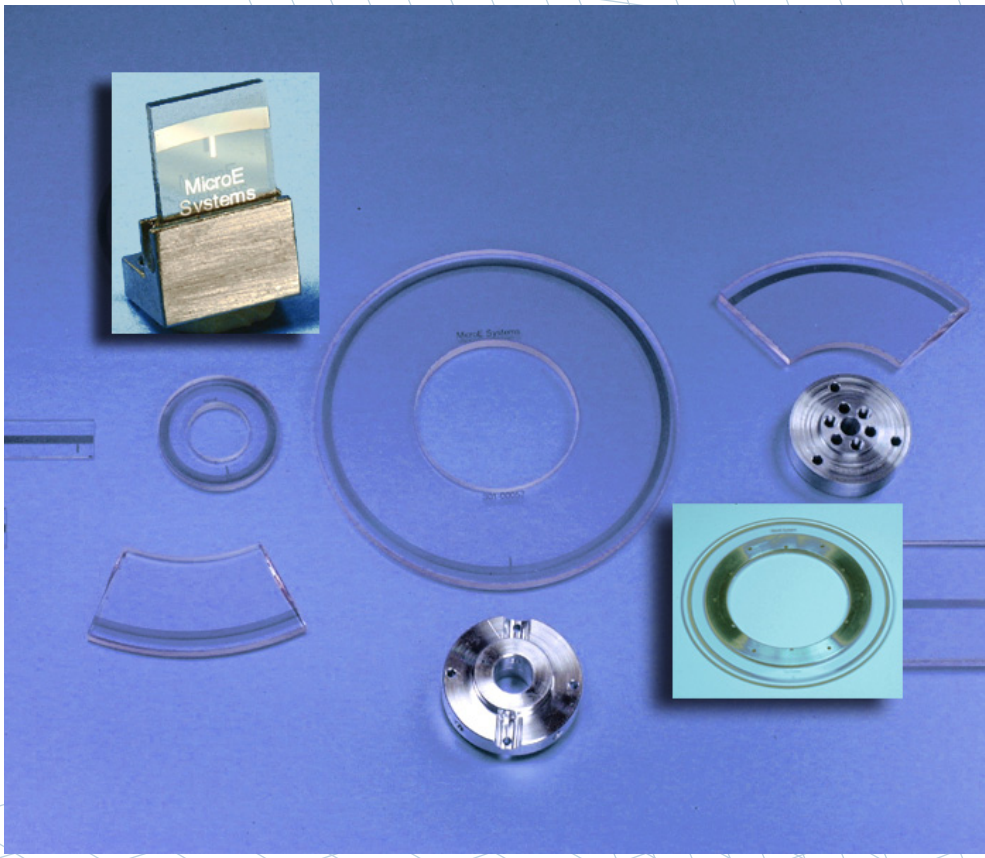
Preliminary
4-29-04

Mercury™ Encoders: Custom Scales- Special Sizes and Rotary Segments



Manual No. TN-Custom_Scales.pdf

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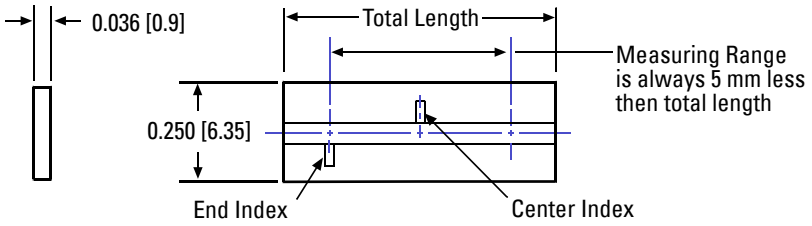
Standard Scales

Introduction

MicroE Systems offers a wide range of standard linear, rotary and segment scales to satisfy most customer applications. If none of the standard configurations meets your application requirements, then MicroE Systems can design a custom linear, rotary or segment scale that is optimized for your specific application.

This document summarizes the range of MicroE Systems' standard linear, rotary and segment scales It also illustrates how the inside diameter of the standard rotary scales can be made larger; and provides design guidelines for custom linear, rotary and segment scales.
Please contact your local MicroE Systems representative for additional information if necessary.

