



National Centre for Radio Astrophysics

Calibration of FPS system and calculation of angular offset generated due to Backlash of Feed Gear box

Mechanical department

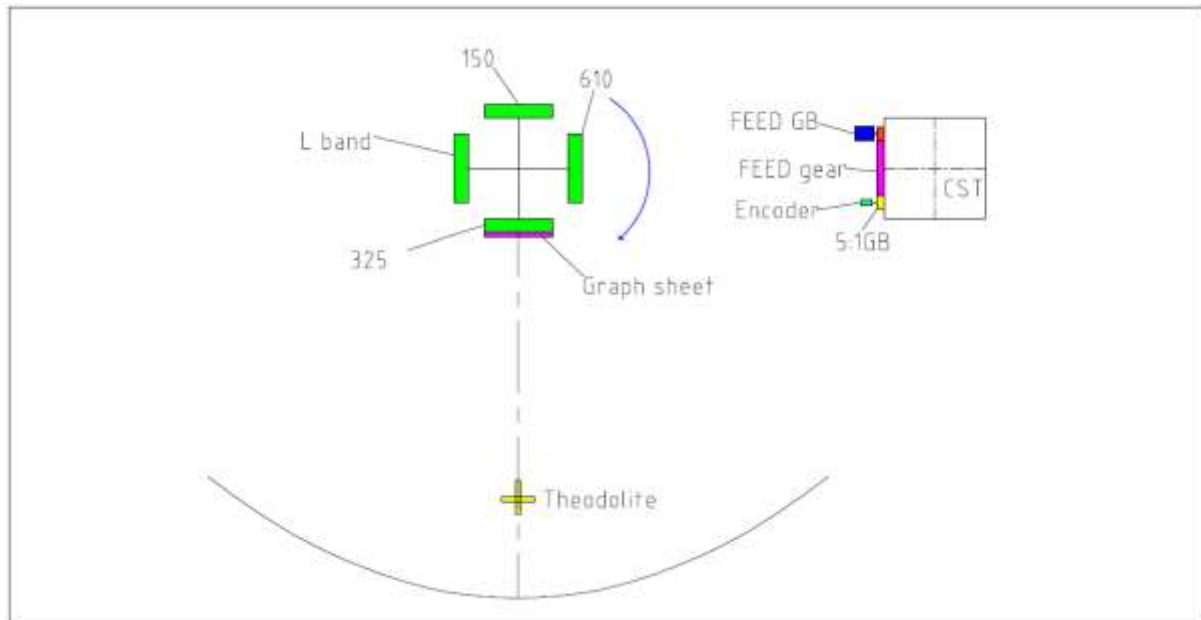
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Objective:- To Calculate angular offset generated due to backlash of feed gear box (Allen berry) at the C05 and C06 antenna

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FPS system View:

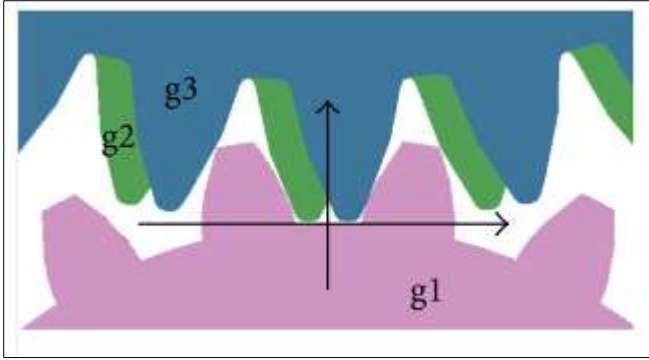


Installation - In our ongoing efforts to enhance precision and performance in our feed gear system, we have successfully installed zero backlash gearboxes. These gearboxes are specifically designed to achieve an exact 1:1 output for Feed Position system (FPS). One notable feature of these gearboxes is the utilization of spring-loaded split pinions, ensuring constant contact with the gear.

The zero backlash gearboxes are instrumental in minimizing any play or clearance between the gears, providing a direct and instantaneous transmission of motion. This configuration is crucial for applications where precise synchronization and accuracy in FPS are paramount.

Key Features:

- ✓ **Zero Backlash Design:** The gearbox design incorporates features that eliminate backlash, preventing any undesired movement or delay in the transmission of motion.
- ✓ **Spring-Loaded Split Pinions:** A notable component of the gearbox is the utilization of spring-loaded split pinions. These pinions are in continuous contact with the gears, guaranteeing a seamless and constant transfer of power.
- ✓ **Enhanced Precision:** The implementation of zero backlash gearboxes significantly enhances the overall precision of the feed gear system. This is particularly important in applications where exact 1:1 output for FPS is critical.
- ✓ **Improved Performance:** With the elimination of backlash, the gearboxes contribute to improved system performance by reducing wear and tear, ensuring smoother operation, and prolonging the overall lifespan of the equipment.



Split pinion Picture g1-FPS gear ,g2 and g3 are split pinions

Encoder calibration Procedure:

To ensure accurate encoder calibration, a meticulous process was employed utilizing graph paper and a theodolite. The procedure involved affixing graph paper to the centre of the FEED, with the theodolite precisely focused on the graph paper's centre. Readings were then recorded at this point, and the process was repeated multiple times to validate the consistency of encoder positioning.

