OPTUS 10 SATELLITE

PAYLOAD INFORMATION

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YOUR EYE IN THE SKY

1.0 Introduction

A SATELLITE FLEET TO BE PROUD OF

OPTUS SATELLITE OPERATES AN AUSTRALIAN DOMESTIC SATELLITE SYSTEM WHICH PROVIDES COVERAGE OVER CONTINENTAL AUSTRALIA, TASMANIA, NEW ZEALAND AND WITH LIMITED OPTIONS AVAILABLE WHEREBY COVERAGE IS POSSIBLE OF PAPUA NEW GUINEA, NORFOLK ISLAND, LORD HOWE ISLAND, COCOS ISLAND, CHRISTMAS ISLAND, EAST ASIA, HAWAII AND ANTARCTICA. SERVICES ARE CURRENTLY PROVIDED IN KU AND L BAND. THE OPTUS SATELLITE FLEET CONSISTS OF THE SATELLITES B3, C1, D1, D2, D3 AND OPTUS-10.

What we manage

The Optus-10 satellite provides increased fleet resilience and additional capacity to deliver voice, data and video services over mainland Australia, New Zealand and Australia's surrounding islands and territories.

What's in this book?

This document provides an overview of the Optus-10 satellite commercial payload, describing the satellite and the general performance characteristics. The information in this document is intended to provide a general indication of the Optus-10 satellite's service capabilities.

The Optus-10 satellite operates in the Ku band with coverage for Australia and/or combined Australia and New Zealand. New Zealand only coverage is not provided by the Optus-10 satellite. The Optus-10 satellite also provides limited coverage of Papua New Guinea (in FSS band) and McMurdo Sound in Antarctica (in FSS band at the 160°E orbit location). The Optus-10 satellite is able to operate in the Fixed Satellite Services band (FSS) and/or the Broadcasting Satellite Services (BSS) band for Australia and/or combined Australia and New Zealand. Currently the BSS band is not provided in New Zealand due to regulatory restrictions.

The Optus-10 satellite is currently station kept at the 164°E orbit location, co-located with the inclined orbit B3 satellite. The satellite operates into antennas of 1.2m minimum diameter in accordance with agreements with other satellite operators.

Customers are advised that the same operational requirements for the Optus-10 satellite will apply as with the other existing Optus satellites. This includes ensuring transmit earth stations conform to minimum performance standards. Information on the requirements for earth stations accessing Optus satellites is outside the scope of this satellite information document.

The information in this document is intended for use as a technical guide only for the Optus-10 satellite and does not constitute an indication or representation that services are or may be available.

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1.1 Satellite System Management

All Optus satellites are operated within parameters which are dependent on the satellite performance capability and the requirements of the communication services. The specific nature and application of the technical requirements is dependent on many factors such as the service technology, the amount of satellite capacity used and the transponder in which the service is operated. All these factors are interdependent and need to be managed to ensure the quality of all services is preserved over the life of the satellite. As the owner, operator and manager of the satellite system, Optus controls the performance of all satellite services, including by determining transponder allocations and setting operating characteristics while minimising interference with other services.

Satellite system management is not a simple task and in some cases Optus may need to apply special conditions to a service that are designed to preserve the performance integrity of the satellite system.

2.0 THE OPTUS 10 SATELLITE

2.1 Satellite Summary

The Optus-10 Satellite was manufactured under contract to Space Systems Loral.

The Optus-10 satellite in the deployed configuration is shown in **Figure 2.1.**

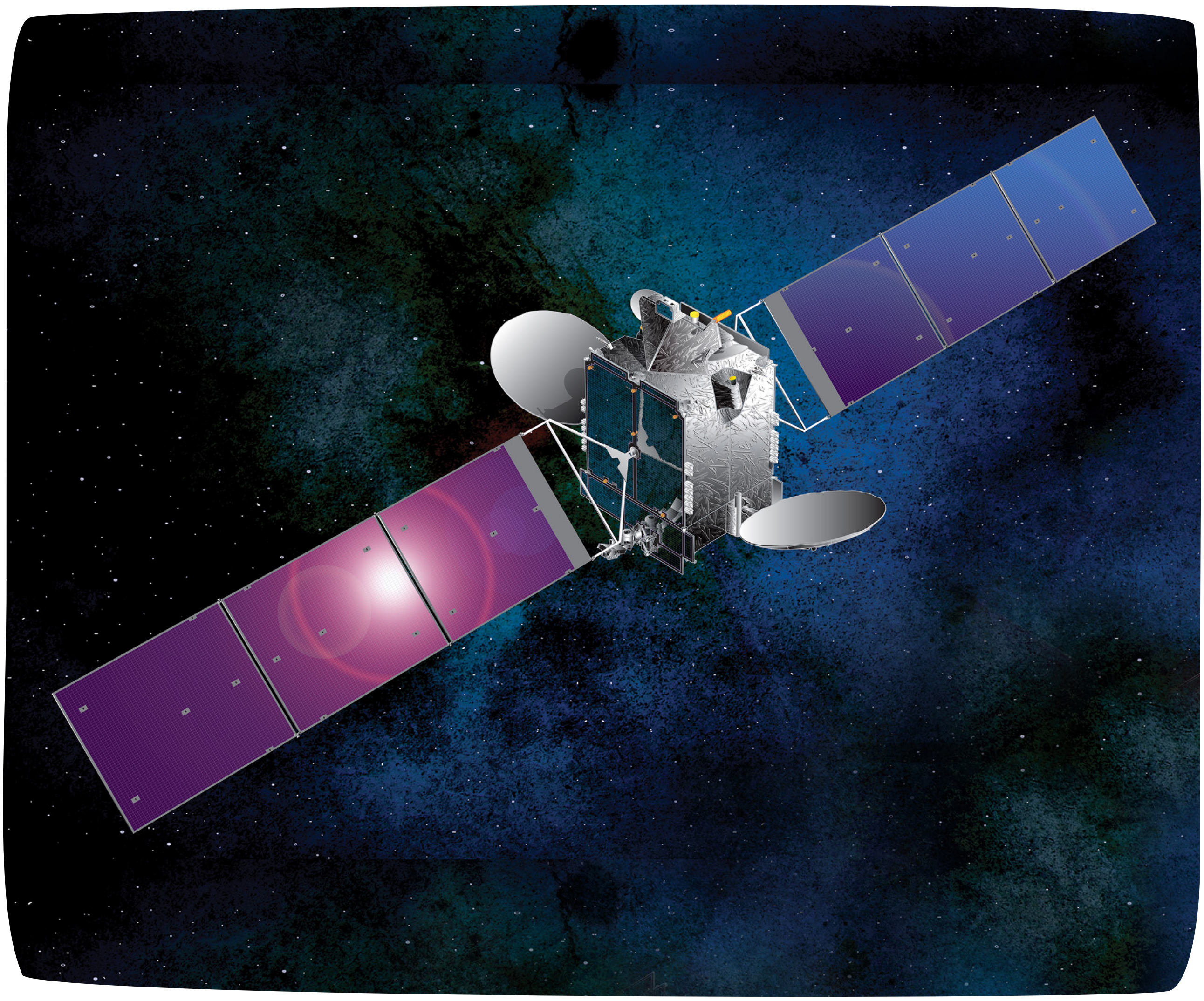

FIGURE 2.1 OPTUS 10 SATELLITE

OPTUS 10 SATELLITE PAYLOAD INFORMATION

The Optus-10 satellite consists of a space platform or "spacecraft bus" which provides various support systems required to control and maintain the satellite in orbit and operate the on-board communications system. The reliability of the platform itself is designed to be extremely high, and extensive protection from platform failures is provided by built-in redundancy and by extensive emergency operating procedures which have been developed to counter foreseeable on-station emergency situations. The platform includes the power supply (solar cells and battery) which have been designed with an adequate margin for successful in-orbit operation extending well beyond the satellite design life.

The Optus-10 satellite payload comprises a Ku Band repeater designed to provide switchable Fixed Satellite Services (FSS) & Broadcast Satellite Services (BSS) to Australia and/or combined Australia and New Zealand regions. Service provision extends to Cocos, Christmas, Norfolk and Lord Howe Islands. Service is also provided to Papua New Guinea (in FSS band) and McMurdo Sound (in FSS band from the 160°E orbit location). A total of twenty-four active linearised transponders are provided. Eight switchable beams are possible via the Optus-10 satellite providing connectivity to the FSS National Australia A (FNA), FSS National Australia B (FNB), FSS National Australia and New Zealand A (FNANZ), FSS National Australia and New Zealand B (FNBNZ), BSS National Australia A (BNA), BSS National Australia B (BNB), BSS National Australia and New Zealand A (BNANZ) and the BSS National Australia and New Zealand B (BNBNZ) beams. Although currently there is no regulatory approval to operate BSS into New Zealand the satellite is capable of operating in this configuration if required. The A and B beams operate in orthogonal polarisations and each uplink beam operates in the polarisation orthogonal to its corresponding downlink beam.

The twenty-four active transponders can be switched individually to operate as FSS or BSS transponders and can be individually switched to Australia or combined Australia and New Zealand coverage.

Telemetry and control of the spacecraft is provided by Optus Satellite Operations staff from the Sydney Satellite Facility at Belrose, with back up from Perth Satellite Facility at Lockridge.

The Optus-10 transponders are all 36MHz in bandwidth and generally mirror the C1 (FSS) and D3 (BSS) satellite frequency plans.

2.2 Satellite Orbital Positions

The Optus-10 satellite is located at 164° East, co-located with the B3 satellite which is in inclined orbit. During its lifetime, Optus-10 can be moved to an alternate orbit location, subject to the necessary regulatory requirements, to meet Optus' business needs. Optus-10 was designed to be able to operate at any slot between 152° East and 164° East to increase the resilience of the Optus satellite fleet.

2.3 Station Keeping Performance

A satellite in a "geostationary" orbit will gradually change its orbit position primarily due to the combined gravitational effects of the sun, moon and earth. Optus employs two forms of station-keeping to maintain the nominal satellite position. These are Geostationary and Inclined Orbit operation.

The Optus-10 satellite is designed to operate in geostationary mode. The Optus-10 satellite is currently maintained in orbit with a tolerance of ±0.07° in latitude and longitude about the sub-satellite point. (The sub-satellite point is the point on the earth's surface directly below the nominal satellite position).

Earth station antennas of up to about 7m in diameter accessing the Optus satellites in the Ku-band frequencies of 14/12GHz and 17/11GHz generally do not require tracking capability when the satellites are in geostationary orbits.

OPTUS 10 SATELLITE PAYLOAD INFORMATION

3.0 OPTUS-10 SATELLITE

The main characteristics of the Optus-10 satellite are listed in **Table 3.1** below.

	Optus 10 Satellite
Physical Structure	Rectangular Prism body with solar wings
Dimensions	24.8 metres across extended solar panels
Dry Mass	1677 kg
Antenna	Two 2.4m offset Gregorian antennas
Stabilisation Method	3 Axis Momentum Stabilised
Solar Power Capacity	7700 watts (at end of life)
Battery Capacity	Full operation during eclipse
Geostationary Design Life	15 years
Inclined Life Extension	5yrs (nominal)
Number of Transponders	24 Ku-Band
Transponder Power	133 watts saturated RF power per transponder Tpdrs 1-24
Transponder Bandwidth	36MHz
Communications payloads	Ku-Band communications UPC Beacon (Ku-Band)

TABLE 3.1 OPTUS-10 SATELLITE SUMMARY

3.1 OPTUS-10 COMMERCIAL COMMUNICATIONS PAYLOAD OVERVIEW

A simplified block diagram of the Optus-10 satellite communications payload is shown in **Figure 3.1** below.

