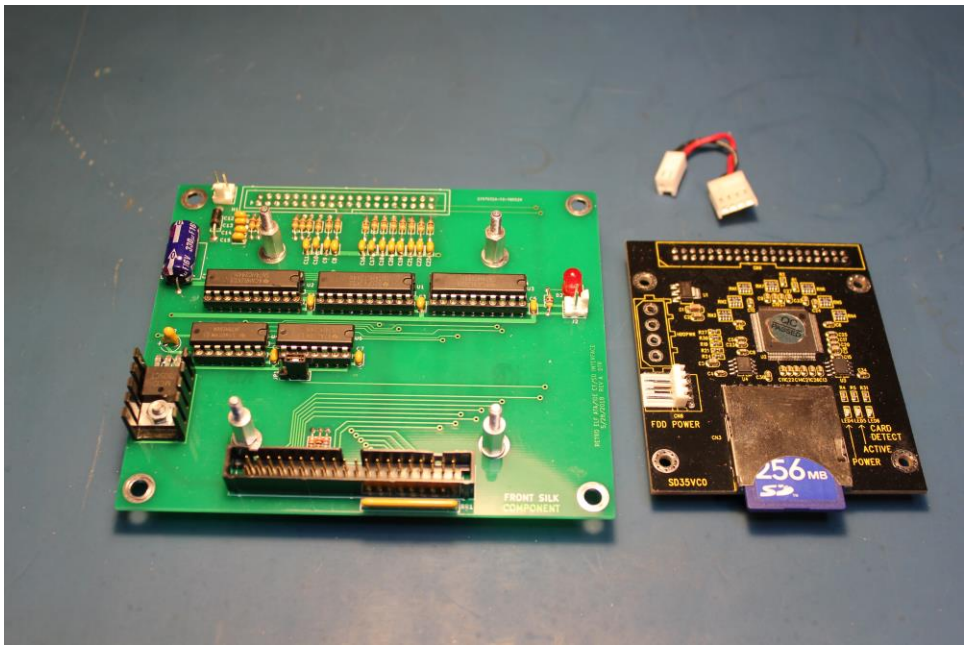


Retro Elf Plus - ATA/IDE Interface Board – Revision A

1 – About the ATA/DE Interface board

In the course of developing the Retro Elf system, it was clear from the start that some form of high capacity internal storage would be needed. Back in the days when the CDP1802 processor was released, data storage was normally handled by some form of magnetic media. Like many of the systems out during the 70's, the COSMAC Elf hobbyist most likely used cassette tape. Some more advanced systems used 8-inch or 5 ¼-inch floppy disks.

For the Retro Elf project, the storage goals where some form of internal storage.

The final design selected a system that mimicked the classic ATA/IDE hard drive interface. While the ATA/IDE standard became popular later in the 80s, this drive interface would allow me to fit the storage system in the tight space within my version the Retro Elf's case and eliminate the need for a second external box.

When coupled with Mike Riley's Elf OS, the resulting storage system would provide a maximum capacity of 268,431,360 bytes. More than enough to support all the Retro Elf's storage needs.

An interface card that supported the use of a 256MB SD for the storage media. While the design goal was to have a fixed internal storage system, this configuration would allow the user that ability to exchange the storage media as need by simply ejecting the SD card.

The need for the ATA/IDE Interface card comes from the need to interface the normal SD to IDE card's 3-volt logic to the Elf's 5-volt logic. There was also the issue of signal switching noise. A low-pass filter needed to be place between all signals being presented to the SD card to IDE board.

The use of low power CMOS components helps keep the board's power needs to a minimum. The ATA/IDE board only uses 95mA of current with a 12-volt DC power supply. A simple on board 5-volt DC voltage regulator is implemented to power the board. This regulator can supply 5 volts at up to half an amp when an 8-12 volts DC input is supplied to the board. A protection diode is used to help protect against accidental reversal of input power.

2- Assembly

Before you begin, some helpful hints

Follow the instructions carefully and read the entire step before you perform the operation. Solder a part or group of parts only when you are instructed to do so.

Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify that same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

- In the Parts List
- At the beginning of each step where a component is installed
- In the schematic

SAFETY WARNING: *Safety glasses are recommended. Avoid eye injury when you cut off excess lead lengths. Hold the leads so they cannot fly toward your eyes.*

Soldering

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

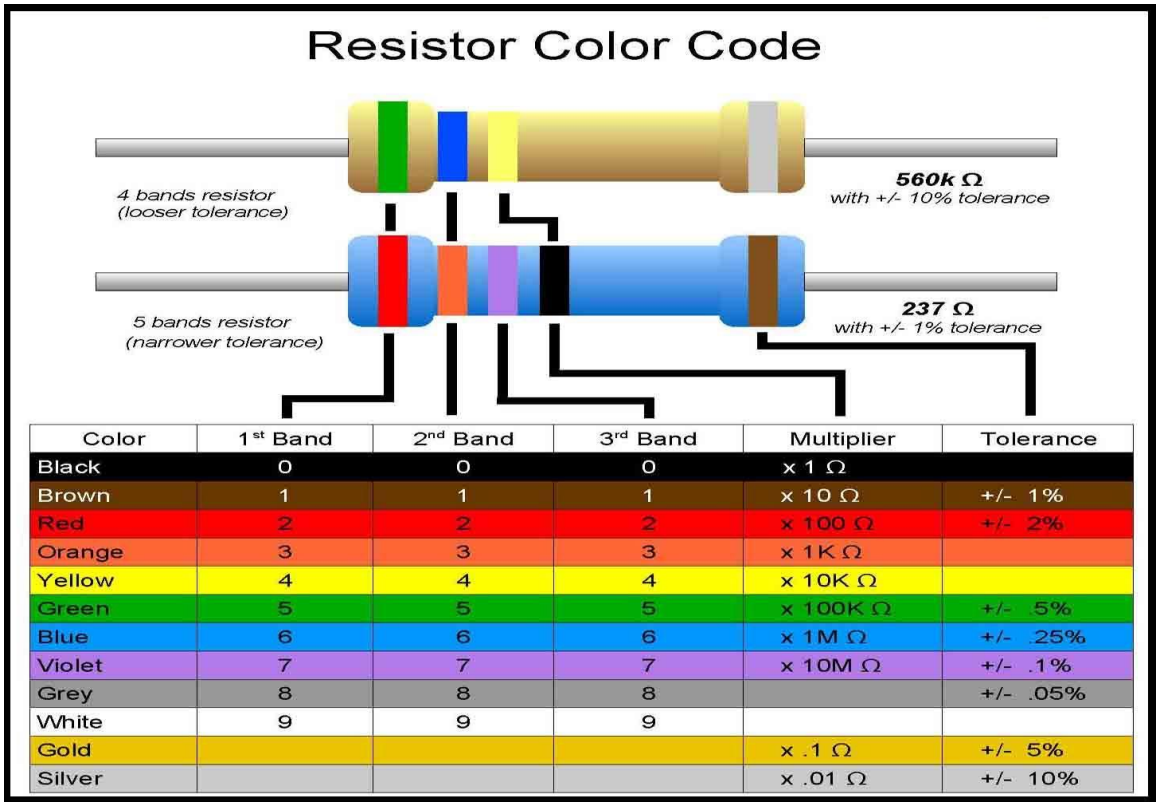
It is easy to make a good solder connection if you follow a few simple rules:

- Use the right type of soldering iron. If available, a temperature controlled soldering iron is recommended. Otherwise us a 25 to 40-watt pencil soldering iron. In either case use a 1/8" or 3/16" chisel or pyramid tip for best results.
- Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.
- Use only a high quality rosin-core, 62/36/2 silver-bearing solder with a 0.020 or 0.015 inch diameter.
- A good solder connection is made when you heat the component lead and the foil on the circuit board at the same time. This will allow the solder to flow evenly onto the lead and foil. The solder will then make a good electrical connection between the lead and the foil.

Board Assembly

Refer to the silk screen on the printed circuit board or the Board Layout in Appendix C for parts locations on the board.

In the first group of steps, you will be installing the twenty 1/8 watts resistors. Each step will have the color code needed for the resistor being installed for that step. The following resistor color code table is provided as an extra reference for your information.



Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

( ) R1: 470 ohm, 1/8-watt, 5% (yellow-violet-brown)

( ) R2: 1K ohm, 1/8-watt, 5% (brown-black-red)

( ) R3: 5.6K ohm, 1/8-watt, 5% (green-blue-red)

( ) R4: 10K ohm, 1/8-watt, 5% (brown-black-orange)

( ) Solder the leads to the foil and cut off the excess lead lengths

( ) R5: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R6: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R7: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R8: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R9: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R10: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R11: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R12: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) Solder the leads to the foil and cut off the excess lead lengths

( ) R13: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R14: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R15: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R16: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R17: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R18: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R19: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) R20: 47 ohm, 1/8-watt, 5% (yellow-violet-black)

( ) Solder the leads to the foil and cut off the excess lead lengths

NOTE: *In the next step a diode will be installed. The diode is polarized and needs to be installed with the banded end matching the outline on the PC board or the board layout. The lead on the banded in should be inserted into the square hole on the PC board.*

( ) D1: Black diode labeled 1N4001

( ) Solder the leads to the foil and cut off the excess lead lengths.

