SL7000 IEC7

User Guide

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Contents

1. About this guide

1.1. Audience

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

1.2. 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

1.3. Abbreviations

AC	Alternating current	**M**	Mega (10^6)
ANSI	American national standards institute	**Max**	Maximum
CE	European conformity (logo)	**MDI**	Maximum demand indicator
Cosem	Companion specification for energy metering	**MID**	Measurement instruments directive (European Union)
CT	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
HHT	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
Ib	Base current	**secs**	Seconds
I/O	Inputs and outputs	**T**	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

2. Certification

2.1. Applicable standards

The SL7000 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 62053-24 (Project)** Electricity metering equipment (AC) - Particular requirements, part 24: Static meters for reactive energy (classes 0,5 S, 0,5, 1S and 1)
- **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)
- **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.

2.2. 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) : SL761B / SL761E (type)

- compteur statique d'énergie électrique à branchement derrière transformateur :SL761B
- compteur statique d'énergie électrique à branchement direct : SL761E
- Triphasé 4 fils et triphasé 3 fils
- 3x57,7/100…3x240/415 V et 3x57,7/100…3x277/480 V(seulement pour compteur derrière transformateur)
- Courant de référence pour SL761B : 1 ; 1,5 ; 2,5 or 5A avec un courant maximum plus petit ou égale à 10A
- Courant de référence pour SL761E : 5 ; 10 ; 15 or 20A avec un courant maximum plus petit ou égale à 120A
- 50 Hz / 60 Hz

Declare that the product(s) : SL761B / SL761E (type)

- Electrical energy static meter for in-direct connecting : SL761B with maximum current smaller or equal to 10A
- Electrical energy static meter for direct connecting : SL761E with maximum current smaller or equal to 120A
- Three-phase four-wire network and three-phase three-wire network
- 3x57,7/100…3x240/415 V and 3x57,7/100…3x277/480 V(only for indirect connecting meter)
- Reference current for SL761B : 1 ; 1,5 ; 2,5 or 5A
- Reference current for SL761E : 5 ; 10 ; 15 or 20A
- 50 Hz / 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 des directives 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 Directives :

- **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 :

- **IEC 62052-11** Electricity metering equipment (AC) : General requirements
- **IEC 62053-22** Electricity metering equipment (AC) : Particular requirements-Active energy (class 0.2 S and 0.5 S)
- **IEC 62053-23** Electricity metering equipment (AC) : Particular requirements-Reactive energy (class 2)

- **EN 50470-1** Electricity metering equipment (AC) : Part 1 General requirements
- **EN 50470-3** Electricity metering equipment (AC) : Part 3 Particular requirements

(NMI test report : CVN-705077-01 : ref Actaris D2002169)
(NMI test report : CVN-9200079-01 : ref Actaris D201 3808)

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 : **15 Juin 2009**
Date of affixing « CE » marking: **15th June 2009**

Signature : J.TALBOT
QSE Manager

Title : SL7000-IEC5/VAL/CE_CERTIF			
Type of doc : Product_Qualification_Report Filename : MARQUAGE_CE_SL761B_E.DOC	Project : AMBER	Released	Rev. date : 17/06/2009
Owner : FERTILLET Claude	Itron	Page : 1/1	D2002170-AB

2.3. End-of-life disposal

SL7000 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.

3. 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.

4. General information

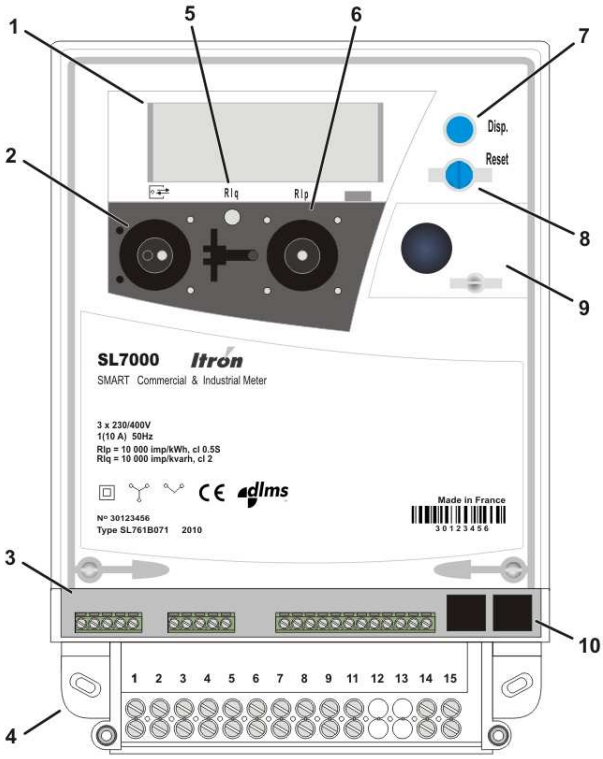
4.1. Meter overview

The SL7000 is a static, polyphase, four-quadrant, multi-rate meter. It is intended for large industrial to substation 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 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
Load profiling	2 independent sets of 8 recording channels giving up to 16 load profile channels Incremental data
Communication	RS232 + RS232 or RS485 DLMS-Cosem compliant PSTN, LAN (TCP/IP), GSM and GPRS media supported Remote Firmware upgrade possibility
Network quality monitoring	Voltage cuts, sags and swells Total Harmonic Distortion (THD) Waveform capture (per phase Urms and Irms)

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



1 Liquid crystal display (LCD)
2 Infrared communication port
3 Auxiliary I/O terminal blocks
4 Main wiring terminal block (Transformer connection type shown)
5 Reactive power metrology LED (Rlq)
6 Active power metrology LED (Rlp)
7 Display pushbutton
8 Reset pushbutton
9 Battery holder
10 Serial communication ports

4.2. General specifications

Frequency	50/60 Hz
Connection wiring	3 or 4 wire
Connection configuration	Direct or Transformer
Terminal wiring	VDE (asymmetrical) and for CT only : USE (symmetrical)
Real Time Clock backup	Field-replaceable battery and Internal super-capacitor
Enclosure type	Panel mounting DIN compliant
Environmental protection	IP 51
Operating temperature	Storage : -40°C to +70°C
Relative Humidity	< 75% (maximum 95%)
Net weight	1.9kg
Maximum meter dimensions (W x H x D)	
Meter body	179 x 261 x 83mm
With short terminal cover	179 x 270 x 83mm
With long terminal cover	179 x 359 x 83mm
Standard terminal cover	179 x 324 x 83mm

Direct connection specifications

Voltage	3 x 57.7/100V up to 3 x 277/480V auto ranging	
Current	Nominal (Ib)	Ib 5A
	Maximum (Imax)	Imax : 120A at 50Hz 100A at 60Hz
Accuracy	Active energy	Class 1
	Reactive energy	Class 1 or 2

Transformer connection specifications

Voltage	3 x 57.7/100V up to 3 x 277/480V auto ranging	
Current	Nominal (Ib)	1A or 5A
	Maximum (Imax)	10A
Accuracy	Active energy	Class 1 / Class 0.5 / Class 0.2
	Reactive energy	Class 1 or 2

Auxiliary power supply specifications

Auxiliary Power Supply	48V DC to 145V DC 48V AC to 288V AC

4.3. Meter support tools

The SL7000 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 tool is currently available:

ACE Pilot

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

- XP (SP3)
- 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

The meter can be equipped with three levels of optional input and output (I/O) ports, as shown:

I/O	No	Light	Full
Control inputs	0	1	2
Pulse inputs	0	2 (only 1 if TCODE option)	4 (only 3 if TCODE option)
Control outputs	0	2	4
Pulse inputs	0	2	6
1st COM port	RS232 or RS485	RS232 or RS485	RS232 or RS485
2nd COM port	RS232	RS232	RS232
TCODE (optional) (see note below)	possible	possible	possible

Note: TCODE is the Terminal Cover Open Detection option..

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
W	CT Class 0.2
X	CT Class 0.5 & Class 1
Y	DC

I/O and COM configuration

Code	Option	I/O Level
06	2 x RS232	Full
07	1 x RS232 + 1 x RS485	Full
08	2 x RS485	Full
20	2 x RS232	No
21	1 x RS232 +1 x RS485	No
22	2 x RS485	No
23	2 x RS232	Light
24	1 x RS232 + 1 x RS485	Light
25	2 x RS485	Light

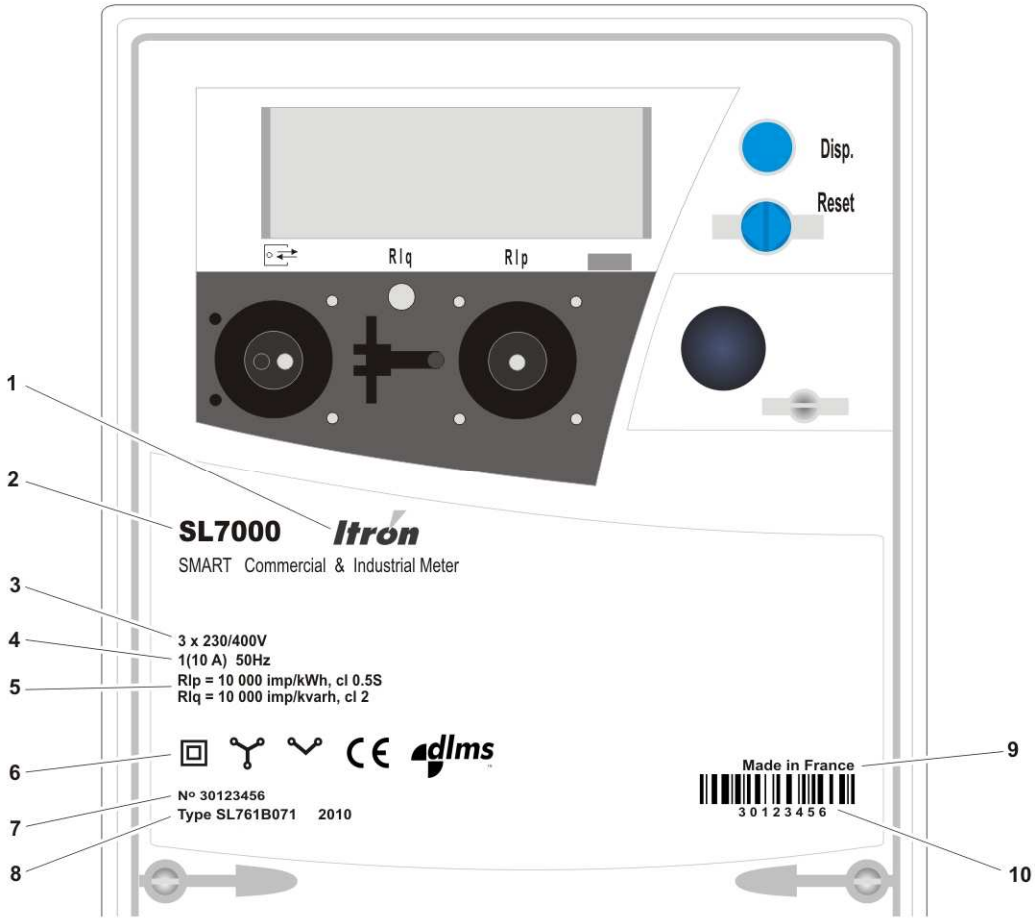
Auxiliary Power Supply (APS)

Code	Option
0	No APS
1	APS fitted

Note: Legal product code is composed of “SL76” + “product version” + “Connection and class”. Following numbers composing the product code are not legal part (for internal and market use only).

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.



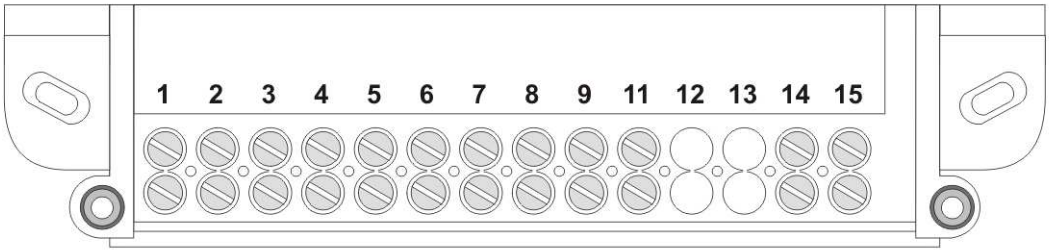
1	Manufacturer name
2	Meter type
3	Nominal voltage
4	Nominal / maximum current and frequency
5	Metrology constant and accuracy class
6	Appropriate symbols (IEC 62053-52) identifying insulation class, measuring elements, and other relevant characteristics
7	Manufacturers unique serial number
8	Meter legal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

4.5.1. Terminal numbering

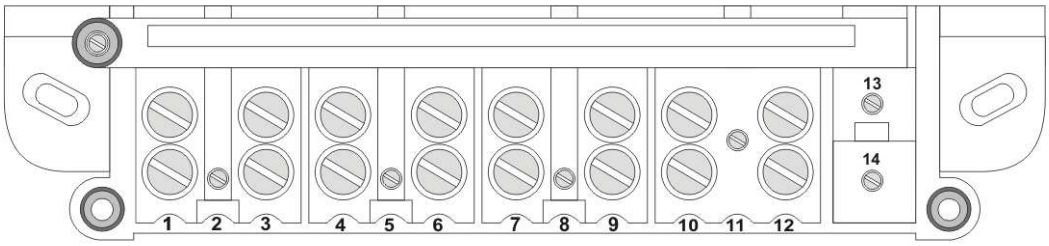
A connection diagram is displayed on the inside surface of the terminal cover showing typical main supply connections for the meter configuration and type.

Terminal numbers corresponding to the connection diagram are moulded into the meter case, either above or below the terminal block depending on the meter connection type.

