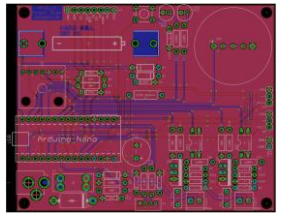
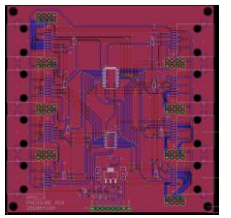
Project Apollo





Why

- Ventilators need oxygen! (typical FiO2 0.3 … 1)
- Oxygen generation is a big problem in developing countries.
  - No established infrastructure.
  - Oxygen bottles are expensive
- People are already looking at alternative (local) ways for producing oxygen

What it is

- Goal of the Apollo prototype = enabling people around the world to build the prototype as fast as possible
- Focus = Simplicity and speed of build
  - Open source, off-the-shelf materials
  - Very low cost (aspirational target = $100 for 5 liters/min @ 90%)
- Final goal = Enable people to iterate and publish their own designs in the community

How to build it

- Follow the published build documentation
- Buy/source the materials (check out the BOM)
- Build the prototype
- Validate O2 concentration and flow. Use a **good** reference O2 and flow sensor for calibration
- Think about risk analysis and assessment: template for Apollo-derived design
- Document and iterate your own design. Publish your findings to the community!

Collaborations

- Helpful Engineering, Oxikit, Public Invention, Quick2space.org, Microsoft Garage

