Radar Development and Testing on Government Contract

RE: Antenna Registration Q4: Directional Antenna Information, Exhibit
File Number: 0550-EX-CN-2019
Confirmation Number: EL675086
Date: July 10, 2019

Experiment Overview

Systems & Technology Research (STR) is leading efforts on the DARPA radar development project called "Radar Net." We are supporting a Phase 2 development effort.

This phase will involve performance testing of our radar system. A maximum of two aircraft will be outfitted with systems and simultaneously operating in the same region with identical radar equipment. Both systems will employ identically constructed phased array antennas. Refer to file number 0935-EX-CN-2018 for more information on the radar systems.

To support this effort, we require multi-node data communications between two aircraft and two ground-based nodes. The aircraft will contain the radar systems, and telemetry and position data will be shared between the systems and the ground nodes using MANET data radios made by Trellisware, Inc.

We require a minimum of 10 MHz bandwidth centered at 2.39GHz, and AFTRCC coordination has been obtained for a 10 MHz bandwidth centered at 2.39 GHz. Our request reflects this coordinated result.

This effort will be expected to begin in July, 2019, and extend for up to 24 months or contract end.

For all computations we consider the highest desired bandwidth and ERP of the systems.

Antenna Parameters:

We are asking to use several systems, each outfitted with antennas.

The two airborne systems will be outfitted with vertical polarized omni-directional azimuthal antennas. These are Haigh-Farr 6130-6 blade antennas, rated between 2.20 – 2.50 GHz. The antenna will be mounted to the bottom of the aircraft. The gains are approximately 0dBi in azimuth, and between -5 dBi and +5 dBi for elevations between the horizon and the ground, with a peak of +5 dBi at a 20° depression angle between the horizon and ground. The datasheet with the corresponding antenna patterns for this antenna is attached.

There will be a ground-based receiver/transmitter outfitted with a sectoral antenna. This is to enable high data rate data communications between the airborne platforms that are between 10 - 40 km away from this antenna. The antenna selected is a Laird SA24-120-16-WB. It has a 120° azimuth and 9° elevation 3 dB beamwidth. It will be mounted to a temporary tripod/mast, of up to 6m (18 ft) in height, the objective being to get above any treeline obstructions and maintain line of sight to the aircraft. The boresight elevation angle from the horizon will be manually raised between 6.5° - 11.5° to support an aircraft flight envelope between 2.0° and 15.3° during testing. Any use near proximity to airports will comply with FAA and local airport regulations for proximity (and therefore height) to their facility.

Additionally, a second ground-based antenna will be utilized. It will use a vertically polarized, 360° omnidirectional azimuth whip halfwave dipole antenna, Trellisware TW-1161, with a 1 dBi maximum gain, between 675– 2600 MHz. The vertical beamwidth is 70° - 90° depending on frequency. It will be mounted to a temporary tripod/mast, of up to 6m (18 ft) in height, the objective being to get above any treeline obstructions and maintain line of sight to the other ground node. The data for this antenna is provided in the Trellisware DD-1494 appendix, page 11.

Connected to each antenna is a MANET data radio made by Trellisware, model TW-950. These are tunable radios, with a maximum transmit power of 2W. The modulation waveform is a CPM waveform. The Trellisware DD-1494 for this system is also submitted with this application.

Power Parameters:

The MANET radio's peak transmit power is 2 Watts.

For the airborne antenna, the maximum transmit gain is 5 dB, therefore the peak ERP is 2 * 3.16 = 6.3W.

