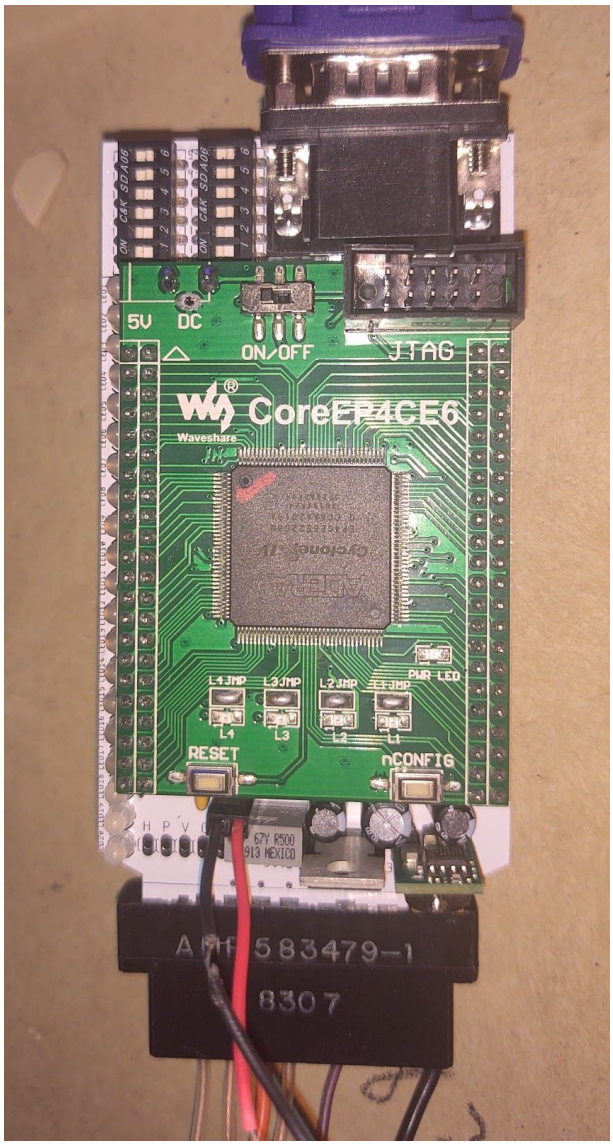
M4ToVGA v1.1



Thank you for purchasing an M4ToVGA board for your TRS-80 Model 3 or 4 computer!

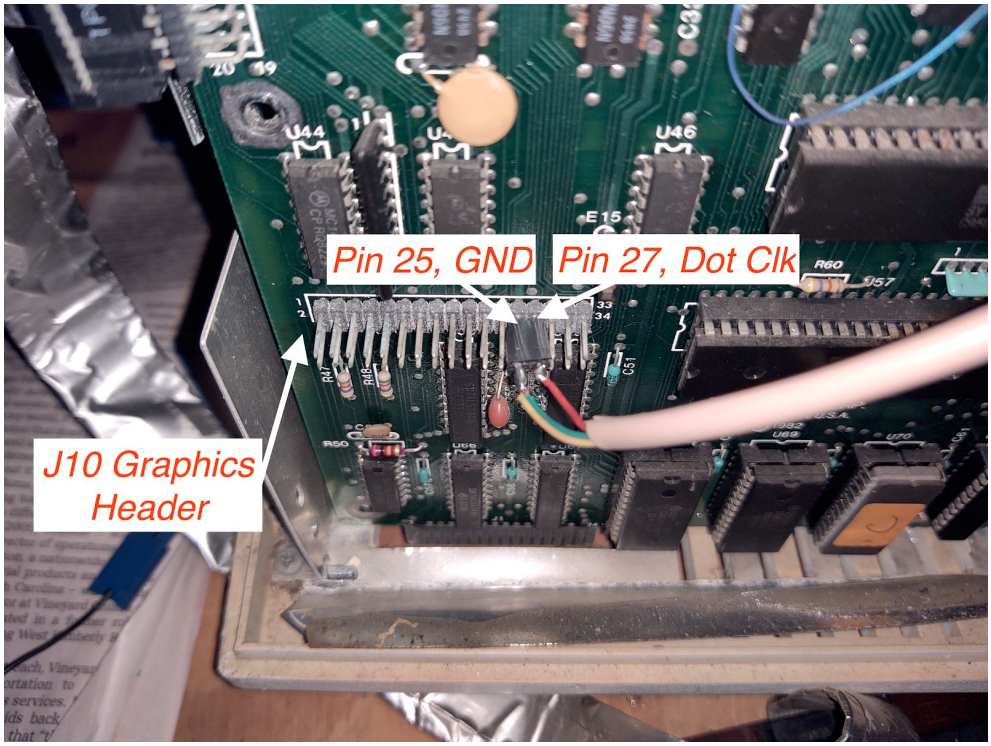
This board allows you to connect your retro TRS-80 to a VGA monitor. Replacement CRTs are becoming scarce for the TRS-80 (and are now considered hazardous wastes in many communities due to their phosphorus content), and so I designed a simple solution that attempts to be as unobtrusive as possible.

