L. S. Compliance, Inc.
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L. S. Compliance, Inc.

Compliance Testing of:

DELCO/ DELPHI

TSSM, HARLEY DAVIDSON NORTH AMERICA

KEYLESS ENTRY TRANSMITTER

Prepared for:

Curt Kell

Delphi Electronics

Oak Creek, WI

Test Report Number: 90248B

Date(s) of Testing:

September 17, 20, 1999

All results of this report relate only to the items that were tested.

Table of Contents

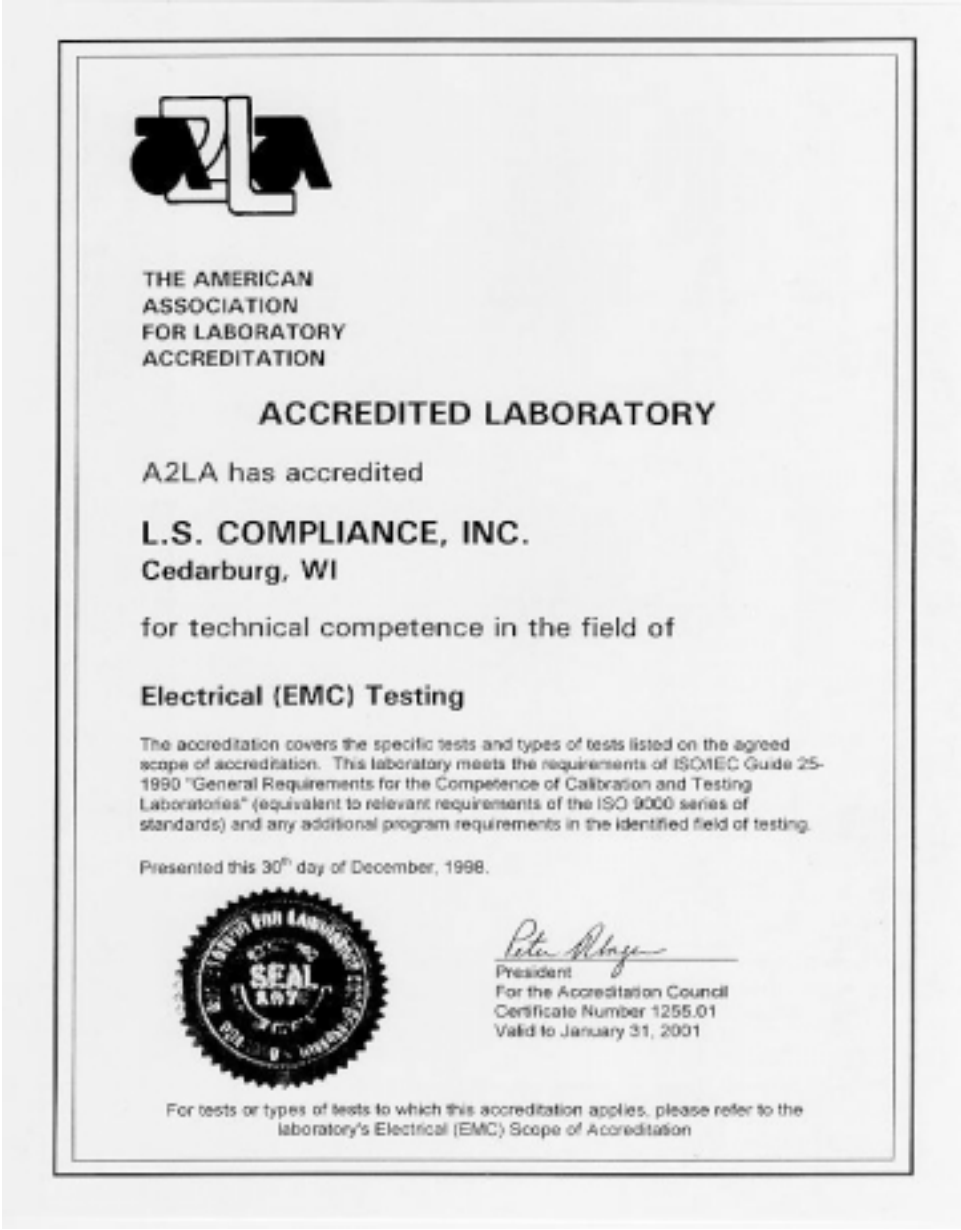
DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

ID Number: 31040/SIT

1300F2

" The site referenced above has been found to comply with the test site criteria found in ANSI C63.4-1992 and 47CFR Section 2.948."



THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical (EMC) Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.

Presented this 30th day of December, 1998.

