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Environmental Engineering (EE);
Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks);
Part 4: AC distribution power system control and monitoring information model

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document is part 4 of a multi-part deliverable covering Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks), as identified below:

Part 1: "Generic Interface";

Part 2: "DC power system control and monitoring information model";

Part 3: "AC UPS power system control and monitoring information model";

Part 4: "AC distribution power system control and monitoring information model";

Part 5: "AC diesel back-up generator system control and monitoring information model";

Part 6: "Air Conditioning System control and monitoring information model";

Part 7: "Other utilities system control and monitoring information model";

Part 8: "Remote Power Feeding System control and monitoring information model";

Part 9: "Alternative Power Systems";

Part 10: "AC inverter power system control and monitoring information model";

Part 11: "Battery system control and monitoring information model".

1 Scope

The present document applies to monitoring and control of AC distribution power systems for telecommunication or IT equipment in telecommunications or datacenter.

The control and monitoring interface is covering:

- AC distribution boards inputs and outputs;
- AC generators (Diesel, fuel cell, renewable energy generator, etc.) outputs;
- inverter or UPS inputs and outputs.

The present document defines:

- The monitored and controlled AC distribution power system architectures.
- The minimum set of exchanged information required at the interface, described in "natural language" in text tables.
- The XML files with tags and variables corresponding to the data in the tables.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI ES 202 336-1: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks) Part 1: Generic Interface".

[2] ETSI ETS 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

[3] ETSI EN 300 132-3: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V".

[4] ETSI EN 302 099: "Environmental Engineering (EE); Powering of equipment in access network".

[5] ETSI ES 202 336-3: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks); Part 3: AC UPS power system control and monitoring information model".

[6] ETSI ES 202 336-10: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks); Part 10: AC inverter power system control and monitoring information model".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEEE 802.1 to 802.11: "IEEE Standard for Local & Metropolican Area Network".

[i.2] ISO/IEC 10164: "Information technology -- Open Systems Interconnection -- Systems Management: Objects and attributes for access control".

[i.3] ISO/IEC 8879: "Information processing -- Text and office systems -- Standard Generalized Markup Language (SGML)".

[i.4] ETSI TR 102 336: "Environmental Engineering (EE); Power and cooling system control and monitoring guidance".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

NOTE: Terms referring to energy interface, equipment and distribution are described in power distribution standards ETS 300 132-1 [2], EN 300 132-3 [3] for ac and dc interface and EN 302 099 [4] for access network equipment powering.

AC distribution power system: device or system that distribute AC voltage or convert DC voltage to AC voltage and provides electrical power without interruption in the event that commercial power drops to an unacceptable voltage level

alarm: any information signalling abnormal state, i.e. different to specified normal state of hardware, software, environment condition (temperature, humidity, etc.)

NOTE: The alarm signal should be understood by itself by an operator and should always have at least one severity qualification or codification (colour, level, etc.).

EXAMPLE: Rectifier failure, battery low voltage, etc.

battery: complete arrangement of battery cells or blocks in one string or more in parallel

battery block: battery cell (e.g. 2V for lead-acid) connected and placed in the same container (forming 4V, 6V or 12V blocks)

battery cell: basic electrochemical element (e.g. a 2 V nominal cell for a high capacity lead acid battery)

battery string: number of serially interconnected battery blocks or cells

Control Unit (CU): integrated unit in an equipment to monitor and control this equipment through sensors and actuators

Data Gathering Unit (DGU): functional unit used for several functions:

- collect serial, digital, and analog data from several equipment;
- option to send (output) serial or digital commands;

- forward/receive information to/from the Local/Remote Management Application via agreed protocols;
- mediation between interfaces and protocols.

