The Latest Standards and Best Practices for Electrical System Metering & Monitoring

Contents

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Contents

Introduction

Every building served by an electric utility today features at least one electricity meter: the one used by the utility to measure energy use for billing purposes. But meters, along with performance-monitoring devices, installed throughout a facility's distribution system can provide owners and managers with a range of additional information that can be critical to improving their systems' efficiency and reliability. For this reason, a number of international efficiency standards and directives are calling for greater use of meters and monitors, and electrical designers and manufacturers have begun considering best practices for when and where such devices make sense, even in jurisdictions in which they aren't required.

Meters, along with performance-monitoring devices, can provide information that can be critical to improving their systems' efficiency and reliability.

This Schneider Electric eGuide offers insight into one of the most important metering-related standards, the International Electrotechnical Commission's Standard 61557-12, "Electrical safety in low voltage distribution systems up to 1000V a.c. and 1500V d.c. – Equipment for testing, measuring, or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)." Beyond simply describing how to meet a single standard, though, this eGuide also describes how to best put metering and monitoring programs into place – and how such efforts can pay for themselves quickly, through energy savings and improved power quality.

So read on to learn more about the powerful advantages offered by today's power meters and monitors. For more information on specific products and related system-design questions, be sure to register for Schneider Electric's Consulting Engineer portal.

About the Author:

Franck Gruffaz spent half of his career in R&D as a project manager or technical manager in the field of Industry, MV and LV protection and measurement before moving to standardization activities. He is now a senior standardization manager at Schneider Electric in topics such as power quality, energy efficiency and power metering, and is involved in IEC committees such as IEC TC85, IEC SC77A, IEC SC65A and IEC SC77B.

Contents

Guide to Measuring Applications on the Supply and Demand Side

Measuring and managing – these two concepts go hand in hand. You can't manage what you can't measure, as the classic business adage says, and you also can't see how well you're managing without measuring on an ongoing basis. With power costs climbing, and the importance of good power quality on the rise, building owners and grid operators are seeing greater need for metering programs on both the supply and demand sides of electricity transactions.

As Figure 1 shows, meeting all these needs requires metering devices in a number of locations throughout a facility and the connected grid. Specifiers need to understand both the goals of each specific metering installation, along with any standards that might be relevant to the location and purpose of the device.

Specifically, today's specifying engineers are being asked to address the major needs described below. In a series of articles, I'll be going into each of these needs, in depth, describing goals and requirements. The following offers a brief overview of these applications.

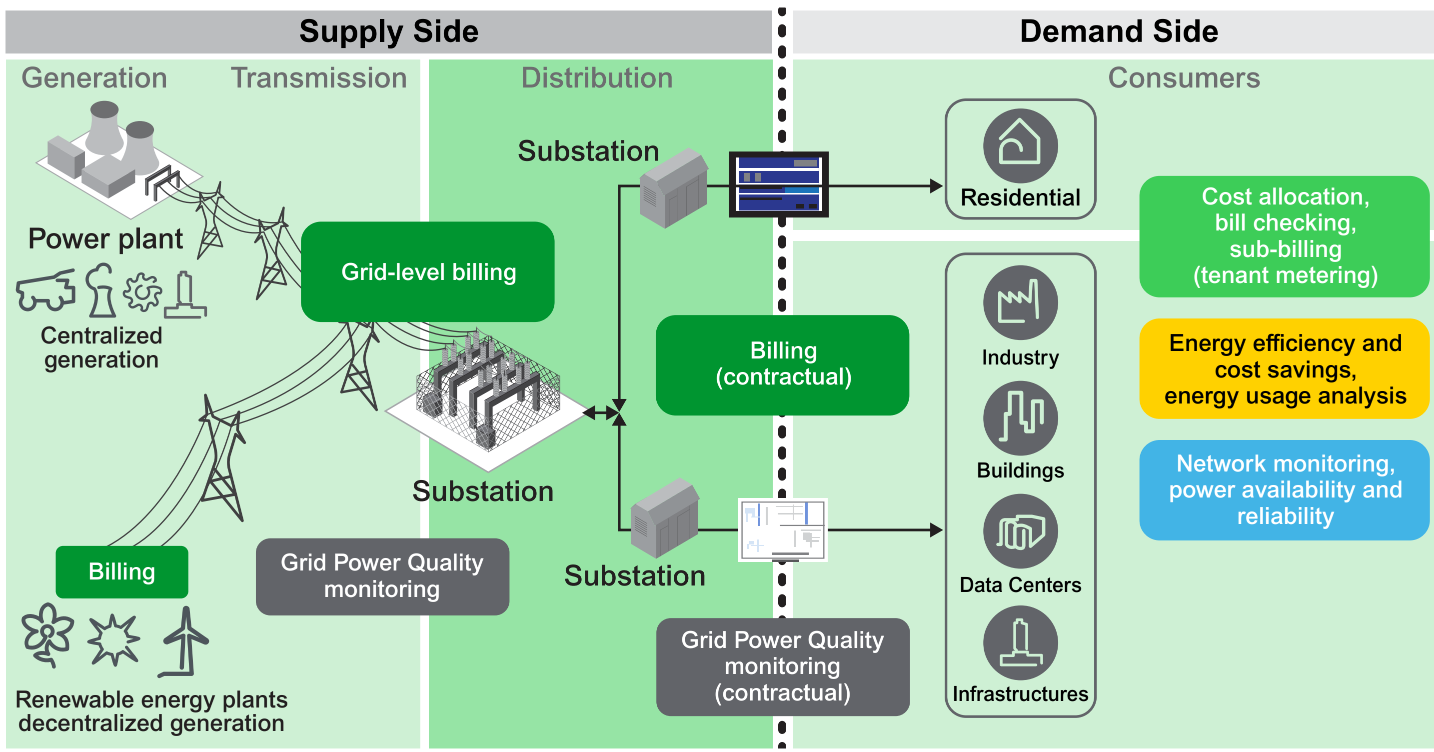

Figure 1: The main measurement applications in relationship to the supply side and the demand side.

Contents

Guide to Measuring Applications on the Supply and Demand Side (cont.)

Specifiers need to understand both the goals of each specific metering installation, along with any standards relevant to the location and purpose of the device.

