Tertiary Rotator Setup Procedure

Introduction

This document is derived from an email from Adrian Loeff and describes the procedure to follow to setup a tertiary rotator.

Background

The encode resolution on the RHS-14-3003-E100AL actuator is 100,000 cts/rev. This is 4x interpolated by PMAC, resulting in 400,000 cts/rev. 180 degree should result in 200,000 cts.

The fatal error limit for the M3 rotator axis is set by:

I0711 = 15000

Note that the units of this variable are 16ths of a count so the actual fatal error is 937.5 encoder counts. Theoretically this means the motor can be driven against the spring force and can incur 937 encoder counts of following error before the PMAC will kill the axis. In practice, however, this point should never be reached. Even driving against a spring the PMAC should strive to maintain a zero following error, particularly if the integral gain of the axis is non-zero. So the PMAC will ramp up the DAC output to the motor until it pushes hard enough against the spring to reach the commanded position and stay there (i.e. the following error is zero).

The fatal following error specified in I0711 is mainly intended to protect the system from being over-driven if the motor is ever commanded to a position that completely winds up the spring. As the spring winds up it will eventually get to the point where the coils lock together and the motor (and encoder) will stop rotating. Attempting to drive further will then cause the following error to increase until the fatal following error limit (937 counts) is exceeded. Naturally this could over-stress the mechanism so this situation should be avoided.

In normal operation you should command the PMAC to drive the motor (and encoder) to about 1000 encoder counts past the point where the hard stop is initially reached. This will cause the spring to wind up by about 1.1 degrees, which should be enough to hold the mirror solidly against the hard stops. If you suspect that the mirror is shifting away from the hard stop as the telescope moves (especially as it accelerates in azimuth, such as while tracking a star through zenith or when applying position offsets in azimuth), then you may wish to increase the overdrive value to 2000 counts or more. This value also relies on the accuracy of the proximity limit switch is used for homing.

Note that the overdrive value of “1000 counts” has nothing to do with the fatal error, since even at this position the following error should be very close to zero.

You will have to determine the initial target position to which the M3 rotator should be driven in order to align the tertiary mirror with each Nasmyth port. The following procedure should work:

Procedure

1. Start by homing the M3 rotator axis using the DPRAM command specified in ALLFILES.pmc (M3951=1). The M3 rotator will home to the proximity limit at the negative end of travel, which should be activated prior to reaching the hard stop. This proximity limit represents the zero position for the axis.

2. After homing the M3 rotator should be carefully jogged until it just touches each hard stop and note down the encoder count at these two positions.

3. Set the target position for each port to a value of 1000 encoder counts beyond these positions. Test these target positions to ensure that the mirror is held in position and the motor is not being stressed.

Example of above steps:
Homing the M3 rotator:

M3580=1 ; resets the PMAC
M3950=1 ; enables the M3 rotator axis
M3951=1 ; starts homing the M3 rotator axis

Wait for the axis to stop and M3975 (M3 rotator Homed OK) to change from 0 to 1.

Jog the rotator slowly towards the nearest hard stop:

I0722=0.1 ; set speed to about 0.1 degrees/second
#7J- ; jog in the negative direction
#7J/ ; stop jog when it touches the hard stop

Suppose the current position is now -3542 counts. Then the target position for this port should be:

-3542 – 1000 = -4542 counts

Test that this position holds the mirror firmly against the hard stop without causing undue stress:

#7J=-4542

4. Monitor the following error for axis #7 and make sure it settles close to zero. Also check the DAC output (M0702) to make sure the motor isn't pushing too hard against the spring. If the following error and the DAC output are both close to zero, and if the mirror seems to be held firmly against the hard stop, then this value of -4542 should be set as the port position in the Telescope Server configuration file.

5. If the following error or the DAC output is quite high (e.g. either is more about than about three times the normal value when the motor is holding the mirror in position somewhere in the middle of its range) then it may indicate that there is too much force opposing the motor. In this case try using an overdrive value less than 1000 counts. However, the tertiary mirror must still be held reasonably firmly in position.

6. Jog to the other hard stop and repeat this process (don't bother re-homing the axis again).

For Example: If the M3 rotator touches the hard stop at 197551 counts then the target position for this port should be **197551 + 1000 = 198551 counts**

Additional Notes

The above test should be reasonably repeatable. Confirm that the tertiary mirror is held firmly against its hard stop.

Another way to check this is to check the value of M0703 after each homing operation. This M-variable represents the raw encoder value when the home switch/proximity limit was detected. This variable should vary by less than 100 counts from one test to another.

At some point after these initial port positions have been determined the actual position of the hard stops will probably have to be adjusted so that the optical path is correctly aligned with each port. After adjusting the hard stops the above procedure should be repeated to calculate the new M3 rotator positions for Telescope Server.

As part of the optical alignment process for the telescope you should adjust the small balls that connect with the hard stops such that the tertiary mirror is correctly aligned with each port when it is driven up against each hard stop. I believe that there are micrometers for precise adjustment of the balls.

Troubleshooting and FAQ

- *The gear ratio of the actuator prevents the rotator from backing off from this position once power is removed.*

This means that theoretically it should be possible to disable the M3 rotator motor once it reaches the desired position, which could be useful for reducing the heat generated by this motor. Since this motor is close to the optical path the heat it generates may adversely affect the image quality. However, the shutting off of the motor on an actual telescope whilst tracking stars has never been tested so no guarantee can be made that it will work as planned. It may be best just to leave the motor enabled and driving against the spring force.

- *Are the hard stops on the M3 exactly 180 degrees apart? I.e. once the M3 is aligned to one port, does the hard stop on the other port not need adjustment?*

The hard stops on the M3 rotator are “nominally” 180 degrees apart. They are intended to stop the M3 mirror at the correct positions to line it up with the Nasmyth port on each side of the telescope. However, these stops have never been accurately adjusted. There has been no attempt to set the hard stops exactly 180 degrees apart meaning that the exact counts end to end will vary from what they are once alignment is complete.