Transformer connection terminal block



Direct connection terminal block



5. Technical specification

General

Parameter	Description	Data
Meter Type	SL7000	
Connection wiring	3 or 4 wires	
Connection configuration	Direct or Transformer	
Terminal wiring	VDE (asymmetrical) and for CT only : USE (symmetrical)	
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 / Class 0.2

Voltage

Parameter	Details
Reference voltage for autoranging board	3 x 57.7/100V up to 3 x 277/480V auto ranging
Reference voltage for board with APS option	3x57.7/100V up to 3x110/190V
Reference voltage for MRD500 PSU Board	3x230/400V (accepts 3 X 500/860V during 10 seconds)
Operating voltage	-20% to + 15% Un
Voltage Interruptions	1 second

Direct connection current

Parameter	Details
Nominal current (Ib)	5A
Maximum current (Imax)	120A at 50Hz 100A at 60Hz

Transformer connection current

Parameter	Details
Nominal current (Ib)	1A
Maximum current (Imax)	10A

Direct connection starting current and short-time over current

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

Transformer connection starting current and short-time over current

Parameter	Details
Class 1	Ib/500
Class 0.5 / Class 0.2	Ib/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
Type	Liquid Crystal Display (LCD)	
Digit height	Main	12mm
Digit height	OBIS code	8mm
Resolution	Number of digits	9

Communications

Parameter	Description	Data
Optical communications	i.a.w IEC62052-21	Y
	Mode of operation	C
Meter Constant	Direct connection type	1000 pulses per kWh
	Transformer connection type	10000 pulses per kWh Alternative values can be programmed at manufacture
Serial Data Communications	RS232, and RS232 or RS485	RJ45 connectors
	Baud rate	9600 up to 19200
Supported protocols	DLMS/Cosem	Y
Communication media types	TCP	With external LAN modem
	GPRS	With external modem
	GSM	With external modem

Parameter	Description	Data
Real-time operation “Real Time Port”	i.a.w. IEC62056-21	Y
Modem power supply	10V -10/+20%, 300mA, 3W max	on RJ45 connectors. 3W is the maximum shared on the 2 ports for a triphased power supply >100V (Ph/N)

Input and output

Parameter	Description	Data
Control input	Optically-isolated, high-level	Up to 2 inputs + common connection point
	Minimum input voltage	40V (AC/DC)
	Maximum input voltage	288V DC 300V AC
	Maximum input current	3mA
Control output	Optically-isolated, high-level	Up to 4 outputs + common connection point
	Maximum switching voltage	288V DC 300V AC
	Maximum switching current	100mA
Pulse input (DIN S0)	Optically-isolated	Up to 6 inputs + common connection point
	Maximum switching voltage	27V DC (provided by the meter)
	Maximum switching current	30mA
	Impedance	1.1kΩ
Pulse output (DIN S0)	Optically-isolated	Up to 4 outputs + common connection point
	Impedance	$< 300\Omega$

Environmental

Parameter	Description	Data
Temperature Range	Operating range	-40°C to +70°C
Humidity range	Maximum operating value	95%
Protection class	According to IEC 60529	IP 51
Isolation Protection	AC voltage at 50Hz for 1 minute	4kV Class 2
Immunity to impulse voltage	According to IEC 62052-11 Waveform of pulse voltage 1.2/50µsecs Source impedance 500ohms, energy 0.5 joules	8kV
Immunity to magnetic fields	Magnetic AC (50Hz) field 0.5mT according to IEC62053 - 21 (400AT	Fully immune

Parameter	Description	Data
	coil)	
	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 main circuits	According to IEC61000-4-5 Source impedance 2 ohms	4kV
Surge immunity auxiliary circuits	According to IEC61000-4-5 Source impedance 42 ohms	1kV
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 80MHz to 2GHz	10V/m
	Without current, 80MHz to 2GHz	30V/m
Fast transient burst	Main circuits : Fast transient burst i.a.w. IEC 61000-4-4	4kV common-mode and pseudo differential
	Auxiliary circuits : Fast transient burst i.a.w. IEC 61000-4-4	2kV common-mode
Radio Interference	RF suppression	CISPR22 Class B

Weight and Dimensions

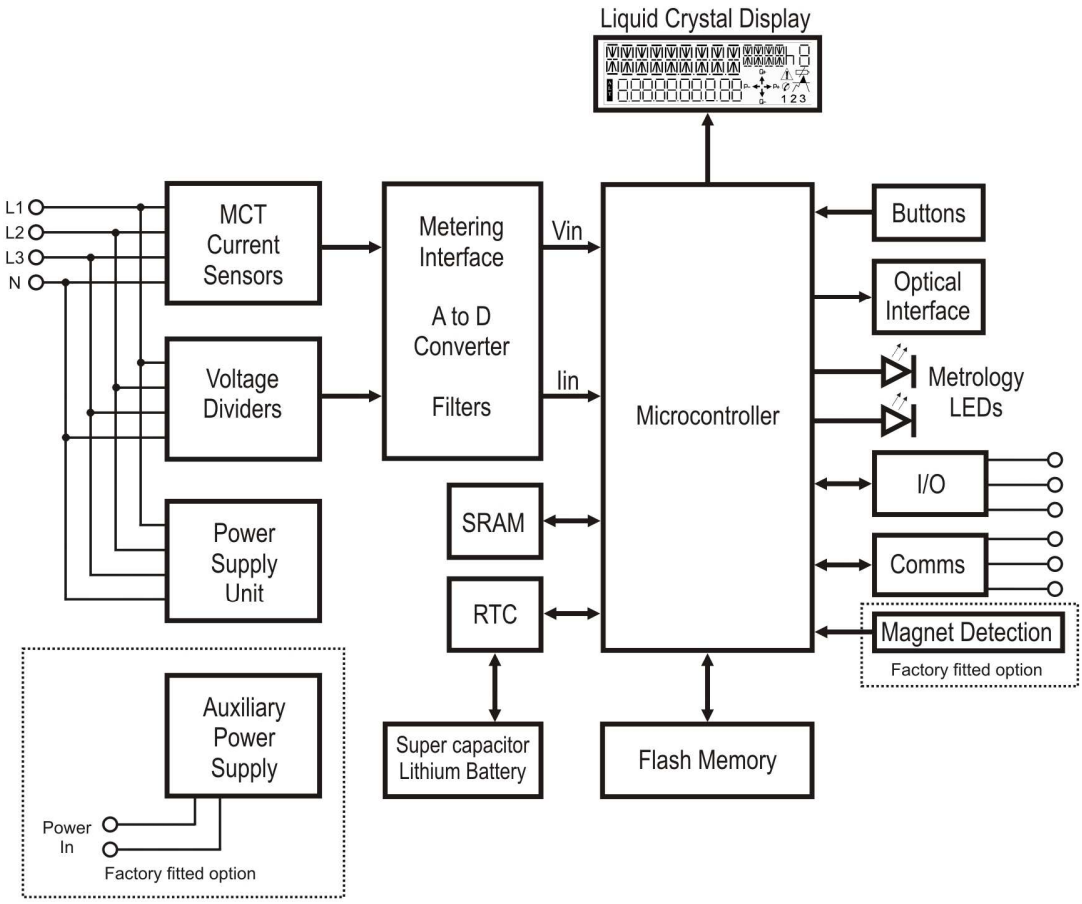
Parameter	Description	Data
Weight		1.9kg nominal
Dimensions (width x height x depth)	Without terminal cover	179 x 261 x 83mm
	With short terminal cover	179 x 270 x 83mm
	With long terminal cover	179 x 359 x 83mm
	With standard terminal cover	179 x 324 x 83mm

6. Technical description

The main components of the SL7000 meter are assembled onto three printed circuit boards (PCBs):

- metrology voltage divider circuitry and the switched-mode power supply
- microcontroller and memory devices and I/O circuitry
- 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.

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.

Note: This feature is not available for MID compliant meters.

6.2. External connections

The meter may be configured with a number of input and output facilities, as detailed in this section.

6.2.1. Control input

The meter can be factory-configured with a number of control inputs for connection to further meters or other external equipment such as time switches.

The control inputs can be individually assigned and used to trigger meter actions such as:

- forcing the end of an integration (EOI) or billing (EOB) period
- clock synchronisation
- indicating an external alarm
- changing the tariff rate
- changing calendar parameters such as season or day profile
- display scrolling
- pulse input direction

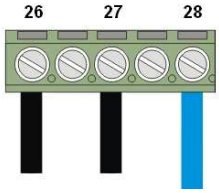
Control input terminals

The control input terminal block provides a common connection point and accepts cables up to 2.5mm².

Minimum input voltage = **40V (AC/DC)**

Maximum input voltage = **288V AC, 300V DC**

Maximum input current = **3mA**

Terminal	Function	Typical wiring
26	Control input 1	
27	Control input 2	
28	Common	

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:

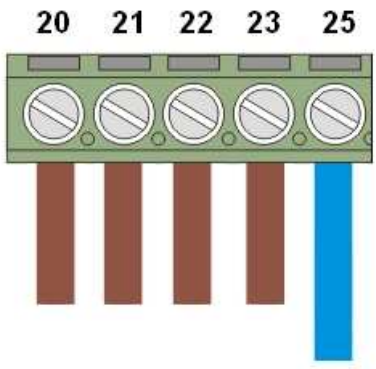
- the end of an integration (EOI) or billing (EOB) period
- an alarm
- tariff indication
- a clock synchronisation pulse
- a pulse output
- an excess demand or phase cut

Control output terminals

The control output terminal block provides a common connection point and accepts cables up to 2.5mm².

Maximum switching voltage = **288V AC, 300V DC**

Maximum current = **100mA**

Terminal	Function	Typical wiring
20	Control output 1	
21	Control output 2	
22	Control output 3	
23	Control output 4	
25	Common	

Note: Depending on the factory configuration, the meter may not be fitted with Control outputs 3 and 4.

Pulse input

The meter can be factory-configured with a number of optically-isolated pulse inputs for connection to further DIN S0 meters or other pulse output devices that are compliant with IEC 62053-31.

Received pulses are recorded in separate external-energy registers as total pulse counts and can represent metered energy types such as electricity, water or gas as either import or export energy values. Depending on the meter configuration, these external-energy register values can be included in the metering data in a number of ways.

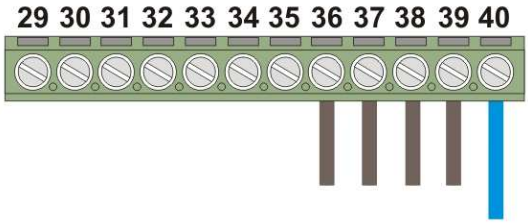
Pulse input terminals

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

Maximum input voltage (provided by the meter) = **27V DC**

Maximum current = **30mA**

Impedance = **1.1kΩ**

Terminal	Function	Typical wiring
36	Pulse input 1	
37	Pulse input 2	
38	Pulse input 3	
39	Pulse input 4	
40	Common	

Note: Depending on the factory configuration, the meter may not be fitted with Pulse inputs 3 and 4.

Pulse output

The meter can be factory-configured with a number of optically-isolated pulse outputs for connection to further DIN S0 meters or other pulse input devices that are compliant with IEC 62053-31.

Pulse output characteristics such as duration and frequency can be individually programmed and each output can be assigned to represent a configurable quantity of either import or export metered energy.

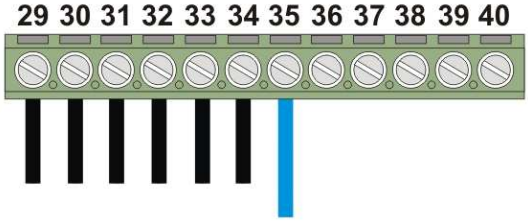
Pulse outputs can be redirected to Control outputs and can also be configured to provide a metrological output (when the LED flashes a pulse is sent).

Pulse output terminals

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

Maximum output voltage = **27V DC**

Impedance < **300Ω**

Terminal	Function	Typical wiring
29	Pulse output 1	
30	Pulse output 2	
31	Pulse output 3	
32	Pulse output 4	
33	Pulse output 5	
34	Pulse output 6	
35	Common	

Note: Depending on the factory configuration, the meter may not be fitted with pulse outputs 3 to 6.

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 62052-11 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 1 second.

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

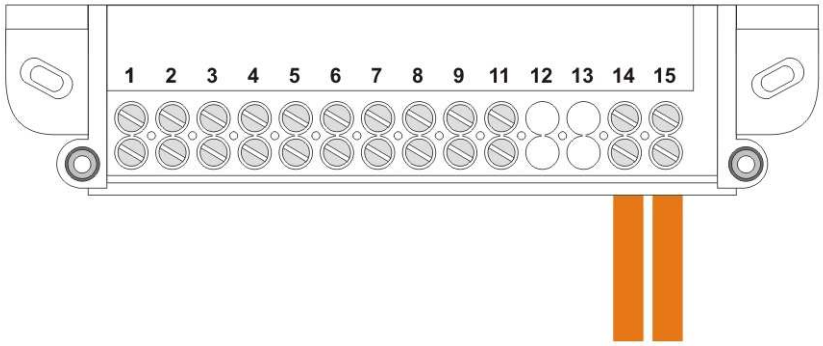
Auxiliary power supply

The meter can be optionally equipped with an Auxiliary Power Supply (APS) which allows the meter to be powered from an external source as an alternative to the distribution-network. Both APS source and network voltages can be applied to the meter at the same time and while the APS source is present, no power is drawn from the network during normal meter operation.

If the APS source is present and the network supply fails the metrology stops operating but metered data can be read.

