PUBLIC CONSULTATION - TECHNICAL SPECIFICATIONS FOR TERMINAL COMMUNICATION EQUIPMENT

INVITATION FOR COMMENTS ON THE TECHNICAL SPECIFICATIONS FOR TERMINAL COMMUNICATION EQUIPMENT

1. The National Communications Authority (NCA) intends to introduce general standards and specifications for Terminal Communication Equipment (TCE) to be used on the Electronic Communications Network, which employs the Global System for Mobile Communications Technology (GSM), the ITU IMT-2000 (UTRA FDD and E-UTRA FDD) technologies, and IMT 2020. This is in accordance with the NCA Act 769, 2008, Section 3(n) and Sections 66 and 67 of the Electronic Communications Act, 2008.

2. In line with our mandate under Section 27 of the Electronic Communications Act, 2008 (Act 775) and Section 4.1 of the National Telecommunications Policy 2005 (NTP'05), we invite views and comments from Licensed Communications Service Providers, consumers and the general public regarding the technical specifications.

3. The draft Guidelines is available on the Authority's website(www.nca.org.gh).

4. The public consultation begins on **9th February, 2026** and shall expire on **9th March, 2026**.

5. Submit all responses as email attachments in Microsoft Word format to info@nca.org.gh.

6. All submissions must include a completed response cover sheet (refer to Page iii of this document).

7. We encourage respondents to specify the sections with which they agree or disagree. Where a respondent disagrees, provide a rationale with supporting evidence.

8. In the interest of transparency, all responses will be considered non-confidential and will be published on our website upon receipt.

9. By submitting your response, you grant the NCA the right to use the copyright and any associated intellectual property contained in your submission to meet its legal obligations.

10. Following the conclusion of the public consultation, the NCA will finalise the Technical Specifications for Terminal Communication Equipment and gazette same.

Issued by
The Acting Director General
10th February, 2026

COVER SHEET FOR RESPONSE TO PUBLIC CONSULTATION

DETAILS

Name of respondent:

Representing (self or organisation/s):

Physical Address:

Digital Address:

Email Address:

Telephone Number:

DECLARATION

I hereby confirm that the correspondence accompanying this cover sheet constitutes a formal consultation response. I consent to its full publication on the NCA website and authorize the NCA to utilize the information contained herein to fulfill its legal obligations. In the event that this response is transmitted via email, any standard disclaimer regarding the non-disclosure of email content and attachments shall be disregarded by the NCA.

Name: Signed (if hard copy)

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1. Part One (1): Introduction

1.1 Background

1.1.1 This technical document is developed to provide general standards and specifications for Terminal Communication Equipment (TCE) to be used on the Electronic Communications Network, which employs the Global System for Mobile Communications Technology (GSM), the ITU IMT-2000 (UTRA FDD and E-UTRA FDD) technologies, and IMT 2020. This is in accordance with the NCA Act 769, 2008, Section 3(n) and Sections 66 and 67 of the Electronic Communications Act, 2008.

1.1.2 The technical standards are in respect to terminal communication equipment and is pursuant to Sections 66 and 67 of the Electronic Communications Act 2008. NCA has a mandate under the Act to promote an open and technically interoperable network accommodating varied but compliant range of customer premises equipment that can support the required standards of service for public benefit.

1.1.3 The document outlines the minimum requirements for the terminal communication equipment for use in the Electronic Communications Network operating from 450MHz to 26GHz frequency bands or any other frequency bands that may be designated for access communications from time to time.

1.1.4 All suppliers, dealers of terminal communication equipment, operators of electronic communication networks, and service providers are required to comply with this technical standard. This is to ensure that terminal equipment imported for the Ghanaian market complies with these technical requirements.

1.1.5 Terminal Communication Equipment brought into the country by individuals are also subject to compliance with these technical requirements.

1.2 Document Structure

1.2.1 Part One (1) – Introduction

1.2.2 Part Two (2) – General Requirements for Terminal Electronic Communication Equipment

1.2.3 Part Three (3) - Requirements for Wireless Terminal Electronic Communication Equipment

a. Mobile Terminal Electronic Communication Equipment (MTECE)
b. Cellular Mobile Terminal Electronic Communication Equipment (CMTECE)
c. Fixed Wireless Terminal Electronic Communication Equipment (FWTECE)

1.2.4 Part Four (4) – Requirements for Fixed Terminal Electronic Communication Equipment

1.2.5 Part Five (5) - Appendices

1.3 Scope of Specification

This specification defines the minimum technical requirements for Terminal Communication Equipment to be used on the Public Electronic Communications Network. The document is intended for communication service providers, terminal equipment users, terminal equipment manufacturers, brand owners, suppliers and dealers, general telecommunication carriers, and the public.

1.3.1 The standard and specification cover the following areas;

1.3.1.1 Electrical safety requirement,
1.3.1.2 Electromagnetic compatibility,
1.3.1.3 Radiation safety standards,
1.3.1.4 Type Approval Requirement
1.3.1.5 Operating frequencies,
1.3.1.6 Technical compliance,
1.3.1.7 Environmental and Ruggedness requirements.
1.3.1.8 Accessibility requirements
1.3.1.9 Other administrative issues

1.4 Objectives

The principal objectives of this document are:

1.4.1 To ensure that individual terminal communications equipment can be interconnected to obtain the desired end-to-end performance.

1.4.2 To ensure that performance standards are met,

1.4.3 To define non-proprietary interfaces between terminal communication equipment that may themselves involve proprietary technology, to ensure that such proprietary ownership by particular vendors does not unnecessarily prevent the supply of their complementary terminal communication equipment,

1.4.4 To prevent or minimize harmful radio interference, to protect the health and safety of users,

1.4.5 To provide a basis for widespread acceptance of specific handsets for ease of circulation between countries, especially in the case of international and national roaming,

1.4.6 facilitate access to emergency services, and

1.4.7 To protect the integrity of public networks.

1.5 Abbreviations and Definitions

Terminal Electronic Communication Equipment (TECE) - refers to devices that are connected to outlets within a customer's premises in a network or used by a customer to access network services. Terminal Communication Equipment can be either mobile or fixed.

Wireless Terminal Electronic Communication Equipment (WTECE) – refers to an electronic communication device, such as a handheld, portable mobile phone, or vehicle-mounted equipment that transmits and receives information using radio waves or other electromagnetic signals

Cellular Mobile Terminal Communication Equipment (CMTCE) – refers to any portable or handheld device, or vehicle-mounted equipment that connects to cellular networks for communication

Fixed Terminal Communication Equipment (FTCE) refers to terminal communication equipment that is capable of using cable or emission and/or reception of radio waves utilizing the spectrum allocated to terrestrial/space radio communication, but in a stationary or normadic mode.

International Telecommunication Union (ITU) - is a specialized agency of the United Nations responsible for many matters related to information and communication technologies.

International Mobile Equipment Identity (IMEI) - is a numeric identifier, usually unique for 3GPP and iDEN mobile phones, some terminal devices, as well as some satellite phones.

Specific Absorption Rate (SAR) – is the rate at which energy is absorbed per unit mass of a biological tissue when exposed to a radio frequency (RF) electromagnetic field.

Public Communication Service (PCS) - encompasses the methods and channels used to disseminate information to the general public or specific segments of it.

Public Communication Network (PCN) is a system designed to facilitate the transmission of information to a broad audience over a public network.

Electromagnetic Compatibility (EMC) refers to a device's ability to function properly in its electromagnetic environment without causing unacceptable interference to other devices.

