CT Operated 3-Phase Smart Meter (EMP1.cx)

BSC Code of Practice 5 & 10 Version with

LTE-M Communications module

User Manual

V1.0

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Revision History

Version number	Revisions
1.0	First release

Specification subject to change without notice

Contents

1 Introduction

This manual applies specifically to the BSC (Balancing and Settlement Code) Code of Practice 5 & 10 version of the EM-Lite Low Voltage CT operated 3-phase smart meter, model type EMP1.cx

1.1 Purpose

This manual provides the necessary information required to operate the meter when used for its intended purpose:

- Construction, characteristics and functionality.
- Information about possible dangers, their consequences and measures on how to prevent them.
- Detailed description of the tasks to be performed during the life-cycle of the meter (configuration, installation, commissioning, operation and any maintenance).

1.2 Target Group

This manual is aimed at technically qualified electricians and personnel of meter operator companies for installation, commissioning, operation, maintenance, decommissioning and disposal of the meters.

2 Warnings

2.1 Intended Use and Installation

Meters are intended for installation in a in a Class E2 electromagnetic environment, with electromagnetic disturbances corresponding to those likely to be found in industrial buildings, and a Class M1 Mechanical Environment, where vibrations and shock are of low significance, according to Measuring Instruments Regulations (SI 2016 No. 1553). For this purpose, they are either installed indirectly onto the distribution companies incoming supply cables as a billing meter or fitted beyond the billing meter as a sub-meter of independent circuits. Meters must be installed either in an indoor position or in an external meter cabinet.

Meters must be fitted by qualified personnel and should be used in accordance with the technical specifications provided here and within associated data sheets. Meters must be installed away from sources of electromagnetic interference.

Meters have no user serviceable parts and must be returned to the manufacturer for repair or maintenance.

Meters must not be installed or used outside of the operation detailed within this manual. Applications of these meters outside of those described are considered as non-intended use.

Meters are classified as Cat III devices according to EN61010-1 2001

2.2 Safety Regulations

Warning - The following safety regulations must be observed at all times. Failure to observe precautions could result in severe physical injury or death:

- Do not work on the equipment unless the electrical supply is isolated. Means of isolation from the supply must be provided as part of the building installation. If isolation is made by removal of fuses or other cut-outs, the removed devices must be kept secure from replacement whilst work is performed. If isolation is provided by a switch, the switch shall conform to the requirements of IEC 947-1 and IEC 947-3 or equivalent.
- Overcurrent protection is not provided by the equipment and must be provided as part of the building installation.
- Only suitably trained and qualified personnel shall be allowed to work on the equipment. Local safety standards shall be observed and shall take precedence over these regulations in points of conflict.
- The meters must be held securely during installation. They can cause injuries if dropped.
- Meters that have fallen must not be installed. Even if no damage is apparent, meters must be returned to the manufacturer for testing. Internal damage can result in functional disorders or short-circuits.
- The meters must only be cleaned whilst disconnected with a dry cloth without solvent and on no account be cleaned with running water or with high-pressure devices. Penetrating water can cause internal short-circuit.
- A terminal cover protects inadvertent exposure to the meter tail connections. The terminal cover must be fitted prior to energising the electrical supply.

2.3 Responsibilities

It is the responsibility of the meter asset owner to ensure that all persons engaged on meter related work:

- Have read and understood the relevant sections of the user manual.
- Are sufficiently qualified for the work to be performed.
- Strictly observe the safety regulations (according to section 2.2) and the operating information in the individual chapters.

In particular, the owner of the meter bears responsibility for the protection of persons, prevention of material damage and the training of personnel.

3 Meter Overview

This manual covers the following model of the EM-Lite EMP1 3-phase meter range -

Model	Description
EMP1.cx	Current Transformer (CT) operated meter Two pulsed outputs for supply of pulsed energy information. Auxiliary relay for control of off-peak circuits or end of demand period notification. No display backlight. IEC optical port.

The meter is an indirect, CT connected, 3-phase, 4-wire meter, maximum current carrying capacity of 6 Amps per phase.

The base meter provides metrology and energy register recording across four quadrants along with Maximum Demand and Interval Data recording. An internal battery backed clock supports a time-of-use function providing energy registration over eight time-of-use rates.

The meter is both Measuring Instruments Regulations (SI 2016 No. 1153) approved and Nationally approved and listed on Schedule 4 of the regulations (SI 1998 No.1556). Meters are marked with UKCA markings as appropriate.

An IEC optical port allows onsite programming and reading.

GPRS and LTE Cat M1 communications modules are available. Modules are fitted with a standard SIM card in the bottom of the unit, the card cannot be accessed once the module is fitted. The communications module installs to the top of the meter and is protected from removal by a single sealable screw. Standardly the meter and module are factory assembled and delivered with SIM card fitted.

4 Electrical Rating and General Description

4.1 Meter Ratings

Voltage	
Operating Voltage	230/400V
Operating voltage range	184V to 276V
Maximum operating voltage	276V
Frequency	50Hz, approved to an operating variation of ± 2%, operational to -6 +4%.
Network system	Three-phase, four wire supply
Current	
Reference Current	(I_{ref}) (I_b) 5A
Starting current	Factory set automatically according to reference current
Max. Current	Rated maximum current (I_{max}) 6A per phase
Accuracy	
Active energy	Class B according to BS EN 50470-3 Class 1 according to BS EN 62052-11, 62053-21
Reactive energy	Class 2 according to BS EN 62053-23
Environmental	
Operating temperature	Operating temperature range -25 °C to +55°C, non-condensing humidity.
Ingress Protection	Protected against dust and water ingress to IP54 according to EN 60529
Protection Class	Protection class II according to BS EN 50470
Overload protection	
Voltage Overload	Capable of withstanding a phase to neutral over-voltage of 415V continuously
Current Overload	Capable of passing 200% of its maximum current rating in each line circuit without undue overheating or damage.
Clock	
Type	Mains frequency locked with battery backed crystal cock
Accuracy	Within ±0.5 seconds/day at 23°C Accuracy deviation due to temperature variation from the reference: No more than ±0.15 seconds/per day for each 1°C.

4.2 Terminal configuration

4.2.1 Main meter connections

The terminal layout and lower meter fixings conform to the basic requirements of DIN 43857, excluding terminal spacing.

Main current terminals are constructed from solid brass and provide an 8.2 mm diameter cable entry. Two Steel slotted M6 terminal screws are provided in each terminal for cable fixing (optionally, brass screws may be requested).

Voltage terminals have a single brass screw and allow connection of 4mm^2 cable.

4.2.1.1 Terminal numbering

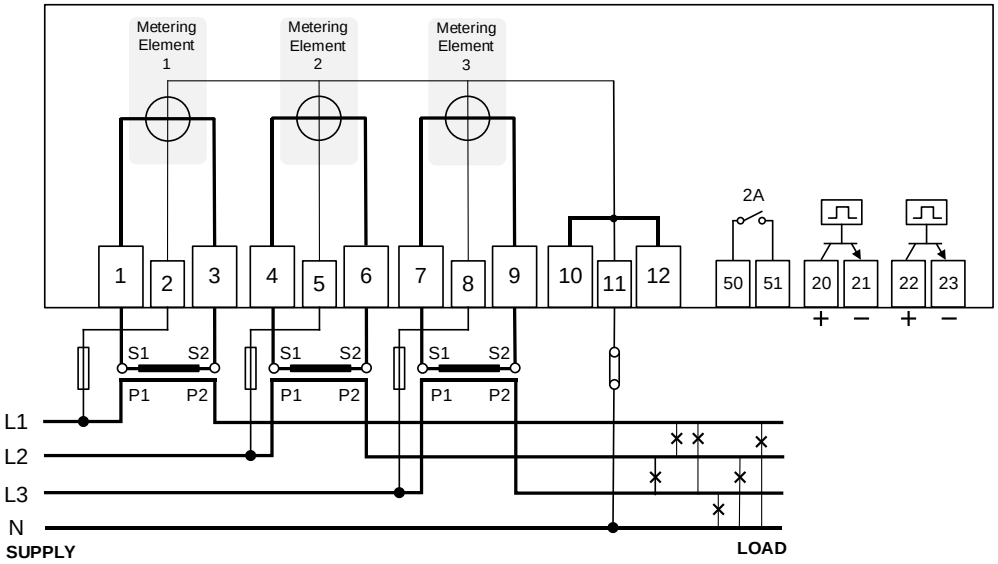
All meter terminals are numbered to aid identification as follows:

Voltage supply terminals are numbered (L1) 2, (L2) 5, (L3) 8 and (N)11.

CTs are connected to the main terminals (L1) 1 & 3, (L2) 4 & 6, (L3) 7 & 8.

Output terminals are numbered according to output type, see connection diagram.

4.2.2 Connection Diagram



4.2.3 Pulsed outputs (terminals 20, 21 & 22, 23)

Two pulsed outputs are fitted. The outputs may be used to feed pulsed energy information into a building management system or similar.

The outputs are electrically isolated, transistor type. The outputs conform to class A, IEC 62053-31. The polarity of each output must be observed when connecting equipment.

