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221-37

Surtronic 3

Operators Handbook

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SPECIFICATION

Display–traverse unit

Measuring ranges:	0–9·99 and 0–25 µm Ra 0–999 µin Ra
Cut-off values:	0·25, 0·8, 2·5 mm (0·01, 0·03, 0·1 in) 0·8 mm (0·03 in) over the full 25 mm (0·98 in) traverse (or, to special order, over a 1·75 mm (0·07 in) traverse)
Standard traverse lengths:	Nominally 5× selected cut-off + 0·5 mm i.e. 1·75, 4·5, 13 mm (0·07, 0·18, 0·52 in) and 25 mm (0·98 in) full traverse
Traverse speeds:	1 mm/s for Ra measurement 0·25 mm/s for recording (0·04 and 0·01 in/sec)
Readout:	Digital; liquid crystal display
Height of digits:	Approx. 6·5 mm (0·25 in)
Display	Three digits, decimal point, error sign ("E"), and measuring sign (- - -)
Output for recording:	10 mV/µm on 99·9 µm range 100 mV/µm on 9·99 µm range 1 mV/µin on 999 µin range Minimum load impedance for recorder output: 10 kΩ
Overall accuracy of Ra measurement:*	± 2% of reading ± 1 unit in the least significant decade.
Accuracy of reference specimen:	Within 4% of marked value
Ambient conditions for operation within the accuracy stated above:	
Temperature:	+5 to +40°C
Humidity:	0 to 99% r.h.

* This accuracy value excludes any uncertainty in the reference standard, and applies only when the correct cut-off and skid for the surface being measured are used.

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Dimensions (H × W × D):	80 × 135 × 80 mm (3·1 × 5·3 × 3·1 in)
Weight:	Less than 1 kg
Power supply:	Rechargeable battery 9V
Battery capacity:	See section 9.3
Charger:	105-250V, 50-60 Hz a.c.

Pick-ups

Type:	Variable reluctance
Stylus material:	Diamond
Stylus tip radius:	5 µm (200 µin) except 112/1503 which is 10 µm ±2·5 µm (400 µin ± 100 µin)
Stylus force:	3 mN (300 mgf)
Range of stylus movement:	0·5 mm (0·02 in) minimum
Dynamic range:	400 µm peak-to-peak
Skid force:	
In standard holder:	50 mN (5 gf)
In biased holder:	
Downwards:	270 mN (27 gf)
Inverted:	170 mN (17 gf)
Vertical:	225 mN (22·5 gf)

Note - These values are approximate and will be different if the extension rod is used

Dimensions:	See Table 2
Effective length of extension rod:	184 mm (7·2 in)

Recorder (optional accessory)

Vertical magnifications, Vv:	×100, ×200, ×500, ×1000, ×2000, ×5000, ×10 000
Horizontal magnifications Vh:	×20, ×100
Chart speeds:	5 and 25 mm/s (0·2 and 1·0 in/s)
Chart width:	50 mm or 2 in
Chart length:	45 m (150 ft)
Linearity:	± 1·5%
Recording method:	Heated stylus
Accuracy of horizontal magnifications within:	± 4% at 25°C or ±9% over the temperature range +5 to +40°C
Overall stylus-to-recorder accuracy within:	3% of full scale deflection
Power supply voltage:	Either 210-250V, 50 Hz or 105-125V, 60 Hz, as ordered
Consumption:	25W approx.
Ambient operating temperature:	0-50°C

Stand (optional accessory)

Base dimensions:	535 × 255 × 60 mm (21·0 × 10·0 × 2·4 in)
Surface plate area:	380 × 255 mm (15·0 × 10·0 in)
Overall height:	465 mm (18·3 in)
Range of vertical adjustment:	320 mm (12·6 in)
Range of longitudinal adjustment:	100 mm (3·9 in)
Rotational range:	360°
Tee slot dimensions:	See Figure 40

Parameter unit (optional accessory)

Parameters:	Rp, Rpm, Rt, Rtm, Pc, tp
Range of measurement:	
Rp, Rpm, Rt, Rtm:	0 – 199·9 or 0 – 19·99 µm 0 – 1999 µin
Pc:	0 – 1999 per inch
Peak-to-peak bandwidth:	0 – 199·9 or 0 – 19·99 µm 0 – 1999 µin
tp:	0 – 100%
Depth:	0 – 199·9 or 19·99 µm 0 – 1999 µin
Cut-off and traverse lengths:	As display–traverse unit
Accuracy:	
Rp, Rpm, Rt, Rtm, tp:	Within ±2% of reading ±1 least significant digit
Pc:	Depends on traverse length, but for 25 mm traverse it is within ±1 least significant digit
Power supply:	From the display-traverse unit
Consumption:	See section 9.3
Dimensions:	80 × 135 × 80 mm
Weight:	0·6 kg

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1 — INTRODUCTION

1.1 WHAT IS SURFACE ROUGHNESS MEASUREMENT

Before reading the description of the instrument the user should understand what it is for and what it measures.
A surface which is nominally flat and smooth thus



may be afflicted with waviness thus



In any case it can never be perfectly smooth and will always have some roughness texture



which may vary from fine to coarse according to the finishing process used.

Some surfaces may exhibit both roughness and waviness like that shown in Figure 1.

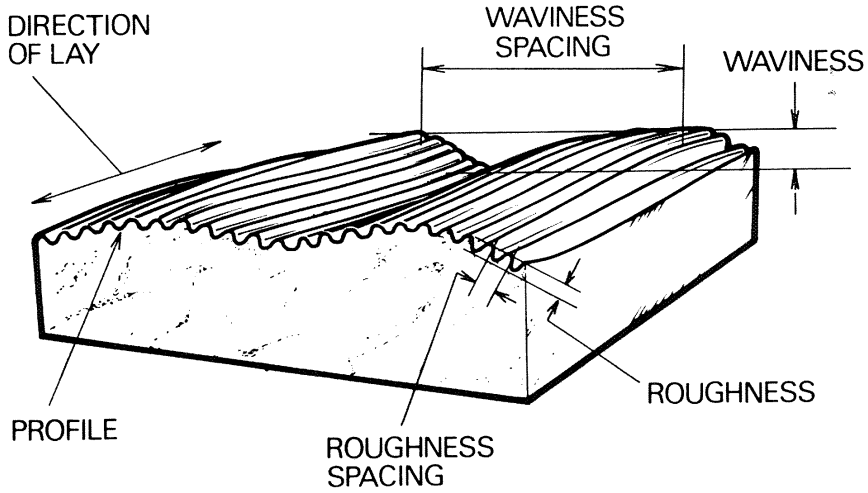
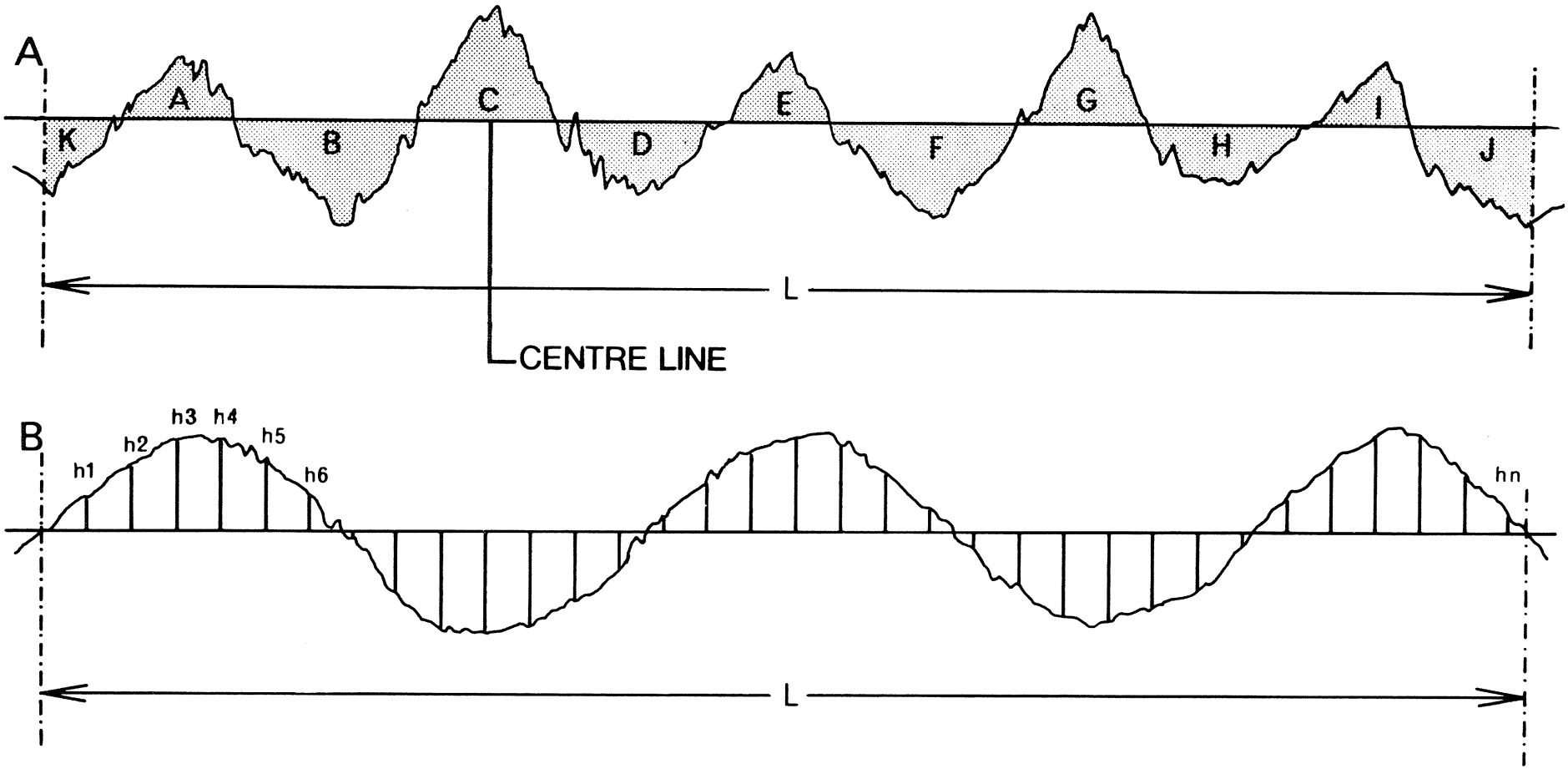


Figure 1 Surface characteristics

Surtronic 3 provides a numerical assessment of the roughness (but not the waviness or curvature) by what is known as the Ra (Roughness average) method. Six more parameters can be measured by the addition of the optional parameter module described in section 7.
The Ra height of the roughness irregularities on a surface is defined as the average value of the departures from its centre line, throughout a prescribed sampling length. This is illustrated in Figure 2A.
Over a length of surface L, the centre line is a line drawn such that the sum of the areas embraced by the surface profile above the line is equal to the sum of those below the line. In the illustration
areas A + C + E + G + I = areas B + D + F + H + J + K



$$R_a = \frac{h1+h2+h3---hn}{L}$$

Where h is the height of the profile above or below the centre line at points at unit distances apart.

L Units=Sampling length.

Figure 2 Derivation of R_a.

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The Ra value of the surface is then the average height of the profile above and below this centre line (Figure 2B).
The profile can be recorded by means of the optional recorder although the waviness may be attenuated due to the use of the skid on the pick-up.

1.2 CUT-OFF

Surtronic 3 measures the surface irregularities due to roughness and is made unresponsive to the more widely-spaced irregularities caused by waviness or curvature. Even in the roughness range the spacing of the irregularities varies. For example a surface may, depending on the method of finishing, have a profile like this



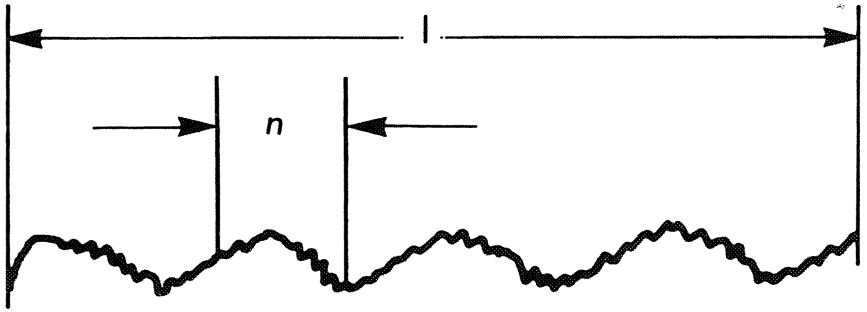
or like this.



or like this



Some surfaces may exhibit both the closely spaced and widely spaced roughness irregularities, thus



On a surface like this, sampled over a length *l* the Ra value would be largely determined by the more prominent wider spaced irregularities. If, as is often the case, it is desired to measure the Ra value of the closely spaced irregularities, it is necessary to shorten the sampling length to *n* for example. This is called the cut-off length, further details of which are given in section 4.3. The cut-off length must not be confused with the traverse length, which is the length of surface examined by the instrument. Within the three standard shorter traverse lengths of Surtronic 3 there are five cut-off lengths, which are used to establish the Ra value.

1.3 BRIEF DESCRIPTION

Surtronic 3 (Figure 3) comprises two parts: the battery-operated display-traverse unit and the pick-up.

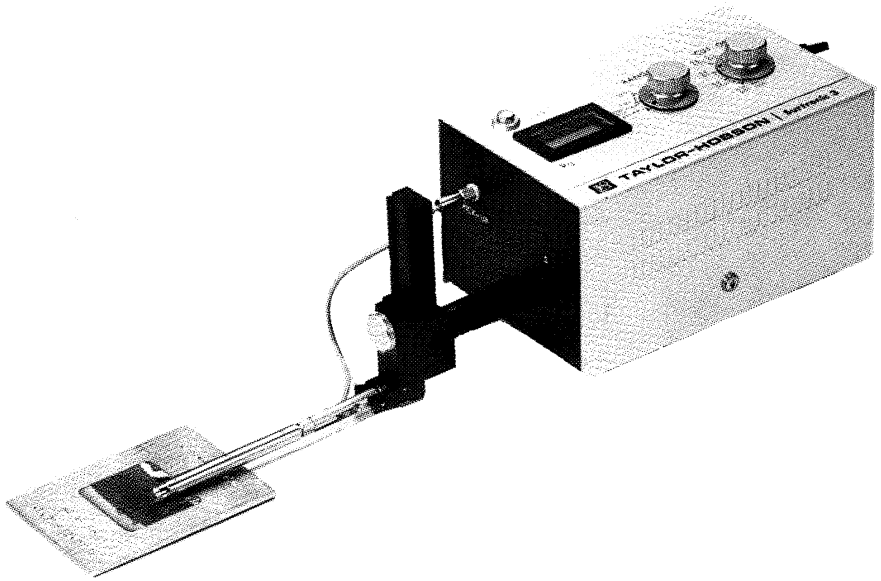


Figure 3 Surtronic 3

1.3.1 – Display-traverse unit

This unit contains a drive motor which traverses the pick-up across the surface to be measured. The measuring stroke always starts from the extreme outward position, and at the end of the measurement the pick-up returns to this position ready for the next measurement. The traverse length is automatically selected by the cut-off switch to include the correct number of cut-off lengths.

The unit also contains the electronic circuits for computing and displaying the Ra value.

1.3.2 – Pick-up

The pick-up is a variable reluctance type transducer which is supported on the surface to be measured by a skid, a curved support projecting from the underside of the pick-up in the vicinity of the stylus (Figure 4). As the pick-up traverses across the surface, movements of the stylus relative to the skid are detected and converted into a proportional electrical signal. The radius of curvature of the skid is much greater than the roughness spacing, so it rides across the surface almost unaffected by the roughness, thus providing a datum representing the general form of the surface. Even so, where the waviness is widely spaced it will be necessary to use the pick-up with shoe, in conjunction with the 2·5 mm (0·1 in) cut-off.

