# NARRATIVE STATEMENT OF MARK IV INDUSTRIES, LTD. APPLICATION FOR EXPERIMENTAL LICENSE

In this application, Mark IV Industries, Ltd. – IVHS Division ("Mark IV") requests an experimental license to continue technical research and equipment development, field testing and customer demonstration of its FCC type-accepted non-multilateration Location & Monitoring Service ("LMS") systems for toll collection and other transportation systems at facilities and locations through most of the United States, except for certain excluded regions.

Mark IV has been conducting testing under nationwide experimental license WA2XNL since 1997. Mark IV's application for renewal of this license is pending. See File 0186-EX-RR-2001. Based on advice from FCC staff, Mark IV is submitting this application for a new experimental license, which excludes specific geographic areas, but is otherwise a continuation of the testing previously authorized under the prior license. Mark IV will withdraw its request for renewal of license WA2XNL upon grant of this license, and will not operate in the excluded geographic area in the interim.

The only changes from the existing experimental license are as follows:

- Mark IV shall not conduct any testing in or near the geographic area bound as follows:

| | |
|---|---|
| **105º 30' W, 32º N** | **107º W, 32º N** |
| **105º 30' W, 34º N** | **107º W, 34º N** |

- Mark IV is reducing the ERP from 16 watts (in the existing experimental license) to 4 watts.

- Mark IV is increasing the number of LMS Tag readers from 20 to 50, plus associated transponders.

- Mark IV is updating the technical description to cover testing of TDMA technology.

## A. Program of Testing

Mark IV Industries, Ltd. ("Mark IV") is requesting this authority to continue conducting (1) experimentations; (2) research; (3) technical demonstrations; (4) field demonstrations; (5) demonstrations of equipment to prospective purchasers; (6) testing; and (7) developments of radio technique, equipment, operational data, or engineering data.

Mark IV is continuing to develop new FCC Type Accepted/Approved Transportation Infrastructure Radio Service equipment and promote its use for non-multilateration Location and Monitoring Service ("LMS") systems at toll bridge, customs and other facilities.

Mark IV's LMS systems will be operated at trade shows and other venues to demonstrate how to automatically identify vehicles and expedite their passage at toll facilities, weigh stations, border crossings, parking facilities and for other private fleet management purposes. The system consists of a reader that transmits a wake-up trigger in each lane to a Part 15 type accepted and/or unlicensed Part 90 vehicular mounted transponder, that responds with a unique identification number and other trip related data using low power transmission powered from an internal battery, or via the vehicle's battery. The equipment to be used also includes new generations of LMS tag readers developed by Mark IV IVHS to meet requirements of the northeastern E-ZPass Interagency Group and of others with similar electronic toll collection and vehicle monitoring requirements. As well, Mark IV plans field demonstrations using USDOT proposed "Sandwich Specification" compatible TDMA transponders and readers, which fall into the same device categories. Each reader unit contains RF modules and transmitters that are operated in sequential fashion to poll transponders for virtual toll ticketing and other purposes.

The operation of Mark IV's LMS systems as proposed here will contribute to the development and extension of radio technology to enhance the efficiency of use of the transportation infrastructure, improve mobility and reduce traffic congestion, enable quicker emergency incident response from public safety agencies, improve safety inspections of commercial vehicles while reducing costly weigh station and border crossing delays, reduce health care costs attributable to traffic accidents, improve the management and security of the flow of hazardous materials throughout the nation and help realize billions of dollars of gains in economic productivity.

## B. Equipment Description

A system block diagram of Mark IV's LMS system equipment is attached (Figure 1), although specific model numbers may be different than illustrated. The three main components are the transponder, the antenna, and the reader electronics. The interior transponders (Figure 2) are mounted on the vehicle's windshield, upper center behind the rear view mirror. Generally, the transponders have an internal battery sufficient to operate the transponder for 5 years, without requiring vehicular power connection. It is also possible to place an exterior transponder on the bumper for reading by the overhead antenna.

Up to 8 antennas can be operated by a single reader. The reader controller is typically mounted in an electronics equipment cabinet on the roadside or in a nearby building. The "transmitter" portion of the reader controller is known as the RF module (Figure 3), generally located in the same enclosure, although optional remote location is possible. The RF module is connected to the antenna by a low loss coaxial feedline.

Readers will be located at testing facilities such as toll booths and weigh stations. At each site, between one and eight RF modules are installed in each of the readers. In addition to the fixed reader(s), the system operation requires portable readers to program transponders, and to provide for data verification.

