

Evaluation Kit

Seiko 20 μ m period encoders

VC America precision scales

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Overview

The SMD-0xx KIT series include a PCB for mounting SMD-0xx encoder plus interconnect via FFC ribbon cable to a breakout board to connect power and signals for testing.

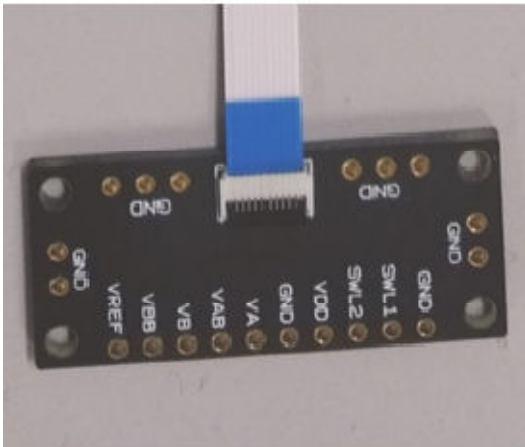
The kits include a 20µm (micron) period precision linear or rotary scale rotary glass scale with either SMD-01B or SMD-04B encoder.



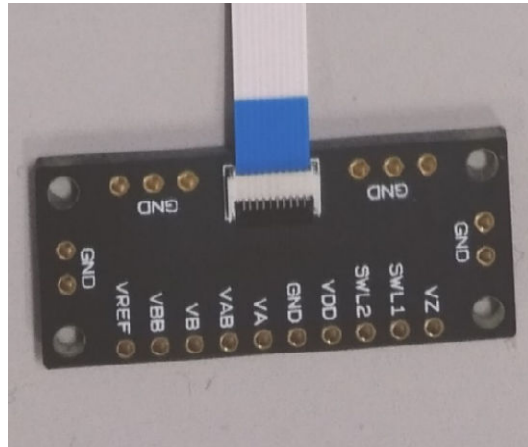
Assembled boards with ribbon cable



SMD-0xx evaluation board



**SMD-AB-PCB breakout board
for SMD-01B**

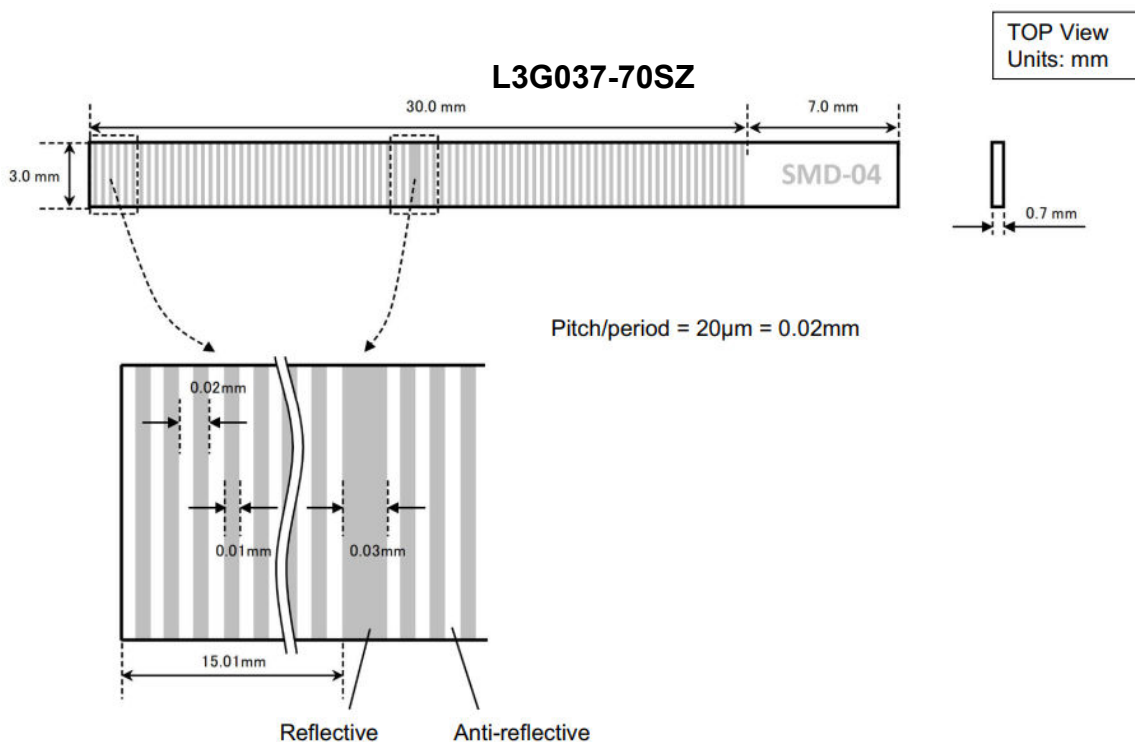


**SMD-ABZ-PCB breakout board
for SMD-04B with index
(Compatible with SMD-01B)**

Kit Parts List (BOM)

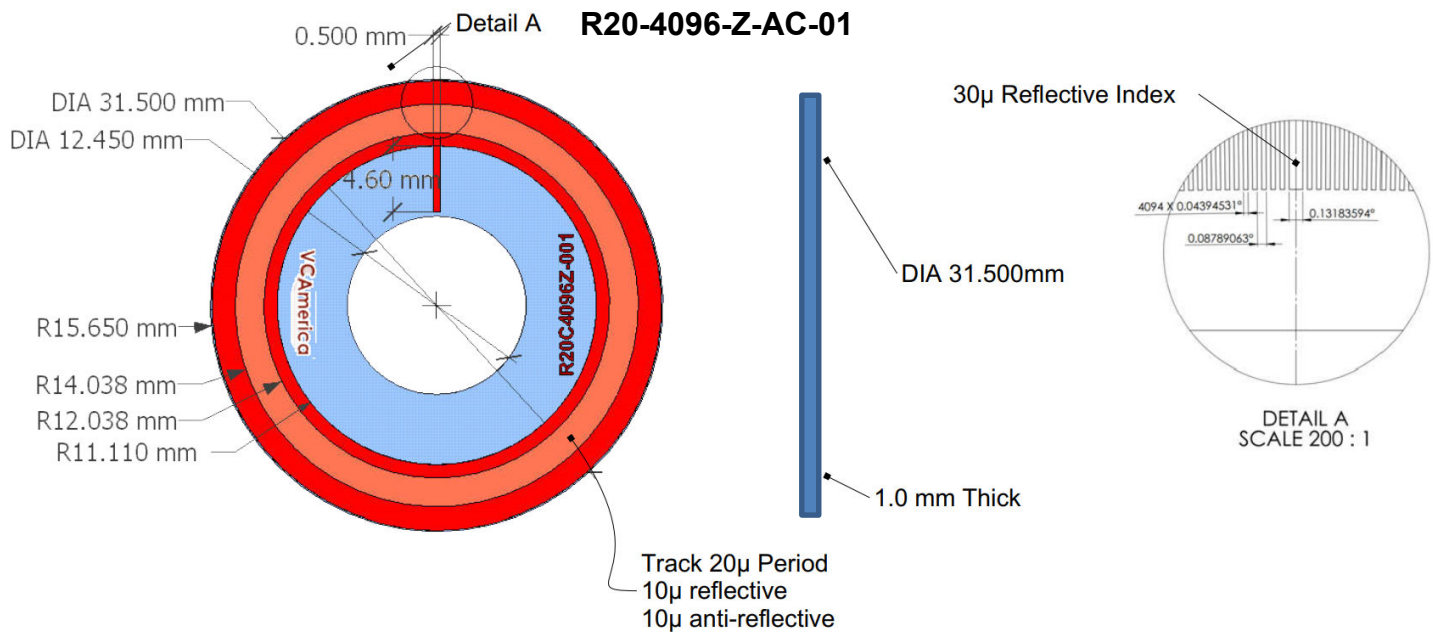
SMD-04B-L37-KIT Linear scale

Item Name	Part number	BOM Qty	Description
Precision Scale	L3G037-70SZ	1	Dimensions 37mm x 3mm x 0.7mm thick. 20μm scale and track length=30mm, with 30μm mid-point index.
Encoder Module	SMD-04B	1	Optical Read Head 20μm period with index function (APC setting)
Connection/breakout PCB	SMD-ABZ-PCB	1	Connection board with encoder board via FFC cable. Dimensions = 35mm x15mm x 1.6mm
Encoder board	SMD-0xx PCB	1	Dimensions= 25mm x 9mm x 1.6mm
Capacitor, ceramic	Multiple	1	0.01μF 50V, 0603 (1608 metric) capacitor
Capacitor, ceramic	Multiple	1	1 μF ≥16V, 0603 (1608 metric) capacitor
FFC Connector	Multiple	2	FFC right angle 0.5mm pitch 10 pins
Ribbon Cable	Multiple	1	0.5mm pitch Ribbon Cable 200mm (7.87"), contacts same side



SMD-04B-R4096-KIT Rotary 4096 period scale

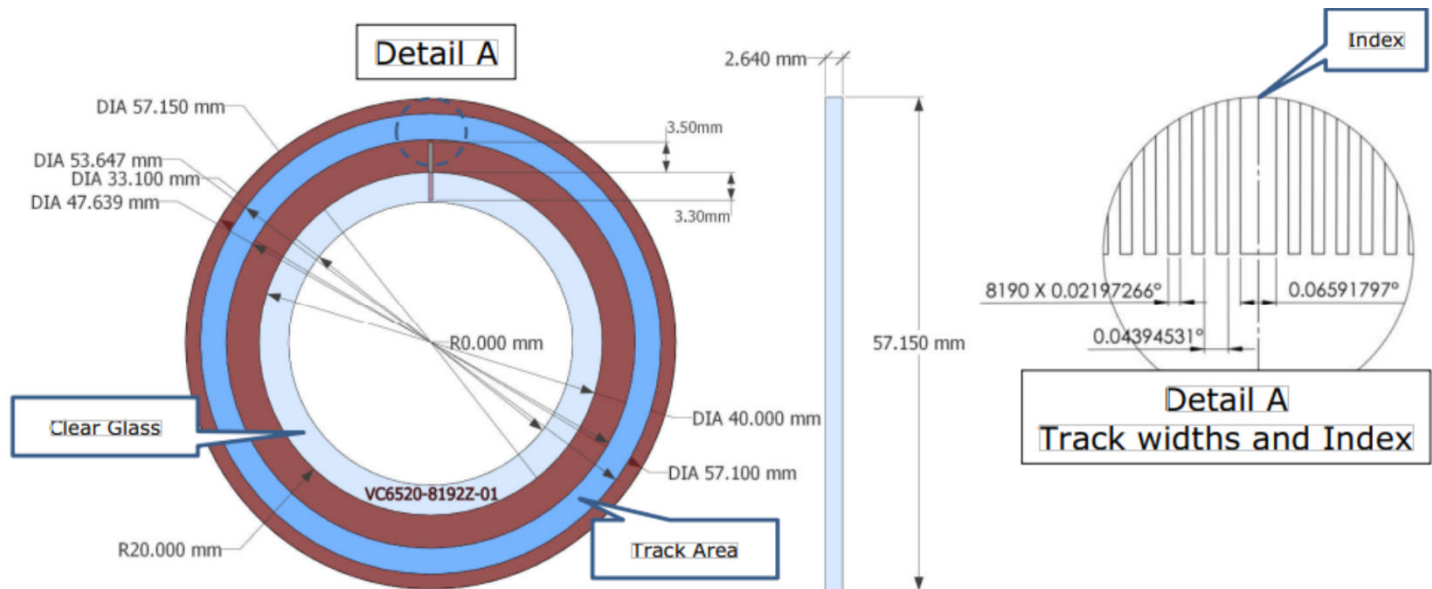
Item Name	Part number	BOM Qty	Description
Precision Scale	R20-4096-Z-AC-01	1	Scale 31.50mm OD 12.45mm ID 4096 period track w/ 30μ Index; reflective chrome & AR coatings; clear center zone; 1.0mm thick soda-lime glass; Marking= R20C4096Z-001
Encoder Module	SMD-04B	1	Optical Read Head 20μm period with index function (APC setting)
Connection/ breakout PCB	SMD-ABZ-PCB	1	Connection board with encoder board via FFC cable. Dimensions = 35mm x15mm x1.6mm
Encoder board	SMD-0xx_PCB	1	Dimensions= 25mm x 9mm x 1.6mm
Capacitor, ceramic	Multiple	1	0.01μF 50V, 0603 (1608 metric) capacitor
Capacitor, ceramic	Multiple	1	1 μF ≥16V, 0603 (1608 metric) capacitor
FFC Connector	Multiple	2	FFC right angle 0.5mm pitch 10 pins
Ribbon Cable	Multiple	1	0.5mm pitch Ribbon Cable 200mm (7.87"), contacts same side



