



**Freescale Semiconductor, Inc.**

M68HC05E24EM/D2

July 1994

**HC05E24  
EMULATOR MODULE  
USER'S MANUAL**

Revision 2.0

**Freescale Semiconductor, Inc.**

© MOTOROLA Inc., 1994; All Rights Reserved

**For More Information On This Product,  
Go to: [www.freescale.com](http://www.freescale.com)**



## **Freescale Semiconductor, Inc.**

Motorola reserves the right to make changes without further notice to any products herein to improve reliability, function, or design. Motorola 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 its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part.

Motorola and the Motorola logo are registered trademarks of Motorola Inc.

Motorola Inc. is an Equal Opportunity/Affirmative Action Employer.

**For More Information On This Product,  
Go to: [www.freescale.com](http://www.freescale.com)**

**CONTENTS**

<b>CHAPTER 1 INTRODUCTION .....</b>	<b>1-1</b>
1.1 Development Systems .....	1-1
1.1.1 Motorola Modular Development System ( MMDS05 ) .....	1-1
1.1.2 M68HC05EVS Evaluation System ( HC05EVS ) .....	1-2
1.2 EM Layout .....	1-3
1.3 Connectors P4 and P5 Pin Assignments .....	1-4
<b>CHAPTER 2 MMDS05 CONFIGURATION AND OPERATION .....</b>	<b>2-1</b>
2.1 Setting E24EM Jumper Headers .....	2-2
2.1.1 Factory Test Header ( J 1 ) .....	2-2
2.1.2 Reset Select Header ( J 2 ) .....	2-3
2.1.3 Clock Source Select header ( J 3 , J 4 ) .....	2-3
2.1.4 Platform Board Select Header ( J 5 ) .....	2-3
2.2 The Emulated MCU .....	2-4
2.2.1 MC68HC705E24 Emulation Limitations .....	2-5
2.2.2 MC68HC05E24 Emulation Limitations .....	2-5
2.3 Remaining System Installation .....	2-6
<b>CHAPTER 3 HC05EVS CONFIGURATION AND OPERATION .....</b>	<b>3-1</b>
3.1 Setting E24EM Jumper Headers .....	3-1
3.1.1 Factory Test Header (J1) .....	3-2
3.1.2 Reset Select Header ( J 2 ) .....	3-2
3.1.3 Clock Stretch Select Header (J3, J 4 ) .....	3-3
3.1.4 Platform Board Select Header ( J 5 ) .....	3-4
3.2 The Emulated MCU .....	3-4
3.2.2 MC68HC705E24 Emulation Limitations .....	3-4
3.2.3 MC68HC05E16 Emulation Limitations .....	3-4
3.3 EVS Limitations .....	3-5
3.4 Logic Analyzer Connector P 1 .....	3-6
3.5 Remaining System Installation .....	3-8

**FIGURES**

<b>Figure</b>		<b>Page</b>
1-1	HC05E24 Emulator Module .....	1-3
1-2	Connectors P4 and P5 Pin Assignments .....	1-4
3-1	Connector P1 Pin Assignments .....	3-7

**TABLES**

<b>Table</b>		<b>Page</b>
2-1	MCUs and Personality Files .....	2-4
3-2	Logic Analyzer Connector P1 Signal Descriptions .....	3-7

## CHAPTER 1

### INTRODUCTION

This user's manual explains connection, configuration, and operation information specific to the HC05E24EM Emulator Module (E24EM). The E24EM makes possible emulation and debugging of target systems based on these microcontroller units (MCUs):

MC68HC705E24

MC68HC05E16

The E24EM can be part of two development systems. This chapter describes those systems and explains the layout of the E24EM.

The factory installs an MC68HC705E24 resident MCU in the E24EM.

#### 1.1 DEVELOPMENT SYSTEMS

Your E24EM can be part of two Motorola development tools: the HC05 Motorola Modular Development System (MMDS05) or the M68HC05EVS Evaluation System (HC05EVS).