Note: *Capacitors C1 and C2 will be installed in a later step.*

Install the fourteen capacitors at the following locations.

( ) C3: 0.1uF ceramic (sometimes labeled 104)

( ) C4: 0.1uF ceramic (sometimes labeled 104)

( ) C5: 0.1uF ceramic (sometimes labeled 104)

( ) C6: 0.1uF ceramic (sometimes labeled 104)

( ) C7: 0.1uF ceramic (sometimes labeled 104)

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) C8: 100pF ceramic (sometimes labeled 101)

( ) C9: 100pF ceramic (sometimes labeled 101)

( ) C10: 100pF ceramic (sometimes labeled 101)

( ) C11: 100pF ceramic (sometimes labeled 101)

( ) C12: 100pF ceramic (sometimes labeled 101)

( ) C13: 100pF ceramic (sometimes labeled 101)

( ) C14: 100pF ceramic (sometimes labeled 101)

( ) C15: 100pF ceramic (sometimes labeled 101)

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) C16: 100pF ceramic (sometimes labeled 101)

( ) C17: 100pF ceramic (sometimes labeled 101)

( ) C18: 100pF ceramic (sometimes labeled 101)

( ) C19: 100pF ceramic (sometimes labeled 101)

( ) C20: 100pF ceramic (sometimes labeled 101)

( ) C21: 100pF ceramic (sometimes labeled 101)

( ) C22: 100pF ceramic (sometimes labeled 101)

( ) C23: 100pF ceramic (sometimes labeled 101)

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: *14-pin and 20-pin IC (integrated circuit) sockets are used in this kit. Make sure all pins are straight. Carefully insert the socket pins in to the circuit board holes. Make sure that the index notch on the IC socket is on the same end as pin one (a square pad indicates pin 1) of that IC's location. All sockets are placed on the compunet side and solder on the solder side of the board. Start by soldering only a single pin to the board. Verify that the socket is aligned and tight against the component side of the board. If not, carefully reheat the pin and reposition the IC socket as needed. Once the IC socket is correctly placed, solder the remaining pins.*

( ) U1: Install a 20-pin IC socket.

( ) U2: Install a 20-pin IC socket.

( ) U3: Install a 20-pin IC socket.

( ) U4: Install a 14-pin IC socket.

( ) U5: Install a 14-pin IC socket.

Note: *U6 will be installed in a later step.*

NOTE: *The part is a serial-inline-package or SIP resistors. This part must be oriented correctly for the ATA/IDE board to work. On the SIP resistor there will be a small dot or line indicating pin one on the SIP. The SIP must be oriented so the indicated pin one is placed into the hole with the square pad outlined by a square box in the silkscreen around this pad. Like the sockets above, start by soldering only a single pin to the board. Verify that the SIP is aligned and tight against the component side of the board. If not, carefully reheat the pin and reposition the SIP as needed. Once the SIP is correctly placed, solder the remaining pins.*

( ) RN1: Install a 9-Pin, 4.7K x 8, SIP resistor.

NOTE: *The next two capacitors are polarized and have positive and negative leads. Make sure that the positive lead is inserted into the hold marked + (the square hole) on the board.*

( ) C1: 220uF polarized aluminum electrolytic capacitor.

( ) C2: 1uF polarized tantalum capacitor.

NOTE: *Installing the LED, position the flat side as shown to match the outline on the board. Note that the short LED lead is in the square hole on the board. Hold the LEDs tight to the board and solder the leads to the foil and cut off the excess lead lengths.*

( ) D2: Red LED at location labeled POWER.

Note: *When installing the next 40-pin header, make sure to install the 40-pin header so that pin 1 is in the hole with the square pad on the board. Solder only one pin then verify that the header is align and tight to the board and pin 1 is in the correct hole. Then solder the remaining pins.*

( ) H2: Install a 40-pin header

( ) J1: 2-pin header. Match the silk screen or board layout and solder.

( ) J2: 2-pin header. Match the silk screen or board layout and solder.

( ) JP1: 3-pin jumper header. Match the silk screen or board layout and solder.

NOTE: Location H1 will be using a 40-pin connector with extended lead lengths. This connector will be installed on the bottom side of the ATA/IDE board and solder on the component side. This extended lead connector creates enough gap between the ATA/IDE board and expansion boards to give needed clearance for the components on the Expansion board bellow.

