

## DESIGN AND DEVELOPMENT OF ATTITUDE CONTROL SYSTEMS FOR REUSABLE LAUNCH VEHICLE

Lala Surya Prakash, G. C. Arun, Biswaroop Sarkar,  
B. Sathis Kumar  
Control Systems and Umbilical Design Group  
Liquid Propulsion Systems Centre (LPSC)  
Department of Space, Valiamala  
Thiruvananthapuram - 695 517, India  
Email : [ls\\_prakash@lpsc.gov.in](mailto:ls_prakash@lpsc.gov.in)

L. Sampath  
Operational Launch Vehicle Project/ GSLV  
Vikram Sarabhai Space Centre (VSSC), ISRO  
Post  
Thiruvananthapuram - 695 022, India

V. Krishnanandan  
Control Systems Design and Integration Group  
Liquid Propulsion Systems Centre (LPSC)  
Department of Space, Valiamala  
Thiruvananthapuram - 695 517, India

### Abstract

This paper brings out the design and development of attitude control systems employed in the Reusable Launch Vehicle - Technology Demonstrator (RLV-TD) of ISRO. Precise attitude control of the winged body vehicle is a challenging task when compared to the expendable satellite launch vehicles. The Secondary Injection Thrust Vector Control (SITVC) is employed for the control of combined solid booster and TDV (wing body vehicle) and the Reaction Control System (RCS) is employed for controlling the TDV. During the ascent phase especially during lift-off, the SITVC system is used for controlling the Pitch and Yaw moments and the roll thrusters mounted on the wings of TDV is used for controlling rolling moments of the combined vehicle. After the first stage (burnt booster motor) separation, the control and orbit orientation of the TDV is carried out by hydrazine based monopropellant Reaction Control System (RCS). Initially, trade off studies and design assessments were conducted on SITVC and RCS systems which includes, injectant/propellant selection, injection valve selection, pressurization system configuration, system valve/component selection. After successful completion of the Preliminary Design Review, the realization of major elements like gas bottles, propellant tanks, toroidal injectant tank, 3 pintle electro mechanical injection valves, thrusters assemblies, control components and module assemblies were carried out. The developmental challenges, qualification programme, flight hardware acceptance testing are also discussed in this paper.

**Keywords:** RLV-TD, Reaction Control System, Secondary Injection Thrust Vector Control, System Design, Injectant, Three Pintle Electro Mechanical Injection Valves