

**M68EM05D32/D**

Nov 1995

**M68EM05D32  
EMULATOR MODULE  
USER'S MANUAL**

First Edition

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## CHAPTER 1

### INTRODUCTION

This user's manual explains connection, configuration, and operation information specific to the M68EM05D32 Emulator Module (D32EM). The D32EM makes possible emulation and debugging of target systems based on these microcontroller units (MCUs):

MC68HC05D9      MC68HC705D9      MC68HC05D24      MC68HC05D32

The D32EM can be part of two development systems. This chapter describes those systems and explains the layout of the D32EM.

#### 1.1 DEVELOPMENT SYSTEMS

Your D32EM 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 D32EM: 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 D32EM gives the MMDS05 the ability to emulate several MC68HC05D-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 D32EM 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 D32EM: 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 HC05D32 EVS emulates several MC68HC05D-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 D32EM 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 D32EM. Jumper J1 must be set to position C/D. Jumper headers J2 and J3 let the user select the clock source. Jumper J4 determines the logic direction of the RESET signal at the target connector. Switch array S1 determines which device is to be emulated. Switch array S2 must have all switches set to closed.

Connectors P4 and P5 provide the interface to the target system. If you install the D32EM 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).

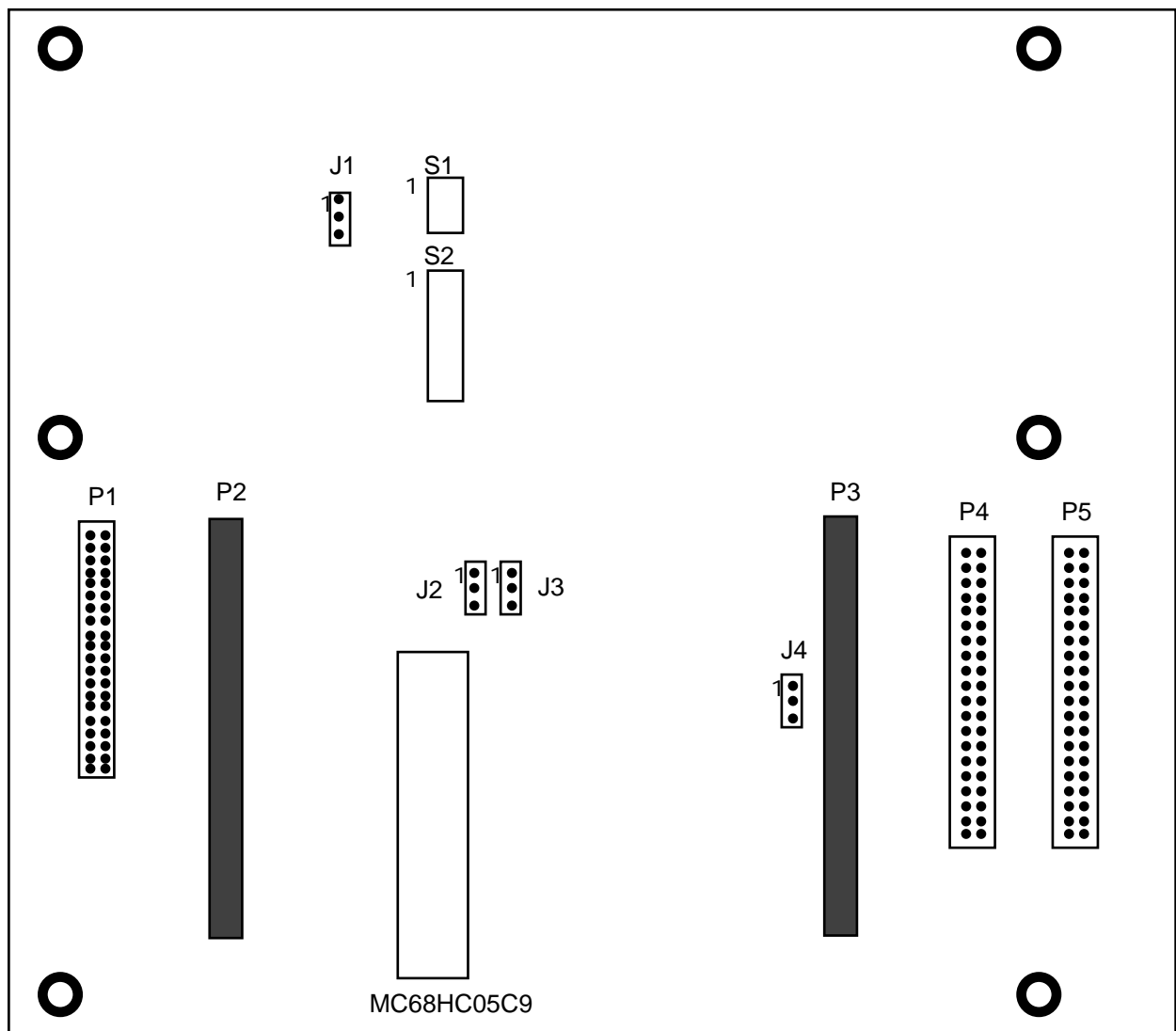


Figure 1-1. HC05D32 Emulator Module

### 1.3 CONNECTORS P4 AND P5 PIN ASSIGNMENTS

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

P4				P5					
GND	1	• •	2	NC	1	• •	2	NC	
NC	3	• •	4	GND	NC	3	• •	4	NC
PA7	5	• •	6	PA6	PA5	5	• •	6	PA4
PA3	7	• •	8	PA2	PA1	7	• •	8	PA0
RESET*	9	• •	10	IRQ*	GND	9	• •	10	NC
Vdd Detect	11	• •	12	NC	OSC1	11	• •	12	NC
PD7	13	• •	14	TCMP/PD6	TCAP	13	• •	14	GND
PD3	15	• •	16	PD2	PD5	15	• •	16	PD4
NC	17	• •	18	NC	PD1	17	• •	18	PD0
GND	19	• •	20	NC	NC	19	• •	20	NC
NC	21	• •	22	NC	NC	21	• •	22	NC
NC	23	• •	24	GND	NC	23	• •	24	NC
PC0	25	• •	26	PC1	NC	25	• •	26	NC
PC2	27	• •	28	PC3	GND	27	• •	28	NC
PC4	29	• •	30	PC5	NC	29	• •	30	NC
PC6	31	• •	32	PC7	NC	31	• •	32	GND
PB4	33	• •	34	PB5	PB6	33	• •	34	PB7
PB0	35	• •	36	PB1	PB2	35	• •	36	PB3
NC	37	• •	38	GND	NC	37	• •	38	GND
NC	39	• •	40	GND	NC	39	• •	40	GND

**Figure 1-2. Connectors P4 and P5 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 D32EM for use as part of an MMDS05, follow the instructions of Chapter 2. To configure your D32EM 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 D32EM 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 D32EM as part of an HC05EVS system, go to Chapter 3 for corresponding information.)

Paragraph 2.1 explains how to set D32EM 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 D32EM 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

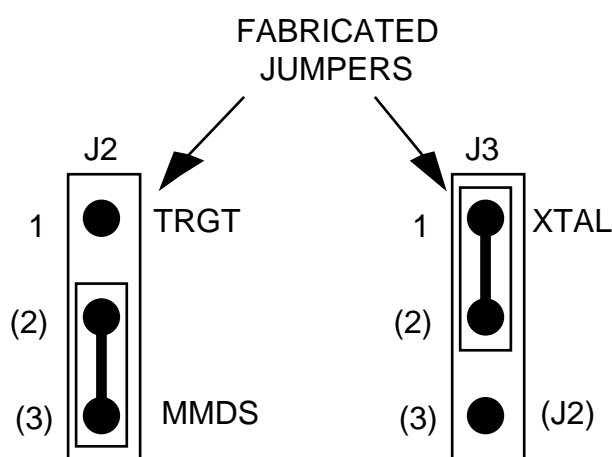
Be sure to switch off power if you reconfigure an installed EM. Reconfiguring EM jumper headers with power left on can damage MMDS05 circuits.