NOTE: This function may be integrated as part of specific equipment.

ethernet: LAN protocol

NOTE: Equivalent to IEEE 802.1 to 802.11 [i.1].

event: any information signalling a change of state which is not an alarm: e.g. battery test, change of state of battery charge

NOTE: The event signal should be understood by itself by an operator and should always have at least one severity qualification or codification (colour, level, etc.). It should be transmitted in a formatted structure with text message and other fields like for alarm, e.g. an event can be coded as an alarm with severity "0".

eXtensible Mark-up Language (XML): application profile or restricted form of SGML

NOTE: By construction, XML documents are conforming SGML the Standard Generalized Markup Language (ISO/IEC 8879 [i.3]). Documents.XML is designed to describe data and focus on what data is. XML should be discerned from the well known Hypertext Transfer Mark-up Language (HTML) which was designed to display data and to focus on how data looks.

eXtensible Style sheet Language (XSL): language for expressing style sheets

NOTE: It consists of two parts, a language for transforming XML documents, and an XML vocabulary for specifying formatting semantics. An XSL style sheet specifies the presentation of a class of XML documents by describing how an instance of the class is transformed into an XML document that uses the formatting vocabulary.

infrastructure equipment: power, cooling and building environment systems used in telecommunications centres and Access Networks locations

EXAMPLE: Cabinets, shelters, underground locations, etc.

intranet: internal company network generally using Ethernet protocol and extended IP addresses

object: class description of items that accept a set of properties or functions

NOTE: Generic objects can include more specific items and inherit from their properties. If correctly structured, object programming can allow the system to evolve, i.e. be more future-proof. The code should intrinsically be open and structured.

Simple Object Access Protocol (SOAP): way to communicate between applications running on different operating systems, with different technologies and programming languages

NOTE: SOAP communicates over HTTP, because HTTP is supported by all Internet browsers and servers, SOAP traffic is not blocked by firewalls and proxy servers (see W3C).

Systems Management Function (SMF): object properties or classes with projection on CMIS application context communication

NOTE: Set of ISO system management functions according to ISO/IEC 10164 [i.2].

Web: common name for the Internet or Intranet

World Wide Web Consortium (W3C): consortium founded in October 1994 to develop common interoperable protocols and promote World Wide Web

NOTE: See http://www.w3c.org.

XCU: CU enabled to communicate using XML interface as defined in the present document

XHTML: stricter and cleaner version of HTML. XHTML consists of all the elements in HTML 4.01 combined with the syntax of XML. It can be read by all XML browsers (see W3C)

XML Schema Definition (XSD): new more detailed XML description compared to the previous one, the DTD

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
CMIS	Common Management Information Service
CU	Control Unit of an equipment
DC	Direct Current
DEG	Diesel Engine Generator
DG	Diesel Generator
DGU	Data Gathering Unit
DTD	Document Type Definition
HTML	Hypertext Transfer Make-up Language
HTTP	HyperText Transfer Protocol
I_{AC}	Alternative current I
IP	Internet Protocol
LAN	Local Array Network
PF	Power Factor
PFC	Power Factor Correction
RMA	Remote Management Application
SBS	Static Bypass Switch
SGML	Standard Generalized Markup Language
SMF	Systems Management Function
SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol for IP
UPS	Uninterruptible Power Supply
W3C	World Wide Web Consortium
W	Watt
XCU	XML enabled CU
XML	eXtensible Mark-up Language (see W3C)
XSD	XML Schema Definition
XSL	eXtensible Style sheet Language

4 AC distribution power system

The AC distribution power systems subset described in ES 202 336-1 [1] distribute AC:

- from AC mains;
- from AC distribution board outputs;
- from AC generators (back-up engine or fuel-cell generator or renewable energy generator (e.g. PV system with AC inverter);
- from AC inverter with interface A1 in ETS 300 132-1 [2]; or
- from UPS output defined in EN 300 132-3 [3] for telecom centre and provides electrical power without interruption in the event that commercial power drops to an unacceptable voltage level or outside normal frequency range.

