



L. S. Compliance, Inc.  
W66 N220 Commerce Court  
Cedarburg, Wisconsin 53012

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# L. S. Compliance, Inc.

*Compliance Testing of:*

*Teklogix Inc*

*900 MHZ MICRO RADIO*

*Prepared for:*

*Mr. Sada Dharwarkar*

***UPDATED per FCC Reference Number 10436***

*Test Report Number: 90030*

*Date(s) of Testing:*

*September 8,9,29, 1999*

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

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Section 1.1

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. ”*

**Section 1.2**

***SIGNATURE PAGE***

Tested By:

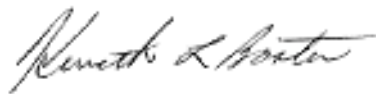


30  
Sept.  
1999

Thomas T Lee, EMC Engineer

Date

Prepared By:

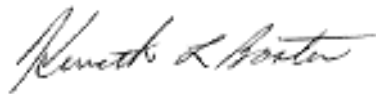


30  
Sept.  
1999

Kenneth L. Boston, EMC Lab Manager

Date

Approved By:



30  
Sept.  
1999

Kenneth L. Boston, EMC Lab Manager

Date

PE #31926

Registered Professional Engineer

(State of Wisconsin)



1.3 SUMMARY OF TEST REPORT

MANUFACTURER: Teklogix Incorporated  
MODEL: 900 MHz Micro Radio  
SERIAL: pre-production  
DESCRIPTION: 900 MHz FSK transceiver  
FREQUENCY RANGE: 902.652-904.150 MHz; 925.764-927.262 MHz

The 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 8, 9 and 29 of 1999, a series of Radiated Emissions tests were performed on two sample models of the Teklogix Micro Radio, a small wireless 900 MHz transceiver combined with a handheld data terminal used to interface with a data terminal. 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 15.249 for a low power transmitter. These tests were performed by Thomas T Lee of L. S. Compliance, Inc.

#### 1.5 PURPOSE

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

|        |        |
|--------|--------|
| 15.109 | 15.209 |
| 15.205 | 15.249 |

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 sample was operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. The sample was placed on an 80cm high wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. Each test sample was powered via a short cable to the handheld scanner containing an internal battery. The test samples were configured to run in a continuous transmit mode (either cw carrier or a repetitive data string) during the radiated emission measurements. Both test samples were set to operate on standard channels and were tested as intentional radiators, in order to determine compliance within a frequency range of-902-928 MHz, as determined by FCC part 15.31m

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 15.249 limits for low power 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 ( $\mu\text{V}/\text{m}$ ). 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. These frequencies, and their associated limits, are referenced in Appendix A. 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.

Significant emissions, which were investigated, include the transmitter fundamental, clock harmonics associated with the data terminal, and some harmonics. For the frequency range 30-10000 the samples were tested for transmitter emissions to CFR 47; 15.249. The unit was scanned for emissions in both transmit and receive modes, over the range 30 to 5000 MHz to establish compliance with Part 15.109 for both the transmitter and the receiver (which is subject to verification under Part 15.101b)., The same procedures as detailed for the transmitter tests described above were used to perform these measurements.



## 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. 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 Average 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, or the battery located in the handheld scanner, as opposed to using a power cord, it was not necessary to perform a test for Conducted Emissions.

Manufacturer: Teklogix  
Model: Micro Radio  
Serial Number(s): preproduction

**1.10 - Restricted Bands affecting this product**

| Frequency (MHz) | Limit ( $\mu$ V) | Limit (dB/ $\mu$ V/m) |
|-----------------|------------------|-----------------------|
| 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                  |
| 3260-3267       | 500              | 54.0                  |
| 3332-3339       | 500              | 54.0                  |
| 3345.8-3358     | 500              | 54.0                  |
| 3600-4400       | 500              | 54.0                  |
| 4500-5150       | 500              | 54.0                  |
| 5350-5460       | 500              | 54.0                  |
| 7250-7750       | 500              | 54.0                  |
| 8025-8500       | 500              | 54.0                  |
| 9000-9200       | 500              | 54.0                  |

1.11 – Photos taken during testing



View of the Scanner and transceiver during the Radiated Emissions tests. This view shows the orientation of the product where the maximum signal levels were present (horizontal polarity).



View of the Scanner during the Radiated Emissions tests. This view shows the sample during the 1 meter measurements above 5 GHz.



