

# NUMERICAL CONTROL

# Principle of Numerical Control (NC)

**A system in which actions are controlled by direct insertion of numerical data.**

# NC Machine Tool

## Foundation for

- > Robotics
- > Flexible Manufacturing Cell
- > Flexible Manufacturing
- > CAD/CAM System
- > Computer-Integrated Manufacturing

# Traditional Machine Tools

**Milling Machines**

**Lathes**

**Drilling & Boring Machines**

**Grinders**

# Advantages of NC

**Flexibility**

**Capability for Complex  
Work-pieces**

**Manage Large Work-pieces**

**Reduced Jig & Fixture Cost**

**Higher Quality**

# NC System Components

**Machine Tool**

**Machine-Control Unit**

**> Data Processing Unit (DPU)**

DPU processes coded data from hard drive & passes to CLU.

**> Control-Loops Unit (CLU)**

Motion control duties. Operates drives Feedback on actual position. Acts as a translator for machine commands (motor on/off, tool speed, distance).

# Direct Numerical Control

## Advantages:

- > **Library of programs**
- > **Instant modifications**
- > **Links with CAD**
- > **Increase Information Response**
- > **Instant Reports**

# Computer Numerical Control (CNC)

## **Advantages:**

- > CRT allows review/editing**
- > Pre-check/simulation**
- > Interface allows more capability**
- > Accurate positioning**
- > More functions**



# CAD/CAM

Computer Aided Design

Computer Aided Manufacturing

**Advantages:**

- > Eliminate blueprints
- > Database of parts
- > Production Schedules
- > BOM
- > Process instructions
- > Simulations

# NC Motion Control Objective

**Execute precise motion in a given set of reference frames.**

**> Generally described by Cartesian space X-Y-Z.**

# NC Position Movement

## Incremental

> Taking the “Last” position as the zero position.

## Absolute

> Locations on Part – Fixed Reference Frame with Home position for reference.

# Degree of Motion Control

## Point-to-Point (PTP)

- > Good for holes & slots
- > Position tool over point.

## Contouring

- > Complex curved surfaces
- > Computers needed for complex calculations
- > Motion control to motors: varying voltages to DC servo motors.

# NC Part Programming

## Block Formats

> Each block is a statement.

## Computer Language

> Programming language designed to execute complex geometrical outlines.

>>> APT (Automated Programming Tool)

Geometrical data with motion statements or NC.

# Available Block Formats

**Fixed Sequential**

**Block Address**

**Tab Sequential**

**Word Address\*\***

> Used by CNC controller systems. Alphabetic character is used as a code at the beginning of each word. Utilize words that describe an address (identifier) & a number that specifies its content.

# Example of Word Address

**N01 G02 X1500 Y2000 F4 S400 T10**

**N: identification number**

**G: preparatory command**

**X: x axis**

**Y: y axis**

**Z: z axis**

**I,J,K: coordinate values**

**F: feed rate S:spindle speed**

**T: tool number**

# Binary-Coded Decimal (BCD)

**Machine code used for numerical control.**

- > Easier to read than binary.
- > Four binary digits are required to represent 0 to 9.
- > Code that is saved in RAM.

**Example: 439 = 10000111001**

ASCII uses channels 1 - 4 for digits;  
channels 5 – 7 indicate which group (numbers or alphabetic);  
channel 8 is for parity.



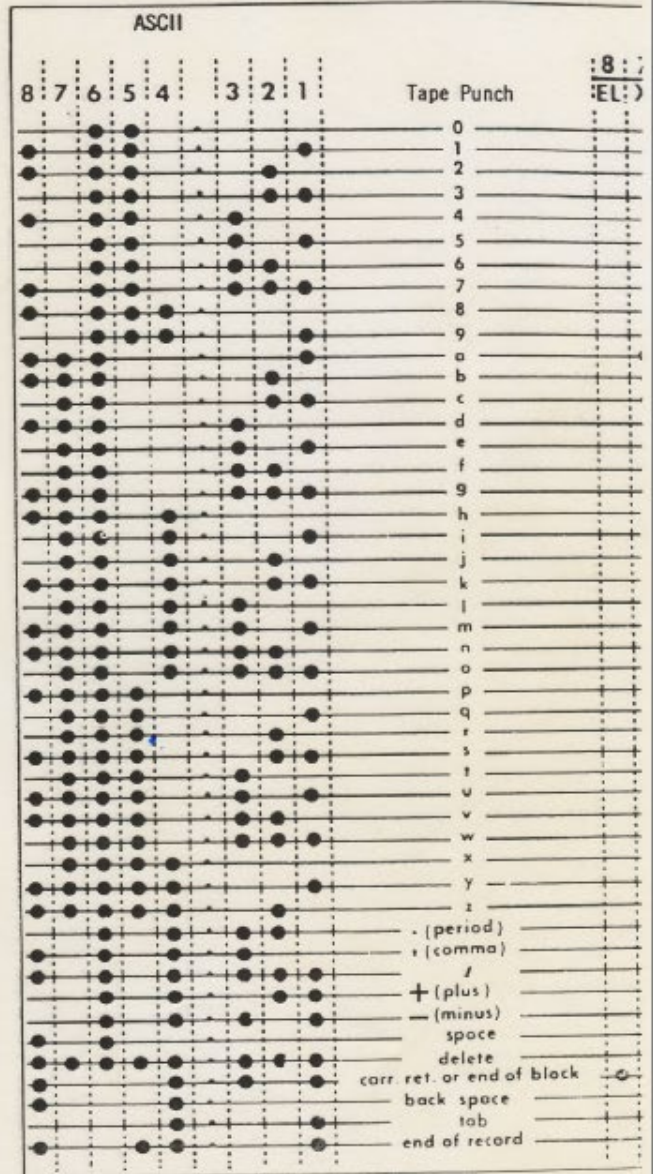


FIGURE 5.7 Comparison of ASCII and EIA 244A standards

