JEDEC PUBLICATION

Part Model Thermal Guidelines for Electronic-Device Packages – XML Requirements

JEP30-T100B.01

(Revision of JEP30-T100B, August 2024)

February 2025

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

NOTICE

JEDEC standards and publications contain material that has been prepared, reviewed, and approved through the JEDEC Board of Directors level and subsequently reviewed and approved by the JEDEC legal counsel.

JEDEC standards and publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for use by those other than JEDEC members, whether the standard is to be used either domestically or internationally.

JEDEC standards and publications are adopted without regard to whether or not their adoption may involve patents or articles, materials, or processes. By such action JEDEC does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the JEDEC standards or publications.

The information included in JEDEC standards and publications represents a sound approach to product specification and application, principally from the solid state device manufacturer viewpoint. Within the JEDEC organization there are procedures whereby a JEDEC standard or publication may be further processed and ultimately become an ANSI standard.

No claims to be in conformance with this standard may be made unless all requirements stated in the standard are met.

Inquiries, comments, and suggestions relative to the content of this JEDEC standard or publication should be addressed to JEDEC at the address below, or refer to www.jedec.org under Standards and Documents for alternative contact information.

Published by
©JEDEC Solid State Technology Association 2025
3103 10th Street North
Suite 240S
Arlington, VA 22201

.

PRICE: Contact JEDEC

DO NOT VIOLATE
THE
LAW!

For information, contact:

JEDEC Solid State Technology Association
3103 10th Street North
Suite 240S
Arlington, VA 22201
https://www.jedec.org/contact

This page intentionally left blank

.

PART MODEL THERMAL GUIDELINE FOR ELECTRONIC-DEVICE PACKAGES - XML REQUIREMENTS

Contents

PART MODEL THERMAL GUIDELINE FOR ELECTRONIC-DEVICE PACKAGES - XML REQUIREMENTS

Tables

Figures

PART MODEL THERMAL GUIDELINE FOR ELECTRONIC-DEVICE PACKAGES - XML REQUIREMENTS

(From JEDEC Board Ballots JCB-24-53, JCB-24-29, JCB-17-48 formulated under the cognizance of the JC-11 Committee on Mechanical Standardization.)

1 Scope

This standard establishes the requirements for exchanging part data between part manufacturers and their customers for electrical and electronic products. This standard applies to all forms of electronic parts. It forms part of the Part Model XML Schema, which covers the parental structure for the electrical, physical, supply chain, thermal, design kits, generated ECAD models, assembly process classification data along with materials and substances that may be present in the supplied product or sub-products. This Guideline specifically focuses on the Thermal sub-section of the Part Model.

All releases of the *Thermal* sub-schema must be under the umbrella of the Part model Schema to ensure that the Part model schema is referencing the correct version of the thermal sub-schema. In addition, this will enable the *Thermal* sub-schema to connect to the Manufacturer Part Number and the Manufacturer of the Part.

1.1 Purpose

This standard is intended to benefit part manufacturers and their customers by providing consistency and efficiency to the transfer of part data from part manufacturer to customers. This standard specifically covers data applicable to the thermal modelling of the device.

2 Applicable Documents

The following documents form a part of this standard to the extent specified herein. The revision of the document in effect at the time of solicitation shall take precedence.

2.1 JEDEC (www.jedec.org)

JESD30J, *Descriptive Designation System for Electronic-device Packages*

JEP30, *Part Model Guidelines for Electronic-Device Packages – XML Requirements*

JEP30-10, *Part Model Schema*

JEP30-T101, *Part Model Thermal Schema*

JEP30-D10, *Part Model Schema Types Dictionary* (Required to support the Part Model Schema and each of its sectional sub-schemas.)

JESD15, *Thermal Modelling Overview*

JESD15-1, *Compact Thermal Model Overview*

JESD51*, Methodology for the Thermal Measurement of Component Packages (Single Semiconductor Device),* Dec. 1995

JESD51-1, *Integrated Circuits Thermal Measurement Method – Electrical Test Method (Single Semiconductor Device)*

2.1 JEDEC (www.jedec.org) **(cont'd)**

JESD51-2, *Integrated Circuit Thermal Test Method Environmental Conditions – Natural Convection (Still Air)*

JESD51-6, *Integrated Circuit Thermal Test Method Environmental Conditions – Forced Convection (Moving Air)*

JESD51-12, *Guidelines for Reporting and Using Electronic Package Thermal Information*

JESD51-13, *Glossary of Thermal Measurement Terms and Definitions*

JESD51-53, *Terms, Definitions and Units Glossary for LED Thermal Testing*

JESD99C, *Terms, Definitions, and Letter Symbols for Microelectronic Devices*

2.2 IPC (www.ipc.org)

IPC-T-50, *Terms and Definitions for Interconnecting and Packaging Electronic Circuits*

3 Requirements

The following terms and definitions are applicable to this XML Schema.

3.1 Terms and Definitions

All definitions and terms associated with the Thermal Data are defined in the JESD51 series of documents, as listed in the applicable documents section. The Thermal details of the part are defined in the *ThermalSection* of the XML Schema.

All common Terms and Definitions that are used by more than one sectional sub-schema, such as any of the Electrical, Package, Environmental, Assembly Process Classification, are defined in the "Part Model Schema Types Library".

All other definitions and terms necessary to define the schema, are defined by this document.

Part Model: A Part Model is a data representation described in an XML file that conforms to the rules and structure of the Part Model XML Schema.

NOTE 1 Companies who use the Part Model XML Files and claim compliance to JEDEC, must ensure that their Part Model XML file conforms to the specific released version of the Part Model XML Schema released by JEDEC.

NOTE 2 Section 4 will define the outline of the structure of the Thermal XML Schema. Specific components of the XML Schema and their hierarchy are specifically controlled by the JC-15 Standards Committee who retain the expertise for these structures.

NOTE 3 The *ThermalSection* of the schema forms part of the Part Model XML Schema and is not intended to act as a standalone schema. In addition, there is a "Part Model Schema Types Library" XML Schema, which is a common set of xml structures shared across the Part Model XML Schema and all of its sub-section schemas.

3.2 XML Schema Key Terms and Definitions

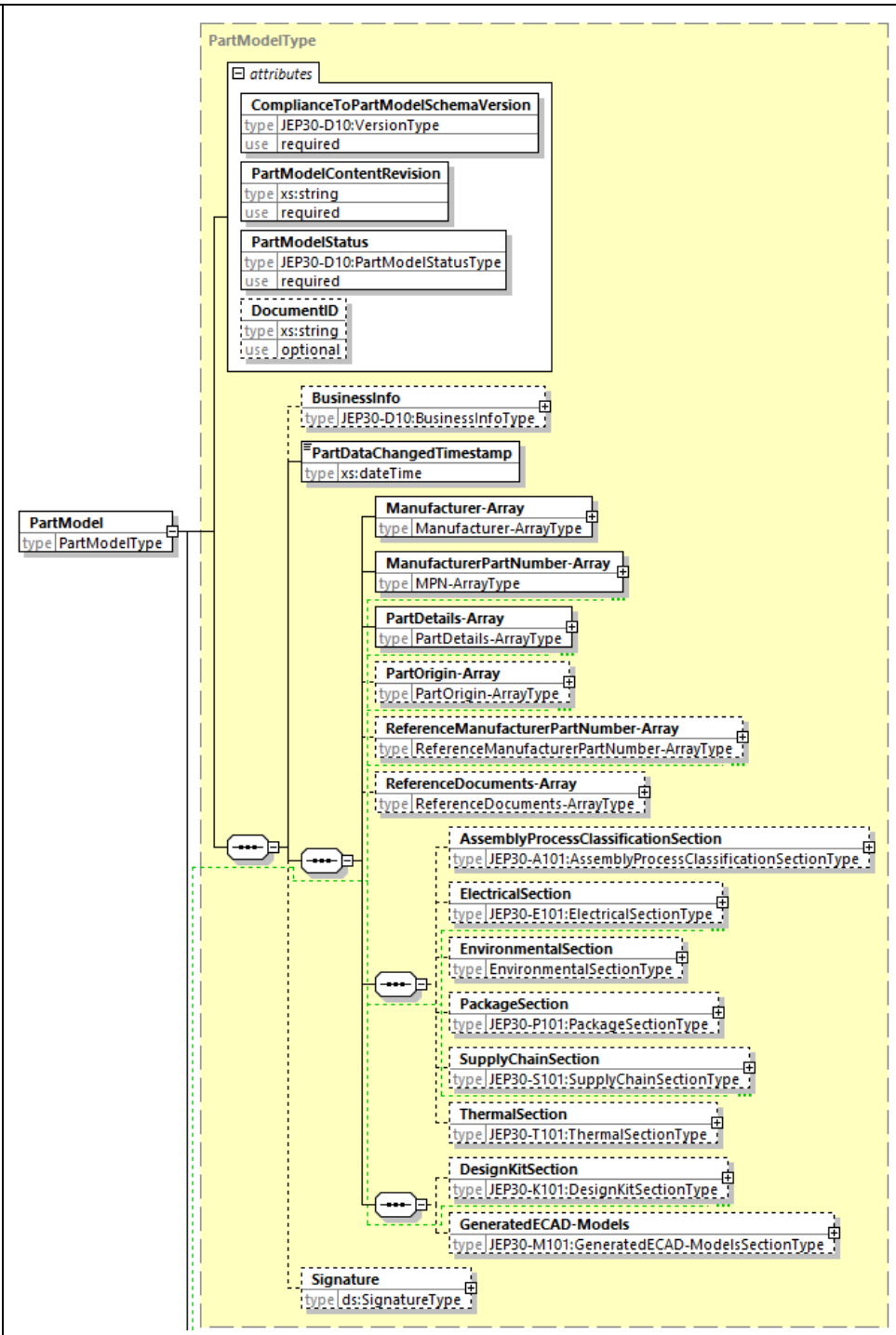
Reference the JEP30 publication for details of the "XML Schema Key Terms and Definitions".

4 Part Model Schema Definition

The following section describes the XML Schema structure.

4.1 Part Model - Thermal Section

diagram



type **PartModelType -> ThermalSection**

4.1 Part Model - Thermal Section (cont'd)

The *PartModelType* belongs to the "Part Model XML Schema". The *ThermalSection* belongs to the "Part Model Thermal XML Schema". The primary purpose of the Part Model Schema is to provide the structure for identifying unique parts (Manufacturer and MPN), and the structure to include the sub schemas which define the part details, as outline in the JEP30 - Part Model Guidelines for Electronic-Device Packages – XML Requirements.

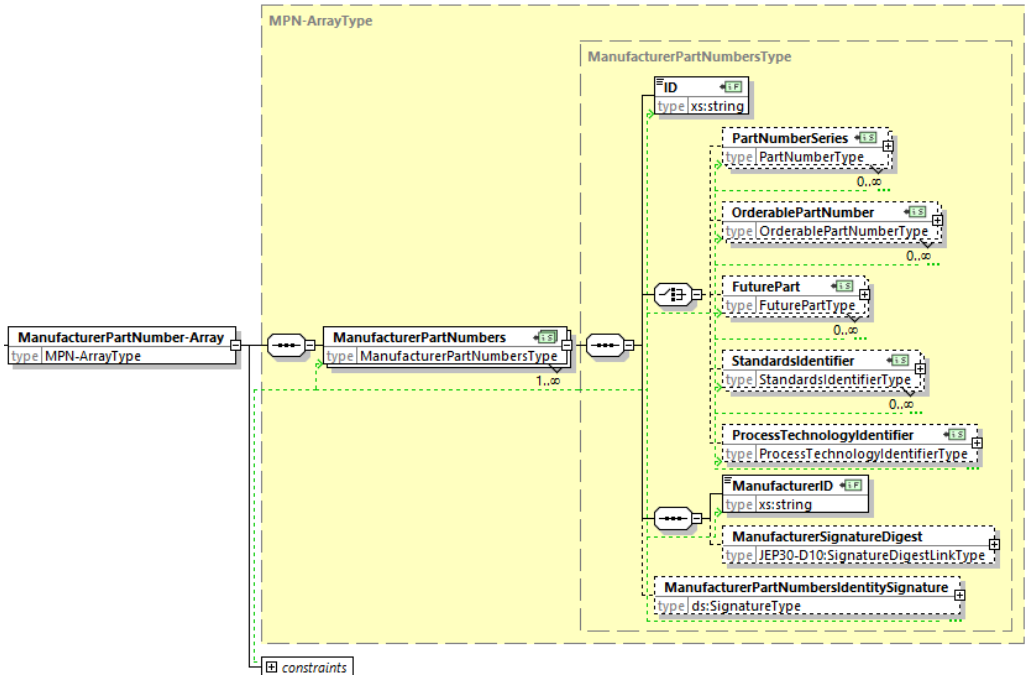
This document covers the *ThermalSection*, which is referenced from its parent's structure, the *PartModel*. The contents under the *ThermalSection* is tied to the Manufacturer's name and Manufacturer's part number.

The *ComplianceToPartModelSchemaVersion* indicates the version of the Schema to which the XML file is to be validated against. All new releases to this document or XML Schema is governed by the rules outlined in JEP30, and must be released in sync with the Part Model.

> *"Each time that a Sub-schema gets updated, then the part model version also gets updated in order to release that Sub-schema under the umbrella of the Part model. This is because the Part Model must now reference the new version of Sub-schema, since all subschemas have their own version number. The parent schema includes them by referring to a precise version, so a version bump in the subschema requires a version bump in the parent only at the time of release of the Parent."*

The *PartModelContentRevision* indicates the revision of the data for the Part that is submitted in the XML file. This enables the Component Manufacturer to provide a new XML file for a Part each time they wish to upgrade a new set of data for a part, in any of the sub-sections such as this *ThermalSection*.

