



# United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

## REPORT OF CALIBRATION of Aerial Mapping Camera

March 17, 2003

Camera type:	Wild RC30*	Camera serial no.:	5268
Lens type:	Wild Universal Aviogon /4-S	Lens serial no.:	13389
Nominal focal length:	153 mm	Maximum aperture:	f/4
		Test aperture:	f/4

Submitted by: Tuck Engineering, Inc.  
Big Stone Gap, Virginia

Reference: Leica Geosystems GIS & Mapping purchase  
order No. 1117-03, dated March 14, 2003.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type 157-01 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: 153.518 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	-2	-3	-3	-1	1	3
Decentering (um)	0	1	2	3	4	6

Symmetric radial  
distortion parameters

Decentering  
distortion parameters

Calibrated  
principal point

$$\begin{aligned} K_0 &= 0.8691 \times 10^{-4} \\ K_1 &= -0.1262 \times 10^{-7} \\ K_2 &= 0.3643 \times 10^{-12} \\ K_3 &= 0.0000 \\ K_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} P_1 &= -0.7737 \times 10^{-7} \\ P_2 &= 0.3788 \times 10^{-6} \\ P_3 &= 0.0000 \\ P_4 &= 0.0000 \end{aligned}$$

$$\begin{aligned} x_p &= -0.013 \text{ mm} \\ y_p &= -0.007 \text{ mm} \end{aligned}$$

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: 84

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	95	95	95	95	95	80	67
Tangential lines	95	95	95	95	95	67	57

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. 7925 accompanying this camera are within 10 seconds of being parallel. This filter was used for the calibration.

### V. Shutter Calibration

Indicated time (sec)	Rise time ( $\mu$ sec)	Fall Time ( $\mu$ sec)	$\frac{1}{2}$ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/125	1696	1716	8.35	1/140	87
1/250	864	861	4.19	1/270	87
1/500	449	451	2.18	1/530	87
1/1000	227	226	1.08	1/1060	87

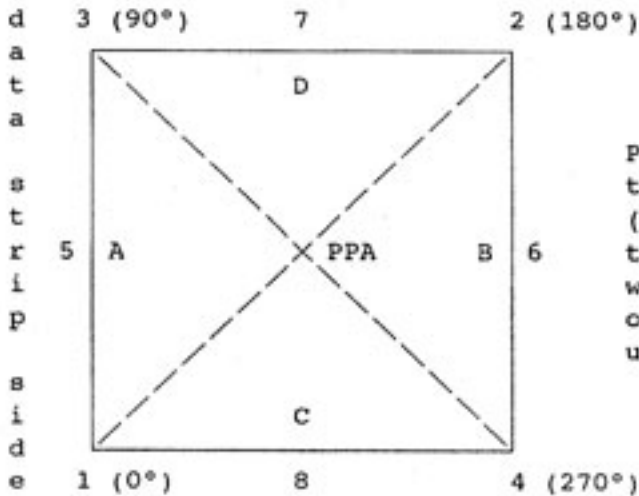
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

### VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5268-631 does not depart from a true plane by more than 13  $\mu$ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "631" in the data strip area for each exposure.

VII. Principal Points and Fiducial 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.

	X coordinate	Y coordinate
Indicated principal point, corner fiducials	-0.020 mm	0.007 mm
Indicated principal point, midside fiducials	-0.021	0.009
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) $x_p, y_p$	-0.013	-0.007

Fiducial Marks

1	-106.009 mm	-105.988 mm
2	105.968	106.001
3	-106.022	105.999
4	105.986	-105.988
5	-112.011	0.009
6	111.971	0.009
7	-0.027	112.004
8	-0.014	-111.985

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.790 mm                      3-4: 299.809 mm

Lines joining these markers intersect at an angle of 90° 00' 04"

Midside fiducials

5-6: 223.982 mm                      7-8: 223.989 mm

Lines joining these markers intersect at an angle of 90° 00' 12"

Corner fiducials (perimeter)

1-3: 211.987 mm                      2-3: 211.990 mm

1-4: 211.995 mm                      2-4: 211.989 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 277 mm.

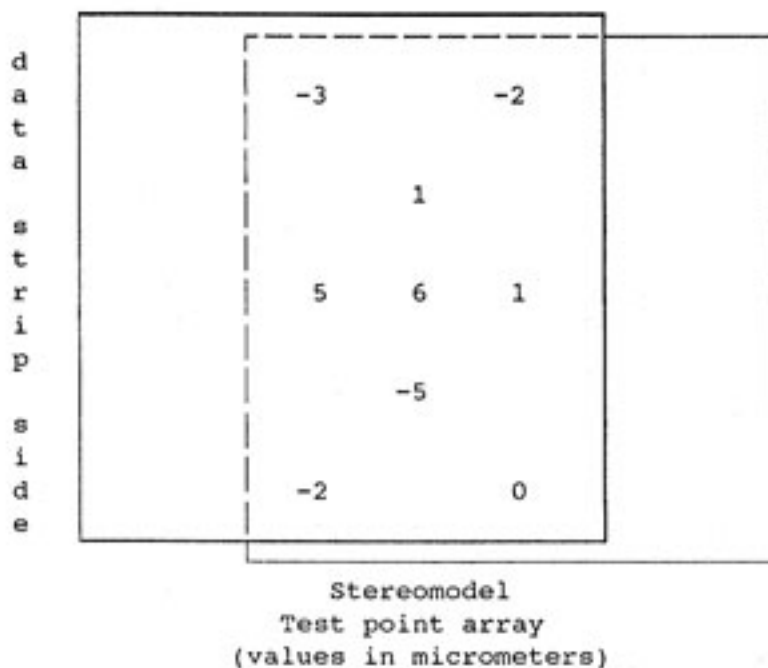
IX. Stereomodel Flatness

FMC Drive Unit No.: 5268-631

Base/Height ratio: 0.6

Platen ID: 631

Maximum angle of field tested: 40°



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 can vary by as much as  $\pm 5 \mu\text{m}$  from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 44

Film: Type 2405

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	48	48	48	48	48	48	40
Tangential lines	48	48	48	40	48	40	34

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