##### 1.1.1 Motorola Modular Development System (MMDS05)

The MMDS05 is an emulator system that provides a bus state analyzer and real-time memory windows. The unit's integrated design environment includes an editor, an assembler, user interface, and source-level debug. A complete MMDS05 consists of:

- **a station module** — the metal MMDS05 enclosure, containing the control board and the internal power supply. Most system cables connect to the MMDS05 station module. (The cable to an optional target system, however, runs through an aperture in the station module enclosure to connect directly to the emulator module.)
- **an emulator module (EM)** — such as the E24EM: a printed circuit board that enables system functionality for a specific set of MCUs. The EM fits into the station module through a sliding panel in the enclosure top. The EM has a connector for the target cable.
- **two logic clip cable assemblies** — twisted-pair cables that connect the station module to your target system, a test fixture, a clock, or any other circuitry useful for evaluation or analysis. One end of each cable assembly has a molded connector, which fits into station-module pod A or pod B. Leads at the other end of each cable terminate in female probe tips. Ball clips come with the cable assemblies.

- a **9-lead RS-232 serial cable** — the cable that connects the station module to the host computer RS-232 port.
- a **9- to 25-pin adapter** — a molded assembly that lets you connect the 9-lead cable to a 25-pin serial port.
- **system software** — software, on 3-1/2 inch diskettes.
- **MMDS05 documentation** — an MMDS05 operations manual (MMDS05OM/D) and the appropriate EM user's manual.

As mentioned, your E24EM gives the MMDS05 the ability to emulate the MC68HC(7)05E24/16 MCU. By substituting a different EM, you can enable your MMDS05 to emulate an MCU of a different series. (Your Motorola representative can explain all the EMs available.)

Chapter 2 explains how to configure and use your E24EM as part of an MMDS05 system. For information about MMDS05 software or the station module, see the MMDS05 operations manual. For layout and configuration information pertaining to a different EM, see the corresponding EM user's manual.

### 1.1.2 M68HC05EVS Evaluation System (HC05EVS)

An HC05EVS is an economical, two-board tool for designing, debugging, and evaluating target systems based on an MC68HC05 MCU. A complete HC05EVS consists of:

- a **platform board (PFB)** — the bottom board, which supports the emulator module. The platform board has connectors for power and for the terminal or host computer.
- an **emulator module (EM)** — such as the F4EM: a printed circuit board that enables system functionality for a specific set of MCUs. The EM fits onto the PFB. The EM has connectors for a target cable and for a cable to a logic analyzer.
- an **RS-232 serial cable** — the cable that connects the PFB to the host computer RS-232 port.
- **system software** — software, on 3-1/2 inch diskettes.
- **HC05EVS documentation** — an HC05EVS operations manual (HC05EVSOM/D) and the appropriate EM user's manual.

As mentioned, your HC05E24 EVS emulates the MC68HC705E24 and the MC68HC05E16 MCUs. By substituting a different EM, you can enable your HC05EVS to emulate an MCU of a different series. (Your Motorola representative can explain all the EMs available.)

Chapter 3 explains how to configure and use your E24EM as part of an HC05EVS system. For information about HC05EVS software or the platform board, see the HC05EVS operations manual. For layout and configuration information pertaining to a different EM, see the corresponding EM user's manual.

## 1.2 EM LAYOUT

Figure 1-1 shows the layout of the E24EM. Jumper header J1 selects factory test or user mode. J2 controls the path of a target reset. J3 and J4 allow the clock source to be selected. J5 selects between MMDS05 and EVS operation.

Connector P1 is for a logic analyzer. (Connector P1 has more significance for an EVS system, as an MMDS05 system includes a bus analyzer.) Expansion header connectors P2 and P3 connect together the EM and the control board (for an MMDS05) or the EM and the platform board (for an EVS). Finally, Connectors P4 and P5 allow for connection of a target cable which is available separately. If you install the E24EM board in the MMDS05, the target cable passes through a slit in the MMDS05 enclosure.

