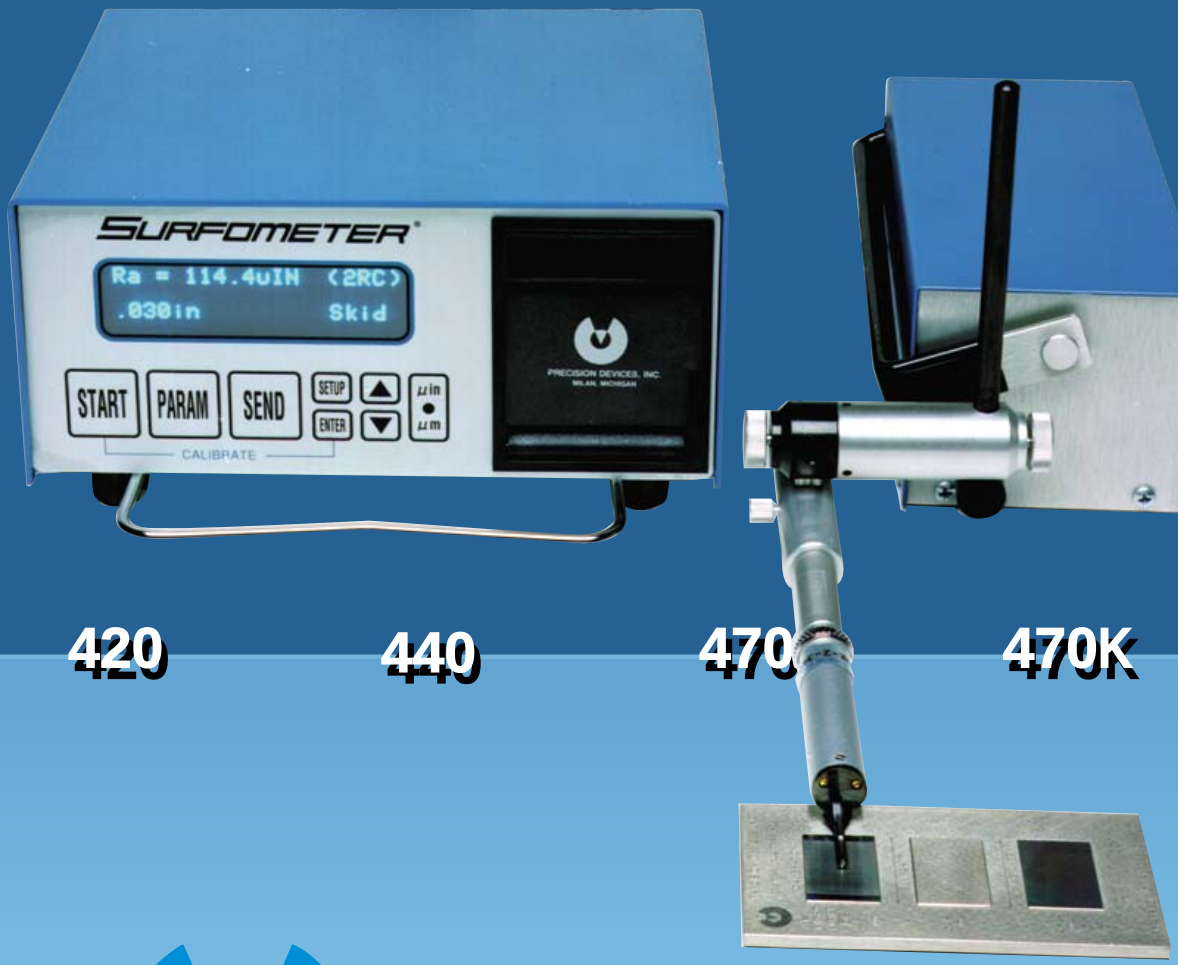
SURFOMETER®

400 SERIES

410 430 460 460K



420 440 470 470K

PRECISION DEVICES, INC.

The 400 series

Always at the forefront of technological development in surface measurement systems, PDI introduces the completely modular Series 400.

All 400 series models utilize the same basic hardware, with model differences determined by the software installed, style of tracer and optional plotter. Starting with a basic Ra (Roughness Average) system, the units may be upgraded for future needs by simply adding parameter modules. Simplicity is also inherent in the operation of the instrument, with prompts to guide the operator as the system gathers data, calculates the results and automatically displays the selected parameter, cutoff and system settings. The vacuum fluorescent display is bright and has a wide viewing angle, making it easy to read from any position.

The Amplifier

The Series 400 Amplifier is a sophisticated yet easy to use instrument with a modular surface texture program.