The solution is built around an Altera Cyclone IV chip, which is a field programmable gate array (FPGA) device. The solution is delivered as a daughter board that attaches to a CoreEP4CE6 board, which is a minimalist FPGA host board containing little more than a clock, power regulators, and a flash device for boot up. The CoreEP4CE6 can be reprogrammed via the JTAG interface if necessary.

Installation

The M4ToVGA plugs in where the CRT monitor board would normally connect on an M3/M4 into an AMP connector. The connector is “keyed” so that it cannot be installed upside down. The board does however need an additional signal to operate properly. You will notice two pins on the bottom of the PCB labelled “DOT CLK”. One of these pins is a ground pin (the left pin when observing from the top), and the other is a dot clock signal that comes from your Model 3 or Model 4.

On the model 4, both the ground and the dot clock pin are accessible on the J10 graphics header on the TRS-80 motherboard as shown below. They are located on the top row of the header and are pins 25 and pins 27 (notice that they are right next to one another as the header is numbered with all the odd pins on top and all the even pins on bottom).



On the Model 3, the dot clock can be acquired at pin 4 of U4 or at pin 7 of U52 (see the Model 3 Service Manual), which is described as a “shift” signal. You will need to decide how to best attach the dot clock wire to one of these locations. There are different sources for this clock on the M3, and it seems that some of them work better than others, so be advised. Also, be aware, a 10mhz clock signal won’t go very far without some shielding, so you should use an appropriately shielded wire. I have been successful using CAT-5 twisted pair wire with all the conductors except one connected to ground. In most cases however, just a plain twisted pair seems to work. One has been provided for you in the kit. RG-174 coax is probably the best if you have a way to acquire it and properly crimp it.

Once you have the wires attached, before powering up it is a good idea to double check that you have everything connected properly. Before powering up, use a multimeter in continuity mode to make sure that the PCB is grounded properly.

When you power on, you should notice an LED flashing on the CORE EP4CE6 board. This indicates that the board is receiving a clock signal. If you do not see a flashing LED, immediately power off the system, and determine why you are not getting a dot clock signal to the board.

You may also notice some flashing LEDs along the side of the daughter board. These LEDs are indicators of various signals that the FPGA is processing, and in future revisions of the board may be decipherable by changing dip switch settings. The current firmware really only shows what video mode the FPGA has detected (noticeable when switching between 80 column and 64 column modes).

Dip Switch Settings

You will notice two dip switches at the top of the board near the VGA connector. One of them controls background color, and the other controls foreground color. The TRS-80 is a monochrome system, but using these dip switches you can alter the colors on your VGA monitor. There are six switches for foreground and six switches for background. Thus, there are two bits for each color (red, green, blue). If you accidentally set both sets of dip switches to the same values, the FPGA will assume you want white text on a black background and will ignore the dip switch settings.

AMP Connector

The AMP connector on your TRS-80 Model 4 has several connections. When viewing it from the top (as it plugs in) going left to right those connections should be: vsync, video, +12v, hsync, contrast, and ground. The vsync signal is a normally high, toggling low signal. The hsync is a normally low, toggling high signal. The video signal is the pixel signal and it varies depending on what is on the screen, with black being low and white being high.