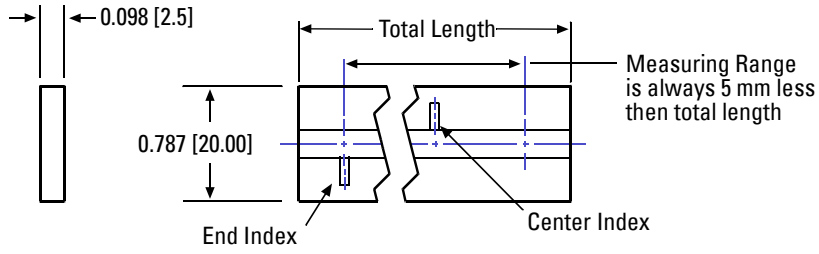
Standard Short Linear Scales 130mm and Shorter



Specifications	
Accuracy	±1µm or ±3µm
Material	Soda lime
Typical CTE	8ppm/°C
Index	Center or End

Model	L30	L55	L80	L105	L130
Scale Length*	1.181 [30]	2.165 [55]	3.150 [80]	4.134 [105]	5.118 [130]

Standard Long Linear Scales 155mm and Longer



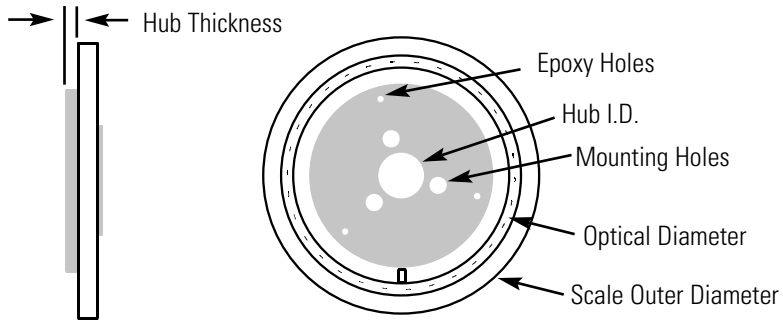
Specifications	
Accuracy	±5 µm <1m
	±5 µm/m >1m
Material	Soda lime
Typical CTE	8ppm/°C
Index	Center or End

Model	L155	L225	L325	L425	L525	L1025	L2025
Scale length*	6.102 [155]	8.858 [225]	12.795 [325]	16.732 [425]	20.669 [525]	40.354 [1025]	79.724 [2025]

*Note Measurement length is always 5 mm less than total length

Key: inches[mm]

Rotary Scales



Specifications	
Material	Soda lime
Typical CTE	8ppm/°C

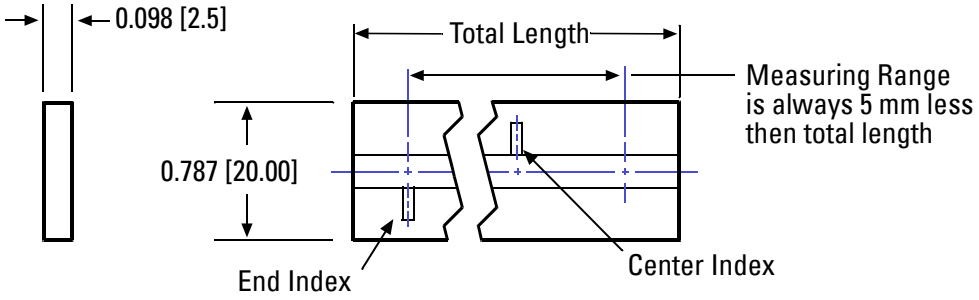
Standard Rotary Scales

Model No.	Scale Outer Diameter +.0005/-0.0000	Scale Inner Diameter	Optical Diameter	Hub Inner Diameter	Hub Thickness	Fundamental CPR
R1206	0.472 [12.00]	0.250 [6.35]	0.413 [10.50]	0.1253 [3.18]	0.040 [1.02]	1650
R1910	0.750 [19.05]	0.375 [9.52]	0.627 [15.92]	0.1253 [3.183]	0.040 [1.02]	2500
R3213	1.250 [31.75]	0.500 [12.70]	1.027 [26.08]	0.2503 [6.358]	0.050 [1.27]	4096
R5725	2.250 [57.15]	1.000 [25.40]	2.053 [52.15]	0.5003 [12.708]	0.060 [1.52]	8192
R10851	4.250 [107.95]	2.000 [50.80]	4.106 [104.30]	1.0003 [25.408]	0.080 [2.03]	16384