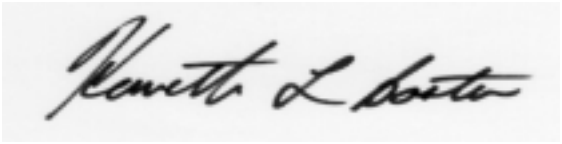
President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2001

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical (EMC) Scope of Accreditation

SIGNATURE PAGE

Tests performed by:

Approved By:



9 Nov 1999

Kenneth L. Boston, EMC Lab Manager — Date
PE #31926
Registered Professional Engineer
(State of Wisconsin)

1.3 SUMMARY OF TEST REPORT

MANUFACTURER:	Delphi Electronics
MODEL:	T.S.S.M., Harley Davidson North America
SERIAL:	preproduction prototype
DESCRIPTION:	KEYLESS ENTRY HANDHELD TRANSMITTER
FREQUENCY RANGE:	TRANSMITTER; 315 MHz

The Delphi model TSSM RKE transmitter was found to **"meet"** the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator

1.4 INTRODUCTION

On September 17, 20 of 1999, a series of Radiated Emissions tests were performed on two sample models of the TSSM keyless entry transmitter, a small handheld key fob unit, which is designed to transmit a coded signal used to allow a person to operate their Motorcycle. These tests were performed using the test procedures outlined in ANSI C63.4-1992 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.231a,b for a periodic transmitter. These tests were performed by Kenneth L. Boston, PE, of L. S. Compliance, Inc. and witnessed by Curt Kell of Delphi, Inc.

1.5 PURPOSE

The above mentioned tests were performed in order to determine the compliance of the TSSM keyfob with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.109	15.231b
15.205	15.231c
15.209	

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-1992). Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference (CISPR) number 16-1 (1993).

1.6 RADIATED EMISSIONS TEST SETUP

The test samples were operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. The samples were placed on an 80cm high wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on its own [new] internal battery. The battery voltage at the beginning of the tests was measured to be 3.2 volts. One test sample was configured to run in a continuous transmit mode during the 15.231c and 15.231b measurements. The other test sample was configured to transmit a continuous carrier.

Please refer to Section 1.11 for pictures of the test setup.

1.7 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 15.231b limits for periodic devices. For the calculations used to determine the limits applicable for each of the two test samples (at their respective operating frequencies) refer to Appendix A. These limits are expressed in decibels (dB) above 1 microvolt per meter (μV/m). The samples were tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when the fundamental or spurious signals were located within any of the restricted bands as described in Part 15.205a. These frequencies, and their associated limits, are referenced in Section 1.10. The samples were placed on a nonconductive (wooden) pedestal in the 3 Meter chamber and the antenna mast was placed such that the antenna was 3m from the test object. A biconical antenna or tuned dipole was used to measure emissions from 30 to 200 MHz, a log periodic or tuned dipole was used to measure emissions from 200 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1 GHz. The test object was programmed to operate in continuous transmit, and the resultant signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters. The test object was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities.

No significant emissions were found aside from the transmitter fundamental and several harmonics. The unit was scanned for emissions while in continuous transmit, over the range 30 to 3500 MHz to establish compliance with Part 15.209 and 15.231. No other spurious signals, other than the noise floor of the system at the band edges, could be found within 20 dB of the limits.

In addition to measuring the levels of radiated emissions, the occupied bandwidth of the transmitters were measured. In accordance with FCC Part 15.231c, the 20dB bandwidth of the transmitted signal should be within a window of 0.25% of the center carrier frequency. The calculation for this bandwidth can be found in Appendix A, which for this product is 787.5 kHz. The resolution bandwidth was set either to 120 kHz or to the closest available filter setting on the HP8546A EMI system that corresponded to 5% of the allowable bandwidth determined in the calculation mentioned above, without going below the resolution bandwidth of 10kHz, as dictated in ANSI C63.4-1992 section 13.1.7.

The samples were activated to transmit in a continuous mode and were placed on the aforementioned pedestal within the 3 meter chamber. The transmitted signal was received on a tuned dipole antenna and fed to the HP8546A EMI System, where the fundamental frequency was displayed, and a plot of the occupied bandwidth was produced. These plots are included in Appendix C.

From the data supplied; and an indicated –20dBc bandwidth of 295 kHz, it can be seen that the test samples do indeed **"meet"** the bandwidth requirement established by FCC Part 15.231(c).

1.8 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 1.13, which includes the calibration information as well as the equipment description. All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database. The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic changes in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. When a reading is taken using the peak detector, a duty cycle correction factor can be applied for conversion to an average reading. This operation can be used when measuring periodic data transmission, under FCC part 15.231b, and Part 15.35c. The calculation for deriving this duty factor can be found in Appendix A. The resulting average reading was then compared to the appropriate limit in order to determine compliance. The HP 8546A EMI receiver was operated with a bandwidth of 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16. Both the peak and Quasi-peak detector functions were used.

1.9 CONDUCTED EMISSION TEST

Due to the fact that this product operated on its own internal battery power, as opposed to using a power cord, it was not necessary to perform a test for Conducted Emissions.

