

Computer Aided Manufacturing



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Cleansing through Breathing

Nadi Suddhi
(Alternate
Nostril breathing)



1 min

Unit II

DRIVES AND CONTROL

Spindle and feed drives - **Sensors - Position, Encoders, Proximity, Limit switch** -Interfacing system -Microcontroller and PLC based -Introduction to Graphical User interface - Communication protocol -RS232, RS 485, USB, Ethernet - PLC -Ladder diagram -Peripherals -Timer, Counter, Encoder interface, Human Machine Interface

Prerequisites Knowledge

- Measuring devices

Recap and review of previous class

Let's
Recap



5 mins

Evocation



General Objective (GO)

- Students will be able to understand the spindle and axis drives in Computer Numeric Control (CNC) machines and evaluate their suitability to achieve precision of machining.

Specific Objectives

Students will be able to

- Recognize the type of drives used in CNC machines (R/F) (T)
- Explain the working concept of the drives used for spindles and feed in CNC machines. (U / C) (E)
- Attribute the requirements for spindle and axis drives used in CNC machines for smooth operation. (An / C) (E)
- Check the two drives suitable for axis movement in CNC machines based on precision machining of automobile steel part to fit and function at high speed rotation. (E / P) (E)

What is sensing?

Sensing is converting a quantity that you want to measure into a useable signal (usually electronic).

Perception is the interpretation or understanding of these signals.

Example:

Sensing: Sound waves -> vibrating eardrums -> signals to brain

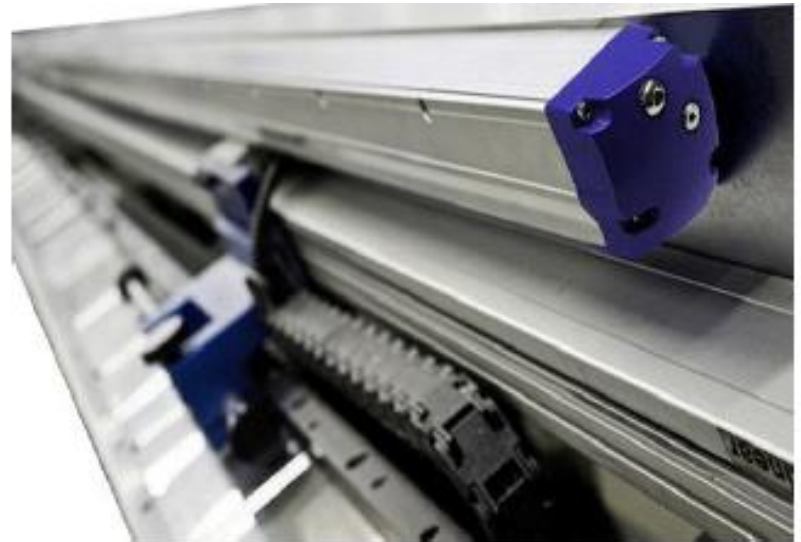
Perception: Understanding that I am talking to you about sensors.

Feedback Devices

Two types of feed back devices normally used are:

1. Positional Feed Back Devices

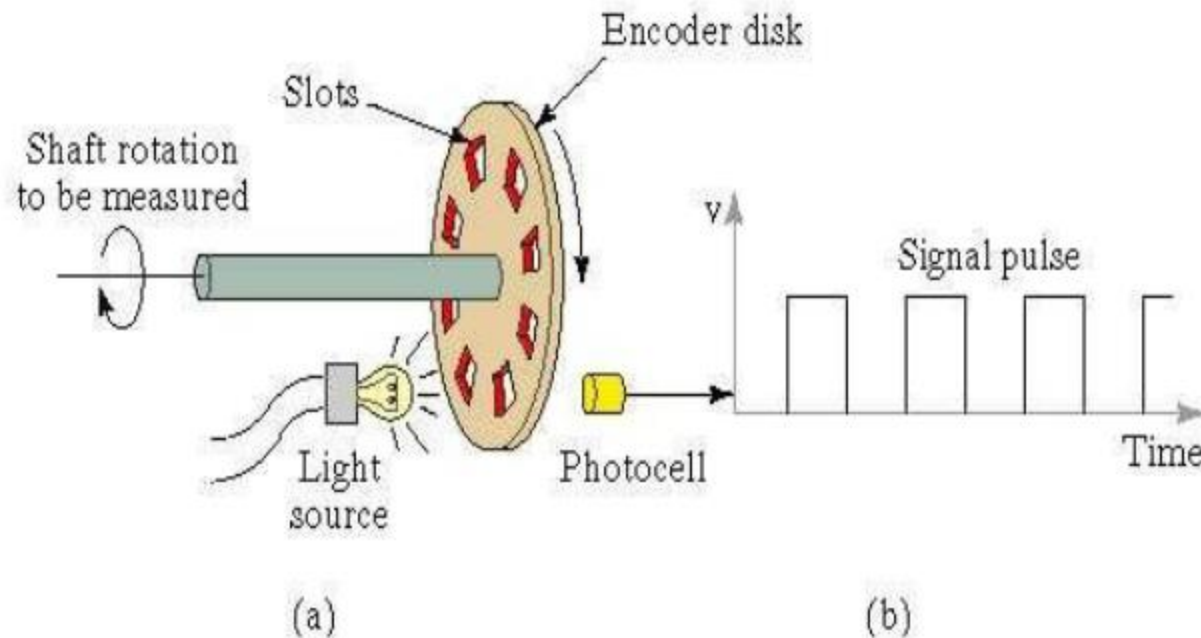
1.1 Linear Transducers - a device mounted on the machine table to measure the actual displacement of the slide in such a way that backlash of screws, motors etc. would not cause any error in the feed back data.