International Electrotechnical Commission (IEC) refers to a global organization that develops and publishes international standards for electrical, electronic, and related technologies.

Central Equipment Identity Register (CEIR) – refers to a national, centralized database that tracks mobile devices by their unique IMEI numbers.

Permanent Equipment Identifier (PEI) – refers to a unique code identifying a mobile device (User Equipment or UE) on a 3GPP network (like 4G/5G), essentially the device's hardware fingerprint, most commonly in the form of an IMEI, used for network access control, device tracking, and security, such as blacklisting stolen phones.

National Frequency Allocation Table – refers to the official document issued and managed by the National Communication Authority (NCA), Ghana, detailing how radio-frequency spectrum bands are divided among different services.

2 Part Two (2): General Requirements

2.1 Equipment Identification and Marking Requirements

2.1.1 The Terminal Communication Equipment shall be marked with the manufacturer's brand or identification mark, and the manufacturer's model or type reference. The marking required shall be legible, indelible, and readily visible.

2.1.2 The Terminal Communication Equipment shall be marked with the NCA Type Approval marking.

2.1.3 Each Terminal Communication Equipment shall be allocated a unique equipment ID, such as 'International Mobile Station Equipment Identity (IMEI)', Media Acces Control (MAC) address, etc. where applicable. The manufacturer shall ensure that adequate security measures have been taken to protect against duplication, unauthorized removal, or altering of such Unique ID.

2.1.4 User and installation manuals must include safety warnings, mounting instructions, maintenance schedules and end-of-life disposal guidelines in English and any required local languages, where applicable.

2.2 Environmental and Ruggedness Requirements

Terminal Electronic Communication Equipment intended for the Ghanaian market shall conform to the criteria below:

2.2.1 Operational Temperature Range

Devices must operate continuously between –10 °C and +55 °C to withstand sub-Saharan diurnal extremes in conformance with IEC 60068-2-2 and IEC 60068-2-30.

2.2.2 Storage Temperature Range

Equipment shall tolerate –20 °C to +70 °C, covering transportation and non-operational storage periods in conformance with IEC 60068-2-2.

2.2.3 Humidity Tolerance

Operational relative humidity shall span 5 %–95 % non-condensing. Critical electronics must use conformal PCB coatings and gasketed seals on all connectors in conformance with IEC 60068-2-38.

2.2.4 Vibration Resistance

Equipment shall pass IEC 60068-2-6 vibration testing (sinusoidal sweeps from 5 Hz to 150 Hz) to endure transport and in-service mechanical vibration.

2.2.5 Shock Resistance

Devices shall satisfy IEC 60068-2-27 shock testing (half-sine pulses up to 15 g) to withstand drops and impacts.

2.2.6 Dust Exposure

For high-dust environments (e.g., unpaved roads, mining), terminals must pass IEC 60068-2-68 dry-dust and blowing-dust tests, ensuring operation during sandstorms.

2.2.6.1 Additional Durability

Enclosures and mounting hardware shall be rated for termite resistance where relevant, and all exposed metalwork must feature corrosion-proof coatings to guarantee long-term service life.

2.3 Technical Requirements

2.3.1 Keypad

2.3.1.1 Any keypad used in the Terminal communication equipment shall be alpha-numeric, and the relationships between the letters and digits shall comply with the ITU-T Recommendation E.161 (02/2001), Sections 2.2, 3.1.1, and 3.6.

2.3.1.2 Manufacturers shall ensure that any hard keyboard provided with a terminal device includes Braille functionality.

2.3.2 Health and Safety

2.3.2.1 All terminal communication equipment shall comply with IEC 62368-1 (or successor standards) to protect against electric shock, fire and mechanical hazards, 2020 ICNIRP guidelines, and any national safety and health standards for communication equipment.

2.3.2.2 All Terminal Communication Equipment must show compliance with but not limited to the following, and other EMC standards applicable to such equipment that may be adopted: CISPR32: Information Technology Equipment, EN55032: EMC Testing of Multimedia Equipment (MME), EN50082-1: Electromagnetic Compatibility – Generic immunity Standards, EN50081-1: Electromagnetic Compatibility – General Emission Standards and, EN6100-3-2/3: Electromagnetic Compatibility – Limits of harmonics.

2.3.2.3 Compliance with the radiation safety standards specified in 2.3.2.2 does not by itself confer immunity from legal obligations and requirements imposed by national health or safety authorities. The NCA may invalidate the equipment registration if so requested by the relevant authority for reasons of safety or hazards that would likely be caused to users.

2.3.2.4 Where applicable, the equipment supplier shall provide the SAR information in printed form or other appropriate form, in the user guide or as a leaflet or brochure in the equipment package. Furthermore, the supplier shall provide each unit of approved Mobile Terminal Communication Equipment with advisory information about electrical safety and non-ionizing radiation hazards and on the safe operation of the Mobile Terminal Communication Equipment at potentially hazardous areas such as in moving vehicles, in aircraft and at fuel depots, chemical plants, and blasting sites.

2.3.2.5 Insulating barriers, creepage distances, and protective earth connections must meet the requirements for Information Technology Equipment, and all exposed metal parts shall be bonded or double-insulated.

2.3.3 Power Supply Requirements

2.3.3.1 AC adaptor for Terminal Communication Equipment shall not affect the capability of the equipment to meet this specification. The operating voltage shall be 240V +/ -10% and frequency 50Hz ± 1% or 230 V + 10% and frequency 50Hz ± 1 %.

2.3.3.2 The adaptor must be pre-approved by the relevant regulatory body before it can be used with the equipment and shall comply with GS IEC 60884-2-5 (or successor standards).

2.3.4 Power Supply cord and mains plug requirements

2.3.4.1 The equipment shall be fitted with a suitable and appropriate approved power supply cord and mains plug. Both are regulated products and must be pre-approved by the relevant regulatory body before it can be used with the equipment.

2.3.4.2 The supply cord and mains shall be in compliance with the Ghana Energy Commission Electrical Wiring Cables and Electrical Wiring Accessories Regulations, 2023 (L.I. 2478) and GS IEC 60884-2-5

2.3.5 Direct Current (DC) Input and External Power Sources

2.3.5.1 Telecom Central-Office / Shelter Supply (–48 V DC Nominal): Devices intended for fixed-site use shall operate correctly across a –40 V to –60 V DC input range, in accordance with ITU-T K.45. Input stages must incorporate reverse-polarity protection, surge and lightning transient suppression (IEC 61000-4-5), and inrush-current limiting to protect both the device and upstream rectifier/battery plant.

2.3.5.2 Automotive / Mobile DC Supply (12 V DC Nominal): Vehicle-mounted terminals shall accept 12 V ± 1 V DC, with transient protection per ISO 7637-2 for load-dump and ignition interference. Input circuitry must guard against reverse polarity and include filtering sufficient to meet EN 55022 radiated and conducted emission limits when operating from the vehicle's electrical system.

2.3.5.3 Power over Ethernet (PoE):Where applicable, equipment shall support IEEE 802.3af (15.4 W) or IEEE 802.3at (30 W) PoE sourcing. PoE interfaces must negotiate class designation correctly, comply with signature resistance, and maintain isolation barriers per IEEE 802.3 and IEC 623681 requirements.

Each DC-powered terminal shall indicate via front-panel LEDs or management-interface alarms when the input source falls below safe operational thresholds (e.g., 42 V DC in central-office systems, 10.5 V DC in automotive), and shall safely shut down non-critical functions before power loss.

