



European Network of
Transmission System Operators
for Electricity

SENSITIVITY MATRIX PROFILE SPECIFICATION

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33

Revision History

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83 1 Introduction

84 The sensitivity matrix profile is a profile to exchange sensitivity matrices that are needed within
85 the process.

86 The sensitivity matrix allows to define different kind of sensitivity matrix like Remedial Action
87 Influence Factor or PTDF amongst others.

88 2 Application profile specification

89 2.1 Version information

90 The content is generated from UML model file CIM17-2_CGMES31v01_PROF-
91 20v02_NC23v65_MS10v01_DES10v01.eap.

92 This edition is based on the IEC 61970 UML version 'IEC61970CIM17v40', dated '2020-08-24'.

- 93 - Title: Sensitivity Matrix Vocabulary
- 94 - Keyword: SM
- 95 - Description: This vocabulary is describing the sensitivity matrix.
- 96 - Version IRI: <https://ap-voc.cim4.eu/SensitivityMatrix/2.3>
- 97 - Version info: 2.3.1
- 98 - Prior version: <http://entsoe.eu/ns/CIM/SensitivityMatrix-EU/2.2>
- 99 - Conforms to: urn:iso:std:iec:61970-600-2:ed-1|urn:iso:std:iec:61970-301:ed-
100 7:amd1|file:///iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:
101 std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-
102 2|file:///CIM100_CGMES31v01_501-20v02_NC23v62_MM10v01.eap
- 103 - Identifier: urn:uuid:d89a8510-528b-49a9-81f1-c51be51caa6f

104

105 2.2 Constraints naming convention

106 The naming of the rules shall not be used for machine processing. The rule names are just a
107 string. The naming convention of the constraints is as follows.

108 "{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}"

109 where

110 rule.Type: C – for constraint; R – for requirement

111 rule.Standard: the number of the standard e.g. 301 for 61970-301, 456 for 61970-456, 13 for
112 61968-13. 61970-600 specific constraints refer to 600 although they are related to one or
113 combination of the 61970-450 series profiles. For NC profiles, NC is used.

114 rule.Profile: the abbreviation of the profile, e.g. TP for Topology profile. If set to "ALL" the
115 constraint is applicable to all IEC 61970-600 profiles.

116 rule.Property: for UML classes, the name of the class, for attributes and associations, the name
117 of the class and attribute or association end, e.g. EnergyConsumer, IdentifiedObject.name, etc.
118 If set to "NA" the property is not applicable to a specific UML element.

119 rule.Name: the name of the rule. It is unique for the same property.

120 Example: C:600:ALL:IdentifiedObject.name:stringLength

121 2.3 Profile constraints

122 This clause defines requirements and constraints that shall be fulfilled by applications that
123 conform to this document.

124 This document is the master for rules and constraints tagged "NC". For the sake of self-
125 containment, the list below also includes a copy of the relevant rules from IEC 61970-452,
126 tagged "452".

- 127 • C:452:ALL:NA:datatypes

128 According to 61970-501, datatypes are not exchanged in the instance data. The
129 UnitMultiplier is 1 in cases none value is specified in the profile.

- 130 • R:452:ALL:NA:exchange

131 Optional and required attributes and associations must be imported and exported if they
132 are in the model file prior to import.

- 133 • R:452:ALL:NA:exchange1

134 If an optional attribute does not exist in the imported file, it does not have to be exported
135 in case exactly the same data set is exported, i.e. the tool is not obliged to automatically
136 provide this attribute. If the export is resulting from an action by the user performed after
137 the import, e.g. data processing or model update the export can contain optional
138 attributes.

- 139 • R:452:ALL:NA:exchange2

140 In most of the profiles the selection of optional and required attributes is made so as to
141 ensure a minimum set of required attributes without which the exchange does not fulfil
142 its basic purpose. Business processes governing different exchanges can require
143 mandatory exchange of certain optional attributes or associations. Optional and required
144 attributes and associations shall therefore be supported by applications which claim
145 conformance with certain functionalities of the IEC 61970-452. This provides flexibility
146 for the business processes to adapt to different business requirements and base the
147 exchanges on IEC 61970-452 compliant applications.

- 148 • R:452:ALL:NA:exchange3

149 An exporter may, at his or her discretion, produce a serialization containing additional
150 class data described by the CIM Schema but not required by this document provided
151 these data adhere to the conventions established in Clause 5.

- 152 • R:452:ALL:NA:exchange4

153 From the standpoint of the model import used by a data recipient, the document
154 describes a subset of the CIM that importing software shall be able to interpret in order
155 to import exported models. Data providers are free to exceed the minimum requirements
156 described herein as long as their resulting data files are compliant with the CIM Schema
157 and the conventions established in Clause 5. The document, therefore, describes
158 additional classes and class data that, although not required, exporters will, in all
159 likelihood, choose to include in their data files. The additional classes and data are
160 labelled as required (cardinality 1..1) or as optional (cardinality 0..1) to distinguish them
161 from their required counterparts. Please note, however, that data importers could
162 potentially receive data containing instances of any and all classes described by the
163 CIM Schema.

- 164 • R:452:ALL:NA:cardinality
- 165 The cardinality defined in the CIM model shall be followed, unless a more restrictive
- 166 cardinality is explicitly defined in this document. For instance, the cardinality on the
- 167 association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall
- 168 be associated with one and only one BaseVoltage, but a BaseVoltage can be associated
- 169 with zero to many VoltageLevels.
- 170 • R:452:ALL:NA:associations
- 171 Associations between classes referenced in this document and classes not referenced
- 172 here are not required regardless of cardinality.
- 173 • R:452:ALL:IdentifiedObject.name:rule
- 174 The attribute “name” inherited by many classes from the abstract class IdentifiedObject
- 175 is not required to be unique. It must be a human readable identifier without additional
- 176 embedded information that would need to be parsed. The attribute is used for purposes
- 177 such as User Interface and data exchange debugging. The MRID defined in the data
- 178 exchange format is the only unique and persistent identifier used for this data exchange.
- 179 The attribute IdentifiedObject.name is, however, always required for CoreEquipment
- 180 profile and Short Circuit profile.
- 181 • R:452:ALL:IdentifiedObject.description:rule
- 182 The attribute “description” inherited by many classes from the abstract class
- 183 IdentifiedObject must contain human readable text without additional embedded
- 184 information that would need to be parsed.
- 185 • R:452:ALL:NA:uniqueIdentifier
- 186 All IdentifiedObject-s shall have a persistent and globally unique identifier (Master
- 187 Resource Identifier - mRID).
- 188 • R:452:ALL:NA:unitMultiplier
- 189 For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance,
- 190 etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is “none”.
- 191 • C:452:ALL:IdentifiedObject.name:stringLength
- 192 The string IdentifiedObject.name has a maximum of 128 characters.
- 193 • C:452:ALL:IdentifiedObject.description:stringLength
- 194 The string IdentifiedObject.description is maximum 256 characters.
- 195 • C:452:ALL:NA:float
- 196 An attribute that is defined as float (e.g. has a type Float or a type which is a Datatype
- 197 with .value attribute of type Float) shall support ISO/IEC 60559:2020 for floating-point
- 198 arithmetic using single precision floating point. A single precision float supports 7
- 199 significant digits where the significant digits are described as an integer, or a decimal
- 200 number with 6 decimal digits. Two float values are equal when the significant with 7
- 201 digits are identical, e.g. 1234567 is equal 1.234567E6 and so are 1.2345678 and
- 202 1.234567E0.
- 203 • R:NC:ALL:Region:reference

204 The reference to the Region is normally a reference to the capacity calculation region,
205 which is identified by "Y" EIC code of the capacity calculation region.

206 • R:NC:ALL:NA:serialization

207 The profiles are defined in the EnterpriseArchitect application and have multiple artifacts
208 that describe them. The main artifacts are:

- 209 1) the EAP file (EnterpriseArchitect project file),
210 2) the profiles' specification document and
211 3) the application profiles (RDFS and SHACL).

212 Due to the complexity of the profiles, there are various cross profile associations that,
213 from profiling and profile maintenance point of view, it is not practical to include the
214 complete inheritance structure in all profiles. If this is done the documentation provided
215 for all profiles would also include duplicated information on the description of classes
216 defined in other profiles. The following cases are often observed in profiles:

- 217 ○ Case 1: An association end refers to an abstract class
- 218 ○ Case 2: An abstract class (stereotyped with "Description") has an association
219 (direction to another class)
- 220 ○ Case 3: An abstract class (not stereotyped with "Description") has an
221 association (direction to another class)
- 222 ○ Case 4: An abstract class has attributes and subclasses are not in the profile

223 In all cases, the datasets shall only include the subtypes of the abstract classes with
224 the related properties (i.e. association or attributes) defined in the profile. The
225 information is taken from either canonical model or the profiles where complete
226 (expected) inheritance structure for the related abstract class is described. SHACL
227 based constraints include constraints only for the concrete classes that are subtypes of
228 the abstract class in the profile, and this can be used to inform which are the concrete
229 classes expected in a dataset that conforms to this profile.

230 It should be taken into account that this approach deviates from MVAL5 (IEC 61970-
231 600-1:2021), which creates multiple inheritance at serialization. For instance, with this
232 more explicit exchange the serialization of the association between abstract class
233 Equipment and abstract class Circuit for a PowerTransformer will be serialized as
234 follows:

- 235 ○ for association

236 <cim:PowerTransformer rdf:about="_c328f787-bc17-47ad-a59f-6ba7133340d0">

237 <nc:Equipment.Circuit rdf:resource="#_9ced16ac-d076-4ef9-a241-a998a579e77b"/>

238 </cim:PowerTransformer>

- 239 ○ for attribute

240 <cim:ACLineSegment rdf:about="_04f681aa-6999-4fb3-9775-acaa5eb7ceff">

241 <cim:Equipment.inService>true</cim:Equipment.inService>

242 </cim:ACLineSegment>

243 The usage of rdf:ID or rdf:about depends on the stereotype of the class. rdf:about is
244 used if the class has the stereotype "Description".

245 An example of not allowed serialization, as the Equipment is an abstract class

246 <cim:Equipment rdf:about="_c328f787-bc17-47ad-a59f-6ba7133340d0">

247 <nc:Equipment.Circuit rdf:resource="#_9ced16ac-d076-4ef9-a241-a998a579e77b"/>

248 </cim:Equipment>

249

250 **2.4 Metadata**

251 ENTSO-E agreed to extend the header and metadata definitions by IEC 61970-552 Ed2. This
252 new header definitions rely on W3C recommendations which are used worldwide and are
253 positively recognised by the European Commission. The new definitions of the header mainly
254 use Provenance ontology (PROV-O), Time Ontology and Data Catalog Vocabulary (DCAT). The
255 global new header applicable for this profile is included in the metadata and document header
256 specification document.

257 The header vocabulary contains all attributes defined in IEC 61970-552. This is done only for
258 the purpose of having one vocabulary for header and to ensure transition for data exchanges
259 that are using IEC 61970-552:2016 header. This profile does not use IEC 61970-552:2016
260 header attributes and relies only on the extended attributes.

261 **2.4.1 Constraints**

262 The identification of the constraints related to the metadata follows the same convention for
263 naming of the constraints as for profile constraints.

- 264 • R:NC:ALL:wasAttributedTo:usage

265 The prov:wasAttributedTo should normally be the “X” EIC code of the actor or their URI
266 (prov:Agent).

267

268 **2.4.2 Reference metadata**

269 The header defined for this profile requires availability of a set of reference metadata. For
270 instance, the attribute prov:wasGeneratedBy requires a reference to an activity which produced
271 the model or the related process. The activities are defined as reference metadata and their
272 identifiers are referenced from the header to enable the receiving entity to retrieve the “static”
273 (reference) information that is not modified frequently. This approach imposes a requirement
274 that both the sending entity and the receiving entity have access to a unique version of the
275 reference metadata. Therefore, each business process shall define which reference metadata
276 is used and where it is located.

