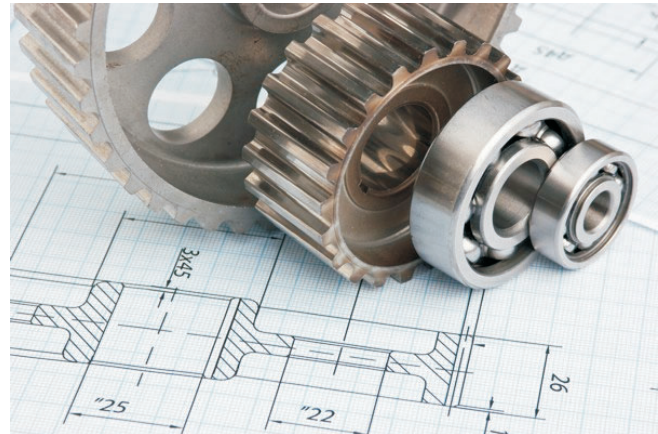


# Lines and Symbols

**L**INE TYPES and symbols are the common language of drafting and manufacturing. They represent a language that decodes technical and mechanical drawings. These standardized drawing elements allow for a common interpretation of the drawings when read by architects, engineers, manufacturers, construction supervisors, HVAC contractors, pipefitters, and electricians. Learning to read and decode lines and symbols requires practice.



## Objective:



Review line types and weights, and interpret technical drawing symbols.

## Key Terms:



bill of materials  
break lines  
center lines  
dashed lines  
dimension lines  
drawing scale

extension lines  
hidden lines  
leader lines  
leaders  
line types  
line weights

mechanical drawings  
section lines  
solid lines  
symbols  
technical drawings

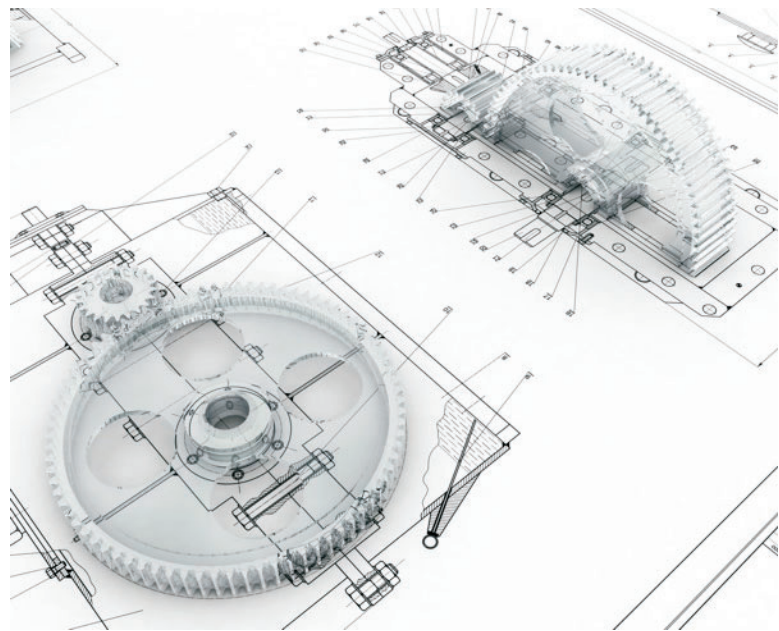
## Line Types, Line Weights, and Symbols

**Technical drawings** are graphic representations of objects or concepts that use a universal language of graphic symbols. Technical drawing (drafting) is a form of drawing used by architects, engineers, artists, and designers. Technical drawings have standardized elements, including:

- ◆ Line types and weights
- ◆ Symbols

- ◆ Layout
- ◆ Text
- ◆ View projections
- ◆ Dimensioning
- ◆ Descriptive geometry

**Mechanical drawings** are technical drawings that provide information about mechanical systems: HVAC, electrical, plumbing, etc. Other terms for mechanical drawing are “engineering drawings” and “blueprints.” Engineering drawings express geometry—the shape of an object from different angles. They also show dimensions, materials, and the finish for the object.



**FIGURE 1.** Engineering drawings express geometry—the shape of an object from different angles. Learning to visualize the workpiece from a drawing requires you to interpret the lines and symbols on a mechanical drawing.

On mechanical drawings, lines, line types, and line weights are used to represent different parts or forms of products. Each line represents a feature or a material within the object. Lines are used to define the outlines of materials or to suggest reference points for locating objects.

## LINE TYPES AND WEIGHTS

Various line types and weights are used. The type and weight selected are based on what the line represents.

### Line Types

**Line types** are line patterns. Each line type is recognized as a typical symbol or object in the construction and manufacturing industries. Following are the standard types of lines used in technical drawings.

