

# DEUTSCHER KALIBRIERDIENST **DKD**

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

AKKREDITIERT DURCH DIE

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB)



Kalibrierschein  
*Calibration Certificate*

Kalibrierzeichen  
*Calibration mark*

0641
DKD-K- 05202
99-08

Gegenstand <i>Object</i>	Aerial Survey Camera
Hersteller <i>Manufacturer</i>	Carl Zeiss D-73446 Oberkochen
Typ <i>Type</i>	RMK A 15/23
Fabrikat/Serien-Nr. <i>Serial number</i>	119 035
Auftraggeber <i>Customer</i>	Agricultural and Forestry Aerialsurvey Institute, Taiwan Forestry Bureau No. 61-3 Chao Chow St., Taipei, Taiwan, ROC
Auftragsnummer <i>Order No.</i>	651 1 0206
Anzahl der Seiten des Kalibrierscheines <i>Number of pages of the certificate</i>	4
Datum der Kalibrierung <i>Date of calibration</i>	31.08.99

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.*

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Physikalisch-Technischen Bundesanstalt als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit.

*This calibration certificate may not be reproduced other than in full except with the permission of both the Physikalisch-Technische Bundesanstalt and the issuing laboratory. Calibration certificates without signature and seal are not valid.*

Stempel <i>Seal</i>	Datum <i>Date</i>	Leiter des Kalibrierlaboratoriums <i>Head of the calibration laboratory</i>	Bearbeiter <i>Person in charge</i>
	08.09.1999	 Dr. Wiedenmann	 Müller

Carl Zeiss  
Servicebereich Qualität  
Meß- /Kalibrierzentrum  
73446 Oberkochen

Telefon 07364-20-3731  
Telefax 07364-20-4511

CAMERA TYPE: RMK A 15/23  
 LENS TYPE: PLEOGON A  
 MAX. APERTURE: F/4

SERIAL NO. 119035  
 SERIAL NO. 119004  
 NOM. FOCAL LENGTH 153 MM

1) CALIBRATED FOCAL LENGTH = 153.031 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
5	0	1	1	2	4	4	4	4	4	4	3
6	0	0	0	1	1	2	2	3	3	5	6
7	0	0	-1	0	-1	-2	-1	-1	-3	-5	-7
8	0	0	-1	-2	-3	-2	-2	-4	-3	-5	-6
AV.	0	0	0	0	0	0	1	1	0	0	-1

Distortion for image heights larger than 100 mm not measurable.

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

P.P. OF AUTOCOLLIMATION PPA	X=	.007	Y=	.007 MM
FIDUCIAL CENTRE FC	X=	.018	Y=	.005 MM

4) FIDUCIAL MARKS, REFERRING TO PPS

X1= 112.962	X2=-112.998	X3= .012	X4= .024 MM
Y1= -.001	Y2= .011	Y3= 112.992	Y4=-112.963 MM
DISTANCES 1-2= 225.960		3-4= 225.955 MM	

5) PHOTOGRAPHIC RESOLVING POWER, IN CYCLES PER MM  
 (AS PER DEFINITION, R. P. IS NOT A CALIBRATED DATUM)  
 AREA WEIGHTED AVERAGE RESOLUTION 40