Communications Payload (Ku-Band)

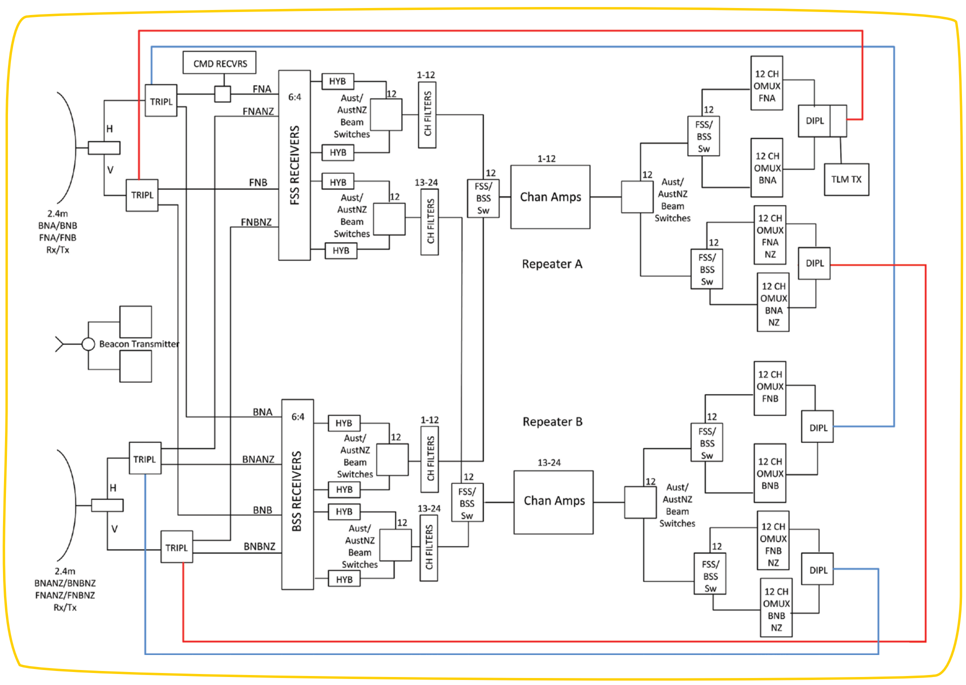

FIGURE 3.1 OPTUS-10 SATELLITE COMMUNICATIONS PAYLOAD BLOCK DIAGRAM

OPTUS 10 SATELLITE PAYLOAD INFORMATION

The Ku-band payload of the Optus-10 satellite is divided into two repeaters called A and B.

The A repeater consists of twelve transponders whose uplinks are switchable from the FSS and BSS A pol uplinks and the Australian A pol or combined Australia plus NZ A pol beams.

The B repeater consists of twelve transponders whose uplinks are switchable from the FSS and BSS B pol uplinks and the Australian B pol or combined Australia plus NZ B pol beams.

The transponders receive and transmit on orthogonal linear polarisations. Transponders 1 to 12 are identified as repeater A and receive on horizontal polarisation and transmit on vertical polarisation. Transponders 13 to 24 are identified as repeater B and receive on vertical polarisation and transmit on horizontal polarisation.

The Ku-band payload of the Optus-10 satellite can be conveniently divided into twelve sections described below:

i) Receive and Transmit Antennas

The receive and transmit antennas consist of two 2.4 metre offset Gregorian shaped main reflectors with 0.7m sub-reflectors, illuminated with six port dual linear transmit and receive feeds mounted on the earth deck.

ii) FSS Receivers

The FSS receiver section contains six receivers in a 6-for-4 redundancy ring for the Australia and Australia plus NZ FSS beams. The receivers amplify the entire 500MHz spectrum and translate it by 1748MHz from the 14GHz band to the 12GHz band.

iii) BSS Receivers

The BSS receiver section contains six receivers in a 6-for-4 redundancy ring for the Australia and Australia plus NZ BSS beams. The receivers amplify the entire 500MHz spectrum and translate it by 5600MHz from the 17GHz band to the 11GHz band.

iv) Input Hybrids

The receivers are followed by the 1:4 input hybrids. One hybrid is provided for each receive beam. Each of the outputs is routed to a 1:3 hybrid. These hybrids divide the received signal for presentation to the input beam switches.

v) Input Beam Switches

Each hybrid output is followed by an input beam switch. There is one input beam switch per channel filter. The input beam switches select the required uplink beam for each channel filter.

vi) Channel Filters

The channel filters divide or "channelise" the receive bands into a number of Ku-band channels. In each repeater twelve Ku-Band channels are derived. Channel filters are provided for channels 1-12 FSS, channels 13-24 FSS, channels 1-12 BSS, and channels 13-24 BSS.

vii) Receive FSS/BSS Switches

Each channel filter output is switched via the FSS/BSS Switches to a Channel Amplifier. The received signal from FSS or BSS band is selected for connection to the Channel Amplifiers.

viii) Channel Amplifiers

Each channel amplifier section consists of a Linearised Channel Amplifier (LCAMP) followed by a Travelling Wave Tube Amplifier (TWTA). The LCAMP controls the transponder gain setting and is discussed in **Section 4.5.**

All transponders in the Optus-10 repeaters have the same saturated RF power output - 133W.

Input and output redundancy switching is provided for the channel amplifiers such that the A and B repeaters have access to a ring providing 28-for-24 redundancy.

ix) Harmonic Filters

Each channel amplifier output is filtered by a harmonic filter to limit signals outside the transmit band.

x) Transmit Beam Switches

Following the channel amplifiers are the transmit beam switches. These are configured by ground command to select a particular transmit beam for a particular transponder.

xi) Transmit FSS/BSS Switches

Following the transmit beam switches are the transmit FSS/BSS switches. These are configured by ground command to select a particular transmit band for a particular transponder corresponding to the selected receive band.

xii) Output Multiplexers (OMUX)

All transponders switched to a given transmit beam are recombined into a 500MHz spectrum in an output multiplexer (OMUX) bank before being fed to the transmit antenna. An OMUX bank is provided for each downlink beam. The OMUX banks provide channel filtering in conjunction with the prior harmonic filters to absorb and reject TWTA harmonics.

4.0 OPTUS-10 KU-BAND COMMUNICATIONS PAYLOAD

The Optus-10 satellite can provide twenty-four active transponders operating in a dual polarisation frequency re-use scheme. Each transponder can be individually configured to operate in any combination of Australia only or Australia and NZ, FSS band or BSS band. Twelve transponders are provided in each repeater.

4.1 Optus-10 Frequency Plan

The Optus-10 satellite will receive and transmit at the following Ku-Band frequencies:

FSS Band	**Receive**	14,000-14,500 MHz	(14.00-14.50 GHz)
	Transmit	12,250-12,750 MHz	(12.25-12.75 GHz)
BSS Band	**Receive**	17,300-17,800 MHz	(17.30-17.80 GHz)
	Transmit	11,700-12,200 MHz	(11.70-12.20 GHz)

The transponder channel plan is shown in **Figure 4.1, Figure 4.2** and **Table 4.1**.

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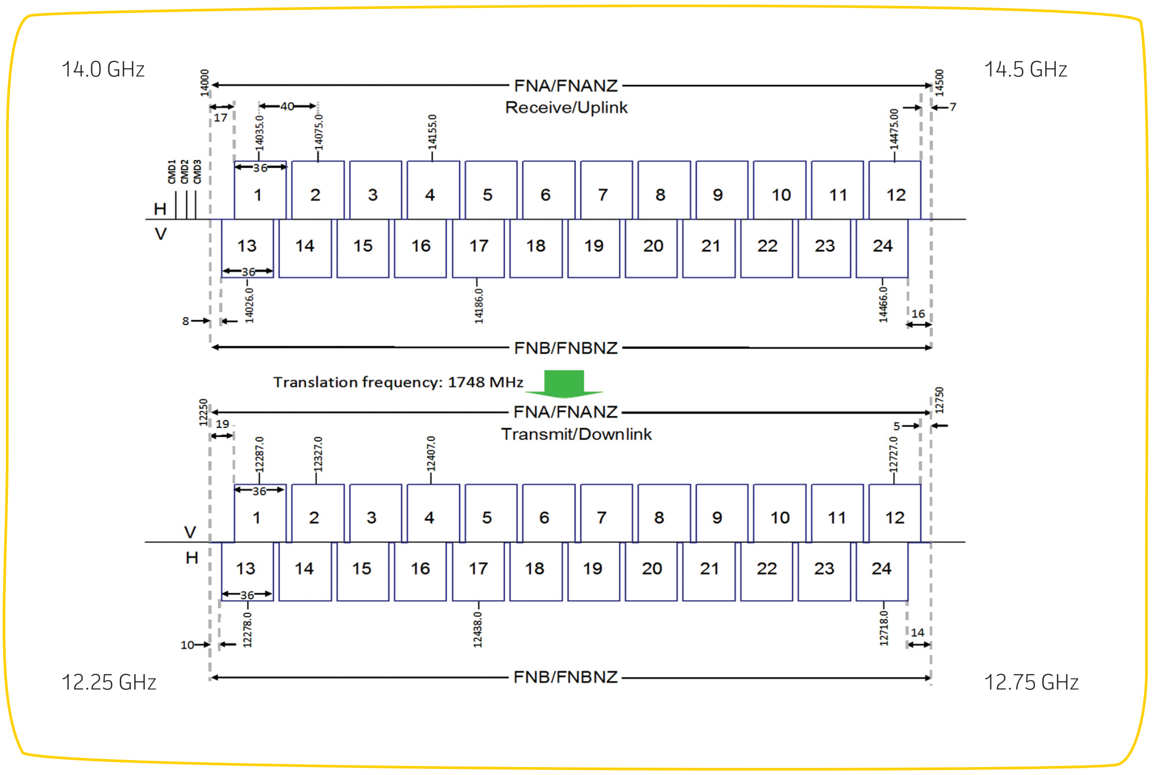