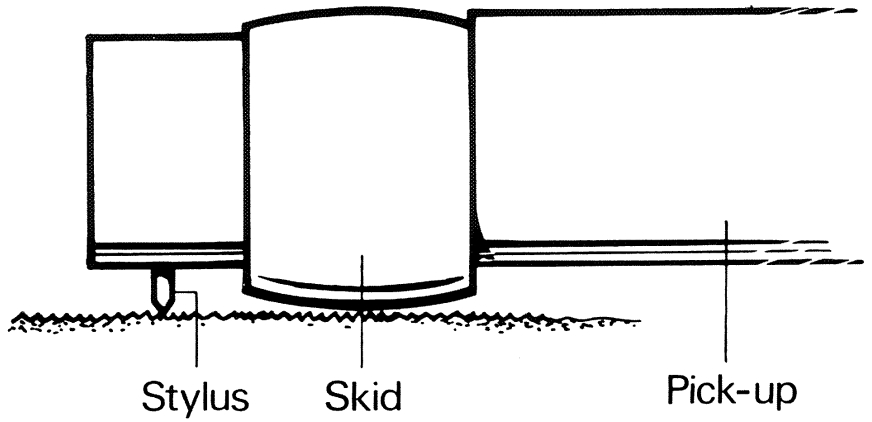


Figure 4 The pick-up is supported on the workpiece by the skid

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There are several different types of pick-up available, designed for different applications; details of these are given in section 5. They differ only in the stylus tip radius, the dimensions of the housing or position or shape of the skid. The stylus material in all the pick-ups is diamond for low wear.

The skids of the standard pick-ups are of red ruby, although earlier versions of 112/1502 had a chromed steel skid of shorter radius.

1.4 THE EQUIPMENT

Surtronic 3 includes:

19/1680	Display-traverse unit
120/311	Rechargeable battery
112/1502	Standard pick-up
112/1509	Roll and bore plate
112/1107	Roughness standard
112/1501	Battery charger
112/1510	Pick-up extension rod
112/1257	Pick-up lead
112/1511	Recorder lead (2 m)
112/1512	Remote start lead (2·4 m)
19/1677	Biased/reversed pick-up holder
19/1652	Unbiased pick-up holder
	Wooden case
221/37	Operators Handbook.

The accessory parameter module includes a larger wooden case which will take both units.

2 — DETAILED DESCRIPTION

2.1 DISPLAY-TRAVERSE UNIT

2.1.1 – Controls and panel components

On top of the unit (Figure 5) are:

Start button Pressing this switch will initiate a measuring traverse.

Display (Figure 6) Normally blank. While a measuring traverse is in progress three horizontal lines are displayed; at the end of the measurement the Ra value is shown and remains visible for about 20 seconds. There is no need to wait until the display is blank before another measurement is made. If certain conditions are not fulfilled, the letter E (for error) will be displayed, and the value shown must be disregarded. Note that if the range switch is moved while the display is visible,

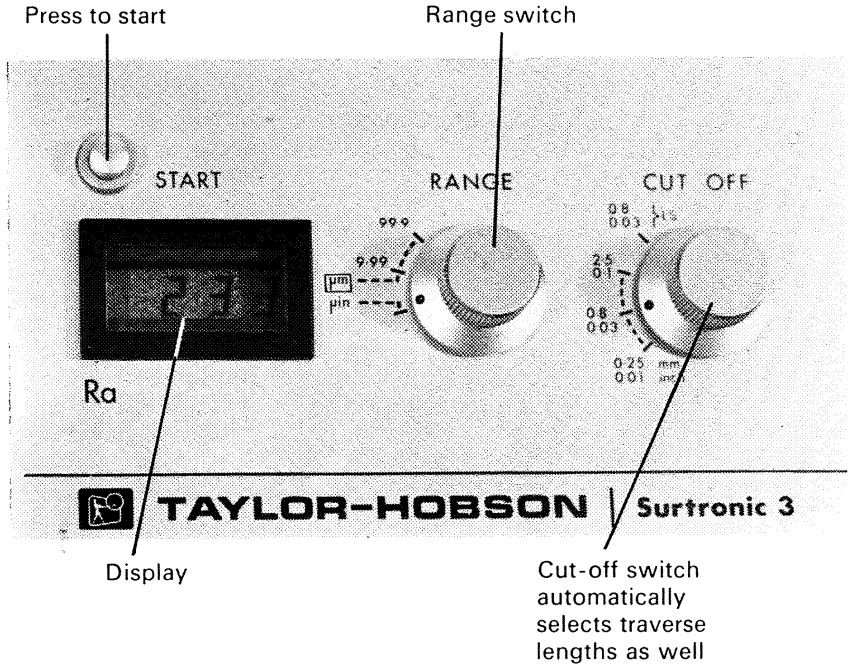


Figure 5 Operating controls

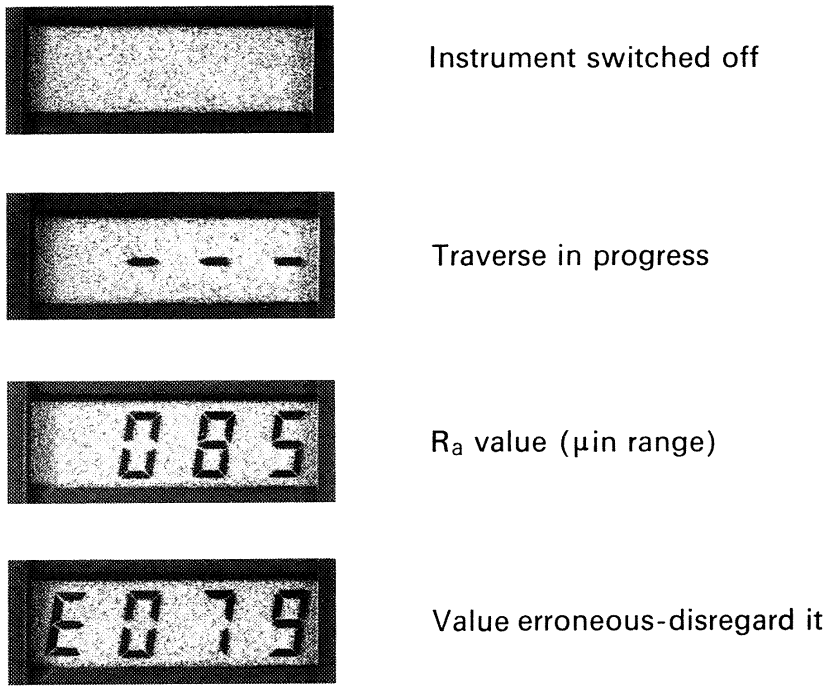


Figure 6 The display

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the decimal point will change but not the figures; hence the display will be correct only if the range switch is kept at the position it was during measurement.

Range switch This selects the micro-inch range (0–999 µin) or one of the two micrometre ranges. Although the range of the display selected by the upper position of the switch is 99·9, in practice the value displayed will never exceed about 25 µm, a limit set by the available stylus movement.

The range switch also selects the position of the decimal point in the display.

Cut-off switch This not only controls the cut-off but also selects the appropriate traverse length as follows:

Cut-off	(mm)	0·25	0·8	2·5	Long stroke
	(in)	0·01	0·03	0·1	Long stroke
Traverse length	(mm)	1·75	4·5	13	25
	(in)	0·07	0·18	0·52	0·98

The long stroke setting can be changed to a short stroke (1·75 mm) traverse by inserting the special accessory link plug into the "Accessories" socket on the rear of the unit (or of the parameter unit when the latter is used).

As this plug alters the length of *all* the strokes selected by the cut-off switch, the other positions of the switch should not be used while the link plug is in.

To return to long stroke and the correct stroke length for the other cut-off switch positions, remove the link plug.

On the front (Figure 7) are:

Pick-up socket This accepts one end of the pick-up lead, the other end of which screws into the pick-up.

Sensitivity adjustment A screwdriver adjustment enabling the overall stylus-to-display gain to be set with reference to the roughness standard. The gain should be checked, and if necessary adjusted, whenever a different pick-up is used (see section 9.4).

Drive shaft This supports the pick-up mounting components (see section 2.1.2). In its normal inoperative position it is fully extended and all measuring traverses are made by an inward movement of the shaft.

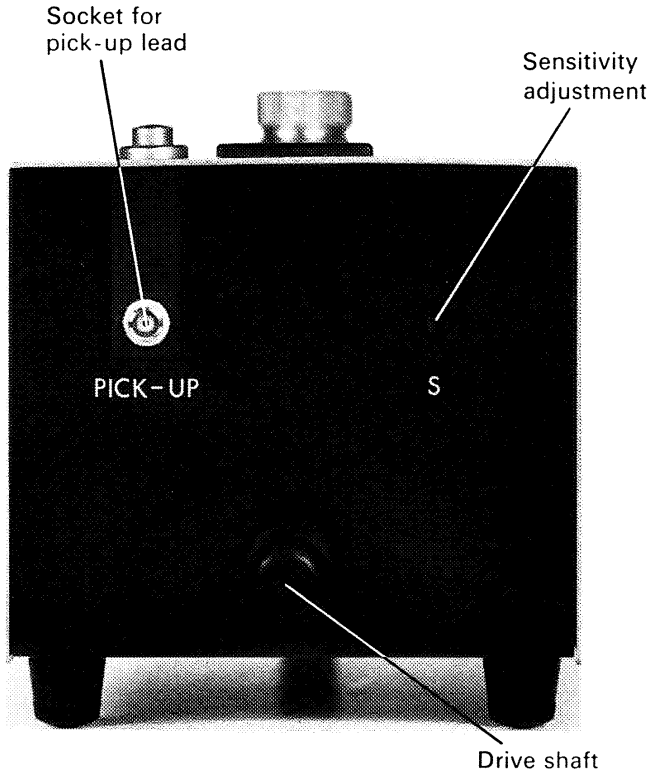


Figure 7 Front panel

On the rear (Figure 8) are:

Charger/Remote Start socket

(a) To charge the battery, connect the charger to an a.c. mains supply and plug it into this socket. An internal circuit will prevent the battery from being overcharged.

If necessary Surtronic 3 can be run from the mains by leaving the charger connected, but on 110 V mains the battery must be left in place in the unit.

Caution – Do not use the charger if a non-rechargeable dry battery is in the instrument.

(b) To initiate a traverse remotely, connect the remote start lead to this socket and momentarily short the connections with a suitable switch or contact device.

Accessory socket For the connection of accessories such as the parameter module.

Recorder socket The output from this socket consists of the unfiltered pick-up signal, which is available during the pick-up traverse.

Record/Ra switch The functions of the two positions of this switch are:

"Ra" – Display operational. Traverse speed 1 mm/s.

"Record" – Display inoperative. Traverse speed reduced to 0·25 mm/s. Cut-off filters not used, the cut-off switch merely selects the traverse length.

Battery To insert a battery, open the compartment by sliding the door to the left and insert the battery with the positive terminal at the side marked on the base of the compartment.

The battery should be charged after use and should not be allowed to remain in a discharged condition.

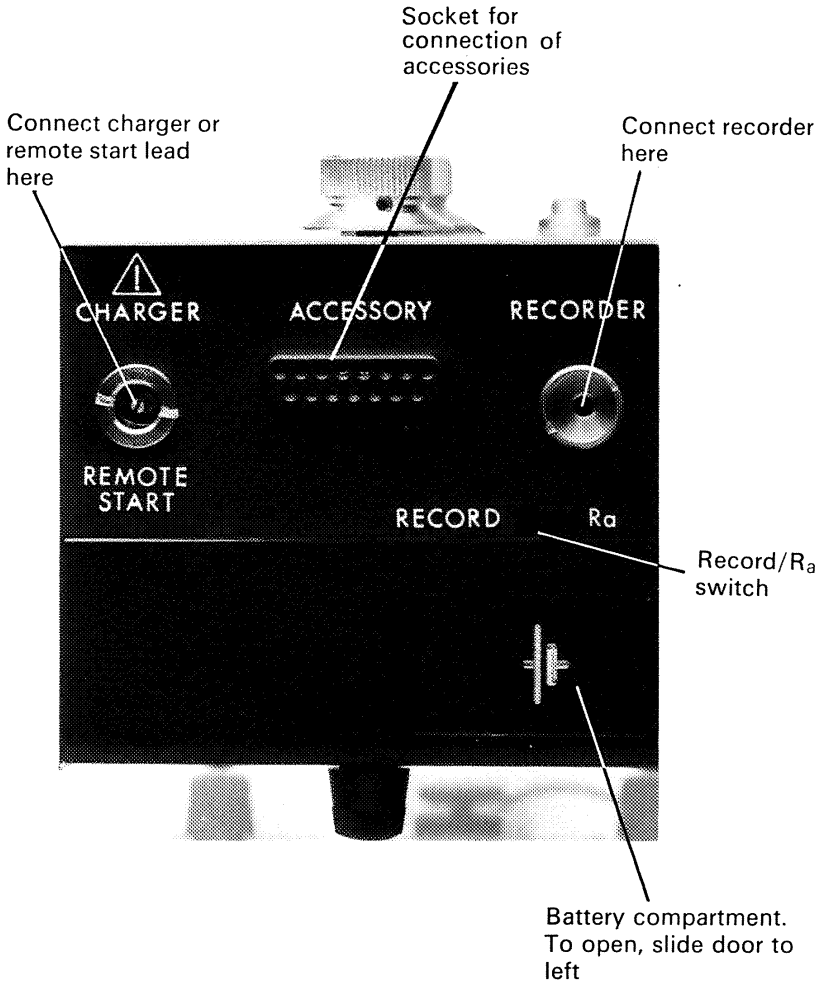


Figure 8 Rear panel

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2.1.2 – Pick-up mounting components

The pick-up is fastened to the drive shaft by the following means (see Figure 9):

Mounting bracket This is clamped to the drive shaft by means of a knurled knob. Although normally used upright as shown in Figure 9, it can be turned to angle the pick-up or to take it off the centre line, as illustrated in Figure 10. It can also be mounted sideways on the drive shaft (see Figure 11A) when the right-angle pick-up is in use.

