

Nigerian Electricity Smart Metering Regulation



NIGERIAN ELECTRICITY SMART METERING REGULATION

REGULATION NO: NERC/REG/4/2017

In exercise of the powers to develop Standards and make Regulations conferred by Sections 81 and 96(1) of the Electric Power Sector Reform Act 2005 (Act No. 6 of 2005) respectively, and all other powers enabling it in that behalf, the Nigerian Electricity Regulatory Commission makes the following Regulations for Physical, functional, interface and data requirement for smart metering systems operation in the Nigerian Electricity Supply Industry.

Version 01

Nigerian Electricity Smart Metering Regulation

Contents

1. INTRODUCTION.....	4
1.1. General.....	4
1.2. Scope.....	4
1.3. Interpretation of Terms	4
1.4. Normative References	9
2. PHYSICAL REQUIREMENTS	9
3. FUNCTIONAL REQUIRMENENTS.....	10
3.1 Clock.....	10
3.2 Communications	10
3.3 Data storage.....	11
3.4 Display of information	11
3.5 Monitoring	12
3.6 Payment Mode.....	12
3.7 Pricing.....	14
3.8 Recording	14
3.9 Security	16
3.10 Voltage quality measurements	17
4. INTERFACE REQUIREMENTS.....	19
4.1. HAN Interface Consumer Device Information Provision	19
4.2. HAN Interface Microgeneration Meter Information Forwarding	19
4.3. User Interface Commands	20
4.4. WAN Interface Commands	21
5. DATA REQUIREMENTS	24
5.1. Constant data.....	24
5.2. Configuration data	24
5.3. Operational data	28
6. IN HOME DISPLAY (IHD) TECHNICAL SPECIFICATION.....	31
6.1. General.....	31
6.2. Physical requirements.....	31
6.3. Functional Requirements.....	31
6.4. Interface Requirements	34
6.5. Data requirements.....	34
7. SMART METER SPECIFICATIONS AND SMS OWNERSHIP	34

Nigerian Electricity Smart Metering Regulation

7.1.	Smart Meter.....	34
7.2.	Meter Protection and design	35
7.3.	Ownership of SMS.....	36
8.	AMENDMENT AND REPEAL.....	36

1. INTRODUCTION

1.1. General

This is a technical regulation that sets out the minimum physical, functional, interface and data requirements for a Smart Metering System in the Nigerian Electricity Supply Industry. This Regulation applies to all licensees that may wish to deploy Smart Metering. It is based on International and European standards. It spells out the physical, functional, interface, data, In House Display, ownership requirements for the entire Smart Metering System. It states the standards and specifications for the equipment, communication protocols and security.

1.2. Scope

This regulation sets out the minimum physical, functional, interface and data requirements for a Smart Metering System. This covers all classes and types of smart meters, communication systems, and other components of an Advanced Metering Infrastructure (AMI) deployment in order to measure electrical energy consumption, support billing (Multi-Tariff and Multi-Source), Pre-paid and Credit Payment functionality, remote Load Control (connection/disconnection) and to report events/alarms to other control and monitoring systems e.g. Outage Management Systems (OMS).

The system shall provide Information and data to support smart grid applications and have the capability of extending its functionality to Load Control, Demand Response and Demand Side Management (DSM) services.

1.3. Interpretation of Terms

Active Energy means the integral with respect to time of the Active Power in units of watt-hours (Wh) or standard multiples thereof (for example, kWh, MWh).

Active Power means the product of voltage and the in-phase component of alternating current measured in units of watts (W) or standard multiples thereof (for example, kW, MW).

Alarm means a short-lived audible signal.

Alert means a warning generated in response to a problem or the risk of a potential problem.

Ambient means the representation of information in a form that can be understood at a glance.

Armed means the Load Switch is in a state whereby it will close in response to a Command to Enable Supply for an SMS.

Arm Load Switch means to establish a state whereby a Load Switch will close in response to a Command to Enable Supply and “Arming” shall be construed accordingly.

Nigerian Electricity Smart Metering Regulation

Authentication means the method used to confirm the identity of entities or Devices wishing to communicate and “Authenticated” and “Authenticity” shall be construed accordingly.

Authorisation means the process of granting access to a resource directly or indirectly and “Authorised” shall be construed accordingly.

Battery means a component that produces electricity from a chemical reaction.

Block Counter means storage for recording Consumption for the purposes of combined Time-of-use and Block Pricing.

Block Pricing means a pricing scheme used in conjunction with Time-of-use Pricing where Price varies based on Consumption over a given time period.

Block Tariff means a Tariff for Block Pricing.

Clock means a timing mechanism operating the UTC primary time standard which has a minimum resolution of 1 second.

Command means an instruction to perform a defined function

Communications Link means a means of communication between a system or Device and another system or Device to exchange information.

Confidentiality means ensuring that information, in transit or at rest, is not accessible by unauthorised parties through either unintentional means or otherwise.

Consumer has the same meaning as in the Electric Power Sector Reform Act 2005.

Consumer Device means an IHD or any other Device incorporating a HAN Interface with the means of providing a Consumer access to the information stored in the SMS (as appropriate) via that interface.

Consumption means Electricity Consumption.

Credit Mode means a mode of operation of a SMS whereby Consumers are billed for some or all of their Consumption retrospectively.

Cryptographic Algorithm means an algorithm for performing one or more of the following functions: Encryption; Decryption; digitally signing or hashing of information, data, or messages; or exchange of Security Credentials.

Currency Units means the units of monetary value in major and minor units.

Data Integrity means the state of data being unaltered by parties not Authorised.

Data Store means an area of a SMS capable of storing data or information for future retrieval.

Day means the period commencing 00:00:01 Local Time and ending at the next 00:00:00.

Decryption means the process of converting encrypted information by an Authorised party to recover the original information and like terms shall be construed accordingly.

Demand Response means Changes in electric usage by consumers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized

Nigerian Electricity Smart Metering Regulation

- Designated Premises** shall have the meaning given to that term in the Terms and Conditions of Distribution License.
- Device** means a physically distinct part of a system.
- Disable** means the act of interrupting the flow of electricity by opening the Load Switch and like terms shall be construed accordingly.
- Domestic Premises** shall have the meaning given to that term in the Terms and Conditions of Distribution License.
- Electricity Consumption** means the Active Energy Imported into the Premises and “Consumed” shall be construed accordingly.
- Electricity Meter** means an instrument used to measure, store and display the amount of electrical energy passing through an electrical circuit or circuits.
- Emergency Credit** means credit (that can be made available) to ensure that the Supply is not interrupted in circumstances (including situations of emergency) defined by the Supplier to the Premises.
- Enable** means the act of restoring the flow of electricity by closing the Load Switch and like terms shall be construed accordingly.
- Encryption** means the process of converting information in order to make it unintelligible other than to Authorised parties and like terms shall be construed accordingly.
- Energy Consumption** means the amount of electricity in kWh, MWh supplied to the Consumer Premises as recorded by the Smart Meter.
- Export** means the flow of electricity out of the Premises, and like terms shall be construed accordingly.
- Firmware** means the embedded software programmes and/or data structures that control electronic Devices.
- Head End System (HES)** means a system which provides means to access Electricity Smart Metering Systems (as the case may be) by the sending of Commands and receiving of Responses and alerts across the Wide Area Network Interface.
- Home Area Network (HAN) Interface** means component of SMS, IHD or other Consumer Device that is capable of sending and receiving information to/from other Consumer Devices.
- IHD** means In-Home Display.
- Import** means the flow of electricity into the Premises, and like terms shall be construed accordingly.
- Integrity** means the state of a system where it is performing its intended functions without being degraded or impaired by changes or disruptions.
- Load Switch** means a component that can close or open (including on receipt of a Command to that effect) to Enable or Disable the flow of electricity.
- Local Time** means time as UTC+1.
- Microgeneration Meter** means an electric energy measuring instrument used to measure energy from microgeneration which is designed to communicate with the SMS via the SMS’s HAN Interface.

Nigerian Electricity Smart Metering Regulation

Open Standards The following are the minimal characteristics that a specification and its attendant documents must have in order to be considered an open standard:

- i. The standard is adopted and will be maintained by a not-for-profit organisation, and its ongoing development occurs on the basis of an open decision-making procedure available to all interested parties (consensus or majority decision etc.);
- ii. The standard has been published and the standard specification document is available either freely or at a nominal charge. It must be permissible to all to copy, distribute and use it for no fee or at a nominal fee;
- iii. The intellectual property - i.e. patents possibly present - of (parts of) the standard is made irrevocably available on a royalty free basis; and
- iv. There are no constraints on the re-use of the standard.

