PC-Retro Manual: MTM Scientific, Inc.

Remember: The PC-Retro is a copy of the original IBM 5150 PC

Consequently: All manuals, documents, drawings and instructions for the original IBM 5150 PC and 64/256K motherboard apply to the PC-Retro.

Introduction

The PC-Retro is a kit for building a clone of the IBM 5150 PC Computer, which was first released in early 1980's. The computer is based on the 8088 CPU. The motherboard memory range is 64KB to 256KB. The form factor, layout and operation of the PC-Retro is identical to the original IBM PC. The BIOS ROM supplied with this kit is known as the 'Anonymous BIOS' because it is an open source version with enhanced features. (The original IBM 10/27/1982 BIOS will also work with the PC-Retro. It was not provided because of the copyright.)

Construction and operation of the the PC-Retro Kit is an advanced electronic hobbyist project. No refunds will be made after kit construction begins. We are also not able to provide individualized technical assistance, however there is an active user forum support group at the Vintage Computer Forum (VCF).

Kit Contents

The standard kit contents are shown in Figure 1. The main components are the Motherboard PCB, IC Socket Kit, IC Chip Kit, Resistor Kit, Capacitor Kit and Hardware Kit.

Optional kits available are: Memory Upgrade Kit and the ROM Upgrade Kit

Kit Assembly

Kit construction requires the usual assortment of quality electronic assembly tools: Most notably a fine-tipped soldering iron, electronic grade rosin core solder, hand tools, a multimeter, static-safe work surface and a small bench vise. We advise that you work slowly, carefully and methodically… assembly mistakes are very difficult to detect after-the-fact.

The construction sequence we suggest is as follows:

1) Install the IC Sockets (Pay attention to the orientation, No socket U-100)
2) Install the resistors (Check resistors with a multimeter before installing.)
3) Install the capacitors (Use the photo of Figure 4 thru 7 as a guide.)
4) Install the connectors and miscellaneous hardware.
5) And finally, insert the IC Chips (Paying attention to the orientation.)

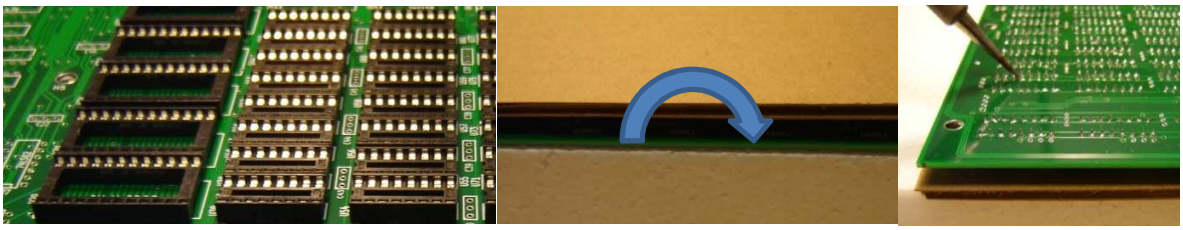

Figure 1. Insert the IC sockets, cover with a flat sheet of cardboard, flip 180 degrees, and then solder from above.

The next step after installing the IC sockets is to install the resistors. Figure 2 is a list of the resistors and their color codes.

R1, 18 KOhm, Brown Gray Orange
R2, 1 MOhm, Brown Black Green
R3, 18 KOhm, Brown Gray Orange
R4, 18 KOhm, Brown Gray Orange
R5, 18 KOhm, Brown Gray Orange
R6, 150 Ohm, Brown Green Brown
R7, 1200 Ohm, Brown Red Red
R8, 4.7 KOhm, Yellow Purple Red
R9, 3.9 KOhm, Orange White Red
R10*, 33 Ohm, Orange Orange Black
R11, 180 Ohm, Brown Gray Brown
R12, 220 Ohm, Red Red Brown
R13, 27 Ohm, Red Purple Black
R14, 27 Ohm, Red Purple Black
R15, 27 Ohm, Red Purple Black
R16, 27 Ohm, Red Purple Black
R17, 27 Ohm, Red Purple Black
R18, 27 Ohm, Red Purple Black
R19, 27 Ohm, Red Purple Black
R20, 27 Ohm, Red Purple Black
R21, 27 Ohm, Red Purple Black
R22, 510 Ohm, Green Brown Brown
R23, 30 Ohm, Orange Black Black
R24, Not Present
R25, 510 Ohm, Green Brown Brown
TD2, 470 Ohm, Yellow Purple Brown

*R10 is 1/2 Watt. All others 1/4 Watt

Figure 2. Resistors for the PC-Retro with color band codes.

