Installation manual/Inbetriebnahmeanleitung
Manuel d'installation
Linear Measuring System (LMS5.1)

4822 873 20464

PHILIPS

PHILIPS

CONTENTS

1 INTRODUCTION

The transducer LMS5.1 is basically an opto-electronic system that processes the reflected signal received from an optically grated scale.
The use of digital interpolation techniques enables very high resolutions to be achieved. Motion dependent output signals are RS422 compatible square waves S00 and S90 and the reverse signals S00N and S90N.

The optical signal is continuously scanned by a photocell array, which permits contamination of the scale and/or transducer to be monitored. In case of potential measurement problems, the system generates pre-alarm and/or alarm data.

Using the information given in this manual the Philips linear Measuring System can be correctly installed, aligned and serviced.
The information given in this manual is for various types of Transducers, Scales and Cables that comprise the Philips Linear Measuring System. These items embrace the following PE numbers.

1.1 ORDERING NUMBERS

Name	*Type*	*Ordering code*	*Service ordering code*
Transducers			
Transducer LMS 5.1 resolution 0,1 μm without area switch	PE 2520/20	9418 025 20201	
Transducer LMS 5.1 resolution 0,1 μm with area switch	PE 2520/30	9418 025 20301	
Transducer LMS 5.1 resolution 0,5 μm without area switch	PE 2520/40	9418 025 20401	
Transducer LMS 5.1 resolution 0,5 μm with area switch	PE 2520/50	9418 025 20501	
Transducer LMS 5.1 resolution1 μm without area switch	PE 2520/60	9418 025 20601	
Transducer LMS 5.1 resolution1 μm with area switch	PE 2520/70	9418 025 20701	
Accessories			
Optic cap.	PE 2521/10	9418 025 21101	
Flex. cap.	PE 2521/20	9418 025 21201	
Connectors			
12 pin fem. conn. LMS5.1	PE 2521/30	9418 025 21301	
14 pin fem. conn. LMS5.1	PE 2521/40	9418 025 21401	

for connections see fig. 22 and fig. 23

Name	*Type*	*Ordering code*	*Service ordering code*
Scales			
flat type			
Scale nom. length 240 mm	PE 2462/00	9418 024 62001	
Scale nom. length 480 mm	PE 2468/00	9418 024 68001	
Scale nom. length 720 mm	PE 2463/00	9418 024 63001	
Scale nom. length 960 mm	PE 2464/00	9418 024 64001	
square type			
Scale nom. length 240 mm	PE 2482/00	9418 024 82001	
Scale nom. length 335 mm	PE 2488/00	9418 024 88001	
Scale nom. length 480 mm	PE 2483/00	9418 024 83001	
Scale nom. length 720 mm	PE 2484/00	9418 024 84001	
Scale nom. length 960 mm	PE 2485/00	9418 024 85001	
Cables			
Extension cable LMS 5.1 (per meter)	PE 2523/00	9418 025 23001	
Installation parts			
Insulating plate			5322 466 92284
Insulating sleeve			5322 530 20821
Insulating washer			5322 532 52046

In order to install suitable measuring system for a particular application a choice of each item is available. The degree of accuracy required will of course determine the time spent for accurate mounting as well as the items needed to install the system.

In the same way the tools and extra materials required for the installation will also need to be considered and made available before any steps are taken (these are not provided by Philips).

It is for this reason that the differences and general requirements of these items are outlined in each chapter and should be read before proceeding with the installation.

At the end of this manual are two drawings giving the necessary assembly information for both types of scales.
Extracts from these drawings have been used in chapter 4, where a detailed description of each is also given.

2 TRANSDUCERS PE 2520/20 AND UPWARDS WITH OR WITHOUT AREA SWITCH

The types of transducers are very similar: transducers with an build in area switch and transducers without. The significance of this is that the triggering of the area signal for reference point search (refer to chapter 5) is accomplished in different ways.

The build in area switch (figure 2) is triggered by a vane (an inductive cam) mounted on the same side as the scales at the selected location of the reference point. The material of the vane must be steel or cast iron and is not supplied.

When using the types without area switch (figure 1) a micro-switch must be fixed externally . To activate it, a cam will need to be mounted at the appropriate point along the axis.
To adjust the reference point setting refer to chapter 5.

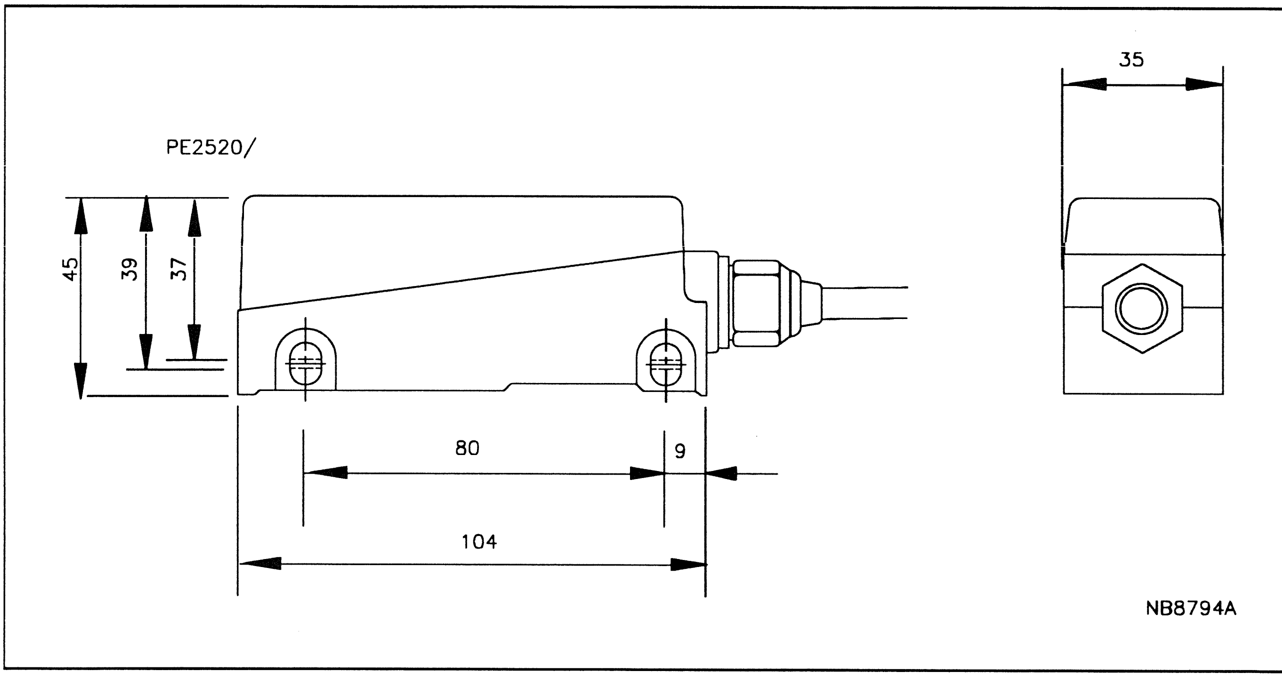


Fig. 1 PE2520 without area switch

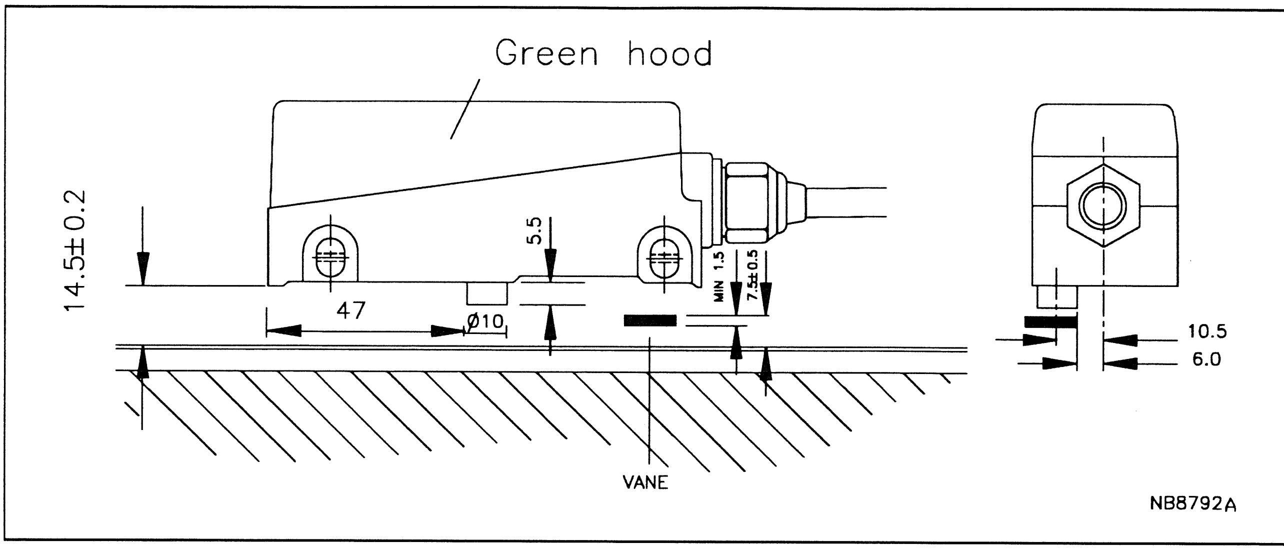


Fig. 2 PE2520 with area switch

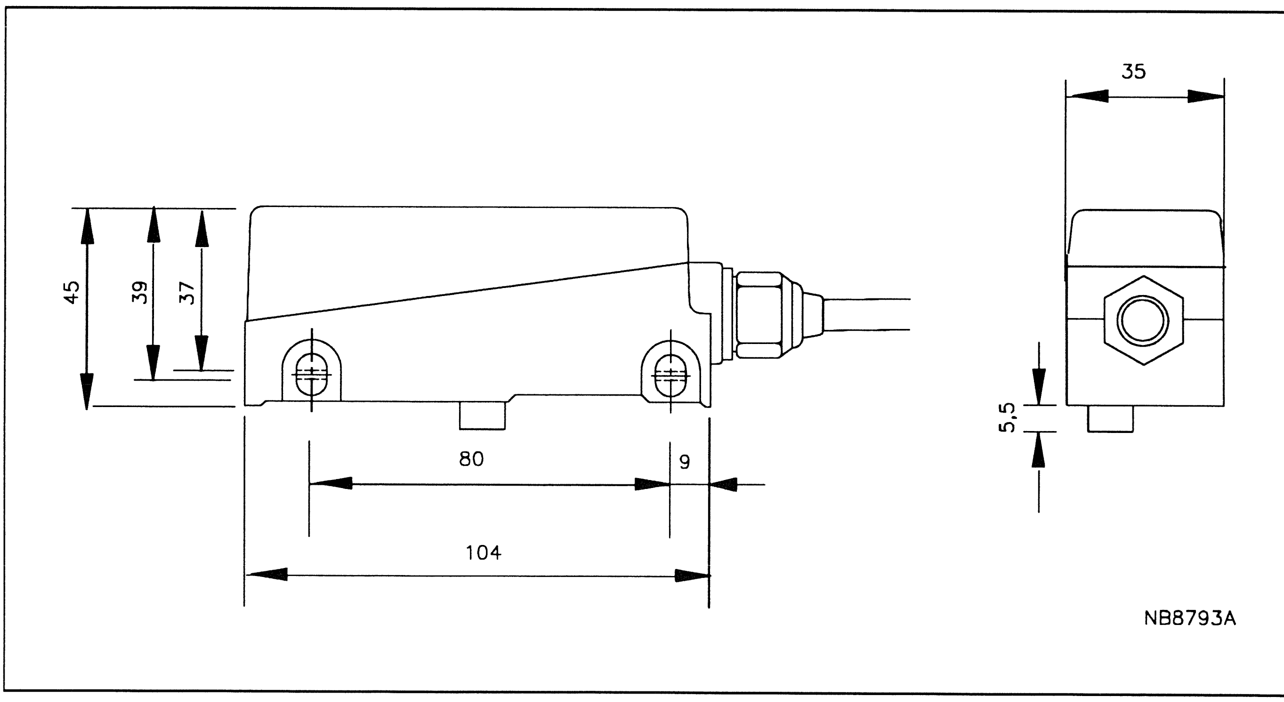


Fig. 3 PE2520 with area switch

2.1 MOUNTING

The transducers (one per axis) are normally attached to the moving slide while the scales are attached to the machine tool frame; this can be changed around if more convenient. If necessary the transducers should be attached with a mounting bracket (not supplied); its shape being determined by the type of machine tool being used (an example is given in figure 4)

The transducer is mounted with two 5 mm Allen bolts. Insulating plate, sleeves and washers are provided to prevent earth loops as shown in figure 5. A cable is standard connected (fixed) to the transducer. A plug can be supplied for extensions of the cable. The total length of the transducer is as shown in figure 6 (including swivel and cable).
The position of the transducers in relation to the scales is given in detail in chapter 4.

The gap between transducer and scale as shown in figure 5 is 14.5 ± 0.2 mm. This spacing (and parallelism - for square scales only) between scale and transducer can be determined by using a spacing block made from aluminium, the dimensions of which are given in figure 7. It must also be noted that the centre of the transducer lens must coincide with the centre of the scale, where a tolerance of 0.2 mm maximum must be observed (figure 5).

The mounting holes on the bracket must be drilled and tapped with M5 thread. These holes must be aligned centrally to the transducer mounting holes to enable minor corrections for the final adjustment of the transducer. The final adjustment is also described in chapter 4

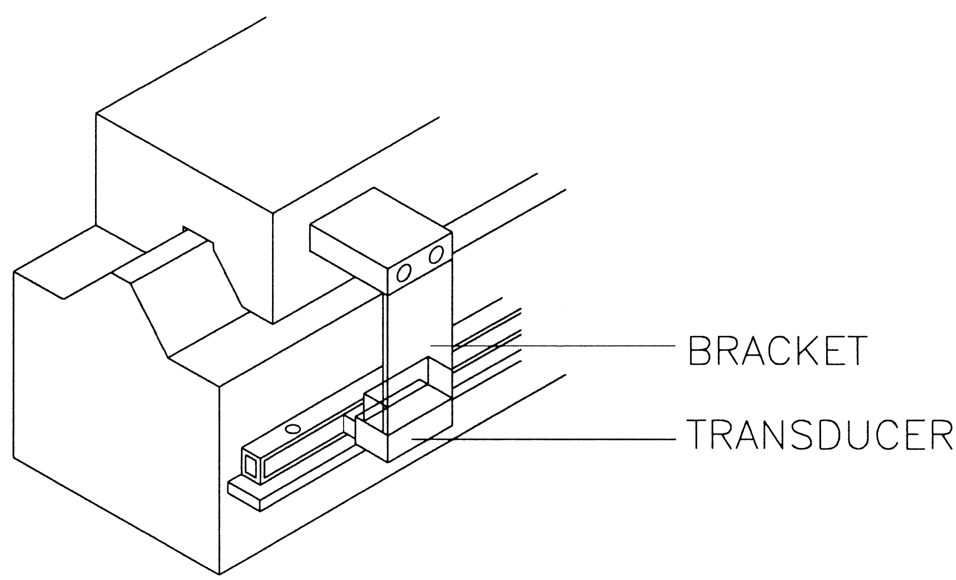


Fig. 4 Mounting bracket (example)

