

Total Access Communication System (T.A.C.S) —

Part 1: Specification for performance requirements for mobile stations

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- British Broadcasting Corporation
- British Radio and Electronic Equipment Manufacturers Association
- British Telecom
- Department of Trade and Industry — Radiocommunications Division
- Institution of Electronic and Radio Engineers
- Radio Electrical and Television Retailers Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- British Approvals Board for Telecommunications
- ERA Technology Ltd.
- Electronic Engineering Association
- GAMBICA (BEAMA Ltd.)
- OFTEL (Office of Telecommunications)
- Radio Society of Great Britain
- Telecommunication Engineering and Manufacturing Association
- User Standards Forum for Information Technology — Institute of Data processing Management

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Foreword

This Part 1 of BS 6940 has been prepared under the direction of the Electronic Equipment Standards Policy Committee. This standard specifies the performance requirements for mobile stations operating with land stations within the Total Access Communication System (T.A.C.S.) and also gives requirements both for information to be provided with the system and labelling. This ensures that the mobile station is compatible with the United Kingdom Total Access Communication System Mobile Station — Land Station Compatibility Specification Issue 3, as amended by amendment No. 3 and with the British Approvals Board for Telecommunications (BABT) specification for the Type Approval of Terminal Equipment for use in the T.A.C.S., reference BABT/SITS/84/13/A, Issue 1, as amended by amendment No. 8.

T.A.C.S. is designed to provide mobile telephone users with high quality communication anywhere within its service area.

The system provides for vehicular mobile stations, transportable stations and hand portable stations at different power levels up to a maximum of 10 W. Calls can be made to and from existing telephone services whether fixed, mobile, national or international.

T.A.C.S. provides communication by reusing closely spaced duplex channels in a network of contiguous radio “cells” occupying a total bandwidth of 50 MHz in the 900 MHz region. It has a design capacity for 1 000 channels, nationwide.

Each “cell” has a base station (i.e. land station) operating on a dedicated set of radio channels which are different from those of adjacent cells. Each base station provides two different types of radio channels, control channels for the transmission of digital data control information using frequency shift keying and voice channels providing telephone quality speech using frequency modulation. The base station is connected to a Mobile Switching Centre (M.S.C.), which in turn is connected to the Public Switched Telephone Network (PSTN).

Each MS, similarly, uses a control channel for establishing communication with the appropriate land station (LS) and a voice channel for conversation, referred to as the Reverse Control Channel (RECC) and Reverse Voice Channel (REVC) respectively.

The MS digital signalling system directs the equipment into specific tasks to meet the requirements of the land station which includes the transfer from one cell to the next as the MS moves its location.

This specification is one of a two-Part British Standard for T.A.C.S. The other Part is:

— *Part 2: Specification for performance and tests of the signalling system of mobile stations.*

Attention is drawn to the fact that products conforming to this British Standard must be certified by the British Approvals Board for Telecommunications under Section 22 (2) of the Telecommunications Act 1984. This standard is the type approval specification covering the minimum performance requirements that BABT will apply in satisfying the Secretary of State.

Attention is also drawn to the need to comply with the Department of Trade and Industry Performance Specification MPT 1324: “*Angle modulated equipment for use at base and mobile stations in the public radiophone service operating in the 900 MHz frequency band*” and the relevant UK Health and Safety legislation.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 64, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This Part of BS 6940 specifies the performance requirements for Mobile Stations for use in the Total Access Communications System (T.A.C.S.) operating over the radio frequency bands 890 MHz to 905/915 MHz (mobile station transmit band) and 935 MHz to 950/960 MHz (mobile station receive band) with a nominal separation between adjacent carrier frequencies of 25 kHz. It also gives requirements both for information to be provided with the system and labelling.

NOTE 1 Appendix H provides cross references between the clauses of this standard and those of BAPT/SITS/84/13/A, Issue 1, to Amendment No. 8.

NOTE 2 References in *square* brackets relate to BS 6940-2:1989.

NOTE 3 This Part refers only to r.f. and acoustic tests. It should be noted that the specification is not complete without reference to the appropriate text of the Part 2 of this standard.

NOTE 4 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Terminology

For the purposes of this Part of BS 6940 the following definitions, terms and abbreviations apply. Definitions of specific characteristics are defined in the relevant clauses.

