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INTERNATIONAL STANDARD

colour inside

Wind energy generation systems – Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

IEC 61400-25-6:2016-12(en)

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WIND ENERGY GENERATION SYSTEMS –

Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

FOREWORD

International Standard IEC 61400-25-6 has been prepared by IEC technical committee 88: Wind energy generation systems.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Major restructuring of the datamodel to accommodate needed flexibility.

b) UFF58 format is no longer used.

c) Access to data is now using the standard reporting and logging functions.

d) Recommendations for creating datanames to accommodate needed flexibility have been defined.

The text of this standard is based on the following documents:

FDIS	Report on voting
88/606/FDIS	88/611/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

As the title of technical committee 88 was changed in 2015 from *Wind turbines* to *Wind energy generation systems* a list of all parts of the IEC 61400 series, under the general title *Wind turbines* and *Wind energy generation systems* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC 61400-25 series defines information models and information exchange models for monitoring and control of wind power plants. The modelling approach (for information models and information exchange models) of IEC 61400-25-2 and IEC 61400-25-3 uses abstract definitions of classes and services such that the specifications are independent of specific communication protocol stacks, implementations, and operating systems. The mapping of these abstract definitions to specific communication profiles is defined in IEC 61400-25-4[1].

This document defines an information model for condition monitoring information and explains how to use the existing definitions of IEC 61400-25-2 as well as the required extensions in order to describe and exchange information related to condition monitoring of wind turbines. The models of condition monitoring information defined in this document may represent information provided by sensors or by calculation.

In the context of this document, condition monitoring means a process with the purpose of observing components or structures of a wind turbine or wind power plant for a period of time in order to evaluate the state of the components or structures and any changes to it, in order to detect early indications of impending failures. With the objective to be able to monitor components and structures recorded under approximately the same conditions, this document introduces the operational state bin concept. The operational state bin concept is multidimensional in order to fit the purpose of sorting complex operational conditions into comparable circumstances.

Condition monitoring is most frequently used as a predictive or condition-based maintenance technique (CBM). However, there are other predictive maintenance techniques that can also be used, including the use of the human senses (look, listen, feel, smell) or machine performance monitoring techniques. These could be considered to be part of the condition monitoring.

Condition monitoring techniques

Condition monitoring techniques that generate information to be modelled include, but are not limited to, measured or processed values such as:

a) vibration measurements and analysis;
b) oil debris measurement and analysis;
c) temperature measurement and analysis;
d) strain gauge measurement and analysis;
e) acoustic measurement and analysis.

Components and structures can be monitored by using automatic measurement retrieval or via a manual process.

Condition monitoring devices

The condition monitoring functions may be located in different physical devices. Some information may be exposed by a turbine controller device (TCD) while other information may be exposed by an additional condition monitoring device (CMD). Various actors may request to exchange data values located in the TCD and/or CMD. A SCADA device may request data values from a TCD and/or CMD; a CMD may request data values from a TCD. The information exchange between an actor and a device in a wind power plant requires the use of information exchange services as defined in IEC 61400-25-3. A summary of the above is shown in Figure 1.

1 To be published.

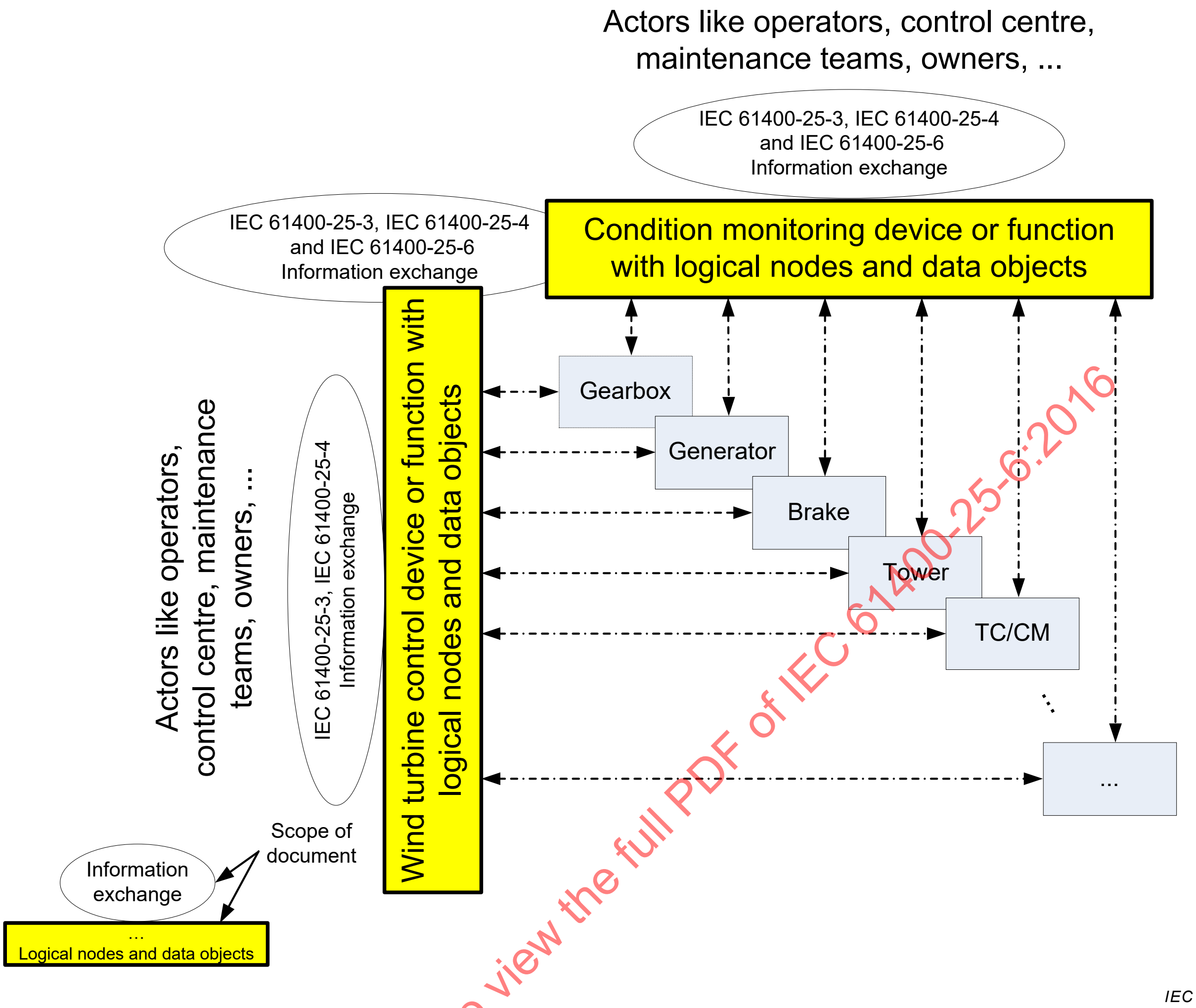

Figure 1 – Condition monitoring with separated TCD/CMD functions

The state of the art in the wind power industry is a topology with separated devices for control and condition monitoring applications. Based on this fact, the information and information exchange modelling in the present document is based on a topology with a TCD and a CMD.

IEC 61400-25-6 represents an extension of the IEC 61400-25 series focussing on condition monitoring.

WIND ENERGY GENERATION SYSTEMS –

Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring

1 Scope

This part of IEC 61400-25 specifies the information models related to condition monitoring for wind power plants and the information exchange of data values related to these models.

NOTE Conformance to IEC 61400-25-6 presupposes in principle conformance to IEC 61400-25-2, IEC 61400-25-3 and IEC 61400-25-4.

Figure 2 illustrates the information flow of a system using condition monitoring to perform condition based maintenance. The figure illustrates how data values are refined and concentrated through the information flow, ending up with the ultimate goal of condition based maintenance; actions to be performed via issuing work orders to maintenance teams in order to prevent the wind power plant device to stop providing its intended service.

