

GD&T Cheat Sheet

Characteristic symbols · datums · modifiers · position, bonus and virtual condition

Form

-  **Straightness**
Datum: Never · Modifiers: MMC/LMC on axis only
Keeps a line on a surface, or the axis of a pin or hole, within two parallel lines or a thin cylinder.
-  **Flatness**
Datum: Never · Modifiers: Median plane only; unit area
Keeps every point of a flat surface between two parallel planes; no datum.
-  **Circularity**
Datum: Never · Modifiers: None (free state only)
Keeps each cross-section of a round feature between two concentric circles; no datum.
-  **Cylindricity**
Datum: Never · Modifiers: None
Keeps a whole cylindrical surface between two coaxial cylinders; no datum.

Orientation

-  **Angularity**
Datum: Required · Modifiers: MMC/LMC on axis; (T)
Holds a surface or axis at a basic angle to a datum within two parallel planes.
-  **Perpendicularity**
Datum: Required · Modifiers: MMC/LMC on axis; (T); (P)
Keeps a surface, axis or centre plane at 90° to a datum within a zone of fixed width.
-  **Parallelism**
Datum: Required · Modifiers: MMC/LMC on axis; (T)
Keeps a surface or axis parallel to a datum within two parallel planes.

Location

-  **Position**
Datum: Usually · Modifiers: MMC, LMC, RFS; (P); MMB
Locates the axis or centre plane of a hole, pin or slot within a zone around its true position.
-  **Concentricity**
Datum: Required · Modifiers: RFS only
Controlled the median points of a round feature to a datum axis; removed from ASME Y14.5 in 2018.
-  **Symmetry**
Datum: Required · Modifiers: RFS only
Controlled the median points of a slot or tab to a datum plane; removed from ASME Y14.5 in 2018.

Profile

-  **Profile of a line**
Datum: Optional · Modifiers: (U); MMB/LMB on datums
Keeps each cross-section of a surface within a band around its true profile; datums optional.
-  **Profile of a surface**
Datum: Optional · Modifiers: (U), all around; MMB/LMB on datums
Keeps a whole surface within a 3D band around its true shape; with datums it also locates it.

Runout

-  **Circular runout**
Datum: Required · Modifiers: None (RFS)
Limits wobble of each cross-section as the part spins on a datum axis; one indicator reading per section.
-  **Total runout**
Datum: Required · Modifiers: None (RFS)
Limits wobble, taper and form of a whole surface as the part spins on a datum axis.

Modifiers and datums

-  **Maximum material condition (MMC)**
Datum: n/a · Modifiers: (M) after tolerance or datum
The size with the most material (smallest hole, largest pin); a circled M grants bonus tolerance away from it.
-  **Least material condition (LMC)**
Datum: n/a · Modifiers: (L) after tolerance or datum
The size with the least material (largest hole, smallest pin); a circled L protects wall thickness.
-  **Regardless of feature size (RFS)**
Datum: n/a · Modifiers: Default (no symbol)
The default: the geometric tolerance stays the same at every size, with no bonus.
-  **Datums and the datum reference frame**
Datum: n/a · Modifiers: RMB default; (M)/(L) after letter
Three perpendicular planes, built from datum features in order, that every located tolerance is measured from.

Formulas and rules

Feature control frame order

symbol | tolerance + modifiers | primary | secondary | tertiary datum

Read left to right; datum order sets the order of contact

Position deviation (2D)

$$\varnothing_{\text{actual}} = 2 \cdot \sqrt{(\Delta x^2 + \Delta y^2)}$$

Δx , Δy measured offsets from true position (mm); compare with the diameter zone

Bonus tolerance at MMC

$$\text{bonus} = |\text{actual size} - \text{MMC size}|$$

Added to the stated tolerance when the frame has (M)

Virtual condition, MMC

$$\text{internal: VC} = \text{MMC} - \text{tol}; \text{external: VC} = \text{MMC} + \text{tol}$$

Worst-case mating boundary; sets functional gauge size

Rule #1 (envelope)

Perfect form at MMC for a feature of size

ASME Y14.5; size limits also control form unless stated otherwise