DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für die Meßgröße der geometrischen Optik
Calibration laboratory for measured quantities geometric optics

AKKREDITIERT DURCH DIE
PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB)

ZEISS

Kalibrierschein
Calibration Certificate

Kalibrierzeichen
Calibration mark

0811
DKD-K-05202
05-03

Gegenstand *Object*	Aerial Survey Camera
Hersteller *Manufacturer*	Carl Zeiss D-73446 Oberkochen
Typ *Type*	RMK A 15/23
Fabrikat/Serien-Nr. *Serial number*	134 635
Auftraggeber *Customer*	I.A.S. Italiana Aero Servizi S.r.l. Aeroporto S.Egidio I-06080 Perugia, Italy
Auftragsnummer *Order No.*	235780
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	4
Datum der Kalibrierung *Date of calibration*	07.05.03

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).

Der Deutsche Kalibrierdienst ist Unterzeichner des multilateralen Übereinkommens der European co-operation for Accreditation of Laboratories (EA) zur gegenseitigen Anerkennung der Kalibrierscheine.

Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).

The Deutscher Kalibrierdienst is signatory to the multilateral agreement of the European co-operation for Accreditation of Laboratories (EA) for the mutual recognition of calibration certificates.

The user is obliged to have the object recalibrated at appropriate intervals.

Stempel *Seal*	Datum *Date*	Leiter des Kalibrierlaboratoriums *Head of the calibration laboratory*	Bearbeiter *Person in charge*
DKD-K 05-03	10.05.03	Dr. Wiedenmann	Müller

Carl Zeiss
Industrielle Messtechnik GmbH
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CAMERA TYPE: RMK A 15/23 SERIAL NO. 134635
LENS TYPE: PLEOGON A2 SERIAL NO. 134660
MAX.APERTURE: F/4 NOM. FOCAL LENGTH: 153 MM

1) CALIBRATED FOCAL LENGTH = 153.557 MM

2) DISTORTION /0.001 MM, REFERRING TO P.P. OF SYMMETRY PPS

S/MM=	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
5	0	0	0	1	1	2	2	2	1	0	-1	-1	0	1	2	1
6	0	0	0	0	0	1	1	0	-1	-1	-1	-1	1	1	2	2
7	0	-1	0	0	0	1	1	1	0	-1	-2	-2	-1	-1	0	-2
8	0	0	0	1	1	2	1	0	-1	0	0	-1	-1	-1	-2	-2
AV.	0	0	0	0	1	1	1	1	0	-1	-1	-1	0	0	1	0

3) P.P. OF AUTOCOLLIMATION AND FIDUCIAL CENTRE, REFERRING TO PPS

P.P. OF AUTOCOLLIMATION PPA X= -0.003 Y= -0.006 MM
FIDUCIAL CENTRE FC X= -0.007 Y= -0.010 MM

4) FIDUCIAL MARKS, REFERRING TO PPS

X1= 112.990 X2=-113.006 X3= -0.007 X4= -0.007 MM
Y1= -0.010 Y2= -0.010 Y3= 112.993 Y4=-113.005 MM
DISTANCES 1-2= 225.996 3-4= 225.998 MM

5) PHOTOGRAPHIC RESOLVING POWER, IN CYCLES PER MM
(AS PER DEFINITION, R. P. IS NOT A CALIBRATED DATUM)
AREA WEIGHTED AVERAGE RESOLUTION 80

FIELD ANGLE /DEG =	0	7	14	21	28	35	42
RADIAL LINES	130	115	100	96	91	84	76
TANGENTIAL LINES	130	128	109	90	80	49	57

FILM: KODAK PANATOMIC X 3412 SPEED 40 ASA
DEVELOPED IN AGFA G 74 C AVIPHOT

6) Filter

7) Magazines

8) Measuring uncertainty
Distortion: U = 3 µm ; Point of symmetrie and collimation: U = 3 µm ; Image center: U = 5 µm : Camera constant: U = 5 µm

The specification indicates the upgraded measuring uncertainty resulting from the multiplication of the standard measuring uncertainty by the factor k = 2. It was determined in conformity with DKD-3. The values of the measurement parameter lie within the specified range with a probability of 95%.

