**SME-08A Reflective type Optical Encoder IC**

Compact package size
Built in interpolation function
Various built-in functions

3.95mm(L) x 3.4mm(W) x 1.0mm(H)
Incremental signals can be interpolated
Origin detection, LED Auto power control etc

1. SME-08A Overview

The SME-08A is a compact encoder IC that integrates a light source LED and a OEIC (Opto-Electric Integrated Circuit) in a small surface-mount package and is capable of outputting 2-phase digital incremental signals with interpolation function and digital origin signals. The incremental signal output is greatly improved by arraying the photodetector to minimize signal degradation due to mounting misalignment, and is less susceptible to misalignment between the scale and IC.

It is ideal for various applications that require the following features

[Features]

- ♦ Miniature clear molded package 3.95mm (L) × 3.4mm (W) × 1.0mm (H)
- ♦ Digital incremental output
 - A-phase/B-Phase digital output with interpolation function
 - Origin detection signal (Z-phase) output
- ♦ Selectable origin signal width in product version
 - Signal width: 90°e / 180°e / 360°e
- ♦ By providing an index pattern within the incremental pattern, the origin signal is output in a single track
- ♦ Light source LEDs built into the package
- ♦ Built-in Automatic Power Control (APC) to compensate for changes in light source brightness due to temperature changes and aging
- ♦ Supply voltage range: 4.5 to 5.5 V
- ♦ Low current consumption 27mA (typ)
- ♦ Easy positioning/installation
- ♦ Reflow mounting (*confirm suitability of reflow conditions)

[Typical Applications]

- ♦ Encoders for Motion Control
- ♦ Encoders for motor rotation detection
- ♦ Encoders for robot and machining center position detection
- ♦ Consumer devices such as camera lenses that require high-precision position control
- ♦ Other devices requiring position/speed control, such as printing machines and card readers
- ♦ Other position/speed control applications requiring miniaturization and high accuracy

2. Principle of operation, features of SME-08A, and product version

The components of the encoder using the SME-08A consist of the LED and OEIC built into the SME-08A and an external scale. The light emitted from the LED is reflected by the scale, and the bright/dark pattern created by the reflected light on the OEIC is monitored by the photodetector (photodiode) to realize the encoder function.

To monitor the pattern for incremental signals, the OEIC has an array of photodetector with a pitch that is exactly 1/4 of the light/dark cycle of the reflected light.

The photo detector array of the pattern for incremental signals is configured to simultaneously monitor several cycles of reflected light from the scale and output the average value. This photodetector array is designed to provide stable output even if the SME-08A and the scale deviate slightly from the perfectly parallel state, because the effects of the deviation are canceled out by the A and B phases.

The photodetectors of the SME-08A have a shape and arrangement suitable for rotary scales. Therefore, in the case of linear scales or rotary scales with small or large diameters, the output signal amplitude and distortion of the photodetector may be affected by a discrepancy between the light/dark pattern caused by reflected light from the scale and the arrangement of the photodetector. As a result, the output signal of the IC may be affected depending on the operating conditions and environment, such as misalignment between the IC and the scale.

When using a linear scale or a rotary scale with a small or large diameter, please conduct a thorough evaluation in the actual operating environment.

SME-08A has two signal output functions: digital incremental signal with built-in interpolation function and origin signal (Z-phase). The width of the origin signal is determined by the product version. The following three models are available.

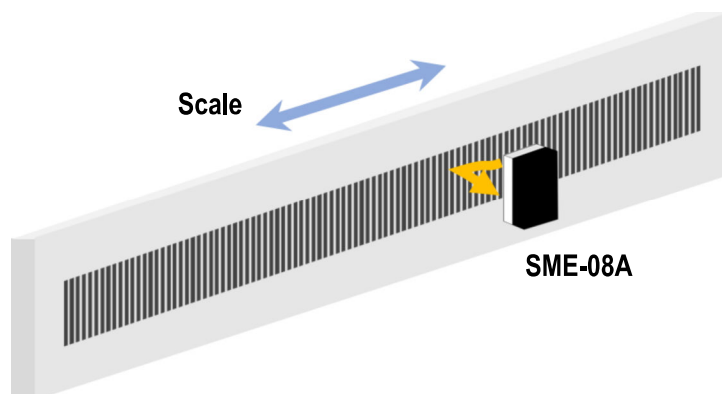
Product version	Incremental signal	Interpolation	Z-phase width *1	Power supply
SME-08A11	Digital output	1x / 2x / 4x (By terminal setting)	90°e	4.5 to 5.5V
SME-08A12			180°e	
SME-08A13			360°e *2	