Outcome means the result of executing a Command, expressed as success or failure.

Payment-based Debt Recovery means a means of recovering debt based on a percentage of a payment.

Personal Data means any information comprising Personal Data as such term is defined in the relevant laws of Nigeria.

Premises means any location to which electricity services is supplied.

Prepayment Mode means a mode of operation of a SMS whereby payment is generally made in advance of Consumption.

Price means the amount of money in Currency Units charged for one (1) kWh unit of electricity consumed.

Random Number Generator means a component used to generate a sequence of numbers or symbols that lack any predictable pattern.

Reactive Energy means the integral with respect to time of Reactive Power in units of volt-amperes reactive-hours (Varh) or standard multiples thereof (for example, kVarh, MVarh).

Replay Attack means a form of attack on a Communications Link in which a valid information transmission is repeated through interception and retransmission.

Response means a reaction sent containing information and/or the Outcome from the execution of a Command.

RMS means Root Mean Square.

Secure Perimeter means a physical border surrounding the SMS which is capable of preventing and detecting physical access from unauthorised persons.

Security Credentials means data used to identify and authenticate an individual or system.

Sensitive Event means each of the following events:

- i. a failed Authentication or Authorisation;
- ii. a change in the executing Firmware version;
- iii. the detection of Unauthorised Physical Access or any other occurrence that has the potential to put Supply at risk and/or compromise the Integrity of the SMS;

Nigerian Electricity Smart Metering Regulation

- iv. unusual numbers of malformed, out-of-order or unexpected Commands received;
 - v. a change of credit which is not reflective of normal Consumption; and
 - vi. any other threat to its security detected by a SMS.
- SMS** means Electricity Smart Metering System
- Supplier** means a person authorised by licence to Supply electricity to Customer Premises or to the Electricity Grid.
- Supply** means the supply of electricity to Premises and “Supplied” shall be construed accordingly.
- Tamper Event** means the detection of Unauthorised Physical Access or any other occurrence that has the potential to put Supply at risk and/or compromise the Integrity of the SMS.
- Tariff** means the structure of Prices and other charges relating to electricity Supply.
- Tariff Register** means storage for recording Consumption for the purposes of Time-of-use Pricing.
- Time-based Debt Recovery** means a means of recovering debt based on an amount in Currency Units per unit time.
- Time-of-Use Band** means a period for a SMS over which Tariff Prices are constant.
- Time-of-Use Pricing** means a pricing scheme with one or more Time-of-Use Bands.
- Time-of-use Tariff** means a Tariff for Time-of-Use Pricing.
- TOU** means Time-of-Use.
- Trusted Source** means a source whose identity is confidently and reliably validated, such as an individual or system, where the identity is established either directly via a credential such as a password, or indirectly whereby a third party vouches for the identity of the individual or system.
- Unauthorised Disclosure** means the release of information to a person who is not authorised to receive the information.
- Unauthorised Physical Access** means unauthorised access to the internal components of any Device within a SMS through the physical outer casing.
- Unique Transaction Reference Number (UTRN)** means a cryptographic code used to convey credit through human transfer to a SMS operating in Prepayment Mode.
- User Interface** means an interface for providing local human interaction with a SMS or IHD which supports input, visual and audible output.
- UTC** means Coordinated Universal Time.
- Week** means the seven day period commencing 00:00:00 Monday Local Time and ending at 00:00:00 on the immediately following Monday.
- Wide Area Network (WAN) Interface** means a component that is capable of sending information to and receiving information from a Head End System.

1.4. Normative References

- “Smart Metering Equipment Technical Specifications” Smart Metering Implementation Programme, Department of Energy and Climate Change, 3 Whitehall Place, London SW1A 2AW
- Nigeria Electricity Metering Code Version 02 as amended.

2. PHYSICAL REQUIREMENTS

- 2.1. A Smart Metering System shall, as a minimum, include the following components:
 - i. a Clock;
 - ii. a Data Store;
 - iii. an Electricity Meter;
 - iv. a HAN Interface;
 - v. a Load Switch;
 - vi. a User Interface; and
 - vii. a WAN Interface.
 - viii. Back-up battery
- 2.2. A Smart Metering System shall be mains powered and be capable of operating at a nominal voltage of 230VAC and consuming no more than an average of 4 watts of electricity under normal operating conditions.
- 2.3. A Smart Metering System shall be capable of automatically resuming operation after a power failure in its operating state prior to such failure.
- 2.4. Each device forming part of the Smart Metering System shall:
 - i. Display the *Device Identifier (5.1.1)*;
 - ii. Have a Secure Perimeter.
- 2.5. The WAN Interface of a Smart Metering System shall:
 - i. be capable of being replaced without also requiring the replacement of the Electricity Meter; and
 - ii. Support communications based on Open Standards.
- 2.6. The HAN Interface of a Smart Metering System shall be capable of:
 - i. Being replaced without also requiring the replacement of the Electricity Meter; and
 - ii. Supporting communications based on Open Standards.
- 2.7. The electricity smart meter shall comply with the provisions of the Nigeria Electricity Metering Code as amended.

3. FUNCTIONAL REQUIRMENTS

This section sets out the minimum functions that a Smart Metering System shall be capable of performing.

3.1 Clock

The Clock forming part of a Smart Metering System shall be capable of operating so as to be accurate to within 10 seconds of UTC+1 at all times.

3.2 Communications

3.2.1 A Smart Metering System may be capable of establishing Communications Links via each of its interfaces (including its HAN Interface and its WAN Interface).

3.2.2 A Smart Metering System, and any Device forming part of it, may be capable of ensuring that the security characteristics of all Communications Links it establishes meet the requirements in §3.9.3.

3.2.3 For all Commands received via any Communications Link the SMS may be capable of:

- i Authenticating the source of the Command and on failure to do so generate an entry in the *Security Log* (5.3.16) to that effect and discarding the Command without execution and without sending a Response;
- ii verifying that it is the intended recipient of the Command and if it is not the intended recipient, generating an entry in the *Security Log* (5.3.16) to that effect and discarding the Command without execution and without sending a Response;
- iii verifying the validity of the contents and format of the Command and if invalid, sending a Response to that effect via its WAN Interface; and
- iv on detection of Unauthorised access of the nature described in §3.9, discarding the Command without execution and without sending a Response.

3.2.4. Communications with Consumer Devices over the HAN Interface

3.2.4.1 An SMS may be capable of establishing a Communications Link via its HAN Interface with at least one Consumer Device that is capable of providing the Consumer with access to the information set-out in §4.1.

3.2.4.2 In establishing the Communications Link, the SMS shall be capable of receiving Security Credentials to enable it to Authenticate the Consumer Device.

3.2.4.3 Where it has established a Communications Link with a Consumer Device the SMS shall be capable of:

- i Sending data and information (set-out in § 4.1) to the Consumer Device; and
- ii Sending Alerts to the Consumer Device.

3.2.5. Communications with Microgeneration Meters over the HAN Interface

- 3.2.5.1 An SMS shall be capable of establishing a Communications Link via its HAN Interface with at least one Microgeneration Meter.
- 3.2.5.2 In establishing the Communications Link, the SMS shall be capable of identifying and Authenticating the Microgeneration Meter with which it has established a Communication Link.
- 3.2.5.3 Where it has established a Communications Link with a Microgeneration Meter, the SMS shall be capable of:
- i. sending requests for data and information (at the minimum, those set-out in §4.2) to the Microgeneration Meter; and
 - ii. receiving data and information (at the minimum, those set-out in §4.2) from the Microgeneration Meter.

3.2.6. Communications with a HES over the WAN Interface

- 3.2.6.1. A SMS shall be capable of establishing a Communications Link via its WAN Interface with a HES.
- 3.2.6.2. In establishing the Communications Link, the SMS shall be capable of exchanging Security Credentials to enable mutual Authentication with the HES.
- 3.2.6.3. Where it has established a Communications Link with a HES the SMS shall be capable of:
- i. receiving the Commands (at the minimum, those set-out in §4.4) from the HES;
 - ii. sending the Responses (at the minimum, those set-out in §4.4) to the HES; and
 - iii. sending Alerts to the HES.

3.3 Data storage

A SMS shall be capable of retaining all information held in its Data Store when in operation and during loss of power.

