APS-U Stepper Motor Connections

Beamline Controls Recommendations (DRAFT)

Kurt Goetze, Joe Sullivan APS/XSD/Beamline Controls

What it is:

- **Recommendation** for connecting common, low-power stepper motors and stages to typical controls hardware

- Good connections, electrically and mechanically, Economical

- Based on many years of BC Group experience and feedback from the APS beamlines

What it isn't:

- Comprehensive standard that covers every motor and connection situation

- High voltage or high current solution. Use vendor or Engineered/QEW solutions for systems above the hazard threshold, and of course DEEI inspect.
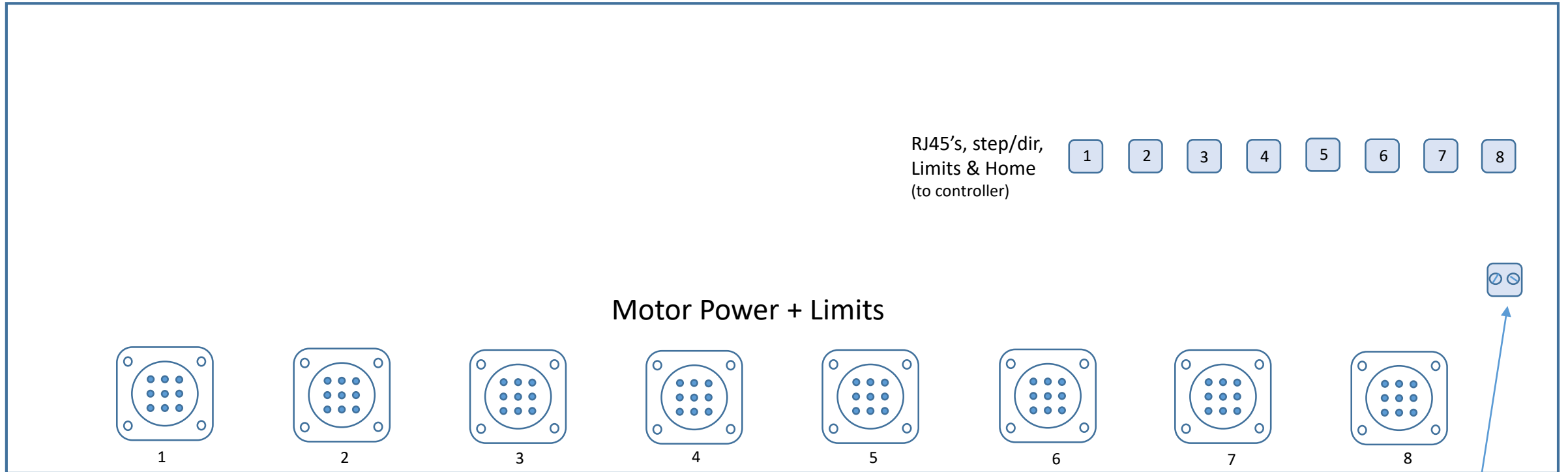
- ~~Expensive~~

Why revise the APS stepper motor connections?

ELCO has worked reasonably well for decades but,
the revised recommendation improves in the following ways:

- Robust, less fragile motor connector: TE Connectivity/AMP CPC →

- Very good connection, electrically *and mechanically*

- Inexpensive

- Common, in-stock parts

- All parts (including cable!) available via AMOS vendors
    - (Newark has over 3,000 of the motor connector in stock at $3.38/ea. in multiples of 25)

- Easy to terminate / modify motor connections

- ~~Power separated from Signal wiring, run limits and home with db9~~

- TE Connectivity/AMP CPC Series1 motor connector is NRTL listed and rated to 600V. *However:*
    - These recommendations are for motor systems operating at less than 50V to the motors.
    - This covers most of the typical stepper motor systems in use at the APS.
    - For higher voltage systems (servos, etc.) it is recommended that the vendor's connectors/cabling be used.

