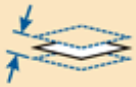
Definition of Position and Profile

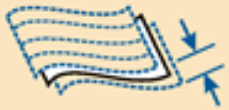
[x] Position

	Cylindrical boundary, within which the center axis of a cylindrical feature of size is permitted to vary from the true (theoretically exact) position
	Parallel planes, within which the center plane of a slot is permitted to vary from the true (theoretically exact) position

[g] Profile of a Surface

	A uniform boundary equally disposed along the true (theoretically exact) profile within which the elements of the surface must lie

[u] Profile of a line

	A uniform boundary equally disposed along the true (theoretically exact) profile, within which the surface elements of each cross-section must lie

Advantages of Position and Profile

[x] Position

1) Accurately represent Design Intent
2) Optimally use available tolerance
   -Feature Bonus
3) More reliable PASS/FAIL analysis
   -less likely to reject a good part or accept a bad part

[g] Profile

1) Accurately represent Design Intent
2) Optimally use available tolerance
   -Datum Bonus
3) Eliminates measurement error caused by feature calculation
   -i.e. small arc radii
4) More reliable PASS/FAIL analysis
   -less likely to reject a good part or accept a bad part

Critical Components to Accurate Measurement of Position and Profile
(all GD&T)

[x] Position

1) Datum Simulation
2) Bonus Calculation
   - Feature Bonus
   - Datum Bonus
3) Feature calculation
   - Actual Mating Envelope (AME)

[g] Profile

1) Datum Simulation
2) Bonus Calculation
   - Datum Bonus
3) Fitting
   - Remaining Degrees of Freedom (if any) after Datum constraints

Component 1 - Datum Simulation
(Position and Profile)

- **Planar Datum**
  - Need to fit to “True Geometric Counter-part” (TGC)
    - Either by using a surface plate or an algorithm that simulates the ASME fit
  - As a primary datum, constrains 3 degrees of freedom
    - 2 rotational, 1 translation
- **Cylindrical Datum**
  - Need to fit to “True Geometric Counter-part” (TGC)
    - By creating a max-inscribed cylinder on a hole, or a min-circumscribed cylinder on a stud (if a primary datum @ RFS)
  - Bonus allowed
  - As a primary datum, constrains 4 degrees of freedom (DOF)
    - 2 rotational, 2 translation
  - As a secondary datum, datum must be simulated at nominal orientation to primary datum
    - If perp to primary, constrains 2 additional DOF, otherwise 3
- **Conical Datum**
  - Need to fit to “True Geometric Counter-part” (TGC)
  - As a primary datum, constrains 5 degrees of freedom
    - 2 rotational, 3 translation

Component 1 - Datum Simulation
(Position and Profile)