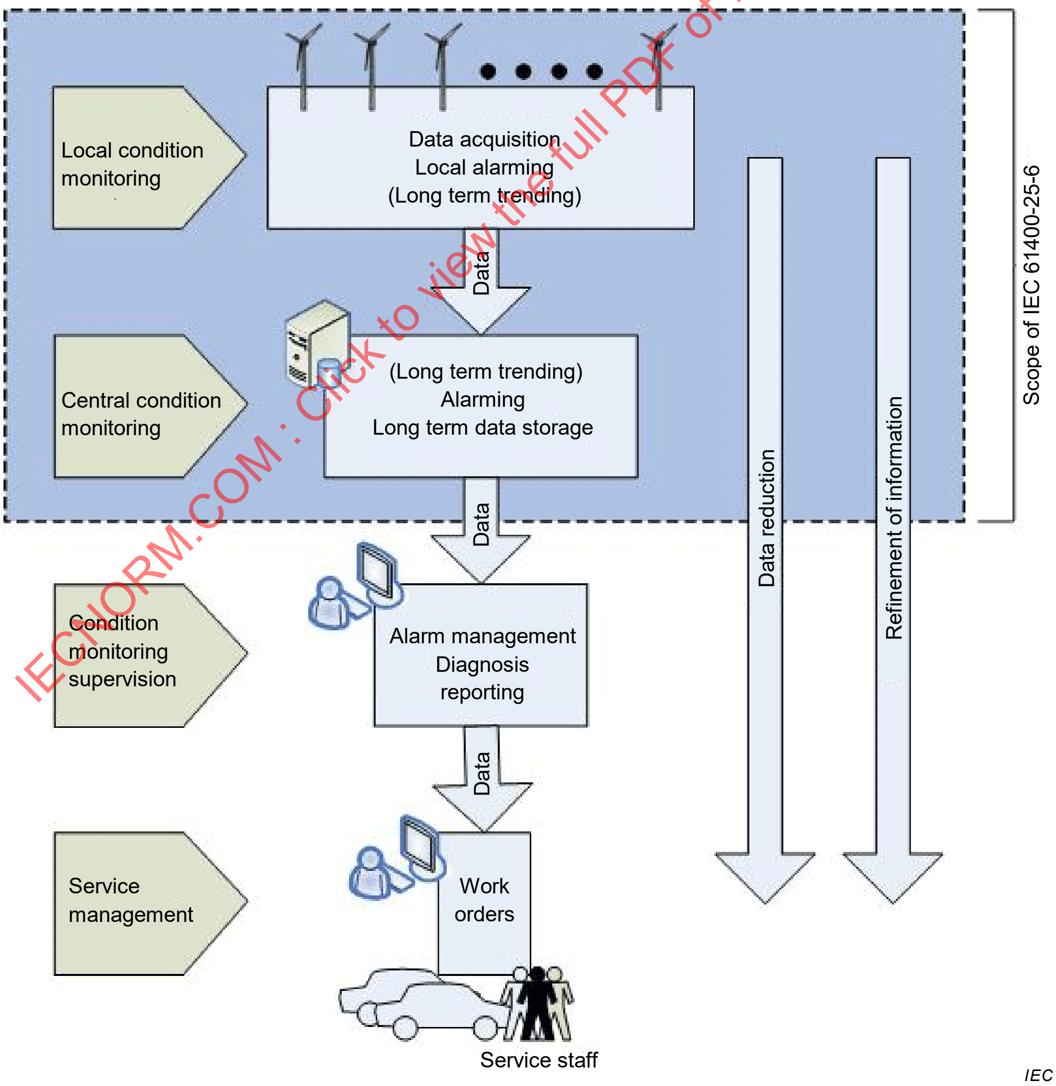

Figure 2 – Schematic flow of condition monitoring information

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61400-25-1:2006, *Wind turbines – Part 25-1: Communications for monitoring and control of wind power plants – Overall description of principles and models*

IEC 61400-25-2:2015, *Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants – Information models*

IEC 61400-25-3:2015, *Wind turbines – Part 25-3: Communications for monitoring and control of wind power plants – Information exchange models*

IEC 61400-25-4:2016, *Wind energy generation systems – Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile*

IEC 61400-25-5:—[2], *Wind energy generation systems – Part 25-5: Communications for monitoring and control of wind power plants – Conformance testing*

IEC 61850-7-1:2011, *Communication networks and systems for power utility automation – Part 7-1: Basic communication structure – Principles and models*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-3:2010 *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

ISO 13373-1:2002, *Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 1: General procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61400-25-1, IEC 61400-25-2, IEC 61400-25-3, IEC 61400-25-4 and IEC 61400-25-5 apply.

An exhaustive description of the term "**bin**" has been given in 5.4.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
actor
any entity that receives (sends) data values from (to) another device

Note 1 to entry: Examples of actors could be SCADA systems, maintenance systems, owner, etc.

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2 To be published.

3.2
mandatory
M
specific content provided to ensure compliance with this document

3.3
optional
O
specific content that can be provided to ensure compliance with this document

3.4
conditional
C
depending on stated conditions, specific content defined to ensure compliance with this document

3.5
frequency analysis
raw time waveforms recorded by the sensor are post processed to measurement types in the frequency domain

Note 1 to entry: The most common measurement type is the auto spectrum (AUS).

3.6
scalar value
data type representing a quantity which can be described by a single number, such as a temperature

Note 1 to entry: A scalar value is a post processing of the raw vibration signal into one or more scalar values, also called descriptors (see ISO 13379-1:2012). Each descriptor (scalar) value is used to indicate the presence of a certain failure mode of a monitored machine part. E.g. one descriptor can indicate if a bearing fault is present by measuring the vibration level at the outer ring of a certain bearing, another can indicate the vibration level of the shaft running speed and can indicate misalignment, unbalance or other shaft related faults.

3.7
time waveform
sampled vibration signal recorded from the transducer

Note 1 to entry: Time waveform recordings have a certain length in time and represent the actual vibration level at any instance during the recording of the waveform.

3.8
root mean square value
RMS
measure of the level of a signal calculated by squaring the instantaneous value of the signal, averaging the squared values over time, and taking the square root of the average value

Note 1 to entry: The RMS value is the value which is used to calculate the energy or power in a signal.

4 Abbreviated terms

CDC	Common data class
CM	Condition monitoring (function)
CMD	Condition monitoring device
DC	Data class
ING	Common data class for integer setting value (see IEC 61850-7-3)
LD	Logical device
LN	Logical node
LPHD	Logical node physical device information
RCB	Report control block
RMS	Root mean square
SAV	Common data class for sampled analogue values (see IEC 61850-7-3)
SHS	Statistical and historical statistical data (as defined in IEC 61400-25-2:2015, Annex A)
SMV	Sampled measured values; sometimes short: SV = sampled values
TC	Turbine controller (function)
TCD	Turbine controller device
TMF	Tooth meshing frequency
TOC	Turbine operation conditions
WPP	Wind power plant
WT	Wind turbine

Abbreviated terms used to build names of data classes found in LNs shall be as listed in Table 1 below and in the table of abbreviated terms in IEC 61400-25-2:2015, Clause 4.

Table 1 – Abbreviated terms applied

Term	Description
Acc	Accuracy; Acceleration
An	Analogue
Ane	Anemometer
Ang	Angle
Av	Average
Ax	Axial
Azi	Azimuth
Bec	Beacon
Bn	Bin (e.g. Power Bin)
Cab	Cable
Ccw	Counter clockwise
Cw	Clockwise
Dcl	Dc-link
Deb	Debris
Dec	Decrease
Dir	Direction
Dsp	Displacement
Dtc	Detection
Emg	Emergency
En	Energy
Ent	Entrance
Ety	Empty
Ext	Excitation
Flsh	Flash
Gri	Grid
Gs	Grease
Harm	Harmonic
Hi	High
Hor	Horizontal
Hum	Humidity
Hz	Frequency
Ice	Ice
Idl	Idling
Inl	Inline
Lev	Level
Lft	Lift
Lo	Low (state or value)
Lum	Luminosity
Max	Maximum
Met	Meteorological
Min	Minimum
Mult	Multiplier
Pc	Power class
Per	Period, periodic
PF	Power factor
Ph	Phase
Plu	Pollution
Pos	Position
Prcd	Processed
Pres	Pressure
Prod	Production
Pwr	Power
Ra	Radial
React	Reactive
RMS	Root-mean-square
Roof	Roof
Sb	Sideband
Sdv	Standard deviation
Smok	Smoke
Snd	Sound pressure
Spd	Speed
Stld	Structural load
Stn	Strain
Stop	Stop
Str	Start
Sw	Switch
Swf	Swarf
Tmp	Temperature
Torq	Torque
Trd	Transducer
Trg	Trigger
Trs	Transient
V	Voltage
Vbr	Vibration
Ver	Vertical
Wdp	Wind power
Wup	Windup
Xdir	X-direction
Ydir	Y-direction

5 General

5.1 Overview

The primary objective of condition monitoring is to detect symptoms of a potential failure of a wind turbine component before it leads to functional failure resulting in serious damage or destruction of the wind turbine.

In condition monitoring systems, predefined triggers are applied to initiate a sequence of events, for example issuing an alarm to the local SCADA system or sending a message to a monitoring centre in order to prevent further damage on components or structures. In general, such messages can be used by a condition monitoring supervision function to generate actionable information which can be used by a service organization to create work orders and initiate actions. Figure 2 illustrates the information flow of a system using condition monitoring to perform condition based maintenance.

Condition monitoring is mainly associated with the following kinds of information.

a) Time waveform records (samples) of a specific time interval to be exchanged either directly or as processed values for analysis (e.g. acceleration, position detection, speed, stress detection).
b) Status information and measurements (synchronized with the waveform records) representing the turbine operation conditions.
c) Results of time waveform record analysis of vibration data (scalar values, array values, statistical values, historical (statistical) values, counters and status information).
d) Results of, for example, oil debris analysis.