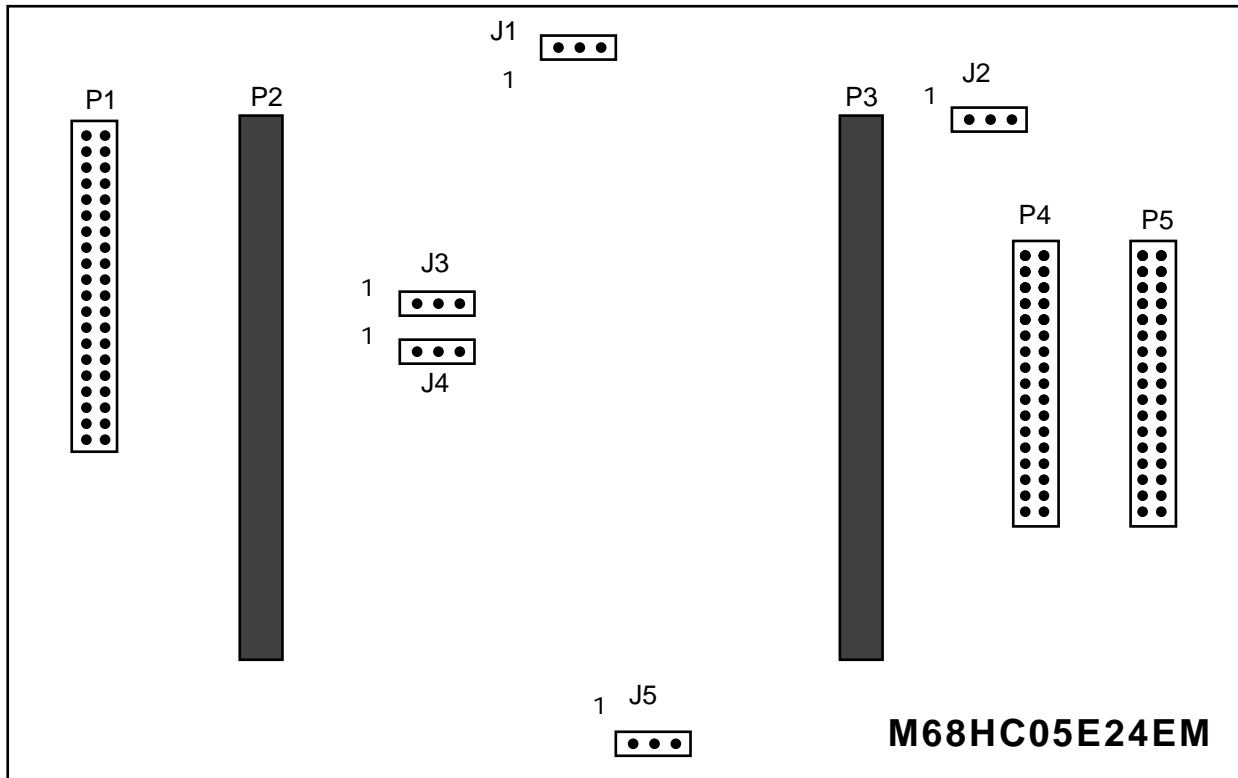


Figure 1-1. HC05E24 Emulator Module

### 1.3 CONNECTORS P4 AND P5 PIN ASSIGNMENTS

Figure 1-2 shows the pin assignments for connectors P4 and P5. For signal descriptions, consult the technical data book for the specific MCU.

Connector P4				Connector P5			
XOSC1	1	● ●	2 RESET	PA7	1	● ●	2 PA6
N.C.	3	● ●	4 N.C.	PA5	3	● ●	4 PA4
PC7	5	● ●	6 PC6	PA3	5	● ●	6 PF0
PC5	7	● ●	8 N.C.	PE7	7	● ●	8 N.C.
N.C.	9	● ●	10 PC4	PE6	9	● ●	10 PE5
PC3	11	● ●	12 PC2	PE4	11	● ●	12 PA2
PC1	13	● ●	14 PC0	PA1	13	● ●	14 PA0
PD0	15	● ●	16 PD1	PB7	15	● ●	16 PB6
PD2	17	● ●	18 PD3	PB5	17	● ●	18 PB4
PD4	19	● ●	20 PD5	PB3	19	● ●	20 PB2
PD6	21	● ●	22 PD7	PB1	21	● ●	22 PB0
PF6	23	● ●	24 PF5	PE3	23	● ●	24 PE2
PF4	25	● ●	26 PF3	PE1	25	● ●	26 N.C.
PF2	27	● ●	28 PF1	PE0	27	● ●	28 IRQ0
VSS	29	● ●	30 VREFL	IRQ1	29	● ●	30 LVI
PG0	31	● ●	32 PG1	N.C.	31	● ●	32 OSC1
VREFH	33	● ●	34 VDD	CLKOUT	33	● ●	34 N.C.