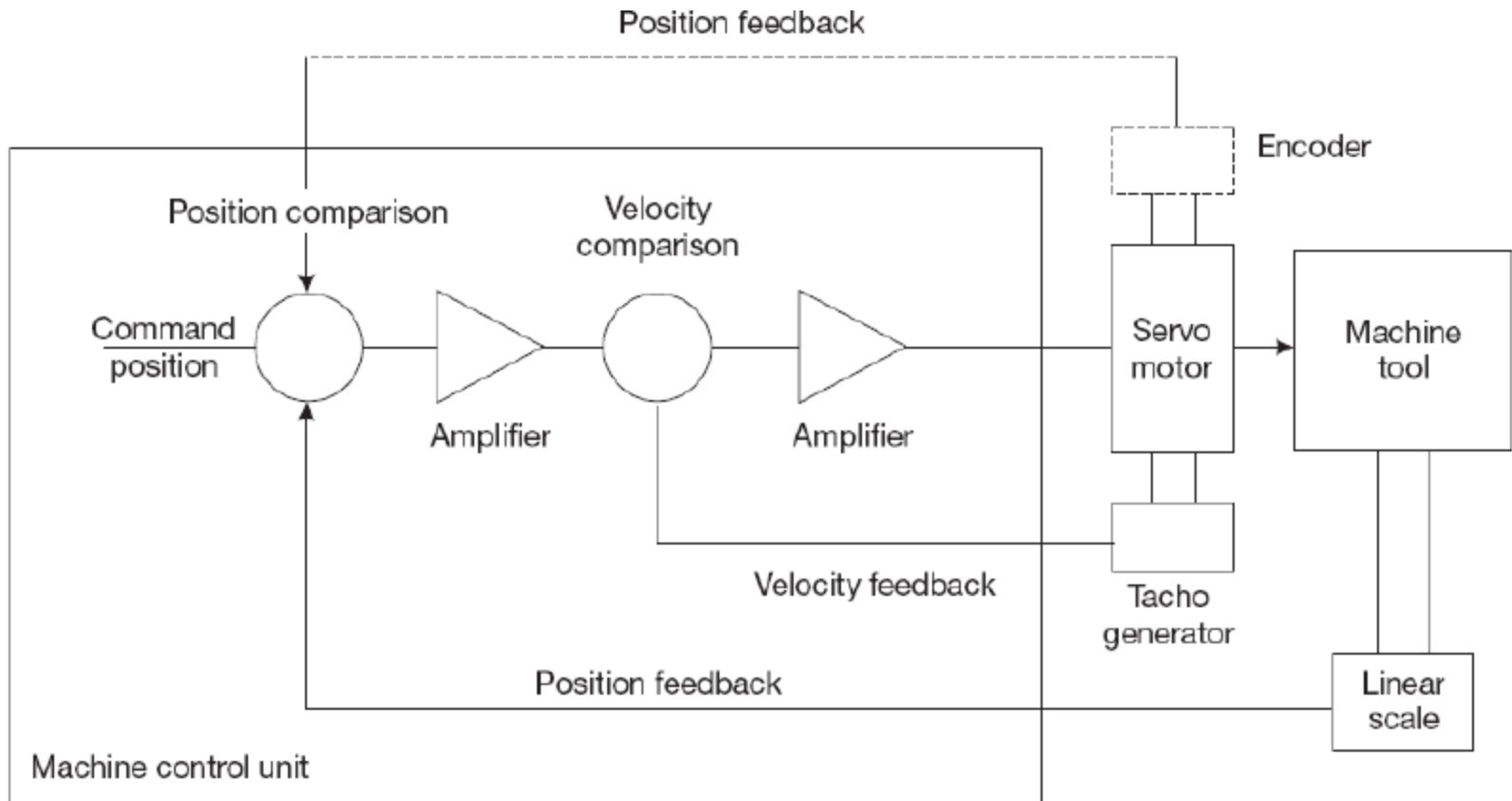
<https://www.indiamart.com/proddetail/cnc-linear-encoder-12573739991.html>

