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RADIO SPECTRUM MEASUREMENTS OF INDIVIDUAL MICROWAVE OVENS

VOLUME 2

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ACKNOWLEDGMENT

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NTIA appreciates the support and cooperation of the American Home Appliance Manufacturers (AHAM), and microwave oven manufacturers in providing most of the microwave ovens units for the tests.

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APPENDIX A

UNOFFICIAL FCC PART 18 COMPLIANCE TESTING PROCEDURES USING A SPECTRUM ANALYZER

Due to the difficultly in obtaining some of the test equipment specified in FCC/OST MP-5 (1986), deviations from the MP-5 test procedures have been accepted by the FCC staff. One such procedure involves the use of a spectrum analyzer instead of a field intensity meter. Based on verbal instructions from the FCC Laboratory staff, Underwriter's Labs has used a spectrum analyzer to perform Part 18 compliance testing. Underwriters performs Part 18 compliance testing of microwave ovens for one of the two major U.S. manufacturers of microwave ovens. Similar procedures were conveyed to NTIA/ITS staff in preparation its microwave oven measurements. For more information concerning this procedure or other permissible deviations from MP-5, contact FCC Laboratory, 7435 Oakland Mills Road, Columbia, MD 21046.

The test procedures for use of a spectrum analyzer are as follows.

EQUIPMENT

1) Spectrum analyzer

2) The 6 db bandwidth shall not be less than 1 MHz for measurements above 1000 MHz. Therefore, a 3 dB bandwidth (as is commonly specified) greater than or equal to 1 MHz is acceptable.

3) Emission measurements above 1000 MHz need not be performed on an outdoor range, but may be made at a suitable indoor site.

4) A linearly polarized horn antenna shall be used.

TESTS TO BE PERFORMED

1) Oven output power measurements via calorimetric testing shall be measured.

2) Radiated emission measurements shall be measured.

TEST PROCEDURES

1) The power measurement is performed by placing 1 liter of water at a known temperature in the center of the cavity and heating it at "full power" for a known period of time (5 minutes is suggested). The temperature of the water is measured after the heating, and the total energy coupled into the load is computed by assuming

1° C temperature increase per milliliter of water per calorie. The energy is divided by the time of heating to get total energy rate, in Joules/second = Watts. The equation to be used is:

$$\text{Watts coupled into load} = (\Delta T(^\circ C) * 4187)/\Delta t(\text{seconds}).$$

2) Radiated emission level measurements are performed with a peak detector, 0 Hz span, 1 MHz IF bandwidth, and 3 Hz video bandwidth and linear amplification. Distance from the unit under test is 3 meters. Measurement height is 1 meter above the ground. Measured amplitudes are converted to field strength in dBμV/m at 300 meters, as per MP-5 § 4.6.1.

3) Emission levels are measured at selected frequencies adjacent to the 2400-2500 MHz ISM band. These frequencies are based on peaks observed in initial wide bandwidth measurements.

4) The second through fifth harmonics are measured with the same measurement configuration as described above (MP-5 § 2.3 requires that field intensity meter measurements be performed up to the 10th harmonic or the highest detectable emission).

APPENDIX B

FREQUENCY DOMAIN MEASUREMENTS

This Appendix contains measurements of microwave emission spectra for all the ovens that were included in the NTIA tests. These measurements were made using a 3 meter separation between the oven and the antenna; the oven door facing the center of the measurement antenna (orientation) 1 meter above the floor, and a load of 1 Liter of tap water. Oven emission spectra were measured and are shown in a variety of different measurement bandwidths.

Each graph identifies the measurement bandwidth as well as the oven under test. The data file and record are identified, for the most part, in the lower left-hand corner of the graph in question. Under certain situations, such as where there are multiple files or records, the lower left-hand corner bears the data file description of that graph.

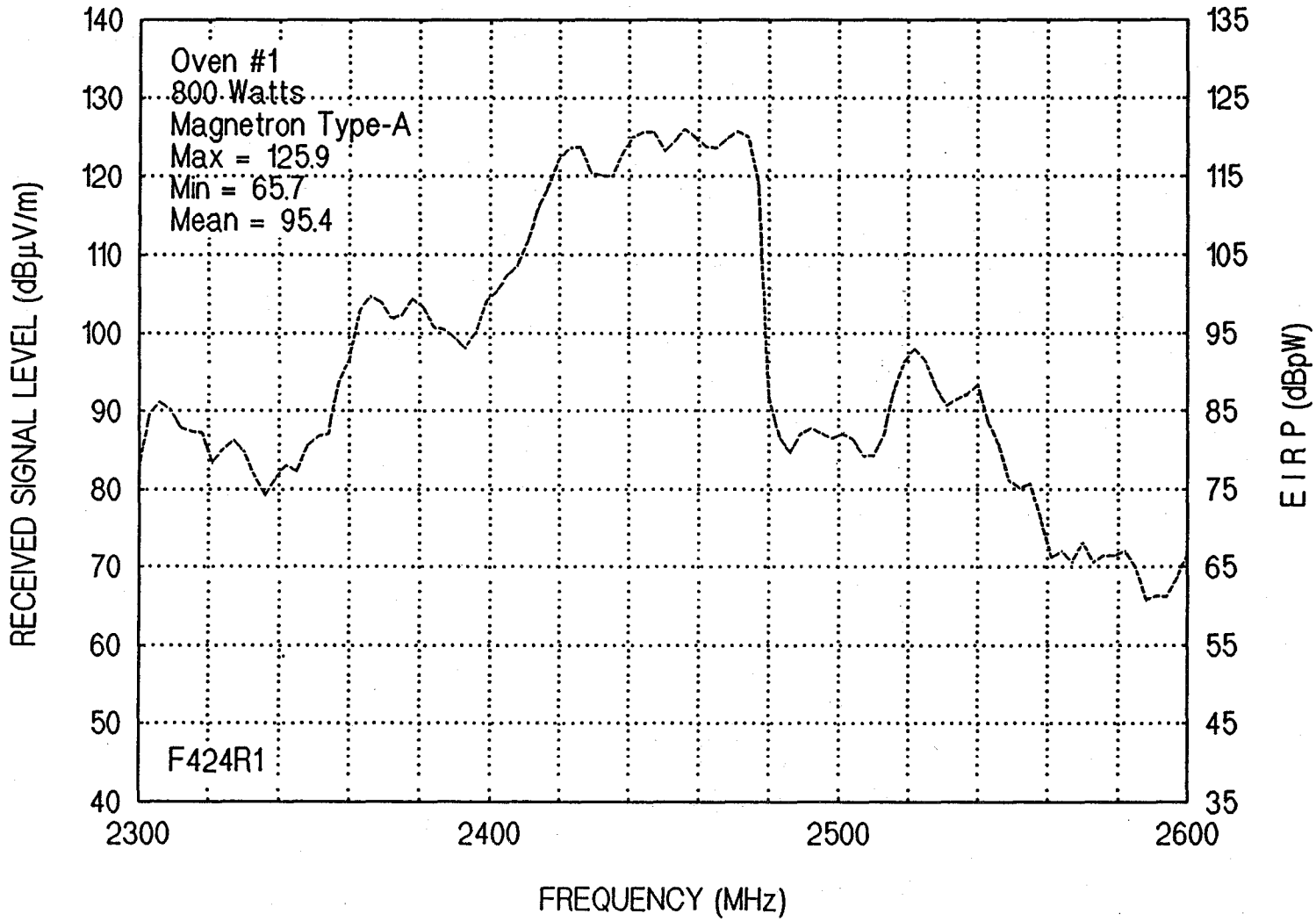


Figure B-1. Oven #1, amplitude vs. frequency.

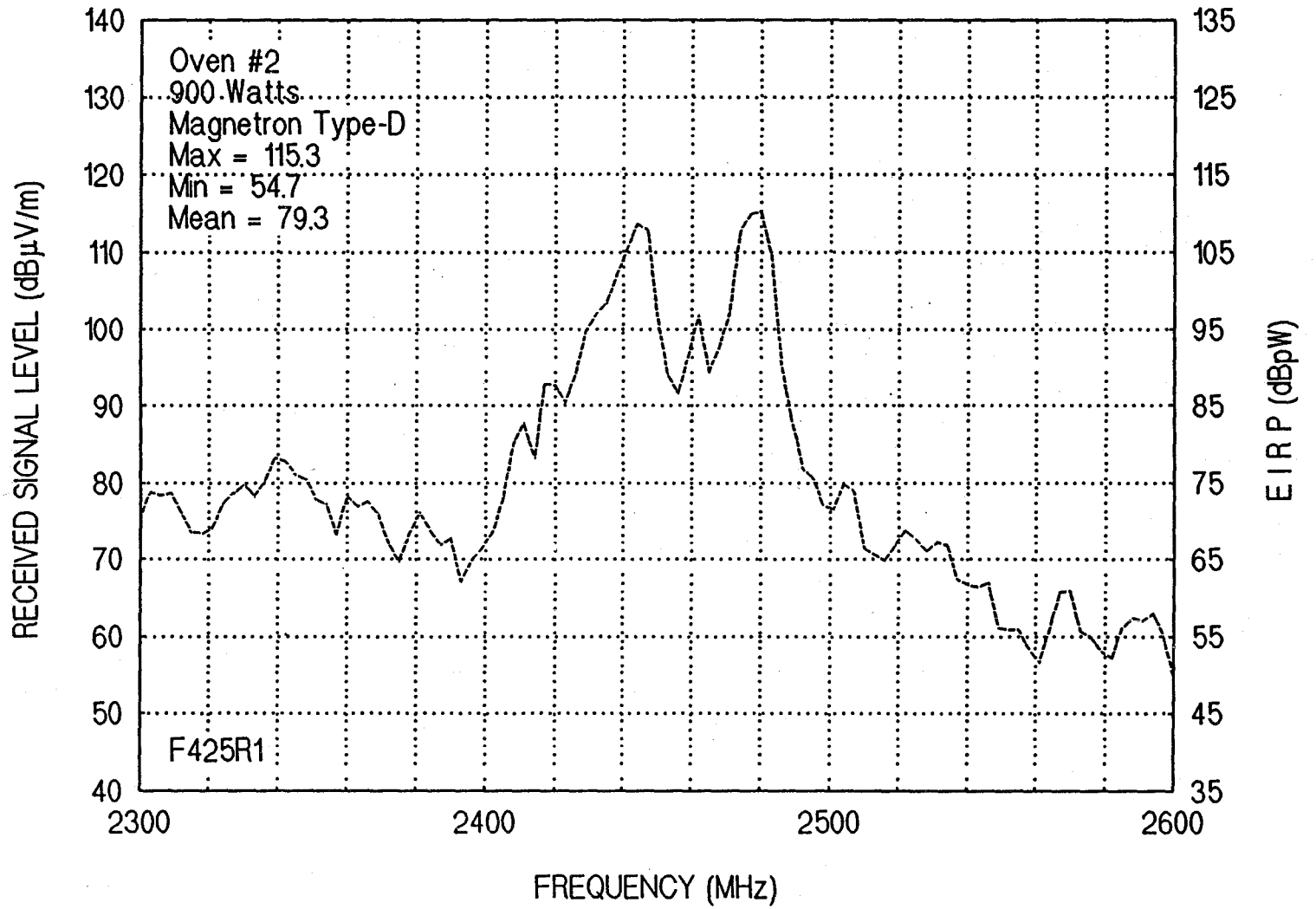


Figure B-2. Oven #2, amplitude vs. frequency.

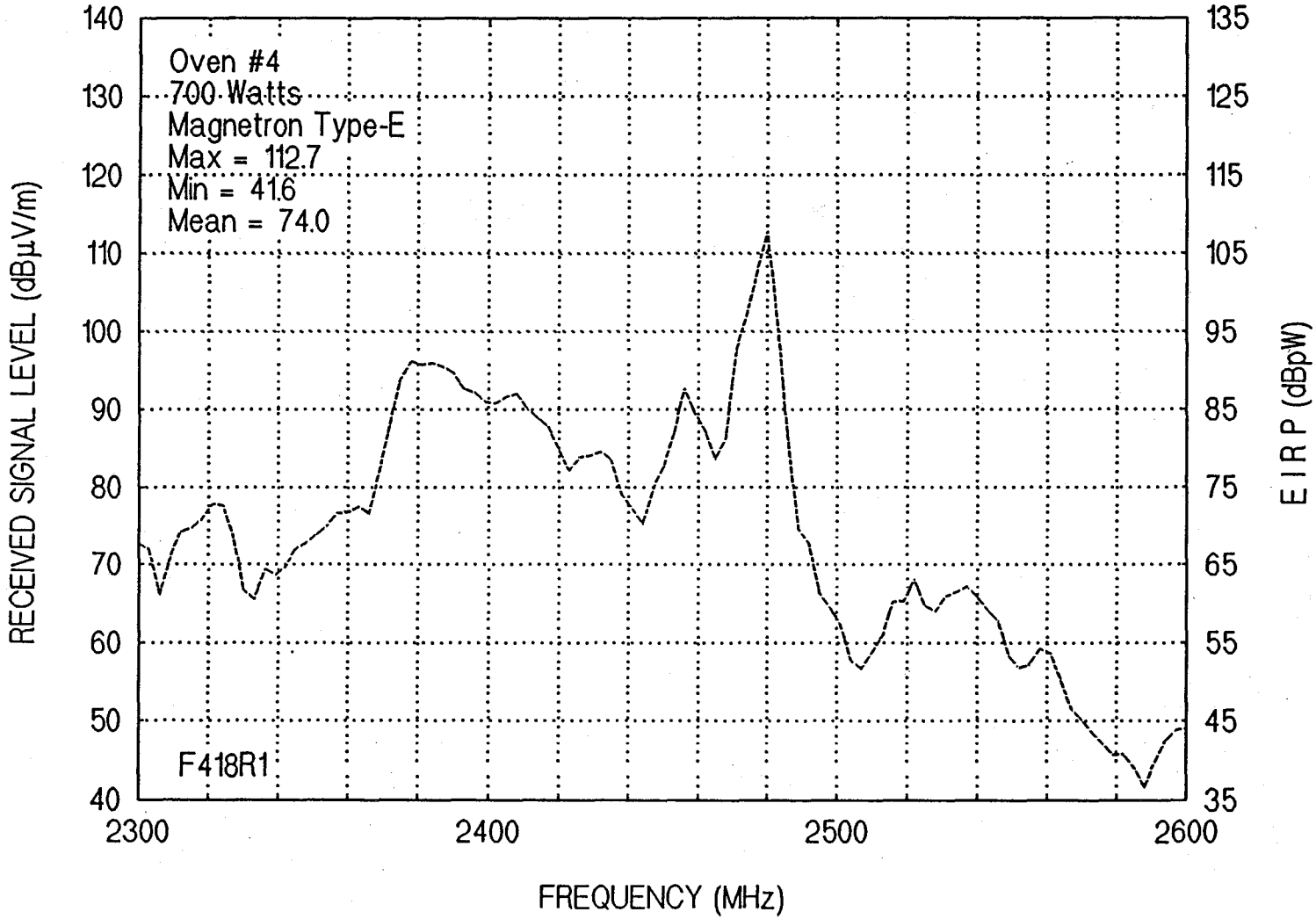


Figure B-3. Oven #4, amplitude vs. frequency.

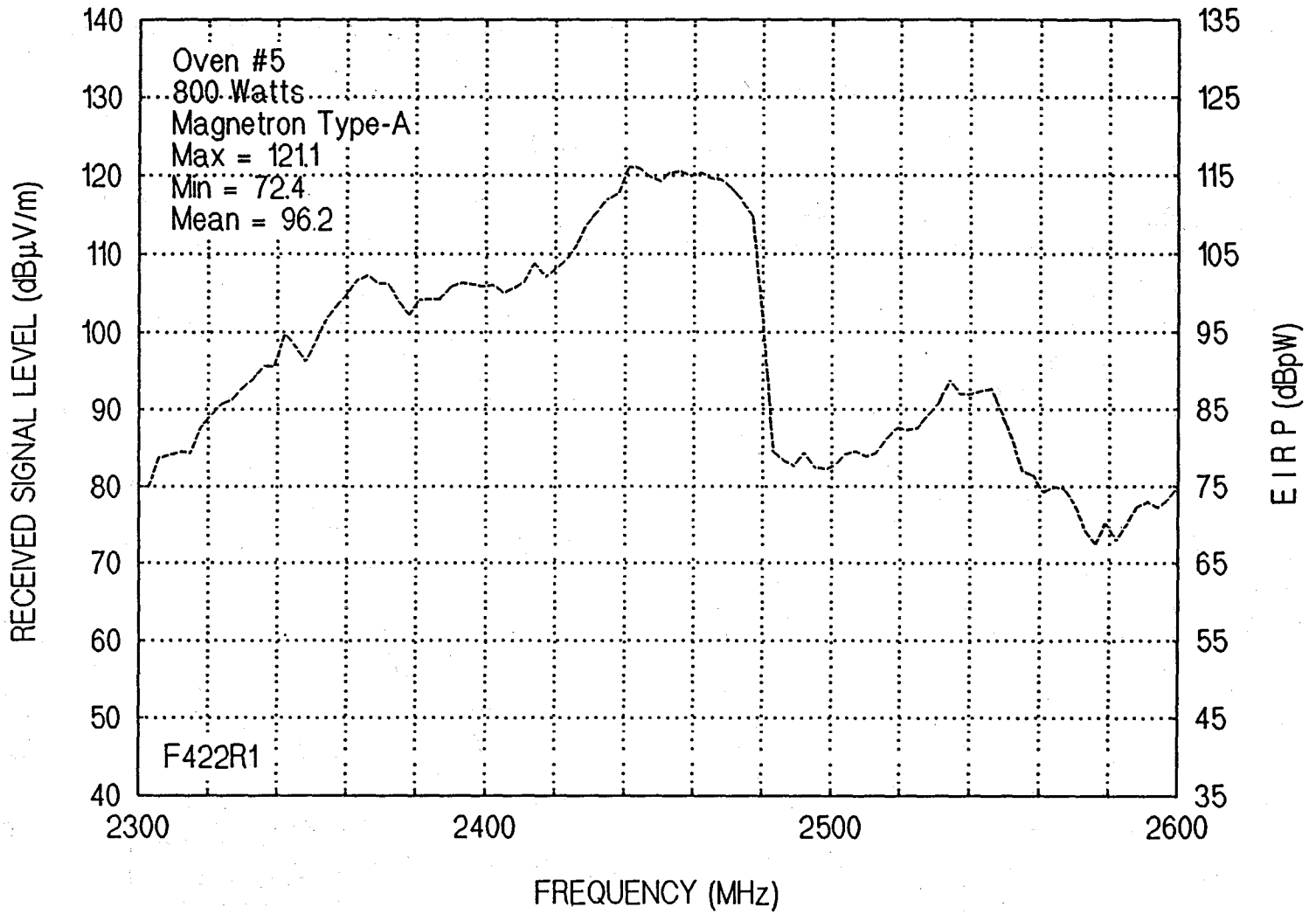


Figure B-4. Oven #5, amplitude vs. frequency.

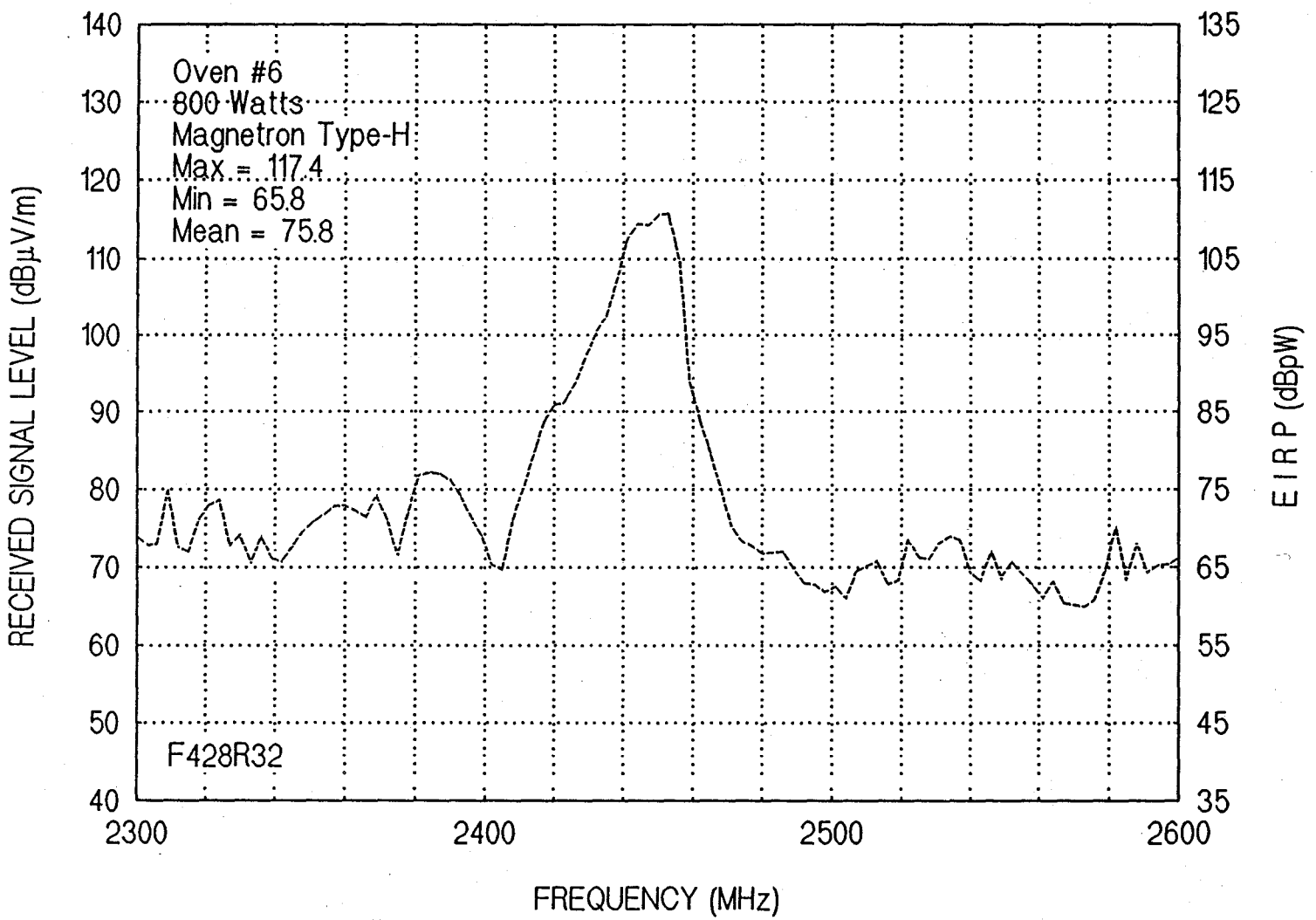


Figure B-5. Oven #6, amplitude vs. frequency.

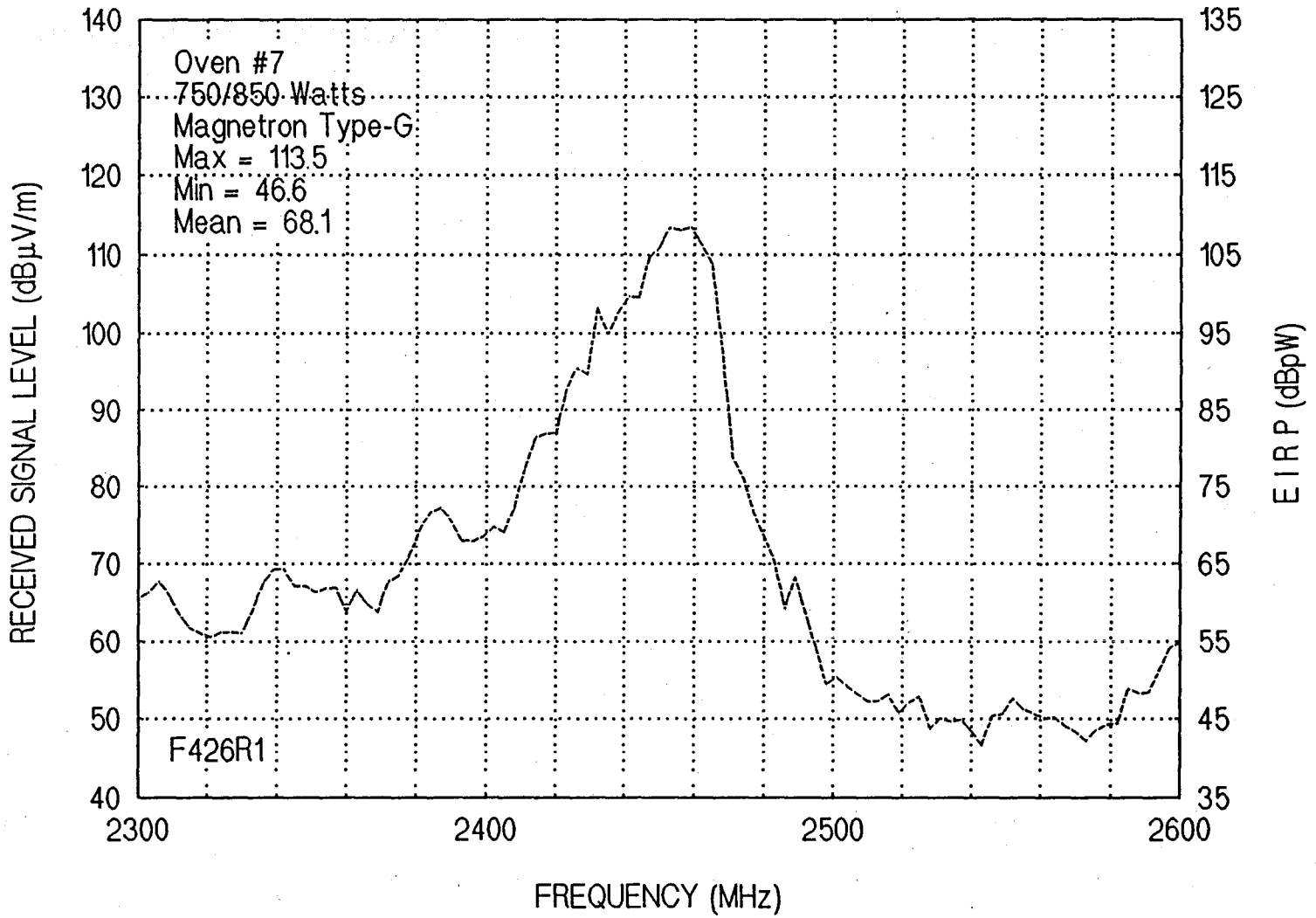


Figure B-6. Oven #7, amplitude vs. frequency.

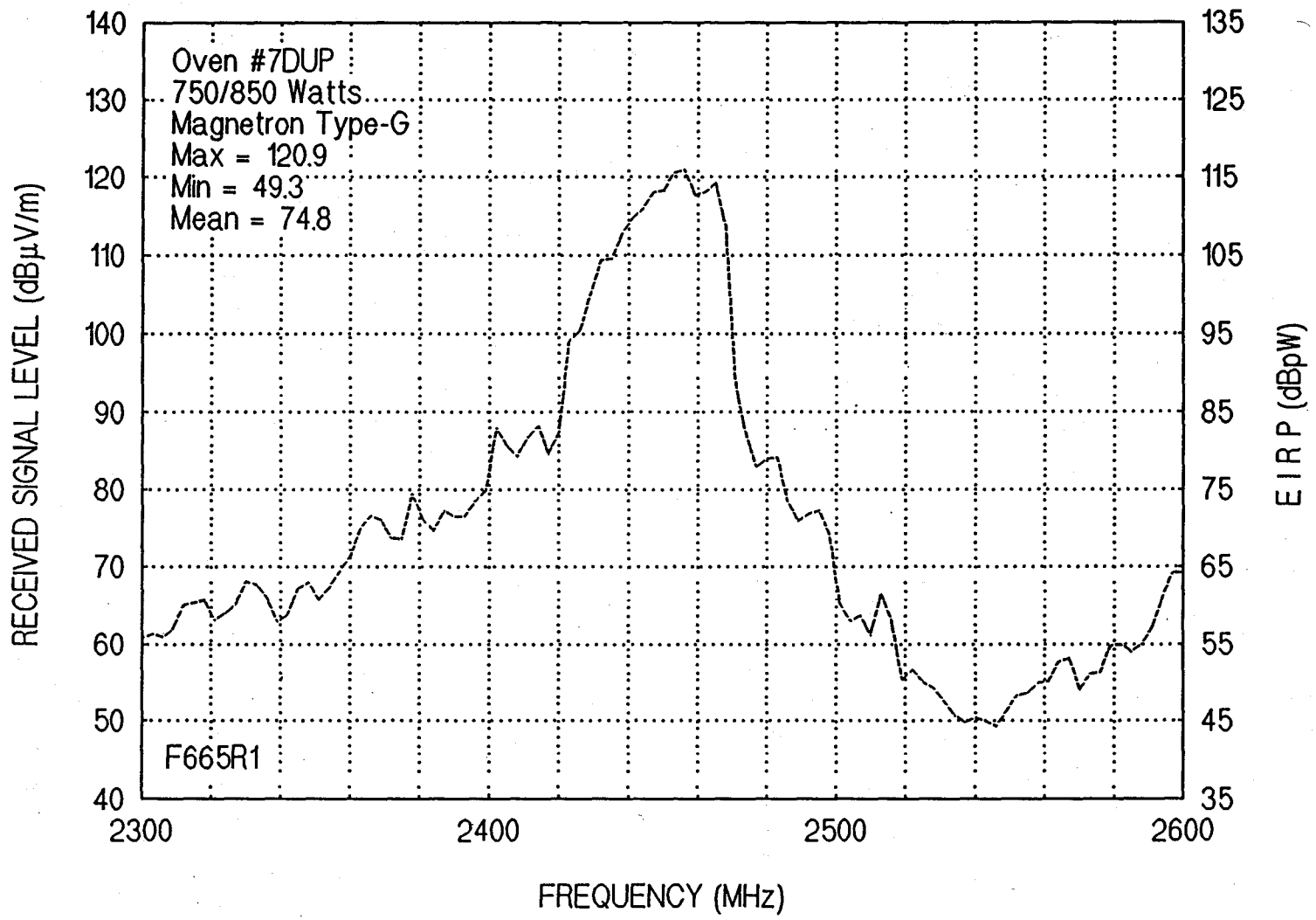


Figure B-7. Oven #7DUP, amplitude vs. frequency.

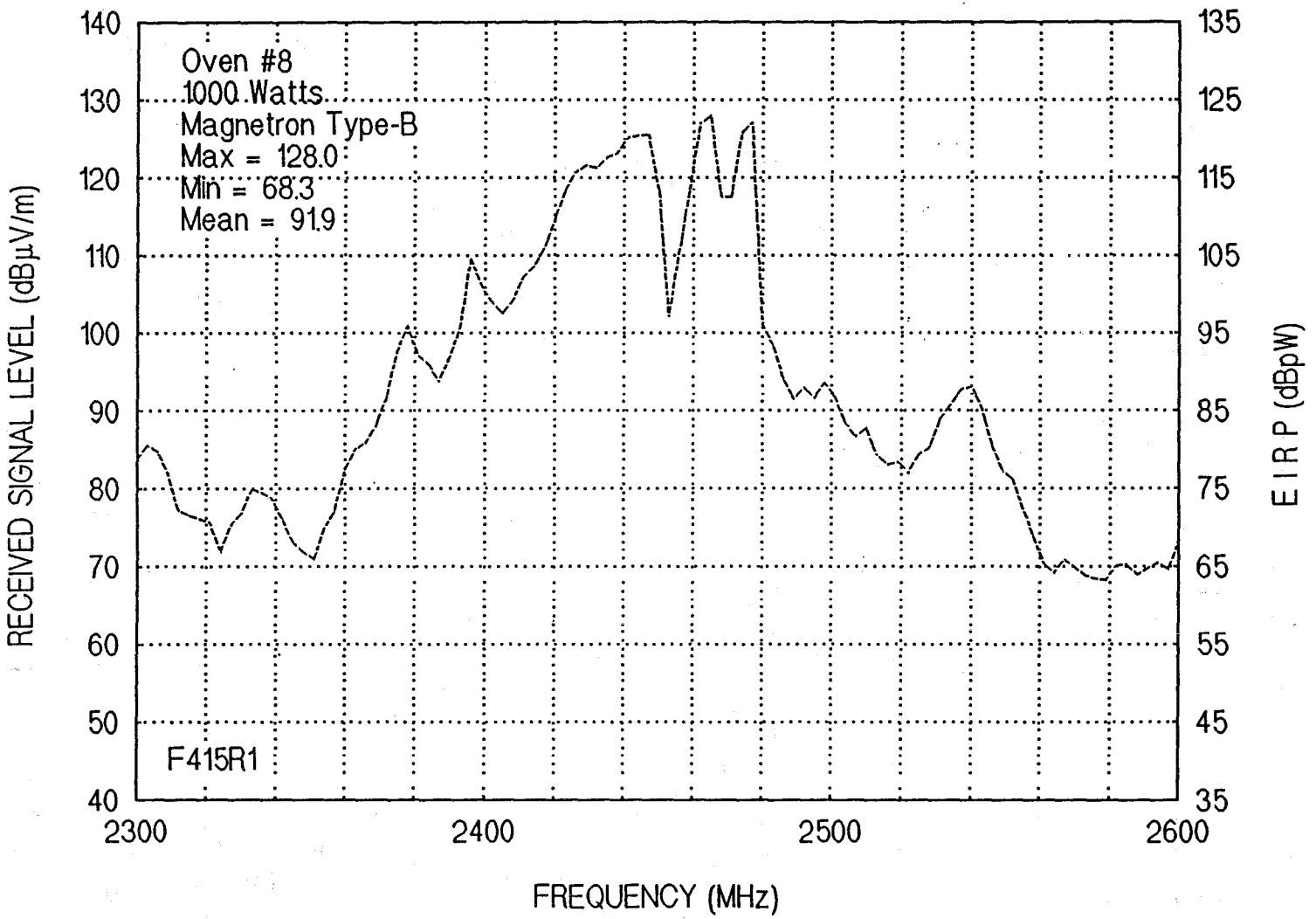


Figure B-8. Oven #8, amplitude vs. frequency.

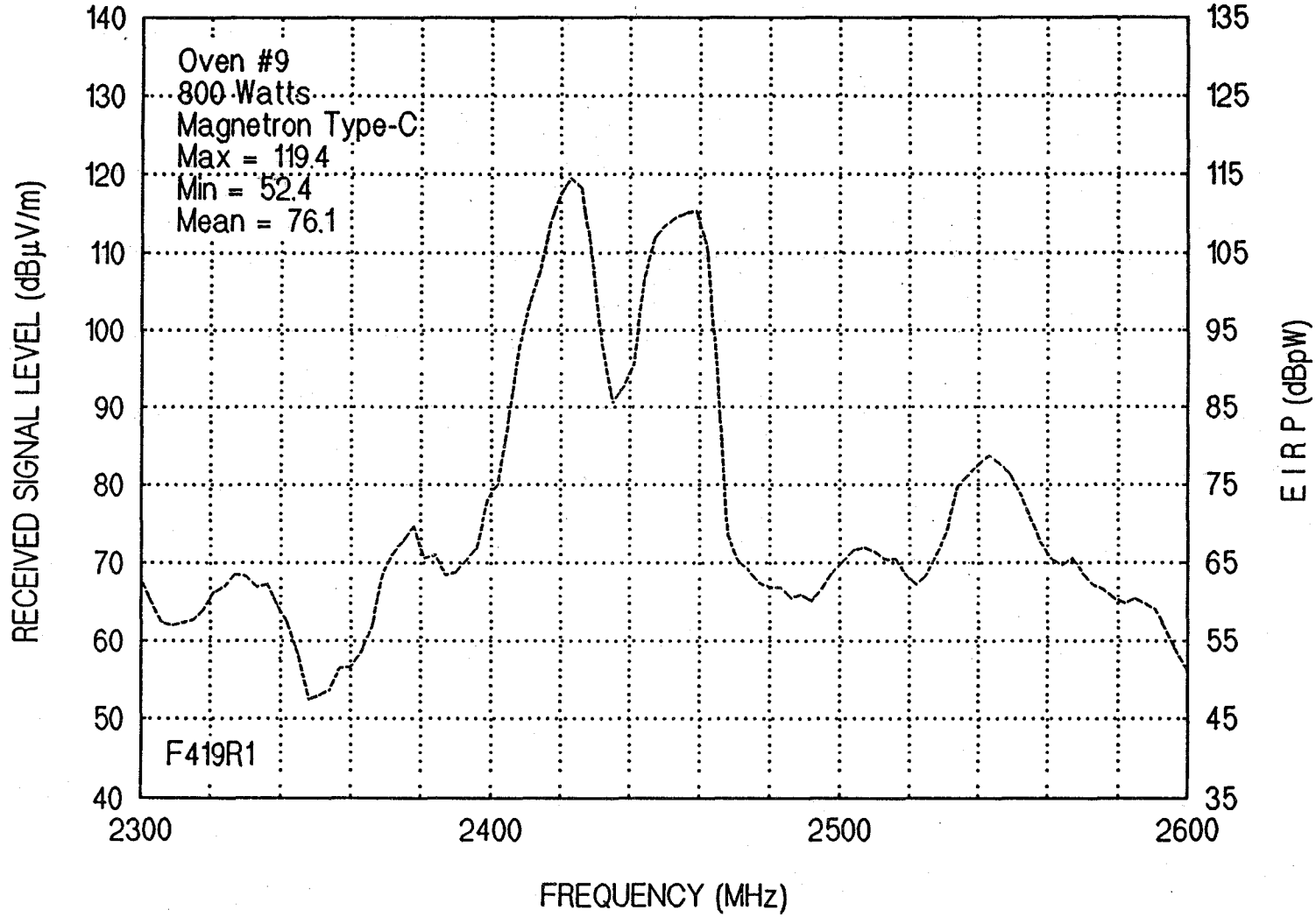


Figure B-9. Oven #9, amplitude vs. frequency.

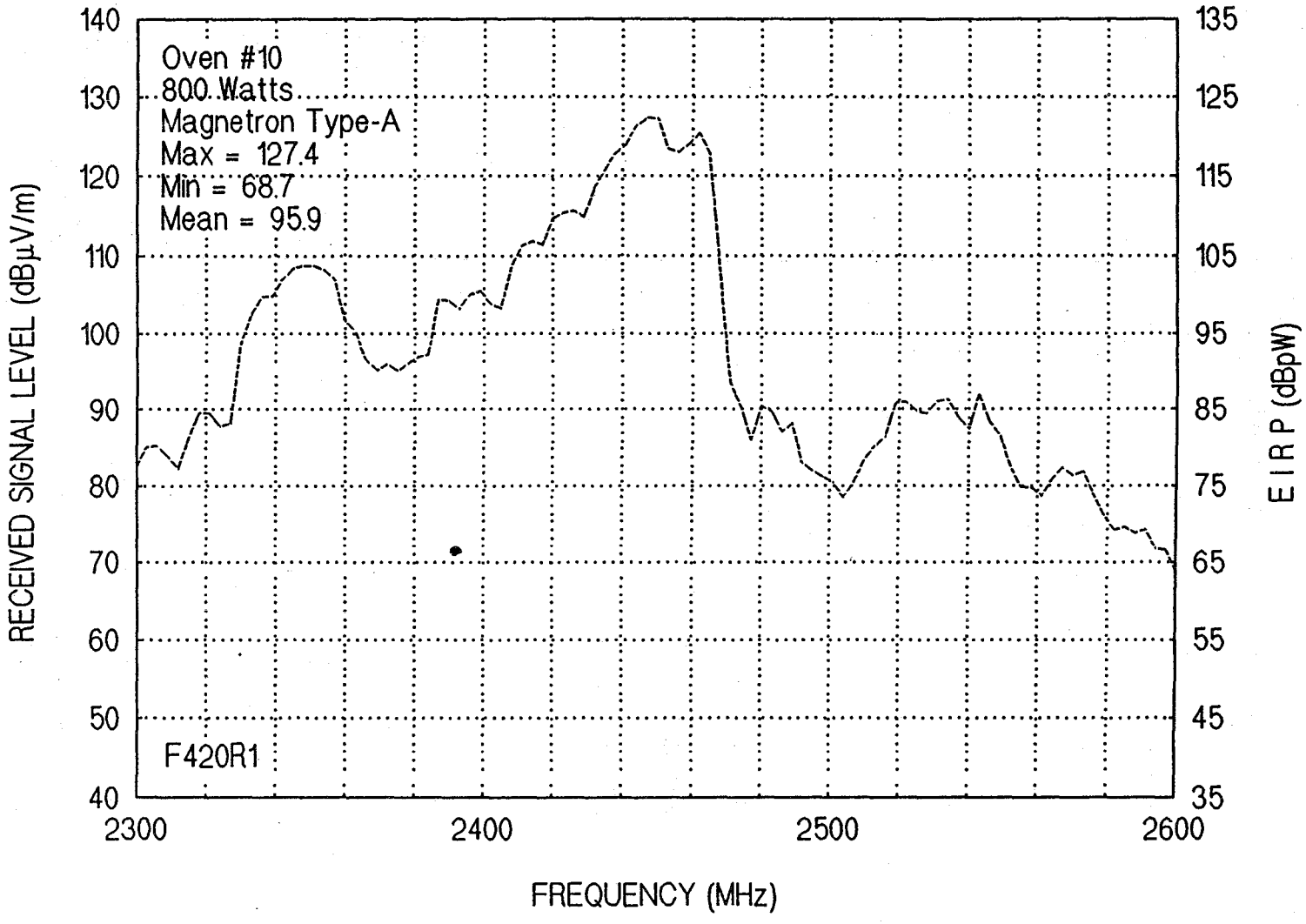


Figure B-10. Oven #10, amplitude vs. frequency.

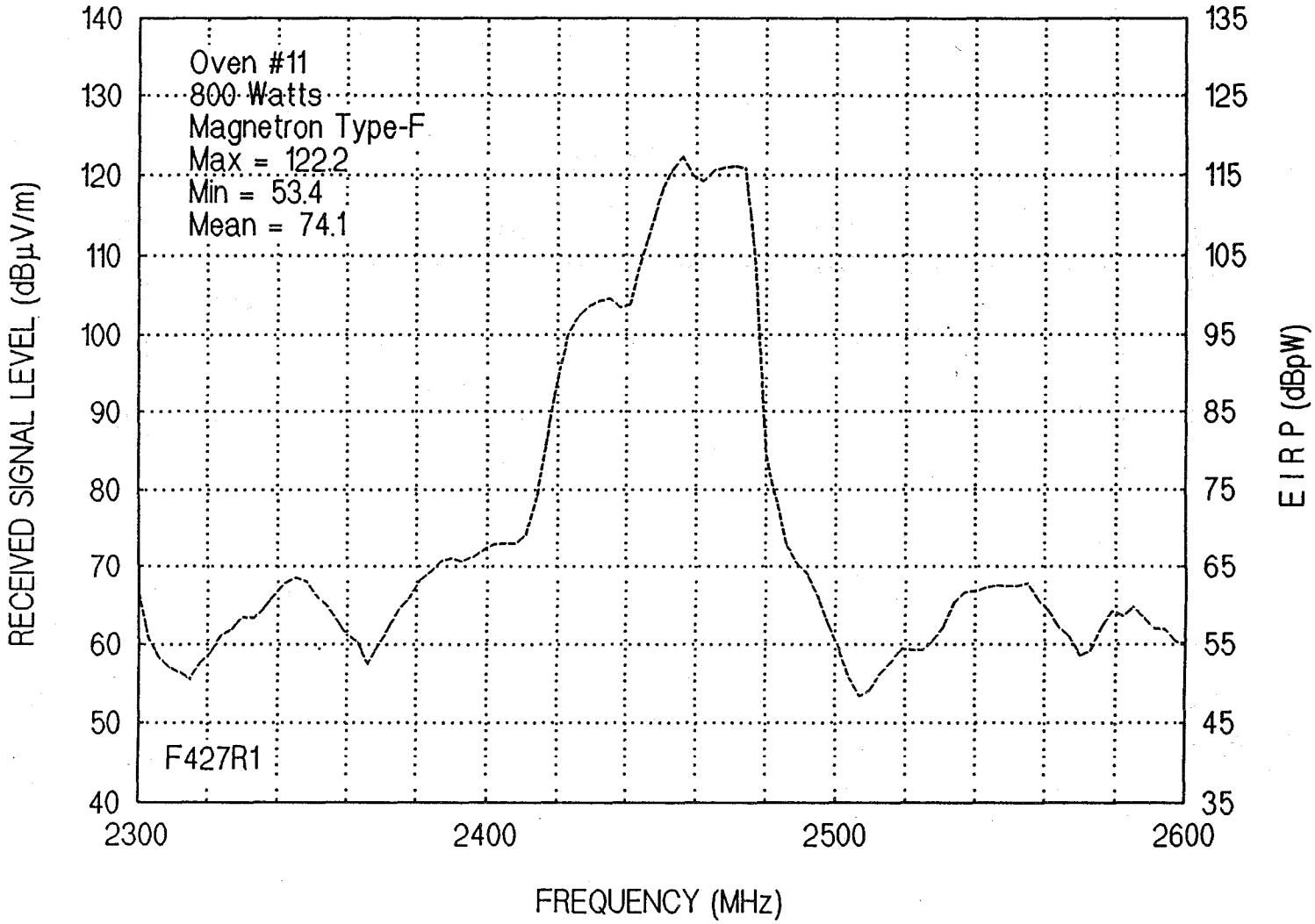


Figure B-11. Oven #11, amplitude vs. frequency.

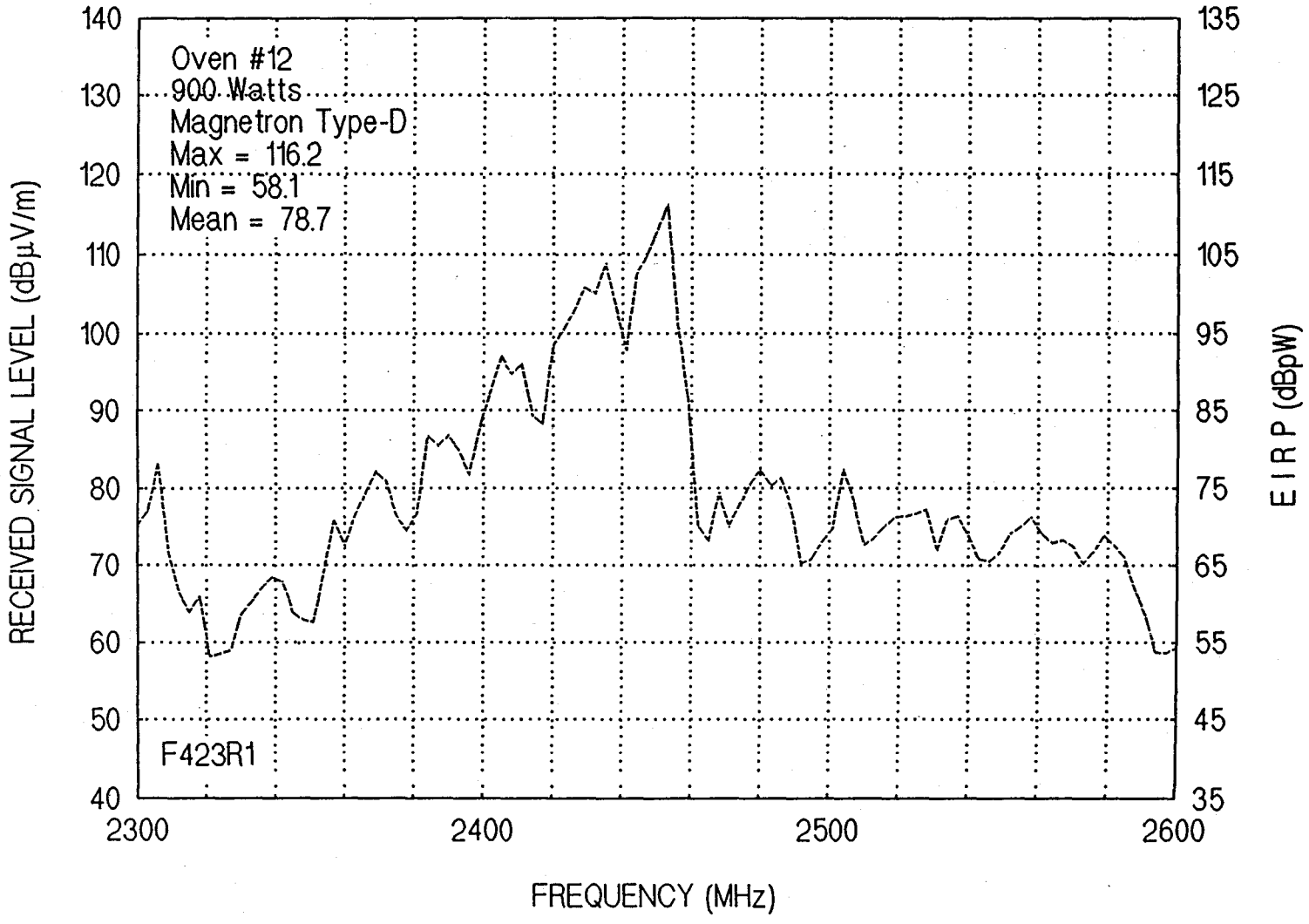


Figure B-12. Oven #12, amplitude vs. frequency.

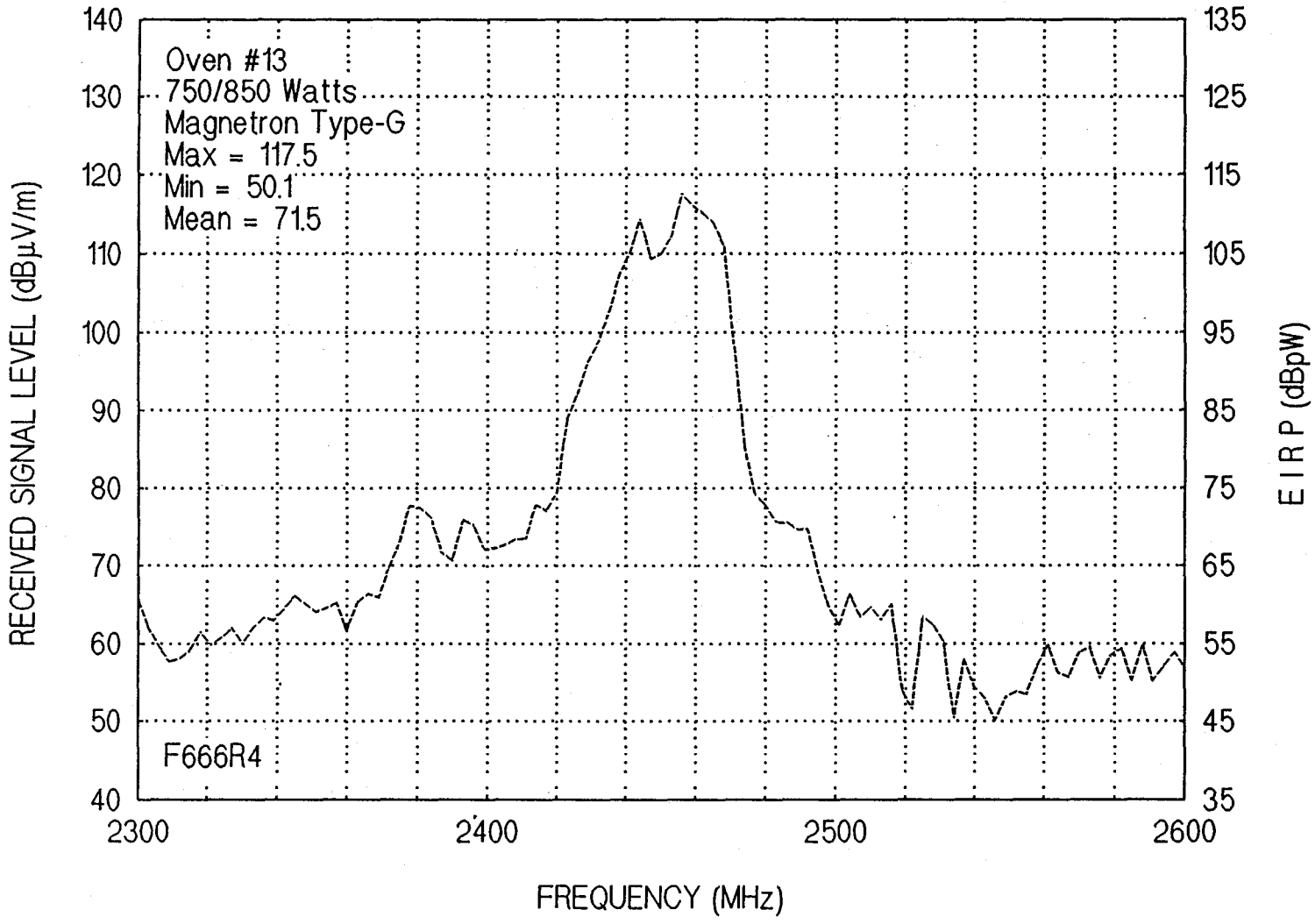


Figure B-13. Oven #13, amplitude vs. frequency.

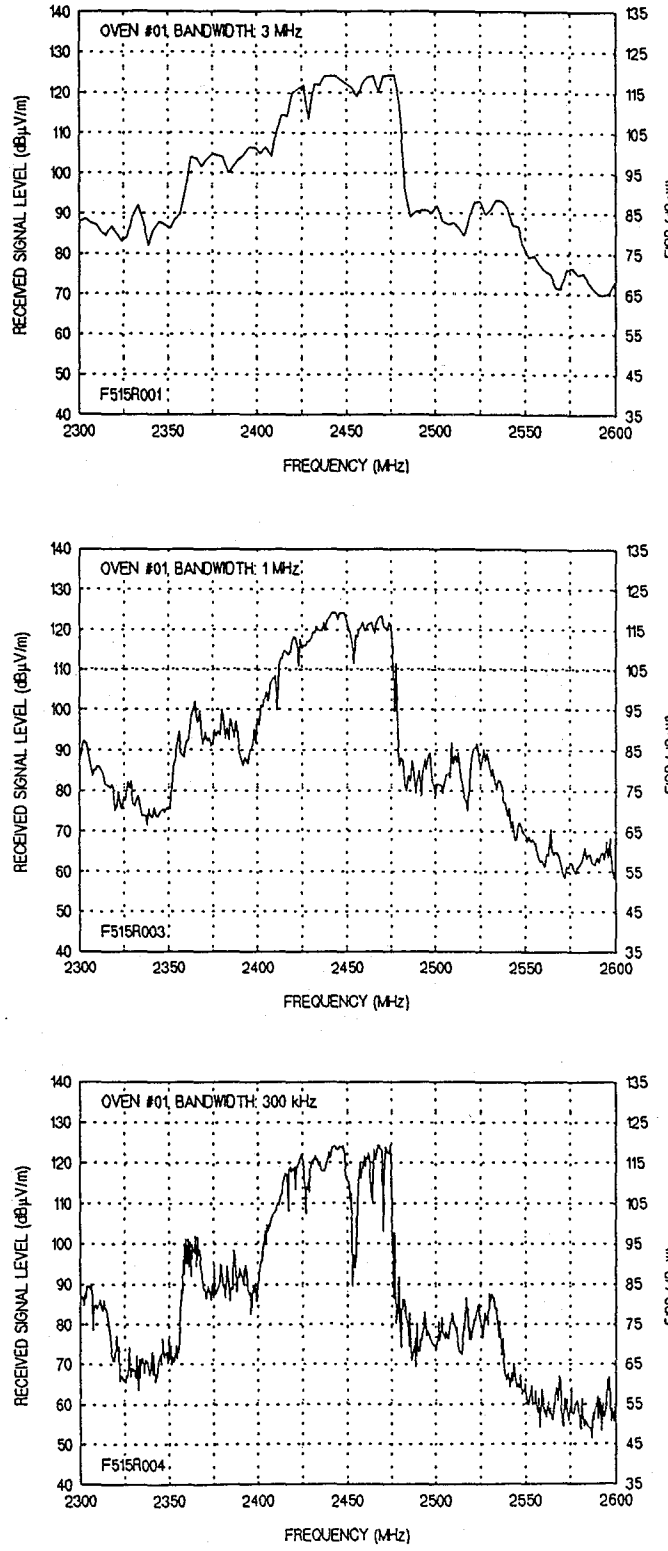
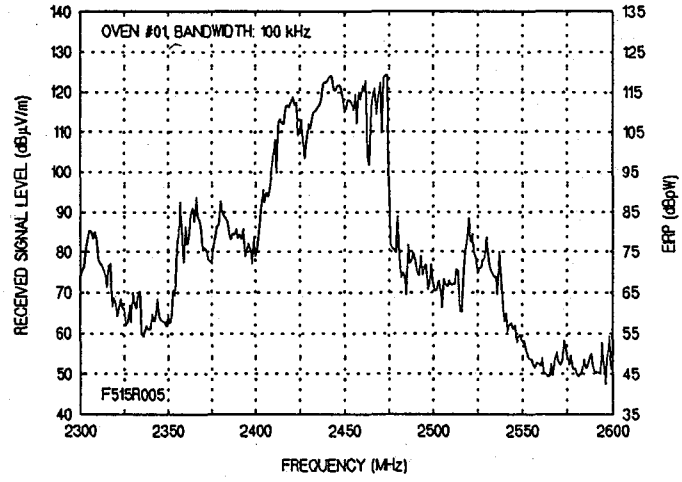


Figure B-14. Oven #1, Emission Spectra as a Function of Measurement Bandwidth.



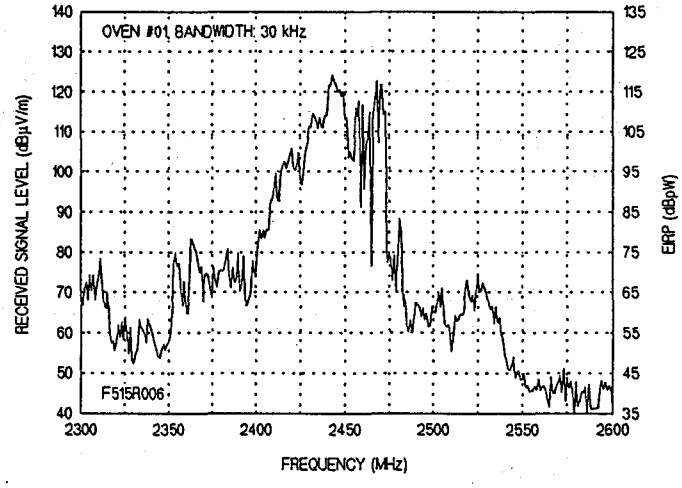
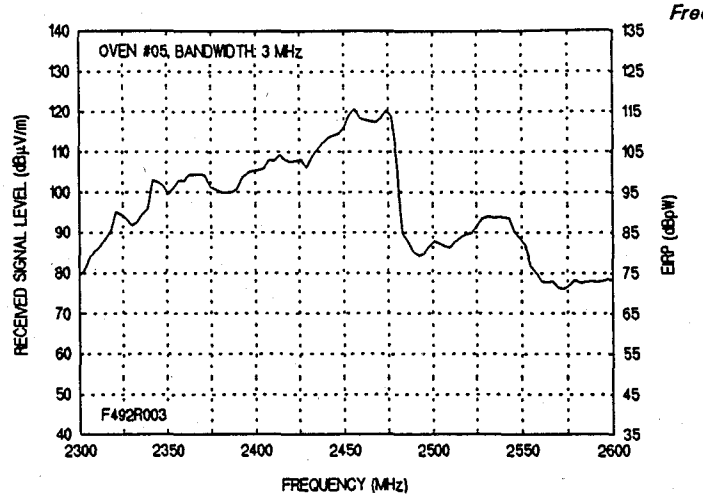
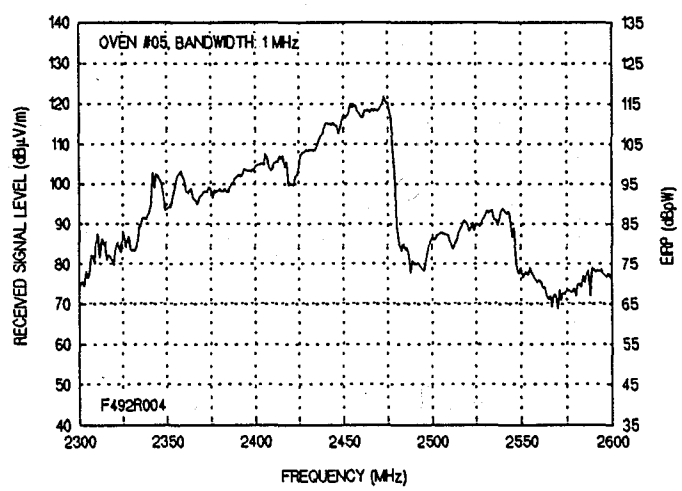


Figure B-14 (continued). Oven #1, Emission Spectra as a Function of Measurement Bandwidth.





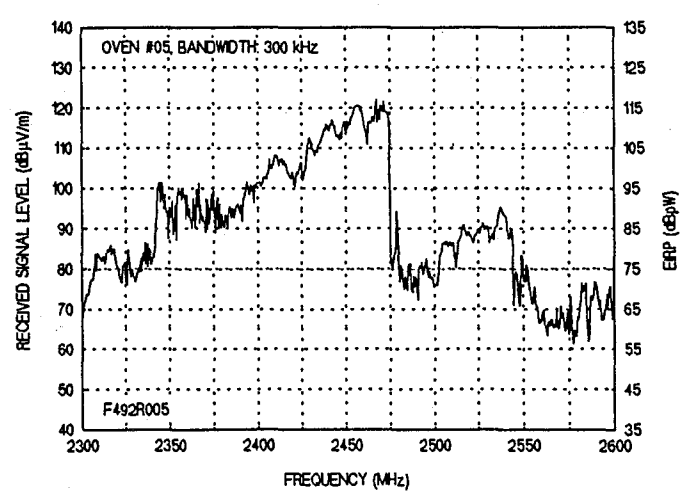
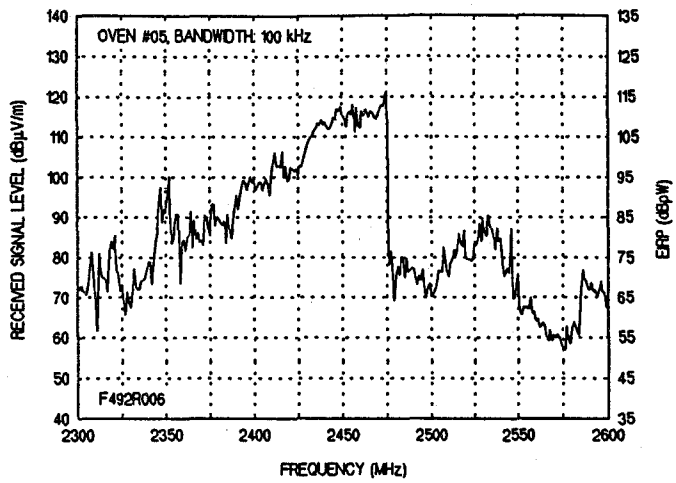


Figure B-15. Oven #5, Emission Spectra as a Function of Measurement Bandwidth.



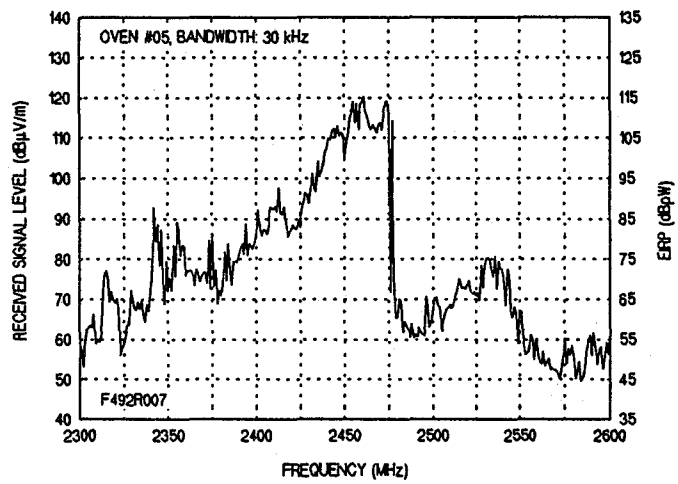
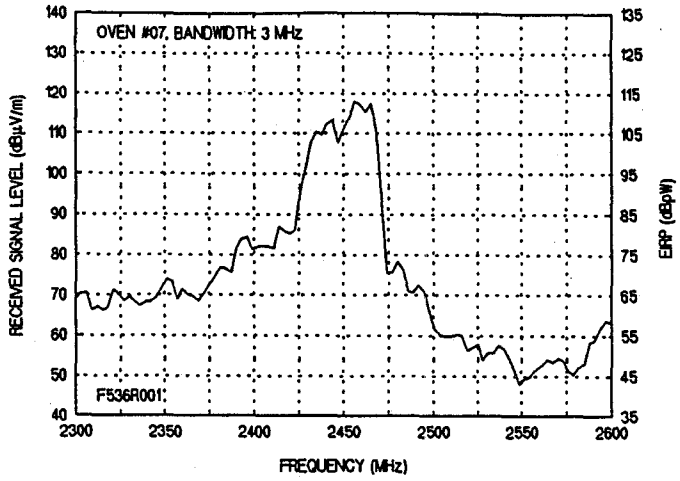
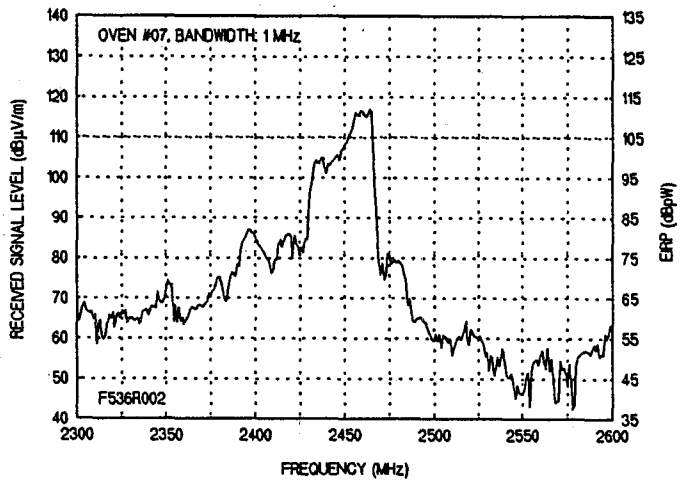


Figure B-15 (continued). Oven #5, Emission Spectra as a Function of Measurement Bandwidth.





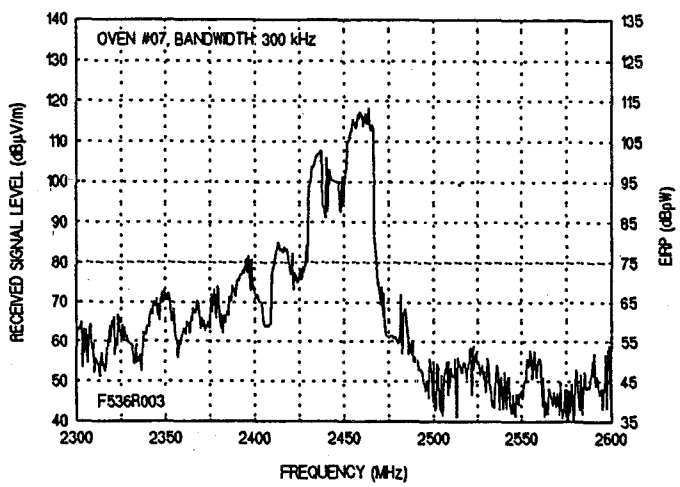
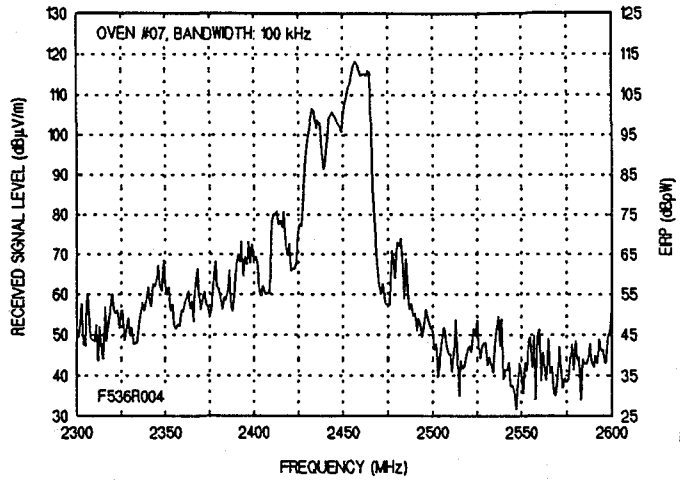


Figure B-16. Oven #7, Emission Spectra as a Function of Measurement Bandwidth.



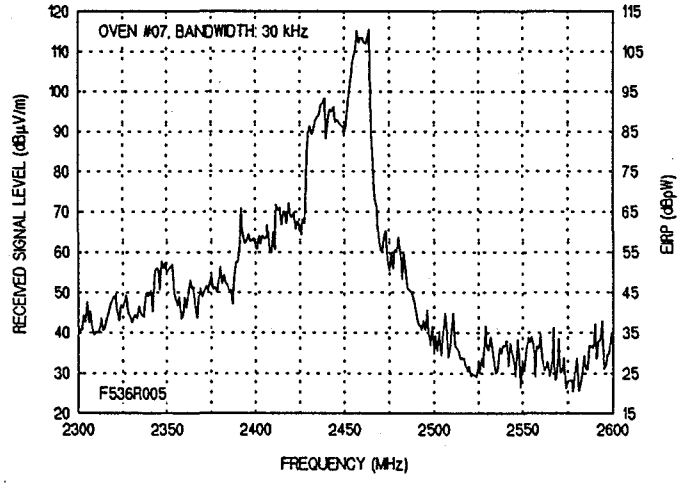


Figure B-16 (continued). Oven #7, Emission Spectra as a Function of Measurement Bandwidth.

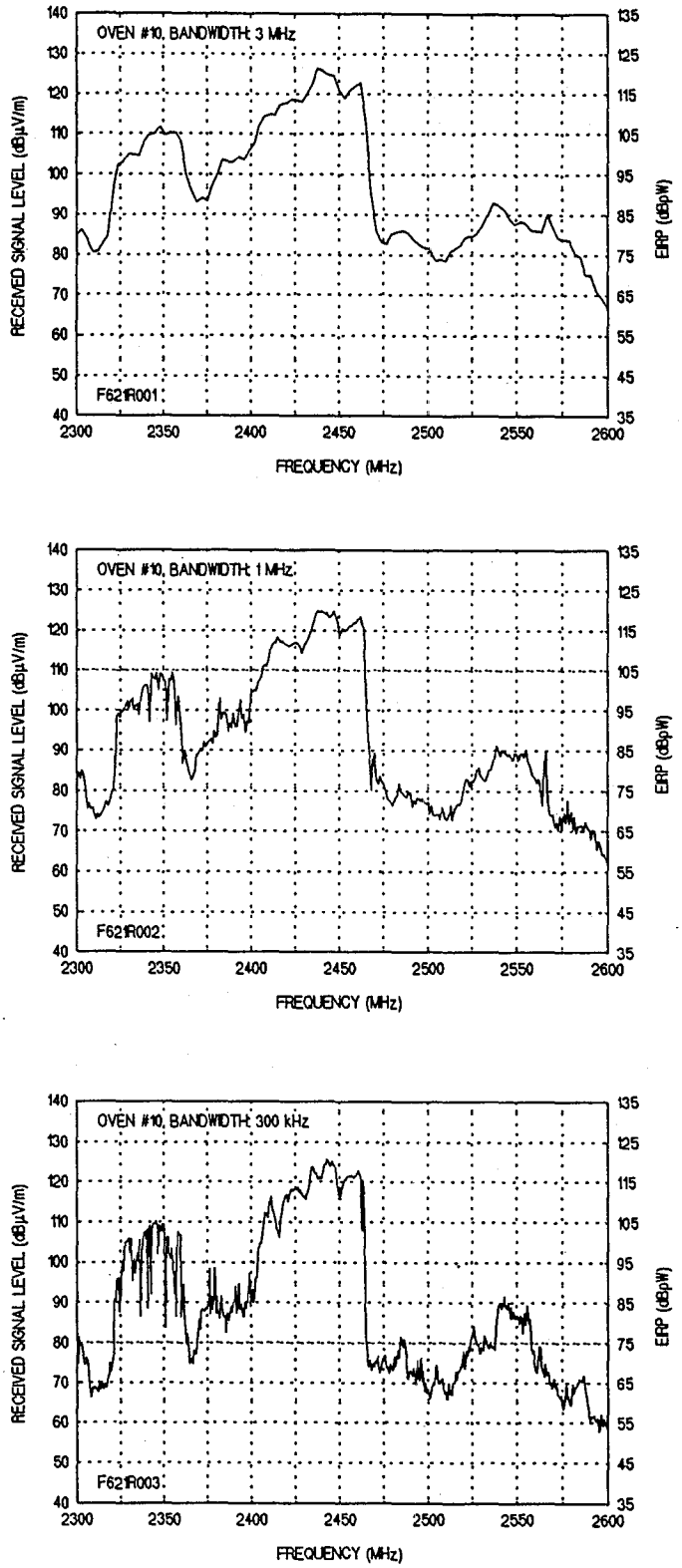
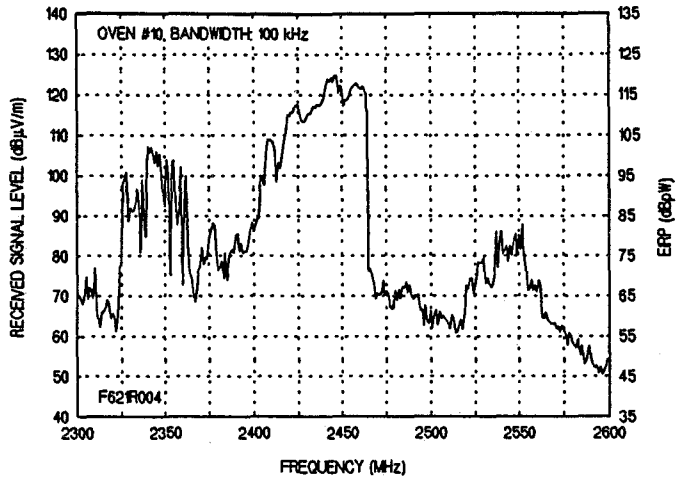


Figure B-17. Oven #10, Emission Spectra as a Function of Measurement Bandwidth.



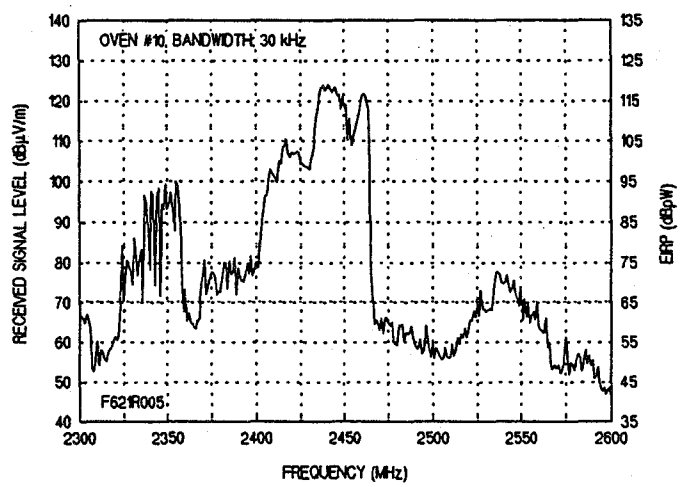
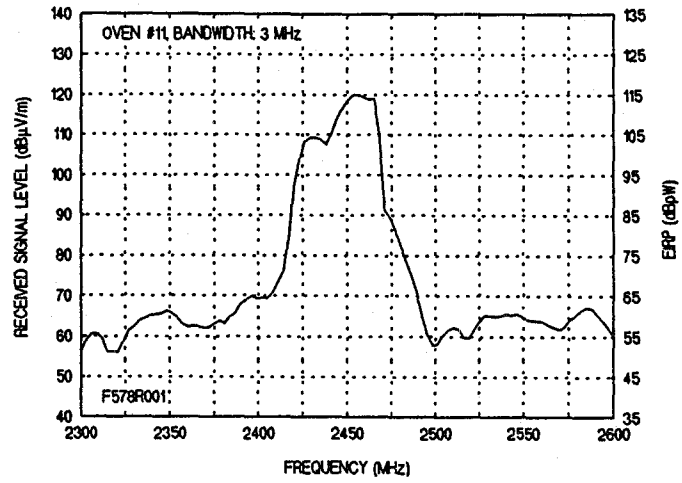
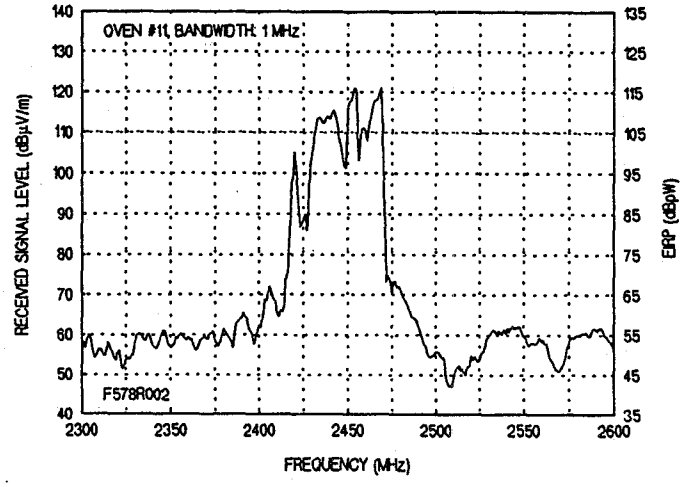


Figure B-17 (continued). Oven #10, Emission Spectra as a Function of Measurement Bandwidth.





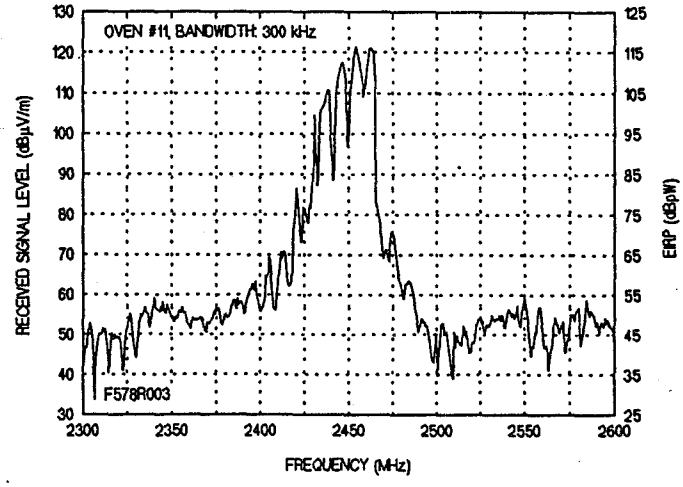
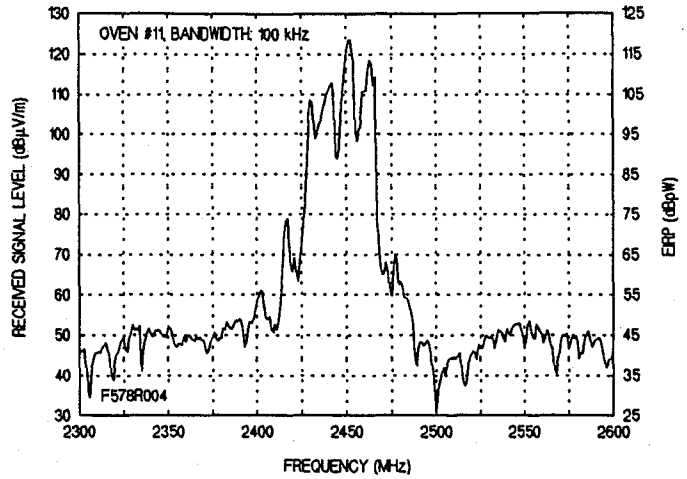


Figure B-18. Oven #11, Emission Spectra as a Function of Measurement Bandwidth



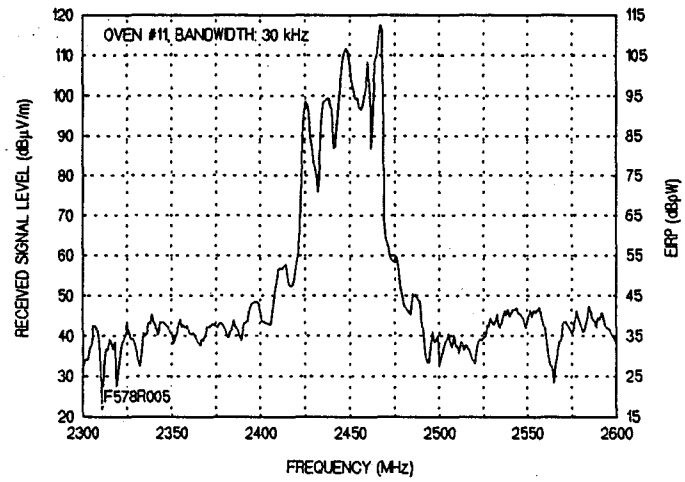


Figure B-18 (continued). Oven #11, Emission Spectra as a Function of Measurement Bandwidth.

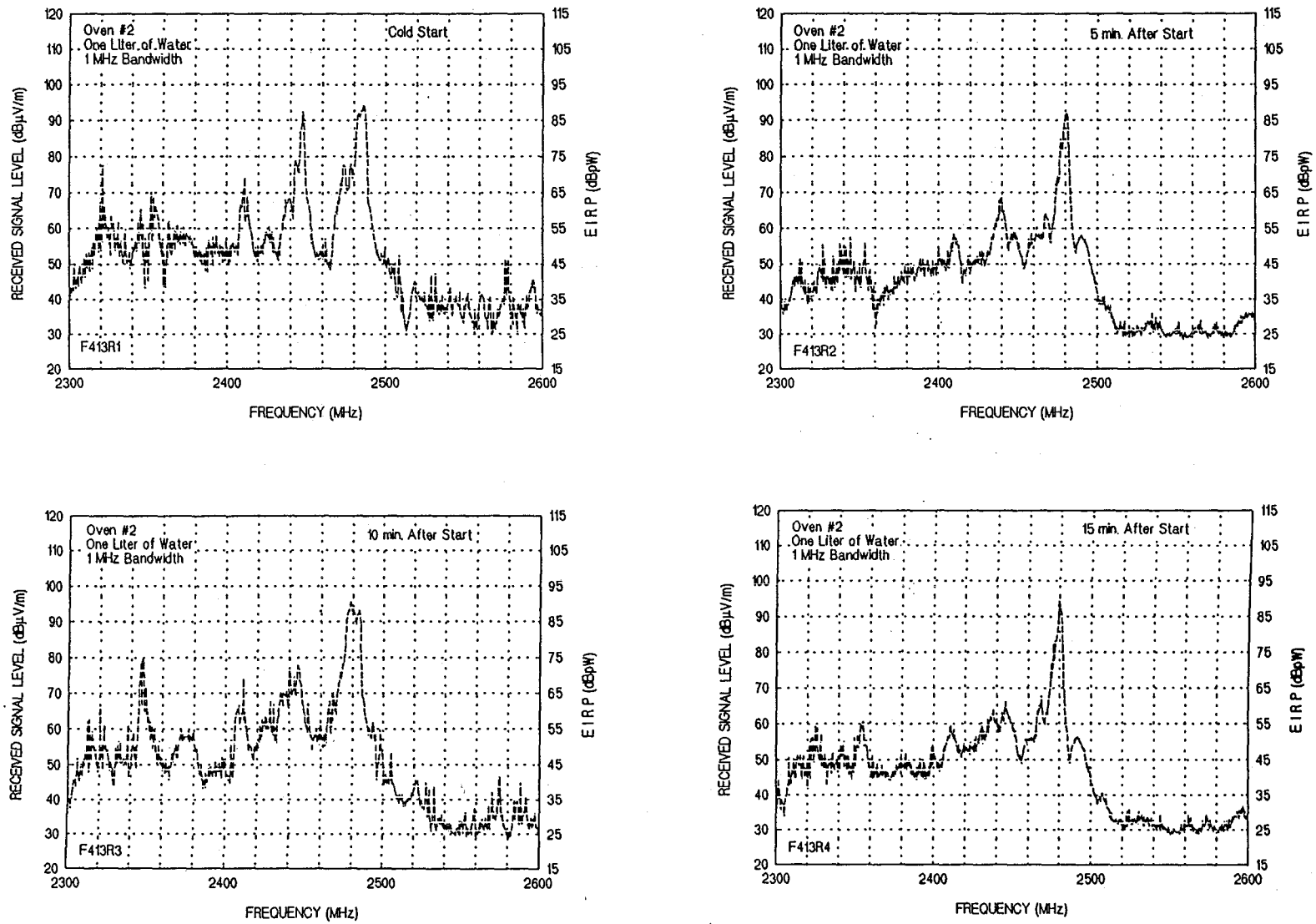
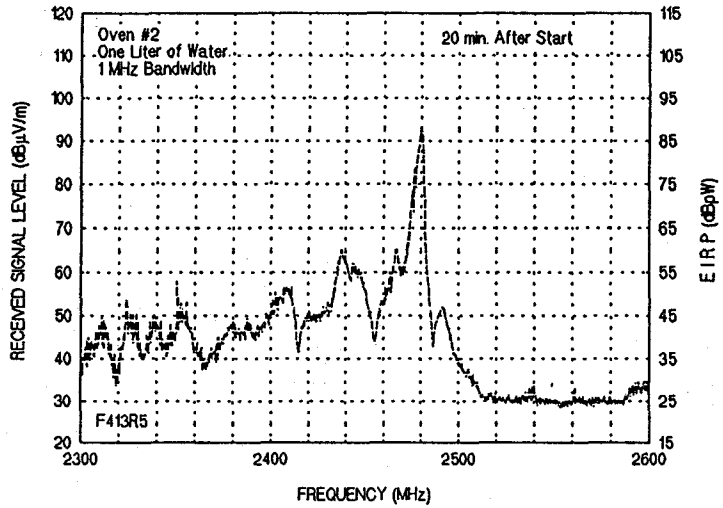
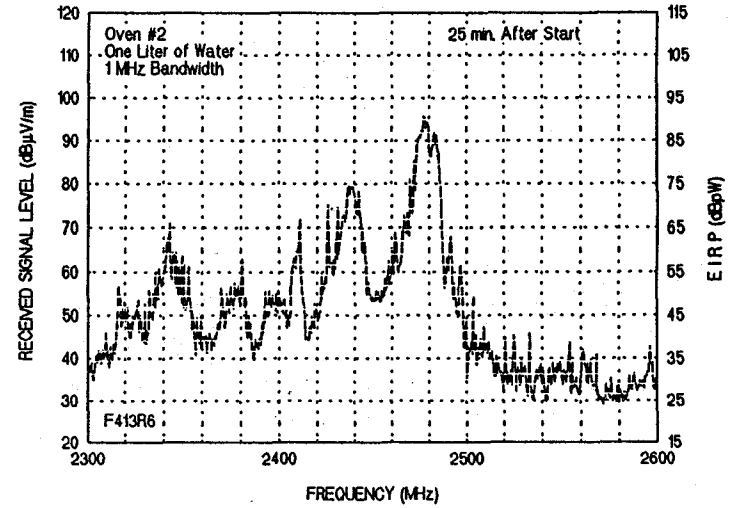


Figure B-19. Oven #2. Emission Spectrum Variability as a Function of Oven Running Time with 1 MHz Bandwidth.





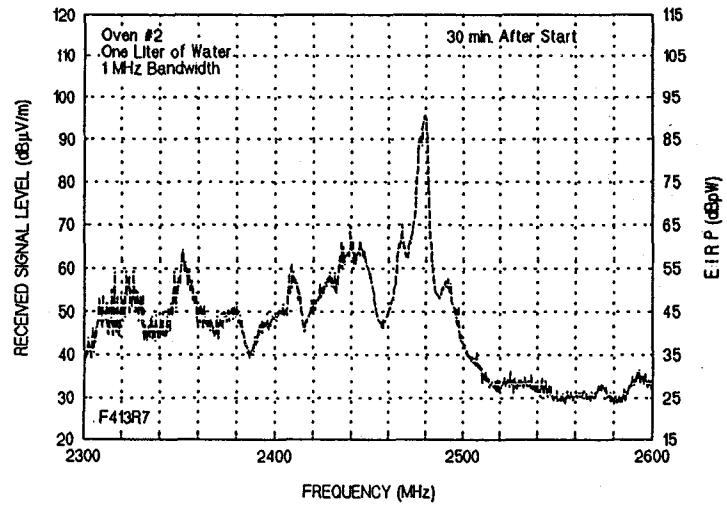


Figure B-19 (cont.). Oven #2. Emission Spectrum Variability as a Function of Oven Running Time with 1 MHz Bandwidth.

