European Network of
Transmission System Operators
for Electricity

STEADY STATE INSTRUCTION PROFILE SPECIFICATION

2022-09-21

SOC APPROVED
VERSION 2.1

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NOTE CONCERNING WORDING USED IN THIS DOCUMENT

The force of the following words is modified by the requirement level of the document in which they are used.

- SHALL: This word, or the terms “REQUIRED” or “MUST”, means that the definition is an absolute requirement of the specification.
- SHALL NOT: This phrase, or the phrase “MUST NOT”, means that the definition is an absolute prohibition of the specification.
- SHOULD: This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- SHOULD NOT: This phrase, or the phrase “NOT RECOMMENDED”, means that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
- MAY: This word, or the adjective “OPTIONAL”, means that an item is truly optional.

Revision History

Version	Release	Date	Paragraph	Comments
0	1	2021-10-12		For CIM EG review
1	0	2022-02-16		SOC approved.
2	1	2022-09-21		SOC approved.

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1 Introduction

The steady state instruction profile enables an exchange of additional information related to MTU.

2 Application profile specification

2.1 Version information

The content is generated from UML model file CIM100_CGMES31v01_501-20v02_NC21v47_MM10v01.eap.

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

- Title: Steady state instruction Vocabulary
- Keyword: SSI
- Description: This vocabulary is describing the steady state instruction profile.
- Version IRI: http://entsoe.eu/ns/CIM/SteadyStateInstruction-EU/2.1
- Version info: 2.1.0
- Prior version:
- Conforms to: urn:iso:std:iec:61970-600-2:ed-1|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2|file://CGMES-30v25_501-20v01.eap
- Identifier: urn:uuid:6d01969f-38fd-460d-b260-b839a8123319

2.2 Constraints naming convention

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

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

where

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

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

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

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

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

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

2.3 Profile constraints

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

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

- C:452:ALL:NA:datatypes

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

- R:452:ALL:NA:exchange

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

- R:452:ALL:NA:exchange1

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

- R:452:ALL:NA:exchange2

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

- R:452:ALL:NA:exchange3

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

- R:452:ALL:NA:exchange4

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

- R:452:ALL:NA:cardinality

The cardinality defined in the CIM model shall be followed, unless a more restrictive cardinality is explicitly defined in this document. For instance, the cardinality on the association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall be associated with one and only one BaseVoltage, but a BaseVoltage can be associated with zero to many VoltageLevels.

- R:452:ALL:NA:associations

  Associations between classes referenced in this document and classes not referenced here are not required regardless of cardinality.

- R:452:ALL:IdentifiedObject.name:rule

  The attribute “name” inherited by many classes from the abstract class IdentifiedObject is not required to be unique. It must be a human readable identifier without additional embedded information that would need to be parsed. The attribute is used for purposes such as User Interface and data exchange debugging. The MRID defined in the data exchange format is the only unique and persistent identifier used for this data exchange. The attribute IdentifiedObject.name is, however, always required for CoreEquipment profile and Short Circuit profile.

- R:452:ALL:IdentifiedObject.description:rule

  The attribute “description” inherited by many classes from the abstract class IdentifiedObject must contain human readable text without additional embedded information that would need to be parsed.

- R:452:ALL:NA:uniqueIdentifier

  All IdentifiedObject-s shall have a persistent and globally unique identifier (Master Resource Identifier - mRID).

- R:452:ALL:NA:unitMultiplier

  For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance, etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is “none”.

- C:452:ALL:IdentifiedObject.name:stringLength

  The string IdentifiedObject.name has a maximum of 128 characters.

- C:452:ALL:IdentifiedObject.description:stringLength

  The string IdentifiedObject.description is maximum 256 characters.

- C:452:ALL:NA:float

  An attribute that is defined as float (e.g. has a type Float or a type which is a Datatype with .value attribute of type Float) shall support ISO/IEC 60559:2020 for floating-point arithmetic using single precision floating point. A single precision float supports 7 significant digits where the significant digits are described as an integer, or a decimal number with 6 decimal digits. Two float values are equal when the significant with 7 digits are identical, e.g. 1234567 is equal 1.234567E6 and so are 1.2345678 and 1.234567E0.

- C:NC:SSI:GridStateAlteration.inService:dependency

If GridStateAlteration.inService is false, then GridStateAlteration.enabled shall be false or missing (NULL). If GridStateAlteration.inService is true, then GridStateAlteration.enabled is required and it can be true or false.

2.4 Metadata

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

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

2.4.1 Constraints

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

- R:NC:ALL:wasAttributedTo:usage

  The prov:wasAttributedTo should normally be the “X” EIC code of the actor (prov:Agent).

2.4.2 Reference metadata

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

3 Detailed Profile Specification

3.1 General

This package contains steady state instruction profile.