With power costs climbing, and the importance of good power quality, there is a greater need for metering programs on both the supply and demand sides of electricity transactions.

- **Billing.** The process that allows energy suppliers or their representatives to invoice their customers according to a defined contract, for measured usages or services. (These applications may be covered by international standards or covered by regulations such as MID [Measuring Instruments Directive] in Europe or NMI [National Measurement Institute] in Australia, sometimes in addition to utility specifications.)
- **Grid power-quality monitoring.** The process that allows energy suppliers and/or their customers to verify the quality of energy delivered/received is in line with a defined contract or regulation. (Limits for European public networks are defined in EN 50160.)
- **Cost allocation.** The process that allows a facility manager to allocate energy expenses to their related internal departments or cost centers, such as manufacturing floors or data centers.
- **Sub-billing (or tenant metering).** The process that allows a landlord, property management firm, condominium association, homeowner association or other multi-tenant property to spread out invoice over tenants (assign portions of invoice to tenants), for measured usages or services. This fee is usually combined with other tenant's facility fees. (These applications are sometimes covered by regulations, as they are in the UK, Canada and some U.S. states.)
- **Bill checking.** The process that allows customers to check if invoice sent by energy suppliers or their representatives is correct.
- **Energy efficiency and cost savings, energy usage analysis.** The process that allows a facility manager to assign energy consumption/costs to zones (e.g., plants, floors and workshops) and to specific usages (e.g., HVAC, lighting, appliances and processes)

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Contents

Guide to Measuring Applications on the Supply and Demand Side (cont.)

over time, in order to optimize energy consumption and energy costs.

- **Network monitoring, power availability and reliability, facility planning.** The process that allows a facility manager to monitor its electrical installation in order to ensure availability and reliability of energy as well as asset durability.

All these applications are covered by various standards, as specified in the following table.

Meeting today's needs

Fortunately, the growing need for meters to address all these applications (except billing applications) can now be met with a new generation of PMDs (power metering and monitoring devices) coming to market. Schneider Electric is leading the industry with its PowerLogic PM8000 Series, with models designed for key metering points throughout a facility's energy infrastructure. We invite you to learn more about this versatile line-up on our website.

Regulations and/or product standards					
Applications	**Device**	**Europe**	**USA**	**Australia**	**Other countries**
Billing	Revenue meter, utility meter, electricity meter, billing meter (for legal metrology applications)	MID EN 50470	Local regulations ANSI C12.20	Local regulations NMI M6	Local regulations Standards
Sub-billing (tenant metering)	Legal tenant meter or legal sub-meter (for legal metrology applications)	If applicable: MID EN 50470	If applicable: ANSI C12.20	If applicable: NMI M6	If applicable: Local regulations & standards
	Tenant meter or sub-meter	IEC 61557-12 (C-PMD1, i.e. with active energy independently certified, covered by manufacturing audits, meeting measurement durability requirements and providing an indication of manufacturing date for periodic verification)			
Bill checking	Power meter	IEC 61557-12 (C-PMD1, i.e. with active energy independently certified, covered by manufacturing audits, meeting measurement durability requirements and providing an indication of manufacturing date for periodic verifications)			
Cost allocation		IEC 61557-12 (PMD1)			
Energy efficiency	Power meter	IEC 61557-12 (PMD1, PMD2, or PMD3)			
Network Monitoring	Analog electrical measuring instruments	IEC 60051			
	Power meter	IEC 61557-12 (PMD2 or PMD3)			
	Class S power meter	IEC 61557-12 (PMD3) embedding IEC 61000-4-30 class S functions (tested according to IEC 62586-2)			
Grid power quality monitoring	Power quality instrument	Relevant product embedding IEC 61000-4-30 class A functions (tested according to IEC 62586-2)			

NOTE – Some devices are providing qualitative data, resulting from reduced acquisition performance or from simplified calculation algorithms. These approximate values are used for indication (e.g. current flowing or not), comparison (e.g. significant variation in consumption of an equipment between two time-periods) or estimation (e.g. low level of Power Factor) and cannot be compared to measurements provided by the above devices.

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Contents

Monitoring Building's Energy Use – EE Standards & Regulation to Optimize Energy Performance

From the European Union to Japan, India and some U.S. states, regulations are going into place that are intended to reduce building-related emissions of carbon dioxide and other greenhouse gases.

Understanding a building's energy use is more than just good business sense – under a number of jurisdictions around the globe, it's becoming the law. From the European Union to Japan, India and some U.S. states, regulations are going into place that are intended to reduce building-related emissions of carbon dioxide and other greenhouse gases. These new rules require building owners to become more aware of the energy performance of their buildings' heating, cooling, lighting and other systems. As I describe in this article, these rules are driving growing demand for power metering and monitoring devices (PMDs) complying with the International Electrotechnical Commission's Standard IEC 61557-12, as specifiers seek solutions for meeting these rules.

European Union requirements

Two directives developed by the European Union (EU) are among the farthest reaching, internationally. The European Union's 2006 Energy Performance of Buildings Directive (EPBD) and 2012 Energy Efficiency Directive (EED), are now the law across most of Europe and the United Kingdom. The latter is especially comprehensive, with a set of binding measures to ensure EU member states use energy more efficiently throughout the value chain, from production to final consumption. Metering equipment can monitor consumption and help facilities establish both baselines and targets under continuous-improvement projects.

Both directives can be mapped to standards that address methodologies for conducting audits, and installing monitoring and measuring systems. Under the EED, for example, companies must either perform facility-wide energy audits on a regular basis or set up an energy-management plan, as shown in Figure 1. Organizations maintaining such an energy-management system are exempt from annual audit requirements because, in essence, such benchmarking is built into their regular business processes.

Other regions have their own requirements. These include the U.S. state of California, where the California Energy Commission's recently enacted revisions to its Title 24 energy-efficiency standard – now require building owners to separately meter lighting, air conditioning and other building

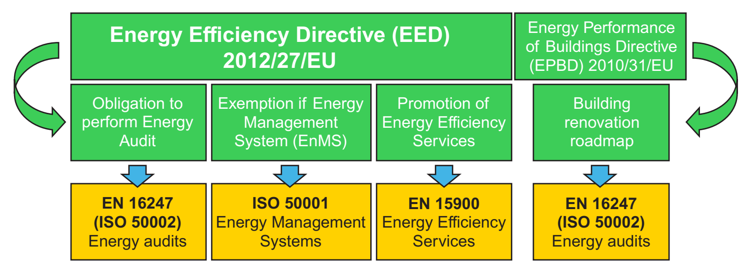

Figure 1 – EPBD and EED directives

Contents

Monitoring Building's Energy Use – EE Standards & Regulation to Optimize Energy Performance (cont.)

energy demands. PMDs complying with IEC 61557-12 can help meet this requirement.