- ◆ **Solid lines** are continuous lines used to represent a visible object that can be seen in plan, elevation, or 3D views. Solid lines can represent the outlines of tools or the edge lines of manufactured parts. Also, they are used as leader lines and dimension lines.
- ◆ **Hidden lines** are object edges invisible on 2D drawings and in 3D views. They are composed of short dashed lines; they may represent features (parts or edges) on the opposite side of the product or on the inside of a product or material. Hidden lines are useful to show the extent of a material beyond the line of sight.

◆ **Dashed lines** are patterns of long dashes compared to those used to indicate hidden lines. Dashed lines are used to show items above or behind an object or the view of the drawing and may indicate shelving or cabinets above a counter.

◆ **Center lines** are a series of long lines and short dashes used as reference points to designate the center of an object. They can be used as reference points for manufacturing parts or to designate cutouts. Center lines may represent centers of circles and arcs or the center axis of a circular or symmetrical form. In some cases, they may not be shown in isometric projections, depending on the use of the drawing.

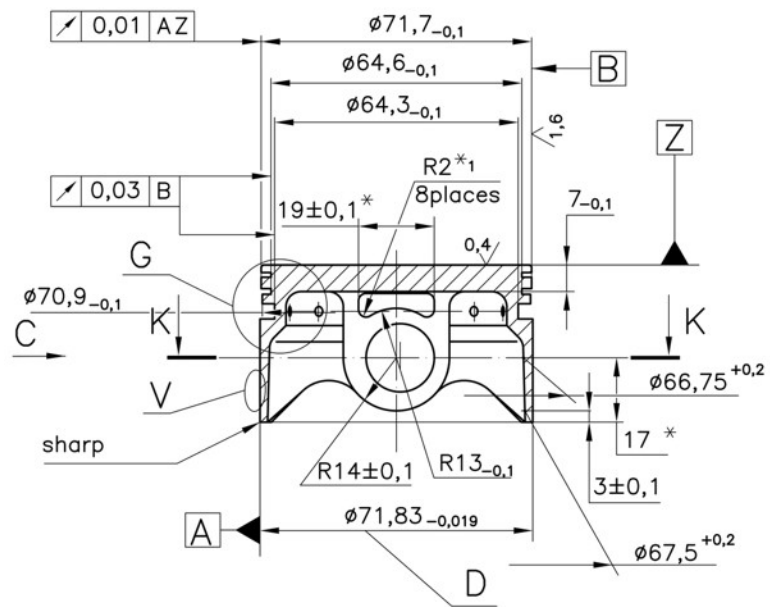
◆ **Dimension lines** are lines that indicate the measurements (dimensions) of objects, including length, width, height, diameter, etc. They are drawn with thin, solid lines and are parallel to the lines/features they are dimensioning. Typically, arrowheads are affixed to either end of dimension lines. Some dimension lines have an open space in the center in which to place the measurement.

◆ **Extension lines** are thin solid lines that indicate the two end points of a feature being dimensioned out to the dimension line. They show the exact location of the dimension. Extension lines cross object lines, center lines, and hidden lines. To avoid confusion, however, they do not cross dimension lines. Drafters and designers attempt to extend all dimension lines beyond the object and then locate the dimension statistics outside of the object to keep the drawing clear and less cluttered.

◆ **Leaders** are lines that connect specific notes, references, or descriptions to objects or lines in drawings. Leaders are sometimes called leader lines. **Leader lines** are lines that begin as solid lines and end in arrowheads; they may be drawn at an angle or curved where the text is located. Typically, the end of the leader (near the text) is drawn on the outside of the object.

◆ **Break lines** are long and short lines with Z breaks for flat objects and S breaks for round objects. Solid, thick freehand lines are used for short break lines. Solid, thin-ruled lines are used for long breaks. Break lines reduce the size of drawings so they can be shown on smaller sheets of paper.

◆ **Section lines** are lines that show a cutaway view of a floor plan using repeating “dash, dot, dot” patterns. They are used in section drawings to show that a cut has been made through solid material. The portion of the drawing that represents the solid material is