The best method of establishing the correct gapping between boards will require both the Expansion and ATA/IDE boards:

1. First plug the 40-pin connector with extended leads into the Expansion board's 40-pin header at J3.
2. The four hex standoffs that physically setup the spacing between boards stack are installed.
3. Place the expansion board carefully on top on the Expansion board so that the 40 long pins on the connector pass through the correct holes at the matching location on connector H1 of the ATA/IDE Interface board.
4. Use four screws to attach the expansion board to the four hex standoffs. Make sure the connector is fully engaged in to J3 on the Expansion board and the pins extend up to the ATA/IDE Interface board.
5. Recheck the physical board placement and 40-pin placement then carefully sold the socket's pins into place from the **component side** of the ATA/IDE Interface board.

( ) H1: Using the above procedure, install the 40-pin socket.

( ) U6: Locate the following four parts used to assemble the 7805 voltage regulator to the board:

- Phillips machine screw, M3 x 8mm
- Hex Nut, M3
- TO-220 heatsink
- IC, 7805 5 volt regulator in a TO-220 case

( ) The three leads on the 7805 need to be pre-bent before installation. Notice that the leads on the 7805 are wider where they exit the black body of the 7805 and then narrow down. Where the transition from wide to narrow occurs, bend the three leads down towards the metal heat sink side of the 7805 to an angle of 90 degrees. Temporarily set the 7805 aside until required.

( ) From solder side of the board, insert the M3 x 8mm machine screw through the mounting hole at U6. On the component side of the board, Place the TO-220 heatsink's mounting hole over the protruding M3 machine screw. Make sure to align the heatsink so that it fits best on the large foil area for U6.

( ) Install the 7805 at U6 so that the three pre-formed leads pass through the correct holes and the mounting hole on the metal heatsink tab passes through the protruding M3 machine screw. Do not solder.

( ) Secure the heatsink and 7805 regulator to the board using the M3 machine screw with the M3 hex nut. Torque the nut on to the screw just enough to secure the parts. Do not over tighten.

( ) Verify the correct placement and alignment of the 7805 assembly and, solder the leads to the foil and cut off the excess lead lengths.

Testing

Before we install the integrated circuits; we will perform a few basic powerup tests.

( ) Carefully check for any solder bridges between pins and foil pads. If a solder bridge has occurred, hold the circuit board solder side down and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.

( ) Verify that all parts are in their correct locations.

( ) Set an ohm meter to read the lowest resistance setting and measure across the two pins on J1. If the resistance reading in less than 20 ohms then some form of electrical short may exists. Carefully inspect the board assembly for solder bridges or parts installed backwards or at incorrect locations. Correct and issues found and re perform this test.

( ) Reverse the meter leads on J1 and reread the resistance. Like before, if the reading is less than 20 ohms then some form of electrical short exists. Carefully inspect the board assembly for solder bridges or parts installed backwards or at incorrect locations. Correct and issues found and re perform this test.

( ) In this step we will be using a bench or other 8 to 16-volt DC power supply able to supply ½ amp of current. Make sure the power supply is off. Connect the positive lead from the power supply to pin 1 on J1 (the pin with the square pad) and the negative lead to pin 2.

( ) Set a voltmeter to read a positive 5-volts reading on the DC range. Connect the positive lead of the voltmeter to pin 20 on U2 and the negative lead to pin 10.

( ) Turn on the power supply and note the reading on the voltmeter. You should be reading a positive DC voltage between 4.9 and 5.1 volts. The red POWER LED should be on. Turn off the power supply.

This completes the simple testing. Disconnect the power supply and continue.

Final assembly

NOTE: *In the following steps, install ICs (integrated circuits) in the designated sockets. Be careful to match the pin 1 end of each integrated circuits to the index mark on the socket. Before you apply downward pressure to an integrated circuit, make sure each integrated circuits pin is centered in its proper socket hole. Handle integrated circuits with care, as their pins bend very easily.*

CAUTION: *The integrated circuits that you will install are CMOS or MOS devices that can be damaged by static electricity. Use the following sequence when you install the integrated circuits.*

1. *Pick up the conductive foam block with the desired integrated circuits mounted on it.*
2. *Hold the IC in one hand and pull the conductive foam pad from the pins.*
3. *Pick up the circuit board while you hold the integrated circuits.*
4. *Carefully insert the IC in its socket before you set the circuit board down in to your work surface.*

The IC is now protected by circuit board's sockets and foil.

NOTE: *DIP = Dual Inline Package.*

CAUTION: *There are two different versions of octal line drivers used on the board. Be careful to use the 74HC**T**244 for U1 and the 74HC244 for the other two U2 and U3 locations. Placing the 74HCT244 or*

74HC244 in to the wrong location will not damage the board but will result in inconstant performance when accessing the SD storage.

