MODS Motion Control Requirements

The purpose of this document is to define the requirements and desirable features of the MODS motion control electronics.

<table>
<thead>
<tr>
<th>Mechanism Name</th>
<th>Qty</th>
<th>Topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Slide Open/Close</td>
<td>1</td>
<td>Two Position Linear, 2 limits</td>
</tr>
<tr>
<td>Calibration Insert</td>
<td>1</td>
<td>Two Position Linear, 2 limits</td>
</tr>
<tr>
<td>Mask Select</td>
<td>1</td>
<td>Indexed Linear drive, 24 discrete positions, 2 limits, 5 code bits, “Position Valid” bit, bar codes on cassettes</td>
</tr>
<tr>
<td>Mask Insert</td>
<td>1</td>
<td>Two Position Linear, 2 limits</td>
</tr>
<tr>
<td>Front Acquire &amp; Guide X-Y</td>
<td>2</td>
<td>Continuous Linear, Limits</td>
</tr>
<tr>
<td>Front Acquire &amp; Guide Focus</td>
<td>1</td>
<td>Continuous Linear, Limits</td>
</tr>
<tr>
<td>Front Acquire &amp; Guide filter</td>
<td>1</td>
<td>Indexed Rotary, 4 discrete positions, 2 code bits, “Position Valid”, no limits</td>
</tr>
<tr>
<td>Dichroic Select</td>
<td>1</td>
<td>Indexed Rotary, 3 discrete positions, 2 code bits, “Position Valid”, no limits</td>
</tr>
<tr>
<td>Collimator Tip/Tilt/Focus</td>
<td>6</td>
<td>Continuous Linear, 2 limits</td>
</tr>
<tr>
<td>Grating Tilts</td>
<td>4</td>
<td>Continuous Linear, 2 limits</td>
</tr>
<tr>
<td>Grating Select</td>
<td>2</td>
<td>Indexed Linear, 4 discrete positions, 2 limits, 2 code bits, “Position Valid” bit, (bi-directional to avoid cable wrap-up)</td>
</tr>
<tr>
<td>Shutters</td>
<td>2</td>
<td>Two Position Linear, in &amp; out sensors, 2 limits</td>
</tr>
<tr>
<td>(Read special notes on mechanism data sheet for use of sensors)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camera Primary Focus</td>
<td>2</td>
<td>Continuous Linear, 2 Limits</td>
</tr>
<tr>
<td>Camera Filter Wheel</td>
<td>2</td>
<td>Indexed Rotary, 8 positions, 3 code bits, “Position Valid” bit, no limits</td>
</tr>
<tr>
<td>Total Mechanism Count</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

These mechanisms have four topologies:

- Two Position Linear (e.g. Dark Slide, Shutters,
- Indexed Linear (e.g. Mask Select, Grating Select)
- Continuous Linear (e.g. Collimator TTF, Grating Tilt, AGW Stages)
- Indexed Rotary (e.g. Filter Wheels)
General Requirements

- Use the same drive or drive family for all mechanisms to simplify design, support, spare parts, and software development
- Allow for simultaneous motion of mechanisms where it could significantly reduce the time for instrument configuration
- Ability to handle a wide range of mechanism types, motor sizes, and feedback types
- Support microstepping for smooth and quiet operation
- All mechanisms are zero power when not moving

Desirable Features

- High voltage operation for high speed performance and reduction of mid-range problems or just that drives be smooth and reliable

Controller Features

- Programmable current for normal operation, acceleration, hold current, and zero current.
- Local non-volatile memory for storage of mechanism control low level programs. This reduces communication requirements

Motor Types

- The number of different motor sizes and types should be minimized
- The default motor type is a stepper motor.
- Current Requirements are 3.5 amps rms continuous duty
- Inductance range

Feedback Types

- opto-isolation on all input lines
- ability to use a variety of switch closures for limit switches and general purpose digital inputs
- Digital incremental encoder feedback should be available

Communication Protocol

- Serial communication, RS 232, RS 485 or other such as CAN, Ethernet, or ?? or ???
- Upload instructions to drive
- Download status from drive

Software

- Simple language for independent lab development of test programs on a PC
- Language that is easy to integrate into our software environment
- Execute commands from host computer in a single line mode or execute programs that are stored on the drive.
- Ability to verify software resident on drive, if any

Packaging Issues

- It will be highly desirable from some standpoints to have a compact self contained drive requiring only a communication line and power line in.
- Logical distribution of functions to easily mated/demated output connectors

09/08/06
EMI/RFI
Some of the controllers will be required to operate during integration (e.g. for flexure compensation drives) and possibly during detector readout. Detector readout is included both because readout and exposure are the same for frame transfer and we need to leave open the possibility of using “ir” type detectors. They must be evaluated for compatibility with the detector electronics.

Power Dissipation
Power dissipation should be less than 10 watts/axis total over a typical 15 minute period which includes both a quiet and busy interval.

Cost Issues
Low Cost is good. Drives should be less than $1500 per axis total installed cost.

Long Term Support
A company with a long history in this business and a stable product line is desirable. Good availability of replacement drives or use of generic parts is a must. LBT should anticipate stocking significant numbers of spares to insure long term availability.
Intelligent Microstep Drives, Ideal Feature Set

Packaging
- External Unregulated DC power supply to reduce size and weight of drive
- Easy to mount to panel, high density on panel

Interconnect
- Logical division of functions to connectors
- An interconnect arrangement that permits easy swapping of the drives for troubleshooting, or an installed and wired “hot spare” that can be used for troubleshooting by merely changing the address and swapping the mechanism cable

Motor Power Section
- At least 3.5 amps/phase continuous rms
- At least 40 volts DC, 80 volts desirable for better high speed performance
- Software selectable drive current
- Software selectable idle current
- Software Selectable microstepping resolution
- Support of Full Step Mode
- Zero Current to motor when motor is turned off
- PHASE memory so motor powers up at same step where it was turned off

Encoder Support
- Incremental Encoder support should be available as an option or standard on the unit

Inputs
- Dedicated Limits that have full flexibility in their response to an asserted limit. Decel or no Decel, keep motor current on or turn motor off, branch to program step on limit, set fault output on limit, etc.
- At least 6 additional opto-isolated programmable inputs. 8 or 10 would be better.

Outputs
- At least 2 programmable outputs with 100milliamp rating desirable
- 1.0 amp rating desirable, can eliminate brake relays

Communication Protocol
- Serial communication, RS 232, RS 485 or other such as CAN, Ethernet, or ???
- Upload instructions to drive
- Download status from drive

Software
- Adequate command set for all of our needs.
- Ability to execute commands from the host in a sequential command mode and/or ability to run stored programs from input triggers and from external commands.
- Upload/download programs from the host computer to the drive memory (or buffers) without use of proprietary software
- Flexible firmware to set parameters such as response to Limits, Homing routines, etc.
- Store drive configuration on the drive in Flash memory and store the drive configuration in an external file

09/08/06
• Simple language for independent lab development of test programs on a PC. This would typically be a Windows development environment provided by the drive manufacturer with ASCII characters and RS232 communication or could be an environment in EXCEL, Labview, Visual Basic, etc.

• High level (e.g. C++) development library provided by manufacturer

• Adherence to industry standard motion protocol like CANopen, Modbus, DEVICENET, etc. could be very beneficial.

Support
• The company should be stable to insure long term availability of hardware and support

Cost
• Cost should be < $1000 per drive unit