

EXHIBIT 1

Submitted by Wavetronix, LLC

(a) The program of research and experimentation consists of the design, construction, and evaluation of an X-band FMCW (chirp) sensor capable of monitoring and recording vehicular traffic patterns. The data obtained can be used to control traffic flow and also provide driver information.

Using printed circuit board technology the complete sensor, including the associated antennas, will be housed in a single weatherproof polycarbonate box mounted on existing roadside and intersection poles. The sensor will be about 3"x12"x12". Mounting will be by pole banding in accordance with present transportation department practice. Power for the unit will be a rechargeable battery in close proximity to the sensor and connected by a weatherproof cable assembly. Since the sensors are pole mounted they are classified as non-invasive. Figure 1 illustrates the proposed experimental deployment with the antenna pattern and nominal sensor coverage (not to scale).

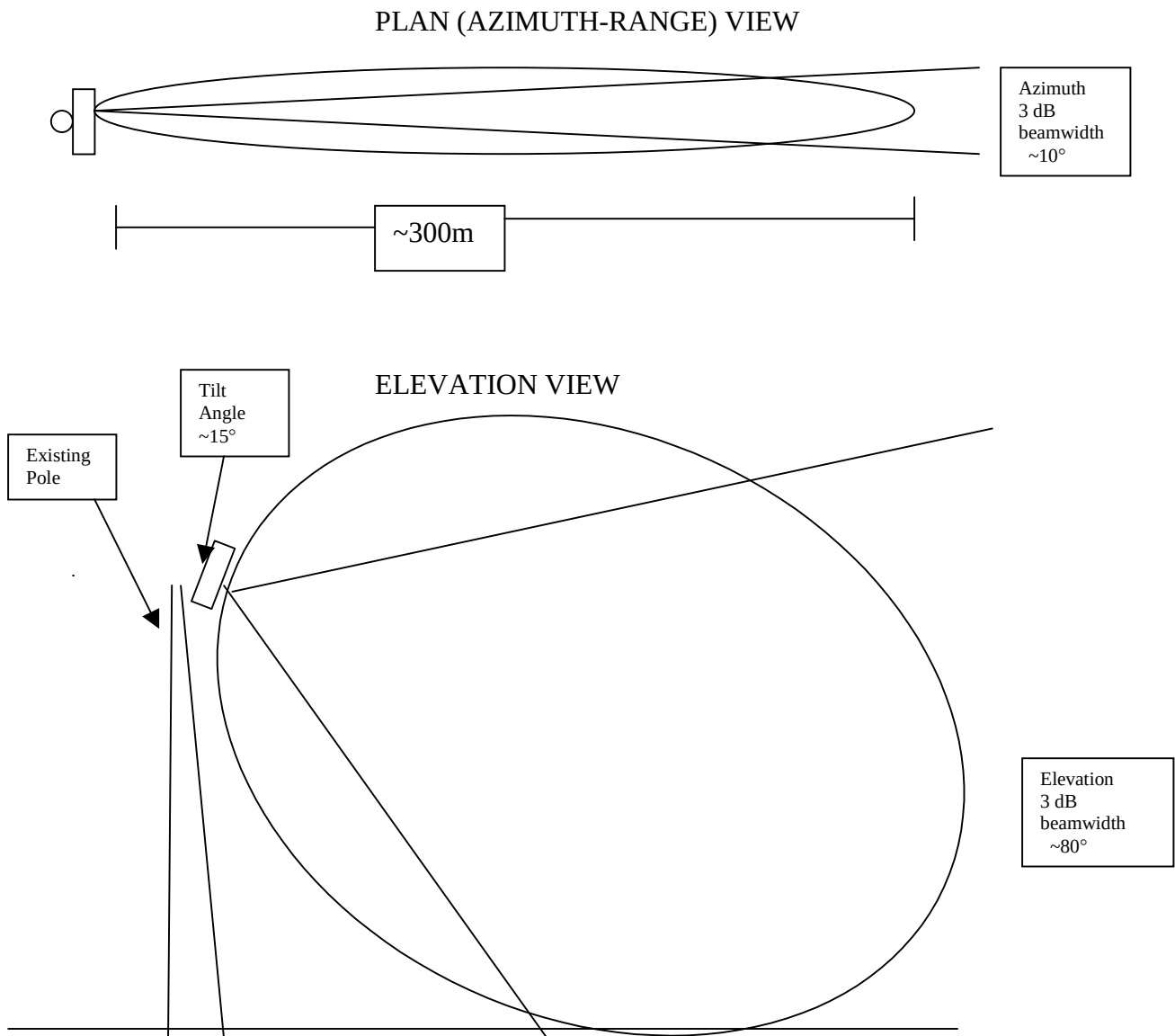


Fig. 1

The transmitted signals for both FXN and D9D transmissions will have a periodic chirp (FMCW) variation approximately as shown in Figure 2, extending over a time interval of about 3 ms as indicated. The D3D signal will also have an amplitude code component used primarily for telemetry on a particular sensor.

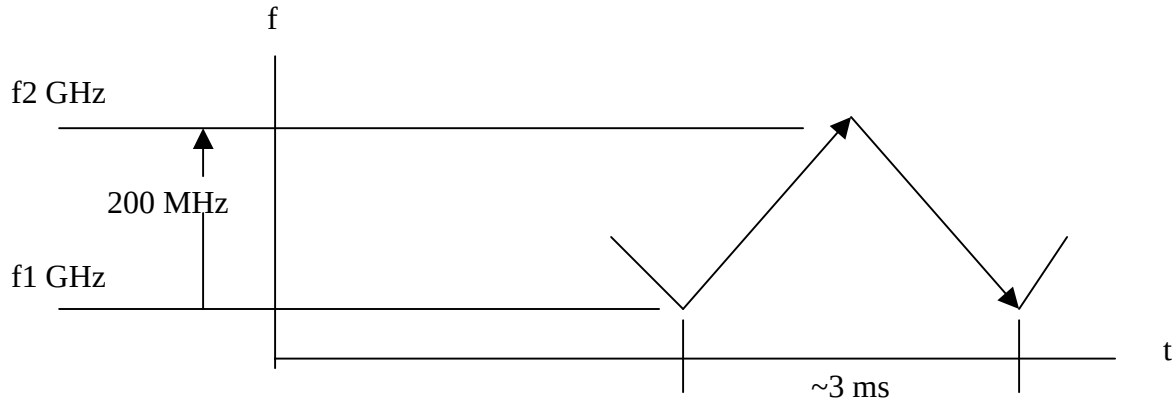


Fig. 2

Due to the small fractional deviation of the FM (less than 2%) over a time interval very long compared with the carrier period, the spectral distribution is that shown in Figure 3. Since the power transmitted is less than 10 mW over a 200 MHz band, the power per hertz is correspondingly very small.