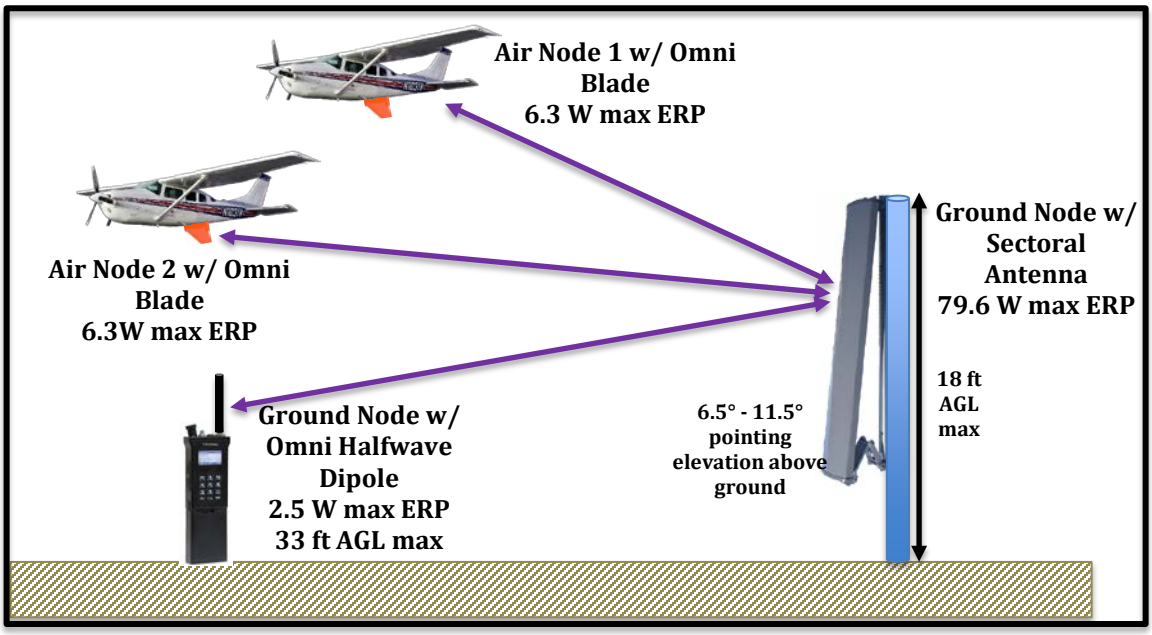
For the ground based node with sectoral antenna, the maximum transmit gain is 16 dB, or a factor of 39.8, therefore the peak ERP is 2 * 39.8 = 79.6 W.

For the ground based node with halfwave dipole antenna, the maximum transmit gain is 1 dB, or a factor of 1.26, therefore the peak ERP is 2 * 1.26 = 2.5 W.

Operations / Flight Routes:

Flights are currently planned for the Boston, MA area primarily near Lawrence, MA (KWLM) but at times extending south to operations near Cape Cod CGAS (KFMH) and north to Portsmouth Intl (KPSM). These flight operations will occur not continuously, but rather as discrete test events during the execution of the contract.

A nominal flight altitude of 8500 ft MSL is planned, but could vary from 4500 ft to 9,000 ft MSL depending on weather conditions and VMC minimum requirements.



BLADE ANTENNAS

The Haigh-Farr family of rugged Blade antennas is available in frequencies ranging from UHF to upper C-band, and may be provided in either straight or rounded blade configurations.

These blade antennas exhibit quasi-uniform null-free hemispherical patterns.

These antennas have demonstrated proven reliability in over 30 years of high-performance airborne applications.

Blade antennas are also used extensively in ground-based vehicles such as race cars, trucks, tanks, and motorcycles, to name a few.

FEATURES:

- **Hemispherical Coverage** (see patterns on next pages)
- **Frequencies from UHF to C-Band**
- **Small, Compact Footprint**
- **Aerodynamic Design**
- **Common Footprint for All Models**
- **Built to Withstand Extreme Shock & Vibration Environments**

APPLICATIONS:

- **Data Links, Telemetry, Transponder**
- **Aircraft**
- **UAVs**
- **Helicopters**
- **Tactical Missiles**
- **Ships**
- **Ground-Based Vehicles**
- **Single or Array Implementations with Matching Power Dividers and Cables**

DESIGN CAPABILITY:

Haigh-Farr has more than 50 years history of designing and producing exceptionally rugged, high- performance antennas. If you don't find an antenna meeting your requirements in our standard list of products, Haigh-Farr has the experience and modeling capability to customize a solution. Adaptations of existing designs can be done with very short lead times. Contact Haigh-Farr for a review of your antenna requirements.

