Company and Technology Background

IMSAR LLC has radar technology that is able to track moving targets, image the surface of the earth, create digital elevation maps, assist in search and rescue operations, and detect small changes in a scene, such as the movement of a vehicle. Various branches of the US military, including the Navy, Army, and Air Force, as well as some commercial businesses, have expressed interest in this technology. The size, weight, power, and cost of IMSAR's Synthetic Aperture Radar (SAR) system, known as NanoSAR, are an order of magnitude less than similar systems.

IMSAR performs SAR tests from a small aircraft typically flying between 2,000 and 10,000 feet in altitude (above ground level). Directional transmit and receive antennas are nominally pointed toward the earth. Reflected signals are collected and processed to create images of the ground. Transmission is a linear frequency modulated continuous wave (LFM-CW), or a "chirp," with the frequency being swept from the minimum to the maximum frequency 1000 times per second. A chirp signal is illustrated in Figure 1. Because the frequency sweeps are very rapid, the average power at any given frequency is extremely low, as is the likelihood of detection by (i.e., interference to) ground based systems operating in the same frequency range.

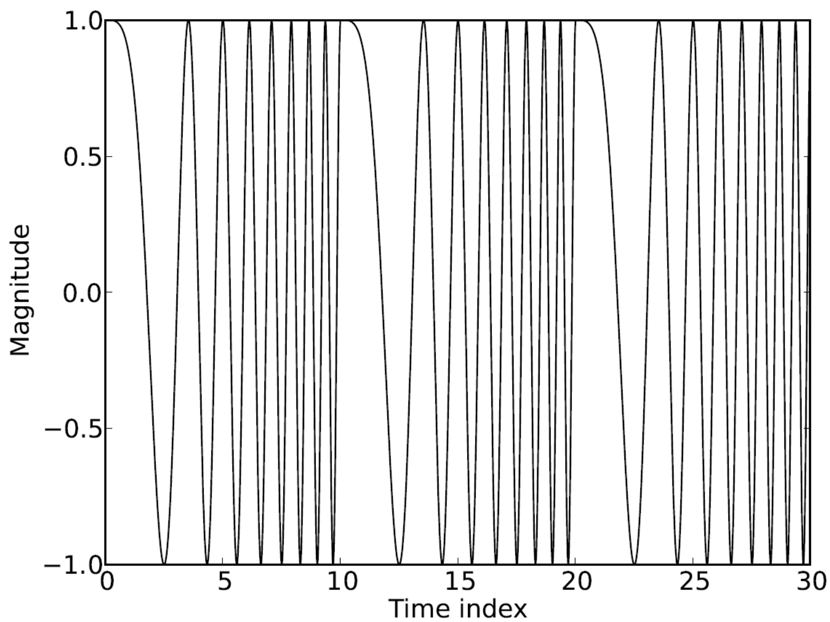

Figure 1. Example LFM chirp signal, increasing in frequency from left to right, then repeating.

An example of the geometry of a SAR is shown in Figure 2.

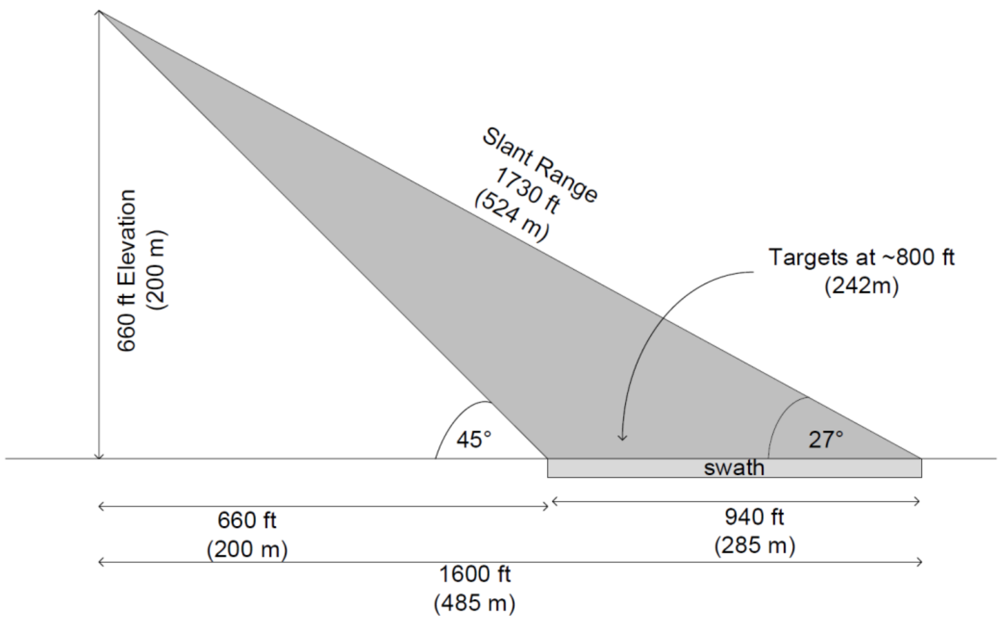

Figure 2. Example SAR geometry, from an airborne platform.