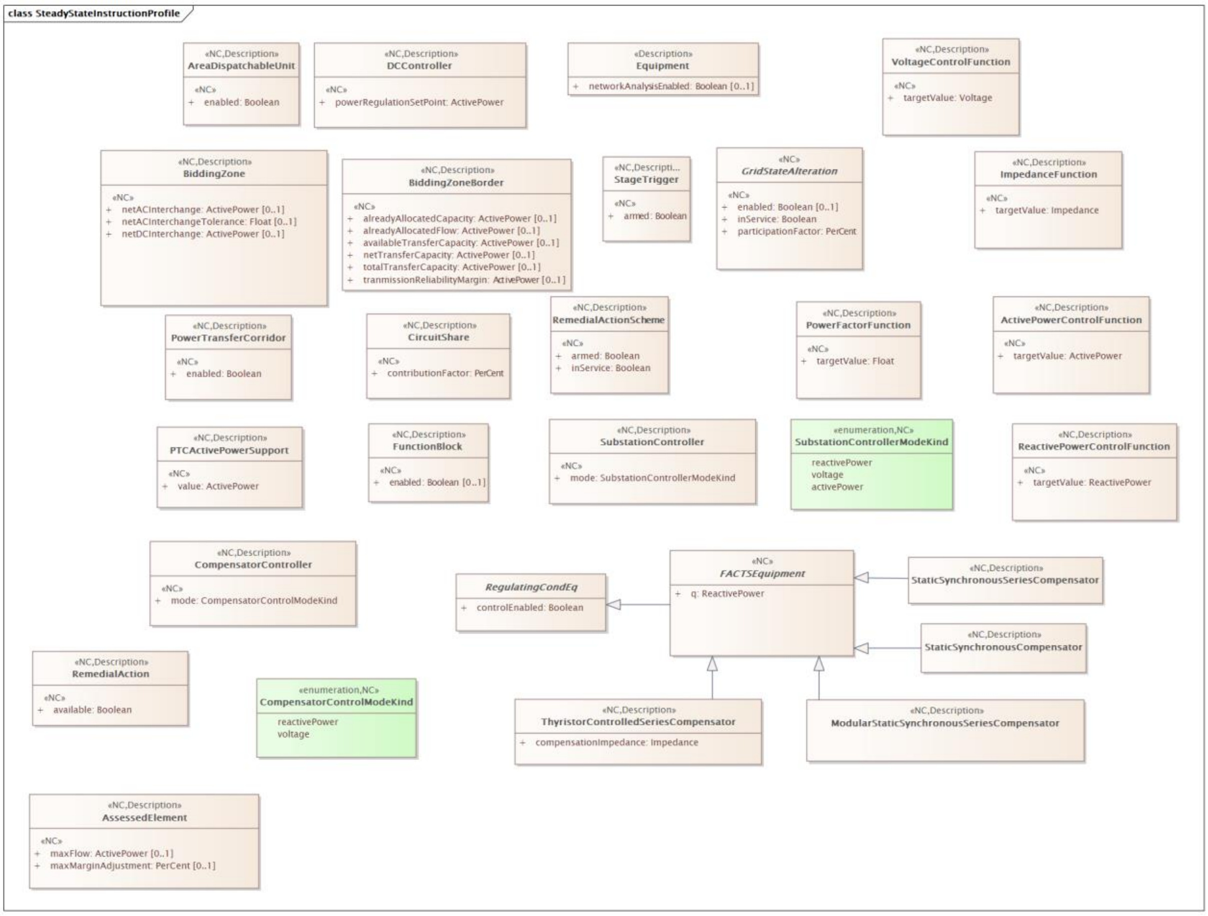

Figure 1 – Class diagram SteadyStateInstructionProfile::SteadyStateInstructionProfile

Figure 1: The diagram shows steady state instruction related classes.

3.2 (NC,Description) ActivePowerControlFunction root class

Active power control function is a function block that calculate the controlled equipment operation point to archive the target active power.
Table 1 shows all attributes of ActivePowerControlFunction.

Table 1 – Attributes of SteadyStateInstructionProfile::ActivePowerControlFunction

name	mult	type	description
targetValue	1..1	ActivePower	(NC) Target value for the active power that the control function is calculating to archive by adjusting the operational setting to the controlled equipment.

3.3 (NC,Description) AreaDispatchableUnit root class

Allocates a given producing or consuming unit, including direct current corridor and collection of units, to a given control area (through the scheduling area) for supporting the control of the given area through dispatch instruction.
Table 2 shows all attributes of AreaDispatchableUnit.

Table 2 – Attributes of SteadyStateInstructionProfile::AreaDispatchableUnit

name	mult	type	description
enabled	1..1	Boolean	(NC) Identifies if the unit is enabled to accept a dispatch instruction. If true, the unit is enabled to accept a dispatch instruction. If false, the unit has the capability, but it is not enabled to receive a dispatch instruction.

3.4 (NC,Description) 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 information of the validity period of the assessed element is derived from the conducting equipment.

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

Table 3 shows all attributes of AssessedElement.

Table 3 – Attributes of SteadyStateInstructionProfile::AssessedElement

name	mult	type	description
maxFlow	0..1	ActivePower	(NC) Maximum flow on an a conducting equipment or a collection of conducting equipment forming a power transfer corridor. For assessed elements that is becomes critical due to contingency, this value represents the maximum flow with remedial action taken into consideration.
maxMarginAdjustment	0..1	PerCent	(NC) Maximum adjustment, relative to maximum flow allowed for exceeding the maximum flow of this assessed element.

3.5 (NC,Description) BiddingZone root class

A bidding zone is a market-based method for handling power transmission congestion. It consists of scheduling areas that include the relevant production (supply) and consumption (demand) to form an electrical area with the same market price without capacity allocation.

Table 4 shows all attributes of BiddingZone.

Table 4 – Attributes of SteadyStateInstructionProfile::BiddingZone

name	mult	type	description
netACInterchange	0..1	ActivePower	(NC) The netted aggregation of all AC external schedules of an area. Positive sign means flow into the area (Import).
netACInterchangeTolerance	0..1	Float	(NC) The area AC Net Position tolerance.
netDCInterchange	0..1	ActivePower	(NC) The netted aggregation of all DC external schedules of an area. Positive sign means flow into the area.

3.6 (NC,Description) BiddingZoneBorder root class

Defines the aggregated connection capacity between two Bidding Zones.

Table 5 shows all attributes of BiddingZoneBorder.

Table 5 – Attributes of SteadyStateInstructionProfile::BiddingZoneBorder

name	mult	type	description
totalTransferCapacity	0..1	ActivePower	(NC) Total Transfer Capacity (TTC) is the maximum exchange program between two areas compatible with operational security standards applicable at each system if future network conditions, generation and load patterns were perfectly known in advance.
tranmissionReliabilityMargin	0..1	ActivePower	(NC) Transmission Reliability Margin (TRM) is the minimum reserve that system operators must have available at their connections so that they can help other countries to which their system is directly or indirectly connected, if necessary.
netTransferCapacity	0..1	ActivePower	(NC) Net Transfer Capacity (NTC) is defined as NTC = TTC – TRM and corresponds to the maximum exchange between two areas compatible with operational security limits applicable in both areas and taking into account the technical uncertainties on future network conditions.
alreadyAllocatedCapacity	0..1	ActivePower	(NC) Already Allocated Capacity (AAC) means the total amount of allocated transmission rights i.e. transmission capacity reserved by virtue of historical long-term contracts and the previously held transmission capacity reservation auctions.
availableTransferCapacity	0..1	ActivePower	(NC) Available Transfer Capacity (ATC) means the transmission capacity that remains available, after allocation procedure, to be used under the physical conditions of the transmission system. ATC value is defined as: ATC = NTC - AAC.
alreadyAllocatedFlow	0..1	ActivePower	(NC) The maximum allowed flow on the collection of interconnection between two bidding zones.

3.7 (NC,Description) CircuitShare root class

Defines the share of the circuit which is part of this power transfer corridor. Table 6 shows all attributes of CircuitShare.

Table 6 – Attributes of SteadyStateInstructionProfile::CircuitShare

name	mult	type	description
contributionFactor	1..1	PerCent	(NC) Contribution factor for the circuit which is part of a power transfer corridor.

3.8 (NC,Description) CompensatorController root class

Compensator controller is controlling the equipment to optimize the use of the compensators. Table 7 shows all attributes of CompensatorController.

Table 7 – Attributes of SteadyStateInstructionProfile::CompensatorController

name	mult	type	description
mode	1..1	CompensatorControlModeKind	(NC) Mode of the compensator controller.

3.9 (NC,Description) DCController root class

The direct current controller providing the power regulation setpoint for one or more direct current poles.

Table 8 shows all attributes of DCController.

Table 8 – Attributes of SteadyStateInstructionProfile::DCController

name	mult	type	description
powerRegulationSetPoint	1..1	ActivePower	(NC) Power regulation setpoint giving the instruction for the controller.

3.10 (Description) Equipment root class

The parts of a power system that are physical devices, electronic or mechanical.
Table 9 shows all attributes of Equipment.

Table 9 – Attributes of SteadyStateInstructionProfile::Equipment

name	mult	type	description
networkAnalysisEnabled	0..1	Boolean	The equipment is enabled to participate in network analysis. If unspecified, the value is assumed to be true.

3.11 (abstract,NC) FACTSEquipment

Inheritance path = RegulatingCondEq
Flexible Alternating Current Transmission System regulating equipment.
Table 10 shows all attributes of FACTSEquipment.

Table 10 – Attributes of SteadyStateInstructionProfile::FACTSEquipment

name	mult	type	description
q	1..1	ReactivePower	Reactive power injection. Load sign convention is used, i.e. positive sign means flow out from a node. Starting value for a steady state solution.
controlEnabled	1..1	Boolean	inherited from: RegulatingCondEq

3.12 (NC,Description) FunctionBlock root class

Function block is a function described as a set of elementary blocks. The blocks describe the function between input variables and output variables.
Table 11 shows all attributes of FunctionBlock.

Table 11 – Attributes of SteadyStateInstructionProfile::FunctionBlock

name	mult	type	description
enabled	0..1	Boolean	(NC) True, if the function block is enabled (active). Otherwise false.

3.13 (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.
Table 12 shows all attributes of GridStateAlteration.

Table 12 – Attributes of SteadyStateInstructionProfile::GridStateAlteration

name	mult	type	description
enabled	0..1	Boolean	(NC) The status of the GridStateAlteration set by an operation or by a signal resulting from a control action.

name	mult	type	description
participationFactor	1..1	PerCent	(NC) It defines the participation of this grid state alteration. If 0 this grid alteration does not participate. The sum of all participation factors for all grid state alterations associated with same remedial action shall be equal to 100%.
inService	1..1	Boolean	(NC) Specifies the availability of the grid state alteration. If true, the grid state alteration is available for processing. if false, the grid state alteration is treated as if it is not in the model.

3.14 (NC,Description) ImpedanceFunction root class

Impedance function is a function block that calculates the controlled equipment operation point to archive the target impedance.
Table 13 shows all attributes of ImpedanceFunction.

