

ACE6000

User Guide



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1. About this guide

1.1. Preliminary notice

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1.2. Audience

This guide is intended for use primarily by meter installers, utility testers and specifying engineers.

1.3. Scope

This guide provides all information required to:

- understand the principles of operation of the meter
- assess the suitability of the meter for any particular application
- install the meter safely and correctly
- test meter functionality and configuration
- use and interpret the meter displays

This guide is intended for meter firmware version: 2.65 - March 2011

2. Abbreviations

AC	Alternating current	М	Mega (10 ⁶)
ANSI	American national standards institute	Мах	Maximum
CE	European conformity (logo)	MDI	Maximum demand indicator
Cosem	Companion specification for energy metering	MID	Measurement instruments directive (European Union)
СТ	Current transformer	Min	Minimum
DC	Direct current	mm	Millimetres
DLMS	Device language message specification	Nom	Nominal
DST	Daylight savings time	NVM	Non-volatile memory
EOB	End of billing	OBIS	Object identification system
EOI	End of integration	PF	Power factor
EMC	Electro-magnetic compatibility	PSTN	Packet switching telephone network
G	Giga (10 ⁹)	PSU	Power supply unit
GSM	Global system for mobile communications	RF	Radio frequency
GPRS	General packet radio service	RH	Relative humidity
ннт	Hand-held terminal	RMS	Root mean square
HF	High frequency	RTC	Real-time clock
Hz	Hertz	RWP	Read without power
I	Current	SAP	Service access point (Cosem)
i.a.w	In accordance with	SCADA	Supervisory control and data acquisition
lb	Base current	secs	Seconds
I/O	Inputs and outputs	Т	Tera (10 ¹²)
IR	Infrared	TER	Total energy register
IEC	International electrotechnical commission	THD	Total harmonic distortion
k	Kilo (10 ³)	TOU	Time of use
LAN	Local area network	V	Volt
LCD	Liquid crystal display	VT	Voltage transformer
LED	Light emitting diode	WEEE	Waste electrical and electronic equipment directive (European Union)
LP	Load profile	W	Watt

3. Certification

3.1. Applicable standards

The ACE6000 meters comply, where applicable, with the following standards and regulations.

- IEC 62052-11 Electricity metering equipment (AC) General requirements, tests and test conditions, part 11: Metering equipment (equivalent to EN 6205-11)
- IEC 62053-21 Electricity metering equipment (AC) Particular requirements, part 21: Static meters for active energy (classes 1 and 2), (equivalent to EN 62053-21)
- IEC 62053-22 Electricity metering equipment (AC) Particular requirements, part 22: Static meters for active energy (classes 0,2 S and 0,5 S)
- IEC 62053-23 Electricity metering equipment (AC) Particular requirements, part 23: Static meters for reactive energy (classes 2 and 3)
- IEC 62053-31 Electricity metering equipment (AC) Particular requirements, part 31: Pulse output devices for electro-mechanical and electronic meters (equivalent to EN 62053-31)
- IEC 62053-52 Electricity metering equipment (AC) Particular requirements, part 52: Symbols
- IEC 62053-61 Electricity metering equipment (AC) Particular requirements, part 61: Power Consumption and Voltage Requirements
- IEC 62054-21 Electricity metering equipment (AC) Tariff Load control, part 21: Particular requirements for time switches (equivalent to EN62054-21)
- IEC 62056-21 Electricity Metering Data exchange for meter reading, tariff and load control Direct local data exchange (supersedes IEC61107)
- **IEC 62056-42** Electricity Metering Data exchange for meter reading, tariff and load control, part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange
- IEC 62056-46 Electricity Metering Data exchange for meter reading, tariff and load control, part 46: Data link layer using HDLC protocol
- IEC 62056-47 Electricity Metering Data exchange for meter reading, tariff and load control, part 47: COSEM transport layers for IPv4 networks
- IEC 62056-53 Electricity Metering Data exchange for meter reading, tariff and load control, part 53: COSEM Application layer
- IEC 62056-61 Electricity Metering Data exchange for meter reading, tariff and load control, part 61: Object identification system (OBIS)
- IEC 62056-62 Electricity Metering Data exchange for meter reading, tariff and load control, part 62: Interface classes
- European Directive 2004/22/EC for Measurement Instrument Directive (MID)

The HF resistance is relative to the frequency domain from 2kHz to 150kHz. See Addendum A to this document.

The following outline the approval standards in the regulated frequency ranges which all Itron MID approved meters comply with:

- EN61000-3-2 Defines the harmonic range 100Hz 2kHz
- EN61000-4-6 Defines resistance against conducted perturbations induced by radio-electrical fields > 150kHz
- EN55022/CISPR22 Defines (ClassB) radio-electrical conducted emissions in the range > 150kHz

EMC Directive 2004/109/EC as amended by 92/31/EEC and 93/68/EEC. Compliance has been • demonstrated by compliance with EN62052-11 and EN62053-21.

3.2. CE Certificate of conformity

Déclaration «CE» de conformité CE Declaration of conformity

Nous, We,

ITRON ZI de Chasseneuil, avenue des temps modernes 86361 Chasseneuil du Poitou - FRANCE

Entreprise certifiée ISO 9001 par l'AFAQ ISO 9001 certified by AFAQ

Déclarons que l'(les)appareil(s) : ACE 6000 type ACE661D / ACE661B / ACE662D / ACE662B

- 3-phases 4-fils et 3-phases 3-fils
- 3x57,7/100V.....3X240/415V
- compteur statique d'énergie électrique à branchement direct: 5(100)A (ACE661D/ACE662D) .
- compteur statique d'énergie électrique à branchement indirect: 1(10)A (ACE661B ;ACE662B)
- 50/60 Hz

Declare that the product(s) : ACE 6000 type ACE661D / ACE661B / ACE662D / ACE662B

- 3-phases 4-wires system and 3-phases 3-wires system
- 3x57,7/100V.....3X240/415V
- Electricity Static meter : Direct connected meter : 5(100)A (ACE661D/ACE662D) •
- Electricity Static meter : Indirect connected meter : 1(10)A (ACE661B/ACE662B) •
- 50/60 Hz

Sous réserve qu'il soit installé, maintenu et utilisé pour l'usage auquel il est destiné, dans le respect des règles de l'art de la profession et conformément aux instructions du fabricant, satisfait aux dispositions de la directive du Conseil : Provide that it is installed, maintained and used in the application for which it is made, with respect of the « profession's practices », relevant installation standards and manufacturer's instructions, complies with the provisions of Council Directive(s)

- 89/336/CEE, 92/31/CEE, 93/68/CEE
- 2004/22/CE

et est conforme aux normes ou autre(s) documents normatifs suivants :

and is in conformity with the following harmonised standard(s) or other normative documents :

- EN 62052-11 Electricity metering equipment (AC) : General requirements
 EN 62053-21 Electricity metering equipment (AC) : Particular requirements
- EN 62053-23 Electricity metering equipment (AC) : Particular requirements-Reactive energy class 2
- INF EN 50470-1 Electricity metering equipment (AC) : Part 1 General requirements
- Image: NF EN 50470-3 Electricity metering equipment (AC) : Part 3 Particular requirements

NMI test report : CVN-609218-02 and CVN-703237-01 and CVN-708275-01 (Itron reference: D2006454)

Information complémentaire :

Additional information:

Le dossier technique est consultable en nos locaux de Chasseneuil. The technical file is available for consultation in Chasseneuil.

Date d'apposition du marquage CE : Date of affixing « CE » marking:

15 Juin 2009 15th June 2009

Signature : J.TALBOT QSE Manager

Title: CE declaration of conformity for ACE6000 INTL and ST4					
Type of doc : Product_Qualification_Report Filename : Declaration CE de conformité ACE66xx.DOC	Project: Released		Rev. date : 30/08/2010		
Owner : DABADIE Eric	Itrón	Page: 1/1	D2007627-AE		

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3.3. End-of-life disposal

ACE6000 meters comply with the requirements of WEEE regulations for recycling or reuse of materials.

At the end of their service life, meters should be uninstalled and then passed to a licenced/certified contractor for disposal in accordance with these regulations and with all applicable local regulations.

Before passing the meters to the contractor the legal certification stamps or marks must be removed or defaced.

4. General information

4.1. Meter overview



The ACE6000 is a static, polyphase, four-quadrant, multi-rate meter. It is intended for large commercial to industrial applications.

Depending on the factory configuration, the meter provides the following **minimum** features and functions:

Multi-energy registering	Active, Reactive and Apparent energy (import and export)			
	Units - Watt (W), Kilowatt (kW) and Megawatt (MW)			
	Maximum 32 individual energy rate registers for 10 energy channels (incremental or cumulative)			
	 Up to 3 excess energy channels (included in the maximum number of energy channels) 			
	Up to 8 energy rates per channel			
Multi-rate billing and switching	Billing for both energy and demand			
	Energy rate switching performed by internal clock/calendar			
	Up to 12 seasons			
	Up to 24 day profiles			
	Up to 16 switching times per day profile			
	Up to 100 special days (repetitive or non-repetitive)			
Demand registering	Maximum 24 individual demand rate registers for 10 demand channels			
	• Up to 8 energy rates per channel (3 peak values associated with each rate)			
	 Up to 10 rates can be configured for excess demand (3 excess demand control mode) 			
	1 specific demand channel for cumulative excess demand			
	1 power factor channel			
	1 power factor register			
Load profiling	 2 independent sets of 8 recording channels giving up to 16 load profile channels available to record every 1 minute up to every 60 minutes the following data: Energy type quantity (per phase or aggregate) 			

	Excess energy		
	Power factor aggregate quantity		
	RMS voltage and current per phase quantity		
	• Frequency		
	Ambient temperature		
	Alarm status		
	Power factor per phase		
	Incremental data		
Communication	RS232 or RS485		
	DLMS-Cosem compliant		
	PSTN, LAN (TCP/IP), GSM and GPRS media supported		
Network quality monitoring	Voltage cuts, sags and swells		

The diagram below shows the main functional elements of the meter:



- Liquid crystal display (LCD)
- Battery holder
- 3 Control output terminal block
- 4 Main wiring terminal block
- 5 Reactive power metrology LED (kvarh)
- 6 Active power metrology LED (kWh)
- 7 Display pushbutton
- 8 Reset pushbutton
- 9 Hinged front cover latch
- 10 Infrared communication port
- **11** Serial communication port
- 12 Terminal cover switch
- 13 Read without power (RWP) battery holder (optional)

4.2. General specifications

Frequency	50/60 Hz	
Connection wiring	3 or 4 wire	
Connection configuration	Direct or Transformer	
Terminal wiring	VDE (asymmetrical)	
Real Time Clock backup	Field-replaceable battery and	
	Internal super-capacitor	

Enclosure type	Panel mounting DIN compliant	
Environmental protection	IP 54	
Operating temperature	Range -40°C to +70°C	
Relative Humidity	< 75% (maximum 95%)	
Net weight	1.1kg	
Maximum meter dimensions (W x H	1 x D)	
Meter body	152 x 238 x 68mm	
With short terminal cover	241 x 173 x 74mm	
With long terminal cover	301 x 173 x 78mm	

Direct connection specifications

Voltage	3 x 57.7/100V up to 3 x 277/480V auto ranging		
Current	Nominal (Ib) 5A		
	Maximum (Imax)	100A	
Accuracy Active energy		Class 1	
	Reactive energy	Class 2	

Transformer connection specifications

Voltage	3 x 57.7/100V up to 3 x 277/480V auto ranging			
Current	Nominal (Ib) 1A to 5A			
	Maximum (Imax) 10A			
Accuracy	Active energy	Class 1 / Class 0.5		
	Reactive energy	Class 2		

4.3. Meter support tools

The ACE6000 meters have an extensive range of optional facilities and settings, enabling them to be configured to suit individual requirements. In general, a meter is fully configured and programmed for its intended application prior to despatch from the factory.

However, some aspects of the configuration may be changed at any time using dedicated Windows [™]-based support tools that typically communicate via the optical port on the front of the meter.

Support tool applications provide the following main features:

- metering point management
- configuration creation and editing
- configuration programming and reading
- meter data reading
- meter firmware upgrading

The following support tools are currently available:

AIMS Pro

AIMS Pro is compliant with the following Microsoft Windows™ operating systems:

- Windows 98
- NT and XP
- 2000 and 2003

ACE Pilot

ACE Pilot is compliant with the following Microsoft Windows™ operating systems:

- XP (SP2+)
- 2003 and 2008
- Vista and Seven

4.4. Configuration options

4.4.1. Meter identification

Meter options are specified by a multi-character product code, in which each option is designated by one or more characters. The meter cover is laser-marked with this legally required identification code.

4.4.2. Meter product coding

Legal product code

The example below illustrates the options and the positions of the associated characters in the product code.



