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1N, 20N, 400N AND HERITAGE THRUSTER

CHEMICAL MONOPROPELLANT THRUSTER FAMILY

CHEMICAL MONOPROPELLANT THRUSTER FAMILY

ArianeGroup first engaged in hydrazine propulsion technologies in 1966. Since that time, the Centre has become an international leader in the development, production and testing of hydrazine thrusters and propulsion systems for commercial, scientific and military spacecraft.

Since 1966, a wide range of thrust levels were required for the many different programs. Today, the thruster range has been rationalized to the more frequently demanded 'work horse' thrusters with the benefit of a consistent production line type manufacturing process. The units currently available are the 1 N, 20 N and 400 N thrusters. However you will find in this data sheet also information of our heritage thrusters.

1N

20N

400N

EM 007

1N CHEMICAL MONOPROPELLANT THRUSTER

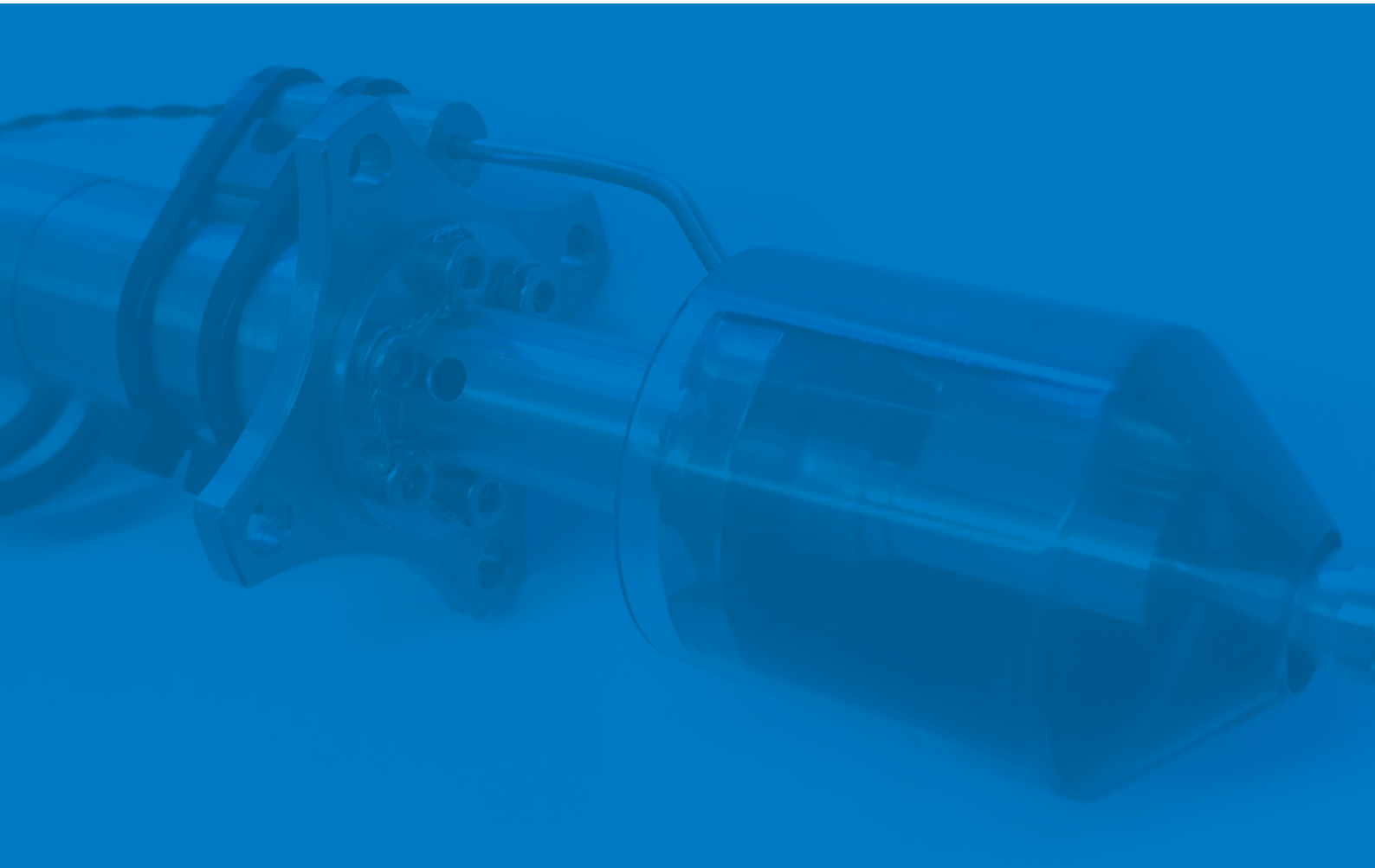
RELIABLE CONTROL FOR SMALL AND MIDSIZE SPACECRAFT.

