FCC CERTIFICATION REPORT

for

Lucas Automotive Electronics
Stratford Road
Solihull
England B90 4GW

FCC ID: KHH17TN

June 26, 1999

WLL PROJECT #: 5026X

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WASHINGTON LABORATORIES, LTD.
7560 Lindbergh Drive • Gaithersburg, Maryland 20879 • (301) 417-0220 • Fax (301) 417-9069 • (800) 839-1649
website: http://www.wll.com • e-mail: info@wll.com

STATEMENT OF QUALIFICATIONS

for

Chad M. Beattie

Washington Laboratories, Ltd.

I have eight years of electronics experience with an Associates in Electronic Systems Technology. The last year being directly involved in EMI testing. I am qualified to perform EMC testing to the methods described in this test report. The measurements taken within this report are accurate within my ability to perform the tests and within the tolerance of the measuring instrumentation.

By:

Chad M. Beattie
Compliance Engineer

Date: June 26, 1999

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Lucas Automotive Electronics

FCC ID: KHH17TN

1.0 Introduction

This report has been prepared on behalf of Lucas Automotive Electronics to support the attached Application for Equipment Authorization. The test and application are submitted for a Periodic Intentional Radiator under Part 15.231 of the FCC Rules and Regulations. The Equipment Under Test was the Lucas Automotive Electronics Low Power Transmitter.

All measurements herein were performed according to the 1992 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and field Strength Instrumentation. Calibration checks are made periodically to verify proper performance of the measuring instrumentation.

All measurements are performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

All results reported herein relate only to the equipment tested. The measurement uncertainty of the data contained herein is ±2.3 dB. Refer to Appendix A for Statement of Measurement Uncertainty. This report shall not be used to claim product endorsement by NVLAP or any agency of the US Government.

1.1 Summary

The Lucas Automotive Electronics Transmitter complies with the limits for a Periodic Intentional Radiator under Section 15.231.

2.0 Description of Equipment Under Test (EUT)

The Lucas Automotive Electronics Transmitter is a 315 MHz low power transmitter used for wireless remote control for vehicle keyless entry systems. The battery powered transmitter is manually operated and used with FCC certified receiver, FCC ID: KHH5RXA. The transmitter is battery powered (3VDC), manually operated and stops transmitting once the push-button is released.

2.1 On-board Oscillators

The Lucas Automotive Electronics Transmitter contains a 315 MHz SAW oscillator.

3.0 Test Configuration

To complete the test configuration required by the FCC, the transmitter was tested in all three orthogonal planes.

3.1 Testing Algorithm

The transmitter was turned on and constantly transmitting. The system was tested in all three orthogonal planes. Worst case emissions are recorded in the data tables.

3.2 Conducted Emissions Testing

Conducted emissions testing is not required since the EUT is battery powered.

3.3 Radiated Emissions Testing

The EUT was placed on an 80 cm high 1 x 1.5 meters non-conductive motorized turntable for radiated testing on a 3 meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Biconical, log periodic, and horn broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to peak. For emissions below 1 GHz, the measurement bandwidth on the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. For emissions above 1 GHz, the measurement bandwidth on the spectrum analyzer system was set to at least 1 MHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

3.3.1 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limit, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are grouped into a composite antenna factor (AFc) and are supplied in the AFc column of Table 1. The AFc in dB/m and AFd (duty cycle factor) in dBμV (see Exhibit 1) are algebraically added to the Spectrum Analyzer Voltage in dBμV to obtain the Radiated Electric Field in dBμV/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Voltage:	VdBμV
Composite Antenna Factor:	AFcdB/m
Duty Cycle Factor:	AFddBμV
Electric Field:	EdBμV/m = VdBμV + AFcdB/m + AFddBμV
To convert to linear units:	EμV/m = antilog (EdBμV/m/20)

Data is recorded in Table 1.

