**Document History**

<table>
<thead>
<tr>
<th>Release</th>
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<tr>
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<td>Update &amp; extended for 2nd test round</td>
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- Adding JointType  
- adding PartTransportFeature for cable, and wire  
- WireIdentification with definition to PartTransportFeature  
- fixing CableOccurrenceTerminal  
- replacing attribute LocationGroup by ElementOf |
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- updating all test cases for new XML schema from 2021-09-16  
new WirePartIdentification; previous WireIdentification renamed  
to WireOccurrenceIdentification;  
- adding new Connectivity5 test case;  
- changed test case Connectivity3 to use the new capability for  
complex connectors to reflect lower level terminals to a higher level  
- minor fixes in previous test case specifications |
| 5.0     | 2022-11-29     | For the 5th test round:  
- xxx  
- new production test case Gulfstream1 |

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1 Introduction
This document describes the suite of test cases to be used for the EWIS Interoperability Forum. The EWIS-IF is a joint testing forum, organized and facilitated by AFNeT and PDES.

2 Formal Test Syntax
This clause defines a formal syntax for the definition of synthetic test cases in the terms of the Domain Model. Purpose of this syntax is to formulate test cases in a clear, easy readable and unambiguous way. A macro capability allows to define standard patterns once and then apply them again and again. It is intended to convert test cases using this syntax into XML Schematron for the

The formal test syntax allows the definition of patterns of instances of Application Objects (AO); here they are AOs of the Domain Model. The test syntax is used to define the test specifications for both import and export of STEP XML files.

Instances of AOs and other values (string, real, ...) are identified (ID) by a leading “@” followed by a positive number. This number is unique within a particular test case and macro. If the same ID is used several times within a test case or macro, then this means the same AO instance or other value. If the same ID is used in different test cases or macros this does not have any meaning.

Every instance or other value has to have a definition statement. Such a statement starts with the ID, followed by a “:” and then followed by it's type that is defined in the domain model. After this constraints on the attribute values of instances or the value itself can be stated within “(...)”.

The order of IDs within a macro is significant. They should start with @1, @2, @3 … @N. When invoking a macro from another test case or higher level macro, these IDs are replaced with the IDs and values defined within the macro invocation.

3 Macros

3.1 Part_with_PartView
This macro constrains single instances of a Part, a PartVersion, a PartView and a ViewContext to be linked together. Only the name for a Part is constrained as the ID of a Part is often rather system dependent. The ViewContext used as the initialContext for the PartView is constrained for the predefined LifeCycleStage “design”.

Macro Part_with_PartView {
  @1:Part( Name=@2, Versions[i]=@3 );
  @2:CharacterString
  @3:PartVersion( Views[i]=@4 );
  @4:PartView( InitialContext=@5 );
  @5:ViewContext( LifeCycleStage=PredefinedApplicationDomainEnum(design) );
};

3.2 Part_with_ID_and_PartView
This macro is similar to the macro Part_with_PartView but instead of constraining the name of a Part the ID of a part is constraint.

Macro Part_with_ID_and_PartView {
  @1:Part( Id=@2, Versions=(@3) );
  @2:Identifier;
  @3:PartVersion( Views=(@4) );
3.3 **Part_WiringHarnessAssemblyDesign**  
This macro is similar to the macro Part_with_PartView and constraints single instances of a Part, a PartVersion, a WiringHarnessAssemblyDesign (that is a sub-subtype of PartView) and a ViewContext to be linked together. The Part is constrained for the PartType "wiring_harness".

Macro Part_WiringHarnessAssemblyDesign (  
  @1:Part( Name=@2,  
      Versions[i]=@3,  
      PartTypes[i]=PartCategoryEnum(wiring_harness) );  
  @2:CharacterString  
  @3:PartVersion( Views[i]=@4 );  
  @4:WiringHarnessAssemblyDesign( InitialContext=@5 );  
  @5:ViewContext( LifeCycleStage=PredefinedApplicationDomainEnum(design),  
                     ApplicationDomain=PredefinedApplicationDomainEnum(electrical) );  
);  

3.4 **Part_WiringHarnessAssemblyDesign_with_topology**  
This macro is an extension of the macro Part_WiringHarnessAssemblyDesign. In addition to this it adds a constraint for an additional ViewContext with the predefined LifeCycleStage "wiring_harness_segment_topology".

Macro Part_WiringHarnessAssemblyDesign_with_topology (  
  Part_WiringHarnessAssemblyDesign(@1,@2,@3,@4,@5);  
  @1:Part;  
  @2:CharacterString;  
  @3:PartVersion;  
  @4:WiringHarnessAssemblyDesign( AdditionalContexts[i]=@6 );  
  @5:ViewContext;  
  @6:ViewContext( ApplicationDomain=PredefinedApplicationDomainEnum(  
                     wiring_harness_segment_topology) );  
);  

3.5 **Joint2**  
This macro constrains an AssemblyDefinition and two OccurrenceShapeFeatures (that belong to Occurrences that are brought into the assembly by NextAssemblyOccurrenceUsage to be connected by an AssemblyShapeJoint with a specified AssemblyJointTypeEnum value.

Macro Joint2 (  
  @1:AssemblyDefinition;  
  @2:OccurrenceShapeFeature;  
  @3:OccurrenceShapeFeature;  
  @4:AssemblyJointTypeEnum;  
  @5:AssemblyShapeJoint( ElementOf=@1, JointType=@4 );  
  @6:AssemblyShapeJointItemRelationship( Relating=@5, Related=@2 );  
  @7:AssemblyShapeJointItemRelationship( Relating=@5, Related=@3 );  
);
3.6 **Undirected_edge**

This macro constrains an edge with two vertices so that either one of the Vertices is the EdgeStart and the other Vertices is the EdgeEnd. In STEP all Edges are by default directed, however for the design of the topology of an EWH the direction of an Edge is not relevant (however it might be relevant for the purpose of manufacturing).

Macro Undirected_edge (  
    @1=Edge( ( EdgeStart=@2, EdgeEnd=@3)  
        OR  
        ( EdgeStart=@3, EdgeEnd=@2) );  
    @2=Vertex;  
    @3=Vertex;  
);  

4 **Test Case Specifications**

4.1 **EWH-Assembly1**

This test case focuses on a very basic flat assembly structures as it might show up in EWH. This test does not address connectivity or topological information. This test is an extension of the typical assembly structure as provided in the document “Recommended Practices for AP242 Business Object Model XML Assembly Structure”.

The following elements are tested:

- Part with PartCategories: discrete_part, raw_material_by_length, wire, cable, connector, lug
- WiringHarnessAssemblyDesign that is a subtype of AssemblyDefinition
- specific kinds of Part Occurrences: SingleOccurrence, QuantifiedOccurrence, WireOccurrence, CableOccurrence
EWIS Interoperability Forum
Test Suite v5.0

EWH-Unit-Assembly1

Figure 1: EWH-Assembly1
Formal test-case specification:

Test EWH-Assembly1 {

@4:ViewContext;
@5:ViewContext;
@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@100:Part( PartTypes[i]=PartCategoryEnum(connector), PartTypes[i]=PartCategoryEnum(discrete) );
@101:PartVersion;
@102:PartView;
Part_with_Name_and_PartView( @100, "Connector-A", @101, @102, @4);
@111:SingleOccurrence( Id=IdentifierString("J1"), Definition=@102 );
@121:SingleOccurrence( Id=IdentifierString("J2"), Definition=@102 );

@200:Part( PartTypes[i]=PartCategoryEnum(terminal_lug), PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;
@202:PartView;
Part_with_Name_and_PartView( @200, "Lug-B", @201, @202, @4);
@211:SingleOccurrence( Id=IdentifierString("J3"), Definition=@202 );
@221:SingleOccurrence( Id=IdentifierString("J4"), Definition=@202 );

@300:Part( PartTypes[i]=PartCategoryEnum(wire), PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@301:PartVersion;
4.2 EWH-Topology1

This test case focuses on a very basic topological structure needed for EWH without any other information. The test consists of a flexible topological/geometric representation of the harness, consisting of 6 vertices and 5 edges with length.
Formal test-case specification:

Test EWH-Topology1 (

@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign( Topology=@9901 );
@9003:ViewContext;
@9004:ViewContext;
Part_WiringHarnessAssemblyDesign_with_topology(9000, "EWH Test-Case Topology1", @9001, @9002, @9003, @9004);

@9900:GeometricCoordinateSpace( Units=@8, DimensionCount=1 );
@9901:EdgeBasedTopologicalRepresentationWithLengthConstraint( Items=(@9902), ContextOfItems=@9900 );
@9902:ConnectedEdgeSet( ConnectedEdges=(@9931, @9932, @9933, @9934, @9935) );

@9911:Point();
@9912:Point();
@9913:Point();
@9914:Point();
@9915:Point();
@9916:Point();

@9921:VertexPoint( name='N1' VertexGeometry=@9911 );
@9922:VertexPoint( name='N2' VertexGeometry=@9912 );
@9923:VertexPoint( name='N3' VertexGeometry=@9913 );
@9924:VertexPoint( name='N4' VertexGeometry=@9914 );
@9925:VertexPoint( name='N5' VertexGeometry=@9915 );
@9926:VertexPoint( name='N6' VertexGeometry=@9916 );

@9931:EdgeBoundedCurveWithLength( name='S1', EdgeGeometry=@9941 ); undirected_edge(@9931, @9921, @9923)
@9932:EdgeBoundedCurveWithLength( name='S2', EdgeGeometry=@9942 ); undirected_edge(@9932, @9922, @9923)
@9933:EdgeBoundedCurveWithLength( name='S3', EdgeGeometry=@9943 ); undirected_edge(@9933, @9923, @9924);
@9934:EdgeBoundedCurveWithLength( name='S4', EdgeGeometry=@9944 ); undirected_edge(@9934, @9924, @9925);
Figure 3: Example in CATIA

Provided test files:
AP242ed2 XML: EWH-UseCase-Topology1.xml
4.3 **EWH-Topology2**

This test case is an extension of test case EWH-Topology1 that is merged with a simplified EWH-Assembly1 test case.

- the topology model is extended for Paths, SubEdges and PointOnCurves
  - Path P1 traverses the EdgeBoundedCurveWithLength S1, S3, S4
  - Path P2 traverses the EdgeBoundedCurveWithLength S2, S3, S5
  - Path P3 traverses the SubEdges S2.2, S3.1
  - for the definition of the VertexPoints for the SubEdges, two PointOnCurves are defined in the middle of the underlying BoundedCurveWithLength
  - it is up to the implementations to ensure that the orientations of the Edges in the EdgeList of a Path fits with the orientation of the underlying BoundedCurveWithLength. See the attributes *Path.OrientationList* and *EdgeCurve.SameSense* for this purpose.

- the simplified assembly structure consists of
  - a single wire
  - a single cable
  - a protective covering for only a certain region

- two simple 2-pin connectors and two terminal lugs; one at each extremity of the harness topology

- geometry-to-topology association of
  - wire/cable/protection Occurrences to Paths
  - connectors and terminal lug Occurrences to VertexPoints

*Figure 4: EWH-Topology2*
Formal test-case specification:

(Draft; not completed yet; references depends on the available p21 files)

Test EWH-Topology2 (}

@0: Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@100: Part( PartTypes[i]=PartCategoryEnum(connector),
            PartTypes[i]=PartCategoryEnum(discrete) );
@101: PartVersion;
@102: PartView( DefiningGeometry=@191 );
 Part_with_name_and_PartView( @100, "Connector-A", @101, @102, @4);
@111: SingleOccurrence( Id=IdentifierString("J1"), Definition=@102 );
@121: SingleOccurrence( Id=IdentifierString("J2"), Definition=@102 );
@190: GeometricCoordinateSpace( DimensionCount=3 );
@191: GeometricModel( items[i]=@192, ContextOfItems=@190 );
@192: AxisPlacement;

@200: Part( PartTypes[i]=PartCategoryEnum(terminal_lug),
            PartTypes[i]=PartCategoryEnum(discrete) );
@201: PartVersion;
@202: PartView( DefiningGeometry=@291 );
 Part_with_name_and_PartView( @200, "Lug-B", @201, @202, @4);
@211: SingleOccurrence( Id=IdentifierString("J3"), Definition=@202 );
@221: SingleOccurrence( Id=IdentifierString("J4"), Definition=@202 );
@290: GeometricCoordinateSpace( DimensionCount=3 );
@291: GeometricModel( items[i]=@292, ContextOfItems=@290 );
@292: AxisPlacement;

@300: Part( PartTypes[i]=PartCategoryEnum(wire),
            PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@301: PartVersion;
@302: PartView( DefiningGeometry=@391 );
 Part_with_name_and_PartView( @300, "Wire-C", @301, @302, @4);
@311: WireOccurrence( Id=IdentifierString("W1"),
                      Definition=@302, Quantity=3.5 );
@390: GeometricCoordinateSpace( DimensionCount=2 );
@391: GeometricModel( name='2D cross section',
                      items[i]=@392, ContextOfItems=@390 );
@392: AxisPlacement; # placeholder for 2D centre

@400: Part( PartTypes[i]=PartCategoryEnum(cable),
            PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@401: PartVersion;
@402: PartView( DefiningGeometry=@491 );
 Part_with_name_and_PartView( @400, "Cable-D", @401, @402, @4);
@411: CableOccurrence( Id=IdentifierString("W2"), Definition=@402,
                      Quantity=1.8 );
@490: GeometricCoordinateSpace( DimensionCount=2 );
@491: GeometricModel( name='cross section', items[i]=@492,
                      ContextOfItems=@490 );
@492: AxisPlacement;
@500:Part( PartTypes[i]=PartCategoryEnum(protective_covering),
PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@501:PartVersion;
@502:PartView( DefiningGeometry=@591 );
Part_with_Name_and_PartView(@500, "Protection-E", @501, @502, @4);
@511:QuantifiedOccurrence( Id=IdentifierString("W3"),
Definition=@402, Quantity=@412 );
@512:NumericalValue( Unit=@8, ValueComponent=1.2 );
@590:GeometricCoordinateSpace( DimensionCount=2 );
@591:GeometricModel( name='cross section',
items[i]=@592, ContextOfItems=@590 );
@592:AxisPlacement;

@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign( Topology=@9901 );
@9003:ViewContext;
@9004:ViewContext;
Part_WiringHarnessAssemblyDesign_with_topology(@9000, "EWH Test-Case Topology2", @9001, @9002, @9003, @9004);

@9101:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@111,
Placement=(@9111) ); # connector J1
@9102:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@121,
Placement=(@9112) ); # connector J2
@9103:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@211,
Placement=(@9113) ); # terminal lug J3
@9104:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@221,
Placement=(@9114) ); # terminal lug J4
@9105:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@311,
Placement=(@9115 ) ); # wire W1
@9106:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@411,
Placement=(@9116 ) ); # cable W2
@9107:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@511,
Placement=(@9117 ) ); # protection W3

@9111:GeometryToTopologyModelAssociation ( Relating=@9901, Related=@191, Origin=@192, Target=@9921); # connector J1
@9112:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@191, Origin=@192, Target=@9925); # connector J2
@9113:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@291, Origin=@292, Target=@9922); # terminal lug J3
@9114:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@291, Origin=@292, Target=@9926); # terminal lug J4
@9115:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@391, Origin=@392, Target=@9952); # wire W1
@9116:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@491, Origin=@492, Target=@9951); # cable W2
@9117:GeometryToTopologyRepresentationAssociation( Relating=@9901, Related=@591, Origin=@493, Target=@9953); # protection W3
@9900: GeometricCoordinateSpace( Units=\texttt{m}, DimensionCount=1 );
@9901: EdgeBasedTopologicalRepresentationWithLengthConstraint(
    Items=(@9902, @9951, @9952, @9953), \# the ConnectedEdgeSet + paths
    ContextOfItems=@9900);
@9902: ConnectedEdgeSet( ConnectedEdges=(@9931, @9932, @9933, @9934, @9935) );
    \# only main edges, not sub-edges

@9911: Point();
@9912: Point();
@9913: Point();
@9914: Point();
@9915: Point();
@9916: Point();
@9917: PointOnCurve( BasicCurve=@9942, Parameter=2.0 );
    \# in the middle of the basic curve
@9918: PointOnCurve( BasicCurve=@9943, Parameter=3.0 );
    \# in the middle of the basic curve

@9921: VertexPoint( name='N1', VertexGeometry=@9911 );
@9922: VertexPoint( name='N2', VertexGeometry=@9912 );
@9923: VertexPoint( name='N3', VertexGeometry=@9913 );
@9924: VertexPoint( name='N4', VertexGeometry=@9914 );
@9925: VertexPoint( name='N5', VertexGeometry=@9915 );
@9926: VertexPoint( name='N6', VertexGeometry=@9916 );
@9927: VertexPoint( name='N7', VertexGeometry=@9917 );
@9928: VertexPoint( name='N8', VertexGeometry=@9918 );

@9931: EdgeBoundedCurveWithLength( name='S1', EdgeGeometry=@9941 );
    undirected_edge(@9931, @9921, @9923)
@9932: EdgeBoundedCurveWithLength( name='S2', EdgeGeometry=@9942 );
    undirected_edge(@9932, @9922, @9923)
@9933: EdgeBoundedCurveWithLength( name='S3', EdgeGeometry=@9943 );
    undirected_edge(@9933, @9923, @9924);
@9934: EdgeBoundedCurveWithLength( name='S4', EdgeGeometry=@9944 );
    undirected_edge(@9934, @9924, @9925);
@9935: EdgeBoundedCurveWithLength( name='S5', EdgeGeometry=@9945 );
    undirected_edge(@9935, @9924, @9926);
@9936: SubEdge( name='S2.2', ParentEdge=@9932 );
    undirected_edge(@9936, @9927, @9923);
@9937: SubEdge( name='S3.1', ParentEdge=@9933);
    undirected_edge(@9937, @9923, @9928);

@9941: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(2.0) );
    \# for S1
@9942: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(4.0) );
    \# for S2
@9943: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(6.0) );
    \# for S3
@9944: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(8.0) );
    \# for S4
@9945: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(10.0) );
    \# for S5
# vendors to ensure that the edge are oriented in correct way
@9951:Path( name="P1", EdgeList=(@9931,@9933,@9934) ); # S1+S3+S4
@9952:Path( name="P2", EdgeList=(@9932,@9933,@9935) ); # S2+S3+S5
@9953:Path( name="P3", EdgeList=(@9936,@9937) ); # S2.2+S3.1

sizeof(Part) = 6;
sizeof(PartVersion) = 6;
sizeof(PartView) = 5;
sizeof(WiringHarnessAssemblyDesign) = 1;
sizeof(NextAssemblyOccurrenceUsage) = 7;
sizeof(SingleOccurrence) = 4;
sizeof(WireOccurrence) = 1;
sizeof(CableOccurrence) = 1;

sizeof(GeometricCoordinateSpace) = 1;
sizeof(EdgeBasedTopologicalRepresentationWithLengthConstraint) = 1;
sizeof(ConnectedEdgeSet) = 1;
sizeof(BoundedCurveWithLength) = 5;
sizeof(EdgeBoundedCurveWithLength) = 5;
sizeof(VertexPoint) = 8;
sizeof(Point) = 6;
sizeof(CartesianPoint) = 0;
sizeof(PointOnCurve) = 2;
sizeof(SubEdge) = 2;
sizeof(Path) = 3;

);

4.4 **EWH-Topology3**

This test case is an extension of the content in EWH-Topology2 for:

- external references into p21 files:
  - complete p21 files for discrete parts "Connector-A" and "Lug-B"
  - element reference into p21 file for centre-curves and axis-placements
- topology-to-geometry association

This test case is likely to be refined later on as the topic of XML “external element references” is new to the community of STEP implementers, and there are no final recommended practices yet for this area (need common work with CAX-IF and PDM-IF). So even if only a subset of the below gets implemented would already be a success.

