

Si Detectors Power & Cabling

Preliminary Design Review for Si Detector Power & Cable Requirements
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It looks like the cable sizing specified from the Nov 11th meeting are a bit overestimated at 14AWG. The **ITS-3 sensors** analog and digital voltage requirement is **1.2V**.

I-Digital: ~500ma @ 1.2V

I-Analog: ~200ma @ 1.2V

=> add %20 for power conversion losses

ITS-3 Power: Total => ~850ma * 1.2V = 1W => coincides with 1W power estimates

- ⇒ So, a *1x9 sensor module* will draw ~8.0A...meaning that 16AWG cable is required (~0.55cm cable diameter).
- ⇒ Direct PSU cabling from racks to detector at 1.2V is not practical to implement, and the sheer mass of copper cabling would interfere with beam.

Practical Approach Methods to power PIXEL detectors:

-> Two powering schemes are being considered.

1- Use CERN rad/magnet tolerant DC/DC converters mounted on a PCB ***assembly inside the detector***

Looking at PN: bPOL12V

2- Series powering using a Voltage Regulator ASIC (*possibly mounted on 1x9 sensor module*) NOTE: **Referencing** R&D Project eRD104

- example: **powering 4X of 1x9 modules** => supply to each is 48V @ 1A => (36W / 48V = 750ma -> with losses ~1.0A)

Both topologies 1 & 2 are under investigation and are intended to greatly reduce cable mass required.



Si Detectors Power & Cabling: Power Regulator Board

bPOL12V_V6



Radiation tolerant 10W Synchronous Step-Down Buck DC/DC converter

Features

- Input voltage range 5.5 to 12V
- Continuous 4A load capability

14W Power Regulator

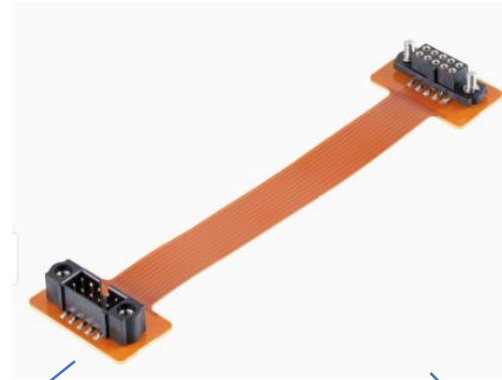
2x bPOL12V => D Power (NOTE: need separate rails. Not recommended to parallel bPOL12V)
i.e. Power 4x ITS-3 and 5x ITS-3 chips

1x bPOL12V => A Power

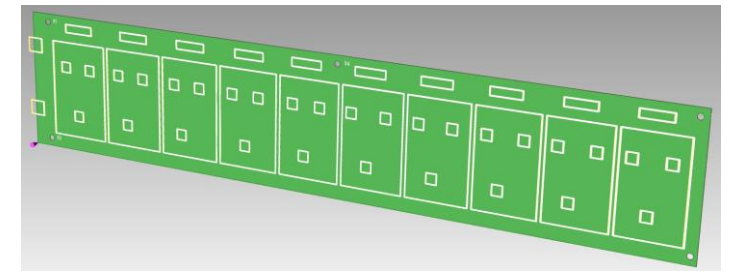
Powers single 1x9 module

Meeting on Jan/9 to discuss powering options w/ CERN power group

POWER per each 1x9 module
D Power => 0.5A x 9 = 4.5A => 5.4W
A Power => 0.2A x 9 = 1.8A => 2.16W



Custom 4 Layer PCB ribbon cable
 Powers each 1x9 module
 Length should be optimized depending on PRB location
 Harwin connector PN: [M80-5021042](#) shown as example



Power Regulator Board (PRB) 13.25 x 2.64 93mil PCB

Quantity of 10 Channel Boards Required:

42x => Electron side

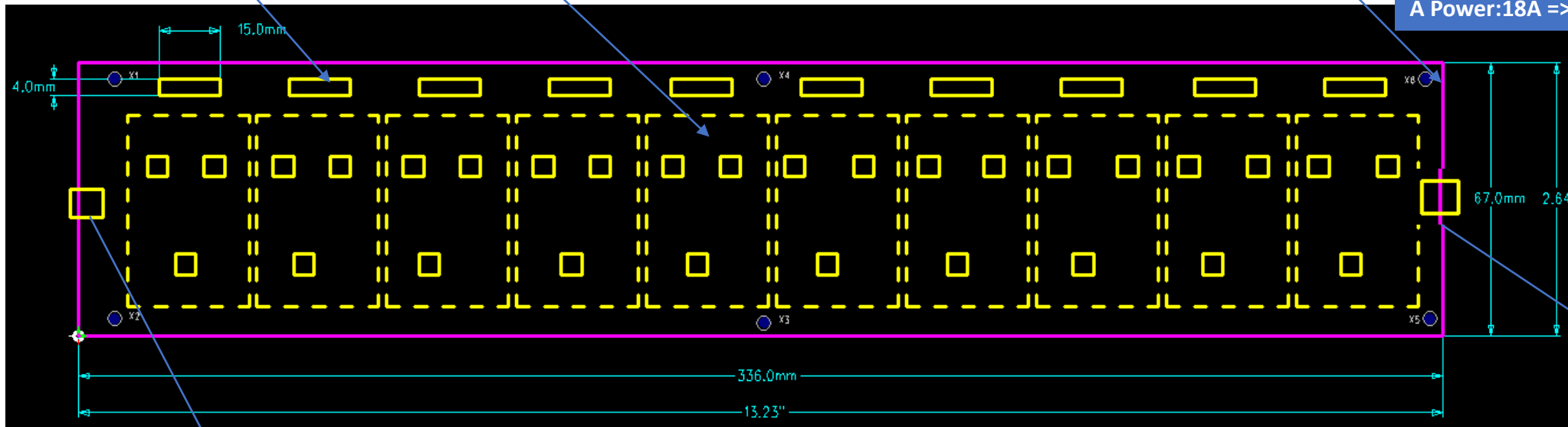
48x => Hadron side

130x => Disk

Total Power Supplied

D Power: 45A => 54W

A Power: 18A => 22W



Power Input
3-pin Molex Connector

Regulator footprint based on STAR sTGC ROB

3-pin Molex connector
 Power pass through the next regulator board

A 12V in @ 2.0A

D 12V in @ 4.5A

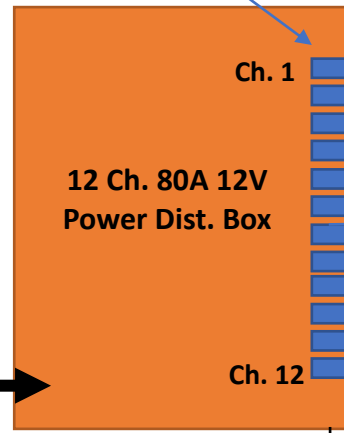
Option 1: Power Regulator Board (PRB): Distribution power cabling

Required LV cable from DIST box to Power Regulator Boards:

16 AWG 3-Conductor: Belden PN 85103: Cable Ø 5.4mm

1x Cable / PRB with conductor from magnet ground

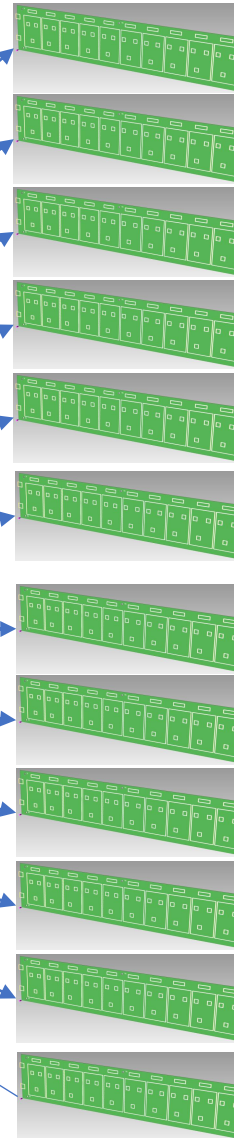
3-pin Molex connector
+ Power
- Return
Magnet Ground



