Optical Testing and Measuring Instruments for Industry

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Surveying Instruments
Optical Tooling Theodolites
Repaired-Serviced
Bought-Sold-Traded

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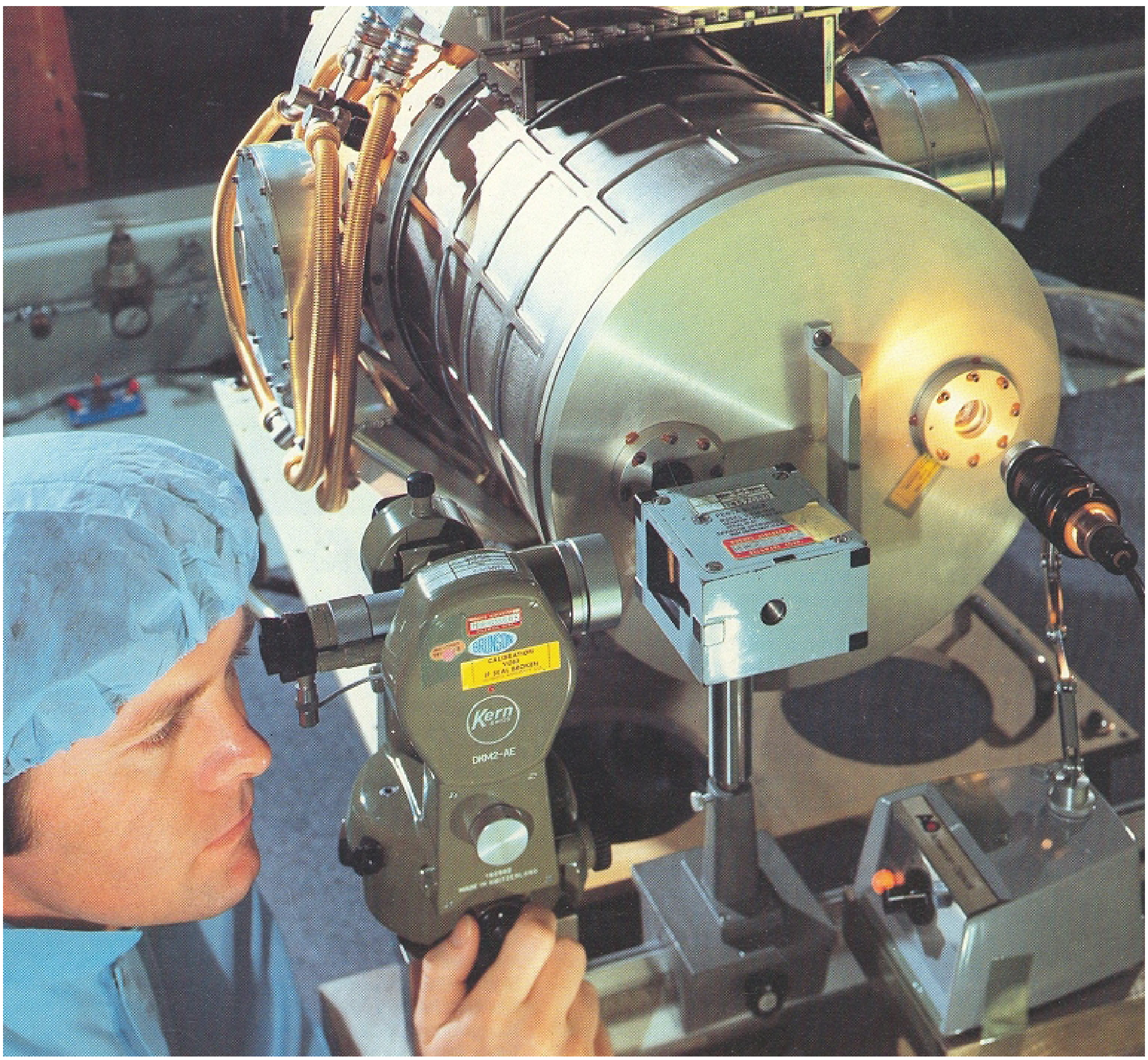
Kern
Modular
Instrument
System

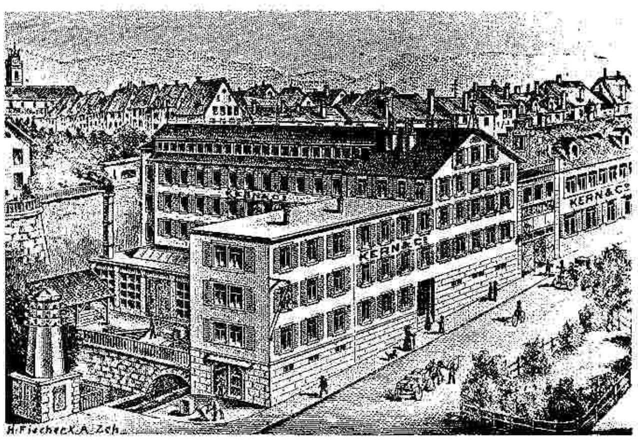


YESTERDAY . . .
TODAY . . .
TOMORROW . . .

Jakob Kern, the founder of our company received his education in the local schools of Aarau, Switzerland. In 1809 he began his journeyman's years, working and traveling to acquire in-depth knowledge of geodetic- and astronomic instruments, working with leading European manufacturers of precision instruments. He also spent much time with a leading physicist by the name of Fraunhofer, a pioneer in optics-design.

Jakob Kern returned to Aarau in 1819, a master in his field. The same year he opened his own mechanical workshop which soon expanded to include all types of physical instruments. In 1824 he received his first request to build a *Theodolite*. The growing reputation which he earned in his field was confirmed by Dufour when ordering a Kern-built theodolite for Switzerland's first trigonometric survey. Mr. Dufour later became commander in chief of the Swiss army.

Soon, Kern's clientele reached beyond Swiss borders. The advent of railroad building increased the demand for his surveying-instruments and his workforce had grown to 42 when he decided to build his own factory. Operations there began in 1857, at which time two of his sons joined the company. In 1867 Jakob Kern died at the age of 77, leaving his successful and growing business to his sons and with it, establishing a *Tradition* which carries into TODAY, when the company is led by the fifth generation of "Kerns".



The company continued to grow in both personnel and plant space. In the 1920's Kern started to produce its own optical components which formed the basis for continued developments in technological progress. Near the end of 1935, *Dr. Heinrich Wild* who had left the firm in Heerbrugg in 1932, began designing new theodolites—the so-called "Double Circle Theodolites". The exclusive rights to manufacture these new instruments were granted to Kern & Co., Ltd., as were all ensuing new designs of Dr. Wild. He wrote about his relationship to Kern as follows: "The most carefully designed instrument is worthless if it is not manufactured meticulously in accordance with its specifications, to the last detail. Fortunately, the factory of Kern & Co., Ltd., offers the fullest possible guarantee in this respect, for the machinery, tools and special equipment of this firm meet the most stringent requirements of modern industrial techniques".

On the Job Wherever People Plan and Build

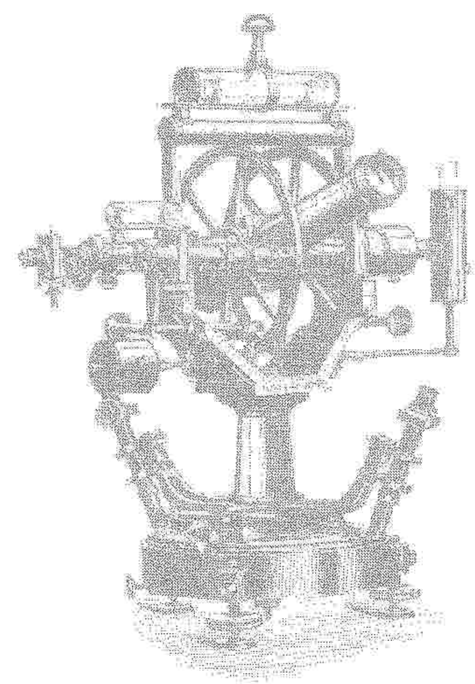
TODAY, the product line of Kern & Co., Ltd., Aarau, Switzerland includes a complete line of integrated *Surveying Systems* to meet the top requirements of both the surveying profession and industry, as well as a complete line of photogrammetric equipment. The *Electronic Surveying Instruments* introduced in 1973 are made by Kern in their own electronics department near the site of Jakob Kern's first factory.

TOMORROW is a challenge to Kern. It is also a challenge to YOU. Just as the 1930's brought profound changes to better serve the profession around the world, in the same way Kern is responding in the 1980's. Presenting the *Modular Instrument System* was a first step. The introduction of *Data Collection Peripherals* and the all new *Electronic Theodolite* is now at hand. Much of it may be integrated right into your present system.

Over a century and a half of progress and reliability is culminated by more than 130 sales and service offices *Around The World.* Kern is looking forward to serve YOU now and in the future . . .