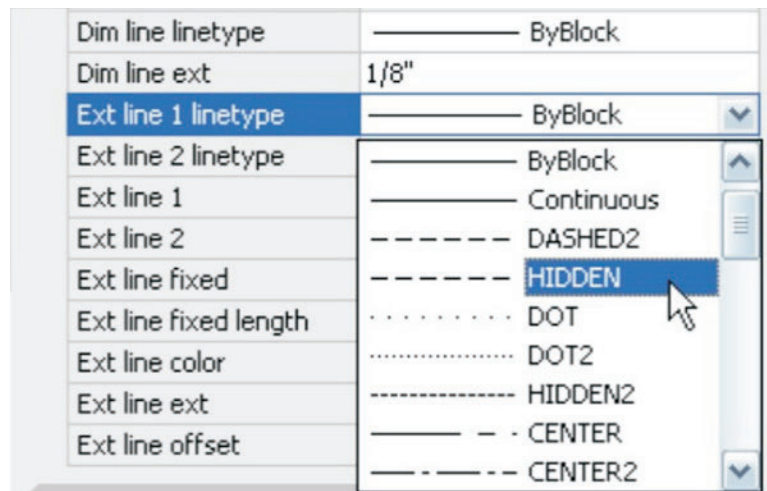
**FIGURE 2.** Which line types are represented on this technical drawing of an internal combustion engine?

filled with section lines. Typically, section lines are thin lines; they are usually shown at a 45-degree angle. The section line repeats fairly close together, and all are parallel to one another.

## Line Weights

**Line weights** are the lightness or darkness and the thickness (width) of the lines. The number of line weights in a drawing may vary, but most drawings use three line weights. Architects, builders, manufacturers, and others use design drawings to complete tasks. The lines must be crisp and dark to ensure accurate interpretation of the line weights by all professionals.

- ◆ Light line weights are used to show details within a material and to represent potential object movement (e.g., door swings and hinge direction). In a section cut, the wood grain or material designation pattern would be drawn with light line weights. In general, action lines, information lines (e.g., dimension lines, center lines, and leader lines), and fill patterns are drawn with light lines.



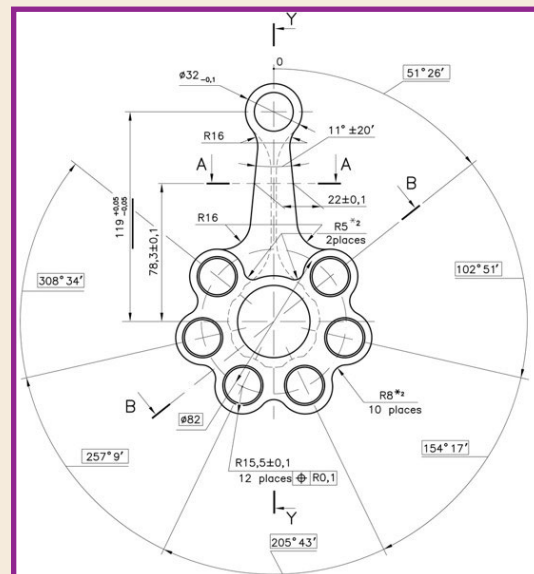
**FIGURE 3.** Line types are standard in the field, and one technical drawing can use 20 to 30 different types.



## FURTHER EXPLORATION...

### ONLINE CONNECTION: The Alphabet of Lines in Technical Drawing

Line types—section lines, cutting-plane lines, and center lines—can be difficult to interpret at first. It may be confusing to learn to draw all the line types. With practice, drawing line types becomes easier. Visit this link to help visualize the various line types and how they are used: <http://www.fostercad.com/Notes%20PDF/The%20Alphabet%20of%20Lines.pdf>



Practice interpreting technical drawings, such as this one of a piston rod with a clipping path.

- ◆ Medium line weights are used to indicate the outline of a material or form within an object, especially secondary objects. Secondary objects include doors, furnishings, counters, and cabinets. In detail sections, medium line weights can be used to designate visible lines between materials.
- ◆ Heavy line weights are reserved to show the outline of a primary object's entire detail or element. These weights can be used to designate the visible line around the outside of products (e.g., walls in plan view or the outline of the perimeter of an elevation or 3D object). Heavy lines are bold, dark, and thick.
- ◆ Halftone line weights are any in gray scale. They are used to indicate patterns within materials or to indicate joints or folds on elevation drawings.

## TECHNICAL DRAWING SYMBOLS

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You must be familiar with symbols to properly interpret technical drawings.

### Title Blocks

Title blocks for technical drawings and renderings include:

- ◆ The name of the company or organization
- ◆ The final issue date
- ◆ Any pertinent information about the drawing/project
- ◆ The print name and reference number or letter
- ◆ A **bill of materials**, which is a listing of all parts and/or materials by name, the number of each part required, and the material callout (e.g., plastic or steel) for each part

### Reference Number

The drawing's reference number identifies each drawing in a set. There are usually multiple drawings (or sheets) in a project set. Drawings that convey similar information are grouped with a common number or letter code.

### Cover Sheet

Cover sheets list all the drawings that exist in a set with their reference numbers. They list all symbols, terms (and definitions), and abbreviations used on the print set.