Maximum voltage 27Vdc

Maximum current 27mA

4.2.4 **Auxiliary relay (terminals 50, 51)**

The meter is fitted with an auxiliary relay for the control off-peak loads or to signal the end of a demand period. The operation of the relay is programmable.

The auxiliary relay is a normally open, single pole, voltage free contact.

The relay screw terminals allow connection of cable up to 4mm^2.

Relay is nominally rated at 230Vac, 2A max.

5 Meter installation

The meter is fitted using a hanging bracket situated uppermost on the rear side of the meter and two lower mounting screw points situated either side of the terminal block.

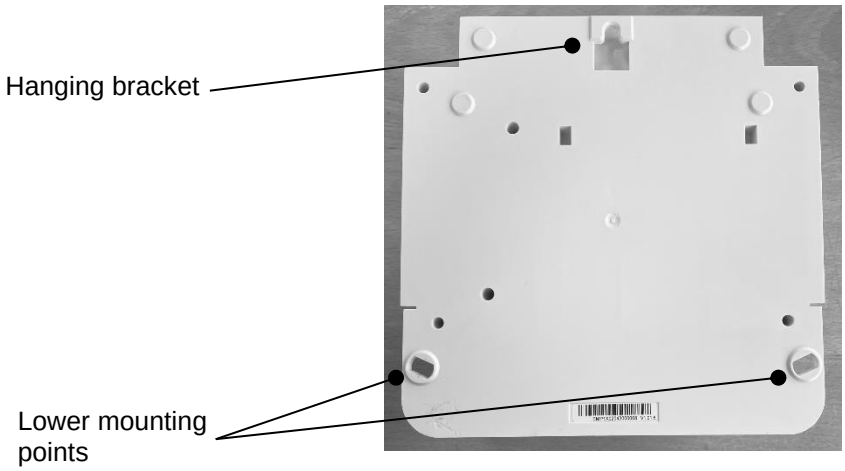


Figure 1 – Meter fixing points

When installing the meter, it should initially be hung from the rear hanging bracket using a suitable round headed screw. The screw depth should be adjusted so that the head fits snugly under the hanging point and the meter is held firmly against the meter board/wall. The meter should be mounted vertically and further secured using suitable screws into the two fixing points under the terminal cover.

5.1 Terminal covers and sealing

The extended terminal cover fits over the terminal block and extends 50mm past the cable entry face. A number of breakouts are fitted in the lower edge of the cover, these may be removed with snippers as required.

Figure 2 – Extended Cover

Once fitted, the terminal cover should be sealed to prevent removal. The fixing screws carry a seal fixing hole allowing a Bowden cable and crimped ferrule seal type to be fitted.

5.1.1 **Finger guard**

An additional finger guard may be installed over the terminal block. The finger guard allows the terminal cover to be removed for safe access to the output terminals while preventing access to the main meter terminals.

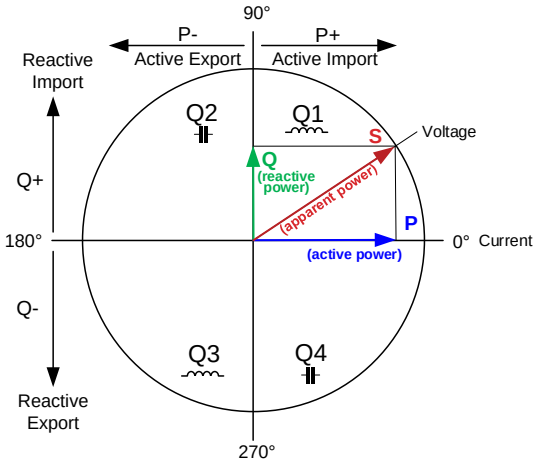
Figure 3 – Finger guard installation

The finger guard is installed by locating the lugs fitted along the guard's bottom edge into the terminal block lower face recesses, the guard has an interference fit to prevent it falling out. The guard should be sealed using the centre fixing by Bowden cable and crimped ferrule.

6 Measurement

6.1 Measured Quantities

The meter measures Active (P) and Reactive (Q) energy over four quadrants. Apparent energy (S) is calculated from these values. Individual phase voltages, currents and quality of supply values are also measured.



The overall energy direction is indicated on the display via an energy direction indicator showing the quadrant of the energy flow.

Measured energy is scaled according to the set CT ratio and recorded in individual phase registers, quadrant registers and totalised registers. Energy is also recorded across set time periods (time-of-use).

Registers may be read though the meter's optical data port, remotely or via the display.

6.1.1 Accuracy

When measuring Active energy (kWh) below 100kW (CoP10), the meter is approved and the nameplate marked in accordance with the UK Measuring Instruments Regulations (MIR). The meter meets the accuracy requirements of class B as defined in BS EN 50470-1 and 3.

For the measurement of Active energy above 100kW (CoP5), the meter is Nationally approved and listed on Schedule 4 of the regulations SI 1998 No.1556. The meter is additionally tested according to BS EN 62052-11 and 62053-21, meeting Class 1 accuracy requirements and the nameplate marked accordingly.

For Reactive energy (kvarh), the meter meets class 2 as defined in IEC 62053-23.

6.1.2 Metrology Indicator operation

Two separate visible red LEDs pulse to indicate energy registration (for calibration purposes). The LEDs indicate as follows:

Active energy (upper LED) - pulses at 10,000 impulses/kWh (0.1Wh/pulse)

Reactive energy (lower LED) - pulses at 10,000 impulses/kvarh (0.1varh/pulse).

Pulse on-time is 10ms.

The energy indicated by the metrology LEDs is:

- The summation of the energy registered across all three phases according to the Measuring Mode
- Output according to the measured secondary currents of the connected CTs (the output is not scaled to the set CT ratio).

When no energy is recorded or the recorded energy is of a very low value the meter will enter an anti-creep mode. While in anti-creep mode the metrology indicators are continuously lit and no energy is recorded in the energy registers. An anti-creep threshold value is factory set according to the reference current rating of the meter. The meter will exit anti-creep mode when 0.1Wh of energy is recorded.

6.1.3 CT Ratio

The primary and secondary values of the CT connected are programmed as a pair. The ratio may be set for Current Transformers with a secondary output of 5 Amps. The CT ratio may be displayed as part of the normal or extended display cycles.

Energy, Power, Demand and Current values are scaled according to the set CT ratio.

6.1.4 Compensation of Measurement Transformer Error

An adjustment value to compensate for CT errors may be set into the meter. The adjustment value may be set as a percentage adjustment to a maximum of -3.2768 to +3.2767%. The adjustment value effects energy being measured; it does not affect energy already accumulated in registers.

Example:
If the power measured by a meter is 10000.0W with the Adjustment Value set as 0, an Adjustment Value of 20000 (+2%) would result in the same power being measured as 10200.0W

6.1.5 Test Modes

6.1.5.1 Metrology indication

A set of test modes are available to change the operation of the test Indicators. The test mode is set via the optical port.

When set into a test mode, the operation is automatically cancelled when the supply voltage is removed. The meter reverts to normal operation when the supply voltage is reconnected.

The following test modes may be set by programming the associated test key:

Test Key		Upper indicator	Lower indicator
1	L1 active energy	Pulses for active energy registered on L1 element only	off
2	L2 active energy	Pulses for active energy registered on L2 element only	off
3	L3 active energy	Pulses for active energy registered on L3 element only	off
4	L1 reactive energy	Pulses for reactive energy registered on L1 element only	off
5	L2 reactive energy	Pulses for reactive energy registered on L2 element only	off
6	L3 reactive energy	Pulses for reactive energy registered on L3 element only	off
7	Total active energy	Pulses for total active energy summated on L1, L2 and L3 elements.	off
8	Total reactive energy	Pulses for total reactive energy summated on L1, L2 and L3 elements.	off
9	Revert to normal operation	Pulses for total active energy summated on L1, L2 and L3 elements.	Pulses for total reactive energy summated on L1, L2 and L3 elements.

6.1.5.2 3 decimal place display mode

The meter may be programmed to temporarily show energy registration to 3 decimal places (Wh resolution).

The following test displays may be set by programming the associated test key:

Test Key		Display
1	Active energy import	Overrides display list and shows Tot. Act. Imp. kWh display to 3 decimal places (Wh's)
2	Active energy export	Overrides display list and shows Tot. Act. Exp. kWh display to 3 decimal places (Wh's)
3	Reactive energy import	Overrides display list and shows Tot. Reactive Imp. kvarh to 3 decimal places (varh's)
4	Reactive energy import	Overrides display list and shows Tot. Reactive Exp. kvarh 3 decimal places (varh's)
5	Revert to normal operation	Reverts to configured display list

When the meter is in a 3dp test mode the most significant digits of the register are not shown.

When the supply voltage is removed, the test operation is cancelled. The meter reverts to normal operation when the supply voltage is reconnected.

6.2 Measuring Modes

The meter operates in one of three measuring modes, defining how the total energy registers are calculated from the energy recorded per phase.

The measuring mode is configured as a factory setting. As a default, a meter will be programmed to the Vector Summation mode, unless otherwise requested.

The measuring modes are described in the following sections.