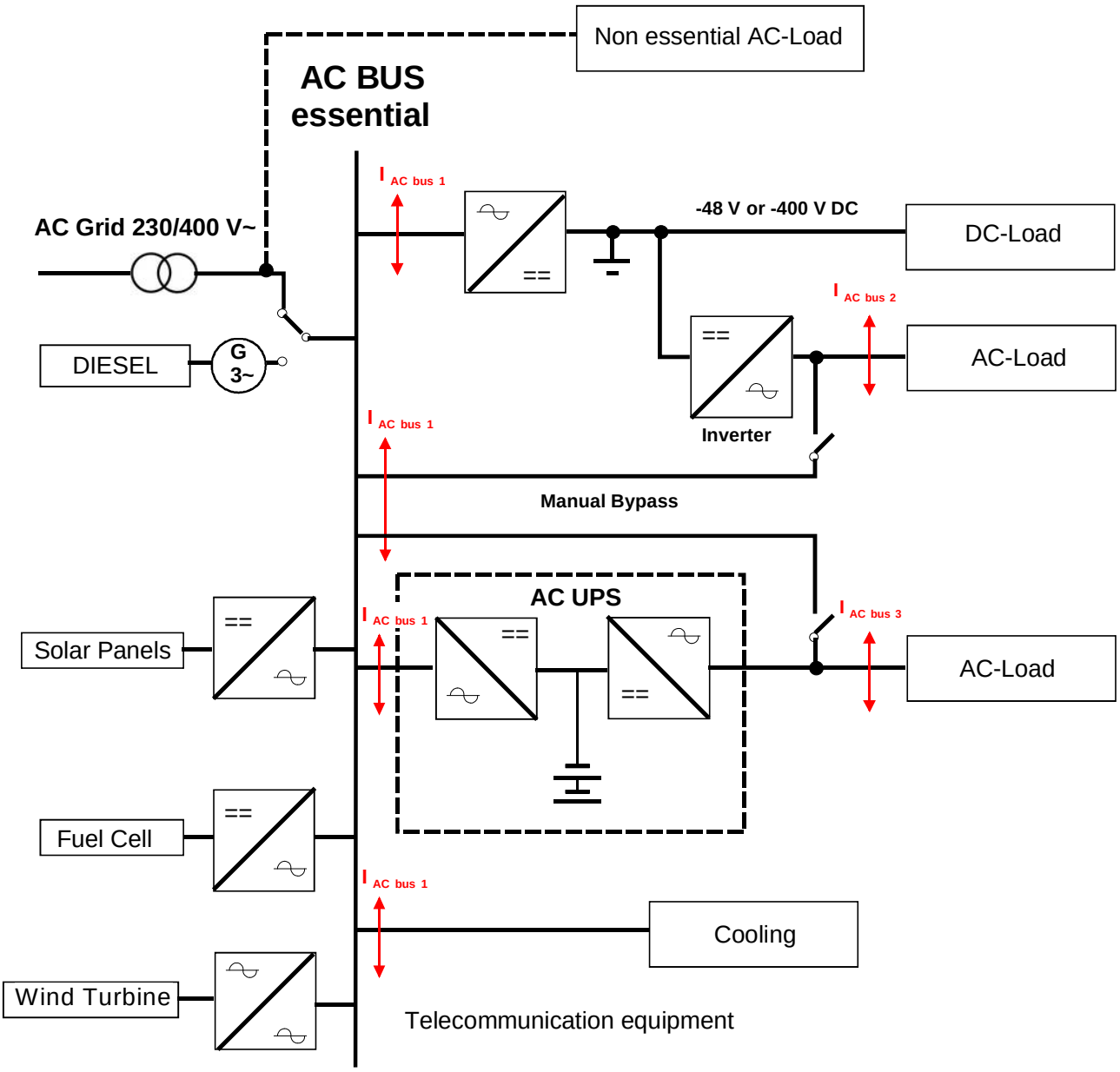
NOTE 1: The present document gives additional information to the control/monitoring interface of inverter using -48 V DC at input as defined in ES 202 336-10 [6], and the control monitoring interface of UPS as defined in ES 202 336-3 [5].

NOTE 2: The AC distribution power system provides backed-up or uninterruptible 230 V/400 V; 50 Hz voltage according ETS 300 132-1 [2] or EN 300 132-3 [3], for a period defined by the capacity of an installed back-up battery. The mains elements of the power architecture are defined in ES 202 336-1 [1] and described in TR 102 336 [i.4]. A back-up battery is used in DC system and in UPS system.

The AC distribution power systems addressed by the present document can be single phase output or three phases output.

The AC distribution power systems addressed by the present document are depicted in figure 1. One single control unit XCU can monitor and control several power cabinets through field bus. Field bus is outside the scope of the present document.

Figure 1 presents the AC distribution power system. Figure 2 gives an example of the circuital scheme of a static transfer switch and figure 3 shows the source of the AC distribution from inverter power system connected to a DC power supply systems with battery backup.



NOTE: The Network operator decides the structure, which equipment is to be connected to the essential (generator backed) (for instance fans of the cooling system) or non-essential AC distribution.

Figure 1: Typical AC distribution power system

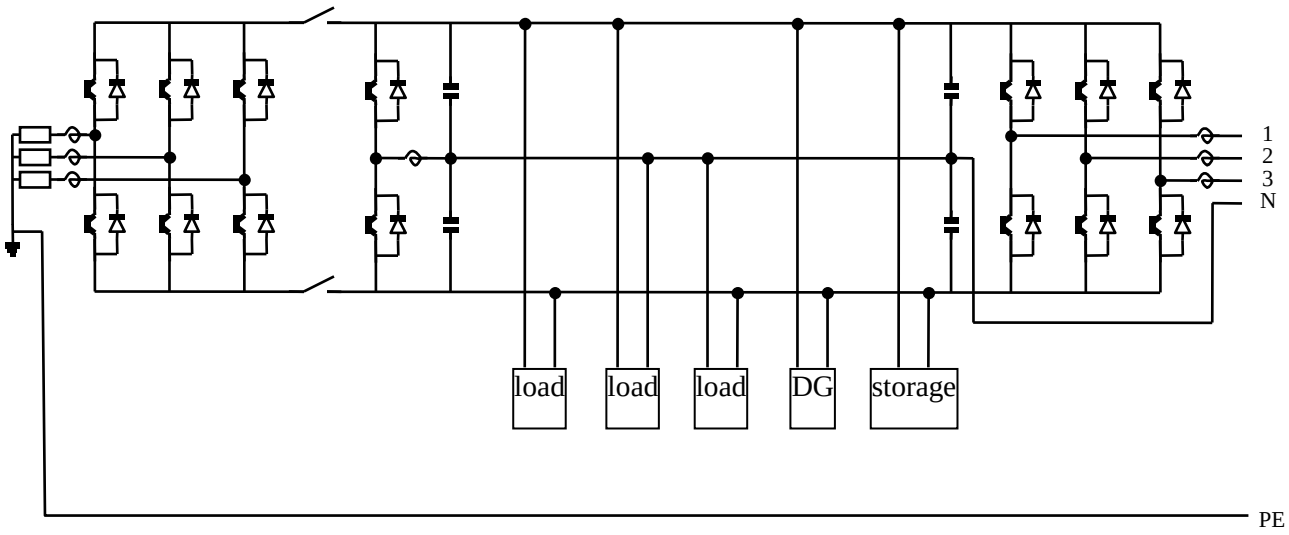


Figure 2: Example for a transfer static switch circuital schemes

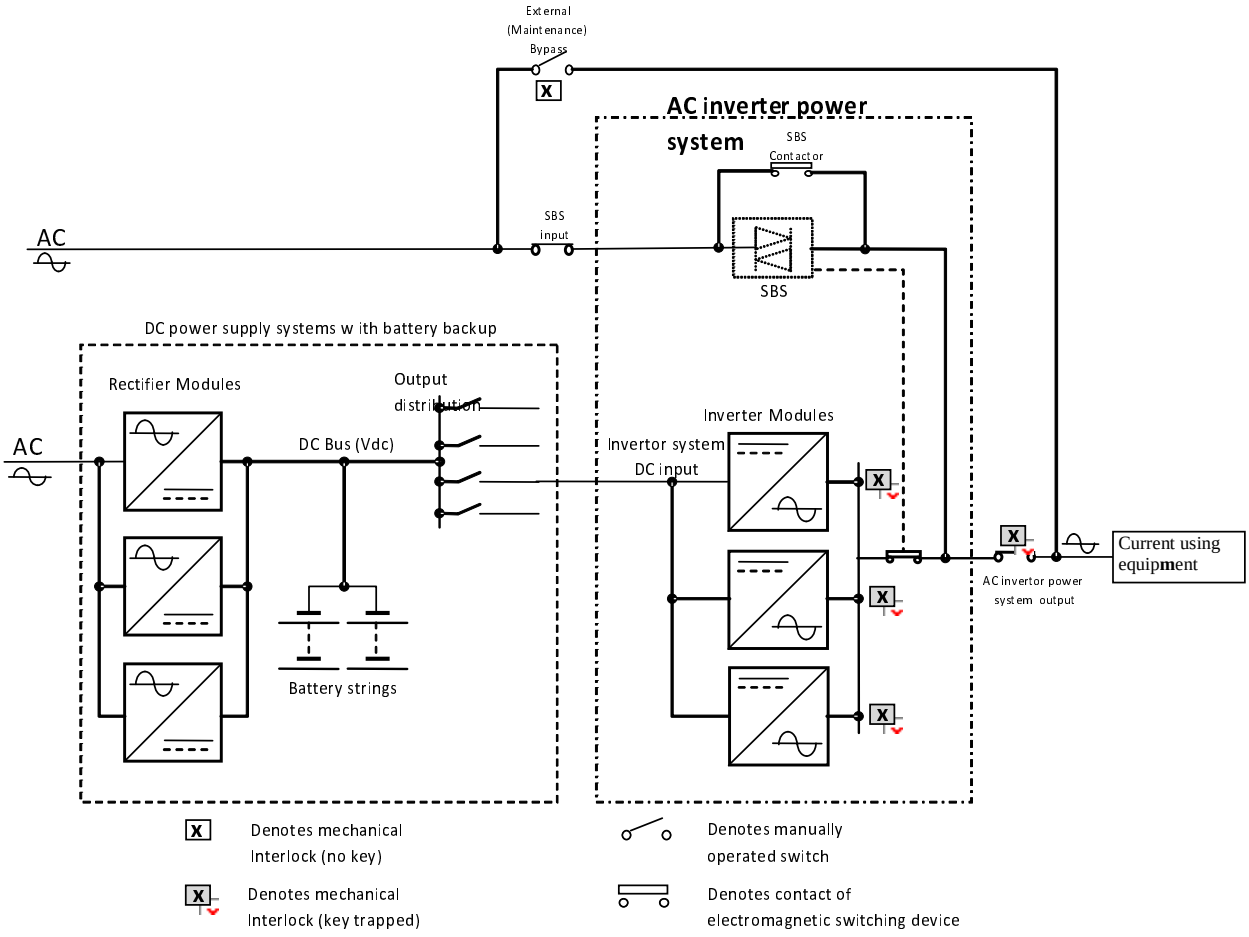


**Figure 3: AC inverter power system
connected to the output of the DC power supply systems with battery backup
(see figure 1 referencing ES 202 336-10 [6])**

The main elements of AC distribution power systems are:

- AC transformer;
- AC distribution frames and power busses (Interface $I_{AC\ bus\ 1}$);

- AC circuit breakers or protective devices;
- Passive or active PFC circuitry;
- Auxiliary power for control of power switches and breakers;
- AC power switch between mains and optional back-up sources;
- Voltage, current, phases/frequency measurement sensors;
- AC power and energy meters units;
- AC power supply from the mains or from the inverter modules (one or more) (Interface $I_{AC\ bus\ 2}$) or UPS (Interface $I_{AC\ bus\ 3}$);
- Static Bypass Switch (SBS) monitors output AC voltage of inverter and mains AC voltage, and synchronizes inverter output voltage to the mains AC voltage, or transfers the mains AC voltage to the inverter output to supply Current using equipment;
- External (Manual) Bypass that transfers mains AC voltage to the inverter output to supply Current using equipment, in the case of AC distribution power system failure, service, maintenance, etc. (see clause 4 of ES 202 336-3 [5] and ES 202 336-10 [6]);
- a system monitoring and control unit (XCU) to monitor voltage, current, power, temperature etc, extend alarms and provide system control functionality.

