CADSAGA

"GD&T Masterclass"

(Basic GD&T + Adv. GD&T + Tolerance Stack-up Analysis)

Course Contents

GD&T: What, Where, When, Why.. ?

- Introduction to GD&T?
- Feature Control Frame (FCF) and its placement
- Part Features, Feature of Size, Non-size Features
- When to use MMC, LMC and RFS modifier in design
- Bonus tolerance calculations
- Rule # 1 and Rule # 2

Virtual Condition & Resultant Condition Boundaries

- Importance of Virtual condition & Resultant condition in designs
- Virtual condition and Resultant Condition calculations on MMC basis
- 100% interchangeability guarantee in design phase itself
- Exercise for virtual condition & Resultant condition

Form Tolerances

- Straightness tolerance for line elements
- Flatness tolerance for single planar feature
- Flatness tolerance with MMC modifier
- Flatness tolerance on unit-basis
- Circularity Tolerance
- Cylindricity Tolerance
- Inspection methods to verify form 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 tool

Actual Mating Envelopes

- Related actual mating envelope
- Unrelated actual mating envelope

Datums

- What is datum?
- Six Degrees of Freedom
- 3-2-1 Principle
- Datum Reference Frame (DRF)
- Datum Feature Selection, Functional Hierarchy
- Datum feature identification / placements and interpretation
- Datum plane, Datum axis, Datum center plane
- Datum feature simulators
- Datum feature qualification
- Datum Precedence
- 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)
- Datum Feature Shift (or Datum Shift)

Orientation Tolerances

- Perpendicularity tolerance
- 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
- Inspection methods to verify orientation tolerances

Location Tolerances

A) Position Tolerance

- How to apply? Tolerance zone shapes
- Position tolerance for cylindrical features (holes / shafts) on MMC, LMC and RFS basis
- Detailed table calculations for position tolerance on MMC, LMC and RFS
- 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)
- 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 tolerance

C) Profile Tolerances

- Profile of a Line Tolerance
- Profile of a Surface Tolerance
- 4 types of Profile Tolerance Zones
  - Bi-lateral
  - Unilateral – IN (Unequally Disposed)
  - Unilateral – OUT (Unequally Disposed)
  - Bi-lateral Un-equal (Unequally Disposed)
- Controlling extent of profile tolerance: Between symbol
- All-around and all-over modifiers
- 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

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

"Tolerance Stack-up Analysis"

- 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 circular runout
- Part stack using total runout
- Part stack using position with bonus (planar & RFS datums)
- Part stack using position with bonus tolerance (MMC)
- 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 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 !