### 2.1 SETTING D32EM JUMPER HEADERS

Your D32EM has four jumper headers, J1 through J4 and two switch arrays S1 and S2. Paragraphs 2.1.1. through 2.1.4 explain how to configure these headers and switches.

### 2.1.1 Clock Source Select Headers (J2 and J3)

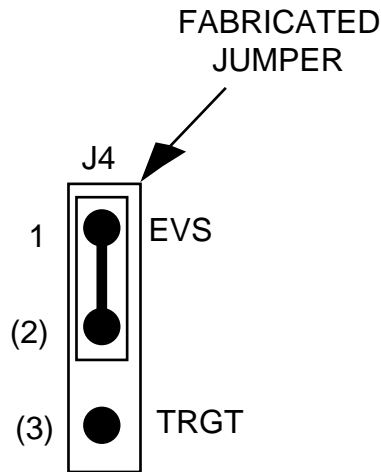
Jumper headers J2 and J3 select the source of the clock oscillator for the MCU. You may choose between on-board oscillator (EM), MMDS supplied oscillator (MMDS) or clock from the target system (TRGT). To select MMDS you must place the J3 jumper at the (J2) position as well as correctly selecting the J2 setting. The diagram below shows the factory configuration: the fabricated jumper on J3 between pins 1 and 2 selects the D32EM on-board canned oscillator clock source.



Alternatively, you may use a clock source originating from the control board. To do so, position the J3 jumper between pins 2 and 3, then use the MMDS05 OSC command to select a frequency. To use a clock source originating from the target system position the J3 jumper between pins 2 and 3, then position the J2 jumper between pins 1 and 2.

**2.1.2 Reset Select Header (J4)**

Jumper header J4 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 J4 configuration for a D32EM that is part of an MMDS05.

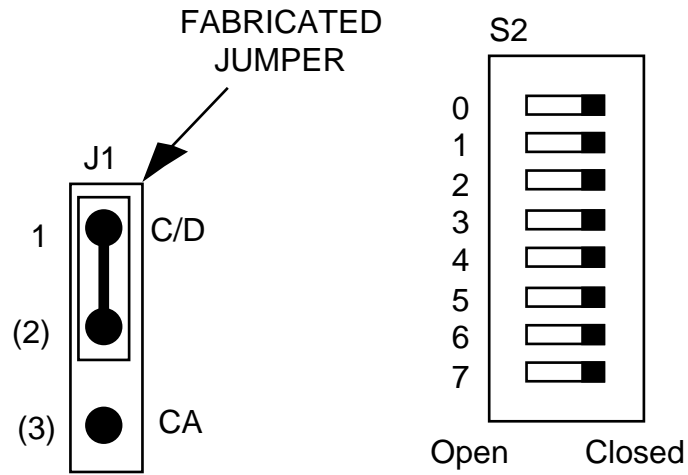


**NOTE**

The J2 pins 2-and-3 configuration is not correct for a D32EM that is part of an MMDS05 system. Such a configuration would interfere with correct operation of the RESETIN and RESETOUT commands.

**2.1.3 Configuration switches and jumpers (J1 and S2)**

Jumper header J1 and switch array S2 are required for a different configuration of the printed circuit board. For correct D32EM operation Jumper J1 must always be in the C/D position and the switch array must have all switches in the closed position as shown below.