Figure 1-2. Target Connector

As connector P1 has more importance to an HC05EVS than to an MMDS05, pin assignments for connector P1 are in Chapter 3.

To configure your E24EM for use as part of an MMDS05, follow the instructions of Chapter 2. To configure your E24EM for use as part of an HC05EVS, follow the instructions of Chapter 3.





## CHAPTER 2

### MMDS05 CONFIGURATION AND OPERATION

This chapter explains how to configure and use your E24EM as part of an MMDS05. For other parts of system installation or configuration, see the MMDS05 operations manual (MMDS05OM/D). (If you intend to use your E24EM as part of an HC05EVS system, go to Chapter 3 for corresponding information.)

Paragraph 2.1 explains how to set E24EM jumper headers. Paragraph 2.2 explains considerations pertaining to the MCU you emulate. Paragraph 2.3 explains remaining system installation.

Note that you can configure a E24EM already fitted in the MMDS05 station module enclosure. To do so, switch off station-module power, remove the top panel, then follow the guidance of this chapter.

#### CAUTION

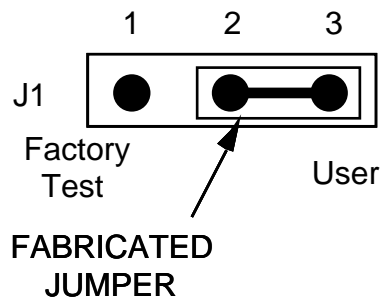
Be sure to switch off power if you reconfigure an installed EM. Reconfiguring EM jumper headers with power left on can damage MMDS05 circuits.

## 2.1 SETTING E24EM JUMPER HEADERS

Your E24EM has five jumper headers, J1 to J5. This section explains how to configure these headers.

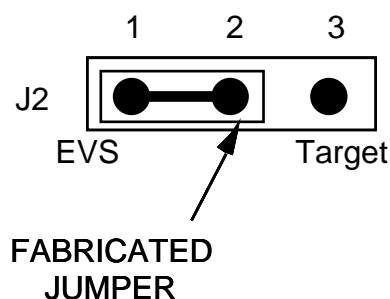
### 2.1.1 Factory Test Header(J1)

Jumper header J1 is used for factory test purposes only. The fabricated jumper installed between pins 2 and 3 is the only correct configuration for this header.



### 2.1.2 Reset Select Header (J2)

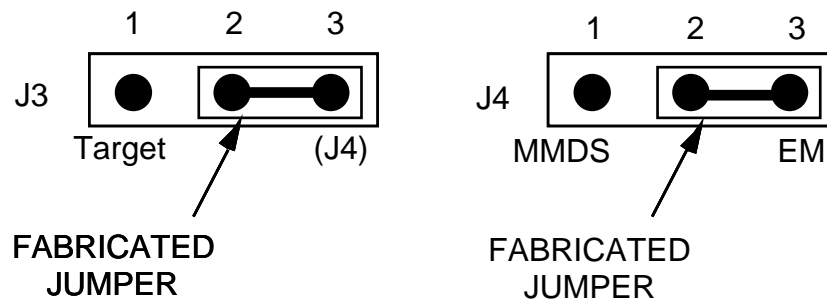
Jumper header J2 controls the path of a target reset. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 enables your software to control resets. This is the **only** correct J2 configuration for a E24EM that is part of an MMDS05.



