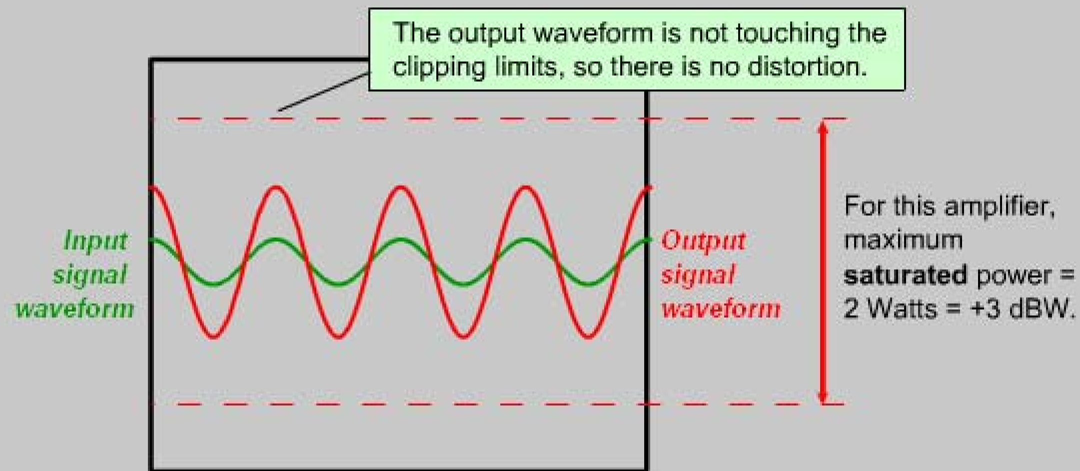
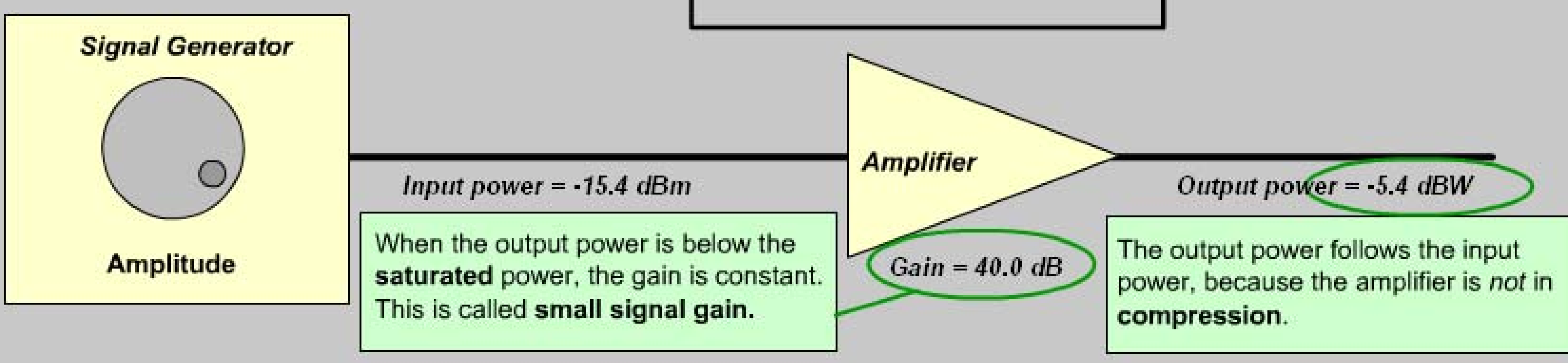
Amplifier saturation

All amplifiers, including the amplifiers in iDirect transmitters, have a maximum output power capability. If you drive the input level high enough, the output waveform will "clip" at its maximum value. That means that the output power cannot keep increasing beyond a certain level even if the input level is increased. It also means that the signal waveform will be distorted. Watch carefully to what happens to the output waveform:

- *Watch the output waveform and power change as the input level is varied.*
- *Try it for yourself. Turn the knob to adjust the amplitude of the input signal to the amplifier.*

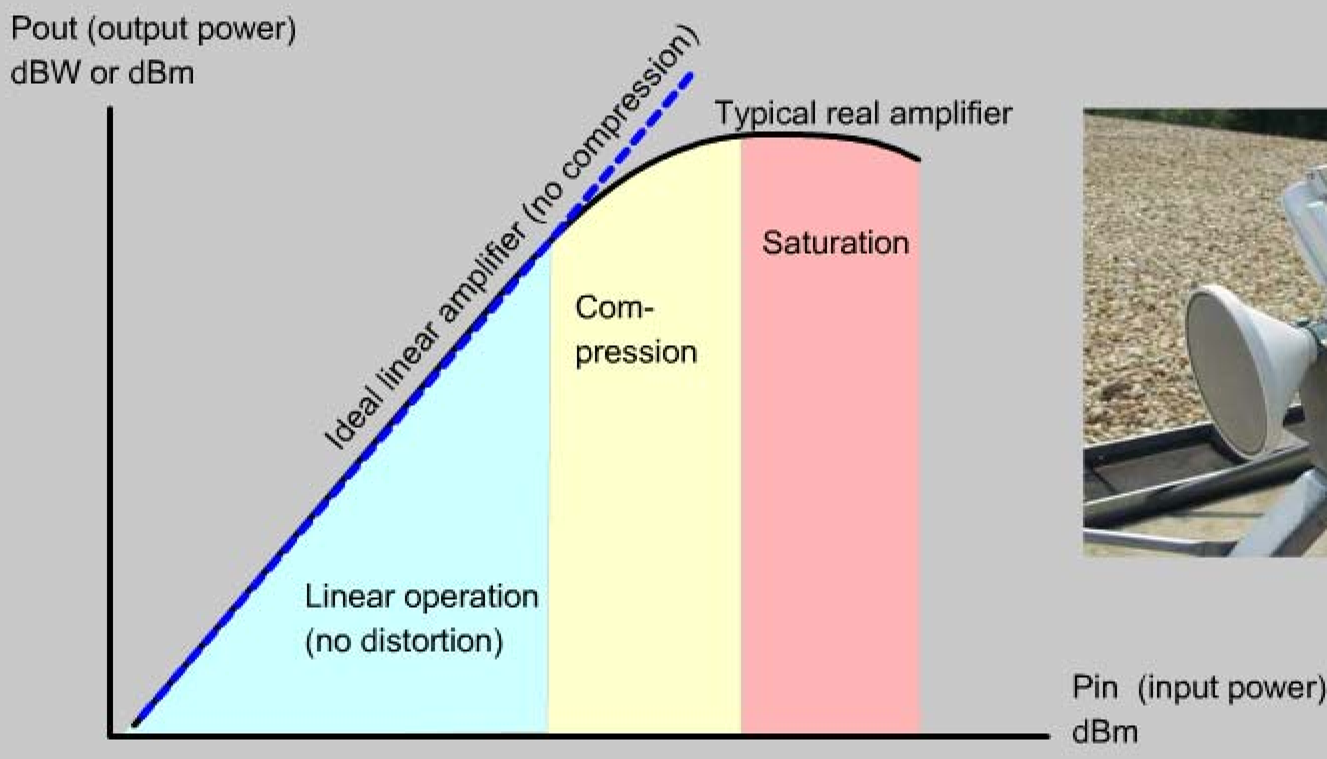




Compression

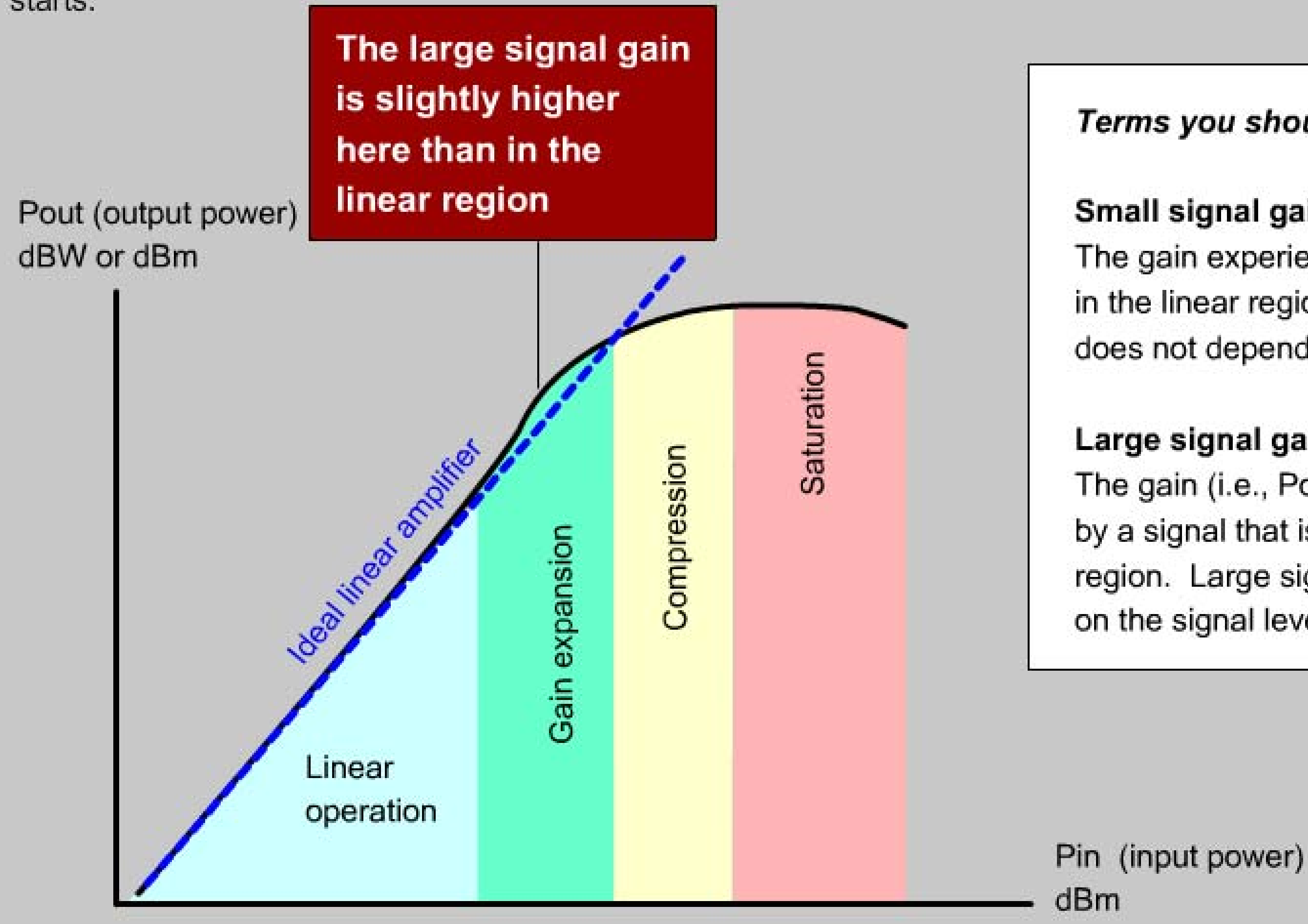
The amplifier in a VSAT terminal transmitter that experiences compression is almost always the final power amplifier in the BUC. Usually they are made with transistors and so are also called "Solid State Power Amplifiers" or SSPAs. The SSPA is often built into the BUC, but it can be a separate unit (booster).

If we measure the output power of an SSPA vs. its input power, we get a curve that looks like this:



Gain expansion

In high-power or very efficient SSPAs, sometimes we see the gain actually ***increase*** a little before the compression region starts:



Terms you should know:

Small signal gain
The gain experienced by a signal that is in the linear region. Small signal gain does not depend on the signal level.

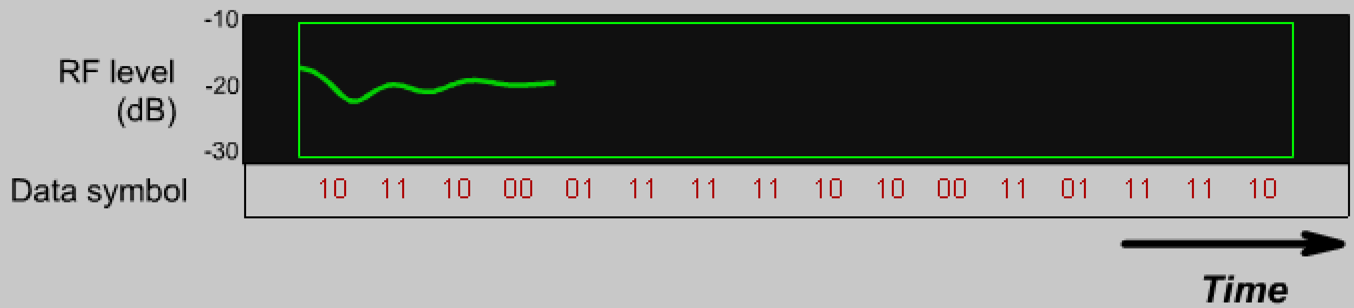
Large signal gain
The gain (i.e., Pout - Pin) experienced by a signal that is above the linear region. Large signal gain ***does*** depend on the signal level.

