



## Installation and Maintenance Manual

### Scale cylinder (Monosashi-kun) Series CE1\*\*-\*



#### 1 Safety Instructions

- This manual contains essential information for the protection of users and others from possible injury and/or equipment damage.
- Read this manual before using the product, to ensure correct handling, and read the manuals of related apparatus before use.
- Keep this manual in a safe place for future reference.
- These instructions indicate the level of potential hazard by label of "DANGER", "WARNING" or "CAUTION", followed by important safety information which must be carefully followed.
- To ensure safety of personnel and equipment the safety instructions in this manual and the product catalogue must be observed, along with other relevant safety practices.

<b>CAUTION</b>	If instructions are not followed there is a possibility of injury or equipment damage.
<b>WARNING</b>	If instructions are not followed there is a possibility of serious injury or loss of life.
<b>DANGER</b>	In extreme conditions, there is a possibility of serious injury or loss of life.

#### WARNING

- The compatibility of pneumatic equipment is the responsibility of the person who designs the pneumatic system or decides its specifications.**  
Since the products specified here can be used in various operating conditions, their compatibility with the specific pneumatic system must be based on specifications or after analysis and/or tests to meet specific requirements.
- Only trained personnel should operate pneumatically operated machinery and equipment.**  
Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced personnel.
- Do not service machinery/equipment or attempt to remove components until safety is confirmed.**
  - Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
  - When equipment is to be removed, confirm the safety process as mentioned above. Switch off air and electrical supplies and exhaust all residual compressed air in the system.
  - Before machinery/equipment is re-started, ensure all safety measures to prevent sudden movement of cylinders etc. (Supply air into the system gradually to create back pressure, i.e. incorporate a soft-start valve).
- Do not use this product outside of the specifications. Contact SMC if it is to be used in any of the following conditions:**
  - Conditions and environments beyond the given specifications, or if the product is to be used outdoors.
  - Installations in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverage, recreation equipment, emergency stop circuits, press applications, or safety equipment.
  - An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.

#### CAUTION

- Ensure that the air supply system is filtered to 5 microns.

#### 1 Safety Instructions (continued)

##### Operating and Storage Environments

#### WARNING

##### Environments to avoid

- Avoid using or storing the products in the following environments which may cause failures. If the products need to be used or stored in these environments, take necessary measures.
- Place where ambient temperature exceeds the range of 0 °C to 50 °C.
  - Place where ambient humidity exceeds the range of 35% to 85% RH.
  - Place where condensation occurs due to sudden temperature change.
  - Place where atmosphere containing corrosive gas, flammable gas or organic solvent.
  - Place where atmosphere containing conductive powder such as dust, iron chips, oil mist, salt, or organic solvent, or splashing cutting chips, dust and cutting oil (water, liquid) over the products.
  - Place where the products are exposed to direct sunlight or radiated heat.
  - Place where strong electromagnetic noise is generated (place where strong electric field, strong magnetic field or surge is generated).
  - Place where static electricity is discharged or condition that the products have electrostatic discharge.
  - Place where strong high frequency is generated.
  - Place where damage by lightning is possible.
  - Place where vibration or impact is directly given to the products.
  - Condition that the products are deformed by force or weight applied.

##### Do not use close to any objects, which are affected by magnets.

Since magnets are built into the cylinders, do not place near magnetic disks, magnetic cards or magnetic tapes. The data may be destroyed.

##### This product is class A equipment that is intended for use in an industrial environment.

##### Design

#### WARNING

- There is a possibility of dangerous sudden movement by cylinders if sliding parts of machinery are twisted due to external forces, etc.**  
In such cases, human injury may occur; e. g., by catching hands or feet in the machinery, or damage to the machinery may occur.

##### Provide a cover to minimize the risk of human injury.

When driving objects or moving parts of a cylinder there is a risk of human injury, design a structure to avoid contact with human body.

##### Securely tighten all stationary parts and connected parts of cylinders to ensure that they will not become loose.

Tighten cylinders securely especially when they are used in high frequency or in locations where direct vibration or impact shock, etc. will be applied to the body of the cylinder.