2.3.6 Rechargeable Battery Systems

Where uninterrupted operation is required, terminals shall include internal or externally swappable rechargeable battery packs satisfying the following criteria:

2.3.6.1 Chemistry and Standards Compliance: Cells must conform to IEC 61960 (lithium-ion/polymer) or IEC 62133 (Ni-MH), and shall be tested per UN 38.3 for transport safety.

2.3.6.2 Capacity and Autonomy: Under typical load profiles, batteries shall provide a minimum of eight hours of continuous operation for handheld/mobile terminals, and a minimum of two hours for fixed-site CPE.

2.3.6.3 Battery Management: Integrated Battery Management Systems (BMS) shall monitor cell voltages, temperatures, and state-of-charge, implementing overcharge, over-discharge, short-circuit, and thermal runaway protections.

2.3.6.4 User Indication: A low-battery warning must be triggered at no less than 10 % remaining capacity, providing both audible and visual alerts. A “critical battery” state shall initiate graceful shutdown or transition to external power backup.

2.3.7 Seamless Power Transition and Backup

All terminal communication equipment combining multiple power sources (AC, DC, and battery) shall implement an automatic, near-zero-delay transfer mechanism. In the event of primary-source failure, devices must switch to the secondary source without resetting or dropping active sessions. Fixed-site installations that require continuous availability (e.g. emergency call panels, VoIP gateways) shall be capable of accepting an external DC-UPS or battery-plant feed, and automatically revert to mains or central battery when restored.

2.3.8 Power Monitoring, Reporting, and Maintenance

Terminal Communication Equipment shall expose status and metrics via local display or network management protocols (SNMP, TR-069, NETCONF), including:

a. Input voltage and current on each power rail (AC, DC, PoE)
b. Battery state-of-charge and health (cycle count, temperature)
c. Power-source events, such as source switchover, brown-out, or surge detection

Manufacturers must supply recommended maintenance procedures and intervals for battery replacement, DC-plant filter cleaning, and verification of protection circuits.

2.3.9 Interoperability and connectivity requirements

2.3.9.1 Interoperability: The terminal communication equipment shall have the ability to communicate with two or more systems or components on a communication network, irrespective of the vendor or manufacturer.

2.3.9.2 Connectivity: The terminal communication equipment shall have the ability to link with other programs and devices to allow interoperability.

2.3.10 Electrical Safety Requirements.

2.3.10.1 A terminal communication equipment operating with mains power supply shall comply with internationally accepted electrical safety standards, including but not limited to the following, and other electrical safety standards that may be adopted in the country from time to time;

2.3.10.2 IEC 62368-1 –Safety of Information Technology Equipment,

2.3.10.3 Where provision is made for the connection of any class of mobile station (mobile handset) to supply units or battery chargers using voltages in excess of 50V rms ac or 75 dc, user manual shall specify the power unit(s) or battery charger(s) approved for use with the mobile station/mobile handset and shall include the following statement:

"The Mobile equipment is intended for use when supplied with power from identification of battery charger(s) and/or power supply units(s). Other usage will invalidate any approval given to the apparatus and may be dangerous."

2.3.10.4 Compliance with the radiation safety standards specified in clause 7.2 does not by itself confer immunity from legal obligations and requirements imposed by national health or safety authorities. The NCA may invalidate the equipment registration if so requested by the relevant authority for reasons of safety or hazards that would likely be caused to users.

2.3.10.5 Additionally, the supplier shall provide each unit of the respective approved terminal communication equipment with advisory information about electrical Safety and non-ionizing radiation hazards and on safe operation.

2.3.11 Mechanical Integrity

Enclosures and connectors shall withstand normal handling and installation stresses. Devices must pass IEC 60068-2-6 vibration and IEC 60068-2-27 shock tests, and panel-mounted equipment shall include strain relief for all cabling.

2.3.12 Software/Firmware Integrity

Terminals shall implement secure-boot with digitally signed images and support authenticated over-the-air or local firmware updates. A rollback mechanism shall prevent "brick" conditions, and cryptographic logging of update events must be exposed via management interfaces.

2.3.13 User Interface & Accessibility

Interfaces (keypads, screens, LEDs) must be legible under daylight and low-light conditions. Critical alerts (emergency call, low battery) shall be indicated both visually and audibly. Menus and prompts shall support multiple languages and conform to accessibility best practices.

2.3.14 Reliability & Diagnostics

Devices shall achieve a minimum Mean Time Between Failures (MTBF) of 50,000 hours. Built-in diagnostics shall monitor power-rail voltages, environmental sensors (temperature/humidity) and radio-link quality, exposing status via SNMP, TR-069 or local logs.

2.3.15 Maintenance & Life-Cycle

Where applicable, manufacturers must supply recommended maintenance intervals (e.g. battery replacement, filter cleaning) and guarantee the availability of critical spare parts for a minimum of five years. End-of-life procedures shall follow Waste Electrical and Electronic Equipment (WEEE) guidelines for electronics recycling.

2.3.16 Essential Requirement

Mobile Terminal Communication Equipment shall be so constructed that it effectively uses the spectrum allocated to avoid harmful interference.

2.4 Emergency Functions

2.4.1 Emergency Call Access:

Terminals shall permit unauthenticated dialing of designated emergency numbers (e.g. “112”, “911” or any other numbers that may be designated by the state) and establish a bearer to the Public Safety Answering Point (PSAP) with QoS priority. Emergency calls shall bypass SIM/authentication checks and be carried on dedicated or pre-emptive bearers. If call setup fails, the device shall immediately issue both audible and visual alerts and, where supported, automatically transmit an SMS or data-session-based notification to a preconfigured emergency contact endpoint.

2.4.2 Location Transmission:

Within five seconds of emergency-call initiation, equipment shall deliver network-based location information. If GNSS hardware is integrated, a two-dimensional fix (latitude, longitude) with horizontal accuracy ≤ 10 m and timestamp shall be obtained within 30 seconds and sent using the PIDF-LO format (RFC 4119). Terminals supporting both methods shall merge network and GNSS data to maximize reliability, including altitude where available.

2.4.3 CAP v1.2 Reception:

Equipment shall support OASIS Common Alerting Protocol v1.2 over Cell Broadcast (GSM/UMTS/LTE CB), concatenated SMS or IP (UDP/TCP/HTTPS). Incoming CAP XML must validate against the CAP 1.2 schema, extract header fields (identifier, sender, sent, status, msgType) and info blocks (category, event, urgency, severity, certainty, effective, expires, instruction), and render them in the local language with an audible/visual alert. Devices shall cache the last three alerts, allow user acknowledgment, and honor CAP “parameter”-defined repetition intervals.

2.4.4 Health Monitoring and Reporting:

CAP-capable and emergency terminals shall generate periodic health-check messages (default every 24 h) to a central monitoring system via SNMP (using standard MIB-II plus trap generation) or HTTPS. Reports shall include primary and backup power status, firmware version, CAP reception count, and emergency-module readiness. Loss of scheduled health checks or detection of power-source faults shall trigger immediate SNMP traps or HTTP callbacks.

2.5 Type Approval Specification

Manufacturers and importers must submit an application and equipment for type approval under the NCA's Equipment Guidelines (or any regulations on equipment authorization). Conformity assessment shall include test reports from accredited laboratories, covering electrical safety, EMC, radio performance (where applicable), and SAR. Labels indicating the NCA approval number shall be affixed in line with the Type Approval Guidelines or subsequent amendments.