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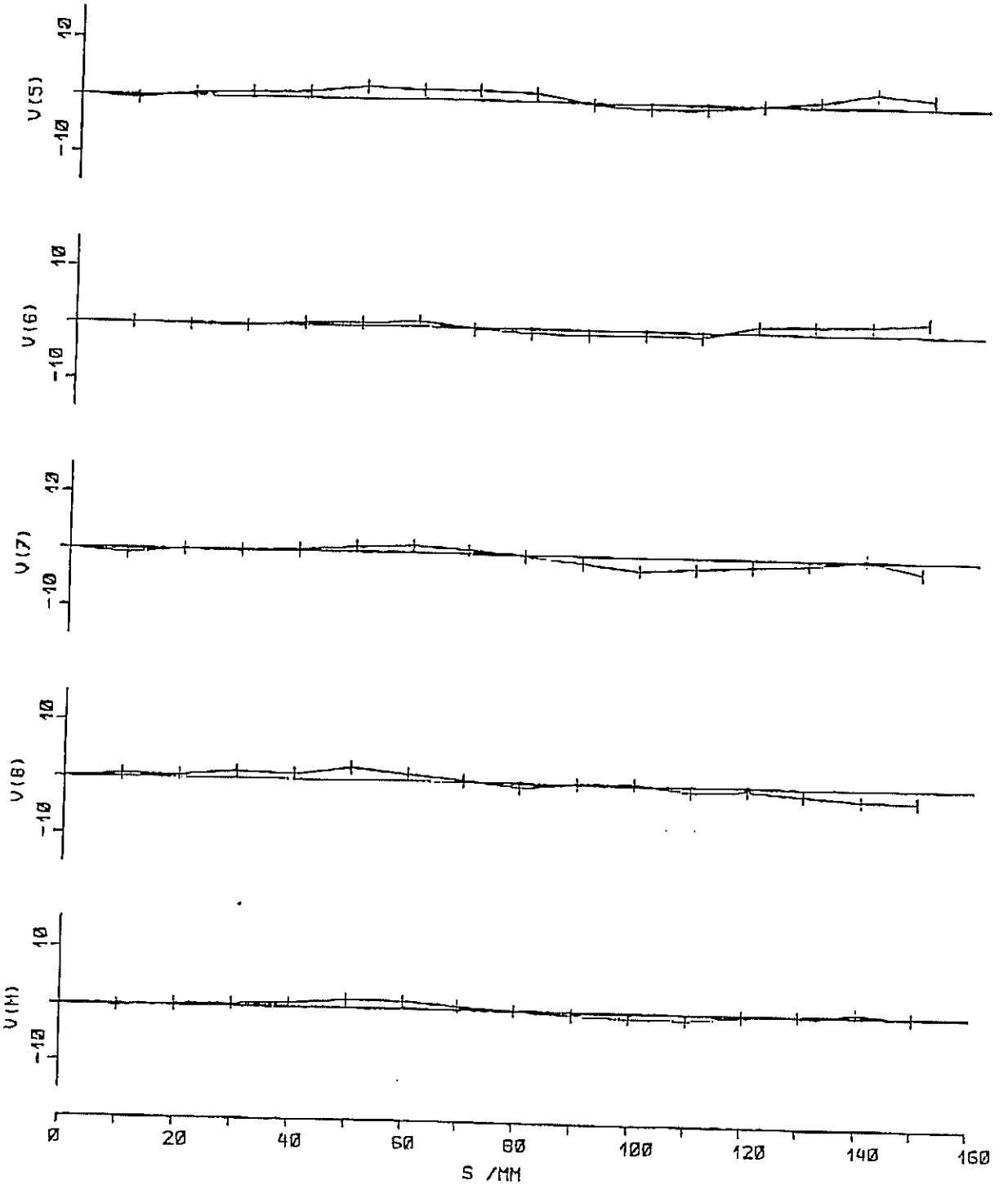
RMK A 15/23 NO. 134635
PLEOGON A2 4/153 NO. 134660
CFL=153.557 MM

