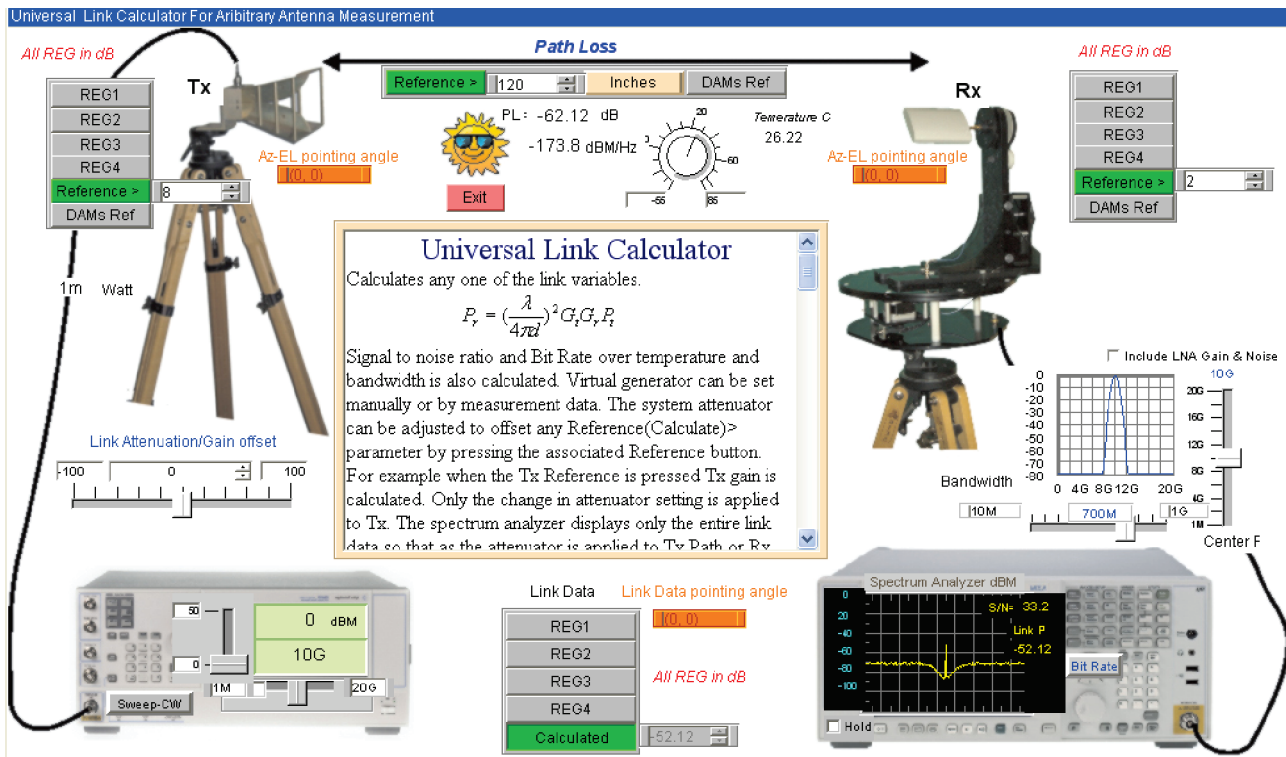


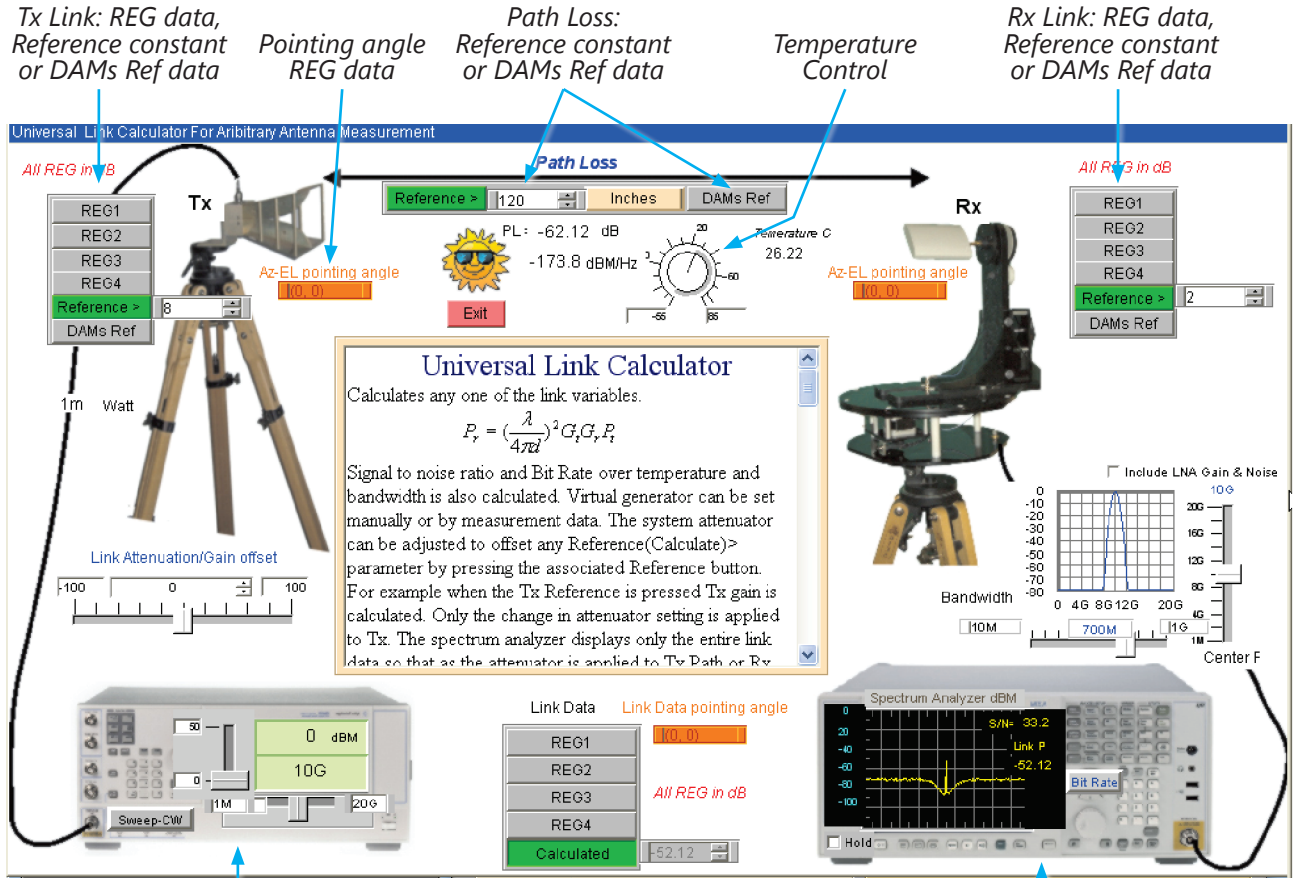
DAMs Universal Link Commander

Application Note



The Link Commander enables link analysis with or without DAMs measured data. It also enables range and Bit Error rate(Shannon's limit) determination. This application note will guide you through the usage of the Link Commander.