Key: inches[mm]

Custom Linear Scales

For limited production or prototype evaluation custom length linear gratings are cut by hand from the a larger size grating. As a result of cutting by hand, the positional tolerance of the overall length, measured length and index mark location increase to from ±0.005 in [±0.13 mm] to ± 0.020 in [± 0.5 mm]. For this reason, the cut ends of the grating can no longer be used as a reference surface. If a grating is needed in high volume, then a new design is required so that the tolerance will be restored. At this point the end edges will again be suitable for reference surfaces.



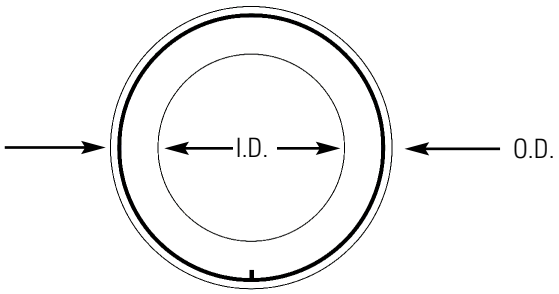
Custom Linear scale

A _____ Total Length
B _____ Measured Length
C _____ Scale Width
D _____ Scale Thickness
E _____ Location of grating pattern (normally 0.95 inch [2.43 mm] from reference edge)
F _____ Index location from left edge
G _____ Scale material (Soda lime, Zerodur or quartz)

Modified Standard Rotary Scales

Standard Rotary Scale with Larger IDs

The Inside diameter (ID) of a standard grating can be made larger by machining. This is a labor intensive process that adds cost and at least 2 weeks to the delivery of the encoder system. At higher volumes, customers should consider ordering a custom grating instead of coreing standard gratings.



Annulus = (O.D - I.D)/2

Figure 1.0

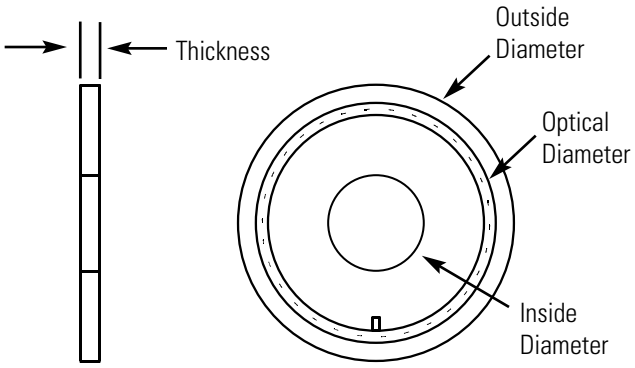
Figure 1.0 illustrates the limit of the ID and Table 1.0 below lists the limits for each standard grating.

Model No.	Outer Diameter	Inner Diameter	Annulus	Max cored I.D.	CPR
R1206	0.472 [12.00]	0.25 [6.35]	0.11 [2.825]	Cannot core	1,650
R1910	0.75 [19.05]	0.375 [9.52]	0.188 [4.765]	Cannot core	2,500
R3213	1.25 [31.75]	0.50 [12.7]	0.375 [9.525]	Cannot core	4,096
R5725	2.25 [57.15]	1.00 [25.4]	0.625 [15.875]	1.500 [38.10]	8,192
R10851	4.25 [107.95]	2.00 [50.8]	1.125 [28.575]	2.610 [66.30]	16,384

Table 1.0

Note: The ID of the grating should be at least 0.92 mm [0.036 inch] larger than the OD of the hub's shoulder. This provides sufficient clearance for centering the grating.