All models feature a vacuum fluorescent display and sealed membrane keypad. An RS-232 communication port is standard (RS-485 optional), along with a remote start switch port and lockout key switch. Battery power is included on all models with the graphic plotter, and is optional on all other models.

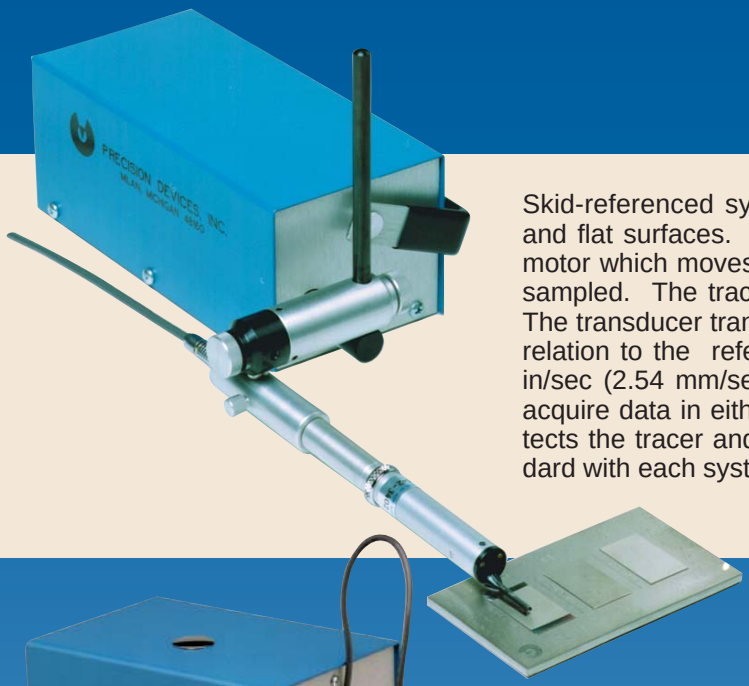
Operation is at once simple, sophisticated and secure. The instrument is configured by an easy-to-use set-up menu. The user selects the proper settings for the cutoff, stroke length, standard 2RC and Gaussian filters (Rk filter optional), parameter functions, serial port and plotter operation. Set the exact stroke length required or use the standard 5-cutoffs. After setting, the programming can be secured by a turn of the lockout key, which prevents inadvertent changes. Once configured, the system operates by pressing the Start Button or through use of an optional remote start switch.

SERIES 400 MODELS

SKID-REFERENCED MODELS	PARAMETERS AVAILABLE	SKIDLESS MODELS
MODEL 410 **Single Parameter Unit**	**Ra (Roughness Average)**	**MODEL 420** **Single Parameter Unit**
MODEL 430 **Multiple Parameter Unit**	**Ra Plus:** **Rq, Rt, Rt (1-5), Rmax, Rp, Rpm, R3z, Pc, Rz, Rz (DIN), Rz (ISO), Rv**	**MODEL 440** **Multiple Parameter Unit**
MODEL 460 **Advanced Parameter Unit**	**All the above, plus:** **tp, Htp, Hsc, Sm, Rsk, & Rku**	**MODEL 470** **Advanced Parameter Unit**
MODEL 460K **Rk Parameter Unit**	**All the above plus:** **Rk, Rpk, Rvk, Mr1, Mr2, Rpk*, Rvk*, Vo, Δa, Δq, λa, λq**	**MODEL 470K** **Rk Parameter Unit**