Link Commander Overview

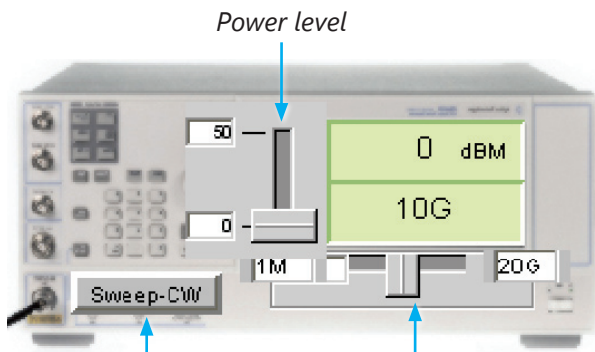


Sweep generator

Any Reference becomes Calculated data when pressed

Spectrum Analyzer

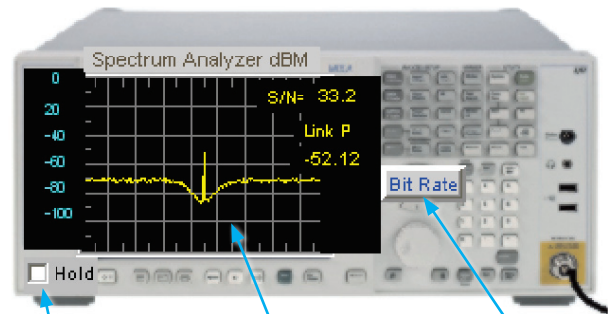
Sweep generator



Sweep or CW

Sweep generator assumes REG data frequency array if present. Default is 1MHz to 20GHz with 201 points.

