K1DM3 Technical Note

872-LTN1024

Actuator Load Requirement Calculations

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1 Introduction

The Exlar actuators are experiencing problems in moving the swing arm and mirror assembly between the retracted and deployed conditions for various gravity vectors. Calculations were performed to determine the expected mechanical loads and the forces required from the actuators for worst case conditions.

2 Geometry

Based upon the product literature (Reference 1) our Actuator model is capable of about 2000 pounds. Geometry for the calculations was extracted from the CAD models. The rotational drum assembly was opened in the retracted configuration. A 3D sketch was used to generate the elements shown in Figures 1 & 2. These elements are the hinge and actuator axes and the location of the mirror center. Some additional construction geometry (Figures 3 & 4) was generated to obtain the moment arm of the actuator and its angle relative to the plane normal to the hinge axis.

3 Calculations

3.1 Mechanical Weight and CG

Since the instrument is assembled the CAD model data was used. The mirror and swing arm assembly (872-LM4700) weight is currently 207 pounds. To be conservative a weight of 250 pounds was assumed and placed at the center of the mirror face.

3.2 Moments and Loads

The worst case structural moment load is

$$M = 250\ (lbs)\ x\ 32.19" = 8047.5\ in\text{-}lbs \tag{1}$$

At the retracted position the moment arm to the plane of the actuators is 4.23". The force needed to counter this moment is

$$F = \frac{M}{4.23} = \frac{8047.5}{4.23} = 1902.48\ lbs \tag{2}$$

The force provided by each actuator is half, or 951.24 lbs. Since the actuators are tilted by 7.13°, the load required by each actuator is

$$Load = \frac{951.24}{\cos(7.13)} = 958.65\ lbs \tag{3}$$

4 Discussion

Based on the Exlar specs the actuators need less than half of their peak load capacity. Although the true moment load is unknown, the estimate is conservative. It is very likely the required load is less than 900 lbs.

The moment load should be measured. The actuators should be disconnected at one end, with the swing arm assembly in the worst gravity orientation, supported with a load cell. Position and reading on the cell will give us the required moment needed to support and drive the instrument.

