PDES Inc. Report

Mapping from 3D Assembly Geometric Model to 2D Assembly Geometric Model for AP 210

Background:

AP 210 provides capability to exchange product model data in an assembly context, where explicit relationships are established between components and the assembly, irrespective of the representations of the shapes of the components and the assembly. AP 210 provides capability to exchange product model data that specifies component features that are joined during an assembly process, irrespective of the representation of the shape of the joint or of the features. AP 210 provides capability to specify features intended for mounting (assembly) applications. AP 210 treats interconnect substrates as a component instance.

AP 210 provides capability to exchange product model data for assemblies through two fundamentally different geometric contexts:

- Three dimensional
- Augmented two dimensional

The three dimensional context provides full capability to locate and orient a component in the context of the assembly using geometric models provided in ISO 10303-42:1994 and the representation model provided in ISO 10303-43:1994.

The augmented two dimensional context provides full capability to locate and orient a component shape in the context of the assembly by combining the two dimensional geometry from ISO 10303-42:1994 and the representation model in ISO 10303-42:1994 with AP specific data types that incorporate the interconnect substrate component in the specification of location and orientation.

The entities from ISO 10303-42:1994 include:

- axis_placement
- cartesian_transformation_operator_2d

The entities from ISO 10303-43:1994 include:

- mapped_item
- representation_map
- representation
- descriptive_representation_item

The AP specific data types include:
- assembly_joint (subtype of shape_aspect, shape_aspect_relationship)
- component_location (subtype of representation)
- component_shape_aspect (subtype of shape_aspect)

In addition to the AP specific subtypes, the following attribute values of shape_aspect.description (ISO 10303-41) are provided:

- 'interconnect module primary surface',
- 'interconnect module secondary surface',
- 'interconnect module edge segment surface',
- 'interconnect module edge surface'.

The 'interconnect module edge surface' is included in this document for completeness. It has no role in component location determination.

If the component_location contains a descriptive_representation_item with a name of 'mounting style', the following attribute values are permitted for the description attribute:

- 'normal'
- 'reversed'

If the representation name is 'seating plane', the axis_placement in the representation shall be the seating plane for that definition.

Fundamental Assumptions for 2D Representations

Industry domain practice incorporates the notions of 'normal', 'reversed', 'top', 'bottom', 'mirror', in addition to translation in x, y and rotation. These concepts are divided into two classes: descriptive information needed for assembly, geometric transformations needed to modify shapes for presentation on drawings. Explicit assumptions:

- In a 2D CAD system, the viewer is always looking down from the top side, and when a component is mounted on the bottom of the board, that component is still viewed from the top, but the board is transparent.
- The base geometric definition is a 3D CAD model, where the seating plane is a plane in that model.

Explicit definitions in AP 210 to formalize industry practice:

- The seating plane normal is the z-axis of the seating plane. When the normal of the seating plane is parallel to the normal of the surface of the substrate in the assembly (where the surface is specified by the assembly_joint), the mounting_style attribute value is 'normal'. When the normals are anti-parallel, the mounting_style attribute value is 'reversed'.
- Angular orientations of the z-axis of the component with respect to the substrate other than 0 or 180 degrees are handled by implementing an Alternate_package ARM data type.
- This algorithm assumes all 2D views are from the top of the substrate (as seen in the typical 2D CAD system).
- All coordinate systems are right handed. Mirroring does not change the handed-ness of a coordinate system.

Example: TO-220 packages may have straight leads or bent leads, with the bent leads case being an instance of an Alternate_package, where the straight leads is the 'usual' case.

The 3D to 2D Package Geometry Conversion Relationship in AP 210

The algorithm under development is converting the 3d representation to the augmented 2d representation.
Input data:

Package definition in 3D,
Packaged_part definition

Output data:

Package definition in 2D

Is this a conversion algorithm or a mapping definition?

The 3D to 2D Placement Conversion Algorithm internal to AP 210

The algorithm under development is converting the 3d representation to the augmented 2d representation.
Input data:

Package definition in 3D,
Package definition in 2D,
Packaged_part definition,
Interconnect_module_usage_view,
Component_3d_location of the Assembly_component mounted on the substrate,
Component_3d_location of the Interconnect_module_component subtype of Assembly_component,
Assembly_joint associating a feature of the Assembly_component with a feature of the Interconnect_module_component (for edge mounting and for pin 1),
Planar_projected_shape,
Volume_shape_projection,
Physical_unit_planar_shape,
Physical_unit_

IMC Seatface, Feature?

Output data:

Cartesian_transformation_operator_2d
Component_2d_location.mounting_surface
Component_2d_location.mounting_style,
Component_2d_location.transformation
Component_2d_edge_location.reference_terminal_assembly_joint

Procedure method 1:

a) Determine the substrate mounting surface:

IMC ← {CF SCF. def → A{B}

For case of seating plane parallel or anti-parallel to interconnect_module_component.component_feature → shape_aspect with description of 'interconnect module primary surface'. /* This filters out the edge mounting condition. */
Do:
For each interconnect_module_component.component_feature → {shape_aspect with description of 'interconnect module primary surface' | 'interconnect module secondary surface' }

definer?

If 'this surface' is 'interconnect module primary surface' then 'opposite surface' is 'interconnect module secondary surface'
If 'this surface' is 'interconnect module secondary surface' then 'opposite surface' is 'interconnect module primary surface'
If 'opposite surface' is not between {Assembly_component.usage_definition.seating_plane | Assembly_component.usage_definition ←physical_unit_3d_shape.shape_representation.seating_plane}/* the first case is for package, the second is for generic physical units. */
And 'this surface', then 'this surface' is component_2d_location.mounting_surface.definition

If the seating plane is parallel to the plane of 'this surface' then the value of component_2d_location.mounting_style = 'normal'.
If the seating plane is anti-parallel to the plane of 'this surface' then the value of component_2d_location.mounting_style = 'reversed'.

For case of seating plane not parallel and not anti-parallel to the primary_surface
Do:
Assembly_component ←
component_feature.associated_component
Component_feature

{component_feature.definition →
part_feature
part_feature ➔
primary_reference_terminal}
Component_feature←
assembly_joint.features[1]
Assembly_joint
Assembly_joint.features[2] →
component_feature
{Component_feature ➔
Interconnect_module_component_terminal
Interconnect_module_component_terminal.definition →
Interconnect_module_terminal
Interconnect_module_terminal.feature_shape →
Feature_shape_occurrence}
Component_feature.associated_component →
Interconnect_module_component
.definition.terminal_of_package=====??For each instance of shape_aspect with description of 'interconnect module edge segment surface' determine whether that instance is parallel or anti-parallel to the

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ENTITY component_2d_edge_location
    SUBTYPE OF (component_2d_location);
   reference_terminal_assembly_joint: assembly_joint;
END_ENTITY; -- component_2d_edge_location

ENTITY component_2d_location
SUPERTYPE OF (component_2d_edge_location)
SUBTYPE OF (managed_design_object);
mounting_style: OPTIONAL mounting_position;
placement_fixed: BOOLEAN;
   transformation: cartesian_transformation_operator_2d;
mounting_surface: OPTIONAL
interconnect_module_component_surface_feature;
END_ENTITY; -- component_2d_location

ENTITY component_3d_location
    SUBTYPE OF (managed_design_object);
   transformation: axis_placement_3d;
   placement_fixed: BOOLEAN;
END_ENTITY; -- component_3d_location

ENTITY component_assembly_2d_position
    SUBTYPE OF (managed_design_object);
   component_model: assembly_component_2d_shape;
   transformation: component_2d_location;
   assembly_model: physical_unit_planar_shape;
   component: next_higher_assembly_relationship;
END_ENTITY; -- component_assembly_2d_position

ENTITY component_assembly_3d_position
    SUBTYPE OF (managed_design_object);
   component_model: assembly_component_3d_shape;
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   transformation: component_3d_location;
   assembly_model: physical_unit_3d_shape;
   component: next_higher_assembly_relationship;
END_ENTITY; -- component_assembly_3d_position

ENTITY physical_unit_3d_shape
    SUBTYPE OF (managed_design_object);
   application_technology_constraint: ee_requirement_occurrence;
   shape_representation: bound_volume_shape;
   shape_characterized_physical_unit: physical_unit;
   shape_material_condition: material_condition;
   shape_purpose: purpose;
   shape_environment: environment;
   centroid_location: OPTIONAL cartesian_point;
END_ENTITY; -- physical_unit_3d_shape

ENTITY planar_projected_shape
    SUBTYPE OF (planar_curve);
 INVERSE
   curve_basis: SET [0:1] OF volume_shape_projection FOR
surface_projection;
END_ENTITY; -- planar_projected_shape

ENTITY volume_shape_projection
    SUBTYPE OF (managed_design_object);
   surface_projection: planar_projected_shape;
   projected_volume: bound_volume_shape;
   orientation_seating_plane: axis_placement;
END_ENTITY; -- volume_shape_projection
```

b) Determine the relative orientation of the Z axis of the component with respect to the Z axis of the substrate mounting surface

The 3D to 2D Extraction Algorithm external to AP 210

There are two ______of the algorithm:

- Component placement information for assembly machine data generation
- Component assembly drawing shape transformation needed to indicate the placement information on an assembly drawing.

This algorithm assumes all views are from the top of the substrate (as seen in the typical 2D CAD system).

Machine data generation:

- Placement x, y
- Rotation
- Substrate side
- Mounting style

Assembly drawing generation:

- Placement x, y
- Rotation
- Substrate side
- Mounting style
- Mirroring

Three dimensional source data includes the placement of the component and the substrate in the assembly, and component features identified in the library as mounting and orientation features, and the explicit relationship established between the component and the substrate by Assembly_joint instances. This method will use Express-X as a mechanism. The instances of the AP 210 AIM will be indicated as AIM_3D_assembly, AIM_2D_assembly, and AIM_2D_drawing.

Placement and Rotation Algorithm:

Constraints: Seating plane of the component is parallel or anti-parallel to that of the substrate surface.

Determine: Substrate side

Substrate side is 'top'

- If the plane representing the top surface of the substrate is congruent with the seating plane of the component
- If the plane representing the top surface of the substrate is between the seating plane of the component and the plane representing the bottom surface of the substrate.
- If the seating plane of the component is congruent with an internal surface of the substrate whose normal of the internal mounting surface is parallel with the normal of the top surface.
- If the plane representing the top surface of the substrate is closer to the seating plane of the component than is the plane representing the bottom surface of the substrate.

Substrate side is 'bottom'

- If the plane representing the bottom surface of the substrate is congruent with the seating plane of the component.
- If the plane representing the bottom surface of the substrate is between the seating plane of the component and the plane representing the top surface of the substrate.
- If the seating plane of the component is congruent with a surface of the substrate whose normal of the internal surface is parallel with the normal of the bottom surface.
- If the plane representing the bottom surface of the substrate is closer to the seating plane of the component than is the plane representing the top surface of the substrate.

Note: Figures 26 and 82 in ISO/IEC DIS 10303-210 illustrate this. ISO 10303-42 defines Y axis to be derived from X axis in 2D coordinate system.

Therefore, only the local X direction vector of the component is used to determine component rotation with respect to that of the substrate.

Determine: Mounting style

Mounting style is 'normal' if the Z axis of the seating plane of the component is parallel to that of the mounting surface. Plane representing the substrate side determined______

Case 1: Given: Substrate side = top, Mounting style = 'normal'

Derive: X, Y, Rotation

- Position of the component on the substrate is obtained by subtracting the position vector of the substrate from the position vector of the component.
- Rotation of the component on the substrate is obtained by subtracting the angle of the X direction vector of the substrate from the angle of the X direction vector of the component.
- Mirroring = No, T = 1.0

Case 2: Given: Substrate side = Top, Mounting style = 'reversed'

- Mirroring = Yes, T = -1.0

Case 3: Given: Substrate side = Bottom, Mounting style = 'normal'

- Mirroring = Yes, T = -1.0

Case 4: Given: Substrate side = Bottom, Mounting style = 'reversed'

- Mirroring = No, T = 1.0