SANDERS
A Lockheed Martin Company

January 28, 1997

Mr. Carl Huie
Federal Communications Commission
Experimental Licensing Branch
Suite 230
2000 M St. MS1300E1
Washington, DC 20554

RE: Sanders (A Lockheed Martin Company)
WA2XCT (File No. 5225-EX-PL-96)
Manchester, NH

Dear Mr. Huie:

Sanders, A Lockheed Martin Company, hereby submits its First Semiannual Progress Report to the Federal Communications Commission (FCC) on the status of its Personal Communications Service (PCS) experiments. The intent of this report is to provide the FCC with Sanders' recent PCS developmental activities and Sanders' utilization of its experimental license.

Sincerely,

Michael Prussel

1. EXECUTIVE SUMMARY

FCC experimental license WA2XCT was granted to allow experiments using the Sanders PCS-Over Cable CMI/HIC system at it's facility on 955 Perimeter Road in Manchester, NH. This report documents progress from July 15, 1996 through January 15, 1997.

The Sanders PCS-Over-Cable System provides the means to distribute wireless Personal Communication System (PCS) services over existing and future Cable TV (CATV) infrastructures. The system utilizes the Code Division Multiple Access (CDMA) spread spectrum protocol for communication. The Version 1.0 Remote Antenna Driver/Remote Antenna Signal Processor (RAD/RASP) prototype system developed in 1995 solved many of the inherent problems of RAD/RASP PCS deployment. This year's efforts have been devoted to developing and producing a system that is responsive to the new and/or refined customer requirements, which were released in June, 1996. The result of this effort was the Version 1.7 (v1.7) Cable Microcell Integrator/Headend Interface Converter (CMI/HIC) system. Progress highlights for 1996 on this effort include:

- Completion of hardware and software development, including solutions to several critical technical issues, to meet the new and refined customer requirements.
- Successful completion of v1.7 qualification testing: Design Verification Test, Environmental Qualification Test, Software Verification Test, FCC qualification, and UL certification.
- Development and release of all v1.7 drawings and specifications in preparation for production by Lockheed Martin Commercial Electronics and the Sanders NHQ facility.
- Establishment of a product support program including packaging and labeling, technical manuals, training source data, and warranty repair system.
- Production and delivery of over 1100 CMIs, 65 HICs and 30 HEE/Expansion Rack assemblies.

2. TEST SUMMARY

A. Sanders' CMI/HIC System

The following is a description of the Sanders' CMI/HIC system components:

CMI: The CMI is the interface between the cable plant and the PCS handsets, providing the frequency up-conversion from the cable plant to the handsets, as well as the frequency down-conversion from the handsets to the cable plant. A modular design approach was selected to provide factory and field testability, and on-wire serviceability for the CATV technicians. A CMI contains four modules: Transceiver, Power Amplifier, Power Supply and Power Extractor.

The v1.7 Power Amplifier and Power Supply are procured from commercial suppliers.

The Transceiver and Power Extractor designs were developed by the Telecommunications engineering staff. The Transceiver contains two circuit card assemblies (CCAs), used for upstream and downstream communications. The CCAs are installed in an Electromagnetic Interference (EMI) resisting enclosure to prevent leakage of internally-generated signals and limit susceptibility to interference from sources outside the Transceiver. The Power Extractor contains a single CCA, and it provides the interface with the cable plant for AC power and CATV/RF signals. The Power Extractor was designed to meet the stringent requirements of UL 1950. Specifications were established for several major purchased components in the transceiver and power extractor units, including synthesizers and filters.

The mechanical design of the CMI was developed to meet strict physical size and weight requirements as well as severe environmental conditions. The CMI is installed on a wire strand below the CATV cable. The unit interfaces with the CATV cable through a coupler, and with the PCS handset through one transmit and two receive diversity antennas. All interconnection hardware, cabling and antennas are provided by the customer. A two-piece hinged, cast aluminum housing with an environmental/EMI seal was selected for the CMI. The approach was selected for thermal transfer and water-tightness capability, along with low cost. The four modules within the CMI are interconnected via a wiring harness.

HIC: The HIC processes the signal received from the CMI over the cable plant and converts it into a format usable by the PCS base station. The HIC tunes the CMI's signal to an assigned CATV channel, translates the upstream CATV frequency received from the CMI to the PCS base station frequency, translates the signal received from the PCS base station to the downstream CATV frequency, and adjusts the power levels required via communication with both the HECU and the PCS base station. Each HIC is designed to provide the communications link with up to 24 CMIs in each of its three sectors.

The HIC consists of an aluminum housing with an internal CCA. Specifications were developed for many of the major components, including synthesizers, filters and power supplies. The HIC is installed in the HECU at the headend facility, with connections to/from the PCS base station and CATV headend provided by the customer.