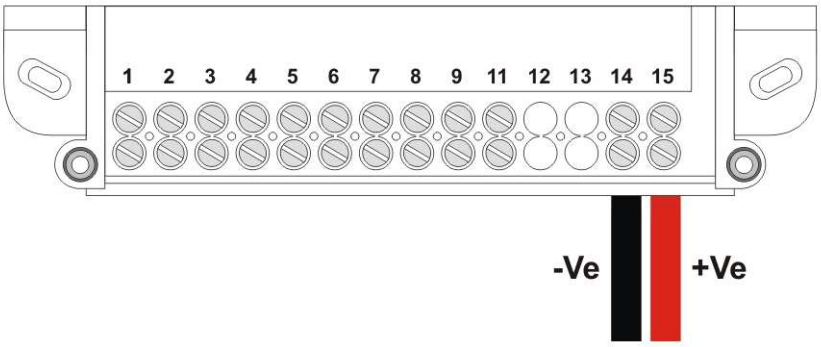
The APS accepts an AC voltage input ranging from 48V to 288V. The APS is isolated from the measurements voltages (2kV of isolation).

Typical AC voltage APS terminal wiring illustrated below:



Alternatively, the APS also accepts an external DC voltage ranging from 48V to 145V.

Typical DC voltage APS terminal wiring illustrated below:



Note: There is no polarization for DC APS (we can connect +Ve on terminal 14 and –Ve on terminal 15.

6.4. Power-fail operation

In the event of a continuous absence of power, all SL7000 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 59) 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.

Note: Tariff switching can also be achieved using external control signals.

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).

The following example illustrates individual weekly profiles for five seasons:

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

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 33) 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 39) and demand (page 42) 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 42).

- **Clock Loss**

  When a clock loss event is detected (backup power supply (page 34) 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:

- **Light capacitor (serial)**

  An internal device specified to provide a minimum capacity of 2 hours power outage carry-over period.

- **Super-capacitor (option)**

  An internal device specified to provide a minimum capacity of 7 days power outage carry-over period.

- **Lithium battery (option)**

  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.

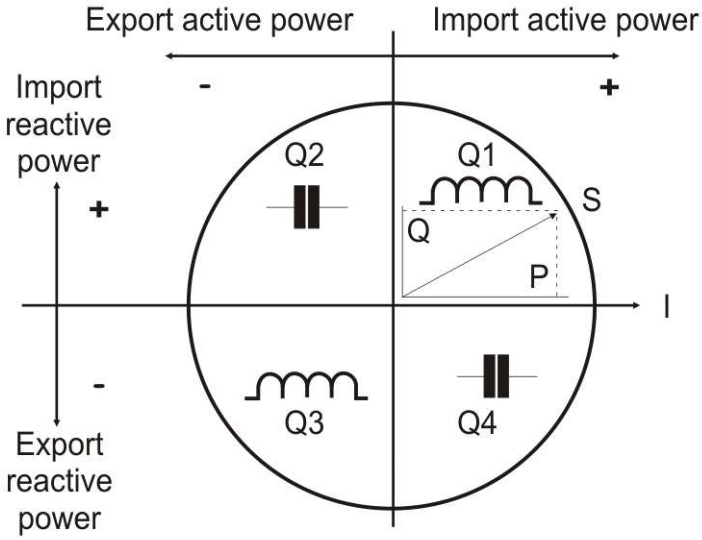
An icon on the LCD is lit when the battery voltage falls below a preset threshold value (nominal battery voltage value 3V).

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

6.9. Metered quantities

6.9.1. Four quadrant metering

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



6.9.1.1. 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

Per quadrant
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 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 Ib/10)

- **Vectorial**

  Quadratic sum of active and reactive powers.

  $S = \sqrt{(P^2 + Q^2)}$ (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.

External Energy - 8 Quantities

Quantity	Direction
External 1+	Import
External 1-	Export
External 2+	Import
External 2-	Export
External 3+	Import
External 3-	Export
External 4+	Import
External 4-	Export

The meter can register up to four external energy inputs from other electricity, water or gas meters, quantities can be measured in:

- kWh
- kvarh
- kVAh

6.9.1.2. 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
Sum 1
Sum 2
Sum 3
Sum 4

Summation energy quantities can be measured in:

- **kWh**
- **kvarh**
- **kVAh**

6.9.1.3. Instantaneous energy quantities

The following quantities are measured and updated every second:

Phase Angles - 6 Quantities

Per phase
Angle U1/I1
Angle U2/I2
Angle U3/I3

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

RMS - 6 Quantities

Voltage	Current
Urms ph 1	Irms ph 1
Urms ph 2	Irms ph 2
Urms ph 3	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)

Total Harmonic Distortion - 14 Quantities

Voltage	Current
U1 (magnitude and relative)	I1 (magnitude and relative)
U2 (magnitude and relative)	I2 (magnitude and relative)
U3 (magnitude and relative)	I3 (magnitude and relative)
U agg (RMS and relative)	I agg (RMS and relative)
U1rms (fundamental)	I1rms (fundamental)
U2rms (fundamental)	I2rms (fundamental)
U3rms (fundamental)	I3rms (fundamental)

6.9.2. 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, pulse input and summation register values.

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

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

The maximum energy register value is just under 1000TWh.

6.9.3. Energy registering

All the measured energy quantities (page 35) recorded by the meter are available for energy registering, such as:

- **Per phase**
- **Aggregate**
- **Summation**

6.9.3.1. 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.

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.

6.9.3.2. 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 39) 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 47) the energy rate registers are read and the values recorded to historical buffer registers (page 48).

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 contract-specified tariff structure.

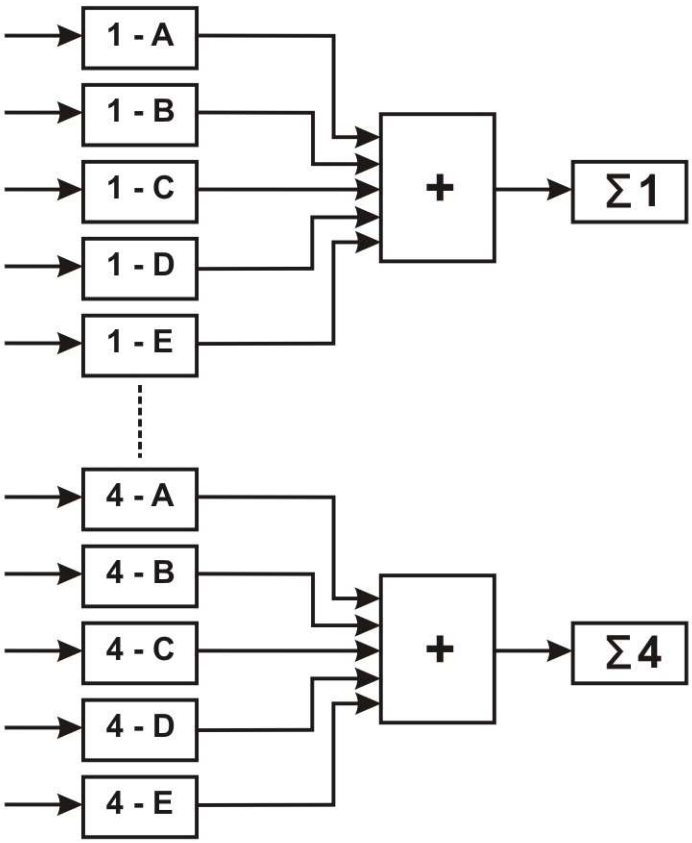
Note: At any one time, only one tariff rate is active for each energy channel.

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.

6.9.3.3. 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 (internal or external) 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.

The summation calculation takes place once-a-second, so any pulse input signal used for summation must have a frequency higher than 1Hz to ensure accuracy.

6.9.4. 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 35) recorded by the meter are available for demand registering, such as:

- **Per phase**
- **Aggregate**
- **Summation**

6.9.4.1. 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.

6.9.4.2. 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**.

6.9.4.3. 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.

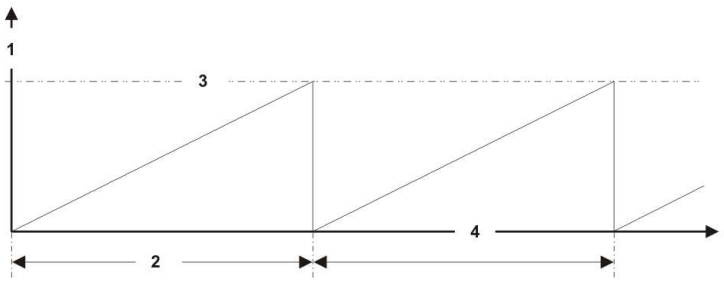
At the end of each completed integration period (EOI):

- 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:



1 Rising value

2 Integration period duration

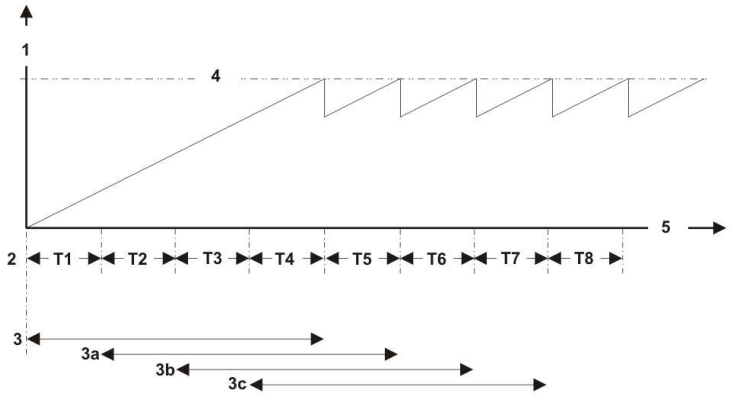
3 Actual demand value

4 Elapsed time

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:



1 Rising value
2 Integration periods
3 First sliding period
3a Second sliding period
3b Third sliding period
3c Forth sliding period
4 Actual demand value
5 Elapsed time

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.

6.9.4.4. 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 - the meter records the 5 highest peaks in the current billing period

The threshold comparison for excess demand detection and the EOI time stamping is also carried out.

6.9.4.5. 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.

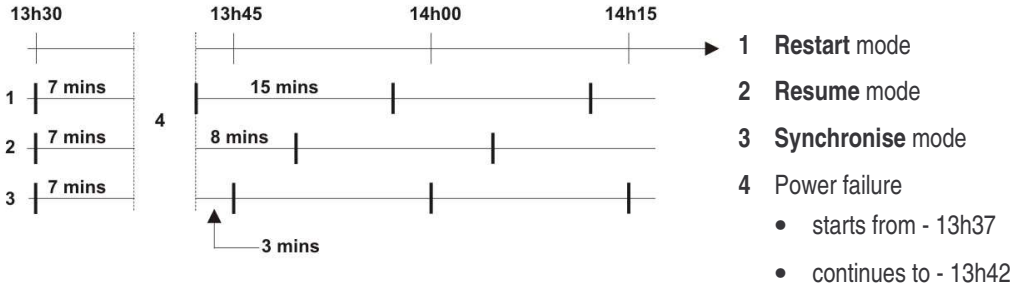
- **Resume**

  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:



6.9.4.6. 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.

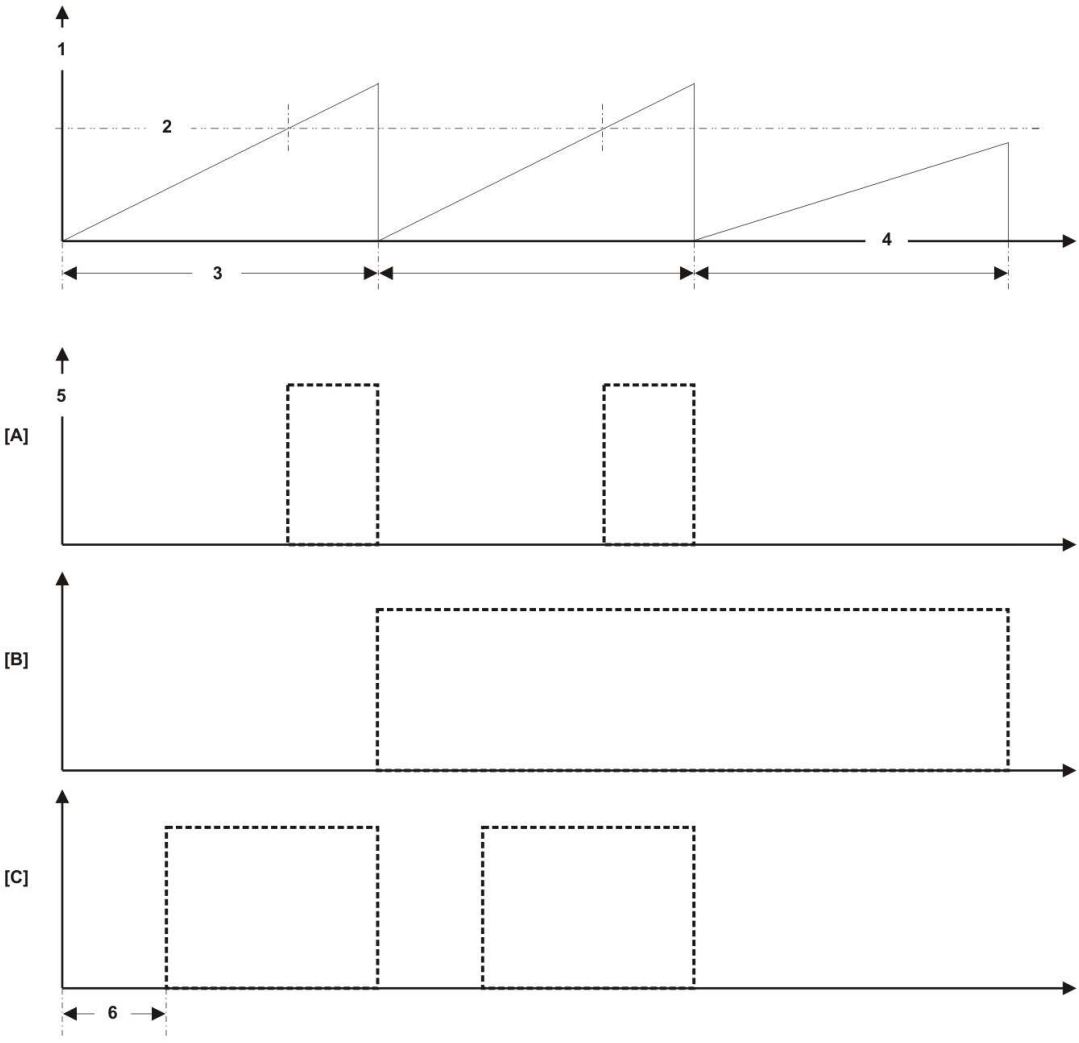
- **End of integration**

  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:



[A] Rising demand mode
[B] End of integration mode
[C] Projection mode

1 Rising value
2 Excess demand threshold
3 Integration periods
4 Elapsed time
5 Excess demand indication
6 30% of integration period

6.9.5. 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 42) 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 35) and certain instantaneous 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

6.9.5.1. 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.

