INTELSAT EARTH STATION STANDARDS (IESS)

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PERFORMANCE CHARACTERISTICS FOR DEMAND ASSIGNED MULTIPLE ACCESS (DAMA) DIGITAL CARRIERS

(Standard A, B, F and H Earth Stations)

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TABLE OF CONTENTS PAGE

TABLE OF CONTENTS PAGE

LIST OF TABLES Page

LIST OF FIGURES PAGE

INTELSAT EARTH STATION STANDARDS (IESS)

PERFORMANCE CHARACTERISTICS FOR DEMAND ASSIGNED MULTIPLE ACCESS (DAMA) DIGITAL CARRIERS

1. INTRODUCTION

This document provides the performance characteristics for Demand Assigned Multiple Access (DAMA) digital carriers for operation with Standard A, B, F–3, F–2, F–1, H–4, H–3 and H–2* earth stations accessing the Intelsat VI, VIII and IX series of satellites.

This document is intended to assist users in planning their earth station RF equipment and terrestrial network interfaces for operating with the Intelsat–Managed DAMA system and its Network Management Control Center.

2. GENERAL DEMAND ASSIGNED MULTIPLE ACCESS (DAMA) SYSTEM REQUIREMENTS

2.1 System Description

The Intelsat DAMA system consists of at least one network management and control center (NMCC) per network and of a number of DAMA traffic terminals. Day–to–day network operations and management are performed from the DAMA Headquarters Management Facility (HQMF), which is part of the Intelsat Operations Center in Washington, D.C., U.S.A. The system is capable of operating in C–band Global beam transponders as well as those Hemispheric beam transponders that are configured for loopback operation. Carrier access to the satellite transponders is frequency division multiple access (FDMA), with Demand Assignment on a call–by–call basis.

The basic communication services that are supported include information rates† of 8 kbit/s‡ for voice service using CS–ACELP (conjugate–structure algebraic code excited linear predictive coding), 16 kbit/s using LD–CELP (low–delay code excited linear predictive coding) for voice, facsimile and voice–band data and 64 kbit/s for switched digital data. Higher information rates of n x 64 kbit/s up to 8.448 Mbit/s can also be supported subject to capacity availability. The DAMA system is a multi–node network where circuits are established between two nodes in a mesh configuration upon demand. The connectivity is

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* The Standard H–1 designation has been reserved for future use. Standard H–2 is not available for Global beam operation.

† The information rate is defined as the bit rate entering the modem/FEC (forward error correction) subsystem, prior to the application of FEC.

‡ Offered in the Hemispheric beam to support domestic rural telephony and will not be used for International PSTN.

subject to network routing parameters, and is limited by the off–axis emission limitations of Rec. ITU–R S.524–7.

Call setup and termination are accomplished via control messages exchanged between the NMCC and the traffic earth stations. Upon receipt of a call request message from a traffic earth station, the NMCC assigns connection details to the calling and called terminals, subject to satellite circuit availability within permitted connectivities. The connection assignment information contained in the NMCC control messages is utilized by the DAMA terminal equipment to automatically tune to the assigned operating frequencies and to automatically set the transmit EIRP. The control messages also convey system management information.

When a call is terminated, the connection is released and the associated resources returned to a common resource pool.

2.2 DAMA Carrier Characteristics

Three types of carriers are transmitted by an Intelsat DAMA traffic earth station: traffic carrier, control carrier, and engineering service (ESC) carrier. All earth stations in the DAMA network shall be capable of transmitting and receiving traffic and control carriers. All Standard A, B, and F–3 DAMA earth stations shall be equipped for transmitting and receiving ESC carriers.

The traffic carriers in the Intelsat DAMA system employ QPSK modulation operating at information rates of 16 kbit/s and n x 64 kbit/s (with n = any integer ranging from 1 to 132) and BPSK modulation operating at an information rate of 8 kbit/s.

The Control carrier for control messages between a traffic earth station and the NMCC employ either QPSK or BPSK modulation and normally operate at the information rate of 19.2 kbit/s*. Control carriers are transmitted to the relatively large NMCC station operate in random burst mode (ALOHA) and are not expecting to contribute significantly to the DAMA earth station's total transmit EIRP requirement.

The ESC carrier operates at an information rate of 16 kbit/s and employs QPSK modulation.

Table 1 provides the traffic carrier information rates and their corresponding performance objectives. DAMA carriers may share transponders with carriers employing other approved modulation techniques and/or with other DAMA networks.

* 8 kbit/s voice service uses 16 kbit/s control carrier.

3. EQUIVALENT ISOTROPICALLY RADIATED POWER (EIRP)

DAMA earth station high power amplifier's (HPAs) shall be sized to meet the maximum EIRP values shown in Table 2 through Table 4 and the emission constraints of Section 4.

A DAMA earth station may operate with a variety of receive earth station standards ranging from Standard A to Standard H–2*. The maximum required EIRP is determined by the maximum information rate and/or smallest receive earth station anticipated in the communications. In addition, the sizing of the earth station HPA should take into account the number and types of DAMA carriers as well as other Intelsat approved carriers that may need to be transmitted simultaneously.

3.1 EIRP Correction Factors

The EIRP values listed in Table 2 through Table 4 apply to earth stations with a 10º elevation angle and that are located at the edge of the satellite beam coverage. For elevation angles other than 10º and earth station locations other than at satellite beam edge coverage, the EIRP correction factors K_1 and K_2 given in IESS–402 (EIRP Correction Factors) can be used to reduce the maximum required EIRP.

Intelsat may from time–to–time either change the location of a satellite or require an earth station to transfer operations from one satellite to another. In addition, correspondent earth stations may change. These changes may result in new correction factors such that the EIRP requirements may increase, but within the limits of Table 2 through Table 4. These factors and anticipated future traffic growth should be considered in the design of the earth station transmitting equipment.

3.2 EIRP Dynamic Adjustment

The required EIRP per carrier during clear–sky condition is a function of the satellite sensitivity, the geographic location of the transmit earth station, the receive earth station G/T and the carrier information rate. The NMCC commands the DAMA channel unit to an appropriate IF transmit level, on a call–by–call basis, which will translate to the required earth station EIRP for each carrier.

3.3 EIRP Stability

Tropospheric scintillation can occur in C–Band under both adverse weather and clear weather conditions. The effects of scintillation may be significant on links having elevation angles less than 20º. On links having elevation angles near 5º, scintillation effects can be severe. Antennas employing active tracking on low elevation paths may experience antenna mispointing or may transmit excessive EIRP levels when uplink power control is employed. The use of program

* Standard H–2 earth station is not available for Global beams.

tracking is, therefore, highly recommended on links operating with elevation angles less than 20º for those periods when tropospheric scintillation is severe. Program tracking is also recommended as the primary tracking method for antennas with elevation angles below 10º.

The EIRP in the direction of the satellite shall, under clear–sky condition and light wind, meet the stability requirements of Table 5. This tolerance includes all factors causing variation, such as HPA output power instability, frequency response of the uplink transmit equipment across the bandwidth allocated for DAMA operation, transmitting equipment gain instability and antenna tracking error, added on a root–sum–square basis.

4. EMISSION CONSTRAINTS

4.1 Spurious Emissions Within The Satellite Band (5,850 to 6,425 MHz and 14,000 to 14,500 MHz)

4.2 Off–Axis Emission Constraint and Allowable Connectivity

The maximum EIRP radiated by an earth station is constrained by Rec. ITU–R S.524–7 off–axis emission density limit. Table 6 through Table 13 identify the allowable earth station–to–earth station connectivities on a bi–directional duplex circuit basis, for the DAMA carrier services defined herein, and for each satellite beam type.

The connectivity constraints are based on satellite beam edge parameters and the earth station sidelobe radiation patterns described in IESS–207. These connectivity constraints can be relaxed if earth stations have certain geographical advantage and/or have demonstrated sidelobe radiation patterns that are better than those described in IESS–207. The programming of the allowable earth station–to–earth station paths at the NMCC is performed and controlled by Intelsat.

4.2.1 Spurious Emissions (Except Intermodulation Products)

DAMA services are presently envisioned on Intelsat VI, VIII and IX. The EIRP outside of the satellite bandwidth unit allocated for DAMA services, which results from spurious tones, bands of noise, or other undesirable signals, but excluding the multicarrier intermodulation products and spectral spreading due to earth station non–linearities, shall not exceed 4 dBW in any 4 kHz band within the following frequency ranges:

Operating Satellite	Frequency Range
Intelsat VI, VIII & IX	5,925 to 6,425 MHz

4.2.2 Spurious Emissions – Intermodulation Products

The mandatory EIRP limits for intermodulation products resulting from multicarrier operation of the earth station wideband RF equipment are addressed in a separate module (IESS–401).

4.2.3 RF Out–of–Band Emission (Carrier Spectral Sidelobes)

To limit interference into adjacent carriers, the EIRP density outside of the satellite bandwidth unit allocated for each carrier resulting from spectral re–growth due to earth station nonlinearities measured in a 4 kHz band shall be at least 26 dB below the main carrier spectral density when transmitted from a Standard A, B or F earth station and at least 23 dB below the main carrier spectral density for transmissions from a Standard H earth station.

The above limits apply only to the spectral sidelobes, which may experience re–growth due to earth station nonlinearities. The EIRP density in the frequency range from 0.35R to 0.5R Hz away from the nominal center frequency shall be at least 16 dB below the peak EIRP density, measured in a 4 kHz band where R is the channel transmission rate*.

In order to meet the requirements in this section and to ensure satisfactory system performance, it is recommended that the HPA output backoff be maintained to at least 3 dB at all times.

4.3 Unwanted Emissions Outside The Satellite Band

The definition of unwanted emissions (out–of–band and spurious) from both earth stations and spacecraft operating in the Fixed Satellite Service (FSS) are defined in Chapter 1 of the Radio Regulations, Nos. 1.144 and 1.145, respectively.

The out–of–band (OOB) domain comprises the region extending from the edge of the earth station amplifier's passband to the boundary between the OOB domain and the spurious domain. This boundary is normally located at a frequency offset from the edge of earth station high power amplifier's passband that is equal to twice the amplifier's bandwidth. The spurious emissions domain extends from the boundary with the OOB domain outwards. (Refer to Recommendations ITU–R SM.329–9, SM.1539 and SM.1541.)

Users should note that national regulators may impose additional domestic constraints on earth stations beyond those listed in this section. Users should, therefore, consult with their domestic regulatory authority to determine if such limits exist and to comply with them.

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* The channel transmission rate, R, is defined as the information rate divided by the FEC rate.

4.3.1 Out–Of–Band (OOB) Emissions

The Radio Regulations provide some general guidance on the need to limit OOB emissions to protect those services operating in the adjacent frequency bands (see RR No. 4.5).

The level of undesirable emissions in the out–of–band (OOB) domain should conform with the requirements of Annex 5 of ITU–R Recommendation SM.1541.

4.3.2 Spurious Emissions in the Spurious Domain – For Earth Stations Brought Into Service After 1 January 2003

All earth stations brought into service after 1 January 2003 shall ensure that spurious emissions in the spurious domain meet the mandatory requirements of Section 2 of Appendix 3 of the Radio Regulations.

4.3.3 Spurious Emissions in the Spurious Domain – For All Earth Stations After 1 January 2012

After 1 January 2012, all earth stations shall meet the mandatory requirement of Section 2 of Appendix 3 of the Radio Regulations.

5. FREQUENCY TOLERANCES AND SPECTRUM INVERSION

5.1 Carrier RF Tolerance

The carrier frequency tolerance limit specified below shall apply to the frequency instability attributable to the earth station RF equipment alone. Improvement realized in the frequency stability due to the DAMA network AFC (Automatic Frequency Control) system shall not be assumed in the following specifications.