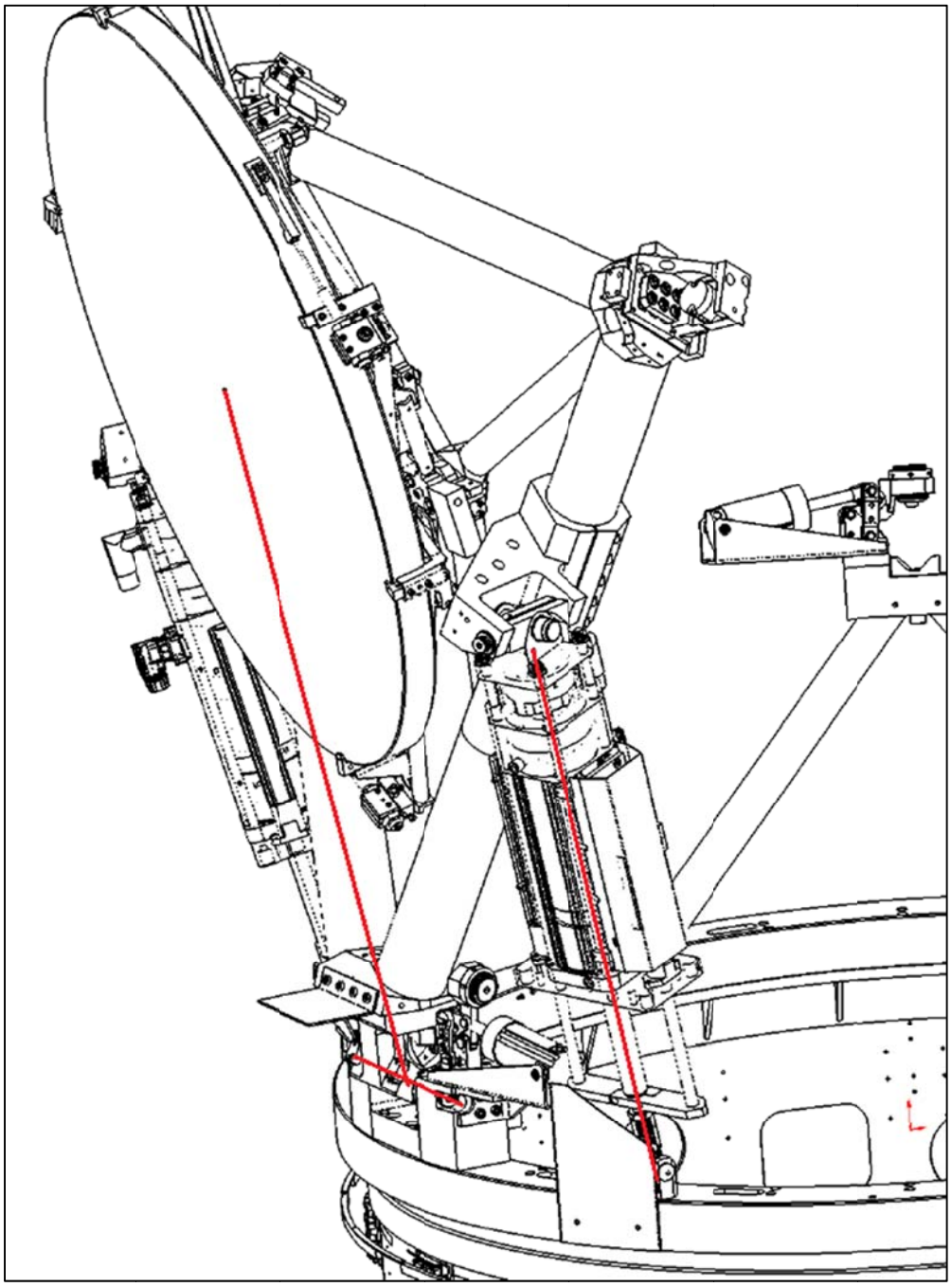

Figure 1 - Geometry extracted from the CAD model with swing arm in the retracted position.

