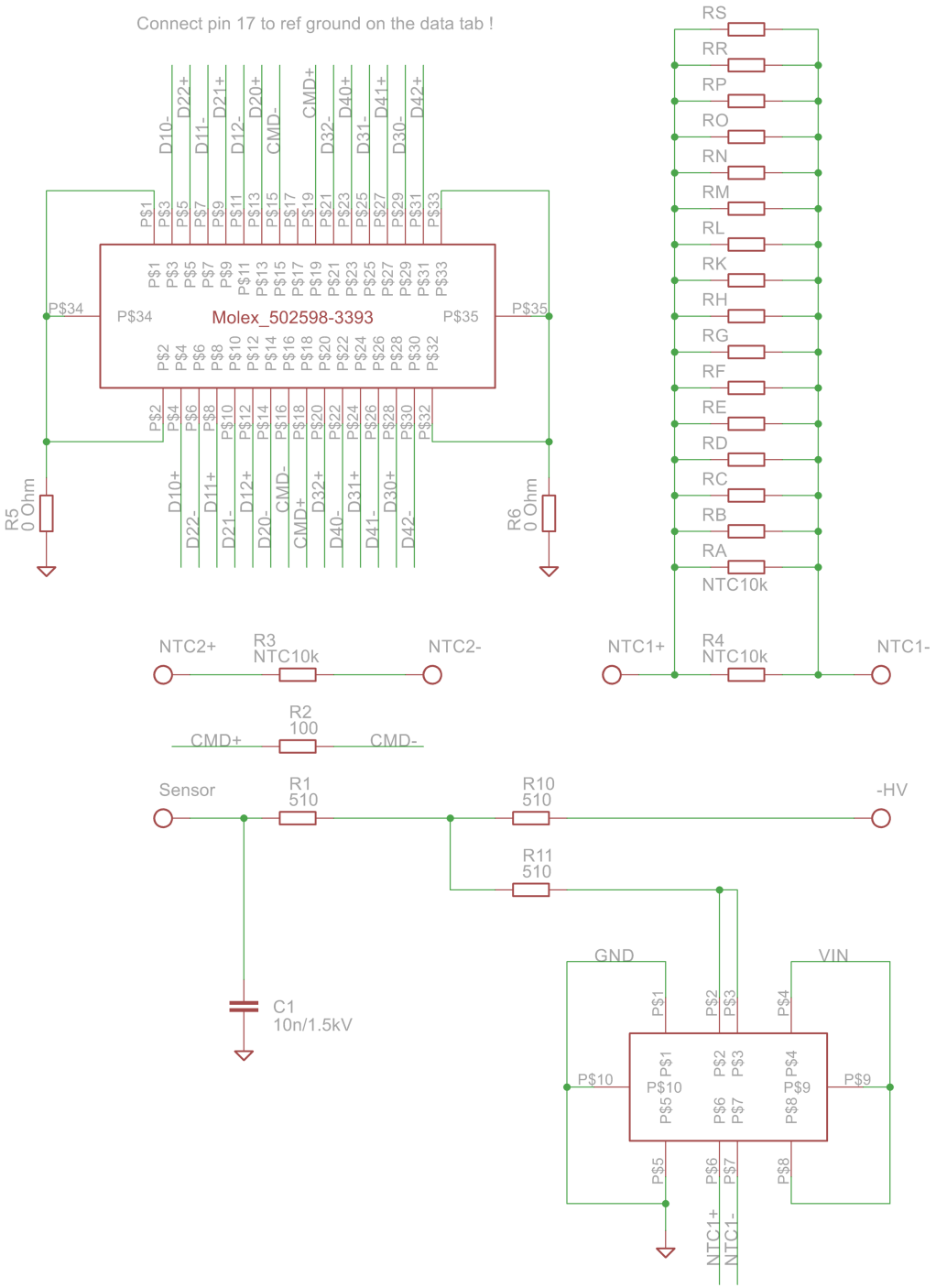
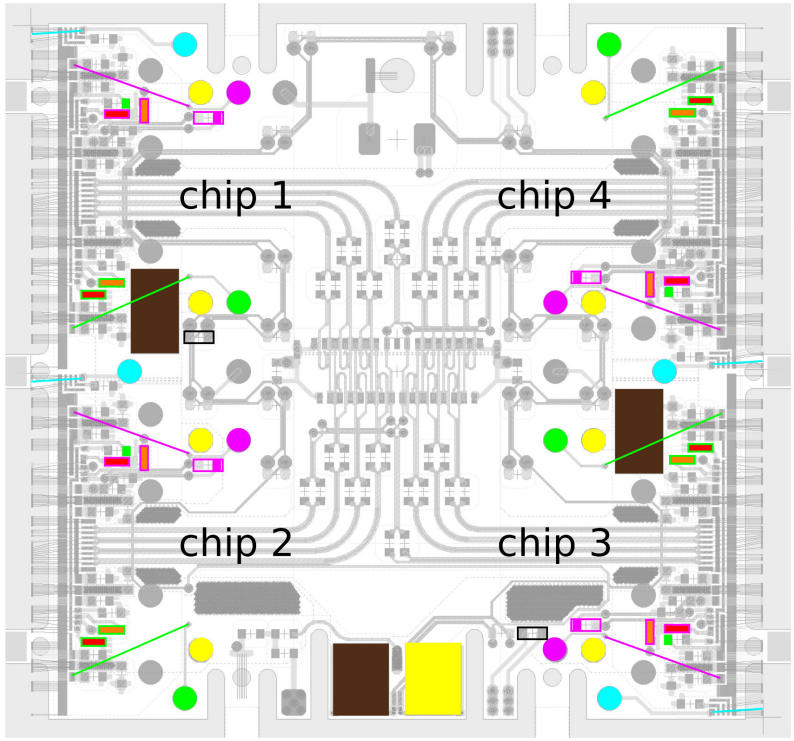
# RD53A Coupled Ring Powering Scheme