**NOTE:** Using the E24EM with the fabricated jumper installed between pins 2 and 3 will interfere with correct operation of the RESETIN and RESETOUT commands. The J2 pins 2-and-3 configuration is **not** correct for a E24EM that is part of an MMDS05 system.

### 2.1.3 Clock Source Select Headers (J3, J4)

Jumper headers J3 and J4 determines the source of the clock signal. The diagram below shows the factory configuration of these jumpers: the fabricated jumper between pins 2 and 3 of J4 selects the E24EM canned oscillator clock source.

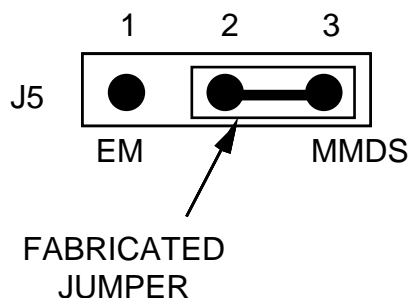


Alternatively, you may use a clock source originating from the MMDS05 control board. To do so, reposition the J4 jumper between pins 1 and 2. The MMDS OSC command can then be used to select clock frequency.

Jumper J3 can be used to select between an internal generated clock or a external clock generated by the target system. If the target clock is selected by placing the jumper on J3 between pins 1 and 2, the position of J4 is not important.

### 2.1.4 Platform Board Select Header (J5)

The factory configuration of header J5 is shown below. The fabricated jumper must be installed between pins 2 and 3 for MMDS operation.



**NOTE:** The only valid position of the J5 fabricated jumper is between pins 2 and 3 when using the E24EM as part of an MMDS system.

## 2.2 THE EMULATED MCU

Your MMDS05 system uses a specific personality file for the MCU type being emulated. For example, to emulate an MC68HC705E24 MCU, the system uses personality file 0020DVxx.MEM this file contains device specific information such as memory map, required by the MMDS05 for correct operation.

Table 2-1 lists all the personality files that pertain to the E24EM. Note that personality file names follow the pattern **OOZZZVxx.MEM**, where **ZZZ** is the EM identifier or MCU name, and **xx** is the version of the file.

**Table 2-1. MCUs and Personality Files**

EMULATED MCU	PERSONALITY FILE	RESIDENT MCU	COMMENTS
MC68HC705E24	0020DVxx.MEM	MC68HC705E24	See paragraphs 2.2.1.
MC68HC05E16	00ME16Vxx.MEM	MC68HC705E24	See paragraphs 2.2.2.

MMDS05 software loads the default personality file for the EM board installed on powerup. To manually load a different personality file, use the LOADMEM command. (For more information about the LOADMEM command, see the explanation in the MMDS05 operations manual.)

Alternatively, you can insert the line LOADMEM 00ZZZVxx.MEM in the STARTUP.05 script file. This way, the system automatically loads the specified personality file as part of system startup. (For more information about the STARTUP.05 script file, see the SCRIPT command explanation in the MMDS05 operations manual.)

Note:- For correct operation the personality file must be installed in the same directory as the MMDS05 software, only the latest versions of these files should be held in this directory. If the personality file required for the EM board is not installed in the same directory you will be prompted for one. This may be selected anywhere on the drive on which the MMDS05 software resides.



### **2.2.1 MC68HC705E24 Emulation Limitations**

Operation of at frequencies above 2.2MHz ECLK is not possible.

Ports A and B are rebuild by a PRU. The drive capability of this PRU is greater than that of the MCU.

COP operation is not supported.

For more information about the MC68HC705E24, see the corresponding technical data books.

### **2.2.2 MC68HC05E16 Emulation Limitations**

Limitations are as per 2.2.1.



## 2.3 REMAINING SYSTEM INSTALLATION

When you have configured headers J1 to J5 and made sure that the resident MCU is appropriate, you are through with E24EM configuration:

- To install the E24EM in an MMDS05 station module, remove the panel from the station-module top. Fit together EM connectors P2 and P3 (on the bottom of the board) and control-board connectors P11 and P12. Snap the corners of the EM onto the plastic standoffs. Connect the target cable, if appropriate. Replace the panel.
- If your E24EM already is installed in the station module, reconnect the target cable (if necessary). Replace the panel.

At this point, you are ready to make remaining cable connections, as necessary, and restore power. For instructions, consult the MMDS05 operations manual (MMDS05OM/D).



## **CHAPTER 3**

### **HC05EVS CONFIGURATION AND OPERATION**

This chapter explains how to configure your E24EM for use as part of an HC05EVS. For other parts of system installation or configuration, see the HC05EVS operations manual (HC05EVSOM/D). (If you will use your E24EM as part of an MMDS05 system, go to Chapter 2 for configuration information.)

Paragraph 3.1 explains how to set E24EM jumper headers. Paragraph 3.2 explains considerations pertaining to the MCU you emulate. Paragraph 3.3 lists limitations on using the E24EM in an HC05EVS. Paragraph 3.4 explains pin assignments and signal descriptions for the logic analyzer connector (P1). Paragraph 3.5 explains remaining system configuration.

Note that you can configure a E24EM already installed on the HC05EVS platform board. To do so, disconnect platform-board power, then follow the guidance of this chapter.

#### **CAUTION**

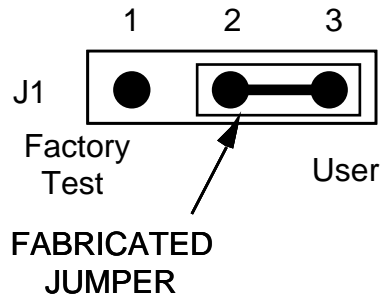
Be sure to disconnect power if you reconfigure an installed EM. Reconfiguring EM jumper headers with power left on can damage HC05EVS circuits.

### **3.1 SETTING E24EM JUMPER HEADERS**

Your E24EM has four jumper headers, J1 to J4. Sections 3.1 explain how to configure these headers.

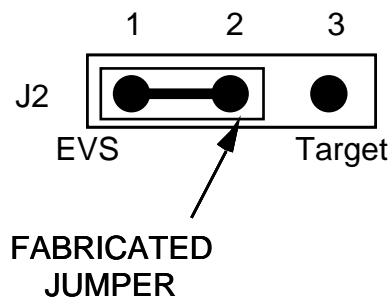
### 3.1.1 Factory Test Header(J1)

Jumper header J1 is used for factory test purposes only. The fabricated jumper installed between pins 2 and 3 is the only correct configuration for this header.



### 3.1.2 Reset Select Header (J2)

Jumper header J2 controls the path of a target reset. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 enables your E24EVS to reset the target when you press the user or master reset switch.



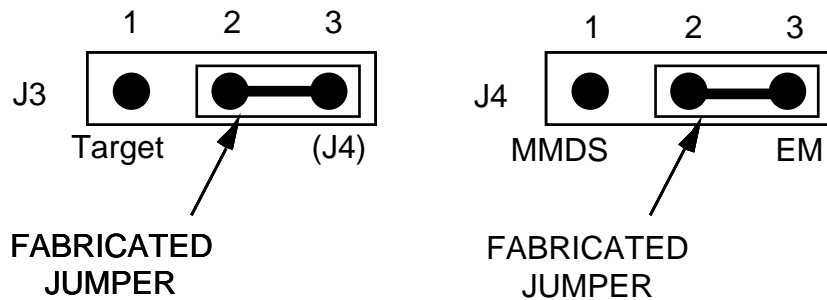
Alternatively, you may enable the target system to reset the E24EVS. To do so:

- Reposition the E24EM J1 jumper between pins 2 and 3, and
- Insert a fabricated jumper into platform-board header J3.



**3.1.3 Clock Source Select Headers (J3, J4)**

Jumper headers J3 and J4 determines the source of the clock signal. The diagram below shows the factory configuration of these jumpers: the fabricated jumper between pins 2 and 3 of J4 selects the E24EM canned oscillator clock source.