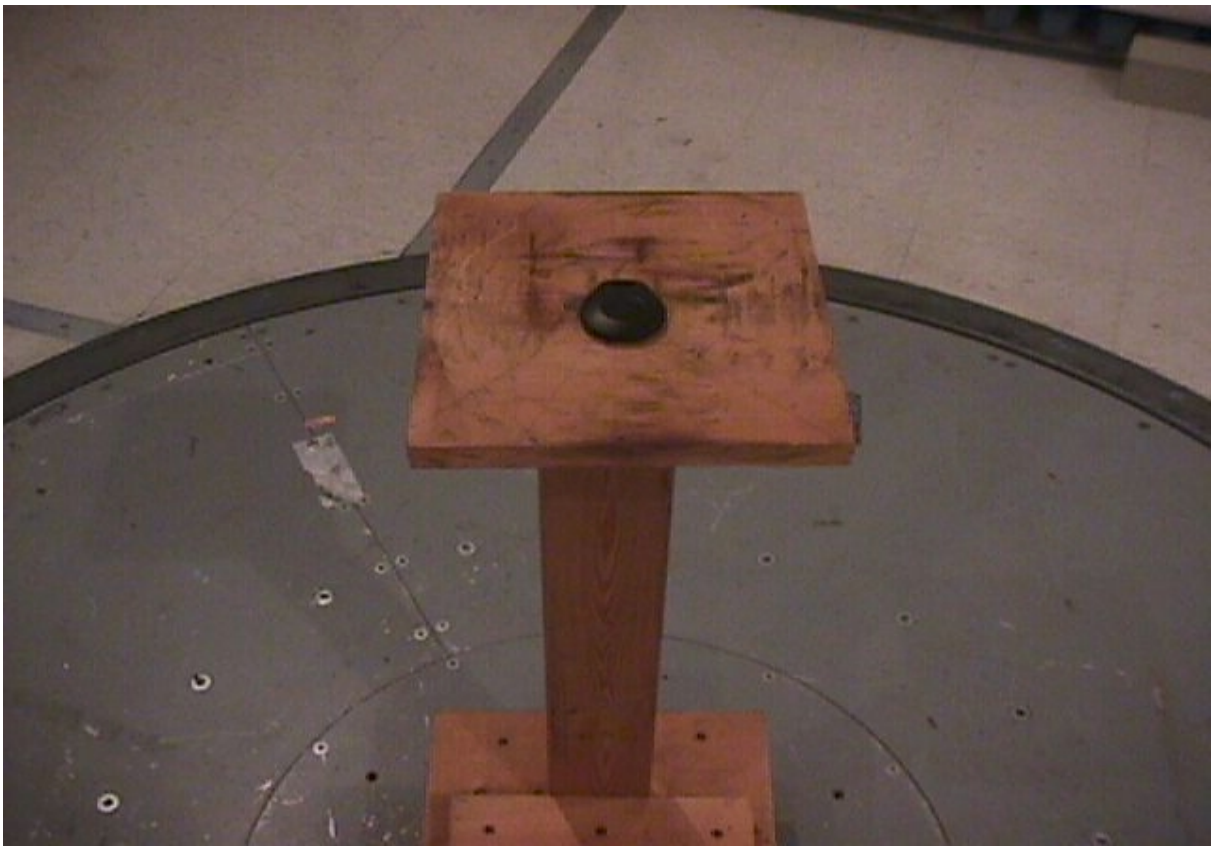
FCC ID: L2C0008T

Manufacturer: Delphi Electronics
Model: TSSM (Harley Davidson N.A.)
Serial Number(s): pre-production prototype

1.10 - Restricted Bands affecting this product

Frequency (MHz)	Limit (µV)	Limit (dB/µV/m)
322-335.4	200	46.0
399.9-410	200	46.0
608-614	200	46.0
960-1240	500	54.0
1300-1427	500	54.0
1435-1626.5	500	54.0
1645.5-1646.5	500	54.0
1660-1710	500	54.0
1718.8-1722.2	500	54.0
2200-2300	500	54.0
2310-2390	500	54.0
2483.5-2500	500	54.0
2655-2900	500	54.0

1.11 – Photos taken during testing



View of the Delphi HDNA transmiter during the Radiated Emissions tests. This view shows the orientation of the product where the maximum signal levels were present (horizontal polarity).

1.12 SUMMARY OF RESULTS AND CONCLUSIONS

Based on the procedures outlined in this report, and the test results included in appendices B and C, it can be determined that the model TSSM keyless entry transmitter does **"meet"** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

1.13 - Test Equipment

Asset #	Manufacturer	Model #	Serial#	Description	Due Date
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	3aug2000
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	3aug2000
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	1aug2000
EE960004	EMCO	2090	9607-1164	Mast/Ttable controller	I.O.
EE960014	HP	85460	3617A00320	EMI receiver Display section	23aug2000
EE960013	HP	85462	3205A00103	EMI receiver Preselector section	23aug2000
CC000221	HP	E4407b	Us39160256	26.5 GHz Spectrum Analyzer	16june2000
	LSC	Cable	0011	3 meter heliax	23 feb2000
	LSC	Cable	0038	1 meter RG214	30dec1999
	LSC	cable	0050	10 meter RG214	30dec2000

APPENDIX A:

SAMPLE CALCULATIONS

FCC ID: L2C0008T

Manufacturer: Delphi Electronics
Model: TSSM (HDNA)
Serial Number(s): prototype

Calculation of Radiated Emissions limits for FCC Part 15.231(b) (260-470 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The calculation involves a linear interpolation of 3750 to 12500 μV / m over 260-470 MHz, Where field strength of the fundamental frequency (f_0) when, $260 \leq f_0 \leq 470$ MHz, can be found by: $3750.0+41.667(f_0-260)$, where f_0 is in MHz.

