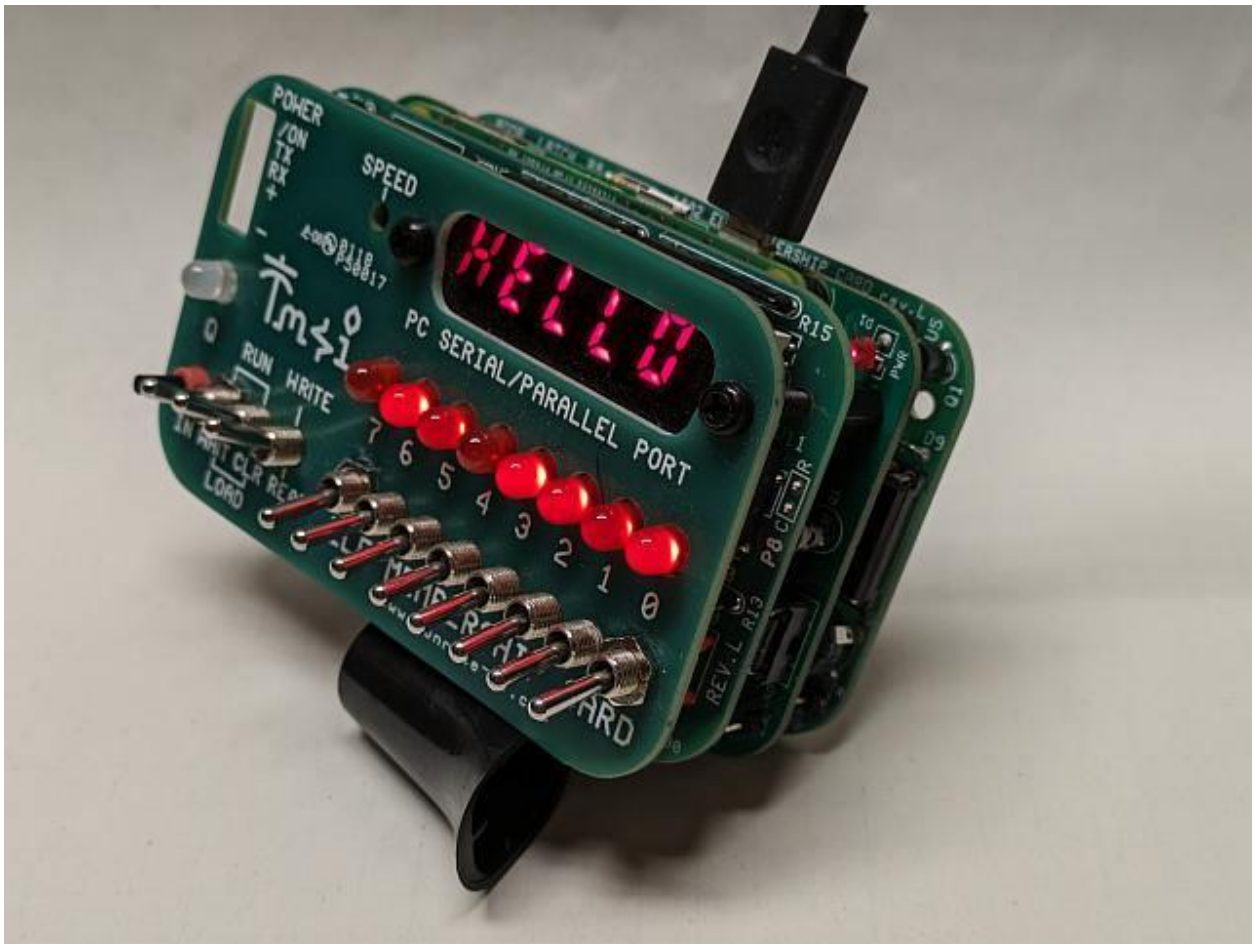
PiLoader Build Instructions

A PiZero Adapter for Lee Hart's Membership Card

BOM and Instruction Rev 3.1

Project Web Page : http://anthonylhill.github.io



Introduction

There is a lot to like about Lee Hart's Membership Card (MC). It comes in a compact attractive form factor supporting a 4 MHz 1802, up to 64K of RAM, serial I/O, and lots of switches and blinkenzee lights. Supplied in kit format, it's a fun build with an amazing amount of documentation, not to mention Lee Hart's personal support to help you get things running if you have trouble.

Having said all that, after a few months of usage you'll find there was a little more needed if you are going to do any serious programming with the MC. Toggling in programs with the front panel switches starts out fun but gets old fast. Programming EEPROMs is a slow process and they cut into the 64K of available RAM. Adding serial program download capability to a monitor program is a viable option but requires either an EPROM or a fairly long manual program load via switches.