Guiding standards for a number of other regions are outlined in Table 1.

Green Building Certification	Influence
LEED EB O&M	USA
Title 24	USA, California
BREEAM-In-Use	UK
NF HQE Exploitation	France
CASBEE	Japan
DNGB for Existing Building	Germany
IGTC, GRIHA	India

Table 1 – Green Building certification

ISO 50001 (and its related set of standards as stated in Table 2) remains one of the most used standards to improve Energy Efficiency of plants.

New rules require building owners to become more aware of the energy performance of their buildings' heating, cooling, lighting and other systems.

Application Assessment Standards or Rules	Methods Standards	Product Standards
ISO 50001 Energy Management Systems - Requirements with guidance for use	**ISO 50006** Energy Baseline (EnBs) & Energy Performance Indicators (EnPIs) **IEC 60364-8-1** Low voltage installations - Part 8-1:Energy Efficiency **FD X30-147** Measurement plan for energy performance monitoring	**Power Meters** **IEC 61557-12** Power metering & monitoring devices (PMD) **Gateways, energy servers, data loggers** **IEC 62974-1** Monitoring and measuring used for data collection, gathering and analysis - Part 1: Device requirements

Table 2 – ISO 50001 related set of standards

New options make metering easier

PMDs offer many advantages beyond power monitoring. They also can provide information on voltage, harmonics frequency – all critical factors in optimizing equipment efficiency and performance – along with remote load management. These functions are all accessible via dedicated touchscreen displays or via web browsers. Plus, in many cases, the panels' integrated communications interfaces are ready to connect to existing energy-management platforms.

To learn more about Schneider Electric Smart Panels, please click here. Also, be sure to register for our Consulting Engineer portal for free access to additional tools, resources and product information.

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Using PMDs (Power Metering & Monitoring Devices) to Measure and Manage Energy Costs

Electricity meters have been critical components in facility electrical design since utility customers began paying for the commodity. However, while traditional meters at service-entrance points provide utilities with the consumption data they need for billing, they aren't very helpful for facility owners and managers, who are more interested in how electricity is used, once it enters the building. Now, power metering and monitoring devices (PMDs) can help meet a range of needs, from monitoring the accuracy of the utility's revenue meter to … This article outlines three valuable applications for PMDs.

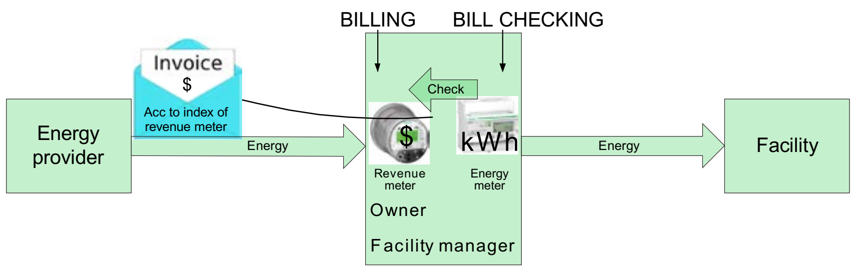

Figure 1 – Use of a PMD for bill checking application

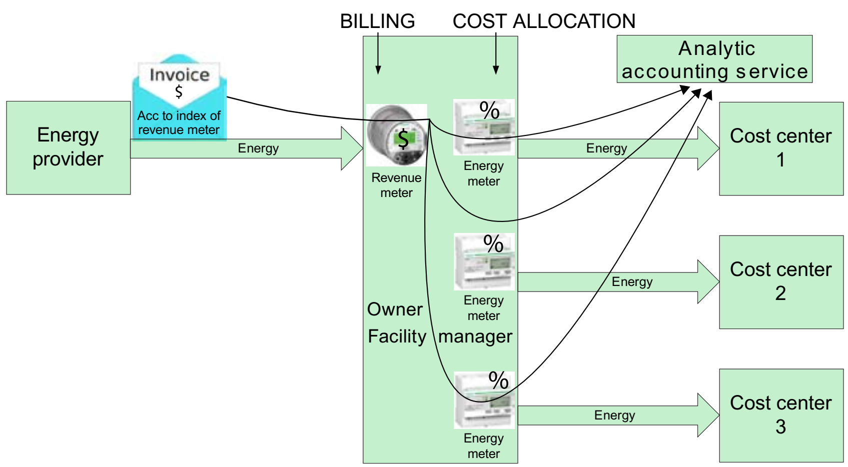

Figure 2 – Use of PMDs for cost allocation application

Bill checking

Electric utility bills often are simply accepted, as is, but that can be a big mistake for facility owners and managers because revenue meters aren't infallible. For example, rate tariffs established years ago might no longer be accurate, thanks to efficiency upgrades installed over time. Additionally, billing intervals might be too long or too short, which can skew demand charges. Even mistakes in the building owner's favor can be expensive in the long run, because supply contracts can allow the utility to recover missed charges months or years after an error occurs. For a commercial building owner, this could mean costs aren't recoverable if tenants have moved out.

Figure 1 illustrates the relationship of a PMD to the utility's revenue meter in a bill-auditing (also called "shadow metering" or "shadow billing") application. As the figure shows, the PMD in this application is installed in parallel with the utility meter to calculate an accurate "shadow bill" that includes all expected energy and demand charges. This bill (invoice) can then be compared to the utility bill to identify any inconsistencies. Note that the data in this use remains facility-wide.

Cost allocation

Owners of multi-building campuses, industrial plants and other facilities with multiple cost

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Using PMDs (Power Metering & Monitoring Devices) to Measure and Manage Energy Costs (cont.)

centers can benefit from access to clear information on each operation's energy use. For example, such verified data can help owners better allocate energy expenses against specific revenues, as well as aid in establishing benchmarks and tracking the impact of efficiency upgrades, over time.

