

High-Temperature Gas Injection Distributor



The gas distributor is intended for gas injection into LRE chamber nozzle supersonic section for engine thrust vector control in pitch (P) and yaw (Y).

Basic Technical Characteristics

Working medium	Reducing generator gas
Hydraulic booster working fluid	UDMH Kerosene
Gas temperature, K	1073
Maximal gas pressure, MPa	14.7
Maximal gas flow rate, kg/s	1.6
Fluid pressure, MPa	44.1
Half-coupling torque moment, N · m	1.47
Resource of transpositions drive shaft – gear wheel and valve spindle within ± 30 degrees	Not less than 90000
Mass, kg, not more	2.5
Structural materials	Heat-resistant alloys, stainless steel, rubber sealing rings with fluoroplastic washers

Hydraulic Throttle with Movable Sleeve 1



The hydraulic throttle (HT) is intended to regulate fluid flow and is activated by electric drive. It is used as actuator of the fuel flow rate regulation systems in the engine combustion chamber and gas generator passages. It ensures working medium flow regulation in the wide range of flow rates and pressures. It is used on Zenit LV and Cyclone-4 LV upper stages.

Basic Technical Characteristics

Characteristics	HT1	HT5
Nominal diameter of passage section, mm	26	8
Working medium	Kerosene	UDMH
Nominal flow rate (water), kg/s	7	0.63
Operating pressure, MPa	23.5	16.9
Range of pressure drops regulation reduced to nominal flow rate, MPa	0.5...7.8	0.3...10.3
Required torque, N · m, not more	3	3.9
Operating temperature range, °C	-40...+60	
Overall dimensions (A*B*C), mm, not more	203x98x104	139x73x103
Mass, kg	1.6	1
Materials	Stainless steels, fluoroplastic-4	

Hydraulic Throttle with Movable Sleeve 2



The hydraulic throttle (HT) is intended to regulate fluid flow and is activated by electric drive. It is used as actuator of the fuel flow rate regulation systems in the engine combustion chamber passages. It ensures working medium flow regulation in the wide range of flow rates and pressures. It is used in space LV main engines.

Basic Technical Characteristics

Characteristics	HT1	HT2
Nominal diameter of passage section, mm	85	100
Working medium	Kerosene	
Nominal flow rate (water), kg/s	107.5	165
Operating pressure, MPa	45	47
Range of pressure drops regulation reduced to nominal flow rate, MPa	2.5...98	2.5...98
Required torque, N · m, not more	7	7
Operating temperature range, °C	-20...+60	
Overall dimensions (A*B*C), mm, not more	380x200x215	425x234x241
Mass, kg	20.9	34
Materials	Titanium and aluminum alloys, stainless steel, rubber, fluoroplastic-4	

Hydraulic Throttle with Movable Needle



The hydraulic throttle is intended to regulate fluid flow and is activated by electric drive. It is used as actuator of the fuel flow rate regulation systems in the engine gas generator passages.

It ensures working medium flow regulation in the wide range of flow rates and pressures.

It is used on Zenit LV second stage.

Basic Technical Characteristics

Nominal diameter of passage section, mm	10
Working medium	Kerosene
Nominal flow rate (water), kg/s	0.35
Operating pressure, MPa	33
Range of pressure drops regulation reduced to nominal flow rate, MPa	0.5...10.5
Required torque, N · m, not more	5
Operating temperature range, °C	-40...+60
Mass, kg	0.87
Materials	Stainless steels, bronze, fluoroplastic -4

Two-Mode Throttle of Cam Type



The two-mode throttle of the pressure maintenance system (PMS) is intended for engine switchover from main mode to throttling mode and for maintaining these modes by the engine regulation system with required accuracy. It is used as actuator of the fuel flow rate regulation systems in the engine gas generator passages.

It is used on Dnepr LV upper stage engine.

Basic Technical Characteristics

Nominal diameter of passage section, mm	6
Working medium	UDMH
Flow rate (water), kg/s: - in the first mode - in the second mode	0.138 0.183
Operating pressure, MPa	13
Range of pressure drops regulation reduced to nominal flow rate, MPa	1.1...5.8
Required torque, N · m, not more	3.4
Operating temperature range, °C	-10...+30
Mass, kg	1.05
Materials	Stainless steels, graphite

High-Temperature Gas Throttle



The throttle is intended to change high-temperature gas flow rate.
The throttle is used to regulate Cyclone-3 launch vehicle engine thrust.

Basic Technical Characteristics

Working medium	Reducing generator gas
Nominal diameter of passage section, mm: at input at output	20 26
Gas pressure, MPa	up to 6
Gas flow rate, kg/s	0.015 to 0.1
Gas temperature, °C	up to 950
Throttle shaft torque, kgf · m, not more	1
Mass, kg, not more	0.8
Structural materials	Heat-resistant alloys, stainless steel, anti-friction graphite material

Throttle-High-Temperature Gas Distributor



The throttle-distributor is intended to distribute high-temperature generator gas between the nozzles of rocket stage control in pitch (P), yaw (Y) and roll (R).

