Triple Redundant UAV Autopilot

Triple redundancy (3X) gives autopilot technology the reliability necessary to safely carry out sensitive flight missions and transport valuable payloads. A triple redundant arrangement is comprised of three similar software and hardware systems. If any one of the three systems fails, the remaining two take over, offering a double redundancy arrangement. If one of the other two systems should fail, the third takes over. An additional mechanism is also included to oversee these three systems. Triple redundant systems are highly tolerant of autopilot hardware failures.

- Fly both fixed-wing and helicopter UAVs.
- Multiple communication links for onboard devices such as cameras and aircraft transponders.
- Redundant datalinks to ground control station.
- Configuration, state and waypoint synchronization among all three autopilots.
- 11 serial ports including RS232 and RS485.
- 16 independently-generated servo signals.
- 8 high current drivers controlled independently by each autopilot.
- Pass or fail voting logic reliably selects the appropriate autopilot.
- HORIZON® ground control station software with built-in software in the loop simulator.
- Feedback loop synchronization ensures smooth transition when switching autopilots.
Servo & Mixing 16
Servo outputs                 16
Servo resolution (Servos 1-10)          11 bit
Servo resolution (Servos 11-16)          10 bit
Elevons, flaplers, 4 servo flap/aileron, separate flaps, v-tail, x-tail, split rudders, differential thrust  Yes
3 servo mechanical               Yes
3 servo 90° CCPM                  Yes
4 servo 90° CCPM                  Yes
3 servo 120° CCPM                  Yes
4 servo 4 corner CCPM              Yes
Servo update rate                 50-200 Hz
Separate servo and main battery power supply   Yes
Separate voltage monitor for main and servo battery power supplies   Yes
Integrated manual override in LRC-PIC mode            Yes

Control System
Gain scheduling for optimum performance   Yes
Selectable inner loop update rates  30/60/180Hz
Autonomous takeoff and landing supported by AGL        Yes
User definable PID feedback loops                8
(for camera stabilization etc)
User definable table lookup functions          8
MP plug-in compatible with XTENDER™ software   Yes
developer's kit
High current solid-state relay outputs              8

Sensors
Altimeter maximum altitude  12,000m
5g, 3 axis accelerometers        Yes
Maximum angular rate      250° per second
Attitude update rate       200Hz
15 state Kalman filter      Yes
ADC input channels          16
3 axis magnetometers         3

Telemetry, Datalog & Video
Telemetry (user defined fields transmitted each second)          100
Telemetry update rate      5 - 30 Hz
Datalog update rate     5 - 30 Hz
User definable datalog fields         24
Video overlay (number of user definable fields)     16

Navigation
GPS update rate (primary receiver) 20Hz
GPS update rate (2nd and 3rd receivers) 4Hz
Move servo at waypoint             Yes
Change altitude at waypoint       Yes
Change airspeed at waypoint       Yes
User definable holding patterns   Yes
User definable error handlers (loss of GPS, low battery etc.)  Yes
RPV and UAV modes                  Yes
Supports DGPS accuracy            Yes
Supports carrier phase GPS accuracy   Yes
Commands                           1,000

Ground Control Station
HORIZON™ ground control software included with system            Yes
SWIL autopilot simulator for operator training  Yes
Ground control software developer's kit                          Yes
(XTENDER™ required)
Gains can be adjusted in flight                             Yes
Change waypoints in flight                              Yes
Payload servos controlled from ground station             Yes
Fly in RC mode via datalink (both stabilized and normal, LRC base required)   Yes
Point-and-click waypoint editor                            Yes

Physical Characteristics
Weight                     859g (30 oz)
(not including GPS antenna)
Power (typical)            750mA @ 12V
Supply Voltage             9 - 27V
Size - Length              227 mm (8.938in)
Size - Width               127 mm (5.031in)
Size - Height              54 mm (2.125in)
Software upgradable in the field                        Yes
Autopilot                  MP2128®
GPS Receiver               1x Novatel, 2x Ublox

Mean Time Between Failure
0°C MTBF(hrs) 25°C MTBF(hrs) 50°C MTBF(hrs)
1 allowable failure from 3  56,866  35,293  25,505
2 allowable failure from 3  115,156  71,233  48,040
Multiple Communication Links

The MP2128³x acts as the UAV’s communication hub. Two radio modems can be installed, which offers two independent lines of communication between the autopilot and the ground control station. Devices such as Pan-Tilt-Zoom cameras (PTZ) and aircraft transponders (which enable ground control to identify the UAV) can also be connected to the autopilot. The MP2128³x’s redundant datalink between the UAV and the ground control station ensures the UAV operator can continue to monitor and control the UAV as well as other important on-board equipment even if one radio link fails. The MP2128³x switches communication links when flight operation is transferred from one autopilot to another. This ensures the operator on the ground is always monitoring and controlling the autopilot flying the UAV.
**MP2128³X Ultimate Reliability Measures**

In addition to the three MP2128HEL²s incorporated into the MP2128³X, MicroPilot’s triple redundant autopilots provide even more backup components. These include provisions for multiple communication links, backup high current drivers, backup power supplies and independently generated servo signals. Two different types of global positioning systems are also used to improve reliability.

**Supporting Products**

MicroPilot’s UAV autopilots are available with a complete suite of development tools. MicroPilot modified several of its auxiliary products to support the MP2128³X. For example: its update program was simplified to more efficiently renew data stored in three separate autopilots. HORIZON™ and in-the-loop simulator programs are also members of MicroPilot’s suite of MP2128³X development tools.

- HORIZON™
- qHWIL Simulator
- trueHWIL² Simulator

Although triple redundant technology is established within the aviation industry, triple redundant autopilots are a relatively new addition to unmanned aerial vehicles (UAVs). MicroPilot, the leading UAV autopilot manufacturer, is setting the benchmark for triple redundant UAV autopilots. MicroPilot, based in Canada, has been designing autopilots for fixed-wing, transitional and helicopter UAVs since 1994. In 2006 MicroPilot started designing a triple redundancy autopilot for helicopter and fixed-wing UAVs.

The MP2128³X is comprised of three MicroPilot MP2128HEL² autopilots, mounted on an adapter board, or redundancy board. The three MP2128HEL²s are prioritized. At the start, the autopilot in position one flies the airframe. If this autopilot should fail, the MP2128HEL² in position two takes over, and so on. The redundancy board provides several input/output (I/O) ports. The board also includes two RS232 serial ports designed to communicate with a ground control system via radio modems. As a result of this design, users never need to work directly with bare circuit boards. Additionally, the autopilots do not have an individual casing, keeping overall weight to a bare minimum; however, the entire redundancy board is enclosed to protect the system.

Three complete autopilots, advanced voting logic, carrier phase GPS for helicopter and fixed-wing.