FIGURE 4.1 OPTUS-10 FSS FREQUENCY PLAN

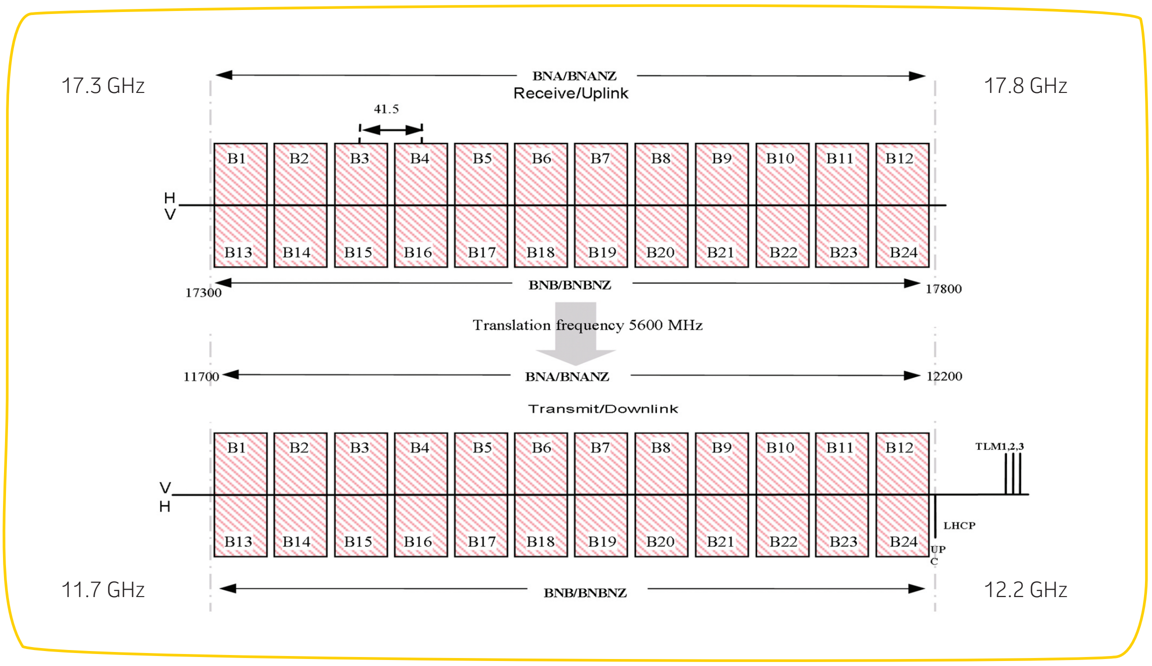

FIGURE 4.2 OPTUS-10 BSS FREQUENCY PLAN

OPTUS 10 SATELLITE PAYLOAD INFORMATION

FSS Centre Frequencies (MHz)		
Channel	Uplink	Downlink
1	14035.0	12287.0
2	14075.0	12327.0
3	14115.0	12367.0
4	14155.0	12407.0
5	14195.0	12447.0
6	14235.0	12487.0
7	14275.0	12527.0
8	14315.0	12567.0
9	14355.0	12607.0
10	14395.0	12647.0
11	14435.0	12687.0
12	14475.0	12727.0
13	14026.0	12278.0
14	14066.0	12318.0
15	14106.0	12358.0
16	14146.0	12398.0
17	14186.0	12438.0
18	14226.0	12478.0
19	14266.0	12518.0
20	14306.0	12558.0
21	14346.0	12598.0
22	14386.0	12638.0
23	14426.0	12678.0
24	14466.0	12718.0

BSS Centre Frequencies (MHz)		
Channel	Uplink	Downlink
B1	17320.5	11720.5
B2	17362.0	11762.0
B3	17403.5	11803.5
B4	17445.0	11845.0
B5	17486.5	11886.5
B6	17528.0	11928.0
B7	17569.5	11969.5
B8	17611.0	12011.0
B9	17652.5	12052.5
B10	17694.0	12094.0
B11	17735.5	12135.5
B12	17777.0	12177.0
B13	17320.5	11720.5
B14	17362.0	11762.0
B15	17403.5	11803.5
B16	17445.0	11845.0
B17	17486.5	11886.5
B18	17528.0	11928.0
B19	17569.5	11969.5
B20	17611.0	12011.0
B21	17652.5	12052.5
B22	17694.0	12094.0
B23	17735.5	12135.5
B24	17777.0	12177.0
UPC		12202.1
TLM1		12233.5
TLM2		12235.5
TLM3		12237.5

TABLE 4.1 OPTUS-10 SATELLITE CHANNEL FREQUENCY PLAN

4.2 Optus-10 Frequency Translation Characteristics

Satellite frequency translation characteristics for the Ku band communications payload, including expected stability performance, are as follows:

Optus-10 Satellite Parameter FSS	Performance Measure
Translation Frequency	1,748 MHz
Short-term Drift	±1.75 kHz/month
Long-Term Drift (over satellite life)	±17.5 kHz

Optus-10 Satellite Parameter BSS	Performance Measure
Translation Frequency	5,600 MHz
Short-term Drift	±5.6 kHz/month
Long-Term Drift (over satellite life)	±56.0 kHz

TABLE 4.2 OPTUS-10 TRANSLATION FREQUENCY CHARACTERISTICS

OPTUS 10 SATELLITE PAYLOAD INFORMATION

4.3 Optus-10 Satellite Beam Information

The Optus-10 satellite has several receive and transmit beams on both horizontal and vertical polarisation.

Receive and transmit connectivity may be configured by ground command from the Optus Satellite Control Centre to match system operational requirements as they occur throughout the life of the satellite.

4.3.1 Receive Beams

The receive beams for the Optus-10 satellite are as follows:

Transponders FSS	Optus-10 Satellite Receive Beams
Transponders 1-12	FNA or FNANZ
Transponders 13-24	FNB or FNBNZ

Transponders BSS	Optus-10 Satellite Receive Beams
Transponders 1-12	BNA or BNANZ
Transponders 13-24	BNB or BNBNZ

TABLE 4.3 OPTUS-10 SATELLITE RECEIVE BEAMS

4.3.2 Transmit Beams

The transmit beams for the Optus-10 satellite are as follows:

Transponders FSS	Optus-10 Satellite Transmit Beams
Transponders 1-12	FNA or FNANZ
Transponders 13-24	FNB or FNBNZ

Transponders BSS	Optus-10 Satellite Transmit Beams
Transponders 1-12	BNA or BNANZ
Transponders 13-24	BNB or BNBNZ

TABLE 4.4 OPTUS-10 SATELLITE TRANSMIT BEAMS

OPTUS 10 SATELLITE PAYLOAD INFORMATION

4.3.3 Optus-10 Transponder and Beam Connectivity

Transponder connectivity may be configured by ground command from the Optus Satellite Control Centre to match system operational requirements as they occur throughout the life of the satellite.

The connectivity available on the Optus-10 satellite is shown in **Table 4.5** below.

Note that cross-banding (eg. FSS uplink, BSS downlink on a single transponder) is not possible.

Trans-ponder No.	Receive Beam								Transmit Beam							
	FNA (H)	FNA NZ (H)	FNB (V)	FNB NZ (V)	BNA (H)	BNA NZ (H)	BNB (V)	BNB NZ (V)	FNA (V)	FNA NZ (V)	FNB (H)	FNB NZ (H)	BNA (V)	BNA NZ (V)	BNB (H)	BNB NZ (H)
1	S	S			S	S			S	S			S	S		
2	S	S			S	S			S	S			S	S		
3	S	S			S	S			S	S			S	S		
4	S	S			S	S			S	S			S	S		
5	S	S			S	S			S	S			S	S		
6	S	S			S	S			S	S			S	S		
7	S	S			S	S			S	S			S	S		
8	S	S			S	S			S	S			S	S		
9	S	S			S	S			S	S			S	S		
10	S	S			S	S			S	S			S	S		
11	S	S			S	S			S	S			S	S		
12	S	S			S	S			S	S			S	S		
13			S	S			S	S			S	S			S	S
14			S	S			S	S			S	S			S	S
15			S	S			S	S			S	S			S	S
16			S	S			S	S			S	S			S	S
17			S	S			S	S			S	S			S	S
18			S	S			S	S			S	S			S	S
19			S	S			S	S			S	S			S	S
20			S	S			S	S			S	S			S	S
21			S	S			S	S			S	S			S	S
22			S	S			S	S			S	S			S	S
23			S	S			S	S			S	S			S	S
24			S	S			S	S			S	S			S	S

TABLE 4.5 OPTUS-10 TRANSPONDER AND BEAM CONNECTIVITY

(Each transponder may be switched to one of the beams as shown)

Legend of abbreviations:

FNA FSS band National Beam A

FNB FSS band National Beam B

FNANZ FSS band National Australia plus New Zealand Beam A

FNBNZ FSS band National Australia plus New Zealand Beam B

BNA BSS band National Beam A

BNB BSS band National Beam B

BNANZ BSS band National Australia plus New Zealand Beam A

BNBNZ BSS band National Australia plus New Zealand Beam B

S Switchable between beams marked with S for respective transponder

(V) Vertical polarisation

(H) Horizontal polarisation

4.4 Optus-10 Satellite Beam Performance Levels

Contour maps of satellite beam performance, in terms of G/T and EIRP, are provided for the Optus-10 satellite in **Attachments 1** and **2**.

For the Optus-10 satellite, the FNA, FNB, FNANZ & FNBNZ EIRP maps and the BNA, BNB, BNANZ & BNBNZ EIRP maps are based on 133W (saturated).

Service designs based on satellite beam performances need to include allowances for the normal performance variations to be expected between different satellite transponders over the operating life of the satellites. To assist design engineers in taking these effects into account, Optus has established a number of "Beam Performance Levels" which include different assumptions about satellite performance. The most important of these is the "General Design Level" which is the only beam performance level for which information is provided in this guide.

4.5 Optus-10 Transponder Gain Control

Each satellite transponder contains a Linearised Channel Amplifier (LCAMP) (see section 3.1) which provides a means of controlling the transponder gain. This gives the transponder a range of operating C/T values to suit the characteristics of the systems operating on it at a given time. The C/T (called "C-to-T") is the uplink saturated carrier-to-noise-temperature ratio and is a fundamental design parameter of a satellite transponder. It is related to the SFD and G/T by the following equation:

$$C/T = SFD + G/T + 10\log_{10}(\lambda^2/4\pi)$$

- where -

C/T = Saturated carrier-to-noise-temperature ratio (dBW/K)

SFD = Saturated flux density (dBW/m^2)

G/T = Satellite receive gain-to-noise-temperature ratio (dB/K)

$\lambda^2/4\pi$ = Isotropic area conversion factor (m^2)

Note that for a given transponder gain setting the C/T is fixed, meaning that the sum (SFD + G/T) is also fixed, i.e. the SFD and G/T vary in inverse proportion over the satellite receive beam pattern.

On the Optus-10 satellite two methods are used to provide transponder gain control for a range of C/Ts. Fixed Gain Mode (FGM) and Variable Gain Mode (VGM) are selectable by ground command in accordance with the following specifications.

4.5.1 Fixed Gain Mode (FGM)

FGM corresponds to traditional gain-step control in which a variable step-attenuator is switched by ground command to one of a number of settings or "attenuation steps".

The Optus-10 satellite has an attenuation step control range covering a nominal uplink saturated C/T range of 116 to -135 dBW/K in 1dB steps. At a point in the satellite uplink beam where the G/T is +2dB/K, the corresponding uplink SFD is as specified in **Table 4.6**. Note that the satellite is expected to operate over a C/T range substantially less than shown in this table. The correct selection of operating attenuation step is important in order to minimise uplink interference between transponders using polarisation or spatial re-use.

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Nominal C/T (dBW/K)	Approx. SFD (at +2dB/K G/T contour) (dBW/m^2)
-108	-65
-144	-101

TABLE 4.6 OPTUS-10 FGM ATTENUATION STEP RANGE

Each transponder is provided with independent ground commandable attenuator adjustment capability to facilitate selection on any transponder attenuation step as indicated in **Table 4.6**.

The satellite is designed so that the C/T required for transponder saturation at any selected attenuation step should not vary by more than ±1dB over any 24 hour period, and ±2dB over the spacecraft service life.

4.5.2 Variable Gain Mode (VGM)

VGM (also known as ALC - Automatic Level control) provides a form of automatic gain control. Under VGM a feedback-loop maintains a constant input drive level to the transponder TWTA over an operating uplink C/T range. This compensates for uplink fading at the cost of gradually degrading the uplink C/N.

When the spacecraft is illuminated by a single carrier or multiple carriers within the transponder usable bandwidth, at a level required to produce a total receive carrier-to-noise temperature ratio (C/T) in the range 123 dBW/K to 143 dBW/K, the transponder operating point is maintained at a total input backoff, selectable by ground command for each transponder, of between -2.5dB (ie 2.5dB input overdrive) and 15.5dB (in 0.5dB steps) relative to that required for single carrier saturation.

VGM operates on the total transponder power (signal plus noise) and has a time constant of between 10ms and 100ms. VGM is therefore intended for either single-carrier operation, or for multiple carriers where all carriers are uplinked from the same location and therefore undergo an uplink fade at the same time. VGM may be used with uplink power control if desired to extend the range of uplink fade compensation.