SMD-04B-R8192-KIT Rotary 8192 period scale

Item Name	Part number	BOM Qty	Description
Precision Scale	R20-8192-Z-AC-01	1	Scale 57.15mm OD 33.10mm ID 8192 period track with 30μ index; reflective chrome and AR coatings & clear center zone; soda-lime glass; Marking=VC6520-8192Z-01
Encoder Module	SMD-04B	1	Optical Read Head 20μm period with index function (APC setting)
Connection/breakout PCB	SMD-ABZ-PCB	1	Connection board with encoder board via FFC cable. Dimensions = 35mm x15mm x1.6mm
Encoder board	SMD-0xx_PCB	1	Dimensions= 25mm x 9mm x 1.6mm
Capacitor, ceramic	Multiple	1	0.01μF 50V, 0603 (1608 metric) capacitor
Capacitor, ceramic	Multiple	1	1 μF ≥16V, 0603 (1608 metric) capacitor
FFC Connector	Multiple	2	FFC right angle 0.5mm pitch 10 pins
Ribbon Cable	Multiple	1	0.5mm pitch Ribbon Cable 200mm (7.87"), contacts same side

R20-8192-Z-AC-01

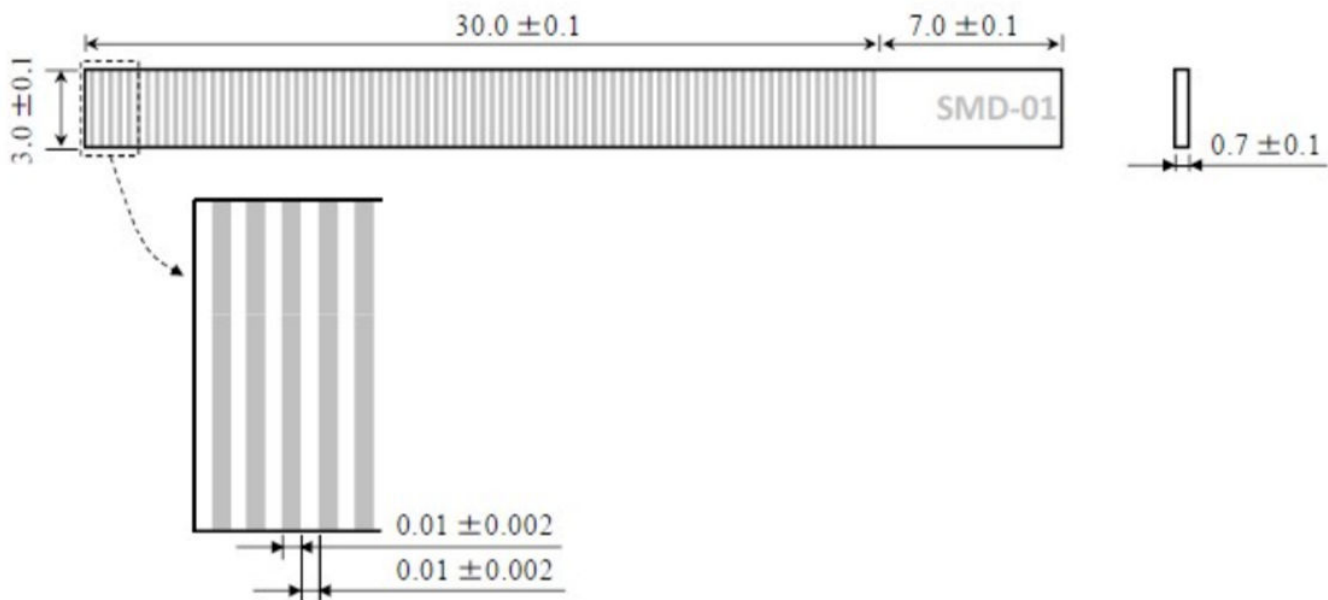


Item Name	Part number	BOM Qty	Description
Precision Scale	L3G037-70S	1	37mm x 3mm x 0.7mm thick 20μm scale track
Encoder Module	SMD-01B	1	Optical Read Head 20μm period, no index function
Connection/ breakout PCB	SMD-AB-PCB*	1	Connection board with encoder board via FFC cable. Dimensions = 35mm x15mm x 1.6mm
Encoder board	SMD-0xx_PCB	1	Dimensions= 25mm x 9mm x 1.6mm
Capacitor, ceramic	Multiple	1	0.01μF 50V, 0603 (1608 metric) capacitor
Capacitor, ceramic	Multiple	1	1 μF ≥16V, 0603 (1608 metric) capacitor
FFC Connector	Multiple	2	FFC right angle 0.5mm pitch 10 pins
Ribbon Cable	Multiple	1	0.5mm pitch Ribbon Cable 200mm (7.87"), contacts same side

*SMD-ABZ-PCB may be used as substitute

LSG037-70S

TOP View
Units: mm



Pitch/period = 20μm (0.02mm)

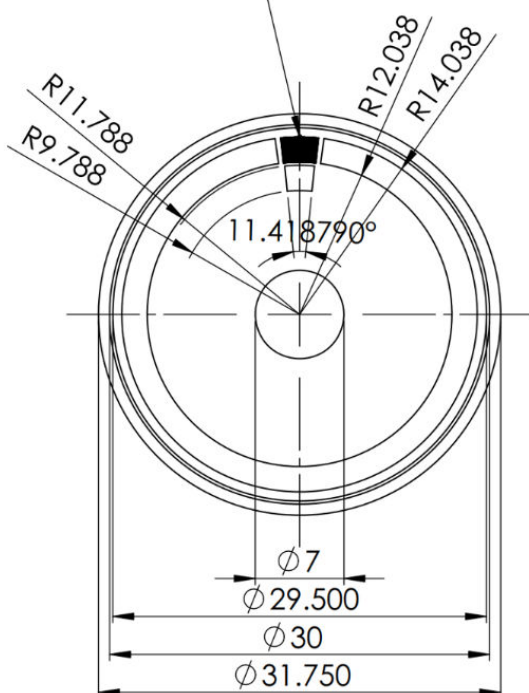
SMD-01B-R4096-KIT Rotary 4096 period scale