Phytron/APSU 8-Ch ZMX+ Driver Unit Rear Panel

RJ45's, step/dir,
Limits & Home
(to controller)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Motor Power + Limits

1 2 3 4 5 6 7 8

External Limits Power screw terms
(routed out limits db9's)

- Motor Power connector: TE Connectivity AMP CPC part no. 211769-1
- RJ45's, standard network-type, APS pinout
- Motor Power connectors pinout TBD
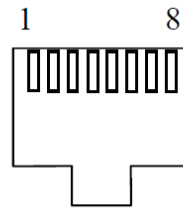
RJ45 Connector Details

RJ45 Pinout

Pin, Function
 1,   Step+
 2,   Step-
 3,   Dir+
 4,   Lim+
 5,   Lim-
 6,   Dir-
 7,   Home
 8,   GND

RJ45 Receptacle:

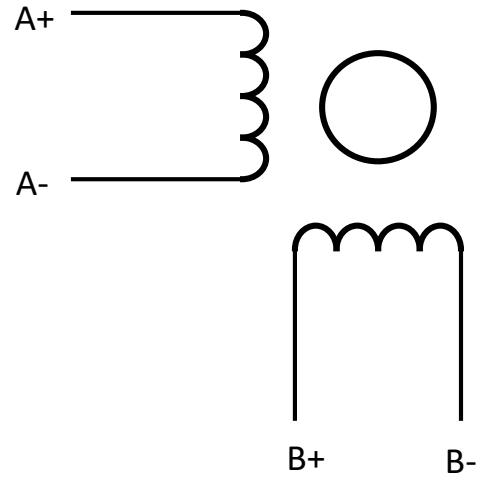# db9 Encoder Connector Details

Encoder db9 Connector Pinout

Pin, Function
 1,   Index +
 2,   Phase A +
 3,   Phase B +
 4,   +V
 5,   Home
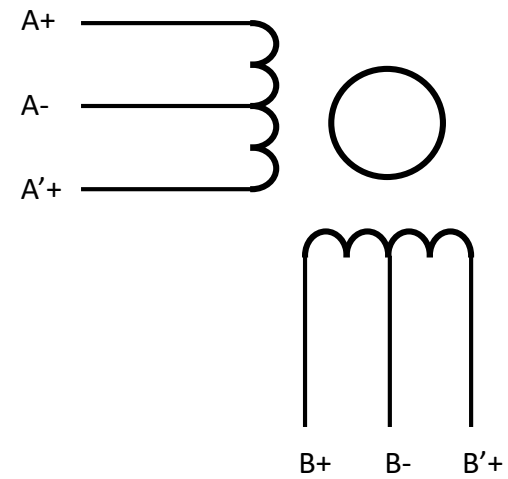 6,   Index -
 7,   Phase A -
 8,   Phase B -
 9,   Gnd
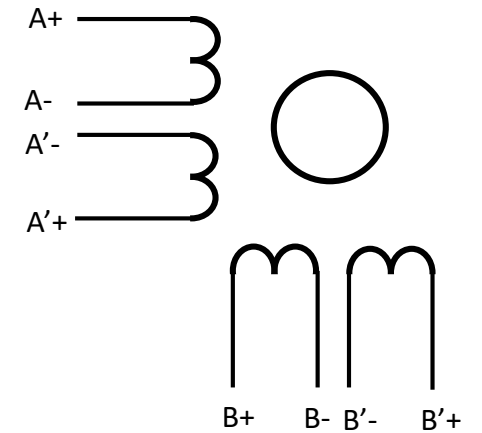
Stepper Motor Coils Naming Convention

2-Phase 4-Lead Stepper Motor
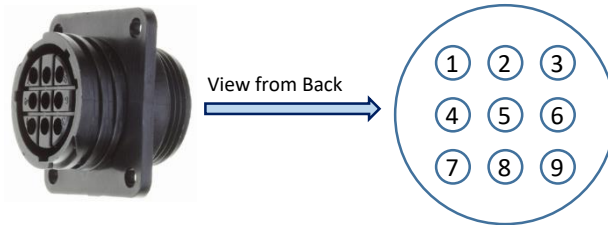
2-Phase 6-Lead Stepper Motor

2-Phase 8-Lead Stepper Motor

Stepper Motor Power Connector Details

TE Connectivity AMP CPC part no. 211769-1 (Chassis mount, Sockets)
(see "motor cable" details for cable/connector part numbers)