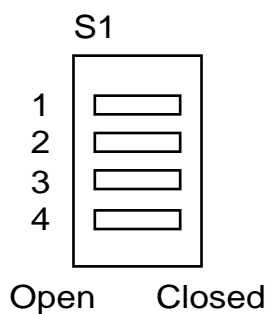


### 2.1.4 Emulation Device Selection (S1)

Switch array S1 allows the user to determine the device which is to be emulated; it selects the size of the memory map available to the MCU and also some device specific features. The following table shows the settings of S1 which are required for each MCU emulated. Section 2.2 discusses the MMDS05 personality files to be used with each device and the operation of replacing the resident MCU where this is necessary.

**Table 2-1. MCUs Emulation Selection**

DEVICE	S1 SWITCH 1	S1 SWITCH 2	S1 SWITCH 3	S1 SWITCH 4
M68HC05D9	CLOSED	OPEN	CLOSED	CLOSED
M68HC705D9	CLOSED	OPEN	CLOSED	CLOSED
M68HC05D24	CLOSED	CLOSED	OPEN	CLOSED
M68HC05D32	OPEN	CLOSED	OPEN	CLOSED



## 2.2 THE EMULATED MCU

Your MMDS05 system uses a specific personality file for the MCU type being emulated. For example, to emulate an MC68HC05D32 or MC68HC705D32 MCU, the system uses personality file 0021AVxx.MEM. Table 2-1 lists all the personality files that pertain to the D32EM. 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 2-2. MCUs and Personality Files**

EMULATED MCU	PERSONALITY FILE	COMMENTS
M68HC05D9	00212V01.MEM	See paragraphs 2.2.1 and 2.2.4.
M68HC705D9	00212V01.MEM	See paragraphs 2.2.1 and 2.2.4.
M68HC05D24	00214V01.MEM	See paragraphs 2.2.1 and 2.2.3.
M68HC05D32	00215V01.MEM	See paragraph 2.2.2.

MMDS05 software loads the personality file upon powerup. 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 startup. (For more information about the STARTUP.05 script file, see the SCRIPT command explanation in the MMDS05 operations manual.)

### 2.2.1 Resident MCU Substitution

The socket at D32EM location U9 contains the resident MCU. The factory ships the D32EM with an MC68HC05D32 resident MCU, which is appropriate for emulating a number of MCUs with some qualifications as described in the following paragraphs 2.2.2 through 2.2.4.

Occasionally it may be necessary to replace the resident MCU with another to improve the level of emulation of a particular feature.

When you are ready to install the substitute MCU, turn off MMDS05 power and make sure that you are grounded. Then remove the MCU from D32EM location U9, insert the new resident MCU, and restore power.

### 2.2.2 D32 Emulation

To emulate an MC68HC05D32 use the MC68HC05D32 for the resident MCU. The D32 has single mask option for oscillator selection. This has no effect on emulator operation.

### 2.2.3 D24 Emulation

To emulate an MC68HC05D24, use the MC68HC05D32 for the resident MCU. An MC68HC05D24 device can also be installed as the resident MCU, however, this will make no difference to the emulation characteristics. The D24 has single mask option for oscillator selection which has no effect on emulator operation.

For more information about the MC68HC05D24, see the corresponding technical data books.

### 2.2.4 (7)05D9 Emulation

To emulate an MC68HC05D9, use an MC68HC(7)05D9 device as the resident MCU. The MC68HC05D32 can be used as the resident MCU, however writes to the OPTION register require to be made to two addresses (\$3FDF and \$7FDF) for correct operation. The HC05D9 has single mask option for oscillator selection which has no effect on emulator operation.

For more information about the MC68HC05D9 and MC68HC705D9 features, see the corresponding technical data books.

## 2.3 REMAINING SYSTEM INSTALLATION

When you have configured headers J1 through J4 and switches S1 and S2, and made sure that the resident MCU is appropriate, you are through with D32EM configuration:

- To install the D32EM 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 D32EM 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 D32EM 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 D32EM as part of an MMDS05 system, go to Chapter 2 for configuration information.)