## 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 Micro Radio does “**meet**” the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. The level of the fundamental carrier is found to be only **1.5 dB** below the limit at channel 0, and **1.9 dB** below at channel 8. As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

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**

| <b>Asset #</b> | <b>Manufacture<br/>r</b> | <b>Model #</b> | <b>Serial#</b> | <b>Description</b>               | <b>Due Date</b> |
|----------------|--------------------------|----------------|----------------|----------------------------------|-----------------|
| AA960003       | EMCO                     | 3146           | 9512-4276      | Log Periodic Antenna             | 3aug2000        |
| AA960003       | EMCO                     | 3110B          | 9601/2280      | Biconical Antenna                | 3aug2000        |
| AA960003       | EMCO                     | 3115           | 99111-4198     | Double Ridge Horn Antenna        | 1aug2000        |
| AA960003       | EMCO                     | 2090           | 9607-1164      | Mast/Ttable controller           | I.O.            |
| AA960003       | HP                       | 85460          | 3617A00320     | EMI receiver Display section     | 23aug2000       |
| AA960003       | HP                       | 85462          | 3205A00103     | EMI receiver Preselector section | 23aug2000       |
| AA960003       | HP                       | E4407b         | Us39160256     | 26.5 GHz Spectrum Analyzer       | 16june2000      |



## **APPENDIX A:**

### SAMPLE CALCULATIONS

Manufacturer: Teklogix  
Model: Micro Radio  
Serial Number(s): Preproduction

**Calculation of Radiated Emissions limits for  
FCC Part 15.249 (902-928 MHz)**

**FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:**

Limit of 50,000 uV/m; in dB;  $20 \log(50,000) = 94$  dBuV/m

**FIELD STRENGTH OF HARMONIC FREQUENCIES:**

Limit of 500 uV/m; in dB;  $20 \log(500) = 54$  dBuV/m

**FIELD STRENGTH OF SPURIOUS/ FREQUENCIES:BY 15.249 (C)**

Limit of -50 dBc of the fundamental limit;  $94 - 50 + 44$  dBuV/  
Except where the 15.209 limits will allow a higher limit to be used.

| <b>Frequency<br/>(MHz)</b> | <b>limit<br/>(<math>\mu</math>V/m)</b> | <b>limit<br/>(dB <math>\mu</math>V/m)</b> |
|----------------------------|--|---|
| 902-928                    | 50,000                                 | 94  |
| f2,f3,f4....               | 500                                    | 54  |
| Spurs; 30-88               | 159                                    | 44  |
| Spurs; 88-216              | 159                                    | 44  |
| Spurs; 216-960             | 500                                    | 46  |
| Spurs; 960-9280            | 500                                    | 54  |





## **APPENDIX B:**

### DATA CHARTS

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 9280 MHz

|                 |  |                   |   |
|-----------------|--|-------------------|---|
| Date of Test:   | <u>September 8,9,29, 1999</u>  | Manufacturer:     | <u>Teklogix</u>   |
| Location:       | <u>L.S. Compliance, Inc.</u><br><u>W66 N220 Commerce Court</u><br><u>Cedarburg, WI 53012</u>               | Model No.:        | <u>Micro radio</u>  |
| Specifications: | <u>Title 47CFR, FCC Part 15.231b</u>   | Serial No.:       | <u>Pre-production</u>   |
| Distance:       | <u>3 meters, 1 meter</u>   | Configuration:    | <u>Continuous transmit</u>                                    |
| Equipment:      | <u>HP 8546A EMI Receiver</u><br><u>EMCO 3115 Double Ridged Waveguide</u><br><u>EMCO 3146A Log Periodic</u> | Detector(s) Used: | <u>Quasi-peak, below 1 GHz</u><br><u>Average, above 1 GHz</u> |

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°) | Channel | EMI Meter Reading (dB μV/m) | 15.249 Limit (dB μV/m) | Margin (dB) |
|-----------------|------------------|-----------------|---------------------|---------|-----------------------------|------------------------|-------------|
| 902.63          | V                | 1.0             | 216                 | 0       | 92.5                        | 94.0                   | 1.5         |
| 903.92          | V                | 1.0             | 83                  | 6       | 89.0                        | 94.0                   | 5.0         |
| 925.76          | V                | 1.0             | 85                  | 8       | 92.1                        | 94.0                   | 1.9         |
| 927.26          | V                | 1.0             | 85                  | 15      | 90.8                        | 94.0                   | 3.2         |
| 1855            | V                | 1.0             | 255                 | 15      | 37.5                        | 54.0                   | 16.5        |
| 1855            | H                | 1.0             | 23                  | 15      | 39.8                        | 54.0                   | 14.2        |
| 1805            | H                | 1.0             | 60                  | 0       | 42.0                        | 54.0                   | 12.0        |

## Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 9280 MHz

|                 |   |                   |   |
|-----------------|---|-------------------|---|
| Date of Test:   | September 8, 9 and 29, 1999   | Manufacturer:     | Teklogix  |
| Location:       | L.S. Compliance, Inc.<br>W66 N220 Commerce Court<br>Cedarburg, WI 53012               | Model No.:        | Micro Radio                                     |
| Specifications: | Title 47CFR, FCC Part 15.231b   | Serial No.:       | Pre-production                                  |
| Distance:       | 3 meters  | Configuration:    | Continuous xmit , chs. 0 & 15                   |
| Equipment:      | HP 8546A EMI Receiver<br>EMCO 3115 Double Ridged Waveguide<br>EMCO 3146A Log Periodic | Detector(s) Used: | Quasi-peak, below 1 GHz<br>Average, above 1 GHz |

The following table depicts the level of significant spurious emissions found:

| Frequency (MHz) | Antenna Polarity | Height (meters) | Azimuth (0° - 360°) | EMI Meter Reading (dB $\mu$ V/m) | 15.249 Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|------------------|-----------------|---------------------|----------------------------------|-----------------------------|-------------|
| 176.0           | H                | 1.3             | 0                   | 34.4                             | 44.0                        | 9.6         |
| 208.0           | H                | 1.3             | 17                  | 30.1                             | 44.0                        | 13.9        |
| 256.0           | H                | 1.0             | 169                 | 32.7                             | 46.0                        | 13.3        |
| 288.0           | H                | 1.0             | 169                 | 34.3                             | 46.0                        | 11.7        |
| 288.0           | V                | 1.0             | 62                  | 28.8                             | 46.0                        | 17.2        |
| 320.0           | H                | 1.4             | 306                 | 37.3                             | 46.0                        | 8.7         |
| 432.0           | H                | 1.0             | 130                 | 40.3                             | 46.0                        | 5.7         |
| 928.0           | H                | 1.2             | 200                 | 39.3                             | 46.0                        | 6.7         |
| 2056.0          | V                | 1.0             | 178                 | 40.2                             | 54.0                        | 13.8        |
| 2552.0          | V                | 1.0             | 193                 | 38.8                             | 54.0                        | 15.2        |
| 2565.0          | H                | 1.0             | 104                 | 37.1                             | 54.0                        | 16.9        |

