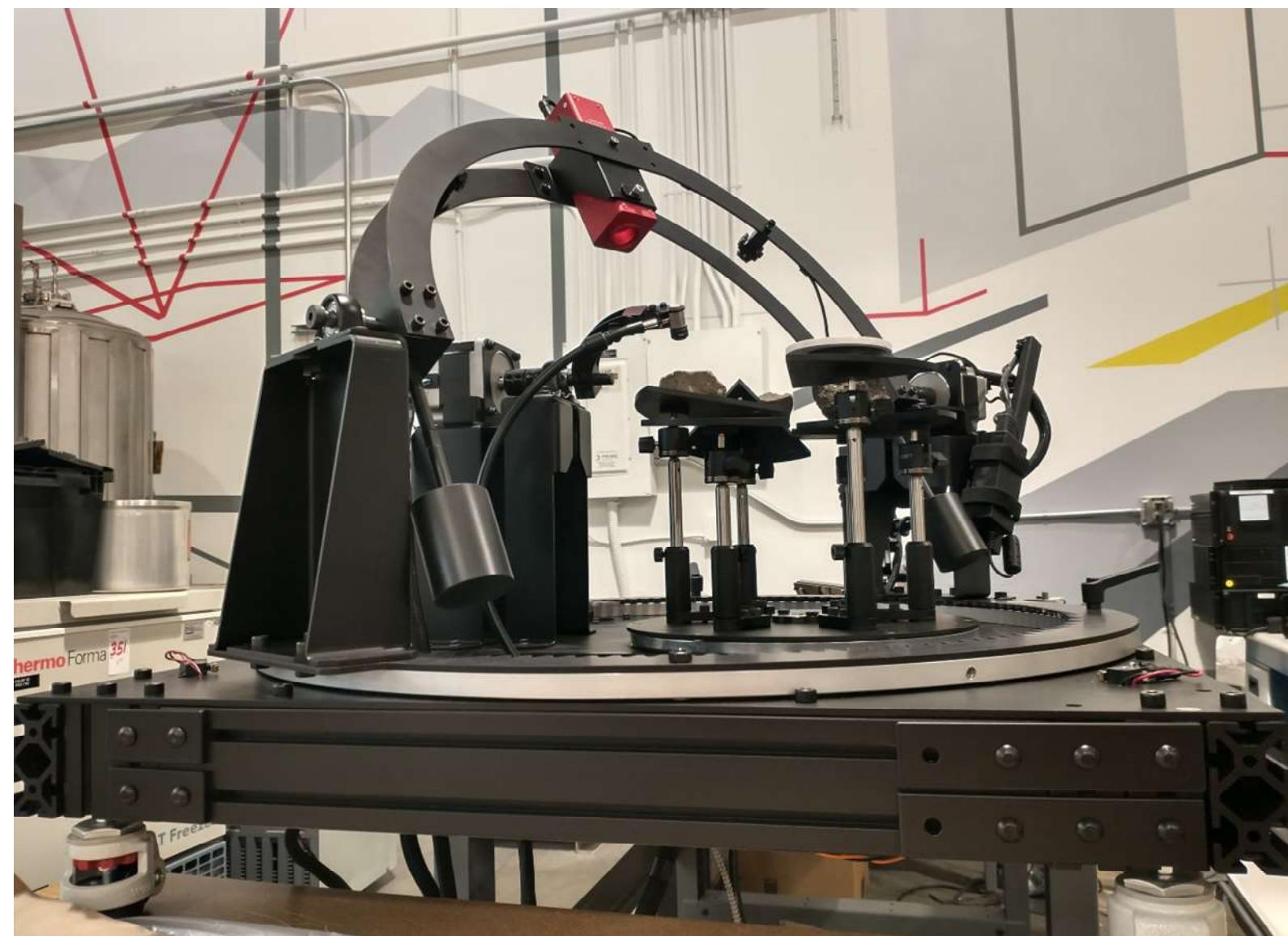


Goniometer Electrical Schematics

D



C

D

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C

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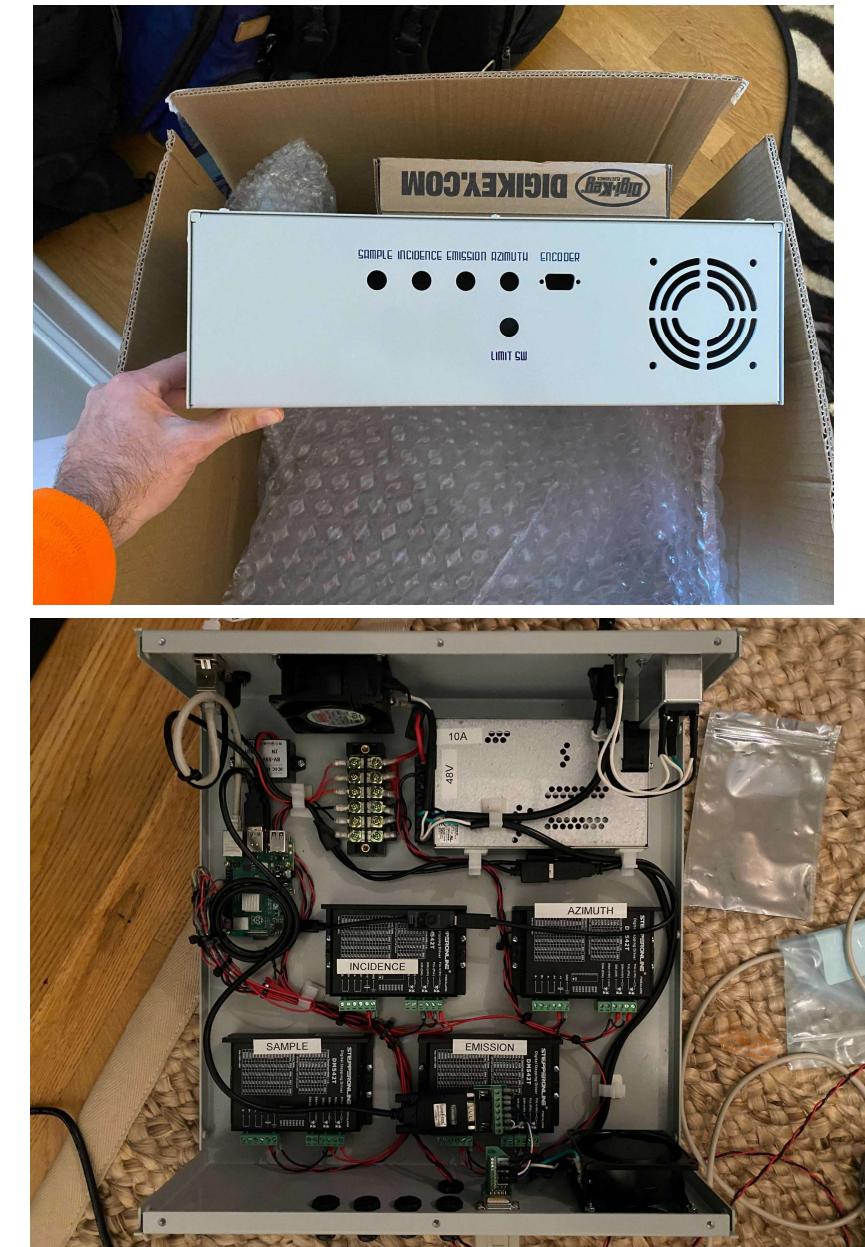
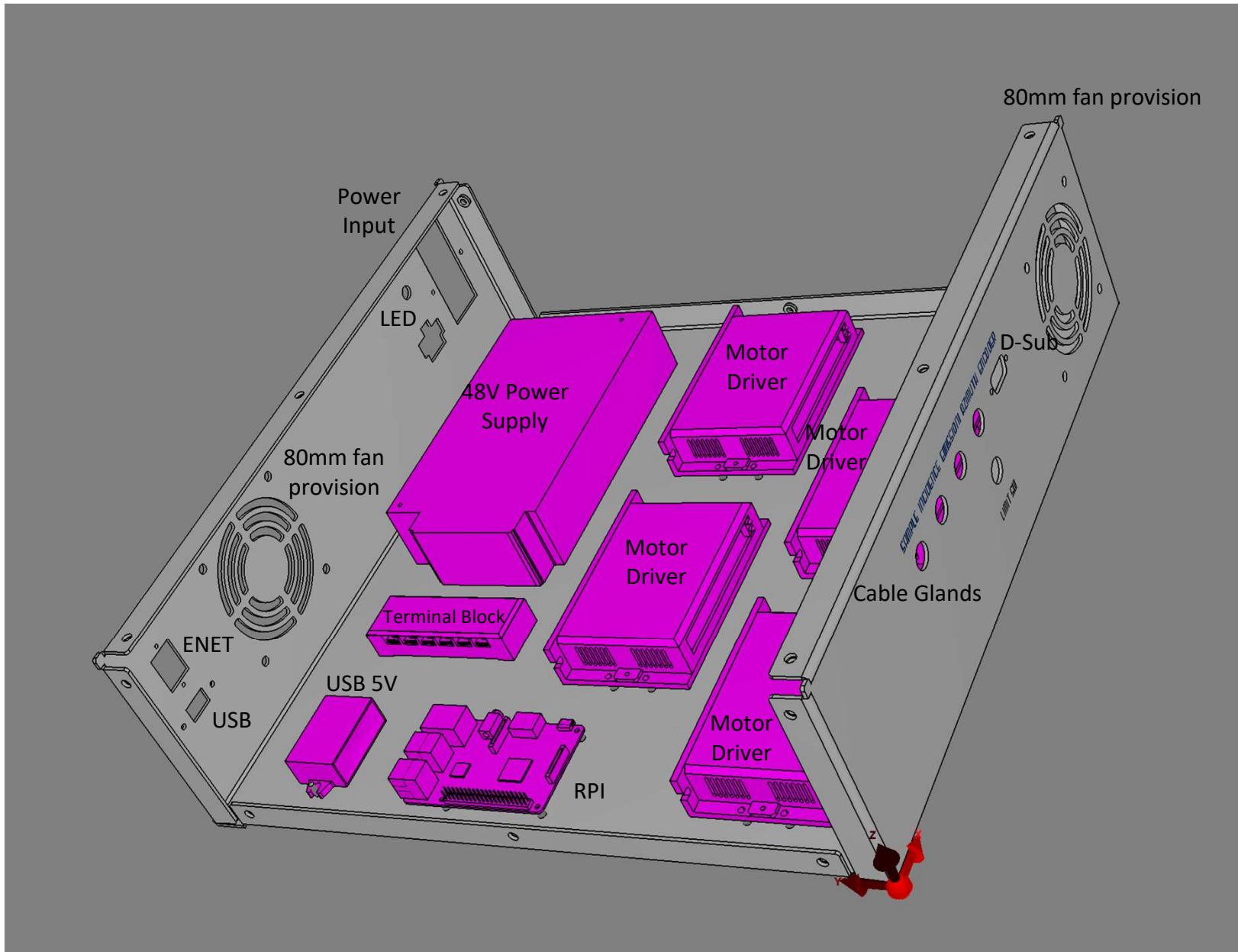
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A

TITLE / DESIGN		DOCUMENT / DRAWING NUMBER		REVISION
GONIOMETER ELECTRICAL SCHEMATICS		XXX		1.0
PROJECT	CLIENT	ENGINEER	RELEASE DATE	
GONIOMETER	WU	J. KARCH	2021-01-07	
CHECKED		YYY		
FIL	GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX	SCAL	NONE	CAG 81ZN9 TIM 16:04 2021-04-30

Refer to
mechanical
drawings

Enclosure
Layout



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GONIOMETER ELECTRICAL SCHEMATICS		XXX		1.0
PROJECT	CLIENT	ENGINEER	RELEASE DATE	
GONIOMETER	WU	J. KARCH	2021-01-07	
FIRST MODE		CHECKED	YYY	
BUILDING THE BARELY POSSIBLE				
2220 WESTERN AVENUE SEATTLE, WA 98121 USA				
FILE	GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX	SCAL	NONE	CAG 81ZN9 TIM 16:04 2021-04-30