( ) U1: 74HCT244 - , 20-pin DIP

( ) U2: 74HC244 - , 20-pin DIP

( ) U3: 74HC244 - , 20-pin DIP

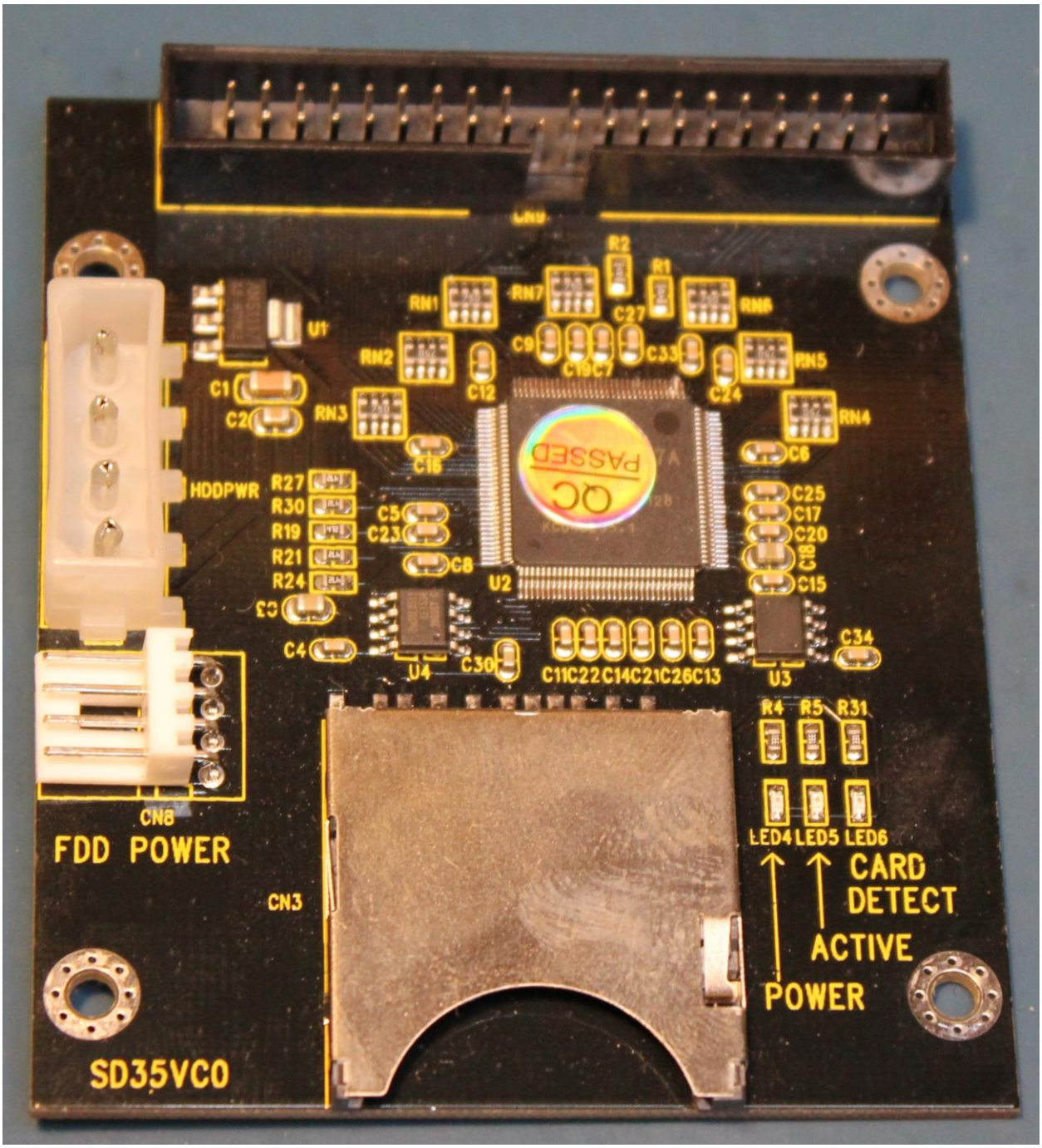
( ) U4: 74HC00 - , 14-pin DIP

( ) U5: 74HC04 - , 14-pin DIP

This completes the assembly of the ATA/IDE Interface board. Now is the time to take a last look over the finished assembly once more looking for any issues like bent pins under ICs, unsoldered connections, cold solder joints and parts in wrong locations.

2- Selecting the SD to IDE board. The ATA/IDE interface board is used to bridge the gap of using a modern 3.3-volt SD interface board to the 5-volt logic levels used in the Retro Elf environment. All the testing performed to date with the ATA/IDE Interface board was done using an inexpensive Chines made SD to IDE daughter board easily found on EBay or Amazon. These boards have a price point around $10.

The version of daughter board I selected is shown below and is labeled with part number SD35VCO. The manufactures name is unclear since each vendor has it listed differently if at all. But the part number seems to be consistent.



