












Type	Control	Symbol	Material Condition Options ASME Y14.5	Material Condition Options ISO 1101	Tolerance Zone Shape	Datum Reference	Material Condition on Datum Ref. ASME Y14.5	Material Condition on Datum Ref. ISO 1101	Formulas and Abbreviations
Form Unrelated Features	Straightness	—	RFS, MMC, LMC	RFS, MMC, LMC	1, 6	Never	N/A	N/A	Bonus Tolerance, MMC Basis: Bonus = MMC – Actual Size
	Flatness		RFS, MMC, LMC	RFS Only	2	Never	N/A	N/A	
	Circularity	○	RFS Only	RFS Only	3	Never	N/A	N/A	Datum Shift, MMB Basis: Shift = Virtual Condition – Actual Size
	Cylindricity		RFS Only	RFS Only	4	Never	N/A	N/A	
Profile Related or Unrelated	Profile of a Line		RFS Only	RFS Only	7	Usually	RMB, MMB, LMB	RFS, MMC, LMC	Virtual Condition, MMC Basis: Internal Feature = MMC-G-Tol External Feature = MMC+G-Tol
	Profile of a Surface		RFS Only	RFS Only	2, 5, 8	Usually	RMB, MMB, LMB	RFS, MMC, LMC	
Orientation Related Features	Angularity		RFS, MMC, LMC	RFS, MMC, LMC	1, 2, 6	Always	RMB, MMB, LMB	RFS, MMC, LMC	LMB: Least Material Boundary
	Perpendicularity		RFS, MMC, LMC	RFS, MMC, LMC	1, 2, 6	Always	RMB, MMB, LMB	RFS, MMC, LMC	LMC: Least Material Condition
	Parallelism	//	RFS, MMC, LMC	RFS, MMC, LMC	1, 2, 6	Always	RMB, MMB, LMB	RFS, MMC, LMC	MMB: Maximum Material Boundary
Location Related Features	Position		RFS, MMC, LMC	RFS, MMC, LMC	1, 2, 6, 9	Always	RMB, MMB, LMB	RFS, MMC, LMC	MMC: Maximum Material Condition
	Concentricity		RFS Only	RFS, MMC, LMC	6	Always	Axial Datum RMB	RFS, MMC, LMC	RMB: Regardless of Material Boundary
	Symmetry		RFS Only	RFS, MMC, LMC	2	Always	RMB Only	RFS, MMC, LMC	RFS: Regardless of Feature Size
Runout Related Features	Circular Runout		RFS Only	RFS Only	3	Always	Axial Datum RMB	Axial Datum RFS	www.gdt-tolerancestack.com
	Total Runout		RFS Only	RFS Only	2, 4, 5	Always	Axial Datum RMB	Axial Datum RFS	

Tolerance Zones (not exhaustive): 1-Two Parallel Lines, 2-Two Parallel Planes, 3-Two Concentric Circles, 4-Two Concentric Cylinders, 5-Two Concentric Cones, 6-A Cylinder, 7-Two Lines, 8- Two 3D Limits, 9-A Sphere

Datum Selection Guidelines

- Select datums based on contact with mating parts that establish orientation and location relationships; choose datums by analyzing the part within the context of the assembly when fully seated, fully assembled.
- Establish “mirrored” datum and dimensional schemes between mating parts and/or features. When multiple options are possible, consider manufacturing and inspection practices, and also choose datums with more surface area or that will provide better repeatability; avoid relatively short or small surface area primary datums that might introduce projected error during inspection.
- Manufacturing datums should dimensionally be tied back to functional datums. Consider datum targets to reflect functional contact or mfg. setups, especially for machined parts.
- Create additional datum schemes when appropriate to better reflect local functional relationships and to open or close tolerances on groups of related features.

Modifier Application Guidelines

On tolerances...

- Per ASME Y14.5 and ISO 1101, RFS is implied for all tolerances and datum references unless otherwise specified. MMC or LMC modifiers can only be used on features of size (typically when controlling axes or center planes).
- MMC should be the first choice on position and perpendicularity tolerances when locating features of size that are primarily concerned with assembly. Use RFS (or both MMC and LMC) only when more precise centering is required.
- Consider LMC when material conservation is a primary consideration; should be considered for pre-machined features of size on cast, forged, or stock size features, and can also be used on o-ring grooves.

On datum references...

- MMB or LMB modifiers (which are the same modifier symbols used after the tolerances, but with a different meaning) are typically used on axis or center plane datums (derived from features of size), and provide datum shift tolerance.
- If the feature of size datum will have an interference or press fit in the assembly, it should be referenced RMB (no modifier); if the feature of size datum will have a clearance, running, or line to line fit in the assembly, it can be referenced MMB or RMB.