3.4 Display of information

- 3.4.1. A SMS shall be capable of displaying the following up to date information on its User Interface ,including standard or defined symbols:
- i. the *Payment Mode* (5.2.17) currently in operation, being Prepayment Mode or Credit Mode;
 - ii. the *Tariff Register Matrix* (5.3.18) and the *Tariff Block Counter Matrix* (5.3.17);
 - iii. the *Credit Balance* (5.3.13);
 - iv. whether Emergency Credit is available for activation;
 - v. whether the SMS has suspended the disablement of Supply during a period defined in the *Non-Disablement Calendar* (5.2.16) (as set-out in §3.6.2);

- vi. the *Emergency Credit Balance* (5.3.9) when Emergency Credit is activated;
- vii. any low credit condition;
- viii. the Supply status, being Enabled or Disabled;
- ix. any Time-based Debts and Time-based Debt Recovery rates;
- x. any Payment-based Debt;
- xi. any accumulated debt recorded in the *Accumulated Debt Register* (5.3.1); and
- xii. any *Fixed Charge* (5.2.26).

3.4.2. A SMS shall be capable of displaying Currency Units in Nigerian Naira.

3.5 Monitoring

A SMS shall be capable of determining when the Active Power Import (5.3.2) exceeds, for a continuous period of thirty seconds or more, the *Load Limit Power Threshold* (5.2.11) and on such an occurrence the SMS shall be capable of:

- i. generating an entry to that effect in the *Event Log* (5.3.10);
- ii. counting the number of such occurrences in the *Load Limit Counter* (5.3.11);
- iii. sending an Alert to that effect via its WAN Interface and its User Interface;
- iv. Disabling the Supply in circumstances where the *Load Limit Supply State* (5.2.12) is configured to require Disablement and then immediately Arming the Load Switch and displaying any such change in state of the Load Switch on its User Interface; and
- v. notifying the change in state via its HAN Interface and WAN Interface.

3.6 Payment Mode

A SMS shall be capable of operating in Credit Mode and Prepayment Mode and of being remotely switched from one mode to the other with the consent of the consumer.

3.6.1. Credit Mode

A SMS when operating in Credit Mode shall be capable of maintaining a calculation of the *Credit Balance* (5.3.13) based on:

- i. the Consumption in the *Tariff Register Matrix* (5.3.18) multiplied by the Prices in the *Tariff TOU Price Matrix* (5.2.33) and,
- ii. if operating Time-of-Use with Block Pricing, the Consumption in the *Tariff Block Counter Matrix* (5.3.17) multiplied by the Prices in the *Tariff Block Price Matrix* (5.5.2.30); and
- iii. the *Fixed Charge* (5.2.26), and displaying the *Credit Balance* (5.3.13) on its User Interface.

3.6.2 *Prepayment Mode*

3.6.2.1. A SMS shall be capable of operating in Prepayment Mode, including during

Nigerian Electricity Smart Metering Regulation

Emergency Credit Balance periods, periods of loss of its Communications Link via its WAN Interface. It shall maintain a balance of credit, *Credit Balance*, and reflect any reduction in credit based on Consumption, Fixed Charge and Time-based Debt Recovery.

- 3.6.2.2. A SMS shall be capable of adding credit to the *Credit Balance* (5.3.13) (as set out in §4.3.4 and §4.4.7) and reducing the amount of credit in the *Credit Balance* (5.3.13).
- a. A SMS shall be capable of making Emergency Credit available to the Consumer (by means of the *Emergency Credit Limit* (5.3.9)) if the *Credit Balance* (5.3.13) is below the *Emergency Credit Threshold* (5.2.10).
 - b. The SMS shall be capable of displaying the availability of Emergency Credit on its User Interface. The amount of Emergency Credit made available to the Consumer shall be equal to the *Emergency Credit Limit* (5.2.9).
 - c. A SMS shall be capable of reducing the amount of credit in the *Emergency Credit Balance* (5.3.9) in the case where Emergency Credit is activated by the Consumer (as set out in §4.3.3 and §4.4.6) and the *Credit Balance* (3.13) is exhausted. Any Emergency Credit used shall be repaid when credit is added to the SMS (as set out in §4.3.3 and §4.4.6).
 - d. A SMS shall be capable of reducing the *Credit Balance* (5.3.13) until exhausted followed by reducing the *Emergency Credit Balance* (5.3.9), if activated, until exhausted on the basis of:
 - I. the Consumption in the *Tariff TOU Register Matrix*(5.3.18) multiplied by the Prices in the *Tariff TOU Price Matrix*(5.2.33) and,
 - II. if operating Time-of-Use with Block Pricing, the Consumption in the *Tariff Block Counter Matrix* (5.3.17) multiplied by the Prices in the *Tariff Block Price Matrix* (5.2.30);
 - III. the *Fixed Charge* (5.2.26); and
 - IV. the recovery of debt through each of the *Time Debt Registers* [1 ... 2] (5.3.19) at rates determined by the *Debt Recovery Rates* [1 ... 2] (5.2.6) with the SMS recording the amount of debt recovered in the *Billing Data Log* (5.3.7).
 - e. A SMS shall be capable of monitoring the *Credit Balance* (5.3.13) and the activated *Emergency Credit Balance* (5.3.9) and:
 - I. when the combined credit of the *Credit Balance* (5.3.13) and *Emergency Credit Balance* (5.3.9) falls below the *Low Credit Threshold* (5.2.13), the SMS shall display an Alert to that effect on its User Interface, and send an Alert to that effect via both its HAN and WAN Interfaces;
 - II. when the combined credit of the *Credit Balance* (5.3.13) and *Emergency Credit Balance* (5.3.9) falls below the *Disablement Threshold* (5.2.8), the SMS shall disable the Supply, displaying an Alert to that effect on its User Interface and sending an Alert to that effect via its HAN and WAN Interfaces; and
 - III. suspend the Disablement of Supply during periods defined in the *Non-Disablement Calendar* (5.2.16), and display an Alert that the Disablement of Supply has been suspended on its User Interface.

Nigerian Electricity Smart Metering Regulation

- f. A SMS shall be capable of controlling recovery of debt in cases where :
 - I. Emergency Credit is in use by operating in a *Suspend Debt Recovery - Emergency (5.2.29)* state
 - II. Supply is disabled by operating in a *Suspend Debt Recovery – Disabled (5.2.28)* state.

- g. In circumstances where the Supply is Disabled, the SMS shall be capable of:
 - i. The continuous recovery of Time-based Debt (if so configured as set out in 3.6.2.2f(ii) above) and *Fixed Charge (5.2.26)*, and
 - ii. Keeping records of the debt recovered in the *Accumulated Debt Register (5.5.3.1)*.

3.7 Pricing

A SMS shall be capable of applying all allowable tariff classes like Time-of-Use Pricing and Time-of-Use with Block Pricing, as configured by *Tariff Type (5.2.34)*.

3.7.1 Time-of-use Pricing

- 3.7.1.1. A SMS shall be capable of recording Consumption according to Time-of-use Bands in one of forty eight Tariff Registers in the *Tariff Register Matrix (5.3.18)*.
- 3.7.1.2. A SMS shall be capable of switching between different Tariff Registers once every half hour. The switching between Time-of-use Bands and thus Tariff Registers shall be based on time of Consumption and switching rules defined in the *Tariff Switching Table (5.2.31)*.

3.7.2 Time-of-use with Block Pricing

- 3.7.2.1 A SMS shall be capable of recording Consumption according to Time-of-use Bands in one of eight Tariff Registers in the *Tariff Register Matrix (5.3.18)*.
- 3.7.2.2 A SMS shall also be capable of accumulating Consumption in one of four Block Counters in the *Tariff Block Counter Matrix (5.3.17)* for each of the eight Time-of-use Bands. The SMS shall be capable of switching between Block Counters according to the Consumption thresholds in the *Tariff Threshold Matrix (5.2.32)*.
- 3.7.2.3 A SMS shall be capable of switching between different Tariff Registers once every half hour. The switching between Time-of-use Bands and thus Tariff Registers shall be based on time of Consumption and switching rules set out in the *Tariff Switching Table (5.2.31)*.

3.8 Recording

3.8.1 Billing data

A SMS shall be capable of taking a date and time stamped copy of and storing the *Tariff Register Matrix (5.3.18)* and the *Tariff Block Counter*

Matrix (5.3.17) in the Billing Data Log (5.3.7) in accordance with the timetable set out in the Billing Calendar (5.2.4) and then immediately resetting the Block Counters in the Tariff Block Counter Matrix (5.3.17) and if operating in Credit Mode immediately resetting the Credit Balance (5.3.13).

