

Scilab Manual for  
Satellite Communication  
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<http://spoken-tutorial.org/NMEICT-Intro>. This Scilab Manual and Scilab codes  
written in it can be downloaded from the "Migrated Labs" section at the website  
<http://scilab.in>



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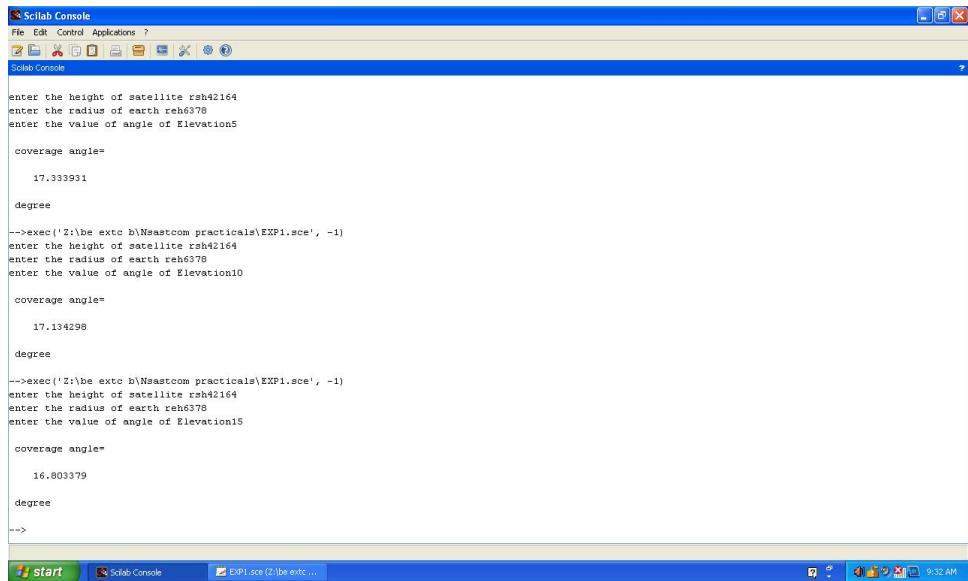
# Experiment: 1

## To calculate coverage angle.

Scilab code Solution 1.1 Coverage angle

```
1 // find coverage angle for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 clc;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14
15 alpha=reh/rsh;
16 ca=2*asind(alpha*cosd(E));
17 disp ("degree", ca,"coverage angle");
```

---



The image shows a Scilab Console window with a blue header bar containing the title "Scilab Console" and standard window controls. Below the header is a toolbar with various icons. The main area of the window is a text console where the user has run several commands. The commands involve calculating coverage angles for different satellite positions. The user enters the height of the satellite (rsh42164), the radius of the Earth (reh6378), and the elevation angle (Elevation5, Elevation10, Elevation15). For each set of inputs, the program calculates a coverage angle in degrees (17.333931, 17.134298, 16.803379 respectively) and then exits the script (exec command) back to the console prompt (--) twice.

```
Scilab Console
File Edit Control Applications ?
Scilab Console

enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

coverage angle=
17.333931
degree

-->exec('Z:\be extc b\Nsatcom practicals\EXP1.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

coverage angle=
17.134298
degree

-->exec('Z:\be extc b\Nsatcom practicals\EXP1.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

coverage angle=
16.803379
degree
-->
```