Rev 1 01/18 approved for release

Haigh-Farr, Inc. 43 Harvey Road, Bedford, NH 03110
sales@haigh-farr.com | 603-644-6170 | Fax: 603-644-6190

BLADE ANTENNAS

Round Blade P/N	Straight Blade P/N	Frequency Range GHz	VSWR MAX/TYPICAL	5KW[1] ALTITUDE	PEAK[2] POWER	Height Inches [mm]	Weight (SMA) OZ [grams]
6107	6007	1.060 ± .030	2.0:1/1.50:1	116	160 W	2.30 [58.4]	1.0 [28.3]
6108	6008	0.9165 ± .025	2.0:1/1.50:1	116	160 W	2.30 [58.4]	1.0 [28.3]
6109	6009	1.35 – 1.54	2.0:1/1.50:1	116	160 W	1.75 [44.3]	0.9 [26]
6110	6010	1.43 – 1.54	1.5:1/1.25:1	116	160 W	1.68 [42.7]	0.8 [23]
6110-2	6010-2	1.425 – 1.525	1.5:1/1.25:1	116	160 W	1.68 [42.7]	0.8 [23]
6110-3	6010-3	1.45 – 1.65	2.0:1/1.50:1	116	160 W	1.68 [42.7]	0.8 [23]
6110-4	6010-4	1.50 – 1.80	2.0:1/1.50:1	116	160 W	1.68 [42.7]	0.8 [23]
6115	6015	1.60 – 1.70	1.5:1/1.25:1	116	160 W	1.54 [39.1]	0.8 [23]
6120	6020	1.71 – 1.85	1.5:1/1.25:1	114	240 W	1.45 [36.8]	0.8 [23]
6125	6025	2.00 – 2.10	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6125-1	6025-1	2.00 – 2.30	2.0:1/1.50:1	110	350 W	1.19 [30.2]	0.7 [20]
6130	6030	2.20 – 2.30	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6130-1	6030-1	2.30 – 2.40	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6130-2	6030-2	2.40 – 2.50	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6130-3	6030-3	2.20 – 2.40	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6130-4	6030-4	2.30 – 2.50	1.5:1/1.25:1	110	350 W	1.19 [30.2]	0.7 [20]
6130-6	6030-6	2.20 – 2.50	1.75:1/1.50:1	110	350 W	1.19 [30.2]	0.7 [20]
6135-1	6035-1	3.10 – 3.30	1.5:1/1.25:1	106	350 W	1.19 [30.2]	0.7 [20]
6135-2	6035-2	3.45 – 3.55	1.5:1/1.25:1	106	350 W	1.19 [30.2]	0.7 [20]
6135-3	6035-3	3.65 – 3.85	1.5:1/1.25:1	106	350 W	1.19 [30.2]	0.7 [20]
6140	6040	4.50 – 5.00	1.5:1/1.25:1	104	1.5 kW	0.90 [22.9]	0.6 [17]
6140-1	6040-1	4.40 – 5.50	1.5:1/1.25:1	104	1.5 kW	0.90 [22.9]	0.6 [17]
6150	6050	5.40 – 5.90	1.5:1/1.25:1	102	2.2 kW	0.75 [19.1]	0.6 [17]
6150-1	6050-1	5.25 – 5.85	1.5:1/1.25:1	102	2.2 kW	0.75 [19.1]	0.6 [17]
6150-2	6050-2	6.40 – 6.60	1.5:1/1.25:1	102	2.2 kW	0.75 [19.1]	0.6 [17]
6150-3	6050-3	6.40 – 7.20	1.5:1/1.25:1	102	2.2 kW	0.75 [19.1]	0.6 [17]

- **Thermal environments: -50°C to 150°C; 300°C Transient**
- **Polarization: Linear, predominately vertical**
- **Connector: SMA (50 Ω Standard; TNC (50 Ω Optional)**
- **Required Mounting Screws: 82° Flathead #4 Standard; 100° Flathead #4 or M3 optional**
- **UHF models are available in different configurations**
- **Mechanical outline drawings are available upon request**