Calculating the optical diameter from the counts per revolution (**CPR)**
Since the spacing of the grating pattern is fixed, there is a direct relationship between the desired CPR and the optical diameter.



$$\text{Optical Diameter} = \text{CPR} \times \frac{0.020 \text{ mm}}{\pi}$$

Sample calculation given
CPR = 20,420

Optical Diameter = 20,420 x (0.020 mm / π)

= 130.00 mm

Optical Diameter = 130.0 mm

Design Considerations

The difference between the Scale Outside Diameter and the Inside Diameter must be no less than 1 inch [25.4 mm] (O.D. - I. D. < 1 inch [25.4 mm]), see Table 1.0.

See Hub Design Guidelines for more information on designing hubs for customer gratings.

WORKSHEET

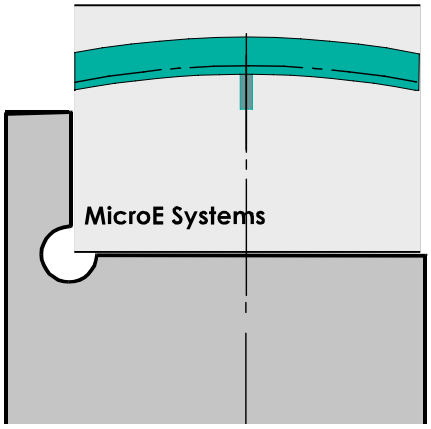
$$\text{Optical Diameter} = \text{CPR} \times \frac{0.020 \text{ mm}}{\pi}$$

Optical Diameter = _____ mm

Custom Segment Scales

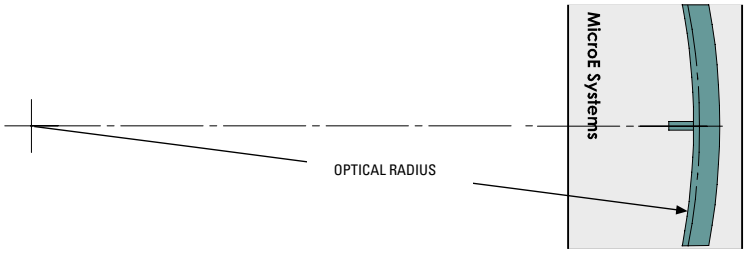
Custom Segment Scales

For applications that only need a small angular range, segment scales are a space saving alternative to using a full 360 rotary grating. Since most segment scales are made for the specific needs of each application the following section helps users design their own rotary segment. Please contact MicroE for more information on rotary segments.



1 Calculating the Optical Radius from the CPR

Since the spacing of the grating pattern is fixed, there is a fixed relationship between the desired CPR and the optical radius.



$$\text{Optical Radius} = \text{CPR} \times \frac{0.020\ \text{mm}}{2 \times \pi}$$

Sample calculation given

CPR = 20,420

Optical Radius = 20,420 x (0.020 mm / (2*π))