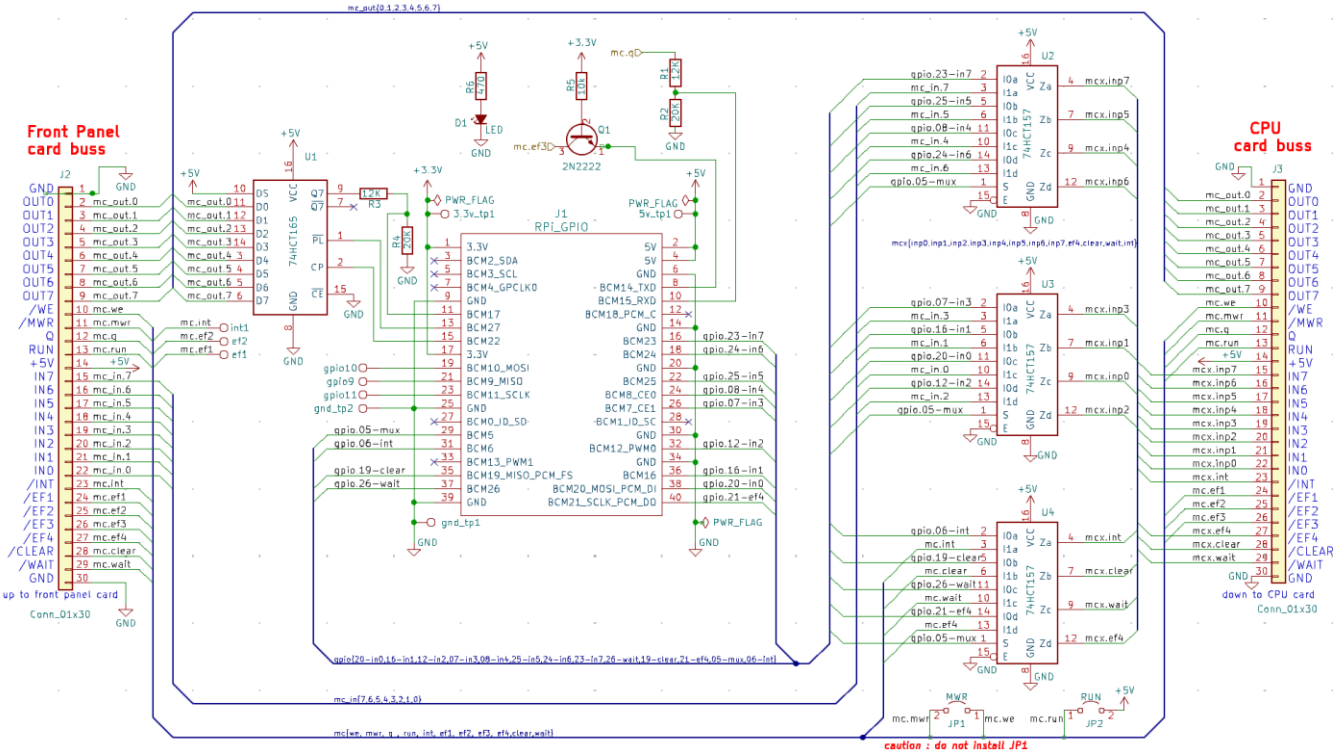
Earlier MC models had a DB25 connector that could be hooked up to an old school printer port (or GPIO on a microcontroller). Functional but it required an ugly ribbon cable with limited distance cluttering up your workspace. But with the release of the newest MC front panel card, the DB25 used for downloading code went away in favour of six 7 segment LEDs.

So this project is a PCB Raspberry PiZero W loader card that's format compatible with the MC and inserts in the middle of the Membership card's two card stack. That maintains the look and feel of the MC while allowing just a thin 5V power cable as the only hookup to the MC. The built-in Pi Zero contains a complete 1802 development environment (editor & A18 & source files) interfaced with a few simple scripts to access the 1802 itself.

And the best part is that it's all 100% accessible via WiFi from any PC or laptop running SSH. Alternatively you can attach a USB keyboard and HDMI (or composite video monitor) for local programming. And maybe even a GUI based environment if that interests you. Of course the GUI option could be used remotely over X or via VNC.