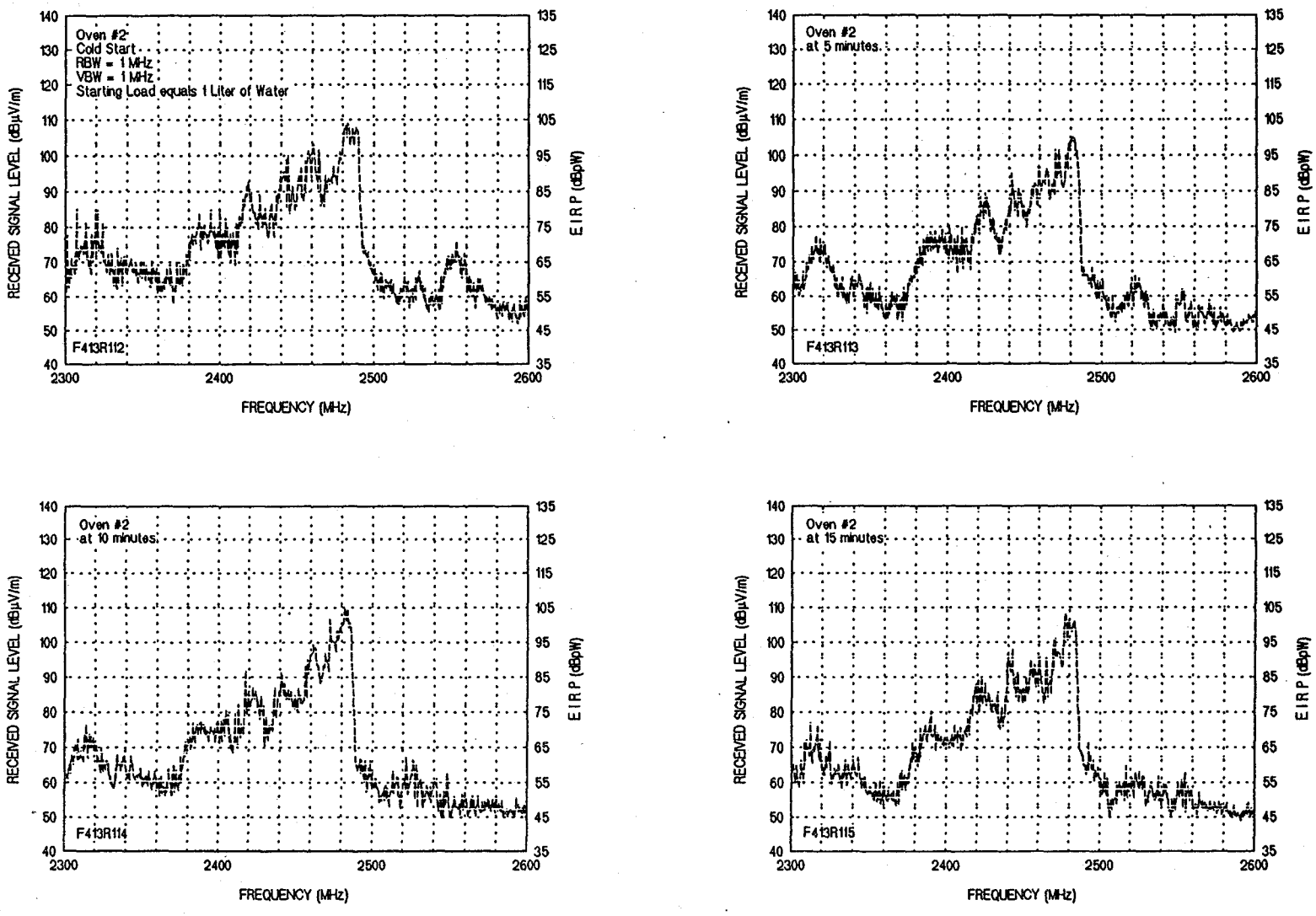
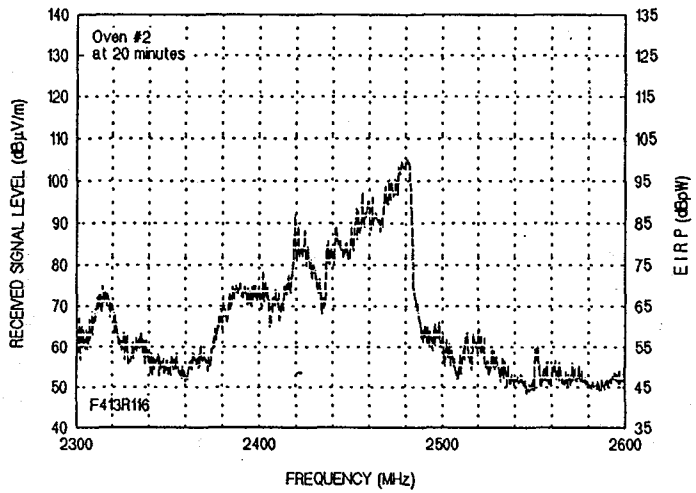
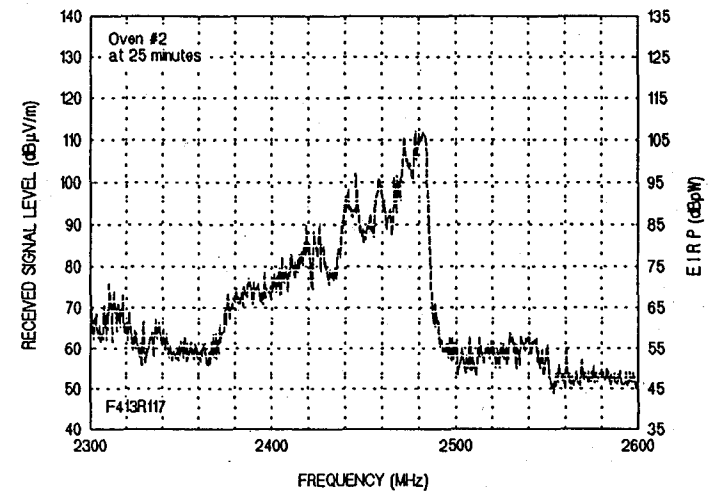


Figure B-20. Oven #2, Emission Spectrum Variability as a Function of Oven Running Time with 1 MHz Bandwidth.





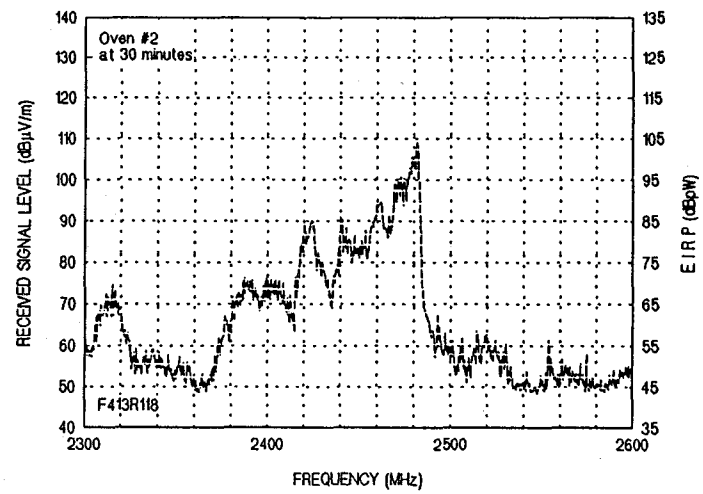


Figure B-20. (cont.). Oven #2, Emission Spectrum Variability as a Function of Oven Running Time with 1 MHz Bandwidth.

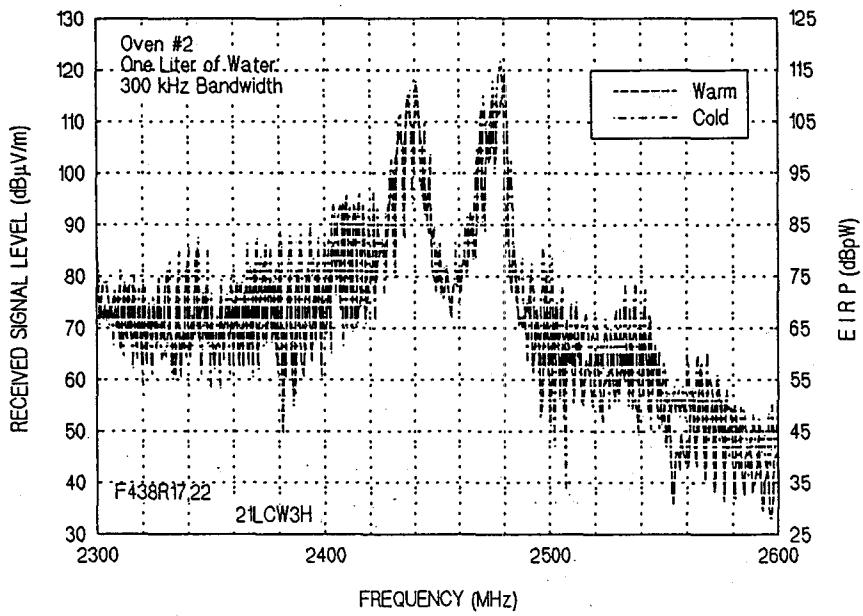


Figure B-21. Oven #2, Variability as a Function of Start Temperature with 1 ℓ/300 kHz BW.

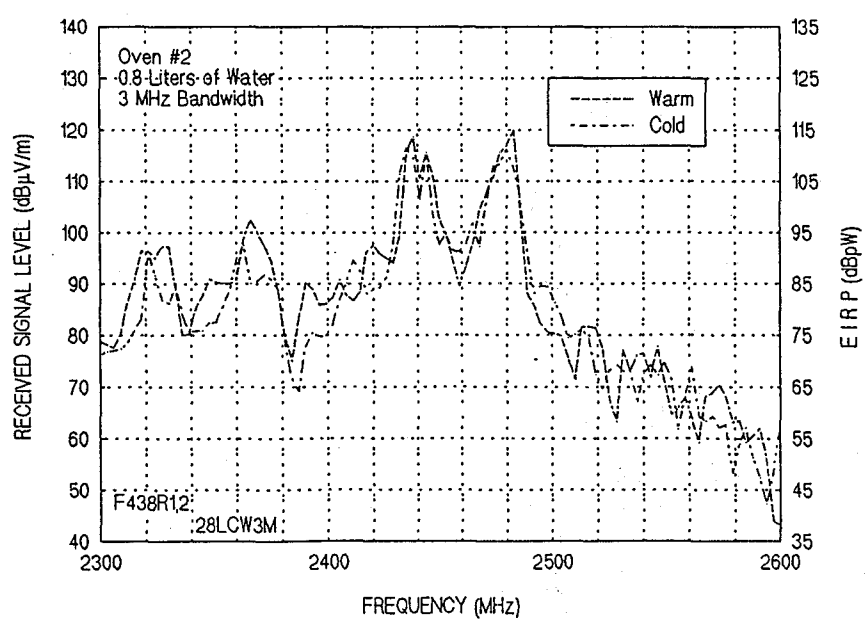


Figure B-22. Oven #2, Variability as a Function of Start Temperature with 0.8 ℓ/3 MHz BW.

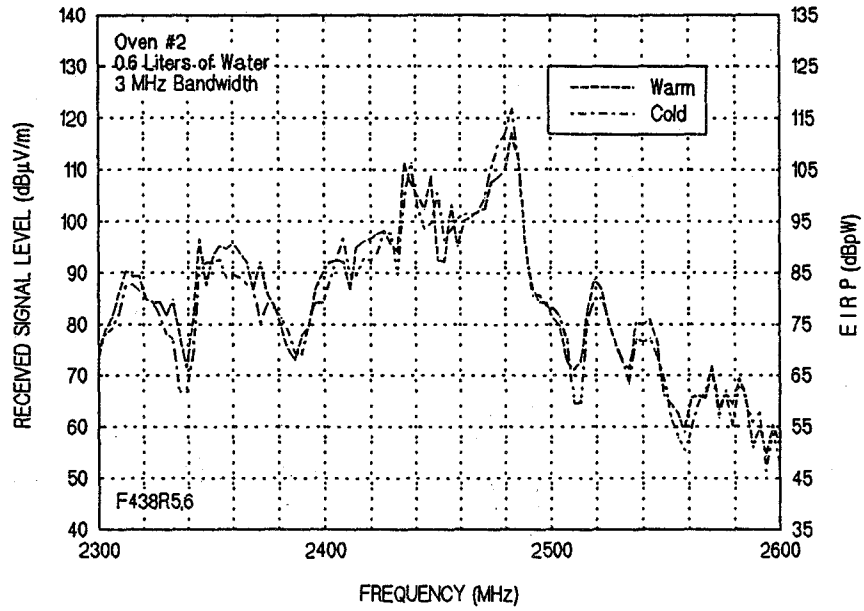


Figure B-23. Oven #2, Variability as a Function of Start Temperature with 0.6 ℓ/3 MHz BW.

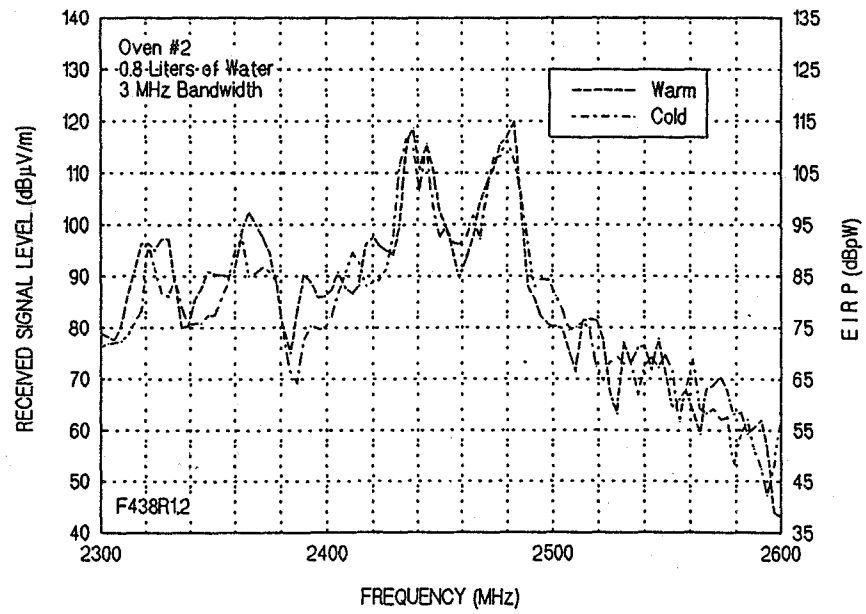


Figure B-24. Oven #2, Variability as a Function of Start Temperature with 0.4 ℓ/3 MHz BW.

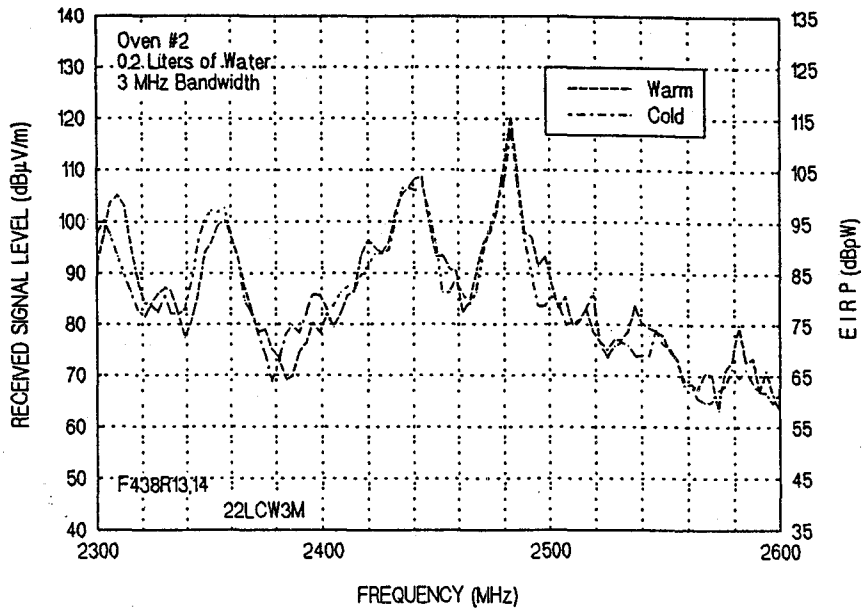


Figure B-25. Oven #2, Variability as a Function of Start Temperature with 0.2 ℓ/3 MHz BW.

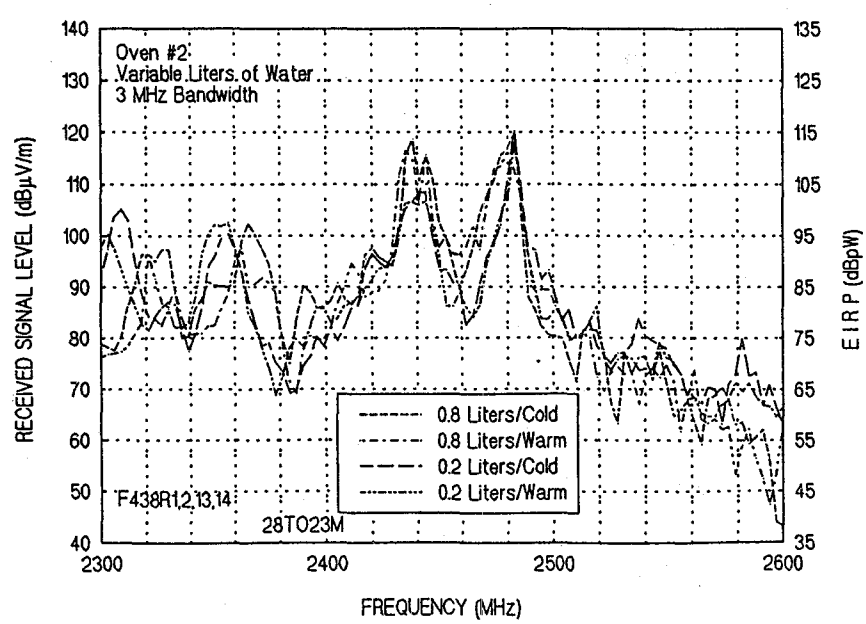


Figure B-26. Oven #2, Variable Start Temperatures 0.8 ℓ/3 MHz BW and 0.2 ℓ/3 MHz BW.

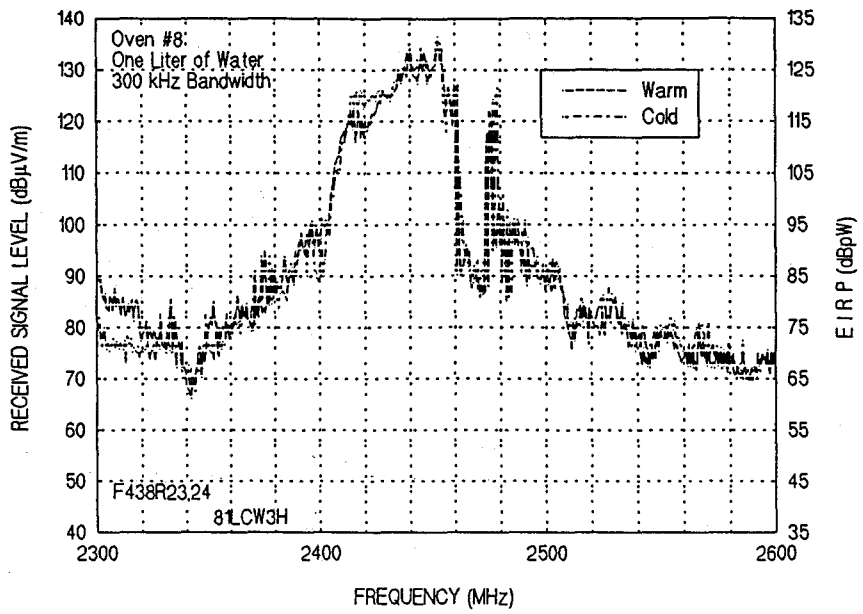


Figure B-27. Oven #8, Variability as a Function of Start Temperature with 1 ℓ/300 kHz BW.

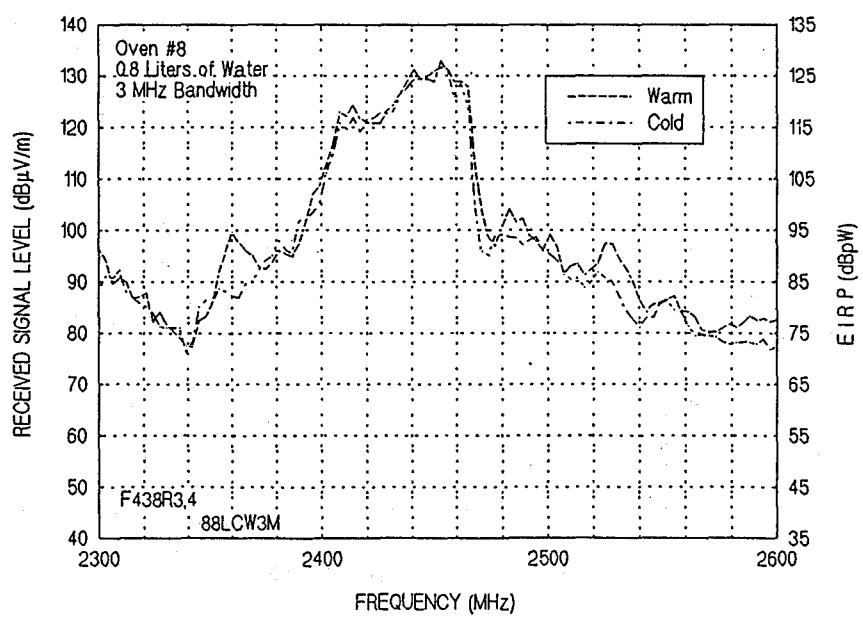


Figure B-28. Oven #8, Variability as a Function of Start Temperature with 0.8 ℓ/3 MHz BW.

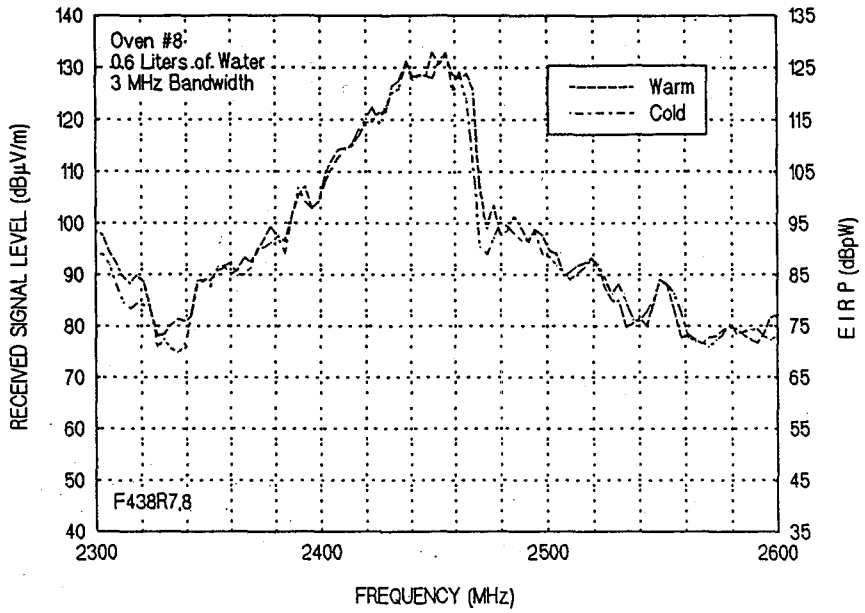


Figure B-29. Oven #8, Variability as a Function of Start Temperature with 0.6 ℓ/3 MHz BW.

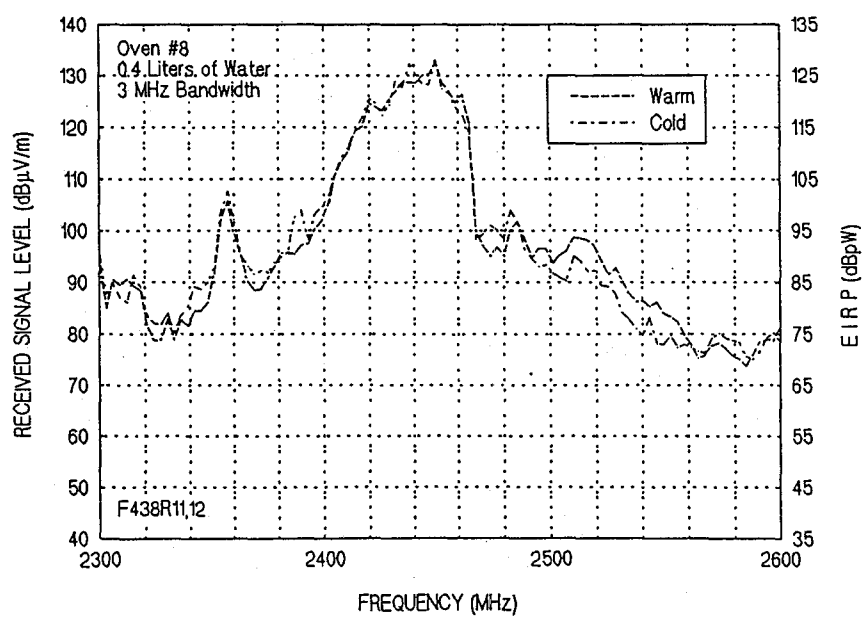


Figure B-30. Oven #8, Variability as a Function of Start Temperature with 0.4 ℓ/3 MHz BW.

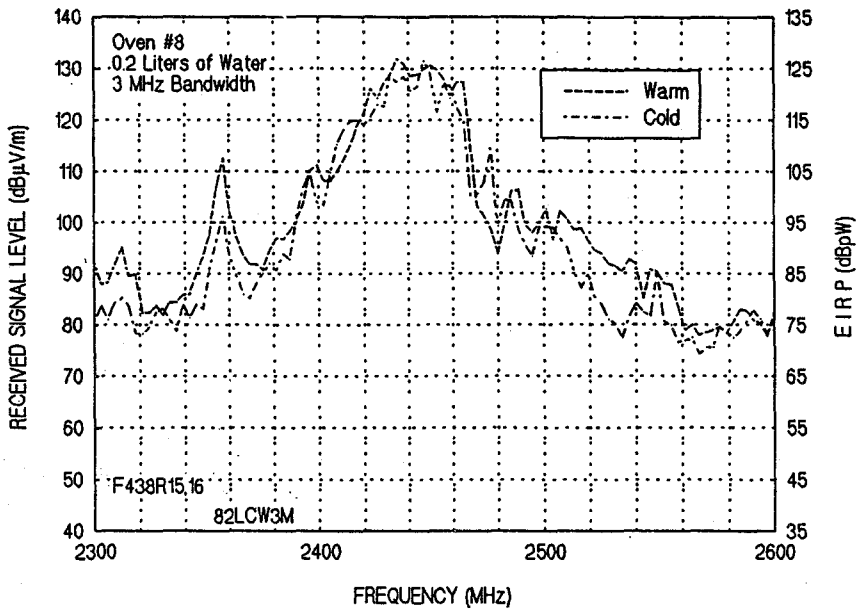


Figure B-31. Oven #8, Variability as a Function of Start Temperature with 0.2 ℓ/3 MHz BW.

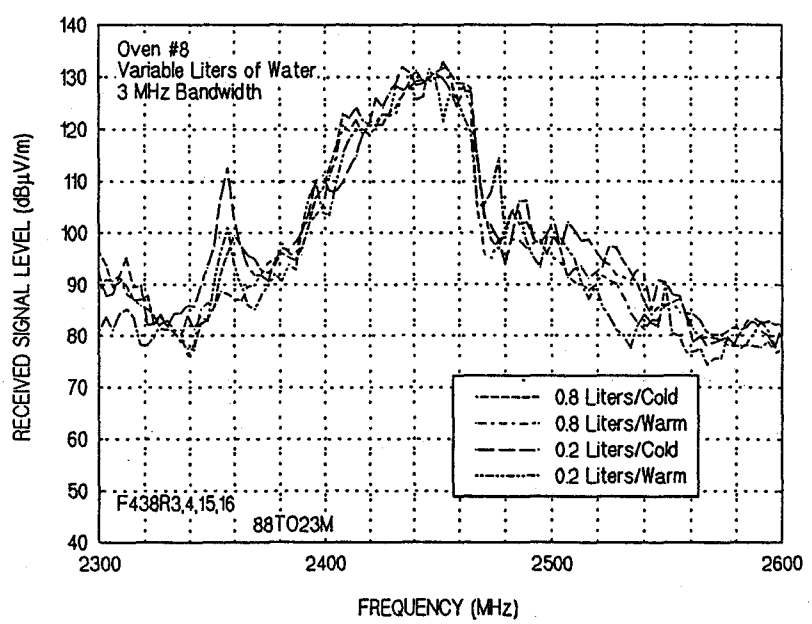
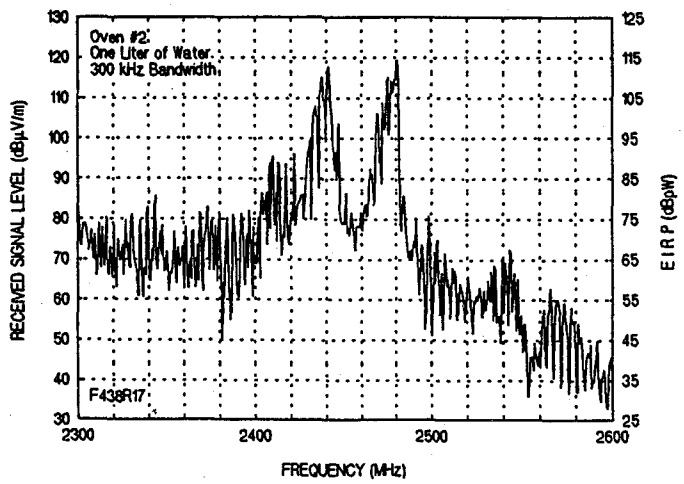
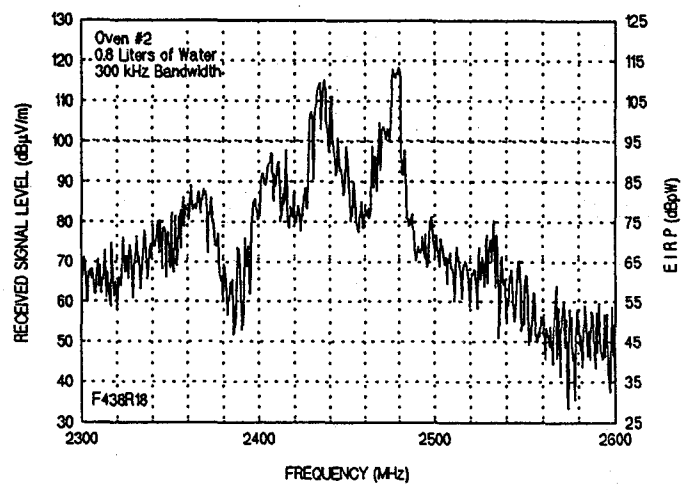


Figure B-32. Oven #8, Variable Start Temperatures 0.8 ℓ/3 MHz BW and 0.2 ℓ/3 MHz BW.





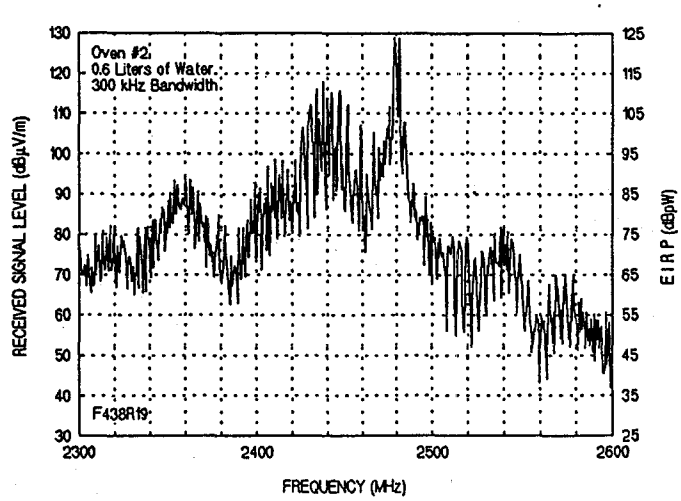
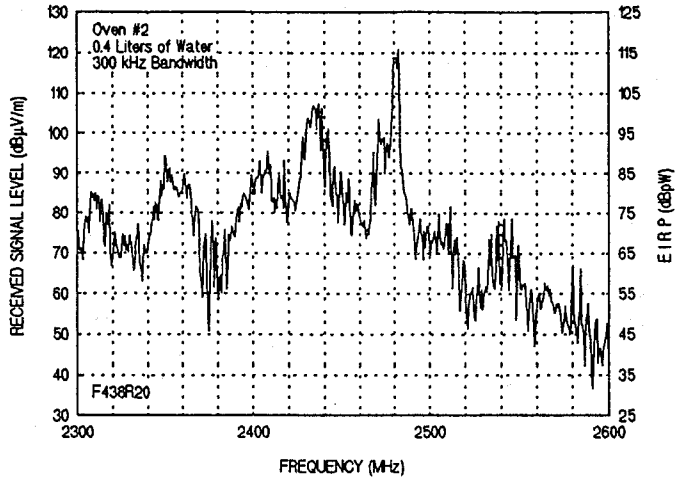
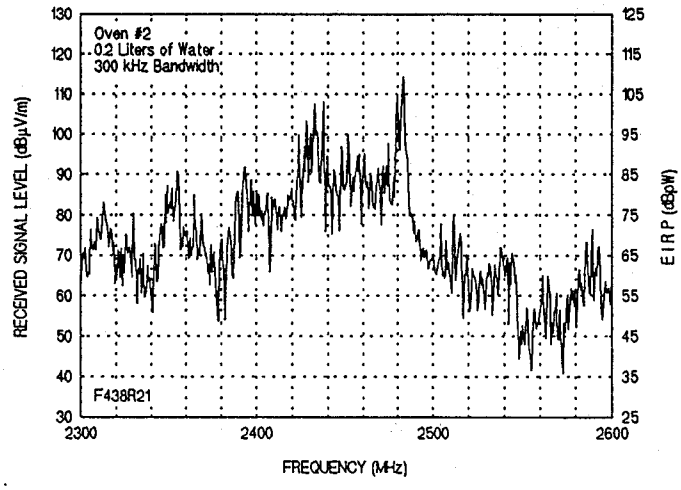


Figure B-33. Oven #2, Emission Spectrum Variability as a Function of Water Load with 300 kHz Bandwidth.





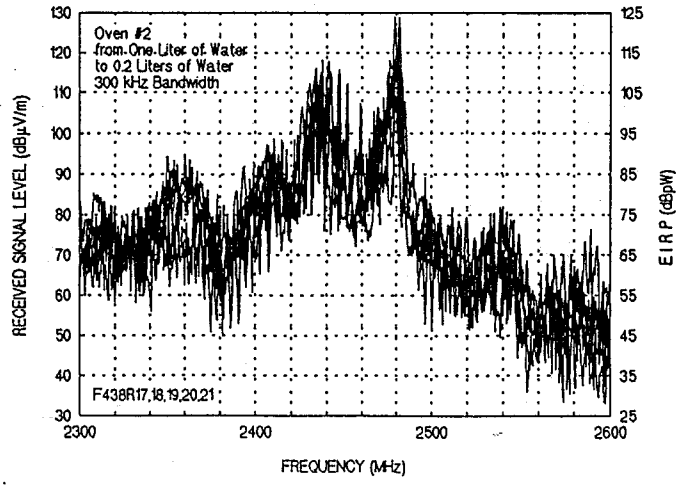
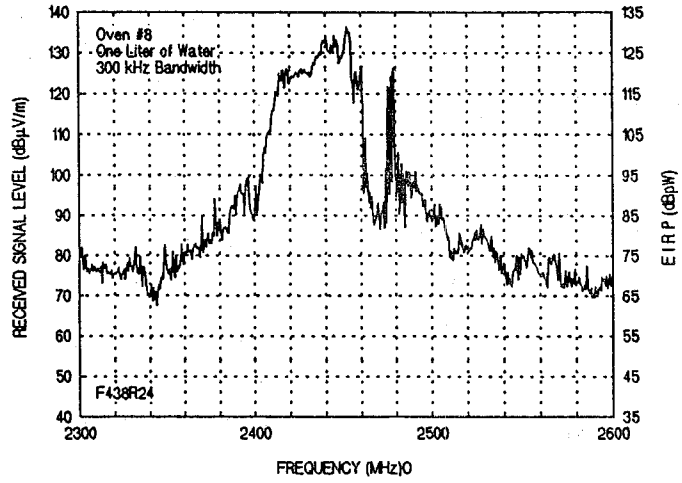
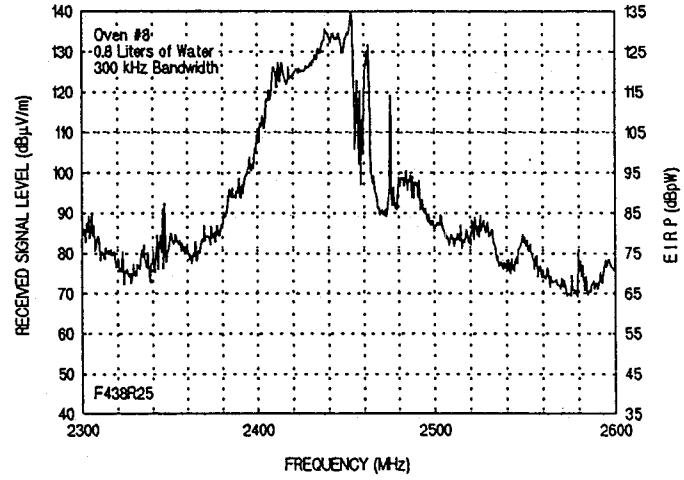


Figure B-33. (cont.) Oven #2, Emission Spectrum Variability as a Function of Water Load with 300 kHz Bandwidth.





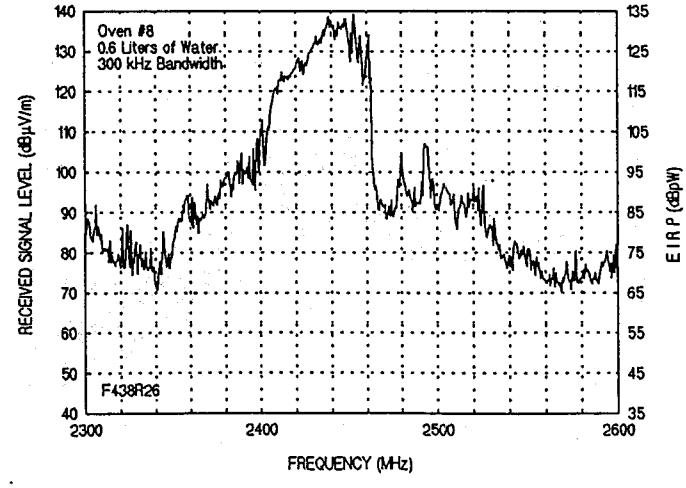
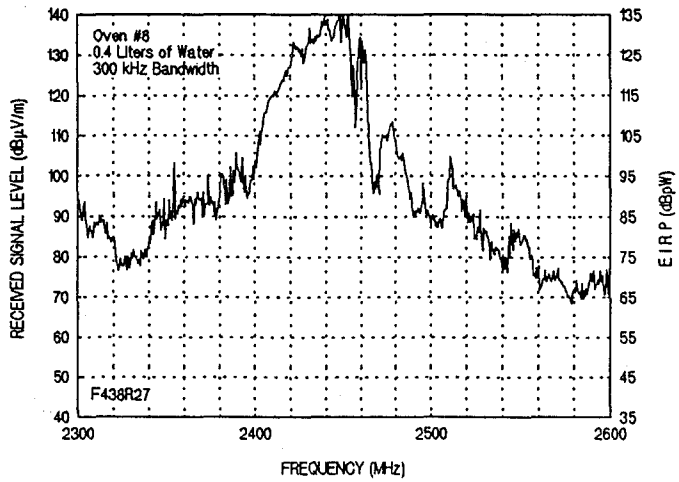
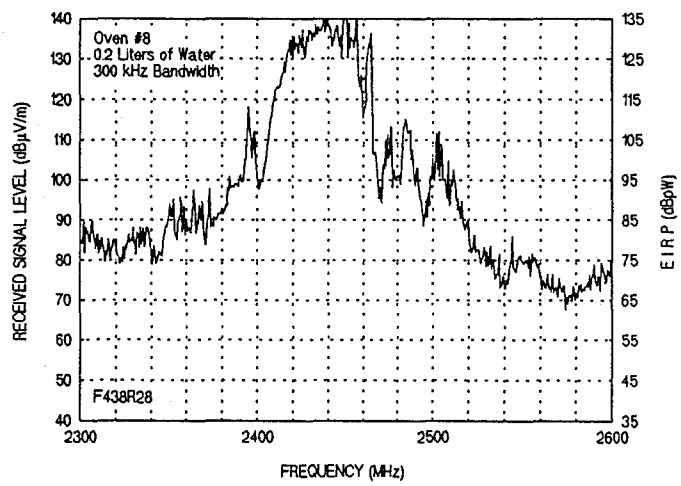


Figure B-34. Oven #8, Emission Spectrum Variability as a Function of Water Load with 300 kHz Bandwidth.





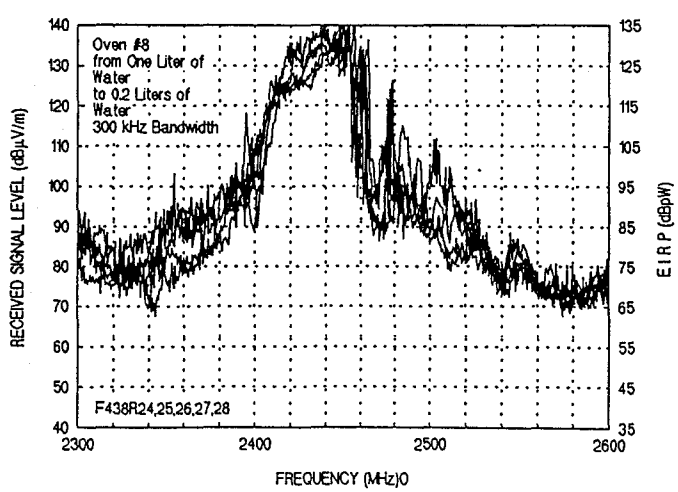
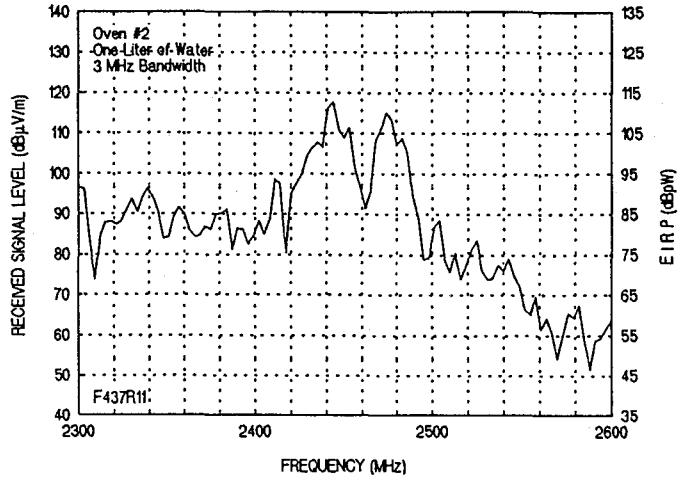
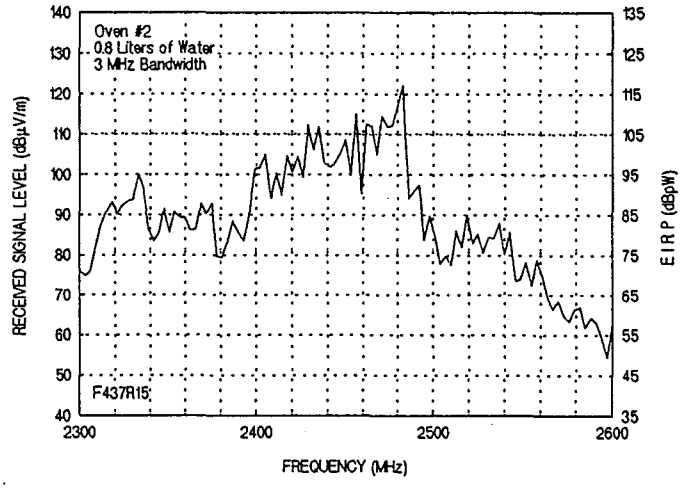


Figure B-34. (cont.) Oven #8, Emission Spectrum Variability as a Function of Water Load with 300 kHz Bandwidth.





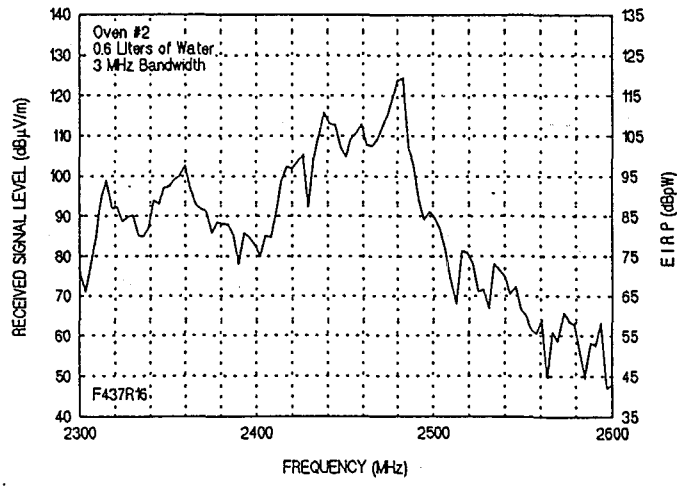
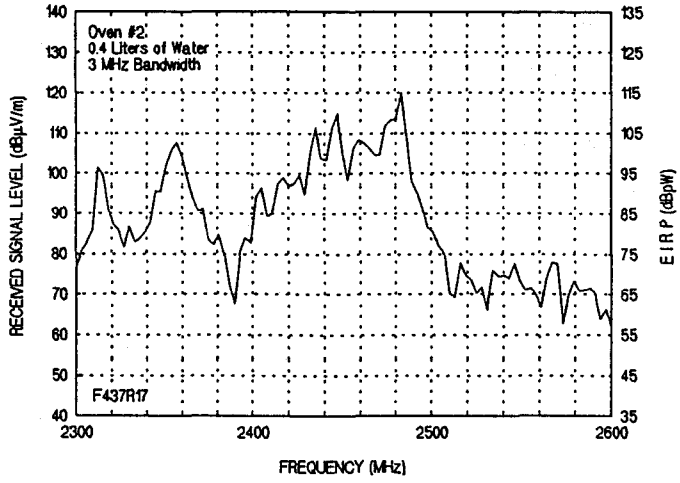
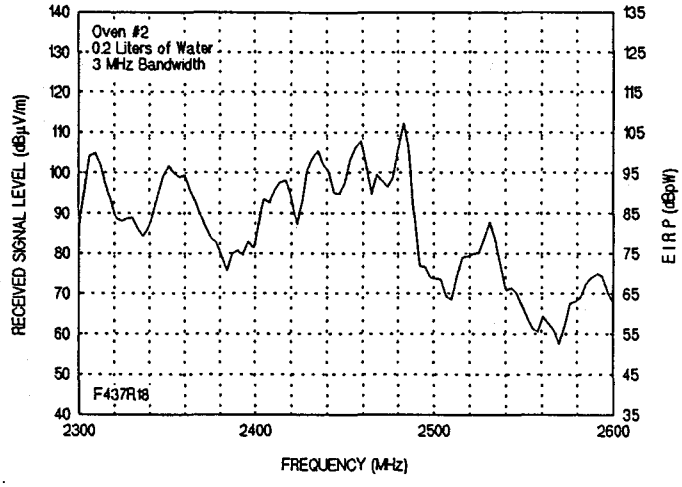


Figure B-35. Oven #2, Emission Spectrum Variability as a Function of Water Load with 3 MHz Bandwidth.





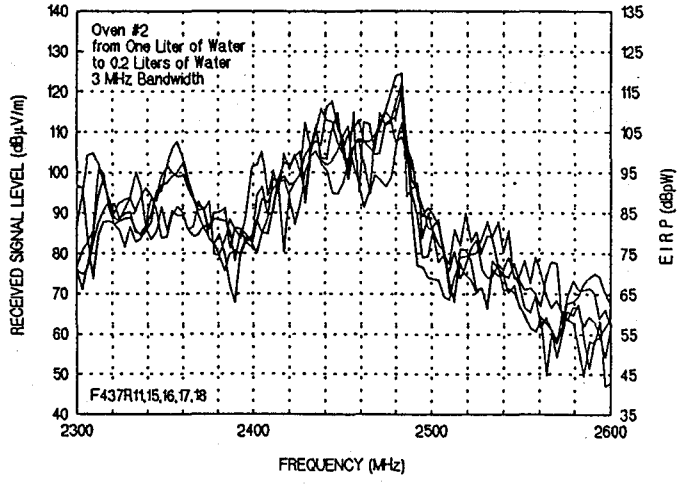
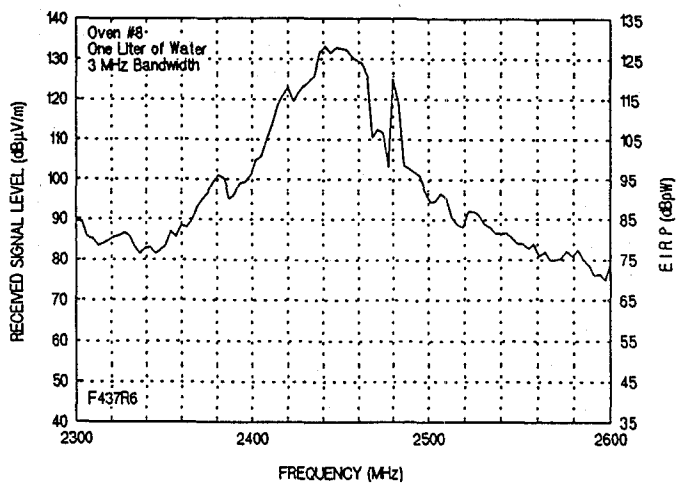
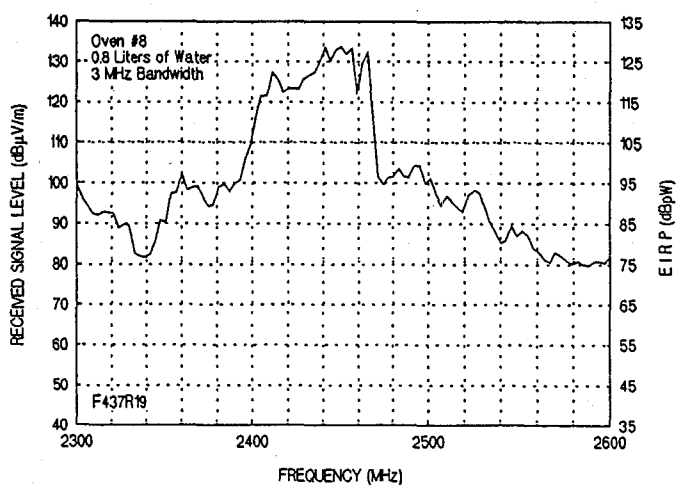


Figure B-35. (cont.) Oven #2, Emission Spectrum Variability as a Function of Water Load with 3 MHz Bandwidth.





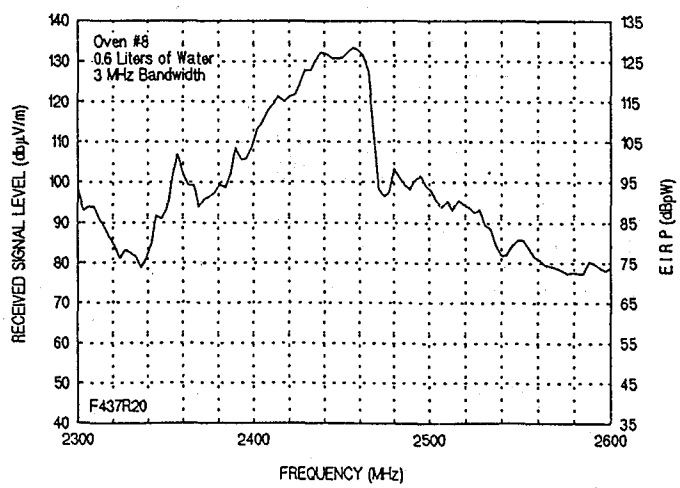
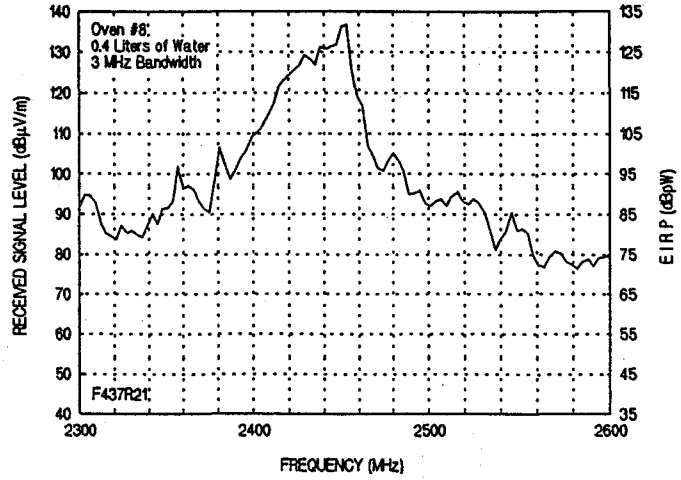
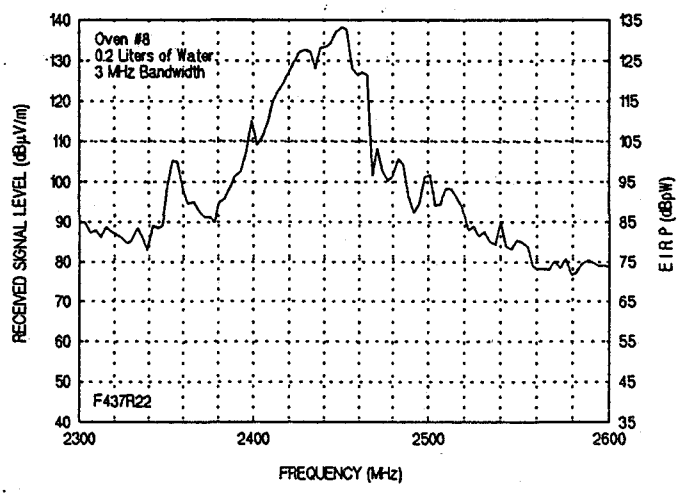


Figure B-36. Oven #8, Emission Spectrum Variability as a Function of Water Load with 3 MHz Bandwidth.





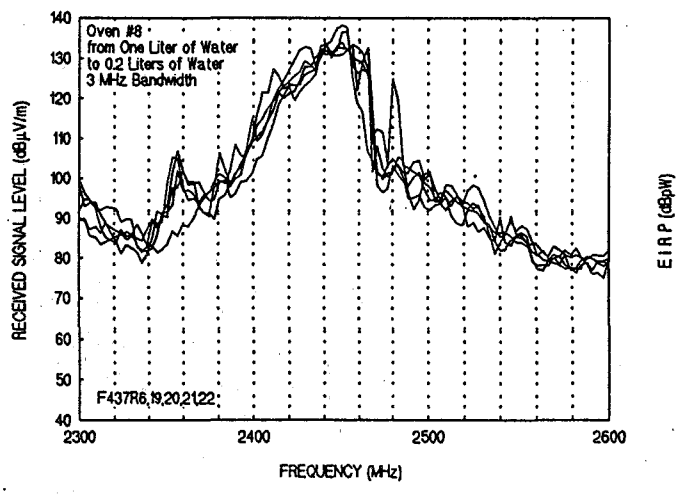


Figure B-36. (cont.) Oven #8, Emission Spectrum Variability as a Function of Water Load with 3 MHz Bandwidth.

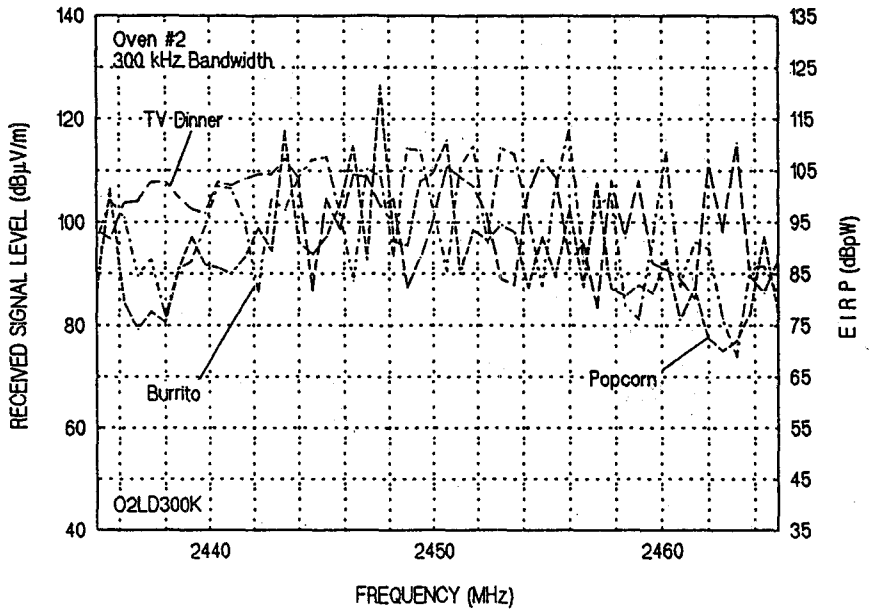


Figure B-37a. Oven #2, Emission Spectrum Variability as a function of Consumer Load at 300 kHz in the range of 2435-2475 MHz

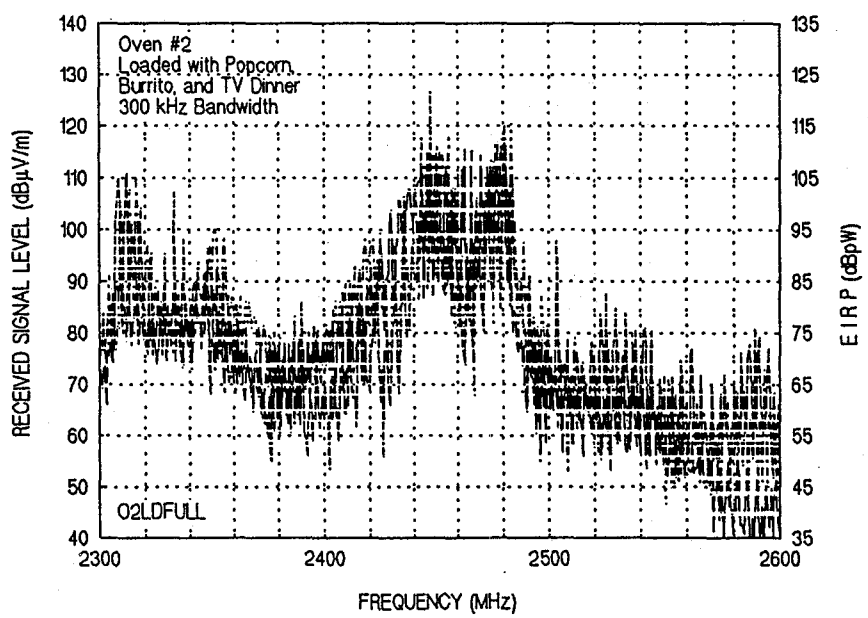


Figure B-37b. Oven #2, Emission Spectrum Variability as a function of Consumer Load at 300 kHz in the range 2300-2600 MHz.

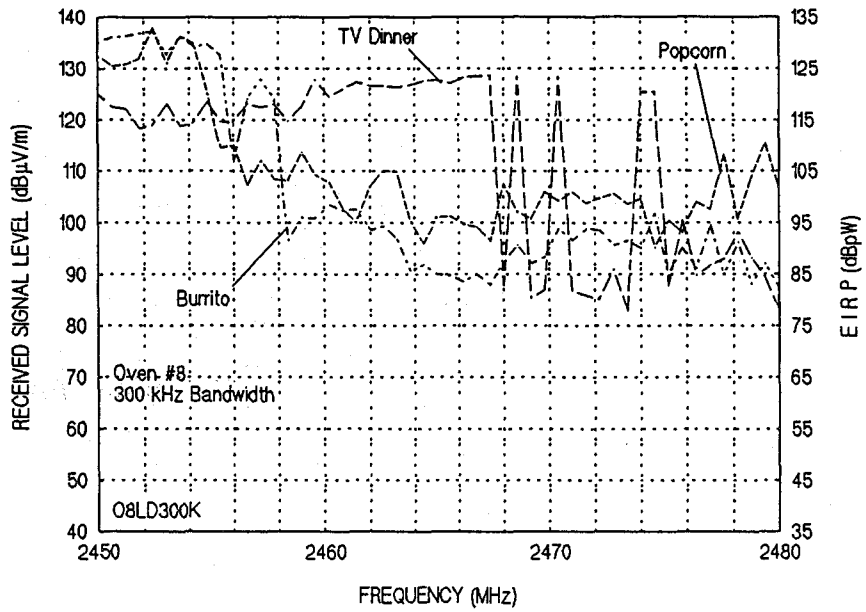


Figure B-38a. Oven #8, Emission Spectrum Variability as a function of Consumer Load at 300 kHz in the range of 2450-2480 MHz

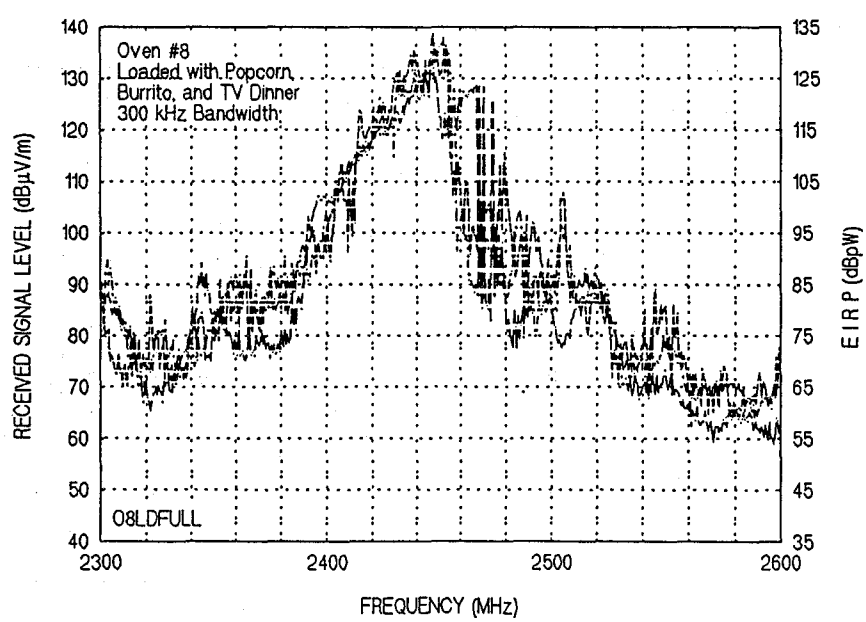


Figure B-38b. Oven #8, Emission Spectrum Variability as a function of Consumer Load at 300 kHz in the range 2300-2600 MHz.

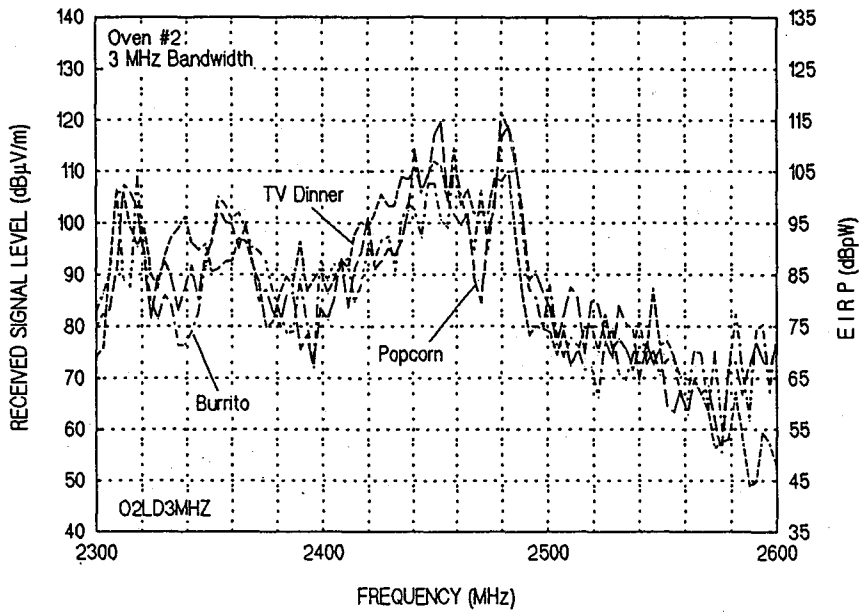


Figure B-39. Oven #2, Emission Spectrum Variability as a Function of Consumer Load with 3 MHz Bandwidth.

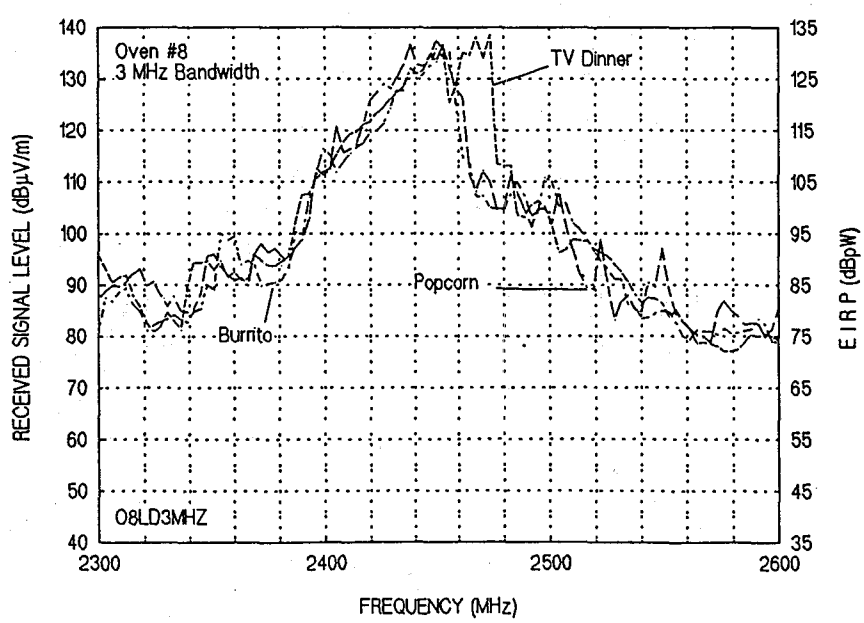


Figure B-40. Oven #8, Emission Spectrum Variability as a Function of Consumer Load with 3 MHz Bandwidth.

APPENDIX C
TIME DOMAIN MEASUREMENTS

This Appendix contains detailed time waveform measurements and associated amplitude-probability distribution (APDs) curves. The APD data is derived from the raw time scan (time waveforms) measurements. Time domain measurements at single frequencies provide information necessary for assessing the feasibility of operating receivers in close proximity to microwave ovens. Due to the time required to perform them, the detailed time waveform measurements were conducted on five of the thirteen ovens. These ovens included #1, #5 and #10 representing the ovens with the highest adjacent band emission spectrum characteristics, and ovens #7 and #11 representing ovens with the lowest adjacent band emission spectrum characteristics (see Volume 1, Figures 5-5a, 5-6a, 5-7a, 5-12a and 5-17a).

For these measurements, a pre-selector and pre-amplifier were used ahead of the spectrum analyzer to increase the spectrum analyzer sensitivity thus permitting detailed time waveform measurements at lower noise levels. One hundred scans were performed at six different bandwidths (10, 30, 100, and 300 kHz, as well as 1 and 3 MHz) and seven different frequencies (2300, 2350, 2400, 2450, 2500, 2550, and 2600 MHz). Each time scan measurement was composed of 1001 points acquired in 20 ms using the sample detector. Thus, at each frequency and bandwidth combination, a total of 100,000 points, at 20 μs per point, was accumulated. A total of 2 seconds of time waveform data was acquired with 20 μs resolution at each combination of bandwidth and frequency for each of the five ovens. Though this approach limited the number of pulses recorded in each scan, it increased the resolution of the recorded signals and the associated APDs.

Vast amounts of data were taken by NTIA/ITS throughtout this project and therefore, a limited set of data is displayed in this Appendix. Ovens #1, #5, and #11 show a 3 MHz bandwidth with four time waveforms per frequency per page at frequencies of 2300, 2350, 2400, 2450, 2500, 2550, and 2600 MHz. An associated APD for each oven is shown at the above frequencies with a 3 MHz bandwidth. Ovens #7 and #11 show three different bandwidths (30 kHz, 300 kHz, and 3 MHz) with four time waveforms per frequency per page at the above frequencies. An associated APD for each oven is shown at each frequency with the above bandwidths.

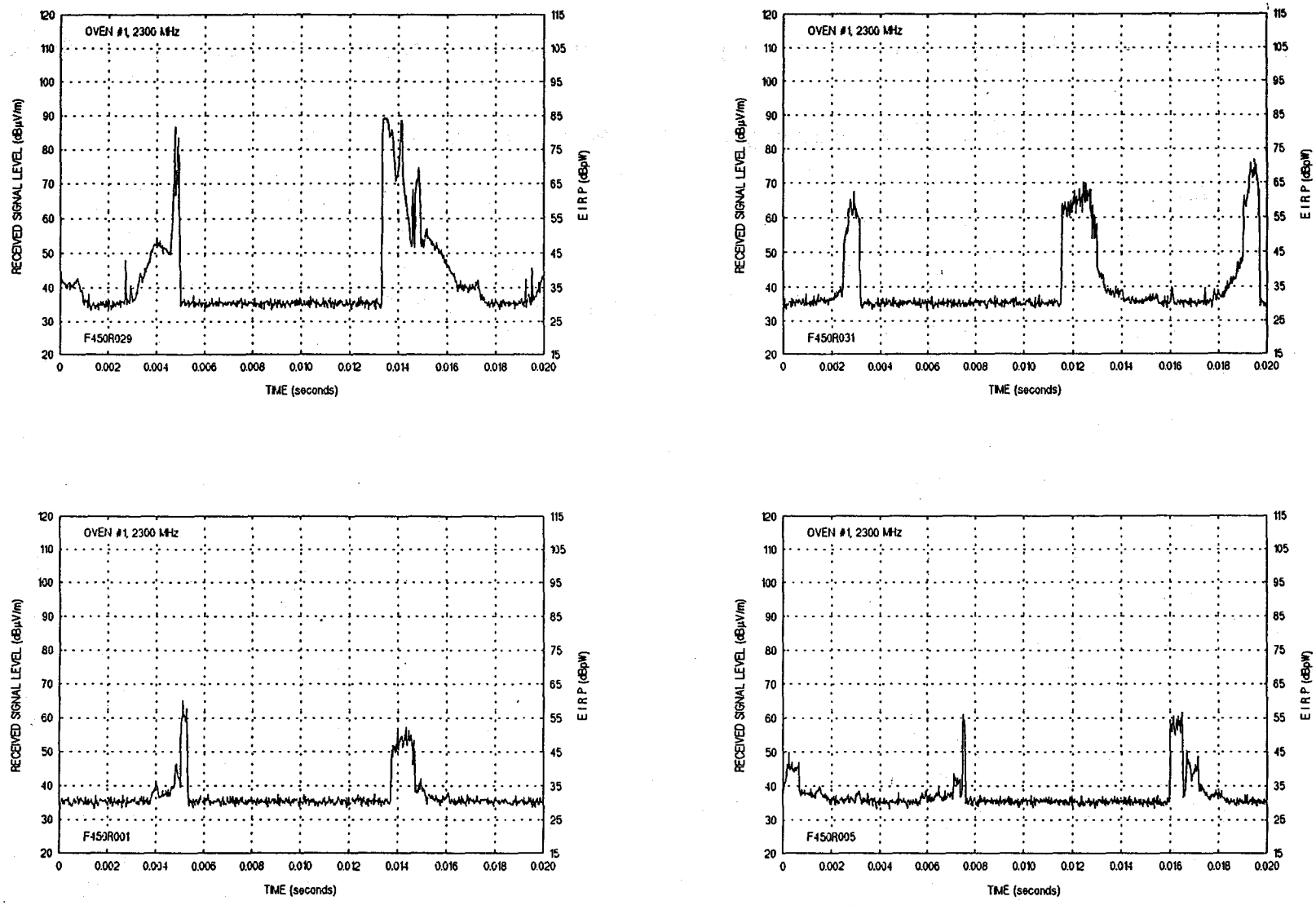


Figure C-1. Oven #1, Time vs. Amplitude displays at 2300 MHz with 3 MHz bandwidth.

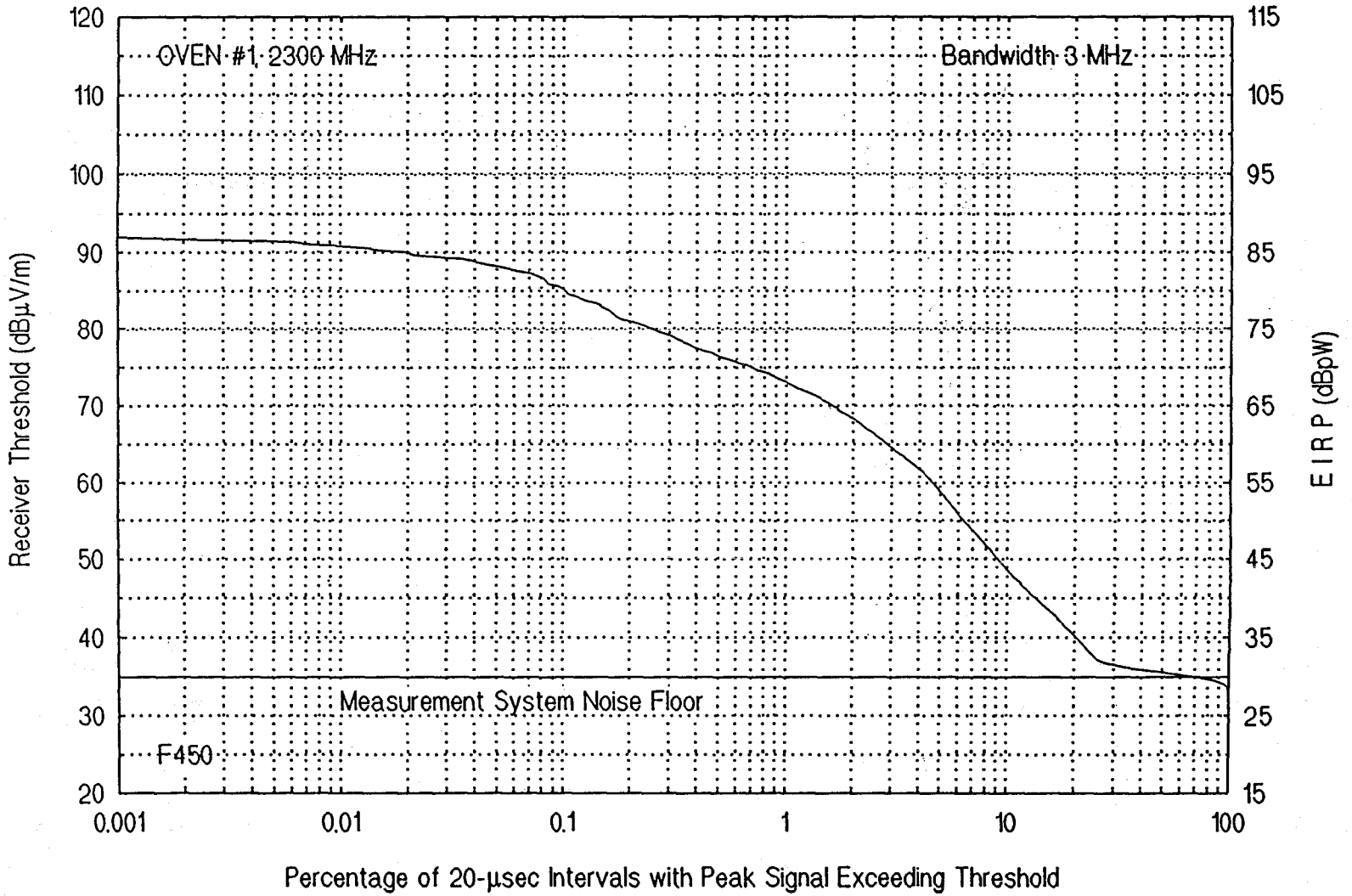


Figure C-2. Oven #1, Amplitude-Probability Distribution at 2300 MHz with 3 MHz bandwidth.

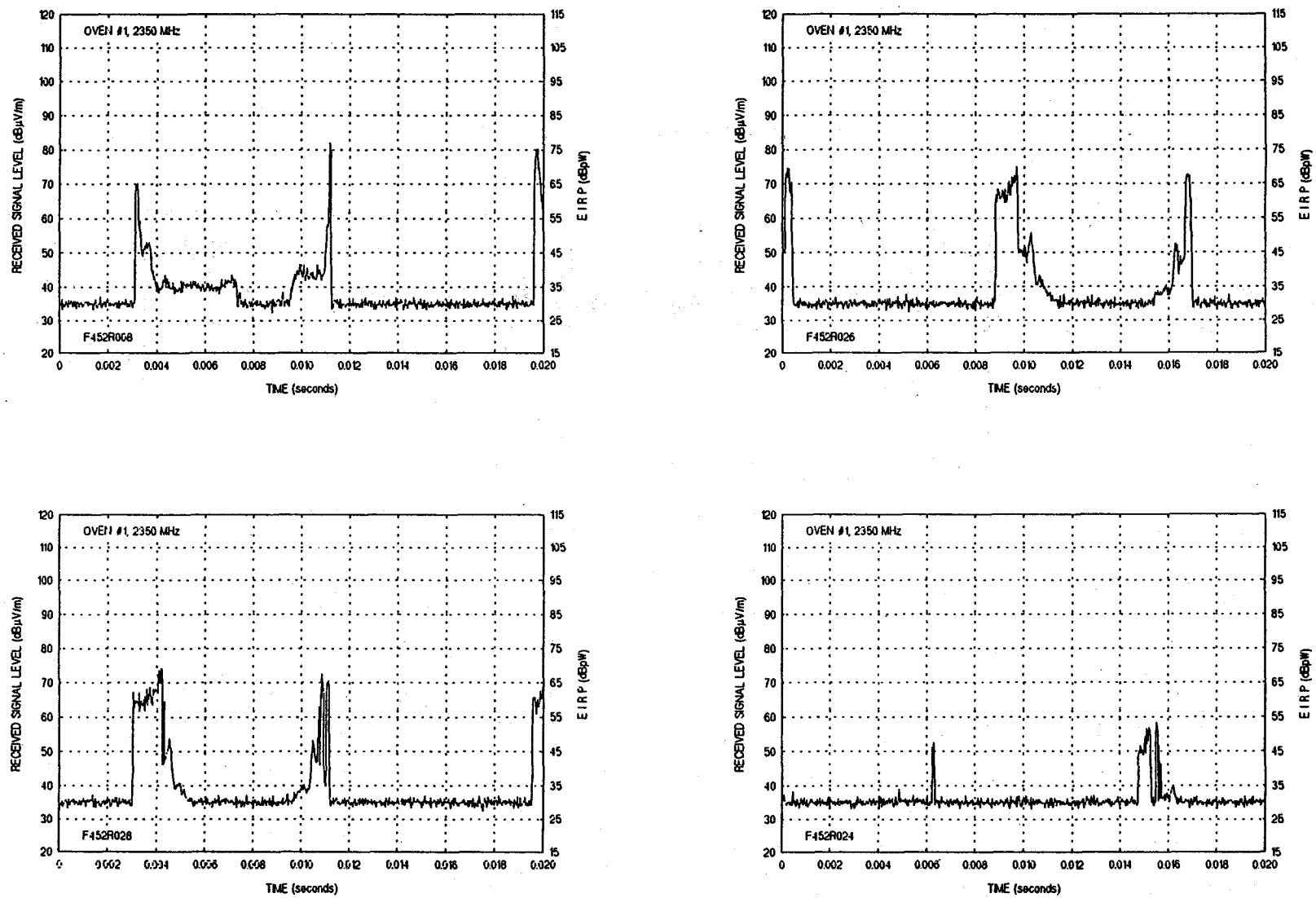


Figure C-3. Oven #1, Time vs. Amplitude displays at 2350 MHz with 3 MHz bandwidth.

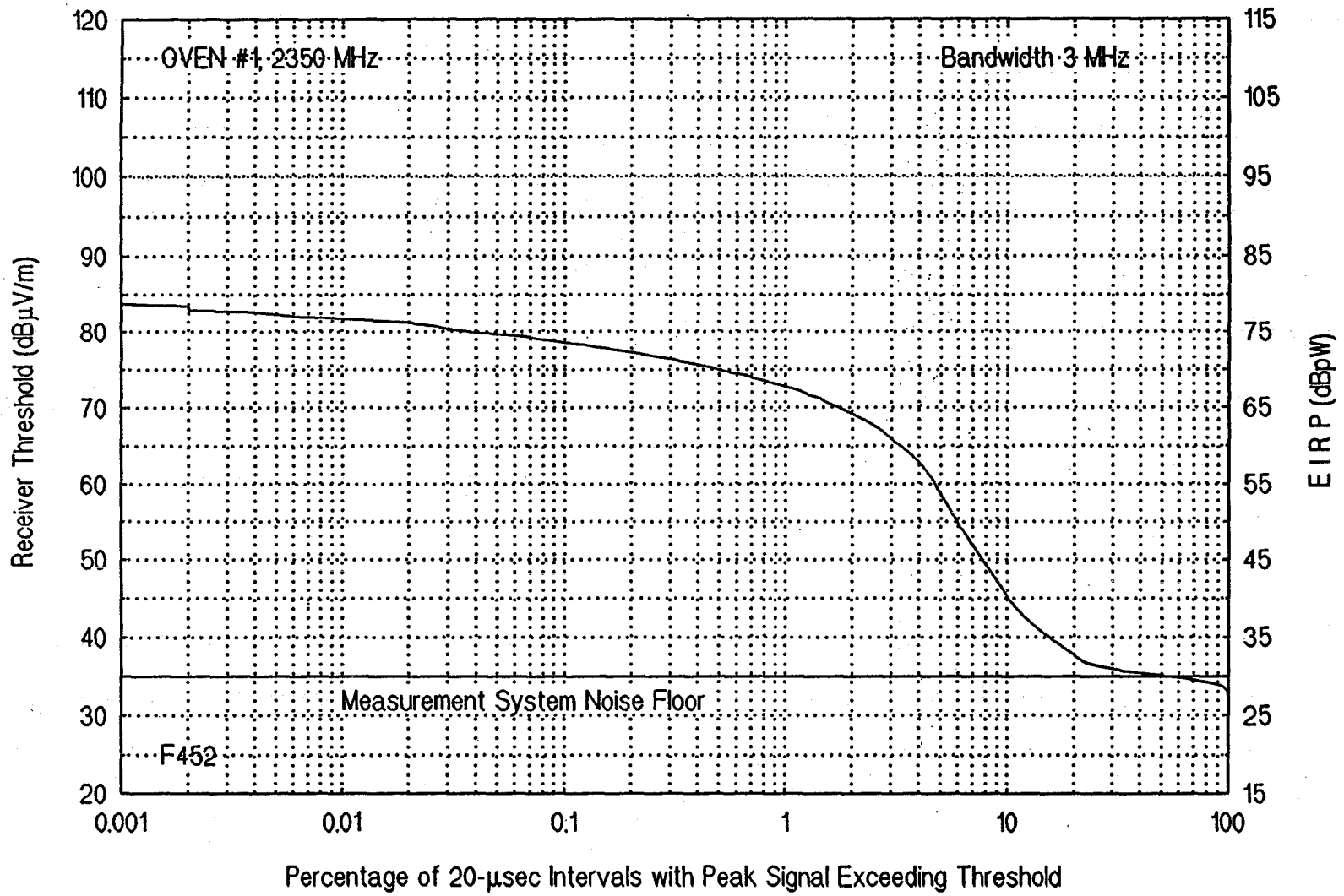


Figure C-4. Oven #1, Amplitude-Probability Distribution at 2350 MHz with 3 MHz bandwidth.

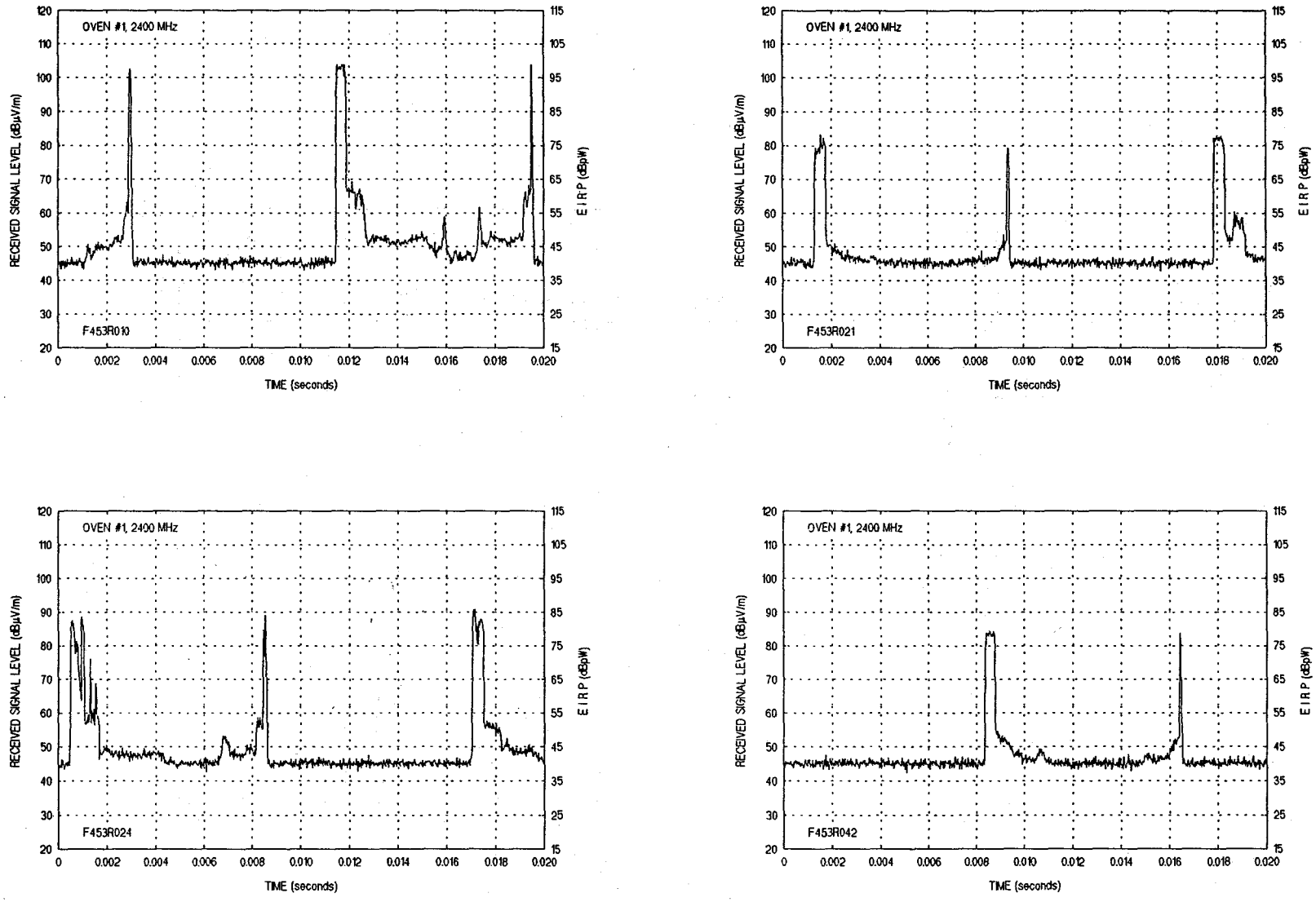


Figure C-5. Oven #1, Time vs. Amplitude displays at 2400 MHz with 3 MHz bandwidth.