The following tables provide full details of the individual options:

Product version

Code	Option
1	International

Connection and Class

Code	Option
В	CT Class 0.5
С	CT Class 1
D	DC Class 1 100A

I/O Configuration

Code	Option	
00	No I/O + RS232	
01	No I/O + RS485	
	With daisy-chaining capability	

04	4 x Control outputs + RS232
05	4 x Control outputs + RS485
	With daisy-chaining capability

Voltage connection

Code	Option	Comments
4A	3 x 220/380V to 3 x 240/415V	3 or 4 Wire
4B	3 x 57.7/100V to 3 x 63.5/110V	3 or 4 Wire
4C	3 x 57.7/100V to 3 x 240/415V	3 or 4 Wire

Reading without power (RWP)

Code	Option
0	No RWP fitted
1	RWP fitted

Magnet features

Code	Magnetic protection	Magnetic detection
AB	No shield	Sensor fitted
BB	Shield fitted	Sensor fitted

4.5. Meter markings

The meter cover is laser-marked with at least the information illustrated below, in accordance with IEC 62053-52. Additional markings may be present, and the layout of the markings will vary, according to the meter configuration and specific customer requirements.



Item	Marking
1	Appropriate certifications identifying accuracy class
2	Meter legal product code
3	Nominal voltage and frequency
4	Nominal and maximum current
5	Metrology constant
6	Manufacturers unique serial number
7	Place and date of manufacture
8	Meter type
9	Connection diagram showing typical main supply connections for the meter configuration
10	Appropriate symbols (IEC 62053-52) identifying insulation class, measuring elements, and other relevant characteristics
11	Manufacturer name
12	Meter serial number - barcode and numerical format
	This number may be the same as the manufacturers serial number (6) or be a customer-specified identification number

4.5.1. Terminal numbering

Terminal numbers corresponding to the connection diagram are moulded into the meter case, below the terminal block.



Auxiliary terminal labels are laser-printed onto the case, adjacent to the terminals. Any terminal numbering will be in accordance with the relevant DIN standard at the time of manufacture unless alternative custom numbering is requested.



5. Technical specification

General

Parameter	Description	Data
Meter Type	ACE6000	
Connection wiring	3 or 4 wires	
Connection configuration	Direct or Transformer	
Terminal wiring	VDE (asymmetrical)	
Metrology	Four quadrant	Active and Reactive
		(import and export)
Metrology sensors	Mutual Conductance Transformers	
Registering modes	4 selectable algorithms	Ferraris
		Static
		Net result
		Anti-fraud
Direct connection accuracy	i.a.w. IEC62053-21	Class 1
Transformer connection accuracy	i.a.w. IEC62053-21, 22	Class 1 / Class 0.5

Voltage

Parameter	Details
Reference voltage	3 x 57.7/100V up to 3 x 277/480V auto ranging
Operating voltage	-20% to + 15% Un
Peak voltage	3 x 277/480V + 15% auto ranging or
Ph to Ph and Ph to N	3 x 500/866V for 10secs mono range
Voltage Interruptions	1 second

Direct connection current

Parameter	Details
Nominal current (lb)	5A
Maximum current (Imax)	100A

Transformer connection current

Parameter	Details
Nominal current (lb)	1A to 5A
Maximum current (Imax)	10A

Direct connection starting current and short-time over current
--

Parameter	Details
Starting current	lb/250
Maximum load capacity (over half- cycle)	30Imax

Transformer connection starting current and short-time over current

Parameter	Details
Class 1	lb/500
Class 0.5 / Class 0.2	lb/1000
Maximum load capacity 0.5 secs	20Imax

Voltage Circuit Power Consumption

Parameter	Details
Voltage per phase	<2W
Apparent power per phase at Un	<10VA

Current Circuit Power Consumption

Parameter	Details
Burden (per phase) at Ib	<1VA

Display

Parameter	Description	Data
Туре	Liquid Crystal Display (LCD)	
Digit height	Main	8mm
Digit height	OBIS code	6mm
Resolution	Number of digits	8

Communications

Parameter	Description	Data
Optical communications	i.a.w IEC62056-21	Read out only
	i.a.w IEC62056-47,53,61 & 62	Read/Write
	Mode of operation	Read out mode C
Meter Constant	Direct connection type	1000 pulses per kWh
	Transformer connection type	10000 pulses per kWh
Serial Data Communications	RS232 or RS485	1 x RJ45 connector fitted for RS232
		2 x RJ45 connectors fitted for RS485 (daisy-chaining)
	Baud rate	9600 up to 19200
Supported protocols	DLMS/Cosem	IEC62056-47,53,61 & 62
Communication media types	TCP	With external LAN modem

Parameter	Description	Data
	GPRS in tunnelling mode	With external modem
	GSM	With external modem
Real-time operation	i.a.w. IEC62056-21	Y
Modem power supply	approx 10V, 100mA, 0.9W max	on RJ45 connectors

Output

Parameter	Description	Data
Control output	Optically-isolated, high-level	4 outputs + common connection point
	Maximum switching voltage	288V DC
		320V AC
	Maximum switching current	100mA

Environmental

Parameter	Description	Data
Temperature Range	Operating range	-40°C to +70°C
	Storage and transport	-40°C to +85°C
Humidity range	Maximum operating value	95%
Protection class	According to IEC 60529	IP 54
Isolation Protection	AC voltage at 50Hz for 1 minute	4kV Class 2
Immunity to impulse voltage	According to IEC 62052-11	10kV
	Waveform of pulse voltage 1.2/50µsecs	
	Source impedance 500ohms, energy 0.5 joules	
Immunity to magnetic fields	Magnetic AC (50Hz) field 0.5mT according to IEC62053 - 21 (400AT coil)	Fully immune
	Magnetic AC field according to IEC61000-4-8 (1000AT)	Fully immune
	Magnetic DC field according to IEC 62053-21 (electromagnet with 1000AT)	Fully immune
	Magnetic DC field according to VDEW (perm magnet) field strength 200mT	Fully immune
Surge immunity	According to IEC61000-4-5	5kV
main circuits	Waveform of pulse voltage 1.2/50µsecs	
	Source impedance 2 ohms	
Surge immunity	According to IEC61000-4-5	1kV
	Waveform of pulse voltage	

Parameter	Description	Data
auxiliary circuits	1.2/50µsecs	
	Source impedance 42 ohms	
Electrostatic discharge	Electrostatic discharge according to IEC61000-4-2	
	Contact discharge	8kV, 10 cycles
	Air discharge	15kV, 10 cycles
Immunity to RF fields	RF fields i.a.w. IEC61000-4-3	
	With current	10V/m
	80MHz to 2GHz	
	Without current,	30V/m
	80MHz to 2GHz	
Fast transient burst	Fast transient burst i.a.w. IEC	4kV
main circuits	61000-4-4	common-mode and pseudo differential
Fast transient burst	Fast transient burst i.a.w. IEC 61000-4-4	2kV
auxiliary circuits		common-mode
Radio Interference	RF suppression	CISPR22 Class B

Weight and Dimensions

Parameter	Description	Data
Weight		1.1kg nominal
Dimensions	Without terminal cover	152 x 238 x 68mm
(width x height x depth)		
	With short terminal cover	241 x 173 x 74mm
	With long terminal cover	301 x 173 x 78mm

6. Technical description

The main components of the ACE6000 meter are assembled onto two printed circuit boards (PCBs):

- the PSU board contains all the metrology voltage divider circuitry and the switched-mode power supply
- the top I/O board contains all the other meter circuitry including the I/O and communication ports, microcontroller, memory devices and LCD display

The block diagram below shows the main functional elements of the meter:



6.1. Metrology

The meter current sensors are integral Mutual Conductance Transformers, which provide a wide dynamic range and guarantee high stability over the operating temperature range of the meter.

The three current sensors generate a signal per phase that is proportional to the instantaneous current, while voltage signals are derived by dividing the distribution-network line voltages through a resistive divider.

The current and voltage input signals are sampled and digitised 40 times per cycle (50Hz) by an analogue to digital (A-to-D) converter, then processed by a microcontroller to derive various energy values. The microcontroller records these values in a suite of registers that are independent of any meter configuration and are always available.

These registers accumulate their respective energy values in an incremental fashion, until they reach the register limit. At that point they are automatically reset to zero in the same way as roll-over electromechanical meter types.

The contents of these registers can be displayed at any time as instantaneous values on the meter LCD.

The microcontroller also controls the data transfer to the various inputs and outputs, visible metrological LEDs and infrared port.

High frequency resistance

A low-pass filter with a cutting frequency at 2kHz is introduced on the I and V measurement channels.

These filters make the metrology resistant against High Frequency (HF) currents superimposed on 50Hz nominal currents and added harmonic currents and also resistant against HF voltage superimposed on 50Hz nominal voltages and added harmonic voltages.

This HF resistance is relative to the frequency domain from 2kHz to 150kHz. See Addendum A to this document.

6.1.1. Measurement error correction

The meter can be configured to take into account any measurement errors introduced by the current (CT) and voltage transformers (VT). This facility increases the global accuracy by applying a correction to the applicable measured and/or calculated values within the meter.

Two types of correction can be applied:

- voltage and current amplitude correction to compensate for any transformer ratio errors
- voltage and current phase angle correction to compensate for any transformer angle errors

CT/VT correction can only be configured using the meter support tool and must be carried out with regard to the accuracy of the connected transformer.

6.2. External connections

The meter may be configured with output facilities, as detailed in this section.

Control output

The meter can be factory-configured with a number of individual control outputs that function as high-level switches for connection to further meters or other external equipment.

The control outputs can be individually programmed and used to transmit or indicate meter events such as:

- the end of an integration (EOI) or billing (EOB) period
- an alarm
- tariff indication
- a clock synchronisation pulse
- a pulse output
- an excess demand or phase cut
- excess current

external contactor drive

Control output terminals

The control output terminal block provides a common connection point and accepts cables up to 1.5mm².

Maximum switching voltage = 288V AC, 320V DC

Maximum current = 100mA

Terminal	Function	Typical wiring
1	Control output 1	1 2 3 4 C Outputs
2	Control output 2	
3	Control output 3	
4	Control output 4	

С	Common	
---	--------	--

Metrology LED indicators

Visible metrology pulses proportional to active and reactive energy consumption are provided via two red LED indicators. These indicators flash in accordance with the metrological constant marked on the front of the meter (imp/kWh or imp/kvarh).

The metrology LED outputs comply with IEC 62053-21 and are used for metrological verification and meter accuracy testing.

6.3. Power supplies

Power for the meter's internal electronics is provided by a three-phase switched-mode PSU, supplied from the measured distribution-network voltages. To maintain meter accuracy in both 3 and 4 wire configurations, the power supply can tolerate any of the following network failure conditions:

4 wire systems

- missing one or two phases
- missing neutral or neutral and one phase
- inversion of one phase and neutral

3 wire systems

• missing one phase

The power supply has enough reserve energy to withstand three-phase power outages up to 0.5 seconds.

On power-down, the unit unconditionally maintains sufficient energy for all critical data to be saved to non-volatile memory.

6.4. Power-fail operation

In the event of a continuous absence of power, all ACE6000 meter data is saved in a non-volatile memory, with a retention time of at least 10 years without the aid of any backup power.

The contents of the non-volatile memory are regularly checked with checksum markers and a fatal alarm (page 61) is raised if data corruption is detected.

6.5. Real-time clock

The meter incorporates a Real-Time Clock (RTC) to facilitate time- and date-based energy rate switching, interval measurement and time stamping of events.

The RTC can be configured to use either the mains supply or an integral quartz crystal as its default frequency reference. Where the mains supply is used, the RTC will automatically be maintained during periods of power failure by the quartz crystal powered from the meter's lithium battery or super-capacitor.

The quartz crystal is temperature-compensated to ensure accuracy over the operating range of the meter.

The meter can also be configured to synchronise the RTC against an externally-sourced control I/O signal, either every hour or once a day.

The RTC meets the requirements for IEC 62052-21 and IEC 62054-21 time-switches for metering.

6.6. Calendar

The calendar provides a flexible and configurable switching regime that handles up to sixteen energy rate switches per day. The calendar also has the ability to apply different energy rate regimes during different seasons of the year and on designated individual days.

Two completely separate calendar switching regimes are available and can be programmed into the meter:

Current

The switching regime currently in use by the meter.

• Future (latent)

An alternative switching regime that will be used by the meter once a pre-programmed due date is reached.

This feature accommodates any contractually agreed energy rate changes and automatically applies them when they are due to come into force. At the due date, the future calendar becomes the current one; a further future calendar can then be programmed into the meter.

6.7. Energy rate switching

The contract between the customer and the utility will usually specify how many energy rates are available and at what times of the day these rates can be applied. These energy rate regimes are known as **tariffs**.

Tariffs are defined and downloaded to the meter using the meter support tool. New tariffs can be defined and loaded at any time.

A tariff specifies a set of energy and demand rates for one energy quantity and only energy registers associated with those rates are updated; all other energy registers are not modified. For billing purposes, each tariff is associated to an energy cost.

The real-time clock and calendar enable the meter to perform Time-Of-Use (TOU) energy rate switching under control of these programmable tariff regimes.

6.7.1. Daylight saving

The meter can be programmed to follow seasonally-based changes in local time, generally referred to as Daylight Saving Time (DST) or Summer Time.

Where the facility is enabled, the meter clock times will be advanced and retarded automatically by up to 2 hours each year.

The DST configuration can be defined in a number of ways to allow for use in both the Northern and Southern hemispheres and accommodate the different rules that apply in different countries.

Generic

All the date parameters for the DST transitions are individually programmable.

Programmed

Specific dates of change for the DST transitions can be chosen for each year. Up to five years values can be programmed in advance.

• Generic with season

The individually programmable DST transition dates are linked to a pre-defined season value.

Programmed with season

The specific dates of change for the DST transitions are linked to a pre-defined season value.

6.7.2. Seasons

The meter supports up to twelve seasons per year, for which different tariff regimes can be programmed. These seasons are defined by start dates, which can be set individually or derived from programmed daylight saving dates/times.

The start date of the first tariff season is always defined as 1st of January.

The following example illustrates four individually configured seasons:

Season	Starting Date
1	01/01
2	01/04
3	01/07
4	01/11

6.7.3. Week profiles

A week profile is always associated with a season and contains a collection of seven individually-defined day profiles (Monday through to Sunday).

Season	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	DP1	DP1	DP1	DP1	DP1	DP1	DP4
2	DP2	DP2	DP2	DP2	DP2	DP2	DP4
3	DP3	DP3	DP3	DP3	DP3	DP3	DP5
4	DP2	DP2	DP2	DP2	DP2	DP2	DP4
5	DP1	DP1	DP1	DP1	DP1	DP1	DP4

The following example illustrates individual weekly profiles for five seasons:

6.7.4. Day profiles

Each Day Profile (DP) enables the tariff rate to be changed (switched) up to 16 times over a 24-hour period. Each tariff rate switch has a pre-configured index (page 30) associated with it and a switching-time resolution of 1 minute.

Up to 24 individual day profiles can be defined with a total usage limit of 100 switching-time operations.

The meter will apply the same day profile every day unless the tariff specifies different profiles for weekends, special days and different seasons.

The start time of a day profile is always defined as 00:00.

The following example illustrates five daily profiles with seven switching-times:

Profile	TS1	TS2	TS3	TS4	TS5	TS6	TS7
DP1	00:00 [3]	06:00 [2]	09:00 [1]	11:00 [2]	18:00 [1]	20:00 [2]	20:00 [3]
DP2	00:00 [3]	06:00 [2]	22:00 [3]				
DP3	00:00 [5]	06:00 [4]	22:00 [5]				
DP4	00:00 [3]						
DP5	00:00 [5]						

Note: The numbers in enclosed brackets, e.g. [3], show the associated index.

6.7.5. Indexes

The contractually specified tariffs define the energy and demand rates being used by the meter. However, in many cases, active energy has more rates defined (for billing purposes) than reactive energy.

An index describes a combination of energy and demand rates that are activated simultaneously.

The meter index structure provides a mechanism to manage:

- up to fifty different rate switching schemes for active and reactive energy
- any overlapping rates for demand
- the activation of any assigned control outputs

Note: The energy (page 36) and demand (page 39) channels must already be defined in the meter before indexes can be configured and the required control outputs must be assigned to index use.

6.7.5.1. Index activation

Indexes can be activated as follows:

Immediately

The rate change is applied immediately as defined in the calendar day profile.

Delayed

The rate change is delayed until the end of any running demand calculation integration period (page 39).

Clock Loss

When a clock loss event is detected (backup power supply (page 30) sources exhausted), the meter will switch to a pre-configured index with a low tariff rate to ensure the customer is not penalised during this period.

6.7.6. Special days

The special days facility is intended to allow energy consumption charges on any locally-significant days, such as religious or public holidays, to be different from the rest of the week in which they occur.

The meter can accommodate up to 100 entries in an internal special days list. Each entry can be either repetitive or non-repetitive and have a different day profile (DP) applied.

Repetitive

These allow different day profiles to be applied on fixed dates during the year. The same dates will be used for all subsequent years.

Non-repetitive

These allow a different day profile to be applied on a specific day. Each non-repetitive entry is completely independent and when the last entry is reached it will be necessary to reprogram the meter with new values.

6.8. Backup power supply

To ensure the real-time clock and the cover opening detector are maintained during periods of power failure, the meter is equipped with a backup power supply comprising:

Super-capacitor

An internal device specified to provide a minimum capacity of 1 day power outage carry-over period.

Lithium battery

An optional field-replaceable device, specified to provide a minimum capacity of 3 years continuous operation at 25°C and a minimum shelf-life of 10 years, with less than 10% loss of capacity due to self-discharge at 25°C.

During a power failure, the super-capacitor is the first backup device to be drained.

An icon on the LCD is lit when the battery voltage falls below a preset threshold value (nominal battery voltage value 3V).

The battery can be replaced without any interruption to meter operation.

6.9. Reading without power (RWP)

The meter can be factory-fitted with an option that allows meter reading even when main network power is missing. The power for this Reading Without Power (RWP) feature is provided by two dedicated ($\frac{1}{2}$ AA type) batteries fitted in a holder located under the meter terminal cover, as shown:



The expected battery life is 10 years based on a typical usage cycle of 5 x 5minute readings a year.

The meter monitors the RWP battery voltage and raises a non-fatal alarm in the logbook when it falls below a programmable threshold.

An RWP session is initialised by pushing the display pushbutton.

During an RWP session

There is no LCD back light and an RWP icon is lit on the meter display.

A meter reading can be taken immediately or after an EOB. An EOB action can be performed using the Reset pushbutton (if enabled in configuration) or using the optical communication port. Only one EOB action can be performed during an RWP session.

Certain alarms will be detected, typically:

- Watchdog activity
- External clock and programming incoherence
- Excess demand only when an EOB is done during the RWP session
- Clock loss
- RWP and RTC Battery low

Many meter functions are not available or inhibited, for example:

- metrology (this is stopped, so there is no voltage measurement)
- communication via serial ports
- auxiliary I/O
- most alarms
- non-volatile memory save
- DST management

The RWP session is closed automatically if no further action occurs during a programmable time out period. Once the RWP session has ended, a programmable lock out interval prevents a successive RWP session from being immediately initialised.

6.10. Metered quantities

6.10.1. Four quadrant metering

The meter measures various energy values or quantities, in all four quadrants of the AC waveform.



6.10.1.1. Measured energy quantities

The following measured energy quantities are updated every second and recorded in a series of total energy registers (TER):

Active Energy - 8 Quantities

Per phase	Direction
kWh ph 1+	Import
kWh ph 1-	Export
kWh ph 2+	Import
kWh ph 2-	Export
kWh ph 3+	Import
kWh ph 3-	Export

Aggregate	Direction
kWh agg+	Import
kWh agg -	Export

Reactive Energy - 24 Quantities

Per phase	Direction
kvarh ph 1+	Import
kvarh ph 1-	Export
kvarh ph 2+	Import
kvarh ph 2-	Export
kvarh ph 3+	Import
kvarh ph 3-	Export

Aggregate	Direction
kvarh agg+	Import
kvarh agg -	Export

kvarh Q1 ph 1 kvarh Q2 ph 1 kvarh Q3 ph 1 kvarh Q4 ph 1 kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q2 ph 1 kvarh Q3 ph 1 kvarh Q4 ph 1 kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q3 ph 1 kvarh Q4 ph 1 kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q4 ph 1 kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q1 ph 2 kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q2 ph 2 kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q3 ph 2 kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q4 ph 2 kvarh Q1 ph 3
kvarh Q1 ph 3
kvarh Q1 ph 3
kvarn Q2 pn 3
kvarh Q3 ph 3
kvarh Q4 ph 3

Aggregate
kvarh Q1 agg
kvarh Q2 agg
kvarh Q3 agg
kvarh Q4 agg

Apparent Energy - 8 Quantities

Per phase	Direction
kVAh ph 1+	Import
kVAh ph 1-	Export
kVAh ph 2+	Import
kVAh ph 2-	Export
kVAh ph 3+	Import
kVAh ph 3-	Export

Aggregate	Direction
kVAh agg+	Import
kVAh agg -	Export

Depending on the meter configuration, apparent energy is calculated by one of the following methods:

• Arithmetical

Multiplication of the RMS voltage and current values.

S = Urms . Irms (true apparent power - this method gives good results above lb/10)

Vectorial

Quadratic sum of active and reactive powers.

S = P²+ Q² (this method is more precise at low currents)

Note: The arithmetical method is not available on meters configured for 3 wire operation, therefore, the apparent energy calculation will be done using the vectorial method.
6.10.1.2. Summation energy

The meter can be configured with up to four summation energy registers that algebraically sum the contents of up to five energy rate registers recording the same type of energy.

Summation - 4 Quantities

Quantity	Summation energy quantities can be measured in:
Sum 1	● kWh
Sum 2	• kvarh
Sum 3	• kVAh
Sum 4	

6.10.1.3. Instantaneous energy quantities

The following quantities are measured and updated every second:

Phase Angles - 6 Quantities

Ph to Ph
Angle U1/U2
Angle U2/U3
Angle U3/U1

RMS - 6 Quantities

Voltage		
Urms ph 1		
Urms ph 2		
Urms ph 3		

Current
Irms ph 1
Irms ph 2
Irms ph 3

Power Factor - 4 Quantities

Quantity	
PF ph 1	
PF ph 2	
PF ph 3	
PF agg	

Network - 3 Quantities

Quantity
Frequency
Neutral (residual) Voltage (Urms)
Neutral Current (Irms)

6.10.2. Total energy registers (TER)

Total energy registers (TER) are:

- dedicated to storing the total accumulation of an energy quantity
- independent of any tariff switching or calendar definition
- not reset at the end of a billing period
- not programmable

Total energy registers can be configured to accumulate energy in three discrete multiplier steps, as shown in the watt hour (Wh) example below (kvarh and kVAh follow the same pattern):

Unit	Value	Name
Wh		Watt hour
kWh	10 ³	Kilowatt hour
MWh	10 ⁶	Megawatt hour

Note: It is very important that the register multiplier is chosen correctly with regard to the meter installation requirements and summation register values.

Energy register contents are displayed with a maximum of eight digits, the following table illustrates the full range available for each unit multiplier:

Unit	Energy register unit	Energy register max value
Wh	99 999 999 Wh	99 999.999 kWh
kWh	99 999 999 kWh	99 999.999 MWh
MWh	99 999 999 MWh	99 999.999 GWh

The maximum energy register value is just under 100TWh.

6.10.3. Energy registering

All the measured energy quantities (page 33) recorded by the meter are available for energy registering, such as:

- Per phase
- Aggregate
- Summation

6.10.3.1. Energy channels

For energy registering purposes the meter can be configured with up to ten independent energy channels, each channel being selected from the available measured energy quantities. If required, a specific energy quantity can be allocated to more than one channel and three channels are available for excess energy accumulation.

Typically, only energy channels configured with active and reactive energy types are used for billing purposes. However, it is possible to configure any remaining channels with alternative energy quantities for analysis purposes.

6.10.3.2. Energy rate registers

The meter records the consumption of all tariff-based metered energy in up to thirty-two individual energy rate registers. Each of the meter energy channels (page 36) can have a maximum allocation of eight energy rate registers from within this limit.

The correct configuration of energy rate registers is of major importance as they are directly linked to the billing of metered energy.

The meter offers two modes of energy rate register operation:

Incremental

The registers are reset to zero at the end of a billing period (EOB).

Cumulative

The registers are never reset and the energy will continue to accumulate during the next billing periods.

At the end of a billing period (page 45) the energy rate registers are read and the values recorded to historical buffer registers (page 46).

Further specific registers are dedicated to store the working time of each energy rate register (in seconds). These registers are never reset after an EOB.

Tariff rate switching

The meter calendar will automatically switch energy rates during the day in accordance with the current contractspecified tariff structure.

Note: At any one time, only one tariff rate is active for each energy channel.

Tariff rate switching can be completely independent between energy channels with, for example, several rates specified for active energy and one rate for reactive energy.

6.10.3.3. Summation registers

The meter can be configured with up to four summation energy registers that algebraically sum the contents of up to five energy rate registers recording the same type of energy.

The illustration below shows two (out of four) summation paths with five inputs (A,B,C,D and E) each.



The result of the summation process is only stored in the register if it is a positive value. Negative or null results are equal to zero and not stored.

6.10.4. Demand registering

The contract between the customer and the utility company may specify certain energy demand limitations or threshold parameters. Exceeding those stated limits could result in penalties being issued.

Meter-based demand registering is a convenient way for both the customer and the utility to monitor energy consumption.

All the measured energy quantities (page 33) recorded by the meter are available for demand registering, such as:

- Per phase
- Aggregate
- Summation

6.10.4.1. Demand channels

For demand registering purposes the meter can be configured with up to ten independent demand channels, each channel being selected from the list of available measured energy quantities.

In addition, the calculated aggregate power factor can be allocated to a demand channel.

Tariffs are applied to these demand channels, with the exception of the aggregate power factor channel.

At any time, several tariff rates can be active for a particular demand channel and it is possible to have different tariff rate configurations in each demand channel.

6.10.4.2. Demand registers

The meter records energy demand in up to twenty-four individual demand registers. Each of the meter demand channels can have a maximum allocation of eight demand registers from within this limit. The demand registers are dedicated to recording the average energy demand over a fixed time known as the **integration period**.