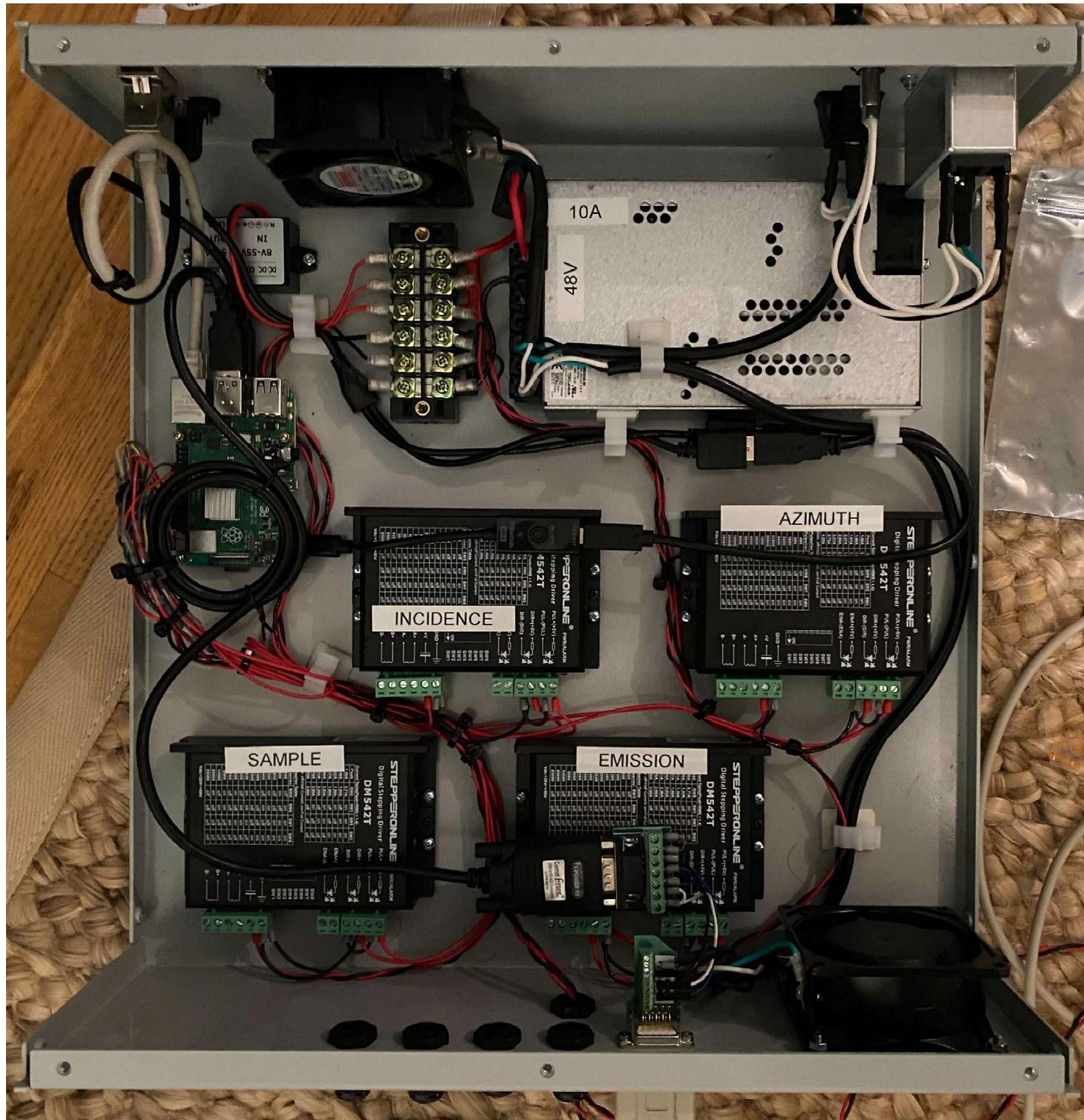
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Enclosure Physical Images



NOT DRAWN TO SCALE:



2220 WESTERN AVENUE SEATTLE, WA 98121 USA

TITLE / DESIGN	DOCUMENT / DRAWING NUMBER	REVISION
GONIOMETER ELECTRICAL SCHEMATICS	XXX	1.0
PROJECT	ENGINEER	RELEASE DATE
GONIOMETER	J. KARCH	2021-01-07
CLIENT	CHECKED	
WU	YYY	
FILE	SCALE	REVISION
GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX	NONE	16:04 2021-04-30

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Assembly Tools:

Phillips head screw drivers

Metric nut driver set

59250 Aircraft Crimper. Find older version on eBay for about \$300

<https://www.newark.com/amp-te-connectivity/59250/crimp-tool-pidg-strato-therm-plasti/dp/50F546>

1400 W Heat Gun

40W Soldering Iron

Using PIDG splices and lugs:

https://www.youtube.com/watch?v=n_qfxC7Lndg



Mounting to frame:

Use 10mm long M3 and M4 screws, with associated split washers and nuts to mount fans and power supplies.

Mounting to chassis standoffs

Use 8mm long M3 screws, with associated split washers to mount motor controllers to chassis standoffs. Use M2.5 standoffs or 6mm M2.5 screws to mount Raspberry Pi to chassis.

Wiring standards:

Cut apart standard 120VAC power cables and use the embedded wiring to connect power input. Apply heat shrink to shield all high voltage wires. Black is Line, White is Neutral, and Green is Earth Ground.

Use ferrules for all terminal strips.

Use zip ties or cable clamps to tie wires to chassis



NOT DRAWN TO SCALE:

Assembly Notes:

Using Raychem Solder Sleeves

<https://www.youtube.com/watch?v=7Wh5gM8GM70>



TITLE / DESIGN		DOCUMENT / DRAWING NUMBER		REVISION
GONIOMETER ELECTRICAL SCHEMATICS		XXX		1.0
PROJECT		RELEASE DATE		
GONIOMETER		J. KARCH	2021-01-07	
FILE	CHECKED	YYY	CAG	TIM
GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX	SCAL	81ZN9	16:04 2021-04-30	E
	NONE			

Parts List

Name	Quantity	Part #	Manufacturer	Purpose
Stepper motor	4	PL34HD0L4350-E	Moons industries	Move incidence arm, emission arm, azimuth turntable, sample turntable
Motor driver	4	DM542T	StepperOnline	Convert signal to azimuth motor
Absolute optical encoder	4	AMT212A-V	CUI devices	Inform closed-loop control.
Encoder-converter cable	4	AMT-06C-1-036	CUI Devices	cable with connector for encoder pinout
RS485/USB-A converter cable	1	USB-422-1	CommFront	Encoder/RPi interface
Encoder programming cable	1	AMT-PGRM-06C	CUI Devices	Set addresses on encoders
Controller	1	Raspberry Pi 4B	Raspberry Pi	Control motors, Starter kit with heat sinks and power cable
Positioning lasers	2	B083FTWJ16	Inflight	Locate target point on samples
Light source	1	SLS201L	Thorlabs, Inc	Illuminate samples
Power Input	1	FN283-4-06	Schaffner, Inc	Power Input
Ethernet jack	1	ECF504-SC5E	L-Com	Ethernet Jack
Enclosure	1	TBD	Protocase, Inc	First Mode Custom Enclosure
Ferrules 20 AWG	50	60175	Swanstrom	terminal block ferrules
Ferrules 17 AWG	50	60110	Swanstrom	terminal block ferrules
splices	50	323975	TE Connectivity	Splices
Cable Gland	5	PPC7 BK080	Alpha	Cable Gland
power supply alternative	1	RWS300B48	TDK Lambda	Power Supply to drive Motors
terminal strip, 6 pos x 2	1	TB2506-L	Uxcell	Terminal Block
5v USB supply	1	Fulree 5003AA	Fulree	USB supply for RPI
LED indicator	1	L79D-G125-W-ND	Communications Company (VCC)	Visual Power on indicator
USB Jack	1	908	Adafruit	USB connection to RPII
Connection wires	2	825	Adafruit	0.1" jumper wires for wiring up motor
Ethernet Patch Cord	1	TRD-855	L-Com	Ethernet Patch cord from RPI to Jack
Encoder Solder Sleeves	100	656077-000	TE-Connectivity	Splices
Limit switch	2	V7-7B17D8-201	Honeywell	limit switch
PIDG Lug	50	8-640917-1	TE	limit switch connector
PIDG Spade	48	1-52410-0	TE	Power Distribution
NEMA 5-15 outlet	1	738W-X2/01	Qualtek	Power outlet for illumination source
Power cable	2	AK500-U-2	Assmann	For wiring up 120VAC in the box
PIDG 0.25"	50	55675-1	TE	Power wiring
USB A to C	1	CA-USB-AM-CM-1FT	Adam Tech	Power from USB to 5V supply
USB Cables	2	U050-003	Tripp-Lite	For powering various devices
D-Sub to terminal blocks	1	1688379	Phoenix Contact	For connecting encoder
D-Sub cables	2	AK178-3	Assmann	Interconnect
16 AWG wire, stranded, red	1 roll	6715 RD005	Alpha	connect power to drivers
16 AWG wire, stranded, black	1 roll	6715 BK005	Alpha	connect power to drivers
Cable Ties	100	CT010B	Essentra Components	Cable management
Pull up resistor	10	RNMF14FTC10K0	Stackpole	for switches
Termination Resistor	10	RNMF14FTC120R	Stackpole	RS-485 termination resistor
Mating D-Sub	1	1731140094	Molex	RS-485 mating D-Sub for Encoder RS-485
Fans (Cooling)	2	UF80A12-BTHR	Mechatronics Fan Group	Cooling Fans (optional), possibly not needed.

Additional generic parts			
M3 phillips button head screws (8mm)			
M4 phillips button head screws (10 mm)			
M3 nuts, split washers			
M2.5 standoffs (to secure Raspberry Pi)			
M4 nuts, split washers			
Heat Shrink tubing			
Cable clips			
Optional Upgrades			
Level Shifters	2	12009	Sparkfun
Screw Nuts for D-Sub	2		Used to secure D-Sub to frame

Motor control cable:

https://www.automationdirect.com/adc/shopping/catalog/cables/bulk_multiconductor_cable/high_flex_continuous_flexing_control_cable/shielded/cfl0-ul-15-05-1

 FIRST MODE <small>BUILDING THE BARELY POSSIBLE</small>	TITLE / DESIGN		DOCUMENT / DRAWING NUMBER	REVISION
	GONIOMETER ELECTRICAL SCHEMATICS		XXX	1.0
	PROJECT	GONIOMETER	ENGINEER	RELEASE DATE
	J. KARCH	2021-01-07		
CLIENT	CHECKED			
WU	YYY			
FILE	GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX		SCAL	16:04 2021-04-30
E	None	CAG	81ZN9	TIME

Notes from prototype build 0.0 and differences from this version

The design enclosure was built with protocase designer (www.protocase.com) and the design had a few errata that should be noted.

(1) The case design had an issue where USB and HDMI connections on the Raspberry Pi were a tight fit, squeezing up against both the motor driver module and the 48V-5V USB source. In the final version of the Protocase design files I moved the Raspberry Pi over to make more room, and relocated the 48V to USB source.

(2) The 48V to USB power supply box had two studs sticking out of the case that were slightly far apart. I moved those studs 4mm closer together to make a better mount.

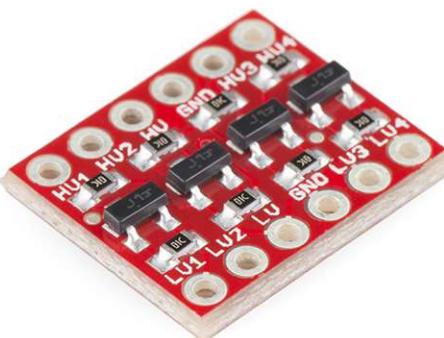
(3) The same 48V to USB power supply box produces 4.55V under load. It might be worth it to consider alternative supplies, but the RPI works normally, as does the USB-422/485 converter.

(4) The power distribution terminal blocks had M5 studs that were too large, these were replaced with M4 studs.

(5) The D-Sub 9 to Terminal block converter doesn't come with standoffs for mounting a D-sub cable. An M2.5 screw was used in the meantime to hold the terminal block converter to the case.

(6) For all Motor Driver channels: These devices state that they require a 5V GPIO to directly drive the "PUL+" and "DIR+" signals. Testing has shown that these signals do respond to a 3.3V signal through the opto-isolator. If an issue occurs with stepping one option is to connect the PUL+ and DIR+ signals up to 5V, disconnect PUL- and DIR- from GND, and connect the signals originally connected to PUL+ and DIR+ to PUL- and DIR-. Then, all that is needed is to invert the polarity of the drive pins in software, that is-- make an "on" signal an "off" signal and vice-versa. However it does seem this drive is 3.3V tolerant from testing. Another option would be to find a level shifting board on sparkfun and place between the Pi and the Motor drivers, but at this point this is not required. Example level shifter: <https://www.sparkfun.com/products/12009>. Two of these are required to cover 8 channels.

(7) Due to noise picked up on encoder, it was necessary to add shielded motor cable to the connections going from the motor to the controller. The ground wire should be tied at the controller end to minimize noise, along with any drain wires for all four motor channels. Since the Goniometer moves, A flexible shielded cable such as https://www.automationdirect.com/adc/shopping/catalog/cables/bulk_multiconductor_cable/high_flex_continuous_flexing_control_cable/shielded/cfl0-ul-15-05-1 is highly recommended.



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GONIOMETER	WU	J. KARCH	2021-01-07	
FIRST MODE	FIL	CHECKED	YYY	
BUILDING THE BARELY POSSIBLE	2220 WESTERN AVENUE SEATTLE, WA 98121 USA	SCAL	NONE	CAG 81ZN9 TIM 16:04 2021-04-30
GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX		E	E	E

Notes on bringing up the Raspberry Pi.

Noobs was used to initialize the Raspberry Pi, as it came as part of the Canakit 8GB kit. Select "Headless Mode" upon inserting the uSD card, connect to Ethernet, and install Raspbian (Debian) OS.