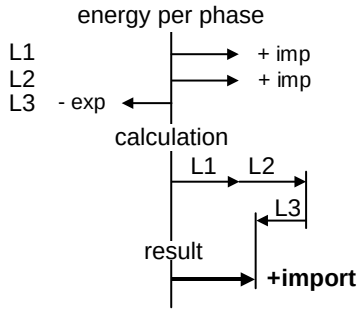
6.2.1.1 **Measuring mode 1: Vector Summation**

This mode simulates the operation of a Ferraris disk meter and assumes one or more of the phases are capable of legal reverse running e.g., due to local generation.

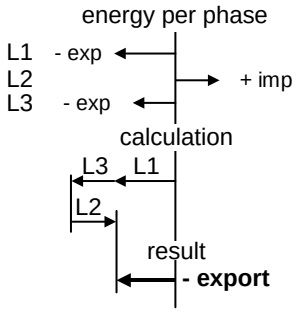
The total import or export registers are advanced by the vector addition of the energy in the three phases. When the vector sum of the three vectors L1, L2 and L3 is positive, the energy is added to the import energy register. If the vector sum of the three phases is negative, the energy is added to the export register. Only one of the import or export total registers will therefore advance at any time.

Example diagrams of energy registration:

a) (Overall result is import energy registration)



b) (Overall result is export energy registration)



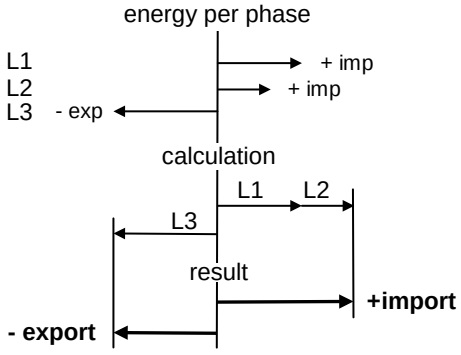
6.2.1.2 **Measuring mode 2: Magnitude summation**

Mode 2 advances the total registers according to the sign of each phase's energy value. Phases recording positive (import) energy are summed and added to the total import register.

Phases with negative signs (export) are also summed and added to the total export register.

Both import and export total registers may advance at any one time and assumes the reverse running is capable due to local generation. The metrology LED will only indicate import energy.

Example diagram of energy registration:

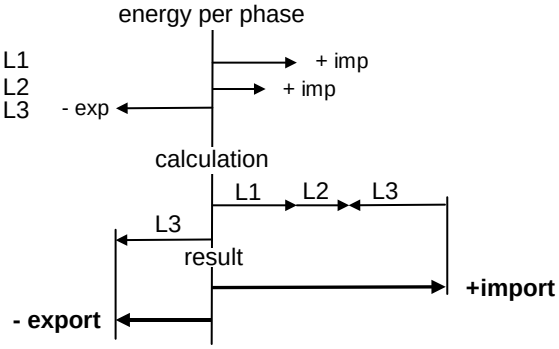


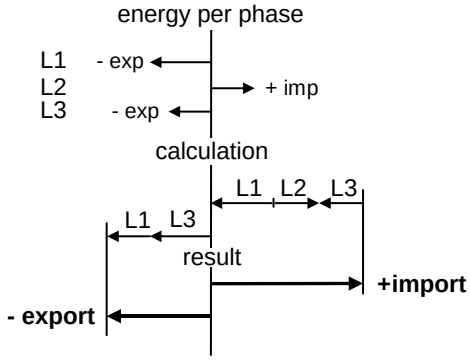
6.2.1.3 **Measuring Mode 3: Unidirectional**

This mode may be used to detect and deter energy fraud (fraud attempts to turn meter backwards) where no export energy is possible. The export register may be used to determine the amount of fraud attempted.

Mode 3 adds all energy into the total import register irrespective of the energy sign. Phases with positive signs are added to import register, phases with negative signs are also added to the import register. Phases with –signs are independently added into the export register.

Example diagrams of energy registration:





6.3 Energy registers

All energy registers are stored as 64-bit numbers. The large size of each register provides sufficient storage to record any energy value that might be accrued over several times the meter's lifetime, even when at constant full load. For this reason, no rollover of the stored register value is required (however, a displayed register will appear to rollover as the value increases past the largest digit shown).

Depending on the energy type, registers are stored to 0.1Wh, varh or vah.

6.3.1 **Total Energy registers**

The meter records and stores the following total energy registers:

Energy type	Registers	Object ID	Unit
Active energy	Total active import energy	1.8.0	Internal storage to 0.1 Wh Displayed with leading zeros to kWh or MWh
	Total active export energy	2.8.0	
Reactive energy	Total reactive import energy	3.8.0	Internal storage to 0.1 varh Displayed with leading zeros to kvarh or Mvarh
	Total reactive export energy	4.8.0	
Apparent energy	Total apparent import energy	9.8.0	Internal storage to 0.1 vah Displayed with leading zeros to kvah or Mvah
	Total apparent export energy	10.8.0	

Total registers are summated from the energy measured in each of the 3 phases according to the configured measuring mode.

6.3.1 **Total Reactive energy per quadrant**

Energy type	Registers	Object ID	Unit
Reactive energy	Total Reactive Energy Quadrant 1 (Active Import related Import varh)	5.8.0	Internal storage to 0.1 varh. Displayed with leading zeros to kvarh or Mvarh
	Total Reactive Energy Quadrant 2 (Active Export related Import varh)	6.8.0	
	Total Reactive Energy Quadrant 3 (Active Export related Export varh)	7.8.0	
	Total Reactive Energy Quadrant 4 (Active Import related Export varh	8.8.0	

6.3.2 **Energy registers per phase/quadrant**

The meter records the following energy registers for individual phases and quadrants:

6.3.2.1 **Total energy per phase**

Energy type	Registers	Object ID	Unit
Active energy, import	Active import energy, phase L1	21.8.0	Internal storage to 0.1 Wh Displayed with leading zeros to kWh or MWh
	Active import energy, phase L2	41.8.0	
	Active import energy, phase L3	61.8.0	
Active energy, export	Active export energy, phase L1	22.8.0	
	Active export energy, phase L2	42.8.0	
	Active export energy, phase L3	62.8.0	
Reactive energy, import	Reactive import energy, phase L1	23.8.0	Internal storage to 0.1 varh Displayed with leading zeros to kvarh or Mvarh.
	Reactive import energy, phase L2	43.8.0	
	Reactive import energy, phase L3	63.8.0	
Reactive energy, export	Reactive export energy, phase L1	24.8.0	
	Reactive export energy, phase L2	44.8.0	
	Reactive export energy, phase L3	64.8.0	

6.3.2.2 **Energy per quadrant**

Energy type	Registers	Object ID	Unit
Active energy	L1 Active energy, Quadrant 1	37.8.0	Internal storage to 0.1 Wh Displayed with leading zeros to kWh or MWh
	L1 Active energy, Quadrant 2	38.8.0	
	L1 Active energy, Quadrant 3	39.8.0	
	L1 Active energy, Quadrant 4	40.8.0	
	L2 Active energy, Quadrant 1	57.8.0	
	L2 Active energy, Quadrant 2	58.8.0	
	L2 Active energy, Quadrant 3	59.8.0	
	L2 Active energy, Quadrant 4	60.8.0	
	L3 Active energy, Quadrant 1	77.8.0	
	L3 Active energy, Quadrant 2	78.8.0	
	L3 Active energy, Quadrant 3	79.8.0	
	L3 Active energy, Quadrant 4	80.8.0	
Reactive energy	L1 Reactive energy, Quadrant 1	25.8.0	Internal storage to 0.1 varh Displayed with leading zeros to kvarh or Mvarh.
	L1 Reactive energy, Quadrant 2	26.8.0	
	L1 Reactive energy, Quadrant 3	27.8.0	
	L1 Reactive energy, Quadrant 4	28.8.0	
	L2 Reactive energy, Quadrant 1	45.8.0	
	L2 Reactive energy, Quadrant 2	46.8.0	
	L2 Reactive energy, Quadrant 3	47.8.0	
	L2 Reactive energy, Quadrant 4	48.8.0	
	L3 Reactive energy, Quadrant 1	65.8.0	
	L3 Reactive energy, Quadrant 2	66.8.0	
	L3 Reactive energy, Quadrant 3	67.8.0	
	L3 Reactive energy, Quadrant 4	68.8.0	

6.3.3 **Time-of-Use Registers**

The meter records active and reactive energy across 8 time-of-use rate registers:

Energy type	Registers	Object ID	Unit
Rated active import energy	Rate 1 Active import energy	1.8.1	Internal storage to 0.1 Wh Displayed with leading zeros to kWh or MWh
	Rate 2 Active import energy	1.8.2	
	Rate 3 Active import energy	1.8.3	
	Rate 4 Active import energy	1.8.4	
	Rate 5 Active import energy	1.8.5	
	Rate 6 Active import energy	1.8.6	
	Rate 7 Active import energy	1.8.7	
	Rate 8 Active import energy	1.8.8	
Rated active export energy	Rate 1 Active export energy	2.8.1	
	Rate 2 Active export energy	2.8.2	
	Rate 3 Active export energy	2.8.3	
	Rate 4 Active export energy	2.8.4	
	Rate 5 Active export energy	2.8.5	
	Rate 6 Active export energy	2.8.6	
	Rate 7 Active export energy	2.8.7	
	Rate 8 Active export energy	2.8.8	

Time-of-use registers continued…

Rated reactive import energy	Rate 1 Reactive import energy	3.8.1	Internal storage to 0.1 varh Displayed with leading zeros to kvarh or Mvarh
	Rate 2 Reactive import energy	3.8.2	
	Rate 3 Reactive import energy	3.8.3	
	Rate 4 Reactive import energy	3.8.4	
	Rate 5 Reactive import energy	3.8.5	
	Rate 6 Reactive import energy	3.8.6	
	Rate 7 Reactive import energy	3.8.7	
	Rate 8 Reactive import energy	3.8.8	
Rated reactive export energy	Rate 1 Reactive export energy	4.8.1	
	Rate 2 Reactive export energy	4.8.2	
	Rate 3 Reactive export energy	4.8.3	
	Rate 4 Reactive export energy	4.8.4	
	Rate 5 Reactive export energy	4.8.5	
	Rate 6 Reactive export energy	4.8.6	
	Rate 7 Reactive export energy	4.8.7	
	Rate 8 Reactive export energy	4.8.8	

6.4 Power

Parameter	Registers	Object ID	Unit
Active power (Instantaneous value)	System Active power	1.7.0	Internal storage as 0.1W or var Stored as a signed value Displayed in kW/MW or kvar/Mvar units, using import/export indicator to show energy direction
	Active power, phase L1	21.7.0	
	Active power, phase L2	41.7.0	
	Active power, phase L3	61.7.0	
	System Reactive power	3.7.0	
	Reactive power phase L1	23.7.0	
	Reactive power phase L2	43.7.0	
	Reactive power phase L3	63.7.0	

Values are averaged and refreshed every second.

System active power is the summation of the power values in the 3 phases.

6.5 Power Quality

The following power qualities are measured:

Item	Registers	Object ID	Unit
Voltage (Instantaneous value, phase to neutral)	Voltage, phase L1	32.7.0	Internal recording to 0.1V Displayed to xxx or xxx.x V
	Voltage, phase L2	52.7.0	
	Voltage, phase L3	72.7.0	
Current (Instantaneous value)	Current phase L1	31.7.0	Internal recording to mA Displayed to xxx.x or xxx.xx A
	Current phase L2	51.7.0	
	Current phase L3	71.7.0	
Frequency	Network frequency	14.7.0	Internal recording to 0.1Hz Displayed to xx.x Hz
Power Factor	System Power factor	13.7.0	Internal recording to 0.001 PF Displayed to x.xx PF
	Power factor, phase L1	33.7.0	
	Power factor, phase L2	53.7.0	
	Power factor, phase L3	73.7.0	

Values are averaged and refreshed every one second.

RMS voltage is measured phase to neutral.

7 Functional

7.1 Display operation

7.1.1 Energy direction indicator

An energy direction indicator provides an instantaneous indication of the overall direction of the energy measured by the meter, the indicator showing the direction of energy as a summation across the three phases. The resulting quadrant is displayed when current is flowing:

Energy direction	Indicator
Quadrant 1 (active import, reactive import)	
Quadrant 2 (active export, reactive import)	
Quadrant 3 (active export, reactive export)	
Quadrant 4 (active import, reactive export)	
No current flowing (or in anti-creep)	

7.1.2 Phase supply indicators

Phase indicators are displayed when a supply voltage (above 100V) is connected to the corresponding phase.

When all phases are below 100V the meter remains in a low power non-functional mode and displays ‘Lo’.

If one or more phases are above 100V but a phase is supplied with voltage below this value the indicator is not shown for that phase, denoting a phase outage.

Phase	Indicator
Supply voltage supplied to L1	
Supply voltage supplied to L2	
Supply voltage supplied to L3	

7.1.2.1 Incorrect phase rotation

If phase voltages are connected in the incorrect order e.g., L3 - L2 - L1, the indicators will flash

7.1.3 Display list configuration and display advance

A display cycle advance button is fitted to allow the user to manually cycle through the display list. The meter may be configured with a display list which is manually or automatically cycled.

7.1.3.1 Push button advance

Two display cycles are available in the meter, a normal (consumer) display cycle and an extended (engineering) display cycle. Each display list holds references for up to 32 displays, defining the content and the sequence of each display cycle.

The first position in the normal display cycle defines the normal operating display (shown when no push button advances have been made). The normal display cycle is advanced by a short press of the display cycle button or may be set to auto-cycle, advancing automatically.

The extended display is gained by a long press (3 seconds) of the display button. Once selected, the extended cycle is further advanced by short presses of the display cycle button. The meter returns to the normal operating display either by a further long press or a display timeout.

Upon reaching the end of either display list an ‘END’ message is shown. The meter will return to the beginning of the list.

If there are no button presses for 30 seconds a display timeout will occur and the display will return to the normal operating display.

7.1.3.2 Auto-cycling display

An auto-cycling feature automatically advances through the normal display cycle with a set time period between each advance. The duration between advances is configurable, between 1 and 30 seconds. When the display is configured to auto-cycle only the display list is shown, the ‘END’ message is omitted at the end of the cycle.

The auto-cycling feature may also be used in conjunction with the meters display push button. A short press of the display button during auto-cycling will advance the cycle one position; a long press will enter the extended display cycle.

When entering the extended cycle, the extended display list will be auto cycled at the set duration until the final display is shown, after this the ‘END’ message is shown and the display returns to the normal operating display. While in the extended display, a short press of the display button will advance the cycle one position.

A value of 0 set into the auto-cycling time value disables the auto-cycling function and push button cycling is used.

7.1.4 Display resolution

For normal operation, the energy registers may be configured to one of the following resolutions:

a) 6 whole numbers only;
b) 6 whole numbers + 1 decimal place;
c) 6 whole numbers + 2 decimal places;
d) 7 whole numbers only;
e) 7 whole numbers + 1 decimal place; or
f) 8 whole numbers only.

The meter may be configured to 3 decimal places by special test key - for testing purposes only.

7.1.5 Register units

Registers may be configured to show values in M or k units.

Energy registers may be configured separately from Demand and Power registers.

A displayed item is automatically shown in the configured unit and the unit of measurement shown on the bottom line of the display.

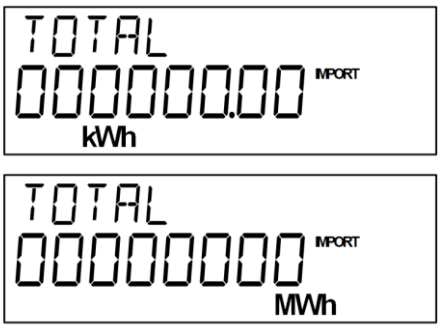
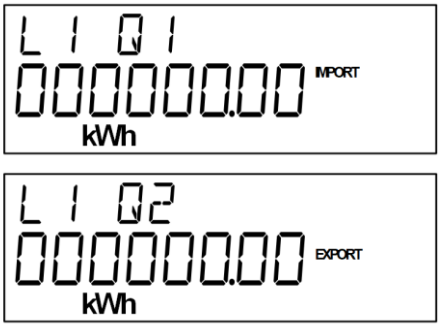
7.1.6 **Display items**

A description and the format of all available display types is provided in this section.

Instantaneous values are updated every second, energy registers are updated as the energy value changes by the least significant digit displayed.

7.1.6.1 **Energy register display formats**

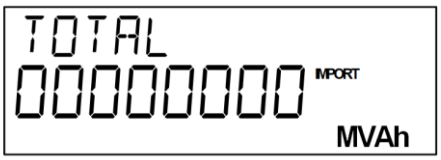
Active Energy Totals

Total Active import • Register shown to the configured resolution with leading zeros. • Examples shown with kWh and MWh unit configuration.	
Total Active export • Register shown to the configured resolution with leading zeros. • kWh or MWh units as configured.	
Total Active import, per phase • Separate displays for L1, L2, L3 values. • Register shown to the configured resolution with leading zeros. • kWh or MWh units as configured. •	
Total Active export, per phase • Separate displays for L1, L2, L3 values. • Register shown to the configured resolution with leading zeros. • kWh or MWh units as configured.	
Active energy per phase, per quadrant • Displays the energy recorded in each phase, per quadrant (import/export references the quadrant). • Register shown to the configured resolution with leading zeros. • kWh or MWh units as configured.	

Reactive Energy Totals

Total Reactive import • Register shown to the configured resolution with leading zeros. • Examples shown with kvarh and Mvarh unit configuration. • kvarh or Mvarh units as configured.	 
Total reactive export • Register shown to the configured resolution with leading zeros. • kvarh or Mvarh units as configured.	
Total Reactive per quadrant • Total reactive energy for each of the 4 quadrants • Register shown to the configured resolution with leading zeros. • kvarh or Mvarh units as configured.	
Total Reactive import, per phase • Separate displays for L1, L2, L3. • Register shown to the configured resolution with leading zeros. • kvarh or Mvarh units as configured.	
Total Reactive export, per phase • Separate displays for L1, L2, L3 values • Register shown to the configured resolution with leading zeros. • kvarh or Mvarh units as configured.	
Reactive energy per phase, per quadrant • Displays the energy recorded in each phase, per quadrant (import/export references the quadrant). • Register shown to the configured resolution with leading zeros. • kvarh or Mvarh units as configured.	 