Feedback Devices

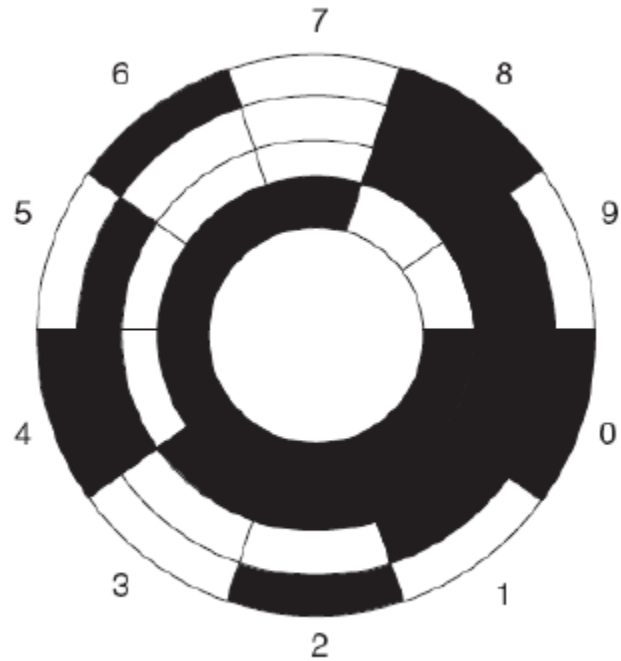
1.2 Rotary Encoders: a device to measure the angular displacement. It cannot measure linear displacement directly so that error may occur due to the backlash of screw and motor etc.



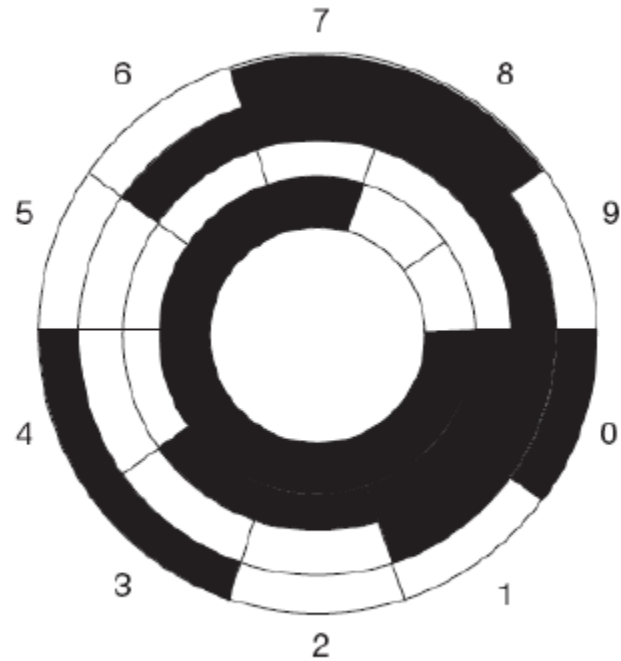
The closed loop feedback control system



The absolute encoder disc for rotary position measurement.

