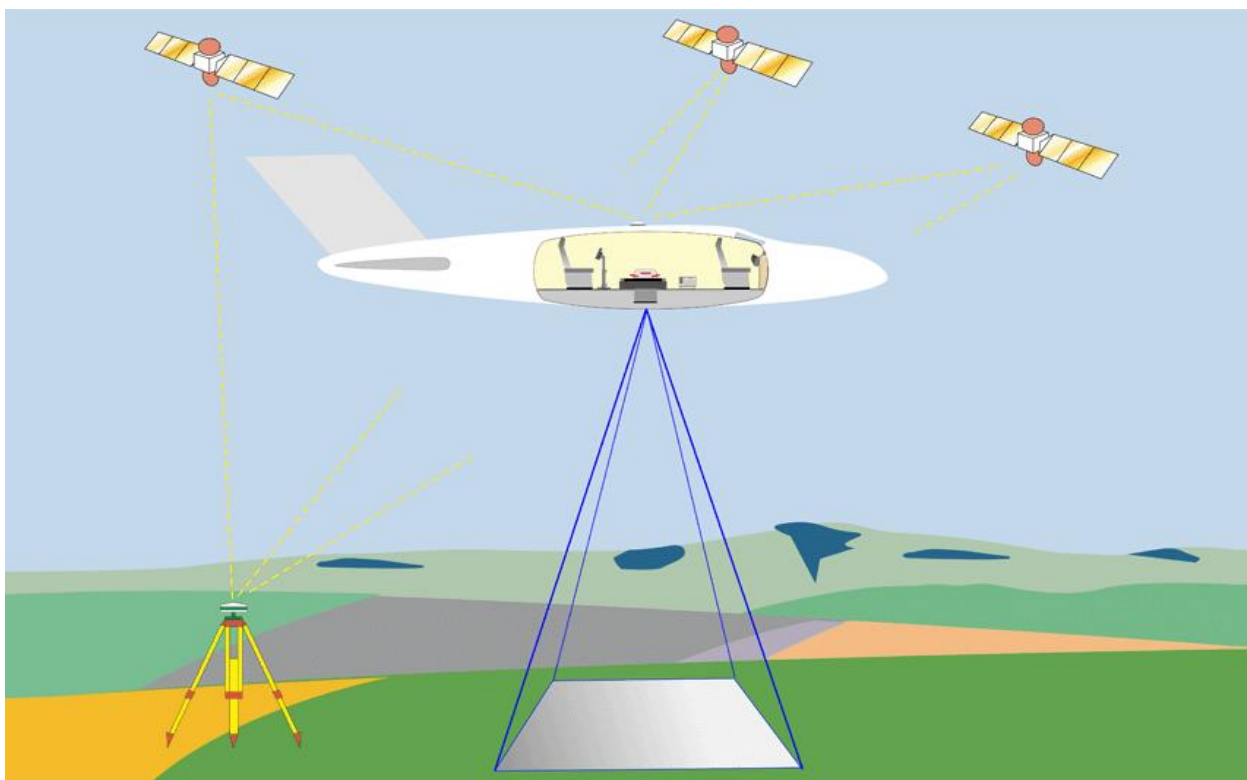



Leica RCD30 Calibration Certificate



This certificate is valid for Camera Head Serial Number Lens Serial Number
CH82 82067 NAG-D 4.0/50 50071

Calibration certificate issued on **16 October 2018**

Inspector

Robert Bosch

Certificate and calibration data ID

RCD30_Geometry_CameraHead-82067-E-798528_LensSystem-50071-A-785422_DateTime-20181012-090731.xml

Leica Geosystems AG
Heinrich-Wild-Strasse
9435 Heerbrugg
Switzerland

Document code 791649

- when it has to be **right**

Leica
Geosystems

Additional Components

Component	Device	Type	Serial Number
GNSS/IMU	SPAN	LCI 500 MHz	1153

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	0.0052	7752	10320	7788	10336
NIR	0.0120	3654	4478	3366	4500

Camera model of distortion free images

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

Leica 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 3893.5, column 5167.5).
k0, k1, k2: radial symmetric distortion	Zero
p1, p2 : decentering distortion	Zero
b1, b2: non-orthogonality	Zero
Pixel size (height and width)	0.0052 mm for RGB and 0.006 mm for NIR
Image rows	7788
Image columns	10336

Calibration process

Adjustment of optical systems in optical laboratory



		Passed	Date	Inspector
<i>DSNU (Dark Signal Non-Uniformity)</i>	<i>checked</i>	ok	01.10.18	Bernhard Riedl
<i>PRNU (Photo Response Non Uniformity)</i>	<i>calibrated</i>	ok	01.10.18	Bernhard Riedl
<i>FMC origin</i>	<i>calibrated</i>	ok	01.10.18	Bernhard Riedl
<i>CCD Saturation (VNS)</i>	<i>calibrated</i>	ok	01.10.18	Bernhard Riedl
<i>CCD blemish list</i>	<i>created</i>	ok	01.10.18	Bernhard Riedl
<i>Best image plane</i>	<i>adjusted</i>	ok	01.10.18	Bernhard Riedl

Flight and data processing

		Passed	Date	Inspector
<i>Test flight</i>		ok	05.10.18	Raphael Weber
<i>Image quality check</i>		ok	11.10.18	Bernhard Riedl
<i>GNSS and IMU data processing</i>		ok	08.10.18	Robert Bosch
<i>Geometrical calibration</i>		ok	12.10.18	Cesar Mendoza

