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Intelligent transport systems — Localized communications — ITS-M5

Systèmes intelligents de transport — Communications localisées — M5

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This second edition cancels and replaces the first edition (ISO 21215:2010) which has been technically revised.

The following main changes have been made since the last edition:

— document restructured in support of different regulatory regions;

— requirements applicable for usage in the European Union added;

— LDP/SNAP replaced by EPD;

— ASN.1 aligned with latest developments in ISO/TC 204;

— provisioning for path and flow management added;

— normative annex related to conformance testing, that contains the PICS proforma, added;

— editorial improvements.

Introduction

Localized communications is an essential component of hybrid communications in Intelligent Transport Systems (ITS). Various access technologies are suited for localized communications. A major focus of ITS stakeholders for "Cooperative ITS" and "Urban ITS" is on the access technology originally specified by IEEE in the standard IEEE Std 802.11™-2016. For usage in ITS, IEEE specified the operational mode "Outside the Context of a BSS" (OCB), also known under the acronym of 802.11p.

This document primarily provides complements to IEEE Std 802.11™-2016 OCB needed to operate as an ITS access technology in the various regions of the world, and optionally also supports ordinary WiFi operation, i.e. not applying OCB. An implementation of this document is referred to as an ITS-M5 communication interface (CI).

ITS-M5 CIs are capable of

— interoperating with IEEE WAVE devices, and

— receiving messages from ETSI ITS-G5 devices.

This document supports usage of ITS-M5 in various station contexts. Precise specifications are provided for the context specified in ISO 21217 and ISO 21218. Optional support for "Path and Flow Management" specified in ISO 24102-6[8] is also provided.

Intelligent transport systems — Localized communications — ITS-M5

1 Scope

This document provides specifications of a communication interface (CI) named "ITS-M5". The name "ITS-M5" indicates microwave frequency bands in the range of 5 GHz.

ITS-M5 CIs are based on the wireless LAN technology standardized at IEEE. This document specifies the additions to and deviations from IEEE Std 802.11™-2016 required to make ITS-M5 CIs compatible with the ITS station and communication architecture specified in ISO 21217.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8825-2, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)*

ISO 21217, *Intelligent Transport Systems — Communications access for land mobiles (CALM) — Architecture*

ISO 21218, *Intelligent Transport Systems — Hybrid communications — Access technology support*

ETSI EN 301 893, *5 GHz RLAN; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU*

ETSI EN 302 571, *Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU*

IEEE Std 802™, *IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture*

IEEE Std 802.11™-2016, *IEEE Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
EtherType
2-octet unsigned Integer number with allowed values ≥1 536 (0x06.00), assigned by the IEEE Registration Authority and used in data link layer frames, which identifies the protocol in the ITS networking & transport layer able to parse and process the ITS-NTPDU contained in the data link layer frame

4 Symbols and abbreviated terms

I-Parameter	Parameter of a CI or virtual CI (VCI) specified in ISO 21218.
M5-parameter	Parameter of an ITS-M5 CI / VCI specified in this document.
,	Commas within numbers are used as decimal points.
e.i.r.p.	Equivalent isotropic radiated power
NPDU	Network PDU
EPD	EtherType protocol discrimination
ITS-SU	ITS station unit (composed of one or several ITS-SCUs)
ITS-SCU	ITS station communication unit
LLC	Logical link control (sub-layer of the data link layer)
LPD	LLC protocol discrimination
LPDU	Link PDU
SNAP	Sub-network access protocol
ITS-NTPDU	ITS networking & transport layer PDU
PDU	Protocol data unit
RLAN	Radio LAN
BRAN	Broadband radio access network
LAN	Local area network
OCB	Outside the context of a BSS
BSS	Basic service set (specified in IEEE Std 802.11™-2016)
PHY	Physical (layer)
MAC	Medium access control (sub-layer of the data link layer)

5 General requirements

5.1 IEEE 802.11

An ITS-M5 implementation shall be compliant with IEEE Std 802.11™-2016, with restrictions and amendments as specified in this document.

5.2 Architecture

The ITS station architecture specified in ISO 21217 is presented in Figure 1. The ITS-M5 CI is allocated in the ITS-S access layer of the ITS station architecture.

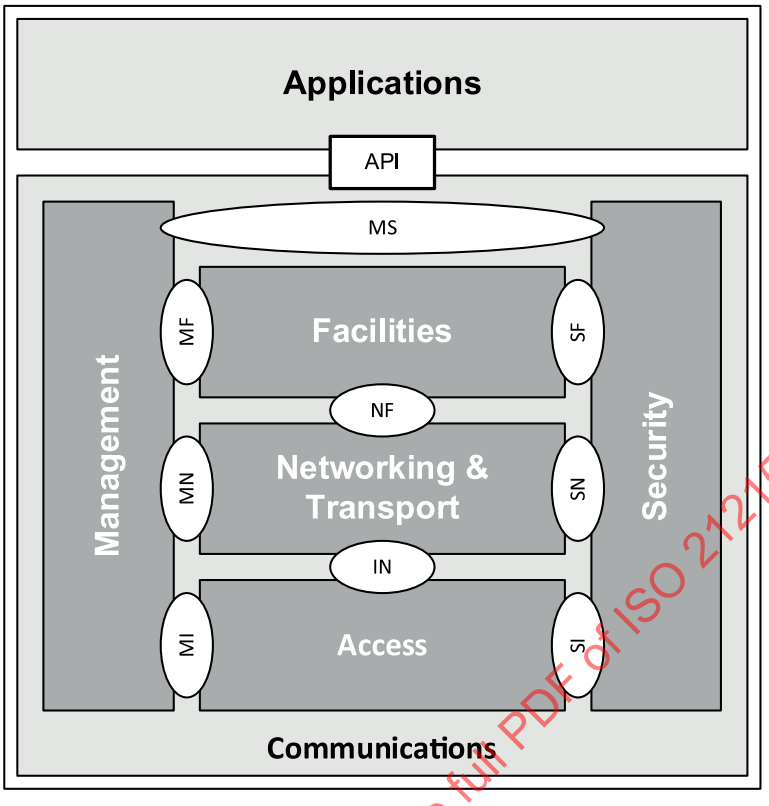

Figure 1 — ITS station architecture

Figure 2 shows the architecture diagram of an ITS-M5 communications interface (CI) embedded in the general ITS station architecture.

