1. SUMMARY

Telephonics/SEG are applying for an FCC Special Temporary Authority (STA) Experimental License in order to demonstrate a foliage penetration radar prototype to the [REDACTED] during the week of February 2nd 2015.

Demonstration is in response to [REDACTED]

The system operates with the following parameters:

- Center frequency 250 MHz, 50 MHz bandwidth
- Average transmit power 1.6W, Peak transmit power 50W
- [REDACTED] dBi gain directional antenna
- Emitter designation: 50M0Q1N

The following precautions have been made to prevent potential interference:

- Pulsed radar, not a CW radar, and, so very low duty cycle [REDACTED]
- Power spread over a 50 MHz bandwidth
  - Narrowband operations only see a fraction of the total power
- Frequency notching of transmitted waveform
  - [REDACTED]
- Directional antenna limits zone of potential influence
  - [REDACTED]
- Test location (29°59'17.83"N,82° 0'44.49"W) is in a remote densely wooded location 5 km from nearest active airport (Camp Blanding Aaf/Ng)
  - [REDACTED]
  - [REDACTED]
- Horizontally polarized, so cross-polarization loss to other in-band systems

2. RADAR CHARACTERISTICS

2.1 GENERAL

The radar has the characteristics shown in Table 2-1.

Table 2-1. Radar Characteristics

[REDACTED]

2.2 ANTENNA

The radar employs a [REDACTED] MHz horizontally polarized log-periodic antenna with [REDACTED] dBi of gain as depicted in Figure 1a. With a horizontal beamwidth of [REDACTED] degrees, vertical beamwidth of [REDACTED] degrees and a front-to-back ratio exceeding [REDACTED] dB emissions can be constrained in direction.

[REDACTED]

Figure 1 a) FPSTR-1 log-periodic antenna on telescoping mast, b) Measured antenna pattern in the horizontal plane

2.3 ANTENNA POINTING

The antenna can be scanned in azimuth to cover sectors sizes of [REDACTED] degrees. For the requested STA, operation will be constrained to less than a [REDACTED] degree sector which is opposite of the angle pointing to the nearest airport (Camp Blanding Aaf/Ng).

2.4 MAST

The antenna is mounted on a telescoping mast which when extended lifts the antenna to a height of [REDACTED]. At this height, the antenna will still be far below the canopy of the surrounding forests such that emissions will be significantly attenuated by foliage.

3. ARGUMENT FOR LICENSING AS AN EXPERIMENTAL RADIATOR

3.1 OVERVIEW

This section argues that despite exceeding the power limits of current licensing regulations and its operation within the 225-328 MHz band for UHF-AM Air/Ground communications, the operation of the FPSTR-1 radar can operate concurrently with no significant interference.

3.2 PULSED-DOPPLER OPERATION

The FPSTR-1 is a pulsed Doppler radar, <u>not a CW radar,</u> and, as such its maximum duty cycle is very low [REDACTED]. The system also spreads its power over a 50 MHz bandwidth, so narrowband UHF/AM operations only see a fraction of the total power transmitted by FOPEN.

3.3 ANTENNA DIRECTIVITY

The antenna has a [REDACTED] degree azimuthal beamwidth and is configured to typically scan a sector of [REDACTED] degrees. Emissions out the backlobe and sidelobes are significantly minimized due to a front-to-back ratio greater than [REDACTED] dB and front-to-side ratio greater than [REDACTED] dB. The potential of the radar to interfere with another receiver can therefore be constrained to a [REDACTED] degree sector opposite of the nearest susceptible receiver.

3.4 POLARIZATION

The FPSTR-1 radar radiates horizontally polarized radio waves. As UHF-AM communications are vertically polarized, potential interference to these systems will experience a cross polarization loss of up to 20 dB or more.

3.5 FOLIAGE ATTENUATION

The FPSTR-1 radar is intended to be operated exclusively while embedded in dense foliage scenarios. Therefore, any interference to other radio receivers will be significantly attenuated due to foliage propagation losses. Weissberger's model is a well accepted model for the additional propagation losses due to the presence of dense foliage. The losses are computed as:

$$L_W(\mathrm{dB}) = \begin{cases} 1.33 \times f^{0.284} d_f^{0.588} & 14\,\mathrm{m} < d_f \leq 400\,\mathrm{m} \\ 0.45 \times f^{0.284} d_f & 0\,\mathrm{m} \leq d_f < 14\,\mathrm{m} \end{cases}$$

where f is the frequency in GHz, and d_f is the foliage depth in meters.

As depicted in Figure 2, potential interfering signals radiated by the FPSTR-1 will be attenuated by more than 35 dB beyond 1 kilometer.

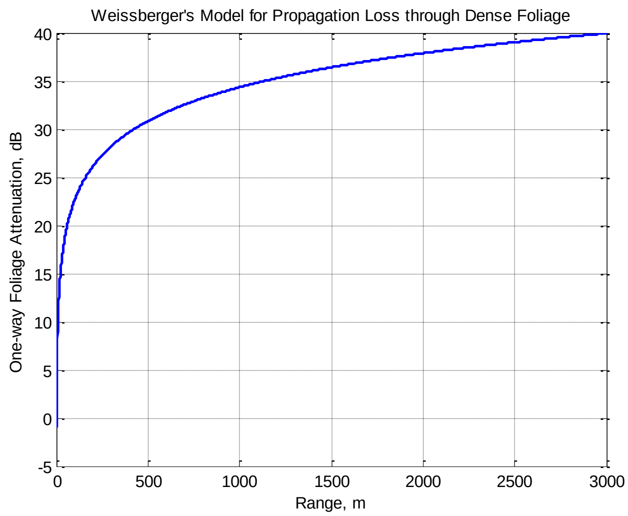

Figure 2 Weissberger's Model for Propagation Loss through Dense Foliage

3.6 FREQUENCY NOTCHING CAPABILITY

The FPSTR-1 radar is capable of notching its transmitted waveform in frequency to avoid interfering with a narrowband receiver channels. Up to [REDACTED] notch frequencies are programmable with user selectable widths and attenuations. As shown in Figure 3, a sample notch at 254.005 MHz achieves [REDACTED] dB of attenuation at the notch center frequency and [REDACTED] dB over a 25 kHz span. This allows the FPSTR-1 radar to avoid transmitting on a one or more of the locally used UHF-AM radio channels.