Spectrum Analyzer

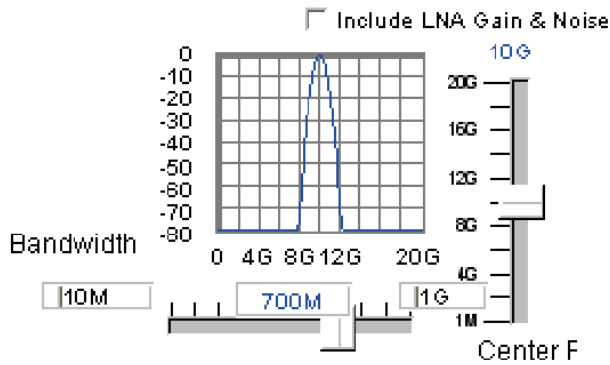


Holds display data

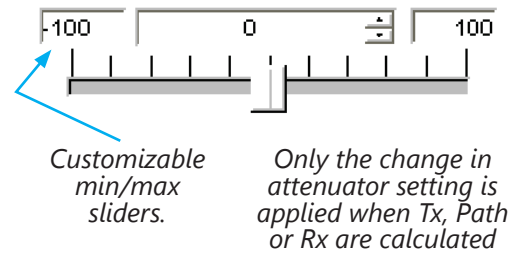
Spectrum Analyzer follows sweeper. Sweeper bandwidth sets noise level

Invokes Bit Error rate plot

System Bandwidth & Center frequency



Link Attenuation / Gain Offset



PROBLEM: Cell Phone Range

Assume that a measurement has been made using the DAMs. The AUT gain(Az,EL,f[51 points]) has been processed using the Gain Transfer Module and the linear gain is resident in REG1. If you are using the DAMs with no platform or test equipment then choose an antenna from the simulation library and make your measurements. Remember the library results are linear gain so the Gain Transfer module is not used.

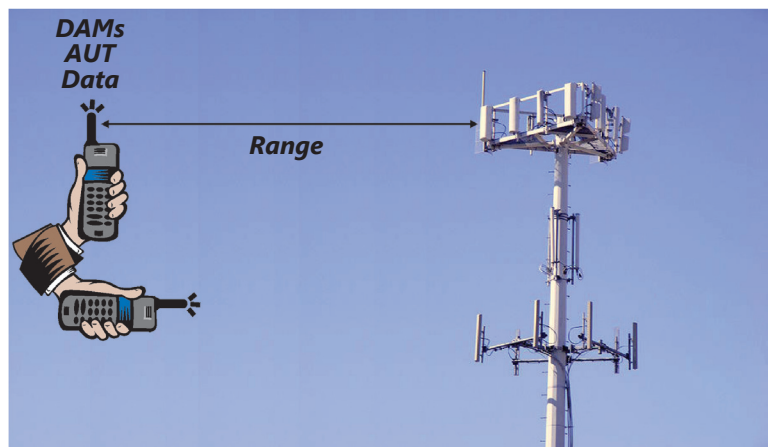
Assume the following:

1. CDMA
2. Frequency = 900MHz analyze from 850MHz to 950MHz
3. CDMA band width = 20MHz
4. Cell phone power = 2 Watts
5. Cell tower power = 10 Watts
6. Cell phone antenna gain (Measured with DAMs)
7. Cell tower sector gain = 8dBi
8. Temperature = +50c
9. Assume CDMA SNR threshold = 10dB8
10. Cell Phone Gain = 40dB Block and LNA gain, noise = 10dB,6dB
11. Cell Phone maximum output power = 0dBm

Determine the maximum line of site range and the associated maximum bit rate(over the bandwidth) for the system.

Repeat the above for a non line-of-site Azimuth angle of 90 deg. Cell antenna pointed at tower.

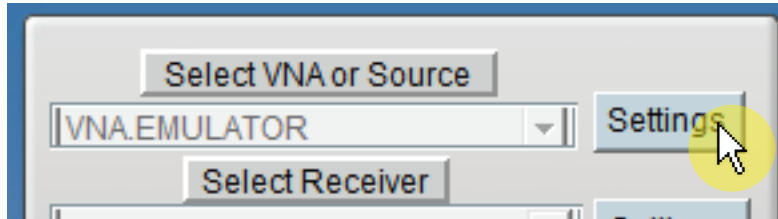
Determine the AGC range necessary for 300 ft operation.



SOLUTION: Cell Phone Range

Follow the directions below to generate measured data using the Dipole in the Emulator Library.

NOTE: Emulator data is generated in linear gain units. DAMs measurement data is linear "Link Data". The AUT gain data must be generated using the DAMs Gain Transfer.



Select VNA Emulator as your source and click Settings (shown above) which opens the Antenna Simulation Library (shown below). In the top-most drop down box select "Dipole arbitrary length and radius".

Antenna Library

Reference Antenna Simulations

These are standard antennas which may be used for creating reference antennas.