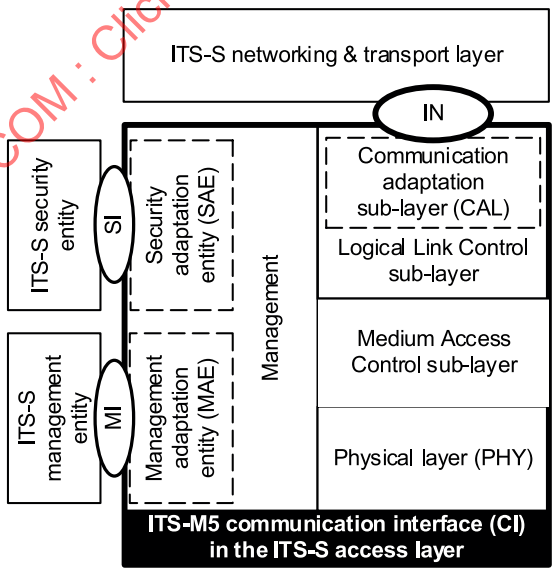

Figure 2 — ITS-M5 CI architecture

The communication protocol layers of the ITS-M5 CI are

a) Physical layer for microwave communications (PHY), and

b) Medium access control sub-layer (MAC).

An ITS-M5 CI as specified in this document is an ITS wireless CI of CI class CIC-I1 for general simultaneous bi-directional communications with multiple peer-stations as specified in ISO 21218. An implementation may also be configured as an ITS wireless CI of CI class CIC-I3 (groupcast transmitter), and CI class CIC-I4 (receiver only).

An ITS-M5 CI provides the functionality of the IN-SAP specified in ISO 21218, and uses the functionality of the MI-SAP, and the SI-SAP, as specified in ISO 24102-3[6].

NOTE 1 Service primitive functions for the SI-SAP are not identified so far.

NOTE 2 Multiple ITS-M5 CIs per ITS station unit (ITS-SU) are possible, regardless of whether the CIs belong to the same ITS-SCU or to different ITS-SCUs of the same ITS-SU; see ISO 21217 for the specifications of ITS-SU and ITS-SCU.

5.3 Hybrid communications support

An ITS-M5 CI shall support the hybrid communications functionality of ISO 21218, and may implement this functionality in a strict way compliant with ISO 21217, but also in different ways supporting other station architectures.

5.4 Path and flow management support

Support of path and flow management specified in ISO 24102-6[8] is optional.

Details of path and flow management applicable for the ITS-S access layer are specified in ISO 21218.

Path and flow management uses MI-COMMAND and MI-REQUEST service primitive functions presented in Annex B and in Annex C, respectively. Specific behaviour of ITS-M5 upon reception of such MI-COMMANDs, and the procedures to present MI-REQUESTs beyond the requirements set up in ISO 21218 are specified in Annex E.

5.5 MI-SAP support

An ITS-M5 CI shall support the MI-SAP functionality of ISO 24102-3[6] with details specified in ISO 21218, and may implement this functionality in a strict way compliant with ISO 21217, but also in different ways supporting other station architectures.

6 Communication interface protocol stack

6.1 Physical layer

An ITS-M5 implementation shall be compliant with the specification of

— Orthogonal frequency division multiplexing (OFDM) specified in IEEE Std 802.11™-2016, Clause 18.

Other PHY specifications from IEEE Std 802.11™-2016 are not applicable for ITS-M5.

According to regional requirements an ITS-M5 implementation shall

— support applicable congestion control mechanisms, and

— support applicable mitigation techniques enabling coexistence with nearby other services, e.g. mitigation techniques specified in ETSI TS 102 792[21].

EXAMPLE Coexistence with the European "Electronic Toll Collection" (ETC) services based on 5,8 GHz backscatter communications is essential in Europe.

An ITS-G5 implementation shall support self-interference mitigation techniques, e.g. cross-CI prioritization specified in ISO 21218, if self-interference mitigation techniques are applicable for a given implementation.

Radio frequency parameters such as centre frequency, channel spacing, (default) data rates, TX power (density) limits, channel usage are as required by regional regulation.

6.2 Medium access control sub-layer

The "Frame body" field of data frames specified in IEEE Std 802.11™-2016, Figure 9-1 contains the ITS-M5 LPDU (Link Protocol Data Unit) as illustrated in Figure 3.

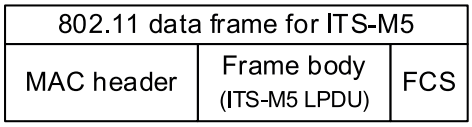

Figure 3 — 802.11 data frame

6.3 Logical link control sub-layer

IEEE Std 802.11™-2016 does not specify a logical link control sub-layer protocol. Related functionality is part of the communication adaptation sub-layer specified in 6.4.

The Length/Type field specified in IEEE 802.3-2015[26] contains a 2-octet unsigned Integer number. Dependent on the value, the field provides either length information or EtherType information. If the value contained in this field is equal to or larger than 1 536 = 0x06.00, the field contains an EtherType address. Ethertype addresses are assigned by the IEEE Registration Authority, and are used to identify the protocol employed directly above the ITS-S access layer. This method of addressing is named "EtherType Protocol Discrimination" (EPD). An ITS-M5 CI shall support EPD specified in IEEE Std 802™.

EXAMPLE ISO FNTP specified in ISO 29281-1[9] is identified by the EtherType 0x89.50. IPv6 is identified by the EtherType 0x86.DD. GeoNetworking specified in the ETSI multi-part standard EN 302 636[20] is identified by the EtherType 0x89.47. The IEEE WSMP specified in IEEE 1609.3[24] is identified by the EtherType 0x88.DC.

NOTE 1 Allocations of EtherType values are published at http://standards.ieee.org/develop/regauth/ethertype/eth.txt.

NOTE 2 EPD replaces LLC Protocol Discrimination (LPD). ETSI ITS-G5 is the only known ITS access technology still using LPD.

