■ Technical Term

Descriptions also include terms specified in the industry as well as terms prescribed by MIDORI.

● Common Term

◆ General

1. Potentiometer

It is one of precision variable resistor and it is used for precision measurement other than the volume. It is essentially a voltage divider used for measuring electric voltage by shaft's mechanical movement. Basic connection is 3 wires, Input(+), GND, Output(OUT). It is used many kinds of applications as an analog position sensor. In recent years, contactless potentiometers using Hall-IC have been developed.

2. Orange Pot

It is our product line Trademark which is the Contactless Potentiometer using Hall-IC. Its label is color of orange. It cannot be measured by resistance value because of built-in amplifier.
Hall-IC is the semiconductor element so that total resistance value choice nor measuring resistance value are not available like contact type potentiometer.

3. Blue Pot

It is our product line Trademark which is the Contactless Potentiometer using Magneto-Resistive Element. Its label is color of blue. Resistance values are not selectable because it is fixed by element size.

4. Green Pot

It is our product line Trademark which is the Potentiometer using Conductive Plastic Element. Its housing or label are color of green. It is needed to be selected total resistance value.

5. Magnetic Encoder

It is the Encoder using Magnet and Magnetoelectric Conversion Element.

◆ Mechanical

1. Total mechanical travel

Angle / Stroke which can be moved mechanically. If end point such as mechanical stopper is not available, Angle / Stroke is endless.

2. Torque

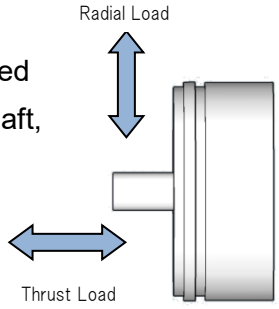
A force which rotates shaft. Standardly, it is value of running torque.

3. Friction

A force which moves shaft of the linear potentiometer.

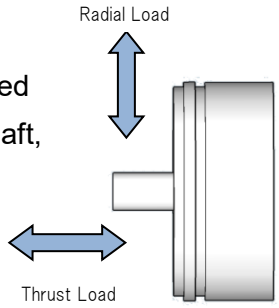
4. Radial load tolerance

It is maximum load to vertical direction of the shaft of angle sensor.
Catalog specification is based on laboratory condition. If the shaft are loaded force excessively, it may cause of failure. If you would like to load to the shaft, please contact us.



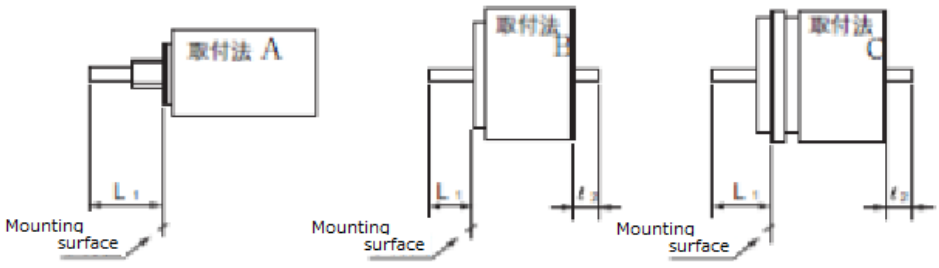

5. Thrust load tolerance

It is maximum push / pull force to the shaft of angle sensor.
Catalog specification is based on laboratory condition. If the shaft are loaded force excessively, it may cause of failure. If you would like to load to the shaft, please contact us.




6. Shaft length

L1 is mounting side and l2 is opposite. L1 is the length from mounting surface to shaft end. (Note: It is not shaft length only.) For special shaft length, please contact us.




◆ Electrical

1. Effective electrical travel

Defined angle(°) / stroke (mm) of each product which can be got output change characteristic.

2. Electrical travel

Defined angle(°) / stroke (mm) of each product which can be got output. It include the short-circuited portion where output is stable.