6.10.4.3. Integration period

Calculating demand over a period of time helps avoid any short peak values (typically, transients caused by starting heavy inductive loads) from affecting the calculation.

The integration period has:

- a programmable duration in discrete (sub multiples of 60) steps from 1 minute to 60 minutes
- two modes of operation:
 - Fixed (or block mode)
 - Sliding

The meter applies the selected integration period mode and duration value across all demand channels.

During the integration period a set of **rising values** are available that represent the currently calculated demand for each demand channel. These rising values are updated every second by integrating the energy consumed since the beginning of the period over the total duration of the period.

At the end of each completed integration period (EOI):

- the demand calculations are made
- if the current demand value is greater than the previous maximum demand value recorded, the new value is time stamped and replaces the previous maximum
- the current demand registers are set to zero
- the EOI time-stamping is carried out and a new integration period is started

Fixed or block mode

In the fixed or block mode the integration periods have a single predefined duration value.

The illustration below shows two successive fixed or block integration periods with, for example, a duration of 15 minutes. The rising demand value is based on a constant load:



Sliding mode

In the sliding mode the demand period is divided into between 1 and 15 fixed integration periods. The total maximum duration of a sliding demand period is 15 (maximum periods) x 60 (maximum minutes) = 900 minutes.

The illustration below shows a sliding mode demand period comprising 4 integration periods with, for example a duration of T = 5 minutes. The sliding demand period total duration = 20 minutes with the rising demand value based on a constant load:



At the end of each completed integration period (T) the demand value is calculated and temporarily stored.

At the end of the first sliding period (3), an average demand value based on the results from all integration periods within that sliding period (T1,T2,T3,T4), is calculated.

When the next integration period (T5) ends, a new average demand value based on the results of integration periods (T2,T3,T4,T5), is calculated.

This process is then repeated at the end of every successive integration period until an end of billing event occurs.

6.10.4.4. Demand calculation

At the end of each integration period (EOI), the meter calculates the following:

- average demand over the integration period
- average three-phase power factor over the integration period
- minimum power factor the meter records the lowest values in the current billing period
- average power factor over the current billing period
- maximum demand coincident values if enabled

If **coincident values** is set on channel 1 and a maximum demand is recorded, the demand on the last channel is also recorded (even if a maximum demand is not detected on that channel)

- cumulative maximum demand the meter records this value over the current billing period
- maximum demand the meter records the 3 highest peaks in the current billing period.

The meter offers two maximum demand modes (applied across all channels):

- Maximum mode this default mode registers the maximum demand peaks only, any preconfigured thresholds will be ignored.
- Maximum Excess mode this mode activates the preconfigured thresholds. If a threshold is defined for a channel, only the maximum demand peak value *above* the threshold is recorded. If no threshold is defined the operation is identical to Maximum mode (as above).

6.10.4.5. End of integration (EOI)

The meter can be configured so that up to five different sources can trigger an end of integration period (EOI):

- the meter real-time clock
- a time change
- an active signal on a control input
- a change of tariff rate
- a power failure

The behaviour of the meter after a power failure is configurable:

Restart

A new integration period starts after power-up.

Resume

The integration period interrupted by power failure is continued after power-up.

• Synchronise

The integration period is always synchronised with the next whole hour.

The following illustration shows the three modes of after power failure operation with a block integration period of 15 minutes:



6.10.4.6. Excess demand modes

The meter detects an excess demand when the calculated demand value rises above predefined thresholds for the current rates. Depending on specific requirements, up to ten excess demand thresholds can be defined.

The meter records the following values for each excess demand:

- number of excess demand integration periods
- total excess demand duration
- cumulated excess demand

Excess demand is indicated by the following methods:

- an icon is lit on the meter LCD
- a logbook entry and alarm
- a switch is activated on a preconfigured control output

Excess demand control can be programmed according to one of the following modes:

Rising demand

Every second, the meter calculates and compares the rising demand value with the demand threshold. If the demand threshold value is exceeded, the meter immediately indicates an excess. At the end of the current integration period all excess demand indicators are reset.

• End of integration

If the threshold value is exceeded during the integration period, the meter indicates an excess at the end of the integration period and during subsequent integration periods. At the end of each integration period the excess demand indicators are reset only if the rising value has remained lower than the excess threshold.

• Projection

Every second, the meter calculates and extrapolates the demand to the end of the current integration period. If the demand threshold value is exceeded by the extrapolated value, the meter immediately indicates an excess. This calculation is always inhibited during the first 30% of the integration period.

The illustration below shows the different excess demand indication characteristics for each of the modes:



6.10.5. Load profiles

Load profiles are of interest to both the utility and the end customer as they can help determine which electricity contract and tariff rates may be the most appropriate.

As well as analysis, load profile data can be used for billing purposes.

A load profile is a continuous record of an energy quantity taken over a preset period of time (the **recording interval**). Each profile is recorded as an independent channel into one of the meter's two internal memory arrays (LP1 & LP2).

The recording interval is programmable in discrete (sub multiples of 60) steps from 1 minute to 60 minutes and applied as a common value across all profile channels in an array. It can be a different value from the demand integration period (page 39) except when a load profile channel is configured with excess energy (see below).

Operating modes

Each load profile channel can operate in one of two modes:

• Cumulative

The energy quantity allocated to the load profile is cumulated over the recording interval and then stored in the load profile array (cumulated unit-hours).

As this mode records energy consumption over the recording interval, only energy type quantities can be allocated.

Average

The energy quantity allocated to the load profile is cumulated over the recording interval and then corresponding average power stored in the load profile array (cumulated unit-hours divided by the integration period).

This mode can be used with all energy quantity types.

In addition, certain specific meter status and event information is also recorded as date-stamped data elements in the load profile memory array, for example:

- clock setting
- daylight saving time (DST)
- external synchronisation
- power failure
- watchdog reset

All the measured energy (page 33) and certain instantaneous (page 35) and calculated energy quantities recorded by the meter are available for load profiling. Typically, active and reactive energy types are used but other energy types and meter parameters can also provide useful profile data, such as:

- excess energy
- per phase Urms and Irms
- per phase and aggregate PF
- frequency, ambient temperature and alarm status

Load profile parameter summary

Parameter	LP1	LP2
Number of load profile channels (max)	8	8
Capacity for the load profile array with a recording interval of 15 mins	148 days	35 days

6.10.5.1. Excess energy

Up to three channels in each load profile array can be configured as excess energy channels. These are triggered to record energy quantities once the specified quantity has exceeded a configurable threshold.

These channels can also be configured as simple load profile channels.

6.10.6. Meter billing

The customer is billed for their consumption of energy at regular time intervals called **billing periods**.

6.10.6.1. Billing periods

A billing period is defined as the time between two successive end of billing (EOB) events. At the end of a billing period all the energy registers are read and their values recorded as meter data in historical buffer registers.

The utility company then reads this stored meter data and uses it to generate the customer energy-consumption bills.

6.10.6.2. End of billing (EOB) event

The meter can be configured so that up to four different sources can trigger an end of billing (EOB) event:

- generic calendar dates and times (for example, last day of month at 12:00)
- specific calendar programmed dates (for example, 31st May)
- a command from a communication channel or protocol
- the front-panel pushbutton reset switch

The meter will always process an EOB event immediately and perform various actions, such as:

- calculate the cumulative maximum demand value
- reset the Maximum Demand Indicator (MDI)
- set the minimum power factor to a value of 1
- reset various data registers to zero, for example:
 - Urms
 - Irms

Power failure behaviour

Scheduled EOB events that become due during a period of power failure will be resumed upon meter power-up. However, only one event is processed at power-up regardless of how many should have occurred during the power failure period.

Lock-out time

End of billing (EOB) source triggers can also disable other EOB sources from having any effect for the duration of a pre-configured **lock-out** time. This prevents any further spurious or unnecessary EOB events from occurring.

Using the meter support tool, the lock-out option for each EOB source can be enabled or disabled and the duration configured.

In addition, interactions between the EOB source triggers can be programmed, as follows:

The latest EOB source trigger can:

- have no influence on the lock-out time of a specific source
- cancel the lock-out time of a specific source, if it is active
- re-trigger a new lock-out time for a specific source this lock-out time will not be cancelled on a three-phase
 power failure
- re-trigger a new lock-out time for a specific source this lock-out time will be cancelled on a three-phase power failure

6.10.6.3. Historical buffer registers

The historical buffer register architecture is circular and operates in a first-in first-out (FIFO) fashion.

Meter data stored in the historical buffer registers can be read at any time and used for billing purposes. However, when all historical buffer registers are full, the oldest data set is overwritten at the end of each subsequent billing period.

Note: If the data to be overwritten has not been read, it will be lost.

The meter can be configured to record up to 36 sets of meter data in the historical buffer registers when triggered by an EOB source.

A typical EOB historical data set comprises the contents of the:

- total energy registers (TER)
- energy rate registers
- demand registers

For each rate:

- time stamped maximum demand and excess demand
- cumulative maximum demand
- time stamped peak demand values (x3)

For the Power Factor (PF) channel:

- time stamped min PF
- average PF

In addition, other sets of meter data values are recorded, for example:

- time stamped min/max:
 - RMS voltage and current
 - frequency
 - meter temperature
- aggregate active power (import and export)
- aggregate reactive power (import and export)
- EOB summary data

EOB summary registers

These historical buffer registers record a specific set of values associated with end of billing (EOB) events, as follows:

- number of EOB actions (cumulative)
- EOB date and time
- EOB source trigger:
 - communication
 - front-panel pushbutton
 - programmed calendar dates and times
- since the last EOB event, the:
 - number of days
 - average power factor
 - minimum power factor
 - min/max distribution-network frequency

6.11. Network quality monitoring

As a manufacturing option, 4 wire system meters can be configured to monitor various distribution-network voltage-quality parameters. However, this facility is only available if specifically requested at the time of manufacture and it is not available on 3 wire system meters.

Note: Meters supplied *without* the voltage-quality option can be configured on-site, if necessary, to 3 or 4 wire system operation.

The meter detects voltage-quality defect events by continually sampling and analysing the per phase RMS voltages (Urms) and comparing these voltages against a series of pre-defined values.

These values are thresholds which the sampled phase voltage must either fall below, or rise above, depending on the defect type being recorded. Typically, for each defect event there is a high and a low threshold value, crossing one threshold starts the event, crossing the other finishes it.

Threshold values are independently programmed using the meter support tool and can be either fully userdefined or set to defaults calculated as a percentage of the nominal input voltage (Unom).

The meter calculates the magnitude of the defect as an average value over the duration of the event.

For all defect magnitude calculations, the first and the last 40 ms period of the defect is not taken into account. If the defect does not last at least 120 ms, the defect magnitude is set to zero, whatever defect type.

For each voltage-quality defect event, the meter records the:

- phase involved
- start and end times (with a one second resolution)
- duration in tens of milliseconds (with a fixed accuracy of +/- 80ms)
- average level (with a 0.5% accuracy in 1/100 Volt limited to the first 2 hours)

Certain parameters of each defect type are recorded as historical meter data for subsequent analysis, such as:

- number of defects per phase (incremental)
- cumulated duration of defects per phase
- duration of the longest and the shortest defects per phase (with time stamp)
- 10 last defects (with time stamp, duration, magnitude, phase)

Voltage cuts

A voltage cut is detected if the distribution-network input voltage drops below the cut start threshold value and continues until the voltage rises above the cut end threshold value.

If the meter is configured for default values, the threshold percentages are:

- Cut start (low) threshold 48% (Unom)
- Cut end (high) threshold 77% (Unom)

A typical voltage cut defect event is illustrated below:



Voltage sags

A voltage sag is detected if the distribution-network input voltage drops below the sag start threshold value and continues until the voltage rises above the sag end threshold value.

However, if the input voltage drops below the sag start threshold and then subsequently drops below the cut start threshold, the sag defect is ignored as a cut start always erases a sag start.

If the meter is configured for default values, the threshold percentages are:

- Sag start (low) threshold 83% (Unom)
- Sag end (high) threshold 85% (Unom)

A typical voltage sag defect event is illustrated below:



Voltage swells

A voltage swell is detected if the distribution-network input voltage rises above the swell start threshold value and continues until the voltage falls below the swell end threshold value.

If the meter is configured for default values, the threshold percentages are:

- Swell start (high) threshold 130% (Unom)
- Swell end (low) threshold 132% (Unom)

A typical voltage swell defect event is illustrated below:



6.12. External Contactor drive :

It is possible to dedicate one or more control outputs of the meter to drive (open or close) an external contactor.

The contactor operation is done through the state changes(open or close) of the associated control outputs of the meter (wired to the contactor) and programmed as dedicated to the contactor operation.

The control outputs that are not programmed for contactor operation can be programmed for other types of operation.

The output contacts dedicated to contactor operation cannot be programmed simultaneously for other types of operation.

Disconnection operation:

The disconnection command is sent to the control outputs according to their respective positive or negative logical active level.

Such command is sent upon reception by the meter of a remote cosem script communication.

Disconnection operation is done only on remote command.

Reconnection operation:

The reconnection command can be sent to the control outputs upon reception of a remote cosem script communication or through push button operation.