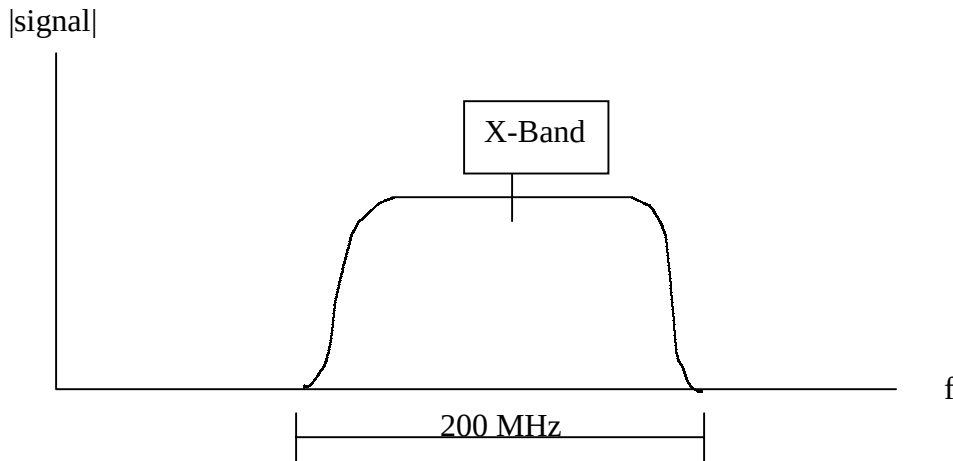


Fig. 3

The theory of a linear FMCW (chirp) system is based on the relationship between the transmitted chirp and the delayed chirp returned from a reflecting object. The primary use of this relationship is to determine the range of the object. The theoretical relationship used to determine range can be derived using the time-frequency diagram of Figure 4, where the up-chirp component (increasing frequency) is indicated.

The parameters in the figure are:

B =chirp bandwidth, Hz
 τ =round trip delay time of return chirp, s
 f_d =difference frequency between transmitted and received chirps, Hz
 R =range to object, m
 c =speed of light, m/s
 f_o =unmodulated carrier frequency, Hz
 k =chirp rate of rise, Hz/s = B/T
 T =chirp interval

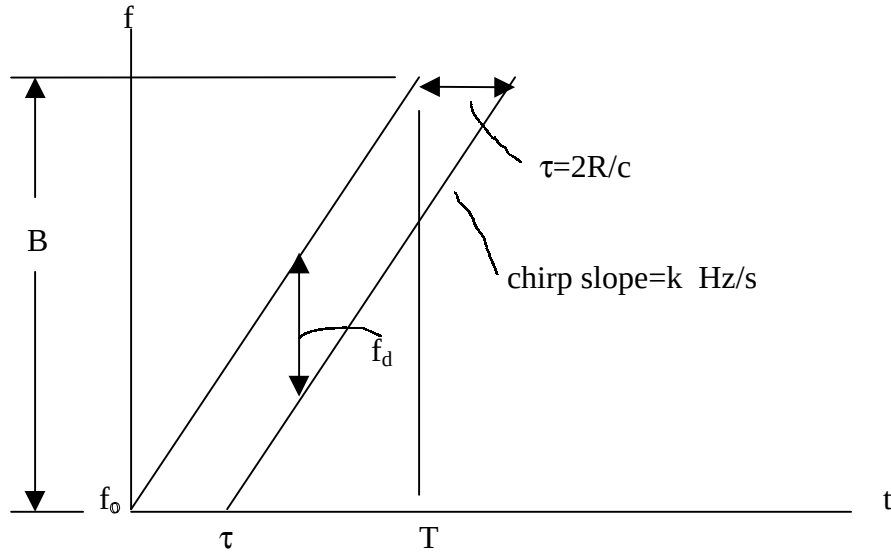


Fig. 4

At time τ the frequency of the transmitted chirp is $f_o + k\tau$. Thus, the difference frequency between the transmitted and received chirps is obtained as:

$$f_d = (f_o + k\tau) - f_o = k\tau = (B/T)\tau = (B/T)(2R/c) = (2BR)/(cT)$$

A difference frequency can be obtained by mixing the transmitted chirp with the received chirp and appropriate filtering. From the equation above the range can then be computed using

$$R = cTf_d/2B$$

The experimental portion of the program will involve deploying several sensors at typical highway and intersection configurations where camera and loop detectors are already installed. This will allow comparison and evaluation of performance characteristics. The effects of chirp bandwidth on sensor accuracy and precision will be investigated.

- (b) Specific objectives sought from a series of experiments are:
 - (1). Optimum (minimum) required bandwidth for a desired traffic characterization, including resolution, precision, and accuracy.
 - (2). Required transmitted power levels for given range and traffic configurations.
 - (3). Chirp linearity requirement.
 - (4). Data storage requirements and possible data transmission to interested parties.
- (c) Contributions of the experiments should include:
 - (1). Determination of a minimum bandwidth for required sensing objectives.
 - (2). Determination of a minimum power level for given sensor region configuration.