This board comes ready to be installed in a formfactor compliant to standard PC mount systems. You can use this board as delivered using a 40-pin interconnection ribbon cable.

In the Retro Elf Project, the 40-pin header was removed and replaced with the same 40-pin stacking header used between the CPU and Expansion boards. While not needed, the 4-pin Molex connector labeled PDDPWR was also removed since it was not needed.

The ATA/IDE Interface board has four mounting holes in place to receive the above board with the 40-pin connector is alignment with the 40-pin connecter on the SD to IDE board allowing to a neat stacking of the boards.

3– Theory of operation

Details on the revision A of the ATA/IDE Interface board such as part locations, parts list and schematics, are located in appendix A and C.

The Retro Elf ATA/IDE Interface board performs three operations:

1. Provide a stable +5-volt DC power source.
2. Provide a digital level conversion interface between the Retro Elf's 5-volt logic and the SD-to-IDE board's 3.3-volt logic output.
3. Reduce the high frequency logic switching noise floor found on the Retro Elf to a point that the 3.3-volt input logic on the SD-to-IDE board is not influenced by false digital triggering.

Five-volt power regulation is provided by is simple analog voltage regulator circuit made up of D1, C1, U6 and C2. Power is presented via connector J1. The positive side is passed through the 1N4001 diode (D1). The 1N4001 helps prevent accidental reversals on the power supply input voltage. In normal operation the 1N4001 is forward biased allowing current to flow through. If the voltage becomes reversed, the diode will be reverse biased blocking current flowing in to the regulator circuits. The 330uF electrolytic capacitor in location C1 provided some DC input voltage ripple stabilization. The 7805 regulator (U6) is used to regulate any input voltage between 8 and 12 volts DC down to a regulated 5 volts DC at up to one half an amp. The 7805 should be mounted to an appropriate heat sink when input voltage are at 12 volts DC and the optional front panel is installed. The 3.3uF capacitor (C2) is used to stabilize the final regulated output voltage of the 7805. Five 0.1uF capacitors (C3, C4, C5, C6, and C7) are used to help decuple IC generated power line noise on the 5-volt supply.

A power monitor LED is provided and is made up of LED D2 and the 470-ohm current limiting resistor R1.

H1 is used to connect the Retro Elf to the ATA/IDE Interface board.

All control signal inputs to the SD-to-IDE board are passed through simple 47-ohm resistors (R13 through R20) and 100pF capacitors (C16 through C23) to form a low pass filter. These filter outputs are then passed to one of the inputs of the 74HC244 (U3). The combination of the RC low-pass filter and the 74HC244's characteristics that the normal switching noise floor present in the 5-volt Retro Elf is reduced to allow for proper operational signaling to the SD-to-IDE board.

Likewise, the eight-bit data bus between the Retro Elf and the SD-to-IDE board has a similar 47-ohm resistor (R5 through R12) and 100pF capacitor (C8 through C15) input section feeding a second 74HC244 (U2) before being passed to the SD-to-IDE board. Data passing from the SD-to-IDE board back to the Retro Elf is passed through a 74HCT244 (U1). It is here that the 3.3-volt logic of the SD-to-IDE board is converted to support the 5-volt logic used by the Retro Elf.

Both the 74HC00 (U4) and the 74HC04 (U5) make up the data bus direction select signals that will control the output select for the 74HCT255 (U1) and the input select for the 74HC244 (U2). U4A is used as a NOR gate for the two chip selects -CS0 and -CS1. While both –CS0 and –CS1 are not selected (both high) the output of U4A is held low deselecting the next two NAND gates U4B and U4D.

If ether of the two chip selects are selected (become low), the output of U4A will go high selecting both the inputs on U4B and U4D. The direction of data is then finally selected based on the state of the two data I/O select signals.

–DIOW is used for writing data from the Retro Elf to the SD-to-IDE board and inverted by U5A before passing into U4D who's output is in turn connected to the chip select for the 74HC244 (U2) input buffer IC.

The –DIOR is used for reading data out of the SD-to-IDE board back to the Retro Elf and is also inverted by U5B before being passed into U4B who's output is connected to the chip select for the 74HCT244 (U1) output buffer IC.

There are several desecrate components used to control logic level inputs for unused signals found on the ATA/IDE devices, like the SD-to-IDE board, that are being connected to H2. Since many of the CF and SD-to-IDE boards are designed to support a 16-bit data bus design, a 4.7K x 8 single-inline-package resistor (RR1) is used to pull low the eight unused data bits (DD8 through DD15). Three more resistors a 1K (R2), 5.6K (R3) and 10K (R4) are used to pull high the IORDY signal, pull low the DMARQ signal and pull low the CSEL signal.