[REDACTED]

Figure 3 Detail of the notched waveform as measured on an omni-directional antenna and spectrum analyzer placed 6 feet from the transmitting antenna. Note the notch at 254.005 MHz is [REDACTED] dB down from the waveform's primary response.

3.7 RADIATED EMISSION LIMITS

Part 15.209 of CFR Title 47 imposes a radiated emission limit of 200 µV/m measured at 3 meters for an intentional radiator in the band of 216-960 MHz. Despite the radar exceeding these limits, emitted field strengths are minimal when considering foliage losses and frequency notching.

3.8 ESTIMATED RADIATED EMISSIONS

The estimated radiated emissions of the FPSTR-1 are presented in Table 2-1 for several scenarios. While the electric field strength in free space at 3m is exceeded, the radar is designed for exclusive operation while embedded in dense foliage, typically in remote areas. Therefore, the electric field intensity has been computed for the FPSTR-1 at a distance of [REDACTED] through foliage using Weissberger's model and at a distance of 50 nautical miles. Table 2-1 shows that the electric field intensity through [REDACTED] of foliage ([REDACTED] µV/m) is on par with the threshold. A range of [REDACTED] meters brings the field intensity within threshold.
Field intensity is calculated from peak power using the relationship of :

$$(PG)/(4\pi d^2) = (E^2)/(120\pi)$$

Or solved for field intensity:

$$E = sqrt\,(30*PG)/d$$

Where:
P = Peak power
G = Antenna gain
D = Distance from antenna in meters
E = Electric Field Intensity in V/m
120π = impedance of free space

[REDACTED]

Table 2 Estimated peak Field Strength of the FPSTR-1 radar in free space and foliage scenarios. Field strengths are listed with and without a [REDACTED] dB notch in the spectrum of the transmitted waveform.

3.9 AREA OF INFLUENCE

SEG/Telephonics is requesting an STA to operate the FPSTR-1 radar at the following location near Camp Blanding in Starke, Florida.

Latitude: 29°59'17.83"N

Longitude: 82° 0'44.49"W

Figure 4 shows the intended test location and its [REDACTED] area of operation within the red circle. Note that the surrounding area is remote and heavily wooded with very minimal infrastructure. Figure 5 shows a wider perspective of the test location and the locations of potential UHF/AM operations (airports) to be several miles away. In Table 3 distances from the test location to airports are listed. Note that even the closest airport (Camp Blanding) is 3 miles away and well beyond the radar's operational range [REDACTED].

[REDACTED]

Figure 4 Satellite image of the FPSTR-1 test location near Camp Blanding. Maximum operational range of the radar [REDACTED] shows little to no infrastructure and emissions will be constrained to the [REDACTED] degree sector opposite of Camp Blanding Aaf/Ng.

[REDACTED]

Figure 5 Potential UHF/AM operations (airports) in the region of the test location are well beyond the radar's operational range.

Airport Name	Distance from Radar site
Camp Blanding Aaf/Ng	4.97 km (3.09 mi)
Spencers Airpark	9.38 km (5.83 mi)
Keystone Heights Airport	15.94 km (9.91 mi)
Cecil Airport	28.48 km (17.7 mi)
Department of Corrections Field	33.1 km (20.6 mi)
Reynolds Airpark	33.5 km (20.8 mi)
Gainesville Regional Airport	41.52 km (25.8 mi)

Table 3 Distances from test location at Camp Blanding to surrounding airports.

3.10 EFFECTS ON OTHER OUT OF BAND SYSTEMS

3.10.1 Band Pass Filtering

The transmitted signal is analog band-pass filtered before being transmitted. The band-pass filter has greater than [REDACTED] dB stop-band attenuation at frequencies less than [REDACTED] MHz or greater than [REDACTED] MHz.

3.10.2 Antenna Frequency Response

The antenna is designed for frequencies of [REDACTED] MHz. Any frequencies emitted outside this range will be attenuated at least [REDACTED] dB.

4. CONCLUSIONS

In the request for an STA for the week of February 2nd at Camp Blanding, SEG/Telephonics have allotted for several precautions to minimize potential interference with other in-band systems. The FPSTR-1 radar is a foliage penetration radar with a maximum detection range of less than [REDACTED] through dense woods. The requested test location (29°59'17.83"N, 82° 0'44.49"W) is a very remote area with minimal infrastructure and the operation of UHF/AM communications in the immediate area is unlikely. SEG/Telephonics are requesting that the FAA/FCC restrict its interference search range to a [REDACTED] range about the test location, well beyond FOPEN detection capability in foliage. Also, consider that the antenna directivity will limit the sector of influence to approximately [REDACTED] degrees opposite of the nearest active airport, Camp Blanding Aaf/Ng. Note that radiated emissions will be directed through [REDACTED] of foliage and therefore be attenuated by more than [REDACTED] dB. Furthermore, likelihood for interference is further reduced by the radar's horizontally polarized configuration and its operation as a very low duty cycle ([REDACTED]) pulsed system. Finally, concurrent operation of the radar with UHF/AM communications is possible through inserting programmable frequency notches in the transmitted waveform to mitigate interference with narrowband receivers.

5. CONTACT INFORMATION

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