The 1N monopropellant hydrazine thruster is a small rocket engine for attitude-, trajectory- and orbit-control of small satellites. More than 500 units of this thruster operate successfully in space.

Generally, the 1 N thruster is part of the satellite propulsion subsystem. Each thruster is equipped with a flow control valve, consisting of two identical monostable, normally-closed valves placed in series within a single housing. This double stage flow control valve is used to control the propellant supply to the thruster. Additionally each thruster is equipped with an internal redundant catalyst bed heater and with thermal insulation to guarantee optimum start up.

All materials used in the valve and thrust chamber assembly have been selected for compatibility with hydrazine propellant.

The main function of the thruster is to generate thrust, when the valve is commanded to open and feed propellant to the thrust chamber where a chemical / thermal decomposition with the catalyst takes place. The thruster is also designed to serve as heat barrier for protecting the flow control valve and the S/C structure against improper high temperatures. In addition, the thruster is qualified for multiple cold starts.



1N Monopropellant Thruster Key Technical Characteristics	
Characteristics	
Thrust Nominal	1 N
Thrust Range	0.320 ... 1.1 N
Specific Impulse, Nominal	220 s
Pulse, Range	200 ... 223 s
Mass Flow, Nominal	0.44 g/s
Mass Flow, Range	0.142 ... 0.447 g/s
Inlet Pressure Range	5.5 ... 22 bar
Minimum Impulse Bit	0.01 ... 0.043 Ns
Nozzle Expansion Ratio	80
Mass, Thruster with valves	290 g
Propellant	Hydrazine (N_2H_4), High-Purity Grade
Qualification	
Total Impulse	135,000 Ns
Cycle Life	59,000 cycles
Propellant Throughput	67 kg
Single Burn Life	12 h
Accumulated Burn Life	50 h
No of Cold Starts <10°C	10

1N Mono-Propellant Thruster Heritage and Future Missions

More than 500 units of the thruster operate successfully in space and future missions rely also on ArianeGroup 1N thruster. The table below starts with the year 2010. For earlier satellites please contact ArianeGroup.

Spacecraft	Launch Year
TANDEM-X	2010
Alsat 2A	2010
CosmoSkymed-4	2010
Alsat 2B	2010
Elisa-1	2011
Elisa-2	2011
Elisa-3	2011
Elisa-4	2011
Pleiades HR1	2011
SSOT	2011
AstroTerra 1	2012
Pleiades HR2	2012
Jason-3	2013
Vietnam-1	2013

Spacecraft	Launch Year
AstroTerra 2	2014
KRS	2014
SEOSAR (Paz)	2015
SEOSAT (Ingenio)	2015
Taranis	2015
Sentinel 2A	2015
Sentinel 2B	2016
Sentinel 5P	2016
CSO-1	2016
CSO-2	*
CSO-3	*

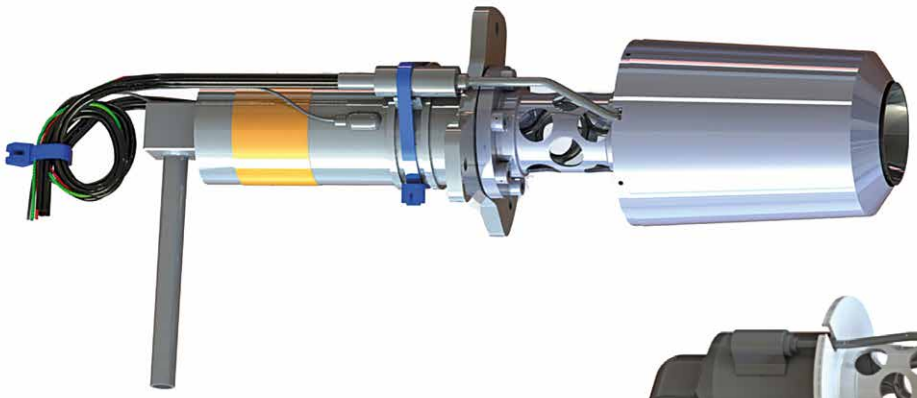
20N CHEMICAL MONOPROPELLANT THRUSTER

DESIGNED FOR ATTITUDE, TRAJECTORY AND ORBIT CONTROL OF SATELLITES, SPACECRAFT AND PLATFORMS.

