GLINT NO. 380
August 1, 1970
Revised Nov. 1, 1970

DECLINATION DRIVE POWER EXPECTATIONS

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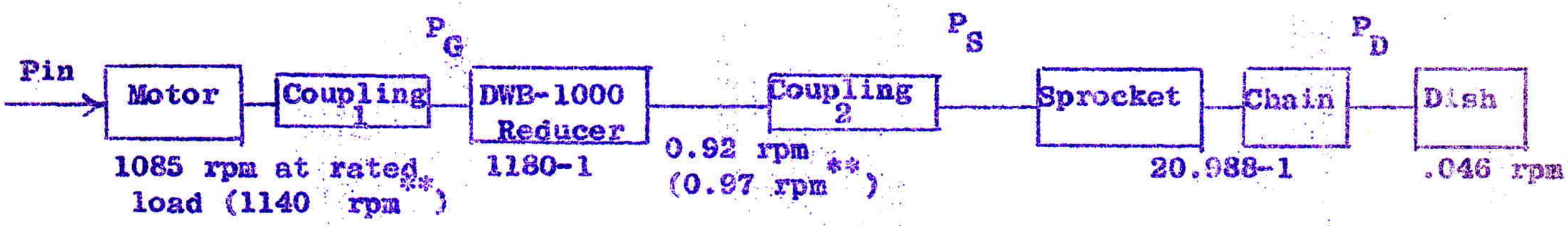
References: Glint No. 330, Declination Drive Power Budget Summary
Glint No. 366, The Antenna Jacking Experiment
Glint No. 368, Summary of Worm Reducer Testing
Glint No. 337, Wind Loads on Declination Drive Reexamined



With 24,000 lbs. pretension,

$Pin = 1.14\ P_G = 2.89\ P_D + 0.71$ hp.

$\eta_{motor} = 0.89$ (Glint No. 391) at rated power.

$\eta_{coupling\ 1} = 0.99$

$\eta_{reducer} = 0.48^{*}$ Glint No. 368

$\eta_{coupling\ 2} = 0.99$ estimated

$P_S = 1.21\ P_D + 0.30$ hp. Glint No. 366, (with 24,000 lbs. pretension),
(+ 0.38 hp with 30,000 lbs. pretension).
(See Appendix IV for derivation) and
(See Appendix V for effect of supertension).

* The overall efficiency (including oil churning loss) as measured by Link Belt when reducer is warm.

** Measured lifting Tertio off north stow position.

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Possible values (Glint No. 366)

	No Wind	35 mph	50 mph
P_D	1.47 hp	2.5 hp	3.45 hp
P_G	4.3	7.0	8.5
P_{IN}	4.96	7.94	9.68

The reducer is rated at P_G = 2.35 hp with an overload capacity of 500-600%. The motor is rated at P_{OUT} ($\approx P_G$) = 7.5 hp with a 300% overload capacity. The above table assumes chain and sprocket friction to vary directly with total chain tension, and motor efficiency to stay equal to its value at P_{OUT} = 7.5 hp.

The values in the above table are based on the "Antenna Jacking Experiment", (see Appendix I), and are 10% more than the values predicted by calculation in Appendix II. They are 13% less than the observed motor input power (Appendix III).

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APPENDIX I

ANTENNA JACKING EXPERIMENT (Glint 366)

	Equivalent Chain Pull	hp to Pull Chain at Slew Speed
Experimental evidence:		
Lift reflector weight from N stow position	24,700 lbs.	1.46 hp
Overcome friction	11,700 lbs.	0.69 hp
Total	36,400 lbs.	2.15 hp

i.e. $P_D = 1.46$ hp

$P_S = 2.15$ hp

power used (no wind) lifting reflector off north stow position at observed slew rate (.046 rpm). Total chain pretension is 30,000 lbs. Estimated accuracy of experimental results is ± 5%. See Appendix IV for derivation of power formula.

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APPENDIX II

CALCULATED POWER TO LIFT REFLECTOR IN DECLINATION (Glint 330, Appendix I)

$$P_D = 1.35 \sin\theta \text{ hp}$$

$$P_D = 1.34 \text{ hp at north stow position}$$

where reflector weight is 20,000 lbs* and sprocket speed is .046 rpm. $\theta = 0^o$ at 0^o declination. There is a discrepancy between the 1.34 hp of this calculation and the 1.46 hp observed in Appendix I for P_D. Implication is that the reflector weight is 21,900 lbs or the distance of the C.G. from the declination axis is greater than calculated in Glint No. 293 (7.6 ft.).

*Based on new Tertio reflector weight calculation of 20,000 lbs.

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APPENDIX III

OBSERVED MOTOR INPUT POWER TO LIFT TERTIO REFLECTOR (Glint No. 379)

P_{IN} = 5.76 hp (4.3 kw 16.0 amps)

No wind, reducer warm, lifting reflector off north stow position, DWB-1000, 30,000 lbs pretension.

Appendix I jacking experiment predicts

$$P_{IN} = (2.89)(1.46) + 0.8 \quad \text{(30,000 lbs pretension)}$$
$$= 5.02 \text{ hp}$$

assuming motor efficiency of $\eta_M = 0.89$. [P_{IN} predicted at 5.76 hp if $\eta_M = 0.79$. This is inconsistent as η_M is expected to drop only a few per cent at lower motor powers.]

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APPENDIX IV

DERIVATION OF POWER FORMULA (Glint 366)

P_S = 2.15 hp and P_D = 1.46 hp when total chain tension at liftoff from north stow position was 66,400 lbs = 24,700 (wt) + 11,700 (friction) + 30,000 (pretension). Assume friction varies directly as chain tension. Then the extra chain pull to overcome the friction force generated by a given chain tension is $\frac{11,700}{54,700} = 0.213$. The pretension of 24,000 lbs will always give a friction loss of 0.30 hp. And

$$P_S = 1.213\ P_D + 0.30 \text{ hp.}$$

Since

$$P_{IN} = \frac{P_G}{\eta_M \eta_{C1}} = \frac{P_S}{\eta_M \eta_{C1} \eta_R \eta_{C2}}$$

where

η_M = motor efficiency = 0.89 estimate
η_{C1} = Coupling 1 (1085 rpm) efficiency = 0.99 estimate
η_{C2} = Coupling 2 (1 rpm) efficiency = 0.99 estimate
η_R = reducer efficiency = 0.48 average

$$P_{IN} = 1.14\ P_G = 2.89\ P_D + 0.71 \text{ hp}$$

also

$$P_G = 2.54\ P_D + 0.62 \text{ hp}$$

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APPENDIX V

EFFECT OF SUPER-TENSION

Glint No. 295 recommends "super-tension" be applied to the chains to decrease pointing errors. With a 45,000 lb. super-tension

$$P_{IN} = 2.89P_D + 1.5 \text{ hp}$$

Thus P_{IN} is increased 0.8 hp by the application of 21,000 lbs. super-tension, assuming chain and sprocket friction vary directly with total chain tension. This is not significant considering the short period of time the declination drive will be operating.