Features

- Create 1802 programs, edit, assemble, and load to MC's 1802 memory entirely over Wifi
- Programs loaded to 1802 memory via DMA and override of the MC front panel switches
- The PiZero can start, halt, or reset 1802 in addition to loading code to memory.
- Intercepts the 1802's interrupt signal from the front panel when PiZero is in control so that front panel interrupts from LED MUX circuit don't disrupt downloads.
- Serial console interface for terminal I/O between PiZero and 1802 via Q & EF3 to PiZero's UART GPIO pins (with PiZero running minicom)
- Able to read parallel output from 1802 to MC Front Panel for debugging or for high speed data exchange between PiZero&1802 in conjunction with switch overrides
- Prototype interconnect area with connections for three uncommitted PiZero GPIO pins and the 1802 ef1, ef2, & interrupt pins (plus 5v , 3.3v, & GND)
- Jumpers to short the RUN connections from front panel
- Power, USB, and HDMI video available via accessible PiZero connectors on rear of stack
- Composite video available with a soldered connection to the PiZero
- Power both MC and PiZero via a single USB wall wart
- Maintains MC's all-in-one compact form factor (requires extension ring to fit into Altoids tin)
- Works with either version of MC front panel. Or without any front panel
- Safely manages 3.3v to 5v to 3.3v level conversions as needed
- Ground connection post for scope or logic probe.
- PiZero utility written in C to load program code to 1802



	Component	Manufacturers Part #	Description	Notes
1	J1	Adafruit part # 2243	Raspberry Pi GPIO female header	https://www.adafruit.com/product/2243
2	U1	74HCT165	8 bit shift register	must be HCT
3	U2, U3, U4	74HCT157	quad 2:1 mux	must be HCT
4	J2	1x30 pin header	0.1” spacing, 11.25mm height	up to front panel card
5	J3	Molex 22-18-2101	30 female connector	down to CPU card
6	Q1	2N2222	Small signal NPN transistor	could use 2N3094 or equivalent
7	R1,R3	12K ohm	Resistor – any wattage and precision	5V to 3.3V level shift
8	R2,R4	20K ohm	Resistor – any wattage and precision	5V to 3.3V level shift
9	R5	10K ohm	Resistor – any wattage and precision	3.3V to 5V level shift
10	R6	470 ohm 1/8 watt	Resistor – any wattage and precision	Optional – power LED current limit adjust value to change brightness
11	D1	T-1 $^{3}/_{4}$	LED Power indicator	Optional (with R6)
12	JP1, JP2	2.54mm 2 pin header	Jumper **caution : do not install JP1	jumper for Front Panel Power Switch and Memory Protect
13	-	2×20 Pin Male Header	GPIO header for Raspberry Pi	see instructions before soldering
14	-	Nylon standoffs	Assorted 10mm M3 male & female	look for a Jucoan 380 piece kit
15	-	Raspberry Pi	PiZero, PiZeroW, PiZeroW2	**without header pins preinstalled – see Note 2 in assembly instructions.**