The condition monitoring information can be described by specified data attributes, trigger options and data objects of the following common data classes:

- condition monitoring measurement (CMM);
- measurement value (MV);
- scalar value array (SVA);
- complex measurement value (CMV);
- complex measurement value array (CMVA);
- condition monitoring bin (CMB);
- alarm (ALM).

The purpose of this document is to model condition monitoring information by using the information modelling approach as described in 6.2.2 of IEC 61400-25-1:2006 and by extending the information model as specified in Clause 5 of IEC 61400-25-2:2015 with an additional logical node WCON for modelling information specific to condition monitoring of wind power plants.

As the WCON class is modelled using the approach of IEC 61400-25-1 and IEC 61400-25-2, the information exchange models as specified in IEC 61400-25-3 and the mapping to communication profiles as specified in IEC 61400-25-4 can be used for exchanging condition monitoring information.

5.2 Condition monitoring information modelling

When applicable, the binding of a specific condition monitoring information to a specific sensor and a specific location in a wind turbine shall be specified using:

a) a definition of the coordinate system applied for specifying direction and angles; see 5.3;

b) data attributes for identifying the environment for a condition monitoring measurement – operational state bin concept, see 5.4;

c) data attributes for identifying a condition monitoring measurement by sensor type, angular orientation, direction of motion, and physical location in a wind turbine such as shaft number, bearing position as well as identification of the primary measurement object for a sensor. For further details, see Clause 8.

The sensor and location specifications in this document are in principle coordinated with the specifications defined in ISO 13373-1, where coordination has been applicable.

5.3 Coordinate system applied for identifying direction and angles

In order to be able to unambiguously identify a sensor location, a coordination system is used as a reference to specify all directions and angles. Figure 3 shows an X, Y, Z coordinate system superimposed on the wind turbine drive train. The drive train is seen in the direction of the wind. It is defined that the Z direction is always the same as the wind direction.

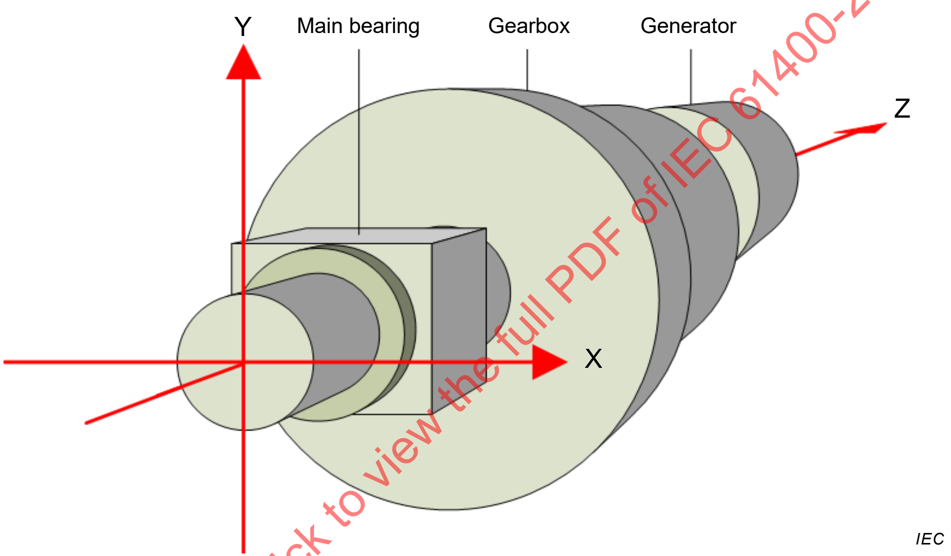


Figure 3 – Reference coordinates system for the drive train

Table 2 lists other commonly used designations as related to the reference coordinate system defined in this document.

Table 2 – Coordinate system and wind turbine related characteristics

Used in this document	Other designations
Z direction	Downwind (as opposed to Upwind)
	Axial (wind direction)
X direction	Lateral
	Transverse
	Horizontal
	Right (as opposed to Left)
Y direction	Vertical
	Up (as opposed to Down)

5.4 Operational state bin concept

5.4.1 General

In order to describe the environment for a set of condition monitoring measurements, the operational state bin concept has been developed. A wind turbine operates in principle over a wide range of wind speeds causing a large variety of loads on the mechanical structures. An adaptive monitoring technique is often applied to secure a higher degree of reliability and repeatability of measurements used to detect developing faults in the full operating range, thus reducing the risk of triggering false alarms. In order to adapt to the varying operating conditions, data can be stored according to several operational states in multiple dimensions. The basic principle of condition monitoring is to observe the evolution of specific measured variables by comparing new measurements with previous measurements. The effect of changes in operational conditions can be limited by comparing information belonging only to the same operational state bin.

5.4.2 Example of how to use active power as an operational state

Active power levels are used for the adaptive monitoring technique rather than the wind speed as the vibration level measured and the stress on the turbine components are found to be closely related to the active power production of the turbine. By using the active power level as measurement trigger, it is also ensured that vibration measurements are recorded only when a wind turbine is producing active power.

An example of vibration data from the generator Drive End (DE) which are individually compared to trigger limits for five different "active power bins" with individual alarm trigger levels is given in Figure 4.

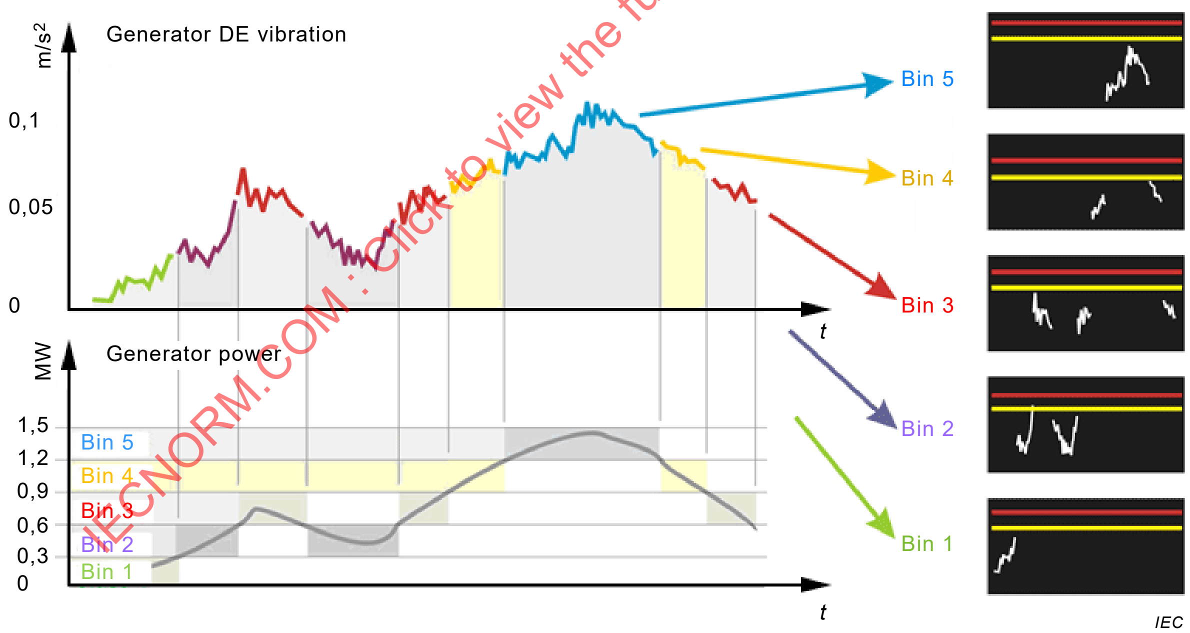


Figure 4 – Active power bin concept

6 Logical nodes for wind turbine condition monitoring

6.1 General

Information collected with the purpose of monitoring the conditions of a wind turbine can all be related to particular parts of a wind turbine, with the objective of having a complete picture of the operational conditions in a wind turbine. The logical node WCON shall only comprise required data for condition monitoring systems that has not already been specified in IEC 61400-25-2.

6.2 Logical nodes inherited from IEC 61400-25-2

WCON access to the logical nodes which are specified in IEC 61400-25-2 are mandatory as these logical nodes include relevant measured values to condition monitoring, such as WGEN.W (Active Power Generation), WTRM.GbxOilTmp (Gearbox Oil Temperature) or the WALM logical node for reading and setting alarm status information.

6.3 Wind turbine condition monitoring logical node WCON

6.3.1 General

The data object names of the WCON class have restrictions as specified below. In many cases, it will not be possible to provide a meaningful naming of a condition monitoring measurement just by using the data object name. It is recommended to supplement the data object name with a more descriptive tag name by using the “d” attribute of the data classes of the WCON logical node. The “d” attribute shall be constructed as a concatenation of the “trd”, “shfId”, “brgPos” and “mxType” as specified in Clause 8. Annex A and Annex B provide a guideline for descriptive tag naming to be used for the “d” attribute.