As Figure 2 shows, PMDs in this application are installed for each cost center to be tracked. Software systems compile the data from the PMDs and main revenue meter to determine each cost center's contribution (as a percentage) to the facility's total monthly electricity bill.

Sub-billing (also called tenant metering)

Similar to their use for cost allocation, PMDs in this

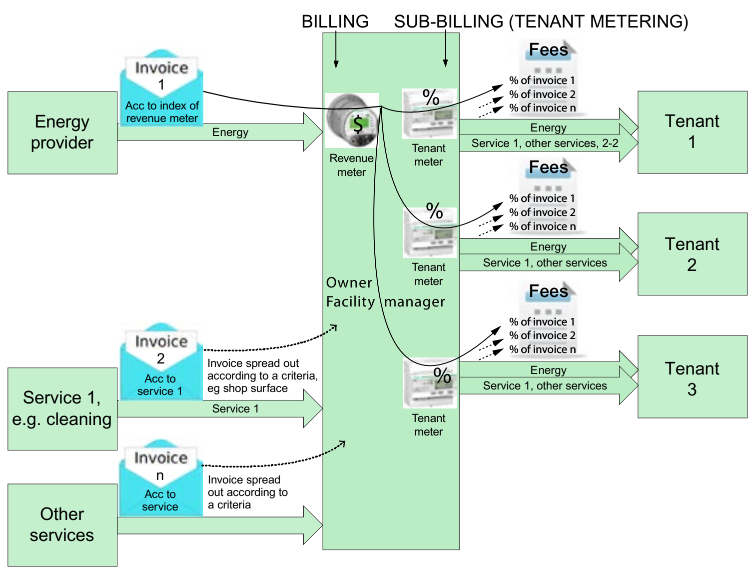

Figure 3 – Use of PMDs for sub-billing application

application can help building owners allocate electricity costs by use – in this case, by the use of individual tenants in a larger commercial office or retail facility. As shown in Figure 3, these costs are usually combined with those for other services in tenants' monthly facility bills. PMDs complying with the International Electrotechnical Commission's Standard 61557-12 can be used for sub-billing purposes, as permitted by local regulations.

Table 1 outlines the regulations and product standards related to these applications.

Compliance to IEC 61557-12 is a minimum requirement for all cost-allocation, bill checking and sub-billing applications. For even greater assurance of durability and measurement accuracy, Schneider Electric recommends specifiers call for devices that have been third-party certified. Manufacturers of such "C-PMD" products undergo regular manufacturing audits to ensure product quality and the devices, themselves, are subject to testing

Application Assessment Standards or Rules	Methods Standards	Product Standards
Bill checking Cost allocation Sub-billing (tenant metering), in general	...	IEC 61557-12 Power metering and monitoring devices (PMD)
Sub-billing (tenant metering), when covered by local or regional regulation	...	Standards related to billing meters upon local or regional regulations. See BIL application.

Table 1

to ensure they can stand up to rigors in the field.

Contents

Monitoring Electrical Distribution Network on the Demand Side – Beyond Just On and Off

To a single end user, measuring the availability of power is an easy exercise: Flip the nearest wall switch and observe whether the lights come on or you remain in the dark. Determining the quality of that power, though, is a more complex endeavor. This process of tracking whether current is being provided at levels connected equipment requires is only becoming more important in today's increasingly sophisticated commercial and industrial facilities. This article will provide an overview of a concept Schneider Electric has termed "demand side power quality," along with a look at the power metering and monitoring devices (PMDs) now available to aid power-management efforts.

The qualifier "demand side" is important to this concept of demand side power quality because it highlights the fact that most current irregularities are caused by problems within a facility, itself (the "demand" side of the electrical distribution system), rather than by the power supplied by the electric utility. These problems can include voltage fluctuations or dips, frequency deviations and current-harmonics disturbances, and their consequences can be significant. Fan motors, lighting-control systems, cabling and other components all can suffer performance setbacks and premature failure if electrical current isn't delivered at consistent and appropriate levels. High-precision manufacturing operations are especially vulnerable to such problems.


Determining the quality of that power is a complex endeavor.

Specifiers now can choose from a range of PMDs complying with International Electrotechnical Commission Standard 61557-12 to help facility personnel monitor current demand side power quality conditions and to develop longer-term tracking and trending programs. Among the characteristics these devices can identify are the following:

- **Power Factor (measured as PF)**. As power factor declines from the ideal ratio of 1.0, energy is wasted, and energy providers may begin assessing penalties. Additionally, such a condition can mean cables that aren't oversized can begin to overheat.
- **Voltage and current harmonics (measured as THDu or THDi)**. Negative sequence harmonics will slow down motor operations, leading to early failure. Zero-sequence harmonics result in wasted energy.
- **Permanent or frequent voltage deviation (U)**. Voltage fluctuations can cause connected equipment to work outside specified ranges, which can lead to early failure (especially with motors).
- **Voltage imbalance (Uimb)**. These conditions can lead to inefficient motor operation and early equipment failure.
- **Dips (Udip) and interruptions (Uint)**. These events can lead to very expensive process interruptions.

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Monitoring Electrical Distribution Network on the Demand Side – Beyond Just On and Off (cont.)

- **Frequency (f)**. Changes in frequency can cause speed changes in rotating machines. In some cases, as with variable frequency motors and drives, this is intentional – but, even in such applications, frequency should be monitored to ensure it varies as anticipated.
- **Flicker (Pst) or RVC**. Flicker can create annoying – and, possibly, dangerous – lighting conditions.

Standards to follow

As demand side power-quality issues have become more important to both equipment efficiency and service life, standards have developed to help specifiers ensure the devices they select to monitor power-system operations function as intended. Table 1 summarizes several of the most important of these standards.