= 65 mm

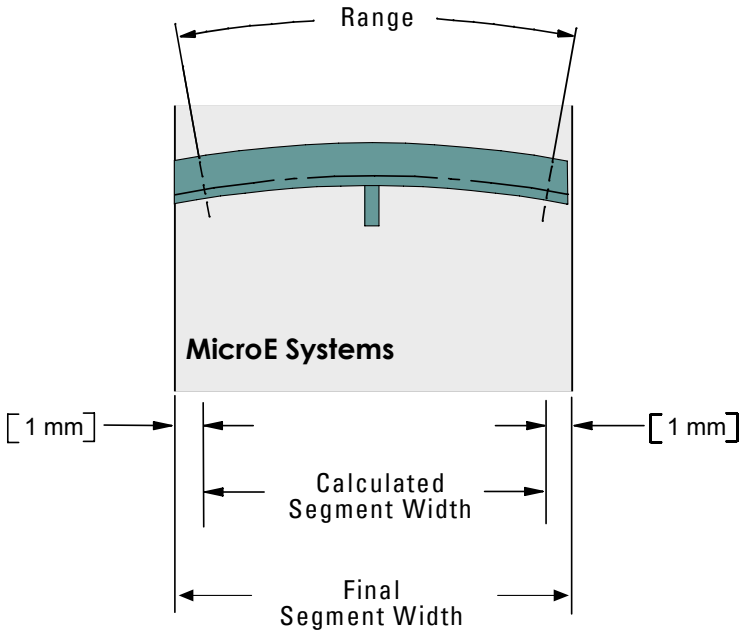
Optical Radius = 65 mm

WORKSHEET

$$\text{Optical Radius} = \text{CPR} \times \frac{0.020\ \text{mm}}{\pi}$$

Optical Radius = ___ mm

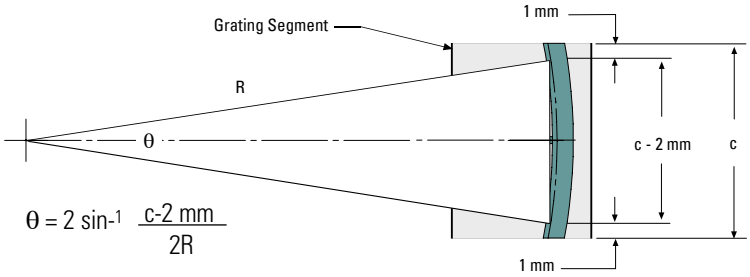
2 Calculating the Segment Width



Mercury sensors need an “extra” 1 mm of grating pattern at each edge of the segment to work correctly. You will need to add 2 mm to the segment width calculated from the measuring range (see part 3 below).

Custom Segment Scales

3 Calculating the Measuring Range from the Segment Width



$\theta = 2 \sin^{-1} \frac{c\text{-}2\ mm}{2R}$

Where:
- θ = measuring range (degrees)
- c = segment width
- R = optical Radius

Note: The -2 mm is needed for the beam overlap at the edge of the range.

Sample calculation given
- Segment width = 14 mm
- Optical radius = 65 mm

$\theta = 2 \sin^{-1} \frac{c\text{-}2\ mm}{2 \times R} = 2 \times \sin^{-1} \frac{14\ mm - 2\ mm}{2 \times 65\ mm}$

$\theta = 10.6°$

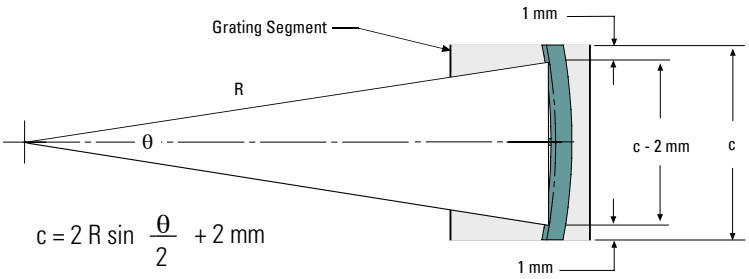
WORKSHEET

$\theta = 2 \sin^{-1} \frac{c - 2\ mm}{2\ R}$

$\theta = 2 \times \sin^{-1} \frac{\_\_\_\_ mm - 2\ mm}{2 \times \_\_ mm}$

$\theta =$ _____ degrees

Calculating the Segment Width from the Measuring Range



$c = 2\ R \sin \frac{\theta}{2} + 2\ mm$

Where:
- c = segment width
- θ = measuring range (degrees)
- R = Optical Radius

Note: The 2 mm is needed to allow for laser beam overlap.

Sample calculation given
- Measuring range = 12°
- Optical radius = 65 mm

$c = 2\ R \sin \frac{\theta}{2} + 2 = 2 \times 65 \sin \frac{12°}{2} + 2\ mm = 15.59\ mm$