*1 Unit of output width (°e): Angular unit of 360 degrees for one cycle of the phase A signal.

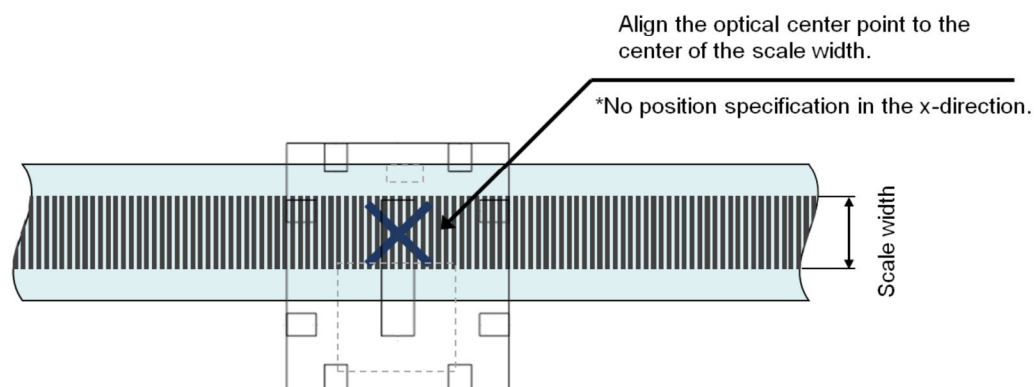
*2 When interpolation is set to 1x: 430°e

3. Typical SME-08A Encoder Configurations

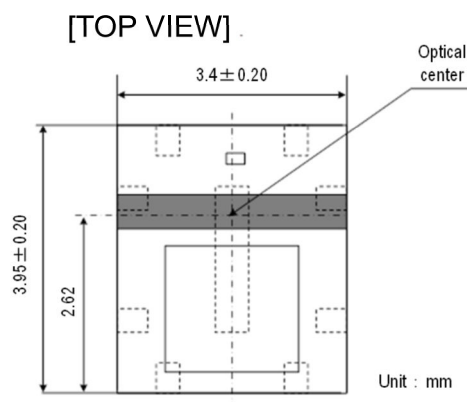
3.1. Linear Encoder Configuration and Alignment



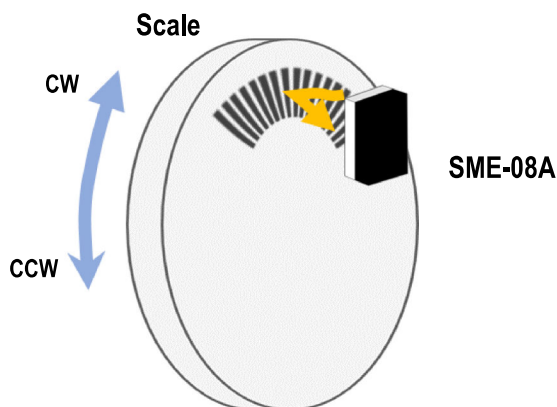
A linear encoder can be configured with a linear scale and SME-08A. The optical center of the SME-08A should be aligned with the center of the scale width of the incremental pattern of the linear scale. In addition, the axis of the package center passing through the optical center and the axis in the longitudinal direction of the scale pattern should be parallel. At this time, make sure that there is no tilt between the scale plane and the SME-08A package surface.



The optical center is located 2.62 mm from the bottom edge of the package on the central axis passing through the midpoint of the top and bottom edges of the package shown below.