Table 13 – Attributes of SteadyStateInstructionProfile::ImpedanceFunction

name	mult	type	description
targetValue	1..1	Impedance	(NC) Target value for the impedance that the control function is calculating to archive by adjusting the operational setting to the controlled equipment.

3.15 (NC,Description) ModularStaticSynchronousSeriesCompensator

Inheritance path = FACTSEquipment : RegulatingCondEq
Modular static synchronous series compensator (MSSSC) is a type of flexible AC transmission system regulating equipment which consists of solid-state voltage source inverter connected in series with a transmission line. This is similar to static synchronous series compensator (SSSC), but without injection transformer. This enables the MSSSC to be truly modular with the ability to simply install a number of equipment in series to provide a desired maximum level of impedance. MSSSC can be dispersed into multiple location in a circuit working collectively under the same controller scheme.
Table 14 shows all attributes of ModularStaticSynchronousSeriesCompensator.

Table 14 – Attributes of SteadyStateInstructionProfile::ModularStaticSynchronousSeriesCompensator

name	mult	type	description
q	1..1	ReactivePower	inherited from: FACTSEquipment
controlEnabled	1..1	Boolean	inherited from: RegulatingCondEq

3.16 (NC,Description) PowerFactorFunction root class

Power factor function is a function block that calculates the controlled equipment operation point to archive the target power factor.
Table 15 shows all attributes of PowerFactorFunction.

Table 15 – Attributes of SteadyStateInstructionProfile::PowerFactorFunction

name	mult	type	description
targetValue	1..1	Float	(NC) Target value for the power factor that the control function is calculating to archive by adjusting the operational setting to the controlled equipment.

3.17 (NC,Description) PowerTransferCorridor root class

A power transfer corridor is defined as a set of circuits (transmission lines or transformers) separating two portions of the power system, or a subset of circuits exposed to a substantial portion of the transmission exchange between two parts of the system.
Table 16 shows all attributes of PowerTransferCorridor.

Table 16 – Attributes of SteadyStateInstructionProfile::PowerTransferCorridor

name	mult	type	description
enabled	1..1	Boolean	(NC) It enables/disables the monitoring/assessment of a power transfer corridor. True means that the monitoring of the power transfer corridor is assessed. False means the power transfer corridor is not assessed.

3.18 (NC,Description) PTCActivePowerSupport root class

Defines the active power capability (support) of the scheme in relation to a PowerTransferCorridor.
Table 17 shows all attributes of PTCActivePowerSupport.

Table 17 – Attributes of SteadyStateInstructionProfile::PTCActivePowerSupport

name	mult	type	description
value	1..1	ActivePower	(NC) The support that a System Integrity Protection Scheme (SIPS) gives to a Power Transfer Corridor (PTC).

3.19 (NC,Description) ReactivePowerControlFunction root class

Reactive power control function is a function block that calculate the controlled equipment operation point to archive the target reactive power.
Table 18 shows all attributes of ReactivePowerControlFunction.

Table 18 – Attributes of SteadyStateInstructionProfile::ReactivePowerControlFunction

name	mult	type	description
targetValue	1..1	ReactivePower	(NC) Target value for the reactive power that the control function is calculating to archive by adjusting the operational setting to the controlled equipment.

3.20 (abstract) RegulatingCondEq root class

A type of conducting equipment that can regulate a quantity (i.e. voltage or flow) at a specific point in the network.
Table 19 shows all attributes of RegulatingCondEq.

Table 19 – Attributes of SteadyStateInstructionProfile::RegulatingCondEq

name	mult	type	description
controlEnabled	1..1	Boolean	Specifies the regulation status of the equipment. True is regulating, false is not regulating.

3.21 (NC,Description) 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.
Table 20 shows all attributes of RemedialAction.

Table 20 – Attributes of SteadyStateInstructionProfile::RemedialAction

name	mult	type	description
available	1..1	Boolean	(NC) It identifies if the remedial action is available. True means available, False means unavailable.

3.22 (NC,Description) RemedialActionScheme root class

Remedial Action Scheme (RAS), Special Protection Schemes (SPS), System Protection Schemes (SPS) or System Integrity Protection Schemes (SIPS).
A Remedial Action Scheme consists of one or more stages that can trigger and execute a protection action.
Table 21 shows all attributes of RemedialActionScheme.

Table 21 – Attributes of SteadyStateInstructionProfile::RemedialActionScheme

name	mult	type	description
armed	1..1	Boolean	(NC) Defines the arming status of the remedial action scheme. It is set by operation or by signal.
inService	1..1	Boolean	(NC) Specifies the availability of the Remedial Action Scheme (RAS). If true, the RAS is available for contingency processing. If false, the RAS is treated by contingency processing as if it is not in the model.

3.23 (NC,Description) StageTrigger root class

Stage that is triggered either by TriggerCondition or by gate condition within a stage.
Table 22 shows all attributes of StageTrigger.

Table 22 – Attributes of SteadyStateInstructionProfile::StageTrigger

name	mult	type	description
armed	1..1	Boolean	(NC) The status of the class set by operation or by signal. Optional field that will override other status fields.

3.24 (NC,Description) StaticSynchronousCompensator

Inheritance path = FACTSEquipment : RegulatingCondEq
Static synchronous compensator (STATCOM), also known as a static synchronous condenser (STATCON), is a type of flexible AC transmission system regulating equipment used on alternating current electricity transmission networks. It is based on a power electronics voltage-source converter and can act as either a source or sink of reactive AC power to an electricity network. If connected to a source of power it can also provide active AC power.
Table 23 shows all attributes of StaticSynchronousCompensator.