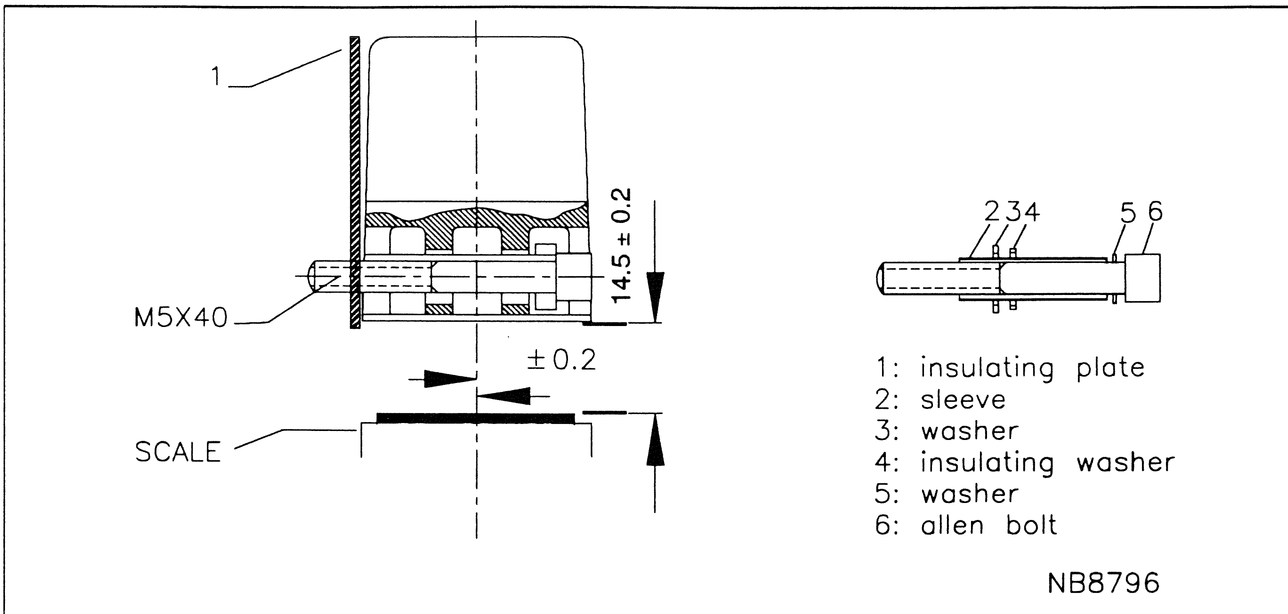


Fig. 5 Transducer mounting fixtures

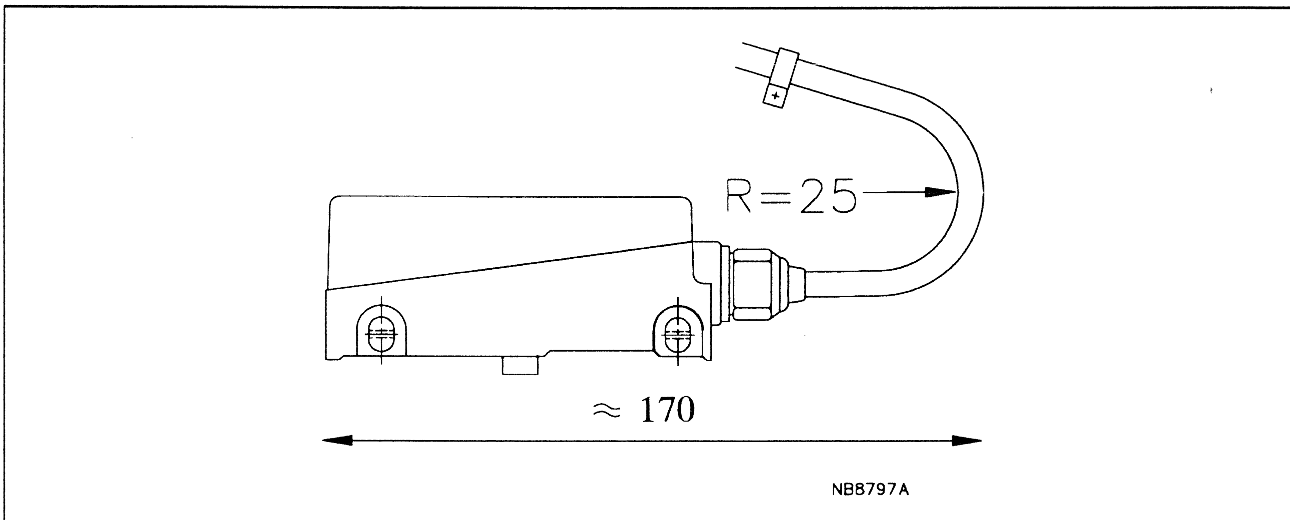


Fig. 6 Overall length

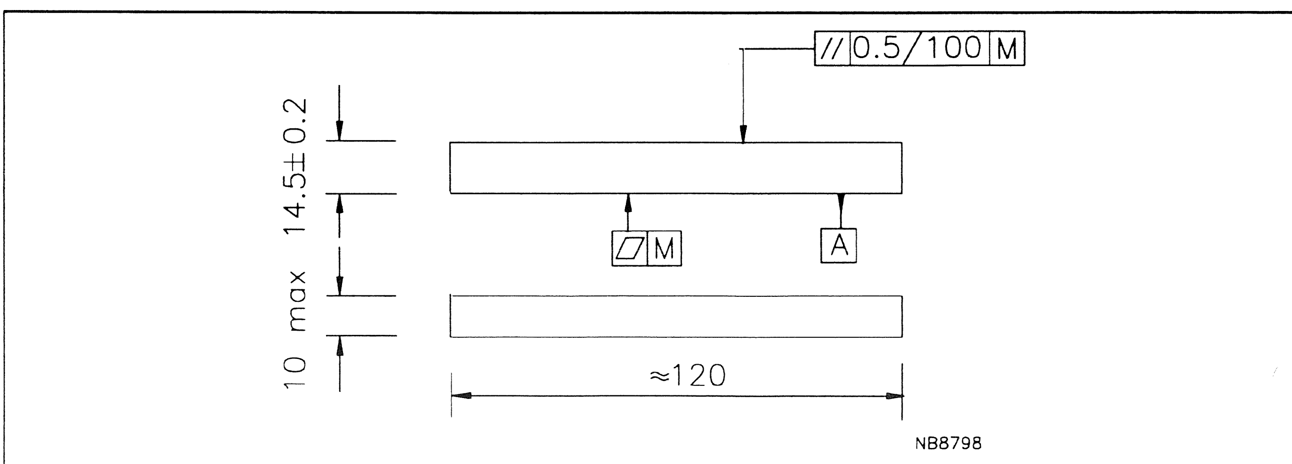


Fig. 7 Spacing block

3 SIGNAL DESCRIPTION

The following paragraph gives a description of the output for the LMS5.1 measuring system. This chapter gives suggestions of how to connect the LMS5.1 to subsequent electronics (remark: use the 5V power supply for the LMS5.1).

3.1 INCREMENTAL SIGNALS S00, S90, S00N AND S90N.

S00 and S90 and the reverse signals S00N and S90N are signals (figure 8) according to RS422 standard . S90 is shifted in phase by 90 degrees with reference to S00 to discriminate the direction of the movement.

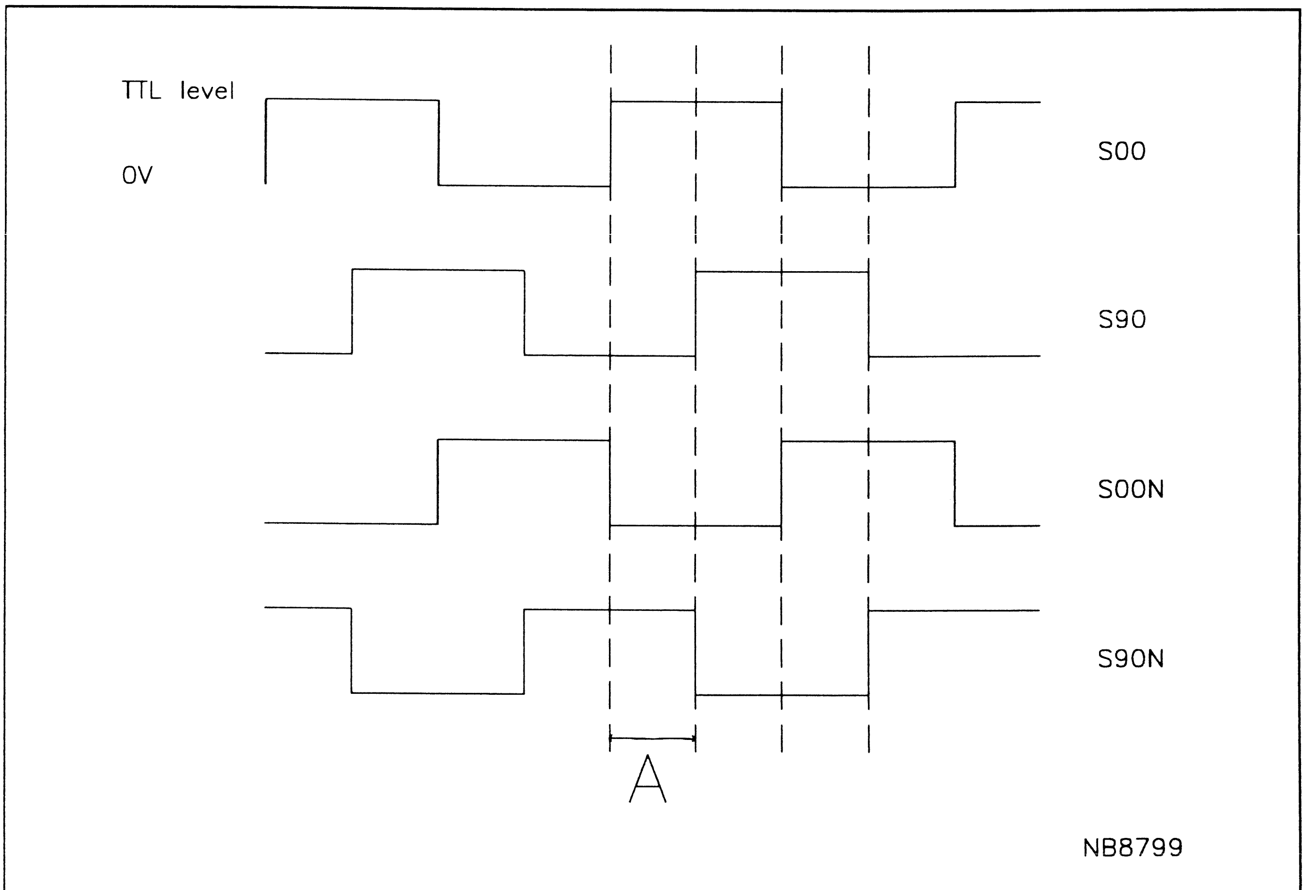


Fig. 8 S00/S90 signals

Remark: The distance between two S00/S90 edges (A) :

- At resolution of 0.1 µm and traverse speed 50 m/min ≥ 0.1 µsec
- At resolution of 0.2 µm and traverse speed 50 m/min ≥ 0.2 µsec
- At resolution of 0.5 µm and traverse speed 100 m/min ≥ 0.3 µsec
- At resolution of 1.0 µm and traverse speed 100 m/min ≥ 0.6 µsec

Depending on the chosen resolution the displacement output signals S00 and S00N resp. S90 and S90N have a maximum frequency. Because of the internal processing of the signals the following maximum frequencies (figure 9-12) are given out as the output.

S00/S90 frequencies:

The continuous line is the mean value, the dashed lines is the maximum possible frequency.

max. 2.5 MHz for 0.1 micrometer resolution at max. speed of 50 m/min.

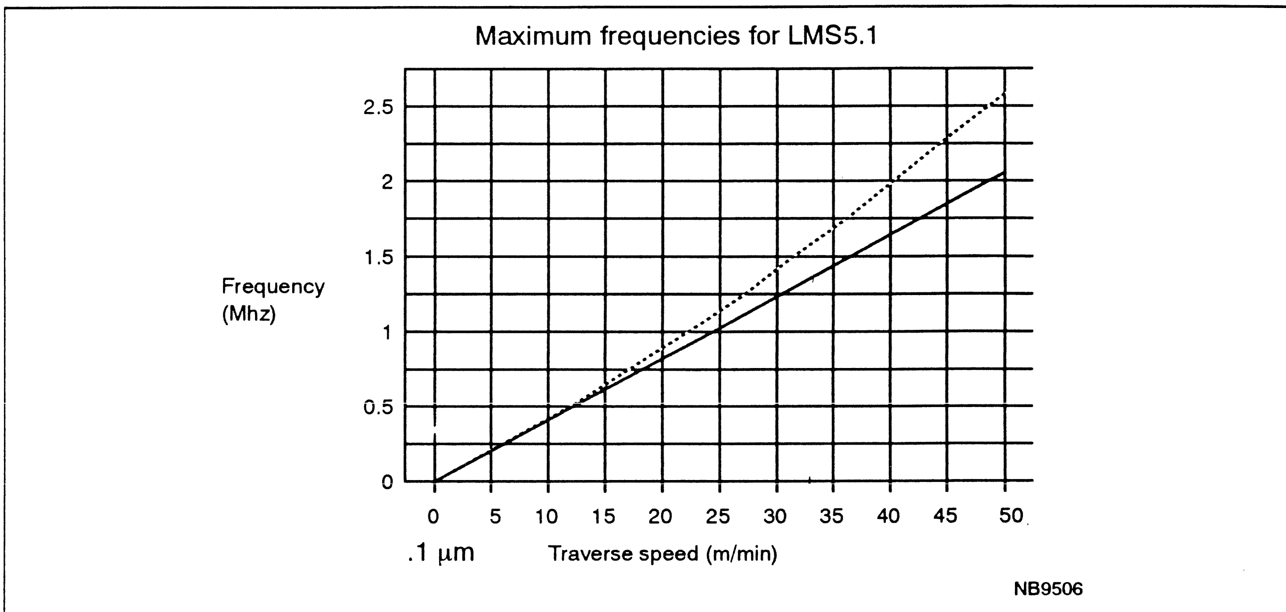


Fig. 9 S00/S90 frequencies for LMS5.1 (.1 µm resolution)

max. 1.25 MHz for 0.2 micrometer resolution at the max. speed of 50 m/min.

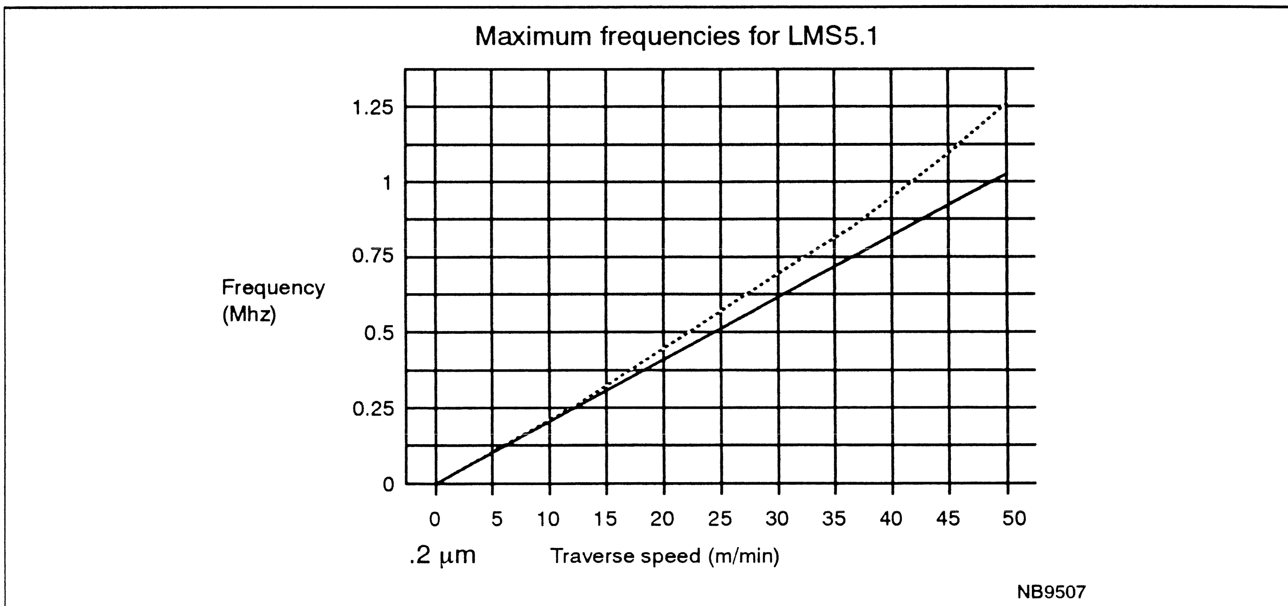


Fig. 10 S00/S90 frequencies for LMS5.1 (0.2 µm resolution)

max. 0.95 MHz for 0.5 micrometer resolution at the max. speed of 100 m/min.

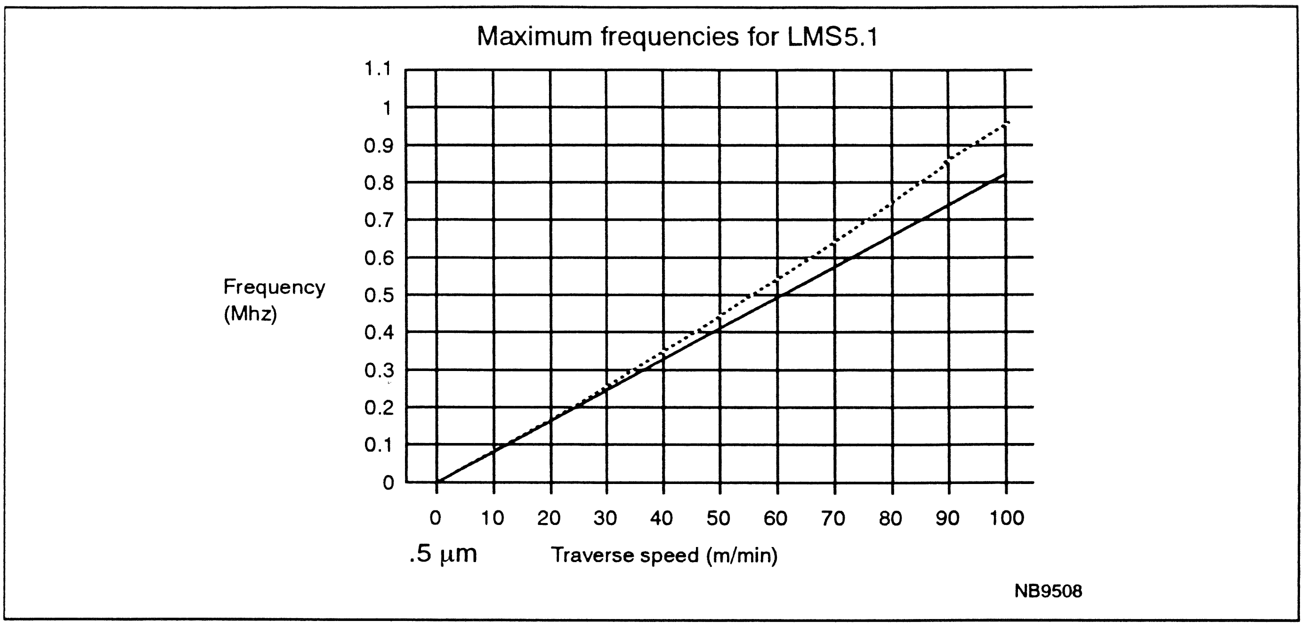


Fig. 11 S00/S90 frequencies for LMS5.1 (0.5 µm resolution)

max. 0.42 MHz for 1 micrometer resolution at the max speed of 100 m/min.