Basic Technical Characteristics

Working medium	Reducing generator gas
Maximal gas flow rate, kg/s	1
Input pressure, MPa	up to 0.69
Gas temperature, K	up to 1073
External leakage in air, cm ³ /s, not more	20
Shutter torque during operation on generator gas, N·m, not more	4.9
Resource of shutter transpositions within ± 40 degrees	not less than 1000
Mass, kg, not more	1.9
Structural materials	Heat-resistant alloys, stainless steel, anti-friction graphite material

Input Valve



The valve is intended to open and close fluid or gass supply line.

The valve is mass-produced and used on oxidizer pump feed line of Zenit space launch vehicle engine turbopump unit, is highly reliable.

Basic Technical Characteristics

Type	Normally-closed with bellows actuator
Nominal diameter of passage section, mm	60
Working medium: – in passage section	Liquid oxygen, air or nitrogen
– in control manifold	Helium, air
Working medium pressure, MPa, not more	1.2
Working medium pressure in control manifold , MPa, not more	23
Liquid oxygen flow rate, kg/s	18.572
Pressure losses in valve at liquid oxygen consumption, MPa, not more	0.04 (0.1 with built-in filter)
Sutter leakage at checking with air, cm ³ /s, not more	0.5
Number of actions, not less	500
Operating temperature range, °C	–182 ... + 50
Structural materials	Stainless steel, bronze
Mass, kg, not more	13.7

Shut-off Valve



The valve is intended to control fuel supply into combustion chamber.

Basic Technical Characteristics

Valve type	Normally-closed with piston actuator
Working medium: – in passage section – in control manifold	UDMH Helium
Internal air leakage, cm ³ /s, not more	1
External air leakage, cm ³ /s, not more	0.2
Working medium pressure in passage section, MPa, not more	15.79
Working medium input pressure at opening moment, MPa, not more	5.88
Working medium pressure in control manifold, MPa, not more	8.34
Nominal diameter of passage section, mm	28
Hydraulic losses at water flow rate of 7.122 kg/s, MPa, not more	0.49
Number of actions, not less	100
Mass, kg, not more	2.15
Structural materials	Stainless steel, fluoroplastic, rubber

Pneumatic Valve



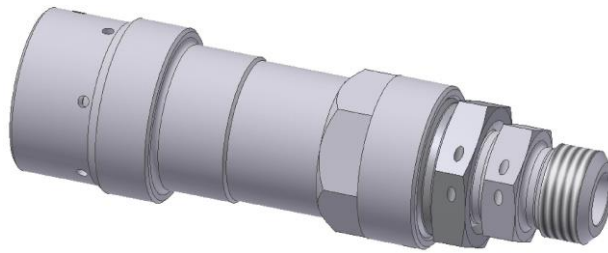
The pneumatic valve is intended to supply helium to TPU turbine in the process of engine start.

The pneumatic valve is used in Cyclone-4 launch vehicle III stage main engine.

Basic Technical Characteristics

Valve type	Normally-closed with piston actuator
Nominal diameter of passage section, mm	24
Working medium	Helium, nitrogen, air
Internal air leakage, cm ³ /s, not more	0.1
External air leakage, cm ³ /s, not more	$1 \cdot 10^{-2}$
Working medium pressure in passage section, MPa	3.92 to 31.38
Working medium pressure in control manifold, MPa	5.98 to 8.34
Number of actions, not less	45
Mass, kg, not more	1.2
Operating temperature range, °C	-50...+50
Structural materials	Stainless steel, aluminum alloy, polyamide, fluoroplastic, rubber

Safety Valve



The safety valve is intended to limit gas pressure in a line with specified accuracy.

Basic Technical Characteristics

Valve type	Direct-action
Working medium	Helium, air, nitrogen
Input pressure upper limit at which valve's shutter is tightly closed, MPa	$2.96^{+0.05}$
Input pressure lower limit at which valve's shutter begins unsealing, MPa	$3.1^{+0.15}$
Maximal input air pressure, MPa	3.8
Input gas temperature, °C	– 50...+35
Flow rate through valve, l/s	~1.5
Input pipeline diameter, mm	4
Mass, kg	0.15
Structural materials	Aluminum alloy, stainless steels, polymers

Diaphragm Valve 1



The diaphragm valve is intended for leak-tight separation of engine and TVCS manifolds in delivery line before engine ignition and for manifolds connection after ignition.

The valve is used in the thrust vector control system (TVCS) of Cyclone-4 launch vehicle III stage main engine and is highly reliable.

Basic Technical Characteristics

Valve type	Normally-closed with piston actuator
Working medium:	
–in storage	МГ–7Б or АМГ-10 oil
–in flight	UDMH
Valve actuation pressure, MPa	4.5±0.7
Operating pressure, MPa, not more	17
Leakage of input/output manifolds joint, l · Hgμm/s, not more	1·10 ⁻⁵
Hydraulic losses at water flow rate of 0.09 kg/s, MPa	0.2
Nominal diameter of passage section, mm	6
Mass, kg, not more	0.25
Operating temperature range, °C	–35...+65°C
Structural materials	Stainless steel, fluoroplastic and rubber
Number of actions	one

Diaphragm Valve 2



The diaphragm valve is intended for separation of engine fuel manifold and TVCS manifold in the drain line during stage storage, technological checks and in flight (before engine first ignition) and for continuous communication of engine and TVCS manifolds after engine first ignition.