In the operation, the reader sends out 915.75 MHz pulses of the format and specific amplitude described below to each antenna in turn, thereby establishing an RF field in a confined stretch of each roadway lane. When a vehicle equipped with a transponder enters the field, the pulses activate the transponder and cause it to respond with a data transmission.

It should be noted that the transponder is only activated by the 20μS (microsecond) pulses of the reader field. The transponder data received by the reader in an overhead antenna is decoded for processing. If it is determined that reprogramming of the transponder is necessary, the reader sends an additional pulse stream to the transponder for this purpose.

- The modulating signal is a trigger pulse of 20μS repeated every 6 to 16 milliseconds. Data transmission is at 500 Kbps for 700μS when the transponder is being programmed by the reader.

- The necessary bandwidth of the transmission is based on the calculation below using the definition of Section 2.202(b) of the Commission's rules:

Bn = 2 K/t where K depends on pulse width to rise time ratio.
Assuming: K = 60 for 20 μS trigger pulses and K = 3 for 1 μS data (i.e.: tr = 0.33)
Then: For 20 μS trigger pulses, Bn = 2X60/20 = 6 MHz
For 1 μS data pulses, Bn = 2X3/1 = 6 MHz

The occupied bandwidth as defined in Section 2.202(a) is based on a spectrum analyzer measurement of the actual signal radiated by the system. Figure 4 is a digitized plot of the signal with a noise floor of –60 dB below the radiated peak power. The total energy was then distributed so that 0.5% was above the upper bandwidth limit and 0.5% was below the lower bandwidth limit. Improved RF modules are being installed to operate at 915.75 MHz, with a spectra shown in Figure 5. The RF modules meet the rules in Part 90, specifically 90.210(k)(2) highest emission at subband edge 55 + log (P) dB, and 90.213, Frequency Tolerance of .00025 percent (2.5 ppm). Requested peak power of 4 W (ERP), is well below the 30 watts (ERP) authorized maximum for LMS systems operating in this band. *See* 90.205(k).

## C. Justification For Broad Geographic Scope

Mark IV has had requests to consider testing its systems from a number of municipalities, government agencies, and companies around the country. Cooperation and collaboration with these entities is essential for commercial deployment of automated tolling systems. These entities often require on-site demonstrations to gain familiarity with equipment compatibility, functionality on their systems, and the range of potential uses which they can serve. This large area license (covering most of the U.S.) would be more efficient for the FCC staff than having Mark IV file numerous duplicative STA requests, in which the only substantive difference would be the location of the testing.