1 Dipole arbitrary length and radius
Uses numerical integration (runs slow)

$$G = \frac{120}{Rr} \left(\frac{\cos(xl \cos(\theta) \cos(\theta))}{\sin(\theta)} \right)^2$$

$$Rr = \frac{\eta}{2\pi} \int_0^\pi \left(\frac{\cos(xl \cos(\theta)) - \cos(xl)}{\sin(\theta)} \right)^2 d\theta$$

Limitations

$$.1 < \frac{l}{r} < 1000$$

$$\beta l < 8\pi$$

2 Ideal Dipole (Computes fast)
Quarter Wave at every frequency

3. Patch Antenna (Simple)

NOTE:
For Single Frequency enter
Start(Hz)top(Hz)
No. Points = 1

Frequency List Enabled

Start Freq. (Hz)	850M
Stop Freq. (Hz)	950M
No. Points	101

Antenna Simulation Library

Dipole arbitrary length and radius

LongWave Dipole

Enter Dipole Length (in) and Radius(in)

Orientation

Horizontal Vertical Apply

L =

r =

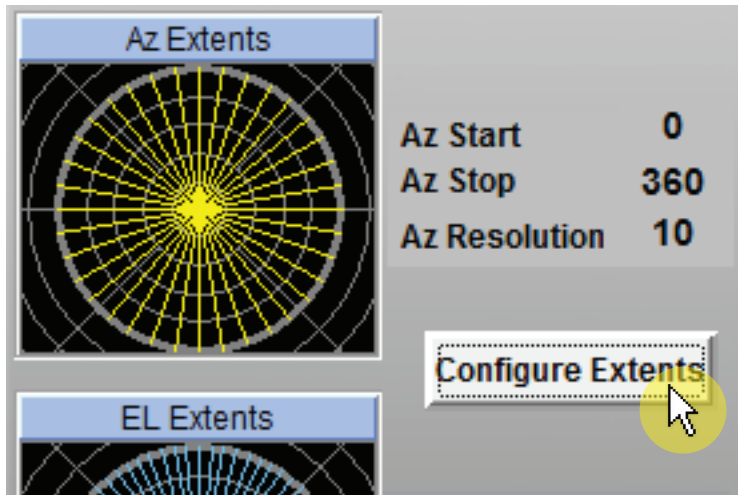
Alternate Parameter Single Cut Include Multipath (Arb. Beam only)

Multipath Simulator : unit

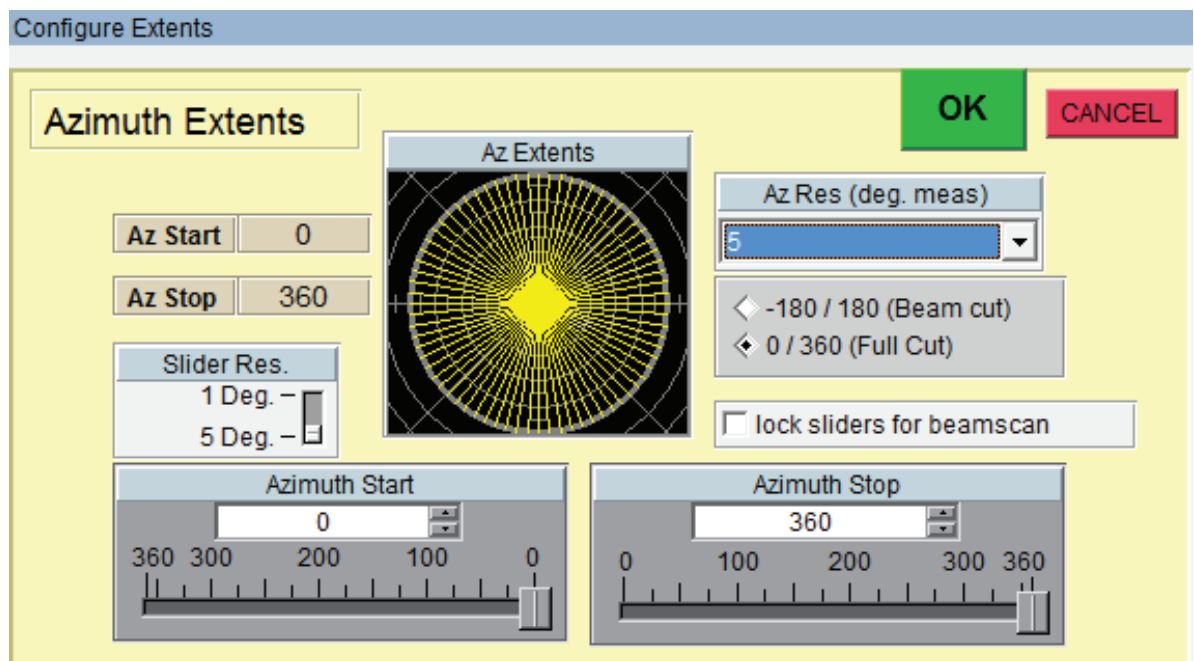
Under Orientation, select Horizontal and enter 2 (inches) as the length of the dipole. Leave the default radius of 100m (NOTE: the m stands for mili-inches, not meters). Finally, enter the beginning and ending frequencies and the desired number of points. Click done, and return to the main window.