Piloters/Motor Drives

The Skid-Referenced Piloter

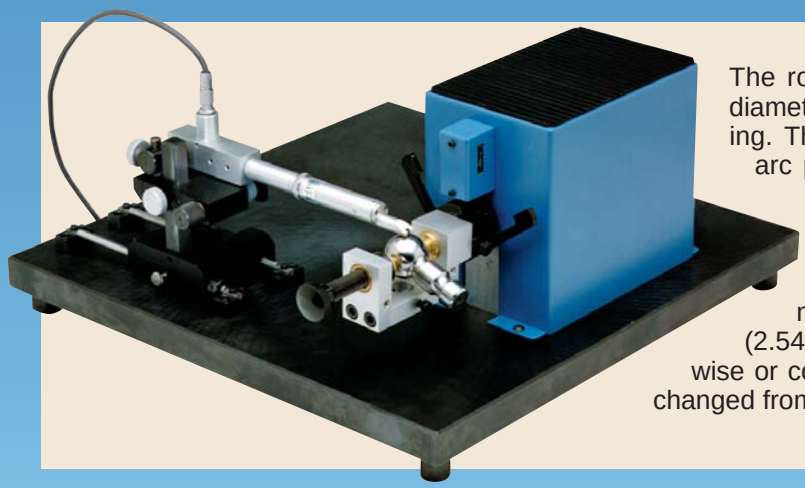


Skid-referenced systems are designed to measure normal I.D., O.D., and flat surfaces. The skid-referenced motor drive (piloter) contains a motor which moves the linkarm with the tracer across the surface to be sampled. The tracers have skidpads which establish a reference line. The transducer translates the vertical motion of the diamond tip stylus in relation to the reference line. The piloter traverses at a speed of 0.1 in/sec (2.54 mm/sec) for the travel length specified and can be set to acquire data in either direction. Our patented Lite-Touch Linkarm protects the tracer and surface from inadvertent damage and comes standard with each system, unless otherwise specified.

The Skidless Piloter

The skidless motor drive has an internal reference in the drive unit. Skidless instruments of the 400 Series are designed to evaluate small, difficult-to-reach areas that are not accessible by skid-type tracers. The motor drive is mounted on a granite base to minimize vibration and to provide a level, stable surface for locating the workpiece. For more precise measurement setup, the stroke length can be set to the proper distance for the surface being measured. This is ideally suited for short stroke requirements such as grooves. This drive may also be programmed to acquire data in either direction.

The Rotary Piloter



The rotary piloter is designed to measure inside and outside diameters of parts such as balls, ball studs, and extruded tubing. The part is rotated across a stationary tracer, through an arc perpendicular to the lay. The drive, with proper tooling, will trace parts with a range from 6.35 mm to 63.5 mm (0.250 in to 2.500 in) inner or outer diameter. The amplifier will automatically adjust the speed of the rotary piloter, based upon the diameter of the measurement area, to attain a constant speed of 0.1 in/sec (2.54 mm/sec). The piloter is able to take readings in clockwise or counterclockwise directions. It is easy to use, and can be changed from one part to another in seconds.

Specifications & Features

AMPLIFIER

Filters	Standard: 2RC and Digital Gaussian; Optional: DIN 4776 (Rk)
Cutoff Values	0.08 mm (0.003 in) 0.25 mm (0.010 in) 0.8 mm (0.030 in) 2.5 mm (0.100 in)
P_C Threshold Values	Adjustable from 0 µm to 12.7 µm (0 µin to 500 µin)
Wavelength Sensitivity	Cutoff to 2.5 µm (100 µin)
Dynamic Range	150 µm (6000 µin) total peak-to-valley max
Display	Digital 2 x 20 character vacuum fluorescent
Keypad	Sealed membrane
Serial Port	Standard: RS-232 Interface; Optional: RS-485 SPC data collection or serial printer modes user selectable Serial Command Protocol for remote computer control, monitoring and data transfer available
Lockout Key Switch	Standard; locks amplifier settings so they cannot be changed
Remote Start Switch Connector	Standard; allows for optional external START switch
Power Supply	Input: 120 ± 5% V AC, 60 hz Output: 12 V DC, 1.2 A Other options available
Temperature Range	Operation: 10° to 32° Celsius (50° to 90° Fahrenheit) Storage: -1° to 43° Celsius (30° to 110° Fahrenheit)
Relative Humidity	10% to 90% non-condensing
Physical Dimensions	220 mm L x 234 mm W x 111 mm H (8 5/8 in L x 9 3/16 in W x 4 3/8 in H (without handle)
Weight	2.16 kg (4 lb 12 oz) 3.52 kg (7 lb 12 oz) with battery 3.86 kg (8 lb 8 oz) with battery and graphic plotter

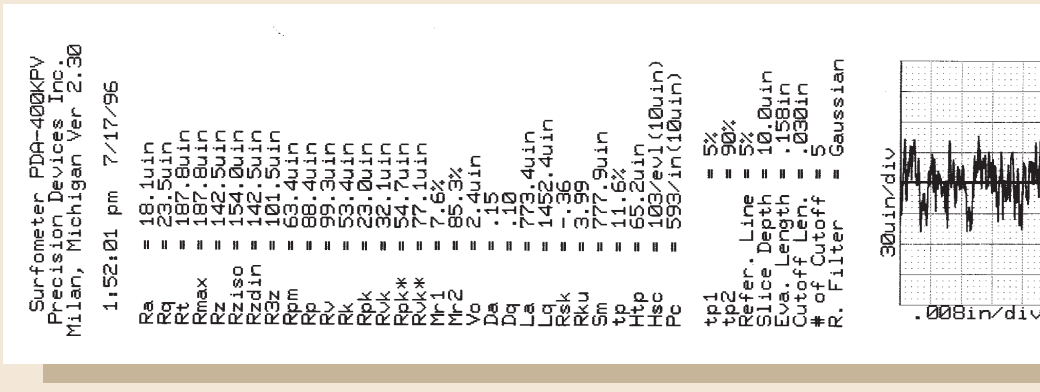
Optional Battery

Battery Type	Sealed gel cell
Battery Life	Over 8 hours of continuous use (including plotting) between overnight charges

Optional Thermal Graphic Plotter

An internal graphic plotter can be added to any of the 400 series amplifiers. The plotter is totally configurable to produce output that is appropriate to the user's needs.

Plotter operation can be disabled, enabled or set for automatic plot. The user may print any combination of setup information, parameter values, roughness profile and Bearing Area Curve (BAC). The roughness profile printout has selectable horizontal and vertical magnification.



Optional Graphic Plotter

Grid size	6 mm x 6 mm (0.24 in x 0.24 in)
Writing Method	Direct Thermal
Resolution	32 dots/mm Y-axis, 8 dots/mm X-axis (800 dots/in Y-axis, 200 dots/in X-axis)
Chart Speed	25 mm/sec (1 in/sec)
Print Width	48 mm (1.89 in)
Paper	5.1 cm x 30.5 m (2 in x 100 ft) roll, thermal graphic

PILOTERS/MOTOR DRIVES

Linear

Stroke Length	Adjustable from 1.27 mm to 12.7 mm (0.05 in to 0.50 in). For evaluation length of five cutoffs, the drive will traverse an additional two cutoffs for all cutoff values
Piloter Speed	2.54 mm/sec (0.1 in/sec)
Set Start Point	Sets the exact START point of the piloter to a selected position
Physical Dimensions	Skid-referenced: 203.2 mm L x 82.5 mm W x 95.3 mm H (8 in L x 3 1/4 in W x 3 3/4 in H) Skidless: 235 mm L x 146 mm W x 121 mm H (9 1/4 in L x 5 3/4 in W x 4 3/4 in H)
Weight	Skid-referenced: 2.1 kg (4 lb 10 oz) Skidless: 4.5 kg (10 lb) without Granite Base 84 kg (185 lb) with Granite Base

Rotary

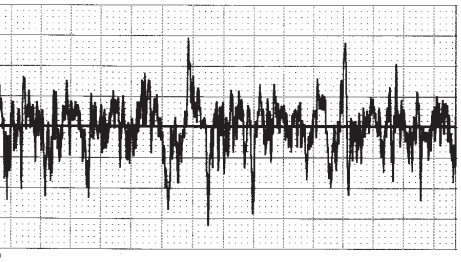
Diameter Range	Standard: 6.35 mm to 63.5 mm (0.250 in to 2.500 in)
Piloter Speed	Automatically set by entering Part Diameter into Amplifier
Set Start Point	Sets the exact START point of the piloter to a selected position
Dimensions & Weight	Based upon part configuration

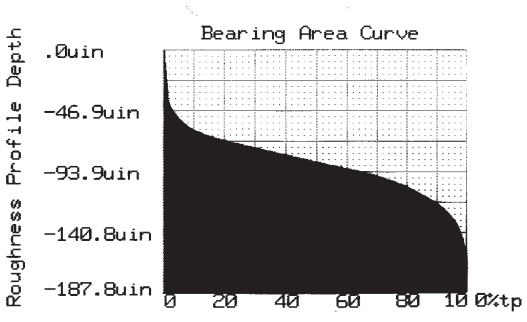
TRACER

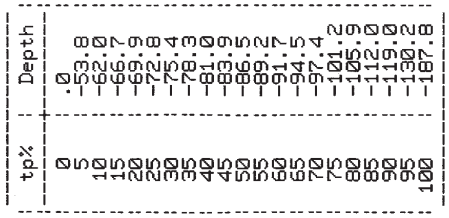
Detection Method	Moving Coil
Stylus Material	Diamond
Stylus Tip Radius	Standard: 10 µm (0.0004 in) Optional: 5 µm (0.0002 in) and 2.5 µm (0.0001 in)
Stylus Force	0.016 N (1.6 gf) or less

PRECISION REFERENCE STANDARD

3-Patch Master	Consists of Calibration, Linearity and Diamond Stylus Condition Patches traceable to N.I.S.T.







Surface Roughness Terminology & Parameters

Terminology

Sampling Length, ***l,*** is the nominal wavelength used for separating roughness and waviness. Also known as Cutoff Length or Cutoff.

Evaluation Length, ***L,*** is the length over which the values of surface parameters are evaluated. It is recommended that the evaluation length consist of five sampling lengths although it may comprise any number of sampling lengths. Also known as Assessment Length.

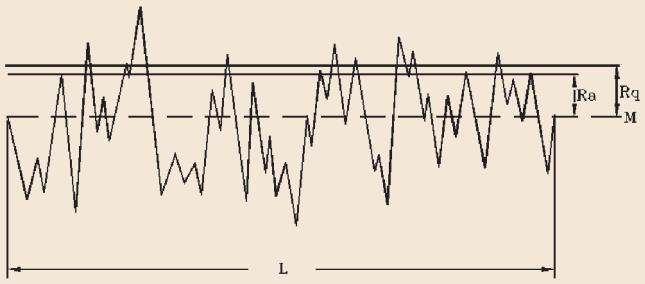
Mean Line, ***M,*** is the reference line about which the profile deviations are measured. The mean line of the roughness profile is usually established by analog or digital filters with the selected cutoff corresponding to the roughness sampling length.

Profile Peak is the point of maximum height on a portion of a profile that lies above the mean line and between two intersections of the profile with the mean line.

Profile Valley is the point of maximum depth on a portion of a profile that lies below the mean line and between two intersections of the profile with the mean line.

P**rofile Irregularity** is a profile peak and the adjacent profile valley.

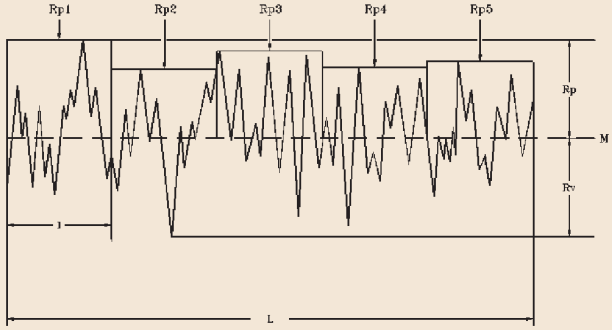
Ra, Rq



Roughness Average, ***Ra,*** is the arithmetic average of the absolute values of the profile heights over the evaluation length.

RMS Roughness, ***Rq,*** is the root mean square average of the profile heights over the evaluation length.

Rp, Rpm, Rv

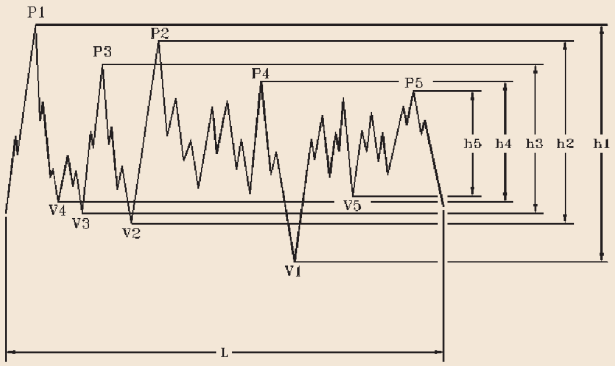


Maximum Profile Peak Height, ***Rp,*** the distance between the highest point of the profile and the mean line within the evaluation length.

Average Maximum Profile Peak Height, ***Rpm,*** is the average of the successive values of Rpi calculated over the evaluation length.

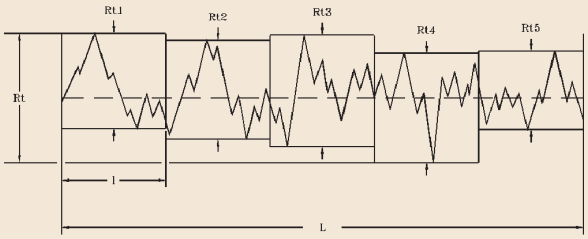
Maximum Profile Valley Depth, ***Rv,*** is the distance between the deepest valley of the profile and the mean line within the evaluation length.

Rz(ISO)



Ten Point Height of Irregularities, ***Rz(ISO),*** is the average value of the absolute values of the heights of five highest profile peaks and the depths of five deepest profile valleys within the evaluation length.

Rt, Rti, Rz, Rz(DIN), Rmax



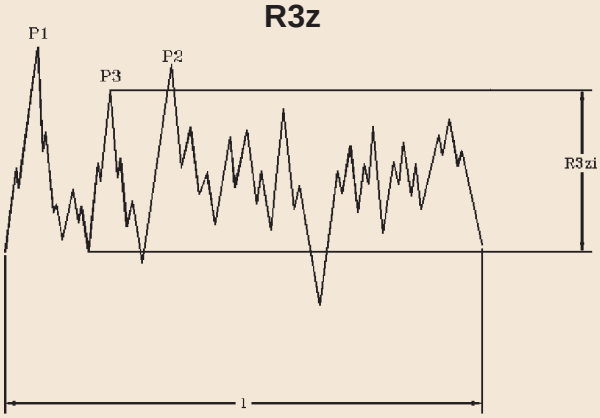
Maximum Height of the Profile, ***Rt,*** the vertical distance between the highest and lowest points of the profile within the evaluation length.

Maximum Height within a Sampling Length, ***Rti,*** the vertical distance between the highest and lowest points of the profile within a sampling length.

Average Maximum Height of the Profile, ***Rz,*** is the average of the successive values of Rti calculated over the evaluation length. This parameter is the same as Rz(DIN) when there are five sampling lengths within the evaluation length.

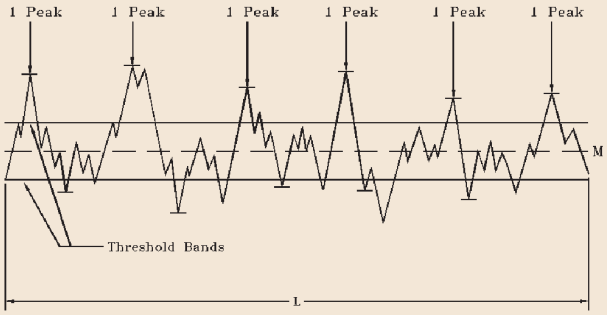
Maximum Roughness Depth, ***Rmax,*** is the largest of the successive values of Rti calculated over the evaluation length.

R3z



Third Maximum Peak-To-Valley Height, ***R3z,*** is the mean of the third maximum peak-to-valley heights in the evaluation length.

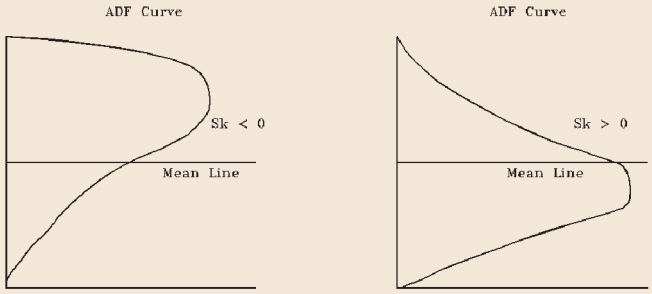
Pc



Peak Density, ***Pc,*** is the number of SAE peaks per unit length measured at a specified peak count level.

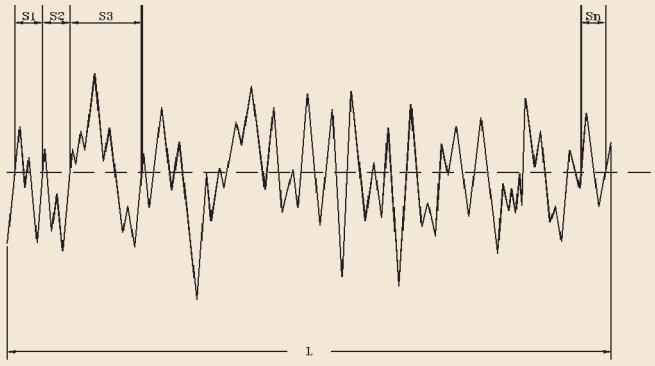
Note: An SAE peak (ANSI/ASME B46.1.1-1995) is a profile irregularity wherein the profile intersects consecutively a lower and upper boundary line.

Rsk



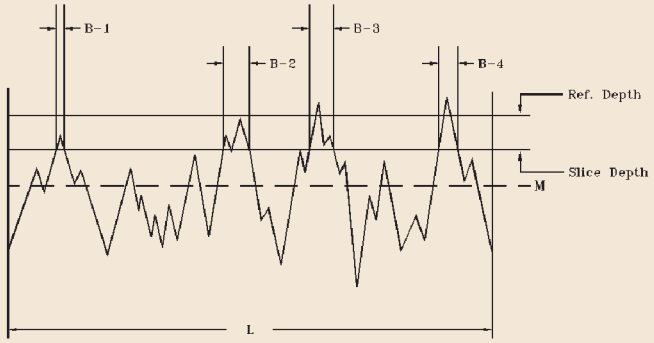
Skewness, ***Rsk,*** is a measure of the asymmetry of the profile about the mean line. A negative skewness indicates that a greater percentage of the profile is above the mean line and a positive value indicates that a greater percentage is below the mean line.

Sm



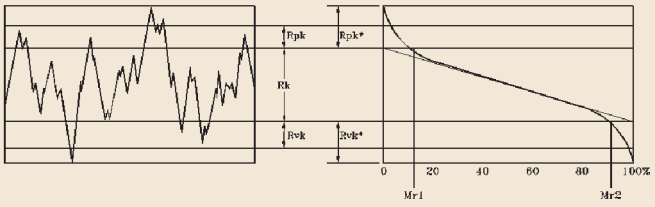
Mean Spacing of Profile Irregularities, ***Sm,*** is the mean value of the spacing between profile irregularities within the evaluation length.

tp



Profile Bearing Length Ratio, ***tp,*** the ratio of the profile bearing length to the evaluation length at a specified level.

Rk, Rpk, Rvk, Mr1, Mr2, Rpk*, Rvk*, Vo



Core Roughness, ***Rk,*** is the core height of the profile along the Y-axis of the BAC curve generated by placing a 40% line on the curve at the minimum slope point and extending the lines to the 0% and 100% points.

Reduced Peak Height, ***Rpk,*** is the height on the Y-axis of a triangle with the same area as the BAC curve from the 0% point to the Mr1 point.

Reduced Valley Depth, ***Rvk,*** is the height on the Y-axis of a triangle with the same area as the BAC curve from the Mr2 point to the 100% point.

Peak Height, ***Rpk*,*** is the distance between the highest profile peak and the intersection line of the surface ratio Mr1.

Valley Depth, ***Rvk*,*** is the distance between the intersection line of the surface ratio Mr2 and the deepest valley.

Retention Volume, ***Vo,*** is the area between the material ratio curve and the 100% material line below the core roughness.

Additional Parameters

Kurtosis, ***Rku,*** is a measure of the peakedness of the profile about the mean line.

Average Absolute Slope, ***Δa,*** is the arithmetic average of the absolute value of the rate of change of the profile height calculated over the evaluation length.

RMS Slope, ***Δq,*** is the root mean square average of the rate of change of the profile height calculated over the evaluation length.

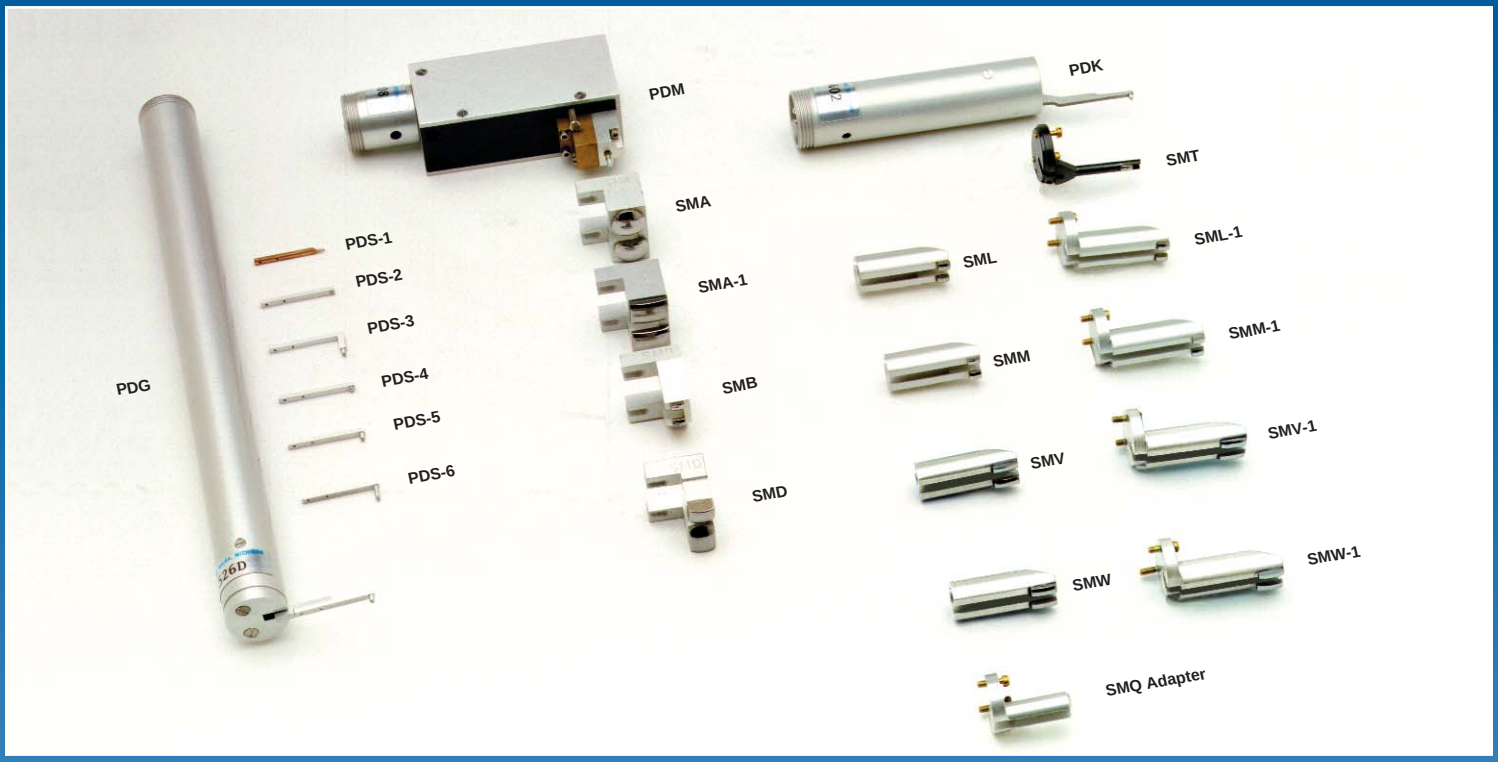
Average Wavelength, ***λa,*** is the average wavelength of the surface profile.