The maximum RF tolerance (maximum uncertainty of initial frequency adjustment plus long–term drift) on all DAMA earth station transmitted carriers shall be ± 2 kHz. Long term is assumed to be at least six months.

The earth station receive chain frequency stability should be consistent with the frequency acquisition and tracking range of the demodulator. However, in order for AFC to operate properly, the maximum frequency tolerance of the earth station receive chain equipment on all DAMA receive carriers shall not exceed ± 2.0 kHz.

5.2 Satellite Transponder Frequency Tolerance

The translation frequency tolerance due to the satellite should be assumed to be no worse than ± 25 kHz for the Intelsat VI, VIII and IX satellites over their lifetime. The translation frequency tolerance over any one–month is typically about ± 2.5 kHz for Intelsat satellites.

5.3 Spectrum Inversion

The transmitted RF carrier spectrum shall not be inverted with respect to the modulator output spectrum.

6. OPERATING BANDWIDTH AND FREQUENCY TUNING CAPABILITY

The earth station transmit and receive subsystems shall permit the DAMA equipment to operate over a range of ± 18 MHz (36 MHz total). The center frequency of this ± 18 MHz operating range shall be tunable over the entire frequency range of (5,925 – 6,425)/(3,700 – 4,200 MHz) in steps of 2.5 MHz, starting from 5,925/3,700 MHz, plus the fine–tuning capability to meet the RF tolerance requirements in Section 5.1.

7. PHASE NOISE

7.1 Earth Station (Transmit)

The single sideband phase noise on the transmitted carrier shall satisfy either of the following two limits:

Limit 1: The single sideband phase noise is assumed to consist of a continuous component and a spurious component. The single sideband power spectral density of the continuous component shall not exceed the envelope shown in Figure 1 for DAMA carriers with information rates less than or equal to 32 kbit/s (i.e., 8 kbit/s and 16 kbit/s.) The required spectral density mask or carriers with information rates greater than 32 kbit/s shall follow the corresponding Limit 1 phase noise requirement in IESS–308 (IDR).

A spurious component at the fundamental AC line frequency shall not exceed –30 dB relative to the level of the transmitted carrier. The single sideband sum (added on a power basis) of all other individual spurious components shall not exceed –36 dB relative to the level of the transmitted carrier. (The total phase noise including both sidebands can be up to 3 dB higher);

or

Limit 2: The single sideband phase noise due to both the continuous and spurious components integrated over the bandwidth 100 Hz to 0.3 R Hz away from the center frequency, where R is the maximum carrier transmission rate in bits per second (after FEC is applied) that will be transmitted from the DAMA earth station, shall not exceed 2.2 degrees RMS. The total phase noise due to both sidebands shall not exceed 2.8 degrees RMS.

The option of satisfying either of these two limits has been provided in recognition of the possibility that the phase noise spectrum can have various distributions which, when integrated, will have the same overall effect.

7.2 Earth Station (Receive)

The phase noise performance of the earth station shall be consistent with the proper operation of the carrier recovery system of the demodulator given the allowable phase noise contribution of the corresponding earth station and that expected from the satellite. Users are referred to the IESS–400 series of modules for information on the expected phase noise contribution from the satellite. As a minimum, it is recommended that the phase noise requirements specified in Section 7.1 be also met for the earth station receive equipment.

8. CARRIER LINE–UP AND IN–SERVICE MONITORING

As a minimum, the requirement for initial line–up may be satisfied by a provision for measuring the EIRP of the transmitted carrier and the E_b/N_0 of the received carrier (either with a spectrum analyzer or through a filter of known noise bandwidth).

One or more of the DAMA traffic channels will be selected by Intelsat for use during the line–up tests. Continuous transmission of DAMA test carriers is used during carrier line–up under NMCC command. The full procedures covering the DAMA carrier line–up are contained in SSOG–311, Part 1.

In–service carrier performance is performed via periodic reporting of carrier performance from the DAMA traffic earth stations and is collected at the NMCC. Long–term trending or statistical analysis may be performed by Intelsat.

9. INTERFACES (NOT APPLICABLE TO 8 KBIT/S SERVICE)

9.1 IF Interface

The interface of the earth station upchain and downchain RF equipment to the DAMA traffic terminal at IF equipment shall comply with the following requirements:

Center frequency:	70 MHz or optionally 140 MHz*
Bandwidth:	± 18 MHz
Characteristic impedance	50 Ohm:
Return loss:	20 dB minimum
Transmit level range:	–20 dBm to –40 dBm (per 16 kbit/s carrier at the IF terminal output)
Nominal receive level	–53.6 dBm (per 16 kbit/s carrier at the IF terminal input)

* Via a 70/140 MHz converter (not included in the basic DAMA terminal).

Maximum receive level	–25 dBm (Total aggregate power level at terminal input)

9.2 Terrestrial Interface*

9.2.1 Digital Interface

9.2.1.1 Physical and Electrical Characteristics

The Digital terrestrial interface to the DAMA equipment shall be at 2.048 Mbit/s with physical and electrical interface characteristics meeting Rec. ITU–T G.703. Terrestrial clock timing towards the interconnected terrestrial network shall be selectable from one of the following sources:

(i) clock recovered from the received terrestrial 2.048 Mbit/s stream

(ii) local DAMA terminal timing source

(iii) central DAMA network timing

(iv) local earth station timing source

9.2.1.2 Frame Structure

The frame structure of the terrestrial digital interface shall comply with Rec. ITU–T G.704 for a 30 PCM channel multiplex. The G.704 16–frames multiframe structure shall be used by default. A–law companding for the voice frequency signals in time–slots 1–15 and 17–31 shall be provided as per Rec. ITU-T G.711.

Channel time–slot 0 is used for frame alignment, alarm indication and other purposes. Channel time–slot 16 shall be assumed unavailable for traffic.

