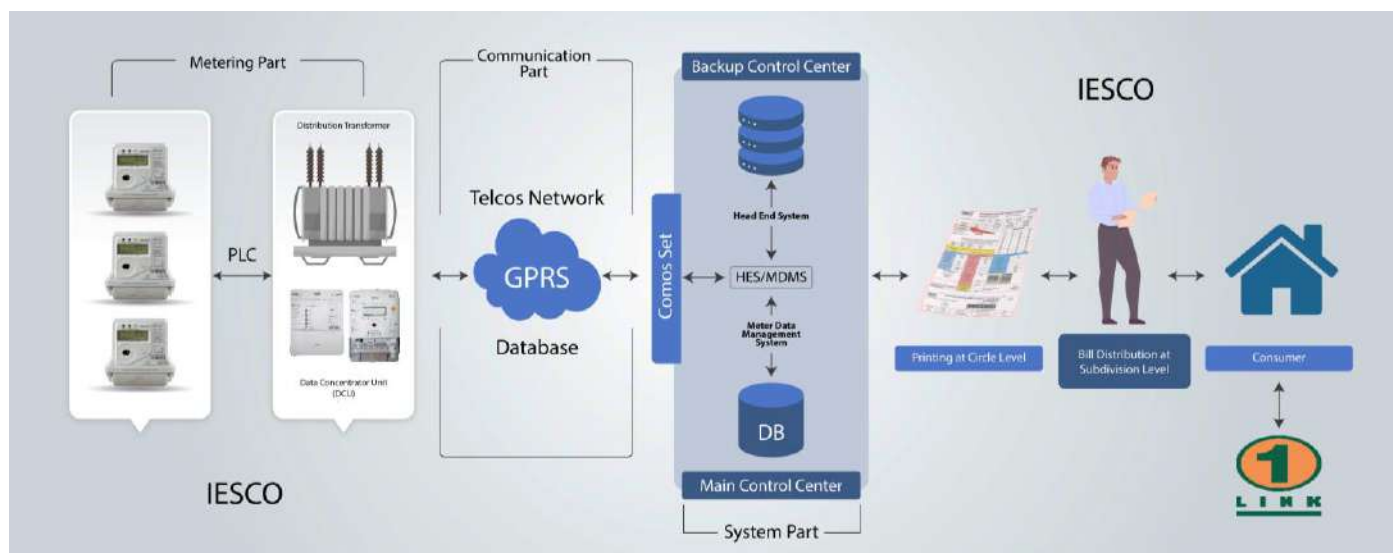
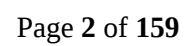




TSW-AMI-02

Single Phase -2 Wire Whole Current AMI Energy Meter



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Abbreviation

+A	Active energy import
-A	Active energy export
+R	Reactive energy import
-R	Reactive energy export
R1	Reactive energy for quadrant 1
R2	Reactive energy for quadrant 2
R3	Reactive energy for quadrant 3
R4	Reactive energy for quadrant 4
P	Active power
+P	Active power import
-P	Active power export
Q	Reactive power
+Q	Reactive power import
-Q	Reactive power export
MD	Maximum Demand
PF	Power Factor
TOU	Time Of Use
RTC	Real Time Clock
PLC	Power Line Communication
RBAC	Role-Based Access Control
DLMS	Device Language Message Specification
COSEM	Companion Specification for Energy Metering
HLS	High Level Security
ESD	Electrostatic Discharge
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
SIM	Subscriber Identity Module
RSSI	Received Signal Strength
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
APN	Access Point Name
PDP	Program Decision Package
DHCP	Dynamic Host Configuration Protocol
IMEI	International Mobile Equipment Identity
PAP	Password Authentication Protocol
CHAP	Challenge Handshake Authentication Protocol
IMSI	International Mobile Subscriber Identity
FDD	Frequency Division Duplexing
CAT	LTEUE-Category
RADIUS	Remote Authentication Dial In User Service
MAC	Media Access Control
FCC	Federal Communications Commission
DBPSK	Differentially coherent Binary Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
D8PSK	Eight-Ary Differential Phase-Shift Keying
AES	Advanced Encryption Standard
GCM	Galois/Counter Mode

HLV	Hazardous live voltage
SELV	Safety extra low voltage
ICMP	Internet Control Message Protocol
PAN	Personal Area Networks
RS	Router Solicitation
RA	Router Advertisement
4G	The 4 th generation mobile communication technology
2G	2-Generation wireless telephone technology
UART	Universal Asynchronous Receiver/Transmitter
TRP	Total Radiated Power
TIS	Total Isotropic Sensitivity
SWR	Voltage Standing Wave Ratio

1. FOREWORD

- 1.1 The TSW Department of IESCO has prepared this Specification.
- 1.2 This Specification is intended for the purpose of technical specification only for the procurement of material and does not include provisions of contract, unless otherwise provided in the contract.
- 1.3 This Specification is subject to revision as and when required.

2. SCOPE

- 2.1 This specification pertaining to Single Phase Multi Rate Tariff ,Single Element ,2-Wire ,230 volts, 5(40) Amp, 50 Hz Whole Current Energy meter ,KWh Accuracy Class 1 and KVARh accuracy class 2, Bi-Directional AMI Energy Meter and covers the design, engineering, manufacture, assembly, inspection, testing at manufacturer's premise before dispatch.
- 2.2 The complete Build unit (CBU) ie meter, internal CTs and Communication Module 4G/2G or PLC (As per tender Inquiry) shall be housed in the same enclosure. The meter shall have provision in such a way that supply / service cable of consumer shall be directly passed through the meter for current measurement. Piercing screws shall be used in the meter for voltage connection.
- 2.3 The meter shall be capable to measuring, record and display the following Features

A	Active Energy Export(KWH)
B	Reactive Energy Export(KVARH)
C	Active Energy import(KWH)
D	Reactive Energy import(KVARH)
E	Maximum Demand of Active Energy Export(KW)
F	Maximum Demand of Reactive Energy Export (KVAR)
G	Maximum Demand of Active Energy import(KW)
H	Maximum Demand of Reactive Energy import(KVAR)

- 2.4 It supports multi-tariff, monthly billing, daily billing, energy load profile, power quality load profile, event detection, neutral current detection, supply control and prepayment function etc. A modular-designed communication 4G/2G module, or PLC module (As per tender Inquiry) ¹ which supports plug and play without power off the meter. Some functions are kept disabled by default, e.g. export energy segments but are configurable and can be activated later on demand of purchaser.

1. Purchaser will mention the type of communication module in bidding document.

- 2.5 The material shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the purchaser.
- 2.6 Purchaser will interpret the meanings of drawings and specification and shall have the right to reject any work or material which in his judgment is not in accordance therewith. The offered materials shall be complete with all components, accessories necessary for their effective and trouble free operation in the system for energy measurement

3. REFERENCE STANDARDS

- 3.1 The Reference standards to be used for manufacturing of Energy meters and testing are listed and provided in Annex – I.
- 3.2 In case of parameter or any other condition of this specification, deviates from International standard, then provision of this specification shall prevail.

4. DEFINITIONS

Sr.	Terms	Definition
1	Static Watt-Hour Meter	Meter in which current and voltage act on solid-state (electronic) element to produce an output proportional to watt-hour.
2	Multi-Rate Meter	Energy meter provided with a number of registers, each becoming operative at specified time intervals corresponding to different tariffs
3	Measuring Element	Part of the meter which produces an output proportional to the energy.
4	Test Output	Device which can be used for testing the meter
5	Operational Indicator	Device, which gives a visible signal of the operation of the meter.
6	Memory	Element which stores digital information
7	Non-volatile memory	Storage device which can retain information in the absence of power
8	Display	Device which displays the content(s) of memory (ies)
9	Register	Electronic device comprising both memory and display, which stores and displays information.
10	Current circuit	Internal connections of the meter and part of the measuring element through which flows the current of the circuit to which the meter is connected.
11	Voltage circuit	Internal connections of the meter, part of the measuring element and power supply for the meter supplied with the voltage of the circuit to which the meter is connected
12	Auxiliary circuit	Elements (lamps, contacts, etc.) and connection of an auxiliary device within the meter case intended to be connected to an external device for example clock, relay, and impulse counter.
13	Constant	Value expressing the relation between the energy registered by the meter and the corresponding value of the test output. If this value is a number of pulses, the constant should be either pulses per kilowatt-hour (imp/kWh) or watt-hours per pulse (Wh/imp).
14	Indoor meter	Meter which can only be used with additional protection against environmental influences (in a house, in a cabinet)
15	Outdoor meter	Meter which can be used without additional protection in an exposed environment
16	Base	Back of the meter by which it is generally fixed and to which are attached the measuring element, the terminals or the terminal block, and the cover.
17	Cover	Enclosure on the front of the meter, made either wholly of transparent material or opaque material provided with window (s) through which the operational indicator (if fitted) and the display can be read.
18	Case	Comprises the base and the cover

Sr.	Terms	Definition
19	Protective earth terminals	Terminal connected to accessible conductive parts of the meter for safety purposes
20	Terminal block	Support made of insulating material on which all or some of the terminals of the meter are grouped together.
21	Terminal cover	Cover, which covers the meter terminals and generally, the ends of the external wires or cables, connected to the terminals.
22	Clearance	Shortest distance measured in air between two conductive parts.
23	Creepage distance	Shortest distance measured over the surface of insulation between two conductive parts.
24	Basic insulation	Insulation applied to live parts to provide basic protection against electric shock.
25	Basic current (in)	Value of current in accordance with which the relevant performance of the meter is fixed.
26	Maximum current (Imax)	Highest value of current at which the meter purports to meet the accuracy requirements of this standard.
27	Reference voltage	Value of the voltage in accordance with which the relevant performance of the meter is fixed.
28	Reference frequency	Value of the frequency in accordance with which the relevant performance of the meter is fixed.
29	Percentage error	Percentage error is given by the following formulas:- $\text{Percentage error} = \frac{\text{Energy registered by the meter} - \text{True energy}}{\text{True energy}} \times 100$ Since the true value cannot be determined, it's approximated by a value with a stated uncertainty that can be traced to standards agreed upon between manufacturer and user or to national standards.
30	Reference conditions	Appropriate set of influence quantities and performance characteristics, with reference values, their tolerance and reference ranges, with respect to which the intrinsic error is specified.
31	Electromagnetic disturbance	Conducted or radiated electromagnetic interference, which may affect functionality or metrological operation of the meter.
32	Rated operating conditions	Set of specified measuring ranges for performance characteristics and specified operating ranges for influence quantities, within which the variations or operating errors of a meter are specified and determined.
33	Specified measuring range	Set of values of a measured quantity for which the error of a meter is intended to lie within specified limits.
34	Specified operating range	Range of values of a Single influence quantity, which forms a part of the rated operating conditions

Sr.	Terms	Definition
35	Limit range of operation	Extreme conditions, which an operating meter can withstand without damage and without degradation of its metrological characteristics when it is subsequently operated under its rated operating conditions
36	Storage and transport conditions	Extreme conditions, which a non-operating meter can withstand without damage and without degradation of its metrological characteristics when it is subsequently operated under its rated operating conditions
37	Normal working position	Position of the meter defined by the manufacturer for normal services.
38	Thermal stability	Thermal stability is considered to be reached when the change in error as a consequence of thermal effects is, during 20 min., less than 0.1 times the maximum permissible error for the measurement under consideration.
39	Advance Metering infrastructure	Advance Metering infrastructure (AMI) are systems that measure, collect and analyze energy usage and communicate with metering devices such as electricity meter, either on request or on schedule. These systems include hardware, software, communications, HES and meter data management (MDM) software etc.
40	MDM	Meter data management server is a system in advance metering infrastructure used to obtain data from the meters and store in the database.
41	HES	Head-End System is hardware and software that receives the stream of meter data brought back to the utility through the AMI
42	Pull	Pull is a mechanism in which MDM demands for specific information or data from meter and meter send data in response.

5. SERVICE CONDITIONS

5.1 The meter to be supplied against this specification shall be suitable for continuous operation under the following tropical conditions:

Climatic Condition

- | | | | |
|-----|---------------------------------------|---|----------------------------|
| a). | Peak ambient temperature | - | 55°C |
| b). | Mean max. temperature during 24 hours | - | 45°C |
| c). | Minimum temperature | - | -10°C |
| d). | Maximum relative humidity | - | 100% |
| e). | Average annual rain fall | - | 150 mm |
| f). | Maximum Altitude | - | 1000 meter above Sea Level |
| g). | Limit range for storage and transport | - | -25 °C to 80 °C |

5.2 Relative humidity may range upto 100% non- condensing.

5.3 Altitude: Up to 1000 meter above sea level.

6. Electrical construction Requirement

Single Phase whole current AMI Energy meter shall at least meet the following minimum and maximum limits of parameters.

6.1 Technical parameter of Energy Meters

Technical features		Description
I. Standard Ratings		
Connection type		Single-phase two-wire (1P2W), direct connection, Bi-directional measurement
Measurement accuracy		Active power: Class 1 Reactive power: Class 2
Nominal voltage (Un)		230 V
Maximum voltage		440V (max. 6 hours)
Specified operating voltage range		0.7Un ~ 1.2Un
Extended operating voltage range		0.6Un~1.2Un
Limit operating voltage range ²		0.4 Un~1.2Un
Voltage failure bridging time		0.5 Seconds
Voltage restoration function standby after		5 Seconds
Reference Frequency		50 Hz (± 2%)
II. Electrical Requirement of Energy Meters		
Current range		5(40) A, In=5A, Imax=40A
Starting current		0.004 In for Active 0.005In for Reactive
Meter constant		Meter constant should be mentioned in imp/kWh and imp/kVarh
Max Temperature rise	External Surface	25° C with ambient temperature of 40°C
	Terminal	30° C with ambient temperature of 40°C
Power consumption without communication module	Voltage circuit	≤ 2 W / 5 VA
	Current circuit	≤ 4 VA
III. Dielectric Strength		
Short time over current for 0.01 sec		30 I _{max}
Impulse voltage with stand	At 1000 meter	8kV 1.2/50 μs
Power frequency withstand voltage		4kV AC for one minute
Creepage (Min)		20mm
Insulation resistance		≥5 MΩ
Clearance		8mm
IV. Other requirements of Energy Meter		
Display type		Segment type LCD, 8 digits, Digit height: 9mm
Energy LED		One LED for active energy, one for reactive energy

Technical features		Description
Status LED		Refer to LED indicators chapter for the communication status indication.
Display button		Touch type button or any suitable type so that IP-54 can be ensured.
Communication interfaces		IR: Service Interface, Infrared optical interface, 9600bps 4G/2G communication module replaceable communication module
		G3-PLC or 4G/2G communication module, replaceable communication module (As per tender Inquiry)
Relay		Contact Rating: 40A 230Va.c Maximum switching power: 15kVA Maximum switching current: 60A Maximum switching voltage: 276Va.c Maximum overload current: 100A(up to 15minutes) Electrical endurance: 10,000 ops
Real Time Clock		IEC 62054-21 ($\leq \pm 0.5$ sec/ day, 230Vac, 23°C)
Electrostatic discharge	Contact discharge	8kV
	Air discharge	15kV
	Current and voltage circuits	4kV
	Auxiliary circuits	2kV
Fast transient burst		4kV
Surge immunity		4kV
Electromagnetic RF fields		Frequency range 80MHz to 2000MHz With current 10V/m Without current 30V/m
Conducted disturbance		Frequency range 150kHz to 80MHz Voltage level 10V
Radio interference (peak value)		30MHz-1GHz : 30 to 230 MHz <30 dB(μ V) 230 to 1 000 MHz <37 dB(μ V)
Data retention		≥ 15 years
Lifetime		≥ 15 years
Backup power supply		Internal battery, external battery slot
Payment mode		Support post-payment and prepayment mode
Protection class acc.		Class II
Ingress protection		IP-54 or better
Calibration interval		Meter life-time (15 years)

2. $0.4U_n \sim 0.6U_n$, the metrology shall work normally, when voltage no less than $0.6U_n$, all function shall be normally

6.2 Accuracy Features

6.2.1 Limits of error due to variation of the current

When the meter is under reference conditions given in clause 7.9 of IEC 62053-21 and IEC 62053-23, the percentage errors will not exceed the limits. Acceptable percentage error limits with balanced loads

Value of Current	Power Factor	Percentage error Limits for meters	
		Class 1 for active	Class 2 for reactive
$0.05 I_n \leq I < 0.1 I_n$	1.0 Resistive	± 1.5	± 2.5
$0.1 I_n \leq I < I_{max}$		± 1.0	± 2.0
$0.1 I_n \leq I < 0.2 I_n$	0.5 Inductive	± 1.5	± 2.5
	0.8 Capacitive	± 1.5	-
$0.2 I_n \leq I \leq I_{max}$	0.5 Inductive	± 1.0	± 2.0
	0.8 Capacitive	± 1.0	-
$0.2 I_n \leq I \leq I_{max}$	0.25 Inductive	± 3.5	± 2.5
	0.5 Capacitive	± 2.5	-

Acceptable percentage error limits with balanced loads

6.2.2 Limits of error due to influence quantities

The additional percentage error due to the change of influence quantities with respect to reference conditions, as given in clause 7.10 of IEC 62053-21 and IEC 62053-23 will not exceed the limits given below:

Influence quantity	Test clause in IEC 62052-11: 2020	Specified range or value and recommended value of test current (balanced unless otherwise stated)	Power Factor $\cos \phi$ (3)	Percentage error Limits for meters	
				Class 1 for active	Class 2 for reactive
Radiated, radiofrequency, electromagnetic field immunity test – test with current	9.3.5	I_n	1	2.0	3.0
Electrical fast transient/burst immunity test	9.3.6	I_n	1	4.0	6.0
Immunity to conducted disturbances, induced by radio-frequency fields	9.3.7	I_n	1	2.0	3.0

Influence quantity	Test clause in IEC 62052-11: 2020	Specified range or value and recommended value of test current (balanced unless otherwise stated)	Power Factor $\cos \phi$ (3)	Percentage error Limits for meters	
				Class 1 for active	Class 2 for reactive
Immunity to conducted Disturbances and signaling in the frequency range 2kHz to 150kHz at AC power ports	9.3.8	In	1	4.0	6.0
External static magnetic fields (0.7T 65*35*35mm) (5)*	9.3.12	In	1	2.0	3.0
Power frequency magnetic field immunity test	9.3.13	In	1	2.0	3.0
Harmonics in the current and voltage circuits – 5th harmonic test	9.4.2.2	0,5 I _{max}	1 _{udil}	0.8	1.0
Inter harmonics in the current circuit – burst fired waveform test	9.4.2.3	0,5 In	1	3.0	6.0
Odd harmonics in the current circuit	9.4.2.4	0,5 In	1	3.0	6.0
DC and even harmonics half-wave rectified waveform test	9.4.2.5	I _{max} /1.414	1	3.0	6.0
Voltage variation	9.4.3	$I_{min} \leq I \leq I_{max}$ (In)	1	0.5	1.0
		$I_{min} \leq I \leq I_{max}$ (In)	0.5	1.0	1.5
Ambient temperature Variation (2)*	9.4.4	$I_{min} \leq I \leq I_{max}$ (In)	1	0.05	0.10
		$0,2 I_{min} \leq I \leq I_{max}$ (In)	0.5	0.07	0.15
Interruption of phase voltage	9.4.5	In	1	2.0	4.0

Influence quantity	Test clause in IEC 62052-11: 2020	Specified range or value and recommended value of test current (balanced unless otherwise stated)	Power Factor $\cos \phi$ (3)	Percentage error Limits for meters	
				Class 1 for active	Class 2 for reactive
Frequency variation	9.4.6	$I_{min} \leq I \leq I_{max}$ (In)	1	0.5	2.0
		$0,1 I_b \leq I \leq I_{max}$ (In)	0.5	0.7	2.0
Reversed phase sequence	9.4.7	0,1 In	1	0.5	1.0
Operation of auxiliary devices	9.4.9	I_{min}	1	0.2	0.4
Short-time over currents (4)*	9.4.10	In	1	1.5	1.5
Self-heating (1)*	9.4.11	I_{max}	1	0.7	1.0
			0.5	1.0	1.5
Fast load current variations	9.4.12	In	1	2.0	3.0
Dry heat test (4)*	8.3.3	In	1	0.5	1.0
Cold test (4)*	8.3.4	In	1	0.5	1.0
Damp heat cyclic test (4)*	8.3.5	In	1	0.5	1.0

(1) The test shall be carried out for at least 1 h, or until the variation of error during 20 min does not exceed 0,2 %.

(2) These values shall be considered as mean temperature coefficients %/K for meters of class.

(3) Inductive.

(4) For these tests, the meter accuracy is measured before and after the test. The difference in percentage error before and after the test will not exceed the error limits specified in this table. These errors limits may be interpreted as allowable meter accuracy drift induced by the specified test conditions.

(5) According to the IEC standard, the mounting surface is exempted.

7. Mechanical Construction Requirement

7.1 General Mechanical Requirements

Meters shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially

- i. Personal safety against electric shock
- ii. Personal safety against effects of excessive temperature
- iii. Protection against spread of fire
- iv. Protection against penetration of solid objects, such as thin wire. X-ray film
- v. Dust and waterproof
- vi. All parts, which are subject to corrosion under normal working conditions, shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling nor damage due to exposure to air, under normal working conditions. Meters shall withstand solar radiation.

7.2 Electrical Connection

The electrical connection in the energy meter shall be resistant to tempering. These shall be made so as to prevent their opening from outside the energy meter base/top cover accidentally or deliberately without breaking the seal. All the connection wires shall be equipped with sleeves.

7.3 Energy Meter Case

The case is comprised of cover and Base. The energy meter shall have a reasonably dust proof and moisture proof case which can be sealed in such a way that the internal parts of the energy meter are accessible only after breaking the seals. The energy meter shall comply with the degree of protection code IP-54 as per latest IEC 60529.

7.4 Meter Cover

The meter cover is made of UV-resistance, high impact-resistance and self-extinguishing polycarbonate (PC+10%GF). It is sealed in such a way that the internal parts of the meter are accessible only after breaking the seals. The color of the cover is grey. The material can pass a glow wire test at $650^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and duration of application is $30 \pm 1\text{s}$. The thickness of meter cover is 2.5mm (min).

7.5 Terminals and Terminal Block

7.4.1 Terminal

The terminals are made of brass with tin plated (≥ 20 micron) and provide two Zinc-Nickel alloy plated (≥ 5 micron) carbon steel M-8 screws in each current terminal which are better protected against corrosion. The Zinc plated carbon Steel screws can pass 72 hours salt spray test according to IEC 60068. The screw is at least 3 threads in the terminals. The screw head type is Philips and slotted.

The terminal diameter size is $11 + 0.3/0\text{mm}$. The type of wires can be solid cores, composite cores or stranded wires. The terminal block is suitable for cable sleeves, see the figure as below (unit: mm):

7.4.2 Terminal Blocks

The terminal block is made of UV-resistance, high impact-resistance and self-extinguishing polycarbonate (PC+20%GF), the color of the terminal block is grey, and the material can pass a glow wire test at $960^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and duration of application is $30 \pm 1\text{s}$.

The terminal blocks shall be robustly attached with meter base using screw or should be permanent part of meter body so that it does not show any movement between the terminal blocks by force from outside without opening of the meters cover, the design and dimension of terminal block as per drawing.

7.6 Terminal Cover

The terminal cover is made of UV-resistance, high impact-resistance and self-extinguishing polycarbonate (PC+10%GF) and suitable for cables incoming and outgoing vertically from the bottom, and have provision for security sealing. The connection diagram of the meters is shown on the terminal cover.

The color of the terminal cover is grey. The material can pass a glow wire test at $650^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and duration of application is $30 \pm 1\text{s}$.

The thickness of terminal cover is 2.5mm ($\pm 5\%$).

7.7 **Mounting**

The meter uses three-point (A base triangle) mounting which comply with DIN 43857-3. The mounting holes accommodates 5.0 mm mounting screws. Two lower mounting holes are on both sides of the meter bottom part.

7.8 **Polycarbonate Material**

Polycarbonate material shall be used for fabrication of energy meter with following characteristic

- i. Pulse 10% GF
- ii. Scratch resistant
- iii. Flame retardant
- iv. Dielectric properties
- v. Ultra violet stabilized
- vi. Shall not turn yellow over the period of time

7.9 **Display Button**

The meter is equipped with one touch button or any other button type for scrolling display. Button type should be suitable for IP-54 protection and must not compromise IP-54 during testing and real environment.

7.10 **External Battery Slot**

The meter supports an external battery slot for CR2032 type, which is protected by the terminal cover

7.11 **Earthing Connection Arrangement**

As the energy meter base is made of insulating material, the common ground of main PCB shall be internally connected to neutral point of the terminal block.

7.12 **Protection against solar radiation, penetration of Dust and water , Glow wire**

The complete energy meter shall meet the requirement of IEC 620529 and following standard

- | | |
|--------------------------|----------------|
| i. Solar radiation | IEC-60068-2-5 |
| ii. Penetration of water | IEC-60068-2-18 |
| iii. Penetration of Dust | IEC-60068-2-68 |
| iv. Glow wire test | IEC-60695-2-11 |

7.13 **Sealing of Energy meters**

The meter has five security seals:

- i. One seal is for communication module sealing
- ii. Two seals are for terminal cover sealing
- iii. Two seals (Metrology sealing) are for the meter cover

It is impossible to touch the meter metrology part unless physically and transparently destroy the metrology seals and the meter enclosure.

The meter cover will be sealed in manufacture by the supplier, the terminal cover will be sealed on site after meter installation by the utility; in case PLC communication module, the module will be sealed in manufacture by the supplier; in case 2G/4G communication module, if physical SIM card is used, the module will be sealed on site by the utility after SIM card installation, if ESIM is used, the module will be sealed in manufacture by the supplier.

7.14 **METER Serial Number**

7.14.1 Each meter has a permanent, clear and unique serial number, the serial number is permanently print on the meter cover in two types, numbers and bar-code. The bar-code type is auto 128 code.

7.14.2 The meter's unique serial number is also recorded in the non-volatile memory of meter as a permanent value, which can be read out via optical port, or remote command.

7.14.3 The bar-code and the internal memory's serial number consist of 14 digits: the first 4 digits present the meter code with leading zeroes if necessary, and the next 10 digits present the unique serial number where the first two digits present the manufacture year. These 8 digits form also the serial number imprint for visual reception. The figures of the imprinted serial number shall be not less than 2.5 mm height.

7.14.4 The naming rule of meter serial number are as follows:

MMTC YY SSSSSSS

MM: Manufacturer code, it will be defined by HES provider, 01-03 is already assigned to XYZ. However New manufacturer will assigned code from -04 onward.

T: Metrology device type

C: Major communication type

1 - G3-PLC communication

2 - 4/2G communication

YY: The last two number code of manufacture year.

SSSSSSS: Device ID number, from 00000001 to 99999999

Note: Serial numbers on the same logic are already existing in field so after confirmation of order, Employer will share list of existing serial numbers and manufacturer will ensure that serial numbers of meters produced are different from serial numbers already existing.

8. Energy meter Functional Characteristic

The energy meter shall generally comprise of the following characteristic as a minimum

8.1 Measurement/Recording

The meter can measure active, reactive energy, maximum demand, cumulative maximum demand, and instantaneous parameters.

8.1.1 Energy Measurement

The meter support following energy registers:

Description	Register	
Cumulative total active energy	+A	-A
Cumulative active energy for tariff 1	+A, T1	-A, T1
Cumulative active energy for tariff 2	+A, T2	-A, T2
Cumulative active energy for tariff 3	+A, T3	-A, T3
Cumulative active energy for tariff 4	+A, T4	-A, T4
Cumulative total reactive energy	+R	-R
Cumulative reactive energy for tariff 1	+R, T1	-R, T1
Cumulative reactive energy for tariff 2	+R, T2	-R, T2
Cumulative reactive energy for tariff 3	+R, T3	-R, T3
Cumulative reactive energy for tariff 4	+R, T4	-R, T4
Cumulative reactive energy for quadrant 1	R1	
Cumulative reactive energy for quadrant 2	R2	
Cumulative reactive energy for quadrant 3	R3	
Cumulative reactive energy for quadrant 4	R4	

8.1.2 Maximum Demand (MD)

The meter records following MD registers:

- Active MD total, with timestamp
- Active MD import, with timestamp
- Active MD import for each tariff with timestamp
- Active MD export, with timestamp
- Active MD export for each tariff with timestamp
- Reactive MD import, with timestamp
- Reactive MD import for each tariff with timestamp

8. Reactive MD export, with timestamp
9. Reactive MD export for each tariff with timestamp

The demand type is block demand.

The period of maximum demand can be configured to 10, 15, 20, 30 and 60 minutes. Default period is 30 minutes.

The demand period data will be discarded only in case demand period is changed.

When meter powers off or RTC is synchronized, the demand data will NOT be discarded.

8.1.3 Cumulative Maximum Demand

The cumulative maximum demand stores the sums of the corresponding maximum demand register value in all completed billing periods since the beginning of the measurement. The meter provides multiple cumulative maximum demand registers corresponding to the maximum demand registers.

1. Cumulative maximum demand $|+A|+|-A|$ total
2. Cumulative maximum demand $+A$ total
3. Cumulative maximum demand $-A$ total
4. Cumulative maximum demand $+R$ total
5. Cumulative maximum demand $-R$ total
6. Cumulative maximum demand tariff rated register: $|+P|+|-P|$ Tx, $+P$ Tx, $-P$ Tx, $+Q$ Tx, $-Q$ Tx (x:1~4)

8.1.4 Instantaneous Parameters

The meter supports following instantaneous parameters measurement:

- Voltage
- Phase Current
- Neutral Current
- Power factor
- Total active power (KWH)
- Import active KWH
- Export active KWH
- Import reactive KVARH
- Export reactive KVARH
- Current KW
- Total KW

8.2 Real Time Clock

- 8.2.1 The RTC complies with IEC 62052-21/62054-21. At reference voltage and reference temperature (23°C), clock accuracy is better than ± 0.5 s/day.
- 8.2.2 The RTC supports leap year, day light saving time. In case of power off, clock of meter is active for at least two years after manufactured with battery support. If the internal battery for RTC is run out and main power supply is absence, the RTC will reset to default date and time (2020-01-01 00:00:00) and meter will log RTC invalid event. However, the chronology of the measurement values can be sustained. Under RTC invalid condition, if the tariff registers are used, meter will use tariff 1 as a default setting until the date and time is synchronized.
- 8.2.3 The meter shall support broadcast clock synchronization via the DCU once a day, the broadcast synchronization features the following condition:
 - I. The meter is only allowed to receive 3 broadcast clock synchronization within one day.
 - II. The meter only accepts clock synchronization with a clock deviation within 10s to 10min, when clock deviation is less than 10s, the meter will reject the synchronization; when clock deviation is greater than 10 minutes, the meter will also reject the synchronization, and log and push the event "Clock Out Of Tolerance" to the HES. In the case, the HES needs to synchronize the meter clock point-to-point.
 - III. If meter clock is already invalid, the clock synchronization with any time deviation will be accepted by the meter. Meter time and date synchronization is possible through AMI system as well as over the optical port.

8.3 Backup Power Supply

- 8.3.1 The meter provides with an internal non-replaceable lithium battery as a Real Time Clock backup. The battery also support display without main power, anti-tampering features of the meters, i.e. meter cover removal detection, terminal cover removal detection, etc.
- 8.3.2 The battery is operational for the meter lifetime 15 years, and supports at least 24 months when meter without main power supply.
- 8.3.3 The meter monitors the battery status, records low battery voltage event and indicates the low battery icon on the display when the voltage of battery is lower than 80% of rated voltage of battery.
- 8.3.4 As a backup solution in some harsh environment, the meter provides an external battery slot for CR2032 type of battery on the terminal block which is protected by the terminal cover. In case the internal battery voltage is low, an external battery should be installed. The recommended and meter manufacturer verified battery brands are Panasonic, Philips, Maxell, EVE.

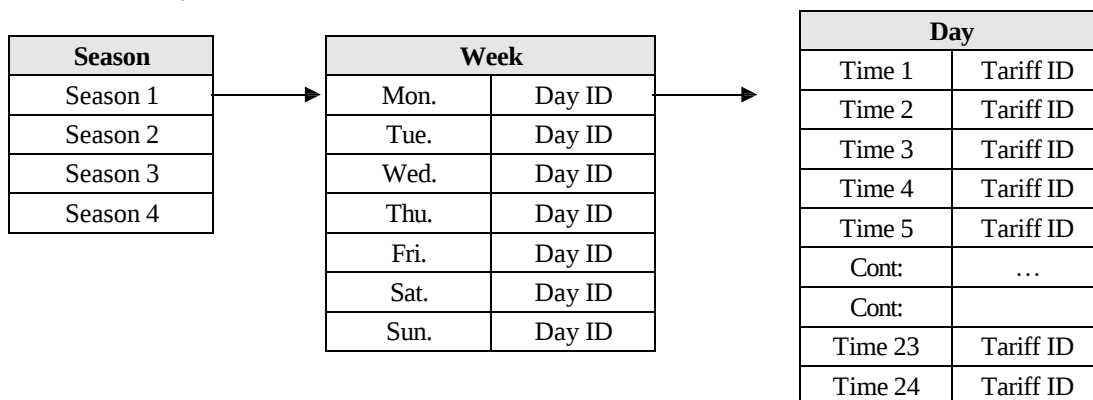
8.4 Tariff

8.4.1 Normal ToU Tariff

The meter supports up to 4 tariffs (T1~T4), 24 TOU, 2 sets of tariff scheme, one is for active tariff, the other is for passive tariff. The passive tariff scheme and active date/time can be configured remotely or locally.

Each tariff scheme supports up to:

- 1) 4 seasons
- 2) 4 weeks
- 3) 4 days' profile
- 4) 24 TOU



Tariff structure:

When doubtful / invalid RTC happens, the meter always records the energy in the default tariff T1. For the default tariff scheme configuration, please refer to Annex 2.

8.4.2 Special day

- 8.4.2.1 Holidays can be defined in meters. The holidays are in conjunction with tariff activity calendar. The linking data is Day
- 8.4.2.2 ID.Special days table support a maximum of 50 entries in order to cover all fixed and flexible holidays. The date may have wildcards for repeating special days. Holidays example is as follows.

Index:	Special day date	Day ID
1	FFFF-01-01 FF	2
2	FFFF-06-10 FF	2
3	2033-11-01 FF	1
4	FFFF-12-25 FF	2

8.4.2.3 The special days are empty by default, which is configured when necessary.

8.5 Billing

8.5.1 Monthly Billing

The meter has one monthly billing profile. there are four way to trigger monthly billing

- 1) When passive tariff is activated, the meter will trigger a billing.
- 2) Automatic billing based on RTC, the billing date and time is programmable; default time is 00:00:00 of the 1st day in every month.
- 3) By a remote or local billing command.
- 4) From post-payment mode to prepayment mode, and vice versa.

The meter saves last 13 history monthly billing data. The billing objects include:

Billing Capture Objects	Status
Time stamp	Y
Billing period counter	Y
Active energy total (+A + -A)	Y
Active energy total (+A + -A) T1	Y
Active energy total (+A + -A) T2	Y
Active energy total (+A + -A) T3	Y
Active energy total (+A + -A) T4	Y
Active energy import (+A)	Y
Active energy import (+A) T1	Y
Active energy import (+A) T2	Y
Active energy import (+A) T3	Y
Active energy import (+A) T4	Y
Active energy export (-A)	Y
Active energy export (-A) T1	Y
Active energy export (-A) T2	Y
Active energy export (-A) T3	Y
Active energy export (-A) T4	Y
Maximum Demand Active total (+P + -P)	Y
Maximum Demand Active total (+P + -P)-Capture Time	Y
Maximum Demand Active total (+P + -P) T1	Y
Maximum Demand Active total (+P + -P)-Capture Time T1	Y
Maximum Demand Active total (+P + -P) T2	Y
Maximum Demand Active total (+P + -P)-Capture Time T2	Y
Maximum Demand Active total (+P + -P) T3	Y
Maximum Demand Active total (+P + -P)-Capture Time T3	Y
Maximum Demand Active total (+P + -P) T4	Y
Maximum Demand Active total (+P + -P)-Capture Time T4	Y
Maximum Demand Active import (+P)	Y
Maximum Demand Active import (+P)-Capture Time	Y

Maximum Demand Active import (+P) T1	Y
Maximum Demand Active import (+P) Capture Time T1	Y
Maximum Demand Active import (+P) T2	Y
Maximum Demand Active import (+P) Capture Time T2	Y
Maximum Demand Active import (+P) T3	Y
Maximum Demand Active import (+P) Capture Time T3	Y
Maximum Demand Active import (+P) T4	Y
Maximum Demand Active import (+P) Capture Time T4	Y
Maximum Demand Active export (-P)	Y
Maximum Demand Active export (-P)-Capture Time	Y
Maximum Demand Active export (-P) T1	Y
Maximum Demand Active export (-P)-Capture Time T1	Y
Maximum Demand Active export (-P) T2	Y
Maximum Demand Active export (-P)-Capture Time T2	Y
Maximum Demand Active export (-P) T3	Y
Maximum Demand Active export (-P)-Capture Time T3	Y
Maximum Demand Active export (-P) T4	Y
Maximum Demand Active export (-P)-Capture Time T4	Y
Cumulative Maximum Demand Active total (+P + -P)	Y
Cumulative Maximum Demand Active total (+P + -P) T1	Y
Cumulative Maximum Demand Active total (+P + -P) T2	Y
Cumulative Maximum Demand Active total (+P + -P) T3	Y
Cumulative Maximum Demand Active total (+P + -P) T4	Y
Cumulative Maximum Demand Active import (+P) total	Y
Cumulative Maximum Demand Active import (+P) T1	Y
Cumulative Maximum Demand Active import (+P) T2	Y
Cumulative Maximum Demand Active import (+P) T3	Y
Cumulative Maximum Demand Active import (+P) T4	Y
Cumulative Maximum Demand Active export (-P) total	Y
Cumulative Maximum Demand Active export (-P) T1	Y
Cumulative Maximum Demand Active export (-P) T2	Y
Cumulative Maximum Demand Active export (-P) T3	Y
Cumulative Maximum Demand Active export (-P) T4	Y
Average power factor total current month	Y
Available credit (only available in prepaid mode)	Y
Charge amount of current month (only available in prepaid mode)	Y
Current month consumption amount (only available in prepaid mode)	Y

*Note:

1. Capture objects with symbol “*” are not present when meter is in post-payment mode, it will automatically be added to capture objects when meter switches to prepayment mode.

2. “Y” means default capture objects of the monthly billing, “-” means the capture can be configured to monthly billing whenever needed in the future.

8.6 Display and Indicators

8.6.1 LED Indicators

Energy meter will comply following indicator

- One active energy pulse LED, the pulse constant
- One reactive energy pulse LED, the pulse constant.
- The initial status of the energy LEDs is off after power on.
- One green-color LED indicates the remote
- communication status:

a) For 4G Downward module:

LED Status	Indicating Status
Off	No communication module is plugged or communication module initial
Blink 0.5s on, 3s off	No SIM card insert or SIM card cannot be detected
Blink 1s on, 0.2s off	Module network registering
Blink 1s on, 3s off	Module network registration is rejected
Blink 1s on, 1s off	Module is registered succeed, TCP connection is ongoing
Blink 0.2s on, 0.2s off	Remote communication is ongoing
On	Meter is registered succeed, no remote communication is ongoing

b) PLC G3-PLC

LED Status	Indicating Status
Off	No communication module is plugged or communication module fails
Blink 1s on, 1s off	Network registration is ongoing
Blink 0.2s on, 0.2s off	Remote communication is ongoing
On	Meter is registered succeed, no remote communication is ongoing

8.6.2 LCD Display

The meter has an 8-digits segment type LCD which with good contrast and wide viewing angle for easy meter readout. The display image area is easily readable from approximately 1 meter. The LCD supports meter's full operational temperature range, and a lifetime of the meter. The height of energy display digit is 11mm. A totally lighted up LCD screen is shown in drawings:

8.6.3 Display Mode

The meter supports auto scroll mode, manual scroll mode and alarm mode, power down display mode. For all the modes, the display parameters are configurable.

8.6.3.1 Auto Scroll Mode

This mode is the default mode at meter power up, it automatically scrolls through all defined display elements every 5 seconds, and the interval can be configured from 1s to 60s. If only a single element is defined for the data scroll sequence, it is permanently displayed on the display. Please refer to Annex 3 for the default display objects for auto scroll mode, the display objects are also configurable.

8.6.3.2 Manual Scroll Mode

User can enter Manual Scroll mode by short pressing the button. When entering the Manual Scroll mode, by short pressing the button, the meter can display all items one by one.

The meter returns to auto scroll mode from manual scroll mode automatically when no pressing button for continuous 60s, and the interval can be configured from 5s to 300s Please refer to Annex 3 for the default display objects for manual scroll mode, the display objects are also configurable.

8.6.3.3 Supply Disconnection Display Mode

When the meter relay is disconnected, the meter will enter supply disconnection display mode, which help the customer to check the reason of the disconnection of power supply. Manual scroll mode can be activated by pushing the display button. When the meter relay is reconnected, the meter returns to Auto Scrolling Mode.

The possible disconnection reasons and display messages are defined as below table:

Error Description	Display Message
Meter disconnected due to meter cover removal (if enabled)	OFF-FCOV
Meter disconnected due to terminal cover removal (if enabled)	OFF-TCOV
Meter disconnected due to strong magnetic field (if enabled)	OFF-MAG
Meter disconnected due to current reverse (if enabled)	OFF-REV
Meter disconnected due to DC injection (if enabled)	OFF-DC
Meter disconnected due to ESD disturbance (if enabled)	OFF-ESD
Meter disconnected due to over current	OFF-OC
Meter disconnected due to remote operation	OFF-REMO
Meter disconnected due to overload	OFF-LOAD
Meter disconnected due to over demand	OFF-DEMD
Meter disconnected due to credit exhausted	OFF-CRDT

8.6.3.4 Power Down Display Mode

The meter supports power down display mode in case of main power outage. Power down display can be activated by pressing the display button for at least 3 seconds when meter is not in low-battery status. During power down display mode, display period of each item is up to 15 seconds. If there is no display button pressing within 15 seconds, the meter will switch off the display. By pressing the display button to scroll the display items. Until the last item is displayed, meter will automatically switch off the LCD display.

During one power off period, power down display can only be activated for five times. For power down display list, please refer to Annex 3 Display Item List.

8.7 Payment Mode

- 8.7.1 The meter is in post-payment mode when shipped out from factory. It can be switched from post-payment mode to prepayment mode by command, and vice versa. A prepayment mode icon will be displayed on the LCD in prepayment mode.
- 8.7.2 For prepayment mode:
- 1) The meter can receive credit in kWh from the central system or local communication port.
 - 2) The meter will disconnect the power supply after credit is fully exhausted, meter will record and spontaneously report (if enabled) the disconnection event to the system.
 - 3) The meter will record and report (if enabled) the low balance alarm event to the system when the remaining credit of the meter is less than the low credit threshold which is configurable. The default low credit threshold is 10 kWh.
- 8.7.3 When the meter is switched from post-payment mode to prepayment mode at the first time, the meter will disconnect automatically because the initial available credit of the meter is 0.
- 8.7.4 The meter manages a charge sequence number to avoid the re-charge for the same command. In prepayment mode, prepayment related registers will be added in the capture objects in billing profile and daily load profile.
- 8.7.5 Prepayment related events will be logged. Refer to the 8.18 Event logs. The maximum available credit is 99999.999 kWh.

8.8 Load Profile

8.8.1 Load Profile Characteristics

Each load profile has the following characteristics:

- 1) A circular buffer is used for each load profile.
- 2) Each entry of load profile has a time stamp and load profile status word.
- 3) If power off cross capture points, the meter will only supplement the first missing points after power on.
- 4) If time is set forward crossing capture points, the meter will only supplement the first missing points.
- 5) If time is set backward crossing capture points, the meter will NOT remove redundant capture points.
- 6) The load profile supports read by time range and by entry and selectable capture objects.

8.8.2 Load Profile Status Word

Bit No.	Remark
Bit0	Critical error: A serious error such as a hardware failure or a checksum error has occurred. At the same time, bit 2 is set
Bit1	Clock invalid: The power reserve of the calendar clock has been exhausted. The time is declared as invalid. At the same time bit 2 is set
Bit2	Data not valid: Indicates that the current entry may not be used for billing e.g. due to time shift or if no values have been recorded during the capture period
Bit3	Daylight saving: Indicates whether the daylight-saving time is currently activated. The bit is set if the daylight-saving time is active (summer) and cleared in winter
Bit4	Reserved
Bit5	Clock is adjusted more than the synchronization limit 60s
Bit6	Reserved
Bit7	Power down: Power failure occurred

8.8.3 Load Profile List

i. The meter supports following load profiles:

Load Profile	Interval	Capacity
Energy load profile	Configurable range: 5/10/15/30/60 minutes (Default 60 minutes)	5760(60 minutes, 240 days)
Daily load profile	Configurable range: every 24 hours at 00:00	31(24 hours, 31 days)
Power quality load profile	Configurable range: 5/10/15/30/60 minutes (Default 60 minutes)	5760(60 minutes, 240 days)

ii. Energy Load Profile default capture objects:

No.	Default Capture Objects
1	Time stamp
2	Energy load profile status
3	Active energy total (+A + -A)
4	Active energy import (+A)
5	Active energy export (-A)
6	Instantaneous status word

iii. Daily Load Profile default capture objects:

No	Default Capture Objects
1	Time stamp
2	Daily load profile status
3	Active energy total (+A + -A)
4	Active energy total (+A + -A) T1
5	Active energy total (+A + -A) T2
6	Active energy total (+A + -A) T3
7	Active energy total (+A + -A) T4
8	Active energy import (+A)
9	Active energy import (+A) T1
10	Active energy import (+A) T2
11	Active energy import (+A) T3
12	Active energy import (+A) T4
13	Active energy export (-A)
14	Active energy export (-A) T1
15	Active energy export (-A) T2

No	Default Capture Objects
16	Active energy export (-A) T3
17	Active energy export (-A) T4
18	Maximum Demand Active total (+P + -P) (Daily Reset)
19	Maximum Demand Active total (+P + -P) capture time (Daily Reset)
20	Maximum Demand Active import(+P) (Daily Reset)
21	Maximum Demand Active import(+P) capture time (Daily Reset)
22	Maximum Demand Active export(- P) (Daily Reset)
23	Maximum Demand Active export(- P) capture time (Daily Reset)
24	Instantaneous status word
25	*Available credit

* Available credit: this object is only present in prepayment mode.

iv. Power Quality Load Profile default capture objects:

No.	Default Capture Objects
1	Time stamp
2	Power quality load profile status
3	Average voltage L1
4	Maximum voltage L1
5	Minimum voltage L1
6	Average current L1
7	Average value of power factor

8.9 Relay Control

The relay of the meter can be controlled by commands or internal status of meter (e.g. prepayment balance exhausted, over power limit, tamper occurs).

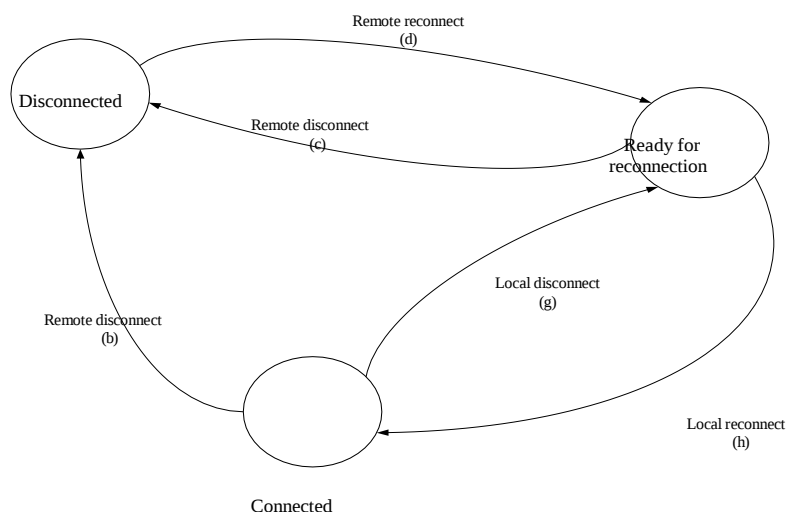
The relay has three states:

Relay status	LCD display
Disconnected	Disconnected icon  is on.
Connected	Connect icon  is on.
Ready for reconnect	Disconnected icon  is blinking.

The meter use Control Mode 6, Disconnect and reconnect can be requested by:

- Remotely, via a communication command: (b)(c) remote disconnect, (d) remote reconnect;
- Locally, by a function of meter, e.g. power limiter, credit exhausted, tamper disconnection (refer to article 8.14 anti-tamper) is detected: (g) local disconnect, (h) local reconnect.
- Manually disconnect and connect are not allowed in the meter.

The chart below indicates the relay state diagram.



8.10 Power Limitation

The meter measures the total active power every second, if the active power is larger than the power thresholds for specified period t_1 , the meter will disconnect the supply. After disconnection lasts for auto-reconnect time t_2 , the meter will automatically connect the supply. If the customer does not reduce the load, the over load will be detected again, then the meter will disconnect the supply again. After counter of auto-reconnect reaches Max Number of Auto-reconnect, if it is disconnected once again due to over load, the meter will keep in disconnection status, only a connect command can connect the supply.

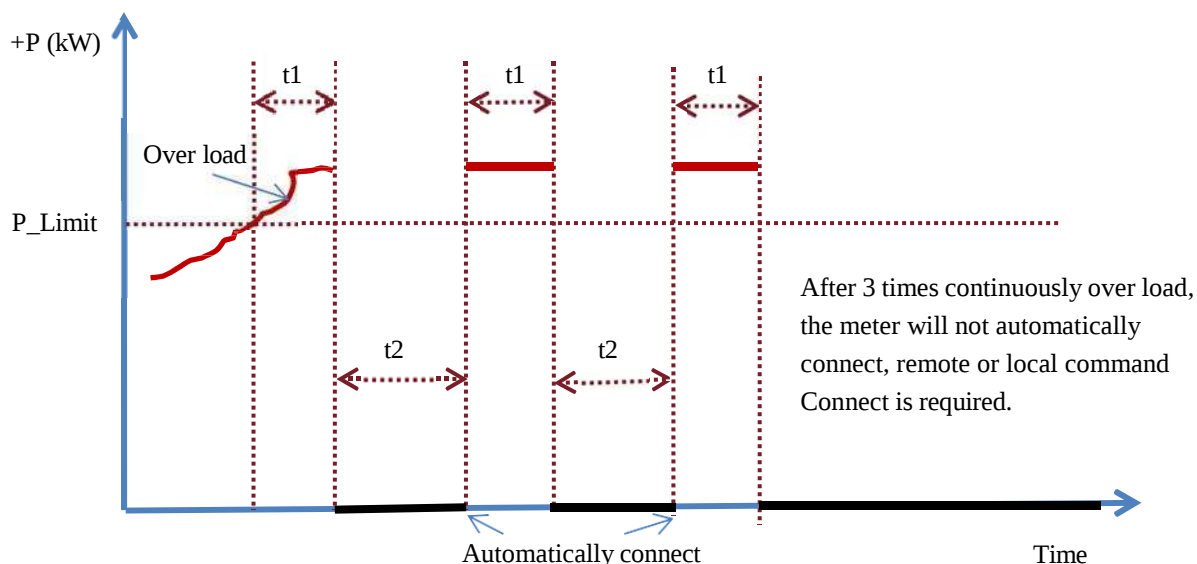
Once the meter is disconnected due to over load, the meter will show “OFF-LOAD” on the LCD. A manual display mode could be activated by pushing the display button, when the meter is timeout from the manual display mode, the meter will return back to display “OFF-LOAD”.

The meter records a counter of auto-reconnect attempt. The counter will be reset after the power withdraw below the power threshold, or after a power off, or after the credit is fully exhausted in prepayment mode, or after executing an effective supply connect command from the system or local hand-held device (when the 3 auto-reconnected process is completed and the overload status is disappeared)

Over load parameters, ranges, and default values:

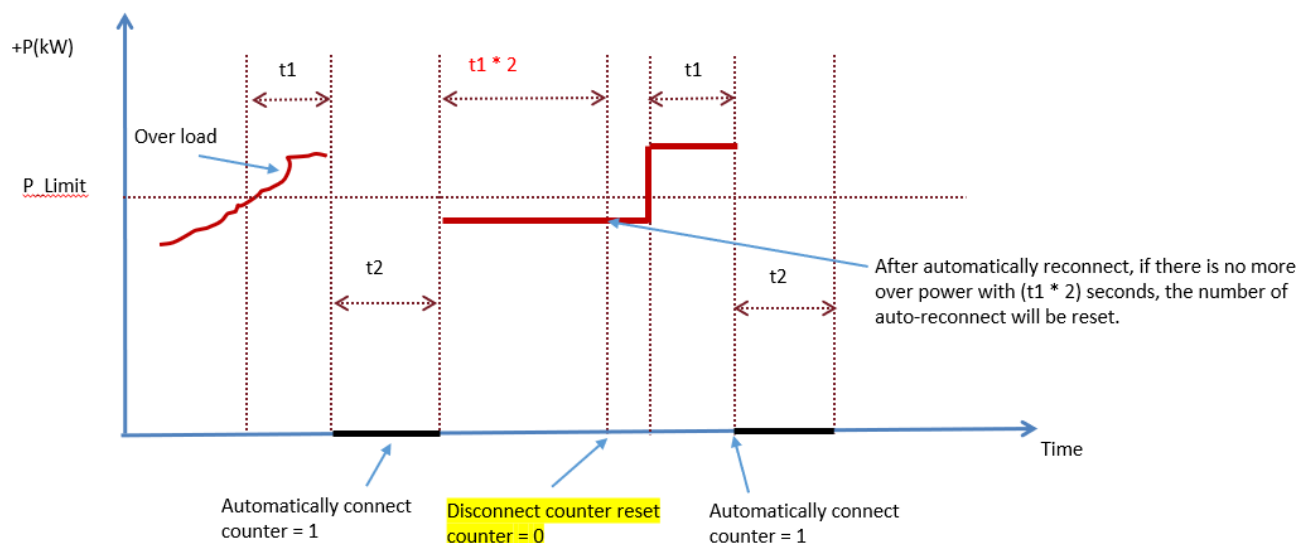
Parameter	Unit	Min. Value	Max. Value	Default Value
Power threshold (P_limit)	kW	0	$U_n * I_{max} * 3 *$ 1.0	$U_n * I_{max} * 3 *$ 0.9
Time to Disconnect for P_limit (t_1)	Second	5	3600	180
Auto-reconnect Time (t_2)	Second	5	3600	180
Max. Number of Auto-reconnect	/	0	5	2

Here below picture show the load control process:



If the power threshold is zero, the relative power limitation is disabled. The demand side management function is also applicable when the meter works in prepayment mode.

During over power period, but the number of auto-reconnect has not been exceeded, after the meter is automatically reconnected, if no over power (continuous t_1 time) occurs again within ($t_1 * 2$) seconds, the number of auto-reconnect will be reset.



8.11 Over current

To protect the meter, if the current of any phase is in the range of $(1.1 * I_{max} \sim 60A)$ for 1 minutes,, the meter will automatically disconnect the power supply. After 3 minutes, the meter will automatically reconnect the power supply. If the customer does not reduce the current, the over current will be detected again, then the meter will disconnect the power supply again. After consecutive 3 times automatic reconnection, if it is disconnected once again due to over current, the meter will keep in disconnection status, only a connect command can connect the supply.

During the disconnection period, the meter will display “OFF-OC”. When current is over 60A, the relay switching is inhibited.

The logic of over current has a separate set of $t1$, $t2$ and the number of auto-reconnect, which are different from Power Limitation and Demand Side Management (article 8.12).

8.12 Demand Side Management

The meter supports different power thresholds for up to 24 time periods. Each time period can be specified start hour time with. The last time period will be ended at 24:00. The demand side management power thresholds are configurable. The following table is an example showing different demand side management thresholds for different time periods:

Start Time (hour)	0	4	6	12	14	18	23
Power threshold (kw)	5	4	3.5	4	3.5	4	5

Table - 15 Example of demand side management thresholds

If the power threshold is zero, then there is no demand side management threshold for this period. The limitation and disconnection mechanism is same as 8.10 Power Limitation. During the disconnection period, the meter will display “OFF-DEMD” instead of “OFF-LOAD”.

But the demand side management shares the same sole set of $t1$, $t2$ and the number of auto-reconnect which described in Table in power limitation(contract power).

The demand side management function is also applicable when the meter works in prepayment mode.

8.13 Export Energy Function

The meter support “Export Energy” measurement and relevant functions for distributed generation this function can be switched ON or switched OFF by command from system remotely or configure locally. “Export Energy” function is switched OFF as default.

When reverse current was detected by meter, according to “8.14 Anti-tamper” described, the current reverse event will be logged.

I. Current reverse event is logged (ON and OFF)

When the “Export Energy” function is switched OFF, if current reverse condition occurs, the reverse current and duration time over a certain threshold which can be configured, an additional action will be performed:

- I. Disconnect relay
- II. Event “Local disconnection due to current reverse” will be logged
- III. The bit 5 “Current reverse” will be set in the Tamper status word
- IV. The LCD displays “OFF-REV”

The meter relay will reconnect when current reverse condition removed and a tamper reset command send from the HES or hand-held device. Or The “Export Energy” is switched ON remotely or locally, the tamper will be reset automatically and the relay will be reconnected.

8.14 Anti-Tamper

8.14.1 The offered type energy meter shall capable to detect tempering event which include following but not limited:

N o.	Tamper Type	Detection Threshold	Detection Duration
1	Main cover removal	Meter cover has been removed	immediately
2	Terminal cover Removal	Terminal cover has been removed	immediately
3	Strong DC magnetic Field	>200mT	The status lasts at least 5 seconds
4	ESD disturbance	>8KV	The status lasts at least 5 seconds
5	Current reverse	The direction of current and voltage of any phase is different	The status lasts at least 60 seconds
6	Current bypass	$\text{Max}(\text{Ip}, \text{Ine}) \geq 20\% \text{In}$, and $ \text{Ip} - \text{Ine} / \text{max}(\text{Ip}, \text{Ine}) \geq 90\%$ Ip: current of phase Ine: current of neutral In: base current Max(Ip, Ine): the bigger value between phase current and neutral current	The status lasts at least 60 seconds
7	DC injection(neutral disturbance)	$V_{\text{peak}} / V_{\text{rms}} > 1.414 * (1-6\%)$, or $V_{\text{peak}} / V_{\text{rms}} < 1.414 * (1+6\%)$	The status lasts at least 60 seconds
8	Phase sequence Reverse	The sequence of phase is wrong.	The status lasts at least 60 seconds
9	Phase & neutral Exchange	Any incoming phase and neutral has exchanged	The status lasts at least 60 seconds
10	Neutral wire cut	Neutral wire has been cut	The status lasts at least 60 seconds

8.14.2 The meter supports to configure if a disconnection should be applied for each kind of tamper event.

8.14.3 The following table shows some tamper indication and the configuration for tamper disconnection

Tamper type	Display Indication	Disconnection enabled/disabled
Meter cover removal	OFF-FCOV	Enabled
Terminal cover removal	OFF-TCOV	Disabled (after 24 hours cumulative power on or cumulative active energy exceeds 5 kWh, enabled automatically)
Strong DC magnetic field	OFF-MAG	Disabled
ESD disturbance	OFF-ESD	Disabled
Current reverse	OFF-REV	Disabled
DC injection (neutral disturbance)	DC TAMP	Disabled
Meter cover removal	OFF-FCOV	Enabled

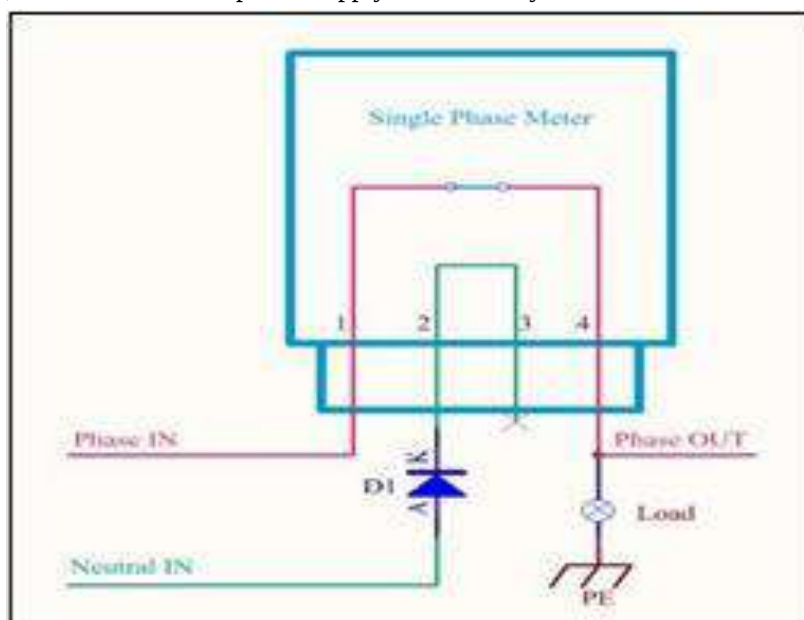
Only the first tamper disconnection reason will be displayed if there are more than one tamper conditions are triggered.

If related tamper disconnection is disabled, even though the tamper condition is triggered, the meter will not disconnect the power supply, and the relative display indication will not be displayed, but the relative event will be logged.

