

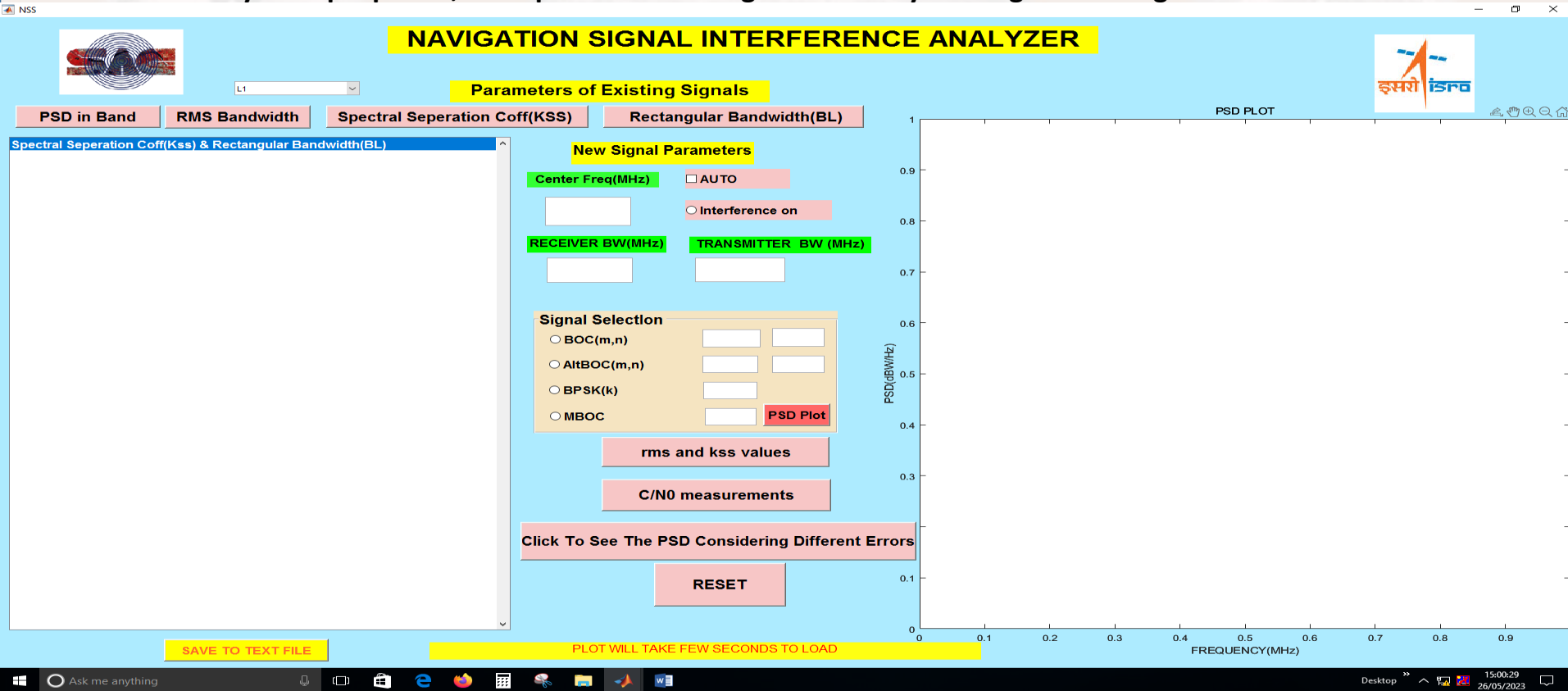


GNSS Signal Interference Analyzer

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- Interoperability and compatibility is the main goal for current GNSS systems. A concept of Global Navigation Satellite System (GNSS) is to use all navigation system together to provide better capabilities compared with those that would be achieved relying solely on one service or signal. Compatibility, on the other hand, assures that existing GNSS signal is not degrading each other below certain threshold. GNSS provider is concerned about their own signal as well as other signals from different service provider for co-existence. For this reason interference analysis of current GNSS signal is the most needed requirement in current scenario.
- An in-house tool is developed with suitable Graphic User Interface (GUI) which provides static analysis of different type of interference parameters and indicates its compatibility with already existing signals. Primary objective of the tool is

- To Analyze Inter and Intra system Interference parameter in each Navigation Band.
- To do the interference analysis due to any new signal proposed in any Navigation band.
- To compute C/No degradation due to current signal or any new proposed signal.
- To analyze multipath error budget due to proposed new signal.
- To analyze tropospheric, ionospheric error budget due to any new signal in navigation band.