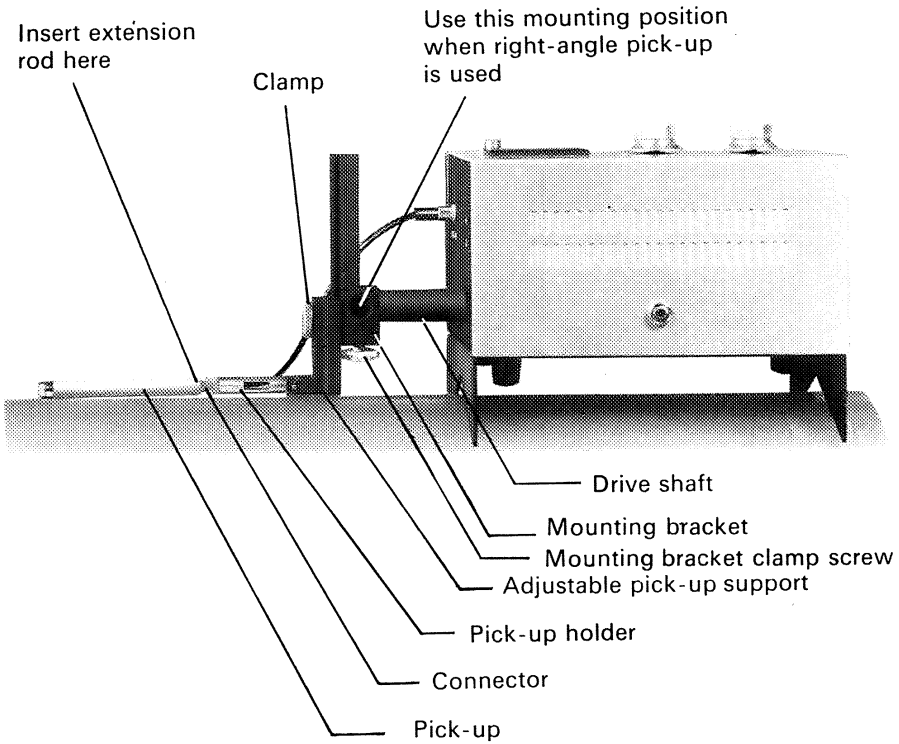


Figure 9 Pick-up mounting



Figure 10

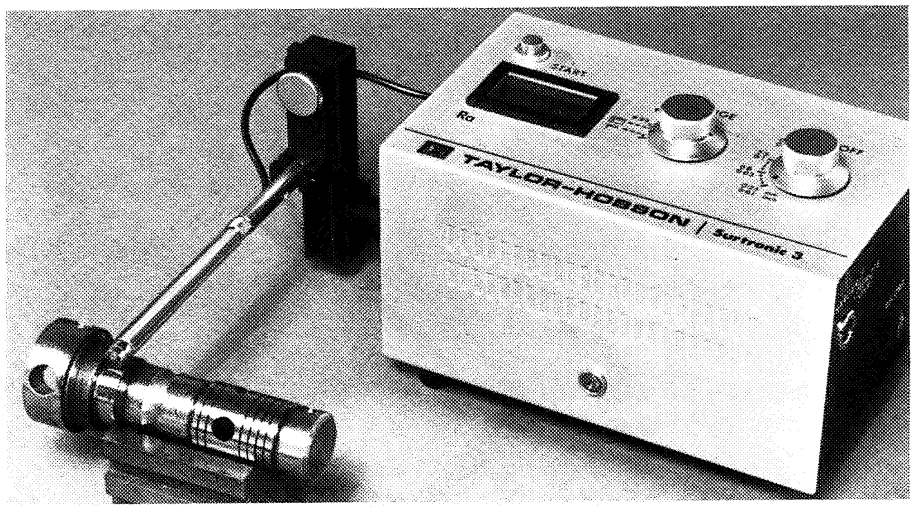


Figure 11A

Adjustable support This can be clamped at any position on the slide of the mounting bracket to provide height adjustment of the pick-up.

Pick-up holder This fits into the crutch of the pick-up support and is held in place by a spring plunger.

Two holders are supplied:

(a) Unbiased. When this holder is in use, the pick-up is pivoted horizontally quite freely, and the only force on the skid is that due to the weight of the pick-up. It is used with the pick-up horizontal and the stylus downwards.

(b) Biased/reversed. When used as illustrated in Figure 9 it exerts a biasing force on the pick-up (depending on which way the holder is inserted into the support crutch). It must be used when the pick-up is used in such a position that its weight will not keep the skid in contact with the surface being measured (e.g. on a vertical surface).

It can also be used to position the pick-up directly underneath the display–traverse unit as shown in Figure 11B.

Both holders will hold the pick-up at right-angles to the drive shaft when it is pivoted away from the surface (e.g. while changing the workpiece).

Connector The connector of the short lead is screwed into the end of the pick-up and is then inserted into the end of the pick-up holder, with the lead coming out through the slot in the holder. It is advisable to connect the lead to the display-traverse unit first and then to the pick-up.

When the extension rod is used, the short pick-up lead is not required and the end of the rod itself is inserted into the holder.

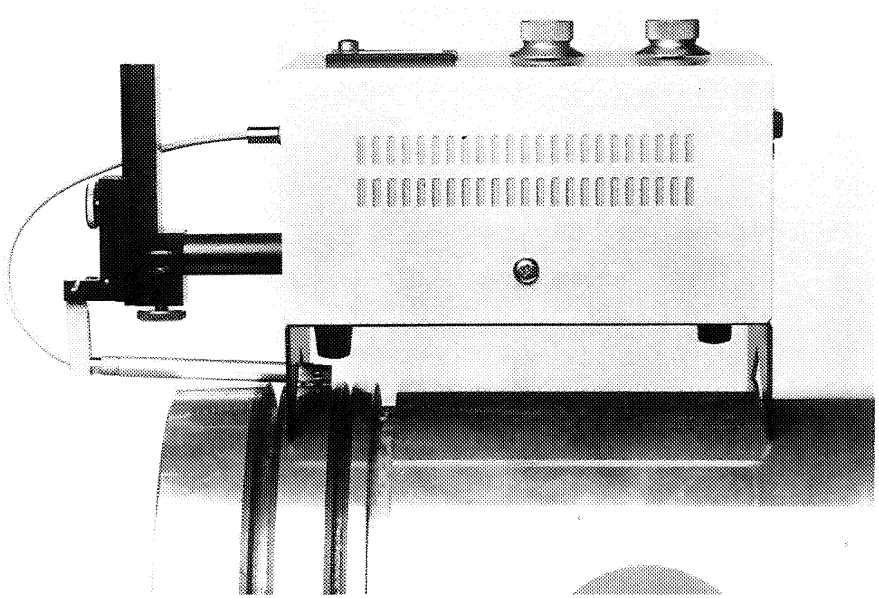


Figure 11B

2.1.3 – Pick-ups

The various pick-ups available are described in section 5. They are identified by the last two figures of the code number.

In every case the rotational attitude of the pick-up must be such as to bring the stylus normal to the surface (i.e. looking at the pick-up end on).

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3 — INSTALLATION

Successful use of Surtronic 3 will only be possible if it is operated on a surface free from external vibration.

Display-traverse unit

Plug the lead into the socket on the front of the unit and mount the pick-up as illustrated in Figure 9. Rotate the pick-up to bring the stylus vertical, this can conveniently be done with reference to the identity number engraved on the end of the pick-up.

If the pick-up has been changed or the instrument is being used for the first time, check and adjust the sensitivity (section 9.4.2).

Charger

Connect a suitable plug to the mains lead wired as follows:

Brown to Line
Blue to Neutral

Remote start lead

Connect a push-button switch to the end of the lead.

Recorder For recorder installation, see section 6.2.

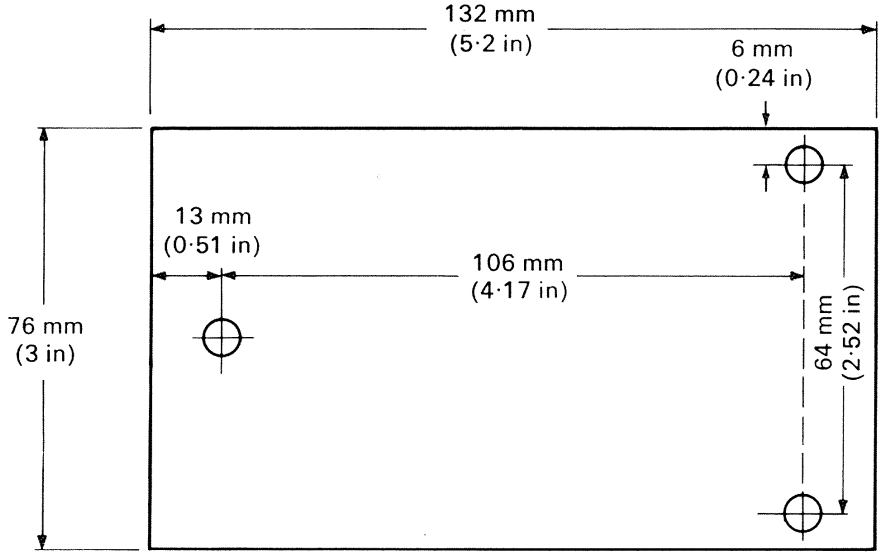
Mounting

On a flat surface the display-traverse unit can be supported on its three feet. If it is required to use it on a roll or in a bore, unscrew the three feet and use them to fasten the roll and bore plate to the bottom of the unit; make sure that the feet are correctly located within the holes in the plate.

If a user wishes to make his own mounting bracket for the unit, the dimensions of the fixing holes are shown in Figure 12.

For mounting on the Surtronic stand, see section 7.

For installation with the parameter module, see section 7.3.



Diameter of clearance holes:
8·2 mm (0·32 in) (for feet)
3·2 mm (0·13 in) (for screw)
Foot screws: M3 thread

Figure 12 Fixing dimensions

4 — METHOD OF USE

4.1 TO MAKE AN Ra MEASUREMENT

4.1.1 – On a horizontal flat surface

1) Use the unbiased pick-up holder on the display-traverse unit.
2) Clean the surface to be measured, so that it is free from abrasive material, grease, suds etc. This is necessary to ensure accurate readings and to reduce wear on the skid.
3) Position the display-traverse unit and pick-up so that the stylus contacts the surface and the pick-up is approximately parallel to the surface. Make sure that the length of surface is sufficient for measurement, remembering that the traverse motion is inwards towards the display-traverse unit.
4) Set the Record/Ra switch to Ra and select the cut-off and range required.
5) Press the Start button. When the traverse is complete, the Ra value will be displayed for 20 seconds and the pick-up will return to its extreme outward position.
6) If the letter "E" appears in the display, disregard the result. Try to identify the cause of the error, correct it and repeat the measurement (see section 4.2).

4.1.2 – On other surfaces

On a cylindrical surface: Fit the roll and bore plate.

In a bore: Fit the roll and bore plate.

On a vertical surface: Use the biased pick-up holder and if necessary hold the display-traverse unit by hand on the surface, making sure it does not move during the measurement (Figure 13).

In a small deep bore: Fit the extension rod between pick-up and holder (Figure 9).

Then follow the procedure detailed above in section 4.1.1.

4.1.3 – Operating notes

i) For successful use of Surtronic 3, the surface must be free from vibration and the instrument must be held completely steady during measurement, and between measurements also if repeat measurements are required.

ii) Always turn the pick-up so that the stylus is visibly perpendicular to the surface.

iii) The pick-up body must be visibly parallel to the surface.

iv) As soon as the pick-up begins its return stroke, the unit can be removed from the surface, the display will remain visible for about 20 seconds.

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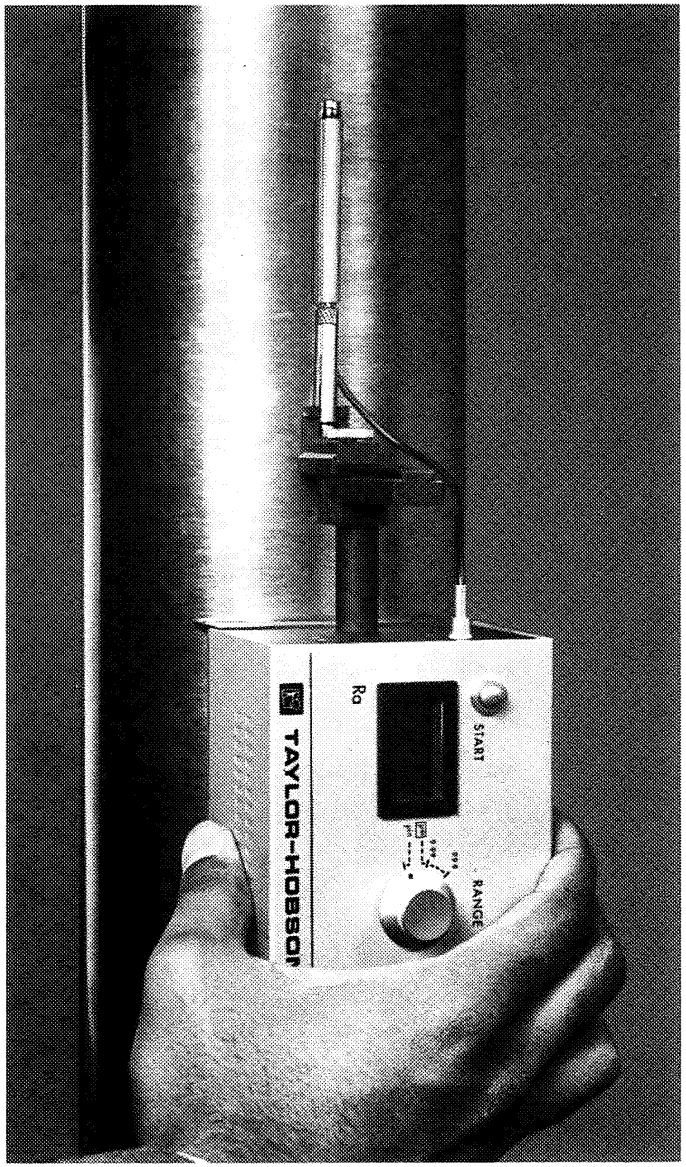


Figure 13 Using Surtronic 3 vertically

v) If, on pressing the Start button, there is no traversing and no display, it means that the battery is run down and must be recharged. There is, however, no need to wait for this to take place before continuing to use the instrument, because it will be operable again as soon as the charger has been connected to the display-traverse unit and switched on.

vi) Where the texture has a prominent directional character (lay), it is important to traverse the pick-up across the lay, not along it.

4.2 OPERATING ERROR INDICATIONS

1) The error indication ("E") will appear at the left of the display if any of the following conditions occur:

   i) Overload, i.e. Ra value exceeds the range of the display. If the 0-9·99 µm range was used, switch to the 0-99·9 µm range and repeat the measurement.

   ii) Pick-up disconnected, pick-up or lead faulty.

   iii) Vibration of the surface being measured or of the display-traverse unit support (resulting in overload).

   iv) If hand-held, the display-traverse unit moved during measurement.

2) The display may show a false or misleading reading without the "E" appearing if:

   i) Range or cut-off switch is moved during a measuring traverse.

   ii) Range switch setting is altered between completion of measurement and reading the display.

iii) Surface being measured or display-traverse unit is affected by external vibration, but not sufficiently to cause an overload.

iv) Cut-off is unsuitable for the type of surface (see next section).

v) Stylus leaves the surface before traverse is completed, either the surface is too short or the cut-off (i.e. traverse length) too long.

vi) Pick-up is not parallel to surface, so that the stylus is displaced outside its measuring range.

vii) Skid is not in contact with the surface throughout the traverse (this could happen if the unbiased holder is used under conditions which require the biased holder).

3) No display of value:

i) Battery needs recharging. If this is the cause there will be no traversing either.

ii) Lines appear but no value displayed: Record/Ra switch set to "Record" instead of "Ra".

4.3 CUT-OFF

A few trial measurements made on different surfaces will soon demonstrate that on some the results obtained are very dependent upon the cut-off selected. This shows that it is important to choose the cut-off to suit the surface. In general fine surfaces require short cut-offs and rough surfaces a longer one. Table I gives some guidance on suitable cut-offs.

The long-stroke cut-off is mainly for use on sheet metal and similar materials, where a longer surface is required to be representative of the material being examined. An alternative short-stroke cut-off (namely 0·8 mm cut-off over a traverse length of 1·75 mm) can be obtained by inserting a special accessory plug into the 'Accessory' socket.

TABLE I

Finishing Process	Approx. range of Ra values µm	µin	Suitable cut-off values 0·25 mm 0·01 in	0·8 mm 0·03 in	2·5 mm 0·1 in
Superfinishing	0·05–0·2	2–8	√	√	
Lapping	0·05–0·4	2–16	√	√	
Honing	0·1–0·8	4–32	√	√	
Grinding	0·1–1·6	4–63	√	√	√
Diamond turning	0·1–0·4	4–16	√	√	
Turning	0·4–6·3	16–250		√	√
Boring	0·4–6·3	16–250		√	√
Drawing	0·8–3·2	32–125		√	√
Broaching	0·8–3·2	32–125		√	√
Extruding	0·8–3·2	32–125		√	√
Milling	0·8–6·3	32–250		√	√
Shaping	1·6–12·5	63–500		√	√

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4.4 REPLICA KIT (112/727)

Surfaces inaccessible to the Surtronic pick-up can be measured indirectly if a replica of the surface is made. The Replica Kit provides prepared quantities of materials for making a replica. On surfaces having an Ra of less than 0·2 µm (8 µin), the Ra of the replica is likely to be higher than that of the original surface, while for surfaces having an Ra greater than 4 µm (160 µin) the roughness of the replica is likely to be lower.

