



**FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTER ENGINEERING**

**WIRELESS AND MOBILE NETWORKS
ENCS5323**

Project – Online Calculator for Wireless and Mobile Network

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Section: 3

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Project Question

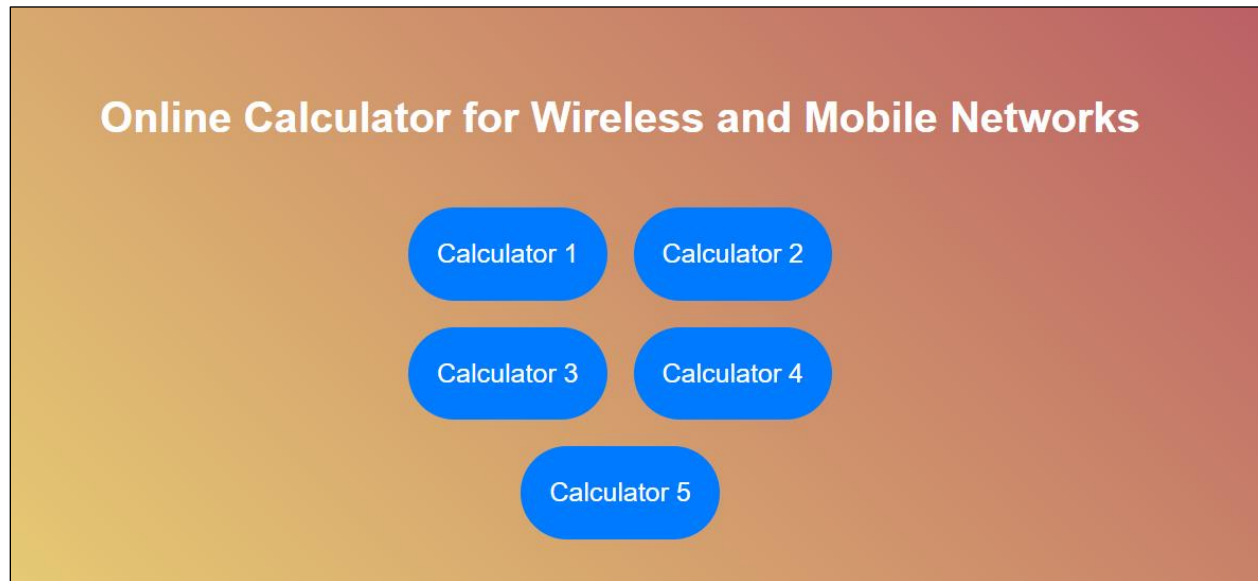
Design and build an online calculator for the following:

1. The number of bits and rate of the sampler, quantizer, source encoder, channel encoder, and interleaver.
2. The number of bits and rate for resource elements, OFDM symbol, Resource Blocks, and maximum transmission using parallel resource blocks.
3. Power transmitted in a flat environment based on the transmitter and receiver specifications.
4. Throughput in percent of Multiple Access techniques.
5. Design of cellular system.

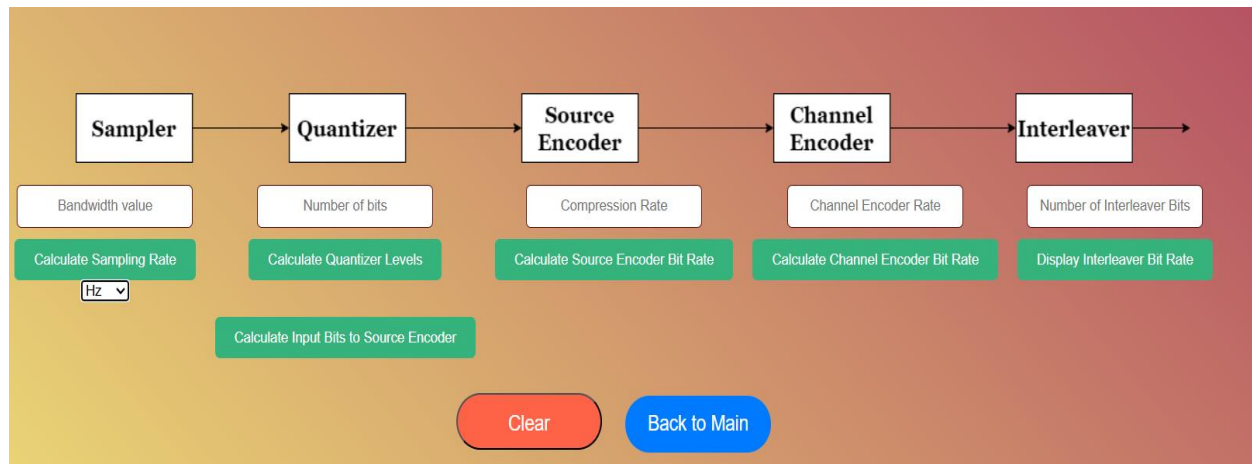
For each of the items above, you must let the user input the maximum system parameters required to solve the computations (refer to the explanation in the video recording of the project). Work in groups of at most two students. Submit, as a reply to this message, a short report that includes the screenshots of each calculator with at least three scenarios.

In our project, we built five calculators to determine various parameters. We used HTML, CSS, and JavaScript to develop these calculators.