4.5.3 TDMA Operation

Up to any four (4) transponders may operate in synchronous TDMA mode with burst repetition rate or switching rate higher than 400 Hz simultaneously.

4.6 Optus-10 Amplitude Transfer Characteristics.

A representative AM/AM transfer characteristic for the TWTAs used in the Optus-10 satellite is shown in **Figure 4.3.** This shows the transfer curves for a single carrier. The X axis defines the Input Backoff (IBO) relative to TWTA saturation for the carrier whilst the Y axis defines the Output Backoff (OBO) for the carrier.

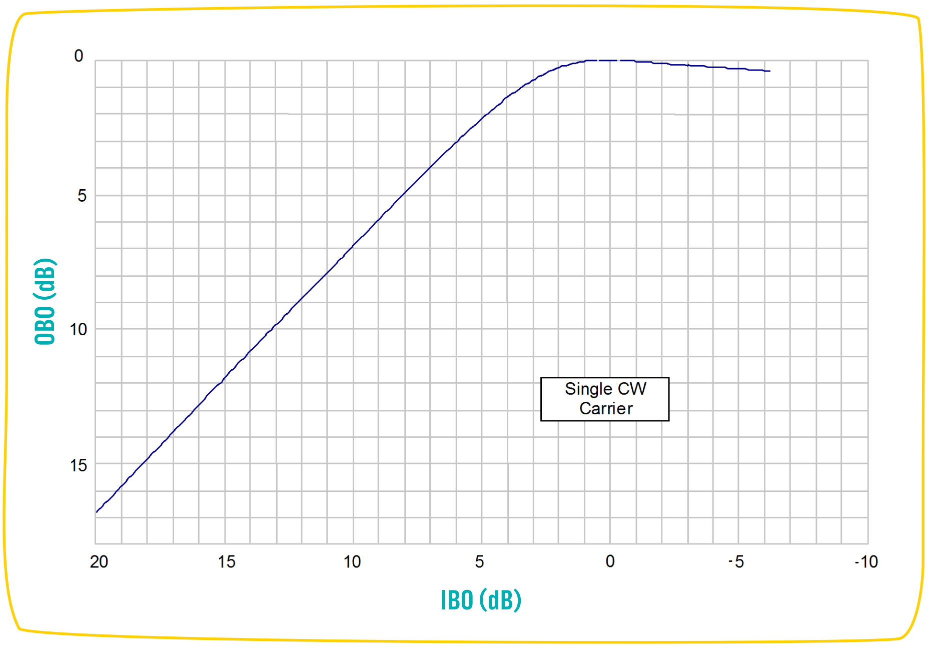

FIGURE 4.3 TYPICAL OPTUS-10 SATELLITE AMPLITUDE TRANSFER CHARACTERISTIC

Figure 4.4 shows the normalised TWTA gain of a typical Optus-10 satellite transponder as a function of Input Backoff (IBO) for a single carrier. The X axis defines the Input Backoff (IBO) relative to TWTA saturation for the carrier whilst the Y axis defines the carrier gain of the transponder.

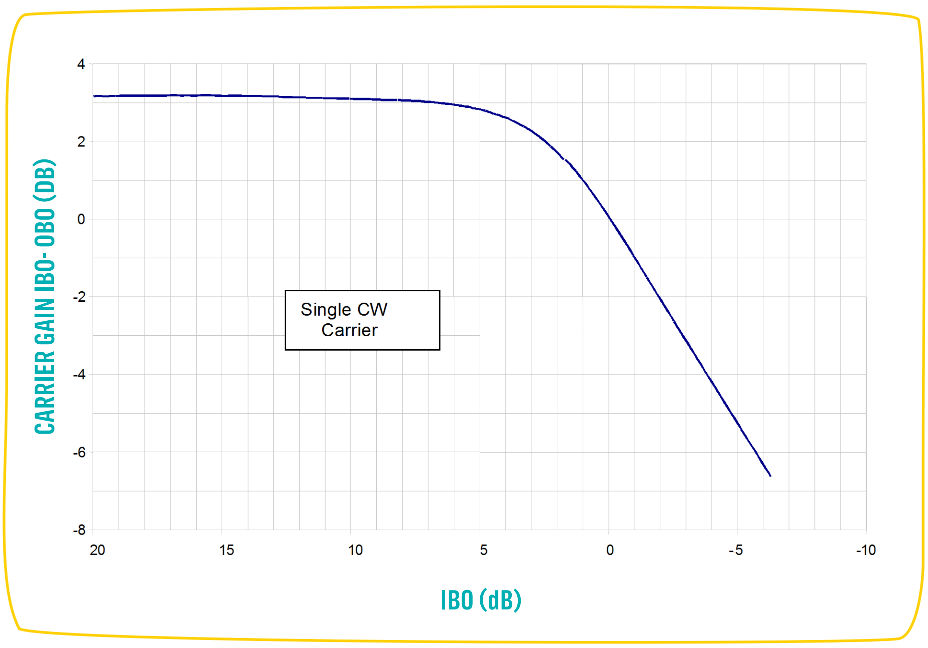

FIGURE 4.4 TYPICAL OPTUS-10 SATELLITE TRANSPONDER GAIN CHARACTERISTIC

OPTUS 10 SATELLITE PAYLOAD INFORMATION

4.7 Optus-10 Satellite Cross Polarisation Discrimination

Cross polarisation performance of the Optus-10 orthogonally polarised repeaters A and B for the satellite receive and transmit beams, will equal or exceed the following performance levels:

For the FNA, FNB, FNANZ and FNBNZ beams, the Satellite Receive Cross Polarisation Discrimination over 100% of the coverage area is at least 27dB.

For the BNA, BNB, BNANZ and BNBNZ beams, the Satellite Receive Cross Polarisation Discrimination over 100% of the coverage area is at least 27dB.

For the FNA, FNB, FNANZ and FNBNZ beams, the Satellite Transmit Cross Polarisation Discrimination over 100% of the coverage area is at least 25dB.

For the BNA, BNB, BNANZ and BNBNZ beams, the Satellite Transmit Cross Polarisation Discrimination over 100% of the coverage area is at least 25dB.

Cross-polarisation performance of the satellite link can be expected to degrade during rain storms and under other adverse weather conditions.

4.8 Optus-10 Satellite Beacons

All Optus satellites transmit beacon signals which are used by Optus to monitor the condition of the spacecraft and which may be used by customer earth stations for antenna tracking and uplink power control (UPC). The UPC beacon is appropriate for tracking by customer earth stations.

4.8.1 Telemetry Beacons

The Optus-10 satellite transmits three telemetry beacons. These beacons are transmitted in Right Hand Circular polarisation via the Omni antenna for transfer orbit activities. For on station service these beacons are transmitted in Vertical polarisation over the Optus-10 satellite FNA/BNA Beam service area. **Table 4.7** indicates specifications of the Telemetry beacons.

Telemetry Beacons	Optus-10
Frequency TM1	12233.5MHz
Frequency TM2	12235.5MHz
Frequency TM3	12237.5MHz
Frequency Stability	± 12.2kHz over any 24 hour period
	± 100kHz over the spacecraft lifetime
Polarisation	Vertical – On Station
EIRP at Sydney	20.0 dBW min on station

TABLE 4.7 OPTUS-10 SATELLITE TELEMETRY BEACONS

4.8.2 Uplink Power Control Beacon

The Optus-10 satellite carries an uplink power control beacon which is used for tracking and Uplink Power Control (UPC). This beacon is radiated in Left Hand Circular Polarisation over the Optus-10 satellite service area. The UPC beacon characteristics are as specified in **Table 4.8**. Within the FSS service area, the received EIRP level of the UPC beacon is at least 10.0dBW measured within a 1kHz bandwidth centred on the beacon centre frequency. The level received will be 3dB lower when received with a linear feed on either polarisation.

OPTUS yes

Optus-10 UPC Beacon	
Frequency	12202.1 MHz
Frequency Stability	± 12.2kHz over any 24 hour period
	± 15kHz over any 1 month period
	± 100kHz over the spacecraft service life.
Polarisation	Left Hand Circular
EIRP across FSS Service Area	>10.0 dBW throughout FSS service area Aust and NZ
EIRP at McMurdo Sound	10.0 dBW **Note 1**
EIRP at Sydney	11.2 dBW

TABLE 4.8 OPTUS-10 SATELLITE TELEMETRY BEACONS

Note 1 Estimate only. This estimate does not take into consideration the effects of multipath interference due to low elevation angles and ice depolarisation.

4.9 Optus-10 Uplink Power Control Operation

When accessing Optus-10 customers may use uplink power control systems (UPC) to compensate for uplink rain attenuation. UPC systems must be approved by Optus before use and are strictly limited in the amount of uplink compensation permitted. Details of the amount of UPC permitted under various operating conditions may be obtained from Optus.

UPC systems use the attenuation measured on a downlink beacon to compensate for attenuation on the uplink. However attenuation is frequency-dependent and a scaling factor needs to be applied to determine the correct uplink compensation.

At 14/12GHz Optus recommends a scaling factor of 1.3.

At 17/11-12GHz Optus recommends a scaling factor of 1.9.

In the case of transferring services from the other Optus satellites to the Optus-10 satellite, all UPC beacons are Left Hand Circular polarisation but there are minor level differences between the satellites as specified in **Table 4.9**.

Transferring Services from	UPC Level variation
C1 to Optus-10	+1.0dB
D1 to Optus-10	+0.5dB
D2 to Optus-10	+0.5dB
D3 to Optus-10	+0.5dB

TABLE 4.9 OPTUS SATELLITES UPC BEACONS LEVEL VARIATIONS

ATTACHMENT 1

Optus-10 Satellite Beam Contours for the FSS Ku-Band Communications Payload from 164°E

The contour diagrams in this Attachment show the General Design Levels for the geostationary Optus-10 satellite operating at 164°E.

This information contains expected Optus-10 Ku-band patterns. The patterns are composites of three frequencies and therefore represent the worst-case over frequency. They also include worst-case beam pointing errors.

Contour diagrams, Figures A1-1 to A1-8 are provided for satellite G/T for FNA, FNANZ, FNB and FNBNZ and for EIRP for FNA, FNANZ, FNB, and FNBNZ.

The satellite G/T indicates the satellite transponder receive performance level at the satellite as “seen” from the ground.

The contour diagrams of EIRP show the radiated satellite transponder power in the direction of the ground locations.

FNA, FNB, FNANZ, and FNBNZ EIRP maps are based on 133W TWTAs (saturated).

All patterns contained within this document are based on the manufacturer’s data.

Contracted performance will be lower than that specified in this document to allow for individual transponder differences, TWT redundancy and different orbital locations.

General Design Level

The General Design Level (GDL) of beam performance represents the best estimate by Optus of the worst-case performance through to end-of-life for any satellite transponder switched to a particular beam. It allows for all possible cases of service restoration or transponder reallocation, and Optus recommends that it be used for the design of satellite systems to ensure that they will work on any satellite transponder through to end-of-life. In particular the General Design Level of beam performance is recommended for the sizing of earth station antennas and High Power Amplifiers (HPAs) on the uplink, and the calculation of earth station receive G/Ts on the downlink.

The contour maps show the General Design Level of beam performance at the time of publication of this guide for the Optus-10 satellite operating in geostationary orbit.

Specific Performance Levels

Beam performance specific to a given transponder on a given satellite in a given orbit position at a given time will be provided by Optus to customers on request. Optus does not recommend that specific performance levels be used to design systems or size earth stations as designs must make allowances for potential service restoration or transponder reallocation.