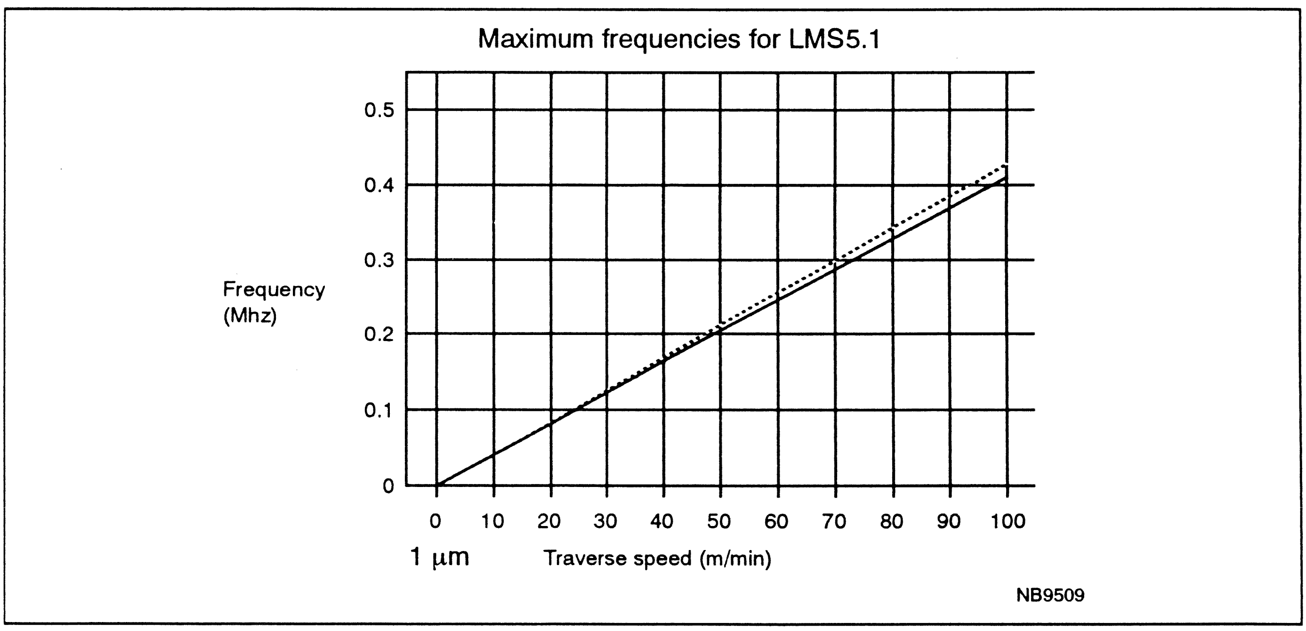


Fig. 12 S00/S90 frequencies for LMS5.1 (1 µm resolution)

As the displacement signals are complementary, the use of a dual line receiver is advisable (75175, MC3486 etc.). Figure 13 shows an example of how to connect subsequent electronics.

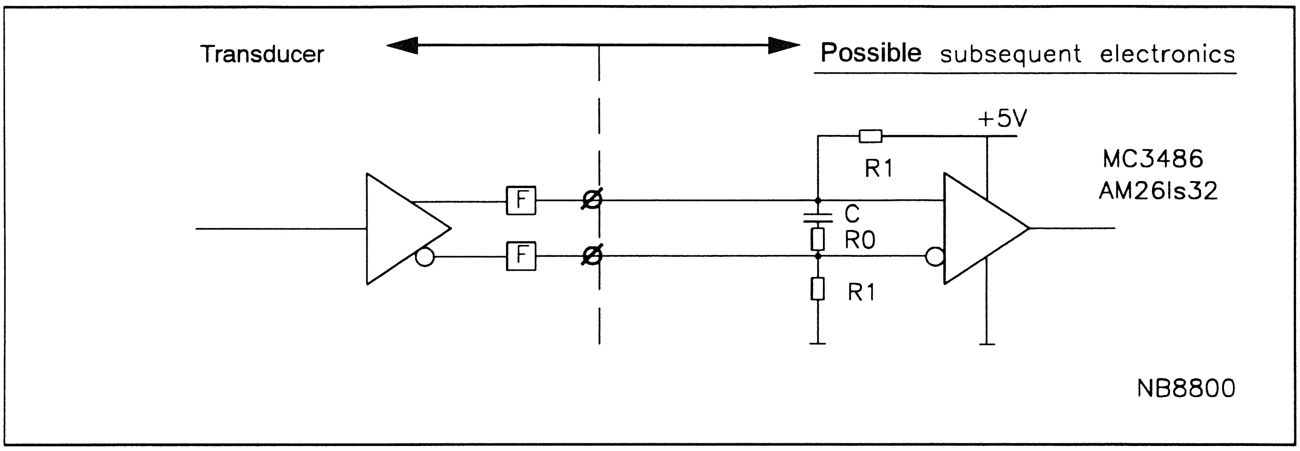


Fig. 13 Subsequent electronics

- R1=4,7K Ω prevents switching of the receiver in case of cable break.
- C =1..10 nF
- R0=120..140Ω Philips cable characteristic impedance.

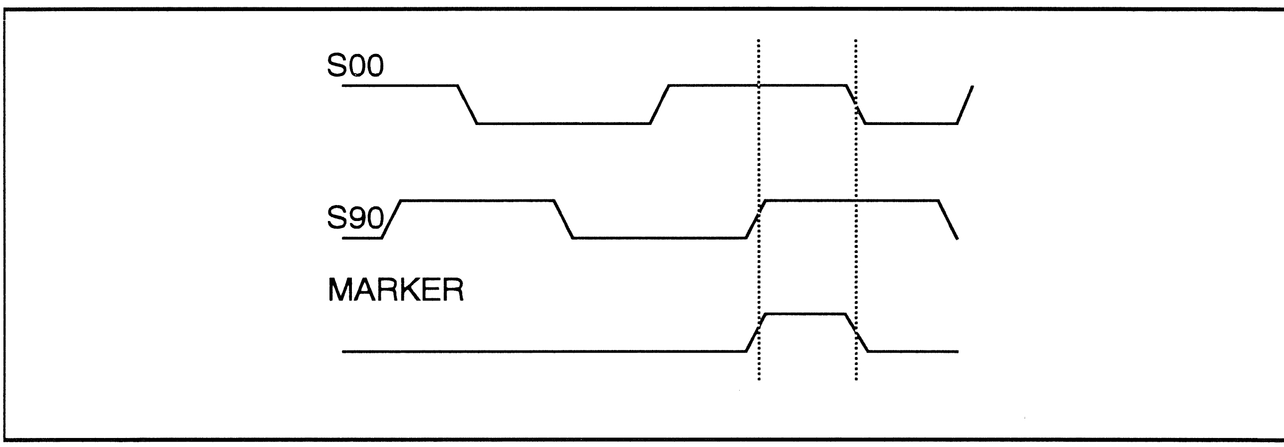


Fig. 14 Position of marker to S00 and S90

3.2 REFERENCE SIGNALS (MARKER and MARKERN)

MARKR and its reverse MARKRN are signals according to RS422 standard. These are reference signals generated at a specific position within each pitch of the scale, i.e., at every 635 microns.

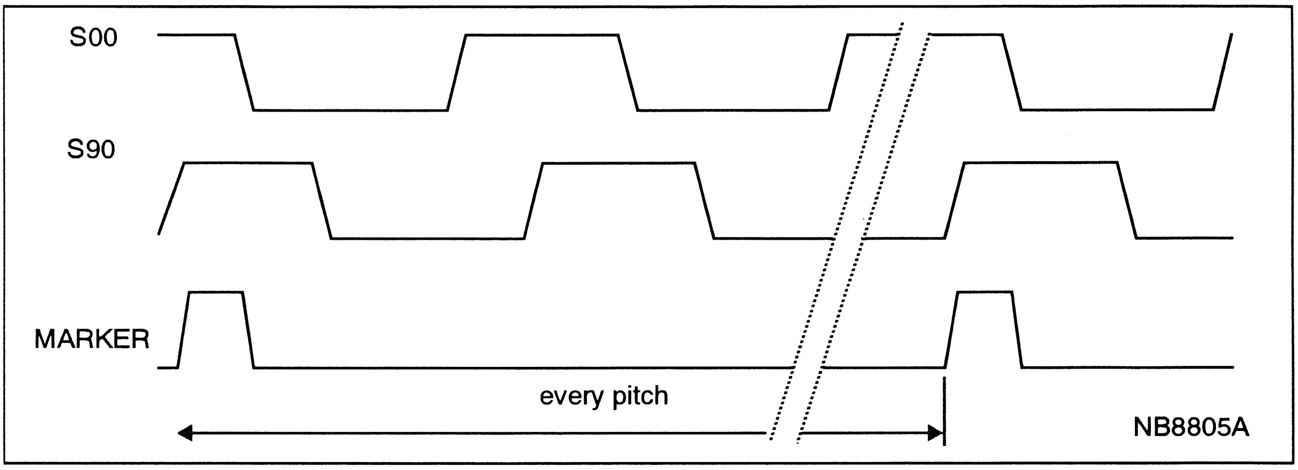


Fig. 15 Marker signals of PE2520/20 and upwards

Remark: for the transducer without area switch the marker signal is always active (figure 15) and is generated every 635 μm. In case of using the transducer with build in area switch the marker signal is generated once after the area signal is active (figure 16).
The marker pulse is synchronised with the high status of S00 and S90

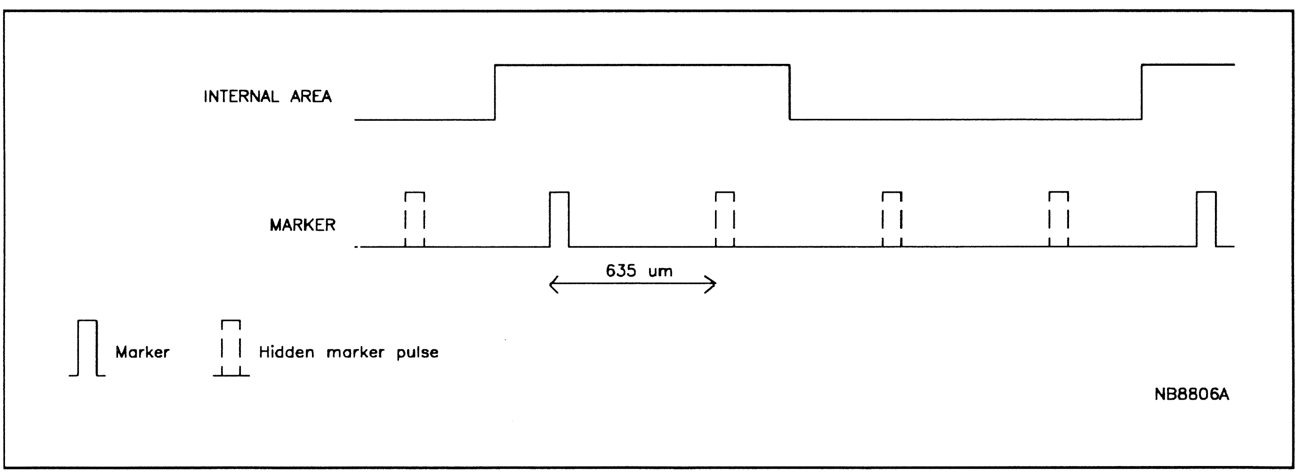


Fig. 16 Marker signals of PE2520/20 and upwards

Remark: the MARKR pulse depends on the transducer resolution and the frequency of S00/S90 signal (i.e. slide velocity) with a width of :

min. 100 ns at 0.1 micrometer resolution.

min. 200 ns at 0.2 micrometer resolution.

min. 250 ns at 0.5 micrometer resolution.

min. 500 ns at 1. micrometer resolution.

For suggested subsequent electronics See figure 13.

3.3 AREA SIGNAL

The AREA signal (made by the area switch) is used to determine the pitch the marker reference is used. The reference point is found on the coincidence of the AREA signal with the marker pulse. An external area switch and cam have to be installed in case of the transducer types without a build in area switch

For the types with a build in area switch, the AREA signal has the following specification:

V out L = ≤ 0.8 V at I out = -20mA
V out H = ≥ 3 V

AREA will be high if the build-in proximity switch is activated by an inductive cam, placed in the relevant position. If the area signal is active the transducer then generates a single marker pulse which is used to establish the machines reference point.

figure 20 shows an example how to connect the AREA to subsequent electronics.

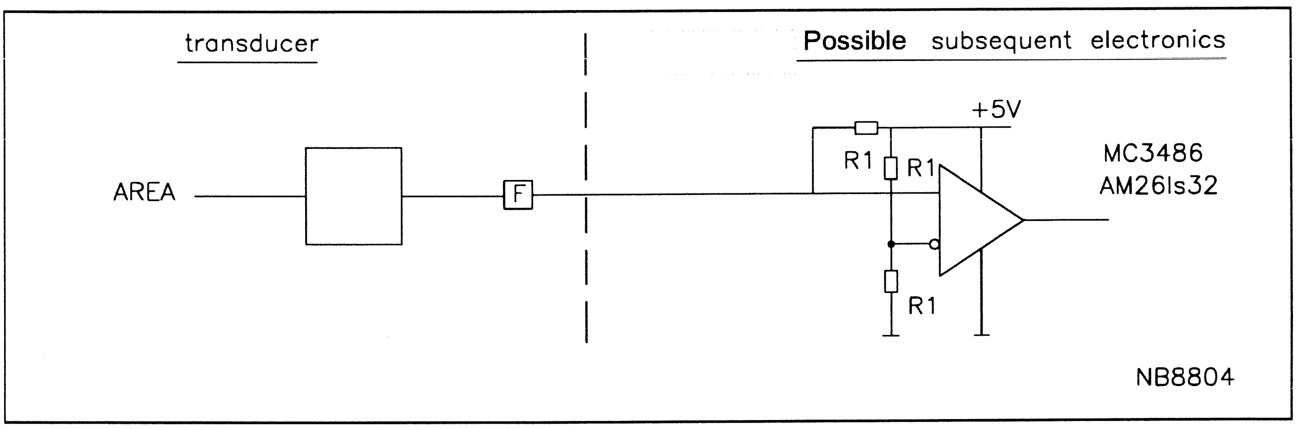


Fig. 17 Subsequent electronics for the area signal

- R1=4,7K Ω prevents switching of the receiver in case of cable break.
- C =1..10 nF
- R0=120..140Ω Philips cable characteristic impedance.

3.4 PRE-ALARM

The signal PREALM has the following specifications :

V out L = ≤ 0.5V at I out = -20mA
V out H = ≥ 2.5 V at I out= 20mA

The PREALM signal is generated at the following circumstances:

Transducer without build in area switch:
- if contamination on the scale or transducer lens exceeds a fixed pre-set level.

Transducer with build in area switch:
- if contamination on the scale or transducer lens exceeds a fixed pre-set level.
- if the AREA-signal is too close to the marker pulse. See chapter 5 for proper installation.

The opto electronics circuit detects contamination on the scales or transducer lens. Although the system is very insensitive to contamination, at a certain degree of contamination a prealarm signal is generated to warn the machine operator.
When the PREALM-signal is active the system is still working properly (NO LOSS OF S00/S90 PULSES). The user should clean the scale/transducer.

PREALM has a minimum pulse width of 160 msec and stays active as long as the contamination is present.

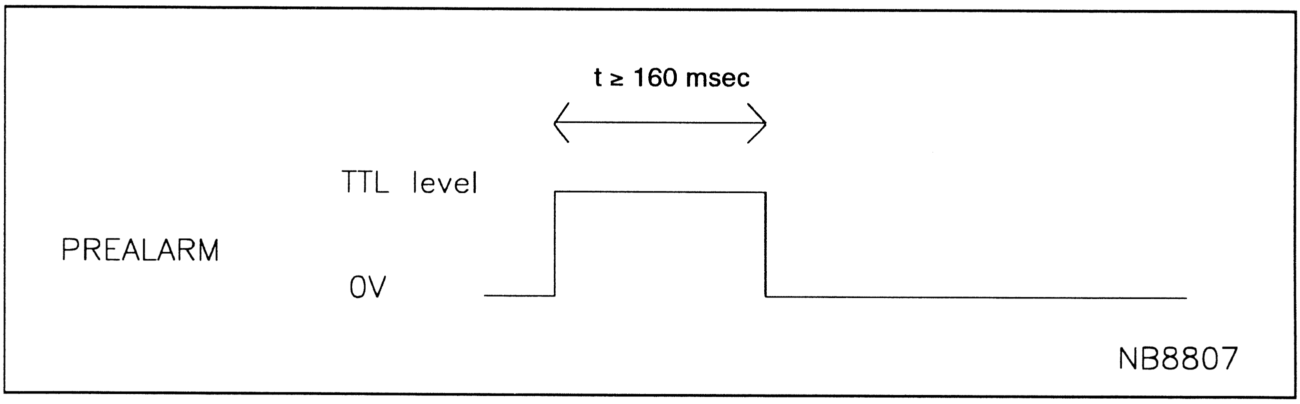


Fig. 18 Prealarm signal

figure 19 shows an example how to connect the PREALM to subsequent electronics.

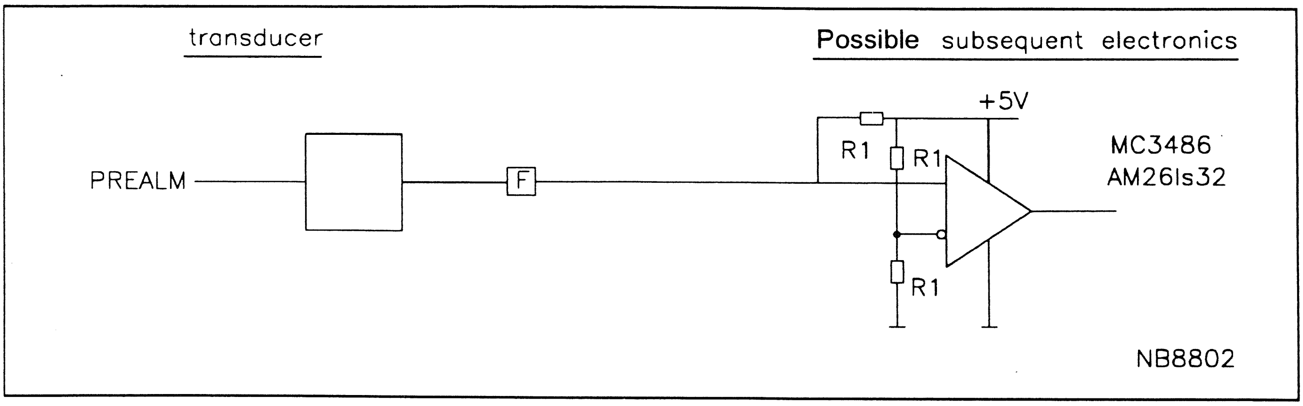


Fig. 19 Subsequent electronics for the PRE-ALARM signal

- R1=4,7K Ω   prevents switching of the receiver in case of cable break.

3.5 ALARMN

The signal ALARMN has the following specifications :

V out L = ≤ 0.5V at I out = -20mA
V out H = ≥ 2.5 V at I out= 20mA

If contamination is too high on the scale or transducer, or an operational error occurs, such as exceeding the maximum traverse speed, then this signal is given. The ALARMN signal, has a minimum pulse width of 160 msec and is 0V when active.