##### Deceleration circuits or shock absorbers are needed in some cases.

If a driven object travels at a high speed or is heavy, impact will not be sufficiently absorbed only with the cylinder cushion. In such cases, use a circuit to decelerate the cylinders speed before the cushion becomes effective or use external shock absorbers to reduce impact. Consider, taking the rigidity of machinery into account.

##### Consider possible drop of pressure in circuit due to power loss.

For cylinders used in clamping mechanism, the work piece may become loose due to less clamping force, caused by pressure drop in circuit at the time of power loss. Install safety devices to prevent human injury and machinery damage. Measures should be taken to prevent the dropping of hanging or lifting equipment.

##### Consider possible loss of power sources.

Measures should be taken to protect against human injury and machinery damage in the event that there is a loss of air pressure, electricity or hydraulic power.

##### Design circuit to prevent sudden movement of a driven object.

A driven object is operates quickly when pressure is supplied to one side of the piston after air in the cylinder is exhausted, in such cases where that cylinder is actuated by exhaust center type of directional control valve or started after residual air is exhausted from the circuit. At this time, human injury may occur; e.g., by catching hands or feet in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed and constructed to prevent sudden movements.

##### Consider emergency stops.

Design the machinery so that human injury and/or damage to machinery and equipment will not occur when the machinery is stopped by a safety device under abnormal conditions, a power loss or a manual emergency stop.

##### Consider actions when operation is restarted after an emergency stop or abnormal stop.

Design the machinery so that human injury or equipment damage will not

#### 1 Safety Instructions (continued)

occur upon restart of operation. When the cylinder is required to return to the initial position, provide the equipment with a safe override.

- Construct the machinery so that moving objects and the moving parts of the cylinder do not come into direct contact with the human body.**
- Use a balanced circuit in which lurching of the cylinder is prevented.**

##### Selection

#### WARNING

##### Confirm the specifications.

The product in this manual is designed to be used only in industrial compressed air system. The product should not be used with pressures or temperatures outside the range of the specifications, as this may cause damage or malfunction, etc.

##### Intermediate stop

When cylinder piston is stopped intermediately by 3-position closed centre type of directional control valve, intermediate stop positions may not be as precise and exact as hydraulic operation due to compressibility of air. Valves and cylinders are not guaranteed for zero air leakage, and stop position may not be held for long periods of time. Consult SMC for long term holding of stop positions.

#### CAUTION

- Mount speed controller and adjust cylinder operation speed gradually from low speed to a desired speed.**

##### Air Supply

#### WARNING

- Do not use the product out of the specified ranges for pressure and temperature to prevent equipment damage and malfunction.**

- Operating pressure:
  - Bore size 12: 0.07 – 1.0 MPa
  - Bore size 20 - 63: 0.05 – 1.0 MPa
- Fluid & ambient temperature: 0 to 60 °C

##### Use clean air.

Do not use this product with compressed air that includes chemicals, synthetic materials (including organic solvents), saline, corrosive gases, etc., as this may cause damage or malfunction.

#### CAUTION

##### Install air filter.

Install air filter before and in vicinity of valve. The filter should be able to collect particles of 5 microns or smaller. A large quantity of particles may cause malfunction of the pneumatic components.

##### Install after cooler, air dryer, auto drain, etc.

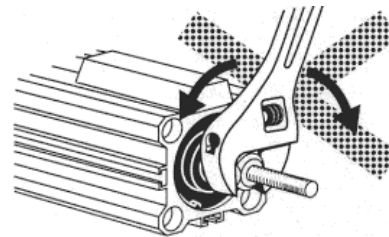
Compressed air that includes excessive condensate may cause malfunction of valve and other pneumatic equipment. To prevent this, install after cooler, air dryer, auto drain, etc.

##### Installation

#### WARNING

- Do not apply torque to the piston rod.**

Applying torque to the piston rod may cause damage and malfunction. When hardware and nuts are screwed into the piston rod end, the piston rod should be fully retracted. Use double nuts to fix work since scale cylinder does not have any parallel parts at the rod.



Please refer to the table for maximum torque.