The reconnection operation will be done successfully through the meter control outputs only if the meter has received previously a "Ready for connection" command.

The reconnection can be done through the non sealable push button located on the meter front face.

When the meter has previously received the "ready for connection" command, as soon as the operator pushes the relevant push button, the contactor is reconnected .

Local or remote reconnection are exclusive. It is not possible to have local and remote reconnection mode on the same meter.

Of course the reconnection mode is programmable thanks to the software tool.

The state of the contactor can be read easily on the meter LCD display in clear messages as:

- Open means "disconnected"
- Ready means "ready for connection"
- Close means "(re)connected"

Note 1: there is no connection/Disconnection operation on event (whatever the event).

Note 2: the connection/Disconnection operation are not date and time stamped in the meter memory

Note 3: it is possible to get a message sent previous to disconnection to another CO, provided there are some available for such function. Such CO can actuate a lamp or a horn in order to inform the end-user about future disconnection to come.

6.13. Monitoring

The meter monitors and records events in the following categories:

- Network
- Anti-tamper or fraud
- Meter status
- Billing

Note: Some of the monitored events could exist in more than one category.

Monitored events

Event name	Network	Anti-tamper	Status
Power failure	Y	Y	
Frequency	Y		
Phase	Y		
Neutral voltage	Y		
Neutral current	Y		
Current reversal	Y	Y	
Absence of current	Y	Y	Y
Excess current	Y	Y	
Internal consumption	Y	Y	Y
Cover opening		Y	Y
Magnetic sensor		Y	
Calibration history			Y
Configurations history		Y	Y
Watchdog activity			Y
Reading without power (RWP)			Y

Power failure

The meter detects a power failure when all three distribution-network phase voltages are lost.

The meter can be configured with a long power failure duration threshold value of between 0 and 255 seconds. Any power failure durations:

- below this preset value are short power failure occurrences
- above this preset value are long power failure occurrences

The meter records the following power failure event parameters:

- number of short power failures (incremental)
- number of long power failures (incremental)
- cumulated duration of long power failures
- duration of the longest power failure (with start time stamp)
- duration of the shortest power failure (with start time stamp)
- the last 10 long power failures (with start time stamp and duration)

Frequency

The meter calculates the instantaneous frequency of the distribution-network voltage waveform using a zero crossing technique that ensures an accurate result even if one or two incoming phases are lost.

The maximum and minimum frequency values within a billing period (page 45) are recorded by the meter.

Neutral voltage

Neutral voltage displacement will typically occur as a result of asymmetrical loads or phase faults.

The meter calculates a neutral voltage displacement value once every second using a standard residual voltage technique (rms value of the vector sum of the phase-to-neutral voltages). When this calculated value exceeds a pre-programmed threshold an alarm can be triggered.

The neutral displacement threshold value is programmed using the meter support tool and **must** represent an actual and realistic value. If left at 0.0V (default) the meter will constantly trigger unnecessary alarms.

Neutral current

Neutral current will typically occur as a result of asymmetrical loads.

The meter calculates a neutral current value once every second using a standard homopolar current technique (rms value of the vector sum of the phase currents). When this calculated value exceeds a pre-programmed threshold an alarm can be triggered.

The neutral current threshold value is programmed using the meter support tool and **must** represent an actual and realistic value. If left at 0.00A (default) the meter will constantly trigger unnecessary alarms.

Current reversal

The meter detects current reversal events and records the following parameters:

- number of current reversals for phases 1, 2 and 3 (incremental)
- the last 10 current reversals (with time stamp, reversal direction and phase number)

Each current reversal triggers a non-fatal alarm.

Absence of current

An absence of current event occurs when the meter detects there have been no metrology pulses for a period of 10 seconds.

The meter records the following parameters:

number of current absence events for phases 1, 2 and 3 (incremental) with time stamp

Excess current

The meter calculates the current value once every second for each phase. When this calculated value exceeds a pre-programmed threshold a non-fatal alarm can be triggered.

The meter records the following parameters:

number of excess current events for phases 1, 2 and 3 (incremental) with total duration

Number of days without internal consumption

The meter records the number of days where none of the energy registers have incremented due to a lack of metrological activity. If the recorded number of days goes over the predefined threshold, then a non-fatal alarm is triggered.

Cover opening

The meter detects cover opening events and records the following parameters:

- number of cover openings (incremental)
- the last 10 cover openings (with time stamp and duration)

The meter detects and records the first cover opening event during a power failure.

Magnetic sensor

The meter detects magnetic attacks and records the following parameters:

- number of magnetic attacks (incremental)
- total duration of magnetic attacks (not including programmable threshold duration)
- the last 10 magnetic sensor events with time stamp and duration

Calibrations history

The meter records the following calibration event parameters:

- number of calibrations (incremental)
- last calibration date and time

Configurations history

The meter records the following configuration event parameters:

- number of objects configured (incremental)
- last configuration date

Watchdog activity

The meter detects watchdog events and records the following parameters:

- number of watchdog events (incremental)
- last watchdog event (with time stamp)

Reading without power (RWP)

The meter records the following RWP event parameters if the RWP option is fitted:

- number of RWP sessions (incremental)
- total duration of RWP sessions

6.14. Fraud protection measures

The meter incorporates the following features designed to prevent tampering and/or assist in the detection of attempted fraud:

Feature	Description	
Anti-fraud measuring mode	The meter may be configured to register energy with an anti-fraud algorithm.	
Meter and terminal seals	The meter body and terminal cover may be independently sealed with conventional wire or plastic seals.	
Protected voltage links	Access to the links requires removal of the sealed terminal cover.	
Monitoring	Anti-tamper events, for example:	
	current reversal or cross-phasing	
	zero sequence U and I	
	duration without internal consumption above a threshold	
	excess current	
	Recorded as date/time stamped events, which can be read from the meter.	
Reverse energy	Recorded as date/time stamped events, which can be read from the meter.	
	Indication provided by an annunciator in the LCD.	
Configurations	When any aspect of the meter is programmed, the meter records the number of objects configured as a date/time stamped event.	
	Typical fraud-related parameters include:	
	Calendar reprogramming (seasons, day profiles, index)	
	CT/VT transformer ratio reprogramming	
Indication of meter cover and/or	Recorded as date/time stamped events:	
terminal cover removal	start date of cover opening	
	duration	
	number of cover opening events	
	The detection remains active during power failure events (one opening is counted regardless of how many occurred)	
Magnetic shielding	The meter enclosure can be optionally fitted with an effective shielding against external magnetic fields.	
Magnetic attack detection	The meter can be optionally factory-equipped with a magnetic field detector. This can be configured to:	
	record the number of magnetic events	
	record the time/date and duration of the last 10 magnetic events	
	• generate a non-fatal alarm and light an annunciator in the LCD	
	increment specific energy registers during the magnetic event	

6.15. Meter communication lock out time after wrong passwords inputs Limitation of COSEM connection attempts

In order to reduce the fraud and to increase the meter security, the COSEM communication can be locked in case of several attempts with wrong password.

Process to lock the meter

The 'lock' is performed independently on both communication port (IR and RS).

There is a current counter to memorize the illegal connection attempts (connection with a wrong password) on each communication port (one counter per port). The counter is incremented each time a wrong password is received.

If there are X (value is configurable) consecutive attempts with a wrong password (even with different COSEM client) on the same port, the communication on this port is locked.

Example: number of wrong password to lock is configured with 5. If the meter receives 5 consecutive wrong passwords on the same communication port, it will lock the port.

When the port is locked a communication with a good password is also rejected.

When the port is locked the meter returns an error "authentication error".

The current wrong password counter is saved on power failure.

The current wrong password counter is reset (if meter is not locked):

• Each hourly top (if a power failure or a clock setting hides an hourly top, the current wrong password counter is reset.

In case of communication with a good password.



Meter configured to

Data recorded in case of wrong password and lock of communication port

The meter logs an event in the logbook if a lock is triggered. Event also provides the identifier of the communication port locked.

For each communication port, the meter records:

The total number of wrong password reception (even if this wrong password doesn't lead to lock the meter)

Date and time of the last 5 wrong password reception.

These data are only available on COSEM protocol

Process to unlock the meter

The time out to unlock the port is configurable with two different ways:

1. Meter is unlocked to the next hourly top

If a power failure or a clock setting hides an hourly top, the lock is reset (same case than a normal hourly top).

2. Meter is unlocked after a programmable time out (in minute)

The timeout counter is incremented every second.

The timeout counter is saved on power failure and takes into account the power failure duration at power up.



Meter configured to unlock to the next top hour



Meter configured to unlock after a time out (ex 120 minute)

Parameters

The following parameters are available:

- Number of wrong password reception to lock a communication
- Time out to unlock the port (ever next hourly top or time out in minutes)
- When one of this parameter is changed, all current wrong password counters are reset.

6.16. Magnetic field detection

The meter can be optionally factory-equipped with a sensor that detects external magnetic fields. This type of field is typically applied to the meter in an attempt (a magnetic attack) to defraud the utility company by disturbing the measurement metrology sensors.

Note: The magnetic field of optical heads used for reading the meter are not detected by the sensor.

If the magnetic detection feature is fitted, it can be enabled or disabled on-site using the meter support tool.

Operation

When the sensor detects a magnetic field:

a non-fatal, trapped alarm is raised once a programmable threshold duration period has passed

Note: The alarm type is self-healing in earlier versions of meter firmware.

all serial communications via the RS232 or RS485 ports is suspended immediately

This occurs even if the magnetic detection feature is disabled or a communication session was in progress.

For the duration of the magnetic attack:

- the meter increments specific energy registers once every second. These registers:
 - accumulate their respective energy type
 - are only reset when they reach maximum value (not at EOB)
 - do not have their values stored in any historical buffer registers at EOB
- all other registers continue to operate normally

At the end of the magnetic attack:

- a time stamped magnetic attack event is stored in the meter logbook
- all serial communication functions are restored
- any alarm-based SMS messages are sent
- depending on the meter firmware version, the alarm disappears when the sensor no longer detects the magnetic field

There are two modes of operation available for incrementing the affected registers:

Imax method

During the magnetic attack, energy is calculated using the meter **Imax** value instead of the actual measured current. If this mode is chosen, then only the **Import Active Aggregate Energy** register is incremented.

Note: Direct and transformer connection meter types use slightly different algorithms for this calculation.

Multiplicative coefficient method

During the magnetic attack, energy is calculated using a programmable **Multiplicative Coefficient** instead of the actual measured current.

If this mode is chosen, up to six of the following aggregate energy registers can be selected:

- Import active or reactive
- Export active or reactive
- Active or reactive Q1, Q2, Q3, Q4

6.17. Alarm and event management

6.17.1. Logbook

The meter is factory programmed with a list of pre-defined metering **Events**. Using the meter support tool, events from the list can be selected so that if they occur, a time-stamped record is made in the meter **Logbook**.

Then, whenever necessary, an analysis of meter behaviour can be made by investigating the logbook contents.

The logbook has a maximum capacity of 500 recorded events. Therefore, to ensure the logbook doesn't become full too quickly, it is recommended that only events related to the installation requirements and the metering context are selected, for example:

- specific action events
- communication events
- fatal and non-fatal alarm events (appearance and disappearance)
- asynchronous events

The selection of all other events should be carefully considered with regard to logbook capacity, for example:

If the event **Periodical EOI** is selected with a period equal to 15 minutes, then 96 Periodical EOI events will be recorded each day, filling the logbook in about 5 days.

An integrated functional element called the Event Manager controls and manages all metered events.

6.17.2. Event histories

In addition to the typical event data (event type and time stamp) recorded in the logbook, some specific events have further associated data elements that also require storage.

These extra data elements are stored in Event History buffers.

The buffer architecture is circular and operates in a first-in first-out (FIFO) fashion, so when the buffer becomes full, the oldest data elements are overwritten with the latest entries. Therefore, if the data to be overwritten has not been read, it will be lost.

Event history storage is non-configurable and any data associated with these specific events is always stored, even if the event itself is not selected to be recorded in the logbook.

The following table contains a typical list of events that are stored in history buffers (these may change due to meter firmware revision):

Event	Maximum
Index change	100
Day profile change	10
Season change	2
Voltage sags	10
Voltage swells	10
Voltage cuts	10
Long power failures	10
Cover openings	10
Current reversals	10
COSEM user connections	10

6.17.3. Alarm type and classification

Alarm types

In addition to logbook events, the meter manages two types of alarm:

Fatal

These alarms cause the meter to enter the non-operational mode (STOP displayed on the LCD) where only instantaneous values are processed and no further registration of energy or demand/load profile calculation is performed.

The meter should be removed from the installation site and tested. It will still contain all the metered data collected up to the point the fatal alarm occurred.

Non-fatal

The meter is still able to operate during this type of alarm and some of these alarms are purely informative.

Alarm classification

Alarms are further classified according to the way they clear, as follows:

Self-healing

These alarms automatically clear when the alarm state disappears.

Trapped

These alarms will only clear when a reset command is performed (via communication or pushbutton) even if the alarm state has disappeared.

Fatal alarm types can only be cleared by a reset command, therefore, they are always trapped.