6.9.6. Meter billing

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

6.9.6.1. 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.

6.9.6.2. End of billing (EOB) event

The meter can be configured so that up to five 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)
- an active signal on a control input
- 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:
    - maxUrms
    - maxIrms

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

6.9.6.3. 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 18 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
  - control input
  - 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

6.10. 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.

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 user-defined 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)

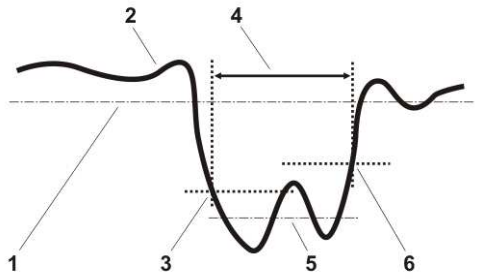
Voltage cuts

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 - 75% (Unom)
- Cut end (high) threshold - 85% (Unom)

A typical voltage cut defect event is illustrated below:



1 Unom
2 RMS Input voltage
3 Cut start threshold
4 Cut duration
5 Cut magnitude
6 Cut end threshold

Voltage sags

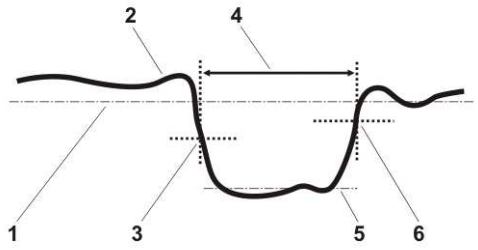
A voltage sag is detected if the distribution-network input voltage drops below the sag start threshold value and continues until the voltage rises above the sag end threshold value.

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 - 90% (Unom)
- Sag end (high) threshold - 95% (Unom)

A typical voltage sag defect event is illustrated below:



1 Unom
2 RMS Input voltage
3 Sag start threshold
4 Sag duration
5 Sag magnitude
6 Sag end threshold

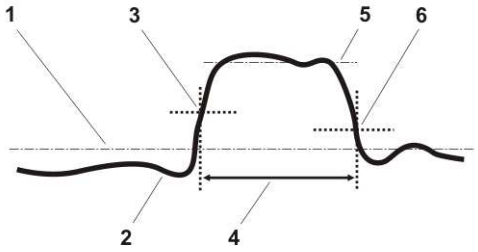
Voltage swells

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 - 110% (Unom)
- Swell end (low) threshold - 105% (Unom)

A typical voltage swell defect event is illustrated below:



1 Unom
2 RMS Input voltage
3 Swell start threshold
4 Swell duration
5 Swell magnitude
6 Swell end threshold

6.11. 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		
Frequency	Y		
Total Harmonic Distortion (THD)	Y		
Phase	Y		
Neutral voltage	Y		
Neutral current	Y		
Current reversal	Y	Y	
Internal consumption	Y	Y	Y
Cover opening		Y	Y
Terminal Cover opening		Y	
Magnetic sensor		Y	
Calibration history			Y
Configurations history		Y	Y
Watchdog activity			Y

Auxiliary Power Supply (APS)

Alarm is managed only if the APS parameter indicates that an auxiliary power supply is connected.

Appearance: The non fatal alarm will be generated when the APS voltage decreases strictly under the lower dynamic threshold

Disappearance: The non fatal alarm will disappear when the APS voltage increases strictly above the upper dynamic threshold.

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 47) are recorded by the meter.

Total harmonic distortion (THD)

The meter can be configured to calculate the per phase Total Harmonic Distortion (THD) value for both:

- Voltage (Uhrms)
- Current (Ihrms)

THD is calculated over the full harmonic range from H2 to H13 for 50Hz networks and from H2 to H11 for 60Hz networks. The calculation is made in accordance with one of the following user-specified standard algorithms:

- ANSI (relative to the RMS value)
- IEC61000-4-7 (relative to the fundamental value)

THD data are computed in a back end task to not disturb the global behaviour of the meter. As THD computing requires a lot of cpu processing, data are updated every 20s.

The Voltage and Current harmonics distortion magnitude on each phase (Vhrmsi and Ihrmsi) are computed with a sliding filter (3 values). The filter is used to provide a stable value on display and to not take into account short variation on THD (especially at power up).

At power up, filtered values will be 0 during the first 3 first THD value computing. As THD data are updated every 20 seconds, THD data are so available after 1 minute.

Additional calculations are done to provide the three-phase aggregate voltage and current THD values.

THD events occur when these values exceed pre-defined thresholds, the meter then records the following defect event parameters:

- number of events (incremental)
- duration
- magnitude

Note about 3-Wire: THD calculation on 3 wires meters is not applicable.

Phase

The meter calculates the following phase-related parameters to within 1° accuracy:

- per phase current (Ii) to voltage (Ui) phase angle (i=1, 2, 3)
- voltage to voltage phase angles (U1 - U2), (U2 - U3), (U3 - U1)
- phase sequence

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.

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.

Terminal Cover opening

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

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

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)

6.12. 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 terminal cover removal (optional)	Recorded as date/time stamped events: • start date of cover opening • duration • number of cover opening events The detection of meter cover removal remains active during power failure events (one opening is counted regardless of how many occurred). The detection of terminal cover removal is not active during a power failure.
Magnetic shielding	The meter enclosure can be optionally fitted with an effective shielding against external magnetic fields. (up to 1,2T).
Magnetic attack detection	The meter is 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

6.12.1. Magnetic field detection

The meter is 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.

Operation

When the sensor detects a magnetic field:

- a non-fatal, trapped alarm is raised

  Note: The alarm type is self-healing in earlier plateforms of SL7K.

- 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

6.13. Alarm and event management

6.13.1. 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.

6.13.2. 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

6.13.3. 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.

6.13.4. 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

6.14. Remote Firmware Upgrade

There is a possibility to use the remote download functionality **for a non MID meter only**. The remote download consists, in the first step, to load firmware applications by image transfer (COSEM protocol) in the meter, which is still in nominal operation (the metrology is running). In a second step, the meter enters in downloading mode on activation order (date or manual), the new firmware is written in flash, and it is taken into account by the next power up. The time between FW activation and restart of the meter is <1min (metrology application do not run during this time).

The following support tools are currently available to manage the remote Firmware Upgrade:

ACE Pilot (upgrade of meters only one after one)

ACE Vision (possibility to group the meters, in order to upgrade many meters with the same Firmware)

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 (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 19200Bd.

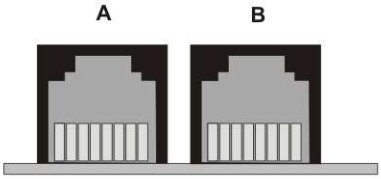
7.2. Serial data ports

The meter can be factory-configured with up to two RS232 or RS485 serial data ports that support independent and concurrent operation in compliance with the requirements of IEC62056-42/46/53/61/62.

Each data port uses the DLMS-COSEM protocol with an operating baud rate between 1200Bd and 19200Bd.

These electrical serial-communication data ports can operate with an external modem or be directly connected to other external equipment, to allow communication between the meter and:

- the utility company, via the **Utility Port** (A)
- the end user/customer via the **Customer Port** (B)



Note: Earlier versions of the meter have these port assignments reversed.

Modem power supply

The RJ45 connectors can provide a DC supply voltage (VMDM) suitable for powering an external modem. 10VDC -10/+20% at 300mA (3W max).

Modem powering restriction

The meter is able to start if at least one phase or the APS is present. All functions are available if :

- APS is present and APS>100V
- or if at least 2 phases are present.

If APS is not present, and meter is powered on 1 phase only, the modem power supply is inhibited.

If meter is powered with APS and APS <100VDC or APS<100VAC, the modem power supply is inhibited.

If meter is powered with 2 phases (modem power is so available) and one phase is lost, then modem power supply is cut immediately.

If meter is powered with more than 2 phases or switch to the APS, the modem power supply management is then authorized.

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.

The meter has several modem-management modes:

- Device dedicated line on utility port

  A modem connected to the port is fully managed and controlled by the meter. In order to improve modem communication the meter will periodically switch off the modem power supply signal (VMDM) to reinitialise the modem.

- Direct line no modem control

  Even if a modem is connected to the port, it is not managed by the meter. Always select this mode when connecting meters together on a communication bus using RS485 daisy-chaining techniques.

- Power supply on

  The modem power supply signal (VMDM) is permanently enabled. Any modem connected to the port will not be managed but will be powered by the meter.

- Power supply off

  The modem power supply signal (VMDM) is inhibited. Any modem connected to the port will not be managed and will require an external power source.

The protocols managed by the meter, that can be used on the communication ports are:

Utility Port	Customer Port
HDLC	HDLC
IEC62056-21	IEC62056-21
	TCP (GPRS or Ethernet)

7.5. 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 two logical devices:

- **Electricity**
- **Management**

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 Laboratory	1	Management device Electricity device	Full read/write
Electricity Utility Field	2	Management device Electricity device	Full read Partial write
Electricity Utility Reader	3	Management device Electricity device	Full read Partial write of: • meter time setting • end of billing
End customer	7	Management device Electricity device	Read only

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.

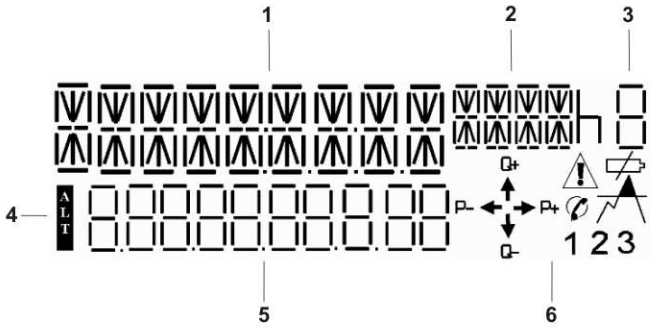
The meter configuration defines which displays are available to the user, the resolution of those displays and the order in which parameters appear. The configuration for any individual meter will initially be defined during manufacture according to the utility requirements. However, it may subsequently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

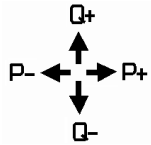


Item	Name	Description
1	**Value**	Displays the currently selected energy quantity or parameter value. This display is configurable (see example below).
2	**Unit**	See table below for range of units.
3	**Rate**	Displays the energy rate allocated to the current energy channel. If there is more than one energy channel configured with the same quantity the current rate of the first channel reached is displayed.
4	**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.
5	**OBIS code**	Displays the associated OBIS code (if applicable) for the energy quantity or meter parameter currently displayed in the LCD.
6	**Icon indicators**	See icon table below.

The following range of energy units can be displayed:

W	Wh	var	varh	VA	VAh	V	A	m^3
kW	kWh	kvar	kvarh	kVA	kVAh	kV	kA	m^3/h
MW	MWh	Mvar	Mvarh	MVA	MVAh	Vh	Ah	Qh
GW	GWh	Gvar	Gvarh	GVA	GVAh			

The annunciator icon indicators represent the following:

Icon	Name	Description
	**Battery status**	Indicates when the measured battery voltage is lower than the programmed threshold, or the cumulative power failure duration exceeds three years.
	**Alarm**	Indicates when the meter has detected an active alarm condition.
	**Excess demand**	Indicates when the calculated demand value is higher than the programmed threshold.
	**Communication**	Indicates that there is active communication in progress between the meter and an external device.
1 2 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.
	**Quadrant**	The four individual arrow icons indicate the direction and type of the energy currently measured by the meter. • Active and Reactive • Import and Export If the incoming supply phase-sequence is incorrect (e.g. 1,3,2) these icons flash.

The following examples show the effect meter configuration parameters such as scaler, number of digits and decimal places, have on the display.

Example 1

The energy channel configured in Wh and the value is **123 456 789 Wh.**

Depending on the scaler value the reading via COSEM read out would be:

- 123456789*Wh
- 123456,789*kWh

Scaler	Decimal	Digits	Displayed value	Unit	Format	Max display value
1	0	6	**456789**	Wh	6+0	999 999 Wh
10^3 (10 E 3)	1	6	**23456,7**	kWh	5+1	999 99,9 kWh
10^3 (10 E 3)	2	6	**3456,78**	kWh	4+2	9 999,99 kWh
1	0	7	**3456789**	Wh	7+0	9 999 999 Wh
10^3 (10 E 3)	1	7	**123456,7**	kWh	6+1	999 999,9 kWh
10^3 (10 E 3)	2	7	**23456,78**	kWh	5+2	99 999,99 kWh

10^3 (10 E 3)	3	7	**3456,789**	kWh	4+3	9 999,999 kWh

Example 2

The energy channel configured in Wh and the value is **123 Wh.**

Leading zeros in the displayed values have been enabled.