The naming conventions described in IEC 61850-7-1:2011, 14.3 and IEC 61850-7-2:2010, Clause 22 shall be applied for the “vendor specific data object name” and “vendor specific bin name”.

a) Maximum length is 12 characters.
b) Shall not start with a number.
c) Shall not contain spaces.
d) The characters allowed shall be:

   “A” to “Z”, “a” to “z”, “0” to “9” and “_”

The WCON logical node shall be defined as specified in Table 3. Vendor specific datanames can be constructed by using the abbreviations of Table 1 and the attribute definitions of Clause 8. Refer to the examples in the explanation column of Table 3.

Table 3 – LN: Wind turbine condition monitoring information (WCON)

WCON class			
Data object name	**Attr. type**	**Explanation**	**M/O**
		LN shall inherit all mandatory data from wind power plant common logical node class (see 6.1.1 of IEC 61400-25-2:2015)	M
Data			
Measured information			
<vendor specific data object name>	CMM	e.g., ConMes001 for vibration of generator drive end	GC_1O
..		…	GC_1O
<vendor specific data object name>	CMM	e.g., ConMes002 for generator shaft vibration	GC_1O
Configuration			
<vendor specific bin name 1>	CMB	e.g., Bn1Pwr	GC_1O
<vendor specific bin name 2>	CMB	e.g., Bn2Pwr	GC_1O
…		…	GC_1O
<vendor specific bin name *n*+1>	CMB	e.g., Bn1Tmp	GC_1O
<vendor specific bin name *n*+2>	CMB	e.g., Bn2Tmp	GC_1O

6.3.2 CDCs applicable for the logical node WCON

All common data classes that are specified or referenced in this document or in IEC 61400-25-2 can be used for specifying the data in the logical node WCON.

7 Common data classes for wind turbine condition monitoring

7.1 General

All common data classes that are specified in IEC 61400-25-2 can be applied for condition monitoring. Additionally, the following common data classes are specifically related to condition monitoring:

a) condition monitoring bin (CMB);

b) condition monitoring measurement (CMM);

c) common data class scalar array value (SVA);

d) complex measurement value array (CMVA).

7.2 Common data classes defined in IEC 61400-25-2

The common data classes specified or referenced in Clause 7 of IEC 61400-25-2:2015 are applicable for modelling condition monitoring information as well as the common data classes defined in the 7.5 up to 7.8.

7.3 Conditions for data attribute inclusion

Subclause 7.3 lists the conditions that specify the presence of a data attribute.

Table 4 gives the conditions used in this document indicating the the presence of data attributes.

Table 4 – Conditions for the presence of a data attribute

Abbreviation	Condition
AC_DLN_M	The data attribute shall be present, if data name space of this data deviates from the data name space referenced by either lnNs of the logical node in which the data is contained or ldNs of the logical device in which the data is contained (applies to dataNs in all CDCs only)
AC_DLNDA_M	The data attribute shall be present, if CDC name space of this data deviates from the CDC name space referenced by either the dataNs of the data, the lnNs of the logical node in which the data is defined or ldNs of the logical device in which the data is contained (applies to cdcNs and cdcName in all CDCs only)
AC_SCAV	The presence of the configuration data attribute depends on the presence of *i* and *f* of the analog value of the data attribute to which this configuration data attribute relates. For a given data object, that data attribute – shall be present, if both *i* and *f* are present, – shall be optional if only *i* is present, and – is not required if only *f* is present. NOTE If only *i* is present in a device without floating point capabilities, the configuration parameter can possibly be exchanged offline.
MF(sibling)	MF(sibling): Parameter *sibling*: sibling element name. Mandatory if *sibling* element is present, otherwise forbidden
GC_1	At least one of the data attributes shall be present for a given instance of DataObject / SubDataObject
M	Data attribute is mandatory
O	Data attribute is optional

7.4 Common data class attribute name semantic

Table 5 lists the semantic for the common data attributes used in this document

Table 5 – Common data class attribute name semantic

Data attribute name	Semantic
bnRef	Condition monitoring bin object reference
trd	Transducer name according to 8.2.2
shfId	Shaft identification according to model from Figure 8
brgPos	Bearing position according to model from Figure 8
mxType	Measurement type according to 8.2.4
stVal	Status of the bin. This means that the “bin” is active or not. The “bin” is active when all the measured values are inside the ranges configured for that bin
refx	Reference to operational state value to be used for binning
minx	Minimum value of operational state value
maxx	Maximum value of operational state value
instMagI	Instant magnitude integer
instMagF	Instant magnitude float
magI	magnitude integer (dead band)
magF	magnitude float (dead band)
numSV	Number of elements in SVA
units	SI unit of elements in SVA or unit of abscissa, e.g. Hz
Db	Dead band used at magI or magF Deadband. Shall represent a configuration parameter used to calculate all deadbanded data attributes. The value shall represent the percentage of the difference between maximum and minimum in increments of 0,001 %
zeroDb	Configuration parameter used to calculate the range around zero, where the analogue value will be forced to zero. The value shall represent the percentage of difference between maximum and minimum in increments of 0,001 %
sVC	Scaled value config – offset and gain
smpRate	Sample rate
Offset	Corresponding abscissa value from first element in array
Delta	Incremental value of abscissa

7.5 Condition monitoring bin (CMB)

CMB common data class includes:

- references to the measured values that defines this bin;
- a minimum and a maximum for the bin definition.

Common data class CMB shall be defined as specified in Table 6.

Table 6 – CDC: Condition monitoring bin (CMB)

CMB class					
Attribute name	**Data attribute type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from data class (see IEC 61850-7-2:2010)				
DataAttribute					
Configuration					
ref1	ObjectReference	CF		Reference to the DataObject on which the bin classification is based (e.g. WTUR.W or WGEN.GnOpSt)	M
min1	FLOAT32	CF		Lower boundary of referenced value for 1st dimension of this bin	M
max1	FLOAT32	CF		Upper boundary of referenced value for 1st dimension of this bin	M
ref2	ObjectReference	CF		Reference to the DataObject on which the bin classification is based (e.g. WTUR.W or WGEN.GnOpSt)	O
min2	FLOAT32	CF		Lower boundary of referenced value for 2nd dimension of this bin	MF(ref2)
max2	FLOAT32	CF		Upper boundary of referenced value for 2nd dimension of this bin	MF(ref2)
ref3	ObjectReference	CF		Reference to the DataObject on which the bin classification is based (e.g. WTUR.W or WGEN.GnOpSt)	O
min3	FLOAT32	CF		Lower boundary of referenced value for 3rd dimension of this bin	MF(ref3)
max3	FLOAT32	CF		Upper boundary of referenced value for 3rd dimension of this bin	MF(ref3)
Descriptive and extension information					
d	VISIBLE STRING255	DC			O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table B.1 of IEC 61400-25-3:2015.					

Multidimensional operational state bins shall be defined by adding as many triples of the DataAttributes ref, min and max as dimensions are required. The index shall be 1, 2, to [*n*].

The bins shall be defined uniquely for each dimension.

The unit of the DataAttributes “min” and “max” shall be as specified in the referenced DataObject referenced by DataAttribute “ref”.

7.6 Condition monitoring measurement (CMM)

Common data class CMM shall be defined as specified in Table 7. Refer to Clause 8 for a definition of the CMM data attributes “trd”, “shfId”, “brgPos” and “mxType”.

Table 7 – CDC: Condition monitoring measurement (CMM)

CMM class					
Attribute name	**Data attribute type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from data class (see IEC 61850-7-2:2010)				
SubDataObject					
val	MV			Measurement value	GC_1
scaValArr	SVA			Scalar value array	GC_1
cpxVal	CMV			Complex measurement value	GC_1
cpxValArr	CMVA			Complex measurement value array	GC_1
DataAttribute					
Measurement					
bnRef	ObjectReference	MX		Reference to bin	O
startTime	TimeStamp	MX			O
stopTime	TimeStamp	MX			O
Description					
trd	VISIBLE STRING255	DC		Transducer / Sensor name	M
shfId	VISIBLE STRING255	DC		Shaft identification	O
brgPos	VISIBLE STRING255	DC		Bearing position	O
mxType	VISIBLE STRING255	DC		Measurement type	O
offset	FLOAT32			Abscissa offset – used at arrays	O
delta	FLOAT32			Abscissa delta – used at arrays	O
units	Unit			Abscissa unit – used at arrays	O
d	VISIBLE STRING255	DC		Descriptive tag name	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table B.1 of IEC 61400-25-3:2015.					

7.7 Scalar value array (SVA)

Common data class SVA shall be defined as specified in Table 8.