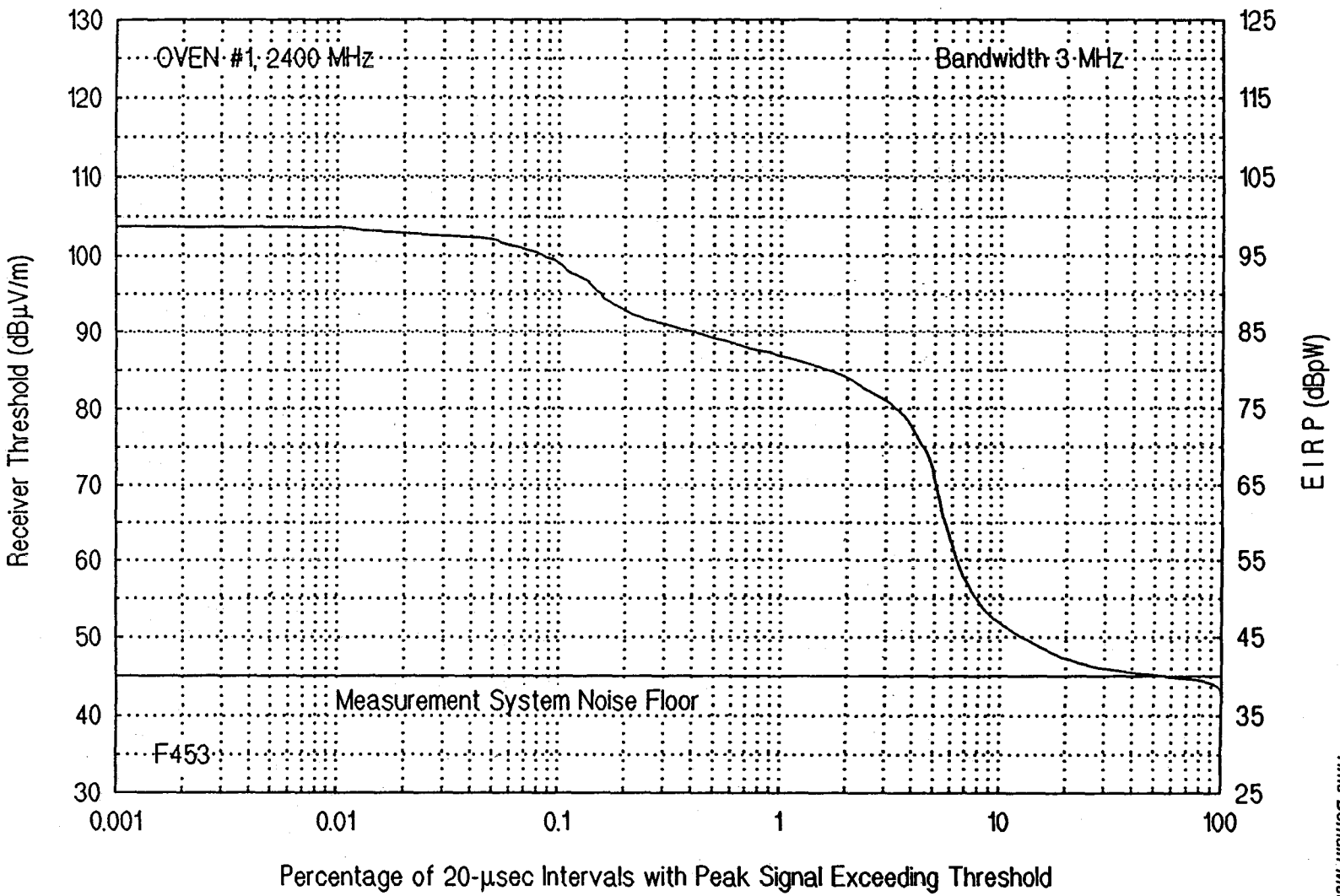


Figure C-6. Oven #1, Amplitude-Probability Distribution at 2400 MHz with 3 MHz bandwidth.

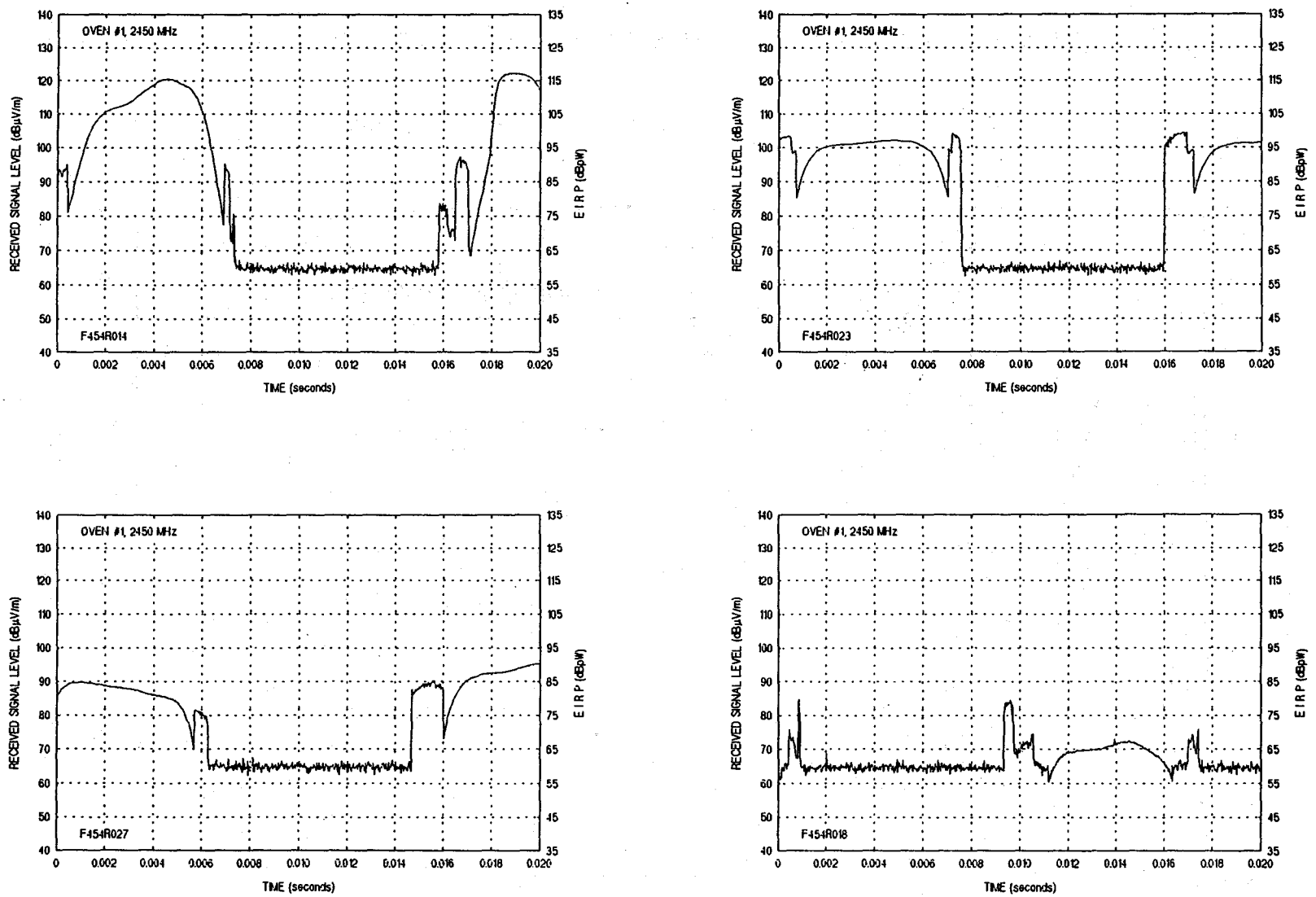


Figure C-7. Oven #1, Time vs. Amplitude displays at 2450 MHz with 3 MHz bandwidth.

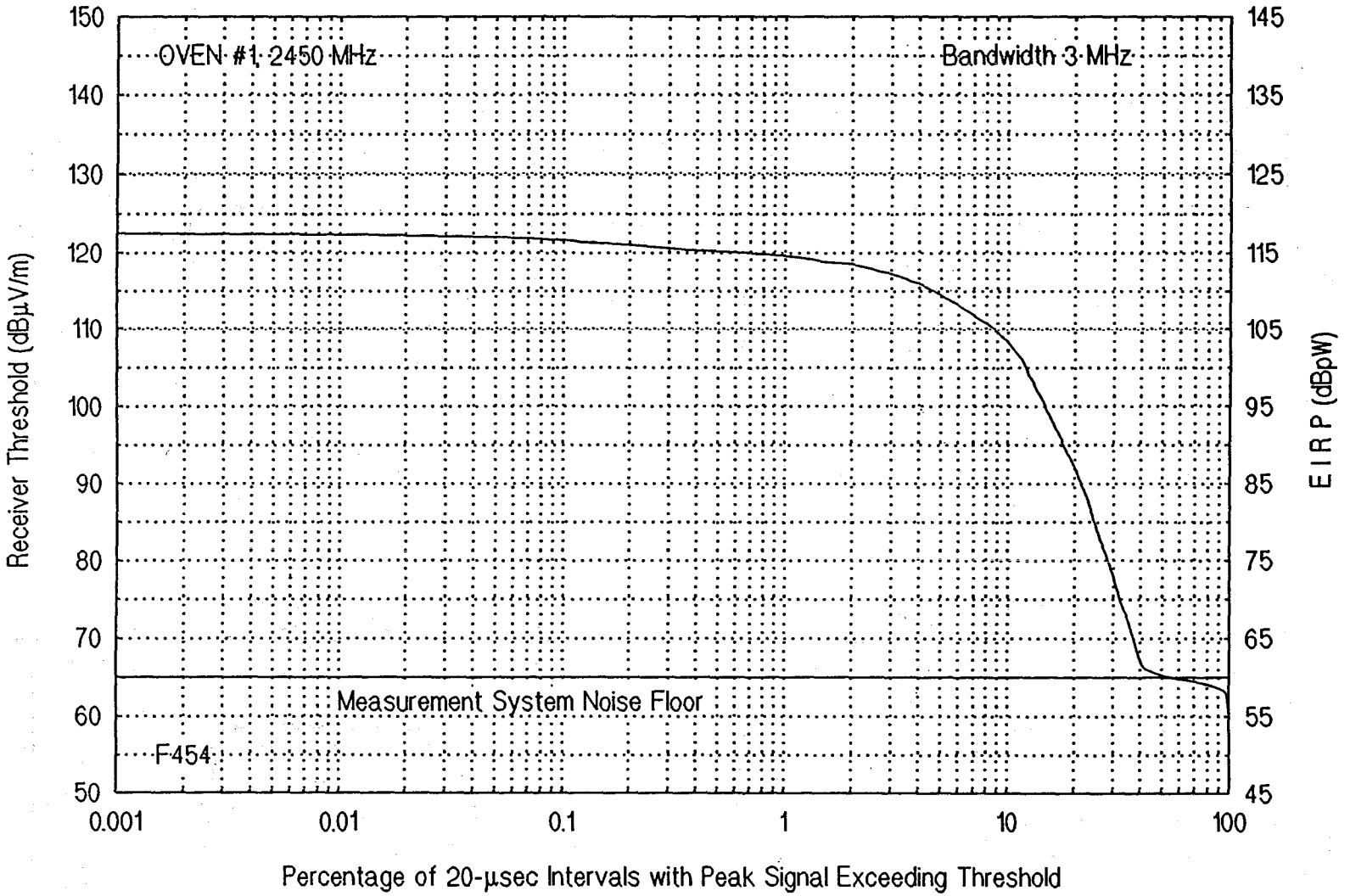
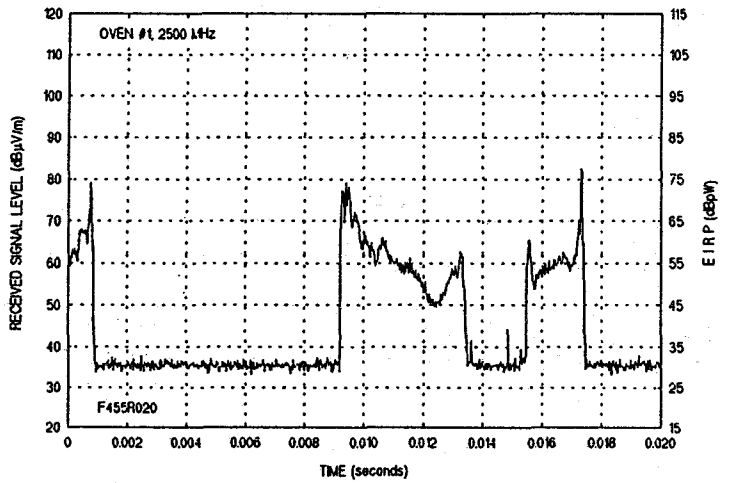
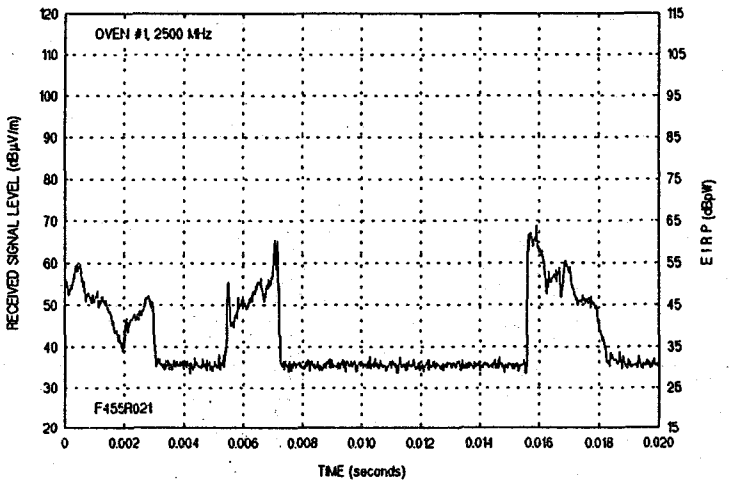
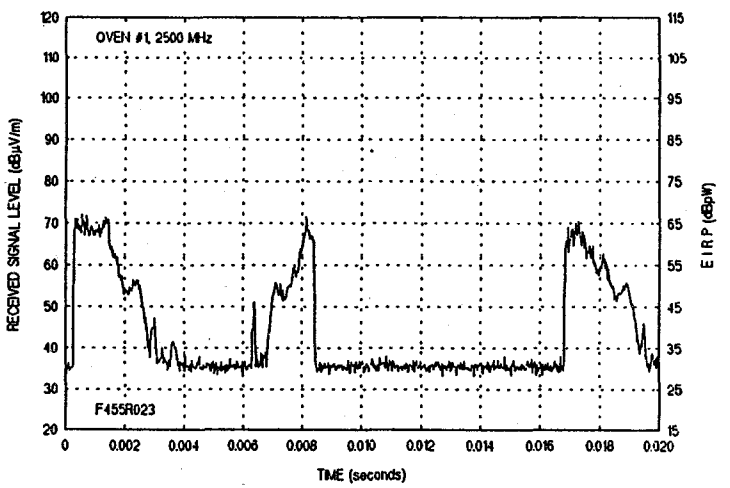


Figure C-8. Oven #1, Amplitude-Probability Distribution at 2450 MHz with 3 MHz bandwidth.







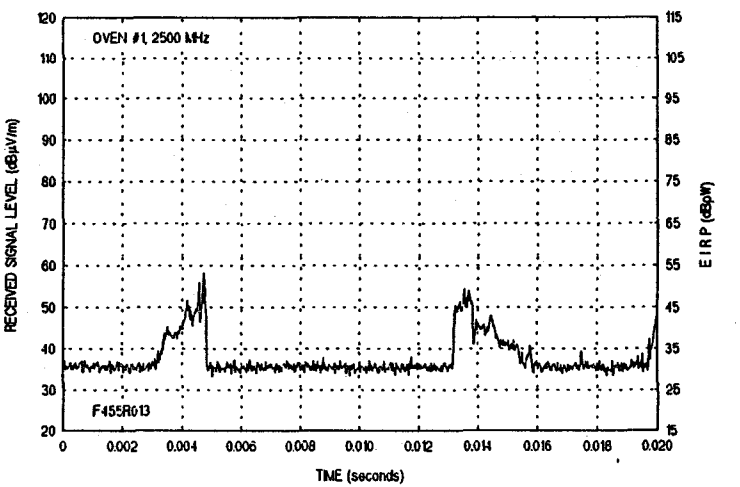


Figure C-9. Oven #1, Time vs. Amplitude displays at 2500 MHz with 3 MHz bandwidth.

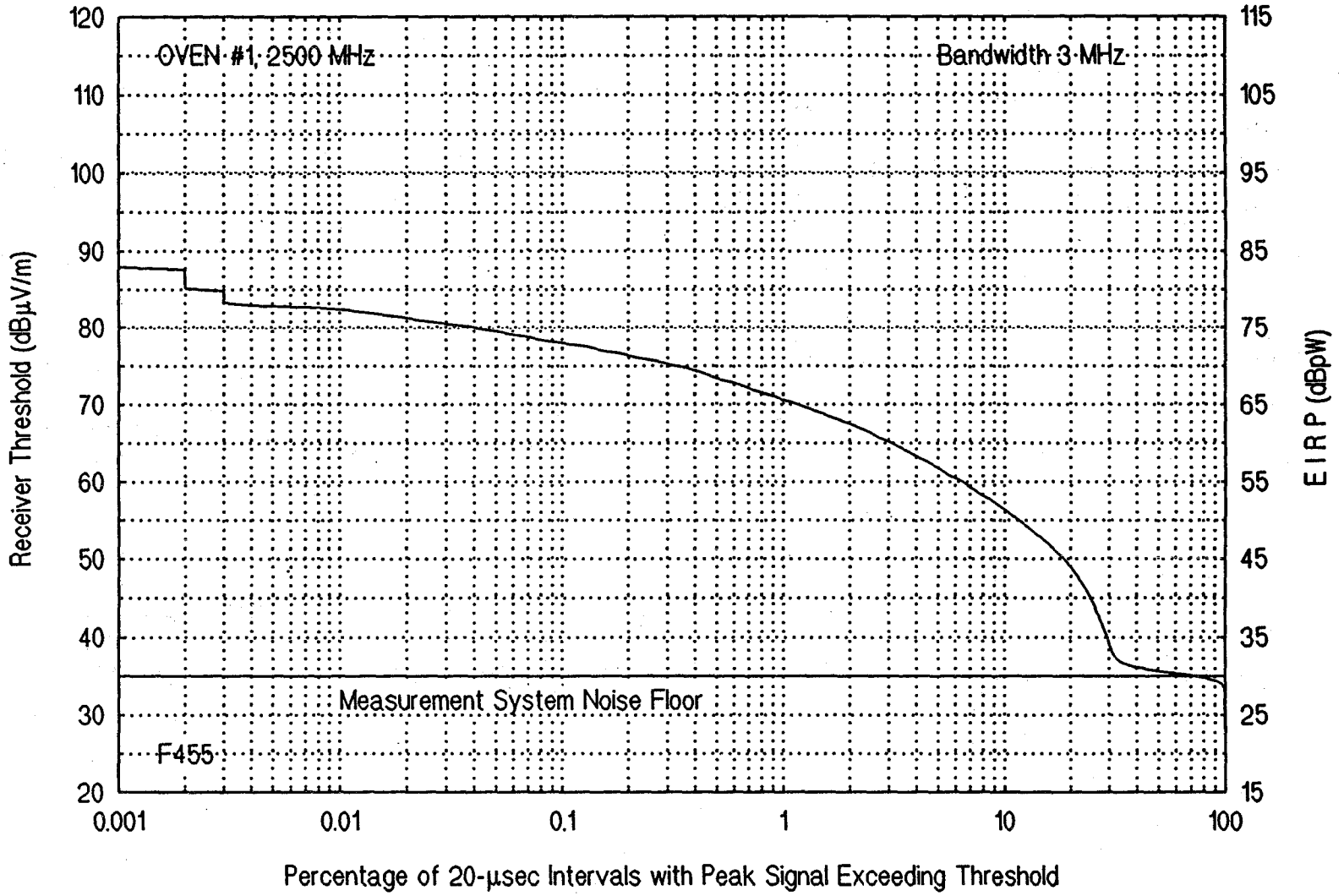


Figure C-10. Oven #1, Amplitude-Probability Distribution at 2500 MHz with 3 MHz bandwidth.

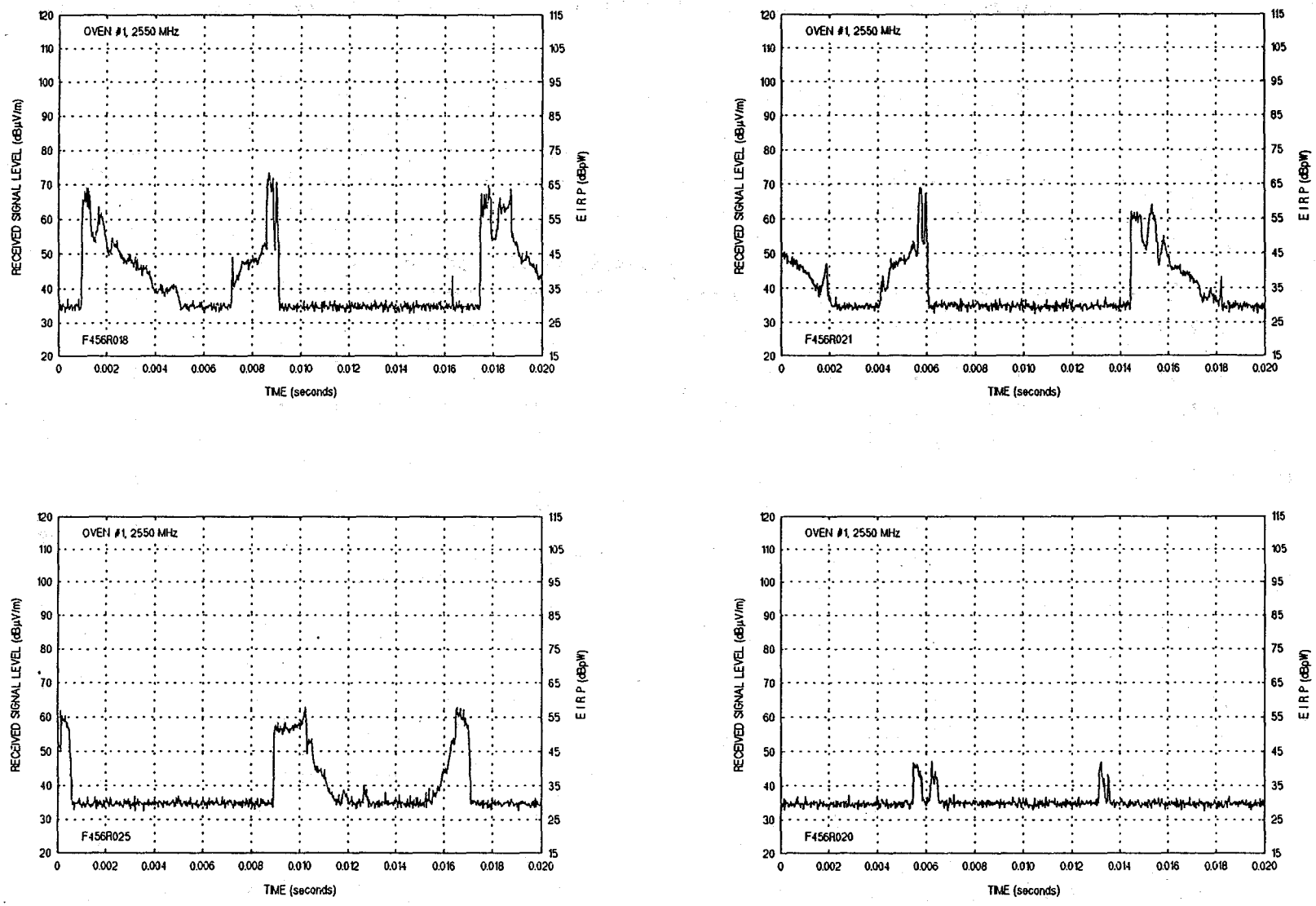


Figure C-11. Oven #1, Time vs. Amplitude displays at 2550 MHz with 3 MHz bandwidth.

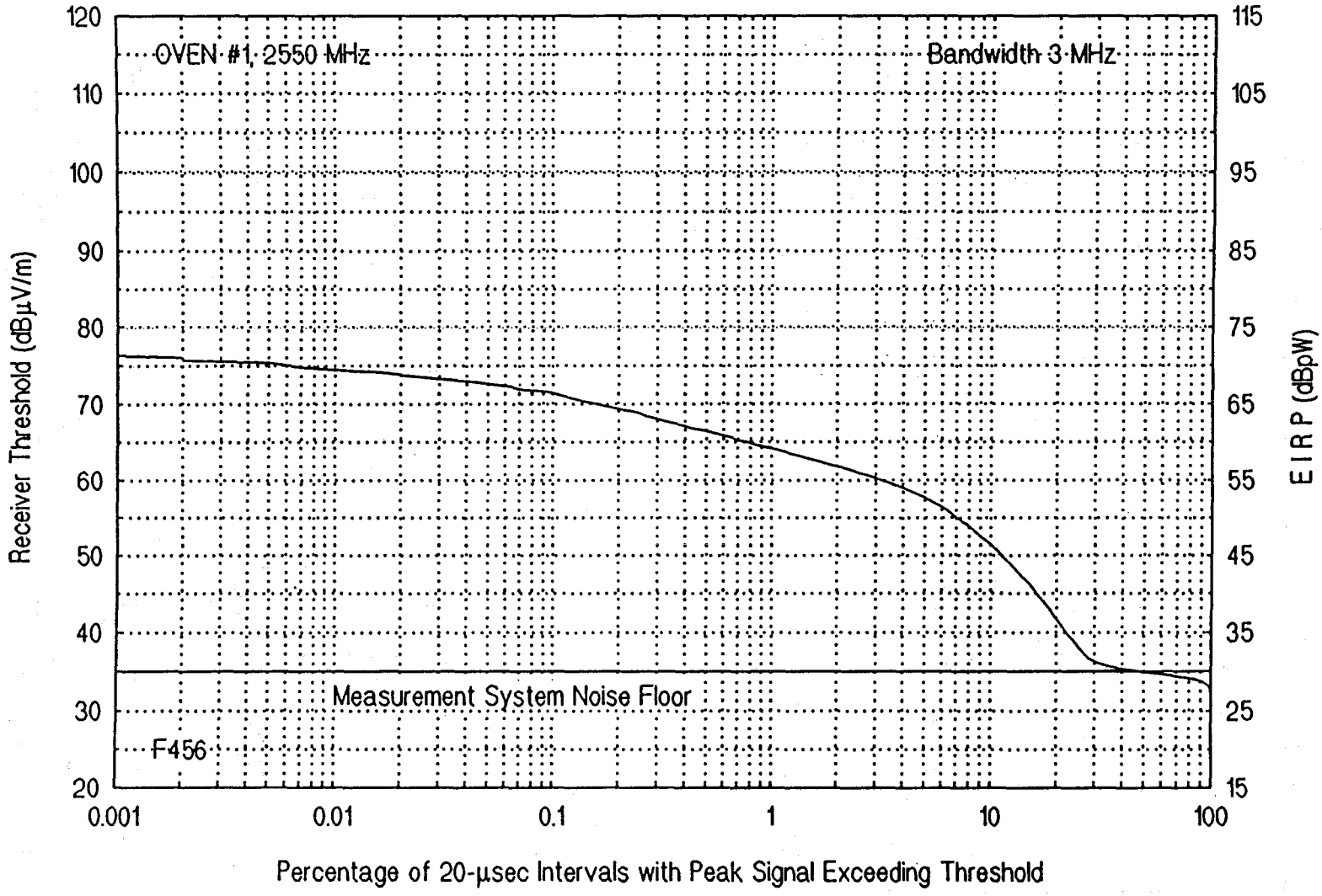


Figure C-12. Oven #1, Amplitude-Probability Distribution at 2550 MHz with 3 MHz bandwidth.

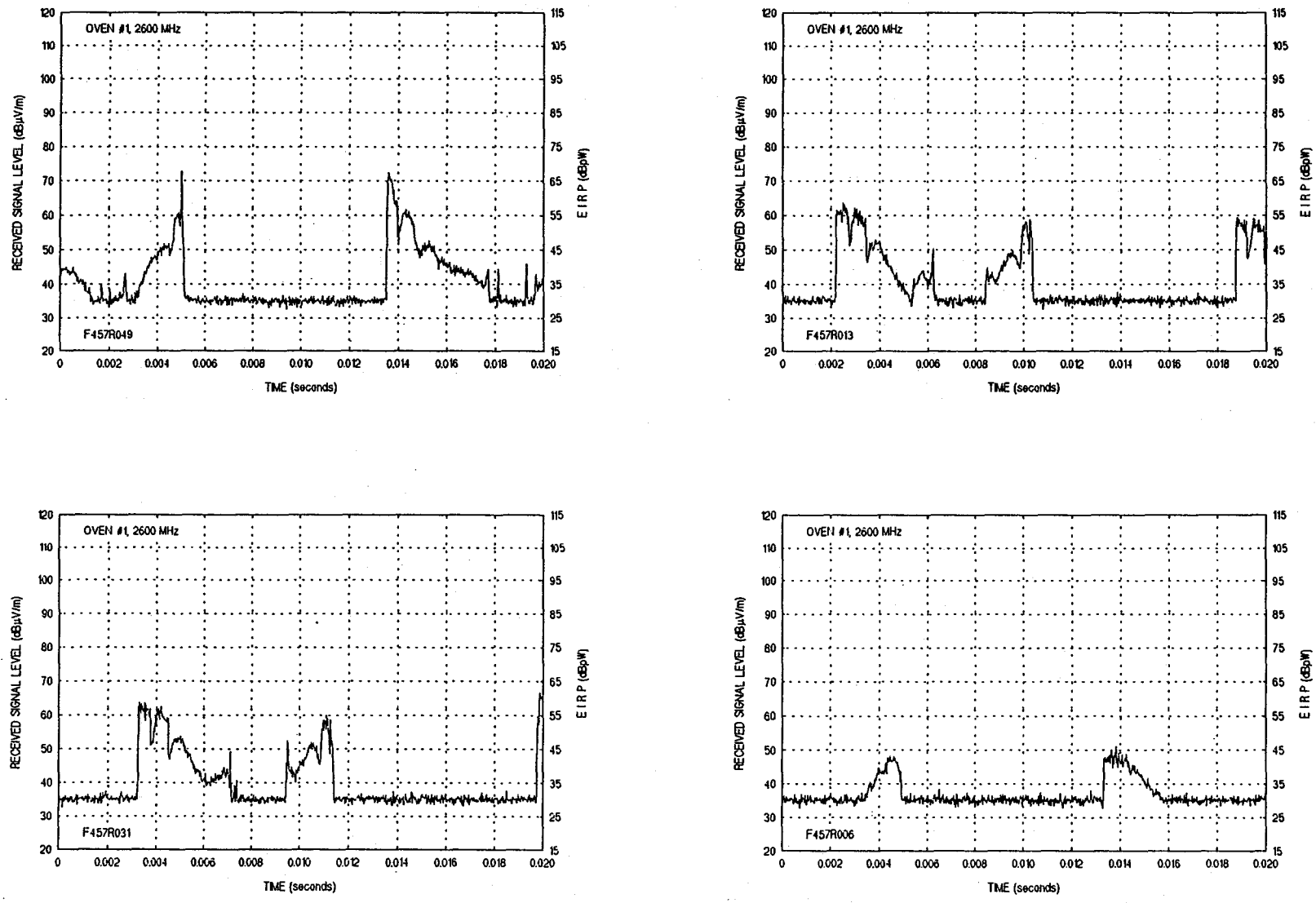


Figure C-13. Oven #1, Time vs. Amplitude displays at 2600 MHz with 3 MHz bandwidth.

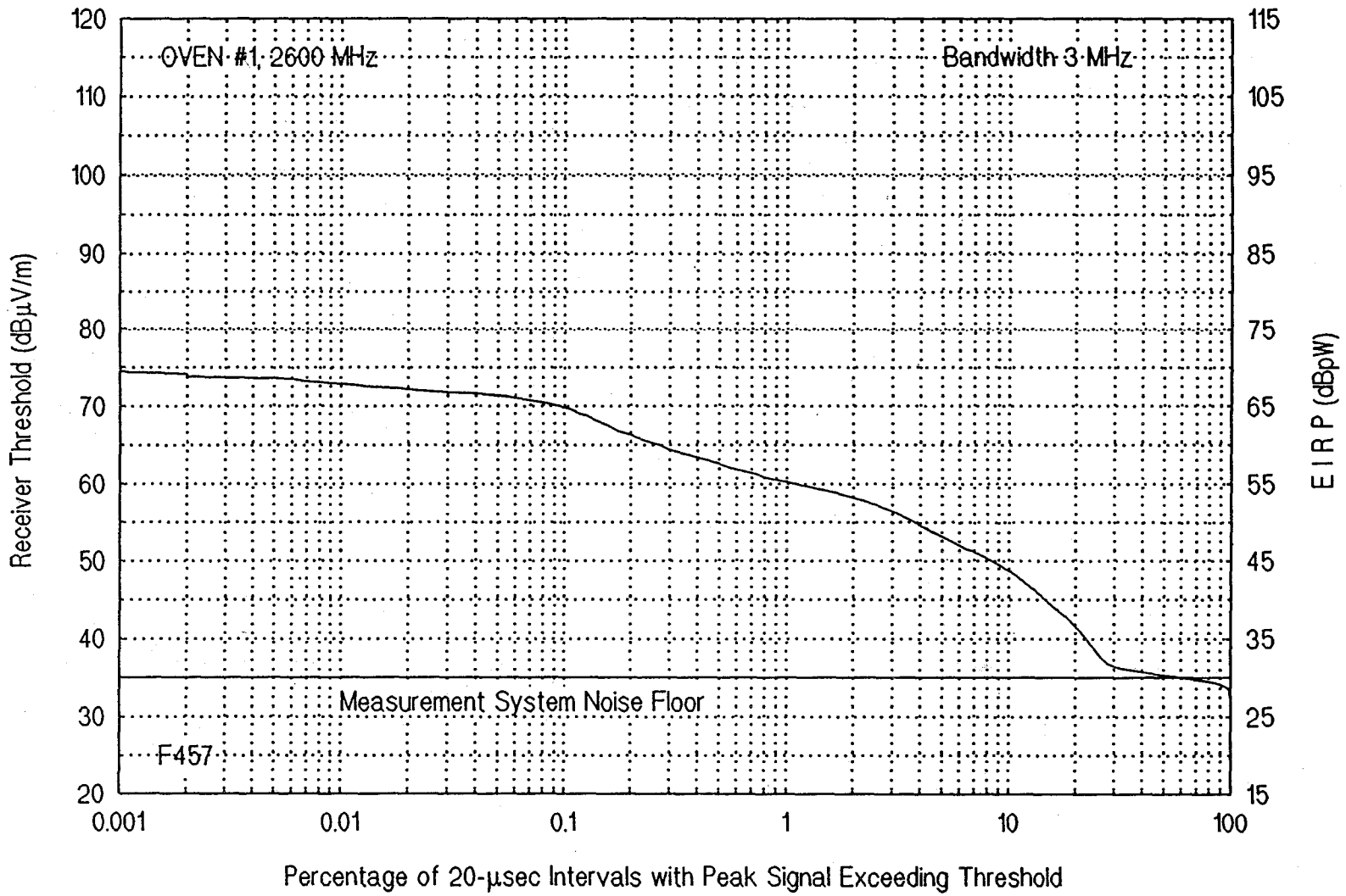


Figure C-14. Oven #1, Amplitude-Probability Distribution at 2600 MHz with 3 MHz bandwidth.

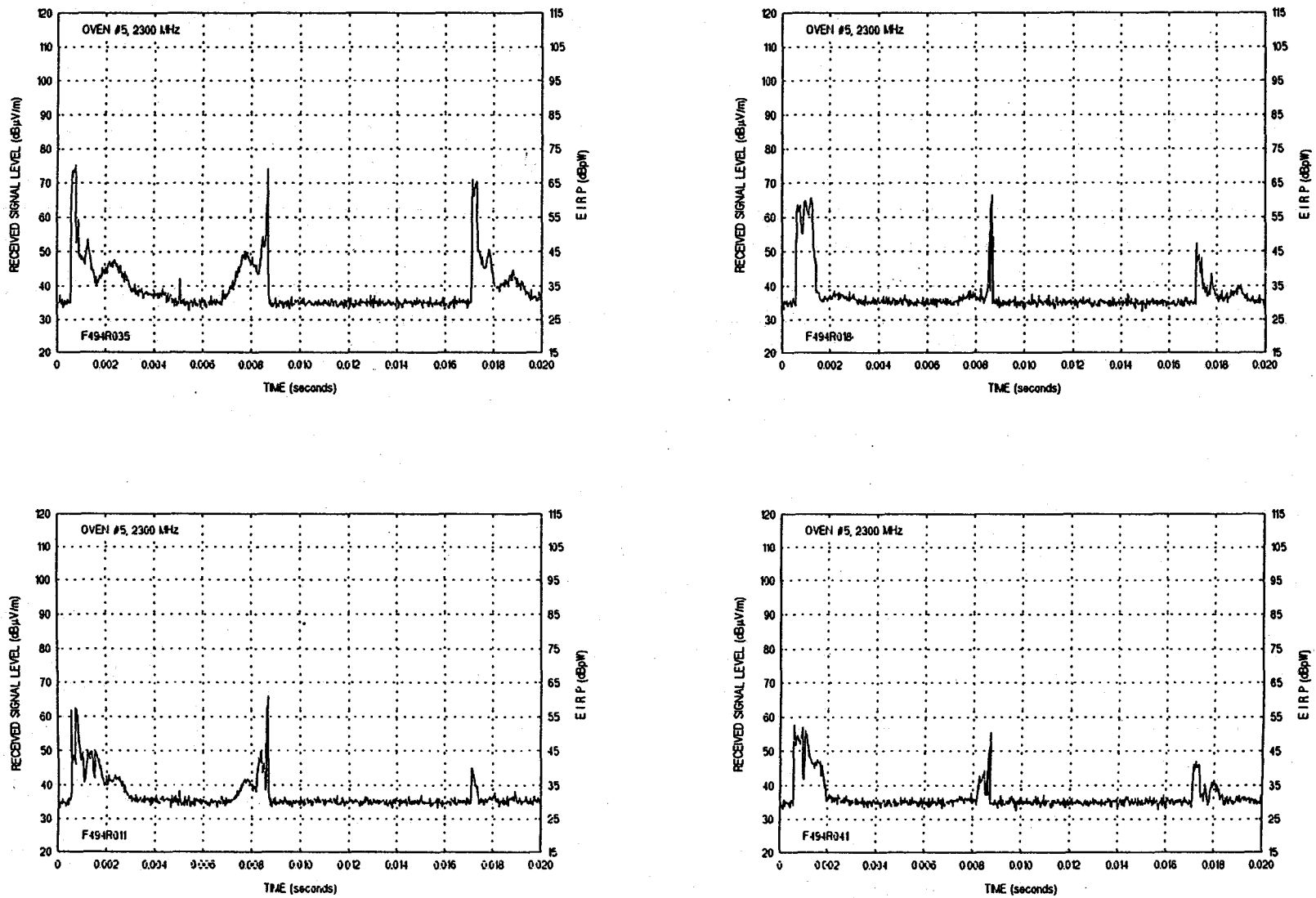


Figure C-15. Oven #5, Time vs. Amplitude displays at 2300 MHz with 3 MHz bandwidth.

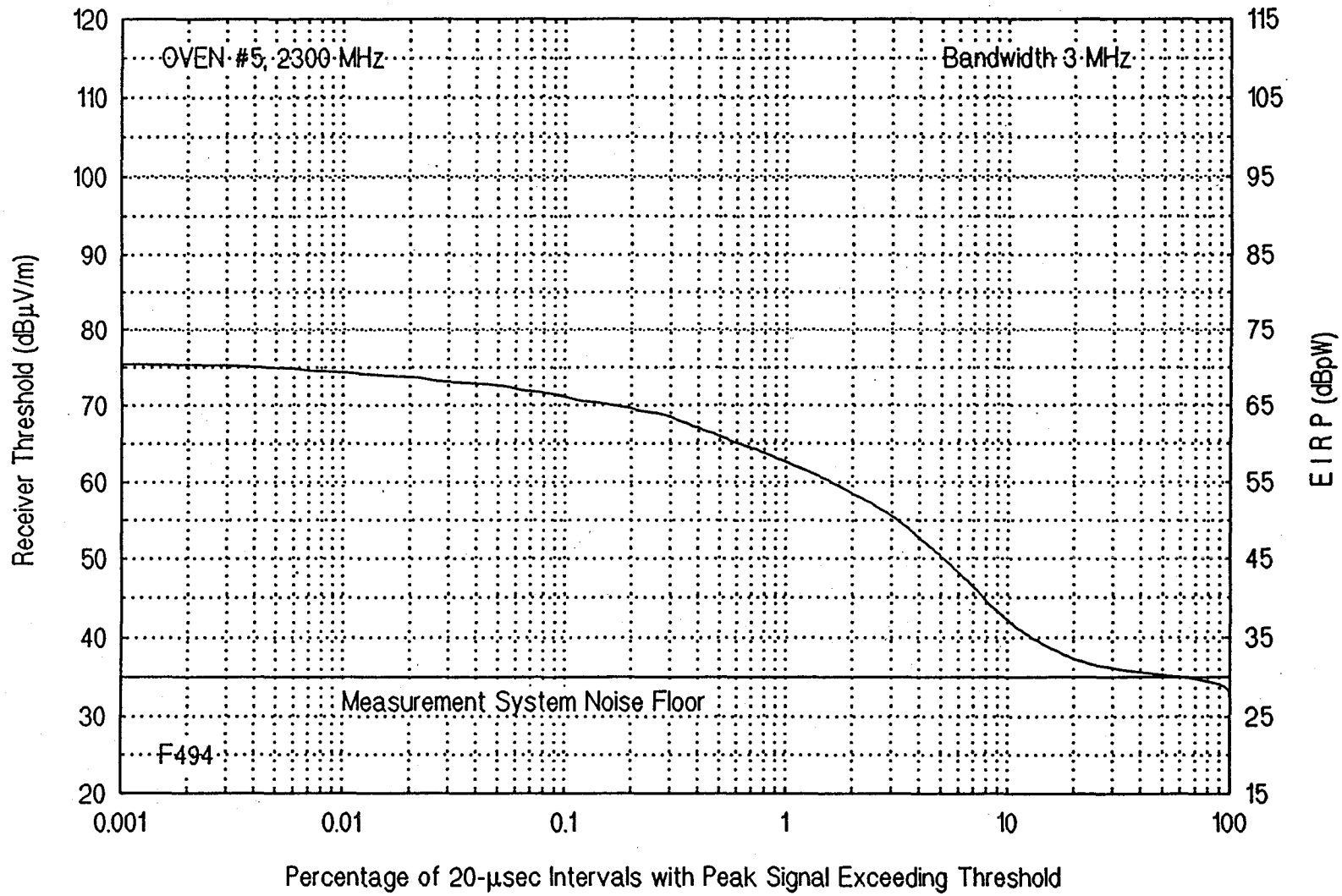


Figure C-16. Oven #5, Amplitude-Probability Distribution at 2300 MHz with 3 MHz bandwidth.

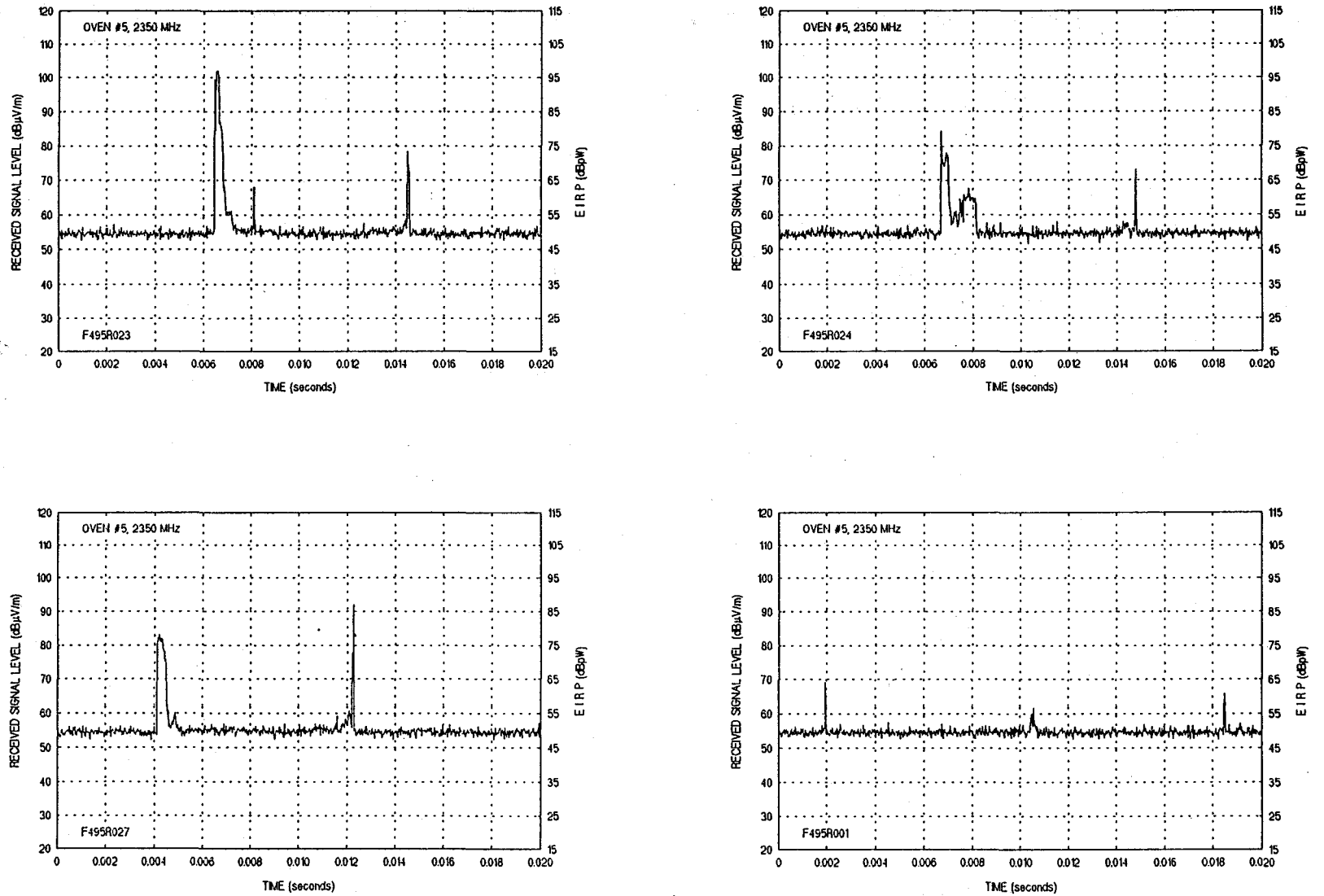


Figure C-17. Oven #5, Time vs. Amplitude displays at 2350 MHz with 3 MHz bandwidth.

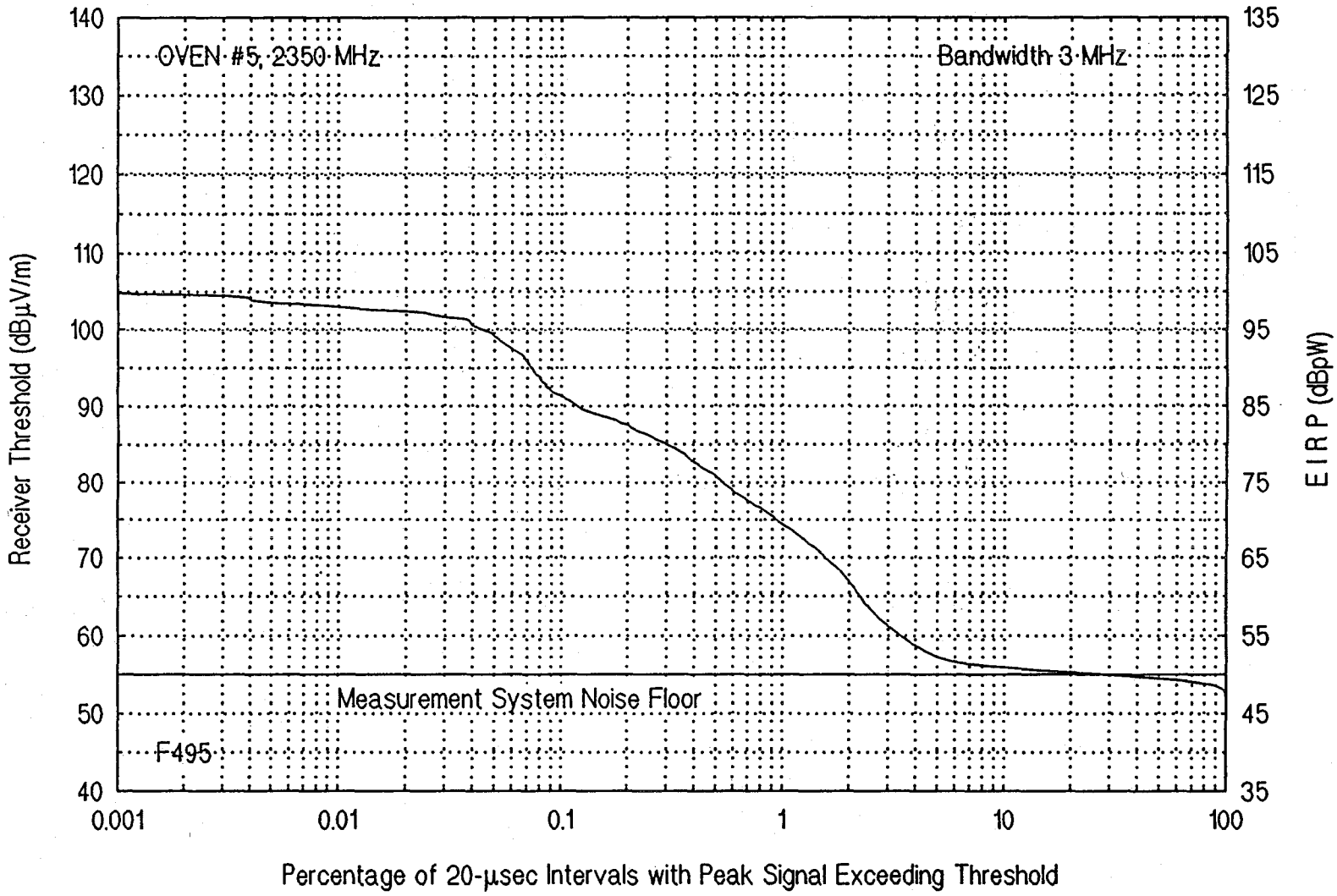


Figure C-18. Oven #5, Amplitude-Probability Distribution at 2350 MHz with 3 MHz bandwidth.

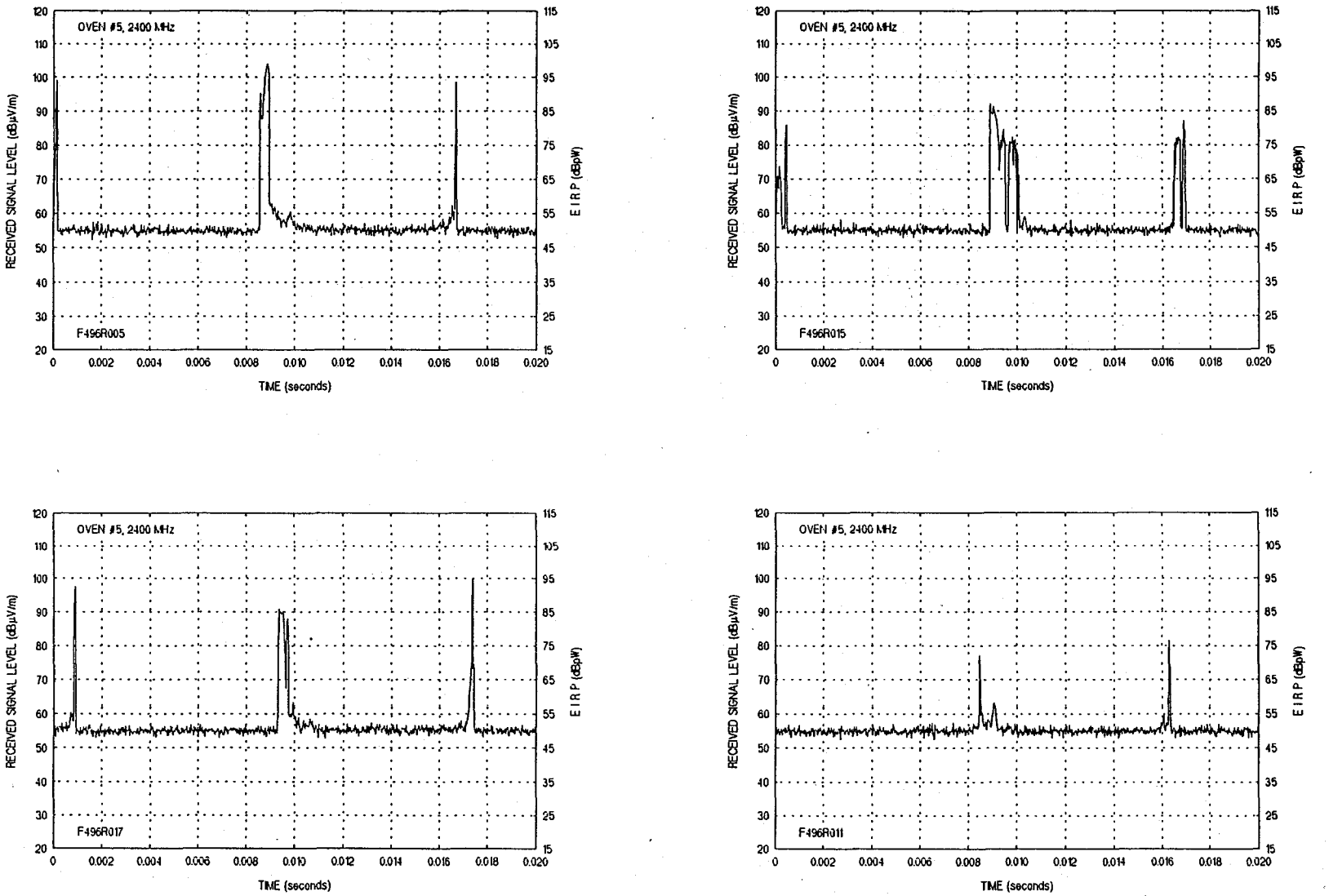


Figure C-19. Oven #5, Time vs. Amplitude displays at 2400 MHz with 3 MHz bandwidth.

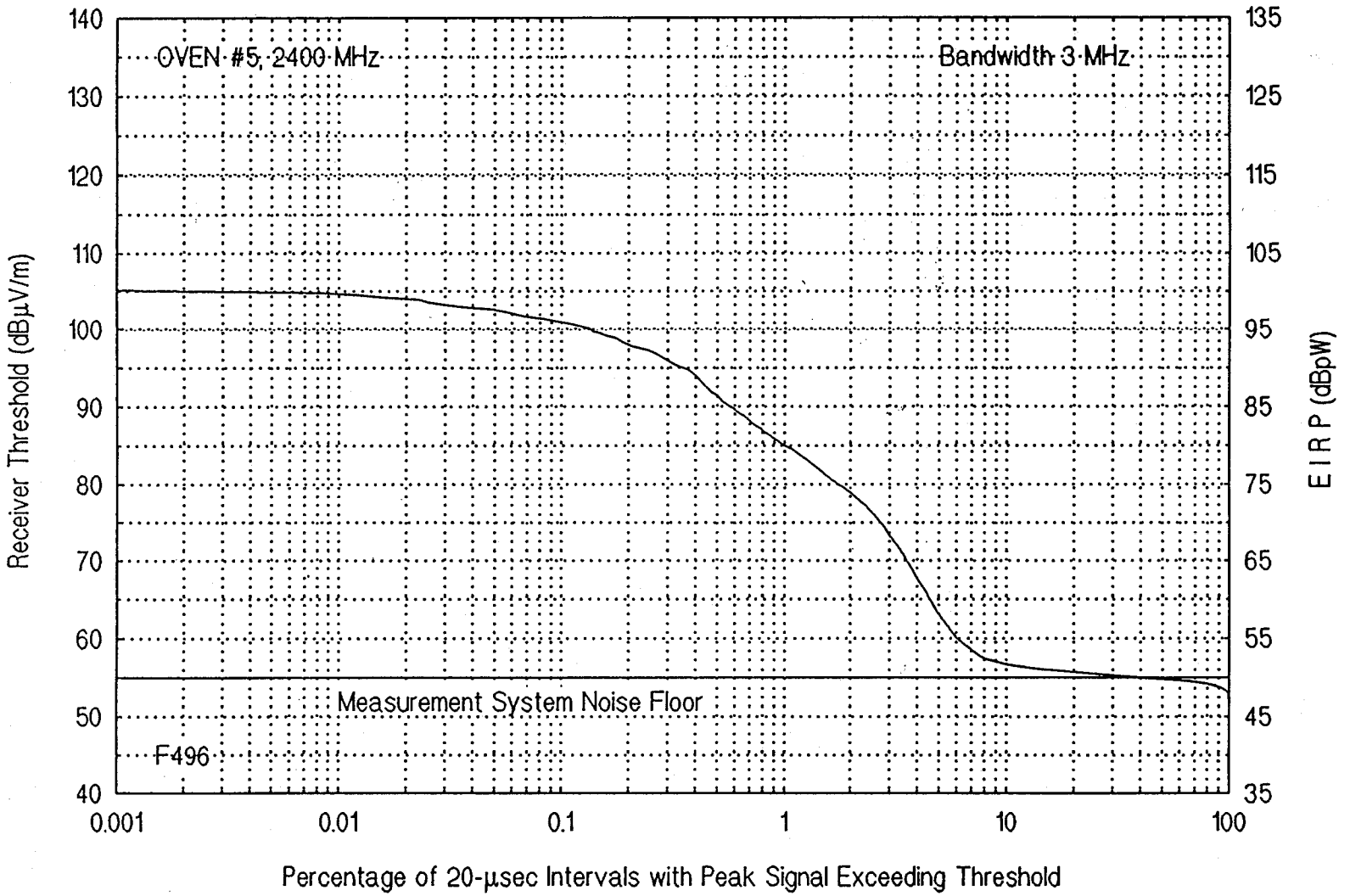


Figure C-20. Oven #5, Amplitude-Probability Distribution at 2400 MHz with 3 MHz bandwidth.

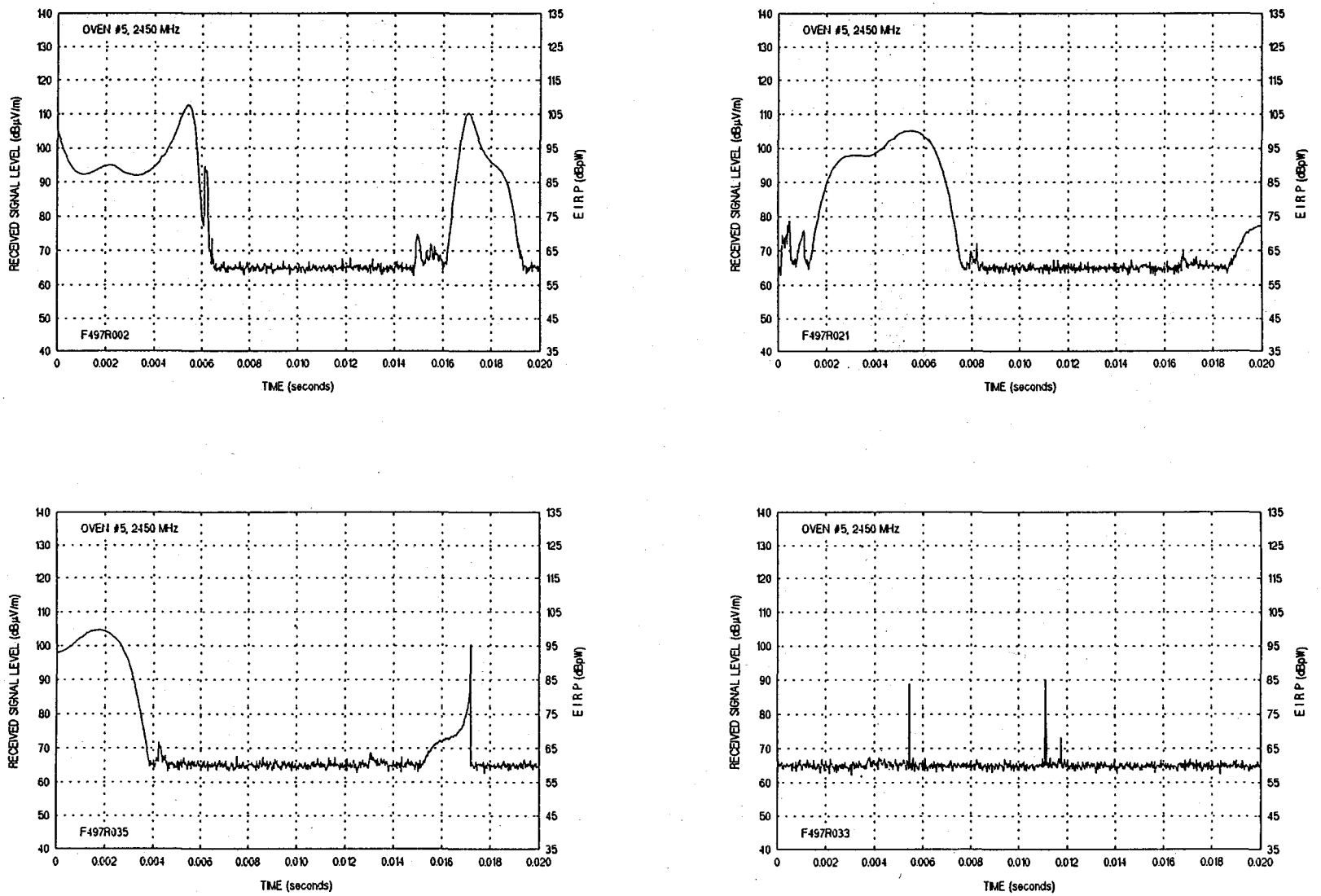


Figure C-21. Oven #5, Time vs. Amplitude displays at 2450 MHz with 3 MHz bandwidth.

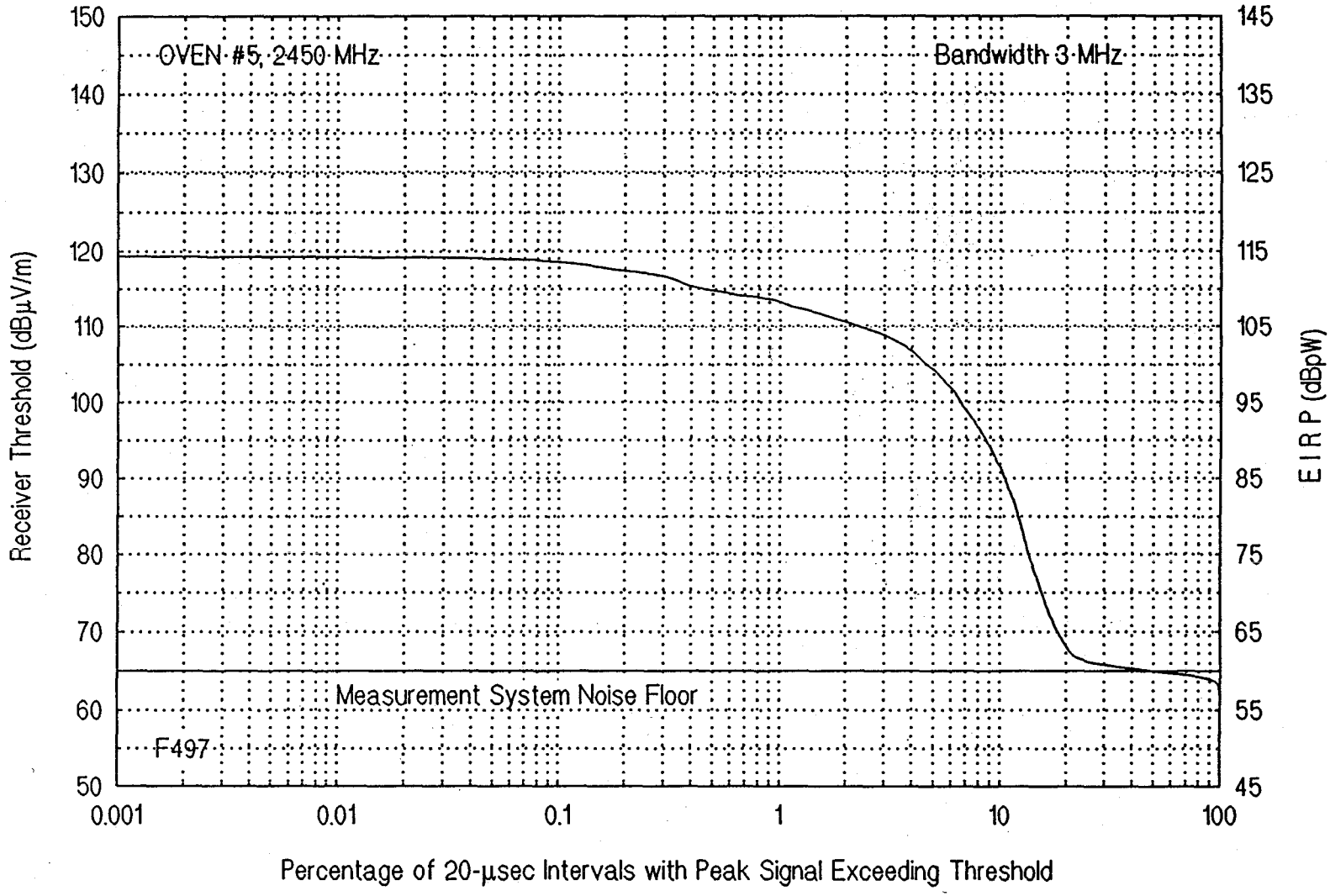


Figure C-22. Oven #5, Amplitude-Probability Distribution at 2450 MHz with 3 MHz bandwidth.

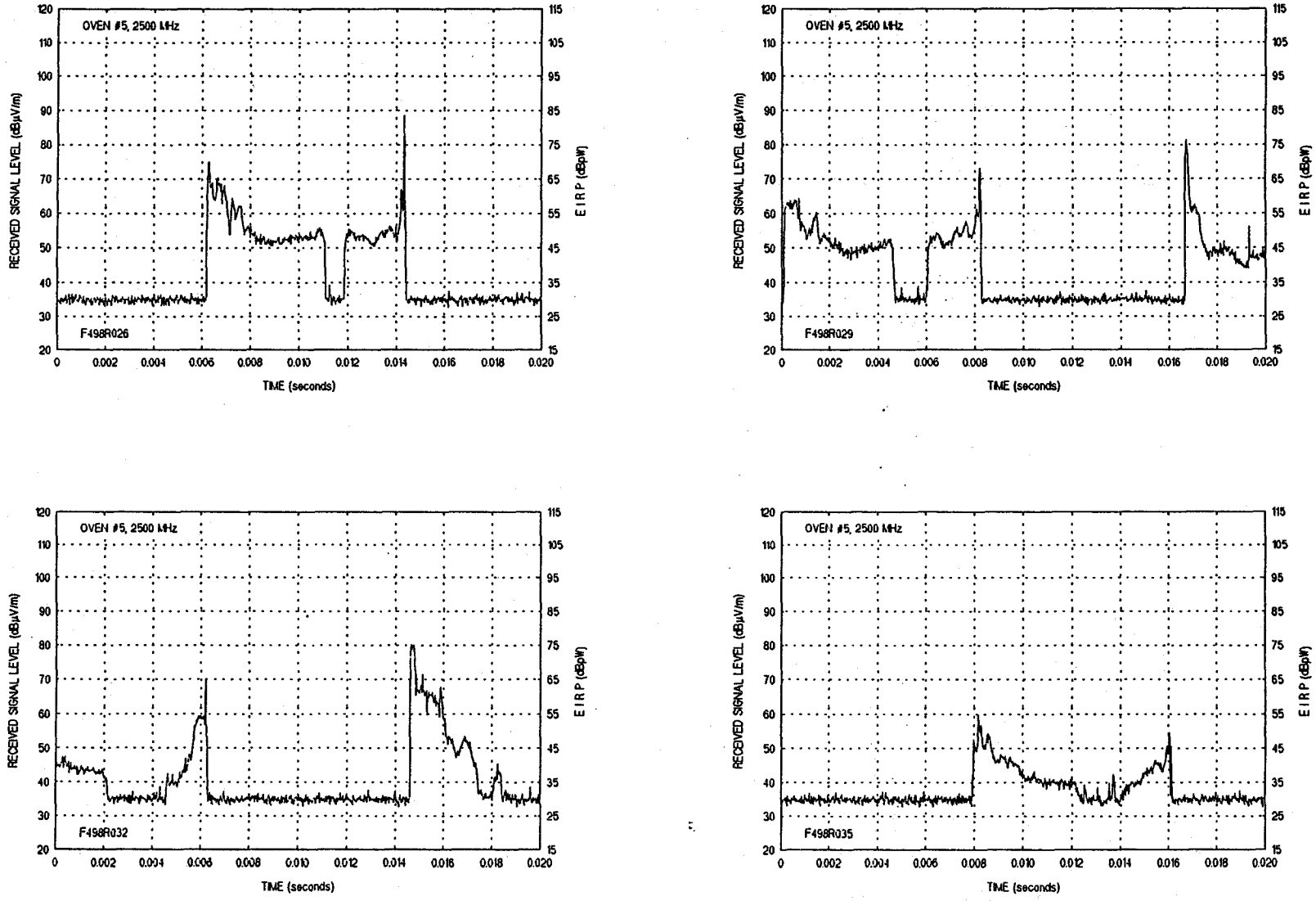


Figure C-23. Oven #5, Time vs. Amplitude displays at 2500 MHz with 3 MHz bandwidth.

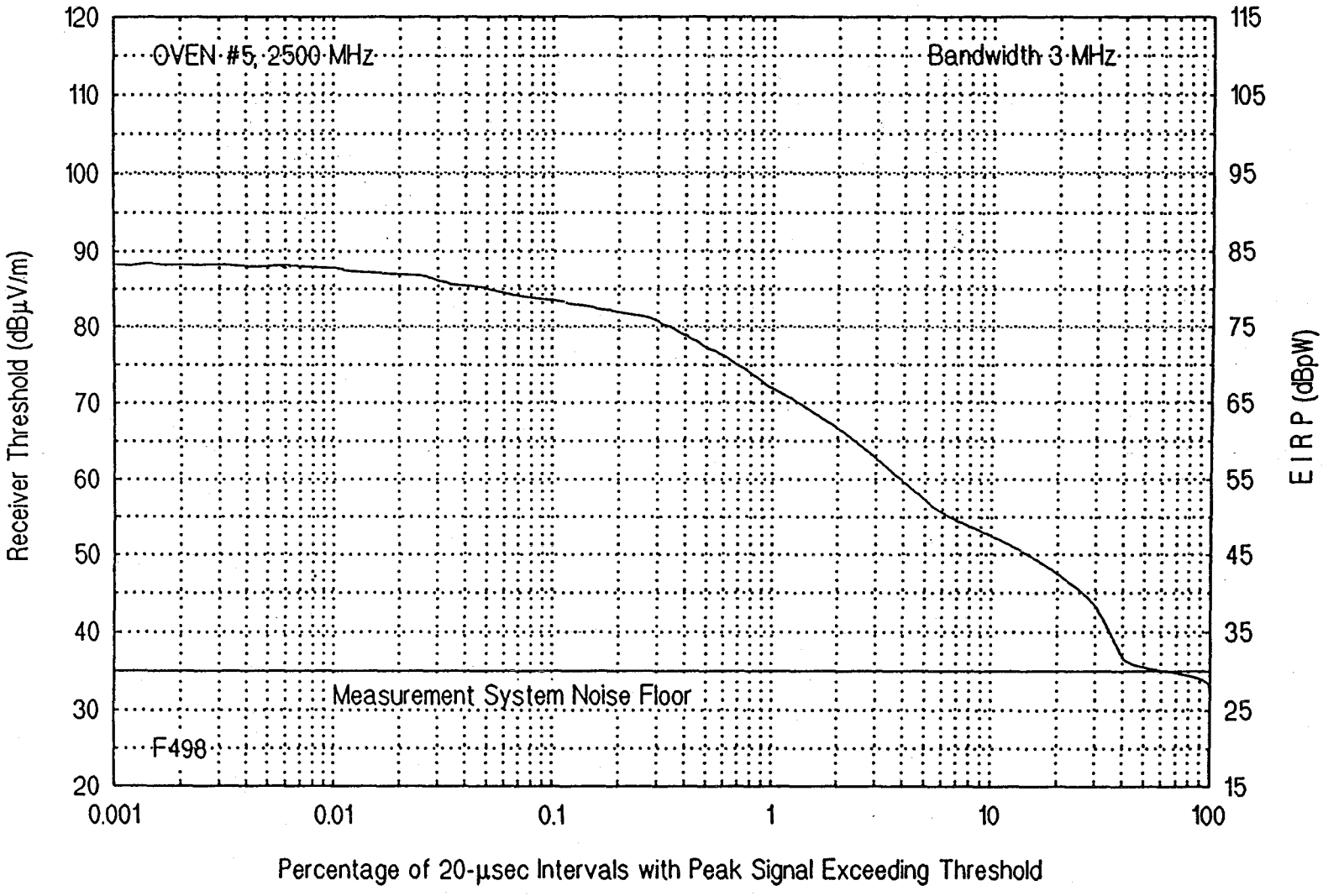


Figure C-24. Oven #5, Amplitude-Probability Distribution at 2500 MHz with 3 MHz bandwidth.

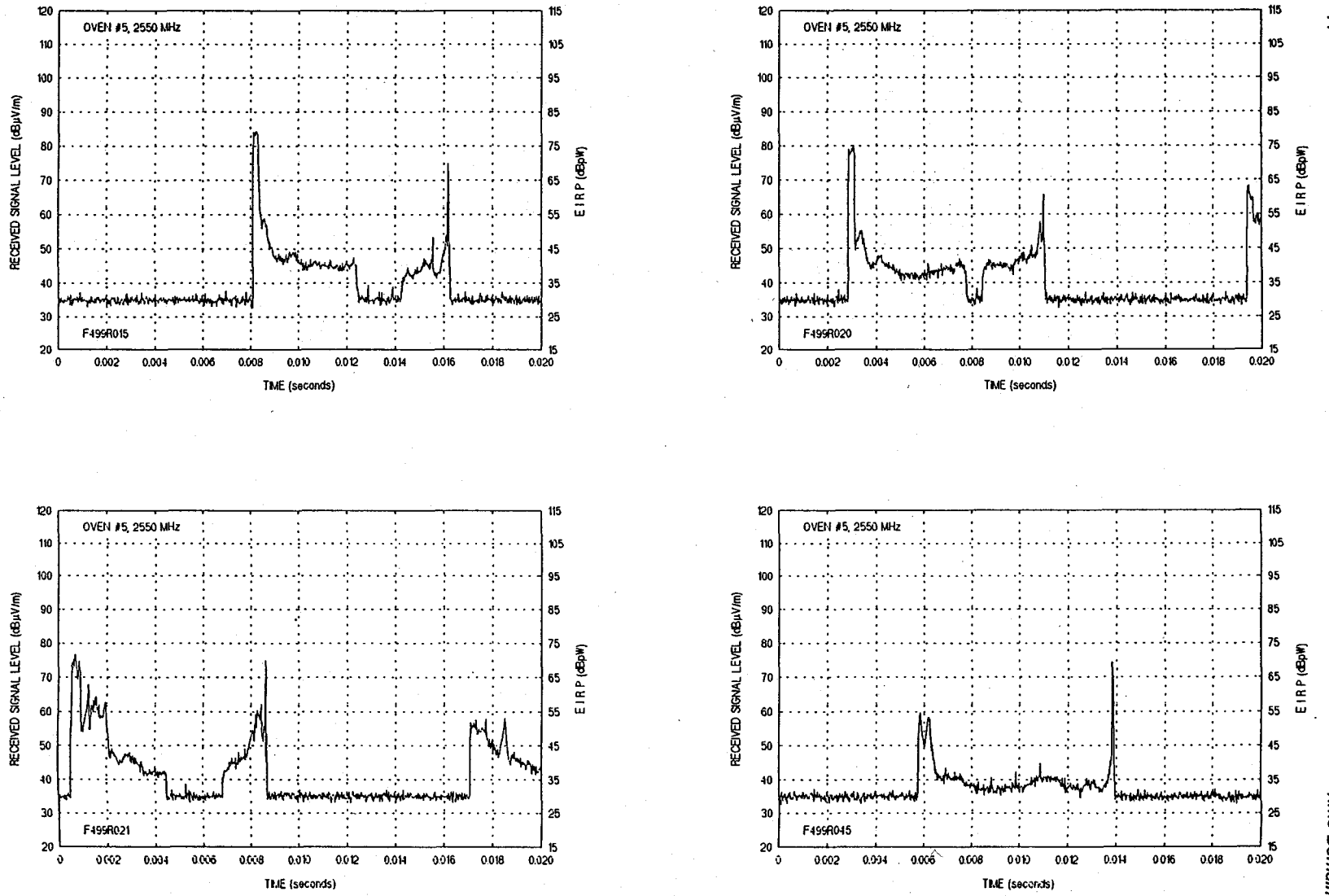


Figure C-25. Oven #5, Time vs. Amplitude displays at 2550 MHz with 3 MHz bandwidth.

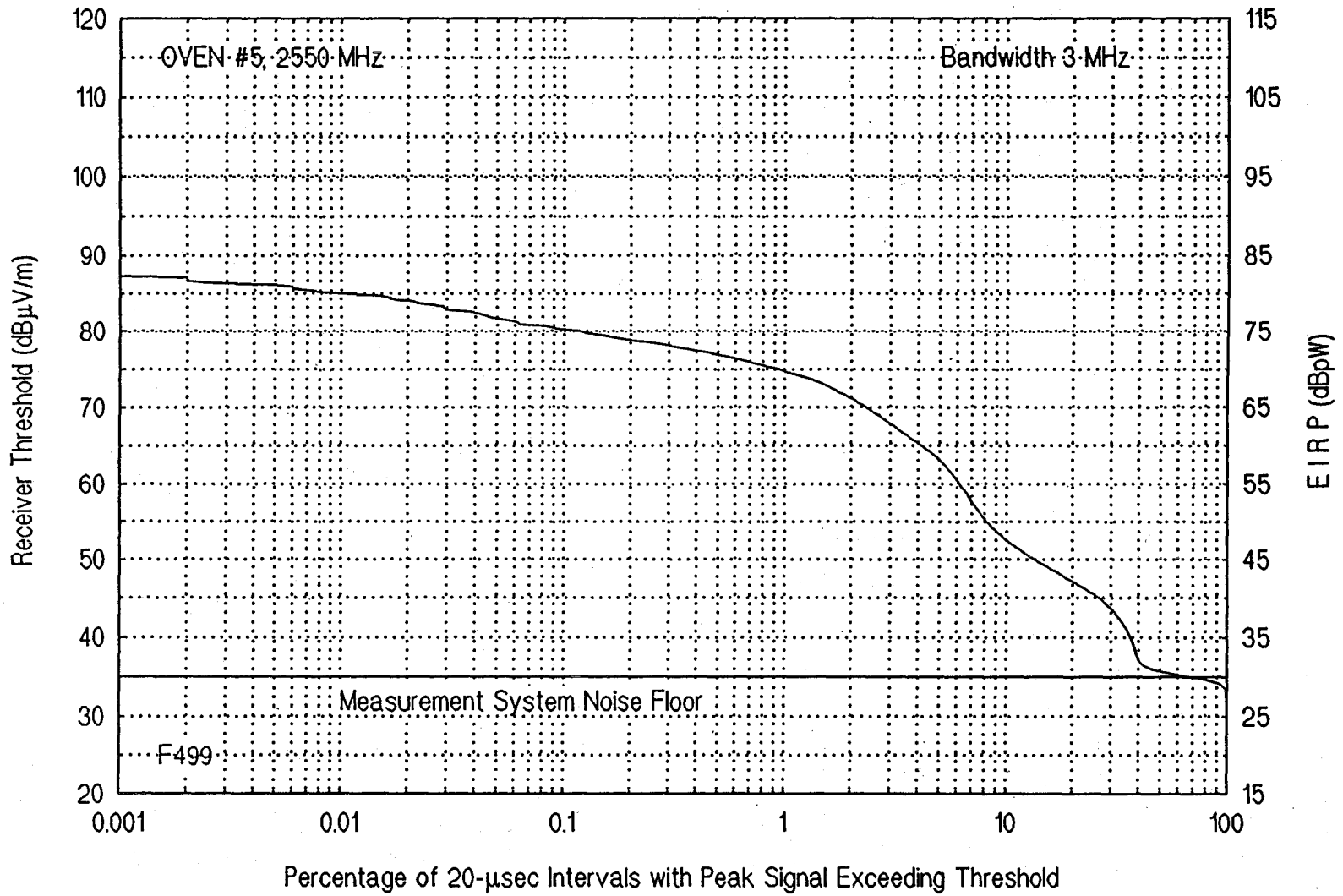


Figure C-26. Oven #5, Amplitude-Probability Distribution at 2550 MHz with 3 MHz bandwidth.

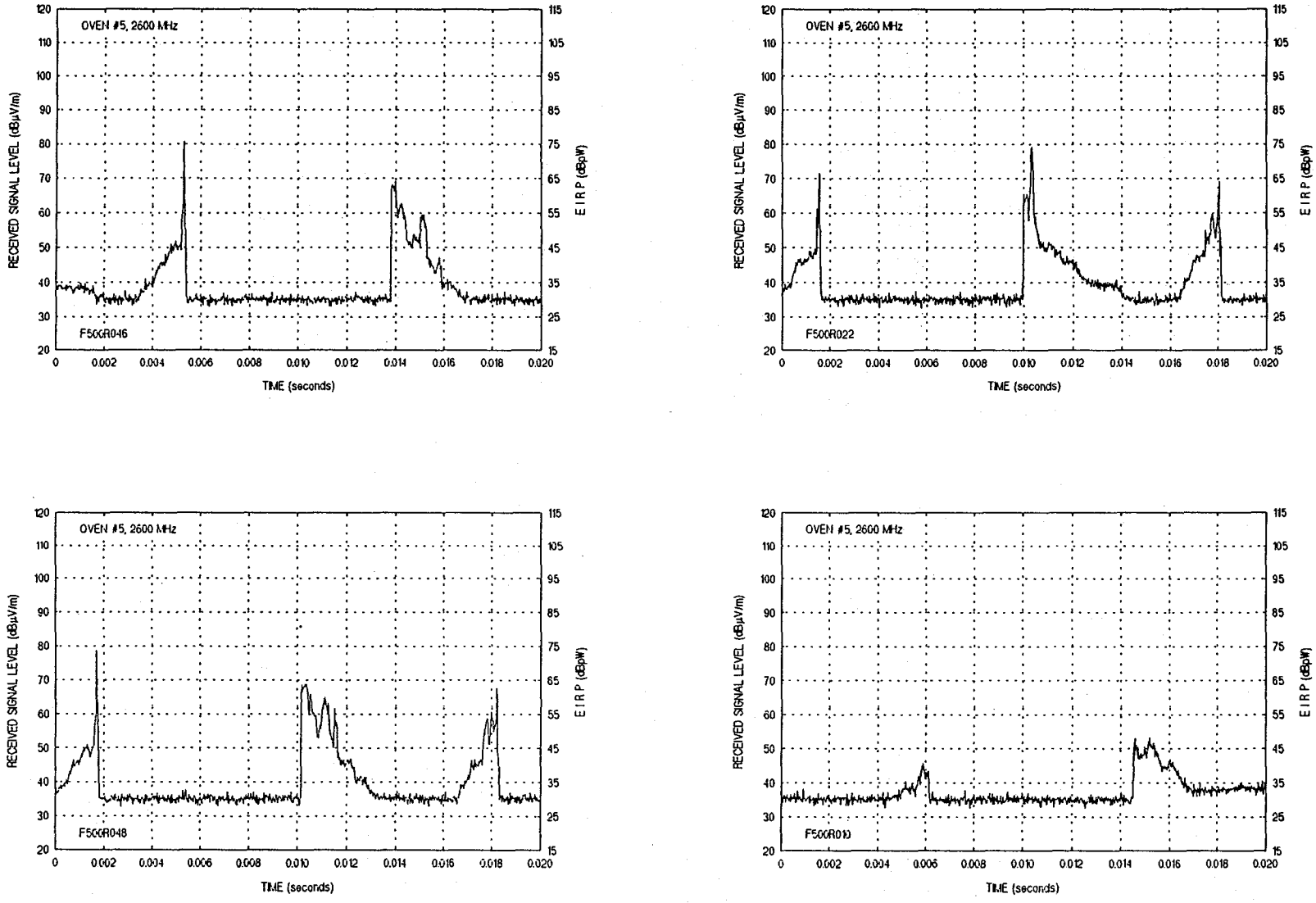


Figure C-27. Oven #5, Time vs. Amplitude displays at 2600 MHz with 3 MHz bandwidth.

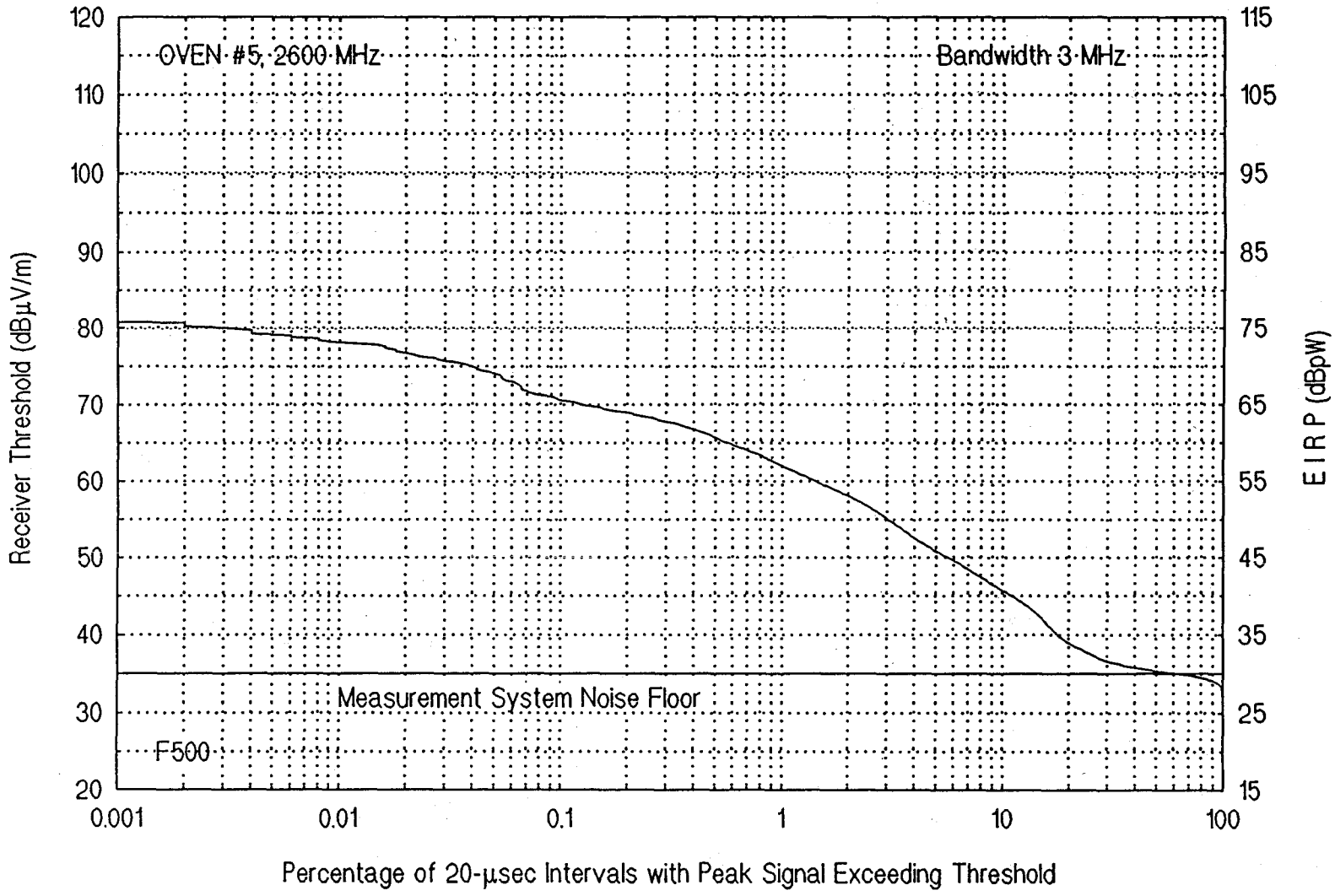


Figure C-28. Oven #5, Amplitude-Probability Distribution at 2600 MHz with 3 MHz bandwidth.