OPTUS 10 SATELLITE PAYLOAD INFORMATION

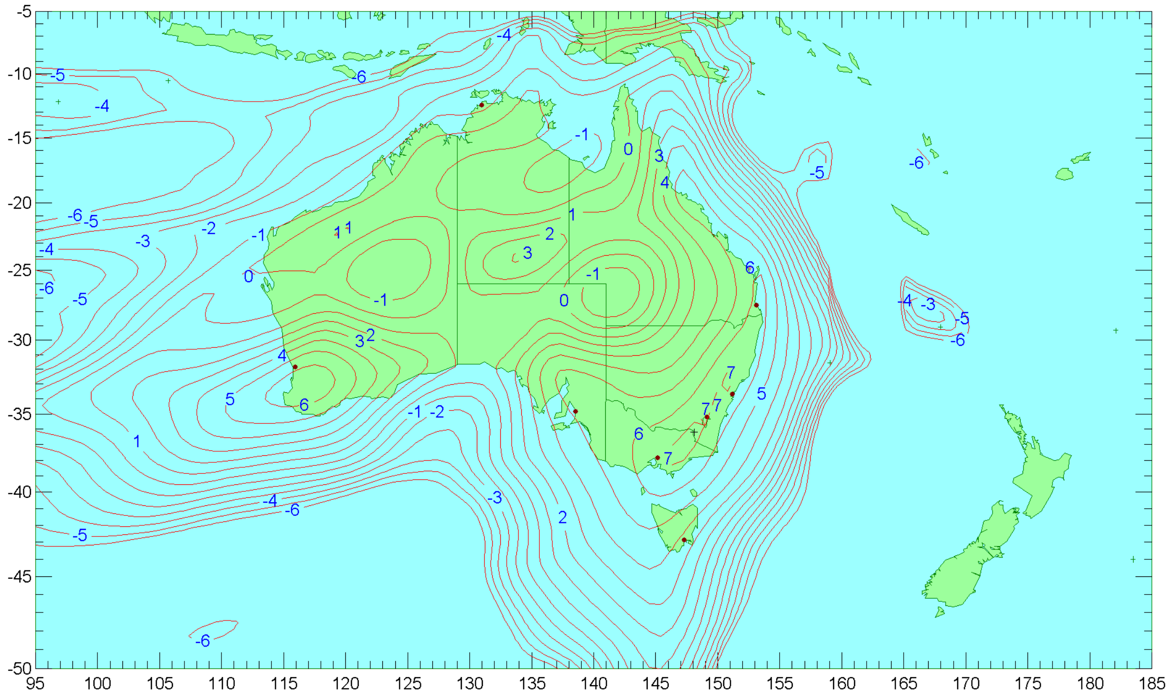

FIGURE A1-1 OPTUS-10 FNA BEAM RECEIVE G/T PERFORMANCE (dB/K) (164°E)

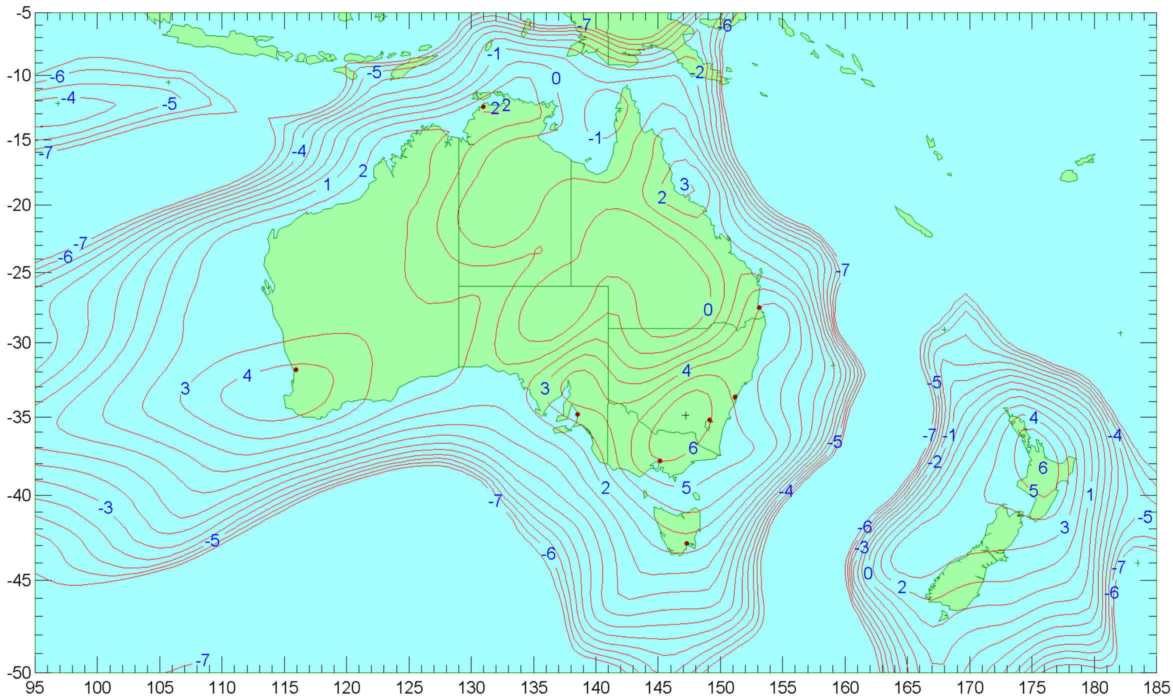

FIGURE A1-2 OPTUS-10 FNANZ BEAM RECEIVE G/T PERFORMANCE (dB/K) (164°E)

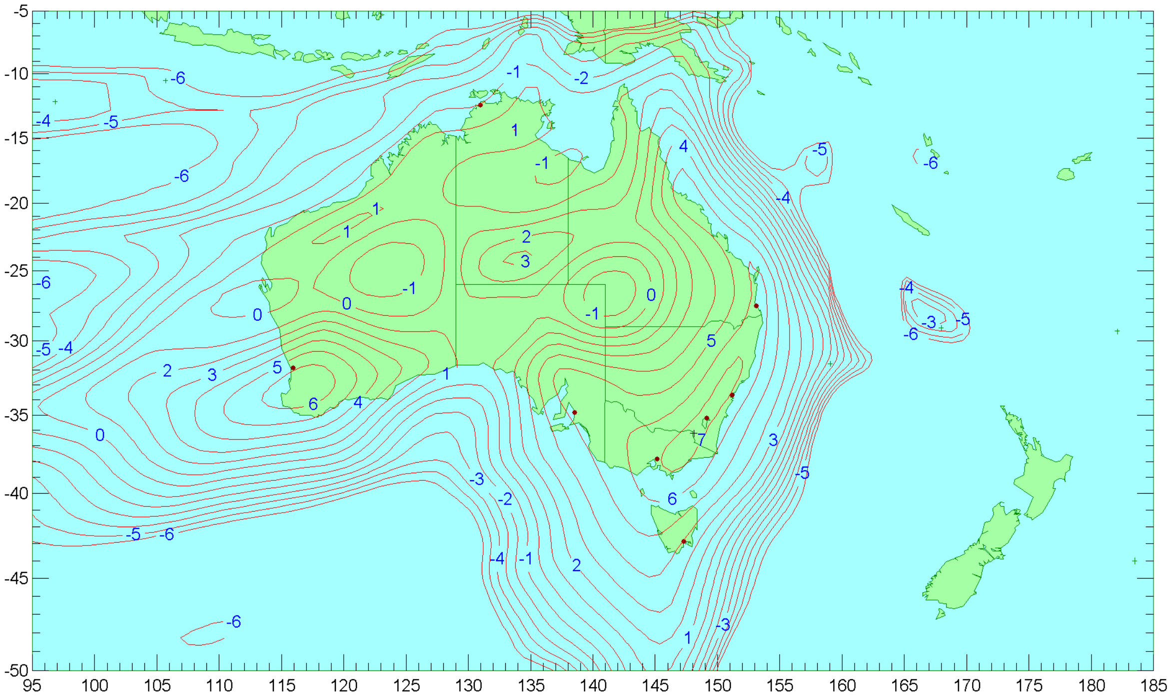

FIGURE A1-3 OPTUS-10 FNB BEAM RECEIVE G/T PERFORMANCE (dB/K) (164°E)

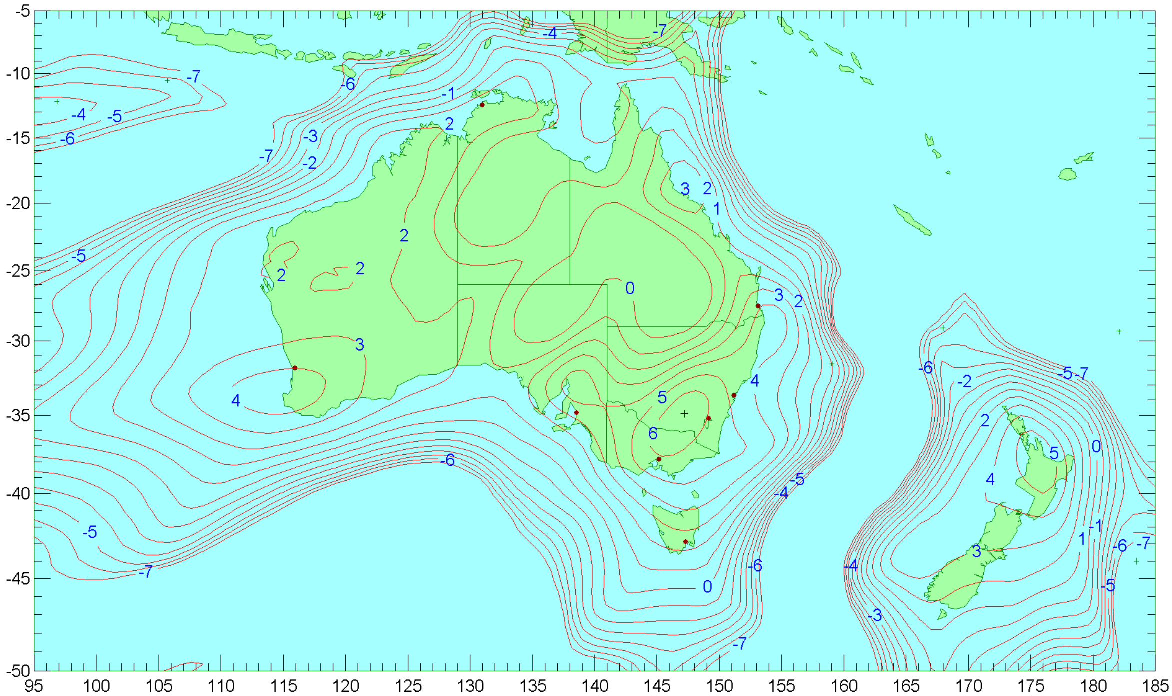

FIGURE A1-4 OPTUS-10 FNBNZ BEAM RECEIVE G/T PERFORMANCE (dB/K) (164°E)

