

“Advanced GD&T + Tolerance Stack-up”

Course Contents

Introduction of GD&T Basics (30 minutes)

- Introduction to GD&T. What is GD&T and NOT?
- Feature Control Frame (FCF) and its placement
- Part Features, Feature of Size, Non-size Features
- Rule # 1 and Rule # 2

Actual Mating Envelopes

- Related actual mating envelope
- Unrelated actual mating envelope

Virtual Condition Boundary

- Importance of Virtual condition in designs
- Virtual condition calculations on MMC basis
- Use virtual condition for mating parts as well to design fixed gauges
- 100% interchangeability guarantee in design phase itself
- Exercise for virtual condition

Form Tolerances

- Straightness tolerance for line elements
- Flatness tolerance for single planar feature
- Flatness tolerance with MMC modifier
- Flatness tolerance on unit-basis

Datums

- 3-2-1 Principle
- Select datum features according to the design intent
- Partial Datum
- Coaxial and Co-planar datums
- New datum features: Conical, Linear extruded shape, Complex Shape
- Temporary datums
- Datum Targets: Points, Line, Area
- Individual datums (Repetitive Patterns of Features)
- Custom datum reference frame
- Datum Feature Shift (or Datum Shift)

Orientation Tolerances

- Perpendicularity tolerance
- Perpendicularity tolerances with multiple datums
- Perpendicularity tolerances applied to feature of size
- Parallelism tolerance
- Tangent modifier
- Angularity tolerance applied to a planar feature
- Orientation tolerances in multiple segment (combined) feature control frame

Location Tolerances

A) Position Tolerance

- Position tolerance for cylindrical features (holes / shafts) on MMC, LMC and RFS basis
- Position on Boundary basis for rectangular or oblong slots
- Zero tolerance at MMC basis
- Projected Tolerance Zone
- Simultaneous requirement
- Separate requirement
- Bi-Directional Tolerancing for pattern of features
- Composite Position tolerancing:
 - Pattern-locating Tolerance Zone Framework (PLTZF)
 - Feature-relating Tolerance Zone Framework (FRTZF)
 - FRTZF with Zero datum / 1 datum / 2 datums / 3 datums
 - Composite tolerance for Linear Coaxial Feature Alignment
- Combined position tolerance with other geometric symbols
- Floating Fastener Formula and calculations
- Fixed Fastener Formula and calculations
- Inspection methods to verify position tolerances
- Exercises for position

B) Runout Tolerances

- Circular Runout Tolerance
- Total Run out Tolerance for cylindrical feature
- Total Run out Tolerance for planar feature
- Runout tolerance with co-axial datum
- Inspection methods to verify runout tolerances

C) Profile Tolerances

- 4 types of Profile Tolerance Zones
 - Bi-lateral
 - Unilateral – IN (Unequally Disposed)
 - Unilateral – OUT (Unequally Disposed)
 - Bi-lateral Un-equal (Unequally Disposed)
- Multi-segment or combined profile tolerance
- Composite tolerances: PLTZF & FRTZF
 - FRTZF with no datum / 1 datum / 2 datums / 3 datums
- Profile on a Unit Basis
- Restraint notes on non-rigid parts - specification
- Inspection methods to verify Profile tolerances
- Exercise for profile

D) Concentricity & Symmetry Tolerances

- How to use position tolerance instead of concentricity
- How to use runout tolerance instead of concentricity
- How to use position tolerance instead of symmetry
- Inspection methods to verify concentricity & symmetry tolerances

Gauges to verify Geometrical tolerances

- Functional / Fixed Gauges:
 - Go-Gauges / No Go-Gauges
 - Functional Gauges (Also known as Attribute / Fixed / Receiving / Qualifying gauges)
 - Gauge design exercises
- Variable Gauges
- Various geometrical tolerance inspection tools

"Tolerance Stack-up Analysis"

Introduction to Tolerance Stack-up Analysis methodology

- Importance of Tolerance Stack-up Analysis: Why, when and how
- Introduction of Two-Column method of doing stack-up analysis
- Introduction to Tolerance Stack-up Analysis:
 - Coordinate dimensioning and tolerancing stacks
 - GD&T stacks
 - Worst case stacks
 - Statistical tolerancing stacks: RSS and MRSS
- Methodical steps involved in any stack-up analysis:
 - Loop diagram creation
 - Universal sign language of tolerance stack-up analysis
 - Identification of correct dimensional contributors (vectors)
 - Correct stack table filling according to Two-column method
 - How to convert and enter various geometric tolerances into the stack table
 - Drawing improvements to reduce adverse impact on tolerance stack

Part Level Stack-up Analysis

- Part stack using coordinate dimensioning and tolerancing
- Part stack using position
- Part stack using bi-lateral profile
- Part stack using circular runout
- Part stack using total runout
- Part stack using concentricity tolerance
- Part stack using symmetry tolerance
- Part stack using position with bonus (planar & RFS datums)
- Part stack using position with bonus tolerance (MMC)
- Part stack using form controls applied to a feature
- Part stack using orientation control applied to a feature without size
- Part stack using orientation control applied to a feature of size (FOS)

Assembly Level Stack-up Analysis

- Assembly stacks using coordinate dimensioning and tolerancing
- Assembly stacks using position
- Assembly stacks using position (Floating fastener assembly stack)
- Assembly stack using bi-lateral profile
- Assembly stack using total runout
- Stack using form controls applied to a feature
- Stack using orientation controls applied to a feature without size
- Stack using orientation controls applied to a feature of size (FOS)
- Introduction to Statistical Tolerancing:
 - RSS (Root Sum Square) stack concept
 - MRSS (Modified Root Sum Square) stack concept
- Comparison between Worst-case method, RSS & MRSS methods
- Assembly stack using statistical tolerancing

Contact

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Thank You !