NOTE 3: AC distribution power system is powering the DC power supply systems and UPS system with battery backup.

NOTE 4: There can be additional SBS or power transfer switch and manual bypass in AC installation in addition to those taken into account in ES 202 336-3 [5] and ES 202 336-10 [6].

Several measurements are possible:

- AC input parameters:
  - voltages;
  - current;
  - power;
  - etc.
- AC output parameters:
  - voltages;
  - current;
  - frequency;
  - power;
  - Power Factor (PF);
  - etc.
- Power modules temperature
- Etc.

NOTE 5: Several controls are possible: to adjust inverter output voltage and frequency, etc. which are defined in ES 202 336-3 [5] and ES 202 336-10 [6].

Table A.1 (see annex A) corresponds to mandatory data that shall be provided for an AC distribution board power system.

Table A.2 (see annex A) corresponds to mandatory data that shall be provided for an AC inverter or UPS distribution power system.

Table B.1 (see annex B) corresponds to non-mandatory data that shall be provided in addition to mandatory for an AC distribution board power system.

Table B.2 (see annex B) corresponds to non-mandatory data that shall be provided in addition to mandatory for an AC inverter or UPS distribution power system.

Annex C standardizes XML coding structures for these data.

Annex A (normative): Summary of mandatory monitoring/supervision information and functions

This annex gathers the information needed on the remote monitoring application for different types of Air conditioning systems. It specifies the mandatory requirements that shall be provided in all cases.

NOTE 1: These tables do not specify the power equipment by itself. These tables refer to subsets or devices that are not necessarily present in each equipment configuration. As a matter of fact, one alarm and its class apply only in case of the presence of this subset or device.

When an optional alarm that requires a parameter set is present, the corresponding parameter set is mandatory in the control section in order to allow remote adjustment under appropriate login procedure.

According to their types (Description, Alarm, Data, etc.), as defined in ES 202 336-1 [1] the information shall be provided by the Control Unit (XCU).

NOTE 2: If there is no XCU this data should be provided by the Data Gathering Unit (DGU).

When a CU has a field data bus connected to the DGU, at least, the DGU shall store data (record measurements, log files). The XCU which has the XML interface over Ethernet TCP/IP shall store these data.

NOTE 3: The "Explanation" column provided in the following data tables has been used where necessary to further explain the statements in the "Monitored information" column. The "Type" column gives the assigned name used in XML coding and the "Monitored information" column provides details of the condition or state being monitored. The identifiers used in the "Type" column of the following tables are described in ES 202 336-1 [1].

NOTE 4: Partial communication network failures e.g. XCU link fault should be detected by an upper element of the network e.g. the RMA (refer to figure 1 of ES 202 336-1) [1].

NOTE 5: Clause 9.4.4 of ES 202 336-1 [1] details the parameters associated with XML elements e.g. time delay, severity of alarm element. The tables below do not include the application of these parameters.

A table is giving minimum set of information for each type of AC distribution System.

A.1 Table for AC distribution system supervision

NOTE: Partial network failure (high error rate, XCU-DGU link fault) is raised by the DGU, not the AC distribution system.

Any network communication failure on the AC distribution system XCU interface shall be detected by the AC distribution system supervision unit.