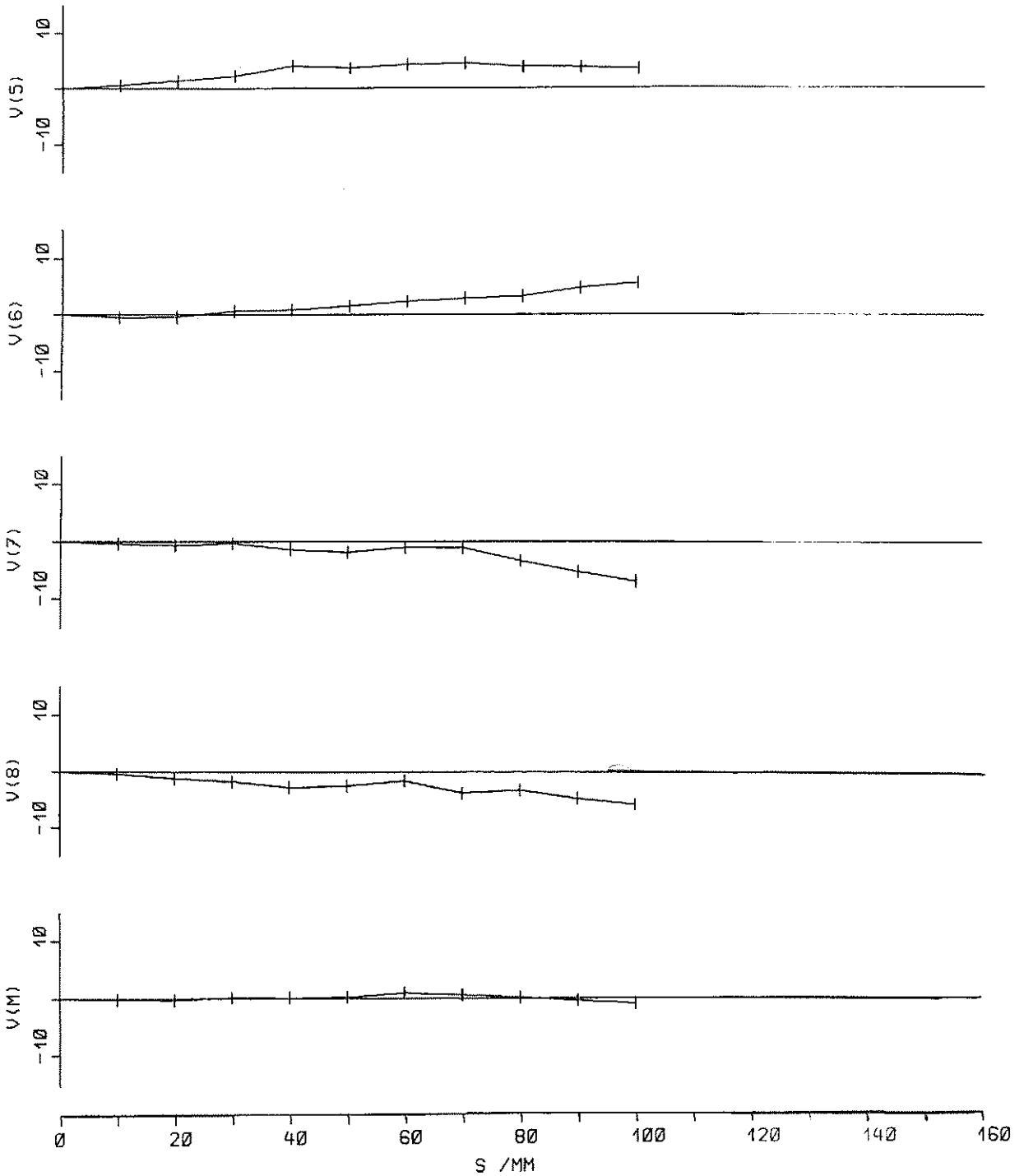
FIELD ANGLE /DEG =	0	7	14	21	28	35	42
RADIAL LINES		52	58	63	61	46	38
TANGENTIAL LINES		52	51	49	57	40	25

FILM: Kodak Panatomic X 3412      SPEED 40 AFS  
 DEVELOPED IN AGFA G 74 C AVIPHOT

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RMK A 15/23 NO. 119035  
PLEOGON A 4/153 NO. 119004  
CFL=153.031 MM