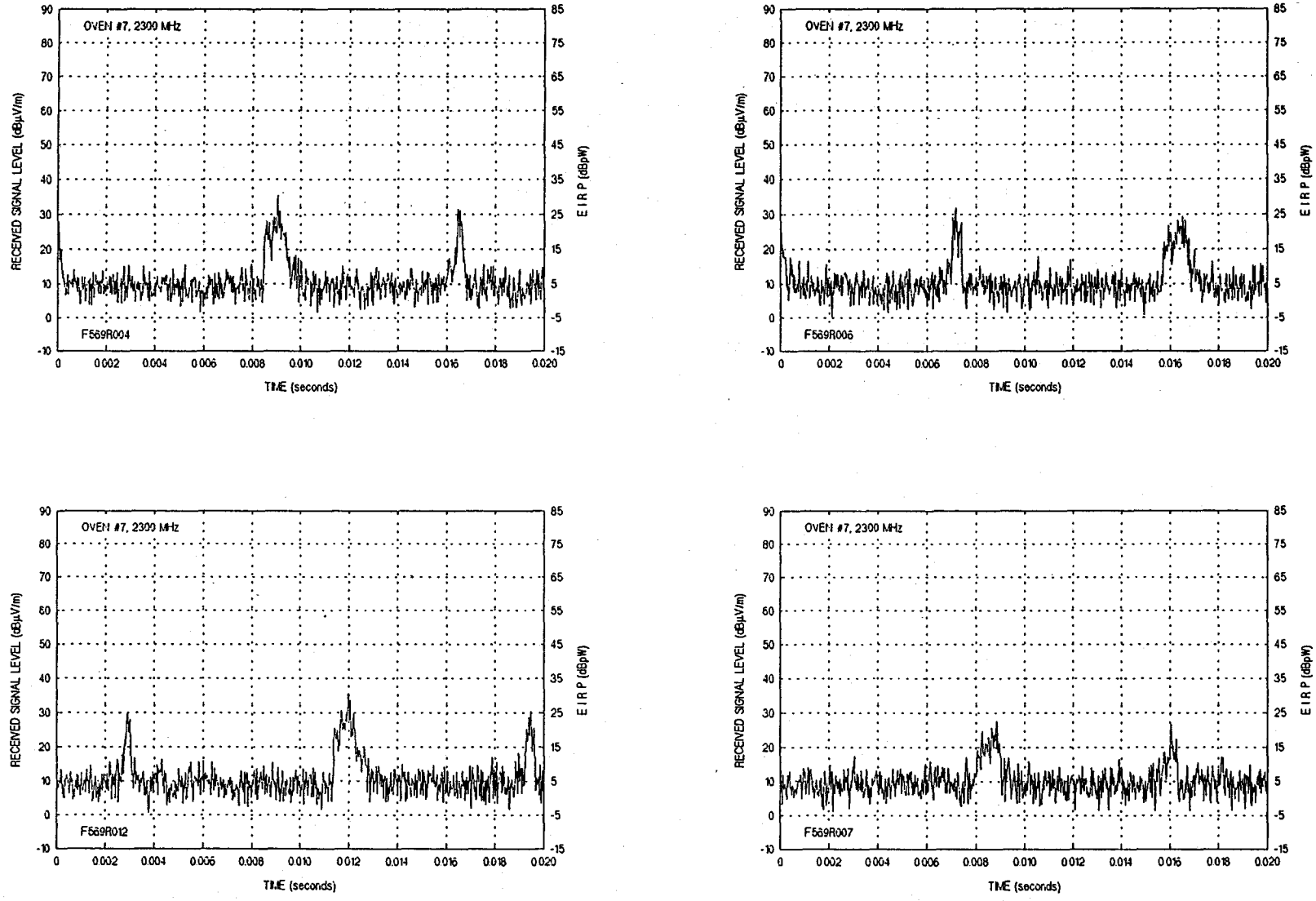


Figure C-29. Oven #7, Time vs. Amplitude displays at 2300 MHz with 30 kHz bandwidth.

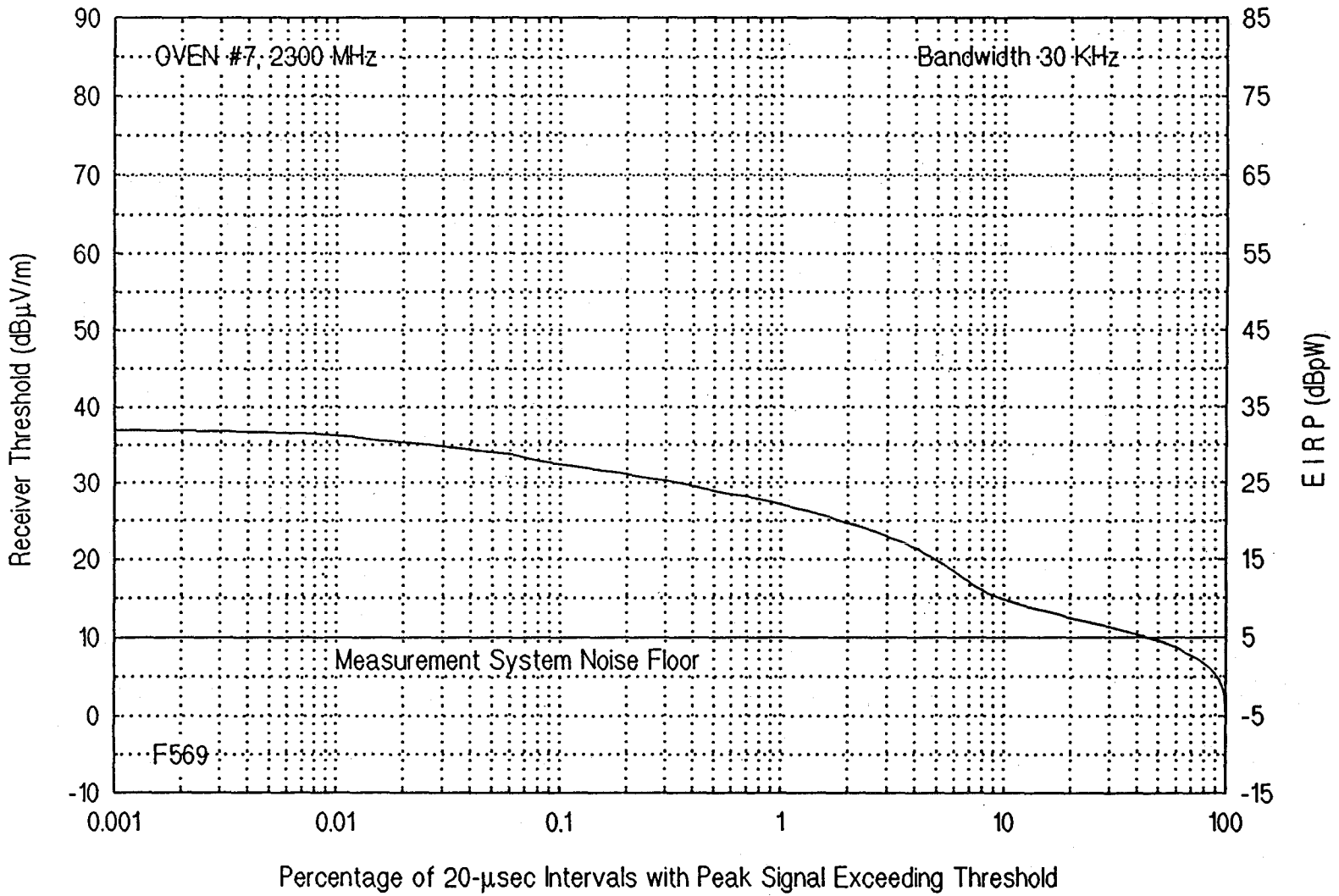


Figure C-30. Oven #7, Amplitude-Probability Distribution at 2300 MHz with 30 kHz bandwidth.

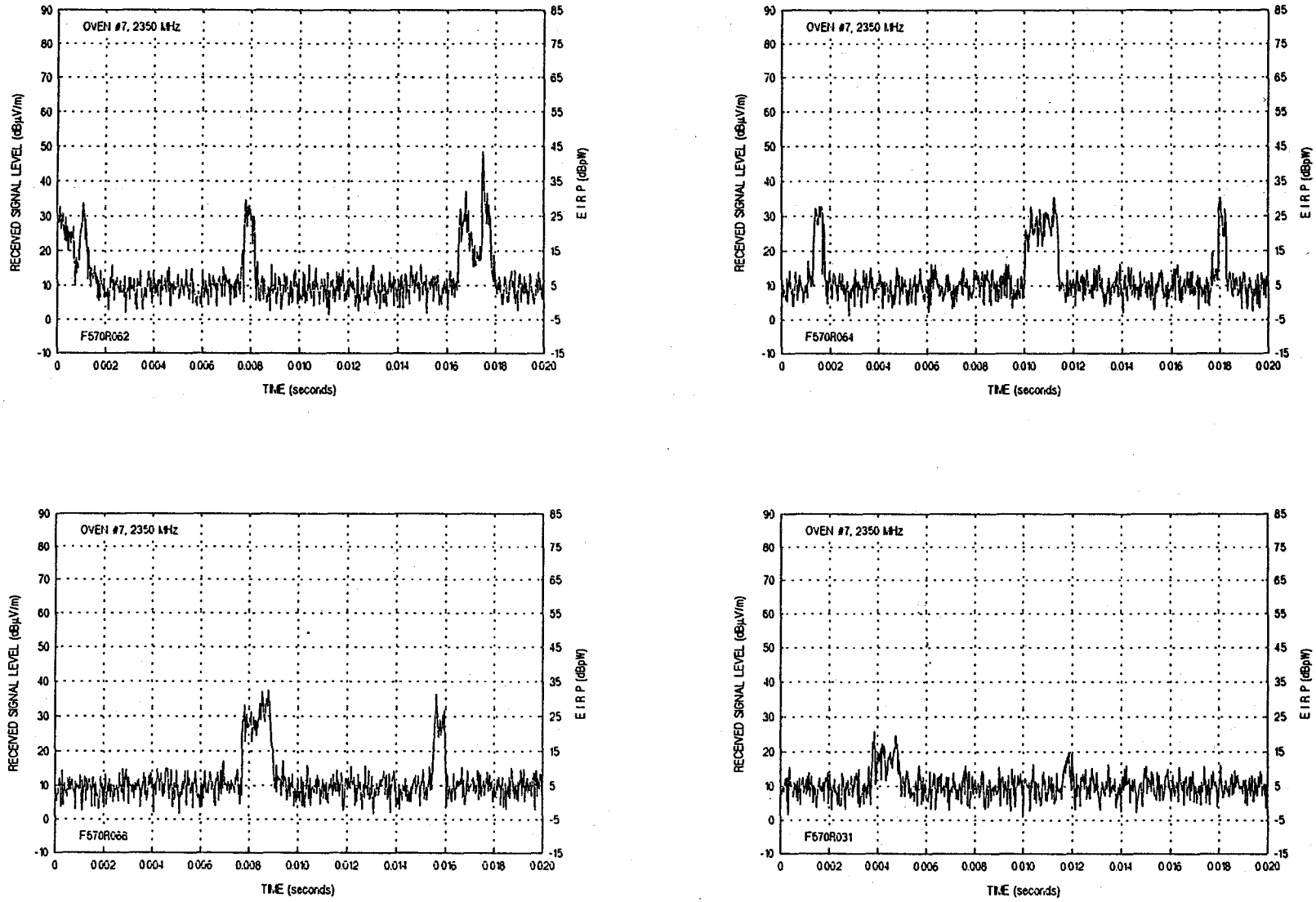


Figure C-31. Oven #7, Time vs. Amplitude displays at 2350 MHz with 30 kHz bandwidth.

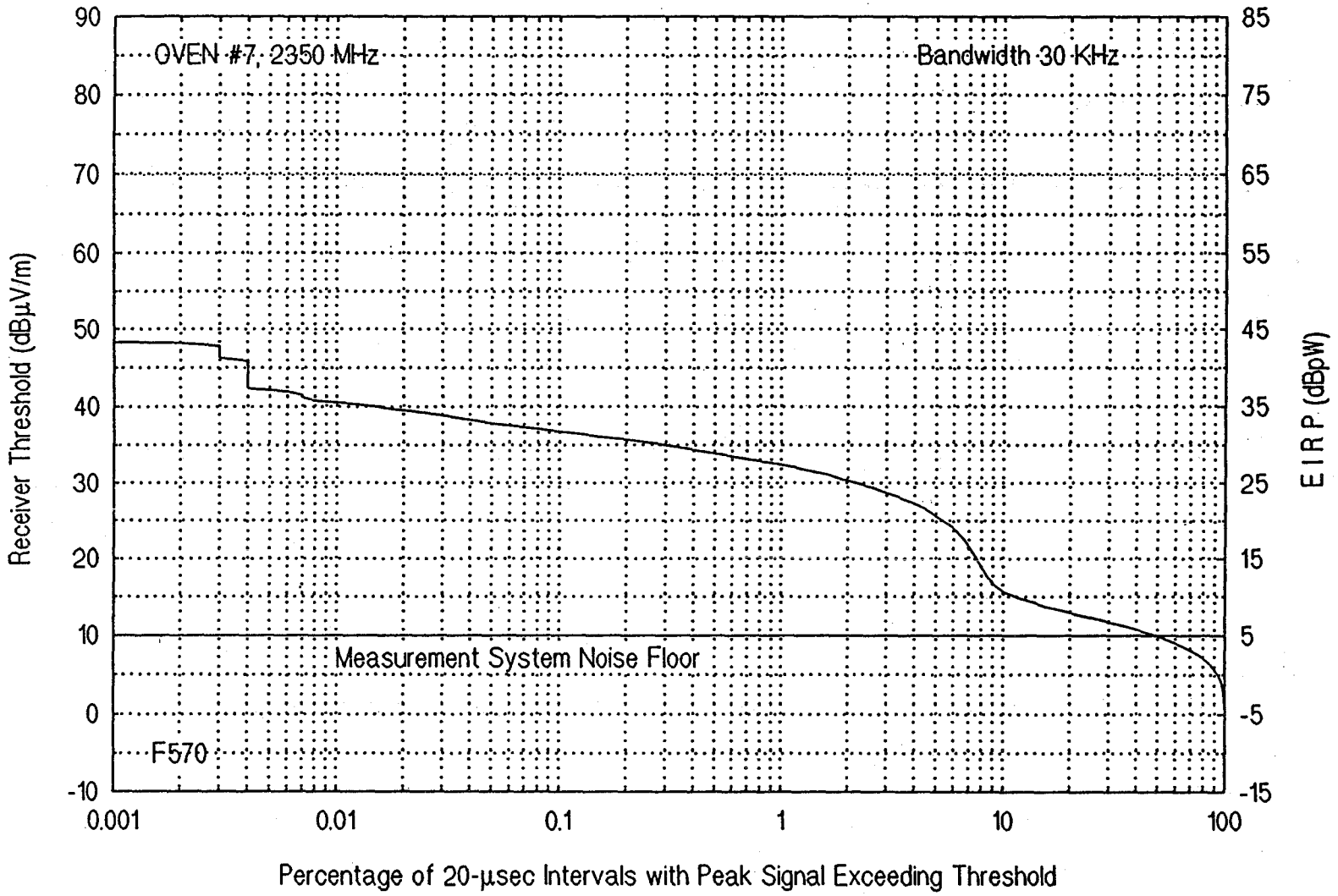


Figure C-32. Oven #7, Amplitude-Probability Distribution at 2350 MHz with 30 kHz bandwidth.

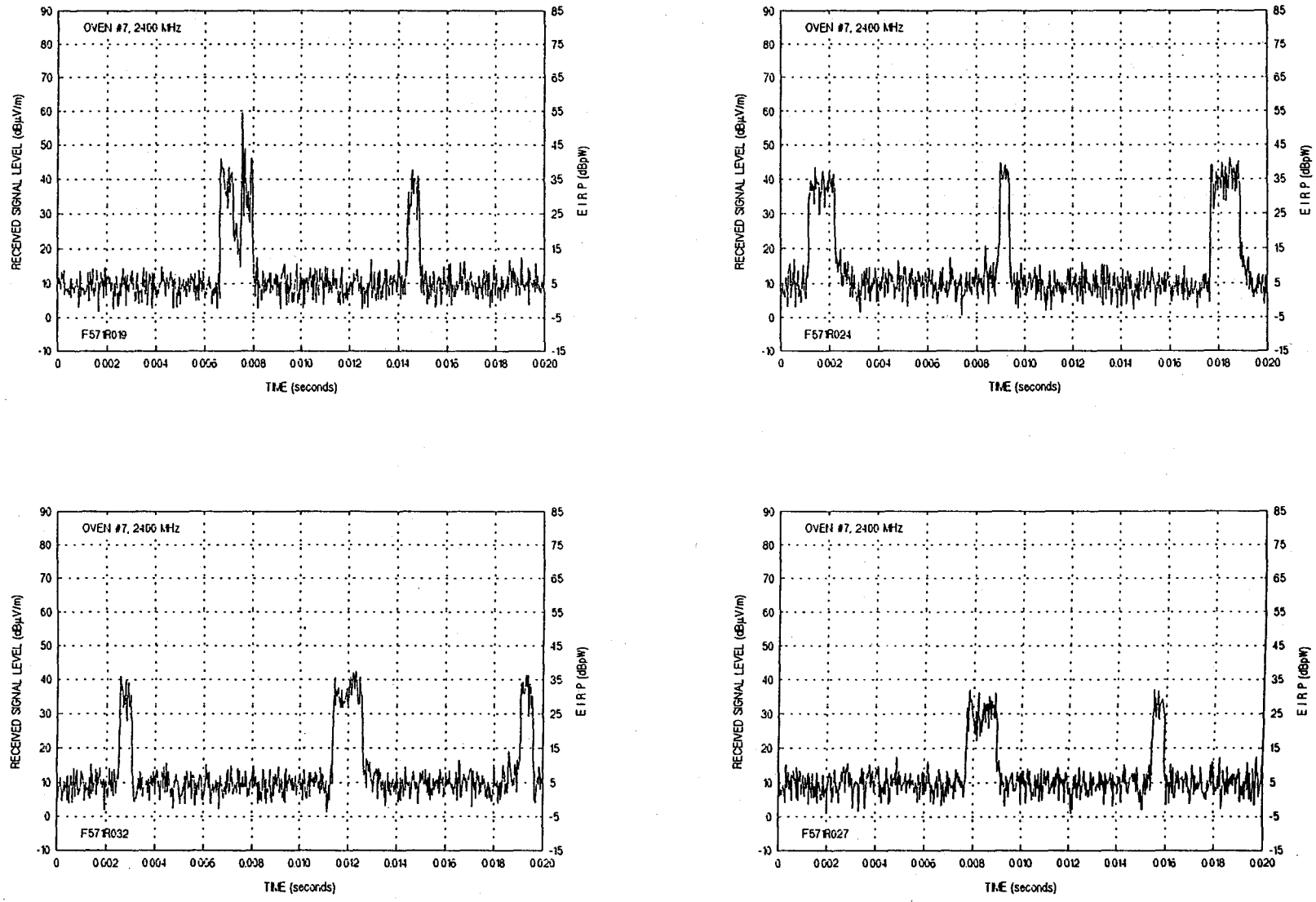


Figure C-33. Oven #7, Time vs. Amplitude displays at 2400 MHz with 30 kHz bandwidth.

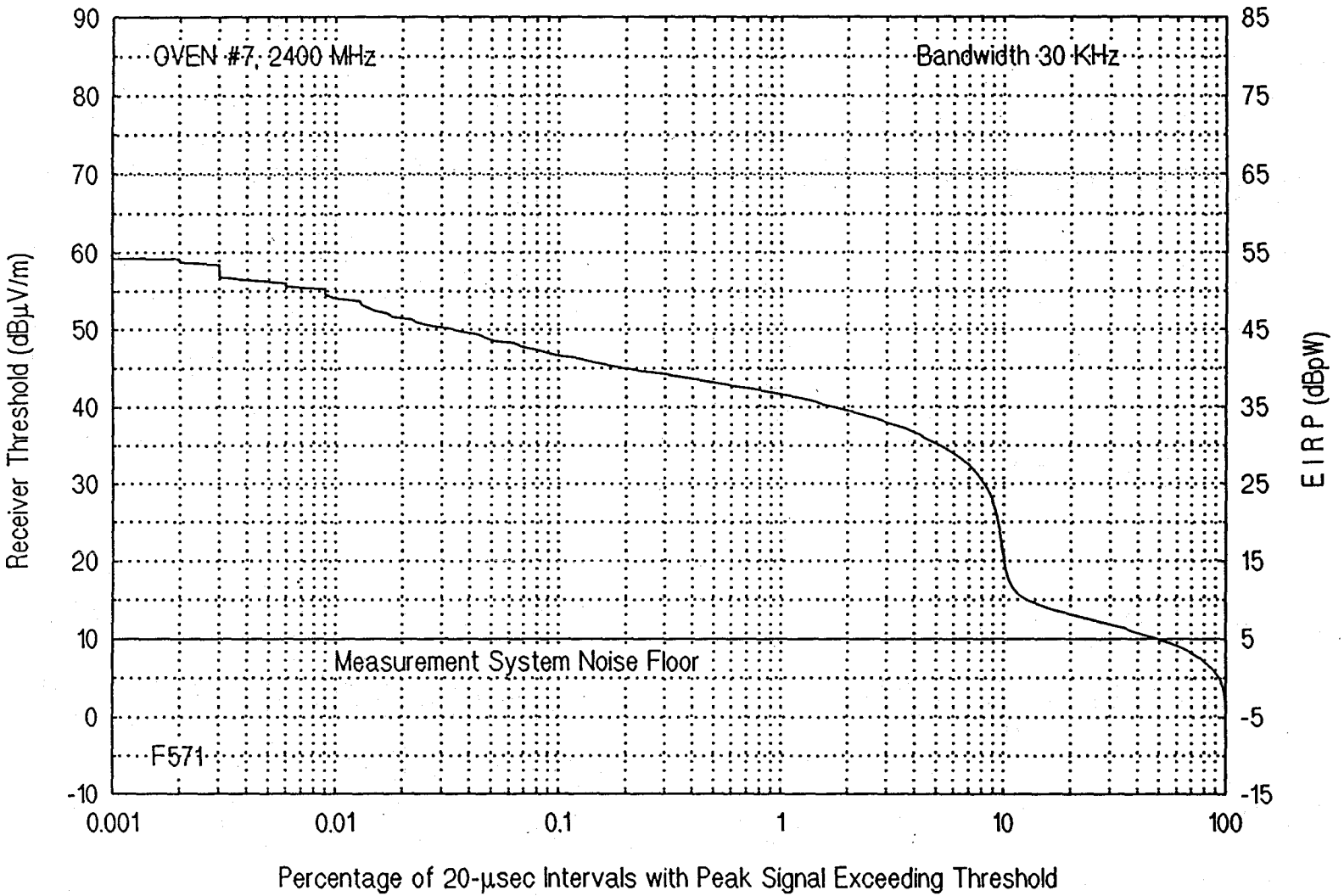


Figure C-34. Oven #7, Amplitude-Probability Distribution at 2400 MHz with 30 kHz bandwidth.

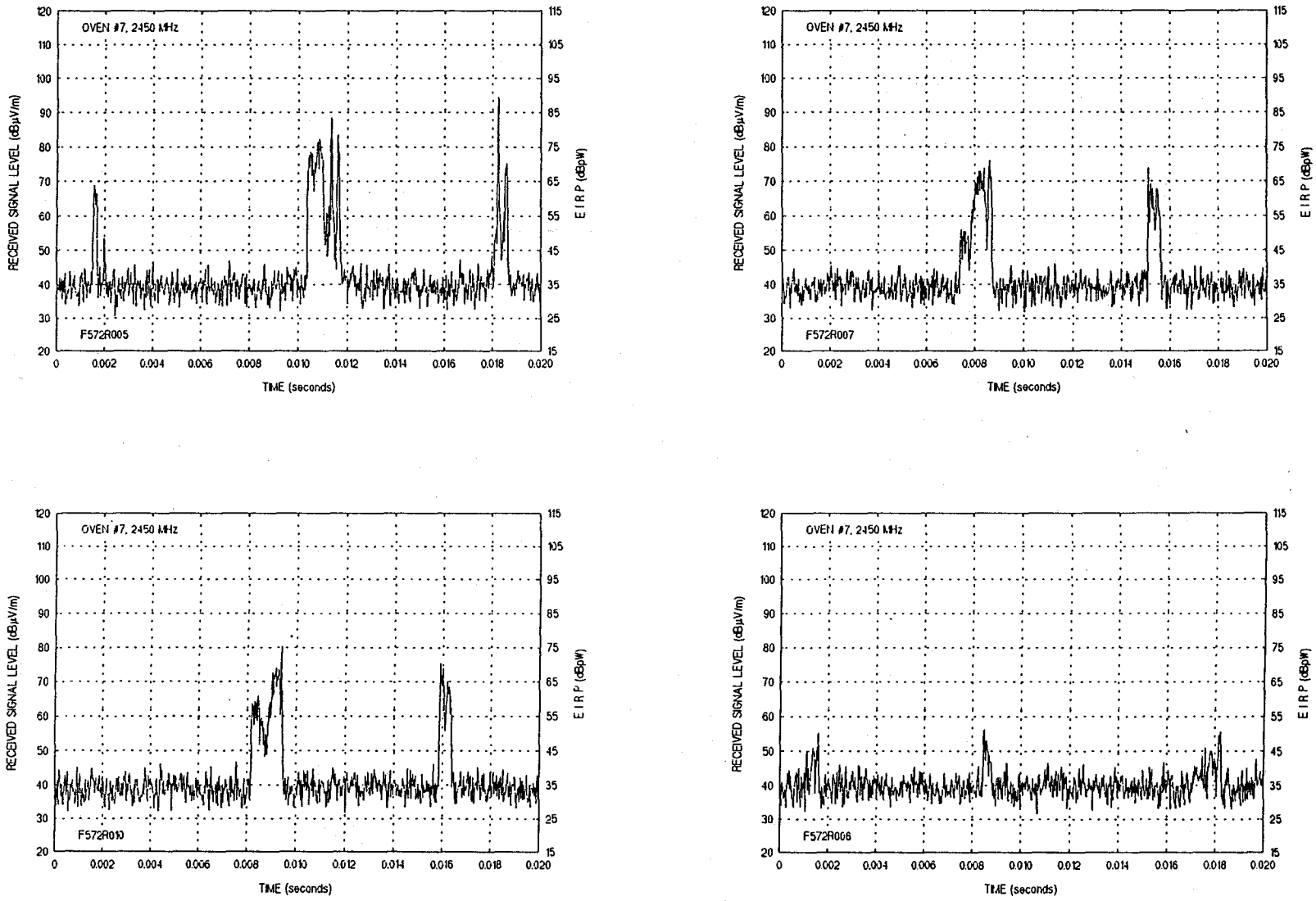


Figure C-35. Oven #7, Time vs. Amplitude displays at 2450 MHz with 30 kHz bandwidth.

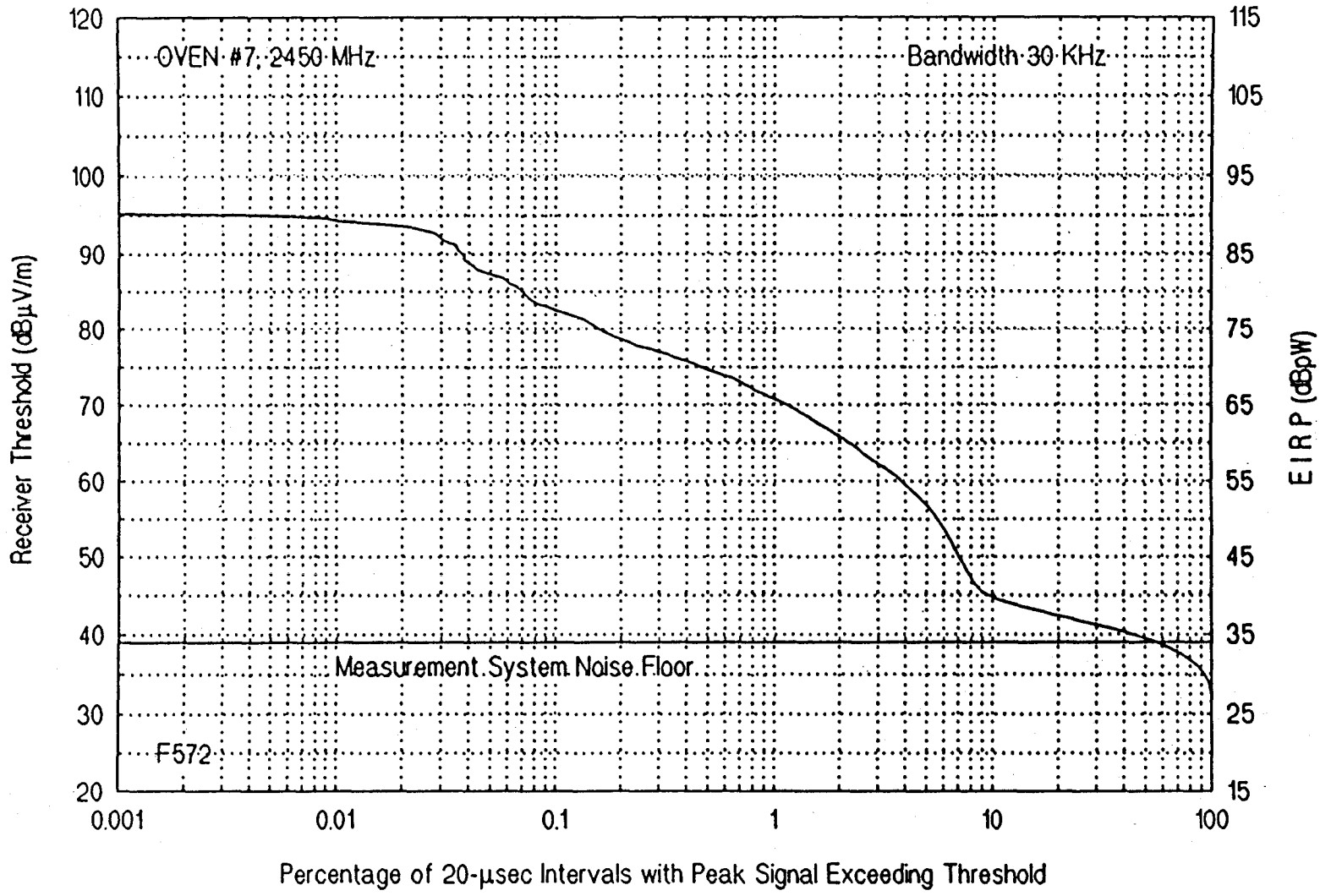


Figure C-36. Oven #7, Amplitude-Probability Distribution at 2450 MHz with 30 kHz bandwidth.

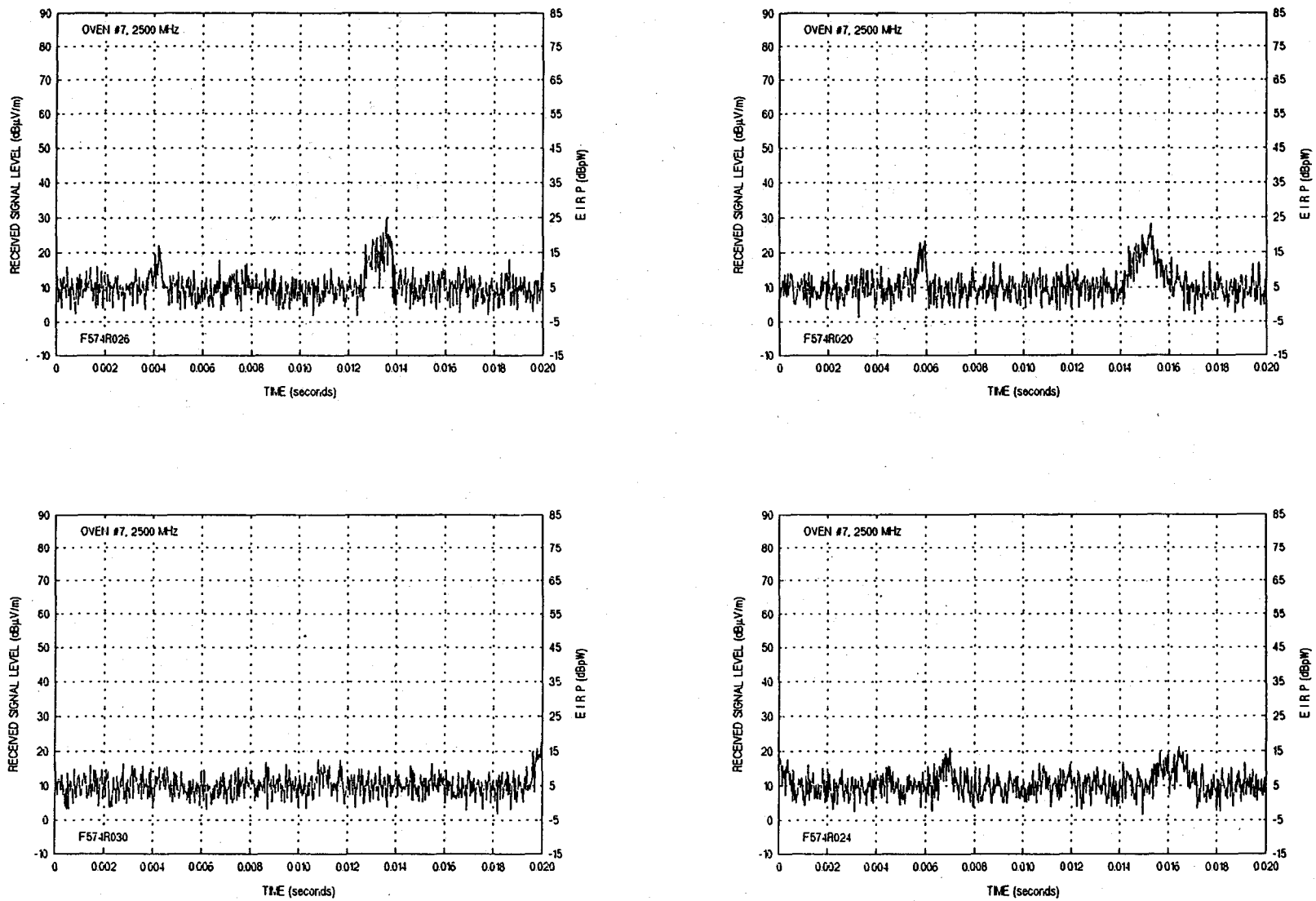


Figure C-37. Oven #7, Time vs. Amplitude displays at 2500 MHz with 30 kHz bandwidth.

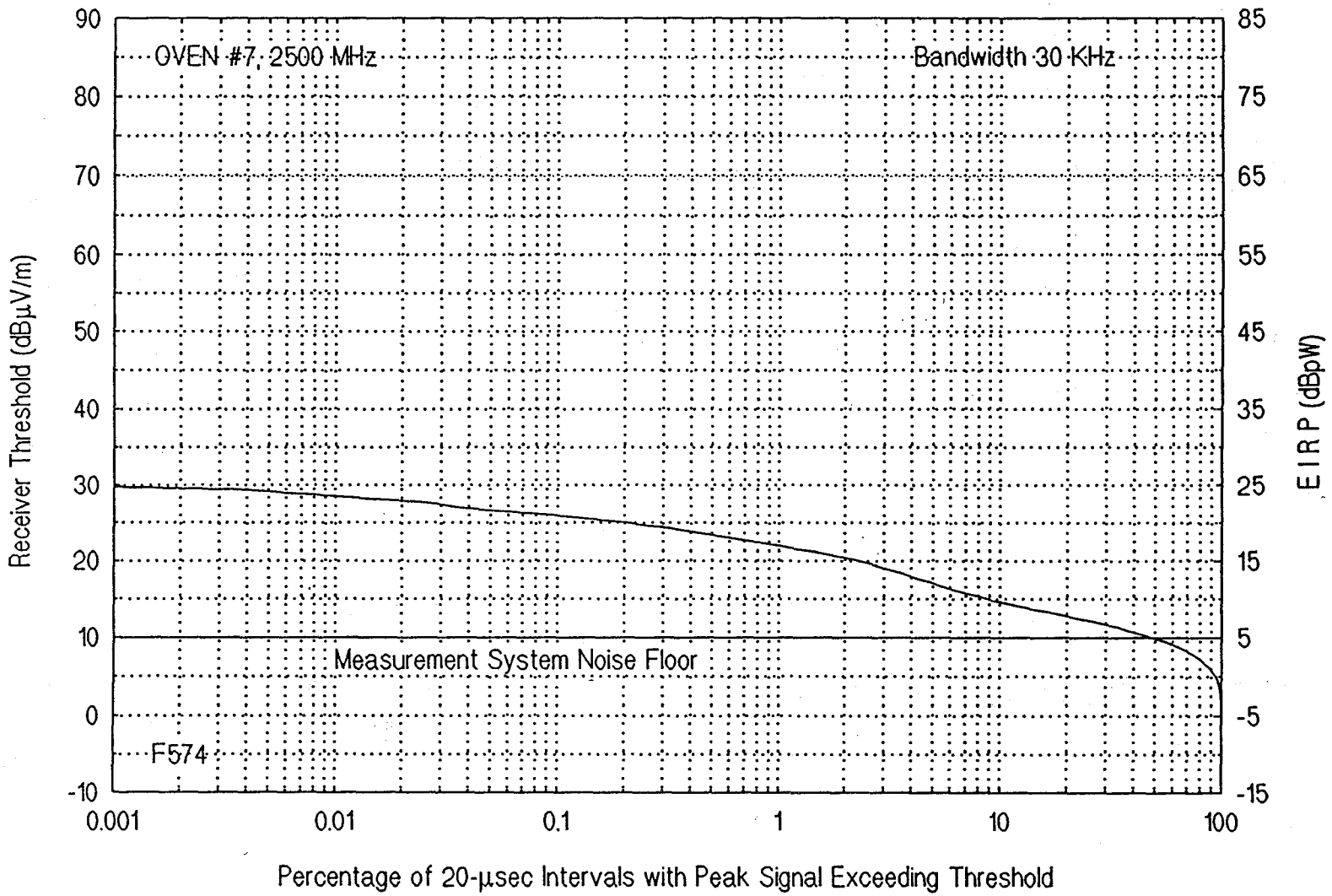


Figure C-38. Oven #7, Amplitude-Probability Distribution at 2500 MHz with 30 kHz bandwidth.

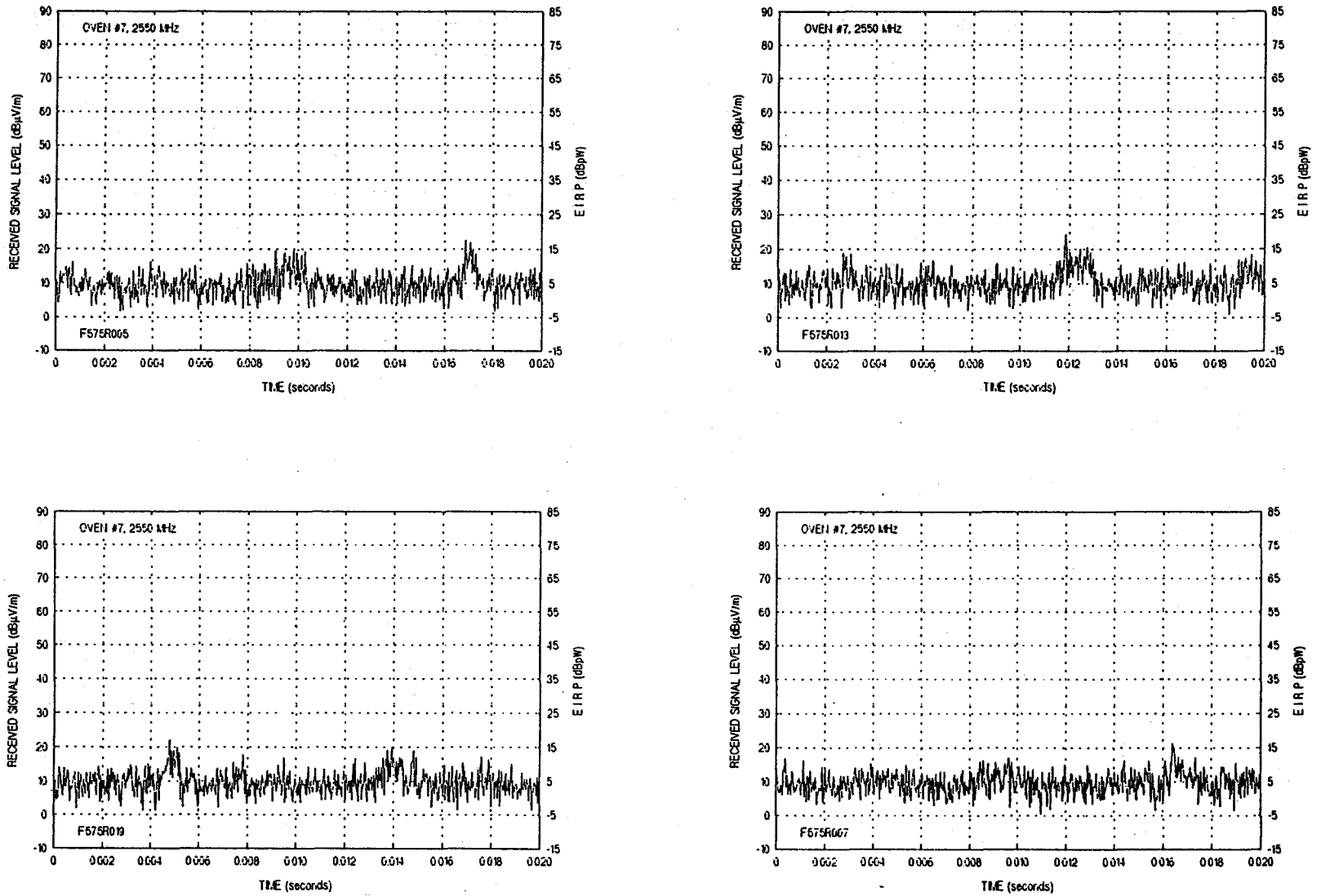


Figure C-39. Oven #7, Time vs. Amplitude displays at 2550 MHz with 30 kHz bandwidth.

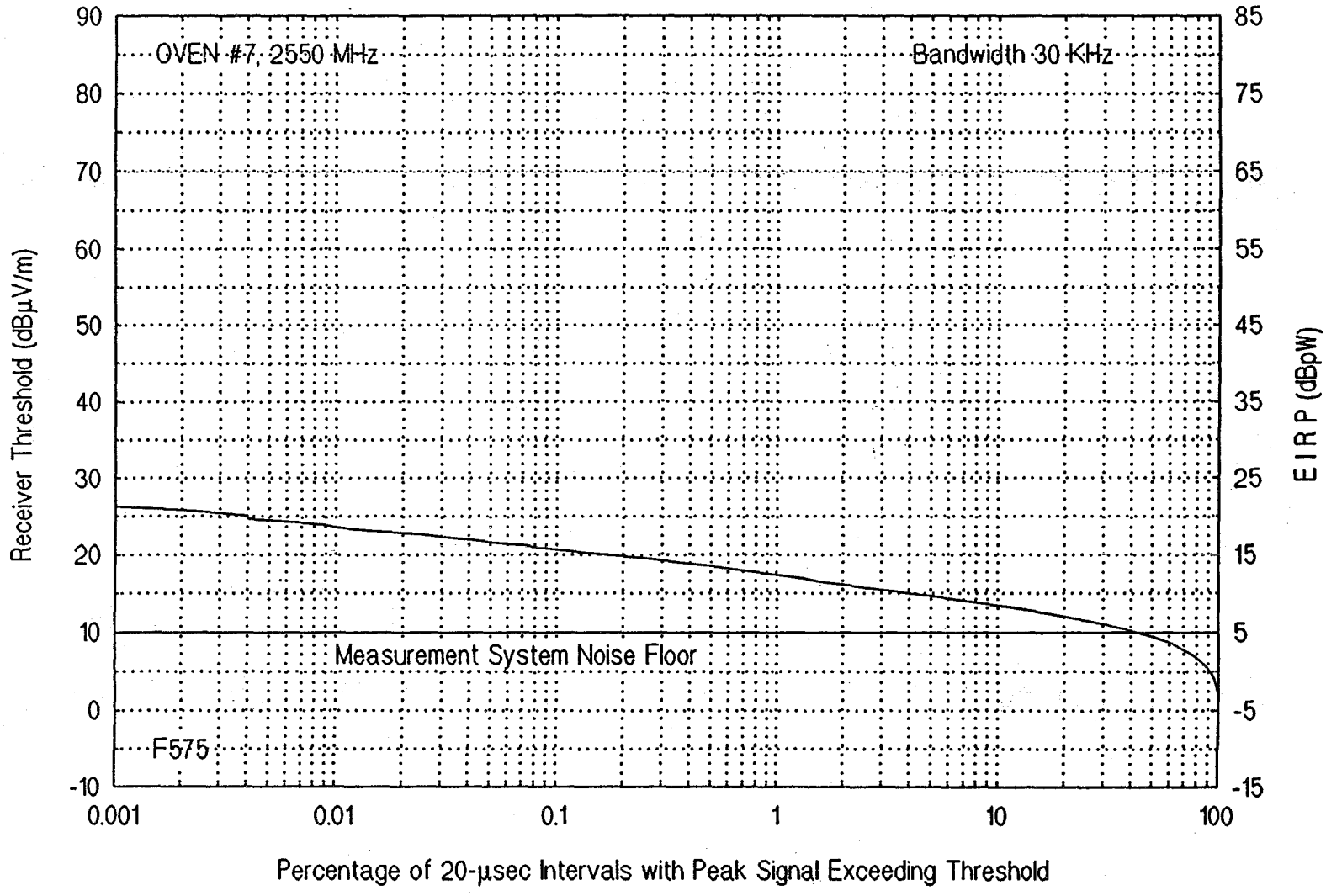


Figure C-40. Oven #7, Amplitude-Probability Distribution at 2550 MHz with 30 kHz bandwidth.

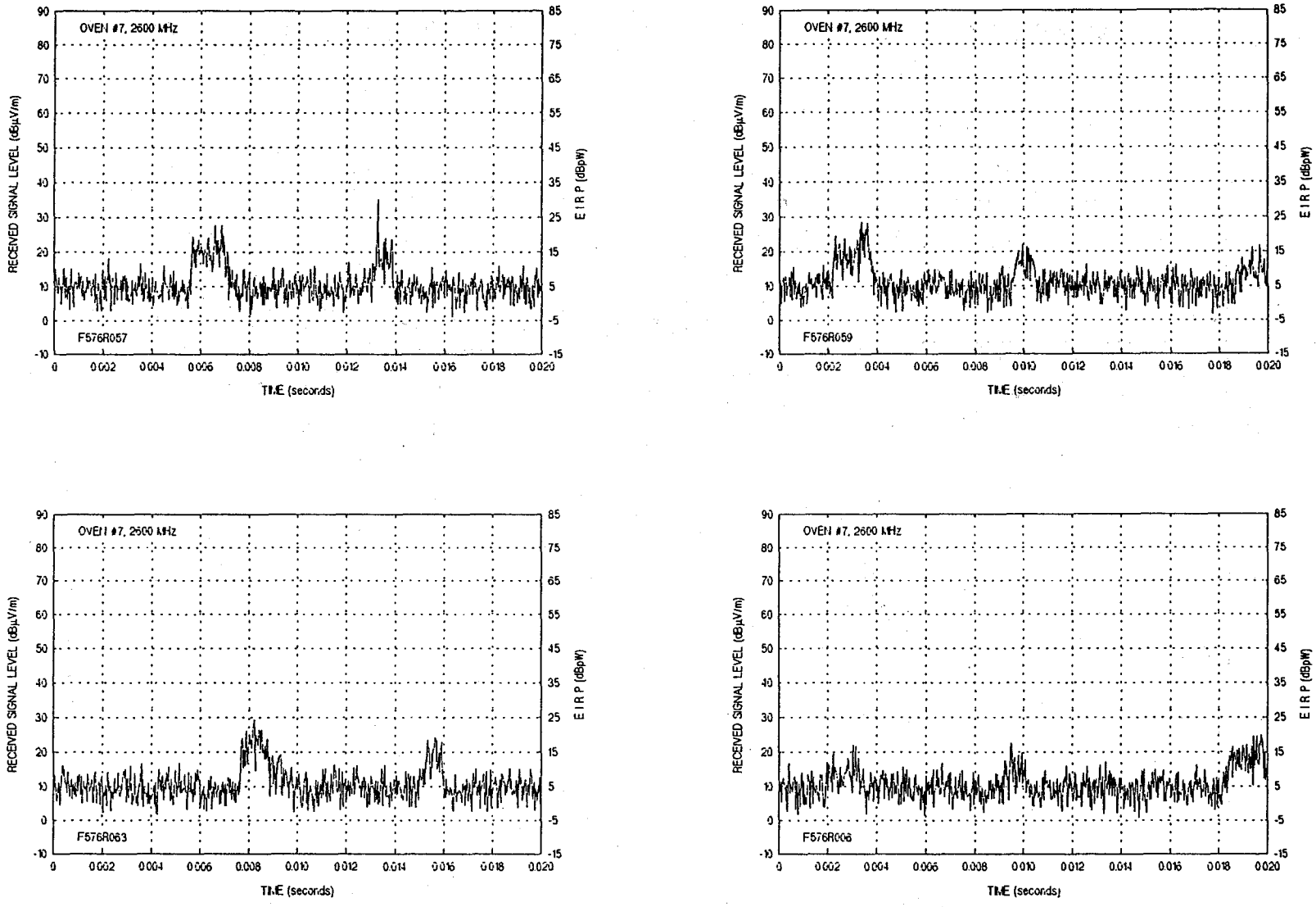


Figure C-41. Oven #7, Time vs. Amplitude displays at 2600 MHz with 30 kHz bandwidth.

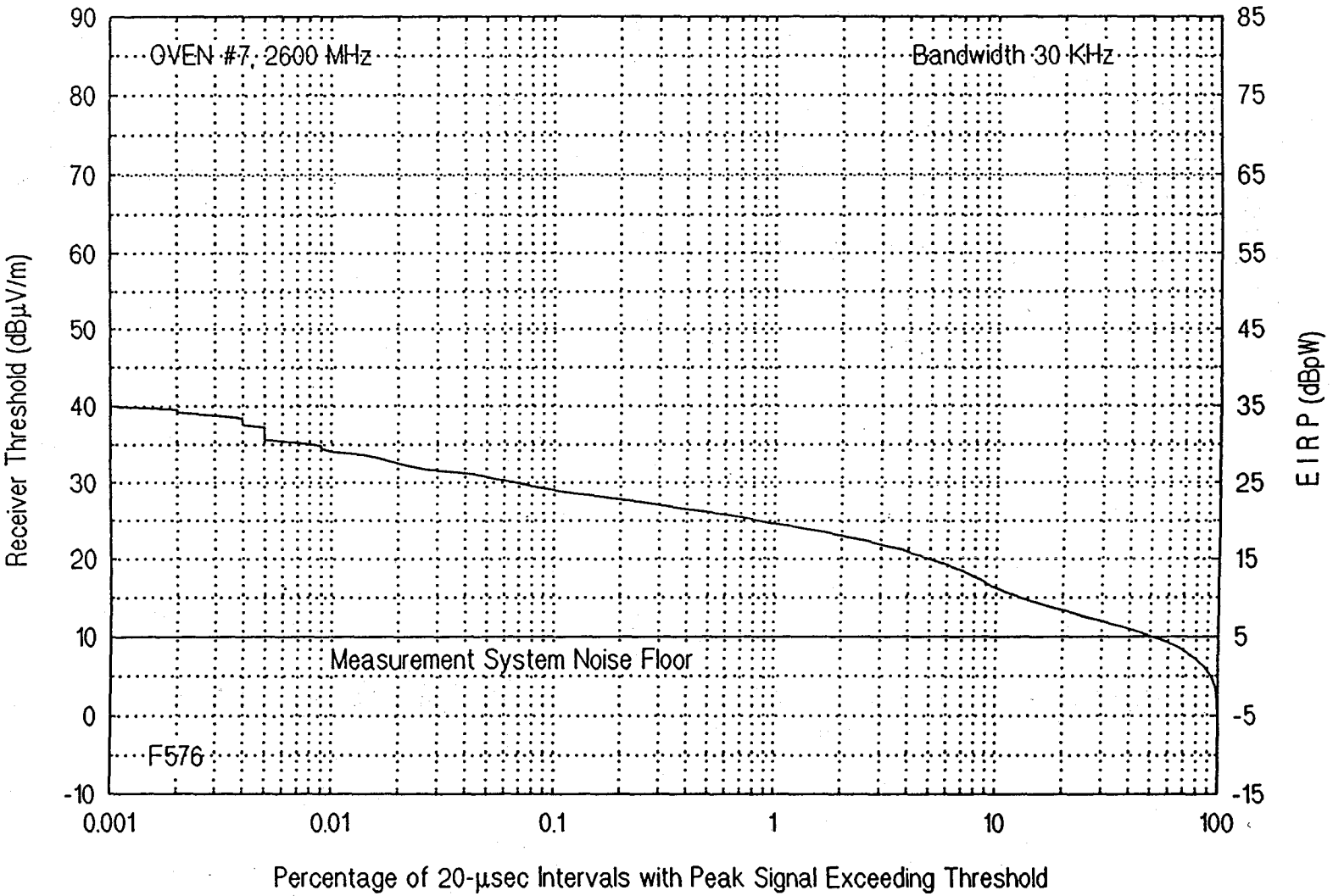


Figure C-42. Oven #7, Amplitude-Probability Distribution at 2600 MHz with 30 kHz bandwidth.

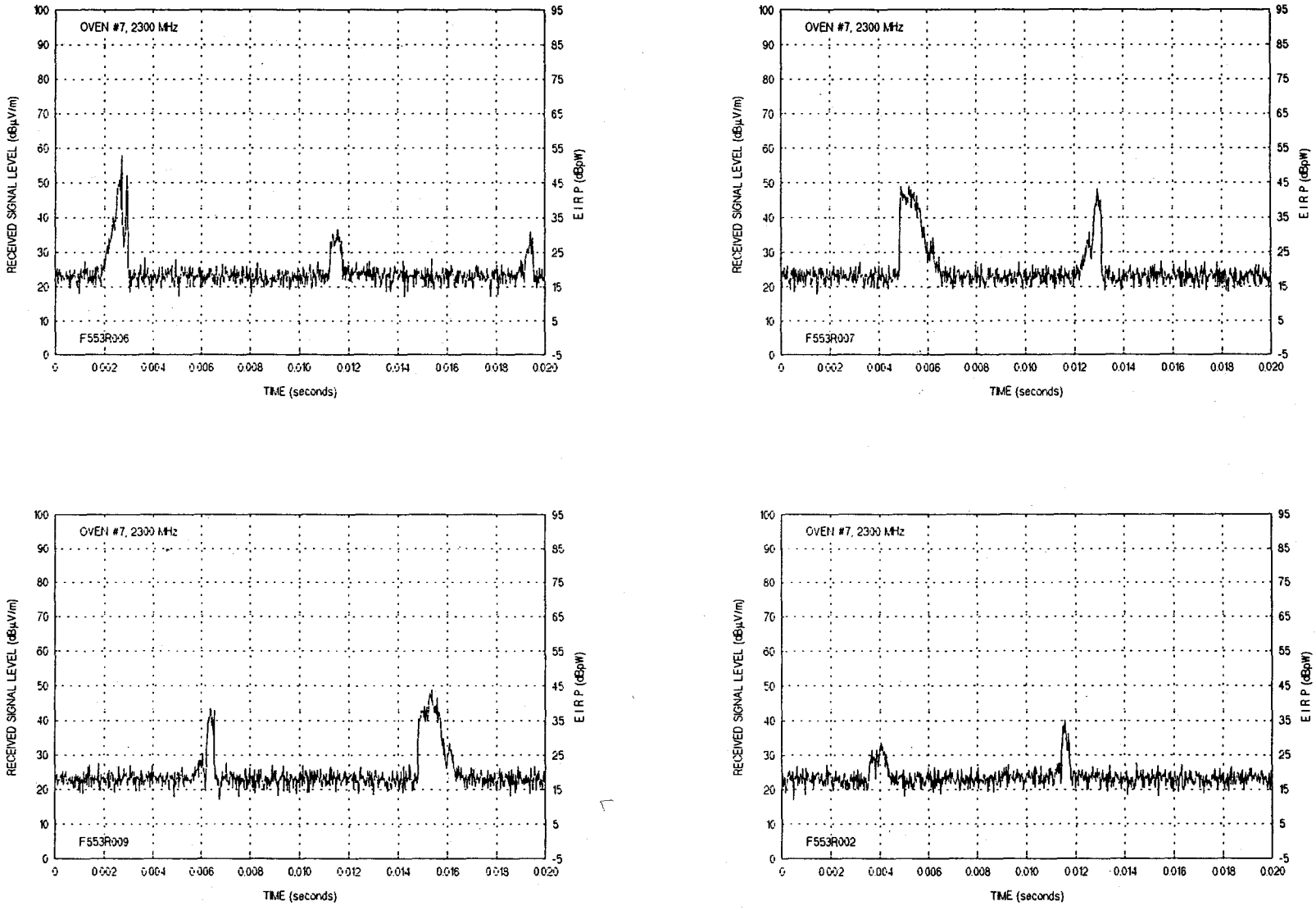


Figure C-43. Oven #7, Time vs. Amplitude displays at 2300 MHz with 300 kHz bandwidth.

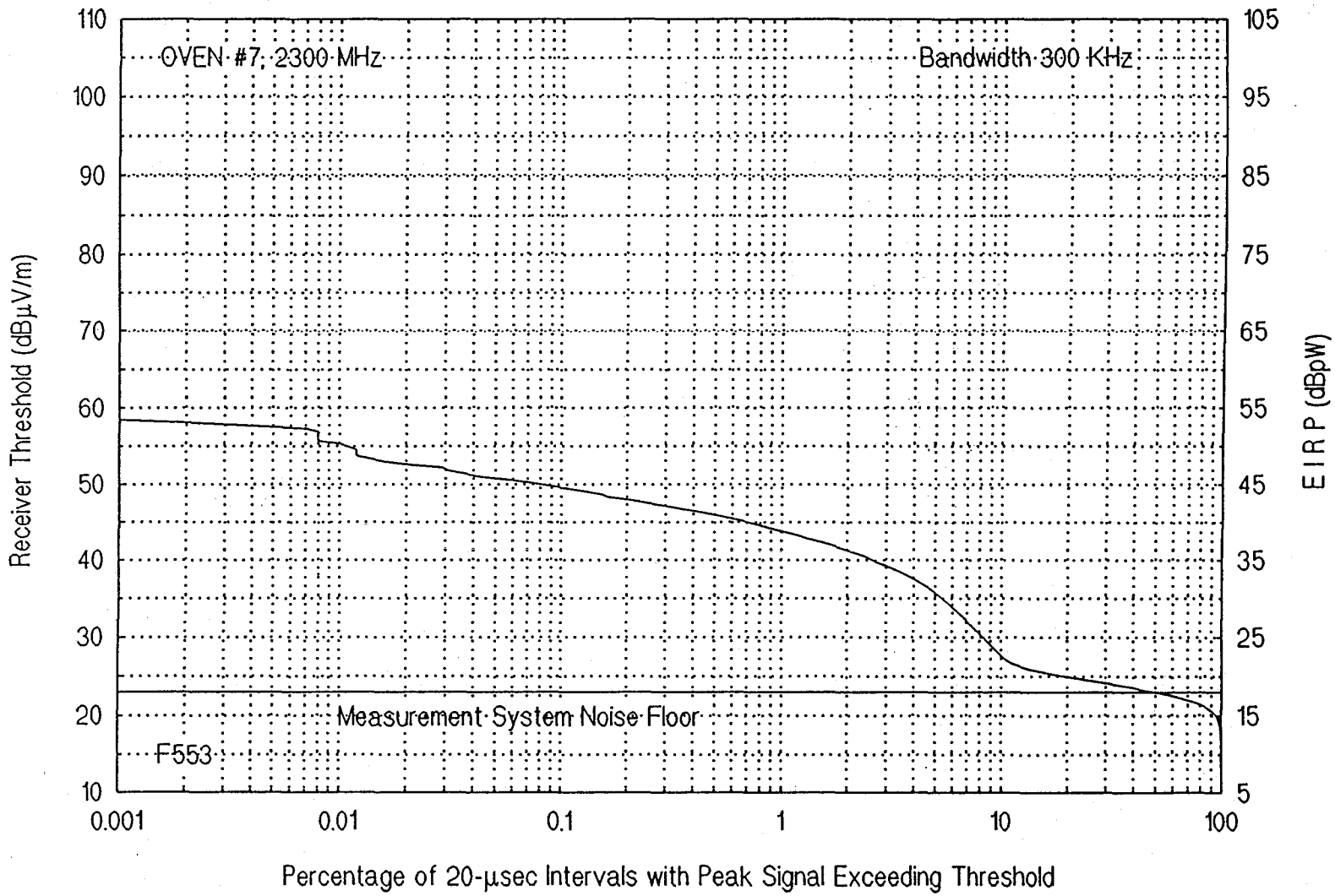


Figure C-44. Oven #7, Amplitude-Probability Distribution at 2300 MHz with 300 kHz bandwidth.

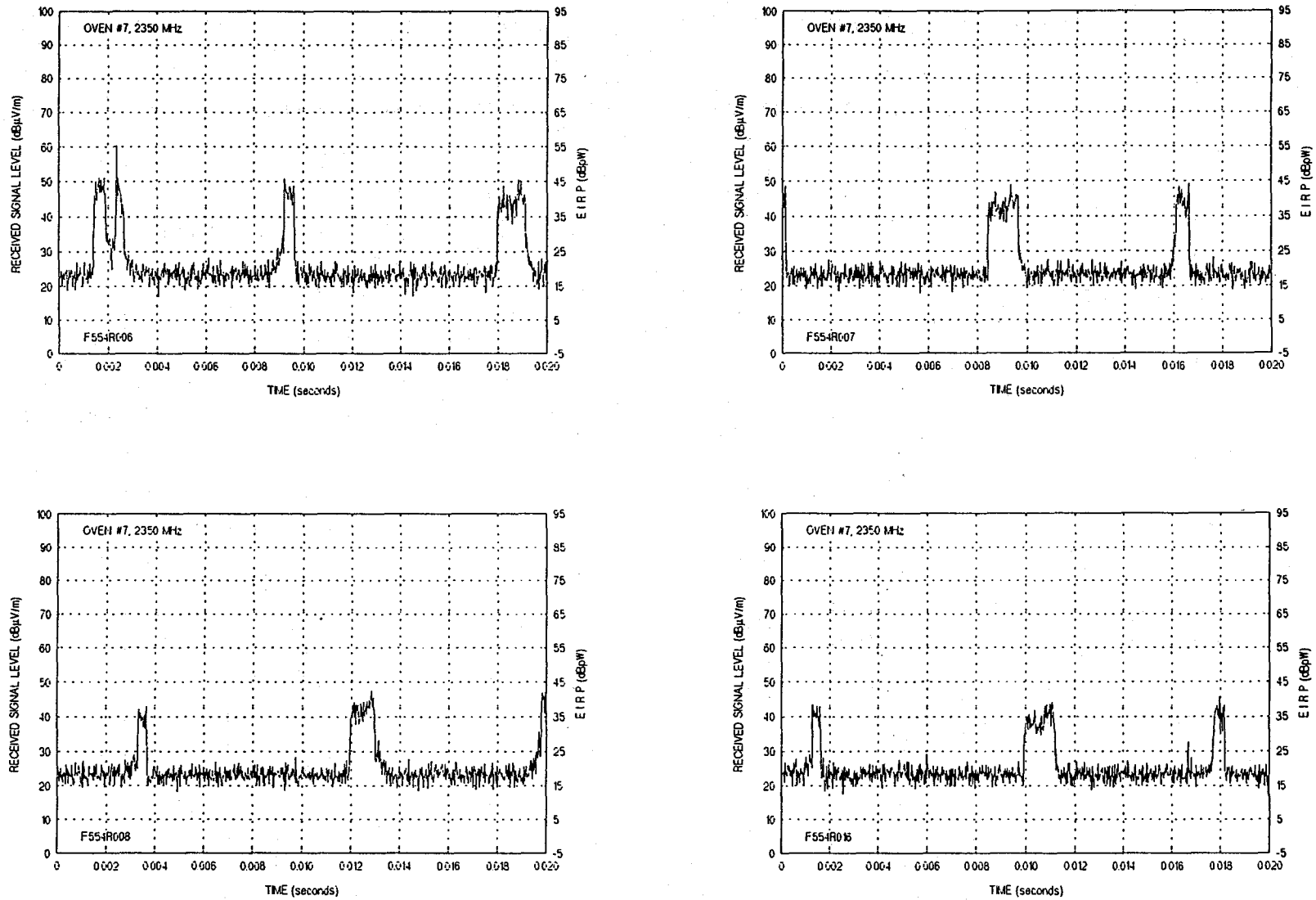


Figure C-45. Oven #7, Time vs. Amplitude displays at 2350 MHz with 300 kHz bandwidth.

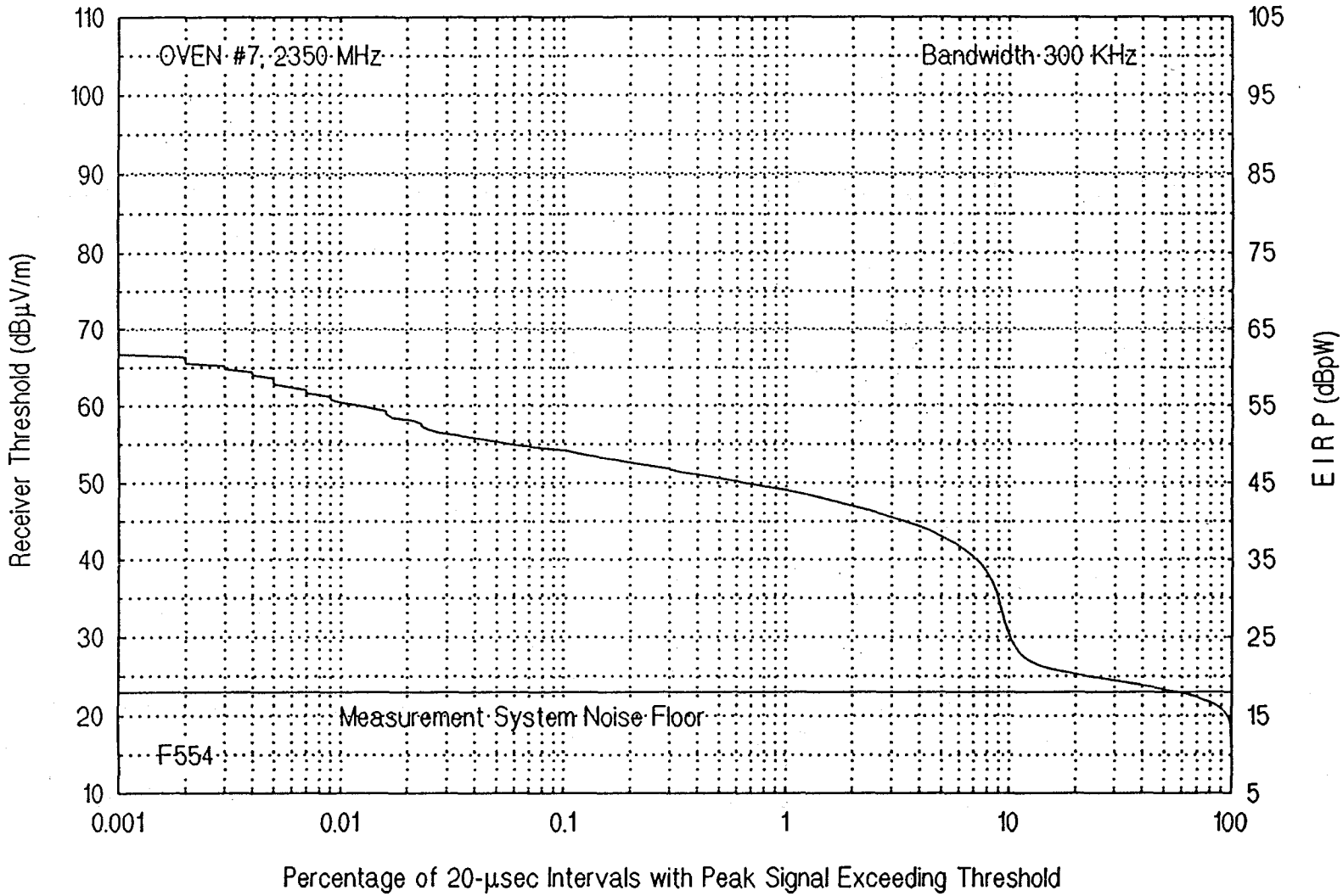


Figure C-46. Oven #7, Amplitude-Probability Distribution at 2350 MHz with 300 kHz bandwidth.

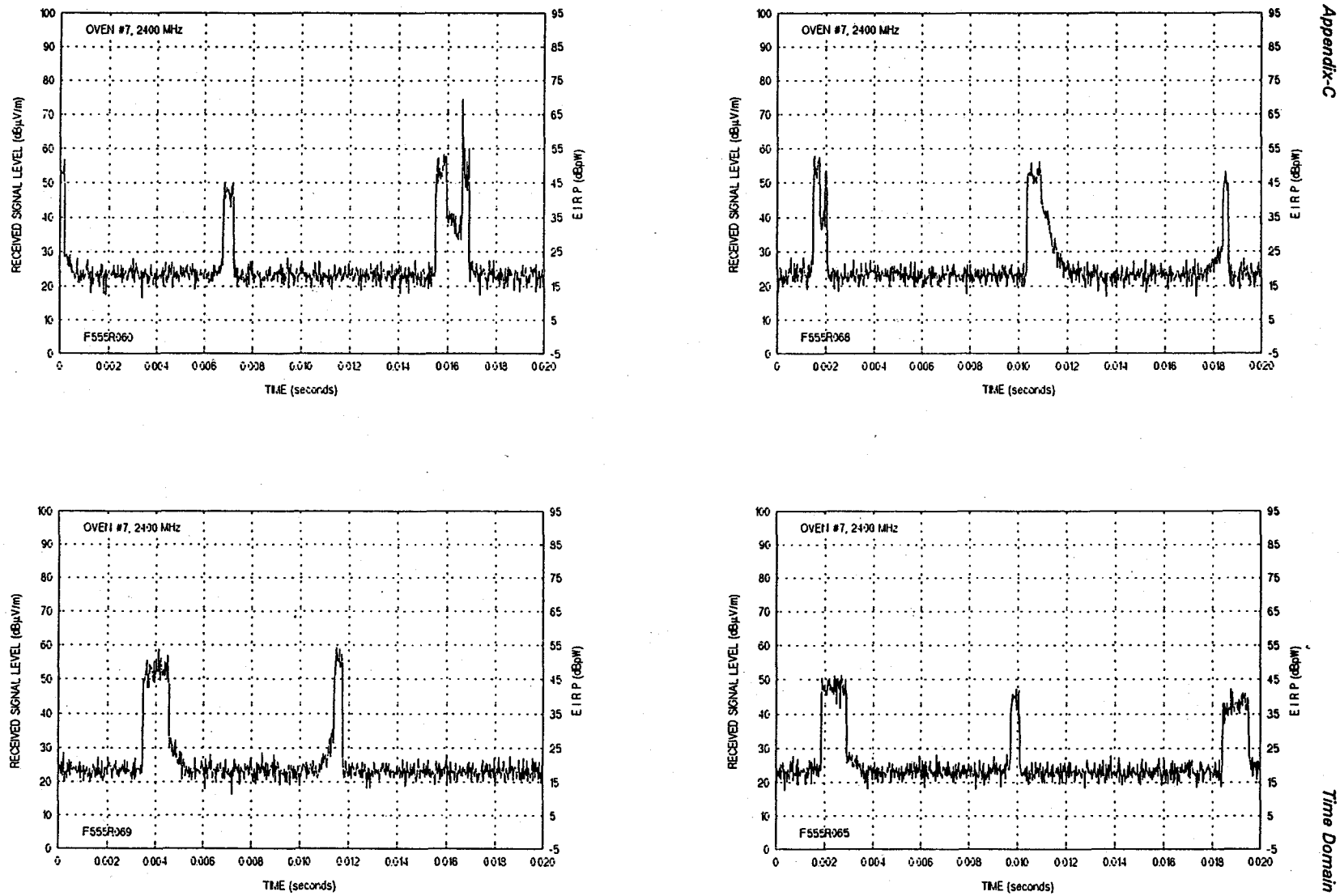


Figure C-47. Oven #7, Time vs. Amplitude displays at 2400 MHz with 300 kHz bandwidth.

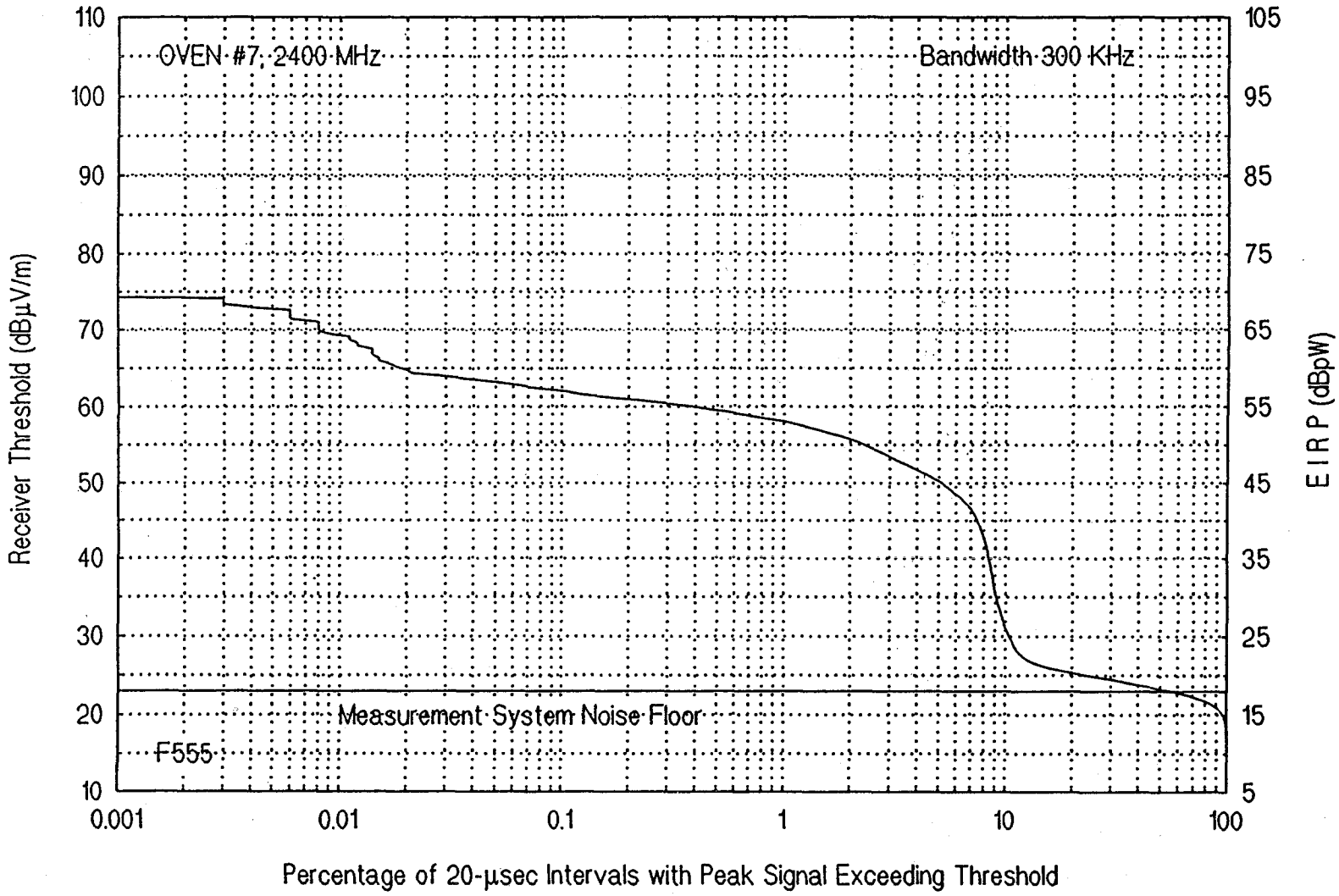


Figure C-48. Oven #7, Amplitude-Probability Distribution at 2400 MHz with 300 kHz bandwidth.

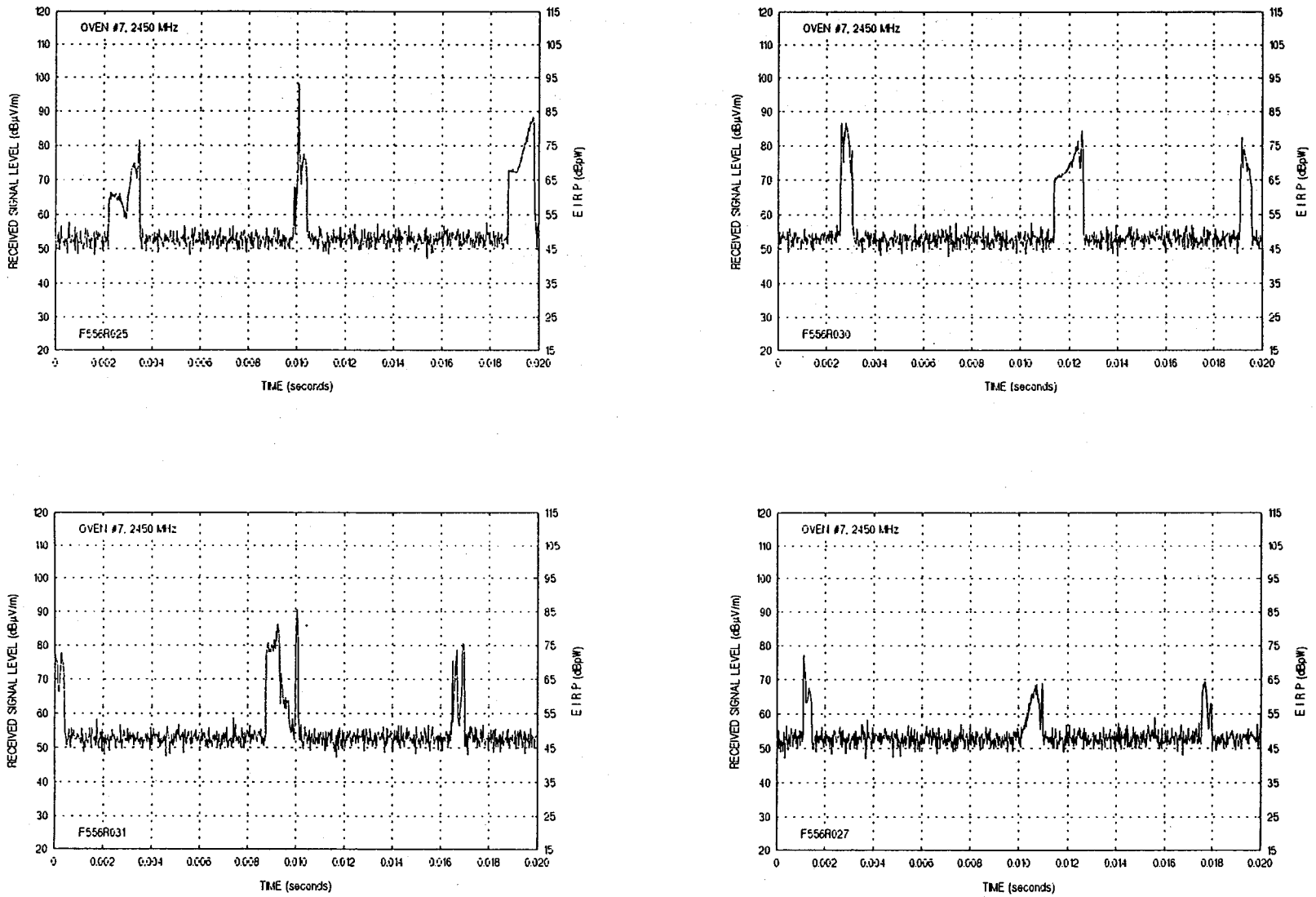


Figure C-49. Oven #7, Time vs. Amplitude displays at 2450 MHz with 300 kHz bandwidth.

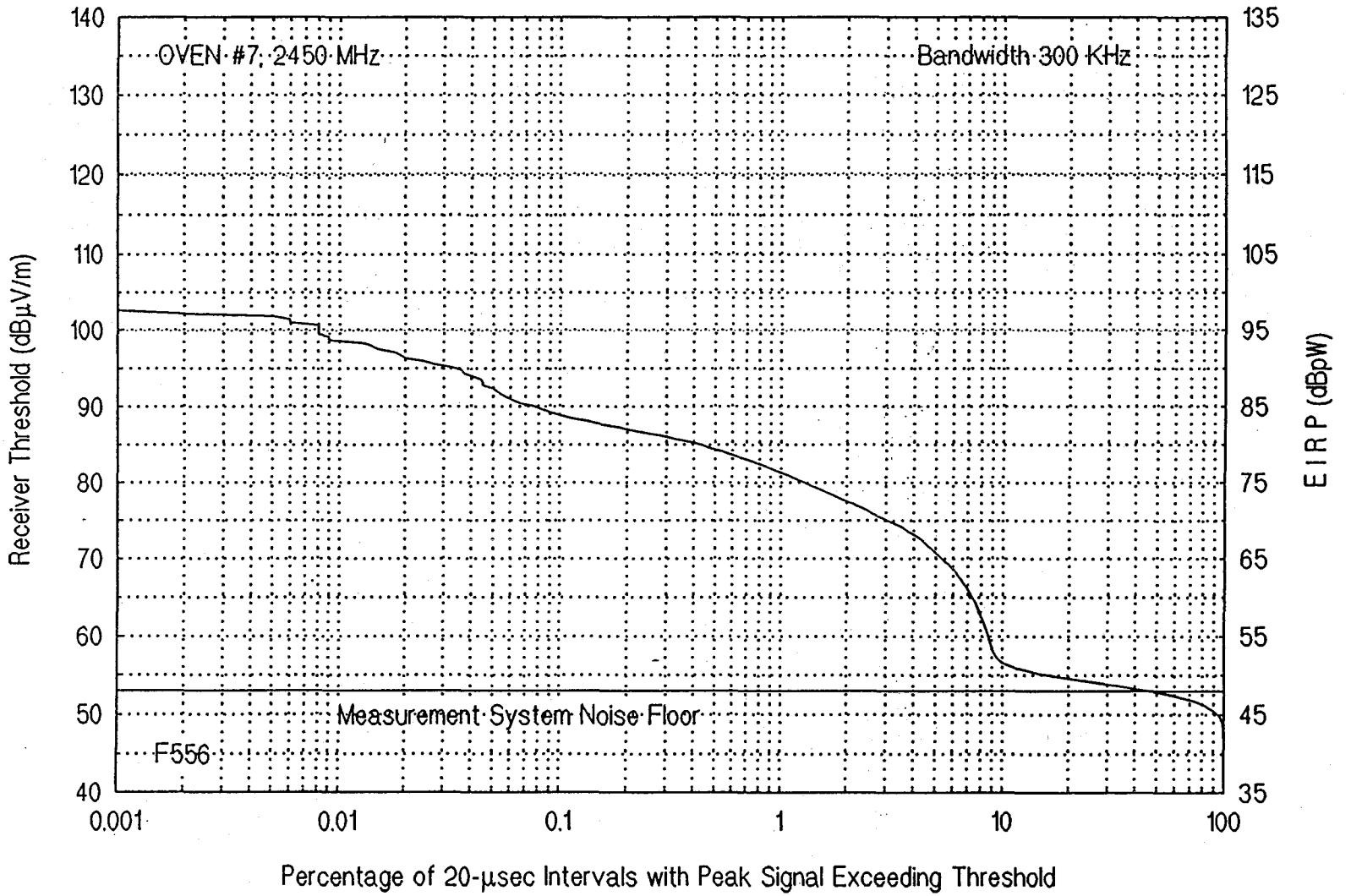


Figure C-50. Oven #7, Amplitude-Probability Distribution at 2450 MHz with 300 kHz bandwidth.

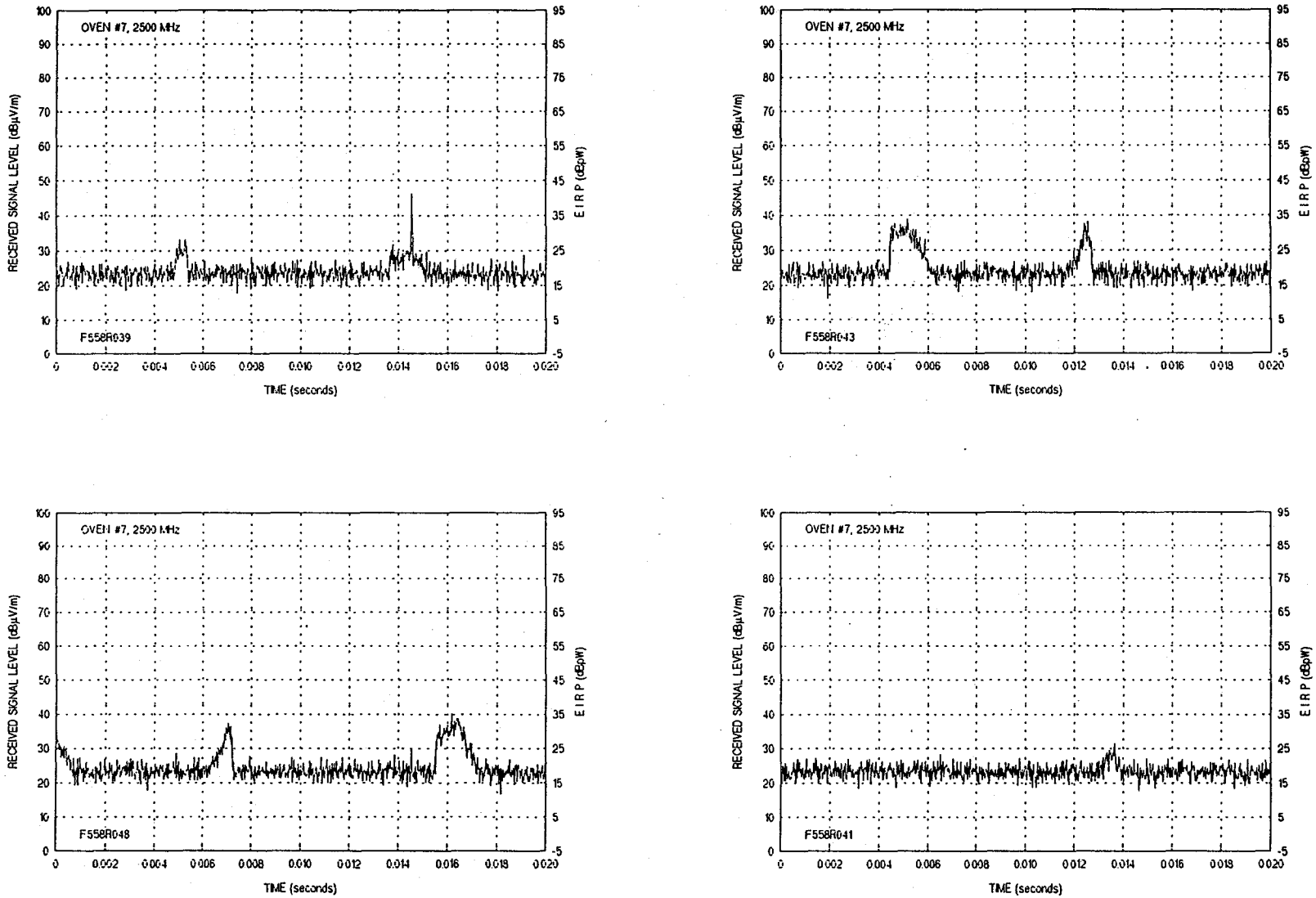


Figure C-51. Oven #7, Time vs. Amplitude displays at 2500 MHz with 300 kHz bandwidth.