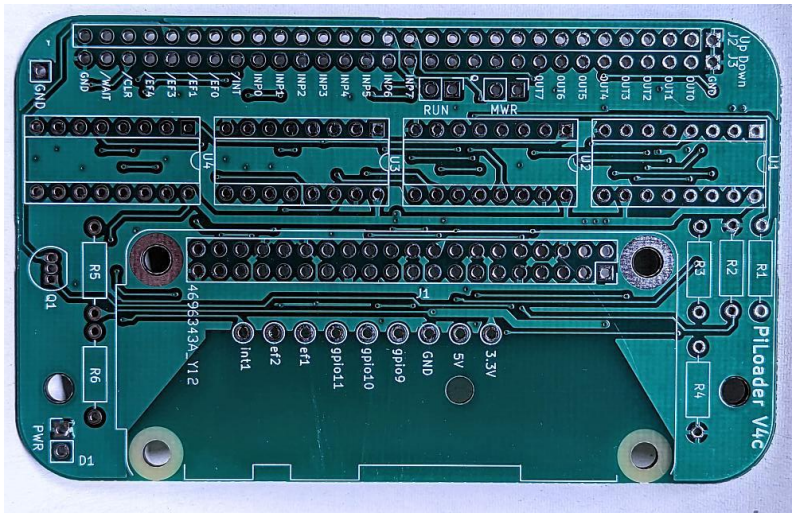
Assembly Instructions

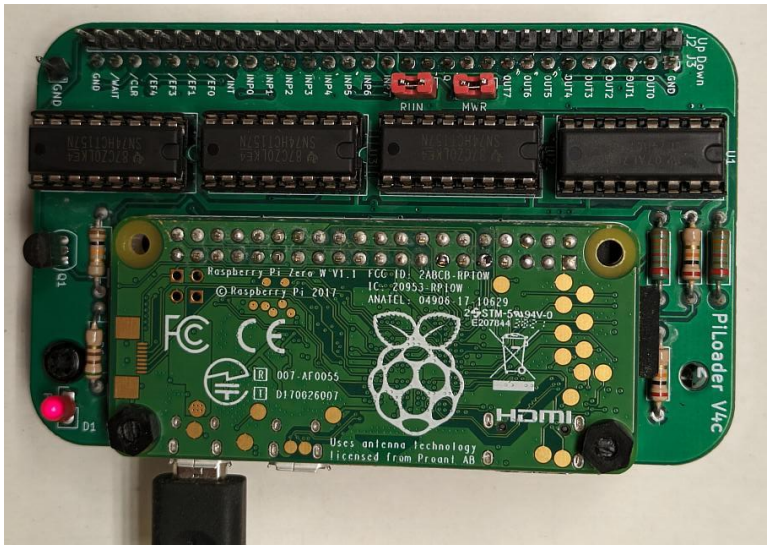
1. Read & follow all construction recommendations in the Membership Card manual (see note 1).
2. The vertical spacing between the three PCB's and the Raspberry PI is very tight. Do trial assemblies to assess fit prior to soldering to make sure the connectors you are using will allow everything to fit and not touch or otherwise short out.
3. Attach a 2x20 pin header to Raspberry PI (see note 2).
4. Solder the 30 pin male header (J2) to the PiLoader PCB (see note 3).
5. Solder the 2 pin headers JP1 and JP2 to PiLoader PCB **Caution : do not install JP1**
6. Solder the three 10 pin female headers to the bottom of the PiLoader PCB (see note 3).
7. Solder four 16 pin DIP sockets for U1 to U4 to PiLoader PCB (see note 4)
8. Solder J1 to PiLoader PCB.
9. Solder R1 to R5 to PiLoader PCB.
10. Solder Q1 to the PiLoader PCB.
11. Optional: solder D1 & R6 to PiLoader PCB if you want a power indicator.
12. Insert U1 to U4 into their sockets (if you did not solder them directly to the PiLoader PCB)
13. Connect the Raspberry Pi Zero to J1 ("upside down")
14. (Optional) **Caution : do not install JP1** ~~Attach a jumper to the MWR pin header (beside U2) if you want to bypass the front panel Read/Write switch and always use Write functionality~~.
15. (Optional) Attach a jumper to the RUN pin header (beside U2) if you want to bypass the front panel /ON power switch function and a let the MC processor card always run whenever power is connected. Note that on front panel revisions L and later you need to also jumper /ON to ground on P4 to enable the data LEDs and 7 segment displays.
16. Assemble the PiLoader PCB in between the MC Front Panel and CPU card. Nylon 10mm M3 standoffs are useful here to secure the three PCB's together.
17. Plug a 5V USB power supply (wall wart) with a microUSB connector into the USB port closest to the PiLoader's power LED (see photo below).

Notes:

1. Follow these assembly instructions in order. It will make clearances for soldering easier.
2. To ensure that the Raspberry Pi fits between the PiLoader card and the Front Panel card, the GPIO 2x20 pin header soldered to the Raspberry Pi should be inserted from the rear so that only 6 mm extends in front. Trim the plastic carrier and excess pin flush with the back of the Raspberry Pi. Note that his technique is described in recent Membership Card instructions (rev K or later) as "**B. The HARD way:"**
3. Follow the recent (rev K or later) Membership Card assembly instructions for installing card interconnection header pins and sockets. Use "***A. The EASY way:"*** instructions for the male pins - do **NOT** install the male pins by following the "**B. The HARD way**:" instructions. Note that it does not matter which instructions you followed when you built your CPU card.
4. If you are brave, solder U1 to U4 directly to card. The height doesn't matter either way. I prefer sockets for testing and troubleshooting and have never had a problem using the cheap ones.

But I’m very careful with how I lead form my IC’s and how I insert them into a socket and then check for bent pins. YMMV.





Software

Raspberry PI Operating System

There are many options for Raspberry Pi operating systems but the recommendation for the PiLoader is Raspberry Pi OS Lite (32-bit). The Lite version does not include a desktop environment (GUI) as it tends to be slow running on a Raspberry Pi Zero.

Raspberry PI Program to Membership Card Interface Programs

There are two simple support programs written in standard C provided. The first is a program for loading assembled code binary files from the Pi to the 1802's memory. The second program is a demonstration of how to read the data displayed on the 1802 Front Panel card LED's from the Pi.

In addition, there are few small utility programs for manipulating the GPIO pins and some 1802 example code.

> Note : for reference there are currently at least seven libraries available to access GPIO pins from a C program running on a Raspberry PI. See https://elinux.org/RPi_GPIO_Code_Samples

Building the Interface Programs

Currently the PIGPIO library is used for accessing the PI GPIOs by the Loader code.
You will probably need to install the package :

- `sudo apt install pigpio`

To compile, use

- `cc –Wall -o 1802load 1802load.c –lpigpio`
- `cc –Wall -o 1802scan 1802scan.c –lpigpio`

To run, use:

- `sudo ./1802load` *`[-h -x -g] <binary file> [load_address] [execute_address]`*
  `- there are various options available – see the README.TXT file`
- `sudo ./1802scan`

Notes :

1. There is a small **README.TXT** file in the software directory that describes what's in that folder and how to use it.
2. Do not cut and paste the above commands from this PDF. The "-" sign in the compile commands gets converted to some other symbol that won't work. Re-type them.