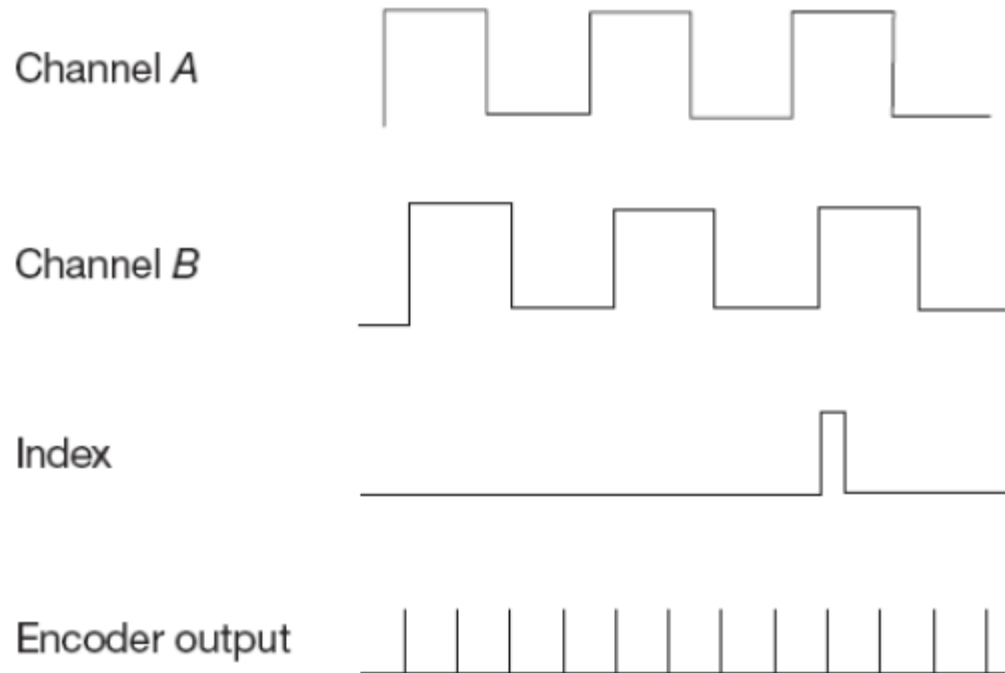


(a) Natural binary

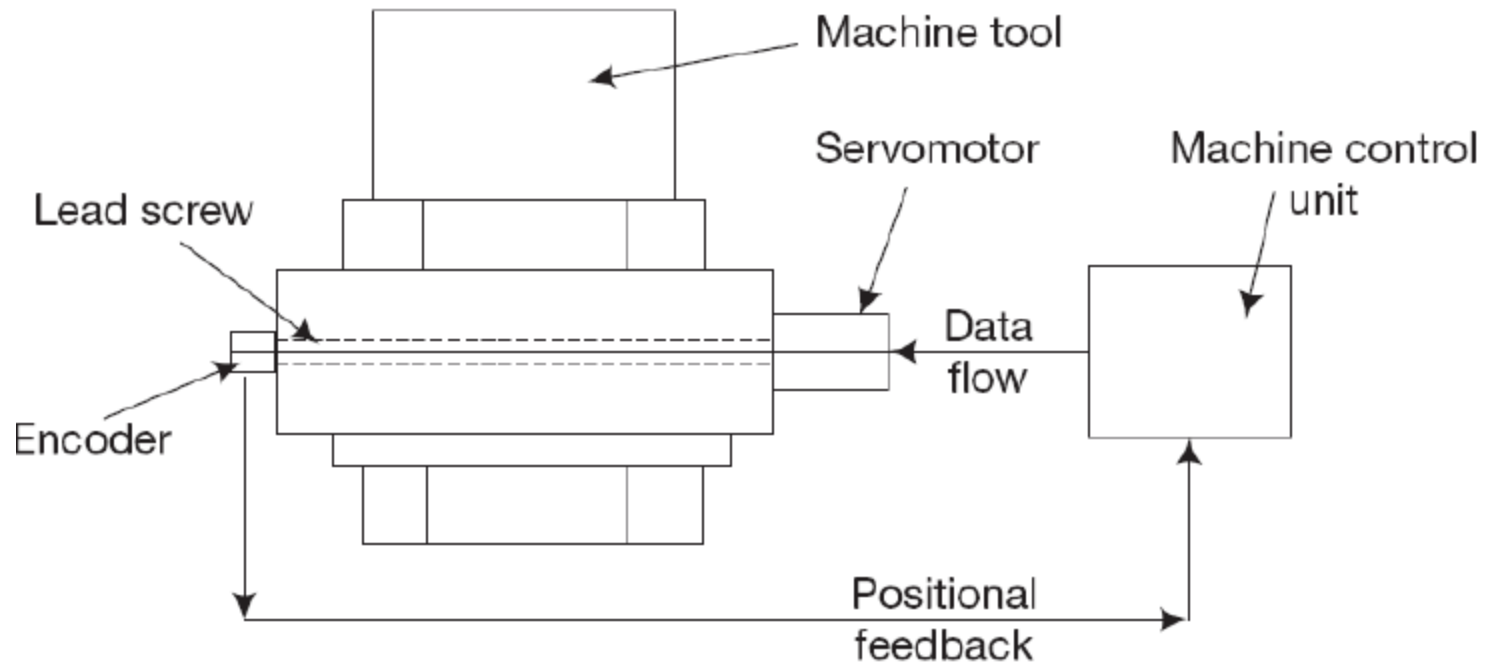


(b) Gray code

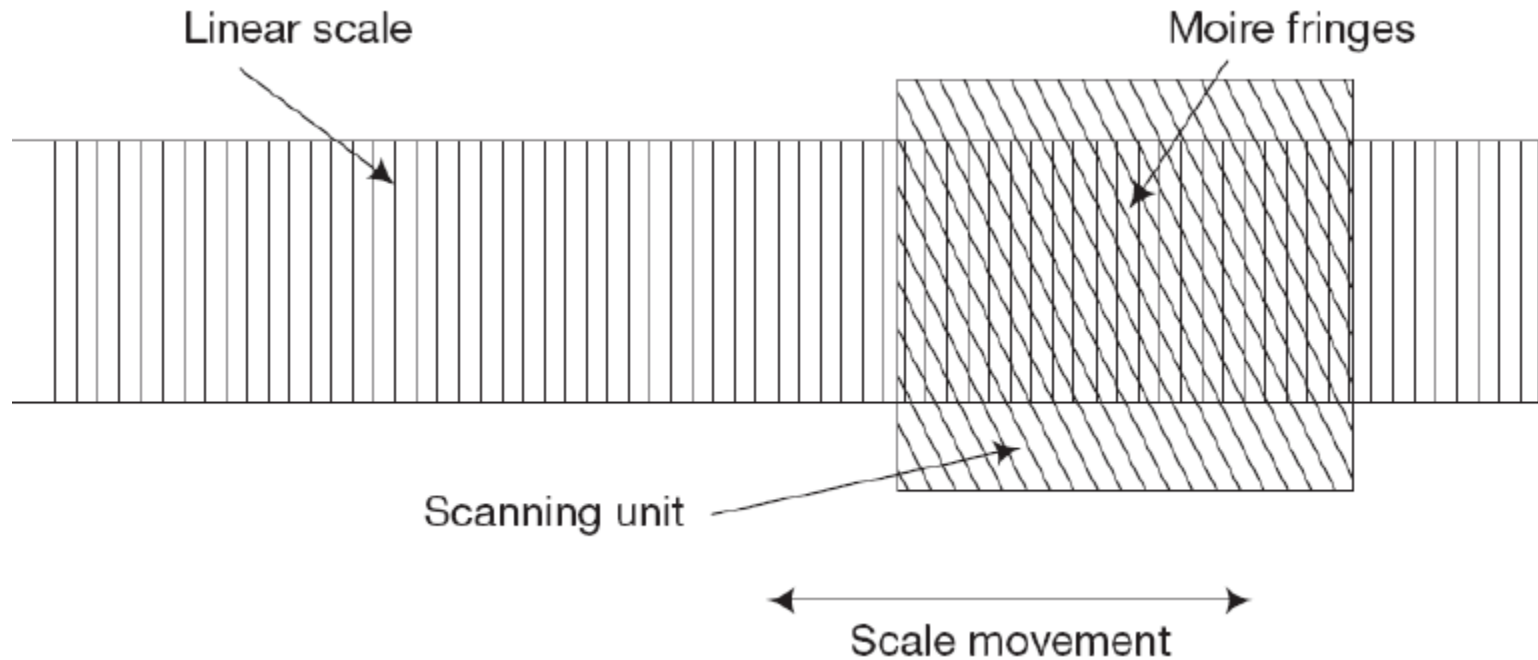
Operation of a digital rotary encoder for position measurement