Table 8 – CDC: Scalar value array (SVA)

SVA class					
Attribute name	**Data attribute type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2:2010)				
DataAttributes					
Measurements					
instMagI	ARRAY [0..numSV-1] OF INT32	MX			GC_1
instMagF	ARRAY [0..numSV-1] OF FLOAT32	MX			GC_1
magI	ARRAY [0..numSV-1] OF INT32	MX	dchg		GC_1
magF	ARRAY [0..numSV-1] OF FLOAT32	MX	dchg		GC_1
q	Quality	MX	qchg		M
Configuration description and extension data attributes					
numSV	INT32U	CF		number of elements in the array of SV	M
units	Unit	CF		see Annex B of IEC 61400-25-2:2015	O
Db	INT32U	CF			O
zeroDb	INT32U	CF			O
sVC	ScaledValueConfig	CF			AC_SCAV
smpRate	INT32U	CF			O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table B.1 of IEC 61400-25-3:2015.					

7.8 Complex measurement value array (CMVA)

Common data class CMVA shall be defined as specified in Table 9. "instMagF_r" is the real value and "instMagF_i" is the imaginary value.

Table 9 – CDC: Complex measurement value array (CMVA)

CMVA class					
Attribute name	**Data attribute type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2:2010)				
DataAttributes					
Measurements					
instMagI_r	ARRAY [0..numSV-1] OF INT32	MX		Real values	GC_1
instMagI_i	ARRAY [0..numSV-1] OF INT32	MX		Imaginary values	MF(instMagI_r)
instMagF_r	ARRAY [0..numSV-1] OF FLOAT32	MX		Real values	GC_1
instMagF_i	ARRAY [0..numSV-1] OF FLOAT32	MX		Imaginary values	MF(instMagF_r)
magI_r	ARRAY [0..numSV-1] OF INT32	MX	dchg	Real values	GC_1
magI_i	ARRAY [0..numSV-1] OF INT32	MX	dchg	Imaginary values	MF(magI_r)
magF_r	ARRAY [0..numSV-1] OF FLOAT32	MX	dchg	Real values	GC_1
magF_i	ARRAY [0..numSV-1] OF FLOAT32	MX	dchg	Imaginary values	MF(magF_r)
q	Quality	MX	qchg		M
Configuration description and extension data attributes					
numSV	INT32U	CF		number of elements in the array of SV	M
units	Unit	CF		see Annex B of IEC 61400-25-2:2015	O
Db	INT32U	CF			O
zeroDb	INT32U	CF			O
sVC	ScaledValueConfig	CF			AC_SCAV
smpRate	INT32U	CF			O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
Services					
As defined in Table B.1 of IEC 61400-25-3:2015.					

8 Common data class CMM attribute definitions

8.1 General

Tag names usually have the format of a text string which also allows for special characters. But the data object names as applied in this document have to be formatted according to the naming convention IEC 61850-7-2:2010, Clause 22, hence it is quite limited in describing the measured value. Therefore, other attributes in the CDC are used to identify the measurement position, information about the sensor, the object for the measurement and the applied measurement type. This information is very important for the operator of a condition monitoring system and shall be available and displayed in a readable format along with the measured data.

The descriptive name (tag name) of a data item shall be specified in the “d” data attribute of the CMM and the CMB classes.

The purpose of the data attributes specified in 8.2.2 up to 8.2.4 is to describe the sensor characteristics, the position of the sensor and the primary aim for the individual sensors. In addition, it is defined how the condition monitoring data attributes can be extended for individual purposes.

8.2 Attributes for condition monitoring measurement description

8.2.1 General

The following descriptive data attributes shall provide a link between the real implementation and the modelling specified in this document and shall be as defined in Table 10.

Table 10 – Data attributes used for measurement description

Data attribute name	Data attribute type	Value/Value range
trd	VISIBLE STRING255	Condition monitoring sensor
shfId	VISIBLE STRING255	Shaft identification
brgPos	VISIBLE STRING255	BearingPosition
mxType	VISIBLE STRING255	ISOA | HFBP | TMF | 2TMF | 3TMF | 1MA | 2MA | BP | TWF | For further descriptions of the mxType values, see Annex A.

8.2.2 Condition monitoring sensor (trd)

8.2.2.1 General

Subclause 8.2.2.1 defines data attributes for providing information about a sensor. The provided information is the location of the sensor, the sensor type and the spatial orientation. The definitions are combined in a way that provides unambiguous sensor identification. Five definitions are used for the sensor identification, see Table 11.

The sensor shall, as a minimum, be identified by its “location”. The designations 2, 3, 4 and 5 are optional and can be used in any combination. The sequence of the designations shall follow the numbering as specified in Table 11. Refer also to the examples in Table 11.

Table 11 – Sensor identification convention for “trd” attribute

	Definition		Length	Example	Comment	M/O/C
1	Location	Component name	No limit	GbxIss-	Gbx and Iss. See Table 12	M
		Other identification		Pos1-	Free text [a, b]	
2	Sensor type code		Two letters	AC	Accelerometer. See Table 13	O
3	Angular orientation		Three digits	280	0° to 360°	O
4	Sensor axis orientation		One letter	R	Radial. See Table 14	O
5	Direction of motion		/ + One letter	/N	Normal. See 8.2.2.5	O

[a] The location identification shall be followed by a “-“.

[b] If a numbering scheme is used, it is recommended to let numbers increase in the Z direction.

EXAMPLE Application of specified convention could be as follows: GbxIss-AC090R/N – Gearbox Intermediate Speed Stage, single-axis accelerometer, positioned 90° counter clockwise from zero, mounted radial, normal motion. This name is used e.g. in the CMM CDC trd attribute.

Table 12 contains recommendations of abbreviated terms used to describe the "Location" part of the sensor identification in Table 11. User defined terms can be applied if a required term is not available in the table. The informative Annex B provides a guideline for tag naming using the abbreviated terms for "location" description.

Table 12 – Abbreviated terms for "trd" – "location" description

Term	Description
1Ps	1st planetary stage
2Ps	2nd planetary stage
3Ps	3rd planetary stage
Bas	Basis
Bl	Blade
Brg	Bearing
Brk	Brake
Cl	Cooling
Cnv	Converter
Cp	Coupling
Cr	Planetary gear carrier
Dehum	De-humidifier
Dn	Down
De	Drive end
Drv	Drive
Elev	Elevator
Fil	Filter
Fr	Front
Gbx	Gearbox
Gn	Generator
Heat	Heating
Hss	High speed stage
Htex	Heat-exchanger
Hy	Hydraulic
Inj	Injection
Inlet	Inlet
Intn	Internal
Iss	Intermediate speed stage
Lss	Low speed stage
Lu	Lubrication
Mid	Middle
Nac	Nacelle
NDe	Non drive end
Oil	Oil
Ov	Over
Pgr	Planetary gear ring
Pgw	Planet gear wheel
Pig	Pinion in gear
Pl	Plant

Term	Description
Pmp	Pump
Pth	Pitch
Ps	Planetary stage
Rot	Rotor (wind turbine)
Rr	Rear
Rtr	Rotor (generator)
Sd	Side
Shf	Shaft
Stg	Stage (1, 2, 3, etc.)
Stt	Stator
Su	Sun wheel in planetary gear
Trf	Transformer
Tur	Turbine
Top	Top Position
Twr	Tower
Un	Under
Upw	Upwards direction (opposite to Down (Dn))
Yw	Yaw

8.2.2.2 Sensor type code

The sensor type shall be designated by a two-letter code as specified Table 13.

Table 13 – Sensor type code

Code	Sensor type
AC	Single-axis accelerometer
AV	Single-axis accelerometer with internal integration
AB	Biaxial accelerometer
AT	Tri-axial accelerometer
AE	Acoustic emission
BS	Blade monitoring
CR	Current probe
DP	Displacement probe
DR	Displacement probe used as phase reference
MP	Magnetic pick-up (shaft speed/phase reference)
MI	Microphone
OD	Oil debris sensor
OP	Optical sensor
PC	Particle counter (e.g. magnetic sensor)
PD	Dynamic pressure
PS	Static pressure
SG	Strain gauge
SW	Stress wave
TC	Temperature-thermocouple
TR	Resistance temperature detector
TT	Torque sensor
TO	Torsion sensor
VL	Velocity sensor
VT	Voltage
OT	Other

8.2.2.3 Angular orientation

The angular position of a sensor shall be measured from zero reference located at 3 o'clock when the drive train is viewed in the Z direction as shown in Figure 5.

The green arrow indicates the angular location of a sensor. The angle increases counter clockwise from 0° to 360°.

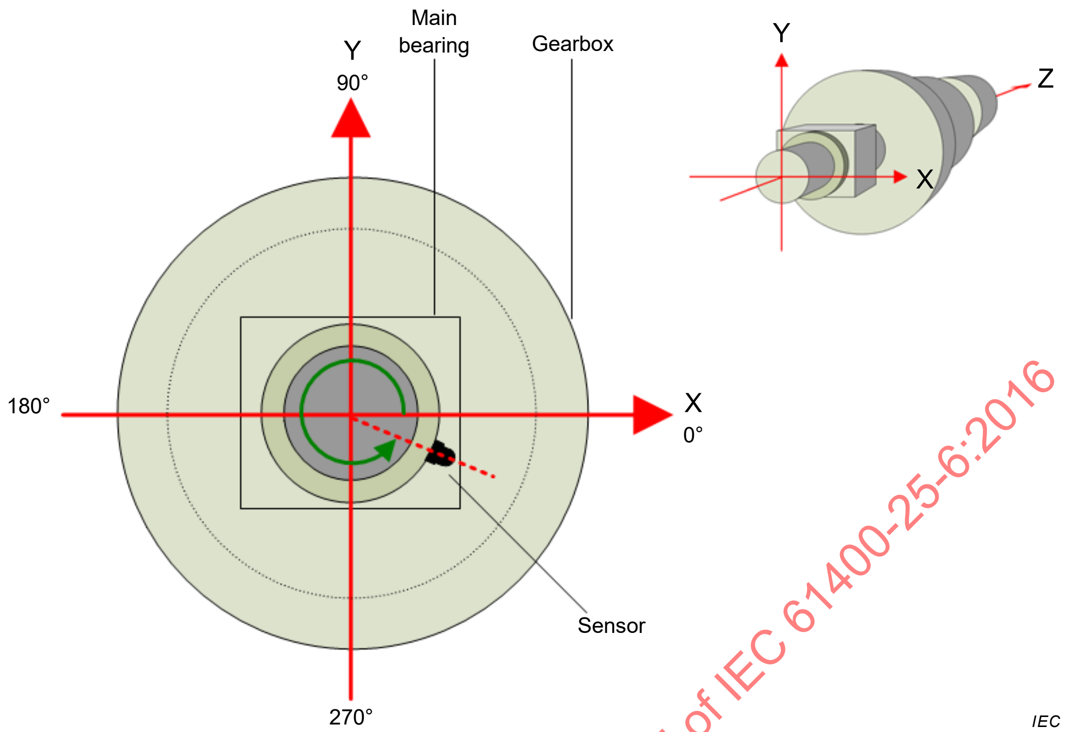


Figure 5 – Sensor angular orientation as seen from the rotor end

8.2.2.4 Sensor sensitive axis orientation

The direction of the sensor sensitive axis shall be coded by a single letter as defined in Table 14.

Table 14 – Reference code for sensor sensitive axis orientation

Code	Direction	Description
R	Radial	Sensor sensitive axis perpendicular to and passes through the shaft axis
A	Axial	Sensor sensitive axis parallel to the shaft axis
T	Tangential	Sensor sensitive axis perpendicular to a radial in the plane of shaft rotation
H	Horizontal	Sensor sensitive axis located at 000° or 180° only
V	Vertical	Sensor sensitive axis located at 090° or 270° only

8.2.2.5 Direction of motion

The final two characters of the measurement location identification code for a sensor shall either be /N (normal) or /R (reverse) to identify the direction of the mounted sensors as shown in Figure 6.

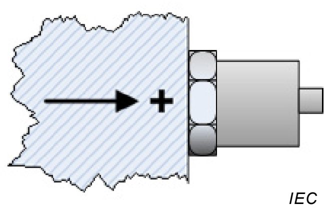


Figure 6 – Sensor motion identification

Motion into the sensor shall be defined as positive (+), motion away from the sensor is designated as negative (–) as shown in Figure 7.

Axial machine motion in the “Z” direction shall be designated as positive. When a sensor is mounted in a way that positive motion towards the sensor produces a positive signal output, the sensor shall be designated “/N” (normal). Likewise, when motion in the Z direction produces a negative signal output, the sensor shall be designated “/R” (reverse).

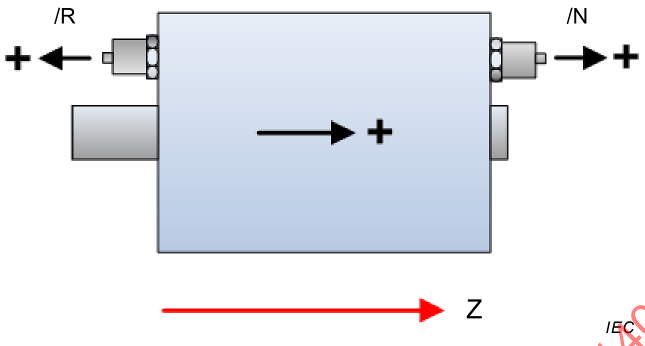


Figure 7 – Sensor normal and reverse motion

The angular orientation shall define the direction of motion for radial mounted sensors. Therefore, a default of /N (normal) should be utilized for sensors mounted radial.

8.2.3 Shaft identification (shfId) and bearing position (brgPos)

The data type of the shfId shall be VISIBLE STRING255.

The data type for brgPos shall be VISIBLE STRING255.

In order to characterize condition monitoring measurements, a data attribute for description of the physical sensor allocation is required. Measurements recorded from sensors mounted on the drive train of a wind turbine can be referred to as follows:

1) a wind turbine component on the drive train,
2) a particular shaft of a wind turbine component, and
3) a particular bearing of a wind turbine component.

Figure 8 shows the principle of shaft and bearing identification used to identify a particular location on a wind turbine gearbox with a three planetary stage gearbox. If using numbers for identification, the shafts and bearings shall be identified with increasing numbers in the Z-direction from the rotor hub to the electrical generator.

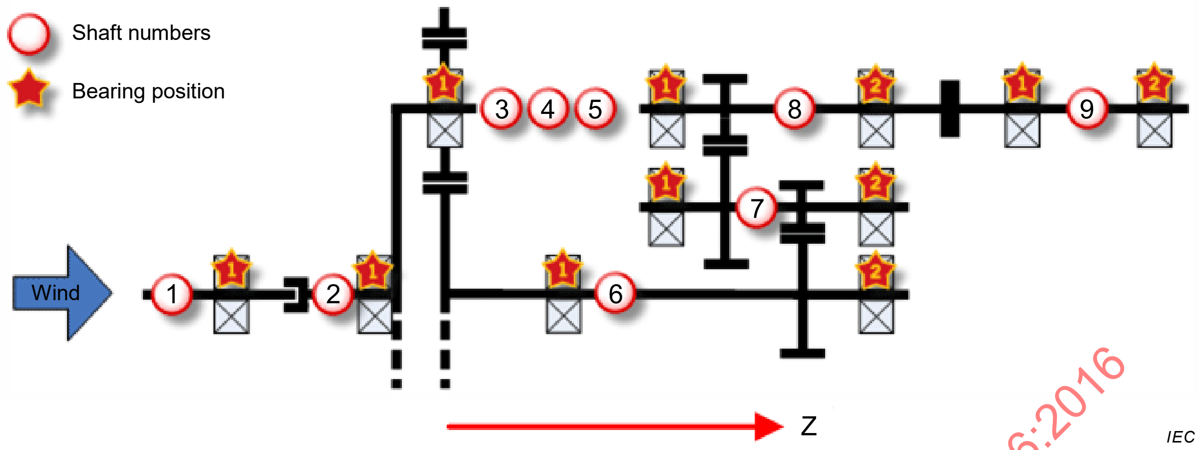


Figure 8 – Principle of shaft and bearing identification along a drive train

Table 15 gives in more detail the individual shafts and stages of the gearbox exemplified either using Shaft Id abbreviations combined with bearing position ids or as an alternative the combination with shaft numbers and bearing position numbers.

Table 15 – Gearbox shaft and bearing identification

Shaft ID		Shaft name	Bearing position		Component or subcomponent
No	Id		Using shaft id.	Using shaft no.	
1	MnShf	Main shaft	MnShf.1	1.1	Main bearing
2	CrShf	Carrier	CrShf.1	2.1	Carrier bearings
3	PlaShf	Planet shaft 1	PlaShf1.1	3.1	Planet bearings
4		Planet shaft 2	PlaShf2.1	4.1	
5		Planet shaft 3	PlaShf3.1	5.1	
6	SuShf	Sun shaft	SuShf.1	6.1	Sun shaft bearings
			SuShf.2	6.2	
7	IssShf	Intermediate shaft	IssShf.1	7.1	Intermediate shaft bearings
			IssShf.2	7.2	
8	HssShf	High speed shaft	HssShf.1	8.1	High speed shaft bearings
			HssShf.2	8.2	
9	GnShf	Generator shaft	GnShf.1	9.1	Generator shaft bearings
			GnShf.2	9.2	

Refer to informative Annex A and informative Annex B for more information on how to apply the data class attributes defined in this subclause.

8.2.4 Measurement type (mxType)

The data type of the data attribute mxType shall be VISIBLE STRING255. The mxType identifies the particular measurement, either a scalar value (descriptor) or an array measurement such as an autospectrum or a time waveform. Please note that this data type allows any vendor to make extensions with new specific proprietary names.

