCU_PORT connector. The MCU_PORT connector may be used to interface power to the module as well as RS-232 communications signals. Care must be exercised when using the MCU_PORT to power the module, as only regulated +3.3V should be applied to this connection.

Five option jumpers and 3 cut-traces setup module operation. Enabling an associated option requires installing a jumper, or shunt, across the appropriate header pins. Removing the shunt disables the associated option. An option that is enabled by a cut-trace can be disabled by removing the circuit trace between the cut-trace component pads. Install a suitably sized 0-ohm resistor or piece of wire to re-enable the option.

POWER SUPPLY

Input power may be applied by external connection to a 2mm barrel connector and 3.3V regulator or directly from connector J1. The input supply is selected by the PWR_SEL option.

PWR Connector

The PWR connector is a 2.0mm barrel connector (PWR) power input. This connector allows the use of external power supply input to support stand-alone operation. Voltage input at this connector should be limited to +5V and +16V.

PWR_SEL Jumper

The PWR_SEL jumper selects the source of power input to the DEMO9S08RG60 module or allows regulated +3.3VDC to be provided to J1 for use by external circuits. The module takes voltage input from the PWR connector input or from the 40-pin MCU connector (J1). Power input at the PWR connector must be DC voltage between +5V and +16V. Power input on the MCU connector **must be** regulated voltage between +3.0VDC and +3.3VDC. The MCU_PORT connector power input allows use of batteries, or other alternate sources, to power the module.

The PWR_SEL option jumper provides 3 possible configurations; source power from the PWR connector, source power from J1, or source power from PWR and supply power to J1. The figures below show the settings for each configuration.

Figure 3: PWR_SEL Jumper Settings

Module powered from external +3.0VDC - +3.3VDC input connected to J1-1 (+) and J1-3 (-)

Module powered from external +5VDC - +16VDC connected to PWR connector. J1-1 is open or not connected.

Module powered from external +3.0VVDC - +3.3VDC connected to J1-1 (+) and J1-3 (-). Module provides +3.3VDC output (up to 50 mA) at pin J1 for use by external circuits.

CAUTION: Module damage may occur if the MCU_PORT power input pin (J1-1) is over-driven.

Reset Switch

The RESET switch provides a method to apply an asynchronous reset to the module. Pressing the RESET switch applies a low voltage level to the PTD1/RESET* input. A resistor tied to the high voltage rail prevents spurious RESET input to the MCU.

Connector J1

Power may be supplied to the module through the pins J1-1 and J1-3. Use of this option requires a regulated voltage input limited to the range of +3.0VDC to +3.3VDC. This input is connected directly to the module power and ground planes. Care should be exercised not to over-drive this input.

This connection may also be used to source power from the on-board regulator to external modules attached to connector J1. The PWR_SEL option header determines how power is routed to and from the module.

Figure 4: MCU I/O Port Connector

VX	**1**	**2**	PTD2/IRQ
GND	**3**	**4**	PTD1/RESET*
PTB0/TXD	**5**	**6**	PTD0/BKGD/MS
PTB1/RXD	**7**	**8**	PTB2
PTC0/KBI2P0	**9**	**10**	PTB3
PTC1/KBI2P1	**11**	**12**	PTB4
PTD6/TPMCH0	**13**	**14**	PTB5
PTB7/TPMCH1	**15**	**16**	PTB6
PTC4/MOSI	**17**	**18**	PTD4/ACMP-
PTC5/MISO	**19**	**20**	PTD5/ACMP+
PTC6/SPSCK	**21**	**22**	PTA0/KBI1P0: User SW1, if enabled
PTC7/SS*	**23**	**24**	PTA1/KB1P1: User SW2, if enabled
PTE0	**25**	**26**	PTA2/KBI1P2
PTE1	**27**	**28**	PTA3/KBI1P3
PTE2	**29**	**30**	PTC2/KBI2P2
PTE3	**31**	**32**	PTC3/KBI2P3
PTE4	**33**	**34**	PTA4/KBI1P4
PTE5	**35**	**36**	PTA5/KBI1P5
PTE6	**37**	**38**	PTAA6/KBI1P6
PTE7	**39**	**40**	IRO

Note:
MCU signals PTD3 and PTA7 are not routed to the MCU_PORT connector

Oscillator

A ceramic oscillator (Y1) provides a 16.0 MHz base operating frequency to the MCU. This provides an 8.0 MHz internal operating frequency. The HCS08 uses dedicated oscillator inputs. This crystal input is not routed to the MCU Port connector

Communications

The DEMO9S08RG60 module provides a single SCI communications port. This port is connected to the MCU_PORT and to the SCI1 connector. An RS-232 translator (U2) has been provided between the SCI1 connector and the MCU. Communication signals applied to the MCU-PORT connector must be directly compatible with the HCS08 device; no translation support is provided through this path. As added development support, handshake signals RTS and CTS are available at the output of U2. These signals are routed to vias located behind the SCI1 connector. RTS has been biased properly to support 2-wire RS-232 communications.

Use of the MCU_PORT interface for RS-232 services requires disabling the on-board RS-232 translator. This is accomplished by opening cut-traces CT1, CT2, and CT3. Simply remove the circuit trace between cut-trace pads to open the circuit. To restore the circuit, install a suitably sized 0-ohm resistor or a short piece of wire across the cut-trace pads. See Cut-Trace Setting above for details.

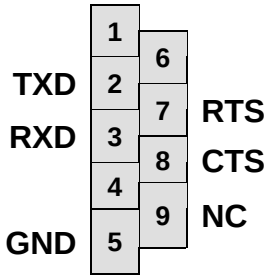
Table 3: SCI1 Connections

HCS08Port	COM Signal	I/O PORT Connector	Signal Disable
	RS-232 Disable		CT3
PTB0/TXD1	SCI1 TXD OUT	3	CT1
PTB1/RXD1	SCI1 RXD IN	4	CT2

SCI1 Connector

A standard 9-pin Dsub connector provides external connections for the SCI1 port. The SCI1 port is used by default with the serial debug monitor. Component U2 provides RS-232 translation services. The figure below details the DB9 connector.

Figure 5: SCI1 Connector



Female DB9 connector that interfaces to the HCS08 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 module.

Pins 1, 4, and 6 are connected together.

User Options

LED Indicators

Indicators LED1 and LED2 are enabled from HCS08 I/O ports by the USER option bank. When enabled, each LED is active low and illuminates when a logic low signal is driven from the respective MCU I/O port. MCU ports PTA7 and PTD3 drive LED1 and LED2 respectively. The table below details the user jumper settings.

Pushbutton Switches

Two push button switches provide momentary active low input for user applications. Switches SW1 and SW2 are enabled to the HCS08 I/O ports by the USER option bank. SW1 and SW2 provide input to HCS08I/O ports PTA0 and PTA1 respectively. These switches are also used for DEMO program selection during RESET or POR (provided the DEMO program is installed in flash at start-up). The table below details the user jumper settings.

Table 4: User Option Jumper Settings

Jumper	On	Off	MCU PORT
User 1	Enable SW1	Disable Sw1	PTA0 (33)
User 2	Enable SW2	Disable Sw2	PTA1 (34)
User 3	Enable LED1	Disable LED1	PTA7 (44)
User 4	Enable LED2	Disable LED2	PTD3 (27)

APPENDIX A

Mechanical Details