3. Linearity / Accuracy

Linearity represents the accuracy of potentiometer which is maximum vertical error between based linear-line and actual output voltage. There are various definitions of based linear-lines and errors.
Error is expressed as a percentage of the output voltage ratio of based linear-line at the effective electrical travel. (%FS)

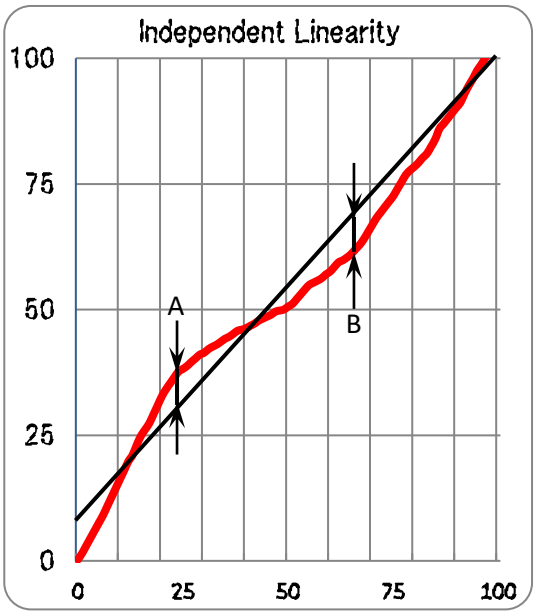
$$\text{Linearity} = \frac{W\theta - V}{\text{Full Voltage}} \times 100(\%)$$

(1) Vθ: Voltage at Maximum error

(2) V: Reference voltage

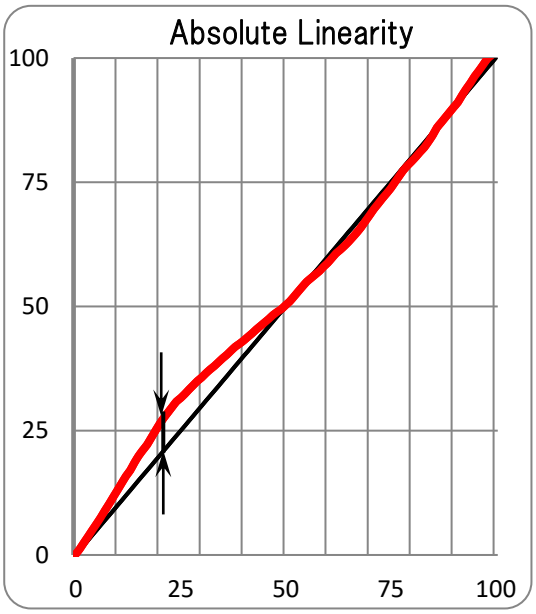
4. Independent Linearity

It is suitable for obtaining the linearity if the range to be used is an arbitrary position.
Set the based linear line to be minimized error from actual output. In the right graph, the error from the point A and B of actual output (Red line) is large. Based line can be set to the smallest and evenest the vertical deviation of the point A and B.



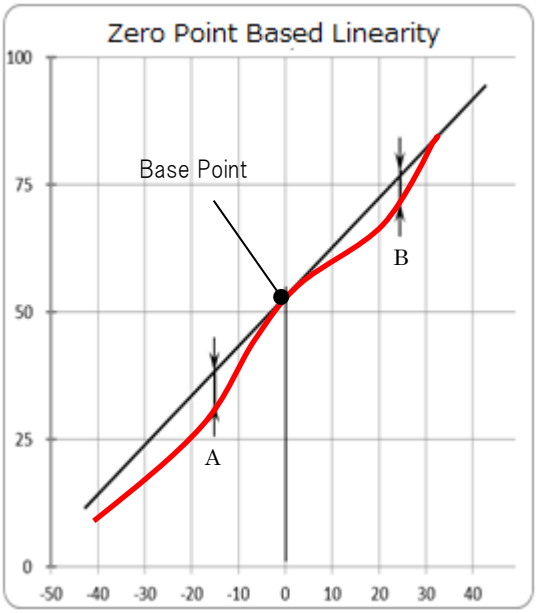

5. Absolute Linearity

It is the maximum error of the output voltage with respect to the based line in a predetermined mechanical effective range.
Since the absolute linearity based line is fixed with respect to the angle range unlike based line of the independent linearity, the maximum error may become large if the range to be used is different from the based line.