Intelsat, through the DAMA Headquarters Management Facility and the NMCC, will provide, in the future, the capability for downloading the configuration data used for remotely mapping the E–1 traffic time–slots to DAMA channel units.

9.2.2 Analog 4–Wire Trunk Interface Characteristics

9.2.2.1 Characteristic Impedance

The input and output impedance of the terrestrial system connected to the DAMA terrestrial voice channels across the 300–3400 Hz voiceband shall be nominally 600 Ohms (balanced) with a return loss not less than 20 dB.

* The relative level in [dBr] is equivalent to the Transmission Level Point [TLP] in [dB].

9.2.2.2 Relative Audio Power Level Adjustment

The relative audio level of the interface, in the direction incoming from the terrestrial circuit into the DAMA channel unit shall have an adjustable range of + 10 to –20 dBr in 1 dB steps.

The relative level of the interface, in the direction outgoing from the DAMA channel unit to the terrestrial circuit shall have an adjustable range of +13 to -17 dBr in 1 dB steps.

9.2.2.3 Trunk Signalling

For international telephony, the terrestrial system connected to the DAMA traffic terminal shall support in–band ITU–T No. 5 trunk signalling system, as defined in the relevant ITU–T Recommendations summarized in Table 15*.

9.2.3 Analog 4–Wire PBX Telephone Interface Characteristics

9.2.3.1 Characteristic Impedance

The input and output impedances of the terrestrial system connected to the DAMA terrestrial voice channels pertaining to the 4–wire Tip and Ring leads across the 300 – 3400 Hz voiceband shall be nominally 600 Ohms (balanced) with a return loss not less than 20 dB.

9.2.3.2 Power Level Adjustment

The relative level of the interface, in the direction incoming from the PBX into the DAMA channel unit shall have an adjustable range of +10 to –20 dBr in 1 dB steps. The relative level of the interface, in the direction outgoing from the DAMA channel unit to the PBX shall have an adjustable range of +13 to –17 dBr in 1 dB steps.

9.2.3.3 DC Interfaces

E and M leads for supervisory and address signalling, signal battery and signal ground shall be provided by the terrestrial system connected to the DAMA voice channel units.

9.2.3.4 Signalling

The terrestrial system connected to the DAMA traffic terminal shall support E and M types I–V line signalling pulse and DTMF register signalling.

* Other trunk signalling systems can be supported on a case–by–case basis.

9.2.4 Analog 2–Wire Subscriber Telephone Interface Characteristics

9.2.4.1 Characteristic Impedance

The input and output impedances of the terrestrial system connected to the DAMA terrestrial channels across the 300 – 3400 Hz voiceband shall be nominally 600 Ohms (balanced) with a return loss not less than 20 dB.

9.2.4.2 Power Level Adjustment

The relative level of the interface, in the direction incoming from the subscriber telephone into the DAMA channel unit shall have an adjustable range of +10 to -20 dBr in 1 dB steps.

The relative level of the interface, in the direction outgoing from the DAMA channel unit to the subscriber telephone shall have an adjustable range of +13 to –17 dBr in 1 dB steps.

9.2.4.3 Line Signalling

The 2–wire subscriber telephone interface shall be selectable as either a loop start interface or a ground start interface by the terrestrial system connected to the DAMA channel units.

9.2.4.4 Register Signalling

The terrestrial system connected to the DAMA terminal shall provide both DTMF and pulse signalling on a selectable basis.

9.2.5 Asynchronous Data Interface

The terrestrial system connected to the DAMA terminal's data interface shall comply with Rec. ITU–T V.24 and the electrical characteristics of Rec. ITU–T V.28 (equivalent to RS–232). The necessary sub–set of Rec. ITU–T V.24 circuits may be found in Rec. ITU–T V.32. The asynchronous data interface shall provide the configuration alternatives listed in Table 14.

9.2.6 Synchronous Data Interface

The terrestrial system connected to the DAMA terminal's data interface shall comply with either Rec. ITU–T V.11 or Rec. ITU–T V.35. It shall be possible to configure the synchronous data interface for either internal or external timing.

9.2.7 Synchronous 64 kbit/s Switched Data Interface

The terrestrial DTE connected to the DAMA terminal for synchronous 64 kbit/s switched data service shall comply with RS–232–D electrically and Rec. ITU–T V.25bis for on–demand circuit setup/termination.

10. ENGINEERING SERVICE CIRCUITS (ESC)

10.1 ESC Requirements For Standard A, B, and F–3 Earth Stations

The Intelsat DAMA network includes an ESC sub–network as a closed DAMA Network User Group (NUG). ESC connectivity is between all DAMA terminals equipped with a dedicated ESC channel unit and a DAMA terminal and the IOC/HQMF. Access to/from the IOC/HQMF (Headquarters Management Facility) will be through the NMCC or other designated earth stations, acting as ESC gateways.

DAMA terminals operating with Standard A, B, and F–3 earth stations shall be part of the Intelsat switched DAMA ESC sub–network. One DAMA channel unit per DAMA terminal shall be dedicated to ESC.

Depending on local earth station ESC arrangements, the DAMA ESC Channel Unit can be configured for connection either to a local ESC terminal (phone/fax combination) through a 2–wire subscriber line interface, or to the earth station ESC PBX through a 4–wire E and M extension. Signalling conversion is required for interfacing to the existing Intelsat 4–wire ESC network with single 2280 Hz tone signalling (IESS–403).

Intelsat coordinates ESC address assignments to DAMA traffic terminals and will centrally configure the ESC Channel Unit profile and addressing as part of the DAMA ESC NUG management.

The ESC carrier employs QPSK modulation and operates at an information rate of 16 kbit/s for voice.

10.2 ESC Requirements For Standard F–2, F–1, H–4, H–3 and H–2 Earth Stations

In view of the numerous earth stations accessing the space segment on a multiple access (simultaneous) basis, any variation in transmit RF frequency, transmit EIRP and antenna tracking could cause interference with other services or cause hazardous conditions in the space segment. Accordingly, it is mandatory that earth stations be controlled at all times to avoid such interference.

