Freescale Semiconductor, Inc.

M68EM05X4
EMULATOR MODULE
USER'S MANUAL

Third Edition

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CHAPTER 1

INTRODUCTION

This user's manual explains connection, configuration, and operation information specific to the HC05X4EM Emulator Module (X4EM). The X4EM makes possible emulation and debugging of target systems based on these microcontroller units (MCUs):

> MC68HC705X4   MC68HC05X4

The X4EM can be part of two development systems. This chapter describes those systems and explains the layout of the X4EM.

The MC68HC705X4 is the resident MCU in the X4 EM.

1.1 DEVELOPMENT SYSTEMS

Your X4EM 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 X4EM: 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 moulded 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 moulded 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 X4EM gives the MMDS05 the ability to emulate both the MC68HC705X4 and MC68HC05X4 -series MCUs. 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 X4EM 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 X4EM: 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 HC05X4 EVS emulates both the MC68HC705X4 and MC68HC05X4-series 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 X4EM 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 X4EM.

Connector P4 is for a cable assembly, this provide the interface to the target system. If you install the X4EM in the MMDS05 station module, the target cable passes through the slit in the station module enclosure. Connector P1 connects to 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).
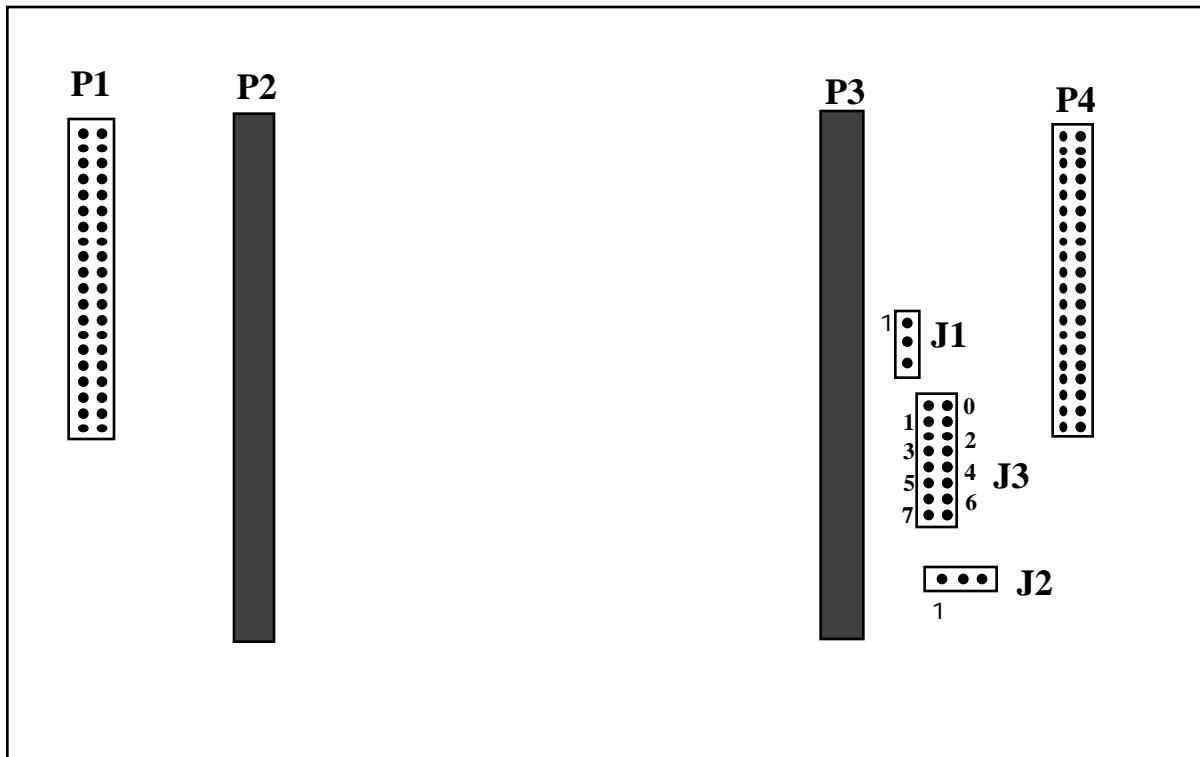
Figure 1-1. HC05X4 Emulator Module

1.3 CONNECTOR P4 PIN ASSIGNMENTS

Figure 1-2 shows the pin assignments for connector P4. The italic numbers correlate the P4 pins with the pins of your MCU (in 28 pin DIL). For signal descriptions, consult the technical data book for the specific MCU.

