SATELLITE TRANSMISSION
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Standard for
COMMUNICATION AND BROADCAST NETWORKS
for FSS/BSS

MANDATORY TECHNICAL INTERFACE REQUIREMENTS
No.TEC/ IR/SCB-08/03.OCT2013
(Supersedes No. TEC/ IR/SCB-08/02.SEP 2009)

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1.0 INTRODUCATION & SCOPE

1.1 This document contains the Mandatory Technical Requirements and Operational Requirements for all satellite based network for FSS, BSS services in the respective bands. Licences for two-way communication services will be issued by Department of Telecom and for one-way broadcasting applications by Ministry of Information & Broadcasting Authorities. The mandatory IRs contained in this document are technical requirements and the regulatory & legal requirements are specified in the Licence conditions. Necessary clearances shall have to be taken from DoT, MI&B, DoS, WPC, NOCC, and SACFA before commencing transmissions.

1.2 This document replaces and supersedes the IR document TEC/IR/SCB-08/02.SEP 2009 published by Telecom Engineering Centre, Department of Telecommunications, New Delhi.

1.3 The document also contains the basic guidelines to be adopted by an applicant for obtaining a Licence from DOT/MI&B and providing services through the INSAT/ any other satellite system.

1.4 The document recommends that the applicant should use the INSAT technical parameters given in Annexure-1 for link calculations, the link budget format as given in Annexure-2 and follow the procedure prescribed in Annexure-3. The latest ITU recommendations on antenna patterns are given as apart of the mandatory requirements for networks to be established by the applicant. Older networks using antennae which are coordinated for use as part of the INSAT system and which follow earlier ITU recommendations of off-axis patterns will continue in operation.

1.5 Satellite networks are expected to be used for Telecommunication and Broadcasting services including but not limited to two-way multi media applications, Intermediate Data Rate (IDR) channels, digital MCPC, closed user group (CUG) digital voice telephony, digital SCPC, video conferencing, Digital Satellite News Gathering (DSNG) with acknowledgement, Direct-To-Home (DTH) television with/without return channel, digital cinema, Digital Video Broadcast (DVB) with RCS, HD TV, 3D TV, satellite radio, digital audio broadcast, Tele-education, Tele-medicine, Tele-agriculture etc. The technical requirements are necessary for meeting international regulatory requirements and optimising the network resources.

2.0 APPLICABLE DOCUMENTS

2.1 ITU Recommendations

The list of current ITU recommendations for Transmit & Receive antenna patterns, off-axis EIRP, Spurious emission limits and control & Monitoring of VSAT Networks are given below:

2.1.1 ITU-R Recommendations S.580-6 (Off-axis transmit and receive radiation pattern)

2.1.2 ITU-R Recommendations S.524-8 (Off-axis EIRP Density Limits)

2.1.3 ITU-R Recommendations S.726-1 (Spurious emission limits)

2.1.4 ITU-R Recommendations S.729 (Control and Monitoring of VSAT Networks)

2.2 OTHER STANDARDS

ITU-R Recommendations H.264 (Advanced Video Coding for Generic Audiovisual Services) or any other recommended international standards for this purpose

3.0 TYPE OF NETWORKS and THEIR DATA RATES

Satellite Network considered in this IR are broadly classified into telecom networks and broadcasting networks. Maximum permissible data rates are subject to mandatory technical requirements in accordance with network link engineering, psd values, EIRP limits and justified requirement for the respective applications.

3.1 TELECOM NETWORK

A network which employs two-way communication is a telecom network. Telecom network are further classified into CUG networks, transmission networks and access networks.

3.1.1 CUG VSAT NETWORKS

This network shall not have PSTN connectivity and can operate in Star, Mesh, or Hybrid configurations.

3.1.1.1 STAR CONFIGURATION

Due to asymmetrical nature of the network, the data rates are defined separately for remote VSATs and hub station.

a. For Remote VSATs: - Multiple carriers will be allowed for transmission from remote VSAT terminal (i.e.; inbound data at Hub). However, total data rate of all carriers from one VSAT shall be limited to 2.0 Mbps

b. For Hub Station: - Multiple carriers will be allowed for transmission from Hub station (i.e. outbound data from hub).

3.1.1.2 MESH CONFIGURATION

Multiple carriers will be allowed for transmission between VSATs subject to total data rate of all carriers limited to 4 Mbps(from one VSAT).

3.1.1.3 HYBRID CONFIGURATION

The Hybrid Configuration is a combination of star and Mesh configuration. The requirements for mesh configuration shall be applicable for VSATs having mesh connectivity and star configuration for star connectivity. For the terminals having both configurations, requirement of mesh connectivity shall be applicable.

3.1.2 TRANSMISSION NETWORK

This network basically consists of connectivity between two nodes of a telecom service provider with no end-user connectivity. Maximum allowed uplink data rate shall depend on antenna size as given in clause no 5.3.1.2.

3.1.3 ACCESS NETWORK

This network shall provide access only to end user. The allowable antenna size shall be as per 5.3.1.1 and data rate shall be as per CUG VSAT network.

3.2 BROADCAST NETWORK

BROADCAST networks are further classified broadly into DTH networks, Distribution networks and DSNG networks. Total data rate of carrier on a transponder shall be limited to the transponder capacity for the DTH and distribution network. The data rates listed take care of the various broadcast applications including HDTV/3D etc.

3.2.1 DTH NETWORK

A radio-communication service in which signals transmitted from satellite are intended for direct reception by the general public. The DTH return channel will be governed by the DOT Licence/ permission.

3.2.2 DISTRIBUTION NETWORK:

A broadcasting network in which signals transmitted from satellite are received by service providers and further retransmitted through terrestrial transmitters/cable network/DTH system.

3.2.3 DSNG NETWORK SERVICES

DSNG terminal are used to gather information from a site with the help of a nomadic earth station. The video/audio is received by the control room of a broadcast station for further telecast/ broadcast. However, no live broadcast directly from DSNG to general public shall be permitted under any circumstances. MCPC mode is not permissible for DSNG terminal.

4.0 MANAGEMENT and CONTROL for NETWORKS

The Management and Control functions at the Hub/Network Control Station shall conform to ITU-R. Recommendation S. 729 and include provision of multi-point connections between Hub/Network Control Station and several VSATs/remote terminals such that monitoring and controls of operational and faulty VSATs/remote terminals in the network can be effected continuously.

The network shall make use of any standard multiple access technique depending on traffic requirements.

5.0 MANDATORY TECHNICAL REQUIREMENTS

5.1 FREQUENCY BANDS

The equipment shall operate in one of the following sets of frequency bands. Specific frequency band may be indicated in the License agreement.

Frequency band	Receive (GHz)	Transmit (GHz)	Service

S-band	2.550-2.630	--	BSS (Broadcast Application Network in FSS),
Lower C-band	3.400-3.700	6.425-6.725	FSS
Normal C-band	3.700-4.200	5.925-6.425	FSS
Extended C-band	4.500-4.800	6.725-7.025	FSS
Ku band	10.7-11.7, 12.2-12.75	12.75-13.25 13.75-14.0* 14.0-14.5	FSS
Ka band	19.3- 21.2 18.32-18.675	29.5 – 31.0 27-27.55	FSS

*For frequency band 13.75-14.0 GHz, the minimum size of the antenna shall be 1.2 m diameter.

"NOTE: - All the above mentioned frequency bands noted in the table above, along with their associated services/application, may be revised as per the National Frequency Allocation Plan" in force.