Introduction To
Precision Measuring Instruments

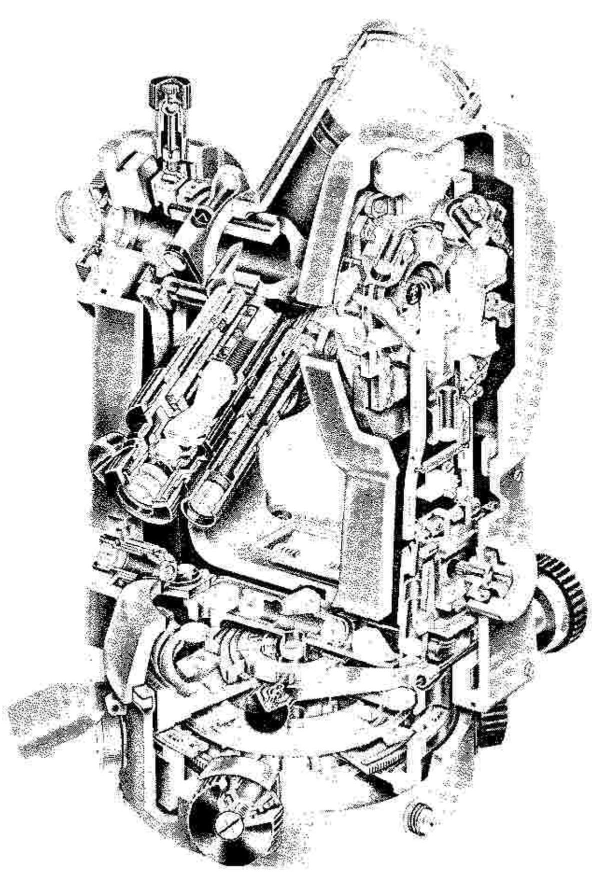
Precise measurements have always played an important part in scientific and technical work. Such measurements are vital. As early as the last century remarkable results were obtained as witnessed, for instance, by the precision with which the Alps were pierced by long railroad tunnels. At that time the instruments were crude by modern standards, which makes the results obtained even more noteworthy.



KERN UNIVERSAL THEODOLITE FOR TRIANGULATION
BUILT APPROXIMATELY 1913

Horizontal and vertical circle readouts to 1 second of arc with micrometer.
Graduations available with either 360° or 400^g.
Telescope magnification 46-75x.
Theodolite had telescope illumination and horizontal circle orientation-drive. Weight: 114 lbs.

Note balanced center of gravity of alidade to achieve maximum instrument-stability.



55 YEARS LATER . . .
(Introduced in 1968,
coincidentally with 150 Years Kern)

THE STANDARD FOR TODAY'S THEODOLITE TECHNOLOGY:
KERN DKM2-A UNIVERSAL THEODOLITE

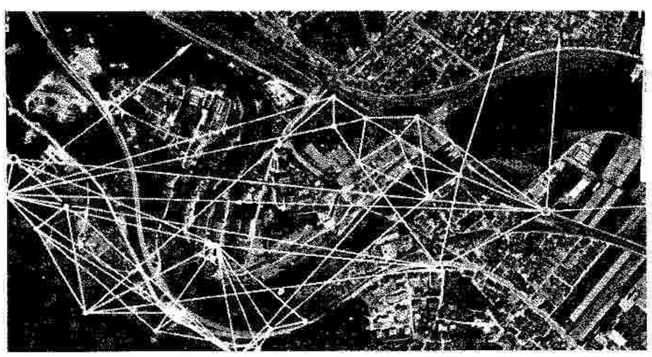
The Kern DKM2-A theodolite has a convenience in handling that has been unattained heretofore. It has a wide range of applications because of numerous accessories which are available. Many special features contribute to increased precision. They include a digitized circle readout to the nearest second and two-speed horizontal and vertical slow-motion drives for convenience and exact pointing.

Standard instrument is equipped with an automatic compensator in a hermetically sealed container. The liquid is a special oil on the surface of which the rays between the two reading positions of the circle are reflected. The compensator and the optical reading elements are mounted on a steel plate in the direct vicinity of the circle.

For special optical tooling applications such instrument use in either a hanging or tilting position, the automatic compensator is replaced with a first surface mirror.

Relative and absolute measuring methods

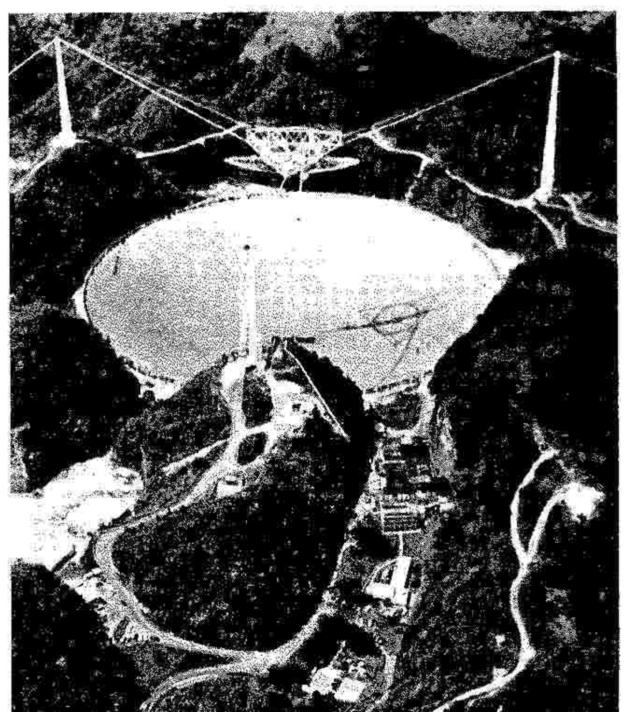
Each measurement problem in construction and assembly, from instrument installation to the construction of, for instance, a complete hydro-electric plant with a range of 100 km (62 miles) or more, can be reduced to the determination of the spatial coordinates of critical points. The interrelationship of these points is generally most simply defined in a Cartesian coordinate system. The unit of length along the coordinate axes may be arbitrarily selected or it may be expressed in international units such as the meter. In the first case, all lengths are referred to an arbitrary unit of length; in the second they are referred to the absolute standard of the meter. The layout of straight lines does not require the use of absolute units. In the case of large structures, however, where layout is frequently based upon triangulation and very much subject to independent measurements, one must refer to an absolute unit of length.



Direct and indirect measuring methods

A magnitude may be measured directly, for example, length by counting units of length, pressures by comparison with a standard pressure, forces by comparison with other forces. It is also possible to measure a magnitude indirectly by measuring another magnitude which is a function of the magnitude sought. Examples of indirect measurement are amperage measurement by measuring the thermal effect of the current, pressure measurement by measuring the deflection of a metal membrane and length measurement by measuring angles as in triangulation. Many of these indirect methods depend upon constants which are properties of a material. The functional relationship between measured and reported magnitude is always the same and it is, of course, the basis of the design of the measuring instrument. In the case of triangulation this is not true. The relationships depend upon the particular problem involved. An error analysis can not be made once and for all. The analysis must be continually performed anew for each problem by means of the least-square method. Indirect methods for determining the relative location of points are preferable as soon as some fixed bridging distance is exceeded. Direct measurement of distance requires tapes, scales, calipers, extensometers, micrometers, and, in modern technology, electronic devices.

Indirect measurement of distance by angle measuring is not restricted to great distances, but is frequently used for short distances. The advantages of triangulation are very high precision and almost complete independence of obstacles of all kinds. With a precise theodolite it is possible to detect angle differences as small as 0.3″; 0.3″ corresponds to an offset of 1 cm (0.4 inch) at a distance of 6.37 km (4 miles) or an offset of 0.1 mm (0.04 inch) at a distance of 64 m. (210 feet)



The National Astronomy and Ionosphere Center located in Arecibo, Puerto Rico. Managed by Cornell University and sponsored by the National Science Foundation, is the largest Radio Telescope in the world. The antenna was recently upgraded with 38,778 3′ x 7′ aluminum panels. For optimum performance of the antenna the panels had to be accurately aligned. The Kern Mekometer ME 3000 owned by the U.S. Bureau of Reclamation, Sacramento, CA office and its personnel accomplished the measurements with an overall RMS of only 0.44mm (0.02in).

Geodetic methods

Geodetic methods determine the relative position and elevation of individual points. Originally, the method was developed for the location of widely separated points but today it is more frequently used for the location of closely spaced points, especially when very high precision is required or when other methods are unsatisfactory. Direct measurement of angles and distances yields the essential quantities. Each geodetic method has a definite limit of precision. This limit is fixed primarily by the instruments used. However, it is also influenced by climatic conditions. Geodetic methods are very flexible; they place few, if any, requirements on relative position or accessibility of points. The magnitude of the distance that can be bridged has no effect upon the choice of method; the desired precision alone is the controlling factor. No other methods of measurement have as certain an error evaluation as the geodetic methods.

A possible disadvantage of the method lies in the great amount of effort it may require. However, this effort should be considered in light of the fact that the results are based on conditions which have no relationship to the specific problem in point. The results are, therefore, independent and reliable.

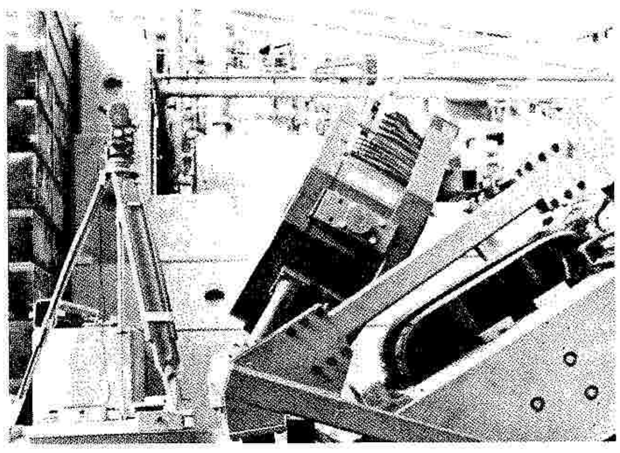
The three coordinates required for spatial location are almost always divided into position coordinates (horizontal coordinates) and elevation (vertical coordinate). Position coordinates are determined principally by triangulation, trilateration, and traverse. Traverse is used when high precision is required in the relative location of neighboring points. Elevation is determined principally by leveling and trigonometric leveling.

Measurements are made in two phases. In the first phase controlling points that are of significance to the entire project, are located. These points are not principal points of the construction itself and their selection is somewhat subordinate to the requirements for the subsequent detail measurement. They may be triangulation points on a structure, fixed points on a machine shaft, starting points in the building site for a tall structure and the like. The skillful selection of these points has a decisive influence on the precision and convenience of all subsequent measurements; points are usually marked by attaching a removable target. In the second phase detail measurements, starting from the previously located points, are made.