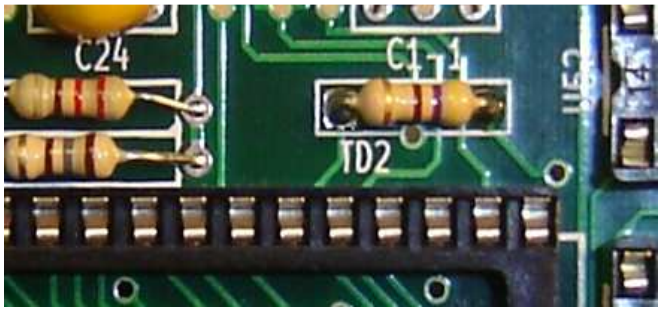

Figure 3. Install a 470 Ohm resistor in location TD2 as shown.

The capacitors used in the PC-Retro are as follows: 13 pcs of 10uF yellow tantulum, 23 pcs of 0.047uF yellow ceramic, 3 pcs of 47pF yellow ceramic, 2 pcs of 0.01uF red tubular and 1 pc of 0.047 red tubular. Only the 10uF capacitors are polarized, and since they have 3 leads, they can't be inserted incorrectly.

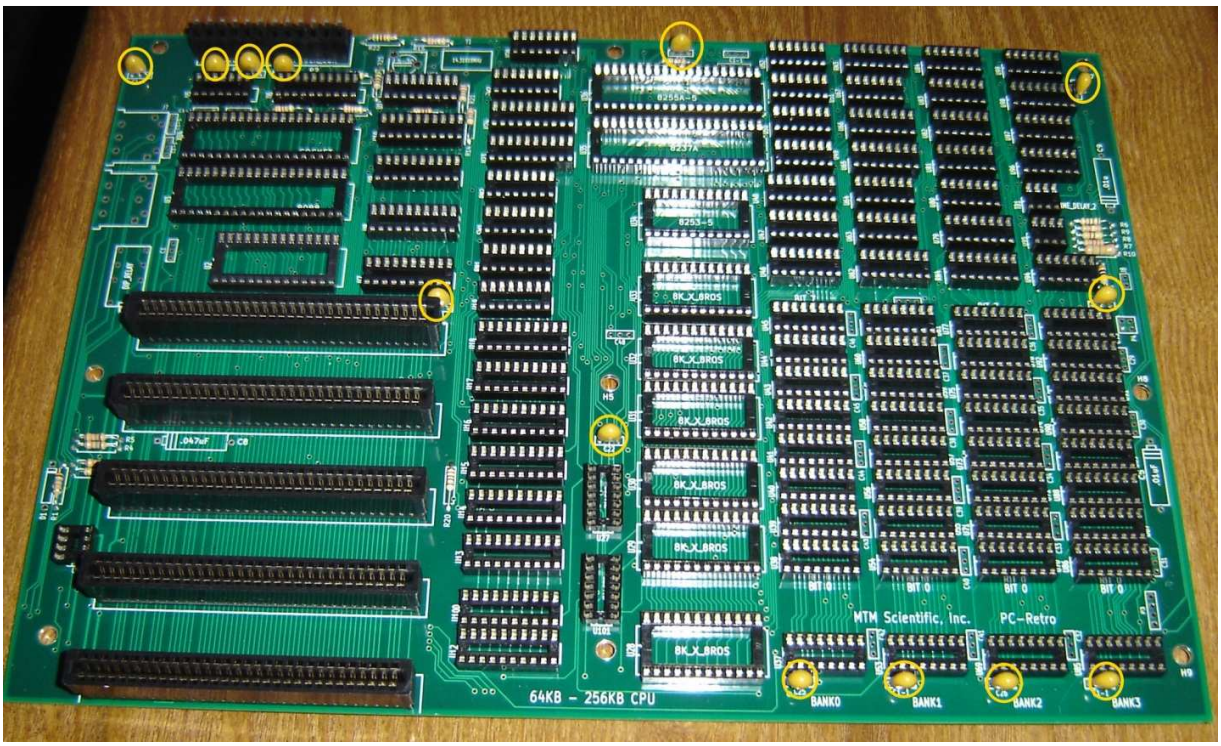

Figure 4. Location of the 10uF tri-lead tantulum capacitors (13 pcs)

The 10uF capacitors have 3 leads. The 3 leads prevent any possibility of reversed assembly. (This is the original IBM design to prevent manufacturing mistakes.)