6. Zero Point Based Linearity

It is a definition by MIDORI which is used for the Tilt Angle type.
The mechanical angle 0 ° (horizontal) is used as the electrical midpoint (base point) for both ends.
Based on the output voltage ratio at an angle of 0 ° (position in the horizontal direction) as the based line, the tilt angle of the based line is changed so that the output error at the points A and B which become the maximum error equally is minimized.
The maximum with respect to this based line the output error is expressed as a percentage.




7. Total Accuracy

Accuracy that comprehensive linearity error (repeatability), hysteresis, temperature drift, etc. in forward and backward of reciprocating sliding.

8. Output Resolution

It represents the minimum value at which the output voltage ratio of the potentiometer changes.

Output resolution of Wire wound Pot is expressed as a percentage of the reciprocal of the resistive wire's total number of turns by effective electrical angle.

Output resolution of Green Pot and Blue Pot is infinitely small, so it is not mentioned in catalog.

Output resolution of Orange Pot is possessed by Hall-IC capability so that it is represented by the number of bit with respect to the input voltage. Therefore, the resolution as the product decreases according to the output range.

9. Linearity guaranteed range

It is range of guaranteed linearity within effective electrical travel.

10. Insulation Resistance

It refers to the performance that current does not leak in the electric path through which current flows. Represent the resistance value to which the voltage applied to the potentiometer does not leak trough the attached the case or shaft.

In addition, some of MIDORI products contain static electricity or noise countermeasure parts (such as feedthrough capacitor, variable resistor, etc.), so some products are not insulated. However, these products have low power input voltage so even if there is current leakage, it is minute and there is no harm to the human body.

11. Dielectric Strength

It is the voltage that can be applied without causing dielectric breakdown in the specified time. If it is applied a voltage to the case or shaft more than value of dielectric strength, the insulation state is destroyed and current flows.

12 Temperature Characteristic

Changing output voltage ratio within a certain temperature range is converted into angle/stroke.

25℃is the reference temperature if it is not specified. It represents the maximum change range of either the high or low temperature from the reference temperature.

$$\frac{\text{Changing output voltage ratio}}{\text{Output voltage ratio at the reference temperature}}$$

13. Temperature Drift

It is angle/stroke conversion of the influence on output in the specified temperature range.

14. Rated Dissipation

It is the maximum allowable power that can be applied continuously. The input voltage that can be applied can be obtained if the resistance value is determined.

$$V = \sqrt{W \times R}$$

V: Maximum Input Voltage
R: Total Resistance - Total Resistance Tolerance
W: Rated Dissipation

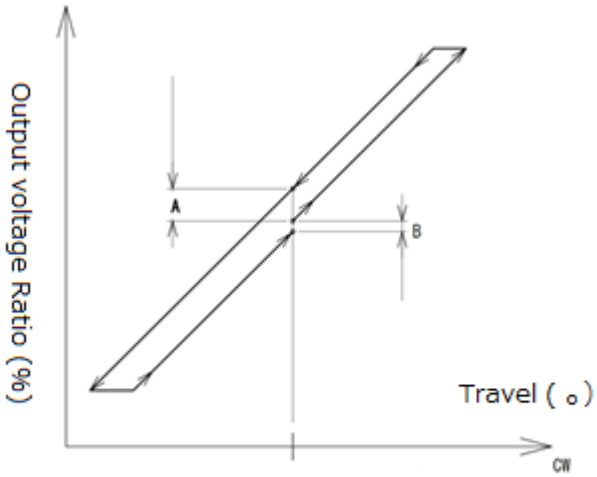
15. Load Resistance

It is the resistor which is connected to the output line. It is the impedance (resistance value) of the device which receives output of the potentiometer. It is also called Load impedance.

16. Hysteresis

It is output error that occurs when the shaft is rotated/slid and reversed and mechanically returned to its original position.