OPTUS 10 SATELLITE PAYLOAD INFORMATION

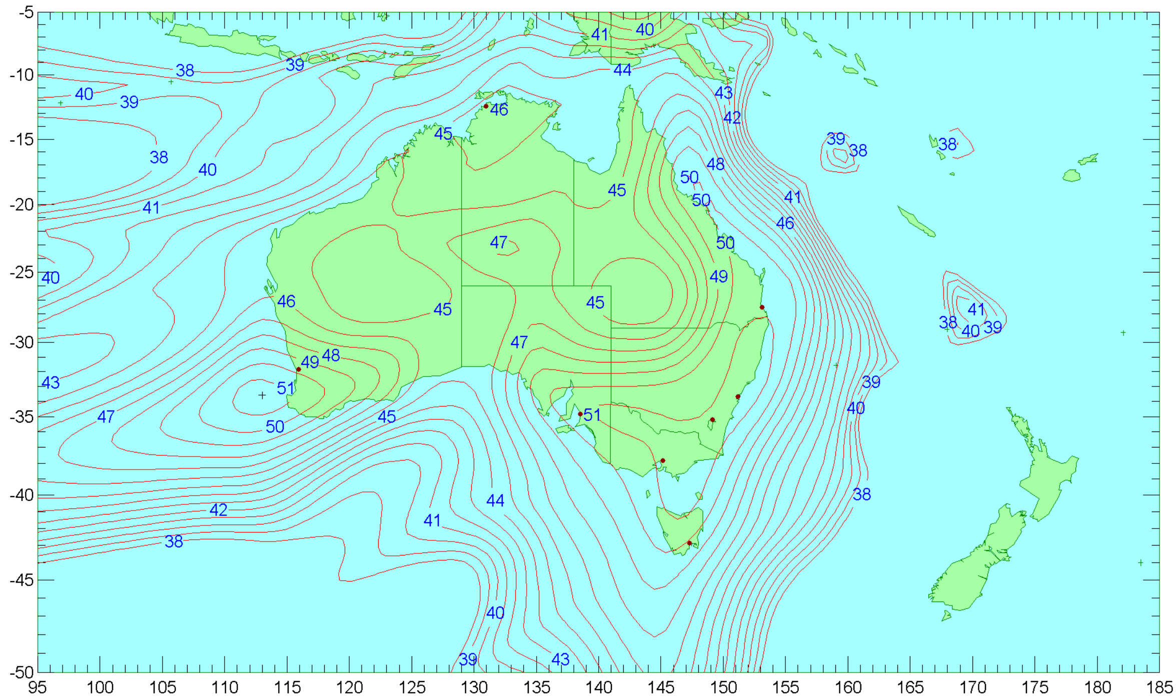

FIGURE A1-5 OPTUS-10 FNA BEAM TRANSMIT EIRP PERFORMANCE (dBW) (164°E)

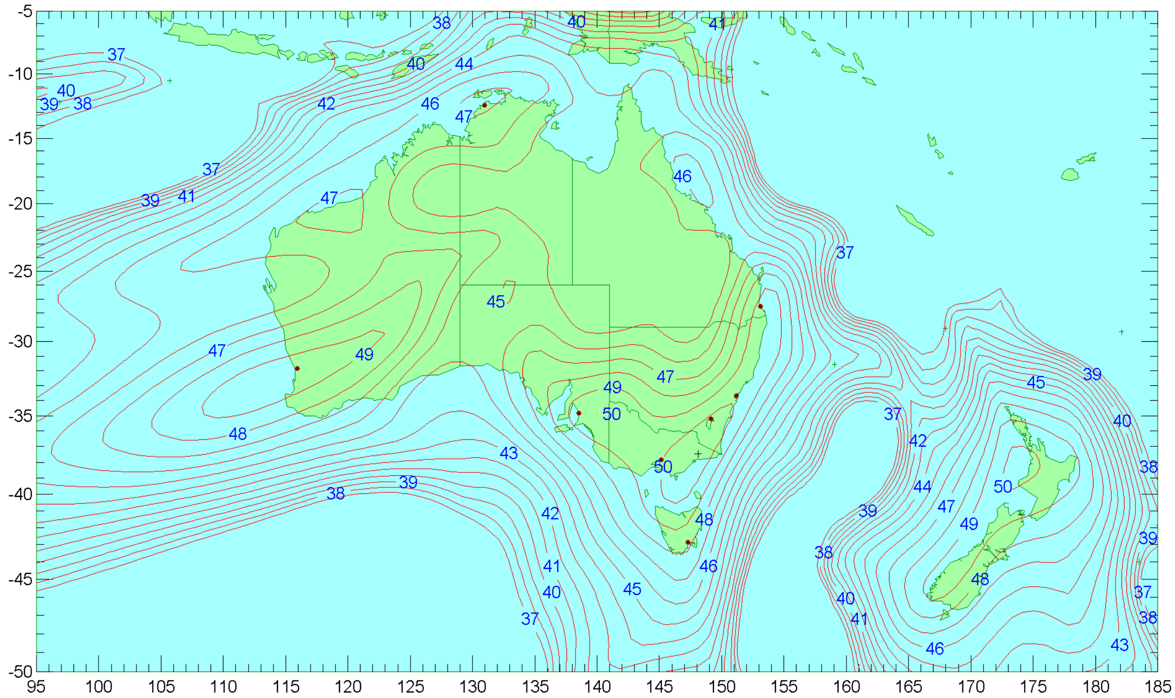

FIGURE A1-6 OPTUS-10 FNANZ BEAM TRANSMIT EIRP PERFORMANCE (dBW) (164°E)

OPTUS yes

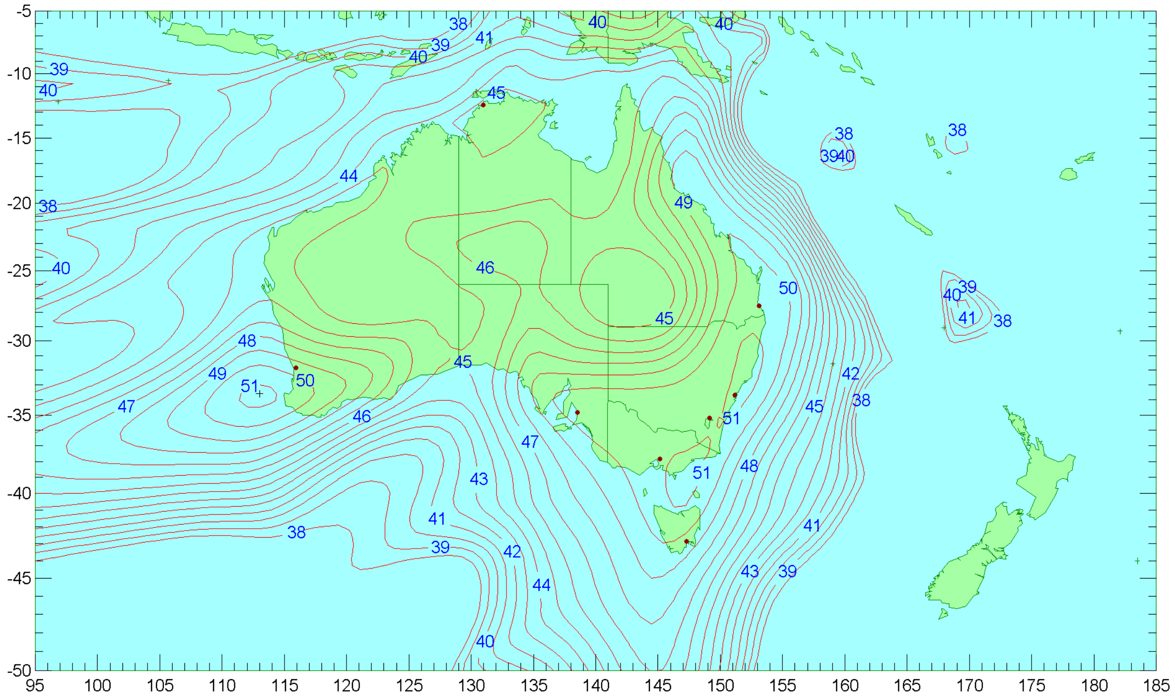

FIGURE A1-7 OPTUS-10 FNB BEAM TRANSMIT EIRP PERFORMANCE (dBW) (164°E)

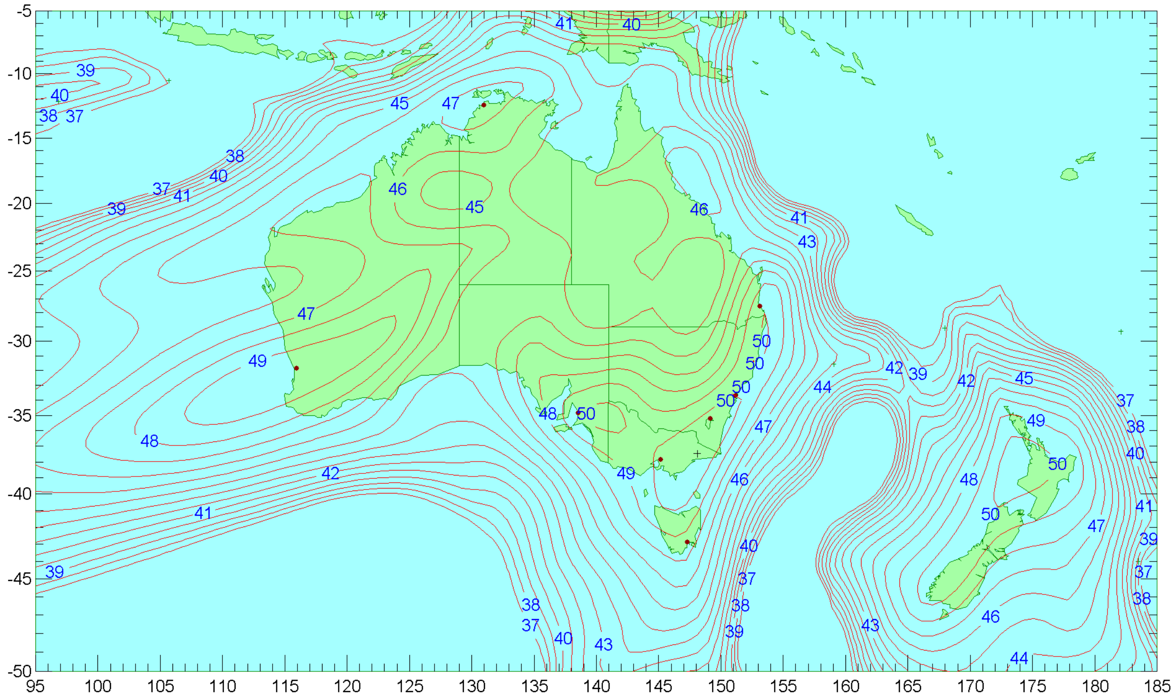

FIGURE A1-8 OPTUS-10 FNBNZ BEAM TRANSMIT EIRP PERFORMANCE (dBW) (164°E)

OPTUS 10 SATELLITE PAYLOAD INFORMATION

ATTACHMENT 2

Optus-10 Satellite Beam Contours for the BSS Ku-Band Communications Payload from 156°E

The contour diagrams in this Attachment show the General Design Levels for the geostationary Optus-10 satellite operating at 156°E. Although Optus-10 is currently located at 164°E, BSS Ku-Band plots from 156°E have been provided in this attachment for information only to display the backup capability for the Optus D3 satellite. Additional plots for both FSS and BSS from other orbital locations can be made available upon request.

This attachment contains expected Optus-10 Ku-band patterns. The patterns are composites of three frequencies and therefore represent the worst-case over frequency. They also include worst-case beam pointing errors.

Contour diagrams, Figures A2-1 to A2-8 are provided for satellite G/T for BNA, BNANZ, BNB and BNBNZ and for EIRP for BNA, BNANZ, BNB, and BNBNZ.

The satellite G/T indicates the satellite transponder receive performance level at the satellite as “seen” from the ground.

The contour diagrams of EIRP show the radiated satellite transponder power in the direction of the ground locations.

BNA, BNB, BNANZ, and BNBNZ EIRP maps are based on 133W TWTAs (saturated).

All patterns contained within this document are based on the manufacturer’s data.

Contracted performance will be lower than that specified in this document to allow for individual transponder differences, TWT redundancy and different orbital locations.