This requirement is considered to be satisfied when earth stations are attended 24-hours per day by operating personnel capable of adjusting frequency, EIRP, and tracking, as required. In the event stations are not manned on a 24–hour per day basis, this requirement is considered to be satisfied when a positive means is available (remotely or otherwise) for immediately turning off RF carriers which are interfering with services or creating hazardous conditions in the space segment.

Table 1

CARRIER PERFORMANCE OBJECTIVES (INTELSAT DAMA SYSTEM)

Parameter				Units
1. Information Rate	8	16	64	kbit/s
2. FEC Rate	3/4	3/4	1/2	
3. Modulation	BPSK	QPSK	QPSK	
4. Noise BW	10.7	10.7	64.0	kHz
5. Allocated BW / Channel Spacing*	17.5	17.5	90.0	kHz
6. Threshold (Minimum Performance)				
– BER	10^{-3}	10^{-6}	10^{-6}	dB
– Eb/No	6.1	8.9	7.5	dB
– C/T	–183.5	–177.7	–173.0	dBW/K
7. Margin to Threshold	2.0	2.0	2.0	dB
8. Clear Sky Performance				
– BER	2×10^{-6}	10^{-9}	10^{-11}	
– C/T	–181.5	–175.7	–171.0	dBW/K
9. Link Availability (w.r.t. Threshold)	99.9	99.9	99.9	% of year

* These are nominal carrier channel spacing values. Intelsat reserves the right to change these carrier channel spacing values as operational requirement dictates.

Table 2

Maximum Earth Station EIRP* Requirements For Operation With Intelsat VI, (dBW) †

Beam	Info. Rate (kbit/s)	Receive Earth Station						
		A	B	F–3	F–2	F–1	H–4	H–3
Global	16	48.4	49.7	51.2	52.9	56.4	56.9	60.5
	64‡	53.1	54.4	55.9	57.6	61.1	61.6	65.2

* The maximum EIRPs have been computed using a beam–edge saturation flux density of -77.6 dBW/m^2 for the Global beam.

† The maximum EIRPs shown in the above table assume the transmit and receive earth stations are located at beam edge.

‡ EIRP requirements for n x 64 kbit/s (n = 2 to 132) carrier will be defined, upon request, by Intelsat.

Table 3

Maximum Earth Station EIRP* Requirements For Operation With Intelsat VIII, (dBW)†

Beam	Info. Rate (kbit/s)	Receive Earth Station							
		A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	16	48.3	49.8	51.4	53.2	56.8	57.4	61.0	N/A‡
	64§	53.0	54.5	56.1	57.9	61.5	62.1	65.7	N/A
Hemi	8	36.5	37.0	37.7	38.6	40.9	41.3	44.3	47.1
	16	42.3	42.8	43.5	44.4	46.7	47.1	50.1	52.9
	64§	47.0	47.5	48.2	49.1	51.4	51.8	54.8	57.6

* The maximum EIRPs have been computed using a beam–edge saturation flux density of -77.0 dBW/m^2 for the Global beam and –82.5 dBW/m^2 for the Hemi beam.

† The maximum EIRPs shown in the above table assume the transmit and receive earth stations are located at beam edge. The maximum EIRPs for the Hemi beam can be 2 to 3 dB lower than the EIRPs shown in the table since the majority of earth stations are located within the 2 dB contour from beam edge.

‡ N/A = Not Available.

§ EIRP requirements for n x 64 kbit/s (n = 2 to 132) carrier will be defined, upon request, by Intelsat.

Table 4

Maximum Earth Station EIRP* Requirements For Operation With Intelsat IX, (dBW) †

Beam	Info. Rate (kbit/s)	Receive Earth Station							
		A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	16	46.4	47.1	48.2	49.5	52.4	52.9	56.3	N/A‡
	64§	51.1	51.8	52.9	54.2	57.1	57.6	61.0	N/A
Hemi	8	36.9	37.2	37.7	38.6	40.5	40.8	43.6	46.2
	16	42.7	43.0	43.5	44.4	46.3	46.6	49.4	52.0
	64§	47.4	47.7	48.2	49.1	51.0	51.3	54.1	56.7

* These maximum EIRP values have been computed using a beam–edge saturation flux density of -81.0 dBW/m^2 for the Global beam and –83.0 dBW/m^2 for the Hemi beam.

† The maximum EIRPs shown in the above table assume the transmit and receive earth stations are located at beam edge.

‡ N/A = Not Available.

§ EIRP requirements for n x 64 kbit/s (n = 2 to 132) carrier will be defined, upon request, by Intelsat.

Table 5

EIRP STABILITY REQUIREMENTS

Earth Station	Maximum Permitted EIRP Variation, dB
A	±0.75
B	±0.75
F–3	±1.6
F–2	±1.6
F–1	±1.6
H–4	±1.6
H–3	±1.6
H–2	±1.6

Table 6

Intelsat VI DAMA Earth Station Off–Axis Emission Margins
(16 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3
Global	A	16.7	14.2	11.7	10.1	5.7	4.0	–2.8
	B	15.4	12.9	10.4	8.8	4.4	2.7	–4.1
	F–3	13.9	11.4	8.9	7.3	2.9	1.2	–5.6
	F–2	12.2	9.7	7.2	5.6	1.2	–0.5	–7.3
	F–1	8.7	6.2	3.7	2.1	–2.3	–4.0	–10.8
	H–4	8.2	5.7	3.2	1.6	–2.8	–4.5	–11.3
	H–3	4.6	2.1	–0.4	–2.0	–6.4	–8.1	–14.9

<u>NOTES</u>:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –77.6 dBW/m^2 for the Global beam.
2. The above margins are applicable to transmissions between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin.