Vapor

# ROADCHECK™

Automatic Vehicle Identification Equipment

## System Block Diagram

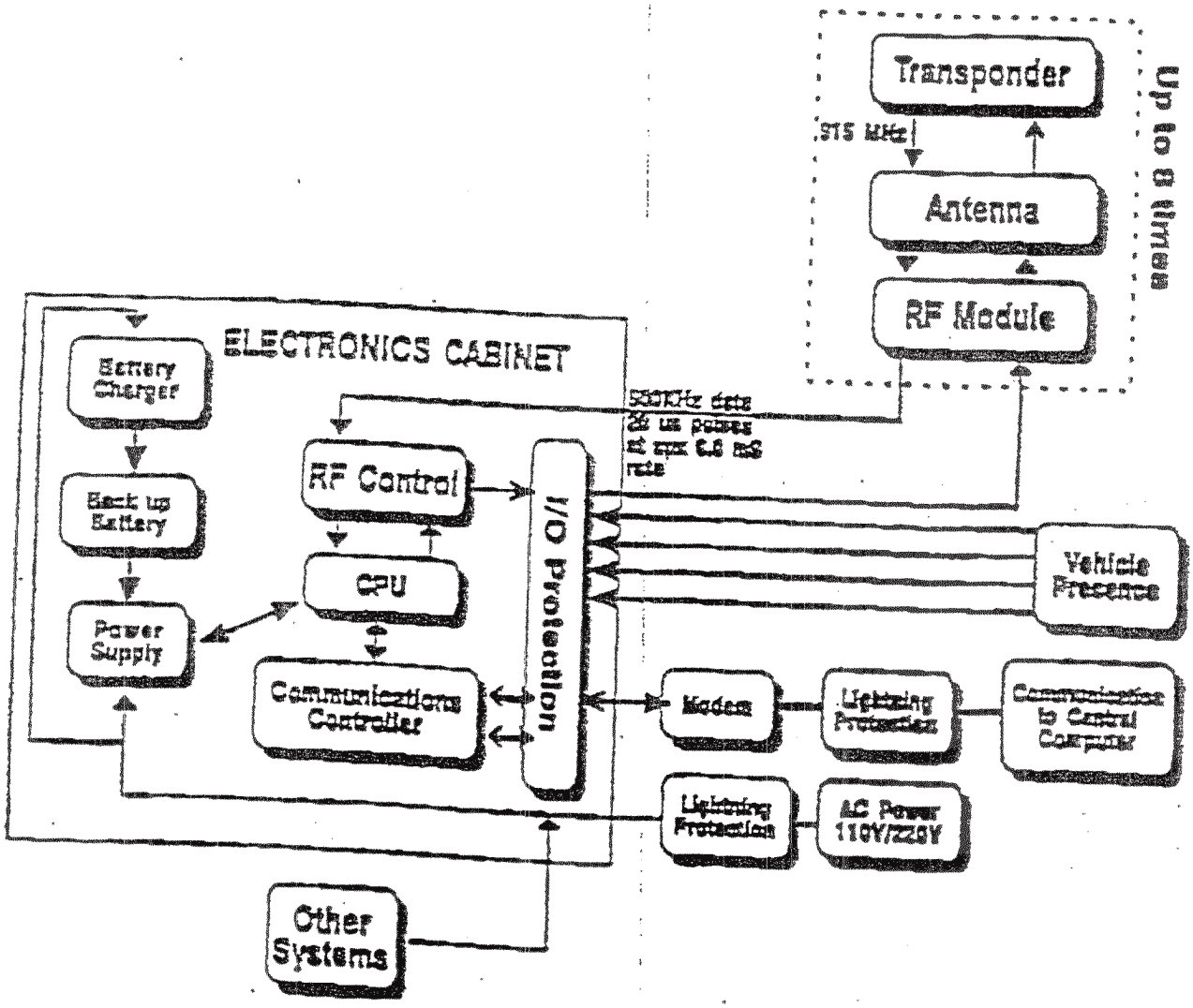
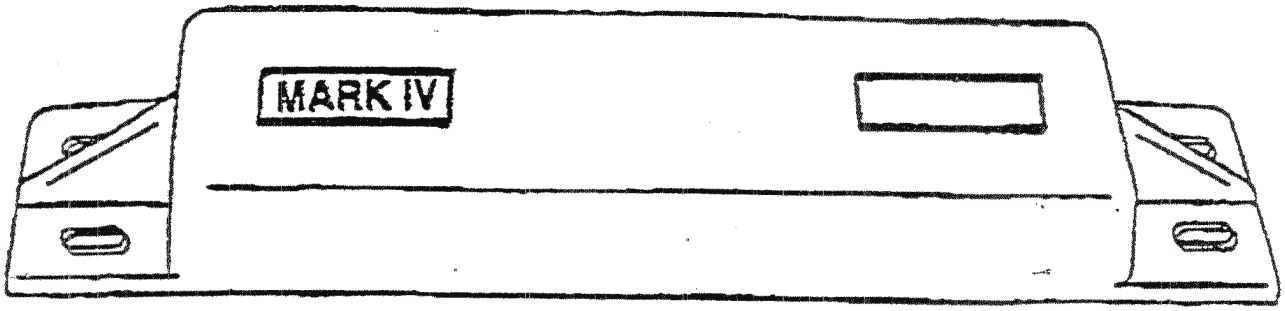
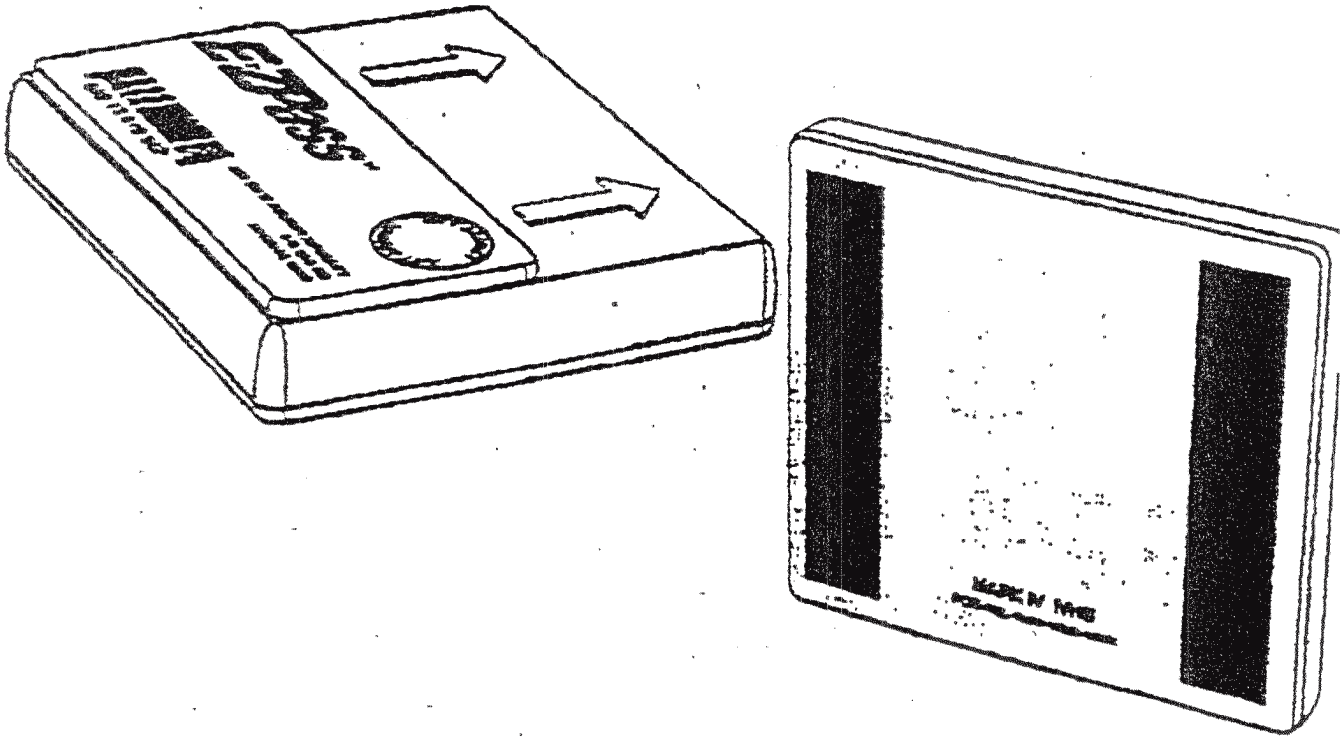