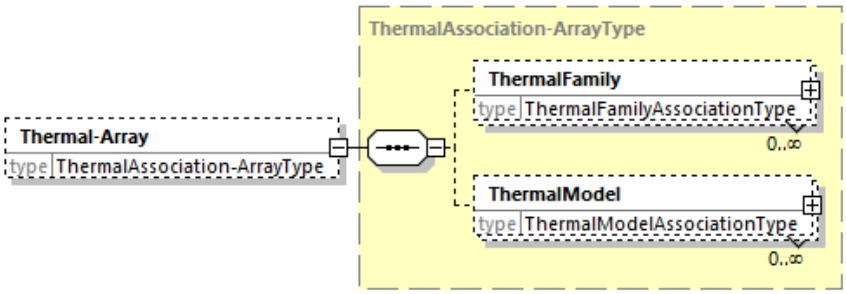
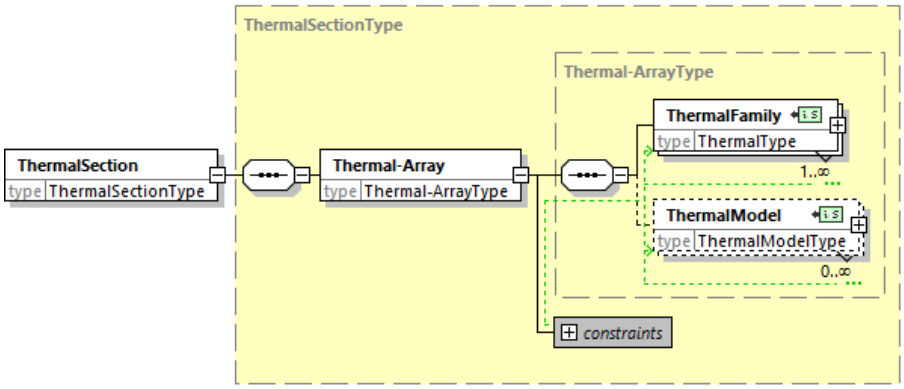
4.2 Manufacturer Part Number - Array

path	**PartModel/ManufacturerPartNumber-Array.**
diagram	
type	**MPN–ArrayType, ManufacturerPartNumbersType, PartNumberType, OrderablePartNumberType, FuturePartType, StandardsIdentifierType, ProcessTechnologyIdentifierType, JEP30-D10:SignatureDigestLinkType, ds:SignatureType.**

The *ManufacturerPartNumber-Array/ManufacturerPartNumber* provides the definition of the part number or a specific Standard, so that it can be connected to the technical specification details in the *ThermalSection* via the *PartDetails-Array* section.

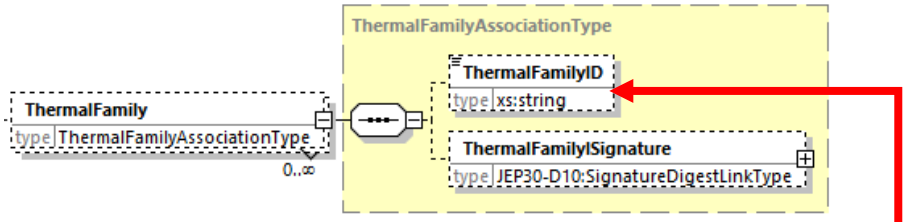
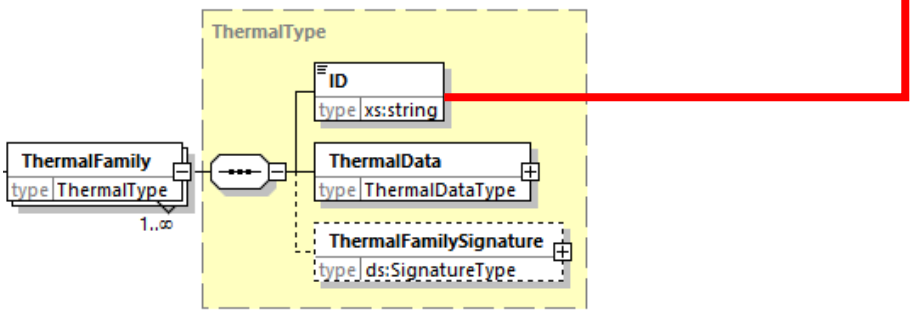
4.3 Linking the Manufacturing Part Number to a specific Thermal Data set

The linking of the Parts to its technical data is done via the *PartDetails-Array* section as outline in the JEP30 - Part Model Guidelines for Electronic-Device Packages – XML Requirements. This consists of two sections called *PartsSelection-Array* and *Association-Array* which defines the relationship between identifying the specific set of parts and how they are associated with the supply chain content. Reference the JEP30 parent document for more details on this association.

path	**PartModel/PartDetails-Array/PartDetails/Association-Array/Association/Thermal-Array**
diagram at the Association level	
type	**ThermalFamilyAssociation-ArrayType, ThermalFamilyAssociationType, ThermalModelAssociationType.**
diagram at the Thermal Section level	
type	**ThermalSectionType, Thermal-ArrayType, ThermalType, ThermalModelType.**

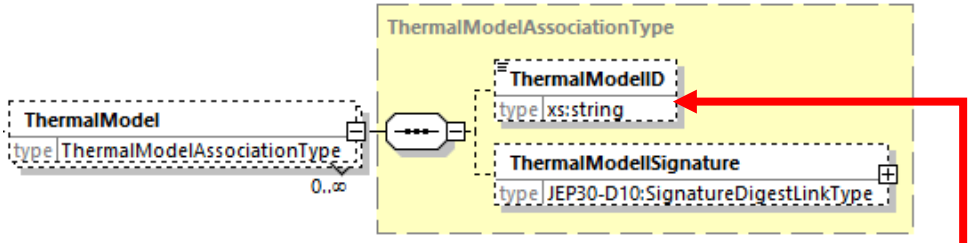
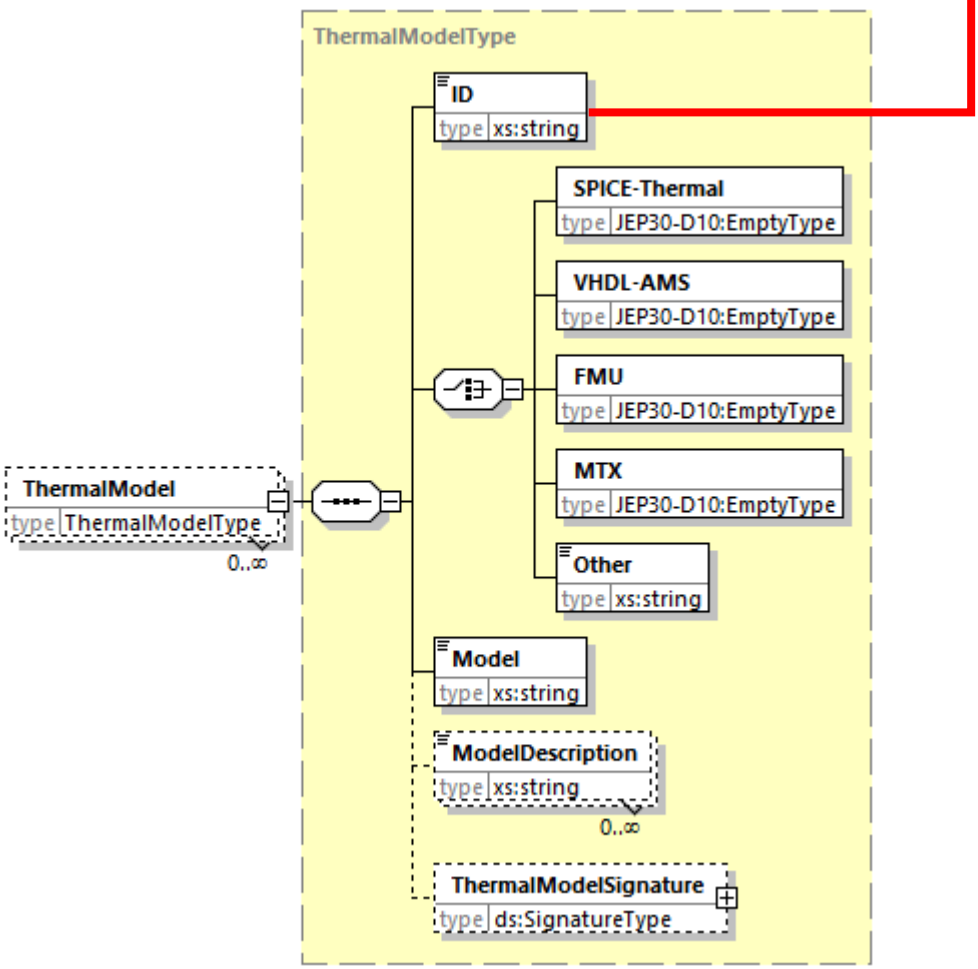
The thermal content is now sub-grouped into 2 major sections as shown in the diagram. This enables each section to be digitally signed independently of each other. The linkage between the 2 sections is shown below.

4.3.1 Linking the Manufacturing Part Number to Thermal Family Content

path	**PartModel/PartDetails-Array/PartDetails/Association-Array/Association/Thermal-Array/ThermalFamily**
diagram at the Electrical Parameters Association level	
type	**ThermalFamilyAssociationType, JEP30-D10:SignatureDigestLinkType.**
path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily**
diagram at the Electrical Parameters-Array level	
type	**ThermalType, ThermalDataType, ds:SignatureType.**

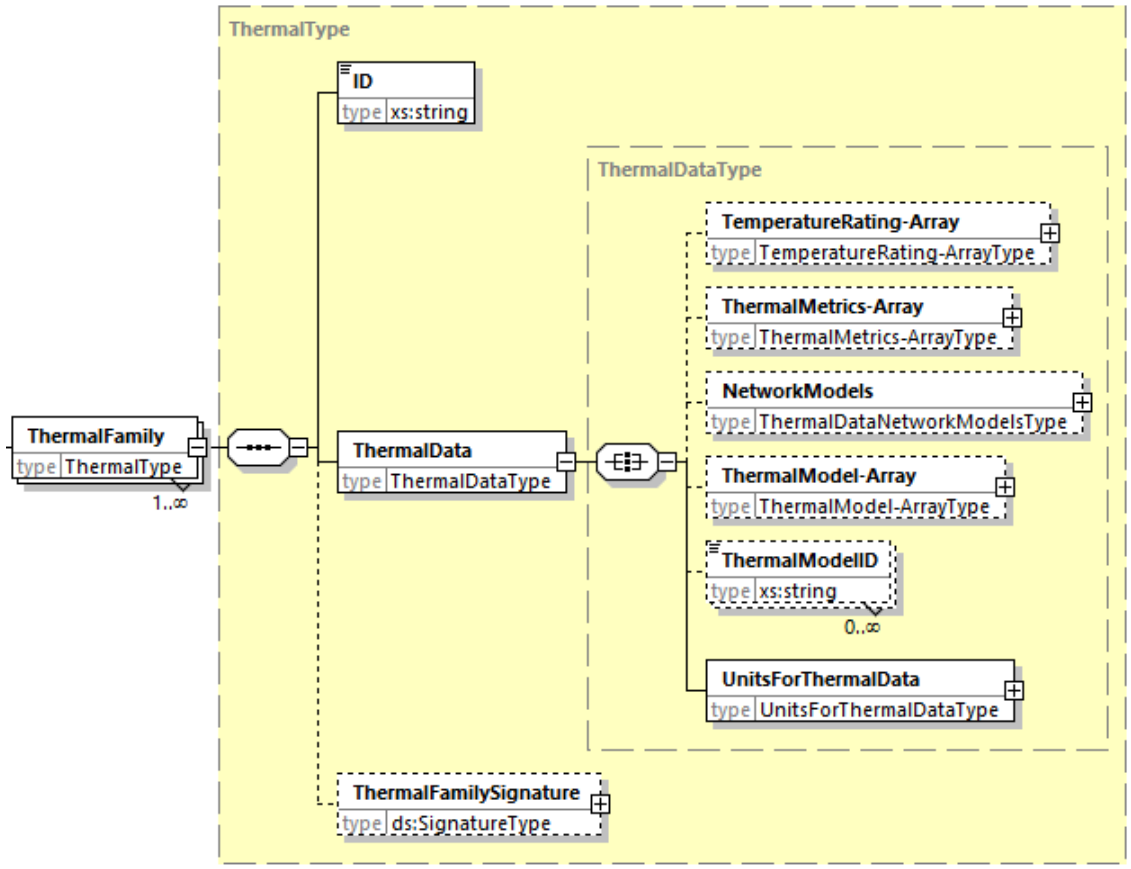
The *ThermalFamilyID* references the *ThermalFamily/ID* under the *ThermalSection/Thermal-Array*. This is enforced by the key named as *ThermalFamilyKey* that is assigned to the *ThermalFamily/ID* element, which is referenced by the *ThermalFamilyID* which has a Keyref that refers to the *JEP30-T101: ThermalFamilyKey*.

4.3.2 Linking the Manufacturing Part Number to Thermal Model Content

path	**PartModel/PartDetails-Array/PartDetails/Association-Array/Association/ThermalFamily-Array/ThermalModel**
diagram at the Electrical Parameters Association level	
type	**ThermalModelAssociationType, JEP30-D10:SignatureDigestLinkType.**
path	**PartModel/ThermalSection/Thermal-Array/ThermalModel**
diagram at the Electrical Parameters-Array level	
type	**ThermalModelType, JEP30-D10:EmptyType, ds:SignatureType.**

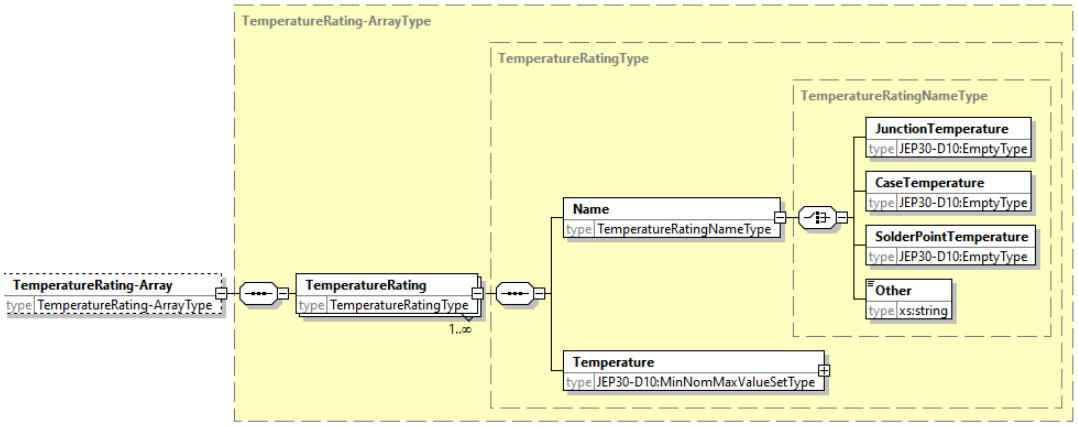
The *ThermalModelID* references the *ThermalModel/ID* under the *ThermalSection/Thermal-Array*. This is enforced by the key named as *ThermalModelKey* that is assigned to the *ThermalModel/ID* element, which is referenced by the *ThermalModelID* which has a Keyref that refers to the *JEP30-T101:ThermalModelKey*.

4.4 Thermal Family

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData.**
diagram	
type	**ThermalType, ThermalDataType, TemperatureRatingArrayType, ThermalMetricsArrayType, ThermalDataNetworkModelsType, UnitsforThermalDataType**

ThermalData allows for the definition of temperature ratings (via the *TemperatureRating-Array*), thermal metrics (via the *ThermalMetrics-Array* and intended for part comparison purposes) and thermal models (via the *NetworkModels* and intended for simulation purposes). The *UnitsForThermalData* apply to all of the previous respective branches where applicable.

4.4.1 Temperature Rating - Array

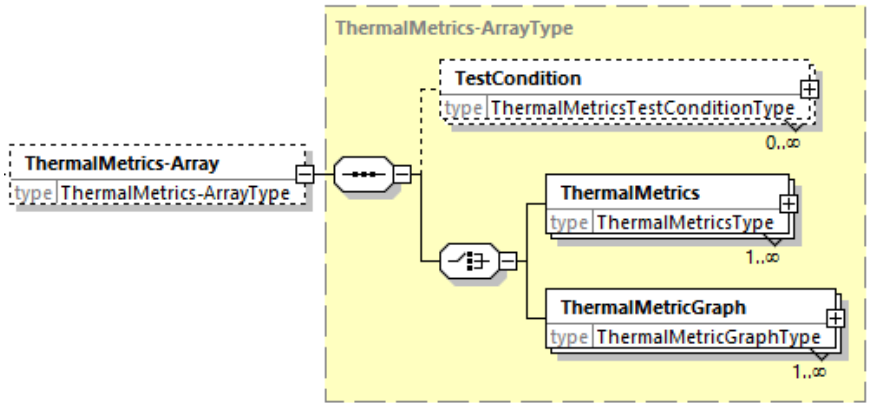
path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/TemperatureRating-Array.**
diagram	
type	**TemperatureRating-ArrayType, TemperatureRatingType, TemperatureRatingNameType, JEP30-D10:EmptyType, JEP30-D10:MinNomMaxValueSetType.**

Minimum, nominal, or maximum temperature rating values can be defined for:

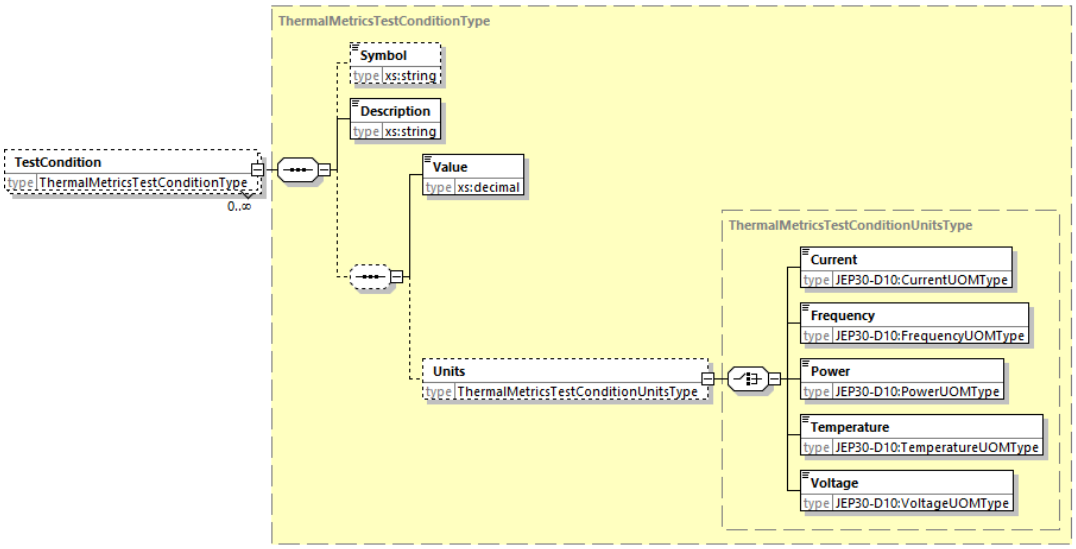
1. *JunctionTemperature*,
2. *CaseTemperature*,
3. *SolderPointTemperature*.

Or any other user defined string(s) indicating the location at which the temperature is rated at.

4.4.2 Thermal Metrics - Array

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array.**
diagram	
type	**ThermalMetrics-ArrayType, ThermalMetricsTestConditionType, ThermalMetricsType, ThermalMetricGraphType**

4.4.2.1 Test Condition

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/TestCondition.**
diagram	
type	**ThermalMetricsTestConditionType, ThermalMetricsTestConditionUnitsType,** **JEP30-D10:Current UOM Type, JEP30-D10:Frequency UOM Type, JEP30-D10:Power UOM Type,** **JEP30-D10:Temperature UOM Type, JEP30-D10:Voltage UOM Type.**

An example *TestCondition* (T_a = 25 °C) is shown below in its XML representation. The use of the _{} parentheses indicate that subscript formatting is applied to the string within those parentheses.

4.4.2.1 Test Condition (cont'd)

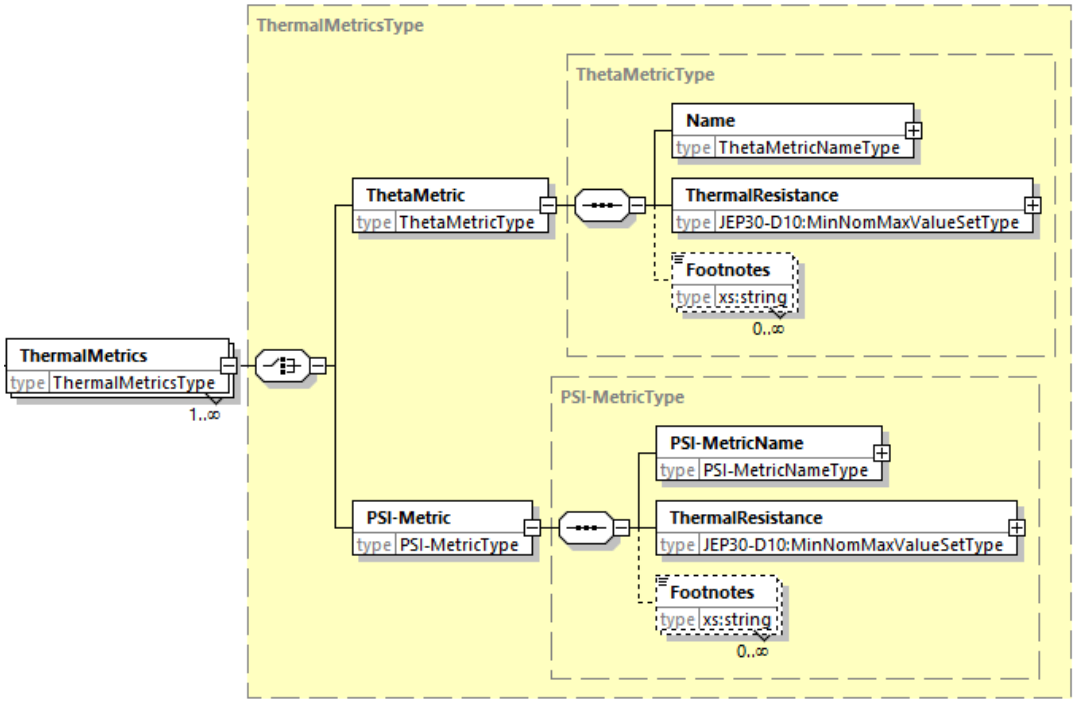
```
<TestCondition>
        <Symbol>T_{a}</Symbol>
        <SymbolDescription>Ambient Temperature</SymbolDescription>
        <Value>25</Value>
        <Units>
                <Temperature>DegC</Temperature>
        </Units>
</TestCondition>
```

The enumerated list of values for each of the UOM's specified above are identified in Table 1 – Test Condition Units UOM Enumerated Lists

Table 1 – Test Condition Units UOM Enumerated Lists

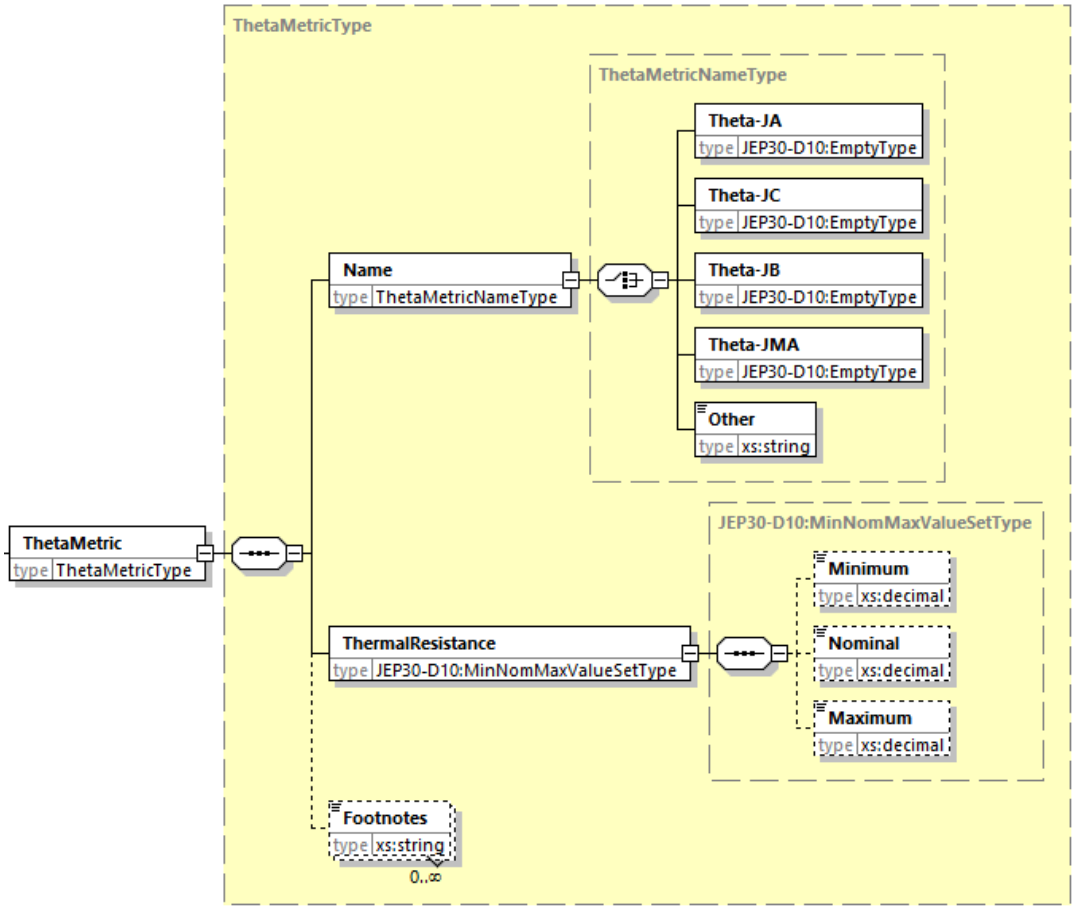
Current	Frequency	Power	Temperature	Voltage
uA	Hz	mW	DegC	mV
mA	KHz	W	DegF	V
A	MHz	kW	K	
	GHz			

4.4.2.2 Thermal Metrics

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetrics.**
diagram	
type	**ThermalMetricsType, ThetaMetricType, ThetaMetricNameType, JEP30-D10:MinNomMaxValueSetType, PSI-MetricType, PSI-MetricNameType.**

Two types of thermal metrics are supported; Theta (Θ) metrics and Psi (Ψ) metrics, as defined in JESD51-2, JESD51-6 and JESD51-12.