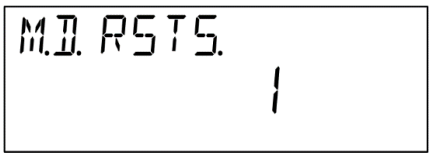
Apparent Energy Totals

Total apparent energy, import • Register shown to the configured resolution with leading zeros. • Examples shown with kVAh and MVAh unit configuration. • kVAh or MVAh units as configured.	 
Total apparent energy, export • Register shown to the configured resolution with leading zeros. • kVAh or MVAh units as configured.	

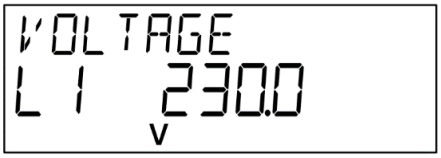
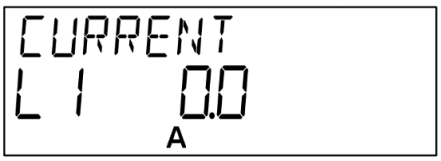
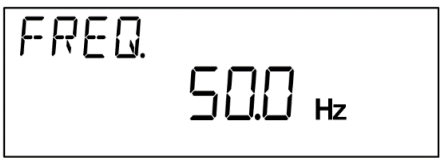
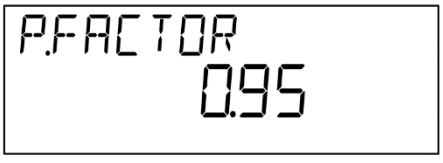
Time-of-use registers

Rate register, active energy • Individual rate register for each of the eight TOU rates • Register shown to the configured resolution with leading zeros. • Separate displays for active import and export values. • kWh or MWh units as configured.	
Rate register, reactive energy • Individual rate registers recording reactive energy • Register shown to the configured resolution with leading zeros. • Separate displays for import and export values. • kWh or MWh units as configured.	
Active rate display • Active rate is identified in the display list with an asterisk against the rate identifier. • An active rate display may also be configured as the default display. The register shows the active TOU rate and the register value for the rate (an asterisk is not shown on this display). • kWh or MWh units as configured.	 

7.1.6.2 **Maximum Demand**

Rising Demand • Indicates the rising demand value in the current interval. • Separate displays for demand values: Import VA, Import W and Export W, shown in K or M units as configured. • Value shown to 2 dp.	
Maximum Demand • Provides the highest demand value in the current billing period. • Separate displays for demand values: Import VA, Import W and Export W, shown in K or M units as configured. • Value shown to 2 dp.	 
Previous Maximum Demand • Last billing period MD value. • Separate displays for demand values: Import VA, Import W and Export W, shown in K or M units as configured. • Value shown to 2 dp.	
Maximum Demand resets • Records the number of MD resets performed to date.	

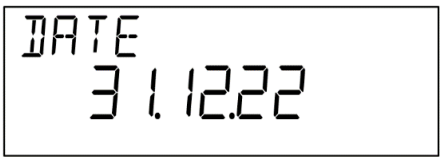
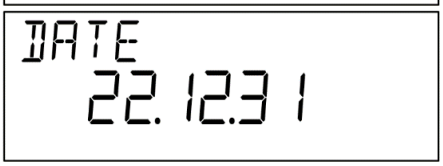
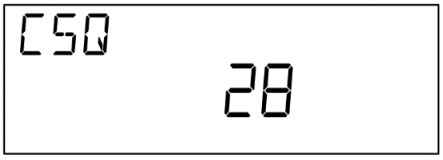
7.1.6.3 **Power quality displays**

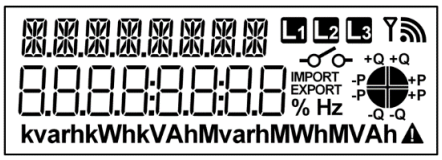
Voltage per phase • Separate displays for L1, L2 and L3 values. • Value may be displayed to 0 or 1 decimal places (using separate displays). • No leading zeros.	
Current per phase • Separate displays for L1, L2 and L3 values. • Current may be displayed to 1 or 2 decimal places (using separate displays). • No leading zeros.	
Frequency • Network frequency value. • Frequency displayed to 1 decimal place. • No leading zeros.	
Power Factor • Separate displays for L1, L2, L3 and overall system power factor (across all 3 phases).	

7.1.6.4 **Power**

Overall active power • Power in all three phases, shown to 2 decimal places. • Import/export indicator changes dynamically as overall direction changes. • Examples shown with kW and MW unit configuration. • kW or MW units as configured.	 
Active power per phase • Separate displays for L1, L2, L3 values. • Import/export indicator changes dynamically as direction changes. • Power shown to 2 decimal places. • kW or MW units as configured.	
Overall reactive power • Power in all three phases, shown to 2 decimal places. • Import/export indicator changes dynamically as overall direction changes. • kW or MW units as configured.	
Reactive power per phase • Separate displays for L1, L2, L3 values. • Import/export indicator changes dynamically as direction changes. • Power shown to 2 decimal places. • kW or MW units as configured.	

7.1.6.5 **Other displays**

Time • Present local time in meter (with automatic correction for daylight saving if set).	
Date • Present date in meter. Two separate displays to allow the date to be shown in two formats: DD-MM-YY YY-MM-DD	 
Signal strength • CSQ value of signal strength, value 0-31.	

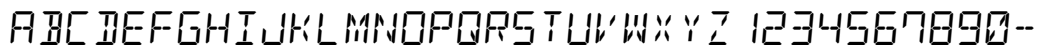
User configurable message (Tariff name) • Configurable message content, see 0	
CT Ratio • CT Ratio as configured.	
CT Adjustment • CT Adjustment values as configured.	
All segments on (test) • Test display with all segments shown.	
Display End • Indicates the end of the display cycle • **NOTE:** Display End **MUST** be entered as the last item of both display lists, otherwise the lists will not terminate correctly.	

7.1.7 **User configurable message**

A user configurable message for purposes such as describing the meter tariff configuration may be added to either the normal or extended display list.

Both lines of the display may be configured, the upper line may be configured with alpha numeric characters, the lower line numeric characters. Both lines hold up to eight characters each.

For the upper line the message may be constructed from the following character set:



For the lower line a message can be generated from the character set;

In both lines a space character is supported.

When the User Configurable Message is entered into a display list without the message content being configured, a blank display will be shown.

7.2 Pulsed output operation

The meter is fitted with two pulsed outputs. Output 1 terminates at terminals 20 and 21, output 2 terminates at terminals 22 and 23.

The pulsed outputs may be configured as follows, or disabled:

Pulsed output (terminals)	20, 21	22, 23
Energy type	Each output configurable separately for either: a) Active Import b) Active Export c) Reactive Import d) Reactive Export e) Apparent Energy	
Energy per pulse	Output pulses are configured as multiples of 100Wh/varh/Vah energy (Configurable 1 to 65535 energy multiples) e.g., a setting of 10 = 1kWh/pulse	
Duration	1 – 255 20ms steps (Configurable 20ms to 5.1 seconds per pulse)	

7.3 Auxiliary relay

7.3.1 Operation

The auxiliary relay can operate in two modes:

a) To signal the end of a demand period
b) As an off-peak control relay

When the relay is set as an off peak control relay, the relay will close according to the set time switches. See, 7.4.2

When configured to indicate end of demand period, the relay will close for a set number of seconds and the end of each demand period. The relay's close time is settable in seconds from 1 to 10 seconds.

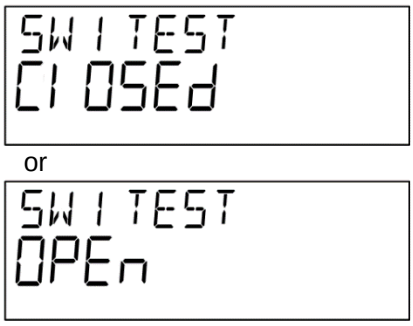
7.3.2 Installation test

A test mode is available to aid the testing of equipment or the electrical circuit connected to the auxiliary relay.

The test mode overrides the normal time switch control of the auxiliary relay and closes or opens the switch for a set period of time. When the test time elapses, the relay returns to its normal operation.

The test mode is activated by sending a command to the meter normally via the optical port. The command allows the switch to be opened or closed for a duration in seconds up to 4.5 hours.

When the test mode is activated, the normal operating display is overridden and a 'Switch 1 Test' display shown as below:



or

At the end of the test period the auxiliary relay and display will automatically revert to their normal operating conditions.

7.4 Time-of-use

The meter supports a seasonal time-of-use tariff structure with the following features:

a) 8 Time-of-use (ToU) rate registers
b) 4 user defined seasons
c) Summer/Winter seasonal switching
d) Day-of-week switching
e) 40 switching times
f) Daylight saving correction

7.4.1 Rate registers

The meter supports 8 ToU rates, each rate is independently time controlled. When a particular ToU rate becomes active, the meter records energy (active import, active export, reactive import and reactive export) into separate ToU registers relating to the active rate.