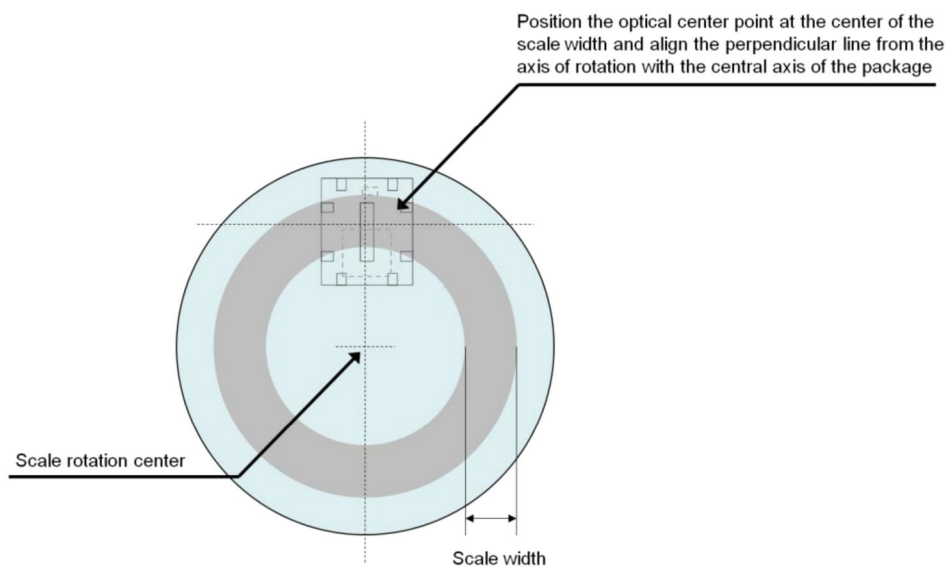


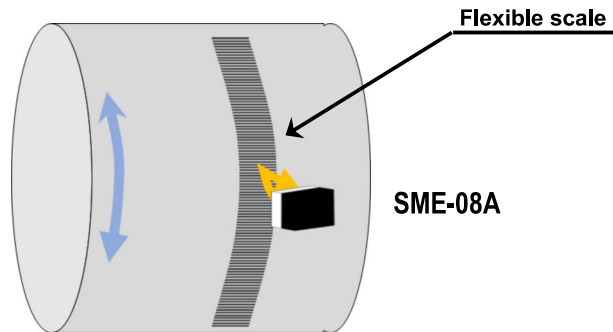
3.2. Rotary Encoder Configuration and Alignment



A rotary encoder can be configured with a rotary scale and SME-08A. The center of the scale width of the incremental pattern of the rotary scale should be aligned with the optical center, and the vertical line from the center of rotation of the scale should be aligned with the center axis of the package passing through the optical center. At this time, make sure that there is no tilt between the plane of the scale and the surface of the SME-08A package.

As shown in the above figure, when the IC placed on the rotation axis side (inside) of the scale is viewed from the back, the rotation direction of the scale is CW (rightward) and CCW (leftward)..



3.3. Cylindrical Rotary Encoder Configuration

By using a flexible scale such as PET, it is possible to directly detect the rotation of a cylindrical rotating object, as shown in the drawing above. However, an 80 μ m pitch scale pattern is required at the joints between the scales to form a complete scale around the circumference, which must be taken into consideration when attaching the scale. Of course, this is not a problem if the scale is attached to just a portion of the cylinder for detecting rotational position of less than 360°.

3.4. Scales for SME-08A

As mentioned above, the SME-08A can be combined with a linear or rotary scale to form a linear or rotary encoder. The scale must be prepared separately from the SME-08A. The following scale manufacturers can provide scales for the SME-08A, so please contact them for more information.

SME-08A is designed for a scale pattern pitch (period) of 80 μm . The scale pattern should be 80 μm (40 μm for reflective area/40 μm for non-reflective area) to match the specified pitch. If the scale pitch is changed, the signal output period cannot be changed.

3.4.1. Metal scale

The following manufacturer can provide metal-based scales. Metal scales are said to have excellent corrosion resistance and durability.