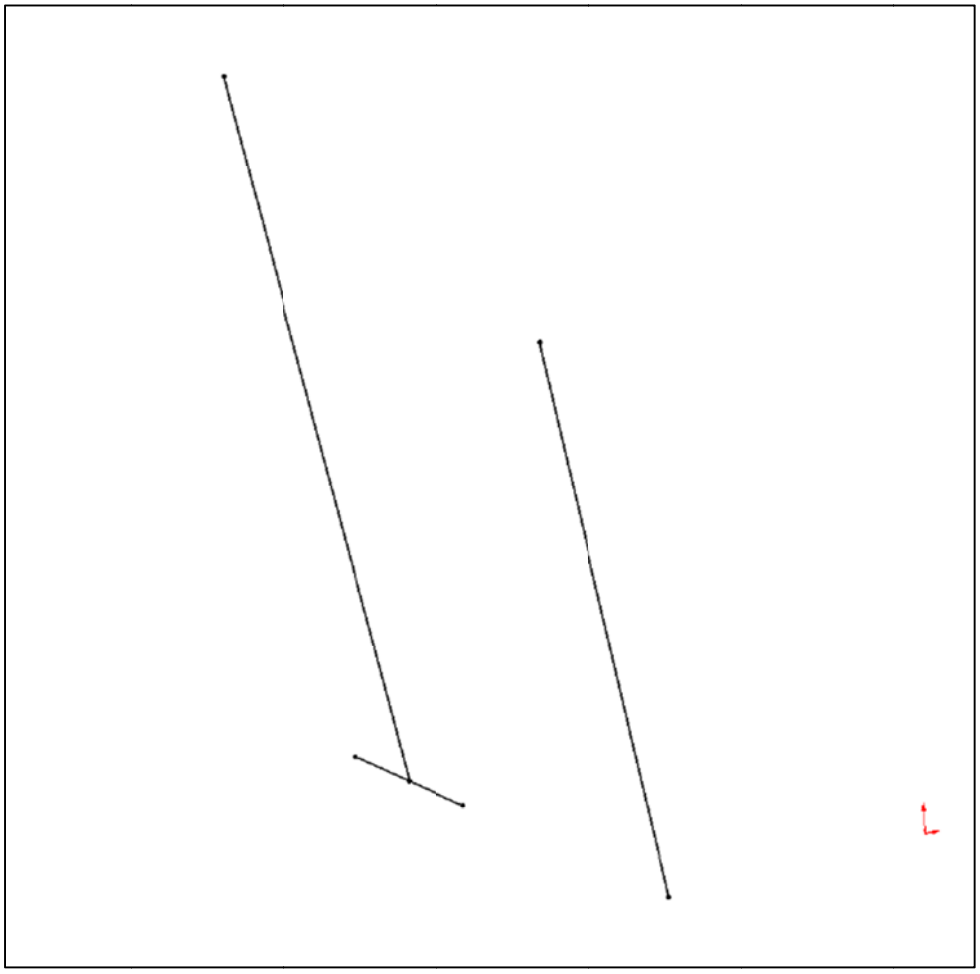

Figure 2 - Geometry sketch showing just the basic elements needed for the calculations; hinge axis, line to center of mirror surface, and axis of an actuator.