• Fugitive

For some alarms (e.g. a communication error) there is only an alarm appearance event. These can only be cleared by a reset command as there is no alarm disappearance event.

Therefore, fugitive alarm types are always trapped.

6.17.4. Alarm notification

Alarms are reported *only* when the corresponding event is logged into the logbook. Therefore, it is important that the following events are selected for inclusion in the logbook:

- Non fatal alarm appearance
- Non fatal alarm disappearance
- Fatal alarm appearance

When an alarm is detected by the meter it can be reported in several ways:

- an alarm display on the meter LCD
- a triggered control output
- an SMS or email message

7. Communications

The meter is provided with two types of communication channel:

Infrared optical interface

Used for the local reading of meter data and meter configuration.

RS232 or RS485 serial communication ports

Used for the direct or remote reading of meter data.

Meters can be connected together using RS485 daisy-chaining techniques or short distance RS232 serial splitter cabling (up to 12m).

Remote connections to the meter communication ports can be established using a variety of media types:

- PSTN Public Switched Telephone Network (landline)
- LAN Local Area Network using TCP/IP (or an Internet connection)
- **GSM** Global System for Mobile communication
- GPRS General Packet Radio Service

For all media types Itron recommends the installation of the Sparklet[™] modem. However, many third-party manufactured modems are supported.

A support tool for the Sparklet modem is available to configure all aspects of operation across all media types.

7.1. Optical interface

The meter has an infrared (IR) optical interface that complies with the requirements of IEC62056-21 and IEC62056-42/46/53/61/62.

This interface is used for transmission of metering values from the meter to a Hand Held Terminal (HHT) or personal computer running suitable software (AIMS Pro or ACE PILOT) to enable communication. It is also possible to program and re-configure the meter using this communications channel.

An internal serial channel is allocated to both this optical interface and to one of the additional electrical communication ports (either RS232 or RS485). By default the electrical port is active, however, when an optical communication demand is detected, the serial channel switches automatically to the IR optical interface.

The baud rate for this interface can be selected between 1200Bd and 9600Bd.

7.2. Serial data port

The meter can be factory-configured with either an RS232 or RS485 serial data port to allow communication between the meter and the utility. This electrical serial-communication data port is primarily designed to operate with an external modem, but can be directly connected to other external equipment, if required.

The data port uses the DLMS-COSEM protocol in compliance with the requirements of IEC62056-42/46/53/61/62 and the baud rate can be selected between 1200Bd and 19200Bd.

Modem power supply

Where fitted, the RJ45 connector is located under the terminal cover and can provide a DC supply voltage (VMDM) suitable for powering an external modem.

Pin	RS232 Function	RS485 Function
1	VMDM	VMDM
	Approx +10V DC at 100mA (0.9W max)	Approx +10V DC at 100mA (0.9W max)
2	No connection	RX -
3	No connection	No connection
4	RX	RX +
5	ТХ	TX +
6	0V - Ground	0V - Ground
7	DTR	TX -
8	No connection	No connection

Note: On RS485 configured meters there are two RJ45 connectors fitted to allow the daisy-chaining of multiple meters.

7.3. Real-time data

The meter can be configured to transmit real-time read-only data in accordance with IEC62056-21 through one of the serial communication ports. This allows an external device or a SCADA (Supervisory Control And Data Acquisition) system to collect and process the pre-defined metering data as and when it is required.

7.4. Modem connection

The meter supports HAYES[™] command-set compatible modems that conform to the following CCITT protocol standards:

Standard	Effective transfer speed
V.22	1200bps
V.22bis	2400bps
V.32	9600bps
V.32bis	14400bps

The meter can perform bi-directional communication with the attached modem to initialise and control its functions. The modem would normally operate in auto-answer mode.

7.5. Modem information delivery

When a connexion is established with a GSM/GPRS modem ('dedicated line' and 'power supply on'), the meter will read periodically the modem diagnostic to get:

- TimeStamp : Date of this diagnostic
- Rs : Received signal strength indication
- MNC : Mobile Network Code
- PWR : Current power level in dBm
- dBm : Receiving level of the BCCH carrier in dBm
- RXLev : Minimal receiving level (in dBm) to allow registration
- ModemStatus : Modem status regarding network and dedicated channel

If the first modem response is not successful, only one attempt of the Diagnostic request shall be done 5 seconds later.

Remark : Diagnostic is not done when a Cosem communication is in progress in the modem connected channel.

The parameter CustomerModemDiagnosticParameters shall be available on COSEM (Read/Write Access); one element of its structure shall configure the period between 2 GPRS modem diagnostic lectures for customer port : ModemDiagnosticPeriod (from 10 second to 1 day, by default period : 1 hour).

When the parameter ModemDiagnosticType (contained in CustomerModemDiagnosticParameters) is configured to NO_DIAGNOSTIC, modem diagnostics on customer port shall be disable.

A data CustomerModemDiagnosticElements containing the historic of customer modem diagnostic values (TimeStamp, Rs, MNC, PWR, dBm, RXLev, NetworkStatus) for the last 24 values shall be available on COSEM in the recording order.

Current customer modem diagnostic values (TimeStamp, Rs, MNC, PWR, dBm, RXLev, NetworkStatus) shall be available on display.

When CustomerModemDiagnosticParameters is configured by COSEM:

- Customer historic shall be reset.
- Time remaining to next request on customer port shall be reset.

If a customer diagnostic request is running when CustomerModemDiagnosticParameters configuration occurs, the running diagnostic is ignored.

After a power failure:

The time remaining to next request on customer port shall be reset.

At clock setting:

- The time remaining to next request on customer port shall not change.

7.6. Communication protocols and networking

The communication between the meter's RS232 or RS485 serial port and a central system (or network) can be managed in the following three modes:

- Direct IP over Ethernet
- Direct IP over GPRS

In the above two modes the meter is communicating directly with the network system through the modem. Therefore, to ensure the modem is transparent to the communication operation, the modem driver must be integrated into the meter.

• Tunnelling GPRS

In this mode the modem receives data from the meter in HDLC protocol (via the serial port) and manages the communication operation.

ACE6000 Compatibility information

All existing Mark 1 and Mark 2 version meters are compatible with the following communication modes when using a suitable RS232 or RS485 Sparklet modem.

- Direct IP over Ethernet
- Tunnelling GPRS

Note: Meters equipped with an RS485 serial port can only communicate with the network system in the above modes.

The Direct IP over GPRS communication mode is:

- Compatible with Mark 2 meters equipped with an RS232 serial port (meter firmware version 2.6 onwards)
- Not supported by RS485 Sparklet modem type

Fixed or Dynamic IP addresses

The meter can be configured for either fixed or dynamic IP address operation when using:

- an APN (Access Point Name)
- the Direct TCP IP communication mode
- the Tunnelling communication mode

7.7. Communication management

In accordance with IEC 62056-53, security access levels of the DLMS/COSEM protocol are applied to meter communication and interfacing.

Confidentiality and privacy of data are managed by COSEM logical devices in the meter (which can be addressed individually) and different COSEM client identifications (connection profiles).

Each connection profile is protected by a dedicated password and all connection attempts by COSEM clients are checked by the meter before establishing a connection.

The meter has three logical devices:

- Electricity
- Management
- End customer

Several client identifications are predetermined, with different authorisations to access data:

- Electricity Utility Laboratory
- Electricity Utility Field
- Electricity Utility Reader
- End customer

Client	SAP	Allowed logical devices	Access rights	
Electricity Utility	1	Management device	Full read/write	
Laboratory		Electricity device		
Electricity Utility	2	Management device	Full read	
Field		Electricity device	Partial write	
Electricity Utility	3	Management device	Full read	
Reader		Electricity device	Partial write of:	
			meter time setting	
			 end of billing 	
End customer 7		Management device	Read only	
		Electricity device		

8. Meter displays

The meter is equipped with a front-panel mounted, high-visibility, liquid crystal display (LCD) capable of showing the values held in all billing and other registers, as well as configuration and other information displays.

The meter configuration defines which displays are available to the user, the resolution of those displays and the order in which parameters appear. The configuration for any individual meter will initially be defined during manufacture according to the utility requirements. However, it may subsequently be changed using the meter support tool.

8.1. Displays and annunciators

The LCD comprises three main alphanumeric character displays, these represent:

- Value
- Unit
- OBIS Code

A range of annunciator icons are used to identify the current meter display mode and provide indication of various conditions.



Item	Display name	Description		
1	Quadrant	Displays the direction and type of energy currently measured by the meter.		
		The arrows indicate:		
		Active and Reactive		
		Import and Export		
		If the incoming supply phase-sequence is incorrect (e.g. 1,3,2) these icons flash.		
2	Rate	Displays the energy rate allocated to the current energy channel.		
		If there is more than one energy channel configured with the same quantity the current rate of the first channel reached is displayed.		
3	Phase	Each of the three icons represent a connected phase.		
		 If a phase is missing, the associated icon is not lit. 		
		• If voltage sags or swells occur on a phase, the associated icon will blink.		
4	Unit	See table below for range of units.		
5	OBIS code	Displays the associated OBIS code (if applicable) for the energy quantity or meter parameter currently displayed in the LCD.		
6	Value	Displays the currently selected energy quantity or parameter value. This display is configurable for decimal point position and scale (see example below).		
7	Indicators S1 to S12	See annunciator table below.		

W	Wh	var	varh	VA	VAh	V	Ah
kW	kWh	kvar	kvarh	kVA	kVAh	А	Vh
MW	MWh	Mvar	Mvarh	MVA	MVAh	Hz	

The following range of energy units can be displayed:

The annunciator indicators represent the following:

No:	lcon	Name	Description
S1	ALT	Alternate	This icon is permanently lit when the alternate long list display mode is active and flashes when the alternate short list display mode is active.
S2		Lab switch	Indicates that the laboratory switch is activated (an internal link). This icon will remain lit for an hour (max) after the meter is powered-up due to a configurable time out on this function.
S3		Excess current	Indicates the presence of an excess current condition.
S4	⋸ਙ	Magnet attack	Indicates the presence of an external magnetic field.
S5		Current cross	Indicates that the current wiring for I1,I2 or I3 is incorrect.
		phasing	Note: This is a special firmware option only.
S 6		RWP mode	Indicates the meter is in the Reading Without Power mode.
S 7	PM		When the time display format is 12 hour, this icon indicates the afternoon.
S8	AM		When the time display format is 12 hour, this icon indicates the morning.
S9		Excess demand	Indicates when the calculated demand value is higher than the programmed threshold.
S10	\triangleleft	Battery status	This icon is permanently lit to indicate that a no battery condition has been detected (if a no battery alarm has been programmed).
			The icon flashes to indicate that the measured battery voltage is lower than the programmed threshold, or the cumulative power failure duration exceeds three years.
S11	Ø	Communication	Indicates that there is active communication in progress between the meter and an external device.
S12		Alarm	Indicates when the Event Manager has detected an active alarm condition. See below for associated alarms.
8.2. Displayed alarms

Typically, the following alarm conditions **will be** indicated by S12 on the LCD (these may change due to meter firmware revision):

Note: Alarm indication through S12 annunciator will occur only if the specific alarm has been programmed = included in the S12 scope with the Software tool ACE PILOT

- internal or external ram error
- internal or external program memory error
- external clock, configuration or programming incoherence
- non volatile memory non fatal error
- watchdog activity
- no internal consumption
- clock loss
- current reversal (all phases)
- temperature

Typically, the following alarm conditions **will not be** indicated by S12 on the LCD (these may change due to meter firmware revision):

- voltage cuts, sags or swells (all phases)
- zero sequence U and I
- cover opening
- RWP battery low

In addition, any alarm condition covered by its own annunciator (e.g: Magnet attack, Battery) will not be indicated by S12.