[Metal scale manufacture]

- ◆ ALPHASEIKO CO.,LTD Sales Department, Encoder Unit
- ◆ 315-1 Shimo-ongatamachi, Hachioji-shi, Tokyo, 192-0154, Japan
- ◆ TEL: +81-42-650-7715
- ◆ URL: <http://www.alphaseiko.jp/>
- ◆ E-mail: info@alphaseiko.jp

3.4.2. Flexible PET scale

The following manufacturer can provide scales using PET as the base material. PET scale is said to be characterized by its flexibility and thinness.

[Flexible (PET) scale manufacture]

- ◆ Meltec Corporation sales Dept.
- ◆ 1038 Nagareyama, Nagareyama City, Chiba 270-0164, Japan
- ◆ TEL: +81-4-7178-8800
- ◆ URL: <https://www.e-meltec.jp>
- ◆ E-mail: info@e-meltec.jp

3.4.3. Pattern of scale

The SME-08A detects refracted light from an incremental pattern of alternating reflective and non-reflective areas on the scale and output 2-phase incremental signal. It is also possible to output an origin signal by placing an index pattern in the incremental pattern, thus eliminating the need for a separate track for origin detection.

See the following section for details on index patterns for rotary and linear scales.

3.4.3.1. Rotary scale

The rotary scale of SME-08A should have the following dimensions at the center of the scale pattern width (R_{OP}).

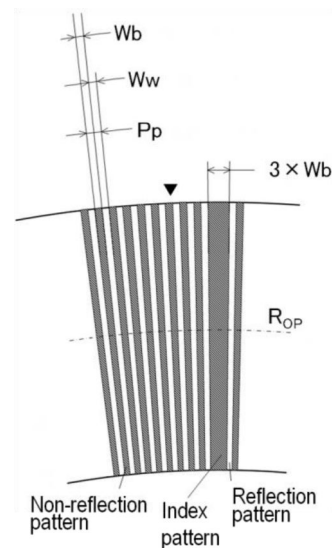
Reflective pattern width (W_w): 40 μm
 Non-reflective area pattern width (W_b): 40 μm
 Pitch of the pattern (P_p): 80 μm
 Index pattern: 120 μm

When the SME-08A is placed on the inside of the scale (lower part of the figure, on the side of the scale rotation axis), the position indicated by ▼ in the figure is the logical origin.

If the number of patterns required for the scale (PPR: number of reflection and non-reflection pairs) is fixed, the radius of the center of the scale pattern (R_{OP}) can be obtained from the following formula.

$$R_{OP} (\text{mm}) = (PPR \times 0.08) \div \pi \div 2$$

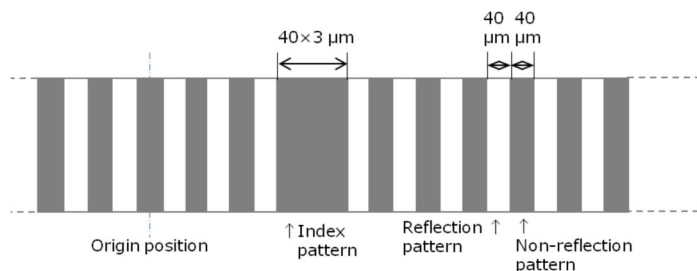
For example, if the number of patterns is 865, then $865 \times 0.08 \div \pi \div 2 = 11.0135$, resulting in 11.0135 mm as the radius of the center of the pattern.



3.4.3.2. Linear scale

For the linear scale pattern of SME-08A, each pattern part should have a fixed width and be arranged as shown in the figure below. In the case of the arrangement shown below, SME-08A is placed at the lower position in the figure, and the origin position in the figure is the logical origin.

If there is no index pattern on the linear scale, SME-08A can be placed in either below or above in the figure below.