5.2 PSD LIMITS

5.2.1 Maximum uplink psd limits at the input to the earth station antenna:

a) -35dBW/Hz for C band (-38dBW/Hz for slot 74°E,-42 dBW/Hz for slot 55°E)

b) -42 dBW/Hz for Extended C band

c) -39 dBW/Hz for Ku band

5.2.2 Maximum downlink psd limits at the input to the earth station antenna:

a) -51.0 dBW/Hz for C band (-65dBW/Hz for slot 74°E,-68 dBW/Hz for slot 55°E)

b) -64.5 dBW/Hz for Extended C band(-65 dBW/Hz for slot 55°E)

c) -53.9 dBW/Hz for Ku band

5.2.3 Maximum downlink EIRP density limits at the output to the satellite antenna:

a) -20.0 dBW/Hz for C band (-34dBW/Hz for slot 74°E,-37 dBW/Hz for slot 55°E)

b) -33.5 dBW/Hz for Extended C band (-65dBW/Hz for slot 55°E)

c) -22.9 dBW/Hz for Ku band

5.3 ANTENNA SIZES

All antennae with circular equivalent of 3.8 meters and above shall have to be approved by NOCC for mandatory performance verification test and certification. The antennae with less than 3.8 meters circular equivalent diameter in CUG & Access network shall be tested and certified by NOCC on a sample basis. All antennae to be used for backhaul connectivity, transmission network, DTH & TV broadcasting Teleport &DSNG terminal and any other new service irrespective of sizes will be tested & certified by NOCC.

5.3.1 TELECOM NETWORKS

5.3.1.1 ACCESS NETWORK, including CUG Network

STAR NETWORK

The hub antenna and remote antenna size for various frequency bands shall be as per the flowing table:

C band		Ext. C band		Ku band	
Hub	VSAT	Hub	VSAT	Hub	VSAT
9m	1.2 m(for 83°E, 93.5°E slots) 1.8 m(for 55°E, 74°E slots)	9 m	1.2 m	8 m	1.0 m 1.2 m (for freq band 13.75 to 14.0 GHz)
7m	2.4 m	7 m	2.4 m	6 m	2.4 m

MESH NETWORK

The circular equivalent diameter of the antenna for the transmitting, VSATs shall be either as specified below or more. Circular equivalent diameter as given below shall be used for determining off-axis performance.

Normal C Band : 2.4 m (for 83°E,93.5°E slots)
: 3.8 m (for 55°E, 74°E slots)

Extended C Band : 2.4m (for 83°E, 93.5°E,95°E,108.2°E slots)

Ku band : 2.4m (for 83°E, 93.5°E, 95°E, 108.2°E slots)

For 13.75 to 14.0 GHz frequency range forminimum size of the antenna please refer **note* in Clause 5.1** above for 83°E & 93.5°E slots for Star as well as Mesh configuration.

5.3.1.2 TRANSMISSION NETWORK

(a) In case of point-to-point or mesh connectivity the circular equivalent diameter of the antenna shall be either as specified below or more. Circular equivalent diameter shall be used for determining off-axis performance.

Normal C Band : 2.4m up to 2MHz(for 83°E, 93.5°E slots)

& Ext. C Band : 3.8 m up to 4.5MHz (for 55°E, 74°E slots)

: 4.5 m up to 9MHz

: 6.1m up to 27MHz

: 7.0m up to 36MHz

: 9.0 m and above – any bandwidth, subject to o the link engineering considerations

Ku band : 2.4mup to 4.5MHz (55°E, 74°E,83°E,93.5°E)

: 3.8m up to 9MHz

: 4.5m up to 18MHz (for 13.75 to 14.0 GHz frequency range for 55°E, 74°E, 83°E, 93.5°E slots)

: 6.1m up to 36MHz

: 8.0 m and above- any bandwidth, subject to the link engineering considerations

(b) In case of star network, the hub for C- band and Ku band shall be 9 m and 8 m respectively. The data rates shall be limited as per the following table:

Data rate limit (MHz)	Ku band antenna size	C band antenna size
2	1.2 m	1.2/1.8 m
4	1.8 m	2.4 m
8	2.4 m	3.8 m
12	3.8 m	--

5.3.2 BROADCAST NETWORKS in FSS

5.3.2.1 DTH network

This service is provided in C & Ku-band.

Minimum uplink teleport antenna circular equivalent diameter required shall be as specified below:

Normal C Band : 9m (for 55°E, 74°E, 83°E, 93°E slots)

Ku Band : 8m (for 55°E, 74°E, 83°E, 93°E, 95°E slots)

No restrictions for antenna sizes for receive only. However, for return channel, antenna size mentioned for CUG VSAT network shall be applicable.

5.3.2.2 DISTRIBUTION NETWORK

This service provides programmes through satellite in C & Ku-band to be re-transmitted by either terrestrial transmitters or through cable network.

Minimum uplink teleport antenna circular equivalent diameter required shall be as specified below:

S Band : 6.1m(for 83°E, 93.5°E, 55°E, 74°E slots) can uplink up to 36 MHz

Normal C Band: 4.5m (for 83°E, 93.5°E, 55°E,74°E slots) canuplink up to 18 MHz

: 6.1m can uplink up to 36 MHz

: 7.0m antennas canuplink up to54 MHz.

: 9.0 m and above – can uplink any bandwidth, subject to the link engineering considerations

5.3.2.3 DSNGNETWORK

DSNGs should be operated in SCPC mode only. Minimum uplink antenna circular equivalent diameter required shall be as specified below.

C Band : 1.2m (minimum) (for 83°E, 93.5°E slots)

: 1.8m (minimum) (for 55°E, & 74°Eslots)

Extended C- Band : 1.2m (minimum) (for55°E, 74°E, 83°E, 93.5°E slots)

Ku- Band : 1m(minimum)(for 55°E ,74°E ,83°E ,93.5°E slots)

: 1.2m (N**ote** at clause no. 5.1 for 13.75 to 14.0 GHz frequency range for 55°E, 74°E, 83°E, 93.5°E slots)

The DSNG transmit antenna size and data rate shall be as per the following table:

Data rate limit (Mbps)	Ku band antenna size	C band antenna size
8	1 m	1.2 m
20	2.4 m	2.4 m
34	3.8 m	3.8 m

Minimum size for receive antenna for DSNG signal in C-Band and Ku-band shall be 4.5m and 3.8m respectively.

In case of the requirement of return channel, antenna sizes mentioned for CUG VSAT NETWORK shall be applicable.

5.4 POLARISATION

Transmit and receive polarisations of the satellite are linear/ circular over entire coverage. The earth station polarisation angle should match the spacecraft polarisation angle under clear sky conditions. Transmit and receive polarisation sense of earth station shall be linear and circular for C band and linear for Extended-C, Ku bands and circular for S-band.

The polarisation sense of earth station is defined as under

a. Polarisation 1 : Uplink –linear horizontal
Downlink –linear vertical

b. Polarisation 2 : Uplink –linear vertical
Downlink –linear horizontal

c. Polarisation 3 : Uplink –RHCP
Downlink –LHCP

d. Polarisation 4 : Uplink – LHCP
Downlink – RHCP

5.5 HUB STATION REQUIREMENTS

5.5.1 G/T REQUIREMENTS

a. S band BSS (6.1 m or above for feeder links in C-Bands):21.0 db/K minimum

b. C band Extended-C band (9.0 m or above) :31.7 db/K minimum

c. Ku band (8m or above) : 37.0 db/K minimum

5.5.2 Off-axis radiation pattern of antenna: As per ITU-R Recommendation S.580-6

5.5.3 Maximum permissible off-axis EIRP: As per ITU-R Recommendation S.524-8
(Please refer Table D in Annexure-4)

5.5.4 Transmit cross-polar Isolations : Better than 33 dB on-axis

5.5.5 Receive cross-polar Isolations : Better than 33 dB on-axis

5.6 EARTH STATION REQUIREMENTS (for Star/Mesh/Hybrid/Transmission networks)

5.6.1 G/T requirements

a)	C & Extended C band (1.2m)	: 9.5 dB/°K minimum
b)	C & Extended C band (1.8m)	:13 dB/°K minimum
c)	C & Extended C band (2.4m)	:15.5 dB/°K minimum
d)	C & Extended C band (3.8m)	: 19.5 dB/°K minimum
e)	C & Extended C band (6.3m)	: 24.3 dB/°K minimum
f)	C & Extended C band (7.0m)	: 25.2 dB/°K minimum
g)	Ku band (1.0 m and above)	: 16.6 dB/°K minimum
h)	Ku band (1.2 m and above)	: 18.2 dB/°K minimum
i)	Ku band (1.8 m and above)	: 21.7 dB/°K minimum
j)	Ku band (2.4 m and above)	: 24.2 dB/°K minimum
k)	Ku band (3.8 m and above)	: 28.2 dB/°K minimum
l)	Ku band (4.5 m and above)	: 29.7 dB/°K minimum

5.6.2 Off-axis radiation pattern of antenna: As per ITU-R Recommendation S.580-6

a) The new antennas of an earth station operating with GEO stationary satellites should have a design objective such that gain, G of at least 90% of the side-lobe peak does not exceed:

$$G = 29\text{-}25 \log \varphi \quad dBi$$

(G being the gain relative to an isotropic antenna and φ being the off-axis angle in the direction of the GSO referred to the main-lobe axis.)

