# RSS-NIR Camera Articulation Axis
# Control with Multiple Motors

The RSS-NIR spectrograph must articulate its camera to angles up to 100° from the incoming beam in 45 seconds of time. The largest 24V version DC brushless servo motor from Allied Motion that will fit in the design space cannot produce the estimated torque needed to meet these requirements. Great effort was expended to find this standard line of reasonably priced motors rated for the -40°C environment of the RSS-NIR pre-dewar. The proposed solution is to add a second motor to assist the primary motor with additional torque.

The idea is to have a primary motor that follows a velocity trajectory to a destination position as if it were the only motor. The PMD ION 500 motor drive connected to this motor will not be commanded in any way to compensate for the presence of the second motor.

The second motor will be commanded to provide 1/3 to ½ of the total torque required to accelerate the load.

The primary motor drive will be RS-485 address 0x07 and the assist motor drive will be address 0x08.

## Initialization

Initialization will be handled in much the same manner as the inserter axis on GFIP, however it will not be possible to completely initialize the primary and then completely initialize the assist motor. The reason is that the axis must move for Phase Initialization and both motors must move for the axis to move.

I suggest that Communications Initialization be done on the primary motor, then Communications Initialization on the assist motor, then Drive Initialization on the primary, then Drive Initialization on the assist, and so on until Phase Initialization is required. If initialization fails on one motor, initialization starts over for both.

Non-zero velocity and acceleration feed-forward terms will be entered in the position loop for both drives. The primary drive will also have non-zero PID parameters whereas the PID parameters for the assist drive will be zero. This means the assist motor will not act on the encoder feedback to servo the position.

Phase Initialization is detailed in the document *RSS-NIR Camera Articulation Axis Phase Initialization for the PMD Ion 500 Motor Drive and Brushless Servo Motor with Encoder Feedback*. The steps through step 13 are the same as for the GFIP inserter axis. The steps that follow are repeated for each drive so that both motors are initialized.

## Motion Control

The primary motor will be controlled in the same manner as the inserter on GFIP. It will be given a destination in incremental encoder counts. The drive will generate a trajectory that the position loop will servo to track. The absolute encoder can be checked for agreement with the position register in the drive.

The velocity and acceleration profiles from the trajectory generator will be fed forward around the PID position loop. This should be an improvement to the way GFIP operated and will be applied to all axes, including GFIP.

The second "assist" motor will have its trajectory generator turned Off. The position loop will be turned On but the PID parameters $K_P$, $K_{ILIM}$, and $K_D$ will be set to zero.

Moving the axis will be done open loop by reading the output command (GetActiveMotorCommand) from the primary motor drive and writing it to the Bias register (SetMotorBias) in the assist motor drive. This will be repeated as fast as possible throughout the move.