ø12	10 N•m
ø20, ø32	20 N•m
ø40, ø50, ø60	30 N•m

- Ensure that the equipment operates properly before use.**

#### 1 Safety Instructions (continued)

#### CAUTION

- Maintenance space**  
When installing the products, allow space for maintenance.
- Installation of jigs**  
When hardware and nuts are screwed onto the piston rod end, the piston rod should be fully retracted. Use double nuts to fix the work piece since scale cylinder does not have any parallel flats on the rod.
- Do not give apply heavy impact and/or excessive moments when mounting the workpiece.**  
External force other than allowable moment may cause vibration at the guide part and/or increase in the sliding resistance.
- Use the product in such a condition that the load is always applied in the axial direction of the piston rod.**  
When the load is applied in directions other than cylinder axial direction, control the load by the use of a guide. Perform a complete centring when cylinder is mounted.
- Avoid using this product where the piston rod is subjected to a constant torque or where excessive impact is applied to the piston rod**
- Be careful to avoid scratches or dents, etc. on the sliding sections of the piston rod.**

##### Wiring

#### WARNING

- Preparation for wiring**  
Shut off the power before wiring (including insertion and removal of connectors). Mount a protective cover on the terminal block after wiring.
- Check the power supply**  
Make sure the power supply has sufficient capacity and voltages are within the specified range before wiring.
- Grounding**  
Ground terminal block F.G. (Frame Ground). Do not ground it with devices generating strong electromagnetic noise.
- Check wiring**  
Incorrect wiring may cause damage or malfunction of the products. Make sure the wiring is correct before operation.

#### CAUTION

- Separation of signal wires from power wire**  
Avoid common or parallel wiring of signal and power wires to prevent malfunction due to noise.
- Wiring arrangement and fixation**  
Avoid bending cables sharply at the connector part or the electrical entry into the wiring assembly. Improper assembly may cause disconnection, which in turn causes malfunction. Fix cables close enough so as not to exert excessive force on to the connector.

##### Piping

#### CAUTION

- Before piping**  
Remove cutting chips, cutting oil, dust, etc. in piping by flushing or cleaning before piping. Care should be taken especially that any cutting chips, cutting oil, dust, etc. do not exist after the filter.
- At piping**
  - Foreign matter should not enter. Entering of foreign matter will cause malfunction.
  - Cutting chips and sealing materials at piping threads should not enter valves when piping and fittings are screwed in. Leave 1.5 to 2 threads when sealing tape is used.

##### Lubrication

#### CAUTION

- Lubrication of cylinder**
  - This cylinder is pre-lubricated and can be used without lubrication.
  - In the case of lubrication, use the equivalent of the turbine oil type 1 ISO VG32. Once lubrication is performed, it should be continued since the initial lubricant flows out causing malfunction.

##### Adjustment

#### CAUTION

- Adjust the mounting position of detection devices such as autoswitches.**

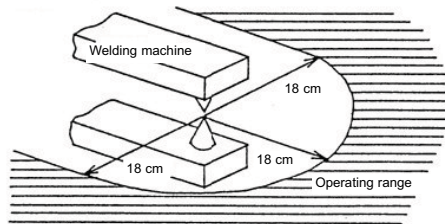
## 1 Safety Instructions (continued)

### Sensor unit

#### CAUTION

- **Do not remove the sensor unit.**  
The position and sensitivity of the sensor is adjusted properly before shipment. Removing or replacing the sensor may cause malfunction.
- **Operate the system with an external magnetic field of 14.5 mT or less.**  
Strong magnetic field in the vicinity may cause malfunction, since CE1 sensor is magnetic type.

This is equivalent to a magnetic field of approximately 18 cm in radius from a welding area using a welding current of almost 15,000 amperes. To use the system in a magnetic field that exceeds this value, use a magnetic material to shield the sensor unit.



- **Do not pull sensor cable with excessive force**  
Such action may cause failure.
- **Power supply line**  
Do not mount any switch or relay to power supply line (12 VDC to 24 VDC).

### Maintenance and Check

#### WARNING

- **Performing regular check**  
Check regularly that the product does not operate with faults. Trained and experienced operators should do the checking.