This requirement should be met for φ between 1 deg or (100λ/D) whichever is greater and 20 deg. for any off-axis director which is within 3 deg. of the GSO.

b) For an off-axis angle, φ, greater than the limits specified above, Recommendation ITU-R.S.465 should be used as a reference. In those cases where there is discontinuity between this design objective recommendation and the reference radiation patterns of Recommendation ITU-R.S. 465, the gain 'G' of at least 90% of the side-lobe peak is defined as follows:

$G = -3.5$ dBi for $20 \text{ deg} < \varphi < 26.3 \text{ deg}$.

5.6.3 Maximum permissible Off-axis EIRP:

As per ITU-R Rec. 524-8, the Off-Axis EIRP Density limits for different off-Axis angles are given in Table D of Annexure-IV.

5.6.4 Transmit cross polar discrimination : On axis- better than 30 dB

5.6.5 Receive cross polar discrimination : On axis- better than 30 dB

5.6.6 Transmit Spurious Limits (in any 100 KHz Band outside the operating frequency band):

Operating Frequency Band	Carrier OFF case	Carrier On case
960 MHz to3400 MHz	48 dBpW	49dBpW
3.4 GHz to10.7 GHz	48 dBpW	55 dBpW
10.7 GHZ to 21.2 GHz	54 dBpW	61 dBpW
21.2 GHz to 40 GHz	60 dBpW	67 dBpW

* Above spurious emission limits are as per ITU-R Recommendation S.726-1

5.7 EIRP Stability : ± 0.5 dB/24 hrs

5.8 Transmit IM Products : 23 dB below two equal carriers at 6 dB output Back-off

5.9 Transmit harmonics : Better than -40 dBc upto second harmonic

5.10 Frequency Stability **:** Better than 1 ppm over the temperature range of -5°C to + 60°C

5.11 Long term frequency stability **:** Better than 0.1 ppm over a day

6.0 Voice over VSAT

CUG VSATs may transmit voice carriers solely for internal communication. Connectivity to any Public Voice Communication Networks is not permitted

7.0 Numbering Plan

VSAT as well as DSNG networks shall follow the unique ID for each terminal specified or approved by the Department of Telecom.

8.0 TECHNICAL REQUIREMENT

8.1 SATELLITE PARAMETERS

The salient parameters of INSAT network for the purpose of link budgeting are as given in Annexure -1.

8.2 LINK BUDGET FORMAT

Sample format for link calculation to be submitted for approval is provided in Annexure-2

8.3 PROCEDURE FOR TELECOM / BROADCASTING OPERATORS

The basis guidelines for satellite communications for obtaining license for Telecom, Broadcast, and operators are given in Annexure-3.

8.4 MAXIMUM UPLINK EIRP DENSITY

Annexure-4 provides typical curve for maximum On-Axis EIRP Density vs. Circular Equivalent Diameter of Antenna whose compliance is to be ensured by the licensees. Off Axis EIRP Density limits are also provided.

Annexure-1

SATELLITE TRANSMISSION

A. INSAT-3C (74°E)

Parameters	C band	Extended C band	S- band BSS
EIRP in full transponder bandwidth under single carrier saturation (EOC)	38 dBW	38 dBW	42 dBW
Saturation Flux Density	-73 to -90 dBW/m^2 (-85 dBW/m^2 nominal)	-73 to -90 dBW/m^2 (-85 dBW/m^2 nominal)	-80 to -92dBW/m^2 (-87 dBW/m^2 nominal)
G/T minimum	-2 dB/°K	-2 dB/°K	-5 dB/°K
Transponder Bandwidth	36 MHz (except 23 & 24) 25 MHz (23 & 24)	36 MHz	36 MHz
Input back off for multiple carriers	6.5 dB	6.5 dB	10 dB
Output back off for multiple carriers	4.0 dB	4.0 dB	4.5 dB
C/3IM	18 dB	18 dB	18 dB
SatelliteTx.Peak Ant gain (dB)	31 dB	31 dB	29 dB

B. INSAT-3A (93.5°E)

Parameters	C band	Extended C band	Ku band
EIRP in full transponder bandwidth under single carrier saturation (EOC)	38 dBW (1 to 6, 10 to 12) 36 dBW (7 to 9)	38 dBW	46dBW
Saturation Flux Density	-73 to -90 dBW/m^2 (-85 dBW/m^2 nominal)	-73 to -90 dBW/m^2 (-85 dBW/m^2 nominal)	-78 to -90dBW/m^2 (-85 dBW/m^2 nominal)
G/T minimum	-2 dB/°K (ECC: -3 dB/°K)	-2 dB/°K	-2 dB/°K
Transponder Bandwidth	36 MHz (all except 11 & 12) 25 MHz (11 and 12)	36 MHz	36 MHz
Input back off for multiple carriers	10 dB TWTA and 6.5 dB for SSPA	6.5 dB	10 dB
Output back off for multiple carriers	4.5dB TWTA and 4 dB for SSPA	4 dB	4.5 dB
C/3IM	18 dB	18 dB	18 dB
SatelliteTx.Peak Ant gain (dB)	31 dB	31 dB	31 dB

C. INSAT-3E (55°E)

Parameters	C band	Extended C band
EIRP in full transponder bandwidth under single carrier saturation (EOC)	38 dBW	38 dBW
Saturation Flux Density	-78 to -90 dBW/m^2 (-86 dBW/m^2 nominal)	-78 to -94 dBW/m^2 (-86 dBW/m^2 nominal)
G/T EoC	-2 dB/°K	-2 dB/°K
Transponder Bandwidth	36 MHz (except 23 & 24) 25 MHz (23 & 24)	36 MHz
Input back off for multiple carriers	6.5 dB	6.5 dB
Output back off for multiple carriers	4 dB	4 dB
C/3IM	18 dB	18 dB
SatelliteTx.Peak Ant gain (dB)	31 dB	31 dB

D. INSAT-4A (83°E)

Parameters	C- band	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	42 dBW	52 dBW
Saturation Flux Density	-75 to -92 dBW/m^2 (-85 dBW/m^2 nominal)	-84 to -96 dBW/m^2 (-90 dBW/m^2 nominal)
G/T minimum	-2dB/°K	+3 dB/°K
Transponder Bandwidth	36 MHz	36 MHz
Input back off for multiple carriers	4 dB	4 dB
Output back off for multiple carriers	2.5dB	2.5 dB
C/3IM	18 dB	18 dB
SatelliteTx.Peak Ant gain	23.5 dB	32.0 dB