Figure 1 Automatic Vehicle Identification System Block Diagram

*Exterior Transponder*




*Interior Transponder*



Back view

Figure 2 Transponders

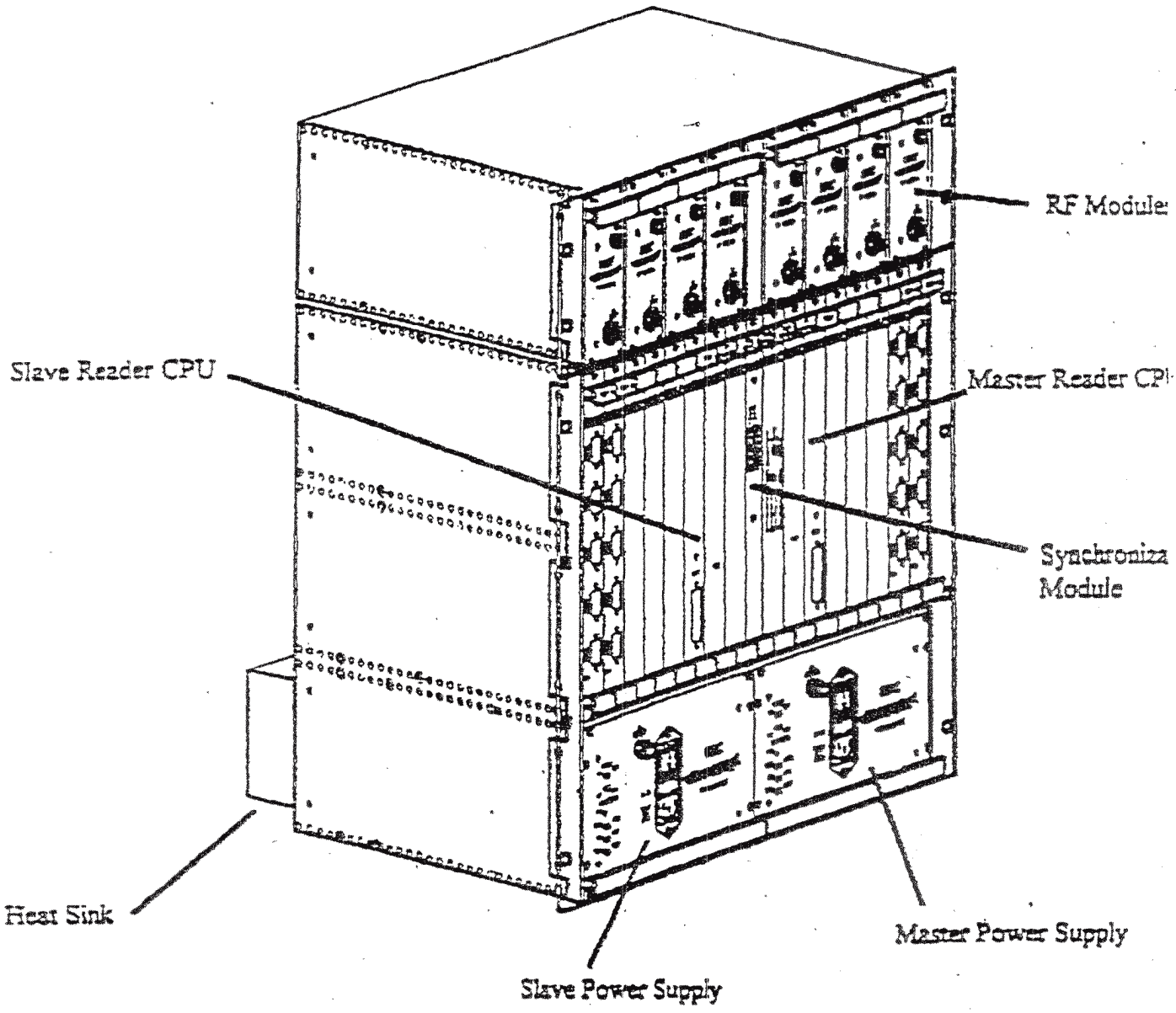
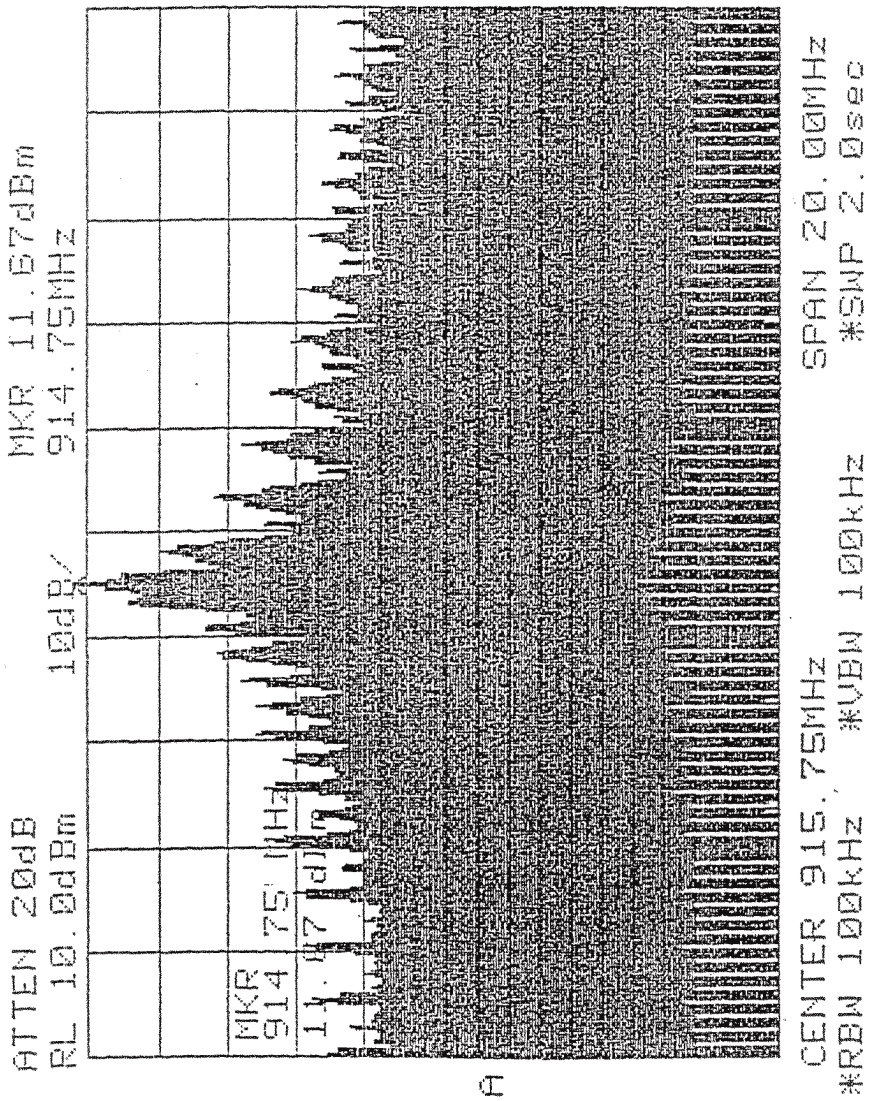



