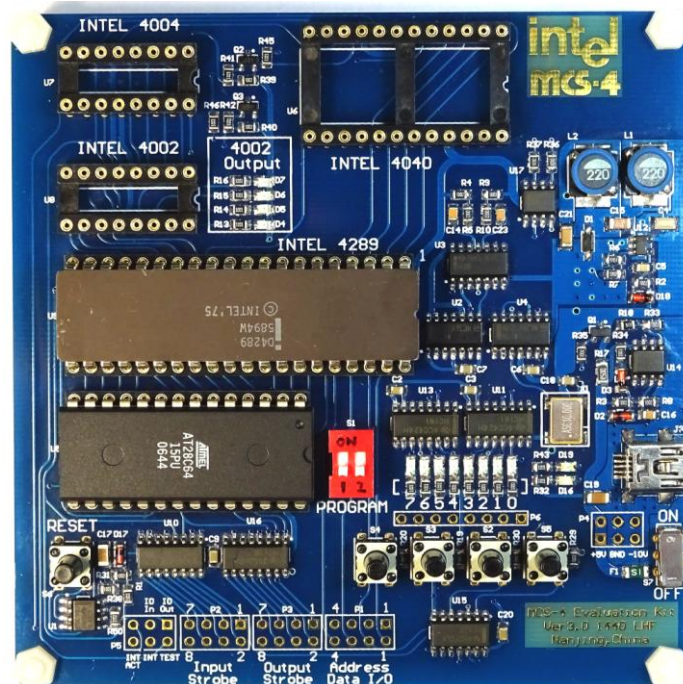


A Brief Introduction to LHF's Intel MCS-4 Evaluation Board

2015-01-11 English Ver.1.1



1. Overview

The LHF's MCS-4 evaluation board features a negative power supply, a clock generator running at 625KHz, an Intel 4289 Memory-I/O interface, an 8KB ROM for storing programs, and buttons/LEDs for input and output. You can plug in a 4004 or 4040 CPU, together with a 4002-1 or 4002-2 RAM at the same time. When powered on, the test program stored in the ROM will run on the 4004/4040, allowing you to see if your chip is in working condition. The test program can also test the status character registers and main registers in the 4002 by writing data and then reading them back. The LEDs attached to 4002's outputs will tell you whether the 4002's output function is normal.

There are two decoders on the board, providing input strobe and output strobe. The I/O ports, as well as the strobe signals, are connected to external connectors, so you may DIY some projects using the board. In the future a calculator extension board is planned that could be attached to this test board, which will use these connectors too. The interrupt circuit for 4040 is also reserved for you.

The board takes power from a Mini USB connector. Single 5V is needed, and the current draw is less than 350mA. There's a protection circuit that monitors the current of the whole system, in order to prevent damages if chips are not functioning properly, or the chips are connected incorrectly.

This is the 3rd revision of the MCS-4 test board. It has the following new features:

- Better clock driver using IC rather than discrete transistors
- Improved over-current protection circuit and interrupt triggering circuit
- Added a power switch

2. Using the test board

2.1. Components of the board

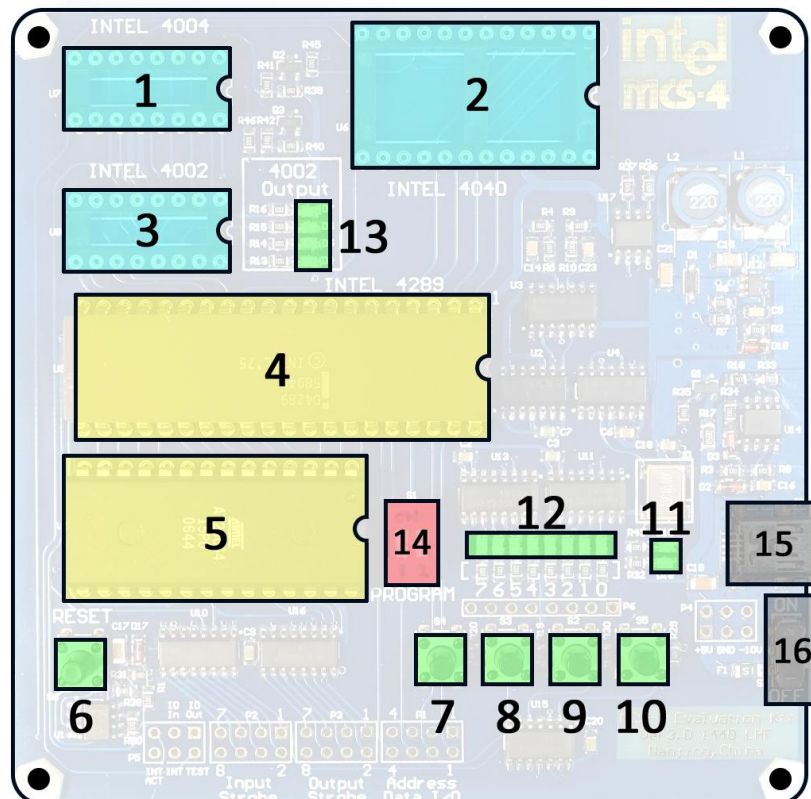


Figure 2

Figure 2 shows the main components of the test board:

- 1: Socket for 4004 CPU
- 2: Socket for 4040 CPU
- 3: Socket for 4002 RAM
- 4: Socket for 4289 ROM&IO interface
- 5: ROM
- 6: RESET button
- 7-10: Input buttons 1-4
- 11: Power/Failure LED
- 12: Output LEDs
- 13: LEDs for 4002's output port
- 14: Program selector
- 15: mini-USB Power supply connector
- 16: Power switch

2.2. Prepare for tests

Before tests, you have to cut off the power supply. You need to first make sure a 4289 chip is in its place. Then, plug in your 4004 or 4040 in the direction shown in Figure 2 (**Pin 1 on the right**). You may also plug in a 4002 in the 4002 socket. If you want to use ZIF sockets, please first put your chips onto the sockets like shown in **Figure 3**. Then you may plug the sockets onto the board.

Figure 4 shows two cases with 4004+4002 and 4040+4002 on the board.

WARNINGS:

1. Putting chips in the wrong direction or using incorrect chips on the board may cause damage to both the board and the chips. Please never do that.
2. Never try to plug in a 4004 and a 4040 at the same time. It may cause unexpected results.
3. Always use the ZIF sockets with care. Their pins are stiff and easy to break.

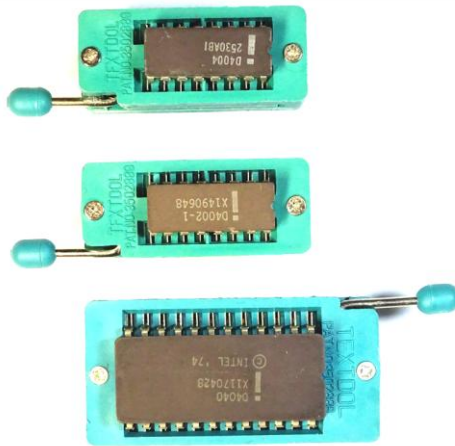


Figure 3

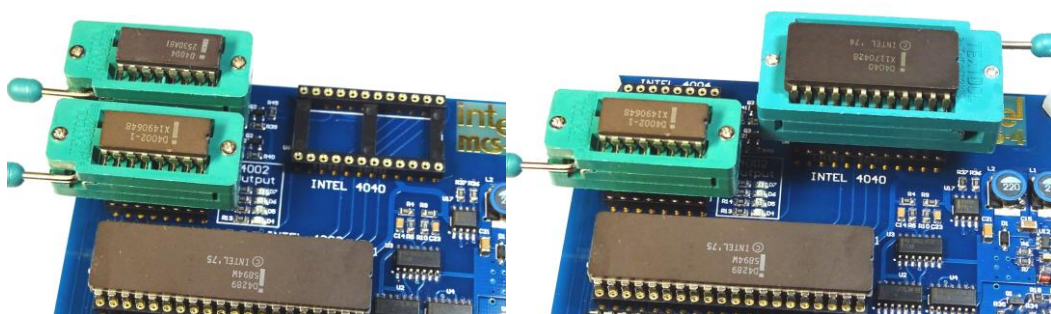


Figure 4

2.3. Testing your 4002 / 4004 / 4040

After the setting up the board, you may conduct the tests. Use a phone charger or computer's USB port as a power source, connect them to the board via Mini-USB cable. Switch the power switch on, at this time, you should see the blue Power LED (No.11 in **Figure 2**) light up. If something is wrong in the MCS-4 circuit or other parts of the board, and the current is beyond the limit, the red Power Failure LED (No.11 in **Figure 2**) will light up. It may be caused by fake chips, chips not plugged in properly, or the chip is damaged/defective. You should cut off the power immediately and check the circuit.

If the 4004 / 4040 is functioning normally, you will see the Output LEDs(12) shifting from right to left. Then, congratulations! 🎉

The four input buttons(7-10) alter the test functions. When the leftmost button is pressed, the output LEDs will shift from right to left, the same as when the board is powered up. If the second button(8) is pressed, the Output LEDs will be counting from 0 to 255. The result is shown in binary form.

The third button is for testing 4002s. The board could test both 4002-1 and 4002-2. If you have a 4002 connected to the board, and it is working, after you push the third button, you will see Output LEDs flashing, indicating the test result. The test program will first test the status character registers in the 4002, by writing 1s, read back; then write 0s and read back again. If the status registers are OK, the program will then test the corresponding main registers. The upper 4-bit of Output LEDs indicate which group of status registers and data registers are being tested, while the lower 4-bit shows the index of data register that is being tested in binary form. If all memory cells are fine, when the test is finished, you will see the eight Output LEDs light at the same time. The LEDs for 4002's output port(13) will also be lit up in sequence, to show you whether the output function of your 4002 is functioning.

If something is wrong with your 4002, or you don't have a 4002 on the board, when the third button is pressed, the Output LEDs will show "10101010" in response.