8.15 DC Immunity

The detection condition of DC injection are shown in Figure, the meter will not saturate on passage of direct current, which can cause the meter either to stop recording/ record inaccurately. When meter detects DC injection occurrence:

- 8.15.1 If the relay disconnect function is enabled for this anti-tamper function, the meter will record the “DC injection” event, and push the event to AMI system, if the pushing of the event is enabled, display “OFF-DC”, and disconnect the power supply automatically



- 8.15.2 If the relay disconnect function is disabled for this anti-tamper function, the meter will record the “DC injection” event, and push the event to AMI system, if the pushing of this event is enabled, the meter will not display “OFF-DC”; user keep using energy, meter will measure energy with voltage of U_n and real current.

8.16 Self-diagnostics and Meter Status Word

8.16.1 Self-diagnostics

The meter shall be capable for self-diagnostic, which includes but not limited:

1) **Measurement system check:**

When measurement chip works abnormally, or the measurement data is not obtaining from chip, the meter will try(continuously each 5s) to restart the chip and get it to work normally, if it still doesn't work properly after 5 consecutive restart attempts, the meter will set measurement system error in instantaneous status word.

2) **Non-volatile memory check:**

The meter checks whether EEPROM and Flash works normally when meter is powered on and periodically. If error is detected, the meter will set non-volatile memory error in instantaneous status word.

3) **RAM check:**

The meter always verifies the data stored in the RAM area, if error is detected, and it will set RAM error in instantaneous status word.

4) **Program memory check:**

The meter periodically check the code area, if error is detected, the meter will set program memory error in instantaneous status word. However, the critical error icon will be displayed if critical error is detected.

8.16.2 Instantaneous Status Word

A 32-bit status word is used to indicate the real-time self-diagnose and working status of the meter. It is defined as below :

Bit No.	Description	Set Condition	Reset Condition
0	Clock invalid	Meter clock is invalid	Meter clock is re-configured
1	Measurement system error	A physical error in the measurement system	The measurement system is recovered
2	NVM(non-volatile memory) error	Physical error in the EEPROM or Flash	The NVM is recovered
3	RAM error	Physical error in the RAM	The RAM is recovered
4	Program memory error	The checksum of meter code area is wrong	The checksum of meter code area is correct
5	Battery low	Battery capacity is low	Battery capacity is restored
6	Missing neutral	Neutral line is lost	Neutral line is restored
7	Phase neutral interchange	Phase & neutral line are interchanged	Phase wires are connected correctly
8	Under voltage L1	Phase L1 voltage is lower than under voltage threshold	Phase L1 voltage returns to normal
9	Over voltage L1	Phase L1 voltage is higher than overvoltage threshold	Phase L1 voltage returns to normal
10	Terminal cover removal	Terminal cover is removed	Terminal cover is closed
11	Main cover removal	Main cover is removed	Main cover is closed
12	Strong magnetic field	Strong magnetic field is detected	Strong magnetic field disappears
13	ESD disturbance	ESD disturbance is detected	ESD disturbance no longer existed
14	Current bypass	Meter is under current bypass condition	Current bypass condition is no longer existed
15	DC injection (neutral disturbance)	Neutral disturbance is detected	Neutral disturbance no longer existed
16	Current reverse	Any phase of current is reverse	All phases of current are normal
17	Relay status bit0	bit0=0, bit1=0: Disconnected bit0=1, bit1=0: Connected bit0=0, bit1=1: Ready for reconnection	
18	Relay status bit1	Terminal cover is removed	
19	Prepayment mode	Meter is in prepayment mode	Meter is in post-payment mode
20	Current without voltage	Any phase has current, but no voltage	All phases of voltage restored
21	Reserved		

8.16.3 Tamper Status Word

A 32-bit tamper status word is used to indicate which tampers have occurred in the meter. It can only be cleared by a clear tamper command.

Bit No.	Description	Set Condition	Reset Condition
0	Meter cover removal	Meter cover is removed	Meter cover is closed and clear tamper command is received
1	Terminal cover removal	Terminal cover is removed	Terminal cover is closed and clear tamper command is received
2	Strong magnetic field	Strong magnetic field is detected	Strong magnetic field disappears and clear tamper command is received
3	DC injection (neutral disturbance)	Neutral disturbance is detected	Neutral disturbance no longer exists and clear tamper command is received
4	ESD disturbance	ESD disturbance is detected	ESD disturbance no longer exists and clear tamper command is received
5	Current reverse	1) When Export Energy function switch OFF, if reverse current value and duration time over certain threshold, this bit will be set. 2) When Export Energy function switch ON, this bit will not be set.	1) When current reverse condition removed and tamper reset command is received 2) When Export Energy function switch ON, this bit will be reset.
6 ~31	Reserved		

8.17 Firmware Upgrade

The meter and communication module support to upgrade firmware remotely and locally. The firmware upgrade is protected with security level 5 of HLS (High Level Security of DLMS security suite 0). The meter verifies the integrity and originator before switching to the new firmware. The meter records the firmware upgrade related events, refer to 8.18 Event Logs.

8.18 Event Logs

The meter can record all the following events.

There is a register to configure which events can be pushed to the DCU/AMI system. In the following table, the column “Push” describes which events are pushed by default once they are generated.

Group	Capacity	Description	Event Generation Condition	Push	Capture Object
Standard event	50	Short Power Down		No	Event code, Timestamp
		Short Power Up		No	
		Long power down		Yes	
		Long power up		Yes	
		Daylight saving time enabled or disabled		No	
		Clock adjusted (old date/time)		No	
		Clock adjusted (new date/time)		No	
		Clock invalid		No	
		Battery low		Yes	
		TOU activated		No	
		Tamper register cleared		No	
		Program memory error		No	
		RAM error		No	
		NV memory error		No	
		Watchdog error		No	
		Measurement system error		No	
		Firmware ready for activation		No	
		Firmware activation failed		No	
		Firmware activated		No	
		FW verification failed		No	
		Passive TOU programmed		No	
		Clock out of tolerance	There is a big difference between the time value issued by DCU or the AMI system and meter clock	Yes	
		Global key(s) changed		Yes	
		Load profile cleared		No	
		Event log cleared		No	
Fraud event	50	Terminal cover removed		Yes	Event code, Timestamp
		Terminal cover closed		Yes	
		Strong DC field detected		Yes	
		No strong DC field anymore		Yes	
		Meter cover removed		Yes	
		Meter cover closed		Yes	
		ESD start	8kV ESD disturbance is detected	Yes	
		ESD end	ESD disturbance tampering no longer exists	Yes	
		Current Reversal L1		Yes	
		Current Reversal L1 end		Yes	
		Communication module removed		No	

		Communication module inserted		No	
		DC injection (neutral disturbance) start		No	
		DC injection (neutral disturbance) end		No	
		Phase neutral exchange start		No	
		Phase neutral exchange end		No	
		Current bypass start		No	
		Current bypass end		No	
		Current without voltage start	Neutral wire is not connected on the meter	No	
		Current without voltage end		No	
		Event log cleared		No	
Communication event	50	Communication start on local interface		No	Event code, Time stamp, client ID, communication port ID(1:optical;2: remote)
		Communication end on local interface		No	
		One or more parameters changed		No	
		Communication problems	a. Rejected DLMS "association-request" in the meter with errors different from authentication failure b. Unauthorized meter communication attempt (Rejected DLMS "association-request" failure due to incorrect credentials)	Yes	
		Configuration problems	a. Rejected DLMS "set-request" in the meter. b. Rejected DLMS "Action-request" in meter (including FW upgrade)	Yes	
		Decryption or authentication failure (n time failure)		No	
		Replay attack	The invocation counter in the data frame receive by the meter is equal to or smaller than which stores in the meter.	No	
		Event log cleared		No	
Disconnect control event	50	Remote disconnection		No	Event code, Timestamp
		Local disconnection due to over power		Yes	
		Local disconnection due to meter cover removal		Yes	
		Local disconnection due to terminal cover removal		Yes	
		Local disconnection due to over demand side threshold		Yes	
		Local disconnection due to strong DC magnetic field		Yes	
		Local disconnection due to DC injection		Yes	
		Local disconnection due to current reverse		Yes	
		Local disconnection due to ESD disturbance		Yes	
		Local disconnection due to over current		Yes	
		Local disconnection due to credit exhausted		Yes	

		Power limiter threshold exceeded (contract power limit and demand side limit)		No	
		Power limiter threshold ok		No	
		Demand side limiter threshold exceeded		No	
		Demand side limiter threshold ok		No	
		Power limiter threshold configured		No	
		Demand side threshold configured		No	
		Local reconnection		Yes	
		Over current start	The phase current is bigger than current threshold in the meter	Yes	
		Over current end	The phase current is lower than current threshold in the meter	Yes	
Power quality event log	50	Under voltage L1		No	Event code, Timestamp
		Overvoltage L1		No	
		Voltage L1 normal		No	
		Event log cleared		No	
Prepayment event log	50	Low credit	Meter available credit is lower than low credit threshold	Yes	Event code, Timestamp
		Switch to prepayment mode		No	
		Switch to post-payment mode		No	
		Credit exhausted		Yes	
		Configure low credit threshold		No	
		Clear recharge sequence number		No	
Recharge event log	50	Event log cleared		No	Timestamp, Recharge sequence number, Recharge amount
		Recharge		No	
Communication module event log	100	P2P: No connection timeout		No	Event code, Timestamp
		P2P: Modem SW reset		No	
		P2P: SIM Card failure		No	
		P2P: SIM Card ok		No	
		P2P: Network registration failure		No	
		P2P: PDP context established		No	
		P2P: PDP context destroyed		No	
		P2P: PDP context failure		No	
		P2P: Modem reset timer expired		No	
		P2P: Signal quality low		No	
		P2P: Modem listen failed		No	
		P2P: Modem communication ready		No	
		P2P: TCP connection establish failed		No	
		P2P: Image download succeed		No	
		P2P: Image download failed		No	
		P2P: Image upgrade succeed		No	
		P2P: Image upgrade failed		No	
		PLC: No connection timeout		No	
		PLC: Modem SW reset		No	
		PLC: Modem Registration Success		No	
		PLC: Modem Registration Failure		No	
		PLC: Modem Kicked		No	
		PLC: Modem HW Reset		No	
		PLC: Modem Request to Reset		No	
		PLC: Modem Initialize Failure		No	



		PLC: Modem Data Request Failure		No	
		PLC: ICMP RA Received		No	
		PLC: ICMP RS Failure		No	
		PLC: ICMP Echo Request Received		No	
		PLC: PAN Conflict Detected		No	
		PLC: No PAN Detected		No	

9 Communication Interfaces

The meter provides two communication interfaces, one for local communication, the other for remote communication. The remote communication port supports plug and play 4G/2G communication module or G3-PLC communication module, and other kind of communication technologies for future extension. The details of the communication ports are defined as below:

Purpose	Interface	Baud Rate	Protocol latest Relies
Local communication	Optical port	9600 bps	DLMS/COSEM, HDLC profile
Remote communication	4G Downward communication	Downlink: max. 10M bps Uplink: 5M bps	DLMS/COSEM,, TCP/IP Profile.
	G3-PLC communication	200 kbps maximum in D8PSK mode	DLMS/COSEM, TCP/IP Profile.

The optical port locates on the basic meter. All communication parameters and data are stored in the meter. Multi-channels (i.e.: optical port, remote port) can communicate simultaneously.

9.1 Optical Port Communication

The optical port is used for reading meter configuration, meter parameter or control the meter locally. In general, a hand- held device is used to communicate with meter via this optical port.

9.2 Remote Communication

The remote communication module can be 4G/2G communication module, or G3-PLC communication module.

9.3 4G/2G Communication

The key features of 4G/2G are listed in below table:

General Function	Performance & Availability	- FDD-LTE CAT1 B1/B3/B5/B8 - GPRS 900/1800 MHz - Control via AT commands - Operation temperature: -25°C to +80°C - Max transmit power: - LTE CAT1 B1/B3/B5/B8: 23±2.7dBm - GPRS 900M/1800M: 33dBm/30±2dBm - Support reconnection behavior after detecting an unexpected interrupted Communication session.
	Roaming	Support national roaming between 4G/2G networks of different national telecom providers. Support SIM cards with multiple IMSI.
	SIM	Support 2FF SIM card. Specially, the recommended thickness is 0.76mm. Support IMEI lock of the USIM card. Support ESIM card.

	Indications of 4G/2G signal Strength	Indicate 4G/2G signal strength in a minimum of 4 separate levels. Refer to LCD display. RSRP, RSRQ value is readable.
	Antenna	Internal antenna
	Wake-up	Support fully qualified domain names. Receive and store the IP addresses of the primary and secondary address when establishing a PDP context based on the DHCP protocol Support data pushing.
	Authentication and security	Changeable APN/password Support RADIUS authentication using PAP or CHAP. Network access information is not saved on the SIM cards Communication settings to be remotely configurable
	Assign IP address	4G downward module support both dynamic IP address assignment and static IP Address

Description of 4G/2G communication

The 4G/2G communication parameters are configurable, generally programmed in the factory.

A communication LED is used to indicate the communication status, refer to 8.6.1 LED Indicators for details.

For the detailed information of 4G/2G communication module, please refer to the 4G/2G module's technical specification.

9.4 G3-PLC Communication

The key features of G3-PLC are list below:

1. Communication frequency: FCC band
2. Auto-repeater, network self-healing
3. Meter auto-registration
4. Meter can work as repeater
5. MAC-layer security
6. Support broadcast firmware

upgrade Technical features:

1. Modulation: (ROBO1/4)/DBPSK/DQPSK/D8PSK
2. Frequencies: FCC : 154.687 kHz to 487.5 kHz
3. Max data rate: FCC: DBPSK: 77.2 kbps, DQPSK: 166.4 kbps , D8PSK:152.899 kbps
4. Power consumption
 - ✓ Standby: < 30mA@15V
 - ✓ Communication: <200mA@15V(average)
 - ✓ Transmit peak :700mA@15V

A communication LED is used to indicate the communication status, refer to 8.6.1 LED Indicators for details.

For the detailed information of G3-PLC communication module, please refer to the G3-PLC module's technical specification.

9.4.1 Physical Features

The dimension of 4G/3G module is(L×W×H) 97.2mm×64.6mm×36.6mm(±2mm).

The module has 15.0V±5% (DC) power supply coming from the meter with a maximum pulse current consumption of 850mA.

The module communication interface to the Meter using UART interface.

The module is equipped with a SIM card holder, supporting 1.8V/3V USIM card.

General View of communication Module

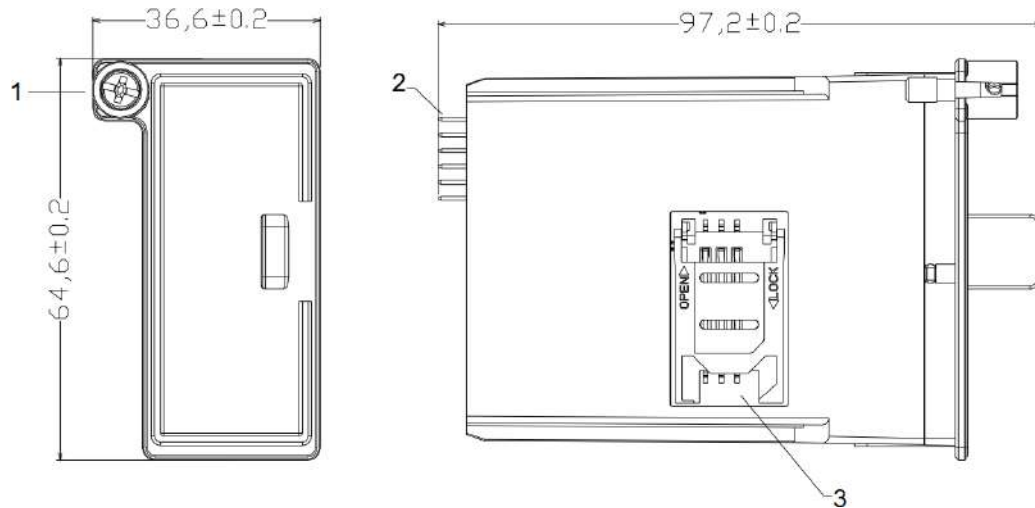
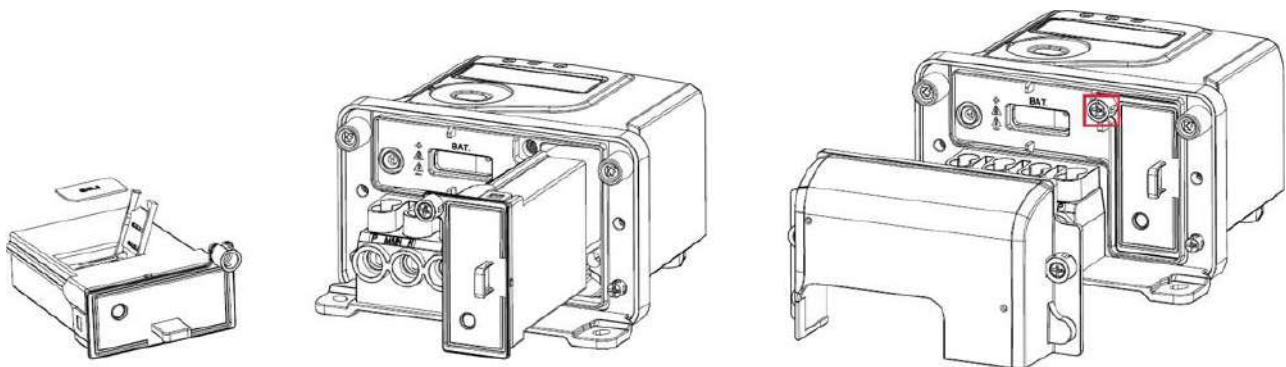


Figure - General view of 4G/2G module

1. 4G/2G module sealing screw
2. DC power supply and UART interface
3. SIM card socket

Mounting of communication module

The module is installed in a plastic housing and mounted inside the meter with sealing screw.

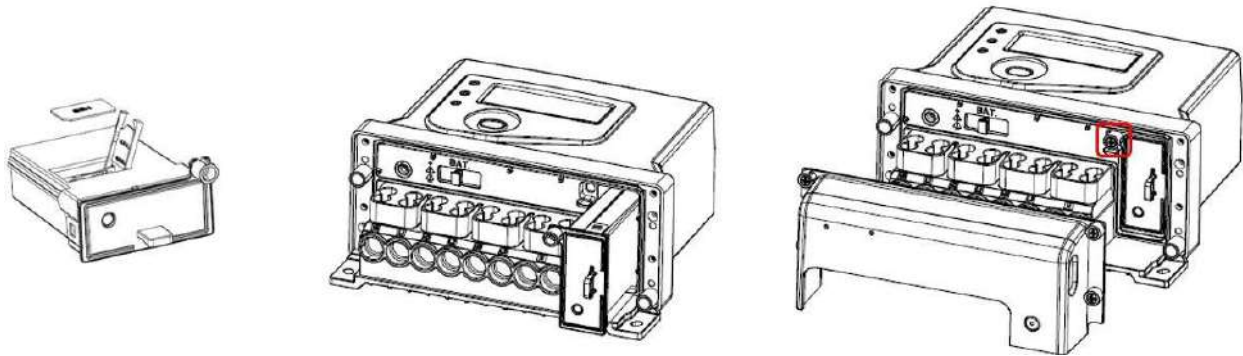


Step1. Insert SIM card

Step2. Insert module to meter

Step3. Install the seal and terminal cover

Figure - Default mounting point for Single-phase meter



Step1. Insert SIM card

Step2. Insert module to meter

Step3. Install the seal and terminal cover

Figure - Default mounting point for Single-phase meter

9.4.2 Function

9.4.2.1 Data Transmission

The module data transmission adopts the wireless transmission mode, and the 4G/2G wireless transmission network is used as the communication medium to realize the reading, monitoring and control of the meter. The system can realize the acquisition and verification of the meter data, the monitoring of the power quality and the working state of the meter, and the remote control of the meter. The transmission process not only ensure the security of data, but also take into account the transmission efficiency.

9.4.2.2 4G/2G Module Communication Status Display

One green-color LED on the meter indicates the 4G/2G module communication status:

LED Status	Indicating Status
Off	No communication module is plugged or communication module fails
Blink 0.5s on, 3s off	No SIM card insert or SIM card cannot be detected
Blink 1s on, 0.2s off	Module network registering
Blink 1s on, 3s off	Module network registration is rejected
Blink 1s on, 1s off	Module is registered succeed, TCP connection is ongoing
Blink 0.2s on, 0.2s off	Remote communication is ongoing
On	Meter is registered succeed, no remote communication is ongoing

Table - Communication status of 4G/2G module

The wireless signal strength of 4G/2G module can be easily readout through the meter LCD.

Number/Symbol	Description
	On: 4G/2G module is inserted in the meter Off: 4G/2G module is not detected.
	Displays the 4G/2G signal strength:  RSSI < -120 dBm (Very poor Signal)  -120 dBm ≤ RSSI < -100 dBm (Poor Signal)  -100 dBm ≤ RSSI < -90 dBm (Bad signal)  -90 dBm ≤ RSSI < -80 dBm (Good signal)  RSSI ≥ -80 dBm (Excellent signal)

Table - Description of wireless signal strength on meter LCD screen

9.4.2.3 Firmware Upgrade of communication module

The communication module support to upgrade firmware remotely. FOTA (Firmware Over-The-Air) upgrade mode is adopted. In-flight download software upgrade of module refers to providing firmware upgrade services for modules through cloud upgrade technology. Users can obtain intelligent terminal system upgrade packages on demand and perform cloud upgrade through FOTA. Complete system repair and optimization.

9.4.3 SIM Card

SIM Card Technical Features

The SIM card provided by the operator needs to meet the following requirements, to get the best performance.

Temperature	Operation temperature: -25°C to +80°C
Dimensions	Plug-in Card(2FF): length 25mm, width 15mm, thickness 0.8±0.08mm Do not use Micro or Nano SIM card
Voltage	3.0V and 1.8V
Reliability	Industrial grade card Meet 1000 hours of dual 85 testing (85°C and 85% humidity)

Table - SIM Card Technical Features

9.4.3.1 External antenna module

When the signal in the area where the meter is located in poor signal area and the build-in antenna module signal cannot communicate, supplier shall provide an external antenna module to replace the build-in antenna module for the meter.

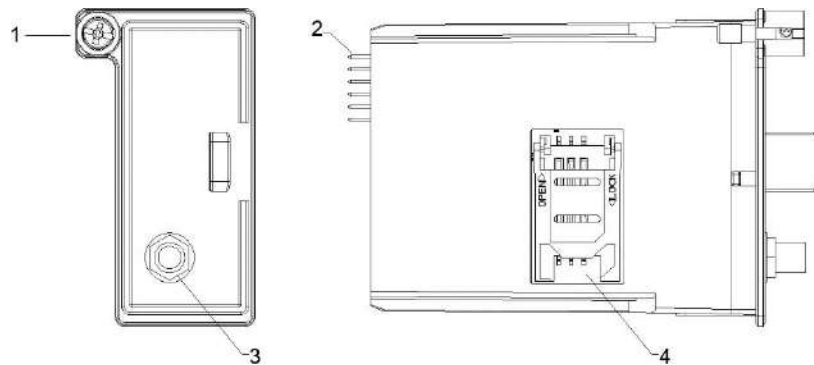


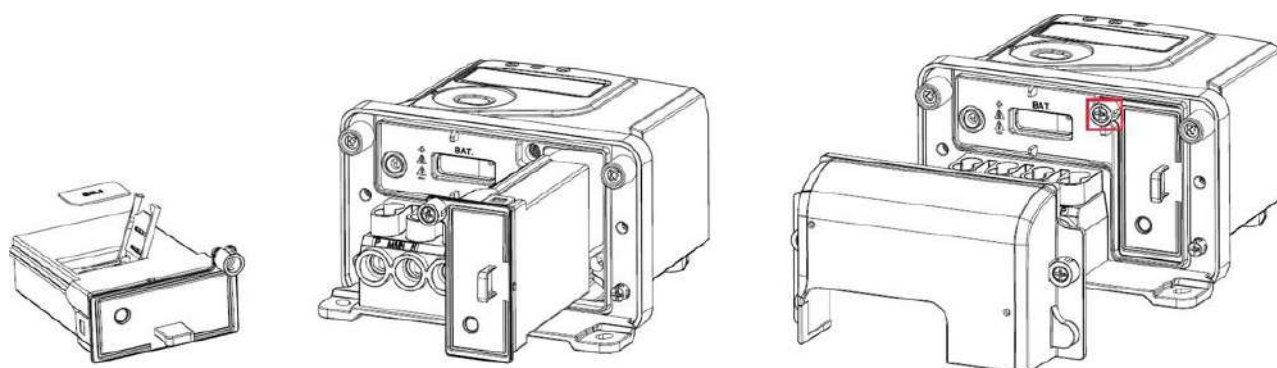
Figure - 4 General view of 4G/2G external antenna module

1. 4G/2G module sealing screw
2. DC power supply and UART interface
3. SMA external antenna interface
4. SIM card socket

There have a SMA pre-cut hole design on meter terminal cover, the hole with a pre-cut on the terminal cover as a default configuration, if the meter with PLC module, and 4G/2G modules with built-in antennas, the pre-cut hole will be kept.

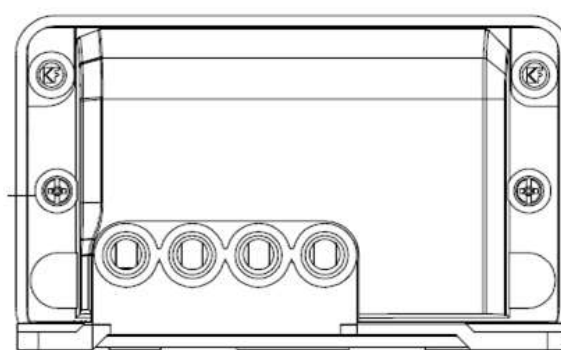
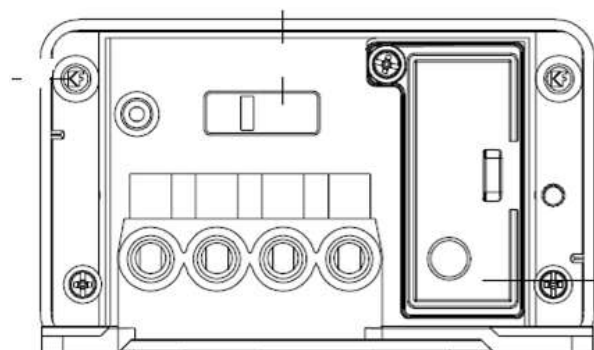
In case of a external antenna 4/2G module is equipped, the pre-cut hole on the terminal cover should be removed for external antenna installation.

FOR SINGLE PHASE METER:



Step 1. Insert SIM card

Step 2. Insert module to meter



Step 3. Connect external antenna through terminal cover and put the rubber plug into the hole on terminal cover

Step 4. Install the module seal, and install terminal cover

Figure – 5 External antenna installation for Single -phase meter

10 Security

10.1 Physical Security

The meter has two seals for the meter cover to seal the metrology part of the meter. It is impossible to access the meter metrology part unless physically and transparently destroy the metrology seals or meter enclosure. The meter detects and records the meter cover removal event and terminal cover removal event in both power on condition and power off condition. The meter immune magnetic field disturbance and records the strong magnetic field event.

The meter has a unique serial number, which is recorded in non-volatile memory of meter, and marked on the name plate of the meter permanently, and is not possible to change once out of factory. The memory serial number can be displayed in the LCD in Manual Scroll Mode.

10.2 Communication Security

The meter supports DLMS security suite 0 defined in DLMS Green Book Edition 10, High Level Security (HLS) mechanism id 5 with both authentication and encryption is used to ensure the data privacy and security in data communication.

The meter supports a Role-Based Access Control (RBAC). Each role has its own access privileges. Here below table lists all the roles, their privileges, security mechanism:

Role	Client ID	Privileges	Security Mechanism
Public	16	Read limited meter information, like the meter serial number.	No
Readout	2	Read meter.	HLS Mechanism id 5 AES-GCM-128
Management	1	Read meter, configure meter, meter key change	HLS Mechanism id 5 AES-GCM-128
Maintenance	6	Read meter, configure meter	HLS Mechanism id 5 AES-GCM-128
Pre-established	102	Event push	No

Table - Description of each role

When the connection to the local port fails, or “action-request”, “set-request” fails, the meter will record the corresponding event, which refers to chapter 5.13 Communication Event for specified events.

10.3 Keys

The meter has the following keys for each DLMS HLS client.

No	Type Name	Description
1	Authentication key	Ensure data integrity and authenticity
2	Encryption key	Ensure data confidentiality
3	Master key	Use to change other keys

Table - Description of keys

Each meter has its own individual keys once out of factory. All keys stored in the meter is encrypted. The key can be changed by key change command from AMI system.

11 TESTS:

Procedure of inspection for Local Manufacturers regarding Routine, Sample and Type Tests as per requirements of IEC standards.

11.1 Routine Testing

Following routine tests shall be carried out by the manufacturer on each energy meter and witnessed by the Inspector as per respective clauses of IEC 62053-21 and IEC 62053-23.

1) - Visual inspection

ii) - Accuracy Test

iii) - Starting Current test

If failure exceeds than 5%, the group offered for routine inspection shall be rejected.

In order to improve the quality and workmanship, after the successful Routine Testing and welding of the energy meters, the displayed quantities kWh, kVARh and kW of each energy meter must be recorded and retained for the official record by the manufacturer for at least One (01) Year.

11.2 Sample Testing, Acceptance and Rejection

The energy meter offered for acceptance shall be grouped into lots containing up to 1000 energy Meters. A sample comprising Five (05) energy meters shall be selected at random from each lot and Subject to following Test.

Clause	Test Description	Samples Drawn	Acceptance	Resampling	Rejection
	VISUAL INSPECTION		Lot shall be accepted, If ONE meter fails in ANY ONE of the tests.	Resampling of the same size should be carried out, If ONE meter fails in any of the TWO tests or TWO meters fail in any ONE test	The lot shall be rejected, If THREE or MORE meters fail in any of the test or ONE meter fails in any THREE or MORE tests or ONE meter fails in any TWO tests and ONE meter fails in ONE test
	ELECTRICAL TESTS				
i.	Test of Accuracy due to variation of Current	05 Nos.			
ii.	Test of Starting Condition				
iii.	Test of No Load Condition				
iv.	Impulse Voltage Test				
v.	AC Voltage Test	02 No. already selected			
vi.	Power Loss Test				
vii.	Influence of DC and Even Harmonics Test				
	EMC Tests				
viii.	Fast Transient Burst Test	Other 02 No. already selected			
ix.	Test of Immunity to Electrostatic Discharge				
x.	Surge Immunity Test				

MECHANICAL TESTS					
i.	Shock and Vibration Test	01 No. on which EMC tests have already been performed (Once in P.O)	The lot shall be accepted, If all meters QUALIFY all the tests	In case, If any meter fails in the RELEVANT test, another sample of DOUBLE the size shall be selected and test be repeated.	If any meter fails in any test during resampling, the entire lot shall be rejected.
ii.	Test of Protection against Penetration of Dust and Water	02 Nos. on which electrical tests already performed			
iii.	Dimensional Check and Verification of Components	01 No. on which Extreme Temperature test already performed			
iv.	Impact Test & Tin Coating Tests				
v.	Extreme Temperature Condition Temperature = 80 °C for 04-Hours V_{ref} = 230 Volts, I_{max} = 100 Amps. Meter shall be energized with reference Voltage and Maximum Current (I_{max}) be flown continuously for Four (4) hours. During the test, accuracy of energy meter should be within the specified limits, which shall determine its qualification in test.	01 No. remaining out of 05 meters			
Software and Security Verification					
vi.	Radar Magnet Test	01 No. on which EMC tests have already been performed			
vii.	Verification of Security Features				
viii.	Accuracy with and without Neutral				
ix.	Software Verification Verification of functionality of Software and Display Features shall be performed by loading/ downloading and auditing of the reports. (Copy of the report be retained for official record).				

11.3 Type Test

Each type smart Energy meter is acceptable subject to type testing requirement as criteria laid down below duly witnessed by one Engineer of TSW and One AMI Meter specialist at cost and arrangement of manufacturer. The validity of Type test report shall be five year depend upon the field performance of meter. In case change in specification or design by manufacturer then manufacturer will carry out fresh type testing as criteria laid down below.

Sr.No	Description	Lab
1	Electrical Test	Any IEC/IEEE registered Lab. However, order of testing shall be as per IEC standard
1.1	Identification of Type and designation	
1.2	Power consumption of voltage circuit.	
1.3	Power consumption of current circuit	
1.4	Voltage dips and short interruptions	
1.5	Short time over current.	
1.6	Influence of self-heating	
1.7	Short circuit withstand	
1.8	Impulse withstand test	
1.9	Power frequency withstand test	
1.10	Accuracy test for active and reactive	
1.11	Influence quantities	
1.12	Starting condition	
1.13	No load condition.	
2	Accuracy requirements	
2.1	Meter constant	
2.2	Initial start-up of the meter	
2.3	Test of no-load condition	
2.4	Starting current test	
2.5	Repeatability test	
2.6	Limit of error due to variation of the current	
2.7	Time-keeping accuracy	
2.8	Test of time-keeping accuracy on operation reserve	
2.9	Test of time-keeping accuracy with temperature	
2.10		
3	Tests for electromagnetic compatibility (EMC) and limits of error due to electromagnetic influence quantities:	
3.1	immunity to electrostatic discharges	
3.2	immunity to electromagnetic hf fields	
3.3	transient burst test	
3.4	radio interference measurement	
3.5	Voltage dips and short interruptions	
3.6	Electrostatic discharges	
3.7	Radiated, radio-frequency, electromagnetic field immunity test – test without current	
3.8	Radiated, radio-frequency, electromagnetic field immunity test – test with current	
3.9	Electrical fast transient/burst immunity test	
3.10	Conducted disturbances induced by radio-frequency fields	

4	Test for immunity to conducted, differential mode disturbances and signaling in the frequency range 2 kHz to 150 kHz at AC power ports	
4.1	Surge immunity test	
4.2	Ring wave immunity test	
4.3	Power frequency magnetic fields of external origin	
4.4	Conducted emission	
4.5	Radiated emission	
5	Tests of immunity to other influence quantities	
5.1	Harmonics in the current and voltage circuits – 5th harmonic test	
5.2	Inter harmonics in the current circuit – burst fired waveform test	
5.3	Odd harmonic in the current circuit	
5.5	DC and even harmonic – half-wave rectified waveform test	
5.6	Voltage variation	
5.7	Ambient temperature variation	
5.8	Interruption of phase voltage	
5.9	Frequency variation	
5.10	Reversed phase sequence	
5.11	Operation of auxiliary devices	
5.12	Short-time over currents	
5.13	Self-heating	
5.14	Fast load current variations	
6	Mechanical Test	ILAC registered independent lab
6.1	Spring Hammer Test	
6.2	Shock Test	
6.3	Vibration Test	
6.4	Heat and Fire resistance test	
6.5	Dust and Water (IP) test	
7	Climate & Environmental Test	
7.1	Dry Heat Test	
7.2	Cold Test	
7.3	Damp Heat Cycle Test	
7.4	Solar Radiation Test	
7.5	Humidity Test	
7.6	Protection against spread of fire	
7.7	Temperature test	
7.8	Protection against penetration of dust	
7.9	Protection against penetration of water	
8	Communication Test	
8.1	Provision of documents for Type Approval from PTA along with 01 Nos. Samples.	

11.4 Pre-Shipment Inspection:

The successful bidder shall offer the meters for testing/inspection, Procedure for pre-shipment inspection is given below:

S.No	Test Description
1	Impulse voltage test
2	AC voltage test
3	Insulation Test
4	Accuracy Test due to variation of current
5	Test on starting Condition
6	Test of no-load condition
7	Power Loss Test
8	Influence of DC& Even Harmonic Test
9	Fast Transient Burst Test
10	Test of immunity to electrostatic discharge
11	Surge immunity Test
12	Shock and Vibration test
13	Test of protection against penetration of dust and water
14	Dimensional check and verification of Component
15	Spring hammer test
16	Tin coating Test
17	Extreme Temperature Condition ,temperature 80Cfor 4 hour ,Vref=230V,Imax=100A
18	Radar Magnet Test
19	Accuracy with and without Neutral
20	Software Verification Test
21	Communication Test ,read Data From HES, Operating Relays from HES

12 Name and Rating Plate

A suitable name/rating plate shall be provided inside at the front of the meter, indicating the following information:

- Name of the manufacturer and country of origin.
- Type of meter.
- Number of phases and number of wires.
- Nominal and maximum current, nominal voltage and frequency.
- Symbol of class insulation
- Disco Name
- Meter constant.
- P.O. No.
- Meter No. and Year of manufacturer.
- Warranty upto
- IP Protection Class
- Relevant DDS/IECs Standard
- Property, not for sale.
- Display sequence should be printed on nameplate.
- ERP SAP item code no.
- Accuracy Class For Active and Reactive Energy
- Connection Diagram
- Normal mode parameters
- Any others necessary information in case of Bi-directional and AMI Metering
- Meter Terminal Box shall not be opened as it'll disconnect the supply. (English/Urdu)

13. Sample for interoperability

In order to ascertain interoperability of meter with communication system, & OBIS, the most advantageous Bidder, before award of contract, shall submit at least three number samples of meter. The employer will issue certificate for the same in case of compatibility tests passed from Employer's lab. In case of failure of interoperability tests, IESCO will issue deficiency report to manufacturer for rectification and improvement. After improvement, manufacturer will submit rectified sample to IESCO for testing of interoperability. If sample does not qualify the tests again the bidder will be declared non-responsive. Bidder will bear cost of interoperability test one time.

14. Accessories

Each meter will be supplied with following accessories

I:Connection sleeve

II:Nut bolts

15. Packing

Each meter shall be individually packed in thermo pore packing or thermo pore lined packing, covered with adhesive tape at joints or plastic strips etc.

The packing shall be strong enough to withstand rigors of ocean, rail, road etc.

16. Warranty

The supplier shall provide 02(Two) years Warranty from date of meter installation and 04 Years from the date of the delivery (which ever comes earlier) for the Successful operation of the Energy Meters including its maintenance as and when required.

17. AMI Mobile Application:

Mobile application is also part of the scope, so the supplier should also provide it. The IR interface is as under:

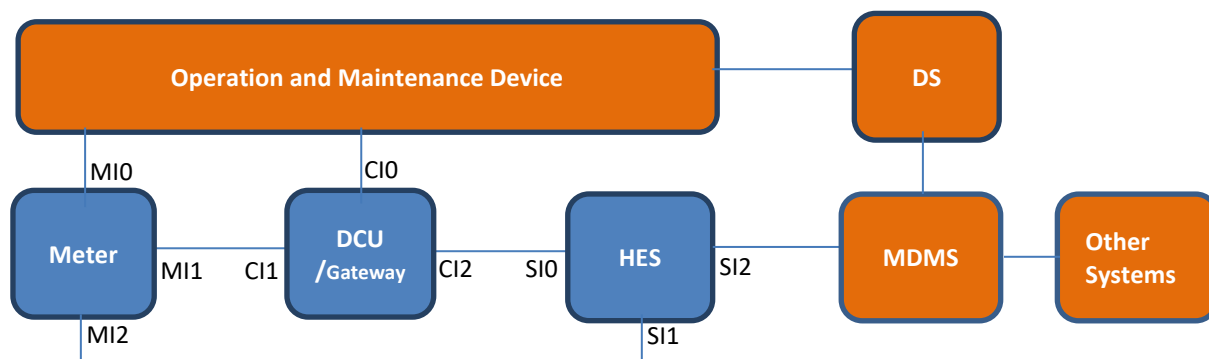


Figure 1: Interface Architecture

1. Meter must have optical port which comply with IEC 62056-46, refer to the interface architecture, the MI0 interface is based on IEC 62056-46 direct HDLC profile.
2. The baud rate shall be at least 9600 bps.
3. All read-out procedures need to be compliant to DLMS / COSEM.
4. The optical port supports to connect to Smart App/Laptop through USB type A or Type C

Annexure:

Annex 1 Reference Standards

The meter complies with the following standards.

1. Metering Standards

No.	Standard	Release time
1	IEC 62052-11 Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment	2020
2	IEC 62052-31 Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 31: Product safety requirements and tests	2015
3	IEC 62053-21 Electricity metering equipment – Particular requirements – Part 21: Static meters for AC active energy (classes 0,5, 1 and 2)	2020
4	IEC 62053-23 Electricity metering equipment – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)	2020
5	EN50470-1 Electricity metering equipment (a.c.) — Part 1: General requirements, tests and test conditions — Metering equipment (class indexes A, B and C)	2006
6	EN50470-3 Electricity metering equipment (a.c.) — Part 3: Particular requirements — Static meters for active energy (class indexes A, B and C)	2006

2. Electrical Testing Standards

No.	Standard	Release time
1	IEC 61000-4-2 Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test	2008
2	IEC 61000-4-3 Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	2006
3	IEC 61000-4-4 Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	2012
4	IEC 61000-4-5 Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	2017
5	IEC 61000-4-6 Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	2013
6	IEC 61000-4-8 Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	2009
7	IEC 61000-4-11 Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	2020
8	IEC 61000-4-12 Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test	2017

9	IEC 61000-4-19 Electromagnetic compatibility (EMC) - Part 4-19: Testing and measurement techniques - Test for immunity to conducted,	2014
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No.	Standard	Release time
	differential mode disturbances and signaling in the frequency range 2 kHz to 150 kHz at a.c. power ports	
10	IEC 61000-4-30 EMC Part 4-30 Testing and measurement techniques – Power quality measurement methods 2015-02 150P	2015
11	IEC 62053-61 Electricity Metering Equipment (a.c.) - Particular Requirements - Part 61 Power Consumption and Voltage Requirements	1998
12	IEC 62058-11 Electricity metering equipment (AC) - Acceptance inspection - Part 11: General acceptance inspection methods	2008
13	IEC 62058-31 Electricity metering equipment (AC) – Acceptance inspection – Part 31: Particular requirements for static meters for active energy (classes 0.2S, 0.5S, 1 and 2)	2008

3. Mechanical Testing Standards

No.	Standard	Release time
1	IEC 60068-2-6 Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)	2007
2	IEC 60068-2-27 Environmental testing – Part 2-27: Tests – Test Ea guidance: Shock	2008
3	IEC 60068-2-5 Environmental testing – Part 2-5: Tests – Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing, IDT	2018
4	IEC 60695-2-11 Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods –Glow-wire flammability test method for end-products	2014
5	DIN 43857-2 Electricity meters in insulation housings for direct connection up to 60A limit current main dimensions for three-phase current meters	1978

4. Environmental Standards

No.	Standard	Release time
1	IEC 60068-2-1 Environmental testing – Part 2-1: Tests – Test A: Cold	2007
2	IEC 60068-2-2 Environmental testing – Part 2-2: Tests – Test B: Dry Heat	2007
3	IEC 60068-2-30 Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)	2005
4	IEC 60529 Degrees of protection provided by enclosures (IP Code)	2013
	IEC 62059-32-1 Electricity metering equipment – Dependability – Part 32-1: Durability – Testing of the stability of metrological characteristics by applying elevated temperature	2011

5. Software Standards

No.	Standard	Release time
1	IEC 62052-21 Electricity metering equipment (a.c.) - General requirements, tests and test conditions Part 21: Tariff and load control Equipment	2004
2	IEC 62054-21 Electricity metering (a.c.) - Tariff and load control - Part 21: Particular requirements for time switches	2004
3	IEC 62056-21 Electricity metering – data exchange for meter reading, tariff and load control – Part 21 Direct local data exchange	2002
4	IEC 62056-46 Electricity metering – Data exchange for meter reading, tariff and load control - Part 46: Data link layer using HDLC protocol	2007
5	IEC 62056-53 Electricity metering - Data exchange for meter reading, tariff and load control - Part 53 Part: COSEM Application layer	2006
6	IEC 62056-61 Electricity metering - Data exchange for meter reading, tariff and load control - Part 61 Part: Object identification system (OBIS)	2006
7	IEC 62056-62 Electricity metering - Data exchange for meter reading, tariff and load control - Part 62: Interface classes	2006

6. PLC communication Standards

No.	Standard	Release time
1	EN-50065-1 2011 Signaling on low-voltage electrical installations in the frequency range 3KHz to 148.5KHz - Part 1: General requirements, frequency bands and electromagnetic disturbances	2011
2	ITU-T G.9903 2014 Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC Networks	2014

7. 2/4G communication Standards

No.	Standard No.	Title
1	3GPP Release 13 LTE Cat.1bis	-
2	ETSI TS 102 221	Smart Cards; UICC-Terminal interface; Physical and logical characteristics (Release 15)

8. Electrical Standards

No.	Standard No.	Title
1	IEC 62054-21	Electricity metering equipment(a.c.)-General requirements, tests and test conditions-Part 21: Tariff and load control equipment
2	EN55032:2015/A1:2020	Electromagnetic compatibility of multimedia equipment - Emission Requirements
3	EN55035:2017	Electromagnetic compatibility of multimedia equipment - Immunity requirements
4	IEC 60068-2-1:2007	Environmental testing-Part 2-1: Tests-Test A: Cold
5	IEC 60068-2-2:2007	Environmental testing-Part 2-2: Tests-Test B: Dry heat
6	IEC 60529 2013	Degrees of protection provided by enclosures (IP Code)
7	IEC 62052-31 2015	Electricity metering equipment (AC) General requirements tests and test conditions Part 31 Product safety

9. Module Configuration List

Module supports configurations of the following parameters for network functions via DLMS protocol.

Item	Class	Obis Code	Attri	Description
Modem setup	45	0-0:25.4.0.255	2	Configuration for APN
			3	Configuration for Pin Code
PPP setup	44	0-0:25.3.0.255	5	Configuration for PPP_authentication, include username and password
TCP-UDP setup	41	0-0:25.0.0.255	6	Configuration for TCP Inactivity timer, if no TCP traffic and the timer is timeout, TCP connection for reading is released.
Auto connect (For push)	29	0-0:2.1.0.255	3	Configuration for Push retry times
		0-0:2.1.0.255	4	Configuration for Push retry interval
		0-0:2.1.0.255	6	Configuration for Push address, support both IP and domain name
FOTA	1	0-1:94.31.22.255	2	Configuration for FOTA URL
	9	0-2:10.0.1.255	2	Configuration for FOTA enable

APN: It's a network access technology and APN is a parameter that must be configured when accessing the Internet through a module.

PinCode: Personal Identification Number, The PIN code of the SIM card is a security measure to protect the SIM card and prevent others from stealing the SIM card. Usually, the PIN code is default disabled. If the PIN code is enabled, a four digits PIN code is needed for inputting for verification after SIM card has power supply first time.

PinCode is enabled or disabled, it depends on the SIM card suppliers. PPP_authentication

Annex 2 Default Tariff Scheme

The default tariff scheme is as follows.

1. Calendar name

Calendar_name
cale

2. Season tariff

Season_profile_name	Season_start	Weekly Profile Name
B	FF-03-01 FF	week_2
C	FF-06-01 FF	week_3
D	FF-09-01 FF	week_4
A	FF-12-01 FF	week_1

3. Week tariff

Weekly_profile_name	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
week_1	1	1	1	1	1	1	1
week_2	2	2	2	2	2	2	2
week_3	3	3	3	3	3	3	3
week_4	4	4	4	4	4	4	4

4. Day tariff

Day_id	Start-time	Tariff
1	17:00:00	T1
	21:00:00	T2
2	18:00:00	T1
	22:00:00	T2
3	19:00:00	T1
	23:00:00	T2
4	18:00:00	T1
	22:00:00	T2

Annex 3 Display Item List

The display list of meter should be configurable from system side in case of receiving command to do so. The display lists are different for meter in uni-directional and bi-directional mode. Each mode has three display types i.e. auto, manual and power down display mode. The default display objects for auto scroll mode details for both uni-directional and bi-directional categories are as under:

Index	OBIS	Description	Format	Unit
1	/	Display all segment	All segments	/
2	96.1.0	Device ID1, manufacturing number	XXXXXXXXXX	/
3	15.8.0	Active energy total (+A + -A)	XXXXXXXXXX	kWh
4	15.6.0	Monthly Maximum Demand Active total (+P + -P)	XXXXXX.XXX	kW
5	13.24.0	Average power factor of current month	X.XXX	/
6	15.7.0	Instantaneous active power total (+P + -P)	XXXXXX.XXX	kW
*7	19.0.0	Available credit	XXXXXX.XXX	kwh

*7: Available credit: this item will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

The default display objects for manual scroll mode are described as follows:

Index	OBIS	Description	Format	Unit
1	/	Display all segment	All segments	/
2	96.1.0	Device ID1, manufacturing number	XXXXXXXXXX	/
3	0.9.1	Local time	HH:MM:SS	/
4	0.9.2	Local date	DD-MM-YY	/
5	32.7.0	Voltage	XXX.X	V
6	31.7.0	Current	X.XX	A
7	13.7.0	Power factor	X.XXX	/
8	14.7.0	Frequency	XX.XX	Hz
9	1.7.0	Instantaneous active power total (+P + -P)	XXXXXX.XXX	kW
10	15.8.0	Active energy total (+A + -A)	XXXXXXXXXX	kWh
11	15.8.1	Active energy total (+A + -A) T1	XXXXXXXXXX	kWh
12	15.8.2	Active energy total (+A + -A) T2	XXXXXXXXXX	kWh
13	15.6.0	Monthly Maximum Demand Active total (+P + -P)	XXXXXX.XXX	kW
14	15.6.1	Monthly Maximum Demand Active total (+P + -P) T1	XXXXXX.XXX	kW
15	15.6.2	Monthly Maximum Demand Active total (+P + -P) T2	XXXXXX.XXX	kW
16	15.2.0	Monthly Cumulative Maximum Demand Active total (+P + -P)	XXXXXX.XXX	kW
17	15.2.1	Monthly Cumulative Maximum Demand Active total (+P + -P) T1	XXXXXX.XXX	kW
18	15.2.2	Monthly Cumulative Maximum Demand Active total (+P + -P) T2	XXXXXX.XXX	kW
19	96.10.6	instantaneous status word	HEX format	/
20	96.10.7	Tamper status word	HEX format	/
21	0.1.0	Billing period counter	XXX	/
22	15.6.0.1	Maximum Demand Active total (+P + -P), for last month	XXXXXXXXXX	kWh
23	15.6.0.1	Maximum Demand Active total (+P + -P), data time, for last month	DD-MM-YY HH-MM-SS	/
24	13.24.12	Average power factor of current month	X.XXX	/
*25	19.0.0	Available credit	XXXXXX.XXX	kwh

*26	41.129.0	Last recharge kwh	XXXXXX.XXX	kwh
*27	40.129.5	*Monthly consumption energy (import active energy) for last month	XXXXXXXXXX	kWh

*25(Available credit), *26(Last recharge kwh), *27(Monthly consumption energy): these items will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

The default display objects for power down display mode are described as follows:

Index	OBIS code	Description	Format	Unit
1	96.1.0	Device ID1, manufacturing number	XXXXXXXXXX	/
2	15.8.0	Active energy total (+A + -A)	XXXXXXXXXX	kWh
*3	19.0.0	Available credit	XXXXXX.XXX	kwh

*3: Available credit: this item will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

Annex 4 Smart Meter Companion Specification (Annexed to Specs)

Companion Specifications are designed to ensure proper communication of meter with the system. The parameters defined in this companion specification will be tested in detail on sample provided by bidder.

1 Overview

This document describes communication profiles for the communication interfaces of the AEM meter based on DLMS/COSEM data model. It is applicable for single phase meter, three phase direct connection meter, three phase CT meter, and three phase CT/PT meter.

This document is only used for meter interoperability to HES system for the AMI project.

2 Normative References

#	Ref.	Title
1	DLMS UA 1000-2 Ed. 10: 31 August 2020	DLMS/COSEM Architecture and Protocols, the —Green Book
2	DLMS UA 1000-1 Ed. 14: 31 August 2020	COSEM Identification System and Interface Classes, the —Blue Book
3	IEC 62056-21 Ed. 1.0:2002	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange
4	IEC 62056-46 Ed. 1.1:2007	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol
5	IEC 62056-53 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM Application layer
6	IEC 62056-61 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 61: Object identification system (OBIS)
7	IEC 62056-62 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface classes

Table: references

3 Abbreviations

Abbreviation	Description
AEM	Advanced Electricity Meter
MDMS	Meter Data Management System
HES	Head End System
DCU	Data Concentrator Unit
HHU	Hand-Held Unit
DLMS	Device Language Message Specification
COSEM	Companion Specification for Electricity Metering
OBIS	Object Identification System
IC	Invocation Counter
G3-PLC	G3-PLC supporting IPv6
HDLC	High-level Data Link Control
HLS	High Level Security
APDU	Application Layer Protocol Data Unit
RLRQ	A-Release Request – an APDU of the ACSE
LTE	Long Term Evolution
SAP	Service Access Point

Table :Abbreviations

4 System and Interface Architecture

The following chart illustrates the components and interface of the AMI system.

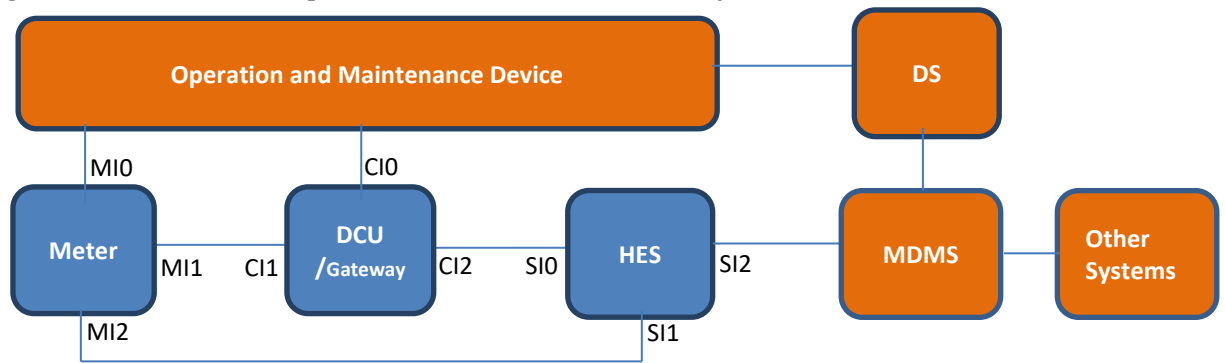


Figure 2: System and Interface Architecture

The AMI system includes:

- 1) **HES system: Head-End System.** The HES consists of SI0 interface to DCU, SI1 interface to electricity meter, and SI2 interface to MDMS.
- 2) **MDMS: Meter Data Management System.**
- 3) **DCU or Gateway: Data Concentrator Unit or Gateway.** DCU is used to collect and manage the information from meters, and send the information to the HES system. It also transfers the request from HES to the meters, and transfers the response from meter to HES. Gateway does not store the data from meter or HES, which is different from DCU. DCU/Gateway has a CI0 interface for local maintenance, a CI1 interface to meters, a CI2 interface to HES system. The CI0 interface can be optical port or RS-232 serial port, or Ethernet. The CI1 interface can be PLC, or RF interface, or RS-485 interface. CI2 interface can be GPRS/3G/4G, or Ethernet.
- 4) **Meter: Electricity meter.** It has MI0 interface for local maintenance, MI1 interface to DCU, MI2 interface to HES. MI0 interface is optical port. MI1 interface is PLC or RF port or RS-485. MI2 interface is GPRS/3G/4G, or NB-IoT/CAT-M, or Ethernet port. The meter normally only equips with one physical MI1 to DCU, or MI2 interface to HES.
- 5) **Operation and maintenance device:** It is a local maintenance device for accessing and operating meter and DCU. In general, it is a Hand-Held Unit.
- 6) **DS: Deployment System.**

4.1 Interfaces Specifications of Electricity Meter

4.1.1 Optical Interface (MI0)

The MI0 interface is based on IEC 62056-46 direct HDLC profile. The baud rate shall be at least 9600 bps. All read-out procedures need to be compliant to DLMS / COSEM. It is used for local communication.

4.1.2 LAN– DCU Interface(MI1)

The MI1 interface is used to communicate with DCU, it can be:

- 1) G3-PLC interface, with TCP-IP profile
- 2) RF interface, LoRa with HDLC profile, Wi-SUN with TCP-IP profile
- 3) RS-485, with IEC 62056-46 direct HDLC profile

4.1.3 WAN– HES Interface(MI2)

The MI2 interface is used to directly communicate with HES. Normally, it is cellular communication, i.e. GPRS/3G/4G/NB-IoT/CAT-M. The MI2 interface is based on the DLMS/COSEM TCP/IP profile.

4.1.4 Parallel Association

Each communication interface of meter shall support the separate association at the same time. Communication on one interface shall not impact the communication on other interfaces.

4.2 Client/Server Architecture

The meter acts as a DLMS sever. It supports 5 association clients:

- 1) **Public client.** According to DLMS/COSEM specification, the Public client is used to read the meter's general information (e.g. logical device name, invocation counter) to reveal the structure of the meter. It is not allowed to read metering data and set the meter parameters. It has lowest level security (no security).
- 2) **Readout client.** The Read client is used to read the data and parameters from the meters. It can't set the meter parameters, and can't control the meter.
- 3) **Maintenance client.** Except to read the data and parameters as that of Read client, the Maintenance client is allowed to set the parameters and control the objects in the meters and execute the firmware upgrade.
- 4) **Management client.** The management client has the highest access security, it supports to read meter, set parameters, control the meter, execute the firmware upgrade.
- 5) **Pre-established client.** The client is mainly used for event push.

The following table describes the features of each client.

Client Name	SAP	Service	Security level	Release
Public client	016	- Block-transfer-with-get - Get - Selective Access	Lowest Level Security	- RLRQ service - Closing or losing transport layer connection - A power-down will automatically close the association
Readout client	002	- Block-transfer-with-get - Get - Get-with-list - Selective Access - Action	- HLS 5 GMAC - Security suite 0	
Maintenance client	006	- Block-transfer-with-get - Block-transfer-with-set - Get - Multiple reference - Set - Selective Access - Action - General-protection	- HLS 5 GMAC - Security suite 0	
Management client	001	- Block-transfer-with-get - Block-transfer-with-set - Get - Set - Multiple reference elective Access - Action - General-protection	- HLS 5 GMAC - Security suite 0	
Pre-established client	102	- Block-transfer-with-get - Block-transfer-with-set - Get - Set - Multiple reference - Selective Access - Action - Event notification - General-protection	Pre-established	

5 DLMS/COSEM Application Layer

5.1 APDU Size

For the MI2 (WAN-HES) interface, the APDU size of receiving and transmission shall be at least 256 bytes and negotiable. This means no segmentation from negotiated size of message shall occur in application layer. If a message is negotiated with size of 1024 bytes, it should be transferred only with size of 1024 byte.

5.2 Security Features

5.2.1 Security Algorithm

The meter uses DLMS security suite 0. The following objects are required for the management of security:

Object / Attribute Name	Class	Ver.	OBIS code
Association LN - Current Client Association	15	3	0-0:40.0.0.255
Association LN - Public Client	15	3	0-0:40.0.1.255
Association LN - Readout Client	15	3	0-0:40.0.2.255
Association LN - Management Client	15	3	0-0:40.0.3.255
Association LN - Maintenance Client	15	3	0-0:40.0.5.255
Association LN - Pre-established Client	15	3	0-0:40.0.6.255
Current Security setups	64	1	0-0:43.0.0.255
Security setup - Readout Client	64	1	0-0:43.0.2.255
Security setup - Management Client	64	1	0-0:43.0.3.255
Security setup - Maintenance Client	64	1	0-0:43.0.5.255
Security setup - Pre-established Client	64	1	0-0:43.0.6.255

Table:
security
objects

Association LN - Current Client Association

This object contains the information of the current association.

Association LN - Public Client/ Read Client/ Maintenance Client/ Management Client/ Pre-established Client

The Association LN objects support the association management of the individual client. The most important information in the association is the object list, through which the client is able to download the whole set of the object model supported by the meter including the access right of each attribute and method.

Security Setup

The management client is the highest authority within the DLMS server.

For the other clients, individual security setup objects exist that allow the management client to change the settings and keys for these clients.

The keys except dedicated key can be changed via the “key_transfer” method of “Security Setup”.

5.2.2 Security policy

The security policy can be combination of the following options (“Security setup” version 1):

Bit0 - unused

Bit1 –unused

Bit2 - authenticated request

Bit3 - encrypted request

Bit4 –unused

Bit5 - authenticated response

Bit6 - encrypted response

Bit7 - unused

5.2.3 Usage of Keys

Depending on the security policy set and the individual access right definition of the attributes and methods, the following keys will be used according to their security context:

- 1) Global unicast encryption key (EK)
- 2) Global authentication key (AK)
- 3) Global broadcast encryption key (BK)
- 4) Master key (KEK)
- 5) Dedicated Key

The meters must accept a single AA established with or without a dedicated key.

When the keys are changed, the AES key wrap algorithm is used. This algorithm is using the master key to encrypt the key that is being changed.

The lifetime of the Global Keys of each security context is limited by the range of the associated Invocation Counters. A global key may be a unicast encryption key (EK), a broadcast encryption key (BK) or an authentication key (AK);

Dedicated keys are valid during the lifetime of an association, i.e. the dedicated key is generated and taken in use with the opening of the association. The key is destroyed automatically by the server upon closing of the association.

5.2.4 Invocation Counter (IC)

For managing the corresponding frame counters, the following objects are required:

Object / Attribute Name	Class	Ver.	OBIS code
Rx frame counter - unicast key - Management Client	1	0	0-0:43.1.0.255
Rx frame counter - unicast key - Readout Client	1	0	0-0:43.1.2.255
Rx frame counter - unicast key - Maintenance Client	1	0	0-0:43.1.4.255

The actual IC value:

Data type: double-long-unsigned

The maximum values: 0xFFFFFFFF

Depending on the security policy set and the individual access right defined for the attributes and methods, the Global unicast Encryption Key (EK) or Global Authentication Key(AK) is used. When the EK is used per security context, the corresponding IC is incremented by 1 and stored in the non-volatile memory. The message will be discarded if the IC in the received message is smaller or equal to the IC in the previously received message.

- A new EK is changed, the corresponding IC are reset to 0.
- When the maximum value of the IC has been reached, any following invocation of the authenticated encryption function shall return an error and the IC shall not be incremented.
- Frame Counters used with dedicated keys are independent of the ICs used with global keys.
- ICs used with dedicated keys are reset to 0 when a new association is established .

6 LTE -WAN Interface

The DLMS TCP-UDP/IP based profile is used for the LTE WAN interface. It includes the protocol layers as follows:

- COSEM Application Layer;
- COSEM TCP-UDP Wrapper Layer;
- TCP/UDP Transport Layer;
- Internet Protocol (IPv4/IPv6) Network Layer;
- IPv4/IPv6 Supporting Data Link Layer;
- Physical Layer;

COSEM application layer (and COSEM Clients/Logical Device) uses the services of TCP or UDP Transport layers via COSEM Wrapper sub-layer. The Transport layer (TCP or UDP) and COSEM wrapper together is called COSEM Transport layer. The meter shall support both TCP and UDP transport layer.

The following objects are supported:

Capture Objects	Class	Ver.	OBIS code
Module chip version	1	0	0-1:94.31.0.255
Module IMEI	1	0	0-1:94.31.2.255
SIM card IMSI	1	0	0-1:94.31.3.255
SIM card ICCID	1	0	0-1:94.31.4.255
Module RSRP	1	0	0-1:94.31.7.255
Module RSRQ	1	0	0-1:94.31.8.255
Module RSSI	1	0	0-1:94.31.9.255
Module SNR	1	0	0-1:94.31.10.255
Module PCI	1	0	0-1:94.31.11.255
Module FOTA HTTP URL	1	0	0-1:94.31.22.255
Module FOTA upgrade status	1	0	0-1:94.31.24.255
Module FOTA script enable	9	0	0-2:10.0.1.255
Auto Connect	29	2	0-0:2.1.0.255
TCP-UDP Setup	41	0	0-0:25.0.0.255
IPv4 Setup	42	0	0-0:25.1.0.255
PPP setup	44	1	0-0:25.3.0.255
Modem setup	45	0	0-0:25.4.0.255
IPv6 Setup	48	0	0-0:25.7.0.255

Table: Communication objects

6.1 Basic information

Module chip version

The LTE module chipset firmware version.

Module IMEI

International Mobile Equipment Identity.

SIM card IMSI

International Mobile Subscriber Identity.

SIM card ICCID

Integrate Circuit Card Identity.

Module RSRP

Reference Signal Receiving Power

RSRP is a key parameter representing the wireless signal strength, reflecting the path loss strength of the current channel, which is used for cell coverage measurement and cell selection / reselection.

RSRP value range: - 44 ~ - 156dbm, the larger the value, the better.

Module RSRQ

Reference Signal Received Quality.

RSRQ refers to the signal-to-noise ratio and interference level of the current channel quality. It is not only related to the re power of RS, but also related to the re power of user data, and the interference of adjacent areas. Therefore, RSRQ changes with the network load and interference. The larger the network load, the greater the interference, and the smaller the RSRQ measurement value.

The value range of RSRQ is: - 3 ~ - 19.5, the larger the value is, the better.

Module RSSI

Received Signal Strength Indicator

Module SNR

Signal Noise Ratio

The ratio of signal power to noise power, the greater the ratio, the better.

Module PCI

The physical cell ID of the service cell, range: 0-503.

Module FOTA HTTP URL

Module firmware upgrade HTTP server address, used to module download the firmware upgrade packet.

Module FOTA upgrade status

Module firmware upgrade status, indicate the schedule for upgrade.

Module FOTA script enable

Module upgrade script, used to trigger the download and upgrade process.

6.2 Network Connecting Mechanisms**Auto Connect**

The LTEs communication module should be always online. Meters shall support mode 101 and 105.

Mode 101 is Always-On mode. In this mode, meter will work as server and wait for remote connection.

Mode 105 is connected mode. In this mode, meter will auto connect HES for first connection and keep alive the TCP connection.

6.3 Communication Configuration Information

To establish communication and exchange data between parties (COSEM Client and Server), all layers shall be configured. In this section, the parameters to configure each layer are presented.

TCP-UDP Setup (Transport Layer Configuration)

The following parameters are considered in TCP-UDP Setup objects to configure transport layer:

- TCP-UDP Port Number: to distinguish between different Applications in each physical device (COSEM client or server), an additional addressing is provided inside the device at transport layer. Both TCP and UDP handle this

addressing capability at the Transport layer. This is called Port. Each Application in physical device has its own TCP-UDP port number. The 4059 port numbers have been considered for DLMS/COSEM.

- Related IP Setup Object: As mentioned, an instance of TCP-UDP and IPv4/IPv6 Setup objects shall be considered for each data link layer is supported by physical device.
The IP reference is 0.0.25.1.0.255 means use IPv4 setup(default).
The IP reference is 0.0.25.7.0.255 means use IPv6 setup.
- Maximum Segment Size: the default value is 1280.
- Maximum Number of Simultaneous Connections: This parameter specifies the maximum number of simultaneous connection supported by COSEM TCP-UDP based transport layer.
- TCP Timeout: This parameter defines the time (in seconds) over which, if no frame is received from the COSEM client, the TCP connection shall be aborted. The default value is "300" seconds.

The "0" value means a TCP connection, once established, will never be aborted by the COSEM server in normal condition (no power failure and so on). This parameter can be changed by HES during operation.

IPv4 Setup (Network Layer Configuration)

The object is considered to configure the network layer and get the ipv4 address.

PPP Setup (Data Link Layer Configuration)

The object is considered to configure the network authentication, PAP authentication, CHAP authentication or no authentication(default), and store the username and password for PAP or CHAP.

LTE Modem Setup (Physical Layer Configuration)

The following parameters are included in this COSEM object:

- APN;
- PIN Code;
- Quality of Service;

The initial values of these parameters should be set before first installation.

IPv6 Setup (Network Layer Configuration)

The object is considered to configure the network layer and get the ipv6 address.

7 G3-PLC LAN Interface

The DLMS/COSEM communication via the LAN interface is based on UDP over the IPV6 stack in combination with the G3-PLC transport layer.

7.1 UDP Transport Layer Settings

This section focuses on the use of the UDP protocol within the G3-PLC metering profile.

7.2 UDP Port Numbering

The DLMS/COSEM application has an interface with UDP transport layer. In the G3-PLC metering profile the UDP ports for the DLMS/COSEM application layer shall be chosen between 61616 and 61631 to benefit from the best compression of 6LoWPAN adaptation layer.

7.3 UDP Header Compression

UDP header compression shall be conformant with G3-PLC Specification.

7.4 ICMPv6 Requirements

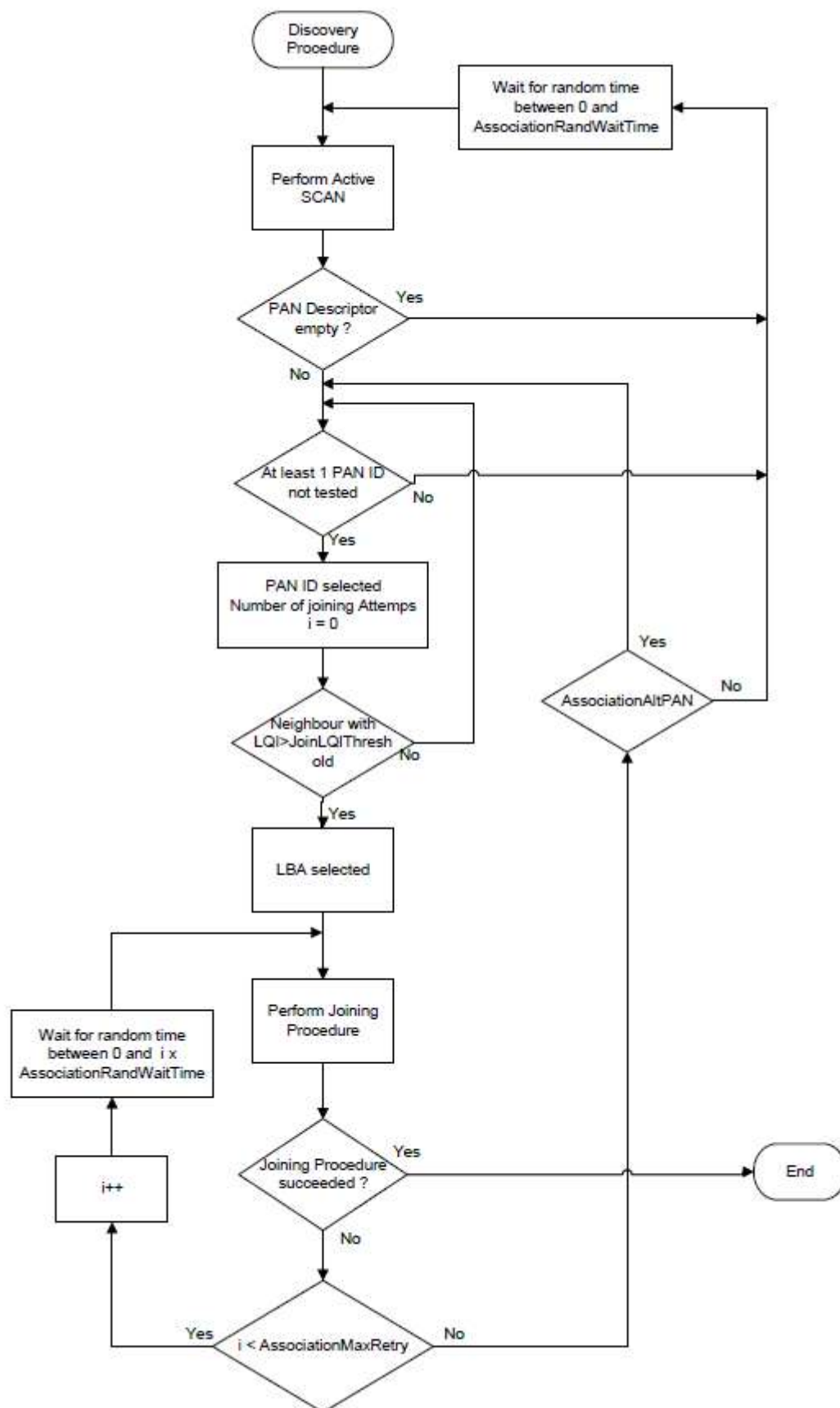
The implementation of ICMPv6 is mandatory for all G3-PLC devices for ping functionality use.

In current scope, “Echo Request Message” and “Echo Reply Message” is mandatory to be implement while others are optional. An “Echo Reply” should be sent in response to an Echo Request message sent to an IPv6 unicast address and not to a multicast address.

7.5 Bootstrapping and Keep-Alive

A standard PAN-Device’s bootstrapping shall start from a discovery procedure. After the discovery procedure, the PAN descriptor list is available. First of all, the PAN chosen shall give preference to the one which have succeed joining and application communication in last bootstrapping. If it is not available, choose the one among the neighbours providing the best link quality (LQI) with the local node. Once the PAN is identified, the LBA chosen is the node providing the lowest route cost toward the PAN-selected coordinator, including the link cost toward the LBA chosen. The route cost computation is similar to a standard route discovery. Based on all beacons received during the active scan, the node computes the link cost toward each possible LBA according to the metric in use, and adds it to the RC_COORD received in the beacon. The node shall set the Weak Link Count to 1 in case the LQI of the link to the LBA is below adp Weak LQI Value. Similar to the G3-PLC protocol, the best route is defined by the lowest route cost among the lowest number of Weak Link computed. This way, the node is able to select the LBA providing the best route toward the coordinator. Note that LBA is not selected if its LQI with the local node is below Join LQI Threshold.

The following algorithm shall be applied for a device to join a PAN:



A route discovery process shall be performed immediately after joining procedure succeeded.

The ID-P used in bootstrapping process shall be set as electrical meter's DLMS/COSEM logical device name.

When a device is operating within a PAN, a keep alive mechanism shall be supported in order to maintain the device's association with the aforementioned PAN.

Each G3-PLC PAN-device shall implement a timer with a PLC Time Out period. When this timer expired, PAN-Device shall generate ADPM-NETWORK-LEAVE .request to return to non-association state and perform bootstrapping immediately.

These messages:

- Path Request (6LoWPAN level),
 - ICMP Echo Request, ICMP Echo Reply (IP level),
 - OPEN request, RELEASE request, GET request, SET request, ACTION request etc. (COSEM level),
- when sent in unicast by the PAN coordinator shall reset the PLCG3TimeOut timer.

Before the device's G3-PLC timeout expires, precisely after a duration indicated by Keep Alive Start Time, PAN-Device also could send periodic ICMP Echo requests intended for the PAN coordinator at a rate provided by the Keep Alive Send Period parameter. This mechanism may be disabled in setting the Keep Alive Enable parameter to FALSE.

7.6 UDP/IP Profile

The DLMS COSEM application connects to the TCP/IP or UDP/IP layer using an additional sublayer called the DLMS/COSEM wrapper. The G3-PLC module must support the DLMS/COSEM wrapper's payload up to 1224 bytes.

The UDP/IP channel is configured and managed via the following COSEM objects:

Object / Attribute Name	Class	Ver	OBIS code
TCP-UDP setup	41	0	0-0:25.0.0.255
IPv6 setup	48	0	0-0:25.7.0.255

The UDP client port number used by the "COSEM Client Application Layer" should be set between 61617 (0xF0B1) and 61631 (0xF0BF) as recommendation.

The UDP server port number used by the "COSEM Server Application Layer" shall be set 61616 (0xF0B0) by default.

The following table summarizes the recommended UDP port numbers for the DLMS/COSEM metering application:

Application	Server UDP ports		Client UDP ports	
	Ports applying for packets emitted by the server to the client		Ports applying for packets emitted by the client to the server	
	Source	Destination	Source	Destination
DLMS/COSEM Pull Service	61616	61616~61629	61617~61629	61616
DLMS/COSEM Push Service	61616	61631	N/A	N/A

Note: the destination port must be 61631 when DLMS/COSEM service used.

7.7 G3-PLC Network Management

The G3 channel is configured and managed via the following COSEM objects:

Object / Attribute Name	Class	Ver	OBIS code
MAC Address Setup	43	0	0-0:25.2.0.255
G3-PLC 6LoWPAN adaptation layer setup	92	2	0-0:29.2.0.255
G3-PLC MAC setup	91	2	0-0:29.1.0.255
G3-PLC MAC layer counters	90	1	0-0:29.0.0.255
G3-PLC Band Plan	1	0	0-0:94.43.128.255
G3-PLC PSK_KEK	1	0	0-0:94.43.133.255
G3-PLC PSK	1	0	0-0:94.33.128.255
G3-PLC Timeout	1	0	0-0:94.33.10.255
G3-PLC Keep Alive	1	0	0-0:94.33.11.255
G3-PLC Mac Coherent Transmission	1	0	0-0:94.33.12.255
G3-PLC Mac Device Table	1	0	0-0:94.33.13.255
G3-PLC Adp LBP Association Setup	1	0	0-0:94.33.14.255
G3-PLC RREP Wait	1	0	0-0:94.33.15.255
G3-PLC LQI Range	1	0	0-0:94.33.16.255

MAC Address Setup

The MAC address setup holds the EUI-64 address of the G3-PLC Modem.

G3-PLC 6LoWPAN adaptation layer setup

This object holds the necessary parameters to set up the 6LoWPAN adaptation sub-layer and provides access to information settings and tables that might be necessary for the network management. Refer to DLMS Blue Book Edition 14.

G3-PLC MAC setup

This object holds the necessary parameters to set up the MAC IEEE 802.15.4 sub-layer and provides access to information settings and tables that might be necessary for the network management. Refer to DLMS Blue Book Edition 14.

G3-PLC MAC layer counters

This object stores the counters relating to exchanges between PHY and MAC. The purpose of these counters is to provide statistical information for maintenance.

Note: when a counter reaches its maximum value (0xFFFFFFFF), it is automatically reset.

G3-PLC Band Plan

This object allows the identification of the current band plan in use.

The supported band plans are

0 = CENELEC-A band

3 = FCC band

If band switch is available through this object, once the configuration change, the module returns to the non-associated state and re-starts its joining process for the reconnection to the PAN coordinator.

G3-PLC PSK_KEK

This object allows changing the PSK Key Encryption Key (128 bits / 16 octets) of the meter.

The new PSK_KEK is wrapped by the AES-128 key wrap algorithm, using the current PSK_KEK as the wrapping key.

G3-PLC PSK

This object allows changing the PSK (128 bits / 16 octets) of the G3-PLC module.

The new PSK is wrapped by the AES-128 key wrap algorithm, using the dedicated PSK KEK as the wrapping key. After the successful change of the PSK (confirmation to the DLMS client), the meter returns to the non-associated state and re-starts its joining process for the reconnection to the PAN coordinator.

G3-PLC Timeout

This data defines the time, in minutes, after which a meter that has not been individually addressed (meaning the meter has not received any Path Discovery message, ICMP ping, nor unicast DLMS APDU) returns to the non-associated state and loses its PAN coordinator. A value equal to 0 is equivalent to cancel the use of the related timeout-not-addressed counter.

G3-PLC Keep Alive

This object defines the parameters used by the “keep alive” mechanism.

KeepAlive ::= structure

```
{
keep_alive_enable: boolean
keep_alive_start_time: long-unsigned
keep_alive_send_period: unsigned
}
```

G3-PLC Mac Coherent Transmission

This object indicates the specific modulation scheme to set in the tone map response.

0 = only differential modulation scheme shall be set in tone map response

1 = only coherent modulations scheme shall be set in tone map response

2 = Either coherent or differential scheme may be set in tone map response.

G3-PLC Mac Device Table

This object describes a table of Device-Descriptor entries.

array Device Descriptor Entry

Device DescriptorEntry ::= structure

```
{
Pan_id: long-unsigned
Short_address: long-unsigned
Frame_counter: double-long-unsigned
}
```

G3-PLC Adp LBP Association Setup

This attributes contains parameters for Bootstrapping procedure setup.

Adp LBP Association Setup ::= structure

```
{
Association Max Retry: unsigned
Association Rand Wait Time :unsigned
Association AlterPAN: boolean
Join LQI Threshold: unsigned
Active ScanDuration: unsigned
}
```

G3-PLC RREP Wait

This object defines the delay for an RREP frame to wait in seconds before being generated after either the arrival of the first RREQ or the transmission of the latest RREP.

G3-PLC LQI Range

The LQI range defines the lower and higher LQI value used for the metric computation.

LQI Range ::= structure

```
{
    adp_low_lqi_value:    unsigned
    adp_high_lqi_value:   unsigned
}
```

8 Device Identification

According to the DLMS/COSEM requirements and to provide the interoperability in whole system, each physical device in system shall be uniquely identified. Each physical device is identified by following designations in system:

- The System Title will be assigned to each physical device during manufacturing stage and based on manufacturer FLAG code, device type and product serial number. It is used as physical device unique ID in all communications in system.
- The Logical Device Name is another format of the system title. The Logical Device Name will be stored in “COSEM Logical Device Name” COSEM object (0-0:42.0.0.255) during manufacturing stage.
- Utility Device ID is the unique device ID designated by utility and stored in the meter during the manufacturing stage. A related barcode will be presented in the meter nameplate.

8.1 System Title

Each physical device (meter) shall be uniquely identified by its “System Title”. The “System Title” shall be constructed as follows according to DLMS/COSEM definition:

Byte 1	Byte 2	Byte 3	Byte 4	Byte5	Byte 6	Byte 7	Byte 8
MFG_ID			DT	FT	MSN		

MFG_ID: Manufacturer ID (three letters flag) defined by DLMS UA, as ASCII (bytes 1, 2, 3).

DT (Device Type):

100	1P Meter
101	3P Direct connection meter
093	3P CT connection meter
097	3P CT/PT connection meter

FT(Function Type, 4 bits) Function type shows whether device supports disconnecter, load management and multi-utility meter or not. Function Type(FT) for HES and DCU/Gateway is 0. The bits arrangement is as follow:

- bit0: Disconnector exists or not
- bit1: Load Management exists or not
- bit2: Multi-utility meter is supported or not
- bit3: reserved for future use

Example:

Function Type for a meter with disconnector, load management features, without Multi-utility function will be 0011.

MSN: Manufacturer specific serial number (the next 28 bits, half of byte5 and bytes 6, 7, 8);

Note: These 28 bits can be derived from the last seven digits of the manufacturing serial number, up to 9 999 999 (equal to 0x98967F).

8.2 COSEM Logical Device Name

Each COSEM logical device can be identified by its unique **COSEM logical device name** (0-0:42.0.0.255). The logical device name is defined as an octet-string of up to 16 octets (bytes). The first three octets shall carry the manufacturer identifier (administered by the DLMS User Association). The logical device name structure is shown in the following figure.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
MFG_ID			DT			FT	
Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16
MSN							

MFG_ID: Manufacturer ID (three letters flag) defined by DLMS UA, as ASCII (bytes 1, 2, 3).

DT: Device Type defined in System Title, as ASCII

FT: Function Type defined in System Title, as ASCII

MSN: The last 8 digits of the manufacturer specific serial number, as ASCII

8.3 Utility Device ID

The Utility Device ID (and corresponding barcode according to Code 128 Barcode) shall be printed on meter body. The Utility Device ID is defined by utility per project.

The different identifiers of each device are presented as device ID. Each device ID is stored in a dedicated COSEM object from interface class. The device IDs that have been used are as following table:

Object / Attribute Name	Class	Ver.	OBIS code
Device ID 1: Serial number	1	0	0-0:96.1.0.255

Table: Device IDs

9 Energy Registers

The meter stores the corresponding energy or demand registers.

9.1 Total Energy Registers

The energy consumption will be accumulated in below registers:

Object / Attribute Name	Class	Ver.	OBIS code
Active energy import (+A)	3	0	1-0:1.8.0.255
Active energy export (-A)	3	0	1-0:2.8.0.255
Reactive energy import (+R)	3	0	1-0:3.8.0.255
Reactive energy export (-R)	3	0	1-0:4.8.0.255
Reactive energy for quadrant 1	3	0	1-0:5.8.0.255
Reactive energy for quadrant 2	3	0	1-0:6.8.0.255
Reactive energy for quadrant 3	3	0	1-0:7.8.0.255
Reactive energy for quadrant 4	3	0	1-0:8.8.0.255

Table: Total energy

For single-phase meter, the detection of neutral line current shall be supported. When the current of neutral line is greater than the current of phase line, which means that tamper probably have occurred at this time. In order to reduce the measurement loss, the meter shall use the current of the neutral line to accumulate energy.

9.2 TOU Energy Registers

The related tariff energy registers should be supported:

Object / Attribute Name	Class	Ver.	OBIS code
Active energy import (+A) tariff x	3	0	1-0:1.8.x.255
Active energy export (-A) tariff x	3	0	1-0:2.8.x.255
Reactive energy import (+R) tariff x	3	0	1-0:3.8.x.255
Reactive energy export (-R) tariff x	3	0	1-0:4.8.x.255

Table: TOU energy registers

Note: x = 1~4, for tariff 1~4

10 Demand Registers

10.1 Demand Registers

The “Demand register” objects measure average value of power during a period. The following demand registers should be supported:

Object / Attribute Name	Class	Ver.	OBIS code
Demand active import (+P)	5	0	1-0:1.4.0.255
Demand active export (-P)	5	0	1-0:2.4.0.255
Demand reactive import (+Q)	5	0	1-0:3.4.0.255
Demand reactive export (-Q)	5	0	1-0:4.4.0.255
Maximum demand active import (+P)	4	0	1-0:1.6.0.255
Maximum demand active export (-P)	4	0	1-0:2.6.0.255
Maximum demand reactive import (+Q)	4	0	1-0:3.6.0.255
Maximum demand reactive export (-Q)	4	0	1-0:4.6.0.255

Table: Demand Registers

The Maximum Demand Registers are reset when the meter executes billing.

10.2 TOU Demand Registers

Related tariff demand objects should be supported as below:

Object / Attribute Name	Class	Ver.	OBIS code
Maximum demand active import (+P) tariff x	4	0	1-0:1.6.x.255
Maximum demand active export (-P) tariff x	4	0	1-0:2.6.x.255
Maximum demand reactive import (+Q) tariff x	4	0	1-0:3.6.x.255
Maximum demand reactive export (-Q) tariff x	4	0	1-0:4.6.x.255

Table: Demand Registers

Note: x = 1~4, for tariff 1~4

10.3 Cumulative Maximum Demand Registers

The cumulative maximum demand stores the sums of the corresponding maximum demand register value in all completed billing periods since the beginning of the measurement.

Object / Attribute Name	Class	Ver.	OBIS code
Cumulative Maximum demand active import (+P)	3	0	1-0:1.2.0.255
Cumulative Maximum demand active export (-P)	3	0	1-0:2.2.0.255
Cumulative Maximum demand reactive import (+Q)	3	0	1-0:3.2.0.255
Cumulative Maximum demand reactive export (-Q)	3	0	1-0:4.2.0.255
Cumulative Maximum demand active import (+P) tariff x	3	0	1-0:1.2.x.255
Cumulative Maximum demand active export (-P) tariff x	3	0	1-0:2.2.x.255
Cumulative Maximum demand reactive import (+Q) tariff x	3	0	1-0:3.2.x.255
Cumulative Maximum demand reactive export (-Q) tariff x	3	0	1-0:4.2.x.255

Note: x = 1~4, for tariff 1~4

11 Power Quality

11.1 Instantaneous Parameters

The meter supports the following instantaneous parameters. These parameters are updated every second.

No.	Default Capture Objects
1	Time stamp
2	Power quality load profile status
3	Average voltage L1
4	Maximum voltage L1
5	Minimum voltage L1
6	Average current L1
7	Average value of power factor

Table: Instantaneous Parameter

11.2 Export energy function

The meter support “Export Energy” measurement and relevant functions for solar power and generator application, this function can be switched ON or switched OFF by command from system remotely or configure locally. “Export Energy” function is switched OFF as default.

When the reverse current is detected, the current reverse event will be logged.

When the “Export Energy” function is switched OFF, if current reverse condition occurs, the reverse current and duration time over a certain threshold which can be configured, an additional action will be performed:

- Disconnect the relay
- Event “Local disconnection due to current reverse” will be logged
- The bit 5 “Current reverse” will be set in the Tamper status word
- The LCD displays “OFF-REV”

The meter relay will reconnect when current reverse condition removed and a tamper reset command send from the HES or hand-held device. Or

The “Export Energy” is switched ON remotely or locally, the tamper will be reset automatically and the relay will be reconnected.

Export energy function is supported by the following objects:

Object / Attribute Name	Class	Ver.	OBIS code
Threshold for current reverse	3	0	1-0:11.35.3.255
Time threshold for current reverse	3	0	1-0:11.44.0.255
Export energy function enable	1	0	1-0:96.0.160.255

12 Calendar and Tariff Management

Object / Attribute Name	Class	Ver.	OBIS code
Activity calendar	20	0	0-0:13.0.0.255
Current active tariff	1	0	0-0:96.14.0.255
Special days table	11	0	0-0:11.0.0.255
Tariffication script table	9	0	0-0:10.0.100.255
Register activation – Energy	6	0	0-0:14.0.1.255
Register activation – Maximum Demand	6	0	0-0:14.0.2.255

Activity calendar

The activity calendar must support at least:

- season_profile => at least 4 seasons
- week_profile_table => at least 4 entries
- day_profile_table => at least 4 entries
- day_profile => up to 24 switching times per day

Special days table

Special days table must support up to 50 entries.

Tariffication script table

The tariffication script table supports up to 4 switching scripts.

Script identifier	Action
1	Tariff 1 are activated
2	Tariff 2 are activated
3	Tariff 3 are activated
4	Tariff 4 are activated

Current active tariff

This object is used for reading the current tariff in use.

Note: when time is invalid, the meter will use the default tariff T1.

13 Clock Synchronization

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Clock	8	0	0-0:1.0.0.255
Local Time	1	0	1-0:0.9.1.255
Local Date	1	0	1-0:0.9.2.255

Table: clock objects

Clock

The standard time zone has 300 minutes deviation from the UTC time.

Clock status:

Bit #	Status
0	invalid value
1	doubtful value
2	Reserved
3	invalid clock status
4	Reserved
5	Reserved
6	Reserved
7	daylight saving active

Synchronization Scheme with DCU

The meter shall support broadcast clock synchronization via the DCU, the broadcast synchronization features the following condition:

- 1) The meter is only allowed to receive 3 broadcast clock synchronization within one day.
- 2) The meter only accepts clock synchronization with a clock deviation within 10s to 10min, when clock deviation is less than 10s, the meter will reject the synchronization; when clock deviation is greater than 10 minutes, the meter will also reject the synchronization, and log and push the event “Clock Out Of Tolerance” to the HES. In the case, the HES needs to synchronize the meter clock point-to-point.
- 3) If meter clock is already invalid, the clock synchronization with any time deviation will be accepted by the meter.

14 Billing

The meter records some specific values for billing purpose. The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Monthly Billing Profile	7	1	0-0:98.1.0.255
Billing period counter	1	0	0-0:0.1.0.255
End of billing period / MDI reset	22	0	0-0:15.0.0.255
End of billing period script table	9	0	0-0:10.0.1.255

Table: billing objects

14.1 Monthly Billing Data

Billing Profile

Billing capacity: 13 entries. (13 months).

Billing objects: The billing objects are in the following table.

Buffer encoding/reading: normal, clock with every entry.

Selective access: by range and by entry.

Sorted method: unsorted (FIFO).

The default capture objects of monthly billing:

Billing Objects	OBIS Code
Time stamp	0.0.1.0.0.255
Billing period counter	0.0.0.1.0.255
Active energy total (+A + -A)	1.0.15.8.0.255
Active energy total (+A + -A) T1	1.0.15.8.1.255
Active energy total (+A + -A) T2	1.0.15.8.2.255
Active energy total (+A + -A) T3	1.0.15.8.3.255
Active energy total (+A + -A) T4	1.0.15.8.4.255
Active energy import (+A)	1.0.1.8.0.255
Active energy import (+A) T1	1.0.1.8.1.255
Active energy import (+A) T2	1.0.1.8.2.255
Active energy import (+A) T3	1.0.1.8.3.255
Active energy import (+A) T4	1.0.1.8.4.255
Active energy export (-A)	1.0.2.8.0.255
Active energy export (-A) T1	1.0.2.8.1.255
Active energy export (-A) T2	1.0.2.8.2.255
Active energy export (-A) T3	1.0.2.8.3.255
Active energy export (-A) T4	1.0.2.8.4.255
Reactive energy total (+R + -R)	1.0.128.8.0.255
Reactive energy total (+R + -R) T1	1.0.128.8.1.255
Reactive energy total (+R + -R) T2	1.0.128.8.2.255
Reactive energy total (+R + -R) T3	1.0.128.8.3.255
Reactive energy total (+R + -R) T4	1.0.128.8.4.255
Reactive energy import(+R)	1.0.3.8.0.255
Reactive energy import(+R) T1	1.0.3.8.1.255
Reactive energy import(+R) T2	1.0.3.8.2.255
Reactive energy import(+R) T3	1.0.3.8.3.255
Reactive energy import(+R) T4	1.0.3.8.4.255
Reactive energy export (-R)	1.0.4.8.0.255
Reactive energy export (-R) T1	1.0.4.8.1.255
Reactive energy export (-R) T2	1.0.4.8.2.255
Reactive energy export (-R) T3	1.0.4.8.3.255
Reactive energy export (-R) T4	1.0.4.8.4.255
Maximum Demand Active total (+P + -P)	1.0.15.6.0.255
Maximum Demand Active total (+P + -P)-Capture Time	1.0.15.6.0.255
Maximum Demand Active total (+P + -P) T1	1.0.15.6.1.255
Maximum Demand Active total (+P + -P)-Capture Time T1	1.0.15.6.1.255
Maximum Demand Active total (+P + -P) T2	1.0.15.6.2.255

Maximum Demand Active total (+P + -P)-Capture Time T2	1.0.15.6.2.255
Maximum Demand Active total (+P + -P) T3	1.0.15.6.3.255
Maximum Demand Active total (+P + -P)-Capture Time T3	1.0.15.6.3.255
Maximum Demand Active total (+P + -P) T4	1.0.15.6.4.255
Maximum Demand Active total (+P + -P)-Capture Time T4	1.0.15.6.4.255
Maximum Demand Active import (+P)	1.0.1.6.0.255
Maximum Demand Active import (+P) capture time	1.0.1.6.0.255
Maximum Demand Active import (+P) T1	1.0.1.6.1.255
Maximum Demand Active import (+P) T1 capture time	1.0.1.6.1.255
Maximum Demand Active import (+P) T2	1.0.1.6.2.255
Maximum Demand Active import (+P) T2 capture time	1.0.1.6.2.255
Maximum Demand Active import (+P) T3	1.0.1.6.3.255
Maximum Demand Active import (+P) T3 capture time	1.0.1.6.3.255
Maximum Demand Active import (+P) T4	1.0.1.6.4.255
Maximum Demand Active import (+P) T4 capture time	1.0.1.6.4.255
Maximum Demand Active export (-P)	1.0.2.6.0.255
Maximum Demand Active export (-P) capture time	1.0.2.6.0.255
Maximum Demand Active export (-P) T1	1.0.2.6.1.255
Maximum Demand Active export (-P) T1 capture time	1.0.2.6.1.255
Maximum Demand Active export (-P) T2	1.0.2.6.2.255
Maximum Demand Active export (-P) T2 capture time	1.0.2.6.2.255
Maximum Demand Active export (-P) T3	1.0.2.6.3.255
Maximum Demand Active export (-P) T3 capture time	1.0.2.6.3.255
Maximum Demand Active export (-P) T4	1.0.2.6.4.255
Maximum Demand Active export (-P) T4 capture time	1.0.2.6.4.255
Cumulative Maximum Demand Active total (+P + -P)	1.0.15.2.0.255
Cumulative Maximum Demand Active total (+P + -P) T1	1.0.15.2.1.255
Cumulative Maximum Demand Active total (+P + -P) T2	1.0.15.2.2.255
Cumulative Maximum Demand Active total (+P + -P) T3	1.0.15.2.3.255
Cumulative Maximum Demand Active total (+P + -P) T4	1.0.15.2.4.255
Cumulative Maximum Demand Active import (+P) total	1.0.1.2.0.255
Cumulative Maximum Demand Active import (+P) T1	1.0.1.2.1.255
Cumulative Maximum Demand Active import (+P) T2	1.0.1.2.2.255
Cumulative Maximum Demand Active import (+P) T3	1.0.1.2.3.255
Cumulative Maximum Demand Active import (+P) T4	1.0.1.2.4.255
Cumulative Maximum Demand Active export (-P) total	1.0.2.2.0.255
Cumulative Maximum Demand Active export (-P) T1	1.0.2.2.1.255
Cumulative Maximum Demand Active export (-P) T2	1.0.2.2.2.255
Cumulative Maximum Demand Active export (-P) T3	1.0.2.2.3.255
Cumulative Maximum Demand Active export (-P) T4	1.0.2.2.4.255
Average power factor of current month	1.0.13.24.128.255
*Available credit	0.0.19.0.0.255
*Charge energy of current month	1.0.140.129.1.255
*Current month consumption energy	1.0.140.129.2.255

Table: Monthly billing capture objects

- *Note:** 1. capture objects with symbol “*” are not present when meter is in post-payment mode, it will automatically be added to capture objects when meter switches to prepayment mode.
2. for CT, CTPT meter, capture objects with symbol “*” are not applicable.

Billing period counter

The object is used to record the number of monthly billing. It starts with 00 and increments with every historical reset. (First historical value identified with 01). This value will not reset to 00 even if the billing data is cleared.

End of billing period/ MDI reset

The billing date and time. The default value is 00:00:00 of the 1st day in every month

End of billing period script table

This object is used for billing and triggered on a regular basis by a scheduler (synchronously) and/or asynchronously by events:

- 1) When passive tariff is activated, the meter will trigger a billing.
- 2) Automatic billing based on the time specified in “**End of billing period/ MDI reset**” object.
- 3) By a remote or local billing command.
- 4) From post-payment mode to prepayment mode, and vice versa. *This is applicable only in SP and PPDC meter.*

15 Load Profiles

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Profile status – Energy load profile	1	0	0-0:96.10.1.255
Energy Load Profile	7	1	1-0:99.1.0.255
Profile status – Daily profile	1	0	0-0:96.10.2.255
Daily Load Profile	7	1	1-0:99.2.0.255
Profile status – Power quality profile	1	0	1.0.96.10.1.255
Power Quality Load Profile	7	1	1-0:99.14.0.255

Table: load profile

15.1 Energy Load Profile

Capacity:	240 days with 60 minutes (exactly 5760 entries)
Capture_period:	Configurable range: 5/10/15/30/60 minutes, default 60 minutes
Captured_objects:	Refer to the below table
Buffer encoding:	option 1: normal: clock with every entry option 2: compressed: if any element can be deducted from the previous buffer entry, then the type “null data” is used. for values: the same as the previous for clock: previous + capture period
Selective access:	by range and by entry
Sorted method:	unsorted (FIFO)

The default capture objects:

Capture Objects	OBIS code
Clock	0.0.1.0.0.255
Profile status– Energy load profile	0.0.96.10.1.255
Active energy total (+A + -A)	1.0.15.8.0.255
Active energy import (+A)	1.0.1.8.0.255
Active energy export (-A)	1.0.2.8.0.255
Reactive energy total (+R + -R)	1.0.128.8.0.255
Reactive energy import(+R)	1.0.3.8.0.255
Reactive energy export(-R)	1.0.4.8.0.255
Instantaneous status word	0.0.96.10.6.25

Table: energy profile capture objects

Note: registers related to “Reactive Energy” are not applicable in single-phase meter.

15.2 Daily Load Profile

Capacity:	31 days with 24 hours (exactly 31 entries)
Structure:	clock.time, profile_status, values
Capture_period:	24 hours
Captured_objects:	Refer to the below table
Buffer encoding:	option 1: normal: clock with every entry option 2: compressed: if any element can be deducted from the previous buffer entry, then the type “null data” is used. for values: the same as the previous for clock: previous + capture period
Selective access:	by range and by entry
Sorted method:	unsorted (FIFO)

The default capture objects:

Capture Objects	OBIS code
Clock	0.0.1.0.0.255
Profile status – Daily profile	0.0.96.10.2.255
Active energy total (+A + -A)	1.0.15.8.0.255
Active energy total (+A + -A) T1	1.0.15.8.1.255
Active energy total (+A + -A) T2	1.0.15.8.2.255
Active energy total (+A + -A) T3	1.0.15.8.3.255
Active energy total (+A + -A) T4	1.0.15.8.4.255
Active energy import (+A)	1.0.1.8.0.255
Active energy import (+A) T1	1.0.1.8.1.255
Active energy import (+A) T2	1.0.1.8.2.255
Active energy import (+A) T3	1.0.1.8.3.255
Active energy import (+A) T4	1.0.1.8.4.255
Active energy export (-A)	1.0.2.8.0.255
Active energy export (-A) T1	1.0.2.8.1.255
Active energy export (-A) T2	1.0.2.8.2.255
Active energy export (-A) T3	1.0.2.8.3.255
Active energy export (-A) T4	1.0.2.8.4.255

Reactive energy total (+R + -R)	1.0.128.8.0.255
Reactive energy total (+R + -R) T1	1.0.128.8.1.255
Reactive energy total (+R + -R) T2	1.0.128.8.2.255
Reactive energy total (+R + -R) T3	1.0.128.8.3.255
Reactive energy total (+R + -R) T4	1.0.128.8.4.255
Reactive energy import(+R)	1.0.3.8.0.255
Reactive energy import(+R) T1	1.0.3.8.1.255
Reactive energy import(+R) T2	1.0.3.8.2.255
Reactive energy import(+R) T3	1.0.3.8.3.255
Reactive energy import(+R) T4	1.0.3.8.4.255
Reactive energy export(-R)	1.0.4.8.0.255
Reactive energy export(-R) T1	1.0.4.8.1.255
Reactive energy export(-R) T2	1.0.4.8.2.255
Reactive energy export(-R) T3	1.0.4.8.3.255
Reactive energy export(-R) T4	1.0.4.8.4.255
Instantaneous status word	0.0.96.10.6.25
Maximum Demand Active total (+P + -P) (Daily Reset)	1.0.15.6.128.255 (attribute 2)
Maximum Demand Active total (+P + -P) capture time (Daily Reset)	1.0.15.6.128.255 (attribute 5)
Maximum Demand Active import(+P) (Daily Reset)	1.0.1.6.128.255 (attribute 2)
Maximum Demand Active import(+P) capture time (Daily Reset)	1.0.1.6.128.255 (attribute 5)
Maximum Demand Active export(-P) (Daily Reset)	1.0.2.6.128.255 (attribute 2)
Maximum Demand Active export(-P) capture time (Daily Reset)	1.0.2.6.128.255 (attribute 5)
*Available credit	0.0.19.0.0.255

Table: daily load profile capture objects

***Note:**

1. capture objects with symbol “*” are not present when meter is in post-payment mode, it will automatically be added to capture objects when meter switches to prepayment mode.
2. for CT, CTPT meter, capture objects with symbol “*” are not applicable.
3. registers related to “Reactive Energy” are not applicable in single-phase meter.

15.3 Load Profile Status

In all load profiles a simplified status code is used for every entry.

The Profile Status code has a size of 1 byte and it is shown in hexadecimal form.

The following table describes the state and the function of all bits:

Bit #	Description
Bit 7 PDN	Power down: This bit is set to indicate that a total power outage has been detected during the affected capture period.
Bit 6	Reserved: The reserved bit is always set to 0.
Bit 5 CAD	Clock adjusted: The bit is set when the clock has been adjusted by more than the synchronization limit.
Bit 4	Reserved
Bit 3 DST	Daylight saving: Indicates whether or not the daylight saving time is currently active. The bit is set if the daylight saving time is active (summer) and cleared during normal time (winter).
Bit 2 DNV	Data not valid: Indicates that the current entry may not be used for billing purposes without further validation because a special event has occurred.
Bit 1 CIV	Clock invalid: The power reserve of the calendar clock has been exhausted. The time is declared as invalid. At the same time the DNV bit is set.
Bit 0 ERR	Critical error: A serious error such as a hardware failure or a checksum error has occurred. If the ERR bit is set then also the DNV bit is set.

Table: profile status

15.4 Special Events

This section describes how different event affect the load profile. A 30 minutes period load profile will be used for the example.

15.4.1 Power Failure Over the Capture Period

In case of power failure (for three-phase meter, all phase power failure), the meter marks PDN = 1 in the load profile status of the affected periods. The periods without power for full period will not be added in the load profile.

For example, when meter power down at 2016-02-15 23:46:00, and power on at 2016-02-16 01:31:00:

[illegible]

15.4.2 Clock Setting

In case adjusting the clock backwards, the meter marks CAD = 1 in the load profile status of the affected periods. If the new clock is in different period from current period, the current period shall be ended with CAD = 1.

If clock is adjusted backwards, the old periods from the new clock will NOT be overwritten.

For example: adjust clock from 03:16:00 to 01:46:00. Profiles before adjusting clock:

[illegible]

16 Load Control Management

The meter can control the relay for the load management or the meter status. Disconnection and reconnection of the relay is supported by the following objects:

Object / Attribute Name	Class	Ver.	OBIS code
Disconnect control script table	9	0	0-0:10.0.106.255
Disconnect control	70	0	0-0:96.3.10.255
Contract power threshold	3	0	1-0:1.35.0.255
Activity calendar for Demand Control	20	0	0-0:13.0.4.255
Demand control script table	9	0	0-0:10.0.112.255
Active demand control threshold set	1	0	1.0.130.0.0.255
Passive demand control threshold set	1	0	1.0.130.0.1.255
Current active demand control threshold	3	0	1-0:1.35.1.255
Current demand control threshold index	1	0	0-0:96.128.10.255
Demand control function enable	1	0	1-0:96.0.161.255
Limiter power time threshold	3	0	1-0:1.44.1.255
Limiter power restore time threshold (Auto-reconnection)	3	0	1-0:1.43.0.255
Auxiliary Disconnect control	70	0	0-1:96.3.10.255
Max number of auto reconnection	1	0	0-0:96.135.0.255
No more reconnection flag	1	0	0-0:96.140.0.255

Table: Load control objects

No more reconnection flag

When the number of auto-reconnection reaches the max number of auto reconnection, the meter will not reconnect, and the no more reconnection flag will be set. Only after the flag is cleared via the HES, the accumulated reconnect count will also be cleared, so that the meter will automatically reconnect again.

Auxiliary Disconnect control

This object is only available in CT and CTPT meter, which is used to control external breaker or device.

The state diagram for disconnector and the possible state transitions are shown in the figure below:

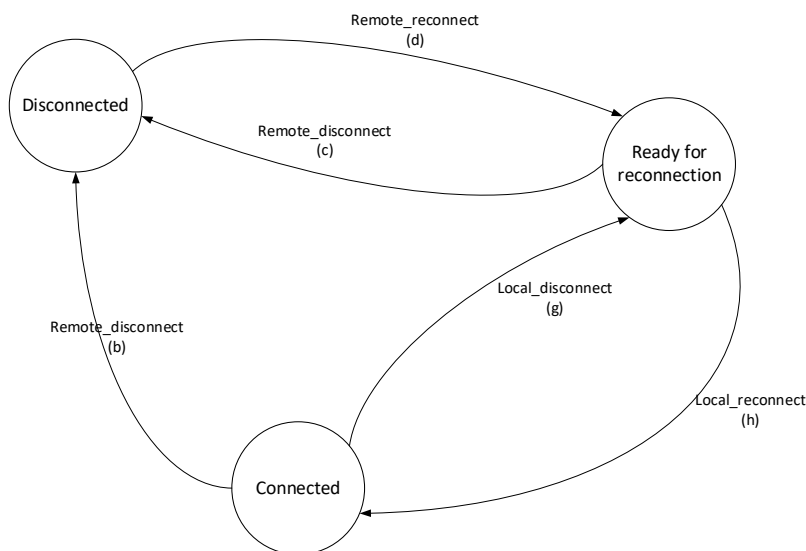


Figure 3: Disconnector state transitions

Disconnect control script table

The disconnect script table contains the following scripts:

Script identifier	Action
1	{2,70,0-0:96.3.10.255,1,0x00}, remote_disconnect
2	{2,70,0-0:96.3.10.255,2,0x00}, remote_reconnect

Disconnect control

The behaviour of the relay includes remote, local and manual disconnection or reconnection. These commands are dependent by the control_mode setting of the **Disconnect control** object.

control_mode	Disconnection				Reconnection			
	Remote		Manual	Local	Remote		Manual	Local
enum:	(b)	(c)	(f)	(g)	(a)	(d)	(e)	(h)
(0)	–	–	–	–	–	–	–	–
(1)	x	x	x	x	–	x	x	–
(2)	x	x	x	x	x	–	x	–
(3)	x	x	–	x	–	x	x	–
(4)	x	x	–	x	x	–	x	–
(5)	x	x	x	x	–	x	x	x
(6)	x	x	–	x	–	x	x	X
NOTE 3	In Mode (0) the disconnect control object is always in 'connected' state.							
NOTE 4 inhibited.	Local disconnection is always possible unless the corresponding trigger is							

Figure 4: Disconnection mode

The meter support control mode: 6.

If the state transition is not allowed by the control mode, then the action is ignored.

Auxiliary Disconnect control

This object is used for auxiliary relay of three phase CT /CTPT meter. The auxiliary relay executes the same control logic as that of Disconnect Control.

The CT/CTPT meter support auxiliary disconnect control for power limitation, demand side management, and over current.

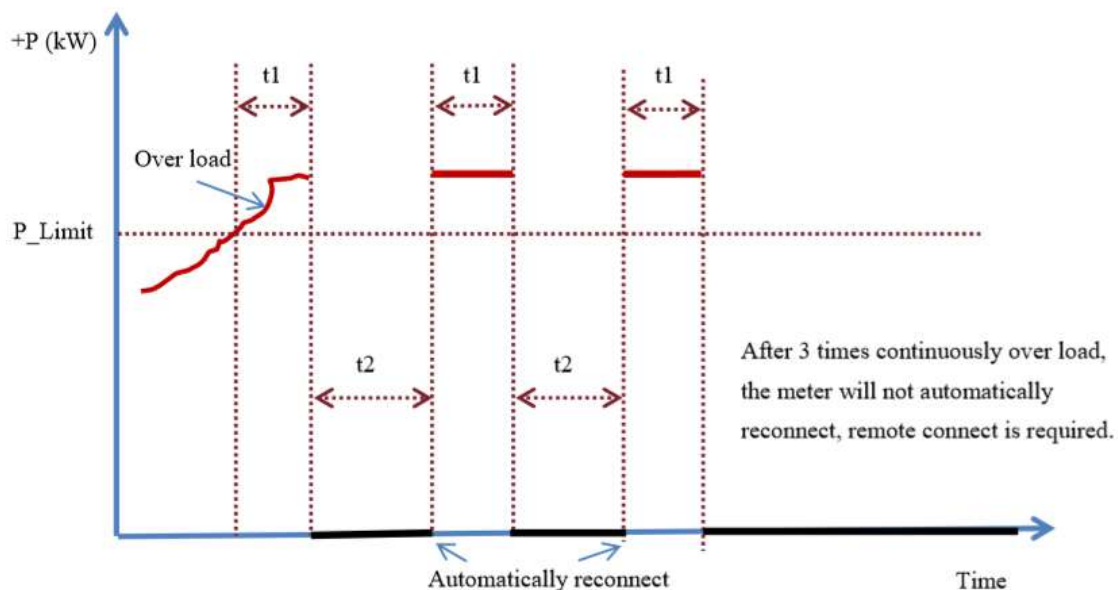
16.1 Power Limitation

The meter measures the active power every second. If the import active power is larger than the active power thresholds for specified period t_1 , the meter will disconnect the supply. After disconnect last for auto-reconnect time t_2 , the meter will automatically connect the supply. If the customer does not reduce the load, the over load will be detected again, then the meter will disconnect the supply again. After counter of auto-reconnect reaches Max Number of Auto-reconnect, if it is disconnected once again due to over load, the meter will keep in disconnection status, only a command that clear the disconnect counters is received by the meter can connect the supply.

The meter records a counter of auto-reconnect attempted. The counter will be reset after the power below the power threshold, or after a power off, or after executing an clear disconnect counters command from remote central system or local hand-held device when allowed auto-reconnect counters is used up.

Here below picture show the load control process:

Here below picture show the load control process for one power threshold.



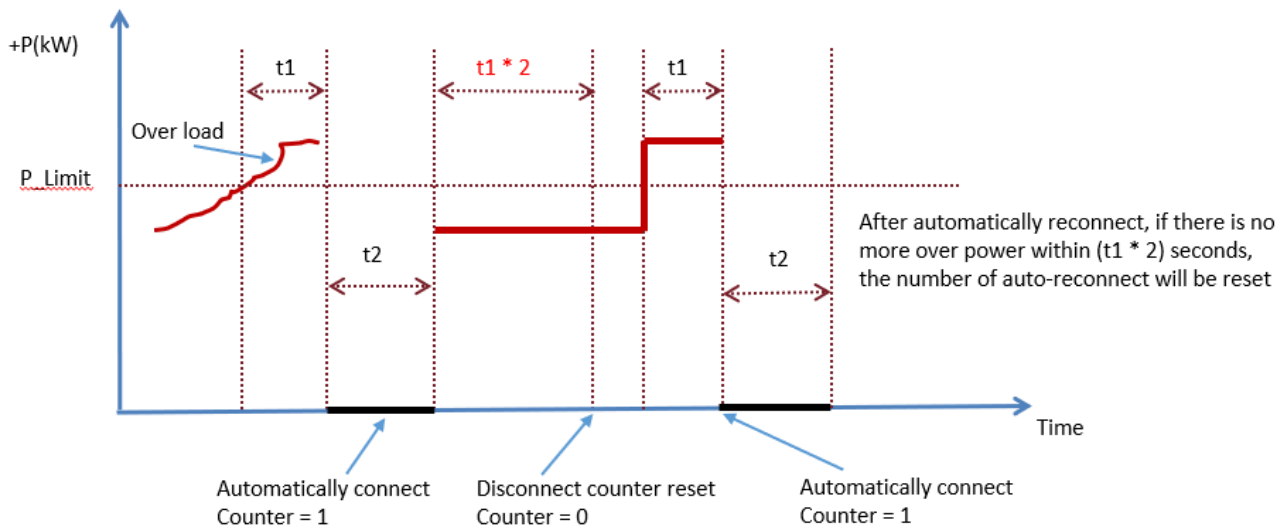
Over load parameters, ranges, and default values:

Parameter	Unit	Min. Value	Max. Value	Default Value
Power limiter threshold (P_{limit})	kW	0	$Un * I_{max} * 3 * 1.0$	$Un * I_{max} * 3 * 0.9$
Power limiter time threshold (t_1)	Second	5	3600	180
Power limiter restore time threshold (Auto-reconnect time) (t_2)	Second	5	3600	180
Max. Number of auto-reconnect for Power limiter	/	0	5	2

Object / Attribute Name	Class	Ver.	OBIS code
Power limiter threshold	3	0	1-0.11.35.4.255
Power limiter time threshold	3	0	1-0:1.44.1.255
Power limiter restore time threshold (Auto-reconnect time)	3	0	1-0:1.43.0.255

Max. Number of auto-reconnect for Power limiter	1	0	0-0:96.135.0.255
---	---	---	------------------

During over power period, but the number of auto-reconnect has not been exceeded, after the meter is automatically reconnected , if no over power is generated again with $(t1*2)$ seconds, the number of auto-reconnect will be reset.



Power limit enable/disable

The function to monitor the active power can be switched on/off. The default state is enable. If the power thresholds are zero, the active power limitation is disabled.

16.2 Demand Control

Demand Control functionality is used to reduce peak loads.

Activity calendar for Demand Control

The activity calendar must support at least:

- season_profile => at least 4 seasons
- week_profile_table => at least 4 entries
- day_profile_table => at least 4 entries
- day_profile => up to 24 switching times per day

Demand control script table

The demand control script table supports up to 8 switching scripts.

Script identifier	Action
1	Power threshold 1 are activated
2	Power threshold 2 are activated
3	Power threshold 3 are activated
4	Power threshold 4 are activated
5	Power threshold 5 are activated
6	Power threshold 6 are activated
7	Power threshold 7 are activated
8	Power threshold 8 are activated

Demand control threshold set

The demand control threshold set contains two set of power threshold, “Active demand control threshold set” and “Passive demand control threshold set”, the data structure of demand control threshold set is as follows:

```
Demand_control_threshold ::= ARRAY
{
    Double_long_unsigned : threshold[8]
}
```

The demand control threshold set supports up to 8 power thresholds.

The passive demand control threshold set is configurable, when the activity calendar for demand control is activated, the active demand control threshold will be replaced with passive demand control threshold set.

The index of active demand control threshold set corresponds to script identifier of demand control script table. For example, when identifier 2 is invoked, the 2nd threshold defined in active demand control threshold set will become active.

When active demand control threshold set has 0 elements of power thresholds, this functionality is disabled.

When clock is invalid, this functionality is disabled.

Current active demand control threshold

This object shows current active demand control threshold

Load shedding

When current active demand control threshold is 0, means the meter is under load shedding condition.

In this situation, the meter will disconnect immediately, and the LCD will display “OFF-SHED”. The meter will reconnect by itself when meter exits load shedding condition.

Demand control function enable

Demand control functionality can enable or disable, when the functionality is disabled, the meter will not detect demand control function any more.

When enabled, The limitation and disconnection mechanism is same as 16.1 Power Limitation, they share the same set of t1, t2 and the number of auto-reconnect.

16.3 Over Current

To protect the meter, if the current of any phase is bigger than over current threshold for 1 minutes, the meter will automatically disconnect the power supply. After 1 minutes, the meter will automatically reconnect the power supply. If the customer does not reduce the current, the over current will be detected again, then the meter will disconnect the power supply again. After consecutive 2 times automatic reconnection, if it is disconnected once again due to over current, the meter will keep in disconnection status, only a connect command can connect the supply. During the disconnection period, the meter will display “OFF-OC”.

When current is over the current threshold of maximum allowable disconnect, the relay switching is inhibited.

The logic of over current has a separate set of t1, t2 and the number of auto-reconnect, which are different from Power Limitation and Demand Side Management (16.1 & 16.2).

the current threshold of maximum allowable disconnect is 60A for SP, 120A for PPDC.

Over load parameters, ranges, and default values:

Parameter	Unit	Min. Value	Max. Value	Default Value
Over current threshold	A	0.5 * Imax	1.3 * Imax	1.1 * Imax
Over current time threshold (t1)	Second	5	3600	60
Over current restore time threshold (auto-reconnect time) (t2)	Second	5	3600	60
Max. Number of auto-reconnect for Over current	/	0	5	2

Object / Attribute Name	Class	Ver.	OBIS code
Over current threshold	3	0	1-0.11.35.4.255
Over current time threshold	3	0	1-0.11.44.3.255
Over current restore time threshold (auto-reconnect time)	3	0	1-0.11.44.8.255
Max. Number of auto-reconnect for Over current	1	0	0-0:96.136.0.255

16.4 Tamper Disconnect

Some events may trigger the meter disconnect the power supply. the following objects are used to enable or disable the disconnect control once the corresponding events happens.

Object / Attribute Name	Class	Ver.	OBIS code
Switch of meter cover open relay disconnect	1	0	1-0.96.0.130.255
Switch of meter terminal open relay disconnect	1	0	1-0.96.0.131.255
Switch of meter magnetic disturbance relay disconnect	1	0	1-0.96.0.132.255
Switch of meter current reverse relay disconnect	1	0	1-0.96.0.134.255
Switch of meter DC injection relay disconnect	1	0	1-0.96.0.145.255
Switch of meter ESD disturbance relay disconnect	1	0	1-0.96.0.146.255
Switch of meter load unbalance relay disconnect	1	0	1-0.96.0.147.255
Switch of meter voltage THD exceed limit relay disconnect	1	0	1-0.96.0.148.255
Switch of meter current THD exceed limit relay disconnect	1	0	1-0.96.0.149.255

Every object above can be set TRUE or FALSE. When the value is TRUE, the relay will automatically disconnect once corresponding event occurs.

For “ Switch of meter load unbalance relay disconnect“, it’s only applicable in PPDC and CT,CTPT meter.

For “ Switch of meter voltage THD exceed limit relay disconnect“ and “ Switch of meter current THD exceed limit relay disconnect“, they are only applicable in CT,CTPT meter.

17 Display

The meter provides user interfaces to display the meter data and status information. The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Auto scroll display readout	7	1	0-0:21.0.1.255
Manual scroll display readout	7	1	0-0:21.0.2.255

The display objects shall

be configurable via attribute 3 “capture_objects”.

In “auto scroll display readout” and “manual scroll display readout”, attribute 4 “capture period” is used to indicate display interval. When “capture period” is reached, the meter will switch to the next screen for display in Auto scroll mode, or return back to Auto scroll mode from Manual scroll mode.

18 Event Management

Event is categorized in different group. Each group has different events and stored in an event log object. Each group of event has a filter objects with a bit-mask for each event to define whether the corresponding events shall be pushed (0: disable, 1: enable) to the system once it occurs.