Depending on the scaler value the reading via COSEM read out would be:

- 123*Wh
- 0,123*kWh

Scaler	Decimal	Digits	Displayed value	Unit	Format	Max display value
1	0	6	**000123**	Wh	6+0	999 999 Wh
10^3 (10 E 3)	1	6	**00000,1**	kWh	5+1	999 99,9 kWh
1	0	7	**0000123**	Wh	7+0	9 999 999 Wh
10^3 (10 E 3)	1	7	**000000,1**	kWh	6+1	999 999,9 kWh
10^3 (10 E 3)	2	7	**00000,12**	kWh	5+2	99 999,99 kWh
10^3 (10 E 3)	3	7	**0000,123**	kWh	4+3	9 999,999 kWh

8.2. 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

The reset pushbutton is typically used to close the current billing period (EOB) and reset the maximum demand indicators (MDI reset). In addition, when the meter is operating in the alternate short mode, many non-fatal alarm conditions can be deleted using this control.

A metrological seal can be fitted to prevent unauthorised use.

Laboratory switch

Located inside the metrological enclosure this switch can be used to protect the meter against unauthorised programming attempts.

8.3. 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 test all the LCD segments and annunciator icons when in this mode, push the display button once (short push).

If the display button is pushed a second time (short push) during the LCD test, the alternate long display mode is activated.

If the reset button is pushed during the LCD test, the alternate short display mode is activated.

Alternate long mode

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

On entering this mode, the LCD is backlit and displays the first in a sequential list of display levels, as follows:

- **STD-DATA**
- **P.01 or P.02**

  These load profile display modes can be enabled/disabled in the meter configuration.
- **MID-DATA**

  This display mode is only applicable to MID compliant meters.
- **END**

To select the next entry in the display level list, push the display button once (short push).

To enter the display level, push the display button once (long push).

To exit this mode, hold down the display button (very long push).

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

Reset pushbutton operation

If the reset button is pushed when in this display mode, one of the following occurs:

- 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 (short push) while the confirmation string is visible.

STD-DATA

On entering this display level, the LCD shows the first of the pre-selected parameters in the alternate long list and the **ALT** annunciator icon is permanently lit.

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

To auto-scroll through the parameter sequence, hold down the display button.

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

Reset pushbutton operation

If the reset pushbutton is pushed when in this 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 (short push) while the confirmation string is visible.

P.01 and P.02

On entering one of these display levels, the LCD shows the first parameter from its non-programmable display list. These parameter values are dependant 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 a display level, push the display button once (long push).

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

Reset pushbutton operation

In these display levels, pushing the reset button has no effect.

MID

This display level operates in the same way as the P.01 and P.02 display levels.

Alternate short mode

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

On entering this mode, the LCD is backlit and will display any status words related to fatal and non-fatal alarms. Pushing the reset button (short push) will clear non-fatal alarm status words one at a time.

To display the first parameter in the alternate short list sequence, push the display button once (short push). The **ALT** annunciator icon will light and flash.

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

To auto-scroll through the entire parameter sequence, hold down the display button.

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

Reset pushbutton operation

In this display mode, the reset button operates in the same way as in the alternate long list **STD-DATA** level.

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:

1. push the reset button (short push) to record the value
2. 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. Installation

9.1. 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.

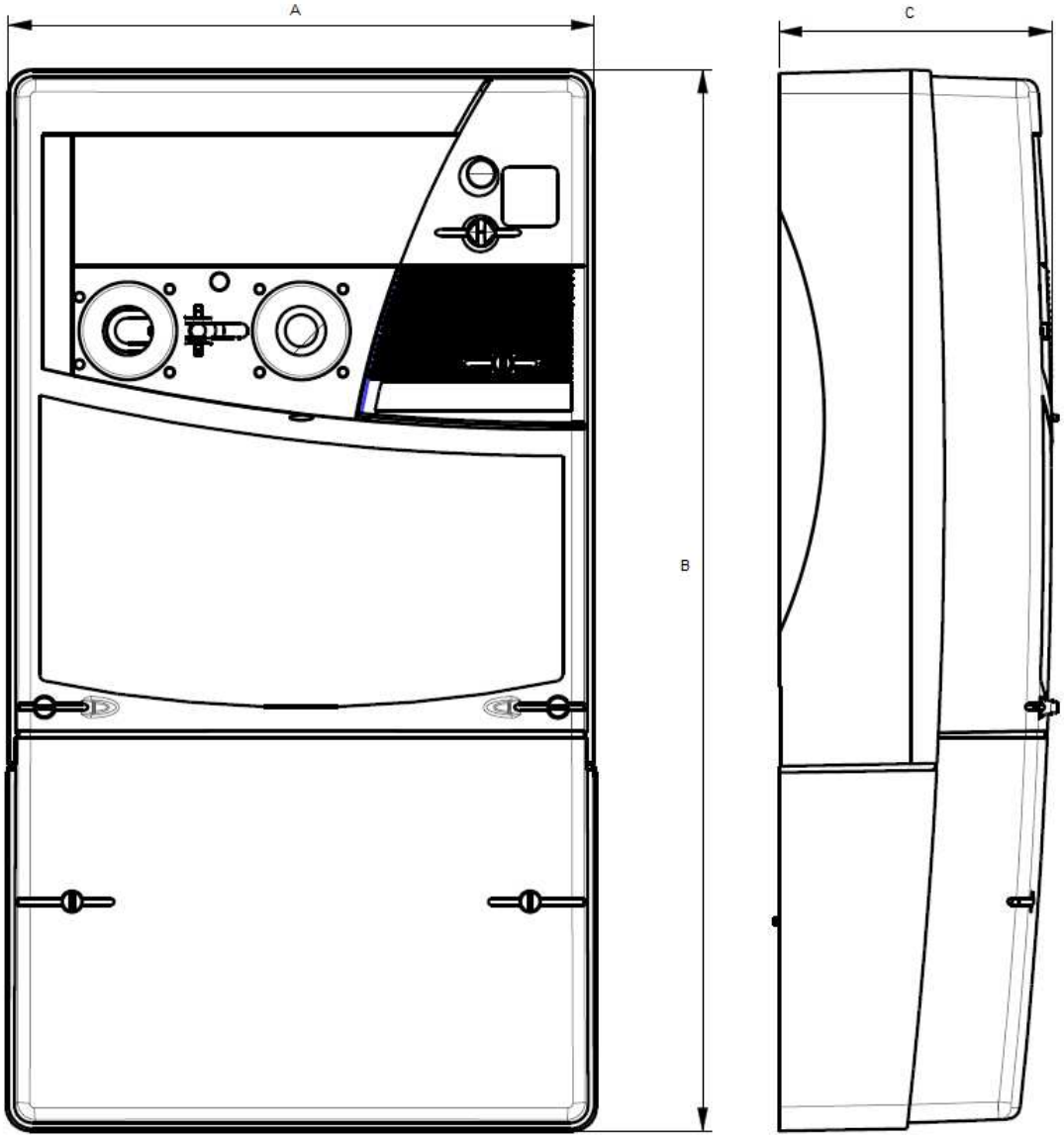
9.2. Environmental

SL7000 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° to +70°
Humidity	Up to 95% RH
Environmental protection	IP 51

9.3. Dimensions

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



Meter dimensions - short terminal cover

Item	Dimension	Description
A	179	Meter body width
B	270	Meter length including terminal cover
C	83	Meter body depth

Meter dimensions - standard terminal cover

Item	Dimension	Description
B	324	Meter length including terminal cover

Meter dimensions - long terminal cover

Item	Dimension	Description

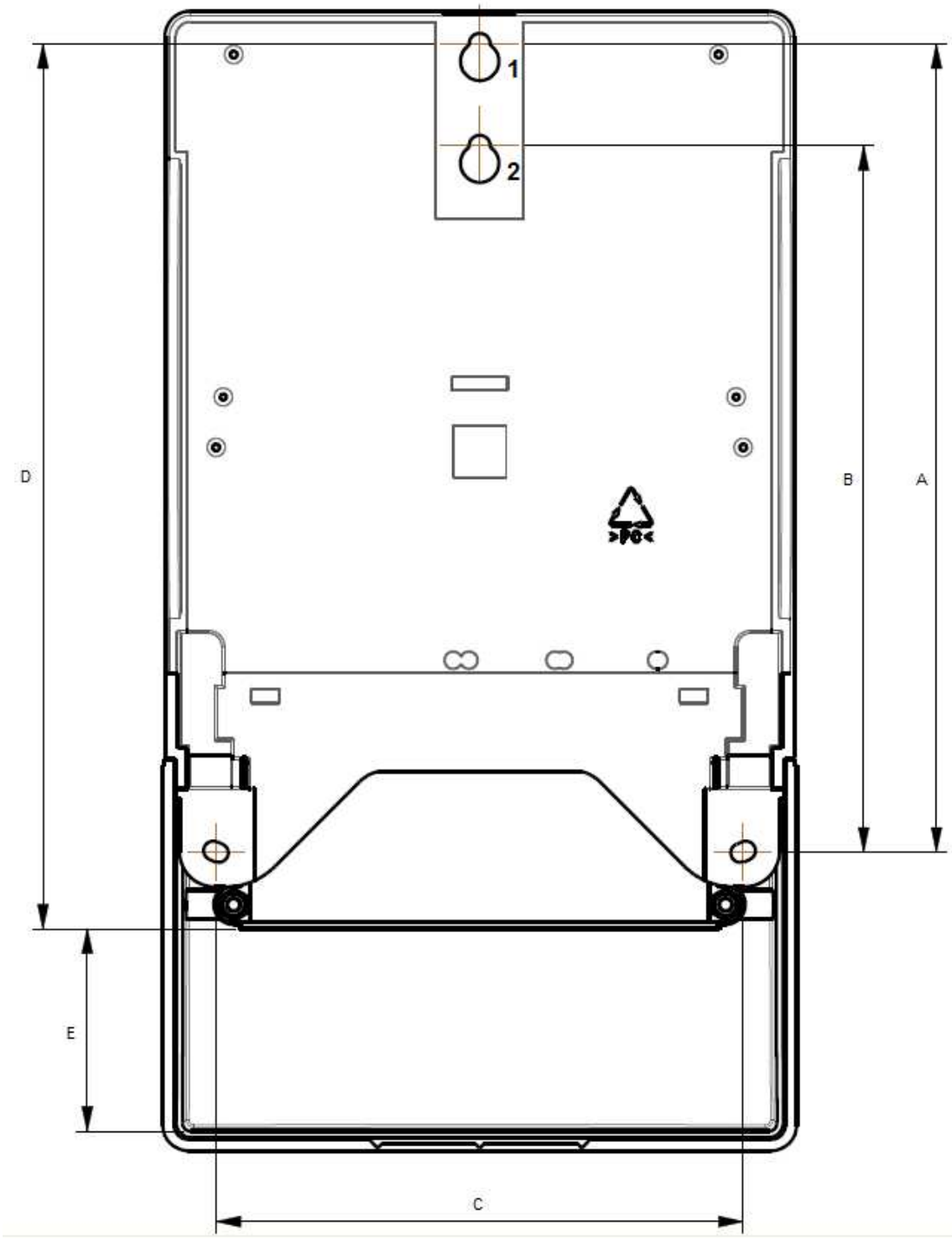
B	359	Meter length including terminal cover

All dimensions are in millimetres.

9.4. Fixings

The meter is provided with two upper fixing points (1) and (2), select the appropriate one to use, as required. A hanging bracket is also provided with the meter.

Two further lower fixing points are located within the terminal area; these can be accessed only by removing the terminal cover.

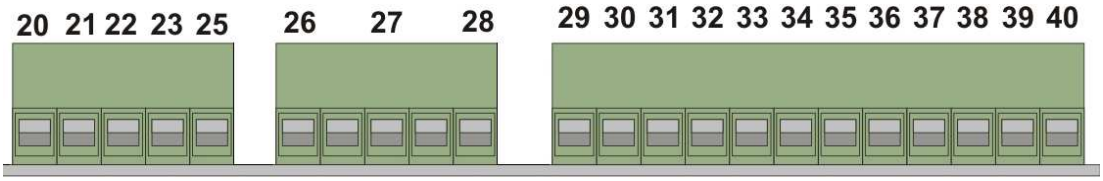


Item	Dimension	Description
A	230	Upper fixing point (1) to lower fixing points (centre to centre)
B	201	Upper fixing point (2) to lower fixing points (centre to centre)
C	150	Left to right lower fixing points (centre to centre)
D	252	Upper fixing point (1) centre to lower edge of meter body
E	4	Lower edge of meter body to lower edge of short terminal cover
E	58	Lower edge of meter body to lower edge of standard terminal cover
E	93	Lower edge of meter body to lower edge of long terminal cover

All dimensions are in millimetres.

9.5. Auxiliary and communication wiring

Auxiliary wiring for Full IO Board

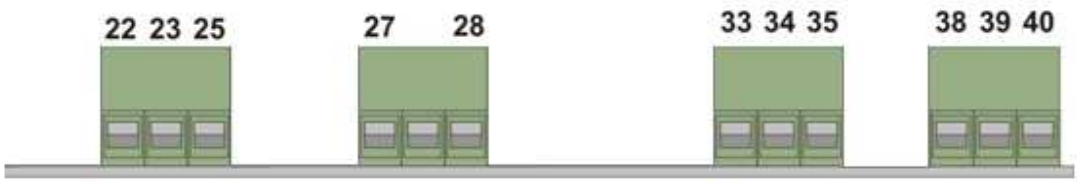


Terminal	Function	Terminal	Function	Terminal	Function
20	Control output 1	**29**	Pulse output 1	**36**	Pulse input 1
21	Control output 2	**30**	Pulse output 2	**37**	Pulse input 2
22	Control output 3	**31**	Pulse output 3	**38**	Pulse input 3
23	Control output 4	**32**	Pulse output 4	**39**	Pulse input 4
		33	Pulse output 5	**40**	PI Common
25	CO Common	**34**	Pulse output 6		
26	Control input 1	**35**	PO Common		
27	Control input 2				
28	CI Common				

The control output and input terminal blocks accept cables up to 2.5mm².

The pulse output and input terminal blocks accept cables up to 1.5mm².

