

**JetCat P250-PRO-S
Turbojet Engine**

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Introduction

The JetCat-P250-PRO type turbo-jet engine is designed as a propulsion unit for RC-aircraft and/or drones.

The engine is lubricated by fuel with oil admixture.

The engine is equipped with a BLDC starter), 1x BLDC fuel pump, 2x fuel solenoids and electronic control system (FADEC type).

The engine may be modified based on customer specific requirements and to meet different operating / installation conditions. The engine is available with two different nozzles (long/short).

Functional description

The JetCat P250-PRO is a single-shaft engine comprising a single-stage radial compressor, annular combustion chamber, single stage axial turbine and fixed exhaust nozzle. At the compressor intake, there is a brushless starter system mounted. Intake air is compressed in the radial compressor stage, proceeds through the radial and axial diffuser into the combustion chamber where it is mixed with vaporized fuel. Combustion gases generated by fuel burning in the combustion chamber expand through the single stage axial turbine and the exhaust nozzle to the atmosphere. The gas exiting the exhaust cone produces the required thrust. The rotor of the engine is mounted on 2 ball bearings lubricated by a fuel/oil mix.

Control options / electrical interface

The JetCat-PRO engine series provides the highest level of integration and maximum ease of installation. All peripheral systems necessary for the engines operation are fully integrated below the engines front cowling.

Highest level of integration:

There are no further external peripherals required like: ECU, pump, valves or ignition system.

All of this is integrated at the engines front end!

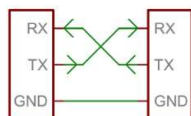
This tremendously eases the installation of the engine, reduces system complexity and frees space for user payloads, otherwise occupied by engine peripheral systems.

Therefore, besides the supply battery, the fuel tank, there are no further external subsystems required!

Engine Control Options

For engine control, per default there is a variety of control interface options already present, like:

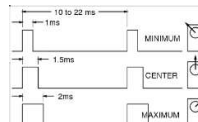
Serial interface



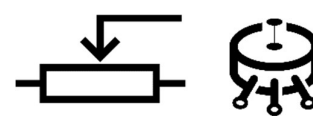
CAN-Bus



Servo-PWM



Analog control



- Via GSU (Ground support unit). GSU is a handheld device used for setup and control of the engine.
- Serial communication interface Rx/Tx (3,3V TTL or +/-12V RS232). Baud rate: 2.4-115k
- CAN-Bus (2.0A-11bit or 2.0B-19bit. Bitrate: 125K-1Mbit/s adjustable)
- 2x Servo PWM inputs for throttle/engine control
- Analog input for engine control (Start/Stop/Thrust control)



The system allows to use one of the above-mentioned control sources for engine control. It also allows to switch between the control sources. Data reporting can be through one or multiple of those interfaces.

Electric Connections

The signals for engine control as well as for power supply are fed out using 70cm long pigtail cable(s).

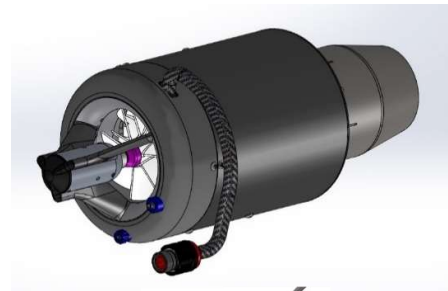
Option A (default) This option uses two separate pigtail cables: One for data and a separate one for power supply. In this configuration the data connector is a 15-pin SUB-D connector (or another customer specific connector upon request). The power supply is made via a second pigtail cable with XT60 connector mounted for direct battery/power supply connection (other power connector types possible upon request)

Option B) This option comprises a single 23-pin MIL connector which, besides the control signals, also has the power supply feed lines incorporated in a single, circular, watertight connector.

A) Dual connector configuration (engine picture is symbolic)



B) P250-PRO-S, with single connector



JetCat P250-PRO engine features/functions

Integrated Engine sided Components:

- ECU (electronic control unit), fully programmable via detachable Ground Support Unit (GSU)
- Brushless starter and seal free brushless fuel pump
- Fuel & Kerosene-start solenoids
- Post Fuel filter downstream of the pump (last barrier filter)
- Barometric altitude / pressure sensor allowing for automatic engine tuning upon operation altitude.
- 4-pin Molex expansion connector (e.g. for smoke pumps/ fuel transfer pumps/GSU)
- Optional bleed-air port (e.g. for pressurization of fuel system)
- Direct quick start on kerosene via integrated high speed / low current ignition system
- High altitude, high flight speed in-air restart capability
- Automatic engine cool down cycle after shutting down.
- Reporting of fuel consumed / fuel flow rate / fuel burned / remaining fuel in tank
- Engine/ECU power On/Off via voltage control signal → No external power switches required
- Engine safety shut down input, for instant engine shut down via (flight) termination system. This will kill power to fuel pump and shut off safety solenoid valves and stop engine in any case on a multiple redundant way, whilst ECU can stay powered on (for continued data reporting and or engine cool down).
- Monitoring and reporting of all currents / voltages (e.g. supply voltage / current, pump driving voltage) as well as all engine life parameters / setpoints.
- Automatic fuel purge feature for automatic filling/purge of fuel feed lines. As soon as fuel arrives at the engine, purging will automatically terminate.
- High performance ceramic bearings



GSU



Technical data

Performance data

Applicable under ISA conditions (15 °C, ambient 101.325 kPa, $v = 0$ m/s)

Maximum thrust	250 [N]
Idle thrust	12[N]
Maximum outer diameter	122 [mm]
Engine weight (with accessories)	2160g
Physical revolutions per minute	35,000 – 117.000 [RPM]
Compression	4.0
Air mass flow	0.47 [kg/sec]
SFC at maximum thrust	0.157 [kg/Nh]
Fuel consumption - idle running	138 [ml/min]
Maximum fuel consumption	820 [ml/min]
Exhaust gas temperature t4	max. 800 [°C]
Time of acceleration from idle to max	5 [s] (5% to 95% thrust)
Time of deceleration to idle	5 [s] (95% to 5% of thrust)
Start-up time (off to idle)	13-20s; 15s typical

Fuel /Oil

Jet A1 or equivalent mixed with 3-5% of turbine oil.
Alternatively, Diesel fuel can be used.

Fuel purity must comply with class 10-11as per GOST 17216-71 or 7-8 as per NAS 1638

Oil types: JetCat turbine oil, Mobil Jet Oil II, Aero Shell 500, or Exxon 2388 (or equivalents)



Electrical

Power supply

Supply voltage	10 to 30V DC (35VDC max.) The chemistry (LiPo, LiFe, Lion, NiCad, Lead, NiMh), the cell count and capacity (mAh) of the actual used battery is user selectable! Ideal battery: 3-4s LiPo or LiFePO4, Capacity > 2000mAh
Min. battery capacity suggested for start:	> 400 mAh
Average energy requirement per start:	200mAh; peak current 15A @12VDC
Peak power consumption (at start):	180W for max. 15s
Power consumptions when running:	11W at idle; 30W at max thrust

Delivery content

The engine assembly consists of:
1x engine, including 70cm long pigtail cable(s) for power and control/data

Operating conditions

Operating conditions for engine start

Ambient temperature range	- 40 to + 50 °C
Altitude range	0 to 6000 m
Flying speed range	0 to 150m/s
Engine position	arbitrary
Inlet fuel pressure	0 to 50 kPa (0-0.5bar)

Operating conditions for engine operation

Ambient temperature range	- 50 to + 50 °C
Altitude range	0 to 10000 m
Flying speed range	0 to 0.9 M
G in engine axis	+ 20 g
perpendicular to engine axis	± 25 g

Operating limitation

Max EGT at starting:	900 °C max. for 3 sec
Max EGT normal operation:	800 °C
Typical starting time:	13-20 sec
Restart after unsuccessful start:	~3 sec
Restart after previous operation:	~20 sec

Time to inspection

25 hours of operation



Fuel system

Fuel is drawn from the external tank via an external to be provided 50 µm filter. There is no further external fuel valve required. From the engine sided fuel inlet port, the fuel is routed directly into the brushless fuel pump and from there through integrated post filter before going into a set of 2x solenoid valves. One of these valves is controlling the fuel to the main fuel supply ending up in the combustion chamber as well as the bearing lubrication system.

The pump/solenoids are controlled by the ECU, depending on the actual operation condition. The engine front mounted fuel supply manifold comprising the fuel inlet/fuel pump/ post filter and solenoids is machined out of a single full metal piece, no further pipes or tubing's.

Bearing lubrication and cooling system

Bearings are cooled and lubricated via the fuel to which 3-5% oil have been added. A small amount of the fuel is then internally routed to the bearings for cooling and lubrication.

Bleed-air port, option for fuel tank pressurization

The optional available bleed-air port can provide compressed air derived from the engine's compressor stage. In order to avoid any possible reverse flow back into the engine, an external one-way valve must be installed to safely avoid otherwise possible reverse flow back into the engine.