Item Name	Part number	BOM Qty	Description
Precision Scale	R20-4096-T-AC-01	1	Scale 31.50 OD 12.45 ID 4096 period track w/ 30μ Index; reflective chrome & AR coatings; clear center zone; 1.0mm thick soda-lime glass; Marking= R20C4096Z-001
Encoder Module	SMD-04B	1	Optical Read Head 20μm period, no index function
Connection/ breakout PCB	SMD-AB-PCB*	1	Connection board with encoder board via FFC cable. Dimensions = 35mm x 15mm x 1.6mm
Encoder board	SMD-0xx_PCB	1	Dimensions= 25mm x 9mm x 1.6mm
Capacitor, ceramic	Multiple	1	0.01μF 50V, 0603 (1608 metric) capacitor
Capacitor, ceramic	Multiple	1	1 μF ≥16V, 0603 (1608 metric) capacitor
FFC Connector	Multiple	2	FFC right angle 0.5mm pitch 10 pins
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*SMD-ABZ-PCB may be used as substitute

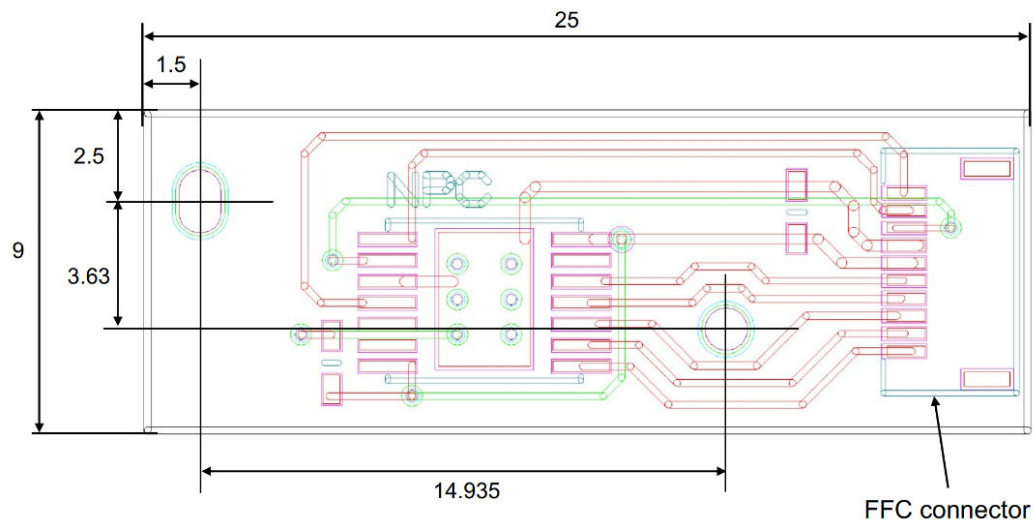
R20-4096-T-AR-01

Quantity 4096 0.043945 degree reflective
0.043945 degree non-reflective
pattern 360 degrees



Encoder Board component placement

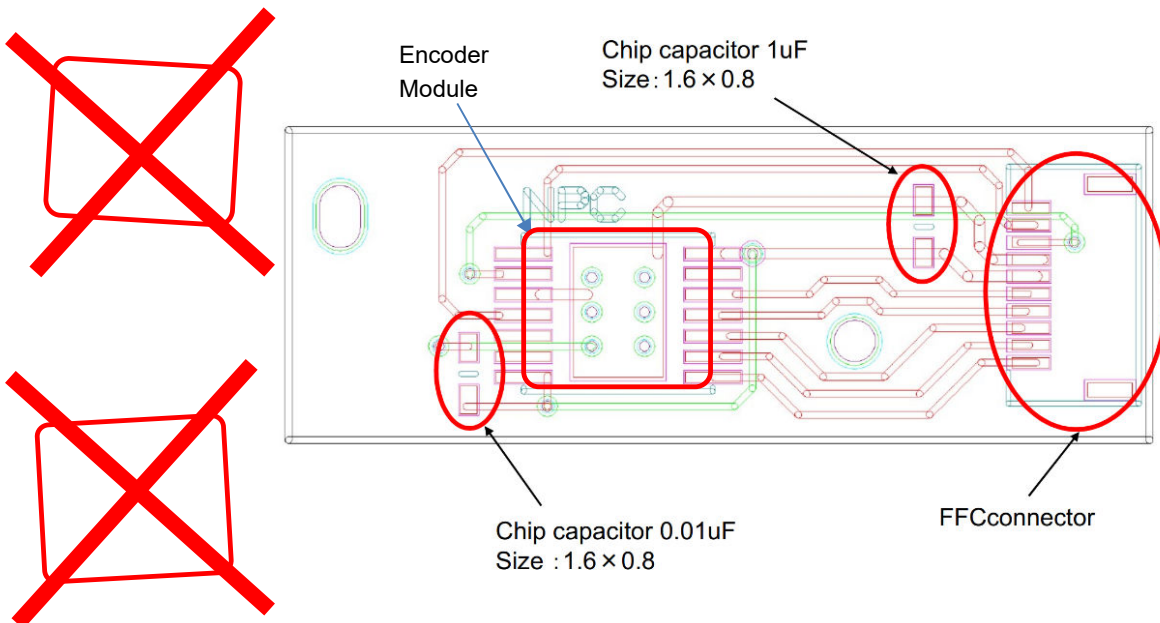
SMD-0xx_PCB Encoder Module Diagram



SMD-0xx_PCB component placement

In addition to encoder module, solder / mount the FFC connector plus four capacitors are shown.

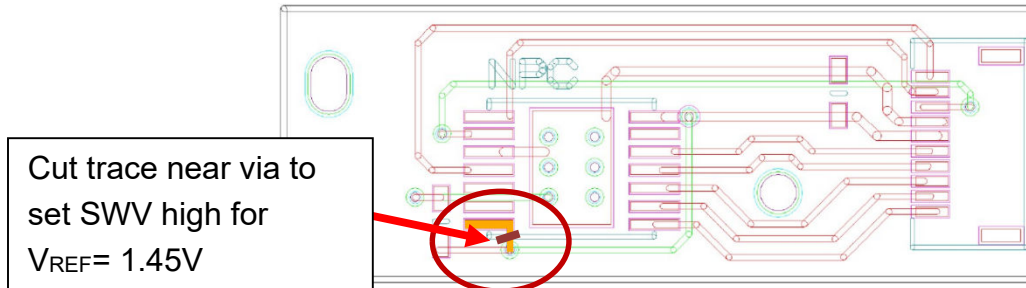
Best performance is attained with module positioned in-line with PCB (no YAW, pitch, roll).