Table 1

FCC 15.231 3 Meter Radiated Emissions Data - Site 2

CLIENT: Lucas Automotive Electronics
FCC ID: KHH17TN
DATE: 28 May 99
BY: Chad M. Beattie
JOB #: 5026X

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (Peak) dBuV	AFc dB/m	Afd dB	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MRGN dB
315.00	H	225.00	1.0	53.1	16.5	-6.6	63.0	1408.9	6043.3	-12.6
315.00	V	270.00	2.5	50.2	16.5	-6.6	60.1	1009.0	6043.3	-15.5
630.00	H	225.00	1.5	17.9	24.1	-6.6	35.4	58.9	604.3	-20.2
630.00	V	270.00	1.0	15.3	24.1	-6.6	32.8	43.7	604.3	-22.8
945.00	H	180.00	2.0	22.3	28.8	-6.6	44.5	167.8	604.3	-11.1
945.00	V	0.00	2.0	20.0	28.8	-6.6	42.2	128.8	604.3	-13.4
1260.00	H	180.00	1.0	52.7	-9.1	-6.6	36.9	70.4	604.3	-18.7
1260.00	V	180.00	1.0	52.7	-9.1	-6.6	36.9	70.1	604.3	-18.7
1575.00	H	45.00	1.0	49.5	-6.7	-6.6	36.2	64.7	500.0	-17.8
1575.00	V	0.00	1.0	51.7	-6.7	-6.6	38.4	83.1	500.0	-15.6
1890.00	H	180.00	1.0	53.7	-4.7	-6.6	42.4	132.4	604.3	-13.2
1890.00	V	180.00	1.0	53.5	-4.7	-6.6	42.2	129.4	604.3	-13.4
2205.00	H	180.00	1.0	49.8	-3.4	-6.6	39.8	97.3	500.0	-14.2
2205.00	V	270.00	1.0	50.8	-3.4	-6.6	40.8	109.2	500.0	-13.2
2520.00	H	180.00	1.0	46.5	-2.6	-6.6	37.2	72.8	604.3	-18.4
2520.00	V	135.00	1.0	50.5	-2.6	-6.6	41.2	115.4	604.3	-14.4
2835.00	H	180.00	1.0	47.2	-2.0	-6.6	38.6	85.5	500.0	-15.3
2835.00	V	225.00	1.0	47.2	-2.0	-6.6	38.6	85.5	500.0	-15.3
3150.00	H	225.00	1.0	46.0	-1.6	-6.6	37.8	77.5	604.3	-17.8
3150.00	V	90.00	1.0	47.8	-1.6	-6.6	39.6	95.7	604.3	-16.0

Table 2

System Under Test

FCC ID: KHH17TN

EUT: Lucas Automotive Electronics Low Power Transmitter; FCC ID: KHH17TN

Table 3

Interface Cables Used

The EUT is battery powered and has no I/O cables.

Table 4

Measurement Equipment Used

The following equipment is used to perform measurements:

Hewlett-Packard Spectrum Analyzer: HP 8568B

Hewlett-Packard Quasi-Peak Adapter: HP 85650A

Hewlett-Packard Preselector: HP 85685A

Hewlett-Packard Preamplifier: HP 8449A

Hewlett-Packard Spectrum Analyzer: HP 8593A

Antenna Research Associates, Inc. Biconical Log Periodic Antenna: LPB-2520A (Site 2)

Antenna Research Associates, Inc. Standard Gain Horn Antenna: DRG-118/A

Solar 50 Ω/50 μH Line Impedance Stabilization Network: 8012-50-R-24-BNC

Solar 50 Ω/50 μH Line Impedance Stabilization Network: 8028-50-TS-24-BNC

AH Systems, Inc. Portable Antenna Mast: AMS-4 (Site 2)

AH Systems, Inc. Motorized Turntable (Site 2)

RG-214 semi-rigid coaxial cable

RG-223 double-shielded coaxial cable

EXHIBIT 1

DUTY CYCLE CALCULATIONS

The following page shows a spectrum analyzer plot of the transmitter coding. The following calculations show the worst case 100 ms duty cycle correction used for calculating the average level of the carrier, harmonics, and emissions.

