Caliola Engineering, LLC
Technical Exhibit:
Application for FCC Special Temporary Authority (STA)

Caliola Engineering, LLC is applying for a new FCC Special Temporary Authority (STA) license in support of their Small Business Innovation & Research (SBIR) Phase II effort with the StrikeLink, Topic # AFX234-DCS02. Caliola will be testing a modern HF data link capability between Colorado Springs, CO and Denver, CO.

Background

The Air Force Global Strike Command's (AFGSC) ability to offer survivable connectivity worldwide in a near-peer threat environment when SATCOM is denied not guaranteed. In this SBIR, Caliola in collaboration with AFGSC is developing an innovative, multicarrier High Frequency (HF) system that will form the foundation for LPx data link. To demonstrate the HF system capability as a reliable LPx data link, we have designed a multicarrier communication protocol and algorithms and implemented the design using Software Defined Radio (SDR) platform with commercial off-the-shelf (COTS) RF front-end and antennas.

Near Vertical Incident Skywave (NVIS) HF over-the-horizon communication test will be used to validate results obtained from our extensive modeling and simulation (M&S) and bench test and demonstrate HF data link performance in ionospheric channel.

Objective

The goal of the over-the-horizon field test is to validate the multicarrier HF waveform performance in actual ionospheric channel against M&S prediction and bench test measured data. We will perform HF filed test using representative set of waveform configurations covering possible link budget, range, and sunspot time to validate the multicarrier data link spectral efficiency.

One of the primary features of our waveform design to be validated is its capability to adapt to channel environment by dynamically selecting optimal mode for reliable operation and as such, the instantaneous channel bandwidth and the multicarrier operational frequency will vary according to the system configuration within the available range of coding, modulation, and frequency.

The transmitted multicarrier signal will occupy at most 48 kHz instantaneous bandwidth potentially non-contiguously across a configurable set of 16 carriers each with signal bandwidth ranging of 3 kHz. The carriers will be spread across a maximum 400 kHz band.

The operational High Frequency (HF) band will be between 4.0 MHz and 12.2 MHz from the locations in Colorado Springs, CO from April 1, 2023, to June 1, 2023. (Note: Our multi-carrier system is power and frequency agile. We plan to observe local and remote spectrum occupancy and transmit on the least likely occupied sub-channels with minimum power to satisfy performance requirements to minimize potential interference.) We will also perform ionospheric sounding for channel characterization using similar interference avoidance procedures.

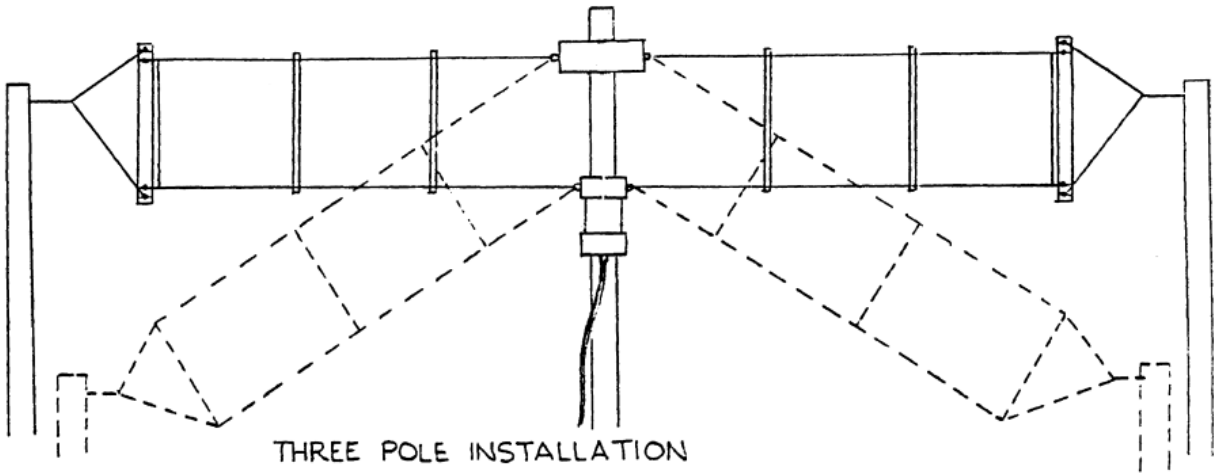
The requested frequencies and transmission operational parameters are those permitted under Section 90.266 of the Commission's Rules, Long Distance Communications on Frequencies below 25 MHz and are identified specifically in the FCC's Electronic Code of Federal Regulations, Title 47 (Telecommunication), Volume 1, Chapter 1, Part 2.106 Table of Frequency Allocations. These frequencies bands requested are designed to avoid the Restricted Bands of Operation outlines in the Electronic Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices), Subpart C Intentional Radiators.

Listed in the following Table (1a) are the requested proposed technical parameters for this Small Business Innovation & Research program.

Transmit Antenna	
Transmit Site Locations	**Transmitter Site #1**
	1045 Elkton Dr.
	Colorado Springs, CO 80907
	38° 53' 55.8" N, - 104° 50' 40.3" W (38.89883°, -104.8445°)
	Antennal Radiation Center: 19 ft AGL
	Antenna Azimuth Orientation: omnidirectional
	Transmit antenna Vertical Plane orientation: horizontal
Requested Frequency ranges (MHz)	4.000 – 4.100, 5.005 – 6.210, 6.320 – 8.250, 10.005 – 10.100, 11.400 – 12.200
Maximum Transmit Power	1 kW peak (average varies between 50 W and 500 W)
Transmitter	Ettus USRP N210 Software Defined Radio
Transmitting Antenna	Dipole from Barker & Williamson Model # BWDS-90N (see Figure 1)
Maximum Occupied Bandwidth	48 kHz non-contiguous (vary from 3 kHz to 48 kHz).
Maximum Transmit Time Duration (Duty)	Most Experiment will be conducted during the daytime hours. Active transmissions for 1 – 10 minute intervals, 50% avg duty cycle.

Table 1 Proposed Transmission Antenna Parameters

The test site antenna configuration and dimension are shown in Figure 1 below.



Antenna Installed: INVERTED "V" AS SHOWN IN BROKEN LINES

Figure 1 Folded Dipole antenna (19 ft AGL)

The antenna at test site is located on the rooftop of one-story building at approximate elevation of 14ft with antenna gain of 0 dBi. The shallow inverted "V" raises the antenna radiation center to maximum height of 19 ft.

While Caliola designed the transmit and receive systems, some of the equipment are purchased from commercial vendors. Table 2 shows a list of the commercially purchased equipment that will be used during testing.

Table 2. Commercially purchased transmission equipment list.

Transmitting Equipment			
Manufacturer	**Model Number**	**No. of Units**	**Experimental (Y/N)**
Ettus USRP	N210	1	N
Electronics & Innovation	A100	1	N
Electronics & Innovation	A150	1	N

This Small Business Innovation & Research Contribution to the Development of the Radio Art

In this SBIR, Caliola is developing an innovative, multicarrier WBHF data link that will form the foundation for HF link that could be deployed at scale as a dependable LPx communication system.

Caliola's work will demonstrate an approach to addressing critical communications capability as a reliable LPx communication system through the application of adaptive multicarrier HF link.

If there are any technical questions with the proposed application, please contact one of the undersigned.

Newfel Seman
Caliola Engineering LLC
11372 Village Ridge Rd
San Diego, CA 92131
(858-735-6802)

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Vlad Fomitchev
Caliola Engineering LLC
4750 Ramblewood Dr.
Colorado Springs, CO 80920
(814-777-5138)

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