E. INSAT-4B (93.5°E)

Parameters	C- band	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	42 dBW	52 dBW
Saturation Flux Density	-75 to -92 dBW/m^2 (-85 dBW/m^2 nominal)	-84 to -96 dBW/m^2 (-90 dBW/m^2 nominal)
G/T minimum	-2dB/°K	+3 dB/°K
Transponder Bandwidth	36 MHz	36 MHz
Input back off for multiple carriers	4 dB	4 dB
Output back off for multiple carriers	2.5dB	2.5 dB
C/3IM	18 dB	18 dB
SatelliteTx.Peak Ant gain	23.5 dB	32.0 dB

saturation over India (EOC)	
Saturation Flux Density	-84 to -96 dBW/m^2 (-88 dBW/m^2 nominal)
G/T minimum	+3 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	4 dB
Output bake off for multiple carriers	2.5 dB
Satellite Tx. Ant Gain (EOC)	31.5 dBi
C/3IM	18dB

F. INSAT-4CR (74°E)

G. GSAT-8 (55°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	48dBW over main land and 47dBW over Andaman & Nicobar islands
Saturation Flux Density	a. Fixed Gain Mode: i. SFD range : (-84 to -96 dBW/m^2) ±2dB ii. Nominal SFD : -90 dBW/m^2 ±2dB b. Automatic Level Control Mode : (-84 to -96dBW/m^2) ±2dB
G/T minimum	+3 dB/°K for Mainland +2 dB/°K for Andaman & Nicobar islands
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output back off for multiple carriers	3dB
C/3IM	18.5dB
Satellite Transmit Antenna Gain	30.5 dB(EoC) to 35.5 dB (Beam Peak)

H. GSAT-12 (55°E)

Parameters	Extended C Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	37dBW over main land and 33dBW over islands
Saturation Flux Density	(-70 to -92 dBW/m^2) ±2 dB (-92 dBW/m^2 Nominal)
G/T minimum	-3 dB/°K for mainland -4.5 dB/°K for islands
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output bake off for multiple carriers	3 dB
C/3IM	18dB
Satellite Tx. Ant Gain	26.3 dB(EoC) to 34 dB (Beam Peak)

I. GSAT-10 (83°E)

Parameters	C- band	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW	52 dBW over main land and 50 dBW over A&N islands
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	(-74 to -92dBW/m^2) ± 2 dB -86dBW/m^2± 2 dB	(-84 to -96dBW/m^2) ± 2 dB -90dBW/m^2± 2 dB (-82 to -102dBW/m^2) ± 2 dB
G/T minimum	-4 dB/°K	+3 dB/°K for mainland +1 dB/°K for A&N islands
Transponder Bandwidth	36MHz	36MHz
Input back off for multiple carriers	6dB	6dB
Output back off for multiple carriers	3dB	3dB
C/3IM	21.5dB	18dB
Satellite Tx. Ant gain	28dBi	32dBi over main land& 30dBi for A&N islands

J. NSS-11/ (GE-1A) (108.2°E)

Parameters	Ku band: 14.0-14.25 GHz in vertical polarisation only will be allowed and 49.5 dBW of EIRP in 12.2-12.75 GHz in horizontal polarisation only will be allowed over India
EIRP in 36 MHz under single carrier saturation over India (EOC)	49.5 dBW
Saturation Flux Density	-93 dBW/m^2 (-87.53 dBW/m^2 nominal)
G/T over India, minimum	+2 dB/°K
Transponder bandwidth	36 MHz
Input back off for multiple carriers	7 dB
Output back off for multiple carriers	4 dB
C/3IM	18 dB

K. NSS-6 (95°E)

Parameters	Ku band
EIRP in transponder bandwidth under single carrier saturation over India (EOC)	44-54 dBW
Saturated Flux Density	-91dBW/m^2 in fixed Gain Mode & -101 dBW/m^2 in ALC Mode
Fixed gain Mode Adjust. Range ALC Mode Adjust. Range	0 to 15 dB -10 to +3 dB w.r.t. saturation
G/T range over India	-4 to + 10 dB
Transponder Bandwidth	54/36 MHz
Input Back off for Multi-Carrier	6dB
Output Back off for Multi-Carrier	3dB
C/3IM	22dB
Satellite Tx. Peak gain[$]	-

L. NSS-12 (57°E)

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density	-87.5 dBW/m^2 nominal
G/T over India	-4 dB/°K
Transponder Bandwidth	72 MHz
Input back off for multiple carriers	4.7
Output Bakoff for multiple carriers	3dB
C/3IM	22 dB
Satellite Tx. Peak Ant gain[$]	-

M. SES-7 (108.2 °E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	48 to 54 dBW
Saturation Flux Density	-86 dBW/m^2 (in ALC Mode)
G/T over India	+2 to +10 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output bake off for multiple carriers	3 dB
C/3IM[$]	-
Satellite Tx. Peak Ant gain[$]	-

N. MEASAT-3 (91.5°E)

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	48 dBW
Saturation Flux density	-107 to -71 dBW/m^2 (-88 dBW/m^2 nominal)
G/T Range over India	+1 dB/°K
Transponder Bandwidth	36 MHz
Input back off Backoff[$]	-
Output Backoff[$]	-
C/3IM[$]	-
Satellite Tx. Peak Ant gain[$]	-

O. MEASAT-3A (91.5°E)

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density	-107 to -71 dBW/m^2 (-88.5 dBW/m^2 nominal)
G/T over India	+1 dB/°K
Transponder Bandwidth	36 MHz
Input back off	6dB
Output Backoff	3dB
C/3IM[$]	-
Satellite Tx. Peak Ant gain[$]	-

P. ST-2 (88 °E)

Parameters	Ku-Band
EIRP range in 54 MHz under single carrier saturation over India	42-53dBW
Saturation Flux Density	-105 to -75 dBW/m^2 (-84.8 dBW/m^2 nominal)
G/T range over India	-5 to +7 dB/°K
Transponder bandwidth	54 MHz
Input back off	2dB
Output Back off	0.5dB
C/3IM	35dB
Satellite Tx. Ant gain	34dBi

Q. IS-17 (66 °E)

Parameters	C-Band
EIRP range in 36 MHz under single carrier saturation over India ,EoC	37.7 dBW
Saturation Flux Density	-88.6 dBW/m^2 nominal
G/T over India,minimum	-2.9 dB/°K
Transponder bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output back off for multiple carriers	4 dB
C/3IM[$]	-
Satellite Tx. Peak Ant gain[$]	-

R. Asiasat-5 (100.5°E)

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	39.5 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 (-66.2 to -96.2dBW/m^2) -88.2dBW/m^2
G/T over India	-4 dB/°K
Transponder Bandwidth	36 MHz
Input back off/ for multiple carriers	6dB
Output Back off for multiple carriers	3 dB
C/3IM	>22 dB
Satellite Tx. Ant gain	23dBi EOC of India

S. Asiasat-3S (105.5°E)

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	38.5 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 (-63 to -93dBW/m^2) -85dBW/m^2
G/T over India	-6 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output Back off for multiple carriers	3dB
C/3IM	>21 dB
Satellite Tx. Ant gain	23.5dBi over EOC of India

T. Asiasat-7 (105.5°E)

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -68.1 to -98.1dBW/m^2 -88.1dBW/m^2
G/T over India	-3.5 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	24dBi at EOC of India

U. Asiasat-6 (120°E) (Future Satellite) Global Beam

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -67 to -97dBW/m^2 -89dBW/m^2
G/T over India	-4.5 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers for multiple carriers	6dB
Output Back off	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	22 dBi EOC of India

V. Asiasat-6 (120°E) (Future Satellite) Regional Beam

Parameters	C-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	34 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1) SFD Range 2) Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -67 to -97dBW/m^2 -89dBW/m^2
G/T over India	-4.5 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	25 dBi Peak

W. Asiasat-5 (100.5°E) Steerable Beam

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	46 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -68 to -98dBW/m^2 -84dBW/m^2
G/T over India	-2 dB/°K
Transponder Bandwidth	54 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	26.8 dBi EOC of India