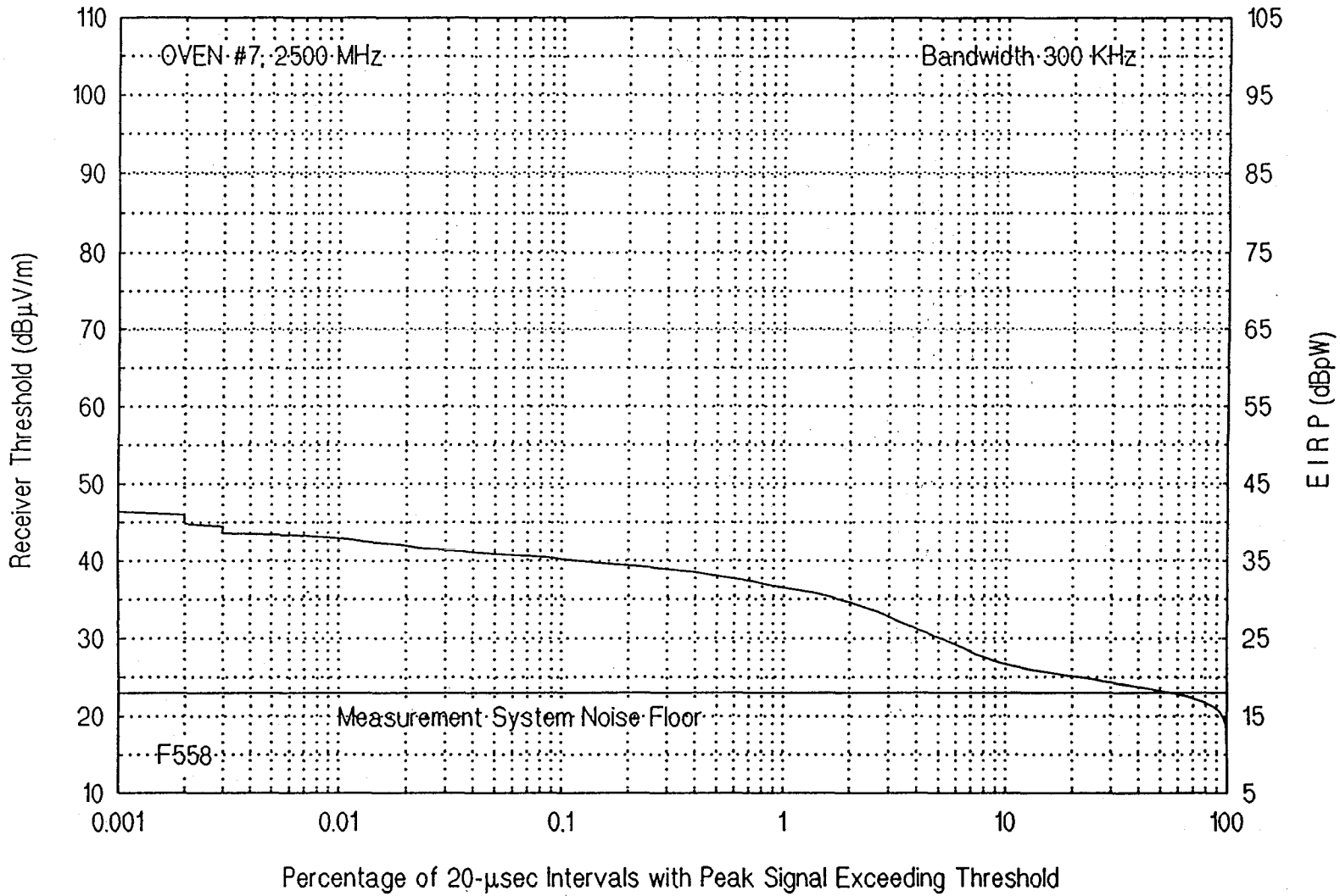


Figure C-52. Oven #7, Amplitude-Probability Distribution at 2500 MHz with 300 kHz bandwidth.

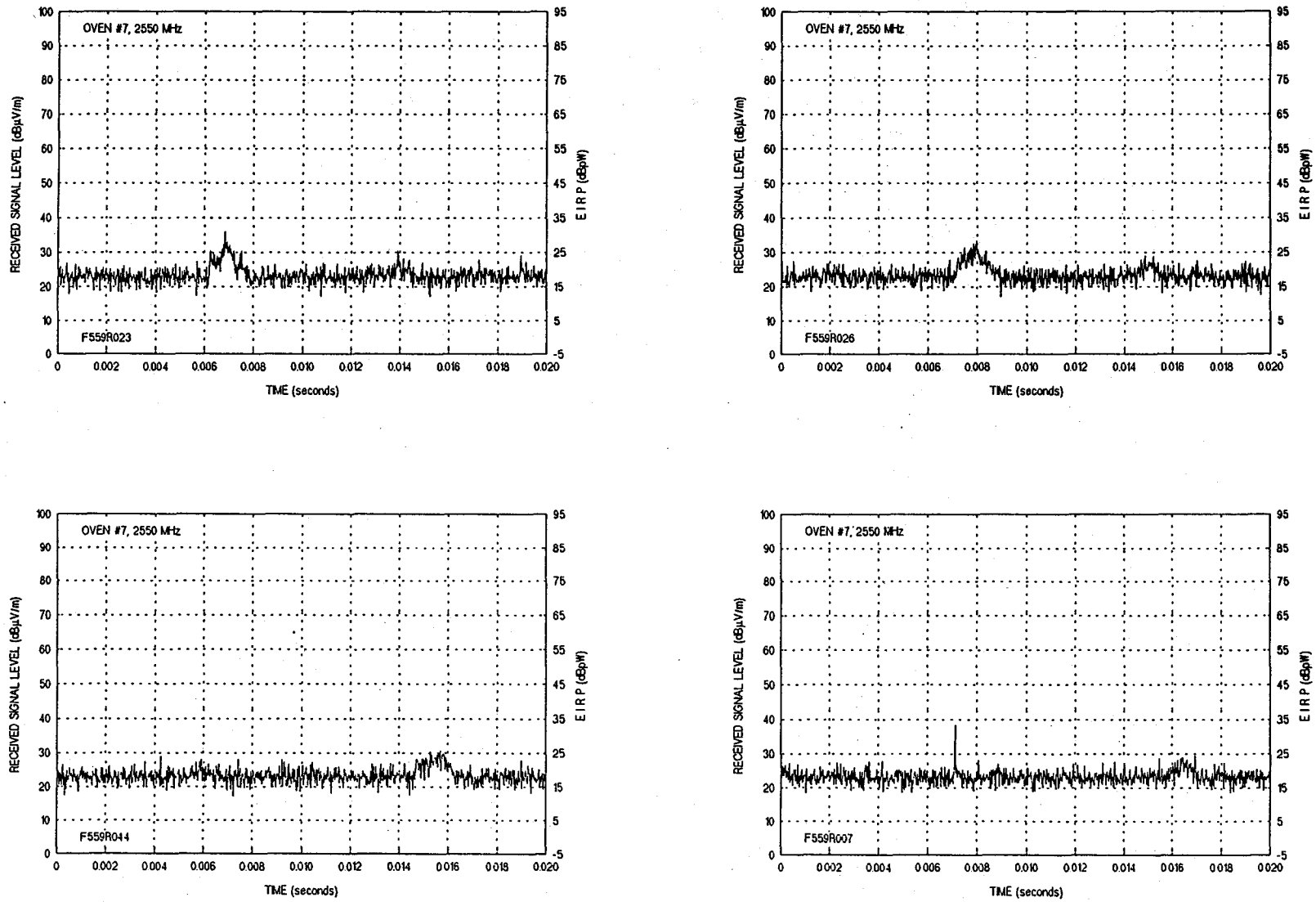


Figure C-53. Oven #7, Time vs. Amplitude displays at 2550 MHz with 300 kHz bandwidth.

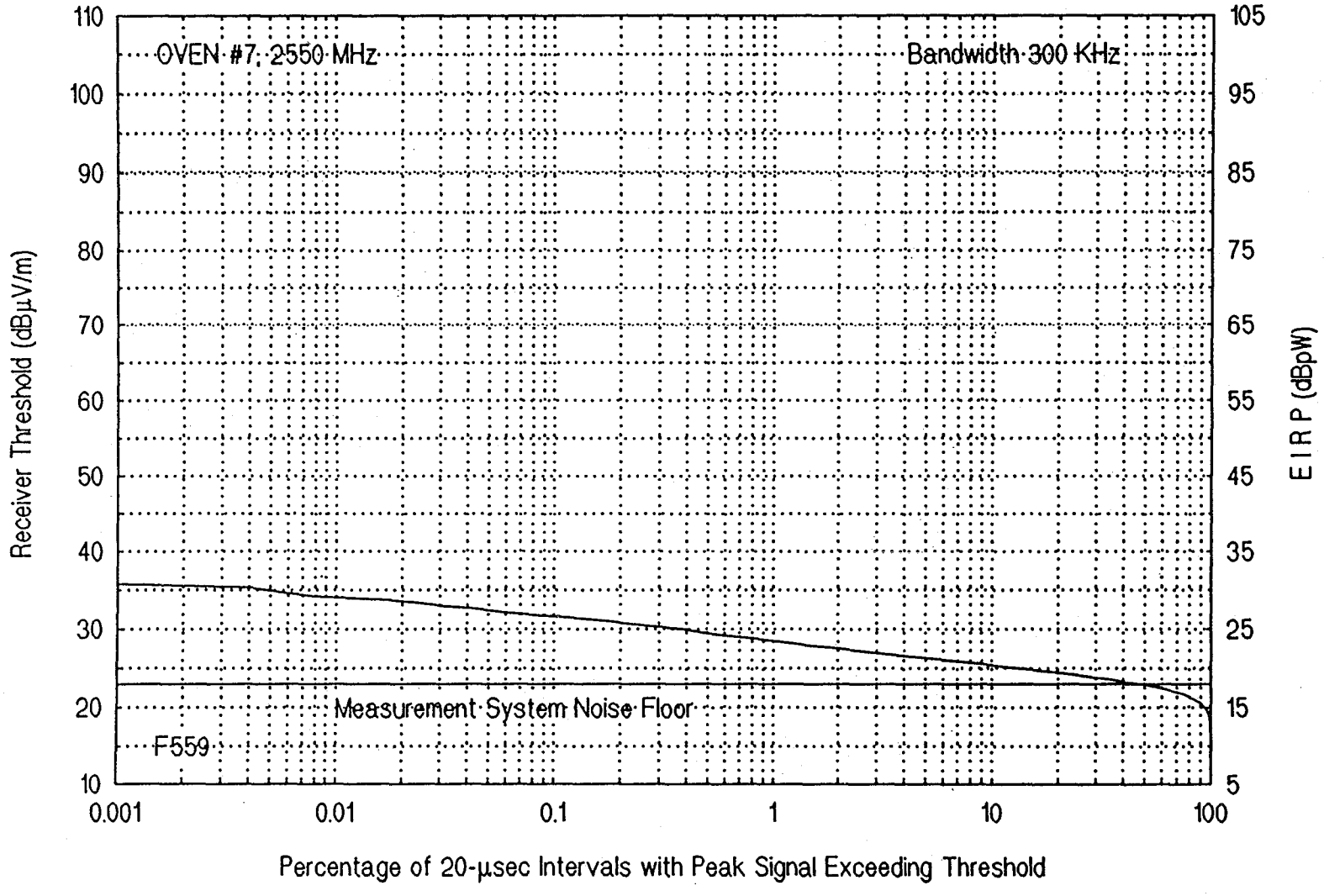


Figure C-54. Oven #7, Amplitude-Probability Distribution at 2550 MHz with 300 kHz bandwidth.

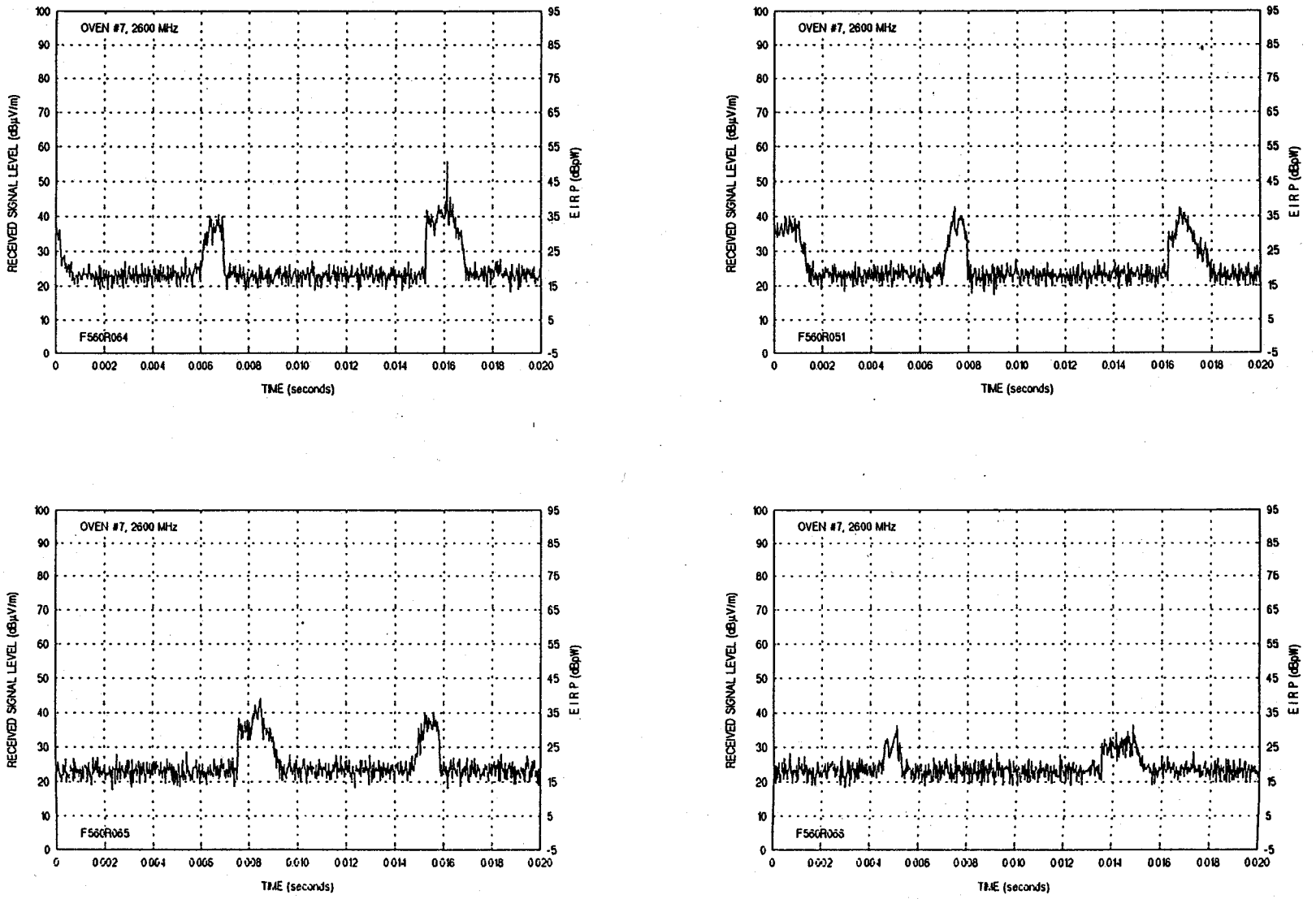


Figure C-55. Oven #7, Time vs. Amplitude displays at 2600 MHz with 300 kHz bandwidth.

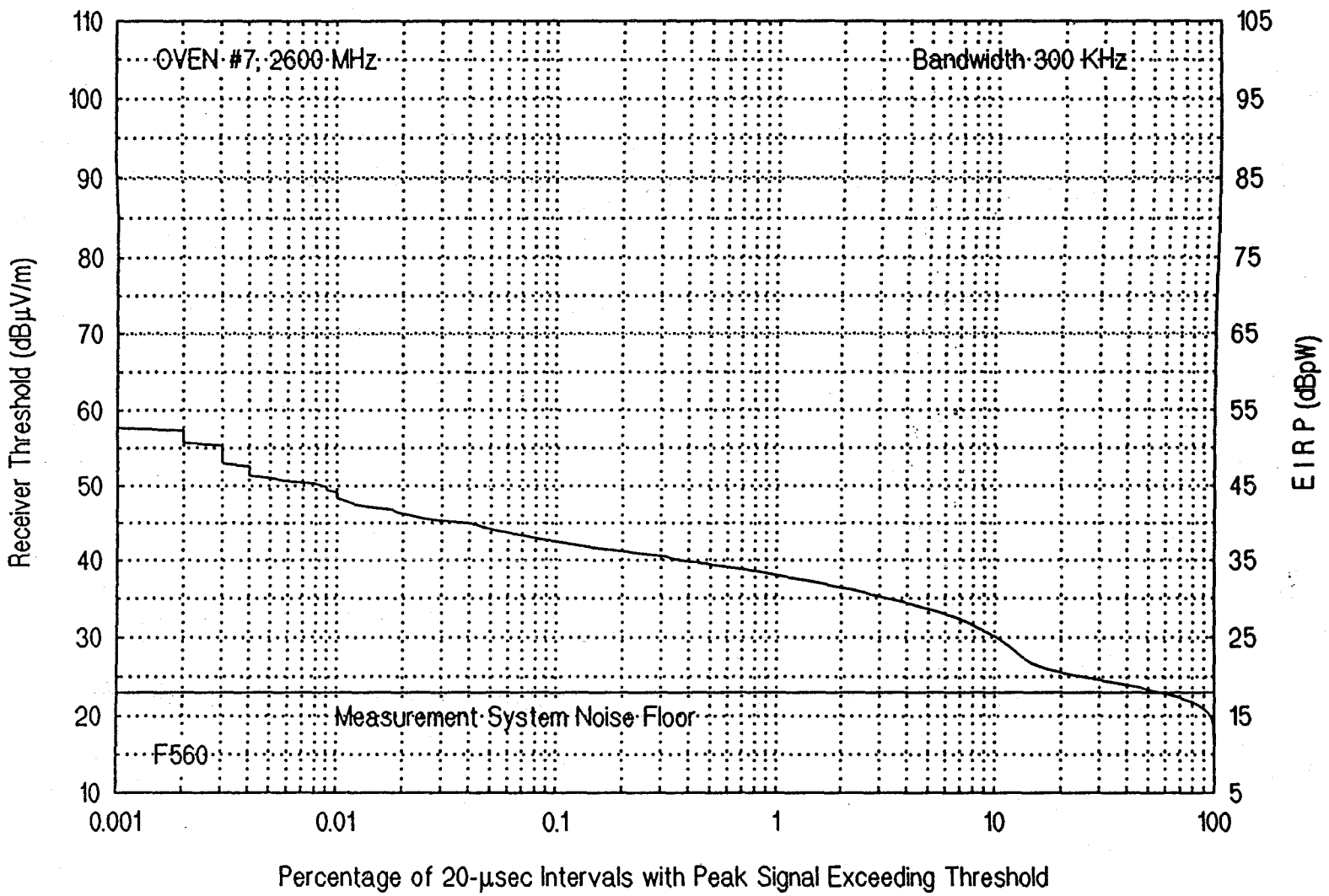


Figure C-56. Oven #7, Amplitude-Probability Distribution at 2600 MHz with 300 kHz bandwidth.

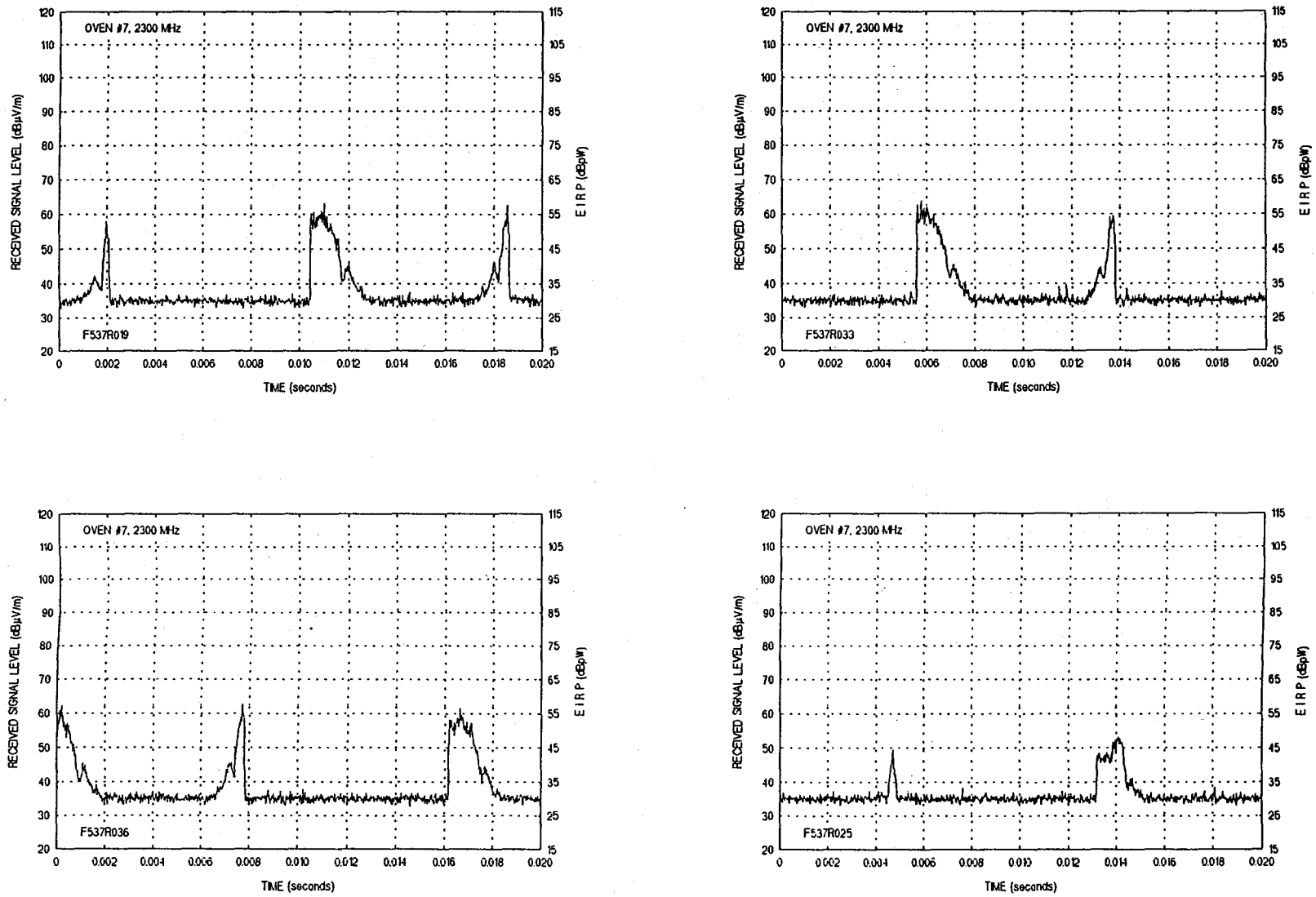


Figure C-57. Oven #7, Time vs. Amplitude displays at 2300 MHz with 3 MHz bandwidth.

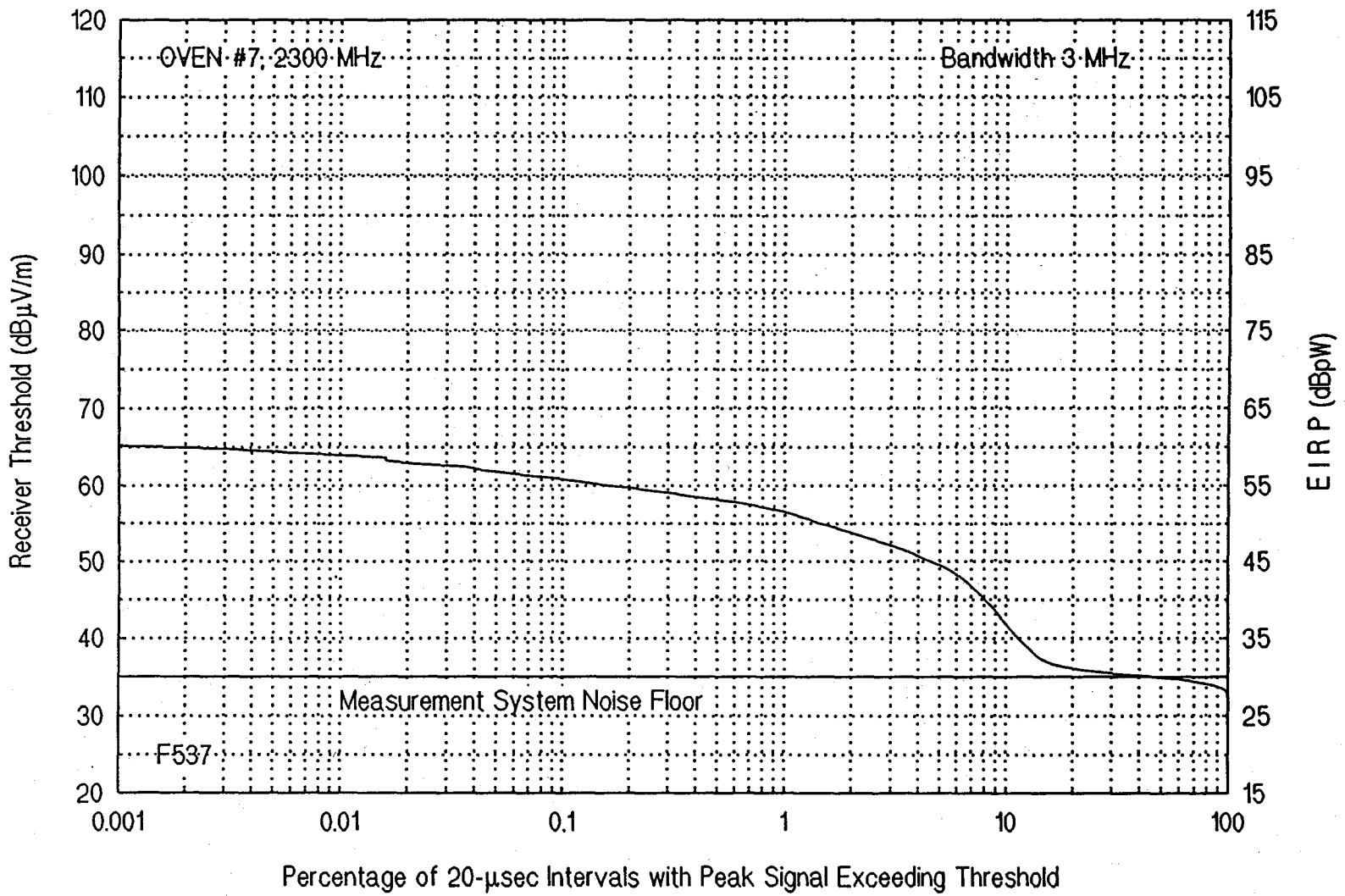


Figure C-58. Oven #7, Amplitude-Probability Distribution at 2300 MHz with 3 MHz bandwidth.

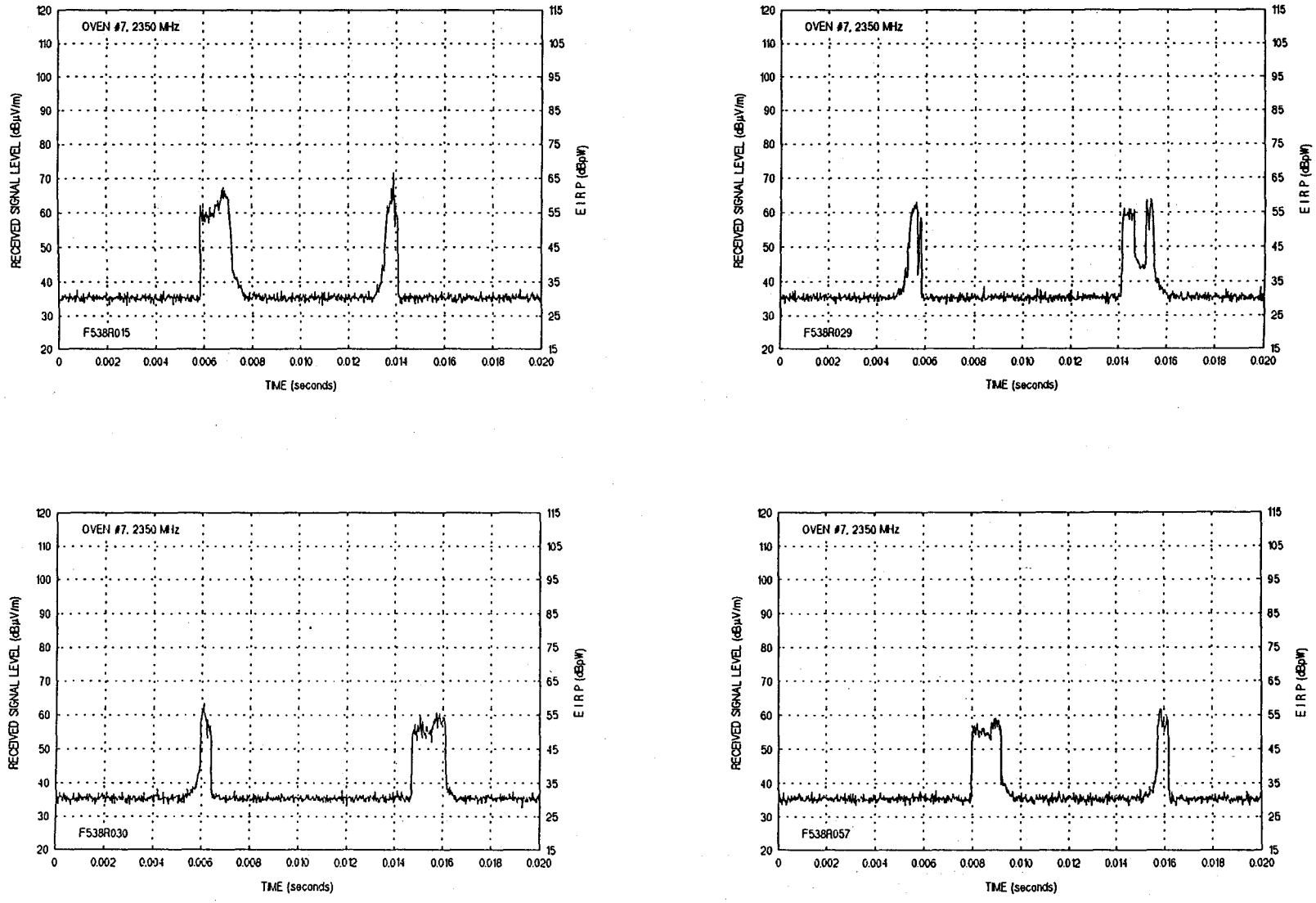


Figure C-59. Oven #7, Time vs. Amplitude displays at 2350 MHz with 3 MHz bandwidth.

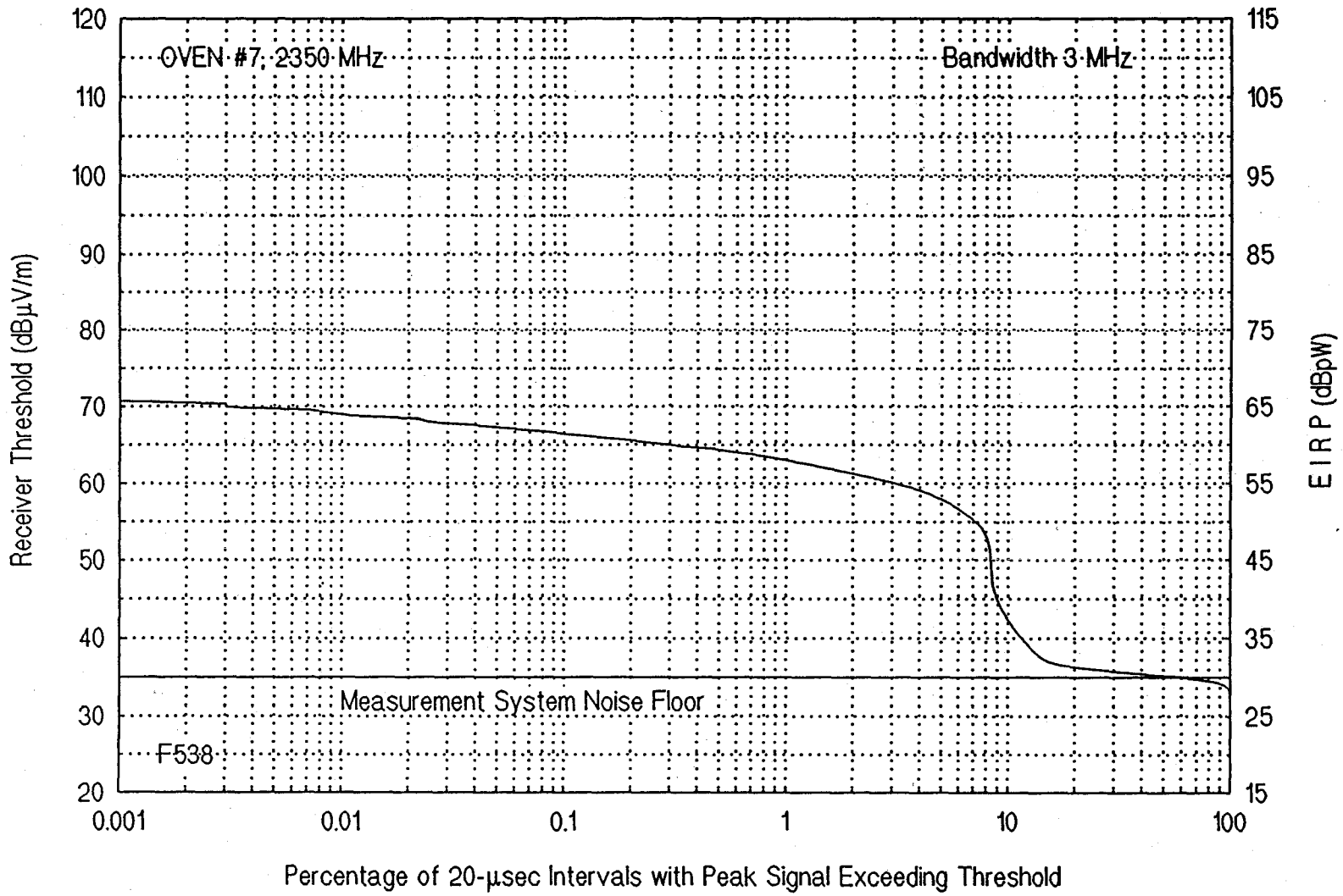


Figure C-60. Oven #7, Amplitude-Probability Distribution at 2350 MHz with 3 MHz bandwidth.

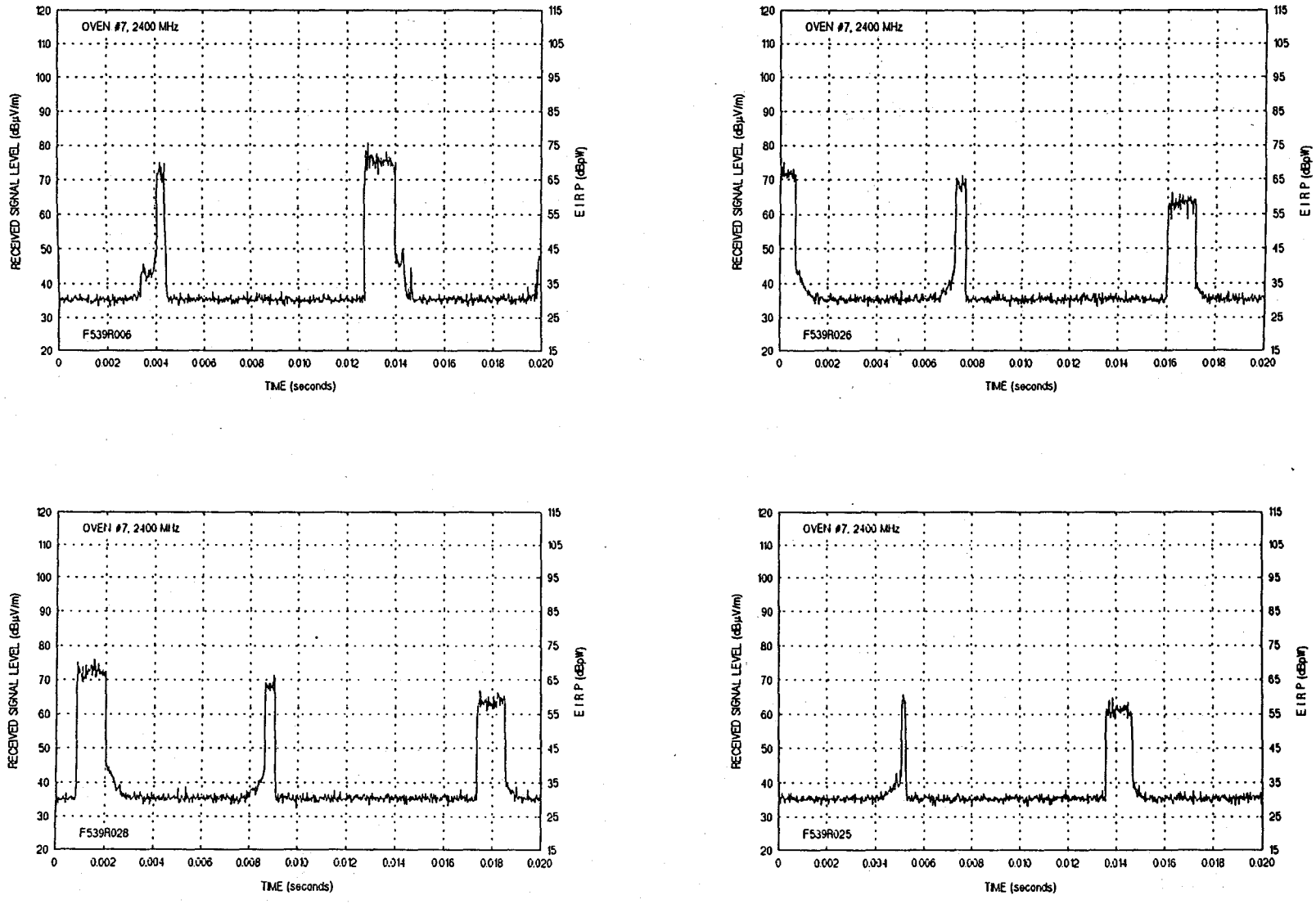


Figure C-61. Oven #7, Time vs. Amplitude displays at 2400 MHz with 3 MHz bandwidth.

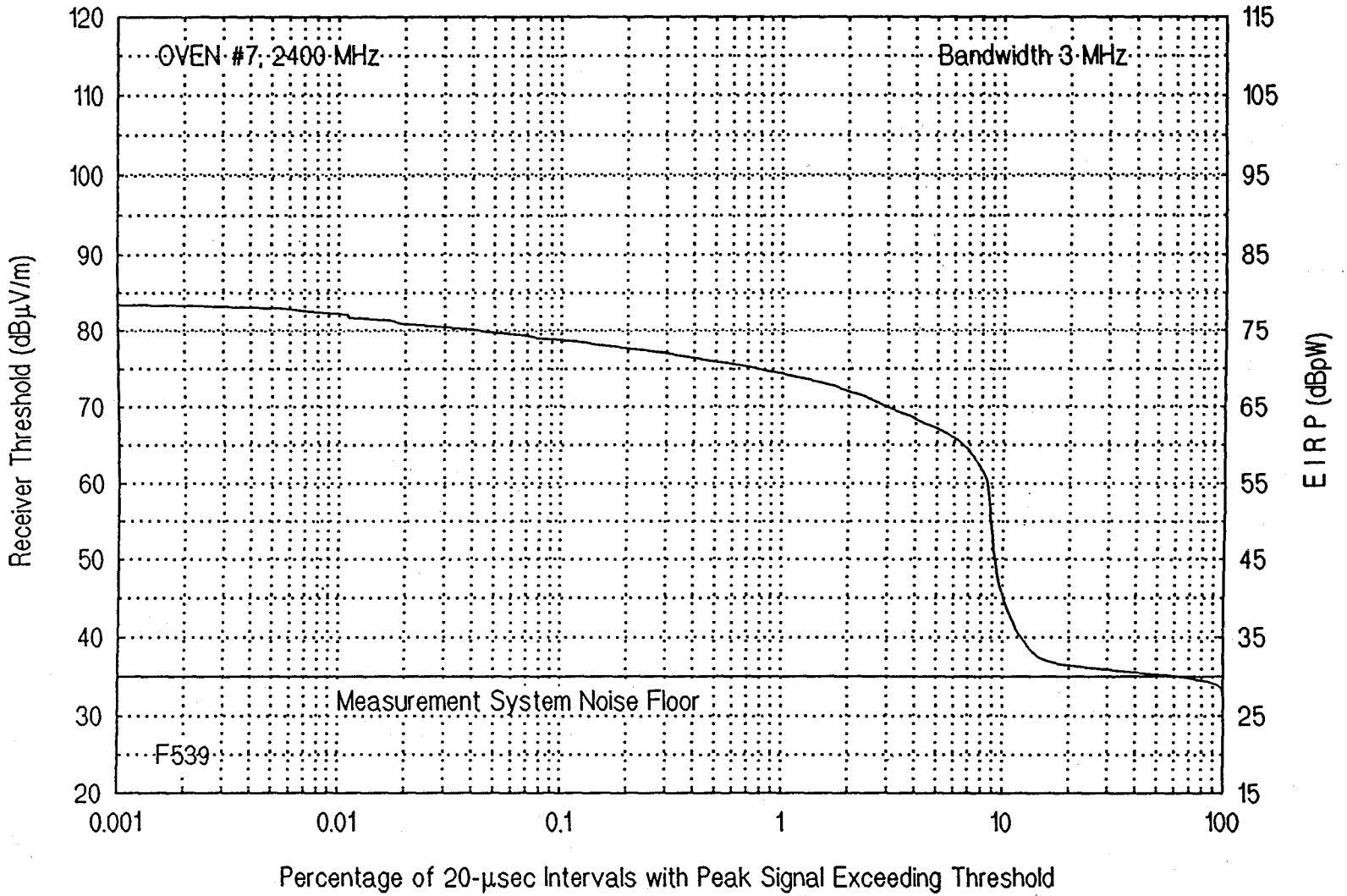


Figure C-62. Oven #7, Amplitude-Probability Distribution at 2400 MHz with 3 MHz bandwidth.

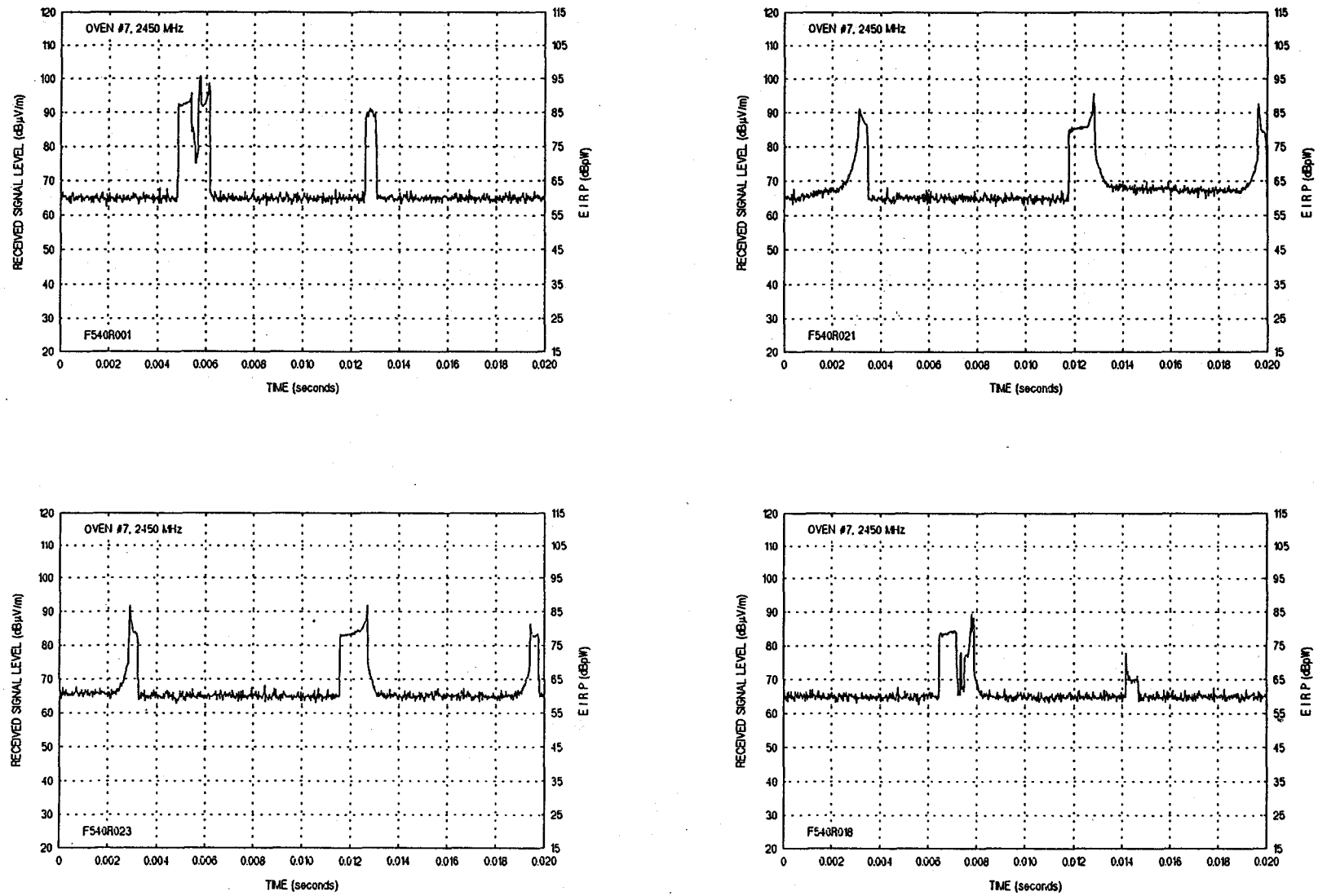


Figure C-63. Oven #7, Time vs. Amplitude displays at 2450 MHz with 3 MHz bandwidth.

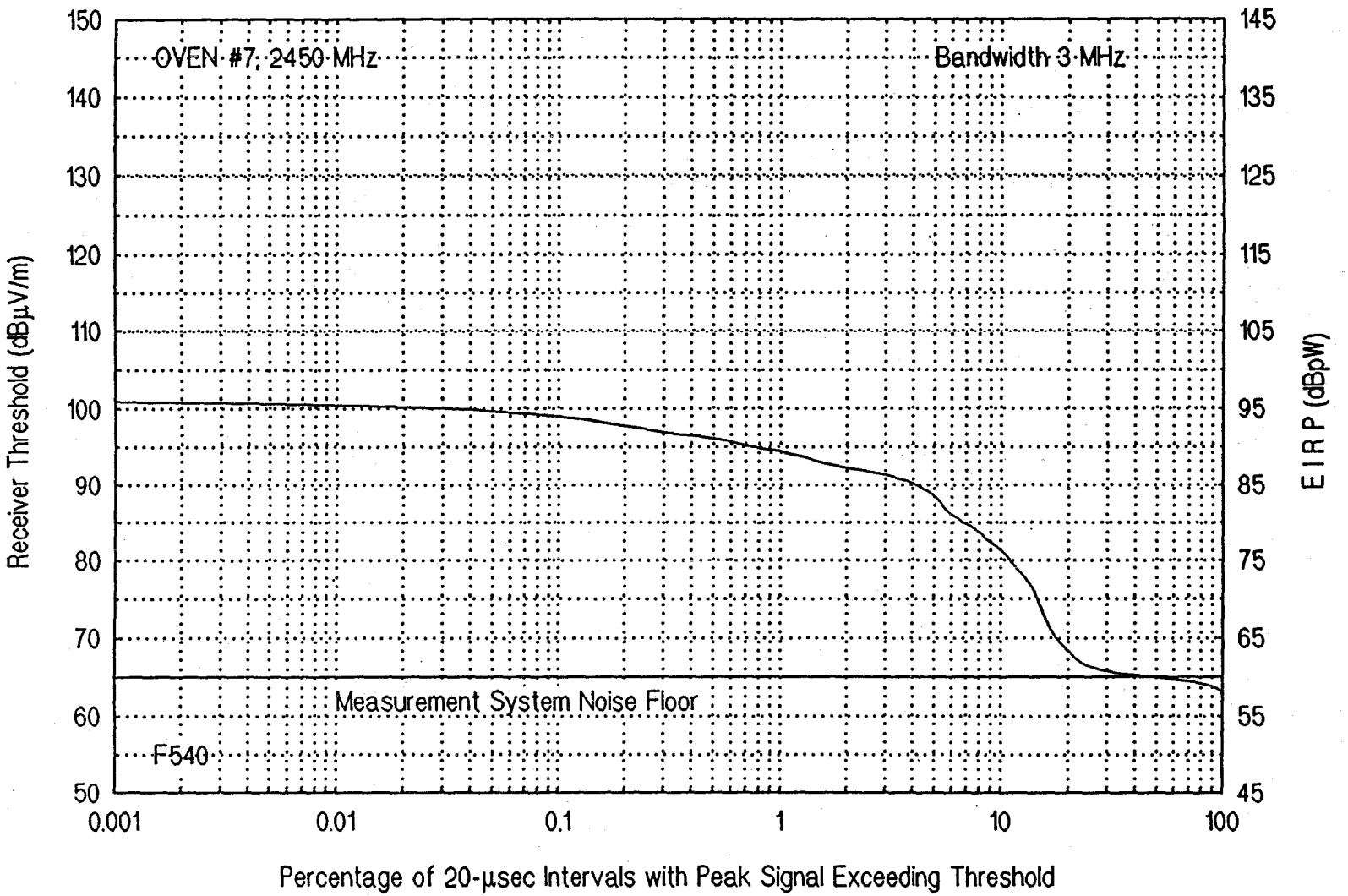
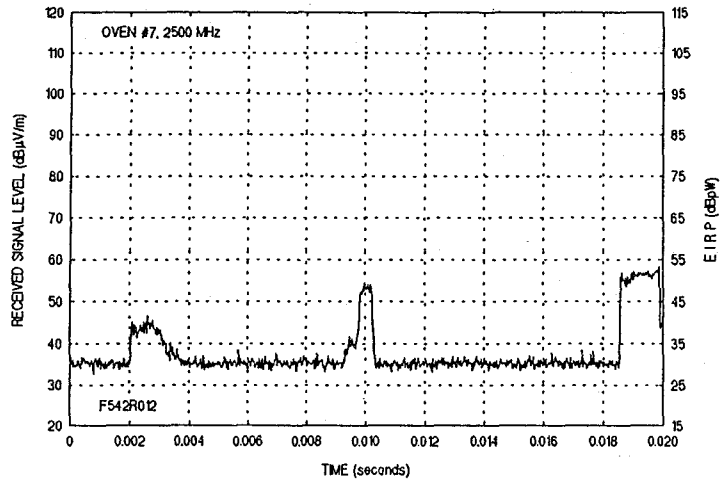
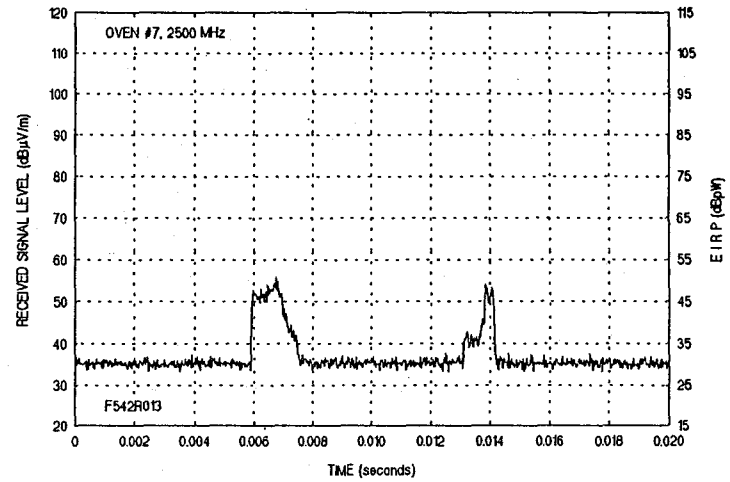
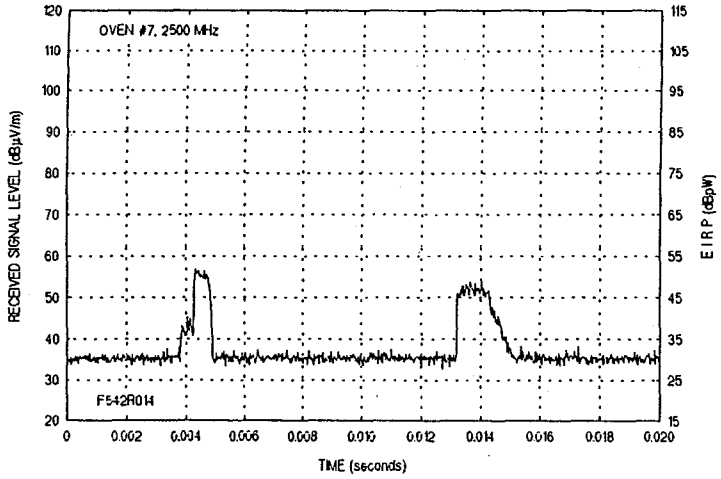


Figure C-64. Oven #7, Amplitude-Probability Distribution at 2450 MHz with 3 MHz bandwidth.







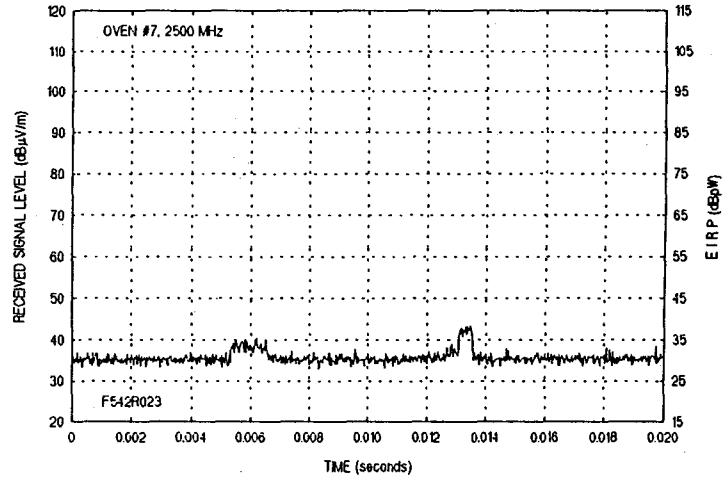


Figure C-65. Oven #7, Time vs. Amplitude displays at 2500 MHz with 3 MHz bandwidth.

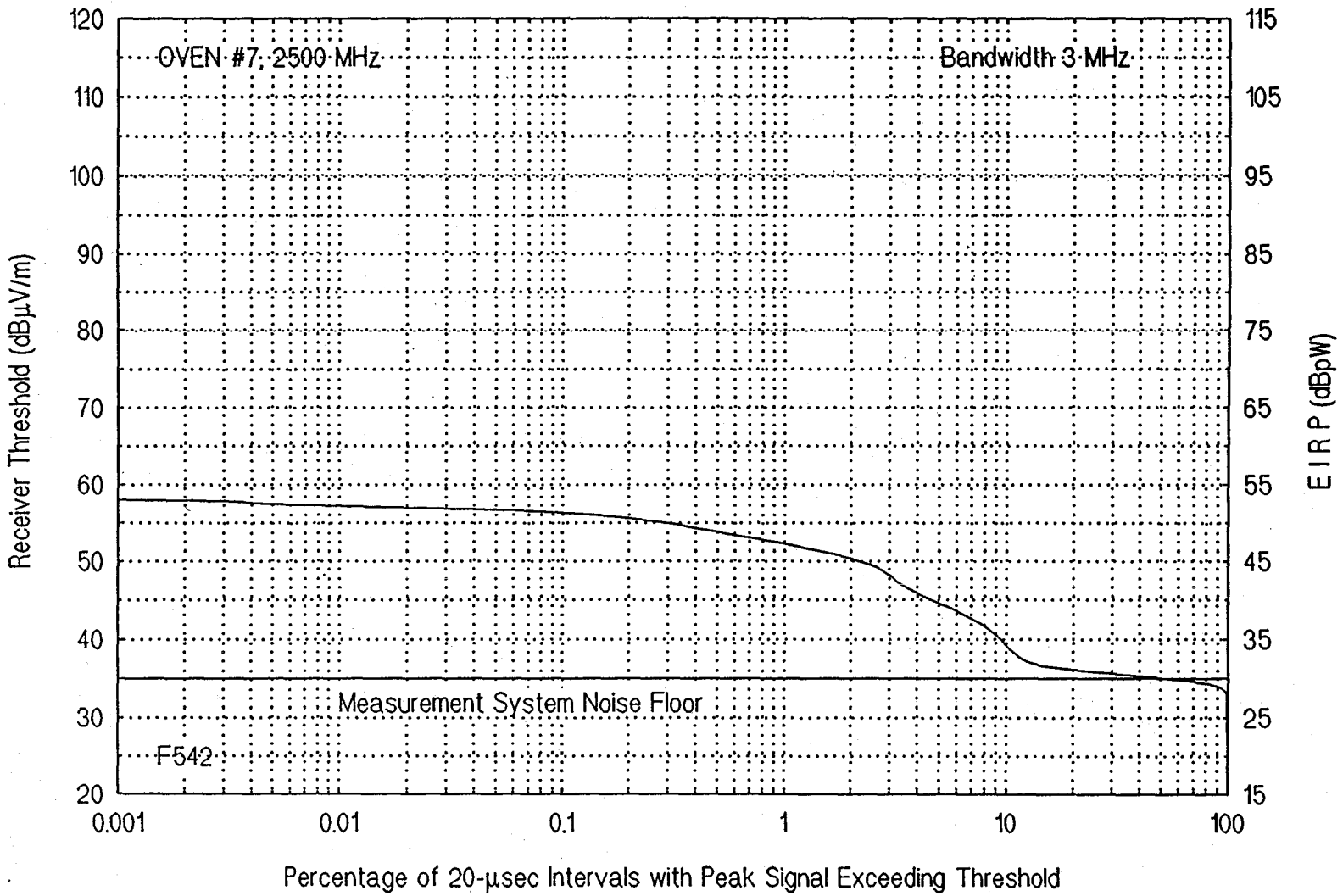


Figure C-66. Oven #7, Amplitude-Probability Distribution at 2500 MHz with 3 MHz bandwidth.

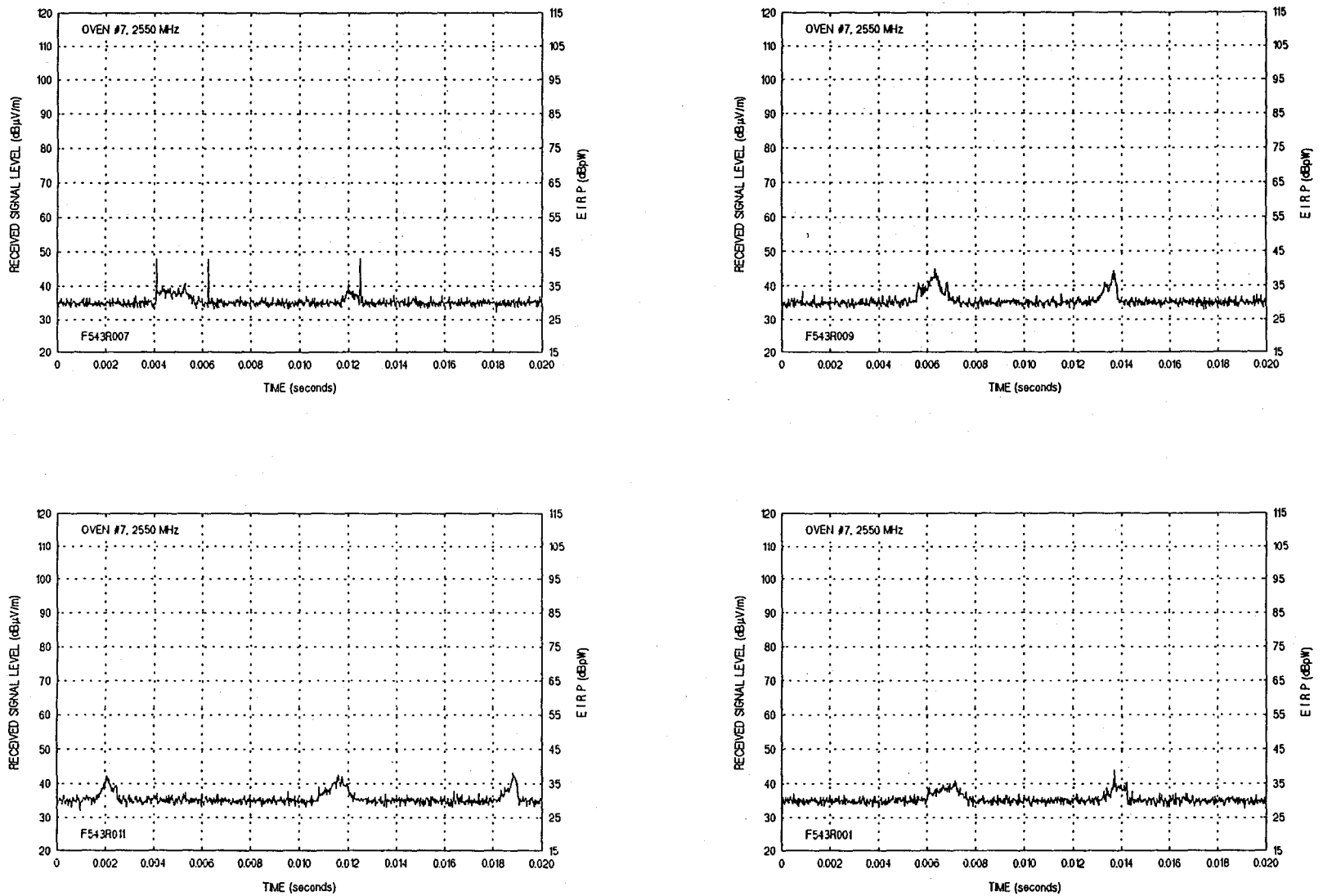


Figure C-67. Oven #7, Time vs. Amplitude displays at 2550 MHz with 3 MHz bandwidth.

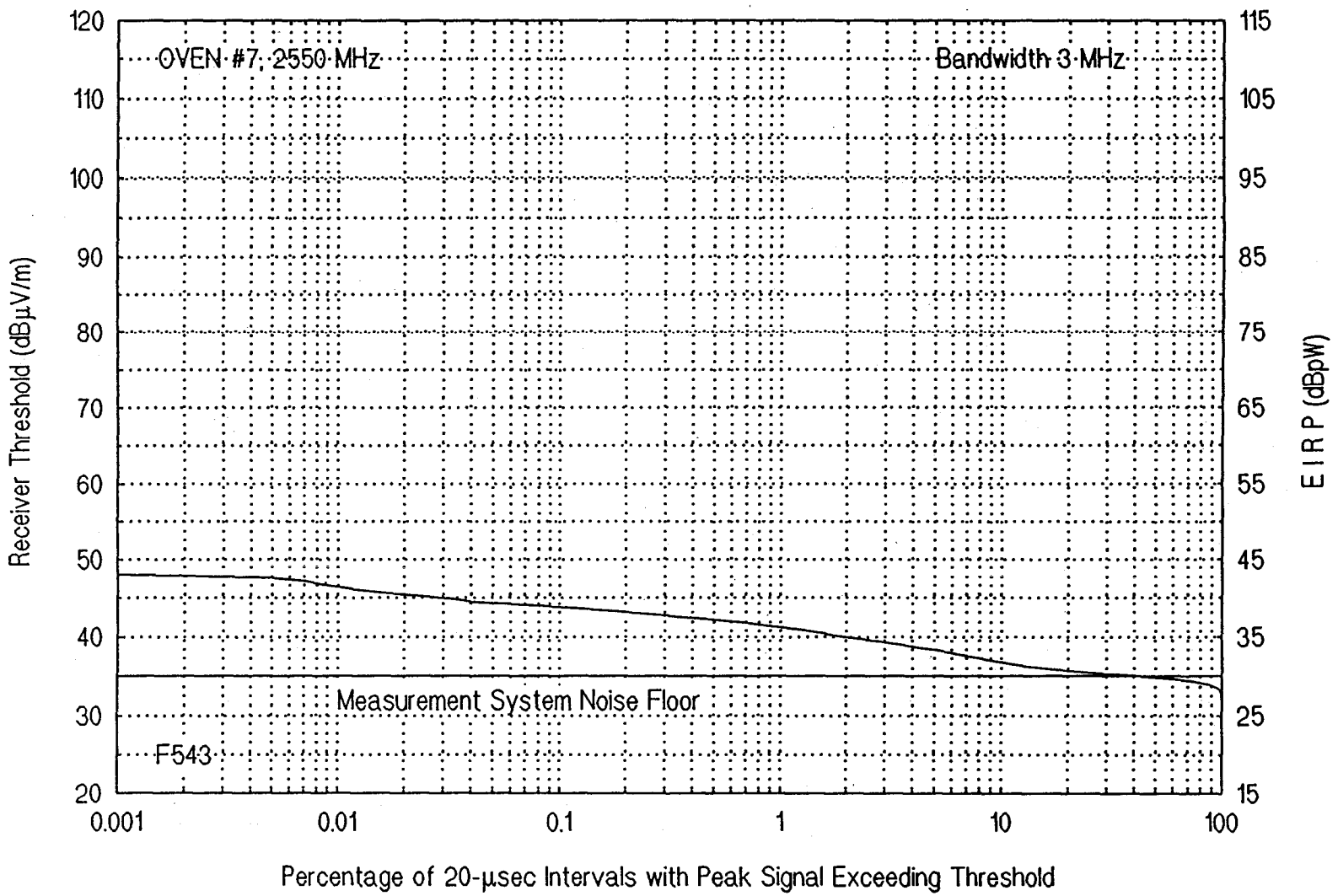


Figure C-68. Oven #7, Amplitude-Probability Distribution at 2550 MHz with 3 MHz bandwidth.

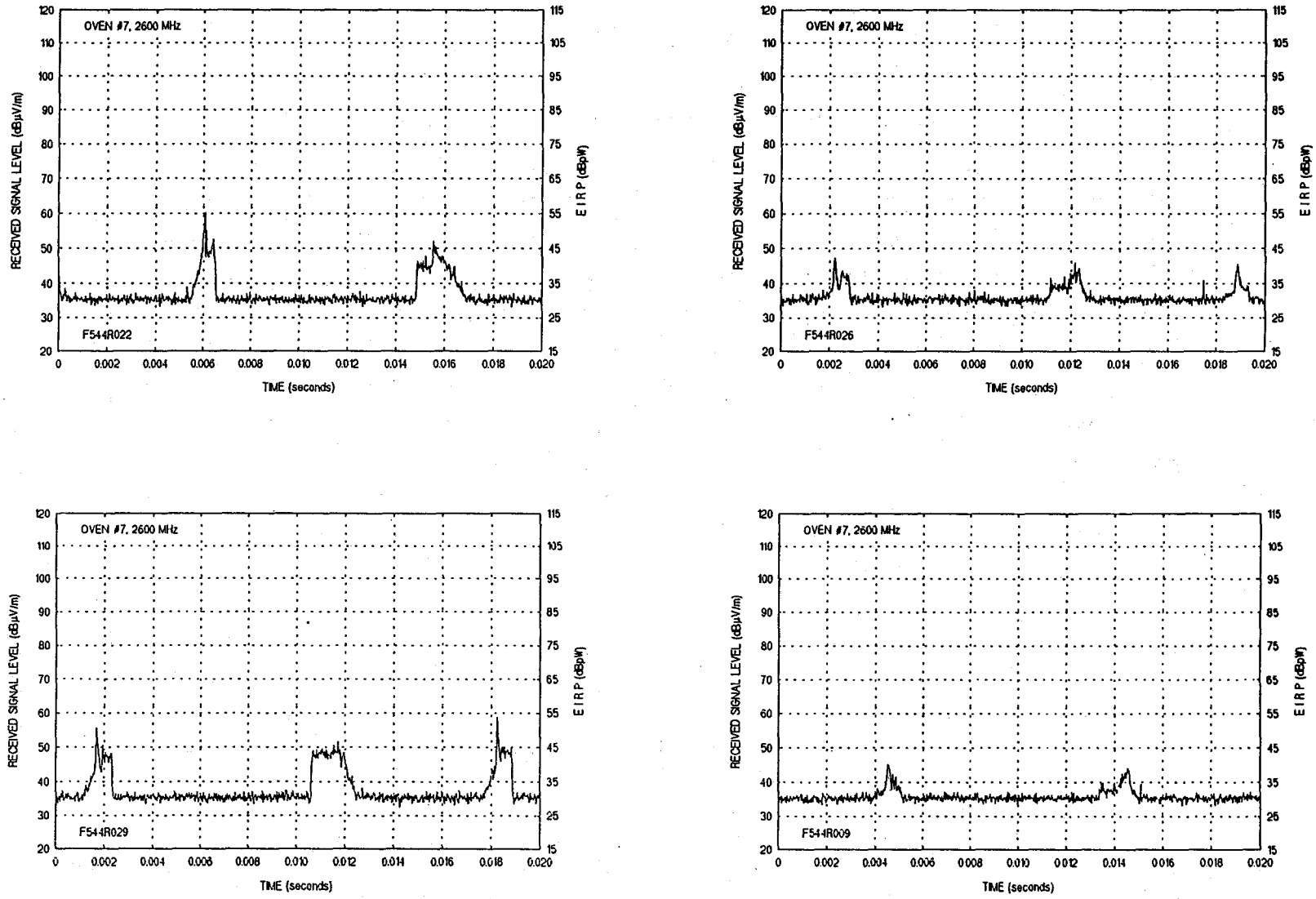


Figure C-69. Oven #7, Time vs. Amplitude displays at 2600 MHz with 3 MHz bandwidth.

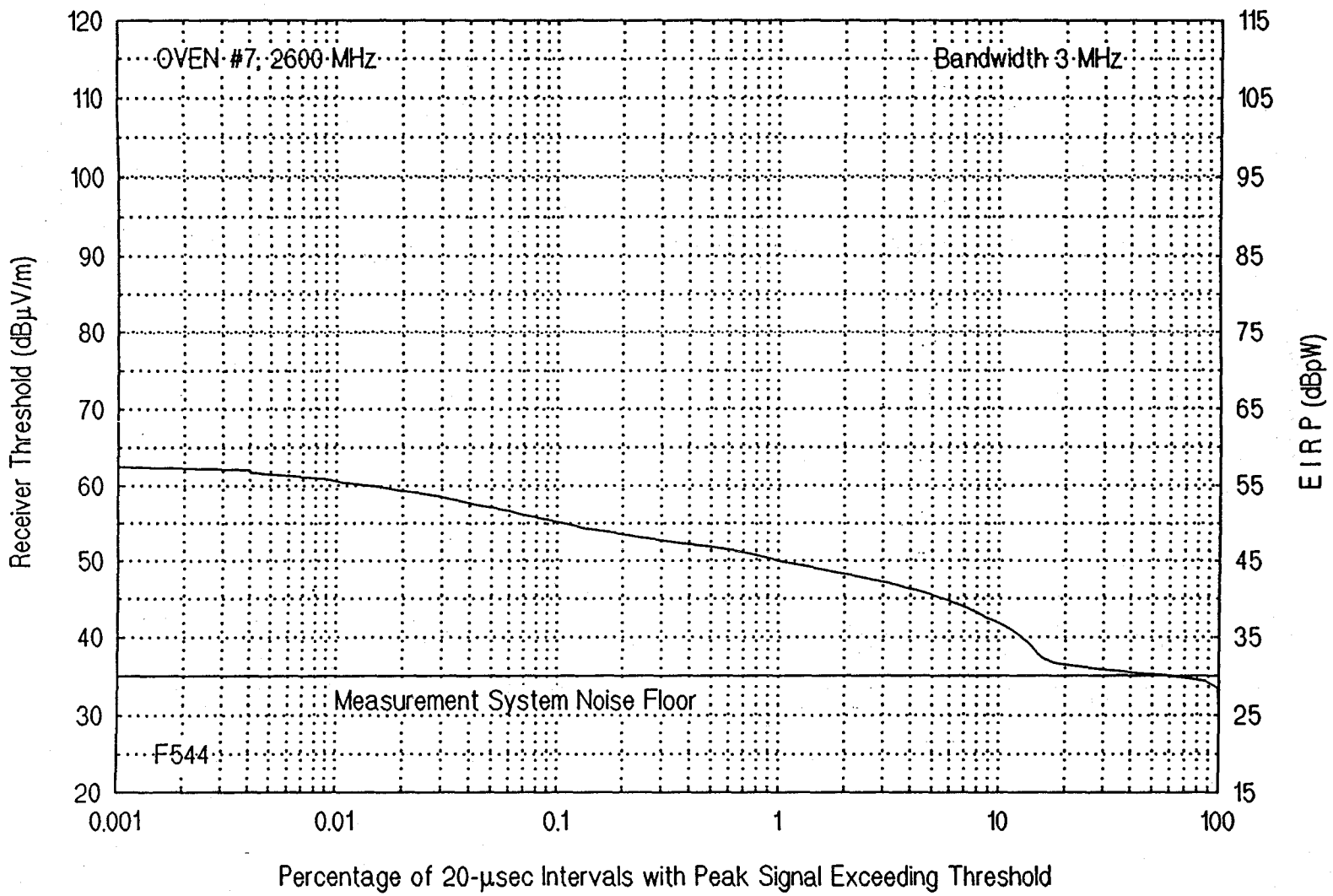


Figure C-70. Oven #7, Amplitude-Probability Distribution at 2600 MHz with 3 MHz bandwidth.

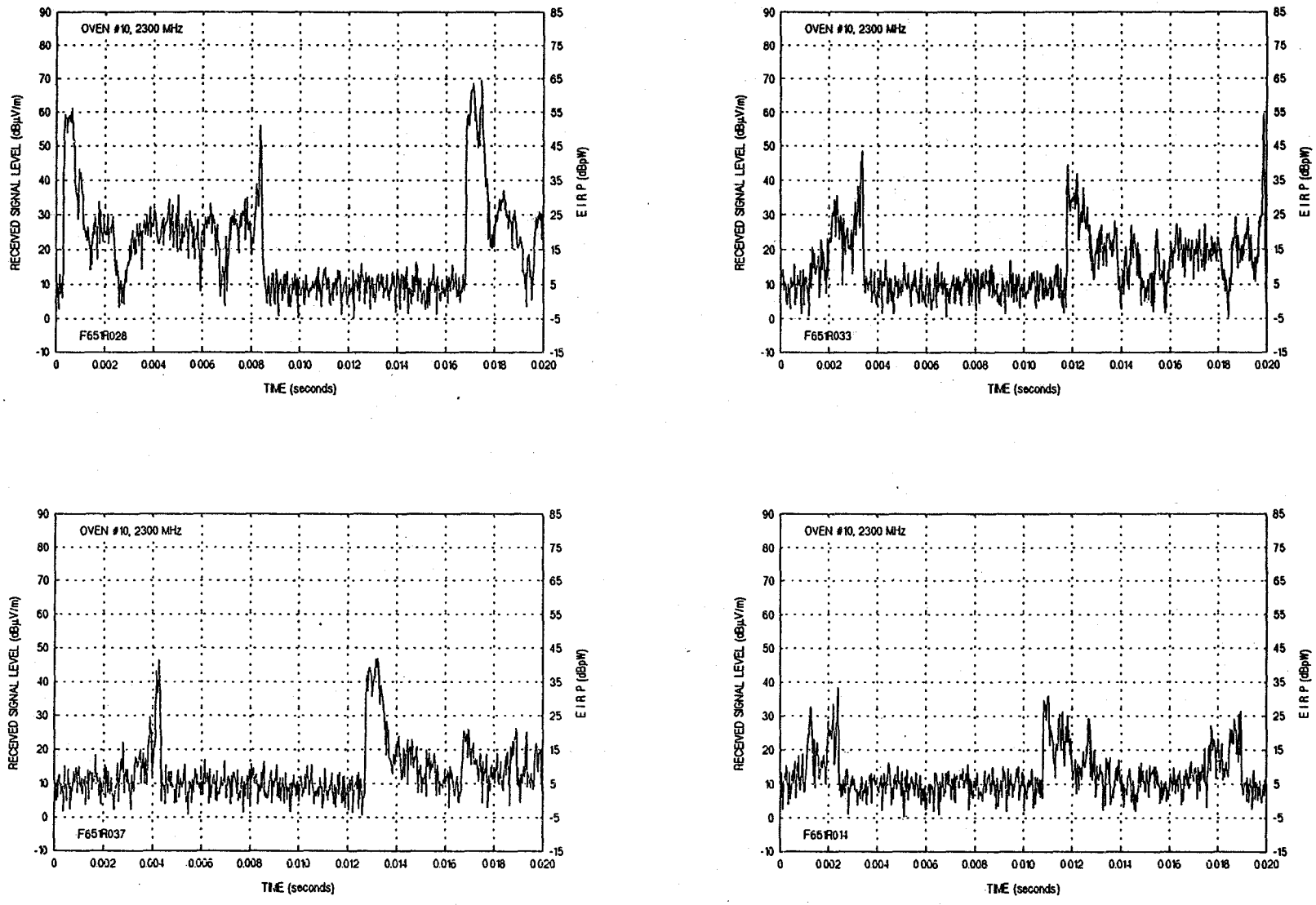


Figure C-71. Oven #10, Time vs. Amplitude displays at 2300 MHz with 30 kHz bandwidth.

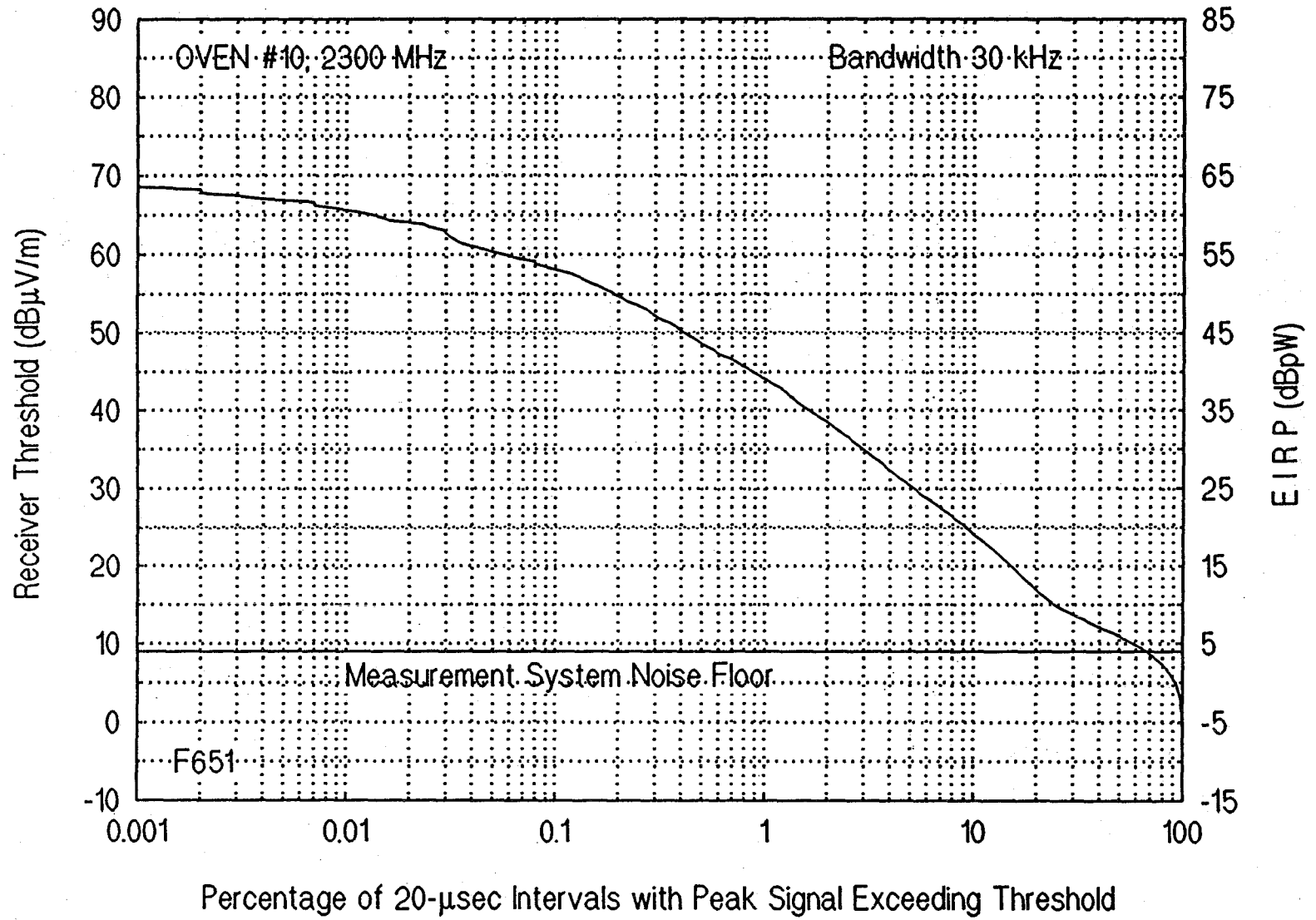


Figure C-72. Oven #10, Amplitude-Probability Distribution at 2300 MHz with 30 kHz bandwidth.

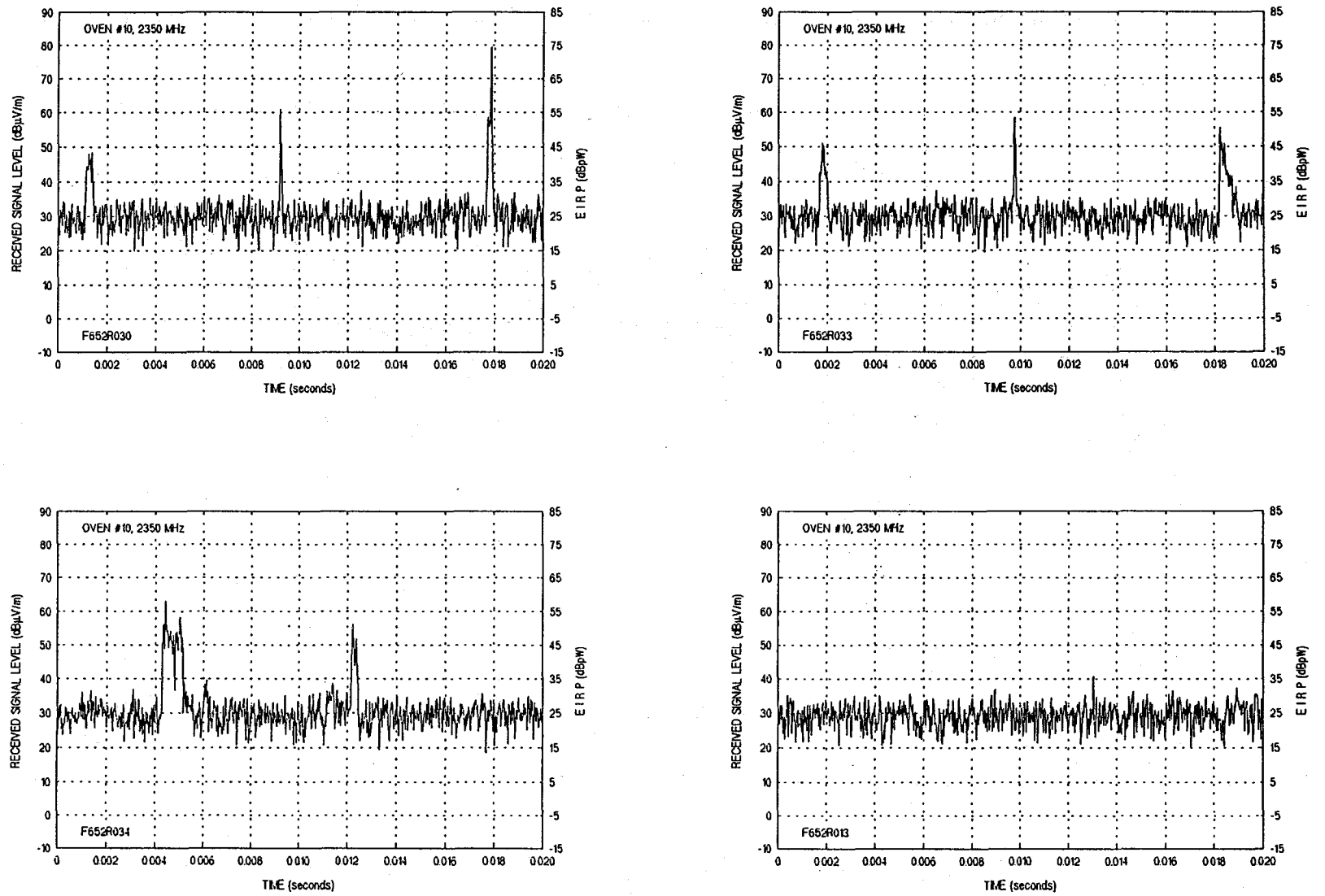


Figure C-73. Oven #10, Time vs. Amplitude displays at 2350 MHz with 30 kHz bandwidth.