Version 2

Sep/24/2022

# RD53A Quad Module Powering Interface



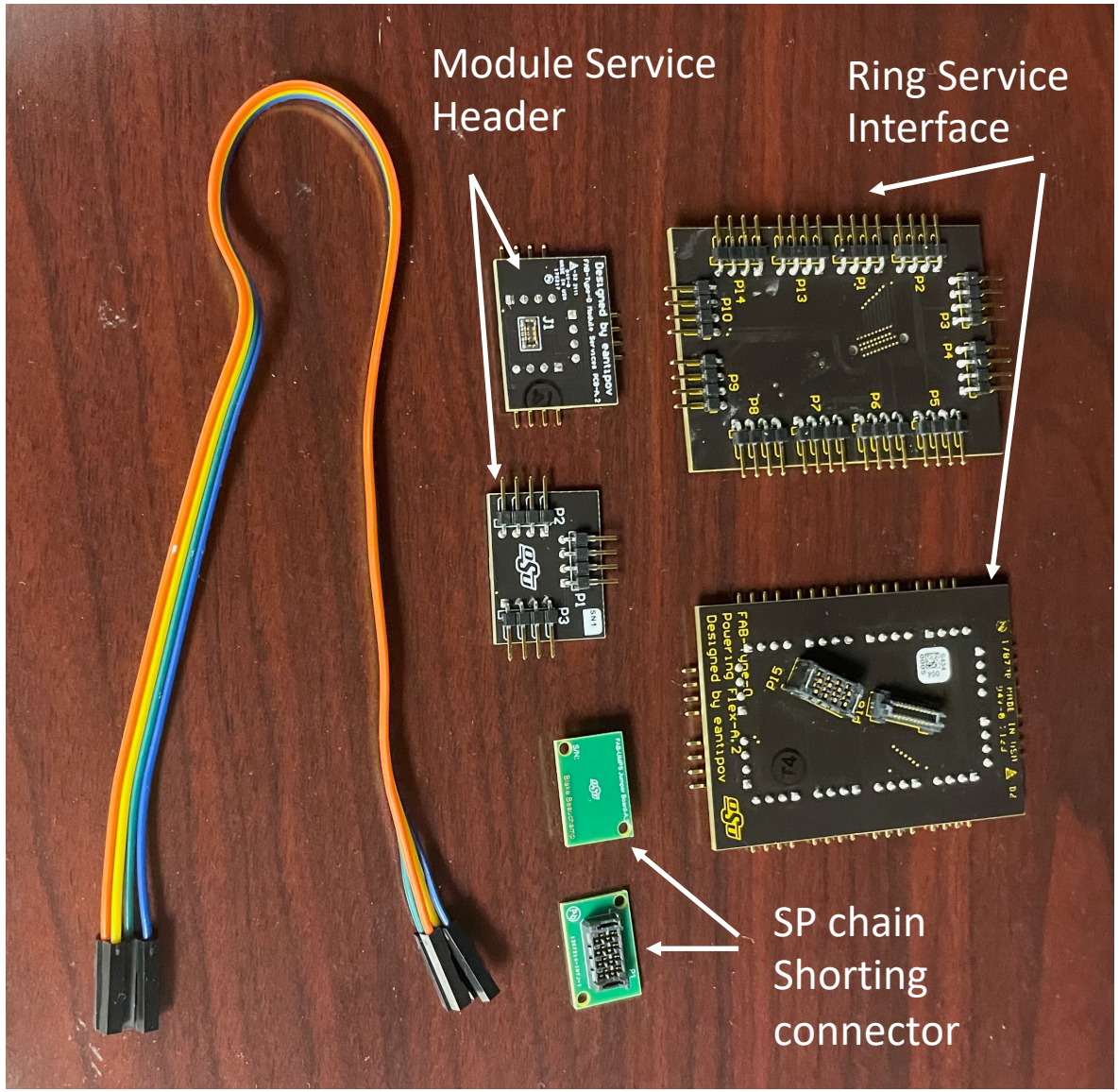

HV LV NTC

Integrated into a BM25 connector

Legend

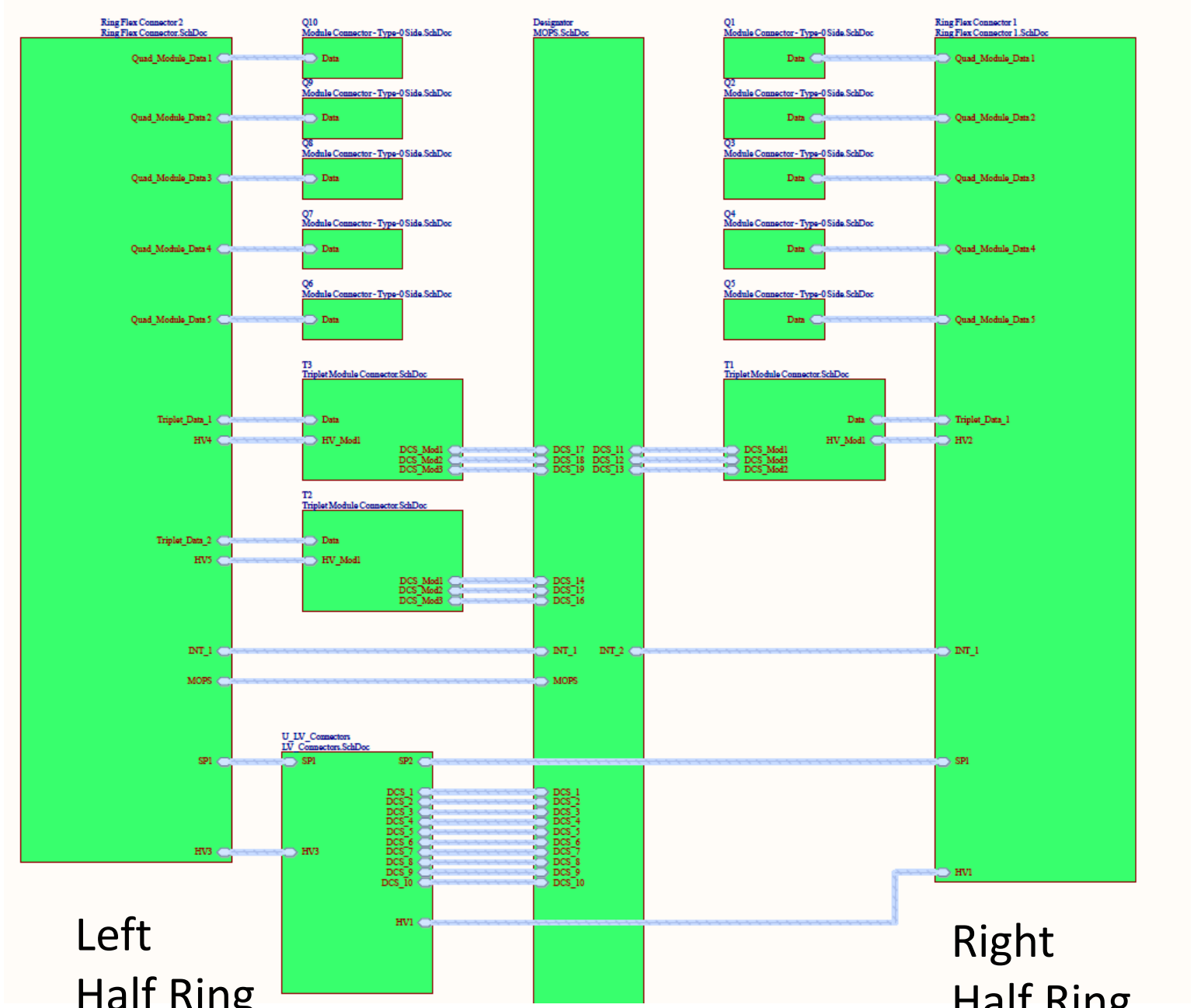
- VIN
- GND
- VMUX: default wirebond and probe pad
- VDDA: optional wirebond and probe pad
- VDDD: optional wirebond and probe pad
- VDDA: default probe pad
- VDDD: default probe pad
- VrefA pull-up resistor
- RextA
- RiofsA
- RextD
- RiofsD
- NTC

# Powering Chain Components





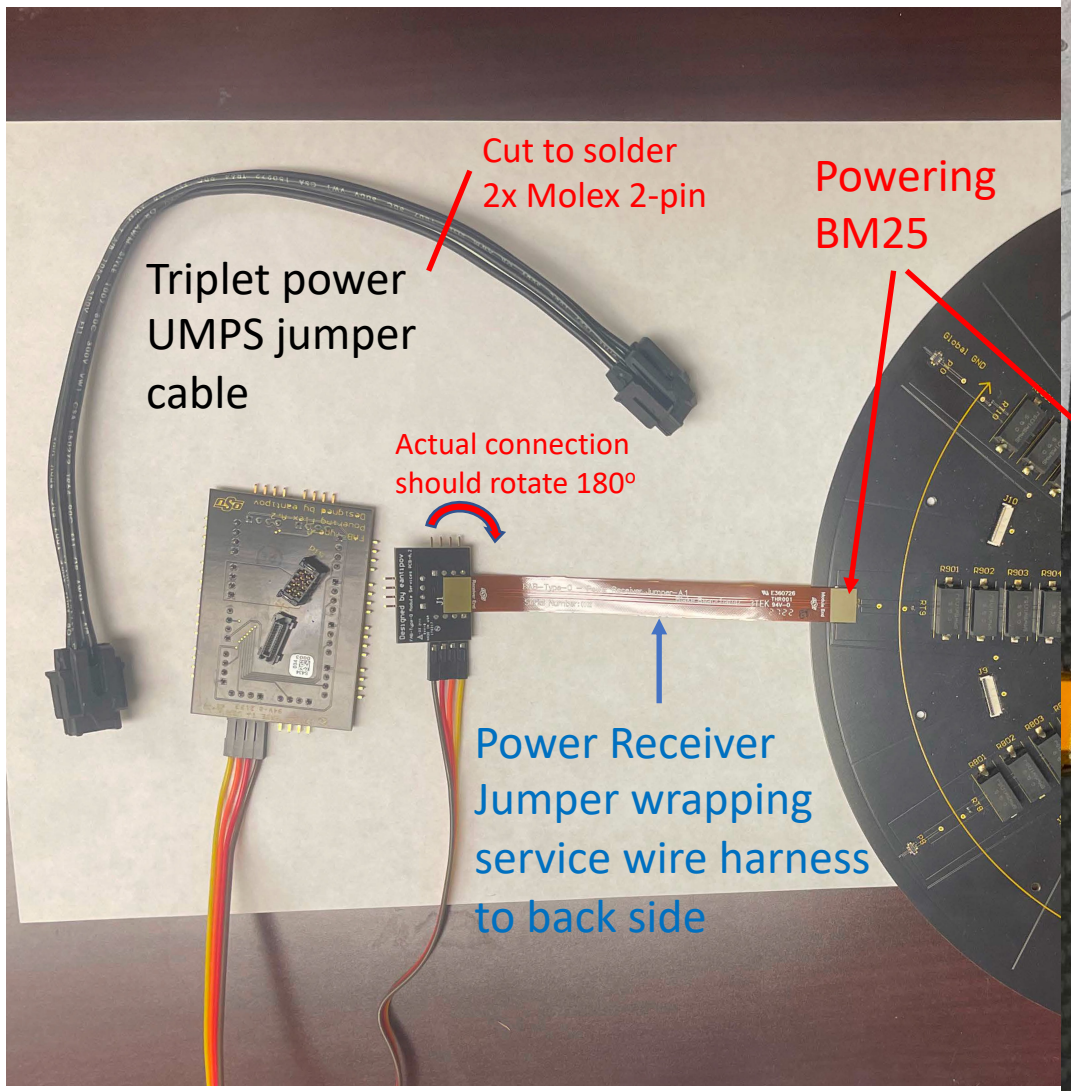
- Module Service Header:
  - BM25 connector interface fan in/out LV/HV/NTC to pin headers
- Module Power Receiver Jumper Flex:
  - Keep compact BM25 header on module to move bulky service header outside the ring
- Ring Service Interface
  - Connect pin header network to Ring Flex connectors for further routing to PP0

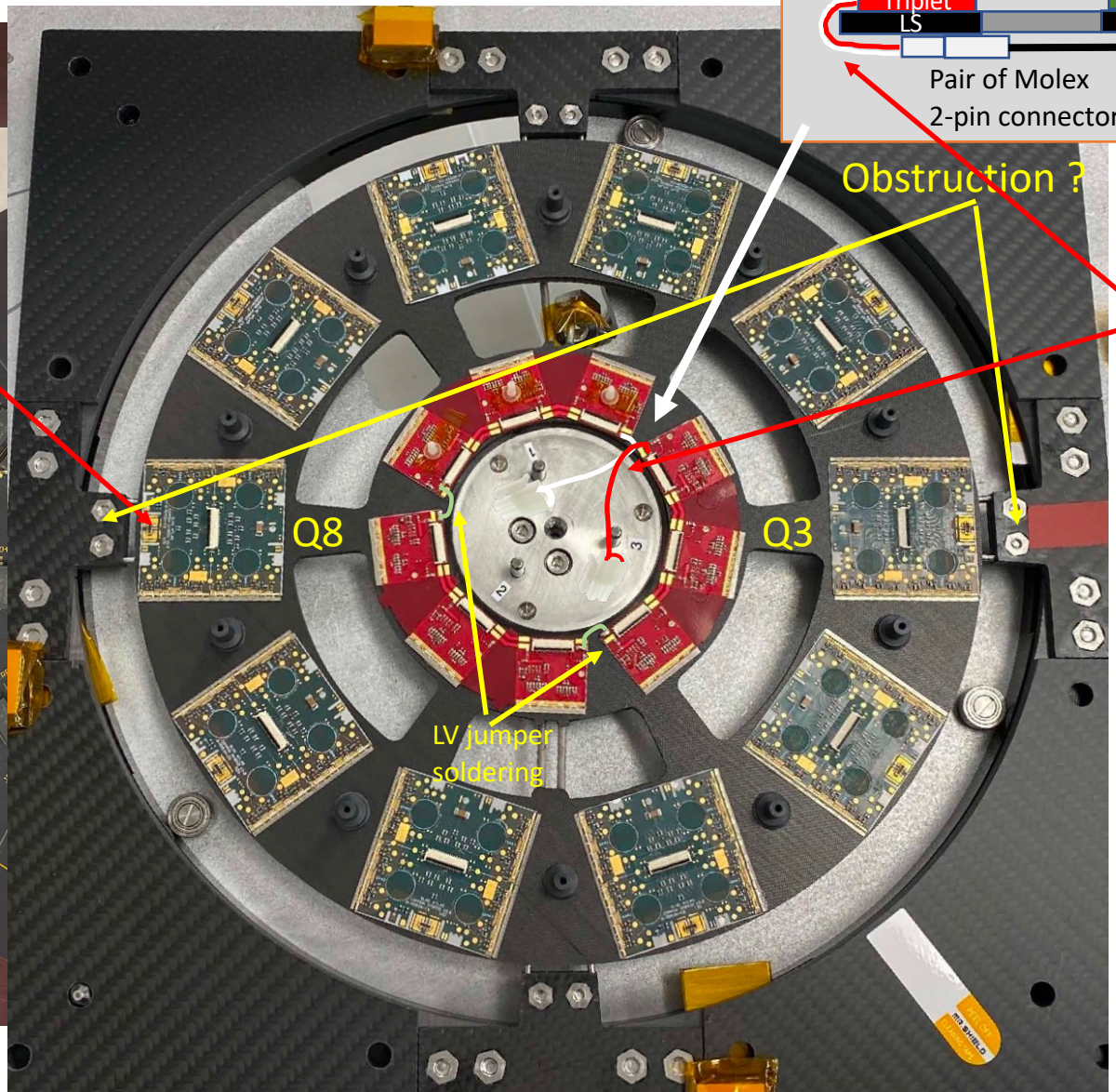


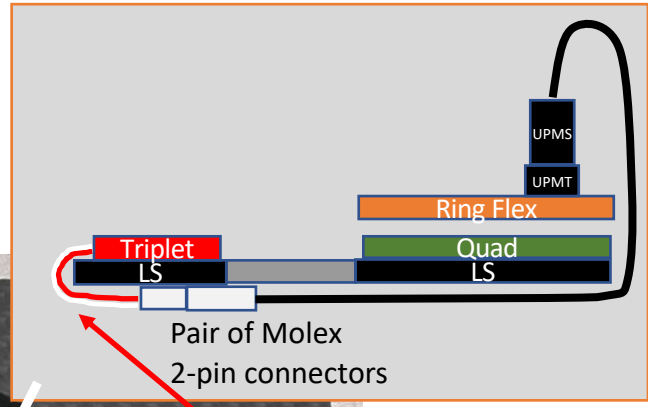

# RD53A Ring Service Top Level Schematic

| Components | Left | Right |
|---|---|---|
| Quads | Q6-10 | Q1-5 |
| Triplets | T2,T3 | T1 |
| LV | SP1(Q) | SP2(T) |
| HV | 3(Q),4,5(T) | 1(Q),2(T) |
| DCS | 6-10(Q), 14-19(T) MOPS | 1-5(Q), 11-13(T) |
| Interlock | INT_2 | INT_1 |