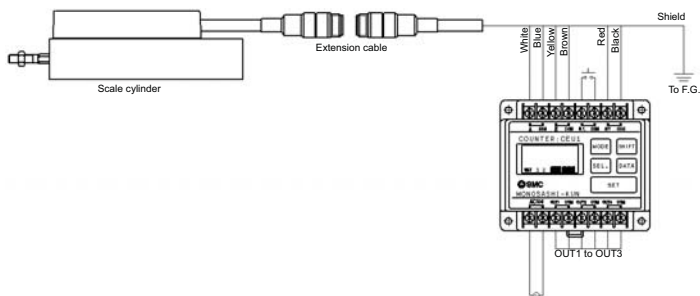
- **Dismantling of product and supply/exhaust of compressed air.**  
Before dismantling, ensure that the drop and runaway preventing measures are properly provided; shut the power source of air supply, and exhaust the compressed air in the system. When starting operation again, operate the product with care after ensuring that measures for preventing extension are properly provided.
- **Prohibition of disassembly and modification.**  
To prevent accidents such as failures and electric shocks, do not remove the cover to perform disassembly or modification. If the cover has to be removed, shut off the power before removal.
- **Disposal**  
Request a special agent for handling industrial waste to dispose the products.

## 2 Product Summary

The scale cylinder has a built-in linear encoder. The scale of the magnetic rod and magnetic sensor detects change in piston position and pulse signal is output with A/B quadrature pulse (90° nominal phase relationship). Position detection in 0.01 mm resolution is possible by inputting this signal to CEU1 or CEU5.

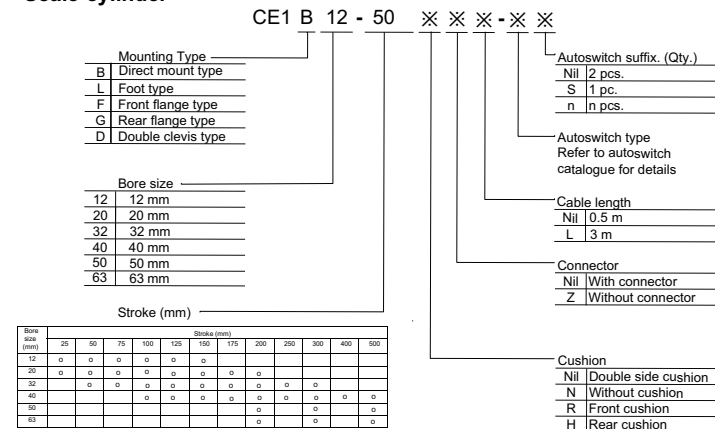
### System Configuration

#### CE1

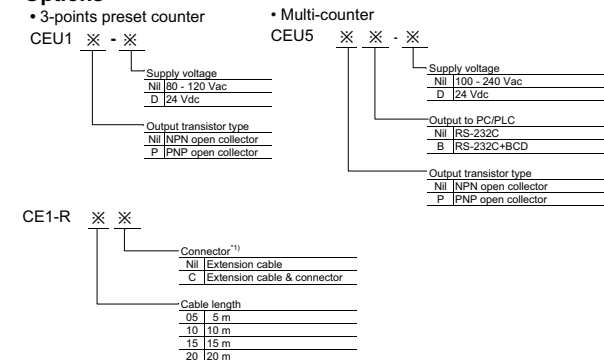


## 2 Product summary (continued)

- **How to Order**
- **Scale cylinder**



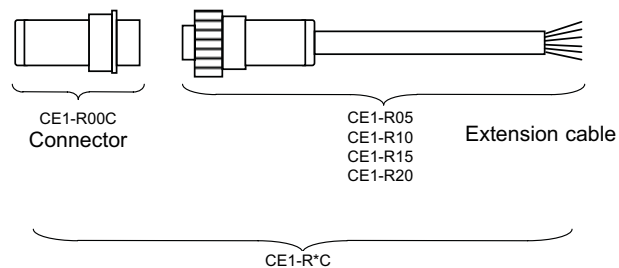
#### Options



\*1) A female connector is attached to one end of the extension cable. The male connector is attached if symbol C is selected. The connector is the same type as that mounted on the CE1.

