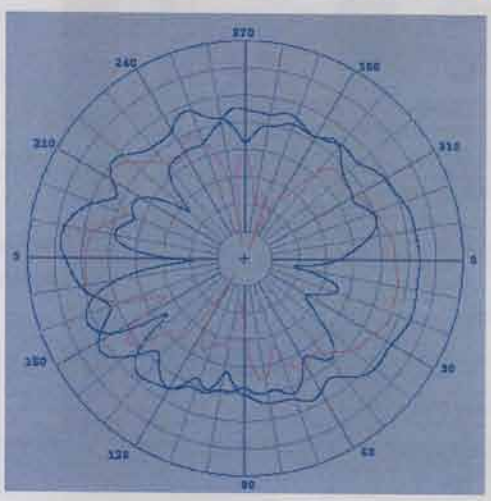
Air Force Research Laboratory

Antenna Radiation Pattern Measurements

Newport, NY



The Air Force Research Laboratory's

Newport Antenna Measurement Facility

is located 30 miles southeast of Rome, NY. The facility is split between two hilltop locations: Irish Hill and Tanner Hill. The hilltops are separated by a distance of 1.5 miles with a 400-foot deep intervening valley. These hilltops, and the facilities on them, provide the Air Force a unique 'far-field, elevated' outdoor antenna test range. The total facility consists of 78 acres with over 24,000 sq. feet of laboratory, office, maintenance, and aircraft modification space.

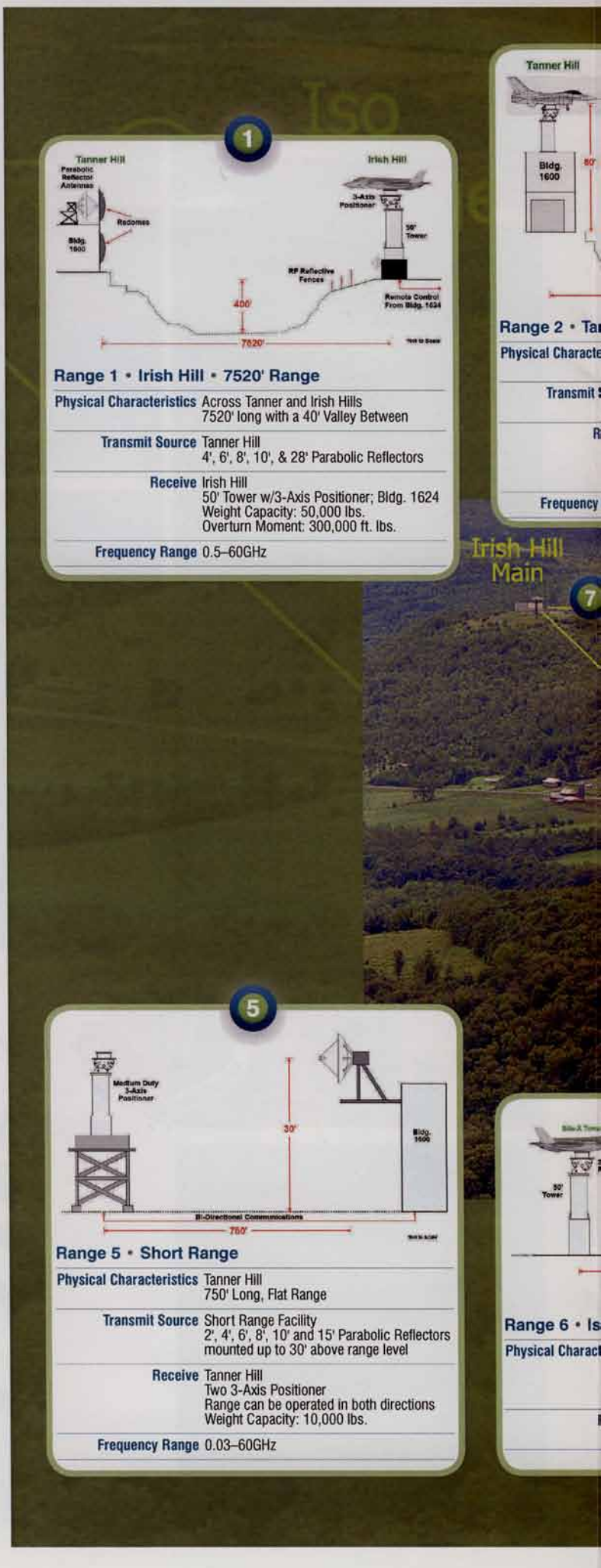
Along with antenna testing, the facility is used to develop state-of-the-art antenna measurement technologies. Specifically, AFRL has developed techniques for measuring the effects of airframe features, including external weapons, pods and tanks, on aircraft antenna radiation patterns in a simulated flight environment. The data obtained can be used to characterize antenna performance of various aircraft configurations or to optimize the antenna to achieve specific performance levels.