Adjustment of a plant

The geometric adjustment of a plant is the principal task of a survey. The adjustment of a plant component may be taken to mean the execution of a movement, in order to bring the component from its actual position into a theoretically required position. The actual position can be determined by geodetic methods. Suitable, easily measurable correction quantitites are then calculated on the basis of the deviations from the required position. The required adjustment can then be made and finally as a control the new actual position is determined, which should agree within the given tolerances with the required position.

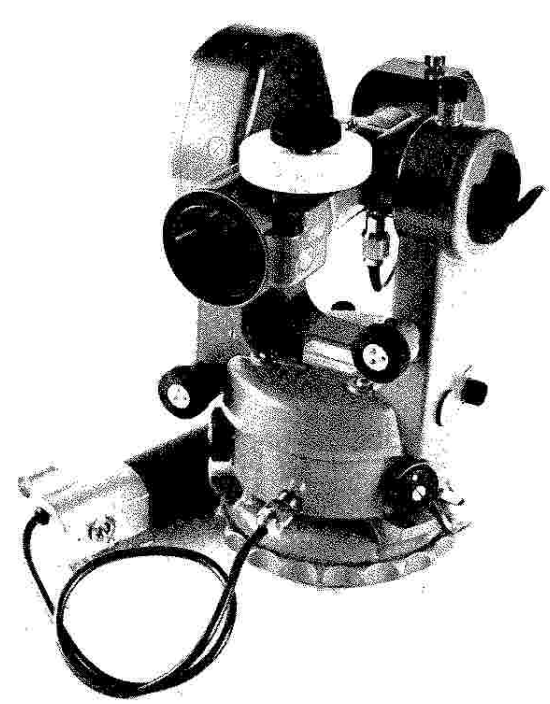
Difficulties often arise over defining in suitable fashion the relative accuracies which are at the heart of any survey problems. One can not expect, in view of possible complex conditions, that anyone will be able to simultaneously solve the accuracy problems of a whole plant by means of a comprehensive error theory.



Measurements of horizontal directions and vertical angles
The DKM2-A theodolite has proven most satisfactory as a measuring instrument. In case of extremely restricted spatial conditions and high accuracy requirements, suitable auxiliary equipment is of great importance.
The problem of the minimum focusing distance can be easily solved with *front lenses*.

Required accuracy of the adjustment

The question of the required accuracy of the adjustment is of great importance, however, it is not always easy to give a satisfactory answer. In many cases, requirements are put forward which are in no way related to the precision of the mechanical devices of principal machinery components or which can not be achieved as a result of insufficient adjustment equipment. Furthermore, the stability of the construction does not always correspond with the accuracy requirements. In view of these difficulties it is to be decided if one has to put up with a reduced accuracy of adjustment.



DKM2-AC Alignment Theodolite with attached micrometer, reading to 0.001 inch. Note counterweight at eyepiece - end of telescope and 3V battery for illumination. Theodolite is mounted on adapter for 3½" x 8 tooling stand.

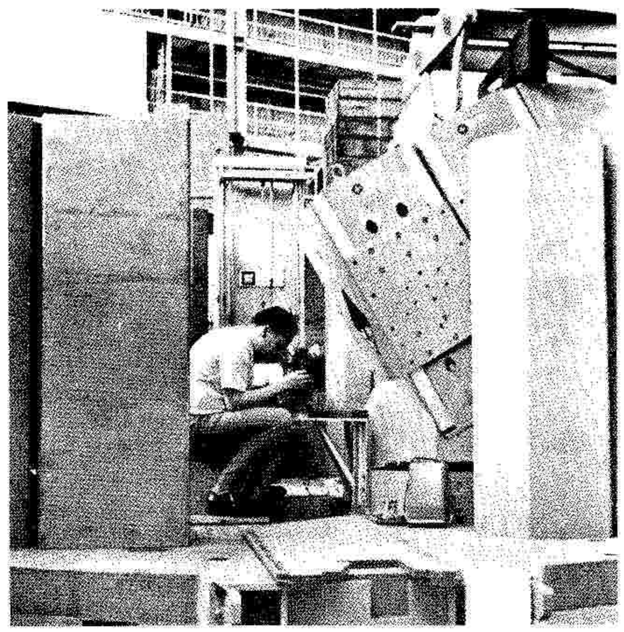
General Principles of the Adjustment of a Plant

A three-dimensional movement has six degrees of freedom which can be selected and defined in suitable fashion.

Definition of the required position

In order to be able to give the required position of a body, agreement is first of all required on the reference elements. The reference elements to be considered are *reference points, reference lines or reference planes.* The theoretical position of a body can then be defined by giving the required position of the reference elements. The reference elements must determine the position of the body sufficiently accurate. The quality of their finish and their mutual position are of great importance. For an adjustment operation a survey is necessary: the selection and position of the reference elements are determined by the available measuring methods. Finally the adjustment can be more simply carried out, if the reference elements are suitably located in relation to the devices used for the adjustment. For these reasons, corners, edges or planes can not be used as reference elements in general. These primary reference elements are replaced by secondary reference targets.

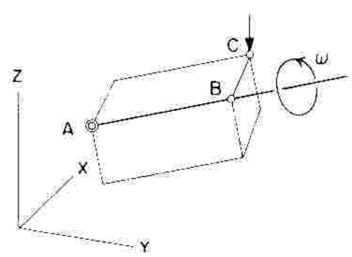
For the definition of the position of a body we require six quantities, the *reference parameters.* When choosing reference elements it is preferable to use quantities which can be easily determined by geodetic means as reference parameters.



Adjustment of quadrupoles. DKM 2-A with front lenses and elbow eyepiece are used.

Considerations of accuracy play an important part in the choice of the reference parameters. Furthermore, it is to be borne in mind that, for example, two points define a vector, for which six parameters are necessary, whereas a straight line is determined merely by four parameters. In practice this presents virtually no difficulty.

Reference element	**Reference parameters**
Point	Coordinates in any desired coordinate system
Straight line (Axis)	(a) *Coordinates* of two points (b) *Coordinates* of one point and azimuth and vertical angle of a direction; with an almost vertical direction both *inclination components* will be used.
Plane	(a) *Coordinates* of three points (b) *Coordinates* of one point and *azimuth* and vertical angle of the surface normal; with an almost horizontal plane both *inclination components* of the surface normal will be used.



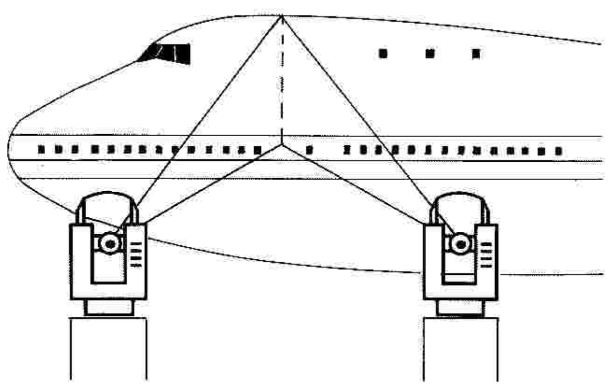
Reference parameters
Point *A:*
coordinates *X, Y, Z*
Straight line *(A, B):*
azimuth *a,*
vertical angle β
Point *C:*
height *Z*

In the case outlined above the selection of 6 reference parameters is desirable: *(AB)* is the longest edge and the differential quotient *dZc/dw* is greater than *dXc/dw* or *dYc/dw.*

Electronic Coordinate Determination System
Kern ECDS-1

Technical advancements in electronic measuring and computing equipment have brought about the development of new, versatile methods for the determination of coordinates. This method makes use of electronic automation to speed up the proven process of triangulation.

Two angles are measured—polar coordinates ϕ to θ from two known control points to a quantity of unknown points; sufficient angular data is collected to determine the coordinates. The process is based on the principle of 3-dimensional triangulation with the theodolites measuring both horizontal and vertical angles thus providing the data for an X, Y and Z coordinate solution.



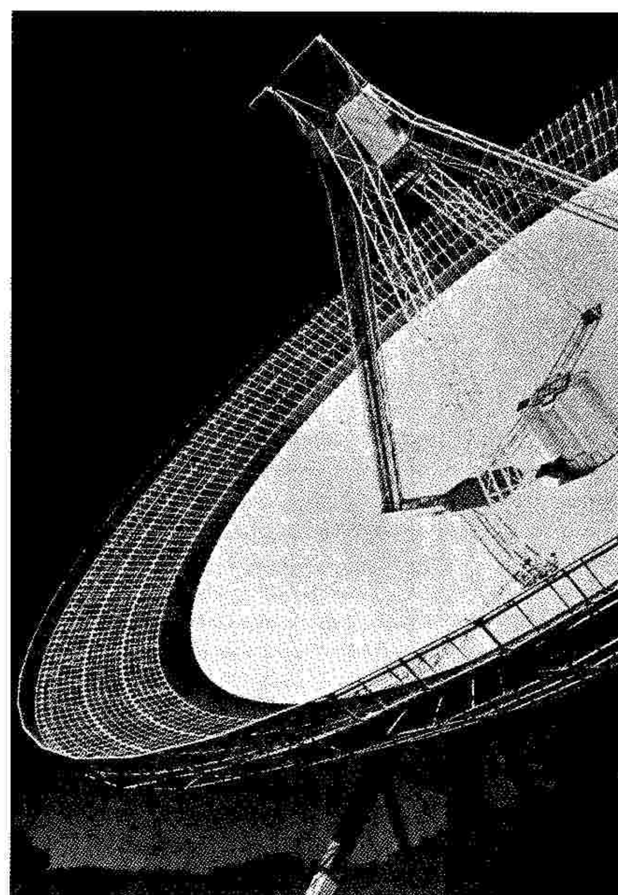
Electronic technology has accelerated speed and accuracy of both the measurement of angles and the subsequent computation.