Paragraph 3.1 explains how to set D32EM jumper headers. Paragraph 3.2 explains considerations pertaining to the MCU you emulate. Paragraph 3.3 lists limitations on using the D32EM 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 D32EM already installed on the HC05EVS platform board. To do so, disconnect platform-board power, then follow the guidance of this chapter.

#### CAUTION

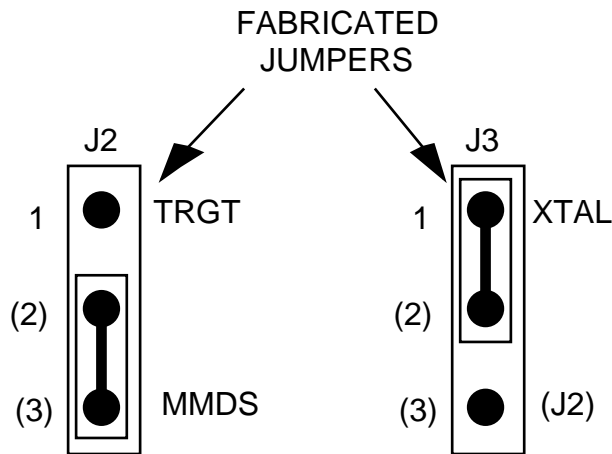
Be sure to disconnect power if you reconfigure an installed EM. Reconfiguring EM jumper headers with power left on can damage HC05EVS circuits.

### 3.1 SETTING D32EM JUMPER HEADERS

Your D32EM has four jumper headers, J1 through J4 and two switch arrays S1 and S2. Paragraphs 3.1.1. through 3.1.4 explain how to configure these headers and switches.

**3.1.1 Clock Source Select Headers (J2 and J3)**

Jumper headers J2 and J3 select the source of the clock oscillator for the MCU. You may choose between on-board oscillator (EM) or clock from the target system (TOSC). To select TRGT you must place the J3 jumper at the (J2) position as well as selecting TRGT on the J2 jumper. The diagram below shows the factory configuration: the fabricated jumper on J3 between pins 1 and 2 selects the D32EM on-board canned oscillator clock source.

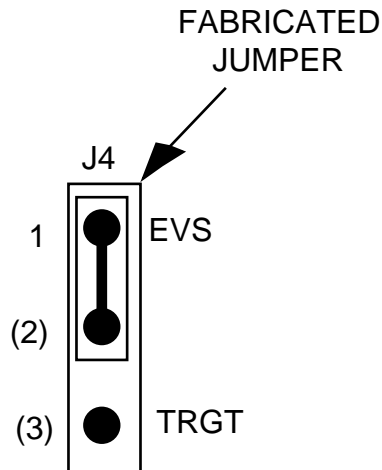


**NOTE**

The J2 pins 2-and-3 configuration is not correct for a D32EM that is part of an HC05EVS system.

### 3.1.2 Reset Select Header (J4)

Jumper header J4 controls the path of a target reset. The diagram below shows the factory configuration: the fabricated jumper between pins 1 and 2 enables your D32EVS to reset the target when you press the user or master reset switch.

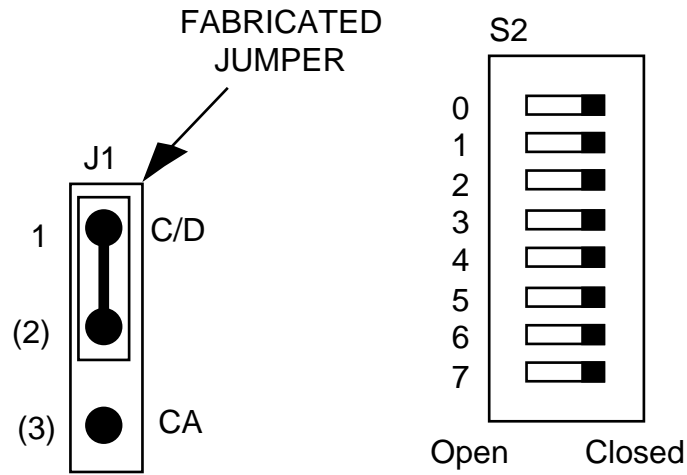


Alternatively, you may enable the target system to reset the D32EVS. To do so:

- Reposition the D32EM J4 jumper between pins 2 and 3, and
- Insert a fabricated jumper into platform-board header J3.