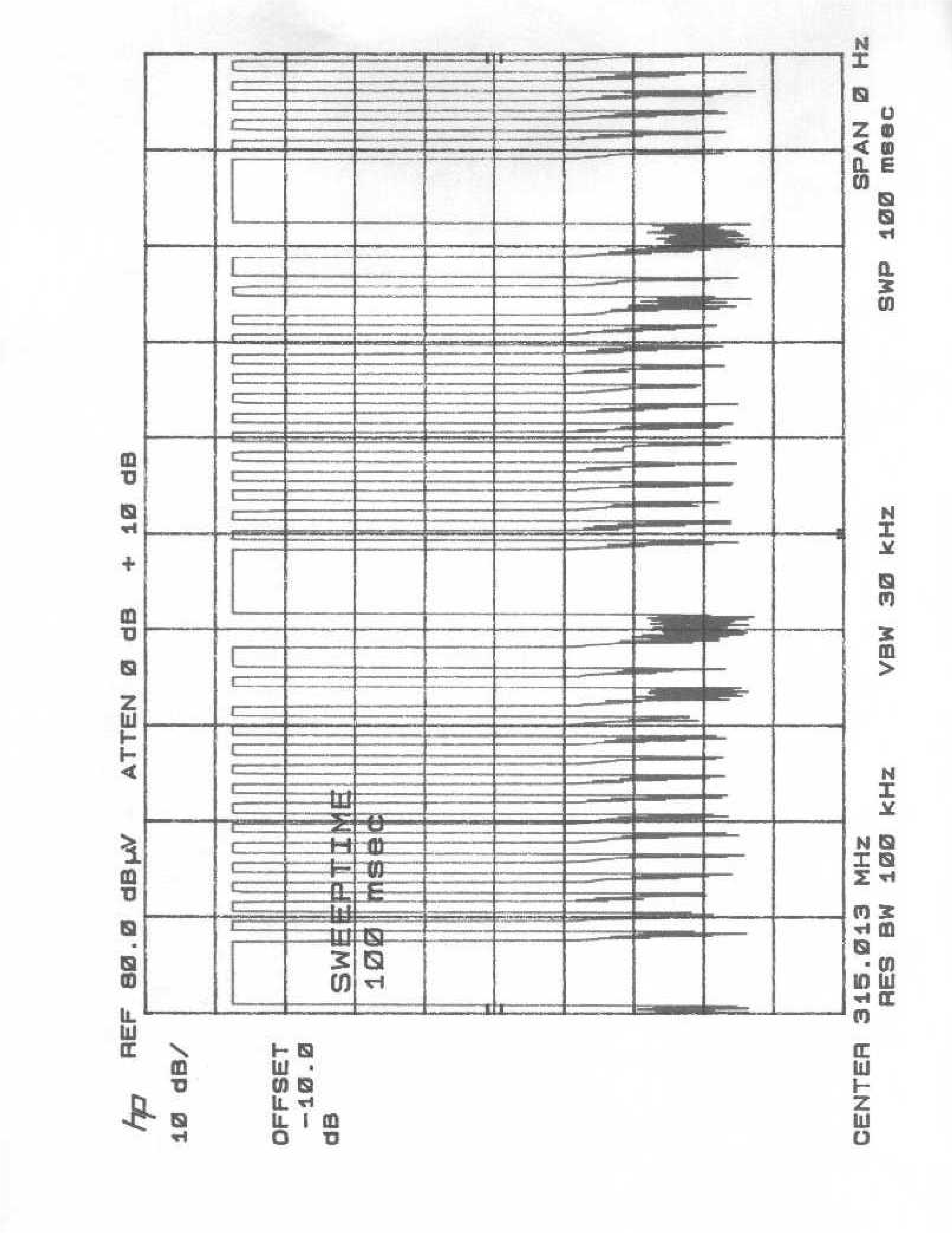
After the initial 6.5 ms pulse, the wide "on" pulse has a pulse width of 1.85 ms and the narrow "on" pulse has a pulse width of 850 us for each code group. Each code group occupies a total time of 41.55 ms and, therefore, there are 2.4067 code groups per 100ms.

ON TIME PER CODE GROUP:

(1 x 6.5 ms) + (1 x 1.85 ms) + (13 x 850 us) = 19.4 ms ON TIME PER CODE GROUP

DUTY CYCLE PER 100 ms:

2.4067 x 19.4 ms	**=**	**46.69 ms**
	=	**46.69% DUTY CYCLE**
	=	**-6.61 dB**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ATTEN 0 dB
+ 10 dB
10 dB/
OFFSET
-10.0
dB
SWEEPTIME
100 msec
CENTER 315.013 MHz
SPAN 0 Hz
RES BW 100 kHz
VBW 30 kHz
SWP 100 msec