NOTE Abbreviations that are not defined in this section are defined at their first occurrence in the text of the specification.

2.1 General terms and definitions

2.1.1 Transmitter

2.1.1.1

carrier power

the mean power delivered at the transmitter output terminals during a radio frequency cycle when connected to a specified load without external modulation

2.1.1.2

effective radiated power (ERP)

the power supplied to the antenna multiplied by the gain relative to a half wave dipole, in a given direction

2.1.1.3

maximum permissible frequency (or phase) deviation

the value to which the peak frequency (or phase) deviation is to be limited

2.1.2 Receiver

2.1.2.1

standard signal-to-noise ratio

ratio of:

the power of the signal-plus-noise-plus-distortion

to

the power of the noise-plus-distortion

at the test load expressed in decibels

the ratio is abbreviated as: $\frac{S+N+D}{N+D}$ and is referred to as

SINAD

where

S is the wanted audio frequency signal due to standard test modulation

N is the noise with standard test modulation

D is the distortion with standard test modulation

NOTE For the purpose of this Part of BS 6940 the value of the standard signal-to-noise ratio is 20 dB (psophometrically weighted).

2.2 T.A.C.S. specific terms and definitions

2.2.1

access channel

a control channel used by a mobile station to access a system to obtain service

2.2.2

analogue colour code

an analogue signal (see **2.2.35**) transmitted by a land station on a voice channel which is used to detect capture of a mobile station by an interfering land station and/or the capture of a land station by an interfering mobile station

2.2.3

area identification (AID)

a digital identification associated with a traffic area; each area is assigned a unique number

NOTE Bits 14-10 identify the country and system and bits 9-1 identify the national traffic area. Bit 0 indicates the serving system status. The value zero is not a valid traffic area, and is reserved for initialization.

2.2.4

busy-idle bits

the portion of the data stream transmitted by a land station on a forward control channel that is used to indicate the current busy-idle status of the corresponding reverse control channel

2.2.5

control channel

a channel used for the transmission of digital control information from a land station to a mobile station or from a mobile station to a land station

2.2.6

digital colour code (DCC)

a digital signal transmitted by a land station on a forward control channel that is used to detect capture of a land station by an interfering mobile station

2.2.7

directed retry

a message sent by the land station following a system access by a mobile station which gives the mobile station a list of alternative control channels on which to repeat the access

2.2.8

flash request

a message sent on a voice channel from a mobile station to a land station indicating that a user desires to invoke additional facilities

2.2.9

forward control channel (FOCC)

a control channel used from a land station to a mobile station

2.2.10

forward voice channel (FOVC)

a voice channel used from a land station to a mobile station

2.2.11

group identification

a subset (bits 2, 1 and 0) of the traffic area identification (AID) that is used to identify a group of traffic areas

2.2.12

handoff

the act of transferring a mobile station from one voice channel to another

2.2.13

hand portable station

a mobile station which is hand carried or worn on the person and where the antenna may be physically attached to the part of the equipment containing the handset. This type of mobile station is designated class 3 or 4 (see Table 1)

2.2.14

home mobile station

a mobile station which operates in the cellular system from which service is subscribed

2.2.15**land station (LS)**

a fixed station in the T.A.C.S. used for radio communications with mobile stations

2.2.16**local control**

a set of messages for local feature activation which can be sent by the system and acted upon by mobile stations in service on that system if their group identification matches the system AID

2.2.17**mobile attenuation code (MAC)**

code for the selection of mobile station power levels (see Table 2)

2.2.18**mobile identification number (MIN)**

the 34-bit number which is a digital representation of the 10-digit International Mobile Station identity (IMSI) assigned to a mobile station

2.2.19**mobile station (MS)**

a station in the United Kingdom T.A.C.S. intended to be used while in motion or during halts at unspecified points and including vehicular mobile stations, transportable stations and hand portable stations

2.2.20**mobile station classes**

mobile station classes are identified as:

- Class 1. very high power mobile station
- Class 2. high power mobile station
- Class 3. mid-range power hand portable station
- Class 4. low power hand portable station

2.2.21**numeric indicators**

indicator groups used to describe the operation of the mobile station (see 2.3)

2.2.22**orders**

control information passed between the land station and mobile station (see 2.4)