SMD-0xx_PCB VREF Settings

The SMD-0xx_PCB layout support +5V operation with $V_{REF} = 2.25V$ which is most common configuration for SMD-01B and SMD-04B.

For 3.3V SMD-01B operation, SWV need be HIGH. The trace from SWV to ground need be cut.



Encoder	SMD-01B SMD-04B		SMD-01B	
V_{DD}	5V		3.3V	
SWV (V_{REF} setting)	H	L	H	L
V_{REF} output	1.45V	2.25V	1.45V	Do not use
VZ digital output	Open drain	CMOS	NA	

SWV, SWL1, SWL2 have internal pull-up resistors (250K min). No connect (NC) = Logic H. If using external resistors for pulldown, we recommend $\leq 50K\Omega$. (We use 30K Ω in our designs.)

LED Brightness Settings

SWL1 and SWL2 are used to adjust analog output voltage by changing LED intensity or enabling the SMD-04B index to function, which occur in APC mode.

LED OFF setting is used when system is in sleep mode to reduce power.

SMD-01B LED settings

SWL1	SWL2	A/B amplitude
H	H	X1.0
H	L	X1.8
L	H	X2.6
L	L	Off

SMD-04B LED Settings

SWL1	SWL2	A/B amplitude	Index
H	H	X1.0	No
H	L	X1.8	No
L	H	APC*	Yes
L	L	Off	No

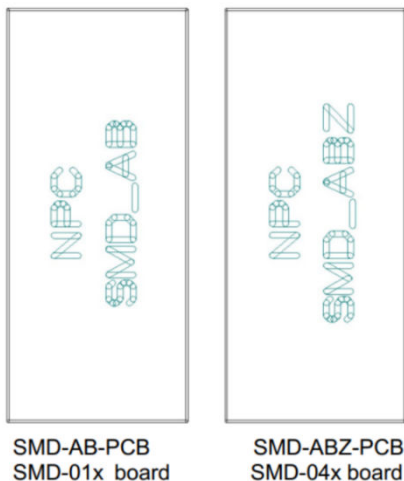
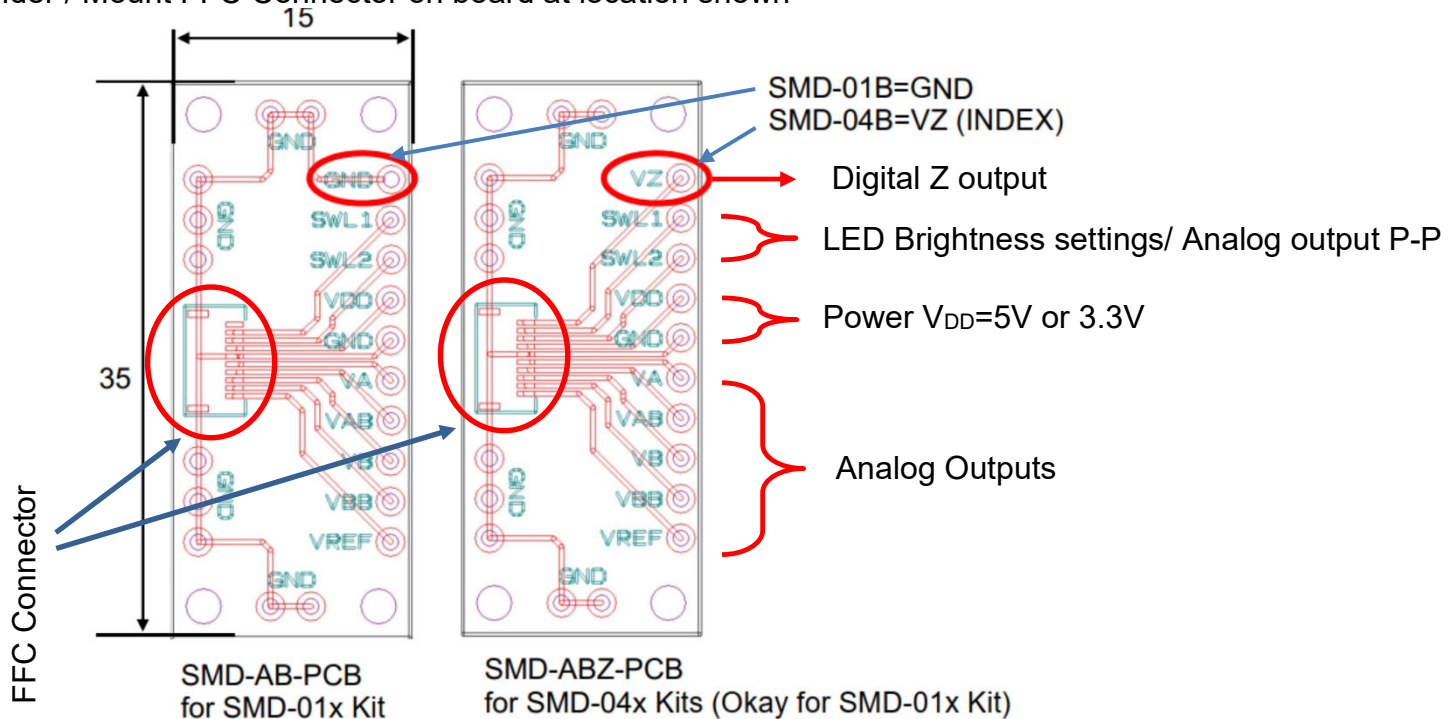
*APC = Auto Power Control

SMD-AB(Z)-PCB Breakout board

SMD-AB-PCB board at left below is supplied for SMD-01B.