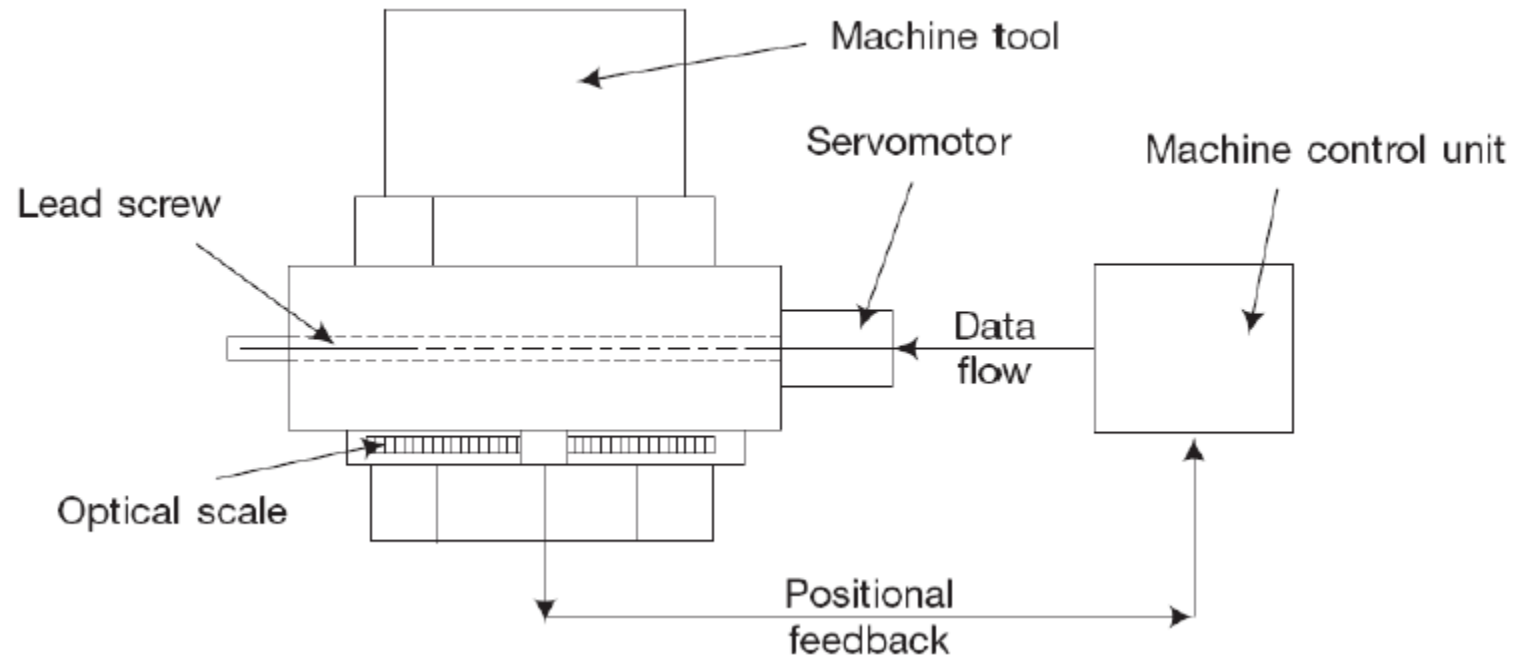
The encoder disc mounted on the lead screw