277 **3 Detailed Profile Specification**

278 **3.1 General**

279 This package contains sensitivity matrix profile.

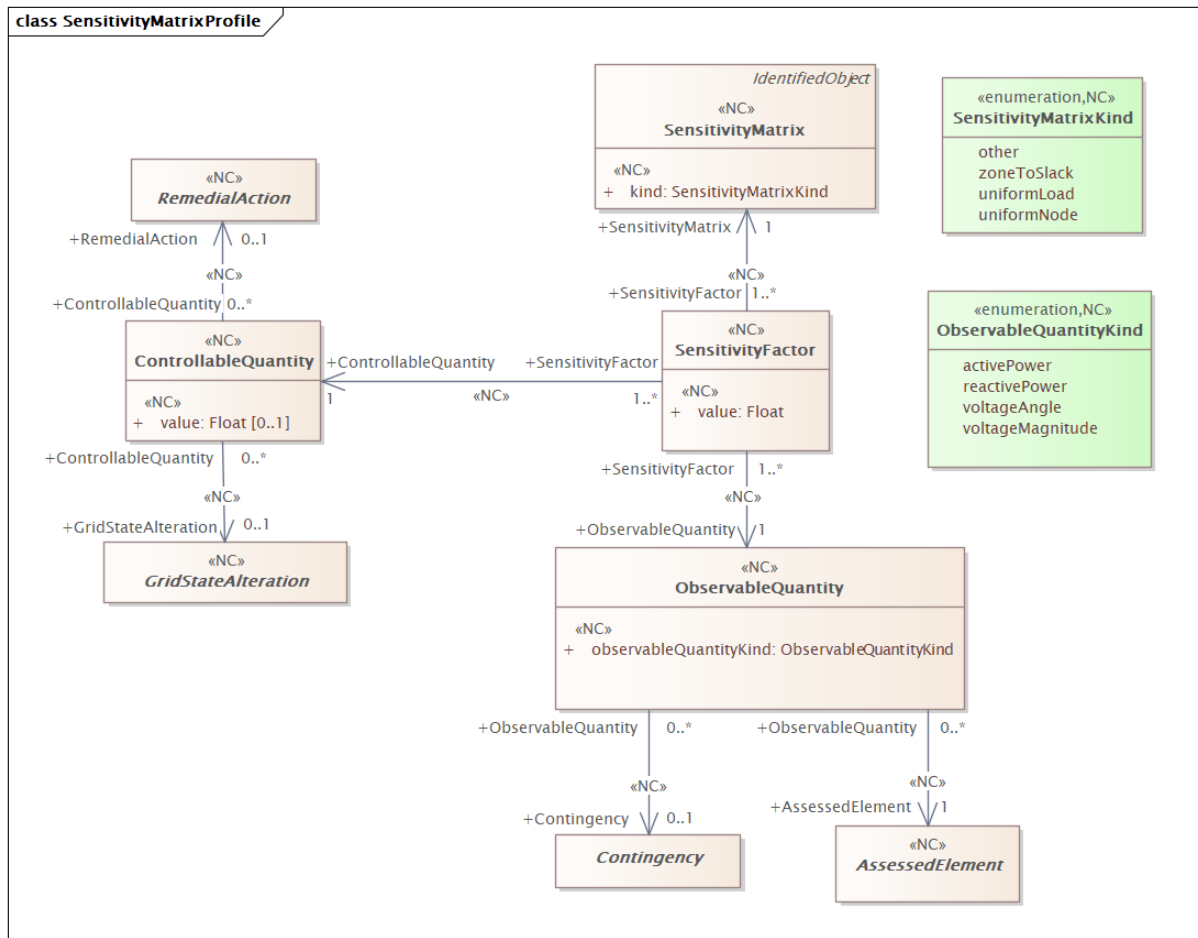


Figure 1 – Class diagram SensitivityMatrixProfile::SensitivityMatrixProfile

Figure 1: The diagram shows classes related to the sensitivity matrix profile.

3.2 (abstract,NC) AssessedElement root class

Assessed element is a network element for which the electrical state is evaluated in the regional or cross-regional process and which value is expected to fulfil regional rules function of the operational security limits.

The measurements and limits are as defined in the steady state hypothesis.

3.3 (abstract) Contingency root class

An event threatening system reliability, consisting of one or more contingency elements.

3.4 (NC) ControllableQuantity root class

Controllable quantity is a set point quantity on a grid state alteration or on a remedial action.

Table 1 shows all attributes of ControllableQuantity.

Table 1 – Attributes of SensitivityMatrixProfile::ControllableQuantity

name	mult	type	description
value	0..1	Float	(NC) The value of the change applied to the grid state alteration or remedial action. In the case of multiple changes or non-quantifiable changes (e.g. Topology changes) the value needs to represent the suitable value that makes the derivable value given in the observable quantity for the purpose of the calculation of the sensitivity factor. The value can be integer, float

name	mult	type	description
			or boolean. In case of boolean 1 equals true and 0 equals false.

Table 2 shows all association ends of ControllableQuantity with other classes.

Table 2 – Association ends of SensitivityMatrixProfile::ControllableQuantity with other classes

mult from	name	mult to	type	description
0..*	RemedialAction	0..1	RemedialAction	(NC) Remedial action which is associated with the controllable quantity.
0..*	GridStateAlteration	0..1	GridStateAlteration	(NC) The grid state alteration for this controllable quantity.

3.5 (abstract,NC) GridStateAlteration root class

Grid state alteration is a change of values describing state (operating point) of one element in the grid model compared to the base case.

3.6 (abstract) IdentifiedObject root class

This is a root class to provide common identification for all classes needing identification and naming attributes.