P4

Left	Pin		Pin	Right
(28)..............PB6.	1		2	PB7/TCOMP..........*(1)*
(27)..............PB5.	3		4	RESET..................*(2)*
(26)..............PB4.	5		6	OSC1.....................*(3)*
(25)..............PB3.	7		8	No Connect
(24)..............PB2.	9		10	TCAP....................*(5)*
(23)..............PB1.	11		12	PA0......................*(6)*
(22)..............PB0.	13		14	PA1......................*(7)*
(21)...........VDDH	15		16	PA2......................*(8)*
(20)..............RX1.	17		18	PA3......................*(9)*
(19)..............RX0.	19		20	PA4.....................*(10)*
(18)..............VSS.	21		22	PA5.....................*(11)*
(17)..............TX1.	23		24	PA6.....................*(12)*
(16)..............TX0.	25		26	PA7.....................*(13)*
(15)...........EVDD	27		28	GND.....................*(14)*
GND	29		30	GND
GND	31		32	GND
GND	33		34	GND
GND	35		36	GND
GND	37		38	GND
GND	39		40	GND

Figure 1-2. Connector P4 Pin Assignments

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 X4EM for use as part of an MMDS05, follow the instructions of Chapter 2. To configure your X4EM for use as part of an HC05EVS, follow the instructions of Chapter 3.

1.4 COP WATCHDOG EMULATION CONSIDERATIONS

Both of the devices emulated by this system include on-chip COP watchdogs. These watchdogs are configurable in the emulator according to the following procedures.

The COP watchdog is disabled by default when the emulator is reset. To enable the watchdog you must first enable the watchdog mask option bit and then override the COP disable bit in regi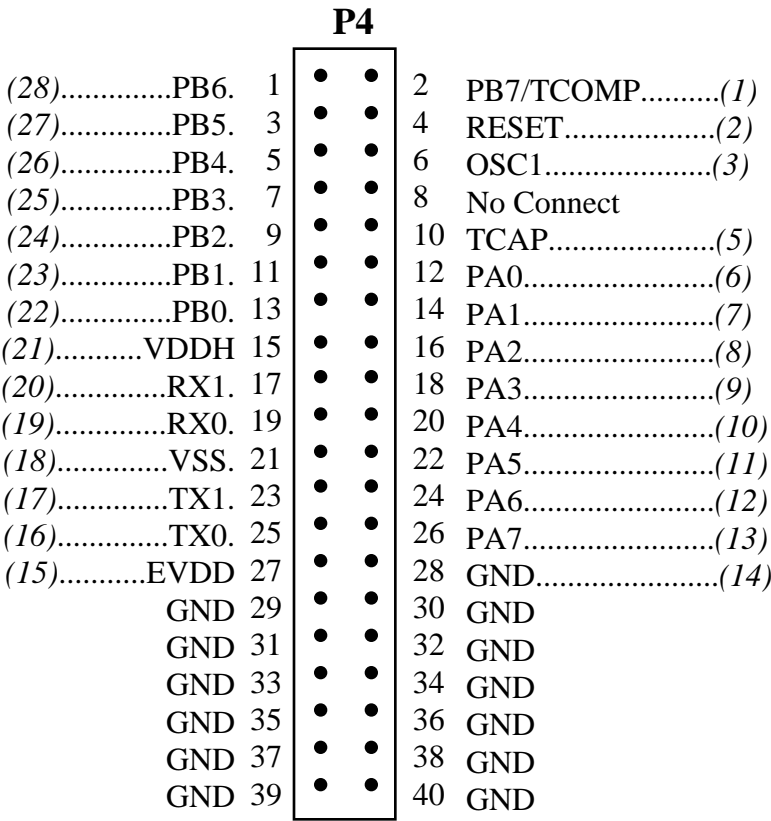ster $001F. You can enable the mask option bit in the MOR at address $1F00 by programming bit 0 to 0 (see the data book for more details). Alternatively, you can override the MOR bit by the following procedure (emulator only):

1. Set bit 7 of register $001C to 1

2. Set bit 0 of $1F00 to 0 by writing as if it were a RAM location.

In either case you must then enable the watchdog by writing bit 2 of address $001F to 1.