By spring flexibility of the wiper, spring board, damper oil (in tilt angle type) and magnetic hysteresis due to the influence of residual magnetism of magnet, hysteresis may occur. It is included backlash if it is the potentiometers with gears.

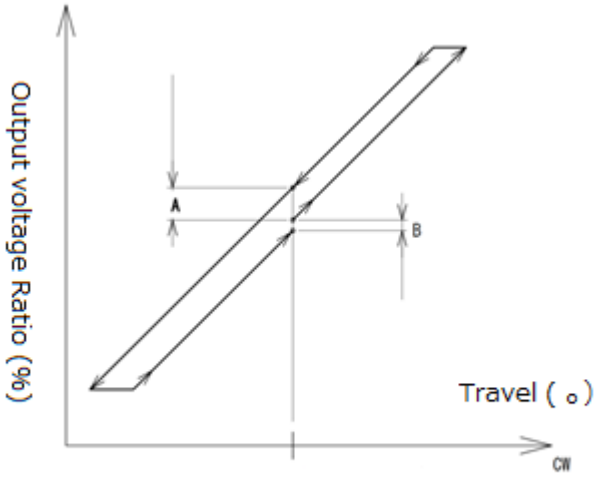



Hysteresis : Tolerance between forward and backward
Repeatability : Tolerance between same direction

17. Repeatability

The degree of dispersion which obtained from the result of repeated measurement for a short time by same measuring procedure, person, system condition and location.

It is different from hysteresis, it is the error of once back to full angle/stroke and restarted.




Hysteresis : Tolerance between forward and backward
Repeatability : Tolerance between same direction

◆ Environment

1. Storage Temperature Range

Temperature Range when the potentiometer is stored.

2. Life cycle

In order to estimate the durability of the potentiometer, it is usually indicated as the number of times which

output does not exceed the specified life time by sliding in the no-load state. The performance of potentiometer which is in normal use appears in noise generation, linearity deterioration, resistance value change, increasing rotational torque, etc. In room temperature and humidity, with rotate speed 60~400rpm, it is expressed in the number of cycle until reaching even only one condition.

- Total resistance value change : Increase +10% from initial value.
- Linearity : 1.5 time of the specification
- Rotational torque : 1.5 time of the specification
- Output smoothness : 1.5 time of the specification

Life time end may be shorter by vibration, dither, harsh temperature condition and out-gas, etc.

In addition, since the actual life cycle is affected by the circuit condition of the load and environmental complex elemental conditions (temperature change, vibration, load on the shaft, etc.), it is a guide to use.

3. Vibration (Sinusoidal)

It is tested under specified conditions (acceleration, frequency, time, direction) and judge whether output is within the specification. During testing, shaft rotation is not allowed. Therefore it does not mean that the unit can be continuously used under test condition.

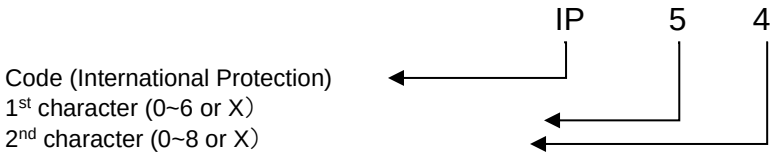
4. Shock

It is tested under specified conditions (acceleration, time, number of times, direction) and judge whether output is within the specification. Therefore it does not mean that the unit can be continuously used under test condition.

5. IP Level

The IP level standardizes the level of protection equipment offers against dust and water. The IEC (International Electrotechnical Commission) specifies protection levels.

