

The high energy intensity of a liquid-propellant rocket engine (LPRE) and its units significantly affects the dynamics of transients caused by changes in control positions. To analyze the stability of the LPRE control process and to assess its accuracy, one has to know the dynamic frequency characteristics of the LPRE control system (CS) actuators. The determination of transient quality, the solution of the problem of choice of the optimum CS, and the analysis of its features call for studying the dynamic characteristics at different values of the dynamic parameters (the regulator transfer coefficients and the time constants and gains of the transfer functions of individual LPRE units).

For rocket space stages (RSSs), with account for the features of their operation, the problem of sustainer LPRE thrust vector control using a combined thrust vector control system (CTVCS) is considered. The RSS CTVCS consists of a large-size interceptor gas-dynamic thrust vector control system (GDTVCS) and a system of control nozzles. This combination of CS actuators allows one to efficiently implement the flight program and counteract off-normal disturbances in the RSS flight.

The aim of this work is to develop a structural schematic for and to calculate the complex transfer function of an interceptor GDTVCS as a part of a CTVCS and to construct frequency characteristics from estimated dynamic parameters for further analysis of CTVCS stability and quality.

A functional diagram was developed for a sustainer engine CTVCS that consists of an interceptor unit (IU) for propellant component injection as a guidance actuator and a system of control nozzles as a stabilization actuator. A structural schematic for a GDTVCS with an IU was developed. The GDTVCS transition function and the amplitude-phase-frequency characteristics of the GDTVCS complex transfer function were calculated from estimated dynamic parameters. The analysis of the numerical results made it possible to identify GDTVCS operational conditions with dynamic characteristics that correspond to a high-quality control process. Further investigations will be aimed to analyzing GDTVCS quality (stability) and searching for optimal combinations of dynamic parameter values with the aim to increase RSS sustainer engine CTVCS efficiency.

Keywords: rocket space stage, rocket engine, thrust vector control system, dynamic characteristics, gas-dynamic system, combined control system.

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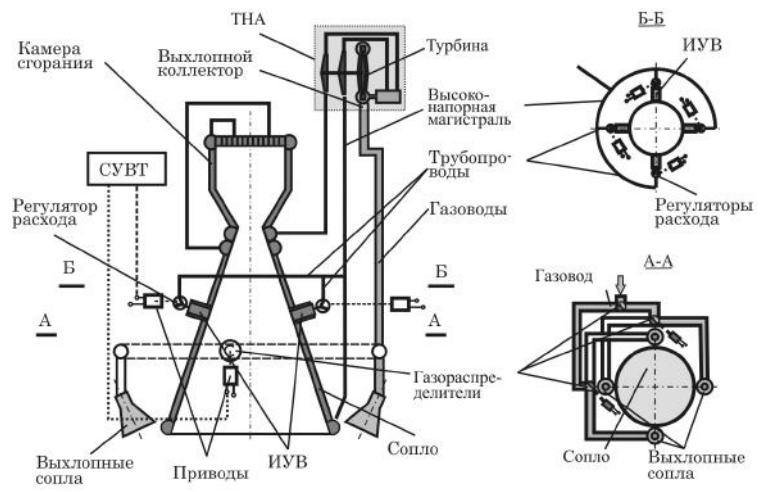
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$$\overline{\Delta p} = K_1 \overline{\Delta p} + K_2 \overline{\Delta x}, \quad (3)$$

$$K_1 = \frac{p}{p}; K_2 = 2 \frac{p}{p} \frac{-p}{p} \left(\mu \frac{x}{F} k_{fx} - \frac{x}{\dot{m}} k_{mx} \right),$$

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$$(T_2 p^2 + T_1 p + 1) \overline{\Delta h} = K_1 \overline{\Delta p}, \quad (4)$$

$$: K_1 = F \frac{p}{h_{\max} c}, T_2 = \frac{M h_{\max}}{c}, T_1 = \frac{k}{c},$$

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$$\overline{\Delta \dot{m}} = K_1 \overline{\Delta p} + K_2 \overline{\Delta p_c}, \quad (5)$$

