

# AEROcontrol



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The airborne computer of the *AEROcontrol* system is used for data recording of

- *IMU-IId* raw data, i.e. angular and acceleration increments (64 Hz, 128 Hz optional)
- GPS raw data, positions and velocities.

Real-time platform calculations allow to use this information as navigational input for IGI's *Standard CCNS4*.

All accumulated raw data (*IMU-IId* 64 Hz; optional 128 Hz and GPS 1 Hz) are stored on the *AEROcontrol* MISSION CARD for post flight processing. They can be introduced as additional observations into aerial triangulation / block adjustment programs (e.g. MATCH-AT or BINGO).

The system approximately records 12MB (64Hz) or 18MB (128Hz) of data per hour giving a maximum mission time of at least 10 hours with available 192 MB PC-Cards.



IGI's *AEROcontrol* system is used to determine precisely the position and attitude of an airborne sensor at a given instant. This can be the position of the projection center and the angles omega, phi, kappa of the aerial camera system.

The *AEROcontrol* system consists of a fibre-optic gyro based Inertial Measurement Unit (*IMU-IId*), a 12 -channel L1/L2 Survey GPS receiver and an airborne computer. The IMU is mounted rigidly to the sensor system.

The *AEROcontrol* system is controlled via the airborne computer or via IGI's *Standard CCNS4* guidance, positioning and management system for aerial survey flight missions. The *Standard CCNS4* and *AEROcontrol* together form a fully integrated system. This system may be operated as separate units or in a single 19" rack mount, 3U or 5U high.