■IP code




■Descriptions for the 1st symbol

| Symbol | Type | Protection level |
|---|---|---|
| 0 | No protection | No special measures were taken for protection. |
| 1 | Protected against intrusion of solid objects larger than 50 mm | Designed and built so that large flat parts of the human body, such as a hand, cannot touch charged components or moving parts inside the equipment. Designed and built so that solid objects exceeding 50 mm diameter cannot get inside the device. |
| 2 | Protected against intrusion of solid objects larger than 12.5 mm | Designed and built so that a fingertip or similar object shorter than 80mm cannot touch charged components or moving parts inside. Designed and built so that solid objects exceeding 12.5 mm diameter cannot get inside the device. |
| 3 | Protected against intrusion of solid objects larger than 2.5 mm | Designed and built so that the tip of a solid such as a tool or wire with a diameter or thickness greater than 2.5mm cannot get inside. |
| 4 | Protected against intrusion of solid objects larger than 1.0 mm | Designed and built so that the tip of a solid such as a tool or wire with a diameter or thickness greater than 1.0mm cannot get inside. |
| 5 | Dust protected | Dust is prevented from getting inside. Designed and built so that the entrance of small amounts of powder inside the device will not affect the normal operation of that equipment. |
| 6 | Dust tight | Designed and built so that dust cannot enter inside. |

■Descriptions for the 2nd symbol

| Symbol | Type | Protection level |
|---|---|---|
| 0 | No protection | No special measures were taken for protection. |
| 1 | Protection against water drops | Designed and built so that is not affected by a vertical water drops. |
| 2 | Protected against water drops when the device is tilted up to 15° away from vertical. | When a device is tilted up to 15 degrees away from its normal vertical position, it should not be affected by water dropping vertically. |
| 3 | Protection against water spray | Must not be affected by water sprayed up to 60 degrees away from vertical. |
| 4 | Protection against splashing water | Must not be affected by water splashing from any direction. |
| 5 | Protected against water jets | Must not be affected by a direct water jet from any direction. |
| 6 | Protection against powerful water jets | No sign of water intrusion after equipment is exposed to a powerful water jet from any direction. |
| 7 | Protection against immersion in water | No sign of water intrusion should be found after the device is immersed in water for a certain period at a specified pressure. |
| 8 | Protection against submergence | Applied when a product is submerged in water continuously under the conditions specified by the manufacturer*. In principle, the device is hermetically sealed. |

6. ESD (Case to each terminal)

It is electrostatic durability in the condition of use after installation and it is resistance to leakage through the internal circuit due to the external static electricity contacting the potentiometer.
However, since it is resistance to the number of times specified by the test standards, the potentiometer must be taken care of away from static electricity.
In addition, test is done in contact with the metal part (shaft etc.) closest to the element on each product structure. Air discharge test is not done.

7. ESD (Between Each Terminal)
It is electrostatic durability through the connection terminals and leadwires of the potentiometer which generated during installation and handling.
However, since it is resistance to the number of times specified by the test standards, the potentiometer must be taken care of static electricity during installation and handling.

8. EMS (Electro Magnetic Susceptibility)
It is resistance to radiation electromagnetic field (disturbance noise) from the other instrument. It is expressed by the variation value of the output voltage ratio and the radiated electromagnetic field is expressed by frequency range (Hz) and electric field strength (V/m). The higher value, the more resistance it is.

Test is done under the following test standards.

| Standards No. | Test | Test Outline |
|---|---|---|
| ISO 11452-1 | general condition, defines terms | The basic principles of the component tests for determining the immunity of electric components of passenger cars and commercial vehicle |
| ISO 11452-2 | Radiated immunity test in a anechoic chamber | Test of the radiated immunity for electronic components for passenger cars and commercial vehicle. |
| ISO 11452-3 | Radiation of electromagnetic field (TEM CELL) | Test of TEM CELL immunity for electrical components for passenger cars and commercial vehicle. |
| ISO 11452-4 | Bulk Current Injection (BCI) | Test of Bulk current injection immunity for r electrical components for passenger cars and commercial vehicle. |

9. Magnetic Field Effect
Output of a contactless potentiometer using a magnet would be affected by the magnetic flux density change from outside factors (magnetic field leakage from a solenoid, a motor, other magnets, a large current power line or a magnetic substance).