Table 7

Intelsat VI DAMA Earth Station Off–Axis Emission Margins
(64 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3
Global	A	19.8	17.3	14.8	13.2	8.8	7.1	0.3
	B	18.5	16.0	13.5	11.9	7.5	5.8	–1.0
	F–3	17.0	14.5	12.0	10.4	6.0	4.3	–2.5
	F–2	15.3	12.8	10.3	8.7	4.3	2.6	–4.2
	F–1	11.8	9.3	6.8	5.2	0.8	–1.0	–7.7
	H–4	11.3	8.8	6.3	4.7	0.3	–1.5	–8.2
	H–3	7.7	5.2	2.7	1.1	–3.4	–5.1	–11.8

NOTES:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –77.6 dBW/m^2 for the Global beam.
2. The above margins are applicable to transmissions between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin.

Table 8

Intelsat VIII DAMA Earth Station Off–Axis Emission Margins
(8 kbit/s)

Beam	Rx E/S	Transmit E/S: A	B	F–3	F–2	F–1	H–4	H–3	H–2
Hemi	A	28.6	26.1	23.6	22.0	17.6	15.9	9.1	6.6
	B	28.1	25.6	23.1	21.5	17.1	15.4	8.6	6.1
	F–3	27.4	24.9	22.4	20.8	16.4	14.7	7.9	5.4
	F–2	26.5	24.0	21.5	19.9	15.5	13.8	7.0	4.5
	F–1	24.2	21.7	19.2	17.6	13.2	11.5	4.7	2.2
	H–4	23.8	21.3	18.8	17.2	12.8	11.1	4.3	1.8
	H–3	20.8	18.3	15.8	14.2	9.8	8.1	1.3	–1.2
	H–2	18.0	15.5	13.0	11.4	7.0	5.3	–1.5	–4.0

NOTES:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –82.5 dBW/m^2 for the Hemi beam.
2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin. The margin of the Hemi beam can be 2 to 3 dB better than the margin shown in the table, since the majority of earth stations are located within the 2 dB contour from beam edge.

Table 9

Intelsat VIII DAMA Earth Station Off–Axis Emission Margins
(16 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	A	16.8	14.3	11.8	10.2	5.8	4.1	–2.7	N/A
	B	15.3	12.8	10.3	8.7	4.3	2.6	–4.2	N/A
	F–3	13.7	11.2	8.7	7.1	2.7	1.0	–5.8	N/A
	F–2	11.9	9.4	6.9	5.3	0.9	–0.8	–7.6	N/A
	F–1	8.3	5.8	3.3	1.7	–2.7	–4.4	–11.2	N/A
	H–4	7.7	5.2	2.7	1.1	–3.3	–5.0	–11.8	N/A
	H–3	4.1	1.6	–0.9	–2.5	–6.9	–8.6	–15.4	N/A
Hemi	A	22.8	20.3	17.8	16.2	11.8	10.1	3.3	0.8
	B	22.3	19.8	17.3	15.7	11.3	9.6	2.8	0.3
	F–3	21.6	19.1	16.6	15.0	10.6	8.9	2.1	–0.4
	F–2	20.7	18.2	15.7	14.1	9.7	8.0	1.2	–1.3
	F–1	18.4	15.9	13.4	11.8	7.4	5.7	–1.1	–3.6
	H–4	18.0	15.5	13.0	11.4	7.0	5.3	–1.5	–4.0
	H–3	15.0	12.5	10.0	8.4	4.0	2.3	–4.5	–7.0
	H–2	12.2	9.7	7.2	5.6	1.2	–0.5	–7.3	–9.8

NOTES:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –77.0 dBW/m^2 for the Global Beam and –82.5 dBW/m^2 for the Hemi Beam.
2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin. The margin of the Hemi beam can be 2 to 3 dB better than the margin shown in the table since the majority of earth stations are located within the 2 dB contour from beam edge.

Table 10

Intelsat VIII DAMA Earth Station Off–Axis Emission Margins
(64 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	A	19.9	17.4	14.9	13.3	8.9	7.2	0.4	N/A
	B	18.4	15.9	13.4	11.8	7.4	5.7	–1.1	N/A
	F–3	16.8	14.3	11.8	10.2	5.8	4.1	–2.7	N/A
	F–2	15.0	12.5	10.0	8.4	4.0	2.3	–4.5	N/A
	F–1	11.4	8.9	6.4	4.8	0.4	–1.4	–8.1	N/A
	H–4	10.8	8.3	5.8	4.2	–0.3	–2.0	–8.7	N/A
	H–3	7.2	4.7	2.2	0.6	–3.9	–5.6	–12.3	N/A
Hemi	A	25.9	23.4	20.9	19.3	14.9	13.2	6.4	3.9
	B	25.4	22.9	20.4	18.8	14.4	12.7	5.9	3.4
	F–3	24.7	22.2	19.7	18.1	13.7	12.0	5.2	2.7
	F–2	23.8	21.3	18.8	17.2	12.8	11.1	4.3	1.8
	F–1	21.5	19.0	16.5	14.9	10.5	8.8	2.0	–0.5
	H–4	21.1	18.6	16.1	14.5	10.1	8.4	1.6	–0.9
	H–3	18.1	15.6	13.1	11.5	7.1	5.4	–1.4	–3.9
	H–2	15.3	12.8	10.3	8.7	4.3	2.6	–4.2	–6.7

NOTES:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –77.0 dBW/m^2 for the Global beam and –82.5 dBW/m^2 for the Hemi beam.
2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin. The margin of the Hemi beam can be 2 to 3 dB better than the margin shown in the table since the majority of earth stations are located within the 2 dB contour from beam edge.