The Kern Electronic Coordinate Determination System (ECDS-1) uses two model E1 Electronic (Digital) Theodolites as the angle measuring instruments. The measured angles are simultaneously displayed on the theodolite itself in digital form (both horizontal and vertical angles at the same time) in both telescope positions. For instant on the sight computational capability and/or limited data collection, an HP41-C/V pocket computer can be directly connected to any Kern theodolite via the Kern Data Interface DIF 41.
For more extensive data collection on plant locations where direct transmission to the computer may not be feasible because of the absence of AC power, a 48K Data Collector can be used.
Generally angle data measured by the Electronic Theodolite is automatically transferred to the Computational System.

Kern selected the Digital Equipment Corporation's Model VT 103 Computer with the DSD 880 Mass Storage Disc Drive. The system has a low cost Graphics capability. A special Software Package includes all the Programs necessary for display of X, Y and Z coordinates. Other Kern systems-options include a Printer and an Automatic Plotting Table.

The Kern Electronic Coordinate Determination System ECDS-1 combines a number of advantages over conventional methods. Results are nearly instantaneous. The theodolite with its high resolution telescope can be used in conjunction with the same line of accessories used on Kern's standard theodolites. They include auto-collimation, front-focus lenses, micrometers and, for expediting visual target pointing, the theodolite can be equipped with a laser eyepiece.

The compact size of the instrumentation means easy portability to your instrument-problems. The Kern ECDS-1 System is simple to operate and does not require extensive operator training. The modular concept of the system allows you to expand as required.

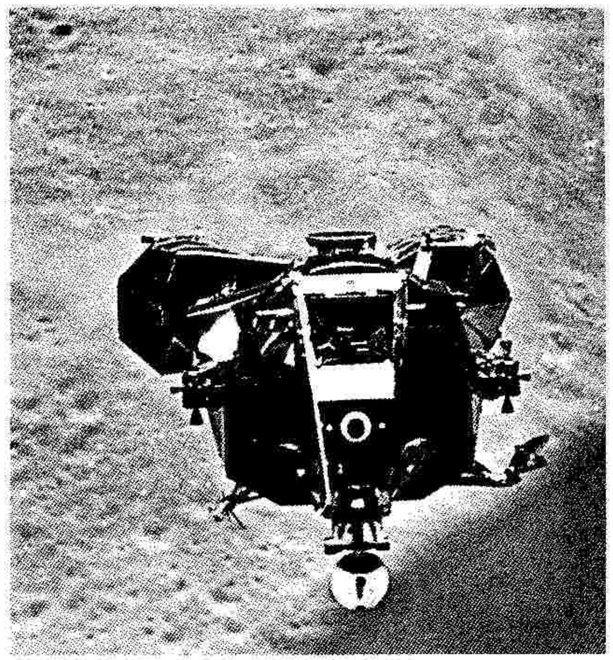


Industrial Measurements with Autocollimation

The use of geodetic instruments outside the field for which they were originally designed is not new. Leveling instruments have been used for many years to set up large machines. In recent years the theodolite and level have been introduced into a wide variety of industries. As the size and complexities of manufactured products or the required precision increased, modern industry found that the customary mechanical measuring instruments no longer met their control and measurement demands.

For many years, Kern instruments have proven to be versatile for optical alignment, inspection and any type of measuring procedures particularly in the aircraft and power industries, in rocket manufacturing, in the construction of cyclotrons and linear accelerators as well as the erection of large machines.

Optical aligment uses two basic principles of optics in addition to standard methods of general surveying. One is the principle of *refraction* of light used in optical micrometers attached to either a level or theodolite. The second principle is the *reflection* of light, utilized to precisely position objects on reference lines, to set out accurate right angles or, to measure deviations. This principle is called *autocollimation*. It is an optical procedure in which the projected image of the cross hair is reflected back upon itself. With the popular Kern "bright-line" system (see Fig. 2), a bright cross is to be alligned with the cross hair.



Kern Lenses were used on several Apollo missions to the moon.

Basically, any ordinary measuring telescope can be used as an autocollimator when it is equipped with an autocollimation eyepiece. As mentioned above, there are two types of autocollimation eyepieces available: one using the "Gauss" system producing a bright "field", the other has a light-dividing cube producing a bright cross (negative reticule).

Fig. 1

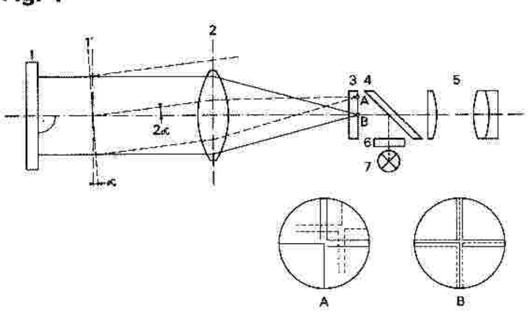


Fig. 2

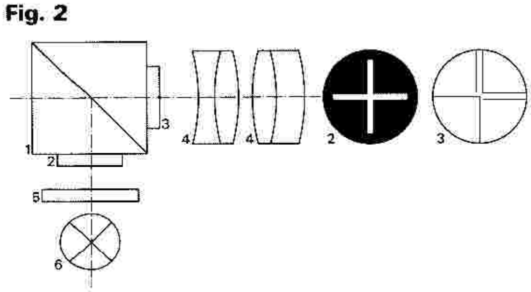


Fig. 1 Autocollimation using the Gauss principle

1 Reflecting plane perpendicular to line of sight
1' Reflecting surface sloping at an angle *a*
2 Telescope objective
3 Reticule
4 Half transparent, half reflective plane plate
5 Eyepiece
6 Color filter
7 Light source
A Direct and reflected reticule patterns not in coincidence
B Direct and reflected reticule patterns in coincidence

Fig. 2 Autocollimation eyepiece with light-dividing cube

1 Beam splitter
2 Light cross (negative reticule)
3 Reticule
4 Eyepiece
5 Color filter
6 Light source

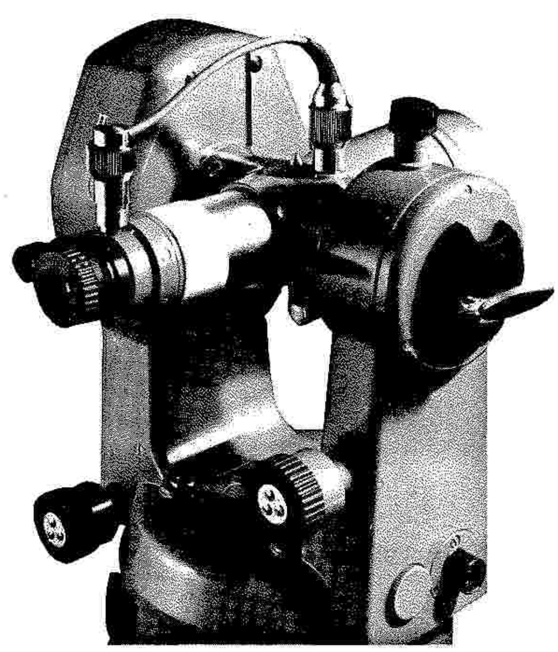
Gauss Autocollimation Eyepiece, bright field (Fig. 1) Kern P/N 356:

This eyepiece can replace the standard telescope eyepiece by simple exchange on Kern theodolites of the following models:
DKM2-A/T and the Electronic Theodolite E1.
It can also be used with the Precise Engineer's Level GK2-A by means of an adapter, the GK 23 series levels and the model OL 48 Optical Precision Plummet by installation.

A Gauss Autocollimation Eyepiece, Kern P/N 357, is also available for the model DKM3 First Order Theodolite.

Autocollimation Eyepiece with Light-dividing Cube, bright line (Fig. 2)

This eyepiece is built-into the instruments. It produces a contrast-rich autocollimation image even at long distances. Coincidence of the reflected illuminated mark and the reticule is established easily and more precisely. The following instruments are available with this eyepiece:



DKM2-AC/T	with inverted telescope image; telescope can be plunged over 360°
DKM2-AEC/T	with erecting telescope image; telescope can be plunged over objective only
DKM2-AMC/T	with erecting telescope image; telescope can be plunged over objective only
E1-C	with erecting telescope image; telescope can be plunged over objective only
DKM 3	with erecting telescope image; telescope can be plunged over 360°
DKM 3-A	with erecting telescope image; telescope can be plunged over 360°

Instruments such as the Kern Universal Theodolite-series DKM2-A, the Electronic Theodolite E1 with digital angle display in lieu of optical readout or, for optimum precision requirements, the models DKM3 and DKM3-A are applied in unlimited numbers of problems related to industrial alignment.

The practical measuring range with autocollimation is in direct relation to the mirror size and quality.

Fields of application in optical tooling range from checking of flatness by means of engineering levels to the most precise horizontal alignment with theodolites. For precise vertical alignment, the Optical Precision Plummet is used. Various accessories increase the versatility of the individual instruments.

Typical Measuring Example with Autocollimation

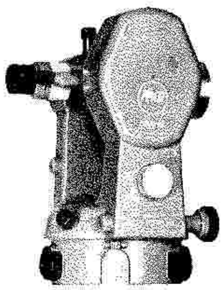
To position an object, the theodolite and target are properly placed to establish the reference line. An autocollimation mirror which must be front-surfaced and optically flat to produce the necessary accuracy is then placed between the theodolite set-up and the original target. When the line of sight of the telescope strikes the mirror, the cross-hairs will be reflected at an angle if the mirror is not perpendicular to the line of sight: angle of incidence must be equal the angle of reflection. The autocollimation mirror placed on the part being positioned must therefore be in direct line *and* perpendicular to the line of sight. In this way the observer looks through the telescope and sees the cross-hairs of the instrument centered on the auto-reflection target.

Geodetic Instruments for Industry
The Kern Modular Instrument System

DKM2-A
Universal One second Theodolite

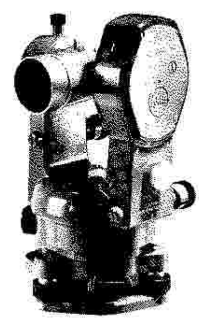
Standard Kern Base with Leveling Cams

High measuring accuracy, simple operation and maximum stability are the design parameters on which the design and manufacture of this instrument are based. High resolution telescope produces a sharp image with maximum contrast. The digital angle readout to 1" of arc virtually eliminates reading errors. The standard theodolite is equipped with a maintenance-free compensator for vertical indexing, therefore ellminating the time-consuming setting of a coincidence level.



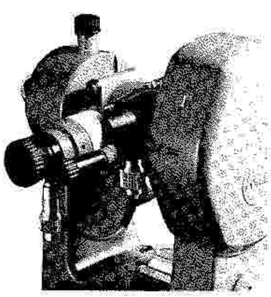
DKM2-AT
Detachable Tribrach Base with Standard Leveling Screws

This instrument is equal to the DKM2-A but is equipped with a detachable tribrach in lieu of the Kern base with a bayonnet-lock attachment and forced-centering to tripod or trivet.
The DKM2-AT variant is therefore interchangeable with other tribrach theodolites with ⅝ x 11" threads.



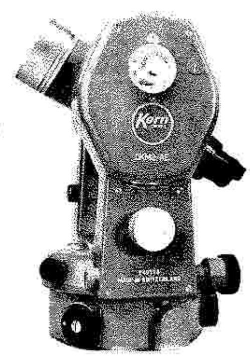
DKM2-A(E)C/T
With Built-in Autocollimation

Autocollimation is an optical procedure in which a projected image of a cross-hair is reflected back upon itself. The technique is advantageously employed when small changes in direction or inclination are to be detected or measured. It is very well suited for precise alignment and for innumerable control problems.



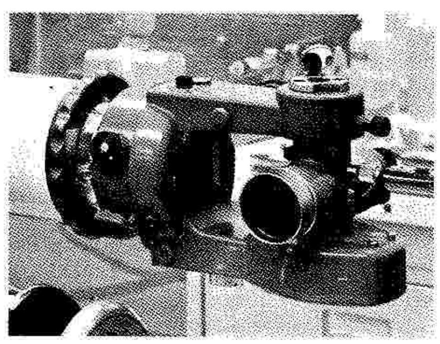
DKM2-AM/T
With Trunnion Axis Micrometer

This instrument is equipped with a trunnion axis micrometer which serves the same purposes as a striding level. It is used to increase the accuracy and reliability of the horizontal directions measured at steep sights. The micrometer permits to measure the inclination component of the instrument-standards in the direction of the trunnion-axis. From these measurements the inclination of the trunnion axis and the correction of the horizontal direction is computed.

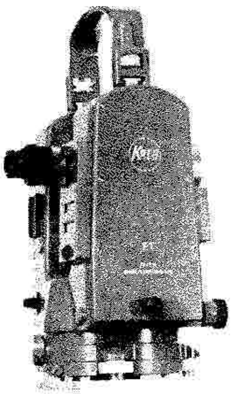


DKM2-A With Preloaded Vertical Axis and Special Trunnion Axis Bearings

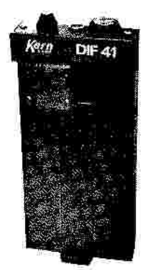
This special version of the DKM2-A Universal theodolite can be used in any instrument position such as tilting or hanging. The standard liquid compensator for vertical indexing is replaced with a first surface mirror. This feature is available on special order only with the standard DKM2-A theodolite.



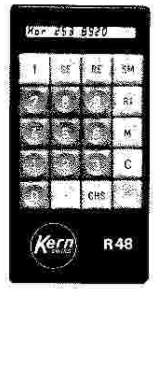
E1/C
Electronic Theodolite
Compact and easy to operate. Clear liquid-crystal display of angles in both telescope positions (if used with electronic distance meter, both horizontal and vertical distances are displayed in Position 1); LCD display can be illuminated. Simple horizontal circle "zeroing" as well as coarse and fine horizontal circle drive. Maintenance-free automatic compensator for vertical circle indexing. Direct readout to 2" of arc in both horizontal and vertical angle positions.
Data can be directly transmitted to the Kern R48 Recording Unit, an HP41C/V Hand Computer by means of the Kern DIF 41 Data Interface or directly to a computer.



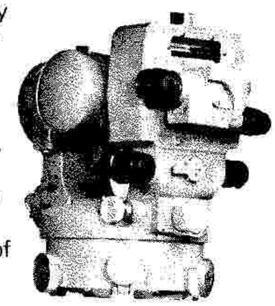
DIF41
Data Interface
Economical Step to Layout Automation.
The DIF 41 Data Interface permits the automatic transmission of measurements from the E1 Electronic Theodolite to a Series HP 41 pocket computer for futher processing and/or data storage. The data interface can also be used in conjunction with conventional Kern theodolites such as the DKM2-A when used with the Kern electronic distance meters.



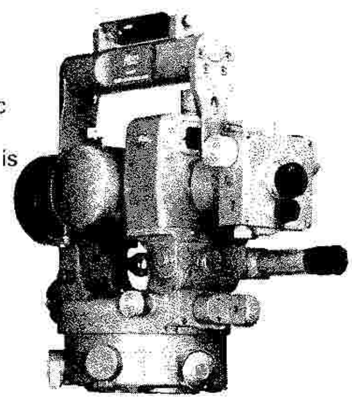
R48
Recording Unit
The R48 is a microprocessor-operated instrument programmed to store geodetic data. A storage program requests the values to be entered. Quantity of data stored can be reviewed at any time. It has a 48K capacity, sufficient to record up to 800 points in polar coordinates. The recording unit can be connected to a computer by means of a V24(RS 232) interface. Special software is available for step-by step data preparation.



DKM3
Triangulation Theodolite
This is the most precise Kern Theodolite. Its mirror-lens telescope produces a completely achromatic image which is very sharp and bright. An auxiliary telescope facilitates pointing. Auxiliary and main telescope make use of the same eyepiece. The DKM 3 meets the highest demands of practice and is also available with built-in autocollimation and a number of standard accessories.

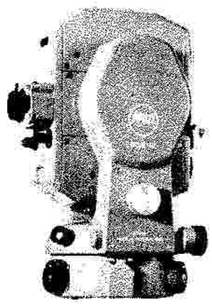


DKM3-A
Triangulation Theodolite
Astronomical Variant
The DKM 3-A is a universal instrument of the highest precision and lends itself advantageously to astro-geodetic observations. Because of its compact design and precision it is extremely suitable in difficult special applications. Autocollimation is also available with this instrument for precise control measurements or the transfer of elevation and azimuth-angles derived from astronomic observations.



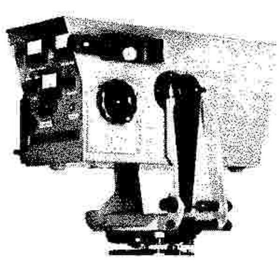
DM502
Electro-optical
Distance Meter

The Kern Modular Instrument System has a distinct advantage: the model DM 502 (or any subsequent models) cannot only be combined with the optical-mechanical Kern instruments including DKM2-A/T, K1-M/T and K1-S/T, but also with the electronic theodolite E1. Because of low weight and compactness, the EDM does not interfer with normal theodolite operation or accuracy. With the meter attached, the telescope is fully transitable. For industrial applications the EDM is especially calibrated to attain a mean accuracy of ± 2mm (0.08 in.)



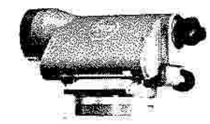
ME3000
Mekometer Electro-optical
High Precision Distance Meter

The internal accuracy of the ME 3000 (Mekometer) is ± 0.2mm + $1 \cdot 10^{-6} \cdot D$. This is obtained by means of the high modulation frequency and the internal electronic frequency-tuning. The optical-mechanical determination of the phase difference is nearly free of instrument errors. Industrial applications include installation and monitoring of machinery and its components. Ideally suited for trilateration networks.



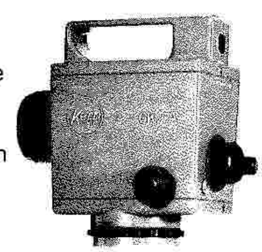
GK23-E/C
Engineer's Level

The GK 23-E/C is a Precise Tilting Level. It has a powerful erecting telescope with excellent image-quality. A bullseye level is used for preliminary leveling. The telescope coincidence level is observed directly through the telescope eyepiece.



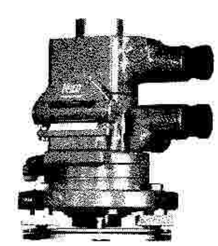
GK2-A/C
Automatic Universal Level

The vertical axis system of both the GK 23-E Tilting-Level and the GK2-A/C Automatic Level consist of a needle bearing possessing stability and strength of resistance attained by no other axis system. The GK2-A/C models are equipped with a proven pendulum compensator with a very high centering accuracy of ± 0.3 seconds.