2.2.23**origination**

the steps by which a mobile station indicates to a land station that the user requires to make a call

2.2.24**paging**

the act of seeking a mobile station when an incoming call has been placed to it

2.2.25**paging channel**

a forward control channel used to page mobile stations and send orders

2.2.26**registration**

the steps by which a mobile station identifies itself to a land station as being active in the system at the time the message is sent to the land station

2.2.27**release request**

a message sent from a mobile station to a land station indicating that the user desires to disconnect the call

2.2.28

reverse control channel (RECC)

the control channel used from a mobile station to a land station

2.2.29

reverse voice channel (REVC)

the voice channel used from a mobile station to a land station

2.2.30

inter-system roamer

a mobile station which operates in a cellular system other than the one from which service is subscribed

2.2.31

area roamer

a mobile station roaming from out of its home traffic area, but within the same system

2.2.32

scan of channels

the procedure by which a mobile station examines the signal strength of each forward control channel

2.2.33

seizure precursor

the initial digital sequence transmitted by a mobile station to a land station on a reverse control channel

2.2.34

signalling tone

an 8 kHz tone transmitted by a mobile station on a voice channel to:

- a) confirm orders,
- b) signal flash requests, and
- c) signal release requests.

2.2.35

supervisory audio tone (SAT)

one of three tones in the 6 kHz region that are transmitted by a land station and transponded by a mobile station

2.2.36

system A

the network operated by Racal-Vodafone Limited in the UK

2.2.37

system B

the network operated by Telecom Securicor Cellular Radio Limited in the UK

2.2.38

transportable station

a mobile station which may be hand carried and where the antenna is not physically attached to the part of the equipment containing the handset. This type of mobile station is designated as class 2 or 3 (see Table 1)

2.2.39

vehicular mobile station

a mobile station which is mounted in a vehicle and in which the antenna is physically mounted to the outside of the vehicle. This type of mobile station is designated as class 1 or 2 (see Table 1)

2.2.40

voice channel

a channel primarily used for voice but on which brief digital messages may be sent from a land station to a mobile station or from a mobile station to a land station

2.3 T.A.C.S. specific numeric indicators

2.3.1

numeric indicator subscripts

the following subscripts are used to clarify the use of the indicators given in 2.3.2 to 2.3.37;

- “s” to indicate a value stored in a mobile station’s temporary memory;
- “sv” to indicate a stored value that varies as a mobile station processes various tasks;
- “sl” to indicate the stored limits on values that vary;
- “r” to indicate a value received by a mobile station over a forward control channel;
- “p” to indicate a value set in a mobile station’s permanent security and identification memory; and
- “sp” to indicate a value stored in a mobile station’s semi-permanent security and identification memory.

2.3.2

ACCOLC_p

a number used to identify which overload class field controls access attempts

2.3.3

AID_p

the home traffic area identification stored in the mobile station’s permanent security and identification memory

2.3.4

AID_{sp}

one of a number of traffic area identifications stored in the mobile station’s semi-permanent security and identification memory

2.3.5

AID_r

the traffic area identification received on a forward control channel

2.3.6

AID_s

the traffic area identification

2.3.7

AIDL_s

the traffic area identification corresponding to the AID of the last traffic area in which the mobile station is registered

2.3.8

BIS_s

identifies whether a mobile station needs to check for an idle-to-busy transition on a reverse control channel when accessing a system

2.3.9

CCLIST_s

the list of control channels to be scanned by a mobile station processing the Directed-Retry Task

2.3.10

CMA_X_s

the maximum number of channels to be scanned by a mobile station when accessing a system

2.3.11

CPA_s

identifies whether the access functions are combined with the paging functions on the same set of control channels

2.3.12

DTX_s

identifies whether the mobile station is permitted to use the discontinuous transmission mode on the voice channel

2.3.13 **E_s**

identifies whether a home mobile station needs to send only $MIN\ 1_p$ or both $MIN\ 1_p$ and $MIN\ 2_p$ when accessing the system

2.3.14 **EX_p**

identifies whether a home mobile station needs to send $MIN\ 1_p$ or both $MIN\ 1_p$ and $MIN\ 2_p$ when accessing the system

NOTE EX_p differs from E_s in that the information is stored in the mobile station's security and identification memory