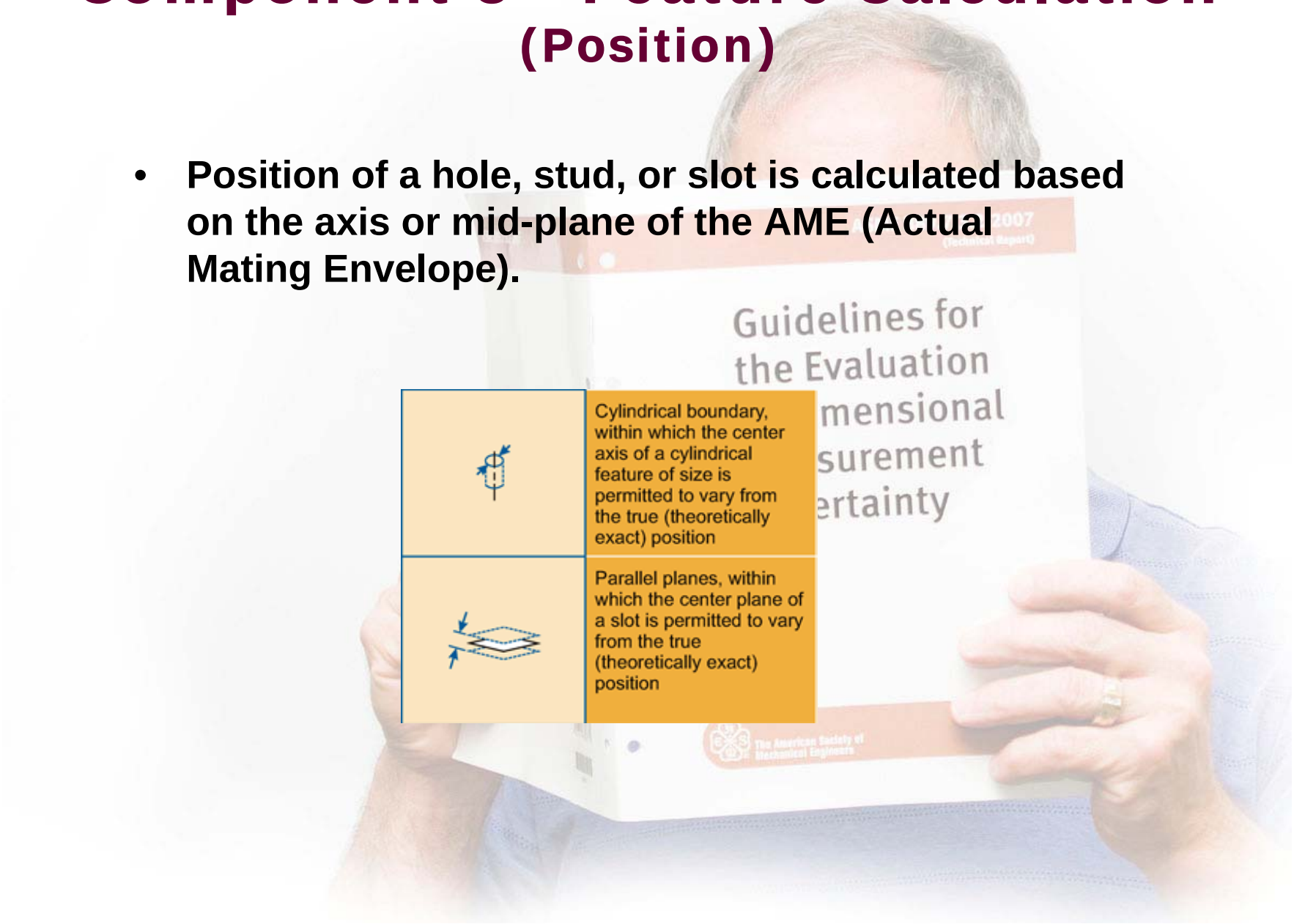
- **Compound Datums**
  - Need to fit to “True Geometric Counterpart”
  - Most common
    - 2 inline cylinders, as a primary datum
    - Multiple cylinders (pattern), as a secondary datum
  - Allows for Bonus if at MMC
  - All features of a compound datum are equal
    - i.e. cannot “zero” on one and rotate to another

Component 2 - Bonus Calculation
(Position and Profile)

- **Position Bonus on a Feature** [x]a.005m]A]
  - As feature (hole, stud, or slot) departs from it's Maximum Material Condition (MMC), feature receives position bonus tolerance
  - Calculated based on Actual Mating Size (AMS)
- **Bonus on Datums** [x]a.005m]A]B m] [g].005]A]B m]
  - Only allowed on Datums that are features of size
  - Bonus is calculated the same as with position, *but not added to tolerance*
    - Calculated bonus is an allowable "part shift" from Datum
  - "Part shift" must be used at the same time for all simultaneous callouts, not an individual shift per callout

Component 3 - Feature Calculation (Position)