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES:

The calculation involves a linear interpolation of 375 to 1250 μV / m over 260 to 470 MHz, Where field strength of the harmonic frequencies ($2f_0$, $3f_0$..), when $260 \leq f_0 \leq 470$ MHz, can be found by: $375.0+4.1667(f_0-260)$, where f_0 is in MHz.

- Where f_0 = 315 MHz
  Fundamental: 3750+41.667(315-260) = 6041.7 μV / m
  Harmonic: 375+4.1667(315-260) = 604.17 μV / m

Frequency (MHz)	Fundamental limit (μV/m)	Fundamental limit (dB μV/m)	Harmonic limit (μV/m)	Harmonic limit (dB μV/m)
315	6041.7	75.62	604.17	55.62

Manufacturer: Delphi Electronics
Model: TSSM
Serial Number(s): prototype

Duty Cycle Correction Factor Calculation

For a graphical presentation of the data bursts being transmitted from the transmitter, refer to Appendix C. for a zero span picture of the modulation burst from one representative unit. Plots are provided that show the repeating burst of data that occurs when a key is held down continuously, and also over a 250 millisecond (worst case) period and a 20 millisecond period, to display the individual pulses in detail.. The Data is Pulse Position modulated. When the total On-time is computed over a100 millisecond window, according to FCC Part 15.35(c), where the packet duration exceeds 100 milliseconds, a total of 22.87 milliseconds is obtained. This results in a relaxation factor of 12.8 dB, which is under the allowable cap of 20 dB, as stated in FCC Part 15.35(b)

The construction of the entire data packet is as follows:

Portion	duration	max on-time
Preamble:	175 ms.	29.167 ms
Header :	8 ms.	1.67 ms.
Data:	70.4ms	17.6 ms
Total	253.4ms	48.43ms

Selecting the worst case 100 millisecond window, which is found to be the end of the packet:

Portion	duration	max on-time
Preamble:	21.6 ms.	3.6 ms

Header	:	8 ms.	1.67 ms.
Data:		70.4ms	17.6 ms
Total		100 ms	22.87 ms

Relaxation Factor = 20 log (22.87 / 100)

= 12.8 dB

FCC ID: L2C0008T

Manufacturer: Delphi Electronics
Model: TSSM (HDNA)
Serial Number(s): preproduction prototype

Occupied Bandwidth Calculations

FCC Part 15.231(c) states that the bandwidth of the periodic device shall be no wider than 0.25% of the center frequency for devices operating between 70 and 900 MHz. Said bandwidth is determined at the

-20 dB reference to peak carrier points.

For 315 MHz, the 20 dB bandwidth is $0.0025 \times 315 = 787.5 \ \ kHz$

Refer to Appendix C for the set of graphs that show the actual occupied bandwidth of the test sample.

APPENDIX B:

DATA CHARTS

FCC ID: L2C0008T

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 3500 MHz

Date of Test:	September 20, 1999	Manufacturer:	Delphi electronics
Location:	L.S. Compliance, Inc. W66 N220 Commerce Court Cedarburg, WI 53012	Model No.:	TSSM
Specifications:	Title 47CFR, FCC Part 15.231b	Serial No.:	Pre-production
Distance:	3 meters	Configuration:	continuous burst, or carrier
Equipment:	HP 8546A EMI Receiver EMCO 3115 Double Ridged Waveguide EMCO 3146A Log Periodic	Detector(s) Used:	Peak below 1 GHz Peak above 1 GHz Corrected to average
Laboratory Conditions:	Temperature: 68-74 deg F Humidity: 35-50% ,		Pressure; 680-1060mbr

The following table depicts the level of significant fundamental and harmonic emissions found:

Higher order harmonics were found to be below the noise floor of the receiving system:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB µV/m)	Duty Cycle Correction (dB)	Corrected Reading (dB µV/m)	15.231b Limit (dB µV/m)	Margin (dB)
314.95	H	1.0	20	81.4	12.8	68.6	75.6	7.0
314.95	V	1.0	165	65.9	12.8	53.1	75.6	22.5
629.9	H	1.45	300	64.1	12.8	51.3	55.6	4.3
629.9	V	1.0	195	58.5	12.8	45.7	55.6	9.3
944.2	H	1.0	115	61.3	12.8	48.5	55.6	7.1
944.8	V	1.4	180	53.3	12.8	40.5	55.6	15.1
1259.7	H	1.15	270	56.7	12.8	43.9	55.6	11.7
1574.7	H	1.4	280	56.6	12.8	43.8	54.0	10.2