Principle of optical grating for position measurement in linear scales



The linear scale fixed to the machine tool structure

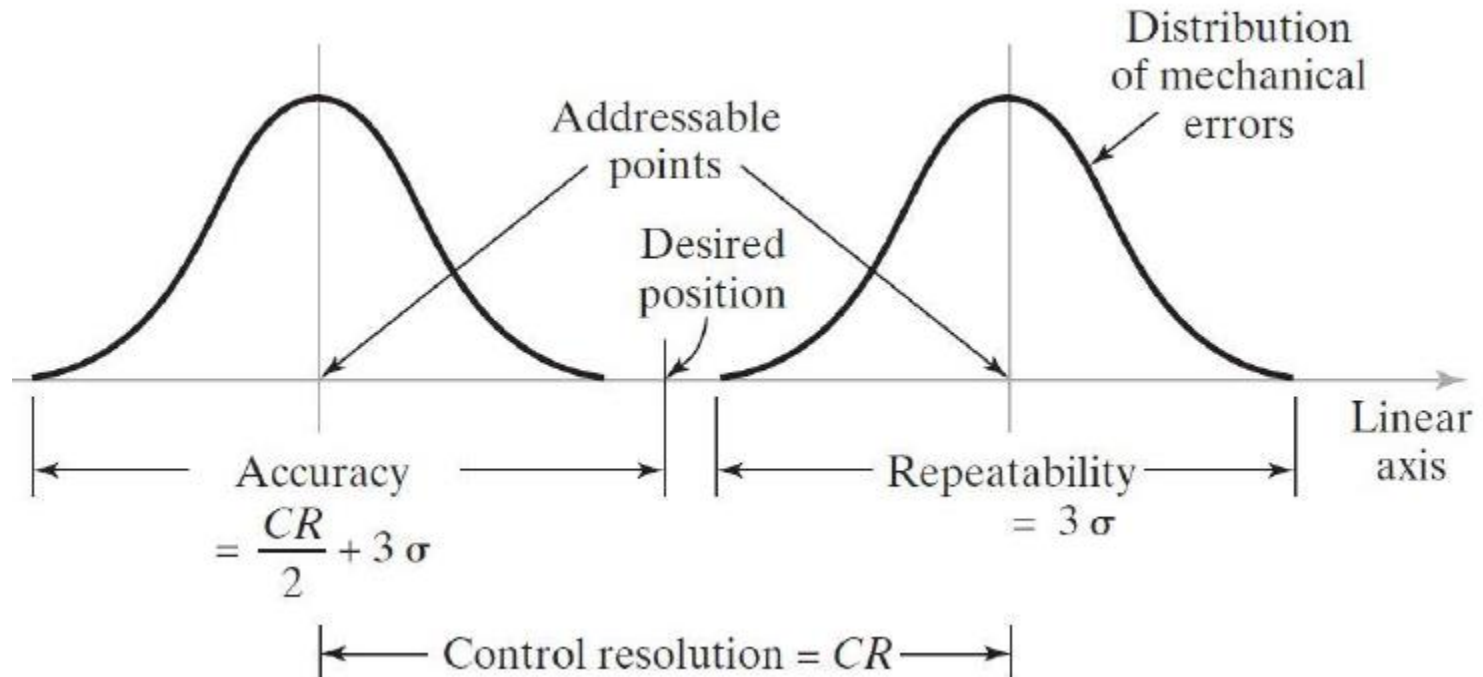


Analysis of Positioning NC Systems

Three measures of precision:

1. Control resolution - distance separating two adjacent addressable points in the axis movement
2. Accuracy - maximum possible error that can occur between the desired target point and the actual position taken by the system
3. Repeatability - defined as $\pm 3\sigma$ of the mechanical error distribution associated with the axis

Control Resolution, Accuracy, and Repeatability



Velocity Feedback Device

- The actual speed of the motor can be measured in terms of voltage generated from a tachometer mounted at the end of the motor shaft.
- The voltage generated by the DC tachometer is compared with the command voltage corresponding to the desired speed.
- The difference of the voltages is used to actuate the motor to eliminate the error.



Proximity Measurement

- Measurement can be caused by ...
 - a known obstacle.
 - cross-talk.
 - an unexpected obstacle (people, furniture, ...).
 - missing all obstacles (total reflection, glass, ...).
- Noise is due to uncertainty ...
 - in measuring distance to known obstacle.
 - in position of known obstacles.
 - in position of additional obstacles.
 - whether obstacle is missed.



Inductive Proximity Switches

Introduction

Inductive Proximity switches are solid state sensing devices which require no physical contact to actuate them.

Main Advantages

- Exceptionally long life & high switching speeds.
- Non contact, zero operation force.
- Wear & maintenance free operation.
- Bounce free signals.
- Reliable switching under extreme conditions.
- Fully waterproof.



Overview of Range

- Cylindrical proximity switches from M8 to M30 diameter with AC or DC operation, flush or non-flush mounting in brass or stainless steel housing.
- Inductive Proximity switches in Flat profile plastic housings. (for applications with constraint on mounting space)
- Inductive Proximity switches in Block housings (similar to limit switches).



Proximity Switches in Cylindrical Housing size M8

Salient Features

- Mounting – Flush
- Extremely rigid Stainless Steel Housing.
- Sensing Distance - $S_n = 1 \text{ mm}$ or 1.5 mm
- Hysteresis $\leq 0.15 \text{ mm}$.
- Repeat Accuracy $\leq 0.05 \text{ mm}$.



Proximity Switches in Cylindrical Housing size M8

Salient Features

- Operating Voltage – 10-30 VDC.
- Connection either through encapsulated cable or plug and socket.
- Switching frequency – 2000 Hz.
- Output polarity : PNP / NPN.
- Output function : NO.
- Short circuit and reverse polarity protection.