18.1 Standard Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Standard event log	7	1	0-0:99.98.0.255
Standard event filter	1	0	0-1:94.14.105.255
Event code - Standard event log	1	0	0-0:96.11.0.255

Table: Standard Event Log

Standard Event Log

min capacity: minimum of 50 entries

```
structure:      clock.time, value
```

capture period: 0 (externally triggered)

```
captured objects:    {0-0:1.0.0.255, clock}
```

{0-0:96.11.0.255, code}

buffer encoding: normal: clock with every entry

selective access: by range and by entry

sorted method: unsorted (FIFO)

18.2 Fraud Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Fraud detection event log	7	1	0-0:99.98.1.255
Fraud detection event filter	1	0	0-1:94.14.106.255
Event code - Fraud detection event log	1	0	0-0:96.11.1.255

Table: Fraud Event Log

Fraud Event Log

min capacity: minimum of 50 entries

```
structure:      clock.time, value
```

capture period: 0 (externally triggered)

```
captured objects:    {0-0:1.0.0.255,clock}
```

{0-0:96.11.1.255,code}

buffer encoding: normal: clock with every entry

selective access: by range and by entry

sorted method: unsorted (FIFO)

18.3 Disconnecter Control Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Disconnecter control event Log	7	1	0-0:99.98.2.255
Disconnecter control event filter	1	0	0-1:94.14.107.255
Event Code - Disconnecter control event log	1	0	0-0:96.11.2.255

Table: Disconnecter Control Event Log

Disconnecter Control Event Log

min capacity: minimum of 50 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.2.255,code}
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.4 Power Failure Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Power failure event log	7	1	1-0:99.97.0.255
Power failure event filter	1	0	0-1:94.14.109.255
Event Code - Power failure event log	1	0	0-0:96.11.6.255
Duration of last long power failure in any phase	3	0	0-0:96.7.19.255

Table: Power Failure Event Log

Power Failure Event Log

min capacity: minimum of 50 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255, clock}
 {0-0:96.11.6.255, code}
 {0-0:96.7.19.255, Duration of last long power failure in any phase}
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.5 Power Quality Event Log

The following objects are supported to record the event:

Object / Attribute Name	Class	Ver.	OBIS code
Power quality event log	7	1	0-0:99.98.4.255
Power quality event filter	1	0	0-1:94.14.108.255
Event Code - Power quality event log	1	0	0-0:96.11.4.255

Table: Power Quality Event Log

Power Quality Event log

min capacity: minimum of 50 entries
structure: clock.time, value
capture_period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.4.255,code}
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.6 Communication Event Log

The following objects are supported to record the event:

Object / Attribute Name	Class	Ver.	OBIS code
Communication event log	7	1	0-0:99.98.5.255
Communication event filter	1	0	0-1:94.14.117.255
Event Code - communication event log	1	0	0-0:96.11.5.255
Client address	1	0	0-0:96.129.0.255
Communication port	1	0	0-0:96.129.1.255

Table: Power Quality Event Log

Communication Event log

min capacity: minimum of 50 entries
structure: clock.time, value
capture_period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.5.255, code}
 {0-0:96.129.0.255, Client address }
 {0-0:96.129.1.255, Communication port }
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.7 Prepay Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Prepay event log	7	1	0-0:99.98.7.255
Prepay event filter	1	0	0-1:94.14.110.255
Event code - Prepay event log	1	0	0-0:96.11.7.255

Table: Standard Event Log

Prepay Event Log

min capacity: minimum of 50 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255, clock}
 {0-0:96.11.7.255, code}
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.8 Recharge Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Recharge event log	7	1	0-0:99.98.8.255
Event code - Recharge event log	1	0	0-0:96.11.8.255
Recharge event filter	1	0	0-1:94.14.111.255
Recharge sequence number	1	0	0-0:128.131.0.255
Recharge amount	3	0	1-0:141.129.0.255

Table: Recharge Event Log

Recharge Event Log

min capacity: minimum of 50 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.8.255, recharge event code},
 {0-0:128.131.0.255, recharge sequence number}
 {1-0:141.129.0.255, recharge amount }
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.9 Communication module Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Communication module event log	7	1	0-0:99.98.10.255
Communication module event filter	1	0	0-1:94.14.119.255
Event code - Communication module event log	1	0	0-0:96.11.10.255

Table: Recharge Event Log

Communication module Event Log

min capacity: minimum of 100 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.10.255, code }
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

18.10 Daily Event Log

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Daily event log	7	1	0-0:99.98.11.255
Event code - Daily event log	1	0	0-0:96.11.11.255

Table: Recharge Event Log

Communication module Event Log

min capacity: minimum of 100 entries
structure: clock.time, value
capture period: 0 (externally triggered)
captured objects: {0-0:1.0.0.255,clock}
 {0-0:96.11.11.255, code }
buffer encoding: normal: clock with every entry
selective access: by range and by entry
sorted method: unsorted (FIFO)

The Daily Event Log is used for DCU/HES to regularly collect events every day, and all the above events will be recorded in the Daily Event Log one more time after they are generated.

19 Push Operations

The meter shall have the functionality that allows sending data to the HES, initiated by the meter. There are several occasions on which data may be ‘pushed’, i.e. sent to the HES without being explicitly requested, e.g.

- Meter registration
- Triggered by the meter due to events

The following object supports this functionality for all possible triggers:

Object / Attribute Name	Class	Ver.	OBIS code
Push script table	9	0	0-0:10.0.108.255

The Push script table contains references for all defined push setup objects:

Script_identifier	logical_name	description
5	0-0:25.9.0.255	Push Setup – On Connectivity

19.1 Meter Connectivity

The Push on Connectivity is triggered each time a new network connection is established.

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Push setup – On Connectivity	40	0	0-0:25.9.0.255

This object defines the data elements for pushing to the HES in case of establishing a network connectivity.

The data notification service is used for meter connectivity push.

The following objects should be defined in push_object_list by default:

Object / Attribute Name	Class	Ver.	OBIS code	attribute
Push setup – On Connectivity	40	0	0-0:25.9.0.255	1
Logical Device Name	1	0	0-0:42.0.0.255	2
Communication Type	1	0	0-0:128.128.0.255	2
Optional parameter	1	0	0-0:128.129.0.255	2

Communication type

The data type of this object is long-unsigned.

The upper byte is defined as follows:

“83” – 4G

“86” – LTE

The lower byte is used only when communication module is P2P module, e.g. NB/LTE/GPRS. The lower byte take value from the attribute 2 of the object “Auto Connect”.

Auto Connect	29	2	0-0:2.1.0.255
--------------	----	---	---------------

Optional parameter

This parameter is used by different modules to carry corresponding required parameters.

For 4G modules:

Optional parameter :: structure

```
{  
    Device IP address :: double-long-unsigned  
    Port :: long-unsigned  
    Cell ID :: double-long-unsigned  
    RSRP signal quality :: integer  
    SINR signal quality :: integer  
    Frequency bands :: double-long-unsigned  
}
```

19.2 Event push

Event push is triggered by an event. When any bit in the event log filters is set to push, it means the event will be sent to HES, using the event notification service, initiated by the meter itself.

20 Self-Diagnosis

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Instantaneous status word	1	0	0-0:96.10.6.255
Tamper status word	1	0	0-0:96.10.7.255

20.1 Instantaneous Status Word

The meter can detect some abnormal status by itself, and set the corresponding bit in the following status word:

Bit No.	Description	Set Condition	Reset Condition
0	Clock invalid	Meter clock is invalid	Meter clock is re-configured
1	Measurement system error	A physical error in the measurement system	The measurement system is recovered
2	NVM(non-volatile memory) error	Physical error in the EEPROM or Flash	The NVM is recovered
3	RAM error	Physical error in the RAM	The RAM is recovered
4	Program memory error	The checksum of meter code area is wrong	The checksum of meter code area is correct
5	Battery low	Battery capacity is low	Battery capacity is restored
6	Missing neutral	Neutral line is lost	Neutral line is restored
7	Phase neutral interchange	Phase & neutral line are interchanged	Phase wires are connected correctly
8	Under voltage L1	Phase L1 voltage is lower than under voltage threshold	Phase L1 voltage returns to normal
9	Over voltage L1	Phase L1 voltage is higher than overvoltage threshold	Phase L1 voltage returns to normal
10	Terminal cover removal	Terminal cover is removed	Terminal cover is closed

Bit No.	Description	Set Condition	Reset Condition
11	Main cover removal	Main cover is removed	Main cover is closed
12	Strong magnetic field	Strong magnetic field is detected	Strong magnetic field disappears
13	ESD disturbance	ESD disturbance is detected	ESD disturbance no longer existed
14	Current bypass	Meter is under current bypass condition	Current bypass condition is no longer existed
15	DC injection (neutral disturbance)	Neutral disturbance is detected	Neutral disturbance no longer existed
16	Current reverse	Any phase of current is reverse	All phases of current are normal
17	Relay status bit0	bit0=0, bit1=0: Disconnected bit0=1, bit1=0: Connected	
18	Relay status bit1	bit0=0, bit1=1: Ready for reconnection	
19	Prepayment mode	Meter is in prepayment mode	Meter is in post-payment mode
20	Current without voltage	Any phase has current, but no voltage	All phases of voltage restored
21	Reserved		

Table: Instantaneous Status Word

20.2 Tamper Status Word

A 32-bit tamper status word is used to indicate which tampers have occurred in the meter. It can only be cleared by a clear tamper command.

Bit No.	Description	Set Condition	Reset Condition
0	Meter cover removal	Meter cover is removed	Meter cover is closed and clear tamper command is received
1	Terminal cover removal	Terminal cover is removed	Terminal cover is closed and clear tamper command is received
2	Strong magnetic field	Strong magnetic field is detected	Strong magnetic field disappears and clear tamper command is received
3	DC injection (neutral disturbance)	Neutral disturbance is detected	Neutral disturbance no longer exists and clear tamper command is received
4	ESD disturbance	ESD disturbance is detected	ESD disturbance no longer exists and clear tamper command is received
5	Current reverse	1) When Export Energy function switch OFF, if reverse current value and duration time over certain threshold, this bit will be set. 2) When Export Energy function switch ON, this bit will not be set.	1) When current reverse condition removed and tamper reset command is received 2) When Export Energy function switch ON, this bit will be reset.
6 ~31	Reserved		

21 Firmware Upgrade

The meter should support firmware upgrade referring to meter firmware upgrade procedure through the DLMS standard image transfer process.

This Companion Standard supports only a single instance of the Image Transfer. In case the meter supports the download of multiple parts of the firmware, it is the manufacturer's responsibility to ensure the proper identification and activation of these images.

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Image transfer	18	0	0-0:44.0.0.255
Image activation scheduler	22	0	0-0:15.0.2.255
Predefined Scripts - Image activation	9	0	0-0:10.0.107.255
Legal firmware version	1	0	1-0:0.2.0.255
Legal firmware signature	1	0	1-0:0.2.8.255
Application firmware version	1	0	1-1:0.2.0.255
Application firmware signature	1	0	1-1:0.2.8.255
Communication firmware version	1	0	1-2:0.2.0.255
Communication firmware signature	1	0	1-2:0.2.8.255

22 Prepayment Function

The prepayment function is only applicable in single-phase meter and three-phase DC meter.

The meter should support both post-payment mode and prepayment mode, and can be switched from post-payment mode to prepayment mode by command, and vice versa.

For prepayment mode:

- 1) The meter can receive credit in kWh from the central system or local communication port.
- 2) The meter will disconnect the power supply after credit is fully exhausted, and record and spontaneously report (if enabled) the disconnection event to the system.
- 3) The meter will record and report (if enabled) the low balance alarm event to the system when the remaining credit of the meter is less than the low credit threshold which is configurable.

When the meter is switched from post-payment mode to prepayment mode at the first time, the meter will disconnect automatically because the initial available credit of the meter is 0.

The maximum available credit is 99999.999 kWh.

The following objects support this functionality:

Object / Attribute Name	Class	Ver.	OBIS code
Account	111	0	0-0:19.0.0.255
Token Credit	112	0	0-0:19.10.0.255
Charge	113	0	0-0:19.20.0.255
Recharge	1	0	0-0:128.140.0.255
Recharge sequence number	1	0	0-0:128.131.0.255
Recharge Energy Of Current Month	3	0	1-0:140.129.1.255
Consumption Energy Of Current Month	3	0	1-0:140.129.2.255
Total Recharge Energy	3	0	1-0:140.129.3.255

Table: Prepayment function

22.1 Recharge

The “Recharge” object makes the meter capable of receiving energy from the system. The meter also manages a “recharge sequence number” to avoid the re-charge for the same command. The sequence number issued during each recharge must be greater than the sequence number issued during the last successfully recharge, otherwise recharge fails.

The datatype of “Recharge” is as follows:

Recharge ::= structure

```
{  
    Recharge_sequence_number:  double-long-unsigned  
    Recharge_amount:           double-long  
}
```

The security of Recharge is guaranteed by the DLMS security of the meter. Which means Recharge is only available on the encrypted dlms association.

22.2 Low Credit

The meter must support low credit alarm. When available credit is lower than low credit threshold, the meter should log the low credit event and report low credit alarm to the system. The low credit threshold is defined in “Token Credit” object.

22.3 Payment Mode Switch

The meter must support the mutual switching between post-payment and pre-payment mode. The attribute is defined in “Account” object. In post-payment mode, the meter does not accept energy recharge.

23 Appendix

23.1 Event Code

Event Code	Name	Standard Event Log	Fraud Detection Log	Disconnector Control Log	Power Quality Event Log	Power Failure Event Log	Communication Log	Communication module Log	recharge	payment	Push
1	short Power Down	X									
2	short Power Up	X									
3	Daylight saving time enabled or disabled	X									
4	Clock adjusted (old date/time)	X									
5	Clock adjusted (new date/time)	X									
6	Clock invalid	X									
8	Battery voltage low	X									√
9	TOU activated	X									
12	Program memory error	X									√
13	RAM error	X									√
14	NV memory error	X									√
15	Watchdog error	X									√
16	Measurement system error	X									√
17	Firmware ready for activation	X									
18	Firmware activated	X									
19	Passive TOU programmed	X									
21	long power down	X									√
22	long power up	X									√
23	Communication problems						X				√
24	Configuration problems						X				√
25	CT open L1 start (CT only)		X								
26	CT open L1 start (CT only)		X								
27	CT open L1 start (CT only)		X								
28	CT open L1 end (CT only)		X								
29	CT open L2 end (CT only)		✕								
30	CT open L3 end (CT only)		✕								
31	CT/PT mismatch start (CT only)		X								
32	CT/PT mismatch end (CT only)		X								
34	Clock out of tolerance	X									√
40	Terminal cover removed		X								√
41	Terminal cover closed		X								√

42	Strong DC field detected		X							√
43	No strong DC field anymore		X							√
44	Meter cover removed		X							√
45	Meter cover closed		X							√
47	One or more parameters changed	X								
48	Global key(s) changed	X								√
49	Decryption or authentication failure (n time failure)					X				
50	Replay attack					X				
51	FW verification failed	X								
53	ESD start		X							
54	ESD end		X							
55	Tamper register cleared	X								
62	Remote disconnection			X						√
65	Power limiter threshold exceeded			X						
66	Power Limiter threshold ok			X						
67	Limiter threshold config changed			X						
69	Local reconnection			X						√
70	Over current L1 start			X						√
71	Over current L1 end			X						√
72	Over current L2 start			X						√
73	Over current L2 end			X						√
74	Over current L3 start			X						√
75	Over current L3 end			X						√
76	Undervoltage L1				X					
77	Undervoltage L2				X					
78	Undervoltage L3				X					
79	Overvoltage L1				X					
80	Overvoltage L2				X					
81	Overvoltage L3				X					
82	Missing voltage L1				X					
83	Missing voltage L2				X					
84	Missing voltage L3				X					
85	Voltage L1 normal				X					
86	Voltage L2 normal				X					
87	Voltage L3 normal				X					
88	Phase sequence reversal		X							√
89	Missing neutral (PP only)		X							√
90	Load unbalance start				X					
140	P2P: No connection timeout						X			
142	P2P:SIM Card failure						X			
143	P2P:SIM Card ok						X			

144	P2P:Modem registration failure							X			
146	P2P:PDP context established							X			
147	P2P:PDP context destroyed							X			
148	P2P:PDP context failure							X			
149	P2P:Modem reboot							X			
156	P2P: Signal quality low							X			
200	Current in absence of voltage at L1 detected (SP,CT only)		X								
201	Current in absence of voltage at L2 detected (CT only)		✕								
202	Current in absence of voltage at L3 detected (CT only)		✕								
204	Current Reversal L1		X								√
205	Current Reversal L2		✕								✕
206	Current Reversal L3		✕								✕
207	Current Reversal L1 end		X								√
208	Current Reversal L2 end		✕								✕
209	Current Reversal L3 end		✕								✕
210	Long power failure in all phases (PP only)					X					
211	Long power failure in phase1					X					
212	Long power failure in phase2 (PP only)					✕					
213	Long power failure in phase3 (PP only)					✕					
214	Communication module removed		X								
215	Communication module inserted		X								
226	Firmware activation failed	X									
229	Phase sequence reversal end		X								√
230	Load unbalance end					X					
236	DC injection(neutral disturbance) start		X								√
237	DC injection(neutral disturbance) end		X								√
240	missing neutral end (PP only)		X								√
241	phase neutral exchange L1 start		X								√
242	phase neutral exchange L2 start		✕								✕
243	phase neutral exchange L3 start		✕								✕
244	phase neutral exchange L1 end		X								√
245	phase neutral exchange L2 end		✕								✕
246	phase neutral exchange L3 end		✕								✕
249	current bypass start		X								

250	current bypass end		X								
251	Current in absence of voltage at L1 detected end (SP, CT only)		X								
252	Current in absence of voltage at L2 detected end (CT only)		X								
253	Current in absence of voltage at L3 detected end (CT only)		X								
254	Load profile cleared	X									
255	Event log cleared	X	X	X	X	X	X			X	
384	meter recharge								X		
385	low credit									X	√
392	switch to PRE-PAYMENT mode									X	
393	switch to POST PAYMENT mode									X	
396	configure passive unit charge									X	
401	Credit exhausted									X	√
402	configure low credit threshold									X	
403	clear recharge sequence number									X	
404	activate passive unit charge									X	
421	Communication start on local interface						X				
422	Communication end on local interface						X				
423	Local disconnection due to meter cover removal			X							√
424	Local disconnection due to terminal cover removal			X							√
425	Local disconnection due to strong DC magnetic field			X							√
426	Local disconnection due to current reverse			X							√
427	Local disconnection due to ESD disturbance			X							√
428	Local disconnection due to DC injection			X							√
429	Local disconnection due to credit exhausted			X							√
430	Local disconnection due to over power			X							√
431	Local disconnection due to over demand side threshold			X							√
432	Local disconnection due to over current			X							√
433	Demand side limiter threshold exceeded			X							
434	Demand side limiter threshold ok			X							
435	Demand side threshold configured			X							

436	Local disconnection due to load unbalance			X							√
437	Local disconnection due to voltage THD exceed limit (CT only)			X							√
438	Local disconnection due to current THD exceed limit (CT only)			X							√
439	Local disconnection due to load shedding			X							√
450	P2P: Modem reset timer expired							X			
451	P2P: Modem listen failed							X			
452	P2P: Modem communication ready							X			
453	P2P: TCP connection establish failed							X			
454	P2P: Image download succeed							X			
455	P2P: Image download failed							X			
456	P2P: Image upgrade succeed							X			
457	P2P: Image upgrade failed							X			
458	PLC: No connection timeout							X			
459	PLC: Modem Registration Success							X			
460	PLC: Modem Registration Failure							X			
461	PLC: Modem Kicked							X			
462	PLC: Modem HW Reset							X			
463	PLC: Modem Request to Reset							X			
464	PLC: Modem Initialize Failure							X			
465	PLC: Modem Data Request Failure							X			
466	PLC: ICMP RA Received							X			
467	PLC: ICMP RS Failure							X			
468	PLC: ICMP Echo Request Received							X			
469	PLC: PAN Conflict Detected							X			
470	PLC: No PAN Detected							X			
480	voltage THD exceed limit (CT only)				X						√
481	voltage THD restore (CT only)				X						√
482	current THD exceed limit (CT only)				X						√
483	current THD restore (CT only)				X						√

23.2 Display Objects

The default display objects for auto scroll mode are described as follows:

index	Logical name	obis	Description	SP	PP	DC	LV	CT	HV	CT
1	{1,0-0:96.128.0.255,2}, /		Display all segment		√		√		√	
2	{1,0-0:96.1.0.255,2},	96.1.0	Device ID1, manufacturing number	√						
3	{1,1-0:0.9.1.255,2},	0.9.1	local time		√		√		√	
4	{1,1-0:0.9.2.255,2},	0.9.2	local date		√		√		√	
5	{3,1-0:1.8.0.255,2},	1.8.0	Active energy import (+A)	√	√		√		√	
6	{3,1-0:1.8.1.255,2},	1.8.1	Active energy import (+A) T1		√		√		√	
7	{3,1-0:1.8.2.255,2},	1.8.2	Active energy import (+A) T2		√		√		√	
8	{3,1-0:2.8.0.255,2},	2.8.0	Active energy export (-A)	√	√		√		√	
9	{3,1-0:2.8.1.255,2},	2.8.1	Active energy export (-A) T1		√		√		√	
10	{3,1-0:2.8.2.255,2},	2.8.2	Active energy export (-A) T2		√		√		√	
11	{3,1-0:3.8.0.255,2},	3.8.0	Reactive energy import (+R)		√		√		√	
12	{3,1-0:3.8.1.255,2},	3.8.1	Reactive energy import (+R) T1		√		√		√	
13	{3,1-0:3.8.2.255,2},	3.8.2	Reactive energy import (+R) T2		√		√		√	
14	{3,1-0:4.8.0.255,2},	4.8.0	Reactive energy export (-R)		√		√		√	
15	{3,1-0:4.8.1.255,2},	4.8.1	Reactive energy export (-R) T1		√		√		√	
16	{3,1-0:4.8.2.255,2},	4.8.2	Reactive energy export (-R) T2		√		√		√	
17	{4,1-0:1.6.0.255,2}	1.6.0	Maximum Demand Register 1 - Active energy import (+P)	√	√		√		√	
18	{4,1-0:1.6.1.255,2}	1.6.1	Maximum Demand Register 1 - Active energy import (+P) T1		√		√		√	
19	{4,1-0:1.6.2.255,2}	1.6.2	Maximum Demand Register 1 - Active energy import (+P) T2		√		√		√	
20	{4,1-0:2.6.0.255,2}	2.6.0	Maximum Demand Register 2 - Active energy export (-P)	√	√		√		√	
21	{4,1-0:2.6.1.255,2}	2.6.1	Maximum Demand Register 2 - Active energy export (-P) T1		√		√		√	
22	{4,1-0:2.6.2.255,2}	2.6.2	Maximum Demand Register 2 - Active energy export (-P) T2		√		√		√	
23	{3,1-0:1.2.0.255,2},	1.2.0	Cumulative Maximum Demand- Active energy import (+P)		√		√		√	
24	{3,1-0:1.2.1.255,2},	1.2.1	Cumulative Maximum Demand- Active energy import (+P) rate 1		√		√		√	
25	{3,1-0:1.2.2.255,2},	1.2.2	Cumulative Maximum Demand- Active energy import (+P) rate 2		√		√		√	
26	{3,1-0:2.2.0.255,2},	2.2.0	Cumulative Maximum Demand- Active energy export (-P)		√		√		√	
27	{3,1-0:2.2.1.255,2},	2.2.1	Cumulative Maximum Demand- Active energy export (-P) rate 1		√		√		√	
28	{3,1-0:2.2.2.255,2},	2.2.2	Cumulative Maximum Demand- Active energy export (-P) rate 2		√		√		√	
29	{1,0-0:0.1.0.255,2},	0.1.0	Billing period counter		√		√		√	
30	{3,1-0:1.7.0.255,2},	1.7.0	Instantaneous active import power (+P)	√	√		√		√	
31	{3,1-0:2.7.0.255,2},	2.7.0	Instantaneous active export power (-P)	√	√		√		√	
32	{3,1-0:13.24.128.255,2},	13.24.12	Average power factor total current month	√	√		√		√	
33	{111,0-0:19.0.0.255,5},	19.0.0	*Available credit	√	√					

*Available credit: this item will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

The default display objects for manual scroll mode are described as follows:

index	Logical name	obis	Description	SP	PP	DC	LV	CT	HV	CT
1	{1,0-0:96.128.0.255,2}, /		Display all segment	√	√		√		√	
2	{1,1-0:0.9.1.255,2},	0.9.1	local time	√	√		√		√	
3	{1,1-0:0.9.2.255,2},	0.9.2	local date	√	√		√		√	
4	{1,0-0:96.1.0.255,2},	96.1.0	Device ID1, manufacturing number	√	√		√		√	
5	{3,1-0:1.8.0.255,2},	1.8.0	Active energy import (+A)	√	√		√		√	
6	{3,1-0:1.8.1.255,2},	1.8.1	Active energy import (+A) T1	√	√		√		√	
7	{3,1-0:1.8.2.255,2},	1.8.2	Active energy import (+A) T2	√	√		√		√	
8	{3,1-0:2.8.0.255,2},	2.8.0	Active energy export (-A)	√	√		√		√	
9	{3,1-0:2.8.1.255,2},	2.8.1	Active energy export (-A) T1	√	√		√		√	
10	{3,1-0:2.8.2.255,2},	2.8.2	Active energy export (-A) T2	√	√		√		√	
11	{3,1-0:3.8.0.255,2},	3.8.0	Reactive energy import (+R)	√	√		√		√	
12	{3,1-0:3.8.1.255,2},	3.8.1	Reactive energy import (+R) T1	√	√		√		√	
13	{3,1-0:3.8.2.255,2},	3.8.2	Reactive energy import (+R) T2	√	√		√		√	
14	{3,1-0:4.8.0.255,2},	4.8.0	Reactive energy export (-R)	√	√		√		√	
15	{3,1-0:4.8.1.255,2},	4.8.1	Reactive energy export (-R) T1	√	√		√		√	
16	{3,1-0:4.8.2.255,2},	4.8.2	Reactive energy export (-R) T2	√	√		√		√	
17	{3,1-0:1.7.0.255,2},	1.7.0	Instantaneous active import power (+P)	√	√		√		√	
18	{3,1-0:2.7.0.255,2},	2.7.0	Instantaneous active export power (-P)	√	√		√		√	
19	{3,1-0:3.7.0.255,2},	3.7.0	Instantaneous reactive import power (+Q)		√		√		√	
20	{3,1-0:4.7.0.255,2},	4.7.0	Instantaneous reactive export power (-Q)		√		√		√	
21	{4,1-0:1.6.0.255,2}	1.6.0	Maximum Demand Register 1 - Active energy import (+P)	√	√		√		√	
22	{4,1-0:1.6.1.255,2}	1.6.1	Maximum Demand Register 1 - Active energy import (+P) T1	√	√		√		√	
23	{4,1-0:1.6.2.255,2}	1.6.2	Maximum Demand Register 1 - Active energy import (+P) T2	√	√		√		√	
24	{4,1-0:2.6.0.255,2}	2.6.0	Maximum Demand Register 2 - Active energy export (-P)	√	√		√		√	
25	{4,1-0:2.6.1.255,2}	2.6.1	Maximum Demand Register 2 - Active energy export (-P) T1	√	√		√		√	
26	{4,1-0:2.6.2.255,2}	2.6.2	Maximum Demand Register 2 - Active energy export (-P) T2	√	√		√		√	
27	{4,1-0:3.6.0.255,2}	3.6.0	Maximum Demand Register 1 - Reactive energy import (+Q)		√		√		√	
28	{4,1-0:3.6.1.255,2}	3.6.1	Maximum Demand Register 1 - Reactive energy import (+Q) T1		√		√		√	
29	{4,1-0:3.6.2.255,2}	3.6.2	Maximum Demand Register 1 - Reactive energy import (+Q) T2		√		√		√	
30	{4,1-0:4.6.0.255,2}	4.6.0	Maximum Demand Register 2 - Reactive energy export (-Q)		√		√		√	
31	{4,1-0:4.6.1.255,2}	4.6.1	Maximum Demand Register 2 - Reactive energy export (-Q) T1		√		√		√	
32	{4,1-0:4.6.2.255,2}	4.6.2	Maximum Demand Register 2 - Reactive energy export (-Q) T2		√		√		√	
33	{3,1-0:1.2.0.255,2},	1.2.0	Cumulative Maximum Demand- Active energy import (+P)	√	√		√		√	
34	{3,1-0:1.2.1.255,2},	1.2.1	Cumulative Maximum Demand- Active energy import (+P) rate 1	√	√		√		√	
35	{3,1-0:1.2.2.255,2},	1.2.2	Cumulative Maximum Demand- Active energy import (+P) rate 2	√	√		√		√	
36	{3,1-0:2.2.0.255,2},	2.2.0	Cumulative Maximum Demand- Active energy export (-P)	√	√		√		√	

37	{3,1-0:2.2.1.255,2},	2.2.1	Cumulative Maximum Demand- Active energy export (-P) rate 1	√	√	√	√
38	{3,1-0:2.2.2.255,2},	2.2.2	Cumulative Maximum Demand- Active energy export (-P) rate 2	√	√	√	√
39	{3,1-0:32.7.0.255},	32.7.0	Voltage of L1	√	√	√	√
40	{3,1-0:52.7.0.255},	52.7.0	Voltage of L2		√	√	√
41	{3,1-0:72.7.0.255},	72.7.0	Voltage of L3		√	√	√
42	{3,1-0:31.7.0.255},	31.7.0	Current of L1	√	√	√	√
43	{3,1-0:51.7.0.255},	51.7.0	Current of L2		√	√	√
44	{3,1-0:71.7.0.255},	71.7.0	Current of L3		√	√	√
45	{3,1-0:13.7.0.255},	13.7.0	Power factor	√	√	√	√
46	{3,1-0:33.7.0.255},	33.7.0	Power factor of L1		√	√	√
47	{3,1-0:53.7.0.255},	53.7.0	Power factor of L2		√	√	√
48	{3,1-0:73.7.0.255},	73.7.0	Power factor of L3		√	√	√
49	{3,1-0:14.7.0.255},	14.7.0	Frequency	√	√	√	√
50	{1,0-0:96.10.6.255,2},	96.10.6	Instantaneous status word	√	√	√	√
51	{1,0-0:96.10.7.255,2},	96.10.7	Tamper status word	√	√	√	√
52	{1,0-0:0.1.0.255,2},	0.1.0	Billing period counter	√	√	√	√
53	{3,1-0:1.8.0.101,2},	1.8.0.1	Active energy import (+A) for last month	√	√	√	√
54	{3,1-0:2.8.0.101,2},	2.8.0.1	Active energy export (-A) for last month	√	√	√	√
55	{3,1-0:3.8.0.101,2},	3.8.0.1	Reactive energy import (+R) for last month		√	√	√
56	{3,1-0:4.8.0.101,2},	4.8.0.1	Reactive energy export (-R) for last month		√	√	√
57	{4,1-0:1.6.0.101,2}	1.6.0.1	Maximum Demand- Active energy import (+P), for last month	√	√	√	√
58	{4,1-0:1.6.0.101,5}	1.6.0.1	Maximum Demand- Active energy import (+P), data time, for last month	√	√	√	√
59	{4,1-0:2.6.0.101,2}	2.6.0.1	Maximum Demand- Active energy export (-P), for last month	√	√	√	√
60	{4,1-0:2.6.0.101,5}	2.6.0.1	Maximum Demand- Active energy export (-P), data time, for last month	√	√	√	√
61	{4,1-0:3.6.0.101,2}	3.6.0.1	Maximum Demand - Reactive energy import (+Q), for last month		√	√	√
62	{4,1-0:3.6.0.101,5}	3.6.0.1	Maximum Demand - Reactive energy import (+Q), data time, for last month		√	√	√
63	{4,1-0:4.6.0.101,2}	4.6.0.1	Maximum Demand - Reactive energy export (-Q), for last month		√	√	√
64	{4,1-0:4.6.0.101,5}	4.6.0.1	Maximum Demand - Reactive energy export (-Q), data time, for last month		√	√	√
65	{3,1-0:13.24.128.255,2},	13.24.12	Average power factor total current month	√	√	√	√
66	{111,0-0:19.0.0.255,5},	19.0.0	*Available credit	√	√		
67	{3,1-0:141.129.0.255,2},	41.129.0	*Last recharge kWh	√	√		
68	{3,1-0:140.129.5.255,2},	40.129.5	*Monthly consumption energy (import active energy) for last month	√	√		
69	{1,1-0:0.4.2.255},	0.4.2	CT ratio numerator			√	√
70	{1,1-0:0.4.5.255},	0.4.5	CT ratio denominator			√	√
71	{1,1-0:0.4.3.255},	0.4.3	VT ratio numerator				√
72	{1,1-0:0.4.6.255},	0.4.6	VT ratio denominator				√

*Available credit, *Last recharge kWh, *Monthly consumption energy: these items will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

The default display objects for power down display mode are described as follows:

index	Logical name	obis	Description	SP	PPDC	LVCT	HVCT
1	{1,0-0:96.1.0.255,2},	96.1.0	Device ID1, manufacturing number	√			
2	{3,1-0:1.8.0.255,2},	1.8.0	Active energy import (+A)-current value	√	√	√	√
3	{3,1-0:2.8.0.255,2},	2.8.0	Active energy export (-A)-current value	√	√	√	√
4	{3,1-0:3.8.0.255,2},	3.8.0	Reactive energy import (+R)		√	√	√
5	{3,1-0:4.8.0.255,2},	4.8.0	Reactive energy export (-R)		√	√	√
6	{4,1-0:1.6.0.255,2}	1.6.0	Maximum Demand Register 1 - Active energy import (+P)	√	√	√	√
7	{4,1-0:2.6.0.255,2}	2.6.0	Maximum Demand Register 2 - Active energy export (-P)	√	√	√	√
8	{111,0-0:19.0.0.255,5},	19.0.0	*Available credit	√	√		

*Available credit: this item will not appear when meter in post-payment mode, when meter is switched to prepayment mode, it will be automatically added to the scroll list.

23.3 Tariff scheme

➤ The default tariff scheme for single phase meter:

1. Calendar name

Calendar_name
Cale

2. Season tariff

Season_profile_name	Season_start	Weekly Profile Name
season_1	FF-01-01 FF	week_1

3. Week tariff

Weekly_profile_name	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
week_1	1	1	1	1	1	1	1

4. Day tariff

Day_id	Start-time	Tariff
1	00:00:00	T1

➤ The default tariff scheme for PPDC and CT & VT meter:

1. Calendar name

Calendar_name
cale

2. Season tariff

Season_profile_name	Season_start	Weekly Profile Name
B	FF-03-01 FF	week_2
C	FF-06-01 FF	week_3
D	FF-09-01 FF	week_4
A	FF-12-01 FF	week_1

3. Week tariff

Weekly_profile_name	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
week_1	1	1	1	1	1	1	1
week_2	2	2	2	2	2	2	2
week_3	3	3	3	3	3	3	3
week_4	4	4	4	4	4	4	4

4. Day tariff

Day_id	Start-time	Tariff
1	17:00:00	T1
	21:00:00	T2
2	18:00:00	T1
	22:00:00	T2
3	19:00:00	T1
	23:00:00	T2
4	18:00:00	T1
	22:00:00	T2

23.4 Default parameter

Demand period interval :	1800s
Energy load profile period :	3600s
Daily load profile period:	86400s
Power quality profile period:	3600s
Threshold for voltage sag:	207V, HVCT:57V
Threshold for voltage swell:	253V, CTPT:70V
Threshold for voltage cut:	115V, CTPT:32V
Time threshold for current reverse:	60s
Current threshold for current reverse relay disconnect:	1A
Time threshold for current bypass:	60s
Time threshold for DC injection:	60s
Time threshold for Phase & neutral exchange:	60s
Time threshold for Current without voltage:	60s

More detailed default parameter will be configured in “OBIS LIST FOR METER_v2.0.xlsx”

Figures:

10.4 View

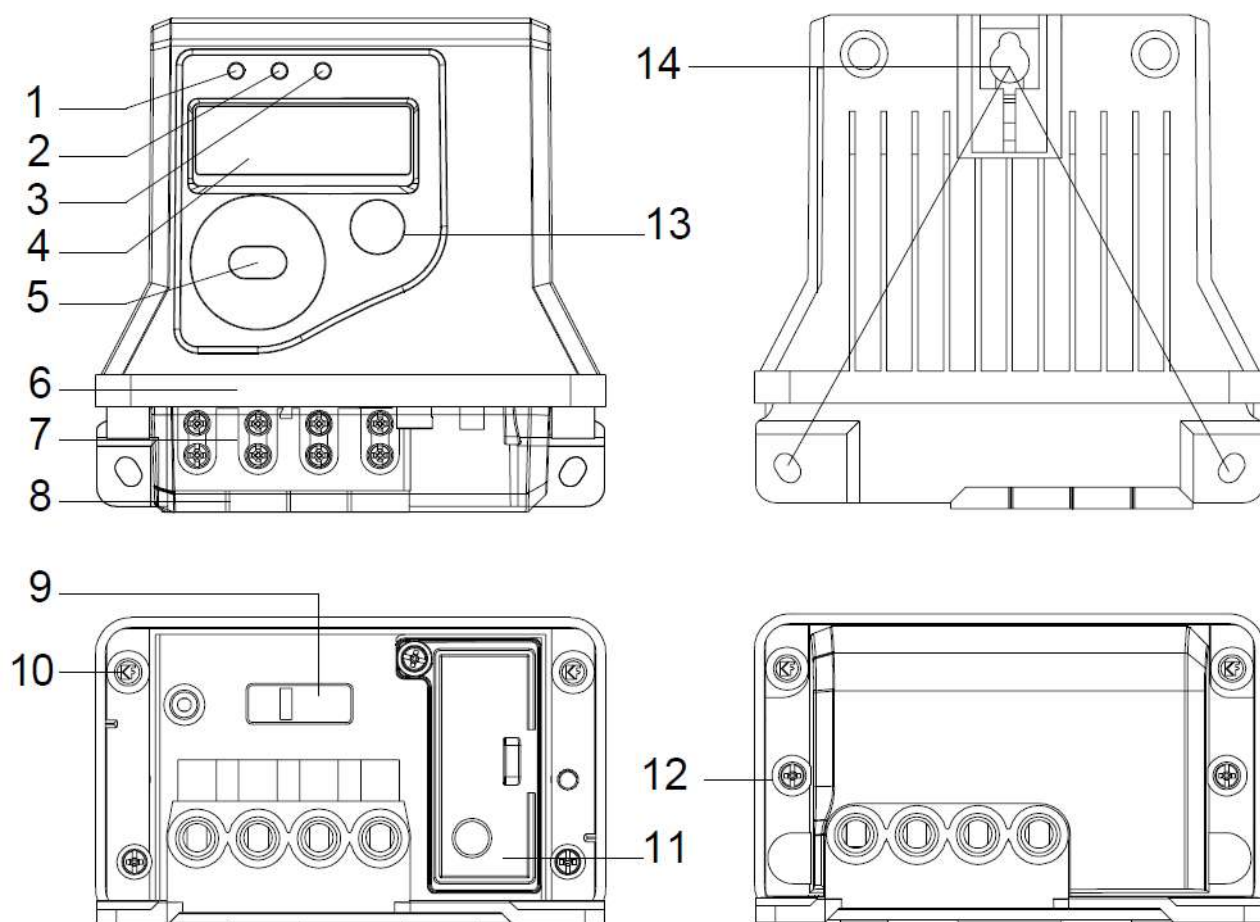


Figure - General view of meter

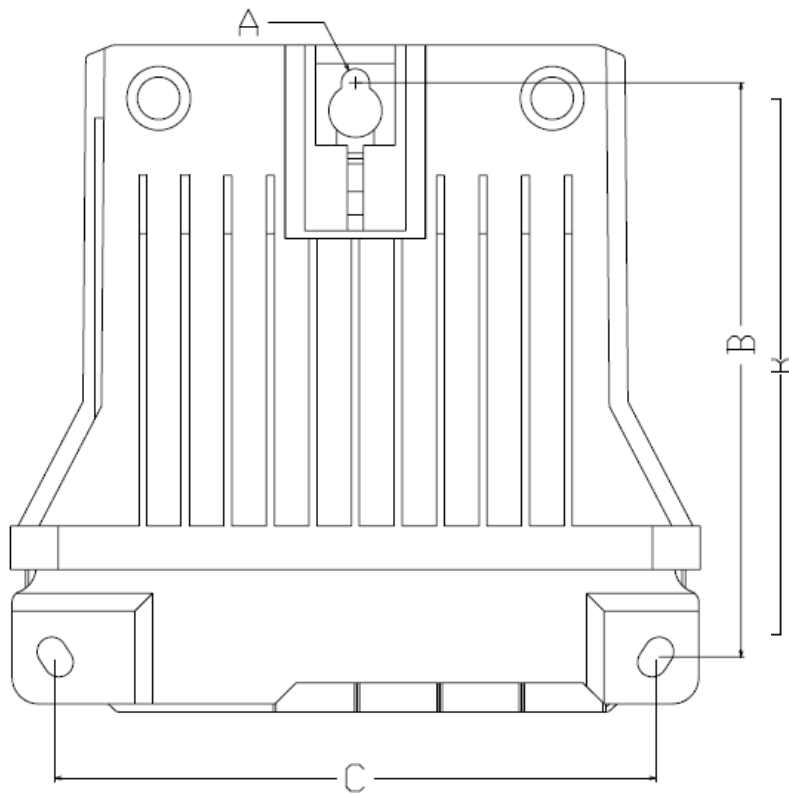
- 1. Active pulse LED
- 2. Reactive pulse LED
- 3. Communication indicator
- 4. LCD display window
- 5. Optical port
- 6. Meter cover
- 7. Main terminals

- 8. Terminal cover
- 9. External battery
- 10. Metrology cover sealing screw
- 11. Communication module
- 12. Terminal cover seal
- 13. Display button
- 14. Hook and mount points

Mechanical Features

Mounting

The meter uses three-point(A base triangle) mounting which comply with DIN 43857-3. The mounting holes accommodates 5.0 mm mounting screws. Two lower mounting holes are on both sides of the meter bottom part.



No.	Dimension(mm)
A	$\varnothing 5.3 \pm 0.3$
B	108 ± 2
C	113 ± 2

Figure —: Mounting point of meter

Terminals and Terminal Block

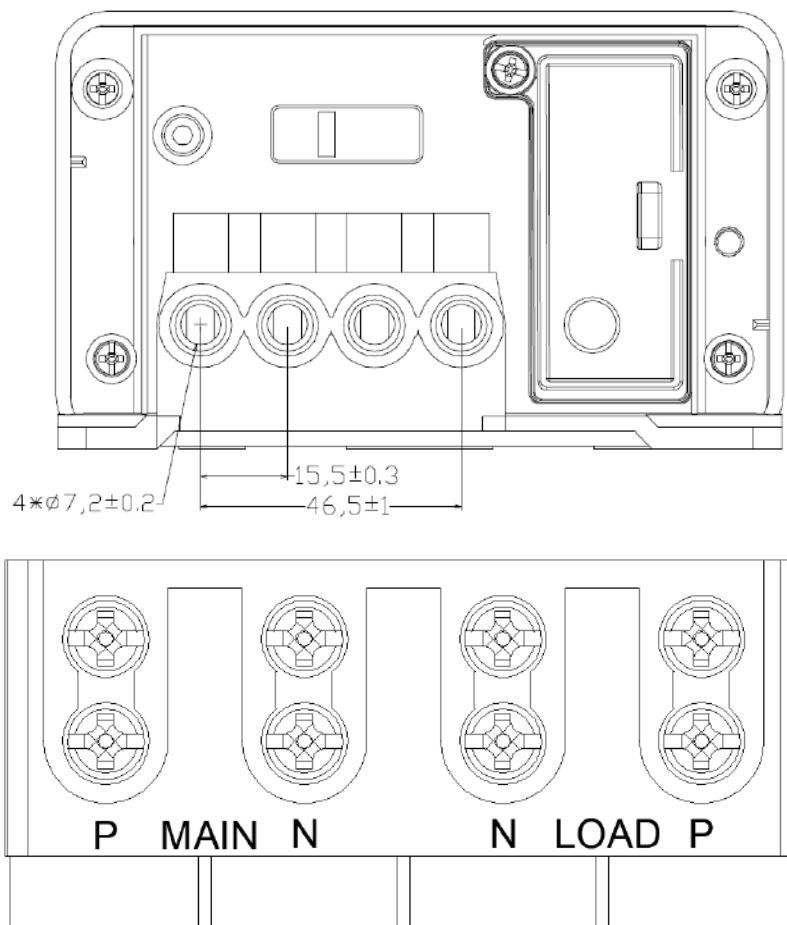


Figure - Dimensions of terminal of Single phase meter

Terminal screw: 7UUIOL;/

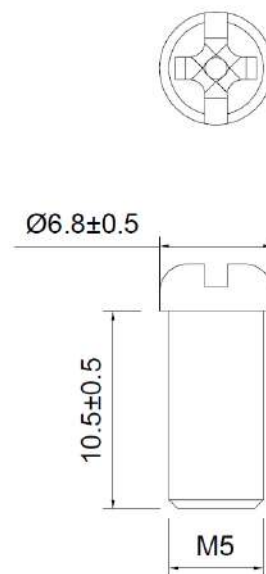


Figure - Dimensions of terminal screw

The terminal block is made of UV-resistance, high impact-resistance and self-extinguishing polycarbonate(PC+20%GF), the color of the terminal block is grey, and the material can pass a glow wire test at $960^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and duration of application is $30 \pm 1\text{s}$.

External Battery Slot

The meter supports an external battery slot for CR2032 type, which is protected by the terminal cover.

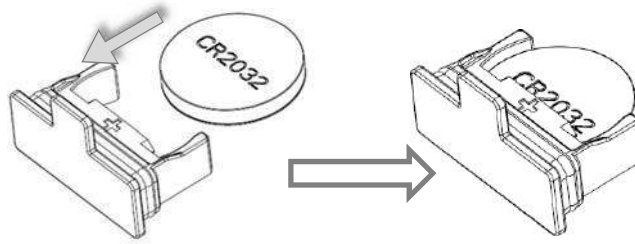
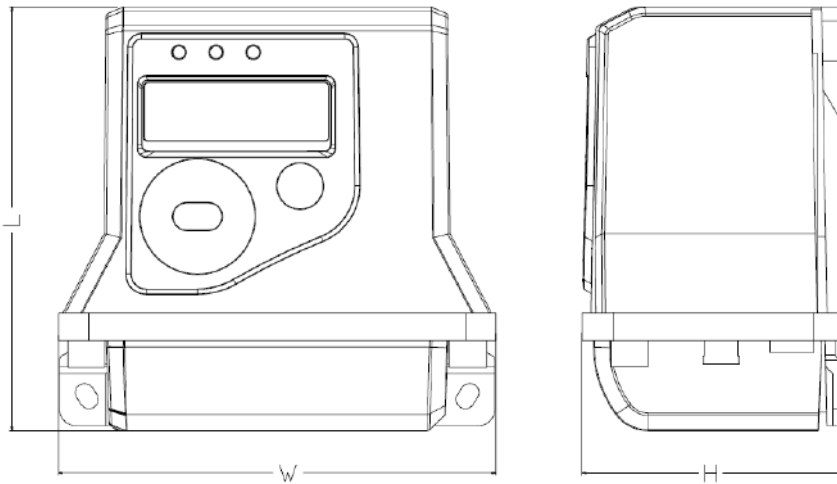


Figure - Battery installation

Dimensions and Weight

The dimension of meter is (L×W×H) , the weight of meter is $\leq 1.8\text{Kg}$.



No.	Dimension
L	126±2
W	130±2
H	78±2

Figure - Dimensions of single phase meter

Nameplate

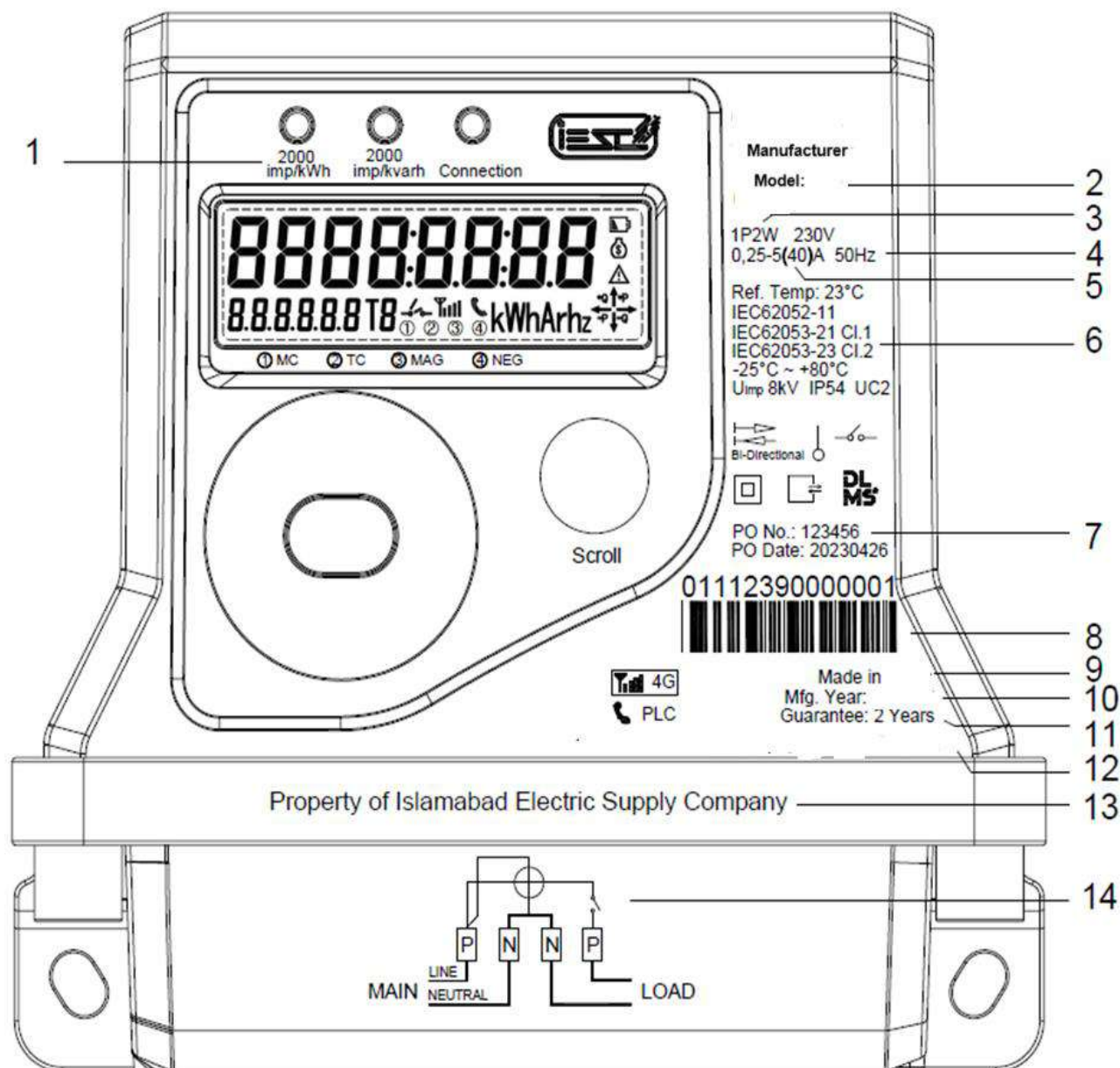


Figure - Marking of single phase meter

- | | |
|---------------------------------|-----------------------------------|
| 1. Meter constant | 8. Serial number |
| 2. Type designation | 9. Country of manufacture |
| 3. Number of phases and wires | 10. Month and Year of manufacture |
| 4. Rated frequency | 11. Guarantee period |
| 5. Current range, rated voltage | 12. Manufacturer's name |
| 6. Class index | 13. Property of utility |
| 7. Purchase Order No. & date | 14. Connection diagram |

Wiring Diagram

A wiring diagram is engraved on the terminal cover.

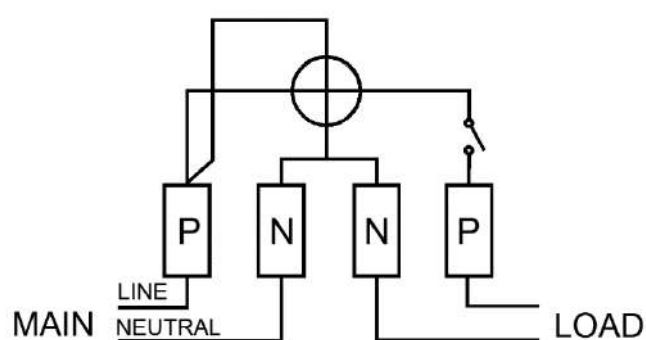


Figure - Wiring diagram of single phase meter

Sealing of Meter

The meter has five security seals:

- One seal is for communication module sealing
- Two seals are for terminal cover sealing
- Two seals (Metrology sealing) are for the meter cover

It is impossible to touch the meter metrology part unless physically and transparently destroy the metrology seals and the meter enclosure.

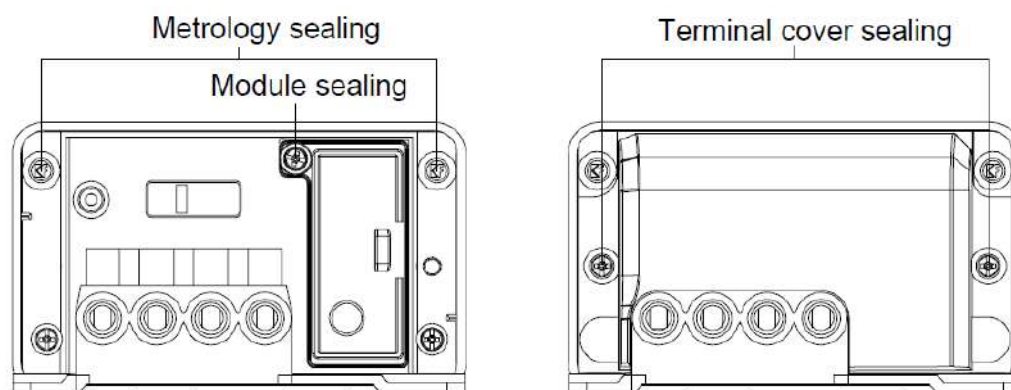


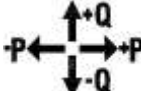
Figure - Sealing of single phase meter

LCD Screen of Meter



Figure - Diagram of LCD screen

Number/Symbol	Description
 (first row)	Display main information of meter, normally for energy registers.
 (left of second row)	OBIS Code
	ON: Meter in prepayment mode: OFF: meter in post-payment mode Blink: low credit warning when meter in prepayment mode
M G	not used
kWhArhz	The units include: A, V, kWh, kvarh, kvah, kW, kvar, kva, Hz, h, W, var, va, Wh, varh, vah..

	Phase indicators:- On: Normal voltage Off: Missing voltage Blink: Current reversal
	Tariff indicator.
	Relay status:
	 ON: relay disconnected  blink: ready for reconnect  ON: relay connected
	On: PLC module is plugged on the meter Off: PLC module is not detected.
	On: 4G/2G module is plugged on the meter Off: 4G/2G module is not detected.
	Displays the 4G/2G signal strength:  RSSI < -120 dBm  -120 dBm <= RSSI < -100 dBm  -100 dBm <= RSSI < -90 dBm  -90 dBm <= RSSI < -80 dBm  RSSI >= -80 dBm
	Low battery indicator: Blink: Battery is low. Off: Battery is normal.
	Self-diagnostic error, refers to chapter 5.11.1 self-diagnostics
	Indicate quadrant of power

	Four small circles are used to indicate four statuses/modes are activated or not. The status/modes are label printed on the meter cover. The status/mode is activated when the above relative circles is lighted. ① : Meter cover open, which needs to be cleared via command. ② : Terminal cover open, which needs to be cleared via command. ③ : Strong magnetic field, which needs to be cleared via command. ④ : Negative consumption flag, when the meter detects the reverse energy, it will be set, and it can't be cleared until a clear command is received or a billing reset is executed.
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Schedule of Technical Data

General		Remarks
1	Bidder's Name & Address	
2	Manufacturer's Name	
3	GPS Coordinates of Office Location	
4	Manufacturer's Manufacturing Address	
5	GPS Coordinates of Manufacturing Location	
6	Manufacturing Experience (Years)	
ENERGY METERS		
1	Model No.	
2	Type	
3	Current (Amp)	
I.	Minimum Starting Current at (mA) at Reference Voltage& Frequency	
II.	Basic	
III.	Maximum	
IV.	Overload Capacity (Amp)	
4	Voltage (Volts)	
I.	Nominal	
II.	Minimum	
III.	Maximum	
5	Accuracy Class	
I.	kWh	
II.	kVARh	
III.	kW	
6	No. of Elements (Nos.)	
7	Power Loss in Voltage Circuit (Max.)	
8	Power Loss in Current Circuit (Max.)	
9	Power Loss in Communication Module (Max.)	
10	Encapsulation Details	
I.	Current Sensor (Type)	
II.	Class of Insulation	
11	Max. Current that Energy Meter can withstand during short circuit for 0.5sec.	
12	Dielectric Strength	
I.	Impulse Voltage Test	
II.	A.C Voltage Test	
13	Insulation Resistance of Energy Meter	
14	Material(s) of	
I.	Case Cover Base Standard(s) to which material(s) are complies with	
II.	Security Box Standard(s) to which material(s) are complies with -	

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III.	Terminal Block Standard(s) to which material(s) are complies with	
15	TERMINALS	
I.	No. of Terminals	
II.	Fixed Terminal Type	
III.	Terminal Material	
IV.	Moving Terminal and Screw Standard(s) to which material(s) are complies with	
16	Printed Circuit Board (All the above shall be indicated on drawing to be supplied with the bid)	
17	Temperature rise of meter	
18	Center to center clearance between different phases	
I.	Creepage Distance	
II.	Clearance	
19	Whether the Energy Meter is compliant to the reference standards for testing mentioned in Annex-C of the specs	
20	Whether the Energy Meter has the following characteristics	
I.	Basic data recording and storage: (as per clause 8 of the spec.), give details	
II.	Back-up Battery (as per clause 8.3 of the spec.), give details	
III.	Security Features, Events recording and Diagnostics: (as per clause 7.2 of the spec.), give details	
IV.	Display (as per clause 8.6 of the spec.), give details	
V.	Energy Meter Programming, Software and Security: (as per clause 10 of the spec.) give details.	
21	Operating ambient temperature range	
I.	Specified Operating Range	
II.	Limit Range of Operation (Extreme Condition)	
III.	Limit Range for storage and Transport	
22	Size and No. of Digit of LCD Display	
23	Whether Energy Meter have the upgradeability option for AMI.	
24	What is the sampling rate	
25	IP Class of Energy Meter	
26	No. of Digits for following Features	
I.	kWh	
II.	kVArh	
III.	Demand kW	
IV.	Cumulative kW	
V.	No. of Reset Digits	
27	What values/readings are controlled through resetting device?	
28	Detail of resetting device with sealing arrangement (give drawing)	
29	Min. No. of tariff/rates for which the tariff register can be programmed for	

[illegible]

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Annex 5 Communication Module Specification

5.1 4G/2G Communication Module

Overview

This product adopts 4G/2G wireless transmission network as communication media to fulfill reading, monitoring and controlling on meters. It supports the HES to collect the data of meters, to monitor the power quality and working status of meters, and to remotely control the working of them. The module is equipped with SIM Card, UART interface and power supply. A unify-designed communication module support both single phase and three phase meters, easily maintenance, with plug & play technology, can install or replace module without power off.

Abbreviation

4G	The 4 th generation mobile communication technology
2G	2-Generation wireless telephone technology
UART	Universal Asynchronous Receiver/Transmitter
TRP	Total Radiated Power
TIS	Total Isotropic Sensitivity
SWR	Voltage Standing Wave Ratio

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Main Technical Features

Wireless Transmission Features

General Function	Performance & Availability	- FDD-LTE CAT1: B1(2100 MHz)/B3(1800 MHz)/B5(850 MHz)/B8(900 MHz) - 2G: 900/1800 MHz - Control via AT commands - Operation temperature: -25°C to +80°C - Max transmit power: LTE CAT1 B1/B3/B5/B8: 23±2.7dBm 2G 900M/1800M: 33dBm/30±2dBm - Support reconnection behavior after detecting an unexpected interrupted communication session.
	Modulation	LTE CAT1: QPSK/16QAM 2G: GMSK
	Data rate	LTE CAT1: 10Mbps 2G: 85.6Kbps
	Roaming	Support national roaming between 4G/2G networks of different national telecom providers.
	SIM	Support 2FF SIM card. Support IMEI lock of the USIM card.
	Indications of 4G/2G signal strength	Indicate 4G/2G signal strength (RSSI) in a minimum of 4 separate levels. Refer to LCD display. RSRP, RSRQ, RSSI and SINR value are readable.
	Antenna	Default built-in antenna, the modem module can be replaced with another version that supports external antennas. built-in antenna Peak Gain: 820-970MHz 3.89 dBi 1710-2170MHz 3.56 dBi
Access and connection	Wake-up	Support fully qualified domain names. Receive and store the IPv4 or IPv6 addresses of the primary and secondary address when establishing a PDP context based on the DHCP protocol. Support data push.
	Authentication and security	Changeable APN/password Support RADIUS authentication using PAP or CHAP Network access information is not saved on the SIM cards Communication settings to be remotely configurable
	Assign IP address	4G/2G module support both dynamic IP address assignment and static IP address

Table - 1 Description of wireless transmission technical features

Physical Features

The dimension of 4G/2G module is(L×W×H) 97.2mm×64.6mm×36.6mm(±0.2mm).

The module has 15.0V±5% (DC) power supply coming from the meter with a maximum pulse current consumption of 850mA. Standby power consumption is less than 30mA, and power consumption is less than 200mA when communicating.

The module communication interface to the Meter using UART interface.

The module is equipped with a SIM card holder, supporting 1.8V/3V USIM card.