RMS Profile Wavelength, ***λq,*** is the RMS value of the profile wavelength.

Height Difference of Bearing Length Ratios, ***Htp,*** is the height difference between two points on the bearing ratio curve set at specified levels of tp, tp1 and tp2.

Terminology and Parameter Definitions are based upon the American Standard ASME B46.1-1995 for Surface Texture and the German Standard DIN 4776 for the Rk group of parameters.

Accessories



SKID-REFERENCED TRACERS

PDK
The versatile PDK tracer, with the single SMT skidmount, can measure a 1/8 in. I.D. and O.D. to flat surfaces. The PDK has a series of standard, interchangeable double skidmounts available for most surface texture requirements.

PDM
Rugged and durable, the PDM style tracer provides accurate reading throughout the surface texture measurement range. From super-fine to high micro finished, the PDM tracer offers the reliability for critical surface evaluation. Standard skidmounts permit measurements on outside diameters as small as 1/8 in to inside diameters from 1 13/16 in to flat surfaces.

SKIDLESS TRACER

PDG
The PDG tracer does not use skids, but has various standard stylus assemblies that mount onto the tracer beam.

Other standard tracers and accessories are available based upon specific applications. If a standard product does not meet your exact need, Precision Devices, Inc. will design and build a tracer or stylus assembly that will satisfy your requirements.

STANDARD SKIDMOUNTS

For PDK Tracers

SMT	3.2 mm (1/8 in) I.D. and O.D. to flat
SML	12.7 mm (1/2 in) I.D. to flat
SMM	9.5 mm (3/8 in) O.D. to flat
SMV	12.7 mm (1/2 in) I.D. to flat for 2.54 mm (0.100 in) cutoff
SMW	9.5 mm (1/2 in) O.D. to flat for 2.54 mm (0.100 in) cutoff
SMQ Adapter	Required for SML, SMM, SMV, and SMW skidmounts
SML-1	12.7 mm (1/2 in) I.D. to flat*
SMM-1	9.5 mm (3/8 in) O.D. to flat*
SMV-1	12.7 mm (1/2 in) I.D. to flat for 2.54 mm (0.100 in) cutoff*
SMW-1	9.5 mm (3/8 in) O.D. to flat for 2.54 mm (0.100 in) cutoff*

*No adapter

For PDM Tracers

SMA	19 mm (3/4 in) O.D. and 46 mm (1 13/16 in) I.D. to flat
SMB	9.5 mm (3/8 in) O.D. to flat
SMD	3.2 mm (1/8 in) to 12.7 mm (1/2 in) O.D. only
SME	19 mm (3/4 in) O.D. to flat, for sideways tracing
SMA-1	19 mm (3/4 in) O.D. and 46 mm (1 13/16 in) I.D. to flat for 2.54 mm (0.100 in) cutoff and 7.62 mm (0.300 in) cutoffs
SMB-1	9.5 mm (3/8 in) O.D. to flat for 2.54 mm (0.100 in) cutoff

STYLUS ASSEMBLIES

For PDG Tracers

PDS-1	Diamond depth 0.05 mm (0.002 in)
PDS-2	Diamond depth 0.5 mm (0.020 in)
PDS-3	Diamond depth 6.5 mm (0.260 in)
PDS-4	Diamond depth 1.2 mm (0.050 in)
PDS-5	Diamond depth 2.2 mm (0.090 in)
PDS-6	Diamond depth 4.5 mm (0.177 in)

LINKARMS, EXTENSIONS

Standard and special linkarms and linkarm extensions are also available. Contact your Precision Devices representative for additional information.

PD400-6M-398

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