Different to the information in IEEE Std 802.11™-2016, 5.1.4, EPD is applicable in all frequency bands as long as dot11OCBActivated is set to true, i.e. activating the operation mode "outside the context of a BSS" (OCB).

The ITS-M5 LPDU illustrated in Figure 4 contains the ITS-NTPDU introduced in ISO 21217, preceded by the EtherType field.

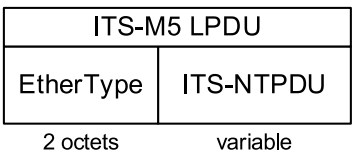

Figure 4 — ITS-M5 LPDU

NOTE 3 Values in the range 0 through 1 535 (0x05.FF) are not allowed to occur in the EtherType field, as these numbers provide length information.

On the basis of "best effort" an ITS-M5 CI may also support reception of 802.11 data frames with a frame body field supporting SNAP (SubNetwork Access Protocol) addressing rather than EtherType addressing. SNAP addressing is illustrated in Figure 5. Discrimination between SNAP and EPD is possible as long as the value 0xAA.AA is not used as an EtherType address.

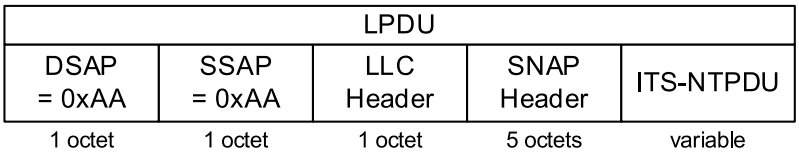

Figure 5 — SNAP addressing

NOTE 4 SNAP is an extension of the deprecated IEEE 802.2 Logical Link Control (LLC) standard, still available as ISO/IEC 8802-1:2001[25]. Currently the only know implementation of SNAP in ITS is standardized in ETSI EN 302 663[19] for ETSI ITS-G5.

NOTE 5 The normative support of EPD enables interoperability with IEEE WAVE devices (e.g. for road safety messages from the BSM message set). The SNAP support in receive mode allows reception of messages from ITS station units conformant with ETSI EN 302 663 (e.g. broadcast road safety messages such as CAM and DENM).

6.4 Communication adaptation sub-layer

The communication adaptation sub-layer (CAL) is introduced in ISO 21218. The major task of CAL is to provide the IN-SAP. ASN.1 details of the IN-SAP IN-UNITDATA service primitives are specified in ISO 21218.

ITS-M5 CIs being compliant with ISO 21218 shall use an EtherType value in the IN-UNITDATA service primitives to identify the applicable ITS-S networking & transport layer protocol.

In other implementation contexts, the EtherType value shall be used in the applicable service access point primitives that exchange service data units between ITS-M5 and the network layer entity; details are outside the scope of this document.

The IN-SAP service primitives of DL-UNITDATA contain the parameter "priority", which is the user priority specified in ISO 21218. In implementations being compliant with ISO 21218 the relation between user priority and IEEE 802.11 access category shall be as specified in Tables 1 and 2.

Table 1 — User priorities and IEEE access categories for TX

User priority	Access category (AC)	Data traffic type	UP in IEEE 802.1D	Data traffic type in IEEE 802.1D
224 – 255	AC_VO	Voice	7	Network control (NC)
192 – 223			6	Voice (VO)
160 – 191	AC_VI	Video	5	Video (VI)
128 – 159			4	Controlled load
96 – 127	AC_BE	Best effort	3	Excellent effort (EE)
64 – 95			0	Best effort (BE)
32 – 63	AC_BK	Background	2	Spare (-)
0 – 31			1	Background (BK)

Table 2 — User priorities for RX

TID	unknown	1	2	0	3	4	5	6	7
User priority	0	31	63	95	127	159	191	223	255

7 Communication interface management

7.1 General management

The ITS-M5 management shall be compliant with IEEE Std 802.11™-2016, with restrictions and amendments as specified in this document.

The default value of the MIB parameter dot11OCBActivated specified in IEEE Std 802.11™-2016 shall be true, enabling OCB communication, i.e. communication outside the context of a "Basic Service Set" (BSS).

Other modes of operation specified in IEEE Std 802.11™-2016 may also be implemented, e.g. ordinary WiFi mode with dot11OCBActivated set to false. However for ordinary WiFi, LPD is required instead of EPD, see IEEE Std 802.11™-2016, 5.1.4.

Operation in some frequency bands, e.g. the RLAN/BRAN band in Europe[20], requires transmit power control (TPC), a procedure for dynamic frequency selection (DFS) and uniform spreading, in order to detect signals from radar systems and to avoid co-channel interference. This functionality is not supported in IEEE Std 802.11™-2016 if the MIB parameter dot11OCBActivated is set to true. In order to optionally enable operation outside of a BSS in such bands, appropriate mechanisms enabling compliance with regulatory requirements on TPC and DFS shall be implemented in a way not necessarily being conformant with IEEE Std 802.11™-2016, if this optional mode of operation is to be supported by an implementation.

ITS-M5 shall transmit data using EDCA as defined in IEEE Std 802.11™-2016, 9.19.2. With the MIB parameter dot11OCBActivated being set to true, EDCA default values are static and not negotiated before transmission. Default values are found in IEEE Std 802.11™-2016, table 8-106. The ITS station manager may update these parameters using information from a trusted source, e.g. applying remote ITS station management specified in ISO 24102-2[5]. Specific settings may be requested e.g. for roadside-to-vehicle communications initiated with service advertisement as specified in ISO 24102-5[3] and ISO 16460[28].

7.2 Management adaptation entity

7.2.1 802.11 parameters and I-Parameters

In implementations compliant with ISO 21218, the following rules apply:

— IEEE 802.11 parameters that have an equivalent I-Parameter defined in ISO 21218 shall be mapped on I-Parameters as specified in Annex A.

— IEEE 802.11 parameters which are relevant for ITS-M5 and do not have an equivalent I-Parameter defined in ISO 21218 shall be made visible to the ITS station management by means of medium-specific I-Parameters as specified in Annex A.

— I-Parameters which are relevant for ITS-M5 but cannot be mapped on an IEEE 802.11 parameters shall be implemented in the MAE as specified in ISO 21218 with details specified in Annex A.