Detailed instructions are included with the kit but briefly the procedure is as follows. An area not exceeding 400 mm^2 ($\frac{3}{4}$ in^2) is enclosed by a thin wall of the 'Plasticine' provided. The solution is then poured on to the area and allowed to harden, which takes about 12-15 minutes. The replica is then removed from the surface and measured with the Surtronic in the usual way. No difficulty is experienced in removing the replica from the surface as this is facilitated by the application of the release agent.

5 — PICK-UPS

5.1 GENERAL

The range of pick-ups available enables the most suitable type to be selected for the work in hand.

Whenever a pick-up is changed, the instrument must be recalibrated (see section 9.4).

When the extension rod is used, an additional 185 mm (7·2 in) reach is added to the pick-up length.

All pick-ups bear the last two figures of the code number as identification.

The stylus radius 5 µm (200 µin) conforms to the requirements of ISO Standard R468 and is equally suitable for recording and Ra measurement.

5.2 DIMENSIONS

See Table 2 and Figures 14 – 20.

5.3 STANDARD PICK-UPS

See Figure 14.

There are two standard pick-ups:
112/1502 with a stylus tip radius of 5 µm and
112/1503 having a stylus tip radius of 10 µm.

5.4 SMALL BORE PICK-UP (112/1504)

See Figure 15.

On this pick-up the skid is integral with the stylus arm housing and is set further back from the stylus. This enables the pick-up to be used in short bores with the skid supported independently of the surface being measured, e.g. by the Datum Support Stand.

5.4.1 – Datum Support Stand (112/865)

This accessory provides an independent straight datum where the surface to be measured is too short to accommodate both stylus and skid of the small bore pick-up. It can also be used with some of the other pick-ups when they are fitted with the detachable skid (section 5.10).

Insert the arm carrying the datum block (Figure 21) into the front of the clamping block (i.e. the face carrying the index line A). Clamp with knob B. Raise the assembly to approximately the right height and clamp with knob F; make sure that knob D is free and use ring E to obtain the height adjustment. Finally clamp by means of knob D. Adjust the position of the stand and datum block to position the block as near to the workpiece as possible. The block must be level in the direction of pick-up traverse and this condition is shown by the line C on the

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TABLE 2 PICK-UP DIMENSIONS

PICK-UP		112/1502 112/1503	112/1504	112/1505	112/1506	112/1524	112/1531	112/1599
Fig. No.		14	15	16	17	18	19	20
A Effective length	mm	60·5	60·2	60·8	62·9	60·6	60·7	66·1
	in	2·38	2·37	2·39	2·48	2·39	2·39	2·6
B Body diameter	mm	6	6	6	6	6	6	6
	in	0·24	0·24	0·24	0·24	0·24	0·24	0·24
C Skid protrusion	mm	0·3	0·3	0·3	5·7	0·3	0·3	0·3
	in	0·012	0·012	0·012	0·22	0·012	0·012	0·012
D Stylus to Skid distance	mm	2·3	8·2	2·3	2·25	2·3	—	—
	in	0·09	0·32	0·09	0·089	0·09	—	—
E End of pick-up to stylus	mm	1·4	0·8	1·4	3·5	1·4	1·3	7·0
	in	0·06	0·3	0·06	0·14	0·06	0·05	0·27
F Stylus arm housing height	mm	—	1·8	—	—	—	1·7	—
	in	—	0·07	—	—	—	0·07	—
G Stylus arm housing width	mm	—	2·5	—	2·5	—	3·8	—
	in	—	0·10	—	0·10	—	0·15	—
H Skid radius	mm	40	6	8	8·7	30	8	10
	in	1·57	0·24	0·31	0·34	1·13	0·31	0·39
K Stylus width	mm	—	—	—	—	1	—	—
	in	—	—	—	—	0·04	—	—
L Skid width	mm	—	—	—	—	5·5	3·8	—
	in	—	—	—	—	0·2	0·15	—
M Stylus arm housing length	mm	—	14·5	—	—	—	12·7	—
	in	—	0·57	—	—	—	0·5	—
N Length of reduced diam portion of housing	mm	—	—	—	—	—	5·0	—
	in	—	—	—	—	—	0·2	—
P Rear portion of stylus arm housing	mm	—	—	—	—	—	2	—
	in	—	—	—	—	—	0·08	—

Stylus tip radius

112/1503 10 ± 2·5 µm (400 ± 100 µin)
All other pick-ups 5 µm (200 µin)

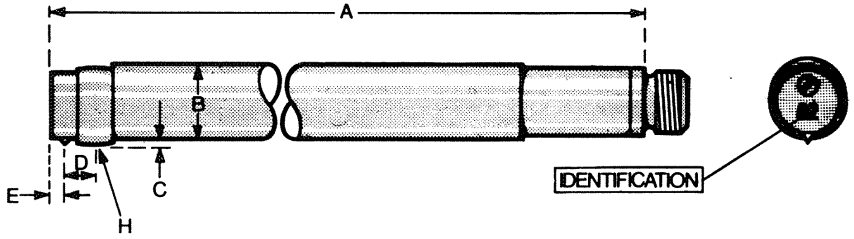


Figure 14 Standard pick-up

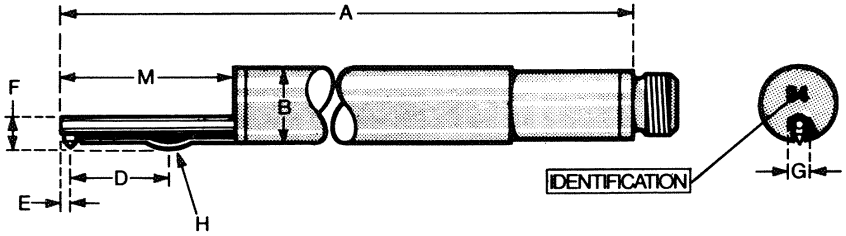


Figure 15 Small bore pick-up

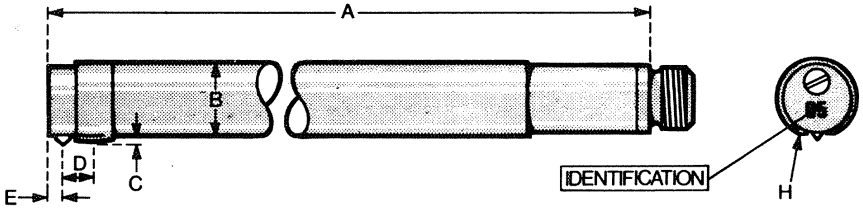


Figure 16 Right-angle pick-up

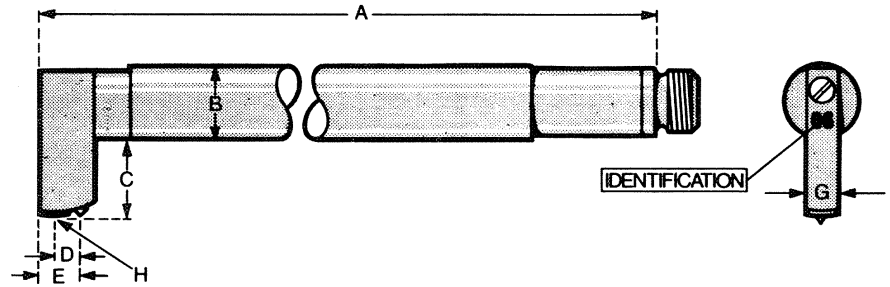


Figure 17 Recess pick-up

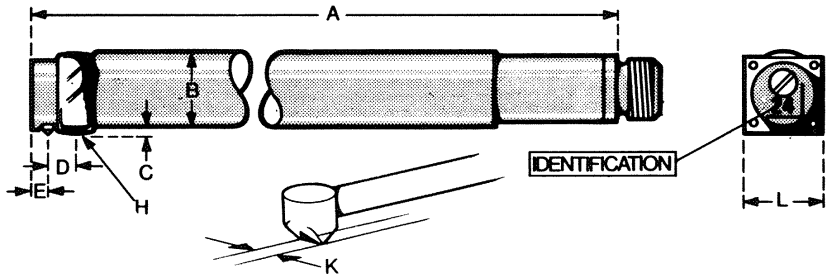


Figure 18 Pick-up with chisel-edge stylus

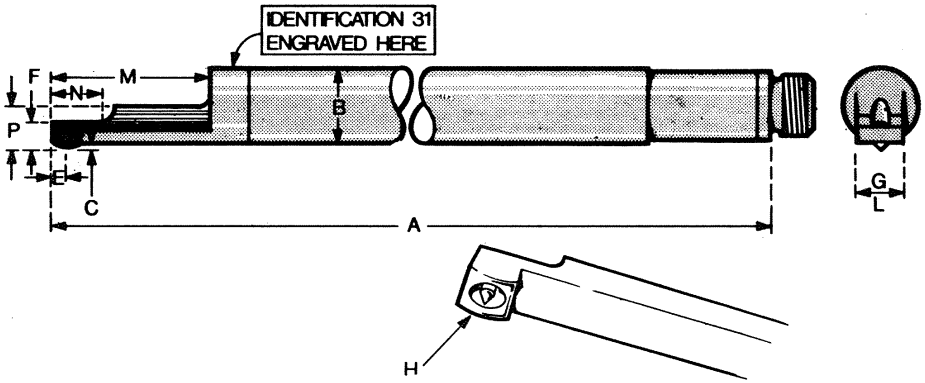


Figure 19 Side skid pick-up

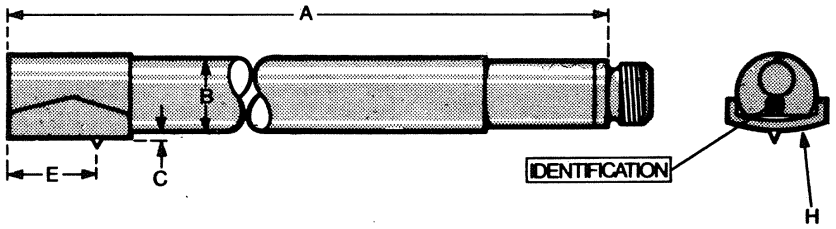


Figure 20 Shoe pick-up

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arm which should be aligned with the line engraved at A. It must be appreciated that this line indicates the correct attitude of the datum block only if the arm is assembled as shown; if the arm is reversed and inserted into the clamp assembly from the other side, the line cannot be used to indicate the correct setting. It may, however, sometimes be necessary to use the Datum Support in this manner, in order to prevent the knobs fouling the workpiece. In this case level the datum block so that the surface is parallel to the pick-up.

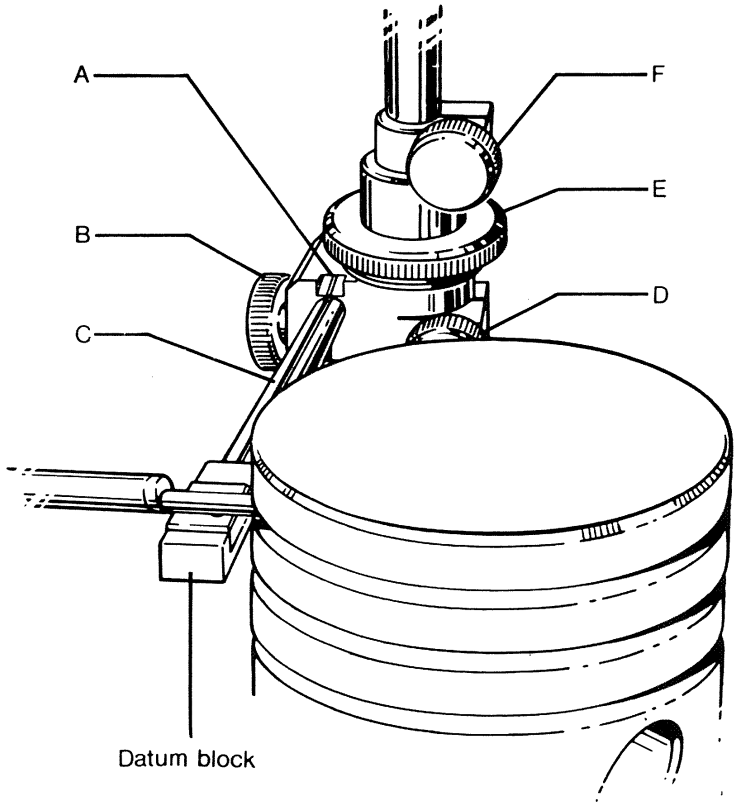


Figure 21 Datum support stand

5.5 RIGHT-ANGLE PICK-UP (112/1505)

See Figure 16.

In this pick-up the skid is set at right angles to its normal position; Figure 11A illustrates how the pick-up should be used. It is particularly useful in grooves or slots where the lay of the surface texture is such that measurement with the standard or small bore pick-up would be unsuitable.

When used on cylindrical workpieces it is important that the stylus and skid should be equidistant from the crest (see Figure 22), and that the workpiece is positioned so that the crest is parallel to the line of traverse.

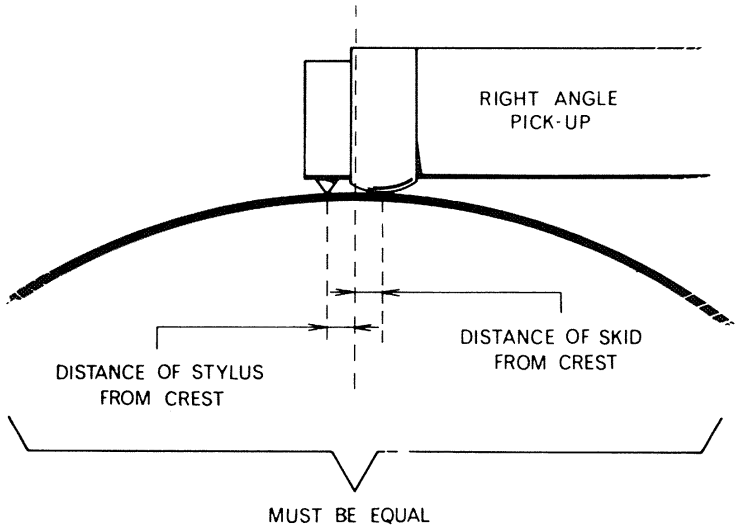


Figure 22 Condition to be observed when the right-angle pick-up is used on a cylindrical workpiece

5.6 RECESS PICK-UP (112/1506)

See Figure 17.

This pick-up has an extended stylus and skid for measuring between shoulders or flanges or at the bottom of a recess up to 5·5 mm (0·21 in) deep.

When using this pick-up make sure that the traverse length is not long enough to cause the stylus or skid to foul the edge of the recess.

5.7 PICK-UP WITH CHISEL-EDGE STYLUS (112/1524)

See Figure 18.

This is for use in measurement along a wire or edge (Figure 23) which cannot be traversed with a pointed stylus. It should not be used on a flat surface. The skid is rotatable (section 8.2).

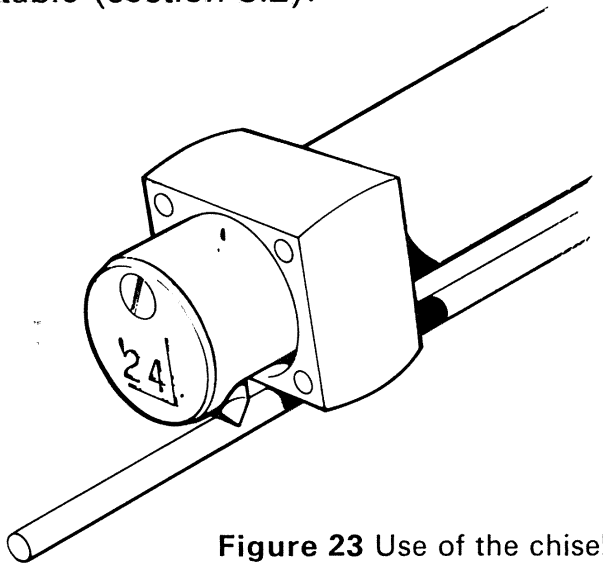


Figure 23 Use of the chisel-edge stylus

5.8 SIDE-SKID PICK-UP (112/1531)

See Figure 19.

This pick-up is for use on curved surfaces, such as gear teeth. The skid surrounds the stylus and the line of contact with the workpiece moves relative to the stylus as the stylus is traversed over the crest of the curve.

With this pick-up it is very important to position it so that contact with the surface is made on the centre line (parallel to the axis of the pick-up) of the skid, i.e. the stylus must be perpendicular to the surface when the pick-up is viewed from the end. This is particularly necessary when the pick-up is used on a concave surface such as a bore, but owing to the form of the skid, this condition is not easy to check. This pick-up cannot be used on concave surfaces having a radius less than 8 mm (0·31 in). It must not be used as a right-angle pick-up nor must it be traversed axially along a cylinder.

5.9 PICK-UP WITH SHOE (112/1599)

This pick-up has a pivoted flat shoe which will ride across the tops of the comparatively widely-spaced irregularities of a rough surface. It is necessary to use this pick-up when measurements are made with the 2·5 mm (0·1 in) cut-off.

This pick-up should never be used on a smooth surface because the shoe would tend to wring to the surface.

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Ideally the pick-up should be parallel to the surface being measured, but in any case the inclination must not exceed ± 10° to ensure that the shoe rides flat on the surface.

5.10 DETACHABLE SKID (112/1191)

This optional accessory (Figure 24) can be clamped to the pick-up body to enable the Datum Support Stand to be used with the standard, recess, right-angle and chisel-edge stylus pick-ups. The normal skid should be removed by undoing the small screw in the end of the pick-up and taking off the end cap, but be careful that the pin next to the skid does not fall out, as it will now be loose. After the end cap has been taken off, there will be no protection for the delicate stylus beam, so be very careful, particularly when measuring in blind bores, not to let the beam foul the workpiece.

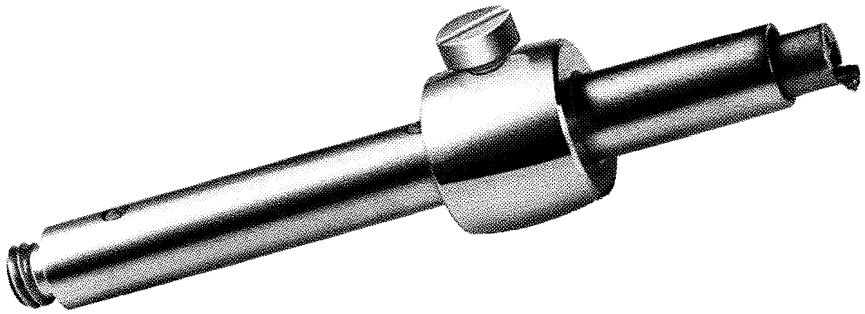


Figure 24 Pick-up fitted with detachable skid; normal skid removed

6 — RECORDER

6.1 GENERAL

The recorder (Figure 25) enables a graph of the unfiltered profile to be recorded at certain selected horizontal (Vh) and vertical (Vv) magnifications. The cut-off filters are not operative during recording and the cut-off switch on the display-traverse unit serves only to select the traverse length. To obtain a true recording, the Record/Ra switch must be set to the "Record" position, which also inhibits the display.

Marking is by means of a heated pen on heat sensitive paper.

6.2 INSTALLATION

Connect a suitable plug to the mains lead wired as follows:

Brown to Line
Blue to Neutral
Yellow/green to Earth

Connect the display-traverse unit and mains leads to the respective sockets on the rear of the recorder, the input is via a 2·5 mm jack plug (already fitted to the lead supplied with Surtronic 3). Insert a roll of chart paper (Figure 29) and adjust the pen heat (section 6.6), after which the recorder is ready for use.

The sensitivity is set at the factory and no adjustment will be necessary. No operator-adjustable gain control is fitted.

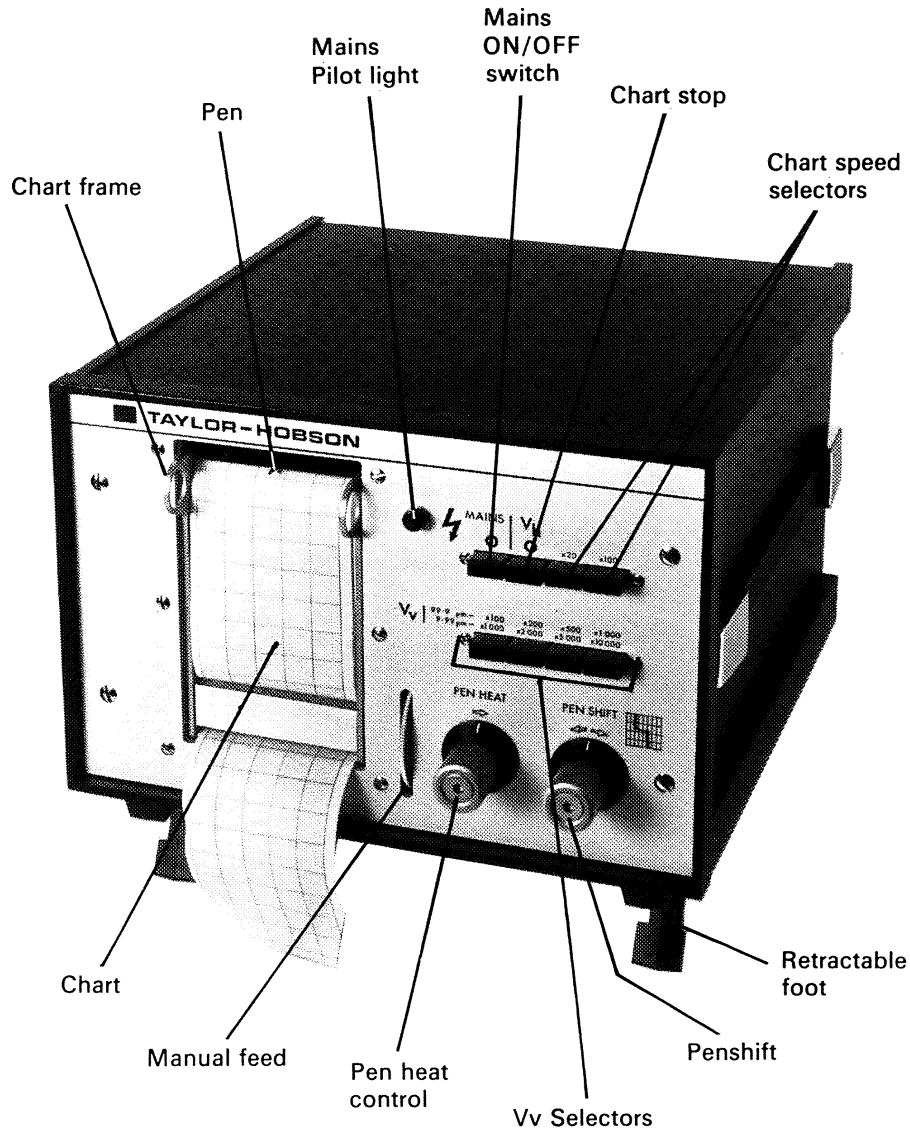


Figure 25 The recorder

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The retractable feet may be used to raise the front of the recorder if this will give a more convenient attitude for working.

6.3 DESCRIPTION (see also Figure 25)

Mains ON/OFF switch Press for on, press again for off.

Pilot light Indicates that the recorder is switched on.

Chart Speed Selectors Pressing either of these switches starts the chart drive at a speed which gives the horizontal magnification indicated.

Chart Stop Pressing this switch fully in stops the chart drive, resets the speed selection switch and reduces the pen heat to the stand-by level.

Vv Selectors In combination with the Range Selector switch on the display-traverse unit, these select the vertical magnifications (Vv) at which the graph is recorded. See Figure 26 or 27 for corresponding chart values.

Penshift After a recording has commenced, this positions the pen so that the graph can be drawn at any position across the chart (see note (iii) at end of section 6.4).

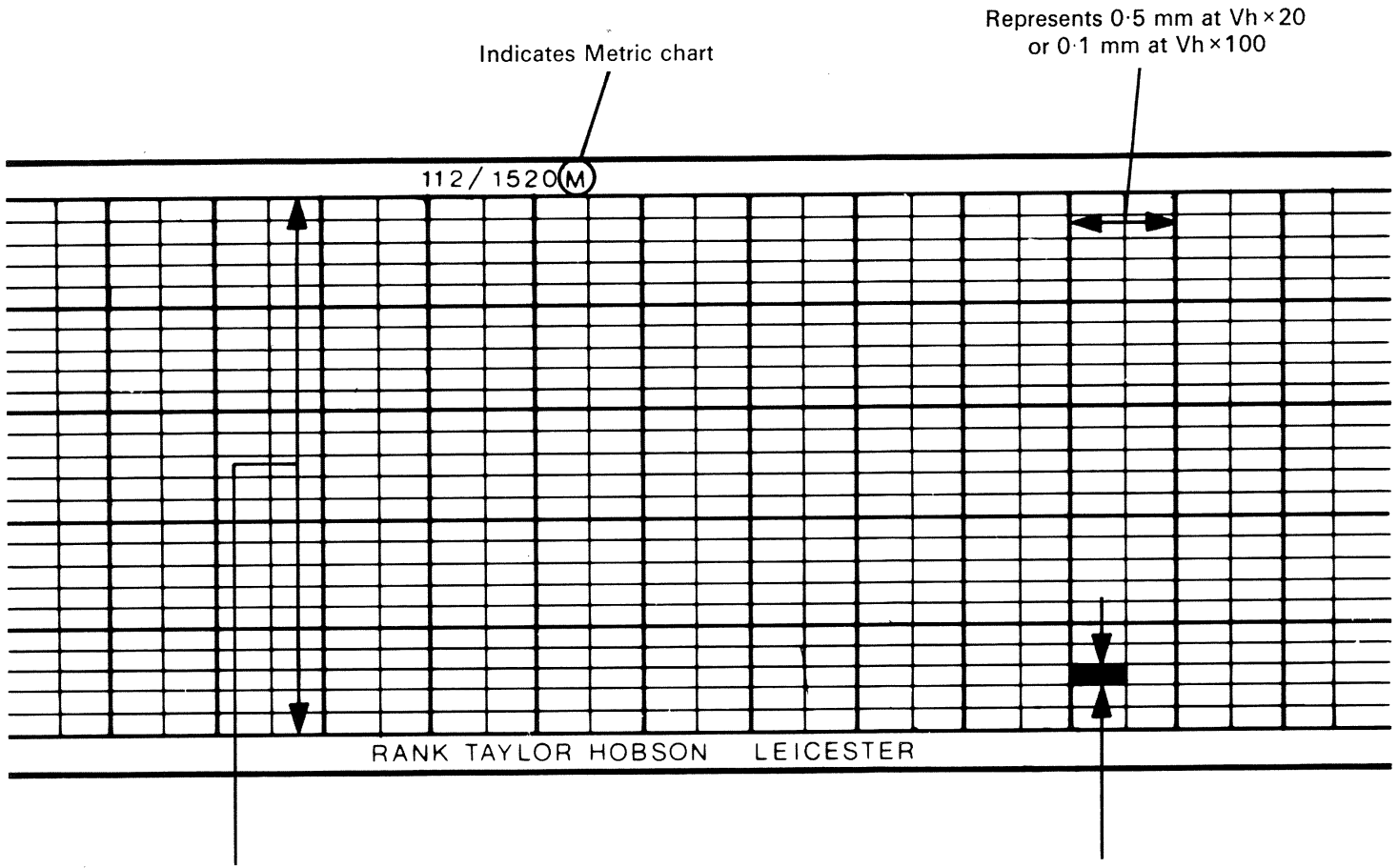
Penheat Adjusts the pen heat to give the best quality trace. Different heats are required for the two recording speeds, but there is automatic compensation for this, and once the optimum setting has been found for one speed, there will be no need to alter it for the other speed. See section 6.6.

Manual feed Used for feeding the chart forward manually.

Pen Once the recorder has been switched on, the pen is in a condition of stand-by heat, so that when the chart drive is switched on the pen rapidly attains its operating temperature.

Chart For chart values, see Figure 26 or 27. To load a new roll of chart paper, see Figure 29.

Chart frame The frame can be hinged forwards for chart loading, using the lugs at the top.



Full scale

at Vv	*represents*
×100	0·5 mm
×200	0·25 mm
×500	0·1 mm
×1000	0·05 mm
×2000	0·025 mm
×5000	0·01 mm
×10 000	0·005 mm

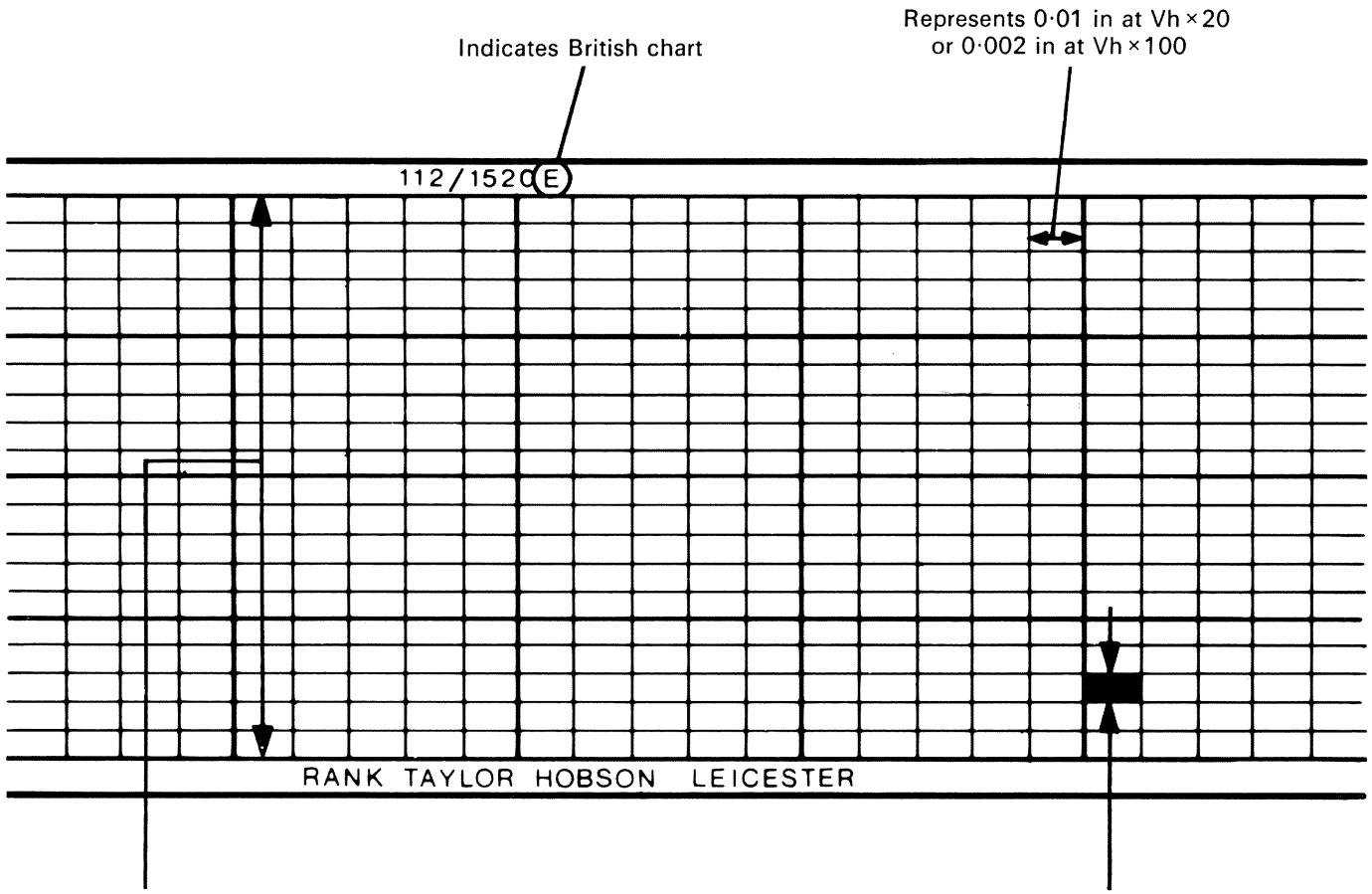
One small division

at Vv	*represents*
×100	20 µm
×200	14 µm
×500	4 µm
×1000	2 µm
×2000	1·4 µm
×5000	0·4 µm
×10 000	0·2 µm

Figure 26 Metric chart

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Full scale

at Vv	*represents*
×100	0·02 in
×200	0·01 in
×500	0·004 in
×1000	0·002 in
×2000	0·001 in
×5000	0·0004 in
×10 000	0·0002 in

One small division

at Vv	*represents*
×100	1000 µin
×200	500 µin
×500	200 µin
×1000	100 µin
×2000	50 µin
×5000	20 µin
×10 000	10 µin

Figure 27 British chart

6.4 TO MAKE A RECORDING

1) Set the display-traverse unit to traverse the stylus across the workpiece.