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Now we must configure the extents of the scan by clicking the "Configure Extents" button shown below:

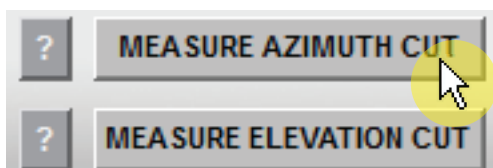


Which brings up the window shown below:

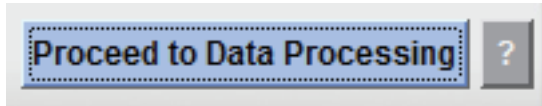


First, set the resolution by clicking the drop down menu under Az Res (deg. meas). For this application, select 5. This sets the scanning resolution to be in 5 degree steps. Next, set the extents to begin at 0 and end at 360 to do a full 360° scan. Once set, click OK, bringing you back to the main window.

Click the "Measure Azimuth Cut" button shown below. DAMs Antenna Studio will now perform the scan and show the results in the main previews.



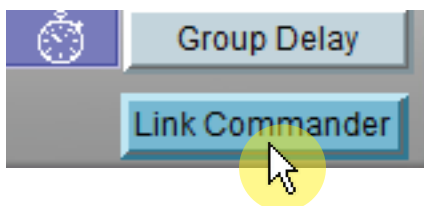
In order to process the scan data, we must save the data to REG1. To do this, click the Proceed to Data Processing button shown below.



This will bring up the Data Processing window shown below. Click the Data Storage Reg 1 button shown below, saving the scan data to REG1.



After saving, click the Link Commander button shown below. Link Commander will convert the data to dB. DAMs measured data is linear voltage [S]

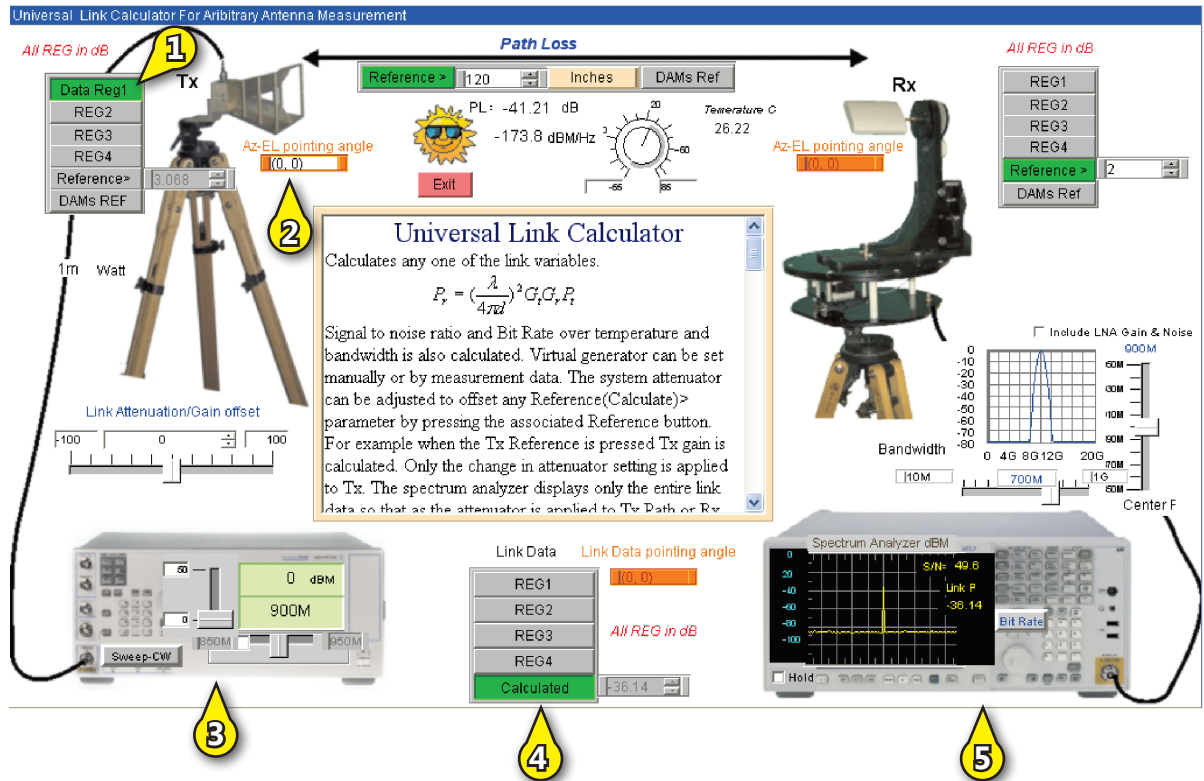


Link Commander will open with the following defaults:

Transmission Gain:	8 dB
Path:	120 in.
Receive Gain:	2 dB
Frequency range:	1 MHz to 10 GHz
Sweep Mode:	CW
Temperature:	26° C
Power Level:	0 dBm
Band width:	700 MHz
Link attenuation:	none

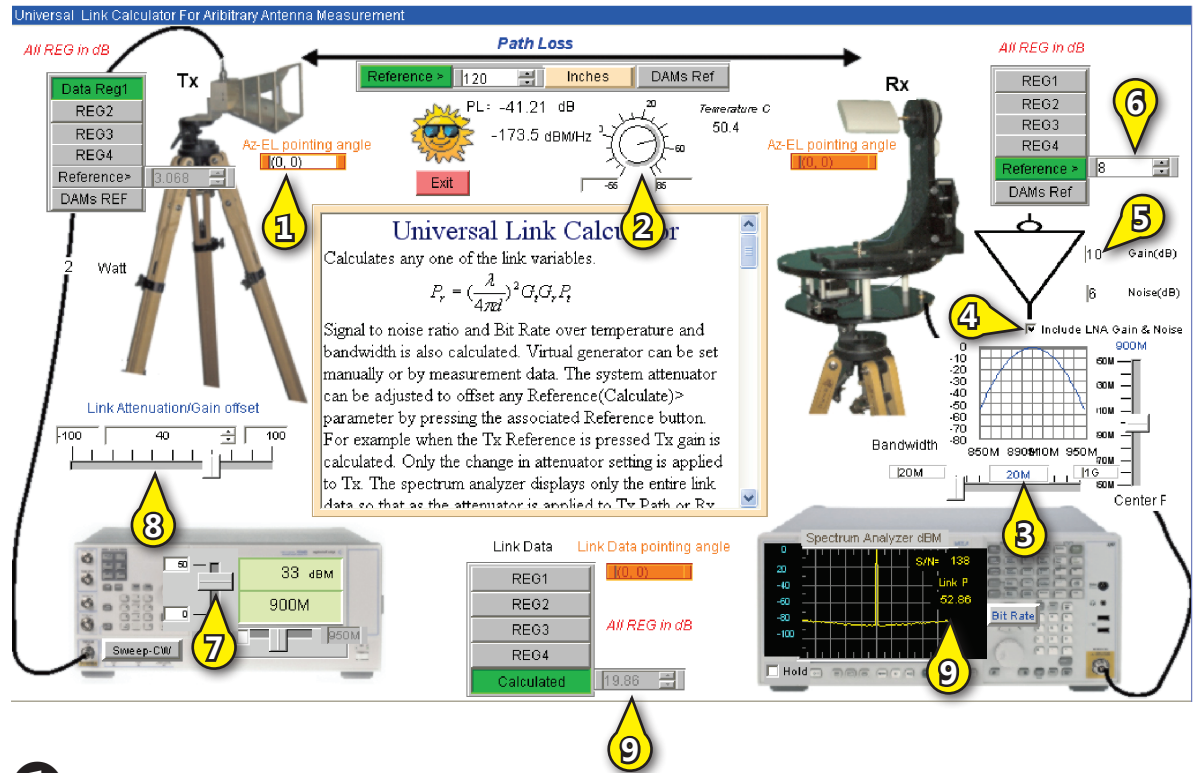
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First we set the transmission settings as illustrated below:



- 1** Recall the dipole measured gain data into the Tx from REG1.
- 2** Measured gain at Az,EL,f = (0,0, 900MHZ)
- 3** Sweeper sets to measured frequency array and cannot be edited. Midband is default.
- 4** Total Link gain is being calculated.
- 5** Spectrum analyzer sweep width follows sweeper.

Next, set Link Commander Link variables to Cell Link constants:



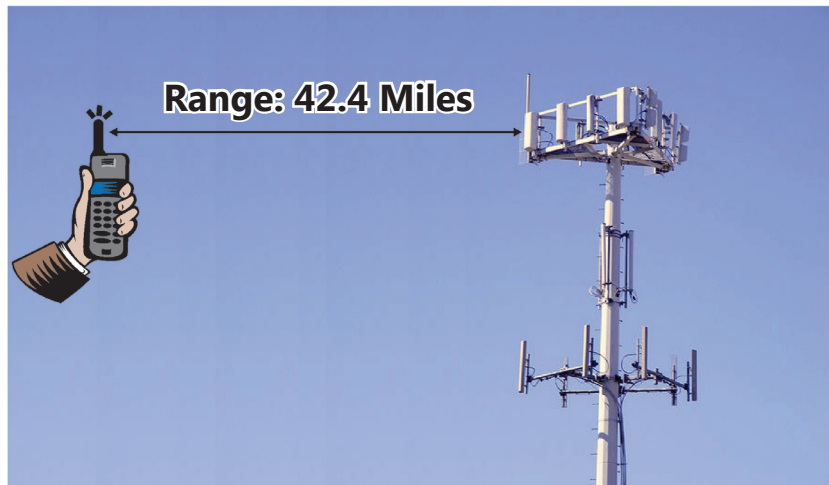
- 1 Set the Pointing Angle to (0,0)
- 2 Set the temperature to 50c
- 3 Set the BW to 20MHz
- 4 Invoke LNA
- 5 Set Gain 10dB and noise 6dB
- 6 Enter Rx Gain 8dB
- 7 Set the Tx power level +33dBm (2 watt)
- 8 Set the Phone gain 40dB
- 9 Note the system gain (19.86dB) and power out +52.86dBm. The system is in deep saturation at 120 inches.