In a terminal, once booted, run the following commands to enable Python access to GPIO for controlling the goniometer:

```
Setup RPI as headless using Noobs
default username pi
password raspberry
```

Tools to install:
Run raspi-config to enable ssh access and set hostname from raspberry.local to goniometer.local
sudo raspi-config
username pi
password YOurP44sw0rd! (make up a password)

OPTIONAL: Set up WiFi. If you don't have Ethernet access you can perform the following steps: however note that a wired Goniometer is strongly recommended because the enclosure may minimize WiFi reception

Identify network ssid:
sudo iwlist wlan0 scan | less
Add network to wpa_supplicant:
sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
Add the following lines to bottom of page:
network={
 ssid="{network_name}"
 psk="{network_password}"
}

Reconfigure:
wpa_cli -i wlan0 reconfigure

Test:

```
ifconfig wlan0
verify that inet field has an address listed.
```

Install updates, Python, and pip

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install git
sudo apt-get install python3-pip
sudo apt-get install python-pip
sudo pip3 install -U numpy
sudo pip install -U numpy
sudo apt-get install python3-dev python3-rpi.gpio
sudo apt-get install libatlas-base-dev
sudo pip3 install pyserial
```

Install tanager-feeder from PyPI:

```
pip3 install tanager-feeder
Test run the software:
```

```
pi-feeder
```

Set up automatic software startup at pi reboot:

```
crontab -e
```

```
Add to bottom of file: @reboot pi-feeder
```

D D Github access (optional): In order to download / contribute to the tanager-feeder app on github you have two options:

Option 1: Use manual authentication and enter user name and password each and Every time you perform a git function.
Option 2: Set up ssh key to match RPI to Git account to make it easier to Develop without passcodes.

```
cd /~
mkdir .ssh
```

1: If you don't have ssh keys yet
add ssh keys for git if you don't already have them set up:

(A) Generate a private key:

```
cd ~/.ssh
ssh-keygen -t rsa -b 4096 -C "your_email@example.com"
<Enter> to use default file location
<Enter> to set no passphrase
<Enter> to confirm
```

(B) Add to github

```
Go to github.com and sign in
Click the user icon on in the upper right
Under 'settings' find 'SSH and GPG keys'
Click 'New ssh key'
Copy contents of id_rsa.pub into box labeled "Key"
```

2: If you already have your keys made:

```
copy your private and public key to .ssh
chmod 600 id_rsa
chmod 644 id_rsa.pub
copy your public key to your github account as in 1B.
eval "$(ssh-agent)"
ssh-add ~/.ssh/id_rsa
```

Download Goniometer package from git

```
git clone git@github.com:westernmarslab/tanager-feeder.git
cd tanager-feeder
python3 -m pip install --upgrade .
run application as a test:
pi-feeder
```

Refer to Goniometer Help File for more information on setting up system

https://docs.google.com/document/d/1_jPl1AlxtOlissyyJVRDXZixKnE0s9J7Qf-vwCG-518/edit?usp=sharing



FIRST MODE
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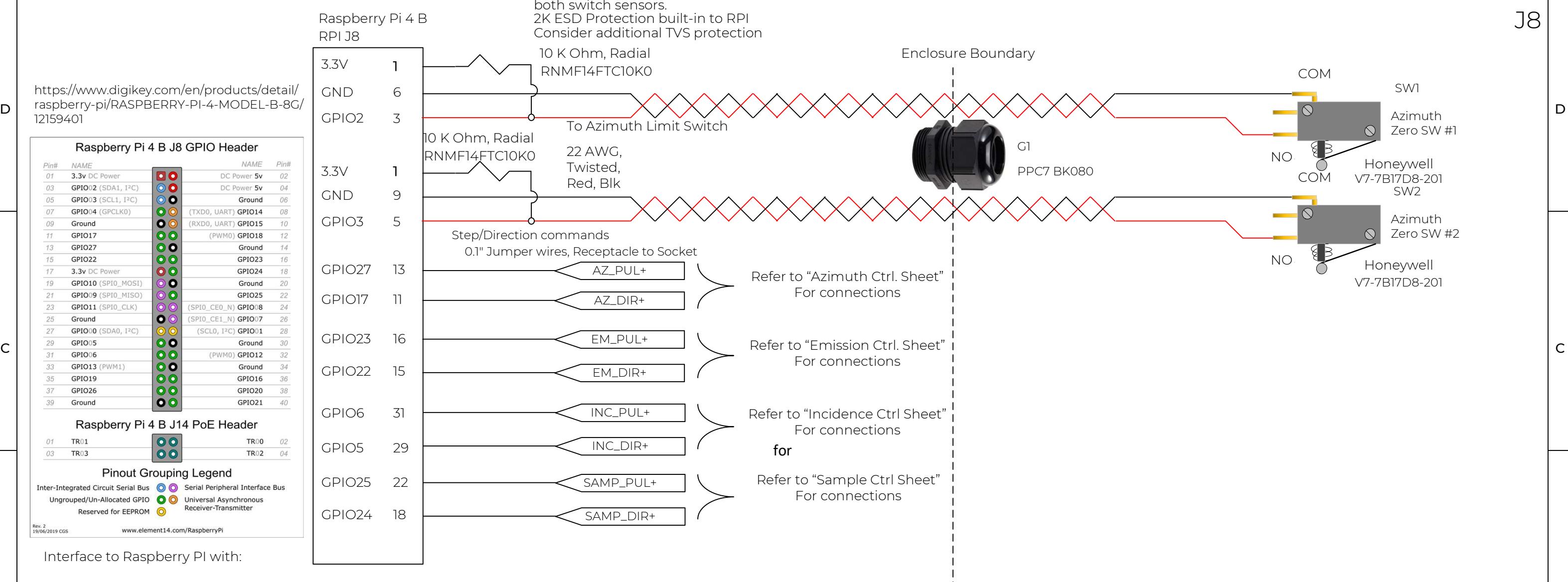
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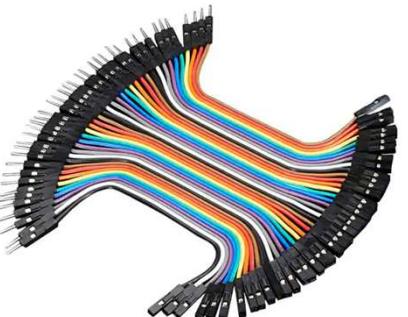
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RPI Controller J8



Interface to Raspberry PI with:



<https://www.digikey.com/en/products/detail/adafruit-industries-llc/825/5353621>

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GONIOMETER ELECTRICAL SCHEMATICS		XXX		1.0
PROJECT	CLIENT	ENGINEER	RELEASE DATE	
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		CAG	81ZN9	TIM
				16:04 2021-04-30

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RS-485 Encoder Details

USB Jack #2 built in to PS2: See "Power Distribution"



Tripp-Lite
USB-type A
U050-003

Cut and extract 5V and GND from cable.
Red is 5V
Black is GND

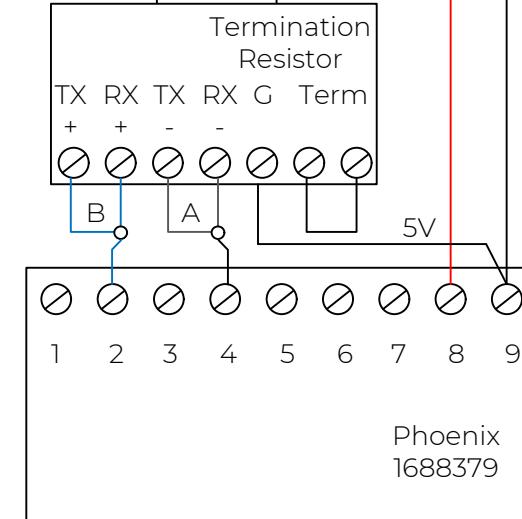
Raspberry Pi



Commfront USB-422-1

To RPI USB Port

Included Terminal Blocks



Enclosure Boundary

D-Sub pinouts

PIN ASSIGNMENT

RS-422/RS-485 Side (DB-9 Male Connector / Terminal Block):

DB-9 Male:	1	2	3	4	5	6,7
Function:	TX-	TX+	RX+	RX-	GND	Tie to turn ON the 120Ω end-of-line terminator

6&7 enables 120 ohm termination

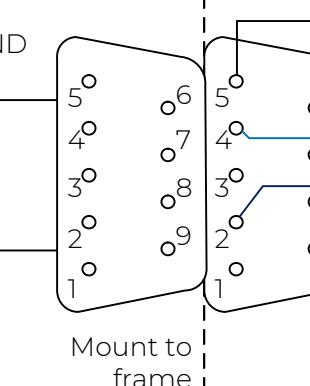
1&4 are jumpered to form the "A" signal
2&3 are jumpered to form the "B" signal.

Tie shielding to pin 5 with a "zap"

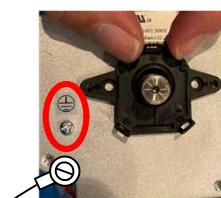
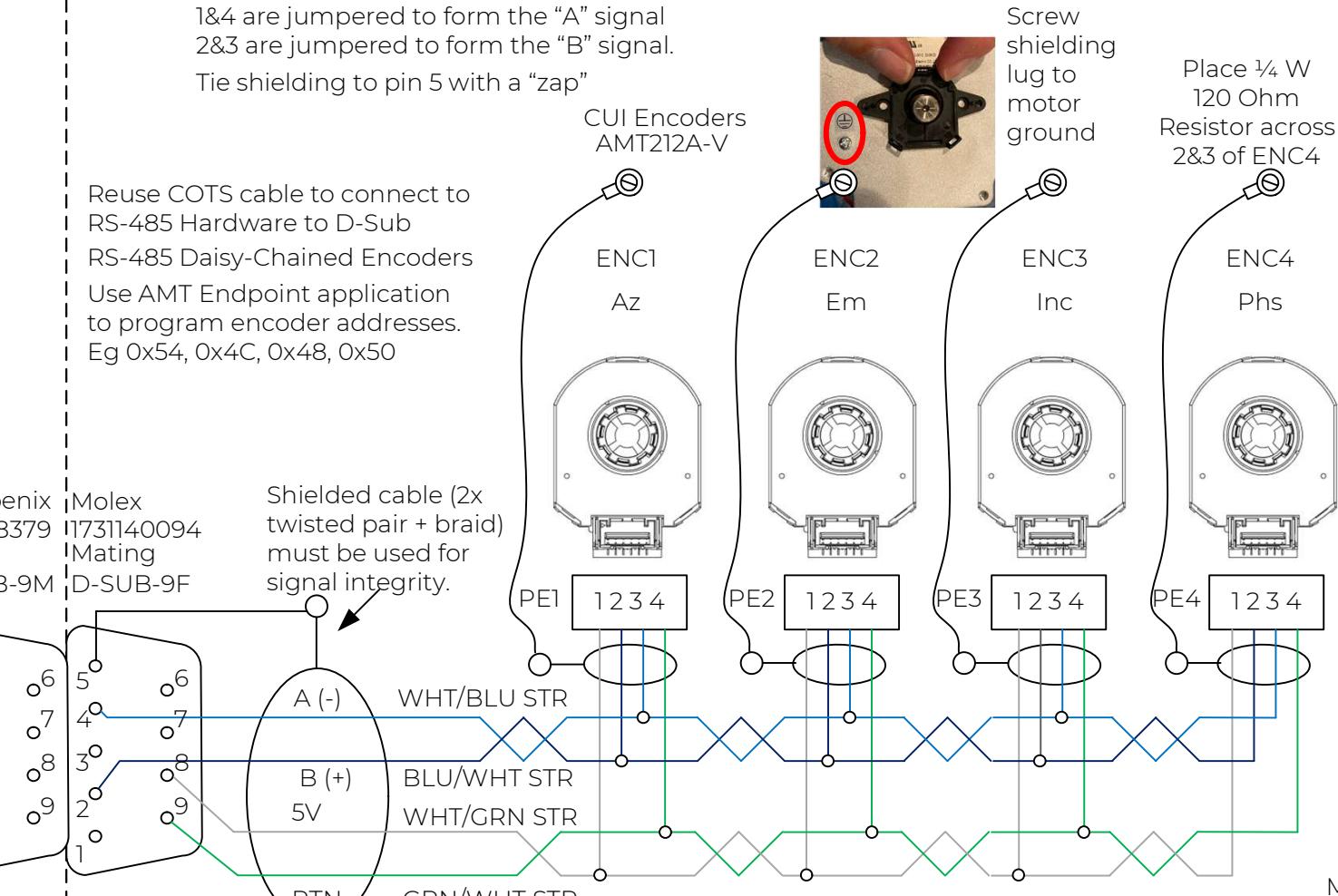
Reuse COTS cable to connect to RS-485 Hardware to D-Sub
RS-485 Daisy-Chained Encoders
Use AMT Endpoint application to program encoder addresses.
Eg 0x54, 0x4C, 0x48, 0x50

Molex 1731140094
Mating
D-SUB-9F

Phoenix 1688379
D-SUB-9M



Mount to frame



Place 1/4 W
120 Ohm
Resistor across
2&3 of ENC4

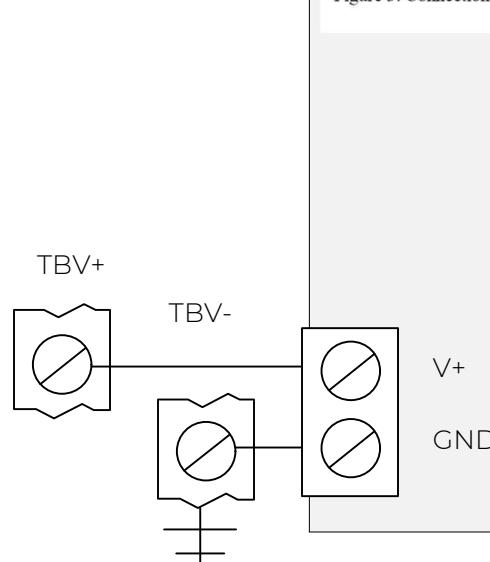
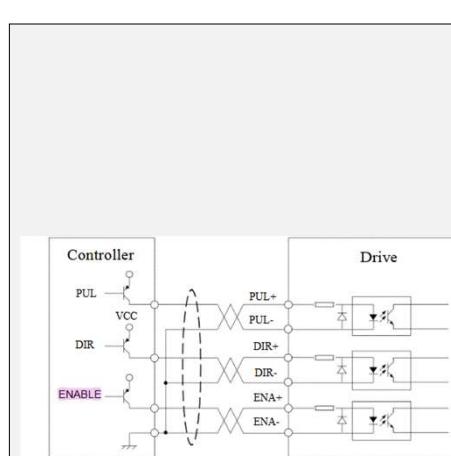
<https://www.commfront.com/products/usb-to-4-wire-rs422-rs485-adapter?variant=9208938115>

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TITLE / DESIGN		DOCUMENT / DRAWING NUMBER		REVISION
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PROJECT		ENGINEER		RELEASE DATE
GONIOMETER		J. KARCH		2021-01-07
CLIENT		CHECKED		
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FIL	GONIOMETER_ELECTRICAL_SCHEMATICS.VSDX	SCAL	NONE	81ZN9 TIM
		E	E	16:04 2021-04-30

NOTE: for all channels: These devices state that they require a 5V GPIO to directly drive the "PUL+" and "DIR+" signals. Testing has shown that these signals do respond to a 3.3V signal through the opto-isolator. If an issue occurs with stepping one option is to connect the PUL+ and DIR+ signals up to 5V, disconnect PUL- and DIR- from GND, and connect the signals originally connected to PUL+ and DIR+ to PUL- and DIR-. Then, all that is needed is to invert the polarity of the drive pins in software, that is-- make an "on" signal an "off" signal and vice-versa. However it does seem this drive is 3.3V