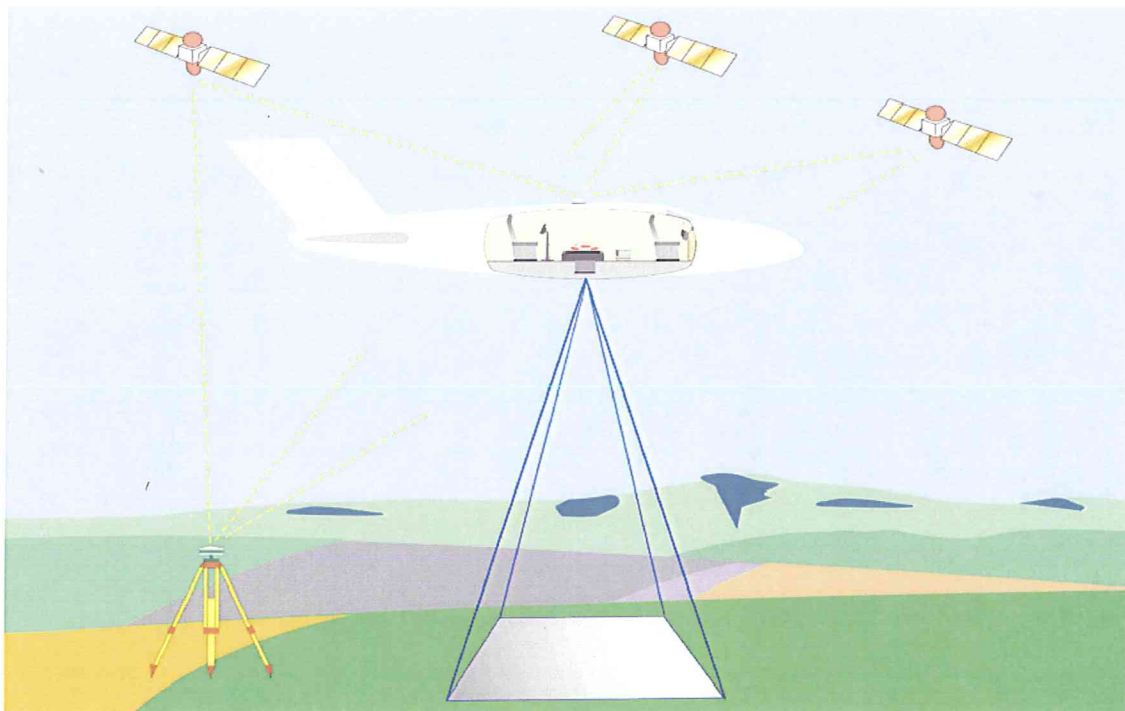


Leica RCD30 Calibration Certificate



This certificate is valid for

| Camera Head | Serial Number | Lens | Serial Number |
|-------------|---------------|---------------------|---------------|
| CH62 | 62091 | NAG-D 3.5/50 | 50116 |

Calibration certificate issued on **09.09.2013**

Inspector
Riedl Bernhard
Riedl Bernhard

Certificate and calibration data ID

RCD30_Geometry_CameraHead-62091-A-777966_LensSystem-50116---785422_DateTime-20130909-151535

Leica Geosystems AG
Heinrich-Wild-Strasse
9435 Heerbrugg
Switzerland

Document code 791649

Leica
Geosystems

Sensor layout of tested system

The RGB CCD carries a BGGR Bayer pattern with overlapping spectral bands. The NIR sensor is a monochrome CCD. It is spectrally separated from RGB through a dichroitic beam splitter device. NIR pixels are 2x2 binned from 0.006 mm to 0.012 mm.

| Sensor | Pixel size [mm] | Active rows | Active columns | Raw rows | Raw columns |
|------------|-----------------|-------------|----------------|----------|-------------|
| RGB | 0.006 | 6708 | 8956 | 6732 | 9000 |
| NIR | 0.012 | 3654 | 4478 | 3366 | 4500 |

Camera model of distortion free images

All factory calibration results contain fixed nominal focal lengths and zero principal point offsets.