- **Power Spectral Density**
- **Spectral Separation Coefficient**
- **Root mean square Bandwidth**
- **Rectangular bandwidth**
- **Carrier Power to noise density ratio**
- **Tropospheric refraction**
- **Ionospheric Refraction**
- **Multipath Analysis**

NAVIGATION SIGNAL INTERFERENCE ANALYZER

L1

Parameters of Existing Signals

- PSD in Band
- RMS Bandwidth
- Spectral Separation Coff(KSS)
- Rectangular Bandwidth(BL)

Spectral Separation Coff(Kss) & Rectangular Bandwidth(BL)

New Signal Parameters

Center Freq(MHz) AUTO

Interference on

RECEIVER BW(MHz) TRANSMITTER BW (MHz)

Signal Selection

BOC(m,n)

AltBOC(m,n)

BPSK(k)

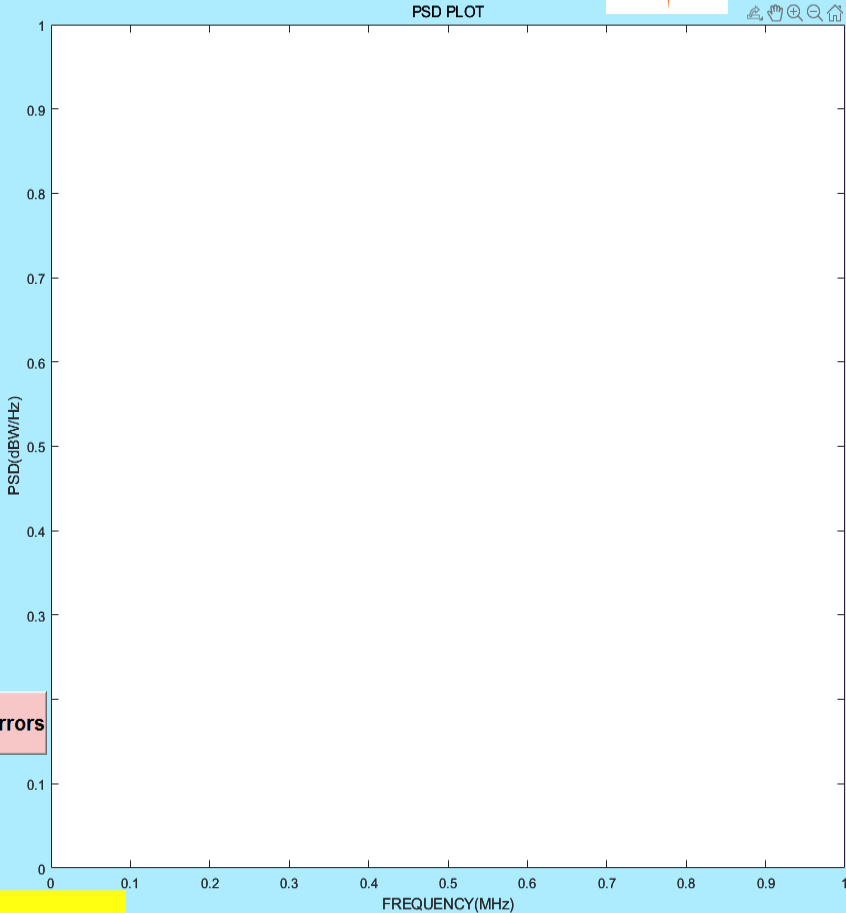
MBOC PSD Plot

rms and kss values

C/N0 measurements

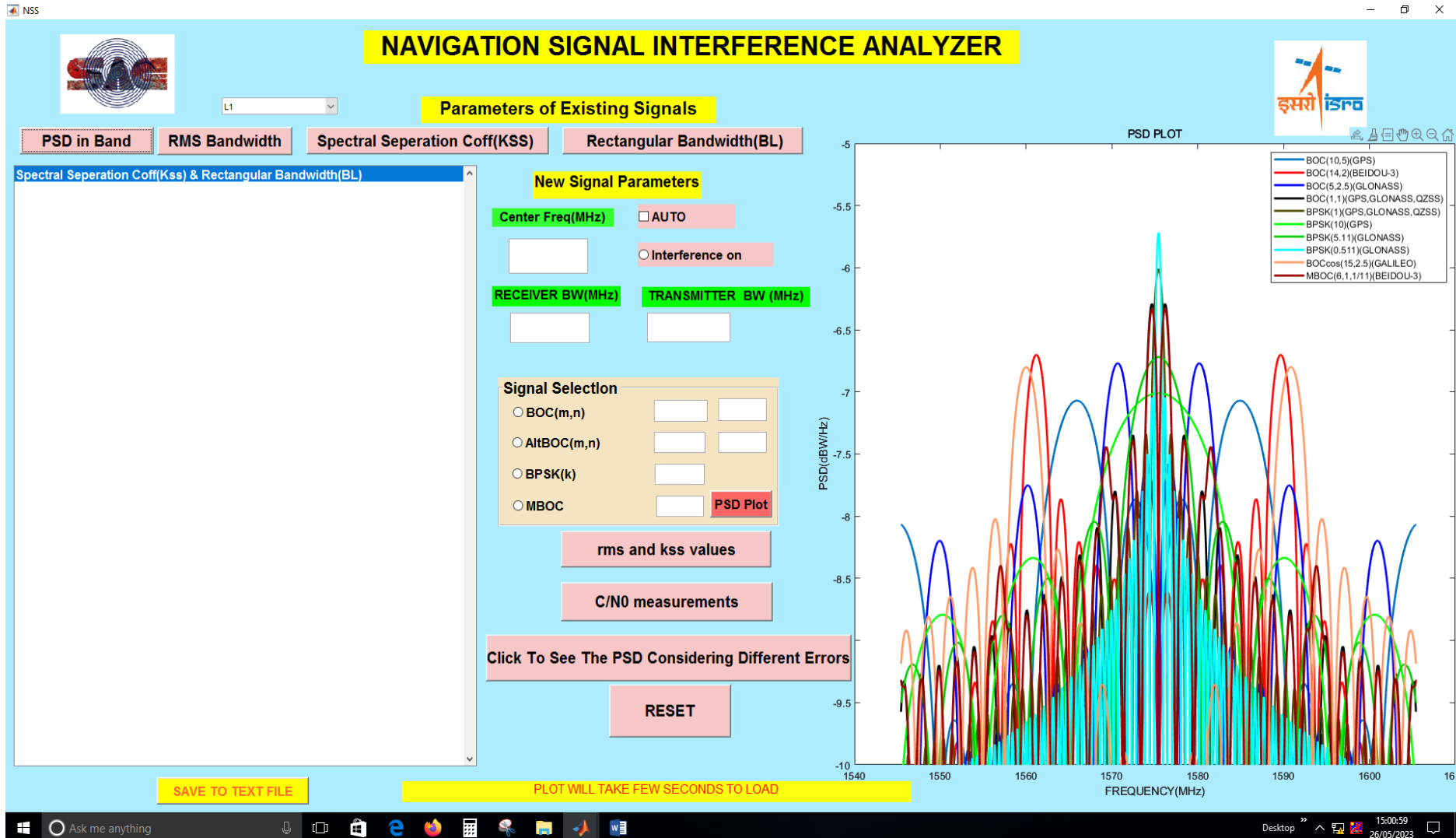
Click To See The PSD Considering Different Errors

RESET



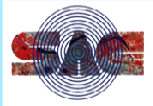
SAVE TO TEXT FILE

PLOT WILL TAKE FEW SECONDS TO LOAD



Spectral Separation Coff(kss)

NAVIGATION SIGNAL INTERFERENCE ANALYZER



L1

Parameters of Existing Signals

PSD in Band RMS Bandwidth **Spectral Separation Coff(KSS)** Rectangular Bandwidth(BL)