# Service Header Flex Mounting Topology



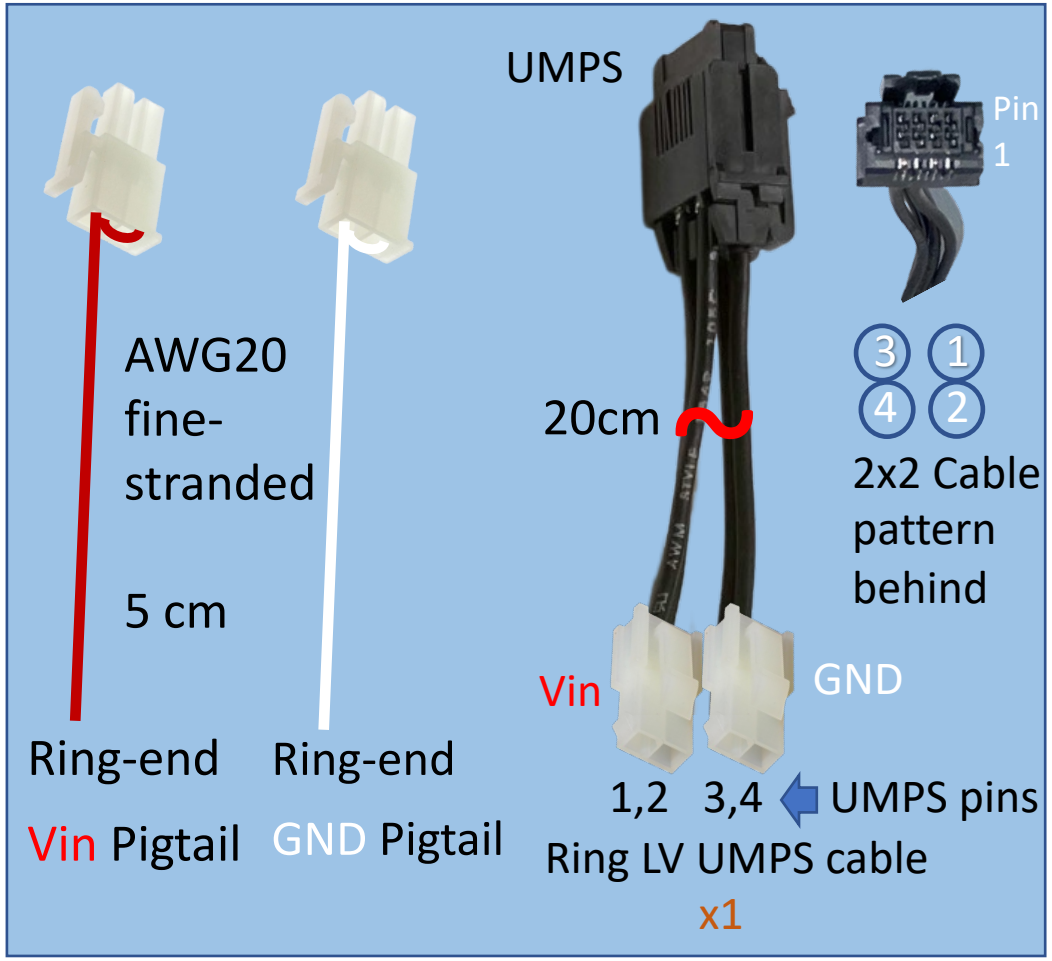



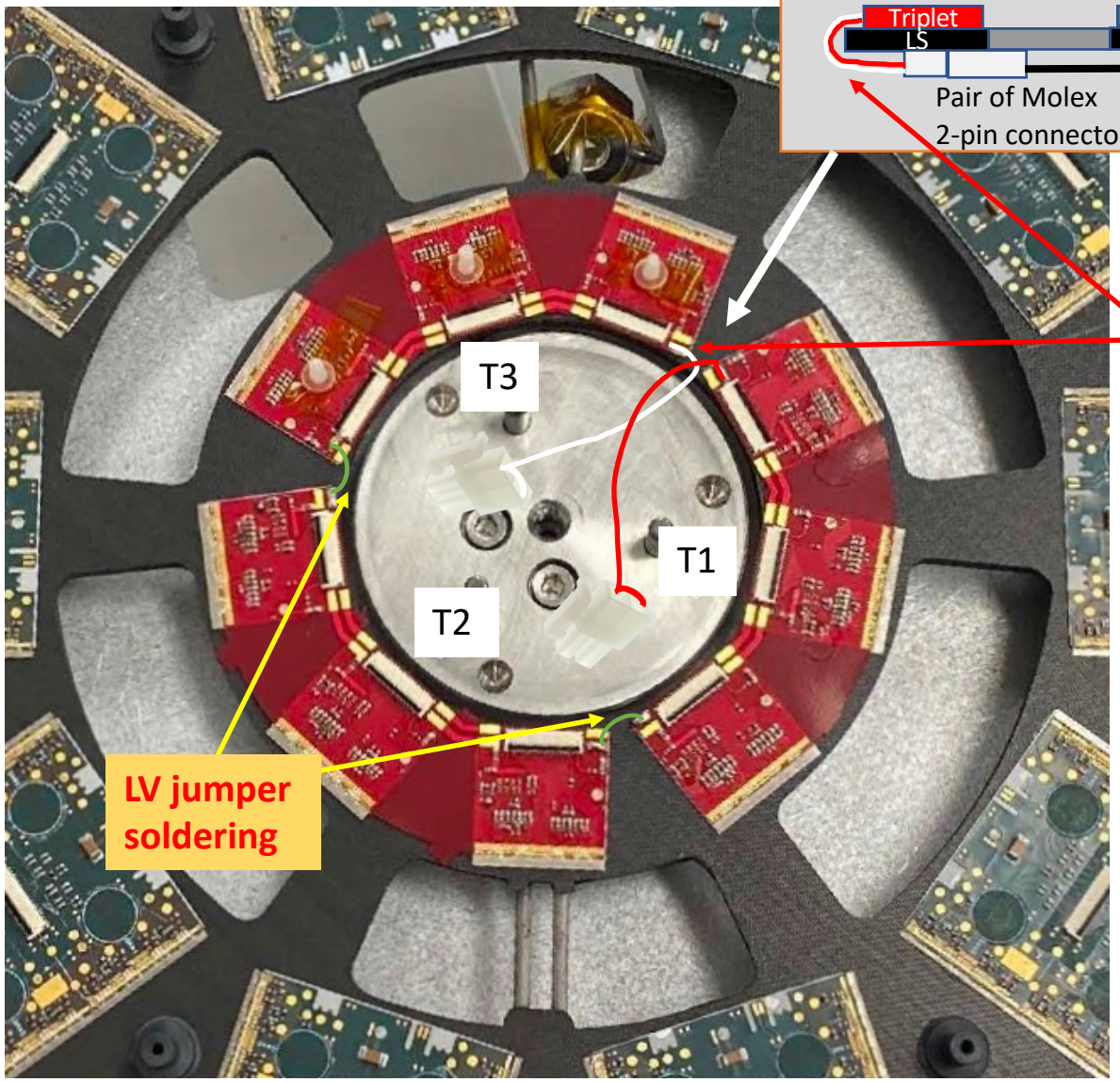

Triplet SP end point strain-relief crucial !

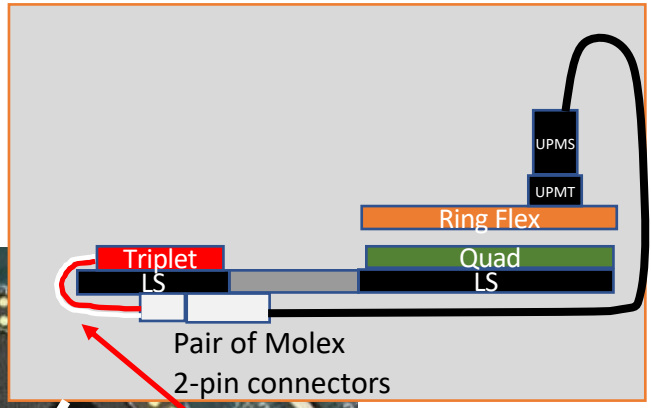
Q3/Q8 power flex wrapping over frame too tight ?

# Triplet Power SP Chain Connections

## Prepare pieces

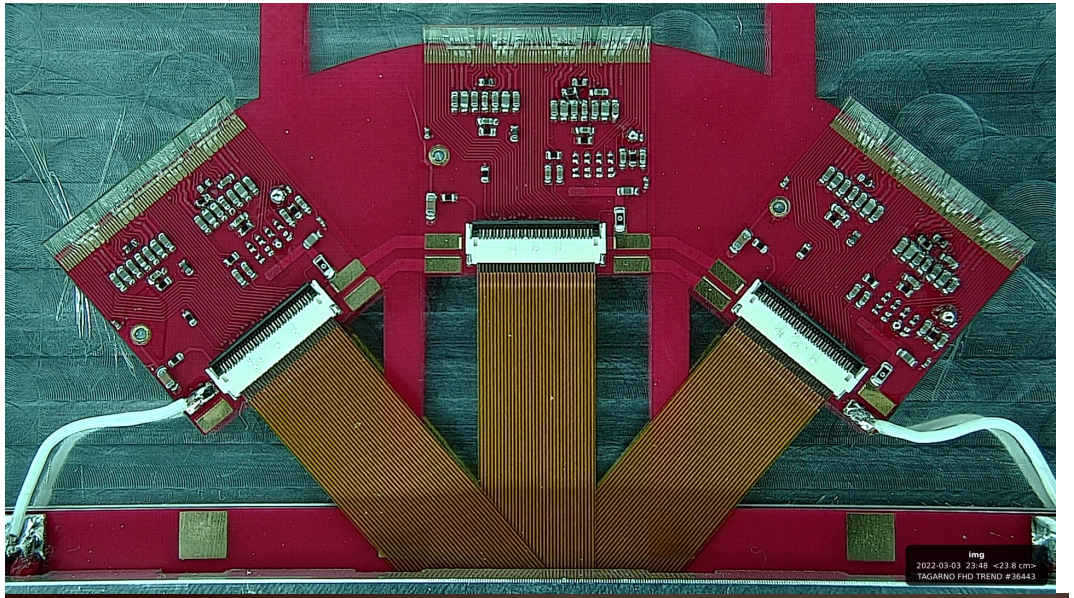


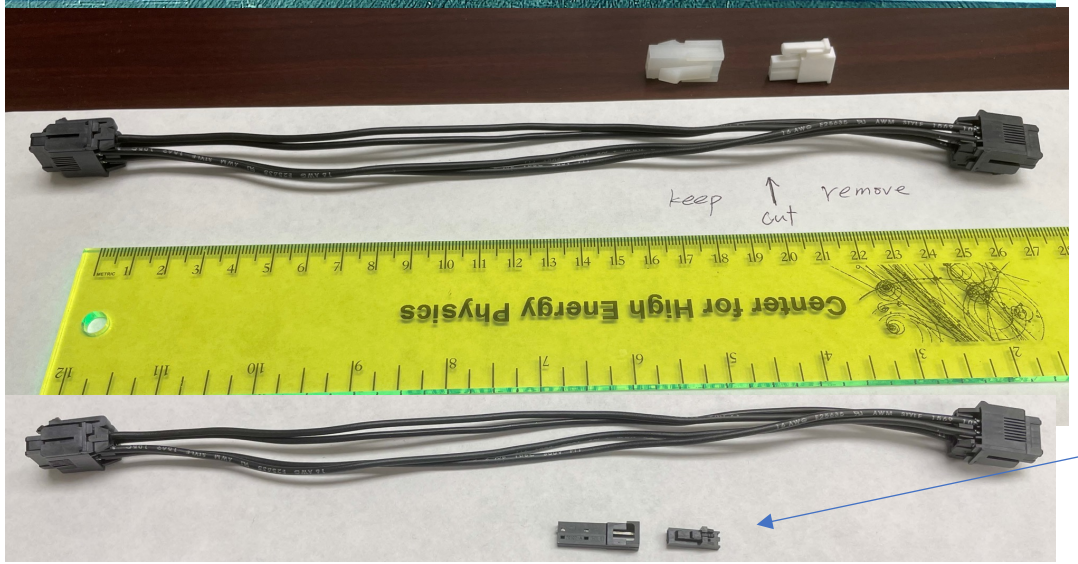




Triplet SP end point strain-relief at the back crucial !