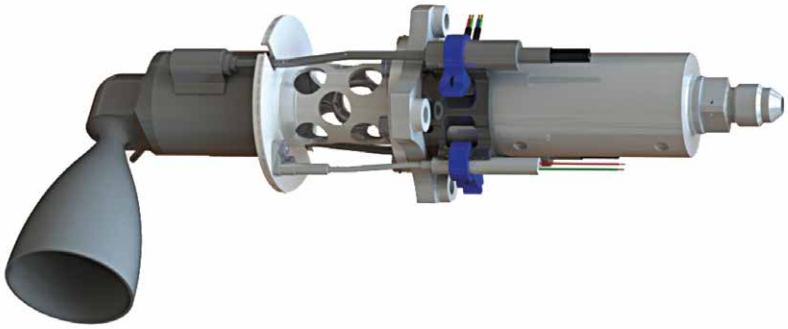
The 20N thruster is equipped with a flow control valve, consisting of two identical monostable, normally-closed valves placed in series within a single housing. This double stage flow control valve is used to control the propellant supply to the thruster. Additionally each thruster is equipped with an internal redundant catalyst bed heater and with thermal insulation to guarantee optimum start up. All materials used in the valve and thrust chamber assembly have been selected for compatibility with hydrazine propellant.

The flow of propellant to the decomposition chamber is controlled by the Flow Control Valve (FCV), which consists of two independent consecutive monostable, normally closed valve stages. When the valve is activated, propellant is supplied through a fuel supply pipe, mounted inside the heat barrier, to the injection plate. The flow rate is adjusted by a constriction in this pipe to ensure that the delivered thrust is within the specified limits. The lower end of the pipe is welded to the injection plate, which provides the correct number and inclination of injection holes to ensure an adequate distribution of the propellant across the catalyst bed.

When the propellant comes in contact with the catalyst, the decomposition reaction is initiated. At low and preheated temperatures the decomposition of the hydrazine is solely due to the contact with catalyst. At higher temperatures (typically above 600°C) a thermal equilibrium is reached across the complete catalyst bed and the hydrazine is solely decomposed due to temperature (thermal decomposition). Subsequent to the decomposition of the hydrazine the reaction gases are expanded through a conical nozzle with an area ratio of 60, thereby generating the desired thrust.

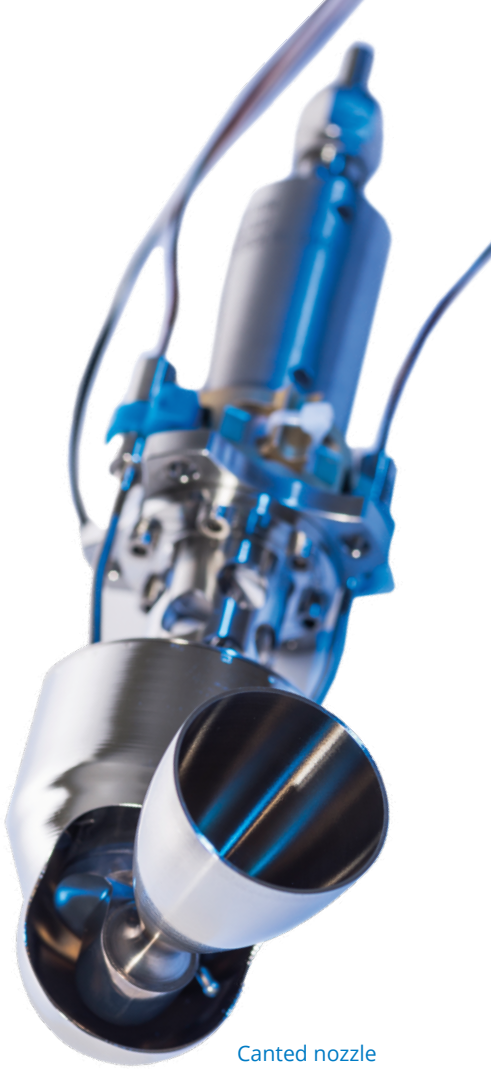


Straight nozzle



Canted nozzle

Characteristics	
Thrust Range	7.9 ... 24.6 N
Supply Pressure Range	5.5 bar - 24 bar
Nominal Mass Flow Range	3.2 g/s ... 10.4 g/s
Nominal Specific Impulse Range	222 s ... 230 s
Minimum Impulse Bit Range	0.238 ... 0.685 Ns
Nozzle area ratio	60
Mass	≈ 650 g (with 1.5 m flying leads)
Propellant	Monopropellant grade Hydrazine (N_2H_4)
Environmental Loads	16.2 grms
Qualification	
Total Impulse	> 517,000 Ns
Total number of pulses	> 93100
Total hydrazine throughput	> 290 kg
Total operating time	10.5 h
Logest steady state burn	1.5 h
Number of cold starts < 20°C	36
Number of cold starts at 0°C	12



Canted nozzle

20N Mono-Propellant Thruster Heritage and Future Missions

Since the 80's over 100 units have been delivered to several ambitious and demanding missions performing successfully. The table below starts with the year 2002. For earlier satellites please contact ArianeGroup.