Table A.1

Type	Monitored information	Explanation
Description	Device description	
Alarm	ac voltage loss after time-out	
	ac circuit breakers trip (gathered or individual) supervision)	
	Manual/maintenance mode (e.g. automatic control disable)	
	Power factor correction failure	It can include over temperature
	ac transformer failure	It can include over temperature
	ac switch-gear failure	It can include over temperature
	DEG/mobile generator switch-gear on position "mobile"	
	Partial network failure (high error rate, CU-DGU link fault, etc.)	
Event	ac switch-gear state (on mains/on DEG)	
Data	ac mains phases voltage (±1 %)	xxxV
	Global output ac phase current (±1 %)	xxxx.xA
	ac energy consumption (±2 % - global metering or individual user metering)	xxxxxxxxxkWh (9 digits)
Data Record	Record of average, min, max power and energy consumption	Average, min and max, power, and Energy consumption recorded periodically e.g. every hour
Config	Parameters set: alarm voltage thresholds (low, high)	
	Parameters set: , Energy record period	
Control	All XCU alarm/event/test/command parameters (time-out, counter, thresholds, etc.) if any	
	XCU program download with default to previous release	Hexadecimal file

A.2 Table for Inverter or UPS AC distribution

Table A.2

Type	Monitored information	Explanation
Description	**Device description (hardware and software)**	
Alarm	Absence of inverter or UPS input voltage or input voltage is out from limited values	From external control (e.g. in a power transfer module)
	Absence of output voltage or output voltage is out from limited values	Idem
	Output frequency is out from limited values	Idem
	Failure on static by-pass	
	AC output protection tripped or open	
	Bypass out of tolerance	Bypass input voltage outside tolerance
	UPS or power transfer switch Input circuit protection tripped or open	fuse or circuit breaker tripped or in open position
Event	Alarm set and clear (data log)	
	Details of any change of configuration and parameters of AC distribution of inverter or UPS system	Change of parameter e.g. output voltage change, etc.
Data	Input AC voltage (±0,2 V)	
	Input AC current (±2 %)	
	Output AC voltage (±2 V)	Phases L1, L2, L3 for 3 phases
	Output AC current (±2 %)	Current in phases L1, L2 and L3 for 3 phases output inverter
	Output AC current (±2 %)	
	Output frequency (±0,1 Hz)	
	Output active power (W)	
	Internal temperature (±1 °C)	Measured at temperature critical place inside AC distribution
Date record	AC output current	Average current data log e.g. at 5 min interval limited to a defined number of records
	AC output voltage	Voltage record e.g. at 1 hour interval limited to a defined number of records
	Output frequency	Average frequency data log e.g. at 5 min interval limited to a defined number of records
Config	Date and time	
	Output low voltage threshold	
Control	Any forced change of operating mode	
	XCU program download with default to previous release	
	Default values resetting (safe value for XCU)	
	Inverter module control	

Annex B (informative): Summary of non-mandatory monitoring/supervision information and functions

According to their types (Description, Alarm, Data, etc.), as defined in ES 202 336-1 [1], the information should be provided by the Control Unit (XCU) or by the Data Gathering Unit (DGU).

The non mandatory information of tables of annex B are provided in addition to the mandatory information defined in tables of annex A.

NOTE: The "Explanation" column provided in the following data tables has been used where necessary to further explain the statements in the "Monitored information" column. The "Type" column gives the assigned name used in XML coding and the "Monitored information" column provides details of the condition or state being monitored. The identifiers used in the "Type" column of the following tables are described in ES 202 336-1 [1].

A table is giving list of useful non mandatory information for each type of AC distribution system.

B.1 Table for AC distribution System

Table B.1

Type	Monitored information	Explanation
Description	Additive information	
Alarm	ac circuit breaker control failure	
	Earth leakage detection (possibly after automatic trial)	
	Mains transient or distortion (ac mains quality drop)	
Event	Details of any change of configuration	
	ac load progressive loading	
	Change of operating mode	
	Control Mode	
Data	ac power (±2 % - global metering or individual user metering)	xxxxxxxxW (8 digits)
Data Record	Additive records	
Config	Sliding time window to capture output AC current All XCU alarm/event/test/command parameters (time-out, counter, thresholds, etc.)	Period of time over which power data logging is carried out
Control	Switch-gear test	run/stop
	Controlled circuit-breakers test	run/stop
	Parameters set: alarm voltage thresholds (low, high)	
	Parameters set: energy counters	xxxxxxxxxkWh (9 digits)
	Parameters set: ac voltage loss time-out	hhmm