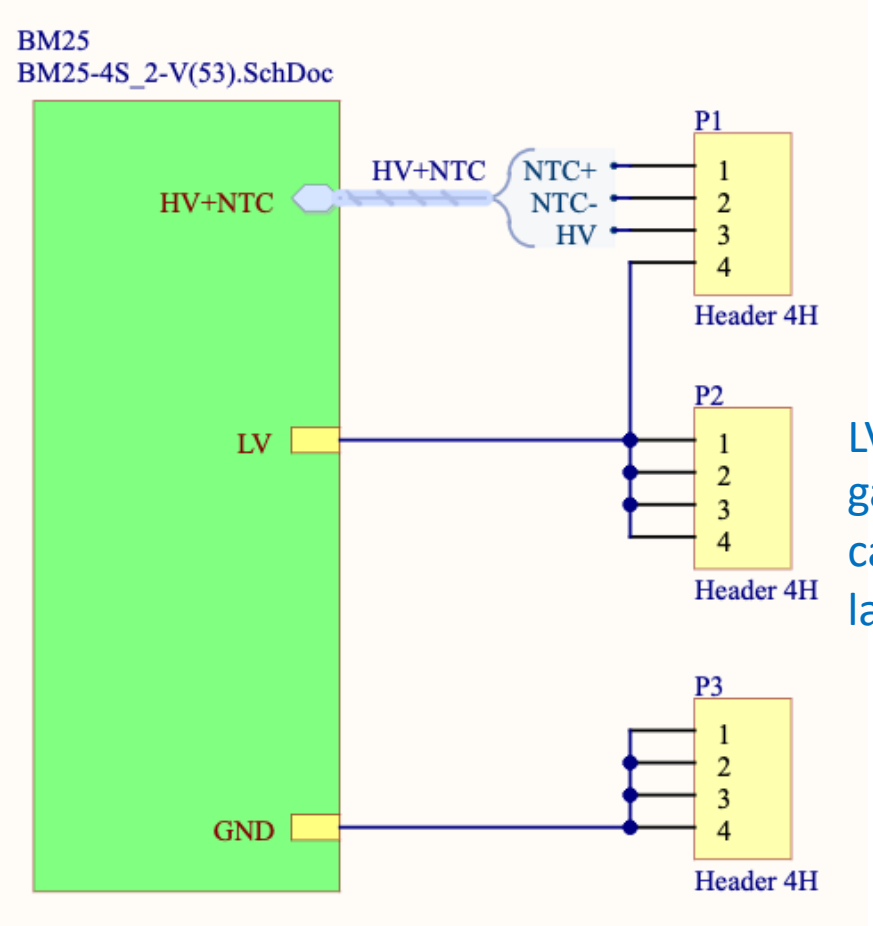
# Triplet LV Cables and Soldering



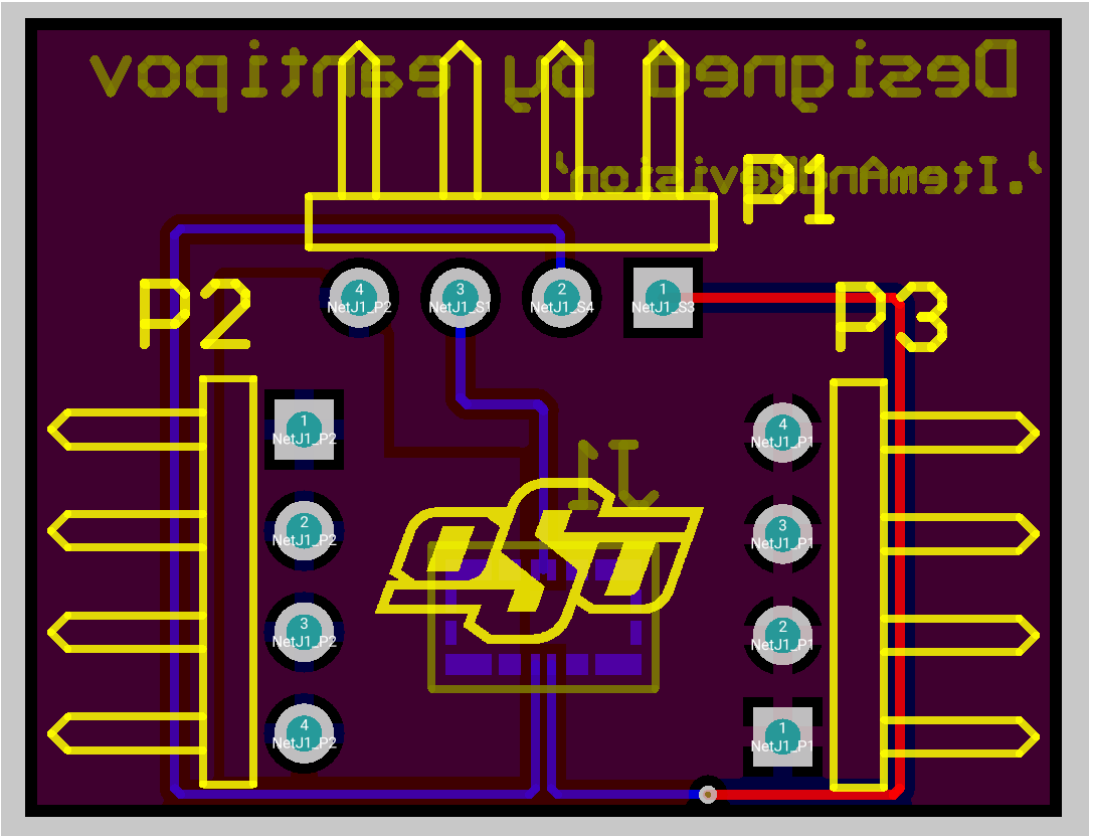



- Triplet LV pads ~ 2x1mm in size. AWG20 may be the best fit ($\phi$=0.81mm) for max soldering contact. Spreading out fine strand slightly and soaking well solder would help.
- UMPS cable bundle has AWG16 wires. Two wires (pin 1,2) ganged for Vin and two wire (pin 3,4) ganged for GND.
- Many disliked to solder cut UMPS cable directly to triplet pads – too heavy a hanging object. Molex power connectors on shorter pigtails are quite a bit lighter (only considering what Lupe has in stock). Pin headers to thin for 5A, would need multiple pins – not easy to arrange against single pigtail wire.
- Baseline 2 pin connector can naturally take in the 2-ganged UMPS cable, but inside pigtail needs a jump to utilize two sockets.
- A 1-pin Molex header looked attractive in an earlier investigation, but can barely crimp AWG20, and AWG16 doesn't fit. This option was dropped.