3 Part Three (3): Requirements for Wireless Terminal Electronic Communication Equipment

3.1 General Radio and Functional Requirements

3.1.1 Regulatory Compliance: Each radio interface shall operate only in frequency bands and power levels authorized by the NCA to harmonized EN/ETSI or ITU Recommendations are mandatory.

3.1.2 Electromagnetic Compatibility (EMC): Devices must pass ETSI EN 301 489 series (or equivalent) for radiated and conducted emissions and immunity. Interfaces to public networks and to other radios within the device must implement coexistence filtering to prevent self-interference.

3.1.3 Safety and SAR: For any device radiating at >10 MHz, Specific Absorption Rate (SAR) shall not exceed 2 W/kg averaged over 10 g of tissue (ICNIRP). Measurement protocols shall follow IEC/IEEE 62209-1528:2020 and EN IEC/IEEE 62209-1528:2021 as applicable.

3.1.4 Security and Privacy: Implementation of at-rest and over-the-air encryption shall conform to recognized industry protocols (e.g., LTE/AES, Lora WAN AES-128, IEEE 802.15.4 AES-CCM). Devices must support secure boot, tamper detection, and authenticated firmware updates.

3.1.5 Location Services: Where required, terminals shall be capable of providing network-based, Assisted Global Navigation Satellite System with optimum accuracy of not more than 10m (2D) under open-sky conditions. This functionality shall be turned on by default, and it shall be compatible with location-based services provided by all mobile network operators in Ghana.

3.1.6 Power Consumption: Radio transmit duty-cycle and power-saving features (e.g. DRX, PSM, eDRX) must comply with 3GPP Release 13+ recommendations to optimize battery life in idle mode, where applicable.

3.2 Operating Frequencies

Wireless Terminal Electronic Communication Equipment (WTECE), shall operate within the frequencies as specified in the National Frequency Allocation Table (NFAT).

3.2.1 The precise operating frequency range of a Terminal communication equipment shall follow that of the Network Operator from whom the service is obtained.

3.2.2 Wireless Terminal Electronic Communication Equipment designed to operate on more than one Frequency band shall be able to transmit and receive in the frequency ranges in the NFAT.

3.3 Mobile Terminal Electronic Communication Equipment

3.3.1 Terminal communication equipment classified as mobile encompasses mobile phones (feature phones and smartphones), tablets with cellular capability, IoT/M2M devcies with cellular connectivity and fixed wireless terminals. They connect wirelessly to public or private networks. Mobile terminals may use traditional cellular radio interfaces (GSM, UMTS, LTE, 5G) or low-power, wide-area "capillary" (non-cellular) technologies such as LoRaWAN, NB-IoT unlicensed variants, Sigfox, IEEE 802.15.4 (Zigbee/6LoWPAN), Bluetooth Mesh, etc. All mobile terminals shall meet the following general criteria, with additional provisions as specified in subsections 9.1 and 9.2.

Data modems and routers

3.3.2 For terminals using low-power, short- or wide-area capillary networks, the following apply:

3.3.2.1 LoRaWAN / Sigfox / NB-IoT Lite (Unlicensed):

a. Frequency Bands: Operate in 863–870 MHz (LoRa) or 868 MHz (Sigfox) ISM bands; ensure adherence to local duty-cycle limits (e.g. ≤1 %).
b. Transmit Power: ≤14 dBm EIRP for LoRaWAN, ≤14 dBm for Sigfox uplink.
c. Certification: Must pass ETSI EN 300 220 (LoRaWAN) or equivalent EN standard for unlicensed devices.

3.3.2.2 IEEE 802.15.4 (Zigbee, 6LoWPAN):

a. Bands & Channels: 2.4 GHz ISM band (16 channels), or sub-GHz variants (e.g. 868 MHz).

b. Channel Occupancy: Comply with duty cycle and listen-before-talk (LBT) requirements per ETSI EN 300 328 or national regulations.
c. Mesh-Network Support: Devices intended for mesh topologies must implement self-healing routing and duty-cycle management to preserve battery life.

3.3.2.3 Bluetooth LE / Mesh:

a. Version: Bluetooth 3.0 or higher, including low-energy power-saving modes.
b. Advertising & Scanning: Must support extended advertising and periodic scanning with configurable intervals to balance latency and power consumption.
c. Security: LE Secure Connections (ECDH key exchange) and encrypted link layer sessions.

3.3.2.4 Radio Performance & Range:

Each technology shall achieve at least 2 km line-of-sight range for LoRaWAN/Sigfox, and 100 m indoor range for 2.4 GHz ISM band devices.

3.3.2.5 Power Profiling:

Duty-cycle Profiler reports (wake-up, transmit, sleep currents) must be published by manufacturers. Under typical reporting intervals (e.g. hourly uplink), devices should maintain multi-year battery lives on primary cells (e.g. AA-Li or coin lithium).

3.3.2.6 Network Integration & API:

Capillary devices shall expose standard interfaces (e.g. MQTT, HTTP REST, CoAP) via gateway equipment, with TLS 1.2+ encryption to the application server.

3.4 Cellular Mobile Terminal Electronic Communication Equipment (CMTECE)

3.4.1 Each individual CMTECE shall be allocated a unique International Mobile Station Equipment Identity (IMEI) in the IMEI format or international Mobile Station Equipment Identity and Software Version number (IMEISV) format. Manufacturer shall ensure that adequate security measures have been taken to protect the IMEI against duplication, unauthorised removal or change.

3.4.2 CMTECE shall comply with IMEI security requirements of ETSI 151 010-1[5] and 3GPP TS 23.003.

3.4.3 Support for at least 3DES or AES-128 in USIM authentication, with secure element protection for subscriber credentials.

3.4.4 Support for SIM and/or eSIM as applicable. CMTECE shall comply with **3GPP TS 11/31/51** SIM standards and shall have support for **emergency services access** without restrictions

3.4.5 CMTECE shall comply with the following requirements:

3.4.6 2G (GSM) Minimum Technical Specifications

3.4.6.1 Technology

- GSM Phase 2+
- GPRS and EDGE support (minimum)

3.4.6.2 Frequency Bands

- GSM 900 MHz
- GSM 1800 MHz

3.4.6.3 Modulation and Access

- GMSK (GSM)
- 8PSK (EDGE)

3.4.6.4 Data Rates

- GPRS: up to 85.6 kbps
- EDGE: up to 236.8 kbps

3.4.6.5 Services

- Voice telephony
- SMS and USSD
- Circuit-switched data
- Emergency call support

3.4.6.6 RF Performance

- Transmit power and receiver sensitivity in compliance with 3GPP TS 45 series
- Adjacent channel leakage ratio (ACLR) within specified limits

3.4.7 3G (UMTS/HSPA) Minimum Technical Specifications

3.4.7.1 Technology

- UMTS Release 99 or later
- HSPA / HSPA+

3.4.7.2 Frequency Bands

- 900 MHz
- 2100 MHz

3.4.7.3 Access and Modulation

- WCDMA
- QPSK / 16QAM

3.4.7.4 Data Rates

- Downlink: minimum 384 kbps
- Uplink: minimum 128 kbps
- HSPA+: up to 42 Mbps

3.4.7.5 Services

- Voice and video telephony
- Packet-switched data
- SMS and MMS
- Emergency services

3.4.7.6 RF and Protocol Compliance

- Compliance with 3GPP TS 25 series
- Fast handover and cell reselection support

3.4.8 4G (LTE) Minimum Technical Specifications

3.4.8.1 Technology

- LTE Release 8 or later
- LTE-Advanced support recommended

3.4.8.2 Frequency Bands

- Band 1(2100MHz)
- Band 3 (1800 MHz)
- Band 7 (2600 MHz)
- Band 20 (800 MHz)
- Band 28 (700 MHz)
- Band 40 (2300 MHz)