Table 23 – Attributes of SteadyStateInstructionProfile::StaticSynchronousCompensator

name	mult	type	description
q	1..1	ReactivePower	inherited from: FACTSEquipment

name	mult	type	description
controlEnabled	1..1	Boolean	inherited from: RegulatingCondEq

3.25 (NC,Description) StaticSynchronousSeriesCompensator

Inheritance path = FACTSEquipment : RegulatingCondEq

Static synchronous series compensator (SSSC) is a type of flexible AC transmission system which consists of a solid-state voltage source inverter coupled with a transformer that is connected in series with a transmission line. This device can inject an almost sinusoidal voltage in series with the line. This injected voltage could be considered as an inductive or capacitive reactance, which is connected in series with the transmission line. This feature can provide controllable voltage compensation. In addition, SSSC is able to reverse the power flow by injecting a sufficiently large series reactive compensating voltage.

Table 24 shows all attributes of StaticSynchronousSeriesCompensator.

Table 24 – Attributes of SteadyStateInstructionProfile::StaticSynchronousSeriesCompensator

name	mult	type	description
q	1..1	ReactivePower	inherited from: FACTSEquipment
controlEnabled	1..1	Boolean	inherited from: RegulatingCondEq

3.26 (NC,Description) SubstationController root class

Substation controller is controlling the equipment to optimize the use of the controlling equipment within a substation.

Table 25 shows all attributes of SubstationController.

Table 25 – Attributes of SteadyStateInstructionProfile::SubstationController

name	mult	type	description
mode	1..1	SubstationControllerModeKind	(NC) Mode of the substation controller.

3.27 (NC,Description) ThyristorControlledSeriesCompensator

Inheritance path = FACTSEquipment : RegulatingCondEq

Thyristor-controlled series capacitors (TCSC) is a type of flexible AC transmission system regulating equipment that is configured with controlled reactors in parallel with sections of a capacitor bank. This combination allows smooth control of the fundamental frequency capacitive reactance over a wide range. The thyristor valve contains a string of series connected high power thyristors. TCSC can control power flows in order to achieve eliminating of line overloads, reducing loop flows and minimising system losses.

Table 26 shows all attributes of ThyristorControlledSeriesCompensator.

Table 26 – Attributes of SteadyStateInstructionProfile::ThyristorControlledSeriesCompensator

name	mult	type	description
compensationImpedance	1..1	Impedance	The operated compensation impedance of the device. The attribute value shall be positive if compensation is in capacitive rating. The attribute value shall be negative if compensation is in inductive rating.
q	1..1	ReactivePower	inherited from: FACTSEquipment
controlEnabled	1..1	Boolean	inherited from: RegulatingCondEq

3.28 (NC,Description) VoltageControlFunction root class

Voltage control function is a function block that calculate the controlled equipment operation point to archive the target voltage.

Table 27 shows all attributes of VoltageControlFunction.

Table 27 – Attributes of SteadyStateInstructionProfile::VoltageControlFunction

name	mult	type	description
targetValue	1..1	Voltage	(NC) Target value for the voltage that the control function is calculating to archive by adjusting the operational setting to the controlled equipment.

3.29 (NC) CompensatorControlModeKind enumeration

Kind of compensator controller mode.

Table 28 shows all literals of CompensatorControlModeKind.

Table 28 – Literals of SteadyStateInstructionProfile::CompensatorControlModeKind

literal	value	description
reactivePower		Reactive power control.
voltage		Voltage control.

3.30 (NC) SubstationControllerModeKind enumeration

Kind of substation controller mode.

Table 29 shows all literals of SubstationControllerModeKind.

Table 29 – Literals of SteadyStateInstructionProfile::SubstationControllerModeKind

literal	value	description
reactivePower		Reactive power control is the primary control of the substation.
voltage		Voltage control is the primary control of the substation.
activePower		Active power control is the primary control of the substation..

3.31 UnitMultiplier enumeration

The unit multipliers defined for the CIM. When applied to unit symbols, the unit symbol is treated as a derived unit. Regardless of the contents of the unit symbol text, the unit symbol shall be treated as if it were a single-character unit symbol. Unit symbols should not contain multipliers, and it should be left to the multiplier to define the multiple for an entire data type.
For example, if a unit symbol is "m2Pers" and the multiplier is "k", then the value is k(m**2/s), and the multiplier applies to the entire final value, not to any individual part of the value. This can be conceptualized by substituting a derived unit symbol for the unit type. If one imagines that the symbol "Þ" represents the derived unit "m2Pers", then applying the multiplier "k" can be conceptualized simply as "kÞ".
For example, the SI unit for mass is "kg" and not "g". If the unit symbol is defined as "kg", then the multiplier is applied to "kg" as a whole and does not replace the "k" in front of the "g". In this case, the multiplier of "m" would be used with the unit symbol of "kg" to represent one gram. As a text string, this violates the instructions in IEC 80000-1. However, because the unit symbol in CIM is treated as a derived unit instead of as an SI unit, it makes more sense to conceptualize the "kg" as if it were replaced by one of the proposed replacements for the SI mass symbol. If one imagines that the "kg" were replaced by a symbol "Þ", then it is easier to conceptualize the multiplier "m" as creating the proper unit "mÞ", and not the forbidden unit "mkg".