8.3. Status word description

Further to the above described alarm indication through the S12 annunciator, it is possible to get the following information on the meter LCD thanks to the error code display:

For the non fatal alarms, the error code is following:

'0000000' (Hexadecimal value)

For the fatal alarms, the error code is following: '00' (Hexadecimal value)

When you check on the LCD, you will have 8 quartets (written 'octet' below) for non fatal alarms:



Correspondence table is below:

Data	Error		
	(8 figures : 8 quartets)		
Non fatal Alarms (AnF on the LCD)			
watchdog activity.	quartet 1 : Bit 0		
battery low alarm	quartet 1 : Bit 1		
neutral loss	quartet 1 : Bit 2		
temperature	quartet 1 : Bit 3		
communications error	quartet 2 : Bit 0		
programming incoherence	quartet 2 : Bit 1		
clock loss	quartet 2 : Bit 2		
external clock incoherence	quartet 2 : Bit 3		
voltage cut (phase 1)	quartet 3 : Bit 0		
voltage sag (phase 1)	quartet 3 : Bit 1		
voltage swell (phase 1)	quartet 3 : Bit 2		
current reversal (phase 1)	quartet 3 : Bit 3		
	1 .		
voltage cut (phase 2)	quartet 4 : Bit 0		
voltage sag (phase 2)	quartet 4 : Bit 1		
voltage swell (phase 2)	quartet 4 : Bit 2		
current reversal (phase 2)	quartet 4 : Bit 3		
voltage cut (phase 3)	quartet 5 : Bit 0		
voltage sag (phase 3)	quartet 5 : Bit 1		
voltage swell (phase 3)	quartet 5 : Bit 2		
current reversal (phase 3)	quartet 5 : Bit 3		
	I		

No internal consumption	quartet 6 : Bit 0
External Alarm (not applicable)	quartet 6 : Bit 1
Zero sequence U	quartet 6 : Bit 2
Zero sequence I	quartet 6 : Bit 3
Excess current	quartet 7 : Bit 0
Configuration incoherence	quartet 7 : Bit 1
Non volatile memory	quartet 7 : Bit 2
Excess demand	quartet 7 : Bit 3
RWP battery low	quartet 8 : Bit 0
Magnet attack	quartet 8 : Bit 1
No battery alarm	quartet 8 : Bit 2
cover opening	quartet 8 : Bit 3
Fatal Alarms (AF on the LCD)	
Internal RAM error.	quartet 1 : Bit 0
External RAM error.	quartet 1 : Bit 1
Internal program memory error.	quartet 1 : Bit 2
External program memory error.	quartet 1 : Bit 3

8.4. Meter pushbuttons

The meter is equipped with two front-panel mounted pushbutton controls located adjacent to the LCD. Typically, the actions generated by these controls depend on:

- the current operating mode and configuration of the meter
- the duration of the button push:
 - **short push** (less than 2 seconds)
 - long push (greater or equal to 2 seconds but less than 5 seconds)
 - very long push (greater or equal to 5 seconds)

Note: Whatever the display mode, pushing both buttons simultaneously has no effect.

The meter can be optionally configured to allow certain parameters to be manually modified using the front panel pushbuttons.

Display pushbutton

This control provides various functions within all display modes as defined by the meter configuration.

Reset pushbutton

Located underneath the hinged front cover, the reset button is typically used to close the current billing period (EOB) and reset the maximum demand indicators (MDI reset).

A metrological seal can be fitted to the hinged front cover to prevent unauthorised use.

8.5. Meter display modes

The meter can be configured with up to three, individual parameter display lists.

Each display list can contain up to a maximum of 100 parameters, such as:

- · the current energy and demand registers values
- fundamental network parameters
- general alarm signal and status word

The parameter display sequence is programmable and globally applied to all three display lists.

Only current parameter values are included in the display lists, as typically, corresponding historical values are displayed automatically, directly after the current parameter value. The meter can be configured to display a number of historical value sets and if they are not available, the display automatically skips to the next current value.

The meter operates in distinct display modes which provide access to the display list contents and other functions, as follows:

Normal mode

This is the default display mode where pre-selected energy parameter values and other meter data automatically scrolls, in sequence, on to the LCD.

Configurable parameters control the following (in one second steps, between 1 and 60 seconds):

- the duration of each displayed parameter
- the period between successive displayed parameters

To exit this mode and activate the:

- alternate long display mode, push the display button once (short push)
- alternate short display mode, push the reset button once (short push)
- load profile (P.01 & P.02) and MID display mode, push the display button once (long push)

Note: The LP and MID display modes are only available if the meter configuration has been programmed accordingly.

On entering either alternate display mode, the LCD is backlit and shows the first parameter in the display sequence.

Alternate long mode

This mode provides a manual display of pre-selected parameters accessible to the end user.

The ALT annunciator icon will be lit.

Alternate short mode

This mode can only be accessed with the reset button unsealed. Typically, it allows the manual display of preselected parameters accessible only by the utility company.

The ALT annunciator icon will flash.

Display navigation

- to advance the display to the next parameter, push the display button once (short push)
- to auto-scroll through the parameter sequence, hold down the display button
- to exit the mode, either auto-scroll or manually advance the display past the last parameter entry. The display will then return to the normal mode and the LCD backlight will automatically turn off

After a predefined inactivity time-out period, the meter returns automatically to the normal mode.

Reset pushbutton operation

If the reset button is pushed (long push) in either display mode, one of the following occurs:

- if the displayed parameter can be modified by the user, the Set mode is activated
- if the displayed parameter cannot be modified by the user and an EOB confirmation has not been selected, an end of billing event (EOB) event occurs
- if the displayed parameter cannot be modified by the user and an EOB confirmation has been selected, the meter displays the pre-configured EOB confirmation string.

To confirm the EOB event, the reset button must be pushed once (long push) while the confirmation string is visible.

P.01 P.02 and MID (page Erreur ! Signet non défini.)

On entering this display mode, the LCD is backlit and shows the first level in the display sequence. These levels will only be displayed if the meter has been configured accordingly.

- to enter the displayed level, push the display button once (long push)
- to advance to the next level, push the display button once (short push)

When the end of the display level sequence has been reached, the LCD shows End.

On entering a display level, the LCD shows the first parameter from its non-programmable display list. These parameter values are dependent on the meter configuration and cannot be modified using the set mode.

To display the next parameter in the list, push the display button once (short push).

Note: There is no auto-scroll function in these display levels.

To exit these display levels, push the display button once (very long push).

After a predefined inactivity time-out period, the meter returns automatically to the normal mode.

Reset pushbutton operation

- if an EOB confirmation has not been selected, an end of billing event (EOB) event occurs
- if an EOB confirmation has been selected, the meter displays any pre-configured EOB confirmation string. To confirm the EOB event, the reset button must be pushed once (long push) while the confirmation string is visible.

Set mode

In this mode, it is possible to modify certain pre-defined meter parameters, such as date or time.

On entering this mode, the leftmost digit of the displayed parameter will be flashing.

If the digit requires modification

- 1. push the display button (short push) to increment the digit value
- 2. when satisfied with the modification, push the reset button (short push) to set the value and automatically move to the next digit

If a digit does not require modification

push the reset button (short push) to move to the next digit

Repeat the above steps for all digits.

When the last digit has been set, the whole parameter will flash:

- 3. push the reset button (short push) to record the value
- 4. push the display button (short push) to advance to the next parameter in the list

After a predefined inactivity time-out period, the meter returns automatically to the previous alternate mode.

9. Technical appendix

9.1. Logbook contents

The following table contains a list of selectable logbook events (these may change due to meter firmware revision):

Event	Description	
PERIODICAL EOI	Periodical end of integration period	
ASYNCHRONOUS EOI	Asynchronous end of integration period	
PERIODICAL EOB	Periodical end of billing period	
PROGRAMMED EOB	Pre-programmed end of billing period	
ASYNCHRONOUS EOB	Asynchronous end of billing period	
INDEX_DPM	Change of index (from index table)	
RESTORE_INTERNAL_INDEX	Prompt for restoring internal index	
DAY_PROFILE_CL	Change of current day profile	
RESTORE_INTERNAL_DAY_PROFILE	Restoring internal current day	
SEASON_SM	Change of current season	
RESTORE_INTERNAL_SEASON	Restoring internal current season	
DST_WITH_SEASON	Change of current season (linked to DST)	
ENTER_DOWNLOAD_MODE	Enter the download mode	
SAVE_MANUFACTURER_PARAMETERS	Backup manufacturing parameters	
ASSOCIATION_LN_PROGRAMMING	Programming action	
INDEX_PARAMETER	Index	
NON_FATAL_ALARM_APPEARANCE	Appearance of a non-fatal alarm	
NON_FATAL_ALARM_DISAPPEARANCE	Disappearance of a non-fatal alarm	
FATAL_ALARM_APPEARANCE	Appearance of a fatal alarm	
PARAMETERS_SAVING	Parameters saving (see note 1 below)	
CLEAR_NON_FATAL_ALARM	Clearing non-fatal alarms	
CLEAR_FATAL_ALARM	Clearing fatal alarms	
INTERNAL_CLOCK_SYNCHRO	Internal clock synchronisation	
CLOCK_SETTING	Clock setting	
DST_WITHOUT_SEASON	DST (without change of season)	
AC_FAIL_APPEARANCE	AC Fail appearance (see note 2 below)	
AC_FAIL_DISAPPEARANCE	AC Fail disappearance (see note 2 below)	
PWR_FAIL_APPEARANCE	Power fail appearance (see note 3 below)	
POWER_UP	Power up	
PROGRAMMING CM	Data programming via communication	

PROGRAMMING DI	Data programming via push button
CANCEL_PROGRAMMING_DI	Cancellation of data programming via push button
RESET_MEASUREMENT_DATA	Reset of measurement data
START_MEASUREMENT	Start measurement
STOP_MEASUREMENT	Stop measurement
START_TRIGGERED_TESTS	Start triggered tests
STOP_TRIGGERED_TESTS	Stop triggered tests
END_OF_DATA_SAVING	End of current data saving
LOAD_PROFILE_RESET	Load profile reset
PASSWORD RESTORATION	Password restoration
INDEX_CLOCK_LOSS	Default clock loss index
SUCCESSFUL COMMUNICATION	Successful communication

Note	Event	Comment
1	PARAMETERS_SAVING	Recorded each time new configuration parameters have been programmed into the meter.
2	AC_FAIL_APPEARANCE AC_FAIL_DISAPPEARANCE	Recorded when a micro power failure (<=1 second) is detected by the meter, at the same time the state of power supply backup is checked.
3	PWR_FAIL_APPEARANCE	Recorded when the meter cut calculation reaches the lower threshold, all meter data is then saved.

9.2. Alarm descriptions

The following table contains a list of alarms (these may change due to meter firmware revision):

Non-fatal alarm	Туре	Description	
WATCHDOG ACTIVITY	Trapped	Watchdog	
		(see note 1 below)	
EXTERNAL CLOCK INCOHERENCE	Trapped	Meter clock programming error	
		(see note 2 below)	
CONFIGURATION INCOHERENCE	Trapped	Incoherence of configuration parameters	
		(see note 3 below)	
NON VOLATILE MEMORY NON FATAL	Trapped	Checksum error in Flash memory	
ERROR		(see note 1 below)	
PROGRAMMING INCOHERENCE	Trapped	Incoherence of parameters programmed	
		(see note 4 below)	
COVER OPENING	Trapped	Detection of abnormal use of terminal cover	
NO INTERNAL CONSUMPTION	Self-healing	No internal energy consumed for more than n days	
ZERO SEQUENCE U	Self-healing		
ZERO SEQUENCE I	Self-healing		

CLOCK LOSS	Self-healing	Incoherence of internal clock after power cut
		(see note 5 below)
NEUTRAL LOSS		
CURRENT REVERSAL (PHASE 1)	Self-healing	Change of direction of current flow on phase 1
CURRENT REVERSAL (PHASE 2)	Self-healing	Change of direction of current flow on phase 2
CURRENT REVERSAL (PHASE 3)	Self-healing	Change of direction of current flow on phase 3
TEMPERATURE	Self-healing	Meter temperature greater than threshold
VOLTAGE CUT (PHASE 1)	Self-healing	Voltage cut on phase 1 longer than threshold
VOLTAGE CUT (PHASE 2)	Self-healing	Voltage cut on phase 2 longer than threshold
VOLTAGE CUT (PHASE 3)	Self-healing	Voltage cut on phase 3 longer than threshold
VOLTAGE SAG (PHASE 1)	Self-healing	Voltage sag on phase 1 longer than threshold
VOLTAGE SAG (PHASE 2)	Self-healing	Voltage sag on phase 2 longer than threshold
VOLTAGE SAG (PHASE 3)	Self-healing	Voltage sag on phase 3 longer than threshold
VOLTAGE SWELL (PHASE 1)	Self-healing	Voltage swell on phase 1 longer than threshold
VOLTAGE SWELL (PHASE 2)	Self-healing	Voltage swell on phase 2 longer than threshold
VOLTAGE SWELL (PHASE 3)	Self-healing	Voltage swell on phase 3 longer than threshold
BATTERY LOW ALARM	Trapped	RTC battery voltage level less than threshold
		(see note 5 below)
RWP BATTERY LOW		
NO BATTERY ALARM		
MAGNET ATTACK		
EXCESS DEMAND	Self-healing	Demand over threshold detected
COMMUNICATIONS ERROR		

Fatal alarm	Туре	Description
INTERNAL RAM ERROR	Trapped	Permanent checksum error in internal RAM
EXTERNAL RAM ERROR	Trapped	Permanent checksum error in external RAM
INTERNAL PROGRAM MEMORY ERROR	Trapped	Permanent checksum error in internal code
EXTERNAL PROGRAM MEMORY ERROR	Trapped	Permanent checksum error in external code

Note	Alarm(s)	Comment
1	WATCHDOG ACTIVITY NON VOLATILE MEMORY NON FATAL ERROR	When these non-fatal alarms are detected, the meter uses the previous 4 hours backup values. It is recommended you remove/replace the meter, or at least erase the fault with the support software and investigate the situation
2	EXTERNAL CLOCK INCOHERENCE	A non-fatal alarm, where the RTC chip does not accept external programming. If it occurs only once, it has little effect on the meters time management.