Proximity Switches in Cylindrical Housing size M12

Salient Features

- Mounting – Flush or Non-flush
- Nickel Plated Brass Housing.
- Sensing Distance - Sn= 2 mm (flush type) or 4 mm (non-flush type)
- **Extended version** has sensing distance of 4 mm on flush type.
- Hysteresis ≤ 0.2 mm (Sn=2 mm) / 0.6 mm (Sn=4 mm).
- Repeat Accuracy ≤ 0.1 mm (Sn= 2 mm).



Proximity Switches in Cylindrical Housing size M12

Salient Features

- Operating Voltage – 10-30 VDC.
- Connection either through encapsulated cable or plug and socket.
- Switching frequency – 1000 Hz.
- Output polarity : PNP / NPN.
- DC 2 wire versions also available.
- Output function : NO / NO + NC
- Short circuit and reverse polarity protection.



Proximity Switches in Cylindrical Housing size M18

Salient Features

- Mounting – Flush or Non-flush
- Nickel Plated Brass Housing
- Sensing Distance - $S_n = 5$ mm (flush type) or 8 mm (non-flush type)
- **Extended version** has sensing distance of 8 mm on flush type
- Hysteresis ≤ 0.5 mm ($S_n = 5$ mm) / 0.8 mm ($S_n = 8$ mm)
- Repeat Accuracy ≤ 0.2 mm ($S_n = 5$ mm)



Proximity Switches in Cylindrical Housing size M18

Salient Features

- Operating Voltage – 10-30 VDC, 90-230 VAC
- Connection either through encapsulated cable or plug and socket
- Switching frequency – 500 Hz. (DC versions only)
- Output polarity : PNP / NPN
- DC 2 wire versions also available
- Output function : NO / NO + NC
- Short circuit and reverse polarity protection. (DC versions only)



Proximity Switches in Cylindrical Housing size M30

Salient Features

- Mounting – Flush or Non-flush
- Nickel Plated Brass Housing.
- Sensing Distance - $S_n = 10$ mm (flush type) or 15 mm (non-flush type)
- Hysteresis ≤ 1.0 mm ($S_n = 10$ mm) / 1.5 mm ($S_n = 15$ mm).
- Repeat Accuracy ≤ 0.5 mm ($S_n = 10$ mm).



Proximity Switches in Cylindrical Housing size M30

Salient Features

- Operating Voltage – 10-30 VDC, 90-230 VAC
- Connection either through encapsulated cable or plug and socket
- Switching frequency – 300 Hz. (DC versions only)
- Output polarity : PNP / NPN
- Output function : NO / NC / NO + NC (only DC version)
- Short circuit and reverse polarity protection. (DC versions only)



Proximity Switches in Flat Profile Housing

Salient Features

- Mounting – through mounting holes
- Plastic Housing.
- Sensing Distance - Sn= 5 mm (FG2 type) or 2 mm (FG4 type)
- Hysteresis \leq 0.5 mm (Sn=5 mm) / 0.2 mm (Sn=2 mm)
- Repeat Accuracy \leq 0.1 mm (Sn= 2 mm)
- Operating Voltage – 10-30 VDC



Proximity Switches in Block Housing

Salient Features

- Mounting – through mounting holes
- Die cast aluminium Housing
- Sensing Distance - $S_n = 5$ mm (SN01 & N1A type)
- Hysteresis ≤ 0.5 mm ($S_n = 5$ mm)
- Repeat Accuracy ≤ 0.2 mm ($S_n = 5$ mm)



Proximity Switches in Block Housing

Salient Features

- Operating Voltage – 10-30 VDC
- Connection either through encapsulated cable or plug and socket
- Switching frequency – 500 Hz
- Output polarity : PNP / NPN
- Output function : NO
- Short circuit and reverse polarity protection



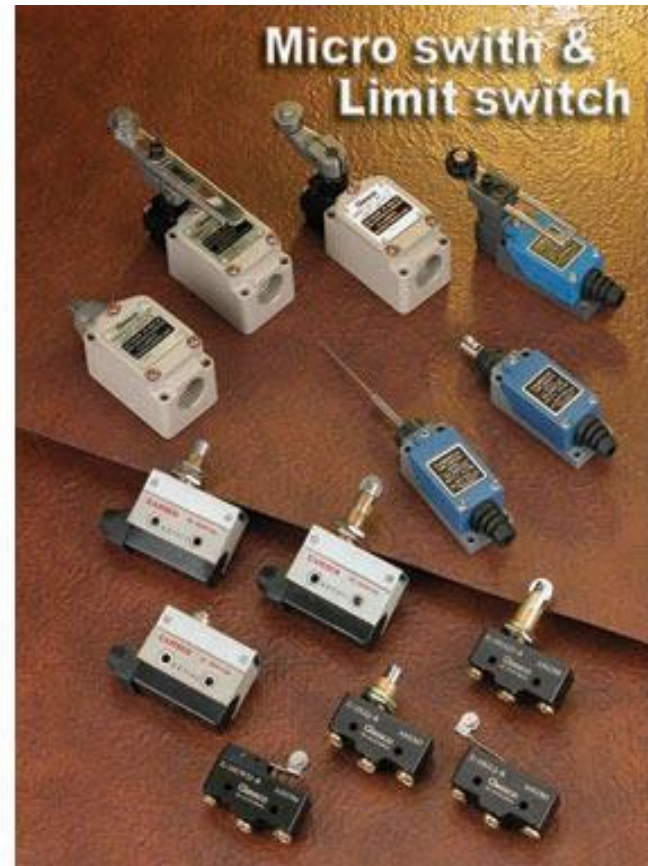
Connectors for Proximity Switches

Types

- Field wire able types SGF and SBF
- Molded cable connectors without LED with PVC or PUR cable.
- Molded cable connectors with LED and PUR cable suitable for PNP type proximity switches.