The main page:



Calculator One:



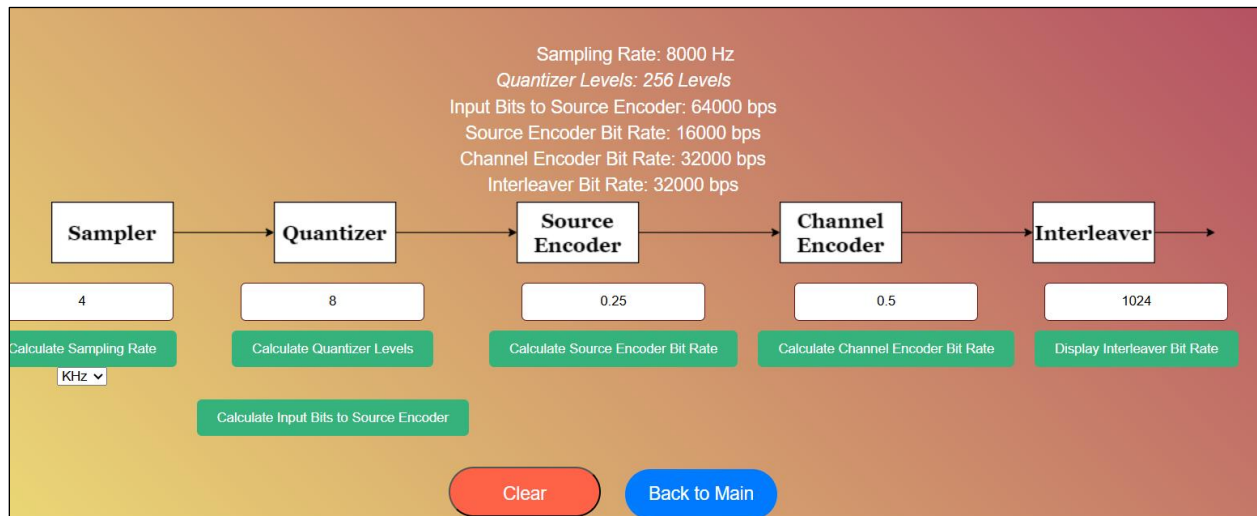
In the first calculator, we need the following inputs:

1. Bandwidth
2. Number of bits for quantization
3. Compression rate
4. Channel encoder rate
5. Number of bits per interleaver

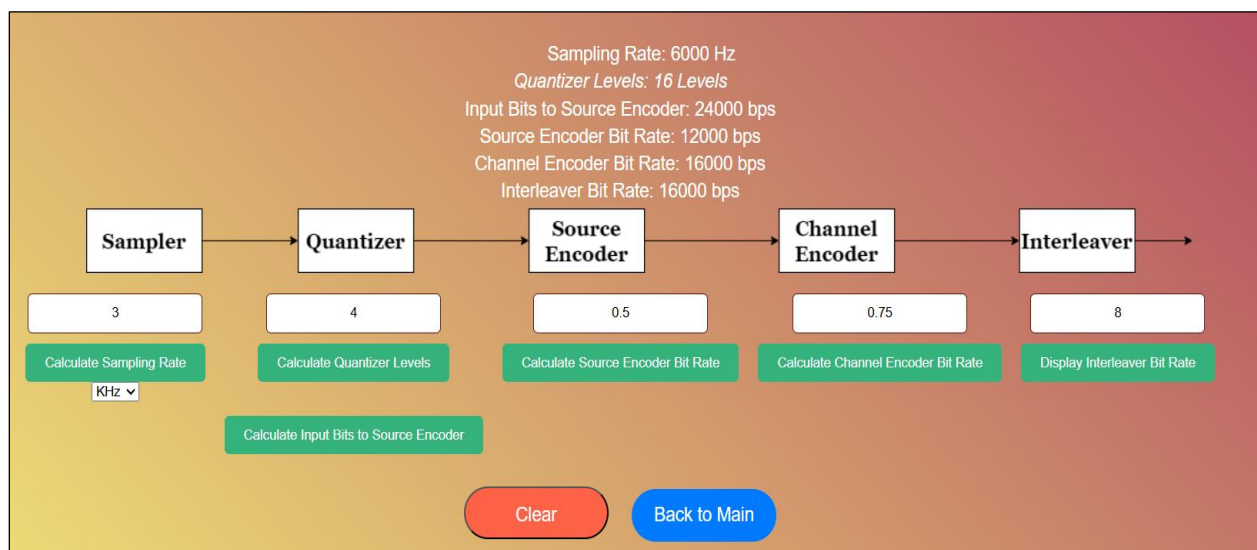
The outputs include:

1. Calculate the sampling frequency.
2. Find the number of quantization levels.
3. Determine the bit rate at the output of the source encoder.
4. Calculate the bit rate at the output of the channel encoder.
5. Calculate the bit rate at the output of the interleaver.

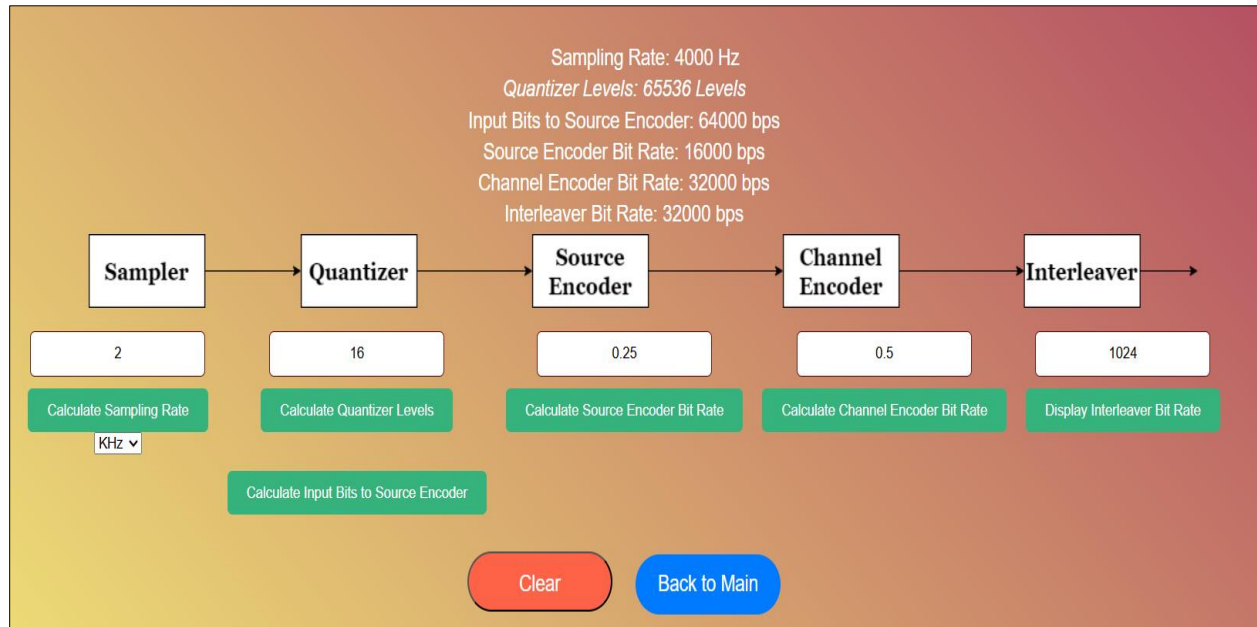
First scenario:



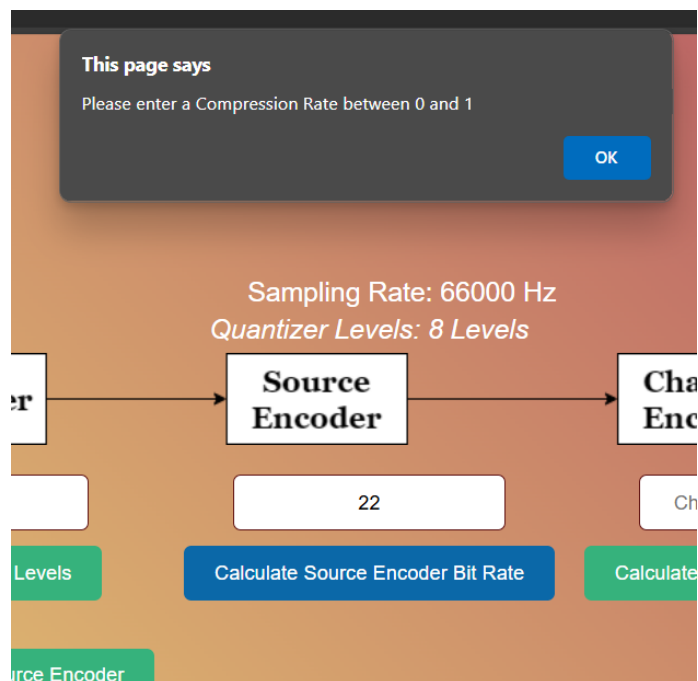
Second scenario:



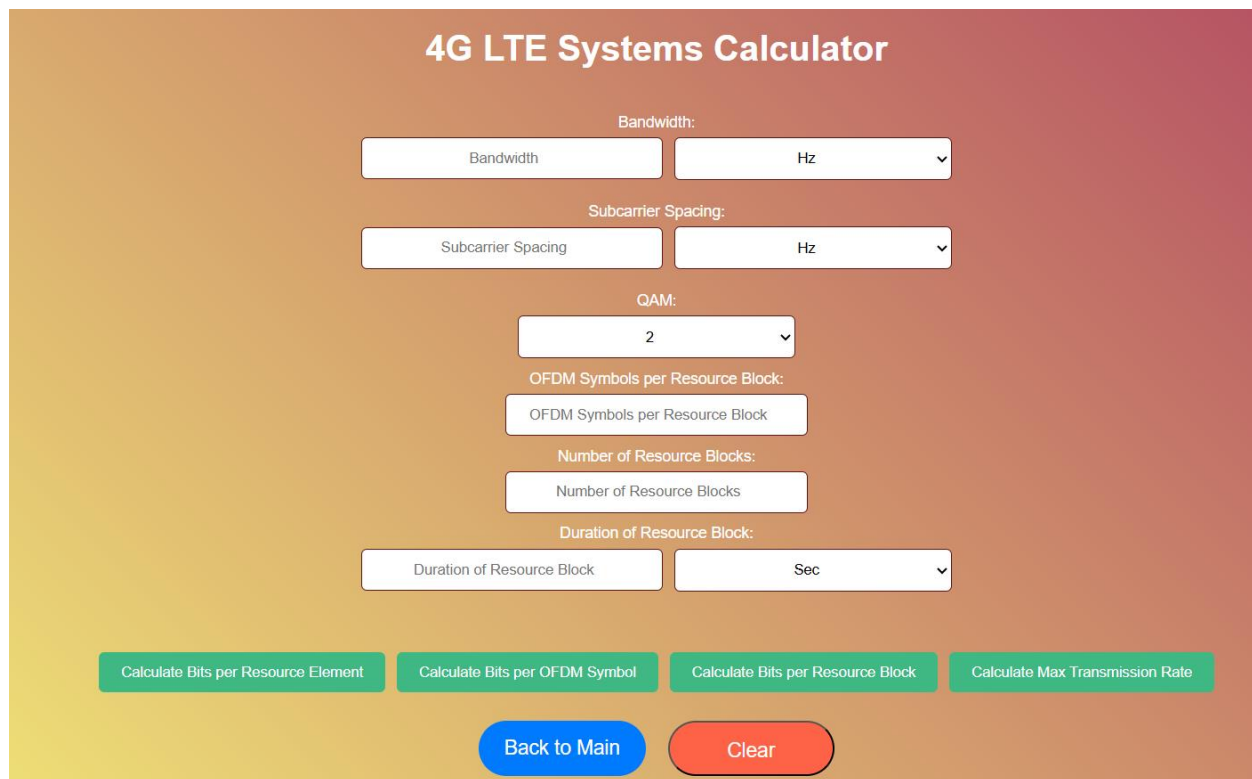
Third scenario:



For the following figure it shows an Error case that the user enter invalid value of rate larger than one:



Calculator Two:



The image shows a web-based calculator titled "4G LTE Systems Calculator". It features a series of input fields and buttons on a gradient background. The inputs are: Bandwidth (a text box with "Bandwidth" and a unit dropdown set to "Hz"), Subcarrier Spacing (a text box with "Subcarrier Spacing" and a unit dropdown set to "Hz"), QAM (a dropdown menu set to "2"), OFDM Symbols per Resource Block (a text box with "OFDM Symbols per Resource Block"), Number of Resource Blocks (a text box with "Number of Resource Blocks"), and Duration of Resource Block (a text box with "Duration of Resource Block" and a unit dropdown set to "Sec"). Below these are four green buttons: "Calculate Bits per Resource Element", "Calculate Bits per OFDM Symbol", "Calculate Bits per Resource Block", and "Calculate Max Transmission Rate". At the bottom are two rounded buttons: "Back to Main" (blue) and "Clear" (red).