Application Assessment Standards or Rules	Methods Standards	Product Standards
Voltage, current or frequency indication	—	**Analog indicators** IEC 60051 Direct acting indicating analog electrical measuring instruments
Electrical Distribution Monitoring, asset management, facility planning	—	**Power meters** IEC 61557-12 Power metering and monitoring devices (PMD)
Electrical Distribution Monitoring, asset management, facility planning when consistent measurement is requested at plant level (comparison between several devices measuring at different locations)	IEC 61000-4-30, **class S** Testing and measuring techniques – Power quality measurement methods	**Class S Power meters** IEC 61557-12 Power metering and monitoring devices **Combined with** IEC 62586-2 Power quality measurement in power supply systems – Functional tests and uncertainty requirements (Compliance to IEC 62586-2 means compliance to IEC 61000-4-30)

Table 1

Grid Power Quality

Power-quality problems, including such issues as voltage irregularities and harmonic disturbances, can cause problems with a facility's equipment and operations. Standards have been developed to help address this issue by defining the voltage characteristics customers can expect from the electricity supplied by public utilities. Additionally, larger utility customers often have contractual agreements with their utilities that can further specify supplied-power requirements. Power quality instruments (PQIs) are great tools for verifying that these requirements are being met.

The European CENELEC Standard EN 50160, "Voltage Characteristics of Electricity Supplied by Public Distribution Systems," and International Electrotechnical Commission

Standards have been developed to help address power-quality problems by defining the voltage characteristics customers can expect from the electricity supplied by public utilities.

(IEC) technical specification IEC/TS 62749, "Assessment of Power Quality – Characteristics of Electricity Supplied by Public Networks," define allowable tolerance ranges for a number of power characteristics. Compliance to these standards and any related contracts, can be ensured through the use of PQIs installed on both sides of the customer's meter. Figure 1 illustrates such an installation.

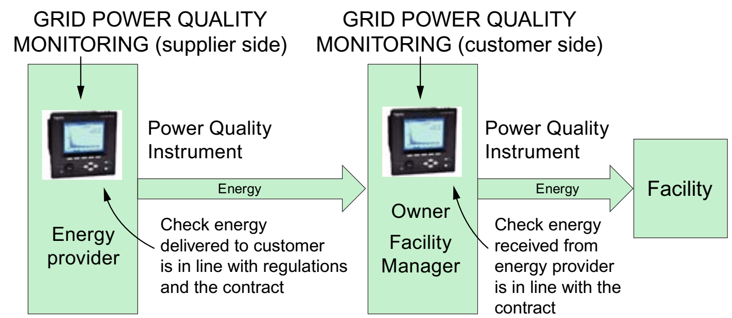

Figure 1 – Use of a PQI on the supply side and the demand side

Verification of compliance can be ensured only with well defined measurement functions, providing matching or comparable results. IEC 61000-4-30 specifies a class A measurement method and a class S measurement method that read:

Class A: *This class is used where precise measurements are necessary, for example, for* ***contractual applications*** *that may require resolving disputes, verifying compliance with standards, etc. Any measurements of a parameter carried out with two different instruments complying with the requirements of Class A, when measuring the same signals, will produce* ***matching results*** *within the specified uncertainty for that parameter.*

Contents

Grid Power Quality (cont.)

Class S: *This class is used for **statistical applications** such as surveys or power quality assessment, possibly with a limited subset of parameters. Although it uses equivalent intervals of measurement as Class A, the Class S processing requirements are much lower. Some surveys may assess power quality parameters of several measurement sites on a network; other surveys assess power quality parameters at a single site over a period of time, or at locations within a building or even within a single large piece of equipment.*

System designers and specifiers also need to be aware of one complementary – and key – standard, IEC 62586-2, "Power Quality Measurement in Power Supply Systems – Part 2: Functional Tests and Uncertainty Requirements." This standard provides testing methods to ensure compliance of measurement functions to IEC 61000-4-30 specifications.

Compliance to international standards and any related contracts, can be ensured through the use of PQIs installed on both sides of the customer's meter.

Additional standards and regulations that apply in grid power quality applications are shown in Table 1.

Application Assessment Standards or Rules	Method Standards	Product Standards
EN 50160 Voltage characteristics of electricity supplied by public electricity networks **IEC/TS 62749** Assessment of Power Quality – Characteristics of electricity supplied by public electricity networks	**IEC 61000-4-30 class A** Testing and measuring techniques – Power quality measurement methods [a]	**Relevant product standard** **Combined with** **IEC 62586-2** Power quality measurement in power supply systems – Functional tests and uncertainty requirements *(Compliance to IEC 62586-2 means compliance to IEC 61000-4-30)*

Table 1-Grid Power Quality Set of Standards

Life Is On Schneider Electric

Contents

The Interest of Legal Metrology for Billing Applications

As anyone, I have to pay for the electricity, the gas or the water I am consuming in my house. As anyone, I would be very angry if I am overcharged and very happy if I am undercharged, and it would be the opposite for my energy provider.

This is why the instruments measuring all this for billing purposes are covered by regulations.

The term *grid-level billing* is related to commercial transactions between utilities, energy providers, or states. The simpler term *billing* is related to a commercial transaction between an energy provider and an energy consumer (customer). Grid level billing and billing are both related to legal metrology.

Legal metrology usually applies to measuring instruments used in:

- Commercial transactions (e.g. weight-price scales for retail stores, petrol pumps, water meters, etc.), when there is a need to protect both the buyer and the seller.
- Operations concerning public health or safety (e.g. gas analyzers, tachographs, radar speed detectors, breathalyzers, etc.).

For more detailed information on legal metrology applications, refer to the following resources:

- OIML website
- LNE website

Billing meters (also known as revenue meters or utility meters) are covered by regulations such as MID (Measuring Instruments Directive, Directive 2014/32/UE) in Europe.

Standards and regulations applicable to billing are shown in Table 1.

Application Assessment Standards or Rules	Methods Standards	Product Standards
Any countries can define its own regulation and/or can refer to international documents, such as the IEC International standards or OIML guide	—	**IEC 62052-xx** **IEC62053-xx**
	OIML MAA [(1)]	**OIML R46** (Organisation Internationale de la Métrologie Légale) [(1)] Participating in the OIML MAA commits the Partici-pants in principle to accepting and using MAA Evaluation Reports issued by Issuing Participants.
European regulation (MID = Measuring Instruments Directive 2014/32/UE	WELMEC guides	**EN 50470-1** **EN 50470-3**
US regulation	—	**ANSI C12.1, ANSI C12.20**
Australian regulation (NMI)	—	**NMI M-6**
Indian regulation	—	**IS 16244, IS 15884, IS 13779, IS 14697**
Chinese regulation	—	**JJG 596**
Canadian regulation	—	**LBM-EG-07**
Russian regulation No.4871-1 issued in 1993 and No.102-FZ issued in 2009	—	**Pattern approval certificate (PAC)**

Table 1 – Documents related to Legal metrology

Contents

European Regulation MID Related to Legal Metrology

As mentioned in my previous article, legal metrology is usually covered by regulations and applies to measuring instruments used in:

- Commercial transactions (e.g. weight-price scales for retail stores, petrol pumps, water meters, electricity meters, etc.), when there is a need to protect both the buyer and the seller.
- Operations concerning public health or safety (e.g. gas analyzers, tachographs, radar speed detectors, breathalyzers, etc.).