3.8.2 Daily read data

A SMS shall be capable of taking a copy of and storing the *Tariff TOU Register Matrix (5.3.18)*, the *Tariff Block Counter Matrix (5.3.17)* and the *Total Active Import Register (5.3.21)* together with a date and time stamp in the *Daily Read Log (5.3.8)* every day at midnight UTC+1.

3.8.3 Half hour profile data

In each thirty minute period (commencing at the start of minutes 00 and 30 in each hour), a SMS shall be capable of recording the following (including details of the thirty minute period to which the data relates) in the *Profile Data Log (5.3.15)*;

- I. Active Energy Imported (Consumption);
- II. Active Energy Exported;
- III. Reactive Energy Imported; and
- IV. Reactive Energy Exported.

3.8.4 Power threshold status

A SMS shall be capable of comparing the *Active Power Import (5.3.2)* against thresholds and recording an indication of the level of consumption as follows:

- I. if the *Active Power Import (5.3.2)* is equal to or lower than the *Low Medium Power Threshold (5.2.14)*, set *Ambient Power (5.3.3)* to low;
- II. if the *Active Power Import (5.3.2)* is higher than the *Low Medium Power Threshold (5.2.14)* and equal to or lower than the *Medium High Power Threshold (5.2.15)*, set *Ambient Power (5.3.3)* to medium; or
- III. Otherwise, set the *Ambient Power (5.3.3)* to high.

3.8.5 Total Active Energy Imported

A SMS shall be capable of recording cumulative Active Energy Imported in the *Total Active Import Register (5.3.21)*.

3.8.6 Total Active Energy Exported

A SMS shall be capable of recording cumulative Active Energy Exported in the *Total Active Export Register (5.3.20)*.

3.8.7 Total Reactive Energy Imported

A SMS shall be capable of recording cumulative Reactive Energy Imported in the *Total Reactive Import Register (5.3.23)*.

3.8.8 *Total Reactive Energy Exported*

A SMS shall be capable of recording cumulative Reactive Energy Exported in the *Total Reactive Export Register (5.3.22)*.

3.9 **Security**

3.9.1 *General*

3.9.1.1 A SMS shall be designed taking all reasonable steps so as to ensure that any failure or compromise of its Integrity shall not compromise the Security Credentials or Personal Data stored on it or compromise the Integrity of any other Device to which it is connected by means of a Communications Link.

3.9.1.2 A SMS shall be capable of verifying the Integrity of its Firmware at power-on and prior to execution.

3.9.1.3 A SMS shall be capable of logging in the *Security Log (5.3.16)* information on all *Sensitive Events*.

3.9.2 *Physical*

3.9.2.1 A SMS shall be designed taking all reasonable steps so as to prevent Unauthorised Physical Access through its Secure Perimeter that could compromise the Confidentiality and/or Data Integrity of:

- I. Personal Data;
- II. Security Credentials;
- III. Random Number Generator;
- IV. Cryptographic Algorithms;
- V. the Electricity Meter; and
- VI. Firmware and data essential for ensuring its Integrity, held or executing on the SMS.

3.9.2.2 A SMS shall be capable of detecting any attempt at Unauthorised Physical Access through its Secure Perimeter that could compromise such Confidentiality and/or Data Integrity and on such detection shall be capable of providing evidence of such an attempt through the use of tamper evident coatings or seals and;

3.9.2.3 Where reasonably practicable:

- I. Generating an entry to that effect in the *Security Log (5.3.16)*;
- II. Sending an Alert to that effect via its WAN Interface; and
- III. Disabling the Supply, in circumstances where the *Supply Tamper State (5.2.27)* is configured to require Disablement.

3.9.3 *Communications*

3.9.3.1 A SMS shall be capable of preventing and detecting, on all of its interfaces, Unauthorised access that could compromise the Confidentiality and/or Data Integrity of:

Nigerian Electricity Smart Metering Regulation

- I. Personal Data whilst being transferred via an interface;
 - II. Security Credentials whilst being transferred via an interface;
 - III. Firmware and data essential for ensuring its Integrity whilst being transferred via an interface and;
- 3.9.3.2 Any Command that could compromise the Confidentiality and/or Data Integrity of:
- I. Personal Data;
 - II. Security Credentials; and
 - III. Firmware and data essential for ensuring its Integrity,
- Held or executing on the SMS, and on such detection shall be capable of:
- i. Generating an entry to that effect in the *Security Log(5.3.16)*; and
 - ii. Sending an Alert to that effect via its WAN Interface.
- 3.9.3.3 A SMS shall be capable of employing techniques to protect against Replay Attacks of information used to Authenticate the identity of a system or individual.
- 3.9.3.4 A SMS shall not be capable of modifying entries from, or executing a Command to modify or delete entries from the *Security Log (5.3.16)*.

3.10 Voltage quality measurements

3.10.1 Average RMS voltage

- A SMS shall be capable of calculating the average value of RMS voltage over a configurable period as defined in the *Average RMS Voltage Measurement Period (5.2.3)*, and:
- i. Recording the value so calculated (including details of the period to which the value relates) in the *Average RMS Voltage Profile Data Log (5.3.4)*.
 - ii. Detecting when the value so calculated is above the *Average RMS Over Voltage Threshold (5.2.1)*, and on detection:
 - a. Generating an entry to that effect in the *Event Log (5.3.10)*;
 - b. Counting the number of such occurrences in the *Average RMS Over Voltage Counter (5.3.4)*; and
 - c. Sending an Alert to that effect via its WAN Interface.
 - iii. Detecting when the value so calculated is below the *Average RMS Under Voltage Threshold (5.2.2)*, and on detection:
 - a. Generating an entry to that effect in the *Event Log (5.3.10)*;
 - b. Counting the number of such occurrences in the *Average RMS Under Voltage Counter (5.3.5)*; and
 - c. Sending an Alert to that effect via its WAN Interface.

3.10.2 *RMS extreme over voltage detection*

A SMS shall be capable of detecting when the RMS voltage is above the *RMS Extreme Over Voltage Threshold (5.2.20)* for longer than the continuous period defined in the *RMS Extreme Over Voltage Measurement Period(5.2.18)*, and on detection:

- i. Generating an entry to that effect in the *Event Log(5.3.10)*; and
- ii. Sending an Alert to that effect via its WAN Interface.
- iii. Disable supply until RMS voltage normalizes

3.10.3 *RMS extreme under voltage detection*

A SMS shall be capable of detecting when the RMS voltage is below the *RMS Extreme Under Voltage Threshold (5.2.21)* for longer than the continuous period defined in the *RMS Extreme Under Voltage Measurement Period (5.2.19)*, and on detection:

- i. Generating an entry to that effect in the *Event Log(5.3.10)*; and
- ii. Sending an Alert to that effect via its WAN Interface.
- iii. disable supply until RMS voltage normalizes

3.10.4 *RMS voltage sag detection*

A SMS shall be capable of detecting when the RMS voltage is below the *RMS Voltage Sag Threshold (5.2.24)* for longer than the continuous period defined in the *RMS Voltage Sag Measurement Period (5.2.22)*, and on detection:

- i. Generating an entry to that effect in the *Event Log (5.3.10)*; and
- ii. Sending an Alert to that effect via its WAN Interface.

3.10.5 *RMS voltage swell detection*

A SMS shall be capable of detecting when the RMS voltage is above the *RMS Voltage Swell Threshold (5.2.25)* for longer than the continuous period defined in the *RMS Voltage Swell Measurement Period (5.2.23)*, and on detection:

- i. Generating an entry to that effect in the *Event Log (5.3.10)*; and
- ii. Sending an Alert to that effect via its WAN Interface.

3.10.6 *Supply outage detection*

A SMS shall be capable of generating entries in the *Event Log (5.3.10)* recording each occasion when the Supply is interrupted and/or restored.

4. INTERFACE REQUIREMENTS

This section sets out the minimum required interactions which a SMS shall be capable of undertaking with Consumer Devices and a Head End System (HES) via its interfaces.