Distortion

Q. Why do we care if the signal is in the linear, expansion, compression, or saturation operating regions of the transmitter amplifier?

A. Because expansion, compression and saturation **distort** the signal, and **distortion** makes **interference**. (It also degrades the quality of the signal.)

To understand why, we must first consider that iDirect uplink signals use filtered QPSK modulation (which we studied in the GVF Level 2 course). That means that the signal level (amplitude) is ***not constant*** - it is ***always changing*** as the data modulates the carrier, as this plot shows:



So to transmit the signal through an amplifier without making distortion, we must accurately preserve the **amplitude** waveform of the signal (and the phase too, of course). That means the signal should stay mostly in the linear region of the amplifier.

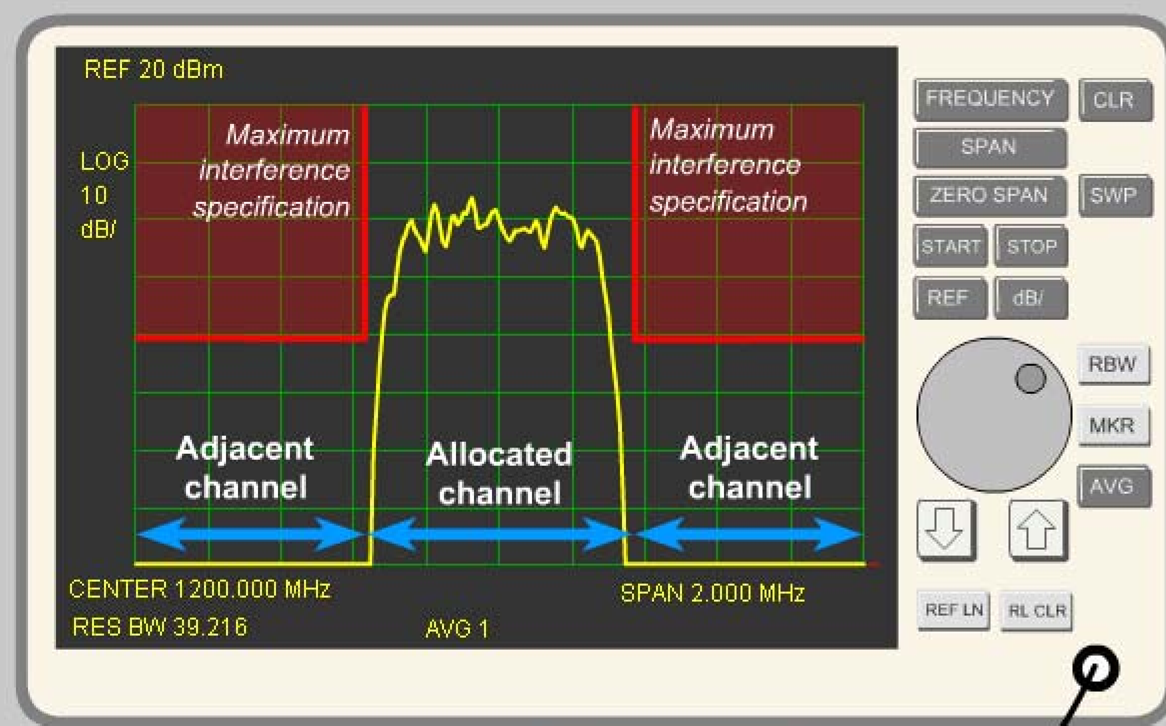
Distortion spectrum

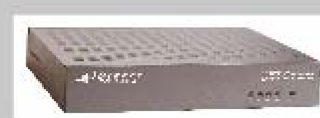
This is an accurate simulation of a QPSK signal passing through a distorting BUC. Observe how driving the SSPA into compression and saturation causes interference to the neighbors' channels. Click **NEXT** to step up the power.

