Project proposal

1. **Title:** Development of Gyromotor for gyro-stabilized platforms

2. **Description:** A gyromotor is an electro-mechanical unit comprising of: Stator, Rotor and Cover

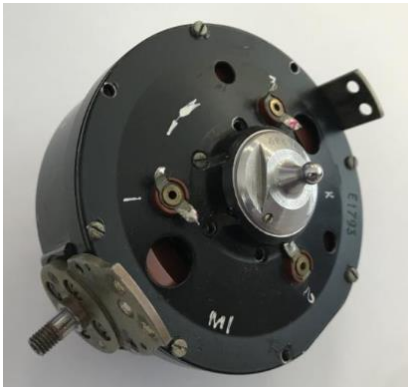

Fig. 1: Photograph of gyromotor

3. **Objectives:** To develop and test a gyromotor comprising of: Stator, Rotor and Cover with the following specifications

- AC power supply - (40±2) V, (500±5) Hz
- Current consumption in each phase – not more than 0.73 A
- Rotation speed – not more than 27900 rpm
- Rotor run-down time – from 11 to 24 mins
- Rotor dynamic unbalance at resonant rotations – not more than 0.034 gcm^2
- Weight – 880 g
- Dimensions – not more than 114.9×80×80 mm

4. **Technological challenges: Being an electromechanical device the challenges faced in developing a gyromotor are not limited to one engineering domain.**

Mechanical:

i. Presence of flywheel (higher inertia) to increase the stability of gyromotor results in balancing issues at high rotational speed (~28000 rpm).
ii. To overcome the resonant frequencies while accelerating to rated angular speed.
iii. Bearings to support rotor at high speed while minimizing losses due to friction. Axial pre-tensioning of bearings to minimize rotor movement in axial direction.
iv. Maintaining clearances (of the order of 50-100 μm) between rotor and stator to maximize flux linkage and between cover, stator and rotor.

Project proposal

Electrical:

i. Developing a custom made 3-phase rotor and stator to achieve rated angular speed with specifications necessary to meet the stated objectives.

Electronics:

i. Developing a custom made VFD (variable frequency drive) capable of accelerating, driving and decelerating the gyromotor necessary to meet the stated objectives.

5. Facilities required for accomplishing the project.

Balancing machine: Standard balancing machine (as available in the market) is available at TriQual. However, there may be a need to modify this setup if required for the project.

Workshop (including lathe, milling, drilling m/c): Available with both TriQual and FCRIT.

Stator winding facility: If not available at FCRIT, may be outsourced.

Software tools to analyse and study the gyromotor.

6. Manpower requirement

Atleast one project guide (Principal Investigator) supervising atleast one student per discipline (Mechanical, Electrical and Electronics).

7. **Testing & Qualification of end product - Acceptance criteria (with respect to unbalance level, winding details, insulation, bearings etc.):** To be evolved by the group for mass production.

8. Time duration - Not exceeding 4 months

9. Deliverables:

1. Successful demonstration of developed Gyromotor (as per project specifications).
2. Technology, drawings, methodology for each component (stator, rotor, bearings, cover shell) to be handed over at the end of the term.
3. Fabrication/ development methodology aimed for mass production.

MoM: FCRIT and TriQual Cryogenics Pvt. Ltd.

Date: Wednesday, 31.05.2023

Location: FCRIT, Vashi

Attendees:

1. Dr. Nilaj Deshmukh
2. Dr. Bindu. R
3. Dr. Dhananjay R. Panchagade
4. Shoumik Kulkarni
5. Trilok Singh
6. Puneet Tulsyan
7. Rajendra Soni
8. Isaac de Souza

Items discussed:

1. Mr. Trilok Singh shared about the gyromotor and the project requirements as per Annexure 1 [attached herewith].
2. It was decided that Dr. Bindu R. would be the principal investigator to address the challenges in the electrical and electronics domain while Mr. Shoumik Kulkarni would be the co-investigator to address challenges in the mechanical domain.
3. Four students from each branch (electrical and mechanical) resulting in a total of 8 will be involved in developing the gyromotor.
4. Creation of WhatsApp group to communicate freely.
5. A visit may be planned for the Investigators and students to observe the facilities available at TriQual Cryogenics Pvt. Ltd.
6. Softcopy of MoU will be sent via email for approval and signatures.
7. TriQual will send (via email) the literature collected thus far in regards to the Gyromotor.
8. Mr. Isaac and Mr. Nitin will be the Principal collaborator (PC) and co-collaborator respectively.

TriQual Cryogenics Pvt. Ltd.
Let us cool
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CIN NO:- U74999MH2016PTC286304, GSTIN:- 27AAFCT9617E1Z5

Project proposal

Form No: TCPL/R&D/LM/23-24/F-3 **Dated: 26/10/2023**

1. **Title:**
   a. Analysis of a linear motor drive
   b. Development of a power supply for driving the linear motor

2. **Description:** A linear motor is an electromagnetic device used to create linear motion (motion along a straight line) as opposed to the rotary motion typically generated by conventional motors.

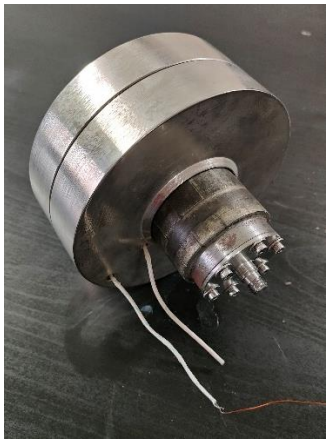

Fig. 1: Photograph of linear motor developed at TriQual Cryogenics Pvt. Ltd.

Video link: https://triqualcryogenics.in/linear-motor

3. **Objectives:**

   a. Analysing the linear motor drive developed by TriQual. This may be achieved via numerical studies using software. The dimensions and parameters will be shared by TriQual.
   b. Modification of existing power supply or development of new power supply to tackle the problems being faced by TriQual. The specifications of the coil, magnet and yoke assembly will be shared by TriQual.
   c. Following **point a**, designing a different linear motor drive specific to the application [will be shared by TriQual at a later date]. This may be achieved via numerical studies using available software. Parameters such as coil dimensions, wire gauge, resistance, number of turns, current, permanent magnet dimensions and flux density, air gaps between stator and

mover, operating frequency can be studied to determine the max. force exerted and length of stroke.

4. Manpower requirement

Atleast one project guide (Principal Investigator) supervising atleast one student.

5. Testing & Qualification of end product - Acceptance criteria (with respect to power requirement, force exerted by drive, stroke length, frequency of operation, weight):

To be evolved by the group for mass production.

6. Time duration – Deadline – May 2024

7. Deliverables:

1. Successful demonstration of developed power supply to run the linear motor developed by TriQual.
2. Technology, design of circuit and power supply, drawings, methodology to be handed over at the end of the term.
3. Fabrication/ development methodology aimed for mass production.
4. Numerical analysis/modelling of linear motor driven matching with experimentally obtained results. i.e. force exerted, frequency and stroke length for a corresponding power input.