4.1. HAN Interface Consumer Device Information Provision

A SMS shall be capable of providing the following information immediately upon establishment of a Communications Link with a Consumer Device (as set out in §3.2.4), with updates of any changes to the instantaneous Active Power measurement every 10 seconds thereafter, and timely updates of any changes to the other information to that Consumer Device:

- i. the *Credit Balance* (5.3.13);
- ii. the date and time of the last update of the *Credit Balance* (5.3.13);
- iii. the Clock time in UTC+1;
- iv. the *Total Active Import Register* (5.3.21);
- v. the *Tariff TOU Register Matrix* (5.3.18) and *Tariff Block Counter Matrix* (5.3.17);
- vi. the *Tariff Switching Table* (5.2.31);
- vii. the *Daily Read Log* (5.3.8);
- viii. the *Emergency Credit Balance* (5.3.9) if Emergency Credit is activated;
- ix. the *Tariff TOU Price Matrix* (5.2.33) and *Tariff Block Price Matrix* (5.2.30) with an indication of the active Tariff Price;
- x. the Time-based Debts from the *Time Debt Registers [1 ... 2]* (5.3.19);
- xi. the Time-based Debt Recovery rates from the *Debt Recovery Rates [1 ... 2]* (5.2.6);
- xii. the Payment-based Debt from the *Payment Debt Register* (5.3.14);
- xiii. the accumulated debt from the *Accumulated Debt Register* (5.3.1);
- xiv. the *Low Medium Power Threshold* (5.2.14) and *Medium High Power Threshold* (5.2.15);
- xv. the instantaneous Active Power measurement;
- xvi. the *Low Credit Threshold* (5.2.13);
- xvii. the *Profile Data Log* (5.3.15); and
- xviii. the *Payment Mode* (5.2.17).

4.2. HAN Interface Microgeneration Meter Information Forwarding

A SMS shall be capable, upon establishment of a Communications Link with a Microgeneration Meter (as set out in §3.2.5), of:

- i. receiving requests for information from the HES via its WAN Interface and forwarding such requests for information to the Microgeneration Meter via its HAN Interface; and
- ii. sending information received from a Microgeneration Meter via its HAN Interface and forwarding such information to the HES via its WAN Interface.

Nigerian Electricity Smart Metering Regulation

4.3. User Interface Commands

4.3.1. A SMS shall be capable of executing immediately the Commands set out in this section (§4.3) following their receipt via its User Interface.

4.3.2. The SMS shall be capable of logging all such Commands received and Outcomes in the *Event Log* (5.3.10).

4.3.3. Activate Emergency Credit

4.3.3.1. A Command to activate Emergency Credit (when the SMS is operating in Prepayment Mode) if Emergency Credit is available (as set-out in §3.6.2).

4.3.3.2. In executing the Command, if the Supply is disabled, the SMS shall be capable of Arming the Load Switch and Enabling the Supply.

4.3.4. Add Credit

4.3.4.1. A Command to add credit to the SMS (when the SMS is operating in Prepayment Mode) on input of a UTRN. In executing the Command, the SMS shall be capable of:

- i. Verifying the Authenticity of the UTRN;
- ii. Verifying that the SMS is the intended recipient of the UTRN;
- iii. Rejecting duplicate presentation of the same UTRN; and
- iv. Controlling the number of invalid UTRN entries processed.

4.3.4.2. The SMS shall be capable, on failure of any of *i* to *iv* above, of generating an entry in the *Security Log* (5.3.17) to that effect.

4.3.4.3. In executing the Command, the SMS shall be capable of applying the credit added in the following order:

- i. recovery of Payment-based Debt of an amount defined by *Debt Recovery per Payment*(5.2.5) from the *Payment Debt Register*(5.3.14) subject to the *Debt Recovery Rate Cap*(5.2.7);
- ii. recovery of debt accumulated in the *Accumulated Debt Register*(5.3.1);
- iii. repayment of Emergency Credit activated and used by Consumer; and
- iv. Adding remaining credit (the credit after deduction of 4.3.4.3 (i, ii and iii)) to the *Credit Balance*(5.3.13).

4.3.4.4. In executing the Command, the SMS shall be capable of Arming the Load Switch if the *Credit Balance* (5.3.13) rises above the *Disablement Threshold* (5.2.8) and displaying any such change in state of the Load Switch on its User Interface and notifying the change in state via its HAN Interface and WAN Interface.

4.3.4.5. In executing the Command, the SMS shall be capable of recording the credit added to the *Credit Balance* (5.3.13) in the *Billing Data Log* (5.3.7).

4.3.5. Enable Supply

A Command to enable the Supply if the Load Switch is Armed.

4.4. WAN Interface Commands

- 4.4.1. A SMS shall be capable of executing the Commands set out in this section (§4.4).
- 4.4.2. A SMS shall be capable of executing Commands immediately on receipt (“immediate Commands”) and at a future date (“future dated Commands”). A future dated Command shall include a date and time at which the Command shall be executed by the SMS.
- 4.4.3. A SMS shall be capable of sending a Response containing the Outcome on execution of an immediate Command.
- 4.4.4. A SMS shall be capable of sending a Response acknowledging receipt of a future dated Command immediately upon its receipt. A SMS shall be capable of sending a Response containing the Outcome at the future date and time of execution of a future dated Command.
- 4.4.5. A SMS shall be capable of over-writing an outstanding future dated Command on receipt of a new future dated Command of the same type. A future dated Command shall be capable of being cancelled by an Authorised party. A SMS shall be capable of cancelling a future dated Command upon receipt of an immediate Command of the same type. A SMS shall be capable of sending an Outcome including the reason for failure of a future dated Command in the event that it has been over-written or cancelled.
- 4.4.6. A SMS shall be capable of logging all such Commands received and Outcomes in the *Event Log* (5.3.10).

4.4.7. Activate Emergency Credit

- 4.4.7.1. A Command to activate Emergency Credit (when the SMS is operating in Prepayment Mode) if Emergency Credit is available (as set-out in §3.6.2).
- 4.4.7.2. In executing the Command, if the Supply is Disabled, the SMS shall be capable of Arming the Load Switch.

4.4.8. Add Credit

- 4.4.8.1. A Command to accept credit to be applied to the SMS (when the SMS is operating in Prepayment Mode). In executing the Command, the SMS shall be capable of applying the credit added in the following order:
- i. recovery of Payment-based Debt of an amount defined by *Debt Recovery per Payment* (5.2.5) from the *Payment Debt Register* (5.3.14) subject to the *Debt Recovery Rate Cap* (5.2.7);
 - ii. recovery of debt accumulated in the *Accumulated Debt Register* (5.3.1);
 - iii. repayment of Emergency Credit activated and used by Consumer; and
 - iv. adding remaining credit (the credit after deduction of 4.4.7.1(i, ii and iii)) to the *Credit Balance* (5.3.13).
- 4.4.8.2. In executing the Command, the SMS shall be capable of Arming the Load Switch if the *Credit Balance* (5.3.13) rises above the *Disablement Threshold*(5.2.8) and displaying any such change in state of the Load Switch

on its User Interface and notifying the change in state via its HAN Interface and WAN Interface.

- 4.4.8.3. In executing the Command, the SMS shall be capable of recording the credit added to the *Credit Balance* (5.3.13) in the *Billing Data Log* (5.3.7).

4.4.9. Adjust Debt

A Command to apply positive and negative adjustments to the *Time Debt Registers [1 ... 2]* (5.3.19) and the *Payment Debt Register* (5.3.14) (when operating in Prepayment Mode).

4.4.10. Adjust Credit Balance

- 4.4.10.1. A Command to apply positive and negative adjustments to the *Credit Balance* (5.3.13).
- 4.4.10.2. If the SMS is operating in Prepayment Mode and, following such adjustment, if the *Credit Balance* (5.3.13) rises above the *Disablement Threshold*(5.2.8), the SMS shall be capable of Arming the Load Switch and displaying any such change in state of the Load Switch on its User Interface and notifying the change in state via its HAN Interface and WAN Interface.

4.4.11. Arm Load Switch

A Command to Arm the Load Switch.

4.4.12. Clear Event Log

A Command to clear all entries from the *Event Log* (5.3.10).

4.4.13. Disable Supply

A Command to Disable the Supply without need for local physical interaction.

4.4.14. Enable Supply

A Command to Enable the Supply without the need for local physical interaction.

4.4.15. Read Configuration Data

- 4.4.15.1. A Command to read the value of one or more of the configuration data items set out in §5.2.
- 4.4.15.2. In executing the Command, the SMS shall be capable of sending such value(s) in a Response via its WAN Interface.

4.4.16. Read Constant Data

- 4.4.16.1. A Command to read the value of one or more of the constant data items set out in §5.1.
- 4.4.16.2. In executing the Command, the SMS shall be capable of sending such value(s) in a Response via its WAN Interface.