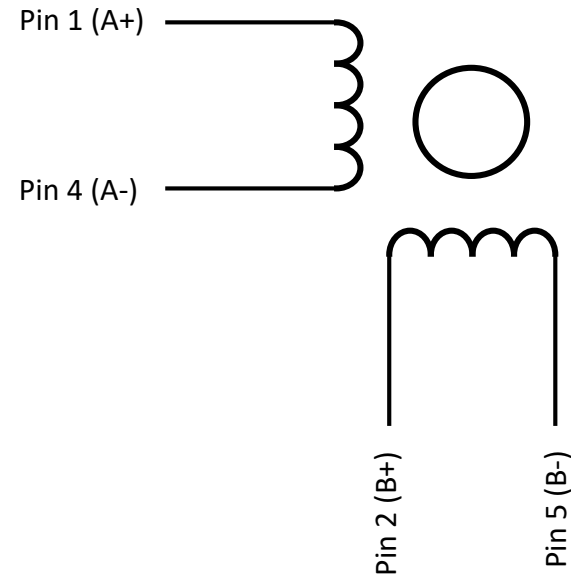- Up to 16 AWG wire to crimp-type sockets (10 Amps)
- Sockets: 1-66101-9
- Pins: 1-66099-5
- Crimp Tool: 58495-1
- Extraction Tool: 305183

<u>AMP CPC Pinout</u>

Pin, Function
1, A+
2, B+
3, Lim+
4, A-
5, B-
6, Lim-
7, Home
8, +V supply
9, GND

View from Back

1 2 3
4 5 6
7 8 9

<u>2-Phase 4-Lead Stepper Motor **Typical Connection**</u>
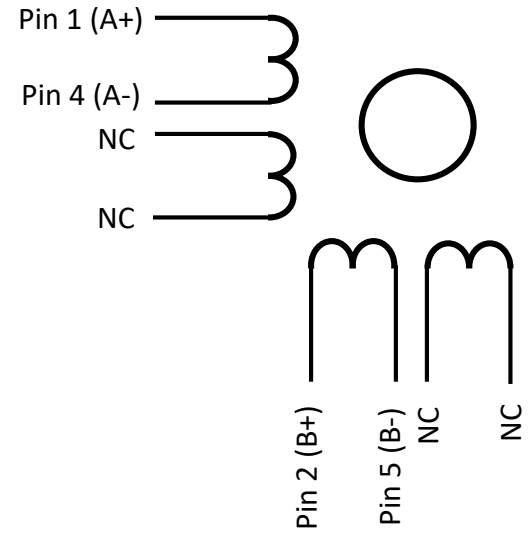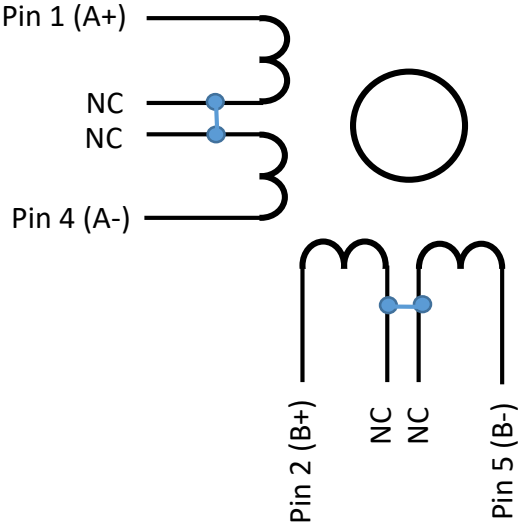
Pin 1 (A+)
Pin 4 (A-)

Pin 2 (B+)
Pin 5 (B-)

2-Phase 6-Lead Stepper Motor Bipolar Connection (series)
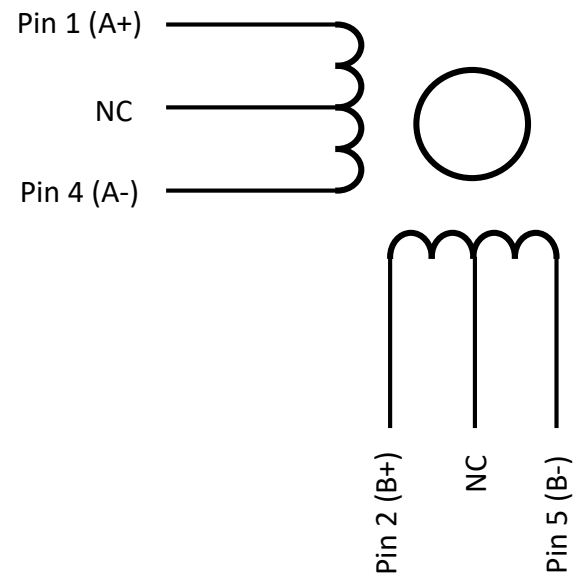
2-Phase 8-Lead Stepper Motor Bipolar Half-Coil Connection

