up the level instrument 10-13 meters away and hold the Invar strip on the point using either the left or right tab and plumb the strip. Take several sets of height measurements and record the heights. Without moving the level, do the same for the other tab. Next, again without moving the level, set the level rod on the point, plumb and take several measurements. If the index is correctly attached to the Invar strip, all of the height readings should be very close, a tenth or hundredths of millimeters. If not, redo the test and, if necessary, adjust or modify the index so readings will be correct.

USING THE INVAR STRIP (Drawings #3 and #4)

As stated earlier, the 60 cm bar-code invar strip is needed to establish elevations on points or marks that cannot be accessed using a standard leveling rod, such as, bench marks set vertically in foundations, bridge abutments, etc., or special elevation points required by a given survey. The index described above was designed primarily for vertically set bench marks, so it may not work for all situations.

Drawing #3 depicts using the invar strip on a vertically set bench mark disk. The 60 cm bar-code invar strip can only be observed at a distance of 20 meters or less. To use the invar strip on a vertically set bench mark, first find the point on the BM disk that will be leveled to, which on a standard NGS disk is the intersection of the horizontal line and shorter vertical line cast at the center of the disk. Hold the invar strip up the mark with the reference index close to the reference line on the disk. Set up the level instrument less than 20 meters away and at a height where when the line of sight of the leveled instrument intersects the invar strip about in the middle. Two people should hold the invar strip, one at the top to keep it plumb and one at the bottom to align the index to the mark. The strip can be plumbed in several ways:

1. By observing it through the instrument and aligning the left or right edge of the strip with vertical reticle line of the instrument.

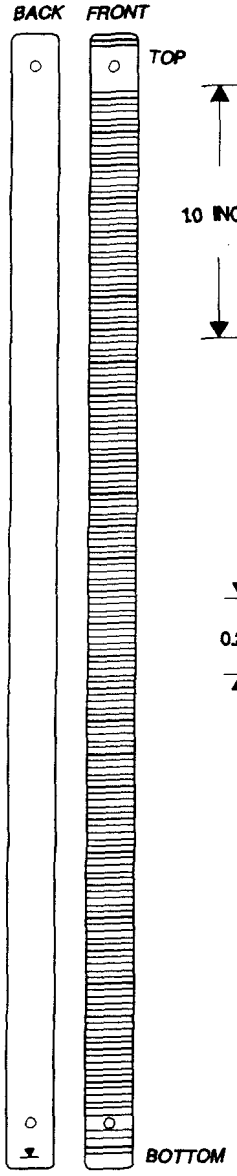
2. Use a carpenters level held up to the side of the strip.

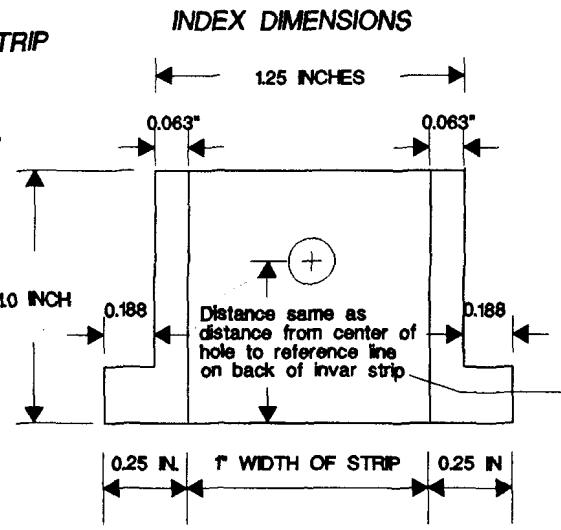
3. Use a handheld level bubble.

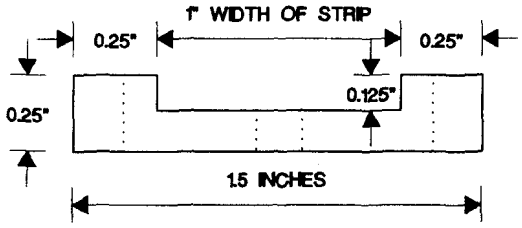
When near plumb, have the person at the bottom of the strip align the bottom of one of the index tabs with reference line on the disk (See Drawing #3). Once assured the index is aligned correctly, the top person check the plumb. If all is correct, press the measure button on the level and take the measurements. Note: The invar strip can also be read in an inverted or upside down position as can the level rods. The instrument, however, must be set for inverted readings. REMEMBER, always reference measurements to the bottom edge of the index tabs, plumb the invar strip and never use the bottom edge of the invar strip as a reference line.