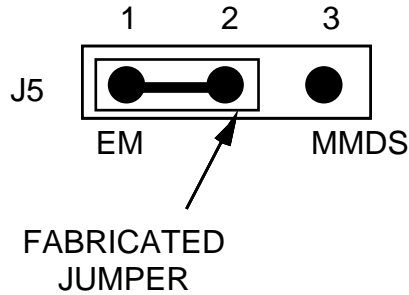
Alternatively, you may use a clock source originating from the MMDS05 control board. To do so, reposition the J4 jumper between pins 1 and 2. The MMDS OSC command can then be used to select clock frequency.

Jumper J3 can be used to select between an internal generated clock or a external clock generated by the target system. If the target clock is selected by placing the jumper on J3 between pins 1 and 2, the position of J4 is not important.

NOTE: The only valid position of the J1 fabricated jumper is between pins 2 and 3 when using the E24EM as part of an EVS system.

### 3.1.4 Platform Board Select Header (J5)

The factory configuration of header J5 is shown below. The fabricated jumper must be installed between pins 1 and 2 for EVS operation.



NOTE: The only valid position of the J5 fabricated jumper is between pins 1 and 2 when using the E24EM as part of an EVS system.

## 3.2 THE EMULATED MCU

The factory ships the E24EM with an MC68HC705E24 resident MCU. This MCU is suitable for emulation of both the MC68HC705E24 and the MC68HC05E16.

### 3.2.2 MC68HC705E24 Emulation

Operation of at frequencies above 2.2MHz ECLK is not possible.

Ports A and B are rebuild by a PRU. The drive capability of this PRU is greater than that of the MCU.

COP operation is not supported.

For more information about the MC68HC705E24 features, see the corresponding technical data books.

### 3.2.3 MC68HC05E16 Emulation

Limitations are as per 3.2.2.

For more information about the MC68HC05E16 features, see the corresponding technical data books.



### 3.3 EVS LIMITATIONS

This paragraph explains the limitations that apply to using your E24EM in an HC05EVS. (These limitations apply regardless of the resident MCU.)

**Limitation 1. CLI/RTI.** You may not trace a clear interrupt mask (CLI) or return from interrupt (RTI) instruction with an interrupt enabled and pending, due to MCU interrupt handling. Attempting such a trace causes an interrupt in the monitor map; this forces a software reset of the HC05EVS. User breakpoints remain in the user map as SWI instructions; you must remove such SWI instructions.

**Limitation 2. Branch.** Do not trace a conditional branch instruction (such as BRCLR) that branches to itself. As the monitor places an SWI instruction on the object of the branch, the system never would execute the instruction. However, it would appear to you that the instruction had executed. You may enter a G command while the PC points to this type of instruction as long as the instruction is not a breakpoint address.

**Limitation 3. IRQ/SWI.** Whenever possible, avoid mixing interrupt requests (IRQs) and user software interrupts (SWIs). This prevents a possible IRQ-SWI timing problem: a concurrent hardware interrupt and SWI could cause an HC05EVS failure that could stop program execution. To recover from such a failure (which occurs very infrequently, statistically), press the master reset switch (SW3).

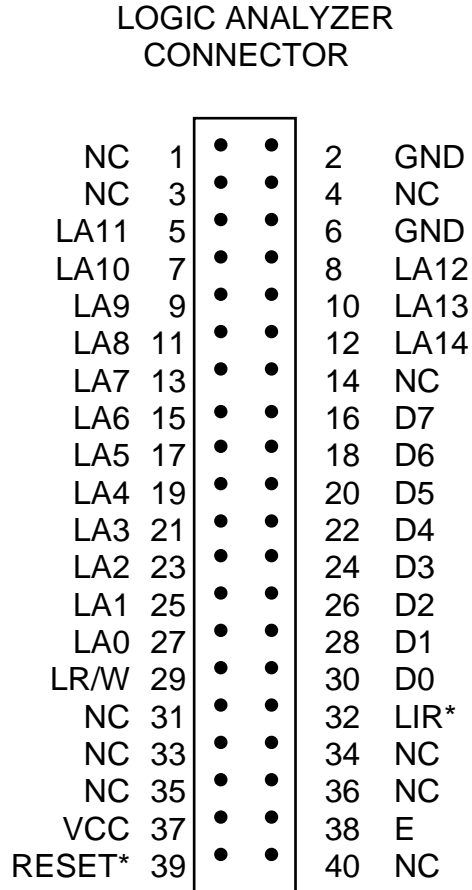
**Limitation 4. Memory Map.** You must be aware of the memory map of the MCU being simulated; be sure to use only valid ROM locations. The HC05EVS does not provide protection to limit user programs to the exact amount of MCU ROM available. (For information about memory maps, consult the technical data book for the MCU.)

