



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

## REPORT OF CALIBRATION of Aerial Mapping Camera

July 13, 2011

<b>Camera type:</b>	Wild RC20*	<b>Camera serial no.:</b>	5116
<b>Lens type:</b>	Wild Universal Aviogon /4-S	<b>Lens serial no.:</b>	13431
<b>Nominal focal Length:</b>	153 mm	<b>Maximum aperture:</b>	f/4
		<b>Test aperture:</b>	f/4
 <b>Submitted by:</b>	Air Photographics, Inc. Martinsburg, WV		

**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:** 153.426 mm

**II. Lens Distortion**

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

<u>Symmetric radial distortion</u>	<u>Decentering distortion</u>	<u>Calibrated principal point</u>
$K_0 = -0.7235E-04$	$P_1 = 0.4352E-07$	$x_p = -0.002$ mm
$K_1 = 0.1329E-07$	$P_2 = 0.3086E-07$	$y_p = -0.001$ mm
$K_2 = -0.4895E-12$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

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 ( $\sigma$ ) of  $\pm 3$  microns.

\* Equipped with Forward Motion Compensation

**III. Lens Resolving Power in cycles/mm**

Area-weighted average resolution: 114

<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	134	134	134	113	134	113	95
Tangential Lines	134	134	113	113	113	113	80

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 525 filter No. 7389 accompanying this camera are within 10 seconds of being parallel. This filter was used for the calibration.

**V. Shutter Calibration**

<u>Indicated Time</u> <u>(sec)</u>	<u>Rise Time</u> <u>(μ sec)</u>	<u>Fall Time</u> <u>(μ sec)</u>	<u>½ Width Time</u> <u>(ms)</u>	<u>Nom. Speed</u> <u>(sec)</u>	<u>Efficiency</u> <u>(%)</u>
1/125	1981	1804	8.02	1/150	85
1/250	879	919	4.14	1/280	86
1/500	467	468	2.16	1/540	86
1/1000	238	236	1.07	1/1080	86

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).

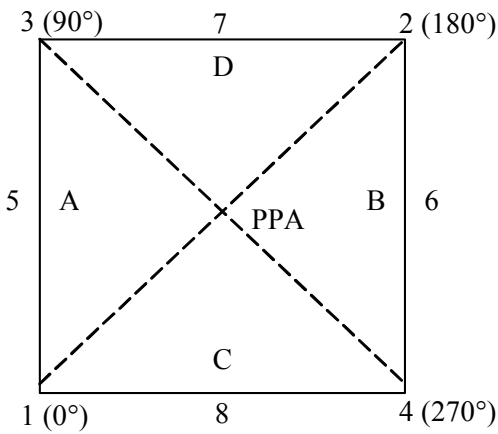
**VI. Film Platen**

The platen mounted in Wild drive unit No. 5116 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 "515" in the data strip area for each exposure.

**VII. Principal Point and Fiducial Mark Coordinates**

d  
a  
t  
a  
  
s  
t  
r  
i  
p  
  
s  
i  
d  
e



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.

	<u>X coordinate (mm)</u>	<u>Y coordinate (mm)</u>
Indicated principal point, corner fiducials	0.015	0.007
Indicated principal point, midside fiducials	0.010	0.006
Principal point of autocollimation (PPA)	0.000	0.000
Calibrated principal point (point of symmetry)	-0.002	-0.001
<u>Fiducial Marks</u>		
1	-105.978	-105.994
2	106.008	106.007
3	-105.990	106.005
4	106.022	-105.994
5	-111.982	0.006
6	112.020	0.006
7	0.006	112.008
8	0.015	-111.992

**VIII. Distances Between Fiducial marks**

Corner fiducials (diagonals)	1-2: 299.804 mm	3-4: 299.821 mm
Lines joining these markers intersect at an angle o	90° 00' 00"	
Midside fiducials	5-6: 224.001 mm	7-8: 224.000 mm
Lines joining these markers intersect at an angle o	90° 00' 08"	
Corner fiducials (perimeter)	1-3: 211.999 mm	2-3: 211.999 mm
	1-4: 212.000 mm	2-4: 212.000 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.

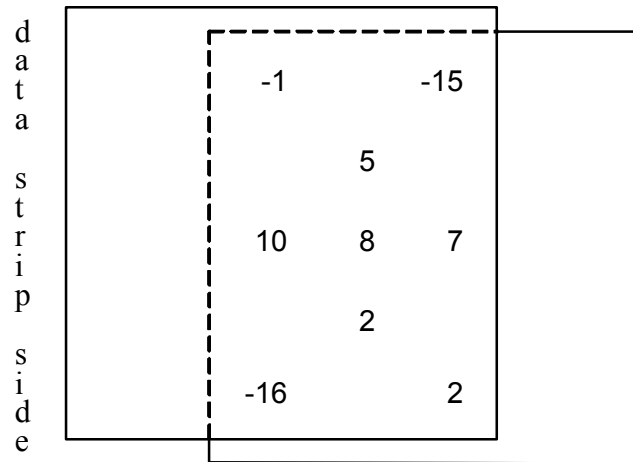
**IX. Stereomodel Flatness**

**FMC Drive Unit No:** 5116

**Base/Height ratio:** 0.6

**Platen ID:** 515

**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 Kodak 4425 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:** 48

**Film:** Type 2405

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

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/3390, dated June 19, 2008.

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