FLEXIPILOT 1.35

Feature list

The autopilot has been designed for low-cost reliable photography using popular RC model planes and is sold pre-tuned for stable pusher motor glider using rudder, elevator and throttle for control.

Performance specifications:

- 20Hz IMU update loop with analog filtering, 20Hz control loop, up to 20Hz logging, up to 20Hz telemetry
- 60Hz servo output with 10bit resolution or 300Hz servo output with 12bit resolution, all can be used as TTL bi-state output
- 6DOF IMU
- External high sensitivity 10Hz GPS, 66 Channels, supporting SBAS (WAAS, EGNOS, MSAS, GAGAN, QZSS), weight 15g
- Flat, single-board design: 50x120x10mm, weight 32g (47g incl. GPS)
- Tightly-coupled GPS course and IMU (20Hz course update)
- Hardware servo override
- 11 input channels, TTL 5V and 3V levels compatible
- 1 RPM input channel
- 6 output channels with built-in RC override (rudder, elevator, throttle and any combination of parachute, 2 triggers, 3 –axis stabilized head, secondary throttle)
- Full channel mixing allowed: turning loop, elevation loop, gyro rates stabilization and two throttle logic
- Barometric altitude sensor (13cm resolution, operational up to 9km), self-calibrating to ground level, accuracy 1m
- Power supply: rev. polarity and overcurrent protected, unregulated 5.35-8V, power consumption @ 6V: typical 140mA, peak 200mA (0.85W typical, 1.2W peak)
- Separately powered RC override logic, RC manual override possible at -55..125C range
- Autopilot designed and tested for -40C…85C temperature range, using direct airspeed control and airspeed sensor possible at -20…85C range
- Barometric altitude precision degraded outside -20…60C (up to 40m worst case), barometer must be powered-up above -20C
- Max measured accelerations 3G or 5G, max roll/pitch/yaw rates 300 or 500deg/s
- Built-in USB interface

- Typical control range: climb +/-3m/s, turn rate +/-40deg/s, roll +/-50deg
- Typical orientation identification precision:
  +/- 0.5...2m altitude, position +/- 1m, angles +/- 1eg, heading +/- 3deg
- Typical control precision:
  +/- 2...5m altitude, position +/- 10m, angles +/- 2deg, heading +/- 5deg
- Worst case control precision during turbulent weather:
  +/- 2...10m altitude, position +/- 25m, angles +/- 5deg, heading +/- 15deg

Options: Update rate 20Hz..32Hz depends on presence of extra features like stabilized head and firmware. All feedback parameters are self-adjusting and portable between both versions. In practice 20Hz main control loop is sufficient for the most agile flying wings.

FLEXIPILOT-CP option with IMU coprocessor

- 120Hz IMU update loop with direct output for stabilized head
- 16bit IMU ADC for maximum smoothness
- Direct servo update to stabilized head: 60, 120, 240 or 300Hz selectable PWM update rate
- Adds 6 non-multiplexed servo outputs (f.ex. 2 triggers, parachute control, 3 gimbal axis) all can be used as TTL bi-state output
- 8 12-bit ADC inputs with voltage divider and filtering
- 16 bi-state TTL inputs

FLEXIPILOT-MS option (Master+Slave)

- Doubles data inputs and outputs
- Slave autopilot works as passive black-box with separate logging
- Slave can use either secondary GPS or bi-directional modem connection
- 12 multiplexed servo outputs
- 22 RC input channels
- 2 RPM input channels
- 4 current+voltage measurement ADC inputs

FLEXIPILOT-MCPS option (Master&Coprocessor+Slave)

- 12 multiplexed servo outputs
- 6 non-multiplexed servo outputs using 120Hz IMU
- 22 RC input channels
- 2 RPM input channels
- 4 current+voltage measurement ADC inputs
- 8 12-bit ADC inputs with voltage divider and filtering
- 16 bi-state TTL inputs

Navigation capabilities:

- 3D waypoints (position and altitude) with trigger action
- Possible automatic landing based on low-speed loiter with motor off or straight approach based on waypoints
- Absolute or relative waypoints
  The position expressed as floating point numbers (6 decimal digits precision), relative to last takeoff position, relative to fixed home position, relative to fixed target position, relative to last waypoint – you can define all-relative pattern and fly several times at different locations without connecting to the computer.
  The altitude in meters nominally up to 32000m is measured relative to takeoff point and accepts negative values.
- Waypoint iterator logic for data compression
  Counting up/down given range of waypoints, N times.
- Guaranteed no-loiter waypoint navigator
  Allows tight satisfy radius without the risk of infinite loiter around remote waypoint.
- Separate landing list
- Adjustable Track-Follower
  Flying along the line connecting waypoints, eliminating crosswind influence.
- Optional navigational situation display using OSD
- Adjustable corner-rounding, anti-overshoot waypoint switching
  For entertainment and tight pattern flying.
- Preserves direction of turns defined by waypoint pattern
  For predictable pattern shape (well defined behavior at visual limits) and loop elimination.
- Loiter after returning home or automatic landing
  Based on circling home with fixed turn rate, motor off and constant descent, possible straight-line approach based on multiple waypoints.
- Landing at takeoff position or fixed home location