7.2.2 802.11 commands and MI-SAP commands and requests

In implementations compliant with ISO 21218 and ISO 24102-3[6], the following rules apply:

— IEEE 802.11 management commands that have an equivalent MI-COMMAND/MI-REQUEST defined in ISO 24102-3[6] shall be mapped on these MI-COMMAND/MI-REQUEST as specified in Annex B and Annex C.

— IEEE 802.11 management commands that are relevant for an implementation of ITS-M5 and do not have an equivalent MI-COMMAND/MI-REQUEST defined in ISO 24102-3[6] shall be made accessible in an implementation specific way.

— MI-COMMANDs / MI-REQUESTs which are relevant for ITS-M5 but cannot be mapped on an IEEE 802.11 management commands are implemented in the MAE as specified in ISO 24102-3[6] with details specified in Annex B and Annex C.

7.2.3 802.11 management frames

An ITS-M5 CI may support transmission of management frames requested by the ITS station management with the MI-COMMAND "MacManagementFrameTX" of ASN.1 type `UnitData` specified in ISO 21218.

An ITS-M5 CI may support forwarding of received management frames to the ITS station management with the MI-REQUEST "MacManagementFrameRX" of ASN.1 type `UnitData` specified in ISO 21218.

The ASN.1 type `UnitData` contains a component with name "parameter" of ASN.1 type `MframeParameter`, that is a medium-specific parameter used to indicate details of the 802.11 management frame, e.g. subtype BEACON/ACTION. For ITS-M5 `MframeParameter` contains the component "parameter" of ASN.1 type M5-MgmtSubTypes, and is selected with value `c-ITSatt-iso21215` of the component "medium". The value `c-ITSatt-iso21215` is specified in ISO 17419[1].

8 Procedures

8.1 Communication interface procedures

8.1.1 Transmit procedures

Upon reception of a transmission request service primitive, e.g. an IN-UNITDATA.request service primitive specified in ISO 21218, CAL shall

a) perform settings of 802.11 transmit parameters, e.g. power, data rate, frequency, as requested,

b) determine the 802.11 access category and TID value from the user priority presented in the transmission request service primitive as specified in Table 1, and

c) request transmission of the data to the indicated destination considering the determined 802.11 access category and TID value.

In case regulation or other standards require predefined 802.11 access categories for specific purposes, step b) above does not apply, and the predefined 802.11 access categories prevail. A required predefined access category or TID may be indicated in I-Parameter TIDcontrol.

8.1.2 Receive procedures

An ITS-M5 CI using a locally administered MAC address shall continuously monitor whether a peer station is using the same MAC address. A detected conflict shall be processed by the MAE as specified in 8.2.1.

Upon reception of a frame, CAL shall

a) calculate the user priority from the 802.11 TID value contained in the received frame as specified in Table 2, and

b) present the received packet to the ITS-S networking & transport layer, e.g. using the IN-UNITDATA. indication service primitive specified in ISO 21218.

8.2 Management procedures

8.2.1 MAC address conflict

In case of a detected MAC address conflict, the conflicting MAC address shall be notified to the ITS station management, e.g. using the MI-REQUEST EventNotification specified in ISO 21218.

NOTE In case of a notified MAC address conflict, the ITS station management may change the MAC address of the related CI (I-Parameter 9 "MACaddrTemp" specified in ISO 21218). Usage of locally administered MAC addresses may be due to privacy regulations (usage of pseudonyms).

8.2.2 Pseudonym MAC address change

In order to comply with privacy regulations, usage of a locally assigned MAC address may be required. Such temporarily used MAC addresses are also referred to as pseudonyms. The ITS station management may request change of the pseudonym MAC address with MI-COMMAND ChangePseudonymMACaddress specified in ISO 21218.

Upon reception of the MI-COMMAND.request ChangePseudonymMACaddress the CI shall select a new value of the pseudonym MAC address.

8.2.3 Cross-CI prioritization

A basic "Cross-CI prioritization procedure" is specified in ISO 21218. For ITS-M5 the option "CI protection" shall be mandatory for all implementations with a CEN DSRC OBU (5,8 GHz backscatter technology) being part of the ITS station unit. If the mitigation technique "DSRC detection" specified in ETSI TS 102 792[21] is implemented, the "CI protection" specified in ISO 21218 is only optional, if not required by other regulations.

8.2.4 Communication range reference

ISO 21218 specifies the I-Parameter "CommRangeRef". Estimation of applicable values may be based on the assumption of line-of-sight communications and applicable settings of radio parameters. Details are out of scope of this document.

9 Conformance

Conformance testing of ITS-M5 is fully specified only in combination with applicable requirements for a specific station architecture, e.g. specified in ISO 21218.

Implementation conformance statements (ICS) specified in Annex G complement those of ISO 21218.

Conformance tests for regional related features are also applicable, e.g. as specified by ETSI in the series of technical specifications TS 102 917-x, currently under development.

10 Test methods

The test suite structure and test purposes (TSS&TP) and an abstract test suite (ATS) for conformance tests will be specified in a future document.

Conformance testing may use upper tester access in the System Under Test (SUT) applying ITS station-internal management communications specified in ISO/TS 20026[2], ISO 24102-4[7], and ISO 24102-3[6].

Conformance tests for regional related features are also applicable, e.g. as specified by ETSI in the series of technical specifications TS 102 917-x, currently under development.

Annex A
(normative)

Communication interface parameters

A.1 General

Communication interface parameters (I-Parameters) are generally specified in ISO 21218 for all access technologies. This normative annex provides details specific to ITS-M5, and additional parameters dedicated to ITS-M5.

A.2 I-Parameters specific to ITS-M5

I-Parameters are specified in ISO 21218. Table A.1 specifies details of I-Parameters that are specific to ITS-M5.