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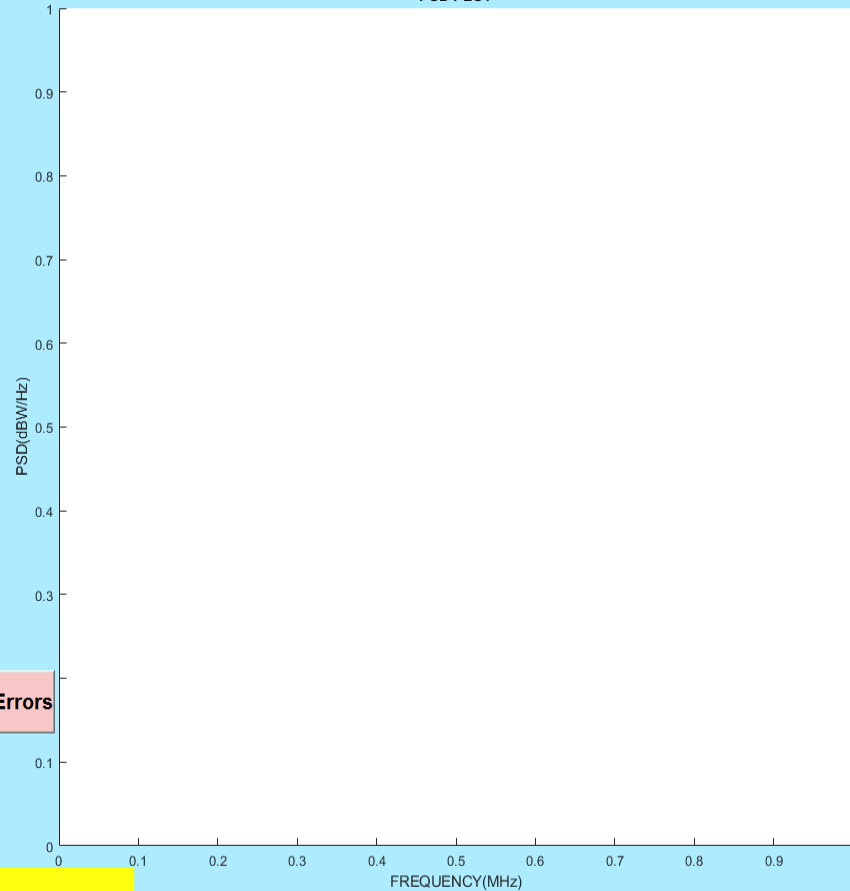
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RESET