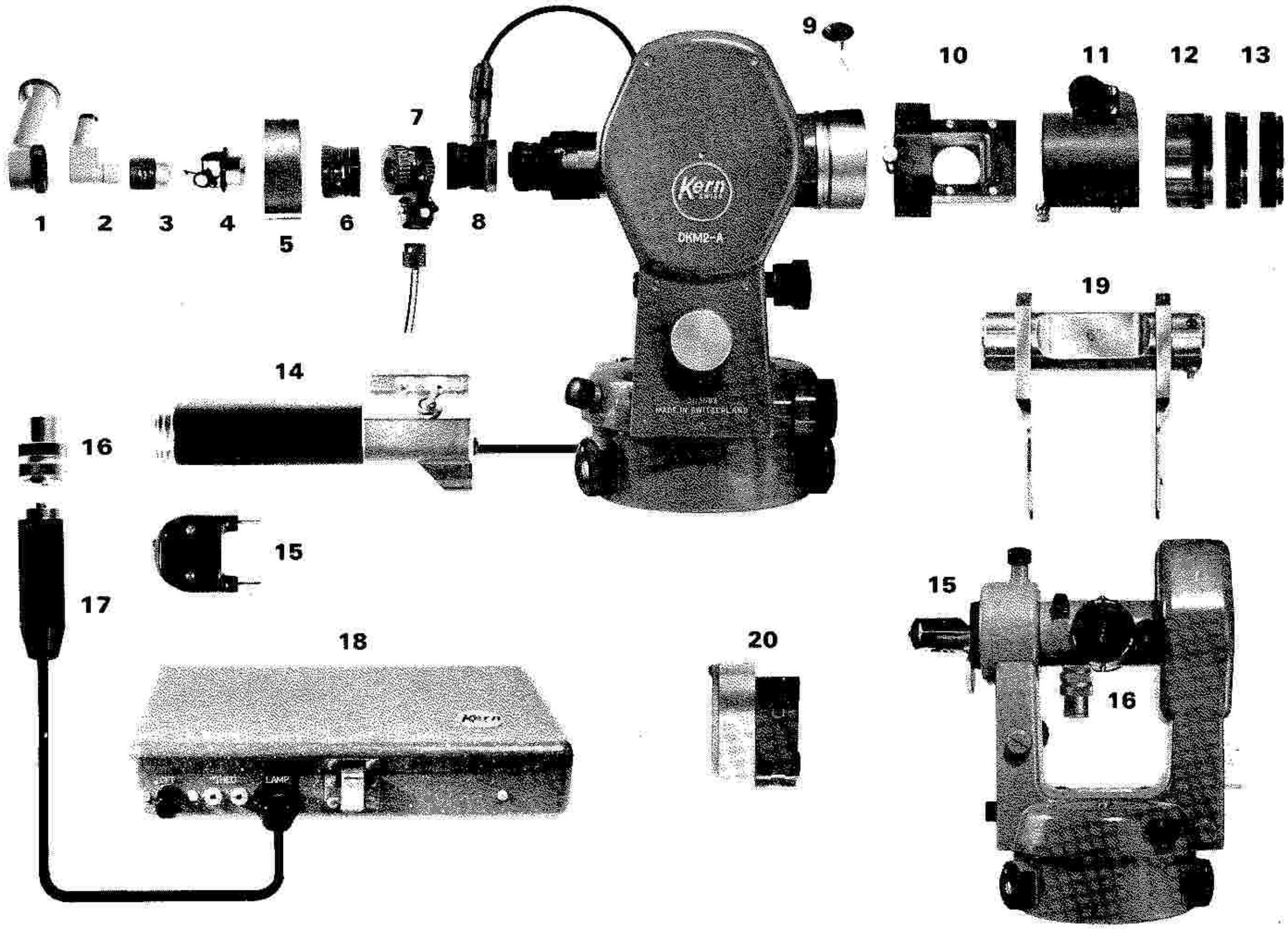


OL
Optical Precision Plummet

Vertical lines can be determined or controlled simply and precisely with the optical precision plummet. The instrument has two separate telescopes which make simultaneous zenith and nadir plumbing possible.
Applications: Vertical alignment or deviation measurements in large machinery, assembly of vertical guide rails on conveyors, elevators, etc.

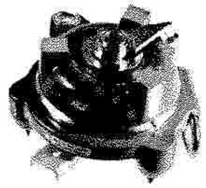


Accessories for Optical Tooling Instruments



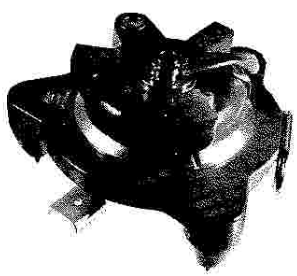
1 115.500.1111 Elbow Eyepiece for Telescope
115.500.1102 Elbow Eyepiece for Telescope
2 115.500.1212 Elbow Eyepiece for Readout
115.803.6408 Case
3 115.500.0100 Eyepiece Prism for Telescope
115.500.0110 Eyepiece Prism for Telescope
4 115.500.0200 Eyepiece Prism for Readout
5 115.532.5013 Counterweight
6 112.746.0137 Exchangeable Eyepiece, 20x
112.746.4050 Exchangeable Eyepiece, 37X
7 115.505.0592 Laser Eyepiece "LO"
115.505.0593 Laser Eyepiece "LO"
115.500.2150 Laser Eyepiece "LO"
8 115.500.2009 Autcollimation Eyepiece, Gauss, bright-field
115.500.2110 Autocollimation Eyepiece 357A, bright-line
115.500.2120 Autocollimation Eyepiece, 357B, bright-line
9 115.505.5005 Reticule Illumination Mirror
10 115.540.5005 90° Pentagonal Prism Attachment*
11 477MI Optical Micrometer, direct 0.001"*
115.501.0000 Optical Micrometer, range 5 mm*
115.501.0010 Optical Micrometer, range 1/100 ft.*
115.501.0100 Optical Micrometer, range 10mm*
115.501.0101 Optical Micrometer, range 5mm*
12 115.501.3100 Front Lens I* 34.2-66.8 in.
13 115.501.3110 Front Lens II* 24.4-35.4 in. (19.6-25.2 in.)†
115.540.4001 Front Lens 8.2-16.7'
115.540.4002 Front Lens 5.6-8.6'
115.501.3201 Front Lens 4.7-8.2'
115.501.3200 Front Lens 2.9-5.2'
14 115.500.1000 Battery Case, 3V
15 115.085.2101 Light Fixture, 3 or 6V (specify)
16 115.505.2152 Light for Handlamp or Plate Level
17 115.570.3095 Handle with Connecting Cable
18 115.505.0012 Battery Box, 3 and 6V.
19 115.502.1103 Striding Level, 5-6"/2mm
115.502.1111 Striding Level, 1.5 - 2.5"/2mm
115.502.1112 Front Lens
115.502.1132 Front Lens
20 115.650.4007 Autocollimation Mirror with magnetic base, parallel and perpendicular to mirror surface. Diameter of mirror is 42 mm (1.65 in.)

*Accessories require counterweight
†Two lenses required



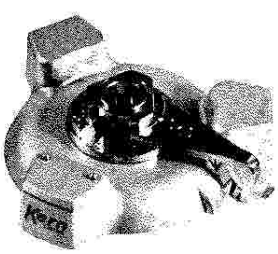
21

115.104.0000 Trivet, 105 mm (4.1 in.) base with centering pin.



22

115.104.0010 Trivet, 158 mm (6.2 in.) base with centering pin.
115.104.0011 Trivet, 158 mm (6.2 in.) base with centering ball and height gauge.
Trivets provide a stable instrument base for work on pillars or brackets.



23

115.085.0000 Centering Plate, 105 mm (4.1 in.)
115.105.0010 Centering Plate, 158 mm (6.2 in.)
Centering Plates are similar to the instrument support plates of the Centering Tripods. The centering plates can be bolted directly to structures.

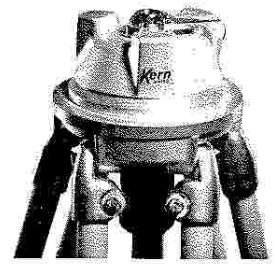
24

112.200.0300 Tribrach, this theodolite-detachable tribrach is supplied with Kern Theodolites DKM2-AT, DKM2-ACT, DKM2-AECT, DKM2-AMT and DKM2-AMCT. This group of Kern theodolites is interchangeable with any tribrach-equipped instrument.

25

A B

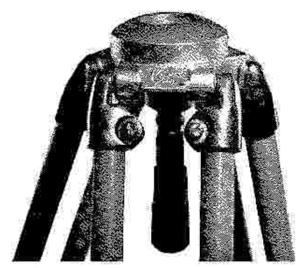
115.361.0004 Bayonnet-lock Insert (A)
112.290.6003 Insert, 5/8" x 11 thread. This combination can be inserted in the standard Kern bayonnet-lock base of the Optical Plummet OL so that instrument attaches to tripod with 5/8" x 11 thread. (B)



26

115.103.1915 Centering Tripod, wood, extension leg.
115.103.1925 Centering Tripod, metal, extension leg.
115.103.3910 Centering Tripod, wood, extension leg, heavy duty
115.103.2920 Centering Tripod for zenith and nadir auto-centering with OL Optical Plummet

With Kern Centering Tripods, standard Kern Theodolites are quickly made ready for operation without plumb-bob or optical plummet. The bullseye level of the centering rod is centered by shifting the tripod head. This centers the instrument over the station point and also levels it roughly. For the precise leveling, only a fractional turn of the leveling cams is required.

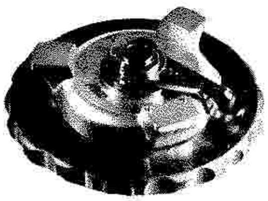


27

115.101.1010 Tripod with spherical head for Kern Levels. This principle requires no foot screws on the instrument and provides a very stable and fast instrument set-up.

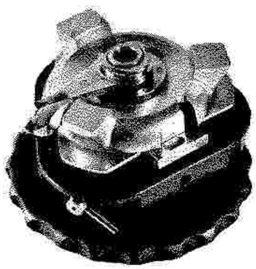
28

112.290.4001 Adapter for Centering Tripod permits placing Kern levels on standard Kern Theodolite tripods.



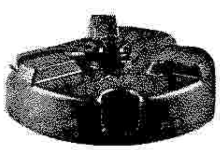
29

193-1214, 105mm
196-1214, 158mm Adapter for standard Kern Theodolites to Tooling Stand with 3½" x 8 thread.



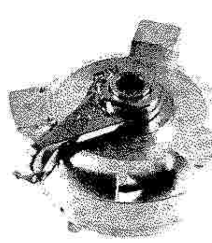
193-1214-181-10, 105mm
196-1214-181-10, 158 mm Adapter for standard Kern Theodolites to Tooling Stand with 3½" x 8 thread. This adapter is required when additional leveling capability is needed.