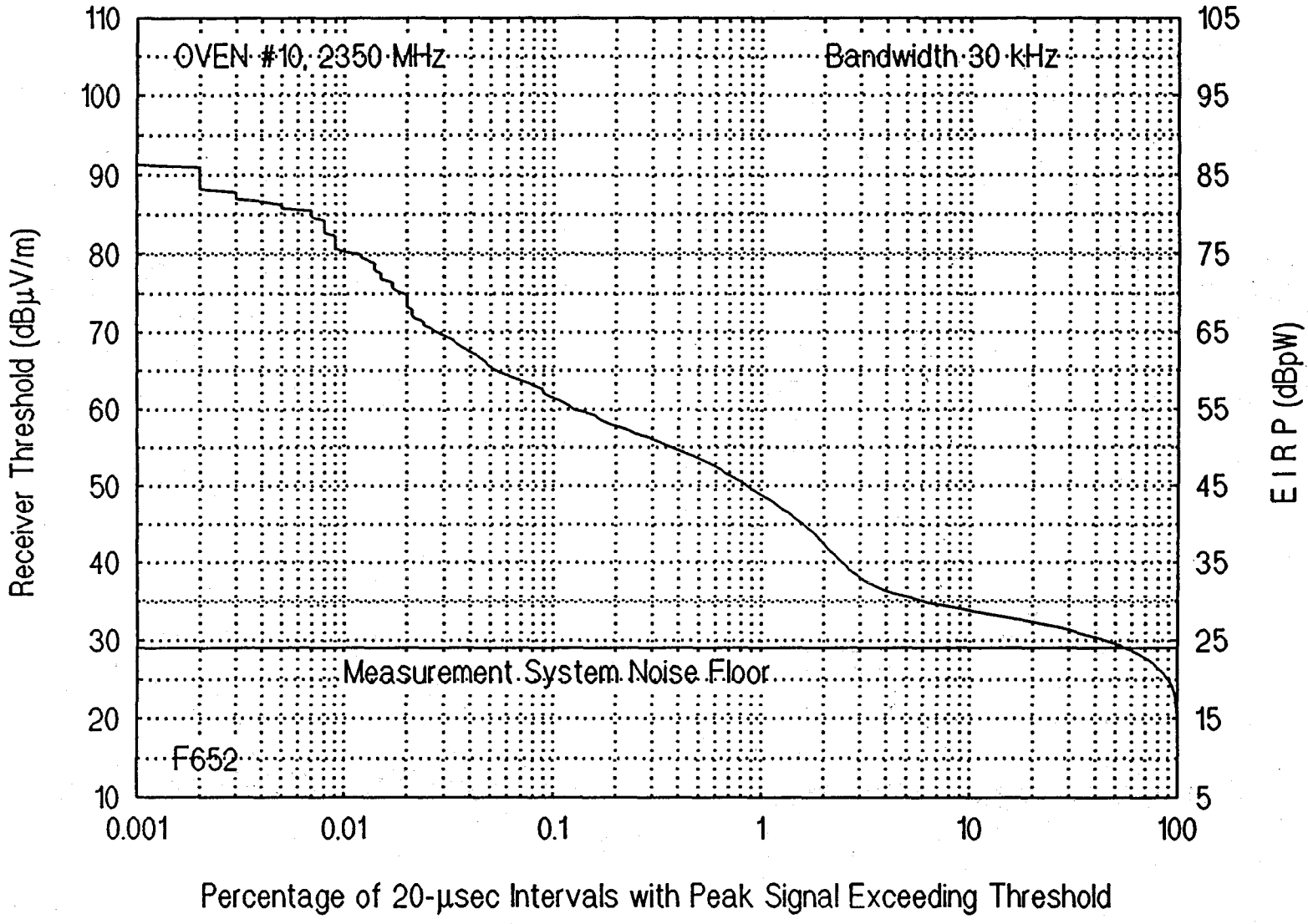


Figure C-74. Oven #10, Amplitude-Probability Distribution at 2350 MHz with 30 kHz bandwidth.

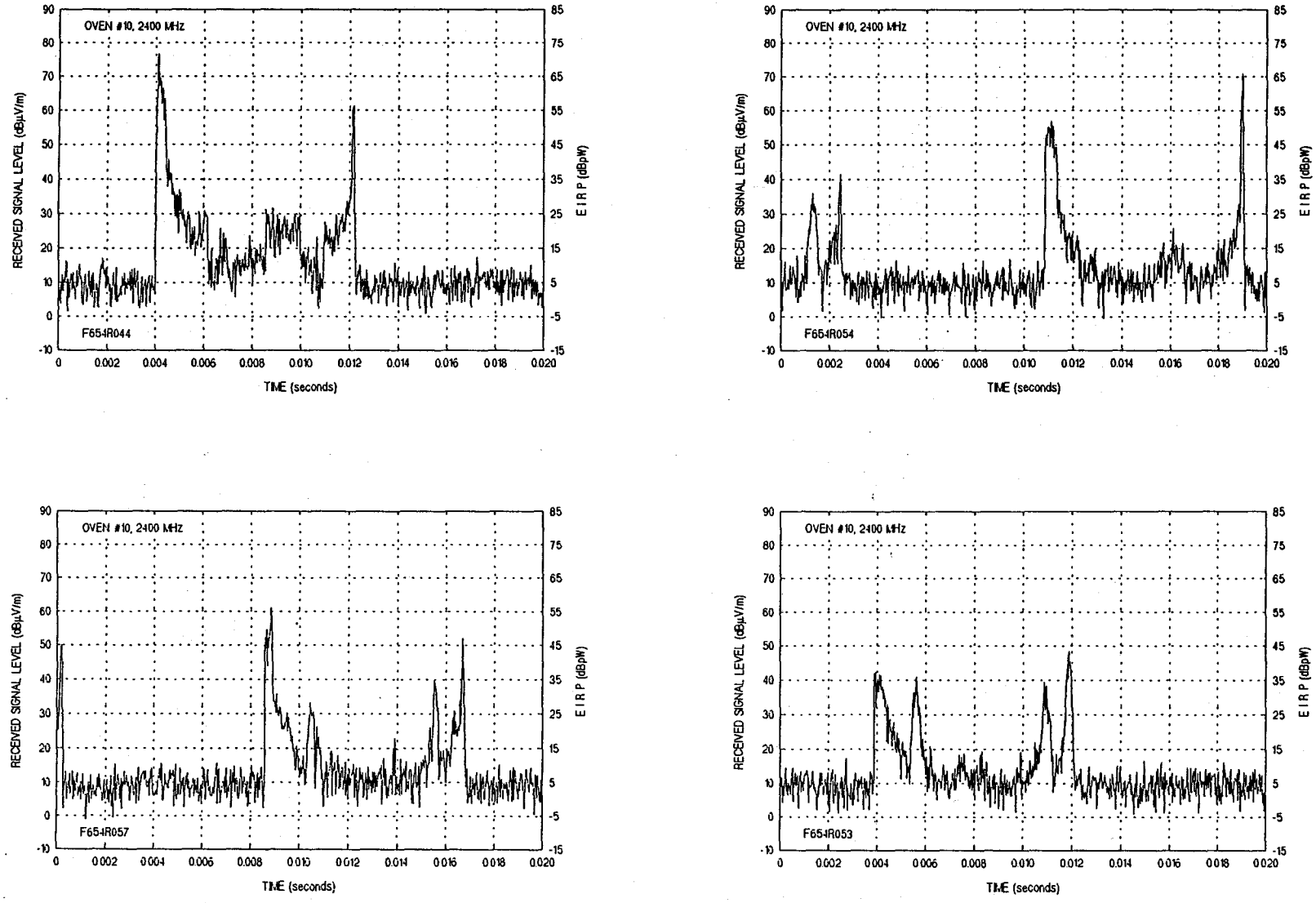


Figure C-75. Oven #10, Time vs. Amplitude displays at 2400 MHz with 30 kHz bandwidth.

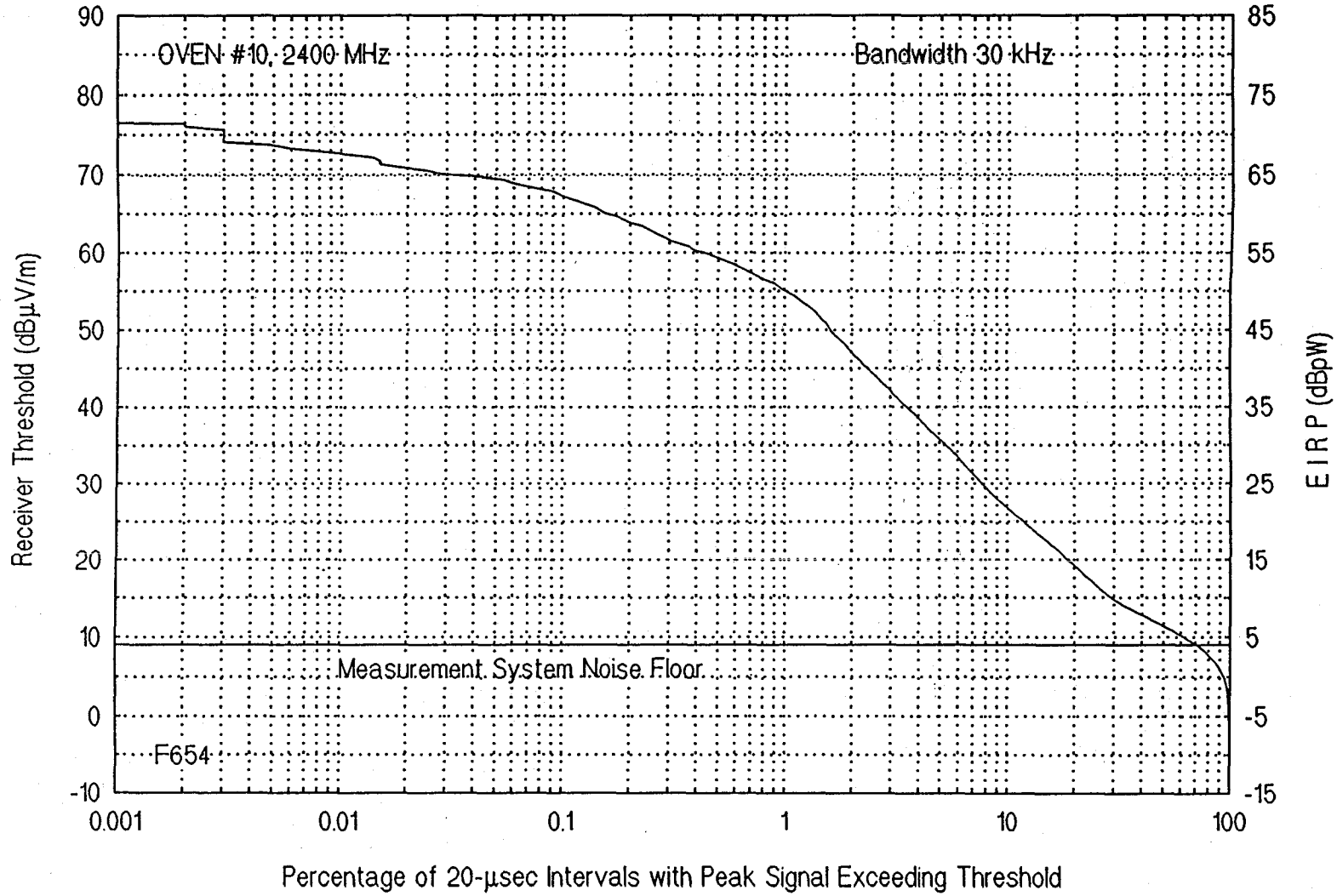


Figure C-76. Oven #10, Amplitude-Probability Distribution at 2400 MHz with 30 kHz bandwidth.

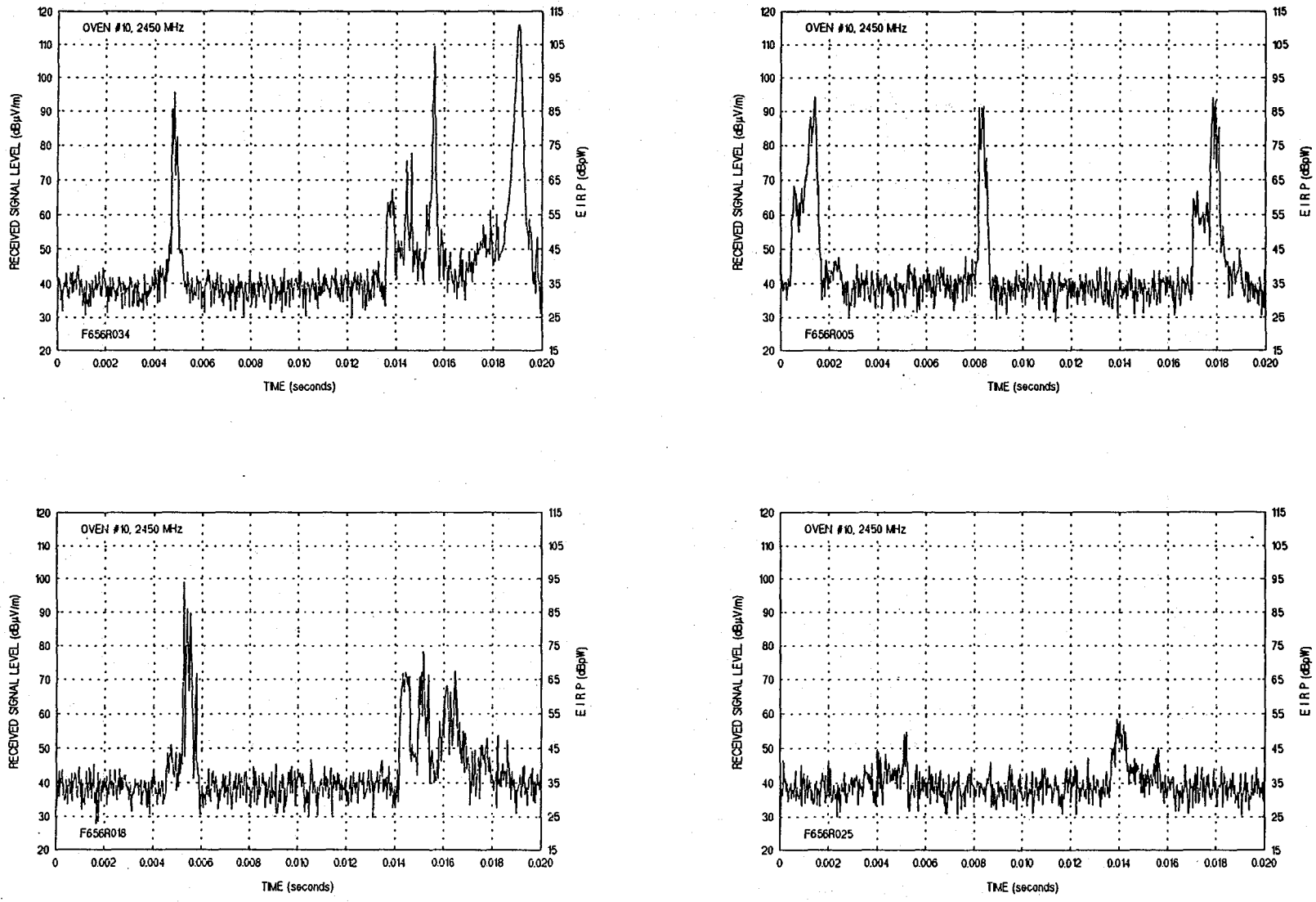


Figure C-77. Oven #10, Time vs. Amplitude displays at 2450 MHz with 30 kHz bandwidth.

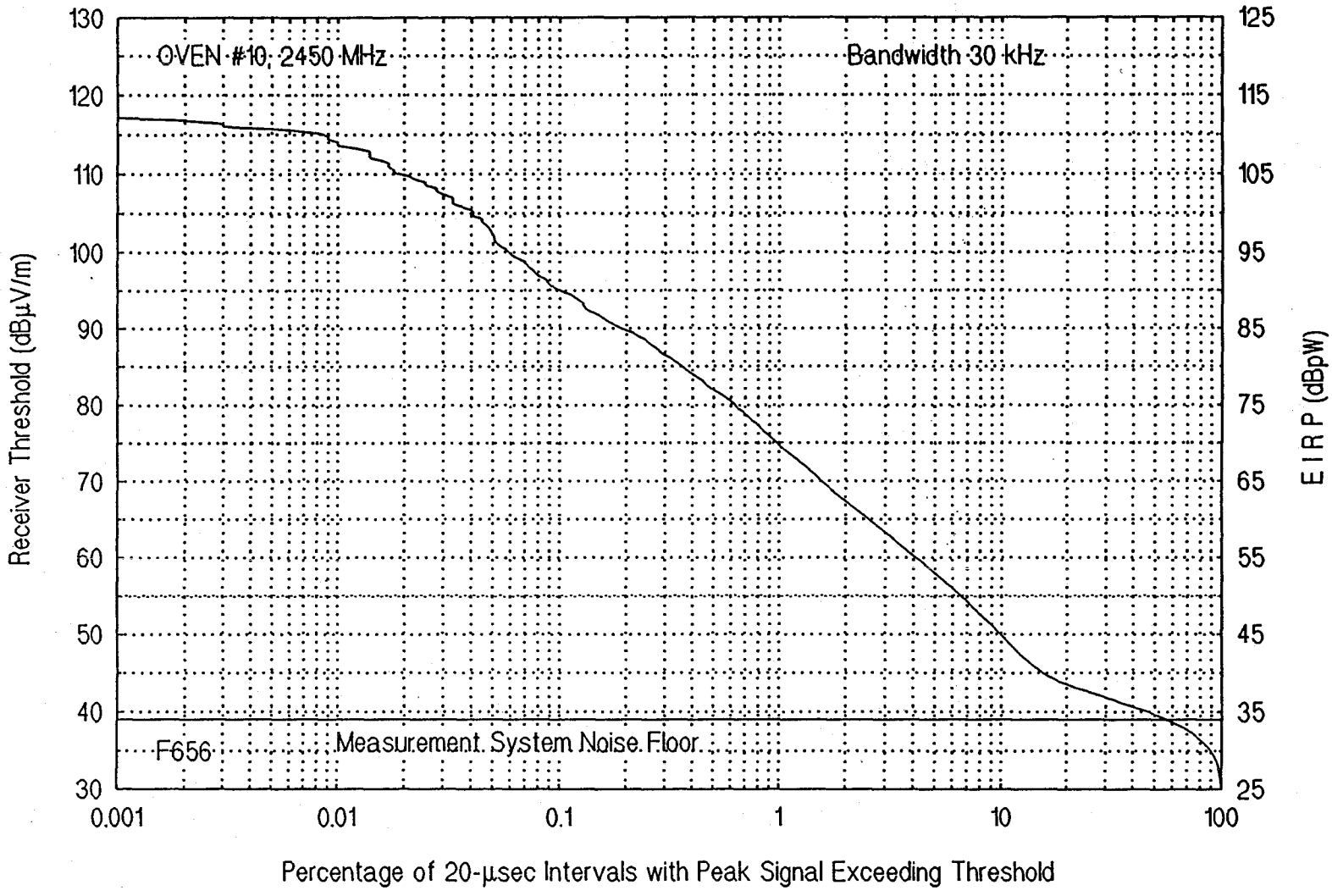


Figure C-78. Oven #10, Amplitude-Probability Distribution at 2450 MHz with 30 kHz bandwidth.

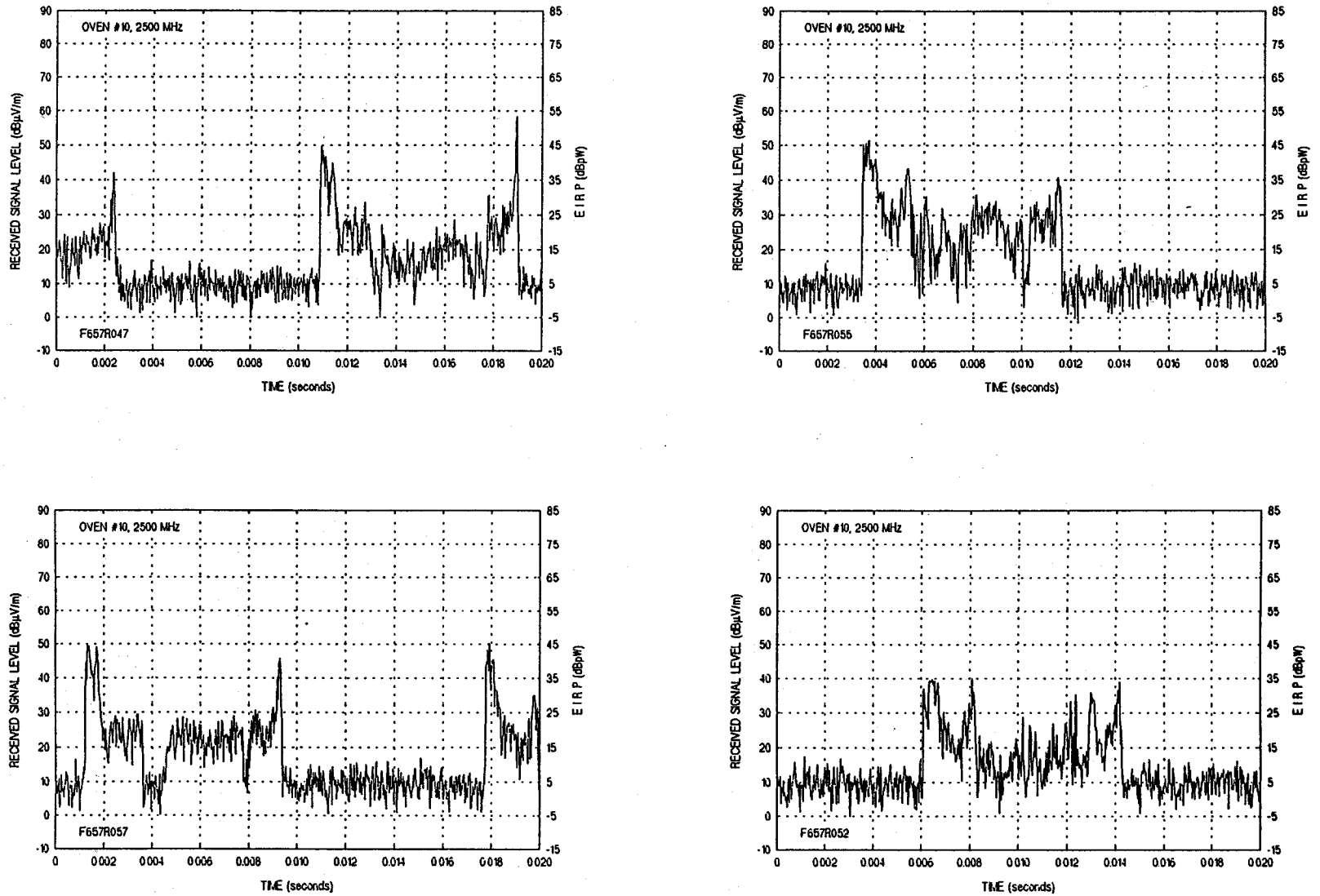


Figure C-79. Oven #10, Time vs. Amplitude displays at 2500 MHz with 30 kHz bandwidth.

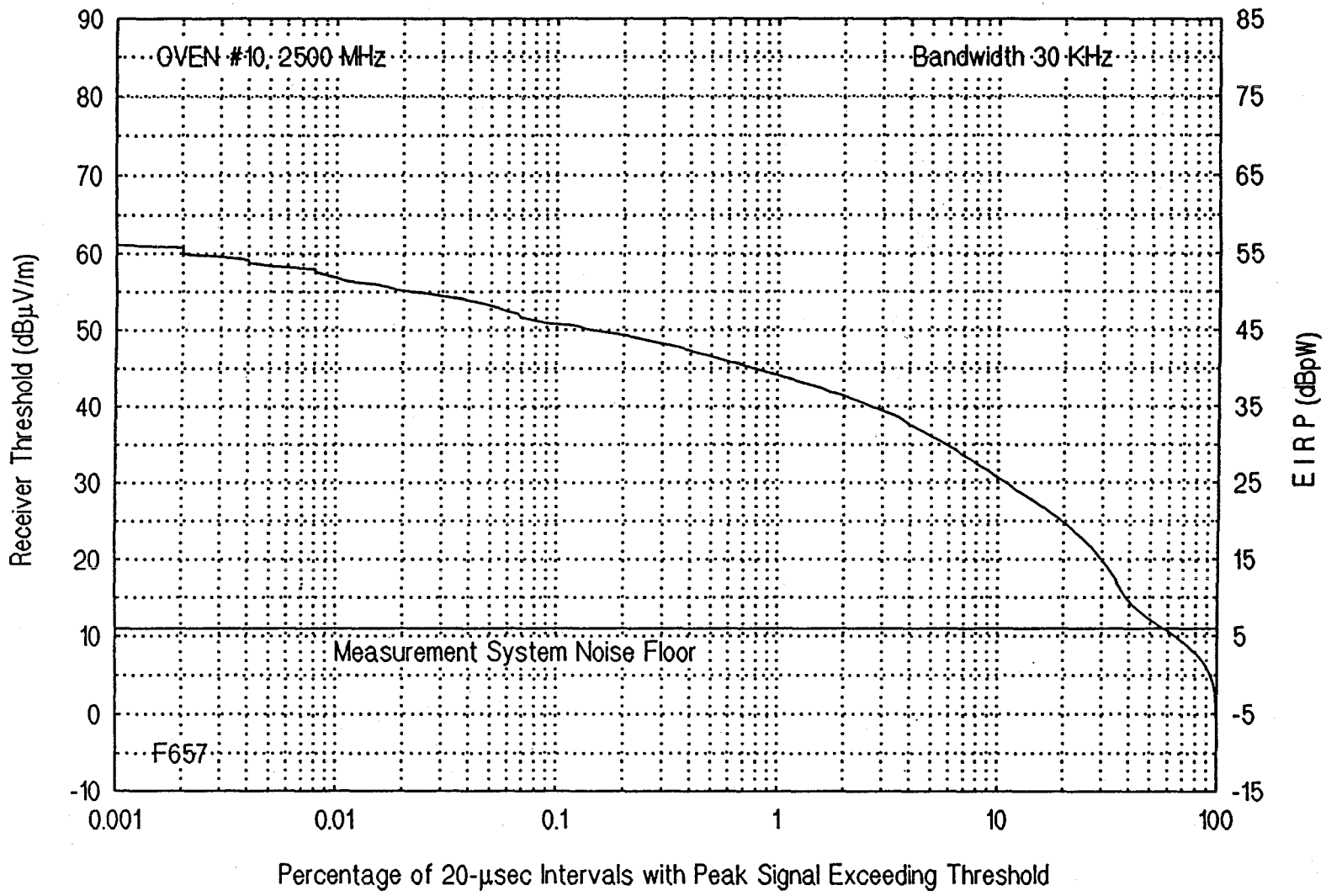


Figure C-80. Oven #10, Amplitude-Probability Distribution at 2500 MHz with 30 kHz bandwidth.

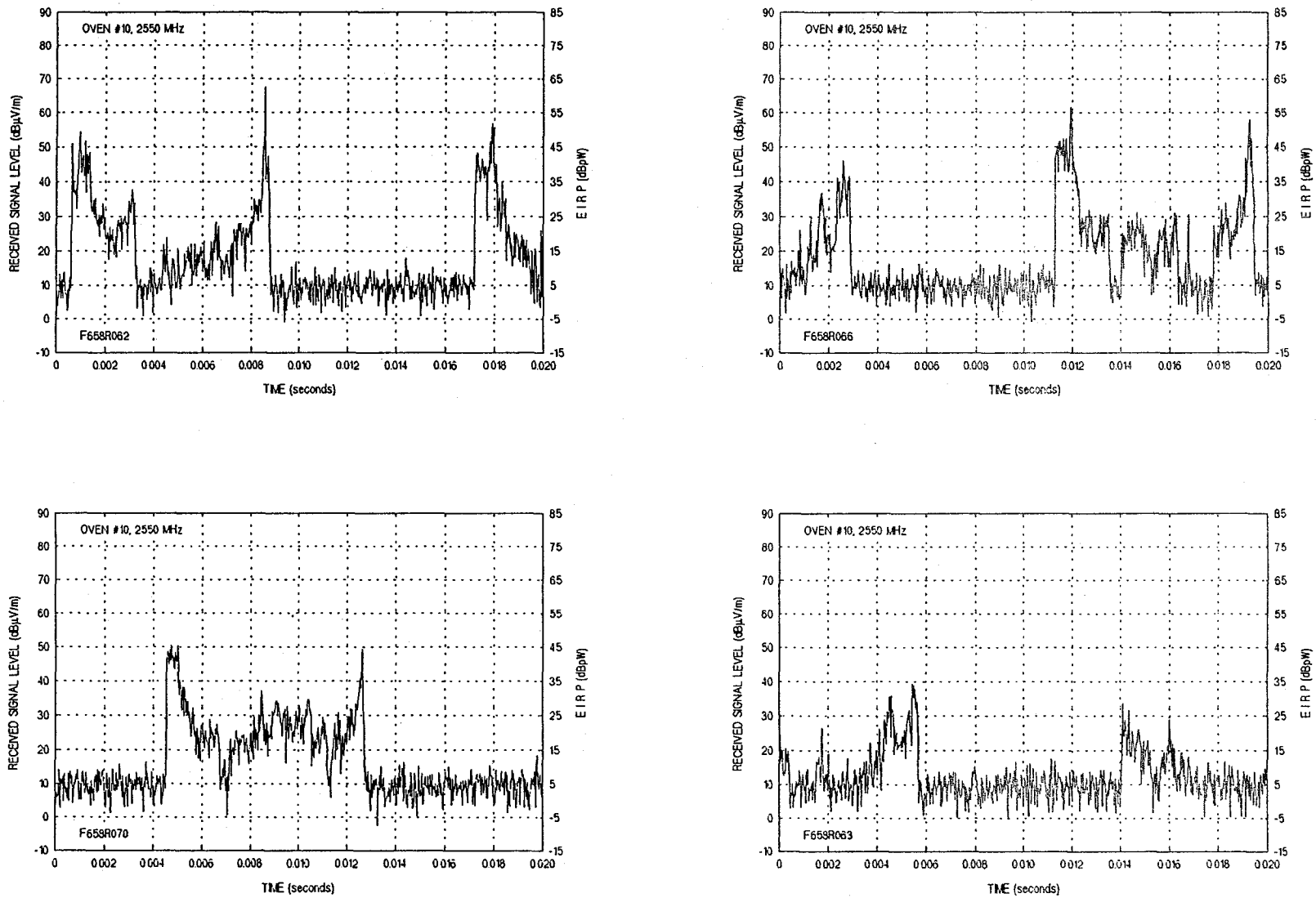


Figure C-81. Oven #10, Time vs. Amplitude displays at 2550 MHz with 30 kHz bandwidth.

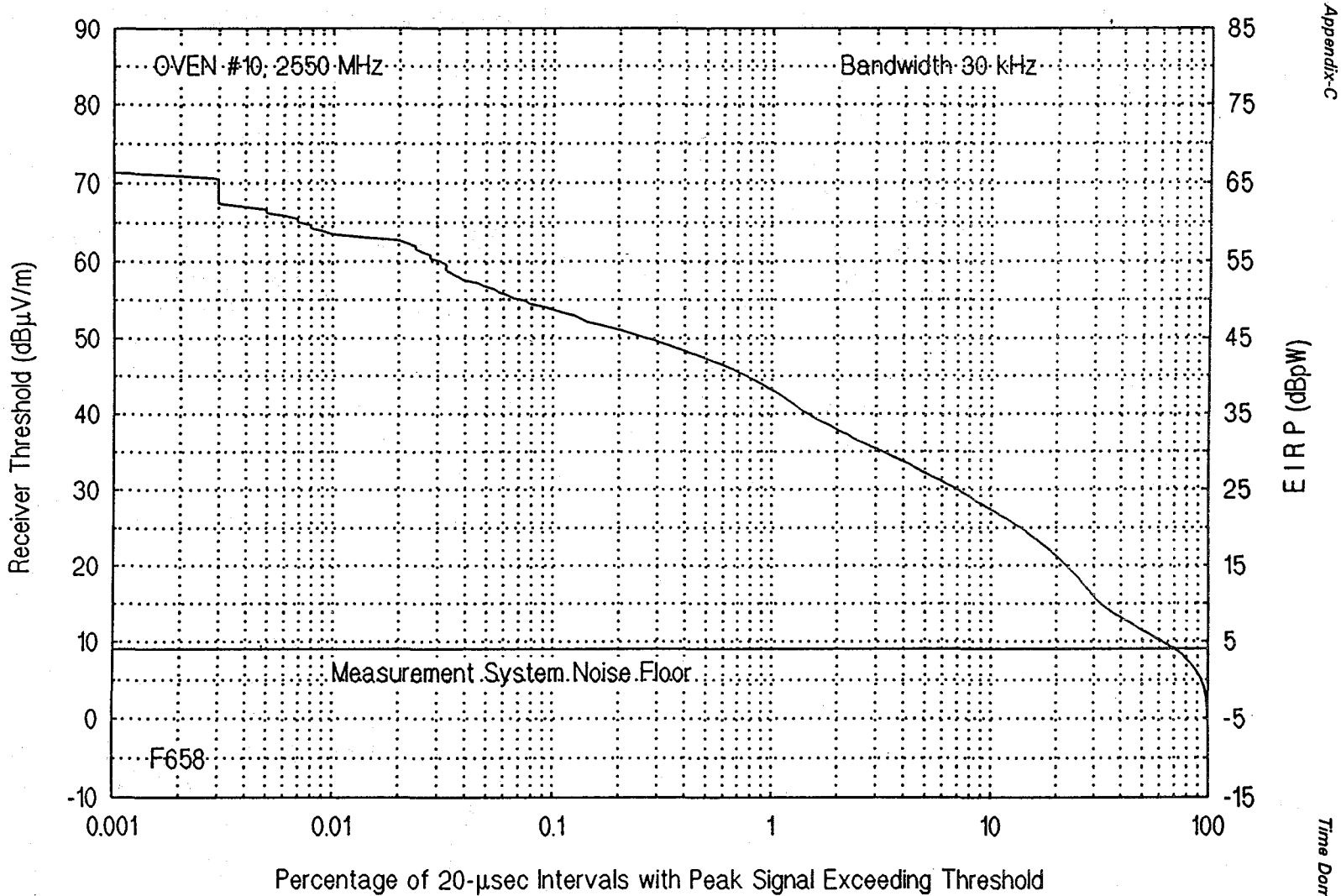


Figure C-82. Oven #10, Amplitude-Probability Distribution at 2550 MHz with 30 kHz bandwidth.

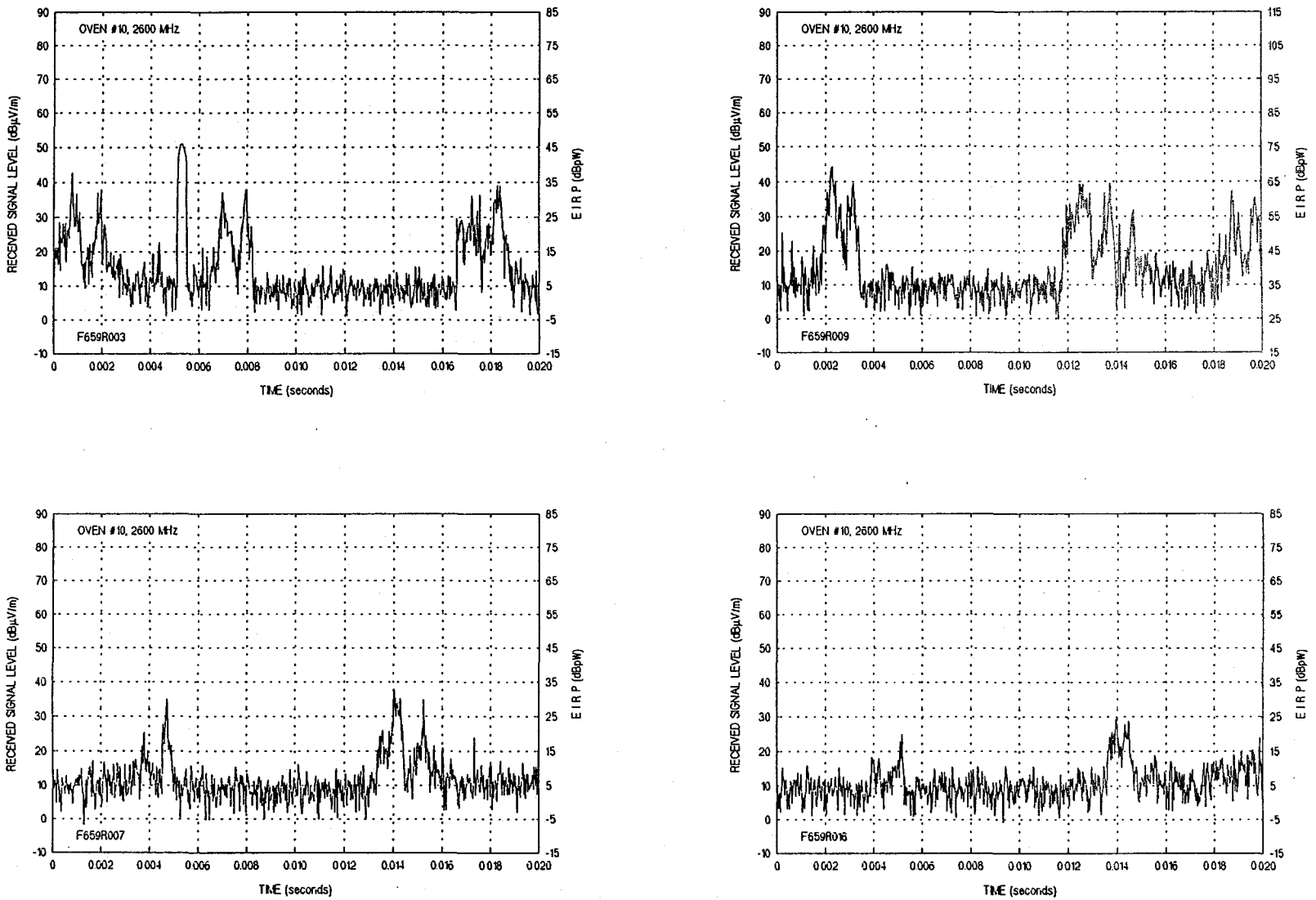


Figure C-83. Oven #10, Time vs. Amplitude displays at 2600 MHz with 30 kHz bandwidth.

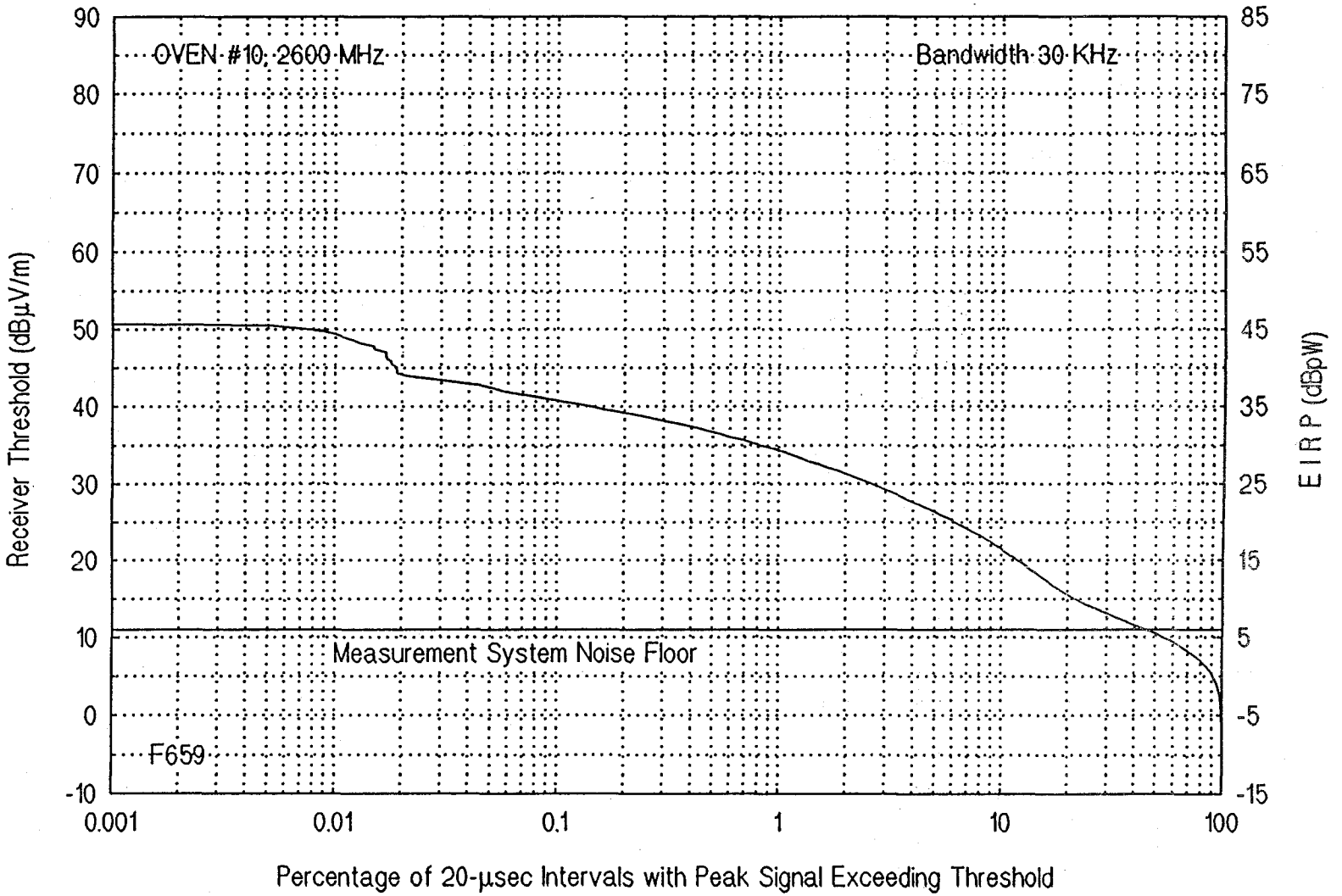


Figure C-84. Oven #10, Amplitude-Probability Distribution at 2600 MHz with 30 kHz bandwidth.

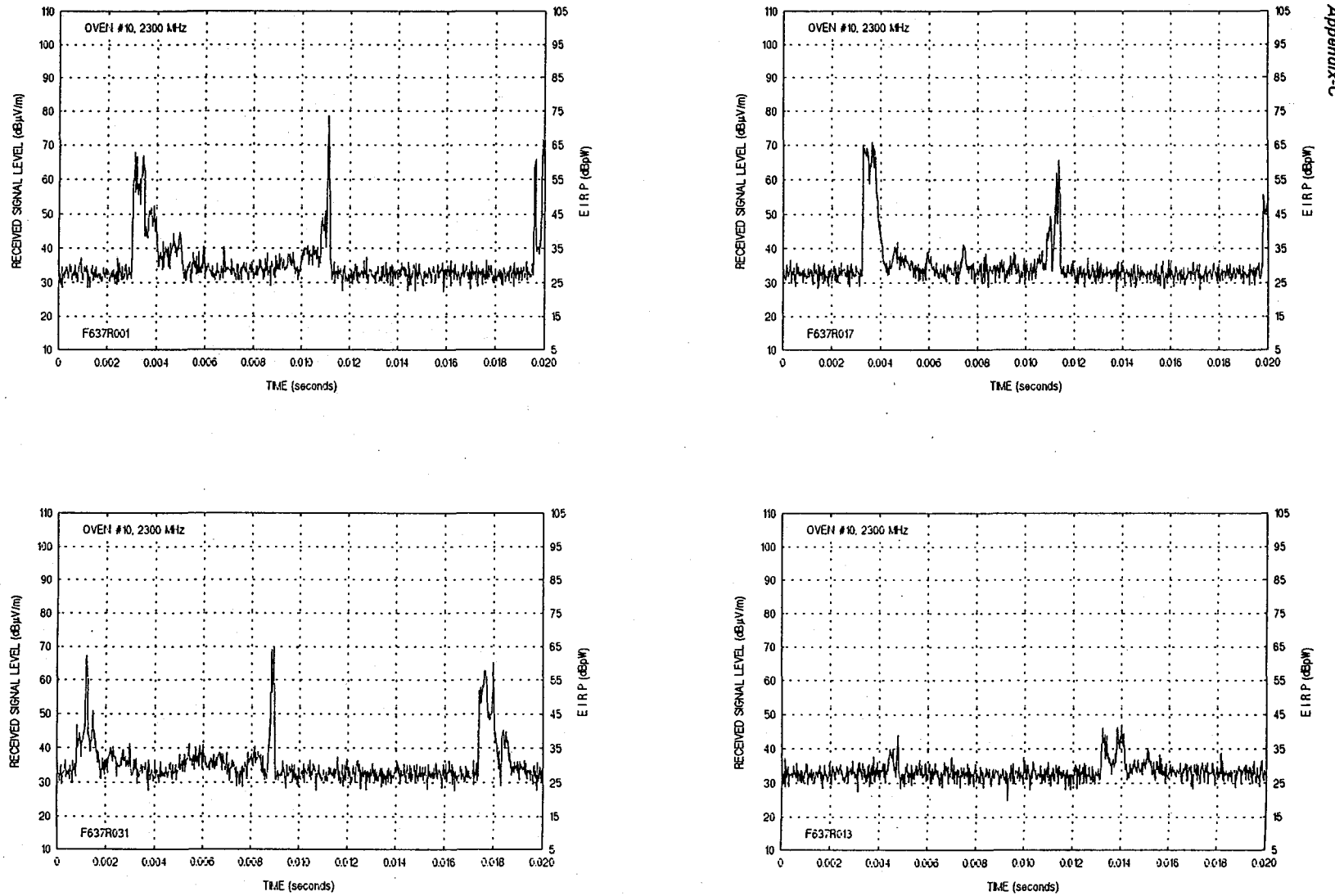


Figure C-85. Oven #10, Time vs. Amplitude displays at 2300 MHz with 300 kHz bandwidth.

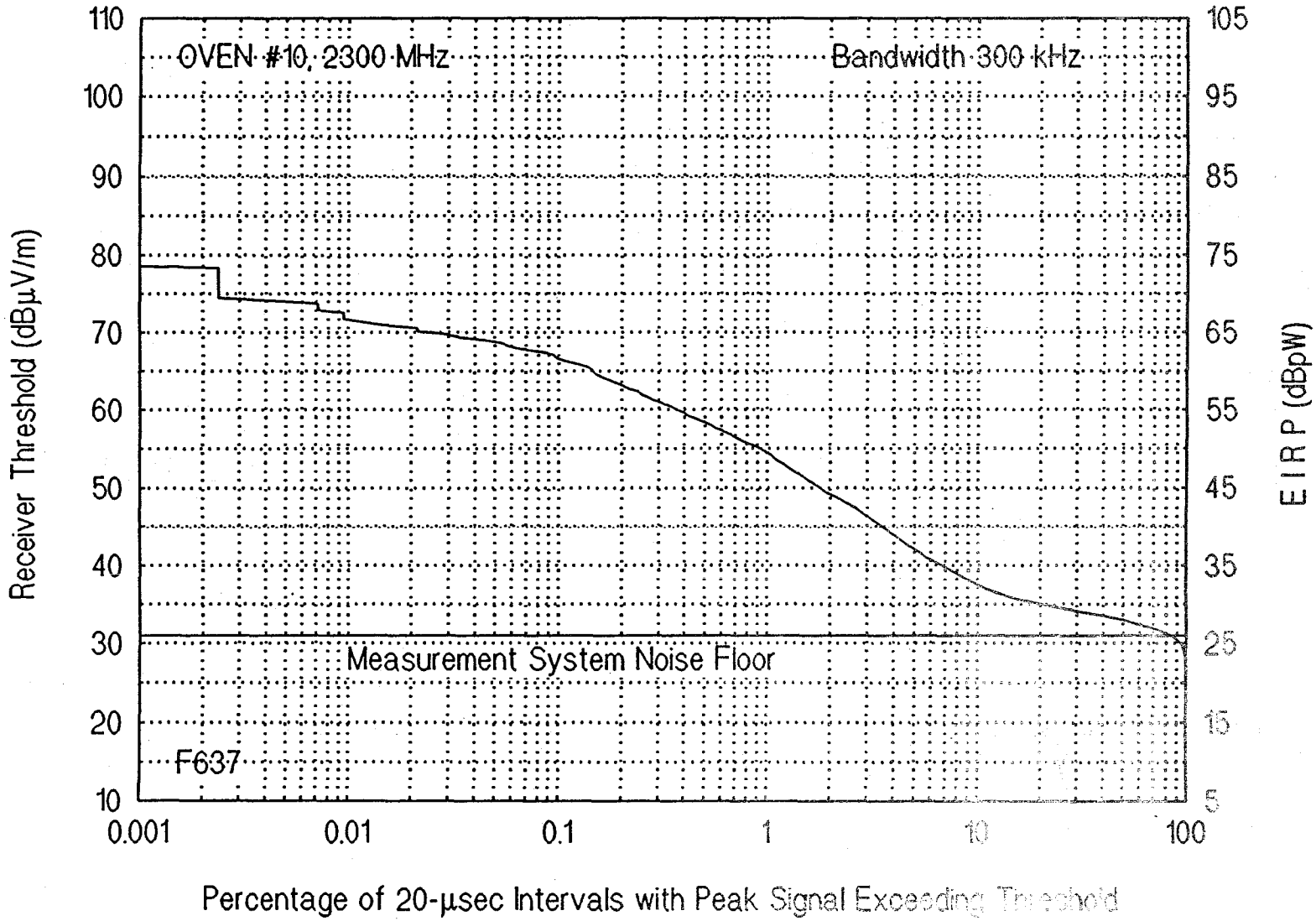


Figure C-86. Oven #10, Amplitude-Probability Distribution at 2300 MHz with 300 kHz bandwidth.

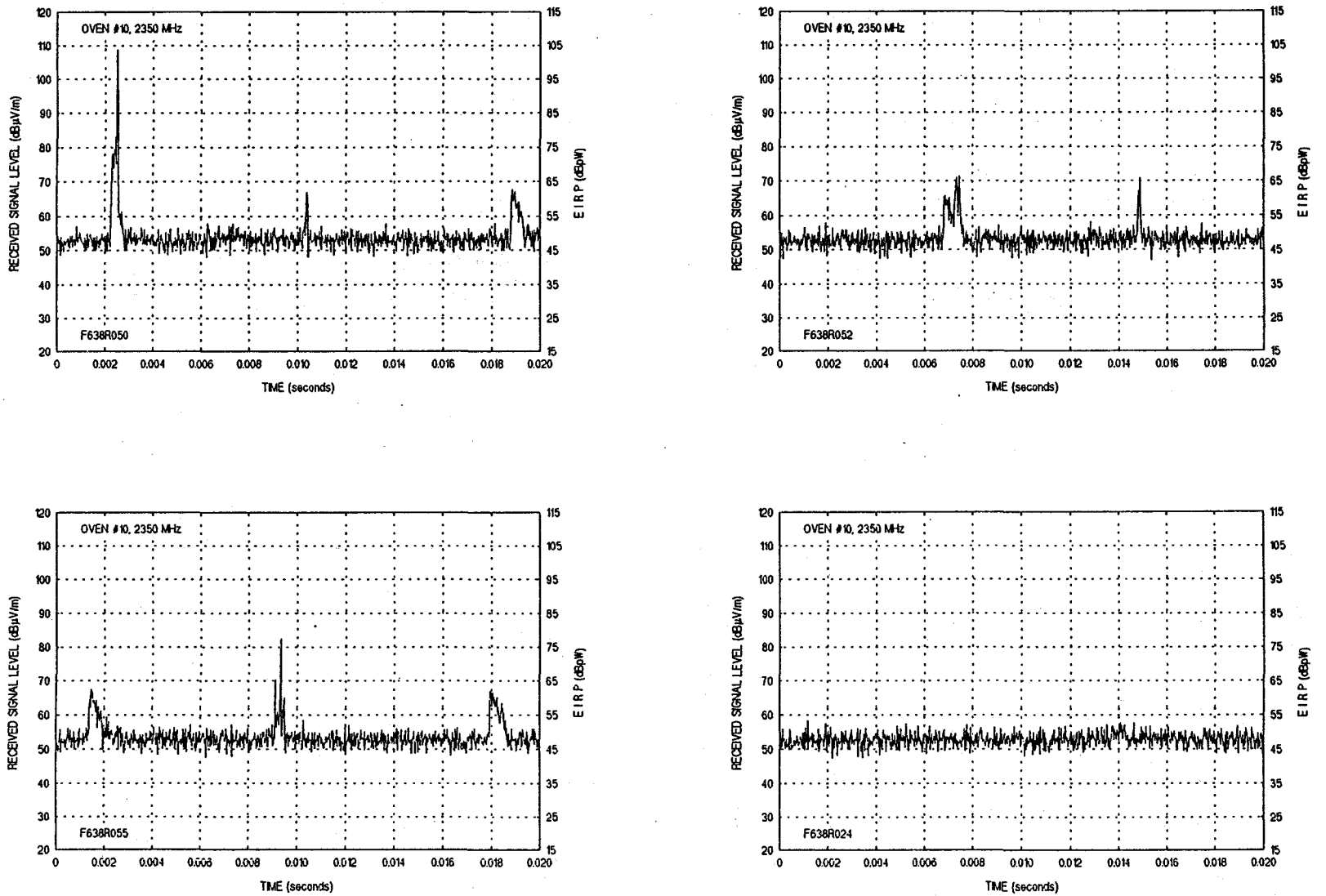


Figure C-87. Oven #10, Time vs. Amplitude displays at 2350 MHz with 300 kHz bandwidth.

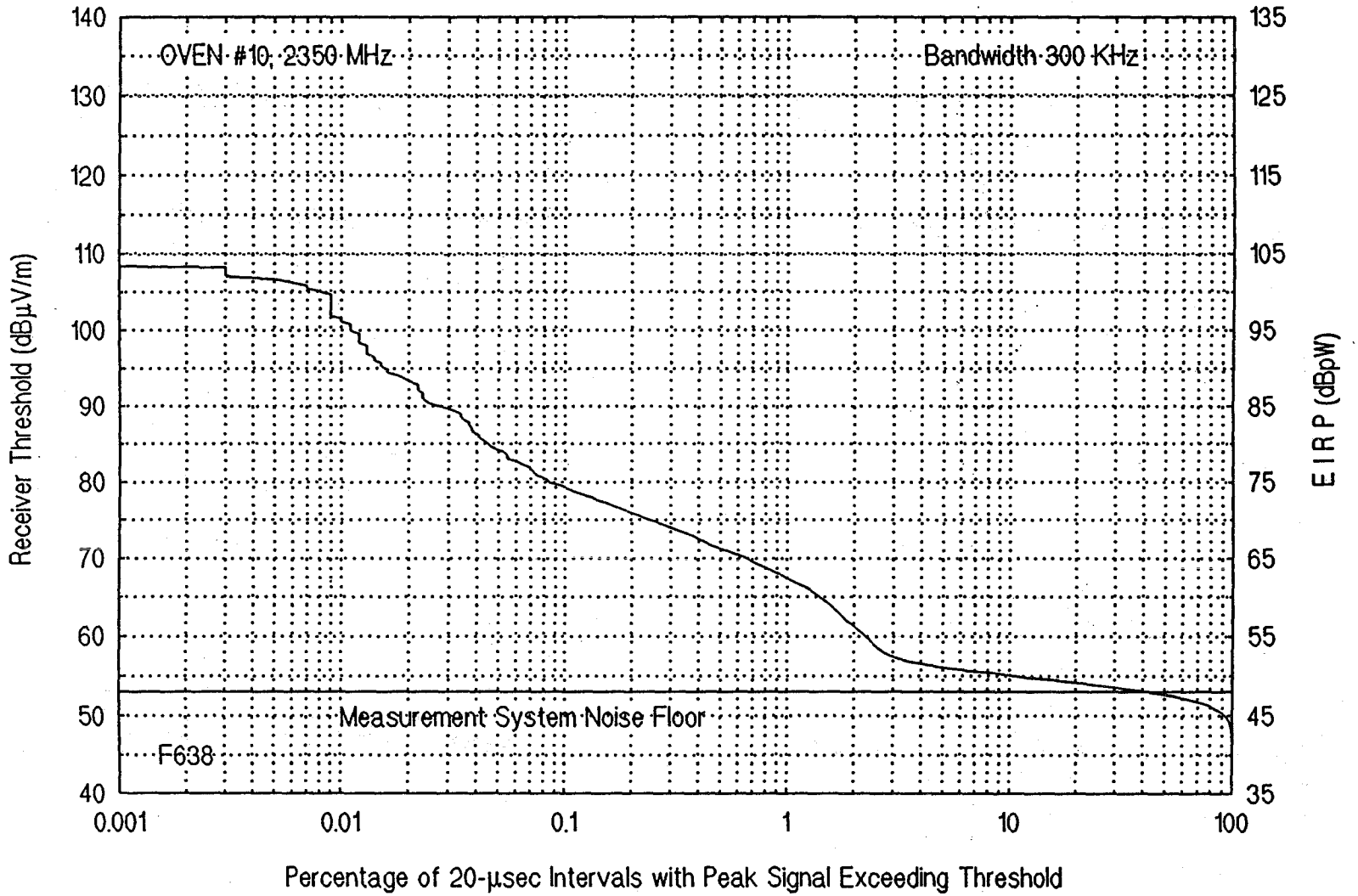
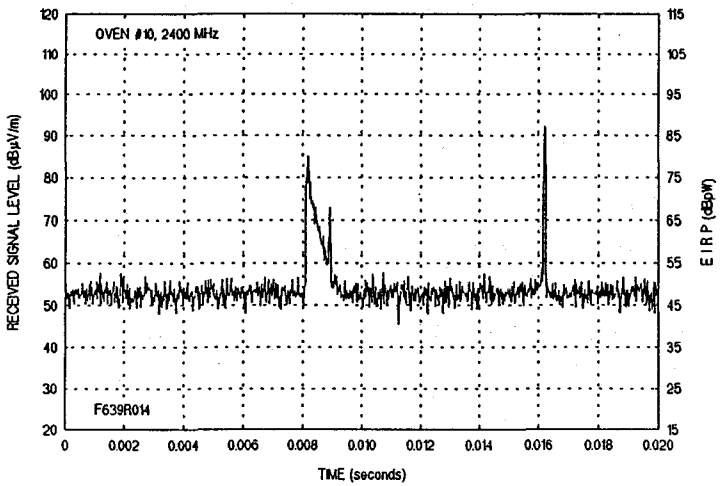
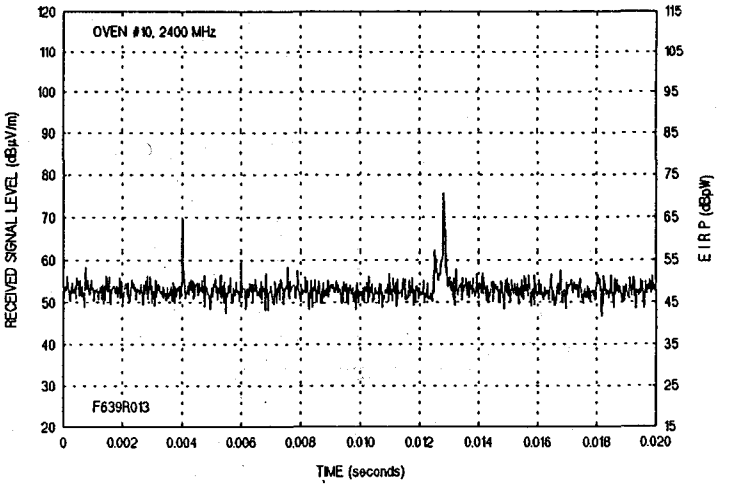
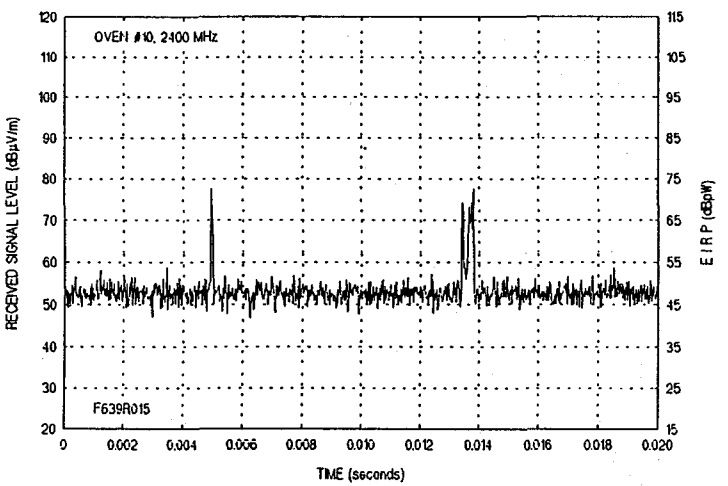


Figure C-88. Oven #10, Amplitude-Probability Distribution at 2350 MHz with 300 kHz bandwidth.







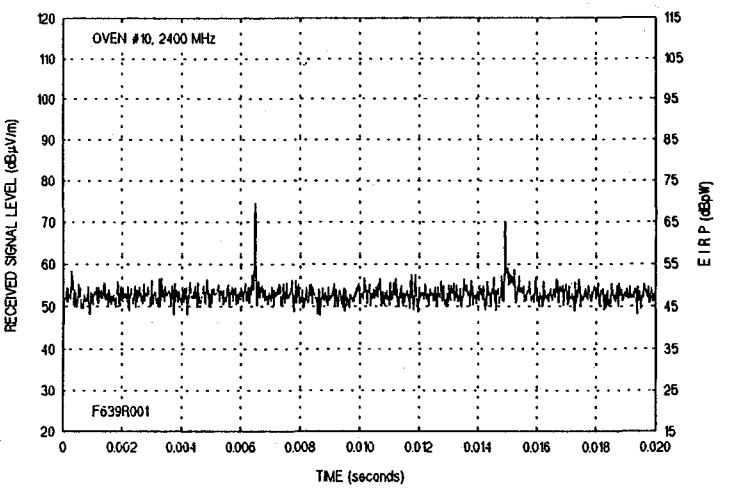


Figure C-89. Oven #10, Time vs. Amplitude displays at 2400 MHz with 300 kHz bandwidth.

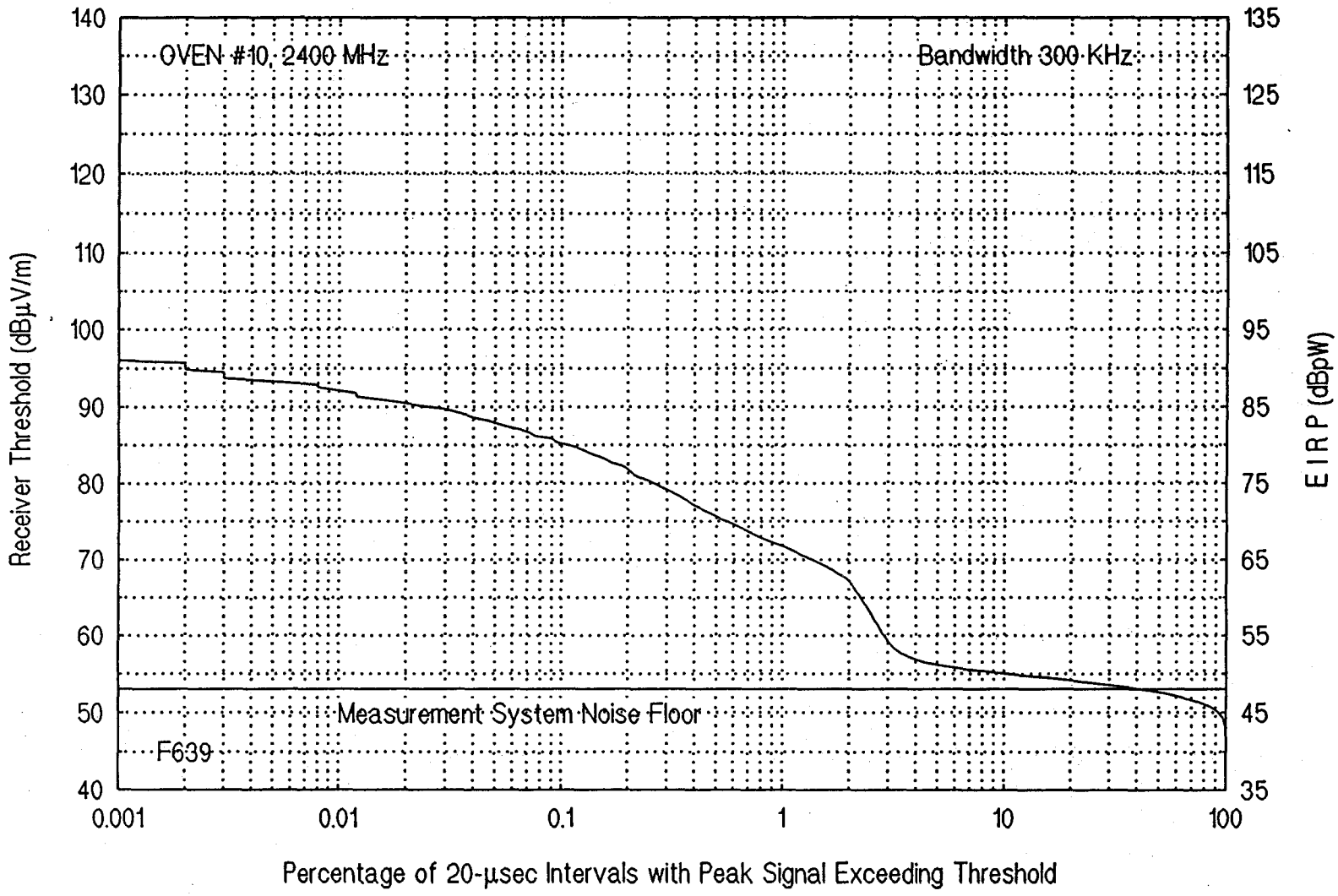


Figure C-90. Oven #10, Amplitude-Probability Distribution at 2400 MHz with 300 kHz bandwidth.

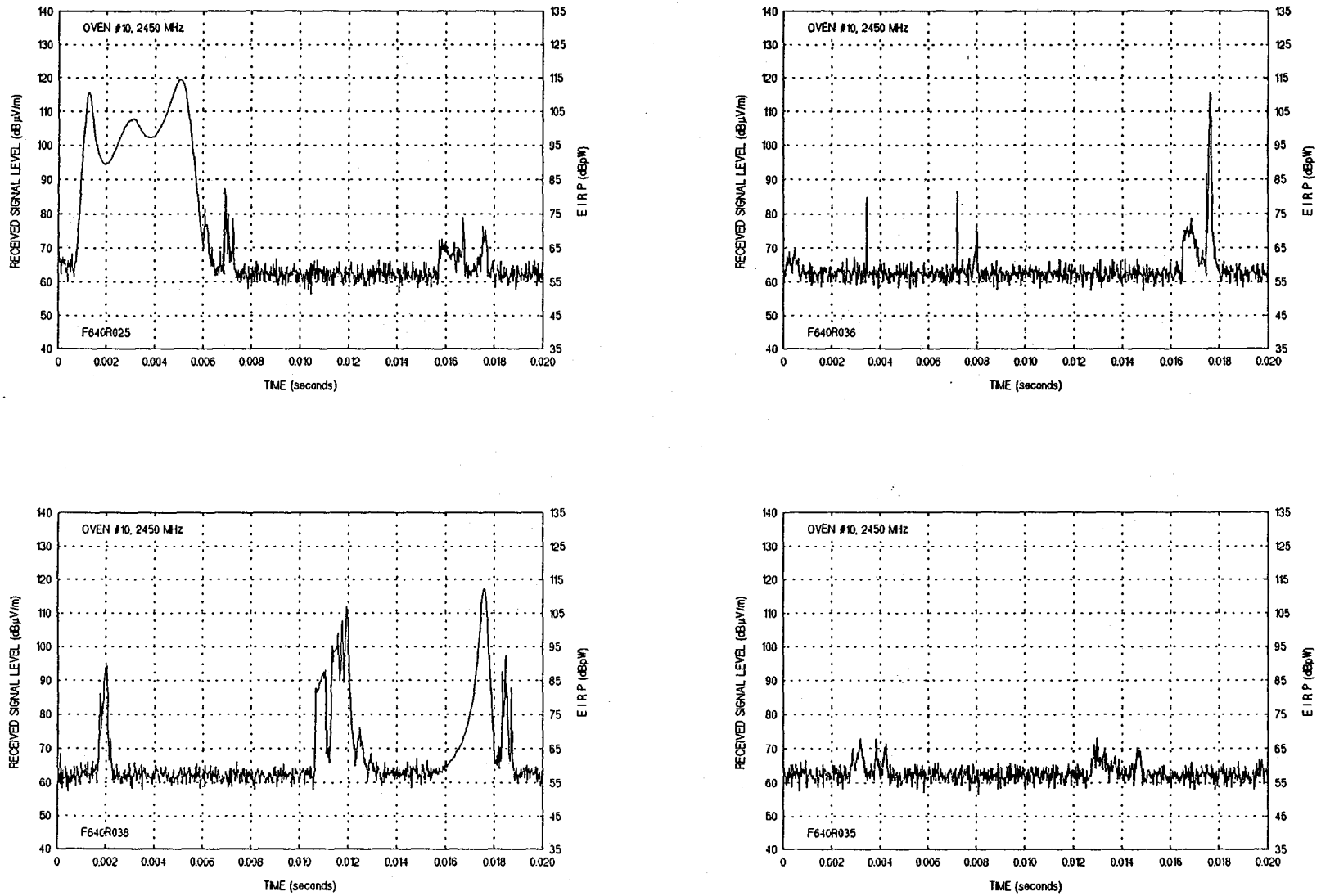


Figure C-91. Oven #10, Time vs. Amplitude displays at 2450 MHz with 300 kHz bandwidth.

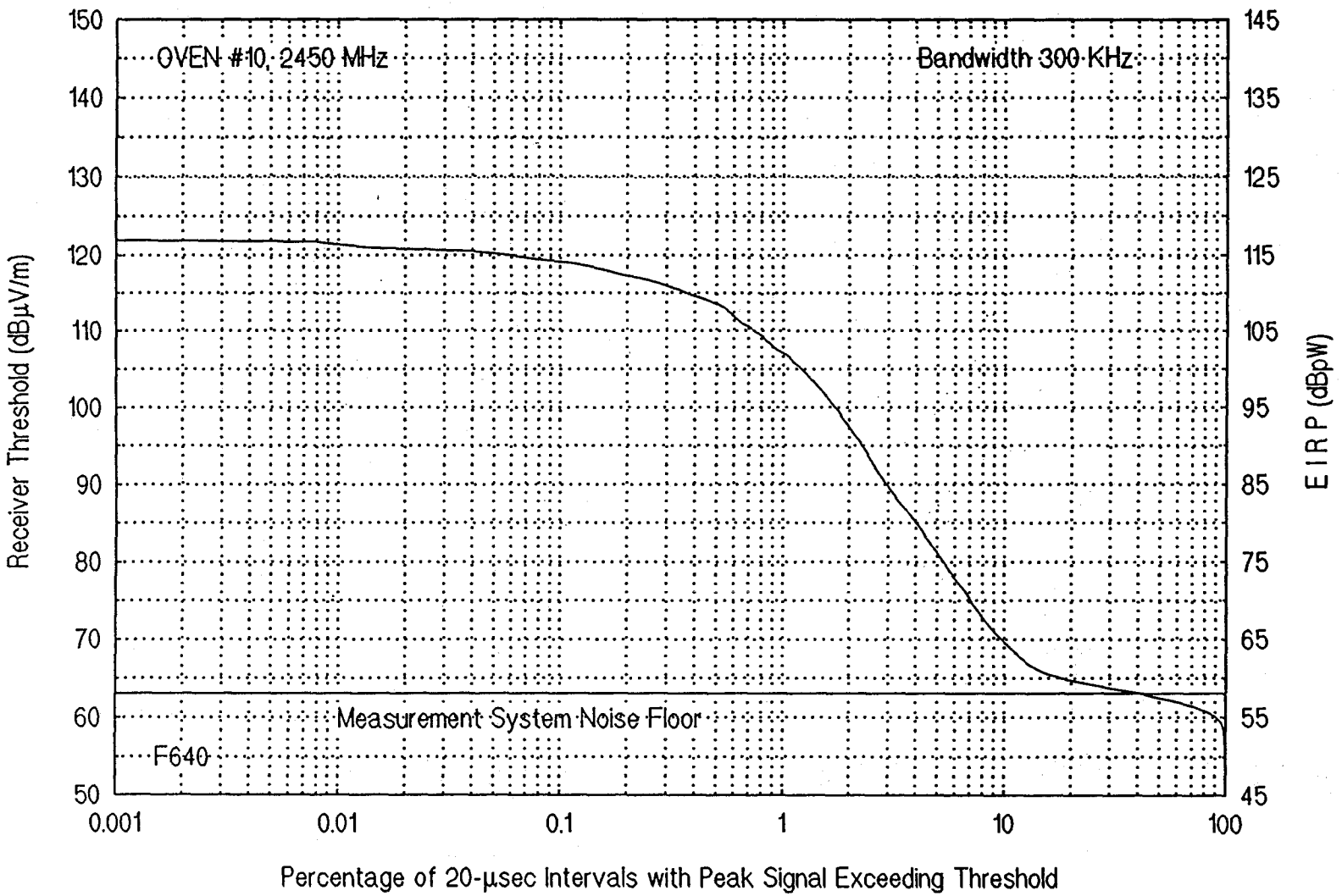


Figure C-92. Oven #10, Amplitude-Probability Distribution at 2450 MHz with 300 kHz bandwidth.

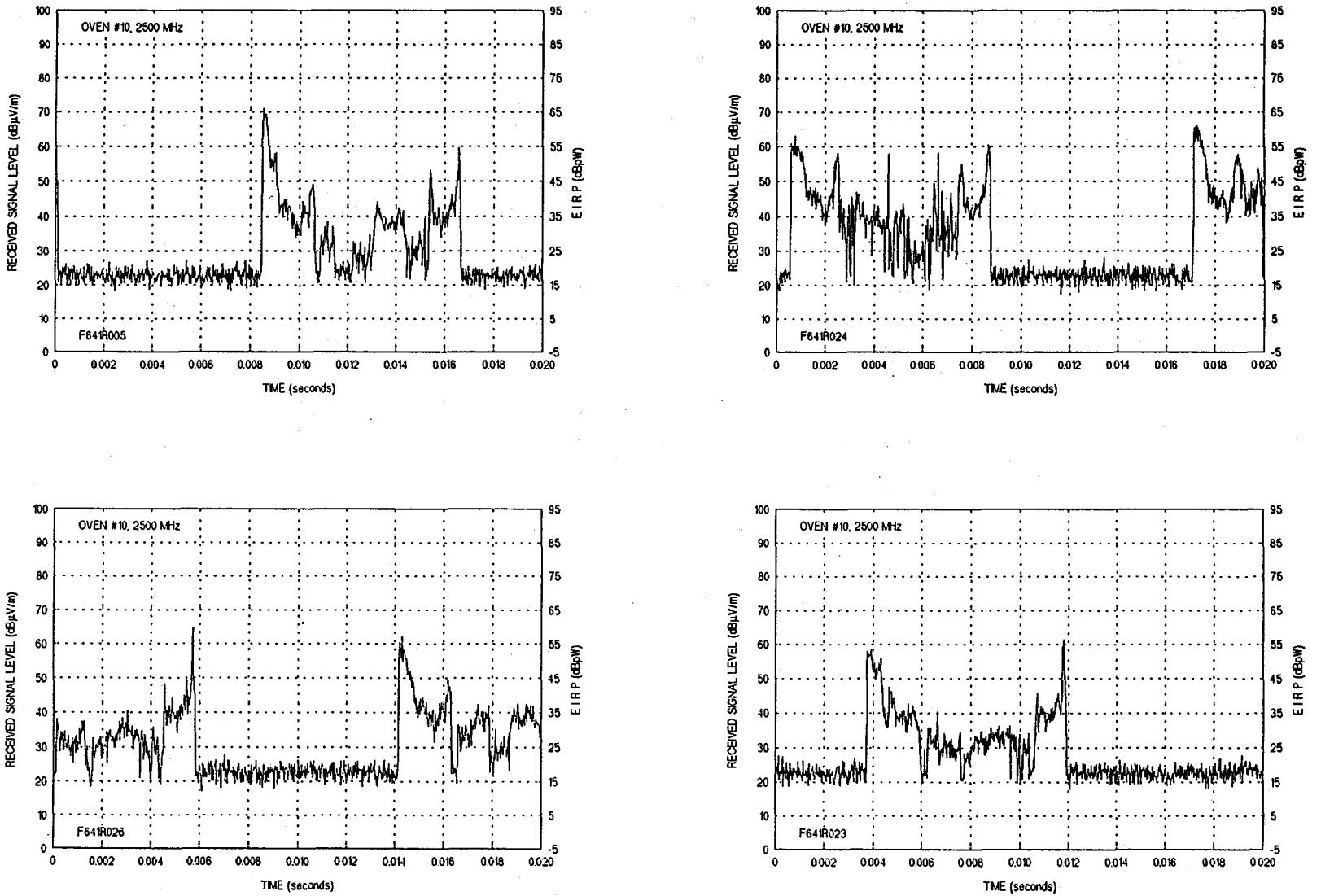


Figure C-93. Oven #10, Time vs. Amplitude displays at 2500 MHz with 300 kHz bandwidth.

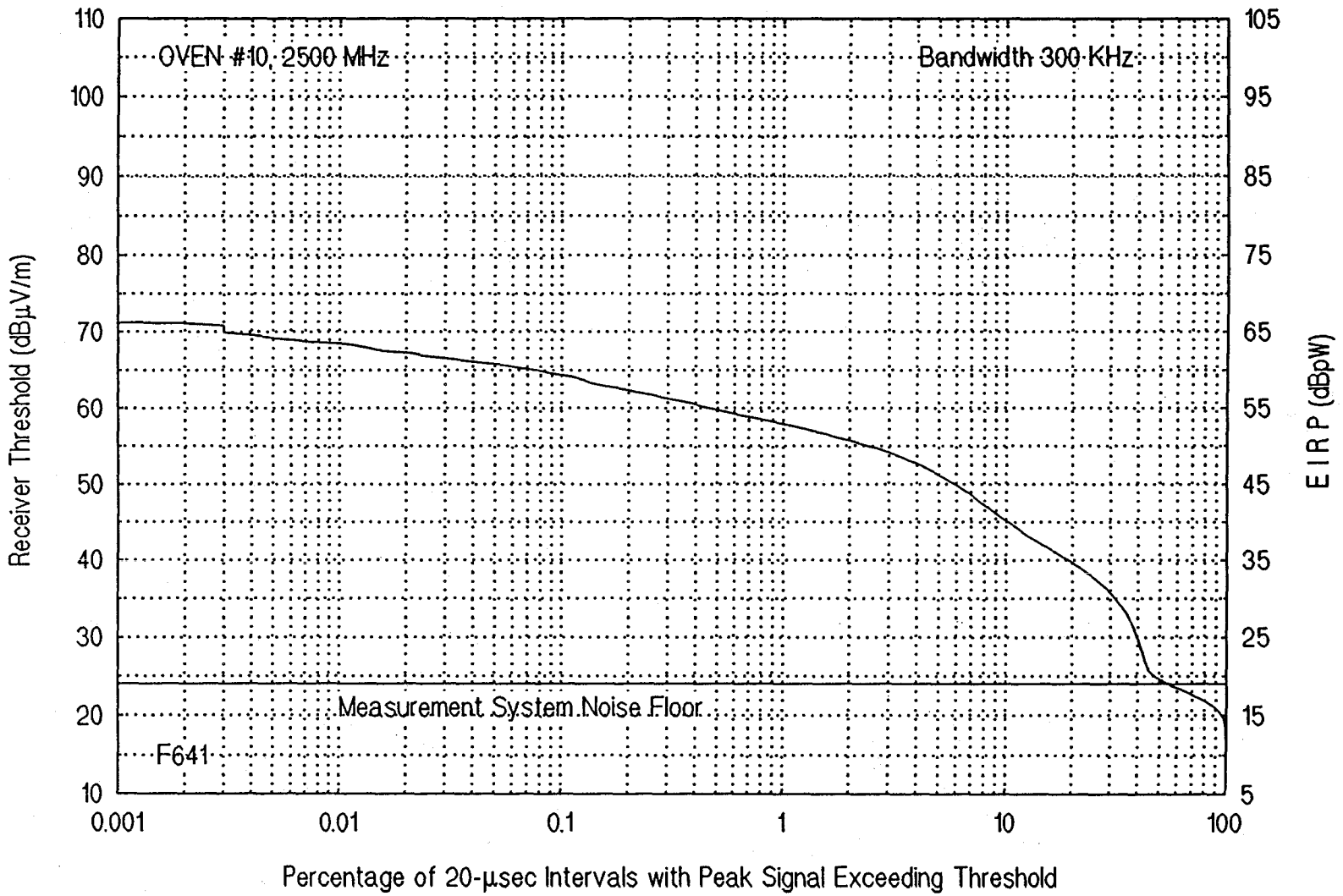


Figure C-94. Oven #10, Amplitude-Probability Distribution at 2500 MHz with 300 kHz bandwidth.

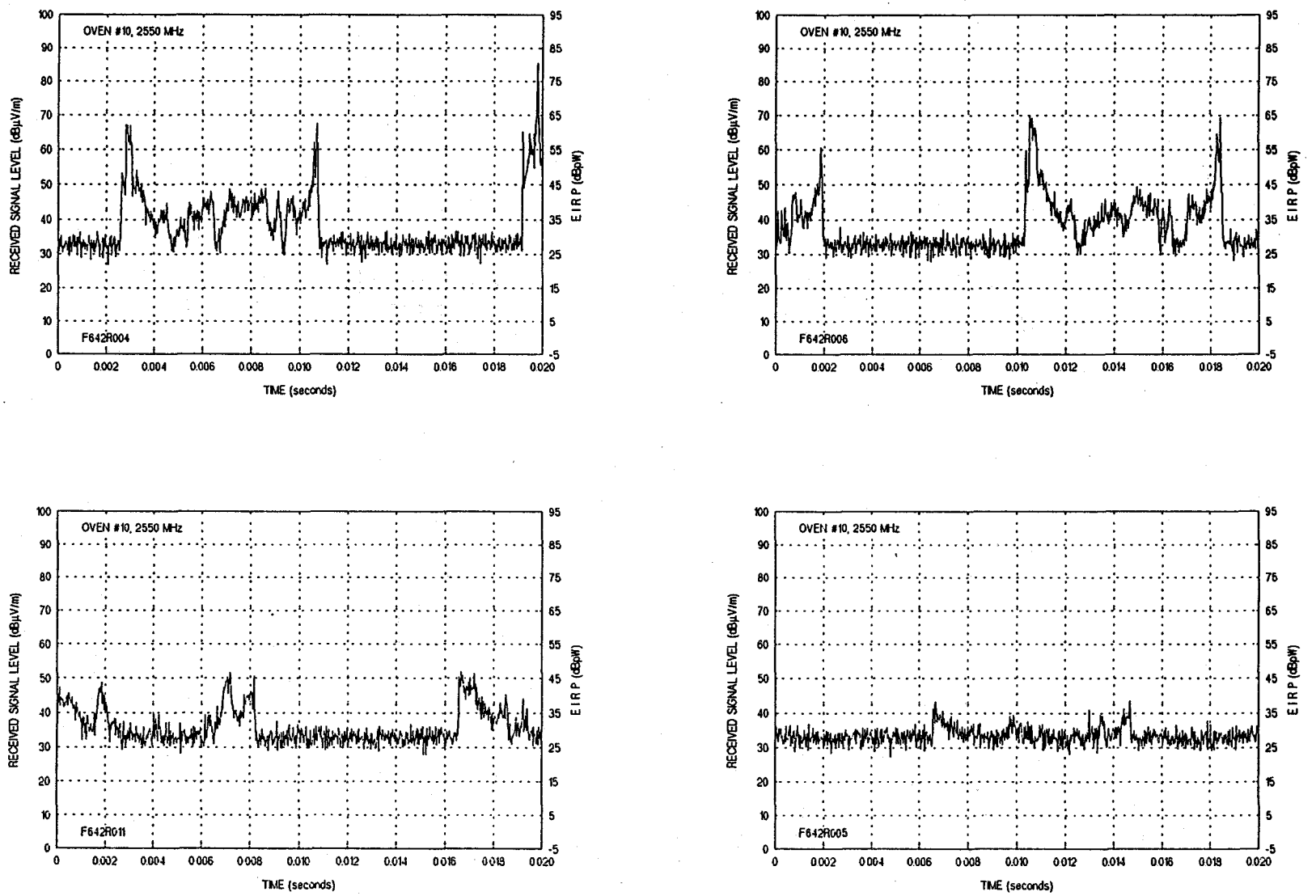


Figure C-95. Oven #10, Time vs. Amplitude displays at 2550 MHz with 300 kHz bandwidth.

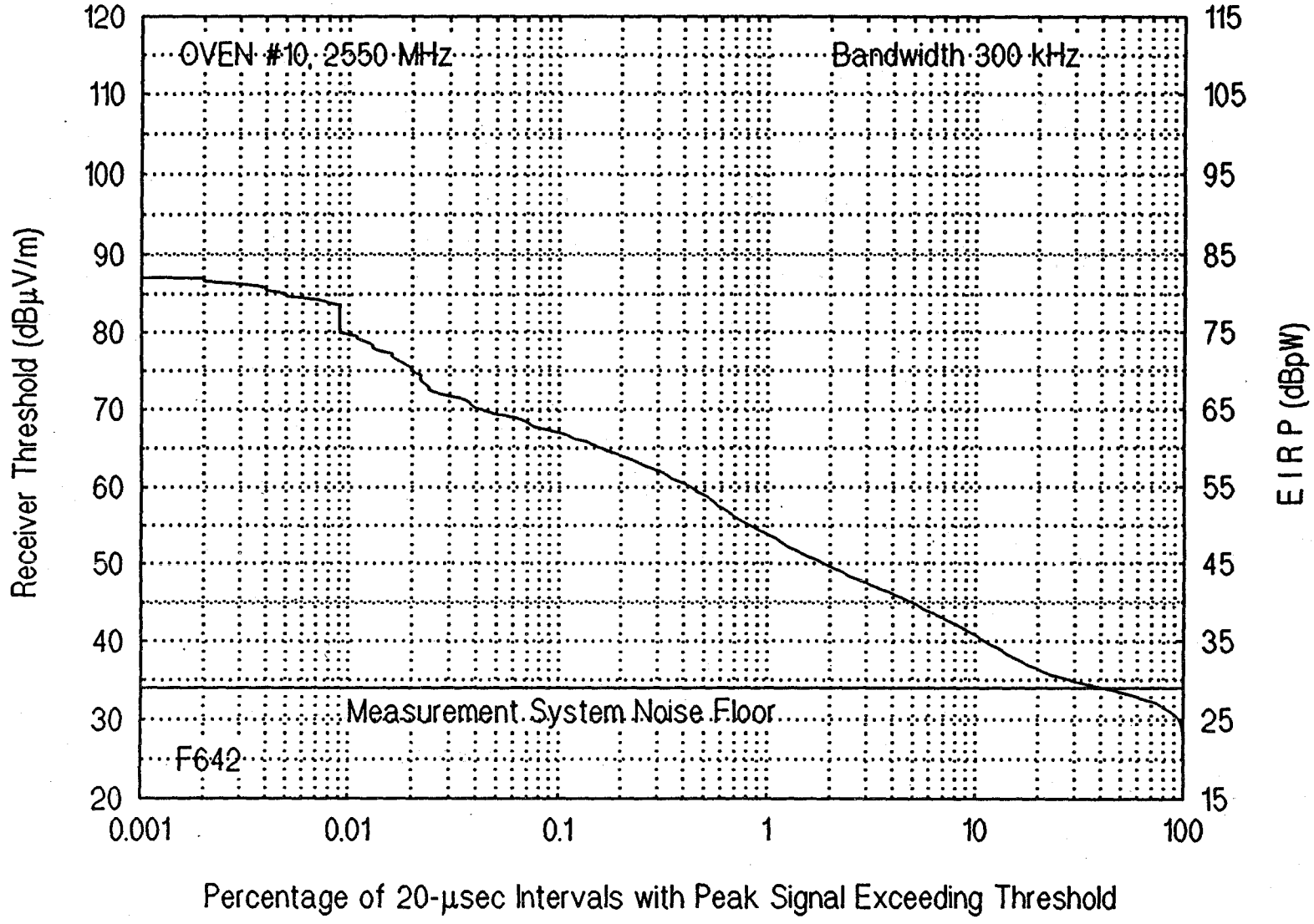


Figure C-96. Oven #10, Amplitude-Probability Distribution at 2550 MHz with 300 kHz bandwidth.