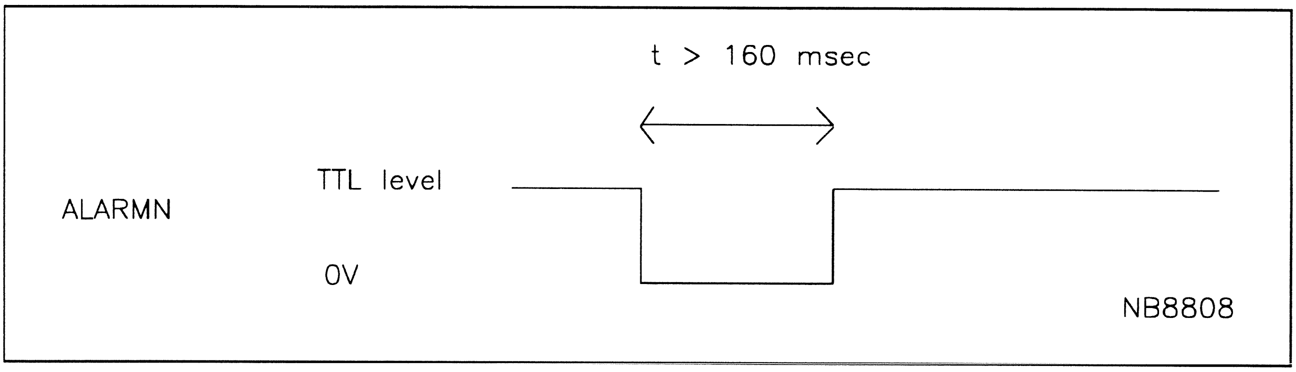


Fig. 20 Alarm signal

figure 21 shows an example how to connect the ALARMN to subsequent electronics.

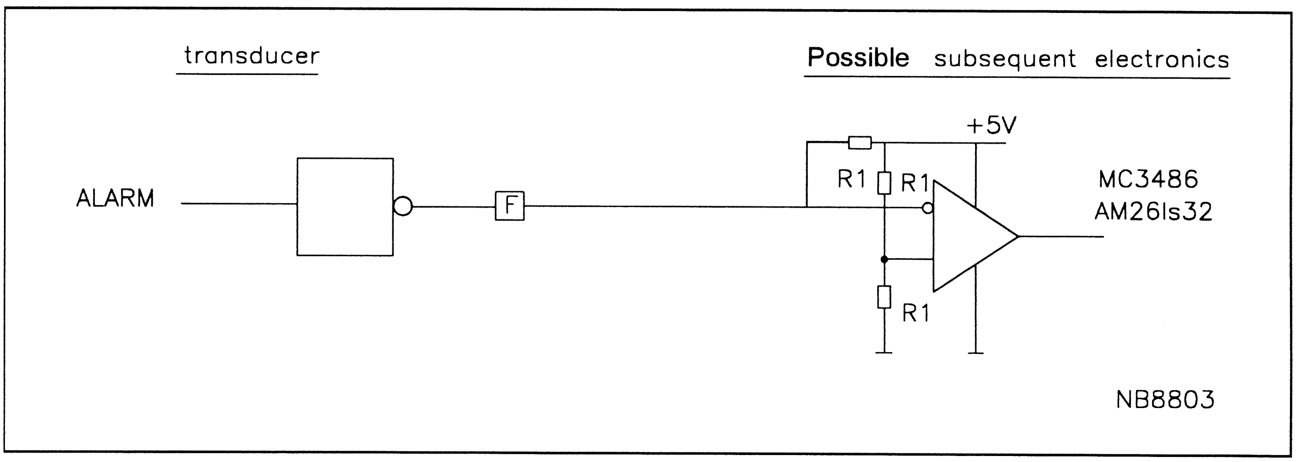


Fig. 21 Subsequent electronics for the ALARMN

- R1=4,7K Ω — prevents switching of the receiver in case of cable break.
- C =1..10 nF
- R0=120..140Ω — Philips cable characteristic impedance.

3.6 TSINE

TSINE is an output signal for testing the optical scale reflection. Only to use by service engineers.

V_{sine} = 2 $V_{p\text{-}p}$ (V_{DC} = 2.5 V).
f_{nom} = 3.15 kHz.

3.7 POWER SUPPLY

The PE2520/20 and upwards should be supplied with a 5V DC source. The technical data for the power supply is +5V_{DC} with a tolerance of ± 5% (measured at the open end on the transducerside of the extension cable).

The transducer has power supply sense lines, if these sense facilities are not used, it is recommended to connect the 0 volt and the 0 volt $_{sense}$ together and the 5 volt and the 5 volt $_{sense}$ together to decrease cable voltage drop.

3.8 POWER-UP

To prevent uncontrolled generation of output signals immediately following power-up, the output signals S00, S90, MARKR, ALARM and PREALM are reset to 0 V for a maximum of 40 ms after power has been turned on.

3.9 WIRING-UP

The length of the connection cable linking the transducer with the read-out, or numerical control, can be up to 100 m when using the sense lines, and up to 50 m when using no sense lines.
The cable-run must be chosen so as to protect the cable from damage by machine parts or swarfs. The cable can be slipped into position or run in plastic or steel conduit. Care must be taken not to puncture the outer plastic coating of the cable since the metal screening underneath must be electrically insulated from the machine tool.
Cables from the transducer can safely be clipped close together. They should be spaced at least 25 cm from other current carrying cables, unless they are separated by steel conduits.
Reference must be made to the relevant documentation for the wiring of the plugs of the electronic system being used.

The transducer is delivered with a fixed 2 m cable, figure 22 and 23 shows the cable along with the wire description. To extend the cable use the Philips extension cable.

The screening of the cable should be connected at one side to the shielding of the extension cable via the metal housing of the recommended connectors and on the other side to the ground (housing) of the subsequent electronics.

Extension cable :

Cable type	:	14 cores twisted pair with overall shielding		
		$(5*2)*0.14mm^2$ + $(2*2)*0.25mm^2$		
Ordering code	:	PE2523/00	9418 025 23001	PHILIPS

Pin	Signalname	Colour
1	S90 N	yellow
2	+ $5V_{sense}$	white/green
3	Marker	gray
4	Marker N	pink
5	S00	white
6	S00 N	brown
7	Alarm N	red
8	S90	green
9	Area *)	blue
10	0V	gray/pink
11	$0V_{sense}$	brown/green
12	+5V	red/blue

*) optional

Note: *the violet and black wire has to be bend back and isolated*

Fig. 22 Connections 12-pole male connector

Pin	Signalname	Colour
1	S90 N	yellow
2	+ $5V_{sense}$	white/green
3	Marker	gray
4	Marker N	pink
5	S00	white
6	S00 N	brown
7	Alarm N	red
8	S90	green
9	Area *)	blue
10	0V	gray/pink
11	$0V_{sense}$	brown/green
12	+5V	red/blue
13	Prealm	violet
14	Tsine	black
15	n.c.	-
16	n.c.	-

*) optional

Fig. 23 Connections 16-pole male connector

4 SCALES

The type of scale used is generally dependent on the available mounting space and on the degree of accuracy required. The flat scales type PE 2460 give a more accurate measuring system than the type PE 2480 square scales. To maintain this higher degree of accuracy the mounting tolerances (given in the dimensional drawings) are more critical for the flat scales.

Furthermore, the surface roughness should also be taken into account when mounting the flat scales; surface tolerance of < 0.05 mm peak to peak. The possibility may arise that due to the shape or surface finish of the frame or machine tool the flat scales cannot be mounted to within these tolerances. In this case a mounting beam made from cast-iron or steel must then be provided by the machine tool builder, shaped in a particular way to mount the flat scales correctly.

The series PE 2480 square scales on the other hand are generally used in applications where the mounting surface is not to a high standard of finish and the installation therefore less complex. This compromise is enhanced by the self aligning washers (supplied and fitted) which give flexibility and rigid support on the mounting surface.

In both cases the various degrees of freedom that are experienced while moving along an axis can affect the accuracy of the system. To minimize this effect the following tolerances should be observed (also refer to figure 24):

When α varies during movement of the transducer
over 0.02°, the maximum error is 5 μm
or
over 0.01°, the maximum error is 2.5 μm.

When A varies during movement of the transducer
over 0.1 mm and α is 0.1°, the maximum error is 0.2 μm
or
over 0.1 mm and α is 0.01°, the maximum error is 0.02 μm.

When β varies during movement of the transducer
over 0.1°, the maximum error is 0.12 μm
or
over 0.5°, the maximum error is 0.6 μm.

When B (figure 24) varies during movement of the transducer
over 0.1 mm, the maximum error is 0.5 μm
or
over 0.2 mm, the maximum error is 1 μm.

The influence of the variation of γ on the accuracy during movement of the transducer is minimal. The scales are normally attached to the machine tool frame and the transducer on the moving slide; this can be changed around if more convenient. In either case the scale must be mounted in such a position that it lies parallel to the direction of movement of the axis it is required to measure and as close as practically possible to the tool spindle.
Furthermore, it is advisable to mount the scales with the gratings in a vertical position to minimize the build-up of dirt on it.

The subsequent paragraphs describe the scales in detail and the corresponding pull-out drawing (end of manual) should be referred to simultaneously.

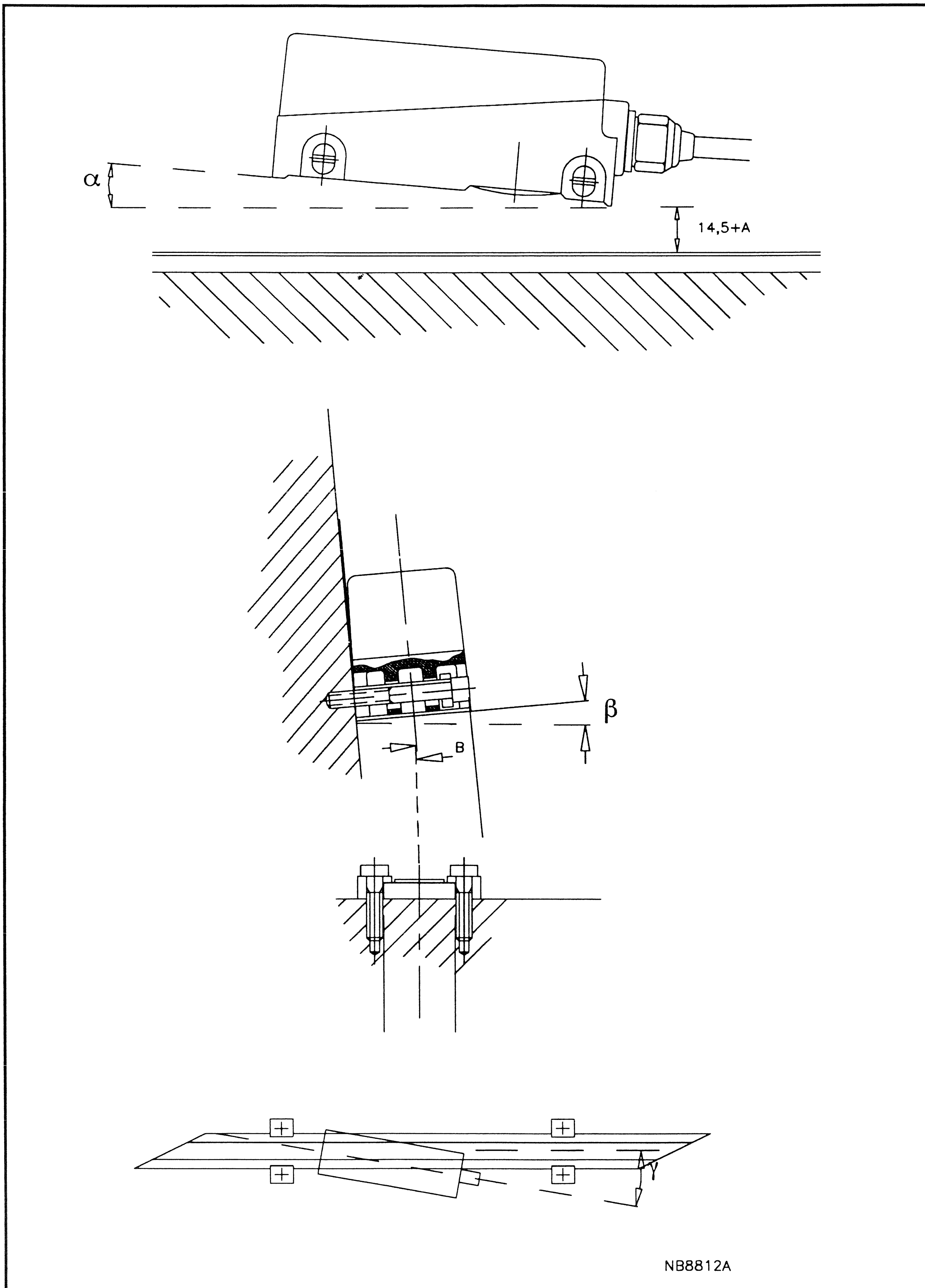


Fig. 24 Dynamic tolerances between transducer and scale

4.1 FLAT SCALES - PE 2460 SERIES

Effective measuring length

The effective (or nett) measuring length is the maximum length of a scale or assembly of scales that can be measured. This is determined by the size of the field of view of the transducer which is shown in figure 25.

The effective measuring length can be calculated by subtracting 30 mm from the nominal total length.
Example:

Nominal length = 960
-30
930 = Effective length

When installing the scales however, the overall length should be taken to establish the actual length needed for the complete assembly. The overall length of the scale (or assembly of scales) can be calculated by adding 22 mm to the nominal total length.
Example:

Nominal length = 960
+22
982 = Overall length

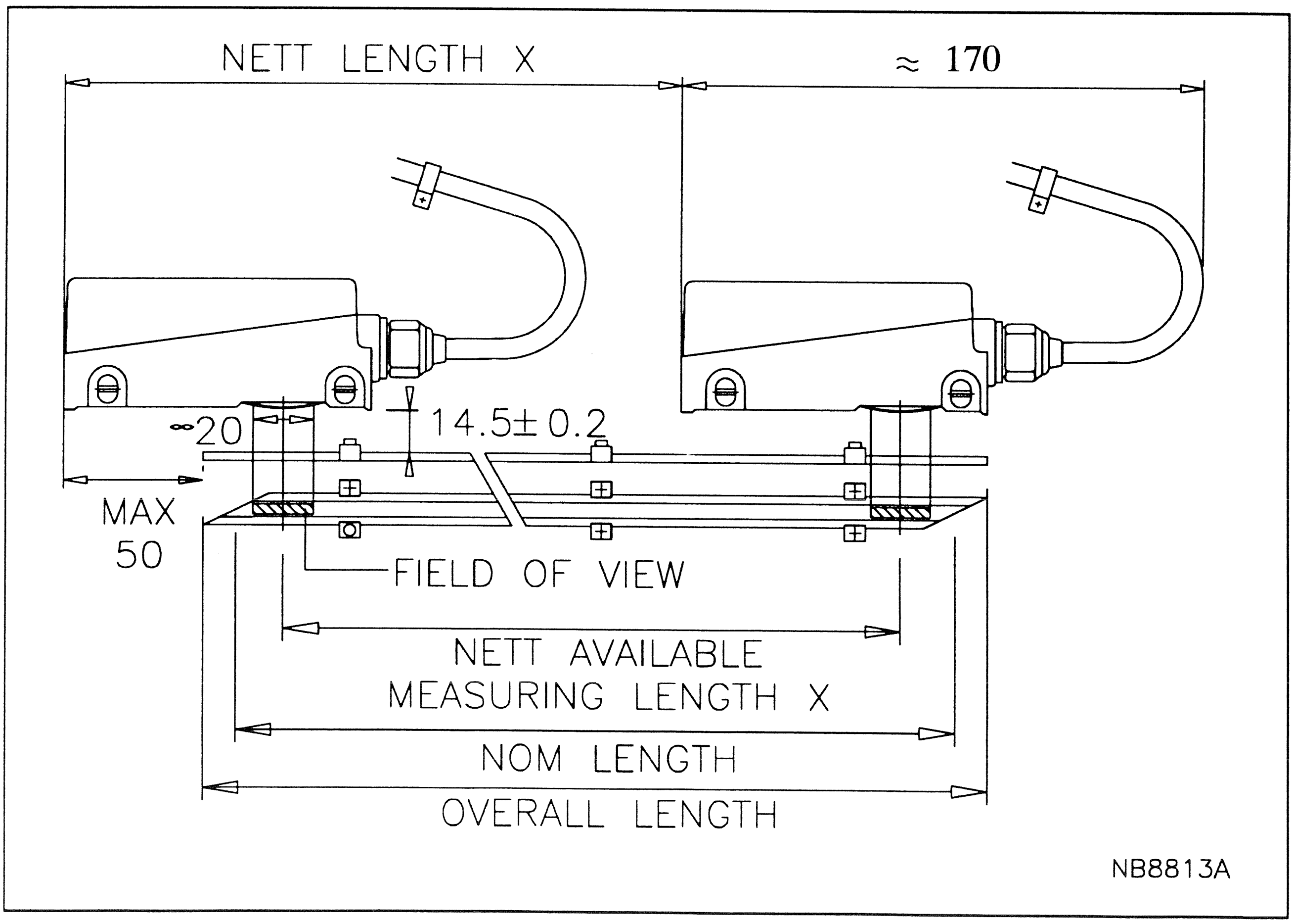


Fig. 25 Measuring length limits

Note: X refers to the pull-out drawing at the end of the manual.

4.2 MOUNTING THE FLAT SCALES

Fixing clamps and Allen bolts are supplied for mounting the scales which must be positioned as indicated in figure 26. In order that the scales run parallel to the machine bed, the pitch between the top and bottom centre points must remain equidistant to each other and parallel to the bed. The pitch (figure 27) must be 27.5 ± 0.3 mm, where the width of the scale is 22 - 0.2 mm.

To acquire this parallelism, a scribing pointer should be attached to the machine slide and the two centre lines scribed onto the mounting surface (machine frame or mounting beam) for the full length of the travel.

Using a centre punch, mark the position of each mounting hole on the scribed lines. Any following scale must be approximately 0.3 mm from the preceding one, where the pitch between the first and last clamp centres of these respective scales must be 68 ± 2 mm.

Drill and tap holes to take bolt screws M5 X 15. The left hand section should be positioned and clamped first with the fixings. The scale sections should be clamped but the screws should not tightened in order to allow final adjustment. During final adjustment (and 3.1.3) the bolts must be tightened to a torque of 2.5 Nm.