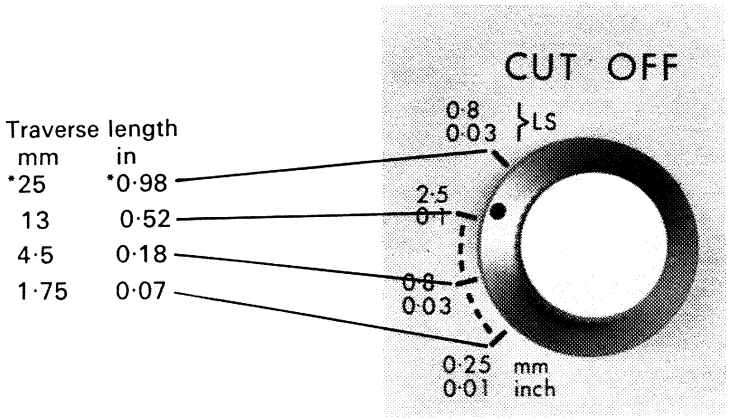
2) Set the Record/Ra switch to "Record".

3) Use the Range switch on the display-traverse unit in conjunction with the Vv Selector on the recorder to select the vertical magnification required. Use the Cut-off switch to select the traverse length (see Figure 28).

4) Start the traverse and watch the movement of the pen. Use the penshift to centralise the pen swing on the chart, and check that the pen remains within the chart limits; if it does not, it will be necessary to use a lower magnification.

5) A recording can now be made. To do this first start the chart drive by depressing one of the Speed Selectors, then start the pick-up traverse. Use the penshift if necessary to position the graph at the best position on the chart.

6) When the pick-up traverse is finished (or before if sufficient length of graph has been recorded), press the Chart Stop switch. Feed the chart forwards manually and tear it off against the lip of the slot through which it emerges. Write on the chart workpiece identity details, and the vertical and horizontal magnifications used; without these details the graph is useless as a permanent record.



*On instruments having the short stroke in place of the long-stroke cut-off, the traverse length will be 1·75 mm (0·069 in)

Figure 28 Traverse lengths selected by the cut-off switch

NOTES

i) Press the Chart Stop switch fully in, failure to do this may stop the chart drive but leave the pen heat at the marking level, resulting in the paper being scorched.

ii) Only the two metric positions on the Surtronic Range switch are used. To change to British units, just use the British chart paper (Figure 27).

iii) When the traverse is initiated, recording always starts at the middle of the chart paper, irrespective of the setting of the penshift control. As soon as the recording has commenced, however, the penshift can be used to re-position the graph on the chart if required.

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6.5 TO INSERT A NEW ROLL OF PAPER

Pull the chart frame forwards, take out the old paper spool and remove the metal spindle from the core. Then carry out the procedure illustrated in Figure 29.

6.6 TO ADJUST THE PEN HEAT

Adjust the pen heat to give a thin, clear and continuous trace.

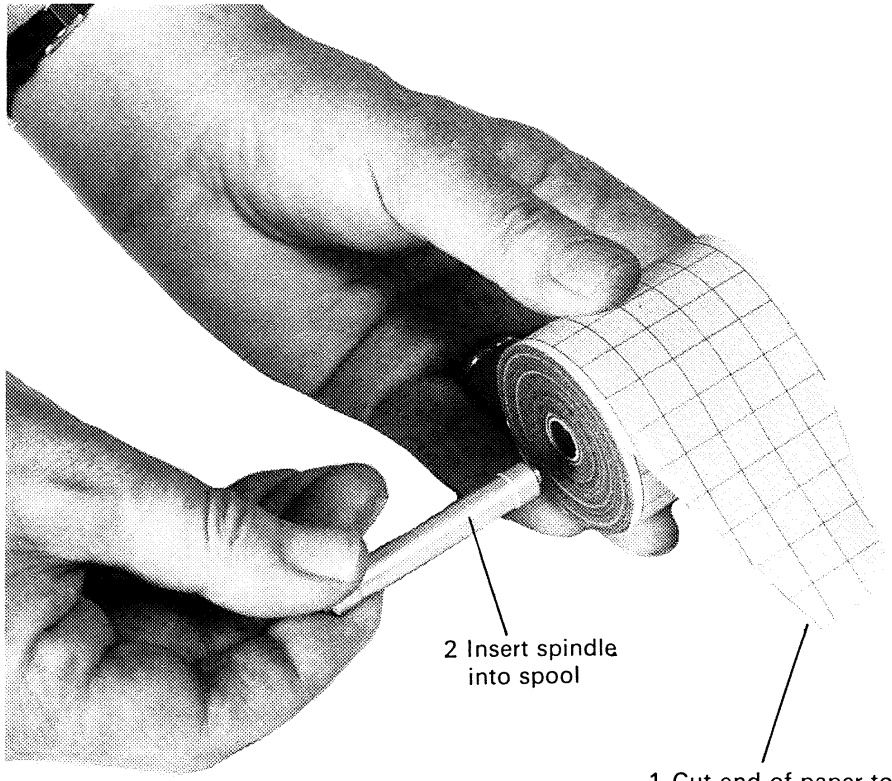


Figure 29A

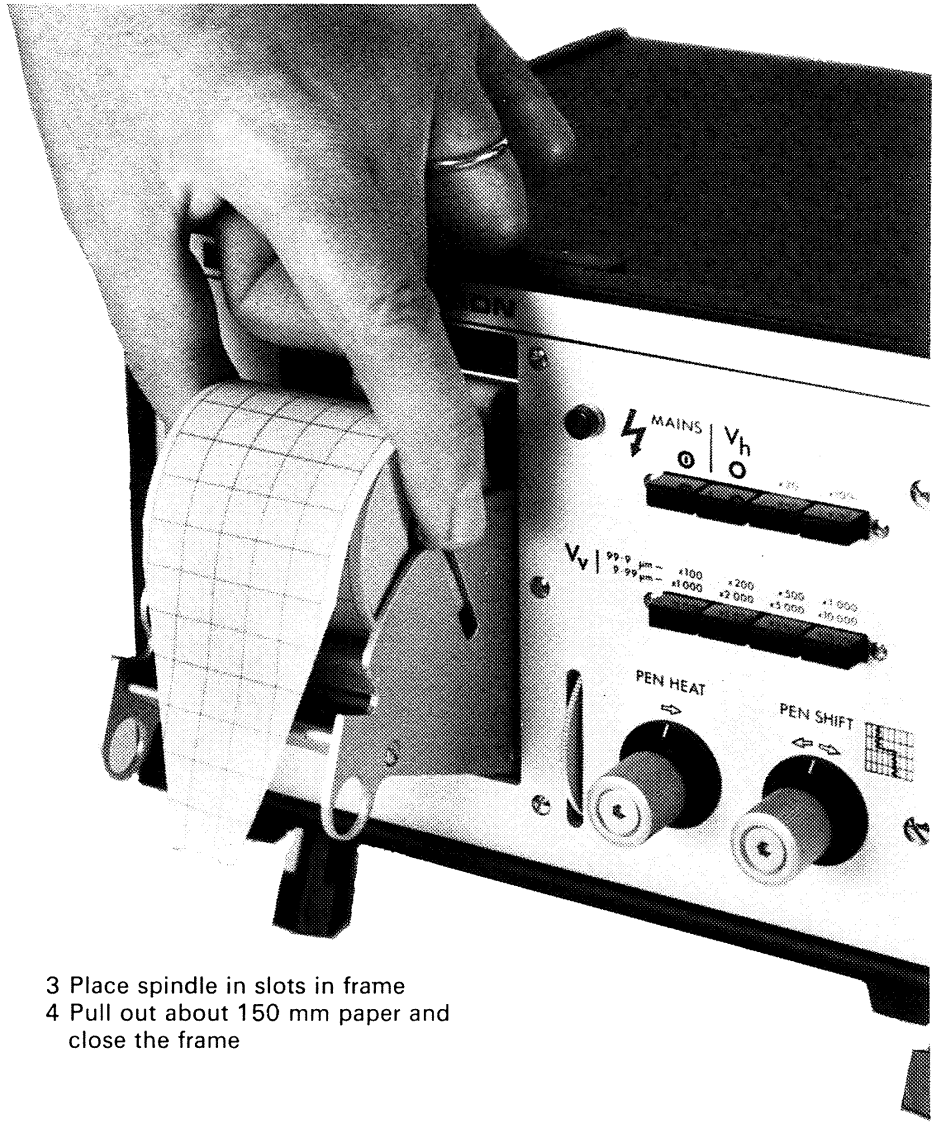
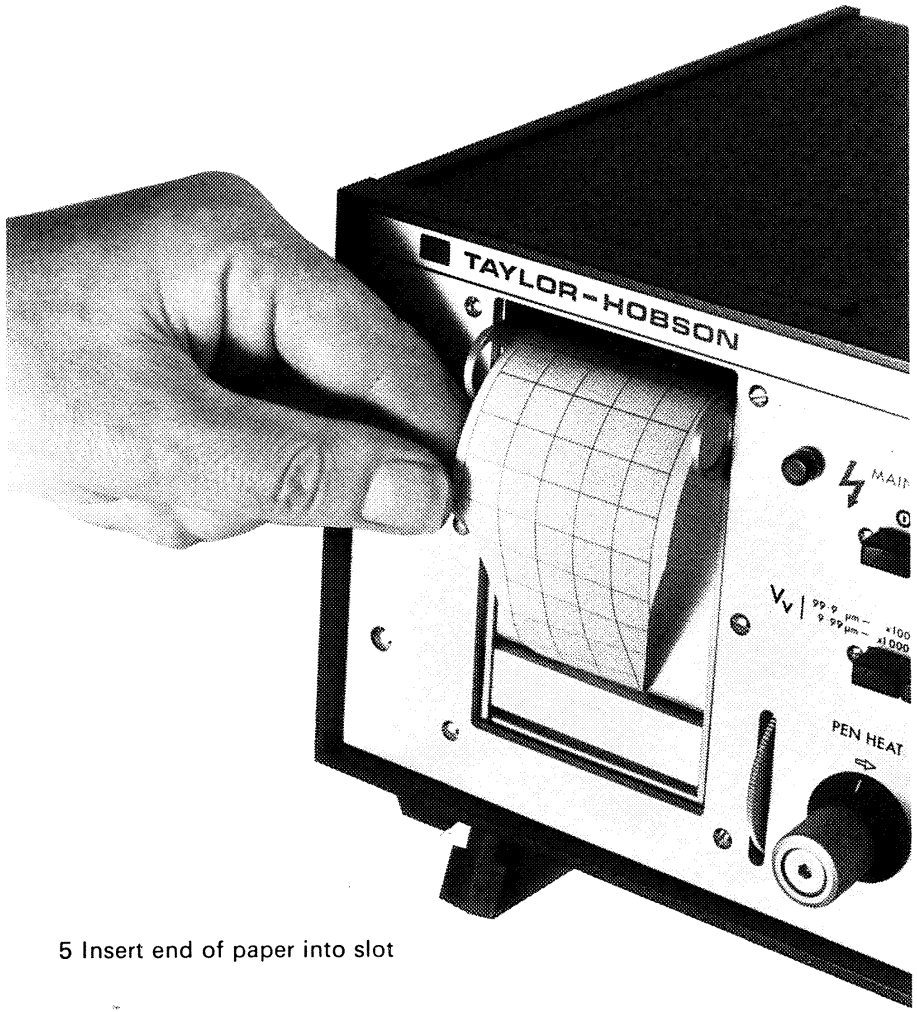
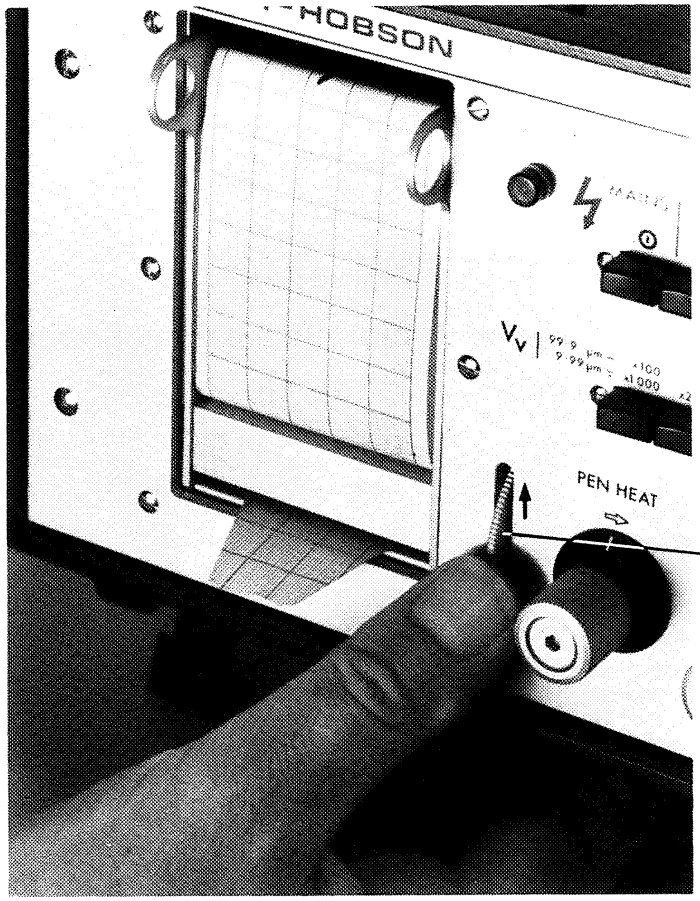


Figure 29B



5 Insert end of paper into slot

Figure 29C



6 Feed paper manually

Figure 29D

6.7 FUSE

250 mA for 210-230V operation. RTH code D235/128
500 mA for 105-125V operation. RTH code D235/202

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7 — PARAMETER MODULE

7.1 GENERAL

The parameter module is an add-on unit for the Surtronic 3 display-traverse unit to provide a display of six additional surface texture parameters. It is powered from the battery in the display-traverse unit and obtains its data input from that unit.

The module can be used directly with display-traverse units having a serial number higher than 698053, but earlier models have no accessory socket. However, a conversion kit is available by which these earlier models can be adapted to take the parameter module.

Two or more of the modules can be used in series if required, to obtain a simultaneous display of more than one parameter, in addition to Ra. The battery consumption will, of course, be proportionally more.

7.2 THE EQUIPMENT

The parts supplied with the parameter module (Figure 30) are:

- Parameter module
- 2 vee supports with fixing screws
- Base Plate
- Interconnecting lead
- Switch plate
- Case to hold the parameter module as well as the display-traverse unit and its accessories.