# Module Service Header Pinout

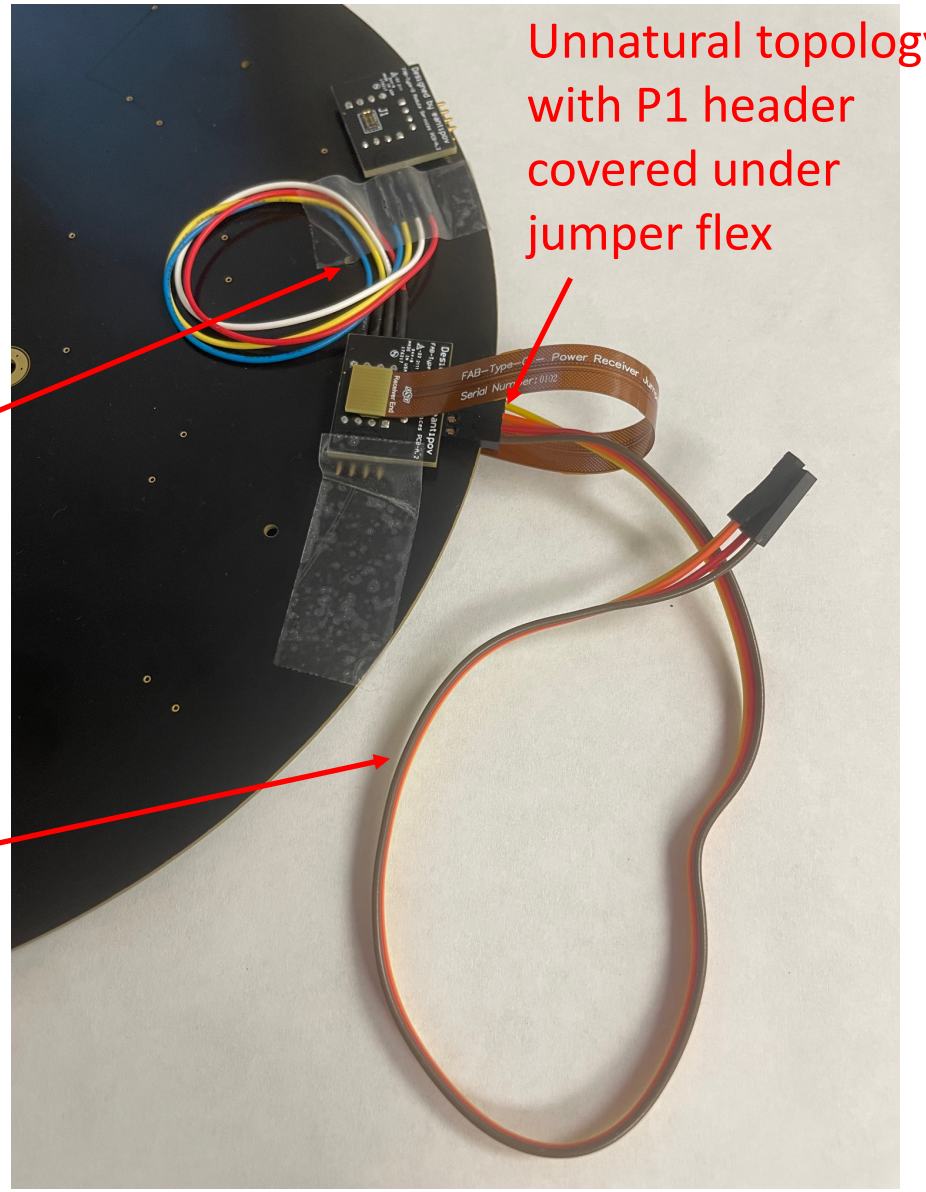



LV 4-wires ganged to carry large current



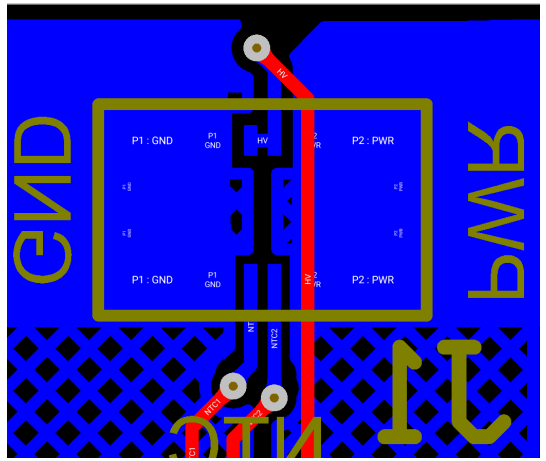
# Pin Header Wire Harness on Backside

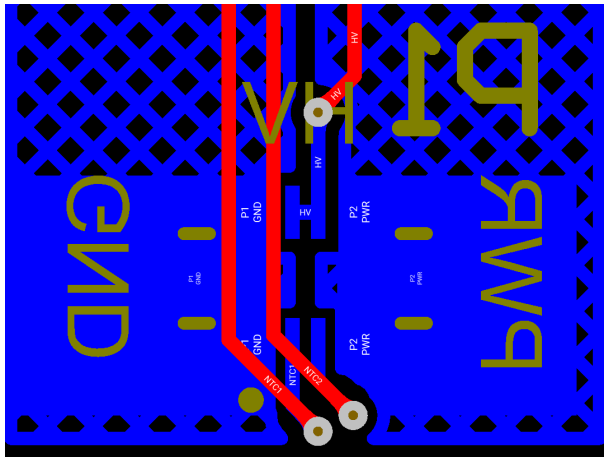
- Needs a service support ring at the back (tube-up) side to mount the Module Service Headers on.
- Side way LV SP chain jump between neighboring Service Headers are awkward short paths. Jumper loops with shorter wires ?
- NTC/HV/Vmon ribbon need long path routing with wrapping over to front for connections on Ring Service Interface PCB.



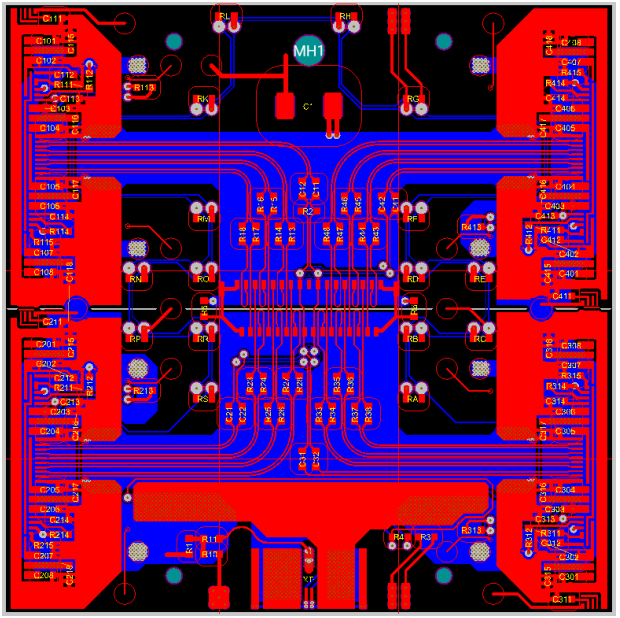
# Power Jumper Header Orientation

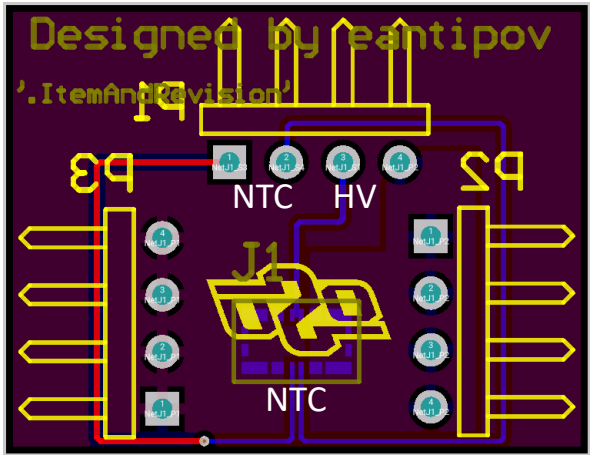
- Planar view from above as how you would connect if components on table
- The naïve natural orientation of P1 pointing outwards would cause NTC<->HV swap so that ganged HV would short NTC.
- Unnatural topology with power receiver P1 header covered under jumper flex is due to jumper flex with BM25 on same face.