EXHIBIT 2

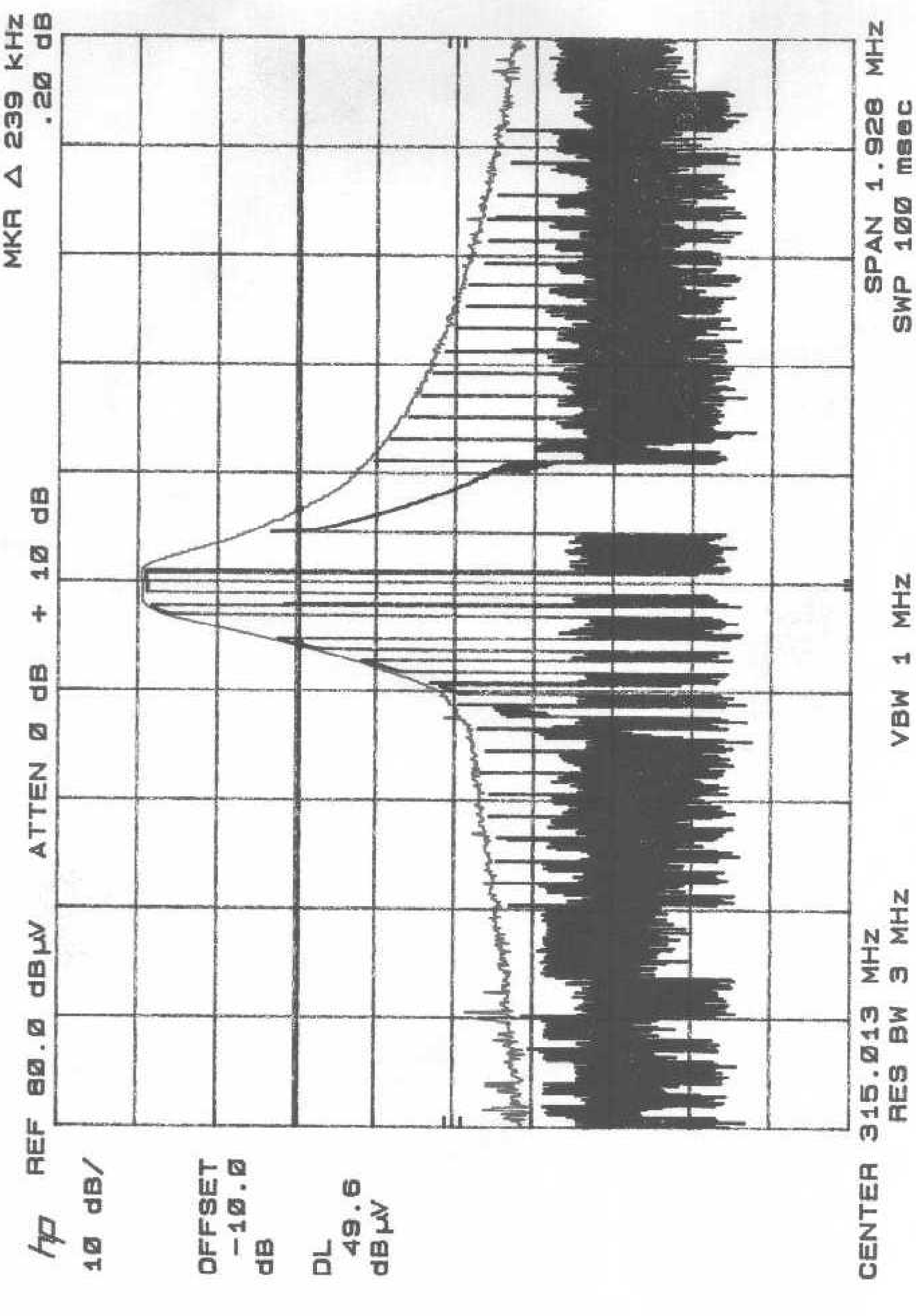
CARRIER BANDWIDTH DATA

The 20 dB modulated bandwidth shall be no wider than 0.25% of the center frequency.

Bandwidth Limit = Carrier Frequency x .0025

Bandwidth Limit = 315 MHz x .0025 = 787.5 kHz

Measured EUT Bandwidth = 239 kHz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ATTEN 0 dB
+ 10 dB
MKR Δ 239 kHz
.20 dB
10 dB/
OFFSET
-10.0
dB
DL
49.6
dBµV
CENTER 315.013 MHz
SPAN 1.928 MHz
RES BW 3 MHz
VBW 1 MHz
SWP 100 msec

Appendix A

Statement of Measurement Uncertainty

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:
A = Antenna calibration uncertainty, in dB = 2 dB
B = Spectrum Analyzer uncertainty, in dB = 1 dB
C = Site uncertainty, in dB = 4 dB
n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB