



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION of Aerial Mapping Camera

September 04, 2009

Camera type:	Wild RC30*	Camera serial no.:	5334
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13374
Nominal focal Length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4
Submitted by:	US Imaging, Inc. Bartow, FL		

Reference:

These measurements were made on Agfa glass plates, 0.19 inch thick, with spectroscopic emulsion type APX Panchromatic, developed in D-19 at 68° F for 3 minutes with continuous agitation. These photographic plates were exposed on a multicollimator camera calibrator using a white light source rated at approximately 5200K.

I. Calibrated Focal Length: 153.802 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (μm)	1	1	1	1	0	-1
Decentering tangential (μm)	0	0	1	1	2	3

Symmetric radial distortion	Decentering distortion	Calibrated principal point
$K_0 = -0.4119\text{E-}04$	$P_1 = 0.1080\text{E-}06$	$x_p = -0.010 \text{ mm}$
$K_1 = 0.5500\text{E-}08$	$P_2 = 0.1109\text{E-}06$	$y_p = -0.005 \text{ mm}$
$K_2 = -0.1438\text{E-}12$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K_0, K_1, K_2, K_3, K_4), Decentering Distortion (P_1, P_2, P_3, P_4), and Calibrated Principal Point [point of symmetry] (x_p, y_p) were determined through a least-squares Simultaneous Multiframe Analytical Calibration (SMAC) adjustment. The x and y-coordinate measurements utilized in the adjustment of the above parameters have a standard deviation (σ) of ± 3 microns.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 118

<u>Field angle:</u>	<u>0°</u>	<u>7.5°</u>	<u>15°</u>	<u>22.7°</u>	<u>30°</u>	<u>35°</u>	<u>40°</u>
Radial Lines	159	159	159	134	134	113	95
Tangential Lines	159	134	134	113	113	95	95

The resolving power is obtained by photographing a series of test bars and examining the resultant image with appropriate magnification to find the spatial frequency of the finest pattern in which the bars can be counted with reasonable confidence. The series of patterns has spatial frequencies from 5 to 268 cycles/mm in a geometric series having a ratio of the 4th root of 2. Radial lines are parallel to a radius from the center of the field, and tangential lines are perpendicular to a radius.

IV. Filter Parallelism

The two surfaces of the Wild 420 filter No. 7849 and 525 filter No. 7851 accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

<u>Indicated Time</u>	<u>Rise Time</u>	<u>Fall Time</u>	<u>½ Width Time</u>	<u>Nom. Speed</u>	<u>Efficiency</u>
<u>(sec)</u>	<u>(μ sec)</u>	<u>(μ sec)</u>	<u>(ms)</u>	<u>(sec)</u>	<u>(%)</u>
1/125	1744	1715	8.15	1/140	87
1/250	875	875	4.26	1/270	87
1/500	456	456	2.17	1/530	87
1/1000	233	228	1.11	1/1040	87

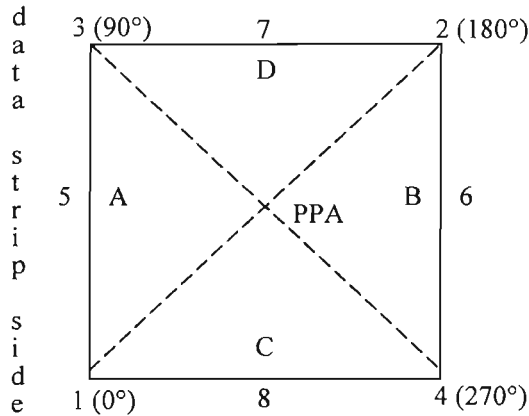
The effective exposure times were determined with the lens at aperture $f/4$. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

VI. Film Platen

The platen mounted in Wild drive unit No. 5334 does not depart from a true plane by more than 13 μm (0.0005 in).

This camera is equipped with a platen identification marker that will register "716" in the data strip area for each exposure.

VII. Principal Point and Fiducial Mark Coordinates



Positions of all points are referenced to the principal point of autocollimation (PPA) as origin. The diagram indicates the orientation of the reference points when the camera is viewed from the back, or a contact positive with the emulsion up. The data strip is to the left.

- Indicated principal point, corner fiducials
- Indicated principal point, midside fiducials
- Principal point of autocollimation (PPA)
- Calibrated principal point (point of symmetry)

X coordinate (mm) Y coordinate (mm)

0.007	0.003
0.005	0.006
0.000	0.000
-0.010	-0.005

Fiducial Marks

1	-105.995	-105.995
2	106.009	106.002
3	-105.989	106.002
4	106.002	-105.995
5	-111.990	0.007
6	112.005	0.005
7	0.009	112.010
8	0.000	-112.001

VIII. Distances Between Fiducial marks

Corner fiducials (diagonals)	1-2: 299.815 mm	3-4: 299.805 mm
Lines joining these markers intersect at an angle of 90° 00' 00"		
Midside fiducials	5-6: 223.995 mm	7-8: 224.010 mm
Lines joining these markers intersect at an angle of 89° 59' 54"		
Corner fiducials (perimeter)	1-3: 211.997 mm	2-3: 211.998 mm
	1-4: 211.997 mm	2-4: 211.998 mm

The Method of measuring these distances is considered accurate within 0.003 mm

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 277mm.

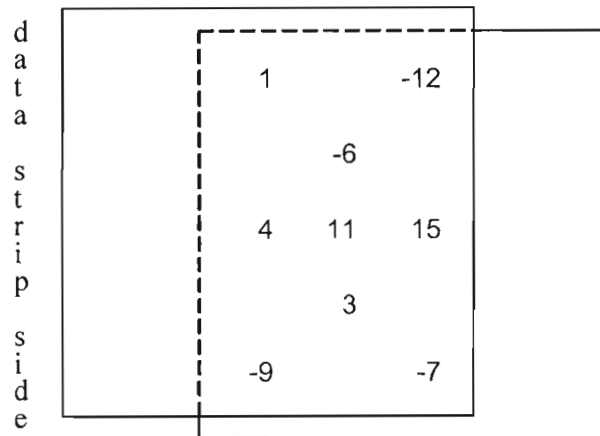
IX. Stereomodel Flatness

FMC Drive Unit No: 5334

Platen ID: 716

Base/Height ratio: 0.6

Maximum angle of field tested: 40°



Stereomodel Test Point Array
(values in micrometers)

The values shown on the diagram are the average departures from flatness (at negative scale) for two computer-simulated stereo models. The values are based on comparator measurements on Agfa Avitone P3P copy film made from Kodak 2405 film exposures. These measurements are considered accurate to within 5 μm.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 50

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	57	57	57	57	57	48	48
Tangential Lines	57	57	57	57	48	40	40

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3286, dated January 5, 2007.

Michael G. Benson
Remote Sensing Technologies Project Manager
Geography Discipline