3	CONFIGURATION INCOHERENCE	Some possible causes for this alarm may be:	
		• All ellergy fale is used but quality is not selected.	
		Day is not defined from the weekly profile calendar.	
		Incorrect scaler is selected from load profile channel.	
		The faults listed above do not normally occur as the support software checks the configuration prior to saving.	
4	PROGRAMMING INCOHERENCE	This fault does not normally occur as the support software checks the configuration prior to saving.	
		If after configuration programming this alarm appears it may mean the previous configuration contained some different objects that are not supported (or erased) by the new configuration.	
5	CLOCK LOSS	In case of clock loss, the meter takes the reference date of	
		01/01/1992 at midnight.	
		The RTC backup battery requires replacement and time/date will need resetting.	

9.3. MID display list

The MID display list will typically contain the following entries. However, further parameters may be included depending on meter configuration, firmware revision and resource level.

Parameter	Code	Example value	Unit
Active TER import phase 1	IMP PH1	0000000	Wh or kWh or MWh,
Active TER import phase 2	IMP PH2	0000000	according active TER
Active TER import phase 3	IMP PH3	0000000	
Active TER import aggregate	IMP AGG	0000000	
Active TER export phase 1	EXP PH1	0000000	
Active TER export phase 2	EXP PH2	0000000	
Active TER export phase 3	EXP PH3	0000000	
Active TER export aggregate	EXP AGG	0000000	
MID Compliance parameters		MId or not Mid	
SAP	MetEr	ACE661	
Internal firmware revision	Int rEV	1 30	
External firmware revision	EXt rEV	01 50	
Internal checksum	Int chS	FFFFFFF	
External checksum	EXt chS	FFFFFFF	
Current connection parameters	connEct	dirEct or trAnSF	
Energy active class		CLASS 02 or CLASS 05 or CLASS 1 or CLASS A or CLASS B or CLASS C	
Current rating Iref	l rEF	1.0	A
Current rating Imax	I MAX	5.0	A
Connection type		uSE or VdE	
Port communication 1	Port 1	no or rS 232 or	

		rS 485 or tcP IP	
Voltage range	VoltAGE	57 7-100 or 127-220 or 230-400	V
Control output number	CO Numb	0 or 4	
Nominal frequency	FrE	50.00 or 60.00	Hz
Value of CT numerator	CTn 1	0000000	
Value of CT denominator	CTd 1	0000000	
Value of VT numerator	VTn 1	0000000	
Value of VT denominator	VTd 1	0000000	
Date of CT/VT programming	DATE 1	DD:MM:YY	
Time of CT/VT programming	TIME 1	HH:MM:SS	
Previous value of CT numerator	CTn 2	0000000	
Previous value of CT denominator	CTd 2	0000000	
Previous value of VT numerator	VTn 2	0000000	
Previous value of VT denominator	VTd 2	0000000	
Previous date of CT/VT programming	DATE 2	DD:MM:YY	
Previous time of CT/VT programming	TIME 2	HH:MM:SS	
Oldest value of CT numerator	CTn 10	0000000	
Oldest value of CT denominator	CTd 10	0000000	
Oldest value of VT numerator	VTn 10	0000000	
Oldest value of VT denominator	VTd 10	0000000	
Oldest date of CT/VT programming	DATE 10	DD:MM:YY	
Oldest time of CT/VT programming	TIME 10	HH:MM:SS	

9.4. OBIS codes for data of the display list

To be completed



Installation Guide

1. Security and safety information

Meters must be installed and maintained only by suitably-qualified personnel. Observe the following safety advice when performing installation or service work on meters.

Meter handling



Before installing or removing a meter, or removing the terminal cover for any reason, isolate the meter from the mains supply by removing the supply-side fuses or using alternative local arrangements. Take appropriate measures to ensure that the isolation cannot be overridden by another person. For example, keep physical possession of the supply fuses.

- Adhere strictly to all relevant national regulations for the avoidance of electrical accidents.
- Always disconnect all measurement and auxiliary circuit connections from the meter before attempting to open the meter housing.
- Use only tools that have been approved for electrical installations.
- Clean meters only with a damp cloth or sponge. Do not use excessive or running water.

Installation



Install meters in accordance with the voltage and current specifications printed on the front panel and the wire and environmental specifications given in the installation information.

- The meter measuring and auxiliary circuits must be galvanically isolated.
- All voltage paths (measurement and auxiliary) must be fused.
- The meter voltage connections must be physically separated from the communication lines in accordance with local laws and regulations.
- Do not install meters that are obviously damaged.
- Do not install meters that have been dropped or otherwise subjected to significant impact even if no damage can be seen.
- Do not HIPOT/Dielectric test the auxiliary or communication circuit connections.
- Do not use any meter functions or features for primary protection purposes.
- Do not install meters where failure of the device could cause death, injury or release sufficient energy to start a fire.
- Following installation, ensure that the meter terminal covers are correctly fitted and sealed to
 prevent user access.

Transformer connections



Observe all industry guidelines and safety precautions when performing any installation or service work on meters connected to Voltage (VT) and/or Current Transformers (CT).

Contact with transformer connections while current is flowing in the primary will result in severe personal injury or death.

Transformers that do not have a ground connection on the secondary may reach dangerously high output voltages.

- Always isolate voltage transformers by removing their fuses.
- Always short-out current transformer secondary circuits.
- Always ensure the transformer secondary circuit is connected to ground unless a special wiring arrangement is required.
- Always exercise extreme caution when handling transformer connections, especially if the transformer secondary does not have a ground connection.

2. Installation

2.1. Warnings



DANGER OF ELECTRIC SHOCK

Before and during installation of a meter, observe all requirements given in the Safety information.

In particular:

- Meters must be installed only by suitably-qualified personnel.
- Ensure that the meter supply cabling is isolated from the mains supply, and that the isolation cannot be overridden by another person.
- Following installation, ensure that the meter covers are correctly fitted and sealed to prevent user access.

2.2. Environmental

ACE6000 meters are certified for indoor use only. Do not install meters outdoors unless they are housed in an enclosure which can maintain the specified environmental requirements.

Parameter	Range		
Temperature	-40°C to +70°C		
Humidity	Up to 95% RH		
Environmental protection	IP 54		

2.3. Dimensions

The meter can be factory-fitted with either a short or long terminal cover.



Meter dimensions - short terminal cover

ltem	Dimension	Description
Α	152	Meter body width
В	173	Terminal cover width
C	234	Meter length including terminal cover
D	241	Overall length, hanging bracket fully retracted
E	68	Meter body depth
F	74	Terminal cover depth

Meter dimensions - long terminal cover

ltem	Dimension	Description		
С	294	Meter length including terminal cover		

D	301	Overall length, hanging bracket fully retracted
F	78	Terminal cover depth

All dimensions are in millimetres.

2.4. Fixings

The meter is fitted with a four-step adjustable hanging bracket that provides an upper fixing point. Two further lower fixing points are located within the terminal area; these can be accessed only by removing the terminal cover.



Item	Dimension	Description
------	-----------	-------------

Α	201	Upper fixing point to lower fixing points (centre to centre)				
		Hanging bracket in first position (fully retracted)				
В	210	Second position				
С	220	Third position				
D	230	Forth position (fully extended)				
E	150	Left to right lower fixing points (centre to centre)				
F	29	Lower fixing point centre to lower edge of short terminal cover				
F	87	Lower fixing point centre to lower edge of long terminal cover				

All dimensions are in millimetres.

2.5. Using aluminium cables



The certification of meters in respect of current rating is valid only when used with **copper supply and load cables** of the **correct diameter**. If aluminium cables are to be used, the meter current rating will be downgraded, and the meters should be ordered with plated terminals instead of standard brass terminals.

Meters with standard brass terminals should not be connected directly to aluminium mains cables, as this may cause corrosion due to electrolytic action.

If a meter with brass terminals must be used in premises with aluminium cables, it is highly advisable to:

- Terminate the aluminium cables in a suitable junction box close to the meter.
- Complete the connections to the meter with copper cables > 0.5m in length.

Alternatively, use suitable copper cable-sheaths on the terminating ends of the aluminium cables.

This will prevent terminal corrosion, and allow the meter to be used at its certified current rating.

2.6. Cabling

Main terminal wiring

The main terminal is the same design and specification for both Direct and Transformer connection meter types.



Terminal	Function	Terminal	Function	Terminal	Function	Terminal	Function
	PH1		PH2		PH3		
1	l1 in	4	l2 in	7	13 in	10/11	Neutral in
2	U1 in	5	U2 in	8	U3 in	12	Neutral out
3	I1 out	6	I2 out	9	I3 out		

Main terminal specification

Terminal type	Clamp screws	Cable diameter (max)	Meter type
Voltage	2 x M3	3.2mm	Transformer only
Current	2 x M6	8mm	Direct and Transformer

The meter can be configured for both 3 and 4 wire cabling, as shown in the following topics.

Note: All examples show three-phase wiring.



4 wire asymmetrical (VDE) current transformer configuration

Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	7	3	I3- CT3 in
2	1	U1 - Voltage	8	3	U3 - Voltage
3	1	I1 - CT1 out	9	3	I3 - CT3 out
4	2	I2 - CT2 in	10/11	Ν	Un - Neutral
5	2	U2 - Voltage	12		No connection
6	2	I2 - CT2 out			

Typical wiring illustrated below:







Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT in	7	3	I3- CT in
2	1	U1 - Voltage	8	3	U3 - Voltage
3	1	I1 - CT out	9	3	I3 - CT out
4		No connection	10/11		No connection
5	2	U2 - Voltage	12		No connection
6		No connection			

Typical wiring illustrated below:



4 wire symmetrical (USE) current transformer configuration



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT in	7	Ν	Un - Neutral
2	1	U1 - Voltage	8	3	I3 – CT out
3	2	I2 - CT in	9	2	I2 – CT out
4	2	U2 - Voltage	10/11	1	I1 – CT out
5	3	I3- CT in	12		No connection
6	3	U3 - Voltage			

Typical wiring illustrated below:





4 wire asymmetrical (VDE) direct connection configuration

Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - Phase 1 in	7	3	I3- Phase 3 in
2		No connection	8		No connection
3	1	I1 - Phase 1 out	9	3	I3 - Phase 3 out
4	2	I2 - Phase 2 in	10/11	Ν	Un - Neutral in
5		No connection	12	Ν	Un - Neutral out
6	2	I2 - Phase 2 out			

Typical wiring illustrated below:



3 wire asymmetrical (VDE) direct connection configuration



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - Phase 1 in	7	3	13 - Phase 3 in
2		No connection	8		No connection
3	1	I1 - Phase 1 out	9	3	I3 - Phase 3 out
4	2	I2 - Phase 2 in	10/11		No connection
5		No connection	12		No connection
6	2	I2 - Phase 2 out			

Typical wiring illustrated below:



4 wire symmetrical (USE) current transformer configuration

2.7. Battery

The meter is designed so the lithium battery can be safely installed or replaced while the meter is operating, as follows:

- 5. Unseal and open the hinged front cover.
- 6. If fitted, remove the seal from the battery holder.
- 7. Gripping the battery holder (1) as shown, gently pull it out from the meter until the stop is reached.
- The meter may be initially shipped with the battery in the forward slot, this is the disconnected position (2). If this is the case, slide the battery to remove it and place in the rearmost slot, this is the connected position (3).

Due to the design of the battery holder it is not possible to slide the battery in the wrong way round.

If the battery is being replaced, ensure the new one is fitted in the connected position.



- 9. Firmly push the battery holder back into the meter until it clicks into position.
- Using the meter support tool, clear any battery error indications/alarms and reset the battery expected life time value.
- 11. Re-seal the meter as necessary.

2.8. Installation checks

Before connecting the mains supply to the installed meter, carefully check that:

- the correct meter type with the right identification number has been installed for this client at this metering point.
- all mains supply and auxiliary cables are connected to the correct terminals.
- all cable clamp screws are securely tightened.
- the battery has been correctly installed.

2.9. Start-up and functional checks

Take the following steps to check that the meter is functioning.

- 12. Connect the mains supply to the meter.
- 13. Check that the LCD display turns on and shows coherent displays.

Depending on the meter configuration, the LCD may move automatically through a sequence of displays, or it may be necessary to use the meter display pushbutton to move through the sequence.

- 14. Check that the meter is in the start mode (STOP is not displayed).
- 15. Check the phase sequence is correct; the quadrant indicator icons in the LCD should not be flashing.
- 16. Apply a load to the meter and check that the metrology LED (active kWh) starts to flash.

The flash rate is proportional to the load.

- 17. Using the IR port, connect a support tool enabled PC to the meter and:
 - read the Total Energy Registers (TER) values
 - read all instantaneous values
 - read the meter status values and its configuration
 - erase any non-fatal alarms
- 18. Carry out the LCD test and confirm all the display segments and annunciator icons are lit.
- 19. Wait for approx 15 minutes while the meter operates.
- 20. Check the TER values have incremented from their initial values.
- 21. Check the maximum demand value is consistent with the applied load.
- 22. Re-check meter status.

If the support tool 'Toolbox' application is available:

- 23. Use the Toolbox functions to verify all aspects of meter operation.
- 24. Save and print the results as evidence of correct operation.

2.10. Sealing the meter

Before leaving the installation site, fit the terminal cover, and seal the meter against unauthorised access or tampering by fitting wire or plastic seals in the following locations:



Battery holder

Underneath hinged front panel

- 2 Main cover
- 3 Hinged front panel
- 4 Terminal cover