2.3.15 **$FIRSTCHA_s$**

the number of the first control channel used for accessing a system

2.3.16 **$FIRSTCHP_s$**

the number of the first control channel used for paging mobile stations

2.3.17 **$FREG_s$**

identifies whether a mobile station is required to register whenever it detects a change of AID_r

2.3.18 **$LASTCHA_s$**

the number of the last control channel used for accessing a system

2.3.19 **$LASTCHP_s$**

the number of the last control channel used for paging mobile stations

2.3.20 **LT_s**

identifies whether the next access attempt is required to be the last try

2.3.21 **$MIN1_p$**

the number derived from the Mobile Network Code (MNC) and the Mobile Station Identification Number (MSIN)

2.3.22 **$MIN2_p$**

the number derived from the Mobile Country Code (MCC) assigned to the system

2.3.23 **$MAXBUSY_{sl}$**

the maximum number of busy occurrences allowed on a reverse control channel

2.3.24 **$MAXSZTR_{sl}$**

the maximum number of seizure attempts allowed on a reverse control channel

2.3.25 **N_s**

the number of paging channels that a mobile station needs to scan

2.3.26 **$NBUSY_{sv}$**

the number of times a mobile station attempts to seize a reverse control channel and finds the reverse control channel busy

2.3.27 **$NSZTR_{sv}$**

the number of times a mobile station attempts to seize a reverse control channel and fails

2.3.28**NXTREG_{sp}**

identifies when a mobile station needs to make its next registration to a system

2.3.29**PL_s**

the mobile station r.f. power level

2.3.30**R_s**

indicates whether registration is enabled or not while the mobile station is served by its preferred system in its home country. Also indicates whether registration and originations are enabled or not while the mobile station is roaming

2.3.31**RCF_s**

identifies whether the mobile station needs to read a control-filler message before accessing a system on a reverse control channel

2.3.32**REGID_r**

the registration number received on the forward control channel

2.3.33**REGID_s**

the value of the last registration number

2.3.34**REGINCR_s**

identifies increments between registrations by a mobile station

2.3.35**S_s**

identifies whether the mobile station needs to send its serial number when accessing a system

2.3.36**SCC_s**

a digital number which is stored and used to identify which SAT frequency a mobile station should be receiving

2.3.37**WFOM_s**

identifies whether a mobile station needs to wait for an overhead message train before accessing a system on a reverse control channel

2.4 T.A.C.S. orders**2.4.1****alert**

informs the mobile station that a call is being received

2.4.2**audit**

used by a land station to determine whether the mobile station is active in the system

2.4.3**call queued**

informs the mobile station that the originated call has been placed on a queue until such time as a voice channel becomes available

2.4.4**charge rate**

used as necessary by mobile stations to determine the charge rate for the call in progress

2.4.5

change power

used by a land station to change the radio frequency power level of a mobile station

2.4.6

intercept

used to inform the mobile station of a procedural error made in placing the call

2.4.7

maintenance

used by a land station to check the operation of a mobile station. All functions are similar to alert but the alerting device is not activated

2.4.8

release

used to disconnect a call that is being established or is already established

2.4.9

reorder

used by a land station to inform a mobile station that all facilities are in use and the call should be placed again

2.4.10

send called-address

used to inform a mobile station that it needs to send a message to the land station with dialled-digit information

2.4.11

stop alert

used to inform a mobile station that it needs to discontinue alerting the user

2.5 Status information on mobile station operation

2.5.1

serving-system status

indicates whether a mobile station is tuned to channels associated with system A or system B

2.5.2

first registration identification status

indicates whether a mobile station has received a registration identification message since initialization

2.5.3

local control status

indicates whether a mobile station needs to respond to local control messages or not

2.5.4

roam status

indicates whether a mobile station is in its home system or not

2.5.5

termination status

indicates whether a mobile station needs to terminate the call when it is on a voice channel

2.5.6

re-registration status

the status is enabled if the mobile station needs to attempt to register after a random time, following a registration failure

2.5.7

forced registration status

the status is enabled when the mobile station accesses the system with a registration indication as the result of a change of area identification

2.5.8**overload distribution status**

the status is enabled by the mobile station when a registration overload is possible. A registration overload may occur when registration is first enabled by the serving system or when one system has failed and mobile stations transfer on to the secondary serving system