If a mounting beam is needed (refer to the beginning of this chapter) it must have a coefficient of linear expansion between 10 and 11 x 10-6/°C. The following also apply (refer to figure 28).

- The beam must be stiff to reduce torsion.
- Shaped to enable the scale to be mounted correctly.
- The sections ends must be cut at 45° similar to the scales when mounting more than one beam.
- When mounting more then one beam, a gap of between 5-6 mm must be left between each beam.

4.3 MOUNTING AND ADJUSTING THE TRANSDUCER

As described in chapter 2 the spacing between scale and transducer (14.5 ± 0.2 mm) can be determined by using a spacing block. All that is needed is to move the transducer to the middle of the scale, place the spacing block between the two and then tighten the transducer to that position as shown in figure 28. The first scale must now be tightened before proceeding with section 4.4.

Note: *Be careful not to mount the spacing block on the glue mounts of the gratings.*

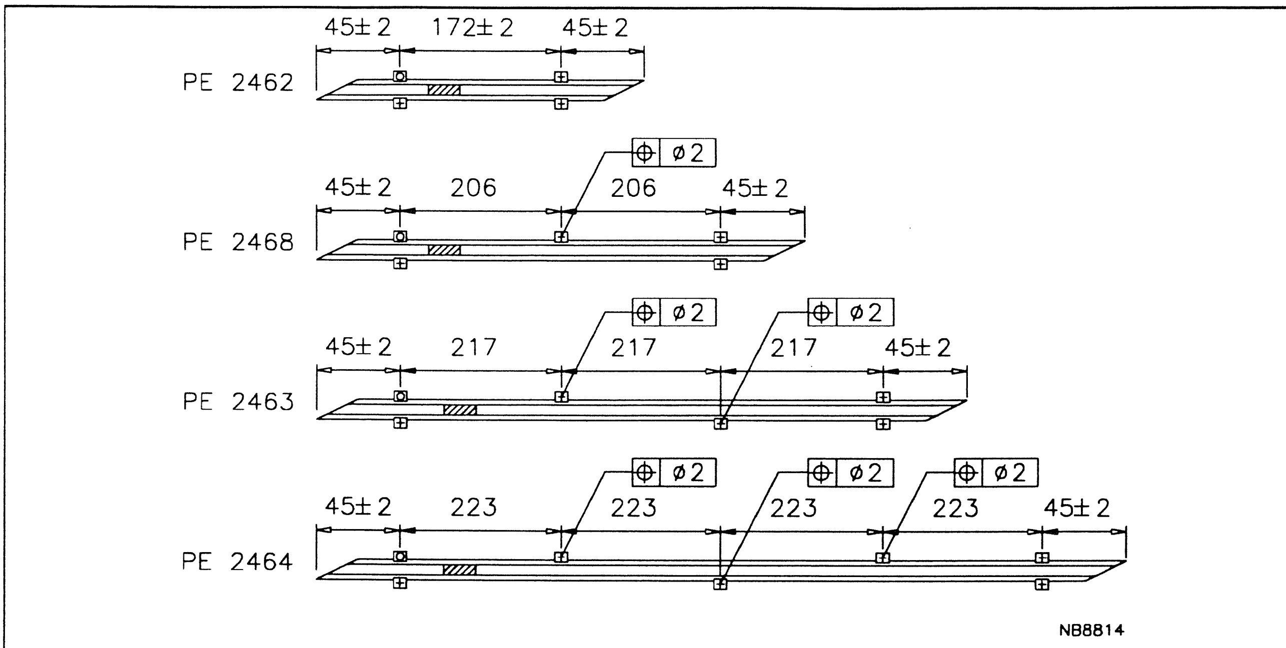


Fig. 26 Position of the clamps

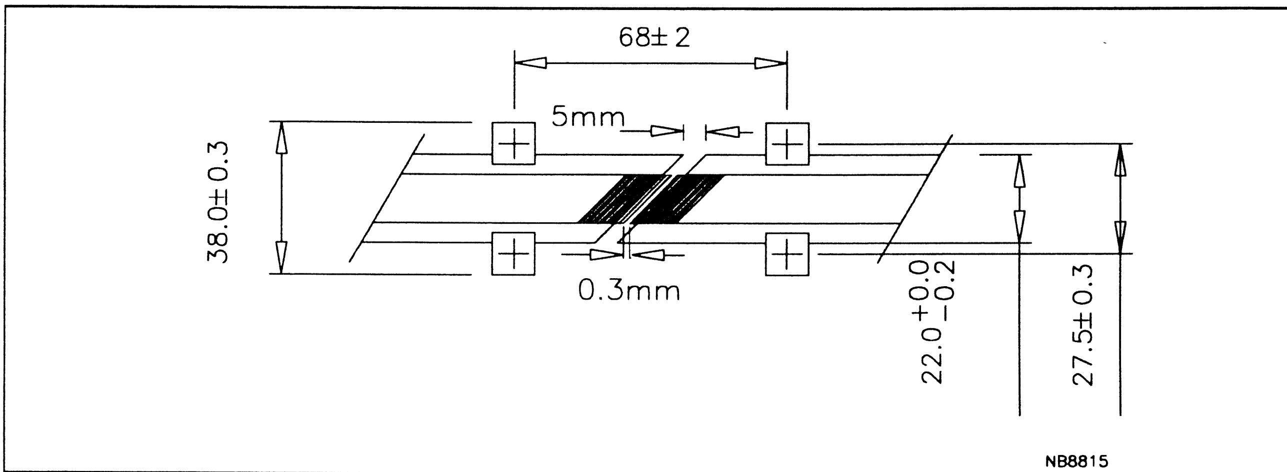


Fig. 27 Mounting beam

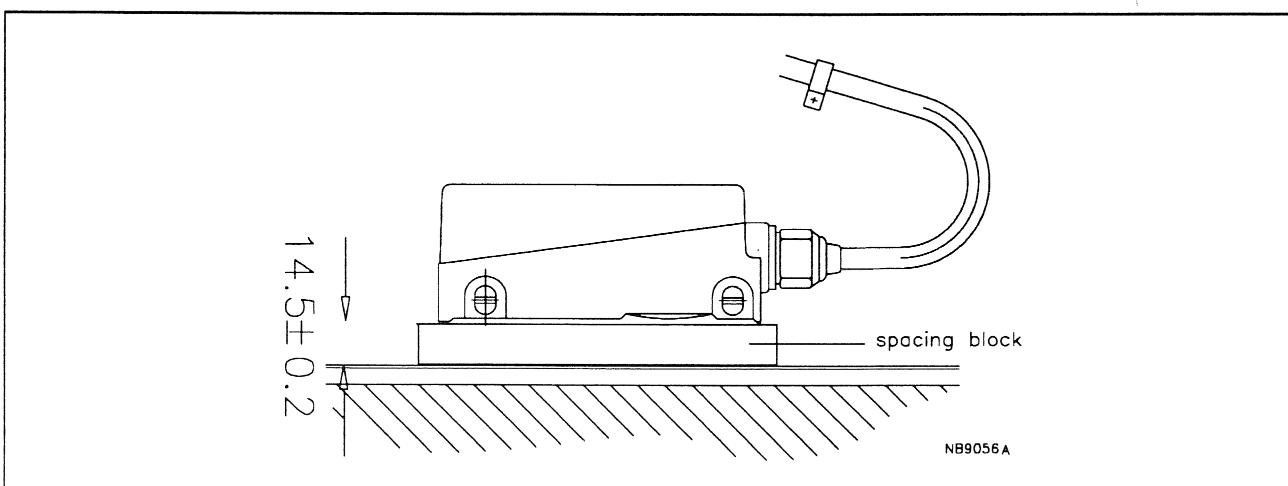


Fig. 28 Adjusting the transducer

4.4 ALIGNING THE FLAT SCALES (FINAL ADJUSTMENT)

When an assembly of scales (more than one) is used to measure the travel of an axis it is necessary to align them correctly for an accurate reading. There are three methods for doing this, one with a higher degree of accuracy - using a laser measuring system - and the other less accurate methods of using block gauges or with two transducers. Before proceeding with the procedure check (by eye) that the gratings at the junction of each adjoining scale are in line with each other and that the measuring system is wired-up and working.

Using block gauges:

Attach a reference block gauge to the machine-tool guide-way at a convenient point which will enable the position of the slide to be measured (by a dial gauge mounted on the slide) relative to the block gauge. The slide should be in such a position that the transducer is just to the left of the junction. (figure 29).

Attach a dial gauge with a resolution of 1 μm, on the machine-tool slide.
Switch on the visual display and allow about 30 min for the electronics to warm up and the gauges to attain the same temperature as the machine-tool. Adjust the visual display to read to 1 μm resolution.

After the completion of the preceding steps and after assuring that the alignment of the transducer and the first scale is correct (see chapter 4.3), proceed with the following alignment procedure:

- Approach reference block gauge by moving the slide to the left and set the dial gauge to read zero (see figure 30)
- Reset the visual display to read zero.
- Move the slide across the junction far enough to be able to insert another block gauge between the reference gauge and the dial gauge.
- Move the slide to the left until the dial gauge makes contact with the end of the second block gauge and reads zero (see figure 30).
- Check the visual display which should read the length of the block gauge plus "stacking factor" of + 1 μm.

If the visual display shows a different reading, then adjust the position of the second scale by lightly tapping it with a hammer using a steel rod. For this purpose, the flat scales are provided with small holes (figure 31).

Repeat the procedure until the alignment is correct and tighten the clamps holding the scale. After tightening recheck measurements.
Repeat the whole procedure with each of the other junctions.
Adjust the visual display to the required resolution.

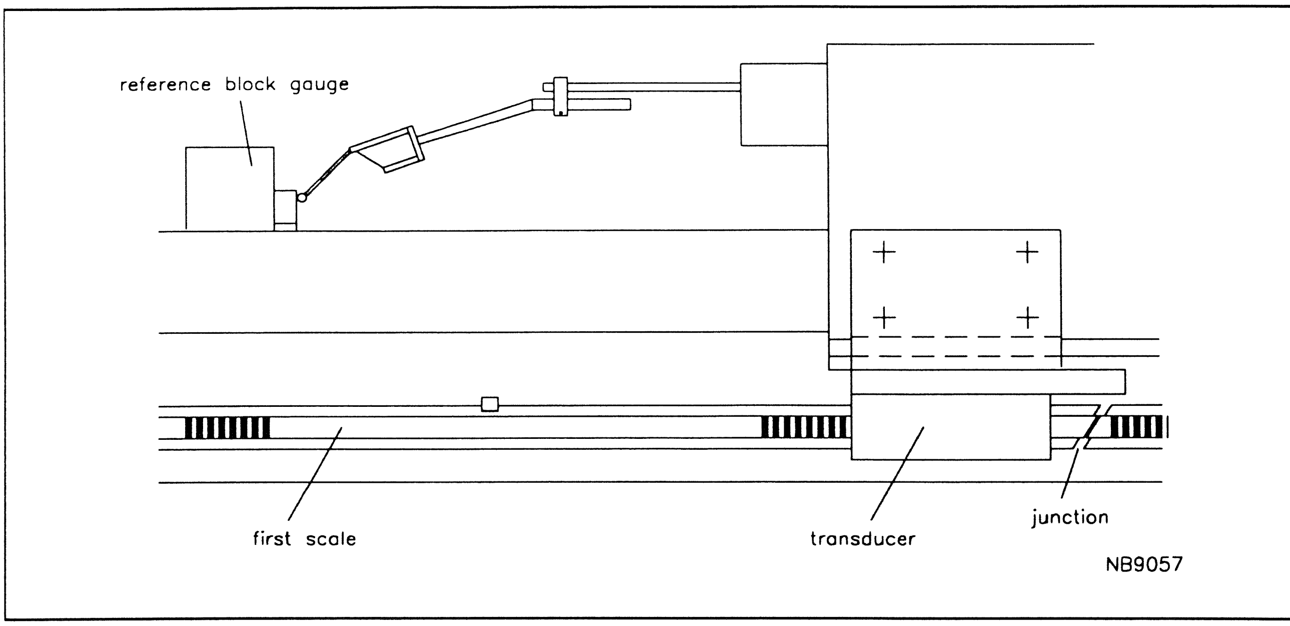


Fig. 29 Final adjustment using block gauges

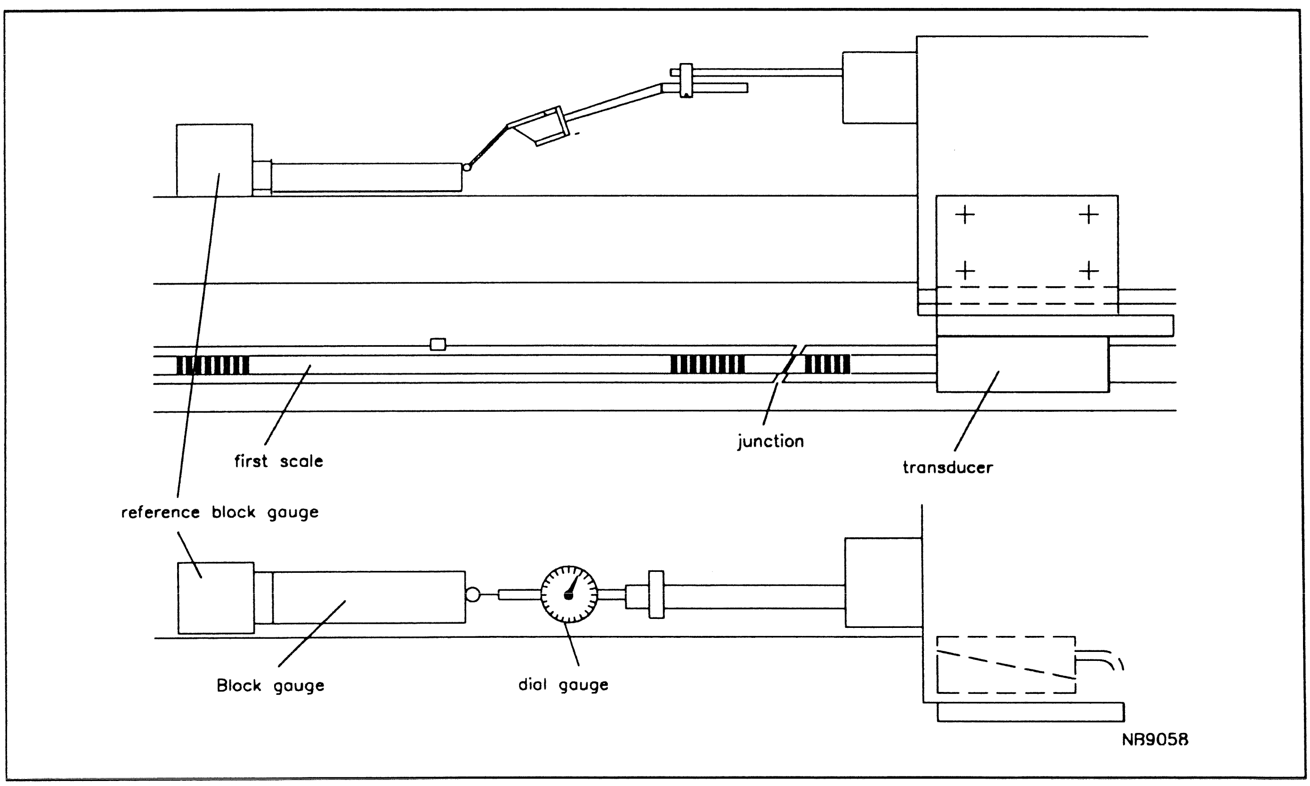


Fig. 30 Final adjustment using block gauges

Using a laser measuring system:

Switch on the visual display and allow about 30 min for the electronics to warm up, having first checked that the visual display is adjusted to read 1 μm resolution.
Set up the laser on the machine-tool guideway so that it can measure the displacements of the machine tool slide. Switch on and allow it to attain a steady working temperature. Correct the laser reading for temperature, humidity and barometric pressure, as well as the thermal coefficient of expansion of the machine before proceeding with the following alignment procedure:

- Reset the visual display as well as the laser display to zero
- By reading both the visual and laser displays take a series of readings (about six to eight) on the left-hand side of the first junction, plot the difference and calculate the average error. (Also refer to figure 32).
- Move the slide over a greater distance than the first scale (make sure that the field of view of the transducer completely passes the junction).
- By reading both the visual and laser displays take a series of readings (about six to eight) on the right-hand side, plot the difference and calculate the average error.
- If a difference in average error (average difference fig 32) between the first set of readings (left-hand side of junction) and the second set of readings is found, adjust the position of the right-hand scale (second) by lightly tapping it with a hammer through a steel rod.

Note: *Use the small holes as shown in figure 31.*

Repeat the procedure until the alignment is correct and tighten the clamps holding the scale. After tightening recheck measurement.

Repeat the whole procedure with each of the other junctions but do not reset to zero to avoid a build-up of errors.

Adjust the visual display to the required resolution.

Using two transducers:

In using an extra (temporary) transducer two readings can be seen on the visual display, one a reference reading (actual distance) and the other of the same distance recorded simultaneously across the junction. To do this effectively the distance between the two transducers must cover at least half and less than the total length of the preceding scale. The two readings can then be taken simultaneously on the visual display when the slide is moved. When the first transducer passes well over the junction to the following scale (while making sure that the second transducer is well within the preceding scale), stop the motion. If a difference is found in the two readings, adjust the following scale by lightly tapping it with a hammer and then repeat the measurement. Continue this until the two readings are the same and then tighten the bolts of the scale. After tightening recheck measurement. Repeat the whole procedure with each of the other junctions.