FramePro applies the grid to create distortion-free images of nominal focal length and pixel size. NIR is interpolated to the resolution of RGB during this process.

| Parameter | Value of distortion free images |
|---|--|
| c: focal length | 53 mm |
| xP, yP: principal point (PPA) | Zero The PPA is the origin of the image coordinate system. It is located in the image center (row 3365.5, column 4499.5). |
| k0, k1, k2: radial symmetric distortion | Zero |
| p1, p2 : decentering distortion | Zero |
| b1, b2: non-orthogonality | Zero |
| Pixel size (height and width) | 0.006 mm, also for NIR |
| Image rows | 6732 |
| Image columns | 9000 |

Calibration process

Adjustment of optical systems in optical laboratory

| | | Passed | Date | Inspector |
|---|-------------------|-----------|-----------------|-----------------------|
| <i>DSNU (Dark Signal Non-Uniformity)</i> | <i>checked</i> | ok | 21.05.13 | Robin Weinbuch |
| <i>PRNU (Photo Response Non Uniformity)</i> | <i>calibrated</i> | ok | 21.05.13 | Robin Weinbuch |
| <i>FMC origin</i> | <i>calibrated</i> | ok | 23.05.13 | Robin Weinbuch |
| <i>CCD Saturation (VNS)</i> | <i>calibrated</i> | ok | 23.05.13 | Robin Weinbuch |
| <i>CCD blemish list</i> | <i>created</i> | ok | 23.05.13 | Robin Weinbuch |
| <i>Best image plane</i> | <i>adjusted</i> | ok | 23.05.13 | Robin Weinbuch |
| <i>Goniometric calibration</i> | <i>created</i> | ok | 09.09.13 | Robin Weinbuch |
| <i>Final image quality check</i> | <i>checked</i> | ok | 09.09.13 | Riedl Bernhard |

Inspection

Inspectors

| | | | |
|-----------------|--------------------------|-----------------|---|
| <i>Name</i> | Bernhard Riedl | 10.09.13 |  |
| <i>Position</i> | RCD30 Production Manager | | |

Leica RCD30 calibration process specification

| | |
|---|--------------------------------|
| <i>Inspection plan</i> | Document code 791755 |
| <i>Leica RCD30 system calibration processes</i> | 791757 |

Results of the calibration in the optical laboratory

The resulting distortion grid file that contains all geometric information, about the camera is attached to this certificate. File name see first page and footer of each page.

All factory calibration results contain fixed nominal focal lengths and zero principal point offsets.

FramePro applies the grid to create distortion-free images of nominal focal length and fixed pixel size of 0.006 mm. NIR is interpolated to the resolution of RGB during this process.

Reference band (green)

| | |
|---------------------------------|--|
| Calibration method | Measurement of image distortion, using a bi-axial highest precision goniometer. The measurement is done on 117 points with the camera rotating in front of a collimator that projects a circular pinhole from infinity into the camera. The measurement is done in two faces to compensate for non-orthogonality of goniometer axes and internal camera effects. |
| Expected accuracy of distortion | Better than 0.003 mm for 90% of the image, and 0.006 mm at the image border |
| Principal point (PPA) | The PPA is determined with an accuracy of .0300 mm |

Other spectral bands

| | |
|--|---|
| Calibration method | Goniometric calibration, using the same set of images as for the reference band. |
| Expected accuracy of co-registration to the reference band | Red and Blue: Better than 0.002 mm Near Infrared: Better than 0.003 mm for 90% of the image, and 0.006 mm at the image border. |

Remark

IMU misalignment can only be calculated based on flight data. Flight data also enables precise determination of the PPA. The procedures how a user can determine the IMU misalignment and the PPA are given in the RCD30 Documentation, Volume2 'Technical Reference Manual', Chapter 'Advanced operation'.