4.4.2.2.1 Theta Metric

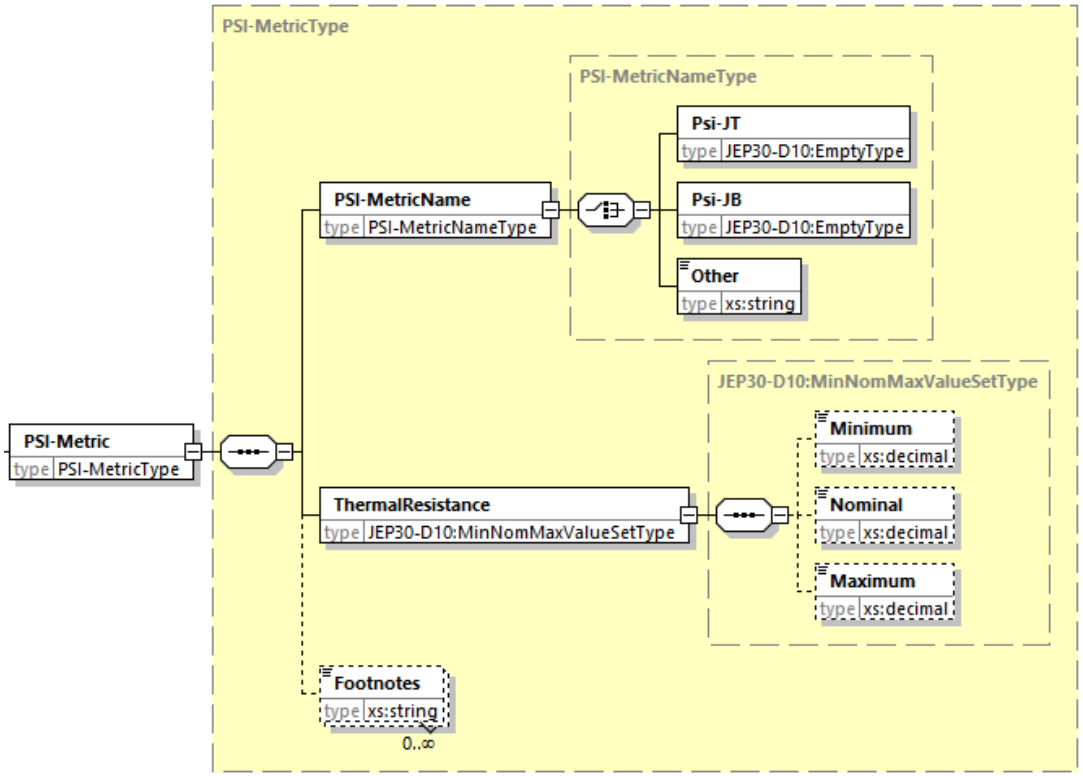
path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetrics/ThetaMetric.**
diagram	
type	**ThetaMetricType, ThetaMetricNameType, JEP30-D10:EmptyType, JEP30-D10:MinNomMaxValueSetType**

Minimum, nominal or maximum values of thermal resistance can be defined for each *ThetaMetric*:-

1. *Theta-JA*,
2. *Theta-JC*,
3. *Theta-JB*,
4. *Theta-JMA*.

Or any other user defined string(s) indicating the name of the Theta metric.

4.4.2.2.2 PSI-Metric

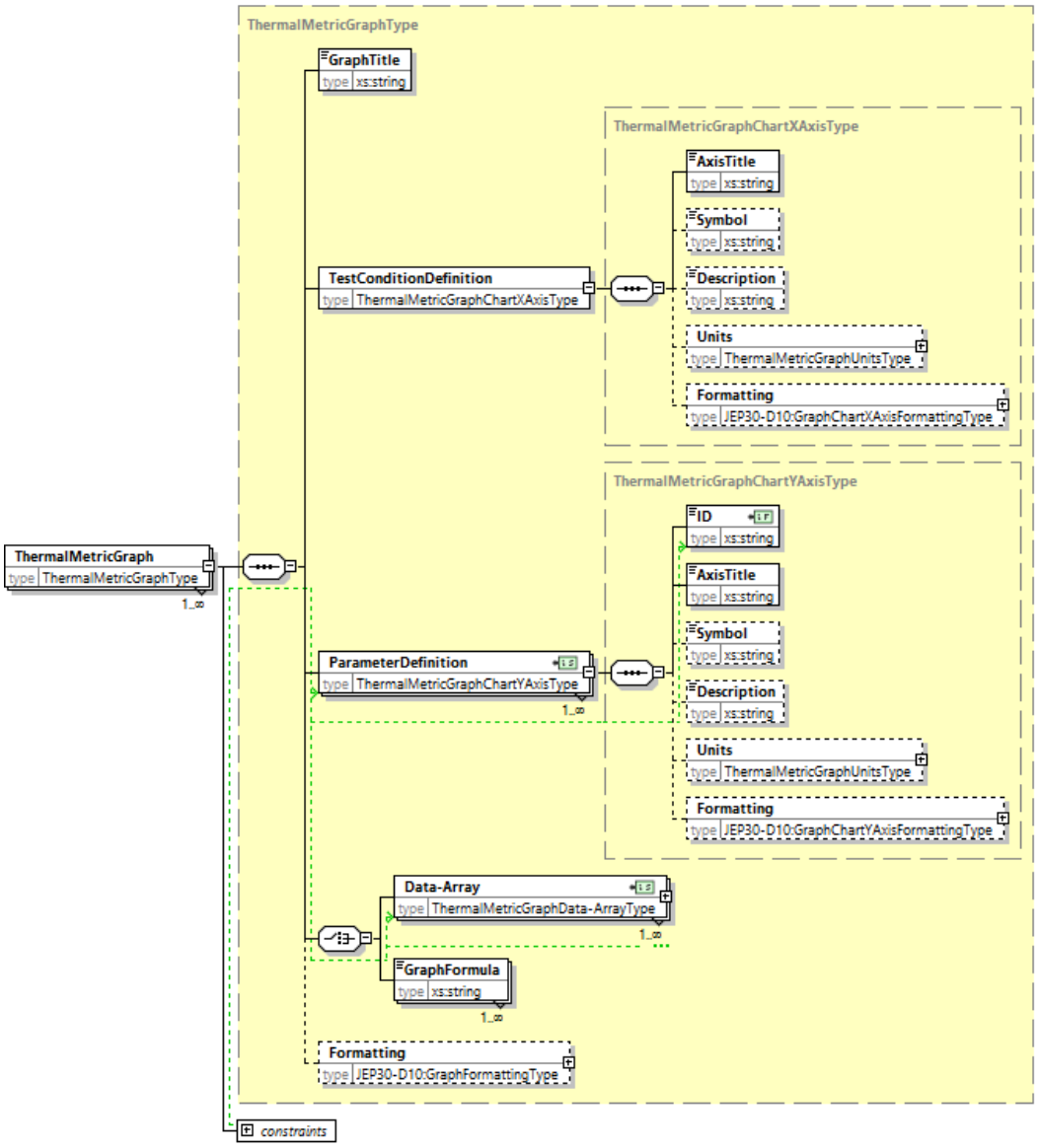
path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetrics/PSI-Metric.**
diagram	
type	**PSI-MetricType, PSI-MetricNameType, JEP30-D10:EmptyType, MinNomMaxValueSetType.**

Minimum, nominal or maximum values of thermal resistance can be defined for each *PSI-Metric*:-

1. *Psi-JT*,
2. *Psi-JB*.

Or any other user defined string(s) indicating the name of the Psi metric.

4.4.2.3 Thermal Metric Graph

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph.**
diagram	
type	**ThermalMetricsType, ThermalMetricGraphChartXAxisType, ThermalMetricGraphChartYAxisType, ThermalMetricGraphData-ArrayType, JEP30-D10:GraphFormattingType, ThermalMetricGraphUnitsType, JEP30-D10:GraphChartXAxisFormattingType, JEP30-D10:GraphChartYAxisFormattingType**

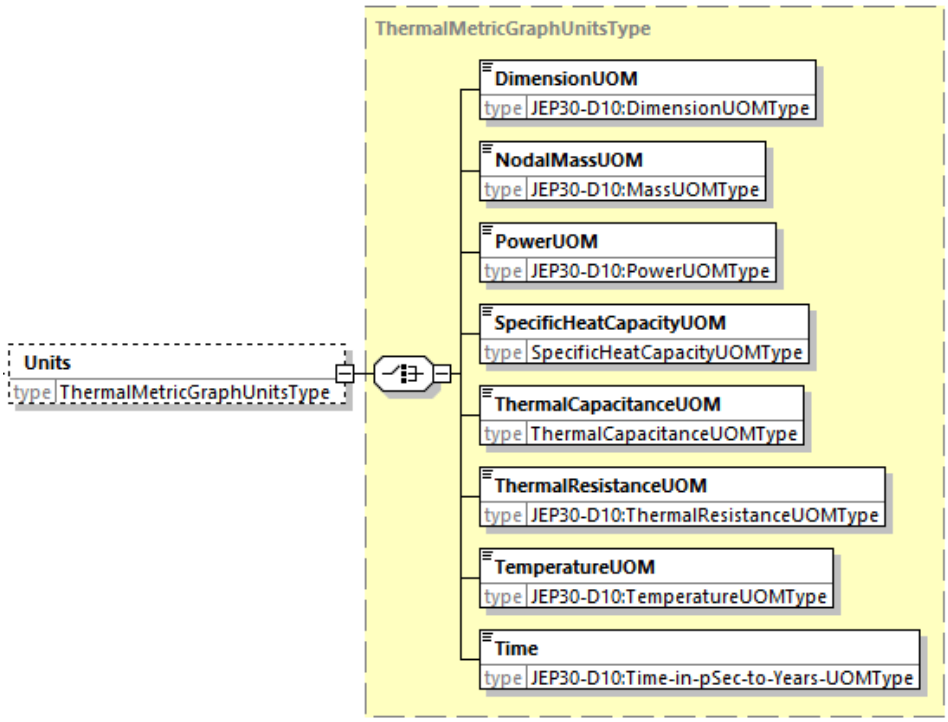
A *ThermalMetricGraph* has 2 axis that are defined by the *TestConditionDefinition* (The X-axis definition), and the *ParameterDefinition* (The Y-axis definition). Each axis is labelled by the *AxisTitle*. When possible, the *Symbol* which represents the *AxisTitle* should be added to the PartModel file and should represent a standards-based symbol as defined in the appropriate Terms and Definitions standards. If appropriate, a more detailed *Description* can be used to describe the definition of the *AxisTitle*. Each axis will also have a pre-defined set of *Units* but can be optionally excluded for those axis' which are unitless.

4.4.2.3 Thermal Metric Graph (cont'd)

Note that the *ParameterDefinition* is unbounded whereas the *TestConditionDefinition* is bounded to a single instance. This is to cater for those graphs in which there are 2 or more y-axis, each with their own definition.

The graph can either be captured under the *Data-Array* or represented via a *GraphFormula* (A string representing the equation of the *ParameterDefinition* relationship to the Test *TestConditionDefinition*).

4.4.2.3.1 Thermal Metrics Graph Units

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/TestConditionDefinition/Units.** **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/ParameterDefinition/Units.**
diagram	
type	**JEP30-D10:DimensionUOMType, JEP30-D10:MassUOMType, JEP30-D10:PowerUOMType, SpecificHeatCapacityUOMType, ThermalCapacitanceUOMType, JEP30-D10:ThermalResistanceUOMType, JEP30-D10:TemperatureUOMType, JEP30-D10:Time-in-pSec-to-Years-UOMType**

The enumerated list of values for each of the UOM's specified above are identified in Table 1 - UOM Enumerated Lists

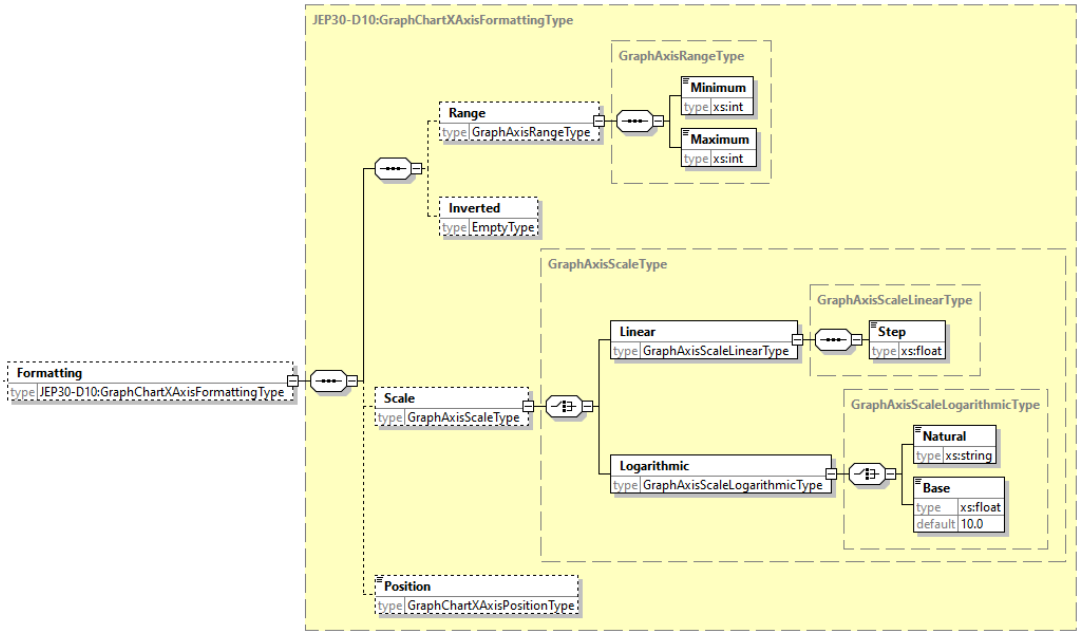
4.4.2.3.1 Thermal Metric Graph Units (cont'd)