As the bleed air can be hot/warm, the use of a Teflon/PTFE tubing for the first 20cm is recommended!

The pressure on the bleed-air port depends on the engine's operational rpm. On full power a pressure of up to 3,5 bars can be reached!

Typically bleed air is used to pressurize the onboard fuel system to avoid degassing/bubbling of the fuel on high altitude operation of the engine (>5000m). For full operation of this feature an additional pressure relief valve needs to be fitted in front of the fuel tank in order not to over pressurize the fuel tank!

The pressure relief valve should have a recommended relief pressure of 0,3-0,5 bars.

Control system

The engine's control system (ECU comprises a 32-bit microprocessor, driver circuitry for pumps/solenoids, and the optional AC/DC converter). It controls safe operation of the engine including engine starting, maintaining required speed, stopping and cooling of the engine after shutting down.

The ECU has inputs for:

- Engine RPM
- Exhaust gas temperature (thermocouple)
- Barometric sensor

The ECU has outputs to control:

- The brushless starter
- The brushless fuel pump
- 2x solenoid valves (1x main fuel, 1x ignition fuel)
- Power to ignition system

All above functions/devices are installed at the engine's frontend, no external equipment required.

ECU monitors engine performance and control systems.

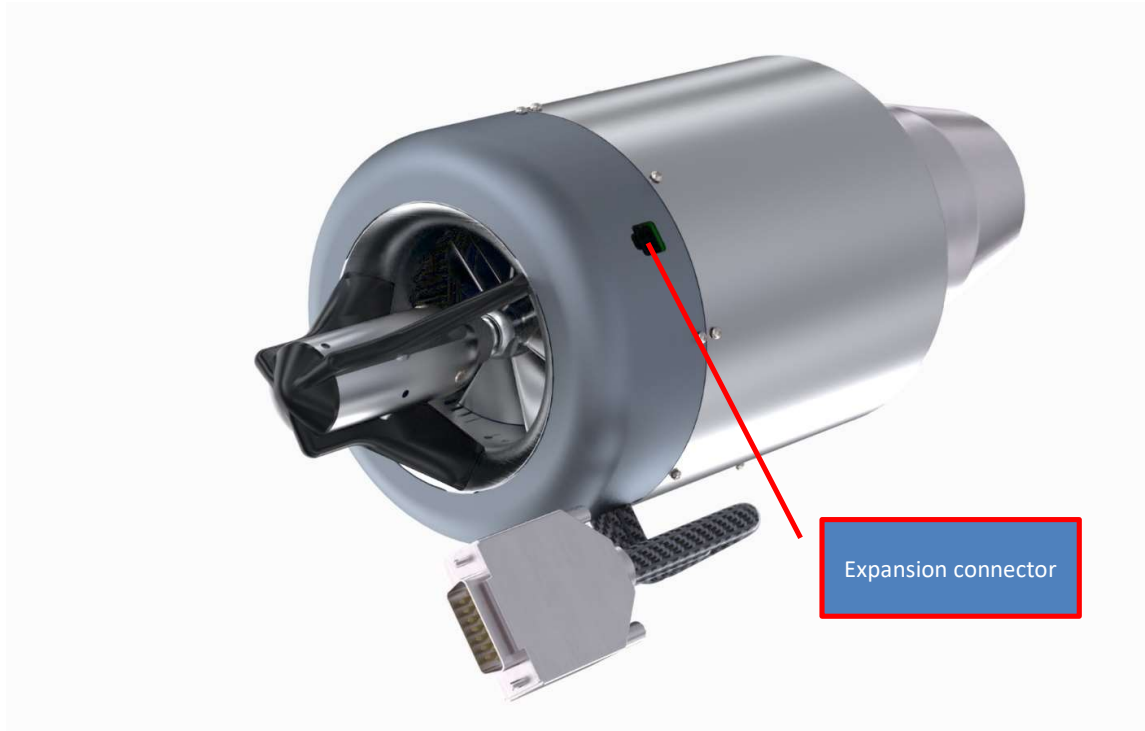
The ECU supports controlled acceleration and deceleration of the engine under all conditions. Engine operation can be controlled and monitored via a serial bus or CAN bus from a master control system. The user software allows the



identification of remaining TBO, statistical data, Engine start/stop control, monitoring of real time parameters like: rpms, EGT, fuel flow, voltages, currents etc.

Expansion output (4 pin Molex, data and power) provided for:

- External devices like smoke pumps / feeder pumps, light control system, GSU etc.



Ignition system

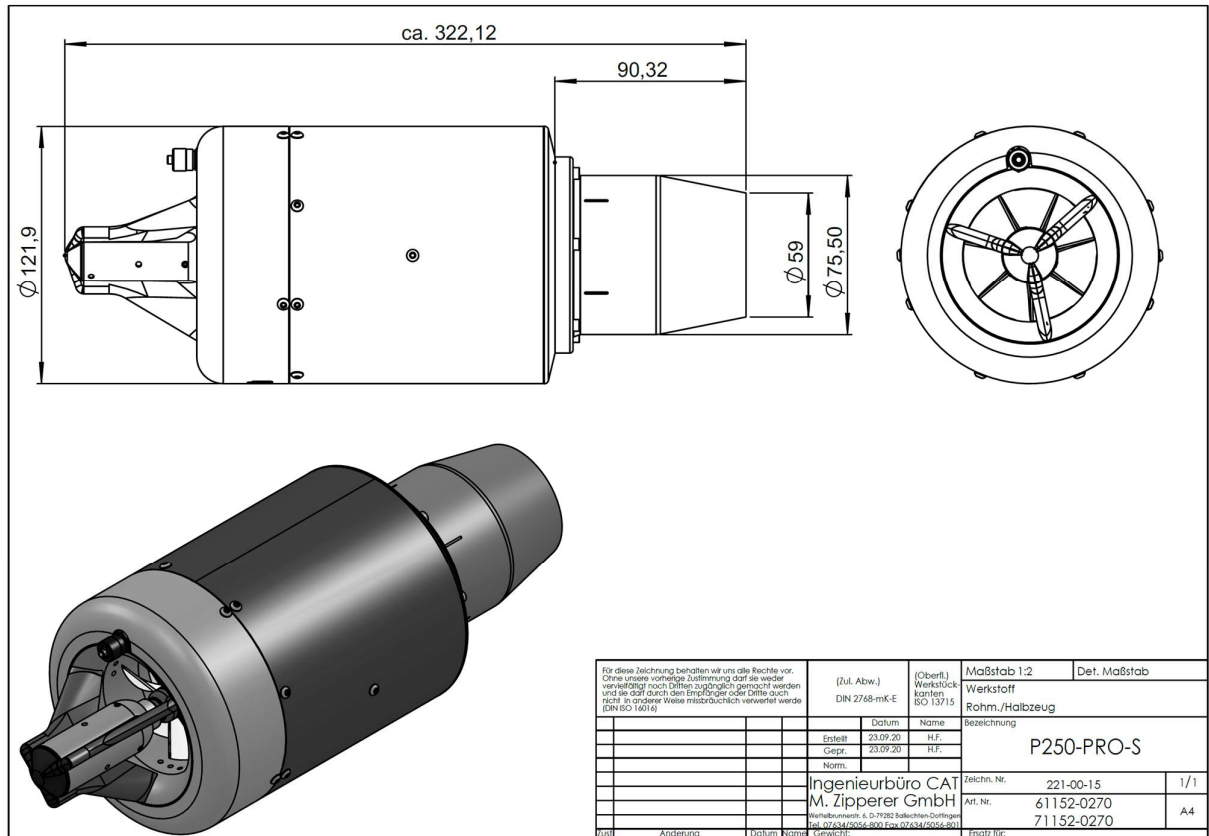
The integrated ignition system allows for super-fast engine startup, with minimum current draw. This new advanced system is not subject to wear / lifetime restriction's like hot surface igniters used so far in small turbine engines. Furthermore, there is no preheat phase required, and the system only requires a few milliamps once activated.

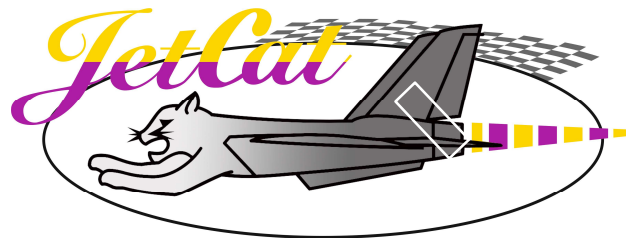
The fully integrated ignition system is active only for a limited time until stable combustion is reached. Due to the performance of the new ignition system, the engine can be ignited at elevated engine rpms and by far higher altitudes compared to traditional kerosene ignition systems used in small turbo jet engines so far.



Appendix

Engine Dimensional Drawings





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