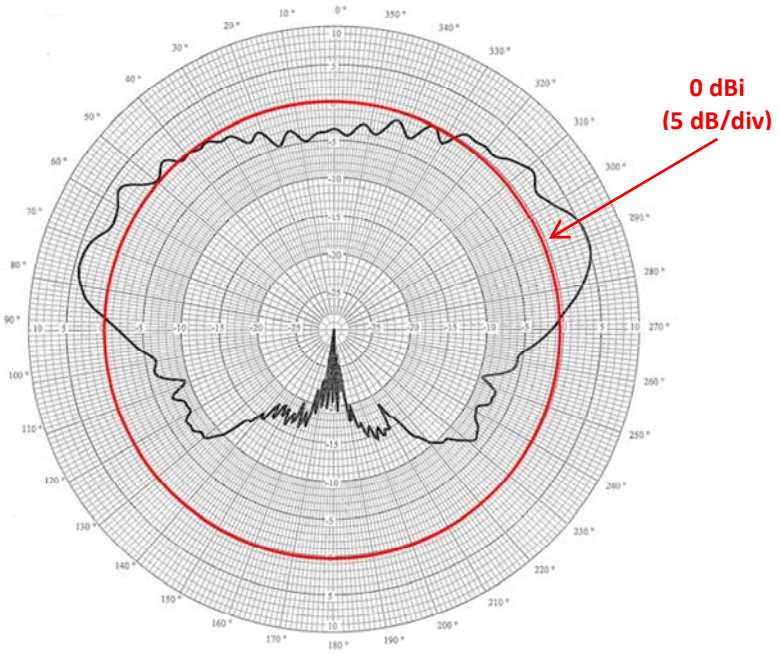
[1] The 5kW altitude (k ft) is the approximate altitude at which the antenna will experience external corona with 5kW peak power.

[2] Peak power indicates the maximum power that may be radiated without experiencing external corona at any altitude. Sufficient airflow is required at the higher power levels. These antennas handle average power in the 25-30W CW range but sufficient airflow is required at these higher power levels for the antennas to perform properly. A static ground test will not provide the adequate airflow required. Haigh-Farr offers both a 60XX and 61XX High Power version of all the above listed blades. These are manufactured with Ultem material and have been tested at 100W CW at 70°C for 60 minutes without any issues.

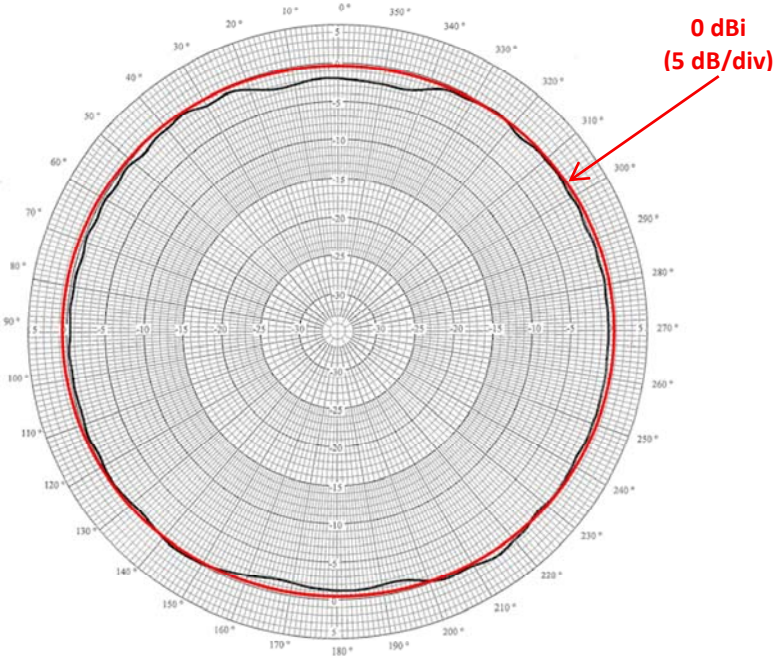
Note: Haigh-Farr Rounded Blades (61XX) are identical in performance to our Straight Blades (60XX). We recommend the use of Round Blades for applications where safety concerns exist.

Rev 1 01/18 approved for release

Haigh-Farr, Inc. 43 Harvey Road, Bedford, NH 03110
sales@haigh-farr.com | 603-644-6170 | Fax: 603-644-6190



ELEVATION (PITCH)
2.250 GHz



AZIMUTH (YAW)
2.250 GHz

Note: The patterns shown above were measured with model 6130 on a cylindrical ground plane but are typical of the other Blades used. Fins and other protrusions on the vehicle will perturb the radiation pattern. The extent of any perturbations cannot be fully determined until radiation patterns are either calculated or measured on a model of the vehicle. Haigh-Farr offers engineering services, which include the calculation of radiation patterns on a specific vehicle.