Calculated Incident Power as a Function of LOS Distance to Receiver

The incident power level decreases with distance between the transmitter and receiver. Figure 3 shows the power level incident at a receiver system as a function of the distance of that system from the IMSAR UHF radar. The vertical line in the plot represents the minimum altitude (AGL) at which the UHF radar can successfully operate. At this "worst case" distance, and for a receiver bandwidth of 10 MHz, the incident power level is estimated to be about -65 dBm, or 320 picowatts. For a system with a smaller receiver bandwidth, the incident power would be even less.

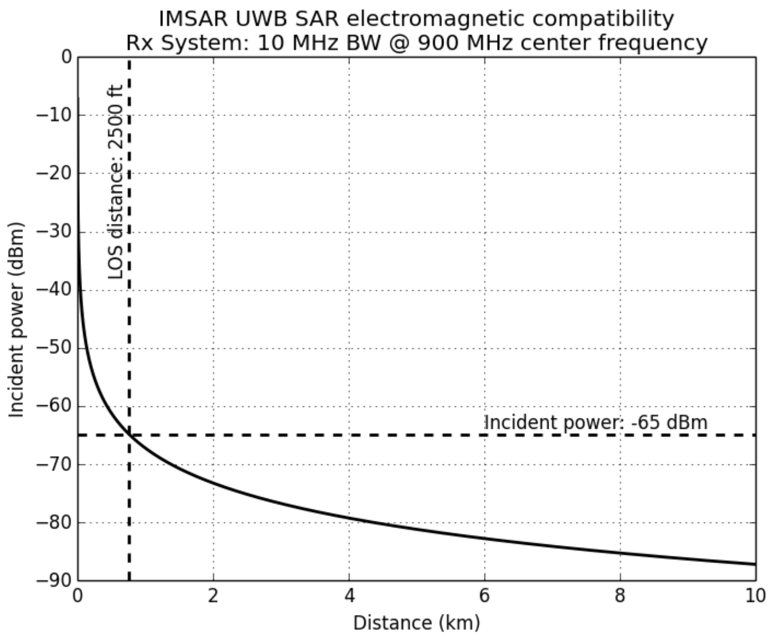

Figure 3. Power incident at a receiver as a function of distance from the UHF radar.

The results of Figure 3 were obtained using the following calculations.

Definitions

rr	ramp rate (Hz/sec)
duty	transmitter duty cycle
B_{Tx}	transmitter bandwidth (Hz)
B_{Rx}	receiver bandwidth (Hz)
P_{Tx}	transmit power (W)
P_{Rx}	receiver power (W)
G_A	transmit antenna gain (linear)
PRF	pulse repetition frequency (Hz)
freq	receiver frequency (Hz)
dist	distance to receiver (m)
FSPL	free space path loss
λ	wavelength (c/freq, where c is speed of light 3e8)

Equations

$$\mathrm{rr} = \frac{\mathrm{B_{Tx}\,PRF}}{\mathrm{duty}}$$

$$\mathrm{FSPL} = \left(\frac{4\pi\,\mathrm{dist}}{\lambda}\right)^2 = 20\log_{10}(\mathrm{dist} * \mathrm{freq}) + 20\log_{10}(4\pi c)$$

$$\mathrm{P_{Rx}} = \frac{\mathrm{B_{Rx}\,P_{Tx}\,PRF\,G_A}}{16\,\mathrm{rr}}\left(\frac{c}{\pi\,\mathrm{dist\,freq}}\right)^2$$

Example

duty	0.63
B_{Tx}	560 MHz (covering 400-960 MHz)
P_T	6 W
G_A	4
PRF	1000 Hz

For a receiver with 10 MHz bandwidth centered on 900 MHz, at 762.2 m (2500 ft) from the transmitter, the power level incident at the receiver is calculated to be 320 pW, or -65 dBm.