Figure 3 Reader equipment showing RF transmitter module in upper portion

Figure 4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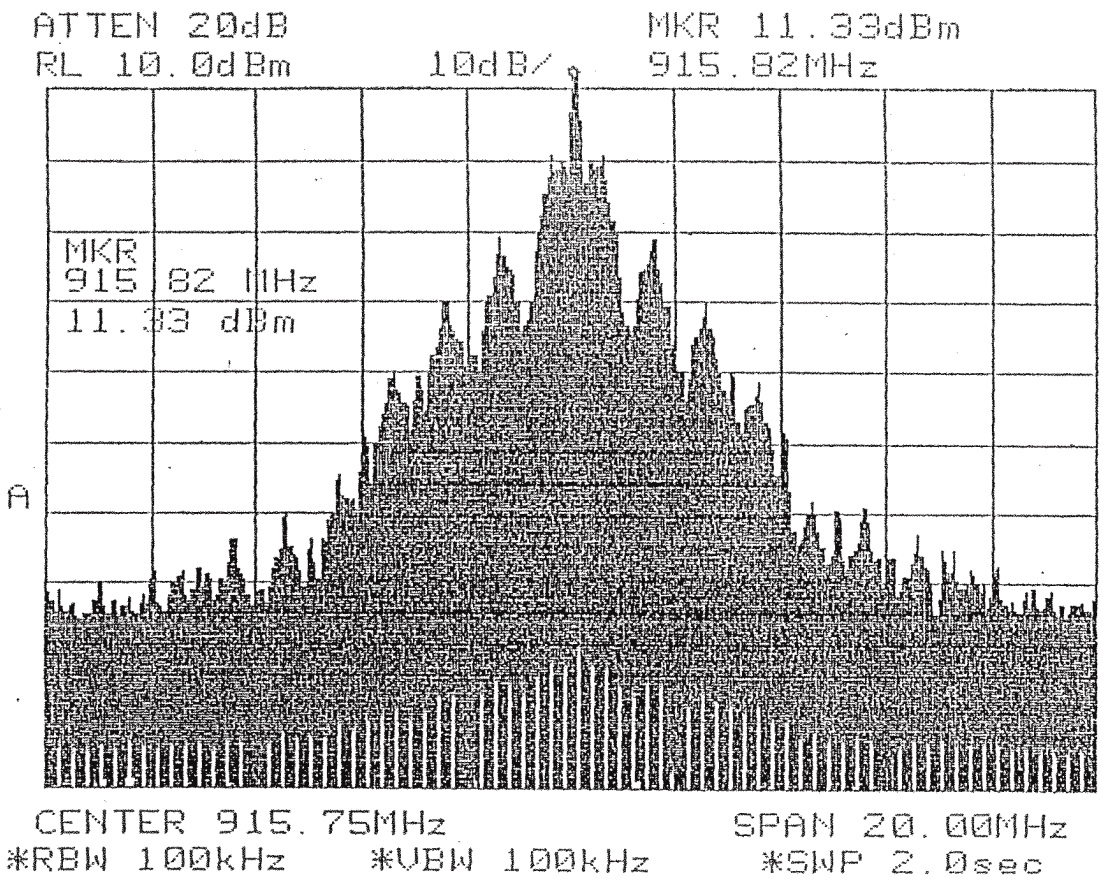
RL 10.0dBm
10dB/
MKR 11.67dBm
914.75MHz
MKR
914
11.47 dB
CENTER 915.75MHz
SPAN 20.00MHz
*RBW 100kHz
*VBW 100kHz
*SWP 2.0sec

OP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RL 10.0dBm
10dB/
MKR 11.33dBm
915.82MHz
MKR
915.82 MHz
11.33 dBm
A
CENTER 915.75MHz
SPAN 20.00MHz
*RBW 100kHz
*VBW 100kHz
*SWP 2.0sec

Figure 5