7.4.2 Time switches

ToU rate switching is controlled by a time switching plan holding 40 time switches. Each programmed time switch defines the time at which a particular rate or settings will become active. The time switches also control the state of the auxiliary relay.

Time switches may be configured to operate during particular seasonal periods or on particular days of the week.

Each Time Switch may be configured with the following information:

Item	Description
Start Time	Time in HH:MM 24hr clock format at which the time switch becomes active.
ToU active rate (1 to 8)	Defines the ToU rate that will become active at the start time.
Active season (Summer/Winter seasons or user defined seasons 1, 2, 3 or 4)	Defines the period of the year when the time switch should operate. Selecting both summer and winter seasons defines all year operation. Seasons may be defined as summer/winter or with specific start dates, see Season 7.4.3
Active day of the week	Defines the day(s) of the week the time switch should operate (Mon-Sun, true or false). Any combination of days are allowed (provides flexibility for separate Weekday/Weekend switching regimes)
Relay Operation	Controls the operation of the auxiliary relay, which may be closed for the duration of the time switch. (The switching plan allows for the operation of two auxiliary relays available in other EMP1 meter versions) Random Offset - A random offset function is available. When enabled the switching of the auxiliary relay is retarded between 10 and 255 seconds from the start time of the time switch.

Where no time switch settings are made, ToU rate 1 will be always be active, any energy measured being recorded in the rate 1 registers.

7.4.2.1 **Examples of TOU operation**

Standard 7 hour off peak time switch plan

Time switch	Start	Active Rate	Seasons	Operational days of week (true 1, false 0)							Relay operation (on 1, off 0)	
				M	T	W	T	F	S	S	RLY1	RLY2
1	00:00	1	S & W	1	1	1	1	1	1	1	1	N/A
2	07:00	2	S & W	1	1	1	1	1	1	1	0	N/A

Off peak rate (1) from midnight to 07:00, standard rate (2) for remainder of day. Operates every day, all year. The auxiliary relay closes during off peak time.

Weekend/Weekday Time Switch plan

Time switch	Start	Active Rate	Seasons	Operational days of week (true 1, false 0)							Relay operation (on 1, off 0)	
				M	T	W	T	F	S	S	RLY1	RLY2
1	00:00	1	S & W	1	1	1	1	1	0	0	1	N/A
2	07:00	2	S & W	1	1	1	1	1	0	0	0	N/A
3	00:00	3	S & W	0	0	0	0	0	1	1	0	N/A

Off peak rate (1) from midnight to 07:00, standard rate (2) for remainder of day, operating on weekdays only, all year. Weekend tariff rate (3) from Sat 00:00 all weekend until 00:00 Mon. Auxiliary relay closes during off peak night time.

Summer/ Winter Seasonal switching plan

Time switch	Start	Active Rate	Seasons	Operational days of week (true 1, false 0)							Relay operation (on 1, off 0)	
				M	T	W	T	F	S	S	RLY1	RLY2
1	00:00	1	W*	1	1	1	1	1	1	1	1	N/A
2	09:00	2	W*	1	1	1	1	1	1	1	0	N/A
3	00:00	1	S*	1	1	1	1	1	1	1	1	N/A
4	07:00	2	S*	1	1	1	1	1	1	1	0	N/A

* Season settings – set to change as per European daylight savings dates

Winter season provides additional two hours off peak during winter season.

Seasonal Switching plan

Time switch	Start	Active Rate	Seasons	Operational days of week (true 1, false 0)							Relay operation (on 1, off 0)	
				M	T	W	T	F	S	S	RLY1	RLY2
1	00:00	1	Season 1*	1	1	1	1	1	1	1	1	N/A
3	01:00	1	Season 2*	1	1	1	1	1	1	1	1	N/A
4	09:00	2	Season 2*	1	1	1	1	1	1	1	0	N/A

* Season settings - season 1 – starts 1st November, Season 2 – Starts 1st February

Off peak winter tariff. Off peak rate (1) is active all winter season 1st Nov- 1st Feb. During summer season off peak rate (1) every day from 01:00 to 09:00, standard rate (2) for remainder of day. Auxiliary relay closed during off peak rate.

7.4.3 **Seasonal Switching**

Two types of seasonal switching are available:

a) User defined seasons
b) Summer/Winter Seasons.

7.4.3.1 **User Defined Seasons**

User defined seasons allow up to four seasons to be specified by start date and month.

Season	Start day and month
1	DD/MM
2	DD/MM
3	DD/MM
4	DD/MM

A season becomes active at 00:00 of the specified start date:

Start Month is represented by a value 1 to 12, January = 1, December = 12. Start dates use a value 1 to 31. A season setting shall be invalid if a non-legal month or date value is used.

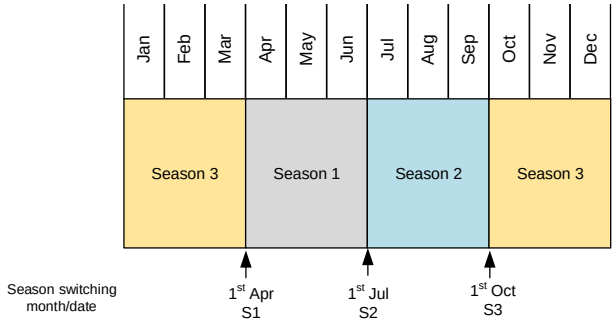
Time switch settings may be applied to any of the user defined seasons. A season will be active until a new season begins. The settings will be applied every year.

A separate ‘Enable Programmable Seasons’ setting is used to enable user defined season operation. The setting is part of the Options setting. User defined seasonal switching may also be disabled by using a default date setting.

7.4.3.2 **Example of user defined seasons**

The diagram below shows the configuration of three seasons:

Season 1: begins starts 1st April (operational from April – end June);
Season 2: begins 1st July (operational from July – end September);
Season 3: begins 1st October (0operational October - end March).



Season numbers 1 to 3 are applied to the time switch settings to apply the time switch to a season.

7.4.3.3 **Summer/Winter seasons**

Summer/Winter season start dates follow the dates set for Daylight Saving Time correction, see 7.5.2.

Daylight Saving settings may be configured without enabling time correction allowing seasonal switching only when time correction is not required.

Summer/winter seasons are applied to a time switch by setting the required summer or winter season in the time switch to true.

7.5 Clock

7.5.1 **Mains locked clock**

The meter is standardly configured (unless otherwise requested) to run a mains locked clock. The mains locked clock function provides a better clock accuracy when used on networks that maintain the network frequency to an average 50Hz over a long-term period.

The mains locked clock function counts the cycles of the mains frequency to derive a one second time signal. On power up (or when the mains-locked clock is first enabled) the meter retrieves the time from the battery backed crystal clock and advances the mains locked clock by one second each time 50 mains cycles is counted. Once every 24-hour period, or on power down, the meter will write the calculated time to the battery backed clock.

7.5.2 **Daylight saving**

The meter may be configured to support daylight saving time (DST) correction.

The start and end date for DST correction is configured through the Summer/Winter season settings, see 7.4.3.3.

DST time correction has a separate enabling option to allow the Summer/winter seasonal settings to operate independently, with or without DST time correction.

When DST time correction settings are applied, the displayed time will automatically correct for DST correction.

ToU time switches follow local time and therefore will operate with DST correction when applied.

DST settings may be programmed with the following settings:

	Date (Day of Month)	Month	Day of Week	Hour	Minute
Summer Start	1-254	1-12	1-7 & 255	0-23	00-59
Summer End	1-254	1-12	1-7 & 255	0-23	00-59

Item	Description
Date (day of month)	Used to specify a particular or the last day of the month the daylight saving starts or ends: A value of 1 to 31 specifies the exact date within the month the season starts/ends. Selecting the last day of the month - A value of 254 specifies the season starts/ends on a last day of the month. The setting is used in conjunction with the Day of Week setting: Setting Date to 254 and the Day of Week between 1 and 7 results in the season starting/ending on the last Monday to Sunday in the month. Setting Date to 254 and Day of Week to 255 corresponds to the season starting/ending on the last day of the month. A Date value of 253 corresponds to the second last day of the month if Day of Week is set to 255 or second last day type of the month (Mon-Sun) if Day of week is set 1 to 7, etc.

Month	The month that daylight saving starts / ends. January is represented by a value of 1, December a value of 12.
Day of Week	Specifies the day of week where Monday is 1 and Sunday is 7. A value of 255 specifies last day of month when used in conjunction with Date setting 254, see above.
Hour/Minute	Specifies time in hour/minutes.

Time is advanced during summer season by a DST deviation value. The Deviation value is a signed value of ±120 minutes. Default value is +60 minutes (advance clock 1hour).

A separate DST correction setting is used to enable the DST correction of the meter clock time. The setting is part of the 'Options' setting.

7.5.2.1 **DST setting example**

To set standard European DST settings:

Summer Start: Last Sunday in March, time move forwards 1 hr at 01:00

Summer End: Last Sunday in October, time moves backwards 1 hr at 01:00

	Date (Day of Month)	Month	Day of Week	Hour	Minute
Summer Start	254	3	7	01	00
Summer End	254	10	7	01	00

7.6 Interval data

Interval data collection within the meter is highly configurable –

- The meter may be configured to record interval data into two separate profile logs
- Each profile log may be set with its own collection interval, 1 to 60 minutes.
    - Meters are factory configured to collect 30-minute interval data but may be changed remotely at a later date if required.
- Each log may be configured to collect up to 16 channels of data
- The available on-board storage may be split and apportioned across the two logs as required.