193-1214S Adapter for preloading of leveling system used for theodolites in hanging or tilting position.



30

115.105.0010 - ⅝ x 11 Adapter for standard Kern Theodolites to Tooling Stand with ⅝" x 11 male thread.



31

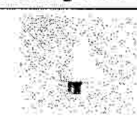
52-193W Adapter with Centering Plate for standard Kern Theodolites adaptable to tribrachs.

32

115.604.2001 Target. This target is suitable for sights from 20m (65 ft.) to 1000m (3280 ft.) in length. The eccentricity of the vertical symmetry-axis with respect to the auto-centering-plug is 0.3-0.4 mm (0.02 in.) The target is available with illumination.

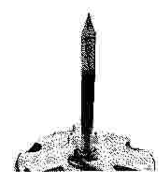
33

115.650.1003 Target for Short Sights. This target is most effective at distances from 4m (13 ft.) to 40m (130 ft.). The eccentricity of the target-circle with respect to the centering axis is about ±0.03 mm (0.001 in.).



34

115.650.3000 Target, small, for very short sights.

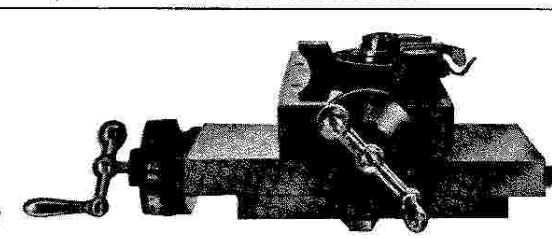


35

115.650.3001 Target, 100mm (4") height.

36

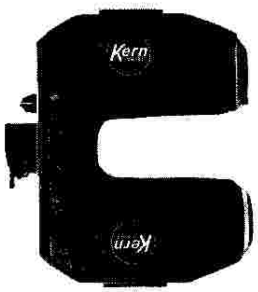
115.650.1040 Target for Plumbing and for coordinate reading. Scales allow for reading a possible offset from station point. Available with illumination.



37

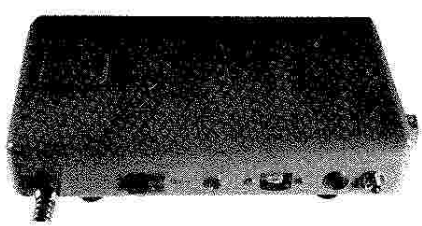
102-45.193.275-128AS Cross-Slide, metric.
102-45.045.193.275-128AS, Cross-Slide, inch
Shifting-range: Y 100mm (3.94 in.) X 90mm (3.54 in.).
Standard adapters include centering-plates for centering tripod and Standard Kern Theodolites.
Specify if other adapters are required.

38 115.302.0117 Invar Rod, 1 meter, 10 mm graduation
115.302.0113 Invar Rod, 1 meter, 5 mm graduation
115.302.0110 Invar Rod, 2 meters, 5mm graduation
Industrial Invar Rods are slender in design and made to facilitate precise leveling in optical tooling. The invar band is held under constant tension by means of a compound lever, compensating for temperature variations. Band and tension mechanism are protected by a casing made of hardened steel. A detachable rod-level is available for plumbing where required.



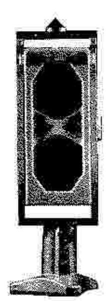
39

118.202.5020 **Electronic Distance Meter** attachable to theodolite-telescope. Measuring Accuracy (calibrated for industry): ±2mm (.08 in.). Measuring Time: ~ 8 seconds. Measuring Range: from min. telescope focusing-range.



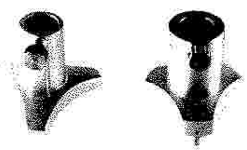
40

118.280.6022 Ni-Cd Battery with built-in charger Out-put 5V Input 110/220 V. AC 10-15V DC. Power Supply for Electronic Distance Meter.



41

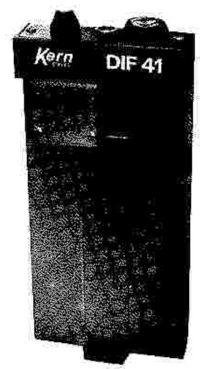
115.604.5017 Reflector, for EDM. Infrared lightbeam of distance-meter is reflected parallel to the direction of incidence.



42

115.604.5018 Base for reflector. Attaches to all Centering-Tripods.

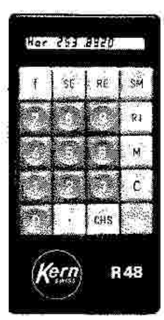
52-102R Base for reflector. Attaches to all detachable tribrachs.



43

115.508.7253 **DIF 41 Data Interface.**
The DIF 41 and series HP 41 pocket computer has many advantages. Among them,

- Fast and reliable execution of any calculations required at the measuring station.
- Reliability with automatic data transmission from electronic theodolite to HP 41 and to computer via V24 (RS 232) Interface.
- Flexibility



44

115.604.8002 **R48 Recording Unit,** complete with connecting cable to Theodolite.
Display: LCD. 15 digits
Built-in Ni-Cd cells provide power for manual operation and data storage.
Data Retention: min. one month
Data Transmission: V24 (RS232 Interface)

Cross-Reference Chart

CODE	ACCESSORY PART NUMBER	ACCESSORY DESCRIPTION	DKM2-A/T	DKM2-AM/T	DKM2-AC/T	DKM2-AEC/T	DKM2-AMC/T	E1	E1-C	DKM3	DKM3-A	GK23-E/C	GK2-A/C	OL
			INSTRUMENT - TYPE											
1	115.500.1111	Elbow Eyepiece, Telescope	●	●				●						
	115.500.1102	Elbow Eyepiece, Telescope								●				
2	115.500.1212	Elbow Eyepiece, Readout	●	●	●	●	●							
	115.803.6408	Case For Elbow Eyepiece Set	●	●	●	●	●	●	●					
3	115.500.0100	Eyepiece Prism, Telescope	●	●	●	●	●	●	●					
	115.500.0110	Eyepiece Prism, Telescope								●				
4	115.500.0200	Eyepiece Prism, Readout	●	●	●	●	●							
5	115.532.5013	Counterweight	●	●	●	●	●	●	●					
6	112.746.0137	Exchangeable Eyepiece 20X	●	●	●	●	●	●	●					
	112.746.4050	Exchangeable Eyepiece 37X											●	
7	115.505.0592	Laser Eyepiece	●	●				●						
	115.505.0593	Laser Eyepiece											●	
	115.500.2150	Laser Eyepiece with Reticule modification												●
	115.500.0512	4mW Laser	●	●				●					●	●
	112.746.2159	Reticule Assembly	●	●				●						
	115.500.2154	Reticule Assembly											●	
	115.505.7912	7Ah Modular Power Supply	●	●				●					●	●
	115.505.7913	10Ah Modular Power Supply	●	●				●					●	●
8	115.505.2009	Autocollimation Eyepiece, Gauss	●	●				●						●
	115.500.2110	Autocollimation Eyepiece, 357A								●				
	115.500.2120	Autocollimation Eyepiece, 357B									●			
9	115.505.5005	Reticule Illumination Mirror	●	●	●	●	●							
10	115.540.5005	90° Pentagonal Prism Attachment	●	●	●	●	●	●	●					
11	477 MI	Optical Micrometer, 0.001"	●	●	●	●	●	●	●			●	●	
	115.501.0000	Optical Micrometer, 5mm	●	●	●	●	●	●	●			●		
	115.501.0010	Optical Micrometer, 1/100 ft.	●	●	●	●	●	●	●			●		
	115.501.0100	Optical Micrometer, 10mm											●	
	115.501.0101	Optical Micrometer, 5 mm											●	
12	115.501.3100	Front Lens I 34.2-66.8 in.	●	●	●	●	●	●	●					
13	115.501.3110	Front Lens II 24.4-35.4 in. (19.6-25.2 in.)	●	●	●	●	●	●	●					
	115.540.4001	Front Lens 8.2-16.7'								●	●			
	115.540.4002	Front Lens 5.6-8.6'								●	●			
	115.501.3201	Front Lens 4.7-8.2'											●	
	115.501.3200	Front Lens 2.9-5.2'											●	
14	115.500.1000	Battery Case 3V	●	●	●	●	●							
15	115.085.2101	Light Fixture	●	●	●	●	●			●	●			
16	115.505.2152	Light For Hand Lamp	●	●	●	●	●			●	●			
	115.505.2152	Light For Alidade Illumination	●	●	●	●	●							
17	115.570.3095	Handle for Hand Lamp	●	●	●	●	●			●	●			
18	115.505.0012	Battery Box, 3 or 6V	●	●	●	●	●			●	●			
19	115.502.1103	Striding Level, 5-6 "/2mm	●		●	●								
	115.502.1111	Striding Level, 1.5-2.5 "/2mm								●				
	115.502.1112	Striding Level, 0.8-1.4 "/2mm								●				
	115.502.1132	Striding Level, 0.8-1.4 "/2mm									●			
20	115.650.4007	Autocollimation Mirror with magnetic base			●	●	●	●	●	●	●			