SMD-ABZ-PCB board at right is supplied for SMD-04B, and can be used with SMD-01B

Solder / Mount FFC Connector on board at location shown



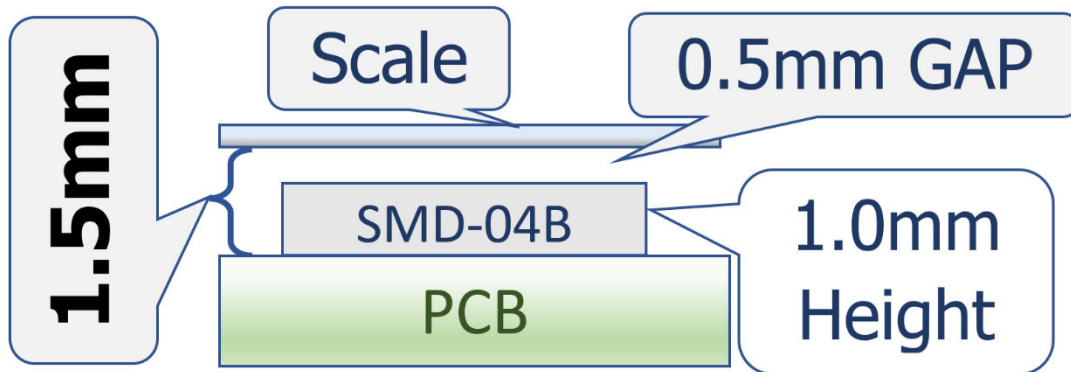
SMD-AB(Z)-PCB Connections

- Inputs
 - VDD and GND to power supply.
 - Vref and LED power settings
- Outputs
 - A, AB, B, BB, V_{REF} outputs
(Connect to interpolation circuit or oscilloscope)
 - Z index digital output to interpolation circuit (SMD-04B)

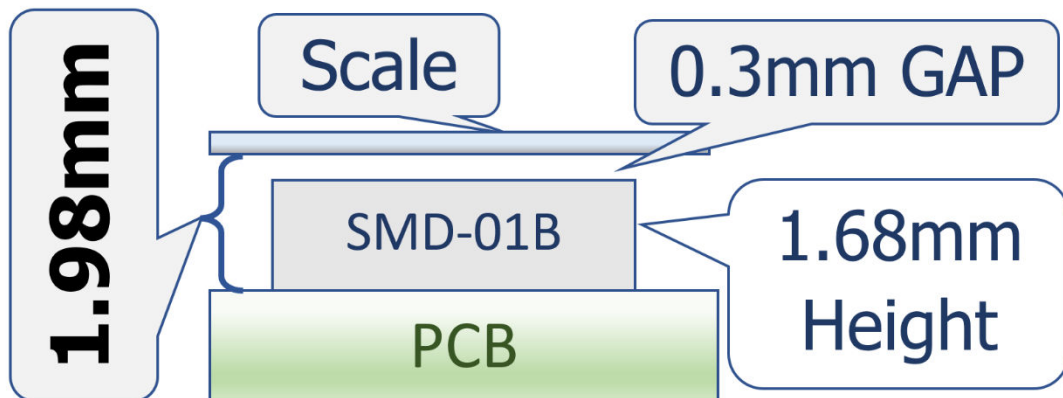
Linear and Rotary Scales

Gap between Scale and encoder

SMD-04B

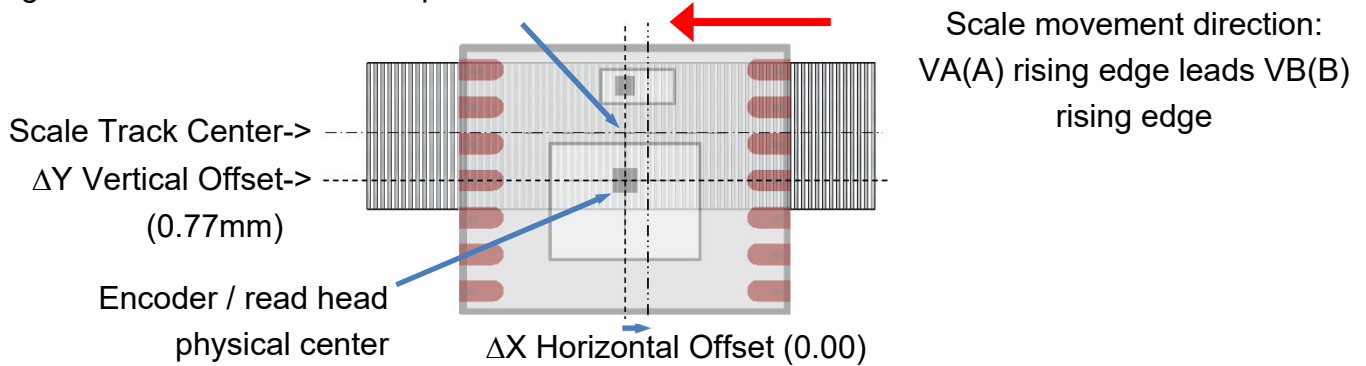


SMD-01B



Optical Center of Encoder

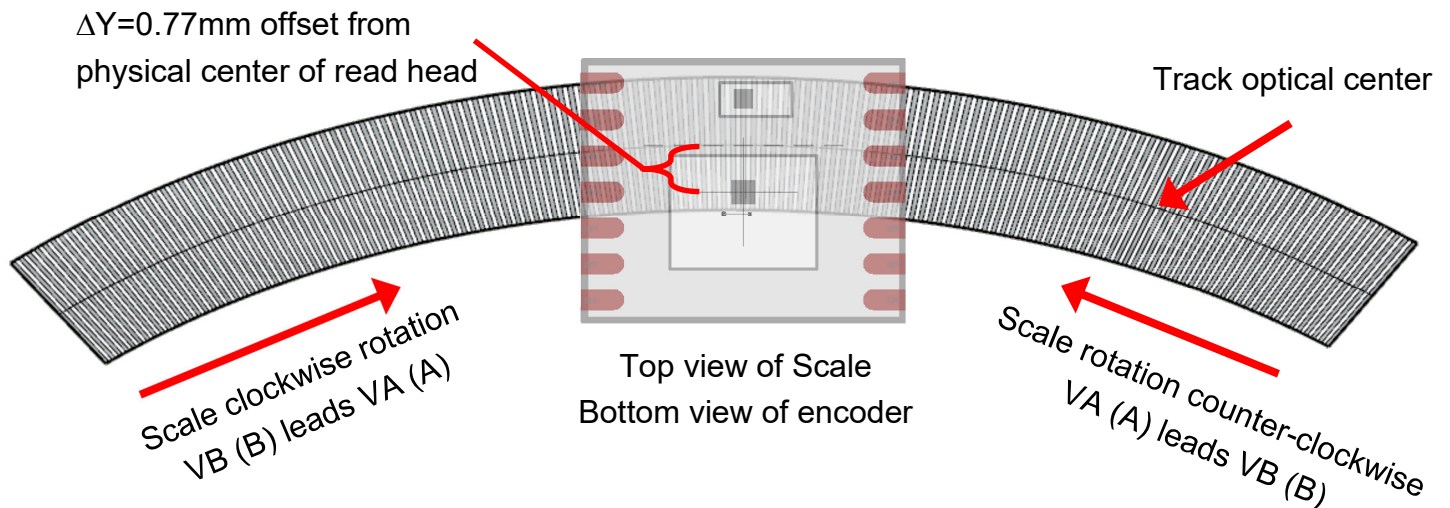
Align linear scale to encoder Optical Center



ΔY offset from center is 0.77mm for SMD-01A, SMD-01B and SMD-04B

The scale (track) can be as narrow as 0.5mm with encoder optical center properly aligned. A 2-3mm wide scale provide for ample ΔY tolerance for placement.