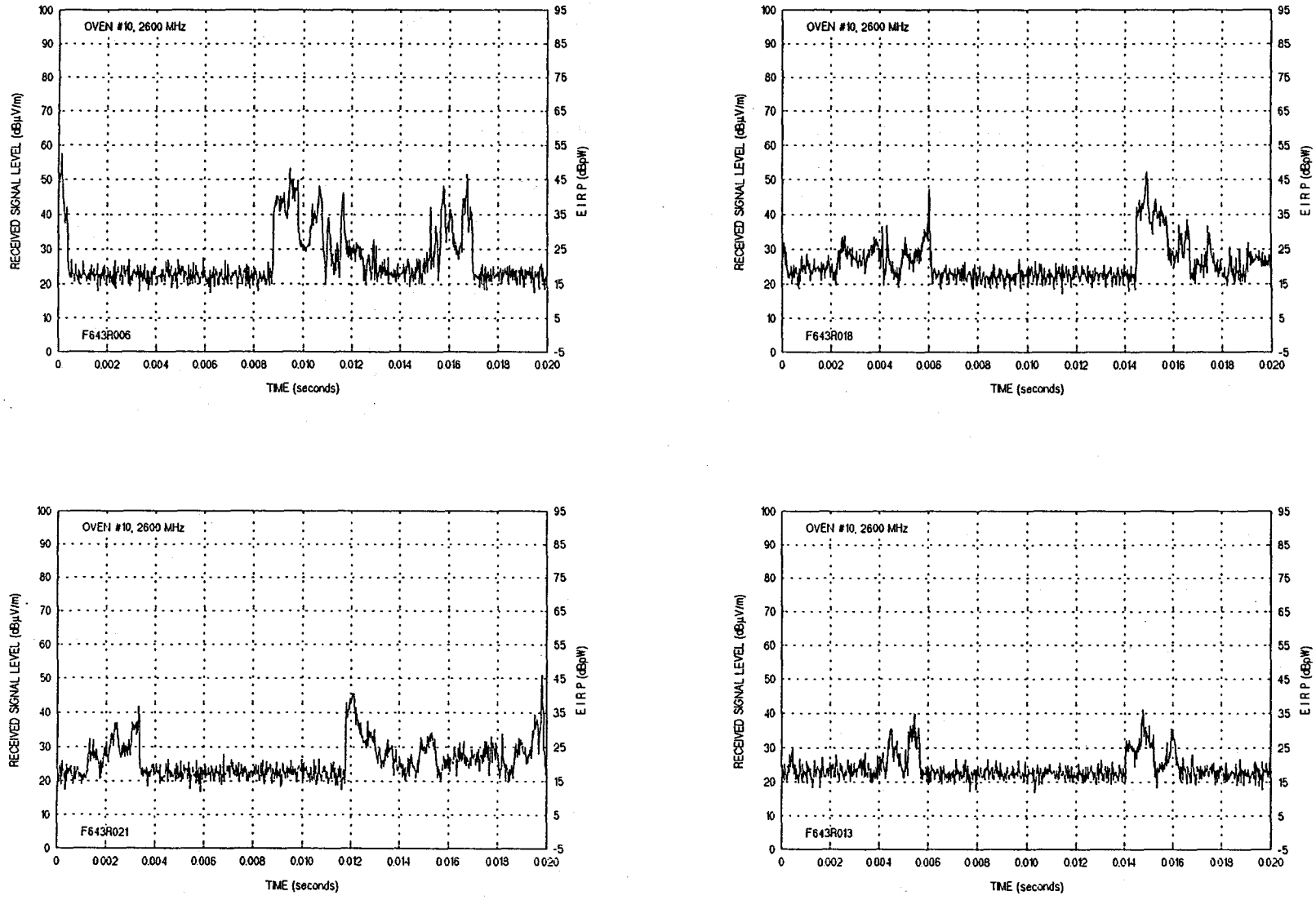


Figure C-97. Oven #10, Time vs. Amplitude displays at 2600 MHz with 300 kHz bandwidth.

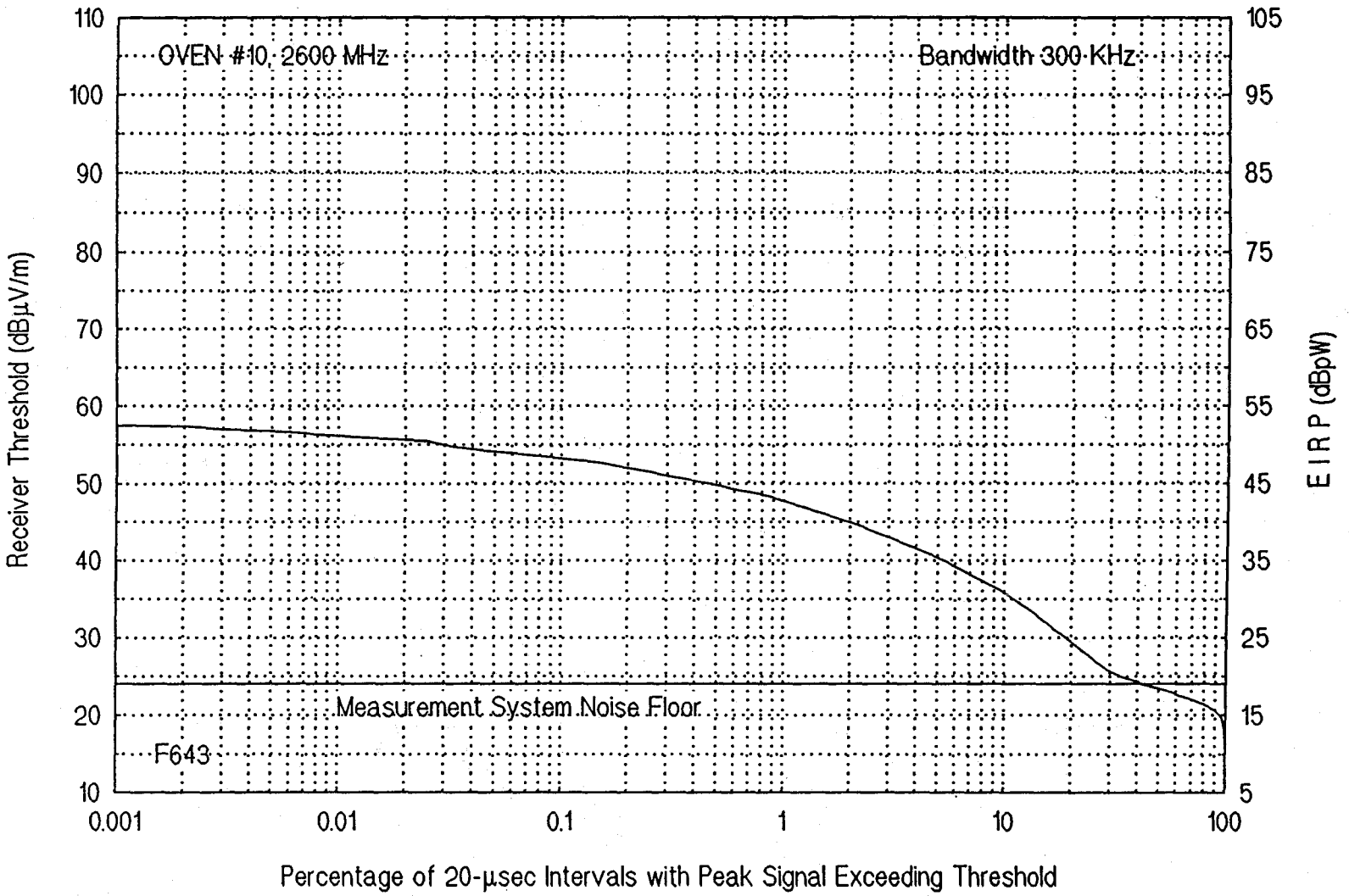


Figure C-98. Oven #10, Amplitude-Probability Distribution at 2600 MHz with 300 kHz bandwidth.

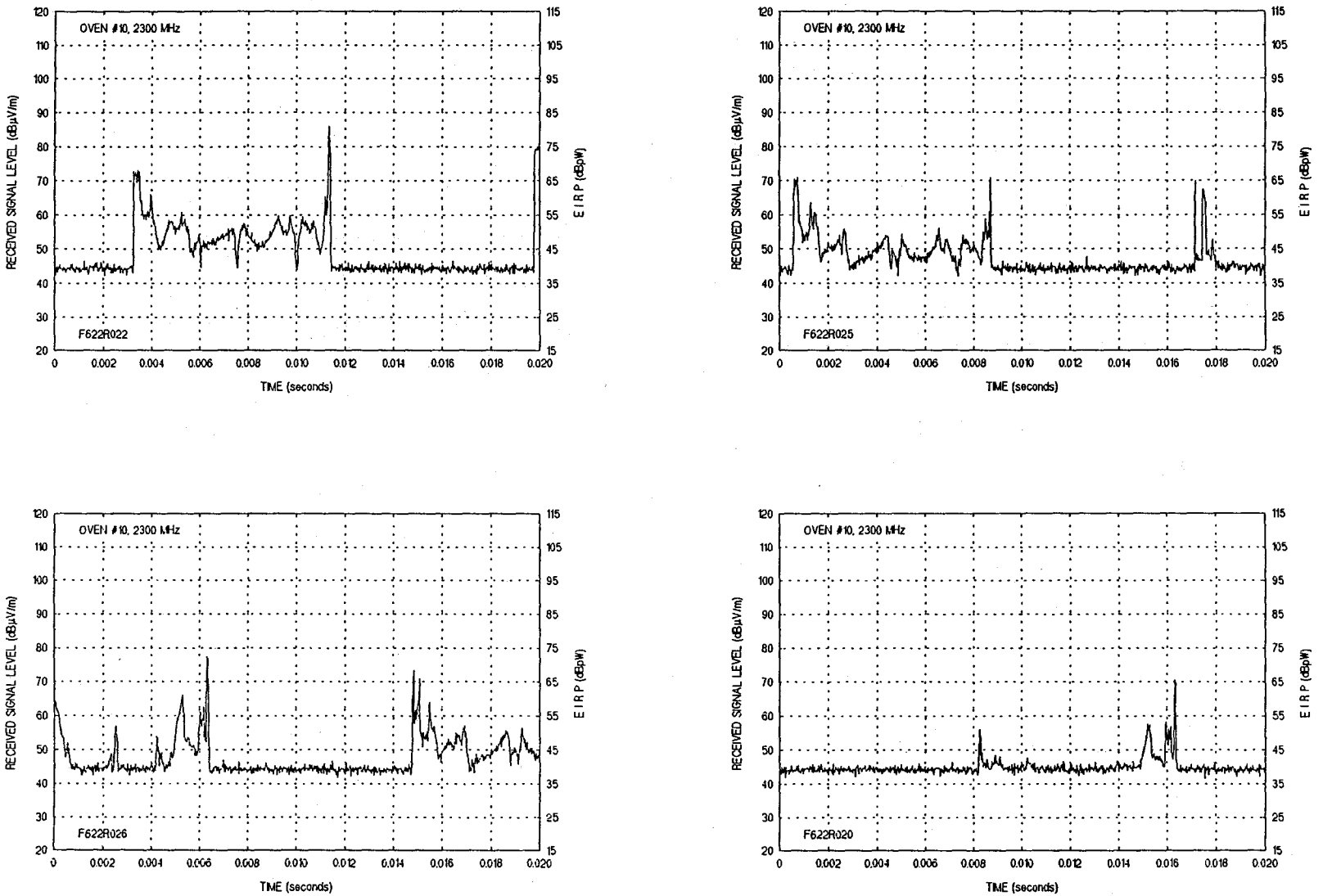


Figure C-99. Oven #10, Time vs. Amplitude displays at 2300 MHz with 3 MHz bandwidth.

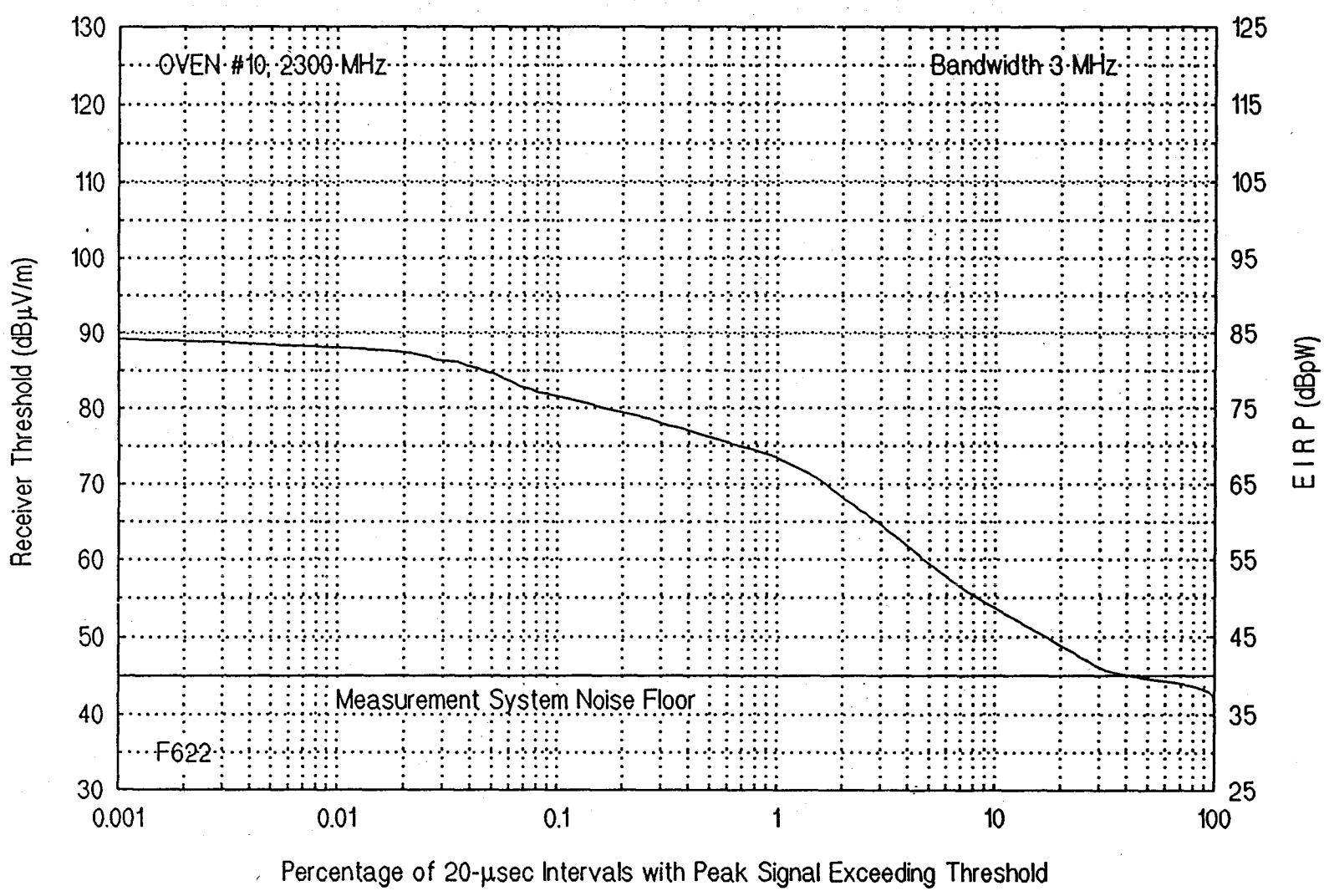


Figure C-100. Oven #10, Amplitude-Probability Distribution at 2300 MHz with 3 MHz bandwidth.

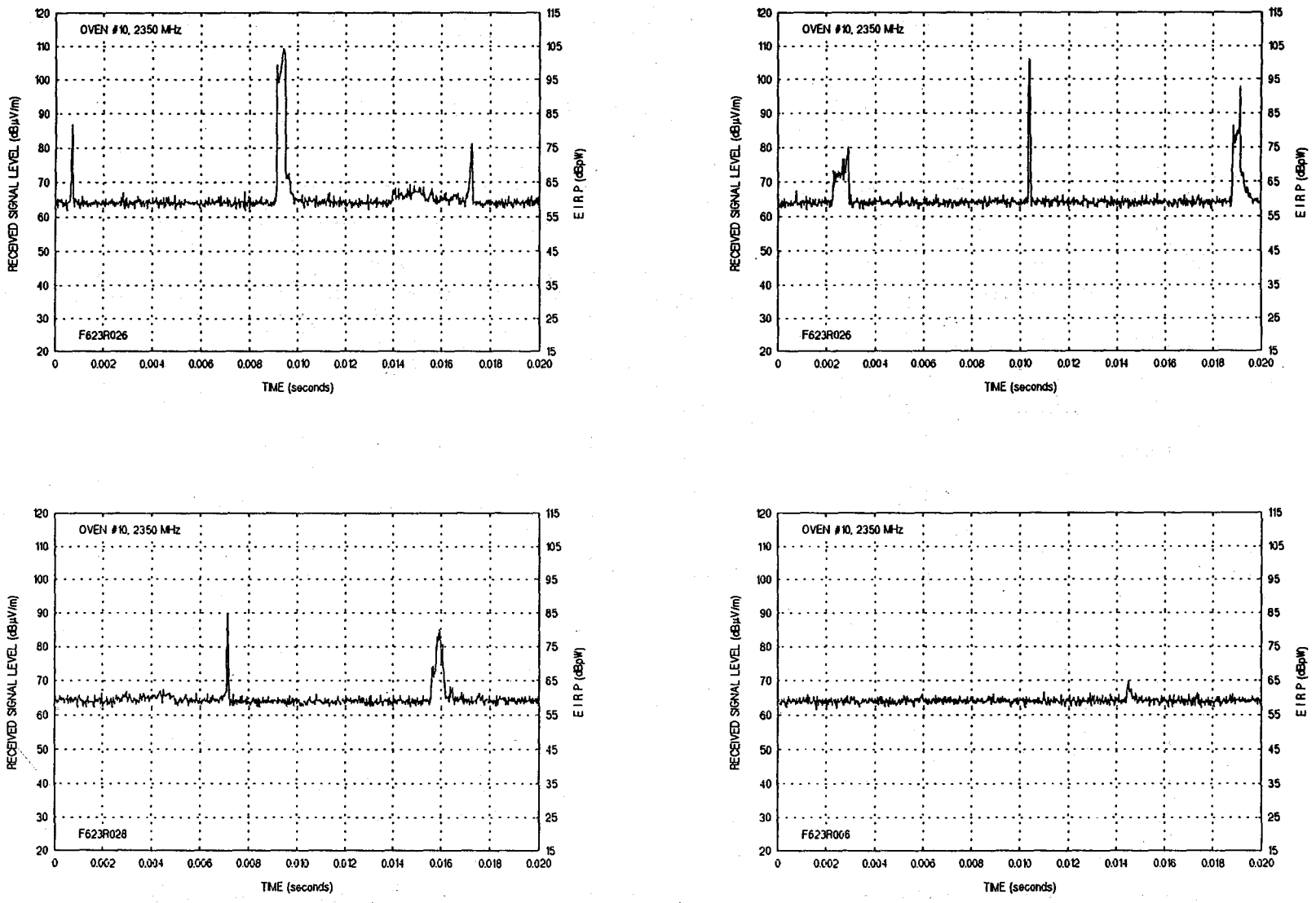


Figure C-101. Oven #10, Time vs. Amplitude displays at 2350 MHz with 3 MHz bandwidth.

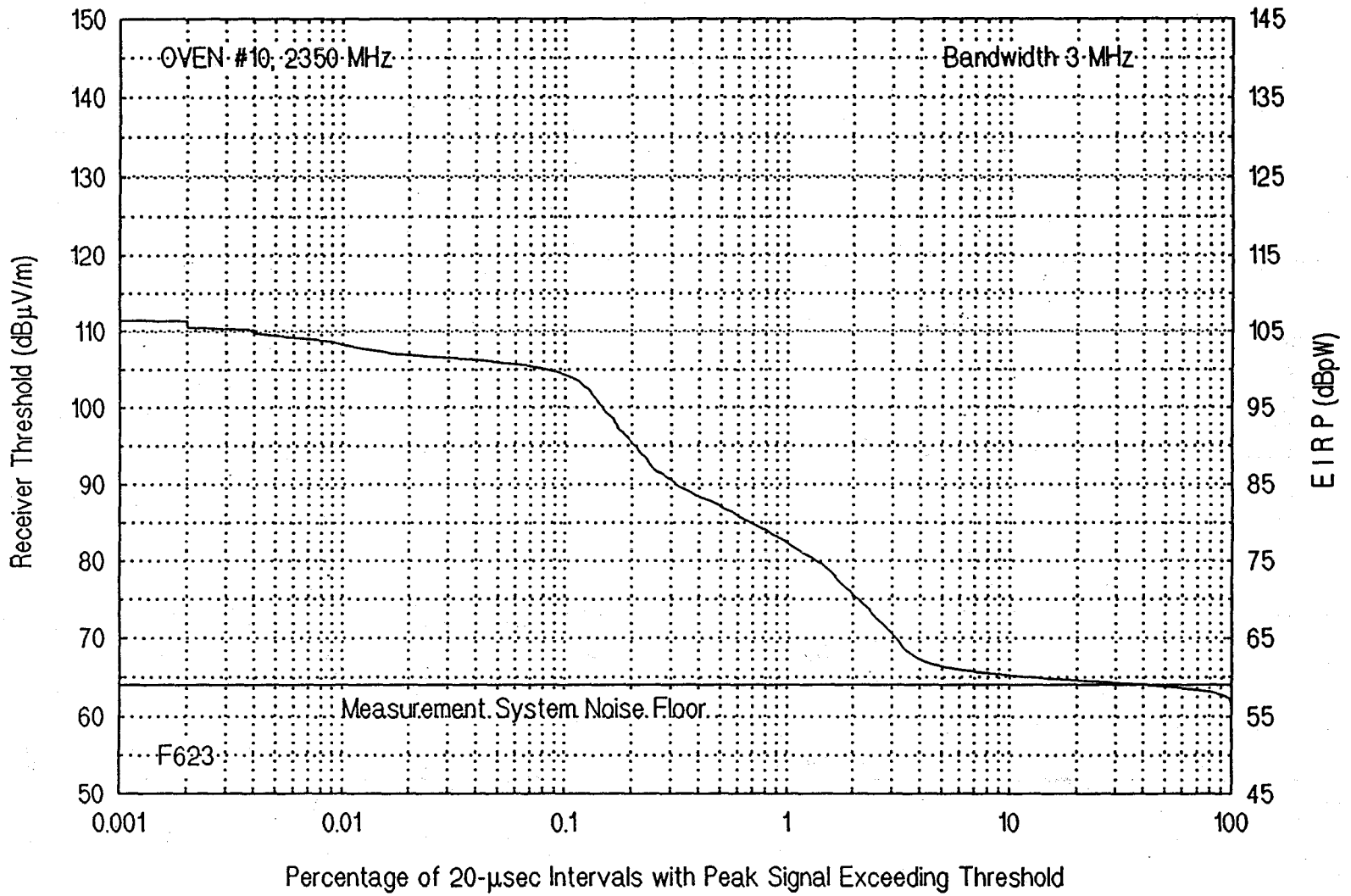


Figure C-102. Oven #10, Amplitude-Probability Distribution at 2350 MHz with 3 MHz bandwidth.

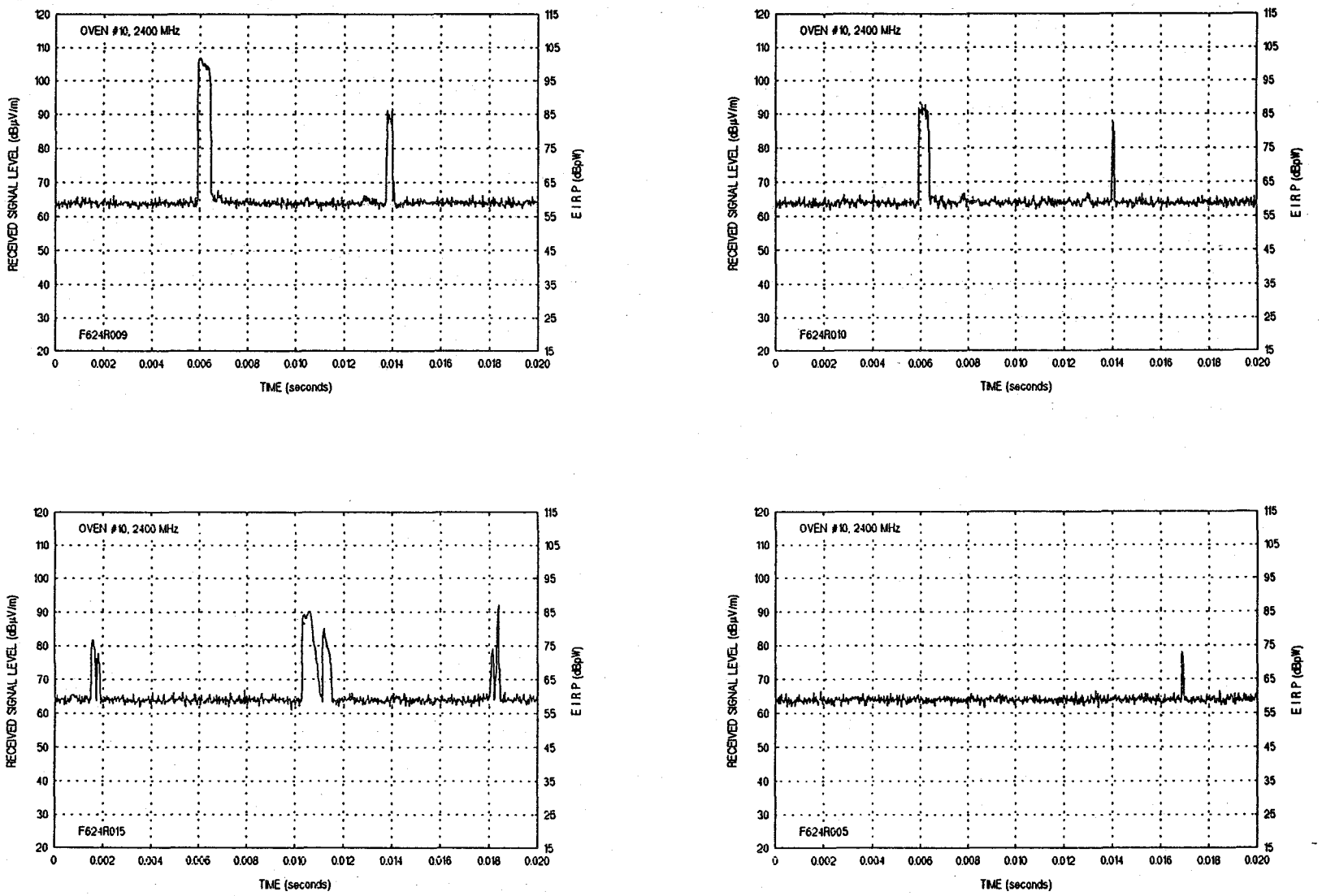


Figure C-103. Oven #10, Time vs. Amplitude displays at 2400 MHz with 3 MHz bandwidth.

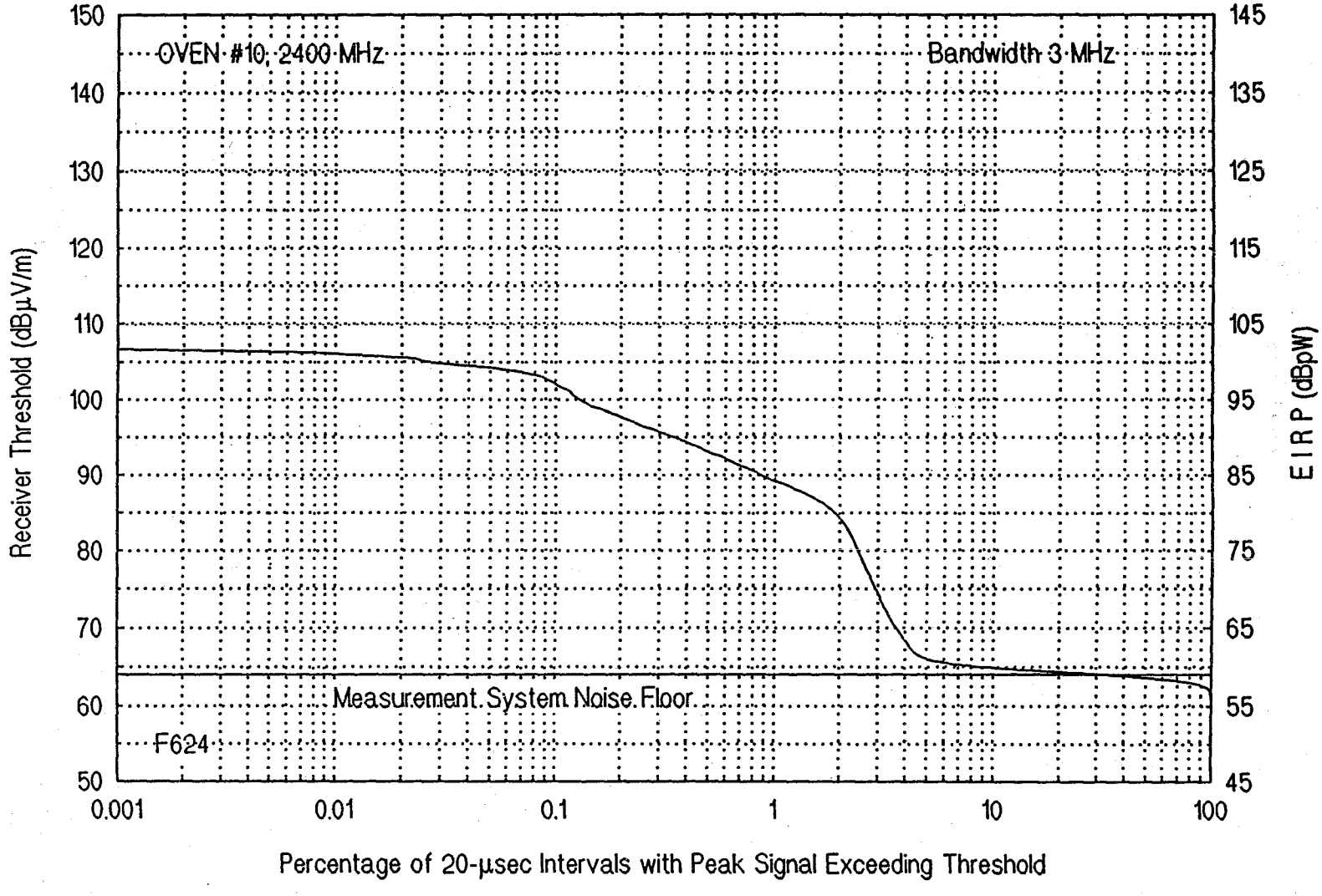
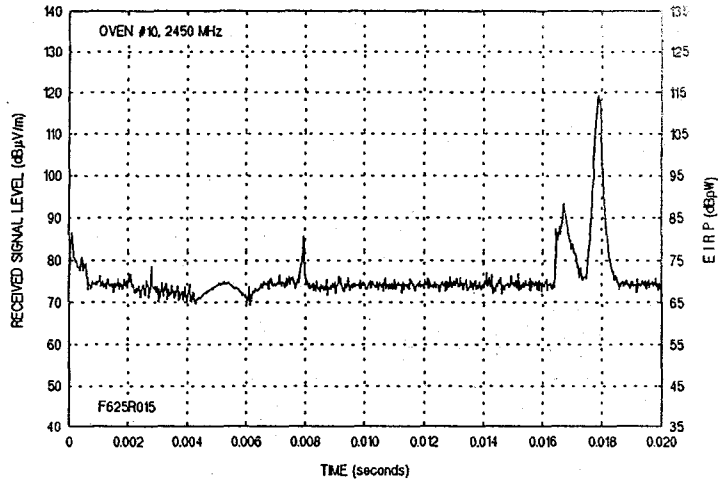
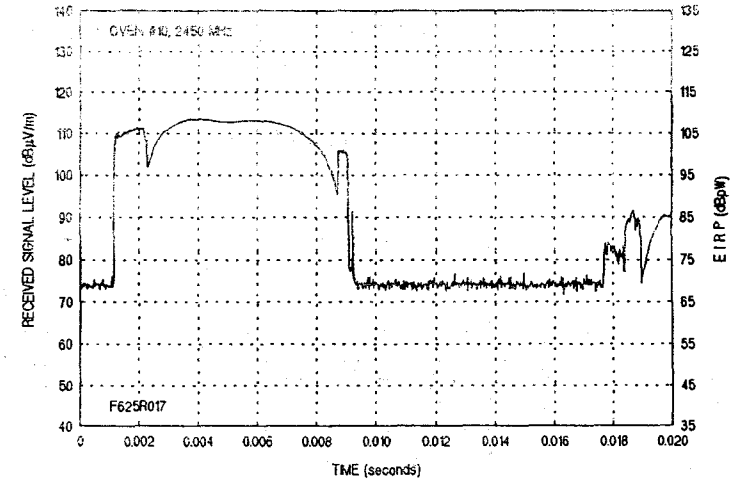
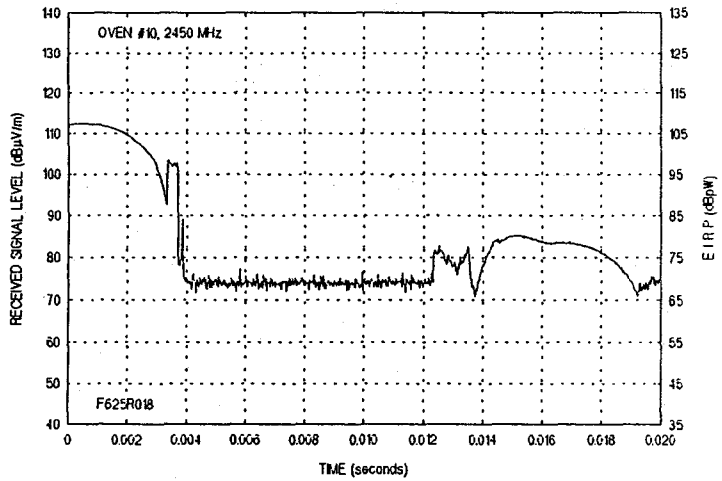


Figure C-104. Oven #10, Amplitude-Probability Distribution at 2400 MHz with 3 MHz bandwidth.







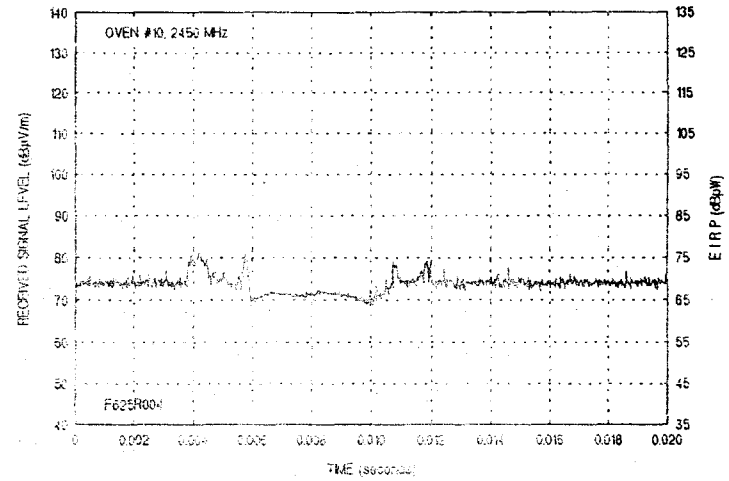


Figure C-105. Oven #10, Time vs. Amplitude displays at 2450 MHz with 3 MHz bandwidth.

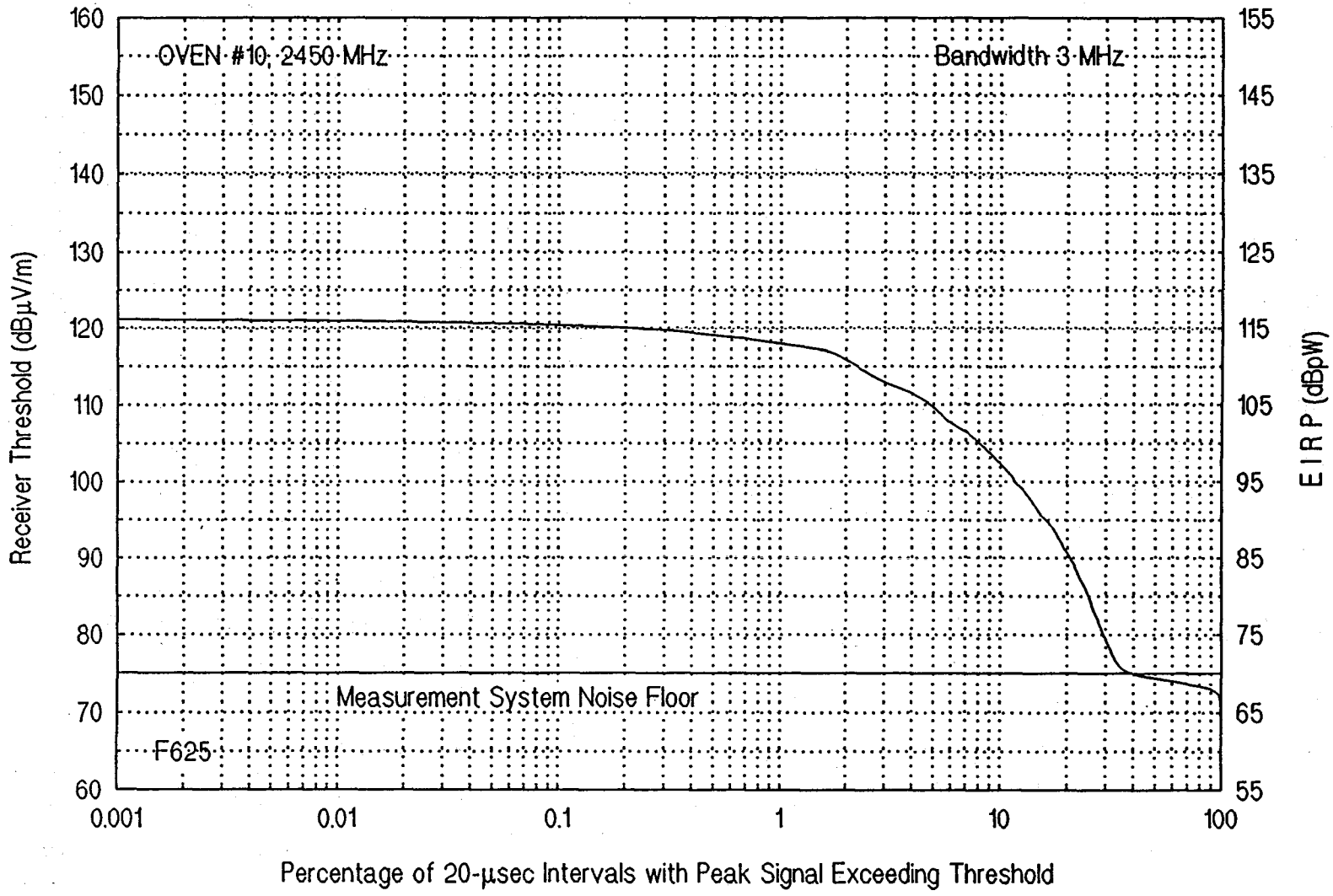
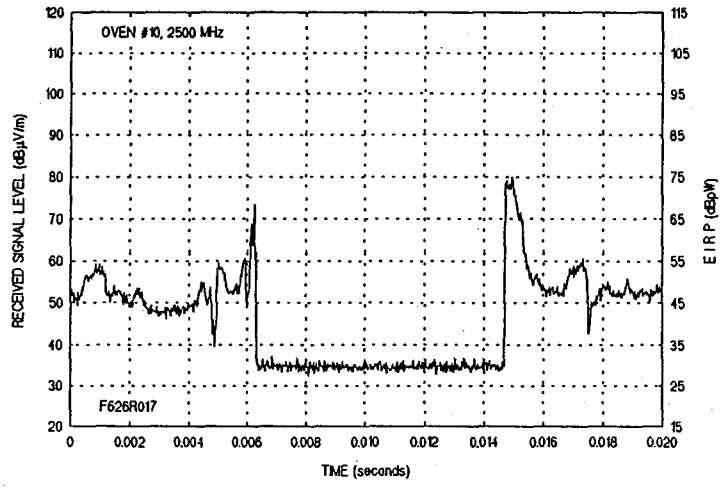
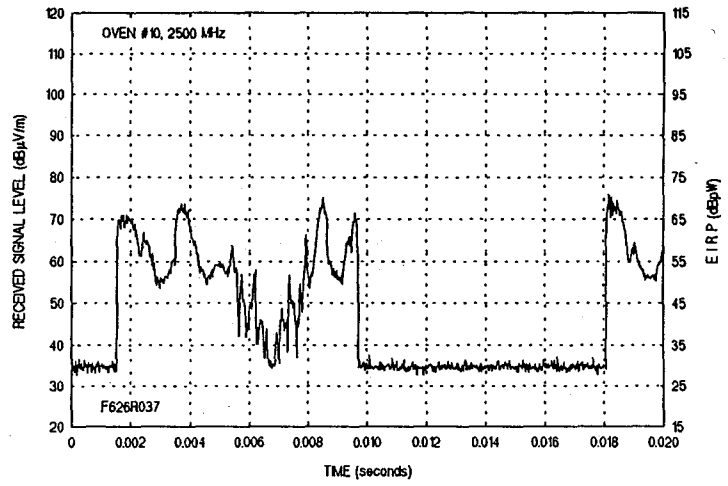
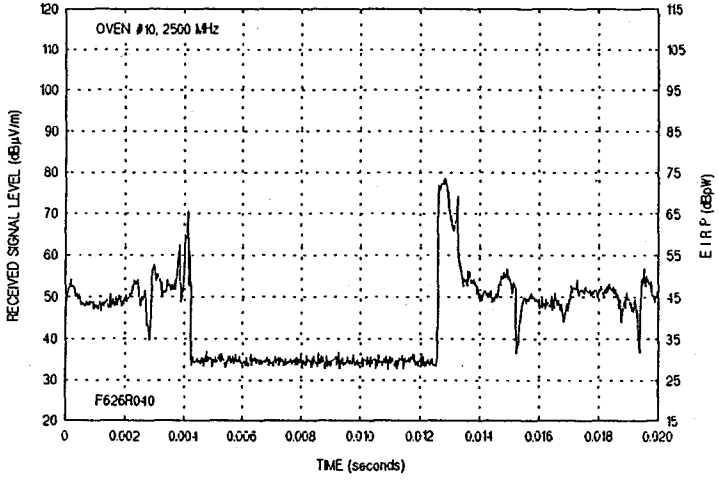


Figure C-106. Oven #10, Amplitude-Probability Distribution at 2450 MHz with 3 MHz bandwidth.







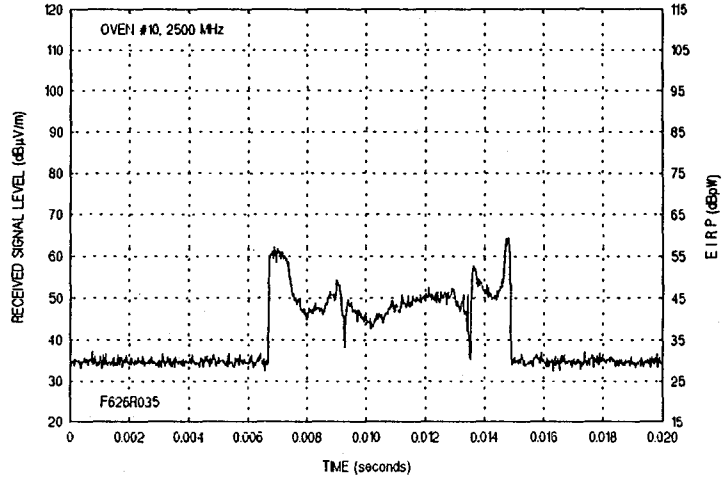


Figure C-107. Oven #10, Time vs. Amplitude displays at 2500 MHz with 3 MHz bandwidth.

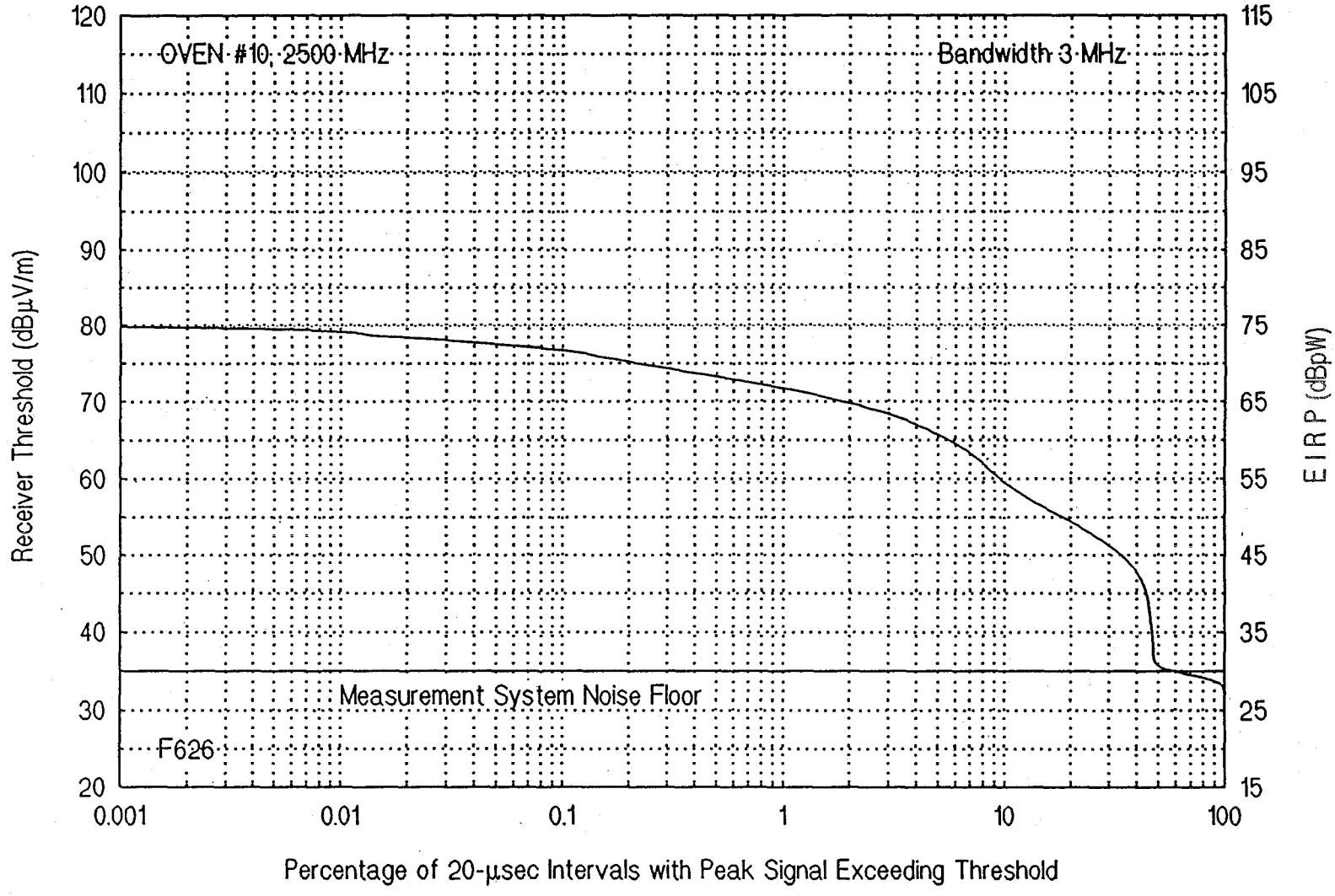


Figure C-108. Oven #10, Amplitude-Probability Distribution at 2500 MHz with 3 MHz bandwidth.

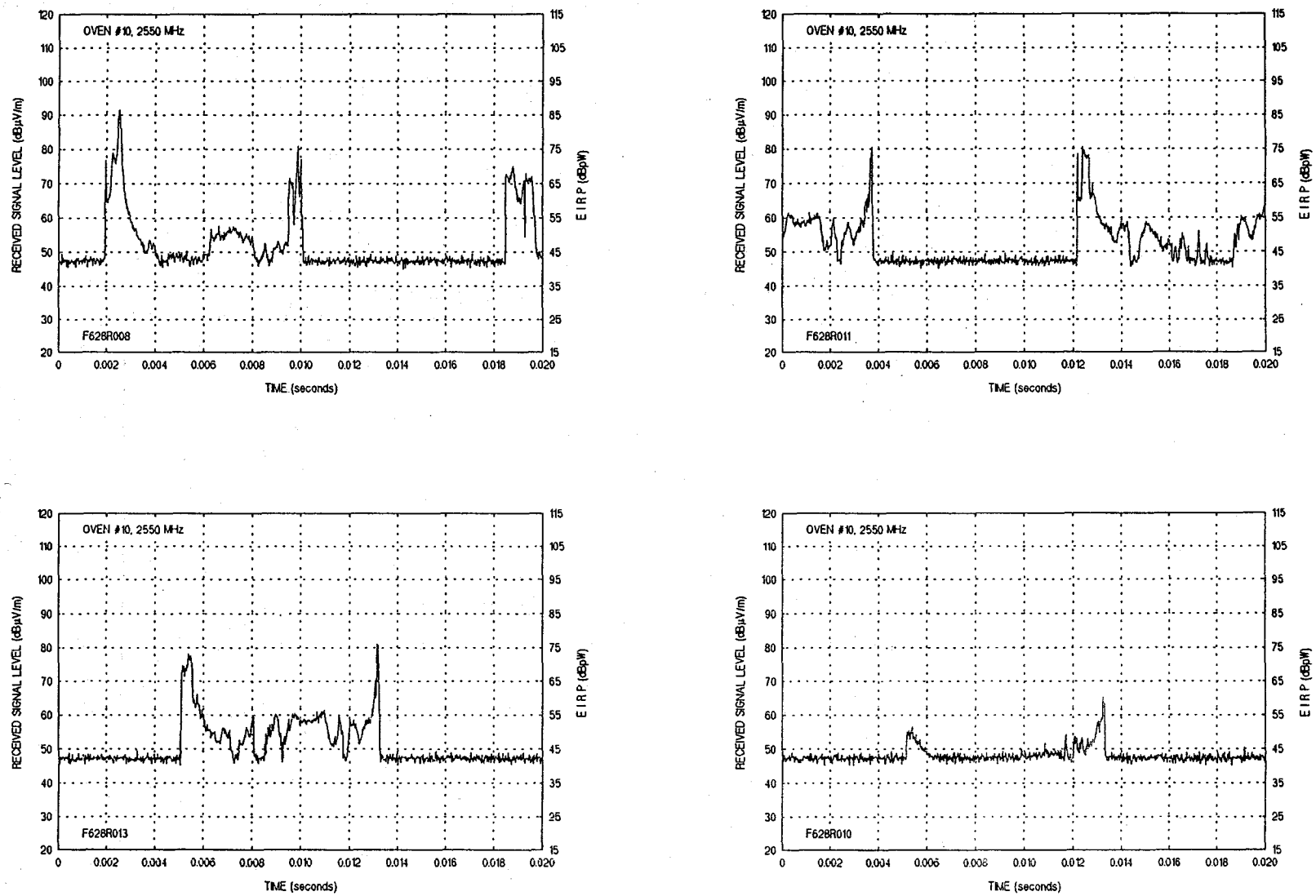


Figure C-109. Oven #10, Time vs. Amplitude displays at 2550 MHz with 3 MHz bandwidth.

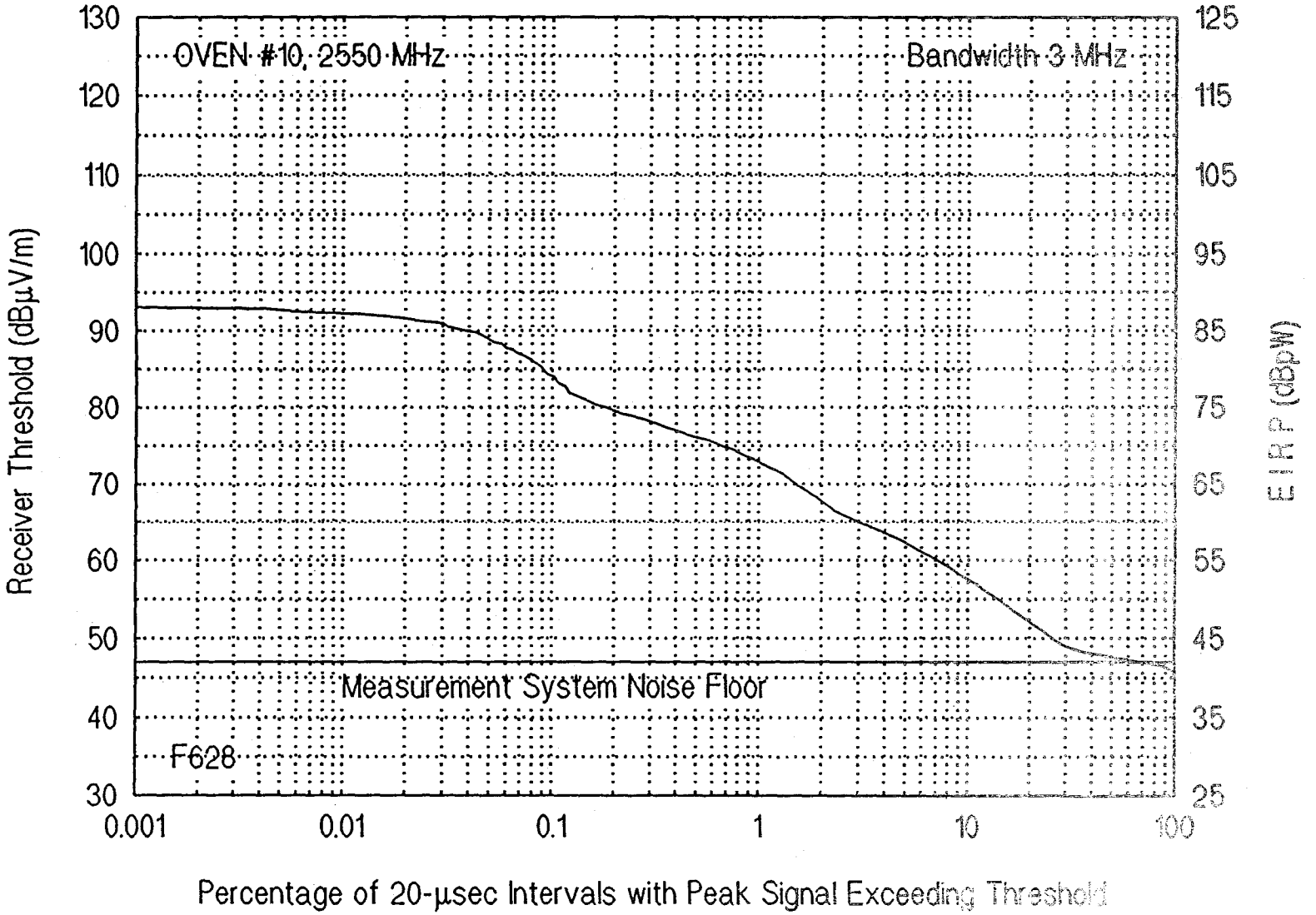


Figure C-110. Oven #10, Amplitude-Probability Distribution at 2550 MHz with 3 MHz bandwidth.

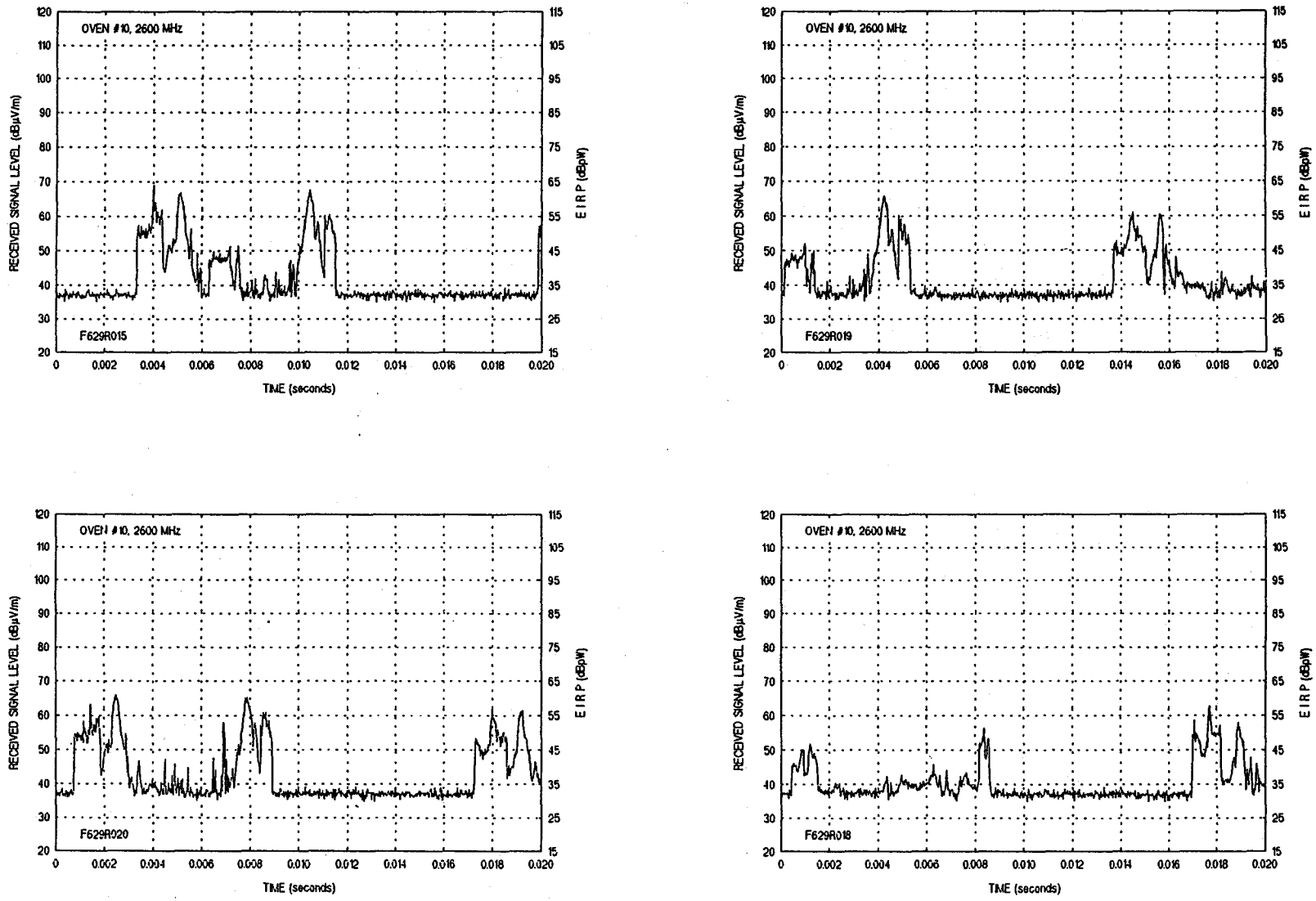


Figure C-111. Oven #10, Time vs. Amplitude displays at 2600 MHz with 3 MHz bandwidth.

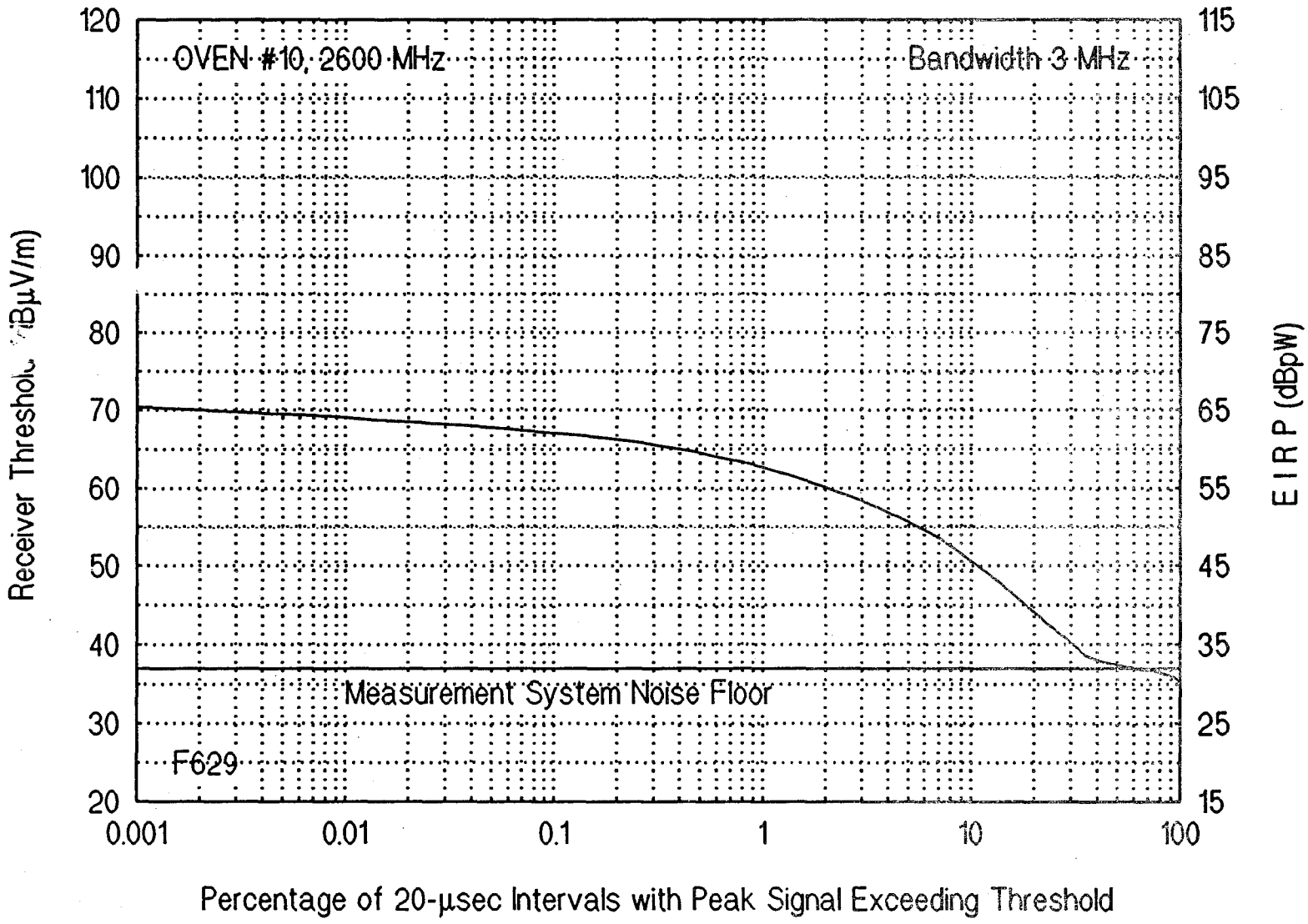


Figure C-112. Oven #10, Amplitude-Probability Distribution at 2600 MHz with 3 MHz bandwidth.

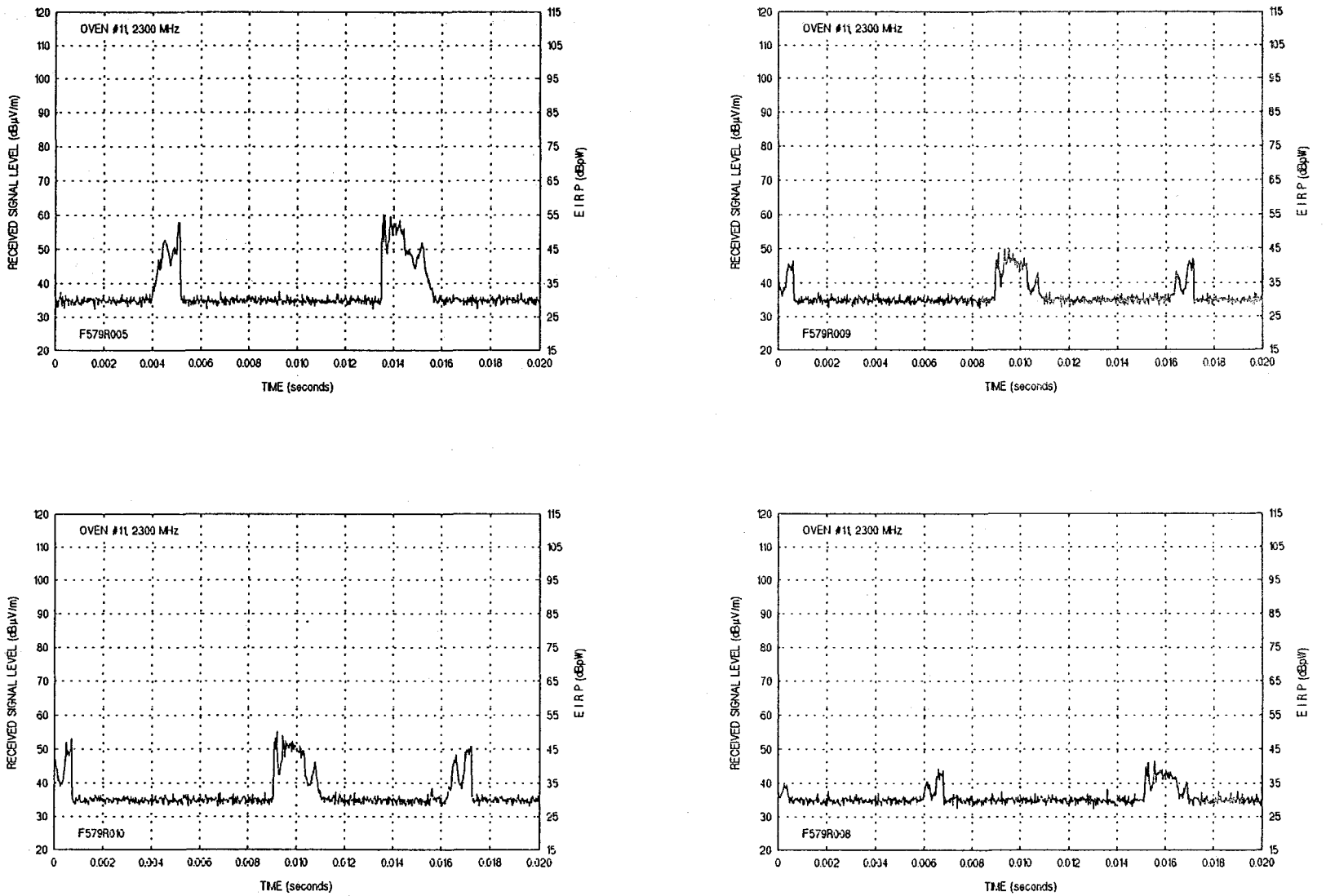


Figure C-113. Oven #11, Time vs. Amplitude displays at 2300 MHz with 3 MHz bandwidth.

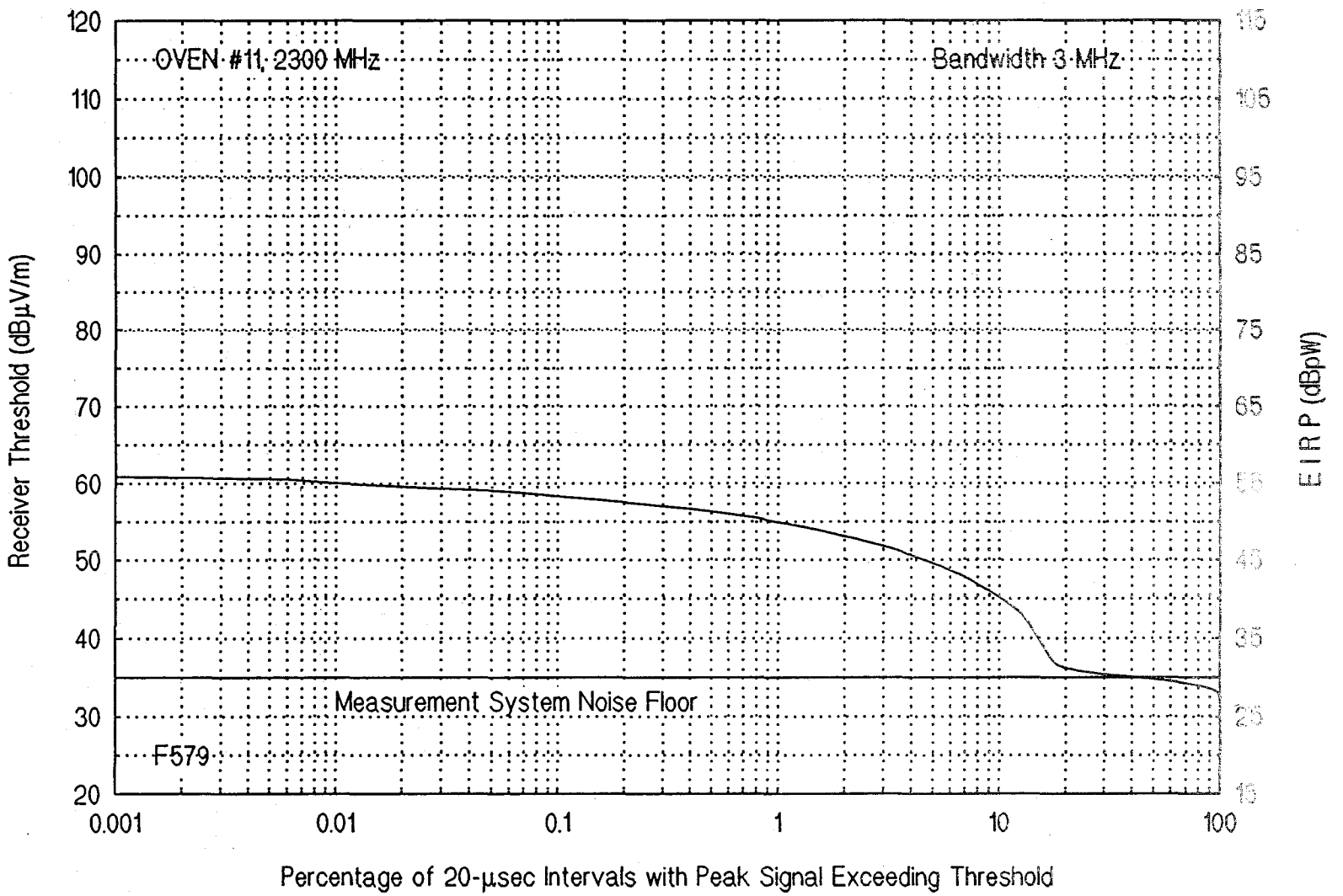


Figure C-114. Oven #11, Amplitude-Probability Distribution at 2300 MHz with 3 MHz bandwidth.

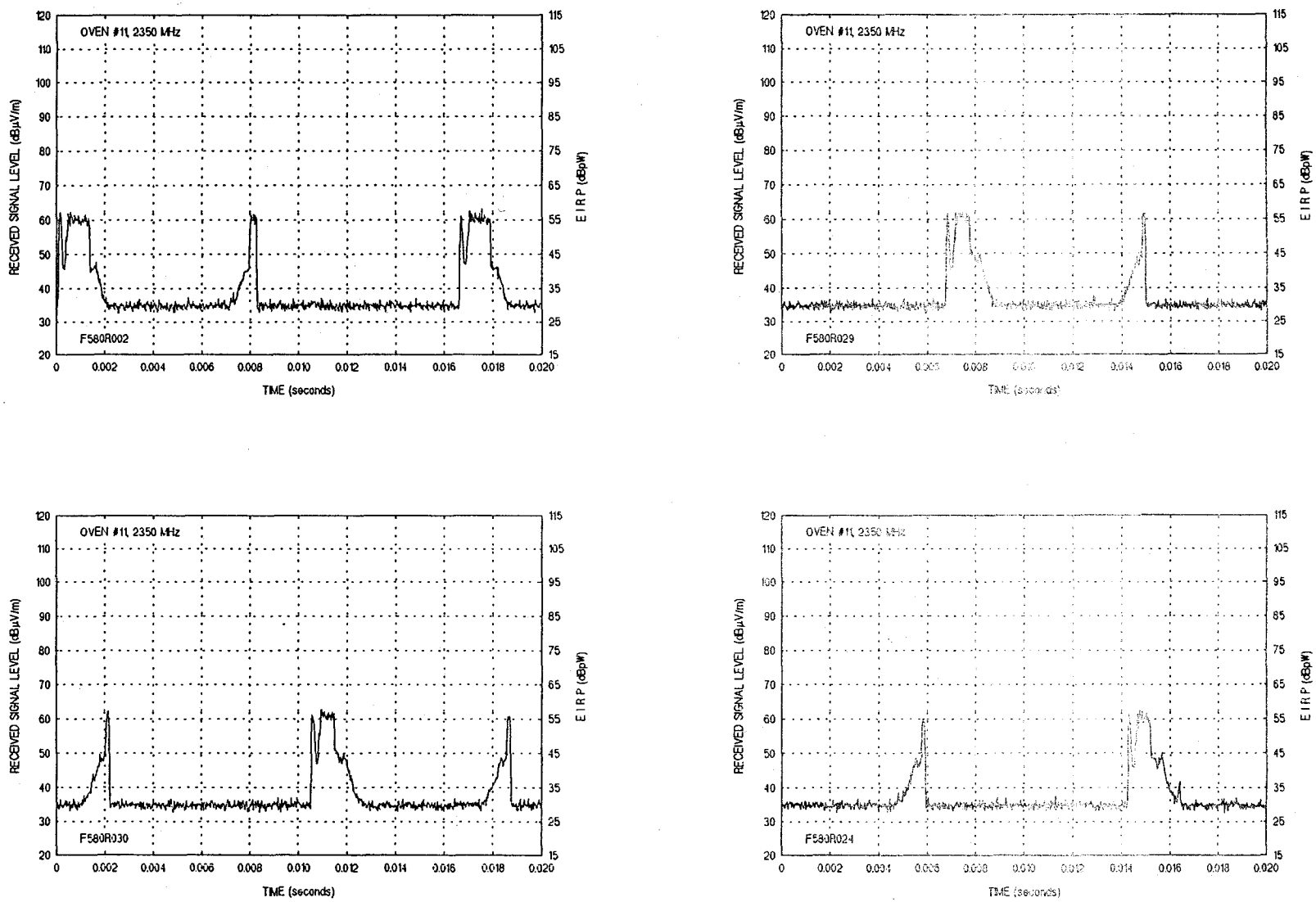


Figure C-115. Oven #11, Time vs. Amplitude displays at 2350 MHz with 3 MHz bandwidth.

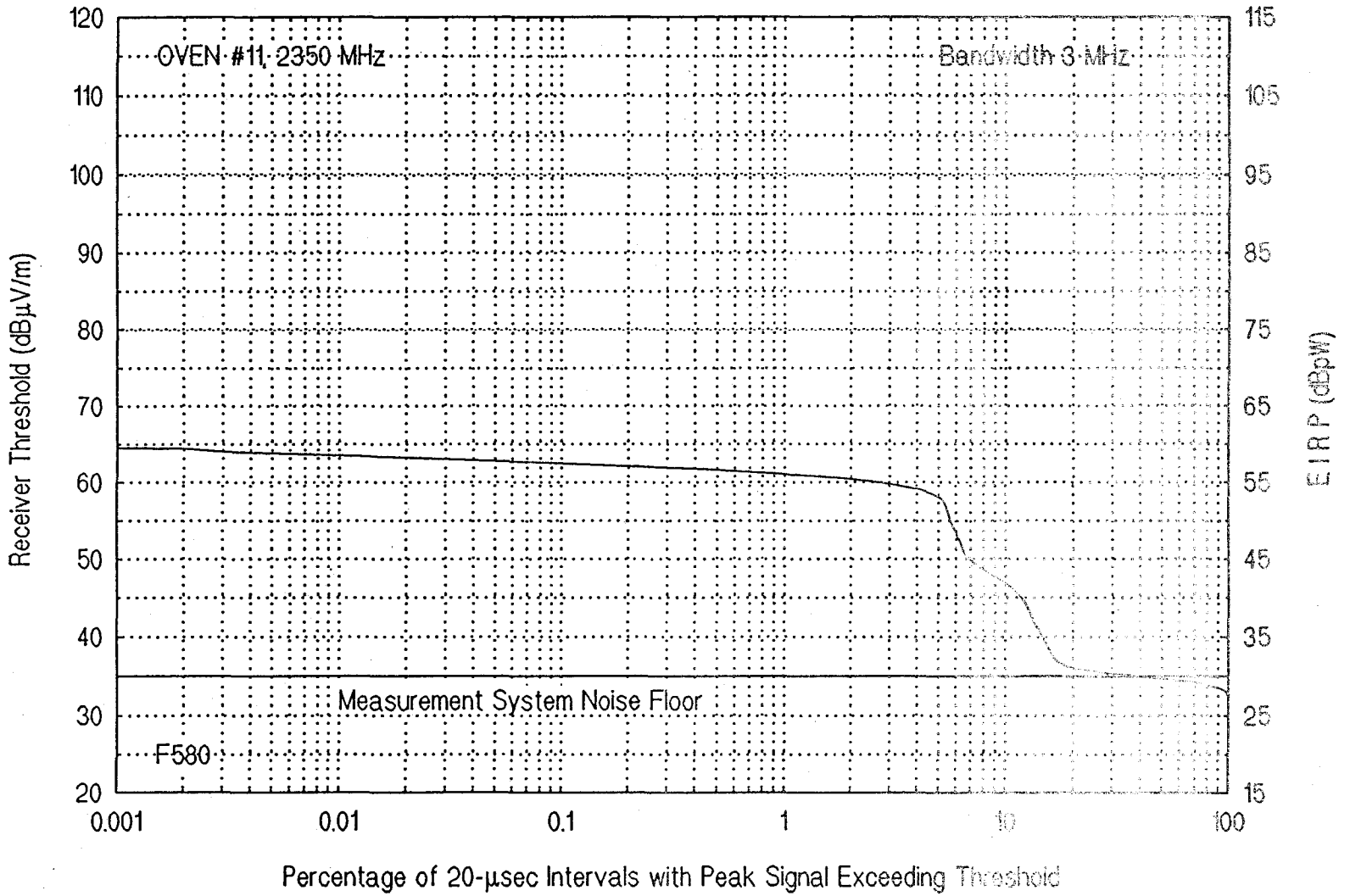


Figure C-116. Oven #11, Amplitude-Probability Distribution at 2350 MHz with 3 MHz bandwidth.

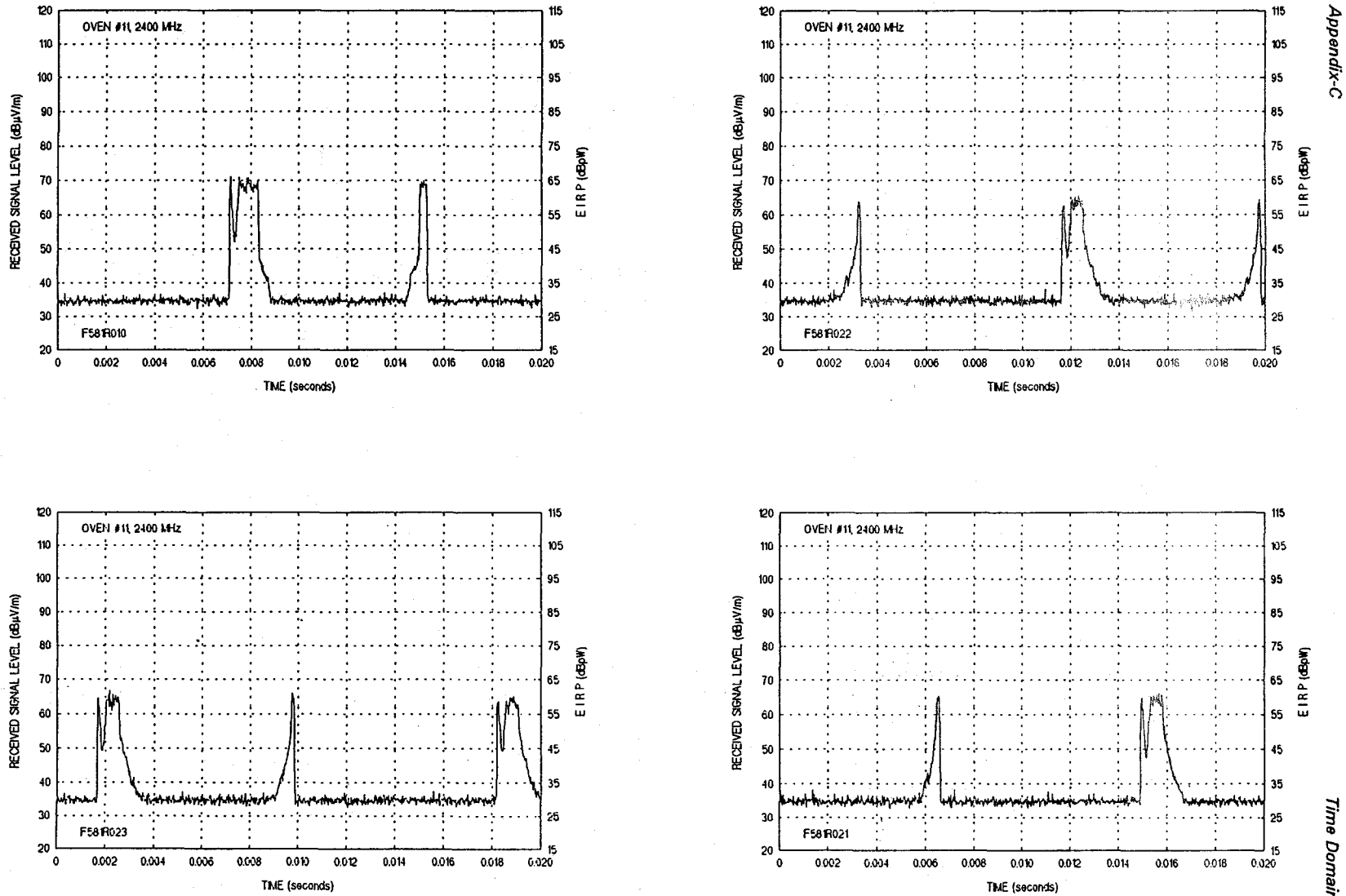


Figure C-117. Oven #11, Time vs. Amplitude displays at 2400 MHz with 3 MHz bandwidth.

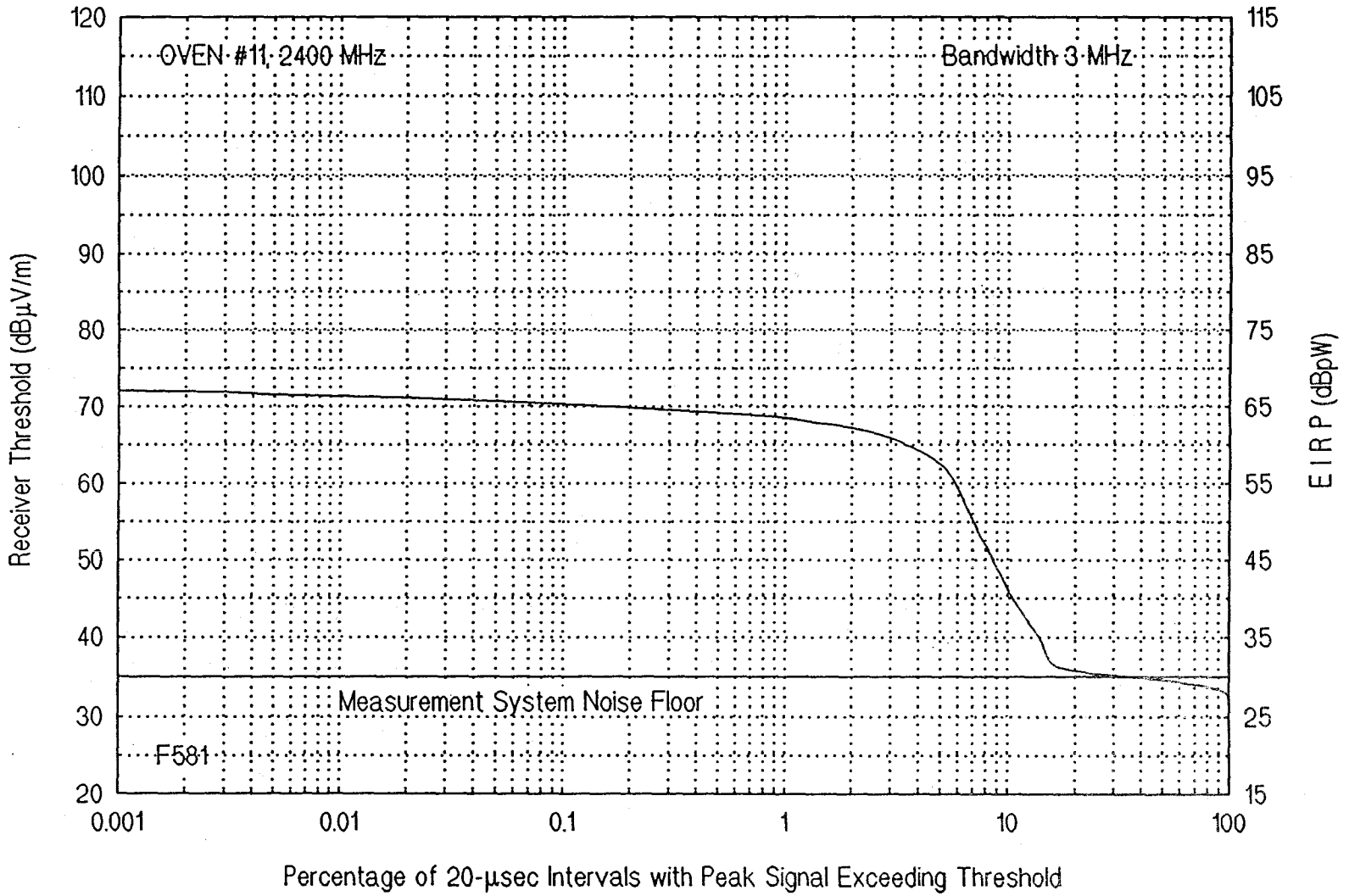
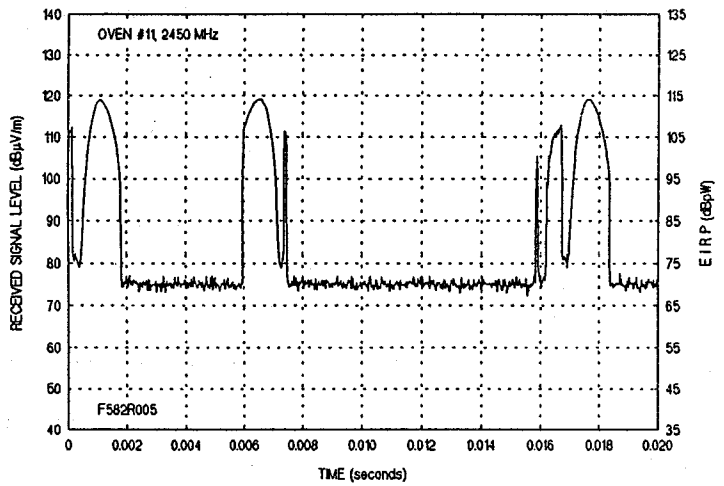
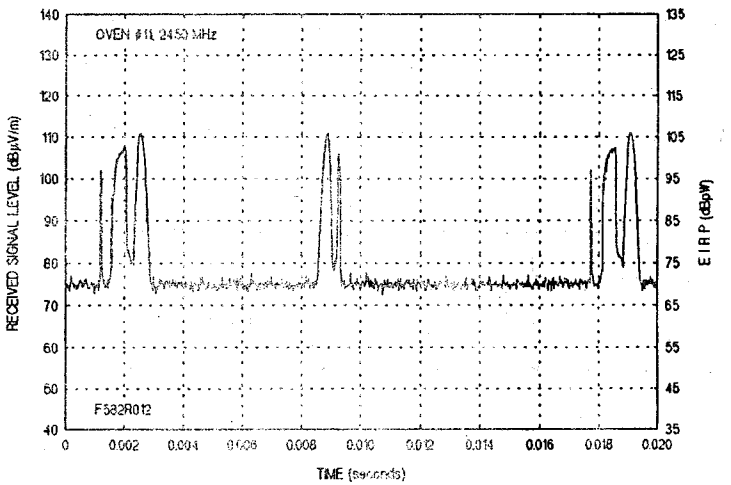
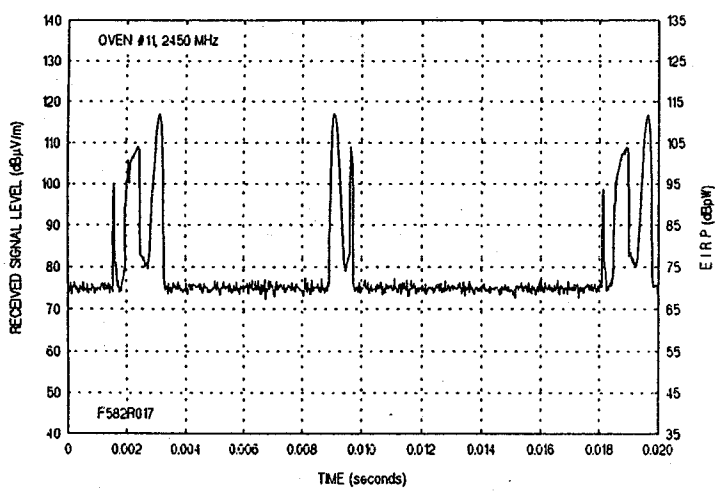


Figure C-118. Oven #11, Amplitude-Probability Distribution at 2400 MHz with 3 MHz bandwidth.