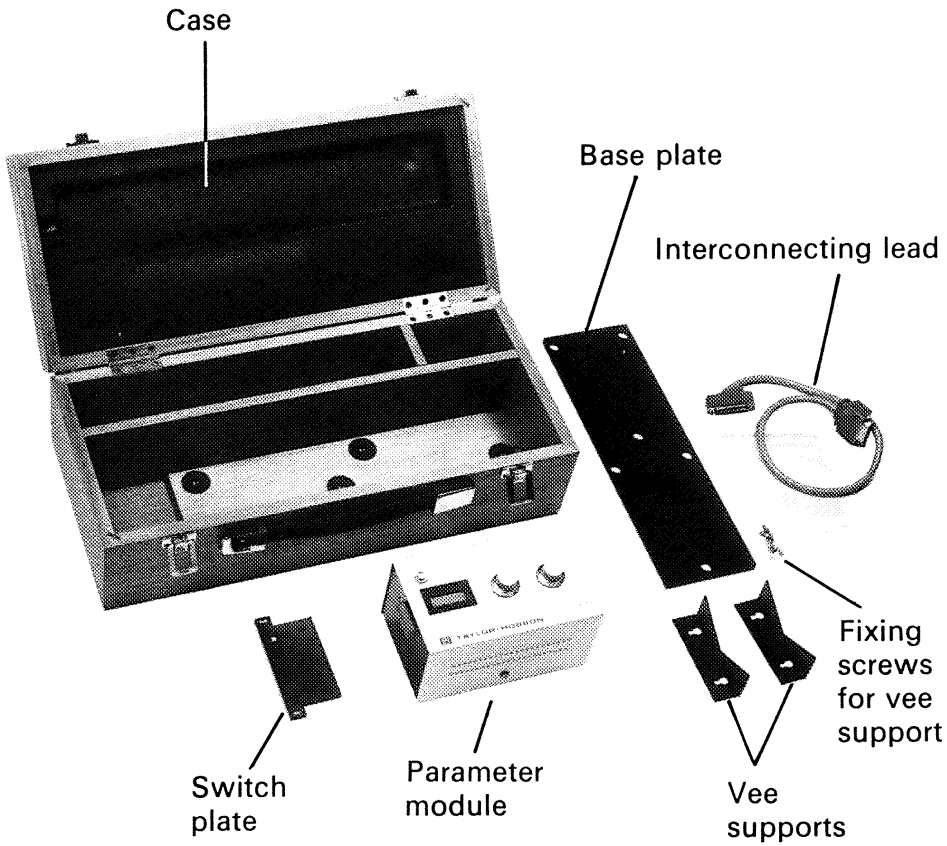


Figure 30

7.3 CONNECTING UP

The two units can either be connected rigidly together (see Figure 31) by means of the base plate supplied with the parameter module, or used apart, connected by the single interconnecting cable.

To join the two units together on the baseplate, place the switch plate (Figure 32) between them so that it will operate the Ra/Record switch and plug the two units together. Then fix the pair of units to the baseplate with the detachable feet. The vee supports can be fastened to the baseplate with the screws provided if necessary.

When the display-traverse unit is used on the stand, the parameter module must be connected to it with the cable.

There is no need to separate the two units from the base plate when putting them in the case (it will, however, be necessary to remove the vee supports).

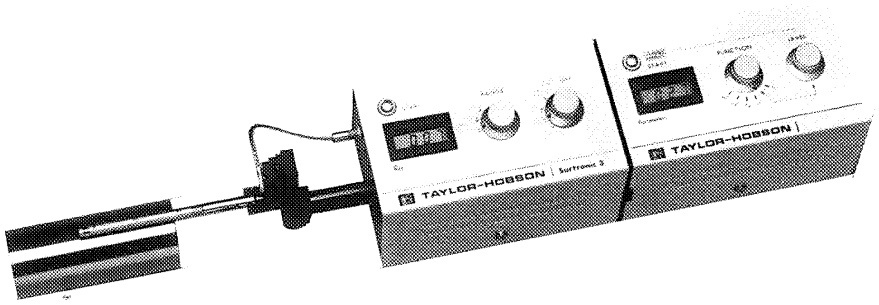


Figure 31 The display–traverse and parameter units.

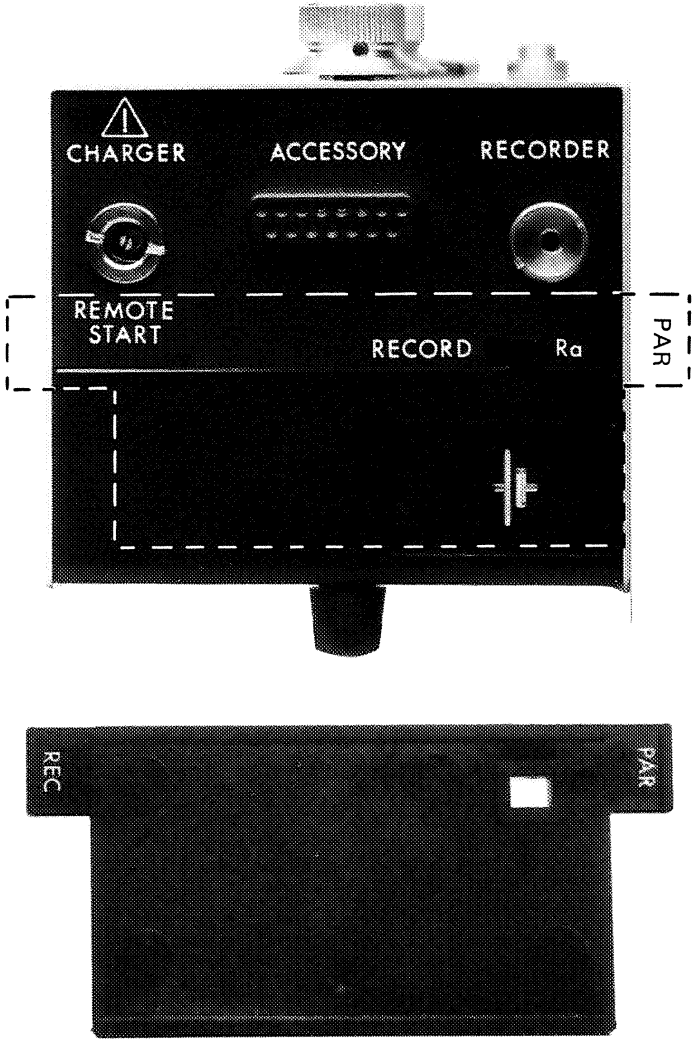


Figure 32 The switch plate.

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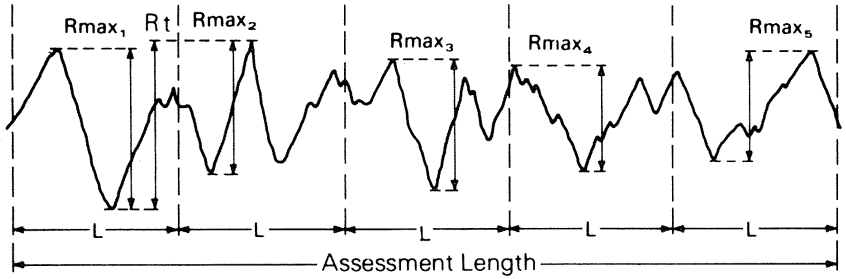
7.4 PARAMETERS

7.4.1 – Rt, Rtm

Rt is the maximum peak-to-valley excursion of the profile within the assessment length, see Figure 33.

Rtm is the mean of the maximum peak-to-valley values (Rmax) from each of five consecutive sampling lengths.

Rt is directly affected by any scratch or particle of dirt on the surface, but Rtm, being an averaged value, reduces the effect of spurious marks and gives a value more representative of the surface being measured.



$$Rtm = \frac{Rmax_1 + Rmax_2 + Rmax_3 + Rmax_4 + Rmax_5}{5}$$

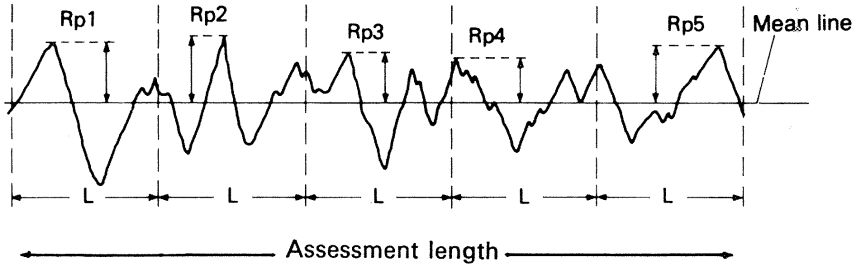
L = Sampling length

Figure 33 Derivation of Rt, Rtm

7.4.2 – Rp, Rpm

Rp is the maximum upwards excursion of the profile from the mean line within the sampling length. The parameter is assessed over five consecutive sampling lengths and the value displayed is the maximum Rp of the five. Thus in Figure 34 Rp_2 would be the Rp value of the whole length of profile because Rp_2 is greater than Rp_1, Rp_3, Rp_4 or Rp_5.

Rpm is the mean of the five individual Rp values. Like Rt and Rtm, Rp is directly affected by a particle of dirt or burr on the surface but Rpm reduces the effect.



$Rp = Rp_2$ in the illustration above

$$Rpm = \frac{Rp_1 + Rp_2 + Rp_3 + Rp_4 + Rp_5}{5}$$

Figure 34 Derivation of Rp, Rpm

7.4.3 – Peak count (Pc)

The peak count is the number of peak/valley pairs per inch projecting through a band of width *b* centred about the mean line (Figure 35). Although the count is determined only over the selected traverse length, the display indicates the proportional number *per inch* (25·4 mm). The peak count obtained from traverse lengths less than 25 mm is obtained by the use of a multiplication factor, this means that for the shorter traverse lengths the count will have a greater tolerance. The parameter should, therefore, be measured over as long a length as possible.

Figure 35 illustrates the method of assessing the count and it will be seen that although the second group

contains two *peaks* there is only one valley projecting below the level band, so these are assessed as one count only.

The level *b* is adjustable.
There can be an ambiguity of ±1 count over the assessment length because the inclusion or exclusion of the first or last peak will depend on where the traverse begins and finishes relative to the profile.

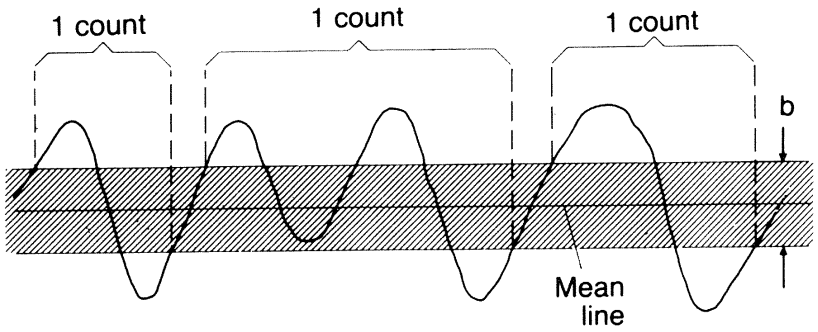
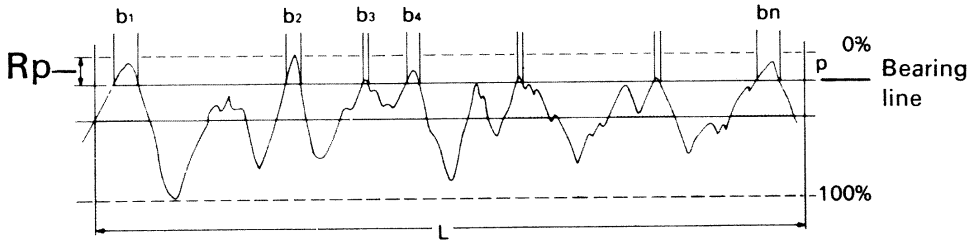


Figure 35 Derivation of Pc

7.4.4 – Bearing ratio (tp)

The bearing ratio is a measure of the length of bearing surface (expressed as a percentage of the assessment length) where the peaks have been cut off at a depth *p* below the highest peak (Figure 36).

When $p = 0$, tp is 0% because no part of the profile projects above the bearing line. When $p = Rt$, tp is 100% because all the profile is above the bearing line. By making a number of measurements at different depths *p*, between these two limits, and plotting *p* against tp, the bearing ratio (or Abbott-Firestone) curve can be drawn.



$$tp = \frac{b_1 + b_2 + b_3 + b_4 \ldots + b_n}{L} \times 100\%$$

Figure 36 Derivation of tp

7.5 THE PARAMETER MODULE

7.5.1 – Top panel (Figure 37)

Start button This operates in parallel with the start button on the display-traverse unit and either one can be used.

It has two functions:

1) When the Function switch is at any setting other than Level, pressing the button will start the traverse.
2) When the Function switch selects the level mode, pressing the Start button will cause the level to be displayed, but will not start the traverse.

Display Similar to the Ra display on the display-traverse unit. As with that display, three lines appear while the traverse is in progress, and an E (error) indicates that the parameter exceeds the range selected, or that the unit is faulty (e.g. faulty pick-up or break in the pick-up lead).

The range of values that can be displayed depends on the setting of the Range switch on the display-traverse unit as follows:

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Range switch	Rp, Rpm, Rt, Rtm	tp	Pc	Level
99·9 µm	0 – 199·9 µm	0 – 100%	0 – 1999 per in	0 – 199·9 µm
9·99 µm	0 – 19·99 µm	0 – 100%	0 – 1999 per in	0 – 19·99 µm
µin	0 – 1999 µin	0 – 100%	0 – 1999 per in	0 – 1999 µin

Function switch Six of the positions select the parameter required. The level position allows the level, set by the selector, to be displayed.

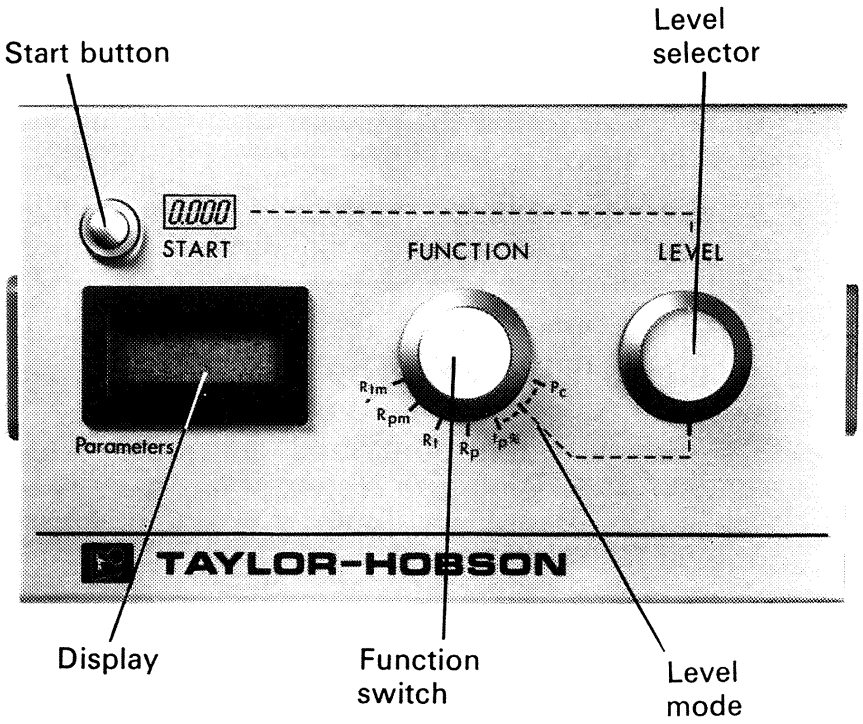


Figure 37 The top panel

Level selector This adjusts the width *b* of the band used for determining the peak count (see Figure 35) or the depth *p* (Figure 36) of the bearing line in the assessment of tp. The value of *p* (for tp) or *b* (for Pc) – in µm or µin according to the setting of the range switch – can be displayed for 20 seconds by setting the Function switch to Level and pressing the Start button. Keeping the button depressed will give a continuous display.