NOTE

Do not attempt to write any other bit at address $001F. Attempting to do so will cause the emulator to malfunction.

1.5 68HC705X4 MASK SET CONSIDERATIONS

Different mask sets for the 705X4 require different oscillator inputs. The following paragraphs describe the differences. Please note that the reference to the oscillator module also applies to external or MMDS05 clocks if they are in use.

• On the 1F88B mask set of the 705X4, the mask option register (MOR) is programmed to select the divide by ten option. For this reason it is necessary to install a 20Mhz oscillator module to achieve a bus speed of 2MHz on Emulator Modules with this mask set installed.

• On the 0F88B mask set of the 705X4, the MOR is programmed to select the divide by two option. For this reason it is necessary to install a 4Mhz oscillator module to achieve a bus speed of 2MHz on Emulator Modules with this mask set installed.

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CHAPTER 2

MMDS05 CONFIGURATION AND OPERATION

This chapter explains how to configure and use your X4EM as part of an MMDS05. For other parts of system installation or configuration, see the MMDS05 operations manual (MMDS05OM/D). (If you will use your X4EM as part of an HC05EVS system, go to Chapter 3 for corresponding information.)

Paragraph 2.1 explains how to set X4EM 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 X4EM already installed in the MMDS05 station module enclosure. To do so, switch off station-module power, remove the 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 X4EM JUMPER HEADERS

Your X4EM has three jumper headers, J1 to J3. Paragraphs 2.1.1. and 2.1.3 explain how to configure these headers.

2.1.1 Target Reset Header (J1)

Jumper header J1 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 J1 configuration for a X4EM that is part of an MMDS05.

TARGET RESET
DRIVEN FROM

(FABRICATED JUMPER)

1

EVS

(2)

(3)

TARGET

J1
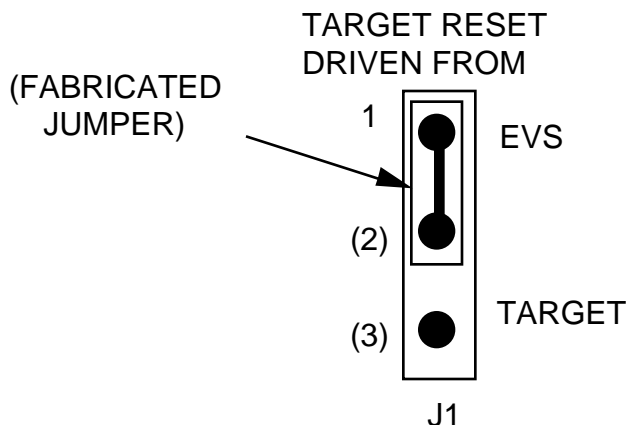
NOTE

The J1 pins 2-and-3 configuration is not correct for a X4EM that is part of an MMDS05 system. Such a configuration would interfere with correct operation of the RESETIN and RESETOUT commands.

2.1.2 Clock Select Header (J2)

Jumper header J2 determines the source of the clock signal. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 selects the X4EM canned oscillator clock source.

1   (2)   (3)

J2

XTAL   MMDS

FABRICATED
JUMPER
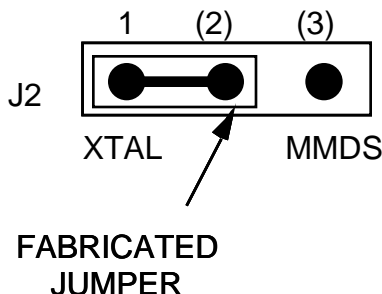
Alternatively, you may use a clock source originating from the control board.   To do so, reposition the J2 jumper between pins 2 and 3, then use the MMDS05 OSC command to select a frequency.

2.1.3 Port B WOI Header (J3)

Jumper header J3 allows the user to select the Port B lines that are to be configured as inputs. Fabricated jumpers should be inserted in the rows corresponding to these inputs. This is not required if the WOI function is not used on Port B.