Table 30 shows all literals of UnitMultiplier.

Table 30 – Literals of SteadyStateInstructionProfile::UnitMultiplier

literal	value	description
y	-24	Yocto 10**-24.
z	-21	Zepto 10**-21.
a	-18	Atto 10**-18.
f	-15	Femto 10**-15.
p	-12	Pico 10**-12.
n	-9	Nano 10**-9.
micro	-6	Micro 10**-6.
m	-3	Milli 10**-3.
c	-2	Centi 10**-2.
d	-1	Deci 10**-1.
none	0	No multiplier or equivalently multiply by 1.
da	1	Deca 10**1.
h	2	Hecto 10**2.
k	3	Kilo 10**3.
M	6	Mega 10**6.
G	9	Giga 10**9.
T	12	Tera 10**12.
P	15	Peta 10**15.
E	18	Exa 10**18.
Z	21	Zetta 10**21.
Y	24	Yotta 10**24.

3.32 UnitSymbol enumeration

The derived units defined for usage in the CIM. In some cases, the derived unit is equal to an SI unit. Whenever possible, the standard derived symbol is used instead of the formula for the derived unit. For example, the unit symbol Farad is defined as "F" instead of "CPerV". In cases where a standard symbol does not exist for a derived unit, the formula for the unit is used as the unit symbol. For example, density does not have a standard symbol and so it is represented as "kgPerm3". With the exception of the "kg", which is an SI unit, the unit symbols do not contain multipliers and therefore represent the base derived unit to which a multiplier can be applied as a whole.

Every unit symbol is treated as an unparseable text as if it were a single-letter symbol. The meaning of each unit symbol is defined by the accompanying descriptive text and not by the text contents of the unit symbol.

To allow the widest possible range of serializations without requiring special character handling, several substitutions are made which deviate from the format described in IEC 80000-1. The division symbol "/" is replaced by the letters "Per". Exponents are written in plain text after the unit as "m3" instead of being formatted as "m" with a superscript of 3 or introducing a symbol as in "m^3". The degree symbol "°" is replaced with the letters "deg". Any clarification of the meaning for a substitution is included in the description for the unit symbol.

Non-SI units are included in list of unit symbols to allow sources of data to be correctly labelled with their non-SI units (for example, a GPS sensor that is reporting numbers that represent feet instead of meters). This allows software to use the unit symbol information correctly convert and scale the raw data of those sources into SI-based units.

538 The integer values are used for harmonization with IEC 61850.
539 Table 31 shows all literals of UnitSymbol.

540 **Table 31 – Literals of SteadyStateInstructionProfile::UnitSymbol**

literal	value	description
none	0	Dimension less quantity, e.g. count, per unit, etc.
m	2	Length in metres.
kg	3	Mass in kilograms. Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
s	4	Time in seconds.
A	5	Current in amperes.
K	6	Temperature in kelvins.
mol	7	Amount of substance in moles.
cd	8	Luminous intensity in candelas.
deg	9	Plane angle in degrees.
rad	10	Plane angle in radians (m/m).
sr	11	Solid angle in steradians (m2/m2).
Gy	21	Absorbed dose in grays (J/kg).
Bq	22	Radioactivity in becquerels (1/s).
degC	23	Relative temperature in degrees Celsius. In the SI unit system the symbol is °C. Electric charge is measured in coulomb that has the unit symbol C. To distinguish degree Celsius from coulomb the symbol used in the UML is degC. The reason for not using °C is that the special character ° is difficult to manage in software.
Sv	24	Dose equivalent in sieverts (J/kg).
F	25	Electric capacitance in farads (C/V).
C	26	Electric charge in coulombs (A·s).
S	27	Conductance in siemens.
H	28	Electric inductance in henrys (Wb/A).
V	29	Electric potential in volts (W/A).
ohm	30	Electric resistance in ohms (V/A).
J	31	Energy in joules (N·m = C·V = W·s).
N	32	Force in newtons (kg·m/s²).
Hz	33	Frequency in hertz (1/s).
lx	34	Illuminance in lux (lm/m²).
lm	35	Luminous flux in lumens (cd·sr).
Wb	36	Magnetic flux in webers (V·s).
T	37	Magnetic flux density in teslas (Wb/m2).
W	38	Real power in watts (J/s). Electrical power may have real and reactive components. The real portion of electrical power (I²R or VIcos(phi)), is expressed in Watts. See also apparent power and reactive power.

literal	value	description
Pa	39	Pressure in pascals (N/m²). Note: the absolute or relative measurement of pressure is implied with this entry. See below for more explicit forms.
m2	41	Area in square metres (m²).
m3	42	Volume in cubic metres (m³).
mPers	43	Velocity in metres per second (m/s).
mPers2	44	Acceleration in metres per second squared (m/s²).
m3Pers	45	Volumetric flow rate in cubic metres per second (m³/s).
mPerm3	46	Fuel efficiency in metres per cubic metres (m/m³).
kgm	47	Moment of mass in kilogram metres (kg·m) (first moment of mass). Note: multiplier "k" is included in this unit symbol for compatibility with IEC 61850-7-3.
kgPerm3	48	Density in kilogram/cubic metres (kg/m³). Note: multiplier "k" is included in this unit symbol for compatibility with IEC 61850-7-3.
m2Pers	49	Viscosity in square metres / second (m²/s).
WPermK	50	Thermal conductivity in watt/metres kelvin.
JPerK	51	Heat capacity in joules/kelvin.
ppm	52	Concentration in parts per million.
rotPers	53	Rotations per second (1/s). See also Hz (1/s).
radPers	54	Angular velocity in radians per second (rad/s).
WPerm2	55	Heat flux density, irradiance, watts per square metre.
JPerm2	56	Insulation energy density, joules per square metre or watt second per square metre.
SPerm	57	Conductance per length (F/m).
KPers	58	Temperature change rate in kelvins per second.
PaPers	59	Pressure change rate in pascals per second.
JPerkgK	60	Specific heat capacity, specific entropy, joules per kilogram Kelvin.
VA	61	Apparent power in volt amperes. See also real power and reactive power.
VAr	63	Reactive power in volt amperes reactive. The "reactive" or "imaginary" component of electrical power (VIsin(phi)). (See also real power and apparent power). Note: Different meter designs use different methods to arrive at their results. Some meters may compute reactive power as an arithmetic value, while others compute the value vectorially. The data consumer should determine the method in use and the suitability of the measurement for the intended purpose.
cosPhi	65	Power factor, dimensionless. Note 1: This definition of power factor only holds for balanced systems. See the alternative definition under code 153.

literal	value	description
		Note 2 : Beware of differing sign conventions in use between the IEC and EEI. It is assumed that the data consumer understands the type of meter in use and the sign convention in use by the utility.
Vs	66	Volt seconds (Ws/A).
V2	67	Volt squared (W^2/A^2).
As	68	Ampere seconds (A·s).
A2	69	Amperes squared (A^2).
A2s	70	Ampere squared time in square amperes (A^2s).
VAh	71	Apparent energy in volt ampere hours.
Wh	72	Real energy in watt hours.
VArh	73	Reactive energy in volt ampere reactive hours.
VPerHz	74	Magnetic flux in volt per hertz.
HzPers	75	Rate of change of frequency in hertz per second.
character	76	Number of characters.
charPers	77	Data rate (baud) in characters per second.
kgm2	78	Moment of mass in kilogram square metres ($kg·m^2$) (Second moment of mass, commonly called the moment of inertia). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
dB	79	Sound pressure level in decibels. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
WPers	81	Ramp rate in watts per second.
lPers	82	Volumetric flow rate in litres per second.
dBm	83	Power level (logarithmic ratio of signal strength , Bel-mW), normalized to 1mW. Note: multiplier “d” is included in this unit symbol for compatibility with IEC 61850-7-3.
h	84	Time in hours, hour = 60 min = 3600 s.
min	85	Time in minutes, minute = 60 s.
Q	100	Quantity power, Q.
Qh	101	Quantity energy, Qh.
ohmm	102	Resistivity, ohm metres, (rho).
APerm	103	A/m, magnetic field strength, amperes per metre.
V2h	104	Volt-squared hour, volt-squared-hours.
A2h	105	Ampere-squared hour, ampere-squared hour.
Ah	106	Ampere-hours, ampere-hours.
count	111	Amount of substance, Counter value.
ft3	119	Volume, cubic feet.
m3Perh	125	Volumetric flow rate, cubic metres per hour.
gal	128	Volume in gallons, US gallon (1 gal = 231 in3 = 128 fl ounce).
Btu	132	Energy, British Thermal Units.
l	134	Volume in litres, litre = dm3 = m3/1000.

literal	value	description
lPerh	137	Volumetric flow rate, litres per hour.
lPerl	143	Concentration, The ratio of the volume of a solute divided by the volume of the solution. Note: Users may need use a prefix such a 'µ' to express a quantity such as 'µL/L'.
gPerg	144	Concentration, The ratio of the mass of a solute divided by the mass of the solution. Note: Users may need use a prefix such a 'µ' to express a quantity such as 'µg/g'.
molPerm3	145	Concentration, The amount of substance concentration, (c), the amount of solvent in moles divided by the volume of solution in m^3.
molPermol	146	Concentration, Molar fraction, the ratio of the molar amount of a solute divided by the molar amount of the solution.
molPerkg	147	Concentration, Molality, the amount of solute in moles and the amount of solvent in kilograms.
sPers	149	Time, Ratio of time. Note: Users may need to supply a prefix such as 'µ' to show rates such as 'µs/s'.
HzPerHz	150	Frequency, rate of frequency change. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mHz/Hz'.
VPerV	151	Voltage, ratio of voltages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mV/V'.
APerA	152	Current, ratio of amperages. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mA/A'.
VPerVA	153	Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
rev	154	Amount of rotation, revolutions.
kat	158	Catalytic activity, katal = mol / s.
JPerkg	165	Specific energy, Joules / kg.
m3Uncompensated	166	Volume, cubic metres, with the value uncompensated for weather effects.
m3Compensated	167	Volume, cubic metres, with the value compensated for weather effects.
WPerW	168	Signal Strength, ratio of power. Note: Users may need to supply a prefix such as 'm' to show rates such as 'mW/W'.
therm	169	Energy, therms.
onePerm	173	Wavenumber, reciprocal metres, (1/m).
m3Perkg	174	Specific volume, cubic metres per kilogram, v.
Pas	175	Dynamic viscosity, pascal seconds.
Nm	176	Moment of force, newton metres.
NPerm	177	Surface tension, newton per metre.