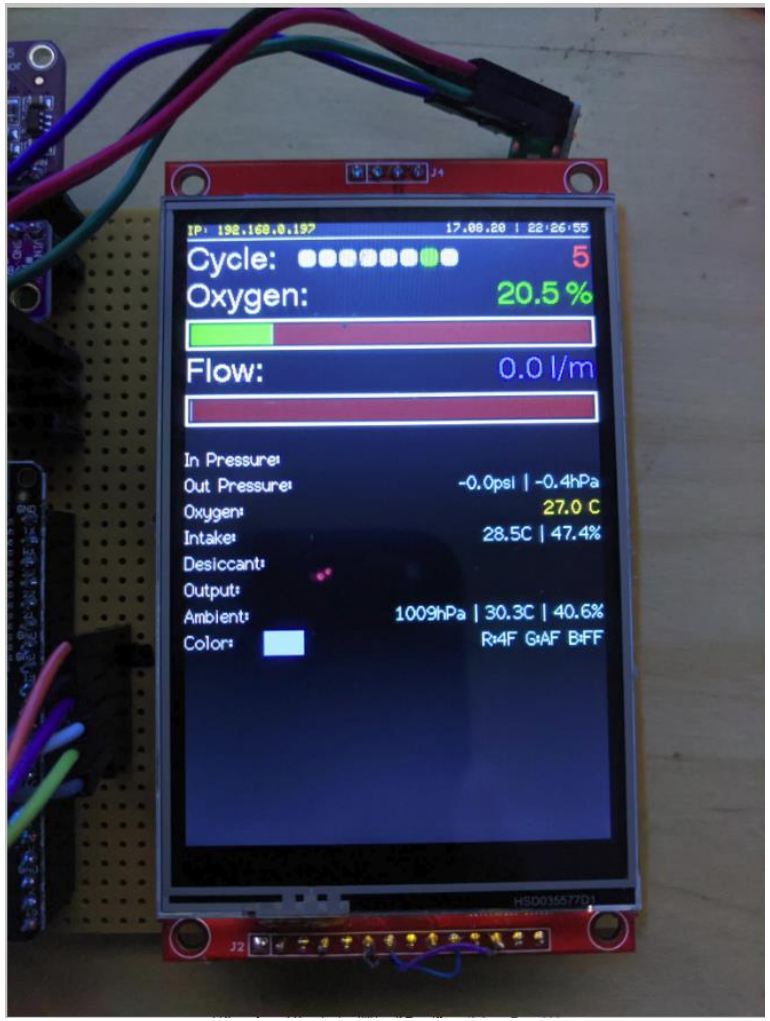
Documentation

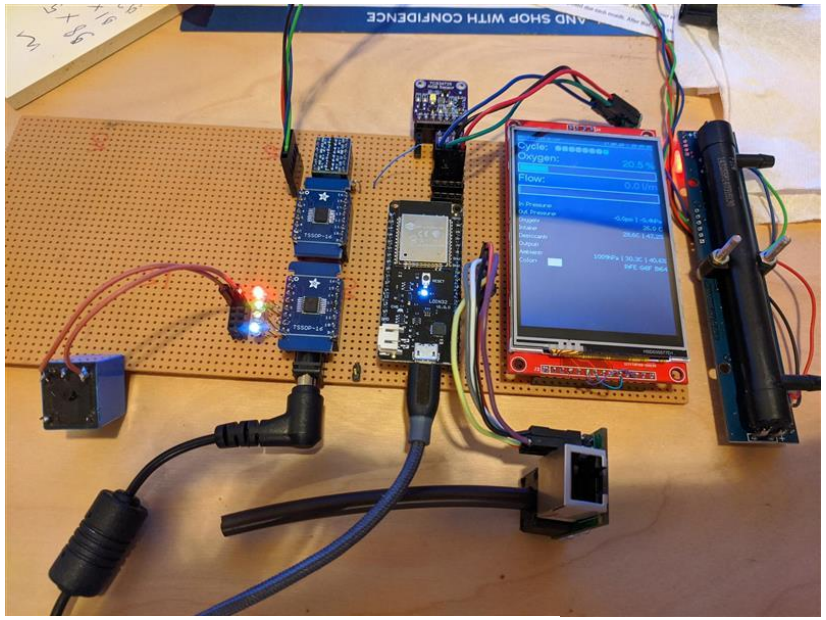
- http://project-apollo.org

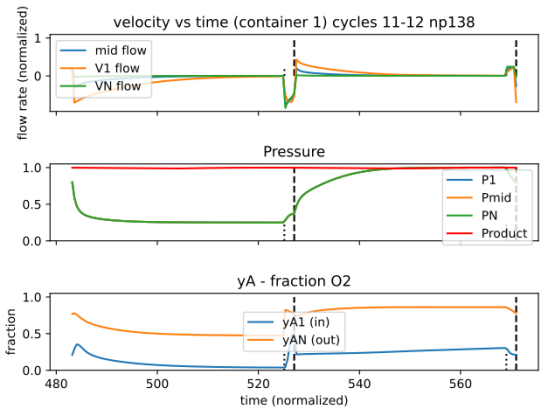
Project Apollo – latest progress

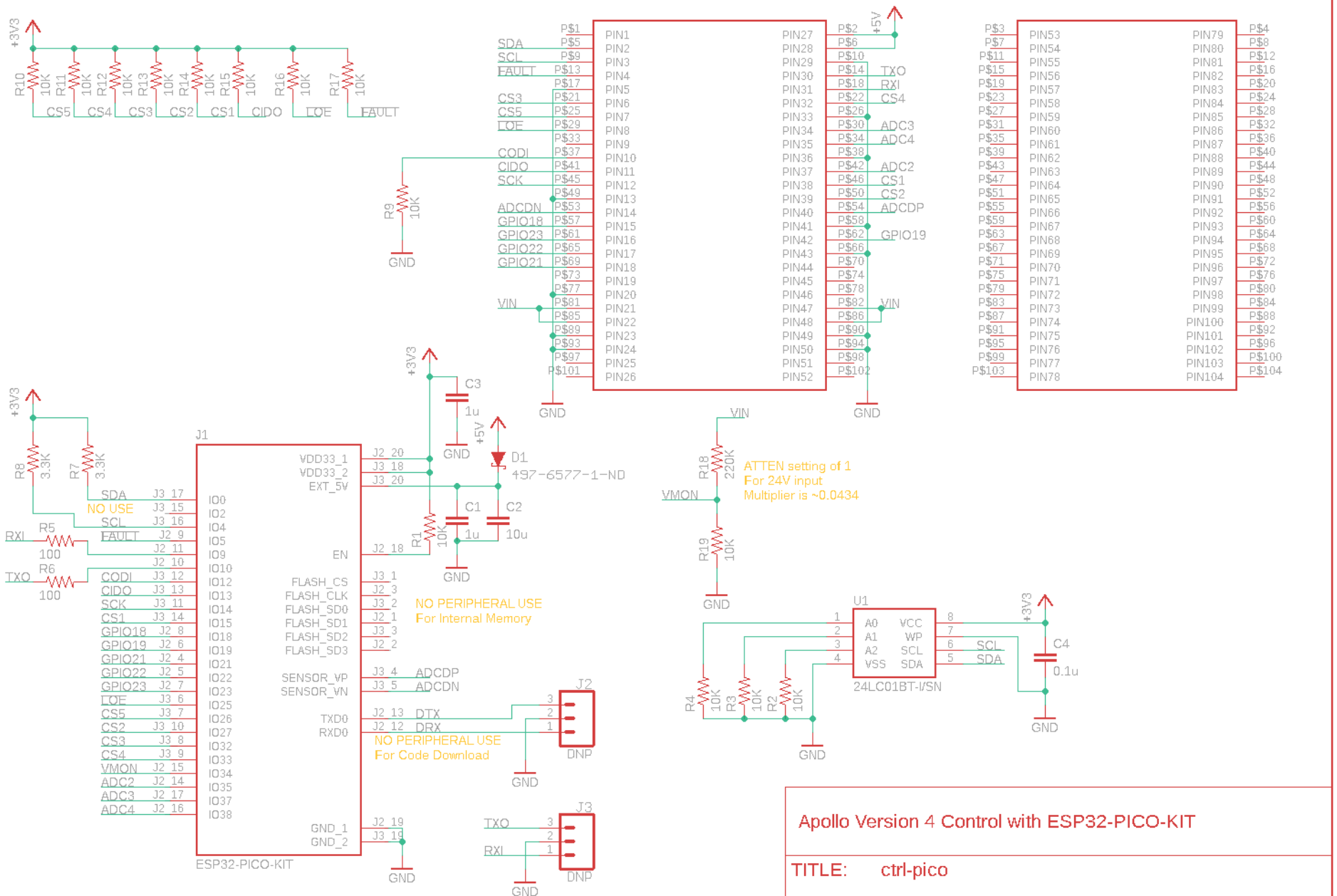
- Next version
  - Focused on safety, user experience and maintainability
  - O2 compatible materials in the oxygen path
  - Dedicated PCB controller board, sensor integration, valve operational sensing
    - 3” TFT touch screen for diagnostic messages, medical-grade buzzer
    - Auto-tuning (valve timing, auto-adjusts to changes in compressed air input pressure)
- Status
  - Mechanical design
    - Focus on FDA approval and manufacturing
    - Please see project “Oxygen Concentrator” from Public Invention (@Ben Coombs)
  - Software prototypes for Apollo v4 – working
    - Simulation software
      - “device in the loop’ optimization strategies – tested and delivering close to theoretical
    - Can control Apollo for O2 generation and basic optimization
    - WiFi and Bluetooth integration TBD
  - Sensor selection
    - Sensors for pressure, humidity, temperature – selected and tested
    - Valve board – schematic done, PCB in progress
    - Controller board – schematic in review, PCB in progress
    - Sensor board – schematic in progress, PCB in progress (similar with Apollo v3)