Figure 1.1: Coverage angle

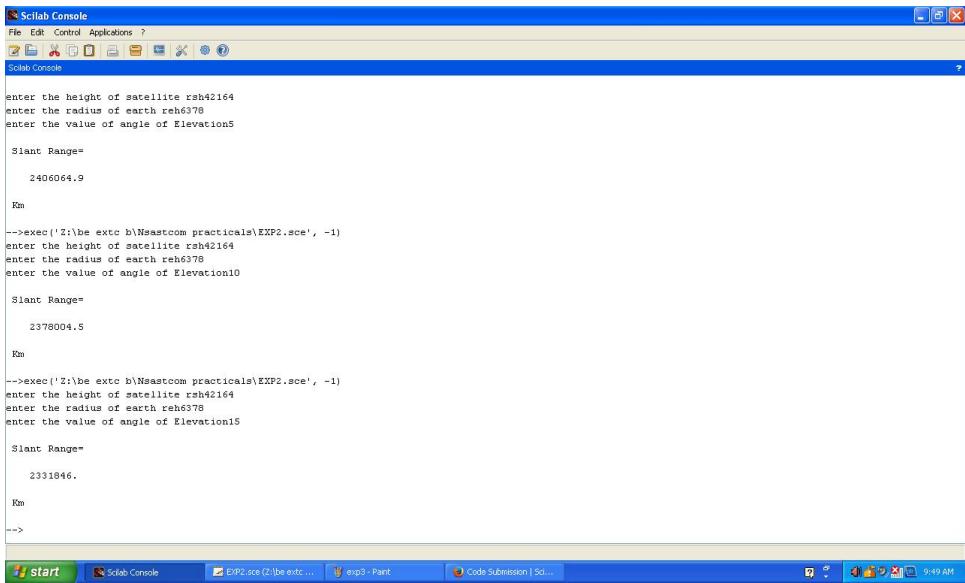
# Experiment: 2

## To calculate slant range .

Scilab code Solution 2.2 slant range

```
1 // find slant range for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 //clc ;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14 //rsh=42164;
15 //reh=6378;
16 //E=5;
17 v=3*10^8;
18 alpha=reh/rsh;
19 S=cosd(E+alpha)*reh/sind(alpha);
20 disp ("Km",S, " Slant Range=");
```

---



The image shows a screenshot of the Scilab Console window. The title bar reads "Scilab Console". The menu bar includes "File", "Edit", "Control Applications", and "?". The toolbar contains icons for file operations like Open, Save, Print, and Help. The main workspace displays the following text:

```
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

Slant Range=
2406064.9

Km

-->exec('Z:\be extc b\Nsastcom practicals\EXP2.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

Slant Range=
2378004.5

Km

-->exec('Z:\be extc b\Nsastcom practicals\EXP2.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

Slant Range=
2331846.

Km

-->
```

The taskbar at the bottom shows several open windows: "start", "Scilab Console", "EXP2.sce (Be exec...)", "exp3 - Part", "Code Submission | 3d...", and others.

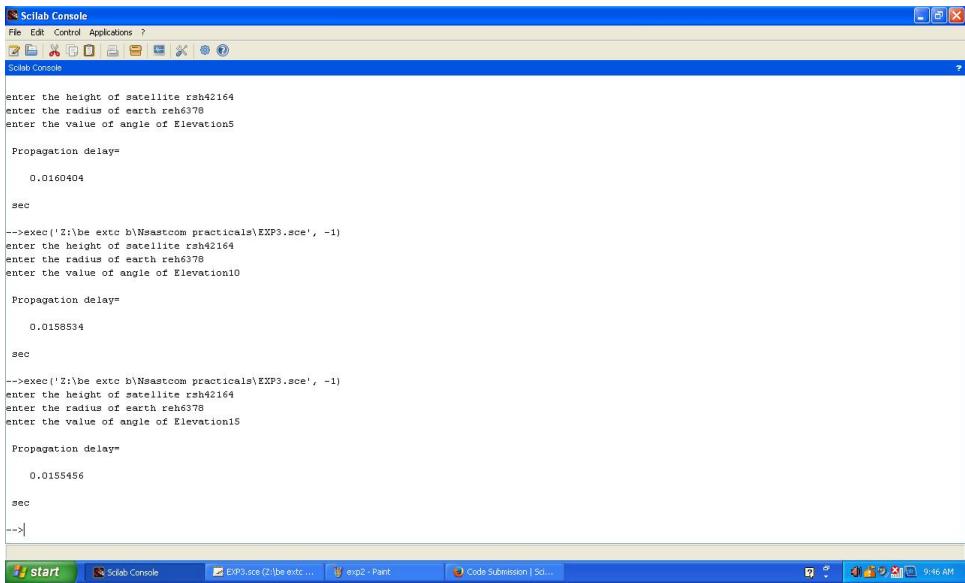
Figure 2.1: slant range

# Experiment: 3

## To calculate propagation delay

Scilab code Solution 3.3 Propagation Delay

```
1 // find propagation delay for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 //clc ;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14 //rsh=42164;
15 //reh=6378;
16 //E=5;
17 v=3*10^8;
18 alpha=reh/rsh;
19 S=cosd(E+alpha)*reh/sind(alpha);
20 P=2*S/v;
21 disp (" sec",P, " Propagation delay=");
```



