

## FCC CERTIFICATION REPORT

for

**Lucas Automotive Electronics**  
Stratford Road  
Solihull  
England B90 4GW

**FCC ID: KHH20TN**

June 21, 1999

**WLL PROJECT #: 5275X**

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### 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:

A handwritten signature of Chad M. Beattie in black ink.

Chad M. Beattie  
Compliance Engineer

Date: June 21, 1999

NVLAP FCC CE UL CSA



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14 June 1999

Chief, Authorizations Branch  
Federal Communications Commission  
7435 Oakland Mills Road  
Columbia  
MD 21046  
USA

**Letter of Agency**

This letter is to serve notice that Washington Laboratories Ltd. is hereby authorized to act on our behalf in connection with the Application for Equipment Authorization attached herewith.

We certify that we are not subject to denial of federal benefits, that includes FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, U.S.C. 862. Further, no party, as defined in 47 CFR 1.2002(b), to the application is subject to denial of federal benefits, that includes FCC benefits.

Signed,

Roger Lee  
Approvals Manager



Lucas Ltd. Registered office: 45 Park Street, London, W1Y 4DZ. Registered in England No. 872948.

**Lucas Automotive Electronics  
KHH20TN  
WLL Project # 5275X**

# FCC CERTIFICATION REPORT

for

**Lucas Automotive Electronics**

**FCC ID: KHH20TN**

## 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  $\pm 2.3$  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 mounted in the head of a key that is used as a wireless remote control for vehicle keyless entry systems. The battery powered transmitter is manually operated and used with FCC certified receivers, FCC ID: KHH16AS and KHH23AS (DOC). The Lucas Automotive Electronics receiver 32AS was tested under the FCC DOC program. The unit stops transmitting as soon as the 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 dB $\mu$ V (see Exhibit 1) are algebraically added to the Spectrum Analyzer Voltage in dB $\mu$ V to obtain the Radiated Electric Field in dB $\mu$ V/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Voltage:

VdB $\mu$ V

Composite Antenna Factor:

AFcdB/m

Duty Cycle Factor:

AFddB $\mu$ V

Electric Field:

EdB $\mu$ V/m = VdB $\mu$ V + AFcdB/m + AFddB $\mu$ V

To convert to linear units:

E $\mu$ V/m = antilog (EdB $\mu$ V/m/20)

Data is recorded in Table 1.

**Table 1**

## FCC 15.231 3 Meter Radiated Emissions Data - Site 1

CLIENT: Lucas Automotive  
 FCC ID: KHH20TN  
 DATE: 18 June 99  
 BY: Chad M. Beattie  
 JOB #: 5275X

FREQ MHz	POL H/V	Azimuth Degree	Ant Height m	SA LEVEL (QP) dBuV	AFc dB/m	Afd dB	E-FIELD dBuV/m	E-FIELD uV/m	LIMIT uV/m	MRGN dB
315.00	H	180.0	1.0	48.0	16.5	-6.0	58.5	842.3	6042.7	-17.1
315.00	V	90.0	2.0	42.0	16.5	-6.0	52.5	422.2	6042.7	-23.1
630.00	H	180.0	1.5	19.5	24.1	-6.0	37.6	76.2	604.3	-18.0
630.00	V	90.0	1.0	22.0	24.1	-6.0	40.1	101.6	604.3	-15.5
945.00	H	0.0	1.0	9.3	28.8	-6.0	32.1	40.4	604.3	-23.5
945.00	V	270.0	1.0	9.8	28.8	-6.0	32.6	42.8	604.3	-23.0
1260.00	V	180.0	1.0	52.7	-9.1	-6.0	37.6	75.7	604.3	-18.0
1260.00	H	90.0	1.0	48.8	-9.1	-6.0	33.7	48.3	604.3	-21.9
1575.00	H	180.0	1.0	53.0	-6.7	-6.0	40.4	104.1	500.0	-13.6
1575.00	V	0.0	1.0	57.5	-6.7	-6.0	44.9	175.2	500.0	-9.1
1890.00	H	270.0	1.0	40.2	-4.7	-6.0	29.6	30.1	604.3	-26.1
1890.00	V	270.0	1.0	41.7	-4.7	-6.0	31.1	35.8	604.3	-24.6
2205.00	H	270.0	1.0	42.3	-3.4	-6.0	32.9	44.1	500.0	-21.1
2205.00	V	270.0	1.0	44.2	-3.4	-6.0	34.8	54.9	500.0	-19.2
2520.00	V	180.0	1.0	45.8	-2.6	-6.0	37.2	72.3	604.3	-18.4
2520.00	H	270.0	1.0	44.3	-2.6	-6.0	35.7	60.8	604.3	-19.9
2835.00	V	180.0	1.0	39.7	-2.0	-6.0	31.8	38.8	500.0	-22.2
2835.00	H	180.0	1.0	36.5	-2.0	-6.0	28.6	26.8	500.0	-25.4
3150.00	H	270.0	1.0	35.5	-1.6	-6.0	27.9	24.9	604.3	-27.7
3150.00	V	180.0	1.0	39.5	-1.6	-6.0	31.9	39.5	604.3	-23.7

**Table 2**

System Under Test

FCC ID: KHH20TN

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EUT: Lucas Automotive Electronics Low Power Transmitter; FCC ID: KHH20TN

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**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 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.

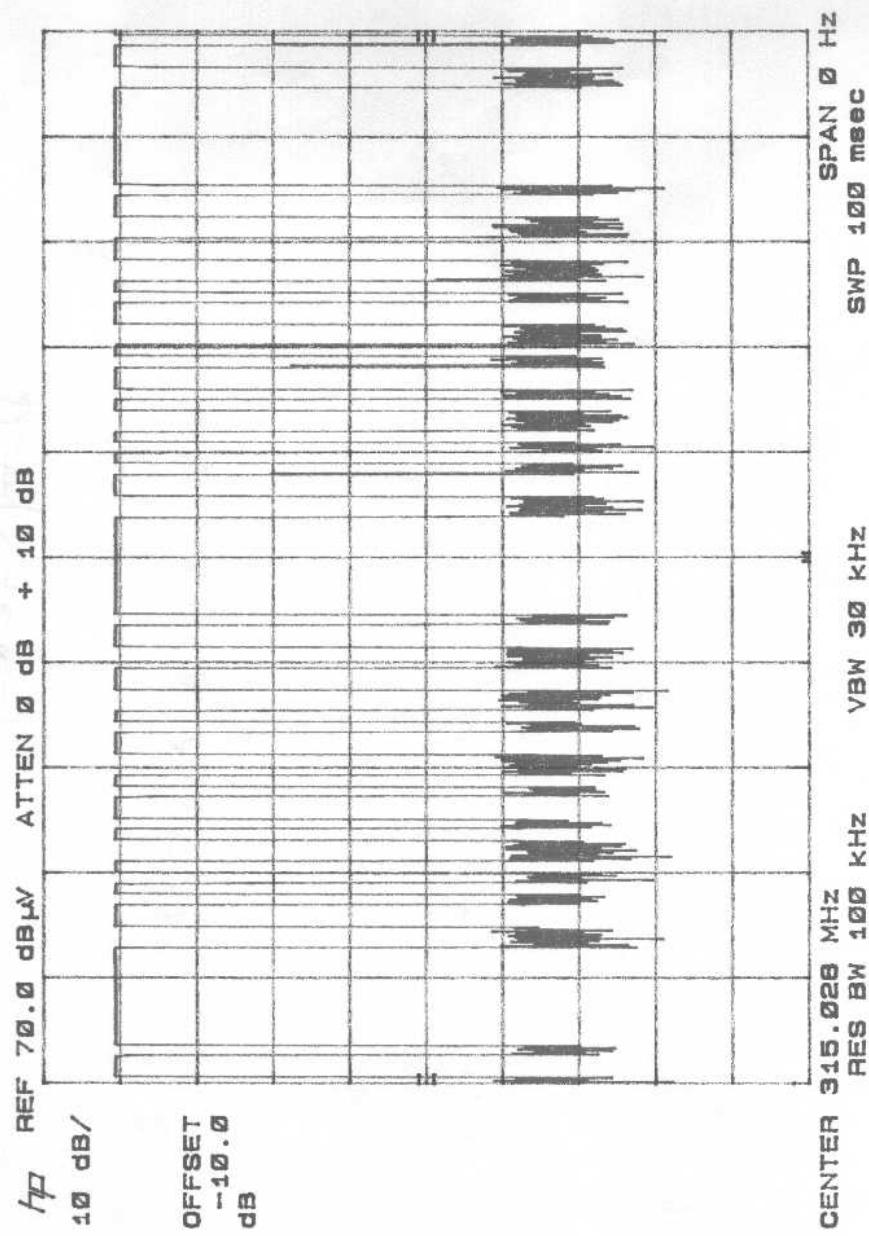
After the initial 6.5 ms pulse, the wide "on" pulse has a pulse width of 1.95 ms and the narrow "on" pulse has a pulse width of 1.0 ms.