The factory configuration of interval data is set according to the requirements of the code of practice:

For CoP10 and Cop5 (CVA metering systems) - Meter will record a single interval data log of 30-minute interval data providing storage for 4746 entries (over 98 days of data).

For Cop5 (SVA metering systems) – Meter records a single interval data log of 30-minute interval data providing storage for 4524 entries (over 94 days of data).

For Code of Practice operation, values are recorded as a W or var Demand value. Demand values are calculated as 2× the Wh or varh energy recorded in the 30-minute period, see 7.7.1 for details of demand calculation.

E.g., if 5 kWh usage is recorded in a 30 min period, the demand value recorded is 10kW.

When interval data is requested from the meter an information header is returned within the data. This header confirms the start time of the data returned, the interval collection period and references of the data objects contained in the interval records.

30-minute data recording is synchronised to 00 and 30 minutes past the hour in UTC time.

Following a power outage, the meter will automatically generate entries missed during the outage and mark the status information as ‘Power Outage’.

When the interval log becomes full, new data overwrites the oldest stored data.

Any log may be reset by a reset command.

7.6.1 Status Information

Status information confirming the validity of an entry, is stored in the form of a status bit field. Each interval record entry is stored with a status field value.

The status value is formed from the following flags:

0x0001 - Interval Data Log Reset
0x0004 - Time update (any time adjustment)
0x0008 - MD Reset (Full MD reset)
0x0010 - Security access (write access with L3 password)
0x0030 - Phase voltage failure L3
0x0040 - Phase voltage failure L2
0x0080 - Phase voltage failure L1
0x4000 - Power outage (during or across the 30 min. period)
0x8000 - Valid data

Multiple flags may be recorded together

7.6.2 **CoP10 and Cop5 (CVA metering systems)**

Both CoP10 and CoP5 (CVA) metering systems, have similar interval data requirements. Each meter type will be factory configured to collect the following 30-minute interval data:

Status information	Demand data			
	Active import	Active export	Reactive import	Reactive Export
bit field	(W)	(W)	(var)	(var)

Each interval record provides the following data channels:

Status information	as detailed in section 7.6.1.
Active import	Recorded as W demand for Active import
Active export	Recorded as W demand for Active export
Reactive import	Recorded as var demand for Reactive import
Reactive export	Recorded as var demand for Reactive export

Demand values are stored as W or var values. Once retrieved, values may be converted to MW or kW as required by the code of practice.

7.6.3 **Cop5 (SVA metering systems)**

A meter configured for CoP5 (SVA) metering will be factory configured to collect the following 30-minute interval data:

Status information	Demand data					
	Active import	Active export	Quadrant 1 Reactive	Quadrant 2 Reactive	Quadrant 3 Reactive	Quadrant 4 Reactive
bit field	(W)	(W)	(var)	(var)	(var)	(var)

Each interval record provides the following data channels:

Status information	as detailed in section 7.6.1.
Active import	Recorded as W demand for Active import
Active export	Recorded as W demand for Active export
Quadrant 1 Reactive	Active Import related, Import var demand
Quadrant 2 Reactive	Active Export related, Import var demand
Quadrant 3 Reactive	Active Export related, Export var demand
Quadrant 4 Reactive	Active Import related, Export var demand

Demand values are stored as W or var values. Once retrieved, values may be converted to kW as required by the code of practice.

7.7 Maximum Demand

7.7.1 Calculating Maximum Demand

The meter runs a Maximum Demand (MD) function capturing the highest 30-minute demand value recorded during a billing period. MD values for import W, export W and import VA are calculated and stored as separate registers. On retrieval the values may be converted to MW or kW as required by the code of practice. Any combination of these registers may be shown on the display.

Demand is calculated over 30 a minute period, the start of each demand period normally synchronised to 00 or 30 minutes past the hour.

For each 30-minute period, the demand is calculated by measuring the energy consumed during the period then scaling the value to provide a demand value for the period, using the following:

$$\text{Demand} = \text{Energy consumed in period} \times \frac{60}{\text{minutes in demand period}}$$

The meter may be configured to display a Rising Demand value. The value is set to zero at the beginning of the 30 min period and rises to provide a kW (MW) or kVA (MKA) equivalent of the usage in the period.

At the end of each 30-minute period, the calculated Demand value is compared to the stored MD value and the MD value overwritten if the Demand value is higher than the stored MD.

MD is calculated as a ‘block’ or ‘slab’ demand (not a rolling demand).

7.7.2 Maximum Demand reset

Maximum Demand may be reset by two means, manual or automatic.

7.7.2.1 Automatic periodic reset

The meter may be configured to reset the MD automatically on a particular day, every month.

A day of month value is configured with a value 1 to 31:

Value 1-31 defines the day of the month the reset shall occurs.

When the configured day is reached, the reset will occur at 00:00. The reset action causes the current months MD value to be written to the previous months MD value, the current months MD value being reset to zero. The action occurs to all MD registers (W and VA).

Where the month is set to a number greater than the actual days in a month the MD will reset on the last day of the month.

When the month value is reconfigured, this will trigger a reset of the current and previous periods MD values.

7.7.2.2 Manual reset

The meter may be manually reset by writing a value to an MD Reset object. Two reset functions are available Normal MD Reset (value 01) and Full MD reset (value 02).

Normal MD Reset will result in the following:

1) The current MD value is written to the previous months MD value;
2) The current MD value is reset to zero;
3) The Maximum Demand Reset Counter will be incremented;
4) An MD Reset event is written to the event log with addition information value 0x01.

Full MD reset results in the following:

1) Both the current and previous period MD registers will be reset to zero;
2) The Maximum Demand Reset Counter will be incremented;
3) An MD Reset event is written to the event log with addition information value 0x02.

7.8 Event log

The meter records an event log which stores details of the important occurrences with the meter.

The event log holds 50 events.

When the event log becomes full, new data overwrites the oldest stored data.

Each event is stored as a numeric ID which is stored together with the timestamp of the occurrence.

Additional data is recorded against each event providing further information on the status of the event e.g., event started, event ended.

7.8.1 **Event types**

The events captured in the event log are shown in the table below:

ID	Event	Description
03	Maximum Demand Reset.	Maximum demand has been reset by external command.
04	Clock battery event.	Battery has failed in the meter
05	Profile log reset	An interval data log has been reset
10	New firmware received	A new firmware image has been received
11	New firmware error	New firmware image has been received but an error has occurred
12	New firmware applied	New firmware has been applied successfully

7.8.1 **Event information**

An additional value is stored against each event logged, this provides information on the status of the event.

Example:

Event	Value	Description
Profile Log Reset	0	Profile log 1 was reset
	1	Profile log 2 was reset
Maximum Demand Reset	1	Normal MD reset, see 7.7.2
	2	Full MD reset

7.1 Firmware update

The meter supports over the air firmware update allowing the working firmware to be replaced with a new version.

A new firmware file can be delivered remotely via the communication module or through the optical port. Due to the lower data rate of the optical port, an optical download may take several minutes.

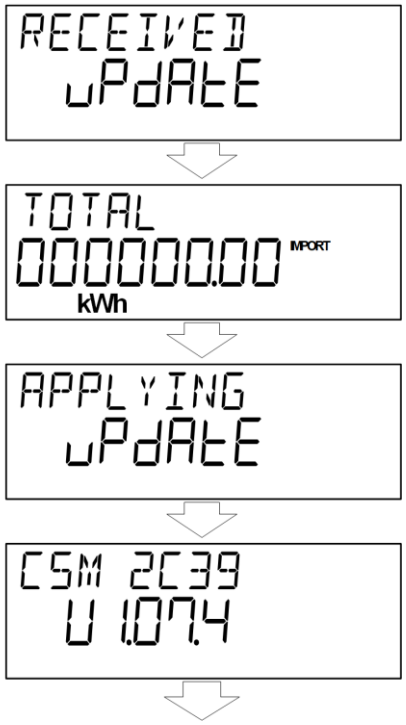
7.1.1 Firmware update process

Once a complete firmware image has been received, the meter will automatically begin the update process.

The newly received firmware image is stored in flash memory and is internally checked for errors. An event is logged to note the receipt of the new image.

If the received image is found to be corrupt or of an incorrect type for the meter, an error is logged in the event log. The upgrade process is halted in this case.

A checked and passed firmware image is loaded from flash memory into the microcontroller's program memory. During the process the normal meter operation is interrupted and update process messages are shown on the display, see below:



Update file received and warning that update process is about to begin.

Returns to normal operating display while firmware is checked for errors. If errors found, update is halted and 'Update Failed' message shown for a short while

Firmware is loaded from flash memory to program memory. Normal operation halted.

Process complete, module automatically restarts and new firmware version id displayed.

Normal display operation

7.2 Security

7.2.1 Password protection

The meter uses password protection as part of the access security. Three levels of password provide access to levels of data and control over reconfiguration.

