Voice Coil Motors with Analog Feedback

BEI Kimco provides voice coil motors with analog (Hall Effect) feedback. These motors may be ordered with –P02 option which specifies 0.1v to 3.3v output range and 2 kHz internal filter. These settings will optimize their performance with the SilverSterling™ controller family. BEI can also provide these units prewired for the SilverSterling™ controller.

Driver Connections

Some of the voice coils may be ordered prewired for QCI connectors, others must be wired by the customer. The Voice Coil Motor has two wires associated with the motor. These are typically color coded as RED for plus (+) and WHITE for minus (−). A positive current moves the shaft in the positive reference direction (see BEI documentation). The SilverSterling™ supports the connection of either a single driver channel (5A continuous) or both driver channels (10A continuous). The input power current is limited to 5A average, but the drivers act switched mode converters. Operation of a 12 or 24v actuator from a 48v supply will allow the full 10A capability (usually limited by the thermal capability of the motor). The driver circuit in the SilverSterling includes output inductors. These inductors allow the two phase outputs to be directly connected when operating a DC motor. If the higher currents are needed, connect Motor A+ to Motor B+, Motor A- to Motor B-. For smaller motors use Motor A+ and Motor A- connections.
## Initialization Code

The controller should be initialized using the Linear DC Motor using MEM Pin.qcp file included in this application note. You will also need a devAux file for your linear actuator. (Contact Support).

<table>
<thead>
<tr>
<th>Line#</th>
<th>Label</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>REM</td>
<td>DC MOTOR Initialization: SilverSteering with B option only</td>
<td></td>
</tr>
<tr>
<td></td>
<td>These programs contain the initialization commands. It can be edited directly or through</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tool: Initialization Wizard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Download the program at the end of the wizard or by pressing the &quot;Download&quot; button in the Program Info</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toolbox. Reboot the device.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(See the description in Scaling for more details)</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>&gt;&gt;&gt; Communications (CDMH)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;&gt;&gt; COMM Identity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UnitID = 15, Group ID = 20</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>&gt;&gt;&gt; COMM Protocol</td>
<td></td>
</tr>
<tr>
<td>PRO</td>
<td>Protocol = 9.6, ASCII</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Stop Bits, No Parity</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>&gt;&gt;&gt; COMM Serial Interface</td>
<td></td>
</tr>
<tr>
<td>SIF</td>
<td>Serial Interface = RS485</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>&gt;&gt;&gt; COMM Baud Rate</td>
<td></td>
</tr>
<tr>
<td>BRT</td>
<td>Baud Rate = 57,600</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>&gt;&gt;&gt; COMM ACK Delay</td>
<td></td>
</tr>
<tr>
<td>ACL</td>
<td>ACK Delay = Auto</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>Load and run Flash Seq if there was a Factory Block fault</td>
<td></td>
</tr>
<tr>
<td>JUMP</td>
<td>Jump to &quot;FAC BLK OK&quot;</td>
<td></td>
</tr>
<tr>
<td>WHEN</td>
<td>&quot;User[1]&quot; = 0</td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>Load and run program</td>
<td></td>
</tr>
<tr>
<td>PROGR</td>
<td>Program = &quot;Factory Block Fault&quot;</td>
<td></td>
</tr>
<tr>
<td>FAc</td>
<td>FAC BLK OK</td>
<td></td>
</tr>
</tbody>
</table>

Set the identity, protocol, and baud rate as needed.