● Potentiometer

1. Total resistance
It is the resistance value between terminal 1 and terminal 3.

2. Total resistance tolerance
It is the error range of total resistance value.

3. Output ratio
Output ratio is ratio of output voltage (Vout) and input voltage (Vin). It is expressed as percentage.

$$\frac{\mathrm{Vout}}{\mathrm{V\,in}} \times 100(\%)$$

Contact type is mentioned with %. Contactless type is mentioned %Vin.

4. Output sensitivity
It represents the amount of change in output voltage ratio per angle/stroke.
(Example 1) Min 2%Vin/10°
Output 2% change per angle 10° .
If it is effective electrical travel is 90° , Output is 18%~Vin.
(Example 2) 1.05~1.75Vin/°
Output is 1.05~1.75%Vin per 1°

5. Tilt sensitivity
It is the minimum tilt angle that can be read as output in terms of tilt angle resolution.
In addition, Tilt sensitivity of MIDORI's tilt angle type includes hysteresis.

6. Output smoothness
Electronical output change is measured for each specified minute area over the effective electrical travel. It is expressed as a percentage of the input voltage.
It is the smoothness of the output. It depends on the smoothness and uniformity of the resistive element surface.
The output voltage sharply changes as this value increases, and output become more unstable as the variation range increases.

7. Equivalent noise resistance (=ENR)
By changing the contact resistance during sliding, when the sliding wiper (contact) is moved, changed in output resistance due to change in contact resistance and irregularity of resistance is expressed by contact resistance.
If the resistive element wears or foreign debris intervenes, the equivalent noise resistance increases and it may affect the output.

8. Temperature coefficient of resistance
Percentage of total resistance value that changes per unit temperature (K).
(Example) ±400ppm/K=±400×0.0001%=±0.04%/K

9. Shorted segment
The part where the output voltage is not changed by making the resistance value 0ohm of the potentiometer.
The intermediate tap (B tap) for voltage application has a shorted segment of about 1~5° at the terminal part.
The contactless potentiometer is refferd as a clamp.

10 .Extra segment
Portion that has resistance outside the effective electrical travel range of the potentiometer. When the resistance value between terminal 1 and terminal 2 is measured by tester, the resistance value change even at the Extra segment part, but there is no change in the voltage.

11. Index point
It is the defined position which is related to output voltage ratio. MIDORI expresses angle 0° .

12 Contact resistance
Resistance caused by contact of sliding wiper, slip-ring or collector spring because of contact type potentiometer. When abrasion powder and foreign debris exist, the resistance becomes instantaneously high, which may affect the noise to the output.

13. Loading error
Linearity will be distorted if a finite load resistance is applied to the output side of the potentiometer.

$$E\ \max\ = \frac{14\ .8}{\frac{RL}{Rp} + 0\ .22}\ (\%)$$

Emax : Max. distorting of linearity
RP : Total resistance value of the potentiometer
RL : Load resistance

For minimize Emax, Load impedance of the potentiometer (load resistance) be as high as possible.

14. Output Phase
Specify intentional misalignment of multiple outputs.
Normally 2 gangs contact type potentiometer is same output phase, 50% output position is matched as the index point.
In addition, the 180° phase is obtained by shifting the start position of the outputs OUT1 and OUT2 180° .

15. 2 output difference
The difference between the outputs of OUT1 and OUT2 as the same mechanical angle, or the error with respect to the reference value of sum, for 2 output type. When using it as a fail-safe or self –diagnostic, two outputs are monitored by the ECU at all times and error diagnosis is made when a remarkable difference occurs. This value is clarifying error of each unit.

16. Output cramp
It is the part where the output of the contactless potentiometer becomes stable (unchanged), and it is set to the upper limit side and the lower limit side outside of the effective electrical travel.

17. Input impedance
Total resistance value of Blue Pot.

18. Tap
It is the connection terminal. If it is in intermediate, it is called the intermediate tap. If it is in the center of output, it is called the center tap.