**ON TIME PER 100 ms:**

$$(3 \times 6.5 \text{ ms}) + (12 \times 1.95 \text{ ms}) + (10 \times 900 \text{ us}) = 51.9 \text{ ms ON TIME PER 100 ms}$$

$$\begin{aligned} &= 51.9\% \text{ DUTY CYCLE} \\ &= -5.7 \text{ dB} \end{aligned}$$

## Duty Cycle Pulse Train



Lucas Automotive Electronics  
KHH20TN  
WLL Project # 5275X

**EXHIBIT 2**  
**CARRIER BANDWIDTH DATA**

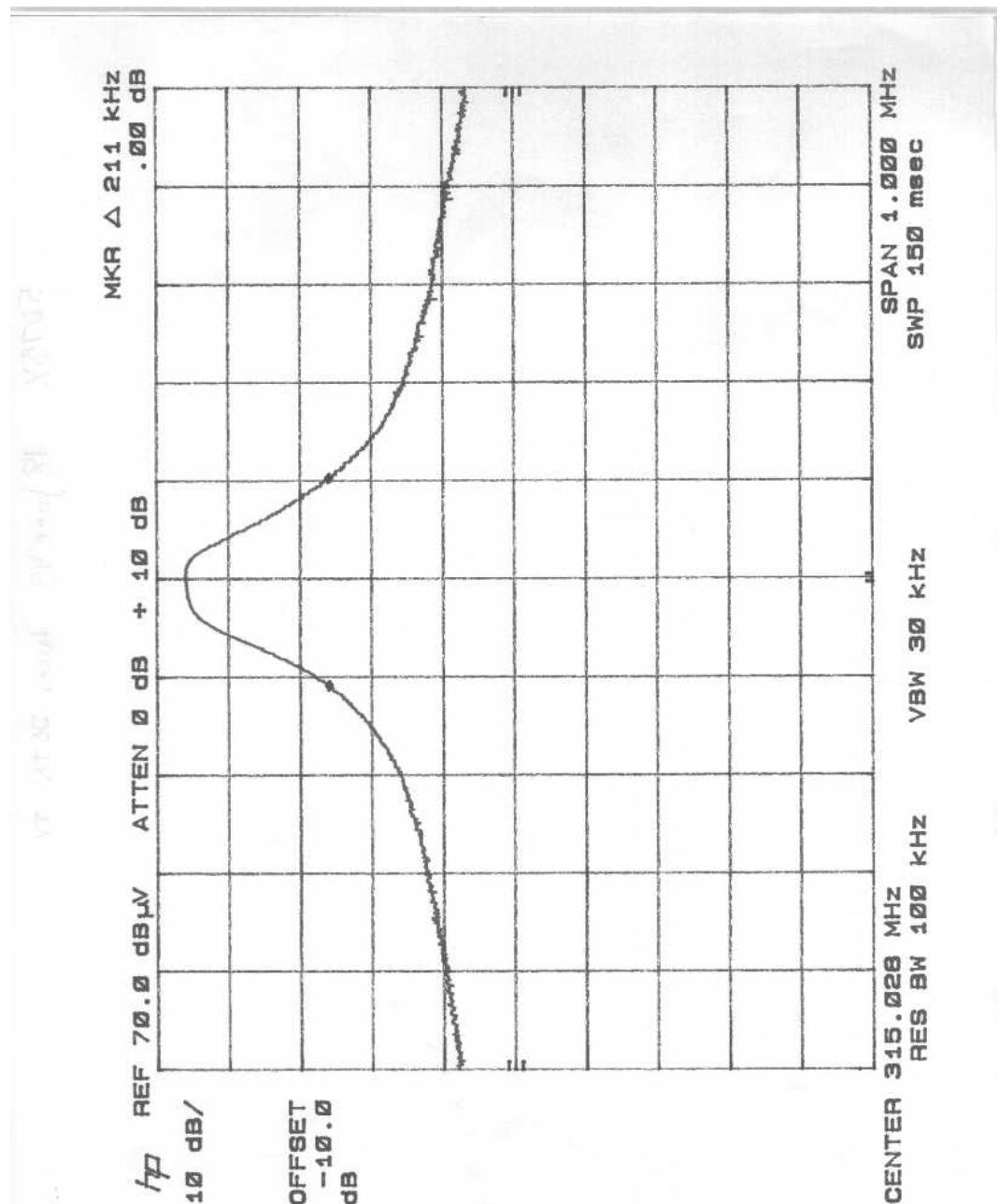
**The 20 dB modulated bandwidth shall be no wider than 0.25% of the center frequency.**

**Bandwidth Limit = Carrier Frequency x .0025**

**Bandwidth Limit = 315 MHz x .0025 = 787.5 kHz**

**Measured EUT Bandwidth = 211 kHz**

## Bandwidth Plot



## Appendix A

### Statement of Measurement Uncertainty

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is  $\pm 2.3$  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

*Lucas Automotive Electronics  
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