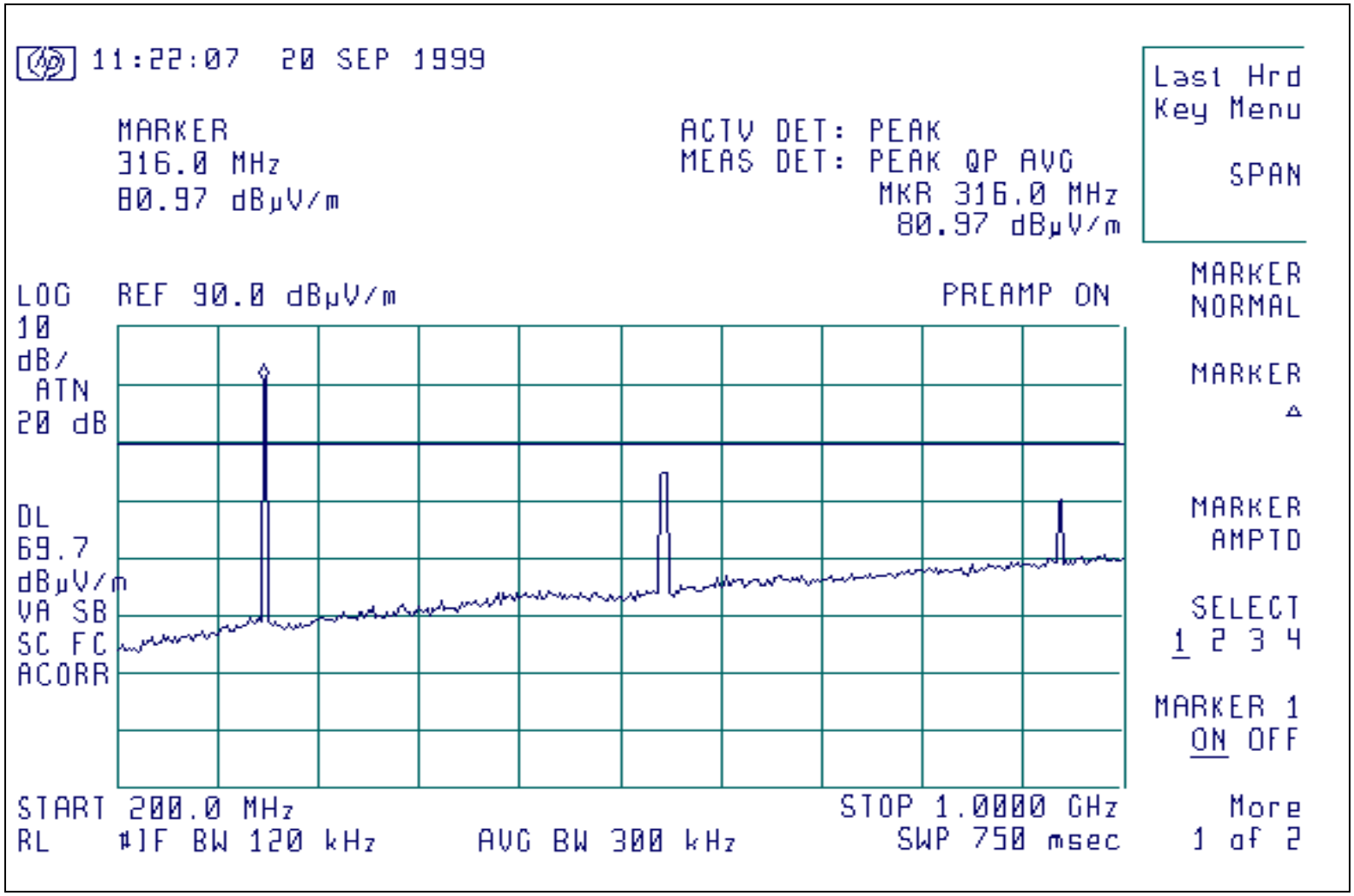
1574.7	V	1.25	335	54.5	12.8	41.7	54.0	12.3
1889.6	H	1.1	45	56.3	12.8	43.5	55.6	12.1
2204.6	H	1.0	65	54.3	12.8	41.5	54.0	12.5
2519.5	H	1.05	310	51.5	12.8	38.7	55.6	16.9
2834.4	H	1.2	330	57.0	12.8	44.2	54.0	9.8
3149.5	H	1.05	100	65.3	12.8	52.5	55.6	3.1
3149.5	V	1.55	30	60.0	12.8	47.2	55.6	8.4

APPENDIX C:

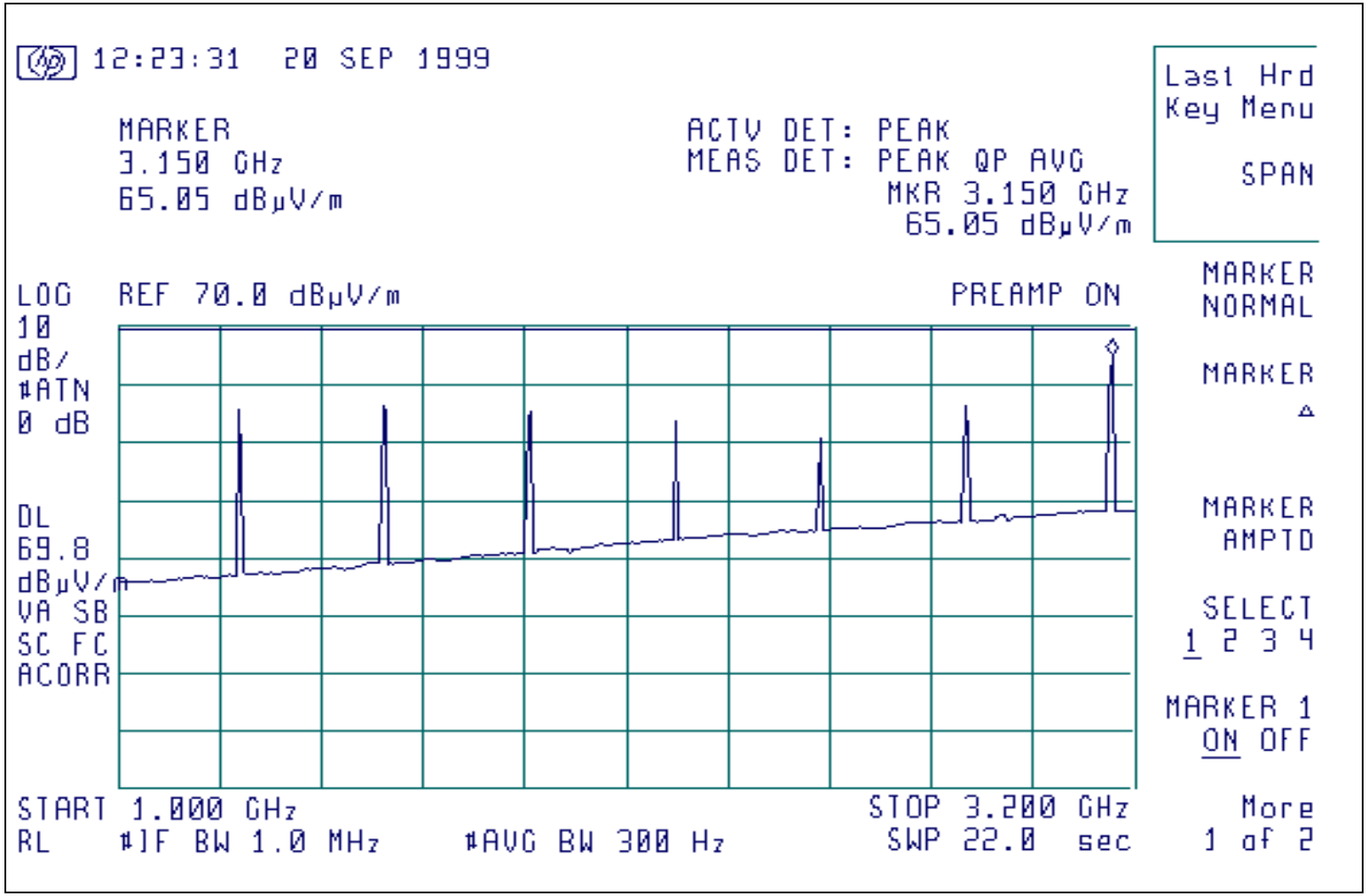
GRAPHS

FCC ID: L2C0008T

315 MHz Key Fob Transmitter, emissions below 1 GHz, horizontal polarity

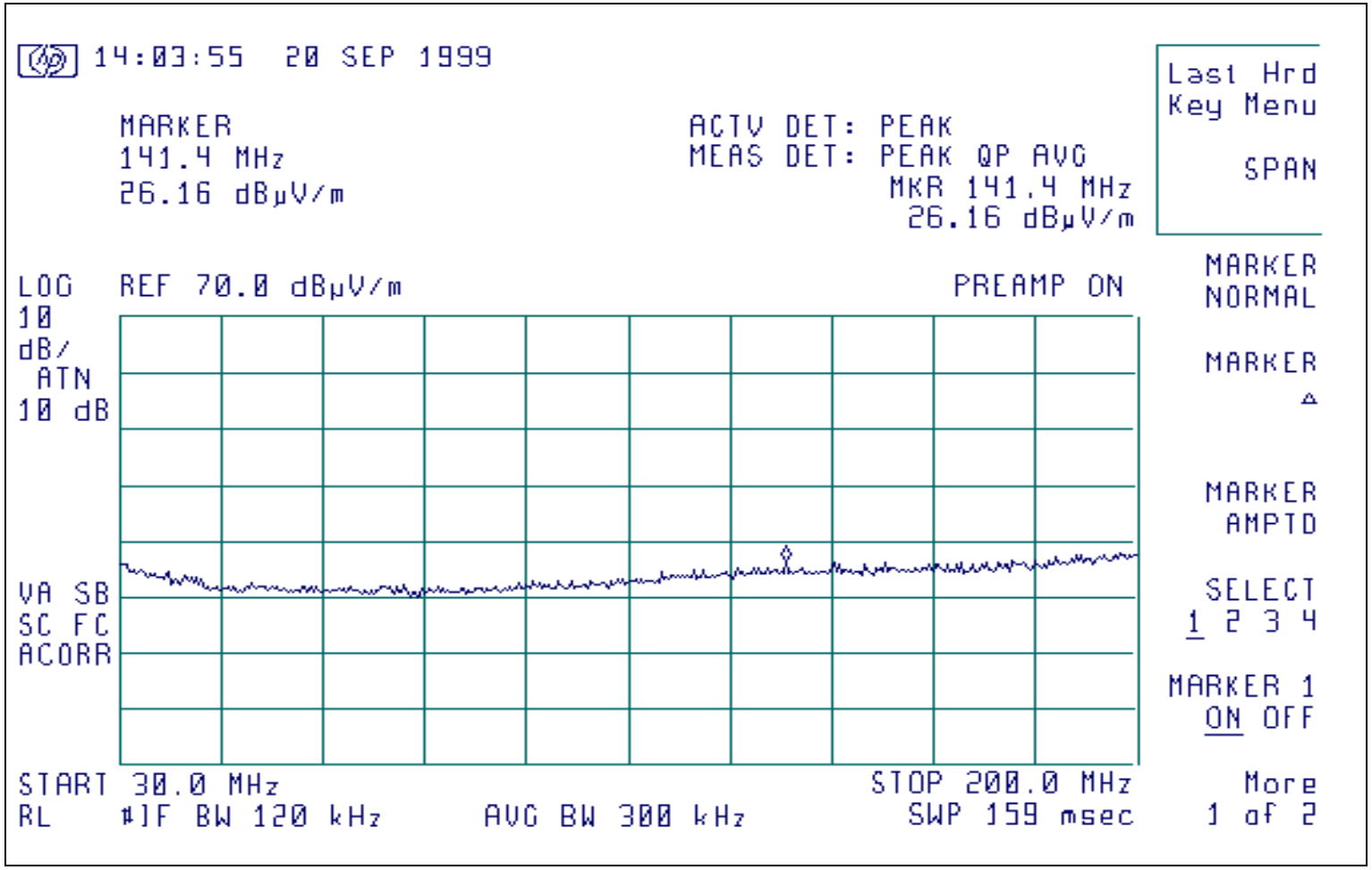


315 MHz Transmitter, emissions above 