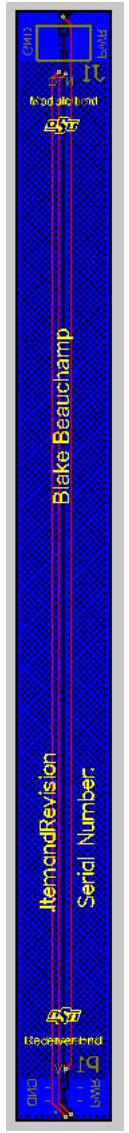

Quad module BM25 face up




Power Receiver BM25 face up

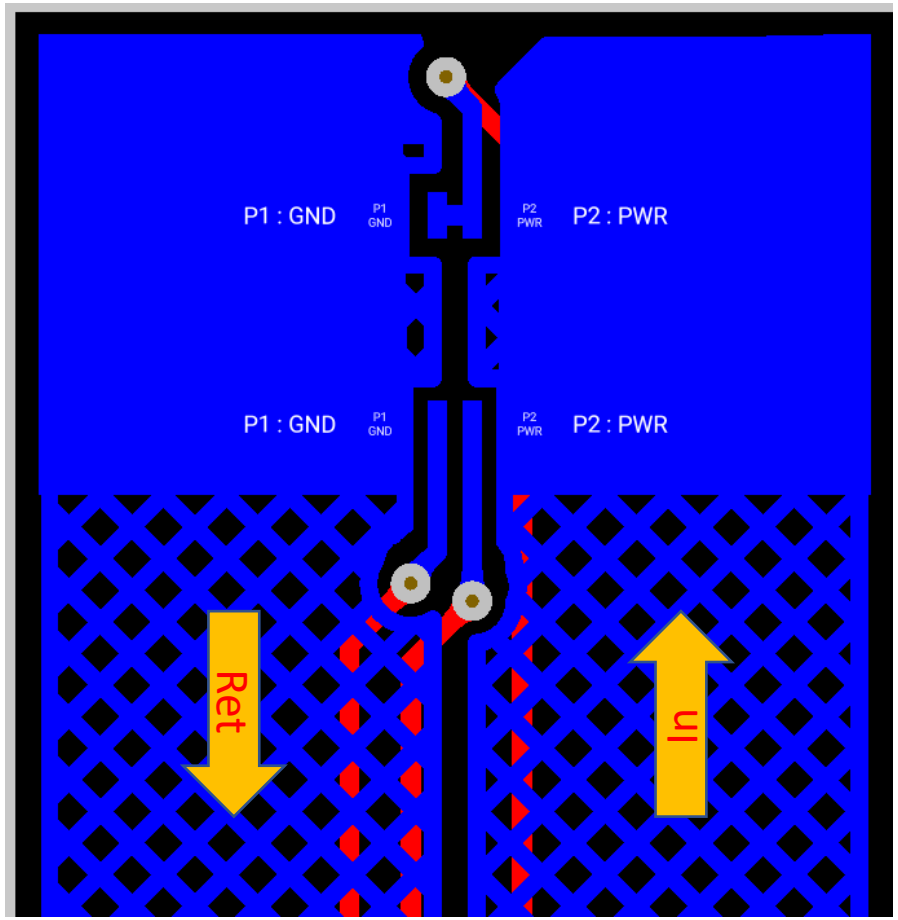
Flex BM25
Face down



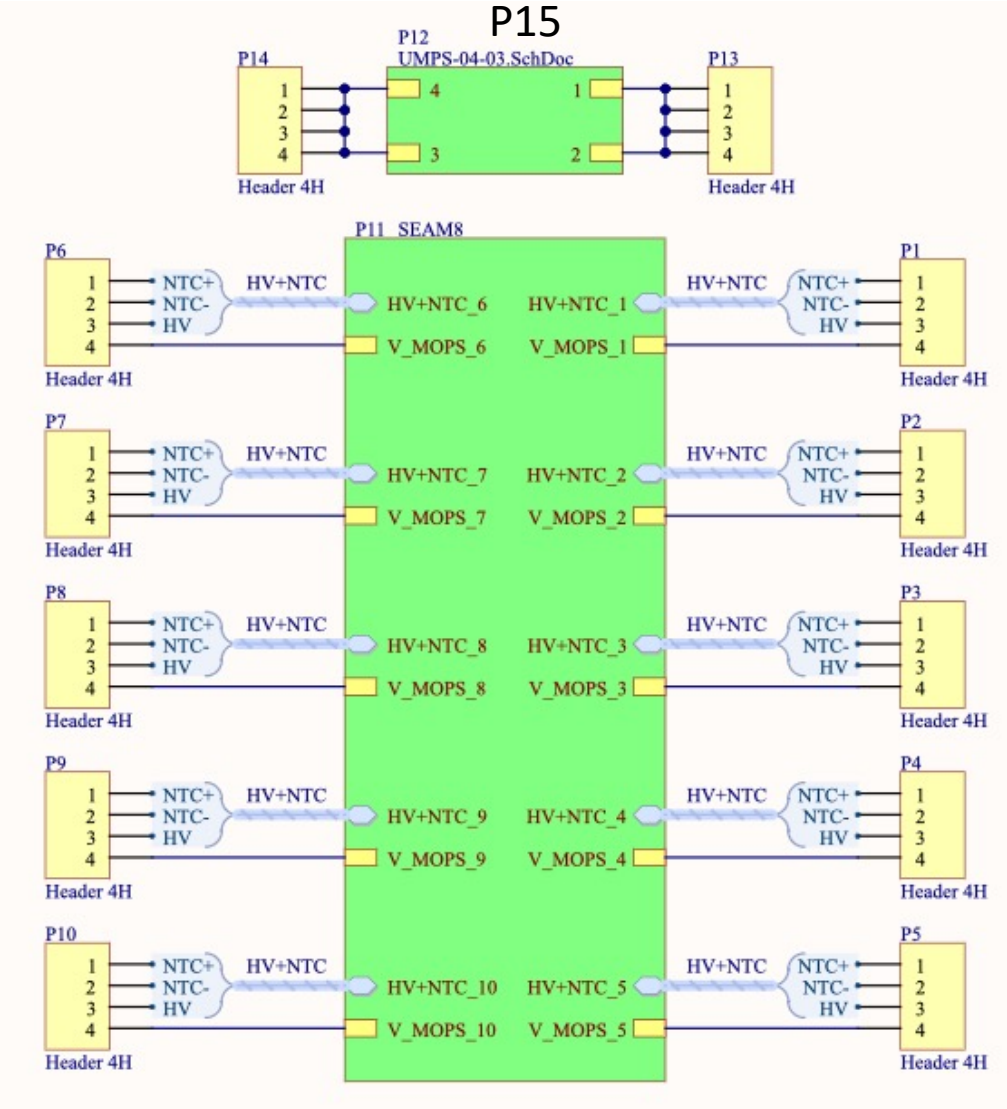
# Power Jumper Flex LV Drop

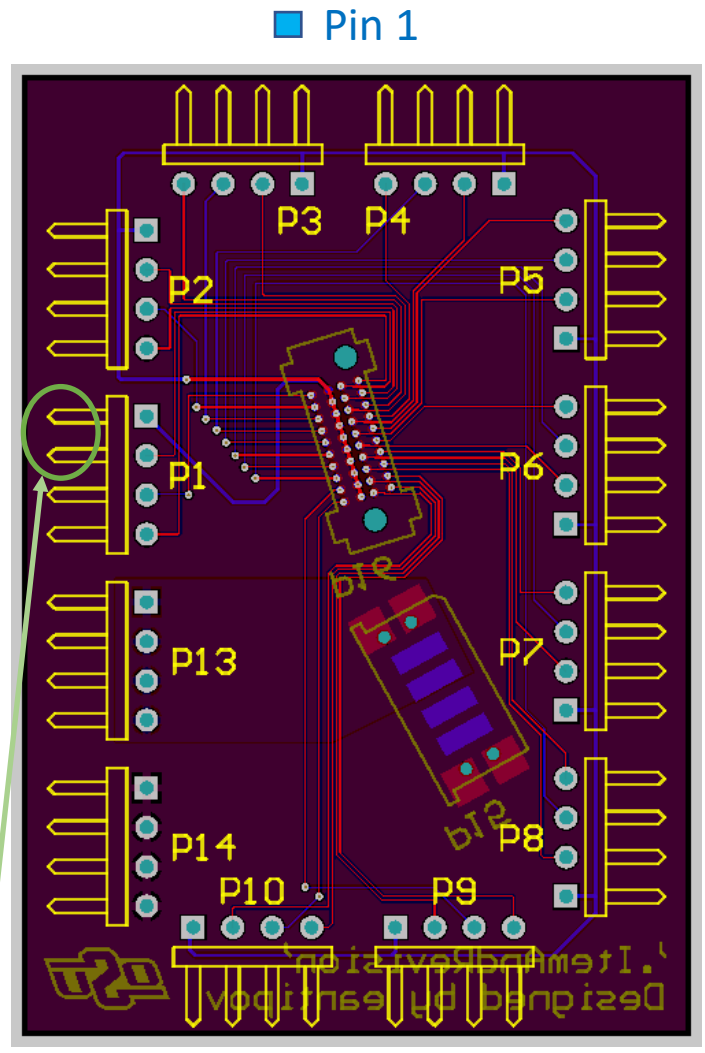
- Power jumper header measured local (Vin-GND) ~2.1V for Isp~4A, while module test power adaptor typically ~1.8V.
- Jumper flex LV path is a single meshed layer divided into In/Ret halves.
- Flex L=116mm, W=10mm, Cu mesh fill factor ~0.64. Used 0.5 Oz Cu (17μm thick). Tried to use 1 Oz Cu in design, but ran into compatibility issue with fine connector pitch.
- => In+Ret round trip path resistance ~0.073Ω, or δV~0.29V @ 4A

  [note: this is at similar level as 3m Type-1]