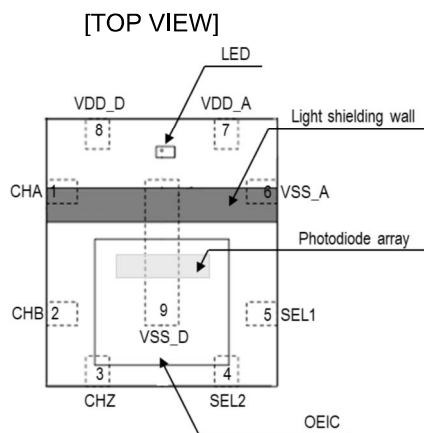


4. Reference Information about SME-08A Specifications

4.1. Reference Information about Package

4.1.1. Layout of SME-08A Internal Components

The LED and OEIC are arranged as shown below.



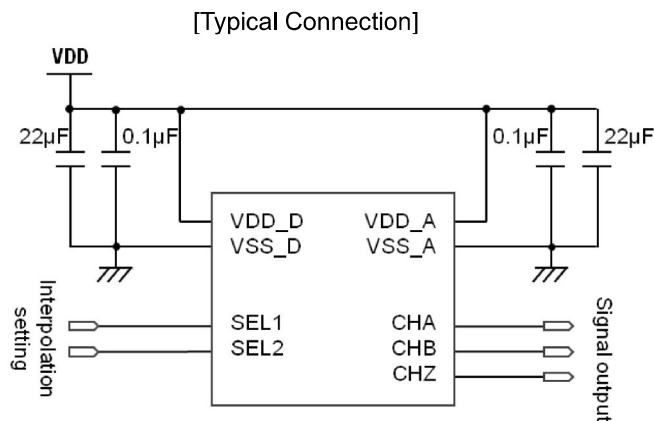
4.1.2. Environmental Data

The SME-08A is a lead-free, PVC-free (polyvinyl chloride), Halogen-free, and RoHS compliant product.

4.2. Electrical Specifications Reference Information

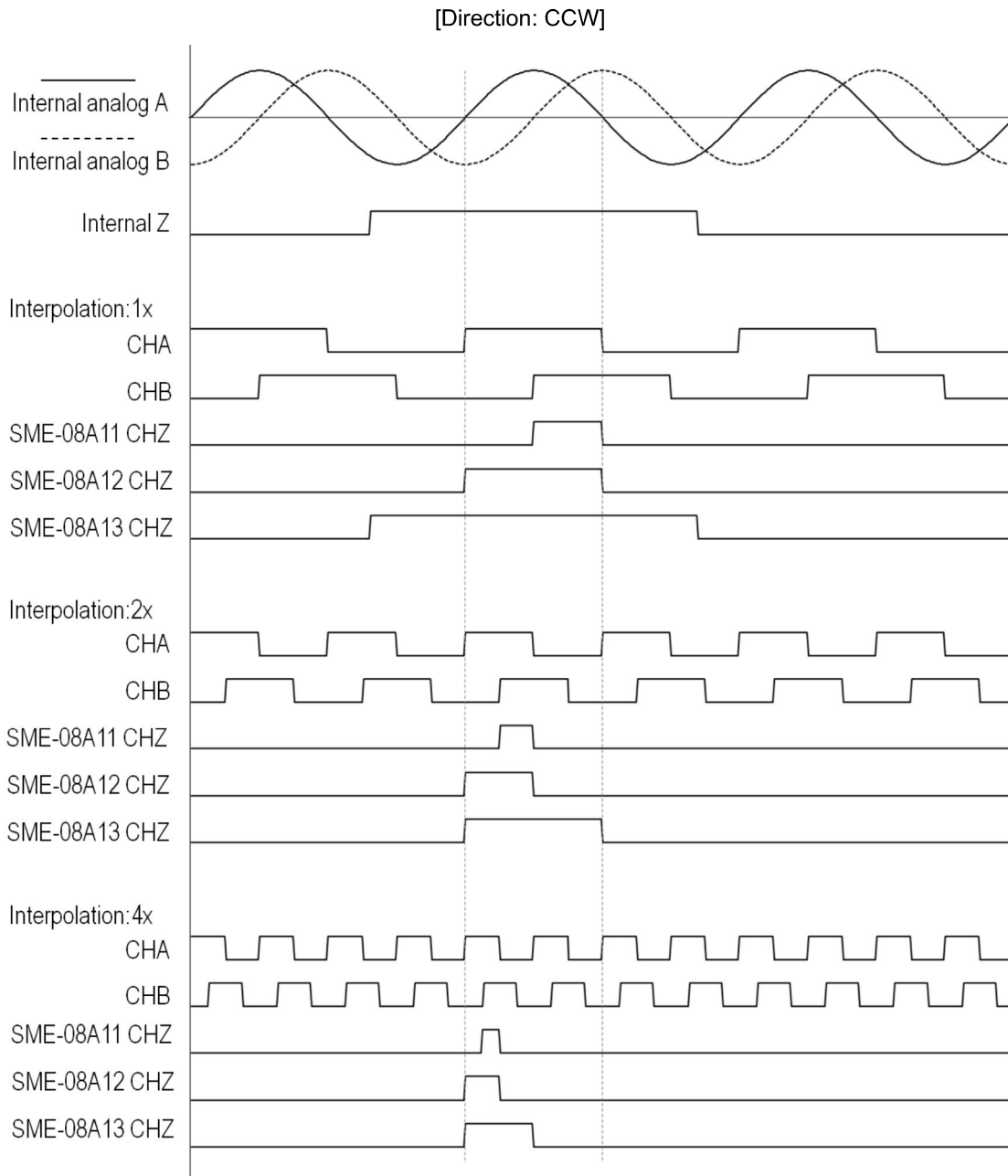
4.2.1. Basic Connection

The SME-08A should be used with bypass capacitors as shown below. The 0.1 μF capacitor should be placed as close to the SME-08A as possible. Ceramic capacitors with good frequency response are suitable as bypass capacitors.