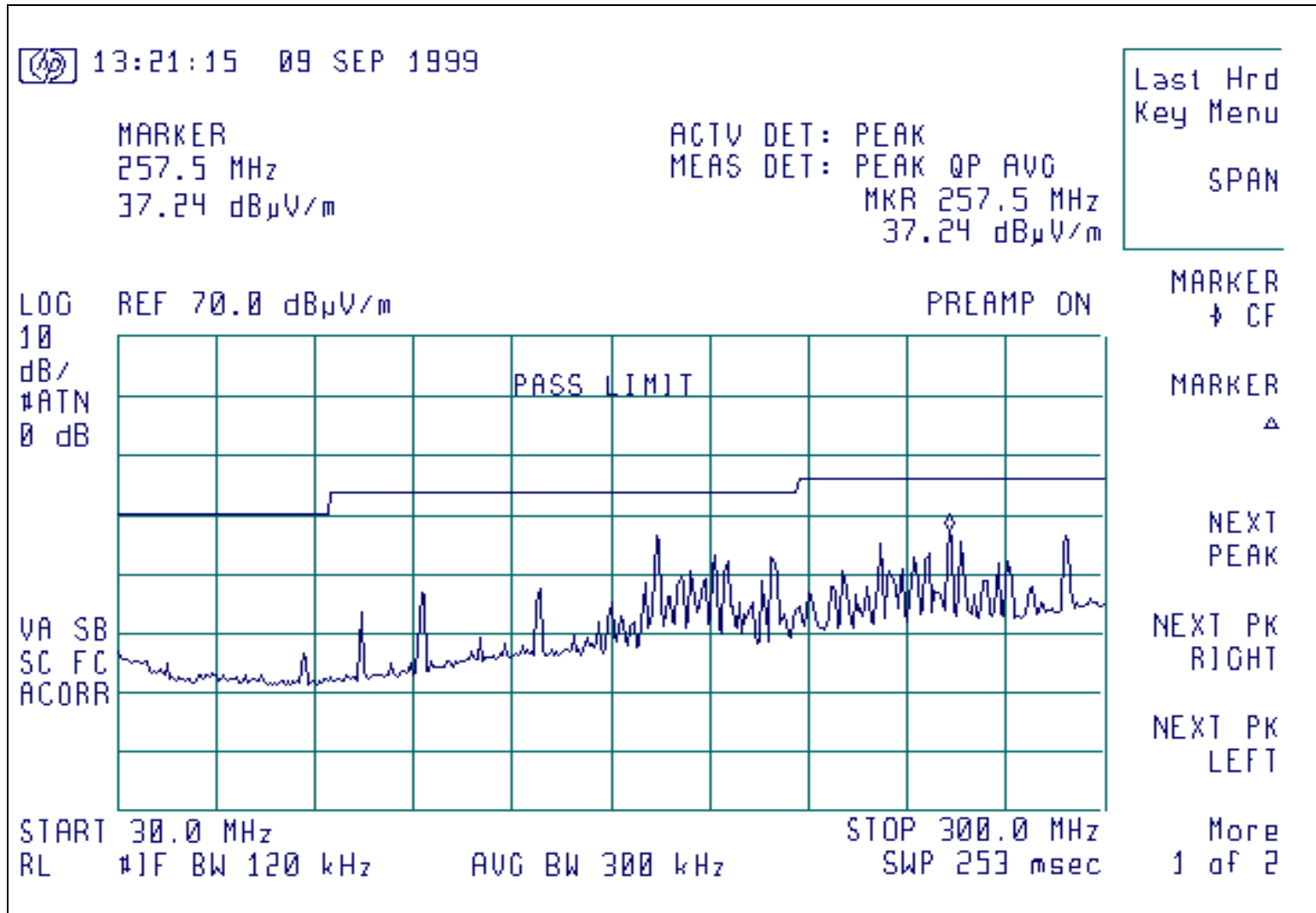


# **APPENDIX C:**

## GRAPHS

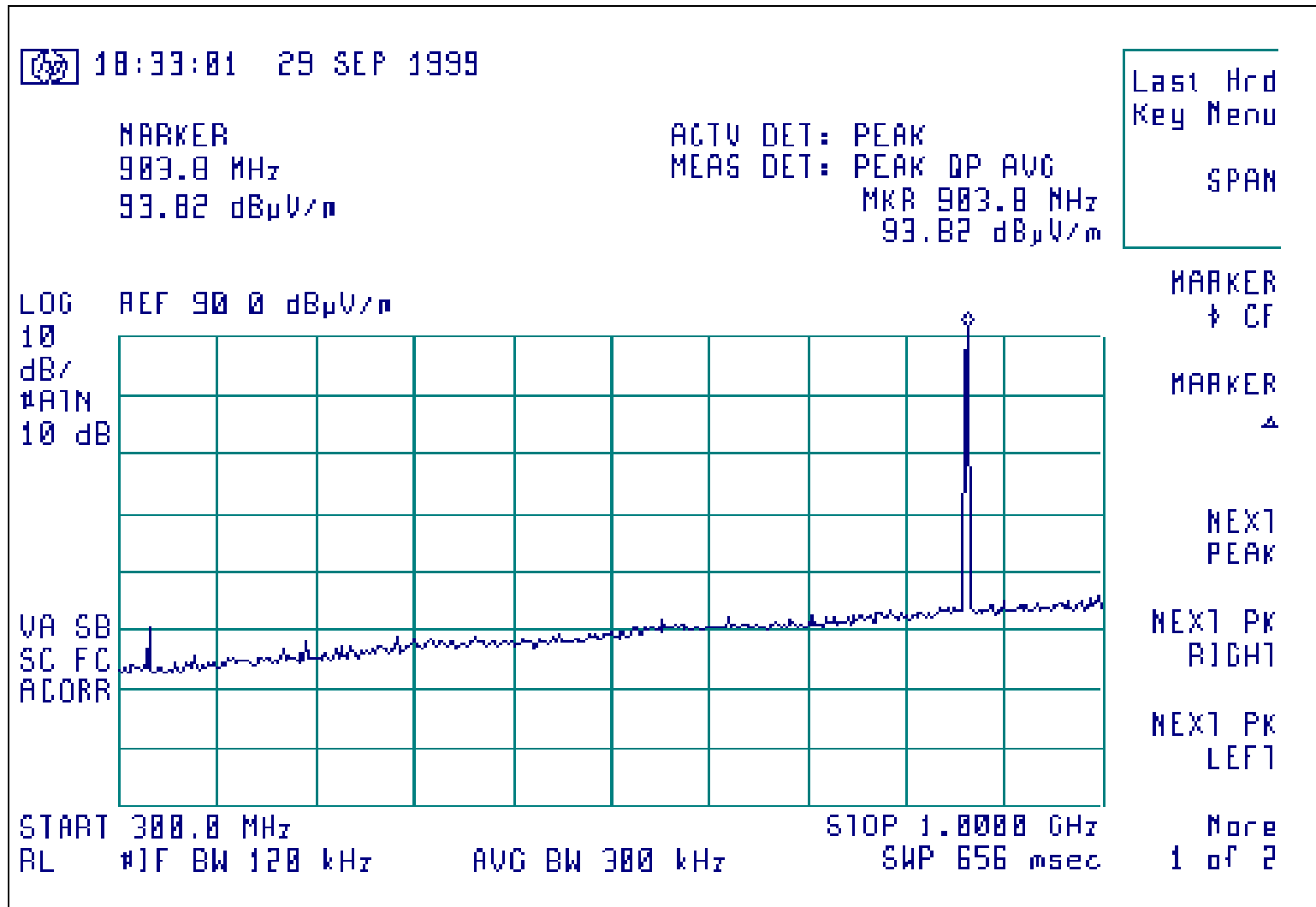


**Transmitter, emissions below 1 GHz, horizontal polarity, Channel 