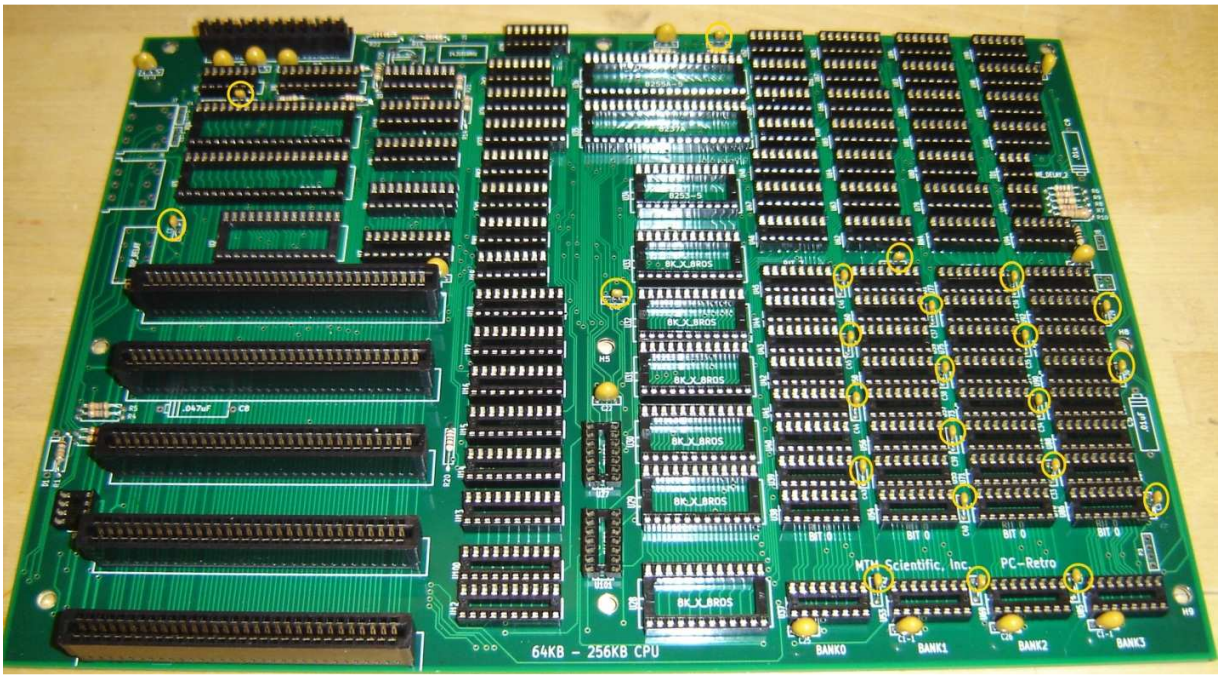

Figure 5. Location of the 0.047uF ceramic capacitors (23 pcs)

The location of the 23 pieces of 0.047 uF ceramic capacitors is shown in Figure 5. These capacitors are non-polarized and can be inserted either direction. Use the center hole and either of the outboard holes when inserting these capacitors, as shown in Figure 6.