X. Asiasat-5 (100.5°E) SA Beam

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -72 to -102dBW/m^2 -88dBW/m^2 -82 to -102dBW/m^2
G/T over India	2 dB/°K
Transponder Bandwidth	54 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	30 dBi EOC of India

Y. Asiasat-3S (105.5°E) SA Beam

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	47 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -62 to -92dBW/m^2 -84dBW/m^2
G/T over India	-1 dB/°K
Transponder Bandwidth	54 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>17.5 dB
Satellite Tx. Peak Ant gain	28 dBi EOC of India

Z. Asiasat-7 (105.5°E) SA Beam

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -73 to -103dBW/m^2 -87dBW/m^2 -82 to -102dBW/m^2
G/T over India	2 dB/°K
Transponder Bandwidth	54 MHz
Input back off for multiple carriers	6dB
Output Back off for multiple carriers	3dB
C/3IM	>22 dB
Satellite Tx. Ant gain	30 dBi EOC of India

AA. Asiasat-8 (105.5°E) (Future Satellite) India Beam

Parameters	Ku-Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	53 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -73 to -103dBW/m^2 -90dBW/m^2
G/T over India	5 dB/°K
Transponder Bandwidth	54 MHz
Input back off Output Backoff for multiple carriers	6dB
Output Back off for multiple carriers	3d**B**
C/3IM	>22 dB
Satellite Tx. Peak Ant gain	31 dBi EOC over India

BB. INTELSAT IS-904 (60°E) East Hemi

Parameters	C-Band
EIRP in 72 MHz under single carrier saturation over India (EOC)	38 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -67 to -89dBW/m^2 -78.2dBW/m^2
G/T over India	-3.3 dB/°K
Transponder Bandwidth	72 MHz
Input back off for multiple carriers	-5.4dB
Output Back off for multiple carriers	-4.5dB
C/3IM	30.5 dB
Satellite Tx. Ant gain	21.7 dBi EOC of India

CC. INTELSAT IS-906 (64°E) S2 Beam

Parameters	Ku -Band
EIRP in 72 MHz under single carrier saturation over India (EOC)	47 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -69 to -87dBW/m^2 -80.1dBW/m^2 -69 to -87dBW/m^2
G/T over India	1.3 dB/°K
Transponder Bandwidth	72 MHz
Input back off for multiple carriers	-7.0 dB
Output Back off for multiple carriers	-5dB
C/3IM	26 dB
Satellite Tx. Ant gain	29.4dBi EOC of India

DD. MEASAT 3B (91.5°E) (Future Satellite)

Parameters	Ku -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	50 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -74 to -97dBW/m^2 -85.5dBW/m^2 -74 to -97dBW/m^2
G/T over India	4 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output Back off for multiple carriers	4 dB
C/3IM	18 dB
Satellite Tx. Ant gain	30 dBi EOC of India

EE. NSS-12 (57°E) Hemi

Parameters	C -Band
EIRP in 36/72 MHz under single carrier saturation over India (EOC)	40 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -79 to -94dBW/m^2 -87.5dBW/m^2
G/T over India	-4 dB/°K
Transponder Bandwidth	36/72 MHz
Input back off for multiple carriers	4.7 dB
Output Back off for multiple carriers	3 dB
C/3IM	22 dB
Satellite Tx. Ant gain	24.25 dBi EOC of India

FF. NSS-11 (108.2°E) South Asia

Parameters	Ku -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -79 to -97dBW/m^2 -87.5dBW/m^2
G/T over India	2 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	8 dB
Output Back off for multiple carriers	4 dB
C/3IM	18 dB
Satellite Tx. Ant gain	32.03 dBi EOC of India

GG. NSS-6 (95 °E) India

Parameters	Ku -Band
EIRP in 36/54 MHz under single carrier saturation over India (EOC)	49 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -78 to -93dBW/m^2 -88dBW/m^2 -80 to -93dBW/m^2
G/T over India	2 dB/°K
Transponder Bandwidth	36/54 MHz
Input back off for multiple carriers	6 dB
Output Back off for multiple carriers	3 dB
C/3IM	22 dB
Satellite Tx. Ant gain	28.41 dBi EOC of India

HH. NSS-12 (57°E) South Asia

Parameters	Ku -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -83 to -98dBW/m^2 -90.5dBW/m^2
G/T over India	4 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6 dB
Output Back off for multiple carriers	3 dB
C/3IM	22 dB
Satellite Tx. Ant gain	30.85dBi EOC of India

II. SES-8 (95 °E) (Future Satellite) South Asia

Parameters	Ku -Band
EIRP in 36/54 MHz under single carrier saturation over India (EOC)	50.6 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -70 to -95dBW/m^2 -85dBW/m^2 -70 to -95dBW/m^2
G/T over India	3 dB/°K
Transponder Bandwidth	36/54 MHz
Input back off for multiple carriers	6 dB
Output Back off for multiple carriers	4 dB
C/3IM	22 dB
Satellite Tx. Ant gain	33.26 dBi EOC of India

JJ. SES-9 (108.2 °E) (Future Satellite) South Asia

Parameters	Ku -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	51 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -76 to -92dBW/m^2 -84dBW/m^2 -76 to -92dBW/m^2
G/T over India	2 dB/°K
Transponder Bandwidth	54 MHz
Input back off for multiple carriers	7 dB
Output Back off for multiple carriers	4 dB
C/3IM	22 dB
Satellite Tx. Ant Gain	31.65 dBi EOC of India

KK. THAICOM-5 (78.5 °E) Regional Beam

Parameters	C -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	38 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -79 to -95dBW/m^2 -87dBW/m^2
G/T over India	-1 dB/°K
Transponder Bandwidth	36MHz
Input back off for multiple carriers	5.2 dB
Output Back off for multiple carriers	4.2 dB
C/3IM	17 dB
Satellite Tx. Ant gain	27.22 dBi EOC of India

LL. THAICOM-7 (120°E) Regional Beam

Parameters	C -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	36 dBW
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	 -78.5 to -94.5dBW/m^2 -86.5dBW/m^2
G/T over India	-4.5 dB/°K
Transponder Bandwidth	36 MHz
Input back off for multiple carriers	6.5 dB
Output Back off for multiple carriers	4.3 dB
C/3IM	20 dB
Satellite Tx. Ant gain	20.4 dBi EOC of India

MM. THAICOM-4 (IPSTAR) (119.5 °E) Spot Beam

Parameters	Ku –Band (Forward link)	Ka –Band (Return link)
Equivalent in EIRP in 36 MHz under single carrier saturation over India (EOC)	49 dBW / 36MHz	50.6 dBW / 36MHz
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	-90 to -115dBW/m^2 / 36MHz at EOC -105dBW/m^2 / 36MHz at EOC	-86.4 to -111.4dBW/m^2 / 36MHz at EOC -96.4dBW/m^2 / 36MHz at EOC
G/T over India	13.3 dB/°K	16.8 dB/°K
Transponder Bandwidth	171MHz / Beam	116MHz / Beam
Input back off/ for multiple carriers	Not Applicable	Not Applicable
Output Back off for multiple carriers	6 dB	9.5 dB
C/3IM	24.8 dB	31.7 dB
Satellite Tx. Ant gain	43.5 dBi EOC	48.2 dBi EOC

NN. THAICOM-4 (IPSTAR) (119.5 °E) Broadcast beam

Parameters	Ku -Band
EIRP in 36 MHz under single carrier saturation over India (EOC)	44.9 dBW / 36MHz
Saturation Flux Density a) Fixed Gain Mode (FGM) 1. SFD Range 2. Nominal SFD Value b) Automatic Level Control Mode(ALC)	-85.4 to -105.4 dBW/m^2 / 36MHz at EOC -90.4dBW/m^2 / 36MHz at EOC
G/T over India	10.36 dB/°K
Transponder Bandwidth	200 MHz (Fwd Only)
Input back off for multiple carriers	Not Applicable
Output Back off for multiple carriers	-5 dB
C/3IM	27.4 dB
Satellite Tx. Ant gain	32.71 dBi EOC