tolerant from testing. Another option would be to find a level shifting board on sparkfun and place between the Pi and the Motor drivers, but at this point this is not required. Example level shifter: <https://www.sparkfun.com/products/12009>. Two of these are required to cover 8 channels.

Motor Controller
MC1
DM542T



Motor control cable:

https://www.automationdirect.com/adc/shopping/catalog/cables/bulk_multiconductor_cable/high_flex_continuous_flexing_control_cable/shielded/cf10-ul-15-05-1

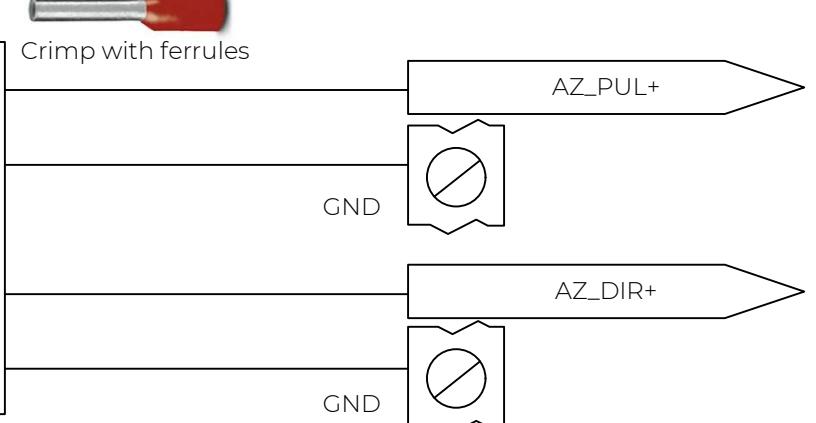
NOT DRAWN TO SCALE:

<https://www.omc-stepperonline.com/download/DM542T.pdf>

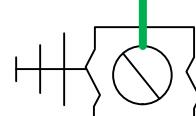
PUL+
PUL-
DIR+
DIR-

EN+
EN-

TBV+
TBV-
V+
GND
A+
A-
B+
B-



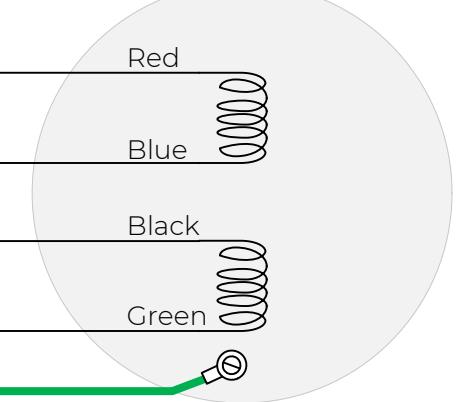
According to Page 3 of manual, N/C



Use shielded 16 AWG flexible motor control cable Igus CF10-UL-15-05-1 Tie "Green" wire plus any drain wire to a ground point on controller.



Splice connections and wire Ts with
<https://www.digikey.com/en/products/detail/te-connectivity-amp-connectors/323975/287718>

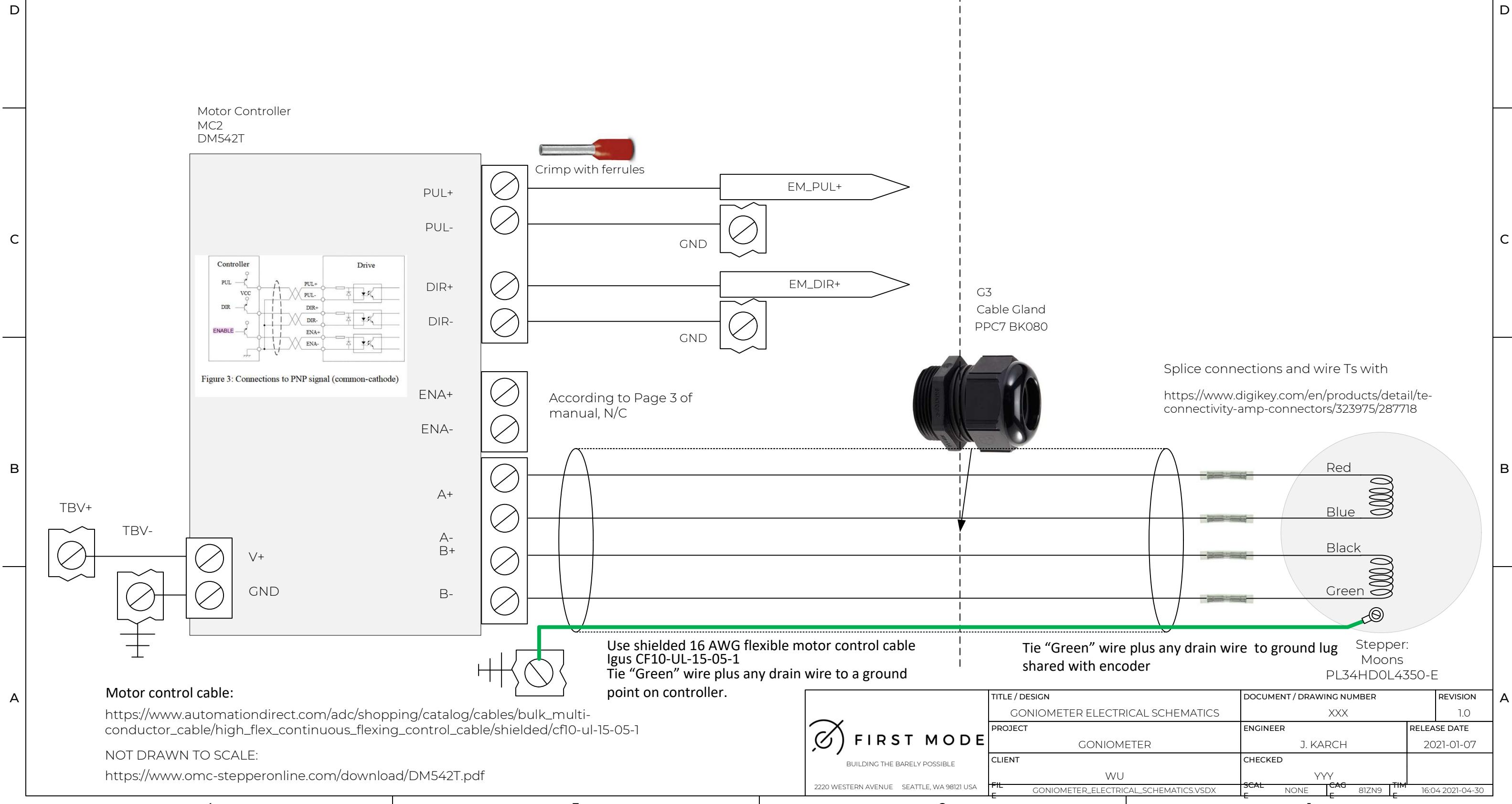


Stepper:
Moons
PL34HD0L4350-E

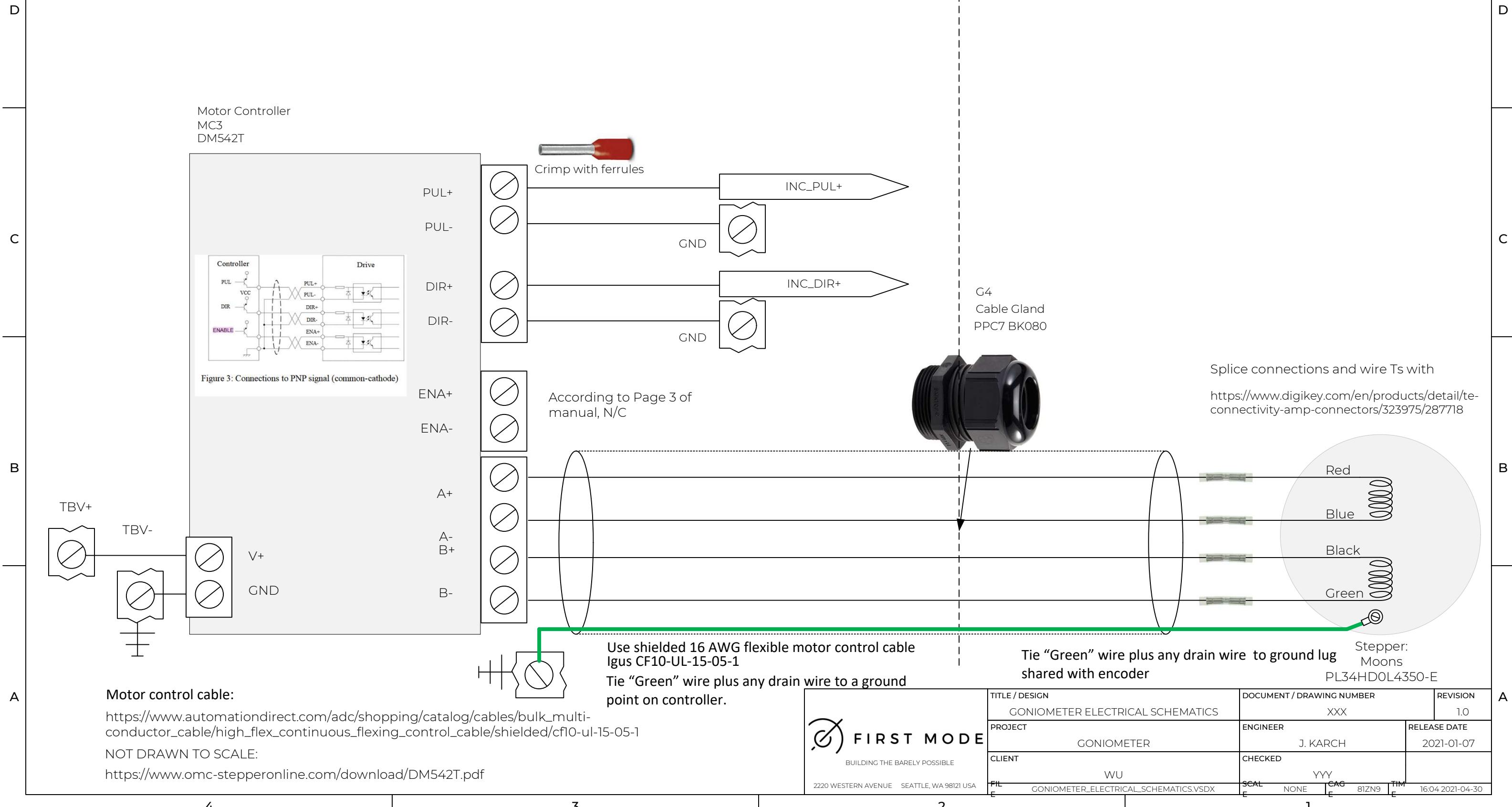
Tie "Green" wire plus any drain wire to ground lug shared with encoder

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GONIOMETER ELECTRICAL SCHEMATICS		XXX		1.0
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GONIOMETER	J. KARCH	2021-01-07		
CLIENT	CHECKED	YY	MM	
WU				
FILE	SCAL	CAG	TIME	
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Emissions Motor Controls



Incidence Motor Controls



Sample Motor Controls