literal	value	description
radPers2	178	Angular acceleration, radians per second squared.
JPerm3	181	Energy density, joules per cubic metre.
VPerm	182	Electric field strength, volts per metre.
CPerm3	183	Electric charge density, coulombs per cubic metre.
CPerm2	184	Surface charge density, coulombs per square metre.
FPerm	185	Permittivity, farads per metre.
HPerm	186	Permeability, henrys per metre.
JPermol	187	Molar energy, joules per mole.
JPermolK	188	Molar entropy, molar heat capacity, joules per mole kelvin.
CPerkg	189	Exposure (x rays), coulombs per kilogram.
GyPers	190	Absorbed dose rate, grays per second.
WPersr	191	Radiant intensity, watts per steradian.
WPerm2sr	192	Radiance, watts per square metre steradian.
katPerm3	193	Catalytic activity concentration, katals per cubic metre.
d	195	Time in days, day = 24 h = 86400 s.
anglemin	196	Plane angle, minutes.
anglesec	197	Plane angle, seconds.
ha	198	Area, hectares.
tonne	199	Mass in tons, “tonne” or “metric ton” (1000 kg = 1 Mg).
bar	214	Pressure in bars, (1 bar = 100 kPa).
mmHg	215	Pressure, millimetres of mercury (1 mmHg is approximately 133.3 Pa).
M	217	Length, nautical miles (1 M = 1852 m).
kn	219	Speed, knots (1 kn = 1852/3600) m/s.
Mx	276	Magnetic flux, maxwells (1 Mx = 10-8 Wb).
G	277	Magnetic flux density, gausses (1 G = 10-4 T).
Oe	278	Magnetic field in oersteds, (1 Oe = (103/4p) A/m).
Vh	280	Volt-hour, Volt hours.
WPerA		Active power per current flow, watts per Ampere.
onePerHz		Reciprocal of frequency (1/Hz).
VPerVAr		Power factor, PF, the ratio of the active power to the apparent power. Note: The sign convention used for power factor will differ between IEC meters and EEI (ANSI) meters. It is assumed that the data consumers understand the type of meter being used and agree on the sign convention in use at any given utility.
ohmPerm	86	Electric resistance per length in ohms per metre ((V/A)/m).

literal	value	description
kgPerJ		Weight per energy in kilograms per joule (kg/J). Note: multiplier “k” is included in this unit symbol for compatibility with IEC 61850-7-3.
JPers		Energy rate in joules per second (J/s).

3.33 ActivePower datatype

Product of RMS value of the voltage and the RMS value of the in-phase component of the current.

Table 32 shows all attributes of ActivePower.

Table 32 – Attributes of SteadyStateInstructionProfile::ActivePower

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=W)
value	0..1	Float	

3.34 Impedance datatype

Ratio of voltage to current.

Table 33 shows all attributes of Impedance.

Table 33 – Attributes of SteadyStateInstructionProfile::Impedance

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=ohm)
multiplier	0..1	UnitMultiplier	

3.35 PerCent datatype

Percentage on a defined base. For example, specify as 100 to indicate at the defined base.

Table 34 shows all attributes of PerCent.

Table 34 – Attributes of SteadyStateInstructionProfile::PerCent

name	mult	type	description
value	0..1	Float	Normally 0 to 100 on a defined base.
unit	0..1	UnitSymbol	(const=none)
multiplier	0..1	UnitMultiplier	(const=none)

3.36 ReactivePower datatype

Product of RMS value of the voltage and the RMS value of the quadrature component of the current.

Table 35 shows all attributes of ReactivePower.

Table 35 – Attributes of SteadyStateInstructionProfile::ReactivePower

name	mult	type	description
value	0..1	Float	
unit	0..1	UnitSymbol	(const=VAr)

name	mult	type	description
multiplier	0..1	UnitMultiplier	

3.37 Voltage datatype

Electrical voltage, can be both AC and DC.
Table 36 shows all attributes of Voltage.

Table 36 – Attributes of SteadyStateInstructionProfile::Voltage

name	mult	type	description
multiplier	0..1	UnitMultiplier	
unit	0..1	UnitSymbol	(const=V)
value	0..1	Float	

3.38 Boolean primitive

A type with the value space "true" and "false".

3.39 Date primitive

Date as "yyyy-mm-dd", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddZ". A local timezone relative UTC is specified as "yyyy-mm-dd(+/-)hh:mm".

3.40 DateTime primitive

Date and time as "yyyy-mm-ddThh:mm:ss.sss", which conforms with ISO 8601. UTC time zone is specified as "yyyy-mm-ddThh:mm:ss.sssZ". A local timezone relative UTC is specified as "yyyy-mm-ddThh:mm:ss.sss-hh:mm". The second component (shown here as "ss.sss") could have any number of digits in its fractional part to allow any kind of precision beyond seconds.

3.41 Duration primitive

Duration as "PnYnMnDTnHnMnS" which conforms to ISO 8601, where nY expresses a number of years, nM a number of months, nD a number of days. The letter T separates the date expression from the time expression and, after it, nH identifies a number of hours, nM a number of minutes and nS a number of seconds. The number of seconds could be expressed as a decimal number, but all other numbers are integers.

3.42 Float primitive

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

3.43 String primitive

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

Annex A (informative): Sample data

A.1 General

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

A.2 Sample instance data

Test data files are available in the CIM EG SharePoint.