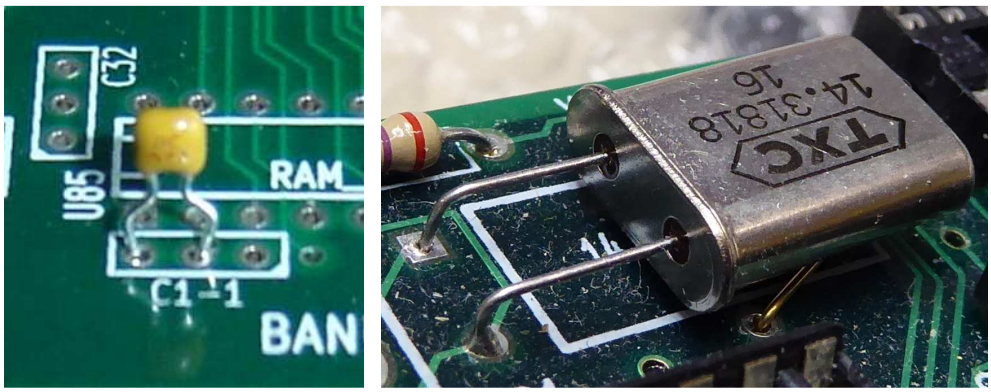

Figure 6. Use the center hole and either outboard hole when mounting the small 47nF (0.047uF) and 47pF capacitors. Insert crystal as shown.

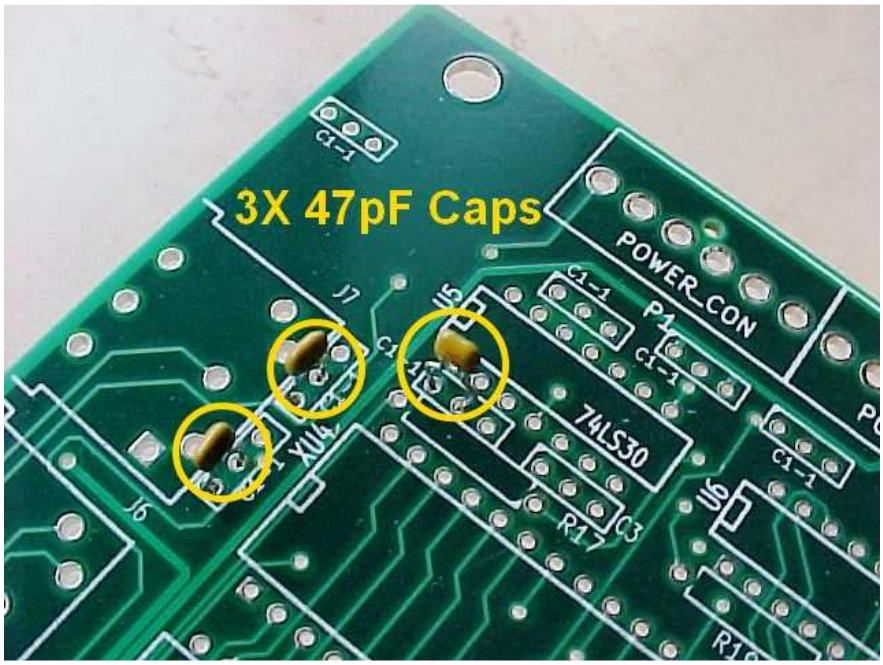

Figure 7. All three 47 pF capacitors are mounted near the keyboard connector.

Setting the DIP Switches

The original IBM PC does not have a CMOS setup. The BIOS software determines the hardware settings during boot by reading 2 DIP switches on the motherboard. The DIP switches must be set correctly by the user to properly boot the computer. Figure 8 shows the most common initial switch settings for kit builders. Refer to the IBM manuals for other configurations.

Location	1	2	3	4	5	6	7	8
Switch 1:	Off	On	Off	Off	On	On	On	On
Description:	One Floppy, No Math CPU, 64K Memory and VGA Graphics							
Switch 2:	On	On	On	On	On	Off	Off	Off
Description:	64KB onboard memory (Bank 0 is filled)							

Figure 8. Typical DIP switch settings for first time PC-Retro boot.

Keyboard

The PC-Retro requires the same type of keyboard as the original IBM PC (IBM Model F, PC/XT, 83-Key). The PC-Retro uses the large 5 pin DIN style keyboard

connector. Important: Although the connector style is identical for the AT style keyboards, an AT keyboard will not work with an IBM PC or the PC-Retro.

Figure 9. Original IBM 83 key PC keyboard.

The Anonymous BIOS will boot without a keyboard, for initial testing purposes.

Power Supply

The power supply for the computer is the standard PC type. A photo is shown in Figure 10. This type of supply is still widely available. When connecting the power supply to the board it is important to remember that the black wires on the dual connectors are next to each other, as shown in Figure 11.