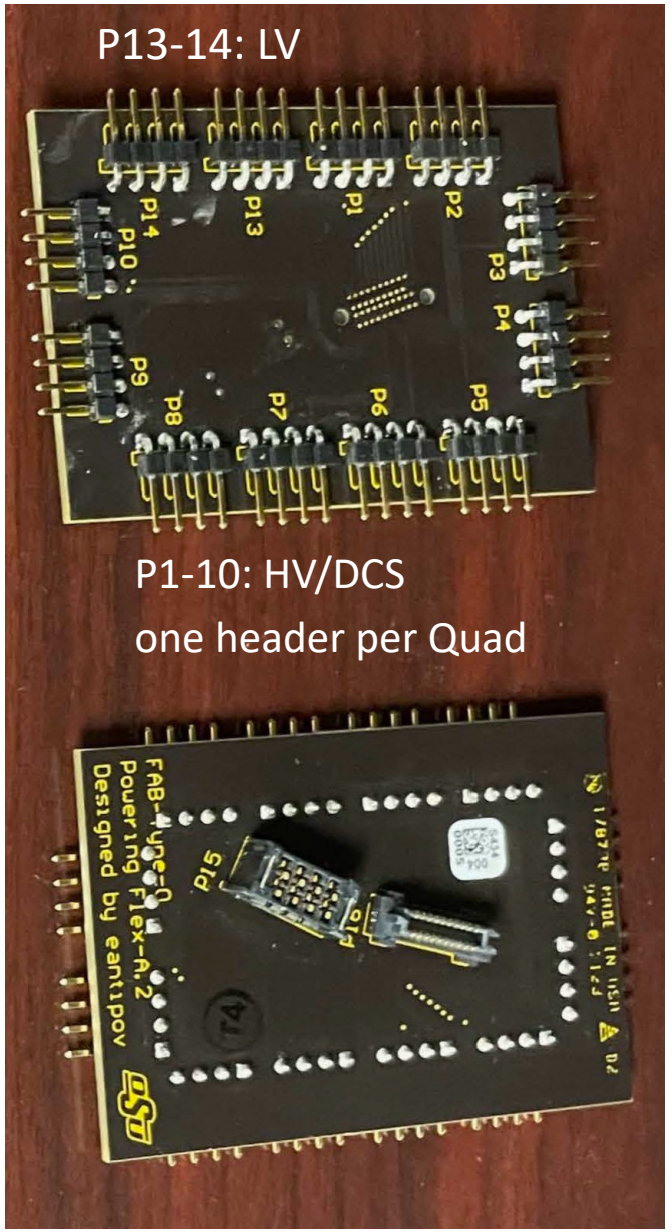


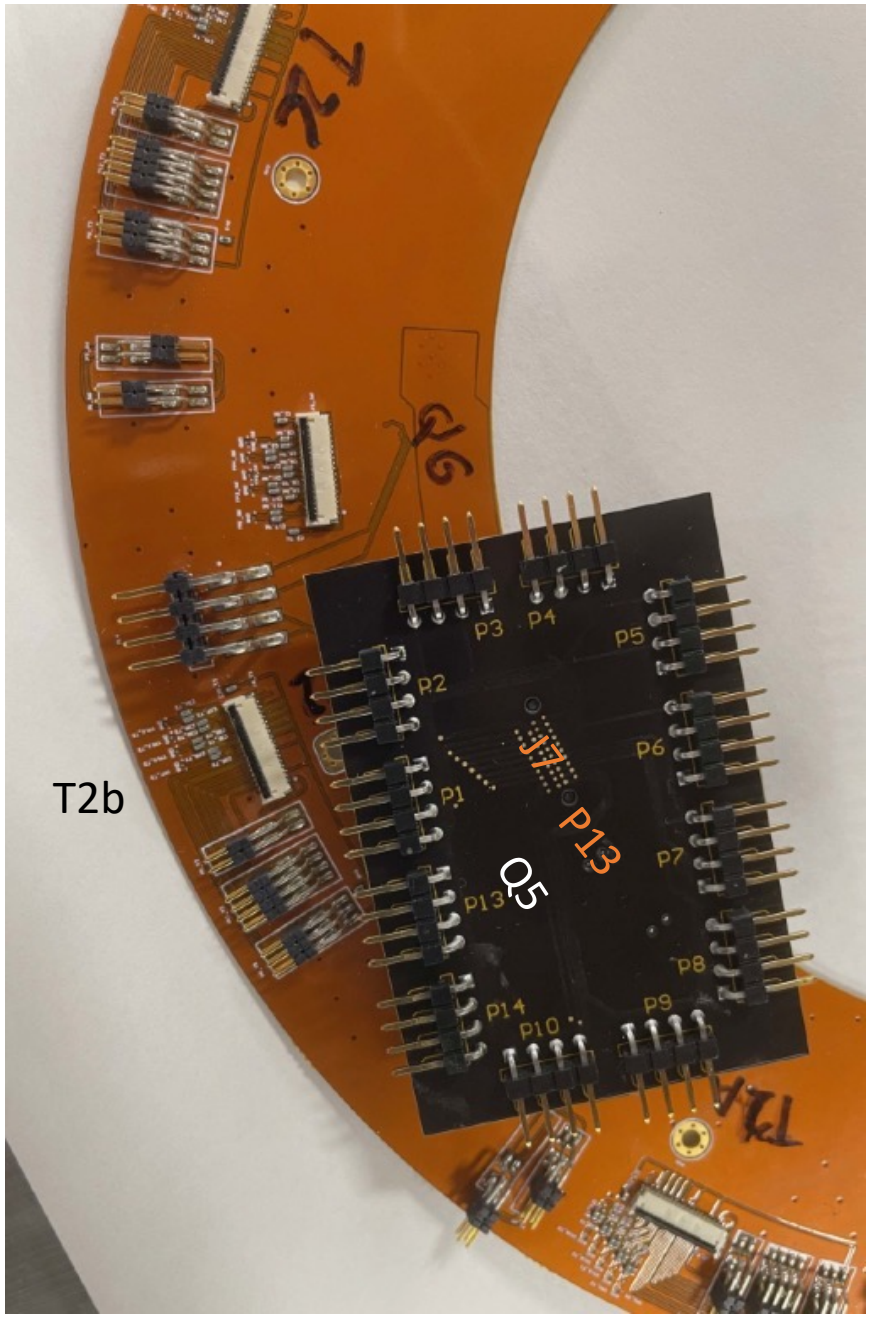
# Ring Service Interface PCB for Quads



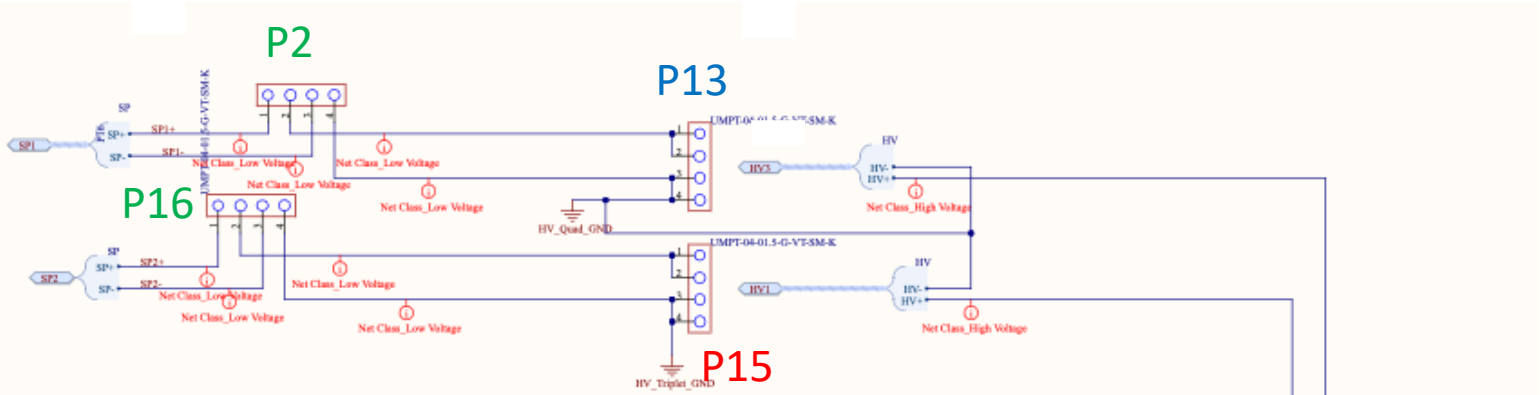

NTC_1 on P1 pins 1-2 is Quad Interlock
Not monitored by MOPS

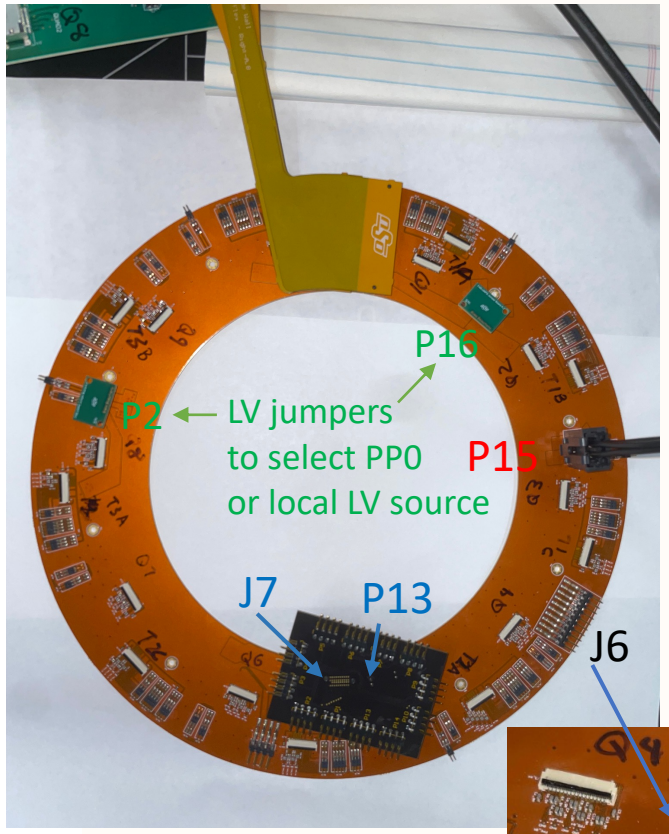


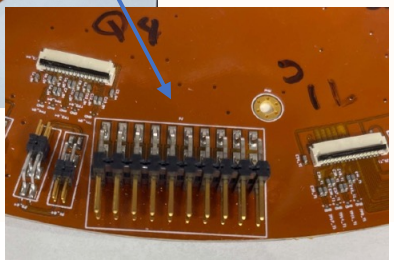


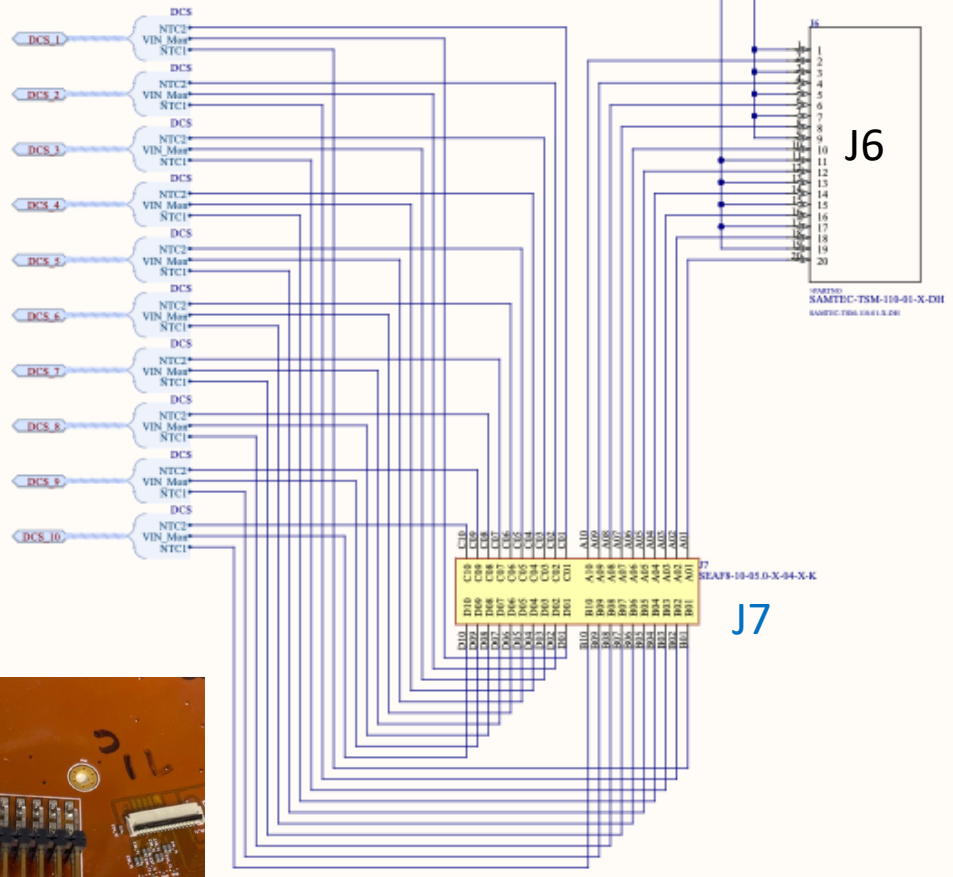

# Ring Service Interface Mounting Conflict

- With the Service interface card on, no longer possible to plug in Q5 data flex.
- Triplet T2b data flex also tricky. The 1 triplet FE $\phi$ shift (40$^o$) connection helps in the right direction to avoid J7.
- Pin header wire ribbons for 10x HV/DCS pin headers (1/Quad) have various lengths from different locations on the Ring. Needs sensible routing/dressing.



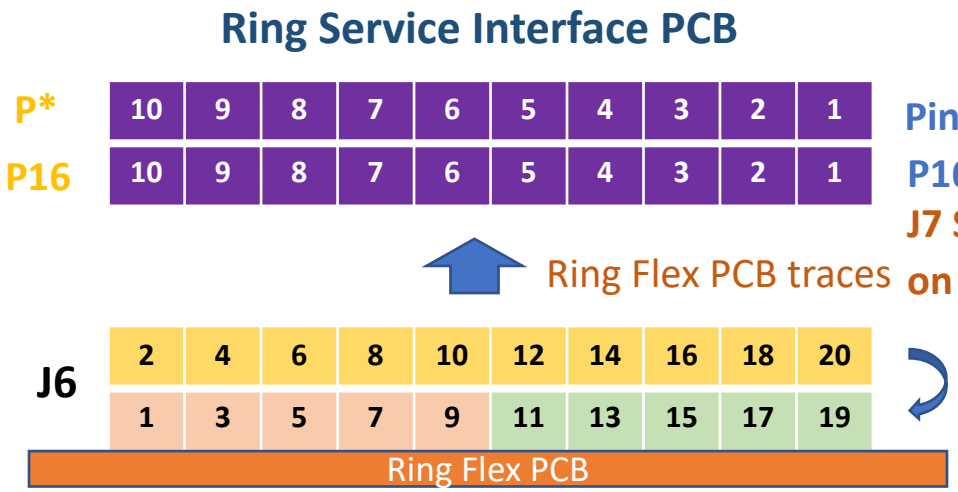





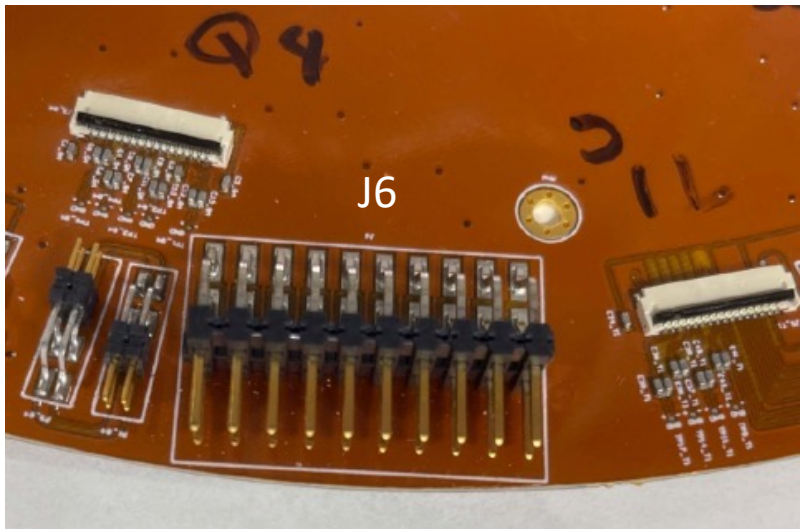

# LV/HV Network

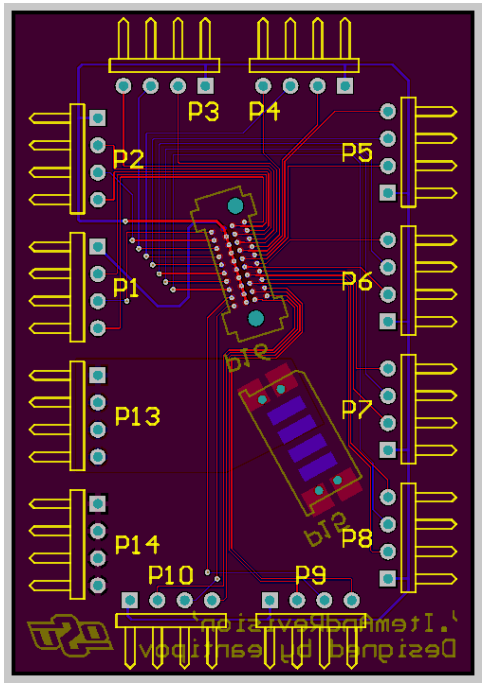
- LV SP1 supplies Quad power
  - Ring Service Interface PCB at P13 connected to Quad SP chain wire harness.
- LV SP2 supplies Triplet power
  - UMPS-banaba jumper cable at P15 to connect Triplet SP chain end point banana at backside.
- Shorting power jumpers P2/P16 select LV sources from PP0 or locally injected power source. (jumper ON=from PP0)
- J6 pin header array selects HV from PP0 or external source for individual Quad.
- Pin headers near each Triplet ZIF selects HV from PP0 or external source.