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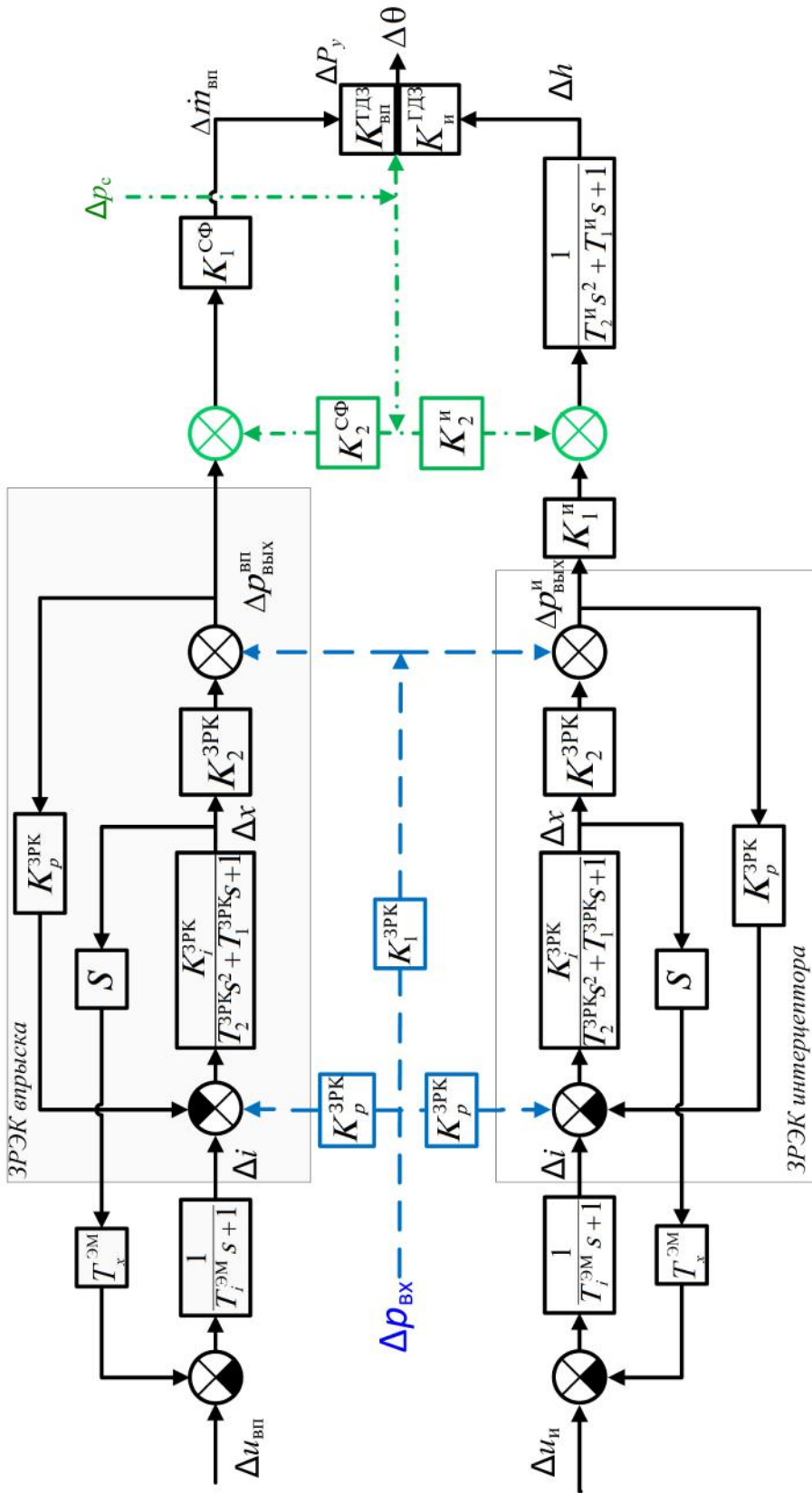
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 & T_2 = 0,00002, T_1 = 0,01, K_p = 6, K_2 = 2, \\
 & K_1 = 1,25, T_2 = 0,001, T_1 = 0,011, = 0,007.
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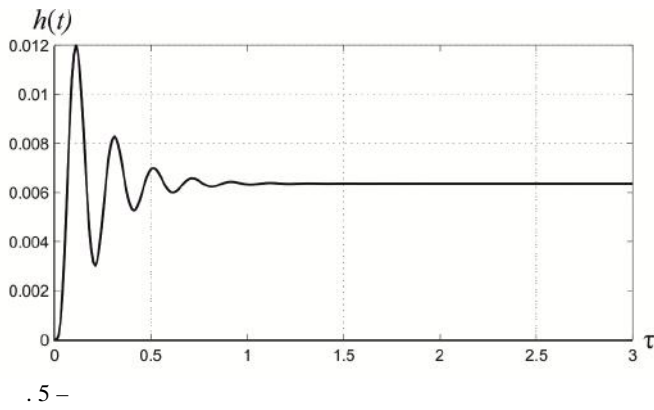
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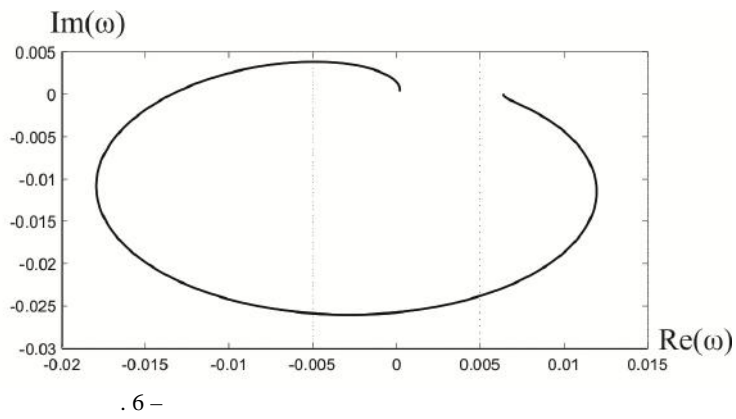
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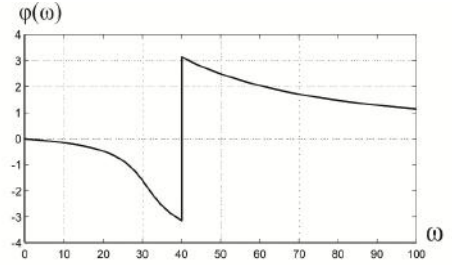
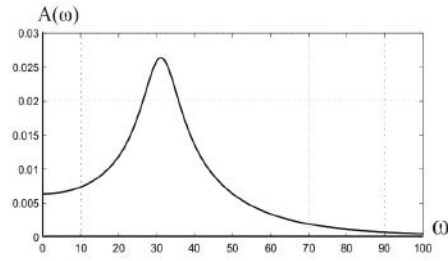


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