DISTORTION /0.001 MM, REFERRING TO PPS



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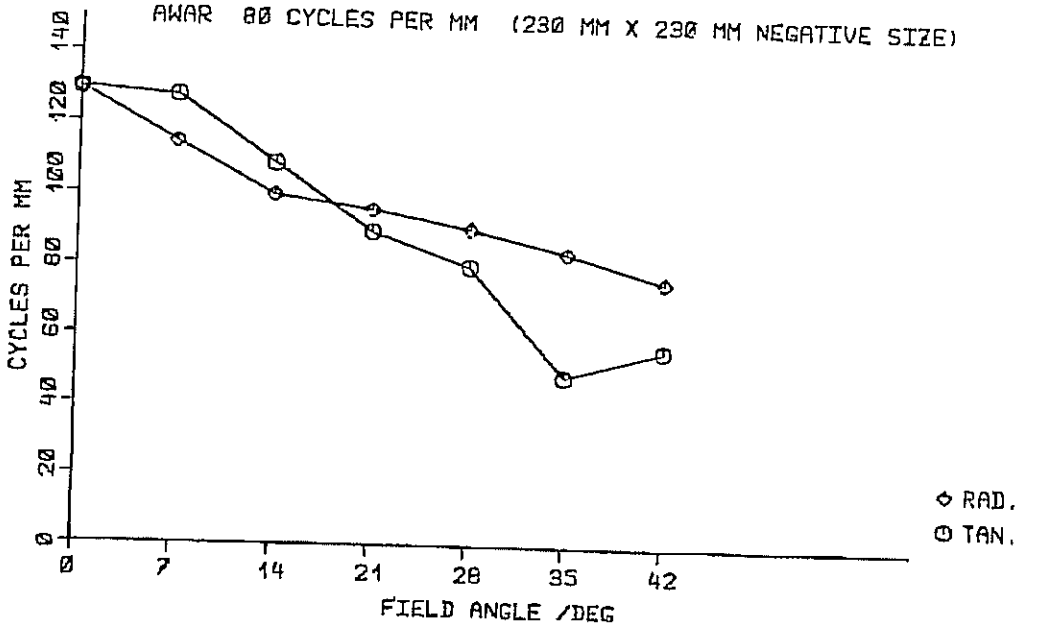
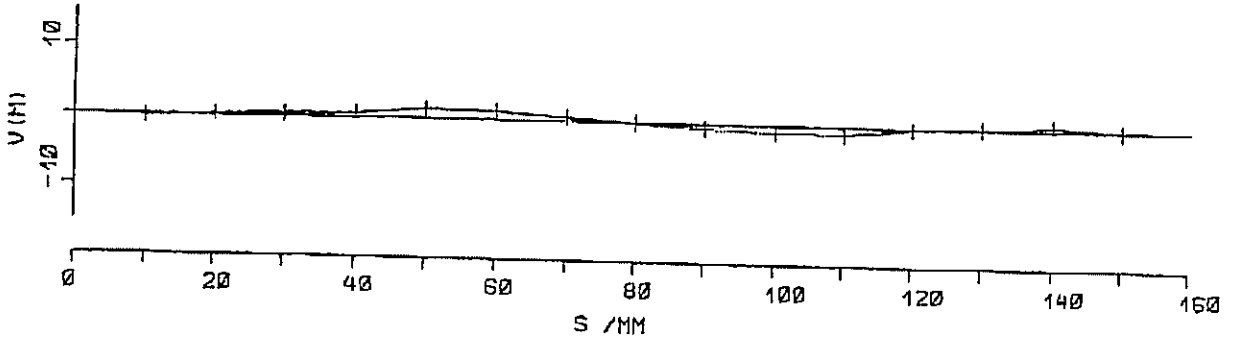
RMK A 15/23 NO. 134635