Recommended names for the data attribute mxType are defined in Annex A.

The objective of defining a set of recommended data names for mxType attributes is to create a uniform scheme for identifying the measured condition monitoring values indicating the actual health of a wind turbine.

Annex A
(informative)

Recommended mxType values

A.1 General about tag names and datanames of the WCON Class

This annex and Annex B propose a systematic naming convention of CMM “mxType” and “trd” attribute values.

A.2 Mapping of measurement tags to mxTypes

A.2.1 General

A part of the condition monitoring measurement is the VISIBLE STRING255 measurement type (mxType).

When using vibration data for condition monitoring, the raw signals from the vibration transducers contain a lot of information about the machine component. Unlike a traditional process value, like a temperature which is measured at a certain location, the raw signal from a vibration sensor can be further processed to extract a number of different measurement types.

This annex recommends a convention for naming the most common measurement types in order to provide a degree of uniformity of data models even if they are implemented by various condition monitoring system vendors. This list of VISIBLE STRING255 can be extended with proprietary measurement types.

A.2.2 Scalar values (MV) (Descriptors)

A scalar value is a post processing of the raw vibration signal into one or more scalar values, also called descriptors. Each descriptor value is used to indicate a certain failure mode of the monitored machine part. E.g. one descriptor can indicate if a bearing fault is present by measuring the vibration level at the outer ring of a certain bearing, another can indicate the vibration level of the shaft running speed and can indicate misalignment, unbalance or other shaft related faults.

A.2.3 Array measurements (SVA) – Frequency domain

These are measurement types where the raw time waveforms recorded by the sensor are post processed to array measurement types in the frequency domain. The most common measurement type is the auto spectrum (AS).

A.2.4 Array measurements (SVA) – Time domain

These are measurement types closest to the raw time waveform recorded by the sensor. Very often the raw time waveform signal can be filtered in order to represent only data in a certain frequency range in order to reveal specific characteristics of the time waveform. In practice, the time domain signals will always be limited by a maximum frequency range decided by the hardware of the system recording the signal. Unfiltered signals are very well suited for detailed analysis by various kinds of analysis tools.

A.3 mxType values

Table A.1 shows a list of common measurement types recommended to be used when applicable.

Table A.1 – Examples of applicable mappings from tag to MxType

Measurement type (scalar values, descriptors)	
Tag	**Explanation**
ISOA	Overall RMS vibration level according to ISO 10816-3. Acceleration domain
ISOV	Overall RMS vibration level according to ISO 10816-3. Velocity domain
ISOD	Overall RMS vibration level according to ISO 10816-3. Displacement domain
ISOA-21[0.1-10]	Measured according to ISO 10816-21. RMS vibration level from 0,1 Hz – 10 Hz. Acceleration domain.
ISOV-21[0.1-10]	Measured according to ISO 10816-21. RMS vibration level from 0,1 Hz – 10 Hz. Velocity domain
ISOV-21[10-1k]	Measured according to ISO 10816-21. RMS vibration level from 10Hz – 1 kHz. Velocity domain
ISOA-21[10-1k]	Measured according to ISO 10816-21. RMS vibration level from 10 Hz – 1 kHz. Acceleration domain
ISOA-21[10-2k]	Measured according to ISO 10816-21. RMS vibration level from 10 Hz – 2 kHz. Acceleration domain
ISOA-21[10-5k]	Measured according to ISO 10816-21. RMS vibration level from 10 Hz – 5 kHz. Acceleration domain
HFBP	RMS vibration level in a frequency band in the high frequency range. E.g. for bearing fault detection
HFPK	Peak vibration level in a frequency band in the high frequency range. E.g. for bearing fault detection.
HFCF	Crest factor level in a frequency band in the high frequency range. E.g. for bearing fault detection
TMF	Vibration level at tooth meshing frequency
2TMF	Vibration level at 2nd order tooth meshing frequency
3TMF	Vibration level at 3rd order tooth meshing frequency
1MA	Vibration level at shaft running speed 1st order magnitude
2MA	Vibration level at shaft running speed 2nd order magnitude
3MA	Vibration level at shaft running speed 3rd order magnitude
<r>MA	Vibration level at any ratio to the running speed. “r” expresses the ratio. Example: 0,5 MA
1PH	Phase value at shaft running speed. 1st order phase
2PH	Phase value at shaft running speed. 2nd order phase
BP[<lf>-<uf>]	Overall RMS vibration level in a band limited by the lower frequency (lf) to the upper frequency (uf). Acceleration domain. Example: BP[300-700]
BP[<lf>-<uf>]pk	Peak value vibration level in a band limited by the lower frequency (lf) to the upper frequency (uf). Acceleration domain. Example: BP[300-700]pk
BPV[<lf>-<uf>]	Overall RMS vibration level in a band limited by the lower frequency (lf) to the upper frequency (uf). Velocity domain. Example: BPV[300-700]
BPV[<lf>-<uf>]pk	Peak value vibration level in a band limited by the lower frequency (lf) to the upper frequency (uf). Velocity domain. Example: BPV[300-700]pk
CF[<lf>-<uf>]	Crest factor level, in a band limited by the lower frequency (lf) to the upper frequency (uf). Example: CF[300-700]
BPFO	The vibration level at the ball passing frequency of the outer ring of a bearing
BPFI	The vibration level at the ball passing frequency of the inner ring of a bearing

Measurement type (scalar values, descriptors)	
Tag	**Explanation**
BSF	The vibration level at the ball spin frequency of a bearing
2*BSF	The vibration level at twice the ball spin frequency of a bearing
FTF	The vibration level at the fundamental train frequency of a bearing. The fundamental train frequency is related to the cage of a bearing
Harm[<nr>X,<mr>X]	The square root of the square sum of the RMS vibration levels of a harmonic family. “X” can be the frequency related to any descriptor such as BPFI. “r” describes the ratio. “n” and “m” are multiplication factors. Ex1: Tag: Harm[BPFI,4BPFI] where n = 1, r = 1, m = 4. is the square root of the square sum of the harmonic family of BPFI to 4BPFI. Ex2: Tag: Harm[1.5MA,6.5MA] n = 3, r = 0,5, m = 13 is the square root of the square sum of the half order
SB[<-sp->,<cf>]	The square root of the square sum of the RMS vibration levels of a sideband family. “cf” indicates the center frequency and can be the frequency related to any descriptor such as TMF. “-sp-“ is the spacing of the sidebands and can be the frequency related to any descriptor such as 1 MA. In this case the descriptor will indicate the sideband family around the TMF with a spacing corresponding to the shaft running speed 1 MA. Ex: Tag: SB[-1MA-,TMF]
1OV	Order Vector. Magnitude and Phase of the vibration level at the running speed
2OV	Order Vector. Magnitude and Phase of the vibration level at twice the running speed
AUS	Auto Spectrum
AUS[<lf>-<uf>]	Auto Spectrum in specified frequency range Ex: Tag: AUS[0-2k]
TAUS or OAUS	Tracked Auto Spectrum. Recorded by the order tracking method. The terms Order and Tracked covers the same technique.
EAUS	Envelope Auto Spectrum
EAUS[<elf>-<euf>,<lf>-<uf>]	Envelope Auto Spectrum in specified frequency range (demodulation and analysis range as specified) Ex: Tag: EAUS[0-1k,4k-8k] Analysis range 0 kHz to 1 kHz, demodulation range 4 kHz to 8 kHz.
TEAUS or OEAUS	Tracked Envelope Auto Spectrum. Recorded by the order tracking method. The terms Order and Tracked covers the same technique.
ZAUS	Zoomed Auto Spectrum
TWF	Time waveform
TTWF or OTWF	Tracked time waveform. Recorded by the order tracking method. The terms Order and Tracked covers the same technique
TWF[<lf>-<uf>]	Band limited time waveform Ex: Tag: TWF[2k-5k]
ETWF	Envelope time waveform

Measurement type (scalar values, descriptors)	
Tag	**Explanation**
TETWF or OETWF	Tracked Envelope time waveform. Recorded by the order tracking method. The terms Order and Tracked covers the same technique.
PC	Power Cepstrum
TPC or OPC	Tracked Power Cepstrum. Recorded by the order tracking method. The terms Order and Tracked covers the same technique.

Annex B
(informative)

Application of data attributes for condition monitoring measurement description for measurement tag naming

B.1 General

In many cases, it is required to have a unique way of naming vibration measurement tags for the different measurement types on a wind turbine. The tags are what the user relates to when getting an overview of the state of a turbine, therefore it is important to use a consistent syntax for these names. This annex shows examples of how to apply the data attributes for condition monitoring measurements to create unique and informative tag names.