The Measuring Instruments Directive (MID) (2014/32/EU, which supersedes directive 2004/22/EC) is related to CE marking issued by the European Union in 2004 and enforced on 30 October 2006. As a directive, this a legal act of the European Union that requires member states to achieve a particular result without dictating the means of achieving that result. Member states have to transpose directives into national regulations, with a certain amount of leeway as to the exact requirements to be adopted.
The MID is intended to harmonize many aspects of legal metrology across all European member states and to lower barriers to trade. It covers a range of measuring instruments, as described in annexes MI-xxx:

- MI-001: Water meters
- MI-002: Gas meters and volume conversion devices
- MI-003: Active electrical energy meters (i.e. this covers measurements of active energy performed by devices called electricity meters, or utility meters, or revenue meters or billing meters)
- MI-004: Heat meters
- MI-005: Measuring systems for the continuous and dynamic measurement of quantities of liquids other than water
- MI-006: Automatic weighing instruments
- MI-007: Taximeters
- MI-008: Material measures
- MI-009: Dimensioning systems
- MI-010: Exhaust gas analyzers

Even beer glasses are included, with a requirement that half-pint level needs to be CE marked as showed below:

MI-001

MI-002

MI-003

MI-008, chapter II

MID essential requirements

European directives intend to provide “technology independent” requirements that are called “essential requirements.” MID essential requirements are described in Annex I of MID, and, in the following summary:

European Regulation MID Related to Legal Metrology (cont.)

Essential requirements specified in Annex I of MID (2014/32/EU)	Meaning of Essential Requirements
1. Allowable errors 2. Reproducibility 3. Repeatability 4. Discrimination and reproducibility	Compliance of metrological characteristics to performance classes, in normal conditions and against environmental conditions (EMC, climatic, mechanical as specified in the directive) is requested. For electricity meters, 3 classes are specified according to EN 50470: class A (similar to class 2), class B (similar to class 1), class C (similar to class 0,5).
5. Durability	Metrological characteristics shall not drift too much during operation. Time before verification is regulated by each member state.
6. Reliability	Mean Time To Failure (MTTF) shall be evaluated.
7. Suitability	Protection of metrological characteristics against fraudulent use or unintentional misuses (anti-tampering, seals ...) shall be available.
9. Information to be born by and to accompany the instrument	Relevant markings, instruction sheets, documentation and technical literature shall be made available.
10. Indication of result	Metrological data shall be displayed to end-customers on an accessible display (to allow them comparison of results provided by the meter to those present on the invoice).
11. Further processing of data to conclude the trading transaction	Metrological data shall be made available to the energy provider for trading transaction (invoicing).
12. Conformity evaluation (assessment according to schemes)	Third party body shall assess the conformity of the device according to routes specified an annex II of MID (e.g. B+F or B+D or H1 for electricity meters).

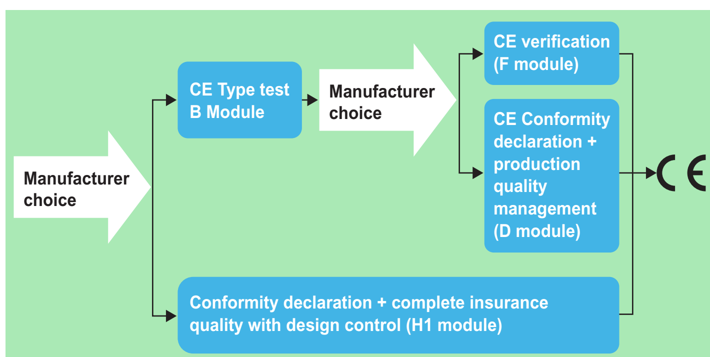

Figure 2: MID conformity assessment routes for electricity meters

MID conformity assessment routes

The MID covers both meter design and its manufacturing, allowing several routes as specified in Annex II. For electricity meters module B + F, or module B + D, or module H1 are allowed as described in Figure 2.

A usual route is to go through module B (meter type testing during design phase) and module D (meter manufacturing audit).

Contents

Contents

European Regulation MID Related to Legal Metrology (cont.)

MID notified bodies

MID requests the conformity assessment to be performed by a test lab or an organization recognized by European authorities as a "Notified Body". When notified, this organization is indicated by a 4 digit number.

MID marking

MID also requests the MID meter to be marked as specified below:

Specific MID requirements for electricity meters (utility meters, revenue meters, billing meters)

Devices need to comply with MID essential requirements, but in practice MID is used in conjunction with a harmonized standard or with OIML R46 standard.
EN 50470-3 is harmonized for MID for static meters, while EN 50470-2 is harmonized for MID electromechanical meters. Both have to be used in conjunction with EN 50470-1.

Specific member-state requirements for electricity meters (utility meters, revenue meters, billing meters)

Some EU member states have established requirements that are unique to their respective jurisdictions. For example:

- In Holland, MID covers only "direct connected" meters (without external sensors) up to 80A.
- In UK, MID covers billing applications and sub-billing applications.
- In France and in Spain, a class D (equivalent to class 0,2 of IEC standards) is specified in addition to class A, B and C.
- Static meters need to be verified every 8 years in Germany, every 10 years in France, and every 10 to 20 years in Belgium.

Additionally, the MID covers only active energy measurement. However, some national approvals might be necessary for reactive energy measurement.

Role of WELMEC

The principal aim of WELMEC is to establish a harmonized and consistent approach to European legal metrology. A lot of WELMEC's work is done by its Working Groups. These groups produce guidance documents which are available on this website.

WELMEC WG11 issued Guide 11.1 related to utility meters.

To learn more about Schneider Electric's range of MID compliant energy meters please visit our website.