Spacecraft	Launch Year
Integral	2002
METOP 1-3	2006
Herschel	2009
Planck	2009
NGSAR	2018 – 2019

400N CHEMICAL MONOPROPELLANT THRUSTER

DEVELOPED FOR LAUNCH VEHICLE ROLL AND ATTITUDE CONTROL SYSTEMS AND ADAPTED TO BE IMPLEMENTED FOR CONTROLLED RE-ENTRY OF SATELLITES.

The 400 N mono-propellant thruster uses the storable propellant hydrazine N_2H_4 and is designed for both long term steady state and pulse mode operation.

This thruster is primarily used for the attitude and roll control of the Ariane 5 launch vehicle during its ascent. The thruster can also be used for re-entry attitude control applications as successfully demonstrated during ARD mission.

The thruster operates over a wide pressure range and is thus ideal for blow down propulsion systems.

The combustion chamber and nozzle are manufactured from Haynes 25 alloy. The structure is also designed to serve as a heat barrier for protecting both the propellant valve and spacecraft structure.

An optional internally redundant catalyst bed heater and thermal insulation guarantees optimum start up conditions. In addition, the thruster is qualified for multiple cold starts.

400N Mono-Propellant Thruster Key Technical Characteristics	
Characteristics	
Thrust Range	120-420N
Supply Pressure Range	5,5-26bar
Nominal Mass Flow Range	58-190 g/s
Nominal Specific Impulse Range	2080 - 2155 Ns/kg
Minimum Impulse Bit Range	< 9Ns
Shortest On-Time	16ms
Nozzle area ratio	30
Propellant	Monopropellant grade Hydrazine (N_2H_4)
Mass	P1-design 2,7 kg P2-design 3,8 kg
Qualification	
Total Impulse	< 188kNs
Total number of pulses	>3900 pulses
Total hydrazine throughput	~300kg
Total operating time	>850s
Longest steady state burn	450s
Number of cold starts < 25°C	19

400N Mono-Propellant Thruster Heritage and Future Missions

Since 1996 the 400N Hydrazine thruster has been used in all Ariane 5 G, GS and ES versions for the roll and attitude control. Till this day the CHT-400N has flown on 30 Ariane 5 flights with more than 170 units.

As a further application of the technology gained with this thruster, a derivative has been developed, qualified and flown successfully on the ESA Atmospheric Re-Entry Demonstrator (ARD).

The application perimeter was further extended since 2005, using the thruster within the RCS systems of IXV (re-entry technology) and EXM2016 Descent Module. CHT-400N thruster is also in progress to be qualified for satellite deorbiting maneuvres were long steady firing are requested.

HERITAGE THRUSTERS - THE FOUNDATIONS OF TODAY'S PRODUCTION LINE HYDRAZINE THRUSTERS

Since 1966, a wide range of thrust levels were required for a variety of different programs. Today, the thruster range has been rationalized to the more frequently demanded 'work horse' thrusters with the benefit of a consistent production line type manufacturing process.

Whilst the heritage thrusters shown here are no longer produced, they have evolved with multiple refinements into the readily available range of today's high performance production line thrusters.

The hydrazine heritage thrusters are the 0.5N, 2N, 5N and 10N. Below you will find data about 5N and 10N. For further information please contact ArianeGroup (Contact data at the end of this factsheet).

5N and 10N Mono-Propellant Thruster Heritage

The 5N and 10N Monopropellant have flown in diverse missions like Meteosat in the 70's and Skynet and Hipparcos in the 80's.

5N Mono-Propellant Thruster Key Technical Characteristics	
Thrust Range	1.85 ... 6.0 N
Supply Pressure Range	5.5 bar - 22 bar
Nominal Specific Impulse Range	206 s ... 226 s
Longest steatdy state firing	1 x 2500, 3x 1800 s
Total Throughput	32.35 Kg
No. of pulses	18100
No. of cold starts (-14 to -10 °C)	4
Minimum Impulse Bit Range Ns	0,03 - 0,1 Ns
Propellant	Hydrazine (N_2H_4)

10N Mono-Propellant Thruster Key Technical Characteristics	
Thrust Range	3.16 to 10.9 N
Supply Pressure Range	5.5 bar to 23 bar
Nominal Mass Flow Range	1.49 to 4.94 g/s
Nominal Specific Impulse Range	215 s to 228 s
Minimum Impulse Bit Range	0.44 to 1.12 Ns
Nozzle area ratio	50
Propellant	Hydrazine (N_2H_4)