**Formal test-case specification:**

Test EWH-Topology3 (

@9:FormatProperty( DataFormat="ISO 10303-242", CharacterCode="ISO 8859-1" );

@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@100:Part( PartTypes[i]=PartCategoryEnum(connector),
          PartTypes[i]=PartCategoryEnum(discrete) );
@101:PartVersion;
@102:PartView( DefiningGeometry=@191 );
Part_with_Name_and_PartView( @100, "Connector-A", @101, @102, @4);
@111:SingleOccurrence( Id=IdentifierString("J1"), Definition=@102 );
@121:SingleOccurrence( Id=IdentifierString("J2"), Definition=@102 );
@190:GeometricCoordinateSpace( DimensionCount=3, Items=(@192) );
@191:ExternalGeometricModel( items=(@192), ContextOfItems=@190,
    ExternalFile=@193 ); # was GeometricModel in EWH-Topology2
@192:AxisPlacement( Position=(0.0, 0.0, 0.0) ); # Axis and RefDirection defaults
    # alternatively use ExternalRepresentationItem to select placement in p21 file
@193:DigitalFile( FileLocations=@194, FileFormat=@9, exists(Id) ); # id=file name

@200:Part( PartTypes[i]=PartCategoryEnum(terminal_lug),
    PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;
@202:PartView( DefiningGeometry=@291 );
Part_with_Name_and_PartView( @200, "Lug-B", @201, @202, @4);
@211:SingleOccurrence( Id=IdentifierString("J3"), Definition=@202 );
@221:SingleOccurrence( Id=IdentifierString("J4"), Definition=@202 );
@290:GeometricCoordinateSpace( DimensionCount=3, Items=(@292) );
@291:ExternalGeometricModel( Items=(@292), ContextOfItems=@290,
    ExternalFile=@293 ); # was GeometricModel in EWH-Topology2
@292:AxisPlacement( Position=(0.0, 0.0, 0.0) ); # Axis and RefDirection defaults
@293:DigitalFile( FileLocations=@294, FileFormat=@9, exists(Id) ); # id=file name

@300:Part( PartTypes[i]=PartCategoryEnum(wire),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@301:PartVersion;
@302:PartView( DefiningGeometry=@391 );
Part_with_Name_and_PartView( @300, "Wire-C", @301, @302, @4);
@311:WireOccurrence( Id=IdentifierString("W1"),
    Definition=@302, Quantity=@312 );
@312:NumericalValue( Unit=@8, ValueComponent=3.5 );
@390:GeometricCoordinateSpace( DimensionCount=2 );
@391:GeometricModel( name='2D cross section',
    items[i]=@392, ContextOfItems=@390 );
@392:AxisPlacement; # placeholder for 2D centre

@400:Part( PartTypes[i]=PartCategoryEnum(cable),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@401:PartVersion;
@402:PartView( DefiningGeometry=@491 );
Part_with_Name_and_PartView( @400, "Cable-D", @401, @402, @4);
@411:CableOccurrence( Id=IdentifierString("W2"), Definition=@402,
    Quantity=@412 );
@412:NumericalValue( Unit=@8, ValueComponent=1.8 );
@490:GeometricCoordinateSpace( DimensionCount=2 );
@491:GeometricModel( name='cross section', items[i]=@492,
    ContextOfItems=@490 );
@492:AxisPlacement;

@500:Part( PartTypes[i]=PartCategoryEnum(protective_covering),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@501:PartVersion;
@502:PartView( DefiningGeometry=591 );
Part_with_Name_and_PartView(500, "Protection-E", 501, 502, 4);
@511:QuantifiedOccurrence( Id=IdentifierString("W3"),
    Definition=402, Quantity=412 );
@512:NumericalValue( Unit=8, ValueComponent=1.2 );
@590:GeometricCoordinateSpace( DimensionCount=2 );
@591:GeometricModel( name='cross section',
    items[i]=592, ContextOfItems=590 );
@592:AxisPlacement;

@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign(
    Topology=9901, DefiningGeometry=9201 );
@9003:ViewContext;
@9004:ViewContext;
Part_WiringHarnessAssemblyDesign_with_topology(9000,
    "EWH Test-Case Topology3",9001,9002,9003,9004);

@9001:NextAssemblyOccurrenceUsage( Relating=9002, Related=111,
    Placement=(1111,19801) ); # connector J1
@9002:NextAssemblyOccurrenceUsage( Relating=9002, Related=121,
    Placement=(1112,19802) ); # connector J2
@9003:NextAssemblyOccurrenceUsage( Relating=9002, Related=211,
    Placement=(1113,19803) ); # terminal lug J3
@9004:NextAssemblyOccurrenceUsage( Relating=9002, Related=221,
    Placement=(1114,19804) ); # terminal lug J4
@9005:NextAssemblyOccurrenceUsage( Relating=9002, Related=311,
    Placement=(1115 ) ); # wire W1
@9006:NextAssemblyOccurrenceUsage( Relating=9002, Related=411,
    Placement=(1116 ) ); # cable W2
@9007:NextAssemblyOccurrenceUsage( Relating=9002, Related=511,
    Placement=(1117 ) ); # protection W3

@9111:GeometryToTopologyModelAssociation( 
    Relating=9901, Related=191, Origin=192, Target=9921); # connector J1
@9112:GeometryToTopologyRepresentationAssociation( 
    Relating=9901, Related=191, Origin=192, Target=9925); # connector J2
@9113:GeometryToTopologyRepresentationAssociation( 
    Relating=9901, Related=291, Origin=292, Target=9922); # terminal lug J3
@9114:GeometryToTopologyRepresentationAssociation( 
    Relating=9901, Related=291, Origin=292, Target=9926); # terminal lug J4
@9115:GeometryToTopologyRepresentationAssociation( 
    Relating=9901, Related=391, Origin=392, Target=9926); # wire W1
@9116:GeometryToTopologyRepresentationAssociation( 
    Relating=9901, Related=491, Origin=492, Target=9951); # cable W2
@9117:GeometryToTopologyRepresentationAssociation(
    Relating=@9901, Related=@591, Origin=@493, Target=@9953); # protection W3

@9200:GeometricCoordinateSpace( Units=@8, DimensionCount=3 );
@9201:ComposedGeometricModel( ContextOfItems=@9200;
    Items=(@9211,@9212,@9213,@9214) );
    # contains the connectors and multi-branchable
@9211=AxisPlacement; # alternative ExternalRepresentationItem from p21 files
@9212=AxisPlacement;
@9213=AxisPlacement;
@9214=AxisPlacement;
@9801:GeometricRepresentationRelationshipWithPlacementTransformation(
    origin=@192, target=@9211,
    relating=@9201, related=@191, Definitional=TRUE ); # connector J1
@9802:GeometricRepresentationRelationshipWithPlacementTransformation(
    origin=@192, target=@9212,
    relating=@9201, related=@191, Definitional=TRUE ); # connector J2
@9803:GeometricRepresentationRelationshipWithPlacementTransformation(
    origin=@292, target=@9213,
    relating=@9201, related=@292, Definitional=TRUE ); # terminal lug J3
@9804:GeometricRepresentationRelationshipWithPlacementTransformation(
    origin=@292, target=@9214,
    relating=@9201, related=@292, Definitional=TRUE ); # terminal lug J4
@9808:GeometricRepresentationRelationshipWithSameCoordinateSpace(
    relating=@9201, related=@9211, Definitional=TRUE ); # for stuff in the
    multi-branchable

@9210:DigitalFile( FileFormat=@9, FileFormat=@9, exist(Id) ); # Id=name of
    p21 file
@9211:ExternalGeometricModel( items=(@9212,@9213,@9214,@9215),
    ContextOfItems=@9200, ExternalFile=@9210 ); # multi-branchable
@9220:AxisPlacement;
@9221:ExternalRepresentationItem( External=@9231 );
@9222:ExternalRepresentationItem( External=@9232 );
@9223:ExternalRepresentationItem( External=@9233 );
@9224:ExternalRepresentationItem( External=@9234 );
@9225:ExternalRepresentationItem( External=@9235 );
@9226:ExternalRepresentationItem( External=@9236 );
@9227:ExternalRepresentationItem( External=@9237 );

# for the following instance the ID attribute must be set
# corresponding to an anchor or instance-id in the target p21 file
@9231:ExternalEntityInstance( exist(Id), Source=@9210 );
@9232:ExternalEntityInstance( exist(Id), Source=@9210 );
@9233:ExternalEntityInstance( exist(Id), Source=@9210 );
@9224:ExternalEntityInstance( exist(Id), Source=@9210 );
@9225:ExternalEntityInstance( exist(Id), Source=@9210 );
@9226:ExternalEntityInstance( exist(Id), Source=@9210 ); # curve for S2.2
@9227:ExternalEntityInstance( exist(Id), Source=@9210 ); # curve for S3.1

# Alternative for @9226 and @9227
# use PointOnCurve with PARAMETER given in p21 file and
# construct a new curve in XML to associat to
@9299: TopologyToGeometryModelAssociation( Relating=@9201, Related=@9901,
# order of pairs: connector J1, ... J2, terminal lug J3, ... J4, edges S1..S5, S2.2, S3.1
# maybe instead of paths we have to map single EdgeBoundedCurveWithLength
    Origin=(@9921, @9925, @9922, @9926, @9931, @9932, @9933, @9934, @9935, @9936, @9937),
    Target=(@9211, @9212, @9213, @9214, @9221, @9222, @9223, @9224, @9225, @9226, @9227));

@9900: GeometricCoordinateSpace( Units=@8, DimensionCount=1 );
@9901: EdgeBasedTopologicalRepresentationWithLengthConstraint(  
    Items=(@9902, @9951, @9952, @9953), # the ConnectedEdgeSet + paths
    ContextOfItems=@9900 );
@9902: ConnectedEdgeSet( ConnectedEdges=(@9931, @9932, @9933, @9934, @9935) );
# only main edges, not sub-edges

@9911: Point();  
@9912: Point();  
@9913: Point();  
@9914: Point();  
@9915: Point();  
@9916: Point();  
@9917: PointOnCurve( BasicCurve=@9942, Parameter=2.0 );  
# in the middle of the basic curve
@9918: PointOnCurve( BasicCurve=@9943, Parameter=3.0 );  
# in the middle of the basic curve

@9921: VertexPoint( name='N1', VertexGeometry=@9911 );
@9922: VertexPoint( name='N2', VertexGeometry=@9912 );
@9923: VertexPoint( name='N3', VertexGeometry=@9913 );
@9924: VertexPoint( name='N4', VertexGeometry=@9914 );
@9925: VertexPoint( name='N5', VertexGeometry=@9915 );
@9926: VertexPoint( name='N6', VertexGeometry=@9916 );
@9927: VertexPoint( name='N7', VertexGeometry=@9917 );
@9928: VertexPoint( name='N8', VertexGeometry=@9918 );

@9931: EdgeBoundedCurveWithLength( name='S1', EdgeGeometry=@9941 );
    undirected_edge(@9931, @9921, @9923)
@9932: EdgeBoundedCurveWithLength( name='S2', EdgeGeometry=@9942 );
    undirected_edge(@9932, @9922, @9923)
@9933: EdgeBoundedCurveWithLength( name='S3', EdgeGeometry=@9943 );
    undirected_edge(@9933, @9923, @9924);
@9934: EdgeBoundedCurveWithLength( name='S4', EdgeGeometry=@9944 );
    undirected_edge(@9934, @9924, @9925);
@9935: EdgeBoundedCurveWithLength( name='S5', EdgeGeometry=@9945 );
    undirected_edge(@9935, @9924, @9926);
@9936: SubEdge( name='S2.2', ParentEdge=@9932 );
    undirected_edge(@9936, @9927, @9923);
@9937: SubEdge( name='S3.1', ParentEdge=@9933);
    undirected_edge(@9937, @9923, @9928);

@9941: BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(2.0) );
4.5 EWH-Connectivity1

This test case consists of a WiringHarnessAssemblyDesign that is composed of

- a terminal lug “LUG01” that is defined by Part “640903-1” with a single terminal “1”
- a connector “PLUG01” that is defined by Part “RCA123” with terminals “0” and “1”
- a connector “P-CONN01” that is defined by Part “IMC16-2002X” with terminals “1” and “2”
- a cable “CABLE01” that is defined by Part “9962 009100” with two wires, one black and the other white
- a wire “WIRE01” that is defined by Part “83027 001100”
- the two connectors are joint to the two ends of the cable.
- the single wire connects LUG01 with terminal “1” of “PLUG01”

![Diagram of Wiring Harness Assembly Design](image)
@4:ViewContext;
@5:ViewContext;
@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@50:Organization( name="MIL ...??")
@51:Organization( name="Deutch Company Ltd ...")
@52:Organization( name="BELDEN company ...")
@60:Identifier( Id=IdentifierString("Standard RCA connector") )

@70:WireColourBasedIdentificationCode( Id="white" );
@71:WireColourBasedIdentificationCode( Id="black" );

# Terminal Lug
@100:Part( PartTypes[i]=PartCategoryEnum(terminal_lug), PartTypes[i]=PartCategoryEnum(discrete) );
@101:PartVersion;
@102:PartView;
@103:Identifier( Id=IdentifierString("640903-1"), IdentificationContext=@50 )
Part_with_ID_and_PartView(@100, @103, @101, @102, @4);
@104:PartTerminal( ElementOf=@102, Id="1", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@111:SingleOccurrence( Id=IdentifierString("LUG01"), Definition=@102 );
@112:OccurrenceTerminal( ElementOf=@111, Definition=@104 );

# Connector with integrated contacts
@200:Part( PartTypes[i]=PartCategoryEnum(connector), PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;
@202:PartView;
@203:Identifier( Id=IdentifierString("RCA123"), IdentificationContext=@60 )
Part_with_ID_and_PartView(@200, @203, @201, @202, @4);
@204:PartTerminal( ElementOf=@202, Id="0", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@205:PartTerminal( ElementOf=@202, Id="1", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@211:SingleOccurrence( Id=IdentifierString("PLUG01"), Definition=@202 );
@214:OccurrenceTerminal( ElementOf=@211, Definition=@204 );
@215:OccurrenceTerminal( ElementOf=@211, Definition=@205 );

# Simplified model for Deutch connector with direct PartTerminals
@300:Part( PartTypes[i]=PartCategoryEnum(connector), PartTypes[i]=PartCategoryEnum(discrete) );
@301:PartVersion;
@302:PartView;
@303:Identifier( Id=IdentifierString("IMC16-2002X"), IdentificationContext=@51 )
Part_with_ID_and_PartView(@300, @303, @301, @302, @4);
@306:PartTerminal( ElementOf=@302, Id="1", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@307:PartTerminal( ElementOf=@302, Id="2", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@311:SingleOccurrence( Id=IdentifierString("P-CONN01"), Definition=@302 );
# Cable
@500:Part( PartTypes[i]=PartCategoryEnum(cable), PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@501:PartVersion;
@502:PartView;
@503:Identifier( Id=IdentifierString("9962 009100"), IdentificationContext=@52 )
Part_with_ID_and_PartView(@500, @503, @501, @502, @4);
@504:WirePartIdentification( ElementOf=@502, Id="CABLE01-WHT", code=@70 );
@505:WirePartIdentification( ElementOf=@502, Id="CABLE01-BLK", code=@71 );
@511:CableOccurrence( Id=IdentifierString("CABLE01"), Definition=@502, Quantity=@512 );
  @512:NumericalValue( Unit=@8, ValueComponent=1.8 );
  @513:WireOccurrenceIdentification( ElementOf=@511, Id="CABLE01-WHT", Definition=@504 );
  @514:WireOccurrenceIdentification( ElementOf=@511, Id="CABLE01-BLK", Definition=@505 );
  @515:CableOccurrenceTerminalLocationGroup( ElementOf=@511, Name="end a" );
  @521:CableOccurrenceTerminal( ElementOf=@515, AssociatedTransportFeature=@513 );
  @523:CableOccurrenceTerminal( ElementOf=@515, AssociatedTransportFeature=@514 );
  @516:CableOccurrenceTerminalLocationGroup( ElementOf=@511, Name="end b" );
  @522:CableOccurrenceTerminal( ElementOf=@516, AssociatedTransportFeature=@513 );
  @524:CableOccurrenceTerminal( ElementOf=@516, AssociatedTransportFeature=@514 );

# Wire
@600:Part( PartTypes[i]=PartCategoryEnum(wire), PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@601:PartVersion;
@602:PartView;
@603:Identifier( Id=IdentifierString("83027 001100"), IdentificationContext=@52 )
Part_with_ID_and_PartView(@600, @603, @601, @602, @4);
@611:WireOccurrence( Id=IdentifierString("WIRE01"), Definition=@602, Quantity=@612 );
  @612:NumericalValue( Unit=@8, ValueComponent=3.5 );
  @613=WireOccurrenceIdentification( ElementOf=@611, DomainType="electrical" ... )
  @614=WireOccurrenceTerminal( ElementOf=@611, AssociatedTransportFeature=@613,
    Name="end a" );
  @615=WireOccurrenceTerminal( ElementOf=@611, AssociatedTransportFeature=@613,
    Name="end b" );

# EWH-Assembly
@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign;
@9003:ViewContext;
Part_WiringHarnessAssemblyDesign( @9000,
"EWH Test-Case Connectivity1",@9001,@9002,@9003 );

@9101:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@111 );
@9102:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@211 );
@9103:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@311 );
@9106:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@511 );
@9107:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@611 );

# connections
@9210:AssemblyShapeJoint( ElementOf=@9002,
JointType="crimped_connection" );
@9211:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@214 );
# PLUG01 / 0
@9212:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@521 );
# CABLE01-WHT / end a
@9220:AssemblyShapeJoint( ElementOf=@9002,
JointType="crimped_connection" );
@9221:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@316 );
# P-CONN01 / 01
@9222:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@522 );
# CABLE01-WHT / end b
@9230:AssemblyShapeJoint( ElementOf=@9002,
JointType="crimped_connection" );
@9231:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@215 );
# PLUG01 / 1
@9232:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@523 );
# CABLE01-BLK / end a
@9232:AssemblyShapeJoint( ElementOf=@9002,
JointType="crimped_connection" );
@9240:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@317 );
# P-CONN01 / 02
@9241:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@524 );
# CABLE01-BLK / end a
@9250:AssemblyShapeJoint( ElementOf=@9002,
JointType="crimped_connection" );
@9251:AssemblyShapeJointItemRelationship( Relating=@9250, Related=@112 );
# LUG01 / 1
@9252:AssemblyShapeJointItemRelationship( Relating=@9250, Related=@615 );
# WIRE01 / end b

sizeof(Part) = 6;
sizeof(PartVersion) = 6;
sizeof(PartView) = 5;
sizeof(WiringHarnessAssemblyDesign) = 1;
sizeof(NextAssemblyOccurrenceUsage) = 5;
sizeof(SingleOccurrence) = 3;
sizeof(WireOccurrence) = 1;
sizeof(CableOccurrence) = 1;
sizeof(PartTerminal) = 5; # only the join terminals
sizeof(OccurrenceTerminal) = 5; # only the join terminals
sizeof(WireColourBasedIdentificationCode) = 2;
sizeof(WireOccurrenceTerminal) = 2;
sizeof(CableOccurrenceTerminalLocationGroup) = 2;
sizeof(CableOccurrenceTerminal) = 4;
sizeof(AssemblyShapeJoint) = 5;
sizeof(AssemblyShapeJointItemRelationship) = 11;

};

4.6 **EWH-Connectivity2**

This test case is very similar to the test case EWH-Connectivity1. The difference is that the connector “P-CONN01” is now modeled more realistically. There is no direct terminal but instead there are the two cavities “1” and “2” for two separate connector contacts:

- a terminal lug “LUG01” that is defined by Part “640903-1” with a single terminal “1”
- a connector “PLUG01” that is defined by Part “RCA123” with terminals “0” and “1”
- a connector “P-CONN01” that is defined by Part “IMC16-2002X” with cavities “1” and “2”
- two connector contacts "P-CONN01-01" and "P-CONN01-02" that are defined by Part "6860-201-20278" that fits into the cavities of a connector of type "IMC16-2002X". Each of the connector contacts has a single join terminal.
- a cable “CABLE01” that is defined by Part “9962 009100” with two wires, one black and the other white
- a wire “WIRE01” that is defined by Part “83027 001100”
- connector “PLUG01” is joint to one ends of the cable, and the two connector contacts are joint to the other end. The connector contacts are then inserted into connector “PLUG01”
- the single wire connects LUG01 with terminal “1” of “PLUG01”

**Initial input data from users to this test:**
Adaptions on the original input data to be used by AP242-EWH:

- the cavities of the connector “IMC16-2002X” are not numbered, but they are in the Deutsch documentation indicated with “1” and “2”. It is essential to not mix them up;
- no terminals are defined for the connector contact “6860-201-20278”, but of course there is an implicit join-terminal (for crimping) and an interface-terminal for the external connection (the later one is not covered here);
- there is no explicit information which connector contact P-CONN01-01/-02 goes into the cavities 1/2 of the connector. This can only be derived from the naming. For

### Table 1: Original part list for connectivity test

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Occurrence (REFDES)</th>
<th>Terminals</th>
<th>Description</th>
<th>Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>640903-1</td>
<td>LUG01</td>
<td>1</td>
<td>MIL standard Receptacle (similar to Lug)</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>RCA123</td>
<td>PLUG01</td>
<td>0</td>
<td>Standard RCA plug (Or Cinch) <a href="https://en.wikipedia.org/wiki/RCA_connector">https://en.wikipedia.org/wiki/RCA_connector</a></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>IMC16-2002X</td>
<td>P-CONN01</td>
<td></td>
<td>Deutch waterproof connector with two cavities</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>6860-201-20278</td>
<td>P-CONN01-01</td>
<td></td>
<td>Deutch Plug Contact</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>9962 009100</td>
<td>BELDEN Cable</td>
<td></td>
<td><img src="image5.png" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td>83027 001100</td>
<td>BELDEN Wire</td>
<td></td>
<td><img src="image6.png" alt="Image" /></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Original wire list for connectivity test

<table>
<thead>
<tr>
<th>From</th>
<th>From Pin</th>
<th>Wire Name</th>
<th>Material</th>
<th>To</th>
<th>To Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLUG01</td>
<td>0</td>
<td>CABLE01-WHT</td>
<td>9962 009100</td>
<td>P-CONN01</td>
<td>P-CONN01-01</td>
</tr>
<tr>
<td>PLUG01</td>
<td>1</td>
<td>CABLE01-BLK</td>
<td>9962 009100</td>
<td>P-CONN01</td>
<td>P-CONN01-02</td>
</tr>
<tr>
<td>PLUG01</td>
<td>1</td>
<td>WIRE01</td>
<td>83027 001100</td>
<td>LUG01</td>
<td></td>
</tr>
</tbody>
</table>
AP242-EWH it is essential to state which connector-contact is inserted into which cavity of the connector (by AssemblyShapeJoint);

- the wire list indicates two connections onto the PLUG01/1 pin. For AP242-EWH this is handled by a triple AssemblyShapeJoint of PLUG01/1 with the cable and single wire terminals.

For the AssemblyShapeJoints the following JointTypes are to be used:

- JointType="soldered_connection" for the electrical joints on PLUG01 and LUG01;
- JointType="crimped_connection" for the electrical connections of P-CONN01-01/-02 with the cable;
- JointType="snap_connection" for the mechanical connection of P-CONN01-01/-02 with P-CONN01.

**Formal test-case specification:**

Test EWH-Connectivity2 (

@4:ViewContext;
@5:ViewContext;
@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@50:Organization( name="MIL ...??")
@51:Organization( name="Deutch Company Ltd ...")
@52:Organization( name="BELDEN company ...")
@60:Identifier( Id=IdentifierString("Standard RCA connector") )

@70:WireColourBasedIdentificationCode( Id="white" );
@71:WireColourBasedIdentificationCode( Id="black" );

# Terminal Lug
@100:Part( PartTypes[i]=PartCategoryEnum(terminal_lug),
    PartTypes[i]=PartCategoryEnum(discrete) );
@101:PartVersion;
@102:PartView;
@103:Identifier( Id=IdentifierString("640903-1"),
    IdentificationContext=@50 )
Part_with_ID_and_PartView(@100, @103, @101, @102, @4);
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Test Suite v5.0

@104:PartTerminal( ElementOf=@102, Id="1", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal" );
@111:SingleOccurrence( Id=IdentifierString("LUG01"), Definition=@102 );
@112:OccurrenceTerminal( ElementOf=@111, Definition=@104 );

# Connector with integrated contacts
@200:Part( PartTypes[i]=PartCategoryEnum(connector),
    PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;
@202:PartView;
@203:Identifier( Id=IdentifierString("RCA123"),
    IdentificationContext=@60 )
Part_with_ID_and_PartView( @200, "", @201, @202, @4);
@204:PartTerminal( ElementOf=@202, Id="0", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal" ); # or left, right m GND ?
@205:PartTerminal( ElementOf=@202, Id="1", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal" );
@211:SingleOccurrence( Id=IdentifierString("PLUG01"), Definition=@202 );
@214:OccurrenceTerminal( ElementOf=@211, Definition=@204 );
@215:OccurrenceTerminal( ElementOf=@211, Definition=@205 );

# Realistic model for Deutsch connector with cavities
@300:Part( PartTypes[i]=PartCategoryEnum(connector),
    PartTypes[i]=PartCategoryEnum(discrete) );
@301:PartVersion;
@302:PartView;
@303:Identifier( Id=IdentifierString("IMC16-2002X"),
    IdentificationContext=@51 )
Part_with_ID_and_PartView( @300, @303, @301, @302, @4);
@306:PartContactFeature( ElementOf=@302, Id="1", PartDefinition=@1001 );
@307:PartContactFeature( ElementOf=@302, Id="2", PartDefinition=@1001 );
@311:SingleOccurrence( Id=IdentifierString("P-CONN01"), Definition=@302 );
    #316:OccurrenceContactFeature( ElementOf=@311, Definition=@306 );
    #317:OccurrenceContactFeature( ElementOf=@311, Definition=@307 );

# Contact for Deutsch connector
@400:Part( PartTypes[i]=PartCategoryEnum(connector_contact),
    PartTypes[i]=PartCategoryEnum(discrete) );
@401:PartVersion;
@402:PartView;
@403:Identifier( Id=IdentifierString("6860-201-20278"),
    IdentificationContext=@51 )
Part_with_ID_and_PartView( @400, @403, @401, @402, @4);
@406:PartTerminal( ElementOf=@402, Id="j", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal" );
@407:PartContactFeature( ElementOf=@402, Id="o", PartDefinition=@1002 );
@411:SingleOccurrence( Id=IdentifierString("P-CONN01-01"),
    Definition=@402 );
    @412:OccurrenceTerminal( ElementOf=@411, Definition=@406 );
    @413:OccurrenceContactFeature( ElementOf=@411, Definition=@407 );
@421:SingleOccurrence( Id=IdentifierString("P-CONN01-02"),
    Definition=@402 );
    @422:OccurrenceTerminal( ElementOf=@421, Definition=@406 );
@423:OccurrenceContactFeature( ElementOf=@421, Definition=@407 );

# Cable
@500:Part( PartTypes[i]=PartCategoryEnum(cable),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@501:PartVersion;
@502:PartView;
@503:Identifier( Id=IdentifierString("9962 009100"),
    IdentificationContext=@52 )
Part_with_Name_and_PartView(@500, "Cable-D", @501, @502, @4);
@504:WirePartIdentification( ElementOf=@503, Id="CABLE01-WHT", code=@70 );
@505:WirePartIdentification( ElementOf=@503, Id="CABLE01-BLK", code=@71 );
@511:CableOccurrence( Id=IdentifierString("CABLE01"), Definition=@502,
    Quantity=@512 );
    @512:NumericalValue( Unit=@8, ValueComponent=1.8 );
    @513:WireOccurrenceIdentification( ElementOf=@511, Id="CABLE01-WHT", Def-
        inition=@504 );
    @514:WireOccurrenceIdentification( ElementOf=@511, Id="CABLE01-BLK", Def-
        inition=@505 );
    @515:CableOccurrenceTerminalLocationGroup( ElementOf=@511, Name="end
        a" );
    @521:CableOccurrenceTerminal( ElementOf=@515, AssociatedTransportFea-
        ture=@513 );
    @523:CableOccurrenceTerminal( ElementOf=@515, AssociatedTransportFea-
        ture=@514 );
    @516:CableOccurrenceTerminalLocationGroup( ElementOf=@511, Name="end
        b" );
    @522:CableOccurrenceTerminal( ElementOf=@516, AssociatedTransportFea-
        ture=@513 );
    @524:CableOccurrenceTerminal( ElementOf=@516, AssociatedTransportFea-
        ture=@514 );

# Wire
@600:Part( PartTypes[i]=PartCategoryEnum(wire),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@601:PartVersion;
@602:PartView;
@603:Identifier( Id=IdentifierString("83027 001100"),
    IdentificationContext=@52 )
Part_with_Name_and_PartView(@600, "Wire-C", @601, @602, @4);
@611:WireOccurrence( Id=IdentifierString("WIRE01"), Definition=@602,
    Quantity=@612 );
    @612:NumericalValue( Unit=@8, ValueComponent=3.5 );
    @613=WireOccurrenceIdentification( ElementOf=@611,
        DomainType="electrical" ... )
    @614=WireOccurrenceTerminal( ElementOf=@611,
        AssociatedTransportFeature=@613, Name="end a" );
    @615=WireOccurrenceTerminal( ElementOf=@611,
        AssociatedTransportFeature=@613, Name="end b" );

# Deutsch IMC Series cavity & contact shapes
@1000:ContactFeatureDefinitionFitRelationship( Name="Deutsch IMC Series
    Size 20 fit",
    Relating=@1001, Related=@1002 );
@1001:ContactFeatureDefinition( Name="Deutsch IMC Series Size 20 cavity",
ShapeFeatureType=cavity_profile );
@1002:ContactFeatureDefinition( Name="Deutsch IMC Series Size 20 pin",
  ShapeFeatureType=contact_profile );

# EWH-Assembly
@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign;
@9003:ViewContext;
Part_WiringHarnessAssemblyDesign( @9000,"EWH Test-Case Connectivity2",
  @9001,@9002,@9003 );

@9101:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@111 );
@9102:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@211 );
@9103:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@311 );
@9104:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@411 ); # "P-CONN01-01"
@9105:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@421 ); # "P-CONN01-02"
@9106:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@511 );
@9107:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@611 );

# electrical connections
@9210:AssemblyShapeJoint( ElementOf=@9002,
  JointType="soldered_connection" );
  @9211:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@214 );
  # PLUG01 / 0
  @9212:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@521 );
  # CABLE01-WHT / end a
@9220:AssemblyShapeJoint( ElementOf=@9002,
  JointType="crimped_connection" );
  @9221:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@412 );
  # P-CONN01-01 / j
  @9222:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@522 );
  # CABLE01-WHT / end b
@9230:AssemblyShapeJoint( ElementOf=@9002,
  JointType="soldered_connection" );
  @9231:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@215 );
  # PLUG01 / 1
  @9232:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@523 );
  # CABLE01-BLK / end a
  @9232:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@614 );
  # WIRE01 / end a
@9240:AssemblyShapeJoint( ElementOf=@9002,
  JointType="crimped_connection" );
  @9241:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@422 );
  # P-CONN01-02 / j
  @9242:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@524 );
  # CABLE01-BLK / end b
@9250:AssemblyShapeJoint( ElementOf=@9002,
  JointType="crimped_connection" );
  @9251:AssemblyShapeJointItemRelationship( Relating=@9250, Related=@112 );
  # LUG01 / 1
  @9252:AssemblyShapeJointItemRelationship( Relating=@9250, Related=@615 );
  # WIRE01 / end b
# mechanical connections
@9260:AssemblyShapeJoint( ElementOf=@9002, JointType="snap_connection" );
  @9261:AssemblyShapeJointItemRelationship( Relating=@9260, Related=@316 );
  # P-CONN01 / 1
  @9262:AssemblyShapeJointItemRelationship( Relating=@9260, Related=@317 );
  # P-CONN01-01 / o
@9270:AssemblyShapeJoint( ElementOf=@9002, JointType="snap_connection" );
  @9271:AssemblyShapeJointItemRelationship( Relating=@9270, Related=@112 );
  # P-CONN01 / 2
  @9272:AssemblyShapeJointItemRelationship( Relating=@9270, Related=@423 );
  # P-CONN01-02 / o

sizeof(Part) = 7;
ssizeof(PartVersion) = 7;
ssizeof(PartView) = 6;
ssizeof(WiringHarnessAssemblyDesign) = 1;
ssizeof(NextAssemblyOccurrenceUsage) = 7;
ssizeof(SingleOccurrence) = 5;
ssizeof(WireOccurrence) = 1;
ssizeof(CableOccurrence) = 1;

sizeof(PartTerminal) >= 4; # there might be interface terminals
sizeof(OccurrenceTerminal) >= 4; # there might be interface terminals
sizeof(PartContactFeature) = 3;
ssizeof(OccurrenceContactFeature) = 4;
ssizeof(WireColourBasedIdentificationCode) = 2;
ssizeof(WireOccurrenceTerminal) = 2;
ssizeof(CableOccurrenceTerminalLocationGroup) = 2;
ssizeof(CableOccurrenceTerminal) = 4;
ssizeof(AssemblyShapeJoint) = 7;
ssizeof(AssemblyShapeJointItemRelationship) = 15;

);
4.7 **EWH-Connectivity3**

This test case consists of a “simple” coaxial cable with two coaxial connectors at the ends. The design is an extract from a bigger commercial product. The used parts are:

- coaxial connector **TC-400-SM-X** from Times Microwave Systems
  [https://www.timesmicrowave.com/Products/Connectors/TC-400-SM-X/](https://www.timesmicrowave.com/Products/Connectors/TC-400-SM-X/)
- coaxial cable **PFLX400-500** from Rockwell Collins

![Table](image)

**Figure 7: EWH-Connectivity3 - Wire-list**

Figure 7 list the inner core and the shield. The mapping of the columns to AP242 is:

- 1, 6: the from and to reference designators are composed by the SingleOccurrence-Id and the Part/OccurrenceTerminal-Id.
- 2, 7: the terminal hardware to which the connection is established. Below these Parts are identified as TC-400-SM-X_contact_pin and TC-400-SM-X_ferrule to have a consistent naming.
- 3: CableOccurrence-Id
- 4, 8: The From and To End Preparation. AP242ed2 does not provide explicit details for wire/cable end preparation, but support the kind of AssemblyShapeJoints to be used
  - ST – Strip and Tin, specified by JointType soldered_connection
  - SC – Strip and Crimp, specified by JointType crimped_connection
- 5: the WireIdentification-Id within the cable
- 9: the cable Part-Id
- 10: the length of the CableOccurrence in inch

![Diagram](image)

**Figure 8: EWH-Connectivity3 - Wiring diagram**
4.7.1 Coaxial Connector Model

Some systems might represent the coaxial connector as a simple piece part with two join terminals (core and shield). The focus of this test case is however to represent the coaxial connector as a (sub) AssemblyDefinition (@102), consisting of five pieces (named CONTACT PIN, INSULATOR, BODY, FERRULE and SHELL):

- The CONTACT PIN has a joint and an interface terminal that are internally connected by a PartConnectivityDefinition
- The BODY has a joint and an interface terminal that are internally connected by a PartConnectivityDefinition
- SingleOccurrences of all five parts (CONTACT PIN, INSULATOR, BODY, FERRULE and SHELL) are assembled with NextAssemblyOccurrenceUsages.
- The AssemblyDefinition (@102) has two join terminals that are reflected back to the OccurrenceTerminals of the SingleOccurrences for the CONTACT PIN and BODY.

The example chosen for this test case is the TC-400-SM-X BNC connector (@100). It is of a male type and suitable to be used for an LMR-400 coax cable (@600). The connector consists of five piece parts named and categorized as:

- body / connector_housing: @200,
- contact pin / connector_contact: @300,
- insulator / <no predefined part category available> : @400,
- shell / backshell: @500,
- ferrule / cable_ferrule: @600.

Because the connector is delivered as a kit, there are no individual part numbers supplied for the piece parts; so we have to make up part numbers for this test case.

The electrical AssemblyShapeJoints of the coaxial connector to an end of a coaxial cable is realized by the JointType soldered_connection for the coaxial core and by the JointType crimped_connection for the crimped_connection.
Figure 9: Datasheet of Coax Connector TC-400-SM-X
General references:

- TC-400-SM-X
  - [https://www.timesmicrowave.com/Products/Connectors/TC-400-SM-X](https://www.timesmicrowave.com/Products/Connectors/TC-400-SM-X) with 3D STEP files as single piece part
  - [https://eu.mouser.com/ProductDetail/Amphenol-Times-Microwave-Systems/TC-400-SM-X?qs=OTrKUuiFdkYP4uoBuXBVRA=](https://eu.mouser.com/ProductDetail/Amphenol-Times-Microwave-Systems/TC-400-SM-X?qs=OTrKUuiFdkYP4uoBuXBVRA=)

- PFLX400-500RF coaxial cable

Formal test-case specification:

```xml
Test EWH-Connectivity3

@4:ViewContext;
@5:ViewContext;
@8:Unit( Name=ClassString("inch"), Quantity=ClassString("length") );

@50:Organization( name="Times Microwaves System" )
@52:Organization( name="Rockwell Collins" )

@70:WireColourBasedIdentificationCode( Id="core" );
@71:WireColourBasedIdentificationCode( Id="shield" );
```
# Connector TC-400-SM-X

@100:Part( Name="RF Connectors",
    Description="Coaxial Connectors SMA-Male (plug) crimp connector; no braid trim"
    PartTypes[i]=PartCategoryEnum(shielded_connector),
    PartTypes[i]=PartCategoryEnum(connector_kit),
    PartTypes[i]=PartCategoryEnum(connector),
    PartTypes[i]=PartCategoryEnum(discrete) );

@101:PartVersion;

# Mandatory assembly view needed to represent the structure of the coaxial connector
@102:AssemblyDefinition;
@103:Identifier( Id=IdentifierString("TC-400-SM-X"),
    IdentificationContext=@50 )
Part_with_ID_and_PartView(@100, @103, @101, @102, @4);

# interface aspects of assembly
@104:PartTerminal( ElementOf=@102, Id="1", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal", PartDefinition=@312 );
@105:PartTerminal( ElementOf=@102, Id="C/S", DomainType="electrical",
    InterfaceOrJoinTerminal="join_terminal", PartDefinition=@212 );

# occurrence level
@111:SingleOccurrence( Id=IdentifierString("connector 1"),
    Definition=@102 ); # connector 1
    @112:OccurrenceTerminal( ElementOf=@111, Definition=@104 );
    @113:OccurrenceTerminal( ElementOf=@111, Definition=@105 );
@121:SingleOccurrence( Id=IdentifierString("connector 2"),
    Definition=@102 ); # connector 2
    @122:OccurrenceTerminal( ElementOf=@111, Definition=@104 );
    @123:OccurrenceTerminal( ElementOf=@111, Definition=@105 );

# internal sub-assembly aspects of assembly
@162:NextAssemblyOccurrenceUsage( Relating=@102, Related=@211 ); # body / connector_housing
@163:NextAssemblyOccurrenceUsage( Relating=@102, Related=@311 ); # pin / connector_contact
@164:NextAssemblyOccurrenceUsage( Relating=@102, Related=@411 ); # insulator
@165:NextAssemblyOccurrenceUsage( Relating=@102, Related=@511 ); # shell / backshell
@166:NextAssemblyOccurrenceUsage( Relating=@102, Related=@611 ); # ferrule / cable_ferrule

# Connector housing
@200:Part(
    PartTypes[i]=PartCategoryEnum(connector_housing),
    PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;
@202:PartView;
@203:Identifier( Id=IdentifierString("TC-400-SM-X_body"), IdentificationContext=@50 )
Part_with_ID_and_PartView(@200, @203, @201, @202, @4);
@204:PartTerminal( ElementOf=@202, Id="C/S", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
# @205 and @206 are optional. They are not needed for this test case
@205:PartTerminal( ElementOf=@202, Id="it", DomainType="electrical",
   InterfaceOrJoinTerminal="interface_terminal" );
@206:PartConnectivityDefinition( ConnectedTerminals=(@204, @205) );
#
@211:SingleOccurrence( Id=IdentifierString("housing"), Definition=@202 );
   @212:OccurrenceTerminal( ElementOf=@211, Definition=@204 );

# Connector contact-pin
@300:Part(
   PartTypes[i]=PartCategoryEnum(connector_contact),
   PartTypes[i]=PartCategoryEnum(discrete) );
@301:PartVersion;
@302:PartView;
@303:Identifier( Id=IdentifierString("TC-400-SM-X_contact_pin"), IdentificationContext=850 )
Part_with_ID_and_PartView(@300, @303, @301, @302, @4);
@304:PartTerminal( ElementOf=@302, DomainType="electrical",
   InterfaceOrJoinTerminal="join_terminal" );
# @305 and @306 are optional. They are not needed for this test case
@305:PartTerminal( ElementOf=@302, DomainType="electrical",
   InterfaceOrJoinTerminal="interface_terminal" );
@306:PartConnectivityDefinition( ConnectedTerminals=(@304, @305) );
#
@311:SingleOccurrence( Id=IdentifierString("???"), Definition=@302 );
   @312:OccurrenceTerminal( ElementOf=@311, Definition=@304 );

# Connector insulator
@400:Part(
   PartTypes[i]=PartCategoryEnum(discrete) );
@401:PartVersion;
@402:PartView;
@403:Identifier( Id=IdentifierString("TC-400-SM-X_insulator"), IdentificationContext=850 )
Part_with_ID_and_PartView(@400, @403, @401, @402, @4);
@411:SingleOccurrence( Id=IdentifierString("???"), Definition=@402 );

# Connector shell
@500:Part(
   PartTypes[i]=PartCategoryEnum(backshell),
   PartTypes[i]=PartCategoryEnum(discrete) );
@501:PartVersion;
@502:PartView;
@503:Identifier( Id=IdentifierString("TC-400-SM-X_shell"), IdentificationContext=850 )
Part_with_ID_and_PartView(@500, @503, @501, @502, @4);
@511:SingleOccurrence( Id=IdentifierString("???"), Definition=@502 );

# Connector ferrule
@600:Part(
   PartTypes[i]=PartCategoryEnum(cable_ferrule),
   PartTypes[i]=PartCategoryEnum(discrete) );
@601:PartVersion;
@602:PartView;
@603:Identifier( Id=IdentifierString("TC-400-SM-X_ferrule"), IdentificationContext=Ø50 )
Part_with_ID_and_PartView(@600, @603, @601, @602, @4);
@611:SingleOccurrence( Id=IdentifierString("???"), Definition=Ø602 );

# Cable
@700:Part(  
    PartTypes[i]=PartCategoryEnum(cable),  
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@701:PartVersion;
@702:PartView;
@703:Identifier( Id=IdentifierString("PFLX400-500"), IdentificationContext=Ø52 )
Part_with_ID_and_PartView(@700, @703, @701, @702, @4);
@704:WirePartIdentification( ElementOf=Ø503, Id="core", code=Ø70 );
@705:WirePartIdentification( ElementOf=Ø503, Id="shield", code=Ø71 );
@711:CableOccurrence( Id=IdentifierString("088-1CX1"), Definition=Ø702, Quantity=Ø712 );
    @712:NumericalValue( Unit=Ø8, ValueComponent=279.79 );
    @713:WireOccurrenceIdentification( ElementOf=Ø711, Id="F48A-4", Definition=Ø705 );
    @714:WireOccurrenceIdentification( ElementOf=Ø711, Id="088-1CX1", Definition=Ø705 );
    @715:CableOccurrenceTerminalLocationGroup( ElementOf=Ø711, Name="end a" );
        @721:CableOccurrenceTerminal( ElementOf=Ø715, AssociatedTransportFeature=Ø713 ); # cable1/core / end a
        @723:CableOccurrenceTerminal( ElementOf=Ø715, AssociatedTransportFeature=Ø714 ); # cable1/shield / end a
    @716:CableOccurrenceTerminalLocationGroup( ElementOf=Ø711, Name="end b" );
        @722:CableOccurrenceTerminal( ElementOf=Ø716, AssociatedTransportFeature=Ø713 ); # cable1/core / end b
        @724:CableOccurrenceTerminal( ElementOf=Ø716, AssociatedTransportFeature=Ø714 ); # cable1/shield / end a

# EWH-Assembly
@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign;
@9003:ViewContext;
Part_WiringHarnessAssemblyDesign( @9000,  
"EWH Test-Case Connectivity3",@9001, @9002, @9003 );
@9101:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@111 ); # SingleOccurrence "connector 1"
@9102:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@121 ); # SingleOccurrence "connector 2"
@9103:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@711 ); # CableOccurrence "088-1CX1"
@9210:AssemblyShapeJoint( ElementOf=@9002, JointType="soldered_connection" );
    @9211:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@112 ); # connector 1/ 1
@9212:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@721 );
# 088-1CX1/core / end a
@9220:AssemblyShapeJoint( ElementOf=@9002, JointType="soldered_connection" );
  @9221:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@122 );
  # connector 2/ 1
  @9222:AssemblyShapeJointItemRelationship( Relating=@9220, Related=@722 );
  # 088-1CX1/core / end b
@9230:AssemblyShapeJoint( ElementOf=@9002, JointType="crimped_connection" );
  @9231:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@113 );
  # connector 1/ C/S
  @9232:AssemblyShapeJointItemRelationship( Relating=@9230, Related=@723 );
  # 088-1CX1/shield / end a
@9240:AssemblyShapeJoint( ElementOf=@9002, JointType="crimped_connection" );
  @9241:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@123 );
  # connector 2/ C/S
  @9242:AssemblyShapeJointItemRelationship( Relating=@9240, Related=@724 );
  # 088-1CX1/shield / end b
);
4.8 **EWH-Connectivity4**

This test case is similar to the previous connectivity test cases. On the left side we have a connector of type PT06A-10-6S with 6 non-removable contact, while on the right side we have a connector with 6 cavities into which either connector-contacts or if not used sealing plugs are to be inserted. Between the two connectors there is a single wire and a shielded cable with two cores. On the left side the shield of the cable is connected to connector terminal “C” by a shield sleeve of type M83519/2-8. A special “Banding and Shrink Boot Adapter” of type 440DS031NF1002-3 is screwed onto the back-shell of the adapter to guide the wire, cable, and shield sleeve. On the right side the shield of the cable is directly connected to the electrified back-shell of the connector (indicated as “B/S”).

Both connectors are delivered as a connector set that have to be assembled while manufacturing the harness. The PT06A-10-6S connector is delivered as three piece parts, the connector_housing, the connector_insert with integrated soldering pins, and the backshell. The MS27484T8F35SB is delivered in likely 8 parts,

![Diagram](image)

*Figure 11: EWH-Connectivity4 - Wiring diagram*

<table>
<thead>
<tr>
<th>Name</th>
<th>Part Number</th>
<th>Nomenclature</th>
<th>Vendor</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>W118E12</td>
<td>M83519/2-8</td>
<td>Shield Sleeve</td>
<td>@100</td>
<td></td>
</tr>
<tr>
<td>021P6</td>
<td>PT06A-10-6S</td>
<td>connector</td>
<td>@200</td>
<td></td>
</tr>
<tr>
<td>021P6E</td>
<td>440DS031NF1002-3</td>
<td>backshell</td>
<td>@300</td>
<td></td>
</tr>
<tr>
<td>021A5P2</td>
<td>MS27484T8F35SB</td>
<td>RFI grounding plug</td>
<td>@400</td>
<td></td>
</tr>
<tr>
<td>021A5P2E</td>
<td>PART OF 021A5P2</td>
<td>Backshell</td>
<td>@500</td>
<td></td>
</tr>
<tr>
<td>118-2S12</td>
<td>04049A22-4</td>
<td>Two Conductor Shielded Cable</td>
<td>@600</td>
<td></td>
</tr>
<tr>
<td>3RA59A22-4</td>
<td>04034-22-9</td>
<td>Wire</td>
<td>@700</td>
<td></td>
</tr>
<tr>
<td>???</td>
<td>680-116-22</td>
<td>Dummy Contact Sealing Plug</td>
<td>@800</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 12: EWH-Connectivity4 - Part List*

![Image](image)

*Figure 13: M83519/2-8: Solder Sleeves & Shield Tubing*
Figure 14: Connector: PT06A-10-6S with 6 solder contacts of size 20

Breakdown of MS27484T8F35SB

- MS: Mil. Prefix
- 27484: RFI grounding plug
- T: With accessory thread
- 8: Shell Size = 8
- F: Finish = Aluminum shell, electroless nickel finish
- 35: Insert Arrangement
- S: S=Socket
- B: Polarization / Keying = B

Figure 15: Two Conductor Shielded Cable 04049A22A02J24
Formal test-case specification:

Test EWH-Connectivity4

@4:ViewContext;  
@5:ViewContext;  
@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@50:Organization( name="TE Connectivity / Raychem" )  
@51:Organization( name="Amphenol" )  
@52:Organization( name="Glenair" )

@70:WireColourBasedIdentificationCode( Id="white" );  
@71:WireColourBasedIdentificationCode( Id="blue" );  
@72:WireColourBasedIdentificationCode( Id="shield" );

# Shield Sleeve
@100:Part( Name="Shield Sleeve",  
  Description="Solder Sleeves & Shield Tubing S-SLEEVE SHLD TRMNTR 22 AWG"  
  PartTypes[i]=PartCategoryEnum(shield_connector),  
  PartTypes[i]=PartCategoryEnum(discrete) );
@101:PartVersion;  
@102:PartView;  
@103:Identifier( Id=IdentifierString("M83519/2-8"),  
  IdentificationContext=@50 )  
Part_with_ID_and_PartView(@100, @103, @101, @102, @4);  
@104:PartTerminal( ElementOf=@102, Id="Shield-Terminal", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );  
@105:PartTerminal( ElementOf=@102, Id="Wire-Terminal", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );  
@111:SingleOccurrence( Id=IdentifierString("W118E12"), Definition=@102 );  
  @112:OccurrenceTerminal( ElementOf=@111, Definition=@104 );  
  @113:OccurrenceTerminal( ElementOf=@111, Definition=@105 );

# connector
@200:Part( name="Miniature Cylindrical Connectors"  
  Description="Bayonet Coupling with Solder Contact Termination"  
  PartTypes[i]=PartCategoryEnum(connector),  
  PartTypes[i]=PartCategoryEnum(discrete) );
@201:PartVersion;  
@202:PartView;  
@203:Identifier( Id=IdentifierString("PT06A-10-6S"),  
  IdentificationContext=@51 )  
Part_with_ID_and_PartView(@200, @203, @201, @202, @4);  
@204:PartTerminal( ElementOf=@202, Id="A", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );  
@205:PartTerminal( ElementOf=@202, Id="B", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );  
@206:PartTerminal( ElementOf=@202, Id="C", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );  
@207:PartTerminal( ElementOf=@202, Id="D", DomainType="electrical",  
  InterfaceOrJoinTerminal="join_terminal" );
@208:PartTerminal( ElementOf=@202, Id="E", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@209:PartTerminal( ElementOf=@202, Id="F", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@210:PartFeature( ElementOf=@202, Id="Thread", DomainType="mechanical" );
@211:SingleOccurrence( Id=IdentifierString("021P6"), Definition=@202 );
 @214:OccurrenceTerminal( ElementOf=@211, Definition=@204 );
@215:OccurrenceTerminal( ElementOf=@211, Definition=@205 );
@216:OccurrenceTerminal( ElementOf=@211, Definition=@206 );
@217:OccurrenceTerminal( ElementOf=@211, Definition=@207 );
@218:OccurrenceTerminal( ElementOf=@211, Definition=@208 );
@219:OccurrenceTerminal( ElementOf=@211, Definition=@209 );
@220:OccurrenceTerminal( ElementOf=@211, Definition=@210 );

# backshell
@300:Part( PartTypes[i]=PartCategoryEnum(backshell), PartTypes[i]=PartCategoryEnum(discrete) );
@301:PartVersion;
@302:PartView;
@303:Identifier( Id=IdentifierString("440DS031NF1002-3"), IdentificationContext=852 )
Part_with_ID_and_PartView(0300, @303, @301, @302, @4);
@307:PartContactFeature( ElementOf=@302, Id="Thread" );
@308:PartFeature( ElementOf=0302, Id="Segment-Opening" );
@311:SingleOccurrence( Id=IdentifierString("021P6E"), Definition=@302 );
@317:OccurrenceContactFeature( ElementOf=@311, Definition@307 );
@318:OccurrenceShapeFeature( ElementOf=0311, Definition=0308 );

# connector
@400:Part( PartTypes[i]=PartCategoryEnum(connector), PartTypes[i]=PartCategoryEnum(discrete) );
@401:PartVersion;
@402:PartView;
@403:Identifier( Id=IdentifierString("MS27484T8F35SB"), IdentificationContext=851 )
Part_with_ID_and_PartView(@400, @403, @401, @402, @4);
@404:PartTerminal( ElementOf=0402, Id="1", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@405:PartTerminal( ElementOf=0402, Id="2", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@406:PartTerminal( ElementOf=0402, Id="3", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@407:PartTerminal( ElementOf=0402, Id="4", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@408:PartTerminal( ElementOf=0402, Id="5", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@409:PartTerminal( ElementOf=0402, Id="6", DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
@410:PartFeature( ElementOf=0402, Id="Thread" );
@411:SingleOccurrence( Id=IdentifierString("021A5P2"), Definition=0402 );
@414:OccurrenceTerminal( ElementOf=0411, Definition=0404 );
@415:OccurrenceTerminal( ElementOf=0411, Definition=0405 );
@416:OccurrenceTerminal( ElementOf=@411, Definition=@406 );
@417:OccurrenceTerminal( ElementOf=@411, Definition=@407 );
@418:OccurrenceTerminal( ElementOf=@411, Definition=@408 );
@419:OccurrenceTerminal( ElementOf=@411, Definition=@409 );
@420:OccurrenceTerminal( ElementOf=@411, Definition=@410 );

# electrified backshell
@500:Part(  
    PartTypes[i]=PartCategoryEnum(electrified_backshell),  
    PartTypes[i]=PartCategoryEnum(discrete) );
@501:PartVersion;
@502:PartView;
@503:Identifier( Id=IdentifierString("PART OF 021A5P2"), IdentificationContext=@51 )
Part_with_ID_and_PartView(@500, @503, @501, @502, @4);
@506:PartTerminal( ElementOf=@502, Id="BS", DomainType="electrical",  
    InterfaceOrJoinTerminal="join_terminal" );
@507:PartContactFeature( ElementOf=@502, Id="Thread" );
@508:PartFeature( ElementOf=@502, Id="Segment-Opening" );
@511:SingleOccurrence( Id=IdentifierString("021A5P2E"), Definition=@502 );
  @516:OccurrenceTerminal( ElementOf=@511, Definition=@506 );
  @517:OccurrenceContactFeature( ElementOf=@511, Definition=@507 );
  @518:OccurrenceShapeFeature( ElementOf=@511, Definition=@508 );

# Cable
@600:Part(  
    PartTypes[i]=PartCategoryEnum(cable), PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@601:PartVersion;
@602:PartView;
@603:Identifier( Id=IdentifierString("04049A22A02J24"), IdentificationContext=@52 )
Part_with_ID_and_PartView(@600, @603, @601, @602, @4);
@604:WirePartIdentification( ElementOf=@603, Id="white", code=@70 );
@605:WirePartIdentification( ElementOf=@603, Id="blue", code=@71 );
@606:WirePartIdentification( ElementOf=@603, Id="shield", code=@72 );
@611:CableOccurrence( Id=IdentifierString("118-2S12"), Definition=@602,  
    Quantity=@612 );
  @612:NumericalValue( Unit=@8, ValueComponent=1.8 );
  @613:WireOccurrenceIdentification( ElementOf=@611, Id="3RA6A22-6 (WHT)" ,  
    Definition=@604 );
  @614:WireOccurrenceIdentification( ElementOf=@611, Id="3RA7A22N-6 (BLU)" ,  
    Definition=@605 );
  @615:WireOccurrenceIdentification( ElementOf=@611, Id="118-2S12", Definition=@606 );
  @615:CableOccurrenceTerminalLocationGroup( ElementOf=@611, Name="end a" );
    @621:CableOccurrenceTerminal( ElementOf=@615, AssociatedTransportFeature=@613);
    @622:CableOccurrenceTerminal( ElementOf=@615, AssociatedTransportFeature=@614);
    @623:CableOccurrenceTerminal( ElementOf=@615, AssociatedTransportFeature=@615);
    @616:CableOccurrenceTerminalLocationGroup( ElementOf=@611, Name="end b" );
# Wire
@700:Part( PartTypes[i]=PartCategoryEnum(wire),
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@701:PartVersion;
@702:PartView;
@703:Identifier( Id=IdentifierString("04034-22-9"),
    IdentificationContext=@52 )
Part_with_ID_and_PartView(@700, @703, @701, @702, @4);
@711:WireOccurrence( Id=IdentifierString("3RA59A22-4"), Definition=@602,
    Quantity=@712 );
    @712:NumericalValue( Unit=@8, ValueComponent=3.5 );
@713:WireOccurrenceIdentification( ElementOf=@611, DomainType="electrical ...
    @714:WireOccurrenceTerminal( ElementOf=@711,
        AssociatedTransportFeature=@713,
        Name="end a" );
    @715:WireOccurrenceTerminal( ElementOf=@711,
        AssociatedTransportFeature=@713,
        Name="end b" );

# EWH-Assembly
@9000:Part;
@9001:PartVersion;
@9002:WiringHarnessAssemblyDesign;
@9003:ViewContext;
Part_WiringHarnessAssemblyDesign( @9000,
    "EWH Test-Case Connectivity4",@9001,@9002,@9003 );

@9101:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@111 ); # left/shield_connector
@9102:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@211 ); # left connector
@9103:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@311 ); # left backshell
@9104:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@411 ); # right connector
@9105:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@511 ); # right electrified_backshell
@9106:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@611 ); # cable
@9107:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@711 ); # wire

# connections
@9210:AssemblyShapeJoint( ElementOf=@9002 );
    @9211:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@621 );
    # left white/end a
    @9212:AssemblyShapeJointItemRelationship( Relating=@9210, Related=@214 );
    # left connector/A
    @9220:AssemblyShapeJoint( ElementOf=@9002 );
4.9 **EWH-Connectivity**

Purpose of this test case is to introduce a complex modular connector with several inserts and cavities. For this test case a connector according to the European standard EN4644 European standard is chosen; the Radiall’s EPX™ connector of type EPXB2


For this particular test case a much smaller example is chosen, consisting of two EPXB2 connectors with the same kind of inserts and connector contacts that are connected with each other in a 1:1 way.

![Figure 16: Example of several EWHs that are using EPXB2 connectors](image)

The right and left side of the stick line schematics is almost symmetric; however there are different lengths and reference designators / IDs.

![Figure 17: Stick Line Schematics; left side](image)
Each EPXB2 connector consists of two inserts, one with 3 cavities for quadrax connector contacts and one with 28 cavities in two sizes for normal single signal contacts. Each quadrax connector is independently connected by a harness segment that contains a single quadrax cable. The three quadrax cable for one quadrax insert are then combined in a harness node and in another harness node the combined 3 quadrax cables are combined with a bundle of wires for the other insert.

The wiring diagrams are identical for the left and right side. Here only the diagrams for the left side are shown; one for each insert.
In the EPX part numbers several characteristics of the connector are encoded.
Instead of a backshell, strain reliefs are used for the EPX B2 connectors.

**Figure 22: Part Numbers for EPX B2 Shells**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>617922007</td>
<td>Straight strain relief (composite)</td>
</tr>
</tbody>
</table>

**Figure 23: Strain Relief for EPX B2 connector**

**Figure 24: EPX B Inserts**

EPXBE3Q3SA Part Numbers

Insert name 3Q3
Insert code C
3 × size 8 quadrax contacts

EPXBE28PB

Insert name 28
Insert code T
22 × size 22 contacts
6 × size 15 or 16 contacts
An EPX B2 Shell has two slots for inserts, A and B. For this test case slot A is populated with an insert of type EPXBE3Q3SA that has 3 cavities for quadrax connector contacts, suitable for Ethernet connections. Slot B is populated with an insert of type EPXBE28PB that has 22 cavities of size 22 and 6 cavities of size 15 or 16.

A quadrax connector/contact is from the modeling point of view a hybrid object. On one hand it is a connector assembly in itself, consisting of a housing, a spacer, an insulator, a ferrule and four connector contacts. But when used inside an EPX insert, the whole quadrax is just a connector contact. For the purpose of this test case we treat the quadrax just as a connector contact with 4 pin terminals and a shield. It is up to the implementors to optionally present the quadrax as a sub-assembly where the terminals of the inner components are “reflected” to the assembly view, similar as it is done for test case EWH_Connectivity3 for the BNC connector. Further information about the quadrax connector/contact is available here:

- Datasheet of 620075050
- How to wire an quadrax connector
  [https://www.radiall.com/media/blfa_files/cabling/ai/rp57339en.pdf](https://www.radiall.com/media/blfa_files/cabling/ai/rp57339en.pdf)
- The tool used to insert Ferrules
  Notice the references to Boeing standards in this document
- An overview of “High-Speed Datalink Connectors and Cables for Ethernet-Grade Protocols”

are connected by quadrax cables that consists of 4 core wires and a shield.

All connector parts are from the EPX series from Radiall.
<table>
<thead>
<tr>
<th>RefDes</th>
<th>Part Type</th>
<th>Part Number</th>
<th>Name</th>
<th>Vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>001A1P1X1</td>
<td>connector_housing</td>
<td>EPXB2PB13N</td>
<td>EPXB, CONNECTOR SHELL</td>
<td>Radiall</td>
</tr>
<tr>
<td>001A1P1XE</td>
<td>strain_relief_accessory</td>
<td>61792207</td>
<td>EPXB, STRAIN RELIEF</td>
<td>-- dito --</td>
</tr>
<tr>
<td>001A1P1XIA</td>
<td>connector_insert</td>
<td>EPXBE3Q3SA</td>
<td>EPXB, 3-8 GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>001A1P1XIB</td>
<td>connector_insert</td>
<td>EPXBE2BPB</td>
<td>EPXB, 22-22.6-16</td>
<td>-- dito --</td>
</tr>
<tr>
<td>001A1P1XIAQ1</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>001A1P1XIAQ2</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>001A1P1XIAQ3</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1X1</td>
<td>connector_housing</td>
<td>EPXB2PB13N</td>
<td>EPXB, CONNECTOR SHELL</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XE</td>
<td>strain_relief_accessory</td>
<td>61792207</td>
<td>EPXB, STRAIN RELIEF</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XIA</td>
<td>connector_insert</td>
<td>EPXBE3Q3SA</td>
<td>EPXB, 3-8 GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XIB</td>
<td>connector_insert</td>
<td>EPXBE2BPB</td>
<td>EPXB, 22-22.6-16</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XIAQ1</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XIAQ2</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>002A1P1XIAQ3</td>
<td>connector_contact</td>
<td>620075050</td>
<td>QUADRAX CONTACT, SOCKET, 8-GA</td>
<td>-- dito --</td>
</tr>
<tr>
<td>-- no -- (18 pieces)</td>
<td>connector_contact</td>
<td>617200</td>
<td>Pin crimp contacts size 22</td>
<td>-- dito --</td>
</tr>
</tbody>
</table>

Table 4: Connector part List

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<tr>
<th>Cable-RefDes</th>
<th>Wire-RefDes</th>
<th>Type</th>
<th>Part Number</th>
<th>Length</th>
<th>Start Join</th>
<th>End Join</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>403-4S1</td>
<td>cable</td>
<td>GAC861AH424S</td>
<td>4.573524</td>
<td></td>
<td>TERM104</td>
<td>TERM128</td>
<td>[BUN807, BUN802, BUN809, BUN811, BUN804]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.573524</td>
<td>TERM100</td>
<td>TERM124</td>
<td>-- dito --</td>
<td>[BUN807, BUN802, BUN809, BUN811, BUN804]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.573524</td>
<td>TERM102</td>
<td>TERM126</td>
<td>-- dito --</td>
<td>[BUN807, BUN802, BUN809, BUN811, BUN804]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.573524</td>
<td>TERM101</td>
<td>TERM125</td>
<td>-- dito --</td>
<td>[BUN807, BUN802, BUN809, BUN811, BUN804]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.573524</td>
<td>TERM103</td>
<td>TERM127</td>
<td>-- dito --</td>
<td>[BUN807, BUN802, BUN809, BUN811, BUN804]</td>
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<td>403-4S2</td>
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<td>GAC861AH424S</td>
<td>4.195626</td>
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<td>TERM109</td>
<td>TERM133</td>
<td>[BUN808, BUN802, BUN809, BUN811, BUN803]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.195626</td>
<td>TERM107</td>
<td>TERM131</td>
<td>-- dito --</td>
<td>[BUN808, BUN802, BUN809, BUN811, BUN803]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.195626</td>
<td>TERM105</td>
<td>TERM129</td>
<td>-- dito --</td>
<td>[BUN808, BUN802, BUN809, BUN811, BUN803]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.195626</td>
<td>TERM106</td>
<td>TERM130</td>
<td>-- dito --</td>
<td>[BUN808, BUN802, BUN809, BUN811, BUN803]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>4.195626</td>
<td>TERM108</td>
<td>TERM132</td>
<td>-- dito --</td>
<td>[BUN808, BUN802, BUN809, BUN811, BUN803]</td>
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<tr>
<td>403-4S5</td>
<td>cable</td>
<td>GAC861AH424S</td>
<td>3.964688</td>
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<td>TERM104</td>
<td>TERM138</td>
<td>[BUN806, BUN802, BUN809, BUN811, BUN805]</td>
</tr>
<tr>
<td>-- dito --</td>
<td>wire</td>
<td>-- dito --</td>
<td>3.964688</td>
<td>TERM112</td>
<td>TERM136</td>
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<td>[BUN806, BUN802, BUN809, BUN811, BUN805]</td>
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<tr>
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<td>wire</td>
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<td>3.964688</td>
<td>TERM110</td>
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<td>wire</td>
<td>-- dito --</td>
<td>3.964688</td>
<td>TERM111</td>
<td>TERM135</td>
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<td>3.964688</td>
<td>TERM113</td>
<td>TERM137</td>
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<tr>
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<td>04034-22-9</td>
<td>2.490851</td>
<td>TERM116</td>
<td>TERM140</td>
<td>BUN810, BUN811, BUN812)</td>
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<tr>
<td>-- no --</td>
<td>wire</td>
<td>04034-22-9</td>
<td>2.490851</td>
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<td>TERM141</td>
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<tr>
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<td>TERM142</td>
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<tr>
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<td>04034-22-9</td>
<td>2.490851</td>
<td>TERM119</td>
<td>TERM143</td>
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<td>[BUN806, BUN802, BUN809, BUN811, BUN805]</td>
</tr>
<tr>
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<td>04034-22-9</td>
<td>2.490851</td>
<td>TERM121</td>
<td>TERM145</td>
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<tr>
<td>-- no --</td>
<td>wire</td>
<td>04034-22-9</td>
<td>2.490851</td>
<td>TERM122</td>
<td>TERM146</td>
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</tr>
<tr>
<td>-- no --</td>
<td>wire</td>
<td>04034-22-9</td>
<td>2.490851</td>
<td>TERM120</td>
<td>TERM144</td>
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<td>[BUN806, BUN802, BUN809, BUN811, BUN805]</td>
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<tr>
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<td>[BUN806, BUN802, BUN809, BUN811, BUN805]</td>
</tr>
</tbody>
</table>

Table 5: Wire List

GAC861AH424S e.g. from Thermax, https://www.thermaxglobal.com/ 04034-22-9 from Carlisle Interconnect Technologies
<table>
<thead>
<tr>
<th>RefDes1</th>
<th>RefDes2</th>
<th>RefDes3</th>
<th>PartNumber</th>
<th>Feature</th>
<th>Join</th>
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<tr>
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<td>C</td>
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<td>-- dito --</td>
<td>-- np -- / 617200</td>
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<td>-- dito --</td>
<td>-- np -- / 617200</td>
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<td>-- dito --</td>
<td>-- np -- / 617200</td>
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</table>

"-- dito --"  same as above
"-- nc --"  "not connected"
"-- np --"  "not provided"

Table 6: Connection list at connector X1
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<th>Bundle</th>
<th>Start Node</th>
<th>End Node</th>
<th>Length</th>
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<td>N1010</td>
<td>N1014</td>
<td>0.381</td>
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<tr>
<td>BUN803</td>
<td>N1011</td>
<td>N1012</td>
<td>0.635</td>
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<td>BUN804</td>
<td>N1011</td>
<td>N1006</td>
<td>1.077468</td>
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<td>BUN805</td>
<td>N1011</td>
<td>N1008</td>
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<td>N1010</td>
<td>N1013</td>
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<td>N1010</td>
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<td>BUN811</td>
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<td>0.381</td>
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<td>N1005</td>
<td>N1015</td>
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Table 7: Edges of the Topological Model

<table>
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<th>Node</th>
<th>Connector RefDes</th>
<th>Bundels</th>
<th>HarnessNode Type</th>
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<td>N1002</td>
<td>001A1P1X1AQ1</td>
<td>(BUN807)</td>
<td>extremity_node</td>
</tr>
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<td>N1003</td>
<td>001A1P1X1AQ2</td>
<td>(BUN808)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1005</td>
<td>002A1P1X1B</td>
<td>(BUN812)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1006</td>
<td>002A1P1X1AQ1</td>
<td>(BUN804)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1008</td>
<td>002A1P1X1AQ3</td>
<td>(BUN805)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1009</td>
<td>001A1P1X1B</td>
<td>(BUN810)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1010</td>
<td>--</td>
<td>(BUN802, BUN806, BUN807, BUN808)</td>
<td>branch_node</td>
</tr>
<tr>
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<td>--</td>
<td>(BUN803, BUN804, BUN805, BUN811)</td>
<td>branch_node</td>
</tr>
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<td>002A1P1X1AQ2</td>
<td>(BUN803)</td>
<td>extremity_node</td>
</tr>
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<td>001A1P1X1AQ3</td>
<td>(BUN806)</td>
<td>extremity_node</td>
</tr>
<tr>
<td>N1014</td>
<td>--</td>
<td>(BUN802, BUN809, BUN810)</td>
<td>branch_node</td>
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<td>N1015</td>
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<td>(BUN809, BUN811, BUN812)</td>
<td>branch_node</td>
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Table 8: Vertices of the Topological Model resp. HarnessNodes

This test case comes together with a corresponding KBL and Capital Harness / Siemens XML file. It is up to implementors to either import these files into their source system or to create the harness anew in their source system.
Formal test-case specification:

Test EWH-Connectivity5 ( "EWIS Interoperability Forum"

@4:ViewContext;
@5:ViewContext;
@8:Unit( Name=ClassString("metre"), Quantity=ClassString("length") );

@50:Organization( name="Radiall"
@51:Organization( name="Thermax"
@52:Organization( name="Carlisle Interconnect Technologies"