The valve is used in the thrust vector control system (TVCS) of Cyclone-4 launch vehicle III stage main engine and is highly reliable.

Basic Technical Characteristics

Valve type	Normally-closed with piston actuator
Working medium:	
–in storage	МГ–7Б or АМГ-10 oil
–in flight	UDMH
Valve actuation pressure, MPa	19.5±5
Operating pressure, MPa, not more	2
Leakage of input/output manifolds joint, l · Hgμm/s, not more	1·10 ⁻⁵
Nominal diameter of passage section, mm	8
Pressure losses in flow line at working fluid flow rate of 0.1 kg/s, MPa, not more	0.01
Mass, kg, not more	0.3
Operating temperature range, °C	–35...+65°C
Structural materials	Stainless steel, titanium alloy, fluoroplastic, rubber
Number of actions	one

Diaphragm Valve 3



The diaphragm valve is intended for sealing the compressed helium storage system and for helium supply to the engine with decreased pressure growth gradient.

The valve is used on Cyclone-4 launch vehicle III stage main engine and is highly reliable.

Basic Technical Characteristics

Valve type	Normally-closed with piston actuator
Working medium	Helium
Working medium pressure, MPa, not more	34
Valve actuation pressure, MPa	21±3
Leakage of manifolds joint before actuation, l · Hgum/s, not more	1·10 ⁻⁵
Number of actions	1
Diameters of passage sections of connecting branches, mm	
– at input	16
– at two connecting branches output	12
– control connecting branch	4
Mass, kg, not more	0.93
Structural materials	Stainless steel, aluminum alloy, fluoroplastic, rubber

Shut-off Pyro Valve



The shut-off pyro valve is intended to close the high-pressure fluid supply line by electric command.

The shut-off valve was used in the engines of series-produced launch vehicles and is highly reliable.

Basic Technical Characteristics

Type	Normally-open
Nominal diameter of passage section, mm	28
Operating pressure, MPa	1÷35
Working medium	UDMH
Leakage of manifolds joint after actuation at check with air, cm ³ /s, not more	2
Action time, s, not more	0.02
Mass, kg, not more	0.8
Number of actions	one
Element ensuring actuation	Pyro cartridge
Pyro cartridge power supply voltage, V	24÷32
Current type	Direct
Current strength, A	2÷7
Structural materials	Stainless steels, aluminum alloy

Pyro Switch



The pyro switch is intended to close the fluid or gas supply line with concurrent switchover of working medium consumption to another line by electric command.

The pyro switch is used on Cyclone-4 launch vehicle and in Dnepr launch vehicle upper stage engine and is highly reliable.

Basic Technical Characteristics

Type	Normally-open in line I and normally-closed in line II
Nominal diameter of passage section, mm	8
Operating pressure, MPa	23
Working medium	N ₂ O ₄ , UDMH, helium
Air leakage of manifolds joint before actuation, cm ³ /s, not more	1·10 ⁻⁸
Air leakage of manifolds joint after actuation, cm ³ /s, not more	1·10 ⁻¹
Mass, kg, not more	0.43
Number of actions	one
Element ensuring actuation	Pyro cartridge
Pyro cartridge power supply voltage, V	24 - 32
Current type	Direct
Current strength, A	2 - 7
Structural materials	Stainless steel

Pyro Valve

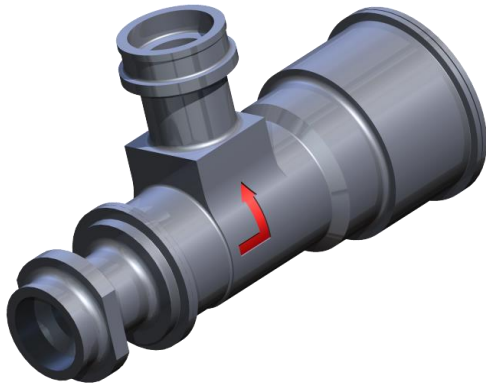


The pyro valve is intended for leak-tight separation of the tanks from the propulsion system manifolds during fueling, storage and for their communication by CS command.

Basic Technical Characteristics

Valve type	Normally-closed
Working medium	Propellant components
Maximal operating pressure, MPa	4.5
Leakage of manifolds joint during testing by air-helium mixture before actuation, $\text{N}\cdot\text{cm}^3/\text{s}$, not more	$1.36\cdot 10^{-8}$
Nominal diameter of passage section, mm	16
Element ensuring actuation	Pyro cartridge
Structural materials	Stainless steel, rubber
Operating temperature range, °C	– 60 ... +60
Number of actions	One
Mass, kg, not more	0.55

Retarder Valve

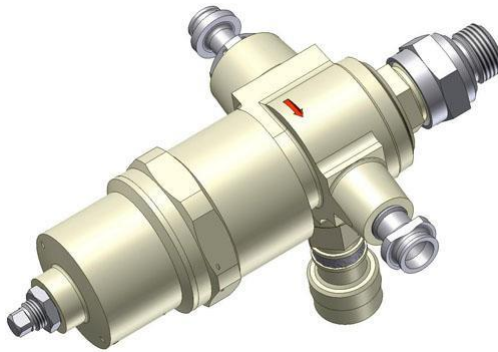


The retarder valve is intended for helium supply into propulsion system line with decreased pressure growth gradient.