J3

FABRICATED
JUMPER

PORT B BIT 0
PORT B BIT 1
PORT B BIT 2
PORT B BIT 3
PORT B BIT 4
PORT B BIT 5
PORT B BIT 6
PORT B BIT 7
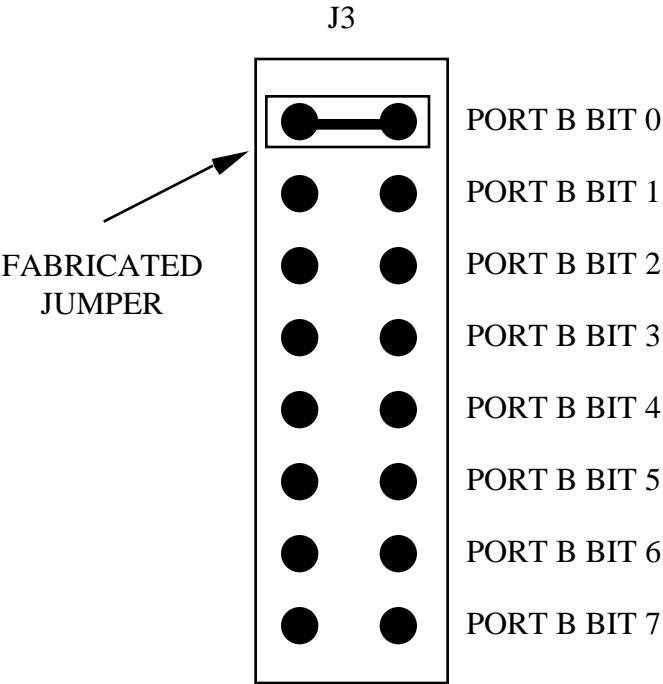
NOTE: Diagram shows J3 configured for WOI on Port B bit 0

2.2 THE EMULATED MCU

Your MMDS05 system uses a specific personality file for the MCU type being emulated. For example, to emulate an MC68HC705X4 or MC68HC05X4, the system uses personality file 00202Vxx.MEM. Table 2-1 lists all the personality files that pertain to the X4EM. Note that personality file names follow the pattern **00ZZZVxx.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
MC68HC(7)05X4	00202Vxx.MEM	MC68HC705X4	See paragraph 2.2.1

MMDS05 software loads the personality file upon powerup; the default personality file is 00202Vxx.MEM for the X4. To replace the default personality file with a different one, 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 start-up. (For more information about the STARTUP.05 script file, see the SCRIPT command explanation in the MMDS05 operations manual.)

2.2.1 MC68HC(7)05X4 Emulation

When emulating a MC68HC05X4 using the X4EM you should not to write to location $001F as this may cause a system malfunction. Also S-records downloads should avoid this location or write 0 into it.

The Computer Operating Properly (COP) is currently not supported.

Fixed pull downs of 100K are connected to all Port A, B lines.   When the WOI registers (obtained by setting bit 0 of register 3) are viewed they will read incorrectly until written. In the actual chip these registers are reset on power up, however on the EVS only the output is reset.

The division ratio on the oscillator is programmed to divide by two. To allow faster CAN operation the 705X4 part would have to be erased and the oscillator module replaced.

For more information about the MC68HC05X4 and MC68HC705X4 features, see the corresponding technical data books.

2.3 REMAINING SYSTEM INSTALLATION

When you have configured headers J1 to J3, you are through with X4EM configuration:

- To install the X4EM 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 stand-offs. Connect the target cable, if appropriate. 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).

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CHAPTER 3

HC05EVS CONFIGURATION AND OPERATION

This chapter explains how to configure your X4EM 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 X4EM as part of an MMDS05 system, go to Chapter 2 for configuration information.)

Paragraph 3.1 explains how to set X4EM jumper headers. Paragraph 3.2 explains considerations pertaining to the MCU you emulate. Paragraph 3.3 lists limitations on using the X4EM 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 X4EM 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 X4EM JUMPER HEADERS

Your X4EM has three jumper headers, J1 to J3. Paragraphs 3.1.1. and 3.1.3 explain how to configure these headers.