@70:WireColourBasedIdentificationCode( Id="shield" );
@71:WireColourBasedIdentificationCode( Id="red" );
@72:WireColourBasedIdentificationCode( Id="blue" );
@73:WireColourBasedIdentificationCode( Id="yellow" );
@74:WireColourBasedIdentificationCode( Id="green" );

# EPX size 8 cavities and contact profiles
@1000:ContactFeatureDefinitionFitRelationship( Name="EPX cavity-plug-contact 8 fit",
                Relating=@1001, Related=@1002 );
@1001:ContactFeatureDefinition( Name="EPX size 8 cavity",
                ShapeFeatureType=cavity_profile );
@1002:ContactFeatureDefinition( Name="EPX size 8 plug/contact",
                ShapeFeatureType=cavity_plug_or_contact_profile );

# EPX size 22 cavities and contact profiles
@1010:ContactFeatureDefinitionFitRelationship( Name="EPX size 22 fit",
                Relating=@1011, Related=@1012 );
@1011:ContactFeatureDefinition( Name="EPX size 22 cavity",
                ShapeFeatureType=cavity_profile );
@1012:ContactFeatureDefinition( Name="EPX size 22 plug/contact",
                ShapeFeatureType=cavity_plug_or_contact_profile );

# EPXB slot and insert profiles
@1020:ContactFeatureDefinitionFitRelationship( Name="EPXB slot-insert fit",
                Relating=@1021, Related=@1022 );
@1021:ContactFeatureDefinition( Name="EPXB slot profile",
                ShapeFeatureType=slot_profile );
@1022:ContactFeatureDefinition( Name="EPXB insert profile",
                ShapeFeatureType=insert_profile );

# EPXB2 housing and backshell profiles
@1030:ContactFeatureDefinitionFitRelationship( Name="EPXB2 housing-backshell fit",
                Relating=@1031, Related=@1032 );
@1031:ContactFeatureDefinition( Name="EPXB2 housing profile" );
@1032:ContactFeatureDefinition( Name="EPXB2 backshell profile" );

# EPX size 15/16 cavities and size 15 and 16 contact profiles
@1040:ContactFeatureDefinitionFitRelationship( Name="EPX size 15-15 fit",
                Relating=@1042, Related=@1043 );
@1041:ContactFeatureDefinitionFitRelationship( Name="EPX size 15-16 fit",
                Relating=1042, Related=1043 );
Relating=@1042, Related=@1044);
@1042:ContactFeatureDefinition( Name="EPX size 15/16 cavity",
    ShapeFeatureType=cavity_profile );
@1043:ContactFeatureDefinition( Name="EPX size 15 plug/contact",
    ShapeFeatureType=cavity_plug_or_contact_profile );
@1044:ContactFeatureDefinition( Name="EPX size 16 plug/contact",
    ShapeFeatureType=cavity_plug_or_contact_profile );

# connector_housing
@1100:Part( Name="EPXB, CONNECTOR SHELL",
    PartTypes[i]=PartCategoryEnum(connector_housing),
    PartTypes[i]=PartCategoryEnum(discrete) );
@1101:PartVersion;
@1103:Identifier( Id=IdentifierString("EPXB2PB13N"),
    IdentificationContext=@50 )
Part_with_ID_and_PartView(@1100, @1103, @1101, @1102, @4);
@1102:PartView;
    @1111:PartContactFeature( ElementOf=@1102, Id="A",
    PartDefinition=@1021 );
    @1112:PartContactFeature( ElementOf=@1102, Id="B",
    PartDefinition=@1021 );
    @1113:PartContactFeature( ElementOf=@1102, PartDefinition=@1031 );
@11010:SingleOccurrence( Id=IdentifierString("001A1P1X1"), Definition=@1102 );
    #11011:OccurrenceContactFeature( ElementOf=@11010, Definition=@1111 );
@11012:SingleOccurrence( Id=IdentifierString("002A1P1X1"), Definition=@1102 );
    #110121:OccurrenceContactFeature( ElementOf=@11012, Definition=@1111 );
@11020:SingleOccurrence( Id=IdentifierString("001A1P1XE"), Definition=@1102 );
    #110201:OccurrenceContactFeature( ElementOf=@11020, Definition=@1111 );
@11022:SingleOccurrence( Id=IdentifierString("002A1P1XE"), Definition=@1102 );
    #110223:OccurrenceContactFeature( ElementOf=@11022, Definition=@1113 );

# strain_relief_accessory
@1200:Part( Name="EPXB, STRAIN RELIEF",
    PartTypes[i]=PartCategoryEnum(strain_relief_accessory),
    PartTypes[i]=PartCategoryEnum(discrete) );
@1201:PartVersion;
@1203:Identifier( Id=IdentifierString("EPXB2PB13N"),
    IdentificationContext=@50 )
Part_with_ID_and_PartView(@1200, @1203, @1201, @1202, @4);
@1202:PartView;
    @12021:PartContactFeature( ElementOf=@1102, Id="B",
    PartDefinition=@1032 );
@12010:SingleOccurrence( Id=IdentifierString("001A1P1XE"), Definition=@1102 );
    #120101:OccurrenceContactFeature( ElementOf=@12010, Definition=@1201 );
@12020:SingleOccurrence( Id=IdentifierString("002A1P1XE"), Definition=@1102 );
    #120201:OccurrenceContactFeature( ElementOf=@12020, Definition=@1201 );

# connector_insert EPXBE3Q3SA
@1300:Part( Name="EPXB, 3-8 GA",
    PartTypes[i]=PartCategoryEnum(connector_insert),
PartTypes[i]=PartCategoryEnum(discrete) );
@1301:PartVersion;
@1303:Identifier( Id=IdentifierString("EPXBE3Q3SA"),
  IdentificationContext=050 )
Part_with_ID_and_PartView(@1300, @1303, @1301, @1302, @4);
@1302:PartView;
  @13021:PartShapeFeature( ElementOf=@1302, Id="1", PartDefinition=@1002 );
  @13022:PartShapeFeature( ElementOf=@1302, Id="2", PartDefinition=@1002 );
  @13023:PartShapeFeature( ElementOf=@1302, Id="3", PartDefinition=@1002 );
  @13024:PartShapeFeature( ElementOf=@1302, PartDefinition=@1022 );
@1311:SingleOccurrence( Id=IdentifierString("001AIPIX1A"), Definition=@1302 );
  @13111:OccurrenceContactFeature( ElementOf=@1311, Definition=@13021 );
  @13112:OccurrenceContactFeature( ElementOf=@1311, Definition=@13022 );
  @13113:OccurrenceContactFeature( ElementOf=@1311, Definition=@13023 );
  @13114:OccurrenceContactFeature( ElementOf=@1311, Definition=@13024 );
@1321:SingleOccurrence( Id=IdentifierString("002AIPIX1A"), Definition=@1302 );
  @13211:OccurrenceContactFeature( ElementOf=@1321, Definition=@13021 );
  @13212:OccurrenceContactFeature( ElementOf=@1321, Definition=@13022 );
  @13213:OccurrenceContactFeature( ElementOf=@1321, Definition=@13023 );
  @13214:OccurrenceContactFeature( ElementOf=@1321, Definition=@13024 );

# connector_insert EPXBE28PB
@1400:Part( Name="EPXB, 22-22, 6-16",
  PartTypes[i]=PartCategoryEnum(connector_insert),
  PartTypes[i]=PartCategoryEnum(discrete) );
@1401:PartVersion;
@1403:Identifier( Id=IdentifierString("EPXBE28PB"),
  IdentificationContext=050 )
Part_with_ID_and_PartView(@1400, @1403, @1401, @1402, @4);
@1402:PartView;
  # for the definition (in library) list all cavities/profiles
  @140200:PartShapeFeature( ElementOf=@1402, PartDefinition=@1022 );
  @140201:PartShapeFeature( ElementOf=@1402, Id="1",
    PartDefinition=@1011 );
  @140202:PartShapeFeature( ElementOf=@1402, Id="2",
    PartDefinition=@1011 );
  @140203:PartShapeFeature( ElementOf=@1402, Id="3",
    PartDefinition=@1011 );
  @140204:PartShapeFeature( ElementOf=@1402, Id="4",
    PartDefinition=@1011 );
  @140205:PartShapeFeature( ElementOf=@1402, Id="5",
    PartDefinition=@1011 );
  @140206:PartShapeFeature( ElementOf=@1402, Id="6",
    PartDefinition=@1011 );
  @140207:PartShapeFeature( ElementOf=@1402, Id="7",
    PartDefinition=@1011 );
  @140208:PartShapeFeature( ElementOf=@1402, Id="8",
    PartDefinition=@1011 );
  @140209:PartShapeFeature( ElementOf=@1402, Id="9",
    PartDefinition=@1011 );
  @140210:PartShapeFeature( ElementOf=@1402, Id="10",
    PartDefinition=@1011 );
@140211:PartShapeFeature( ElementOf=@1402, Id="11", PartDefinition=@1011 );
@140212:PartShapeFeature( ElementOf=@1402, Id="12", PartDefinition=@1011 );
@140213:PartShapeFeature( ElementOf=@1402, Id="13", PartDefinition=@1011 );
@140214:PartShapeFeature( ElementOf=@1402, Id="14", PartDefinition=@1011 );
@140215:PartShapeFeature( ElementOf=@1402, Id="15", PartDefinition=@1011 );
@140216:PartShapeFeature( ElementOf=@1402, Id="16", PartDefinition=@1011 );
@140217:PartShapeFeature( ElementOf=@1402, Id="17", PartDefinition=@1011 );
@140218:PartShapeFeature( ElementOf=@1402, Id="18", PartDefinition=@1011 );
@140219:PartShapeFeature( ElementOf=@1402, Id="19", PartDefinition=@1011 );
@140220:PartShapeFeature( ElementOf=@1402, Id="20", PartDefinition=@1011 );
@140221:PartShapeFeature( ElementOf=@1402, Id="21", PartDefinition=@1011 );
@140222:PartShapeFeature( ElementOf=@1402, Id="22", PartDefinition=@1011 );
@140231:PartShapeFeature( ElementOf=@1402, Id="A", PartDefinition=@1011 );
@140232:PartShapeFeature( ElementOf=@1402, Id="B", PartDefinition=@1011 );
@140233:PartShapeFeature( ElementOf=@1402, Id="C", PartDefinition=@1011 );
@140234:PartShapeFeature( ElementOf=@1402, Id="D", PartDefinition=@1011 );
@140235:PartShapeFeature( ElementOf=@1402, Id="E", PartDefinition=@1011 );
@140236:PartShapeFeature( ElementOf=@1402, Id="F", PartDefinition=@1011 );
@1411:SingleOccurrence( Id=IdentifierString("001A1P1X1B"), Definition=@1402 );
  # for the occurrence only used cavities/profiles are listed
  @141100:OccurrenceContactFeature( ElementOf=@1411, Definition=@140200 );
  @141101:OccurrenceContactFeature( ElementOf=@1411, Definition=@140201 );
  @141102:OccurrenceContactFeature( ElementOf=@1411, Definition=@140202 );
  @141103:OccurrenceContactFeature( ElementOf=@1411, Definition=@140203 );
  @141104:OccurrenceContactFeature( ElementOf=@1411, Definition=@140204 );
  @141105:OccurrenceContactFeature( ElementOf=@1411, Definition=@140205 );
  @141106:OccurrenceContactFeature( ElementOf=@1411, Definition=@140206 );
  @141109:OccurrenceContactFeature( ElementOf=@1411, Definition=@140209 );
  @141113:OccurrenceContactFeature( ElementOf=@1411, Definition=@140213 );
  @141114:OccurrenceContactFeature( ElementOf=@1411, Definition=@140214 );
@1421:SingleOccurrence( Id=IdentifierString("002A1P1X1B"), Definition=@1402 );
  # for the occurrence only used cavities/profiles are listed
  @142100:OccurrenceContactFeature( ElementOf=@1421, Definition=@140200 );
  @142101:OccurrenceContactFeature( ElementOf=@1421, Definition=@140201 );
  @142102:OccurrenceContactFeature( ElementOf=@1421, Definition=@140202 );
  @142103:OccurrenceContactFeature( ElementOf=@1421, Definition=@140203 );
@142104:OccurrenceContactFeature( ElementOf=@1421, Definition=@140204 );
@142105:OccurrenceContactFeature( ElementOf=@1421, Definition=@140205 );
@142106:OccurrenceContactFeature( ElementOf=@1421, Definition=@140206 );
@142109:OccurrenceContactFeature( ElementOf=@1421, Definition=@140209 );
@142113:OccurrenceContactFeature( ElementOf=@1421, Definition=@140213 );
@142114:OccurrenceContactFeature( ElementOf=@1421, Definition=@140214 );

# connector_contact 620075050
@1500:Part( Name="QUADRAX CONTACT, SOCKET, 8-GA",
PartTypes[i]=PartCategoryEnum(connector_contact),
PartTypes[i]=PartCategoryEnum(discrete) );
@1501:PartVersion;
@1503:Identifier( Id=IdentifierString("EPXB2PB13N"),
IdentificationContext=@50 )
Part_with_ID_and_PartView(@1500, @1503, @1501, @1502, @4);
@1502:PartView;
@1591:PartTerminal( ElementOf=@1502, Id="1", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
@1592:PartTerminal( ElementOf=@1502, Id="2", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
@1593:PartTerminal( ElementOf=@1502, Id="3", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
@1594:PartTerminal( ElementOf=@1502, Id="4", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
@1595:PartTerminal( ElementOf=@1502, Id="SC", DomainType="electrical",
InterfaceOrJoinTerminal="join_terminal" );
@1596:PartContactFeature( ElementOf=@1502, PartDefinition=@1002 );
@1597:PartShapeFeature( ElementOf=@1502, Id="EPX quadrax connector_contact to quadrax cable opening" );
@1510:SingleOccurrence( Id=IdentifierString("001A1P1X1AQ1"),
Definition=@1502 );
@1511:OccurrenceTerminal( ElementOf=@1510, Definition=@1591 );
@1512:OccurrenceTerminal( ElementOf=@1510, Definition=@1592 );
@1513:OccurrenceTerminal( ElementOf=@1510, Definition=@1593 );
@1514:OccurrenceTerminal( ElementOf=@1510, Definition=@1594 );
@1515:OccurrenceTerminal( ElementOf=@1510, Definition=@1595 );
@1516:OccurrenceContactFeature( ElementOf=@1510, Definition=@1596 );
@1517:OccurrenceShapeFeature( ElementOf=@1510, Definition=@1597 );
@1520:SingleOccurrence( Id=IdentifierString("001A1P1X1AQ2"),
Definition=@1502 );
@1521:OccurrenceTerminal( ElementOf=@1520, Definition=@1591 );
@1522:OccurrenceTerminal( ElementOf=@1520, Definition=@1592 );
@1523:OccurrenceTerminal( ElementOf=@1520, Definition=@1593 );
@1524:OccurrenceTerminal( ElementOf=@1520, Definition=@1594 );
@1525:OccurrenceTerminal( ElementOf=@1520, Definition=@1595 );
@1526:OccurrenceContactFeature( ElementOf=@1520, Definition=@1596 );
@1527:OccurrenceShapeFeature( ElementOf=@1520, Definition=@1597 );
@1530:SingleOccurrence( Id=IdentifierString("001A1P1X1AQ3"),
Definition=@1502 );
@1531:OccurrenceTerminal( ElementOf=@1530, Definition=@1591 );
@1532:OccurrenceTerminal( ElementOf=@1530, Definition=@1592 );
@1533:OccurrenceTerminal( ElementOf=@1530, Definition=@1593 );
@1534:OccurrenceTerminal( ElementOf=@1530, Definition=@1594 );
@1535:OccurrenceTerminal( ElementOf=@1530, Definition=@1595 );
@1536:OccurrenceContactFeature( ElementOf=@1530, Definition=@1596 );
@1537:OccurrenceShapeFeature( ElementOf=@1530, Definition=@1597 );
@1540:SingleOccurrence( Id=IdentifierString("002A1P1X1AQ1"), Definition=@1502 );
  @1541:OccurrenceTerminal( ElementOf=@1540, Definition=@1591 );
  @1542:OccurrenceTerminal( ElementOf=@1540, Definition=@1592 );
  @1543:OccurrenceTerminal( ElementOf=@1540, Definition=@1593 );
  @1544:OccurrenceTerminal( ElementOf=@1540, Definition=@1594 );
  @1545:OccurrenceTerminal( ElementOf=@1540, Definition=@1595 );
  @1546:OccurrenceContactFeature( ElementOf=@1540, Definition=@1596 );
  @1547:OccurrenceShapeFeature( ElementOf=@1540, Definition=@1597 );
@1550:SingleOccurrence( Id=IdentifierString("002A1P1X1AQ2"), Definition=@1502 );
  @1551:OccurrenceTerminal( ElementOf=@1550, Definition=@1591 );
  @1552:OccurrenceTerminal( ElementOf=@1550, Definition=@1592 );
  @1553:OccurrenceTerminal( ElementOf=@1550, Definition=@1593 );
  @1554:OccurrenceTerminal( ElementOf=@1550, Definition=@1594 );
  @1555:OccurrenceTerminal( ElementOf=@1550, Definition=@1595 );
  @1556:OccurrenceContactFeature( ElementOf=@1550, Definition=@1596 );
  @1557:OccurrenceShapeFeature( ElementOf=@1550, Definition=@1597 );
@1560:SingleOccurrence( Id=IdentifierString("002A1P1X1AQ3"), Definition=@1502 );
  @1561:OccurrenceTerminal( ElementOf=@1560, Definition=@1591 );
  @1562:OccurrenceTerminal( ElementOf=@1560, Definition=@1592 );
  @1563:OccurrenceTerminal( ElementOf=@1560, Definition=@1593 );
  @1564:OccurrenceTerminal( ElementOf=@1560, Definition=@1594 );
  @1565:OccurrenceTerminal( ElementOf=@1560, Definition=@1595 );
  @1566:OccurrenceContactFeature( ElementOf=@1560, Definition=@1596 );
  @1567:OccurrenceShapeFeature( ElementOf=@1560, Definition=@1597 );