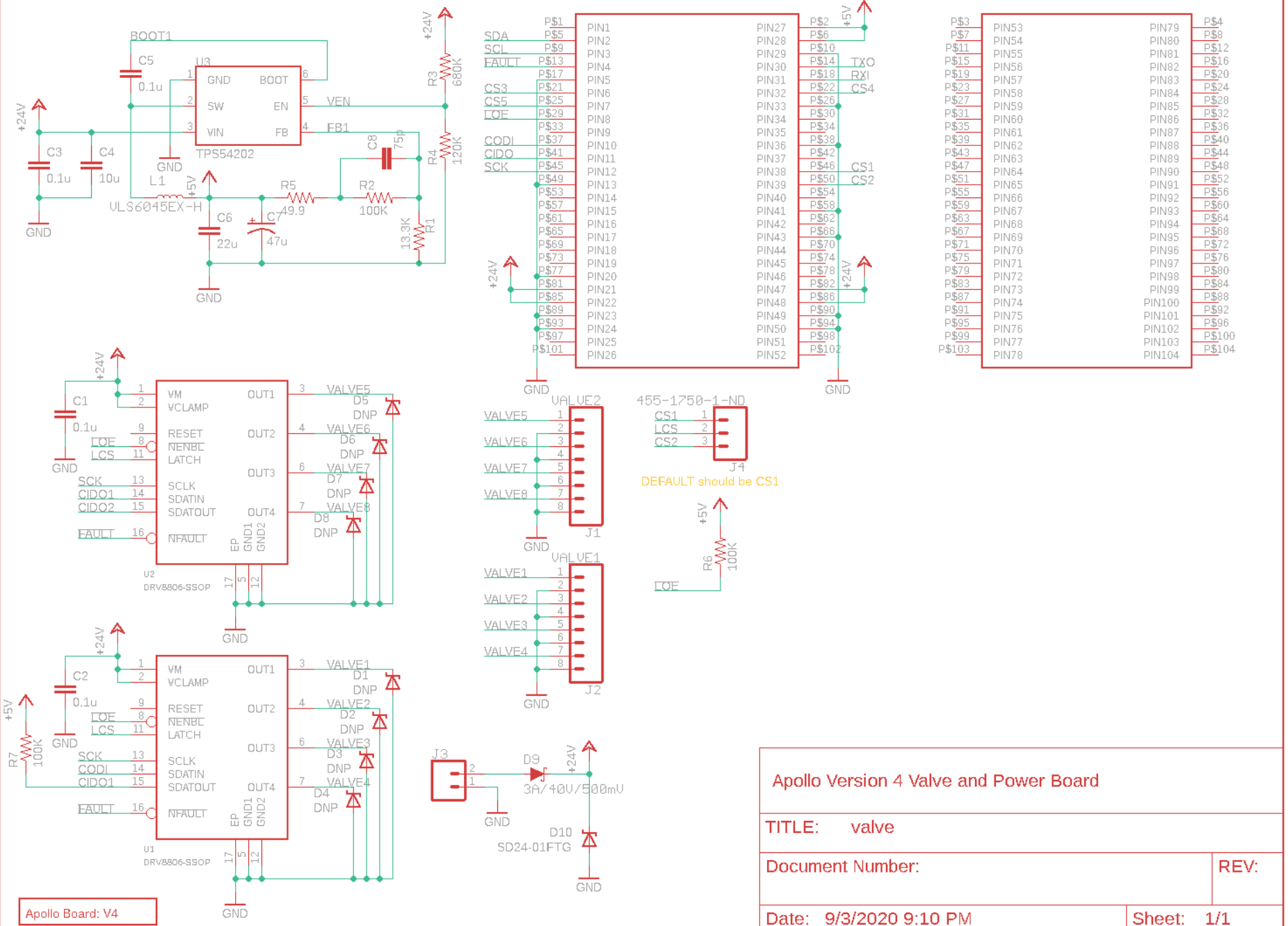
Prototyping effort








+3V3
R10 10K
R11 10K
R12 10K
R13 10K
R14 10K
R15 10K
R16 10K
R17 10K
CS5
CS4
CS3
CS2
CS1
CIDO
LOE
FAULT
SDA
SCL
FAULT
CS3
CS5
LOE
CODI
CIDO
SCK
ADCDN
GPIO18
GPIO23
GPIO22
GPIO21
VIN
R9 10K
GND
+5V
TXO
RXI
CS4
ADC3
ADC4
ADC2
CS1
CS2
ADCDP
GPIO19
VIN
GND
C3 1u
D1 497-6577-1-ND
C1 1u
C2 10u
R1 10K
J1
ESP32-PICO-KIT
VDD33_1
VDD33_2
EXT_5V
EN
FLASH_CS
FLASH_CLK
FLASH_SD0
FLASH_SD1
FLASH_SD2
FLASH_SD3
SENSOR_VP
SENSOR_VN
TXD0
RXD0
GND_1
GND_2
NO PERIPHERAL USE
For Internal Memory
ADCDP
ADCDN
DTX
DRX
NO PERIPHERAL USE
For Code Download
J2
DNP
J3
DNP
R8 3.3K
R7 3.3K
R5 100
R6 100
NO USE
R18 220K
R19 10K
ATTEN setting of 1
For 24V input
Multiplier is ~0.0434
VMON
U1
24LC01BT-I/SN
A0
A1
A2
VSS
VCC
WP
SCL
SDA
R4 10K
R3 10K
R2 10K
C4 0.1u
Apollo Version 4 Control with ESP32-PICO-KIT
TITLE: ctrl-pico
Document Number:
REV:
Date: 9/3/2020 9:10 PM
Sheet: 1/1
Apollo Board: V4


BOOT1
C5
0.1u
U3
GND
BOOT
SW
EN
VIN
FB
TPS54202
VEN
FB1
C3
0.1u
C4
10u
L1
VLS6045EX-H
+24V
+5V
GND
R5
49.9
R2
100K
C8
75p
R4
120K
R3
680K
C6
22u
C7
47u
13.3K
R1
SDA
SCL
FAULT
CS3
CS5
LOE
CODI
CIDO
SCK
PIN1
PIN2
PIN3
PIN4
PIN5
PIN6
PIN7
PIN8
PIN9
PIN10
PIN11
PIN12
PIN13
PIN14
PIN15
PIN16
PIN17
PIN18
PIN19
PIN20
PIN21
PIN22
PIN23
PIN24
PIN25
PIN26
PIN27
PIN28
PIN29
PIN30
PIN31
PIN32
PIN33
PIN34
PIN35
PIN36
PIN37
PIN38
PIN39
PIN40
PIN41
PIN42
PIN43
PIN44
PIN45
PIN46
PIN47
PIN48
PIN49
PIN50
PIN51
PIN52
TXO
RXI
CS4
CS1
CS2
PIN53
PIN54
PIN55
PIN56
PIN57
PIN58
PIN59
PIN60
PIN61
PIN62
PIN63
PIN64
PIN65
PIN66
PIN67
PIN68
PIN69
PIN70
PIN71
PIN72
PIN73
PIN74
PIN75
PIN76
PIN77
PIN78
PIN79
PIN80
PIN81
PIN82
PIN83
PIN84
PIN85
PIN86
PIN87
PIN88
PIN89
PIN90
PIN91
PIN92
PIN93
PIN94
PIN95
PIN96
PIN97
PIN98
PIN99
PIN100
PIN101
PIN102
PIN103
PIN104
C1
VM
VCLAMP
RESET
NENBL
LATCH
SCLK
SDATIN
SDATOUT
NFAULT
OUT1
OUT2
OUT3
OUT4
EP
GND1
GND2
U2
DRV8806-SSOP
VALVE5
VALVE6
VALVE7
VALVE8
D5
D6
D7
D8
DNP
C2
U1
VALVE1
VALVE2
VALVE3
VALVE4
D1
D2
D3
D4
R7
100K
VALVE2
J1
VALVE1
J2
455-1750-1-ND
J4
DEFAULT should be CS1
R6
100K
J3
D9
3A/40V/500mV
D10
SD24-01FTG
Apollo Board: V4
Apollo Version 4 Valve and Power Board
TITLE: valve
Document Number:
REV:
Date: 9/3/2020 9:10 PM
Sheet: 1/1

Conclusion

- Apollo
  - Open source oxygen concentrator with focus on low-cost
  - When Apollo v4 comes out we encourage everyone to build one!
- Please visit us at
  - http://project-Apollo.org
    - Github for designs, PCBs and software
  - http://HelpfulEngineering.org
    - Slack channel = #project-oxygen-concentrator