4.4.17. Read Operational Data

- 4.4.17.1. A Command to read the value of one or more of the operational data items set out in §5.3.

4.4.17.2. In executing the Command, the SMS shall be capable of sending such value(s) in a Response via its WAN Interface.

4.4.18. Reset Load Limit Counter

A Command to reset the *Load Limit Counter* (5.3.11) to zero.

4.4.19. Reset Average RMS Over Voltage Counter

A Command to reset the *Average RMS Over Voltage Counter* (5.3.4) to zero.

4.4.20. Reset Average RMS Under Voltage Counter

A Command to reset the *Average RMS Under Voltage Counter* (5.3.5) to zero.

4.4.21. Restrict Data

A Command to mark configuration and/or operational data as restricted so as to prevent from disclosure on its HAN Interface and its User Interface.

4.4.22. Set Payment Mode

4.4.22.1. A Command to set the payment mode as either Prepayment Mode or Credit Mode and to record the mode of operation in *Payment Mode*(5.2.17).

4.4.22.2. In executing the Command, the SMS shall be capable of recording:

- i. the *Tariff TOU Register Matrix* (5.3.18);
- ii. the *Tariff Block Counter Matrix* (5.3.17);
- iii. the *Credit Balance* (5.3.13);
- iv. the *Emergency Credit Balance* (5.3.9);
- v. the *Payment Debt Register* (5.3.14);
- vi. the *Time Debt Registers [1 ... 2]* (5.3.19); and
- vii. the *Accumulated Debt Register* (5.3.1),
- viii. in the *Billing Data Log* (5.3.7).

4.4.23. Set Tariff

4.4.23.1. A Command to accept new values for *Tariff Type* (5.2.34), *Tariff TOU Price Matrix* (5.2.33), *Tariff Block Price Matrix* (5.2.30), *Tariff Switching Table* (5.2.31), and *Tariff Threshold Matrix* (5.2.32).

4.4.23.2. In executing the Command, the SMS shall be capable of recording:

- i. the *Tariff TOU Register Matrix* (5.3.18);
- ii. the *Tariff Block Counter Matrix* (5.3.17);
- iii. the *Credit Balance* (5.3.13);
- iv. the *Emergency Credit Balance* (5.3.9);
- v. the *Payment Debt Register* (5.3.14);
- vi. the *Time Debt Registers [1 ... 2]* (5.3.19); and
- vii. the *Accumulated Debt Register* (5.3.1),
- viii. in the *Billing Data Log* (5.3.7).

Nigerian Electricity Smart Metering Regulation

4.4.24. *Synchronise Clock*

A Command to synchronise the Clock with UTC+1 over its WAN Interface.

4.4.25. *Update Firmware*

4.4.25.1. A Command to receive new Firmware.

4.4.25.2. In executing the Command, the SMS shall be capable of:

- i. only accepting new Firmware from an Authorised and Authenticated source;
- ii. verifying the Authenticity and Integrity of new Firmware before installation; and
- iii. installing new Firmware using a mechanism that is robust against failure and loss of data.

4.4.25.3. The new Firmware shall include version information which shall be capable of being made available to be read from *Firmware Version* (5.1.2).

4.4.26. *Update Security Credentials*

A Command to update or revoke Security Credentials held within the SMS.

4.4.27. *Write Configuration Data*

4.4.27.1. A Command to record one or more new values of the configuration data items set out in §5.2.

4.4.27.2. In executing the Command, the SMS shall be capable of logging all changes of values in the *Event Log* (5.3.10).

5. DATA REQUIREMENTS

This section describes the minimum information which a SMS is to be capable of holding in its Data Store.

5.1. Constant data

This describes data that remains constant and unchangeable at all times other than through Firmware upgrades.

5.1.1. *Device Identifier*

An identifier used to uniquely identify each Device installed to comply with this regulation.

5.1.2. *Firmware Version*

The operational version of Firmware of the SMS.

5.2. Configuration data

Describes data that configures the operation of various functions of a SMS.

5.2.1. *Average RMS Over Voltage Threshold*

The average RMS voltage above which an over voltage condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter as specified in IEC 62053.

5.2.2. *Average RMS Under Voltage Threshold*

The average RMS voltage below which an under voltage condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter as specified in IEC 62053.

5.2.3. *Average RMS Voltage Measurement Period*

The length of time in minutes that the RMS voltage is averaged over.

5.2.4. *Billing Calendar*

A calendar defining billing dates for the storage of billing related information in the *Billing Data Log* (5.3.7).

5.2.5. *Debt Recovery per Payment*

The percentage of a payment to be recovered against debt when the SMS is operating Payment-based Debt Recovery in Prepayment Mode.

5.2.6. *Debt Recovery Rates [1 ... 2]*

Two debt recovery rates in Currency Units per unit time for when the SMS is using Time-based Debt Recovery in Prepayment Mode.

5.2.7. *Debt Recovery Rate Cap*

The maximum amount in Currency Units per unit time that can be recovered through Payment-based Debt Recovery when the SMS is operating in Prepayment Mode.

5.2.8. *Disablement Threshold*

The threshold in Currency Units for controlling when to Disable the Supply.

5.2.9. *Emergency Credit Limit*

The amount of Emergency Credit in Currency Units to be made available to a Consumer when Emergency Credit is activated by the Consumer.

5.2.10. *Emergency Credit Threshold*

The threshold in Currency Units below which *Emergency Credit Balance* (5.3.9) may be activated by the Consumer if so configured when the SMS is operating in Prepayment Mode.

5.2.11. *Load Limit Power Threshold*

The Active Power threshold in kW above which a load limiting event is recorded.

5.2.12. *Load Limit Supply State*

A setting to control the state of the Supply in the case of a Load Limit Event being detected, being Disabled or unchanged.

Nigerian Electricity Smart Metering Regulation

5.2.13. Low Credit Threshold

The threshold in Currency Units below which a low credit Alert is generated.

5.2.14. Low Medium Power Threshold

A value in kW defining the threshold between an indicative low and medium *Active Power Import* (5.3.2) level.

5.2.15. Medium High Power Threshold

A value in kW defining the threshold between an indicative medium and high power *Active Power Import* (5.3.2) level.

5.2.16. Non-Disablement Calendar

- 5.2.16.1. A calendar defining times, days and dates that specify periods during which the Supply will not be disabled when the meter is operating in Prepayment Mode.
- 5.2.16.2. All time and dates shall be specified as UTC+1.

5.2.17. Payment Mode

The current mode of operation, being Prepayment Mode or Credit Mode.

5.2.18. RMS Extreme Over Voltage Measurement Period

The duration in seconds used to measure an extreme over voltage condition.

5.2.19. RMS Extreme Under Voltage Measurement Period

The duration in seconds used to measure an extreme under voltage condition.

5.2.20. RMS Extreme Over Voltage Threshold

The RMS voltage above which an extreme over voltage condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter as specified in IEC 62053.

5.2.21. RMS Extreme Under Voltage Threshold

The RMS voltage below which an extreme under voltage condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter.

5.2.22. RMS Voltage Sag Measurement Period

The duration in seconds used to measure a voltage sag condition.

5.2.23. RMS Voltage Swell Measurement Period

The duration in seconds used to measure a voltage swell condition.

5.2.24. RMS Voltage Sag Threshold

The RMS voltage below which a sag condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter as specified in IEC 62053.

5.2.25. RMS Voltage Swell Threshold

The RMS voltage above which a swell condition is reported. The threshold shall be configurable within the specified operating range of the Electricity Meter as specified in IEC 62053.

5.2.26. Fixed Charge

A charge to be levied in Currency Units per unit time when operating in Credit Mode and Prepayment Mode.

5.2.27. Supply Tamper State

A setting to control the state of the Supply in the case of a Tamper Event being detected, being Disabled or unchanged.

5.2.28. Suspend Debt Disabled

A setting controlling whether debt should be collected when the SMS is operating in Prepayment Mode and Supply is Disabled.

5.2.29. Suspend Debt Emergency

A setting which determines whether debt should be collected when the SMS is operating in Prepayment Mode and the *Emergency Credit Balance* (5.3.9) is below the *Emergency Credit Limit* (5.2.9).

5.2.30. Tariff Block Price Matrix

A 4 x 8 matrix containing prices for Block Pricing to be determined by the Commission from time to time.