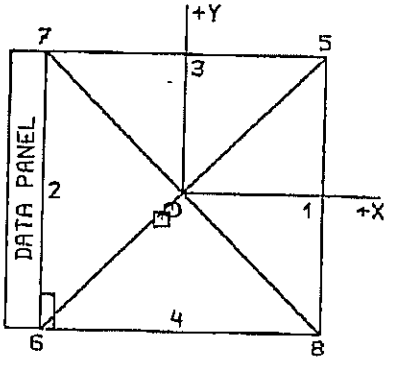
PHOTOGRAPHIC RESOLVING POWER



DEPARTURE OF AVERAGE DISTORTION FROM ZERO REFERENCE



PRINCIPAL POINT(PPA, PPS) AND FIDUCIAL CENTRE (FC)



COORDINATES, REFERRING TO PPS

	X /MM	Y /MM
PPA	-0.003	-0.006
FC	-0.007	-0.010

⊢ 0.01 MM, X-AXIS AS DEFINED BY FIDUCIAL MARK COORDINATES

$\alpha(6) = 0.0^{g}$ $\alpha(8) = \alpha(6) + 90^{g}$

Appendix

This camera has been, tested in accordance with the existing regulations. The methods used are based on the Recommended Procedures for Calibrating Photogrammetric Cameras and for Related Optical Tests (International Scciety of Photogrammetry, 1960, reaffirmed 1964). The optical performance and the external construction are in accordance with our terms of delivery.

1.Calibrated Focal Length

The calibrated focal length is chosen so as to minimize the square sum of the radial measured distortion.

2. Distortion

The values of radial distortion refer to the calibrated focal length and to the principal point of symmetry (Section 3). Regarding the origin for distortion values it must be realized that in the photogrammetric process, the asymmetry due to a displacement of that point is eliminated together with the asymmetry introduced by camera tilt. The principal point of symmetry is chosen as origin for distortion, because only this residual asymmetry cannot be eliminated by simple compensation.

The radial distortion is measured for points of the focal plane separated by 10mm form the axis for each of the four radii 5, 6, 7 and 8. AV is the average radial measured distortion at a given radial distance. A positive value indicates that the image is further from the centre than its distortionfree position. Measurements are made at maximum aperture on the goniometer by attaching the filter D (cut-off wavelength 535 nm at transmittance 50%). The measuring uncertainty (95%; k=2) 0.003 mm.

The maximum tangential distortion, i.e. the displacement of the central image from a straight line connecting corresponding image points at equal but opposite angular separations from the axis, does not exceed 0.005 mm.

3. Principal Point and Fiducial Centre

The position of the principal point of autocollimation and of the fiducial centre (Section 4) are given in a rectangular coordinate system as indicated in the plot, with the principal point of symmetry as origin.

4. Fiducial Marks

For coordinate measurements the fiducial marks are recorded on photographic glass plates. Coordinates of the fiducial marks are given in a rectangular system as shown in the plot, with the principal point of symmetry as origin. Fiducial marks 1 and 2 lie in the line of flight. The location of the fiducial marks can be assumed to be accurate within 0.005 mm.

In the course of camera assembly and maintenance the fiducial marks are adjusted to meet the following specifications:

- The lines joining opposite pairs of fiducial marks intersect at an angle within 30 seconds of 90°.

- The point of intersection (fiducial centre) is within 0.02 mm of the principal point of autocollimation.

5. Photographic Resolving Power

The resolving power is obtained by photographing a series of three line high contrast test figures. The photographs are taken under the recommended standard illumination by using the filter B (cut-off wavelength 490 nm at transmittance 50%). The camera is used at full aperture. The resulting image is examined with a low power stereoscopic microscope to find the spatial frequency of the finest pattern resolved. The values of resolving power are reduced to the image plane and refer to the focus settings as used for determining the calibrated focal length.

6. Filters

The two surfaces of the filters listed in the certificate are within 5 seconds of being parallel.

7. Magazine Platen

The platen mounted in the film magazine, serial no. as indicated in the certificate, does not depart from a true plane by more than 0.010 mm.