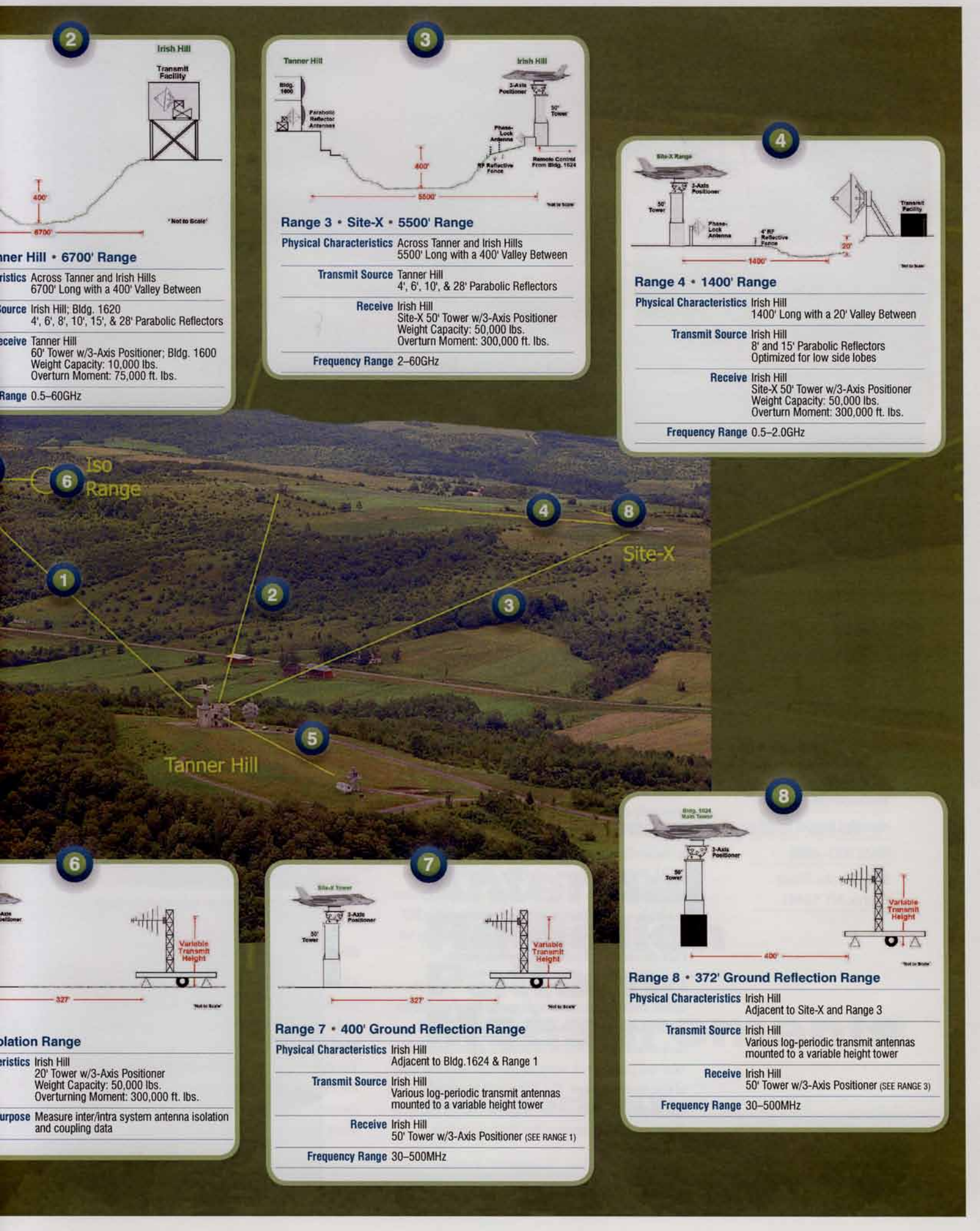
Data collected at the Newport Facility can be done for a fraction of the cost of data collected via flight testing, and because these tests are repeatable to a very high level of accuracy, comparative testing between aircraft configurations or antenna designs can easily be accomplished. The airframes which are currently available for use at the Newport site include A-10, F-16 (A/C), F-15E, F-18 (A/C, E/F), F-22, F-35 and sections of the B-1B and KC-135. Five-foot, 14-foot, and 40-foot Ground Planes are available and may be installed as required.