The image shows a Scilab Console window. The console displays a series of commands and their outputs related to calculating propagation delay. The user enters values for satellite height (rsh42164), Earth radius (reh6378), and angle of elevation (Elevation5, Elevation10, Elevation15). The propagation delay is calculated in seconds (sec) for each case, resulting in values of 0.0160404, 0.0158534, and 0.0155456 respectively. The window has a standard Windows-style title bar, menu bar, and toolbar.

```
Scilab Console
File Edit Control Applications ?
Scilab Console

enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

Propagation delay=
0.0160404
sec

-->exec('Z:\be extc b\Nsastcom practicals\EXP3.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

Propagation delay=
0.0158534
sec

-->exec('Z:\be extc b\Nsastcom practicals\EXP3.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

Propagation delay=
0.0155456
sec
-->
```

Figure 3.1: Propagation Delay

---

# Experiment: 4

## To calculate Antenna Look Angels.

Scilab code Solution 4.4 Look angels

```
1 //find Azimuth and elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //La=39;
6 //dirae='N';
7 //Loe=77;
8 //diroe='W'
9 //Los=99;
10 //diros='W';
11 //re=6318;
12 //rs=42164;
13 clear;
14 close;
15 clc;
16 La=input(" enter the value of Latitude of ES Lae");
17 dirae=input("enter the direction of Lattitude s (N/S
    "));
18 Loe=input("enter the value of Longitude of earth
```

```

        station Loe");
19 diroe=input("enter the direction of Longitude of ES
(E/W)");
20 Los=input("enter the value of Longitude of satellite
Los");
21 diros=input("enter the direction of Longitude of
Satellite (E/W)");
22 re=input("enter the value of earth radius re");
23 rs=input("enter the height of satellite rs");
24 Adash=atand(tand(Los-Loe)/sind(La));
25 El=atand((rs-re*cosd(La)*cosd(abs(Los-Loe)))/(re*
sind(acosd(cosd(La)*cosd(abs(Los-Loe)))))-acosd(
cosd(La)*cosd(abs(Los-Loe)))
26
27 if dirae=='N' then
28     if diroe=='E' & diros=='E' then
29         if Loe>Los then A=180+Adash; else A=180-Adash;
            end; end;
30     if diroe=='E' & diros=='W' then A=180+Adash;end;
31     if diroe=='W' & diros=='E' then A=180-Adash; end
            ;
32     if diroe=='W' & diros=='W' then
33         if Loe>Los then A=180-Adash; else A=180+Adash;
            end; end;
35 end;
36     if dirae=='S' then
37         if diroe=='E' & diros=='E' then
38             if Loe>Los then A=360-Adash; else A=Adash; end;
                end;
39     if diroe=='E' & diros=='W' then A=360-Adash; end
            ;
40     if diroe=='W' & diros=='E' then A=Adash; end;
41     if diroe=='W' & diros=='W' then
42         if Loe>Los then A=Adash; else A=360-Adash;
            end; end;
44 end;
45 disp ("degree", A, "Azimuth=");
46 disp ("degree", El, "Angle of elevation=");

```



The figure shows three vertically stacked Scilab Console windows. Each window has a blue header bar with the title 'Scilab Console' and standard window control buttons (minimize, maximize, close). The main area of each window contains the following text:

```
enter the value of Latitude of ES Lae39
enter the direction of Latitude s (N/S)'N'
enter the value of Longitude of earth station Loe???
enter the direction of Latitude of ES (E/W)'W'
enter the value of longitude of satellite Los99
enter the direction of Longitude of Satellite (E/W)'W'
enter the value of earth radius ref378
enter the height of satellite rs42164

Azimuth=
212.70063
degree
Angle of elevation=
39.386637
degree
-->
```