## 3 Selection

- Use the scale cylinder CE1 with the with 3-point preset pointer CEU1 or the multi-counter CEU5.
- For SMC CE1 series and SMC CEU1 series (CEU5 series), operation check was performed with SMC extension cable CE1-R\*\* for the maximum wire length of 23 m. Since operation check was not performed with other counters and cables, a system designer who selects equipment should check the operation.
- When CE1 with connector is used, extension cable CE1-R\* is necessary. For this extension cable, receptacle connector (female) for CE1 connector (male) is attached.
- When extension cable is connected to CE1 without connector, it is necessary to mount male connector on cylinder side. Use CE1-R\*C extension cable. For connector with mark "C", one piece of cylinder side connector (male) is enclosed.
- CE1 without connector can be directly connected to terminal block of counter.



## 4 Product Specifications

### Cylinder specifications

Action	Double acting, single rod (Non-rotating piston rod)	
Fluid	Air	
Proof pressure	1.5 MPa	
Max. operating pressure	1.0 MPa	
Min. operating pressure	ø12	ø20 to ø63
	0.07 MPa	0.05 MPa
Operating piston speed	70 to 500 mm/s	
Ambient & fluid temperature	0 to 60 °C (No freezing)	
Humidity	25 to 85%RH (No dew condensation)	
Lubrication	Non-lube	
Stroke tolerance range	ø12 to ø20:	ø32 to ø63:
	0 to +1.0 mm	0 to +1.6 mm
Cushion	ø12 to ø32:	ø40 to ø63:
	None	Selectable
Rod non-rotating accuracy	ø12: ±2°;	ø40 to ø63:
	ø20: ±1°	±0.8°
Mounting	Direct mounting front tapping type (standard) Foot type. Front/Rear flange type. Double clevis type	
Thread tolerance	JIS Class 2	

### Sensor Specifications

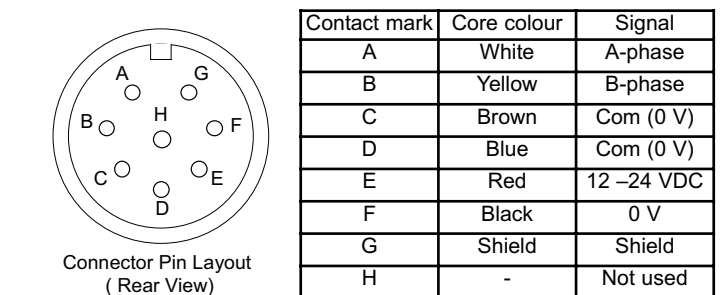
Cable	ø7.6 core twisted pair shield wire (oil, heat & flame resistant) Connector...Tajimi Electronics Co. Ltd., R03-J8M
Maximum transmission distance	23 m (when using SMC cable and counter)
Position detection method	Magnetic scale rod / Sensor head <Incremental type>
Magnetic field resistance	14.5 mT
Power supply	12 - 24 VDC (±10%) (Power supply ripple: max.1%)
Current consumption	40 mA (Max.)
Resolution	0.1 mm (at CEU1 or CEU5)
Accuracy @ 20°C	±0.2 mm <small>Note 1)</small>
Output type	Open collector (Max. 24 VDC, 40 mA)
Output signal	A/B phase difference output
Insulation resistance	500 VDC, min. 50 MΩ (between case and 12E)
Vibration proof	33.3 Hz, 6.8 G, 2 hrs. each in X and Y directions 4 hrs in Z direction based upon JIS D1601
Impact resistance	294.2 m/s <sup>2</sup> , 3 times each in X,Y and Z directions
Enclosure	IP65 (IEC Standard) <small>Note 2)</small>
Extension cable (optional)	CE1-R** 5 m, 10 m, 15 m or 20 m Connector...Tajimi Electronics Co. Ltd., R03-P8F

Note 1) Including error due to digital indication at counter CEU1 or CEU5. The overall measurement accuracy after being mounted to the equipment may vary depending on the mounting state and environment. When accuracy of the equipment as a whole is required, calibration should be performed by the end users.  
Note 2) The cylinder section does not have a water resistant enclosure.

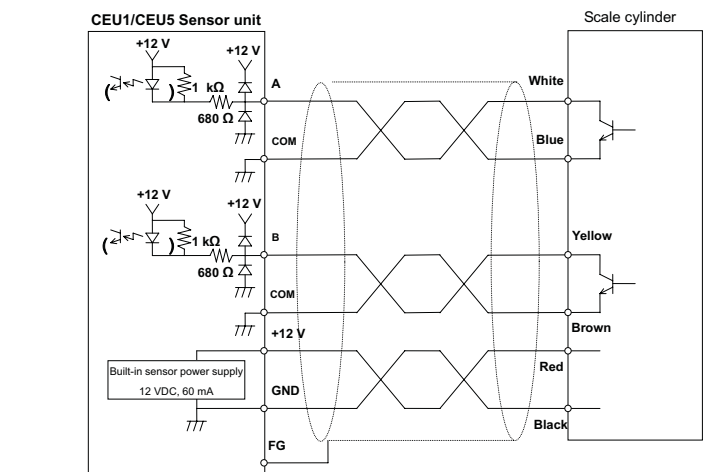
## 5 Wiring

### Connector and wiring table

The table below shows combinations of contact mark and wire core colour. The connector pin layout shows the layout of CEP1 with connector.



### Wiring for Counter

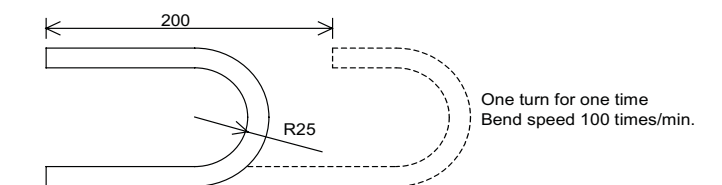


### Connection of extension cable

SMC cable CE1-R\*\* shall be used. If the length is 20 m or longer, use the specified relay box (Part no.: CE1-H0374).

#### CAUTION

- **Operation capability is confirmed at max. transfer distance 23 m. Do not use wiring longer than this. (If a longer distance is required use the relay boxes.)**
- For clamping, care should be taken not to apply excess tension force to the cable connector and sensor connection. If the cable is bent during operation, the bend radius shall be 25 mm or larger.
- Sliding bend performance:  
The number of times the wire can be bent in the conditions shown below before the wire breaks is 4,000,000 times.
- **Noise countermeasures**

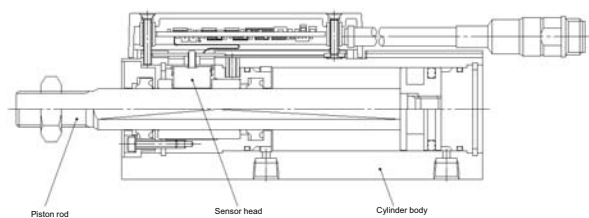


- Follow the instructions below to prevent malfunction due to noise.
- Use SMC extension cable CE1-R\*\* for CEU1/CEU5. Ground the shield wire properly.
  - Keep signal wires away from the power cables in wiring.
  - Mount a ferrite core to signal cables for possible radiated noise effects of cable.
  - Use stable power source for CE1 power supply.
  - Mount a noise filter for possible noise effects of power source.
  - Please read the operation manual of CEU1/CEU5 depending on the counter to be connected.
  - Combination of this product and CEU1(P)-D or CEU5(P)(B)-D complies with the EMC directive.



## 6 Structure and Measuring Principle

### • Structure



The piston rod has a magnetic scale on its circumference. The detection head of the sensor unit (encoder) is placed facing the scale. Along the piston rod travel, the sensor detects its magnetic signal. The sensor converts the signal to a pulse signal. The signal is measured by the counter. In order to maintain the relative position of the scale and the sensor head, an ellipse piston is used to have a structure of a non-rotating cylinder.