ANNEXURE – 2

LINK BUDGET FORMAT

Satellite Name : INSAT- 3A

Type of Service : VAST Telecommunication

Mode of transmission : SCPC/TDM/TDMA

Name of Tx. Earth Station : Bangalore

Name of Rx. Station/Hub : Delhi

Link Type : Inbound, Tx. Antenna with 1m to Rx. Antenna with 5m

	SLANT RANGE CALCULATION	value	units
	Satlat	0	deg
	satlong	93.5	deg
	eslat	12.97	deg
	eslong	77.58	deg
	Elevation	66.1059	deg
	height	36000	Km
	SLANTRANGE	36469.1	Km

	SATELLITE LINK CALCULATION							
	SATELLITE INFORMATION							
1	satellite type	INSAT-3A			UPLINK ANALYSIS	In Cl sky	with rain	units
2	orbital location	93.50	deg	1	Uplink pathloss	207.36	212.76	dB
3	Satellite G/T	-2.00	dB/K	2	Power at satellite antenna	-160.84	-162.57	dBW
4	SFD	-85.00	dBW/m^2	3	Tx EIRP of E/X	46.53	50.20	dBW
5	Input Backoff	10	dB	4	Sat Ant Rx Gain/m^2	44.54	44.54	dB/m^2
6	Output Backoff	4	dB	5	PFD at input of Sat Ant	-116.30	-118.03	dBW/m^2
7	saturation EIRP	46	dBW	6	Input BO/carrier	-31.30	-33.03	dB
8	Transponder Bandwidth	36	MHz	7	Sat G/T	-2.00	-2	dB/deg.K
9	Uplink frequency	14270	MHz	8	Uplink C/N0 Available	65.76	64.03	dB-Hz
10	Downlink frequency	11470	MHz	9	Uplink C/N Available	9.44	7.71	dB
11	IMP+Xpole Isolatn. level	18	dB	10	Uplink PSD	-51.07	-47.40	dBW/Hz
12	Sat Tx Ant Gain	31.00	dB	11	U/L EIRP Density	37.71	40.38	dBW/40KHz
13	Sat Ant Rx Gain/m^2	44.54	dB/m^2		DOWNLINK ANALYSIS			
14	Transponder Gain	181.54	dB	1	Saturation EIRP	46.00	46	dBW
				2	Output BO	4	4	dB
				3	Output BO/carrier	-25.30	-27.03	dB
	LINK PARAMETERS			4	Carrier down EIRP	20.70	18.97	dBW
1	Carrier info rate	512	Kbps	5	Downlink path loss	205.47	208.97	dB
2	FEC*RS Code Rate	0.80637		6	Cl sky G/T	35.30	35.30	dB/deg.K
3	Modulation	QPSK		7	Degradation in G/T	0	2	dB
4	No of Bits / Symbol	2		8	Dn link C/N0 Available	79.13	71.90	dB-Hz
5	Transmission Rate	634.942	kbps	9	Dnlink C/N Available	22.81	15.58	dB

6	Noise bandwidth factor	1.35		10	Dnlink PSD	-66.62	-68.35	dBW/Hz
7	Noise bandwidth	428.586	KHz					
8	Eb/N0 Required	6.2	dB		TOTAL LINK ANALYSIS	In Cl sky	with rain	
9	Cl.Sky C/N0 Required	63.29	dB-Hz	1	Uplink C/N Available	9.44	7.71	dB
10	Cl.Sky C/N Required	6.97	dB	2	D/L C/N Available	22.81	15.58	dB
11	Link availability	99.7	%	3	IMP+XPole Iso.Level	18	18	dB
				4	Comp./N Available	8.7	6.72	dB
				5	Required C/N	6.97	6.97	dB
	Tx.. STATION DETAILS			6	Link margin	1.73	-0.25	dB
1	Antenna Diameter	1	m					
2	Tx. Ant. Efficiency	60	%		TX E/S AMPLIFIER POWER SIZING			
3	Tx. Gain	41.27	dB	1	Tx EIRP of E/S	46.53	50.20	dBW
4	Tx. Ant. pointing Loss	0.5	dB	2	Tx ant gain	41.27	41.27	dB
				3	Power at Tx ant input	5.26	8.93	dBW
				4	Tx. amplr to ant. loss	1.5	1.5	dB
	Rx.. STATION DETAILS			5	Power amplr op/carrier	4.74	11.03	Watts
1	Antenna Diameter	8	m	6	No of carriers	1	1.00	
2	Rx. Ant. Efficiency	60	%	7	Total power output	4.74	11.03	Watts
3	Rx. Ant Gain	57.43	dB					
4	Rx. Ant. Pointing Loss	0.5	dB					
5	Pre LNA losses	0.2	dB		% TRANSPONDER UTILIZATION			
6	LNA Noise Temp	100	deg.k	1	Power wise	0.74	0.5	%
7	Ant Noise temp	45	deg.k	2	Occupied wise	1.19	1.19	%
8	Total Rx.Sys.Noise Temp	156.03	deg.k	4	Allocated BW wise	2.38	2.38	%
9	Cl.Sky G/T	35.30	dB/deg.K					
	MISC. LOSSES							
1	Tx. Rain Zone	N			Power Equivalent BW	266.71	179.08	KHz
2	Rx. rain Zone	N			Allocated BW	857.17		KHz
3	Uplink Rain Attn.	5.4	dB		Symbol Rate	0.317		Msps
4	Downlink Rain Attn.	3.5	dB					
5	Uplink Free Space Loss	206.76	dB					
6	Downlink Free Space Loss	204.87	dB					
7	Uplink Atm. Attn.	0.1	dB					
8	Downlink Atm. Attn.	0.1	dB					

LINK SUMMARY: - Ku - Band INSAT-3A

Type of Carrier	Satellite EIRP for Single Carrier	Satellite EIRP in Watts	No. of Carriers	Total Power in Watts	% of the Transponder Power	Total Power in dBW	BW per Carrier	Total BW	% of Transponder Frequency

FREQUENCY PLAN: -Transponder # 20, INSAT- 3A

Sl. No.	Carrier Size in Kbps	No. of Carriers	FEC & RS	Carrier Type	Modulation	Bandwidth in KHz per Carrier	Total BW in KHz	D/L Satellite EIRP per Carrier	Total D/L Satellite EIRP in dBW	Uplink/Downlink RF Frequency in MHz

Annexure-3

Guidelines / Instructions to Telecom/Broadcast Service Providers For Satellite Communications

1. New Applicant : New applicant willing to have either Commercial/Captive CUG VSAT licence or any permission for operations of telecom/broadcast service using satellite media shall apply for the same to Satellite Cell of DoT in the applicable application form along with all technical details. The application shall be got examined and the licence issued or permission granted after observing all regulatory & technical requirements.

OR

Existing Service Providers : Existing Service Providers having valid license issued by DoT or Ministry of I&B shall approach Satellite cell of DoT with complete proposal for starting a new service on satellite or carrying out reconfiguration/addition /modification in existing network on satellite. The proposal will be examined for technical compliance as well as from regulatory angle and will be issued in-principle clearance.

Both the new applicant as well as existing service provider shall submit following documents along with their application / proposal , failing which their request may not be considered:

(i) Brief write up of the proposed network & services along with schematic diagram.
(ii) Link Engineering for all types of carriers in the enclosed standard format with approved satellite parameters.
(iii) Carrier Power& Bandwidth summary showing total space segment & satellite power requirements.
(iv) Clause-by-clause compliance to applicable mandatory TEC GR/IR.
(v) List of model & make of all the equipment proposed in the network along with their specifications / data sheets.
(vi) Exact locations of Hub / central site and tentative locations of other earth stations / VSATs.
(vii) Comparative statement highlighting modifications / changes in the network in case of existing service providers.