If you have trouble getting the VGA adapter to work, double check that your AMP connector matches the description above. You have the option of using the optional header if it does not.

Optional Headers

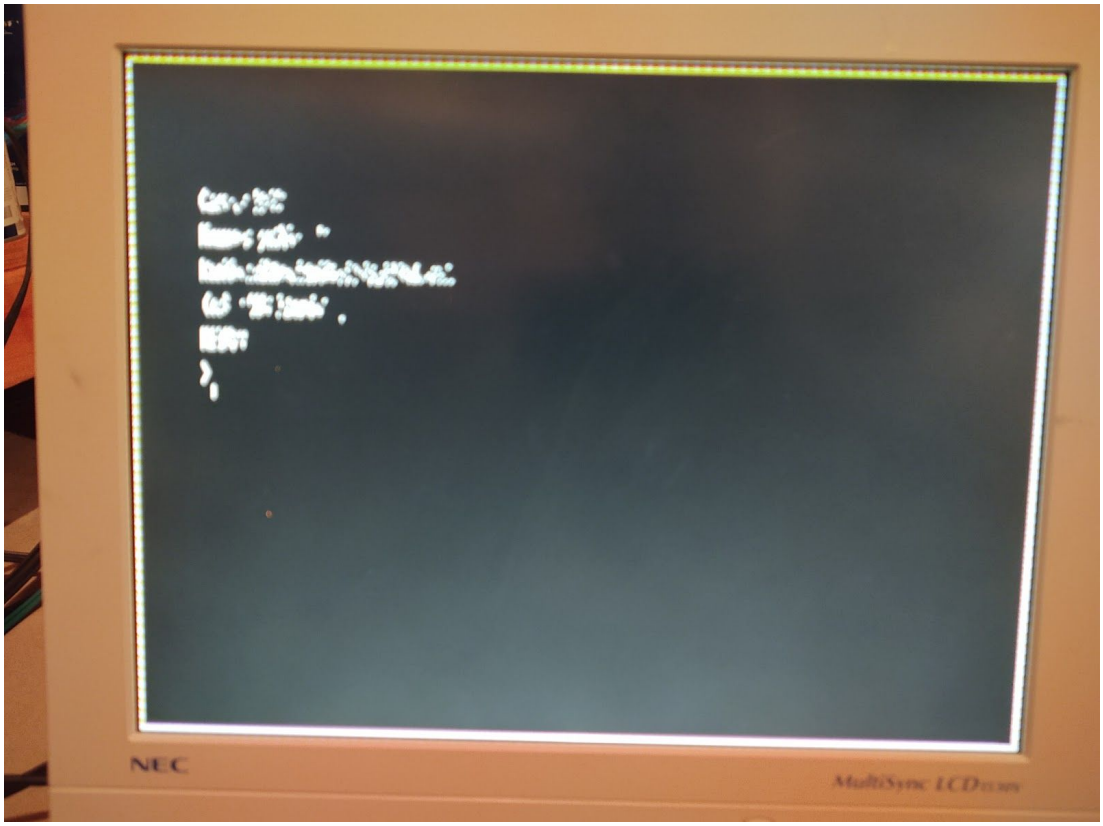
Toward the bottom of the board you will notice a header labelled “H P V G + C”. This header is for systems that do not have an AMP 583479-1 video connector. The pins are: hsync (H), pixel/video (P), vsync (V), ground (G), +12V (+), and contrast (C). Note: contrast is not really used by the board, but the Model 3 / 4 AMP adapter includes it so it is included as well. Also note, +12V doesn’t have to be 12 volts. It just needs to be enough to power the onboard +5V regulator, and thus anything between 7.5V and 15V DC will likely work. The +5V regulator is a switching regulator, so you don’t need to worry too much about efficiency. If you don’t have a +12V source but you do have a +5V source, you could remove the +5V regulator and drive the board with +5v on the regulator’s output pin.

At the top of the board you will notice a header labelled “B G R H V GND”. This is where the VGA signals go before connecting to the VGA port. So, if you would like to attach a VGA cable, but you do not want to connect to the VGA port (perhaps for mounting reasons), you can use this header instead of the VGA port itself.

Potentiometer?

You will notice a small potentiometer toward the bottom of the board. This will have been set for you before shipping. Its purpose is to attenuate the video signal slightly and remove

transmission line ringing. Due to variances in power supplies in TRS-80s, this potentiometer can be used to attenuate the video signal so that it does not overpower the inputs of the buffer chip. You will know this is necessary if your screen looks like this:



You may need to adjust the potentiometer depending on what dot clock wire you use and how long it is.

Brightness

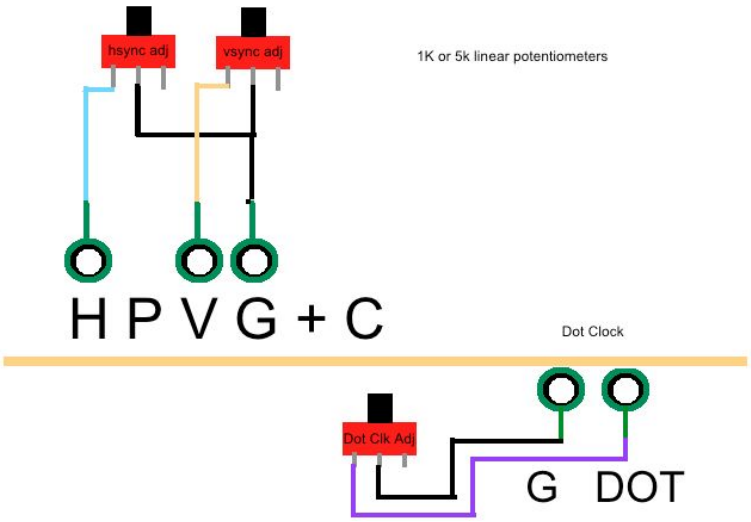
It's easy to confuse yourself if you connect the board and see nothing but a white bar across the top and the bottom. One of the most common causes of this problem is that your brightness knob on the TRS-80 is turned down. It should be set at its brightest setting in order for the video signal to reach the TTL threshold to be recognized by the board.

Transmission Line Effects

The board was provided with only one potentiometer for adjusting the video attenuation. On the Model 4s it has been tested with this has proven to be enough to adjust out noise and transmission line effects. However, it is possible that your mileage may vary, especially if you are wiring the board yourself and using signals from different places on the motherboard. This video can acquaint you with the concept of transmission line effects and impedance if they are foreign to you or if you need a refresher:

https://www.youtube.com/watch?v=AJUGWGsMMfo
“Signal reflections and Transmission lines - Ec-Projects”

If you are seeing symptoms like the screen above, but cannot tune them out with the potentiometer provided, you might try wiring 1k or 5k potentiometers from ground to hsync and vsync signals using the “H P V G + C” optional header (so a pot with the center tap to G, and one of the other taps to H, and a separate pot with the center tap to G and one of the other taps to V). You could also do the same thing with the dot clock signal on the underside of the board (center tap to ground, one of the other taps to the dot clock). If this works, you can just measure the resistance on the pot and then permanently solder a resistor close to the pot’s measured resistance.



Also, symptoms like the above can happen if the video wiring harness to the motherboard is corroded. Make sure it’s making a good solid connection before trying some of the more drastic approaches mentioned above.

Open Source

The M4ToVGA board and the FPGA code that runs it are available as open source code at http://github.com/calphool/M4ToVGA

If you decide to make an improvement to the board or to the code, I would very much appreciate it if you did a couple of things. First, *please give me credit for the original design in anything that you publish*, and *second, please at least give me the opportunity to see your revision up close and decide if I want to include it in the base code (via pull request ideally)*. I may or may not choose to do so, but I feel like I deserve the opportunity to decide. No, I’m probably not going to come after you with a lawyer if you don’t do this, but it’s bad form, and bad karma. :-)

Since the project is open source, you can add feature requests to the “issues” area of github. This is a hobby project, so I can’t promise rapid turn around, but I’m very much interested in feedback.

I hope the adapter works well for you!