Limits, Fits, and Tolerances: A Detailed Guide

1. Introduction

In precision engineering, 'Limits and Fits' define the relationship between mating parts, such as a shaft and a hole. The 'fit' determines whether the parts will move freely against each other, be permanently locked, or something in between. Standardized systems like ISO 286 and ANSI B4.2 ensure interchangeability and functionality.

2. The Hole Basis System

The most common system is the 'Hole Basis System'. Here, the hole size is kept constant (usually with a lower deviation of zero, designated as 'H'), and the shaft size is varied to achieve the desired fit. This is preferred because it is easier to manufacture holes to standard sizes using standard drill bits and reamers.

3. Types of Fits

A. Clearance Fit (e.g., H7/g6, H7/f7)

There is always a gap between the hole and the shaft. The shaft is smaller than the hole. Used for parts that need to rotate or slide freely, such as bearings and sliding gears.

B. Transition Fit (e.g., H7/k6, H7/n6)

Depending on the actual tolerances, this can result in either a small clearance or a small interference. Used for precise alignment where parts must be held securely but can still be disassembled, like locating pins or gears on a shaft.

C. Interference Fit (e.g., H7/p6, H7/s6)

The shaft is always larger than the hole. Assembly requires force (press fit) or thermal expansion (shrink fit). Used for permanent or semi-permanent assemblies requiring high rigidity, like bushings in housings.

Standard Fits and Tolerances Chart (Hole Basis H7)

Fit Type	ISO Symbol	Description	Typical Application
Clearance	H7 / f7	Free running fit	Bearings, Shafts with high speed
Clearance	H7 / g6	Sliding fit	Precision sliding parts, guiding shafts
Clearance	H7 / h6	Locational clearance	Stationary parts, easy assembly
Transition	H7 / k6	Locational transition	Gears, pulleys, precise location
Transition	H7 / n6	Locational transition	Tight assembly, requires light force
Interference	H7 / p6	Locational interference	Solid assembly, standard press fit
Interference	H7 / s6	Medium drive fit	Permanent assembly, heavy duty

Common Tolerance Zones (H7 Hole)

Note: Actual tolerance values (in microns) depend on the nominal diameter of the part. For example, for a diameter of 25mm (Range 18-30mm):

Symbol	Deviation (microns)	Resulting Fit
H7 (Hole)	0 to +21	Base Hole
g6 (Shaft)	-7 to -20	Clearance: 7 to 41 um
k6 (Shaft)	+2 to +15	Trans: +15 (Interf) to +19 (Clear)
p6 (Shaft)	+22 to +35	Interference: 1 to 35 um