3.4.8.3 Access and Modulation

- OFDMA (downlink)
- SC-FDMA (uplink)
- QPSK, 16QAM, 64QAM (minimum)

3.4.8.4 Data Rates

- Downlink: minimum 10 Mbps
- Uplink: minimum 5 Mbps

3.4.8.5 Voice Services

- Voice over LTE (VoLTE)
- Circuit Switched Fallback (CSFB)

3.4.8.6 MIMO and Antenna

- Minimum 2×2 MIMO support
- Adaptive antenna switching

3.4.8.7 Security

- LTE security architecture per 3GPP TS 33 series
- Mutual authentication and encryption

3.4.9 5G Minimum Technical Specifications

3.4.9.1 Technology

- 5G New Radio (NR)
- Standalone (SA) and/or Non-Standalone (NSA)

3.4.9.2 Frequency Bands

- n1(2100 MHz)
- n7 (2600 MHz)
- n20 (800 MHz)
- n28 (700 MHz)
- n40 (2300 MHz)
- n78(3500MHz)
- n258(26GHz)

3.4.9.3 Access and Modulation

- OFDMA
- QPSK, 16QAM, 64QAM, 256QAM

3.4.9.4 Data Rates

- Downlink: minimum 100 Mbps
- Uplink: minimum 50 Mbps

3.4.9.5 Latency

- User plane latency ≤ 10 ms

3.4.9.6 Network Features

- Network slicing support
- Enhanced Mobile Broadband (eMBB)
- Support for IoT and URLLC where applicable

3.4.9.7 Security

- 5G security framework per 3GPP TS 33 series
- Secure boot and firmware integrity

3.4.9.8 Radio Performance:

TABLE 1: RADIO PERFORMANCE REQUIREMENTS

SN	Technology	Sensitivity (dBm)	Max Power
1	GSM	≤–100	As per ETSI EN 301 908-1
	WCDMA		
2	LTE / FDD	≤–107	
3	5G NR	≤–112	

3.4.9.9 CMTECE shall support at least one global GNSS constellation, with multi-constellation support strongly recommended. Global GNSS constellation supported should include GPS (United States – L1 C/A, 1575.42 MHz), GLONASS (Russia), Galileo (European Union) or BeiDou (China)

3.4.9.10 GNSS Performance Requirements

3.4.9.10.1 Positioning Accuracy

Under open-sky conditions:

- **Horizontal accuracy**: ≤ 5 meters (CEP)
- **Vertical accuracy**: ≤ 10 meters (typical)

3.4.9.10.2 Time to First Fix (TTFF)

- Cold start: ≤ 60 seconds
- Warm start: ≤ 30 seconds
- Hot start: ≤ 5 seconds

3.4.9.10.3 Sensitivity

- Tracking sensitivity: ≤ –160 dBm
- Acquisition sensitivity: ≤ –145 dBm

3.4.9.11 Assisted GNSS (A-GNSS)

3.4.9.11.1 CMTECE shall support Assisted GNSS (A-GNSS) to improve location performance in:

- Urban areas
- Indoor or low-signal environments
- Emergency call scenarios

3.4.9.11.2 A-GNSS support shall include:

- Network-based assistance via cellular data
- Secure communication with assistance servers
- Compatibility with LTE and 5G packet-switched networks

3.4.9.12 Emergency Location Services

3.4.9.12.1 Devices shall support location determination for emergency services, including:

- Automatic provision of location information during emergency calls
- Support for hybrid positioning (GNSS + cellular positioning)
- Compliance with applicable **ETSI TS 103 625** or equivalent standards

3.4.9.13 GNSS RF and EMC Compliance

- GNSS receiver operation shall not cause harmful interference to other radio services
- GNSS components shall comply with:
  - ETSI EN 303 413 (GNSS receivers)
  - ETSI EN 301 489 (EMC requirements)
- Receiver spurious emissions shall remain within regulatory limits

3.4.9.14 Security and Integrity

- GNSS data shall be protected against unauthorized access
- Firmware updates affecting GNSS functionality shall be secure and authenticated
- Devices supporting location reporting shall prevent spoofing and tampering to the extent practicable

3.4.9.15 Power Management

- GNSS operation shall support low-power modes
- Assisted and background positioning shall minimize impact on battery life
- GNSS shall automatically deactivate when not required by the user or network services

3.4.9.16 User Control and Privacy

CMTECE shall:

- Provide user control over location services (except where legally mandated)
- Clearly disclose when location data is being accessed
- Comply with applicable **data protection and privacy laws of Ghana**

3.4.9.17 Testing and Certification

GNSS functionality shall be verified through:

- Laboratory testing using GNSS signal simulators
- Field testing under representative conditions in Ghana
- Submission of GNSS test reports as part of NCA type approval

3.4.9.18 Applicability by Device Category

Device Type	GNSS Requirement
Smartphones	Mandatory
Feature phones	Recommended
IoT/M2M devices	Mandatory where location-based services are used
Fixed wireless terminals	Optional
Data modems/routers	Optional

3.4.9.19 Interoperability & Roaming:

Devices shall correctly implement 3GPP TS 23.401/23.501 procedures for inter-RAT handover, attach/detach, and roaming.

3.4.10 Manufacturers and suppliers shall demonstrate that the Cellular Mobile Terminal Communication Equipment has been tested and certified for operating in the frequency bands stated in the NFAT and conformity to any or a combination of the following standards and all applicable standards referenced within:

3.4.10.1 ETSI EN 301 511
Global System for Mobile Communications (GSM); Harmonized EN for mobile stations in the GSM900 and GSM1800 bands covering essential requirements under article 3.2 of the R&TTE Directive (1999/5/EC)

3.4.10.2 ETSI EN 301 908-01
IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 1: Introduction and common requirements.

3.4.10.3 ETSI EN 301 908-02

IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE).

3.4.10.4 ETSI EN 301 908-13
IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE).

3.4.10.5 ITU-R M.1457-9
Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications- 2000 (IMT-2000).

3.4.10.6 ETSI EN 301 908-25
IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 25: New Radio (NR) User Equipment (UE) Release 15.

3.4.10.7 ETSI TS 138 521-1
5G; NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 standalone (3GPP TS 38.521-1 version 18.4.0 Release 18).

3.4.10.8 ETSI TS 138 521-2
5G; NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 2: Range 2 standalone (3GPP TS 38.521-2 version 17.4.0 Release 17).

3.4.11 If a Cellular Mobile Terminal Communication Equipment also supports other wireless modes of operation, such as WLAN, Bluetooth, suppliers shall demonstrate that the Mobile terminal has been tested and certified for conformity to the relevant requirements as given in Technical Specification for Short Range Devices (TS SRD) and reviewed from time to time.

3.5 Voice-Over-LTE (VoLTE) Requirements

3.5.1 Terminal Equipment that support LTE designed for voice calling shall support VoLTE technology as per 3GPP specifications. The VoLTE functionality shall be available and whitelisted by default and it shall be compatible with VoLTE services provided by all mobile network operators in Ghana. The device shall support the necessary VoLTE profiles for each operator to ensure seamless connectivity and interoperability for making and receiving VoLTE calls in Ghana.

3.5.2 The device should be able to automatically receive configuration of VoLTE settings based on the network operator's profile and shall also allow additional emergency numbers sent by the serving network to be downloaded and designated as emergency numbers.

3.6 Fixed Wireless Terminal Electronic Communication Equipment

3.6.1 Fixed-Wireless (FWA) CPE

Routers or gateways using licensed-band 4G/5G or unlicensed-band fixed-LTE shall support 3GPP Release 15+ NR-D, including MIMO antenna arrays, carrier aggregation, and AT command interfaces (e.g. 3GPP TS 27.007). For CBRS or other shared bands, implement DFS/LBT per local regulations.

3.6.2 Fax, Conferencing and Analog Peripherals

Fax/modems shall implement ITU-T T.30, V.34, and fall-back to V.17/V.29. Teleconference bridges must support G.722 wideband audio and G.722.1 Annex C, plus interoperability with H.323/SIP endpoints. Echo cancellation and comfort-noise generation per G.165/G.168.

3.6.3 Environmental, Safety and Durability

3.6.3.1 All fixed-installation CPE must operate at 0 °C to 40 °C (–20 °C to +60 °C storage), 10 %–90 % non-condensing humidity, and be rated at least IP20 indoors. Outdoor or pole-mounted units require IP65 ingress protection and conform to EN 60068 (vibration/shock) tests.

3.6.3.2 Ingress Protection (IP Rating):

Outdoor or pole-mounted units shall carry at least IP66 per IEC 60529 or any subsequent amendment, ensuring complete dust-tight sealing and resistance to powerful water jets. Indoor or sheltered units shall achieve at least IP54 to prevent harmful dust accumulation and water spray ingress.

3.6.3.3 Enclosure Materials & UV Resistance

Housings must be fabricated from UV-stabilized, corrosion-resistant plastics or metals. Finish materials shall conform to ISO 4892-2 for prolonged solar exposure. Coastal or saline environments require validation via salt-fog testing under IEC 60068-2-52.

3.6.3.4 Rain & Immersion

Outdoor or pole-mounted units shall comply with IEC 60068-2-18 drip-box and immersion tests, protecting against heavy rainfall and angled spray.

3.6.3.5 Additional Durability

Enclosures and mounting hardware shall be rated for termite resistance where relevant, and all exposed metalwork must feature corrosion-proof coatings to guarantee long-term service life.

3.6.4 Security and Privacy

CPE shall support firmware authenticity checks (digital signatures), secure-boot chains, and encrypted storage for credentials. SSH v2, TLS 1.2+ for management interfaces, and optional VPN client (IPsec, OpenVPN) are recommended.

Notes & Considerations

i. *If a terminal supports multiple radio interfaces (e.g., cellular + LoRa), it must implement coexistence mechanisms to avoid self-interference (e.g. time-division multiplexer, shared antenna filtering).*
ii. *For mission-critical or safety-of-life applications, consider redundant capillary connectivity (e.g. dual-band LoRa + NB-IoT) with automatic fail-over logic.*
iii. *Detailed frequency-band assignments and duty-cycle limits should be maintained in a separate Annex, updated as the regulator releases new spectrum plans.*

4 Part Four (4): Requirements for Fixed Terminal Electronic Communication Equipment

4.1 Fixed Terminal–Specific Requirements

Fixed terminal communication equipment ("CPE") includes any user-side device permanently or semi-permanently installed at a fixed location. This covers analog/digital telephones, VoIP handsets, PBX extensions, xDSL and cable modems, optical-network terminals, fixed-wireless routers, set-top boxes, fax, and conferencing equipment. All fixed terminals must satisfy the following requirements.

4.1.1 Subscriber-Line Interfaces

4.1.1.1 Analog (PSTN) Ports

Equipment with RJ-11 two-wire ports shall conform to ITU-T Recommendation G.702 for loop-start signaling. Loop current must be 23 mA ± 3 mA and feed 40 VDC nominal. Ring voltage must be 70 VAC ± 10 VAC at 20 Hz ±1 Hz, delivered with 1.5 s on/6 s off cadence. Polarity reversal (battery reversal) between calls and disconnect supervision per ETSI EG 202 057 is required. Echo cancellation shall meet ITU-T G.168 (32 ms tail-length) for VoIP-to-PSTN gateways.

4.1.1.2 Digital (ISDN) Ports

Equipment offering Basic-Rate ISDN (S/T-interface) shall comply with ITU-T I.430 and I.431. Interfaces shall present 2 B-channels (64 kbps each) + D-channel (16 kbps), over RJ-45. Signaling (Q.921/Q.931) and TE-NT interworking shall be implemented for transparent call setup and release.

4.1.2 IP-Network Termination

4.1.2.1 Ethernet Interface

Fixed-IP devices shall provide at least one auto-MDI/MDI-X RJ-45 port supporting 10/100/1000 Mbps full-duplex. For multi-port routers/switches, VLAN-capable ports (802.1Q) are required to segregate voice and data.

4.1.2.2 Power over Ethernet (PoE)

Where device class demands PoE, support IEEE 802.3af (15.4 W), 802.3at (30 W) or 802.3bt (60 W) as appropriate. PD signature and classification must follow IEEE standards; isolation barriers must comply with IEC 62368-1.

4.1.2.3 Quality of Service

Devices must implement DiffServ (RFC 2475) with at least four queues, honoring DSCP marking for voice (EF), video (AF41), and data. Jitter buffers shall adapt dynamically (20–50 ms), and packet-loss concealment per ITU-T G.711 Appendix I or G.726.

4.1.2.4 Management & Provisioning

Support for remote management via TR-069 (CPE WAN Management Protocol) including firmware upgrade, parameter configuration and diagnostics. SNMP v2c/v3 agents with MIB-II and Ethernet-like MIB (RFC 3635) are mandatory. CLI (SSH/Telnet) may be provided for advanced troubleshooting.

4.1.3 xDSL and Cable Modems

4.1.3.1 xDSL Modems

Compliance with ITU-T G.992.1/2 (ADSL), G.992.3/4 (ADSL2/2+), G.993.2 (VDSL2) or ITU-T G.9701 (G.fast), supporting rate-adaptive noise reduction (SRA), seamless rate adaptation and echo cancellation. Line-power feeding (LPE) detection and G.994.1 (G.hs) for multi-vendor interoperability.

4.1.3.2 Cable Modems

DOCSIS 3.0/3.1 compliance, with channel bonding (up to 32 × 8 channels), upstream power-control per SCTE 40 and spectrum management. Downstream OFDM/OFDM-OFDMA support for enhanced throughput.

4.1.4 Optical Network Terminals (ONT)

Devices interfacing with PON networks must implement ITU-T G.984 (GPON) or G.987 (XG-PON) transceivers. Optical budgets and splitter ratios per G.984.3; laser safety Class 1 (IEC 60825-1) labeling; burst-mode reception and dynamic bandwidth allocation (DBA) per G.988.