Auxiliary wiring for Light IO Board



Terminal	Function	Terminal	Function	Terminal	Function
22	Control output 1	**33**	Pulse output 1	**38**	Pulse input 1
23	Control output 2	**34**	Pulse output 2	**39**	Pulse input 2

25	CO Common	**35**	PO Common	**40**	PI Common
27	Control input 1				
28	CI Common				

The control output and input terminal blocks accept cables up to 2.5mm².

The pulse output and input terminal blocks accept cables up to 1.5mm².

Note: Depending on meter factory configuration, some of the inputs and outputs shown above may not be available.

Communication wiring

Both RS232 and RS485 type communication ports use RJ45 connectors:

It is recommended that twisted and shielded cables are used for communication line wiring and that one end of the cable shield should be connected to ground.

Pin	RS232 Function	RS485 Function
1	VMDM 10V -10/+20%	VMDM 10V -10/+20%
2	No connection	RX -
3	No connection	No connection
4	RX	RX +
5	TX	TX +
6	0V - Ground	0V - Ground
7	DTR	TX -
8	No connection	No connection

9.6. 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.

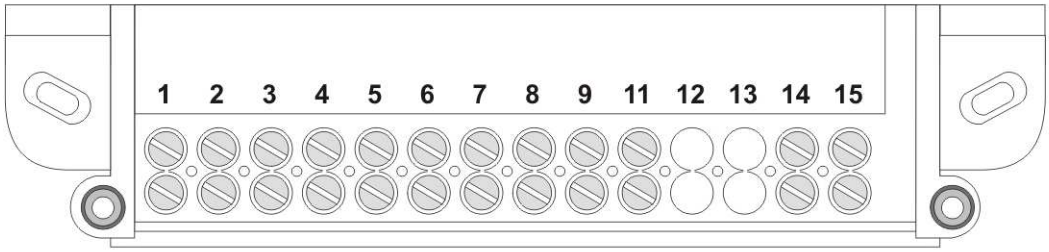
Alternatively, use suitable copper cable-sheaths on the terminating ends of the aluminium cables.

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

9.7. Cabling

The meter is factory-configured for either asymmetrical (VDE) or symmetrical (USE) wiring and the main terminal design and specification is different for Direct and Transformer connection meter types.

Main terminal wiring - transformer connection



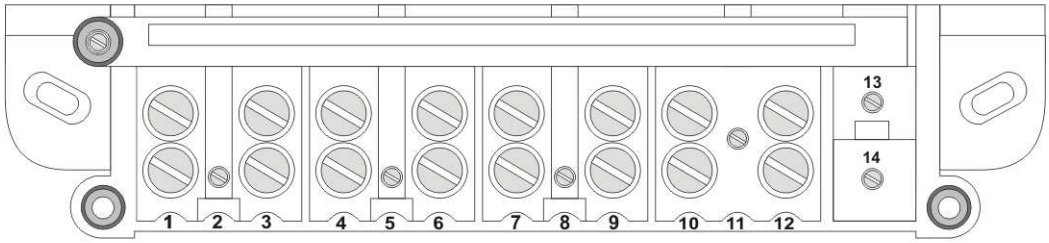
VDE wiring

Terminal	Function	Terminal	Function	Terminal	Function	Terminal	Function
1	I1 in	**4**	I2 in	**7**	I3 in	**11**	Neutral
2	U1 in	**5**	U2 in	**8**	U3 in	**14**	APS
3	I1 out	**6**	I2 out	**9**	I3 out	**15**	APS

USE wiring

Terminal	Function	Terminal	Function	Terminal	Function	Terminal	Function
1	I1 in	**4**	U2 in	**7**	Neutral	**11**	I1 out
2	U1 in	**5**	I3 in	**8**	I3 out	**14**	APS
3	I2 in	**6**	U3 in	**9**	I2 out	**15**	APS

Main terminal wiring - direct connection



Terminal	Function	Terminal	Function	Terminal	Function	Terminal	Function
1	I1 in	**4**	I2 in	**7**	I3 in	**10**	Neutral
2	U1 in	**5**	U2 in	**8**	U3 in	**13**	APS
3	I1 out	**6**	I2 out	**9**	I3 out	**14**	APS

Main terminal specification

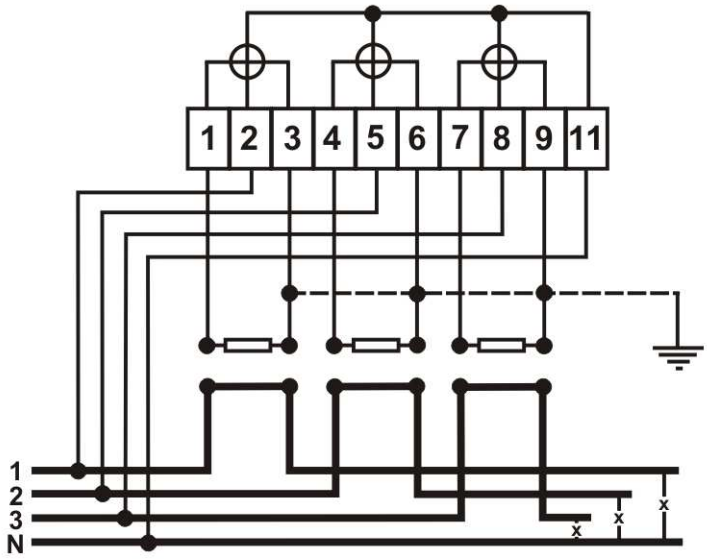
Terminal type	Clamp screws	Cable diameter	Meter type
Voltage	2 x M4	5mm (max)	Transformer
Current	2 x M4	5mm (max)	Transformer
Voltage	2 x M3	3.2mm (max)	Direct
Current	2 x M6	8mm (max)	Direct

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

9.7.1. Three-Phase

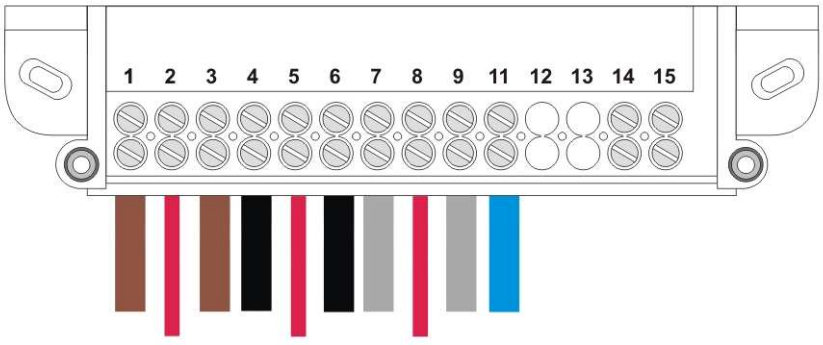
Depending on the number of voltage (VT) and current transformers (CT) available, three-phase meter connections can be configured as follows:

4 wire asymmetrical (VDE) current transformer configuration

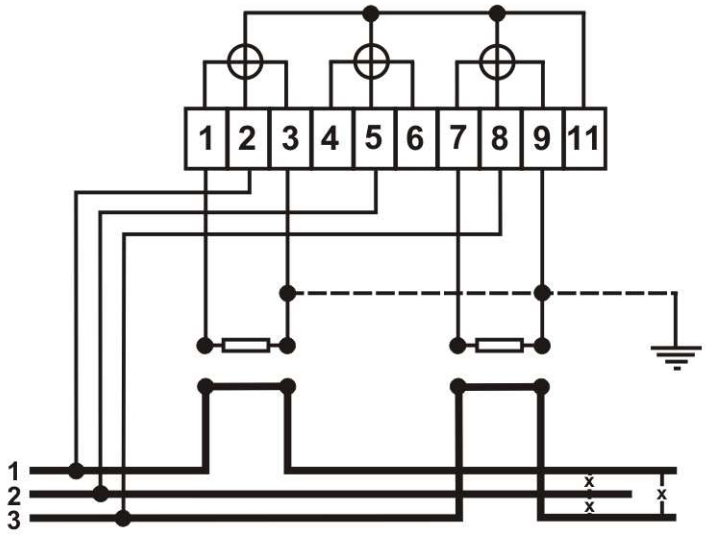


Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT3 in
2	1	U1 - Voltage	**8**	3	U3 - Voltage
3	1	I1 - CT1 out	**9**	3	I3 - CT3 out
4	2	I2 - CT2 in	**11**	N	Un - Neutral
5	2	U2 - Voltage			
6	2	I2 - CT2 out			

Typical wiring illustrated below:

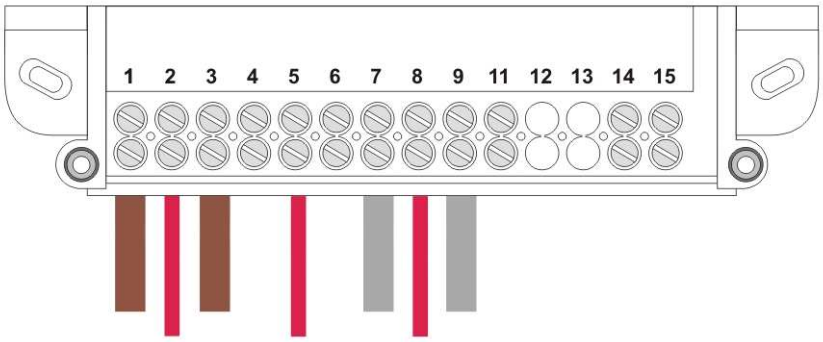


3 wire asymmetrical (VDE) current transformer configuration

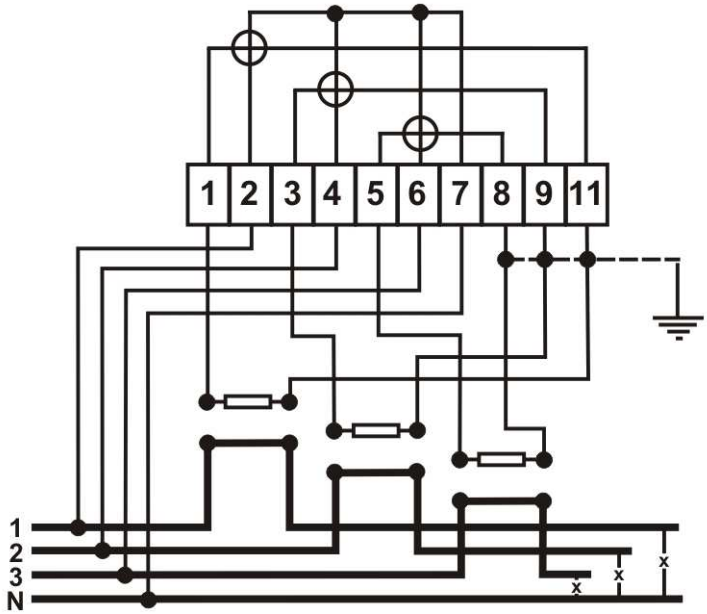


Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT2 in
2	1	U1 - Voltage	**8**	3	U3 - Voltage
3	1	I1 - CT1 out	**9**	3	I3 - CT2 out
4		No connection	**11**		No connection
5	2	U2 - Voltage			
6		No connection			

Typical wiring illustrated below:

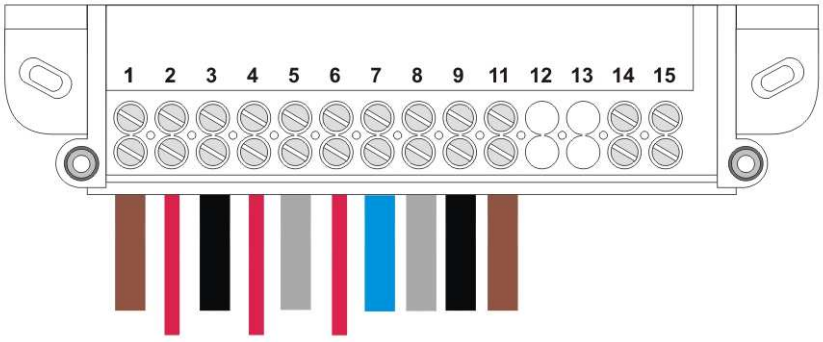


4 wire symmetrical (USE) current transformer configuration

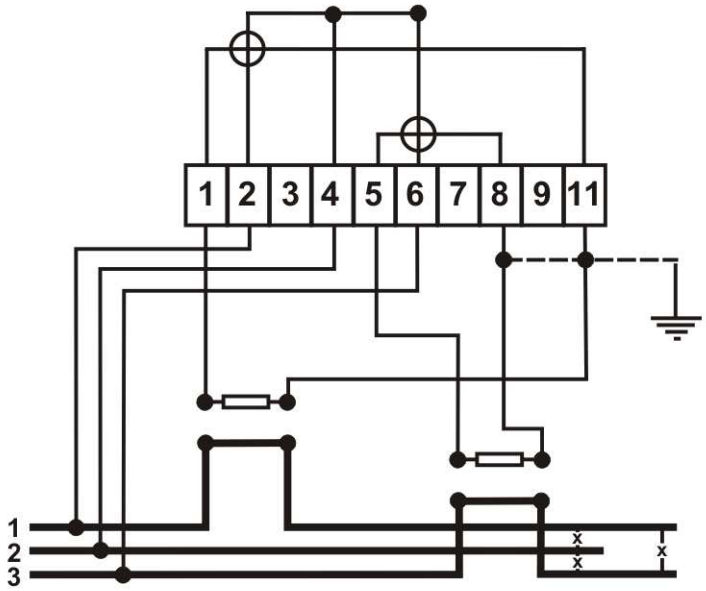


Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	N	Un - Neutral
2	1	U1 - Voltage	**8**	3	I3 - CT3 out
3	2	I2 - CT2 in	**9**	2	I2 - CT2 out
4	2	U2 - Voltage	**11**	1	I1 - CT1 out
5	3	I3- CT3 in			
6	3	U3 - Voltage			

Typical wiring illustrated below:

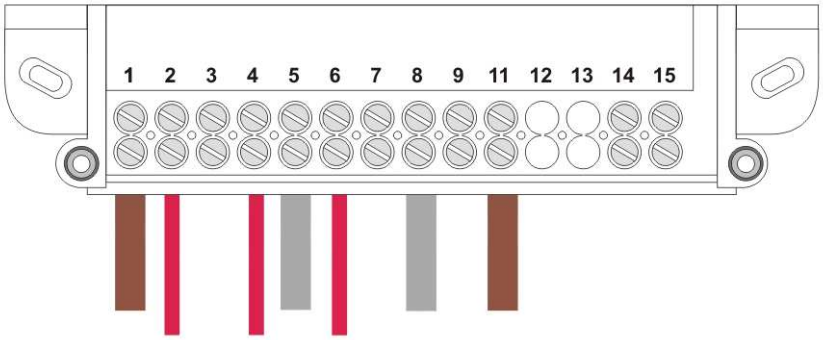


3 wire symmetrical (USE) current transformer configuration



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**		No connection
2	1	U1 - Voltage	**8**	3	I3 - CT2 out
3		No connection	**9**		No connection
4	2	U2 - Voltage	**11**	1	I1 - CT1 out
5	3	I3- CT2 in			
6	3	U3 - Voltage			

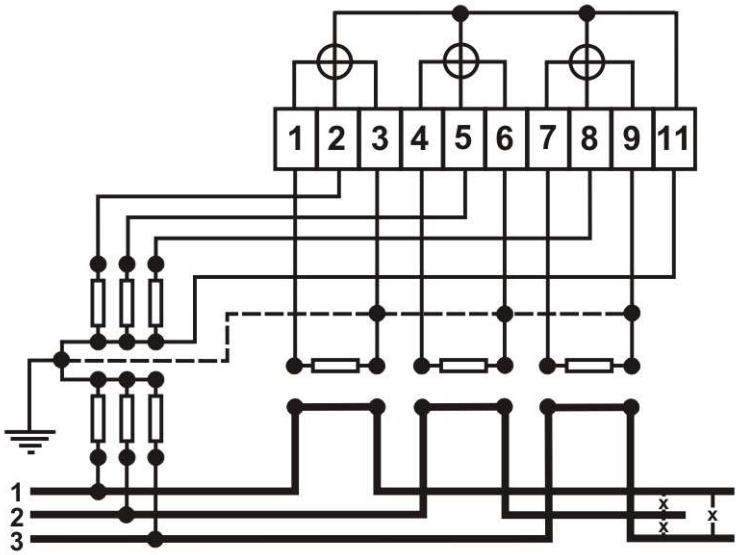
Typical wiring illustrated below:



9.7.1.1. 4-wire 3 x VT and 3 x CT

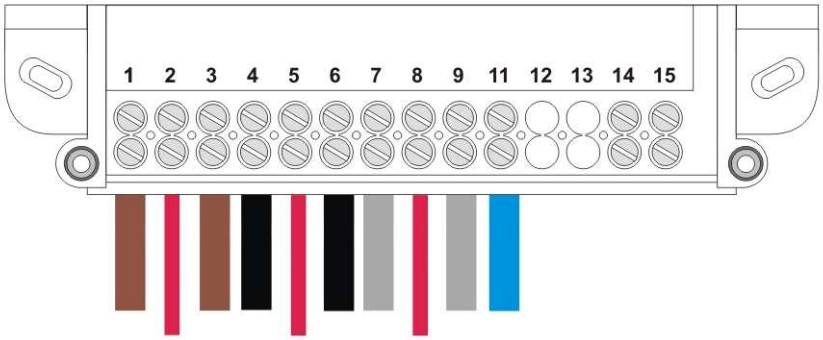
4 wire asymmetrical (VDE) 3 x VT and 3 x CT configuration

Meter configured for 4 wire, 3 element metrology



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT3 in
2	1	U1 - VT1 in	**8**	3	U3 - VT3 in
3	1	I1 - CT1 out	**9**	3	I3 - CT3 out
4	2	I2 - CT2 in	**11**	Un	VT common + ground
5	2	U2 - VT2 in			
6	2	I2 - CT2 out			

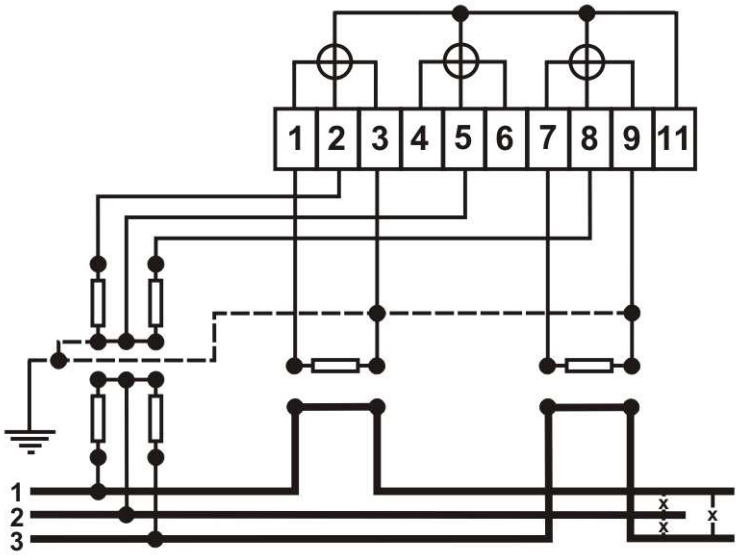
Typical wiring illustrated below:



9.7.1.2. 3-wire 2 x VT and 2 x CT

3 wire asymmetrical (VDE) 2 x VT and 2 x CT configuration

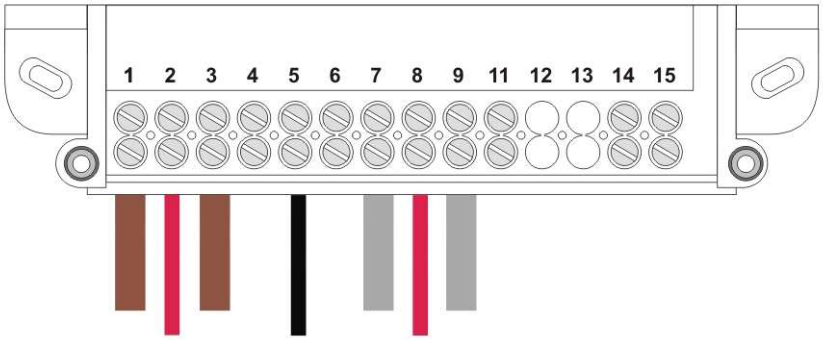
Meter configured for 3 wire, 2 element metrology



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT2 in
2	1	U1 - VT1 in	**8**	3	U3 - VT2 in
3	1	I1 - CT1 out	**9**	3	I3 - CT2 out
4		No connection	**11**	Un	No connection
5		U2 - VT common			
6		No connection			

The Un connection (terminal 11) remains unconnected. Do **NOT** connect it to ground.

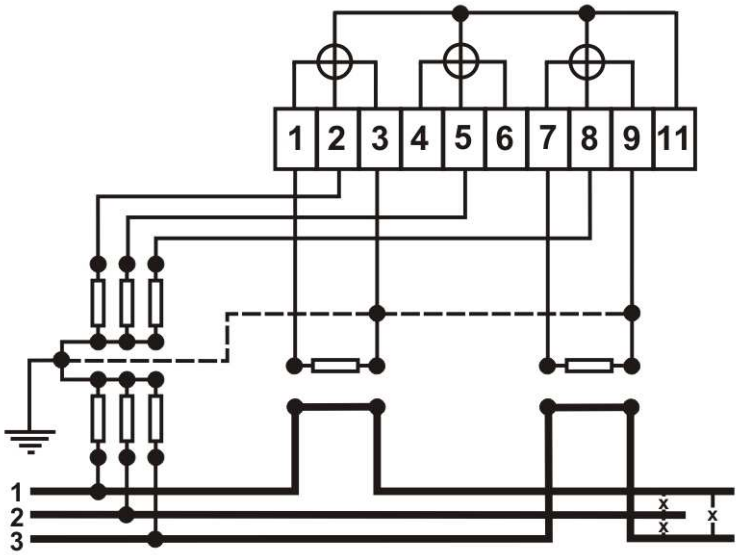
Typical wiring illustrated below:



9.7.1.3. 3-wire 3 x VT and 2 x CT

3 wire asymmetrical (VDE) 3 x VT and 2 x CT configuration

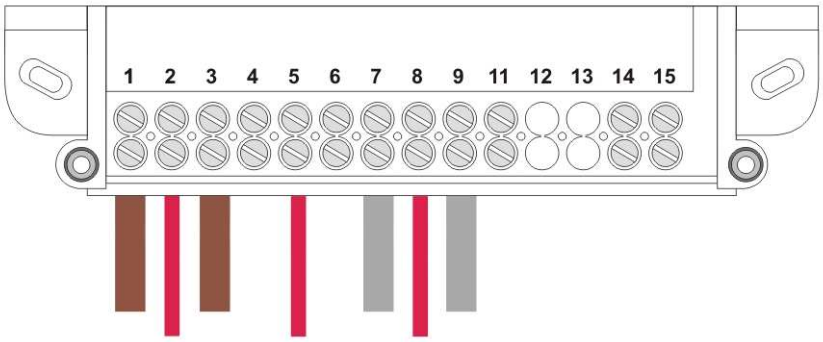
Meter configured for 3 wire, 2 element metrology



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT2 in
2	1	U1 - VT1 in	**8**	3	U3 - VT3 in
3	1	I1 - CT1 out	**9**	3	I3 - CT2 out
4		No connection	**11**	Un	No connection (see note below)
5	2	U2 - VT2 in			
6		No connection			

The Un connection (terminal 11) may remain unconnected or be connected to ground.

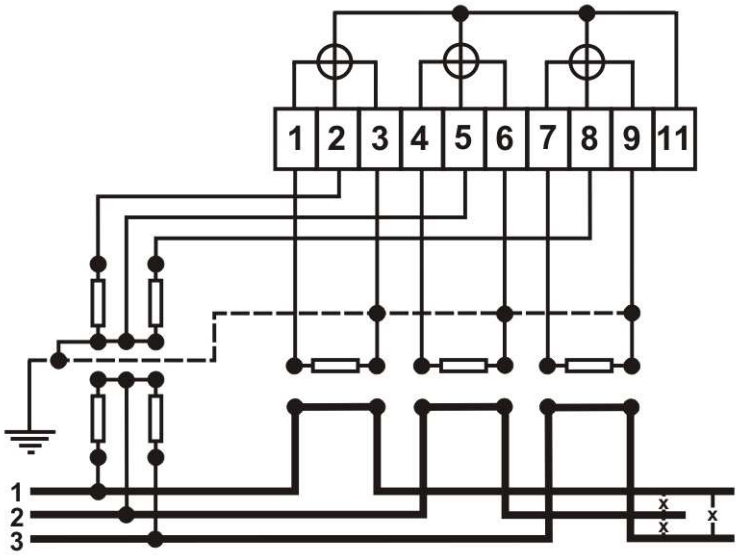
Typical wiring illustrated below:



9.7.1.4. 3-wire 2 x VT and 3 x CT

3 wire asymmetrical (VDE) 2 x VT and 3 x CT configuration

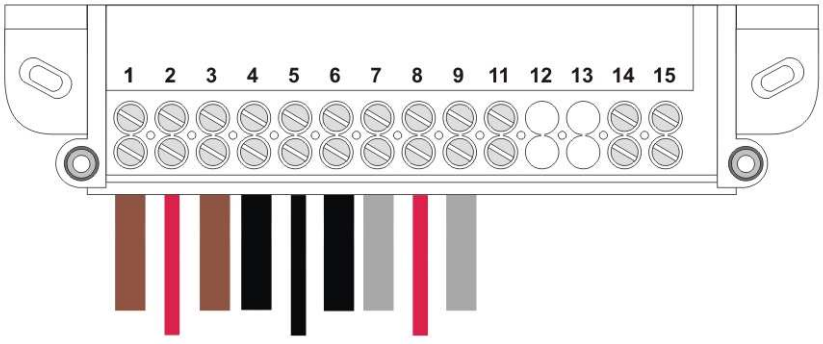
Meter configured for 4 wire, 3 element metrology



Terminal	Phase	Function	Terminal	Phase	Function
1	1	I1 - CT1 in	**7**	3	I3- CT3 in
2	1	U1 - VT1 in	**8**	3	U3 - VT2 in
3	1	I1 - CT1 out	**9**	3	I3 - CT3 out
4	2	I2 - CT2 in	**11**	Un	No connection
5		U2 - VT common			
6	2	I2 - CT2 out			

The Un connection (terminal 11) remains unconnected. Do **NOT** connect it to ground.