# Quad HV J6 Selections

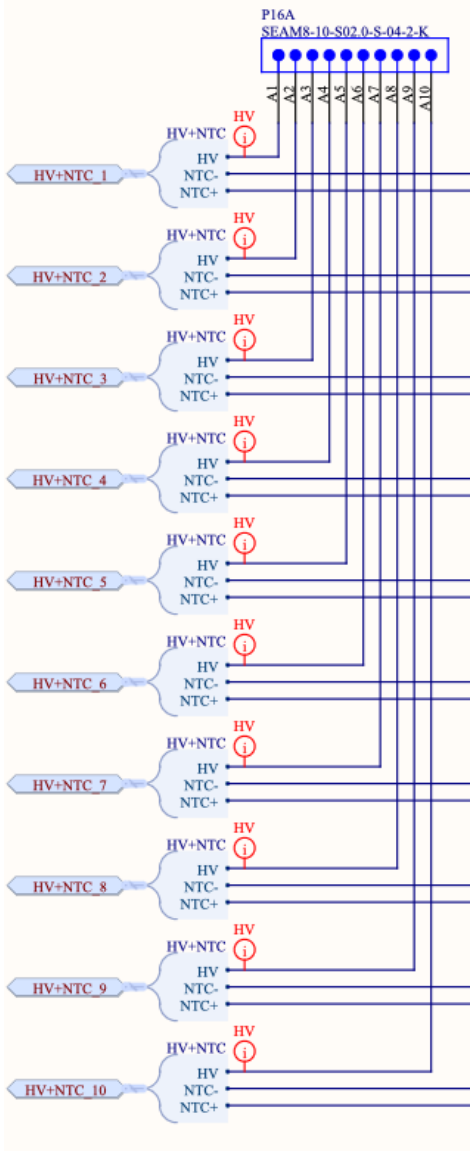



2-pin vertical jumper to set each Quad independently



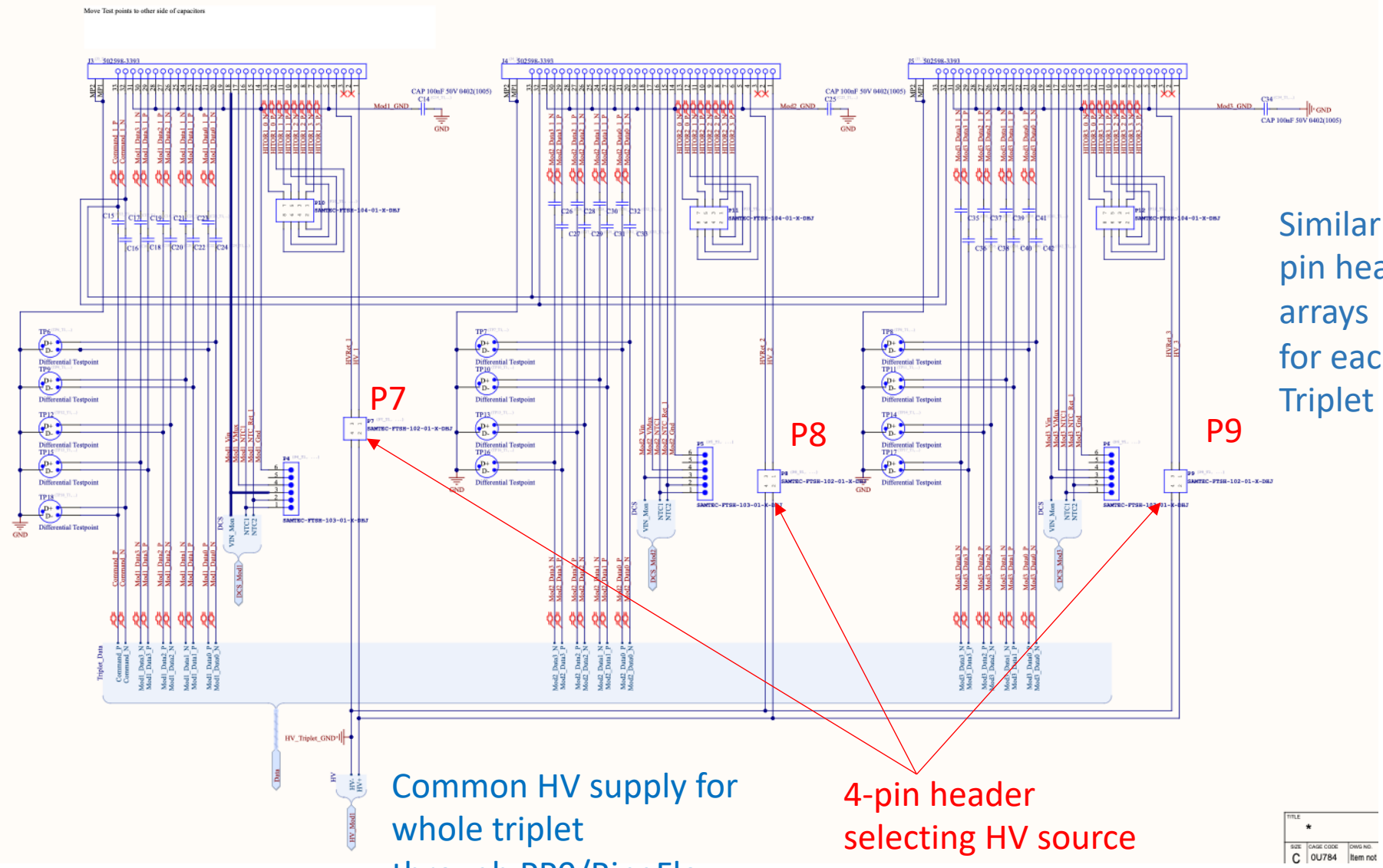

HV = Blue traces to pin 3 of each of P1-P10 Headers




Jumper
ON = from PP0/Ring
OFF = connect your external HV supply top row pin

| | |
|---|---|
| J16 Pin 1,3,5,7,9 | ganged to Ring HV3 |
| J16 Pin 11,13,15,17,19 | ganged to Ring HV1 |

# Triplet HV Control

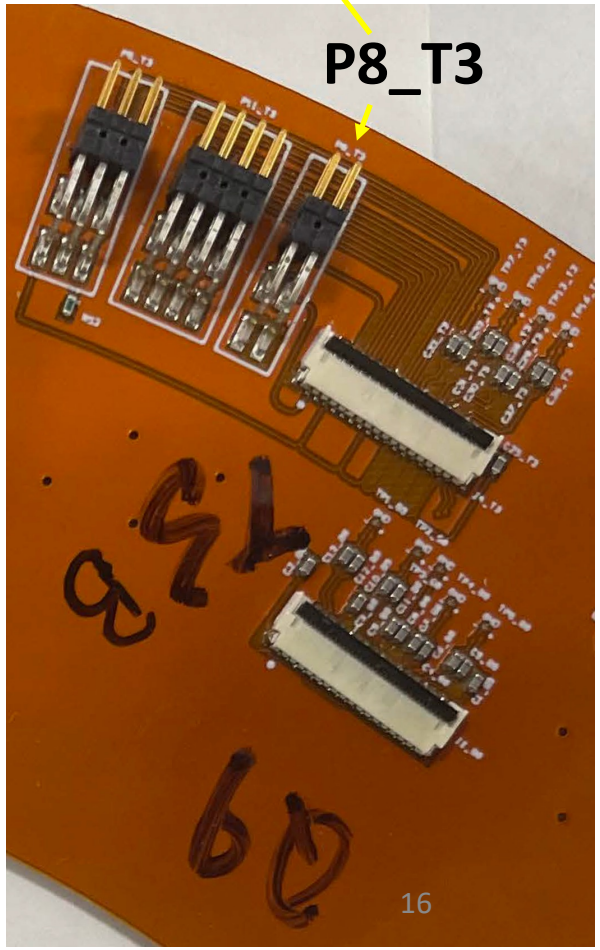



| HV Ring | $HV_{ret}$ Ring |
|---|---|
| HV Module | $HV_{ret}$ Module |

Ring PCB

Vertical Jumpers Select Ring HV

Similar pin header arrays for each Triplet FE



External Interface

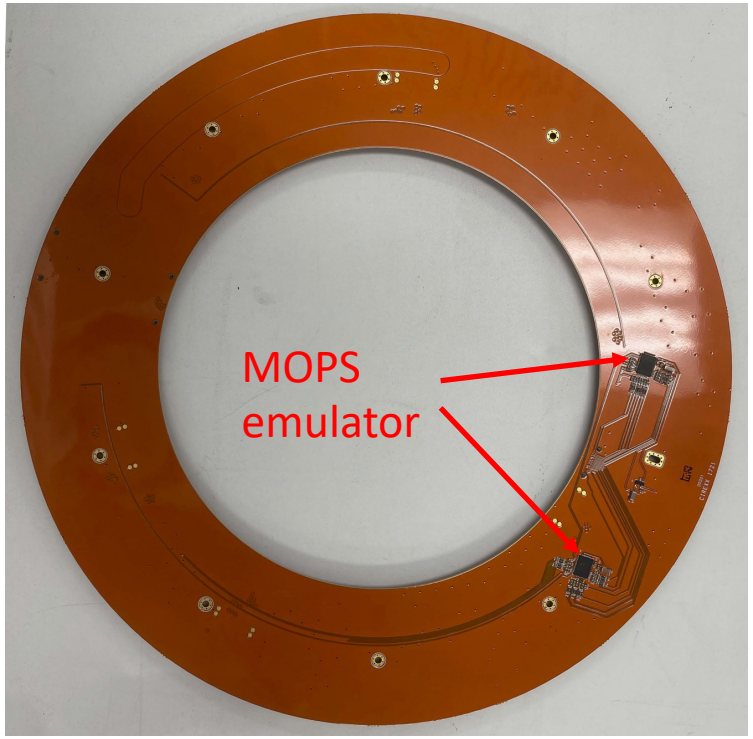
CAN
$V_{CAN}$(5V)

Regulator
‘5V’->1.6V

# DCS Montoring via MOPS Emulator

Quad Interlock (INT_1) fixed to DCS_1 (Interface P1)

Triplet Interlock INT_2 fixed to DCS_11 (T1A)

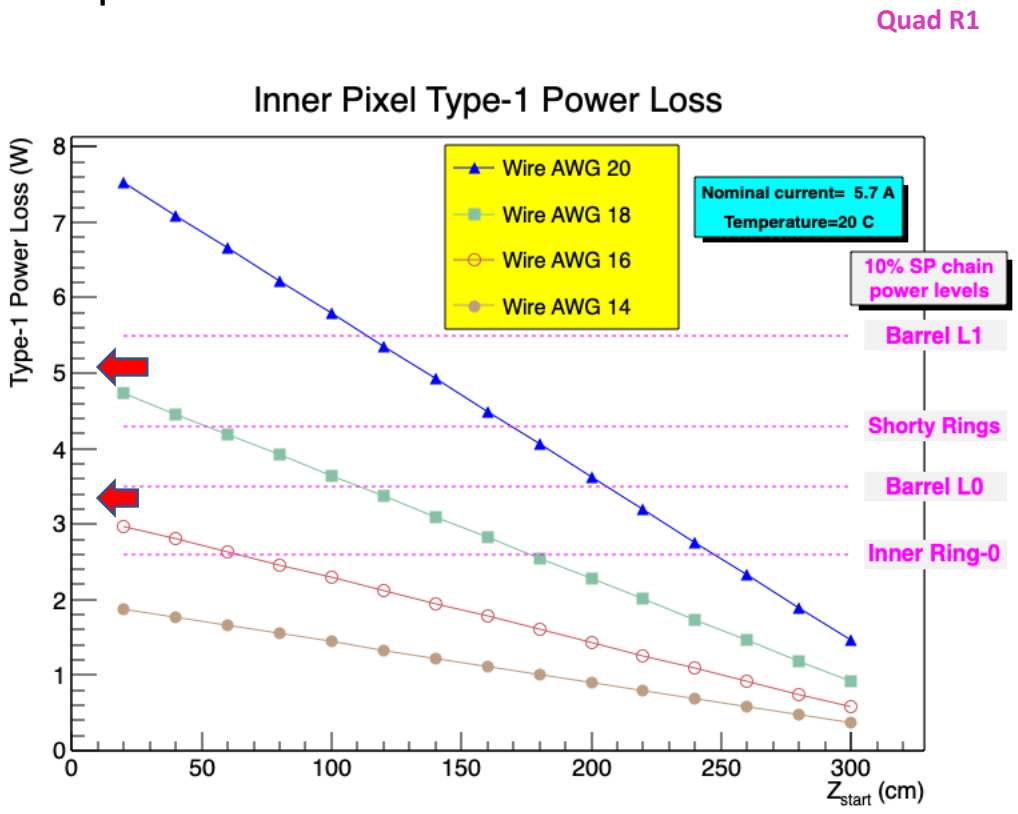


# PP0/Type-1 Interface

- Eventual system design for Type-1 LV wire sizes are based on power loss quota of 10%*detector power for Type-1 stage
- => R1 Quad AWG18 ; R0 Triplet AWG16

Type-1 wire gauge not so important for QC box setup, but need to be prepared for the voltage drop along Type-1: the In+Ret resistance over 2*3m are:

- AWG16: 75 mΩ
- AWG18: 108 mΩ




P2/P3 LV UMPT PP0 printed labels for Triplet/Quad are opposite of actual Ring design