3.1.1 Target Reset Header (J1)

Jumper header J1 controls the path of a target reset. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 enables the EVS to control the target reset.   The fabricated jumper between pins 2 and 3 enables the target hardware to generate the reset.
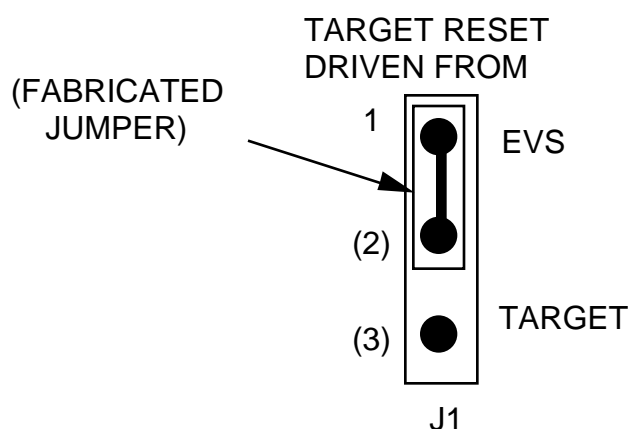
3.1.2 Clock Select Header (J2)
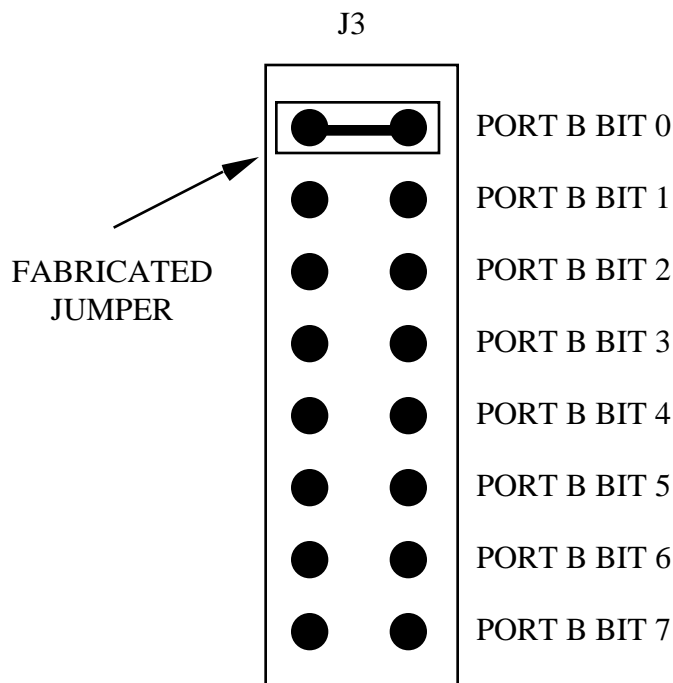
Jumper header J2 determines the source of the clock signal. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 selects the X4EM canned oscillator clock source.

3.1.3 Port B WOI Header (J3)

Jumper header J3 allows the user to select the Port B lines that are to be configured as inputs. Fabricated jumpers should be inserted in the rows corresponding to these inputs. This is not required if the WOI function is not used on Port B.

J3

FABRICATED JUMPER

PORT B BIT 0
PORT B BIT 1
PORT B BIT 2
PORT B BIT 3
PORT B BIT 4
PORT B BIT 5
PORT B BIT 6
PORT B BIT 7
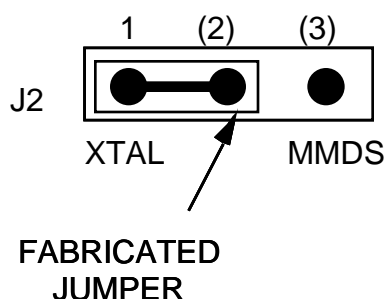
NOTE: Diagram shows J3 configured for WOI on Port B bit 0

3.2 THE EMULATED MCU

 The factory ships the X4EM with an MC68HC705X4 resident MCU, which is appropriate for emulating MC68HC(7)05X4 MCUs.

3.2.1 MC68HC(7)05X4 Emulation

When emulating a MC68HC05X4 using the X4EM you should not to write to location $001F as this may cause a system malfunction. Also S-records downloads should avoid this location or write 0 into it. The Computer Operating Properly (COP) is currently not supported. Fixed pull downs of 100K are connected to all Port A, B lines. When the WOI registers (obtained by setting bit 0 of register 3) are viewed they will read incorrectly until written. In the actual chip these registers are reset on power up, however on the EVS only the output is reset .

The division ratio on the oscillator is programmed to divide by two. To allow faster CAN operation the 705X4 part would have to be erased and the oscillator module replaced.   For more information about the MC68HC05X4 and MC68HC705X4 features, see the corresponding technical data books.

3.3 EVS LIMITATIONS

This paragraph explains the limitations that apply to using your X4EM in an HC05EVS.

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 COP is not supported by the current platform board.