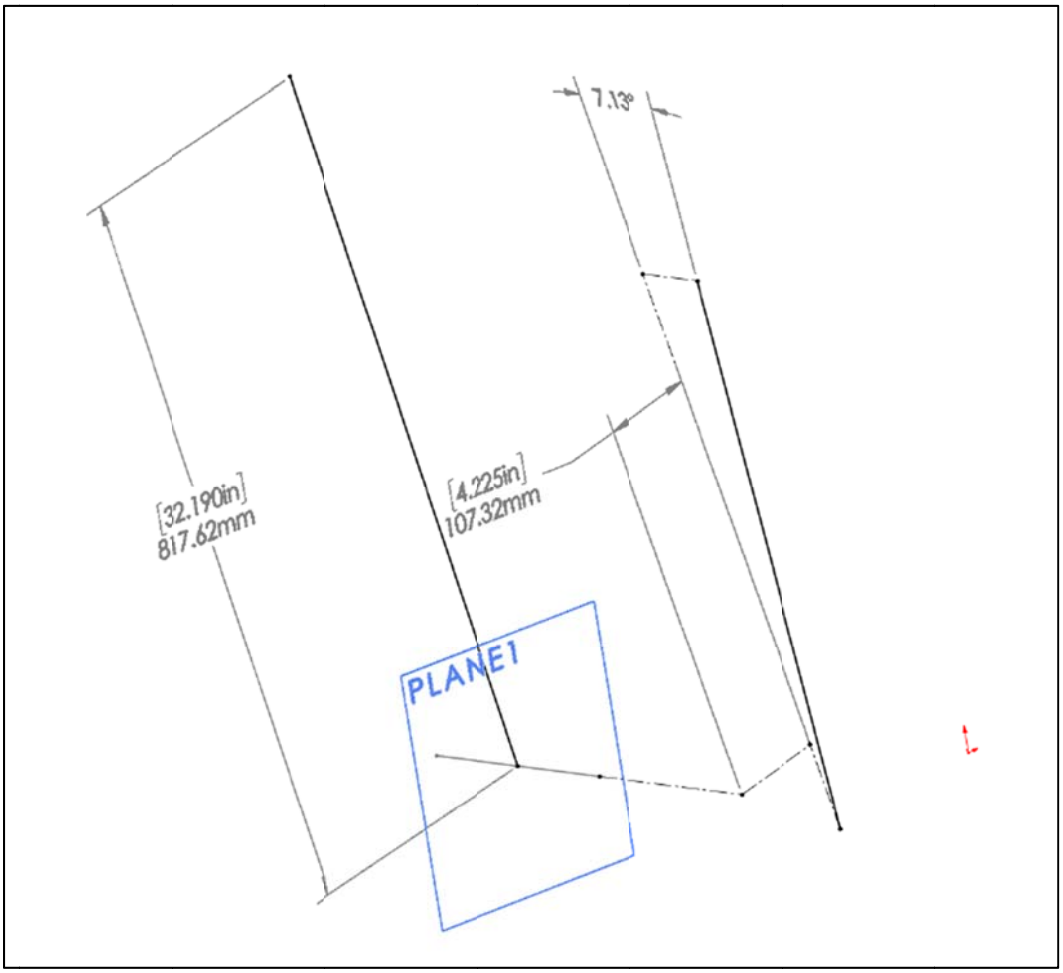

Figure 3 - Additional elements added to determine moment arm of actuator and load angle.

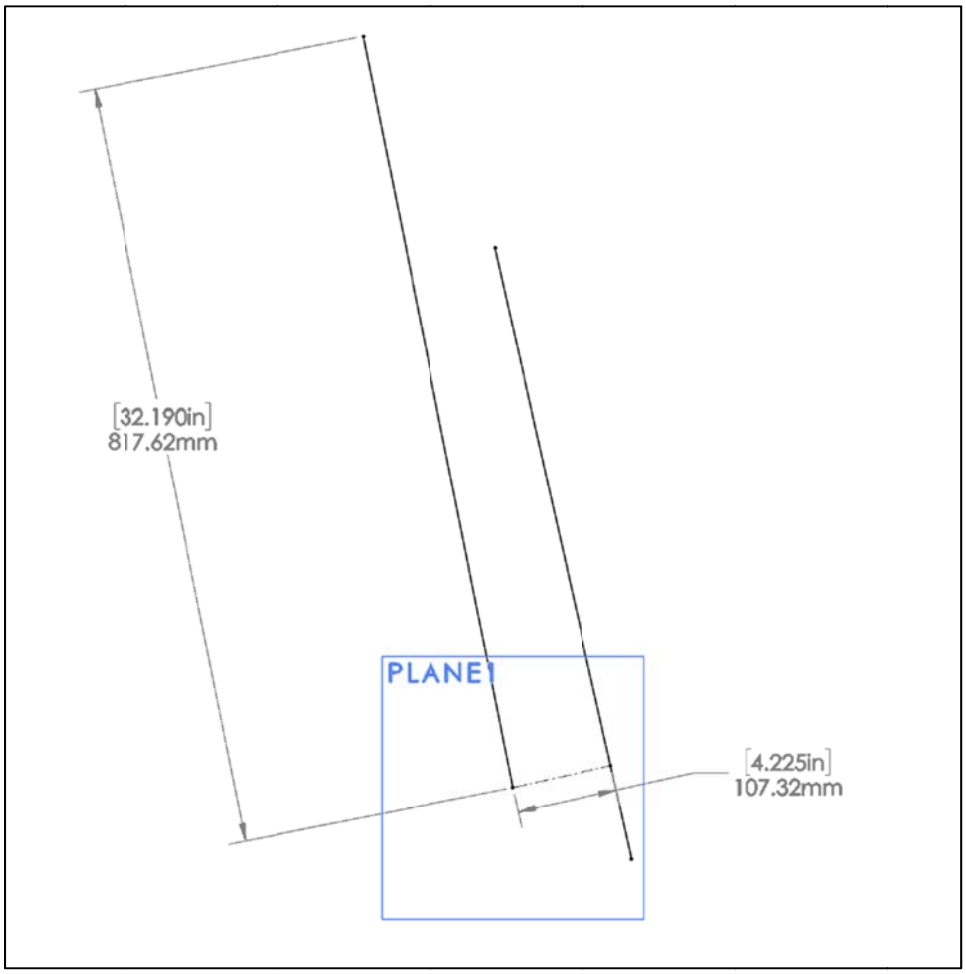

Figure 4 - Side view showing the basic elements and moment arm of the actuator.

5 References

1. *CURTIS-WRIGHT EXLAR, Automation Solutions,* PN23939, full product catalog, Exlar Corporation, 2017

6 Revisions

A Initial release, 24 August 2017