Final draft ETSI ES 202 336-10 V1.1.1 (2011-07)
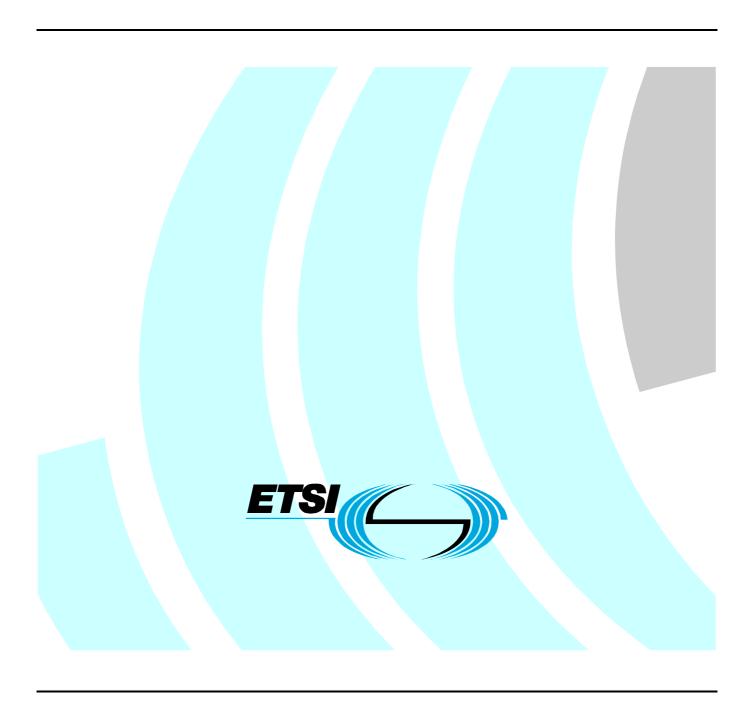
Environmental Engineering (EE);
Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks);
Part 10: AC inverter power system control and monitoring information model

Reference

DES/EE-02037-10

Keywords

control, interface, management, power, system

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI standards Membership Approval Procedure.

The present document is part 10 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

1   Scope

The present document applies to monitoring and control of AC inverter power systems for telecommunication equipment supply using 48 Vdc or 400 Vdc input.

The present document does not apply to inverters included in UPS which are covered in ES 202 336-3 [i.8].

The back-up battery connected to the inverter power system is outside the scope of the present document; they are covered in the standard dealing with the control and monitoring of DC system (ES 202 336-2 [i.7]).

The present document defines:

- The monitored and controlled AC inverter 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: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

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 & Metropolitan 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 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)".

[i.5]   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".

[i.6]   ETSI EN 302 099: "Environmental Engineering (EE); Powering of equipment in access network".

[i.7]   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".

[i.8]   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".

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 300 132-2 [i.4], EN 300 132-3 [i.5] for ac and dc interface and EN 302 099 [i.6] for access network equipment powering.

AC inverter power system: device or system that convert DC voltage to AC voltage and provides electrical power without interruption in the event that commercial power drops to un 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.

alarm loop: electrical loop which open or closed state correspond to alarm start (set) or end (clear) state

alarm message: text parts of the alarm structure

alarm structure: organized set of information fields in an alarm data frame (time stamp, set/clear, text, etc.)

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

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

client post: any device (laptop, PDA, console, etc.) connected to servers via the operation system networks to perform maintenance or supervision operations

Control form Style Sheet (CSS): simple mechanism for adding style (e.g. fonts, colours, spacing) to Web documents, tutorials, books, mailing lists for users, etc.

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.

Dynamic Host Control Protocol (DHCP): protocol used for self configuration of TCP/IP parameters of a workstation assigning IP address and a subnetwork mask

NOTE: DHCP may also configure DNS.

Dynamic Name Server (DNS): associates a single domain name to an IP address

dynamic synoptic: dynamic display of geographical maps, networks, installations and equipment

ethernet: LAN protocol

NOTE: Equivalent to IEEE 802.1 to IEEE 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 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

logbook: chronological file that contains alarm and event messages may be paper or electronic

Management Information Base (MIB): dynamic data base that gathers all objects and should evolve to include automatic and manual configuration tools with self coherence tests

menu: list of possible input command choices that may be presented in different ways on a display

NOTE: Selection is normally made by a keyboard, a pointing device, a mouse or directly by finger on a sensitive screen.

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.

PHP: powerful tool for making dynamic and interactive Web pages

pop-up: information or command screen that appears when a menu choice is selected

EXAMPLE: This may be a pop-up menu when the pointer is on a title button.

REpresentational State Transfer (REST): way to build an application for distributed system as www

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].

warning: low severity alarm

web: common name for the Internet or Intranet

windows: virtual area on the display that corresponds to a specific application

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 browser (see W3C)

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.

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
CSS	Control form Style Sheet
CU	Control Unit of an equipment
DC	Direct Current
DGU	Data Gathering Unit
DHCP	Dynamic Host Control Protocol
DNS	Dynamic Name Server
HTML	Hypertext Transfer Make-up Language
HTTP	HyperText Transfer Protocol
IP	Internet Protocol
LAN	Local Array Network
LVD	Low Voltage Disconnection
MIB	Management Information Base
PF	Power Factor
REST	REpresentational State Transfer
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

W3C	World Wide Web Consortium
XCU	XML enabled CU
XML	eXtensible Mark-up Language (see W3C)
XSD	XML Schema Definition
XSL	eXtensible Style sheet Language

4   AC inverter power system

The AC inverter power systems subset described in ES 202 336-1 [1] transforms DC voltage on interface A defined in EN 300 132-2 [i.4] or on interface A3 defined in EN 300 132-3 [i.5] in AC voltage defined in ETS 300 132-1 [2] for telecom centre and provides electrical power without interruption in the event that commercial power drops to unacceptable voltage level or outside frequency normal range.

The AC inverter power system provides uninterruptible 230V/400V 50 Hz AC voltage according to ETS 300 132-1 [2], in period defined by capacity of installed back-up battery. The back-up battery are connected on DC power supply system are out of the scope of the present document. They can be included in a DC system and monitored and controlled in compliance with ES 202 336-1 [1] and ES 202 336-2 [i.7]
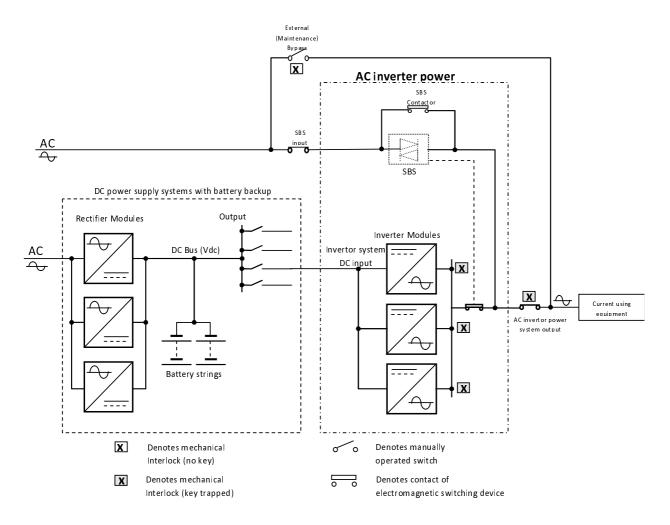
The AC inverter power systems addressed by the present document can be single phase output or three phases output.

The AC inverter power systems addressed by the present document is 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.

In figure 1 is present AC inverter power system connected to the DC power supply systems with battery backup.

Mandatory monitoring/supervision information and functions are given in annex A.

Non-mandatory (optional) monitoring/supervision information and functions are given in annex B.

NOTE: Part of figure 1, with CD power supply system with battery backup is shown for better understanding and is not subject of the present document.

**Figure 1: AC inverter power system
connected to the DC power supply systems with battery backup**

The main elements of AC inverter power systems are:

- inverter module (one or more) that converts DC voltage to AC voltage (i.e. DC voltage to 230VAC/400VAC);

- 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 inverter power system failure, service, maintenance, etc.;

- a system monitoring and control unit (XCU) to monitor voltage, current, power, temperature etc, extend alarms and provide system control functionality.

NOTE: AC inverter power system is connected to the DC power supply systems with battery backup.

Several measurements are possible: AC inverter input parameters: voltages, current, power, etc.; AC inverter output parameters: voltages, current, frequency, power, Power Factor (PF), etc.; inverter modules temperature, etc.

Several controls are possible: to adjust inverter output voltage and frequency, etc.

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

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

Table B.2 (see annex B) corresponds to non-mandatory data that shall be provided in addition to mandatory for an each inverter module.

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 Management Application (RMA) for different types of power supplies. It specifies the mandatory requirements that must 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 element type (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 databus 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 "Element 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.

Table A.1: Minimum set of monitored information

Type	Monitored information	Explanation
Description	**Device description (hardware and software)**	
Alarm	Absence of inverter DC input voltage or DC input voltage is out from limited values	Output DC voltage from rectifier or battery
	Absence of output voltage or output voltage is out from limited values	
	Failure of inverter system	
	Short circuit and overload at the output of Inverter	Supply can be from inverter or static by-pass
	Output frequency is out from limited values	
	Failure on static by-pass	
	Bypass out of tolerance	Bypass input voltage outside tolerance
	Synchronization error	Inverter unable to synchronize with input frequency
	Load is supplied from inverter (Inverter in normal operation)	
	Load is supplied from static by-pass	
	~~Signalization of proper work of inverter system~~	
	~~Signalization of proper work of inverter module~~	
	Failure of inverter module	
	Input inverter system circuit protection	DC fuse or circuit breaker tripped or in open position

Type	Monitored information	Explanation
Description	Device description (hardware and software)	
	Output inverter system circuit protection	AC fuse or circuit breaker tripped or in open position
	Forced cooling failure (fan failure)	In case of inverter forced cooling
Event	Alarm set and clear (data log)	
	Details of any change of configuration and parameters of inverter system	Change of parameter e.g. output voltage change, etc.
Data	Input DC voltage (±0,2 V)	
	Input DC current (±2 %)	
	Output AC voltage (±2 V)	Phases L1, L2, L3 for 3 phases output inverter
	Output AC current (±2 %)	Current in phases L1, L2 and L3 for 3 phases output inverter
	Output AC current (±2 %) of each inverter module	
	Output frequency (±0,1 Hz)	
	Output active power (W)	
	Static by-pass current (±2 %)	
	Internal temperature (±1 °C)	Measured at temperature critical place inside inverter modules, e.g. on the heater with power components
	XCU program download with default to previous release	
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 a table B1 are provided in addition to the mandatory information defined in annex A in table A1.

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 "Element 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].

B.1   AC inverter power system

Table B.1

Element type	Monitored information	Explanation
Description	Device description (hardware and software)	
Alarm	Low DC warning voltage	Battery nearly discharged
	Peak current limiter active	Peak current limiter activated and inverter switched to bypass operation
	Temperature of inverter is out of limit (internal inverter modules temperature out of limit)	Inverter temperature exceeds high limit setting
	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
	Forced cooling failure (fan failure) of specific inverter module	
Event	Change of inverter operating mode	Change of operation e.g. load supplied from static by-pass, etc.
	Indication of restart with back-up or customized parameters (auto-recovery in case of Control Unit reset or replacement)	
	power interconnection	
Data	Input power	In W
	Output line AC voltage (±2 V)	Line L1-L2; L1-L3; L2-L3 for 3 phases output inverter
	Average value of AC output load current I_{Av} (±5 %) over a preset time window	
	Output power factor	
	Output reactive power	In VAr
	Total output power	In VA. 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	

Element type	Monitored information	Explanation
Description	**Device description (hardware and software)**	
Data record	Input (DC) energy consumption over preset period	
	AC output total power	This value can be calculated by the AC power system controller from AC output voltage and current measurements
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
	Range of frequency synchronization	Range of input frequency when the output and input frequency are the same (max ±2,5 Hz)
	Output overload threshold (consumed power/ useful power where useful power is installed power without redundancy or battery recharge power).	
Control	Inverter power device control (inverter, static by-pass, etc.)	
	Acknowledge alarms	

B.2   AC inverter module

The following table is dedicated to each inverter module control/monitoring.

Table B.2

Element type	Monitored information	Explanation
Description	Inverter Reference	
	Inverter Serial Number	
Alarm	AC Failure	
	DC Failure	
	FAN Failure	
	Over Temperature	
Event	Alarm Set/Clear	
Data	Inverter AC power (±1 %)	
	Inverter temperature	
Data record	none	
Config	none	
Control	none	

Annex C (normative):
Mandatory XML structure and elements

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

In the site DGU XML data structure as described in ES 202 336-1 [1].

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

An AC inverter power system XCU will only generate the XML document "ac_ups_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_inverter 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_inverter power_system>
```

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

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

As "AC inverter 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_ups_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

History

Document history		
V1.1.1	July 2011	Membership Approval Procedure MV 20110927: 2011-07-29 to 2011-09-27