Inspection

Inspectors

<i>Name</i>	Bernhard Riedl	16.10.18	
<i>Position</i>	RCD30 Production Manager		
<i>Name</i>	Robert Bosch	16.10.18	
<i>Position</i>	RCD30 Support Engineer		

Maintenance

Last date of service

Recommendations

Results of geometrical calibration

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

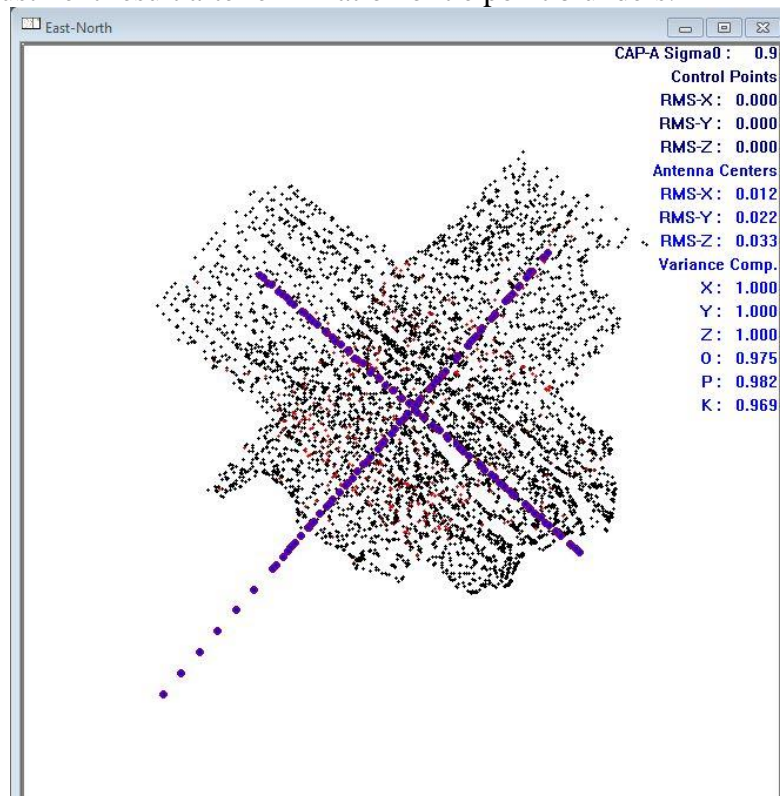
All factory calibration results contain fixed nominal focal lengths and zero principal point offsets.

Leica FramePro applies the grid to create distortion-free images of nominal focal length and fixed pixel size of 0.0052 mm. NIR is interpolated to the resolution of RGB during this process.

Reference band (green)

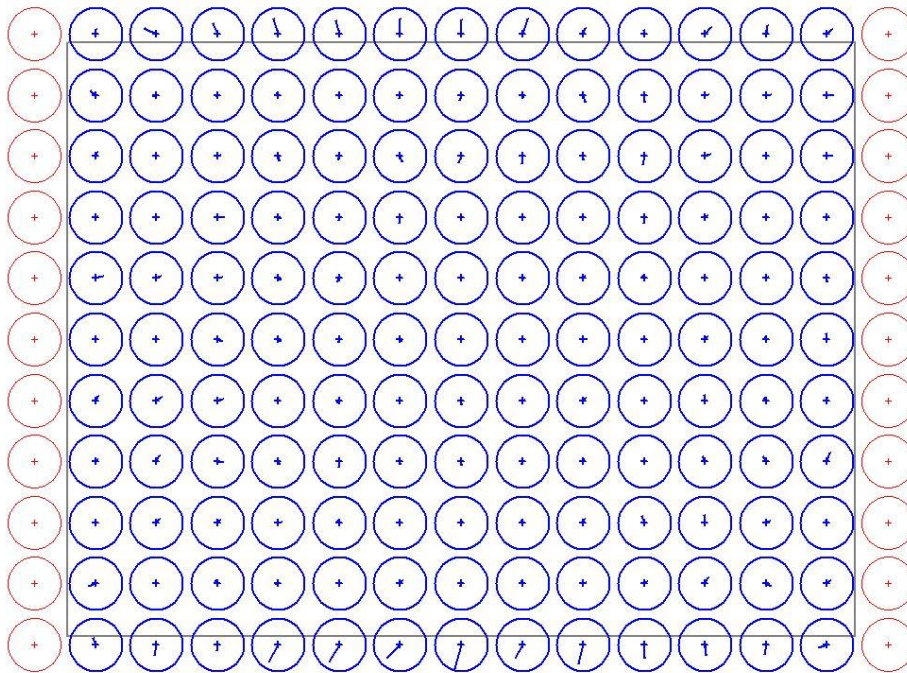
Calibration method	Estimation of additional parameters (focal length, principal point, radial symmetric distortion, correction grid) and IMU misalignment in simultaneous bundle adjustment
Resulting sigma naught of bundle adjustment	0.0009 mm

Final bundle adjustment result after elimination of tie point blunders:



Remaining image space residuals after applying the calibration result (radius of circles is 0.0009 mm):

RMS-X: 0.11
RMS-Y: 0.20



Other spectral bands

Calibration method	Estimation of additional parameters (correction grid), based on the result for green in simultaneous bundle adjustment
Co-registration to green better than	0.002 mm

IMU misalignment

Misalignment results [deg] valid only for this calibration flight		Angle
	ω	0.213573
	ϕ	0.045675
	κ	-0.104324