CODE	ACCESSORY PART NUMBER	ACCESSORY DESCRIPTION	DKM2-A/T	DKM2-AM/T	DKM2-AC/T	DKM2-AEC/T	DKM2-AMC/T	E1	E1-C	DKM3	DKM3-A	GK23-E/C	GK2-A/C	OL
			INSTRUMENT - TYPE											
21	115.104.0000	Trivet	●	●	●	●	●							
22	115.085.0010	Trivet with Centering Ball	●	●	●	●	●	●	●	●	●			
	115.104.0011	Trivet with Centering Pin	●	●	●	●	●	●	●	●	●			
23	115.085.0000	Centering Plate 105mm	●	●	●	●	●							
	115.105.0010	Centering Plate 158mm	●	●	●	●	●	●	●	●	●			
24	112.200.0300	Tribrach	●	●	●	●	●							
25	115.361.0004	Bayonet-lock Insert												●
	112.290.6003	Insert ⅝" x 11												●
26	115.103.1915	Tripod, Centering, Wood	●	●	●	●	●					●	●	●
	115.103.1925	Tripod, Centering, Metal	●	●	●	●	●					●	●	●
	115.103.3910	Tripod, Centering, Heavy Duty	●	●	●	●	●	●	●					
	115.103.2920	Tripod, Centering, Special												●
27	115.101.1010	Tripod, Spherical Head										●	●	
28	112.290.4001	Adapter to Centering Tripod										●	●	
29	193-1214	Adapter to Tooling Stand 3½" x 8 thread	●	●	●	●	●							
	196-1214	Adapter to Tooling Stand 3½" x 8 thread						●	●	●	●			
	193-1214-181-10	Adapter, same as above with leveling capability	●	●	●	●	●							
	196-1214-181-10	Adapter, same as above with leveling capability						●	●	●	●			
	193-1214S	Adapter for preloading of leveling system	○	○	○	○	○							
30	115.105.0010	⅝ x 11 Adapter to Tooling Stand w/⅝" x 11 thread.	■	■	■	■	■	■	■	■	■			
31	52-193W	Adapter for Std. Theod. to Tribrach	●	●	●	●	●	●	●					
32	115.604.2001	Target, large	●	●	●	●	●	●	●	●	●			
33	115.650.1003	Target for short sights	●	●	●	●	●	●	●	●	●			
34	115.650.3000	Target, small	●	●	●	●	●	●	●	●	●			
35	115.650.3001	Target, 100mm	●	●	●	●	●	●	●	●	●			
36	115.650.1040	Target for Plumbing												●
37	102-45.193.275-128AS	Cross Slide, metric	●	●	●	●	●	●	●	●	●			
	102-45.045.193.275-128AS	Cross Slide, inch	●	●	●	●	●	●	●	●	●			
38	115.302.0117	Invar Rod, 1m, 10mm graduation										●	●	
	115.302.0113	Invar Rod, 1m, 5mm graduation										●	●	
	115.320.0110	Invar Rod, 2m, 5mm graduation										●	●	
39	118.202.5020	Electronic Distance Meter, attachable	●	●				●						
40	118.280.6022	Battery with Charger	●	●										
41	115.604.5017	Reflector for EDM	●	●				●						
42	115.604.5018	Base for Reflector, Auto-Cent.-Tripod	●	●				●						
	52-102R	Base for Reflector, Tribrach Tripod	●	●										
43	115.508.7253	DIF41 Data Interface	●	●				●	●					
	115.508.8082	Connecting Cable	●	●				●	●					
	115.508.8084	Connecting Cable, 2m (6.5 ft.)	●	●				●	●					
	115.580.0075	Holder For DIF41	●	●										
	115.505.2106	Light Fixture For DIF41	●	●										
44	115.508.8002	R48 Recording Unit complete						●	●					

○ Available for Theodolites with Preloaded Vertical Axis and Special Trunnion Axis.

■ For Theodolites with Standard Kern Base.

Kern DKM 2-A

Kern Instruments, Inc.
Geneva Road
Brewster, N.Y. 10509
Phone (914) 279 5095
Telex 969624

Kern Instruments
of Canada Ltd.
40 Colonnade Road
Ottawa, Ontario K2E 7J6
Phone (613) 226 1105

Sekundentheodolit mit automatischer Höhenkollimation und aufrechtem Fernrohrbild
DKM 2-AC mit Autokollimationsokular und astronomischem Fernrohr
DKM 2-AM mit Kippachsmikrometer

Kern-Sekundentheodolit mit bisher unerreichtem Bedienungskomfort und reichhaltigstem Zubehör für vielfältigste Anwendung. Erhöhte Genauigkeit der Vertikalwinkelmessung durch wartungsfreien Höhenkreis-Kompensator (Totalreflektion an Flüssigkeitsoberfläche). Digitalisierte Kreisablesung, Seiten- und Höhen-Grobfeintrieb für bequeme, exakte Zielung.

Fernrohrvergrösserung 32 ×
Objektivöffnung 45 mm
Kreisablesung direkt 0,1 mgon/1''
Kreisablesung geschätzt 0,05 mgon/0,1''
Kompensatorbereich ± 40 mgon/2'
Kompensatorgenauigkeit < ± 0,1 mgon/0,3''
Gewicht 6,2 kg

Ausführlicher Prospekt Nr. 141

Théodolite à secondes à collimation automatique et image droite
DKM 2-AC avec oculaire autocollimateur et image invertie
DKM 2-AM avec micromètre pour l'axe horizontal

Théodolite à secondes Kern d'une commodité de manoeuvre inégalée, avec de nombreux accessoires pour de multiples applications. Précision élevée de mesure des angles verticaux par un compensateur du cercle vertical (réflexion totale sur la suface libre d'un fluide). Lecture des cercles chiffrée, commande grossière-fine latérale et verticale pour un pointage commode et précis.

Grossissement de la lunette 32 ×
Ouverture de l'objectif 45 mm
Lecture des cercles:
directe 0,1 mgon/1'',
estimée 0,05 mgon/0,1''
Compensateur:
amplitude ± 40 mgon/2'
précision < ± 0,1 mgon/0,3''
Poids 6,2 kg

Prospectus détaillé no 141

One-second Theodolite with Automatic Collimation and Upright Image
DKM 2-AC with Autocollimating Eyepiece and Inverted Image
DKM 2-AM with Trunnion Axis Micrometer

This one-second theodolite has a convenience in handling that has been unattained heretofore and the widest range of application thanks to numerous accessories. Increased precision of vertical angle measurement due to a maintenance-free vertical circle compensator (total reflection from a liquid surface); digitized circle reading to tens of seconds; and two-speed horizontal and vertical slow-motion drive for convenient and exact pointing.

Telescope magnification 32 ×
Objective aperture 1.8 in (45 mm)
Circle reading, direct 0.1 mgon/1''
Circle reading, by estimation 0.05 mgon/0.1''
Compensator range ± 40 mgon/2'
Compensator precision ± 0.1 mgon/0.3''
Weight 13.7 lb (6,2 kg)

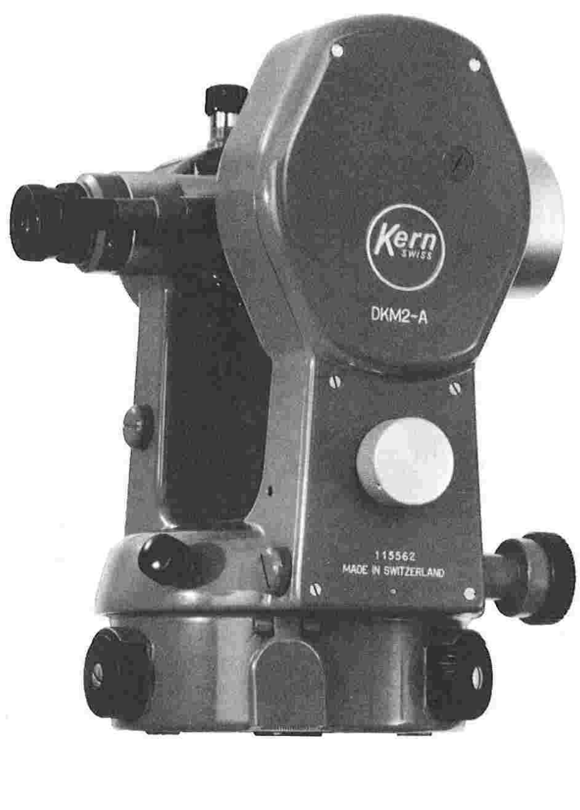
Ask for Prospectus No. 141

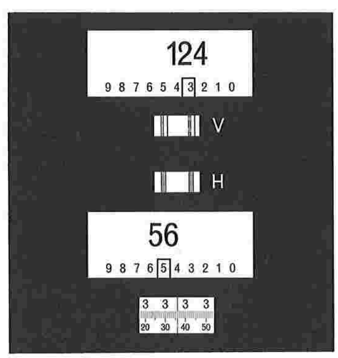
Teodolito de segundos con colimación automática e imagen derecha
DKM 2-AC con ocular de autocolimación e imagen invertida
DKM 2-AM con micrómetro para el eje de basculamiento

Teodolito de segundos Kern, con inigualado confort de manejo y extenso surtido de accesorios. Suma exactitud en la medición de ángulos verticales, gracias al compensador, no necesitando de mantenimiento alguno (reflexión total en la superficie de un liquido). Lectura digitalizada de los limbos. Mando ordinario-fino azimutal y cenital, para un visado cómodo y exacto.

Aumentos del anteojo: 32 ×
Abertura del objetivo: 45 mm
Lectura de los limbos: directa 0,1 mgon/1''
por apreciación 0,05 mgon/0,1''
Compensador: margen de desviación ± 40 mgon/2'
exactitud < ± 0,1 mgon/0,3''
Peso: 6,2 kg

Prospecto detallado No. 141



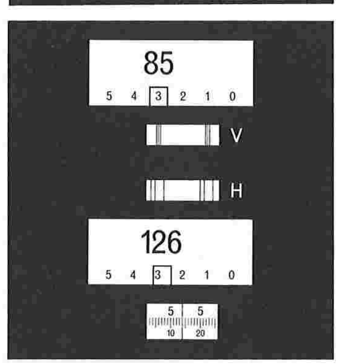


Horizontalkreis 400 gon: 56,5336 gon

Cercle horizontal 400 gon: 56,5336 gon

Horizontal circle 400 gon: 56.5336 gon

Limbo horizontal 400 gon: 56,5336 gon



Vertikalkreis 360°: 85° 35' 14''

Cercle vertical 360°: 85° 35' 14''

Vertical circle 360°: 85° 35' 14''

Limbo vertical 360°: 85° 35' 14''

Kern DKM2-A

Kern SWISS