Table A.1 — I-Parameters specific to ITS-M5

I-ParamNo	I-Parameter name/ ASN.1 Type	Description/range/values
8	LLaddress/ `LLaddress`	These addresses are 48bit MAC address. This type is identified by the reference value `c-ITSatt-iso21215`.
9	LLaddressTemp/ `LLaddressTemp`	
29	LLaddressPeer/ `LLaddressPeer`	
15	RegulatoryInformation/ `RegulatoryScheme`	RI data structure identified by the reference value `c-RegScheme-iso21215` with valid regulatory information, or a statement that no regulation is known or applicable. The specific format is not yet specified[a].
32	RXsensitivity/ `RxSens`	The receiver sensitivity is presented in the format identified by the reference value `c-ITSatt-iso21215`. The RX sensitivity is presented with the ASN.1 type `RxSens80211`, containing an Integer number in the range –128 to +127. The reference sensitivity value for ITS-M5 is –80 dBm which equals the value zero contained in `RxSens80211`. The step size is 0,5 dB. Thus RXsensitivity can present sensitivity values in the range –144 dBm through –16,5 dBm.
33	TXpower/ `TxPower`	The transmit power EIRP is presented in the format identified by the reference value `c-ITSatt-iso21215`. The TX power is presented with the ASN.1 type `TXpower80211` specified in ISO 16460, containing an Integer number in the range –128 to +127. The reference power level EIRP for ITS-M5 is 0 dBm, dBm which equals the value zero contained in `TXpower80211`. The step size is 0,5 dB. Thus TXpower can present EIRP values in the range –64 dBm through 63,5 dBm.
34	TXpowMax/ `TxPowerMax`	
35	PeerTXpower/ `PeerTXpower`	
36	LinkDataRate/ `DataRateLink`	The ITS-M5 link data rate is presented in the format identified by the reference value `c-ITSatt-iso21215`.

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

Table A.1 *(continued)*

I-ParamNo	I-Parameter name/ ASN.1 Type	Description/range/values
53	PhysicalChannelIdentifier/ `PhysicalChannelIdentifier`	The ITS-M5 physical channel identifier is presented in the format identified by the reference value `c-ITSatt-iso21215`.
54	OperationalMode/ `OperationalMode`	The ITS-M5 operational mode is presented in the format identified by the reference value `c-ITSatt-iso21215`.
56	QoSrequirement/ `QoSrequirement`	The ITS-M5 QoS requirements are presented in the format identified by the reference value `c-ITSatt-iso21215`.

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

A.3 Default values of I-Parameters

Table A.2 defines default values of I-Parameters applicable for ITS-M5

Table A.2 — Default values of I-Parameters of ITS-M5

I-ParamNo	I-Parameter name/ ASN.1Type	Default values/Comments
4	ITS-SCU-ID/ ITS-`scuId`	5 (allowed is the range 5 through 65534)
6	LocalCIID/ `LocalCIID`	Calculated from MAC address
7	TimeoutRegister/ `TimeoutRegistration`	100 ms
8	LLaddress/ `LLAddress`	Static MAC address as set by manufacturer
9	LLaddressTemp/ `LLAddressTemp`	Same as LLaddress
10	CIclass/ `CIclass`	CIC-l1
11	CIaccessClass/ `CIaClass`	CIAC-1
12	CIstatus/ `CIstatus`	0: not-existent
13	Notify/ `Notify`	CIstatus, LLaddressTemp
14	MedType/ `ITSatt`	`c-ITSatt-iso21215` = 5: ITS-M5
15	RegulatoryInformation/ `RegInfo`	For intented region of operation. Not yet defined in ASN.1.[a]
16	Connect/ `Connect`	255: manual
19	MinimumUserPriority/ `MinimumUserPriority`	0: no restriction
20	QueueLevel/ `QueueLevelActual`	{priority, 0}
21	QueueLevelThreshold/ `QueueLowThreshold`	{priority, 85}

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

Table A.2 *(continued)*

I-ParamNo	I-Parameter name/ ASN.1Type	Default values/Comments
22	QueueAlarmThreshold/ `QueueAlarmThreshold`	{priority, 170}
24	CommRangeRef/ `CommuniationRangeReference`	See 8.2.4. Calculation based on default values.
25	TimeOfLastReception/ `TimeOfLastReception`	IAT set to 0
26	InactivityTimeLimit/ `InactTimeLimit`	0: no limit
27	MediumUsage/ `MediumUsage`	{receive:0, transmit: 0}
28	MedUseObservationTime / `MedUseObsTime`	1 s
31	MinPrioCrossCI/ `MinimumCrossCiPriority`	0
32	RXsensitivity/ `RxSens`	0: reference sensitivity
33	TXpower/ `TxPower`	0: reference power
34	TXpowMax/ `TxPowerMax`	As required by regulation, otherwise 0: reference power.
36	LinkDataRate/ `DataRateLink`	Default as required by regulation, or minimum possible value
37	DataRateNW/ `DataRateNetwork`	Equal to average of DataRatesNW.minimum and DataRatesNW.maximum
38	DataRatesNW/ `DataRatesNetwork`	{minimum:minimum possible value if known, otherwise 0, maximum:maximum possible value known, otherwise 0}
39	DataRateNWreq/ `DataRateNetworkRequired`	Same as DataRateNW
40	Directivity/ `Directivity`	{fixed, 0, 0, 0, 360, 40} - omnidirectional, or not supported
41	BlockLength/ `BlockLength`	2 300: valid for data frames and management frames
46	Cost/ `MediumCost`	CostClass 0: "tempUnavailable"
47	Reliability/ `Reliability`	255: unknown
48	LogicalChannels/ `LogicalChannels`	Mappings for all supported physical channels and logical channels. Default as required by regional regulation
52	LimitChannelAccess/ `LimitChannelAccess`	{default channel, 200, 0}: no limitation
53	PhysicalChannelIdentifier/ `PhysicalChannelIdentifier`	Default as required by regional regulation, if applicable, or factory setting
54	OperationalMode/ `OperationalMode`	ocbTrue: OCB mode active

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

Annex B
(normative)

MI-COMMANDs

B.1 General

The management service primitives MI-COMMAND.request and MI-COMMAND.confirm and some of the functions of MI-COMMAND.request are specified in ISO 24102-3[6]. Further functions are specified e.g. in ISO 21218 and in ISO 24102-6[8].

B.2 Required functionality

The functionality of MI-COMMANDs shall be supported as specified in Table B.1.