Basic Technical Characteristics

Working medium	Helium
Maximal operating pressure, MPa	33.35
Actuation pressure, MPa	19.13
Nominal diameter of passage section, mm	10
Mass, kg, not more	0.2
Structural materials	Stainless steel, fluproplastic and rubber
Operating temperature range, °C	-60...+60
Number of actions	One

Reducing Valve 1

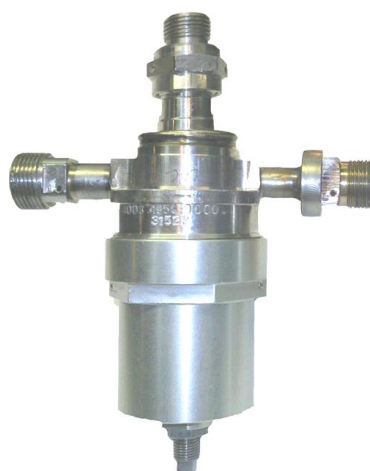


The reducing valve (RV) is intended to maintain helium pressure within specified limits in the engine starter-and-shutoff valves control system. The RV is made according to direct-action scheme. The RV is used in the Cyclone-4 LV III stage engine pneumatic unit.

Basic Technical Characteristics

Valve type	One-stage, direct-action, with vent-and-safety valve (VSV)
Working medium	Helium, air
Input pressure, MPa	9 – 34
Input gas temperature, °C	– 15...+55
Regulated pressure, MPa	6.6±0.15
Pressure in “stop-mode”, MPa, not more	6.9
VSV opening pressure, MPa	8±0.02
Diameter of passage sections, mm:	
input	6
output	8
Mass, kg	0.78
Structural materials	Aluminum alloy, stainless steels, polymers

Reducing Valve 2



The reducing valve (RV) is intended to maintain required gas pressure at the input of rocket upper stage and spacecraft liquid engine propellant supply system pneumopump unit.

Basic Technical Characteristics

Valve type	One-stage, direct-action
Working medium	Helium, air
Input pressure, MPa	3 – 34
Input gas temperature, °C	– 93...+35
Regulated pressure, MPa	2.45±0.12
Pressure in “stop-mode”, MPa, not more	2.9
Diameter of passage sections, mm:	
input	8
output	10
Mass, kg	1.0
Structural materials	Aluminum alloy, stainless steels, polymers

Reducing Valve

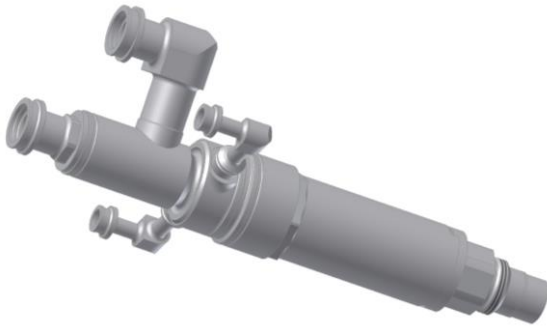


The reducing valve (RV) is intended to maintain constant pressure of nitrogen, helium supplied to starting turbine input during engine ignition and to purge chamber and gas generator cavities. It is used in upper stage engines of space launch vehicles.

Basic Technical Characteristics

Working medium	Nitrogen, helium
Input pressure, MPa	33.3 to 9.8
Regulated pressure, MPa	6.9±0.589
Control pressure, MPa	7.9±0.392
Nitrogen (helium) flow rate, kg/s	1.283 (0.5)
Operating temperature range, °C	-20...+50
Mass, kg	1.2
Materials	Aluminum alloy, stainless steels, rubber, fluoroplastic

High-Temperature Gas Pressure Regulator



The regulator is intended to maintain pressure in powder gas generator.
The regulator is used in onboard power sources of a number of launch vehicles.

Basic Technical Characteristics

Working medium	Powder gas
Nominal diameter of passage section, mm	13
Gas pressure, MPa	up to 7
Pressure maintenance accuracy, %	± 10
Gas temperature, °C	up to 1000
Mass, kg, not more	1.3
Structural materials	Heat-resistant alloys, stainless steel

Pressure Regulator

The pressure regulator (PR) is intended to maintain constant output pressure. Regulation is effected by changing hydraulic resistance of the regulator.

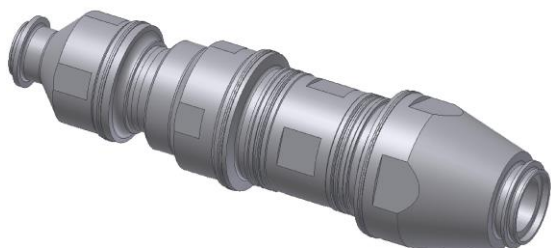
It is used on LV upper stages.