HECU: The Headend Control Unit (HECU) is an industrial rack-mounted computer, providing the man-machine interface (MMI) to the CMI/HIC system. It is installed in a commercial 19-inch rack assembly, designated the Headend Equipment (HEE) rack. The rack also contains a 15-MHz distribution assembly for HIC timing and power distribution system, and it provides physical connection to the base station via cabling to the HICs. The rack may also contain an optional commercial power supply. The rack holds up to 14 HIC assemblies, providing control of up to 42 sectors of CMIs. The HECU with a full complement of HICs can control over 1,000 CMIs. A low-cost expansion rack, identical to the HEE rack but without a HECU, can house an additional 14 HICs per rack. The HECU can control all the HICs in one primary HEE rack and one expansion rack.

The HECU acts as a maintenance tool by monitoring the activities of the CMIs and HICs. The HECU has the ability to identify any faulty components, thereby notifying CATV plant operators where trouble has occurred and allowing them to respond and correct the problem to ensure minimal interrupted service.

The commercial computer, rack, power supply and other purchased components were selected as a cost-effective solution for providing headend command and control. The focus of the design effort was concentrated on the software developed for the HECU.

B. Test Configuration

The Manchester development facility contains a live cable plant (non-broadcasting), connected through the CMI/HIC to a Qualcomm Roving Test Set (RTS), which provides the interface with the telephony system through the local exchange carrier (LEC). A CMI assembly is installed in an open-loop configuration outside the facility on a dedicated cable strand, and hard-wired into the development lab where the HIC, HECU and RTS are located. A cable strand is also installed inside the development lab, and provides the capability to interface with several CMI and HIC units simultaneously. Several portable fixtures, capable of supporting the installation of a single CMI on a cable strand, are also available for use in specialized tests requiring open-loop operation, such as FCC and EMI tests.

C. Test Conduct

Open-loop communication from a CDMA telephone handset, through a v1.7 CMI/HIC, was first achieved during July, 1996, as part of the overall v1.7 integration and test effort. The configuration proved effective for communication in the immediate area surrounding the Sanders facility, with successful establishment of communication at ranges up to 1 km. The configuration also proved to be effective for in-building coverage at the Manchester facility.

The CMI/HIC assets installed inside the development lab were used extensively during the integration and test effort. The majority of the tests in the lab were conducted with the CMI RF output terminated with a dummy load, or attenuated to a safe level for in-lab use. The equipment was used to verify hardware and software functional operation, assist in debug and troubleshooting of problems, and demonstrate system operation to current and potential customers. The lab equipment was also utilized in the conduct of verification and qualification tests. A summary of the test efforts is as follows:

Design Verification Test (DVT): The v1.7 design verification tests were conducted from 9/2 - 9/28/96. All tests were conducted at room temperature (+25° C), as well as at operational temperature extremes of 0° and +70° C. The results of the DVT were successful.

Underwriters Laboratory (UL) Certification: By contract, the v1.7 system is required to be certified by the UL for safety in installation, maintenance and operation under UL 1950 and UL 1419. An extensive battery of tests was conducted on the v1.7 equipment in the Telecommunications lab and in the UL Northbrook, IL and Melville, NY facilities. The testing included:

- CMI, HIC and HEE input current & temperature combined
- CMI and HEE electric strength
- CMI overvoltage
- CMI rain test
- CMI immersion
- CMI hanging bracket strength
- CMI thermal cycle/electric strength
- CMI salt fog (10 day) - ground path - electric strength
- CMI CO_2/SO_2 fog (10 day) - ground path - electric strength
- CMI H_2S fog (10 day) - ground path - electric strength
- CMI gasket tests
- HEE capacitor discharge
- HEE leakage current

Following successful initial testing, the UL granted a provisional listing for the equipment on 9/27/96, allowing the v1.7 hardware to be delivered with the UL insignia on the product label. The remainder of the tests were completed on 10/15/96, and a full listing was received on 10/31/96.

Federal Communications Commission (FCC) Qualification: By contract, the v1.7 hardware is subject to Parts 15, 24 and 76 of Title 47 of the Code of Federal Regulations. To comply, FCC testing was conducted by the Sanders EMI group at the Canal Street and Merrimack test facilities, along with the Telecommunications development lab. The tests were conducted from 8/6 - 8/19/96, and the report was submitted to the FCC on 9/2/96. The equipment was approved, and an FCC grant was received on 10/21/96.

D. Conclusion

The tests conducted under the experimental license were an integral part of the development of the CMI/HIC system. The successful results of the tests, especially DVT, FCC and UL, have allowed Sanders to complete the development and fielding of the v1.7 CMI/HIC product.

3. FUTURE PLANS

Sanders will continue the refinement and improvement of the CMI/HIC product, along with incorporating changes based on industry needs. Test activity should continue throughout 1997.