2.5.9**overload timer status**

the status is enabled whenever an overload timer has been set by the mobile station. The overload timer distributes registration accesses during times of heavy loading

2.5.10**non-preferred system timer status**

indicates whether the non-preferred system timer has been set by the mobile station. The timer ensures that a mobile station in the idle task does not stay on the non-preferred system for a period in excess of 10 min

2.5.11**non-preferred system overload timer status**

indicates whether the non-preferred system overload timer has been set by the mobile station. This timer ensures that a mobile station in the idle task does not stay on the non-preferred system for a period in excess of 1 min if service is barred by the system

2.6 Frequently used abbreviations**2.6.1 T.A.C.S**

Total Access Communication System.

2.6.2 BSS

Base Station Simulator (see Appendix D).

2.6.3 MS

Mobile Station(s).

2.6.4 LS

Land Station.

2.6.5 BCH code

Bose-Chaudhuri-Hocquenghem code.

3 Instructions for use**3.1 General**

The manufacturer shall provide with each equipment all information necessary to operate the mobile station in accordance with its specification and without exceeding general safety limits, it shall include explanation of the function of controls and any necessary installation instructions (see **3.2**).

3.2 Installation instructions

The wide range of vehicles likely to be involved makes it impracticable to specify installation requirements, but manufacturers shall include the following in their installation instructions for vehicle mounted mobile stations.

- a) That the radio equipment is connected to the antenna via a non-radiating cable (e.g. co-axial).
- b) That the antenna is mounted in a position such that no part of the human body will normally rest within 20 cm of any part of the antenna for more than a few minutes whilst the equipment is switched on, unless there is an intervening metallic screen (e.g. metallic roof) of at least 0.3 m² in area.

Compliance with this clause shall be checked during inspection.

3.3 User handbook

A user handbook shall be provided for all MS and shall include the following statements.

“Users are advised to turn off the equipment when at a refuelling point”.

“This apparatus is approved for connection to the cellular radio networks operated by Racal-Vodafone Limited and Telecom Securicor Cellular Radio Limited. The facilities offered by the apparatus are identical on any network in so far as a network is able to support any particular facility”.

Where provision is made for the connection of any class of mobile station to power supply units or battery chargers using voltages in excess of 50 V r.m.s. a.c. or 75 V d.c. the Users Handbook shall specify the power supply unit(s) or battery charger(s) approved for use with the mobile station and shall include the following statement.

“This apparatus is intended for use when supplied with power from . . . (identification of battery charger(s) and/or power supply unit(s). The use of any other mains-operated power supply or battery charger will invalidate any approval given, for reasons of safety”.

Where a change of network cannot be effected by the user of the apparatus and/or instructions for doing so are not included in the user handbook, the following additional sentence shall be included.

“Service providers are able to make the necessary adjustment to enable operation on the network or networks whose service they provide”.

In user handbooks for class 2, class 3 and class 4 transportable and handportable stations the following shall be included in addition.

“Switch off your cellular telephone when in an aircraft; the use of cellular telephones in an aircraft may be dangerous to the operation of the aircraft, disrupt the cellular network and is illegal. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both”.

In user handbooks for class 1 MS the following shall be included in addition.

“As with other mobile radio transmitting equipment, users are advised that, for satisfactory operation of the equipment and for the safety of personnel, it is recommended that no part of the human body shall be allowed to come within 20 cm of the antenna for more than a few minutes during operation of the equipment”.

Compliance with this clause shall be checked during inspection.

4 Additional requirements for type approval tests

4.1 The manufacturer shall provide the following information:

- a) the crystal frequency and method of carrier frequency generation;
- b) the class of station and rated radio frequency output power;
- c) the values to which the following equipment parameters are set:
 AID_p , $FIRSTCHP_p$, MIN_p , SCM_p , $ACCOLC_p$, preferred system (A or B), serial number of the equipment;
- d) operating information including keyboard codes and the means of control of the technical facilities described in 6.5;
- e) the angle of rotation of the artificial ear, if required, for the tests specified in section 4 (see also Appendix G);
- f) the relationship between the frequency of any high level transmitter spurious signals and transmitter carrier frequency;
NOTE High level transmitter spurious signals are those between the levels of – 9 dBm and – 24 dBm, within the MS transmit band (see 7.7).
- g) operational radio frequency band and number of channels available.

4.2 The manufacturer shall also confirm that the equipment is supplied with the following parameters set:

- a) EX_p is set to zero;
- b) $FIRSTCHP_p$ is set to a value which defines a set of a minimum of 21 channels which lie outside the dedicated control channel sets for system A and system B.
- c) The Inter-System Roaming inhibit option [A.2.4] is disabled.

Compliance with the requirements of this clause shall be checked during inspection.

4.3 Where provision is made for the connection of any class of mobile station to power supply units or battery chargers using voltages in excess of 50 V r.m.s. a.c. or 75 V d.c., the manufacturer shall include this information in his submission for type approval and in the User Handbook as indicated in **3.3**. He shall also supply the appropriate power supply units and/or battery chargers with the mobile station for test. These units may themselves be subjected to separate safety testing, details of which may be obtained from BABT.

5 Labelling

The equipment shall be supplied with labels attached to indicate:

- a) the type number;
- b) the station class number (see **7.1.5** and Table 1);
- c) the power supply voltage;
- d) the description under which equipment was submitted for type approval test.

Compliance with the requirements of this clause shall be checked during inspection.

Section 2. Conditions of measurement

6 Standard test conditions

6.1 Normal test conditions

6.1.1 General. All tests shall be carried out under normal test conditions unless otherwise stated in the method of measurement.

6.1.2 Normal temperature and humidity. The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

temperature: + 15 °C to + 35 °C

relative humidity: 20 % to 75 %

NOTE When it is impracticable to carry out the tests under the preceding conditions, a note to this effect, stating the actual temperature and humidity during the tests, should be added to the test report.

6.1.3 Normal test power source

6.1.3.1 Mains voltage. The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purposes of this standard, the nominal test voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed. The frequency of the test power source corresponding to the alternating current mains shall be between 49 Hz and 51 Hz.

6.1.3.2 Regulated lead-acid battery power sources on vehicles. When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source of vehicles, the normal test voltage shall be 1.1 times the nominal voltage of the battery (6 V, 12 V, etc.).

6.1.3.3 Nickel-cadmium battery. When the equipment is intended for operation from the usual type of nickel-cadmium battery, the normal test voltage shall be the nominal voltage of the battery (1.2 V per cell).

6.1.3.4 Other power sources. For operation from other power sources or types of battery (primary or secondary), the nominal test voltage shall be that declared by the equipment manufacturer.

6.2 Extreme test conditions

6.2.1 Extreme temperature. For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in 6.2.2, at the upper value of + 55 °C and lower value of – 10 °C.

6.2.2 Extreme test power source values

6.2.2.1 Mains voltage. The extreme test voltage for equipment to be connected to an a.c. mains source shall be the nominal mains voltage $\pm 10\%$. The frequency of the test power source shall be between 49 Hz and 51 Hz.

6.2.2.2 Regulated lead acid battery power sources on vehicles. When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources of vehicles the extreme test voltages shall be 1.3 times and 0.9 times the nominal voltage of the battery (6 V, 12 V, etc.).

6.2.2.3 Nickel-cadmium battery. When the equipment is intended for operation from the usual type of nickel-cadmium battery, the extreme test voltages shall be 1.25 times and 0.9 times the nominal voltage of the battery.

6.2.2.4 Other power sources. The lower extreme test voltages for equipment with power sources using primary batteries shall be as follows:

- a) for the Leclanche type of battery:
0.85 times the nominal voltage of the battery;
- b) for the mercury type of battery:
0.9 times the nominal voltage of the battery;
- c) for other types of primary batteries:
end point declared by the equipment manufacturer.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be separately specified and recorded with the results.

6.2.3 Procedure for tests at extreme temperatures. Before measurements are made ensure that the equipment has reached thermal balance in the test chamber. Switch off the equipment during this temperature stabilizing period. If the thermal balance is not checked by measurements allow a temperature stabilizing period of at least 1 h, or such period as may be decided by the testing authority. Choose the sequence of measurements to ensure that the humidity content in the test chamber is so controlled that excessive condensation does not occur.

Before tests at the upper temperature place the equipment in the test chamber and leave until thermal balance is attained. Then switch on the equipment in the transmit condition for 1 min followed by 4 min in the receive condition after which the equipment shall comply with the specified requirements.