2 Cond. 6AWG Cable from rack PSU
Floating power
Remote sense

Examples: WIENER PL506/ PL512

Magnet Ground
Power commons tied to single
point magnet ground at
detector side



12 X Power Regulator Boards

Powers 10x 1x9 Modules

Custom 4-layer PCB ribbon cable
See slide #2

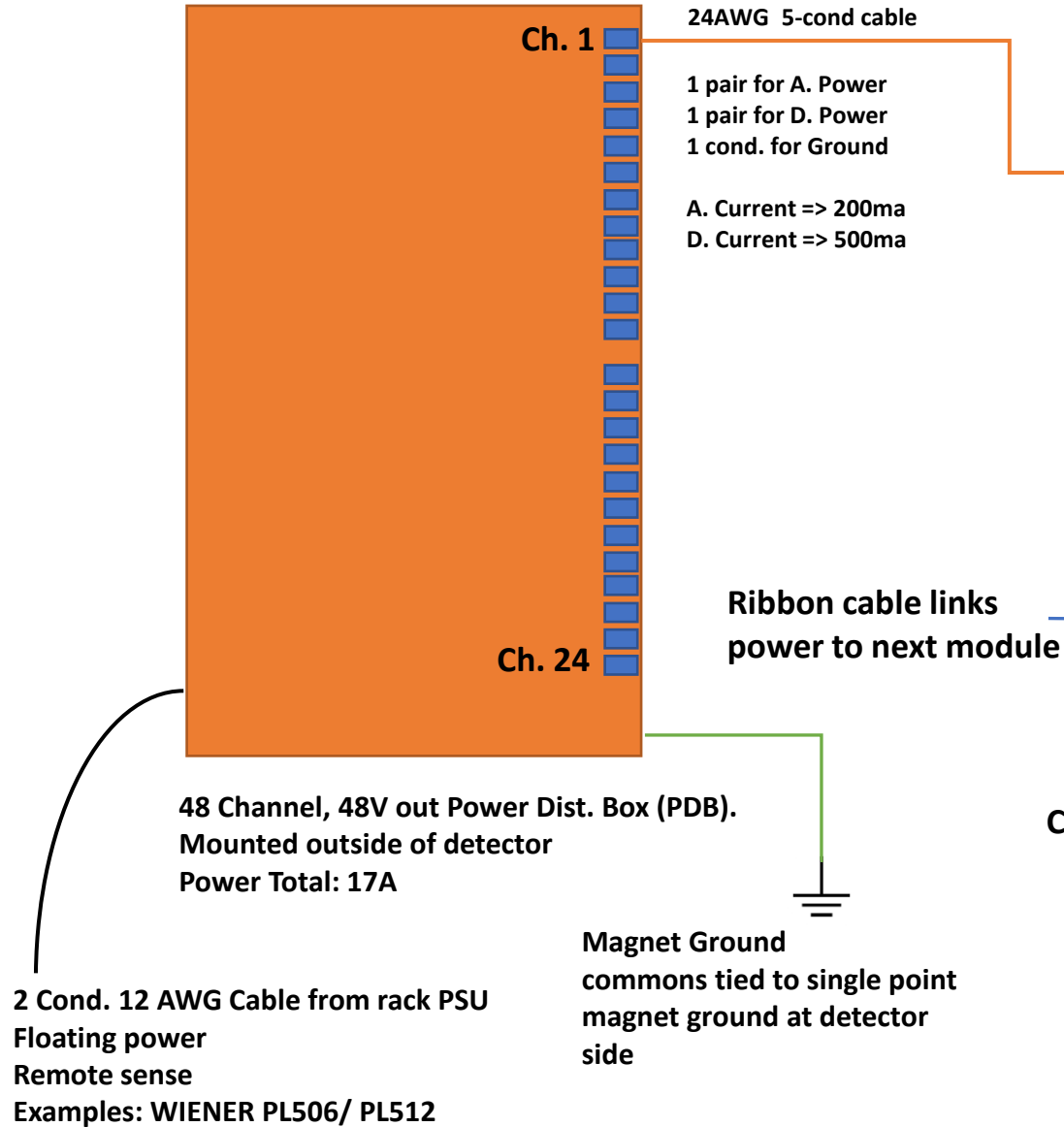
Quantity of 10 Channel Power Regulator
Boards Required for Si Detectors:

42x => Electron side

48x => Hadron side

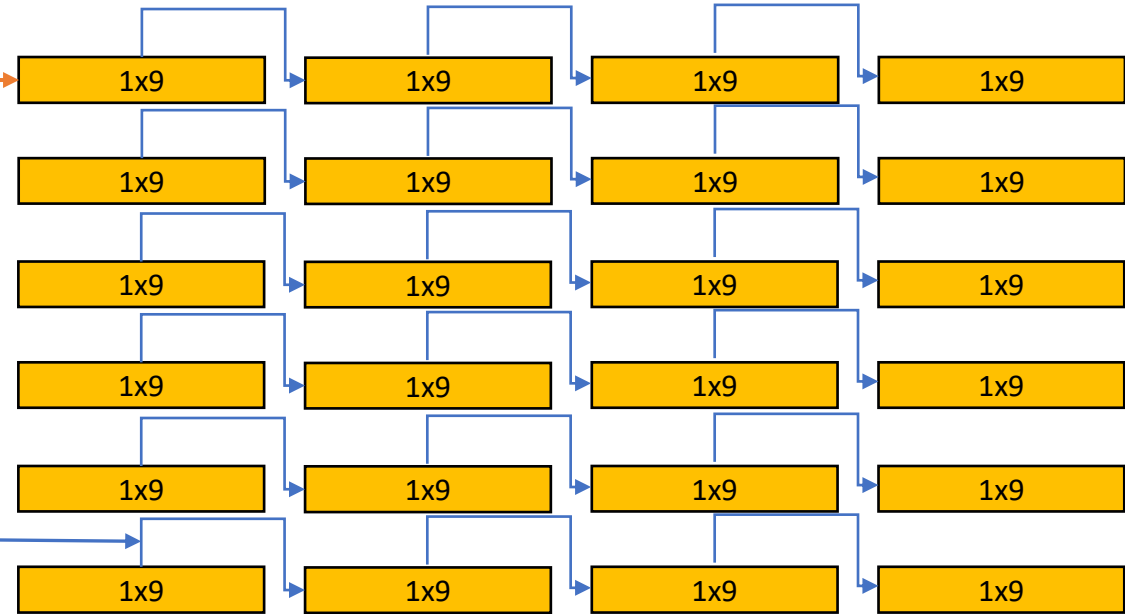
130x => Disk

Option 2: LV Power Cabling for series regulator scheme:



In this scheme much less cabling is required
Smaller AWG required

Note: Series shunt regulator is [R&D project from CERN and LBNL](#)



PDB Powers 96 1x9 modules => 24x sets of 4x series sets

Cable to each group: 5 conductor 24AWG: $\varnothing 4.80\text{mm}$ => Example: Belden 9535

Each group of four 1x9 modules drops 10.8V => $1.2\text{V} * 9\text{x ITS-3 chips} = 10.8\text{V}$
=> Each ITS-3 chip will drop 1.2V

- Digital Power/ channel => 43.2Vout, 500ma
- Analog Power/ channel => 43.2Vout, 200ma

References:

Meeting Nov 11

Powering-options-for-an-EIC-silicon-tracker.pdf

<https://indico.cern.ch/event/681247/contributions/2929073/attachments/1640109/2618527/SerialPowerACES2018.pdf>