0**



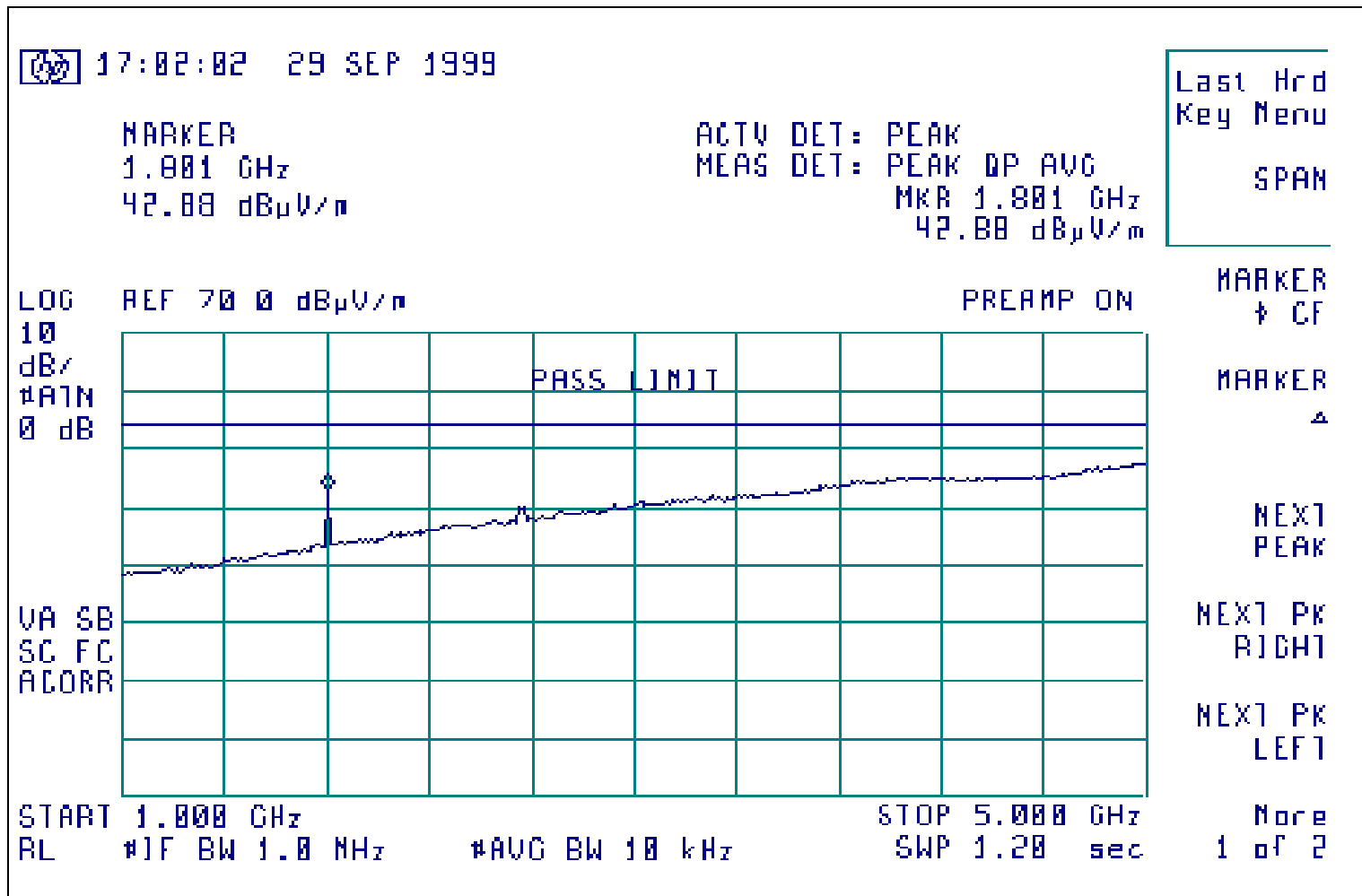


**Transmitter, emissions below 1 GHz, horizontal polarity, channel 0**



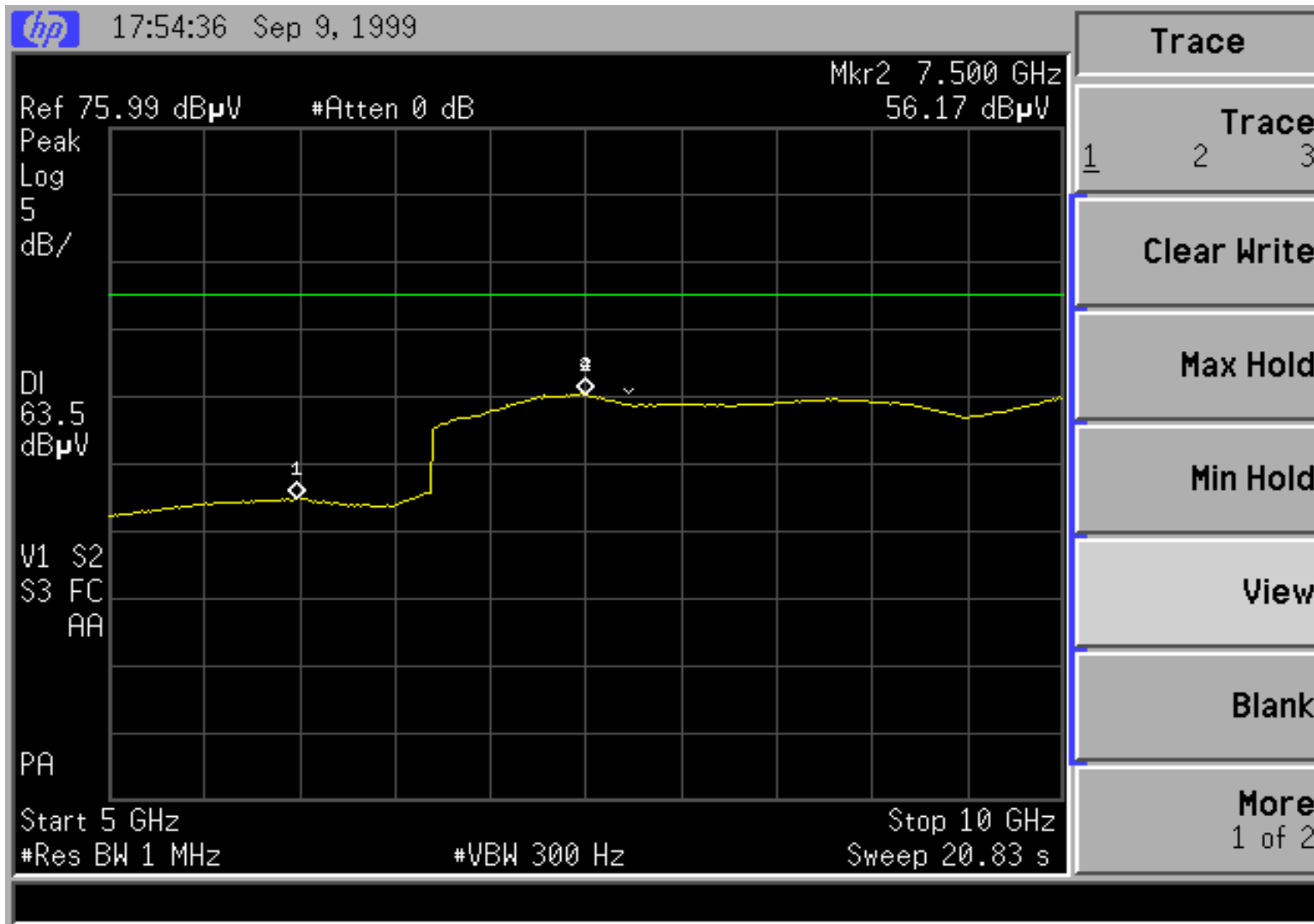