**Limitation 5. COP.** The computer operating properly (COP) update register serves as an EPROM location for the resident MCU. Accordingly, the platform-board write-protect jumper header must enable write protection. Otherwise, any writes to the COP update register change the value stored in user pseudo ROM.

### 3.4 LOGIC ANALYZER CONNECTOR P1

Figure 3-1 shows the pin assignments for logic analyzer connector P1. Table 3-2 lists signal descriptions for this connector.

Note: \* indicates an active low signal



**Figure 3-1. Connector P1 Pin Assignments**



## Freescale Semiconductor, Inc.

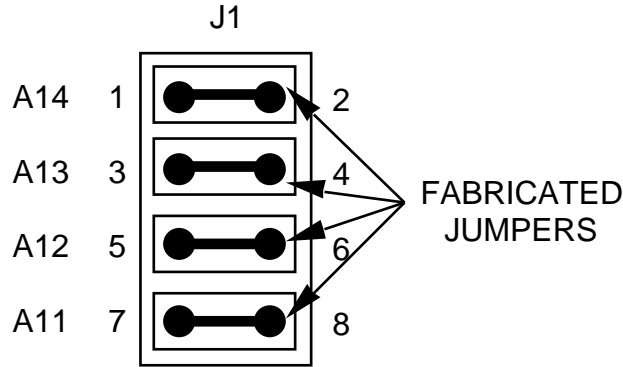
Table 3-2. Logic Analyzer Connector P4 Signal Descriptions

PIN	MNEMONIC	SIGNAL
1, 3, 4, , 12, 14, 31, 33 — 36, 40	-----	No connection
2, 6	GND	GROUND
5, 7,9,11,13. 15, 17, 19, 21, 23, 25, 27	LA11 — LA0	LATCHED ADDRESSES (bits 11—0) - MCU latched output address bus.
8,10,12	LA12,13,14	LATCHED ADDRESSES (bit 12-14) - MCU latched output address bus.
16, 18, 20, 22, 24, 26, 28, 30	AD7 — AD0	DATA BUS (bits 7—0) - MCU multiplexed I/O data bus.
29	LR/W	LATCHED READ/WRITE - Active-high output signal that indicates the direction of data transferred on the bus.
32	LIR	LOAD INSTRUCTION REGISTER - Open-drain, active-low output signal that indicates an instruction is starting.
37	VCC	+5 VDC POWER - Input voltage (+5 Vdc @ 1.0 A) used by EVS logic circuits.
38	E	EXTERNAL CLOCK - Internally generated output clock signal used as a timing reference. The frequency of E clock is 1/2 the input frequency of the signal on the OSC2 pin.
39	RESET	RESET - Active-low bidirectional signal for starting an EVS reset.

### 3.5 REMAINING SYSTEM INSTALLATION

When you have configured headers J1 to J5 and made sure that the resident MCU is appropriate, you are through with E24EM configuration.

Find jumper header J1 of the HC05EVS platform board. Make sure that three fabricated jumpers are installed, per the diagram below.



To install the E24EM on an HC05EVS platform board, fit together EM connectors P3 and P4 (on the bottom of the board) and platform-board connectors P3 and P4. Snap the corners of the EM onto the plastic stand-offs.

At this point, you are ready to make remaining cable connections, as necessary, and restore power. For instructions, consult the HC05EVS operations manual (HC05EVSOM/D).