The Newport facility is comprised of five independent data acquisition facilities and eight measurement ranges. All ranges and both hills are interconnected with a Multi-Fiber Optic Network which interfaces to instrumentation and a high data rate link to a Wide Area Network (WAN) to AFRL at Rome, NY.

The uniqueness of the AFRL Newport Antenna Measurement Facility is the availability of the many airframes and ground planes for use in antenna pattern measurements. In addition to Engineers and Designers, AFRL has a complete facility capable of fabricating antenna mounts as well as whole airframe sections, including fuselages, wings, and tail sections. AFRL uses a FARO laser location system (a 3D measurement system with an accuracy of .001" at approximately 30') to precisely position antennas on full-sized airframes.

The eight measurement ranges are fully instrumented with signal sources, antenna, amplifiers, receivers, computers, displays, recording systems, fiber optic interfaces, positioner controllers, and high speed multiplex systems covering the frequency ranges of 50MHz to 60GHz. The ranges are typically operated with full-size airframes installed on





nner Hill • 6700' Range

ristics Across Tanner and Irish Hills
6700' Long with a 400' Valley Between

Source Irish Hill; Bldg. 1620
4', 6', 8', 10', 15', & 28' Parabolic Reflectors

eceive Tanner Hill
60' Tower w/3-Axis Positioner; Bldg. 1600
Weight Capacity: 10,000 lbs.
Overturn Moment: 75,000 ft. lbs.

Range 0.5–60GHz

Range 3 • Site-X • 5500' Range

Physical Characteristics Across Tanner and Irish Hills
5500' Long with a 400' Valley Between

Transmit Source Tanner Hill
4', 6', 10', & 28' Parabolic Reflectors

Receive Irish Hill
Site-X 50' Tower w/3-Axis Positioner
Weight Capacity: 50,000 lbs.
Overturn Moment: 300,000 ft. lbs.

Frequency Range 2–60GHz

Range 4 • 1400' Range

Physical Characteristics Irish Hill
1400' Long with a 20' Valley Between

Transmit Source Irish Hill
8' and 15' Parabolic Reflectors
Optimized for low side lobes

Receive Irish Hill
Site-X 50' Tower w/3-Axis Positioner
Weight Capacity: 50,000 lbs.
Overturn Moment: 300,000 ft. lbs.

Frequency Range 0.5–2.0GHz

olation Range

eristics Irish Hill
20' Tower w/3-Axis Positioner
Weight Capacity: 50,000 lbs.
Overturning Moment: 300,000 ft. lbs.

urpose Measure inter/intra system antenna isolation and coupling data

Range 7 • 400' Ground Reflection Range

Physical Characteristics Irish Hill
Adjacent to Bldg.1624 & Range 1

Transmit Source Irish Hill
Various log-periodic transmit antennas mounted to a variable height tower

Receive Irish Hill
50' Tower w/3-Axis Positioner (SEE RANGE 1)