Data storage:

- Self-tuning IMU, self-calibrating barometric altimeter,
  stores auto-trimmed control surfaces positions based on manual flight
- All variables editable by name with command-line prompt built-in into the autopilot
- Number of **3D waypoints**: more than 1200
  up to 1550, variable, depending on firmware size
- Real-time log (**LOG**): 4.125MB
  up to 20Hz, selectable frequency, 131 variables, (more than 2h of logging at 1Hz)
- Asynchronous event log (**TRACE**): 8192 events, 256KB
  `flight time;latitiude; longitude;roll angle; pitch angle; altitude; course; GPS DOP, eventID`
  doubles as periodic logger at 1Hz max (more than 2h of logging at 1Hz)
- Fast data transfer at 1Mb/s with compression using USB port
- Optional extended meteo data logging (wind, dewpoint, humidity)

Support software:

- Self-installing USB drivers
- Possibility to use HyperTerm console installed on every Windows system
- The autopilot creates virtual, fixed COM port on the PC
- Log download scripts available (automatic export to **kml** data and exporting trigger events to synthetic **NMEA** data, simulating fixed number of GPS position marks)
- Features automatically connecting command and simulation console, includes IMU viewer and Mission Simulation

Trigger support:

- Uses standard servo output, primarily used for aerial photography
- Can work as 5V TTL switch
- Buffered and filtered servo outputs
- 3-state: Disabled/Enabled/Active
- Each state supports different servo position
- Enabling/disabling at specified waypoints or remotely with RC transmitter, any channel, any position
  You can just move the slider, the actual activation time and servo positions are programmable.
- Possible 'controls freeze' for shake-free photos
  Inhibit elevator moves and throttle change for prescribed time during photo shooting.
- Possible repetitive action
  Advanced timing engine includes: activation delay, activity time, inactivity time, max number of activations, activation by time or/and by distance flown and distance along the line between waypoints, possible to 'reload' max trigger counter at waypoints; the actual 'photo' position is written to the log at prescribed time after activation.

Special features:

- Automatic takeoff support, parachute and two independent engines logic
- Mission set management
- 1D, 2D and 3D stabilized head support

Safety:

- Separate override management processor and hardware servo override specified for wide operating temperature range guarantees taking control with RC equipment, compatible with 5V or 3.3V PCM receivers
- Automatic manual override when the main processor is rebooting means that in (extremely unlikely, except in temperatures around -40C) the case of autopilot software crash, the RC receiver is being used (its nonvolatile fail-safe settings are enabled it the transmitter is turned off)
- Programmable return-home based on cone angle, distance and altitude
- Programmable 'RC watchdog channel' that forces return home if is out of specified bounds
- Always use receivers with programmable failsafe (prevent accidental autopilot disable at distance, use mode channel programmed to magnet-home or use non-recovering return home channel)
- You can use mode channel to steer home at any time without interrupting navigation, with possible resuming as soon as the magnet-home is released
- In autopilot mode you can use rudder stick on your RC transmitter for obstacle avoidance (extreme rudder commands will intuitively command turn rate left or right, navigation resumes after release)
- Possible programmable 'RC receiver ignore, autopilot enable' above specified distance to avoid 'UAV hijacking' when using common RC frequencies
- Status LED indicating barometric pressure calibration, IMU and GPS sanity
- Safety: the motor will not run in autopilot mode before detecting takeoff what requires simultaneously applied throttle, well-calibrated system and moving.
- @@@THRDISABLE command at console
- Smooth throttle management (no sudden high RPM)
- Mission simulator allows evaluating proper waypoint arrangement, uses the triggers on the ground, minimizes 'wasted flight' probability, allows testing of return-home settings and 'RC transmitter off' situations
- Real-time log without file system corruption possibility, no moving parts or sockets
- Full-IMU autopilot is protecting against spin and allows safer, slower flight
- Clear distinction of operation modes: manual or automatic, without partially assisted modes (unless tuning mode is enabled with ground console)
- Single-board design enhances robustness, no jumpers or adjustment dials
- Parachute support
- Automatic multiple home capability
- Automatic takeoff and landing
- Mission memory slots selectable in real-time from RC receiver