Inputs:

1. Bandwidth of a resource block
2. Subcarrier spacing
3. Number of OFDM symbols per resource block
4. Duration of a resource block
5. Modulation type
6. Number of parallel resource blocks assigned continuously

Outputs:

1. Number of bits per resource element
2. Number of bits per OFDM symbol
3. Number of bits per OFDM resource block
4. Maximum transmission rate for a user assigned 4 parallel resource blocks continuously

First scenario

Bandwidth: 180 kHz

Subcarrier Spacing: 15 kHz

QAM: 1024

OFDM Symbols per Resource Block: 7

Number of Resource Blocks: 4

Duration of Resource Block: 0.5 mSec

Calculate Bits per Resource Element Calculate Bits per OFDM Symbol Calculate Bits per Resource Block Calculate Max Transmission Rate

Bits per Resource Element: 10 bits
Bits per OFDM Symbol: 120 bits
Bits per Resource Block: 840 bits
Max Transmission Rate: 6720000 bps

Note: The division of Bandwidth of a resource block by Subcarrier spacing must result in an integer. If not, an error message will be displayed.

For example:

This page says

The division of Bandwidth by Subcarrier Spacing must result in an integer.

OK

Subcarrier Spacing: 15 kHz

4 kHz

Second scenario:

Bandwidth:

Subcarrier Spacing:

QAM Modulation:

OFDM Symbols per Resource Block:

Number of Resource Blocks:

Duration of Resource Block:

[Calculate Bits per Resource Element](#) [Calculate Bits per OFDM Symbol](#) [Calculate Bits per Resource Block](#) [Calculate Max Transmission Rate](#)

Bits per Resource Element: 10 bits
Bits per OFDM Symbol: 100 bits
Bits per Resource Block: 700 bits
Max Transmission Rate: 5600000 bps

[Back to Main](#) [Clear](#)

Third scenario:

Bandwidth:

Subcarrier Spacing:

QAM Modulation:

OFDM Symbols per Resource Block:

Number of Resource Blocks:

Duration of Resource Block:

[Calculate Bits per Resource Element](#) [Calculate Bits per OFDM Symbol](#) [Calculate Bits per Resource Block](#) [Calculate Max Transmission Rate](#)

Bits per Resource Element: 9 bits
Bits per OFDM Symbol: 162 bits
Bits per Resource Block: 1458 bits
Max Transmission Rate: 11664000 bps

[Back to Main](#) [Clear](#)

Calculator Three:

Modulation Type:		Other Losses:	dB Converter	
BPSK/QPSK		Other Losses (dB)	Normal Value:	
BER Value:		Fade Margin:	Normal Value	
10 ⁻²		Fade Margin (dB)	<button>Convert to dB</button>	
Path Loss:		Receiver Amplifier Gain:	Converted dB Value:	
Path Loss (dB)		Receiver Amplifier Gain (dB)	Converted dB Value	
Transmit Antenna Gain:		Transmitter Amplifier Gain:		
Transmit Antenna Gain (dB)		Transmitter Amplifier Gain (dB)		
Receive Antenna Gain:		Noise Figure:		
Receive Antenna Gain (dB)		Noise Figure (dB)		
Data Rate:		Noise Temperature:		
Data Rate (dB)		Noise Temperature (dB)		
Antenna Feed Line Loss:		Link Margin:		
Antenna Feed Line Loss (dB)		Link Margin (dB)		
<button>Calculate Pt</button>				

We built a separate calculator to convert numbers to dB. If you have a value not in dB, you can first convert this value using the calculator, then use the output to find the transmit power in the main calculator:

dB Converter	
Normal Value:	
Normal Value	
<button>Convert to dB</button>	
Converted dB Value:	
Converted dB Value	

First scenario:

The problem was solved using the online calculator:

Given a flat rural environment with a path loss of 140 dB, a frequency of 900 MHz, 8dB transmit antenna gain and 0dB receive antenna gain, data rate of 9.6kbps, 12dB in antenna feed line loss, 20dB in other losses, a fade margin of 8dB, receiver amplifier gain of 24dB, noise figure total of 6dB, a noise temperature of 290K, and link margin of 8 dB. Find the total transmit power required of an 8-PSK modulated signal with a maximum bit error rate of 10^{-4} .

8-PSK	20	Normal Value:
BER Value:	Fade Margin:	290
10^{-4}	8	Convert to dB
Path Loss:	Receiver Amplifier Gain:	Converted dB Value:
140	24	24.62
Transmit Antenna Gain:	Transmitter Amplifier Gain:	
8	0	
Receive Antenna Gain:	Noise Figure:	
0	6	
Data Rate:	Noise Temperature:	
39.82	24.62	
Antenna Feed Line Loss:	Link Margin:	
12	8	
Calculate Pt		
Total Transmit Power (Pt): 9.64 dB and 9.204496 W		

Second scenario:

The problem was solved using the online calculator:

Given an urban environment with a path loss of 160 dB, a frequency of 1800 MHz, 12 dB transmit antenna gain, and 10 dB receive antenna gain, a data rate of 19.2 kbps, 15 dB in antenna feed line loss, 25 dB in other losses, a fade margin of 10 dB, receiver amplifier gain of 20 dB, noise figure total of 8 dB, a noise temperature of 300K, and a link margin of 10 dB. Find the total transmit power required of an 8-PSK modulated signal with a maximum bit error rate of 10^{-3} .

8-PSK	25	Normal Value:
BER Value:	Fade Margin:	300
10^{-3}	10	Convert to dB
Path Loss:	Receiver Amplifier Gain:	Converted dB Value:
160	20	24.77
Transmit Antenna Gain:	Transmitter Amplifier Gain:	
12	0	
Receive Antenna Gain:	Noise Figure:	
10	8	
Data Rate:	Noise Temperature:	
42.83	24.77	
Antenna Feed Line Loss:	Link Margin:	
15	10	
Calculate Pt		
Total Transmit Power (Pt): 35.00 dB and 3162.277660 W		

Third scenario:

Given a suburban environment with a path loss of 150 dB, a frequency of 2500 MHz, 10 dB transmit antenna gain, and 9 dB receive antenna gain, a data rate of 14.4 kbps, 10 dB in antenna feed line loss, 18 dB in other losses, a fade margin of 12 dB, receiver amplifier gain of 22 dB, noise figure total of 7 dB, a noise temperature of 290K, and a link margin of 7 dB. Find the total transmit power required of an 8-PSK modulated signal with a maximum bit error rate of 10^{-5} .

8-PSK	18	Normal Value:
BER Value:	Fade Margin:	290
10^{-5}	12	Convert to dB
Path Loss:	Receiver Amplifier Gain:	Converted dB Value:
150	22	24.62
Transmit Antenna Gain:	Transmitter Amplifier Gain:	
10	0	
Receive Antenna Gain:	Noise Figure:	
9	7	
Data Rate:	Noise Temperature:	
41.58	24.62	
Antenna Feed Line Loss:	Link Margin:	
10	7	
Calculate Pt		
Total Transmit Power (Pt): 13.60 dB and 22.908677 W		

Calculator Four:

This calculator is designed to determine the throughput of various types of Carrier Sense Multiple Access (CSMA) protocols. By inputting specific parameters, users can calculate the throughput in percentage for different CSMA types (Unslotted Non-Persistent, Slotted Non-Persistent, Unslotted 1-Persistent, Slotted 1-Persistent).

CSMA Throughput Calculator

Select CSMA Type:

Unslotted Non-Persistent CSMA

Frame Rate:

Frame Rate

frames/sec

Frame Size:

Frame Size

bits

Data Transmission Bandwidth:

Bandwidth

bps

Propagation Time:

Propagation Time

sec

Calculate Parameters

Back to Main

Clear

First scenario:

In this scenario, we calculate the throughput of an unslotted non-persistent CSMA protocol.

CSMA Throughput Calculator

Select CSMA Type:

Unslotted Non-Persistent CSMA ▼

Frame Rate:

5 Kframes/sec ▼

Frame Size:

10 Kbits ▼

Data Transmission Bandwidth:

20 Mbps ▼

Propagation Time:

40 μ sec ▼

Calculate Parameters

T (Transmission time): 0.000500 sec
G (Offered load): 2.500000
 α (Alpha): 0.080000
Throughput (S): 0.6722 or 67.22%

Back to Main Clear

Note: Users must input positive values for all parameters. The system validates the inputs to ensure the calculations are accurate.

This page says
Please enter positive values for all parameters.
OK

Select CSMA Type:
Unslotted Non-Persistent CSMA ▼

Frame Rate:
5 Kframes/sec ▼

Frame Size:
5 Kbits ▼

Data Transmission Bandwidth:
5 Mbps ▼

Propagation Time:
-40 μsec ▼

Calculate Parameters

Back to Main Clear

Second scenario:

In this scenario, we calculate the throughput of a Slotted non-persistent CSMA protocol.

CSMA Throughput Calculator

Select CSMA Type:

Slotted Non-Persistent CSMA ▼

Frame Rate:

1 Kframes/sec ▼

Frame Size:

10 Kbits ▼

Data Transmission Bandwidth:

10 Mbps ▼

Propagation Time:

50 μ sec ▼

Calculate Parameters

T (Transmission time): 0.001000 sec
G (Offered load): 1.000000
 α (Alpha): 0.050000
Throughput (S): 0.5062 or 50.62%

Back to Main Clear

Third scenario:

In this scenario, we calculate the throughput of an Unslotted 1-persistent CSMA protocol.

CSMA Throughput Calculator

Select CSMA Type:

Unslotted 1-Persistent CSMA ▼

Frame Rate:

2 Kframes/sec ▼

Frame Size:

10 Kbits ▼

Data Transmission Bandwidth:

10 Mbps ▼

Propagation Time:

40 μ sec ▼

Calculate Parameters

T (Transmission time): 0.001000 sec
G (Offered load): 2.000000
 α (Alpha): 0.040000
Throughput (S): 0.3373 or 33.73%

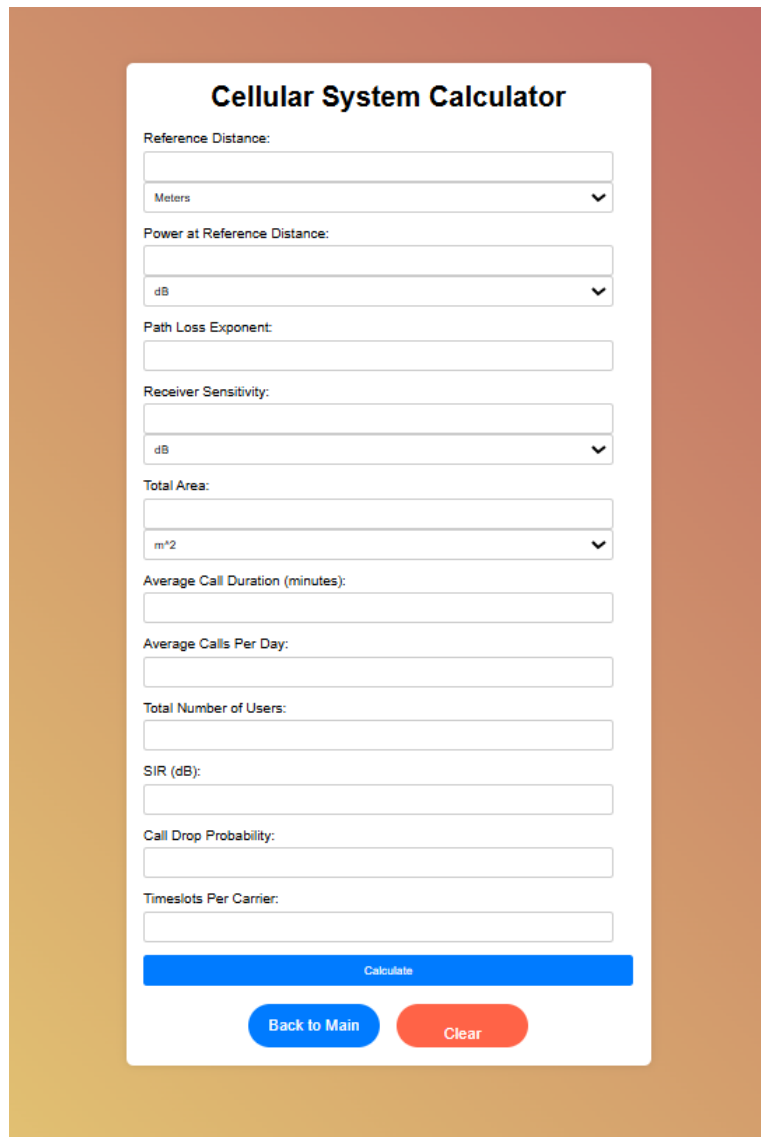
Back to Main

Clear

Calculator Five:

This calculator is cellular system, to calculate several parameters, the maximum distance, maximum cell size, number of cells, total traffic, cell traffic, Number of Cells in Cluster, and Number of carriers in whole system.

the following figure shows the design of the calculator:



The image shows a web-based calculator titled "Cellular System Calculator". It features a series of input fields and dropdown menus for various parameters. The parameters include Reference Distance (with a unit dropdown set to "Meters"), Power at Reference Distance (with a unit dropdown set to "dB"), Path Loss Exponent, Receiver Sensitivity (with a unit dropdown set to "dB"), Total Area (with a unit dropdown set to "m^2"), Average Call Duration (minutes), Average Calls Per Day, Total Number of Users, SIR (dB), Call Drop Probability, and Timeslots Per Carrier. At the bottom, there is a blue "Calculate" button, a blue "Back to Main" button, and a red "Clear" button.

Cellular System Calculator

Reference Distance:

Meters ▼

Power at Reference Distance:

dB ▼

Path Loss Exponent:

Receiver Sensitivity:

dB ▼

Total Area:

m² ▼

Average Call Duration (minutes):

Average Calls Per Day:

Total Number of Users:

SIR (dB):

Call Drop Probability:

Timeslots Per Carrier:

Calculate

Back to Main Clear

First scenario:

Problem #1:

A new mobile network provider acquired the license to provide full-rate duplex voice communication using GSM900 technology in certain city (8 timeslots per carrier). The Area of the city is equal to 4 Km² (4,000,000 m²). The mobile network provider is interested to provide service to 80 thousand subscribers. Subscribers in this city make an average of 8 calls per day and the average call duration is 3 minutes. The service provider is interested to provide the subscribers with a quality of service that guarantees a call drop probability equal to 0.02. The minimum SIR needed to correctly provide the service is equal to 13dB. Assuming -22.0 dB power is measured at a reference distance of 10 meters from base stations, the path loss exponent equals 3 (cellular urban area), receiver sensitivity = 7μ watts, calculate the following

- a) Maximum distance between transmitter and receiver for reliable communication.
- b) Maximum cell size assuming hexagonal cells.
- c) The number of cells in the service area?
- d) Traffic load in the whole cellular system in Erlangs.
- e) Traffic load in each cell in Erlangs.
- f) Number of cells in each cluster (*hint: number of co-channel interfering cells=6*)?
- g) Minimum number of carriers needed (in the whole system) to achieve the required Quality of Service.

The following figure shows the process of enter the inputs

Cellular System Calculator

Reference Distance:

Meters

Power at Reference Distance:

dB

Path Loss Exponent:

Receiver Sensitivity:

Microwatts

Total Area:

Km²

Average Call Duration (minutes):

Average Calls Per Day:

Total Number of Users:

SIR (dB):

Call Drop Probability:

Timeslots Per Carrier:

The following figure shows the Results

Results:

Maximum Distance:
96.5978 meters

Maximum Cell Size:
24243.0092 meters²

Number of Cells:
165

Total Traffic:
1333.3333 Erlangs

Cell Traffic:
8.0808 Erlangs

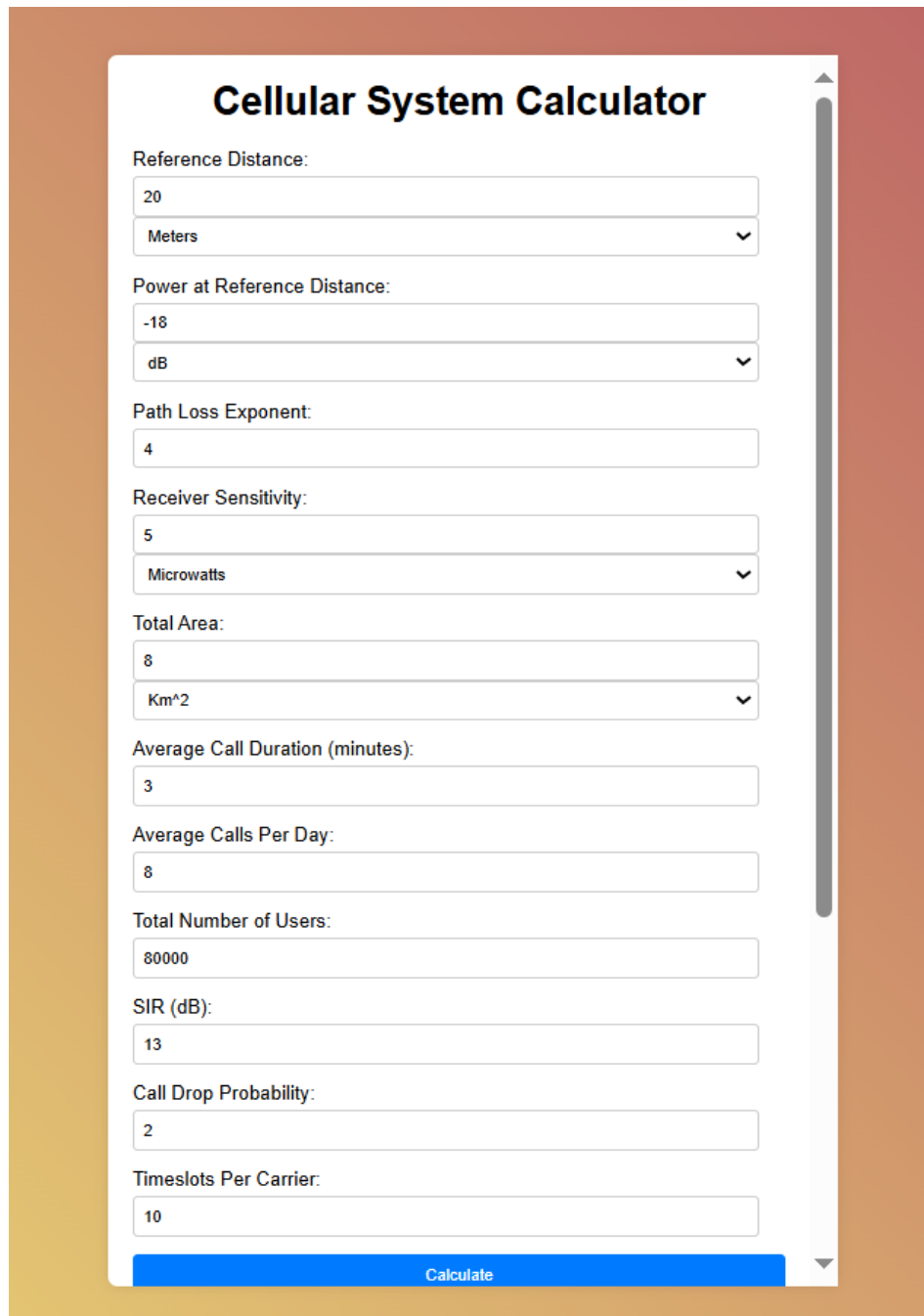
Number of Cells in Cluster:
9.0000

Number of Channels:
Number of Channels: 14 Number of Carriers Per Cell: 2 Number of Carriers In Whole System: 18

[Back to Main](#)
[Clear](#)

Second scenario:

The following figure shows the second scenario inputs



Cellular System Calculator

Reference Distance:

Power at Reference Distance:

Path Loss Exponent:

Receiver Sensitivity:

Total Area:

Average Call Duration (minutes):

Average Calls Per Day:

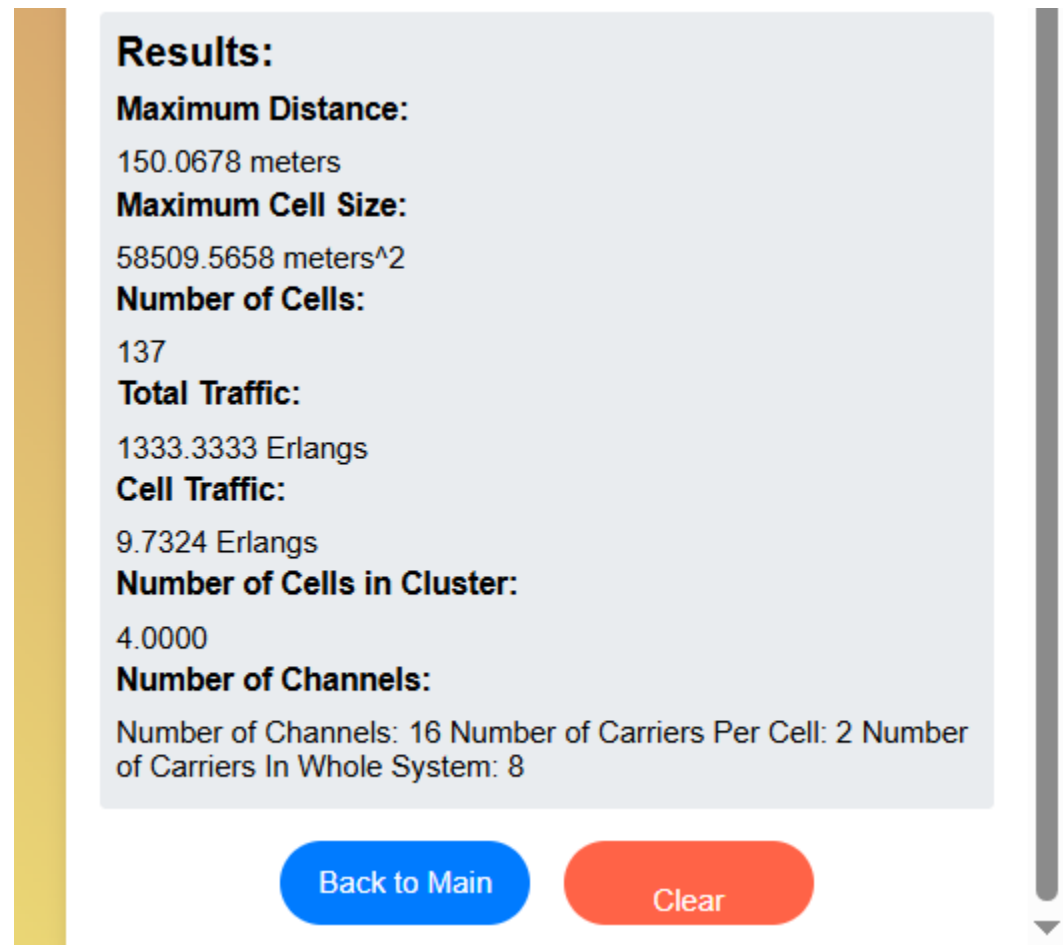
Total Number of Users:

SIR (dB):

Call Drop Probability:

Timeslots Per Carrier:

The following figure shows the Results of the second scenario



Third scenario

The following figure shows the inputs for third scenario

Cellular System Calculator

Reference Distance:

25

Meters

Power at Reference Distance:

-20

dB

Path Loss Exponent:

4

Receiver Sensitivity:

6

Microwatts

Total Area:

10

Km²

Average Call Duration (minutes):

4

Average Calls Per Day:

8

Total Number of Users:

80000

SIR (dB):