Table 11

Intelsat IX DAMA Earth Station Off–Axis Emission Margins
(8 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3	H–2
Hemi	A	28.2	25.7	23.2	21.6	17.2	15.5	8.7	6.2
	B	27.9	25.4	22.9	21.3	16.9	15.2	8.4	5.9
	F–3	27.4	24.9	22.4	20.8	16.4	14.7	7.9	5.4
	F–2	26.5	24.0	21.5	19.9	15.5	13.8	7.0	4.5
	F–1	24.6	22.1	19.6	18.0	13.6	11.9	5.1	2.6
	H–4	24.3	21.8	19.3	17.7	13.3	11.6	4.8	2.3
	H–3	21.5	19.0	16.5	14.9	10.5	8.8	2.0	–0.5
	H–2	18.9	16.4	13.9	12.3	7.9	6.2	–0.6	–3.1

<u>NOTES</u>:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –83.0 dBW/m^2 for the Hemi beam.

2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.

3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.

4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin.

Table 12

Intelsat IX DAMA Earth Station Off–Axis Emission Margins
(16 kbit/s)

Beam	Rx	Transmit E/S							
	E/S	A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	A	18.7	16.2	13.7	12.1	7.7	6.0	–0.8	N/A
	B	18.0	15.5	13.0	11.4	7.0	5.3	–1.5	N/A
	F–3	16.9	14.4	11.9	10.3	5.9	4.2	–2.6	N/A
	F–2	15.6	13.1	10.6	9.0	4.6	2.9	–3.9	N/A
	F–1	12.7	10.2	7.7	6.1	1.7	0.0	–6.8	N/A
	H–4	12.2	9.7	7.2	5.6	1.2	–0.5	–7.3	N/A
	H–3	8.8	6.3	3.8	2.2	–2.2	–3.9	–10.7	N/A
Hemi	A	22.4	19.9	17.4	15.8	11.4	9.7	2.9	0.4
	B	22.1	19.6	17.1	15.5	11.1	9.4	2.6	0.1
	F–3	21.6	19.1	16.6	15.0	10.6	8.9	2.1	–0.4
	F–2	20.7	18.2	15.7	14.1	9.7	8.0	1.2	–1.3
	F–1	18.8	16.3	13.8	12.2	7.8	6.1	–0.7	–3.2
	H–4	18.5	16.0	13.5	11.9	7.5	5.8	–1.0	–3.5
	H–3	15.7	13.2	10.7	9.1	4.7	3.0	–3.8	–6.3
	H–2	13.1	10.6	8.1	6.5	2.1	0.4	–6.4	–8.9

NOTES:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –81.0 dBW/m^2 for the Global beam and –83.0 dBW/m^2 for the Hemi beam.
2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin.

Table 13

Intelsat IX DAMA Earth Station Off–Axis Emission Margins
(64 kbit/s)

Beam	Rx E/S	Transmit E/S A	B	F–3	F–2	F–1	H–4	H–3	H–2
Global	A	21.8	19.3	16.8	15.2	10.8	9.1	2.3	N/A
	B	21.1	18.6	16.1	14.5	10.1	8.4	1.6	N/A
	F–3	20.0	17.5	15.0	13.4	9.0	7.3	0.5	N/A
	F–2	18.7	16.2	13.7	12.1	7.7	6.0	–0.8	N/A
	F–1	15.8	13.3	10.8	9.2	4.8	3.1	–3.7	N/A
	H–4	15.3	12.8	10.3	8.7	4.3	2.6	–4.2	N/A
	H–3	11.9	9.4	6.9	5.3	0.9	–0.9	–7.6	N/A
Hemi	A	25.5	23.0	20.5	18.9	14.5	12.8	6.0	3.5
	B	25.2	22.7	20.2	18.6	14.2	12.5	5.7	3.2
	F–3	24.7	22.2	19.7	18.1	13.7	12.0	5.2	2.7
	F–2	23.8	21.3	18.8	17.2	12.8	11.1	4.3	1.8
	F–1	21.9	19.4	16.9	15.3	10.9	9.2	2.4	–0.1
	H–4	21.6	19.1	16.6	15.0	10.6	8.9	2.1	–0.4
	H–3	18.8	16.3	13.8	12.2	7.8	6.1	–0.7	–3.2
	H–2	16.2	13.7	11.2	9.6	5.2	3.5	–3.3	–5.8

<u>NOTES</u>:

1. The above off–axis emission margins have been computed using a beam–edge saturation flux density of –81.0 dBW/m^2 for the Global beam and –83.0 dBW/m^2 for the Hemi beam.
2. The above margins are applicable to transmission between earth stations located at beam edge and assume a transmit sidelobe gain characteristic of 29 – 25 log θ dBi. Earth stations having a sidelobe characteristic of 32 – 25 log θ dBi will have 3 dB less margin than indicated.
3. A positive margin indicates the extent to which the off–axis emission is below the maximum permitted levels of Rec. ITU–R 524–7. Transmission may be permitted for situations which are indicated above as having a negative margin, provided the transmit earth station has sufficient uplink pattern advantage and/or improved sidelobe performance.
4. Connectivities below the dashed line are not permitted since at least one direction of the duplex link has a negative margin.

Table 14

Asynchronous Data Interface Configuration Alternatives

Item	Configuration Alternatives
Data rates, bits/s	1200, 2400, 4800, 9600, 14400 and 19200
Data bits	7 or 8
Parity bits	none, even, odd, mark, and space
Stop bits	0, 1 or 2