5.2.31. Tariff Switching Table

- 5.2.31.1. A set of switching rules for allocating half-hourly Consumption to a Tariff Register for Time-of-use Pricing and Time-of-use with Block Pricing. The rules stored within the table shall support at least 200 Time-of-use switching rules per annum.
- 5.2.31.2. The rules shall support allocation based on:
 - i. half-hour, half-hours and half-hour ranges;
 - ii. day, days and day ranges; and
 - iii. date, dates and date ranges.
- 5.2.31.3. All dates shall be specified as UTC+1.

5.2.32. Tariff Threshold Matrix

A 3 x 8 matrix capable of holding thresholds in kWh for controlling Block Tariffs.

Nigerian Electricity Smart Metering Regulation

5.2.33. *Tariff TOU Price Matrix*

A 1 x 48 matrix containing prices for Time-of-use Pricing.

5.2.34. *Tariff Type*

The Tariff type in operation.

5.3. **Operational data**

Describes data used by the functions of a SMS for output of information.

5.3.1. *Accumulated Debt Register*

The debt resulting from the collection of *Fixed Charge*(5.2.26) and/or Time-based Debt when no credit or Emergency Credit is available, when operating in Prepayment Mode.

5.3.2. *Active Power Import*

The import of Active Power measured by the SMS.

5.3.3. *Ambient Power*

An indication of the ambient power level, being low, medium or high.

5.3.4. *Average RMS Over Voltage Counter*

The number of times the average RMS voltage, as calculated in §3.10.1, has been above the *Average RMS Over Voltage Threshold* (5.2.1) since last reset.

5.3.5. *Average RMS Under Voltage Counter*

The number of times the average RMS voltage, as calculated in §3.10.1, has been below the *Average RMS Under Voltage Threshold* (5.2.2) since last reset.

5.3.6. *Average RMS Voltage Profile Data Log*

A log for storing 4320 entries (including details of the period to which each entry relates) comprising the averaged RMS voltage for each *Average RMS Voltage Measurement Period* (5.2.3) arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten.

5.3.7. *Billing Data Log*

A log for storing the following date and time stamped entries of:
twelve entries comprising *Tariff TOU Register Matrix* (5.3.18) and *Tariff Block Counter Matrix* (5.3.17);

- i. five entries comprising prepayment credits;
- ii. ten entries comprising time-based debt payments;
- iii. ten entries comprising payment-based debt payments; and
- iv. twelve entries comprising

- a. *Credit Balance* (5.3.13),
- b. *Emergency Credit Balance* (5.3.9),

Nigerian Electricity Smart Metering Regulation

- c. *Accumulated Debt Register (5.3.1)*,
- d. *Payment Debt Register (5.3.14)* and
- e. *Time Debt Registers [1 ... 2] (5.3.19)*,

arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten.

5.3.8. *Daily Read Log*

A log for storing fourteen date and time stamped entries of the

- i. *Tariff TOU Register Matrix (5.3.18)*,
- ii. the *Tariff Block Counter Matrix (5.3.17)* and
- iii. the *Total Active Import Register (5.3.21)*

arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten.

5.3.9. *Emergency Credit Balance*

The amount of Emergency Credit available to the Consumer after it has been activated by the Consumer.

5.3.10. *Event Log*

A log for storing at least one hundred UTC+1 date and time stamped entries of non-security related information for diagnosis and auditing, arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten.

5.3.11. *Load Limit Counter*

The number of times the Active Power Import has exceeded the *Load Limit Power Threshold (5.2.11)* since last cleared.

5.3.12. *Load Switch State*

The state of the Load Switch, being opened, closed or Armed.

5.3.13. *Credit Balance*

The amount of money in Currency Units as determined by the SMS. If operating in Prepayment Mode, the Credit Balance represents the SMS's determination of the amount of credit available to the Consumer (other than any *Emergency Credit Balance (5.3.9)*). If operating in Credit Mode, it represents the SMS's determination of the amount of money due from the Consumer since the Credit Balance was last reset.

5.3.14. *Payment Debt Register*

Debt to be recovered as a percentage of payment when using Payment-based Debt Recovery in Prepayment Mode.

5.3.15. *Profile Data Log*

A log for storing date and time-stamped half hourly data arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten. The log shall be capable of storing a minimum of:

- i. 13 months of Active Energy Imported (Consumption);
- ii. 3 months of Active Energy Exported;
- iii. 3 months of Reactive Energy Imported; and
- iv. 3 months of Reactive Energy Exported.

For Grid Metering

- v. 12 months Active Energy Import
- vi. 12 months Active Energy Export
- vii. 12 months Reactive Import
- viii. 12 months Reactive Export

5.3.16. *Security Log*

A log for storing at least one hundred UTC+1 date and time stamped entries of security related information for diagnosis and auditing arranged as a circular buffer such that when full, further writes shall cause the oldest entry to be overwritten.

5.3.17. *Tariff Block Counter Matrix*

A 4 x 8 matrix for storing Block Counters for Block Pricing.

5.3.18. *Tariff Register Matrix*

A 1 x 48 matrix for storing Tariff Registers for Time-of-use Pricing.

5.3.19. *Time Debt Registers [1 ... 2]*

Two registers recording independent debts to be recovered over time when operating Time-based Debt Recovery in Prepayment Mode.

5.3.20. *Total Active Export Register*

The register recording the total cumulative Active Energy Exported.

5.3.21. *Total Active Import Register*

The register recording the cumulative Active Energy Imported.

5.3.22. *Total Reactive Export Register*

The register recording the cumulative Reactive Energy Exported.

5.3.23. *Total Reactive Import Register*

The register recording the cumulative Reactive Energy Imported.

6. IN HOME DISPLAY (IHD) TECHNICAL SPECIFICATION

6.1. General

This section defines the minimum physical requirements, minimum functional requirements, minimum interface requirements and minimum data requirements of an In-home Display installed to comply with this regulation.

6.2. Physical requirements

- 6.2.1. An IHD shall as a minimum include the following components:
- i. a Data Store;
 - ii. a HAN Interface; and
 - iii. a User Interface.
- 6.2.2. An IHD shall be mains powered and shall be capable of operating at a nominal voltage of 230VAC and consuming no more than an average of 0.6 watts of electricity under normal operating conditions.
- 6.2.3. An IHD shall display the *Device Identifier (6.5.1.1)*.
- 6.2.4. The HAN Interface of an IHD shall be capable of supporting communications based on Open Standards.
- 6.2.5. An IHD shall be designed to enable the information displayed on it to be easily accessed and presented in a form that is clear and easy to understand including by Consumers with impaired:
- i. sight;
 - ii. memory and learning ability;
 - iii. perception and attention; or
 - iv. dexterity.

6.3. Functional Requirements

This section defines the minimum functions that an IHD shall be capable of performing.

6.3.1. Communications

- 6.3.1.1. An IHD shall be capable of establishing Communications Links via its HAN Interface with a SMS.
- 6.3.1.2. An IHD shall be capable of ensuring that the security characteristics of all Communications Links it establishes meet the requirements set-out in §6.3.4.1.
- 6.3.1.3. Communications with Other SMS
- i. An IHD shall be capable of establishing a Communications Link via its HAN Interface with other SMS like Gas SMS (GSMS) or neighbouring electrical SMS as appropriate.

Nigerian Electricity Smart Metering Regulation

- ii. In establishing the Communications Link, the IHD shall be capable of providing Security Credentials to enable it to be Authenticated by the GSMS or SMS as appropriate.
- iii. Where it has established a Communications Link, the IHD shall be capable of receiving the information (set-out in §4.1) from the other SMS.
- iv. The IHD shall be capable of detecting a failure of a Communications Link and on detection of a failure, shall be capable of clearing or suitably annotating the information displayed on its User Interface (set out in §6.3.2) to indicate that the information may be out of date.

6.3.2. Information Pertaining to the Supply of Electricity to the Premises

- a. An IHD shall be capable, upon establishment of a Communications Link with another SMS (as set out in §6.3.1.1), of providing the following information on its User Interface and providing updates of any changes to the information every 10 seconds thereafter.
- b. The IHD shall be capable of displaying Currency Units in Naira.

6.3.2.1. Active Tariff Price [NUM]

The active Tariff Price for Energy Consumption in Currency Units per kWh.

6.3.2.2. Aggregate Debt [NUM]

The sum of all Time-based and Payment-based Debt registers on the SMS operating in Prepayment Mode.

6.3.2.3. Aggregate Debt Recovery Rate [NUM]

The sum of the Time-based Debt Recovery rates on the SMS operating in Prepayment Mode.