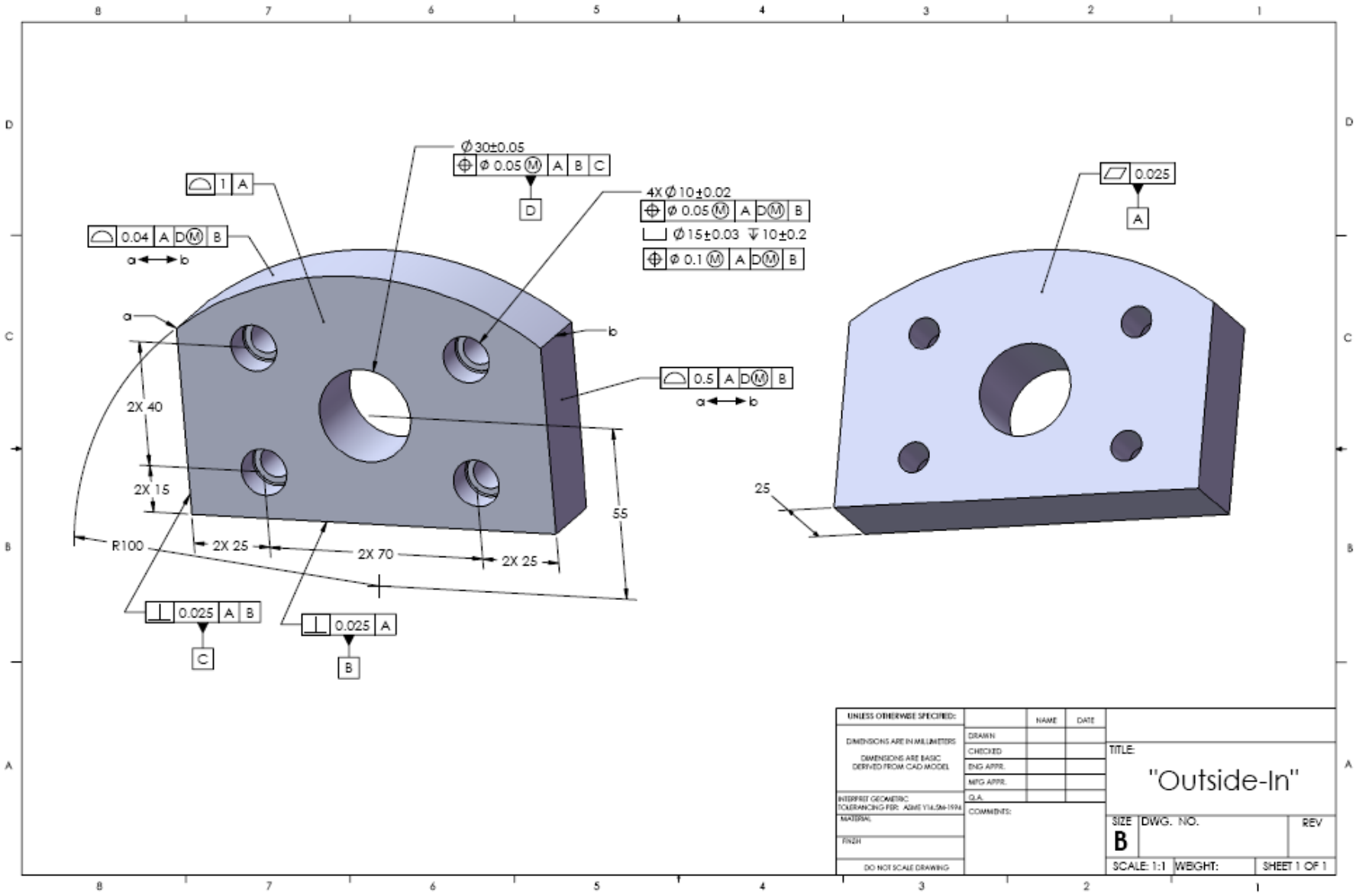
- **Position of a hole, stud, or slot is calculated based on the axis or mid-plane of the AME (Actual Mating Envelope).**



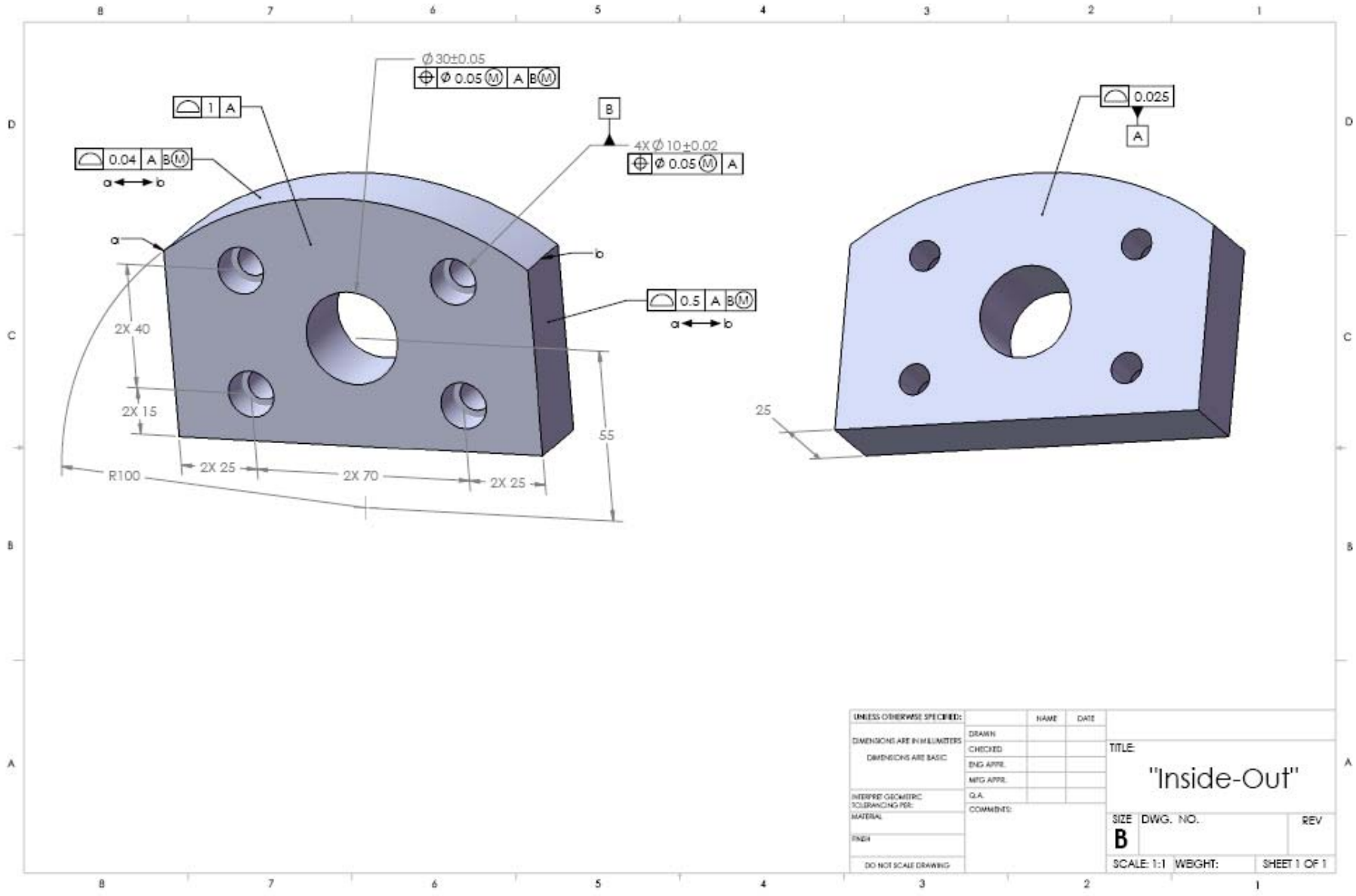
Component 4 - Optimal Fitting (Profile)

- Any remaining degrees of freedom after Datum constraints
  - i.e. [g].005]A] or [g].005]A]Bm]
- Most commonly used Least Squares algorithm does not provide optimal fit.
  - We are not concerned with averaging the errors, but need to determine whether or not the part will fit within the specified tolerance zone.
- Inspection software needs to provide a fitting algorithm that provides optimal fit (Minimizing Maximum error ***with respect to profile tolerance***) for ***all simultaneous callouts***

Example 1


Ø30±0.05
Ø 0.05 M A B C
D
1 A
0.04 A D M B
a ↔ b
4X Ø 10±0.02
Ø 0.05 M A D M B
Ø 15±0.03 ↧ 10±0.2
Ø 0.1 M A D M B
0.5 A D M B
a ↔ b
0.025
A
a
b
2X 40
2X 15
R100
2X 25
2X 70
2X 25
55
25
0.025 A B
C
0.025 A
B
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS ARE BASIC DERIVED FROM CAD MODEL
INTERPRET GEOMETRIC TOLERANCING PER: ASME Y14.5M-1994
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
"Outside-In"
SIZE
B
DWG. NO.
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1

Example 2


Ø30±0.05
Ø 0.05 M A BM
1 A
B
4X Ø 10+0.02
Ø 0.05 M A
0.04 A BM
a ↔ b
0.5 A BM
a ↔ b
0.025
A
2X 40
2X 15
55
25
R100
2X 25
2X 70
2X 25
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
DIMENSIONS ARE BASIC
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
"Inside-Out"
SIZE
B
DWG. NO.
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1

Review of Measurement Components of Position and Profile

[x] Position

1) Datum Simulation
2) Bonus Calculation
   - On holes, studs or slots
   - Datums (Feature of Size)
3) Feature creation
   - Actual Mating Envelope (AME)

[g] Profile

1) Datum Simulation
2) Bonus Calculation
   - Datum (Feature of Size)
3) Fitting
   - Remaining Degrees of Freedom after Datum constraints

***Correct methods for evaluating the items listed above are absolutely critical in providing accurate results. Improper analysis of any of the above has the potential to result in errors *significantly larger than the error of the measurement equipment used*.**