Pin 1 (A+)

NC

Pin 4 (A-)

Pin 2 (B+)

NC

Pin 5 (B-)

Pin 1 (A+)

Pin 4 (A-)

NC

NC

Pin 2 (B+)

Pin 5 (B-)

NC

NC

2-Phase 8-Lead Stepper Motor Bipolar Series Connection

Pin 1 (A+)

NC

NC

Pin 4 (A-)

Pin 2 (B+)

NC

NC

Pin 5 (B-)

2-Phase 8-Lead Stepper Motor Bipolar Parallel Connection

Pin 1 (A+)

NC

NC

Pin 4 (A-)

Pin 2 (B+)

NC

NC

Pin 5 (B-)
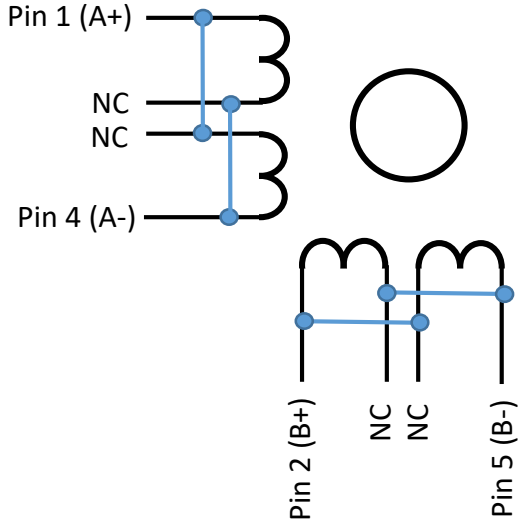
Motor Cable
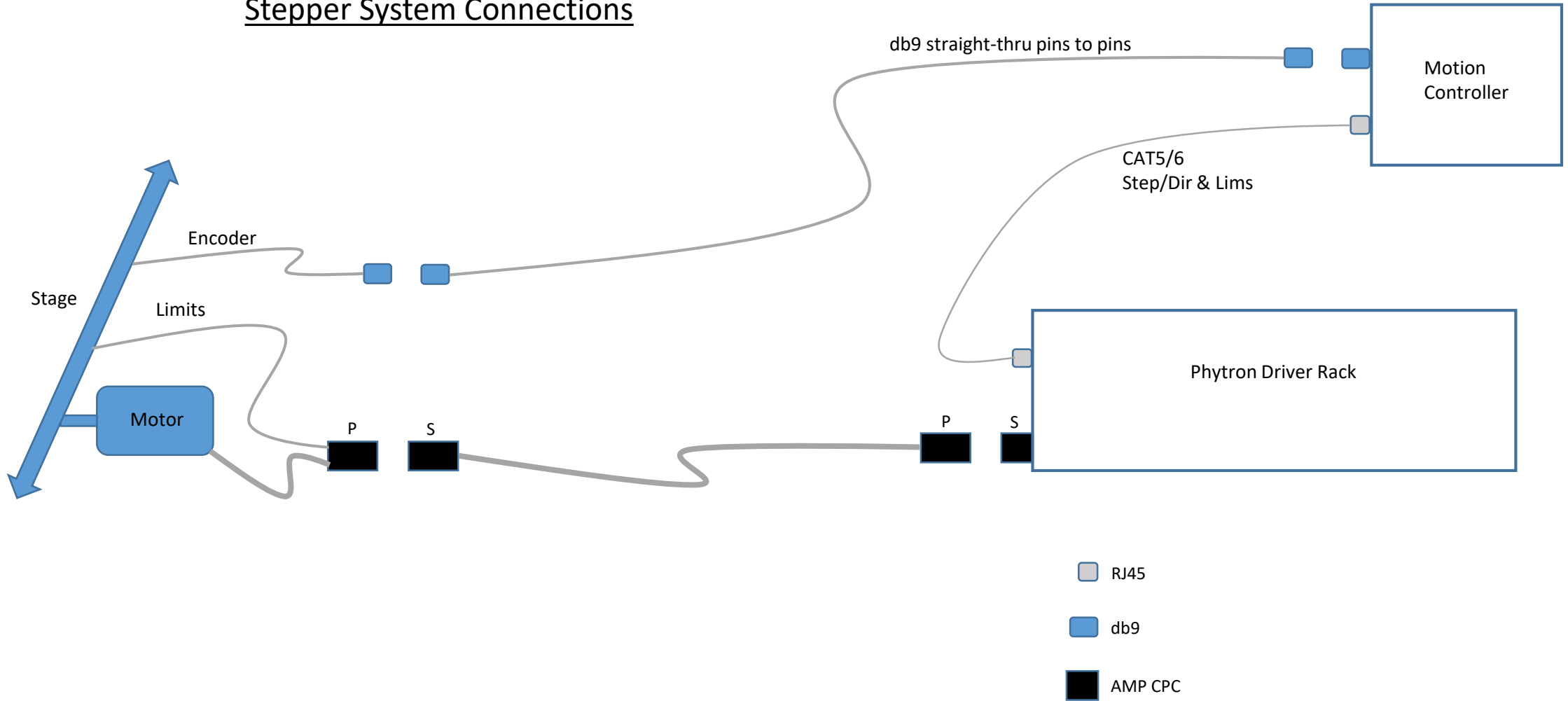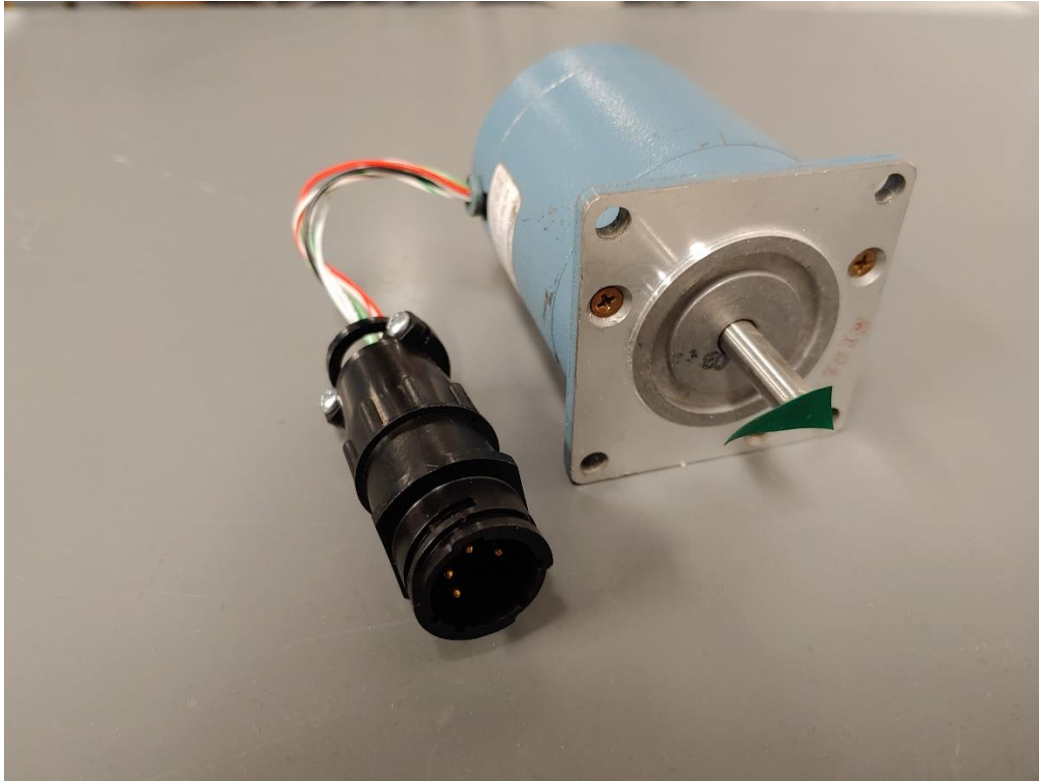
- 10-Conductor 18 AWG Alpha Wire 2245C SL005 ~$480 at Digikey (AMOS) 100' Spool
  - Need to test
  - Possibly use a combined AWG (or custom?) cable

- Limits: Connected via AMP CPC connector
- Encoders: Connected via db9 to controller. APS standard pinout.