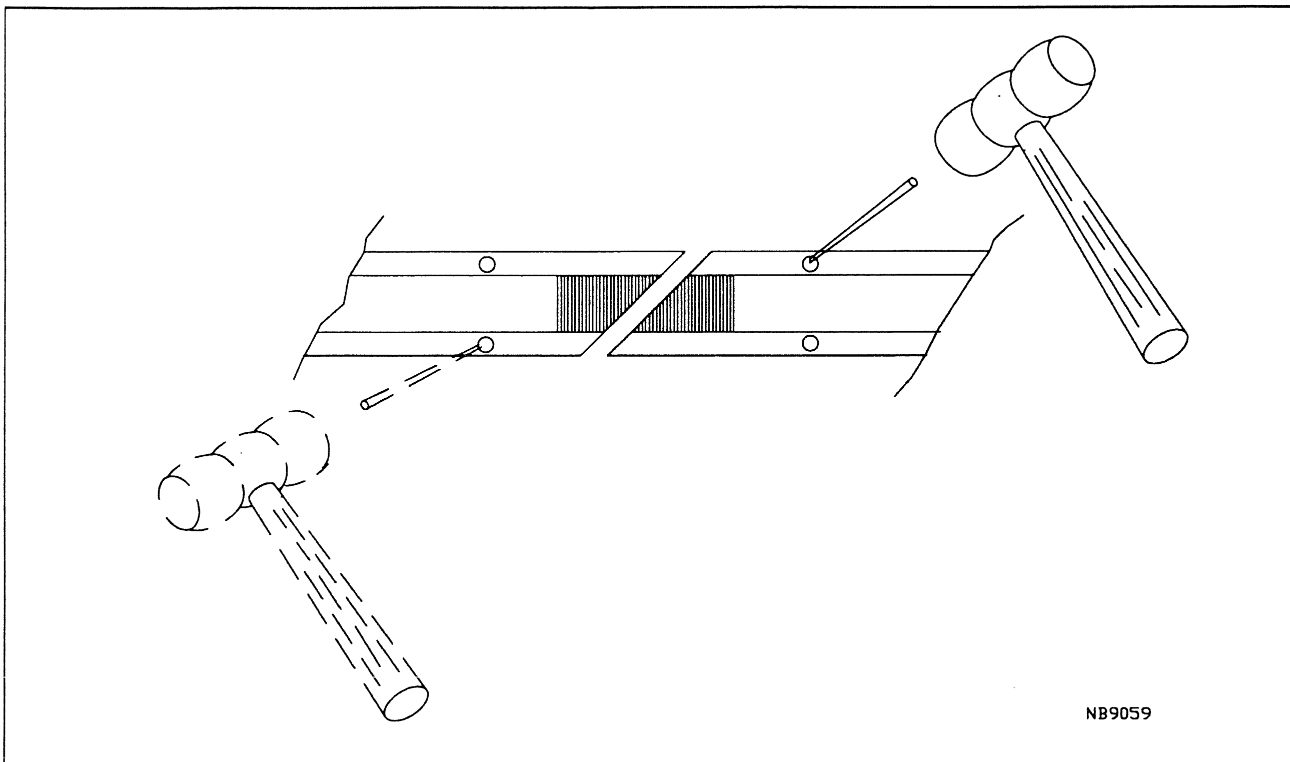


Fig. 31 Tapping the scale into position

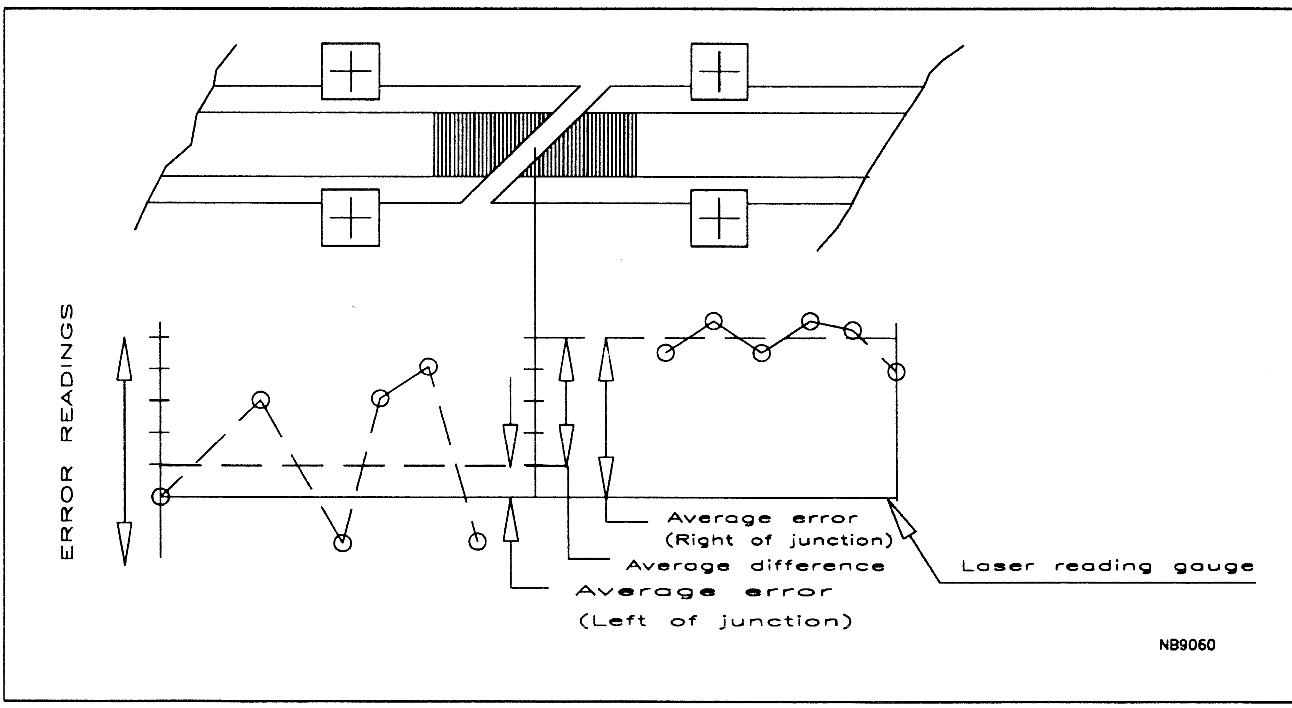


Fig. 32 Using the laser method

4.5 SQUARE SCALES - PE 2480 SERIES

Effective measuring length

The effective (or nett) measuring length is the maximum length of a scale or assembly of scales that can be measured. This is determined by the size of the field of view of the transducer which is shown in figure 33.

When the traverse of an axis consists of only one scale, the effective measuring length can be calculated by subtracting 20 mm from the nominal length. If however, more than one scale is used (assembly of scales) 22 mm must be subtracted from the total nominal length.

Example:

Nominal length = 1920 (2 x PE 2485)
- 22
1898 = Effective length

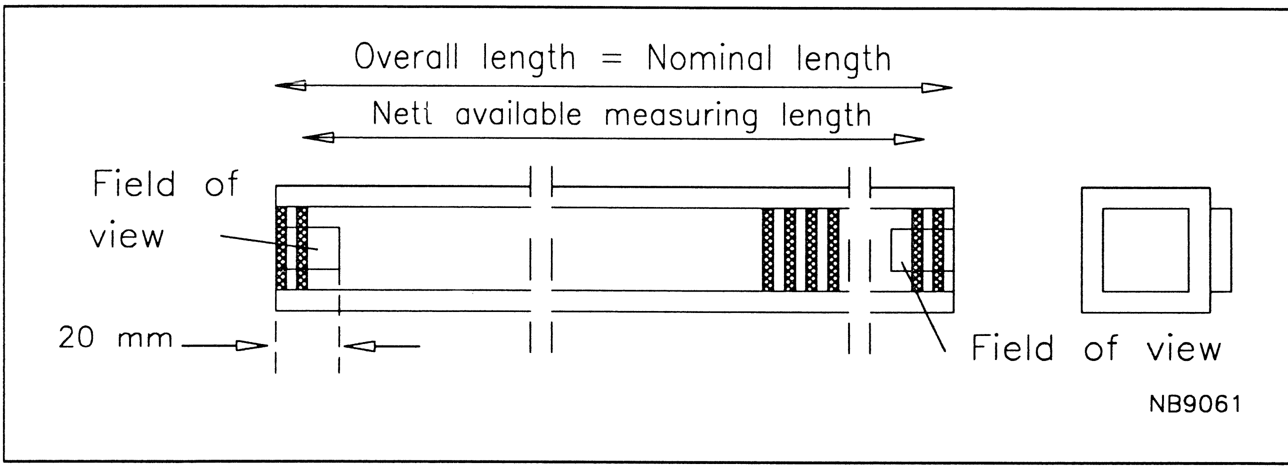


Fig. 33 Measuring length limits

4.6 MOUNTING THE SQUARE SCALES

The scales are pre-fitted with two self aligning washers and screws that enable optimal alignment onto the mounting surface (figure 34).
The pitch between the centres of the mounting holes as indicated in Table 1 column B (figure 35), is different for each scale size.
The distance between the beginning of the scale to the centre of the first hole is given in column A (also indicated in the figure). The column L gives the nominal length, while the X column gives the nett (effective) measuring length (refer to chapter 4.5).

In order that the scales run parallel to the machine bed a scribing pointer should be attached to the machine slide. A centre line can then be scribed onto the mounting surface (machine frame or support) covering the full length of the travel. Using a centre punch, the position of each mounting screw can then be marked on the scribed line.

When mounting an assembly of scales the pitch between the first hole of any preceding scale and the first of the following scale (see figure 35) should be as given in column S. These values should only be used when two similar sized scales are required for the full length of travel. When more than two similar sized scales need to be used, the more precise values given in the SX column must be used.

Table 2 gives the S value when two different size scales follow one another. The first column indicates to which is the first and which is the second of the pair of scales (also indicated in figure 36 by I and II). The cross reference position of the two columns gives the S value.
Examples:

When a PE 2482 scale is followed by a PE 2485 the S value equals 400 mm.

If the positions are swopped around however, the S value would equal 800 mm (refer to Table 2).

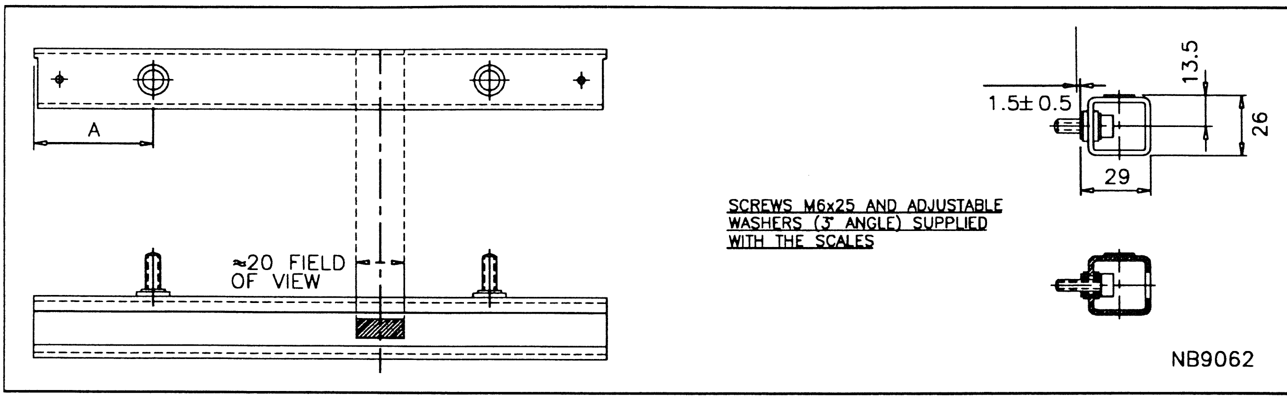


Fig. 34 Mounting fixtures

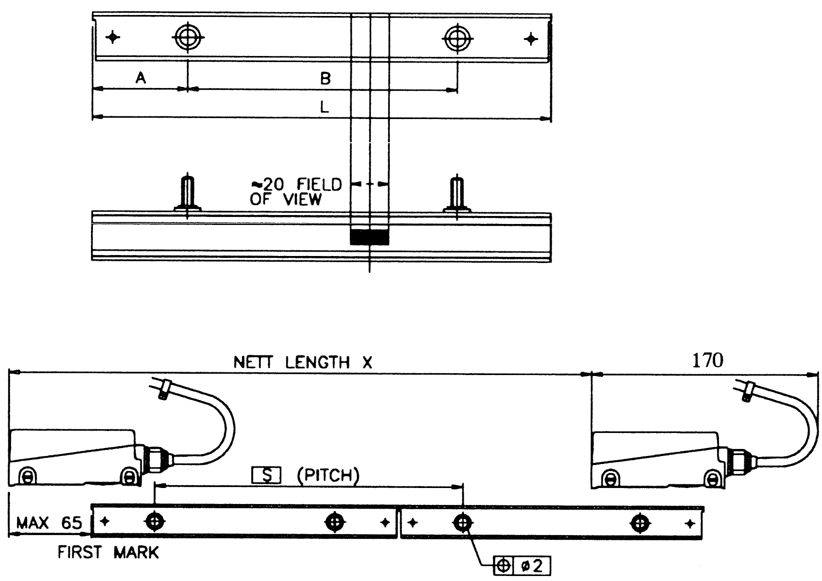


TABLE 1:
DIMENSIONS OF THE VARIOUS SCALES

SCALE	A	B	L	X	S	SX
PE 2482	50	140	239.7	220	240	240.03
PE 2483	50	380	479.7	460	480	480.06
PE 2484	160	400	719.8	700	720	720.09
PE 2485	210	540	959.8	940	960	960.12
PE 2488	50	235	335	315	335	335.28

TABLE 2:
VALUE OF S WHEN JOINING TWO DIFFERENT SIZE SCALES

I \ II	PE 2482	PE 2483	PE 2484	PE 2485	PE 2488
PE 2482		240	350	400	240
PE 2483	480		590	640	480
PE 2484	610	610		770	610
PE 2485	800	800	910		800
PE 2488	335	335	445	495	

NB9063A

Fig. 35 Overall dimensions

Checking the parallelism of the mounting surface,

Procedure:

- Place a dial gauge at the first mounting hole (point 1 figure 36) and note value indicated.
- Move the slide to mounting point 2 and check this is within 0.3 mm at the total mounting surface (see remark).
- Repeat this for every two mounting positions of each scale; point 4 in the figure must be within 0.3 mm of point 3.
- If the difference is too great, note the values and fill the space with appropriate sized washers when mounting the scales.

Note: *The dimensions of the washers are as given in figure 37.*

Remark: Besides the indicated 0.3 mm tolerance, it is also important that the surface around the marked positions (1, 2, 3, 4 etc. in figure 36) is flat (0.05 mm) within a circular area of 12 mm diameter.

Mounting the scales

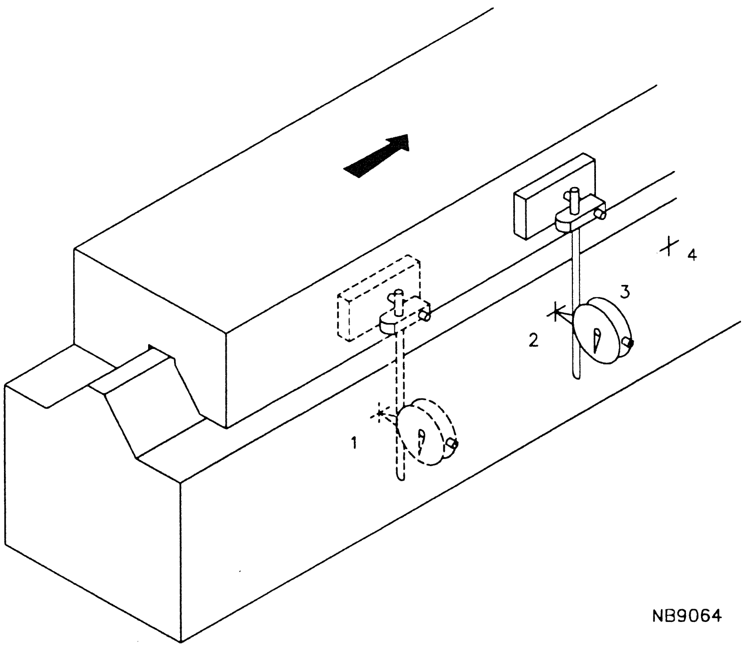
Procedure:

- Drill 5 mm ϕ holes to a depth of at least 18 mm and tap the holes for 6 mm bolts with a tapping depth of at least 15 mm for blind holes.

When drilling the holes ensure that the drill does not deviate more than 5° in all directions from the position perpendicular to the plane A as indicated in figure 38.

- Remove the small springs that keep the bolts and washers in place and mount the scales.
- Tighten the bolts finger-tight to allow final adjustment (as described in chapter 4.7 and 4.8).

During final adjustment (chapter 4.8) the bolts must be tightened to a torque of 2.5 Nm.



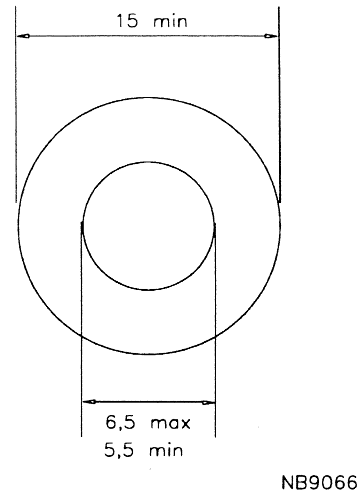


Fig. 36

Fig. 37

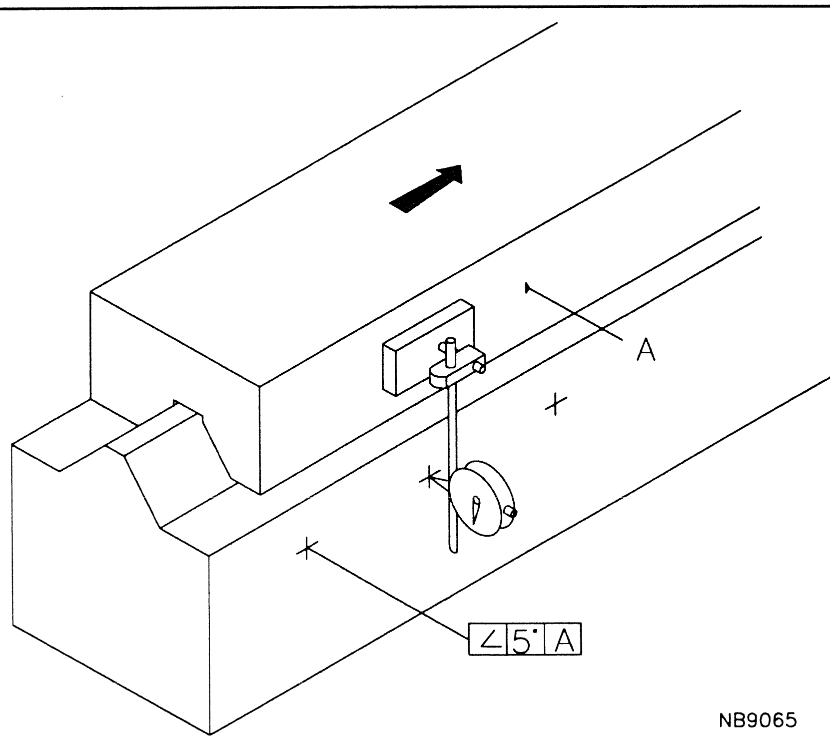


Fig. 38

4.7 MOUNTING THE TRANSDUCER AND ADJUSTMENT OF THE SCALES

As described in chapter 2 the spacing between scale and transducer (14.5 ± 0.2 mm) can be determined by using a spacing block.