**3.1.3 Configuration switches and jumpers (J1 and S2)**

Jumper header J1 and switch array S2 are required for a different configuration of the printed circuit board. For correct D32EM operation Jumper J1 must always be in the C/D position and the switch array must have all switches in the closed position as shown below.

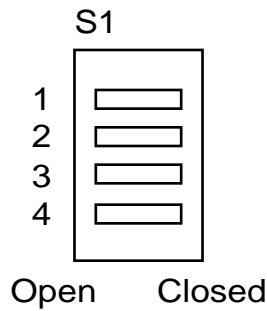


**3.1.4 Emulation Device Selection (S1)**

Switch array S1 allows the user to determine the device which is to be emulated; it selects the size of the memory map available to the MCU and also some device specific features. The following table shows the settings of S1 which are required for each MCU emulated.

**Table 2-1. MCUs Emulation Selection**

DEVICE	S1 SWITCH	S1 SWITCH	S1 SWITCH	S1 SWITCH
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
M68HC05D9	<b>CLOSED</b>	<b>OPEN</b>	<b>CLOSED</b>	<b>CLOSED</b>
M68HC705D9	<b>CLOSED</b>	<b>OPEN</b>	<b>CLOSED</b>	<b>CLOSED</b>
M68HC05D24	<b>CLOSED</b>	<b>CLOSED</b>	<b>OPEN</b>	<b>CLOSED</b>
M68HC05D32	<b>OPEN</b>	<b>CLOSED</b>	<b>OPEN</b>	<b>CLOSED</b>



### 3.2 RESIDENT MCU SUBSTITUTION

The socket at D32EM location U9 contains the resident MCU. The factory ships the D32EM with an MC68HC05D32 resident MCU, which is appropriate for emulating a number of MCUs with some qualifications as described in the following paragraphs 3.2.2 through 3.2.8.

Occasionally it may be necessary to replace the resident MCU with another to improve the level of emulation of a particular feature.

When you are ready to install the substitute MCU, turn off MMDS05 power and make sure that you are grounded. Then remove the MCU from D32EM location U9, insert the new resident MCU, and restore power.

**Table 3-2. Resident MCUs**

EMULATED MCU	RESIDENT MCU	COMMENTS
M68HC05D9	M68HC05D32	See paragraphs 3.2.1 and 3.2.8.
M68HC705D9	M68HC05D32	See paragraphs 3.2.1 and 3.2.8.
M68HC05D24	M68HC05D32	See paragraphs 3.2.1 and 3.2.8.
M68HC05D32	M68HC05D32	See paragraphs 3.2.1 and 3.2.8.

Table 3-1 shows the resident MCU appropriate for your emulation with additional information in the reference paragraphs. Also note paragraphs 3.2.2 through 3.2.8, below, for the information specific to the MCU you emulate.

#### 3.2.1 Resident MCU Substitution

The socket at D32EM location U9 contains the resident MCU. The factory ships the D32EM with an MC68HC05D32 resident MCU, which is appropriate for emulating a number of MCUs with some qualifications as described in the following paragraphs 2.2.2 through 2.2.4.

Occasionally it may be necessary to replace the resident MCU with another to improve the level of emulation of a particular feature.

When you are ready to install the substitute MCU, turn off EVS power and make sure that you are grounded. Then remove the MCU from D32EM location U9, insert the new resident MCU, and restore power.

### 3.2.2 D32 Emulation

To emulate an MC68HC05D32 use the MC68HC05D32 for the resident MCU. The D32 has single mask option for oscillator selection. This has no effect on emulator operation.