Figure 4.1: Look angels

---

# Experiment: 5

## To calculate Limits of visibility.

**Scilab code Solution 5.5 Visibility Limit**

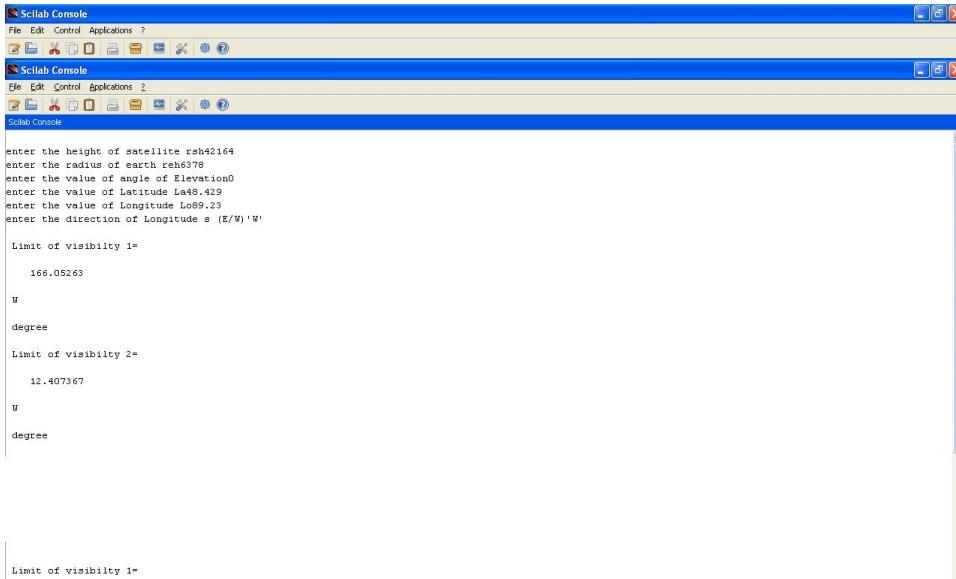
```
1 // find limit of visibility of Earth station at  
    certain latitude and longitude and with certain  
    elevation  
2 //OS=Windows XP sp3  
3 //Scilab version 5.4.0  
4 //Sample Values  
5 //rsh=42164;  
6 //reh=6378;  
7 //E=5;u can also keep E=0,10  
8 //La=48.429  
9 //Lo=89.23  
10 //dir=W  
11 clear;  
12 close;  
13 clc;  
14 rsh=input("enter the height of satellite rsh");  
15 reh=input("enter the radius of earth reh");  
16 E=input("enter the value of angle of Elevation");  
17 La=input("enter the value of Latitude La");  
18 Lo=input("enter the value of Longitude Lo");  
19 dir1=input("enter the direction of Longitude s (E/W)
```

```

    " );
20 x=reh*cosd(E)/rsh;
21 alpha=asind(x);
22 theta=90-E-alpha;
23 beta1=acosd(cosd(theta)/cosd(La));
24 LV1=Lo+beta1; //limit of visibility
25 LV2=Lo-beta1; //limit of visibility
26 if LV1>0 s1=dir1
27 elseif (dir1=='E') s1='W'
28 elseif (dir1=='W') s1='E'
29 end
30 if LV2>0 s2=dir1
31 elseif (dir1=='E') s2='W'
32 elseif (dir1=='W') s2='E'
33 end
34 disp ("degree", s1, abs(LV1),"Limit of visibility 1="
      );
35 disp ("degree", s2, abs(LV2),"Limit of visibility 2="
      );

```

---



The figure shows three separate Scilab Console windows side-by-side. Each window has a blue header bar with the title 'Scilab Console' and standard window controls (minimize, maximize, close). Below the header is a toolbar with various icons. The main area of each window contains the following text:

```

Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?

```

enter the height of satellite rsh42164  
enter the radius of earth reh6378  
enter the value of angle of Elevation0  
enter the value of Latitude La48.429  
enter the value of Longitude Lo89.23  
enter the direction of Longitude s (E/W)'W'  
Limit of visibility 1=  
166.05263  
U  
degree  
Limit of visibility 2=  
12.407367  
U  
degree  
Limit of visibility 1=

Figure 5.1: Visibility Limit



The figure shows three separate Scilab Console windows side-by-side. Each window has a blue header bar with the title 'Scilab Console' and standard window controls (minimize, maximize, close). Below the header is a toolbar with various icons. The main area of each window contains the following text:

```

Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?

```

enter the height of satellite rsh42164  
enter the radius of earth reh6378  
enter the value of angle of Elevation5  
enter the value of Latitude La48.429  
enter the value of Longitude Lo89.23  
enter the direction of Longitude s (E/U)'U'  
Limit of visibility 1=  
158.37017  
U  
degree  
Limit of visibility 2=  
20.089826

Figure 5.2: Visibility Limit

# Experiment: 6

To calculate Antenna Power  
and antenna gain for any given  
satellite communication  
antenna.

Scilab code Solution 6.6 Antenna

```
1 //find the gain of an antenna
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=4
6 //Pt=100
7 //Dt=3
8 clear;
9 close;
10 clc;
11 F=input("enter the value of frequency in Ghz F")
12 c=3e8;
13 lambda= c/(F*1e9);
14 //find the gain of parabolic reflector at given
   frequency and diameter
```



Figure 6.1: Antenna

---

```

15 eta=0.55; // efficiency
16 Pt=input("Power at the input of the antenna")
17 Dt=input("enter the value of daimeter of
transmitting antenna=");
18 Gt=eta*(%pi*Dt/lambda)^2;
19 Gtdb=10*log(Gt);
20 po=Gt*Pt;
21 disp (Gtdb,"Antenna gain in dB=");
22 disp ('Watts',po,"Power output from the antenna");

```

---

# Experiment: 7

To calculate EIPR for any given satelite communication link.

Scilab code Solution 7.7 Link1

```
1 //Find EIRP
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=4
6 //Pt=100
7 //Dt=3
8 clear;
9 close;
10 clc;
11 F=input("enter the value of frequency in Ghz F")
12 c=3e8;
13 lambda= c/(F*1e9);
14 eta=0.55; //efficiency
15 Pt=input("Power at the input of the antenna")
16 Dt=input("enter the value of daimeter of
transmitting antenna=");
17 Gt=eta*(%pi*Dt/lambda)^2;
18 Gtdb=10*log(Gt);
```



Figure 7.1: Link1

```
19 po=Gt*Pt;
20 EIRP=10*log(po);
21 disp (Gtdb,"Antenna gain in dB=");
22 disp ('dB',EIRP,"EIRP=");
```

---

## Experiment: 8

To calculate (C/N) for  
Communication Satellite link  
considering various losses when  
input transmitted power is  
given.

Scilab code Solution 8.8 Link2

```
1 // To find the signal to noise ratio for satellite
   communication link for given input power
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=6.1
6 //Gtbd=54
7 //R=37500
8 //Losses=6
9 //Pt=100
10 //Grdb=26
11 //Ta=35
12 //Tr=500
```

```

13 //B=36
14 clear;
15 close;
16 clc;
17 F=input("enter the value of frequency in Ghz F");
18 c=3e8;
19 lambda= c/(F*1e9);
20 //find the gain of parabolic reflector at given
   frequency and diameter
21 Gtdb=input("enter the value of gain of transmitting
   antenna in dB=");
22 Gt=10^(Gtdb/10);
23 //calculate Free space Loss for given frequency and
   distance between earth and satellite log10
24 R=input("enter the value of distance between earth
   and satellite=");
25 FSL=(4*pi*R*1e3/lambda);
26 FSLdb=20*log10(FSL);
27 losses=input("enter the value of additional losses
   in dB")
28 Totallosses=FSLdb+losses
29 TL=10^(Totallosses/10);
30 //determine received power
31 Pt=input("enter the value of power transmitted in W=");
32 Grdb=input("enter the value receiver antenna gain in
   dB=");
33 Gr=10^(Grdb/10);;
34 Pr=Pt*Gt*Gr/TL;
35 Prdb=10*log10(Pr);
36 //Calculate noise power density and noise power
37 Ta=input("enter the value of antenna noise
   temperature in K=");
38 Tr=input("enter the value receiver noise temperature
   in K=");
39 B=input("enter the value receiver bandwidth MHz=");
40 En=Ta+Tr; //equivalent noise temperature
41 K=1.36e-23; //Boltzman constant