Table B.1 — MI-COMMANDs

COMMAND	Description	Requirement
SimIUTcmd	See ISO 20026[2]and ISO 24102-3[6]	Mandatory if ISO 20026[2] is supported, otherwise optional.
EchoTest	See ISO 24102-3[6]	
CIstateChange	Change of CI status.	Mandatory if path and flow management specified in ISO 24102-6[8] is supported, or mandatory if ISO 21218 is supported, otherwise optional.
MonitorIparameters	Command to request monitoring of parameters.	
ChangePseudonymMACaddress	Command to request change of MAC address or other type of layer 2 address, e.g. LTE Layer-2 ID, which is visible in a link to a peer station. This may be due to privacy regulations.	Mandatory if privacy regulations require it, otherwise optional.
MacManagementFrameTX	Command to request transmission of a data packet in a MAC management frame.	Optional
ManufacturerCommand	Allows for manufacturer-specific access to the CI. Used e.g. for test and maintenance purposes.	Optional
PrioritizedRequestToSend	Information on an intended prioritized transmission of a victim CI presented to interferer CIs.	Mandatory if cross-CI prioritization is supported
RegulatoryInformation	Provisioning of regulatory information.	Mandatory.
VCImanagement	Command to request creation, reset or deletion of a VCI. Setting of parameters different to the default values for a newly created VCI has to be done in subsequent MI-SET commands.	Mandatory if ISO 21218 is supported, otherwise optional.

Annex C
(normative)

MI-REQUESTs

C.1 General

The management service primitives MI-REQUEST.request and MI-REQUEST.confirm and some of the functions of MI-REQUEST.request are specified in ISO 24102-3[6]. Further functions are specified e.g. in ISO 21218 and in ISO 24102-6[8].

C.2 Required functionality

The functionality of MI-REQUESTs shall be supported as specified in Table C.1.

Table C.1 — MI-REQUESTs

REQUEST	Description	Requirement
SimIUTreq	See in ISO/TS 20026[2] and ISO 24102-3[6].	Mandatory if ISO/TS 20026[2] is supported, otherwise optional.
TestMIEcho	See ISO 24102-3[6]	
EventNotification	Notification of an event.	Mandatory if ISO 21218 is supported, otherwise optional.
MacManagementFrameRX	Notification of a data packet received in a MAC management frame.	Optional
PositionUpdate	Requests to receive position updates with update interval as indicated in milliseconds/cancels the request.	Optional
PrioritizationRegistration	Registration of a victim CI for Cross-CI Prioritization.	Mandatory if Cross-CI prioritization is supported, otherwise not applicable
PrioritizationRequest	Real-time request of a victim VCI to get prioritization.	
RegistrationCI	Request to register the CI.	Mandatory if dynamic registration specified in ISO 21218 is supported, otherwise not applicable.

Annex D
(normative)

ASN.1 definitions

D.1 Overview

The ASN.1 basic notation is specified in ISO/IEC 8824-1[27]. The following ASN.1 module is specified in D.2:

— ITSm5 {iso (1) standard (0) calm-m5 (21215) asnm-1 (1) version1 (1)}

Further on this document also provides ASN.1 type and value specifications in D.3 to be registered in the registry of ISO 21218.

In case the ASN.1 specifications given in this Annex are not compliant with illustrations or specifications provided elsewhere in this document, the specifications given in this Annex shall prevail.

Updates of these ASN.1 specifications will be published on http://standards.iso.org/iso/21215/ed-2/en.

Applicable encodings of the types and values defined in this document depend on the usage. ASN.1 BASIC-PER, UNALIGNED, as specified in ISO/IEC 8825-2, shall apply if no other explicit requirement on encoding is given.

D.2 Module ITSm5

```
ITSm5 {iso (1) standard (0) calm-m5 (21215) asnm-1 (1) version1 (1)}
DEFINITIONS AUTOMATIC TAGS ::= BEGIN

IMPORTS

-- C-ITS Data Dictionary (still in ISO 17419)
Logic, UserPriority FROM CITSdataDictionary1 {iso(1) standard(0) cits-applMgmt (17419)
dataDictionary (1) version1 (1)}

; -- End of IMPORTS

-- Operational modes specified in IEEE 802.11
ITS-M5-OperationalMode::=INTEGER{
     unknown        (0),
     ocbTrue        (1), -- operation outside the context of a BSS (OCB)
     ocbFalse       (2) -- ordinary WiFi operation
     }

-- Requested predefined TID value for a specific purpose
-- Carried in I-Parameter QoSrequirements
-- to be provided on a packet-per-packet basis
ITS-M5-TIDcontrol::=INTEGER{
     tid-bk         (0),
      tid-spare     (1),
      tid-be        (2),
      tid-ee        (3),
      tid-cl        (4),
      tid-vi        (5),
      tid-vo        (6),
      tid-nc        (7),
      tid-FromUserPriority      (255)
      } (0..255)

RxSens80211::=INTEGER(-128 .. 127)
```

```
M5-MgmtSubTypes::= INTEGER{
      mgtAssocReq             (0), -- 0x0
      mgtAssocResp            (1), -- 0x1
      mgtReassocReq           (2), -- 0x2
      mgtReassocResp          (3), -- 0x3
      mgtProbeReq             (4), -- 0x4
      mgtProbeResp            (5), -- 0x5
      mgtTimeAdvert           (6), -- 0x6
      mgtBeacon               (8), -- 0x8
      mgtAtim                 (9), -- 0x9
      mgtDisaccoc             (10), -- 0xA
      mgtAuthen               (11), -- 0xB
      mgtDeauthen             (12), -- 0xC
      mgtAction               (13), -- 0xD
      mgtActionNoAck          (14) -- 0xE
      } (0..15)

-- For potential future use
-- MAC Frame Control Field; see IEEE802.11:2012
FrameControl::=SEQUENCE{
      version      FrameControlVersion, -- set to '00'b
      types        FrameControlTypes
      }

FrameControlVersion::=INTEGER(0..3) -- set to zero

FrameControlTypes::=CHOICE{
      management              [0] M5-MgmtSubTypes,
      control                 [1] M5-CtrlSubTypes,
      data                    [2] M5-DataSubTypes
--    other                   [3] OtherSubTypes
      }

M5-CtrlSubTypes::=INTEGER{
      ctrlCtrlWrap            (7), -- 0x7
      ctrlBlockAckReq         (8), -- 0x8
      ctrlBlockAck            (9), -- 0x9
      ctrlPsPoll              (10), -- 0xA
      ctrlRTS                 (11), -- 0xB
      ctrlCTS                 (12), -- 0xC
      ctrlACK                 (13), -- 0xD
      ctrlCfEnd               (14), -- 0xE
      ctrlCfEndAck            (15) -- 0xF
      } (0..15)

M5-DataSubTypes::=INTEGER{
      dataData                (0), -- 0x0
      dataDataCfAck           (1), -- 0x1
      dataDataCfPoll          (2), -- 0x2
      dataDataCfAckPoll       (3), -- 0x3
      dataNull                (4), -- 0x4
      dataCfAckNoData         (5), -- 0x5
      dataCfPollNoData        (6), -- 0x6
      dataCfAckPollNoData     (7), -- 0x7
      dataQoSdata             (8), -- 0x8
      dataQoSdataCfAck        (9), -- 0x9
      dataQoSdataCfPoll       (10), -- 0xA
      dataQoSdataCfAckPoll    (11), -- 0xB
      dataQoSnullNoData       (12), -- 0xC
      dataQoScfPollNoData     (14), -- 0xE
      dataQoScfAckPollNoData (15) -- 0xF
      } (0..15)

/*
   The ASN.1 specification has been checked for conformance to the ASN.1
   standards with the tool OSS ASN-1STEP
*/

END
```

D.3 Definitions to be added in ISO 21218

The following definitions are dynamic extensions of ASN.1 type and value definitions defined in ISO 21218 with ASN.1 CLASS. An up-to-date version of the ISO 21218 ASN.1 module ITSllsap {iso(1) standard(0) calm-ll-sap(21218) asnm-1 (1) version2 (2)} including all dynamic updates is published at http://standards.iso.org/iso/21218/ed-3/en.

IMPORT statement to be added, if not yet existent:

```
-- From ISO 21215
ITS-M5-OperationalMode, RxSens80211, M5-MgmtSubTypes, ITS-M5-TIDcontrol FROM ITSm5 {iso
(1) standard (0) calm-m5 (21215) asnm-1 (1) version1 (1)}

-- From EN ISO 17419-1
c-ITSatt-iso21215 FROM CITSapplMgmtComm {iso(1) standard(0) cits-applMgmt (17419)
applRegistry (2) version2 (2)}

-- From ISO 16460
TXpower80211, ChannelNumber80211 FROM ITSee1 {iso (1) standard (0) localized(16460) ee(4)
version1 (1)}
```

NOTE `TXpower80211, ChannelNumber80211` can also be imported from `ITSee {iso (1) standard (0) localized(16460) ee(4) version0 (0)}`, which is the predecessor ASN.1 module.

Medium specific general I-Parameters to be added:

```
TxPowers MEDSPEC::={
   { TXpower80211 IDENTIFIED BY c-ITSatt-iso21215 } ,
   ...
   }

RxSenss MEDSPEC::={
   { RxSens80211 IDENTIFIED BY c-ITSatt-iso21215 } ,
   ...
   }

PhysicalChannelIds MEDSPEC::={
   { ChannelNumber80211 IDENTIFIED BY c-ITSatt-iso21215 } ,
   ...
   }

OperationalModes MEDSPEC::={
   { ITS-M5-OperationalMode IDENTIFIED BY c-ITSatt-iso21215 } ,
   ...
   }

QoSrequirements MEDSPEC::={
   { ITS-M5-TIDcontrol IDENTIFIED BY c-ITSatt-iso21215 } ,
   ...
}
```

Annex E
(normative)

Path and flow management support

Support of path and flow management is an optional feature.

Further details may be specified in an Amendment to this document.

Annex F
(informative)

Frequency allocations

F.1 General

ITU administrative regions are

a) A (America),

b) B (Western Europe),

c) C (Eastern Europe and Northern Asia), and

d) D (Africa) E (Asia and Australasia).

ITU Radio Regulatory Regions:

— Region 1

  — Europe, Middle East, Africa, the former Soviet Union, including Siberia; and Mongolia;

— Region 2

  — North and South America and Pacific (East of the International Date Line);

— Region 3

  — Asia, Australia and the Pacific Rim (West of the International Date Line).

F.2 Region 1

F.2.1 Europe

Figure F.1 shows frequency allocation in Europe for the RLAN band[11][12][13], the DSRC band[14][15] and the ITS band in 5 GHz[16][17][18] together with the spectral power limits for ITS-M5 operated in either the RLAN band or the ITS bands.