For rotary scales, aligning to optical center of encoder to the track optical center line is required for proper operation and achieve best encoder performance.



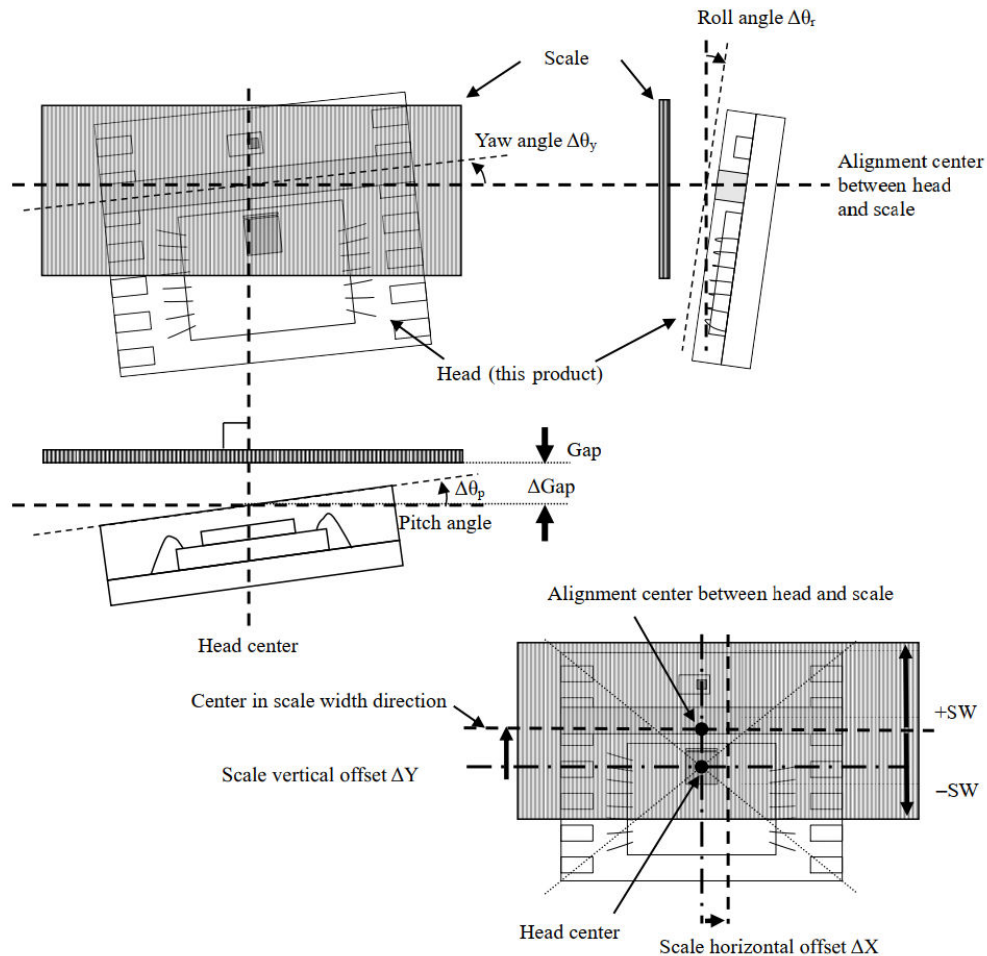
Unwanted reflections are greatly reduced using scales with anti-reflective (AR) coatings, however side reflections from within the encoder cavity may introduce errors which affect A, B, and Z outputs. Care to assure all surfaces are non-reflecting is recommended.

Encoder alignment to scale variation

The optical center of the encoder head is offset from physical center by 0.77mm in the vertical direction (ΔY) and 0.00mm for horizontal (ΔX). For linear scale, position encoder so optical center is over the track; at center line is ideal but within 0.5mm of scale edge is acceptable. Mount with 0° Yaw, 0° pitch, 0° roll, and specified gap.

For rotary scale, the ΔY and ΔX position need be accurately placed over the track optical center for optimum performance. Mount with 0° Yaw, 0° pitch, 0° roll, and specified gap.

See datasheet final pages for plots on output effects of misalignment. Mounting placement effects on amplitude and phase difference are greater for small diameter rotary scales than linear scales.



Scales for encoder applications

Rotary

The best encoder accuracies are achieved using both Seiko NPC encoders and precision glass scales to optimally maintain encoder low distortion and phase outputs. This is significant when seeking low error / highest accuracies.

VC America photolithographic processes are same used in low submicron semiconductor mask making to provide exceptional accuracy.

We supply various glass thicknesses and dimensions needed for your application.

Soda-lime glass and chrome coatings for reflective and anti-reflective patterns support most uses. When required, we'll manufacture with specialized glasses and chrome coatings to meet specific customer requirements

- Scales manufactured to your specifications, to 700mm diameter.
- Reflectivity coatings;
 - 50% minimum (Standard for Seiko encoders)
 - 60% minimum (When required)
- Anti-reflective:
 - None (Clear <5%)
 - Anti-reflective, optimized for 630nm (Glass appears near black)
 - Other coatings for Blue, Infrared, and others
- Rotary scales edge
 - Straight cut
 - Beveled with flat chamfer or round
 - Outside Diameter and/or inner core may be beveled.