For tests at the lower temperature leave the equipment in the test chamber until thermal balance is attained, then switch it to the standby or receive condition for 1 min after which the equipment shall comply with the specified requirements.

6.3 Normal test modulation

For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be ± 5.7 kHz. The amplitude modulation on the test signal shall be less than 1 %.

6.4 Artificial antenna

Tests on the MS transmitter shall be carried out with a non-reactive non-radiating load of $50\ \Omega$ of suitable power rating which replaces the antenna, including any associated transmission lines.

NOTE This is not applicable to tests carried out on equipment incorporating integral antenna.

6.5 Control of equipment and interfaces

Control of the equipment under test shall be by means of both the standard T.A.C.S. signalling protocols, as specified in Part 2 of this standard and additional control functions, as specified below, which shall be provided by the manufacturer.

The standard T.A.C.S. signalling shall be used as specified in the standard to command the MS into a suitable state to allow tests to be carried out.

The additional control functions to be provided by the manufacturer shall be as follows, and are required in order to control the operation of the MS during the tests specified in sections 3 and 4:

- a) to switch the transmitter r.f. output carrier on and off at all of the power levels specified for the class of MS under test;
- b) to control the expander in the receiver voice processing stages;
- c) to set the frequency of operation to any channel within the specified T.A.C.S. frequency bands, taking account of the station class mark;
- d) to control the transmit and receive audio squelch and to disable the squelch during the receiver tests;
- e) to disable the supervisory audio tone, signalling tone and wideband data signals when the transmitter is required to transmit without modulation.

The equipment shall provide audio connection (typically by means of flying leads) to the receive audio path at the ear-piece. The connection points provided shall have a nominal impedance of $600\ \Omega$. In addition, equipment supplied with an integral antenna shall provide audio connection (typically by means of flying leads) to the transmit audio path at the microphone. The connection provided shall have a nominal impedance of $600\ \Omega$.

These connections shall be used when the measurements are made using the artificial ear and mouth and to enable certain tests to be conducted at extremes of temperature. Whatever means are provided to achieve the above conditions of test they shall not affect the normal standard of operation of the equipment or affect results of the tests.

6.6 Radio frequency output and input signal measuring arrangements for equipment with integral antenna

The test load shall be the antenna supplied by the manufacturer. For absolute measurements involving the use of radiated fields, a test site as described in Appendix A, equipped with radiation measurement instruments, shall be used.

For the testing of equipment with integral antenna the manufacturer shall provide to the Testing Authority a test fixture suitable to allow relative measurements to be made on the submitted sample as indicated in Appendix B.

NOTE For audio measurements where an equipment requires the use of an artificial head in which r.f. coupling losses are significant other coupling methods may be used; care should be taken that these do not influence the measurement results.

6.7 Radio frequency input signal level

The input signal level shall be expressed as the Closed Circuit Voltage (CCV) present at the output of the terminated input signal source, when the input signal source impedance is equal to the nominal r.f. input impedance of the receiver. The levels of the test signals shall be expressed in terms of the CCV (in dBm) at the receiver input terminals.

The nominal receiver input impedance shall be 50 Ω .

NOTE The r.f. level applied to the receiver for the tests in section 4 should be 60 dB greater than the r.f. level required to achieve the maximum useable receiver sensitivity as measured in 8.2 unless otherwise stated.

6.8 Test frequencies

6.8.1 The equipment shall be tested on the centre r.f. channel and the upper and lower r.f. channels of the MS operating frequency band unless otherwise stated.

6.8.2 In all tests which involve the measurement of audio characteristics (section 4) the equipment shall be tested on the MS centre r.f. channel.

6.9 Base station simulator

The base station simulator as described in Appendix D can be used to carry out all tests in respect of the radio frequency, audio frequency and signalling parameters of the mobile station.

The reference level (RL) of the r.f. power for signalling test purposes shall be – 50 dBm.

6.10 Acoustic coupling device

The acoustic coupling device as described in G.1 shall be used in all standard test conditions required for a), b) and c) as follows.

- a) The input of audio test signals to the microphone of the telephone handset.
- b) The monitoring of audio test signals at the output of the ear-piece of the telephone handset.
- c) The test for receiver transmit echo loss.