Limitation 6. Pull downs on Ports A and B. Fixed 100K pull downs are connected to Ports A and B.

Limitation 7. At slow E clock rates the MCU will be unable to load S-records correctly. This is due to communication overruns, due to the inability of the MCU to service the communication chip fast enough. To avoid this problem you can slow the transmission rate (not baud rate) or use a faster clock to load the MCU and then slow the clock down.

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.
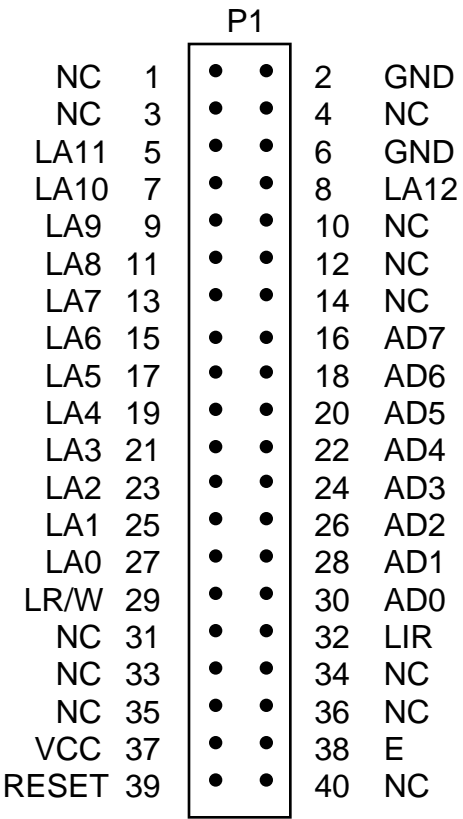
```
             P1
NC     1  [ •  • ]  2    GND
NC     3  [ •  • ]  4    NC
LA11   5  [ •  • ]  6    GND
LA10   7  [ •  • ]  8    LA12
LA9    9  [ •  • ]  10   NC
LA8   11  [ •  • ]  12   NC
LA7   13  [ •  • ]  14   NC
LA6   15  [ •  • ]  16   AD7
LA5   17  [ •  • ]  18   AD6
LA4   19  [ •  • ]  20   AD5
LA3   21  [ •  • ]  22   AD4
LA2   23  [ •  • ]  24   AD3
LA1   25  [ •  • ]  26   AD2
LA0   27  [ •  • ]  28   AD1
LR/W  29  [ •  • ]  30   AD0
NC    31  [ •  • ]  32   LIR
NC    33  [ •  • ]  34   NC
NC    35  [ •  • ]  36   NC
VCC   37  [ •  • ]  38   E
RESET 39  [ •  • ]  40   NC
```

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

Table 3-1. Logic Analyzer Connector P1 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	LA12	LATCHED ADDRESS (bit 12) - 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 OSC1 pin.
39	RESET	RESET - Active-low bi-directional signal for starting an EVS reset.

3.5 REMAINING SYSTEM INSTALLATION

When you have configured headers J1 to J3, you are through with X4EM configuration. Find jumper header J1 of the HC05EVS platform board. Make sure that two fabricated jumpers are installed, per the diagram below.

J1

A14 1 ● ● 2

A13 3 ● ● 4

A12 5 ●━━● 6

A11 7 ●━━● 8

FABRICATED
JUMPERS
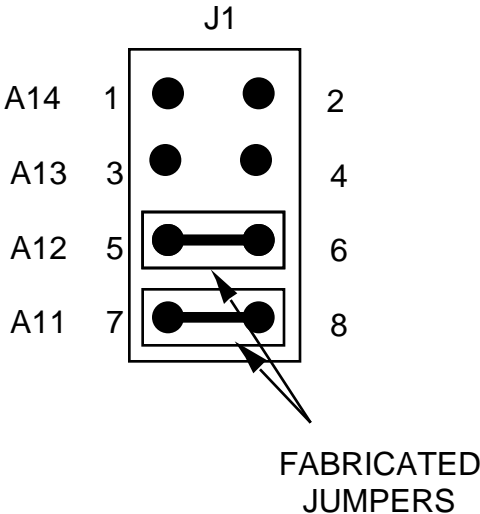
To install the X4EM on an HC05EVS platform board, fit together EM connectors P2 and P3 (on the bottom of the board) and platform-board connectors P3 and P4. Snap the corners of the EM onto the plastic stand-offs.

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).

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