Table 3 shows all attributes of IdentifiedObject.

Table 3 – Attributes of SensitivityMatrixProfile::IdentifiedObject

name	mult	type	description
description	0..1	String	The description is a free human readable text describing or naming the object. It may be non unique and may not correlate to a naming hierarchy.
mRID	1..1	String	Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements.
name	0..1	String	The name is any free human readable and possibly non unique text naming the object.

3.7 (NC) ObservableQuantity root class

Observable quantity is an electrical quantity on an assessed element or an assessed element with contingency.

Table 4 shows all attributes of ObservableQuantity.

Table 4 – Attributes of SensitivityMatrixProfile::ObservableQuantity

name	mult	type	description
observableQuantityKind	1..1	ObservableQuantityKind	(NC) Kind of observable quantity.

Table 5 shows all association ends of ObservableQuantity with other classes.

Table 5 – Association ends of SensitivityMatrixProfile::ObservableQuantity with other classes

mult from	name	mult to	type	description
0..*	AssessedElement	1..1	AssessedElement	(NC) The assessed element with contingency associated with this observable quantity.
0..*	Contingency	0..1	Contingency	(NC) The contingency associated with this observable quantity.

3.8 (abstract,NC) RemedialAction root class

Remedial action describes one or more actions that can be performed on a given power system model situation to eliminate one or more identified breaches of constraints. The remedial action can be costly, and have a cost characteristic, or non costly.

3.9 (NC) SensitivityFactor root class

The sensitivity factor which represents the sensitivity between observable and controllable elements.

Table 6 shows all attributes of SensitivityFactor.

Table 6 – Attributes of SensitivityMatrixProfile::SensitivityFactor

name	mult	type	description
value	1..1	Float	(NC) The value of the sensitivity factor.

Table 7 shows all association ends of SensitivityFactor with other classes.

Table 7 – Association ends of SensitivityMatrixProfile::SensitivityFactor with other classes

mult from	name	mult to	type	description
1..*	ControllableQuantity	1..1	ControllableQuantity	(NC) The controllable quantity for this sensitivity factor.
1..*	ObservableQuantity	1..1	ObservableQuantity	(NC) The observable quantity for this sensitivity factor.
1..*	SensitivityMatrix	1..1	SensitivityMatrix	(NC) The sensitivity matrix which contains this sensitivity factor.

3.10 (NC) SensitivityMatrix

Inheritance path = [IdentifiedObject](#)

The sensitivity matrix which represents the sensitivity factors between observable and controllable elements.

Table 8 shows all attributes of SensitivityMatrix.

Table 8 – Attributes of SensitivityMatrixProfile::SensitivityMatrix

name	mult	type	description
kind	1..1	SensitivityMatrixKind	(NC) The kind of sensitivity matrix.
description	0..1	String	inherited from: IdentifiedObject
mRID	1..1	String	inherited from: IdentifiedObject
name	0..1	String	inherited from: IdentifiedObject

3.11 (NC) ObservableQuantityKind enumeration

Kind of observable quantity.

Table 9 shows all literals of ObservableQuantityKind.

Table 9 – Literals of SensitivityMatrixProfile::ObservableQuantityKind

literal	value	description
activePower		The observable quantity is the active power.
reactivePower		The observable quantity is the reactive power.
voltageAngle		The observable quantity is the angle of terminal voltage.
voltageMagnitude		The observable quantity is the magnitude of terminal voltage.

3.12 (NC) SensitivityMatrixKind enumeration

Kinds of sensitivity matrix.

Table 10 shows all literals of SensitivityMatrixKind.

Table 10 – Literals of SensitivityMatrixProfile::SensitivityMatrixKind

literal	value	description
other		Other kind of sensitivity matrix.
zoneToSlack		Zone to slack kind of sensitivity matrix.
uniformLoad		Uniform load matrix.
uniformNode		Uniform node matrix.

3.13 Float primitive

A floating point number. The range is unspecified and not limited.

3.14 String primitive

A string consisting of a sequence of characters. The character encoding is UTF-8. The string length is unspecified and unlimited.

356 **Annex A (informative): Sample data**

357 **A.1 General**

358 This Annex is designed to illustrate the profile by using fragments of sample data. It is not meant
359 to be a complete set of examples covering all possibilities of using the profile. Defining a
360 complete set of test data is considered a separate activity to be performed for the purpose of
361 setting up interoperability testing and conformity related to this profile.

362 **A.2 Sample instance data**

363 Test data files are available in the CIM EG SharePoint.