Figure 4 is cropped from the Intel MCS-4 Users Manual. It shows how the 4002's memory cells are organized. It may help you understand the testing procedure in more detail.

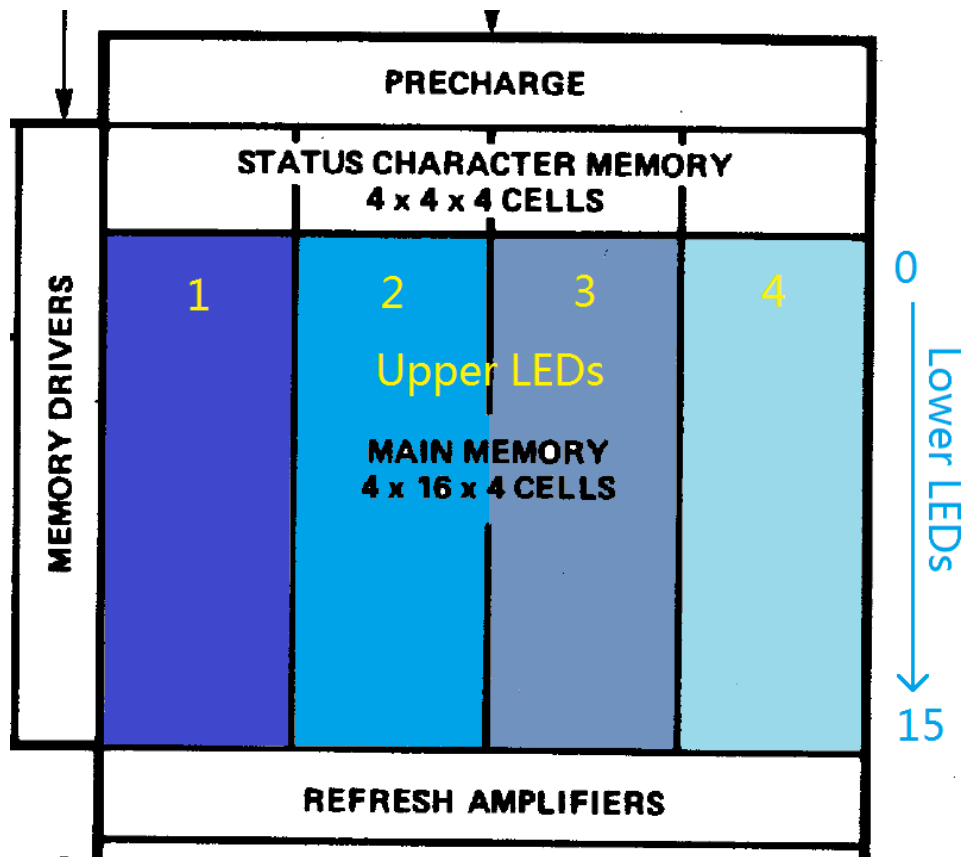


Figure 4

The rightmost button is currently reserved and has no function.

3. Expansion

The connectors on the bottom of the board (*Figure 5*) are for expansion. If you write your own program, you may use tri-state gates such as 74HC125 to connect buttons or other input devices to the board. Latches can be used for outputs, for example, driving LEDs. Here, I recommend 74HC161. Though it was designed as a counter, it has a 4-bit register that can be loaded with external signals. That makes it perfect for 4-bit CPU systems.

The Ports are all TTL compatible, except for the 'INT ACT' pin, which is directly connected to the 4040 CPU. For more information, please refer to the schematic, the MCS-4 Users Manual, or contact me directly.

Besides, I'm planning to make a calculator expansion board that will turn the test board into a real functioning calculator. Works are still in progress, and the board will use these expansion ports as well.

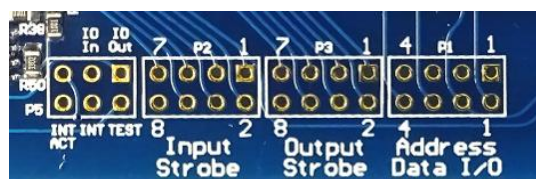


Figure 5

4. Additions

※The program selector switch(No.16 in **Figure 2**) is reserved for accessing different blocks of the ROM. 4004 can only address 4KB of program ROM, but I used an 8KB ROM in this system. This switch, together with the jumper behind the board, determines which block of the ROM is being executed. If the jumper is set to 2KB, you can store four programs with a size of 2KB into the ROM, and use this switch to select one program to execute. Otherwise, If the jumper behind is set to 4KB, you can store two programs with a size of 4KB. Then the right bit of the program selector switch has no use, while the left one determines which program to execute.

Please do not change the switch if you don't use your own program.

※The 4004 or 4040 chips would become little bit hot while running. That's not a problem, because these PMOS chips operate under 15 Volts and consume about 0.5Watt of power.

If you have any question, please e-mail me at lhfjames@163.com, or PM lhf_james in CPU-world forum.

Thank you for all your supports to me and the making of the board!