NOTE: You may have to toggle the Link Data calculate if the link attenuator was set with the Link Calculate initiated.

Next, determine the cell phone range in a vertical position by calculating path loss:

The screenshot shows the 'Universal Link Calculator' software interface. At the top, it displays 'Path Loss' with a calculated value of 42.4 Miles. The interface includes several control panels: 'Tx' (Transmitter) with a 'Reference' value of 3.068 and 'Az-EL pointing angle' of (0, 0); 'Rx' (Receiver) with a 'Reference' value of 8 and 'Az-EL pointing angle' of (10, 0). A central window displays the formula $P_r = \left(\frac{\lambda}{4\pi d}\right)^2 G_t G_r P_t$ and explains that it calculates link variables, signal-to-noise ratio, and bit rate. Below this, a spectrum analyzer shows a signal at 900M with an SNR of 10.9 and Link P of -74.14. The software also features a 'Link Data' section with 'Reference' set to 19.86 and a 'Path Attenuation/Gain offset' slider.

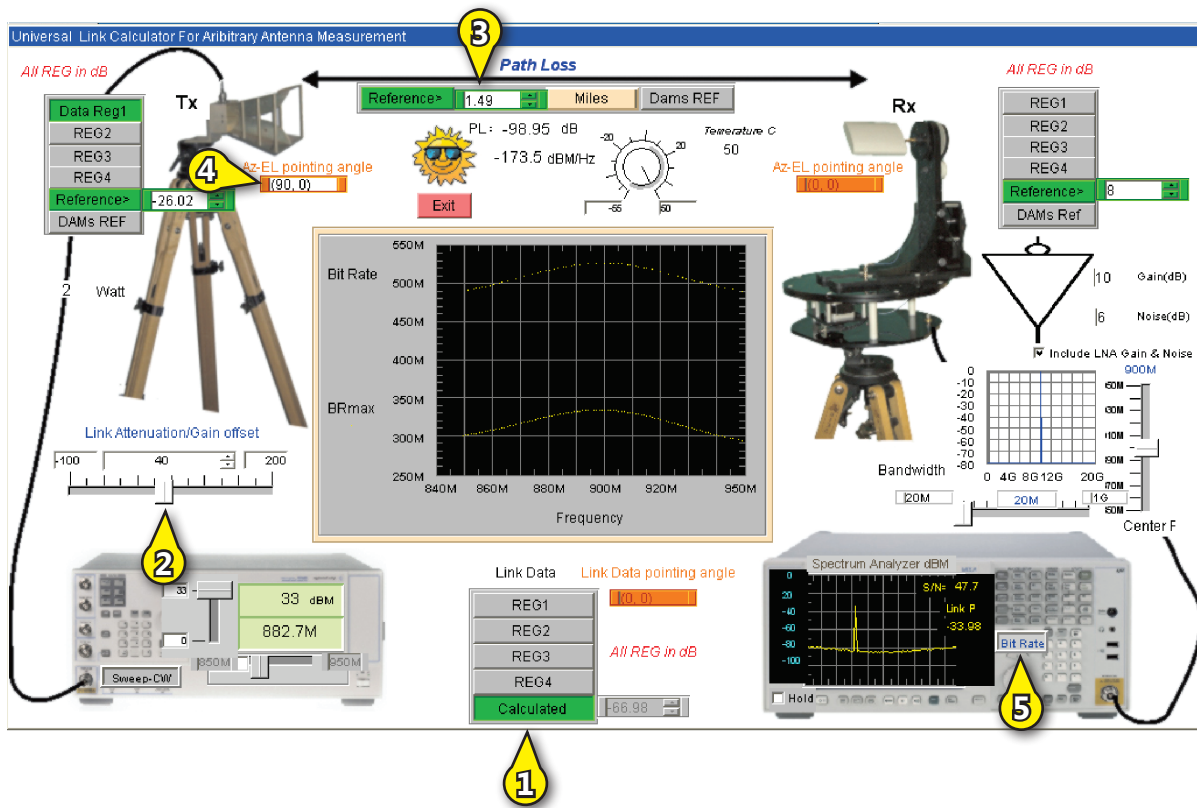
- 1 Initiate Path Loss Calculation
- 2 Toggle units to miles
- 3 Use micro-stepper for small changes
- 4 Adjust the system gain offset from the Link setting of 40dB to calculate the path until the SNR is 10dB. Note the path equals 42.4 Miles
- 5 Note: Link attenuator Max gain was set to 200dB to allow gain offset for SNR = 10dB.