### 3.2.3 D24 Emulation

To emulate an MC68HC05D24, use the MC68HC05D32 for the resident MCU. An MC68HC05D24 device can also be installed as the resident MCU, however, this will make no difference to the emulation characteristics. The D24 has single mask option for oscillator selection which has no effect on emulator operation.

For more information about the MC68HC05D24, see the corresponding technical data books.

### 3.2.4 (7)05D9 Emulation

To emulate an MC68HC05D9, use an MC68HC(7)05D9 device as the resident MCU. The MC68HC05D32 can be used as the resident MCU, however writes to the OPTION register require to be made to two addresses (\$3FDF and \$7FDF) for correct operation. The HC05D9 has single mask option for oscillator selection which has no effect on emulator operation.

For more information about the MC68HC05D9 and MC68HC705D9 features, see the corresponding technical data books.

### 3.3 EVS LIMITATIONS

This paragraph explains the limitations that apply to using your D32EM 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).

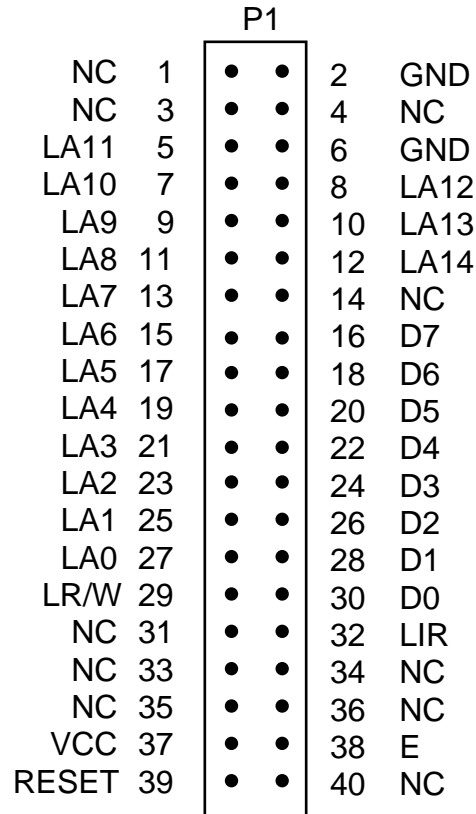
**Limitation 4. Memory Map.** You must be aware of the memory map of the MCU being simulated; be sure to use only valid ROM locations. The HC05EVS does not provide protection to limit user programs to the exact amount of MCU ROM available. (For information about memory maps, consult the technical data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



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

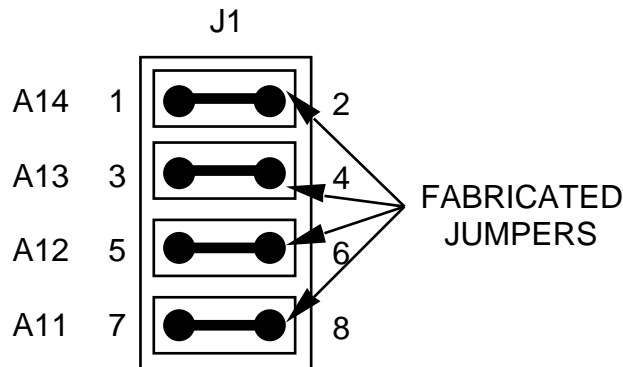
**Table 3-3. Logic Analyzer Connector P1 Signal Descriptions**

PIN	MNEMONIC	SIGNAL
1, 3, 4, 10, 14, 31, 33 — 36, 40	-----	No connection
2, 6	GND	GROUND
5, 7, 8, 9, 11,12, 13,15, 17, 19, 21, 23, 25, 27	LA14 — LA0	LATCHED ADDRESSES (bits 14—0) - MCU latched output address bus. The D9 devices have only LA0—13 valid.
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 through J4 and switches S1 and S2, and made sure that the resident MCU is appropriate, you are through with D32EM configuration.

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



To install the D32EM 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 standoffs.

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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