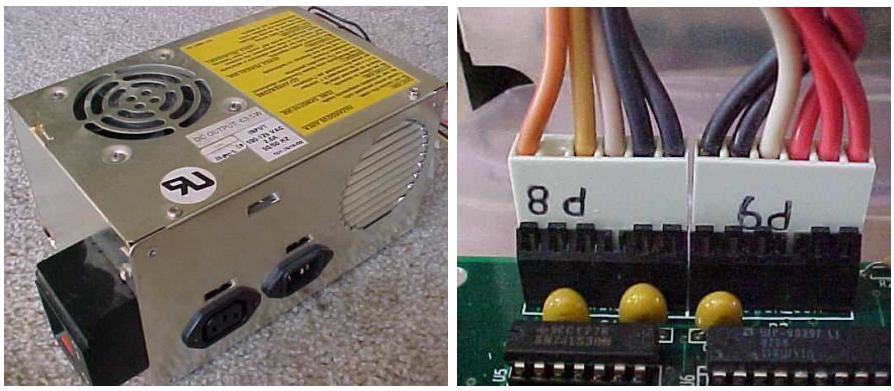

Figure 10. Power supply details for the PC-Retro.

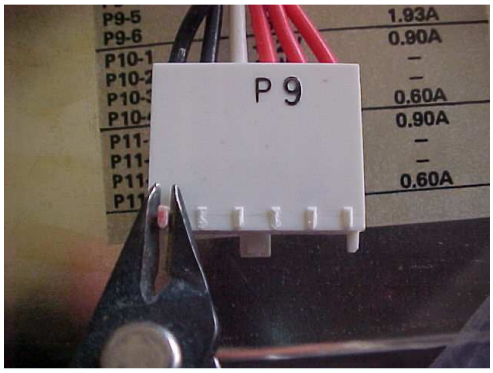

Figure 11. It may be necessary to trim the key tabs from the power connectors.

Video

The PC-Retro does not have an integral motherboard video output. Video output requires the addition of an 8 bit compatible ISA video card. The main choices for video output are MDA, Hercules, CGA, EGA or VGA. The MDA, Hercules and CGA video cards are native vintage choices for the time period, but the monitors compatible with these video modes are difficult to locate and expensive to purchase. However, many ISA VGA cards will work with the PC-Retro and VGA monitors remain widely available. We expect most kit builders will choose the VGA option. Figure 12 shows some typical compatible video cards.

BIOS

The 8K of BIOS software (Basic Input Output System) for the PC-Retro is contained in ROM chip IC U-33 on the motherboard. The ROM IC is an MC68766 from Motorola. The ROM can be erased with an UV eraser and new code 'burned' into the chip, however it is difficult to find a EPROM programmer capable of working with the vintage IC chip. It is also possible to use an adapter in the ROM socket that will allow the use of a more traditional ROM, such as the 28128, etc.

The BIOS provided with the kit is known as the 'Anonymous BIOS'. The source code and tools for recompiling the code are provided on the PC-Retro CD. It is also possible to install the original IBM PC BIOS, such as the 10/27/1982 version, which is widely available on the worldwide web. One caution with working with the original BIOS from IBM: The memory banks must be completely filled with memory, otherwise the board won't boot. It is a bug in the original IBM code!

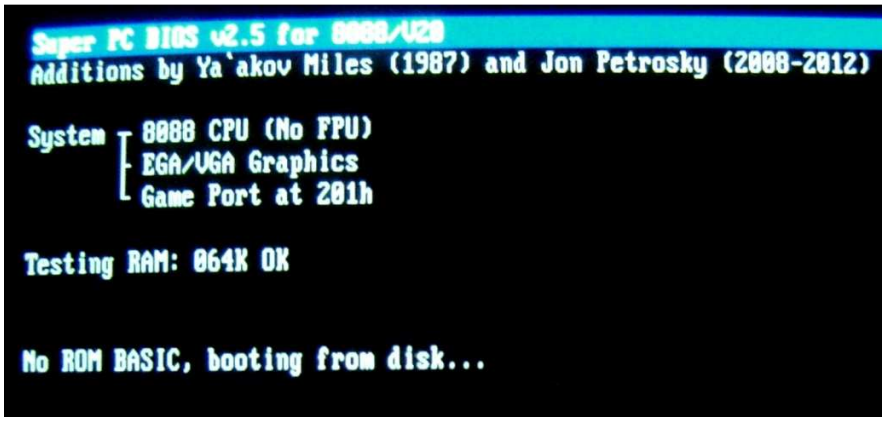

Figure 12. Anonymous BIOS welcome screen.