13

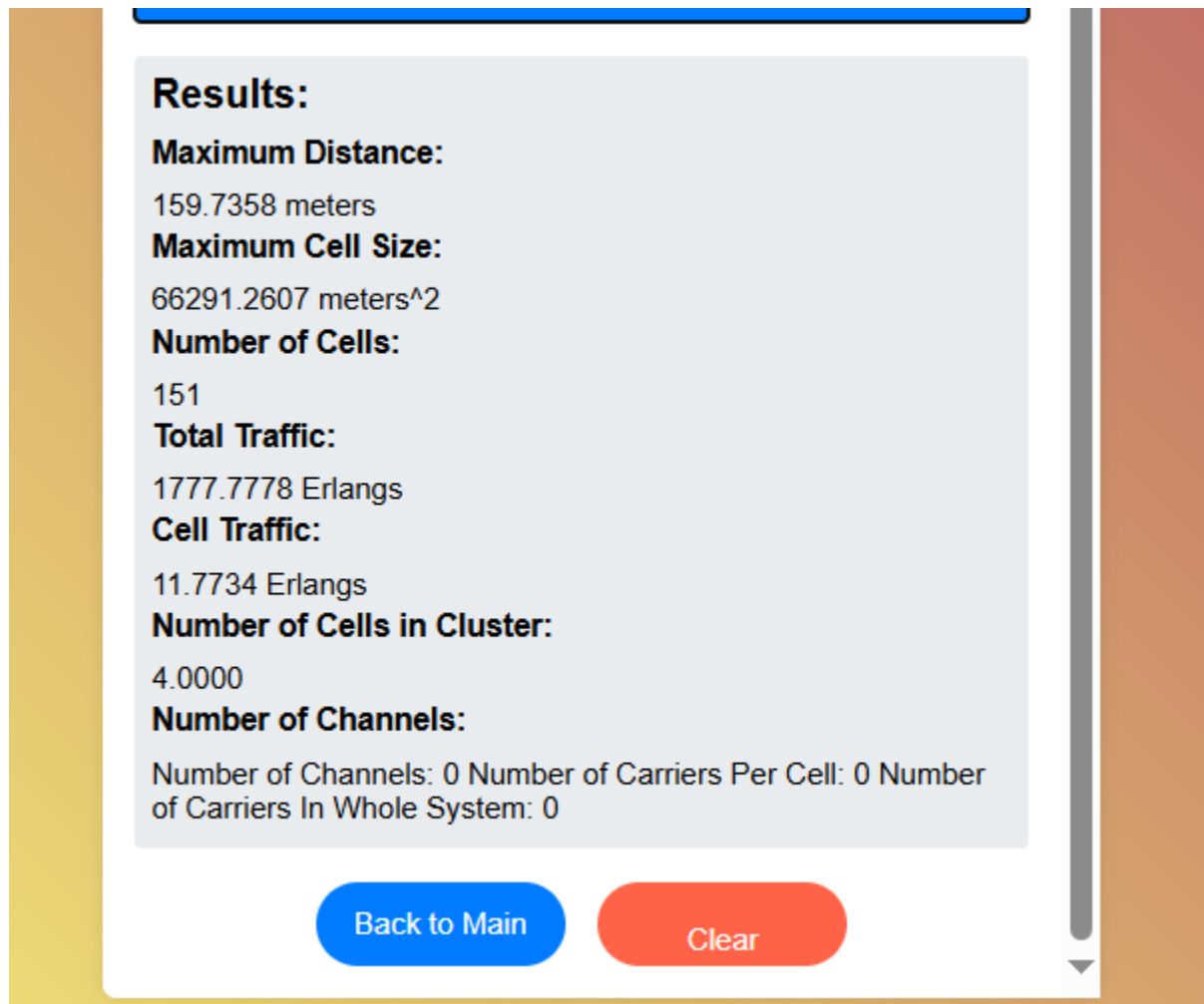
Call Drop Probability:

4

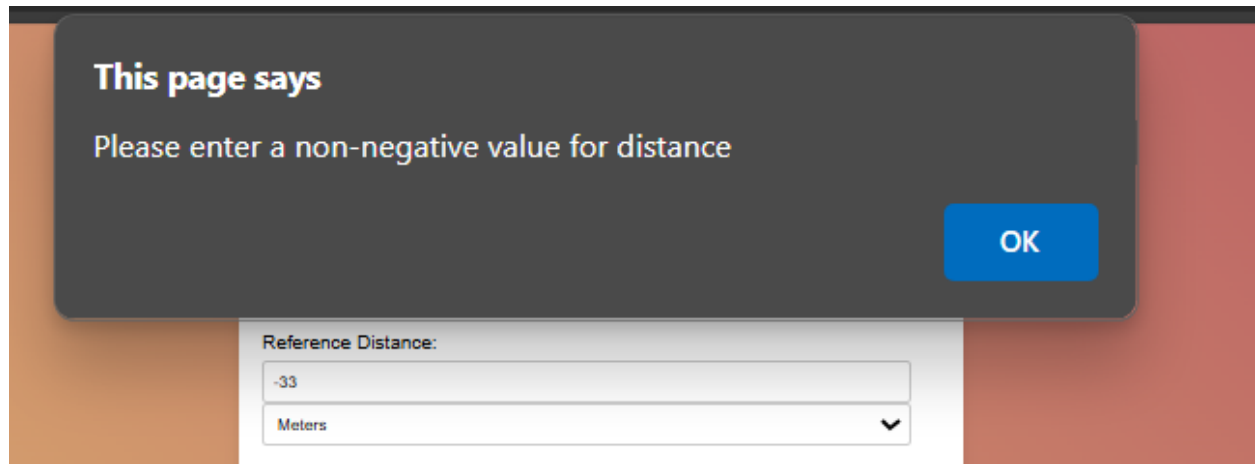
Timeslots Per Carrier:

10

The following figure shows the results of the third scenario



The following figure shows Error case, for example, users must input positive values for the distance



The image shows a web form with a dark grey error message box overlaid on top. The error message box contains the text "This page says" in bold, followed by "Please enter a non-negative value for distance" in a lighter font. A blue "OK" button is located in the bottom right corner of the error box. Below the error box, the form has a label "Reference Distance:" followed by a text input field containing the value "-33". Below the text field is a dropdown menu with the text "Meters" and a downward-pointing arrow. The background of the form is split into two vertical sections: orange on the left and red on the right.