```

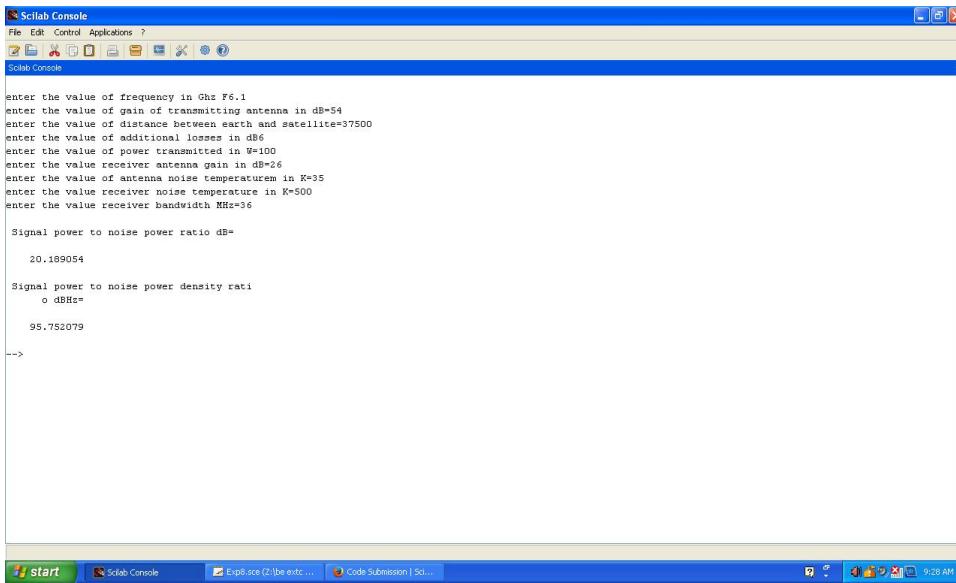


Figure 8.1: Link2

---

```

42 Pno=K*En*B*1e6; // noise power
43 Pnodb=10*log10(Pno);
44 Pnod=K*En; // noise power density
45 PnoddB=10*log10(Pnod);
46 // signal to noise ratio
47 CN=Prdb-Pnodb;
48 CNO=Prdb-PnoddB;
49 disp ('dB',CN," Signal power to noise power ratio dB=
");
50 disp ('dBHz',CNO," Signal power to noise power
density ratio dBHz=");

```

---

## Experiment: 9

To calculate (C/N) for  
Communication Satellite link  
considering various losses when  
saturation flux density is given.

Scilab code Solution 9.9 Link3

```
1 //uplink frequency is given and flux density
   required to saturate the transponder is given
   calculate signal to noise ratio
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=14
6 //R=42164
7 //saidb=-91.4
8 //Bo=11
9 //Pt=100
10 //GT=-6.7
11 clear;
12 close;
13 clc;
```

```

14 F=input("enter the value of frequency in Ghz F");
15 c=3e8;
16 K=-228.6; //dB Boltzman constant
17 lambda= c/(F*1e9);
18 R=input("enter the value of distance between earth
           and satellite=");
19 FSL=(4*pi*R*1e3/lambda); //free space losses
20 FSLdb=20*log10(FSL);
21 saidb=input("enter the value of saturation flux
               density of transponder in dB=");
22 A0db=-10*log10(4*pi/(lambda^2));
23 EIRPdb=saidb+FSLdb+A0db;
24 //disp (EIRPdb," earth station EIRP required for
           saturation of transponder dB=");
25 Bo=input("enter the value of backoff=");
26 GT=input("enter the value of G/T in dB/K");
27 //B=input(" enter the value of bandwidth in Hz");
28 //Bdb=10*log10(B);
29 CNUdb=EIRPdb+GT-Bo-K-FSLdb // -Bdb;
30 disp ('dB',CNUdb," Sinal to noise density ratio
           uplink=");

```

---

The image shows a Scilab Console window titled "Scilab Console". The window has a menu bar with "File", "Edit", "Control", "Applications", and "?". Below the menu is a toolbar with various icons. The main area of the window contains the following text:

```
enter the value of frequency in Ghs F14
enter the value of distance between earth and satellite=42164
enter the value of saturation flux density of transponder in dB=-91.4
enter the value of backoff=11
enter the value of G/T in dB/K-6.7

Signal to noise density ratio uplink=
75.127766
-->
```

The status bar at the bottom shows several open tabs and the time "10:32 AM".

Figure 9.1: Link3

# Experiment: 10

To calculate total C/N after calculating (C/N)Downlink and (C/N)uplink.

Scilab code Solution 10.10 Total SNR

```
1 //For given signal to noise ratio of uplink and down  
link calculate total signal to noise ratio of  
satellite link  
2 //OS=Windows XP sp3  
3 //Scilab version 5.4.0  
4 //Sample Values  
5 //CNUdb=26  
6 //CNDdb=24  
7 clear;  
8 close;  
9 clc;  
10 //for given data of downlink calculate CND and CNT  
11 CNUdb=input("enter the value of uplink signal to  
noise density ratio in dB=");  
12 CNDdb=input("enter the value of downlink signal to  
noise density ratio in dB=");  
13 //CNIdb=input("enter the value of interference signal
```