Frequency Range 30–500MHz

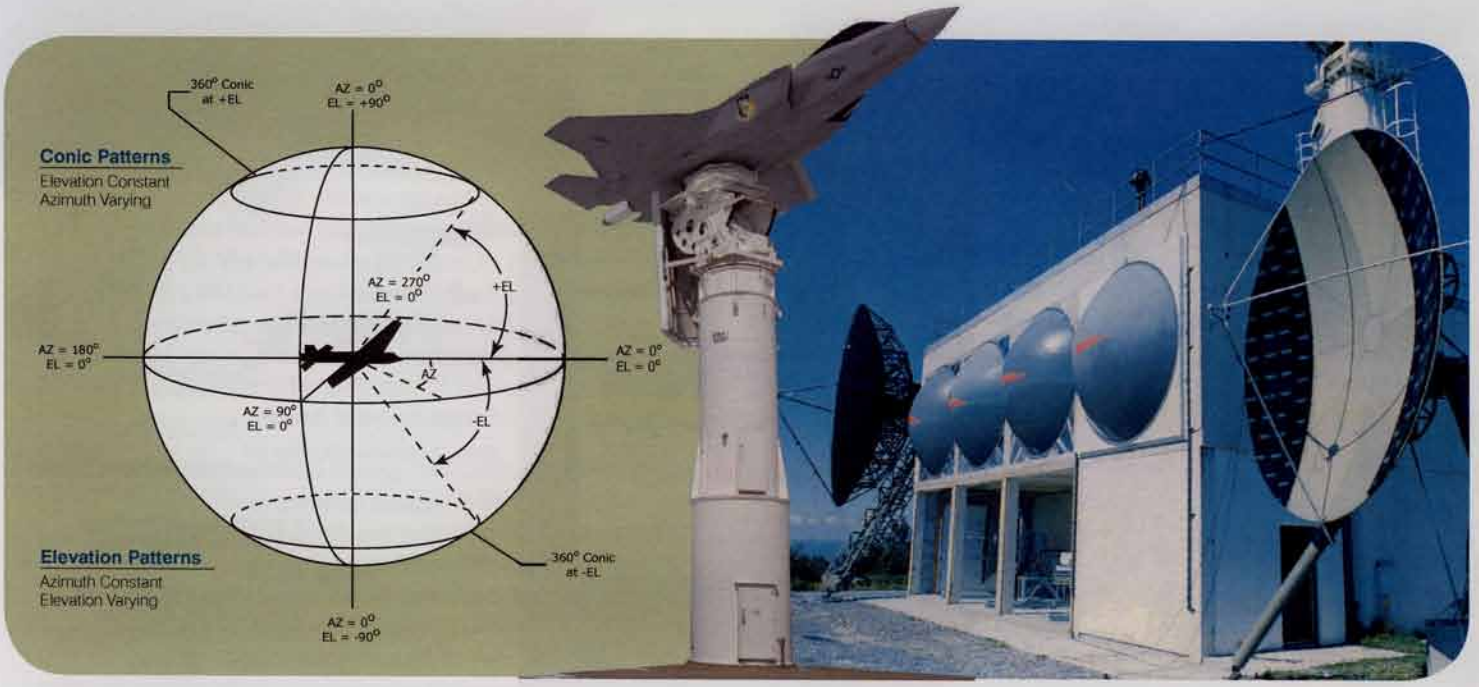
Range 8 • 372' Ground Reflection Range

Physical Characteristics Irish Hill
Adjacent to Site-X and Range 3

Transmit Source Irish Hill
Various log-periodic transmit antennas mounted to a variable height tower

Receive Irish Hill
50' Tower w/3-Axis Positioner (SEE RANGE 3)

Frequency Range 30–500MHz



special heavy-duty, high angular accuracy (±0.05°), 3-axis positioners to accurately simulate all possible flight attitudes. Measurements of antenna radiation patterns are accomplished by illuminating the airframe with a uniform RF field at frequencies of interest. The airframe, with the test antennas installed, is then rotated to produce patterns of amplitude or phase versus azimuth angle or elevation angle.

Measurement Instrumentation

A broadband Radio Frequency (RF) signal source and various RF power amplifiers are used to excite the transmit antennas for each antenna range to provide RF illumination. Selection of individual antennas (ports) is accomplished by means of a remotely controlled PIN-diode switch network located in the airframe. The RF switch network is controlled from the operator's console, via an AFRL microprocessor interface, also located in the airframe. The AFRL microprocessor interface is a high-speed, four-channel programmable RF switch controller capable of controlling up to 16 PIN-diode switches or 240 switch ports.

A Scientific Atlanta Model 1795 Microwave Receiver with an external high speed local oscillator source is located in each receive tower. The phase-lock channel derives its reference signal from the external phase-lock antenna located near the base of the receive tower. The RF signal received on the test channel is down converted to 1KHz, which is digitized by the receiver, for data recording.

Data collection is performed using a distributed control system. Mounted close to the airframe, an industrial PC is connected via a network, to PC workstations located in the operations room. The industrial PC provides the real-time interface and control for the data acquisition hardware. The PC workstations provide the user interface, data presentation, and engineering review functions. These systems can be customized through the integration of COTS or custom hardware and software to support unique measurement requirements.

Coordinate System

Measurement angles are referenced from the boresight position. They represent the angular direction to the transmitted signal with respect to the airframe. Two types of cuts are taken around the airframe with respect to this coordinate system. Conic cuts are taken by varying the azimuth angle around the airframe's yaw axis. Elevation cuts are taken vertically around an axis lying in the plane of the pitch and roll axis.

Data

All antenna pattern data is provided on CD in a standard ASCII format which is easily imported and viewed by common software applications (i.e., Matlab, Excel, Linux suite of Open Office Tools). The data is separated and categorized according to the measurements parameters. The CD contains a directory structure organizing the data in a convenient html, "browser readable" format.

For additional information contact:

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