Procedure:

- Move the slide so that the transducer is at the left-hand end of the first scale (figure 39, point 1).
- Place the spacing block between the two and tighten the transducer.
- Tighten the left-bolt of the scale.
- Remove the spacing block and move the slide so that the transducer is at the right-hand end of the scale (point 2 figure 39).
- Position the scale with the spacing block.
- Tighten the right-bolt of the scale.
- Recheck the spacing (with spacing block) of the left-hand side of the scale.

The spacing and parallelism should now be correct. If not check the parallelism of the scale as shown in figure 37 and correct with washers. Repeat this for the rest of the scales (point 3 and 4 etc.) but do not completely tighten the bolts until during final adjustment (chapter 4.8).

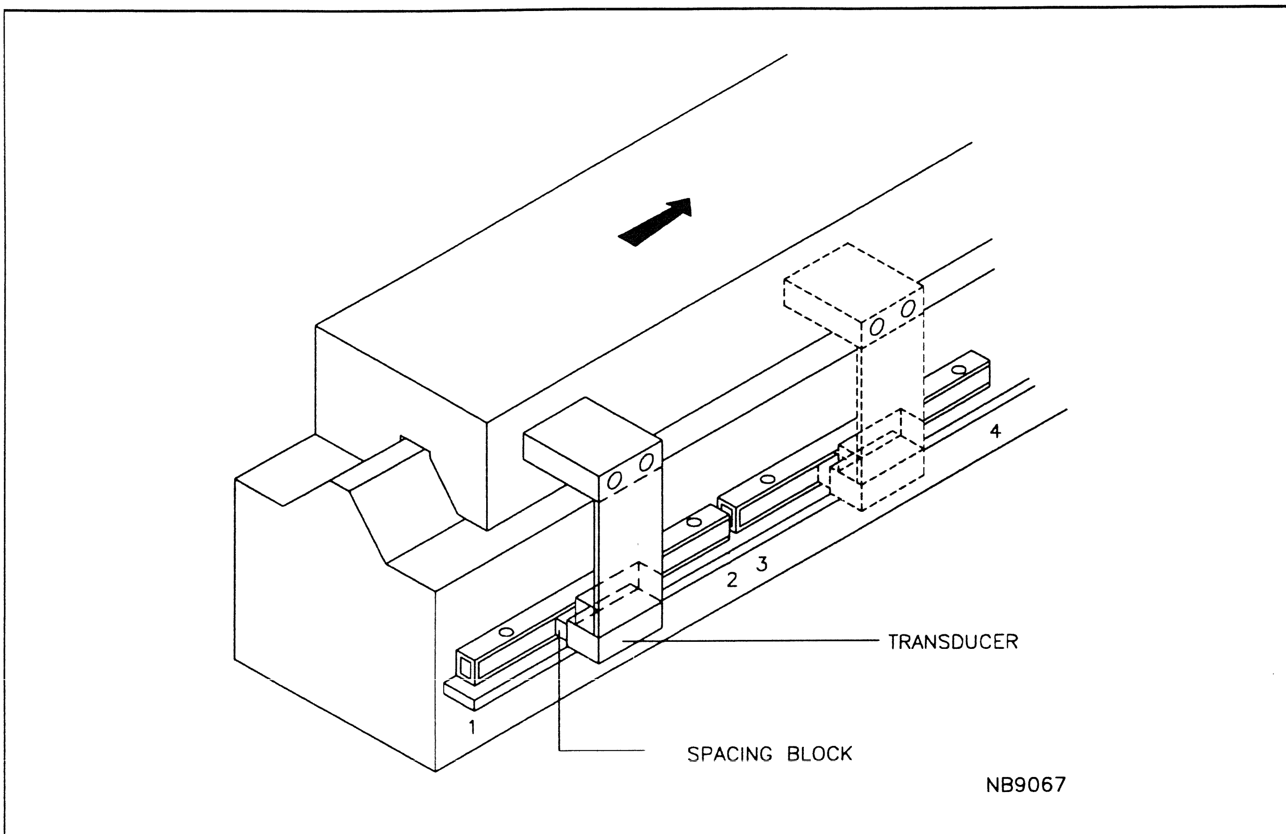


Fig. 39 Adjusting the transducer and scale

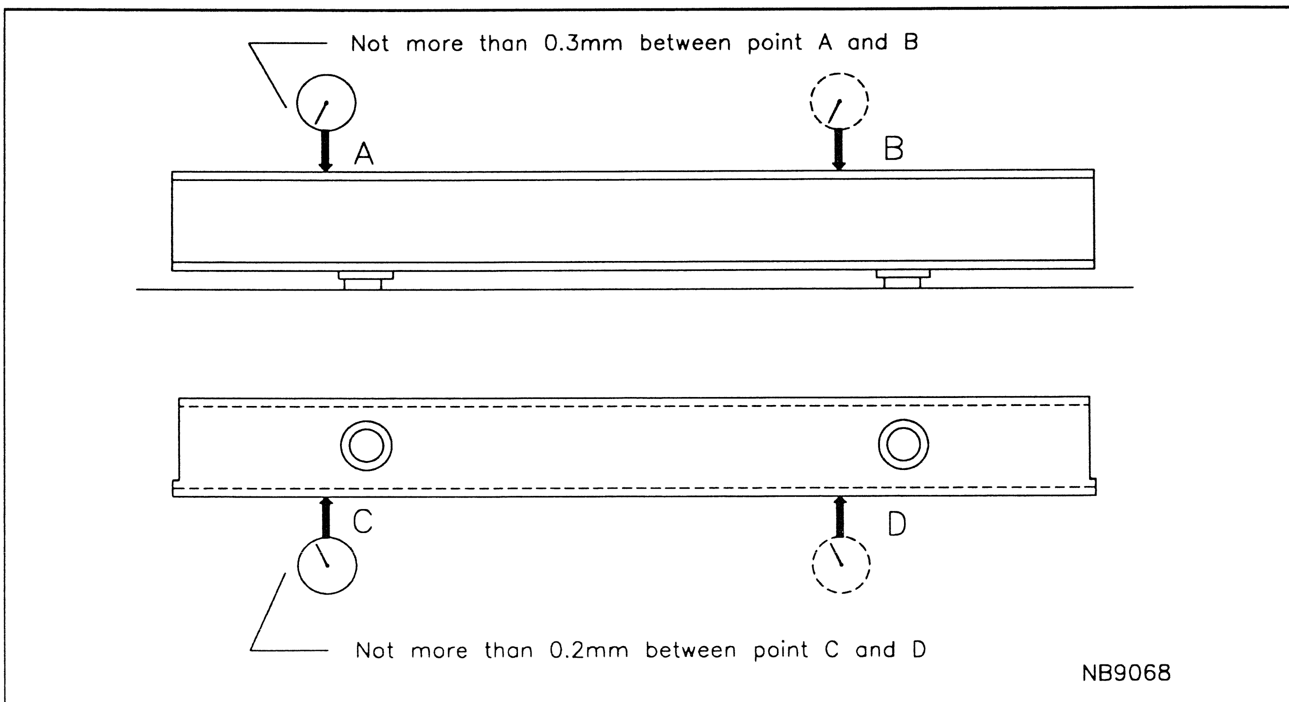


Fig. 40 Checking parallelism of the scale

4.8 ALIGNING THE SQUARE SCALES (FINAL ADJUSTMENT)

When an assembly of scales (more than one) is used to measure the travel of an axis, it is necessary to align them correctly for an accurate reading.
There are three methods for doing this, one with a higher degree of accuracy - using a laser measuring system - and the other less accurate methods of using block gauges or with two transducers. Before proceeding with the procedure make sure that the measuring system is wired up and working.

Using block gauges:

Attach a reference block gauge to the machine-tool guide-way at a convenient point which will enable the position of the slide to be measured (by a dial gauge mounted on the slide) relative to the block gauge. The slide should be in such a position that the transducer is just to the left of the junction.

Attach a dial gauge with a resolution of 1 µm on the machine-tool slide.
Switch on the visual display and allow about 30 min for the electronics to warm up and the gauges to attain the same temperature as the machine-tool. Adjust the visual display to read to 1 µm resolution.

After the completion of the preceding steps and after assuring that the alignment of the transducer and the first scale is correct (see chapter 4.7), proceed with the following alignment procedure:

- Move the slide in such a position that the transducer is just on the right end of the first scale.
- Fit a reference block and a dial gauge to the machine tool and guide way (also shown in figure 27).
- Move the slide to the left until the stylus of the dial gauge touches the reference block.
- Set the dial gauge to zero and reset the visual display to zero.
- Move the slide across the junction far enough to be able to insert another block gauge between the reference block and dial gauge.
  See figure 28.
- Move the slide to the left until the dial gauge stylus makes contact with the end of the block gauge and dial gauge reads zero again.
- Check the visual display which should read the length of the block gauge + 1 µm stacking factor.
- If the visual display shows a different reading adjust the second scale by carefully tapping it with a small hammer until the reading is correct. DON'T TAP AGAINST THE GLASS-SIDE.
- Repeat the procedure until the alignment is correct and tighten the bolts of the scale. After tightening recheck measure.

Repeat the whole procedure with each of the other scales and adjust the visual display to the required resolution.

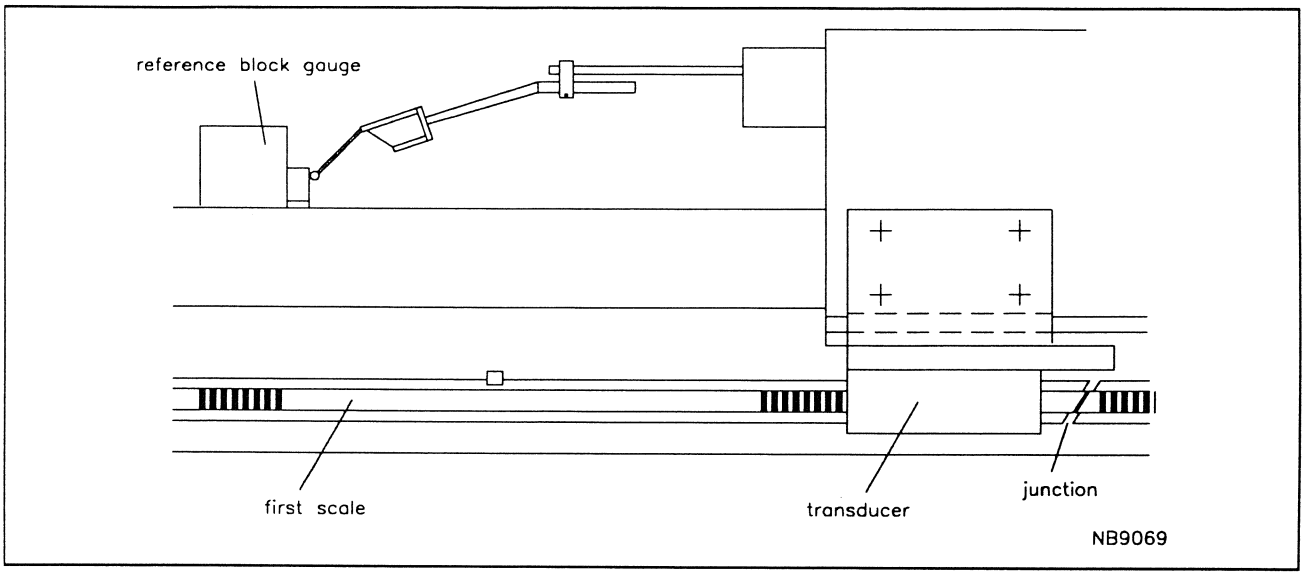


Fig. 41 Aligning the scales

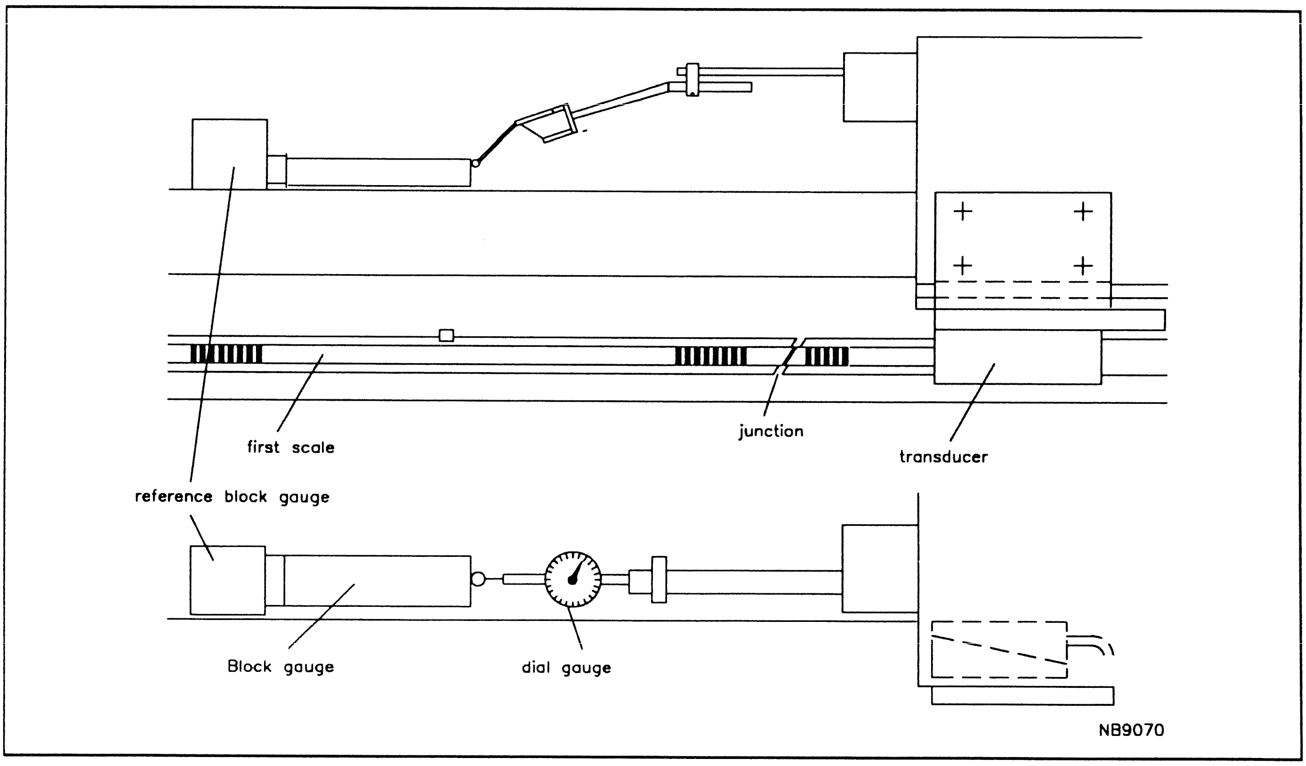


Fig. 42 Aligning the scales

Using a laser measuring system:

Switch on the visual display and allow about 30 min for the electronics to warm up, having first checked that the visual display is adjusted to read 1 µm resolution.
Set up the laser on the machine-tool guideway so that it can measure the displacements of the machine tool slide. Switch on and allow it to attain a steady working temperature. Correct the laser reading for the temperature, humidity and barometric pressure, as well as the thermal coefficient of expansion of the machine before proceeding with the following alignment procedure:

- Reset the visual display as well as the laser display to zero
- By reading both the visual and laser displays take a series of readings (about six to eight) on the left-hand side of the first junction, plot the difference and calculate the average error.
- Move the slide over a greater distance than the first scale (make sure that the field of view of the transducer completely passes the junction).
- By reading both the visual and laser display take a series of readings (about six to eight) on the right-hand side, plot the difference and calculate the average error.
- If a difference in average error between the first set of readings (left-hand side of junction) and the second set of readings is found, adjust the position of the right-hand scale (second) by lightly tapping it with a hammer.

Repeat the procedure until the alignment is correct and tighten the bolts holding the scale. After tightening recheck the measurement.

Repeat the whole procedure with each of the other junctions but do not reset to zero to avoid a build-up of errors.

Adjust the visual display to the required resolution.

Using two transducers:

In using an extra (temporary) transducer two readings can be seen on the visual display, one a reference reading (actual distance) and the other of the same distance recorded simultaneously across the junction.
To do this effectively the distance between the two transducers must cover at least half and less than the total length of the preceding scale. The two readings can then be taken simultaneously on the visual display when the slide is moved. When the first transducer passes well over the junction to the following scale (while making sure that the second transducer is well within the preceding scale), stop the motion.
If a difference is found in the two readings, adjust the following scale by lightly tapping it with a hammer and then repeat the measurement. Continue this until the two readings are the same and then tighten the bolts of the scale. After tightening recheck measurement. Repeat the whole procedure with each of the other junctions.

5 SETTING-UP THE REFERENCE POINT

The consistency (repeat performance) of the reference point can be set to within an accuracy of 0.1 μm, 0.2 μm, 0.5 μm, 2 μm, 5 μm or 10 μm depending on the chosen resolution, The reference point can be set within each pitch (the scales are divided in divisions of 635 μm each part is called a pitch).
The reference point can be set at any pitch of the scale, where a signal (AREA) must be generated to signify this location. Depending on the type of transducer used the generation of the area signal is accomplished in different ways.

When using the transducer without build in proximity switch, the area signal is generated from a micro switch activated by a cam placed at the appropriate position opposite to it. The switch then sends this signal to the subsequent electronic system being used.