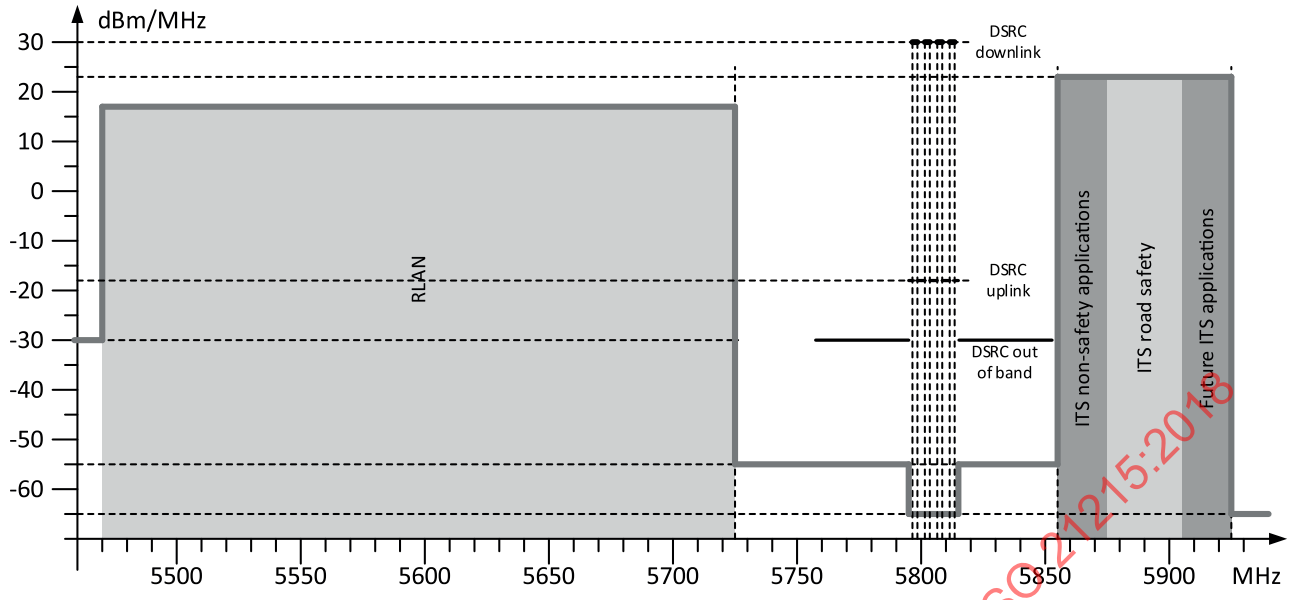

Figure F.1 — Power spectrum density for Europe

Table F.1 shows the frequency ranges, related regulatory requirements, intended usage and harmonized standards to be used for cooperative ITS within the European Union.

Table F.1 — Frequency allocation in the European Union

Band acronym	Frequence range [MHz]	Usage	Regulation	Harmonized standard
ITS-G5C	5 470 to 5 725	RLAN (BRAN, WLAN) ITS based on service advertisement	ERC Decision ERC/DEC(99)23[11] Commission Decisions 2005/513/EC[12] and 2007/90/EC[13]	ETSI EN 301 893
ITS-G5B	5 855 to 5 875	ITS non-safety applications	ECC Recommendation ECC/REC/(08)01[16]	ETSI EN 302 571
ITS-G5A	5 875 to 5 905	ITS road safety related applications ITS based on service advertisement	Commission Decision 2008/671/EC[18]	
ITS-G5D	5 905 to 5 925	Future ITS applications	ECC Decision ECC/DEC(02)01[15]	

Technical characteristics for pan-European harmonized communications equipment operating in the 5 GHz frequency range and intended for road-safety applications and for non-safety related ITS applications are specified in the system reference documents [22] and [23].

More specifically, for transmitter out-of-band emissions the limits presented in Table F.2 apply in Europe:

Table F.2 — Out-of-band maximum power (European regulation)

Out-of-band frequency range	Out-of-band maximum power
<5,4 GHz	As specified in ETSI EN 301 893
5,4 GHz to 5,725 GHz	−55 dBm e.i.r.p. within 1 MHz reference bandwidth
5,725 GHz to 5,795 GHz	−55 dBm e.i.r.p. within 1 MHz reference bandwidth

Table F.2 *(continued)*

Out-of-band frequency range	Out-of-band maximum power
5,795 GHz to 5,815 GHz	−65 dBm e.i.r.p. within 1 MHz reference bandwidth
5,815 GHz to 5,855 GHz	−55 dBm e.i.r.p. within 1 MHz reference bandwidth
5,855 GHz to 5,925 GHz	−55 dBm e.i.r.p. within 1 MHz reference bandwidth
>5,925 GHz	As specified in ETSI EN 302 571

Further details on in-band transmission power are specified in ETSI EN 301 893 and ETSI EN 302 571.

Receiver performance requirements for 10 MHz channel spacing are presented in Table F.3.

Table F.3 — Receiver performance requirements for 10 MHz channel spacing

MCS	Adjacent channel rejection			Non-adjacent channel rejection		
	Minimum required	Enhanced 1	Enhanced 2	Minimum required	Enhanced 1	Enhanced 2
0	16 dB	28 dB	34 dB	32 dB	42 dB	44 dB
1	15 dB	27 dB	33 dB	31 dB	41 dB	43 dB
2	13 dB	25 dB	31 dB	29 dB	39 dB	41 dB
3	11 dB	23 dB	29 dB	27 dB	37 dB	39 dB
4	8 dB	20 dB	26 dB	24 dB	34 dB	36 dB
5	4 dB	16 dB	22 dB	20 dB	30 dB	32 dB
6	0 dB	12 dB	18 dB	16 dB	26 dB	28 dB
7	−1 dB	11 dB	17 dB	15 dB	25 dB	27 dB
NOTE Values for "Minimum required" and "Enhanced 1" are taken from IEEE Std 802.11™-2016.						

Channel allocation in the European Union is illustrated in Table F.4. One physical channel is allocated to be a control channel (CCH), termed G5-CCH. Seven fixed service channels and one variable physical service channel are identified as G5-SCHs.

Table F.4 — European channel allocation

Physical channel acronym	Centre frequency	IEEE 802 11 channel number	Channel spacing	Default data rate	TX power limit	TX power density limit
G5-SCH7	Several in the band 5 470 MHz to 5 725 MHz	94 to 145	several	dependent on channel spacing	30 dBm EIRP (DFS master)	17 dBm/MHz
					23 dBm EIRP (DSF slave)	10 dBm/MHz
G5-SCH4	5 860 MHz	172	10 MHz	6 Mbit/s	0 dBm EIRP	−10 dBm/MHz
G5-SCH3	5 870 MHz	174			23 dBm EIRP	13 dBm/MHz
G5-SCH1	5 880 MHz	176			33 dBm EIRP	23 dBm/MHz
G5-SCH2	5 890 MHz	178		12 Mbit/s	23 dBm EIRP	13 dBm/MHz
G5-CCH	5 900 MHz	180		6 Mbit/s	33 dBm EIRP	23 dBm/MHz
G5-SCH5	5 910 MHz	182			0 dBm EIRP	−10 dBm/MHz
G5-SCH6	5 920 MHz	184				

F.2.2 Middle East

Details to be presented in a future version of this document.

F.2.3 Africa

Details to be presented in a future version of this document.

F.2.4 The former Soviet Union, including Siberia; and Mongolia

Details to be presented in a future version of this document.

F.3 Region 2

Details to be presented in a future version of this document.

F.4 Region 3

Details to be presented in a future version of this document.