### ⚠ CAUTION

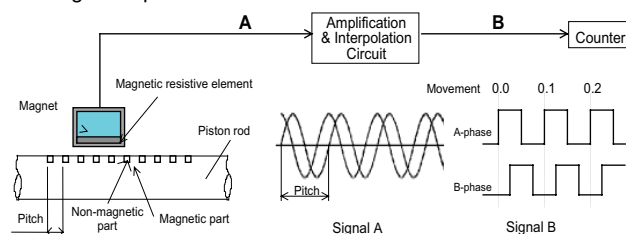
- When using the CE1 series, care should be taken regarding the following points, due to its structural characteristics.
  - **Do not give torque to the piston rod.**  
Giving torque to the piston rod may cause sensor detection failure and cylinder malfunction.
  - **Use the product in such a condition that load is always applied in the axial direction of the piston rod.**  
Offset load may cause abrasion of bearings and packing. In addition, measuring accuracy may deteriorate.
  - **Do not remove the sensor.**  
The position and sensitivity of the sensor is adjusted properly. Removing or replacing the sensor may cause malfunction.
  - **Do not pull sensor cable with excessive force.**  
Such action may cause detection failure and other failures.
- **External magnetic field should be 14.5 mT or less.**  
Strong magnetic field in the vicinity may cause malfunction since CE1 sensor is magnetic type.

This is equivalent to a field in a radius of about 18 cm from a welding part using welding current of about 15000 amperes. When the product is used in stronger magnetic field, take some measures for shielding by covering the sensor part with magnetic material.

### • Measuring Principle

This scale cylinder is an air cylinder that has a function to output piston stroke movement as pulse signal in 0.1 mm resolution

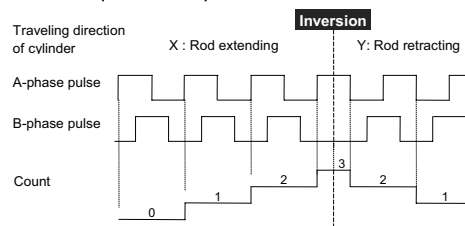
Measuring Principle is as follows:



- The piston rod has a scale consisting of magnetic layer and non-magnetic layer in 0.8 mm pitch.
- Magnetic resistive element receives 2-phase signal (Signal A) of sin. and cos. by piston rod movement. For this waveform, 1 pitch (0.8 mm) is equal to one cycle.
- This is amplified and divided into 1/8. As a result, 90° phase difference pulse signal (Signal B) is output, which is 0.1 mm per pulse.
- By counting this pulse by counter with four-quadrant multiplier, piston position can be detected in 0.1 mm resolution.

### • Relationship Between Pulse and Count

CE1 output is A/B quadrature pulse.



## 6 Structure and Measuring Principle (continued)

- In rod extending direction, A-phase turns on first, then B-phase turns on with the delay of approximately 90° phase difference.
- In rod retracting direction, B-phase turns on first, then A-phase turns on with the delay of approximately 90° phase difference. Counter performs addition in X and does subtraction in Y. When addition in rod retracting direction is needed, switch wiring of A-phase with B-phase.

## 9 Contact

<b>AUSTRIA</b>	(43) 2262-62 280	<b>NETHERLANDS</b>	(31) 20-531 8888
<b>BELGIUM</b>	(32) 3-355 1464	<b>NORWAY</b>	(47) 67 12 90 20
<b>CZECH REP.</b>	(420) 5-414 24611	<b>POLAND</b>	(48) 22 211 9600
<b>DENMARK</b>	(45) 70 25 29 00	<b>PORTUGAL</b>	(351) 21 471 1880
<b>FINLAND</b>	(358) 207 513513	<b>SLOVAKIA</b>	(421) 2 444 56725
<b>FRANCE</b>	(33) 1-64 76 1000	<b>SLOVENIA</b>	(386) 73 885 412
<b>GERMANY</b>	(49) 6103 4020	<b>SPAIN</b>	(34) 945-18 4100
<b>GREECE</b>	(30) 210 271 7265	<b>SWEDEN</b>	(46) 8-603 0700
<b>HUNGARY</b>	(36) 1-371 1343	<b>SWITZERLAND</b>	(41) 52-396 3131
<b>IRELAND</b>	(353) 1-403 9000	<b>UNITED KINGDOM</b>	(44) 1908-56 3888
<b>ITALY</b>	(39) 02-92711		

# SMC Corporation

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