7.5.2 – End panels

One end panel (Figure 38) carries output sockets

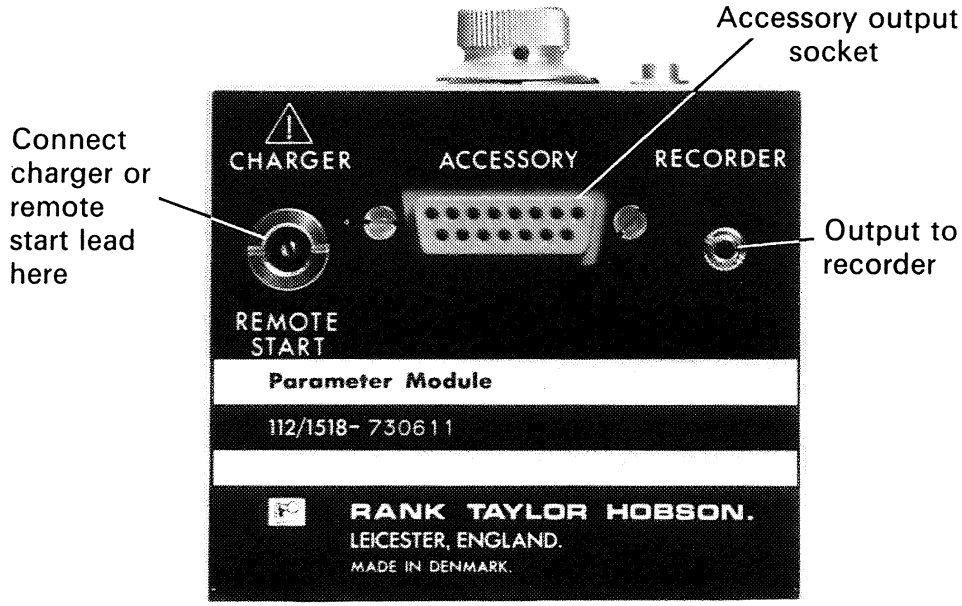


Figure 38 The end panel

duplicating those on the display-traverse unit; the other end panel carries the input connector.

If necessary a second parameter module can be connected to the accessory output socket to obtain a simultaneous display of two parameters, plus Ra. Consult RTH before connecting any non-RTH accessories to the accessories socket.

7.6 METHOD OF USE

To measure Rtm, Rt, Rp or Rpm, as well as Ra, set the PAR/REC switch plate to "AR" and then prepare the instrument to make a traverse over the surface in the usual way (see section 4.1) and select the required parameter. Press either Start button; at the end of the traverse the Ra and selected parameter values will be displayed. If E (error) is displayed, repeat the measurement using the higher range. To obtain other parameters, select the one required and repeat the measurement.

Before measuring tp, set the Function switch to "Level", press either Start button and turn the Level control until the required depth is displayed (the units will be µm or µin according to the setting of the range switch on the display-traverse unit). Then switch to "tp%" and press a Start button again. *Two* traverses will be made. During the first the instrument will measure Rp to set the internal level from which the selected depth is measured, it will not, however, be displayed. At the end of the second traverse tp% will be displayed. If required, the level can be expressed as a percentage of Rt by measuring Rt and then calculating the ratio:

$$\frac{\text{Level}}{\text{Rt}} \times 100$$

Before measuring Pc, similarly set the Level control to obtain the required peak-to-peak bandwidth (again in µm or µin according to the setting of the selector switch). Then turn the Function switch to Pc and press either Start button. At the conclusion of the traverse the peak count *per inch* will be displayed (even when the Range switch is set to a µm range).

7.7 OPERATING NOTES

i) Before use, check that the switch plate is set to "PAR" or "REC" as appropriate. It is easy to inadvertently press the switch plate when picking up the combined units.

ii) If the Function switch is moved during or after a traverse, the display on the parameter unit may disappear.

iii) If the Level control is adjusted during a traverse the tp or Pc value displayed may be incorrect, no error indication being given.

iv) If a second parameter module is connected, the level control on both can be set differently, to obtain a simultaneous measurement of either tp or Pc at two different levels.

v) Note that when the battery is approaching the discharged state, it may be able to drive Surtronic 3 alone, but not the combined Surtronic 3 and parameter unit. Therefore recharge the battery and check again before assuming that the parameter unit is faulty.

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8 — STAND

A stand (Figure 39) is available as an optional accessory to facilitate bench use of Surtronic 3.

Three special nuts are provided with the stand for securing the display-traverse unit to the supporting plate, after the feet fitted to Surtronic 3 have been unscrewed. A tee slot (Figure 40) enables work-holding fixtures to be secured to the base.

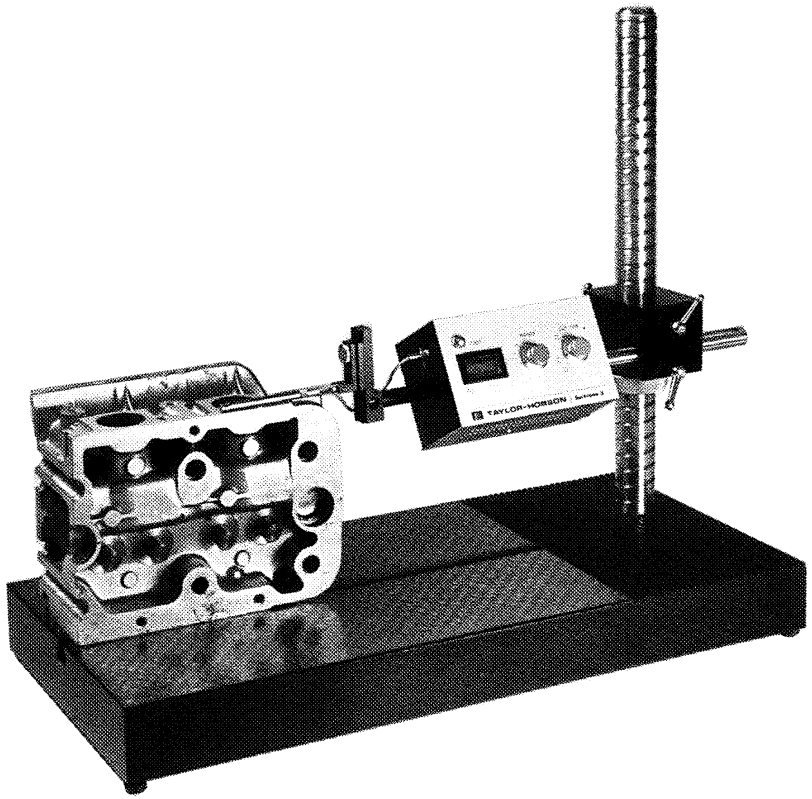


Figure 39 Surtronic 3 mounted on stand

The display-traverse unit can be mounted with the control panel horizontal, vertical, or inclined (as shown in Figure 39). When the unit is mounted with the control panel horizontal, the stylus will be directly above the centre of the tee-slot if the pick-up is set parallel to the slot.

When the parameter module is used, the display-traverse unit is unplugged from the module and mounted on the stand as described above. The parameter module is then connected to it by means of the interconnecting lead supplied with the module (see Figure 41).

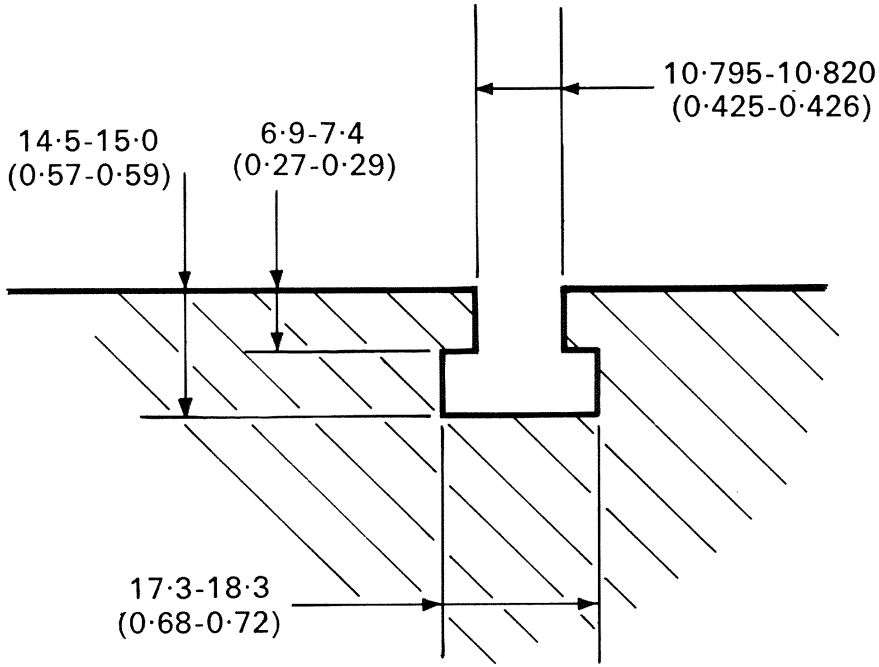


Figure 40 Dimensions of tee slot in millimetres (inches in brackets)

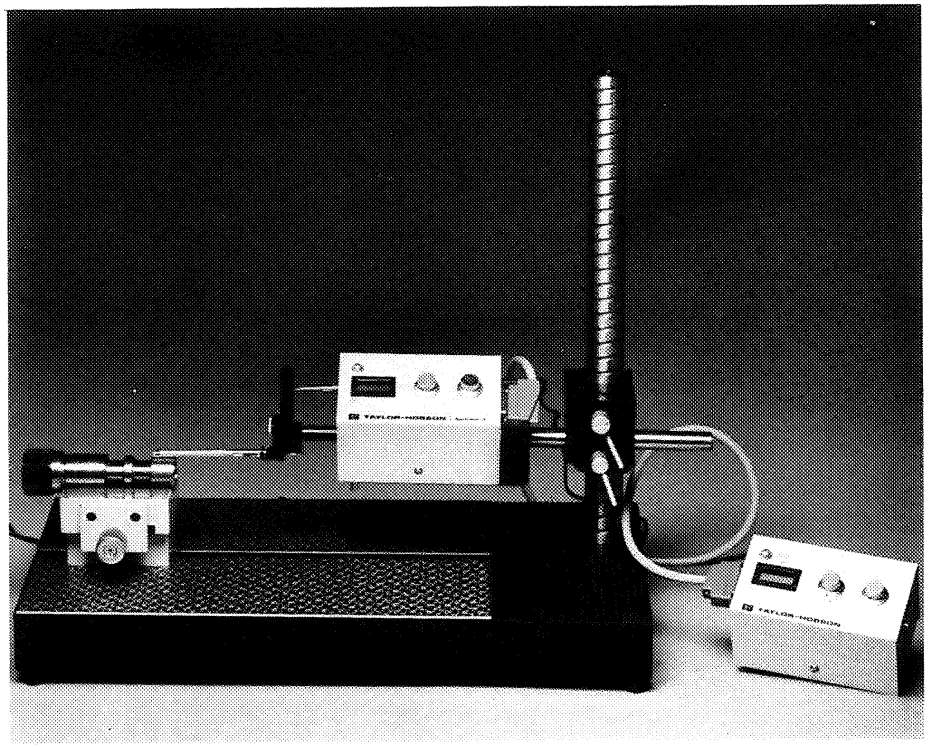


Figure 41

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9 — MAINTENANCE

9.1 CLEANING THE STYLUS

Occasionally clean the stylus with a camel hair brush moistened with a proprietary cleaning agent.

9.2 PICK-UP SKID

On those pick-ups having a rotatable skid, occasionally turn the skid round to present a new contact surface, thus reducing the effect of wear. It is clamped by the screw in the front, but when loosening it be careful not to let the retaining pin next to the skid fall out. When retightening the screw, make sure that the end cover is correctly positioned with respect to the stylus and that the stylus is free to move.

9.3 CHARGING THE BATTERY

Connect the charger to the mains and plug it into the socket marked "Charger". Leave the battery in the display-traverse unit. The instrument can be used while it is on charge.

If the battery is completely discharged, it will fully recharge in 14 hours.

The battery will give 2000–3000 measurements at normal 0·8 mm cut-off on one charge. This number will increase at shorter cut-offs and will be less at longer traverse lengths.

The consumption of the parameter module is approximately 50% of that of the display-traverse unit. This means that the number of measurements made from one charge, when the parameter module is in use, is reduced by about 33%.

9.4 CALIBRATION

The sensitivity of the instrument should be checked at regular intervals (e.g. monthly). It should also be checked whenever the pick-up is changed.

9.4.1 – The roughness standard

The sensitivity is checked with the roughness standard (Figure 42) supplied with the instrument. This comprises a ruled surface having an Ra value accurate to within 4%. Its value is engraved on the mount.

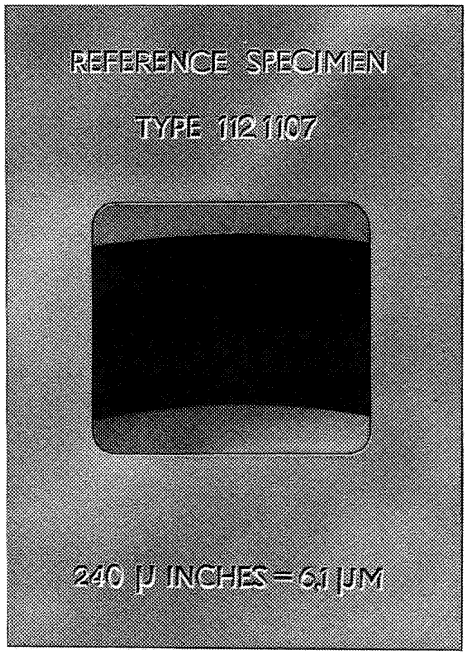


Figure 42 Roughness standard

A BCS calibration certificate can be supplied for this standard.

9.4.2 – Sensitivity check and adjustment

This can be done with any pick-up except the one with chisel-edge stylus (for this see section 9.4.3).

1) Place the standard on a flat surface and set up the instrument to make a traverse across it. Make sure that the pick-up body is parallel to the surface and that the stylus traverses the standard at right angles to the lay of the grooves.
2) Select cut-off 0·8 mm (0·03 in) and the 0–9·99 µm range.
3) Start the traverse and read the Ra value from the display. It should be equal to that engraved on the standard within 2%.
4) If it differs by more than this, use an instrument screwdriver to adjust the sensitivity adjuster marked "S" on the front end panel (Figure 7).

The recorder sensitivity is preset internally and requires no adjustment.

9.4.3 – Pick-up with Chisel-edge Stylus

The sensitivity of this pick-up can only be checked to an accuracy of ± 10 per cent with the roughness standard because of the shape of the stylus. To obtain this accuracy it is essential that the stylus is tangential to the curved ruling on the standard so that the traverse is made along a radius. Take several readings, repositioning the standard between each, and take the highest reading as the Ra value.

9.4.4 – Parameter module

No separate calibration is necessary for the parameter module. If the Ra sensitivity adjustment is correct (checked as described in section 9.4.2), the other parameters will also be correct.

9.5 SERVICING CONTRACT

United Kingdom

Users may wish to avail themselves of the Contract Servicing Scheme operated by RTH, whereby for a fixed annual charge, an RTH service engineer will pay twice-yearly visits to service the equipment.

Full details of the scheme are available upon request from:

The Service Manager,
Rank Taylor Hobson,
Gipsy Lane,
Leicester LE4 7DY
England
Telephone No: 0533 769131

Outside the United Kingdom

Servicing contracts abroad are negotiable with the distributor in the territory in which the equipment is used.

Particulars can be obtained from the distributor or direct from the address quoted above.

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