Table 2 – Thermal Metrics Graph Units UOM Enumerated Lists

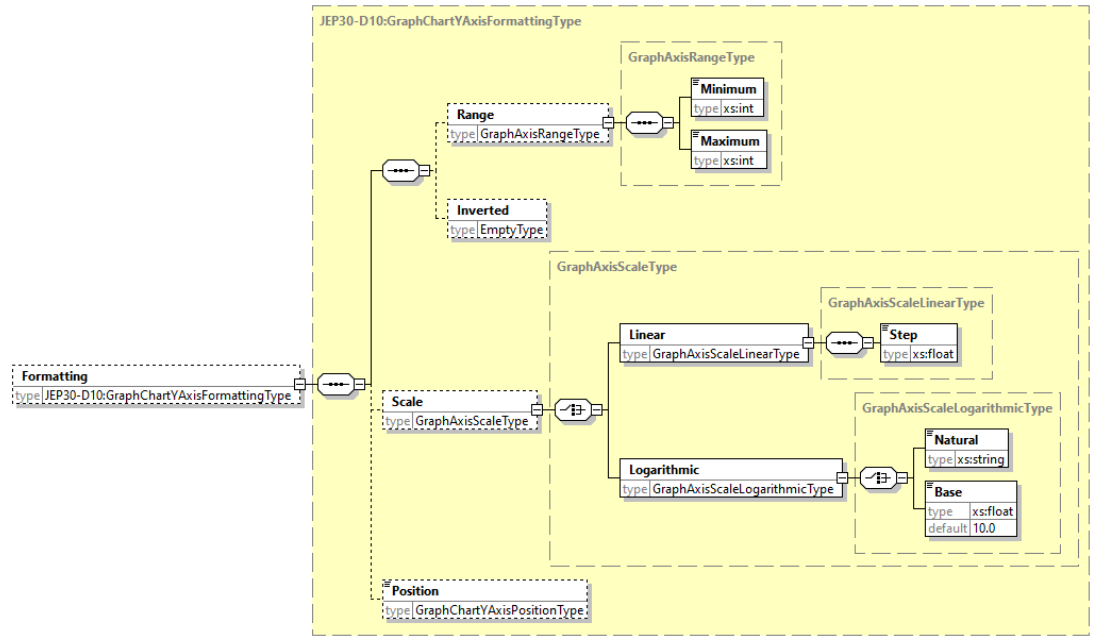
Dimension UOM	Nodal Mass UOM	Power UOM	Specific Heat Capacity UOM	Thermal Capacitance UOM	Thermal Resistance UOM	Temperature UOM	Time
nm	ug	mW	J/kgK	J/K	K/W	DegC	ps
um	mg	W	Cal/gK	mJ/K	DegC/W	DegF	ns
mm	g	kW	BTU/lb DegF			K	us
m	kg						ms
Mil	oz						s
in	lb						min
							h
							d
							wk
							y

4.4.2.3.2 Formatting

The Formatting is an optional set of data that enables the user to re-create the graph for visualization purposes. Formatting applies to the following

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/TestConditionDefinition/Formatting.**
diagram	
type	**JEP30-D10:GraphChartXAxisFormattingType, GraphAxisRangeType, EmptyType, GraphAxisScaleType, GraphAxisScaleLinearType, GraphAxisScaleLogarithmicType, GraphChartXAxisPositionType.**

4.4.2.3.2 Formatting (cont'd)

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/ParameterDefinition/Formatting.**
diagram	
type	**JEP30-D10:GraphChartYAxisFormattingType, GraphAxisRangeType, EmptyType, GraphAxisScaleType, GraphAxisScaleLinearType, GraphAxisScaleLogarithmicType, GraphChartYAxisPositionType.**

The axis range which is usually defined from minimum to maximum can be inverted to show a graph going from maximum to minimum. The scale can be defined in either a linear step amount, a natural logarithm, or a logarithm of the specified base. The *Base* log is set to a default of *Base 10* but can be defined to any base number.

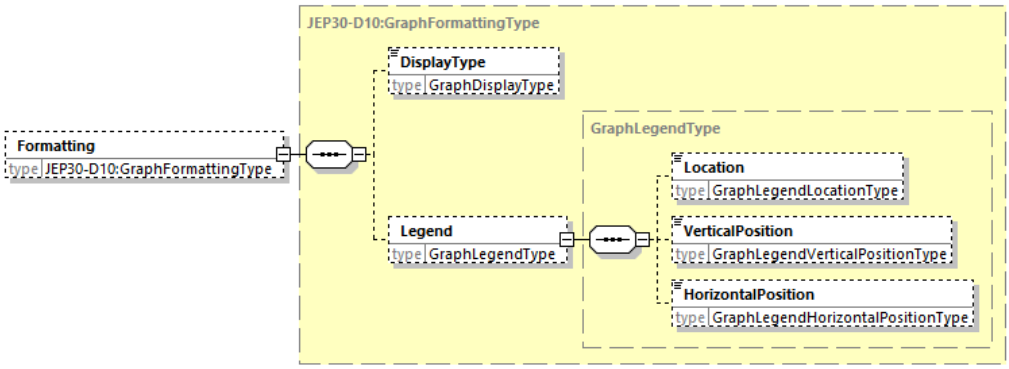
The *Position* enumerated list for the *GraphChartXAxisPositionType* is

- Top
- Bottom

And for the *GraphChartYAxisPositionType*, the enumerated values are

- Left
- Right

4.4.2.3.2 Formatting (cont'd)

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/Formatting.**
diagram	
type	**JEP30-D10:GraphFormattingType, GraphDisplayType, GraphLegendType, GraphLegendLocationType, GraphLegendVerticalPositionType, GraphLegendHorizontalPositionType.**

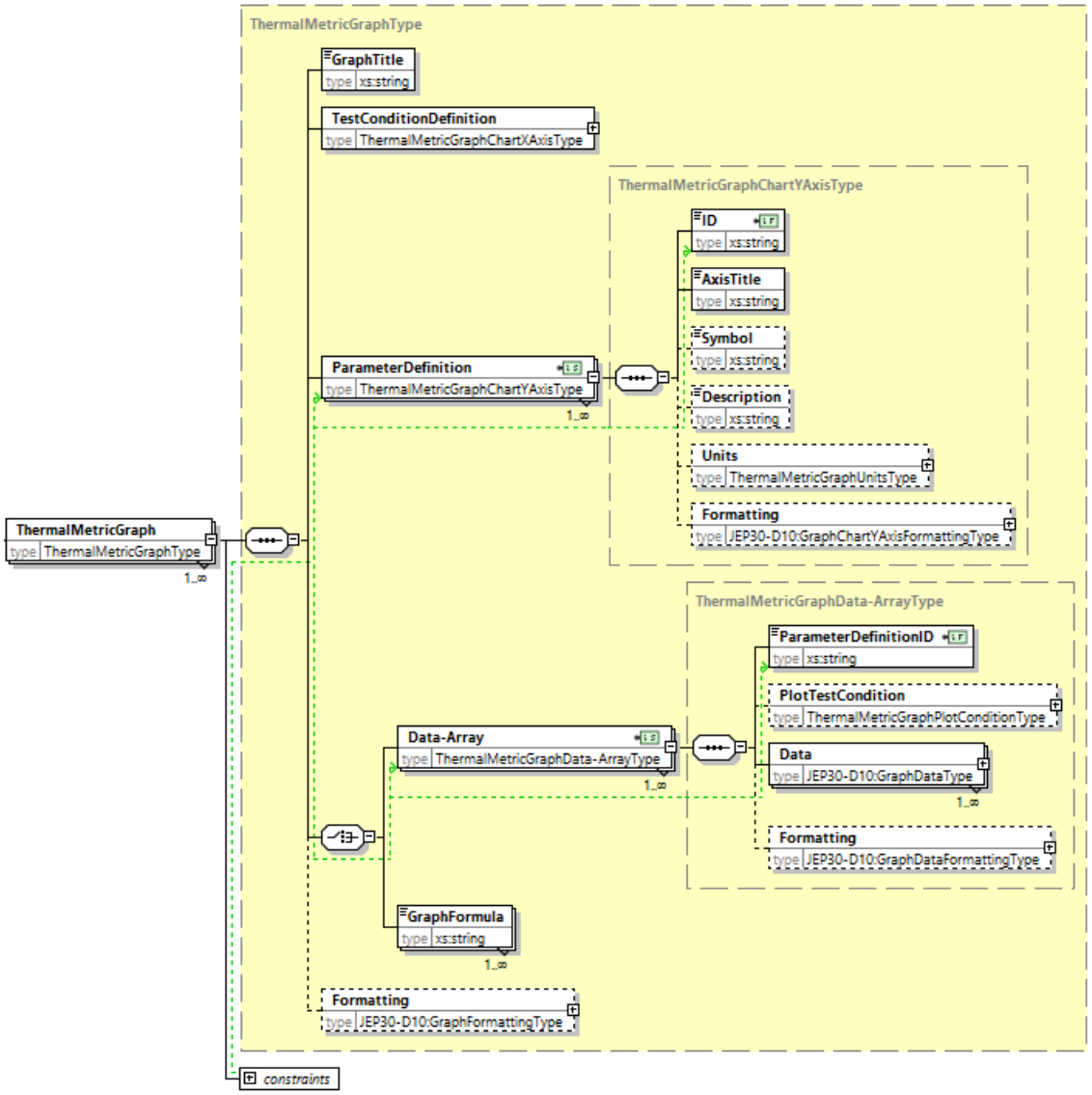
The body of the graph can be formatted under the *GraphFormattingType*. The *DisplayType* enumerated list is

- Line
- Bar

The graph Legend can also be positioned around the graph in any of the following locations:

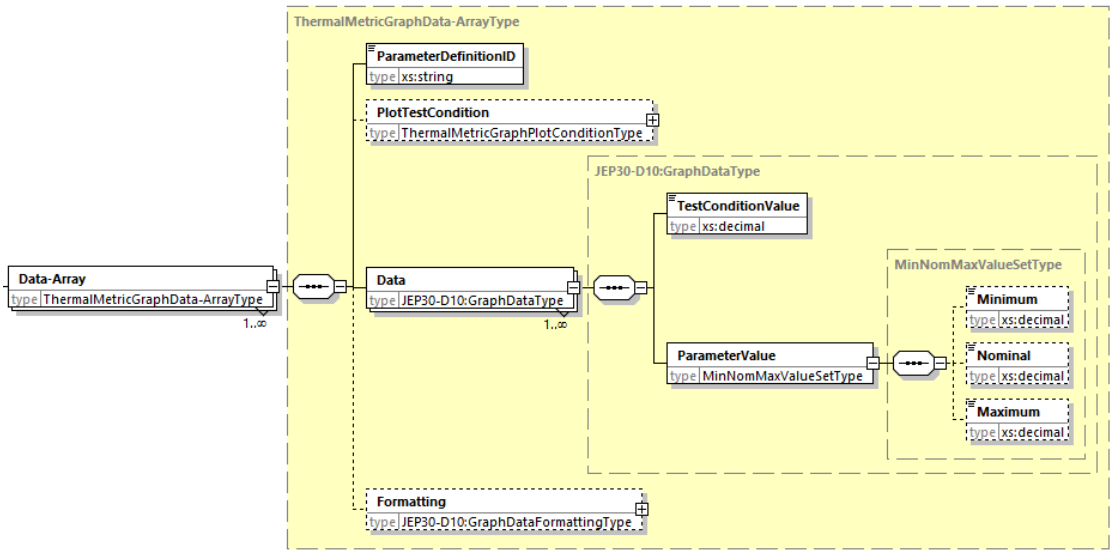
- Location
  - Inside Graph,
  - Outside Graph,
- Vertical Position
  - Top,
  - Center,
  - Bottom,
- Horizontal Position
  - Left,
  - Center,
  - Right.

4.4.2.3.3 Linking the Data-Array to the Appropriate Parameter Definition

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph.**
diagram	
type	**ThermalMetricsGraphType, ThermalMetricGraphChartXAxisType, ThermalMetricGraphChartYAxisType, ThermalMetricGraphUnitsType, JEP30-D10:GraphChartYAxisFormattingType, ThermalMetricGraphData-ArrayType, ThermalMetricGraphPlotConditionType, JEP30-D10:GraphDataType, JEP30-D10:GraphDataFormattingType, JEP30-D10:GraphFormattingType.**

When populating the *Data-Array* for a given graph, the set of data is referenced to the specific *ParameterDefinition* via the *ParameterDefinitionID. The process is replicated for each ParameterDefinition* if there are 2 or more vertical *ParameterDefinition* axis defined. Each set of data captured under the *Data-Array* is now tied to the appropriate *ParameterDefinition* axis.

4.4.2.3.4 Data-Array

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/Data-Array.**
diagram	
type	**ThermalMetricGraphData-ArrayType, ThermalMetricGraphPlotConditionType,** **JEP30-D10:GraphDataType, MinNomMaxValueSetType, JEP30-D10:GraphDataFormattingType**

Each data set consisting of the *TestConditionValue* and the *ParameterValue,* represents one point of a piecewise linear graph. A Z_{th} thermal impedance response example of the *ThermalMetricGraph* is shown and represented in the xml data below.

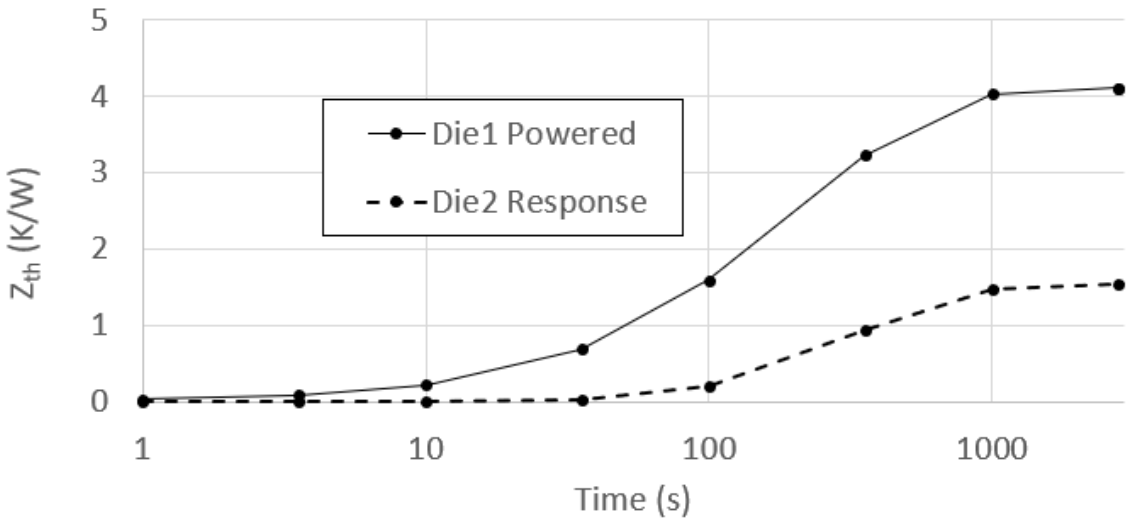
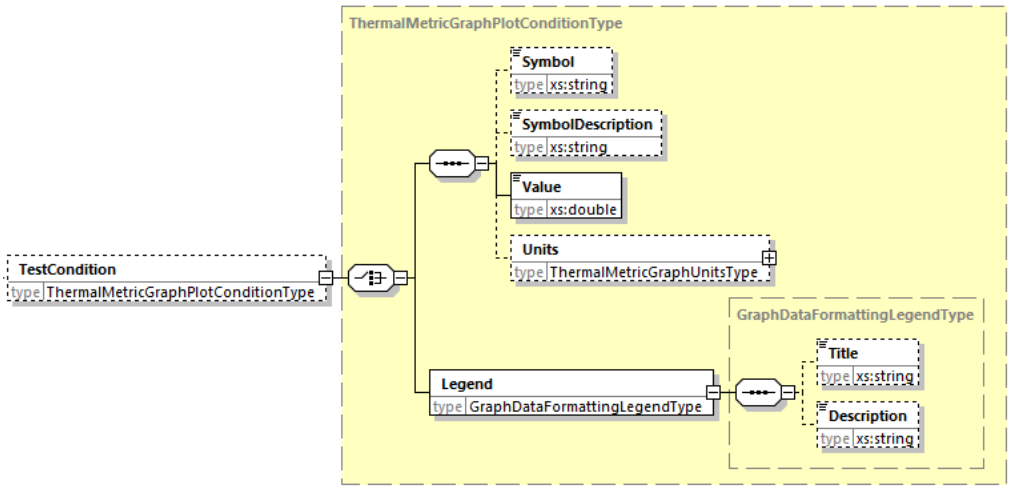


Figure 1 – Zth Thermal Impedance Curves

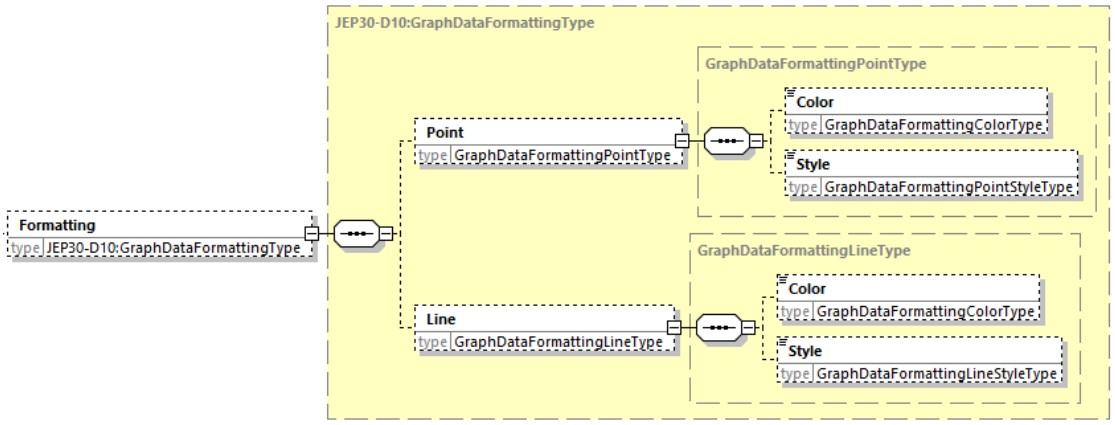
The *TestCondition* represents different plots on the same graph, as shown in Figure 1 - Zth Thermal Impedance Curves . The Z_{th} curves representing 'Die1 Powered' and 'Die2 Response' are captured with their own *TestCondition* as shown in the below XML file (first 2 points only shown for brevity).

4.4.2.3.4 Data-Array (cont'd)

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/Data-Array/PlotTestCondition**
diagram	
type	**ThermalMetricGraphPlotConditionType, GraphDataFormattingLegendType, ThermalMetricGraphUnitsType.**

Depending upon the type of test condition, its value may be a string or label that describes the *TestCondition*, in which case the value is populated under the *Legend* branch.

When possible, the *Symbol* which represents the *TestCondition* should be added to the PartModel file and should represent a standards-based symbol as defined in the appropriate Terms and Definitions standards. If appropriate, a more detailed *SymbolDescription* can be defined to describe the definition of the *TestCondition*. The *Symbol* can have a pre-defined set of *Units* but can be optionally excluded for those *TestCondition* which are unitless.

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/ThermalMetrics-Array/ThermalMetricGraph/Data-Array/Formatting.**
diagram	
type	**JEP30-D10:GraphDataFormattingType, GraphDataFormattingPointType. GraphDataFormattingLineType, GraphDataFormattingColorType, GraphDataFormattingPointStyleType, GraphDataFormattingLineStyleType.**

4.4.2.3.4 Data-Array (cont'd)

The data points can also be formatted. Individual data points can have the following styles

- Point Styles are
  - Circle,
  - Square,
  - Triangle,
  - None.
- Line Style are
  - Solid,
  - Dash,
  - Dot,
  - Dash-dot,
  - Dash-dash-dot,
  - None.
- Colors are
  - Red,
  - Green,
  - Blue,
  - Orange,
  - Brown,
  - Pink,
  - Purple,
  - Yellow,
  - Black.

The xml fragment shown below represents the data plotted in Figure 1 – Zth Thermal Impedance Curves.

```
< ThermalMetricGraph>
        <GraphTitle>Zth Thermal Impedance Curves</GraphTitle>
        <TestConditionDefinition>
                <AxisTitle>Time (s)</AxisTitle>
                <Symbol>t</Symbol>
                <Description>Time since power step</Description>
                <Units>
                        <Time>s</Time>
                </Units>
                <Formatting>
                        <Range>
                                <Minimum>1</Minimum>
                                <Maximum>10000</Maximum>
                        </Range>
                        <Scale>
                                <Logarithmic>
                                        <Base>10</Base>
                                </Logarithmic>
                        </Scale>
                        <Position>Bottom</Position>
                </Formatting>
        </TestConditionDefinition>
```

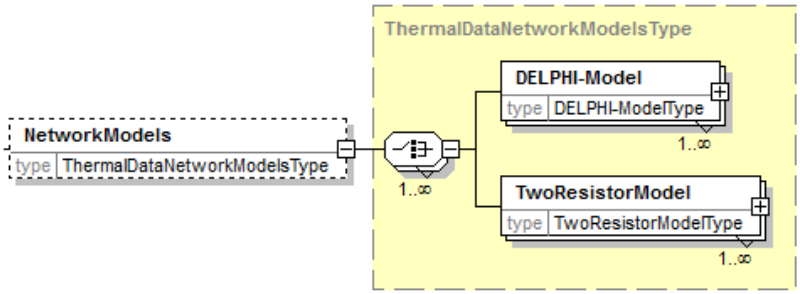
4.4.2.3.4 Data-Array (cont'd)

```
<ParameterDefinition>
        <ID>Y1</ID>
        <AxisTitle>Z_{th} (K/W)</AxisTitle>
        <Symbol>Z_{th}Symbol>
        <Description>Thermal Impedance Response</Description>
        <Units>
                <ThermalResistanceUOM>K/W</ThermalResistanceUOM>
        </Units>
        <Formatting>
                <Range>
                        <Minimum>0</Minimum>
                        <Maximum>5</Maximum>
                </Range>
                <Scale>
                        <Linear>
                                <Step>1</Step>
                        </Linear>
                </Scale>
                <Position>Left</Position>
        </Formatting>
</ParameterDefinition>
<Data-Array>
        <ParameterDefinitionID>Y1</ParameterDefinitionID>
        <TestCondition>
                <Legend>
                        <Title>Die1 Powered</Title>
                </Legend>
        </TestCondition>
        <Data>
                <TestConditionValue>1</TestConditionValue>
                <ParameterValue>
                        <Nominal>0.026</Nominal>
                </ParameterValue>
        </Data>
        <Data>
                <TestConditionValue>3.55</TestConditionValue>
                <ParameterValue>
                        <Nominal>0.085</Nominal>
                </ParameterValue>
        </Data>
                …
                …
</Data-Array>
<Data-Array>
        <ID>Y1</ID>
        <TestCondition>
                <Legend>
                        <Title>Die2 Response</Title>
                </Legend>
        </TestCondition>
        <Data>
                <TestConditionValue>1</TestConditionValue>
                <ParameterValue>
                        <Nominal>9.7e-7</Nominal>
```

4.4.2.3.4 Data-Array (cont'd)

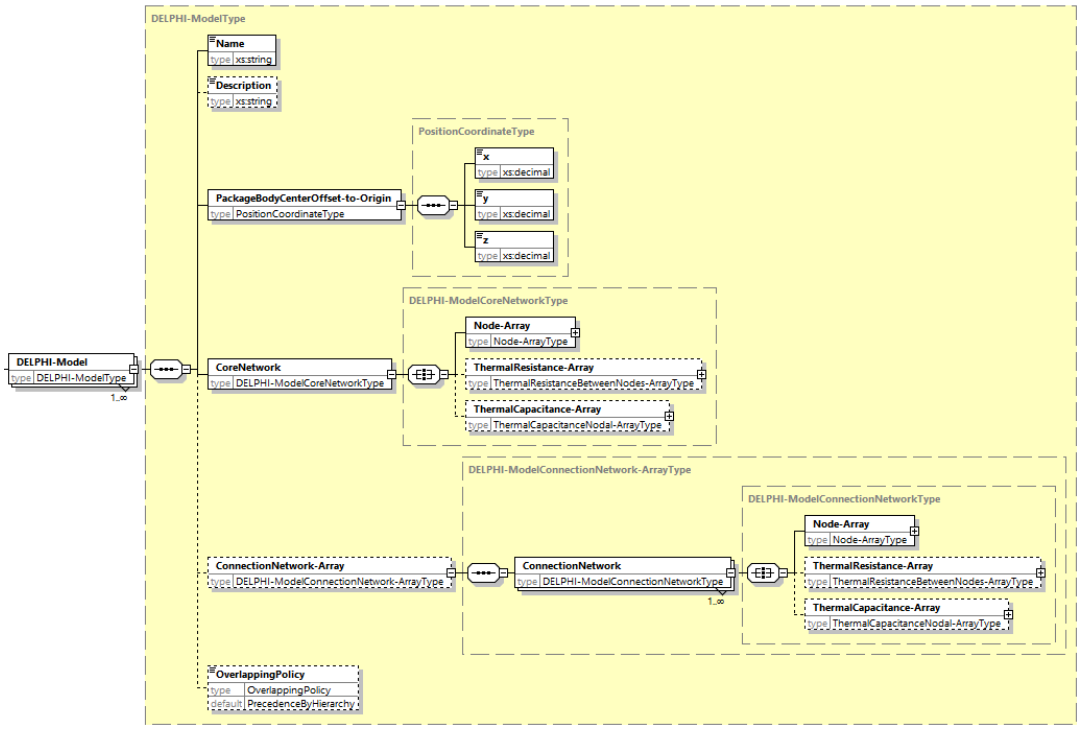
```
                    </ParameterValue>
                </Data>
                <Data>
                    <TestConditionValue>3.55</TestConditionValue>
                    <ParameterValue>
                        <Nominal>4.4e-5</Nominal>
                    </ParameterValue>
                </Data>
                    …
                    …
                <Formatting>
                    <Point>
                        <Color>Blue</Color>
                        <Style>Circle</Style>
                    </Point>
                    <Line>
                        <Color>Black</Color>
                        <Style>Solid</Style>
                    </Line>
                </Formatting>
        </Data-Array>
        <Formatting>
            <DisplayType>Line</DisplayType>
            <Legend>
                <Location>Inside Graph</Location>
                <VerticalPosition>Center</VerticalPosition>
                <HorizontalPosition>Center</HorizontalPosition>
            </Legend>
        </Formatting>
</ThermalMetricGraph>
```

4.4.3 Network Models

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels.**
diagram	
type	**ThermalDataNetworkModelsType, DELPHI-ModelType, TwoResistorModelType**

Two types of thermal *NetworkModels* are supported; *DELPHI-Model*, as defined in JESD15-4 and *2-ResistorModel*, as defined in JESD15-3. Both models involve the definition of a nodal thermal network. Any number of 2-resistor or DELPHI Network Models may be defined.

4.4.3.1 DELPHI-Model

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model.**
diagram	
type	**DELPHI-ModelType, PositionCoordinateType, DELPHI-ModelCoreNetworkType, DELPHI-ModelConnectionNetwork-ArrayType, DELPHI-ModelConnectionNetworkType, Node-ArrayType, ThermalResistanceBetweenNodes-ArrayType, ThermalCapacitanceNodal-ArrayType, OverlappingPolicy.**

A *DELPHI-Model* is defined by a *Name*, an optional *Description*, its *PackageBodyCenterOffset-to-Origin*, a single *CoreNetwork* and optional *ConnectionNetworks* representing level 2 interconnects or sockets (unless those were considered part of the package when the DELPHI-Model was extracted).

In order to connect the Thermal Model to the Package Model, a reference for the position of the Node Array to the Origin is specified, via the *PackageBodyCenterOffset-to-Origin*. Since the Node Array Position is in respect to the Origin, specifying the offset here from the Package Body Center to the Origin will enable the alignment of the Thermal Model to the Physical Model that is defined under the *PackageSection*.

The *CoreNetwork* and *ConnectionNetwork* are defined in the same way, and is similar for a Two Resistor Model Network apart from the ability to define nodal thermal capacitances.

4.5.3.1 DELPHI Model (cont'd)

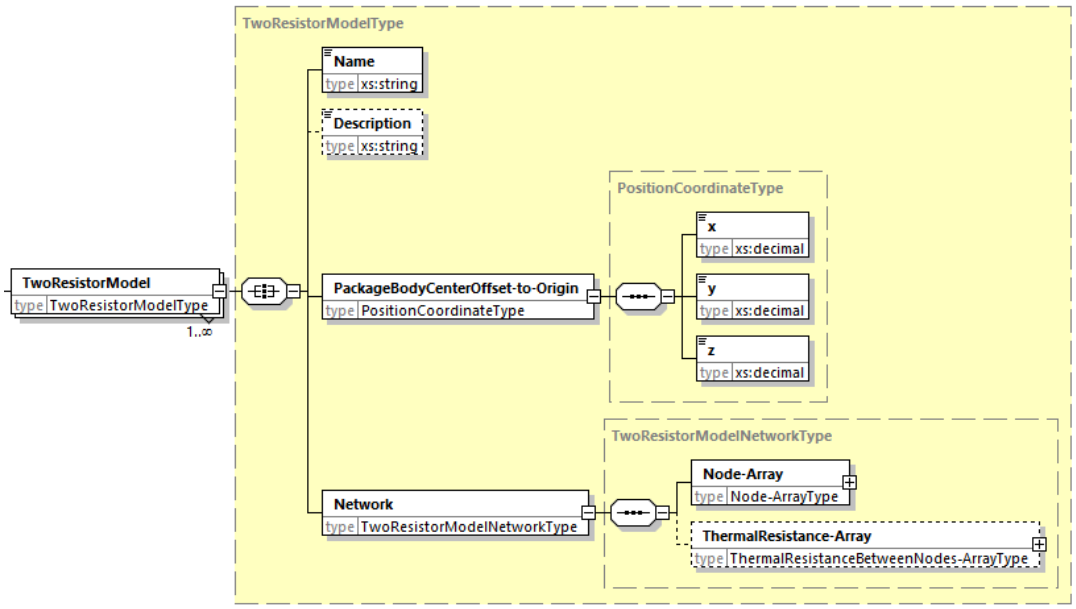
If two *RectangularNodeFaces* (see section 4.14 below) are defined as spatially overlapping, as is commonly the case for 'top inner' and 'top outer' nodal areas, then an *OverlappingPolicy* may be set to one of the following:

1. Precedence By Hierarchy
2. Precedence By Size

PrecedenceByHierarchy indicates that the Rectangular Node Face defined first in the sequence of the xml file will be interpreted as being overwritten by the overlapping *RectangularNodeFace* defined after. *PrecedenceByHierarchy* is the default setting.

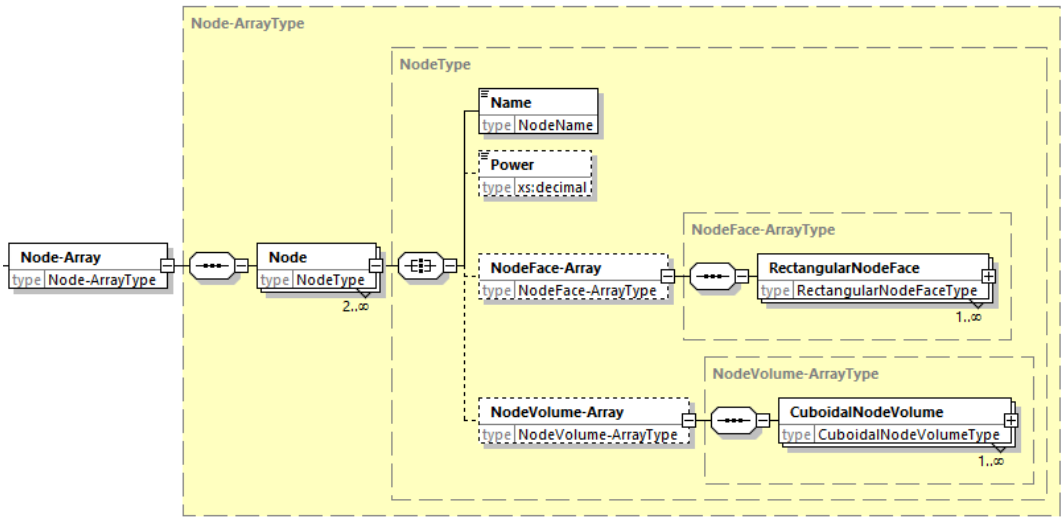
PrecedenceBySize indicates that, regardless of the order in which the *RectangularNodeFaces* are defined in the xml, the smaller one (by area) will be interpreted as overwriting the larger one (by area).

4.4.3.2 2-Resistor Model

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/TwoResistorModel.**
diagram	
type	**TwoResistorModelType, PositionCoordinateType, TwoResistorModelNetworkType, Node-ArrayType, ThermalResistanceBetweenNodes-ArrayType.**

A *TwoResistorModel* is defined by a *Name*, an optional *Description,* its *PackageBodyCenterOffset-to-Origin*, and a *Network*. The Network is defined by a *Node-Array* and a *Thermal Resistance-Array*.

4.4.3.3 Node-Array

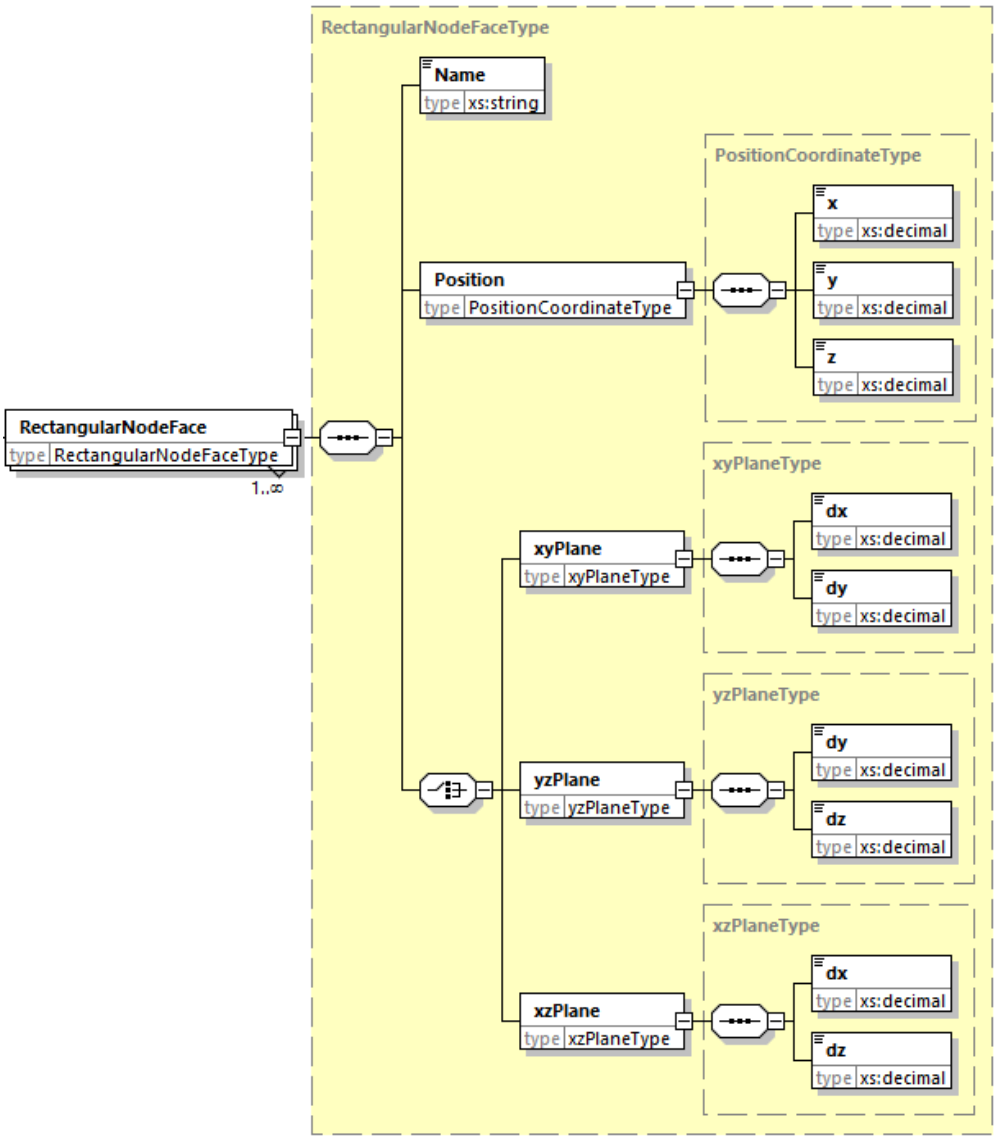
path	1. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/CoreNetwork/Node-Array,** 2. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/ConnectionNetwork-Array/ConnectionNetwork/Node-Array** 3. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/TwoResistorModel/Network/Node-Array.**
diagram	
type	**Nodal–ArrayType, NodeType, NodeFace–ArrayType, NodeVolume–ArrayType,** **RectangularNodeFaceType, CuboidalNodeVolumeType**

The *Node-Array* should consist of at least 2 named *Node* elements. One or more *Nodes* may have a *Power* value defined.

Such a nodal thermal model could be used for thermal or electro-thermal circuit simulation. However, if the model is to be used as part of a 3D simulation it is required to have a 3D physical definition. This is achieved by defining the following shapes, which includes their respective *Name*, *Position* and *Size as shown below*:

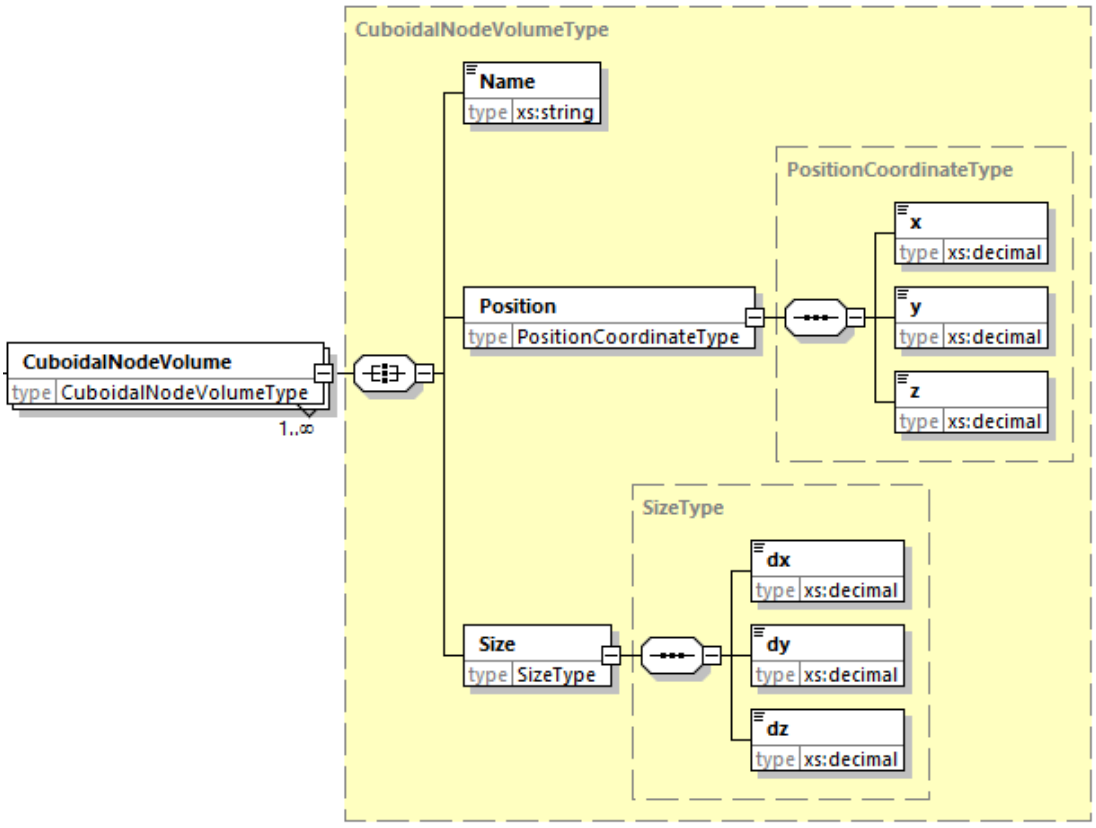
1. Rectangular Node Face
2. Cuboidal Node Volume

4.4.3.3.1 Rectangular Node Face

path	1. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/CoreNetwork/Node-Array/Node/NodeFace-Array/RectangularNodeFace,** 2. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/ConnectionNetwork-Array/ConnectionNetwork/Node-Array/Node/NodeFace-Array/RectangularNodeFace,** 3. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/TwoResistorModel/Network/Node-Array/Node/NodeFace-Array/RectangularNodeFace.**
diagram	
type	**RectangularNodeFaceType, PositionCoordinateType, xyPlaneType, yzPlaneType, xzPlaneType**

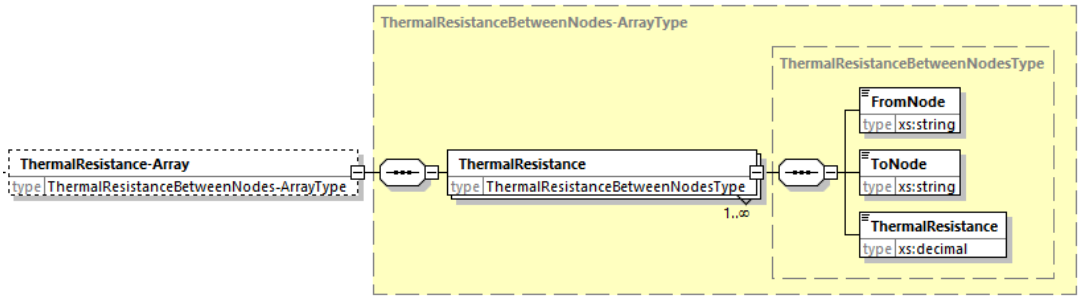
The *RectangularNodeFace* is a 2D rectangular shape defined by a *Name*, an *x*, *y*, and *z Position*, a *xyPlane* or *yzPlane* or *xzPlane* orientation and the dimension of the rectangle in that plane, *dx*, *dy*, *dz*. When defined as a child of a node, it nominates that node to be peripheral in that it will act as a fixed temperature thermal connection to the surrounding 3D simulation space. One or more Rectangular Node Face shapes can be defined as children of a node.

4.4.3.3.2 Cuboidal Node Volume

path	1. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/CoreNetwork/Node-Array/Node/NodeVolume-Array/CuboidalNodeVolume,** 2. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/ConnectionNetwork-Array/ConnectionNetwork/Node-Array/Node/NodeVolume-Array/CuboidalNodeVolume.**
diagram	
type	**CuboidalNodeVolumeType, PositionCoordinateType, SizeType.**

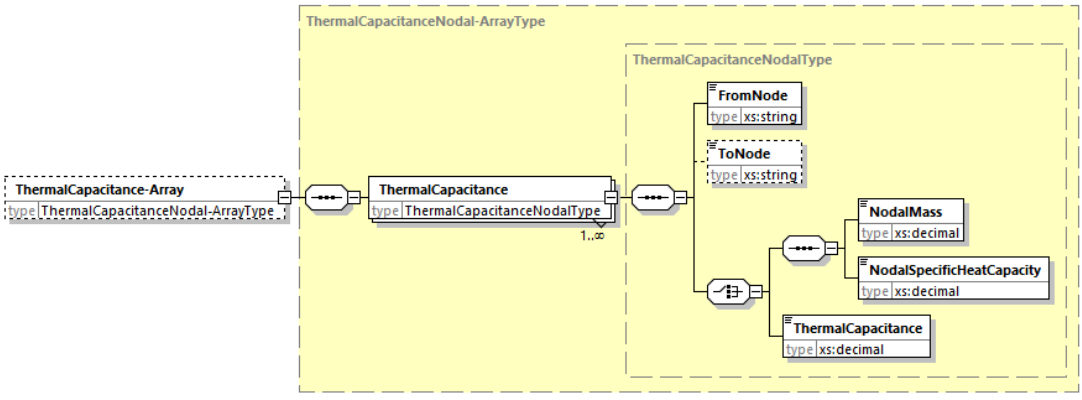
The *CuboidalNodeVolume* is a 3D cuboidal shape defined by a *Name*, an *x*, *y*, *z Position* and *dx, dy, dz Size*. It is intended to block out the physical space occupied by the Part within the 3D simulation context. One or more Cuboidal Node Volume shapes can be defined as children of a Node.

4.4.3.4 Thermal Resistance Between Nodes - Array

path	1. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/CoreNetwork/ThermalResistance-Array,** 2. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/ConnectionNetwork-Array/ConnectionNetwork/ThermalResistance-Array,** 3. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/TwoResistorModel/Network/ThermalResistance-Array**
diagram	
type	**ThermalResistanceBetweenNodes–ArrayType, ThermalResistanceBetweenNodesType**

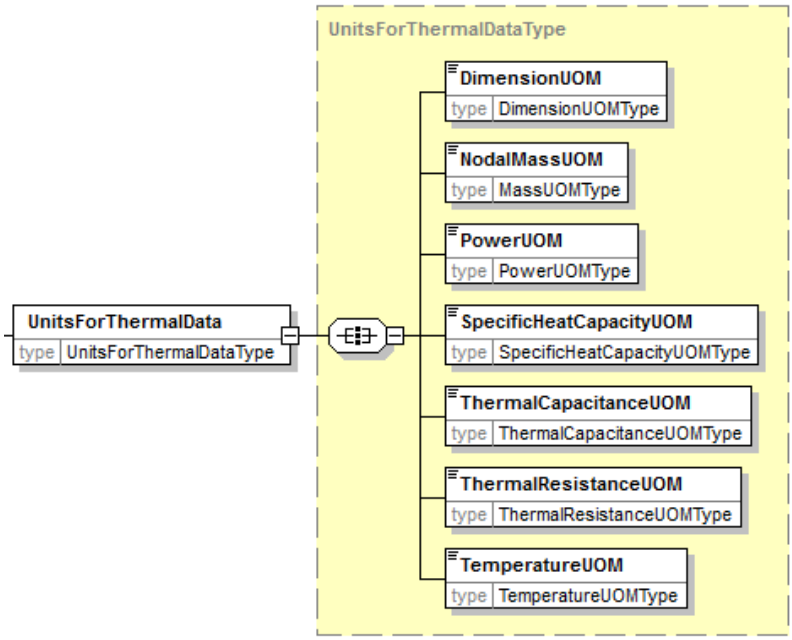
The *ThermalResistance-Array* lists the thermal links of the Network by specifying the *FromNode* name, the *ToNode* name and the *ThermalResistance* value linking them.

4.4.3.5 Thermal Capacitance - Array

path	1. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/CoreNetwork/ThermalCapacitance-Array,** 2. **PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/NetworkModels/DELPHI-Model/ConnectionNetwork-Array/ConnectionNetwork/ThermalCapacitance-Array**
diagram	
type	**ThermalCapacitanceNodal-ArrayType, ThermalCapacitanceNodalType**

ThermalCapacitance are defined by a *ThermalCapacitance-Array* by specifying the *FromNode* name, an optional *ToNode* name and a *ThermalCapacitance* value. If no *ToNode* name is defined, then the thermal capacitance will be assumed to be connected to the thermal ground, e.g., as in a Cauer type network.

4.4.4 Units for Thermal Data

path	**PartModel/ThermalSection/Thermal-Array/ThermalFamily/ThermalData/UnitsForThermalData.**
diagram	
type	**UnitsForThermalDataType, ThermalResistanceUOMType, TemperatureUOMType, ThermalCapacitanceUOMType, DimensionUOMType, PowerUOMType, SpecificHeatCapacityUOMType, MassUOMType**

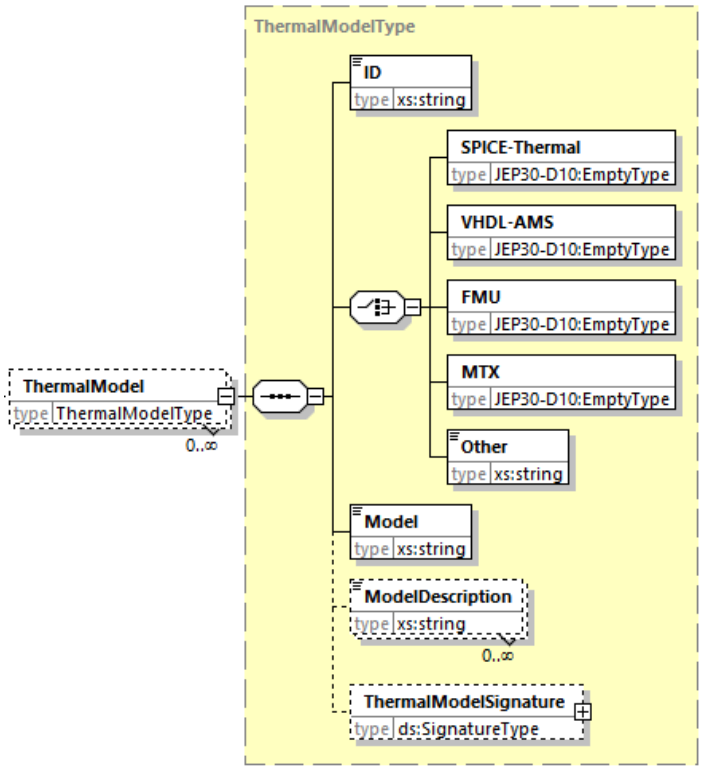
The following are the units of measure used throughout the Thermal section of the schema.

1. Dimension UOM Type,
    a. nm
    b. um
    c. mm
    d. m
    e. in
    f. mil
2. Mass UOM Type
    a. ug
    b. mg
    c. g
    d. kg
    e. oz
    f. lb

4.4.4 Units (cont'd)

3. Power UOM Type,
    a. mW
    b. W
    c. kW
4. Specific Heat Capacity UOM Type,
    a. J/kgK
    b. Cal/gK
    c. BTU/lb DegF
5. Thermal Capacitance UOM Type,
    a. J/K
    b. mJ/K
6. Thermal Resistance UOM Type,
    a. K/W
    b. DegC/W
7. Temperature UOM Type,
    a. DegC
    b. DegF
    c. K

4.5 Thermal Model

path	**PartModel/ThermalSection/Thermal-Array/ThermalModel**
diagram	
type	**ThermalModelType, JEP30-D10:EmptyType, ds:SignatureType.**

One or more references to external thermal simulation model files can be defined by the *ThermalModel* section. The *Model* element can refer to either a file name of a file that is provided together with the corresponding JEP30 xml archive or a URL definition. *ThermalModel* enables a standardized thermal simulation file format to be defined so that the importing tool can correctly interpret that file format. An *Other* file format is accommodated to account for non-standard formats where it is advised that the optional *ModelDescription* element is used to describe the format and its intended usage.

Annex A (informative) Differences between JEP30-T100 and its predecessors

This table briefly describes most of the changes made to entries that appear in this standard, JEP30-T100, compared to its predecessor; Punctuation changes may or may not be included.

Initial Issue: 1	Date: February 2018	Item Number: 11.2-938

Change Record History

Issue: A	Date: March 2023	Item Number: 11.2-938S
Description of changes		
Section 4.5 Thermal Data: Added new section for *External Model-Array*.		
Sections 4.5.1, 4.5.2.2.1, 4.5.2.2.2, :Added “Empty Type” for several elements through schema that did not have types.		
Section 4.5.2 Thermal Metrics: Re-labelled the section title to Thermal Metrics-Array. Added in a new section for “Thermal Metric Graph”. Also added in “Test Conditions” that can be applied to either the “Thermal Metrics” or the “Thermal Metrics Graph”.		
Section 4.5.2.1 Test Condition: Added new “Test Condition” section		
Section 4.5.2.3 Thermal Metric Graph: Added new section to represent thermal parametric data in graph form.		
Section 4.5.3.3: Update descriptive text on the Rectangular Node Face and the Cuboidal Node Volume		
Section 4.5.3.3.1 RectangularNodeFace: Added in “Name” element in under “RectangularNodeFace”		
Section 4.5.3.3.2 CuboidalNodeVolume: Added in “Name” element in under “CuboidalNodeVolume”		
Section 4.5.4 External Model-Array: Added new section to capture external models		

Issue: B	Date: August 2024	Item Number: 11.2-1059
Description of changes		
Section 4.1, and section 4.2: Update sections to align with modifications performed at the JEP30 parent structure		

Issue: B.01	Date: February 2025	Item Number: 11.2-1073
Description of Change		
Sections 1, 4.1, and 4.2: Update sections to align with modifications performed at the JEP30 parent structure.		

This page intentionally left blank.

Standard Improvement Form **JEDEC Standard No. JEP30-T100B.01**

The purpose of this form is to provide the Technical Committees of JEDEC with input from the industry regarding usage of the subject standard. Individuals or companies are invited to submit comments to JEDEC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

JEDEC
Attn: Publications Department
3103 10th Street North
Suite 240S
Arlington, VA 22201

Email: angies@jedec.org

1. I recommend changes to the following:

☐ Requirement, clause number _____

☐ Test method number _____ Clause number _____

The referenced clause number has proven to be:

☐ Unclear ☐ Too Rigid ☐ In Error

☐ Other _____

2. Recommendations for correction:

3. Other suggestions for document improvement:

Submitted by

Name: _____ Phone: _____

Company: _____ E-mail: _____

Address: _____

City/State/Zip: _____ Date _____


JEDEC®