Testing

Before applying power for the first time we suggest measuring the resistance at the power connector between the 5 volt and ground pins. The resistance should be greater than 100 ohms. Do not proceed to apply power until the resistance is correct. Low resistance indicates a direct short or an improperly installed capacitor or IC chip.

Cassette Port

Using the cassette port is an advanced project. The cassette port option was removed in the next version of the IBM product line: The XT Computer. The cassette port cable used on the Radio Shack TRS-80 is also compatible with the PC-Retro. Consult the Vintage Computer Forum for more information regards using the cassette port.

Diagnostic BIOS Option

Included on the PC-Retro CD is a copy of diagnostic ROM software code called the Landmark SuperSoft Diagnostics (LMSS). The LMSS software code can be burned onto a ROM and substituted in IC location U-33, replacing the regular BIOS. The code runs a series of diagnostic tests that determine the status of the motherboard, and is very useful to locate any problems. The only requirement to use the code is regards the video output card, which must be either MDA, Hercules or CGA. The code will not work correctly with EGA or VGA video cards. A screenshot of the software being used is shown in Figure 13.

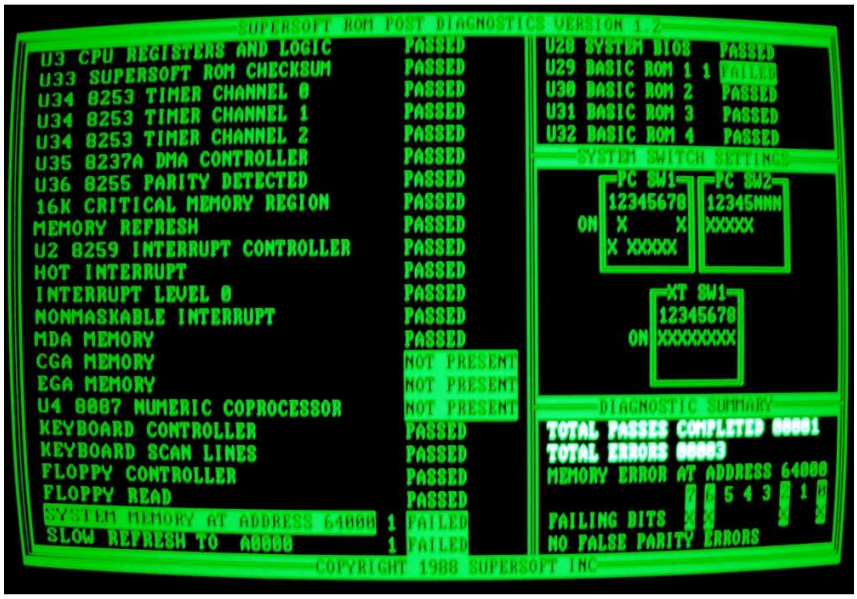

Figure 13. View of the Landmark SuperSoft Diagnostic output screen.

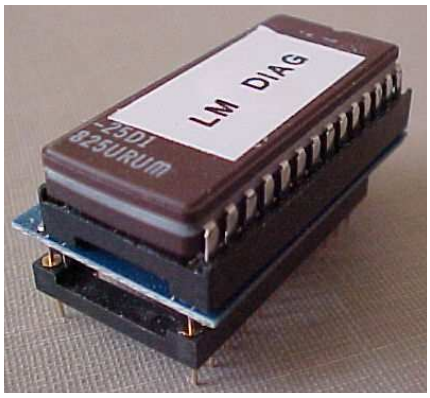

Figure 14. The diagnostic program can be burned on a 27XXX series chip and installed in socket U33 (BIOS Socket) by using an adapter.

Resources

The amount of information available on the worldwide web for the IBM PC is huge. However, there are 3 websites that are absolutely fantastic for starting out…

The single most useful and relevant website for the IBM PC 5150 and PC-Retro is:
http://www.minuszerodegrees.net

The single most useful and active computer forum related to the IBM PC is:
http://www.vintage-computer.com/vcforum/

The website which details the Anonymous BIOS is:

http://www.phatcode.net