c = 15.6 mm

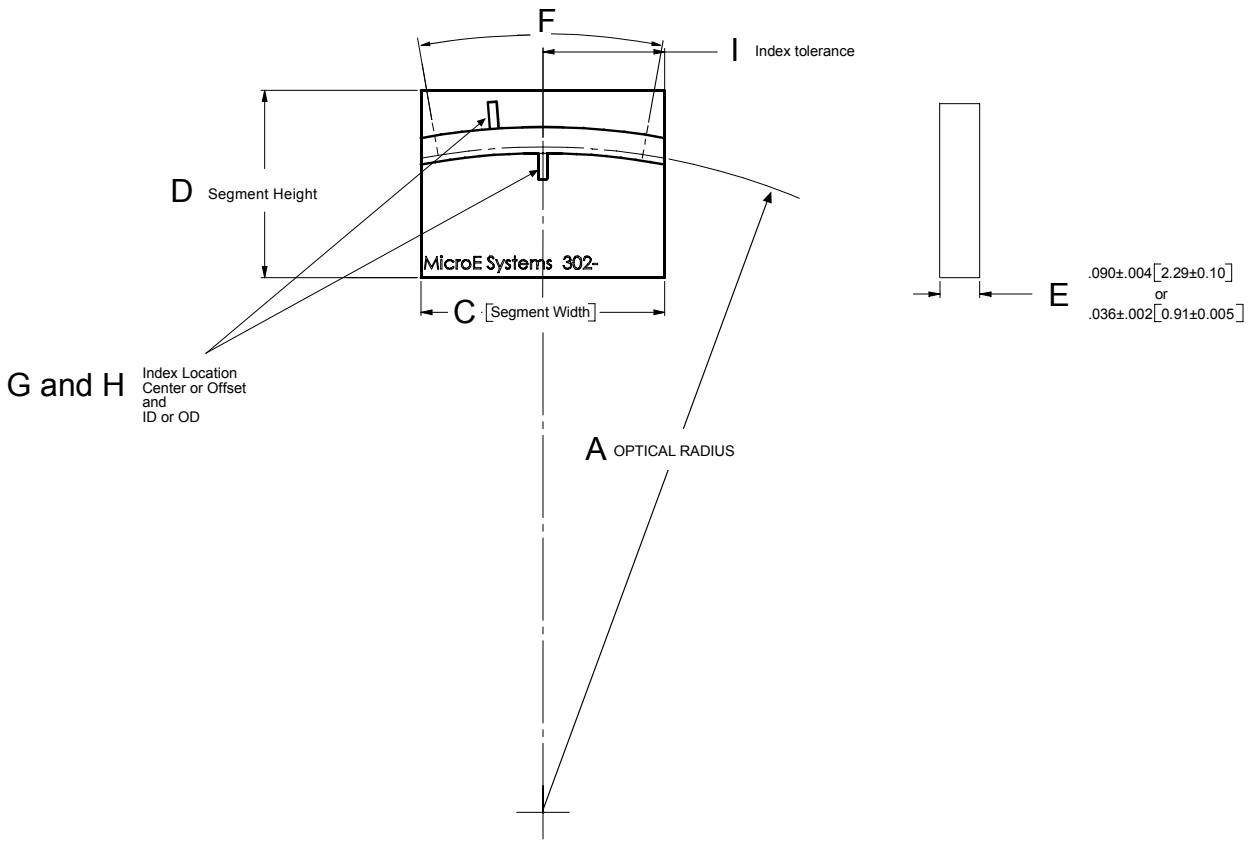
WORKSHEET

$c = 2\ R \sin \frac{\theta}{2} + 2\ mm$

$c = 2 \times \_\_\_ mm \sin \frac{\_\_\_°}{2} + 2\ mm$

c = _____ (mm)

4 Information Needed for a Rotary Segments



A _____ Optical Radius
B _____ Counts per revolution
C _____ Segment width
D _____ Segment height
E _____ Substrate thickness (0.91 mm or 2.29 mm)
F _____ Measuring range (in degrees)
G _____ Location of index: X degrees from center
H _____ Location of index: ID or OD
I _____ Tolerance of index location (± 5 degrees)
J _____ Frosted back (Yes or No)

Contact MicroE Systems

Thank you for purchasing a MicroE product. You should expect the highest level of quality and support from MicroE. If you want to download the Mercury Encoder Installation Manual, Data Sheet or Interface Drawing, or have any questions, browse www.microesys.com to find the information you need. Refer to the Mercury Data Sheets and User's Guide sections.

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