The final section of the board allows the configuration of the drive interrupt line to ether trigger high or trigger low configuration. A three-pin jumper select is used with one pin being connected directly to the INTRQ signal line of the drive. The other side of the three-pin jumper select is connected to inverted U5C which is used to inverted the INTRQ signal. Moving the two-pin shorting jumper allows the selection of normal or inverted signal of the INTRQ line.

4– Technical details

H1 – Retro Elf IDE Connector

Pin	Type	Label	Description
1	Signal	-RESET	IDE device reset signal.
2	Ground	GND	System ground.
3	BiDir	D7	Data bus bit 7.
4	---	Not used	
5	BiDir	D6	Data bus bit 7.
6	---	Not used	
7	BiDir	D5	Data bus bit 7.
8	---	Not used	
9	BiDir	D4	Data bus bit 7.
10	---	Not used	
11	BiDir	D3	Data bus bit 7.
12	---	Not used	
13	BiDir	D2	Data bus bit 7.
14	---	Not used	
15	BiDir	D1	Data bus bit 7.
16	---	Not used	
17	BiDir	D0	Data bus bit 7.
18	---	Not used	
19	Ground	GND	System ground.
20	---	Not used	
21	---	Not used	
22	Ground	GND	System ground.
23	Signal	-IOWR	IDE I/O write request.
24	Ground	GND	System ground.
25	Signal	-IORD	IDE I/O read request.
26	Ground	GND	System ground.
27	---	Not used	
28	---	Not used	
29	---	Not used	
30	Ground	GND	System ground.
31	Signal	INTRQ	Interrupt request.
32	---	Not used	
33	Signal	R1	IDE register select bit 1.
34	---	Not used	
35	Signal	R0	IDE register select bit 0.
36	Signal	R2	IDE register select bit 2.

37	Signal	-CS1FX	IDE system chip select 1.
38	Signal	-CS3FX	IDE system ship select 2.
39	Signal	-DASP	IDE activity signal.
40	Ground	GND	System Ground.

H2 – ATA/IDE Interface Connector

Pin	Type	Label	Description
1	Signal	-RESET	IDE device reset signal.
2	Ground	GND	System ground.
3	BiDir	DD7	Drive Data bus bit 7.
4	BiDir	DD8	Drive Data bus bit 8. (Pulled low but not used by Retro Elf)
5	BiDir	DD6	Drive Data bus bit 6.
6	BiDir	DD9	Drive Data bus bit 9. (Pulled low but not used by Retro Elf)
7	BiDir	DD5	Drive Data bus bit 5.
8	BiDir	DD10	Drive Data bus bit 10. (Pulled low but not used by Retro Elf)
9	BiDir	DD4	Drive Data bus bit 4.
10	BiDir	DD11	Drive Data bus bit 11. (Pulled low but not used by Retro Elf)
11	BiDir	DD3	Drive Data bus bit 3.
12	BiDir	DD12	Drive Data bus bit 12. (Pulled low but not used by Retro Elf)
13	BiDir	DD2	Drive Data bus bit 2.
14	BiDir	DD13	Drive Data bus bit 13. (Pulled low but not used by Retro Elf)
15	BiDir	DD1	Drive Data bus bit 1.
16	BiDir	DD14	Drive Data bus bit 14. (Pulled low but not used by Retro Elf)
17	BiDir	DD0	Drive Data bus bit 0.
18	BiDir	DD15	Drive Data bus bit 15. (Pulled low but not used by Retro Elf)
19	Ground	GND	System ground.
20	Key	Open	Alignment key pin.
21	Signal	DMARQ	DMA request. (Pulled high but not used by Retro Elf)
22	Ground	GND	System ground.
23	Signal	-DIOW	Drive I/O write request.
24	Ground	GND	System ground.
25	Signal	-DIOR	Drive I/O read request.
26	Ground	GND	System ground.
27	Signal	IORDY	Drive I/O ready. (Pulled high but not used by Retro Elf)
28	Signal	CSEL	Drive C select. (Pulled low but not used by Retro Elf)
29	---	Not used	
30	Ground	GND	System ground.
31	Signal	INTRQ	Interrupt request.

32	Signal	-IOCS16	Drive 16-bit I/O ready. (Not used by Retro Elf)
33	Signal	DA1	Drive address register select bit 1.
34	Signal	-PDIAG	Drive diagnostics mode. (Not used by Retro Elf)
35	Signal	DA0	Drive address register select bit 0.
36	Signal	DA2	Drive address register select bit 2.
37	Signal	-CS0	Drive select 0.
38	Signal	-CS1	Drive select 1.
39	Signal	-DASP	IDE activity signal.
40	Ground	GND	System Ground.

J1 – ATA/IDE interface board power

Pin	Type	Label	Description
1	Power	+V	Main expansion board power supply +8 to 16VDC at 1A maxum.
2	Ground	Ground	Power ground.

J2 – ATA/IDE interface board power

Pin	Type	Label	Description
1	Power	+5VDC	Regulated plus 5 volts DC at 400mA max.
2	Ground	Ground	Power ground.

Appendix A - ATA/IDE Inteface board schematic

--Find the schematic in the attached PDF--

Appendix B – ATA/IDE Interface board parts list

Location	Qty	Description	Vendor	Vendor PN	MFG	MFG PN
C3, C4, C5, C6, C7	5	Capacitor CER 0.1uF 50V 20% Radial	Digi-Key	399-4151-ND	Kemet	C315C104M5U5TA
C8, C9, C10, C11 C12, C13, C14, C15 C16, C17, C18, C19 C20, C21, C22, C23	16	Capacitor ceramic 100pF 100V 5% C0G Radial	Digi-Key	399-13988-ND	Kemet	C315C101J5G5TA
C1	1	Capacitor alum 220uF 20% 16V axial	Digi-Key	TVX1C221MAD-ND	Nichicon	TVX1C221MAD
C2	1	Capacitor 1uF Tantalum	Digi-Key	399-3533-ND	Kemet	T350A155K025AT
D1	1	Diode 1N4001 General Purpose 50V 1A DO41	Digi-Key	1N4001GOS-ND	ON Semiconductor	1N4001G
D2	1	1 ¾ Red LED	Digi-Key	754-1266-ND	Kingbright	WP7113LID
H1	1	Stacking Header 40-pin 2x20, 0.1 pitch	Digi-Key	1528-1385-ND	Adafru	2223
H2	1	Header 40-pin 2 x 20, 0.1 pitch	Digi-Key	WM8134-ND	Molex Inc	901310140
J1, J2	2	Connector header 2 position 0.1 pitch vertical tin	Digi-Key	WM4200-ND	Molex Inc	22232021
JP1	1	JUMPER SKT BLACK	Digi-Key	952-2165-ND	Harwin Inc	M7567-46
JP1	1	3-Pin	Digi-Key	3M9448-ND	3M	961103-6404-AR
R1	1	Resistor 470-ohm 1/8-watt 5% CF axial	Digi-Key	CF18JT470RCT-ND	Stackpole	CF18JT470R
R2	1	Resistor 1K-ohm 1/8-watt 5% CF axial	Digi-Key	CF18JT1K00CT-ND	Stackpole	CF18JT1K00
R3	1	Resistor 5.6K-ohm 1/8-watt 5% CF axial	Digi-Key	CF18JT5K60CT-ND	Stackpole	CF18JT5K60
R4	1	Resistor 10K-ohm 1/8-watt 5% CF axial	Digi-Key	CF18JT10K0CT-ND	Stackpole	CF18JT10K0
R5, R6, R7, R8 R9, R10, R11, R12 R13, R14, R15, R16 R17, R18, R19, R20	16	Resistor 47-ohm 1/8-watt 5% CF axial	Digi-Key	CF18JT47R0CT-ND	Stackpole	CF18JT47R0
RN1	1	Resistor Network 4.7K x 8 SIP-9	Digi-Key	4609X-101-223LF-ND	Bourns Inc	4609X-101-223LF
U1, U2, U3	3	Socket IC 20 Pin	Digi-Key	AE10015-ND	Assmann WSW	AR-20-HZL-TT
U4, U5	2	Socket IC 14 Pin	Digi-Key	AE10012-ND	Assmann WSW	AR-14HZL-TT
U6	1	LM7805 - +5 Volt Regulator	Digi-Key	MC7805CT-BPMS-ND	Micro Commercial Co	MC7805CT-BP
U1	1	74HCT244 – IC	Digi-Key		Texas Instruments	SN74HCT244N
U2, U3	2	74HC244 – IC	Digi-Key		Texas Instruments	SN74HC244N
U4	1	74HC00 - IC	Digi-Key		Texas Instruments	SN74HC00N
U5	1	74HC04 - IC HEX INVERTER 14-DIP	Digi-Key	296-1566-5-ND	Texas Instruments	SN74HC04N
U6	1	Heatsink TO-220	Digi-Key	HS107-ND	Aavid Thermolloy	577202B00000G
U6	1	Machine Screw Pan Philips M3x7	Digi-Key	335-1149-ND	APM Hexseal	RM3X8MM 2701
U6	1	Hex Nut M3	Digi-Key	H762-ND	B&F Fastener Supply	MHNZ 003

Appendix C – Printed circuit board parts locations