**Transmitter, emissions above 1 GHz, horizontal polarity, channel 0**  
 (reduced average bandwidth utilized for purpose of signature scan readability)





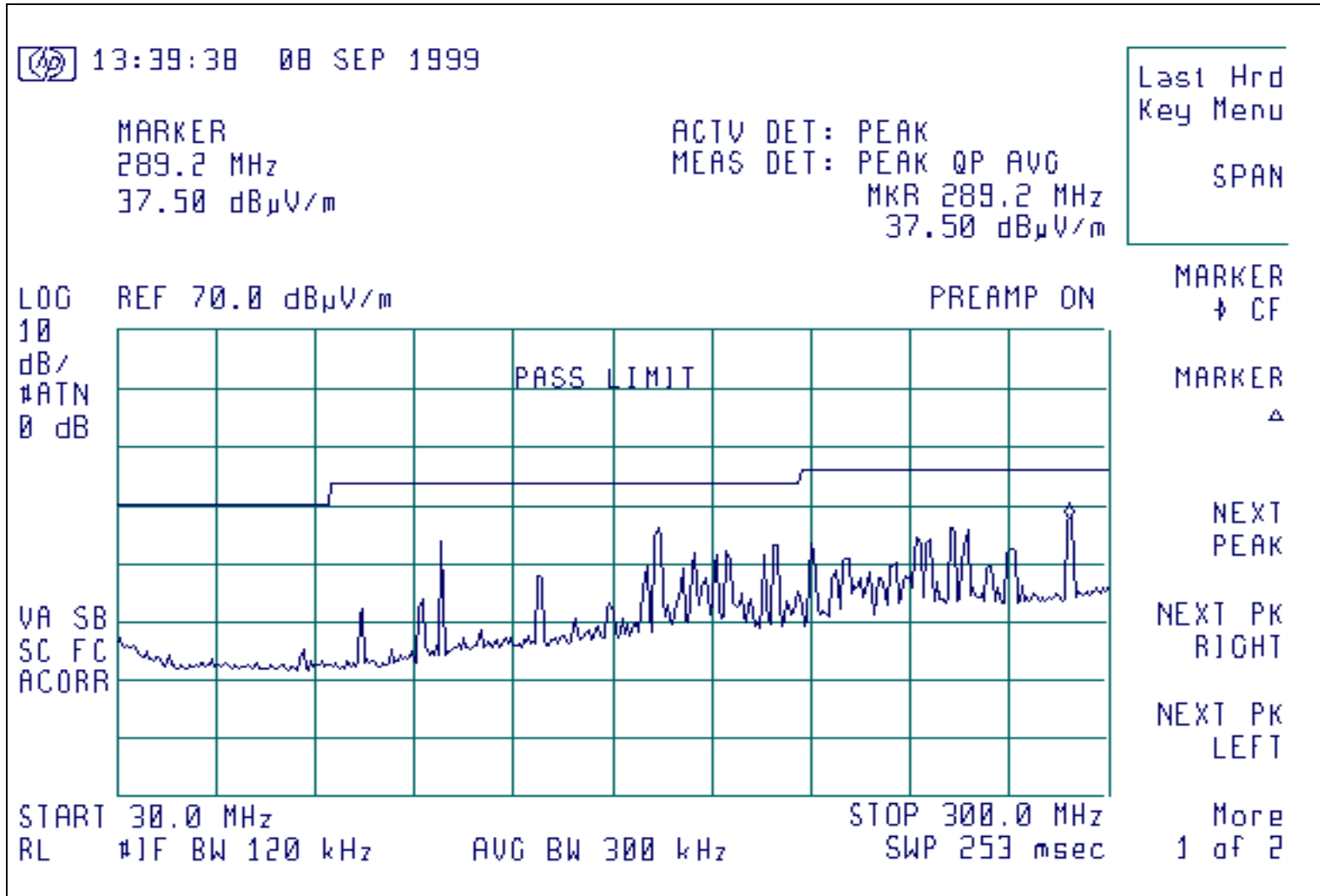
**Transmitter, emissions above 1 gig, channel 0 & 15 (at 1 meter)**  
**(reduced average bandwidth utilized for purpose of signature scan readability)**