### Drawing Scale

**Drawing scale** is the ratio (a comparison) at which real objects have been reduced or enlarged. Prints drawn to scale allow the objects to be rendered accurately and precisely. Scales may be metric or standard. The scale represents the length in the drawing followed by a colon

and the matching length on the real object. The following examples are in standard measure (e.g., inches and feet):

- ◆ 1 inch = 1 inch or 1:1—This scale is interpreted as 1 inch on the drawing and is equal to 1 inch on the actual object or full size. The measured distance on the drawing is the actual size of the object.
- ◆  $\frac{1}{2}$  inch = 1 foot or 1:24—This scale is interpreted as  $\frac{1}{2}$  inch on the drawing equals 1 foot on the actual object. It is called half scale. If a part measures  $1\frac{3}{4}$  inches on the drawing, the actual size of the part is  $3\frac{1}{2}$  feet.
- ◆ Other common manufacturing scale ratios are:
  - 1:4 is 3 inches = 1 foot 0 inches
  - 1:8 is  $1\frac{1}{2}$  inches = 1 foot 0 inches
  - 1:32 is  $\frac{3}{8}$  inch = 1 foot 0 inches
  - 1:48 is  $\frac{1}{4}$  inch = 1 foot 0 inches

## Symbols and Notes

**Symbols** are graphic elements that convey information about features on technical drawings or renderings. Drafters and engineers use standard symbols and terminology to communicate design specifications. Symbols help create clear and organized prints. Generally, standard symbols and notes are used in conjunction with a plan, elevation, section, or detail drawings.

Notes (text) are used with symbols to clarify drawing features and to call out specifications. Notes include terminology to describe or explain design features or parts. Notes are brief and concise. In addition, notes often have leaders that extend straight from the notes to the locations where they apply. For example, a brief note used for a part specification would be “CUT OUT.” Symbol types are:

- ◆ Material and graphic symbols may look different in elevations versus plans and section drawings.



## FURTHER EXPLORATION...

### ONLINE CONNECTION: Drafting Symbols

Across all industries, drafting lines and symbols are a common language for architects, engineers, manufacturers, construction supervisors, HVAC contractors, pipefitters, and electricians. Technical and mechanical drawings all use the “common language” of symbols drawn to an industry agreed-upon standard. Learning to decode these lines and symbols is a step in advancing your career in technical drawing and/or manufacturing. To review the common symbols, visit the following:

<http://www.g-wlearning.com/cad/9781605253282/student/resourceCenter/PDF/Symbols.pdf>

- ◆ Material symbols are located in a “material legend.” The legend includes all materials used in the drawing, and the symbols for the materials are located in a small rectangle with the names next to them. Material symbols “fill in” the outline of a shape or object on the drawing and represent the object’s real material (e.g., brick or stone). Most material symbols in elevation plans look like the actual material or object. Material symbols in a section plan show the object as if it were sliced in half to show its composition.
- ◆ Graphic symbols are used to reference other drawings or schedules. These symbols have a coded letter and/or number to direct a person to the correct drawing. These reference symbols are typically the same in all types of drawings. The numbers and/or letters are enclosed in a circle, rectangle, triangle, or other basic geometry.

## Summary:



Technical drawings are graphic representations of objects or concepts that use a universal language of graphic symbols. Mechanical drawings are technical drawings that provide information about mechanical systems: HVAC, electrical, plumbing, etc. On mechanical drawings, lines, line types, and line weights are used to represent different parts or forms of a product.

Line type is the pattern of the line. Each line type is recognized as a typical symbol or object in the construction and manufacturing industries. Following are the standard types of lines used in technical drawings: solid, hidden, dashed, center, dimension, extension, leaders, break, and section. Line weight is the lightness or darkness and the thickness (width) of the line. The number of line weights in a drawing may vary; most drawings use three line weights. Line weights include light, medium, heavy, and halftone.

Symbols are graphic elements that convey information about a feature on a technical drawing or rendering; they help create clear and organized prints. Drafters and engineers use standard symbols and terminology to communicate design specifications.

## Checking Your Knowledge:



1. Describe line types.
2. Describe line weights.
3. How are leaders or leader lines used in technical drawings?
4. Differentiate between common line weights.
5. Draw five line types. Describe the use of each line type you drew.

## Expanding Your Knowledge:

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There are many tutorials—online and offline—that demonstrate and explain how to use lines and symbols on prints. Do some research, and see what you can learn. Write a two-page paper summarizing what you learned from the tutorials you utilized.

## Web Links:

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### Drawing Conventions and Abbreviations

<http://educare-zone.blogspot.com/2013/12/basic-engineering-drawing-conventions.html>

### Symbols Used on Prints

<http://www.scribd.com/doc/7711916/Engineering-Symbols>

### Architectural Symbols

<http://cms.cerritos.edu/uploads/dmussaw/symbols.pdf>