Basic Technical Characteristics

Working medium	UDMH	NT
Input pressure, MPa	16.6...21.7	7.5...9.8
Adjustment pressure, MPa	1.58	
Flow rate, kg/s	0.037...0.26	0.093...0.425
Static accuracy, %	±7	±9
External leakage, cm ³ /s	1·10 ⁻⁶	
Working medium temperature, °C	0...65	0...45
Nominal diameter of passage section, mm	8	
Mass, kg	0.9	
Materials	Stainless steels, aluminum alloy	

Pressure Drop Regulator



The pressure drop regulator (PDR) is intended to maintain specified pressure drop of working medium supplied to the user in operation mode and at stepwise change of flow rate through the user.

It is used in onboard power sources of launch vehicles.

Basic Technical Characteristics

Characteristics	PDR1	PDR2	PDR3	PDR4	PDR5
Working medium	Oil, kerosene				
Nominal diameter of passage section, mm	10	10	12	26	32
Nominal pressure drop, MPa	3.85	9.0	13.2	15.5	23.4
Flow rate, l/s	0.025...0.25	0.03...0.3	0.03...0.6	0.05...2.34	0.1...2.97
Static accuracy, %	±5	±3	±3	±3	±3
Dynamic accuracy, %	±15				
Working medium temperature, °C	5...100				
Overall dimensions, mm	Ø46x195	Ø60x300	Ø60x300	Ø87x330	Ø87x317
Mass, kg	0.8	2.0	2.0	4.85	5.5
Materials	Stainless steels, fluoroplastic, rubber				

Flow Rate Regulator



The flow rate regulator (FRR) is installed in the gas generator fuel feed line and is intended to regulate engine operation modes by commands from the control system and to maintain constant fuel flow rate when there no command signals. It is used on main engines of space launch vehicles.

Basic Technical Characteristics

Characteristics	FRR1	FRR2
Nominal diameter of passage section, mm	32	26
Working medium	Kerosene	
Maximal pressure at regulator input, MPa	63	54,1
Nominal pressure drop, MPa	11	11,4
Nominal mass flow rate, kg/s	8.02	5.53
Mass flow rate variation range, kg/s	0.9...10.63	0.6...6.86
Required torque, N ·m, not more	7	7
Operating temperature range, °C	-40...+100	
Overall dimensions (A*B*C), mm, not more	297x134x161	270x113x153
Mass, kg	6.8	4.75
Materials	Titanium alloy, bronze, stainless steels, rubber, fluoroplastic-4	

Flow Rate Regulator

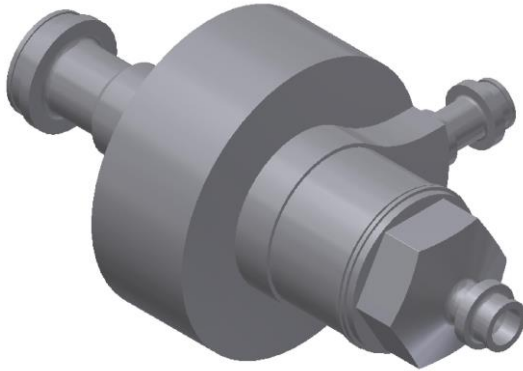


The flow rate regulator (FRR) is installed in the gas generator fuel feed line and is intended to regulate engine operation modes by commands from the control system and to maintain constant fuel flow rate when there no command signals. It is used on space launch vehicles upper stages engines.

Basic Technical Characteristics

Working medium	Kerosene
Maximal pressure at regulator input, MPa	40.3
Nominal pressure drop, MPa	4.9
Nominal mass flow rate, kg/s	0.343
Mass flow rate variation range, kg/s	0.316...0.372
Required torque, N · m, not more	3
Operating temperature range, °C	-5...+85
Mass, kg	1.8
Materials	Stainless steels, high-strength bronze, rubber, fluoroplastic-4

Pressure Drop Stabilizer



The pressure drop stabilizer is intended to maintain constant propellants mixture ratio in gas generator. Regulation is effected by maintaining pressure equality at stabilizer output and control pressure from another component line.

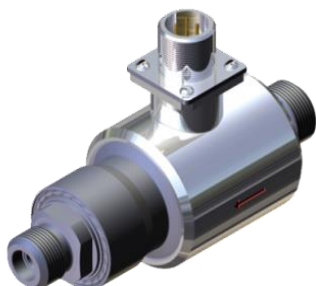
It is used on Cyclone-4 LV third stage engine.