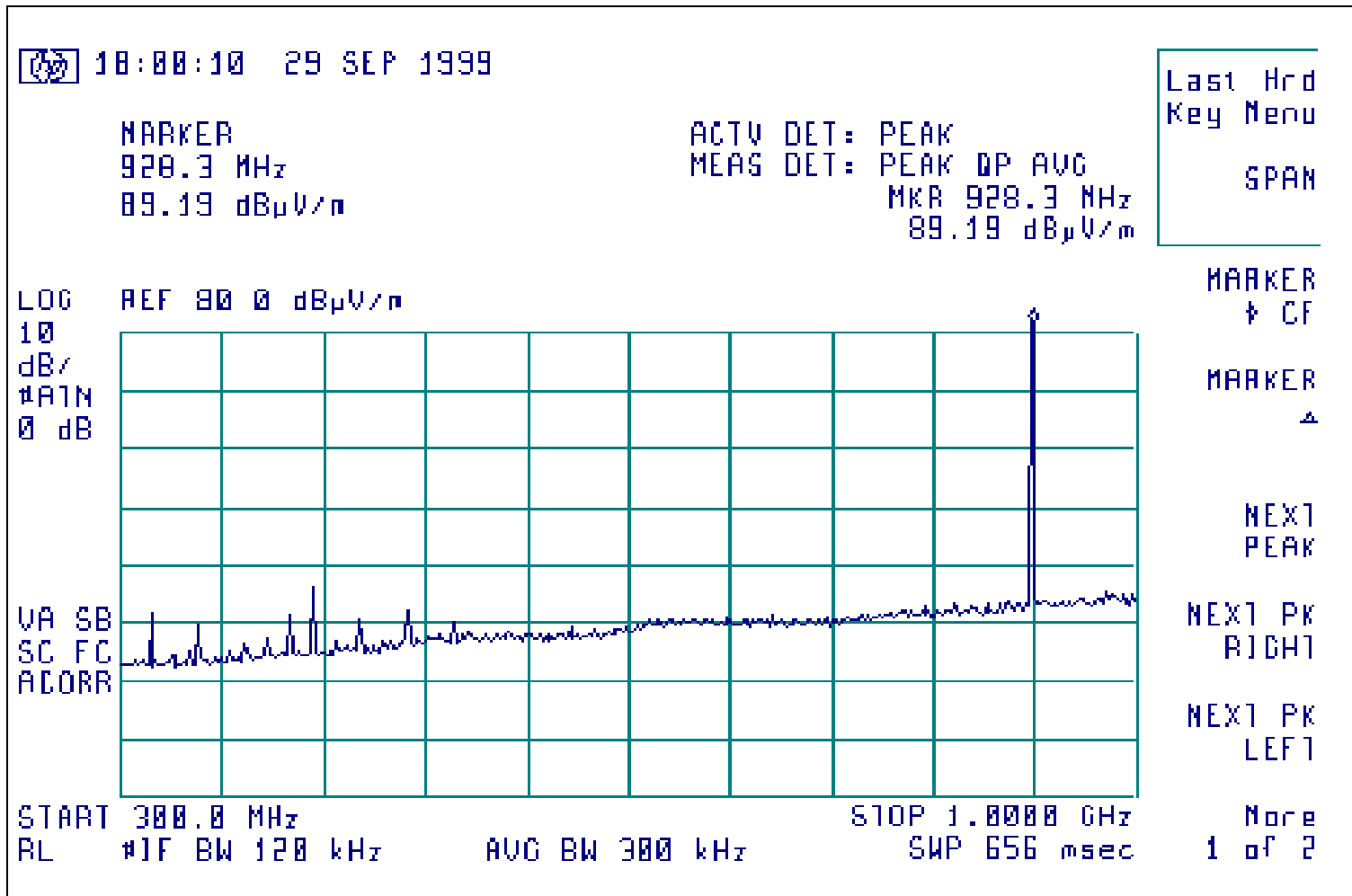


**Transmitter, emissions below 1 GHZ, horizontal polarity, ch15**





**Transmitter, emissions below 1 GHz, vertical polarity ch15**





**Transmitter, vertical above 1 gigahertz, channel 15**  
**(reduced average bandwidth utilized for purpose of signature scan readability)**