Linear

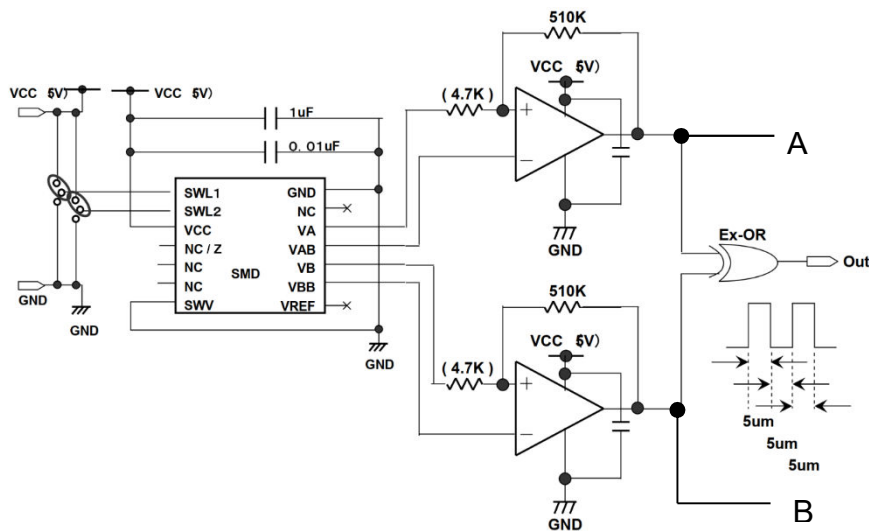
Glass scales for greatest precision up to 700mm in length, using same process outlined for rotary scales above; chrome top-side pattern with bottom side Anti-reflective coating (AR).

Less stringent applications supplied in stainless steel.

More detailed information about scale at sales@vcamerica.com and <https://www.vcamerica.com>

Application Examples

Low resolution (5 μ m) application circuit

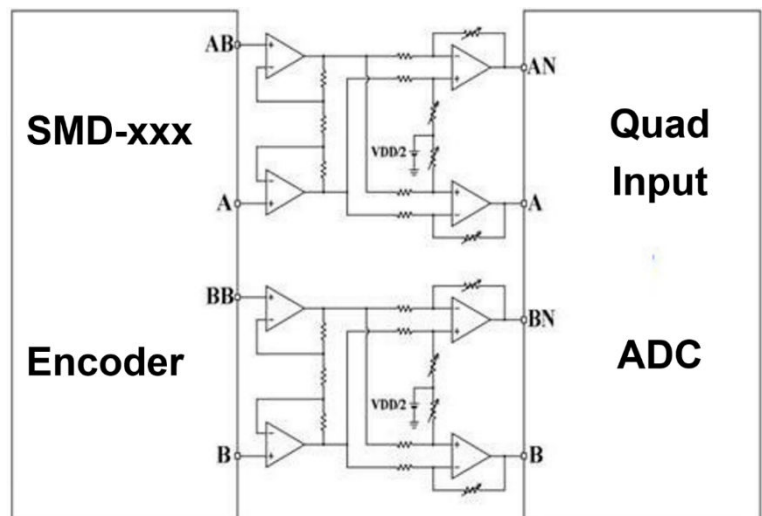


For 5-micron resolution and accuracy within $\pm 1/2$ count, this circuit output 4x quadrature digital outputs without interpolation. Two comparators and Ex-OR gate generate the 5-micron digital output. A and B channels outputs are used to determine direction.

High resolution circuit example

Interpolation using IC or custom circuit using differential op amps and high bit ADC

- 12-bit to 16-bit A/D
- Quad Op amp buffer
- PCB layout and grounding to reduce noise.
- Low noise VDD supply (on-board LDO) to lower supply and ground noise.
- Maximize A/D range for best S/N (signal to noise) ratio



Design Notes

SMD-04B VZ digital output.

When $V_{REF}=2.25V$, Output is 5V CMOS. When lower VZ voltage is required to interface with post-processing / ADC circuitry, logic level translation is required.

Setting (SWV= HIGH) VREF to 1.45V change VZ index output from CMOS to open drain. VZ amplitude is set using pull-up resistor to the desired voltage. Pull-up resistor of 10K Ω is recommended for standard load conditions CL=15pF, however, this may be adjusted for actual load.

Unwanted reflections

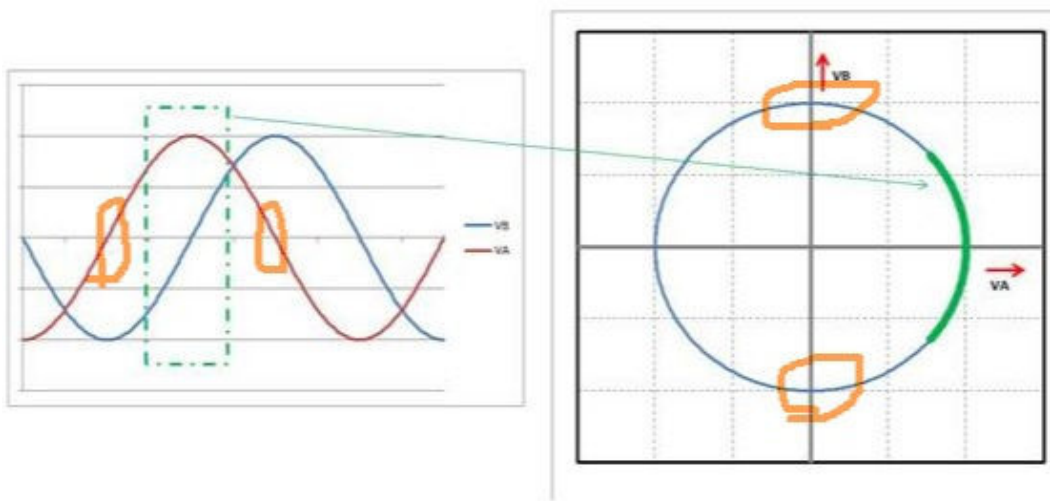
Errors caused by unwanted reflections are greatly reduced using scales with anti-reflective (AR) coatings, however side reflections from within the encoder cavity may still introduce errors which affect A, B, and Z outputs. Care to assure all cavity surfaces are non-reflecting is recommended.

Lissajous curve

A good measure of linearity, generated by an oscilloscope which support XY display mode.

Set up is 2 channel input; one input for X axis and the other Y axis. The graphic below shows the relationship and orientation of resulting circle relative to A and B signals.

SMD-04B exhibits low distortion output with near perfect Lissajous circle pattern.



Support

See our website for more information, or contact sales and technical staff at sales@vcamerica.com or call 1-702-597-2495 x1.