PSD PLOT

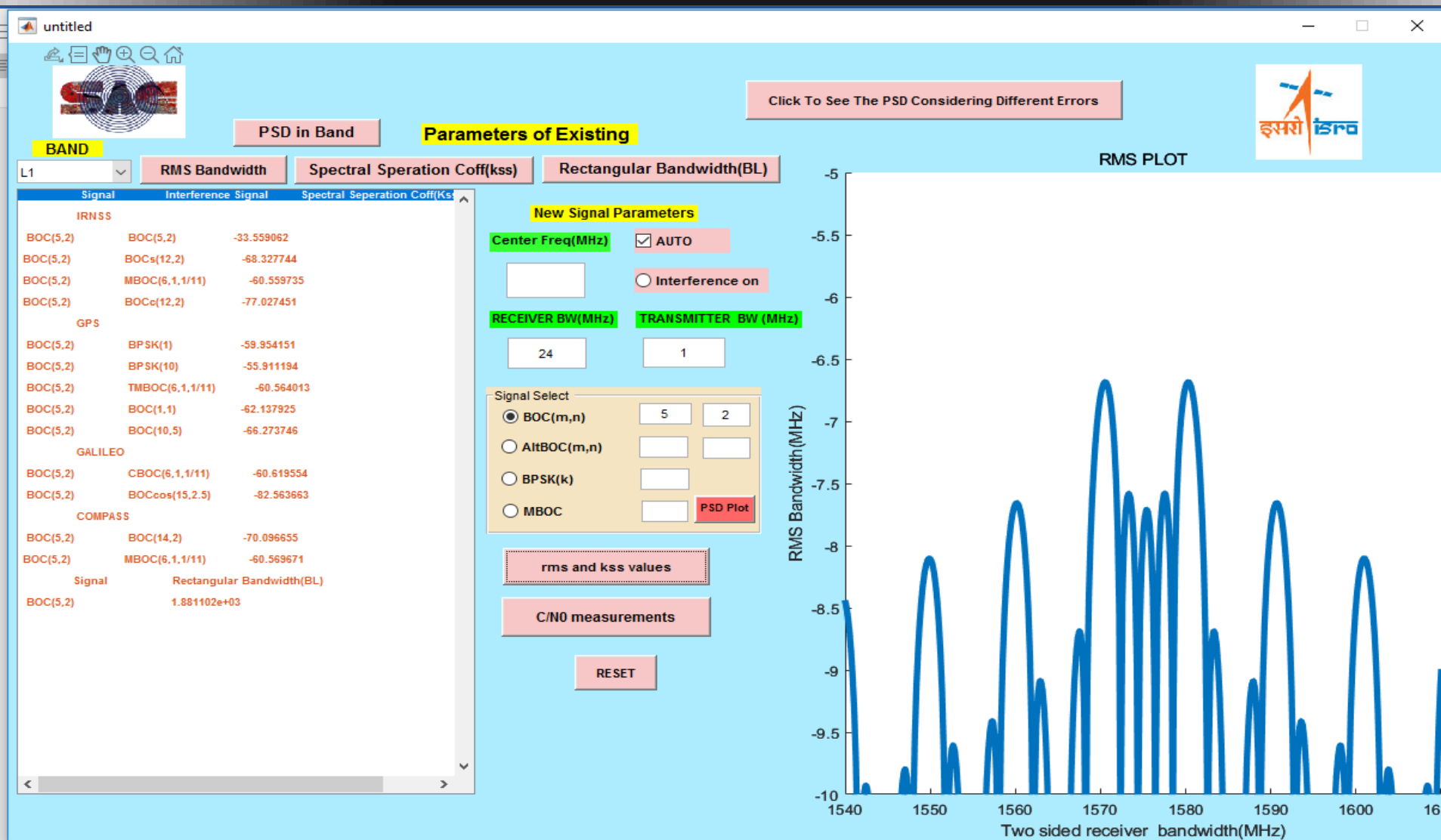


Signal	Interference Signal	Spectral Separation Coff(Kss)
IRNSS	IRNSS	Spectral Separation Coff(Kss)
MBOC(6,1,1/11)	MBOC(6,1,1/11)	-65.339678
MBOC(6,1,1/11)	BOCs(12,2)	-83.531577
MBOC(6,1,1/11)	BOCc(12,2)	-89.534992
BOCs(12,2)	BOCs(12,2)	-68.554088
BOCs(12,2)	BOCc(12,2)	-68.326677
BOCc(12,2)	BOCc(12,2)	-67.975947
IRNSS	COMPASS	Spectral Separation Coff(Kss)
MBOC(6,1,1/11)	MBOC(6,1,1/11)	-65.349570
MBOC(6,1,1/11)	BOC(14,2)	-85.224487
BOCs(12,2)	MBOC(6,1,1/11)	83.533035

SAVE TO TEXT FILE

PLOT WILL TAKE FEW SECONDS TO LOAD

New Signal Analysis



C/No measurements

C/N0 MEASUREMENTS

BAND
SELECT Gagg INPUT

NOTE - ALL INPUTS ARE IN dB WITH SIGN

ASSUMPTIONS AND MODIFICATION FOR ACCURATE RESULTS

Power from various systems

Gagg of GPS

Gagg of GLONASS

Gagg of GALELIO

Gagg of IRNSS

Gagg of QZSS

Gagg of compass MEO

Gagg of compass GSO

processing loss

maximum power recieved

GPS Glonass QZSS
 Galileo IRNSS COMPAS

inter and lintra measurements
new signal
EXECUTE ON BUTTON PRESS

signal select

BOC(m,n)

AltBOC(m,n)

BPSK(k)

MBOC

Total signal degradation

enter these in addition to the above parameters

noise power spectral density

Reciever bandwidht

Total signal to noise degradation

reset

ERRORS IN THE GNSS SYSTEM

TYPES OF ERRORS IN GNSS SYSTEMS

- Troposphere error
- Ionospheric error
- Multi-path error

Read the description before proceeding forward with its calculation

ERRORS IN THE GNSS SYSTEM

TYPES OF ERRORS IN GNSS SYSTEMS

Troposphere error

Ionospheric error

Multi-path error

DESCRIPTION OF THE TROPOSPHERIC ERRORS

Troposphere is the lowermost layer with all the climatic features occurring in it, it extends from 7 km to 18 km. Troposphere is a mixture of all gases and its refractive index is a contribution of these gases is called N . N has contribution due to dry gases and due to water vapour so $N = N_{dry} + N_{wet}$. The N depends on the following parameters: pressure, temperature, water vapour content, temperature. Due to the refractions from these gases there is an excess path delay in the troposphere and this can be divided into T_{dry} and T_{wet} . In this we get the X Y Z coordinates of the receiver and the satellite along with the other physical parameters mentioned above. Then the zenith delay of dry and wet gases are calculated then appropriate changes are done to the coordinates. Then the final delay is obtained--- WAIT FOR SOME TIME FOR THE WINDOW TO APPEAR