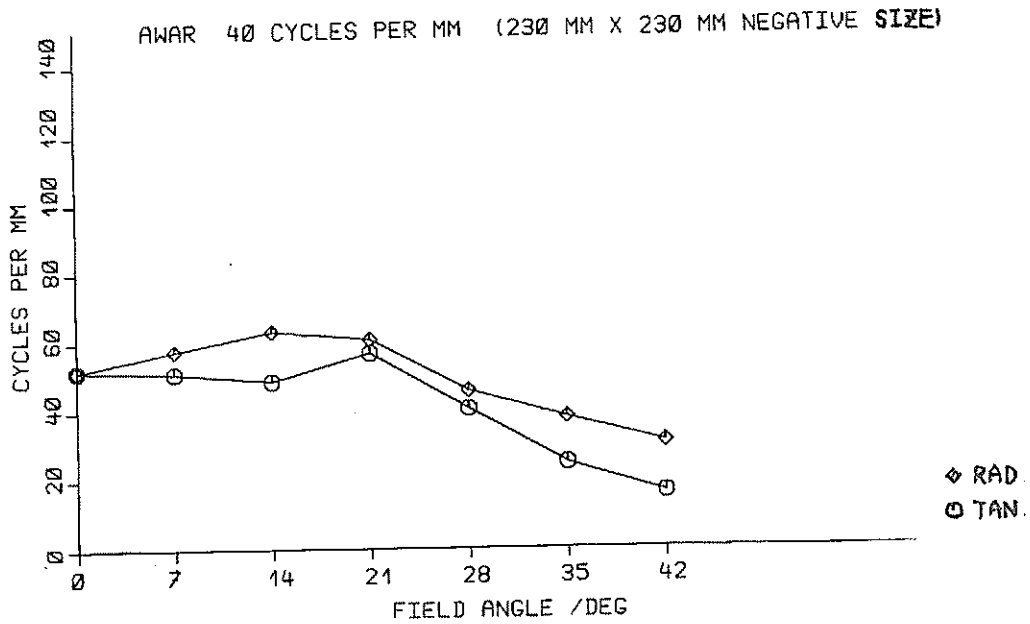
DISTORTION /0.001 MM, REFERRING TO PPS



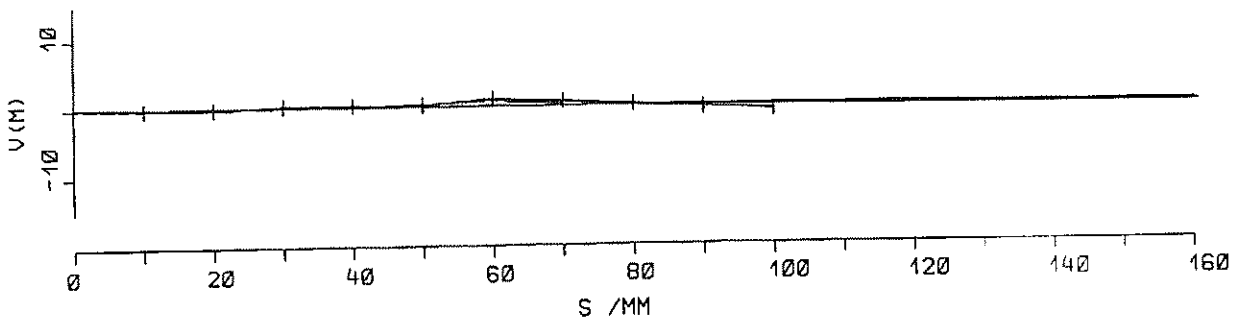
RMK A 15/23

NO. 119035

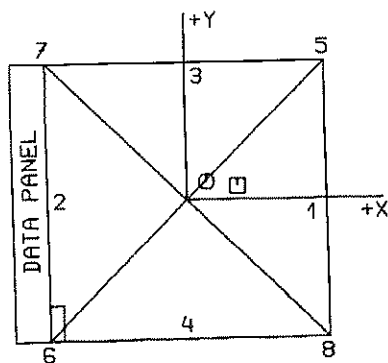
PHOTOGRAPHIC RESOLVING POWER



DEPARTURE OF AVERAGE DISTORTION FROM ZERO REFERENCE



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



COORDINATES, REFERRING TO PPS

	X / MM	Y / MM
○ PPA	0.007	0.007
□ FC	0.018	0.005

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

$\alpha(6) = 0.0^\circ$        $\alpha(8) = \alpha(6) + 90^\circ$

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 Society 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 10 mm from the axis for each of the four radii 5, 6, 7 and 8.  $\Delta V$  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 standard deviation of the distortion values given can be assumed to be less than 0.002 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 positions 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 setting 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.