Basic Technical Characteristics

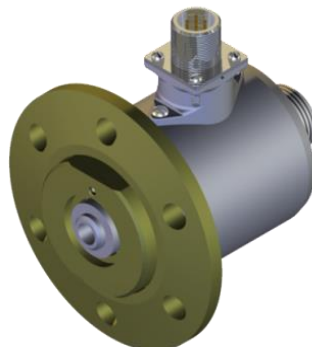
Working medium	NT, UDMH
Maximal input pressure, MPa	15.1
Maximal control pressure, MPa	12.71
Nominal mass flow rate, kg/s	0.127
Accuracy, %	±2.5
External leakage, cm ³ /s	1·10 ⁻⁶
Leakage of membrane separating propellant components, cm ³ /s	1·10 ⁻⁶
Nominal diameter of passage section, mm	6
Mass, kg	1.26
Materials	Stainless steels

Electric Valves

Electric Valve 1



Electric Valve 2



Electric Valve 3



The electric valves (EV) are intended for supply (cut-off) of working media into LRE lines, chamber and gas generator.

Basic Technical Characteristics

Model	EV 1	EV 2	EV 3
Valve type	Normally-closed without drain		
Working medium	Kerosene, nitrogen, NT, UDMH, water and other fluids and gases		
Diameter of connecting branch at input, mm	4	10	4
d.c. power supply voltage, V	28±4	28±4	36±4 (at switch-on) 15±3(at holding)
Winding resistance at temperature 20 °C, Ohm	25±0.5	21±0.5	46±0.5
Maximal consumed power, W, at 20°C	62	49	35 (at switch-on) 8 (at holding)
Action time, s, not more	0.05	0.05	0.03
Working medium temperature range, °C	-80...+70	-30...+50	-40...+80
Maximal operating pressure, MPa	22.5	3.4(at opening) 30(at holding and closing)	3
Hydraulic resistance, MPa, (at water flow rate, g/s), not more	1(0.06)	0.88(0.348)	0.098 (0.085)
Internal air leakage, cm ³ /s, not more	0.2	0.2	1·10 ⁻³
Mass, kg, not more	0.65	1.2	0.2
Guaranteed action resource	1000	400	50000
Structural materials	Stainless and magnetically soft steels, titanium alloys, fluoroplastic, rubber rings, copper enameled wire		

Electrohydraulic Valve 4



The electrohydraulic valve (EHV) is intended to open and close the line of propellants supply to gas generator or to engine combustion chamber.

The EHV was used in a the launch vehicle upper stage multifunctional propulsion system.

Basic Technical Characteristics

Valve type	Normally-closed without drain		
Nominal diameter of passage section, mm	8	12	14
Working medium pressure, MPa	2...24		
Working medium	Water, N ₂ O ₄ , monopropellant and other fluids		
Internal air leakage, cm ³ /s, not more	0.2		
External leakage, cm ³ /s, not more	1·10 ⁻⁶		
Action time, s, not more	0.08		
Power supply voltage, V (direct current)	28±4		
Maximal consumed power (at 20°C), W, not more	36		
Hydraulic losses, MPa, at water flow rate of 0.258 kg/s	0.48	0.013	0.0033
Number of actions, not less	1000		
Mass, kg, not more	0.36		
Operating temperature range, °C	-5...+50		
Structural materials	Stainless and magnetically soft steel, aluminum alloy, fluoroplastic		

Electrohydraulic Valve 5



The electrohydraulic valve (EHV) is intended to open and close liquid oxygen supply line for engine cooling.

The EHV was used in Zenit launch vehicle second stage modified control engine.

Basic Technical Characteristics

Valve type	Normally-closed without drain
Nominal diameter of passage section, mm	4
Working medium pressure, MPa	0...0.62
Working medium	Liquid oxygen, water and other fluids
Internal leakage, not more for air, cm ³ /s for liquid oxygen, g/s	5 0.2
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	0.1
Power supply voltage, V (direct current)	28±4, after 1 s - 15±3
Maximal consumed power (at 20°C), W, not more	65
Hydraulic losses, MPa, at water flow rate of 0.06 kg/s, MPa	0.02
Number of actions, not less	400
Mass, kg, not more	1.55
Operating temperature range, °C	-210...+50
Structural materials	Stainless and magnetically soft steel, aluminum alloy

Electrohydraulic Valve 6



The electrohydraulic valve (EHV) is intended to open and close the line of propellants supply to engine chamber at starting and shutdown and for propellants drain from the chamber after shutdown.

The EHV is used in Vega launch vehicle VG143 9 000C main engine assembly and is highly reliable.

Basic Technical Characteristics

Valve type	Normally-closed with drain
Nominal diameter of passage section, mm	10
Working medium pressure, MPa	2...7
Working medium	Air, water, N ₂ O ₄ , UDMH and other fluids
Internal air leakage in input-output line, cm ³ /s, not more	1·10 ⁻³
Internal air leakage in output-drain line, cm ³ /s, not more	1
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	
- opening	0.08
- closing	0.12
Power supply voltage, V (direct current)	
- in switch-on mode (0.15 s)	28±4
- in holding mode	15±3
Maximal consumed power (at 20°C), W, not more	
- in switch-on mode (0.15 s)	36
- in holding mode	12
Hydraulic losses at water flow rate of 0.44 kg/s, MPa	0.07
Number of actions, not less	200
Mass, kg, not more	0.7
Operating temperature range, °C	+5...+50
Structural materials	Stainless and magnetically soft steel, fluoroplastic

Electropneumatic Valve 2



The electropneumatic valve (EPV) is intended to control supply and subsequent venting of compressed gas in the liquid rocket engine pneumatic systems.