Transducer type with a build in proximity switch which enables the area signal to be generated from the transducer itself. In this case an inductive cam (vane- refer to chapter 2), placed in the appropriate position will trigger the proximity switch of the transducer as it passes by. The transducer then outputs this signal via pin 9 to the subsequent electronic system used (refer to chapter 3.8).

To achieve an accurate reference point, special care must be taken to install the cam/microswitch or the vane.

Due to its nature every switch has a deviation in its repeat performance (actuation point), every time a switch action is made. A good switch has a repeatability < 100 μm.
The reference point does not depend on the (inaccurate) switch performance because the reference point is the coincidence of the area signal together with a marker impulse. The only point is to take care for is to make sure that the area switch is activated within the same pitch of the scale.

Example

The switch is activated just before the marker, MARKR 1 is generated (see figure 43). Due to its repeat performance it is possible that another time the switch is activated at moment 2, resulting in the MARKR 2 signal. The difference between MARKR 1 and MARKR 2 is 635 μm.

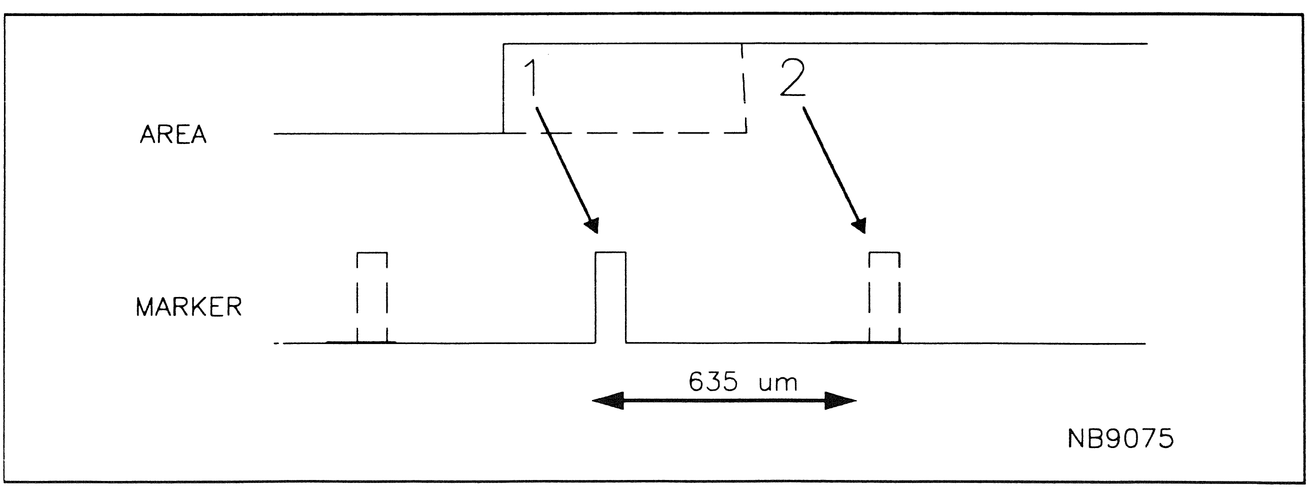


Fig. 43 Coincidence of area signal with marker pulse

In general:

Care must be taken to avoid the area signal to be activated to close to the marker pulse. A certain area around the marker pulse is regarded as a "forbidden area" The distance in between is regarded as "save area" (see figure 44). Transducer with build in proximity switch is equipped with signal processing circuity to ensure the correct switching moment of the proximity switch.
The system regards a forbidden area of 128 μm around the marker pulse (see figure 44). When the area signal is generated within the forbidden area a PRE alarm signal is generated (see chapter 3.4)

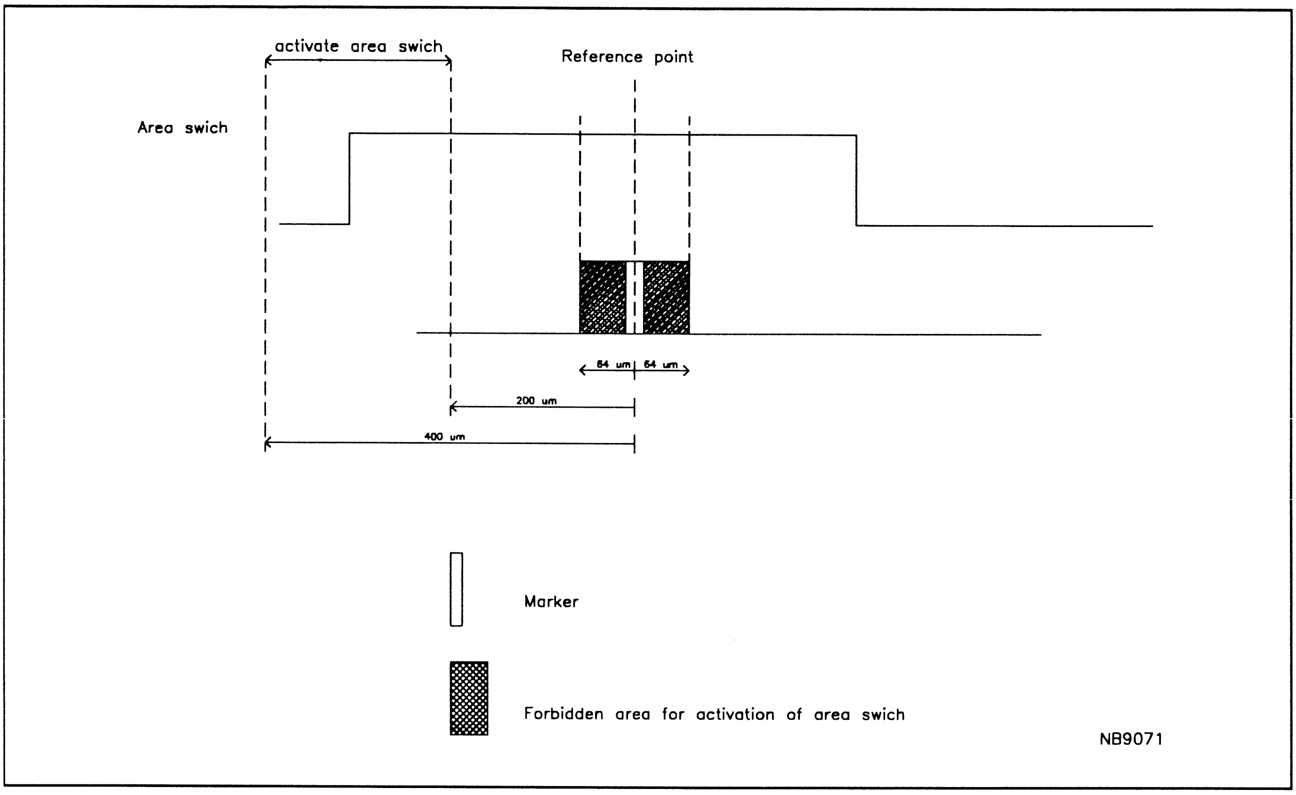


Fig. 44 Reference point

Note: *The position of the transducer determines if the area switch is activated in a forbidden area or in the safe area.*

As mentioned the switch and cam (or vane) should be installed in the approximate position required for the reference point setting. The cam (or vane) should be left loose and have sufficient play to allow the adjustment of the area signal. The scales and transducers should be installed and aligned correctly and all components wired before this adjustment can be made.

When using transducer without built in proximity switch the installation of the area signal has to be done externally.
A possible way is to observe the external area signal and to count the number if increment between the area signal and the next marker pulse.
Care must be taken that the area signal is generated approximately in the middle of the safe area (between 200 μm and 400 μm), otherwise the reference point may carry over to the neighbouring pitch.

6 TECHNICAL DATA

Mechanical

- dimensions	:	see dimensions sketch (fig. 1 and fig. 2)
- weight	:	0.525 kilogram (cable included)
- temperature range	:	operating : +5° to +45° C non operating : -40° to +70° C
- humidity	:	5 % to 90 % (non condensing)
- atmospheric pressure	:	≥ 25 kPa
- vibration	:	< 200 m/sec.sec (1500 Hz max. in 3 directions)
- shockresistance	:	< 100 m/sec.sec
- environmental protection	:	Transducer extension cable: IP 67 acc. to DIN 40050, IEC 529
- max. speed	:	100 m/min at 0.5 , 1, 2, 5 and 10 µm 50 m/min at 0.2 µm resolution 50 m/min at 0.1 µm resolution

Electrical

- voltage rating	:	+5 V +/- 5% at transducer ripple voltage < 0.1 V p.p.
- current rating	:	150 mA
- EMI/RFI protection	:	acc. to IEC 801-4
- cable length	:	2 meter (max cable cap. ≤10 nF)
- resolution	:	configuration : 0.1 µm or 0.5 µm, 1 µm, 2 µm, 5 µm and 10 µm.
- max. S00/S90 frequency	:	depending on velocity and resolution
- following error	:	max 1 increment, during constant velocity movement
- EMC-emission	:	acc. to UN-D-1639/04 class B

Testdata

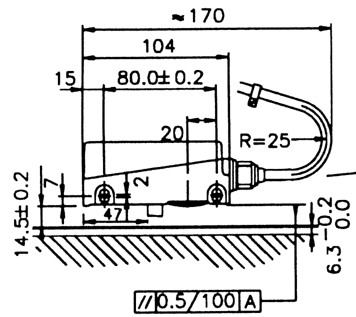
- Mechanical tests	:	Acc. to IEC 68
- Electrical tests	:	Acc. to IEC 204
- Environmental tests	:	mechanical acc. to IEC 68 climatic acc. to IEC 68

General specification

- output signals : V out L = ≤ 0.5 V at I out = -20 mA
  (RS422 signals) V out H = ≥ 2.5 V at I out = 20 mA
  S00, S00N, S90, S90, MARKR, MARKRN, ALARM, PREALM.

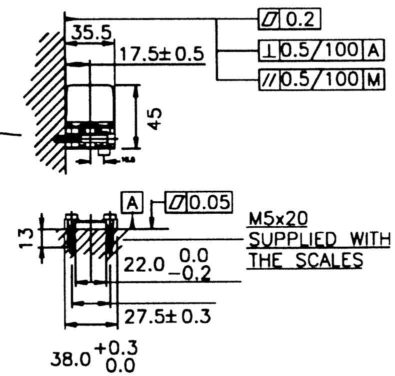
Output signals are measured at frequency f<100kHz
output signals S00, S00N, S90, S90N MARKR, MARKRN meet EIA standard RS 422

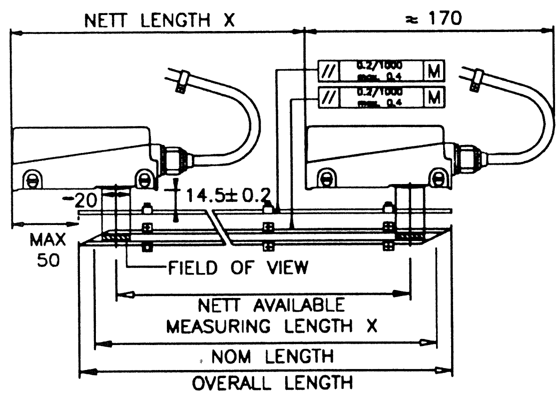
- output signal AREA : V out L ≤ 0.8 V at I out = -24 mA
  V out H ≥ 5 V
- load capacity : C load < 10000 pF (all signals)
- short circuit stability : one of the outputs may permanently be shortcircuited against 0V one at a time without damaging the internal circuitry.
- switching time : risetime < 100 nsec
  falltime < 100 nsec
- Tsine : Test signal only for reflecting check 2V p.p. sinewave.

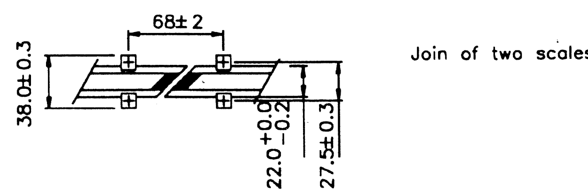


M REFERS TO MACHINE GUIDE

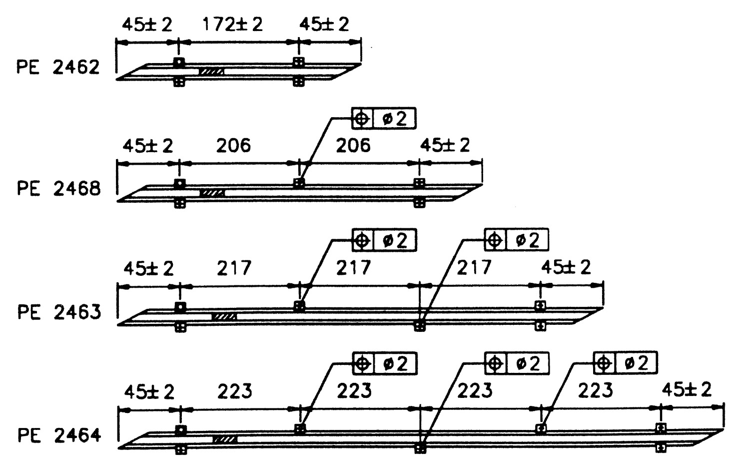
CONNECTOR, SCREWS M5x40 AND ISOLATION MATERIALS SUPPLIED WITH THE TRANSDUCER







X UP TO	NOM. LENGTH	OVERALL LENGTH	PE 2462	PE 2468	PE 2463	PE 2464
210 mm	240 mm	262 mm	1			
450	480	502		1		
690	720	742			1	
930	960	982				1
1170	1200	1222	1			1
1410	1440	1462		1		1
1650	1680	1702			1	1
1890	1920	1942				2
2130	2160	2182	1			2
2370	2400	2422		1		2
2610	2640	2662			1	2
2850	2880	2902				3



NB8674A

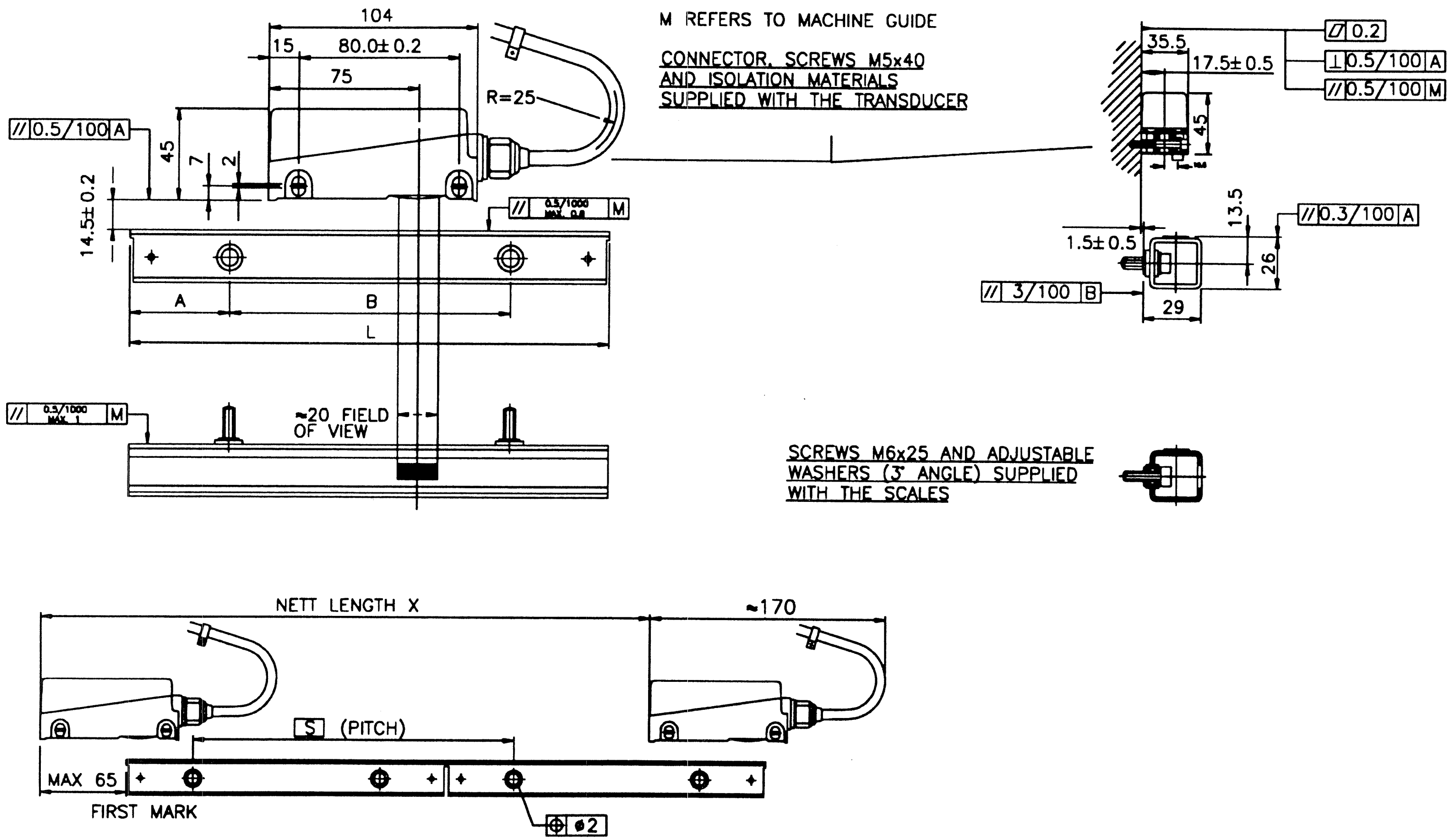


TABLE 1:
DIMENSIONS OF THE VARIOUS SCALES

SCALE	A	B	L	X	S	SX
PE 2482	50	140	239.7	220	240	240.03
PE 2483	50	380	479.7	460	480	480.06
PE 2484	160	400	719.8	700	720	720.09
PE 2485	210	540	959.8	940	960	960.12
PE 2488	50	235	335	315	335	335.28

TABLE 2:
VALUE OF S WHEN JOINING TWO DIFFERENT SIZE SCALES

I \ II	PE 2482	PE 2483	PE 2484	PE 2485	PE 2488
PE 2482		240	350	400	240
PE 2483	480		590	640	480
PE 2484	610	610		770	610
PE 2485	800	800	910		800
PE 2488	335	335	445	495	

NB8772B