2. The Licensee, then, shall get space segment allocated or reserved from DoS or other authorized Satellite operator.

3. Then Licensee shall approach WPC wing of DoT for obtaining FA, SACF Aclearance & operating licence.

4. The services can be started after obtaining NOCC (Network Operations Control Center) clearance.

5. Date of Commissioning of services shall be communicated to Licensor and Satellite Cell of DoT.

6. The Licensee shall submit monthly operation report to Licensor, Satellite Cell of DoT and NOCC by 7^{th} of following month.

7. The operation, control, coordination and monitoring of space segment shall be done by NOCC. The licensee shall pay the NOCC charges, as fixed by DoT, to NOCC.

8. The licensee shall create a separate ground segment for new service and shall not use the ground segment infrastructure created for its VSAT CUG network.

9. The Telecomm Service Provider shall ensure that the telecom services shall not be used for public broadcasting of any television signals.

10. The Services shall not violate any terms& conditions of licence issued by DoT or MI&B or law of land.

11. There will not be any limit on data rates in general, unless and otherwise limited by the Licensor or TEC document.

12. The Off-axis radiation pattern of antenna and Maximum permissible off-axis EIRP shall follow latest ITU-R Recommendations like S.580-6 and S.524-7 respectively.

13. In case space segment is taken on satellite other than INSAT system then restriction on antenna size and psd limits shall be as specified in this document.

NOTE: All the contingency operation due to failure of transponder/satellite or RF interference, monitoring and operational control of space segment usage will be handled by NOCC. Monitoring charges shall be payable by the users to NOCC as per the rate to be decided by DoT.

ANNEXURE-4

Effective Aperture Area of Antenna versus Max. On-Axis EIRP Density

Table A: Effective Aperture Area of Antenna versus Typical Max. On-Axis EIRP Density for C - Band Transmit Antenna

Circular Equi. Antenna Dia	On Axis Transmit Gain of Antenna	Typical Max. On-Axis U/L EIRP Density	Circular Equi. Antenna Dia	On Axis Transmit Gain of Antenna	Typical Max. On - Axis U/L EIRP Density
meter	dB	dBW/4KHz	meter	dB	dBW/4KHz
1.2	35.34	35.82	5.5	48.55	49.05
1.5	37.26	37.76	6	49.3	49.8
1.8	38.86	39.35	6.5	50	50.5
2	39.75	40.26	7	50.64	51.14
2.2	40.59	41.09	7.5	51.24	51.74
2.4	41.34	41.84	8	51.8	52.3
2.8	42.68	43.18	8.5	52.33	52.83
3	43.28	43.78	9	52.83	53.33
3.5	44.62	45.12	9.1	52.92	53.42
3.8	45.34	45.84	9.5	53.3	53.8
4	45.78	46.28	10	53.74	54.24
4.5	46.81	47.3	10.5	54.16	54.66
5	47.72	48.22	11	54.57	55.07

EIRP Density (dBW/4KHz) = Max. P.S.D. + On-Axis Tr. Gain of Antenna + 36
(Antenna Efficiency = 0.6 & Feeder Losses = 0.5 dB assumed)
Uplink Frequency: 6.0 GHz

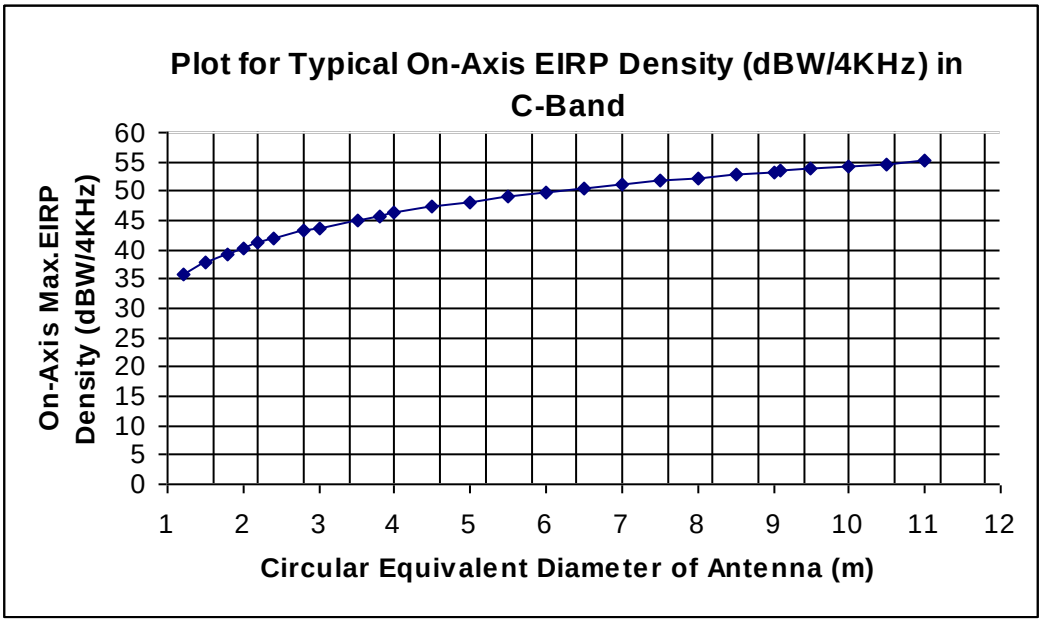

Table B: Effective Aperture Area of Antenna versus Typical Max. On-Axis EIRP Density for Ext.C - Band Transmit Antenna

Circular Equi. Antenna Dia	On-Axis Transmit Gain of Antenna	Typical Max. On-Axis U/L EIRP Density	Circular Equi. Antenna Dia	On Axis Transmit Gain of Antenna	Typical Max. On-Axis U/L EIRP Density
meter	dB	dBW/4KHz	meter	dB	dBW/4KHz
1.2	36.55	30.04	5.5	50.11	43.26
1.5	38.83	31.98	6	50.87	44.02
1.8	40.4	33.56	6.5	51.56	44.71
2	41.32	34.48	7	52.2	45.36
2.2	42.15	35.3	7.5	52.8	45.96
2.4	42.91	36.06	8	53.36	46.52
2.8	44.25	37.4	8.5	53.89	47.04
3	44.84	38	9	54.39	47.54
3.5	46.18	39.34	9.1	54.48	47.64
3.8	46.9	40.05	9.5	54.86	48.01
4	47.34	40.5	10	55.3	48.45
4.5	48.37	41.52	10.5	55.73	48.88
5	49.28	42.43	11	56.13	49.28

Density(dBW/4KHz) = Max. P.S.D. + On -Axis Tr. Gain of Antenna + 36
(Antenna Efficiency = 0.6 & Feeder Losses = 0.5 dB assumed)
Uplink Frequency: 6.9 GHz