5 Part Five (5): Appendices

A: Sample Marking Diagram

B: Keyboard for Mobile Terminal Communication Equipment

Tactile Keypad
Less user-friendly for composing sms

Qwerty Keypad
More user-friendly for composing sms

C: Normative Reference

a. **Electronic Communications Act, 2008 (Act 775)** - An Act that provides for the regulation of electronic communications, the regulation of broadcasting resources, the use of electronic-magnetic spectrum, and for related matters.

b. **IEC 62368-1** – Safety of Information Technology Equipment
c. **EN 55022:2010** – Information Technology Equipment – Radio disturbance characteristics
d. **ICNIRP Guidelines (2020**) – Limits of exposure to time-varying electric, magnetic, and electromagnetic fields
e. **ITU-T E.161 (2001)** – Arrangement of digits, letters, and symbols on telephones
f. **ETSI 151 010-1[5]** - Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification. Part 1: Conformance specification (3GPP TS 51.010-1 version 5.5.0 Release 5)
g. **3GPP TS 23.003** - Numbering, addressing and identification
h. **IEC 60529** – Degree of Protection provided by Enclosures (IP Code)
i. **ISO 4892-2** - Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps
j. **IEC 60068-2-52** - Environmental Testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)
k. **IEC 60068-2-2** - Environmental Testing – Part 2-2: Tests – Test B: Dry heat
l. **IEC 60068-2-30** - Environmental Testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)
m. **IEC 60068-2-38** - Environmental Testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test
n. **IEC 60068-2-27 -** Environmental Testing – Part 2-27: Tests – Test Ea and guidance: Shock
o. **IEC 60068-2-68** - Environmental Testing - Part 2-68: Tests - Test L: Dust and sand
p. **IEC 60068-2-18 -** Environmental Testing – Part 2-18: Tests – Test R and guidance: Water
q. **IEC 62368-1 -** Audio/video, information and communication technology equipment - Part 1: Safety requirements
r. **GS IEC 60884-2-5** - Plugs And Socket-Outlets For Household And Similar Purposes – Part 2-5: Particular requirements for adaptors
s. **Ghana Energy Commission Electrical Wiring Cables and Electrical Wiring Accessories Regulations, 2023 (L.I. 2478)** - a legislative instrument (L.I.) that outlines regulations for the installation and use of electrical wiring cables and accessories in Ghana
t. **ITU-T K.45 -** Series K: Protection Against Interference - Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents
u. **IEC 61000-4-5 -** Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
v. **ISO 7637-2 -** Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only
w. **EN 55022** - Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
x. **IEEE 802.3af** - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access

Method and Physical Layer Specifications - Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI)

y. **IEEE 802.3at -** Local and metropolitan area networks-- Specific requirements-- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements
z. **IEEE 802.3 -** IEEE Standard for Ethernet
aa. **IEC 61960** - specifies performance tests, designations, markings, dimensions and other requirements for secondary lithium single cells and batteries for portable applications.
bb. **IEC 62133** - sets out requirements and tests for the safety and performance of lithium-ion batteries used in portable electronic devices, including cell phones, laptops, tablets, and other devices
cc. **IEC/IEEE 62209-1528:2020** - Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
dd. **EN IEC/IEEE 62209-1528:2021** - Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
ee. **ETSI EN 301 908-1** - IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 1: Introduction and common requirements; Release 15
ff. **3GPP TS 23.401/23.501** - General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access
gg. **ETSI EN 300 220** - Technical requirements for Short Range Devices (SRD) operating in the frequency range of 25 MHz to 1000 MHz
hh. **IEEE 802.15.4** - defines the physical layer (PHY) and media access control (MAC) for low-rate wireless personal area networks (LR-WPANs)
ii. **ETSI EN 300 328** - specifies the requirements for wideband data transmission systems operating in the 2.4 GHz ISM band, such as those used by Bluetooth, Wi-Fi (2.4 GHz), and Zigbee
jj. **ITU-T Recommendation G.70** - Series G: Transmission Systems and Media, Digital Systems and Networks - Supplement on sub 1 Gbit/s services transport over optical transport network
kk. **ETSI EG 202 057** - Speech Processing, Transmission and Quality Aspects (STQ); User-related QoS parameter definitions and measurements
ll. **ITU-T G.168** - International telephone connections and circuits – Apparatus associated with long-distance telephone circuits - Digital network echo cancellers
mm. **ITU-T I.430** - Basic User-Network Interface – Layer 1 Specification
nn. **ITU I.431** - Primary Rate User-Network Interface – Layer 1 Specification
oo. **ITU-T G.711** - Pulse Code Modulation (Pcm) Of Voice Frequencies
pp. **G.726** - 40, 32, 24, 16 Kbit/S Adaptive Differential Pulse Code Modulation (ADPCM)
qq. **ITU-T G.992.1/2 (ADSL)** - Asymmetric digital subscriber line (ADSL) transceivers

rr. **G.992.3/4 (ADSL2/2+)** - Asymmetric digital subscriber line transceivers 2 (ADSL2)

ss. **G.993.2 (VDSL2)** - Very high speed digital subscriber line transceivers 2 (VDSL2)

tt. **ITU-T G.9701** - Fast access to subscriber terminals (G.fast) - Physical layer specification

uu. **ITU-T G.984** - Gigabit Passive Optical Networks

vv. **G.987** - 10-Gigabit-capable passive optical network (XG-PON) systems: Definitions, abbreviations, and acronyms

ww. **G.984.3** - Gigabit-capable passive optical networks (G-PON): Transmission convergence layer specification

xx. **IEC 60825-1** - Safety of laser products - Part 1: Equipment classification and requirements

yy. **G.988** - ONU management and control interface (OMCI) specification

zz. **3GPP TS 27.007** - AT command set for User Equipment (UE)

aaa. ITU-T T.30 - Procedures for document facsimile transmission in the general switched telephone network

bbb. **ETSI EN 301 511** - Global system for mobile communications (GSM); Harmonised standard for mobile stations in the GSM 900 and GSM 1800 bands covering essential requirements under Article 3(2) of the R&TTE directive

ccc. **R&TTE Directive (1999/5/EC)** - Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

ddd. **ETSI EN 301 908-02** - Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive

eee. **ETSI EN 301 908-13** - IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)

fff. **ITU-R M.1457-9** - Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)

ggg. **EN 50360** - Product standard to demonstrate the compliance of wireless communication devices, with the basic restrictions and exposure limit values related to human exposure to electromagnetic fields in the frequency range from 300 MHz to 6 GHz: devices used next to the ear

hhh. **EN 50361** - Basic standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile phones (300 MHz — 3GHz)

iii. **1999/519/EC** - Harmonised standards covering protection from electromagnetic fields (0 Hz to 300 GHz) generated by apparatus included in the scope of either the Low Voltage Directive 73/23/EEC1, (LVD) or the Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive 1999/5/EC

jjj. **ES 59005** - Considerations For Evaluation Of Human Exposure To Electromagnetic Fields (Emfs) From Mobile Telecommunication Equipment (Mte) In The Frequency Range 30 Mhz - 6 Ghz

kkk. **CISPR32** - Multimedia Equipment Emissions requirements

lll. **EN55032** - EMC Testing of Multimedia Equipment (MME)

mmm. **EN50082-1** - Electromagnetic compatibility - Generic immunity standard - Part 1 : Residential, commercial and light industry

nnn. **EN6100-3-2/3** - Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤16 A per phase)

ooo. **ETSI 151 010-1[5]** - Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification (3GPP TS 51.010-1 version 5.5.0 Release 5)

D: CMTECE Conformance Testing / Verification Checklist

This Checklist is intended for facilitating Supplier's Declaration of Conformity to the requirements defined in the NCA Technical Specification for Terminal Communication Equipment (Doc number -----)

Please note:

"CR" indicates that the general or technical requirement set out in a particular section or sub-section the Technical Specification is a Compliance Requirement.

"M" means that it shall be Mandatory for the TCE to comply with the requirement set out in this Technical Specification cited in this Checklist (Table given below) where applicable.

"C" means that compliance with the technical requirement set out in this Technical Specification cited in this Checklist is Conditional. In this case, the need to comply is contingent on the type of TCE, RIT and application indicated in the remarks column.