NOTE 1 However, the test for receive to transmit stability loss requires the handset to be operated in conjunction with apparatus different from the acoustic coupling device and tests requiring the measurement of acoustic output levels under extreme conditions should employ the direct audio connection described in 6.5

NOTE 2 For the purpose of this specification it is assumed that the frequency amplitude characteristic of the acoustic coupling device (artificial mouth and artificial ear) is flat over the frequency range of the measurements.

6.11 Characteristics of measuring equipment

The characteristics of the measuring equipment and its methods of testing shall be as given in Appendix E.

NOTE Care should be taken to ensure that measuring equipment and any coupling devices do not adversely affect the transmitter loading conditions.

6.12 Tolerance of measurements

Tolerances for measurements shall be as stated in Appendix F.

6.13 Receiver volume control

When the handset volume control, if fitted, is required to be set to the centre of its control range it shall be set at 10 dB attenuation for a control with 20 dB range, 5 dB attenuation for a control with 10 dB range, etc. For a stepped volume control where it is not possible to set it to the centre of its control range the volume control shall be set to the position closest to the centre of the control range.

Section 3. Radio frequency characteristics

7 Transmitter

7.1 Maximum carrier power

7.1.1 Definition for transmitters with accessible antenna terminals. The mean power delivered to the artificial antenna during a radio frequency cycle, without external modulation.

NOTE This measurement may be combined with the tests of 7.2.

7.1.2 Method of measurement. The following procedure shall be used.

- a) Connect the MS transmitter to an artificial antenna (see 6.4) and measure the power delivered to the antenna with a power measuring device.
- b) Operate the MS transmitter during the test at its maximum carrier power on one of the frequencies specified in 6.8.1, without external modulation.
- c) Measure the r.f. output power and record the result.
- d) Repeat steps a) to c) for the other test frequencies (see 6.8.1).
- e) Repeat steps a) to d) under extreme test conditions, as specified in 6.2.1 and 6.2.2, applied simultaneously.

7.1.3 Definition for transmitters having integral antennae. The effective radiated power in the direction of the maximum field strength.

7.1.4 Method of measurement. The following procedure shall be used.

- a) On a test site complying with Appendix A, place the MS on the support in the following position:
 - 1) for equipment with internal antenna, in a position which is closest to its position in normal use;
 - 2) for equipment with a rigid external antenna, with the antenna vertical;
 - 3) for equipment with a non-rigid external antenna, the antenna extended vertically upwards by a non-conducting support.
- b) Operate the MS transmitter during the test at its maximum carrier power on one of the frequencies specified in 6.8.1, without external modulation (see 6.5).
- c) Tune the test receiver to the frequency of the signal being measured.
- d) Orientate the test antenna for vertical polarization.
- e) Raise and lower the test antenna through the specified height range (see A.4) until the maximum signal level is detected on the test receiver.

NOTE This maximum may be a lower value than the value obtained at heights outside the specified limits.

- f) Rotate the platform until the maximum signal level is obtained. Record the test receiver input signal level.
- g) Replace the MS with a signal generator and substitution antenna as specified in A.5.
- h) Apply a suitable input signal to the substitution antenna and raise or lower the test antenna through the specified height range (see A.4) until the maximum signal level is received by the test receiver.
- i) Adjust the input signal level to the substitution antenna until an equal or known related level to that recorded in step f) is detected.
- j) Record the carrier power as the power supplied to the substitution antenna increased by the known relationship, if necessary.
- k) Repeat steps a) to j) but vary the test antenna polarization in step d) to ensure that the value recorded in step j) is the maximum. If larger values are obtained, record this fact in the test report.
- l) Repeat steps a) to k) for any alternative antenna supplied by the manufacturer.
- m) Place the equipment in the test fixture (see Appendix B) and connect it to the artificial load (see 6.4), with a means of measuring the power delivered to this load.
- n) In the absence of external modulation operate the transmitter in accordance with the manufacturer's instructions and measure the carrier power under normal test conditions as specified in 6.1.2 and 6.1.3.
- o) Repeat steps b) to n) for the other test frequencies (see 6.8.1).
- p) Repeat step n) under extreme test conditions, as specified in 6.2.1 and 6.2.2, applied simultaneously.