Understanding the IEC 61557-12 Standard that Makes Meter Comparisons Easier - Part 1

Digital power metering and monitoring devices (PMDs) are fast replacing analog equipment, providing more accurate measurements and enabling remote data access. But specifying these devices could become problematic without common reference information describing such factors as, say, appropriate operating temperatures and the exact power parameters the device is capable of tracking. The International Electrotechnical Commission (IEC) has addressed this concern with a standard that establishes a common set of reference requirements for electrical measurement.

Understanding what this standard covers and how to read related manufacturer information can make it easier for engineers and other electrical professionals to compare and select the right PMD for any given application. Its full name is a mouthful: IEC 61557-12: "Electrical safety in low voltage distribution systems up to 1000V a.c. and 1500V d.c. – Equipment for testing, measuring, or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)." However, its impact is equally broad – enough to fill two separate articles. In this article, I'll provide an overview of IEC 61557-12's scope and requirements. Next, I'll provide information on related PMD-testing requirements described by the standard.

Influence quantities refers to environmental conditions, such as temperature and other climatic impacts and electromagnetic perturbations that might be encountered in switchboards or electrical cabinets.

Overview

IEC 61557-12 was developed to help specifiers select the right device for any electricity cost-management application. It also helps promote state-of-the-art electrical management on the demand side of the electrical network. To that end, this standard covers energy measurements, as well as measurement of many other critical electrical characteristics. In this way, IEC 61557-12 differs from standards for electricity metering equipment, which focus only on energy measurements.

In its section on PMD functions, IEC 61557-12 lists all possible electrical characteristics the devices might measure, along with related requirements – such as rated ranges of operation or allowable measurement techniques. The listed characteristics include:

- Active energy (with performance classes equivalent to the classes defined in IEC 62053-21 and IEC 62053-22)
- Reactive energy (with performance classes equivalent to the classes defined in IEC 62053-23)
- Apparent energy

Contents

Understanding the IEC 61557-12 Standard that Makes Meter Comparisons Easier - Part 1 (cont.)

- Active, reactive and apparent power
- Frequency
- Root-mean squared (RMS) phase and neutral current
- RMS voltage
- Power factor
- Voltage dip and swell
- Voltage interruption
- Voltage unbalance
- Harmonic voltage and distortion
- Harmonic current and distortion
- Maximum, minimum, peak, average and demand values

As a big bonus for specifiers, IEC-61557-12 establishes three performance classes for registered devices. The classes define how well a PMD operates across four specific parameters for every type of electrical measurement it is marketed to provide, as shown in Figure 1.

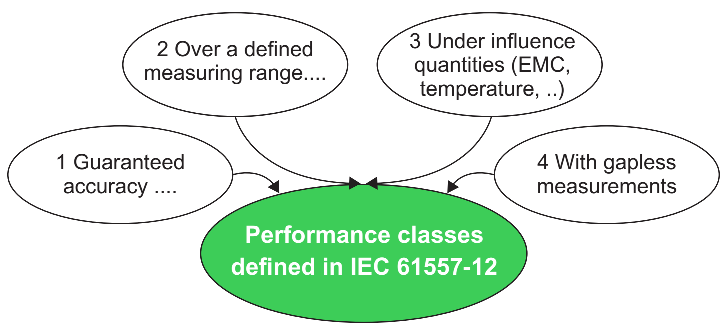

Figure 1

- **Guaranteed accuracy** refers to the limits of uncertainty in the results a PMD provides, over a specified measuring range and under reference conditions. I'll be covering the topic of uncertainty limits in my next article.
- **Defined measuring range** specifies the minimum and maximum values of quantities between which limits of measurement uncertainty are defined. For current, measuring range is specified by manufacturers through:
  - nominal current (In) and maximum current (Imax) for sensor operated PMDs (called PMD/Sx)
  - base current (Ib) and maximum current (Imax) for directly connected PMDs (called PMD/DD)
- **Influence** quantities refers to environmental conditions, such as temperature and other climatic impacts and electromagnetic perturbations that might be encountered in switchboards or electrical cabinets. The standard specifies maximum permitted variations of accuracy due to those influence quantities.
- **Zero-blind (Gapless) measurement** – in other words, continuous (rather than intermittent) monitoring – is required for several capability parameters under the standard, particularly for energy measurements.

Not just for standalone devices

Importantly, IEC 61557-12 applies to PMDs embedded within other equipment as well as standalone devices, which is critical today, when PMD measurement capabilities are increasingly present in protection relays, feeder remote terminal units and a number of circuit breaker offerings. So, when selecting these products, specifiers can refer to the standard to define the required performance class for the embedded measurement function.

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Contents

Understanding the IEC 61557-12 Standard that Makes Meter Comparisons Easier - Part 2

The performance class defined under IEC 61557-12 can give specifiers the information they need to ensure measurement accuracy lives up to expectations.

The International Electrotechnical Commission's (IEC) Standard 61557-12, "Electrical safety in low voltage distribution systems up to 1000V a.c. and 1500V d.c. – Equipment for testing, measuring, or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)," is a benefit for specifiers seeking to compare PMDs on one-to-one basis. The standard defines a number of performance classes, based on the type of energy being measured. In this article, I'll be covering one of those parameters, guaranteed accuracy, in greater depth and helping to decode device markings.

Uncertainty over a measuring range

IEC 61557-12 applies to PMDs with directly embedded sensors (PMD/DD) and those paired with external sensors (PMD/Sx). This is especially important in today's market, in which many electrical devices – including protection relays, remote terminal units and many types of circuit breakers – feature embedded measurement functions. In addition to product standards relating to their primary task (like IEC 60497 for low-voltage switchgear and controlgear), these devices also can reference their performance class under IEC 61557-12. This gives specifiers the information they need to ensure measurement accuracy lives up to expectations.

It's important to note that the performance class for a PMD with an external sensor is calculated differently than that for a product with directly embedded sensors. This is to recognize the impact the external sensor's accuracy will have on the combined system's performance. As Figure 1, below, illustrates, the final performance class under IEC 61557-12 reflects the sensor's accuracy class (as defined under IEC 61869-2) combined with the IEC 61557-12 performance class of the PMD, itself.