The EPV is used in Cyclone-4 launch vehicle third stage engine pneumatic unit.

Basic Technical Characteristics

Valve type	Normally-closed with vent
Nominal diameter of passage section, mm	4
Working medium pressure, MPa	up to 8.5
Working medium	Air, nitrogen, helium and other gases
Internal air leakage in input-output line, cm ³ /s, not more	1·10 ⁻³
Internal air leakage in output-vent line, cm ³ /s, not more	1·10 ⁻³
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	0.05
Power supply voltage, V (direct current)	28±4
Maximal consumed power (at 20°C), W, not more	43.5
Number of actions, not less	1000
Mass, kg, not more	0.85
Operating temperature range, °C	-50...+50
Structural materials	Stainless and magnetically soft steel, aluminum alloy, rubber

Electropneumatic Valve 3



The electropneumatic valve (EPV) is intended to open and close the line of helium supply to turbine starting manifold at engine ignition.

The EPV is used in Cyclone-4 launch vehicle third stage engine.

Basic Technical Characteristics

Valve type	Normally–closed without vent
Nominal diameter of passage section, mm	16
Working medium pressure, MPa	2.5...34
Working medium	Air, nitrogen, helium and other gases
Internal air leakage, cm ³ /s, not more	0,25
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	0,1
Power supply voltage, V (direct current)	28±4
Maximal consumed power (at 20°C), W, not more	41,8
Working medium flow rate, kg/s	1 (air at 9 MPa pressure)
Number of actions, not less	300
Mass, kg, not more	1.55
Operating temperature range, °C	-56...+56
Structural materials	Stainless and magnetically soft steel, aluminum, polyamide

Electropneumatic Valve 4



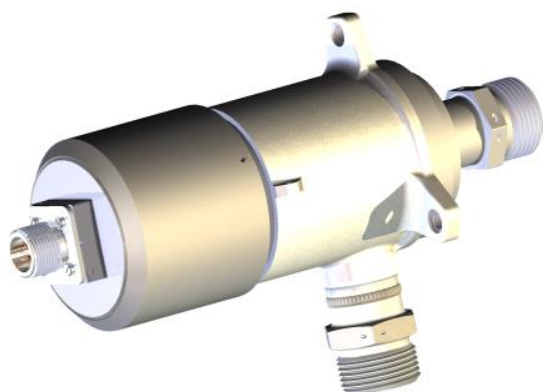
The electropneumatic valve (EPV) is intended to control supply and subsequent venting of compressed gas in liquid rocket engine pneumatic systems.

The EPV is used in launch vehicle engine pneumatic units.

Basic Technical Characteristics

Valve type	Normally–closed with vent
Nominal diameter of passage section, mm	4
Working medium pressure, MPa	1...34
Working medium	Air, nitrogen, helium and other gases
Internal air leakage in input-output line, cm ³ /s, not more	1·10 ⁻³
Internal air leakage in output-vent line, cm ³ /s, not more	0.2
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	0.05
Power supply voltage, V (direct current)	28±4
Maximal consumed power (at 20°C), W, not more	36
Number of actions, not less	1000
Mass, kg, not more	0.4
Operating temperature range, °C	-50...+50
Structural materials	Stainless and magnetically soft steel, aluminum, polyamide

Electropneumatic Valve



The electropneumatic valve (EPV) is intended to open and close high-pressure pneumatic lines by control system commands.

Analog is the EPV which was used in a launch vehicle upper stage propulsion system.

Basic Technical Characteristics

Valve type	Normally–closed without vent
Input diameter of connecting branch passage section, mm	10
Working medium pressure range, MPa	3.43...54.93
Working medium	Argon, helium and other gases
Helium flow rate, kg/s	0.002...0.018
Internal air leakage, cm ³ /s, not more	1.0
External leakage, cm ³ /s, not more	1·10 ⁻⁶
Action time, s, not more	0.1
Power supply voltage, V (direct current)	28±4
Maximal consumed power (at 20°C), W, not more	50
Operating temperature range, °C	-100...+63
Mass, kg, not more	1.6
Structural materials	Stainless and magnetically soft steel, aluminum and titanium alloys, fluoroplastic, phenylon, rubber ring

Pneumopump Unit of Onboard Power Source



The pneumopump unit (PPU) is intended for high-pressure oil supply to hydraulic actuators system and is actuated by reduced gas from pneumatic block. The PPU includes a double-type pump with the system of check valves, pneumohydraulic damper, temperature compensator, pneumatic actuator with end valves and pneumatic distributor. The PPU has low weight and high reliability confirmed by full-scale tests.

The PPU application area – launch vehicle onboard power sources.

Basic Technical Characteristics

Working gas of pneumatic actuator	Helium, nitrogen, air, carbon dioxide et al.
Oil	PM FOCT 15819-85 or other
Nominal input gas pressure, MPa	2.24
Nominal input oil pressure, not more, MPa	0.49
Nominal output oil pressure, not more, MPa	18.14 ... 23.54
Oil flow rate, l/min	2.5 ... 12.6
Operating temperature range, °C: - gas - oil	-20...+80 +5...+80
Efficiency, not less	0.75
Mass, kg	3.6
Materials	Aluminum alloys, stainless steels, titanium, bronze, rubber

Pneumopump Unit for LRE Supply Systems



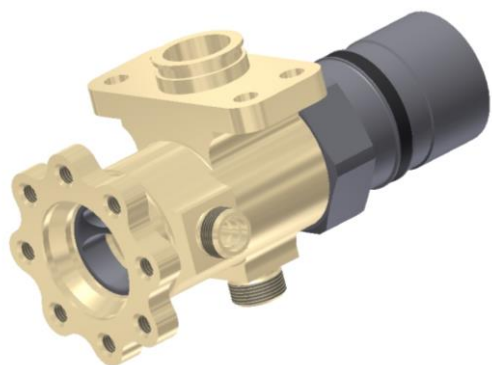
The pneumopump unit (PPU) is intended to supply propellants to combustion chamber of liquid rocket engines of single and multiple ignition.

The PPU application area – the propellant supply systems of rocket upper stages and spacecraft liquid rocket engines with the thrust range from 2450 N to 9800 N.

Basic Technical Characteristics

Working gas of pneumatic actuator	Helium
Oxidizer	NT
Fuel	UDMH
Helium nominal input pressure, MPa	2.29
Nominal pump head, MPa:	
- oxidizer	4.31
- fuel	4.26
Flow rate, kg/s:	
- in oxidizer line	0.966
- in fuel line	0.429
Accuracy of propellant mixture ratio maintaining, %	±0.5
PPU operation frequency, Hz	10.2
Operating temperature range, °C:	
- helium	-20 ... +80
- oxidizer and fuel	-10 ... +30
Efficiency, not less	0.77
Mass, kg	5.3
Materials	Aluminum alloys, stainless steels, bronze, rubber, fluoroplastic-4

Valve

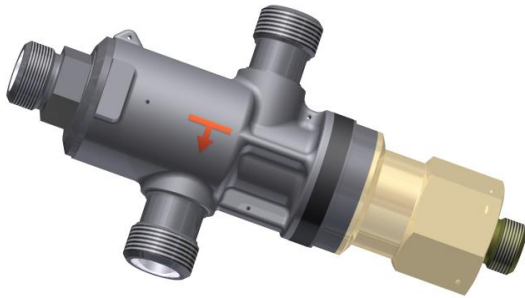


The valve is intended to control fuel supply to to gas generator.

Basic Technical Characteristics

<i>Valve type</i>	<i>Normally-closed</i>
<i>Working medium</i> – <i>in passage section</i>	<i>Kerosene, gaseous nitrogen, helium</i>
– <i>in control manifold</i>	<i>Helium</i>
<i>Working medium pressure in passage section, MPa</i>	<i>42.53</i>
<i>Working medium pressure in control manifold, MPa</i>	<i>17-22</i>
<i>Kerosene maximal input pressure at opening moment, MPa</i>	<i>20.4</i>
<i>Internal air leakage, cm³/s, not more</i>	<i>5</i>
<i>Nominal diameter of passage section, mm</i> – <i>in flow section</i>	<i>30</i>
– <i>in control helium line</i>	<i>6</i>
<i>Number of actions, not less</i>	<i>40</i>
<i>Mass, kg, not more</i>	<i>3.8</i>

Switch



The switch is intended to switch over the generator feed line from starting fuel to main fuel.

Basic Technical Characteristics

<i>Valve type</i>	<i>Two-position with piston actuator</i>
<i>Working medium</i> – <i>in flow section</i>	<i>Kerosene, gaseous nitrogen, starting fuel</i>
– <i>in control manifold</i>	<i>Helium</i>
<i>Working medium pressure in flow section, MPa</i>	<i>59.8</i>
<i>Working medium pressure in control manifold, MPa</i>	<i>17-22</i>
<i>Internal air leakage, cm³/s, not more</i>	<i>0.5</i>
<i>Nominal diameter of passage section, mm</i> – <i>in flow section</i>	<i>10</i>
– <i>in control helium line</i>	<i>6</i>
<i>Number of actions, not less</i>	<i>100</i>
<i>Mass, kg, not more</i>	<i>1.31</i>

Check Valve



The check valve is intended for leak-tight separation of manifolds, including for liquid oxygen, and for their communication at increase of pressure of medium in input manifold over pressure in output manifold.

Basic Technical Characteristics

Valve type	Normally-closed
Working medium	Liquid oxygen
Working medium maximal pressure, MPa	30.8
Working medium nominal flow rate, kg/s	2.403
Operating temperature range, °C	-182...+ 55
Hydraulic resistance at working medium nominal flow rate, MPa, not more	0.38
Nominal diameter of passage section, mm: – input – output	16 20
Number of actions, not less	100
Mass, kg, not more	0.28
Structural materials	Stainless steel