6.3.2.4. Connection Link Quality

The signal quality of the Communications Link to the other SMS.

6.3.2.5. Cumulative Consumption [NUM]

- i. Current Day cumulative Energy Consumption;
- ii. Current Day cost to the Consumer of cumulative Energy Consumption in Currency Units;
- iii. Current Week cumulative Energy Consumption;
- iv. Current Week cost to the Consumer of cumulative Energy Consumption in Currency Units;
- v. Current month cumulative Energy Consumption; and
- vi. Current month cost to the Consumer of cumulative Energy Consumption in Currency Units.

6.3.2.6. Emergency Credit Balance [NUM]

The emergency credit balance if Emergency Credit is activated in the SMS (including a clear indication that the Emergency credit has been activated).

Nigerian Electricity Smart Metering Regulation

6.3.2.7. Historic Consumption

- i. D-1 to D-8 historic Energy Consumption;
- ii. D-1 to D-8 cost to the Consumer of historic Energy Consumption in Currency Units;
- iii. W-1 to W-5 historic Energy Consumption;
- iv. W-1 to W-5 cost to the Consumer of historic Energy Consumption in Currency Units;
- v. M-1 to M-13 historic Energy Consumption; and
- vi. M-1 to M-13 cost to the Consumer of historic Energy Consumption in Currency Units.

where: D-1 = current Day minus 1, D-2 = current Day minus 2, W-1 = current Week minus 1, M-1 = current month minus 1 etc.

6.3.2.8. Instantaneous Active Power Import [NUM]

A near real-time indication of the Active Power Import in kW; and
The cost to the Consumer of that Instantaneous Active Power Import.

6.3.2.9. Local Time

The Local Time as derived from UTC+1.

6.3.2.10. Low Credit Alert

An indication that the combined electricity Credit Balance and electricity emergency credit balance (if Emergency Credit is activated) has fallen below the SMS low credit threshold.

6.3.2.11. Credit Balance [NUM]

The amount of money in Currency Units as determined by the SMS. If operating in Prepayment Mode, the Credit Balance represents the SMS's determination of the amount of credit available to the Consumer (excluding any *Emergency Credit Balance [NUM]*(6.3.3.6)). If operating in Credit Mode, it represents the SMS's determination of the amount of money due from the Consumer since the Credit Balance was last reset.

6.3.2.12. Payment Mode

The current mode of operation of the SMS, being Prepayment Mode or Credit Mode.

6.3.2.13. Power Threshold Status [AMB]

An indication of the level of Active Power Import as high, medium or low.

6.3.3. Security

6.3.3.1. General

- a. The IHD shall be designed taking all reasonable steps to ensure that it is capable of protecting Personal Data and Security Credentials at all times from disclosure or modification that is not authorised.
- b. An IHD shall be designed taking all reasonable steps so as to ensure that any failure or compromise of its Integrity shall not compromise the

Nigerian Electricity Smart Metering Regulation

Integrity of any other Device to which it is connected by means of a Communications Link.

6.3.3.2. Communications

- a. An IHD shall be capable of preventing and detecting, on all of its interfaces, Unauthorised access that could compromise the Confidentiality and/or Data Integrity of:
 - i. Personal Data whilst being transferred via an interface; and
 - ii. Security Credentials whilst being transferred via an interface.
- b. An IHD shall be capable of employing techniques to protect against Replay Attacks of information used to authenticate the identity of a system or individual.

6.4. Interface Requirements

This section sets out the minimum required interactions which an IHD shall be capable of undertaking with other SMS as appropriate via its HAN Interface.

6.4.1. Receipt of information via the HAN Interface

An IHD shall be capable, immediately upon establishment of a Communications Link with a SMS (as set out in §6.3.1.1) of receiving information (and updates of any changes of this information every 10 seconds thereafter) required to meet the display requirements set out in §6.3.2.

6.5. Data requirements

This section describes the minimum information which an IHD is to be capable of holding in its Data Store.

6.5.1. Constant data

Describes data that remains constant and unchangeable at all times.

6.5.1.1. Device Identifier

An identifier used to uniquely identify each IHD installed to comply with the smart metering roll-out licence conditions.

7. SMART METER SPECIFICATIONS AND SMS OWNERSHIP

7.1. Smart Meter

- 7.1.1. Meter specifications are particularly essential to provide for the technical functionalities stipulated in the Nigeria Metering Code and this regulation.
- 7.1.2. The smart meter shall have the ability to function as multi-source meter [utility, generator].
- 7.1.3. Metering Standards
The following are the minimum standards for electric smart meters:

Nigerian Electricity Smart Metering Regulation

- i **IEC Standard 62052-11:** General Requirements for meters.
 - ii **IEC Standard 62053-21:** Alternating current static meters for active energy (classes 1 and 2).
 - iii **IEC Standard 62053-22:** Alternating current static meters for active energy (classes 0.2 S and 0.5 S).
 - iv **IEC Standard 62053-23:** Alternating current static meters for reactive energy (classes 2 and 3).
 - v **IEC Standard 62054 – 21:** Electricity metering (a.c.) - Tariff and load control - Part 21: Particular requirements for time switches ;
 - vi **IEC Standard 62056 – 21:** Electricity metering (a.c.) - Data exchange for meter reading, tariff and load control - Part 21: Direct local data exchange.
 - vii **IEC Standards 62056-61:** Electricity metering - Data exchange for meter reading, tariff and load control - Part 61: Object identification system OBIS- For G, H, W, meters OBIS codes are specified in EN 13757-1 (CEN TC 294), interface objects are common.
- 7.1.4. The maximum service life of Meters and Metering Equipment shall be specified by the manufacturer of such equipment taking into account the technology obsolescence.
- 7.1.5. The maximum service life should take into account the roll out of all meters.
- 7.1.6. The Electric Smart Meter shall be suitable for operation under the following conditions:
- i Operating range voltage input : $230\text{ V} \pm 15\%$;
 - ii Basic current (maximum current) : 5 A (100 A) ;
 - iii Reference frequency : $50\text{ Hz} \pm 5\%$;
 - iv Operating temperature: -40°C to $+70^{\circ}\text{C}$
 - v Average relative humidity: up to 95%, non-condensing
- 7.1.7. The meter shall be equipped with a battery to maintain minimal time during minimal function.
- 7.1.8. The meter shall consume no more than 2 Watts on average during normal operational conditions.
- 7.1.9. Meter should be integrated with in-built communication modem (s) for all its communication interfaces.
- 7.2. Meter Protection and design**
- 7.2.1. The meter shall be installable in current existing meter locations at consumer premises.
- 7.2.2. The smart metering system components shall support local access and configuration by authorized personnel.

Nigerian Electricity Smart Metering Regulation

- 7.2.3. The smart metering system shall be installed and maintained in a manner that protects public safety.
- 7.2.4. The smart metering system shall display energy supply status (enabled or disabled) and origin of supply (grid or generator).
- 7.2.5. The smart metering system shall be protected from physical tampering or interference, e.g. security seals, tamper switches, etc.
- 7.2.6. The smart metering system should integrate a tampering detector, recognizing the following signals:
 - i Removal of terminal cover when the meter is powered as well as when it is not powered
 - ii Reverse current flow
 - iii Phase inversion (single-phase meters)
 - iv Current flow with no voltage
 - v The meter and its measurement technology shall be highly resistant to tamper attempts with DC magnetic fields
 - vi Phase rotation (for three phase meters)
 - vii Single phasing (for three phase meters)

7.3. Ownership of SMS

- 7.3.1 The ownership of the entire SMS should rest with the Nigerian Electricity Market at the Grid level.
- 7.3.2 Ownership of the electric smart meters shall be in accordance with the Nigeria Metering Code.
- 7.3.3 The Independent System Operator shall own, fund, and manage the SMS which covers the networks up to the TSP/DISCO trading points.
- 7.3.4 The DISCOs shall own, fund and manage the SMS from the TSP/DISCO Trading point to the consumer IHD interface.

8. AMENDMENT AND REPEAL

The Commission may amend or repeal, in whole or in part, the provisions of these Regulations.

Nigerian Electricity Smart Metering Regulation

SIGNED BY THE ORDER OF THE COMMISSION

**On this.....day of.....2017 UNDER THE SEAL
OF THE NIGERIAN ELECTRICITY REGULATORY COMMISSION PURSUANT TO
SECTION 32(2) OF THE ELECTRIC POWER SECTOR REFORM ACT 2005**

**Dr. Anthony Akah
Ag. Chairman/CEO**