Motor

P   S

P   S

Phytron Driver Rack

AMP CPC
206705-2

Panel Mount
206705-1

AMP CPC
206708-1

AMP CPC
211768-1

AMP CPC
211769-1

AMP CPC Parts:
- Sockets: 1-66101-9 (Crimp, Tin, 13A)
- Pins: 1-66099-5 (Crimp, Tin, 13A)
- Crimp Tool: 58495-1
- Extraction Tool: 305183
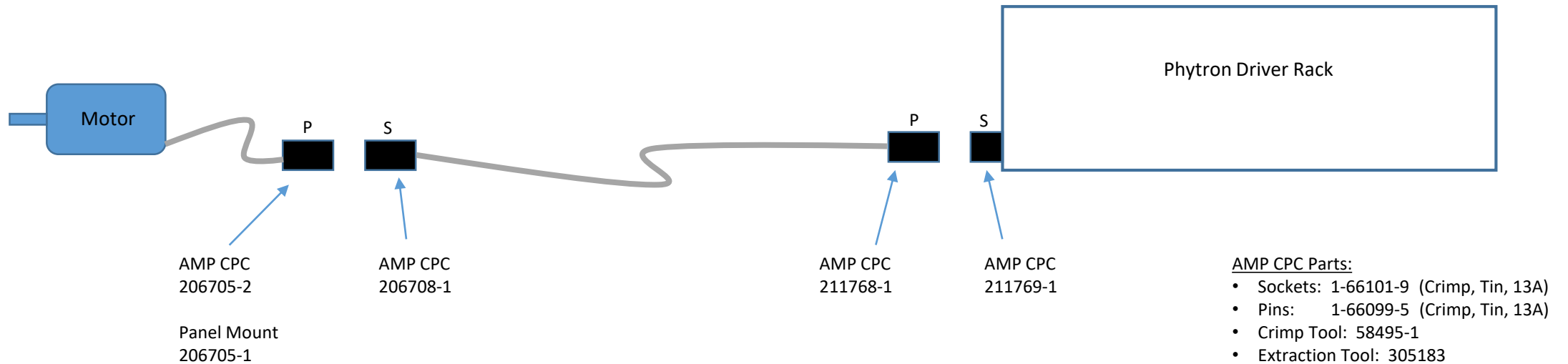
Stepper System Connections

db9 straight-thru pins to pins

Motion Controller

CAT5/6
Step/Dir & Lims

Encoder

Stage

Limits

Motor

P

S

P

S

Phytron Driver Rack

☐ RJ45

☐ db9

■ AMP CPC

Availability

TE.com, 9-DEC-2019

SHOP OUR DISTRIBUTORS

North America ▾   See

Distributor	1	10,000	
Heilind Electronics 7,299 in stock	$2.948	$2.367	
Mouser Electronics 1,637 in stock	$4.530	$2.630	
Master Electronics 1,780 in stock	$2.090	$2.010	
Online Components 1,780 in stock	$2.090	$2.010	
Powell Electronics Inc. 932 in stock	$2.120	$1.980	
Avnet Electronics 1,266 in stock	$3.181	$2.855	
Allied Electronics, Inc. 1,814 in stock	$2.770	$2.280	AMOS
Arrow Electronics Inc. 3,518 in stock	$2.092	$2.092	
Digi-Key Electronics 1,296 in stock	$4.340	$2.346	AMOS
Future Electronics 210 in stock	$3.340	$2.670	
Sager Electronics 4,300 in stock	$2.750	$2.250	
Newark element14 3,260 in stock	$4.260	$2.300	AMOS
A.E. Petsche Co. 15 in stock			
Interstate Connecting Comp. 7,299 in stock	$2.948	$2.401	
Electro Enterprises Inc. 146 in stock	$3.306	$2.808	
Carlton-Bates Company 112 in stock			

QUESTIONS:

1. Do we really want to change or modify our existing standard?

2. If so, how? CPC, NSLSII, Other…?

3. How do we come to a consensus?

Thanks!