Haigh-Farr, Inc. 43 Harvey Road, Bedford, NH 03110
sales@haigh-farr.com | 603-644-6170 | Fax: 603-644-6190

Laird™

Smart Technology. Delivered.™

SA24WB
Vertically Polarized Sector Antennas

2300-2700 MHZ VERTICALLY POLARIZED BASE STATION SECTOR ANTENNA

The 60deg, 90deg and 120deg vertically polarized base station sector antenna systems offered by Laird Technologies are constructed of UV stable fiber glass radomes. The 45deg sector has a UV Stable ASA plastic radome. The radome construction gives long service life under the most demanding conditions. The antennas are constructed using corrosion resistant metal elements and a unique air dielectric system which are more stable than PCB based antenna systems because they don't absorb moisture, which can degrade the performance of PCB based antenna systems. The sectors come with a stainless steel scissor bracket mounting system for ease of installation and alignment.

FEATURES

RoHS

- Vertically polarized wide band performance
- 45, 60, 90, and 120 deg models with gains from 16dBi to 20dBi
- Type N female integrated connector
- Extremely rugged for long service life in extreme environments
- Weatherproof

MARKETS

- WiMAX applications
- Base station antennas
- 802.11b and 802.11g wireless systems
- Point to multi-point systems
- Broadband wireless access
- MMDS applications

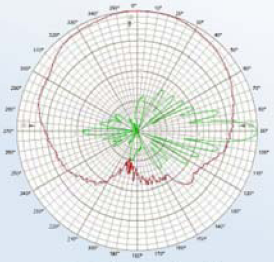
PARAMETER	SA24-45-20-WB	SA24-60-17-WB	SA24-90-17-WB	SA24-120-16-WB
Frequency range	2300 - 2700 MHz	2300 - 2700 MHz	2300 - 2700 MHz	2300 - 2700 MHz
VSWR	1.5:1	1.5:1	1.5:1	1.5:1
Impedance	50 ohm	50 ohm	50 ohm	50 ohm
Input power	50W	50W	50W	50W
Pole diameter (OD)	1"- 2" (25-50mm)	1"- 2" (25-50mm)	1"- 2" (25-50mm)	1"- 2" (25-50mm)
Temperature	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C	-40°C to +70°C
Gain	20 dBi	17 dBi	17 dBi	16 dBi
Horizontal beamwidth	45°	60°	90°	120°
Vertical beamwidth	7°	8°	7°	9°
Front-to-back	25 dB	25 dB	20 dB	21 dB
Mechanical downtilt	30°	30°	30°	30°
Weight	8.4 lbs (3.8 kg)	6.6 lbs (3 kg)	6.6 lbs (3 kg)	6.6 lbs (3 kg)
Dimensions (L x W x H)	34" x 7" x 3.5" (864 x 178 x 89mm)	33.5" x 6.5" x 2.5" (851 x 165 x 64mm)	33.5" x 6.5" x 2.5" (851 x 165 x 64mm)	33.5" x 6.5" x 2.5" (851 x 165 x 64mm)

WIND LOADING

MODEL	SQ. IN	100 MPH	125 MPH	100 MPH 1/2" RADIAL ICE
SA24 WB	247	61.8 lb	96.5 lb	62 lb

SYSTEM ORDERING

SA24-45-20-WB	45deg 20dBi 2300-2700MHz VPOL sector antenna
SA24-60-17-WB	60deg 17dBi 2300-2700MHz VPOL sector antenna
SA24-90-17-WB	90deg 17dBi 2300-2700MHz VPOL sector antenna
SA24-120-16-WB	120deg 16dBi 2300-2700MHz VPOL sector antenna



Typical azimuth and elevation pattern SA24-90-17-WB

Americas: +1.847 839.6925
IAS-AmericasSales@lairdtech.com

Europe: +44.1628.858941
IAS-EUSales@lairdtech.com

Asia:IAS-AsiaSales@lairdtech.com

Middle East & Affrica: +44.1628.858941 IAS-MEASales@lairdtech.com

www.lairdtech.com

ANT-DS-SA24WB 0716