General Design Level

The General Design Level (GDL) of beam performance represents the best estimate by Optus of the worst-case performance through to end-of-life for any satellite transponder switched to a particular beam. It allows for all possible cases of service restoration or transponder reallocation, and Optus recommends that it be used for the design of satellite systems to ensure that they will work on any satellite transponder through to end-of-life. In particular the General Design Level of beam performance is recommended for the sizing of earth station antennas and High Power Amplifiers (HPAs) on the uplink, and the calculation of earth station receive G/Ts on the downlink.

The contour maps show the General Design Level of beam performance at the time of publication of this guide for the Optus-10 satellite operating in geostationary orbit.

Specific Performance Levels

Beam performance specific to a given transponder on a given satellite in a given orbit position at a given time will be provided by Optus to customers on request. Optus does not recommend that specific performance levels be used to design systems or size earth stations as designs must make allowances for potential service restoration or transponder reallocation.

OPTUS 10 SATELLITE PAYLOAD INFORMATION

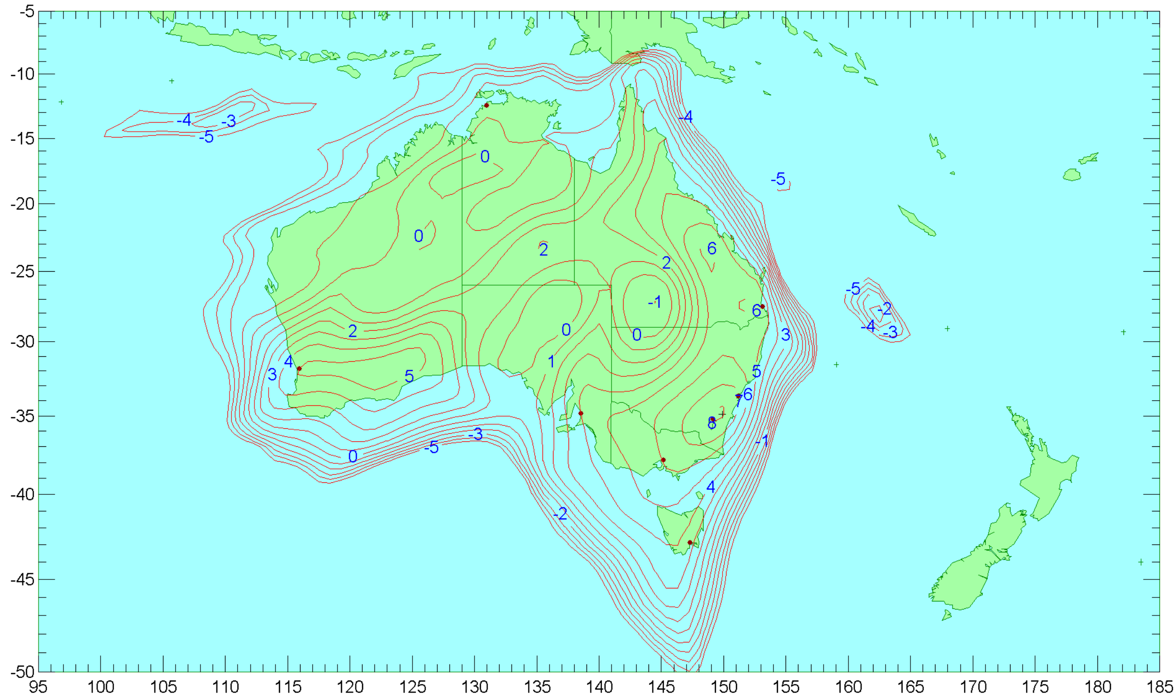

FIGURE A2-1 OPTUS-10 BNA BEAM RECEIVE G/T PERFORMANCE (dB/K) (156°E)

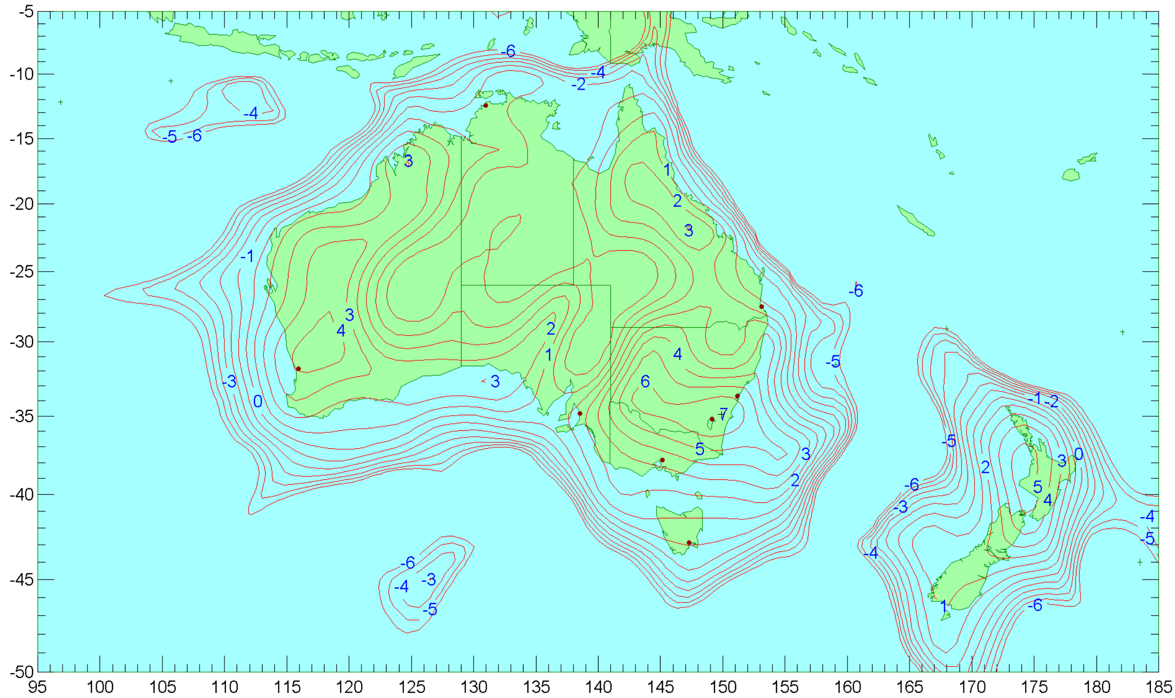

FIGURE A2-2 OPTUS-10 BNANZ BEAM RECEIVE G/T PERFORMANCE (dB/K) (156°E)

OPTUS 10 SATELLITE PAYLOAD INFORMATION

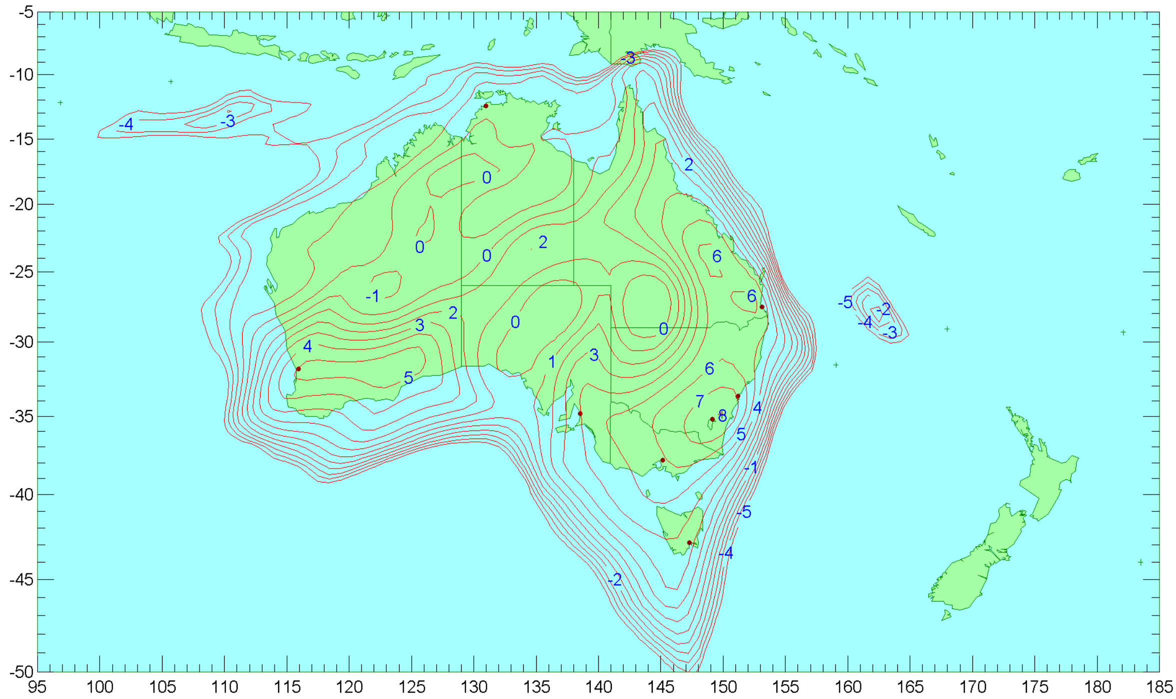

FIGURE A2-3 OPTUS-10 BNB BEAM RECEIVE G/T PERFORMANCE (dB/K) (156°E)

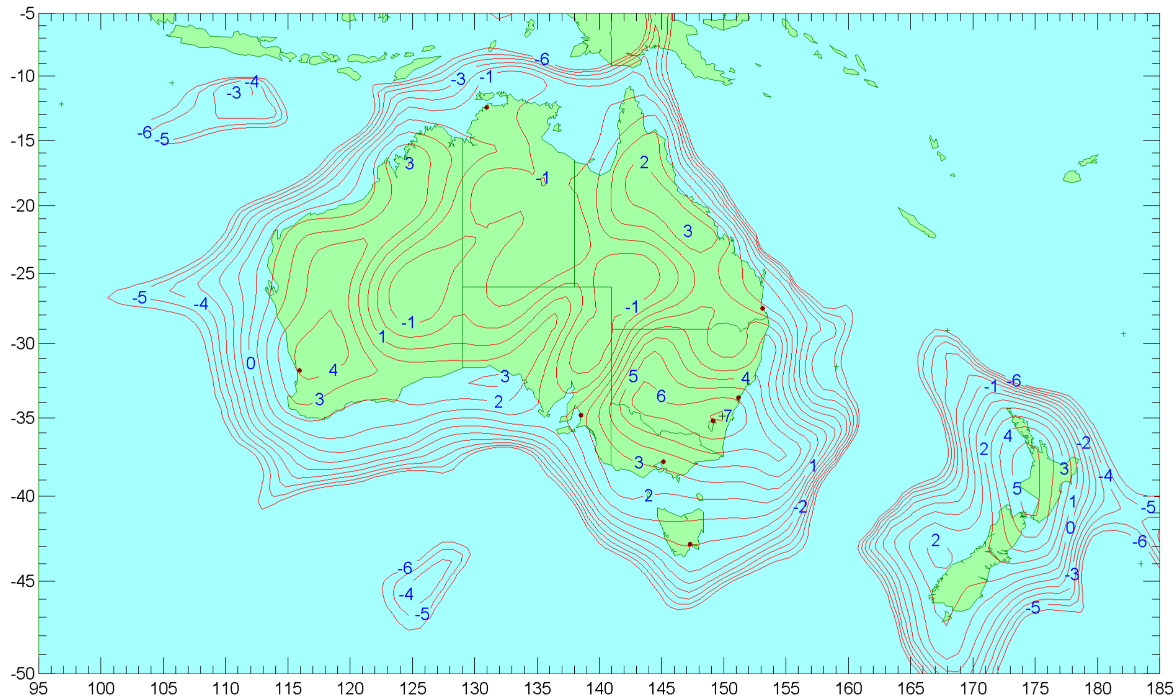

FIGURE A2-4 OPTUS-10 BNBNZ BEAM RECEIVE G/T PERFORMANCE (dB/K) (156°E)