Error limits are set to 0 to disable them when starting up. These can be enabled at a later time by setting them to a non-zero value. The “running” torque level is available for 30 ms following a motion to allow the motion to complete while minimizing the heating if the actuator is not able to make the motion.
<table>
<thead>
<tr>
<th>Line</th>
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<th>Command</th>
</tr>
</thead>
</table>
| 27   | TQL   | Torque Limits: Closed Loop Holding = 0  
|      |       | Closed Loop Moving = 0  
|      |       | Open Loop Holding = 0  
|      |       | Open Loop Moving = 0  |
| 28   | SQL   | Go Open Loop |
| 29   | SLC   | Single Loop Control |
| 30   | REM   | ================  
|      |       | ** Motor (MOTOR)  
|      |       | ================  |
| 31   | REM   | The commands:  
|      |       | Motor Constants (MCT)  
|      |       | Phase Advance (PAC)  
|      |       | are set dependent on input voltage by a factory derived formula. These commands should only be edited by the initialization Wizard. |
| 32   | DMDO  | Disable Motor Driver |
| 33   | REM   | Set mode 2.1 enables DC motor operation. Must be done before motor drive is enabled |
| 34   | SMD   | Set Mode  
|      |       | DC Motor Mode  
|      |       | Enable |
| 35   | REM   | Set mode 7 to select analog feedback from MEM  
|      |       | Jn=3 or 24MEM |
| 36   | SMD   | Set Mode extended  
|      |       | Set mode 5 to select analog/offset frequency  
|      |       | 0  
|      |       | 120 us  
|      |       | 1  
|      |       | 240 us  
|      |       | 2  
|      |       | 360 us  
|      |       | 3  
|      |       | 5ms  
|      |       | 4  
|      |       | 1ms  
|      |       | 5  
|      |       | 2ms  
|      |       | 6  
|      |       | 5ms  
|      |       | 7  
|      |       | 10ms  
|      |       | 8  
|      |       | 20ms  
|      |       | 9  
|      |       | 40ms  |
| 37   | REM   | ================  
|      |       | ** Motor (MOTOR)  
|      |       | ================  |
| 38   | SMD   | Set Mode extended  
|      |       | Set mode 5 filter value sets the filter value used to filter the DC MOTOR drive voltage (only DC motor mode) |
| 40   | SMD   | Set Mode:  
|      |       | DC Motor PwM Filter  
|      |       | 5968 Hz |
| 41   | REM   | ** MOTOR: Motor And Phase Advance Constants  
|      |       | Motor Constants:  
|      |       | Auto |
| 43   | REM   | Phase Advance Constants  
|      |       | This command is edited the same time MCT is edited. The edit dialog box does both at the same time. |
| 44   | PAC   | Phase Advance Constants |
| 45   | REM   | Set overvoltage to no more than 4V above the voltage for which the unit was initialized. |
| 46   | UVT   | Over Voltage Trip = Auto |
| 47   | REM   | ================  
|      |       | ** Servo Tuning (SERVO)  
|      |       | ================  |
| 48   | REM   | ** SERVO: Filter Constants |
| 49   | PLC   | Filter Constants:  
|      |       | Default Settings |
| 50   | REM   | ** SERVO: Control Constants |
| 51   | CTC   | Control Constants:  
|      |       | Default Settings |
| 52   | DLY   | Delay for 100 nSec |
| 54   | REM   | ================  
|      |       | ** Motion (MOTION)  
|      |       | ================  |
| 55   | TTP   | Target to Position |

Line 34 puts the driver into the DC motor mode of operation (defaults to an encoder feedback).

Line 36 selects feedback from the MEM pin on the motor port (or from IO4).

Line 38 sets a 240 us filter (sampling every 40 us).

Line 40 adds a filter to the output of the torque command.

Line 49 and 51 contain the main system tuning parameters. These will need to be adjusted according to the actuator used, the load attached, and the desired operation of the system.
Line 59 sets the torque limits. The voice coil motors may have a fairly high ratio of peak to average allowable current. They will overheat if operated continuously at the peak rated currents. The holding torque is only about 1/5 of the peak torque in this example.

Set soft limits for the requested motions to make sure that they do not exceed or come too close to the limits of the position sensor. Exceeding the limits can lock the actuator at the hardware feedback limit. With a requested (Target) position greater than available feedback values can cause very rapid heating, as the servo position is unable to reach the Target position.

Use of the Soft Stop Limits capability prevents this from happening. These may be adjusted for your particular application.