Linear operation
The signal level is below the point of compression, so there is very little distortion. Note how the signal spectrum stays inside its allocated bandwidth.

Modem output power: -23 dBm

NEXT





Modem (IDU)

BUC with built-in SSPA

This hypothetical test cable represents connecting a sample of the BUC output to the spectrum analyzer.

Exercise: find and peak

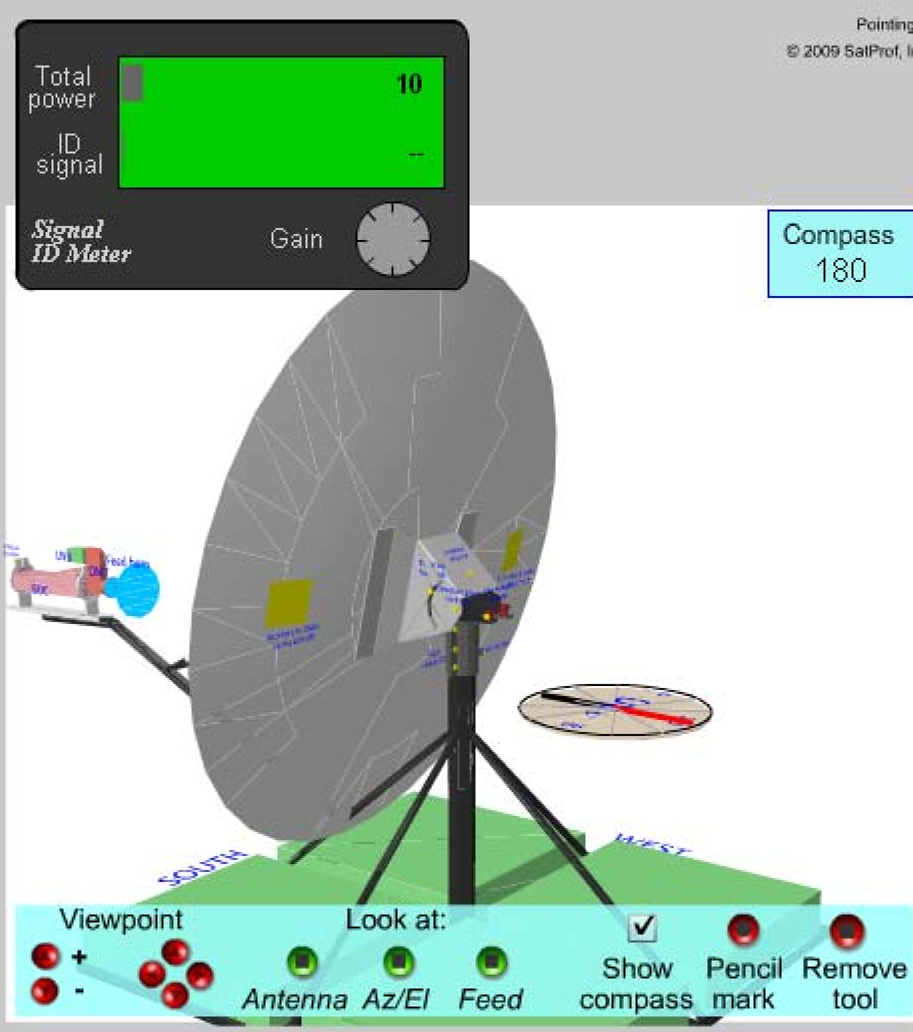
In this exercise you must **find** the satellite and perform the initial **peak in azimuth and elevation**. You may assume the following:

Your location is 156 deg E, 33 deg N.
The satellite is at 141 deg E.
The VSAT will use V downlink polarization.
Pointing angles from your look angle calculator:
Azimuth = 206, Elevation = 48, Pol = 22

Remember your steps:

1. Preset the polarization. Use the Quick Reference Sheet to help make sure you are turning the right way.
2. Preset your elevation.
3. Scan coarse az to find the satellite. Step elevation up and down and scan az again if needed
4. Peak it with the el and fine az adjusters.
5. Lock the coarse azimuth but leave the fine az, el, and pol locks loose.

When you are ready (or if you need a hint), click the SHOW MY RESULTS button to see how well you did. If you are having trouble, click the HELP button.



? HELP

SHOW MY RESULTS

Loading - 100%