Table 15

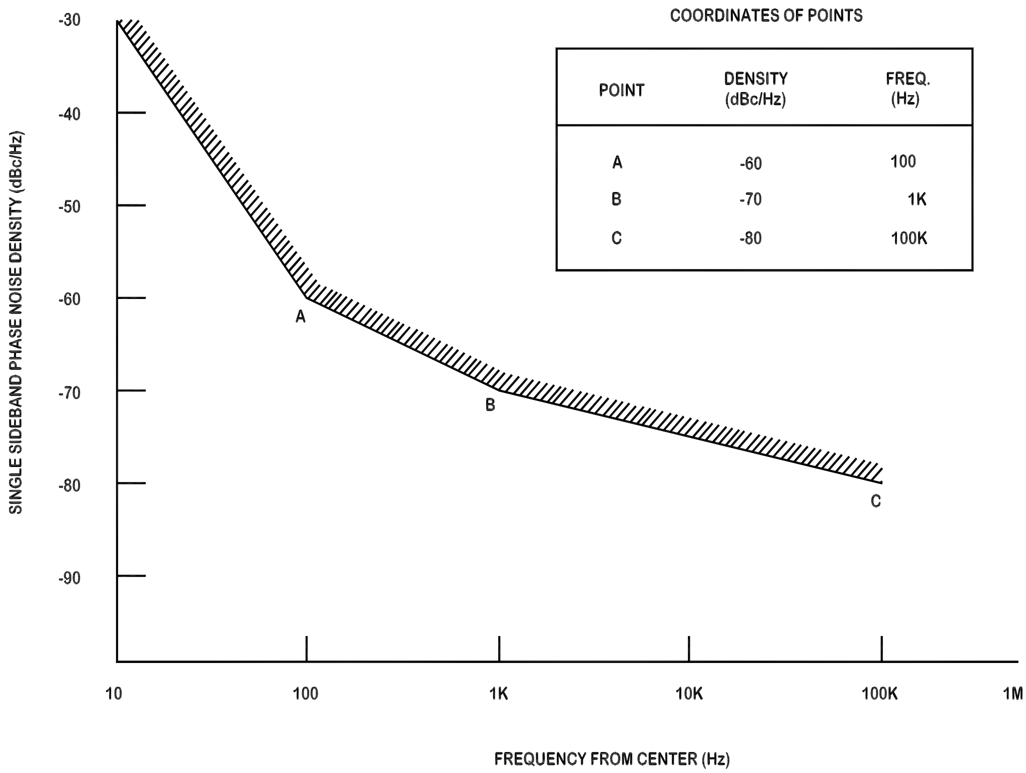
Relevant ITU–T No. 5 Signalling Recommendations

	Line Signalling	Register Signalling
Definition & Functions	Rec. Q.140	Rec. Q.140
Signal Code	Rec. Q.141	Rec. Q.151
Signal Transmission	Rec. Q.143	Rec. Q.153
Signal Reception	Rec. Q.144	Rec. Q.154
Splitting Arrangements	Rec. Q.145	Rec. Q.145
Dual Seizure	Rec. Q.142	
End of Pulsing		Rec. Q.152
Release Register		Rec. Q.156

Figure 1

Single Sideband Phase Noise Spectral Density

*



* THE TRANSMITTED PHASE NOISE REQUIREMENT MAY BE SATISFIED BY MEETING EITHER OF TWO LIMITS (SEE SECTION 7.1). THE ABOVE PHASE NOISE DENSITY REQUIREMENT IS MANDATORY ONLY IN THE CASE THAT LIMIT 1 HAS BEEN SELECTED BY THE USER.

P:\CAD\IESS\311-02.DWG
TITLE: SINGLE SIDEBAND PHASE NOISE SPECTRAL DENSITY
(For carriers with information rates less than or equal to 32 kbit/s)

APPENDIX A

ITU REFERENCES

Radiocommunication Sector Recommendations:

Rec. ITU–R S.524–7	Maximum Permissible Levels Of Off–Axis e.i.r.p. Density From Earth Stations In The Fixed–Satellite Service Transmitting In The 6 And 14 GHz Frequency Bands
Rec. ITU–R SM.329–9	Spurious Emissions
Rec. ITU–R SM.1539	Variation Of The Boundary Between The Out–Of–Band And Spurious Domains Required For The Application Of Recommendations ITU–R SM.1541 and ITU–R SM.329
Rec. ITU–R SM.1541	Unwanted Emissions In The Out–Of–Band Domain
Rec. ITU–R S.614–3	Allowable Error Performance For A Hypothetical Reference Digital Path In The Fixed–Satellite Service Operating Below 15 GHz When Forming Part Of An International Connection In An Integrated Services Digital Network

Telecommunication Standardization Sector Recommendations:

Rec. ITU–T G.703	Published 5 April 1991
Rec. ITU–T G.704	Published 5 April 1991
Rec. ITU–T G.711	Published 25 November 1988
Rec. ITU–T Q.140	Published 25 November 1988
Rec. ITU–T Q.141	Published 25 November 1988
Rec. ITU–T Q.142	Published 25 November 1988
Rec. ITU–T Q.143	Published 25 November 1988
Rec. ITU–T Q.144	Published 12 March 1993
Rec. ITU–T Q.151	Published 25 November 1988
Rec. ITU–T Q.152	Published 25 November 1988
Rec. ITU–T Q.153	Published 25 November 1988
Rec. ITU–T Q.154	Published 25 November 1988
Rec. ITU–T Q.156	Published 25 November 1988
Rec. ITU–T V.11	Published 12 March 1995
Rec. ITU–T V.24	Published 12 March 1995
Rec. ITU–T V.28	Published 12 March 1995
Rec. ITU–T V.32	Published 12 March 1995
Rec. ITU–T V.35	Published 25 November 1988

APPENDIX B

REVISION HISTORY

Revision No.	Approval Date	Major Purpose
Original	10 Nov 1995	• New module.
A	19 Feb 1996	• Update Tables 5(a) to 5(f) to include off–axis emission margin indicators.
1	11 May 2000	• Add Intelsat IX and delete Intelsat VII/VIIA and Hemispheric beams of Intelsat VI. • Delete Standard H–2 earth station for operation with Global beam transponders. • Introduce 8 kbit/s voice carriers and improve the service quality for 16 kbit/s and 64 kbit/s carriers. • Use the Leased transponder backoffs (IESS–410) to recalculate DAMA earth station EIRP requirements.
2	24 Oct 2003	• Modify to conform with Intelsat standard document format. • Add Radio Regulations requirements for unwanted emissions outside the satellite band.