B.2 Table for inverter or UPS AC distribution system

Table B.2

Type	Monitored information	Explanation
Description	Additive information	
Alarm	Static by-pass in normal operation	
	Load is supplied from manual by-pass	
	Static by-pass circuit protection	AC fuse or circuit breaker tripped or in open position
Event	Details of any change of configuration Change of operating mode	
	Test execution report	
	Indication of restart with back-up or customized parameters (auto-recovery in case of Control Unit reset or replacement)	
Data	Output line AC voltage (± 2 V)	
	Average value of AC output load current I_{Av} (± 5 %) over a preset time window	
	Output power factor	
	Output reactive power	
	Total output power	In W. Can be calculated as S = sqrt ($P^2 + Q^2$)
	Total harmonic voltage distortion at the inverter output	In %, or in V per harmonics
	Room temperature (±1 °C)	Temperature in the room where the inverter is mounted
	Power capacity management (ratio) = Used/Installed power	
	AC output total power	This value can be calculated by the AC power system controller from AC output voltage and current measurements
Data Record	All of the data	
Config	Sliding time window to capture maximum output AC current All XCU alarm/event/test/command parameters (time-out, counter, thresholds, etc.)	Period of time over which power data logging is carried out
	Output overload threshold (consumed power/useful power where useful power is installed power without redundancy or battery recharge power)	
Control	Acknowledge alarms	

Annex C (normative): Mandatory XML structure and elements

C.1 Structure of an XML document for a AC distribution power system

In the site DGU XML data structure as described in ES 202 336-1 [1], an AC distribution power system equipment is always a child of a site energy system.

The XML structure shall be as follows:

NOTE: Indicate precisely the generic mandatory XML structure and where to put the information if it exists (where it starts and stops). Every equipment and element, should be considered as a folder in the XML structure.

```
<site id="23" status ="normal">
    ....
    <energy_system id="1" status="normal">
        <description_table>
        …
        </description_table>
        …
        <ac_distribution power_system id="1" status="normal">
            <description_table>
            …
            </description_table>
            <alarm_table>
            …
            </alarm_table>
            <event_table>
            …
            </event_table>
            <data_table>
            …
            </data_table>
            <data_record_table>
            …
            </data_record_table>
            <config_table>
            …
            </config_table>
            <control_table>
            …
            </control_table>

            …

        </ac_distribution power_system>
        …
    </energy_system>
</site>
```

An AC distribution power system XCU will only generate the XML document "ac_distribution power_system.xml". This file can be downloaded by the DGU of the site and embedded in the "site.xml" document. In this case, the structure of the document is as follows:

```
<ac_distribution power_system id="1" status="normal">
    <description_table>
    …
    </description_table>
    <alarm_table>
    …
    </alarm_table>
    <event_table>
    …
    </event_table>
    <data_table>
    …
    </data_table>
    <data_record_table>
    …
    </data_record_table>
    <config_table>
    …
    </config_table>
    <control_table>
    …
    </control_table>

    …
</ac_distribution power_system>
```

C.2 The specific XML elements of an AC distribution power system

Here follows the specific tags for XML elements that are not detailed in ES 202 336-1 [1].

As "AC distribution power system" can be very complex, the manufacturer is free to add sub-equipments in the XML structure to provide more detailed information, data, control, etc.

The allowed child elements of <ac_distribution power_system> are:

Table C.1

Child Element	Description	Datatype
<inverter>	For detailed information about inverter	xs:complexType
<static_bypass_switch>	For detailed information about SBS	xs:complexType
<protection_and_distribution>	For detailed information about the protections and the distribution	xs:complexType

Annex D (informative): Bibliography

ETSI ES 202 336-2: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (Power, Cooling and environment systems used in telecommunication networks); Part 2: DC power system control and monitoring information model".

ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 2: Operated by -48 V direct current (dc)".

ETSI TR 102 121: "Environmental Engineering (EE); Guidance for power distribution to telecommunication and datacom equipment".

History

Document history		
V1.1.0	January 2013	Membership Approval Procedure MV 20130310: 2013-01-09 to 2013-03-11
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