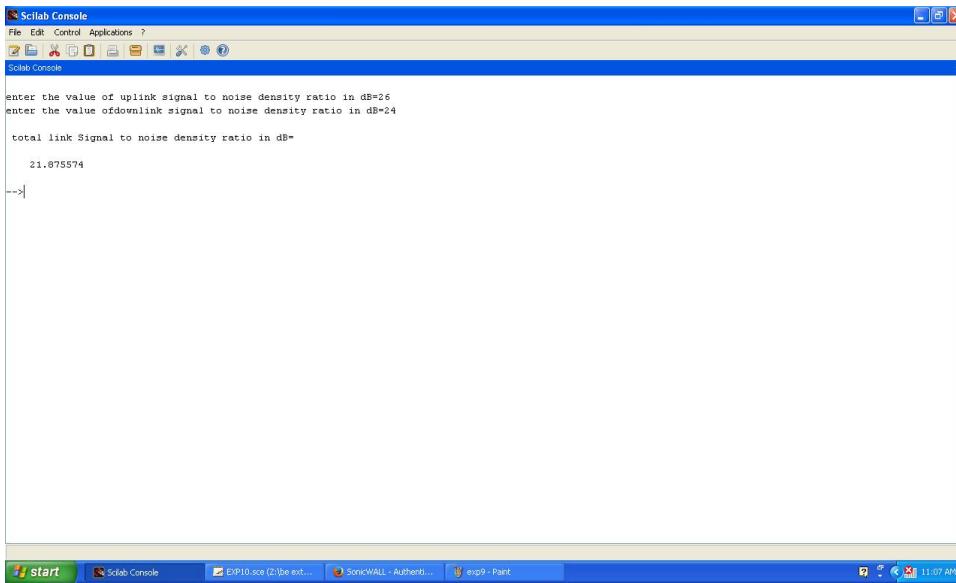


Figure 10.1: Total SNR

```
    to noise density ratio in dB=");
14 CND=10^(CNDdb/10);
15 CNU=10^(CNUdb/10);
16 //CNI=10^(CNIdb/10);
17 CNT=1/((1/CND)+(1/CNU)) // can add this term if
     interfernece is there (1/CNI));
18 CNTdb=10*log10(CNT);
19 disp (CNTdb,"total link Signal to noise density
     ratio in dB=");
```

---

# Experiment: 11

To calculate total noise temperature for any given satelite communication link.

Scilab code Solution 11.11 Noise Temperature

```
1 // find equivalent noise temperature of N stage
  receiver here for lowest equivalent noise
  temperature we r assuming first stage is LNA and
  second stage is waverguide and subsequent stage
  are amplifiers for which noise figure and gain r
  specified
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //N=3
6 //Tant=35
7 //Te1=150
8 //G(1)=50
9 //L=5
10 //F(3)=12
11 //G(3)=5
12 clear;
```

```

13 close;
14 clc;
15 N=input(" enter the No. of stages");
16 Tant=input(" enter the antenna temperature");
17 Te1=input(" enter the equivalent noise temperature of
LNA");
18 G(1)=input(" enter the gain of LNA in dB");
19 Ga(1)=10^(G(1)/10);
20 L=input(" enter the attenuation of waveguide in dB");
21 La=10^(L/10);
22 To=290;
23 Te(2)=Tant+Te1+To*(L-1)/G(1) //gain till second stage
24 Ga(2)=Ga(1)/La;
25 for i=3:1:N//starting from 3rd stage to N stage
26 F(i)=input(" enter the noise figure of next stage in
dB");
27 Fa(i)=10^(F(i)/10)
28 G(i)=input(" enter the gain of next stage amplifierin
dB ");
29 Ga(i)=10^(G(i)/10)
30 Te(i)=Te(i-1)+To*(Fa(i)-1)/(Ga(i-1)*Ga(i));
31 end
32 X=Te(i);
33 disp('K',X,"Equivalent noise temperature");

```

---

```
Scilab Console
File Edit Control Applications ?
Scilab Console Paste
enter the No.of stages3
enter the antenna temperature35
enter the equivalent noise temperature of LNA150
enter the gain of LNA in dB50
enter the attenuation of waveguide in dB5
enter the noise figure of next stage in dB12
enter the gain of next stage amplifierin dB 5

Equivalent noise temperature
208.24306
K
-->
```

Figure 11.1: Noise Temperature