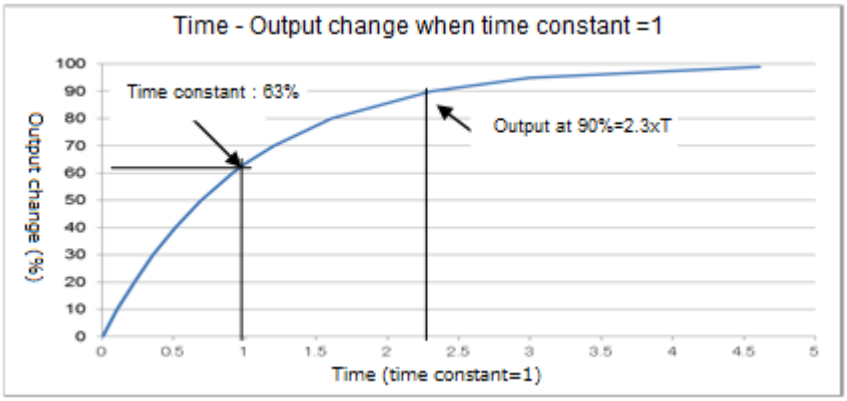
19. Step response time
It is the time required for returning 52% (time constant) output of static stage (horizontal position) when it drastically move back from maximum tilt angle to horizontal position.
From time constant, static time is calculated roughly.

$$E(\%) = \left(1 - e^{\frac{-t}{\tau}}\right) \times 100(\%)$$

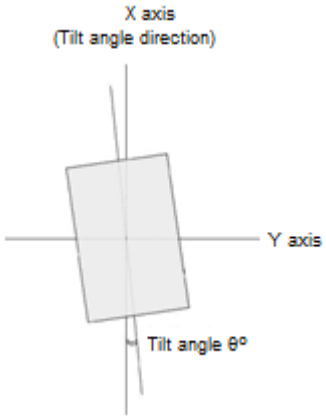
E : Output change
e : the base of natural logarithms (2.718…)
$\tau$ : Time Constant
t : time

If the time contact “T” is known from the above equation, the time “t” at wchin the output change “E” is reached can be calculated by the following equation.

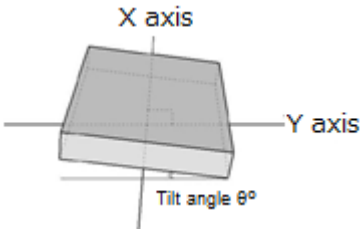
$$t = -LN\left(1 - \frac{E}{100} \times \tau\right)$$




20. Twisting error
Influence of torsion angle of mounting on tilting direction in tilt angle type.




21. Crossing error / cross-axis sensitivity
Influence on the output of the X axis when tilting the Y axis with respect to the tilt angle direction X.




22. Following capability

How much the output voltage is delayed with respect to mechanical movement is expressed by rotational speed etc.
If it is a return-spring type, it includes the influence of the followability of the spring. Hall-IC type has influence of calculation speed of Hall IC.

23. Dither
It is the fine hunting motion which is transmitted in the direction of rotation of shaft due to continuous vibration and resonance phenomenon on the instrument, backlash of the gears or rocking of the actuator, etc. may have a big influence on the durability of contact type potentiometers.

● Encoder

1. Output format
It is the specification of the serial communication's physical layer. For examples, they are RS-232C, RS-422 and RS-485, etc.

2. Data format
It is the format of serial communication. For examples, SSI, SPI and ASI etc.

3. Asynchronous communicator method
A method of outputting a pulse from a slave regardless of the operation of the master in communication between a master (such as a controller) and a slave (such as an encoder).

4. Synchronous communicator method
In the communication between the master (controller etc.) and the slave (encoder etc.), a method in which the slave outputs pulses in synchronization with the clock from the master.

5. Output cycle updating
Period to calculate and determine the position data inside the encoder. This is different from the cycle of outputting data on the serial interface.

6. Cyclic Redundancy Check (CRC)
It is a type of error detection code and is often used mainly for detection of accidental errors caused by data transfer. On the transmitting side, calculations similar to one kind of division are performed on the basis of the input data string, and the remainder is added as a checking value before transmission. On the receiving side, the same calculation is performed based on the received data, and the result is compared with the value for checking to judge the presence or absence of data corruption.