B.2 Naming principle using the data attributes in CMM CDC

The naming of the measurement types is split into two groups.

a) Speed related measurement types. This type of measurement is related to a particular frequency. Either the running speed of a shaft, or frequencies related to the running speed such as a tooth meshing frequency or a bearing frequency such as the ball passing frequency of the outer ring.

b) Non-speed related measurement types. This type of measurement does not adjust its characteristics according to running speed. That is, the measurement has a fixed frequency range. The measurement is not directly related to a specific machine part such as a shaft or a bearing like the speed related measurement type.

Use the attributes defined in Clause 8 to describe the sensor location, its type and orientation followed by the target of the measurement (if it is speed related), e.g. a specific shaft and fianally describe the measurement type. Dots between sensor identification (trd), target and type are used to make the tag more readable. Refer to the examples below.

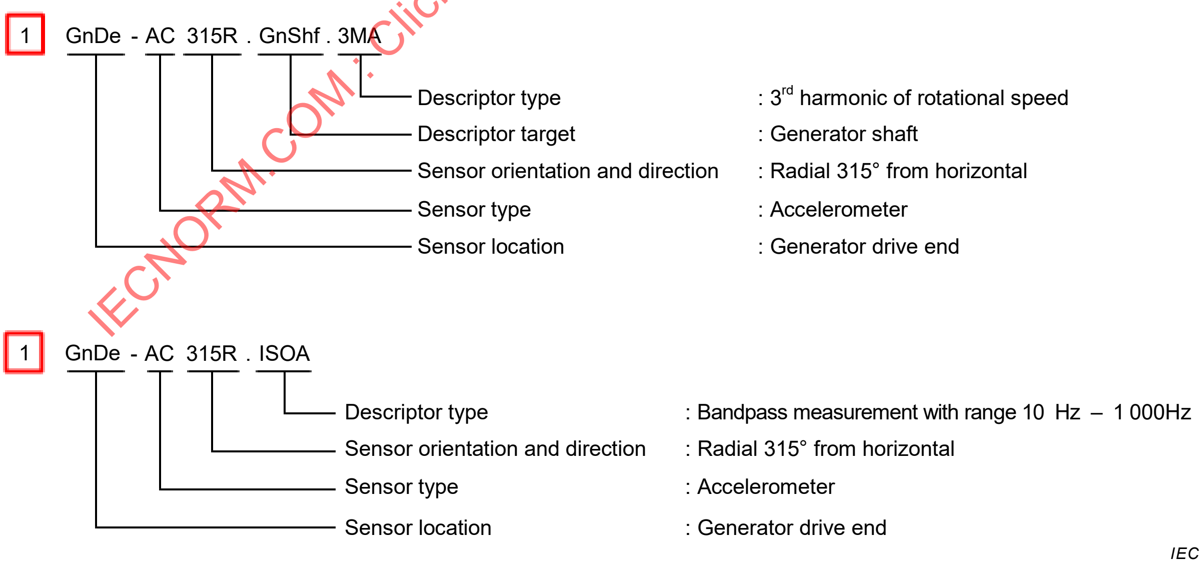


Figure B.1 – Naming principles for trd data attribute

B.3 Examples

Table B.1 shows examples of tag names which can be specified in the "d" data attribute of the CMM class along with an example of a vendor specific dataname to be used in the WCON class.

Table B.1 – Examples of Tag names and corresponding short datanames

Tag names versuss data objectname		
Tag (specified in the "d" data attribute)	**Data objectname**	**Explanation**
GnDe.ISOA	ConMes001	An overall measurement on generator Drive end
GbxIss.1TMF	ConMes002	Toothmeshing frequency of the gearbox intermediate stage. The Descriptor target is IssShf but it can be left out if the shaft relation of the measurement is obvious
GbxHss.HssShf.2.BPFO	ConMes003	Vibration level at outer race frequency of bearing position 2 counted in the Z direction on the high speed shaft of the gearbox. Here the example shows that the BPFO is related to the running speed of the HssShf
GbxPs.PlShf.TPC	ConMes004	Tracked power cepstrum related to the speed of the planetary shaft
NacZdir.BP[0.1-10]	ConMes005	Vibration level of the tower in the Z direction in the frequency range 0,1 Hz – 10 Hz
GbxHss.HssShf.Harm[2X,6X]	ConMes006	The square root of the square sum of the 2^{nd} to the 6^{th} harmonics of the running speed of the HssShf

Annex C
(informative)

Condition monitoring bins examples

C.1 Example 1: One dimensional bins

In this example:

- 5 bins
- Dimension 1: Value of generator Active Power (WGEN.W)
- Naming of data objects e.g. WBn

a) Define one CMG data object for each of the 5 bins according to Table C.1.

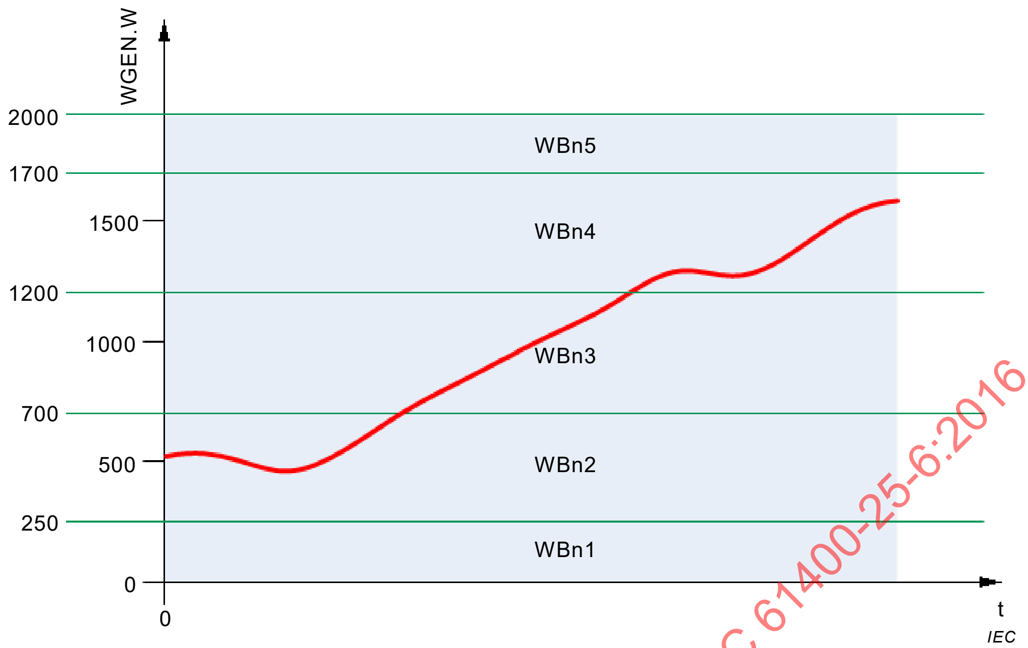
Table C.1 – CMB example 1

Logical Node: WCON	
WBn1	CMB
WBn2	CMB
WBn3	CMB
WBn4	CMB
WBn5	CMB

b) Configure the 5 bins (5 instances of CMB) according to Table C.2 and Figure C.1.

Table C.2 – CMB data object example 1

Common Data Class: CMB	
Ref	ObjectReference
Min	FLOAT32
Max	FLOAT32



5 instances of CMB	
Bin5	WBn5.ref1 = LD/WGEN.W
	WBn5.max1 = 2000
	WBn5.min1 = 1700
Bin4	WBn4.ref1 = LD/WGEN.W
	WBn4.max1 = 1700
	WBn4.min1 = 1200
Bin3	WBn3.ref1 = LD/WGEN.W
	WBn3.max1 = 1200
	WBn3.min1 = 700
Bin2	WBn2.ref1 = LD/WGEN.W
	WBn2.max1 = 700
	WBn2.min1 = 250
Bin1	WBn1.ref1 = LD/WGEN.W
	WBn1.max1 = 250
	WBn1.min1 = 0

Figure C.1 – Bin configuration example 1

C.2 Example 2: Two dimensional bins

In this example:

- 16 bins
- Dimension 1: Value of Wind Speed (WNAC.WdSpd)
- Dimension 2: Value of Generator Active Power (WGEN.W)
- Naming of data objects e.g. PcBn

  a) Define one CMG data object for each of the 16 bins according to Table C.3.

Table C.3 – CMB example 2

Logical node: WCON	
PcBn1	CMB
PcBn2	CMB
PcBn3	CMB
PcBn4	CMB
PcBn5	CMB
PcBn6	CMB
PcBn7	CMB
PcBn8	CMB
PcBn9	CMB
PcBn10	CMB
PcBn11	CMB
PcBn12	CMB
PcBn13	CMB
PcBn14	CMB
PcBn15	CMB
PcBn16	CMB

b) Configure the 16 bins (16 instances of CMB) according to Table C.4 and Figure C.2.

Table C.4 – CMB data object example 2

Common Data Class: CMB	
ref	ObjectReference
min	FLOAT32
max	FLOAT32