To determine the cell phone range in a horizontal position enter the Az angle =90 deg. The range for the previous SNR = 10dB is calculated to be 1.49 miles.



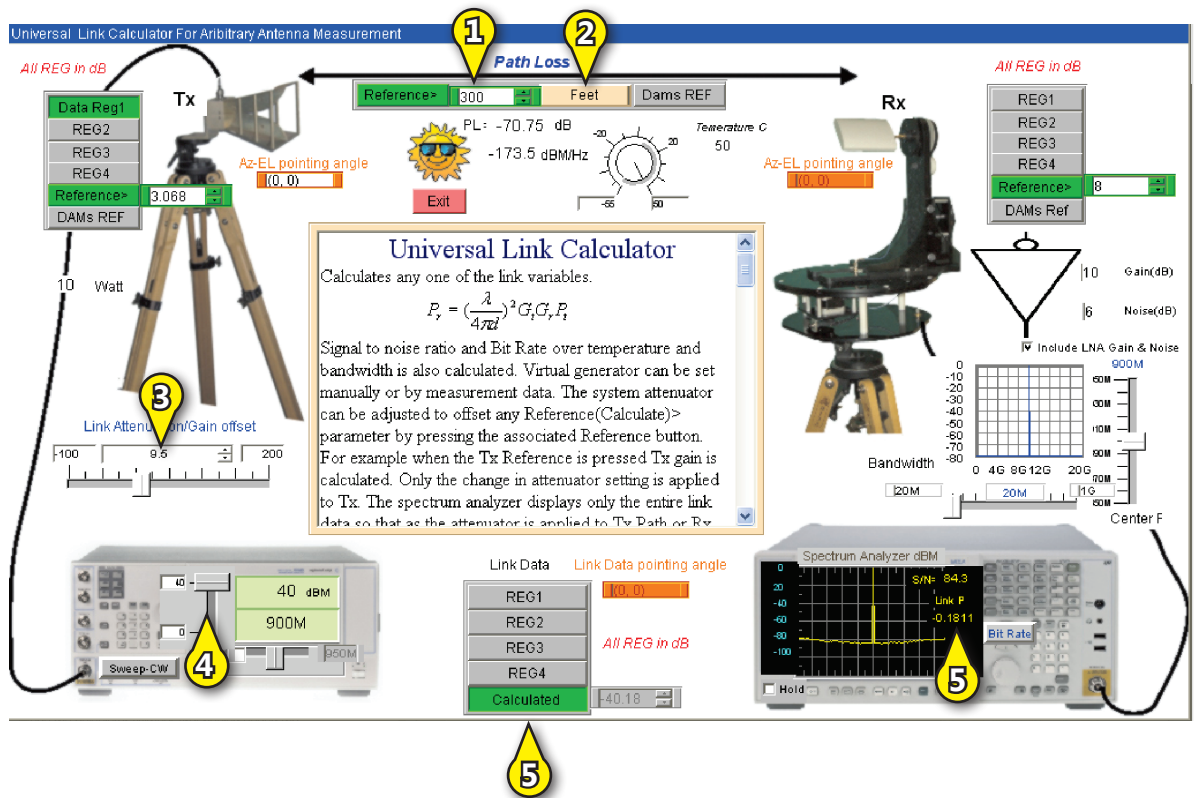
To calculate Cell Link Maximum Bit Rate for AUT at Az = 0 and Az = 90, perform the following steps:



- 1 Invoke Link Calculation
- 2 Set Block Gain to +40dB
- 3 Set Path Loss range to 1.49 miles
- 4 Change AZ from 0 to 90 degrees
- 5 Invoke Bit Rate Plot and sweep will start

Maximum data rate transfer is 300MBS to 500MBs depending on phone antenna angle as illustrated in the graphs.

To determine the AGC range necessary for 300 ft operation:



- 1** Set the Path to 300 ft.
- 2** Toggle to Feet
- 3** Set the tower power to +40 dBm(10 Watt)
- 4** Decrease the system gain until the power out of the receiver is 0dBm (the max)
- 5** Calculate the Link Power

AGC Range = 9.5dB - 40dB = -30.5dB AGC range