"V" means that compliance with the requirement is Voluntary.

"NA" means that the requirement is Not Applicable.

D1 Requirements for CMTECE

SN	Parameter	Reference standard	CR	Remarks
1	IMT-Advanced / LTE-Advanced / LTE-Advanced Pro / IMT-2020 RITs		M	State the type of TCE

2	International Mobile Station Equipment Identity (IMEI); or Permanent Equipment Identity (PEI) in the IMEI format or international Mobile Station Equipment Identity and Software Version number (IMEISV) format		M	See 3GPP TS 23.003 for more information on PEI
3	Keypad	ITU-T E.161	C	
4	RF EMF safety (SAR; power density) requirements	See section 4.3 for standards	M	
5	EMC		M	
6	EMC assessment		M	
7	Radiated emissions	IEC CISPR 32 / ETSI EN 301 489-1 (to be used with ETSI EN 301 489-52)	C	Applicable to ancillary equipment not incorporated in the radio equipment
8	Conducted emission: DC power port		C	Applicable to CMTCE for vehicular use (regardless of DC cable length)
9	Conducted emission: AC mains power port		C	Applicable to CMTCE with dedicated charger/power adapter
10	RF electromagnetic field (80 MHz to 6 GHz)	IEC CISPR 35 / ETSI EN 301 489-1 (to be used with ETSI EN 301 489-52)	V	
11	Electrostatic discharge		V	
12	Fast transients common mode		V	Applicable to CMTCE with dedicated charger/power, and DC power port with cable longer than 3 m
13	RF common mode 0.15 MHz to 80 MHz		V	
14	Transients and surges, vehicular environment		V	Applicable to CMTCE intended for mobile use in vehicles; refer to ISO 7637-2 for conducted
				electrical transients of equipment installed on vehicles
15	Voltage dips and interruptions		V	Applicable to CMTCE with dedicated charger/power adapter
16	Surges		V	
17	Equipment safety testing	IEC 62368-1 (min. Ed. no. 2)	M	Lithium batteries to comply with UL 1642 or IEC 62133

D2 Conformance requirements for all CMTCE

SN	Parameter	Reference standard	CR	Remarks
1	Operating frequencies	As specified by IMDA	M	
2	Radio interface requirements	ETSI EN 301 908-13 / FCC Part 22 / FCC Part 90S	M	
	Radiated emissions	ETSI EN 301 908-1	M	
	Control and monitoring functions		M	
3	Other wireless modes such as WLAN, Bluetooth, etc.	IMDA TS SRD	C	If applicable, the CMTCE shall also be tested to the relevant requirements given in IMDA TS SRD.

D3 Conformance requirements for 4G CMTECE

SN	Parameter	Reference standard	CR
1	Transmitter spectrum emissions mask	ETSI EN 301 908-13	M
	Transmitter adjacent channel leakage power ratio		M
	Transmitter spurious emissions		M
	Transmitter maximum output power		M
	Transmitter minimum output power		M
	Receiver spurious emissions		M
	Receiver blocking characteristics		M
	Receiver spurious response		M
	Receiver intermodulation characteristics		M
	Receiver Adjacent Channel Selectivity (ACS)		M
	Receiver reference sensitivity level		M

D4 Conformance requirements for 5G FR1 CMTECE

SN	Parameter	Reference standard	CR	Remarks
1	**Transmitter**			
	UE maximum output power	ETSI EN 301 908-25 / ETSI TS 138 521-1	M	In addition to the common requirements in ETSI EN 301 908-1, the CMTCE shall be tested to the additional requirements for the NR technology, which includes CA, UL MIMO and SUL where applicable.
	Minimum output power		M	
	Out of band emission		M	
	Spurious emissions		M	
	Receiver			
	Reference sensitivity		M	
	Adjacent channel selectivity		M	
	Blocking characteristics		M	
	Spurious response		M	
	Intermodulation characteristics		M	
	Spurious emissions		M	
	RedCap parameters			
	UE maximum output power	ETSI TS 138 521-1	C	Applicable for CMTCE with Redcap
	Reference sensitivity		C	

D5 Conformance requirements for 5G FR2 CMTECE

SN	Parameter	Reference standard	CR	Remarks
1	**Transmitter**			
	UE Maximum Output Power	ETSI EN 301 908-25 / ETSI TS 138 521-2	M	In addition to the common requirements in ETSI EN 301 908- 1, the CMTCE shall be tested to the additional requirements for the NR technology, which
	Minimum output power		M	
	Out of band emission		M	
	Spurious emissions		M	
	Receiver			

	Reference sensitivity		M	includes CA, UL MIMO and SUL where applicable.
	Adjacent channel selectivity		M	
	Blocking characteristics		M	
	Spurious response		M	
	Spurious emission		M	

D6 Conformance requirements for CMTECE with 5G FR1 and FR2 interworking operation with other radios

SN	Parameter	Reference standard	CR	Remarks
1	**Transmitter**			
	UE maximum output power	ETSI EN 301 908-25	M	In addition to the common requirements in ETSI EN 301 908- 1, the CMTCE shall be tested to the additional requirements for the NR technology, which includes CA and EN-DC where applicable.
	Minimum Output Power		M	
	Out-of-band emissions		M	
	Spurious emissions		M	
	Receiver			
	Reference sensitivity		M	
	Adjacent channel selectivity		M	
	Blocking characteristics		M	
	Spurious response		M	
	Spurious emission		M	

D7 Conformance requirements for CMTECE that operates on band 26

SN	Parameter	Reference Standard	CR
1	Operating frequencies	As specified by NCA	M
2	Radio interface requirements	FCC Part 22 / FCC Part 90S / IEEE ANSI C63.26-2015	M
			M

D8 Conformance VoLTE requirements

S/N	Section number in 3GPP TS 34.229-1	Description	CR
		Registration	
1	8.1	Initial registration	M
2	8.2	User initiated re-registration	M
3	8.4	Invalid behaviour - 423 Interval	M
4	8.16	User initiated re-registration – 423 Interval	M
		Authentication	
5	9.1	Invalid Behaviour – MAC Parameter Invalid	M
6	9.2	Invalid Behaviour – SQN out of range	M
		Subscription	
7	10.1	Invalid Behaviour – 503 Service Unavailable	M
		Notification	
8	11.1	Network initiated deregistration	M
9	11.2	Network initiated re-authentication	M
		Call Control	
10	12.2	MO Call with preconditions at both originating UE and terminating UE – 503 Service Unavailable	M
11	12.2a	MO Call with preconditions at both originating UE and terminating UE – 504 Server Time-out	M
12	12.12	MO MTSI Voice Call Successful with preconditions at both originating UE and terminating UE	M
13	12.13	MT MTSI speech call with preconditions at both originating UE and terminating UE	M
		Codec selecting	
14	16.2	Speech AMR, indicative selective codec modes	M
15	16.3	Speech AMR-WB, indicate all codec modes	M
16	16.4	Speech AMR-WB, indicate selective codec modes	M
		Emergency Service over IMS	

17	19.1.2	Emergency call with emergency registration/Success/Location information not available	M
18	19.4.2	Emergency call without emergency registration / EPS / UE contains an ISIM or USIM / UE is in state EMM-REGISTERED.LIMITED-SERVICE	M
19	19.4.5	Emergency call without emergency registration / UE credentials are not accepted	M
20	19.5.1	New initial emergency registration / UE obtains from the serving IP-CAN an IP address different than the IP address used for the emergency registration	M