OPTUS 10 SATELLITE PAYLOAD INFORMATION

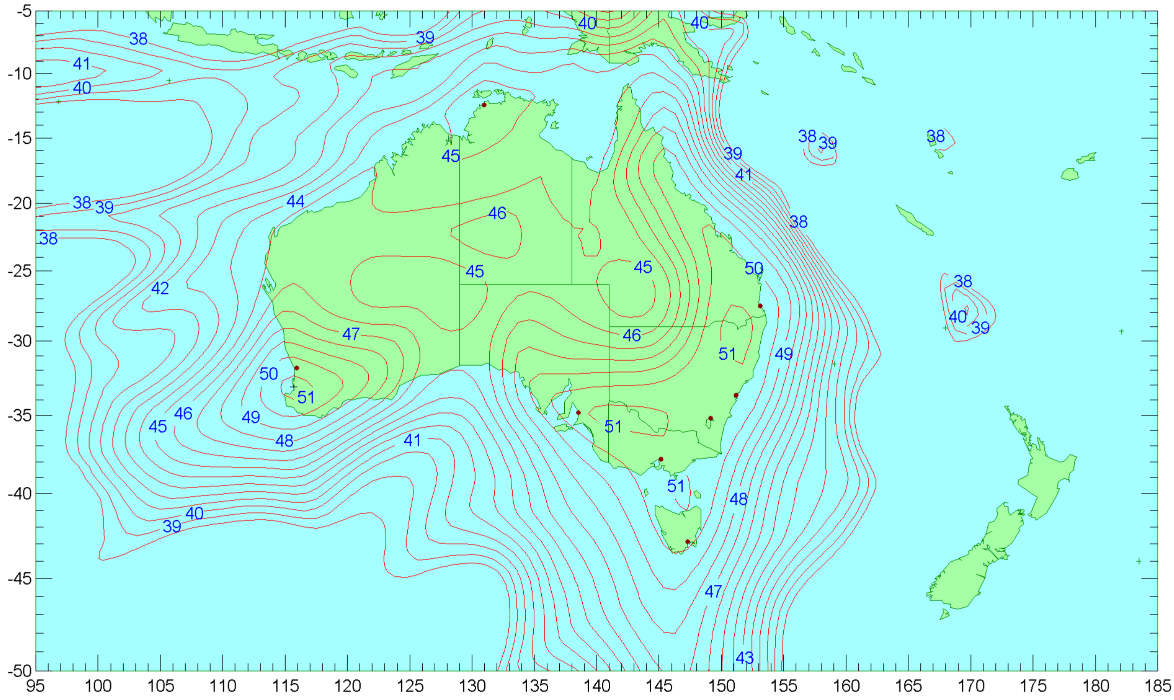

FIGURE A2-5 OPTUS-10 BNA BEAM TRANSMIT EIRP PERFORMANCE (dBW) (156°E)

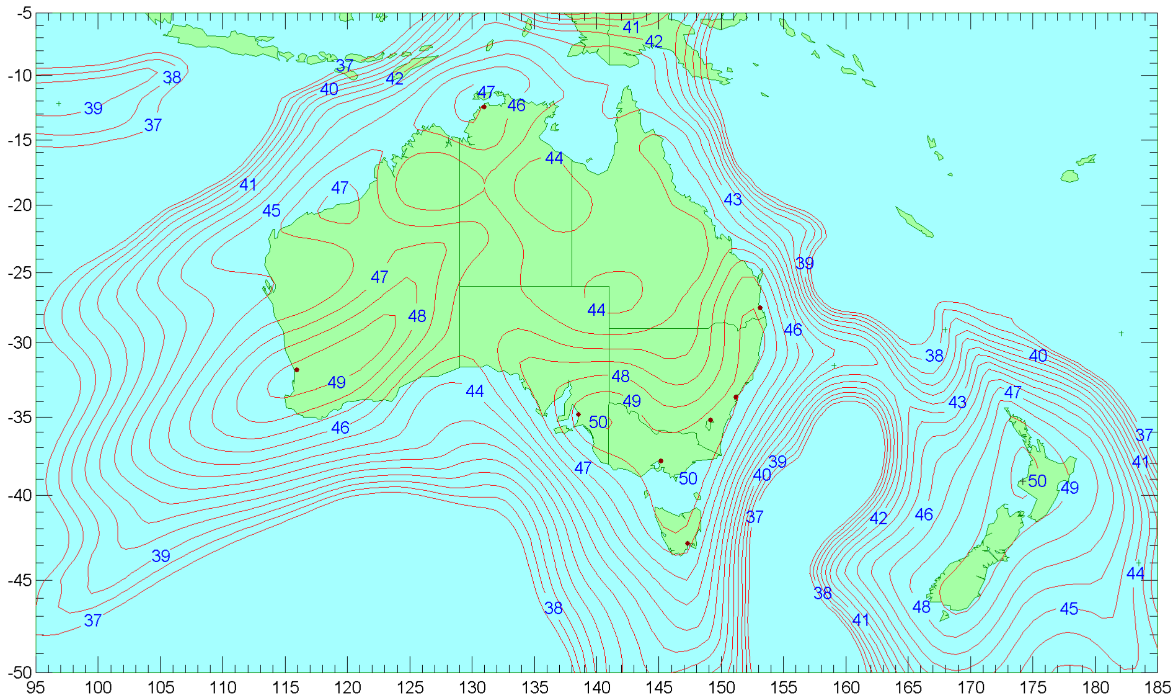

FIGURE A2-6 OPTUS-10 BNANZ BEAM TRANSMIT EIRP PERFORMANCE (dBW) (156°E)

OPTUS 10 SATELLITE PAYLOAD INFORMATION

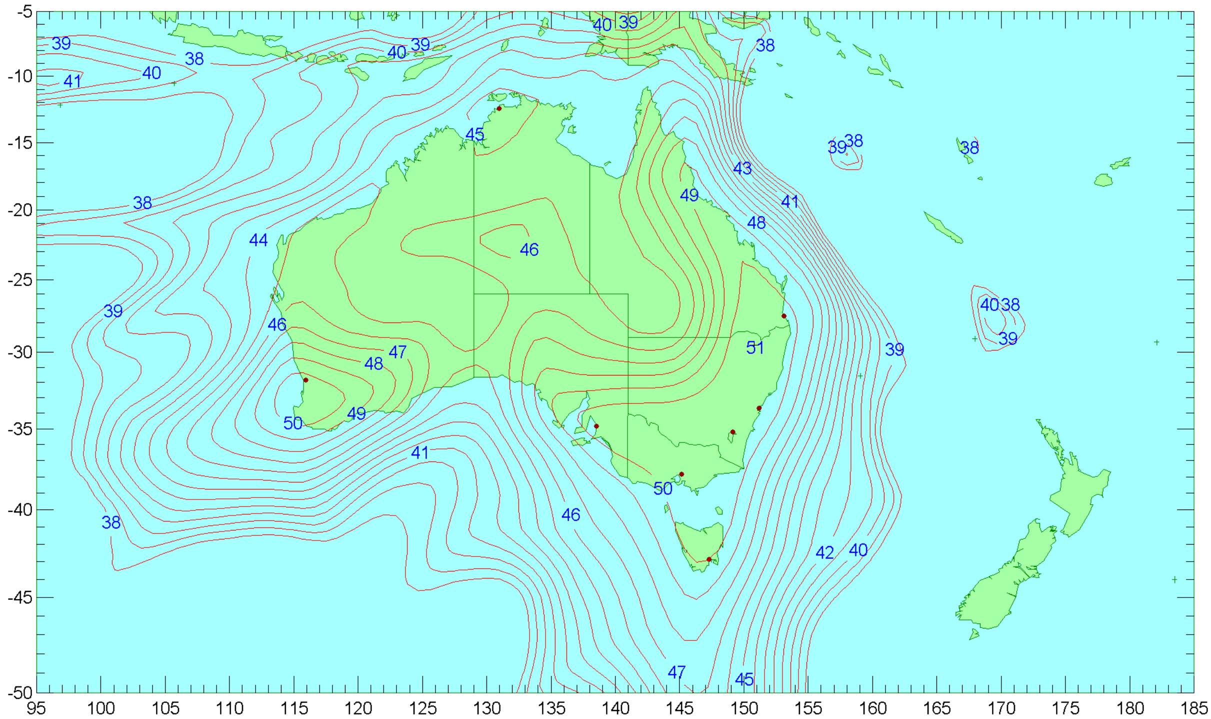

FIGURE A2-7 OPTUS-10 BNB BEAM TRANSMIT EIRP PERFORMANCE (dBW) (156°E)

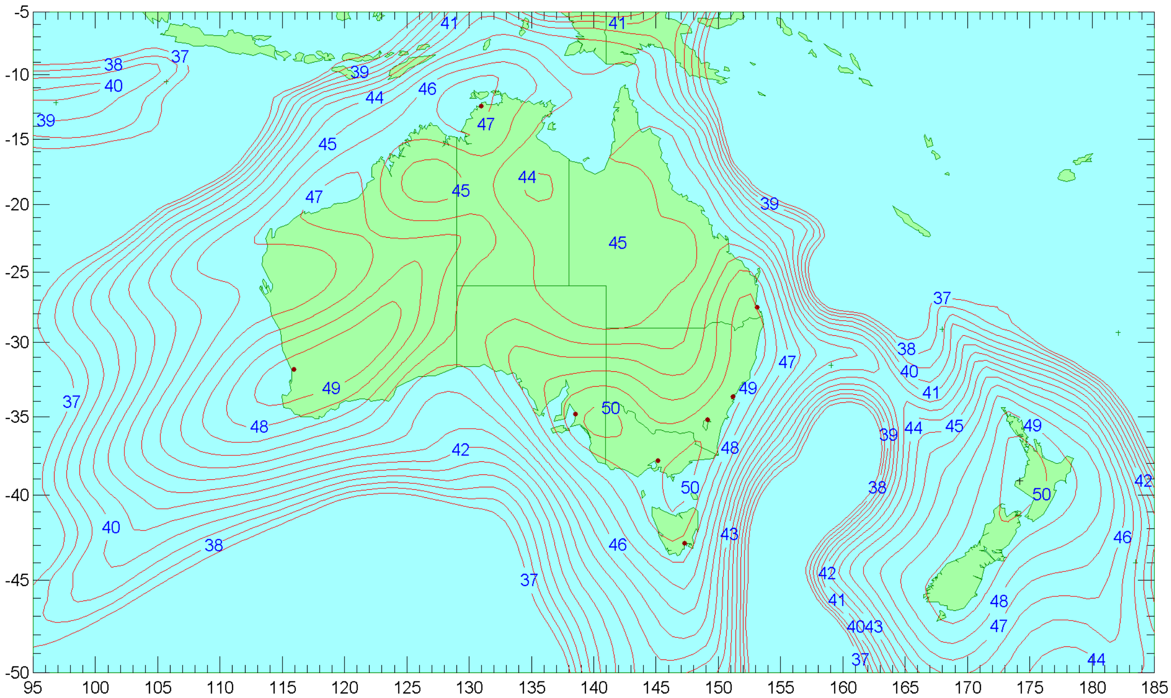

FIGURE A2-8 OPTUS-10 BNBNZ BEAM TRANSMIT EIRP PERFORMANCE (dBW) (156°E)