1 GHz, horizontal polarity, sample transmitting carrier



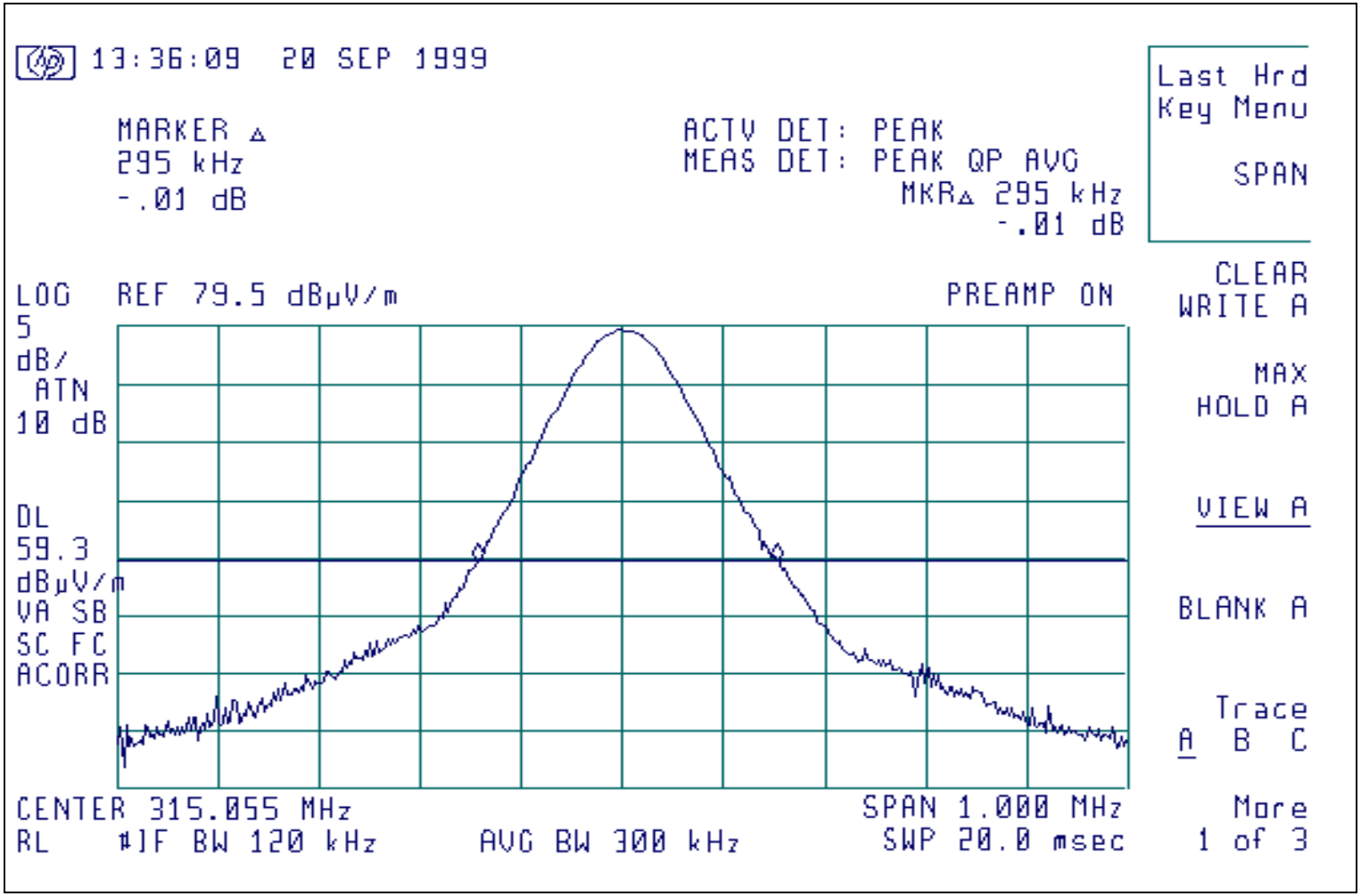
FCC ID: L2C0008T

315 MHz Transmitter, emissions below 1 GHZ, horizontal polarity



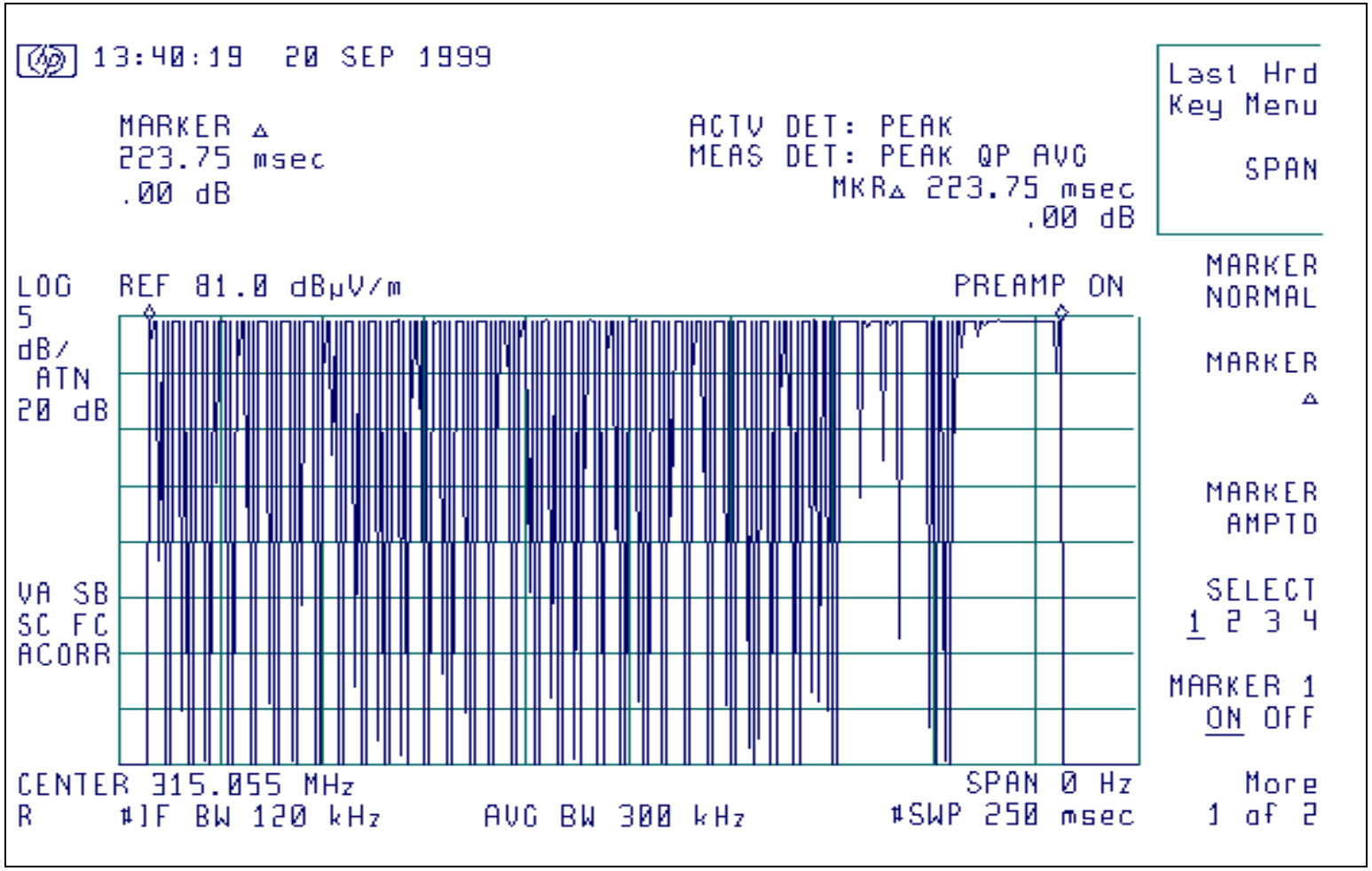
FCC ID: L2C0008T

315 MHz Transmitter, occupied bandwidth



FCC ID: L2C0008T

315 MHz Transmitter duty cycle, showing one entire packet



FCC ID: L2C0008T

315 MHz Transmitter duty cycle, 20 millisecond period