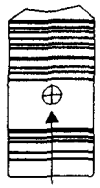
To use the invar strip on a horizontally set bench mark or elevation point, it may be necessary to use a spacer ("plug"). NGS uses calibrated metal 20 mm cylinders (See Drawing #4). Some spacers are magnetic so that they will stick to the steel footplate of a level rod. The spacers are most always used in pairs, one on the backsight rod and the other on foresight rod or invar strip. They raise the rod and invar strip equal amounts so that the difference of elevation between backsight and foresight remains correct. Remember to remove them before reading the next setup. If one is left on, an error, the height of the spacer, will be introduced into the level observations on the next setup. If only one spacer is available, place it first on the backsight rod and take the level measurements, then move it to the foresight and take the measurements.

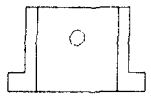
REFERENCE INDEX FOR LEICA 60 CM INVAR STRIP

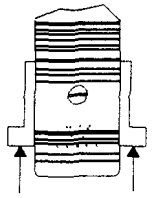


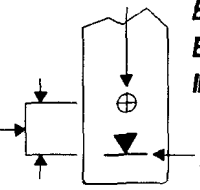


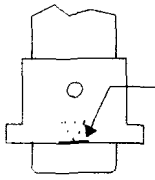


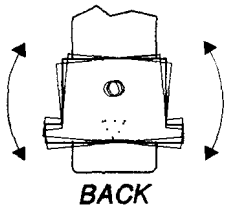




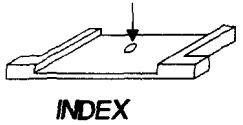




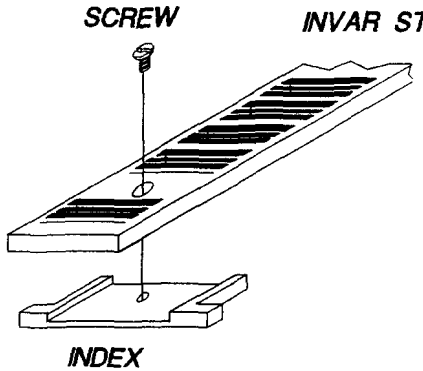


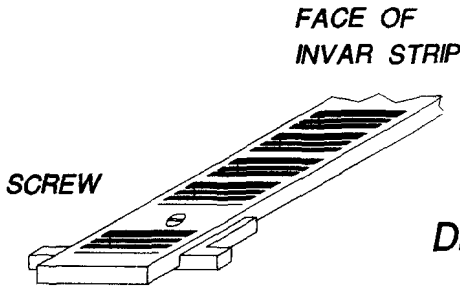


INDEX MUST BE ATTACHED WITH THE BOTTOM EDGE ALIGNED AND PARALLEL WITH THE REFERENCE LINE ON THE INVAR STRIP. IT WILL NOT WORK CORRECTLY IF TILTED SINCE THE TABS WOULD BE HIGHER AND LOWER THAN THE REFERENCE LINE.



USE A SCREW THE FITS THE SIZE OF THE EXISTING HOLE.

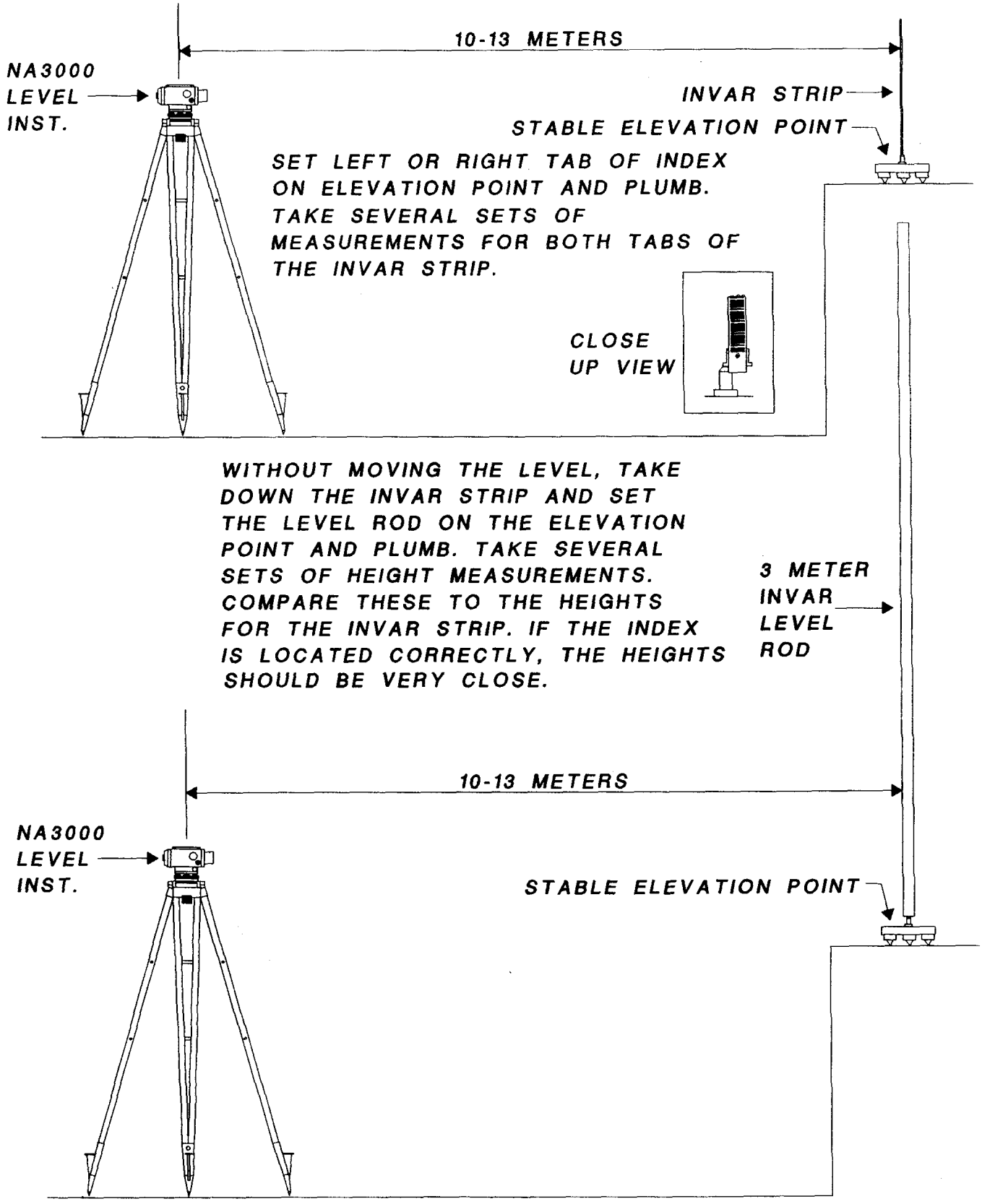




DRAWN BY ORLAND W. MURRAY, NGS, I&M BR. 1/15/98

DRAWING #1

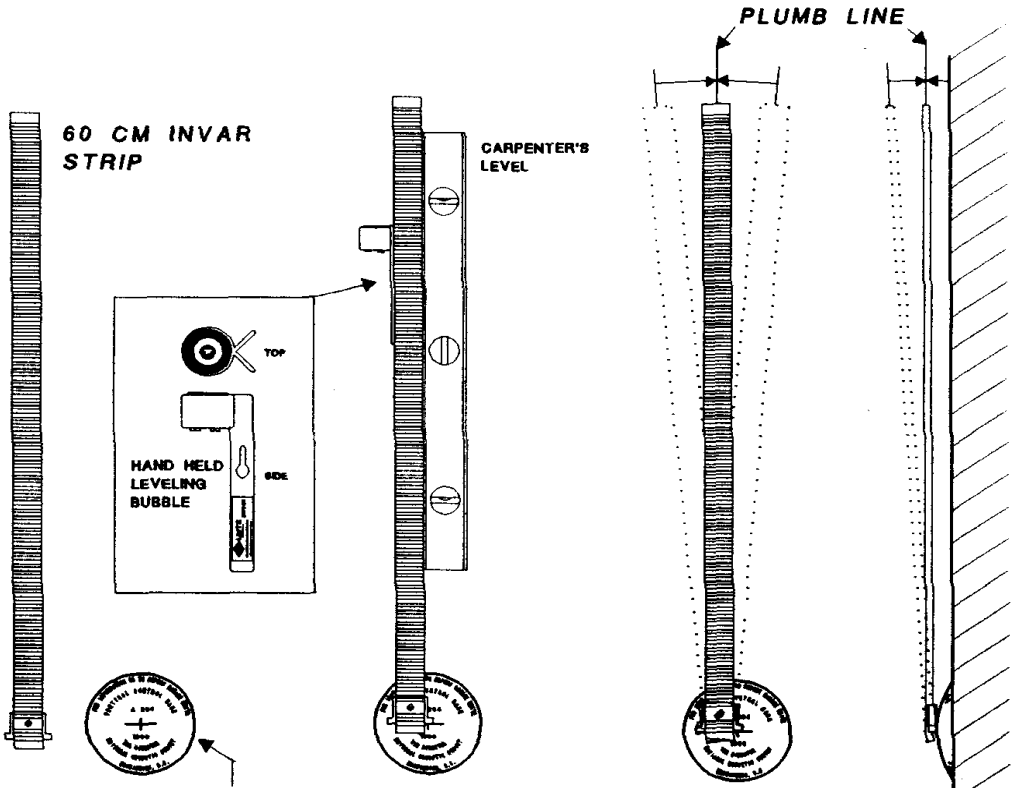
CHECKING LOCATION OF INDEX ON INVAR STRIP



DRAWN BY ORLAND W. MURRAY, NGS I&M BR., 1/20/98

DRAWING #2

USING LEICA'S 60 CM INVAR LEVELING STRIP TO LEVEL TO A VERTICALLY SET BENCH MARK



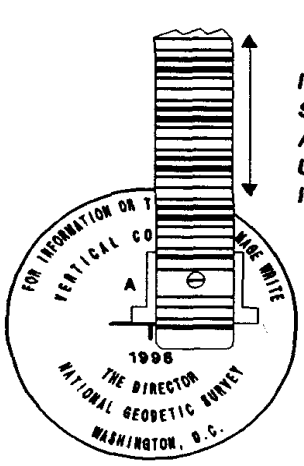
VERTICAL CONTROL MARK OR BENCH MARK SET VERTICALLY IN A WALL OR FOUNDATION

HOLD INVAR STRIP ON MARK WITH INDEX NEAR HORIZONTAL LINE ON DISK

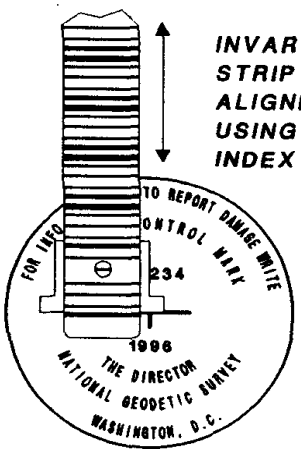
FRONT VIEW

SIDE VIEW

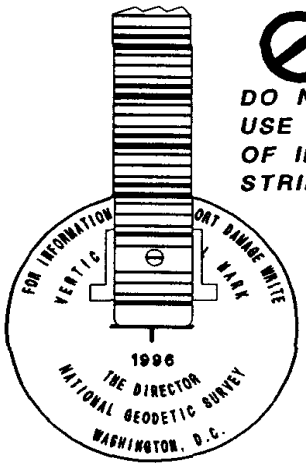
PLUMB INVAR STRIP BOTH SIDE TO SIDE AND FRONT TO BACK



INVAR STRIP ALIGNED USING LEFT INDEX TAB



INVAR STRIP ALIGNED USING RIGHT INDEX TAB

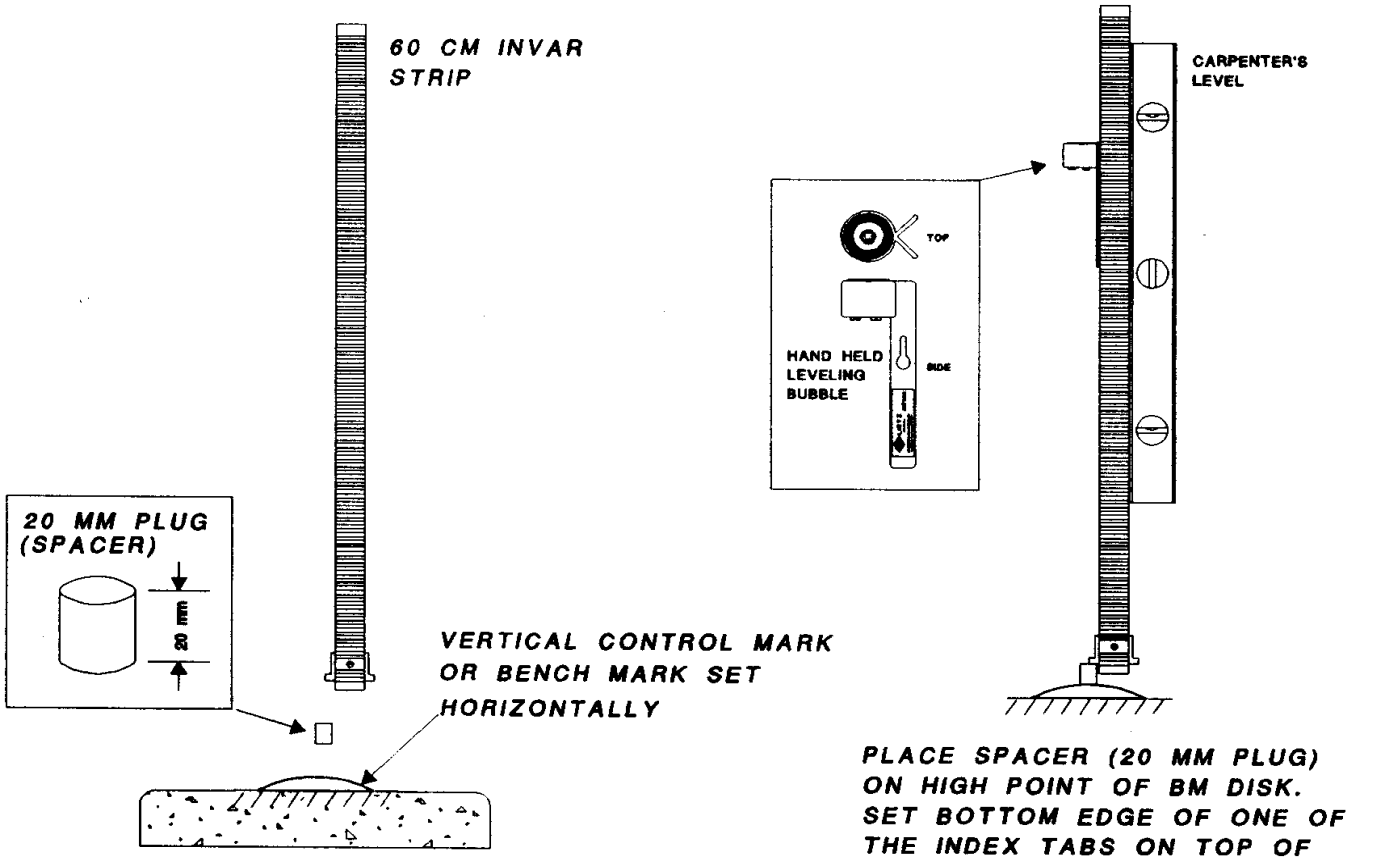


DO NOT USE BOTTOM OF INVAR STRIP

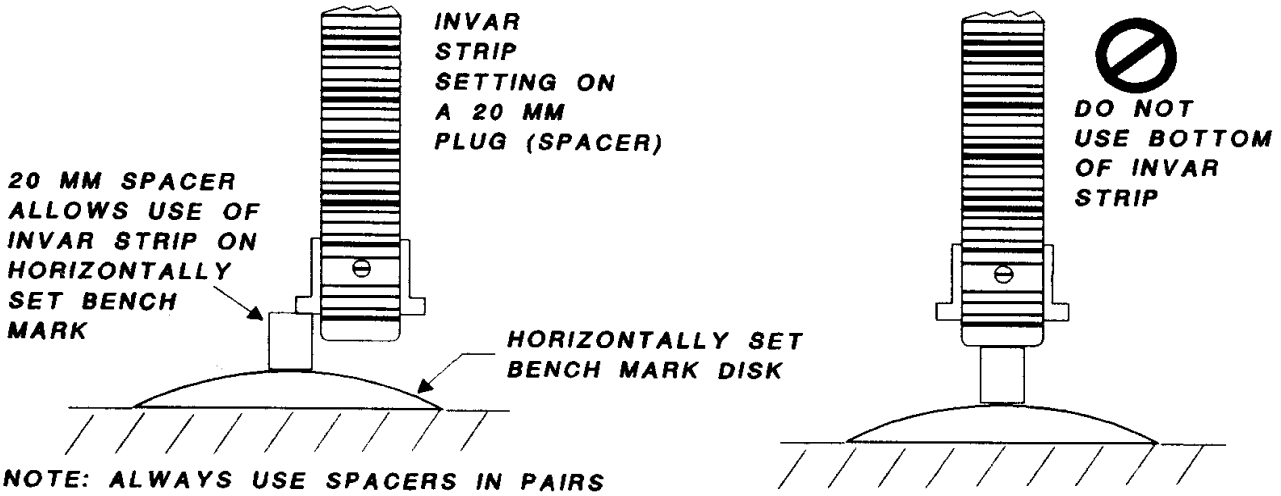
WHILE KEEPING THE INVAR STRIP PLUMB, ADJUST IT UP AND DOWN UNTIL THE BOTTOM EDGE OF THE INDEX REFERENCE TAB IS ALIGNED WITH INTERSECTION OF THE HORIZONTAL AND VERTICAL LINES ON THE VERTICAL CONTROL MARK. USE TWO PEOPLE TO PERFORM THIS PROCEDURE. ONE CAN HOLD AND PLUMB THE INVAR STRIP, WITH THE OTHER ADJUSTS THE INDEX TO THE BENCH MARK. DO NOT USE THE BOTTOM OF THE INVAR STRIP AS THE REFERENCE POINT. USE ONLY THE BOTTOM EDGE OF EITHER OF THE TABS ON THE INVAR STRIP INDEX. (DRAWN BY ORLAND W. MURRAY, NGS)

DRAWING #3

USING LEICA'S 60 CM INVAR LEVELING STRIP TO LEVEL TO A HORIZONTALLY SET BENCH MARK



PLACE SPACER (20 MM PLUG) ON HIGH POINT OF BM DISK. SET BOTTOM EDGE OF ONE OF THE INDEX TABS ON TOP OF SPACER AND PLUMB INVAR STRIP USING HANDHELD BUBBLE OR CARPENTERS LEVEL.



NOTE: ALWAYS USE SPACERS IN PAIRS ONE AS SHOWN ABOVE AND ONE ON THE BACKSIGHT ROD. IF YOU ONLY HAVE ONE SPACER, PUT IT ON THE BACKSIGHT AND READ IT. THEN PUT IT ON THE FORESIGHT AND READ IT.

DRAWN BY ORLAND W. MURRAY, NGS I&M BR.

DRAWING #4

2. Invar scale with bar code GWCL60

2.1. Technical data

Dimensions (L×B×H)	600mm × 25mm × 1.5mm (23.6inch × 0.98inch × 0.06inch)
Division length (region)	0.0cm-59.6cm (0.0-23.5inch)
Weight	0.175kg (0.39lb)
Material	Invar
Divisions	Bar code
Line length	25mm (0.98inch)
Width of a single element	2.025mm
Manufacturing accuracy	According to DIN Norm 18717
Expansion coefficient for the Invar band	< 1ppm/°C
Usable distance	1.8m-20m (5.9ft-65ft). 20m = recommended maximum distance; as when D increases the usable portion of staff decreases.
Usable length	Distance dependent
Reduction	ca. 1% of the distance
At max. usable distance 20m	40cm (15.7inch)
Temperature range	
Working	-20°C to +50°C
Storage	-40°C to +70°C

2.2. Application

Application and accuracy:

Compare with the note found in section 1.2.

2.3. Handling

As with industrial bar coded staffs, the usable length of the staff is dependent on the targeting distance. See also the corresponding note from section 1.3 (reduction of usable length).

The scale has two 3mm diameter holes: one each at top and bottom. You can therefore fix the scale to another object. Make sure that the scale is vertical when installing in this way.

Which end is up (down) on the scale? On the reverse side of the scale, opposite the *MADE IN GERMANY* sign, is a level mark. This mark represents the start of the divisions (0.0cm). See figures 2 to 4.

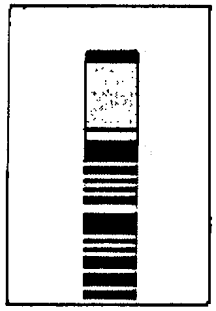


Figure 2: Top end

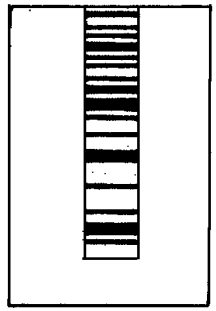


Figure 3: Bottom end

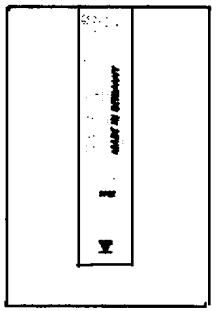


Figure 4: Reverse side, bottom end with zero-mark.