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.
Motor Power + Limits

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

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

External Limits Power screw terms (routed out limits db9’s)
## RJ45 Connector Details

### RJ45 Pinout

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Step+</td>
</tr>
<tr>
<td>2</td>
<td>Step-</td>
</tr>
<tr>
<td>3</td>
<td>Dir+</td>
</tr>
<tr>
<td>4</td>
<td>Lim+</td>
</tr>
<tr>
<td>5</td>
<td>Lim-</td>
</tr>
<tr>
<td>6</td>
<td>Dir-</td>
</tr>
<tr>
<td>7</td>
<td>Home</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
</tr>
</tbody>
</table>

![RJ45 Receptacle Diagram]
**db9 Encoder Connector Details**

**Encoder db9 Connector Pinout**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
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<tbody>
<tr>
<td>1</td>
<td>Index +</td>
</tr>
<tr>
<td>2</td>
<td>Phase A +</td>
</tr>
<tr>
<td>3</td>
<td>Phase B +</td>
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<tr>
<td>4</td>
<td>+V</td>
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<tr>
<td>5</td>
<td>Home</td>
</tr>
<tr>
<td>6</td>
<td>Index -</td>
</tr>
<tr>
<td>7</td>
<td>Phase A -</td>
</tr>
<tr>
<td>8</td>
<td>Phase B -</td>
</tr>
<tr>
<td>9</td>
<td>Gnd</td>
</tr>
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</table>
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

AMP CPC Pinout

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
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<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>B+</td>
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<tr>
<td>3</td>
<td>Lim+</td>
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<td>+V supply</td>
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<td>9</td>
<td>GND</td>
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</table>

2-Phase 4-Lead Stepper Motor Typical Connection

Pin 1 (A+)

Pin 2 (B+)

Pin 3 (A-)

Pin 4 (A-)

Pin 5 (B-)

View from Back
2-Phase 6-Lead Stepper Motor Bipolar Connection (series)

Pin 1 (A+)
NC
Pin 4 (A-)

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

2-Phase 8-Lead Stepper Motor Bipolar Half-Coil Connection

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

2-Phase 8-Lead Stepper Motor Bipolar Parallel Connection
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.

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

- Motor
- Encoder
- Limits
- Stage
- RJ45
- db9
- AMP CPC

Motion Controller

Phytron Driver Rack

- CAT5/6 Step/Dir & Lims
- db9 straight-thru pins to pins
### Availability

<table>
<thead>
<tr>
<th>Distributor</th>
<th>Stock Level</th>
<th>Price</th>
<th>Stock Level</th>
<th>Price</th>
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<td>Arrow Electronics Inc.</td>
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<td>Digi-Key Electronics</td>
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<td>Future Electronics</td>
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<td>Sager Electronics</td>
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<td>A.E. Patcha Co.</td>
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<td>Interstate Connecting Comp.</td>
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<td>Electro Enterprises Inc.</td>
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<td>$3,306</td>
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<td>Carbon-Bates Company</td>
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<td>$3,306</td>
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AMOS

TE.com, 9-DEC-2019
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!