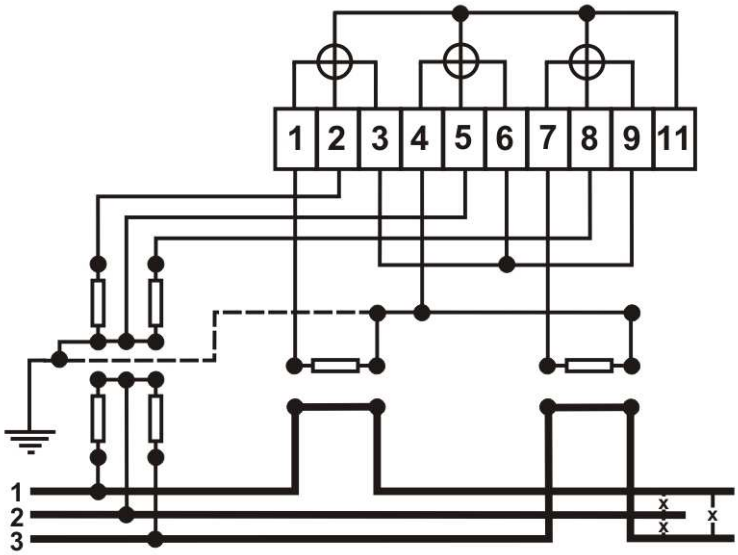
Typical wiring illustrated below:



9.7.1.5. 3-wire ARON connection

3 wire asymmetrical (VDE) 2 x VT and 2 x CT ARON configuration

Meter configured for 4 wire, 3 element metrology



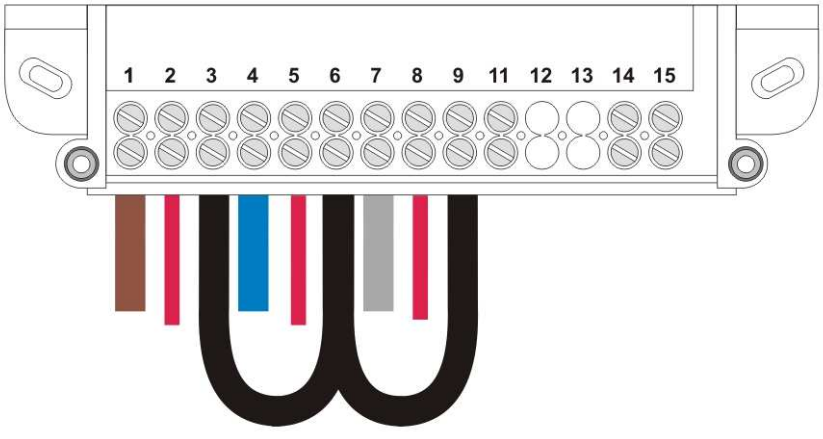
Terminal	Phase	Function	Link to	Terminal	Phase	Function	Link to
1	1	I1 - CT1 in		**7**	3	I3- CT2 in	
2	1	U1 - VT1 in		**8**	3	U3 - VT2 in	
3		I1 - common	I2 and I3	**9**		I3 - common	I1 and I2
4		I2 - CT1 / CT2 out common		**11**	Un	No connection	
5		U2 - VT common					
6		I2 - common	I1 and I3				

The Un connection (terminal 11) remains unconnected. Do **NOT** connect it to ground.

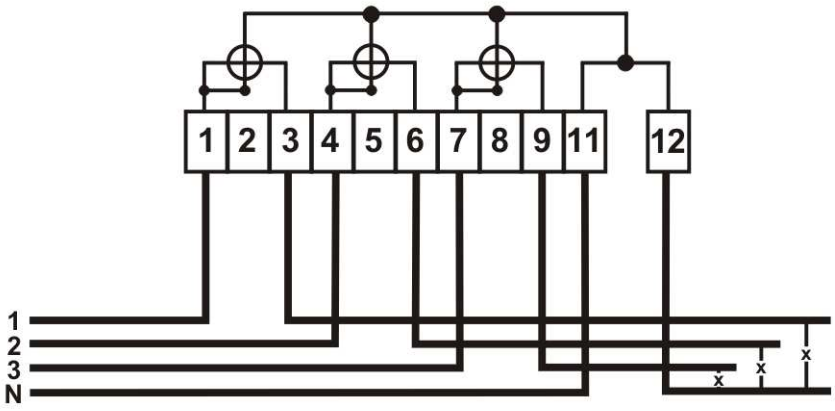
The two current circuit neutral returns are connected in the reverse direction via the missing current circuit.

The wiring diagram is correct if there is no homopolar current (I1+I2+I3=0) in the three-phase network.

Typical wiring illustrated below:

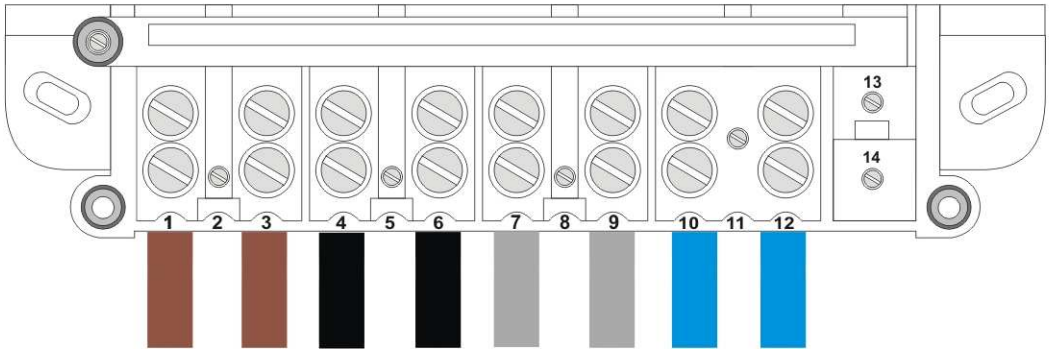


9.7.2. Direct Connected: 4-wire asymmetrical (VDE) direct connection configuration



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**	N	Un - Neutral in
5		No connection	**12**	N	Un - Neutral out
6	2	I2 - Phase 2 out			

Typical wiring illustrated below:

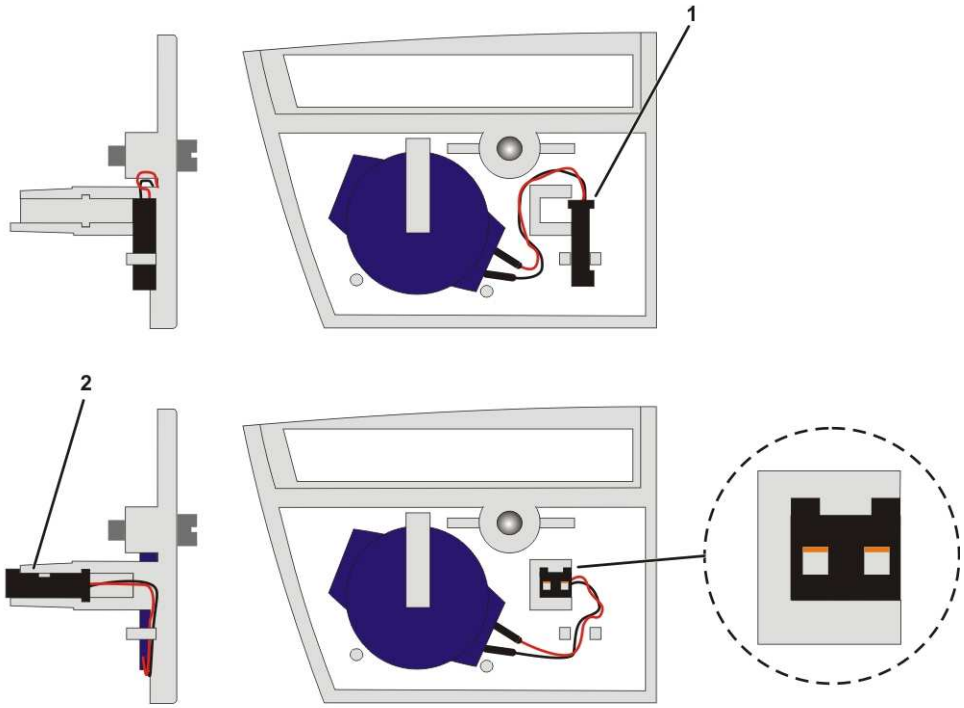


9.8. Battery

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

1. If fitted, remove the seal from the battery holder securing screw.
2. Undo the securing screw and carefully extract the battery holder from the meter housing.
3. The meter may be initially shipped with the battery cable in the disconnected position (1). If this is the case, move and fit the cable connector into the moulded pillar, as shown (2).

   The illustrations show a rear view of the battery holder.



4. If the battery is being replaced, slide the old one out from under the securing tab and exchange.
5. Ensure the battery connector is the correct way round, as shown above.
6. Replace the battery holder into the meter, ensuring the moulded plastic connector pillar is inserted into the lower aperture.
7. Tighten front securing screw.
8. Using the meter support tool, clear any battery error indications/alarms and reset the battery expected life time value.
9. Seal the meter, as necessary.

9.9. 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.

9.10. Start-up and functional checks

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

1. Connect the mains supply to the meter.
2. 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.
3. Check that the meter is in the start mode (STOP is not displayed).
4. Check the phase sequence is correct; the quadrant indicator icons in the LCD should not be flashing.
5. Apply a load to the meter and check that the metrology LED (active - kWh) starts to flash.

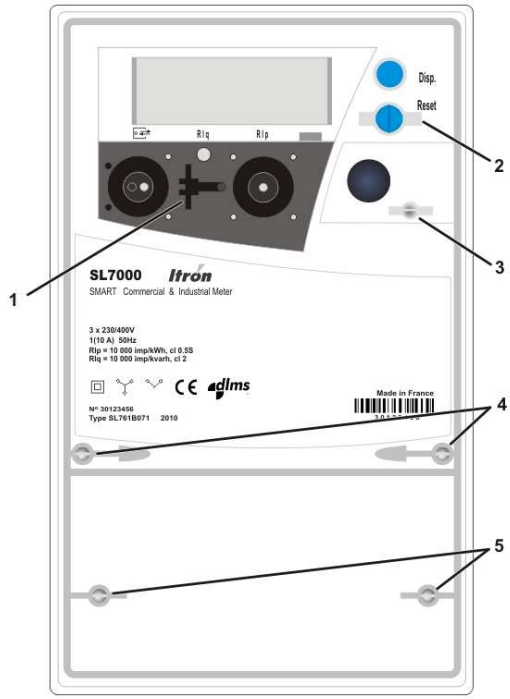
   The flash rate is proportional to the load.
6. Using the IR port, connect a support tool enabled PC to the meter and:
   - read the Total Energy Registers (TER) values
   - read all instantaneous values
   - read the meter status values and its configuration
   - erase any non-fatal alarms
7. Carry out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

If the support tool 'Toolbox' application is available:

1. Use the Toolbox functions to verify all aspects of meter operation.
2. Save and print the results as evidence of correct operation.

9.11. 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, as required, in the following locations:



1 IR Port

2 Reset pushbutton

3 Battery holder

4 Main cover

5 Terminal cover

10. Technical appendix

10.1. 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.

10.2. Alarm descriptions

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

Non-fatal alarm	Type	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 ERROR	Trapped	Checksum error in Flash memory (**see note 1 below**)
PROGRAMMING INCOHERENCE	Trapped	Incoherence of parameters programmed (**see note 4 below**)
COVER OPENING	Trapped	Detection of abnormal use of cover
TERMINAL COVER OPENING	Trapped	Detection of abnormal use of terminal cover
NO INTERNAL CONSUMPTION	Self-healing	No internal energy consumed for more than n days
NO EXTERNAL CONSUMPTION	Self-healing	No external energy (pulse inputs) consumed for more than n days
ZERO SEQUENCE U	Self-healing	Vectoriel sum of U vectors greater than prog. Threshold
ZERO SEQUENCE I	Self-healing	Vectoriel sum of I vectors greater than prog. Threshold

ZERO SEQUENCE I TRAPPED	Trapped	Vectoriel sum of I vectors greater than prog.threshold during a time greater than duration threshold
CLOCK LOSS	Self-healing	Incoherence of internal clock after power cut (**see note 5 below**)
EXTERNAL ALARM	Self-healing	Active signal on control input alarm detected
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	Trapped	Battery voltage level less than threshold (**see note 5 below**)
MAGNET SENSOR	Trapped	External magnetic field detected by sensors
EXCESS DEMAND	Self-healing	Demand over threshold detected
CURRENT REVERSAL AGGREGATE	Trapped	Change of direction of current flow on phase 1 or phase 2 or phase 3
MISSING APS	Self-healing	APS paramter configured with APS and APS voltage not detected

Fatal alarm	Type	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: • An energy rate is used but quantity 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 BATTERY LOW ALARM	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.

10.3. 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	00000000	Wh or kWh or MWh, according active TER group configuration
Active TER import phase 2	IMP PH2	00000000	
Active TER import phase 3	IMP PH3	00000000	
Active TER import aggregate	IMP AGG	00000000	
Active TER export phase 1	EXP PH1	00000000	
Active TER export phase 2	EXP PH2	00000000	
Active TER export phase 3	EXP PH3	00000000	
Active TER export aggregate	EXP AGG	00000000	
MIDComplianceParameters		MID or NOT MID	
SAP	MetEr	ACE761	
Internal firmware revision	5 11A	INT REV	
External firmware revision	5. 30C	EXT REV	
Internal checksum	FFFFFFFF	INT CHECK	
External checksum	FFFFFFFF	EXT CHECK	
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	1.0 I REF	I REF 1.0	A

Current rating Imax	5.0 I MAX	I MAX 5.0	A
Connection type		USE or VDE	
Port communication A (left)	Port A	no or RS 232 or TCP IP	
Port communication B (right)	Port B	no or RS 232 or RS 485 or TCP IP	
Voltage range	57 7-100 or 127-220 or 230-400 or AUTO RANG	VOLTAGE	V
Control output number	0 to 8	CO NUMBER	
Control input number	0 to 8	CI NUMBER	
Pulse output number	0 to 4	PO NUMBER	
Pulse input number	0 to 6	PI NUMBER	
Nominal frequency	50.00 or 60.00	FREQUENCY	Hz
ConnectionTopology		3 WIRES or 4 WIRES	
Value of CT numerator	CTn 1	00000000	
Value of CT denominator	CTd 1	00000000	
Value of VT numerator	VTn 1	00000000	
Value of VT denominator	VTd 1	00000000	
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	00000000	
Previous Value of CT denominator	CTd 2	00000000	
Previous Value of VT numerator	VTn 2	00000000	
Previous Value of VT denominator	VTd 2	00000000	
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	00000000	
Oldest Value of CT denominator	CTd 10	00000000	
Oldest Value of VT numerator	VTn 10	00000000	
Oldest Value of VT denominator	VTd 10	00000000	
Oldest Date of CT/VT programming	DATE 10	DD:MM:YY	
Oldest Time of CT/VT programming	TIME 10	HH:MM:SS	