# connector_contact 617200
@1600:Part( Name="Pin crimp contacts/size 22", PartTypes[i]=PartCategoryEnum(connector_contact), PartTypes[i]=PartCategoryEnum(discrete) );
  @1601:PartVersion;
  @1603:Identifier( Id=IdentifierString("617200"), IdentificationContext=@50 ) Part_with_ID_and_PartView(@1600, @1603, @1601, @1602, @4);
  @1602:PartView;
    @1603:PartTerminal( ElementOf=@1502, DomainType="electrical", InterfaceOrJoinTerminal="join_terminal" );
  @16010:SingleOccurrence( Id=IdentifierString("617200_1"), Definition=@1602 );
    @16011:OccurrenceTerminal( ElementOf=@16010, Definition=@1603 );
  @16020:SingleOccurrence( Id=IdentifierString("617200_2"), Definition=@1602 );
    @16021:OccurrenceTerminal( ElementOf=@16020, Definition=@1603 );
  @16030:SingleOccurrence( Id=IdentifierString("617200_3"), Definition=@1602 );
    @16031:OccurrenceTerminal( ElementOf=@16030, Definition=@1603 );
  @16040:SingleOccurrence( Id=IdentifierString("617200_4"), Definition=@1602 );
    @16041:OccurrenceTerminal( ElementOf=@16040, Definition=@1603 );

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@16050: SingleOccurrence( Id=IdentifierString("617200_5"),
  Definition=@1602 );
  @16051: OccurrenceTerminal( ElementOf=@16050, Definition=@1603 );
@16060: SingleOccurrence( Id=IdentifierString("617200_6"),
  Definition=@1602 );
  @16061: OccurrenceTerminal( ElementOf=@16060, Definition=@1603 );
@16070: SingleOccurrence( Id=IdentifierString("617200_7"),
  Definition=@1602 );
  @16071: OccurrenceTerminal( ElementOf=@16070, Definition=@1603 );
@16080: SingleOccurrence( Id=IdentifierString("617200_8"),
  Definition=@1602 );
  @16081: OccurrenceTerminal( ElementOf=@16080, Definition=@1603 );
@16090: SingleOccurrence( Id=IdentifierString("617200_9"),
  Definition=@1602 );
  @16091: OccurrenceTerminal( ElementOf=@16090, Definition=@1603 );
@16110: SingleOccurrence( Id=IdentifierString("617200_11"), Definition=@1602 );
  @16111: OccurrenceTerminal( ElementOf=@16110, Definition=@1603 );
@16120: SingleOccurrence( Id=IdentifierString("617200_12"), Definition=@1602 );
  @16121: OccurrenceTerminal( ElementOf=@16120, Definition=@1603 );
@16130: SingleOccurrence( Id=IdentifierString("617200_13"), Definition=@1602 );
  @16131: OccurrenceTerminal( ElementOf=@16130, Definition=@1603 );
@16140: SingleOccurrence( Id=IdentifierString("617200_14"), Definition=@1602 );
  @16141: OccurrenceTerminal( ElementOf=@16140, Definition=@1603 );
@16150: SingleOccurrence( Id=IdentifierString("617200_15"), Definition=@1602 );
  @16151: OccurrenceTerminal( ElementOf=@16150, Definition=@1603 );
@16160: SingleOccurrence( Id=IdentifierString("617200_16"), Definition=@1602 );
  @16161: OccurrenceTerminal( ElementOf=@16160, Definition=@1603 );
@16170: SingleOccurrence( Id=IdentifierString("617200_17"), Definition=@1602 );
  @16171: OccurrenceTerminal( ElementOf=@16170, Definition=@1603 );
@16180: SingleOccurrence( Id=IdentifierString("617200_18"), Definition=@1602 );
  @16181: OccurrenceTerminal( ElementOf=@16180, Definition=@1603 );
@16190: SingleOccurrence( Id=IdentifierString("617200_19"), Definition=@1602 );
  @16191: OccurrenceTerminal( ElementOf=@16190, Definition=@1603 );

# Cable
@2100: Part( PartTypes[i]=PartCategoryEnum(cable), PartTypes[i]=PartCategoryEnum(raw_material_by_length) );
@2101: PartVersion;
@2103: Identifier( Id=IdentifierString("GAC861AH424S"), IdentificationContext=@51 )
Part_with_ID_and_PartView(@2100, @2103, @2101, @2102, @4);
@2102: PartView;
  @21020: WirePartIdentification( ElementOf=@2102, DomainType="electrical", code=870 );
  @21021: WirePartIdentification( ElementOf=@2102, DomainType="electrical", code=871 );
@21022:WirePartIdentification( ElementOf=@2102, DomainType="electrical", code=872 );
@21023:WirePartIdentification( ElementOf=@2102, DomainType="electrical", code=873 );
@21024:WirePartIdentification( ElementOf=@2102, DomainType="electrical", code=874 );
@2110:CableOccurrence( Id=IdentifierString("403-4S1"), Definition=@502, Quantity=@2111 );
  @2111:NumericalValue( Unit=8, ValueComponent=1.8 );
  @21120:WireOccurrenceIdentification( ElementOf=@21020, Definition=@2110 );
  @21121:WireOccurrenceIdentification( ElementOf=@2110, Definition=@211021 );
  @21122:WireOccurrenceIdentification( ElementOf=@2110, Definition=@211022 );
  @21123:WireOccurrenceIdentification( ElementOf=@2110, Definition=@211023 );
  @21124:WireOccurrenceIdentification( ElementOf=@2110, Definition=@211024 );
@21125:CableOccurrenceTerminalLocationGroup( ElementOf=@2110, Name="end a" );
  @211250:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21125 );
  @211251:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21125 );
  @211252:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21125 );
  @211253:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21125 );
  @211254:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21125 );
@21126:CableOccurrenceTerminalLocationGroup( ElementOf=@2110, Name="end b" );
  @211260:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21126 );
  @211261:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21126 );
  @211262:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21126 );
  @211263:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21126 );
  @211264:CableOccurrenceTerminal( ElementOf=@2110, AssociatedTransportFeature=@21126 );
@2120:CableOccurrence( Id=IdentifierString("403-4S2"), Definition=@502, Quantity=@2111 );
  @2121:NumericalValue( Unit=8, ValueComponent=1.8 );
  @21220:WireOccurrenceIdentification( ElementOf=@2120, Definition=@2120 );
  @21221:WireOccurrenceIdentification( ElementOf=@2120, Definition=@212021 );
  @21222:WireOccurrenceIdentification( ElementOf=@2120, Definition=@212022 );
  @21223:WireOccurrenceIdentification( ElementOf=@2120, Definition=@212023 );
  @21224:WireOccurrenceIdentification( ElementOf=@2120, Definition=@212024 );
@21225:CableOccurrenceTerminalLocationGroup( ElementOf=@2120, Name="end a" );
  @211250:CableOccurrenceTerminal( ElementOf=@21125, AssociatedTransportFeature=@21120 );
  @211251:CableOccurrenceTerminal( ElementOf=@21125, AssociatedTransportFeature=@21121 );
  @211252:CableOccurrenceTerminal( ElementOf=@21125, AssociatedTransportFeature=@21122 );
  @211253:CableOccurrenceTerminal( ElementOf=@21125, AssociatedTransportFeature=@21123 );
  @211254:CableOccurrenceTerminal( ElementOf=@21125, AssociatedTransportFeature=@21124 );
@21126:CableOccurrenceTerminalLocationGroup( ElementOf=@2120, Name="end b" );
  @211260:CableOccurrenceTerminal( ElementOf=@21126, AssociatedTransportFeature=@21120 );
  @211261:CableOccurrenceTerminal( ElementOf=@21126, AssociatedTransportFeature=@21121 );
  @211262:CableOccurrenceTerminal( ElementOf=@21126, AssociatedTransportFeature=@21122 );
  @211263:CableOccurrenceTerminal( ElementOf=@21126, AssociatedTransportFeature=@21123 );
  @211264:CableOccurrenceTerminal( ElementOf=@21126, AssociatedTransportFeature=@21124 );
@2130:CableOccurrence( Id=IdentifierString("403-4S5"), Definition=@502, Quantity=@2131 );
  @2131:NumericalValue( Unit=@8, ValueComponent=1.8 );
  @21300:WireOccurrenceIdentification( ElementOf=@2130, Definition=@21020 );
  @21301:WireOccurrenceIdentification( ElementOf=@2130, Definition=@21021 );
  @21302:WireOccurrenceIdentification( ElementOf=@2130, Definition=@21022 );
  @21303:WireOccurrenceIdentification( ElementOf=@2130, Definition=@21023 );
  @21304:WireOccurrenceIdentification( ElementOf=@2130, Definition=@21024 );
  @21305:CableOccurrenceTerminalLocationGroup( ElementOf=@2130, Name="end a" );
  @213050:CableOccurrenceTerminal( ElementOf=@21305, AssociatedTransportFeature=@21120 );
  @213051:CableOccurrenceTerminal( ElementOf=@21305, AssociatedTransportFeature=@21121 );
  @213052:CableOccurrenceTerminal( ElementOf=@21305, AssociatedTransportFeature=@21122 );
  @213053:CableOccurrenceTerminal( ElementOf=@21305, AssociatedTransportFeature=@21123 );
  @213054:CableOccurrenceTerminal( ElementOf=@21305, AssociatedTransportFeature=@21124 );
@21306:CableOccurrenceTerminalLocationGroup( ElementOf=@2110, Name="end b" );
  @213060:CableOccurrenceTerminal( ElementOf=@21306, AssociatedTransportFeature=@21120 );
  @213061:CableOccurrenceTerminal( ElementOf=@21306, AssociatedTransportFeature=@21121 );
  @213062:CableOccurrenceTerminal( ElementOf=@21306, AssociatedTransportFeature=@21122 );
@213063:CableOccurrenceTerminal( ElementOf=@21306, AssociatedTransportFeature=@21123 );  
@213064:CableOccurrenceTerminal( ElementOf=@21306, AssociatedTransportFeature=@21124 );

# Wire  
@2200:Part( PartTypes[i]=PartCategoryEnum(wire),  
    PartTypes[i]=PartCategoryEnum(raw_material_by_length) );  
@2201:PartVersion;  
@2203:Identifier( Id=IdentifierString("04034-22-9"),  
    IdentificationContext=052 );  
Part_with_ID_and_PartView(@2200, @2203, @2201, @2202, @4);  
@2202:PartView;  
  @22021:WirePartIdentification( ElementOf=@2202, DomainType="electrical" );  
  @2210:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202,  
    Quantity=@22101 );  
    @22101:NumericalValue( Unit=08, ValueComponent=2.490851 );  
    @22102=WireOccurrenceIdentification( ElementOf=@2210, Definition=@22021 )  
    @22103=WireOccurrenceTerminal( ElementOf=@2210, AssociatedTransportFeature=@22102,  
        Name="end a" );  
    @22104=WireOccurrenceTerminal( ElementOf=@2210, AssociatedTransportFeature=@22102,  
        Name="end b" );  
  @2220:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202,  
    Quantity=@22201 );  
    @22201:NumericalValue( Unit=08, ValueComponent=2.490851 );  
    @22202=WireOccurrenceIdentification( ElementOf=@2220, Definition=@22021 )  
    @22203=WireOccurrenceTerminal( ElementOf=@2220, AssociatedTransportFeature=@22202,  
        Name="end a" );  
    @22204=WireOccurrenceTerminal( ElementOf=@2220, AssociatedTransportFeature=@22202,  
        Name="end b" );  
  @2230:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202,  
    Quantity=@22301 );  
    @22301:NumericalValue( Unit=08, ValueComponent=2.490851 );  
    @22302=WireOccurrenceIdentification( ElementOf=@2230, Definition=@22021 )  
    @22303=WireOccurrenceTerminal( ElementOf=@2230, AssociatedTransportFeature=@22302,  
        Name="end a" );  
    @22304=WireOccurrenceTerminal( ElementOf=@2230, AssociatedTransportFeature=@22302,  
        Name="end b" );  
  @2240:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202,  
    Quantity=@22401 );  
    @22401:NumericalValue( Unit=08, ValueComponent=2.490851 );  
    @22402=WireOccurrenceIdentification( ElementOf=@2240, Definition=@22021 )  
    @22403=WireOccurrenceTerminal( ElementOf=@2240, AssociatedTransportFeature=@22402,  
        Name="end a" );  
    @22404=WireOccurrenceTerminal( ElementOf=@2240, AssociatedTransportFeature=@22402,  
        Name="end b" );
@2250:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202, Quantity=@22501 );
  @22501:NumericalValue( Unit=08, ValueComponent=2.490851 );
  @22502=WireOccurrenceIdentification( ElementOf=@2250, Definition=@22021 )
  @22503=WireOccurrenceTerminal( ElementOf=@2250, AssociatedTransportFeature=@22102,
    Name="end a" );
  @22504=WireOccurrenceTerminal( ElementOf=@2250, AssociatedTransportFeature=@22102,
    Name="end b" );
@2260:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202, Quantity=@22601 );
  @22601:NumericalValue( Unit=08, ValueComponent=2.490851 );
  @22602=WireOccurrenceIdentification( ElementOf=@2260, Definition=@22021 )
  @22603=WireOccurrenceTerminal( ElementOf=@2260, AssociatedTransportFeature=@22102,
    Name="end a" );
  @22604=WireOccurrenceTerminal( ElementOf=@2260, AssociatedTransportFeature=@22102,
    Name="end b" );
@2270:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202, Quantity=@22701 );
  @22701:NumericalValue( Unit=08, ValueComponent=2.490851 );
  @22702=WireOccurrenceIdentification( ElementOf=@2270, Definition=@22021 )
  @22703=WireOccurrenceTerminal( ElementOf=@2270, AssociatedTransportFeature=@22102,
    Name="end a" );
  @22704=WireOccurrenceTerminal( ElementOf=@2270, AssociatedTransportFeature=@22102,
    Name="end b" );
@2280:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202, Quantity=@22801 );
  @22801:NumericalValue( Unit=08, ValueComponent=2.490851 );
  @22802=WireOccurrenceIdentification( ElementOf=@2280, Definition=@22021 )
  @22803=WireOccurrenceTerminal( ElementOf=@2280, AssociatedTransportFeature=@22102,
    Name="end a" );
  @22804=WireOccurrenceTerminal( ElementOf=@2280, AssociatedTransportFeature=@22102,
    Name="end b" );
@2290:WireOccurrence( Id=IdentifierString("W194C22-4"), Definition=@2202, Quantity=@22901 );
  @22901:NumericalValue( Unit=08, ValueComponent=2.490851 );
  @22902=WireOccurrenceIdentification( ElementOf=@2290, Definition=@22021 )
  @22903=WireOccurrenceTerminal( ElementOf=@2290, AssociatedTransportFeature=@22102,
    Name="end a" );
  @22904=WireOccurrenceTerminal( ElementOf=@2290, AssociatedTransportFeature=@22102,
    Name="end b" );

# EWH-Assembly
@9000:Part;
@9001:PartVersion;
@9003:ViewContext;
@9004: ViewContext;
Part_WiringHarnessAssemblyDesign_with_topology( @9000, "EWH Test-Case Connectivity5", @9001, @9002, @9003, @9004 );
@9002: WiringHarnessAssemblyDesign( Topology=@9901 );

@9101: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@11010 ); # 001A1P1X1
@9102: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@11020 ); # 002A1P1X1
@9103: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@12010 ); # 001A1P1XE
@9104: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@12020 ); # 002A1P1XE
@9105: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1311 ); # 001A1P1X1A
@9106: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1321 ); # 002A1P1X1A
@9107: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1411 ); # 001A1P1X1B
@9108: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1421 ); # 002A1P1X1B
@9109: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1510 ); # 001A1P1X1AQ1
@9110: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1520 ); # 002A1P1X1AQ1
@9111: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1530 ); # 001A1P1X1AQ1
@9112: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1540 ); # 002A1P1X1AQ1
@9113: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1550 ); # 001A1P1X1AQ1
@9114: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@1560 ); # 002A1P1X1AQ1
@9115: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16010 ); # 617200_1
@9116: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16020 ); # 617200_2
@9117: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16030 ); # 617200_3
@9118: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16040 ); # 617200_4
@9119: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16050 ); # 617200_5
@9120: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16060 ); # 617200_6
@9121: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16070 ); # 617200_7
@9122: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16080 ); # 617200_8
@9123: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16090 ); # 617200_9
@9124: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16100 ); # 617200_10
@9125: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16110 ); # 617200_11
@9126: NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16120 ); # 617200_12

66
@9127:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16130 ); # 617200_13
@9128:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16140 ); # 617200_14
@9129:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16150 ); # 617200_15
@9130:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16160 ); # 617200_16
@9131:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16170 ); # 617200_17
@9132:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16180 ); # 617200_18
@9133:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@16190 ); # 617200_19
@9134:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2110 ); # 403-4S1
@9135:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2120 ); # 403-4S2
@9136:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2130 ); # 403-4S5
@9137:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2134 ); # 403-4S9
@9138:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2136 ); # 403-4S11
@9139:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2138 ); # 403-4S13
@9140:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2140 ); # 403-4S15
@9141:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2142 ); # 403-4S17
@9142:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2144 ); # 403-4S19
@9143:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2146 ); # 403-4S21
@9144:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2148 ); # 403-4S23
@9145:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2150 ); # 403-4S25
@9146:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2152 ); # 403-4S27
@9147:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2154 ); # 403-4S29
@9148:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2156 ); # 403-4S31
@9149:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2158 ); # 403-4S33
@9150:NextAssemblyOccurrenceUsage( Relating=@9002, Related=@2160 ); # 403-4S35
@9151:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W194C22-4
@9152:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W194D22-4
@9153:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W194J22-4
@9154:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W194H22-4
@9155:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W195EA22-4
@9156:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W195KA22-4
@9157:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W302D22-4
@9158:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W302H22-4
@9159:NextAssemblyOccurrenceUsage( Relating=@9002, Related=0 ); # W304EA22-4