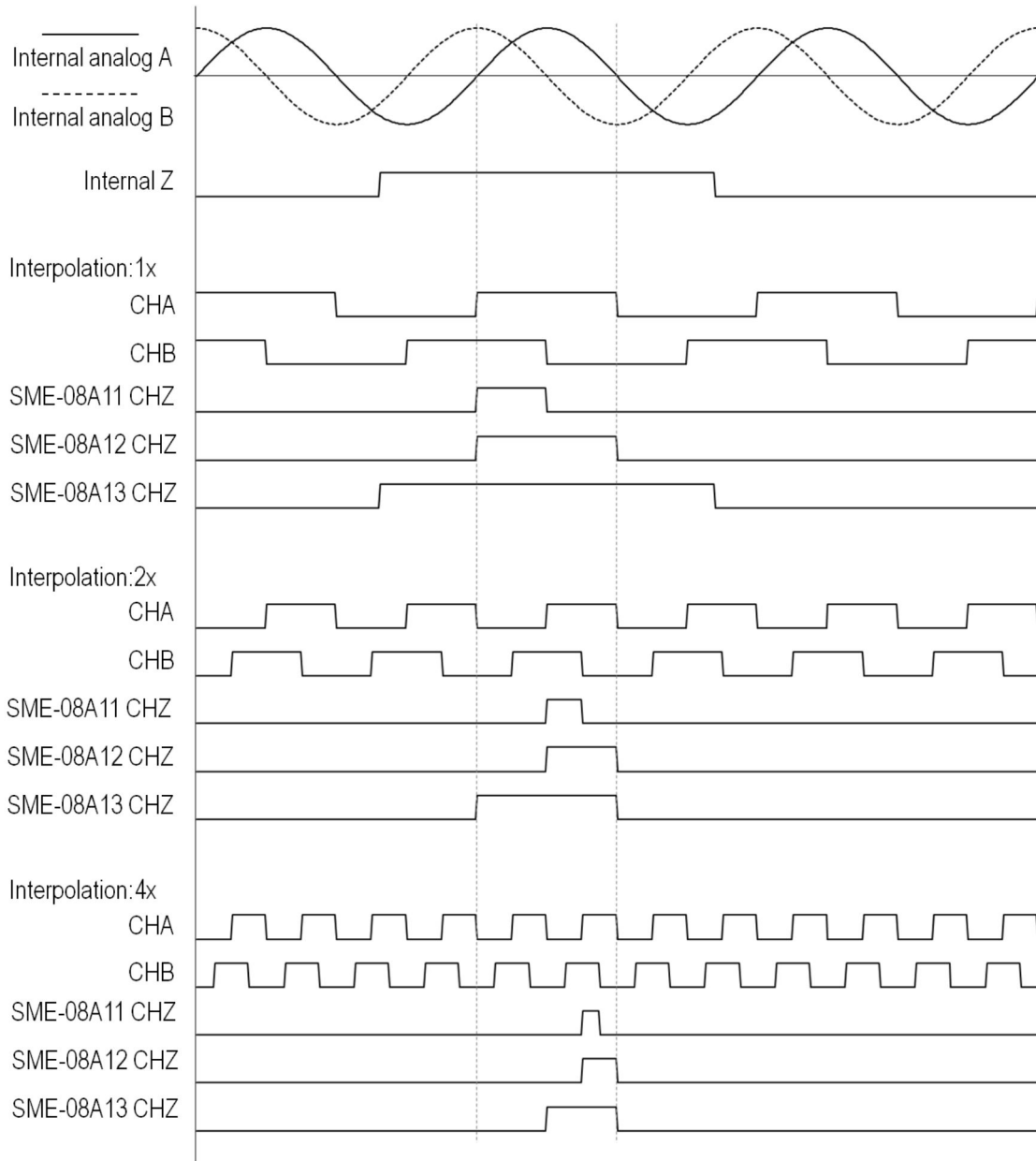


4.2.2. Interpolation setting and Z-phase output

The interpolated digital incremental and origin signals for each interpolation setting of SME-08A are shown in the timing diagram below.

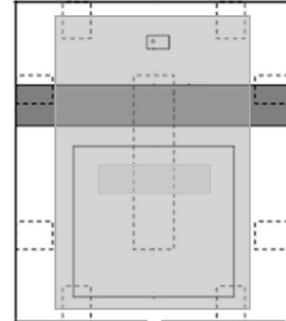


[Direction: CW]



5. Handling Precautions

- ◆ Ensure the gray portion containing the LED and OEIC, shown in the figure on the right, clean and free from dust and other contaminants. If it is dirty, gently wipe the surface with a soft clean cloth dipped in methanol or ethanol to remove all contaminants. The use of other liquids or wiping vigorously may cause scratching, clouding, or otherwise damage the surface of the encoder. Exercise caution when cleaning the device surface.
- ◆ Avoid direct contact with the SME-08A and scale when handling, installing, or adjusting.
- ◆ Ensure that the operating temperature of any unit or housing containing the SME-08A will not exceed the temperature specifications of the device.
- ◆ Please note that there is the potential that strong localized light sources may affect the encoder output.
- ◆ The light intensity of the SME-08A built-in LED does not exceed the value for Class 1 standard visible LED eye safety as prescribed by IEC60825-1.

**6. USAGE AND PRECAUTIONS**

This product is designed and manufactured to the generally accepted standards of reliability as expected for use in general electronic and electrical equipment, such as personal equipment, machine tools, and measurement equipment. This product is not designed and manufactured to be used in any other special equipment requiring extremely high level of reliability and safety, such as aerospace equipment, nuclear power control equipment, medical equipment, transportation equipment, disaster prevention equipment, security equipment.

If you wish to use this product in equipment requiring extremely high level of reliability, please contact our sales department or representative in advance.

In the event that this product is used in such equipment, please take scrupulous care and apply fail-safe techniques including redundancy and malfunction prevention in order to prevent damage to life, health, property, or infrastructure etc. in case there is some malfunction in the product.

This Application Note is provided as a reference for product introduction and customer evaluation purposes for this product. Typical characteristics and other values mentioned in this document are provided as reference data only to demonstrate principles and trends; this document does not include manufacturing tolerances and other characteristics data. Devices should only be used after thorough evaluation under actual operating conditions.

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