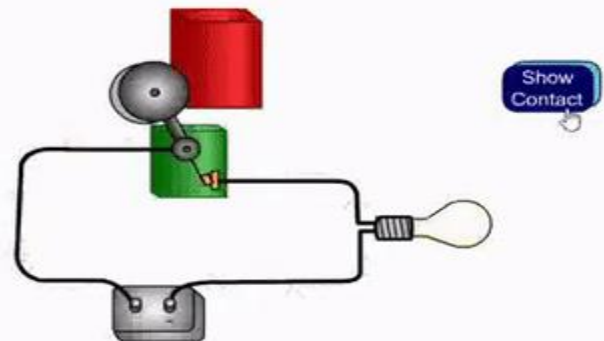
Limit Switches



Limit Switches

- A limit switch has the same ON/OFF characteristics.
- The limit switch usually has a **pressure-sensitive mechanical arm**.
- When an object applies pressure on the mechanical arm, the switch circuit is energized.
- An object might have a magnet attached that causes a contact to rise and close when the object passes over the arm.

When the moving object touches and moves the lever, a set of electrical contacts is forced either open or closed.



Limit Switches

- Limit switches can be either
 - Normally open (NO) or
 - Normally closed (NC) and may have multiple poles.
- A normally open switch has continuity when pressure applied and a contact is made.
- While a normally closed switch opens when pressure is applied.

Limit Switches

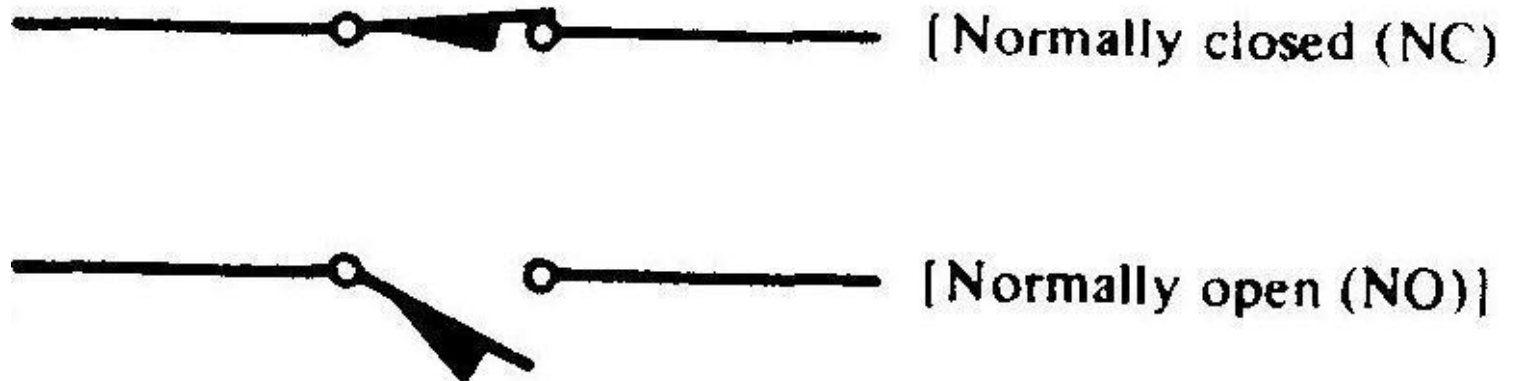


Figure A.2: Normally Open-Normally Closed Limit Switches

Limit Switches- Types

- A **single pole** switch allows one circuit to be opened or closed upon switch contact.
- **Multiple-pole** switch allows multiple circuits to be opened or closed.

Limit Switches

Limit switches are mechanical devices.

Limit Switches has following drawback:

- They are subject to **mechanical failure**.
- Their **mean time between failures** (MTBF) is low compared to non-contact sensors.
- Their **speed of operation** is relatively low; the switching speed of photoelectric microsensors is up to 3000 times faster

Limit Switches -Advantages

- Limit switches are mechanical position-sensing devices that offer **simplicity, robustness, and repeatability** to processes.
- Mechanical limit switches are simplest in which contact is made and a switch is engaged.
- Limit switches are **easy to maintain** because the operator can hear the operation of the switch and can align it easily to fit the application.

Limit Switches -Advantages

- They are also **robust**. They can handle an inrush current 10 times that of their steady state rating.
- **Reliability** is another benefit. Published claims for repeat accuracy for standard limit switches vary from within 0.03mm to within 0.001mm over temperature range of -4 to +200F.
- Limit switch dissipate energy spikes and rarely break down under normal mode surges. They will **not be affected by electromagnetic interferences** (EMI).

Discussion



10 mins

THANK YOU FOR YOUR PATIENCE AND
TIME