Tropospheric Error GUI

tropomodel
— □ ×

Delay calculation models

HOPFIELD MODEL

describe

ambient temp in C ambient pressure in kPa

vapour pressure in kPa Elevation Angle in radians

SAATOMOINEN MODEL

describe

height of the reciever

elevation Angle in radians

HIGHLY APPROXIMATE MAPPING FUNCTION

Elevation Angle in radians describe

TROPOSPHERE DELAY CALCULATION AND THE PSD CALCULATION OF THE DELAY

ratio of reciever to transmitter signal amplitude

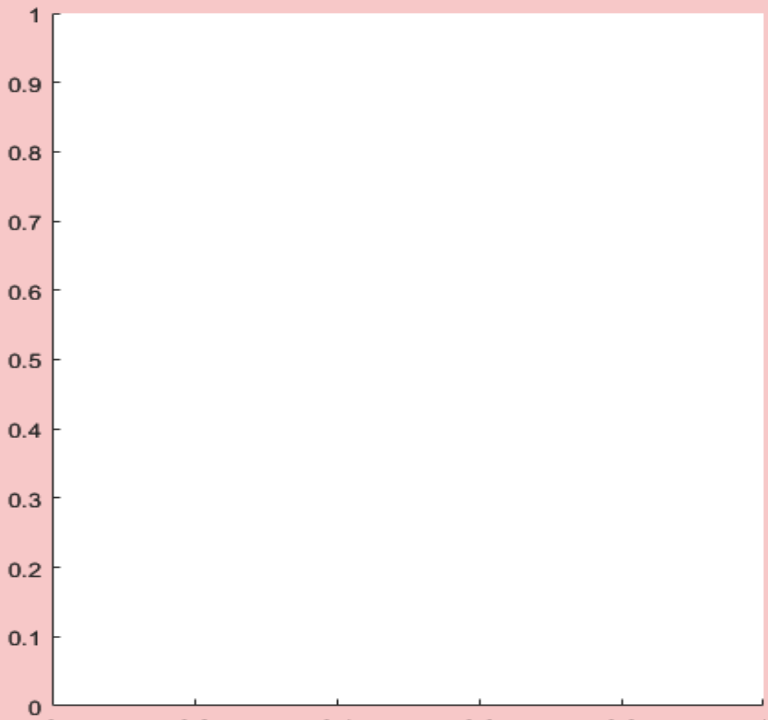
delay PSD approximation

BAND describe this approximation

correlation time

variance of noise

Delays due to troposphere



Ionospheric Error GUI

ionomodel
_ □ ×

IONOSPHERIC DELAYS USING DIFFERENT MODELS PRESENT AND CALCULATION OF THE POWER SPECTRAL DENSITY OF THE IONOSPHERE

Kolbuchar method to find delay

 describe this method

Delay profile of the ionospheric refractor

 BAND
 TEC in TECU
 Zenith angle describe

The transmission loss calculation through the atmosphere

 BAND describe
 distance factor k plot

Transfer function of ionosphere model and display of the PSD

 describe this model BAND
 electron cyclotron frequency
 delay in signal through any model
 Angle vector btw wave and background magnetic field