# electrical AssemblyShapeJoints:
Joint2(@9002, @1511, @211250, "crimped_connection"); # TERM104
Joint2(@9002, @1512, @211251, "crimped_connection"); # TERM100
Joint2(@9002, @1513, @211252, "crimped_connection"); # TERM102
Joint2(@9002, @1514, @211253, "crimped_connection"); # TERM101
Joint2(@9002, @1515, @211254, "crimped_connection"); # TERM103
Joint2(@9002, @1521, @211260, "crimped_connection"); # TERM128
Joint2(@9002, @1522, @211261, "crimped_connection"); # TERM124
Joint2(@9002, @1523, @211262, "crimped_connection"); # TERM126
Joint2(@9002, @1524, @211263, "crimped_connection"); # TERM125
Joint2(@9002, @1525, @211264, "crimped_connection"); # TERM127
Joint2(@9002, @1531, @211250, "crimped_connection"); # TERM109
Joint2(@9002, @1532, @211251, "crimped_connection"); # TERM107
Joint2(@9002, @1533, @211252, "crimped_connection"); # TERM105
Joint2(@9002, @1534, @211253, "crimped_connection"); # TERM106
Joint2(@9002, @1535, @211254, "crimped_connection"); # TERM108
Joint2(@9002, @1541, @211260, "crimped_connection"); # TERM133
Joint2(@9002, @1542, @211261, "crimped_connection"); # TERM131
Joint2(@9002, @1543, @211262, "crimped_connection"); # TERM129
Joint2(@9002, @1544, @211263, "crimped_connection"); # TERM130
Joint2(@9002, @1545, @211264, "crimped_connection"); # TERM132
Joint2(9002, @1551, @213050, "crimped_connection"); # TERM114
Joint2(9002, @1552, @213051, "crimped_connection"); # TERM112
Joint2(9002, @1553, @213052, "crimped_connection"); # TERM110
Joint2(9002, @1554, @213053, "crimped_connection"); # TERM111
Joint2(9002, @1555, @213054, "crimped_connection"); # TERM113
Joint2(9002, @1561, @213060, "crimped_connection"); # TERM138
Joint2(9002, @1562, @213061, "crimped_connection"); # TERM136
Joint2(9002, @1563, @213062, "crimped_connection"); # TERM134
Joint2(9002, @1564, @213063, "crimped_connection"); # TERM135
Joint2(9002, @1565, @213064, "crimped_connection"); # TERM137
Joint2(9002, @16011, @22103, "crimped_connection"); # TERM116
Joint2(9002, @16021, @22203, "crimped_connection"); # TERM117
Joint2(9002, @16031, @22303, "crimped_connection"); # TERM118
Joint2(9002, @16041, @22403, "crimped_connection"); # TERM119
Joint2(9002, @16051, @22503, "crimped_connection"); # TERM121
Joint2(9002, @16061, @22603, "crimped_connection"); # TERM122
Joint2(9002, @16071, @22703, "crimped_connection"); # TERM120
Joint2(9002, @16081, @22803, "crimped_connection"); # TERM115
Joint2(9002, @16091, @22903, "crimped_connection"); # TERM123
Joint2(9002, @16111, @22104, "crimped_connection"); # TERM140
Joint2(9002, @16121, @22204, "crimped_connection"); # TERM141
Joint2(9002, @16131, @22304, "crimped_connection"); # TERM142
Joint2(9002, @16141, @22404, "crimped_connection"); # TERM143
Joint2(9002, @16151, @22504, "crimped_connection"); # TERM145
Joint2(9002, @16161, @22604, "crimped_connection"); # TERM146
Joint2(9002, @16171, @22704, "crimped_connection"); # TERM144
Joint2(9002, @16181, @22804, "crimped_connection"); # TERM139
Joint2(9002, @16191, @22904, "crimped_connection"); # TERM147

# mechanical AssemblyShapeJoints:
Joint2(9002, @1517, @13111, "snap_connection"); # 001A1P1X1AQ1 into 001A1P1X1A/1
Joint2(9002, @1527, @13112, "snap_connection"); # 001A1P1X1AQ2 into 001A1P1X1A/2
Joint2(9002, @1537, @13113, "snap_connection"); # 001A1P1X1AQ3 into 001A1P1X1A/3
Joint2(9002, @1547, @13211, "snap_connection"); # 002A1P1X1AQ1 into 002A1P1X1A/1
Joint2(9002, @1557, @13212, "snap_connection"); # 002A1P1X1AQ2 into 002A1P1X1A/2
Joint2(9002, @1567, @13213, "snap_connection"); # 002A1P1X1AQ3 into 002A1P1X1A/3
Joint2(9002, @16011, @141101, "snap_connection"); # 617200_1 into 001A1P1X1B/1
Joint2(9002, @16021, @141102, "snap_connection"); # 617200_2 into 001A1P1X1B/2
Joint2(9002, @16031, @141103, "snap_connection"); # 617200_3 into 001A1P1X1B/3
Joint2(@9002, @16041, @141104, "snap_connection"); # 617200_4 into 001A1P1X1B/4
Joint2(@9002, @16051, @141105, "snap_connection"); # 617200_5 into 001A1P1X1B/5
Joint2(@9002, @16061, @141106, "snap_connection"); # 617200_6 into 001A1P1X1B/6
Joint2(@9002, @16071, @141109, "snap_connection"); # 617200_7 into 001A1P1X1B/9
Joint2(@9002, @16081, @141113, "snap_connection"); # 617200_8 into 001A1P1X1B/13
Joint2(@9002, @16091, @141114, "snap_connection"); # 617200_9 into 001A1P1X1B/14

Joint2(@9002, @16101, @142101, "snap_connection"); # 617200_10 into 002A1P1X1B/1
Joint2(@9002, @16111, @142102, "snap_connection"); # 617200_11 into 002A1P1X1B/2
Joint2(@9002, @16121, @142103, "snap_connection"); # 617200_12 into 002A1P1X1B/3
Joint2(@9002, @16131, @142104, "snap_connection"); # 617200_13 into 002A1P1X1B/4
Joint2(@9002, @16141, @142105, "snap_connection"); # 617200_14 into 002A1P1X1B/5
Joint2(@9002, @16151, @142106, "snap_connection"); # 617200_15 into 002A1P1X1B/6
Joint2(@9002, @16161, @142109, "snap_connection"); # 617200_16 into 002A1P1X1B/9
Joint2(@9002, @16171, @142113, "snap_connection"); # 617200_17 into 002A1P1X1B/13
Joint2(@9002, @16181, @142114, "snap_connection"); # 617200_19 into 002A1P1X1B/14

Joint2(@9002, @16101, @142101, "screwed_connection"); # 001A1P1X1A into 001A1P1X1/A
Joint2(@9002, @141100, @11012, "screwed_connection"); # 001A1P1X1B into 001A1P1X1/B
Joint2(@9002, @120101, @11013, "screwed_connection"); # 001A1P1XE into 001A1P1X1/(backside)

Joint2(@9002, @120101, @11013, "screwed_connection"); # 002A1P1X1A into 002A1P1X1/A
Joint2(@9002, @142100, @11022, "screwed_connection"); # 002A1P1X1B into 002A1P1X1/B
Joint2(@9002, @120201, @11023, "screwed_connection"); # 002A1P1XE into 002A1P1X1/(backside)

@9801:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99201, Attached-Feature=@ );
@9802:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99202, Attached-Feature=@ );
@9803:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99203, Attached-Feature=@ );
@9804:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99204, Attached-Feature=@ );
@9805:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99205, Attached-Feature=@ );
@9806:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99206, AttachedFeature=@ );
@9807:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99207, AttachedFeature=@ );
@9808:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99208, AttachedFeature=@ );
@9809:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99209, AttachedFeature=@ );
@9810:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99210, AttachedFeature=@ );
@9811:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99211, AttachedFeature=@ );
@9812:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99212, AttachedFeature=@ );
@9813:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99213, AttachedFeature=@ );
@9814:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99214, AttachedFeature=@ );
@9815:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99215, AttachedFeature=@ );
@9816:HarnessNode( ElementOf=@9002, RepresentedGeometry=@99216, AttachedFeature=@ );

@9900:GeometricCoordinateSpace( Units=@8, DimensionCount=1 );
@9901:EdgeBasedTopologicalRepresentationWithLengthConstraint( Items=(@9902), ContextOfItems=@9900 );
@9902:ConnectedEdgeSet( ConnectedEdges=(@99301,@99302,@99303,@99304,@99305, @99306, @99307,@99308,@99309,@99310,@99311 ) );

@99101:Point();
@99102:Point();
@99103:Point();
@99104:Point();
@99105:Point();
@99106:Point();
@99107:Point();
@99108:Point();
@99109:Point();
@99110:Point();
@99111:Point();
@99112:Point();
@99113:Point();
@99114:Point();
@99115:Point();
@99116:Point();

@99201:VertexPoint( name='N1002' VertexGeometry=@99101 );
@99202:VertexPoint( name='N1003' VertexGeometry=@99102 );
@99203:VertexPoint( name='N1005' VertexGeometry=@99103 );
@99204:VertexPoint( name='N1006' VertexGeometry=@99104 );
@99205:VertexPoint( name='N1008' VertexGeometry=@99105 );
@99206:VertexPoint( name='N1009' VertexGeometry=@99106 );
@99207:VertexPoint( name='N1010' VertexGeometry=@99107 );
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@99208:VertexPoint( name='N1011' VertexGeometry=@99108 );
@99209:VertexPoint( name='N1012' VertexGeometry=@99109 );
@99210:VertexPoint( name='N1013' VertexGeometry=@99110 );
@99211:VertexPoint( name='N1014' VertexGeometry=@99111 );
@99212:VertexPoint( name='N1015' VertexGeometry=@99112 );
@99213:VertexPoint( name='N1016' VertexGeometry=@99113 );
@99214:VertexPoint( name='N1017' VertexGeometry=@99114 );
@99215:VertexPoint( name='N1020' VertexGeometry=@99115 );
@99216:VertexPoint( name='N1021' VertexGeometry=@99116 );

@99301:EdgeBoundedCurveWithLength( name='BUN802', EdgeGeometry=@99401 );
undirected_edge(@9931, @9921, @9923)
@99302:EdgeBoundedCurveWithLength( name='BUN803', EdgeGeometry=@99402 );
undirected_edge(@9932, @9922, @9923)
@99303:EdgeBoundedCurveWithLength( name='BUN804', EdgeGeometry=@99403 );
undirected_edge(@9933, @9923, @9924);
@99304:EdgeBoundedCurveWithLength( name='BUN805', EdgeGeometry=@99404 );
undirected_edge(@9934, @9924, @9925);
@99305:EdgeBoundedCurveWithLength( name='BUN806', EdgeGeometry=@99405 );
undirected_edge(@9935, @9924, @9926);
@99306:EdgeBoundedCurveWithLength( name='BUN807', EdgeGeometry=@99406 );
undirected_edge(@9935, @9924, @9926);
@99307:EdgeBoundedCurveWithLength( name='BUN808', EdgeGeometry=@99407 );
undirected_edge(@9935, @9924, @9926);
@99308:EdgeBoundedCurveWithLength( name='BUN809', EdgeGeometry=@99408 );
undirected_edge(@9935, @9924, @9926);
@99309:EdgeBoundedCurveWithLength( name='BUN810', EdgeGeometry=@99409 );
undirected_edge(@9935, @9924, @9926);
@99310:EdgeBoundedCurveWithLength( name='BUN811', EdgeGeometry=@99410 );
undirected_edge(@9935, @9924, @9926);
@99311:EdgeBoundedCurveWithLength( name='BUN812', EdgeGeometry=@99411 );
undirected_edge(@9935, @9924, @9926);

@99401:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.381) );
@99402:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.635) );
@99403:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(1.077468) );
@99404:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(1.170686) );
@99405:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.889) );
@99406:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(1.591056) );
@99407:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(1.655826) );
@99408:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.889) );
@99409:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.635) );
@99410:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.381) );
@99411:BoundedCurveWithLength( CurveLength=PositiveLengthMeasure(0.74041) );
4.10 Production1
This test case is an obfuscated extract from a real production model.

This test case is different from the previous unit tests in that no strict requirement is given which exact business object in which particular pattern to generate. The test input data is provided in different forms:

- EXCEL spreadsheet, file 112233L_A_001 BOM.xlsx
  - sheet 112233L (001) contains an incomplete bill of material with reference designators for the occurrences
  - sheet WireList contains the original wire list we received from the OEM
  - sheet WireListMod is a modified version of WireList with improved structure
- in KBL format, file 112233L_A_001.kbl.xml
- in Siemens/Mentor Capital harness format H2XML, file 112233L_A_001.x2ml.xml
- native CATIA files including CATPart and CATProduct
- traditional STEP p21 format with geometry only for the harness segments
- PDF with formboard diagram

It is up to the implementation to use the input files that are best suited to generate a STEP AP242 XML file for the described EWH. Essential for the end result is that the specified parts or similar parts are used for a harness that is close as possible to the specified one.
4.10.1 Bill Of Material & Reference Designators (RefDes)

The provided bill of material contains reference designators for each occurrence and is therefore more a kind of an assembly structure (with no geometry / transformations).

The part categories for each part is provided. For this test case we use the new category shrink_boot that will be included in the next revision of AP242. There is also a question if the EWIS-IF shall introduce a new part category for fasteners / banding, as these are an essential element to tight the wire shields onto the backshell.

Figure 25: Production1 in JT viewer
4.10.2 Topology

The harness topology is of a Y type with 4 nodes; one in the center and 3 where the connectors P1, P6 and J1 are placed. In the KBL and X2XML file they are named SegmentExtremity.65, .66, .73 and .84. For the purpose of this test we use the shortened names N65, N66, N84 and N73 for the node in the center.

The three harness segments are named W112233-R1, W112233-X2 and W112233-X3. For the purpose of this test we use the shortened names R1, X2 and X3.

- J1:N84 - X3 - N73
- P6:N65 - R1 - N73
- P1:N66 - X2 - N73

There are two paths defined in this EWH design:

- path 4 that is between connectors P1 and J1 following the harness segments R1 and X2. This path is used by only one wire
• path 7 that is between connectors P1 and P6 following the harness segments R1 and X2. This path is used for all wires and cables except of one

The harness is hermetically sealed against the environment with several protective coverings and shrink boots for each connector.

Figure 26: Extract from MIL-STD-1560C for insert arrangement 15-18, for P1 and P6
4.10.3 Harness Node N66 / Connector stuff P1
On node P1 we can find the following occurrences:

• a connector_housing 422DB20P1 that is of MIL-SPEC type D38999/26TD18PN that has 18 cavities named A, B, C, D, E, F, G, H, J, K, L, M, N, P, R, S, T, U (names I, O and Q not used) for pin connector contacts

• a backshell 422DB20P1E of part 440HJ148MT1503-S

• a shrink_boot of type 770-003S304W1

• a fastener / band of type M85049/128-3

• 18 pin connector_contacts of MIL-SPEC type M39029/58-363; one for each cavity of the connector_housing.

• 5 cavity_plugs of MIL-SPEC type MS27488-20-2 that goes into the cavity positions P, R, S, T and U in addition to the connector_contacts in these positions. Note that KBL and X2XML misses this information

4.10.4 Harness Node N65 / Connector stuff P6
On node P1 we can find the following occurrences:

• a connector_housing 036A2P6 that is of MIL-SPEC type D38999/26TD18SN that has 18 cavities named A, B, C, D, E, F, G, H, J, K, L, M, N, P, R, S, T, U (names I, O and Q not used) for socket connector contacts

• a backshell 036A2P6E of type 440HH148MT1503-S

• a shrink_boot of type 770-003S304W1

• a fastener / band of type M85049/128-3

• 18 socket connector_contacts of MIL-SPEC type M39029/56-351; one for each cavity of the connector_housing except for G, J, L, U which are not connected and no statement is made about them for connector contact.

• 2 shield splices of type M83519/2-8 that connect to the connector contacts in cavity A and C

• no statement about the connectivity for the backshell is made

4.10.5 Harness Node N84 / Connector stuff J1
On node P1 we can find the following occurrences:

• a connector 422DB26J1 that is of type 805-003-02Z19-25SA that has 5 cavities named 1 to 5. This connector is not split down into housing and a backshell. It comes with an integrated “banding platform” for shielding / overbraid and a shrink_boot.

• a shrink_boot of type 809A060-2

• a fastener / band of type 600-057

• 1 socket connector_contact of type 809-205 for cavity 1 of the connector.
Cavity 2 to 5 of this connector are unused with no connector contact.

4.10.6 Shield Splice M83519/2-8

The harness uses 2 splices, W224E5 and W224E6, near connector P6 that are of type M83519/2-8 which is a military specification that is meanwhile superseded by the SAE specification SAE-AS83519/2, “Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant with Preinstalled Leads for Cables Having Tin or Silver Plated Shields (Class I).” So these are shield splices that needs to be heated up to connect to the shield of a cable. They consists of:

1. a transparent insulation sleeve that is heat-shrinkable
2. preformed solder with flux and thermal indicator (after heating)
3. melt-able thermoplastic rings to keep the splice open while moving it over the cable
4. a lead wire (6 inch) to that it can be connected to e.g a contact terminal or to a backshell
In the X2XML file the terminals the terminals of this splice are indicated as L (for Left), R (as Right) and X for the lead wire.

This kind of splice is also used by test case EWH-Connectivity4.

4.10.7 Cable 04049A22A04T24
There are 4 cable occurrences 223-4S1, 223-2S1, 223-4S2, 223-2S2 that are of type 04049A22A04T24. This cable has 4 wire cores in the colors GRN, ORN, BLU and WHT that are of wire gage size 22 AWG and a shield around the cores.

4.10.8 Wire 04034-22-9
A single wire of size 22 AWG, see test case EWH-Connectivity4.

4.10.9 Electrical Connections
The electrical connections are spreadsheet WireList (modified, corrected) or can be taken from the KBL or X2XML file.

On the side of connector P1 all the four cable shields are connected to the backshell of P1. On the side of connector P6 the cable shields of 223-4S1 and 223-2S2 are connected to the backshell of P6; the shield of cable 223-2S1 is connected to splice W224E6 through which it is connected to the connector contact in P6.D; the shield of cable 223-4S2 is connected to splice W224E5 through which it is connected connector contact in P6.A.
Connection list, modified and re-arranged from original input.

<table>
<thead>
<tr>
<th>Cable/Wire Occurrence</th>
<th>Transport-Feature (subtype) ID</th>
<th>Transport-Feature -colour code</th>
<th>Occurrence ID</th>
<th>Feature ID</th>
<th>From Connector Contact</th>
<th>Splice Occurrence</th>
<th>To Connector Contact</th>
<th>Occurrence ID</th>
<th>Feature ID</th>
</tr>
</thead>
<tbody>
<tr>
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Note: In general all unconnected removable crimp connector contacts for D38999 connectors require a plug: MS27488-20-2