The data accessible at each password level is detailed in 7.2.2, higher level passwords also giving access to lower-level data. Successful password negotiation with the meter will allow access to the restricted items for a pre-set time period.

Passwords are 12 characters long (12 bytes).

Passwords may be exchanged only when using the highest-level password (Level 3). It is the operator's responsibility to set a security regime to protect password integrity and change passwords when deemed necessary.

There is no level 4 password – calibration can only be performed by breaking seals and removing the front cover.

CoP5 configuration - In the event that an illegal attempt is made to access the meter (password failure), a counter of illegal attempts is incremented. If the number of illegal attempts reaches 7, the meter will lockout. The lockout is cleared after 1 hour.

7.2.2 Password levels

Level 1 (Read access only)
Read only access to the following:
Energy totals
Instrumentation data (voltage, current power etc.)
Time of use rate registers
Maximum Demand registers
Interval data
Event log
Status register
Time/date
Meter serial number
Read configuration settings (including CT ratio, error correction adjustment value)

Level 2 (Read access and restricted programming)
Read only access of all items at level 1, plus the following:
Update of time and date
Manual resetting of MD registers

Level 3 (Full access)
Read only and programming of all items at level 2, plus full configuration of the meter, including:
Display content and format
Time-of-use tariff settings
Season settings
Maximum demand settings
CT ratios and error adjustment value
Resetting of event log, status register, interval data
Modify passwords for levels 1, 2 and 3.
Enable security

8 Communication Module

8.1 Antenna

The meter and communication module are standardly supplied without antenna, unless otherwise agreed. There is no internal antenna and a stub antenna or wired antenna must be fitted to the SMA connector in the back of the module.

Fig. 4 – Rear of communications module showing antenna housing and SMA connector

Normally, at meter installation, the protective cap over the SMA connector is removed and a stub antenna screwed onto the connector.

Fig. 5 – Stub antenna fitted to SMA connector

Alternatively, in cases where the installation location suffers from a low network signal strength, a range of higher gain cabled antenna are available which may replace the stub antenna. Cabled antennae may be routed to an area which provides better signal reception. A cabled antenna is again screwed onto the SMA connector provided. Two knock-outs are provided in the casework to allow the cable to be routed from the antenna housing. These may be removed using cutters.

Fig. 6 – Removable knock-outs for routing cabled antennae through to the side of the module

8.2 Sim card

A SIM card is normally installed during manufacture with a manufacturing file supplied matching the installed SIM card number to the meter nameplate number.

In cases where no SIM card is installed, the card may be fitted by removing the communications module from the meter. The SIM card holder is located on the underside of the module, close to the fixing screw. The card is slid into the holder according to the orientation symbol embossed into the module plastic.

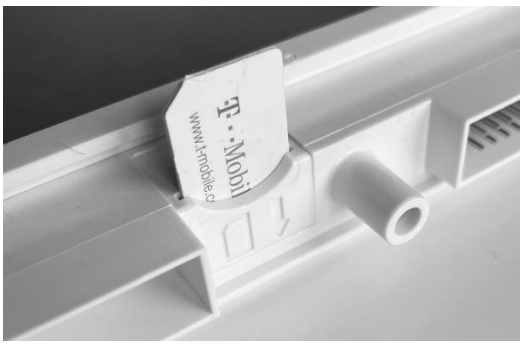


Fig. 7 – SIM card orientation

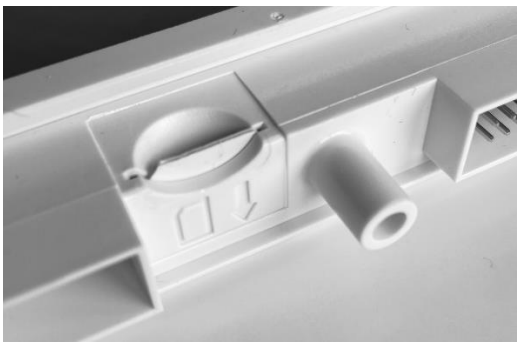


Fig.8 SIM card fully inserted

8.3 Communication status

The communication module is fitted with two LEDs at the front of the unit to indicate the communications status. The LEDs illuminate through the module case and are marked PWR and WAN.

Fig. 9 – Communications module front

The green PWR LED indicates the power status, the orange WAN LED indicates the data connection status. The indicate is as follows:

Power status (Green)

Power ON	Green light ON when module powered up.

Data connection (Orange)

Network searching	Slow flash every 2 seconds - 200ms ON / 1800ms OFF (LED is OFF more than ON)
Connected to network and idle	Slow flash every 2 seconds - 1800ms ON / 200ms OFF (LED is ON more than OFF)
Data transfer ongoing	Fast flash 4 times/second - 125ms ON / 125ms OFF

8.4 Signal Strength indicator

A signal strength indicator provides an indication of the received signal strength of the GSM signal on the meter display.

Where no signal is present the antenna symbol only is shown.

Four levels of signal strength are shown using separate bars:

Level	Indication	CSQ value	dBm value
1 - Low	Antenna symbol + dot B	<=4	-105 dBm or greater
2	Antenna symbol + dot B + bar C	5-16	-81 dBm or greater
3	Antenna symbol + dot B + bars C & D	17-22	-69 dBm or greater
4 - High	Antenna symbol + dot B + bars C, D, & E	28-31	-57 dBm or greater

9 Decommissioning and disposal of meters

At the end of the meter's usable life, the product should be sent to a professional electronic waste treatment company for processing and recycling. The product can be easily dismantled into its major components to aid recycling. Major plastic parts are stamped with the plastic material used.

9.1 Materials

The materials used in the meter part breakdown into the following categories:

Component part	Material	Percentage of product (by weight)
Outer plastic casework	Polycarbonate plastic	37%
Electrical terminals and associated metalwork	Brass/copper	46%
PCB assembly	Mixed electronic components	16%
Battery	Lithium coin cell	<1%

The EMP1.cx meter contains a lithium battery (coin cell) which should be removed from the main printed circuit board assembly. Lithium cells must be handled carefully to avoid the risk of short circuit, overheating and fire.

9.2 Component disposal

The following disposal advice is for general guidelines only; local environmental laws and policies must always take precedence; the recycling of component parts should always be carried out in accordance with local regulations. Waste treatment plants should always be approved by local authorities.

Wherever possible, component parts should be treated as follows:

Component part	Disposal advice
Outer plastic casework	Material should be sorted and re-granulated
Electrical terminals and associated metalwork	Sorted and sent to a metals recycling facility.
PCB assembly	Sent for recycling at specialist electronic waste plants
Battery	Removed from the PCB assembly and delivered to a specialist recycling plant. Note handling caution above.

The product should not be disposed of in landfill or with other regular waste.

10 Dimensions

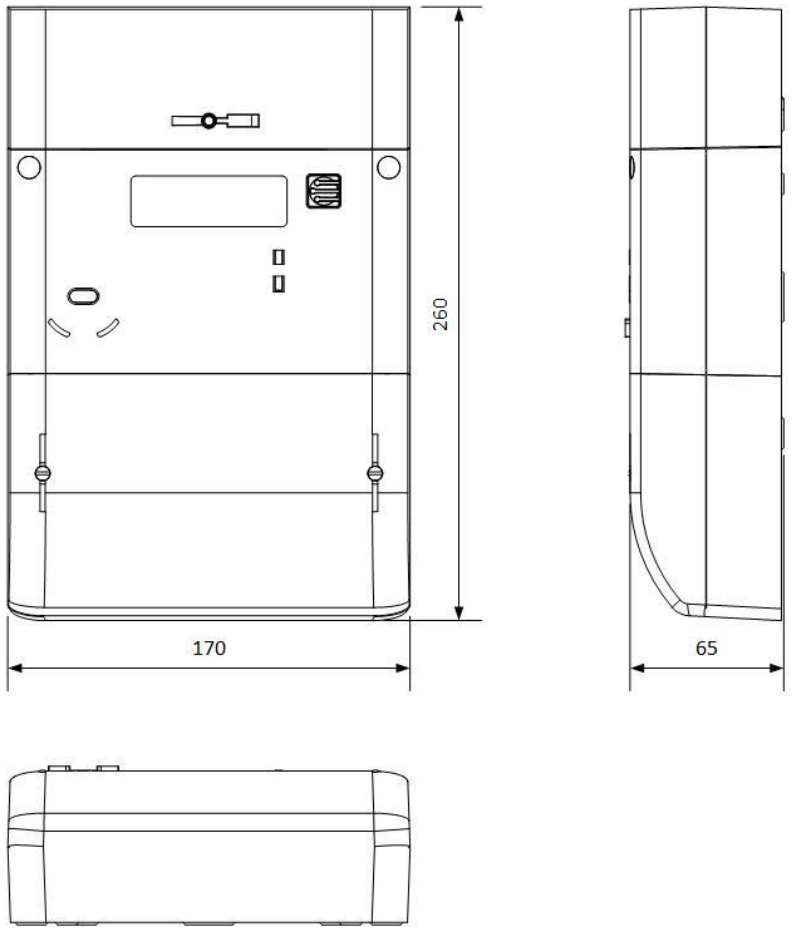


Fig. 10 - EMP1.cx dimensions when fitted with extended terminal cover