psd for GNSS BANDS

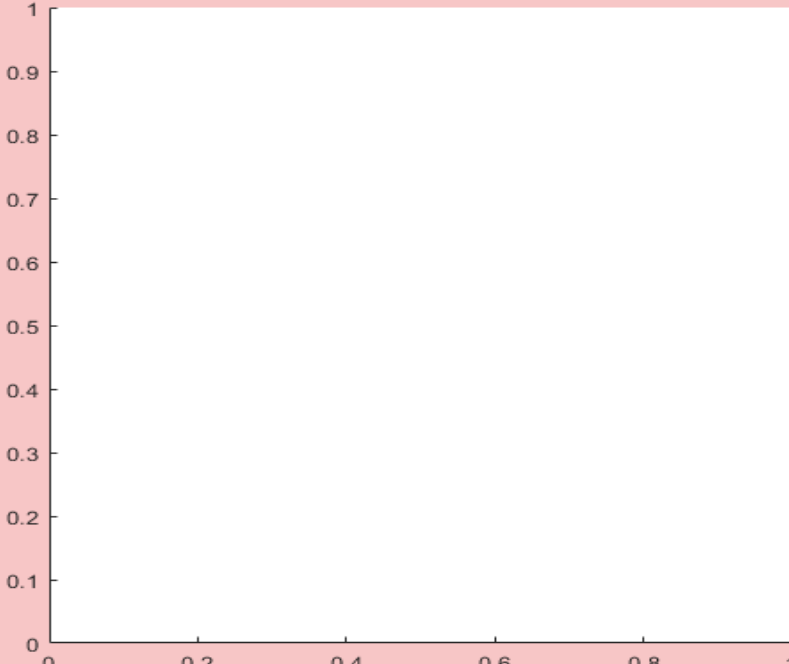
 describe this method connect to net

GISM MODEL to find delay and sintillation

values of alphas

values of betas

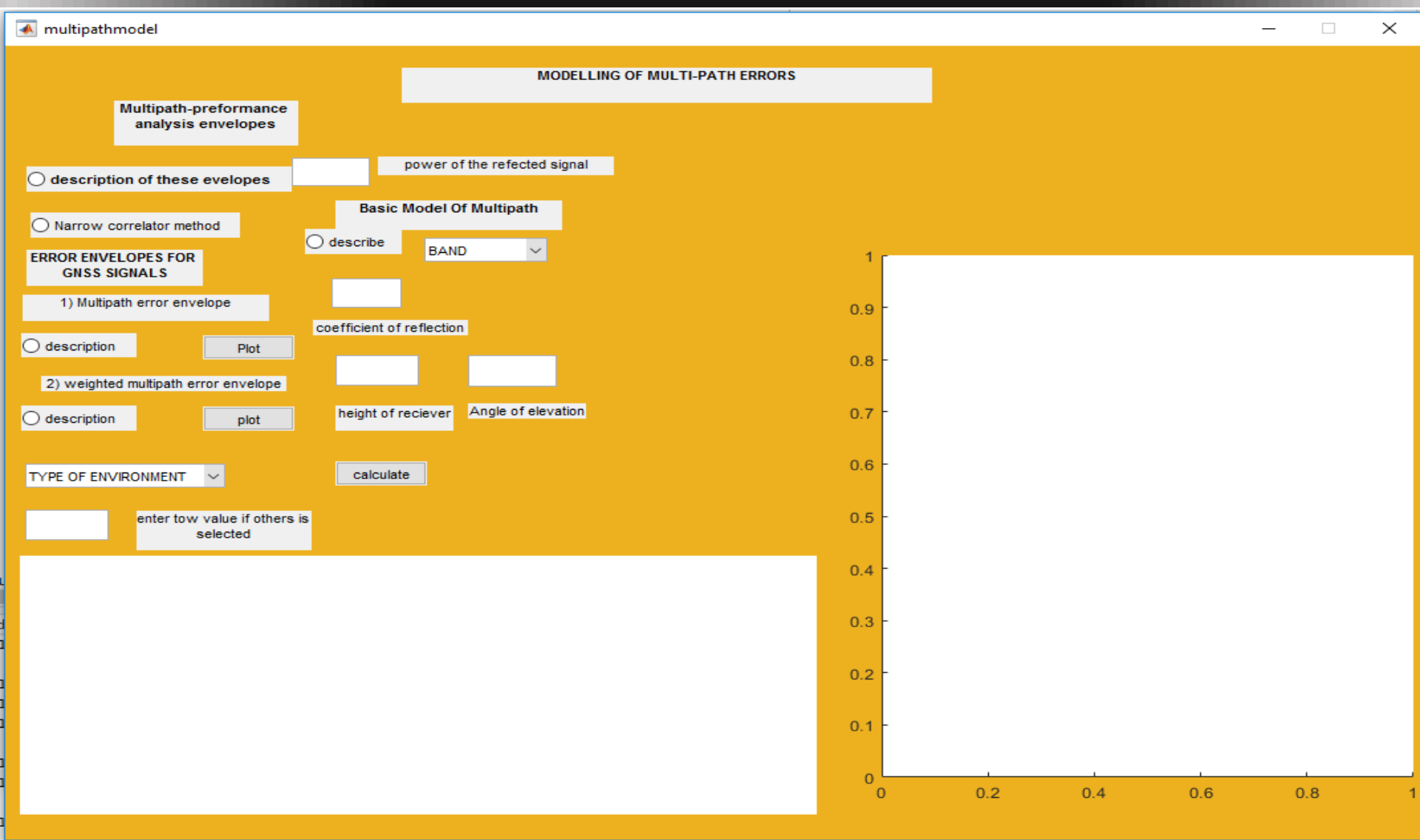
calculate



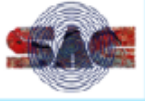
ELEVATION ANGLE

AZIMUTH ANGLE


LATITUDE & LONGITUDE



NAVIGATION SIGNAL INTERFERENCE ANALYZER



L1



PSD in Band

RMS Bandwidth

Spectral Separation Coff(Kss)