IEC 61557-12 also provides a way to calculate the overall system uncertainty of PMD systems that incorporate

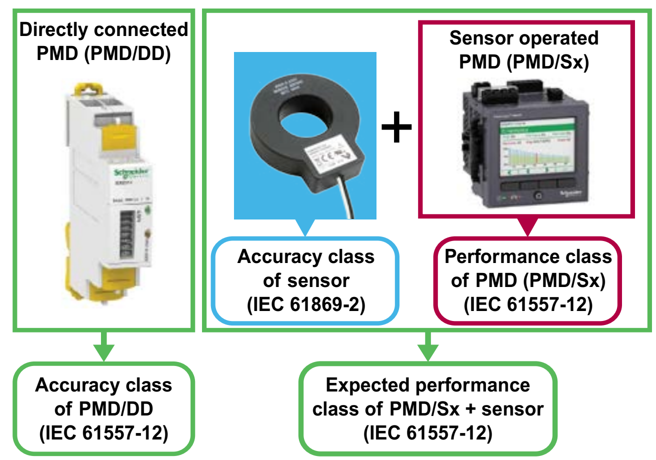


Figure 1. Uncertainties for "sensor operated PMD/Sx" (working with external sensors) and for "directly connected PMD/DD" (working with embedded sensors)

Contents

Understanding the IEC 61557-12 Standard that Makes Meter Comparisons Easier - Part 2 (cont.)

external sensors. The standard's Table 4 provides useful information related to accuracy between meters embedding sensors and meters requiring external sensors.

Performance class of the PMD without external sensors	Recommended sensor class to associate to the PMD [bc]	Expected performance class for PMD-Sx or PMD-xS including their external sensors	Maximum possible sensor class to associate to the PMD [a]
0,1	0,1 or below	0,2	0,2
0,2	0,2 or below	0,5	0,5
0,5	0,5 or below	1	1
1	1 or below	2	2
2	2 or below	5	5
5	5 or below	10	

Table 4

So, as an example, it can be said that a class 1 "directly connected PMD" is expected to be at least equivalent to a class 0,5 "sensor-operated PMD" installed with a class 0,5 sensor.

The related measuring ranges by PMD performance class are described in the following Table 5 and Figure 8.

Measurement ranges of PMDs for Active Energy measurement			
for PMD/Sx (specified with In)		for PMD/DD (specified with Ib)	
Class 1	Up to Imax, down to 2% In, with a starting current of 0,2% In	Class 2[a]	Up to Imax, down to 5% Ib, with a starting current of 0,5% Ib
Class 0,5	Up to Imax, down to 1% In, with a starting current of 0,1% In	Class 1[b]	Up to Imax, down to 5% Ib, with a starting current of 0,4% Ib
Class 0,2	Up to Imax, down to 1% In, with a starting current of 0,1% In	Class 0,5[c]	Up to Imax, down to 2% Ib, with a starting current of 0,2% Ib

[a]Expected to be equivalent to a class 1 PMD/Sx associated with a class 1 sensor
[b]Expected to be equivalent to a class 0,5 PMD/Sx associated with a class 0,5 sensor
[c]Expected to be equivalent to a class 0,2 PMD/Sx associated with a class 0,2 sensor

Table 5

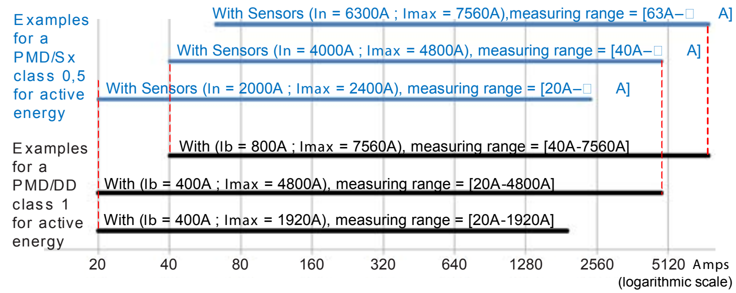
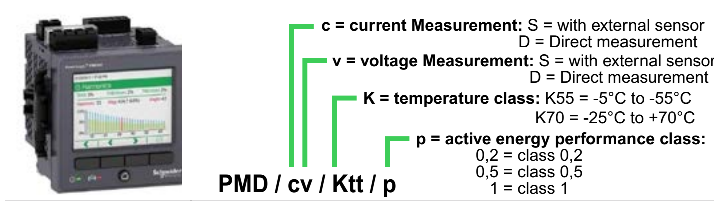


Figure 8

Understanding product markings

The standard also defines a standard marking scheme for easier comparison and specification when evaluating multiple manufacturers' products. This code describes installation options, operating-temperature ranges and accuracy class. You can see this code applied to Schneider Electric's PowerLogic PM8000 Power Meter, below. You can find information for ordering a copy of IEC



Device coding	Meaning
PMD/DD/K70/1	PowerMeter with embedded sensors, working from -25°C to +70°C, with Active Energy measurement class 1
PMD/SD/K55/0,5 (x5A CT) PMD/SD/K55/1 (x1A CT)	PowerMeter working from -5°C to -55°C, with Active Energy measurement class 0.5 when associated with 5A sensors, and class 1 when associated with 1A sensors

61557-12 on the IEC website. For more information about standards and access to additional tools, resources and product information you can register for our dedicated Consulting Engineer portal site.

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Contents

Additional Resources

Theme	Type	Link
IEC 61557-12	White paper	Guide to using IEC 61557-12 standard to simplify the setup of an energy measurement plan
Measurement applications	White paper	Guide to energy measurement applications and standards
ISO 50001	White paper	Recommendations for ISO 50001 compliance
	White paper	Supplement Document to ISO50001 White Paper: Recommendations for Compliance
IEC 60364-8-1	Post	IEC 60364-8-1 – A Systematic Guideline to Continual Assessment of Building Energy Efficiency
	Post	IEC 60364-8-1: Setting a New Standard for Efficient Buildings
EN 15232	Post	CO_2 Reduction and Energy Performance – Setting the Standard for Building Automation with EN 15232
Demand side Power Quality	White paper	A Framework for Implementing Continuous, Iterative Power Quality Management
	White paper	Using Color Codes to Simplify Power Quality Analysis
	White paper	The Impact of Power Management on Building Performance and Energy Costs
Power meters selection guide	White Paper	Power Meter Selection Guide for Large Buildings

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