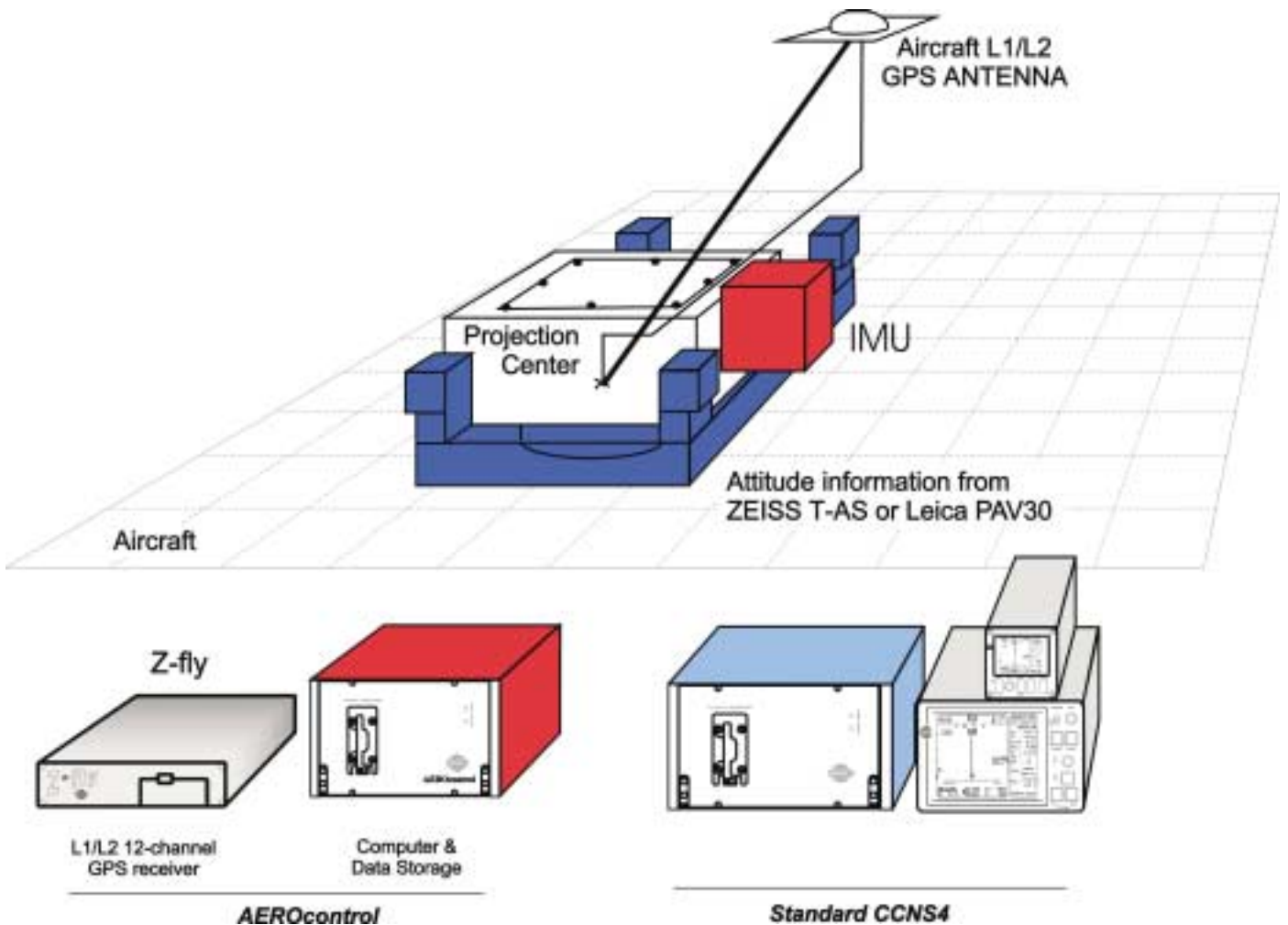


Installation material for the inertial measurement unit (*IMU*) of the *AEROcontrol* system, including mechanical adapter plate, are available for the Wild/Leica RC10A, RC20 / RC30, the Zeiss Jena LMK, LMK-1000, LMK-2000, and the Zeiss Oberkochen RMK-TOP aerial camera systems. The *AEROcontrol-IId* system with IGI's fibre-optic based IMU, together with the *Standard CCNS4* is the only integrated guidance, management, precise positioning and attitude determination system available.

Depending on GPS constellation and distance from GPS Base/Monitor Station, a positioning accuracy better than 0.1m RMS and attitude accuracy of 0.01 deg RMS is available in post-processing.

The "Test Vaihingen 2000" of Stuttgart University (ifp) shows the following results:

- position <0.08m RMS  
Height <0.05m RMS
- phi / omega <0.003deg RMS  
kappa <0.007deg RMS



For the precise position determination of the airborne sensor, the position of the aircraft (a/c) GPS antenna phase center has to be transformed to the sensor position. The lever arm between the GPS antenna and the sensor can be measured directly at the installation in the a/c.

Because of a/c movements in flight, this lever arm has to be corrected for the actual attitude.

- If the camera is rigidly mounted to the a/c's frame, the lever arm remains constant during sensor operation. In this case, the projection center is calculated directly from the constant lever arm and the GPS/IMU information. No additional measurements are needed.
- If the camera is not rigidly mounted to the a/c, e.g. if a stabilized camera mount is operated (Leica PAV 30 or Zeiss T-AS), this lever arm depends on the movement of the camera with respect to the a/c frame.

In this case this movement has to be taken into account for the lever arm correction. This can be done by using the attitude information of the stabilized mount.

If this information is not available, the variable lever arm can be determined by using an additional low-cost IMU, mounted rigidly to the a/c's frame.

If the IMU is installed together with the aerial sensor system, the body frame of the IMU does not exactly match with the sensor frame. For the calculation of the actual sensor attitude, the angles between both frames have to be determined by a flight over a calibration field (boresight alignment). Using these mounting angles, the IMU angles (heading, pitch, roll) are transformed to the real sensor attitude ( $\kappa$ ,  $\phi$ ,  $\omega$ ) for photogrammetric operation, e.g. Orthophoto mapping.

## General

- The *AEROcontrol* system consists of:
  - Inertial measurement unit (*IMU-IId*) with fibre-optic gyros (FOG)
  - Integrated *Z-Xtreme/IGI*, 12-channel L1/L2 Survey GPS receiver (Ashtech), modified for airborne operations
  - Airborne *AEROcontrol* computer
- Operation and management of the *AEROcontrol* system is either
  - as a stand-alone system
  - or controlled by the *Standard CCNS4* as an integrated system
- DGPS system:
  - Portable GPS Base / Monitor station, e.g. from IGI (based on Ashtech Z-Xtreme) with 12 hours or more continuous operating time (battery based)
  - Information from fixed GPS network, e.g. SAPOS in Germany, UK FIXED GPS NETWORK
- *AEROoffice* software package:
  - DGPS computations by GrafNav software package (licence included, others on request)
  - Kalman filter software for combined GPS / IMU calculation
  - Lever-arm correction
  - Boresight transformation

## IMU-IId Specifications

- |   |   |
|---|---|
| ▪ FOG-Bias: 0.1 deg/h<br>FOG-RW: 0.02 deg/sqrt(h)<br>Resolution: 0.0076 mrad    | ▪ Dimensions: <ul style="list-style-type: none"><li>- Length: 133 mm</li><li>- Width: 138 mm</li><li>- Height: 185 mm</li></ul> |
| ▪ Accelerometer Bias: 0.5 mg<br>Resolution: $0.244 \cdot 10^{-3} \text{ m/s}^2$ | ▪ Volume: 3.4 litre   |
| ▪ Update and transmission rate: 64Hz; optional 128Hz                            | ▪ Weight: 3.1 kg  |
| ▪ MTBF: 6.000 h   | ▪ Power consumption: 20 W at 28 VDC   |

## Post-Processing

Depending on GPS conditions, with *AEROcontrol* DGPS and *IMU-IId* data the following accuracies, in a circle of <30 km radius around the GPS Base / Monitor Station, can be expected :

- |                        |                               |
|------------------------|-------------------------------|
| ▪ Position: <0.1 m RMS | ▪ Phi/Omega/Kappa 0.01deg RMS |
| ▪ Height: <0.2 m RMS   |                               |

During the "Test Vaihingen 2000" by Stuttgart University (ifp), the following results have been achieved:

- |                        |                            |
|------------------------|----------------------------|
| ▪ Position: 0.08 m RMS | ▪ Phi/Omega < 0.003deg RMS |
| ▪ Height: 0.05 m RMS   | ▪ Kappa < 0.007deg RMS     |