Rectangular Bandwidth(BL)

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New Signal Parameters

Center Freq(MHz)

AUTO

RECEIVER BW(MHz)

T

Signal Selection
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 MBOC PSD Plot

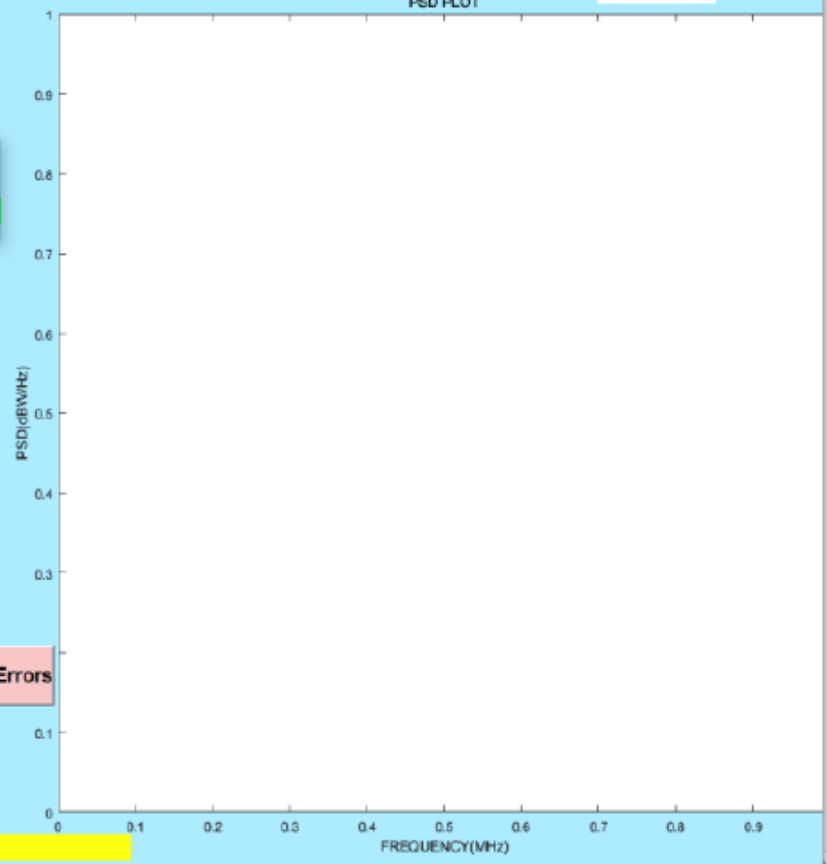
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PSD PLOT



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C/N0 MEASUREMENTS

L1

NOTE - ALL INPUTS ARE IN dB WITH

ASSUMPTIONS AND MODIFICATION FOR ACCURATE RESULTS

Power from various systems

-11 **Gagg of GPS**

-11 **Gagg of GLONASS**

-11 **Gagg of GALELIO**

-11 **Gagg of IRNSS**

-11 **Gagg of QZSS**

-11 **Gagg of compass MEO**

-11 **Gagg of compass GSO**

40
processing loss
maximum power recieved

-136 GPS -140 Gloness -125 QZSS
-130 Galileo 140 IRNSS -120 COMPASS

inter and intra measurements

NEW SIGNAL SELECTION

BOC(m,n) 5 2

AltBOC(m,n)

BPSK(k)

MBOC

Total signal degradation

enter these in addition to the above parameters

-206 noise power spectral density

30
Reciever bandwidth

Total signal to noise degradation

reset

Signal	signal to noise degradation
GPS	
BOC(5,2)	0.00010
GALILEO	
BOC(5,2)	0.00010
COMPASS	
BOC(5,2)	0.00010
IRNSS	
BOC(5,2)	1.010100
BOC(5,2) total signal degradation	1.00000

Tropospheric Delay

satellite type	longitude at the equator(°E)	elevation angle (rad)	delay measured (meters)		
			Hopfield	saastamoinen	Cho's mapping function
geostationary	32.5	0.6429	3.9681	3.9658	3.3297
	83	0.288	8.1849	8.2914	6.97
	131.5	0.4724	5.1849	5.2146	4.3846
geosynchronous	55	1.0507	2.7772	2.7438	2.3
	111	0.84795	3.1961	3.1736	2.6652

- The Hopfield and the Saastamoinen model almost give the same result for different elevation angles. The cho’s mapping function is valid for elevation angles less than 10 degrees but it is a fairly good approximation for the larger angles also.