Observation: Upon recent assessment, a disparity in encoder counts for C05 and C06 antennas was identified. A comprehensive comparison of initial readings and current readings, conducted after an 8-month period, has been tabulated below:

C05 Antenna		Date- 03/04/2023		
Feed (Band)	FPS Count			
	Set 1	Set 2	Set 3	Set 4
Band 2	47901	47904	47903	47894
Band 3	113235	113226	113227	113218
Band 4	14860	14860	14859	14859
Band 5	80581	80576	80577	80578

C05 Antenna		Date- 14/12/2023		
Feed (Band)	FPS Count			
	Set 1	Set 2	Set 3	Set 4
Band 2	48051	48053	48013	48013
Band 3	113385	113380	113343	113340
Band 4	15074	15074	15033	15031
Band 5	80783	80786	80740	80745

C06 Antenna		Date- 06/04/2023		
Feed (Band)	FPS Count			
	Set 1	Set 2	Set 3	Set 4
Band 2	48742	48751	48756	48747
Band 3	114435	11444	114442	114471
Band 4	16209	16213	16234	16231
Band 5	81666	81670	81677	81663

C06 Antenna		Date- 14/12/2023		
Feed (Band)	FPS Count			
	Set 1	Set 2	Set 3	Set 4
Band 2	48542	48533	48537	48537
Band 3	114209	114215	114216	114214
Band 4	15998	15990	15975	15982
Band 5	81376	81359	81350	81367

Calculation for angular offset:

Difference between counts in 8 months

C05 antenna		C06 antenna	
Band 2	152	Band 2	223
Band3	167	Band3	262
Band 4	215	Band 4	259
Band 5	210	Band 5	327

As per servo webpage on GMRT, acceptance accuracy for FPS is 2 arc sec, Following is detail calculation

As per encoder specification

1 degree = 364 encoder count

Using Pythagoras

2arc sec= 2/60=0.033°

$$\tan 0.033 = \frac{x}{18540}$$

Therefore, x =10.78 mm

Similarly Degree at FPS can be calculated

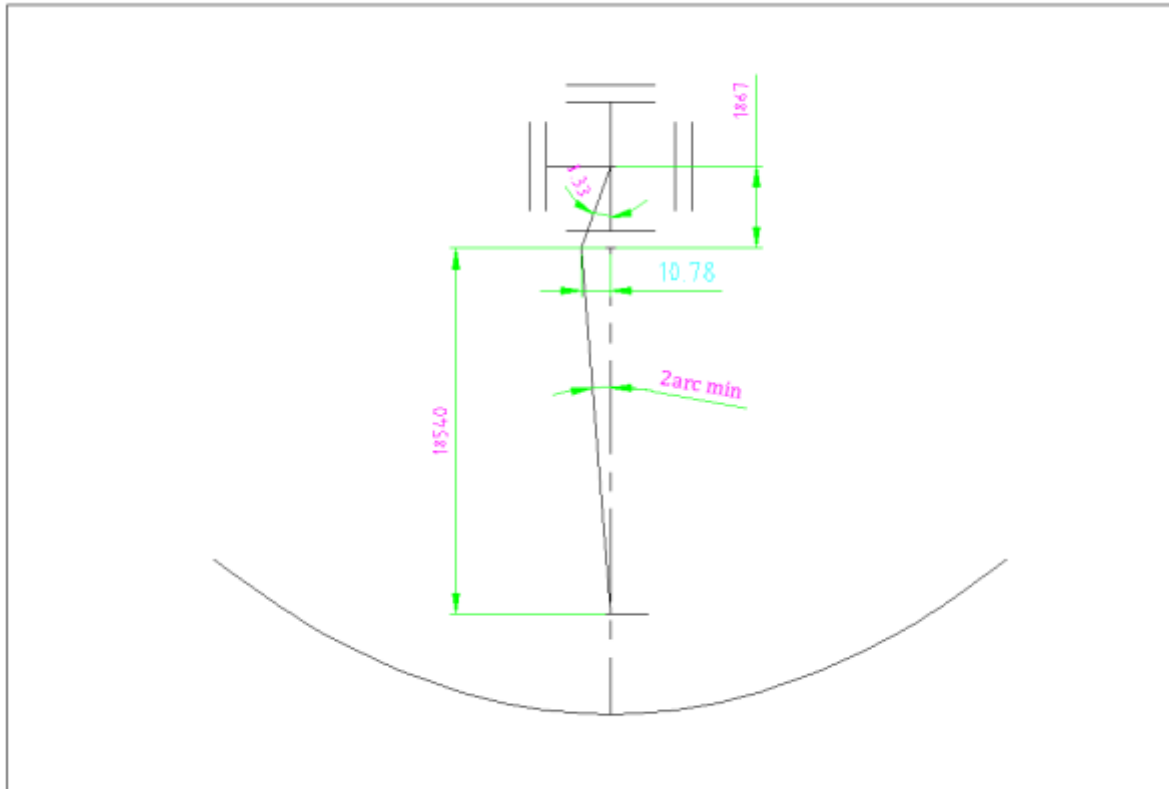
$$\tan \theta = \frac{10.78}{1867}$$

$$\Theta = 0.33^\circ = 121 \text{ counts}$$

Now FPS gear box is having set backlash of 0.5 mm which is equal to 34 counts at encoder

Also dish level is around $1^\circ 30\text{sec}$ at node 12 on PRF 1 and 9 which is equal to 40 counts.

So total encoder count = $121+34+40 \sim 200$ counts will be our acceptance limit at encoder.



Result:

In C06 antenna during our mechanical work we observed that the FPS gear box was leaked due to oil seal damage, as we also observed count difference , so investigated this problem and find that the back lash