Mechanical

General View

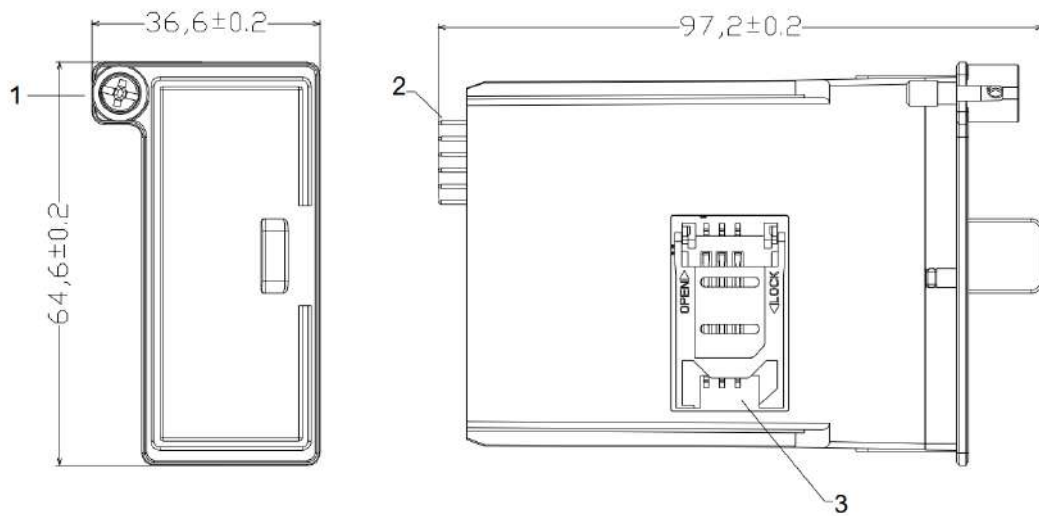
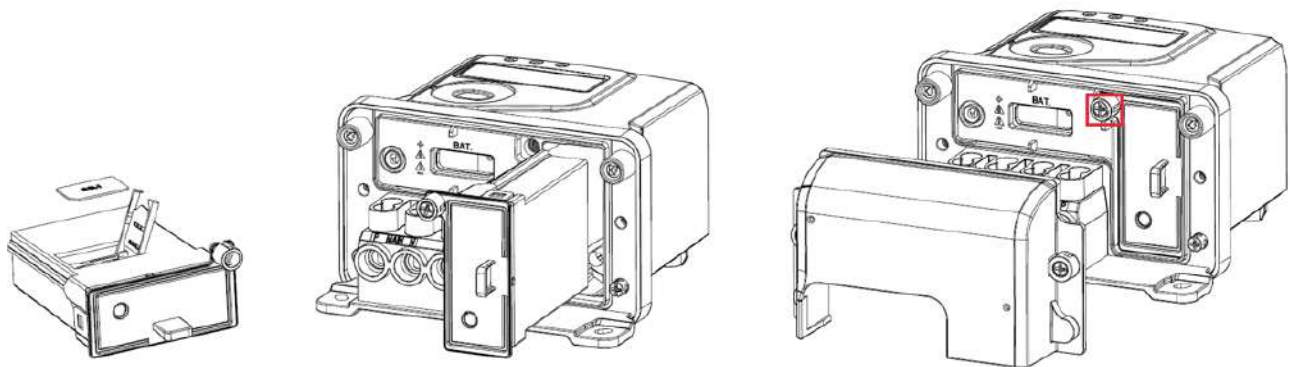


Figure - 1 General view of 4G/2G module

1. 4G/2G module sealing screw
2. DC power supply and UART interface
3. SIM card socket

Mounting

The module is installed in a plastic housing and mounted inside the meter with sealing screw.



Step1. Insert SIM card

4G/2G Module Communication Status Display

One green-color LED on the meter indicates the 4G/2G module communication status:

LED Status	Indicating Status
Off	No communication module is plugged or communication module fails
Blink 0.5s on, 3s off	No SIM card insert or SIM card cannot be detected
Blink 1s on, 0.2s off	Module network registering
Blink 1s on, 3s off	Module network registration is rejected
Blink 1s on, 1s off	Module is registered succeed, TCP connection is ongoing
Blink 0.2s on, 0.2s off	Remote communication is ongoing
On	Meter is registered succeed, no remote communication is ongoing

Table - 2 Communication status of 4G/2G module

The wireless signal strength of 4G /2G module can be easily readout through the meter LCD.

Number/Symbol	Description
	On: 4G/2G module is inserted in the meter Off: 4G/2G module is not detected.
	Displays the 4G/2G signal strength:  RSSI < -120 dBm (Very poor Signal)  -120 dBm ≤ RSSI < -100 dBm (Poor Signal)  -100 dBm ≤ RSSI < -90 dBm (Bad signal)  -90 dBm ≤ RSSI < -80 dBm (Good signal)  RSSI ≥ -80 dBm (Excellent signal)

Table - 3 Description of wireless signal strength on meter LCD screen

Firmware Upgrade

The communication module support to upgrade firmware remotely. FOTA (Firmware Over-The-Air) upgrade mode is adopted. In-flight download software upgrade of module refers to providing firmware upgrade services for modules through cloud upgrade technology. Users can obtain intelligent terminal system upgrade packages on demand and perform cloud upgrade through FOTA. Complete system repair and optimization.

SIM Card

SIM Card Technical Features

The SIM card provided by the operator needs to meet the following requirements, to get the best performance.

Temperature	Operation temperature: -25°C to +80°C
Dimensions	Plug-in Card(2FF): length 25mm, width 15mm, thickness 0.8±0.08mm Do not use Micro or Nano SIM card
Voltage	3.0V and 1.8V
Reliability	Industrial grade card Meet 1000 hours of dual 85 testing (85°C and 85% humidity)

Table - 4 SIM Card Technical Features

External antenna module

When the signal in the area where the meter is located in poor signal area and the build-in antenna module signal cannot communicate, supplier shall provide an external antenna module to replace the build-in antenna module for the meter.

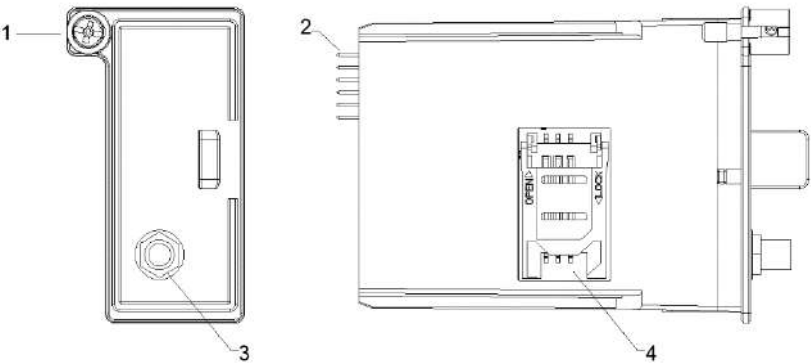


Figure - 4 General view of 4G/2G external antenna module

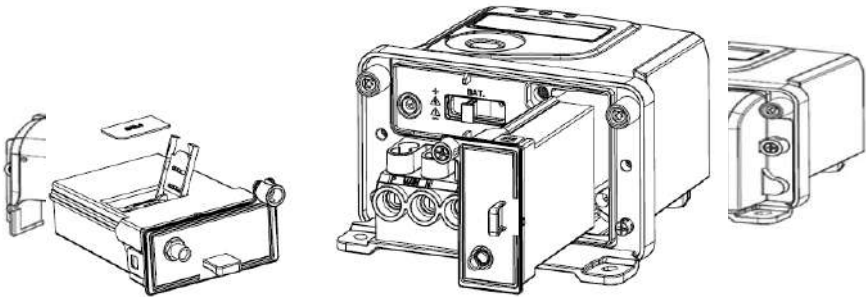
1. 4G/2G module sealing screw
2. DC power supply and UART interface
3. SMA external antenna interface
4. SIM card socket

There have a SMA pre-cut hole design on meter terminal cover, the hole with a pre-cut on the terminal cover as a default configuration, if the meter with PLC module, and 4G/2G modules with built-in antennas, the pre-cut hole will be kept.

In case of a external antenna 4/2G module is equipped, the pre-cut hole on the terminal cover should be removed for external antenna installation.

For single phase meter:

Step 1. Insert SIM card Step 2. Insert module to meter



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Step 3. Connect external antenna through terminal cover Step 4. Install the module seal, and install terminal cover and put the rubber plug into the hole on terminal cover

Figure -5 External antenna installation for Single-phase meter



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Reference Standards

1. Electrical Standards

No.	Standard No.	Title
1	IEC 62054-21	Electricity metering equipment(a.c.)-General requirements, tests and test conditions-Part 21: Tariff and load control equipment
2	EN55032:2015/A1:2020	Electromagnetic compatibility of multimedia equipment - Emission Requirements
3	EN55035:2017	Electromagnetic compatibility of multimedia equipment - Immunity requirements
4	IEC 60068-2-1:2007	Environmental testing-Part 2-1: Tests-Test A: Cold
5	IEC 60068-2-2:2007	Environmental testing-Part 2-2: Tests-Test B: Dry heat
6	IEC 60529 2013	Degrees of protection provided by enclosures (IP Code)
7	IEC 62052-31 2015	Electricity metering equipment (AC) General requirements tests and test conditions Part 31 Product safety

2. 4/2G module Standards

No.	Standard No.	Title
1	3GPP Release 13 LTE Cat.1bis	-
2	ETSI TS 102 221	Smart Cards; UICC-Terminal interface; Physical and logical characteristics (Release 15)

Module Configuration List

Module supports configurations of the following parameters for network functions via DLMS protocol.

Item	Class	Obis Code	Attri	Description
Modem setup	45	0-0:25.4.0.255	2	Configuration for APN
			3	Configuration for Pin Code
PPP setup	44	0-0:25.3.0.255	5	Configuration for PPP_authentication, include username and password
TCP-UDP setup	41	0-0:25.0.0.255	6	Configuration for TCP Inactivity timer, if no TCP traffic and the timer is timeout, TCP connection for reading is released.
Auto connect (For push)	29	0-0:2.1.0.255	3	Configuration for Push retry times
		0-0:2.1.0.255	4	Configuration for Push retry interval
		0-0:2.1.0.255	6	Configuration for Push address, support both IP and domain name
FOTA	1	0-1:94.31.22.255	2	Configuration for FOTA URL
	9	0-2:10.0.1.255	2	Configuration for FOTA enable

APN: It's a network access technology and APN is a parameter that must be configured when accessing the Internet through a module.

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PinCode: Personal Identification Number, The PIN code of the SIM card is a security measure to protect the SIM card and prevent others from stealing the SIM card. Usually, the PIN code is default disabled. If the PIN code is enabled, a four digits PIN code is needed for inputting for verification after SIM card has power supply first time.

PinCode is enabled or disabled, it depends on the SIM card suppliers.

5.2 PLC Communication Module

Overview

This document is to describe the technical specification of G3-PLC module used for single phase and three phase meter. The module is designed for transfer the meter data to DCU. It supports multi-modulation, automatic mapping, routing function etc. A unify-designed communication module support both single phase and three phase meters, easily maintenance, with plug & play technology, can install or replace module without power off. It is a standard product which comply with international G3-PLC alliance's standard.

24 Abbreviation

AARE	Application Association RElease
AARQ	Application Association ReQuest
ACSE	Application Control Service Element
AMI	Advanced Metering Infrastructure
COSEM	Companion Specification for Energy Metering
D8PSK	Differential 8 Phase Shift Keying
DBPSK	Differential Binary Shift Keying
DLMS	Device Language Message Specification
DQPSK	Differential Quadrature Phase Shift Keying
EAP	Extensible Authentication Protocol
EAP-PSK	EAP Pre-Shared Key
EUI	Extended Unique Identifier
GMK	Group Master Key
ICMP	Internet Control Message Protocol
LBA	LoWPAN Bootsstraping Agent
LBD	LoWPAN Bootsstraping Device
LBP	LoWPAN Bootsstraping Protocol
LBS	LoWPAN Bootsstraping Server
LOADng	6LOWPAN Ad-hoc on-Demand distance vector routing – new generation
MAC	Medium Access Control
MIB	Management Information Base
NDP	Neighbour Discovery Protocol
PAN	Personal Area Network
UDP	User Datagram Protocol

25 Main Technical Features

Technical features	Description
Power supply	Voltage: DC15.0V±5% Current: 800 mA
PLC Type	OFDM, G3-PLC
Communication phase	1P meter: Phase and Neutral line
	3P meter: L3 phase and Neutral line
Communication frequencies	FCC Band: from 154.687 kHz to 487.5 kHz
Modulation	ROBO/DBPSK/DQPSK/D8PSK
Data rate	ROBO: 21kbps; DBPSK: 62.2kbps; DQPSK: 124.5kbps, D8PSK: 234.3kbps
Power consumption	Standby: ≤15mA @15V (Idle)
	Communication without load(≥50ohms): ≤40mA@15V
	Communication with 2ohms load: ≤500mA@15V
Ambient condition	Operation temperature range: -25°C to 70°C
	Limit operation temperature range: -25°C to 80°C
	Temperature for storage and transport: -25°C to 80°C
	Max relative humidity: up to 95%, non-condensing
Dimension	97.2mm×64.6mm×36.6mm(±0.2mm)

Table 1 - Description of technical features

26 Mechanical

26.1 General View

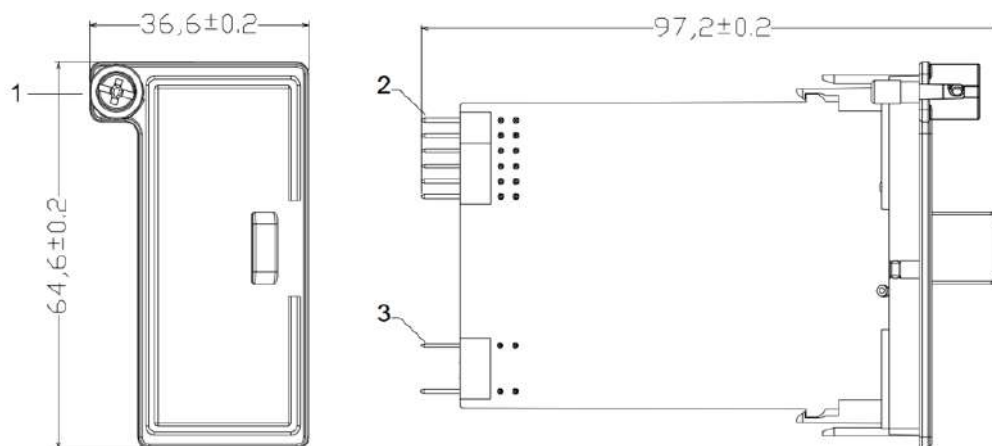
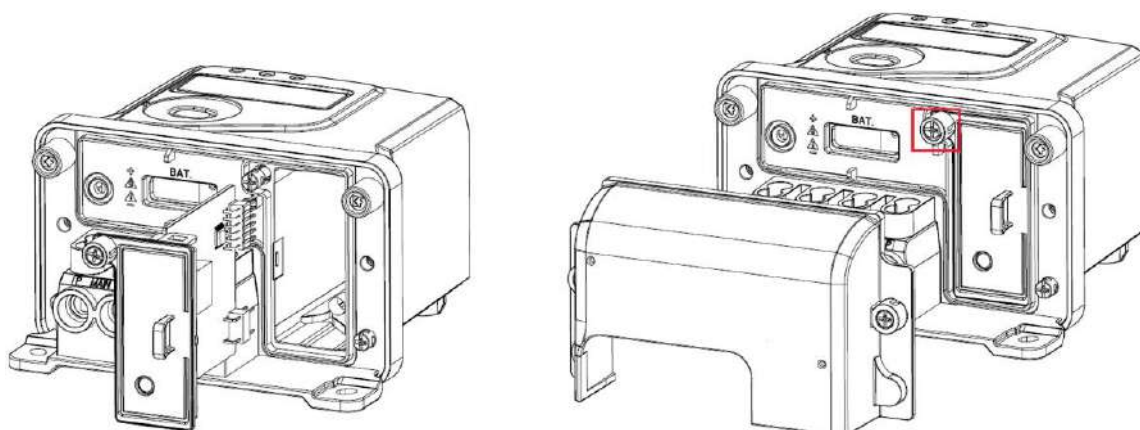


Figure - 1 General view of PLC module

1. PLC module sealing screw
2. DC power supply and UART interface
3. PLC communication interface

26.2 Mounting

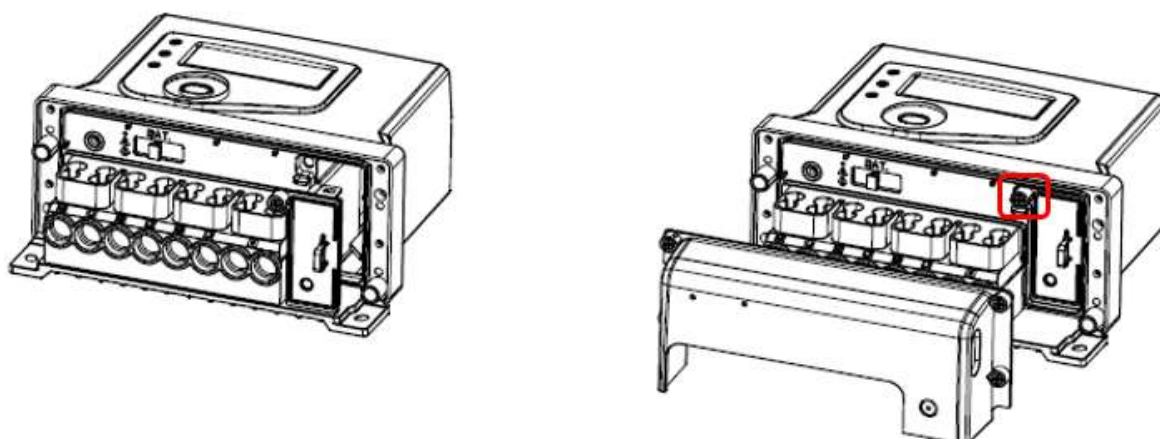
The module is installed in a plastic holder and mounted inside to the meter with sealing screw.



Step1. Insert module to meter

Step2. Install the module seal, then close terminal cover

Figure - 2 Mounting for Single-phase meter



Step1. Insert module to meter

Step2. Install the module seal, then close terminal cover

Figure - 3 Mounting for Three-phase meter

27 Function

28 Communication Status Indicator

One green LED is equipped on meter to indicate the network status of PLC module. The detail as below:

LED Status	Indicating Status
Off	No communication module or communication module fails
Blink 0.5s on, 3s off	Communication module is detecting network
Blink 1s on, 0.2s off	Communication module is registering to network for the first time
Blink 1s on, 3s off	Communication module is trying to registering to network again due to the register request was rejected
Blink 1s on, 1s off	Communication module is re-registering to network due to the register request was not replied
Blink 0.2s on, 0.2s off	Data exchanging with DCU
On	Meter registered succeed, no data exchanging with DCU

Table 2 - Description of LED status

29 Electrical Features

30 Output Level

G3-PLC modems working in the FCC band and conform to the definition in ITU-9901 [1] regarding the output specification relating to the FCC band.

31 Impedance Features

In order to get a better PLC communication performance, a high performance and good quality couplers and analog front end components are used for the communication module, the reception input impedance of module is over 50 ohms, and the transmit output impedance of module is less than 5 ohms in the FCC frequency range [154 kHz - 500 kHz]. The design and test method follow clause 5 of EN 50065-7 [4].

32 DLMS/COSEM Application Profiles and Services

The DLMS/COSEM communication via the LAN interface is based on UDP over the IPv6 stack in combination with the G3-PLC transport layer.

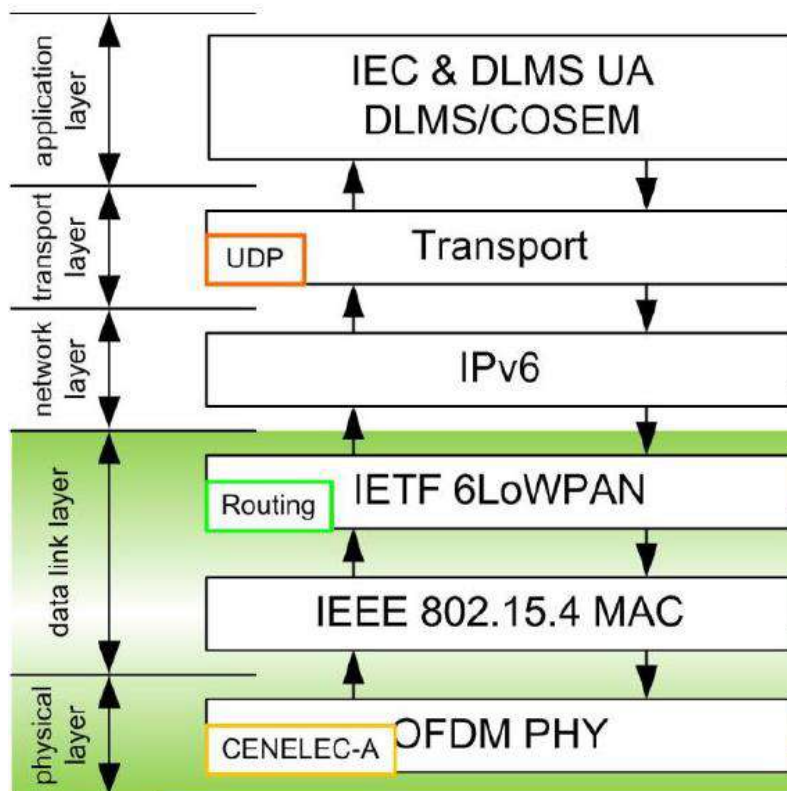


Figure - 4 Block diagram overview

33 UDP/IP Profile

The DLMS COSEM application connects to the TCP/IP or UDP/IP layer using an additional sublayer called the

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DLMS/COSEM wrapper. The G3-PLC module support the DLMS/COSEM wrapper's payload up to 1224 bytes.

The UDP/IP channel is configured and managed via the following COSEM objects:

Object / Attribute Name	Class	Ver	OBIS code
TCP-UDP setup	41	0	0-0:25.0.0.255
IPv6 setup	48	0	0-0:25.7.0.255

Table 4 - UDP/IP channel configuration

The UDP server port number of the PLC module used by the “COSEM Server Application Layer” is set to 61616 (0xF0B0) by default. It also could be modified through DLMS/COSEM objects “TCP-UDP setup”.

The destination port is 61631 when DLMS/COSEM push service used.

34 G3-PLC Network Management

The G3 channel is configured and managed via the following COSEM objects:

Object / Attribute Name	Class	Ver	OBIS code
MAC Address Setup	43	0	0-0:25.2.0.255
G3-PLC 6LoWPAN adaptation layer setup	92	2	0-0:29.2.0.255
G3-PLC MAC setup	91	2	0-0:29.1.0.255
G3-PLC MAC layer counters	90	1	0-0:29.0.0.255
G3-PLC BandPlan	1	0	0-0:94.43.128.255
G3-PLC PSK_KEK	1	0	0-0:94.43.133.255
G3-PLC PSK	1	0	0-0:94.33.128.255
G3-PLC Timeout	1	0	0-0:94.33.10.255
G3-PLC KeepAlive	1	0	0-0:94.33.11.255
G3-PLC MacCoherentTransmission	1	0	0-0:94.33.12.255
G3-PLC MacDeviceTable	1	0	0-0:94.33.13.255
G3-PLC AdpLBPAssociationSetup	1	0	0-0:94.33.14.255
G3-PLC RREPWait	1	0	0-0:94.33.15.255
G3-PLC LQIRange	1	0	0-0:94.33.16.255

Table 5 - G3 channel configuration

MAC Address Setup

The MAC address setup holds the EUI-64 address of the G3-PLC modem.

G3-PLC 6LoWPAN adaptation layer setup

This object holds the necessary parameters to set up the 6LoWPAN adaptation sub-layer and provides access to information settings and tables that might be necessary for the network management. Refer to DLMS Blue Book Edition 14.

G3-PLC MAC setup

This object holds the necessary parameters to set up the MAC IEEE 802.15.4 sub-layer and provides access to information settings and tables that might be necessary for the network management. Refer to DLMS Blue Book Edition 14.

G3-PLC MAC layer counters

This object stores the counters relating to exchanges between PHY and MAC. The purpose of these counters is to provide statistical information for maintenance.

Note: when a counter reaches its maximum value (0xFFFFFFFF), it is automatically reset.

G3-PLC BandPlan

This object allows the identification of the current bandplan in use.

The supported bandplan is FCC band.

G3-PLC PSK_KEK

This object allows changing the PSK Key Encryption Key (128 bits / 16 octets) of the module.

The new PSK_KEK is wrapped by the AES-128 key wrap algorithm, using the current PSK_KEK as the wrapping key.

G3-PLC PSK

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This object allows changing the PSK (128 bits / 16 octets) of the G3-PLC module.
The new PSK is wrapped by the AES-128 key wrap algorithm, using the dedicated PSK KEK as the wrapping key.
After the successful change of the PSK (confirmation to the DLMS client), the meter returns to the non-associated state and re-starts it's joining process for the reconnection to the PAN coordinator.

G3-PLC Timeout

This data defines the time, in minutes, after which a meter that has not been individually addressed (meaning the meter has not received any Path Discovery message, ICMP ping, nor unicast DLMS APDU) returns to the non-associated state and loses its PAN coordinator (DCU). A value equal to 0 is equivalent to cancel the use of the related time-out-not-addressed counter.

G3-PLC KeepAlive

This object defines the parameters used by the “keep alive” mechanism.

KeepAlive ::= structure

```
{
    keep_alive_enable: boolean
    keep_alive_start_time: long-unsigned
    keep_alive_send_period: unsigned
}
```

G3-PLC MacCoherentTransmission

This object indicates the specific modulation scheme to set in the tone map response.

- 0 = only differential modulation scheme shall be set in tone map response
- 1 = only coherent modulations scheme shall be set in tone map response
- 2 = Either coherent or differential scheme may be set in tone map response.

G3-PLC MacDeviceTable

This object describes a table of Device-Descriptor entries.

array DeviceDescriptorEntry

DeviceDescriptorEntry ::= structure

```
{
    Pan_id:                long-unsigned
    Short_address:         long-unsigned
    Frame_counter:         double-long-unsigned
}
```

G3-PLC AdpLBPAssociationSetup

This attributes contains parameters for Bootstrapping procedure setup.

AdpLBPAssociationSetup ::= structure

```
{
    AssociationMaxRetry:    unsigned
    AssociationRandWaitTime:unsigned
    AssociationAlterPAN:   boolean
    JoinLQIThreshold:      unsigned
    ActiveScanDuration:    unsigned
}
```

G3-PLC RREPWait

This object defines the delay for an RREP frame to wait in seconds before being generated after either the arrival of the first RREQ or the transmission of the latest RREP.

G3-PLC LQIRange

The LQI range defines the lower and higher LQI value used for the metric computation.

LQIRange ::= structure

```
{
    adp_low_lqi_value:      unsigned
    adp_high_lqi_value:     unsigned
}
```

Annex 1 Reference Standards

No.	Standard	Release time
1	Recommendation ITU-T G.9901 (06/2017): Narrowband Orthogonal Frequency Division Multiplexing Power Line Communication Transceivers – Power Spectral Density Specification	2017
2	Recommendation ITU-T G.9903 Amendment 1 (05/2021): Narrowband Orthogonal Frequency Division Multiplexing Power Line Communication Transceivers for G3-PLC networks Amendment 1	2021
3	IEEE 802.15.4: IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)	2006
4	EN50065-7: Signaling on low voltage electrical installations in the frequency range 3kHz to 148,5 kHz – Part 7 : Equipment Impedance	2011
5	DLMS UA 1000-1 Ed. 14: 31 August 2020 COSEM Interface Classes and OBIS Object Identification System—Blue Book	2020

Annex 2 Block diagram and Circuit diagram



5.3 Shipment file

1 Overview

This document specifies the shipment format for importing meters and DCUs into the system. As required in the SOR, the device should be imported into Device Park System, and these information will be synchronized to MDMS and HES through interface.

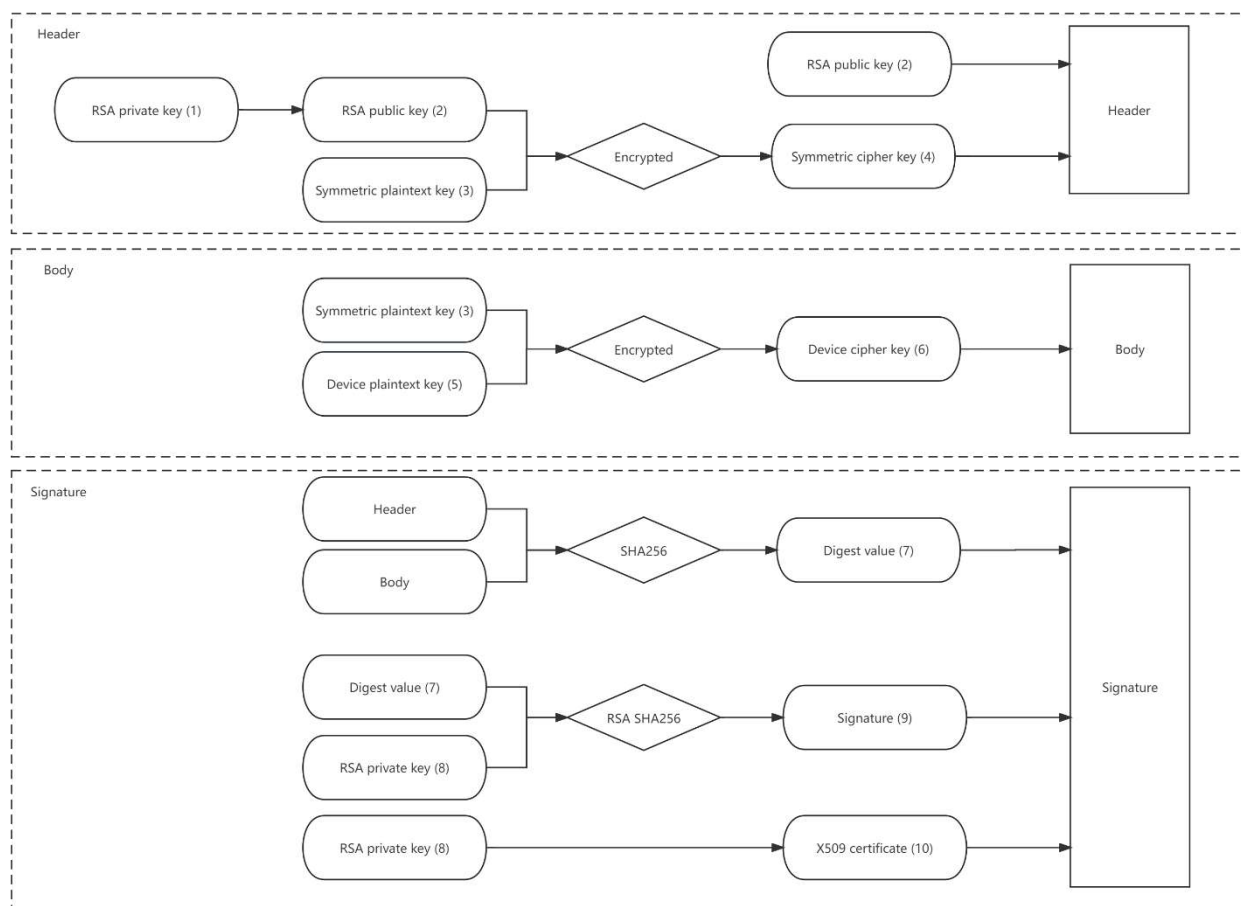
1.1 Shipment File Description

The XML file records all necessary device information. Users can import excel files to the Device Park System.

1.2 Supported Device

- Meter
 - 1) Single Phase Meter
 - 2) Three Phase Meter
 - 3) CT Meter
 - 4) CT/VT Meter
- DCU

2 Shipment file Generation and Delivery



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2.1 Shipment-file file generation process

Step 1:

Export the basic information and key information of the device from the production system, Directly fill in the basic information of the device into the corresponding node of the XML file.

Step 2:

Randomly generate Symmetric plaintext key(3), use the RSA public key(2) provided by the customer, perform asymmetric encryption, generate Symmetric cipher key(4), and put this information in the "/Envelope/Header/Security/Symmetric_key/Cipher_value" node. And put the RSA public Key (2) in the "/Envelope/Header/Security/Public_key/Modulus" node.

Step 3:

Use Symmetric plaintext key(3) to symmetrically encrypt Device plaintext key(5), generate Device cipher key(6), and place it in the node corresponding to Body.

Step 4:

Using all the contents in the "<Header/>" and "<Body/>" nodes of the shipment-file file, use the SHA256 algorithm to derive the Digest value (7) and place it in "/Envelope/Signature/SignedInfo/Reference/DigestValue" node.

Use RSA private key(8) to encrypt Digest value(7) to generate Signature(9) and place it in the "/Envelope/Signature/SignatureValue" node.

Then generate X509 certificate (10) through RSA private key (8) and place it in the "/Envelope/Signature/KeyInfo/X509Data/X509Certificate" node.

Step 5:

After the generation of the XML file, the whole XML file will be encrypted again by certificate (10) through S/MIME using AES-256-CBC cipher, and the file will be converted to DER format.

2.2 Shipment-file file parsing process

Step 1:

Use the RSA private key (8) mentioned above to decrypt the whole XML file.

Step 2:

Use the certificate (10) generated by the RSA private key (8) mentioned above to perform signature verification on the Signature and verify the consistency of the file.

Step 3:

Obtain the Symmetric cipher key(4) in "/Envelope/Header/Security/Symmetric_key/Cipher_value", and use RSA private key(2) to perform RSA decryption to obtain the Symmetric plaintext key(3).

Step 4:

Use Symmetric plaintext key(3) to decrypt Device cipher key(6) and obtain Device plaintext key(5).

Remark:

RSA private key (1) and RSA public key (2) are in the device_key folder.

RSA private key (8) and certificate (10) are in the signiture_key folder.

3 XML Structure

3.1 Base Structure

```

1  <?xml version="1.0" encoding="utf-8"?>
2  <Envelope xmlns:tns="http://schemas.kaifa.cn/shipmentfile/2016-08">
3      <Header>
4          <Security>
5          </Security>
6      </Header>
7      <Body>
8          <Shipment>
9              <Main>
10             </Main>
11             <Header>
12             </Header>
13             <Device_attributes>
14             </Device_attributes>
15         </Shipment>
16     </Body>
17     <Signature>
18     </Signature>
19 </Envelope>

```

• Element description

No.	Element	Parent Elements	Description	Required
2	Envelope		Root of the xml	Yes
3	Header	Envelope		Yes
4	Security	Envelope/Header	Secret key information	Yes
7	Body	Envelope		Yes
8	Shipment	Envelope /Body	Shipment Information The <Body> element contains only one < Shipment >	Yes
9	Main	Envelope/Body/ Shipment		No
11	Header	Envelope/Body/ Shipment		No
13	Device_attributes	Envelope/Body/ Shipment	Device attributes. If there are multiple devices, there will be multiple The <Shipment > element contains only one or more <Device_attributes>	Yes
17	Signature	Envelope	Signature Information	Yes

3.2 Security

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```

1  <Security>
2      <Symmetric_key>
3          <Cipher_value></Cipher_value>
4      </Symmetric_Key>
5      <Public_key>
6          <Modulus></Modulus>
7          <Exponent></Exponent>
8      </Public_key>
9      <Certification_date></Certification_date>
10 </Security>

```

NO	XML line number	Attribute Name	Required
1	2	Symmetric_key	Yes
2	5	Public_key	Yes
3	9	Certification_date	Yes

- Symmetric Key**

```

1  <Symmetric_key>
2      <Cipher_value></Cipher_value>
3  </Symmetric_Key>

```

No.	Element	Parent Element	Description	Length	Type	Required
2	Cipher_value	Envelope/Header /Security/Symmetri c_key		Indefinite length	String	Yes

- Public Key**

```

1  <Public_key>
2      <Modulus></Modulus>
3      <Exponent></Exponent>
4  </Public_key>

```

No.	Element	Parent Element	Description	Length	Type	Required
2	Modulus	Envelope/Header /Security/Public_key		Uncertain length	String	Yes
3	Exponent	Envelope/Header /Security/Public_key		Uncertain length	String	Yes

- Certification Date**

```

1  <Certification_date></Certification_date>

```

No.	Element	Parent Element	Description	Length	Type	Required
1	Certification_date	Envelope/Header /Security/ Certification_date		19	String (yyyy/mm/dd hh:mi:ss)	Yes

3.3 Shipment

- Main**

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```

1 <Main>
2   <Company></Company>
3   <Supplier></Supplier>
4 </Main>

```

No.	Element	Parent Element	Description	Length	Type	Required
2	Company	Envelope/Body/ Shipment	For example: JSC Uzbekenergo	Indefinite length	String	Yes
3	Supplier	Envelope/Body/ Shipment	For example: KAIFA	Indefinite length	String	Yes

- **Header**

```

1 <Header>
2   <Configuration_version></Configuration_version>
3   <Delivery_date></Delivery_date>
4 </Header>

```

No.	Element	Parent Element	Description	Length	Type	Required
2	Configuration_version	Envelope/Body /Main		Indefinite length	String	No
3	Delivery_date	Envelope/Body /Main	Device delivery date	19	String YYYY/MM/DD HH24:MI:SS 2018/11/15 00:00:00	Yes

- **Device_attributes**

Device attributes information. If there are multiple devices, there will be multiple <Device_attributes> </Device_attributes> elements under < Shipment >.

4 Device Attributes

```

<Device_attributes>
  <General>
    <Serial_number>09122400021426</Serial_number>
    <Logic_device_name>KTM1020100021426</Logic_device_name>
    <Device_type>01</Device_type>
    <Device_batch_number>2024-08-21</Device_batch_number>
    <Device_pallet_number>P11A0000000044</Device_pallet_number>
    <Device_box_number/>
    <Date_of_manufactory>20240706</Date_of_manufactory>
    <Hardware_version>V0.1</Hardware_version>
    <App_software_version>000004</App_software_version>
    <Legal_software_version>010003</Legal_software_version>
    <Model_code>KA100M</Model_code>
    <System_title>4046406610005302</System_title>
    <Product_code>KA100M</Product_code>
    <Communication_type>33</Communication_type>
    <Communication_attribute>09122400021426</Communication_attribute>
    <HES>NEW-HES</HES>
  </General>

```

```

<Communication_attributes>
  <modem>
    <Module_model_code></Module_model_code>
    <Module_communication_type></Module_communication_type>
    <Module_software_version></Module_software_version>
    <Module_hardware_version></Module_hardware_version>
  </modem>
</Communication_attributes>
<Dlms_attributes>
  <Master_key>
    <Cipher_data>
      <Cipher_value></Cipher_value>
    </Cipher_data>
  </Master_key>
  <Global_encryption_unicast_key>
    <Cipher_data>
      <Cipher_value></Cipher_value>
    </Cipher_data>
  </Global_encryption_unicast_key>
  <Authentication_key>
    <Cipher_data>
      <Cipher_value></Cipher_value>
    </Cipher_data>
  </Authentication_key>
  <Global_broadcast_key>
    <Cipher_data>
      <Cipher_value></Cipher_value>
    </Cipher_data>
  </Global_broadcast_key>
</Dlms_attributes>
</Device_attributes>

```

NO	XML line number	Attribute Name	HES Required	
			Meter	DCU
1	3	Serial_number	Yes	Yes
2	4	Logic_device_name	Yes	Yes
3	5	Device_type	Yes	Yes
4	6	Device_batch_number	Yes	Yes
5	7	Device_pallet_number	Yes	Yes
6	8	Device_box_number	Yes	Yes
7	9	Date_of_manufactory	Yes	Yes
8	10	Hardware_version	Yes	Yes
9	11	App_software_version	Yes	Yes
10	12	Legal_software_Version	Yes	No
11	13	Model_code	Yes	Yes
12	14	System_title	Yes	Yes
13	15	Product_code	Yes	Yes
14	16	Communication_type	Yes	Yes
15	17	Communication_attribute	Yes	Yes
16	18	HES	No	No
17	22	Module_model_code	Yes	Yes
18	23	Module_communication_type	Yes	Yes
19	24	Module_software_version	Yes	Yes
20	25	Module_hardware_version	Yes	Yes
21	31	Master_key	Yes	Yes
22	36	Global_encryption_unicast_key	Yes	Yes

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23	41	Authentication_key	Yes	Yes
24	46	Global_broadcast_key	Yes	Yes

4.1 Serial Number

Serial_number	
XML line number	3
Element Name	Serial_number
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Device No.
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:Yes
Example	011156431171

4.2 Logic Device Name

Logic_device_name	
XML line number	4
Element Name	Logic_device_name
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Logic Device Name
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:Yes
Example	KFM011156431171

4.3 Device Type

Device Type	
XML line number	5
Element Name	Device_type
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	01 Single Phase Meter 03 Three Phase Meter 04 CT Meter 05 CT/VT Meter 09 DCU
Length	2
Type	Numeric
Required	Meter: Yes DCU:Yes
Example	10

4.4 Device Batch Number

Device Batch Number	
XML line number	6
Element Name	Device_batch_number
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Device Batch Number
Length	Uncertain length

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Type	String
Required	Meter: Yes DCU: Yes
Example	Defined by process:S22A830R0001

4.5 Device Pallet Number

Device Pallet Number	
XML line number	7
Element Name	Device_pallet_number
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Device Pallet Number
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	Maintenance by production: P22A017000004

4.6 Device Box Number

Device Box Number	
XML line number	8
Element Name	Device_box_number
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Device Box Number
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	Maintenance by production: C22A017000054

4.7 Date of Manufactory

Date of Manufactory	
XML line number	9
Element Name	Date_of_manufactory
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Date of manufacture, format YYYYMMDD
Length	Uncertain length
Type	Numeric
Required	Meter: Yes DCU: Yes
Example	20160904

4.8 Hardware Version

Hardware Version	
XML line number	10
Element Name	Hardware_version

Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Hardware Version
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:Yes
Example	V11.2

4.9 App Software Version

App Software Version	
XML line number	11
Attribute Name	App_software_version
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	App Software Version
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:Yes
Example	KF11A017-K01-0000 MA110-B01-S01-02 V0118-00

System Title	
XML line number	14
Attribute Name	System_title

Parent Elements	Envelope/Body/Shipment/Device_attributes/General
-----------------	--

4.10 Legal Software Version

Legal Software Version	
XML line number	12
Attribute Name	Legal_software_version
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Legal Software Version
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:No
Example	KF11A017-K01-0000 MA110-B01-S01-02 V0118-00

4.11 Model Code

Model Code	
XML line number	13
Attribute Name	Model_code
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Model Code
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	MA110U

4.12 System Title

Description	Model_code
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	MA110U

4.13 Product Code

Product Code	
XML line number	15
Attribute Name	Product_code
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Product Code
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	MA110U

4.14 Communication Type

Communication Type	
XML line number	16
Attribute Name	Communication_type
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Communication Type
Length	Uncertain length
Type	06 PLC 33 GPRS
Required	Meter: Yes DCU:Yes
Example	6

4.15 Communication Attribute

Communication Attribute	
XML line number	17
Attribute Name	Communication_attribute
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	Communication Attribute
Length	Uncertain length
Type	String
Required	Meter: Yes DCU:Yes
Example	MCA202102031001

4.16 HES

HES	
XML line number	18

Elements Name	HES
Parent Elements	Envelope/Body/Shipment/Device_attributes/General
Description	The meter or DCU belongs to which HES. This attribute, which will be KAIFA by default, and it's not mandantory for the meters belongs to KAIFA HES, but mandantory for the new brand meters which belongs to the new HES in the future.
Length	Uncertain length
Type	String
Required	Meter: No DCU: No
Example	NEW-HES (The name will be specified in MDMS)

4.17 Module Model Code

Module Model Code	
XML line number	22
Elements Name	Module_model_code
Parent Elements	Envelope/Body/Shipment/Device_attributes/Communication_attributes/Modem
Description	Module Model Code, (multiple are supported in DCU)
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	A30056431090

4.18 Module Communication Type

Module Communication Type	
XML line number	23
Element Name	Module_communication_type
Parent Elements	Envelope/Body/Shipment/Device_attributes/Communication_attributes/Modem
Description	Communication mode (module type) 06 PLC 33 GPRS (multiple are supported in DCU)
Length	1
Type	Numeric
Required	Meter: Yes DCU: Yes
Example	6

4.19 Module Hardware Version

Module Hardware Version	
XML line number	24
Element Name	Module_hardware_version
Parent Elements	Envelope/Body/Shipment/Device_attributes/Communication_attributes/Modem
Description	Module Hardware Version, (multiple are supported in DCU)
Length	Uncertain length
Type	String

Required	Meter: Yes DCU: Yes
Example	V5.0

4.20 Module Software Version

Module Software Version	
XML line number	25
Element Name	Module_software_version
Parent Elements	Envelope/Body/Shipment/Device_attributes/Communication_attributes/Mo dem
Description	Module Software Version, (multiple are supported in DCU)
Length	Uncertain length
Type	String
Required	Meter: Yes DCU: Yes
Example	V0115

4.21 Master Key

Master key	
XML line number	36
Element Name	Cipher_value
Parent Elements	Envelope/Body/Shipment/Device_attributes/Dlms_attributes/Master_key/ Cipher_data
Description	Need to use suplier key for Grid operator encryption (KEK)
Length	Uncertain length
Type	Base64 encoding
Required	Meter: Yes DCU:Yes
Example	Rty3eHO3fW/rasfsVI/N3Ebct3hzt31v62rH7FSPzdxESXkPwZwicFrgFw3 Oh8Vt

4.22 Global Encryption Unicast Key

Global Encryption Unicast Key	
XML line number	41
Element Name	Cipher_value
Parent Elements	Envelope/Body/Shipment/Device_attributes/Dlms_attributes/ Global_encryption_unicast_key /Cipher_data
Description	Need to use suplier key for Grid operator encryption (KEK)
Length	Uncertain length
Type	Base64 encoding
Required	Meter: Yes DCU:Yes
Example	3xIF8od204Je4/flymUSmd8SBfKHdtOCXuP35cplEplESXkPwZwicFrgFw3 Oh8Vt

4.23 Authentication Key

Authentication Key	
XML line number	46

Element Name	Cipher_value
Parent Elements	Envelope/Body/Shipment/Device_attributes/Dlms_attributes/Authentication_key/Cipher_data
Description	Need to use supplier key for Grid operator encryption (AKEY)
Length	Uncertain length
Type	Base64 encoding
Required	Meter: Yes DCU:Yes
Example	H+qnrZMcDUGiojYZ1Gymoh/qp62THA1BoqI2GdRspqJESXkPwZwicFrgFw3Oh8Vt

4.24 Global Broadcast Key

Global Broadcast Key	
XML line number	51
Element Name	Cipher_value
Parent Elements	Envelope/Body/Shipment/Device_attributes/Dlms_attributes/Global_broadcast_key/Cipher_data
Description	Global Broadcast Encryption Key (BK)
Length	Uncertain length
Type	Base64 encoding
Required	Meter: Yes DCU:No
Example	H+qnrZMcDUGiojYZ1Gymoh/qp62THA1BoqI2GdRspqJESXkPwZwicFrgFw3Oh8Vt

5 Signature

```

1  <Signature>
2    <Signed_info>
3    </Signed_info>
4    <Signature_value>
5    </Signature_value>
6    <Key_info>
7    </Key_info>
8  </Signature>

```

NO	XML line number	Attribute Name	Required	
			Meter	DCU
1	2	Signed_info	Yes	Yes
2	4	Signature_value	Yes	Yes
3	6	Key_info	Yes	Yes

• Signed Info

```

1  <Signed_info>
2    <Canonicalization_method Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
3    <Signature_method Algorithm="http://www.w3.org/2001/04/xmldsig-more#rsa-sha256"/>
4    <Reference URI="">
5      <Transform>
6        <Transform Algorithm="http://www.w3.org/2002/06/xmldsig-filter#2">
7          <XPath xmlns:ns3="http://www.w3.org/2002/06/xmldsig-filter#2" Filter="intersect"/*[local-name()='Header' or local-name()='Body']</XPath>
8        </Transform>
9      </Transform>
10     <Digest_method Algorithm="http://www.w3.org/2001/04/xmldsig#sha256"/>
11     <Digest_value></Digest_value>
12   </Reference>
13 </Signed_info>

```

No.	Element	Parent Element	Description	Length	Type	Required
2	Canonicalization_method	Envelope/Signature/Signed_info				Yes
3	Signature_method	Envelope/Signature/Signed_info				Yes
4	Reference	Envelope/Signature/Signed_info				Yes
5	Transforms	Envelope/Signature/Signed_info/ Reference				Yes
6	Transform	Envelope/Signature/Signed_info/Reference/Transforms				Yes
7	XPath	Envelope/Signature/Signed_info/Reference/Transforms/ Transform				Yes
10	Digest_method	Envelope/Signature/Signed_info/ Reference				Yes
11	Digest_value	Envelope/Signature/Signed_info		Uncertain length	String	Yes

- Signature Value**

<pre> 1 <Signature_value> 2 </Signature_value> </pre>						
No.	Element	Parent Element	Description	Length	Type	Required
1	Signature_value	Envelope/Signature/Signed_info		Uncertain length	String	Yes

- Key Info**

<pre> 1 <Key_info> 2 <X509_data> 3 <X509_certificate> 4 </X509_certificate> 5 </X509_data> 6 </Key_info> </pre>						
No.	Element	Parent Element	Description	Length	Type	Required
3	X509_certificate	Envelope/Signature/Key_info/X509_data/		Uncertain length	String	Yes

6 XML Example

Refer to “Shipment File_Meter.xml” and “Shipment File_DCU.xml”.

*****The End *****

Type Test List for Single Phase Meter

- **Tests related to safety**
 1. Impulse voltage test
 2. AC power-frequency voltage test.
 3. Spring hammer test
 4. Protection against spread of fire
 5. Temperature test.
 6. Protection against penetration of dust
 7. Protection against penetration of water
- **Tests of mechanical requirements**
 8. Shock test
 9. Vibration test.
- **Accuracy requirements**
 10. Meter constant
 11. Initial start-up of the meter
 12. Test of no-load condition.
 13. Starting current test
 14. Repeatability test
 15. Limit of error due to variation of the current
 16. Time-keeping accuracy
 17. Test of time-keeping accuracy on operation reserve
 18. Test of time-keeping accuracy with temperature
- **Tests for electromagnetic compatibility (EMC) and limits of error due to Electromagnetic influence quantities**
 19. Voltage dips and short interruptions
 20. Electrostatic discharges.
 21. Radiated, radio-frequency, electromagnetic field immunity test - test without current
 22. Radiated, radio-frequency, electromagnetic field immunity test - test with current
 23. Electrical fast transient/burst immunity test
 24. Conducted disturbances induced by radio-frequency fields
 25. Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports
 26. Surge immunity test
 27. Ring wave immunity test.
 28. External static magnetic fields
 29. Power frequency magnetic fields of external origin
 30. Conducted emission
 31. Radiated emission
- **Tests of immunity to other influence quantities**
 32. Harmonics in the current and voltage circuits - 5th harmonic test.
 33. Interharmonics in the current circuit - burst fired waveform test.
 34. Odd harmonic in the current circuit

- 35. DC and even harmonic - half-wave rectified waveform test.
- 36. Voltage variation
- 37. Ambient temperature variation
- 38. Frequency variation.
- 39. Operation of auxiliary devices.
- 40. Short-time over currents
- 41. Self-heating
- 42. Fast load current variations.
- Climatic condition
 - 43. Dry heat test
 - 44. Cold test
 - 45. Damp heat cyclic test
 - 46. Protection against solar radiation

Interoperability Test Specification

IESCO AMI LAB CONSTRUCTION PROJECT

Revision History

[illegible]

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1 Overview

IESCO AMI project in Islamabad is a state-of-the-art project in Pakistan. The state-of-the-art Laboratory Facility Construction is a critical investment in this project. Through meticulous planning, effective risk management, and active stakeholder engagement, we are committed to delivering a facility that meets the highest standards of quality and functionality.

The construction of a new AMI laboratory facility is a strategic initiative aimed at enhancing IESCO capabilities and supporting the growing needs of AMI interoperability. This project will provide a modern, fully-equipped environment to support the completion of AMI meter test, which include Routine Tests, Interoperability Tests, and Data Retrieve Tests.

This document aims to define the scope, test methods, instruments and implementation details for the Interoperability Test, covering the test design for the following products belongs to the IESCO AMI Project.

- E-Meter with Cellular/G3 PLC communication: Evaluate the meter functionality against requirements, assess module hardware performance, system integration (MI2, MI1 Interface), and performance in real environment simulation.
- DCU with Cellular/G3 PLC communication: Evaluate the DCU functionality against requirements, assess module hardware performance, system integration (CI1, CI2 Interface), and performance in real environment simulation.
- HES CIM Interface: Evaluate the HES CIM interface (SI2) implementation against CIM requirements.
- Filter: Evaluate the function of the filter.

2 Abbreviations

Abbreviation	Description
DUT	Device Under Test
AMI	Advanced Metering Infrastructure
SM	Smart Meter
DLMS	Device Language Message Specification
TCP	Transport Control Protocol
PLC	Power Line Communications
DCU	Data Concentrator Unit
HES	Head End System
MDMS	Meter Data Management System
CIM	Common Information Model
IPS	Isolated Power Supply
BOM	Bill of Materials

3 Test Scope and Method

This chapter will centre on the product, providing a comprehensive overview of the essential tests required when new supplier products are integrated into the IESCO AMI system. It will encompass a detailed description of the testing environment, the equipment utilized, and the specific methodologies employed.

3.1 E-Meter with Cellular Communication

For E-Meter (SP/PP/CT/CTPT) with Cellular Communication, the following tests must be conducted to ensure compatibility and seamless integration with other devices specified in the IESCO AMI Project.

- STEP1 Basic Function Compliance Test
 - E-Meter Functional Test
 - Cellular Communication Performance Test
- STEP2 Integration Test-Cellular Meter to HES(MI2)
- STEP3 Real Environment Simulation Test

The DUT samples and reports/certificate should be provided by meter supplier

No.	Device	Qty.	Provider	Description
1	DUT Sample	30	Meter Supplier	• 1pcs for Function Test • 1pcs for Cellular Test • 1pcs for Integration Test • 20pcs for Real Enviroment SimulationTest • 7pcs backup
2	DLMS Certification	1	Meter Supplier	• DLMS Protocol certificate (CTT4.3)
3	Firmware update file	1	Meter Supplier	• DUT firmware File for upgrade testing
4	DUT Test Report	1	Meter Supplier	• Type test report • Software test report
5	Shipment file	1	Meter Supplier	• Include secret keys of different clients
6	Software Tool	1	Meter Supplier	• Software testing tool offered by different manufacturers to support local/remote connection and operation with Meter
7	Cellular Network	-	IESCO	• Support 2G and LTE • Support verify the APN (Access Point Name) • Support verify the PPP information • Support IPv4/v6 • LTE Support Band1/Band3/Band5/Band8 • 2G

Table 3-1 DUT Requirements for E-Meter with Cellular Communication

3.1.1 E-Meter Functional Test

This test aims to detect if there is any failures or errors of E-meter with Cellular Communication Solution. Testing content mainly includes DLMS protocol conformance, clock, display, measurement, demand, billing, firmware upgrade, tariff, profile, power quality, prepayment, load control, security and communication.

3.1.1.1 Smart Meter Function

3.1.1.1.1 Test Suite

The test suite consists of 17 test groups, which are DLMS protocol conformance, meter basic information, real time clock, LCD display, measurement, demand, load profile, billing profile, calendar and tariff management, power quality, load control, firmware upgrade, event and status word, security, prepayment and optical and RS485 communication.

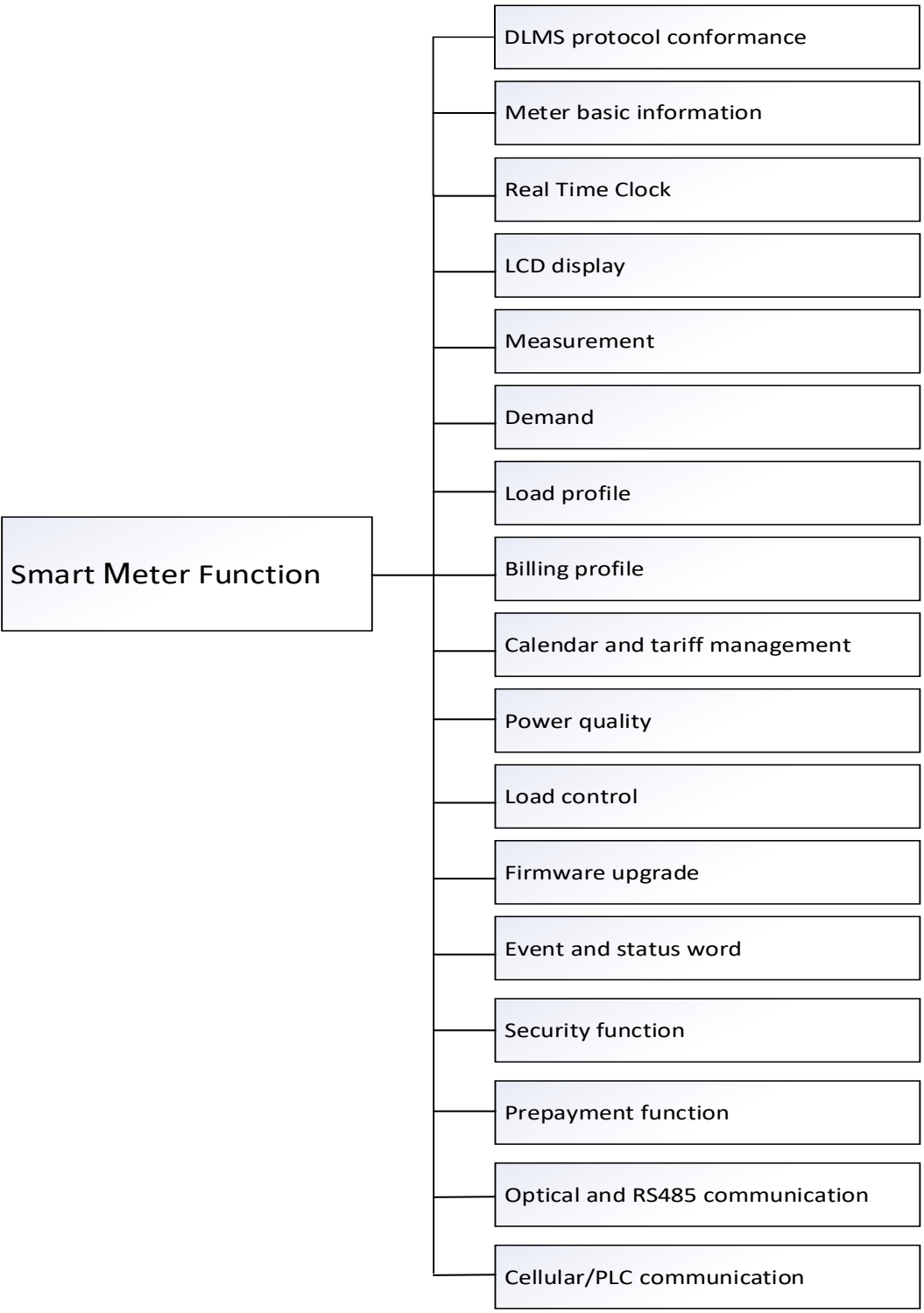


Figure 3-1 Test Groups of Cellular Meter

No.	Test Group ID	Test Group Name
1	SM-FUNC-DLMS	DLMS protocol conformance
2	SM-FUNC-MBI	Meter basic information
3	SM-FUNC-RTC	Real Time Clock
4	SM-FUNC-LCD	LCD display
5	SM-FUNC-ME	Measurement
6	SM-FUNC-DE	Demand
7	SM-FUNC-LP	Load profile
8	SM-FUNC-BP	Billing profile
9	SM-FUNC-TOU	Calendar and tariff management
10	SM-FUNC-PQ	Power quality
11	SM-FUNC-RC	Load control
12	SM-FUNC-FW	Firmware upgrade
13	SM-FUNC-EVE	Event and status word
14	SM-FUNC-SE	Security function
15	SM-FUNC-PM	Prepayment function
16	SM-FUNC-COM	Optical and RS485 communication
17	SM-FUNC-CELL	Cellular communication

Table 3-2 Test Group List of Cellular Meter

3.1.1.1.2 Test Setup

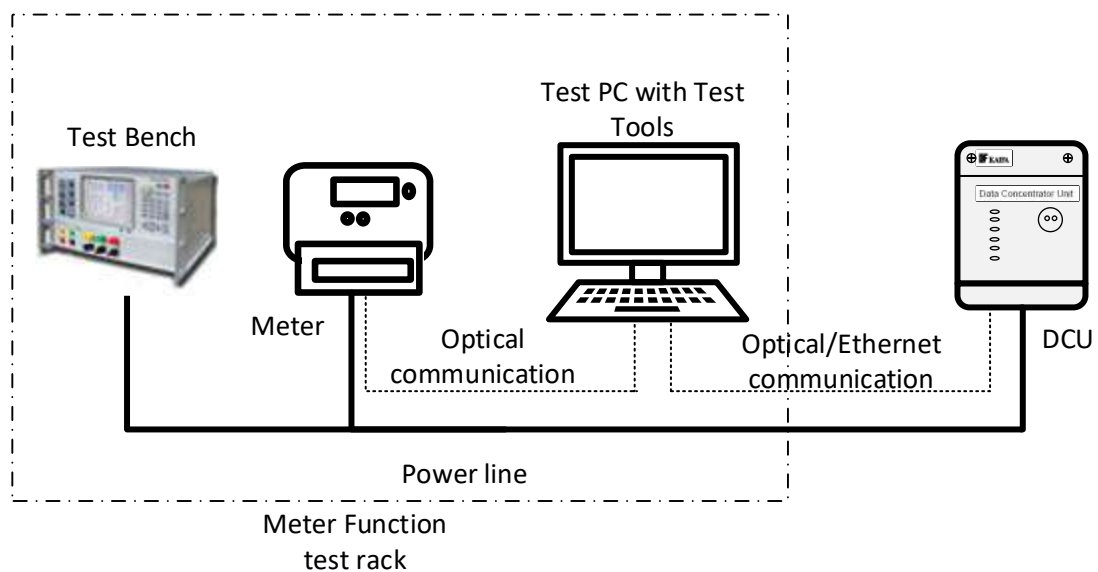


Figure 3-2 Meter Function Auto Test Setup

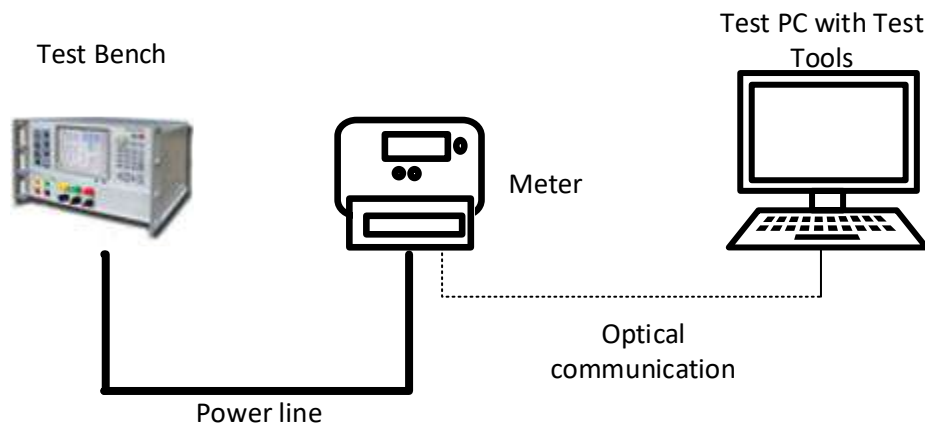


Figure 3-3 Meter Function Manual Test Setup

No.	Device		Qty.	Description
1	Meter Function Test Rack	Test Bench	1	• Meter calibration device, power supply to the DUT(for auto test setup)
2		Rack	1	• Rack(for auto test setup)
3		Test PC	1	• Computer • PC connect DUT meter via Optical port
4		LIS Test Tool	1	• Auto test software, used to schedule automated test execution
5	DCU		1	• Auxiliary test equipment, only used when testing G3 PLC meters.
6	Test Bench		1	• Meter calibration device, power supply to the DUTs
7	Cellular Network		-	• IESCO provided • Support GPRS and LTE • Support verify the APN (Access Point Name) • Support verify the PPP information • Support IPv4/v6

Table 3-3 Device List for Function Test Setup

3.1.1.1.3 Test Group DLMS protocol conformance

Test Group Information			
Test Group ID	SM-FUNC-DLMS	Test Group Name	DLMS protocol conformance
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification, • [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. • [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. • [4] IESCO_AMI_Project, dlms_obis_list		
Test Purpose	• Check class ID and access rights according to Association LN object, including get, set, action.		

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	• The data format in the response from E-meter and communication process must confirm with [2] [3]	
Test Setup and Condition	• Figure 3-2 Meter Function Auto Test Setup	
Test Method	• Automated test platform, using the Auto test Tool to check the class ID and access rights and client application association	
Acceptance Criteria	• The data format in the response from E-meter must confirm with [1] [2] [3] [4] • All test cases in following list are executed and passed.	
Test Case Lists		
ID	Case Title	Test Type
SM-FUNC-DLMS-001	Check the access rights of all clients in SM	Auto
SM-FUNC-DLMS-002	Check communication process complying DLMS protocol	Auto
SM-FUNC-DLMS-003	Check data transfer service of SM	Auto
SM-FUNC-DLMS-004	Check data framed complying corresponding communication profiles	Auto
SM-FUNC-DLMS-005	Invalid value of each data frame field test	Auto

3.1.1.1.4 Test Group Meter basic information

Test Group Information			
Test Group ID	SM-FUNC-MBI	Test Group Name	Meter basic information
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification, [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	Checking the System Title and logical device name		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the Auto test Tool to check the System Title and logical device name and Device ID		
Acceptance Criteria	- The meter basic information must confirm with [1] [2] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-MBI-001	Check the System Title		Auto
SM-FUNC-MBI-002	Check the logical device name and Device ID		Auto
SM-FUNC-MBI-003	Check the firmware version number		Auto

3.1.1.1.5 Test Group Real Time Clock

Test Group Information			
Test Group ID	SM-FUNC-RTC	Test Group Name	Real Time Clock
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Checking default value, data type, right of the corresponding obis - Using equivalent class method to design data for testing clock-related parameters such as time, zone, deviation, status		

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	• Power on meter for a long time and observe the error of clock accuracy	
Test Setup and Condition	• Figure 3-2 Meter Function Auto Test Setup	
Test Method	• Automated test platform, using the Auto test Tool to set and read clock	
Acceptance Criteria	• The data format in the response from E-meter must confirm with [1] [2] • All test cases in following list are executed and passed	
Test Case Lists		
ID	Case Title	Test Type
SM-FUNC-RTC-001	Check clock runs properly	Auto
SM-FUNC-RTC-002	Check default value	Auto
SM-FUNC-RTC-003	Check the adjust time function	Auto

3.1.1.1.6 Test Group LCD Display

Test Group Information			
Test Group ID	SM-FUNC-LCD	Test Group Name	LCD Display
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	- Check the default value and capture object data - Confirming the Auto scroll mode, Manual scroll mode and Supply disconnection display mode are implemented correctly - Confirming the timely display of data updates		
Test Setup and Condition	Figure 3-3 Meter Function Manual Test Setup		
Test Method	Manually test, for the test case which cannot be tested automatically, like LCD display test		
Acceptance Criteria	- Meter can display data correctly - No missing pen, no garbled - The result must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-LCD-001	Auto scroll mode test with default condition and data correction		Manual
SM-FUNC-LCD-002	Auto scroll mode test in prepayment (SP, PPDC).		Manual
SM-FUNC-LCD-003	Auto scroll mode test in export function mode		Manual
SM-FUNC-LCD-004	Auto scroll mode test in prepayment and export function mode (SP, PPDC).		Manual
SM-FUNC-LCD-005	Manual scroll mode test with default condition		Manual
SM-FUNC-LCD-006	Manual scroll mode test in prepayment (SP, PPDC).		Manual
SM-FUNC-LCD-007	Manual scroll mode test in export function mode		Manual
SM-FUNC-LCD-008	Manual scroll mode test in prepayment and export function mode (SP, PPDC).		Manual
SM-FUNC-LCD-009	Supply disconnection display mode test with default condition		Manual
SM-FUNC-LCD-010	Supply disconnection display mode test in prepayment (SP, PPDC).		Manual
SM-FUNC-LCD-011	Supply disconnection display mode test in export function mode		Manual
SM-FUNC-LCD-012	Supply disconnection display mode test in prepayment and export function mode (SP, PPDC).		Manual

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3.1.1.1.7 Test Group Measurement

Test Group Information			
Test Group ID	SM-FUNC-ME	Test Group Name	Measurement
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	Confirming the correctness of the measurement		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the TEST BENCH to add the corresponding load condition and using the Auto test Tool to read the data related to measurement		
Acceptance Criteria	- The measurement algorithm and accuracy must confirm with [1] [2] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-ME-001	Measurement test		Auto

3.1.1.1.8 Test Group Demand

Test Group Information			
Test Group ID	SM-MD	Test Group Name	Demand
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	Confirming the correctness of the demand measurement		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the TEST BENCH to add the corresponding load condition and using the Auto test Tool to read the data related to Demand		
Acceptance Criteria	- The demand algorithm and accuracy must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-MD-001	Demand default value test.		Auto
SM-FUNC-MD-002	Demand measurement test		Auto

3.1.1.1.9 Test Group Load profile

Test Group Information			
Test Group ID	SM-FUNC-LP	Test Group Name	Load profile
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Confirming the correctness of the status word detection logic - Confirming the correctness of the data update of the capture object - Registering and updating rules - Confirming the correctness of data records under normal circumstances		

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	Confirming that the data update rules satisfy FIFO	
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup	
Test Method	Automated test platform, using the Auto test Tool to check the load profile	
Acceptance Criteria	- The result must confirm with [1] [2] - All test cases in following list are executed and passed	
Test Case Lists		
ID	Case Title	Test Type
SM-FUNC-LP-001	Check the default value and configuration range of three load profiles	Auto
SM-FUNC-LP-002	Check Energy load profile with normal condition	Auto
SM-FUNC-LP-003	Check Daily load profile with normal condition	Auto
SM-FUNC-LP-004	Check Power quality load profile with normal condition	Auto
SM-FUNC-LP-005	Check the three load profiles with clock adjust	Auto
SM-FUNC-LP-006	Check the three load profiles with clock invalid	Manual
SM-FUNC-LP-007	Check the three load profiles with power failure	Auto
SM-FUNC-LP-008	Check the data update rules of three load profiles	Auto

3.1.1.1.10 Test Group Billing profile

Test Group Information			
Test Group ID	SM-FUNC-BI	Test Group Name	Billing profile
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Check the default value and capture object data - Confirming the correctness of the data update of the capture object - Registering and updating rules - Confirming the correctness of data records under normal circumstances - Confirming that the data update rules satisfy FIFO		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the Auto test Tool to check the billing profile		
Acceptance Criteria	- The result must confirm with [1] [2] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-BI-001	Check the default value and configuration range of billing profile		Auto
SM-FUNC-BI-002	Check billing profile triggered with normal condition		Auto
SM-FUNC-BI-003	Check the billing profile triggered with clock adjust		Auto
SM-FUNC-BI-004	Check the billing profile triggered with power failure		Auto
SM-FUNC-BI-005	Check remote command billing		Auto
SM-FUNC-BI-006	Check the billing profile triggered with passive tariff activated		Auto
SM-FUNC-BI-007	Check the billing profile triggered with payment mode switch (SP, PPDC)		Auto
SM-FUNC-BI-008	Check the data update rules of billing profile		Auto

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3.1.1.1.11 Test Group Calendar and tariff management

Test Group Information			
Test Group ID	SM-FUNC-TOU	Test Group Name	Calendar and tariff management
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Check the default value and capture object data - Checking default value, data type, right of the corresponding obis - Tariff configuration - Tariff activated		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the Auto test Tool to check the TOU function		
Acceptance Criteria	- DUT can record the energy correctly according to the tariff - DUT can record the event correctly related to tariff correctly - Passive tariff can be activated correctly - The result must confirm with [1] [2] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-TOU-001	Check default tariff table runs properly		Auto
SM-FUNC-TOU-002	Check the configure tariff table runs properly		Auto
SM-FUNC-TOU-003	Check the Configuring of the max TOU.		Auto
SM-FUNC-TOU-004	Check the tariff switch with clock adjust		Auto
SM-FUNC-TOU-005	Check the tariff switch with power failure		Auto

3.1.1.1.12 Test Group Power quality

Test Group Information			
Test Group ID	SM-FUNC-PQ	Test Group Name	Power quality
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Confirming the correctness of voltage sag/swell/cut Event under different conditions - Confirming the correctness of load unbalance monitoring (only in PPDC, CT, CTPT meter). - Confirming the correctness of THD (Total Harmonic Distortion) exceed limit monitoring (only in CT, CTPT meter). - Confirming the correctness of “Export Energy” measurement function		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the TEST BENCH to add the corresponding voltage to generate the sag/swell/cut / load unbalance/ THD/ Export Energy condition and using Auto test Tool to check data		
Acceptance Criteria	- The result must confirm with [1] [2] - All test cases in following list are executed and passed		

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Test Case Lists		
ID	Case Title	Test Type
SM-FUNC-PQ-001	Check voltage sag L1 start and restore. (SP)	Auto
SM-FUNC-PQ-002	Check voltage sag L1/L2/L3 start and restore. (PPDC, CT, CTPT)	Auto
SM-FUNC-PQ-003	Check voltage swell L1 start and restore. (SP)	Auto
SM-FUNC-PQ-004	Check voltage swell L1/L2/L3 start and restore. (PPDC, CT, CTPT)	Auto
SM-FUNC-PQ-005	Check voltage cut L1 start and restore (SP)	Auto
SM-FUNC-PQ-006	Check voltage cut L1/L2/L3 start and restore (PPDC, CT, CTPT)	Auto
SM-FUNC-PQ-007	Check the default value and load unbalance start and restore (PPDC, CT, CTPT)	Auto
SM-FUNC-PQ-008	Check the default value THD start and restore (CT, CTPT)	Manual
SM-FUNC-PQ-009	Check the default value Export Energy function	Manual

3.1.1.1.13 Test Group Load control

Test Group Information			
Test Group ID	SM-FUNC-RC	Test Group Name	Load control
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	Checking the control logic of relay management and status		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using the TEST BENCH to add the corresponding load condition and using Auto test Tool to check the relay status and related event		
Acceptance Criteria	- The local disconnect and remote disconnect mechanism is correct - The result must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-RC-001	Check the default mode of control mode		Auto
SM-FUNC-RC-002	Check the default value and function of power limitation (SP, PPDC)		Auto
SM-FUNC-RC-003	Check the default value and function of power limitation with Auxiliary Disconnect control (CT, CTPT).		Auto
SM-FUNC-RC-004	Check the remote relay control (SP, PPDC)		Manual
SM-FUNC-RC-005	Check the remote relay control with Auxiliary Disconnect control (CT, CTPT).		Manual
SM-FUNC-RC-006	Check the default value and function of over current (SP, PPDC).		Auto
SM-FUNC-RC-007	Check the default value and function of over current with Auxiliary Disconnect control (CT, CTPT).		Auto
SM-FUNC-RC-008	Check the default value and function of Demand control function (SP, PPDC).		Auto
SM-FUNC-RC-009	Check the default value and function of Demand control function with Auxiliary Disconnect control (CT, CTPT).		Auto

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3.1.1.1.14 Test Group Firmware upgrade

Test Group Information			
Test Group ID	SM-FUNC-FW	Test Group Name	Firmware upgrade
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020.		
Test Purpose	- Confirming the DUT upgrade process to meet DLMS, the renewal process to meet [2] - Confirming that DUT can be upgraded successfully when unconfirmed or confirmed service is used - Checking the DUT Data in the metering instrument are not affected in any way by the Firmware update, that including legal-relevant part and non-legal relevant part		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using Auto test Tool to execute upgrading		
Acceptance Criteria	- The DUT upgrade process to meet [2] - The SM support confirmed and unconfirmed service block transfer block - The result must confirm with [1] [2] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-FW-001	Advanced version upgrade.		Auto
SM-FUNC-FW-002	Advanced version upgrade with timed activation.		Auto

3.1.1.1.15 Test Group Event and status word

Test Group Information			
Test Group ID	SM-FUNC-EVE	Test Group Name	Event and status word
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	Checking the correctness of the event detection implementation		
Test Setup and Condition	- Figure 3-2 Meter Function Auto Test Setup - Figure 3-3 Meter Function Manual Test Setup		
Test Method	Partial automatic test, Partial Manually test, for the test case which cannot be tested automatically, like open cover test		
Acceptance Criteria	- The SM can capture the status changed and fraud event in time - The event capture time is the same with SM time - The result must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-EVE-001 ~ SM-FUNC-EVE-030	Standard event - Event refer to [1]		Auto/Manual
SM-FUNC-EVE-031	Fraud detection event - Event refer to [1]		Auto/Manual

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~ SM-FUNC-EVE-080		
SM-FUNC-EVE-081 ~ SM-FUNC-EVE-110	Relay control event - Event refer to [1]	Auto/Manual
SM-FUNC-EVE-111 ~ SM-FUNC-EVE-120	Power failure event - Event refer to [1]	Auto/Manual
SM-FUNC-EVE-121 ~ SM-FUNC-EVE-130	Power quality event - Event refer to [1]	Auto/Manual
SM-FUNC-EVE-131 ~ SM-FUNC-EVE-140	Communication event - Event refer to [1]	Auto/Manual
SM-FUNC-EVE-141 ~ SM-FUNC-EVE-142	Prepay event - Event refer to [1](SP, PPDC)	Auto/Manual
SM-FUNC-EVE-143 ~ SM-FUNC-EVE-155	Recharge event - Event refer to [1](SP, PPDC)	Auto/Manual
SM-FUNC-STA-001 ~ SM-FUNC-STA-032	Instantaneous status word - Event refer to [1]	Auto/Manual
SM-FUNC-STA-033 ~ SM-FUNC-STA-037	Tamper status word - Event refer to [1]	Auto/Manual

3.1.1.1.16 Test Group Security function

Test Group Information			
Test Group ID	SM-FUNC-SE	Test Group Name	Security function
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020.		
Test Purpose	• Checking the correctness of key updating • Verifying that it is not possible to associate with the wrong Authentication key or Encryption key • Verifying that the meter rejects or drops messages with an invalid authentication tag. • Checking the security of frame counter connection mechanism		
Test Setup and Condition	• Figure 3-2 Meter Function Auto Test Setup		
Test Method	• Automated test platform, using Auto test Tool to update key and reconnection to SM with new key and using Auto test Tool to communicate with smaller frame counter		
Acceptance Criteria	• The key update mechanism is correct • The SM cannot be communicated with smaller frame counter • The result must confirm with [1] [3] • All test cases in following list are executed and passed		
Test Case Lists			

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ID	Case Title	Test Type
SM-FUNC-SE-001	Clients with different authorities connect to SM	Auto
SM-FUNC-SE-002	Wrong secret keys connect to SM	Auto
SM-FUNC-SE-003	Key change test of Authentication key	Auto
SM-FUNC-SE-004	Key change test of Encryption key	Auto
SM-FUNC-SE-005	Wrong format of frames to connect to SM	Auto

3.1.1.1.17 Test Group Optical and RS485 communication

Test Group Information			
Test Group ID	SM-FUNC-COM	Test Group Name	Optical and RS485 communication
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	• Checking the communication of optical and RS-485		
Test Setup and Condition	• Figure 3-2 Meter Function Auto Test Setup		
Test Method	• Automated test platform, using Auto test Tool to check the communication of optical and RS-485		
Acceptance Criteria	• The result must confirm with [1] • All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-COM-001	Check the communication of optical		Auto
SM-FUNC- COM-002	Check the communication of- RS-485 (CT, CTPT)		Auto

3.1.1.1.18 Test Group Prepayment function

Test Group Information			
Test Group ID	SM-FUNC-PM	Test Group Name	Prepayment function
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	- Checking the post-paid mode is switched to the prepayment mode under normal electricity consumption. - Checking the correctness of available credit deduction logic		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using Auto test Tool to switch payment mode and read data related to prepayment and using the TEST BENCH to add the corresponding load condition and using auto test tool check the available credit deduction logic		
Acceptance Criteria	- The post-paid mode is switched to the prepayment mode under normal electricity consumption. - The available credit deduction logic is correct - The result must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-PM-001	Check the logic of mode switch (SP, PPDC)		Auto

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SM-FUNC-PM-002	Check the default value of prepayment mode (SP, PPDC)	Auto
SM-FUNC-PM-003	Check the load control status with low credit status and recharge (SP, PPDC)	Auto
SM-FUNC-PM-004	Check the maximum available credit is 99999.999 kWh (SP, PPDC)	Auto
SM-FUNC-PM-005	Check the Available credit deduction in prepayment mode (SP, PPDC)	Auto

3.1.1.1.19 Test Group Cellular Communication

Test Group Information			
Test Group ID	SM-FUNC-CELL	Test Group Name	Cellular Communication Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification		
Test Purpose	- Checking the default value and capture object data - Checking default value, data type, right of the corresponding obis - Checking the communication via LTE module is fine.		
Test Setup and Condition	- Figure 3-2 Meter Function Auto Test Setup - Figure 3-3 Meter Function Manual Test Setup		
Test Method	Partial automatic test		
Acceptance Criteria	- The result must confirm with [1] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-FUNC-CELL-001	Check the default values of Cellular module communication parameters		Auto
SM-FUNC-CELL-002	Check the read and write permissions, data type, and size ranges of Cellular module related parameters		Auto
SM-FUNC-CELL-003	Remote connect meter via Cellular communication		Auto
SM-FUNC-CELL-004	Check APN configuration and correct network access		Auto
SM-FUNC-CELL-005	Check PPP configuration and correct network access		Auto
SM-FUNC-CELL-006	Check the network type configuration and correct network access		Manual
SM-FUNC-CELL-007	Check the signal strength display of the LCD module on the electricity meter		Manual
SM-FUNC-CELL-008	Check the process of registering the meter online to the HES		Manual
SM-FUNC-CELL-009	Check the correctness of remote read (including large packets) and write		Auto
SM-FUNC-CELL-010	Check the correctness of the push data process		Manual
SM-FUNC-CELL-011	Check IPv4 and IPv6 network access		Manual
SM-FUNC-CELL-014	Check the hot swappable module and replace module		Manual
SM-FUNC-CELL-015	Remote upgrade of meter		Manual
SM-FUNC-CELL-016	LTE communication module upgrade		Manual
SM-FUNC-CELL-017	Check the module supports PING operation		Auto
SM-FUNC-CELL-018	Check the module supports domain name address resolution		Manual
SM-FUNC-CELL-019	Check the event about LTE communication module		Manual

3.1.1.2 IDIS conformance

3.1.1.2.1 Test Suite

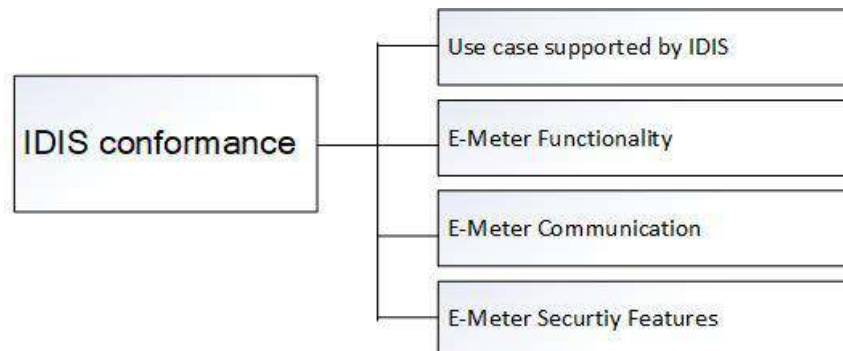


Figure 3-2 Test Groups of IDIS conformance

No.	Test Group ID	Test Group Name
1	SM-IDIS-CASE	Use case supported by IDIS
2	SM-IDIS-FUNC	E-Meter Functionality
3	SM-IDIS-COM	E-Meter Communication
4	SM-IDIS-SE	E-Meter Security Features

Table 3-4 Test Group List of IDIS conformance

3.1.1.2.2 Test Setup

Consistent with section 3.1.1.1.2

3.1.1.2.3 Test Group

Test Group Information			
Test Group ID	SM-IDIS-CASE	Test Group Name	Use case supported by IDIS
References	[5] I. I. Association, IDIS INTEROPERABILITY SPECIFICATION PACKAGE 2 IP PROFILE EDITION 2.0, 2014.		
Test Purpose	Checking that basic function and objects of meter comply IDIS		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Partial automatic test		
Acceptance Criteria	- The result must confirm with [5] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-IDIS-CASE-001	Meter Registration		Manual
SM-IDIS-CASE-002	Remote Tariff Programming		Auto
SM-IDIS-CASE-003	Meter Reading on Demand		Auto
SM-IDIS-CASE-004	Meter Reading for Billing		Auto
SM-IDIS-CASE-005	Meter Clock Synchronization		Auto
SM-IDIS-CASE-006	Firmware Update		Auto

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3.1.1.2.4 Test Group

Test Group Information			
Test Group ID	SM-IDIS-FUNC	Test Group Name	E-Meter Functionality
References	[5] I. I. Association, IDIS INTEROPERABILITY SPECIFICATION PACKAGE 2 IP PROFILE EDITION 2.0, 2014.		
Test Purpose	- Checking default value, data type, right of the corresponding obis - Confirming the correctness of the data update of the capture object - Registering and updating rules - Confirming the correctness of data records under normal circumstances		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using Auto test Tool to check the meter functionality		
Acceptance Criteria	- The result must confirm with [5] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-IDIS-FUNC-001	Load Profiles- structure and parameter		Auto
SM-IDIS-FUNC-002	Load Profiles- normal read and compressed read		Auto
SM-IDIS-FUNC-003	Load Profiles- Power Down within one capture period		Auto
SM-IDIS-FUNC-004	Load Profiles- Power Down across several capture periods		Auto
SM-IDIS-FUNC-005	Load Profiles- Time changes within capture period		Auto
SM-IDIS-FUNC-006	Load Profiles- Advancing the time over several periods		Auto
SM-IDIS-FUNC-007	Billing profile- Advancing the time over the end of the billing interval		Auto
SM-IDIS-FUNC-008	Billing profile- Setting the time back over the start of billing interval		Auto

3.1.1.2.5 Test Group

Test Group Information			
Test Group ID	SM-IDIS-COM	Test Group Name	E-Meter Communication
References	[5] I. I. Association, IDIS INTEROPERABILITY SPECIFICATION PACKAGE 2 IP PROFILE EDITION 2.0, 2014.		
Test Purpose	Checking the communication of GPRS and Ethernet and G3-PLC		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using Auto test Tool to check the meter communication		
Acceptance Criteria	- The result must confirm with [5] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-IDIS-COM-001	Client and Server Architecture		Auto
SM-IDIS-COM-002	Network Connectivity		Auto
SM-IDIS-COM-003	Lower layers for IP communication- GPRS		Auto

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SM-IDIS-COM-004	Lower layers for IP communication- Ethernet	Auto
SM-IDIS-COM-005	Lower layers for IP communication- G3-PLC	Auto

3.1.1.2.6 Test Group

Test Group Information			
Test Group ID	SM-IDIS-SE	Test Group Name	E-Meter Security Features
References	[5] I. I. Association, IDIS INTEROPERABILITY SPECIFICATION PACKAGE 2 IP PROFILE EDITION 2.0, 2014.		
Test Purpose	- Checking the rule of key updating - Checking the application association establishment - Checking the security of frame counter connection mechanism		
Test Setup and Condition	Figure 3-2 Meter Function Auto Test Setup		
Test Method	Automated test platform, using Auto test Tool to check the meter security features		
Acceptance Criteria	- The result must confirm with [5] - All test cases in following list are executed and passed		
Test Case Lists			
ID	Case Title		Test Type
SM-IDIS-CASE-001	Security setup object- Security setup		Auto
SM-IDIS-CASE-002	Security setup object -Frame counters		Auto
SM-IDIS-CASE-003	Application association establishment		Auto
SM-IDIS-CASE-004	Using Keys- Rules to change the Key		Auto

3.1.2 Cellular Performance Test

Evaluating the LTE signal level transmitted by DUT when it connected with Test Equipment.
Validate the correct reception of an LTE signal by the DUT for a very low signal level.

3.1.2.1 Test Suite

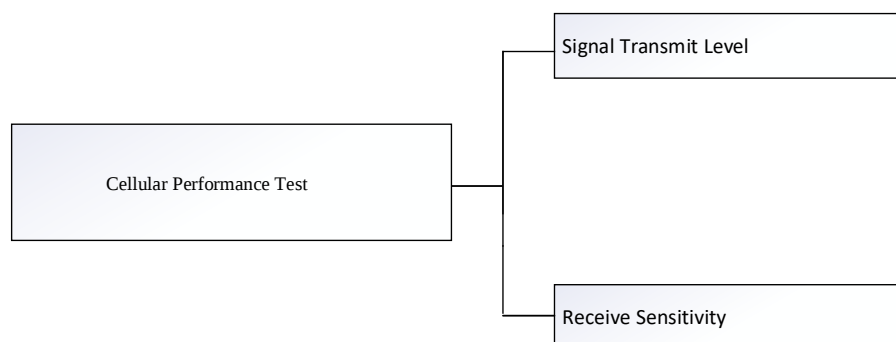


Figure 3-4 Test Group for G3 PLC Module Performance Test

No.	Test Group ID	Test Group Name
1	CELLULAR-PER-STL	Signal Transmit Level
2	CELLULAR-PER-RS	Receive Sensitivity

Table 3-5 Test Group List

3.1.2.2 Test Setup

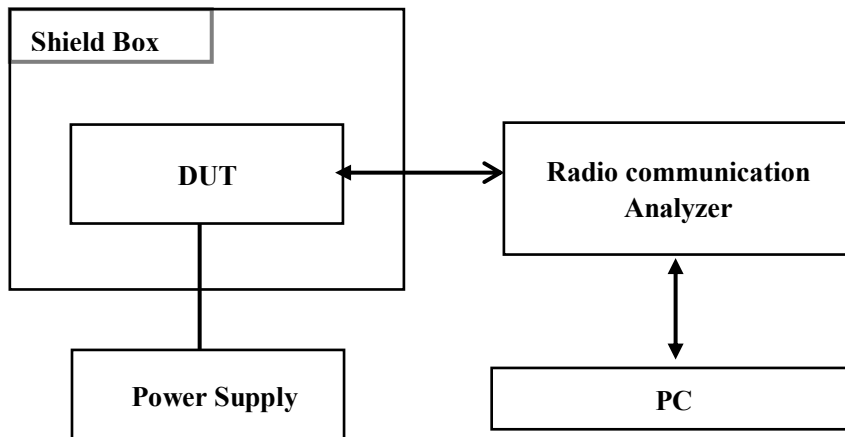


Figure 3-5 Cellular Performance Test Setup

No.	Device	Qty.	Description
1	Radio Communication Analyzer (Comprehensive Tester)	1	30 MHz to 3.8 GHz support GPRS/CDMA/LTE communication performance test
2	Shielding box	1	Shield from external interference
3	PC	1	Loading the test configuration, test the wireless case.

Table 3-6 Device List for Cellular Performance Test

3.1.2.3 Test Case Transmitter output power

Test Case Information			
Test Case ID	CELLULAR-PER-STL-001	Test Case Name	Reference sensitivity level test
References	[6] 3GPP, 3GPP TS 36.521-1, 2022.		
Test Purpose	Test transmitter test, receiver test and performance test of LTE terminal		
Test Setup and Condition	- Figure 3-5 Cellular Performance Test Setup - Normal temperature - SIM card - RF cable		
Acceptance Criteria	The output power meets the standards [6]		
Procedures	Step No.	Action	Output
	1	Put DUT in the shielding box	
	2	Connect the DUT to the power supply	
	3	Insert SIM card, connect the RF cable	
	4	Connect the DUT to the wireless communication comprehensive tester	
	5	Power on the DUT correctly	
	6	Configure the parameters of wireless communication comprehensive tester and connect to the PC	

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	7	Open the Test tool , loading the 4G configuration file	
	8	Set the test file name, and start the test	

3.1.2.4 Test Case Reference sensitivity level test

Test Case Information			
Test Case ID	CELLULAR-PER-RS-001	Test Case Name	Transmitter output power And Reference sensitivity level test
References	[6] 3GPP, 3GPP TS 36.521-1, 2022.		
Test Purpose	Test transmitter test, receiver test and performance test of LTE terminal		
Test Setup and Condition	- Figure 3-5 Cellular Performance Test Setup - Normal temperature - SIM card - RF cable		
Acceptance Criteria	The output power meets the standards [6]		
Procedures	Step No.	Action	Output
	1	Put DUT in the shielding box	
	2	Connect the DUT to the power supply	
	3	Insert SIM card, connect the RF cable	
	4	Connect the DUT to the wireless communication comprehensive tester	
	5	Power on the DUT correctly	
	6	Configure the parameters of wireless communication comprehensive tester and connect to the PC	
	7	Open the Test tool , loading the 4G configuration file	
	8	Set the test file name, and start the test	

3.1.3 Integration Test- Cellular Meter to HES(MI2)

This test is designed to verify the integration of the meter with cellular module installed into the HES system.

3.1.3.1 Test Suite

This section divides the Cellular meter and HES integration into multiple groups according to business type.

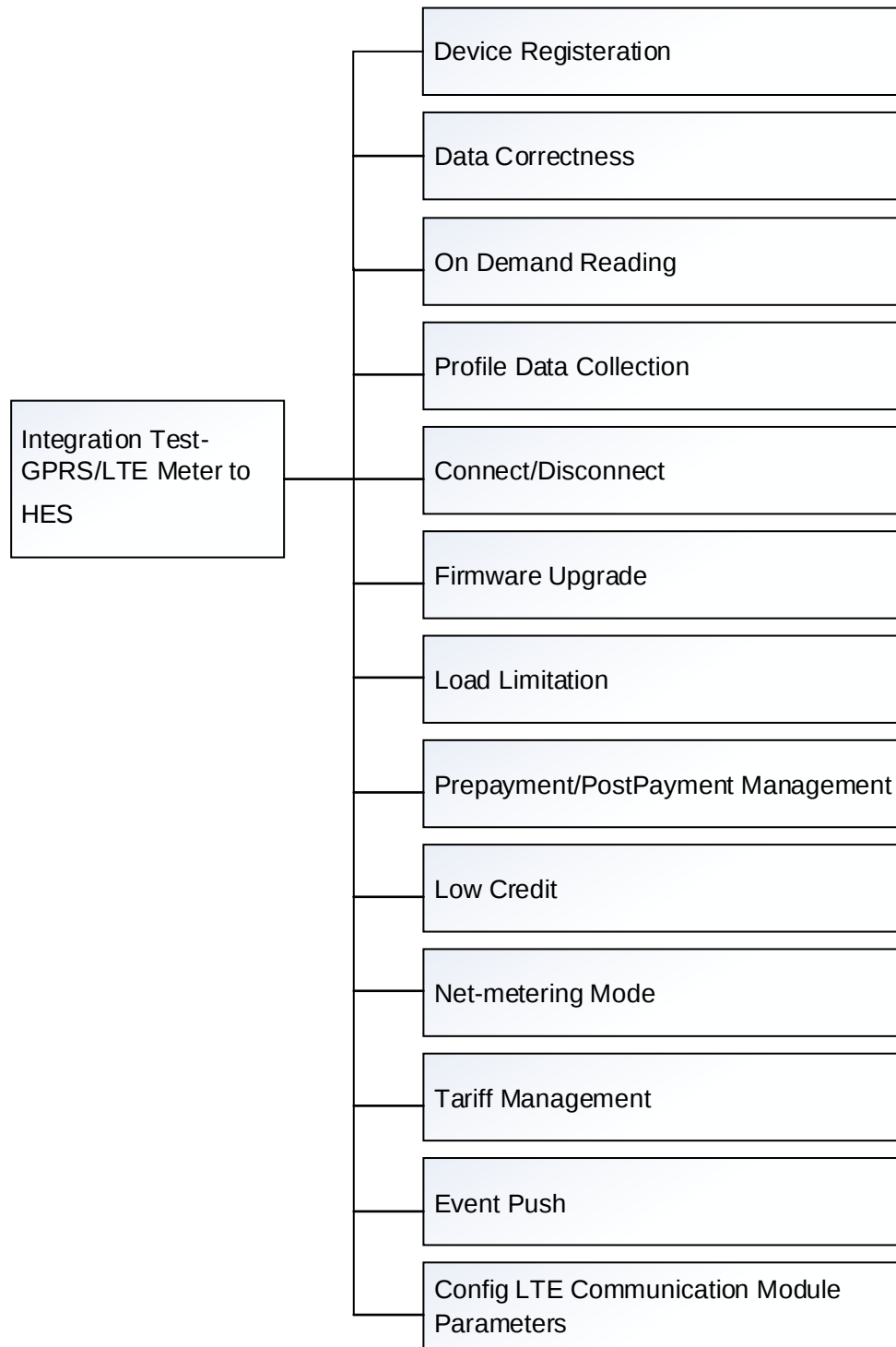


Figure 3-6 Integration Test-Cellular Meter to HES Test Group

No.	Test Group ID	Test Group Name
1	SM-INTE-CE-REG	Device Registration
2	SM-INTE-CE-DATA	Data Correctness
3	SM-INTE-CE-ODO	On Demand Operation
4	SM-INTE-CE-DC	Profile Data Collection

No.	Test Group ID	Test Group Name
6	SM-INTE-CE-RC	Remote Control Connect/Disconnect
7	SM-INTE-CE-FU	Firmware Upgrade
8	SM-INTE-CE-LL	Load Limitation
9	SM-INTE-CE-PM	Prepayment/PostPayment Management
10	SM-INTE-CE-LC	Low Credit
11	SM-INTE-CE-NM	Net-metering Mode
12	SM-INTE-CE-TOU	Tariff Management
13	SM-INTE-CE-PUSH	Event Push
14	SM-INTE-CE-CFG	Cellular Communication Module Parameters Configure

Table 3-7 Test Group List for Cellular Meter Integration Test

3.1.3.2 Test Setup

The following figure shows the relationship between the components of integration testing.

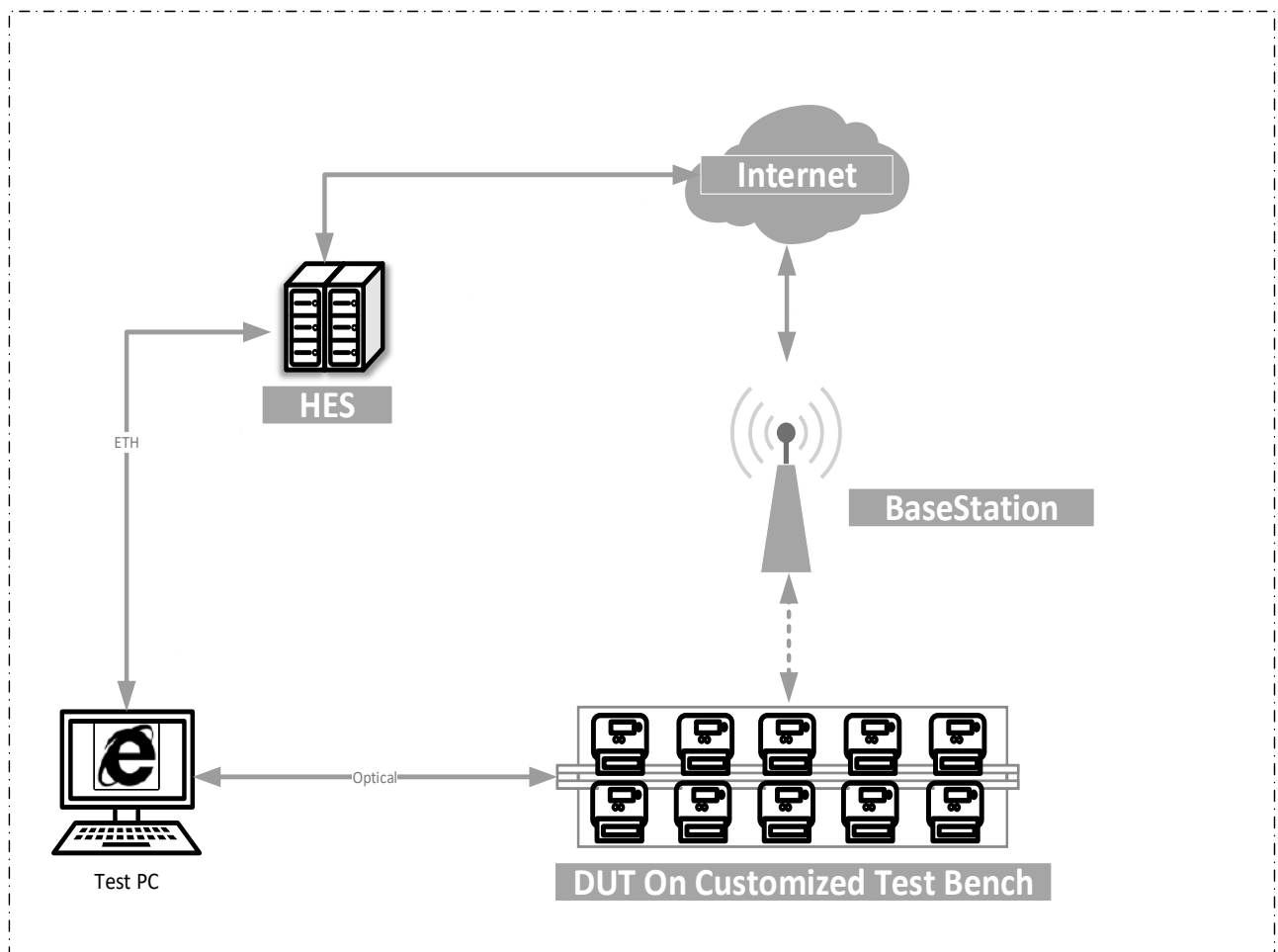


Figure 3-7 Integration Test-Cellular Meter to HES Framework

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No.	Device	Qty.	Description
1	HES	1	Head end system
2	Test PC	1	- Computer - PC connect DUT meter via Optical port
3	DUT	1	Device under test.
4	Customized Test Bench	1	- Including Customized test bench-control unit and Customized test bench-rack - Power the test equipment and support the adjustment of voltage, current, and other parameters to create test conditions.

Table 3-8 Device List for Cellular Meter Integration Test

3.1.3.3 Test Group Device Registration

Test Group Information			
Test Group ID	SM-INTE-CE-REG	Test Group Name	Device Registration
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify meter register to HES.		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	- Manually test - Power on the DUT - Wait the DCU register to HES - Check the registered status about DUT in HES		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-REG-001	Device Registration Test		

3.1.3.4 Test Group Data Correctness

Test Group Information			
Test Group ID	SM-INTE-CE-DATA	Test Group Name	Data Correctness
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify data correctness during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal.		

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	DUT is communicates normally.
Test Method	Manually test, an example for daily profile: - Read Daily Profile of the specified date from HES. - Read Daily Profile of the specified date from Meter by Optical. - Compare two daily settlement data to verify the correctness of the data
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
SM-INTE-CE-DATA-001	Data Correctness Test

3.1.3.5 Test Group on Demand Reading

Test Group Information			
Test Group ID	SM-INTE-CE-ODO	Test Group Name	On Demand Reading
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify meter reading.		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test: 1. Read test item from HES. 2. Check the read result.		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-ODO-001	Reading Clock Test		
SM-INTE-CE-ODO-002	Reading +A Test		

3.1.3.6 Test Group Profile Data Collection

Test Group Information			
Test Group ID	SM-INTE-CE-DC	Test Group Name	Profile Data Collection
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify data collection during integration		

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Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.
Test Method	Manually test, an example for daily profile: 1. Read Daily Profile of the specified date from HES. 2. Check that the collected data is consistent with expectations
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
SM-INTE-CE-DC -001	Daily Profile Collection Test
SM-INTE-CE-DC -002	Monthly Profile Collection Test
SM-INTE-CE-DC -003	Energy Load Profile Collection Test
SM-INTE-CE-DC -004	Quality Load Profile Collection Test

3.1.3.7 Test Group Connect/Disconnect

Test Group Information			
Test Group ID	SM-INTE-CE-RC	Test Group Name	Connect/Disconnect
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify relay control during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test, Take Connected test as an example. 1. Connected the meter remotely through HES 2. Check the meter relay status changes to Relay On.		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-RC-001	Connected Test		
SM-INTE-CE-RC-002	Disconnected Test		
SM-INTE-CE-RC-003	Read Relay Status Test		

3.1.3.8 Test Group Firmware Upgrade

Test Group Information

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Test Group ID	SM-INTE-CE-FU	Test Group Name	Firmware Upgrade
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify firm upgrade.		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally. - Firm file is uploaded to HES.		
Test Method	Manually test 1. Create upgrade task from HES. 2. Wait the task run finished. 3. Check the result of the upgrade task, and check the version of the DUT		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-FU -001	Meter Upgrade Test		
SM-INTE-CE-FU -002	Cellular Module Upgrade Test		

3.1.3.9 Test Group Load Limitation

Test Group Information			
Test Group ID	SM-INTE-CE-LL	Test Group Name	Load Limitation
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify Load Limitation during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test 1. Read Load Limitation by HES. 2. Change the Load Limitation to another value by HES. 3. Read Load Limitation again, and check the read value is the same as the value set in the previous step.		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		

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SM-INTE-CE-LL -001	Read Load Limitation Test
SM-INTE-CE-LL -002	Change Load Limitation Test

3.1.3.10 Test Group Prepayment/Post Payment Management

Test Group Information			
Test Group ID	SM-INTE-CE-PM	Test Group Name	Prepayment/PostPayment Management
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification - IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify payment management during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test 1. Read Payment Mode by HES. 2. Change the Payment mode to another mode by HES. 3. Read Payment Mode again, and check the read value is different with the value read in the first step.		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-PM -001	Prepayment Changed Test		
SM-INTE-CE-PM -002	Post Payment Changed Test		
SM-INTE-CE-PM -003	Read Payment Mode Test		

3.1.3.11 Test Group Low Credit

Test Group Information			
Test Group ID	SM-INTE-CE-LC	Test Group Name	Low Credit
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify payment management during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test 1. Read Low Credit by HES. 2. Change the Low Credit to another value by HES. 3. Read Low Credit value again, and check the read value is the same as the value set in the previous step.		
Acceptance Criteria	The test cases will result in the following verdicts:		

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	Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
SM-INTE-CE-LC -001	Read Low Credit Test
SM-INTE-CE-LC -002	Change Low Credit Test

3.1.3.12 Test Group Net-metering Mode

Test Group Information			
Test Group ID	SM-INTE-CE-NM	Test Group Name	Net-metering Mode
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify payment management during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test 1. Read Net-metering Mode by HES. 2. Change the Net-metering Mode to another value by HES. 3. Read Net-metering Mode again, and check the read value is the same as the value set in the previous step.		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-NM -001	Change Net-metering Mode Test		

3.1.3.13 Test Group Tariff Management

Test Group Information			
Test Group ID	SM-INTE-CE-TOU	Test Group Name	Tariff Management
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify tariff management during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test		

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	1. Read tariff by HES. 2. Change the tariff to other value by HES. 3. Read tariff again, and check the read value is different with the value read in the first step.
Acceptance Criteria	The test cases will result in the following verdicts: • Passed: The interface complies with all the acceptance criteria. • Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
SM-INTE-CE-TOU-001	Read Tariff Test
SM-INTE-CE-TOU-002	Change Tariff Test

3.1.3.14 Test Group Event Push

Test Group Information			
Test Group ID	SM-INTE-CE-PUSH	Test Group Name	Event Push
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify event push during integration		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.		
Test Method	Manually test 1. Trigger the meter to report a specific event. 2. Wait 5 minutes and check if HES received the event		
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.		
Test Case Lists			
ID	Case Title		
SM-INTE-CE-PUSH-001	Event Push Test		

3.1.3.15 Test Group Configure LTE Communication Module Parameters

Test Group Information			
Test Group ID	SM-INTE-CE-CFG	Test Group Name	Config LTE Communication Module Parameters
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify module config during integration		

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Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal. - DUT is communicates normally.
Test Method	Manually test, Take read IP as an example 1. Read IP by HES. 2. Check the read result is consistent with expected
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
SM-INTE-CE-CFG-001	Read Module IP Test

3.2 E-Meter with PLC Communication

For E-Meter with G3 PLC Communication, the following tests must be conducted to ensure compatibility and seamless integration with other devices specified in the IESCO AMI Project.

- STEP1 Basic Function Compliance Test
 - E-Meter Functional Test
 - G3 PLC Performance Test
- STEP2 Integration Test-G3 PLC Meter to DCU/HES(MI1)
- STEP3 Real Environment Simulation Test

The DUT samples and reports/certificate should be provided by meter supplier.

Item	Device	Qty.	Provider	Description
1	DUT Sample	300	Meter Supplier	1pcs for Function Test 1pcs for G3 PLC Performance Test 6pcs for Integration Test 273pcs for Real Enviroment SimulationTest 9pcs backup
2	DLMS Certification	1	Meter Supplier	DLMS Protocol certificate (CTT4.3)
3	G3-PLC Certification	1	Meter Supplier	G3-PLC certification for the communication module or the platform used by the module
4	Firmware update file	1	Meter Supplier	DUT firmware File for upgrade testing
5	DUT Test Report	1	Meter Supplier	- Type test report - Software test report
6	Shipmen file	1	Meter Supplier	Include secret keys of different clients
7	Tool	-	Meter Supplier	Software testing tool offered by different manufacturers to support local/remote connection and operation with DUT

Table 3-9 DUT Requirements for E-Meter with Cellular Communication

3.2.1 E-Meter Functional Test

Due to the differences only in the communication modules between the PLC Meter and the Cellular communication meter, the rest of the functions are identical, this chapter only describes the newly added test content related to PLC Meter, the rest is consistent with chapter 3.1.1

3.2.1.1 Test Suite

This section only describes the newly added test group related to PLC Meter; the rest is consistent with section 3.1.1.1

No.	Test Group ID	Test Group Name
1	SM-FUNC-PLC	PLC communication

Table 3-10 Test Group Added for PLC Meter

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3.2.1.2 Test Setup

Consistent with section 3.1.1.1.2

3.2.1.3 Test Group G3 PLC function

Test Group Information			
Test Group ID	SM-FUNC-PLC	Test Group Name	G3 PLC function
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification Section 7 • [4] IESCO_AMI_Project, dlms_obis_list • [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. • [8] ITU-T, “ITU-T G.9903: Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks,” ITU, 2017.		
Test Purpose	• Checking default value, data type, right of the corresponding obis. • Checking the key configuration is valid. • Checking communication via G3 PLC module is fine. • Checking the key feature of G3 PLC works well.		
Test Setup and Condition	• Figure 3-2 Meter Function Auto Test Setup		
Test Method	Partial automatic test, Partial Manually test • Using auto test tool to compare the G3 default value, data type, right of the corresponding obis • Ping the meter’s IPv6 address to verify the ICMPv6 • Checking communication via G3 PLC module is fine • Trigger the RREQ&PREQ process, to verify the process works well • Manual test: PLC Related LED, LCD		
Acceptance Criteria	• All the test cases are pass		
Test Case Lists			
ID	Case Title		
SM-FUNC-PLC-001	Check ID-P value in bootstrapping process		
SM-FUNC-PLC-002	Check G3 PLC meter register Process (bootstrapping, route discovery)		
SM-FUNC-PLC-003	ICMPv6 test		
SM-FUNC-PLC-004	Remote connect meter via PLC communication		
SM-FUNC-PLC-005	RREQ/RREP		
SM-FUNC-PLC-006	PREQ/PREP		
SM-FUNC-PLC-007	Kick Off		
SM-FUNC-PLC-007	Communication success rate test		
SM-FUNC-PLC-008	G3 PLC timeout timer test		
SM-FUNC-PLC-009	Verify the key feature configuration		
SM-FUNC-PLC-010	Default parameter setting for Keep-Alive		
SM-FUNC-PLC-011	Keep-Alive process test		
SM-FUNC-PLC-012	G3-PLC Network Management		
SM-FUNC-PLC-013	G3 PLC Communication LED indicator		

3.2.2 PLC Performance Test

This test aims to focus on the signal transmission level and receive sensitivity of the PLC communication module.

The PLC module should have good transmission level with load or without load, sensitive signal receive ability, resistance to noise damage. So that the PLC module can have a better communication success rate, stronger switch, and more original coverage in real-world environments.

3.2.2.1 Test Suite

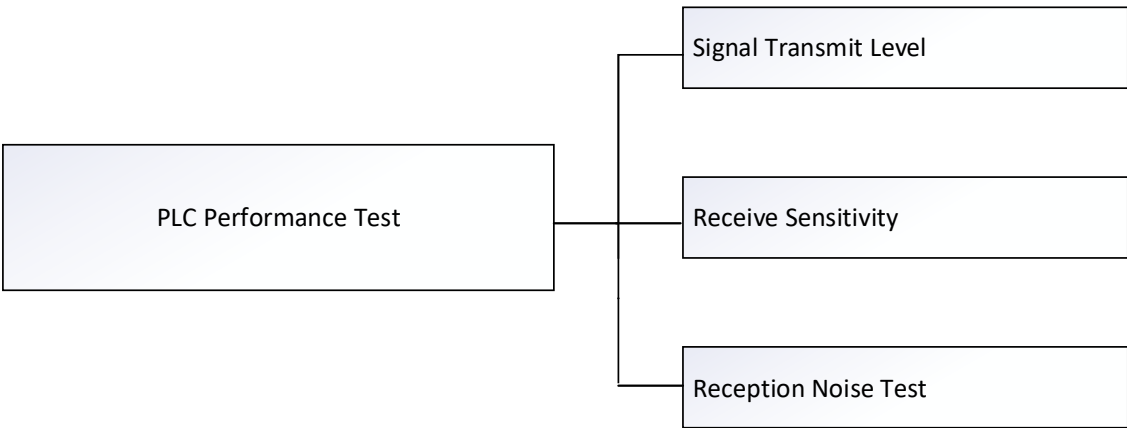


Figure 3-8 Test Group for G3 PLC Module Performance Test

No.	Test Group ID	Test Group Name
1	PLC-PER-STL	Signal Transmit Level
2	PLC-PER-RS	Receive Sensitivity
3	PLC-PER-RNT	Reception Noise Test

Table 3-11 Test Group List

3.2.2.2 Test Setup

3.2.2.2.1 Test Setup Signal Transmit Level

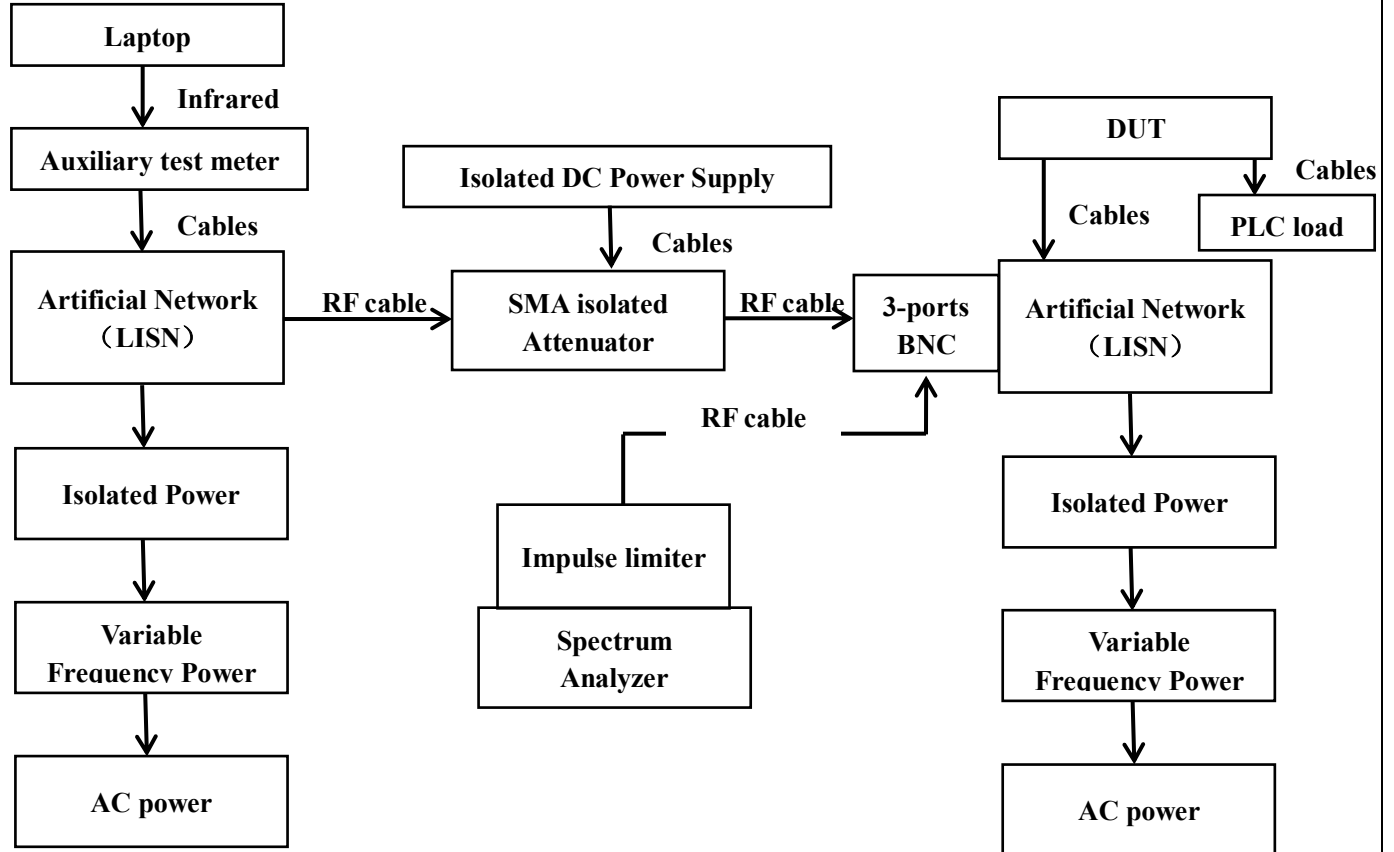


Figure 3-9 Test Setup for PLC Signal Transmit Level Test

No.	Device	Qty.	Description
1	Variable Frequency Power Supply	2	AC power input, output stable 230V 50Hz power, to avoid AC voltage change. Recommended model: ANFC015T
2	Isolated Power	2	Isolate AC power and meter power supply, to avoid PLC signal transmission through AC power, without pass the LISN and Attenuator.
3	Artificial Network (LISN)	2	Isolate AC power and PLC signal. Output PLC signal. Recommended model: NSLK 8126
4	SMA isolated Attenuator	1	Attenuated PLC signal.
5	Spectrum Analyzer	1	Measure PLC signal level.
6	Impulse limiter	1	Filter DC signal and attenuated signal, protect Spectrum Analyzer.

No.	Device	Qty.	Description
7	Isolated DC Power Supply	1	Power to SMA isolated Attenuator.
8	RF cable	3	Connect cable, connect SMA isolated Attenuator to Spectrum Analyzer
9	Laptop	1	Communicate DUT and Auxiliary test meter
10	Auxiliary test meter	1	Communicate with DUT, send data to DUT, receive data from DUT
11	3-ports BNC	1	Connector, connect Spectrum Analyzer and SMA isolated Attenuator and Artificial Network (LISN)
12	2Ω PLC LOAD	1	Add load at PLC signal.

Table 3-12 Device List of PLC Signal Transmit Level Test

3.2.2.2.2 Test Setup Receive sensitivity

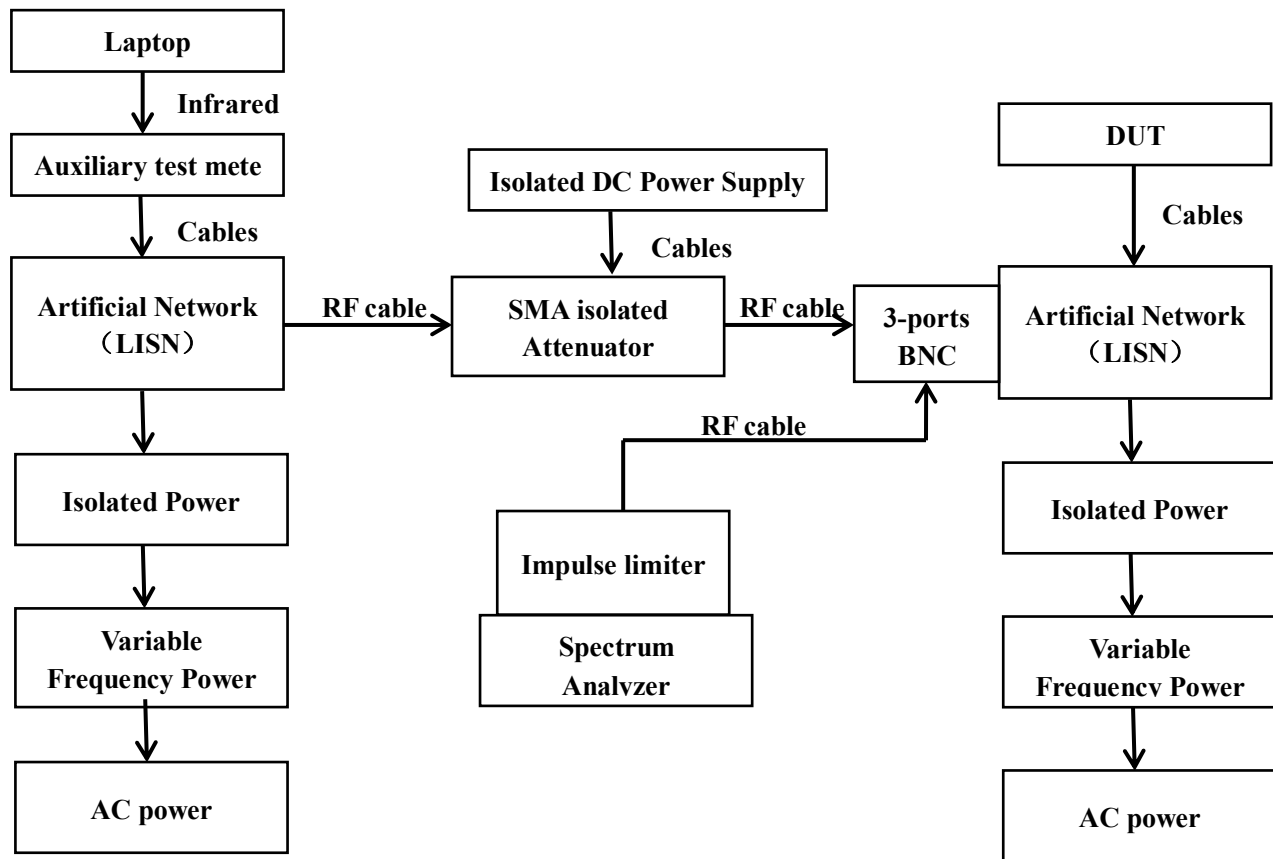


Figure 3-10 Test Setup for PLC Receive Sensitivity Test

No.	Device	Qty.	Description
1	Variable Frequency Power Supply	2	AC power input, output stable 230V 50Hz power, to avoid AC voltage change. Recommended model: ANFC015T
2	Isolated Power	2	Isolate AC power and meter power supply, to avoid PLC signal transmission through AC power, without pass the LISN and Attenuator
3	Artificial Network (LISN)	2	Isolate AC power and PLC signal. Output PLC signal
4	SMA isolated Attenuator	1	Attenuated PLC signal
5	Spectrum Analyzer	1	Measure PLC signal level
6	Impulse limiter	1	Filter DC signal and attenuated signal, protect Spectrum Analyzer
7	Isolated DC Power Supply	1	Power to SMA isolated Attenuator

No.	Device	Qty.	Description
8	RF cable	3	Connect cable, connect SMA isolated Attenuator to Spectrum Analyzer
9	Laptop	1	Communicate DUT and Auxiliary test meter
10	Auxiliary test meter	1	Communicate with DUT, send data to DUT, receive data from DUT
11	3-ports BNC	1	Connector, connect Spectrum Analyzer and SMA isolated Attenuator and Artificial Network (LISN)

Table 3-13 Device List of PLC Receive Sensitivity Test

3.2.2.2.3 Test Setup Reception Noise Test

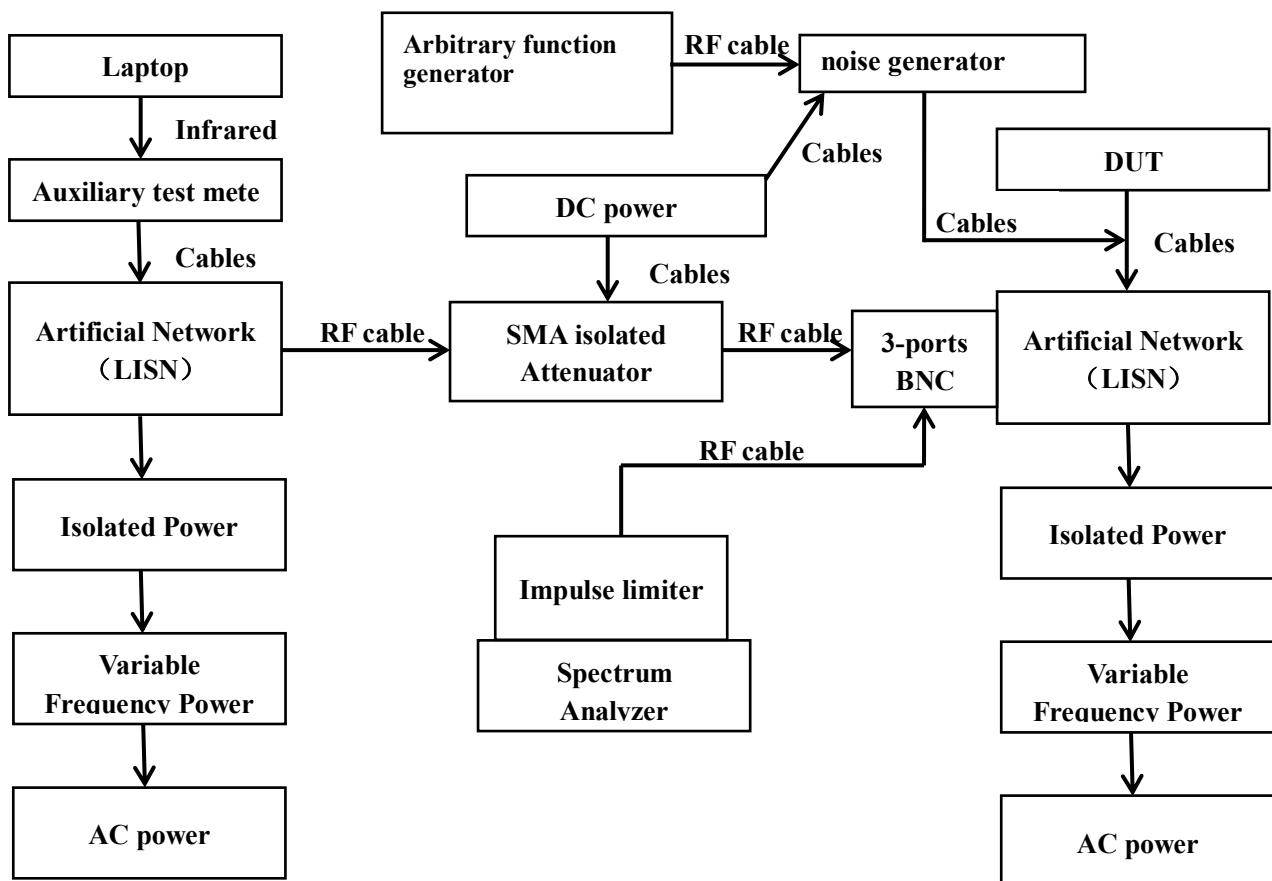


Figure 3-11 Test Setup for PLC Reception Noise Test

No.	Device	Qty.	Description
1	Variable Frequency Power Supply	2	AC power input, output stable 230V 50Hz power, to avoid AC voltage change. Recommended model: ANFC015T

No.	Device	Qty.	Description
2	Isolated Power	2	Isolate AC power and meter power supply, to avoid PLC signal transmission through AC power, without pass the LISN and Attenuator
3	Artificial Network (LISN)	2	Isolate AC power and PLC signal. Output PLC signal
4	SMA isolated Attenuator	1	Attenuated PLC signal
5	Spectrum Analyzer	1	Measure PLC signal level
6	Impulse limiter	1	Filter DC signal and attenuated signal, protect Spectrum Analyzer
7	DC power	1	Power to SMA isolated Attenuator
8	RF cable	3	Connect cable, connect SMA isolated Attenuator to Spectrum Analyzer
9	Laptop	1	Communicate DUT and Auxiliary test meter
10	Auxiliary test meter	1	Communicate with DUT, send data to DUT, receive data from DUT
11	3-ports BNC	1	Connector, connect Spectrum Analyzer and SMA isolated Attenuator and Artificial Network (LISN)
12	Arbitrary function generator	1	Injecting a continuous sinusoidal noise signal. Recommended model: AFG 31000
13	Noise generator	1	Connect Arbitrary function generator, magnification noise signal, and output noise signal to AC power

Table 3-14 Device List of PLC Reception Noise Test

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3.2.2.3 Signal Transmit Level.

This test aims to focus on the signal transmission level with load or without load, The PLC signal power whether strong, It can transmit PLC signal in different environments. And this level is within the standard requirements. The test References is ITU-T G.9901 at 7 Transmitted output voltage specifications relating to the 148.5 kHz–535 kHz band.

The supplier of the device under test needs to confirm that it meets the following requirements.

Test DUT: Conform to “Performance-Test-Specification-for-G3-PLC-Certification” at “1.3 Functional requirement on the DUT”. Conform to “G3-PLC-Alliance-Conformance-Tests-Specification-v0.37” at “2.4 ICMPv6 and UDP responder”

3.2.2.3.1 Test Case signal transmit level with LISN load 50Ω

Test Case Information									
Test Case ID	PLC-PER-STL-001	Test Case Name	signal transmit level with LISN load 50Ω						
References	[9] CENELEC, “EN 50065-1: Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances,” CENELEC, 2011.section 6.3.1.2 b) Wide band signals: [8] ITU-T, “ITU-T G.9903: Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks,” ITU, 2017.section 7 Transmitted output voltage specifications relating to the 148.5 kHz–535 kHz band								
Test Purpose	The level is within the standard requirements.								
Test Setup and Condition	- Test Temperature:20~25°C - Test Power: Provides the rated voltage required by the equipment datasheet - Test Enviroment:Figure 3-9 Test Setup for PLC Signal Transmit Level Test - Test DUT: Conform to [10] section 1.3 Functional requirement on the DUT and [11] section 2.4 ICMPv6 and UDP responder								
Acceptance Criteria	The maximum level is not more than 137dBuv at RBW 100kHz, and maximum level is not more than 120dBuv at RBW 200Hz <table><tr><td>RBW</td><td>Limit(dBuv)</td></tr><tr><td>100kHz</td><td>137</td></tr><tr><td>200Hz</td><td>120</td></tr></table>			RBW	Limit(dBuv)	100kHz	137	200Hz	120
RBW	Limit(dBuv)								
100kHz	137								
200Hz	120								
Procedures	Step No.	Action	Output						
	1	Test Environment : Conform to 6.1.1.4 without PLC load							
	2	Power on, the Variable Frequency Power Supply set 230V 50Hz, then output. c set 230V, then output. DC power set 5V, then output.							
	3	Auxiliary test meter and DUT power on.							
	4	SMA isolated attenuator set 25dB attenuator							
	5	Power on Spectrum Analyzer, Set spectrometer mode. Set center frequency 321093.75Hz. set span 371250Hz. Set occupied bandwidth 328125Hz. Set RBW 200Hz. Set sweep times auto. Set unit is dBuv. Set Max vertical position:132dbuv, set external attenuation: -xxdB							

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		(Conform Impulse limiter). Set sweep is single sweep. Trace configuration set clear. Set detector type is max peak.	
	6	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Signal Transmit Level test” on test tool, the test tool will show “start send 01”. The auxiliary test meter will send data to DUT.	Test app at laptop show “start send 01”
	7	The DUT receive 0x01 will send 0x02. So the Spectrum Analyzer test DUT sends 0x02 data voltage level.	
	8	Set trace configuration is max-hold of the Spectrum Analyzer in spectrometer mode Wait 3 minutes, the test tool will show “end send”, The Spectrum Analyzer in spectrometer mode will record plc signal transmit waveform.	Record plc signal transmit waveform
	9	Check integrity of the plc signal transmit waveform.	
	10	Set mark point is max point in FCC frequency (154.6875kHz~487.5kHz). Record the max point at what frequency and what level. Record the plc signal transmit waveform photo.	Maximum level(dBuv)
	11	Set trace configuration is clear of the Spectrum Analyzer in spectrometer mode, Set RBW is 100KHz	
	12	Repeat step 6 to 10	
	13	End, Power off	

3.2.2.3.2 Test Case PLC signal transmit level with PLC load 2Ω

Test Case Information			
Test Case ID	PLC-PER-STL-002	Test Case Name	Test PLC signal transmit level with PLC load 2Ω
References	[10] G.-P. Alliance, G3-PLC Alliance - Performance Test Specification, V1.0 , G3-PLC Alliance, 2022. Section 2.1 PERF_PHY_001_SIGNAL_INJECTION_LISN_2_Ohms		
Test Purpose	The PLC signal power is strong at load. It can transmit PLC signal in different environments.		
Test Setup and Condition	- Test Temperature:20~25°C - Test Power: Provides the rated voltage required by the equipment datasheet - Test Enviroment:Figure 3-9 Test Setup for PLC Signal Transmit Level Test - Test DUT: Conform to [10] section 1.3 Functional requirement on the DUT and [11] section 2.4 ICMPv6 and UDP responder		
Acceptance Criteria	The maximum level is not more than 137dBuv at RBW 100kHz, and maximum level is not more than 120dBuv at RBW 200kHz		
	RBW	Maximum level(dBuv)	Limit(dBuv)
	100kHz		137
	200Hz		120
	Compare the results of test group 1 and test group 2. Should be not more than 12 dB lower at lisen load and 2Ω PLC load. The level more close , the PLC signal		

	more strong.				
	RBW	Maximum level(dBuv) at lisen load	Maximum level(dBuv) at 2Ω PLC load	level at lisen load subtract level at 2Ω PLC load	Result (Pass/Fail)
	100kHz				
	200Hz				
Procedures	Step No.	Action			Output
	1	Test Environment: Conform to 6.1.1.4 with PLC load			
	2	Power on, the Variable Frequency Power Supply set 230V 50Hz, then output. Isolated Power set 230V, then output. DC power set 5V, then output.			
	3	Auxiliary test meter and DUT power on.			
	4	SMA isolated attenuator set 25dB attenuator			
	5	Power on Spectrum Analyzer, Set spectrometer mode. Set center frequency 321093.75Hz. set span 371250Hz. Set occupied bandwidth 328125Hz. Set RBW 200Hz. Set sweep times auto. Set unit is dBuv. Set Max vertical position:132dbuv, Set external attenuation: -xxdB(Conform Impulse limiter). Set sweep is single sweep. Trace configuration set clear. Set detector type is max peak.			
	6	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Signal Transmit Level test” on test tool, the test tool will show “start send 01”. The auxiliary test meter will send data to DUT.			
	7	The DUT receive 0x01 will send 0x02. So the Spectrum Analyzer test DUT send 0x02 data voltage level.			
	8	Set trace configuration is max-hold of the Spectrum Analyzer in spectrometer mode Wait 3 minutes, the test tool will show “end send”, The Spectrum Analyzer in spectrometer mode will record plc signal transmit waveform.			Record plc signal transmit waveform
	9	Check integrality of the plc signal transmit waveform.			
	10	Set mark point is max point in FCC frequency (154.6875kHz~487.5kHz). Record the max point at what frequency and what level. Record the plc signal transmit waveform photo.			Maximum level(dBuv)
	11	Set trace configuration is clear of the Spectrum Analyzer in spectrometer mode, Set RBW is 100KHz			
	12	Repeat step 6 to 10			
	13	End, Power off			

3.2.2.4 Receive sensitivity

This test aims to verify the smallest PLC signal which can be received by PLC module. The smaller the PLC signal level that the PLC module can receive, the better communication success rate and stronger switch network

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the PLC module has. The test Refer to G3-PLC Alliance - Performance Test Specification at 2.8
PERF_PHY_008_PHY_RX_SENSITIVITY

3.2.2.5 Test Case Receive sensitivity at 60dBuv signal level

Test Case Information					
Test Case ID	PLC-PER-RS-001	Test Case Name		Receive sensitivity at 60dBuv signal level	
References	[10] G.-P. Alliance, G3-PLC Alliance - Performance Test Specification, V1.0 , G3-PLC Alliance, 2022. Section 2.8, PERF_PHY_008_PHY_RX_SENSITIVITY.				
Test Purpose	The receive level is within the standard requirements.				
Test Setup and Condition	- Test Temperature:20~25°C - Test Power: Provides the rated voltage required by the equipment datasheet - Test Environment: Figure 3-10 Test Setup for PLC Receive Sensitivity Test, AC power have not extra noise. - Test DUT: Conform to [10] section 1.3 Functional requirement on the DUT and [11] section 2.4 ICMPv6 and UDP responder				
Acceptance Criteria	Indicate the signal level of a 60dBuv that can be received correctly by the DUT (with FER <5%)				
	RBW	Maximum level(dBuv)	Limit(dBuv)	FER (%)	Result (Pass/Fail)
	200Hz		60		
Procedures	Step No.	Action			Output
	1	Test Environment: Conform to 5.1.2.2			
	2	Power on, the Variable Frequency Power Supply set 230V 50Hz, then output. Isolated Power set 230V, than output. DC power set 5V, than output.			
	3	Auxiliary test meter power on, The DUT power off.			
	4	SMA isolated attenuator set 25dB attenuator			
	5	Power on Spectrum Analyzer, Set spectrometer mode. Set center frequency 321093.75Hz. set span 371250Hz. Set occupied bandwidth 328125Hz. Set RBW 200Hz. Set sweep times auto. Set unit is dBuv. Set Max vertical position:132dbuv, Set external attenuation: -xxdB (Conform Impulse limiter). Set sweep is single sweep. Trace configuration set clear. Set detector type is max peak.			
	6	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 02”. The auxiliary test meter will send data to DUT. The auxiliary test meter sends signal level reduced output gain -12dB.			Test app at laptop show “start send 02”
	7	Set trace configuration is max-hold of the Spectrum Analyzer in spectrometer mode Wait 1 minutes, the test tool will show “end send 02”, The Spectrum Analyzer in spectrometer mode will record plc signal transmit			Record plc signal transmit waveform

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		waveform.	
	8	Check integrality of the plc signal transmit waveform.	
	9	Set mark point is max point in FCC frequency (154.6875kHz~487.5kHz). Record the max point at what frequency and what level. Record the plc signal transmit waveform photo.	Maximum level(dBuv)
	10	Check integrality of the plc signal transmit waveform. Retest step 6~9-unit SMA isolated attenuator set xxdB attenuator the maximum level is 60dBuv.	
	11	Keep the SMA isolated attenuator set, The DUT power on. Remove RF cable SMA-BNC of connect Spectrum Analyzer with 3-ports BNC	
	12	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 02”. The auxiliary test meter will send data to DUT 100 times. The auxiliary test meter sends signal level reduced output gain -12dB.	
	13	The DUT receive 0x01 will send 0x02. The Auxiliary test meter will receive the DUT send 0x02. And the Auxiliary test meter will calculate what times of receive data.	the test tool will show FER
	14	End test, power off	

3.2.2.6 Test Case Receive sensitivity at minimum signal level

Test Case Information					
Test Case ID	PLC-PER-RS-002		Test Case Name	Receive sensitivity at minimum signal level	
References	[10] G.-P. Alliance, G3-PLC Alliance - Performance Test Specification, V1.0 , G3-PLC Alliance, 2022. Section 2.8, PERF_PHY_008_PHY_RX_SENSITIVITY.				
Test Purpose	The receive level is within the standard requirements.				
Test Setup and Condition	- Test Temperature:20~25°C - Test Power: Provides the rated voltage required by the equipment datasheet - Test Environment: Figure 3-10 Test Setup for PLC Receive Sensitivity Test, AC power have not extra noise. - Test DUT: Conform to [10] section 1.3 Functional requirement on the DUT and [11] section 2.4 ICMPv6 and UDP responder				
Acceptance Criteria	Indicate the signal level of a xxdBuv that can be received correctly by the DUT (with FER <5%)				
	RBW	Maximum level(dBuv)	Limit(dBuv)	FER (%)	Result (Pass/Fail)
	200Hz		60	<5%	
Procedures	Step No.	Action			Output
	1	Test Environment: Conform to 5.1.2.2			
	2	Power on, the Variable Frequency Power Supply set 230V 50Hz, then output. Isolated Power set 230V, then output. DC power set 5V, then output.			

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	3	Auxiliary test meter power on, The DUT power off.	
	4	SMA isolated attenuator set 25dB attenuator	
	5	Remove RF cable SMA-BNC of connect Spectrum Analyzer with 3-ports BNC	
	6	SMA isolated attenuator set “The signal level of a 60dBuv that can be received correctly by the DUT” case set, The DUT power on.	
	7	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 02”. The auxiliary test meter will send data to DUT 100 times. The auxiliary test meter sends signal level reduced output gain -12dB.	
	8	The DUT receive 0x01 will send 0x02. The Auxiliary test meter will receive the DUT send 0x02. And the Auxiliary test meter will calculate what times of receive data.	
	9	Add the attenuator value unit received correctly by the DUT with FER <5%. Keep the attenuator value	Record the test tool will show FER and the attenuator value
	10	Connect RF cable SMA-BNC of connect Spectrum Analyzer with 3-ports BNC	
	11	Power on Spectrum Analyzer, Set spectrometer mode. Set center frequency 321093.75Hz. set span 371250Hz. Set occupied bandwidth 328125Hz. Set RBW 200Hz. Set sweep times auto. Set unit is dBuv. Set Max vertical position:132dbuv, Set external attenuation: -xxdB(Conform Impulse limiter). Set sweep is single sweep. Trace configuration set clear. Set detector type is max peak.	
	12	Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 02”. The auxiliary test meter will send data to DUT 100 times. The auxiliary test meter send signal level reduced output gain -12dB.	
	13	Set trace configuration is max-hold of the Spectrum Analyzer in spectrometer mode Wait 1 minutes, the test tool will show “end send 02”, The Spectrum Analyzer in spectrometer mode will record plc signal transmit waveform.	
	14	Check integrality of the plc signal transmit waveform.	
	15	Set mark point is max point in FCC frequency (154.6875kHz~487.5kHz). Record the max point at what frequency and what level. Record the plc signal transmit waveform photo.	Maximum level(dBuv)
	16	End, power off	

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3.2.2.7 Reception noise test

This test aims to focus on the DUT can correct reception of a frame by the DUT in presence of a narrow band noise. The DUT can work ROBO modulation and transmit data on the affected carriers to immune carriers. The test References is G3-PLC Alliance - Performance Test Specification at 2.4
PERF_PHY_004_SIGNAL_RECEPTION_NARROW_BAND_NOISE

3.2.2.8 Test Case Reception noise test

Test Case Information			
Test Case ID	PLC-PER-RNT-001	Test Case Name	Reception noise test
References	[10] G.-P. Alliance, G3-PLC Alliance - Performance Test Specification, V1.0 , G3-PLC Alliance, 2022. Section 2.4 PERF_PHY_004_SIGNAL_RECEPTION_NARROW_BAND_NOISE		
Test Purpose	The DUT can correct reception of a frame by the DUT in presence of a narrow band noise.		
Test Setup And Condition	- Test Temperature:20~25°C - Test Power: Provides the rated voltage required by the equipment datasheet - Test Environment: Figure 3-11 Test Setup for PLC Reception Noise Test		
Acceptance Criteria	The SNR at -20dB level that can be received correctly by the DUT (with FER <5%)		
Procedures	Step No.	Action	Output
	1	Test Environment: Conform to 5.1.2.2	
	2	Power on, the Variable Frequency Power Supply set 230V 50Hz, then output. Isolated Power set 230V, then output. DC power set 5V, then output.	
	3	Auxiliary test meter power on, The DUT power off.	
	4	SMA isolated attenuator set 25dB attenuator	
	5	Power on Spectrum Analyzer, Set spectrometer mode. Set center frequency 321093.75Hz. set span 371250Hz. Set occupied bandwidth 328125Hz. Set RBW 200Hz. Set sweep times auto. Set unit is dBuv. Set Max vertical position:132dbuv, set external attenuation: -xxdB(Conform Impulse limiter). Set sweep is single sweep. Trace configuration set clear. Set detector type is max peak.	
	6	Power on laptop, connect auxiliary test meter by infrared. Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 03”. The auxiliary test meter will send data to DUT. The auxiliary test meter sends signal level reduced output gain -12dB.	
	7	Set trace configuration is max-hold of the Spectrum Analyzer in spectrometer mode Wait 1 minutes, the test tool will show “end send 03”, The Spectrum Analyzer in spectrometer mode will record plc signal transmit waveform.	

	8	Check integrity of the plc signal transmit waveform at Spectrum Analyzer	
	9	Set mark point is max point in FCC frequency (154.6875kHz~487.5kHz). Record the max point at what frequency and what level. Record the plc signal transmit waveform photo.	
	10	Check integrity of the plc signal transmit waveform. Retest step 6~9-unit SMA isolated attenuator set xxdB attenuator the mark point maximum level is 60dBuv.	
	11	Keep the SMA isolated attenuator set, The DUT power on.	
	12	Power on Arbitrary function generator AFG 31000 and KF noise generator. Set AFG 31000, continuous sinusoidal signal, frequency is 300kHz, Vpp is 0.1V, than output	
	13	Check integrity of the noise signal transmit waveform and set Vpp is xxV by AFG 31000 unit the mark point maximum level is 86dBuv. So the SNR is -20dB	
	14	Keep Arbitrary function generator AFG 31000 setting	
	15	Connect auxiliary test meter by infrared. Open “PLC Receive sensitivity test” on test tool, the test tool will show “start send 03”. The auxiliary test meter will send data to DUT 100 times. The auxiliary test meter send signal level reduced output gain -12dB.	
	16	The test tool will show FER	The test tool will show FER
	17	End test, power off	

3.2.3 Integration Test-G3 PLC Meter to DCU/HES (MI1)

This test aims to detect if there is any failures or errors of integration test-G3 PLC meter to DCU/HES.

3.2.3.1 Test Suite

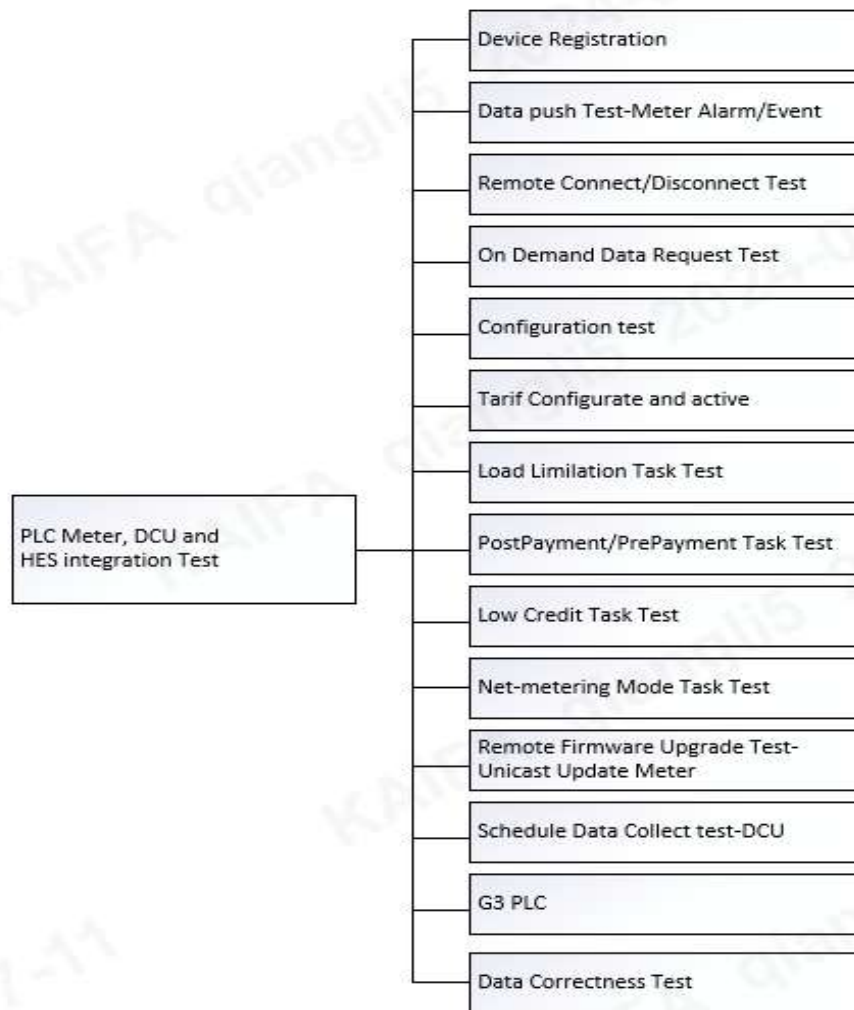


Figure 3-12 Test Groups for PLC Meter Integration Test

No.	Test Group ID	Test Group Name
1	SM-INTE-PLC-REG	Device Registration
2	SM-INTE-PLC-PUSH	Data push Test-Meter Alarm/Event
3	SM-INTE-PLC-RC	Remote Connect/Disconnect Test
4	SM-INTE-PLC-ODO	On Demand Operation Test
5	SM-INTE-PLC-CFG	Configuration test
6	SM-INTE-PLC-TOU	Tariff Management
7	SM-INTE-PLC-LL	Load Limitation Task Test
8	SM-INTE-PLC-PM	Post Payment/Prepayment Task Test
9	SM-INTE-PLC-LC	Low Credit Task Test
10	SM-INTE-PLC-NM	Net-metering Mode Task Test (Export Energy Function)
11	SM-INTE-PLC-FU	Remote Firmware Upgrade Test-Unicast Update Meter
12	SM-INTE-PLC-DC	Schedule Data Collect test-DCU
13	SM-INTE-PLC-COM	G3 PLC Communication
14	SM-INTE-PLC-DATA	Data Correctness Test

Table 3-15 Test Group List

3.2.3.2 Test Setup

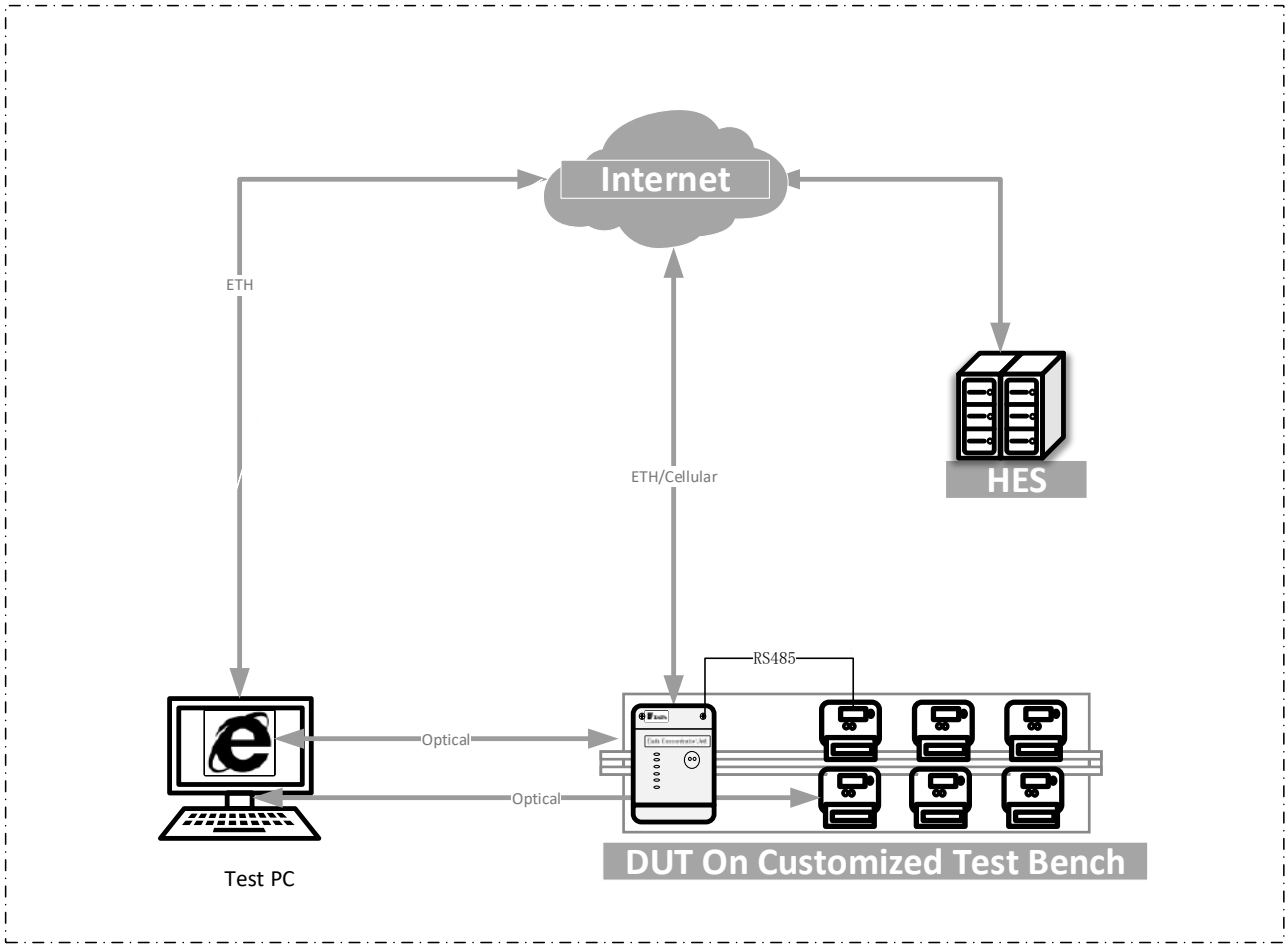


Figure 3-13 Test Setup for PLC Meter Integration Test

No.	Device	Qty.	Description
1	DUT	6	2pcs meters are deployed in phase A. 2pcs meters are deployed in phase B. 2pcs meters are deployed in phase C.
2	DCU	1	Auxiliary test equipment, Simulate DCU operations to verify the correctness of the meter implementation
3	Test PC	1	- Computer - PC connect DUT meter via Optical port - PC Connect DCU via Ethernet
5	HES	1	Head end system
6	Customized Test Bench	1	- Including Customized test bench-control unit and Customized test bench-rack - Power the test equipment and support the adjustment of voltage, current, and other parameters to create test conditions.

Table 3-16 Device List for PLC Meter Integration Test

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3.2.3.3 Test Group Device Registration

Test Group Information			
Test Group ID	SM-INTE-PLC-REG	Test Group Name	PLC Meter Registration
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the device register to DCU & HES		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	- Configure the DUT archive in HES - Power on and check if the Meter register to the DCU and HES		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-REG-001	Device Registration to DCU		
SM-INTE-PLC-REG -002	Device Registration to HES		

3.2.3.4 Test Group Data push Test-Meter Alarm/Event

Test Group Information			
Test Group ID	SM-INTE-PLC-PUSH	Test Group Name	Data push Test-Meter Alarm/Event
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the DUT could push event/alarm correctly to DCU/HES.		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Trigger the DUT push event/alarm and check if it has been pushed to HES.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-PUSH-001	Data push Test-Meter Alarm/Event		

3.2.3.5 Test Group Remote Connect/Disconnect Test

Test Group Information			
Test Group ID	SM-INTE-PLC-RC	Test Group Name	Remote Connect/Disconnect Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the remote relay connect/Disconnect meter works well		

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Test Setup And Condition	Figure 3-13 Test Setup for PLC Meter Integration Test
Test Method	Perform the remote connect/disconnect operation on the HES, and check if the meter action correctly.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
SM-INTE-PLC-RC -001	Remote connect Meter
SM-INTE-PLC-RC -002	Remote disconnect Meter

3.2.3.6 Test Group On Demand Operation Test

Test Group Information			
Test Group ID	SM-INTE-PLC-ODO	Test Group Name	On Demand Operation Test
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [4] IESCO_AMI_Project, dlms_obis_list • [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	• Verify the on-demand data request could be performed correctly		
Test Setup and Condition	• Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	• Perform the on demand request and check the data..		
Acceptance Criteria	• All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-ODO	On Demand Data Request Test		

3.2.3.7 Test Group Configuration test

Test Group Information			
Test Group ID	SM-INTE-PLC-CFG	Test Group Name	Configuration test
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [4] IESCO_AMI_Project, dlms_obis_list • [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	• Verify the configure the meter’s parameter		
Test Setup and Condition	• Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	• Configure the meter’s parameter from HES.		
Acceptance Criteria	• All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-CFG -001	Configuration test		

3.2.3.8 Test Group Tariff configure and active Test

Test Group Information			
Test Group ID	SM-INTE-PLC-TOU	Test Group Name	Tariff configure and active Test

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References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System
Test Purpose	Verify the tariff configure and active with different manufactory DCU and HES
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test
Test Method	Configure and active tariff from the HES
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
SM-INTE-PLC-TOU-001	Tariff configure and active Test

3.2.3.9 Test Group Load Limitation Task Test

Test Group Information			
Test Group ID	SM-INTE-PLC-LL	Test Group Name	Load Limitation Task Test
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [4] IESCO_AMI_Project, dlms_obis_list • [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	• Verify the load limitation with different manufactory DCU and HES		
Test Setup and Condition	• Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	• Configure and active the Load Limitation from the HES. Check if it is work.		
Acceptance Criteria	• All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-LL-001	Load Limitation Task Test		

3.2.3.10 Test Group Post Payment/Prepayment Task Test

Test Group Information			
Test Group ID	SM-INTE-PLC-PM	Test Group Name	Post Payment/Prepayment Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the Post Payment/Prepayment Task integration with different manufactory DCU and HES		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Configure Post Payment/Prepayment Task from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-PM-001	Post Payment/Prepayment Task Test		

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3.2.3.11 Test Group Low Credit Task Test

Test Group Information			
Test Group ID	SM-INTE-PLC-LC	Test Group Name	Low Credit Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the Low Credit Task integration with different manufactory DCU and HES		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Configure Low Credit Task from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-LC-001	Low Credit Task Test		

3.2.3.12 Test Group Net-metering Mode Task Test

Test Group Information			
Test Group ID	SM-INTE-PLC-NM	Test Group Name	Net-metering Mode Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the integration Net-metering Mode Task with DUT and different manufactory DCU and HES		
Test Setup And Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Configure the Net-metering Mode Task from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-NM-001	Net-metering Mode Task Test		

3.2.3.13 Test Group Remote Firmware Upgrade Test

Test Group Information			
Test Group ID	SM-INTE-PLC-FU	Test Group Name	Remote Firmware Upgrade Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify DUT Firmware upgrade test integration with different manufactory		

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	DCU and HES
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test
Test Method	Configure the Remote Firmware Upgrade Task from the HES. Check if it is work.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
SM-INTE-PLC-FU-001	Remote Firmware Upgrade Test-unicast upgrade meter
SM-INTE-PLC-FU-002	Remote Firmware Upgrade Test-unicast upgrade meter G3 PLC Module
SM-INTE-PLC-FU-003	Remote Firmware Upgrade Test-Broadcast upgrade meter
SM-INTE-PLC-FU-004	Remote Firmware Upgrade Test-Broadcast upgrade meter G3 PLC Module

3.2.3.14 Test Group Schedule Data Collect test

Test Group Information			
Test Group ID	SM-INTE-PLC-DC	Test Group Name	Schedule Data Collect test-DCU
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the Up-Stream Schedule Data Collect test integration with different manufactory DCU and HES		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Configure t Schedule Data Collect Test Task from the HES/DCU. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-DC-001	Schedule Data Collect test-DCU		
SM-INTE-PLC-DC-002	Schedule Data Collect test-HES		

3.2.3.15 Test Group G3 PLC Test

Test Group Information			
Test Group ID	TG-013	Test Group Name	G3 PLC Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the G3 PLC integration with different manufactory DCU /HES		
Test Setup and Condition	Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Trigger the G3 PLC network behavior.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		

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TG-013-001	G3 PLC parameter configure and read
TG-013-002	Phase Detection
TG-013-003	RREQ/RREP
TG-013-004	PREQ/PREP
TG-013-005	Kick Off
TG-013-006	Repeater

3.2.3.16 Test Group Data Correctness Test

Test Group Information			
Test Group ID	SM-INTE-PLC-DATA	Test Group Name	Data Correctness Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [4] IESCO_AMI_Project, dlms_obis_list [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	Verify the Data Correctness		
Test Setup and Condition	- The DUT function test is pass ; - Figure 3-13 Test Setup for PLC Meter Integration Test		
Test Method	Check if data correctness by compare the meter’s data both HES and meter.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
SM-INTE-PLC-DATA-001	Data Correctness Test		

3.3 DCU with G3 PLC/Cellular Communication

For DCU with G3 PLC/Cellular Communication, the following tests must be conducted to ensure compatibility and seamless integration with other devices specified in the IESCO AMI Project.

- STEP1 Basic Function Compliance Test
 - DCU Functional Test
 - G3 PLC Performance Test
 - Cellular Performance Test
- STEP2 Integration Test-DCU to HES (CI1, CI2)
- STEP3 Real Environment Simulation Test

The DUT samples and reports/certificate should be provided

Item	Device	Qty.	Provider	Description
1	DUT Sample	6	Supplier	1pcs for Function Test 1pcs for G3 PLC/Cellular Performance Test 1pcs for Integration Test 1pcs for Real Enviroment SimulationTest 2pcs backup

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2	DLMS Certification	1	Supplier	DLMS Protocol certificate (CTT4.3)
3	Firmware update file	1	Supplier	DUT firmware File for upgrade testing
4	DUT Test Report	1	Supplier	Type test report and software test report
5	Shipmen file	1	Supplier	Include secret keys of different clients
6	Tool	-	Supplier	Software testing tool offered by different manufacturers to support local/remote connection and operation with DCU
7	Cellular Network	-	IESCO	• Support 2G and LTE • Support verify the APN (Access Point Name) • Support verify the PPP information • Support IPv4/v6 • LTE Support Band3/Band8/Band20/Band28 • 2G Support 900/1800 MHz

Table 3-17 DUT Requirements for DCU Test

3.3.1 DCU Functional Test

The section is about the introduce of DCU functions test, including DCU DLMS Protocol conformance, security, basic information query, clock management, event, firmware upgrade, meter registration, meter data collection and data report functions and so on.

3.3.1.1 Test Suite

The chapter is about the test suite which can be divided into twenty-one functional test groups as follows:

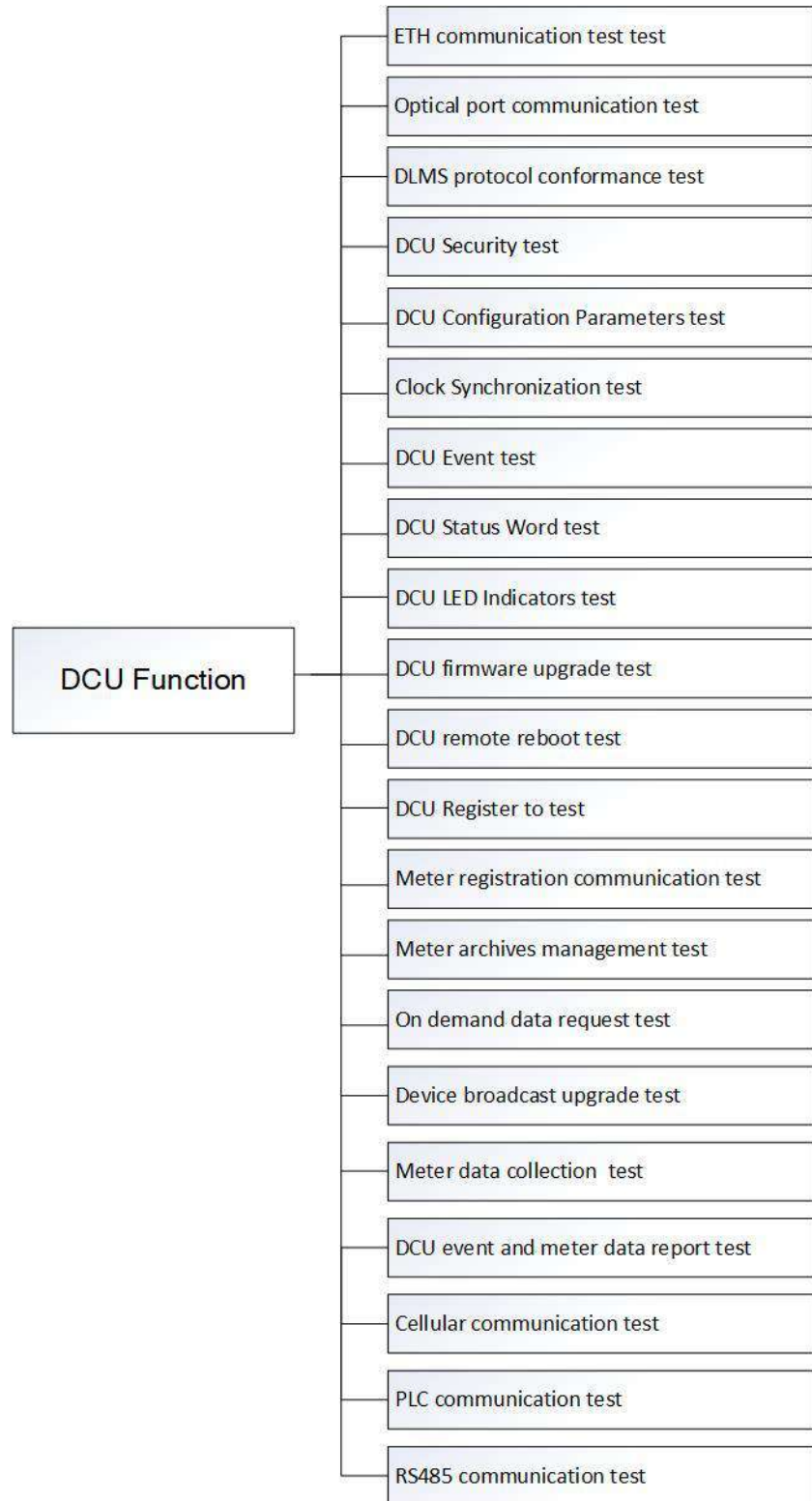


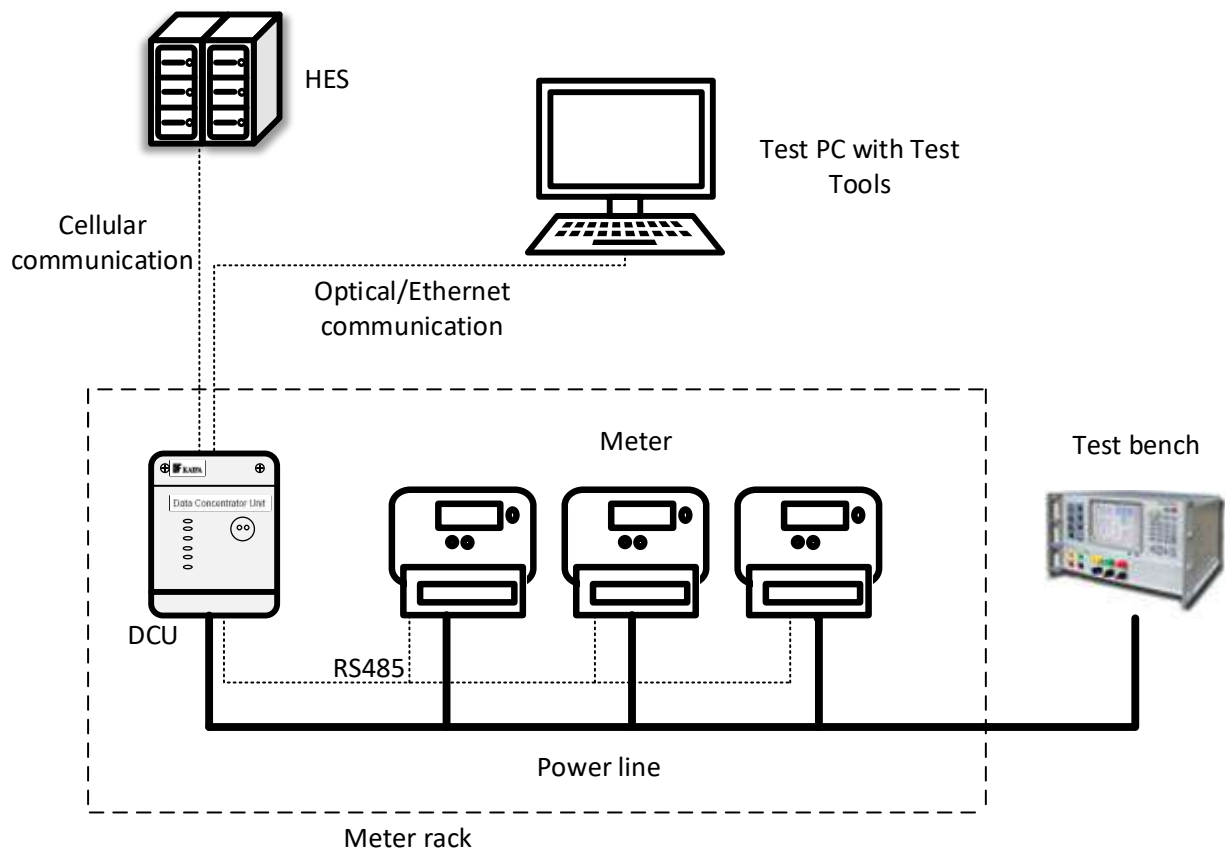
Figure 3-14 Test Groups

No.	Test Group ID	Test Group Name
1	DCU-FUNC-ETH	• ETH communication test
2	DCU-FUNC-OPT	• Optical Port communication test
3	DCU-FUNC-DLMS	• DLMS protocol conformance test

No.	Test Group ID	Test Group Name
4	DCU-FUNC-SE	• DCU Security test
5	DCU-FUNC-BASIC	• DCU Configuration Parameters test
6	DCU-FUNC-CLK	• Clock Synchronization test
7	DCU-FUNC-EVENT	• DCU Event test
8	DCU-FUNC-SW	• DCU Status Word test
9	DCU-FUNC-LED	• DCU LED Indicators test
10	DCU-FUNC-DUS	• DCU firmware upgrade test
11	DCU-FUNC-RBT	• DCU remote reboot test
12	DCU-FUNC-REG	• DCU Register test
13	DCU-FUNC-ME-REG	• Meter registration communication test
14	DCU-FUNC-ME-ARCH	• Meter archives management test
15	DCU-FUNC-ME-OD	• On demand data request test
16	DCU-FUNC-ME-DUS	• Device broadcast upgrade test
17	DCU-FUNC-ME-DC	• Meter data collection test
18	DCU-FUNC-DR	• DCU event and meter data report test
19	DCU-FUNC-CELL	• Cellular communication test
20	DCU-FUNC-PLC	• PLC communication test
21	DCU-FUNC-485	• RS485 communication test

Table 3-18 Test Group List for DCU Function Test

3.3.1.2 Test Setup



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Figure 3-15 Test Setup for DCU Function Test

No.	Device	Qty.	Description
1	DCU	1	DUT
2	Meter	3	Auxiliary test equipment, the meters play a role in providing different meter data for DCU to collect or push the data via DCU when they receive commands from the HES.
3	LIS Test Tool	1	Auto test software, used to schedule automated test execution
4	Test PC	1	- Computer - PC connect meter via Optical port - PC Connect DCU via Ethernet
5	Power Supply	1	Isolation Step-up/down Transformer The machine is used to supply power for devices
6	Cellular Network	-	- IESCO provided - Support GPRS and LTE - Support verify the APN (Access Point Name) - Support verify the PPP information - Support IPv4/v6

Table 3-19 Test Setup for DCU Function Test

3.3.1.3 Test Group ETH Communication test

Test Group Information			
Test Group ID	DCU-FUNC-ETH	Test Group Name	ETH Communication test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 2.1.2 WAN – HES Interface (CI2) [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020.		
Test Purpose	To satisfy the [12] document’s requirements and follow [2] [3]		
Test Setup and Condition	- Figure 3-15 Test Setup for DCU Function Test - Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Check the correctness of ETH communication interface.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-ETH-001	Check ETH related DLMS Parameters		Auto
DCU-FUNC-ETH-002	The Ipv4 communication is normal when using ETH to connect to DCU		Auto
DCU-FUNC-ETH-003	The Ipv6 communication is normal when using ETH to connect to DCU		Manual

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3.3.1.4 Test Group Optical Port Communication test

Test Group Information			
Test Group ID	DCU-FUNC-OPT	Test Group Name	Optical Port Communication test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 2.1.1 Optical Interface (CIO) [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020.		
Test Purpose	To satisfy the DCU Companion Specification document’s requirements and follow DLMS protocol		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Check the correctness of Optical communication interface.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-OPT-001	Check Optical port related DLMS Parameters		Auto
DCU-FUNC-OPT-002	Use Optical port to connect to DCU		Auto

3.3.1.5 Test Group DLMS Protocol conformance test

Test Group Information			
Test Group ID	DCU-FUNC-DLMS	Test Group Name	DLMS protocol conformance test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 2 System and Interface Architecture [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020.		
Test Purpose	To verify compliance of the [2] [3] [12]		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Use the service of each client to test the operation of the objects. - Write automatic scripts to execute the method of each COSEM object. - Write automatic scripts to verify establish application association and release process with DCU, etc.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-DLMS-001	Check the access rights of all clients in SM		Auto
DCU-FUNC-DLMS-002	Check communication process of all clients complying DLMS protocol		Auto
DCU-FUNC-DLMS-003	Check data transfer service of SM		Auto
DCU-FUNC-DLMS-004	Check data framed complying corresponding communication profiles		Auto

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DCU-FUNC-DLMS-004	Invalid value of each data frame field test	Auto
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3.3.1.6 Test Group DCU Security test

Test Group Information			
Test Group ID	DCU-FUNC-SE	Test Group Name	DCU Security test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 3.2 Security Features [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020.		
Test Purpose	To satisfy the [12] document’s requirements and follow [2] [3]		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Select different clients to connect to DCU. - Modify the secret keys of communication via the ‘key transfer” method, and using the new one to connect to DCU, or use the wrong key to connect to DCU. - Connect to DCU with wrong format of frames.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-SE-001	Check the default parameters of Security Management		Auto
DCU-FUNC-SE-002	Management client connects to DCU		Auto
DCU-FUNC-SE-003	Read client connects to DCU		Auto
DCU-FUNC-SE-004	Public client connects to DCU		Auto
DCU-FUNC-SE-005	A wrong Authentication key connects to DCU		Auto
DCU-FUNC-SE-006	A wrong Encryption key connects to DCU		Auto
DCU-FUNC-SE-007	Key change test of Authentication key		Auto
DCU-FUNC-SE-008	Key change test of Encryption key		Auto
DCU-FUNC-SE-009	Wrong format of frames connects to DCU		Auto

3.3.1.7 Test Group DCU Configuration Parameters test

Test Group Information			
Test Group ID	DCU-FUNC-BASIC	Test Group Name	DCU Configuration Parameters test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.1 DCU Configure Parameters		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU basic information query function		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Verify the correctness of different configuration parameters’ interfaces. - Connect to DCU by remote/local communication, and execute DCU basic information query.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			

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ID	Case Title	Test Type
DCU-FUNC-BASIC-001	Check DCU Identification information	Auto
DCU-FUNC-BASIC-002	Check DCU version information	Auto
DCU-FUNC-BASIC-003	Check PLC Communication mode version information	Auto
DCU-FUNC-BASIC-004	Check Cellular Communication mode version information	Auto
DCU-FUNC-BASIC-005	Check and set HES communication parameter configuration	Auto

3.3.1.8 Test Group Clock Synchronization test

Test Group Information			
Test Group ID	DCU-FUNC-CLK	Test Group Name	Clock Synchronization test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.8 Clock Synchronization		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU clock synchronization function		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Verify the correctness of clock management configuration parameters’ interfaces. - Connect to DCU by remote/local communication, and verify the function of DCU clock synchronization automatically or by executing scripts. - Verify that the clock runs well when the power supply is off.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-CLK-001	Check the default value of time zone		Auto
DCU-FUNC-CLK-002	Check and set clock by the interface of class 8		Auto
DCU-FUNC-CLK-003	Check and set NTP Setup - Master parameters by the interface of class 100		Auto
DCU-FUNC-CLK-004	Check and set NTP Setup - Slave parameters by the interface of class 100		Auto
DCU-FUNC-CLK-005	Check the NTP Synchronization Script by the interface of class 9		Auto
DCU-FUNC-CLK-006	Check the Broadcast Clock Synchronization Script by the interface of class 9		Auto
DCU-FUNC-CLK-007	Check the DCU Schedule Setup by the interface of class 10		Auto
DCU-FUNC-CLK-008	The DCU automatically synchronizes its own clock with the NTP server every day		Auto
DCU-FUNC-CLK-009	Synchronize the DCU’s clock with the NTP server by executing the script of class 9		Auto
DCU-FUNC-CLK-010	The DCU automatically synchronizes the clock of the meters once a day		Auto
DCU-FUNC-CLK-011	The DCU broadcast synchronizes the meters’ clock by executing the script of class 9		Auto
DCU-FUNC-CLK-012	Check that the clock runs well when the power supply is off		Auto

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3.3.1.9 Test Group DCU Event test

Test Group Information			
Test Group ID	DCU-FUNC-EVENT	Test Group Name	DCU Event test
References	• [12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.6 Event Management		
Test Purpose	• To satisfy the [12] document’s requirements and verify DCU event record function is normal		
Test Setup and Condition	• Figure 3-15 Test Setup for DCU Function Test		
Test Method	• Use semi-automatic method to execute the cases. • Verify different types of events by the time. • Verify that read the events by the entries normally. • Verify the maximum storing entries of every kind of event. • Connect to DCU by remote/local communication and generate all kinds of events like powering off/on the DCU, or opening/closing the covers of the DCU and so on. Finally, check if the events are recorded and if the recorded time is right.		
Acceptance Criteria	• All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-EVENT-001	Check the different types of events by the time		Auto/Manual
DCU-FUNC-EVENT-002	Check the different events by the entries		Auto/Manual
DCU-FUNC-EVENT-003	Check the maximum storing entries of every kind of event		Auto/Manual
DCU-FUNC-EVENT-004 ~ DCU-FUNC-EVENT-022	Standard event - Event refer to [12] Section 5.6 Event Management		Auto/Manual
DCU-FUNC-EVENT-023 ~ DCU-FUNC-EVENT-026	Fraud event - Event refer to [12] Section 5.6 Event Management		Auto/Manual
DCU-FUNC-EVENT-027 ~ DCU-FUNC-EVENT-030	Access event - Event refer to [12] Section 5.6 Event Management		Auto/Manual
DCU-FUNC-EVENT-031 ~ DCU-FUNC-EVENT-034	High Occurrence event - Event refer to [12] Section 5.6 Event Management		Auto/Manual
DCU-FUNC-EVENT-	Registered event - Event refer to [12] Section 5.6 Event		Auto/Manual

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035	Management	
DCU-FUNC-EVENT-036	Meter Related event - Event refer to [12] Section 5.6 Event Management	Auto/Manual
DCU-FUNC-EVENT-037	Firmware event - Event refer to [12] Section 5.6 Event Management	Auto/Manual
~		
DCU-FUNC-EVENT-040		

3.3.1.10 Test Group DCU Status Word test

Test Group Information			
Test Group ID	DCU-FUNC-SW	Test Group Name	DCU Status Word test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.7 Status Word		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU status word function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use semi-automatic method to execute the cases. (like open/close covers and plug-in/out the modules, etc.) - Connect to DCU by remote/local communication, and generate the events which will trigger the related DCU status word bit to be up. After that, recover the anomalies and check if the related DCU status word bit will be down.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-SW-001	The “Device power up” status word records		Auto
DCU-FUNC-SW-002	The “Cellular Communication module failure” status word records		Manual
DCU-FUNC-SW-003	The “Cellular Communication signal level is too low” status word records		Manual
DCU-FUNC-SW-004	The “PLC module failure” status word records		Manual
DCU-FUNC-SW-005	The “Flash space full alarm” status word records		Manual
DCU-FUNC-SW-006	The “Main cover removal” status word records		Manual
DCU-FUNC-SW-007	The “DCU unlock” status word records		Auto
DCU-FUNC-SW-008	The “Optical port failure” status word records		Manual
DCU-FUNC-SW-009	The “RS-485 failure” status word records		Manual
DCU-FUNC-SW-010	The “Clock invalid” status word records		Auto
DCU-FUNC-SW-011	The “Stand-alone mode” status word records		Auto
DCU-FUNC-SW-012	The “Image downloading” status word records		Manual
DCU-FUNC-SW-013	The “Phase failure” status word records		Auto

3.3.1.11 Test Group DCU LED Indicators test

Test Group Information			
Test Group ID	DCU-FUNC-LED	Test Group Name	DCU LED Indicators test
References	[13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit		

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	Specification Section 5.4.1 DCU LED indicators	
Test Purpose	To satisfy the [13] document’s requirements	
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test	
Test Method	- Use manual method to execute the cases. - Check the display correctness of every single LED indicator.	
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-LED-001	Check the display of Power indicator	Manual
DCU-FUNC-LED-002	Check the display of Phase L1 indicator	Manual
DCU-FUNC-LED-003	Check the display of Phase L2 indicator	Manual
DCU-FUNC-LED-004	Check the display of Phase L3 indicator	Manual
DCU-FUNC-LED-005	Check the display of Alarm indicator	Manual
DCU-FUNC-LED-006	Check the display of WAN indicator	Manual
DCU-FUNC-LED-007	Check the display of LAN PLC indicator	Manual
DCU-FUNC-LED-008	Check the display of LAN RS485 indicator	Manual

3.3.1.12 Test Group DCU firmware upgrade test

Test Group Information			
Test Group ID	DCU-FUNC-DUS	Test Group Name	DCU firmware upgrade test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.9.1 DCU Firmware Upgrade		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU firmware upgrade function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to execute the cases. - Check if the default value of upgrade enable interface is normal. - Verify the correctness of upgrade interface. - Connect to DCU by remote/local communication and execute the upgrading tasks of DCU; after upgrading, check if the software version is updated.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-DUS-001	Check the default value of upgrade enable		Auto
DCU-FUNC-DUS-002	Check upgrade related DLMS Parameters		Auto
DCU-FUNC-DUS-003	Upgrade the DCU by DLMS class id=18		Auto
DCU-FUNC-DUS-004	Upgrade the PLC module of DCU by DLMS class id=18		Auto

3.3.1.13 Test Group DCU remote reboot test

Test Group Information			
Test Group ID	DCU-FUNC-RBT	Test Group Name	DCU remote reboot test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion		

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	Specification, V1.4, 2024. Section 5.11 Remote Reboot	
Test Purpose	To satisfy the [12] document’s requirements and verify DCU remote reboot function is normal	
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test	
Test Method	- Using automatic method to execute the cases. - Connect to DCU by local/remote communication and execute the remote reboot commands to DCU. After the DCU reboot, check if all the applications boot well.	
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-RBT-001	Remote reboot DCU by DLMS class id=9	Auto

3.3.1.14 Test Group DCU Register test

Test Group Information			
Test Group ID	DCU-FUNC-REG	Test Group Name	DCU Register test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.12.1 Push setup – On Connectivity		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU register function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Using automatic method to test the cases. - Check if the correctness of push objects list’s content - Connect to DCU by local/remote communication and choose different communication channels to check if the registration messages that the DCU reports.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-REG-001	Check the correctness of push objects list’s content		Auto
DCU-FUNC-REG-002	Check the registration message of Cellular communication		Auto
DCU-FUNC-REG-003	Check the registration message of ETH communication		Auto

3.3.1.15 Test Group Meter registration communication test

Test Group Information			
Test Group ID	DCU-FUNC-ME-REG	Test Group Name	Meter registration communication test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.3 Meter Registration and Deregistration Procedure		
Test Purpose	To satisfy the [12] document's requirements and verify meter registration communication function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	Use automatic method to test the cases.		

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	• Check the correctness of meter registration management interface • Connect to DCU by local/remote communication and choose meters with different communication types to register to DCU. • Use registered meters with archives to connect to DCU.	
Acceptance Criteria	• All the test cases of this group execution and pass rates are 100%	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-ME-REG-001	Check the correctness of Registration Procedure interface	Auto
DCU-FUNC-ME-REG-002	Check the correctness of Meter Deregistration Procedure interface	Auto
DCU-FUNC-ME-REG-003	Check the correctness of Meter Black White List interface	Auto
DCU-FUNC-ME-REG-004	PLC meters without archives register to DCU for the first time	Auto
DCU-FUNC-ME-REG-005	Registered PLC meters with archives register to DCU again	Auto
DCU-FUNC-ME-REG-006	RS485 meters without archives register to DCU for the first time	Auto
DCU-FUNC-ME-REG-007	Check that the communication recovers normally when the power supply is on again	Auto

3.3.1.16 Test Group Meter Archives management test

Test Group Information			
Test Group ID	DCU-FUNC-ME-ARCH	Test Group Name	Meter archives management test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.2 Meter Archive Table		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU’s meter archives management function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to test the cases. - Check the correctness of meter archives management interface - Connect to DCU by local/remote communication. After the meters have registered to DCU, the HES automatically sends down the meters’ archives to DCU or the tester manually adds archives to DCU. - Modify the meters’ archives in DCU, and check if it works. - Delete the archives of meters from DCU, and the DCU will collect and transmit the meters’ data unsuccessfully.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-ME-ARCH-001	Check the correctness of meter archives management interface		Auto
DCU-FUNC-ME-ARCH-002	Add the archives of Single phase meter (PLC) to DCU		Auto

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DCU-FUNC-ME-ARCH-003	Add the archives of Poly phase meter (PLC) to DCU	Auto
DCU-FUNC-ME-ARCH-004	Add the archives of Current transformer meter (RS485) to DCU	Auto
DCU-FUNC-ME-ARCH-005	Modify the meters' archives in DCU	Auto
DCU-FUNC-ME-ARCH-006	Delete the meters' archives in DCU	Auto

3.3.1.17 Test Group On demand data request test

Test Group Information			
Test Group ID	DCU-FUNC-OD	Test Group Name	On demand data request test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.4 On-demand Command		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU supports on demand requests and responses transferring function		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to test the cases. - Connect to the meters via DCU and read and set the meters’ data.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-OD-001	Read the PLC meters’ data like clock, version, logical name via DCU		Auto
DCU-FUNC-OD-002	Read the RS485 meters’ data like clock, version, logical name via DCU		Auto
DCU-FUNC-OD-003	Set the PLC meters’ data like clock via DCU		Auto
DCU-FUNC-OD-004	Set the RS485 meters’ data like clock via DCU		Auto
DCU-FUNC-OD-005	Upgrade the PLC meters via DCU		Auto
DCU-FUNC-OD-006	Upgrade the RS485 meters via DCU		Auto

3.3.1.18 Test Group Device broadcast upgrade test

Test Group Information			
Test Group ID	DCU-FUNC-ME-DUS	Test Group Name	Device broadcast upgrade test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.9.2 Meter Firmware upgrade		
Test Purpose	To satisfy the [12] document's requirements and verify DCU broadcast upgrade meters function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic the method to test cases. - Check the correctness of broadcast upgrade task interface. - Connect to DCU by local/remote communication and execute broadcast upgrading tasks to different types of meters. - Set the different beginning time to execute upgrading tasks, such as the past		

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	time to execute the tasks immediately or the future time to execute the tasks at the specific time. After upgrading, using the software testing tool to check if the software versions of the meters or PLC modules are upgraded.	
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-METER-DUS-001	Check the correctness of broadcast upgrade task interface	Auto
DCU-FUNC-METER-DUS-002	The DCU broadcast upgrades the PLC meters	Auto
DCU-FUNC-METER-DUS-003	The DCU broadcast upgrades the RS485 meters	Auto
DCU-FUNC-METER-DUS-004	The DCU broadcast upgrades the PLC modules of the meters	Auto

3.3.1.19 Test Group Meter Data Collection test

Test Group Information			
Test Group ID	DCU-FUNC-ME-DC	Test Group Name	Meter data collection test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.5 Data Collection Procedures		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU collect meter data function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use automatic method to test the cases. - Check if the storing data interface of data collection is normal. - Check that reading the storing collection data by the entries is normal. - Check that reading the storing collection data by the time is normal. - Check that reading the storing collection data by the device serial number is normal. - Connect to the DCU by local/remote communication and execute collection tasks immediately or just wait the collection tasks to automatically execute at the scheduled time. - After the DCU collect the meters’ data, using the software testing tool to read the data from the DCU, and then compare them to the data in meters to see if the result is right.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-ME-DC-001	Check the storing data interface of data collection		Auto
DCU-FUNC-ME-DC-002	Check the storing collection data by the entries		Auto
DCU-FUNC-ME-DC-003	Check the storing collection data by the time		Auto

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DCU-FUNC-ME-DC-004	Check the storing collection data by the device serial number	Auto
DCU-FUNC-ME-DC-005	The DCU collects PLC meters' daily billing data	Auto
DCU-FUNC-ME-DC-006	The DCU collects RS485 meters' daily billing data	Auto
DCU-FUNC-ME-DC-007	The DCU collects PLC meters' monthly billing data	Auto
DCU-FUNC-ME-DC-008	The DCU collects RS485 meters' monthly billing data	Auto
DCU-FUNC-ME-DC-009	The DCU collects PLC meters' load profile data	Auto
DCU-FUNC-ME-DC-010	The DCU collects RS485 meters' load profile data	Auto
DCU-FUNC-ME-DC-011	The DCU collects PLC meters' power quality profile data	Auto
DCU-FUNC-ME-DC-012	The DCU collects RS485 meters' power quality profile data	Auto
DCU-FUNC-ME-DC-013	The DCU collects PLC meters' events data	Auto
DCU-FUNC-ME-DC-014	The DCU collects RS485 meters' events data	Auto

3.3.1.20 Test Group DCU Event and Meter Data Report test

Test Group Information			
Test Group ID	DCU-FUNC-ME-DR	Test Group Name	DCU event and meter data report test
References	[12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 5.12 Data Push		
Test Purpose	To satisfy the [12] document’s requirements and verify DCU data push function is normal		
Test Setup and Condition	Figure 3-15 Test Setup for DCU Function Test		
Test Method	- Use partial automatic method to test the cases. - When the meters register to the DCU, check if DCU reports the registration data to HES. - Let the tasks of collecting meters’ data execute immediately and generate some DCU events. After collection data tasks are over and when the DCU events produce, using the HES to check if the data is reported. - Generate the meters events, and check if the DCU can transmit them to HES normally.		
Acceptance Criteria	All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-DR-001	Check the correctness of the power on event message which the DCU reports		Auto
DCU-FUNC-DR-002	Check the correctness of the last gasp event message which the		Auto

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	DCU reports	
DCU-FUNC-DR-003	Check the correctness of the terminal cover open/close event message which the DCU reports	Manual
DCU-FUNC-DR-004	Check the correctness of the top cover open/close event message which the DCU reports	Manual
DCU-FUNC-DR-005	Check the correctness of the meters' events message which the DCU transmits	Manual
DCU-FUNC-DR-006	Check the correctness of the meters' registration information message which the DCU reports	Auto
DCU-FUNC-DR-007	Check the correctness of the meters' daily billing data message which the DCU reports	Auto
DCU-FUNC-DR-008	Check the correctness of the meters' monthly billing data message which the DCU reports	Auto
DCU-FUNC-DR-009	Check the correctness of the meters' load profile data message which the DCU reports	Auto
DCU-FUNC-DR-010	Check the correctness of the meters' power quality profile data message which the DCU reports	Auto
DCU-FUNC-DR-011	Check the correctness of the meters' event profile data message which the DCU reports	Auto

3.3.1.21 Test Group DCU RS485 Communication test

Test Group Information			
Test Group ID	DCU-FUNC-485	Test Group Name	DCU RS485 Communication test
References	• [12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. Section 2.1.3 LAN – Meter Interface (CI1)		
Test Purpose	• To satisfy the [12] document’s requirements and follow DLMS protocol		
Test Setup and Condition	• Figure 3-15 Test Setup for DCU Function Test		
Test Method	• Use automatic method to execute the cases. • Check the correctness of RS485 communication interface.		
Acceptance Criteria	• All the test cases of this group execution and pass rates are 100%		
Test Case Lists			
ID	Case Title		Test Type
DCU-FUNC-PLC-001	Check RS485 related DLMS Parameters		Auto
DCU-FUNC-PLC-002	RS485 Meter register to the DCU		Auto
DCU-FUNC-PLC-003	RS485 communication success rate		Manual
DCU-FUNC-PLC-004	Check RS485 Topology		Manual

3.3.1.22 Test Group DCU Cellular Communication

Test Group Information			
Test Group ID	DCU-FUNC-CELL	Test Group Name	DCU Cellular Communication
References	[14] ADB-PDEIP II-Tranche1-AMI Project-IESCO Package-Edit.pdf. Section 6.5.1.2. Communication with HES [12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024.		

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Test Purpose	To verify DCU LTE-WAN network function is normal	
Test Setup and Condition	- Figure 3-15 Test Setup for DCU Function Test - A DCU with newest software version, LTE module, Smartset, or Optical device. DCU have registered to HES. The uplink communication is normal	
Test Method	Using partial auto test	
Acceptance Criteria	ALL the test cases are pass	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-CELL-001	Check the default values of LTE module communication parameters	Auto
DCU-FUNC-CELL-002	Check the read and write permissions, data type, and size ranges of LTE module related parameters	Auto
DCU-FUNC-CELL-003	Check the network connecting mechanism and correctness of network parameters after network access	Auto
DCU-FUNC-CELL-004	Check APN configuration and correct network access	Auto
DCU-FUNC-CELL-005	Check PPP configuration and correct network access	Auto
DCU-FUNC-CELL-006	Check the network type configuration and correct network access	Auto
DCU-FUNC-CELL-007	Check the process of registering the DCU online to the HES	Manual
DCU-FUNC-CELL-008	Check the correctness of remote read (including large packets) and write	Auto
DCU-FUNC-CELL-009	Check the correctness of the push data process	Manual
DCU-FUNC-CELL-010	Check IPv4 and IPv6 network access	Manual
DCU-FUNC-CELL-011	Check the hot swappable module and replace module	Manual
DCU-FUNC-CELL-012	Remote upgrade of DCU	Auto
DCU-FUNC-CELL-013	LTE communication module upgrade	Auto
DCU-FUNC-CELL-014	Check the module supports domain name address resolution	Manual
DCU-FUNC-CELL-015	Check the LTE communication module LED light	Manual
DCU-FUNC-CELL-016	Check the event about LTE communication module	Manual

3.3.1.23 Test Group DCU G3 PLC Communication

Test Group Information			
Test Group ID	DCU-FUNC-PLC	Test Group Name	DCU G3 PLC Communication
References	[13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification [12] IESCO_AMI_Project, Technical Specification DCU Companion Specification, V1.4, 2024. [15] K. Consortium, OBIS LIST FOR DCU_v1.2.xlsx. [4] IESCO_AMI_Project, dlms_obis_list [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [8] ITU-T, "ITU-T G.9903: Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks," ITU, 2017.		
Test Purpose	To verify DCU G3 PLC network management function		
Test Setup and Condition	- Figure 3-15 Test Setup for DCU Function Test - a DCU with newest software version, LTE module, Smartset, ETH wire or		

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	Optical device. DCU have registered to HES. The uplink communication is normal	
Test Method	- Using partial auto test - Analysis the G3 Network sniffer log - Power on and down the DUT, makes the meter register to the DUT - Triger the network behavior, such as RREQ/PREQ/KICK OFF, etc. from DCU - Get the data from meter through DCU G3 network - Statistic the communication success rate	
Acceptance Criteria	ALL the test cases is pass	
Test Case Lists		
ID	Case Title	Test Type
DCU-FUNC-PLC-001	Check PLC related DLMS Parameters	Auto
DCU-FUNC-PLC-002	DCU G3 PLC event	Manual
DCU-FUNC-PLC-003	G3 Meter register to the DCU	Auto
DCU-FUNC-PLC-004	Kick off meter	Auto
DCU-FUNC-PLC-005	G3 PLC communication success rate	Manual
DCU-FUNC-PLC-006	G3 PLC Topology	Manual
DCU-FUNC-PLC-007	Black/White list	Auto
DCU-FUNC-PLC-008	Check PLC default Multicast addr.	Manual
DCU-FUNC-PLC-009	G3 PLC Communication LED indicator	Manual

3.3.2 Cellular Performance Test

Consistent with 3.1.2.

3.3.3 G3 PLC Performance Test

Consistent with 3.2.2.

3.3.4 Integration Test-DCU (CI1,CI2)

This test aims to detect if there is any failures or errors of Integration Test DCU.

3.3.4.1 Test Suite

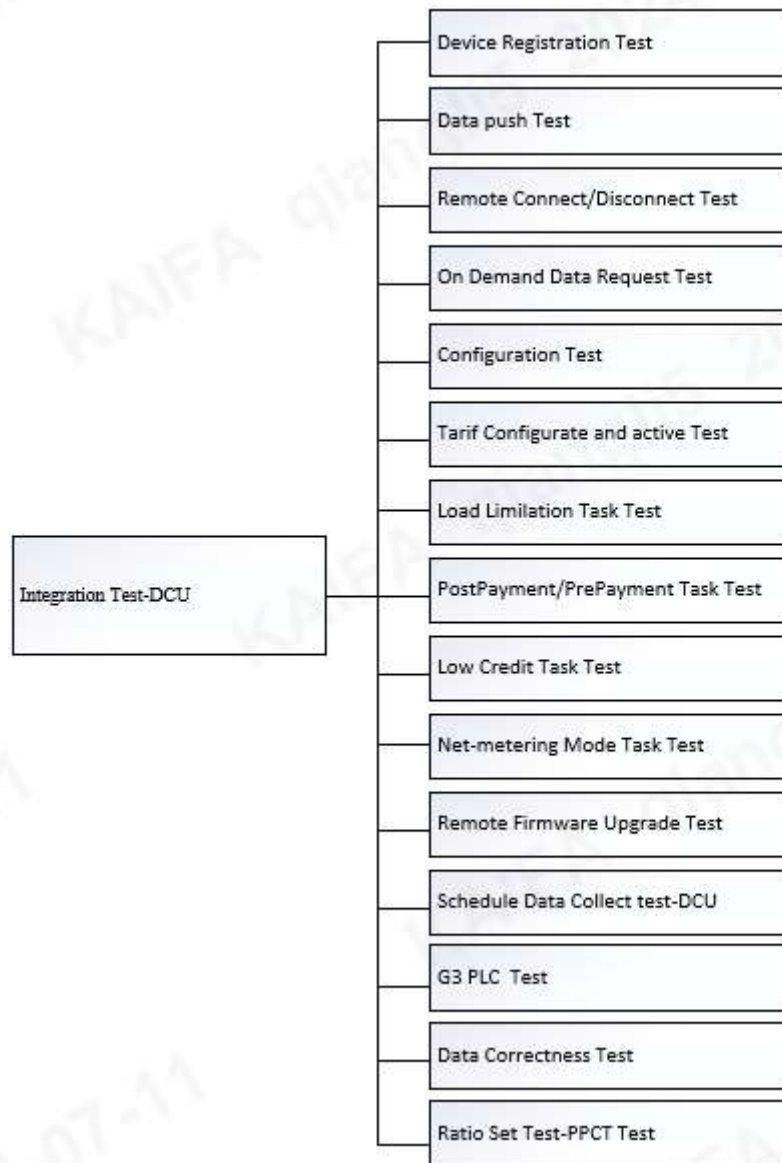


Figure 3-16 DCU Integration Test Setup

No.	Test Group ID	Test Group Name
1	DCU-INTE-REG	Device Registration Test
2	DCU-INTE-PUSH	Data push Test
3	DCU-INTE-RC	Remote Connect/Disconnect Test
4	DCU-INTE-ODO	On Demand Operation
5	DCU-INTE-CFG	Configuration test
6	DCU-INTE-TOU	Tariff Configure and active Test
7	DCU-INTE-LL	Load Limitation Task Test
8	DCU-INTE-PM	Post Payment/Prepayment Task Test
9	DCU-INTE-LC	Low Credit Task Test
10	DCU-INTE-NM	Net-metering Mode Task Test

No.	Test Group ID	Test Group Name
11	DCU-INTE-FU	Remote Firmware Upgrade Test
12	DCU-INTE-DC	Schedule Data Collect test
13	DCU-INTE-COM	G3 PLC Test
14	DCU-INTE-DATA	Data Correctness Test
15	DCU-INTE-RATIO	Ratio Set Test-PPCT

Table 3-20 Test Group List of DCU Integration Test

3.3.4.2 Test Setup

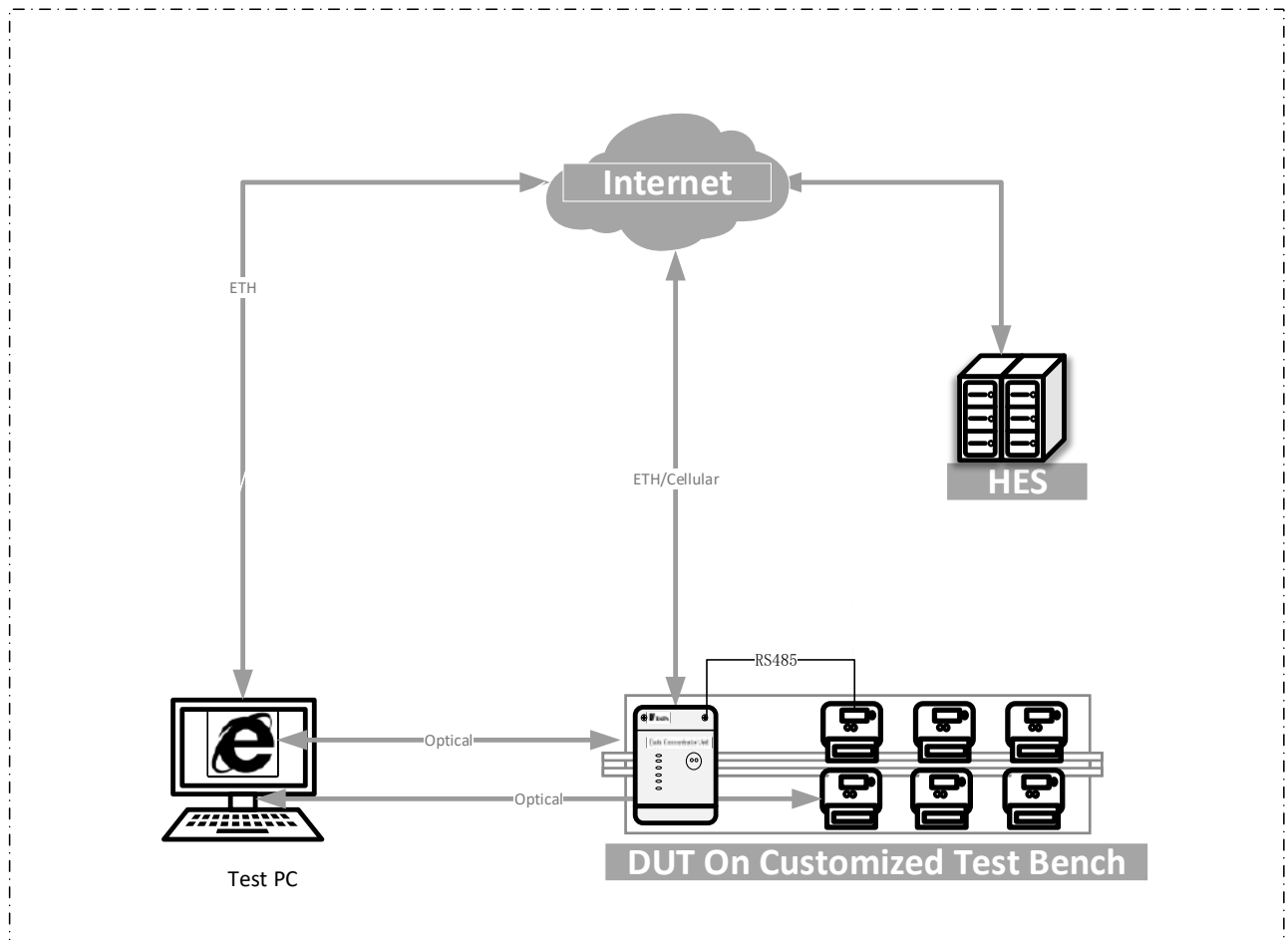


Figure 3-17 Test Setup for DCU Integration Test

No.	Device	Qty.	Description
1	DUT	1	DCU PC Connect DCU via Optical/ETH/Cellular Network
2	Meter	3	Auxiliary test equipment, the meters play a role in providing different meter data for DCU to collect or push the data via DCU when they receive commands from the HES Support PLC/RS485/Optical Communication.
3	Test PC	1	The computer is used for providing a place where automatic scripts can run. PC connect DUT via optical/ETH IP/Cellular IP

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No.	Device	Qty.	Description
4	Customized Test Bench	1	Auto test software, used to schedule automated test execution
5	HES	1	Head end system
6	Cellular Network	-	• IESCO provided • Support GPRS and LTE • Support verify the APN (Access Point Name) • Support verify the PPP information • Support IPv4/v6

Table 3-21 Test Setup for DCU Function Test

3.3.4.3 Test Group Device Registration

Test Group Information			
Test Group ID	DCU-INTE-REG	Test Group Name	Device Registration
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. • [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	• Verify the device register		
Test Setup and Condition	• The DUT function test is pass • Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test • Configure the DUT archive in HES • Power on and check if the Meter register to the DCU and HES		
Acceptance Criteria	• All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-REG-001	Device Registration Test-DCU		
DCU-INTE-REG-002	Device Registration Test-PLC Meter		
DCU-INTE-REG-003	Device Registration Test-485 Meter		

3.3.4.4 Test Group Meter Alarm/Event

Test Group Information			
Test Group ID	DCU-INTE-PUSH	Test Group Name	Data push Test-Meter Alarm/Event
References	• [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification • [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. • [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	• Verify the DUT could push event/alarm correctly to HES.		
Test Setup and Condition	• The DUT function test is pass • Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test		

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	Trigger the DUT push event/alarm and check if it has been pushed to HES.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
DCU-INTE-PUSH-001	Data push Test-DCU Alarm/Event
DCU-INTE-PUSH-002	Data push Test-Meter Alarm/Event
DCU-INTE-PUSH-003	Data push Test-Collected Meter Data
DCU-INTE-PUSH-004	Data push Test-G3 Topology

3.3.4.5 Test Group Remote Connect/Disconnect Test

Test Group Information			
Test Group ID	DCU-INTE-RC	Test Group Name	Remote Connect/Disconnect Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the remote connect/Disconnect meter works well		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Perform the remote connect/disconnect operation on the HES, and check if the meter action correctly.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-RC-001	Remote connect Meter		
DCU-INTE-RC-002	Remote disconnect Meter		

3.3.4.6 Test Group On Demand Data Request Test

Test Group Information			
Test Group ID	DCU-INTE-ODO	Test Group Name	On Demand Data Request Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the on-demand data request could be performed correctly		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		

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Test Method	Manually test Perform the on-demand request, and check the data.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
DCU-INTE-ODO-001	On Demand Data Request Test-Meter
DCU-INTE-ODO-002	On Demand Data Request Test-DCU

3.3.4.7 Test Group Configuration test

Test Group Information			
Test Group ID	DCU-INTE-CFG	Test Group Name	Configuration test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the configure the meter’s parameter		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure the meter’s parameter from HES.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-CFG-001	Configuration test-DCU		
DCU-INTE-CFG-001	Configuration test-Meter		

3.3.4.8 Test Group Tariff Configure and active Test

Test Group Information			
Test Group ID	DCU-INTE-TOU	Test Group Name	Tariff Configure and active Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the tariff configure and active with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test		

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	Configure and active tariff from the HES
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
DCU-INTE-TOU-001	Tariff Configure and active Test

3.3.4.9 Test Group Load Limitation Task Test

Test Group Information			
Test Group ID	DCU-INTE-LL	Test Group Name	Load Limitation Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the load limitation with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure and active the Load Limitation from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-LL-001	Load Limitation Task Test		

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3.3.4.10 Test Group Post Payment/Prepayment Task Test

Test Group Information			
Test Group ID	DCU-INTE-PM	Test Group Name	Post Payment/Prepayment Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the Post Payment/Prepayment Task integration with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure Post Payment/Prepayment Task from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-PM-001	Post Payment/Prepayment Task Test		

3.3.4.11 Test Group Low Credit Task Test

Test Group Information			
Test Group ID	DCU-INTE-LC	Test Group Name	Low Credit Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the Low Credit Task integration with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure the Low Credit Task from the HES and check if it works		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-LC-001	Low Credit Task Test		

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3.3.4.12 Test Group Net-metering Mode Task Test

Test Group Information			
Test Group ID	DCU-INTE-NM	Test Group Name	Net-metering Mode Task Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the integration Net-metering Mode Task with DUT and different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure the Net-metering Mode Task from the HES, check if it works.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-NM -001	Net-metering Mode Task Test		

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3.3.4.13 Test Group Remote Firmware Upgrade Test

Test Group Information			
Test Group ID	DCU-INTE-FU	Test Group Name	Remote Firmware Upgrade Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify DUT Firmware upgrade test integration with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Configure the Remote Firmware Upgrade Task from the HES. Check if it is work.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-FU-001	Remote Firmware Upgrade Test-Unicast Update Meter-SP PLC		
DCU-INTE-FU-002	Remote Firmware Upgrade Test-Unicast Update Meter-PPDC PLC		
DCU-INTE-FU-003	Remote Firmware Upgrade Test-Unicast Update Meter-PPCT PLC		
DCU-INTE-FU-004	Remote Firmware Upgrade Test-Unicast Update Meter-RS485		
DCU-INTE-FU-005	Remote Firmware Upgrade Test-Unicast Update G3PLC Module		
DCU-INTE-FU-006	Remote Firmware Upgrade Test-Broadcast Update Meter-SP PLC		
DCU-INTE-FU-007	Remote Firmware Upgrade Test-Broadcast Update Meter-PPDC PLC		
DCU-INTE-FU-008	Remote Firmware Upgrade Test-Broadcast Update Meter-PPCT PLC		
DCU-INTE-FU-009	Remote Firmware Upgrade Test-Broadcast Update G3 PLC Module		

3.3.4.14 Test Group Schedule Data Collect test

Test Group Information			
Test Group ID	DCU-INTE-DC	Test Group Name	Schedule Data Collect test-DCU
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the Up-Stream Schedule Data Collect test integration with different manufactory Meters and HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		

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Test Method	Manually test Configure Schedule Data Collect Test Task from the HES/DCU. Check if it is work.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
DCU-INTE-DC-001	Schedule Data Collect test-DCU
DCU-INTE-DC-002	Schedule Data Collect test-HES

3.3.4.15 Test Group G3 PLC Test

Test Group Information			
Test Group ID	DCU-INTE-COM	Test Group Name	G3 PLC
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the G3 PLC integration with different manufactory DCU /HES		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		
Test Method	Manually test Trigger the G3 PLC network behavior.		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-COM-001	Phase Detection		
DCU-INTE-COM-002	Black/White List		
DCU-INTE-COM-003	Unregister Meter		

3.3.4.16 Test Group Data Correctness Test

Test Group Information			
Test Group ID	DCU-INTE-DATA	Test Group Name	Data Correctness Test
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the Data Correctness		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test		

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Test Method	Manually test Check if data correctness by compare the meter's data both HES and DCU.
Acceptance Criteria	All the test case of this group is pass
Test Case Lists	
ID	Case Title
DCU-INTE-DATA-001	Data Correctness Test

3.3.4.17 Test Group Ratio Set Test-PPCT

Test Group Information			
Test Group ID	DCU-INTE-RATIO	Test Group Name	Ratio Set Test-PPCT
References	[1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [2] DLMS User Association, DLMS UA 1000-1 Ed.14, 2020. [3] DLMS User Association, DLMS UA 1000-2 Ed.10, 2020. [7] IESCO_AMI_Project, Technical Specification Head End System [13] IESCO_AMI_Project, Technical Specification Data Concentrator Unit Specification		
Test Purpose	Verify the Ratio Set Test-PPCT		
Test Setup and Condition	- The DUT function test is pass - Figure 3-17 Test Setup for DCU Integration Test - DUT is PPCT		
Test Method	Manually test Configure t Ratio Set Test-PPCT Task from the HES/DCU. Check if it is work		
Acceptance Criteria	All the test case of this group is pass		
Test Case Lists			
ID	Case Title		
DCU-INTE-RATIO-001	Ratio Set Test-PPCT		

3.4 HES

3.4.1 Integration Test-MDMS to HES (CIM)

This test aims to verify HES SI2 interface functionality to complete the integration. Empower Test is the test tool to make the integration test with the new HES system following the CIM specification defined by IESCO.

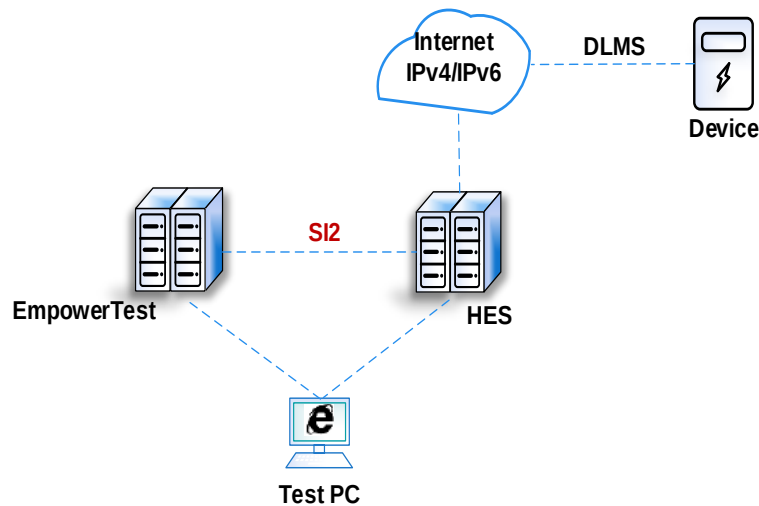


Figure 3-18 System Integration Framework

Figure 3-18 shows the system integration framework. Empower HES is connected to the new HES system, and the new HES system should be connected with the devices via Internet.

3.4.1.1 Test Pre-condition

The HES interface integration test will be carried out while the following test instruments should be ready.

No.	Instrument	Condition
1	HES System	Deployed by the supplier and can be connected by LAB instrument.
2	Device Under Test	Real DUT or simulator which is working normally with test HES
3	Test PC	Working normally with Internet access
4	Empower Test Tool	Can be connected with test HES

Table 3-22 CIM Test Pre-condition

3.4.1.2 Test Suite

According to the interface data flow direction, the test cases are divided into three groups. One group is for system file integration and does not involve electric meter equipment; the second group is for HES command execution, and the third group is for HES to actively report data.

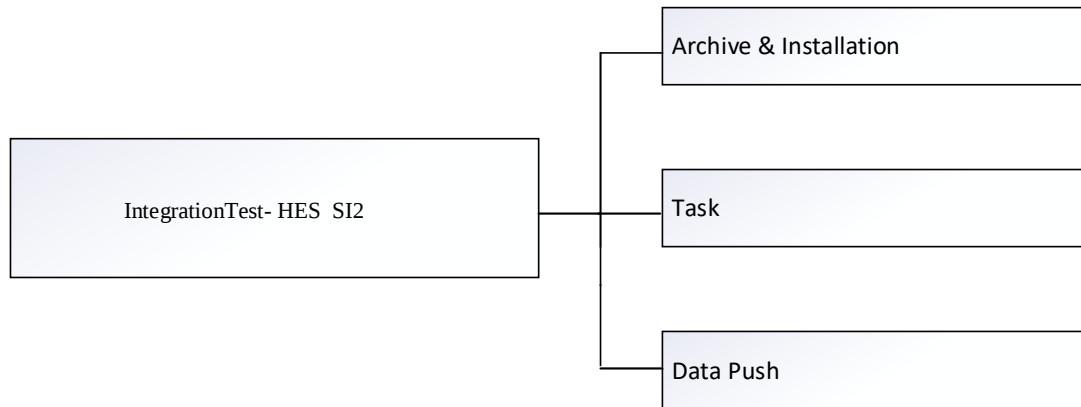


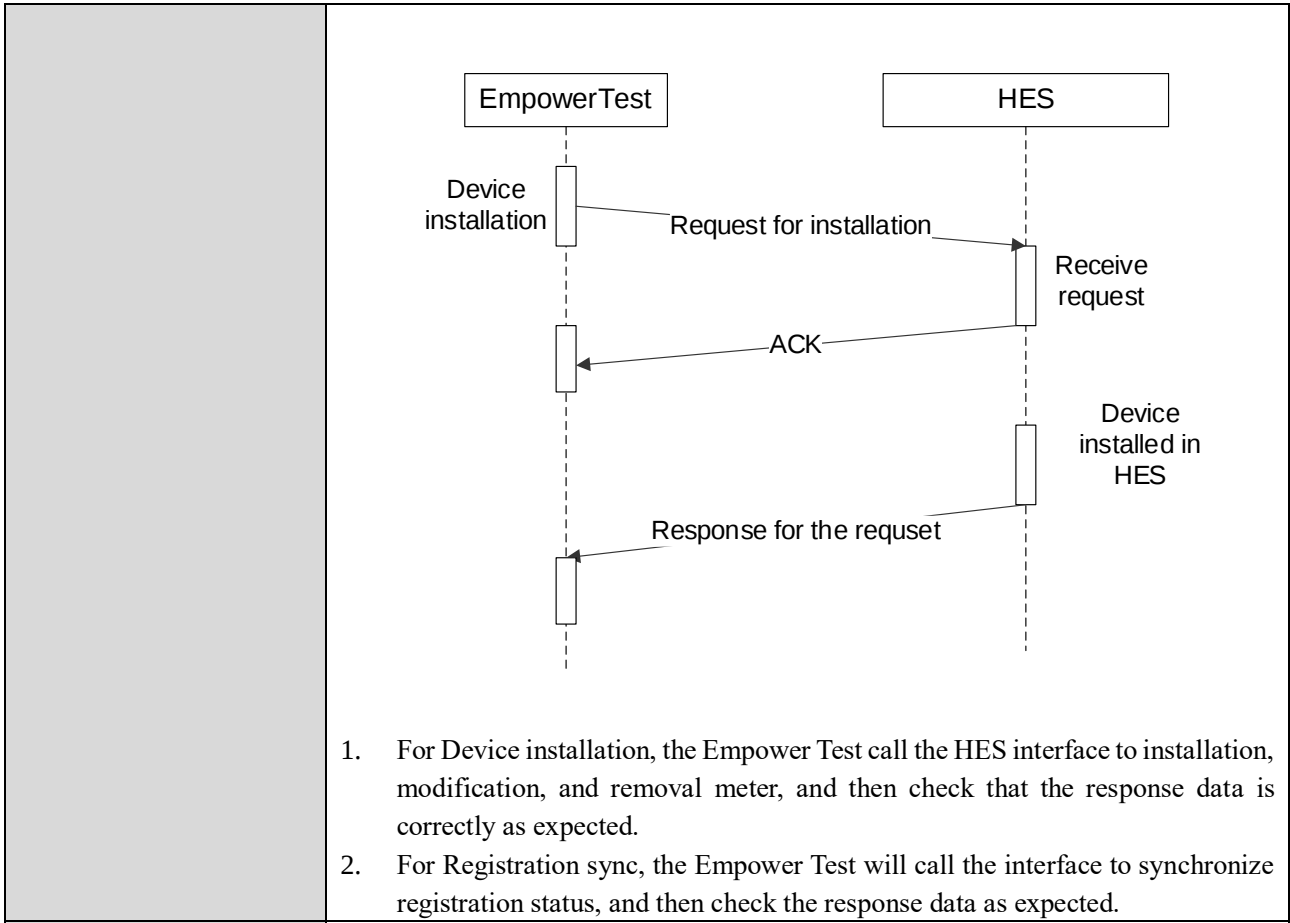
Figure 3-19 System Integration Test Group

Test Group ID	Test Group Name
TG-001	Archive & Installation
TG-002	Task
TG-003	Data Push

Table 3-23 Device List

3.4.1.3 TG-001 Archive & Installation

Test Group Information			
Test Group ID	TG-001	Test Group Name	Archive & Installation
References	[16] IESCO_AMI_Project, CIM Specification		
Test Purpose	This section aims at presenting message structures regarding information exchange from or to HES.		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal.		
Test Method	EmpowerTest HES <pre> sequenceDiagram participant EmpowerTest participant HES EmpowerTest->>HES: Archive has change HES-->>EmpowerTest: Archive sync result </pre> Region: create, delete,modifiedDevice Archive: create, delete,modified EmpowerTest HES <pre> sequenceDiagram participant EmpowerTest participant HES HES->>EmpowerTest: Module updating EmpowerTest-->>HES: Module update result </pre> Module Info Updating - Partial automatic test, Partial Manually test - For Region Info, the Empower Test will call the HES interface to add, modify, and delete regions, and then check that the corresponding regions of HES are updated synchronously. - For Device archive, the Empower Test will call the HES interface to add, modify, and delete meter/DCU archives, and then check that the corresponding archives of HES are updated synchronously. - For Module updating, the test case will simulate HES to call the interface to synchronize module information about device, and then check the response data as expected.		



Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
---------------------	---

Test Case Lists	
ID	Case Title
TG-001-001	Region Info
TG-001-002	Device Archive
TG-001-003	Module Info Updating
TG-001-004	Meter Installation
TG-001-005	DCU Installation
TG-001-006	Registration Synchronization

3.4.1.4 TG-002 Task

Test Group Information			
Test Group ID	TG-002	Test Group Name	Task
References	[16] IESCO_AMI_Project, CIM Specification [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	This group is aims to verify that HES can correctly receive the CIM code		

	defined by the interface and perform corresponding actions
Test Setup And Condition	HES service is running normally
Test Method	<pre> sequenceDiagram participant EmpowerTest participant HES EmpowerTest->>HES: CIM request activate HES HES->>EmpowerTest: ACK deactivate HES activate HES HES->>HES: Operations execution deactivate HES HES->>EmpowerTest: CIM response deactivate HES activate EmpowerTest deactivate EmpowerTest </pre> - Automatic test - For CIM task, the Empower Test call the HES interface to send CIM commands, HES receive the commands, will do some own operations, after that, HES will send the response to Empower Test. Lastly, the Empower Test will check the task result and response data is correctly as expected.
Acceptance Criteria	The test cases will result in the following verdicts: Passed: The interface complies with all the acceptance criteria. Failed: The interface does not meet one or more acceptance criteria and needs to be verified after rectification, change points are provided, and relevant test items need to be retested to evaluate.
Test Case Lists	
ID	Case Title
TG-002-001	Relay Control Task Test
TG-002-002	Tariff Task Test
TG-002-003	Load Limitation Task Test
TG-002-004	Top Up Task Test
TG-002-005	Post Payment/Prepayment Task Test
TG-002-006	Key Change Task Test
TG-002-007	Low Credit Task Test
TG-002-008	Net-metering Mode Task Test
TG-002-009	Meter Reading Test
TG-002-010	Event Reading Test
TG-002-011	Device Parameter Synchronization Test

3.4.1.5 TG-003 Data Push

Test Group Information			
Test Group ID	TG-003	Test Group Name	Data Push
References	[16] IESCO_AMI_Project, CIM Specification [1] IESCO_AMI_Project, Technical Specification Smart Meter Companion Specification [7] IESCO_AMI_Project, Technical Specification Head End System		
Test Purpose	This group is aims to verify that Daily profile, monthly profile, load profile and power quality profile and event will be pushed from HES.		
Test Setup & Condition	- All HES services run normally. - Communication between the test PC and the server is normal.		
Test Method	EmpowerTest		

3.5 PLC filter function test

Verify the functional integrity and performance of the product, the test items are as follows:

- Noise attenuation test
- Power consumption test

3.5.1 Noise attenuation test

3.5.1.1 Test Initiation Criteria

Ambient temperature: 15°C to 35°C;

Ambient relative humidity: 45% to 75%;

Air pressure: 86 kPa to 106 kPa.

3.5.1.2 Test Setup

Refer to the diagram below to set up the testing environment for the filter:

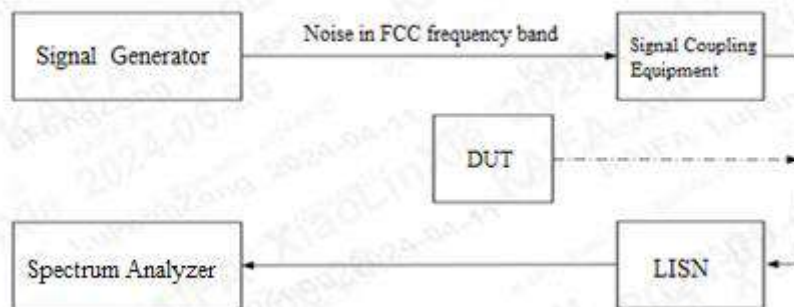


Figure 4-20 Test Setup for PLC filter Function test

Information for measurement equipment:

No	Device name	Qty.	Description
1	Arbitrary Function Generator	1	Generator noise wave in FCC frequency band
2	Spectrum Analyzer	1	Display signal spectrum characteristics
3	LISN	1	Artificial mains network
4	Signal Coupling Equipment	1	Isolation of noise from AC power, output noise signal
5	Variable Frequency Power Supply	1	AC power input, output stable 230V 50Hz power, to avoid AC voltage change. Recommended model: ANFC015T
6	Isolated Power	1	Isolate AC power and DUT power supply, to avoid other signal transmission through AC power, without pass the LISN and Attenuator.

Table 4-24 Test Setup for PLC filter function test

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3.5.1.3 Test case information

Test Case Information			
Test Case ID	Filter FCT-001	Test Case Name	Noise attenuation test
References	[17] IESCO_AMI_Project, Technical Specification PLC Filter Specification for single phase meter [18] IESCO_AMI_Project, Technical Specification PLC Filter Specification for three phase meters		
Test Purpose	Verify the noise attenuation performance of the product.		
Test Setup and Condition	- Test voltage: Un for voltage circuit; - Noise is emitted by signal generator and read spectrum analyzer, compare the noise before and after DUT is connected to the power grid.		
Acceptance Criteria	The attenuation of EUT is ≥ 15 dB in FCC Frequency		
Procedures	Step No.	Action	Output
	1	Use signal generator send out a noise waveform in FCC frequency, coupling the signal into the LISN by RF couple, record the maximum amplitude of the waveform in Spectrum Analyzer.	Record the maximum amplitude of the waveform.
	2	Add filter in test system redo step 1, record the maximum amplitude of the waveform in Spectrum Analyzer.	Record the maximum amplitude of the waveform.
	3	Calculate the difference value between step 1 and step 2.	The attenuation value

3.5.2 Power consumption test

3.5.2.1 Test Initiation Criteria

Ambient temperature: 15°C to 35°C;

Ambient relative humidity: 45% to 75%;

Air pressure: 86 kPa to 106 kPa.

3.5.2.2 Test Setup

The DUT connected to the power analyzer, as show in the following figure:

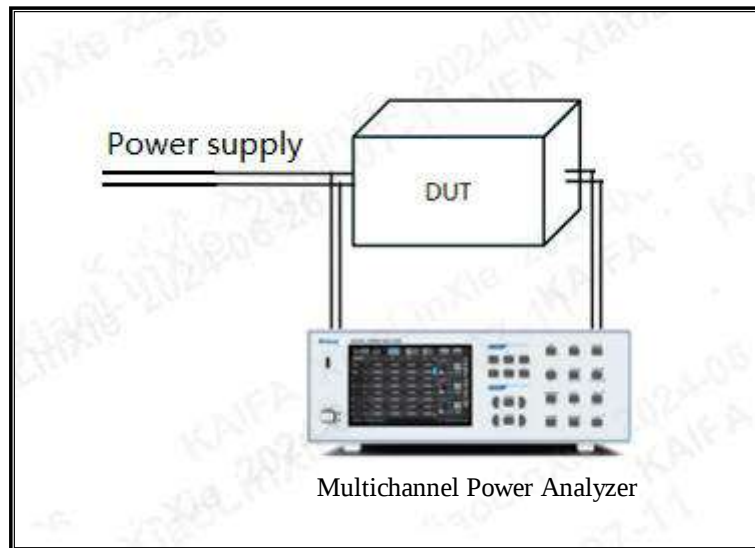


Figure 4-21 Test Setup for PLC filter power consumption test

Information for measurement equipment:

No	Device name	Qty.	Description
1	Multichannel Power Analyzer	1	Power consumption test

Table 4-25 Test Setup for PLC filter power consumption test

3.5.2.3 Test case information

Test Case Information			
Test Case ID	Filter FCT-002	Test Case Name	Power consumption test
References	[17] IESCO_AMI_Project, Technical Specification PLC Filter Specification for single phase meter [18] IESCO_AMI_Project, Technical Specification PLC Filter Specification for three phase meters		
Test Purpose	Verify power consumption of voltage circuit meets the requirements of the technical specification.		
Test Setup and Condition	Test voltage: Un for voltage circuit;		
Acceptance Criteria	The active and apparent power consumption for each voltage circuit shall not exceed 0.6W/16VA.		
Procedures	Step No.	Action	Output
	1	To connect the test equipment and the sample according to the test;	N/A
	2	Use power analyzer to measure the power consumption at the voltage circuit.	Record power consumption

3.6 Real Environment Simulation Test

The Real Environment Simulation Test aims to replicate the various scenarios that products may encounter during actual deployment, including network topology, communication protocols, and device interoperability. This method validates the system’s stability, performance, and impact on business operations in a real-world setting.

The test considers the following points:

Network Topology and Deployment Scheme: Construct a network structure based on the actual deployment plan, ensuring it closely resembles the on-site environment.

Communication Devices and Equipment from Different Manufacturers: Configure electricity meters and Data Concentrator Units (DCUs) from various manufacturers to ensure they can communicate and operate seamlessly. For instance, when introducing a new electricity meter, it is essential to pair it with all possible DCUs and set up the environment according to the Test Setup for comprehensive testing.

Performance Evaluation: Assess the impact of multiple electricity meters operating simultaneously on system business performance in the actual network environment, including metrics such as data collection success rate, stability, and data accuracy.

3.6.1 PLC network performance test

The objective is to test the performance of the G3PLC solution within the environment, focus on the stability and robustness of the test.

3.6.1.1 Test Suite

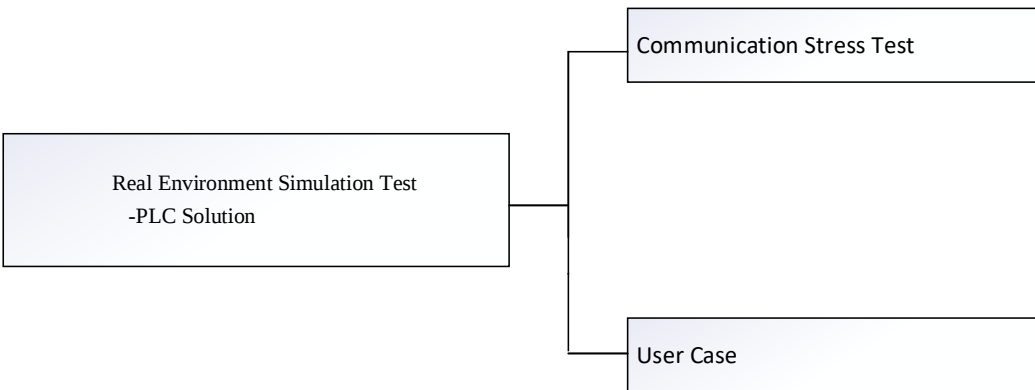


Figure 3-22 Test Suite for PLC Network Performance Test

No.	Test Group ID	Test Group Name
1	RES-PLC-CST	Communication Stress Test
2	RES-PLC-UC	User Case

Table 3-26 Test Group for PLC Network Performance Test

3.6.1.2 Test Setup

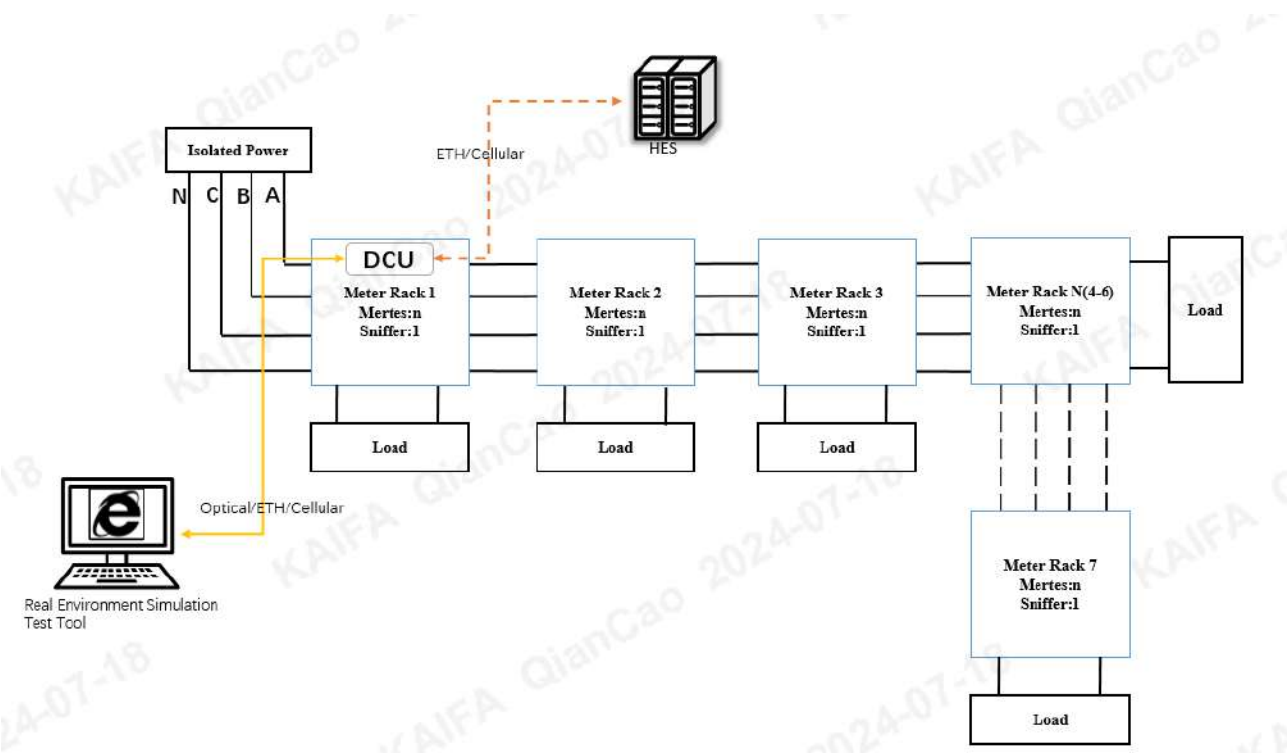


Figure 3-23 Test Setup for PLC Network Performance Test

No.	Device	Qty.	Description
1	Isolated Power	1	Isolate AC power and meter power supply, to avoid PLC signal transmission through AC power
2	Meter Rack	7	Hold on meters
3	DCU	1	It's used to build network
4	Sniffer	7	Catch the power line communication data log
5	Computer	1	It's used to run script
6	LIS Test Tool	1	Auto test software, used to schedule automated test execution
7	Load	7	Use the electric equipment for test
8	Meters	-	Each rack holds 39 meters When DUT is DCU, each rack with at least 5-10 meters from each manufacturer.
9	HES	-	Head end system

Table 3-27 Device Lists

3.6.1.3 Test Group Communication Stress Test

Test Group Information			
Test Group ID	RES-PLC-CST	Test Group Name	Communication Stress Test
References	N/A		

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Test Purpose	Evaluate the solution's capabilities.
Test Setup and Condition	Figure 3-23 Test Setup for PLC Network Performance Test
Test Method	- Manually control the power on and off of the equipment and start the test. After manually clicking start, the automated tool will automatically execute the test tasks and data analysis. - The testing process is divided into two phases. The first phase is to observe the PLC networking situation, expected to last 12 hours. The second phase is to conduct cycle task (short/long communication test, read profile etc), controlling the task execution interval and frequency through automated tools, expected to last 36 hours. - Capture the PLC communication logs during the testing process using a G3 PLC Sniffer in the environment and perform network analysis (connected meter number, offline meter number, re-register meter number etc.) - Using automated testing tools to execute stress testing related tasks and analyze task execution efficiency (task success rate, task duration etc.)
Acceptance Criteria	- ALL Case Pass - All devices registered within 12 hours.
Test Case Lists	
ID	Case Title
RES-PLC-CST-001	Network Analysis
RES-PLC-CST-002	Cycle Task Analysis

3.6.1.4 Test Group User Case

Test Group Information			
Test Group ID	RES-PLC-UC	Test Group Name	User Case
References	• N/A		
Test Purpose	• Execute user cases from HES in a controlled environment to evaluate the solution’s capabilities.		
Test Setup and Condition	• Figure 3-23 Test Setup for PLC Network Performance Test		
Test Method	• Manually control the power on and off of the equipment and start the test. After manually clicking start, tester will interact with the HES to create tasks. • The testing process is divided into two phases. The first phase is to observe the PLC meter register to HES, expected to last 12 hours. The second phase is to conduct test case. • Cases executed in Phase2 includes: Meter Register to HES, Data Collection, On-demand Operation, firmware Update etc.		
Acceptance Criteria	• All test case pass		
Test Case Lists			
ID	Case Title		
RES-PLC-UC-001	Meter Register to HES		
RES-PLC-UC-002	Daily Billing Collect		
RES-PLC-UC-003	Monthly Billing Collect		
RES-PLC-UC-004	Load Profile Collect		
RES-PLC-UC-005	Power Quality Collect		
RES-PLC-UC-006	Meter Firmware Update		

RES-PLC-UC-007	DCU Firmware Update
RES-PLC-UC-007	On-Demand Operation from HES

3.6.2 Cellular network performance test

The objective is to test the performance of the Cellular solution within the environment, focus on the stability and robustness of the test.

3.6.2.1 Test Suite

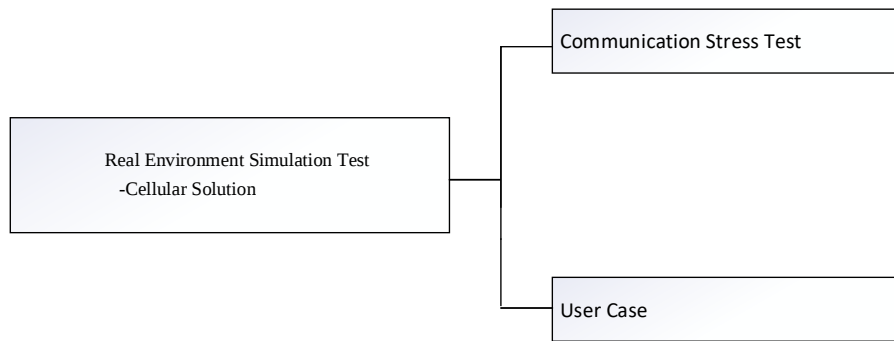


Figure 3-24 Test Suite for Cellular Network Performance Test

No.	Test Group ID	Test Group Name
1	RES-CELL-CST	Communication Stress Test
2	RES-CELL-UC	User Case

Table 3-28 Test Group List

3.6.2.2 Test Setup

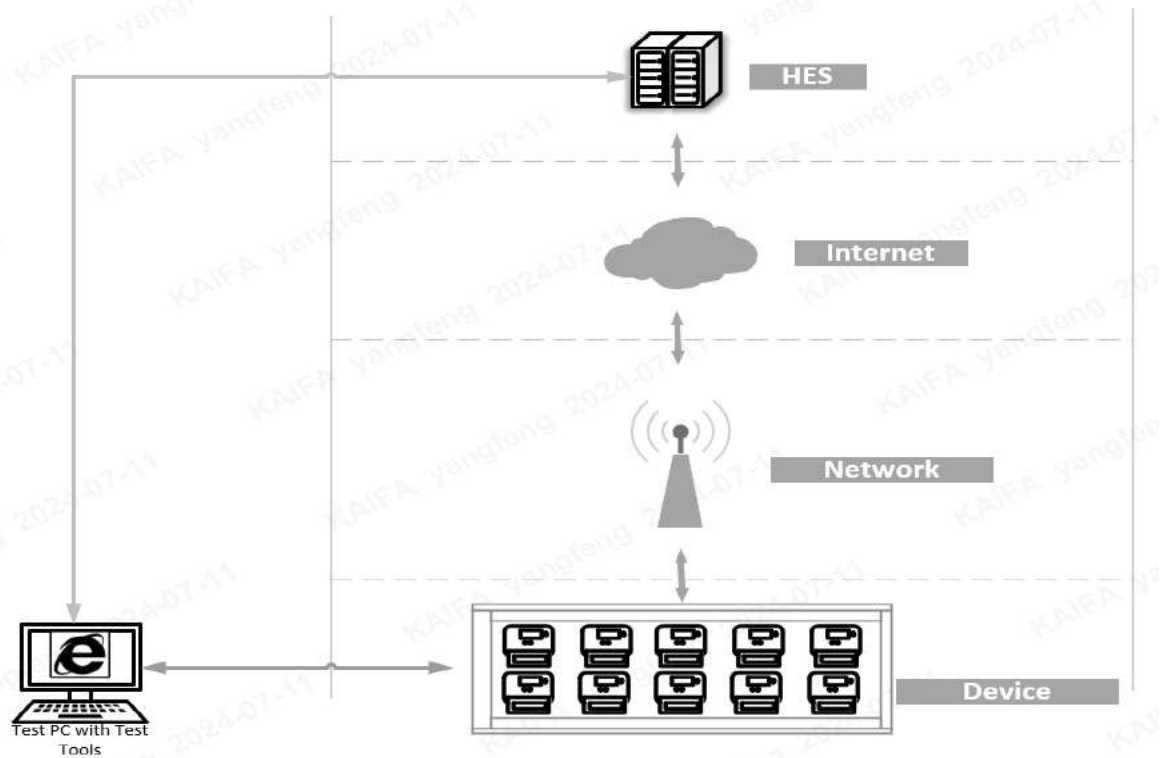


Figure 3-25 Test Setup for Cellular Network Performance Test

No.	Device	Qty.	Description
1	SIM Card	20	Used for module registration online
2	Meter Rack	1	Hold on meters
3	Test PC	1	It's used to run script
4	LIS Test Tool	1	Auto test software, used to schedule automated test execution
5	Meters	20	
6	HES	-	Head end system

Table 3-29 Device List

Title:	Interoperability Test Specification	Ver.	2.0	Page:	101 of 103
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3.6.2.3 Test Group Communication Stress Test

Test Group Information			
Test Group ID	RES-CELL-CST	Test Group Name	Communication Stress Test
References	N/A		
Test Purpose	Evaluate the solution’s capabilities.		
Test Setup and Condition	Figure 3-25 Test Setup for Cellular Network Performance Test		
Test Method	- Manually control the power on and off of the equipment and start the test. After manually clicking start, the automated tool will automatically execute the test tasks and data analysis. - The testing process is divided into two phases. The first phase is to observe the Cellular networking situation, expected to last 3 hours. The second phase is to conduct cycle task (short/long communication test, read profile etc.), controlling the task execution interval and frequency through automated tools, expected to last 36 hours. - Capture the communication logs during the testing process using Wireshark in the environment and perform network analysis (connected meter number, offline meter number, re-register meter number etc.) - Develop automated testing tools to execute stress testing related tasks and analyze task execution efficiency (task success rate, task duration etc.)		
Acceptance Criteria	- ALL Case Pass - All devices registered within 3 hours.		
Test Case Lists			
ID	Case Title		
RES-CELL-CST-001	Network Analysis		
RES-CELL-CST-002	Cycle Task Analysis		

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3.6.2.4 Test Group User Case

Test Group Information			
Test Group ID	RES-CELL-UC	Test Group Name	User Case
References	N/A		
Test Purpose	Execute user cases from HES in a controlled environment to evaluate the solution’s capabilities.		
Test Setup and Condition	Figure 3-25 Test Setup for Cellular Network Performance Test		
Test Method	- Manually control the power on and off of the equipment and start the test. After manually clicking start, tester will interact with the HES to create tasks or obtain task execution results. - The testing process is divided into two phases. The first phase is to observe the PLC meter register to HES, expected to last 12 hours. The second phase is to conduct test case. - Cases executed in Phase2 includes: Meter Register to HES, Data Collection, On-demand Operation, firmware Update etc.		
Acceptance Criteria	All test case pass		
Test Case Lists			
ID	Case Title		
RES-CELL-UC-001	Meter Register to HES		
RES-CELL-UC-002	Daily Billing Collect		
RES-CELL-UC-003	Monthly Billing Collect		
RES-CELL-UC-004	Load Profile Collect		
RES-CELL-UC-005	Power Quality Collect		
RES-CELL-UC-006	Meter Firmware Update		
RES-CELL-UC-007	On-Demand Operation from HES		

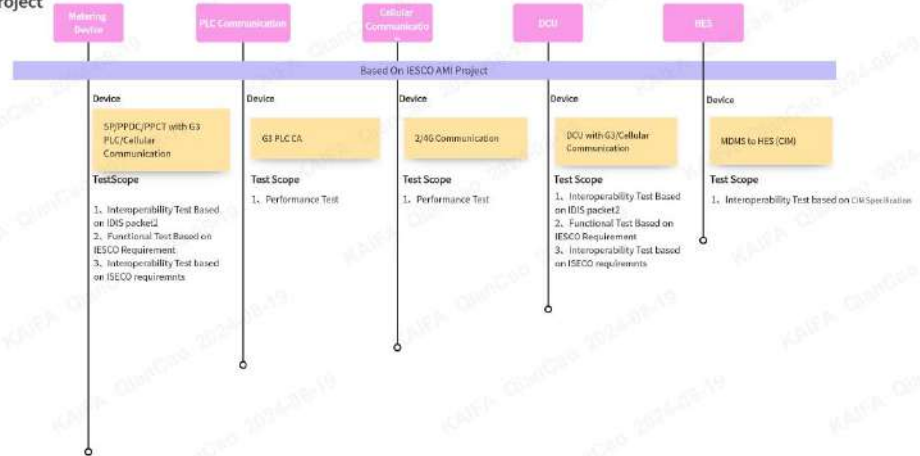
Title:	Interoperability Test Specification	Ver.	2.0	Page:	103 of 103
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4 References

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Interoperability Test Lab

1. Test Based on IESCO AMI LAB Project



2. Future Expansion of Lab