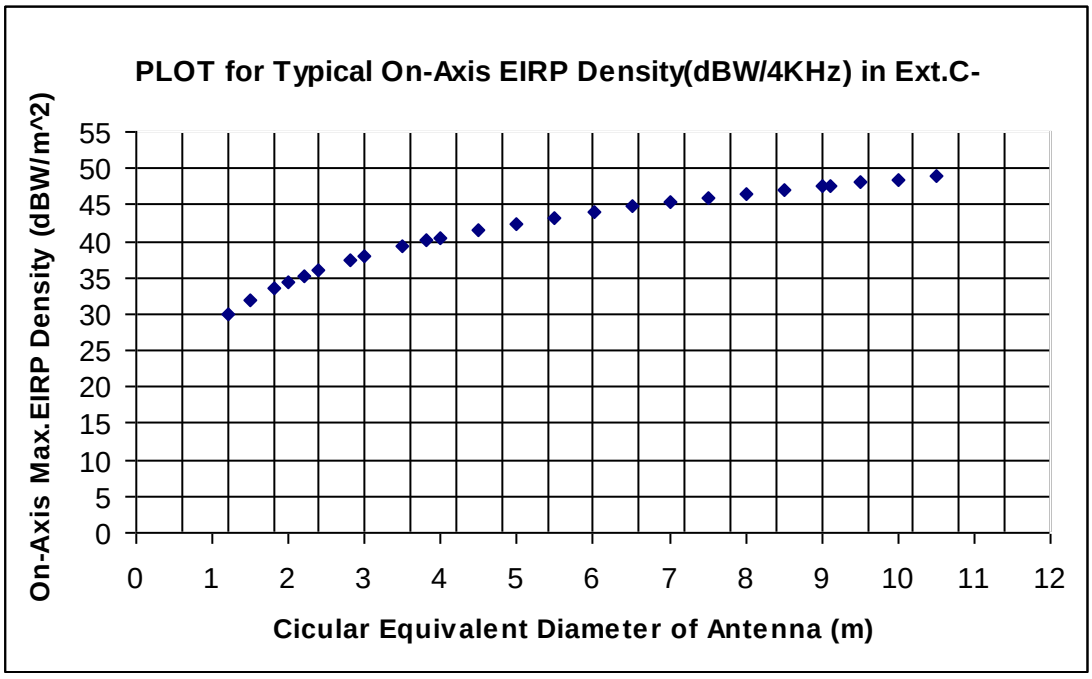

Table C: Effective Aperture Area of Antenna versus Typical Max. On-Axis EIRP Density for Ku - Band Transmit Antenna

Antenna Dia	On -Axis Transmit Gain of Antenna	Typical Max. On - Axis U/L EIRPDensity	Antenna Dia	On Axis Transmit Gain of Antenna	Typical Max. On-Axis U/L EIRP Density
meter	dB	dBW/40KHz	meter	dB	dBW/40KHz
1	41.09	47.62	4.5	54.51	60.68
1.2	43	49.2	5	55.43	61.6
1.5	44.98	51.14	5.5	56.26	62.43
1.8	46.54	52.73	6	57.01	63.18
2	47.47	53.64	6.5	57.71	63.88
2.2	48.3	54.47	7	58.35	64.52
2.4	49.05	55.22	7.5	58.95	65.12
2.8	50.39	56.56	8	59.51	65.68
3	50.99	57.16	8.5	60.04	66.21
3.5	52.33	58.5	9	60.53	66.71
3.8	53.04	59.22	9.1	60.63	66.8
4	53.49	59.66			

EIRP Density (dBW/40KHz) = Max. P.S.D. + On-Axis Tr. Gain of Antenna + 46
(Antenna Efficiency = 0.6 & Feeder Losses = 0.5 dB assumed)
Uplink Frequency: 14.0 GHz

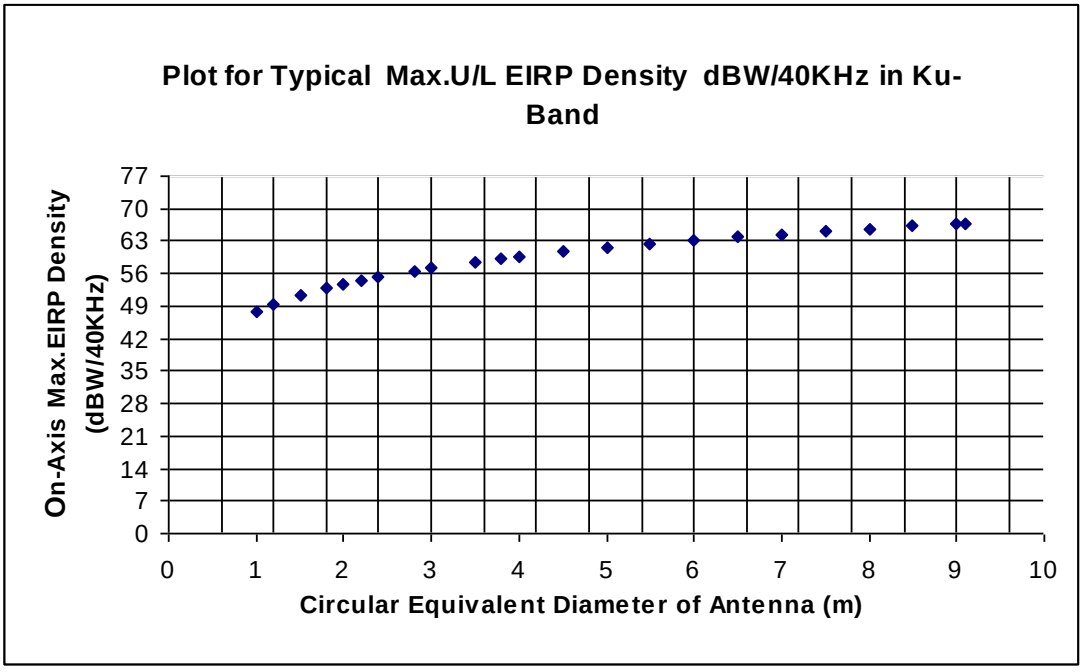

TABLE D: Off-Axis EIRP Density Limits

As per ITU-R Rec. 524-8, the Off-Axis EIRP Density limits for different Off- Axis Angles are given below:

S.No.	Off-Axis Angle (∅) (deg)	Off-Axis EIRP Density Limits	
		C& Ext. C-Bands (dBW/4 KHz)	Ku-Band (dBW/40 KHz)
	2.5 ≤∅≤ 7	(32-25 log ∅)	(39-25 log ∅)
1	2.5	22.0	29.0
2	5.0	14.5	21.5
3	7 ≤∅≤ 9.2	11.0	18.0
	9.2 ≤∅≤ 48	(35-25 log ∅)	(42-25 log ∅)
4	10	10.0	17.0
5	20	2.5	9.5
6	30	-1.9	5.1
7	40	-5.1	1.9
8	48 ≤∅≤ 180	-7.0	0

ABBREVIATIONS:

BER	-	Bit Error Ratio
BSS	-	Broadcast Satellite Service
CUG	-	Closed Users Group
dBc	-	Decibel referenced to the carrier level
dB/K	-	Decibel per degree Kelvin
dBm	-	Decibel referenced to a milli-Watt
dBW	-	Decibel referenced to a Watt
dBW/Hz	-	Decibel referenced to a Watt per Hertz
dBW/m^2	-	Decibel referenced to a Watt per square meter
dBpW	-	Decibel referenced to Pico Watt
DSNG	-	Digital Satellite News Gathering
DTH	-	Direct-To-Home
EIRP	-	Effective Isotropic Radiated Power
EOC	-	Edge of Coverage
FSS	-	Fixed Satellite Service
GHz	-	Giga Hertz
G/T	-	Gain-to-noise temperature ratio for antenna
I-net	-	Packet Switched Public Data Network implemented by BSNL
IM	-	Inter-modulation
INSAT	-	Indian National Satellite System
IR	-	Interface Requirements
ITU-R	-	Radio communication Sector of International Telecommunication Union
kbps	-	Kilo bits per second
kHz	-	Kilo Hertz
LHCP	-	Left Hand Circular Polarisation
m	-	Metre
Mbps	-	Mega bits per second
MHz	-	Mega Hertz
NOCC	-	Network Operation and Control Centre
NMS	-	Network Management System
ppm	-	Part per million
psd	-	Power spectral density
PSTN	-	Public Switched Telephone Network
RHCP	-	Right Hand Circular Polarisation
SFD	-	Saturation Flux Density
SSPA	-	SolidState Power Amplifier
TEC	-	Telecommunication Engineering Centre
TWTA	-	Travelling-wave Tube Amplifier
VAS	-	Value Added Services
VSAT	-	Very Small Aperture Terminal
λ	-	Wavelength
ø	-	Off-axis angle