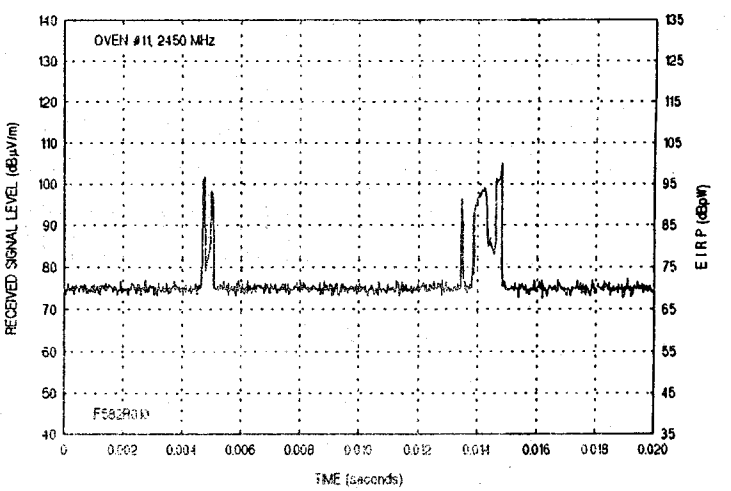


Figure C-119. Oven #11, Time vs. Amplitude displays at 2450 MHz with 3 MHz bandwidth.

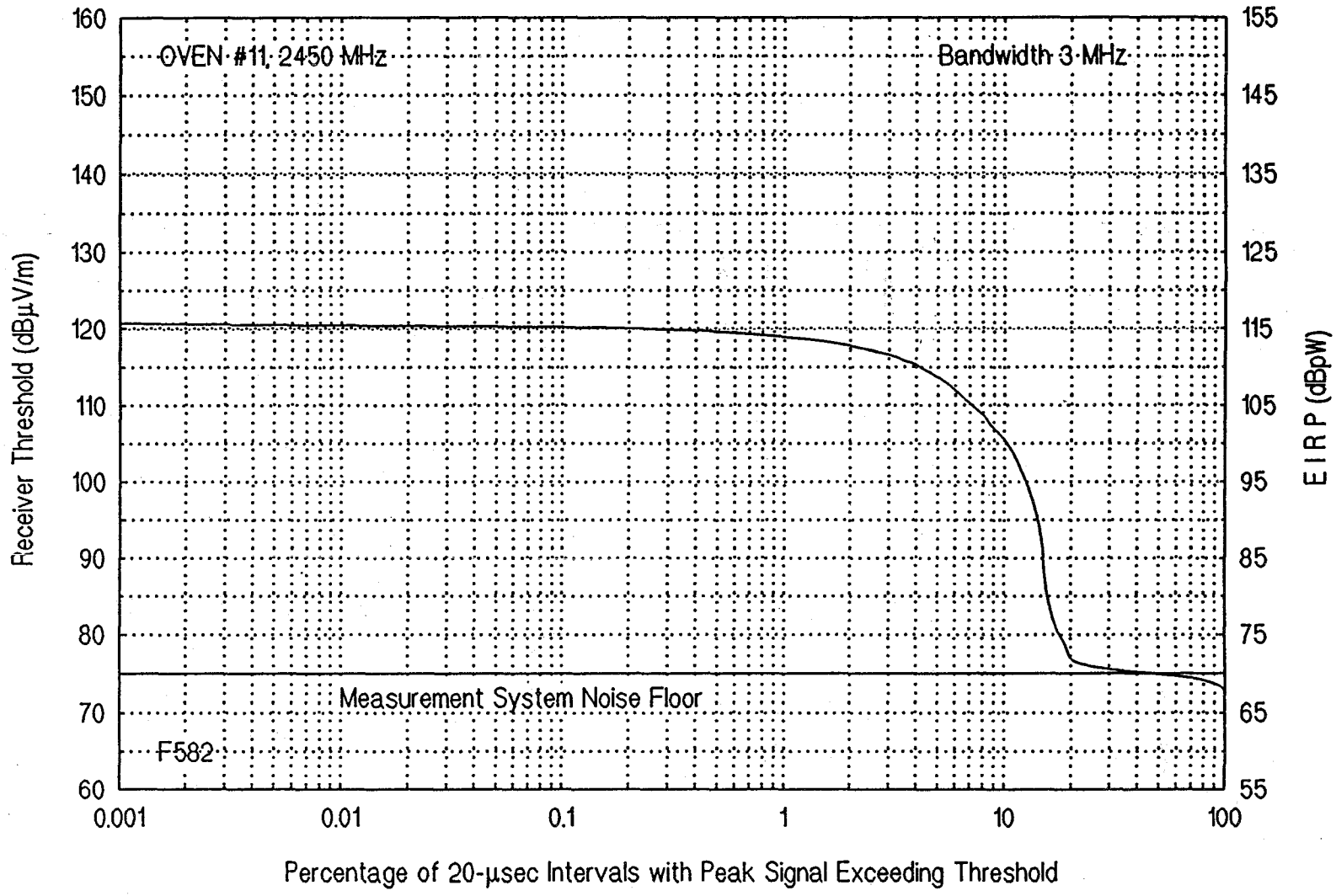


Figure C-120. Oven #11, Amplitude-Probability Distribution at 2450 MHz with 3 MHz bandwidth.

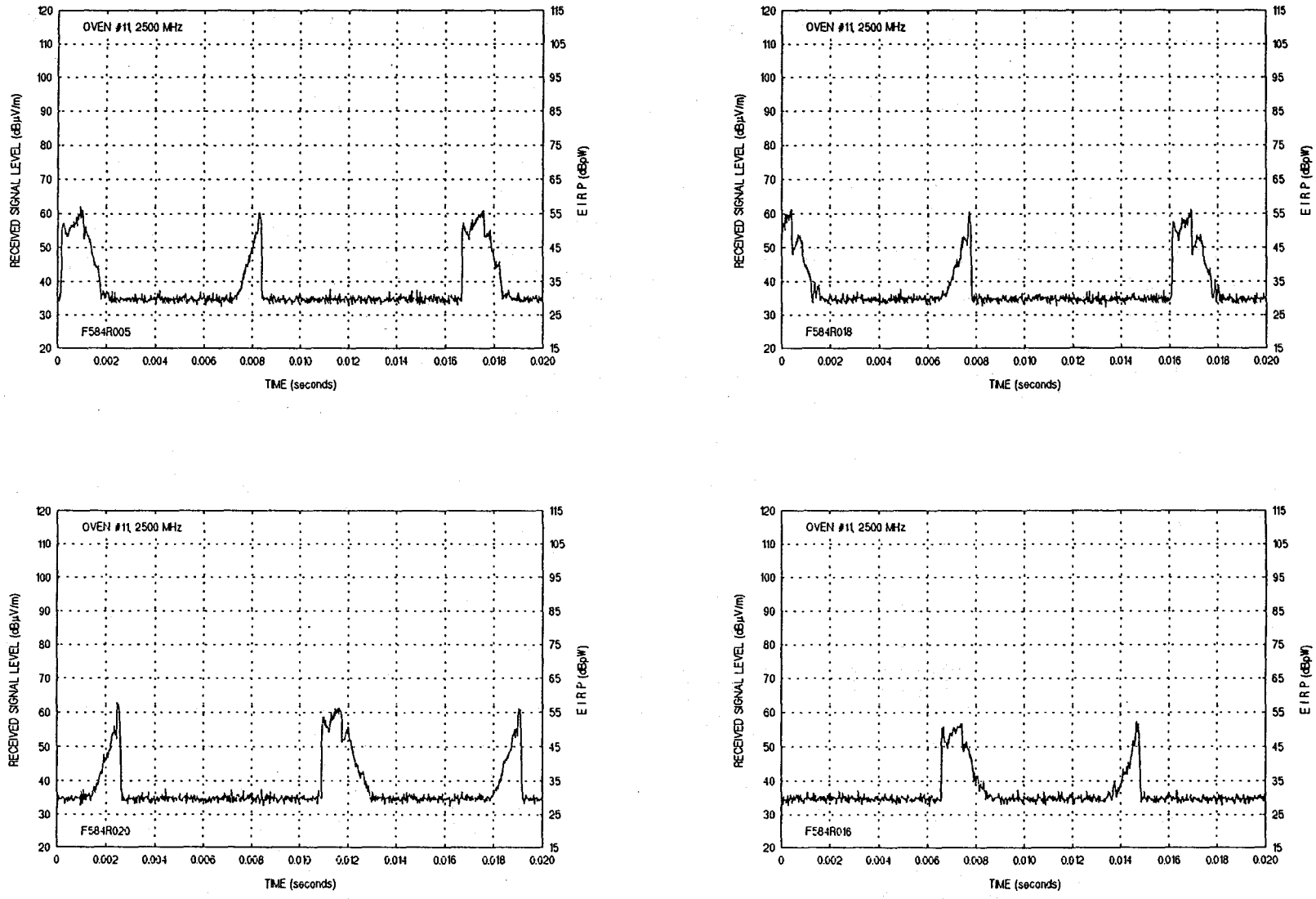


Figure C-121. Oven #11, Time vs. Amplitude displays at 2500 MHz with 3 MHz bandwidth.

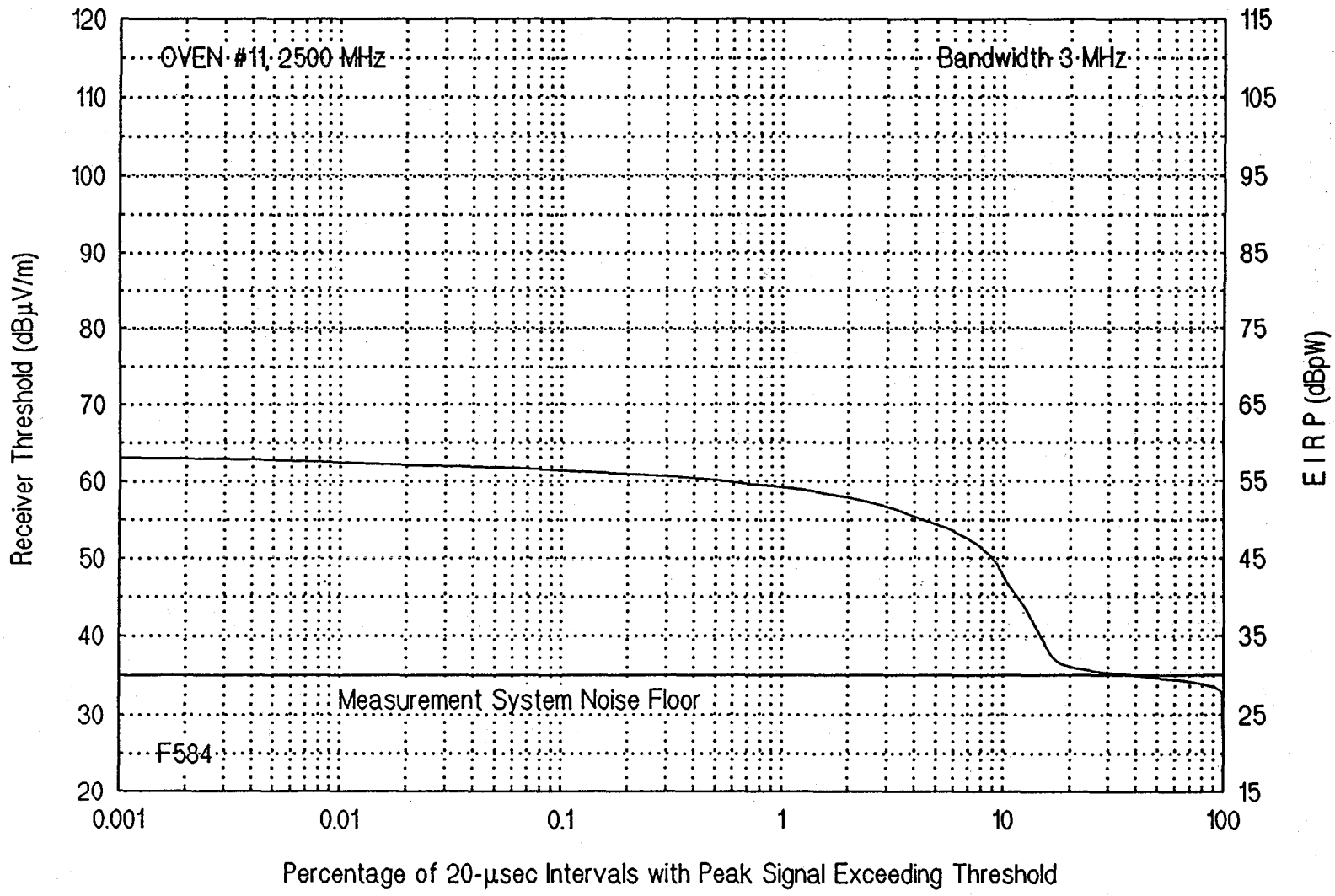
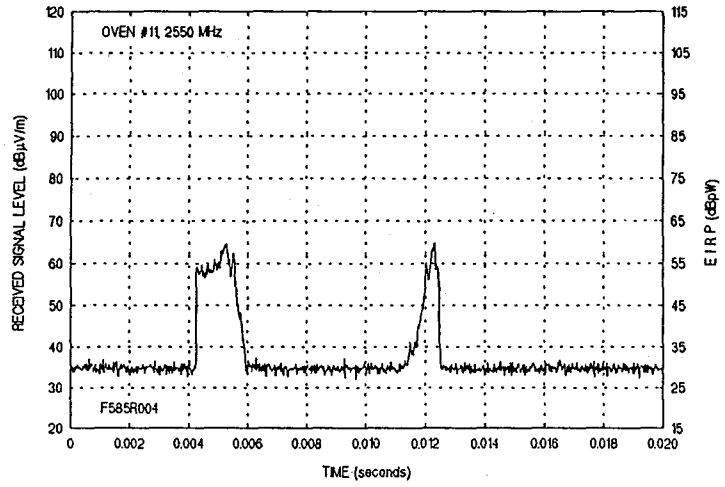
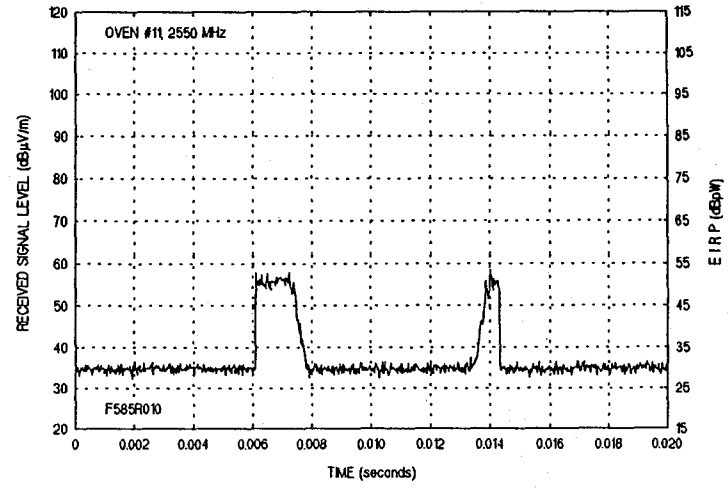
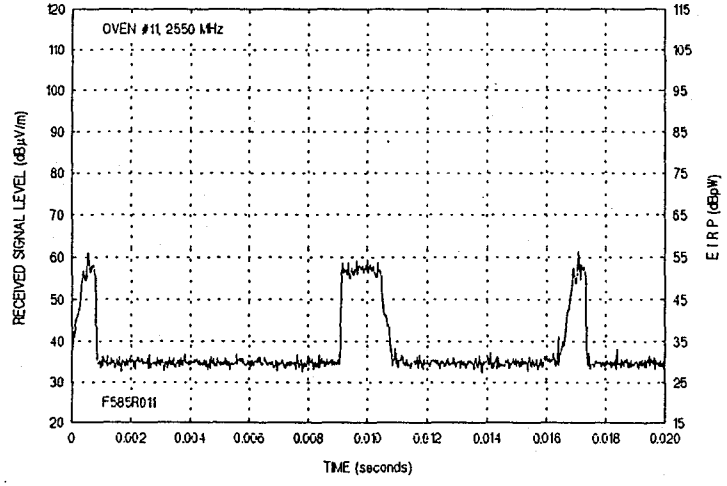


Figure C-122. Oven #11, Amplitude-Probability Distribution at 2500 MHz with 3 MHz bandwidth.







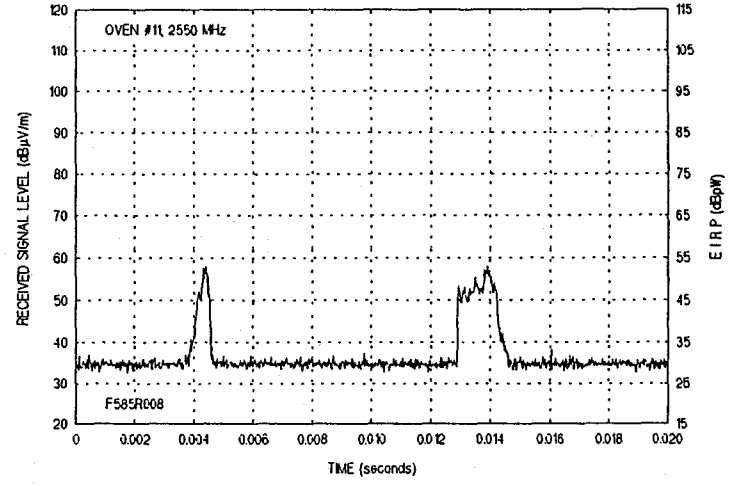


Figure C-123. Oven #11, Time vs. Amplitude displays at 2550 MHz with 3 MHz bandwidth.

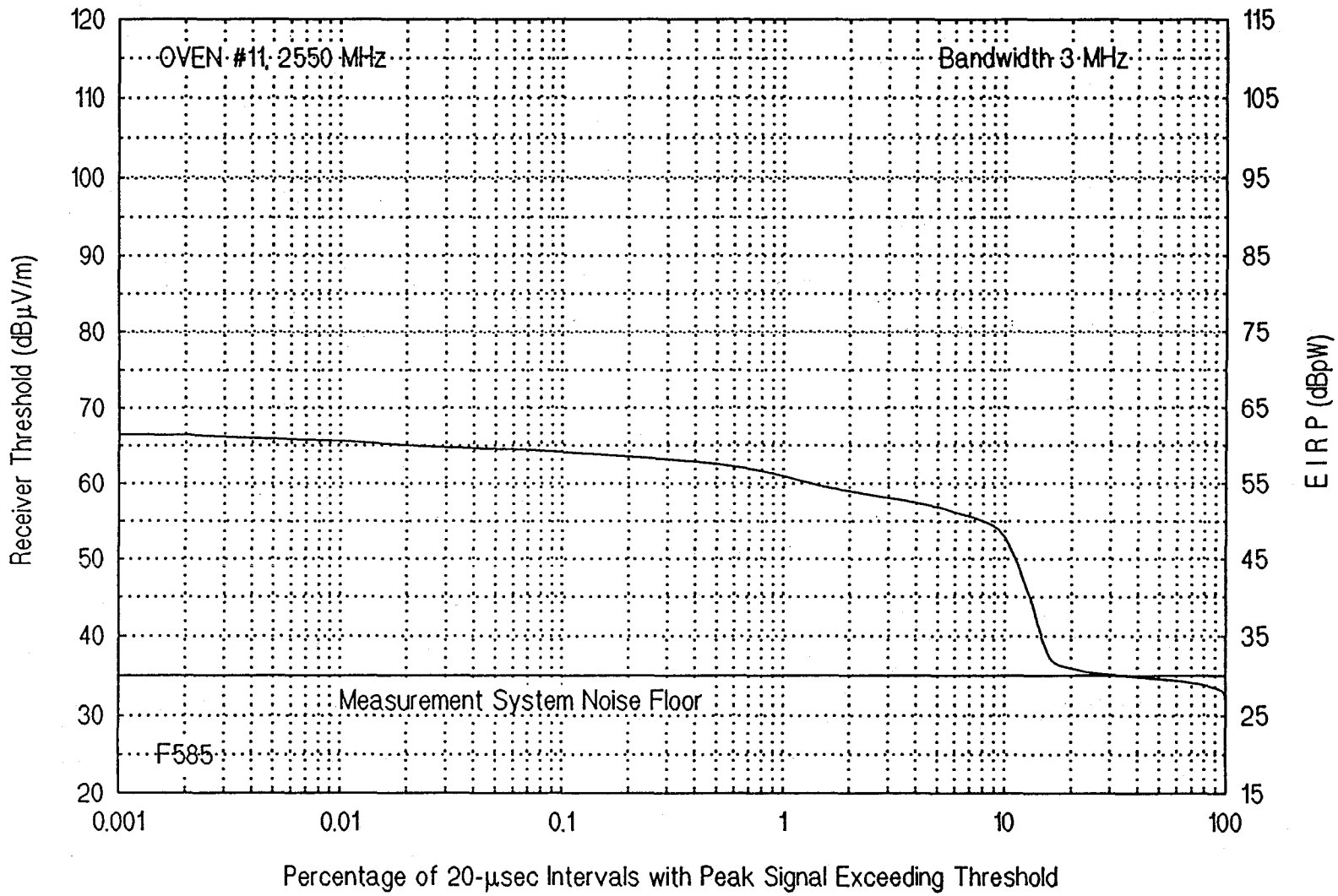


Figure C-124. Oven #11, Amplitude-Probability Distribution at 2550 MHz with 3 MHz bandwidth.

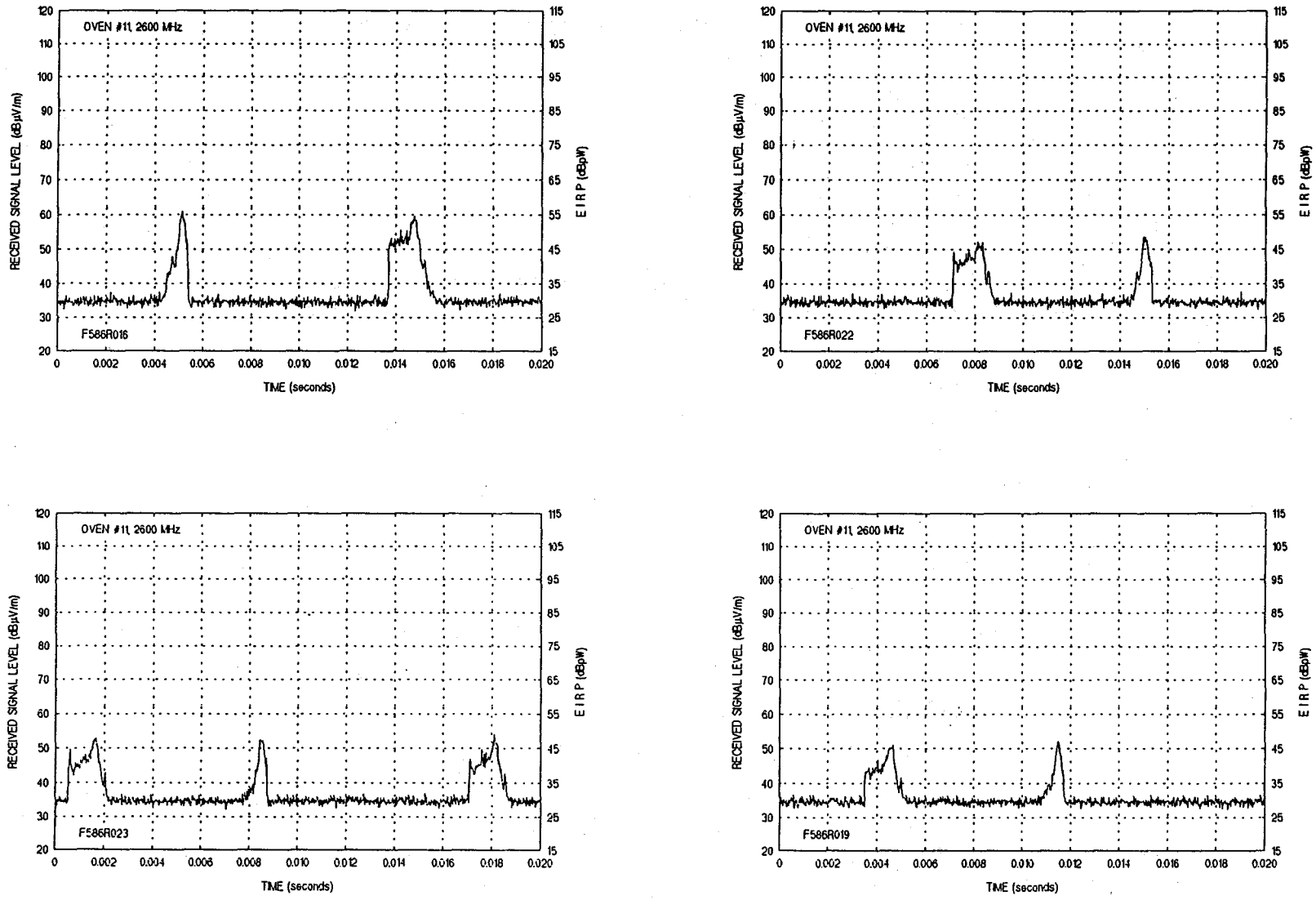


Figure C-125. Oven #11, Time vs. Amplitude displays at 2600 MHz with 3 MHz bandwidth.

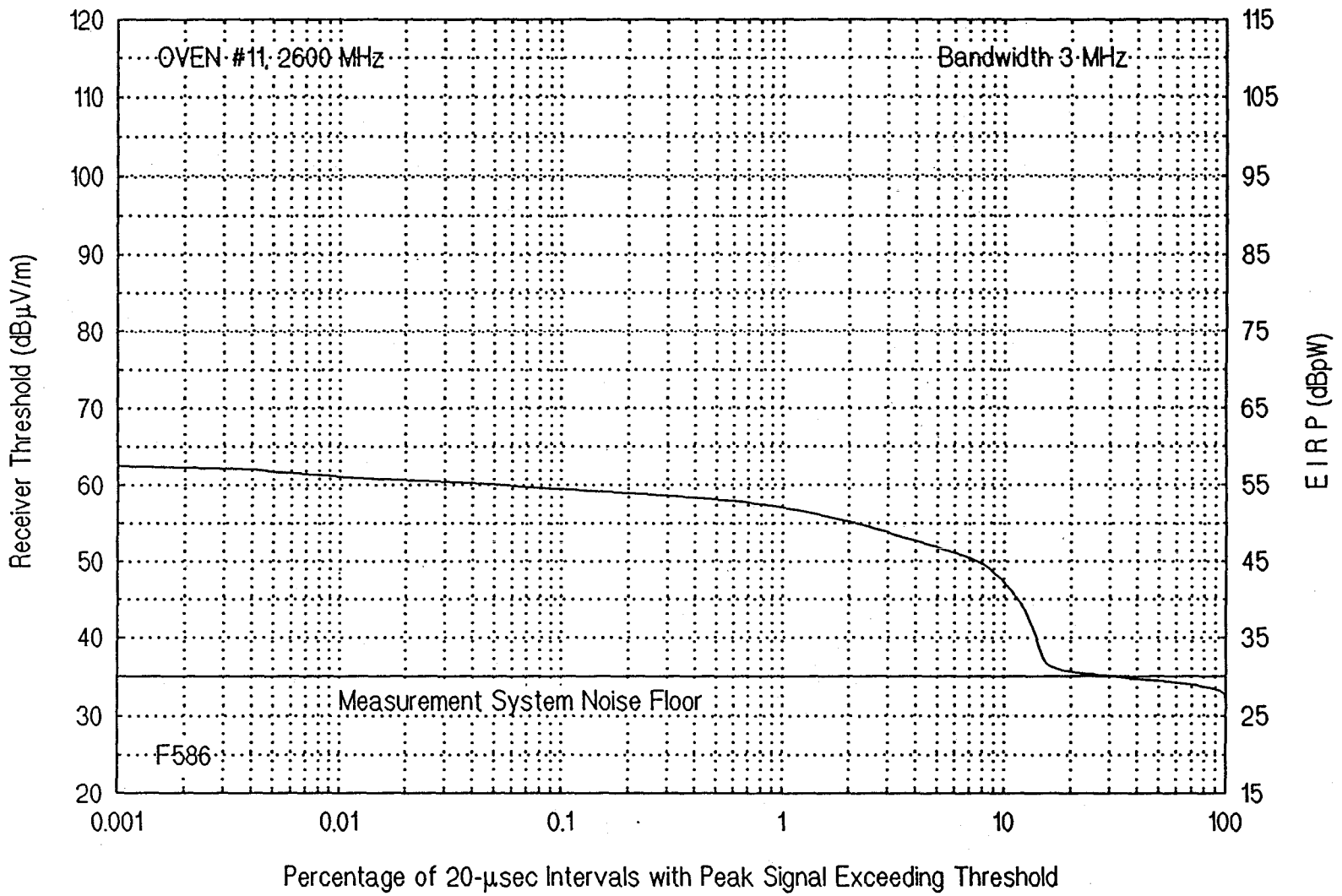


Figure C-126. Oven #11, Amplitude-Probability Distribution at 2600 MHz with 3 MHz bandwidth.

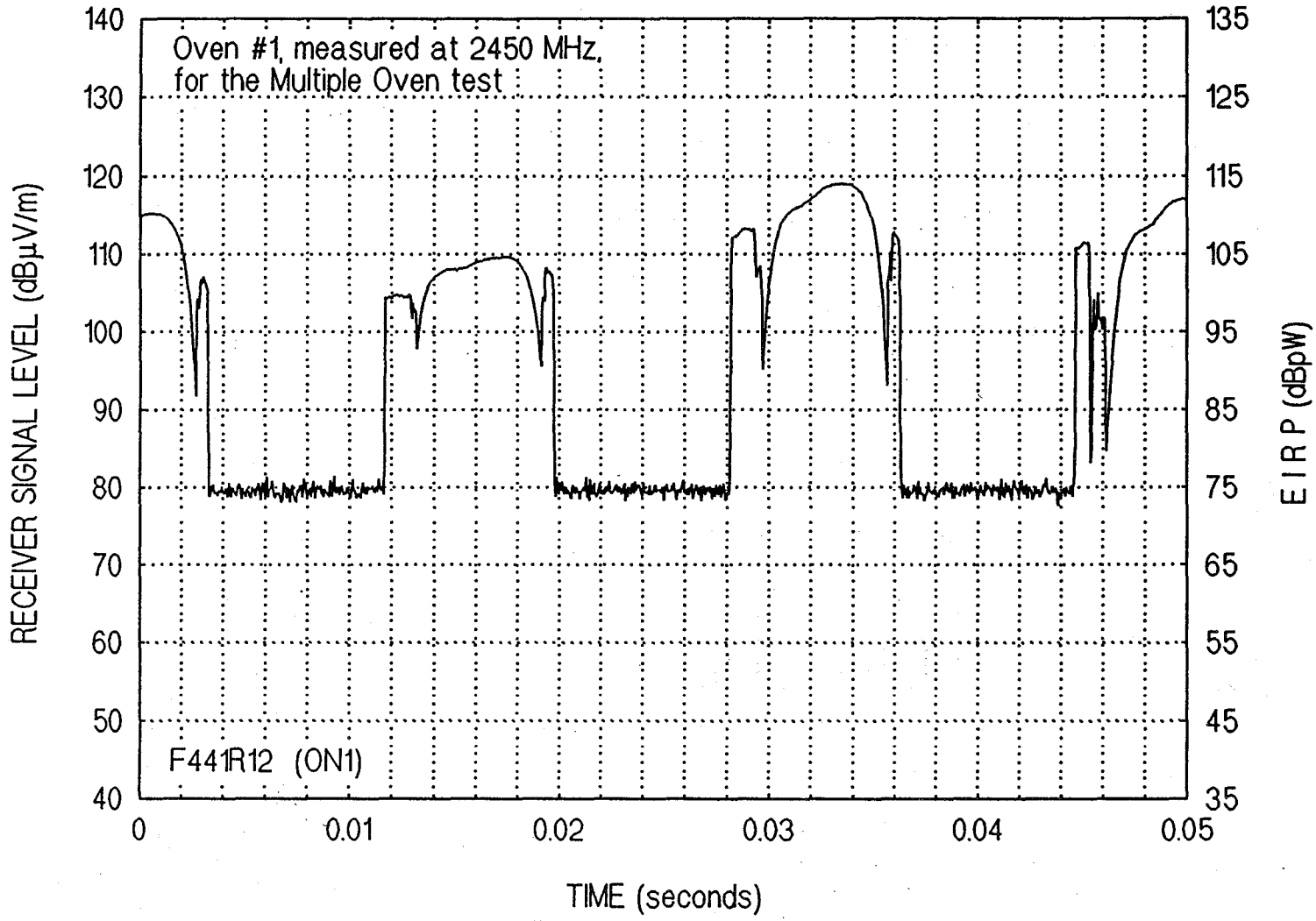


Figure C-127. Oven #1, measured at 2450 MHz, for the multiple oven test.

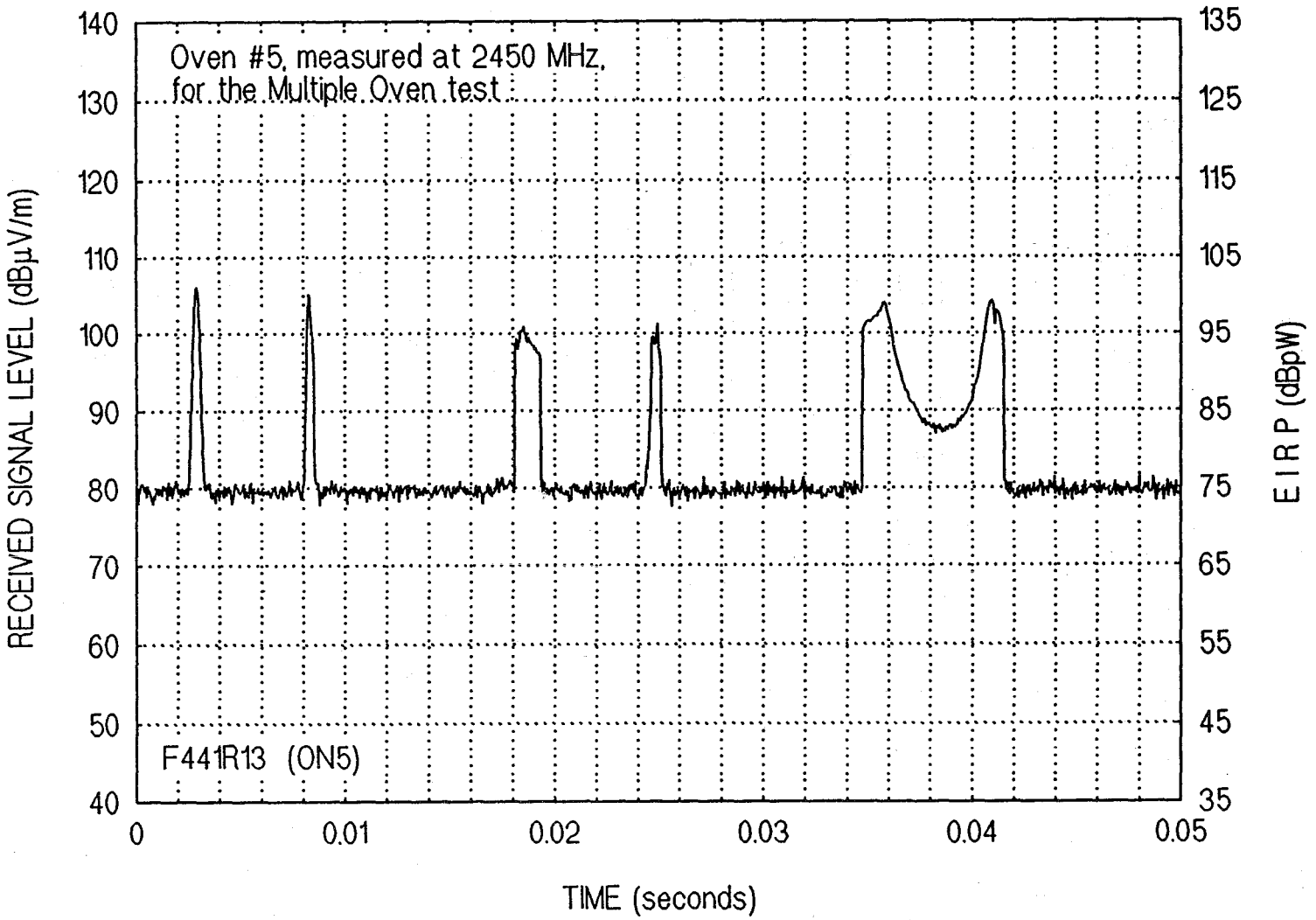


Figure C-128. Oven #5, measured at 2450 MHz, for the multiple oven test.

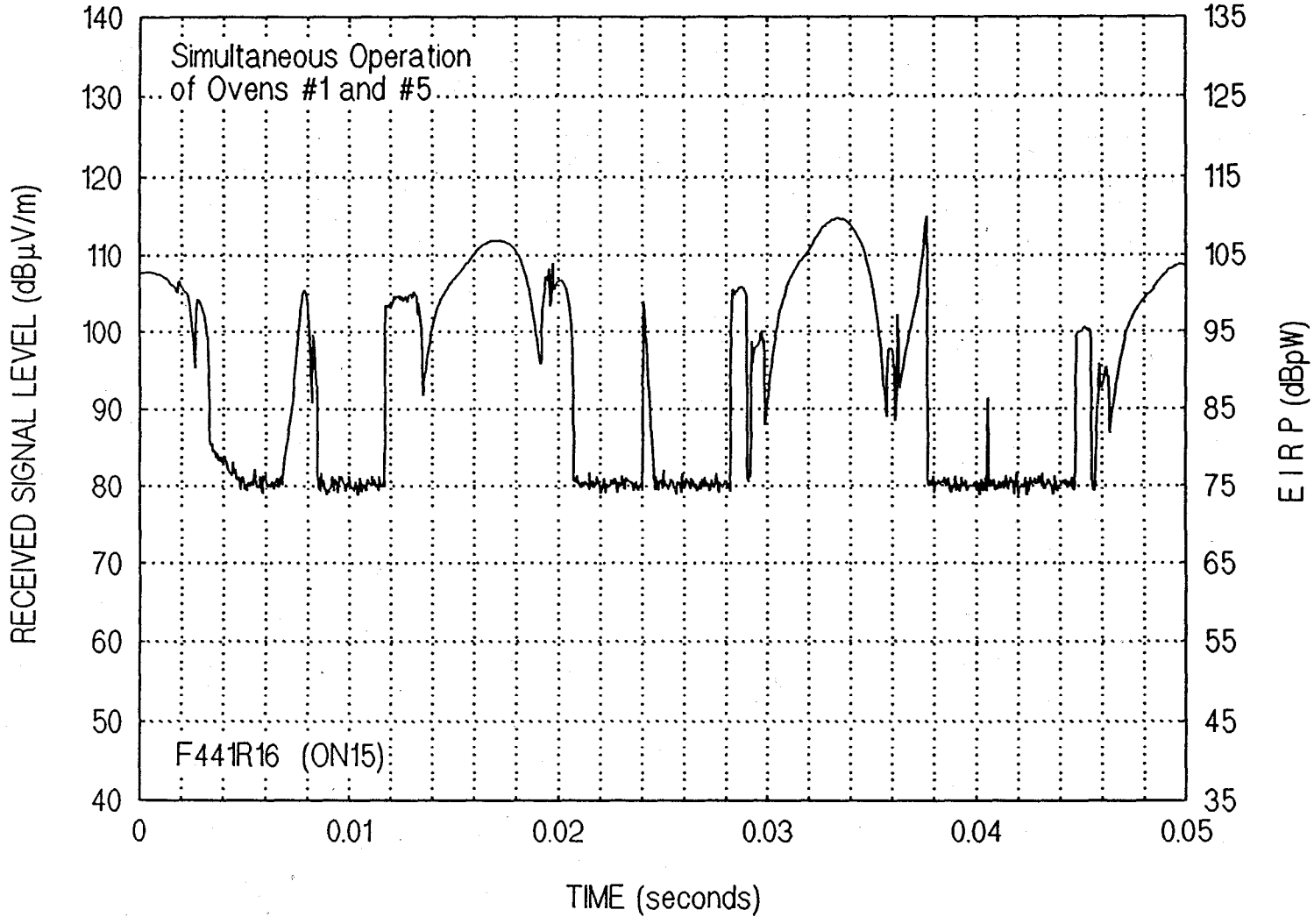


Figure C-129. Simultaneous operation of Ovens #1 and #5, measured at 2450 MHz, for the multiple oven test.

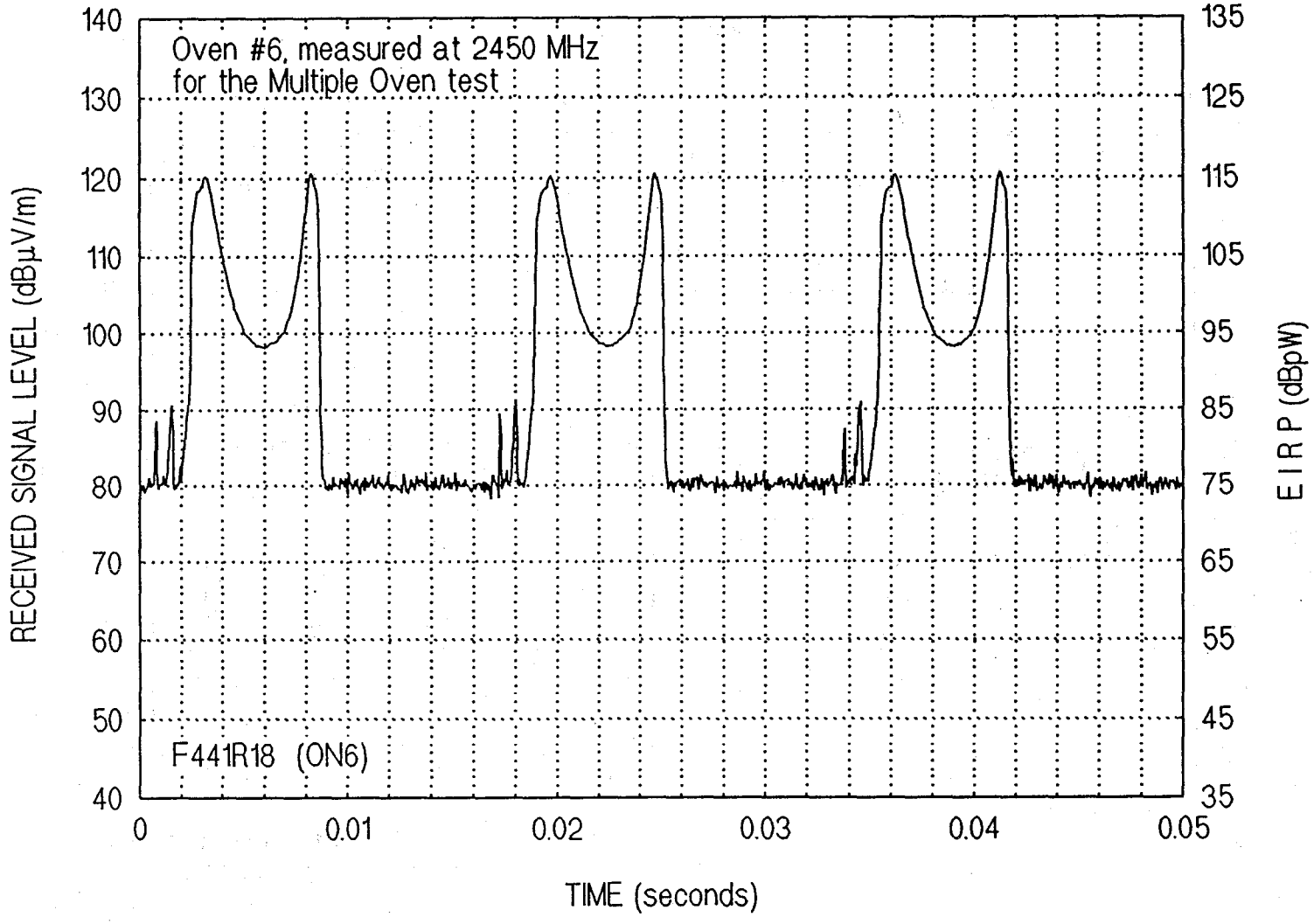


Figure C-130. Oven #6, measured at 2450 MHz, for the multiple oven test.

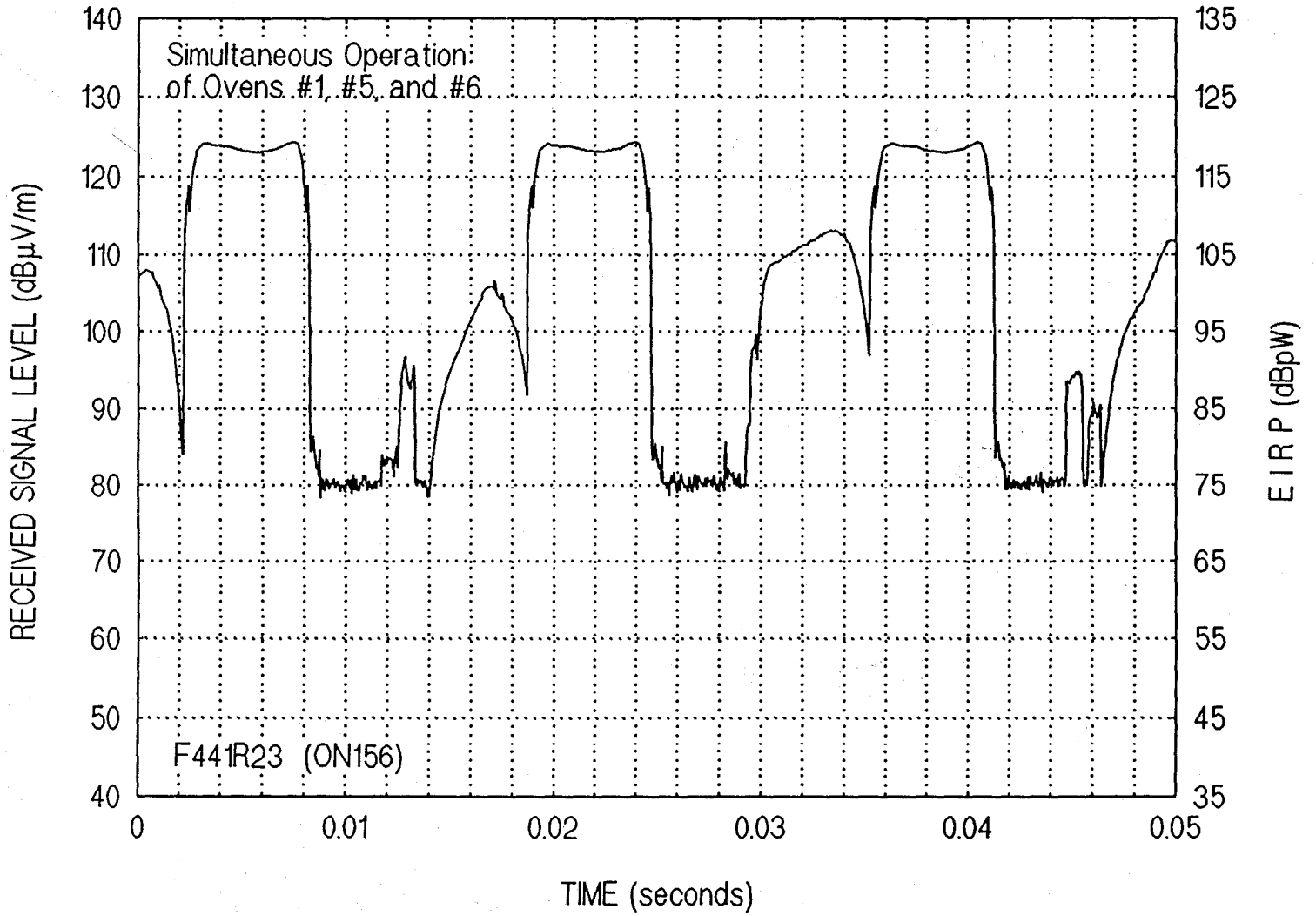


Figure C-131. Simultaneous operation of Ovens #1, #5, and #6, measured at 2450 MHz, for the multiple oven test.

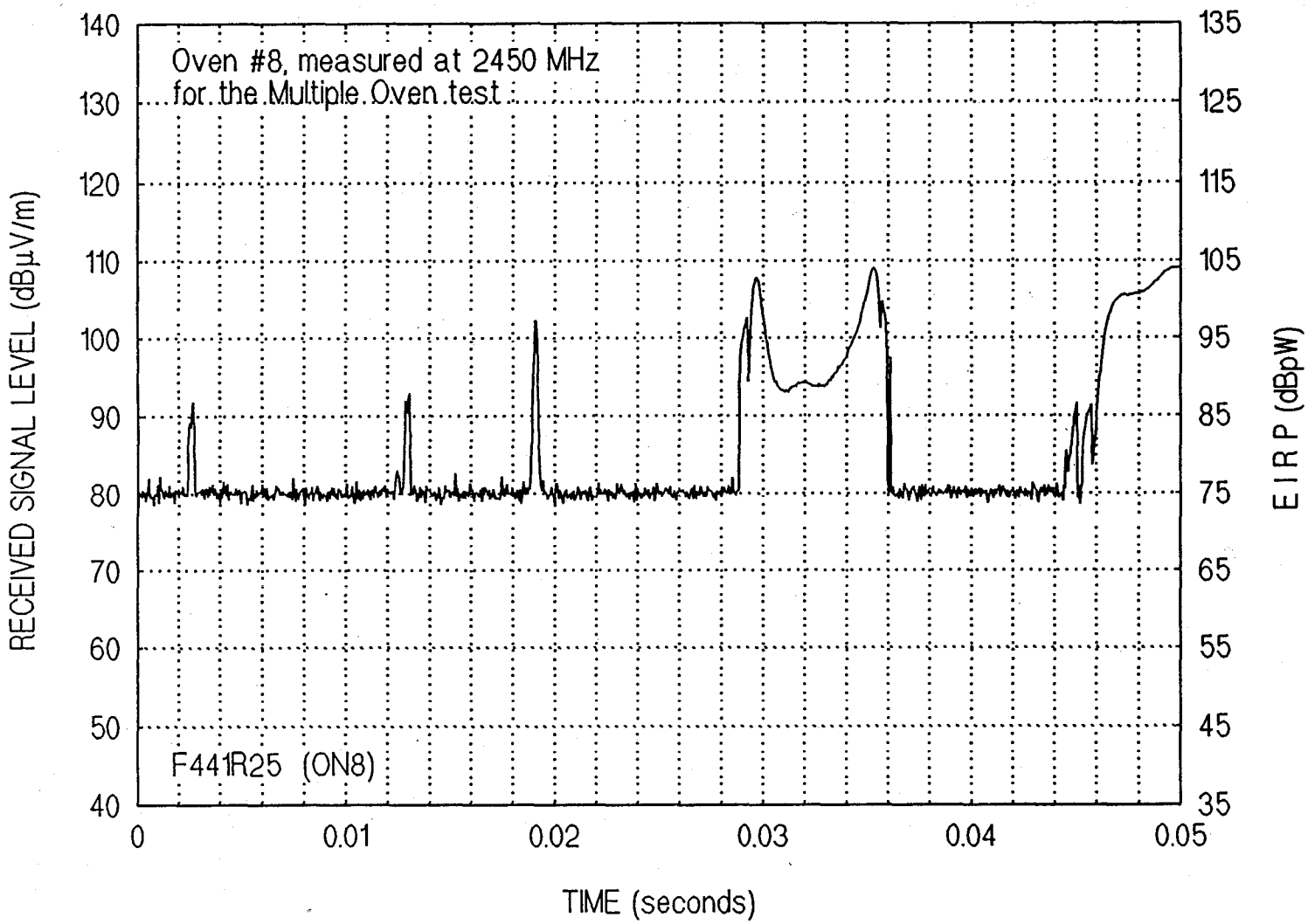


Figure C-132. Oven #8, measured at 2450 MHz, for the multiple oven test.

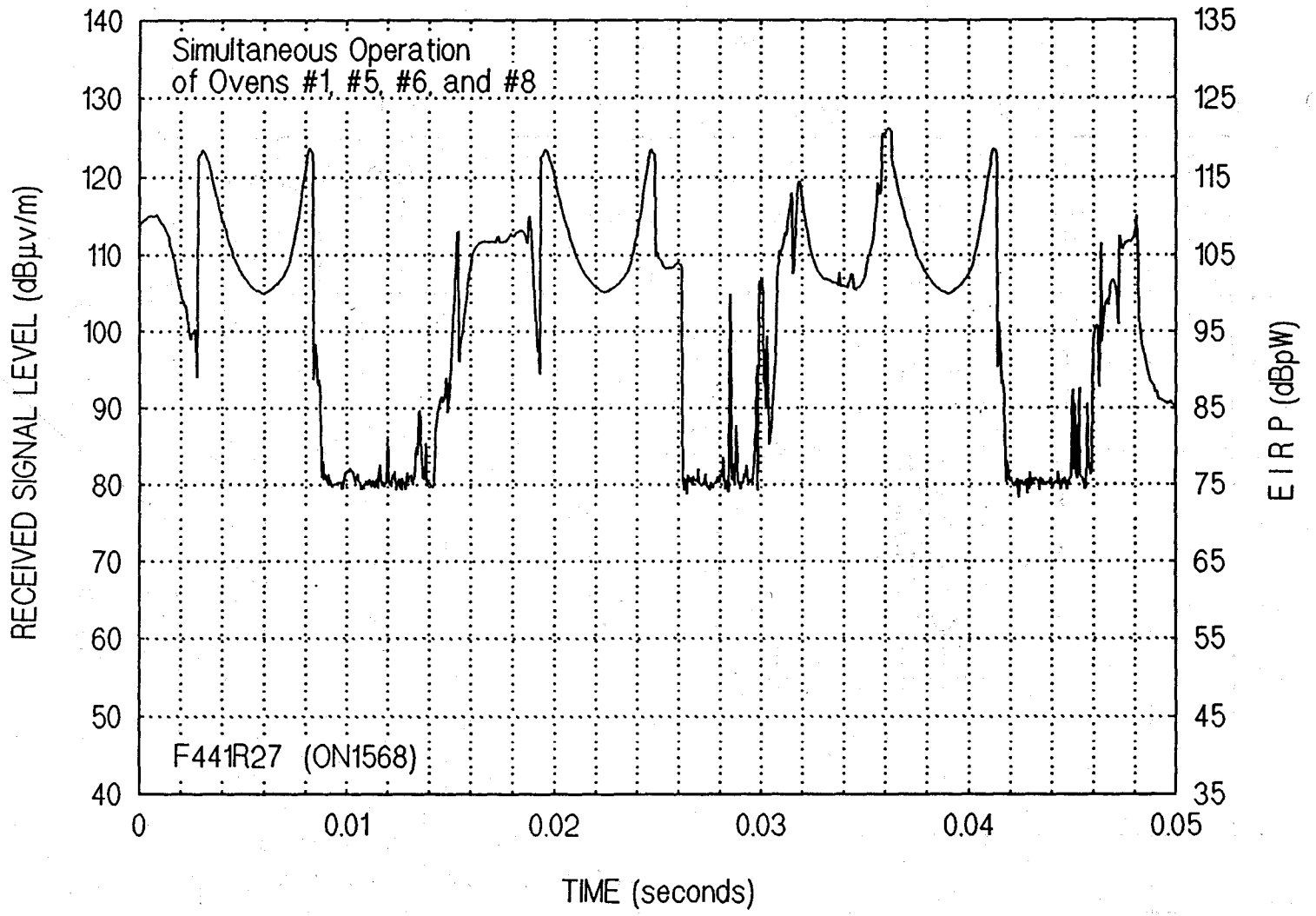


Figure C-133. Simultaneous operation of Ovens #1, #5, #6 and #8, measured at 2450 MHz, for the multiple oven test.

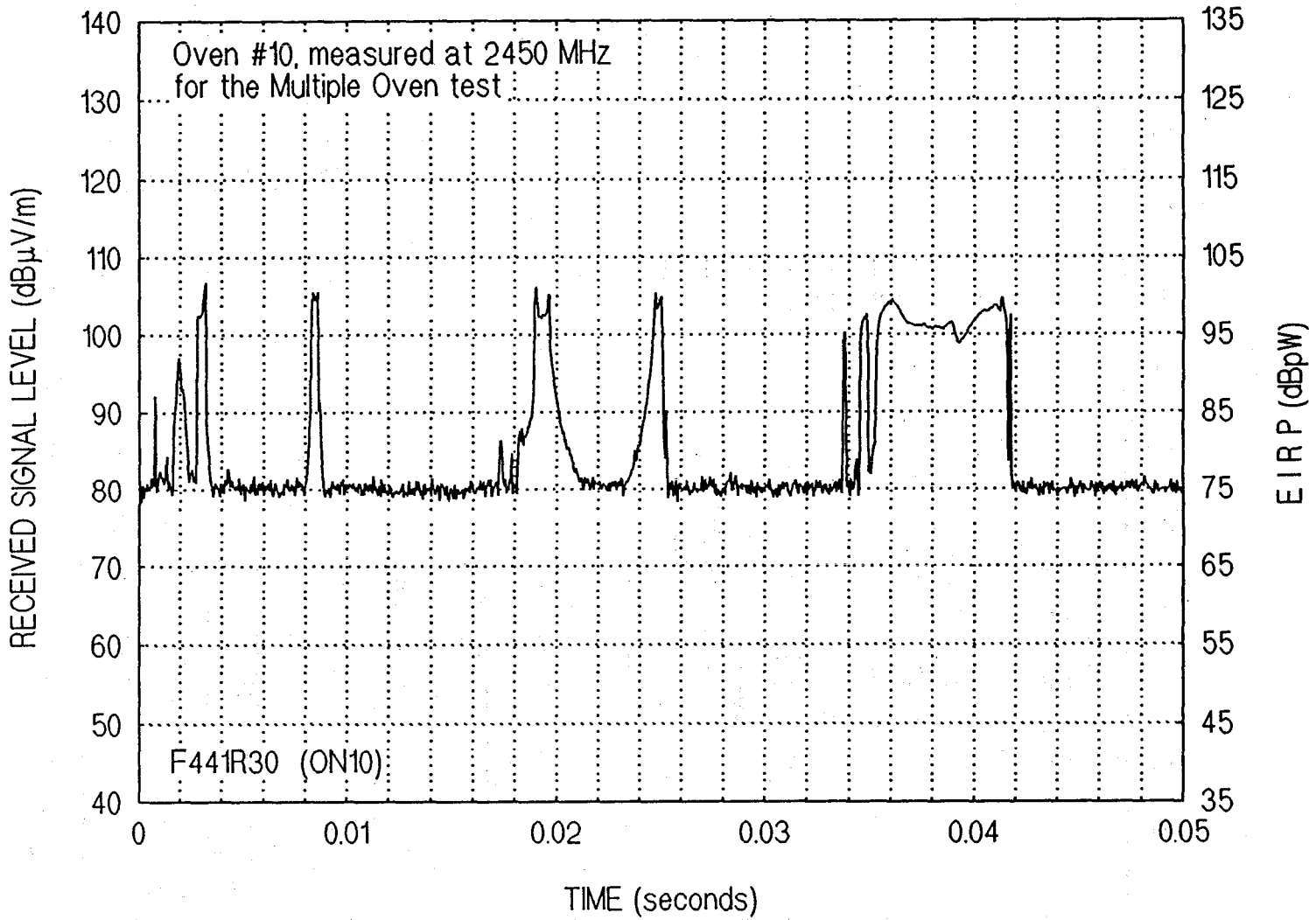


Figure C-134. Oven #10, measured at 2450 MHz, for the multiple oven test.

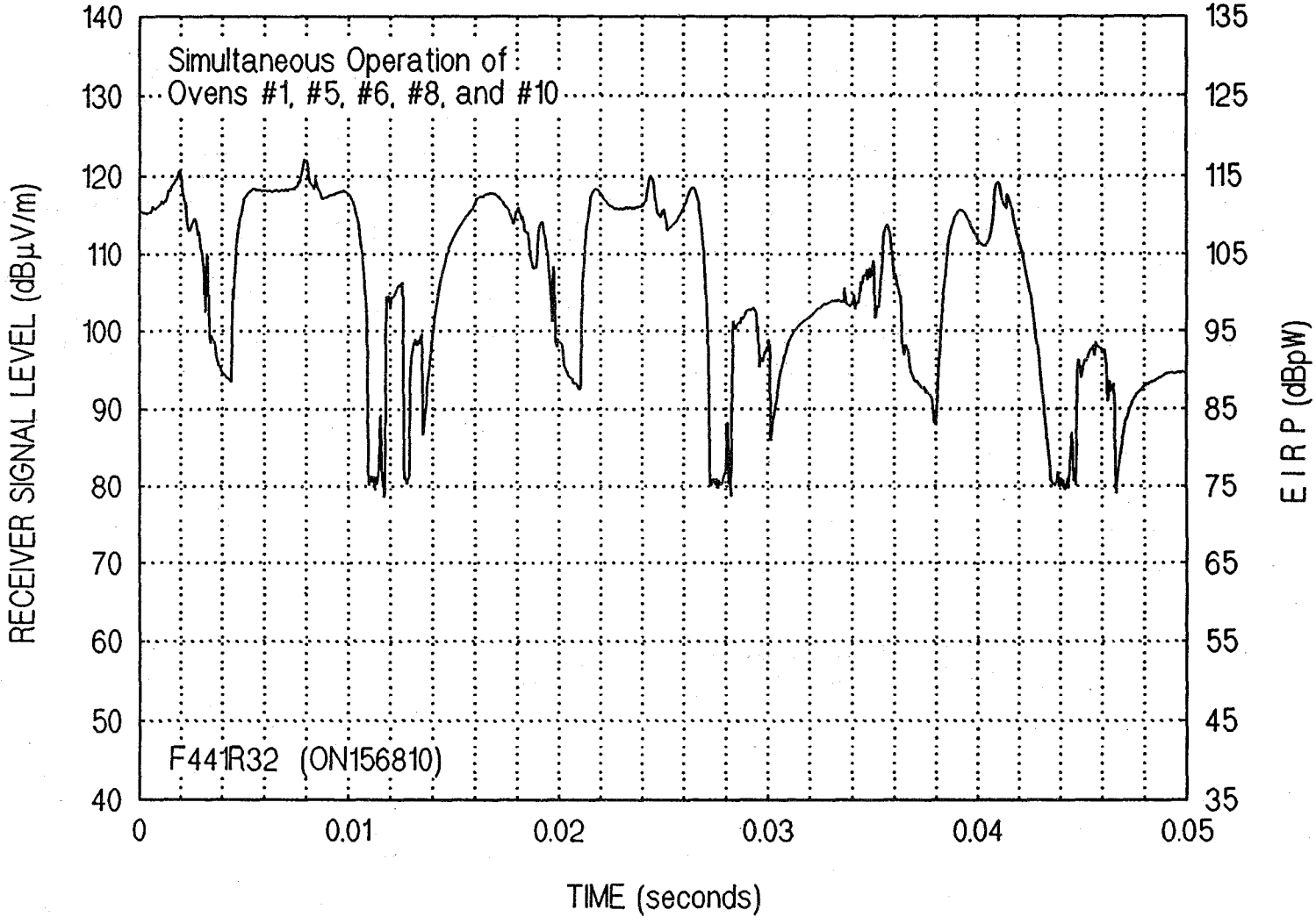


Figure C-135. Simultaneous operation of Ovens #1, #5, #6 #8 & #10, measured at 2450 MHz, multiple oven test.

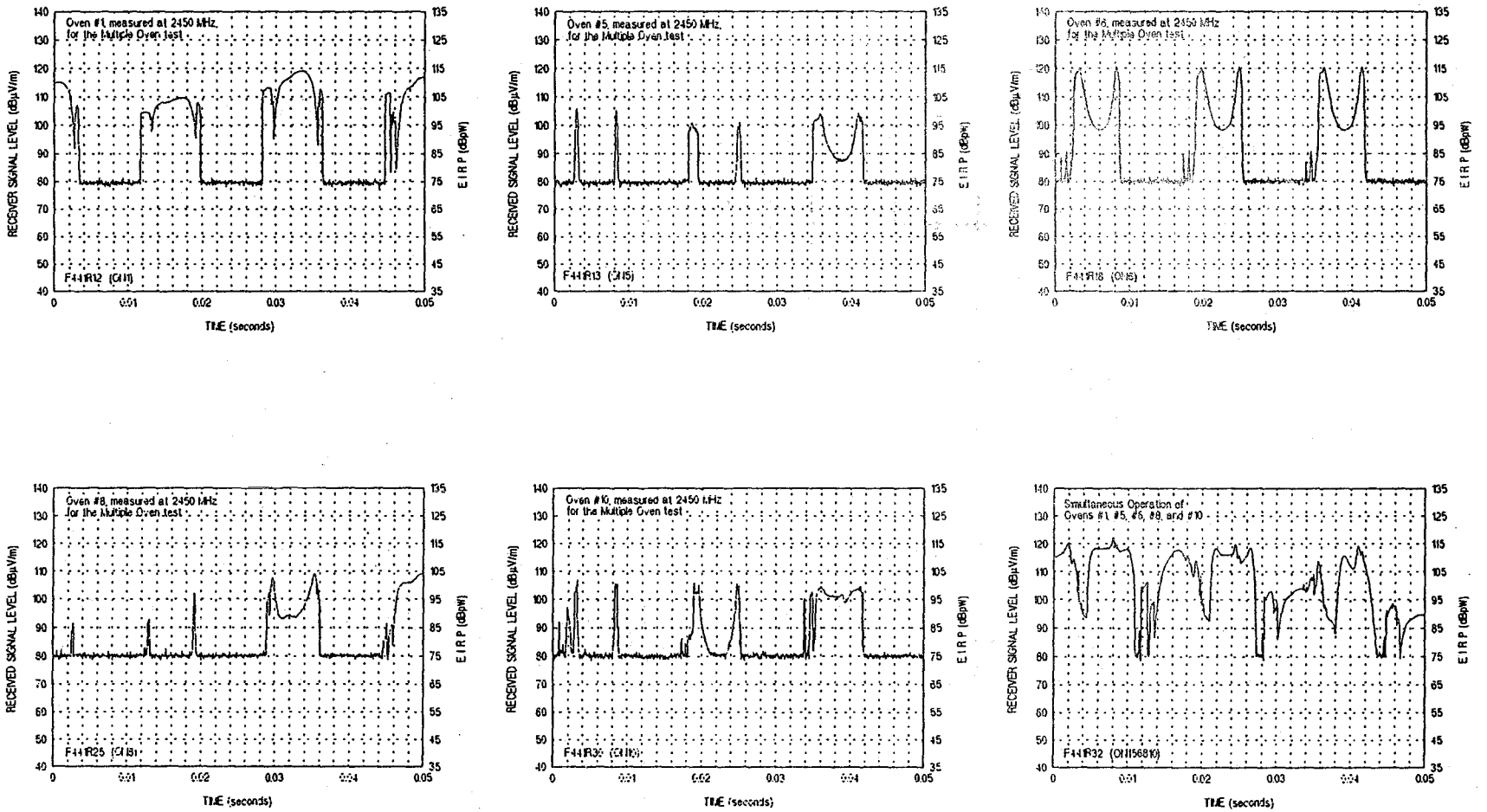
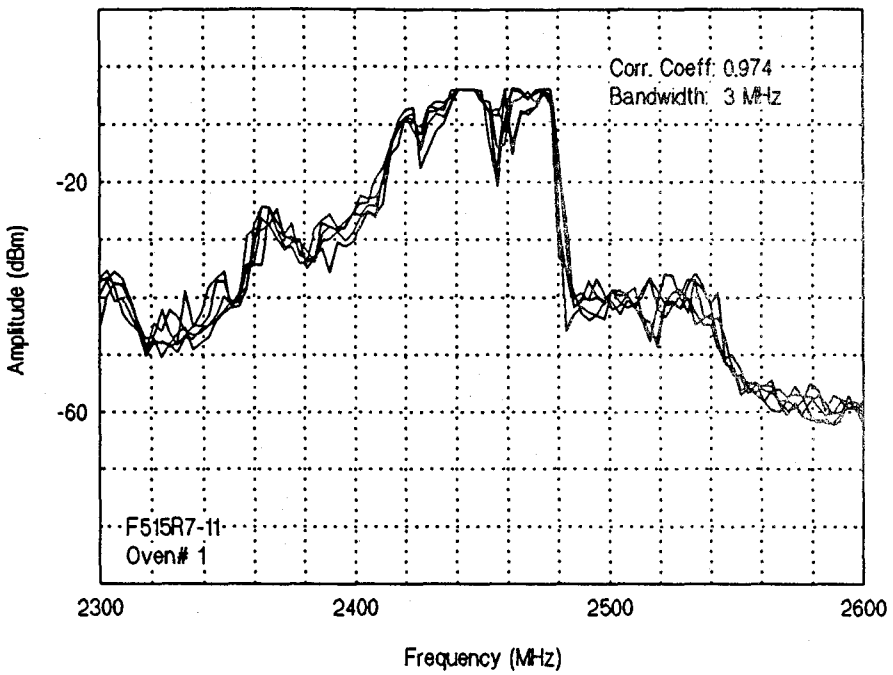


Figure C-136. Ovens #1, #5, #6, #8, and #10, all measured at 2450 MHz. Simultaneous operation of Ovens #1, #5, #6, #8, and #10 in a multiple oven test.

APPENDIX D

SPECTRUM VARIABILITY MEASUREMENTS

This Appendix contains a compilation of spectrum variation tests. The bandwidth condition and Pearson's correlation coefficient are noted individually on each of the first eleven graphs. The first 11 graphs are representations of five identical tests done at different times within a 15 minutes time span. These are displayed in Figures D-1 through D-6. The next five graphs display the findings of data in a 3 MHz measurement bandwidth that were put through a process to determine the maximum, the minimum, and the mean values. These are displayed in Figures D-7 through D-11.



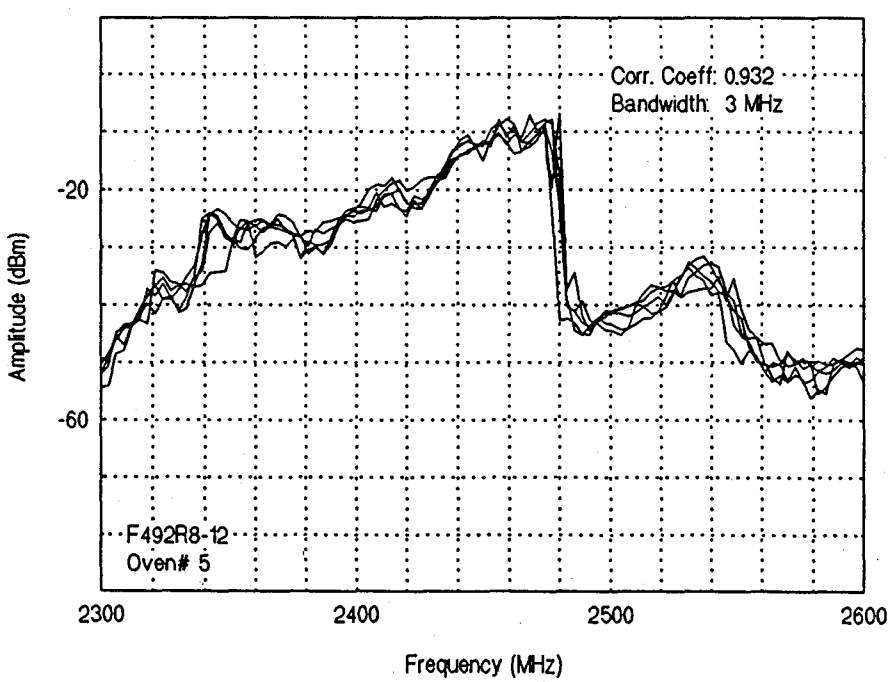
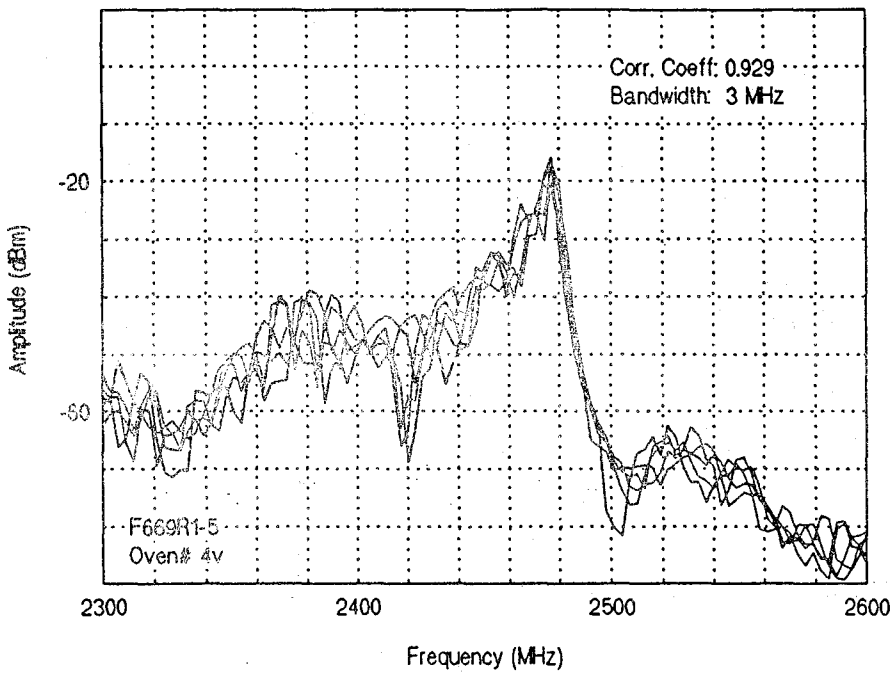


Figure D-1. Ovens #1 & #5, Oven Variability Tests.



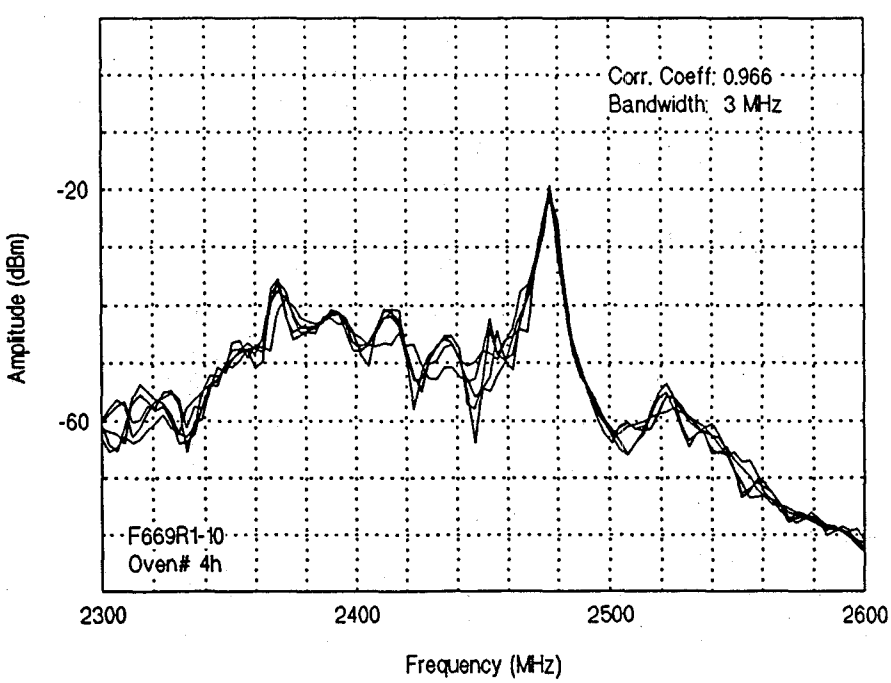
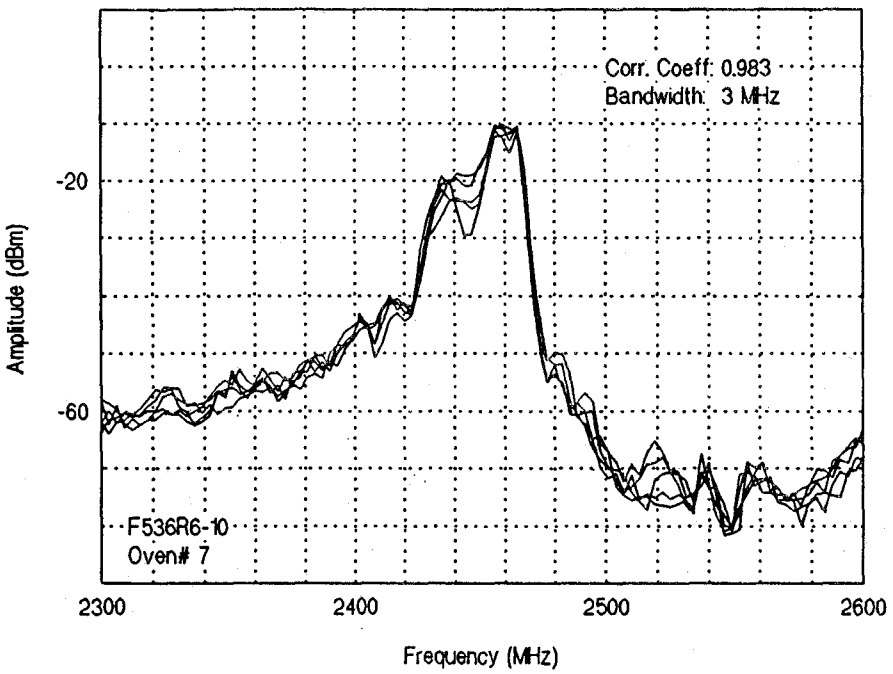


Figure D-2. Oven # 4. Oven Variability Tests.



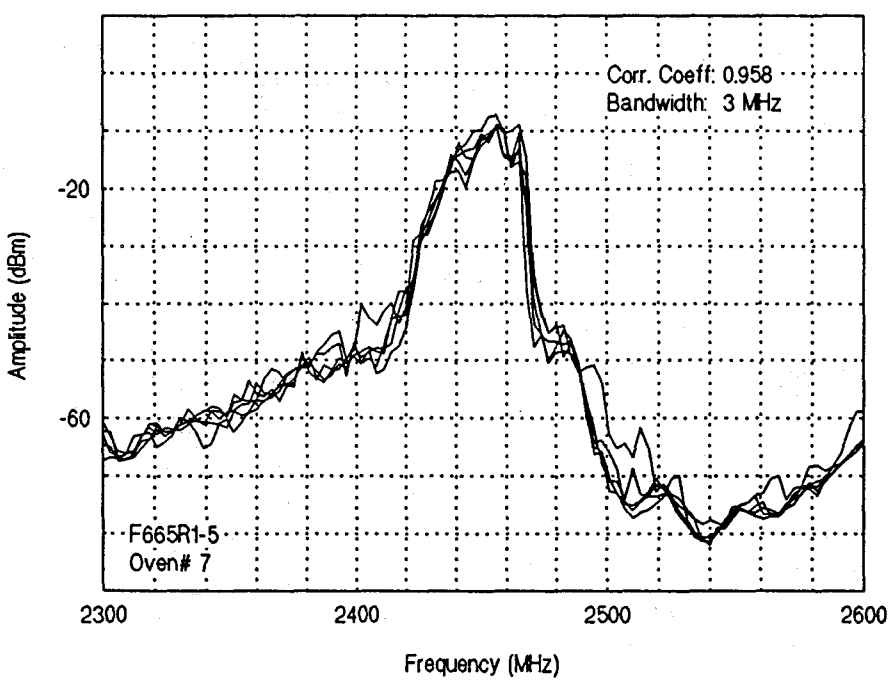
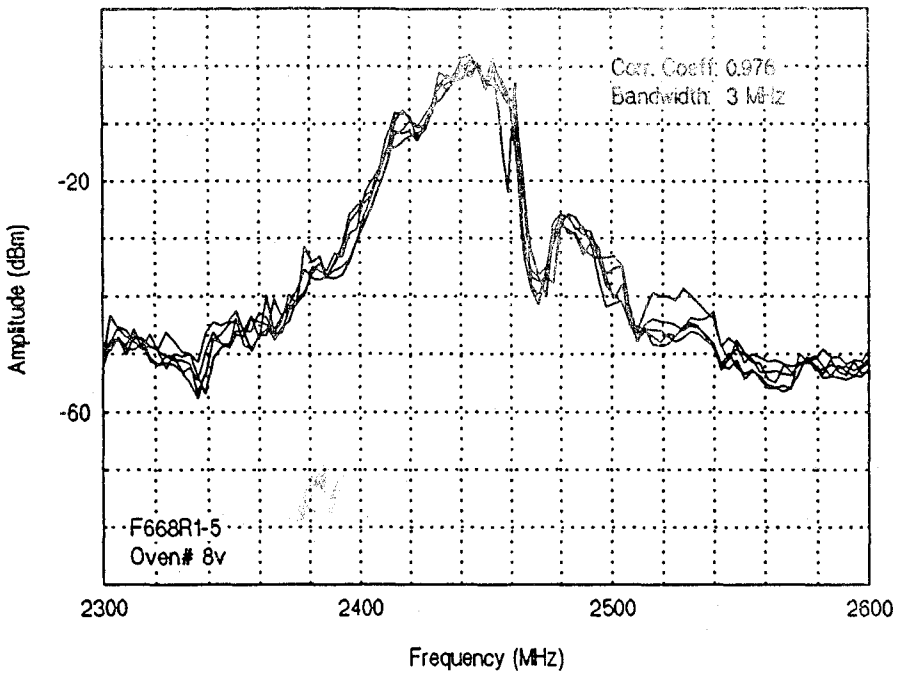


Figure D-3. Ovens #7 and #7DUP, Oven Variability Tests.



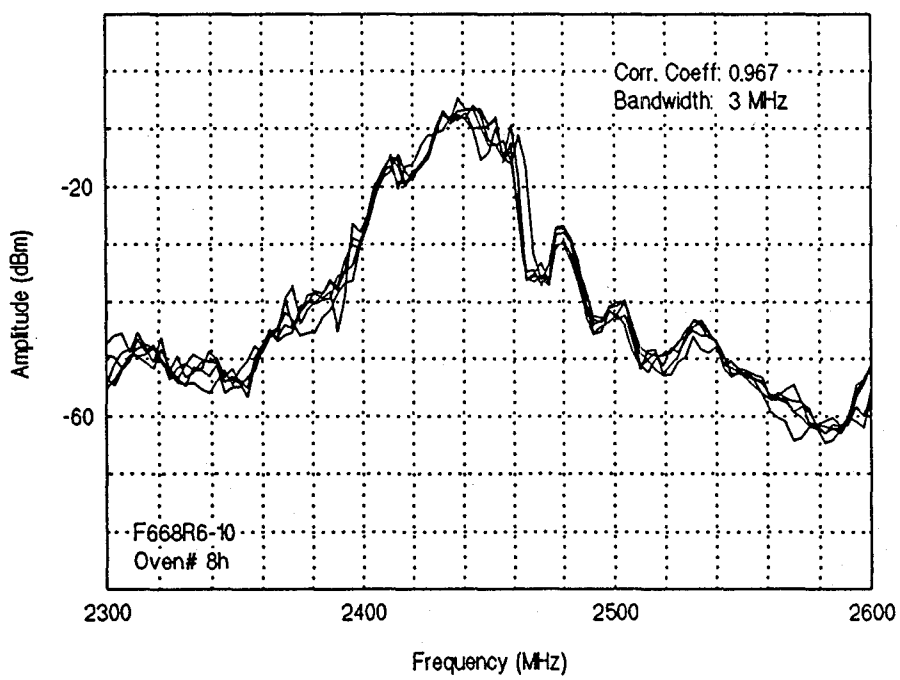
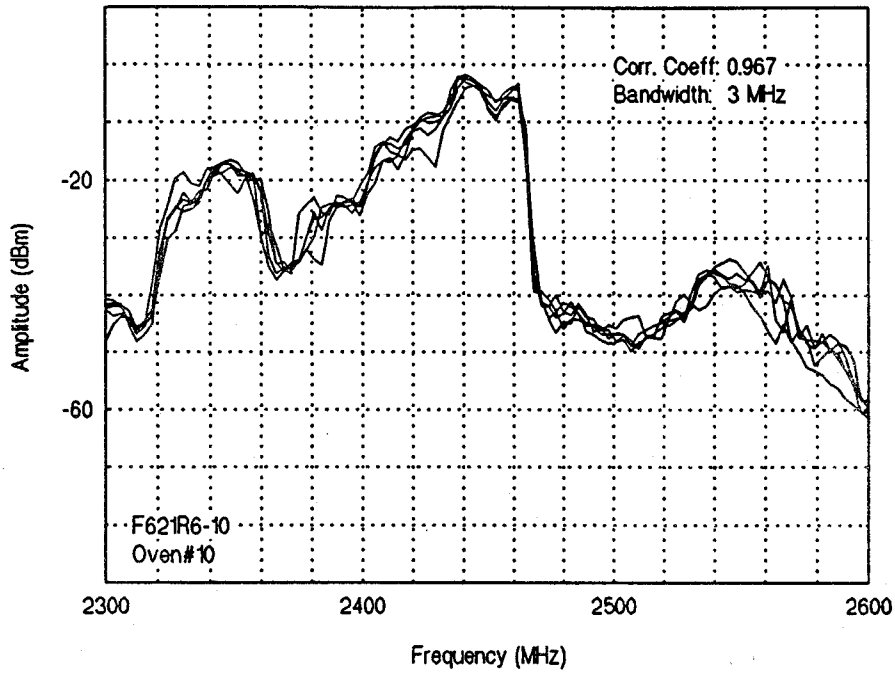


Figure D-4. Oven #8, Oven Variability Tests.



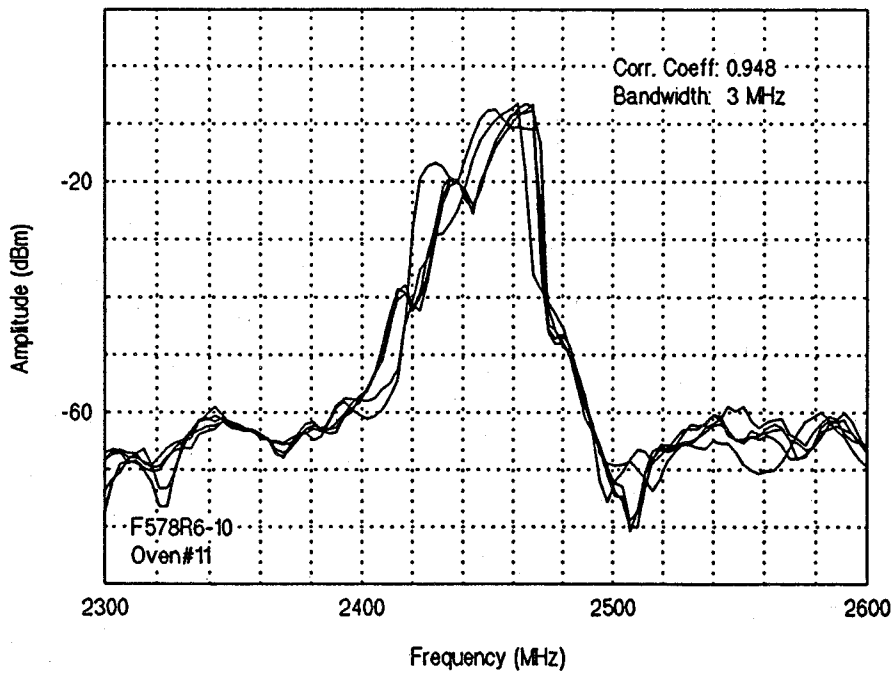


Figure D-5. Ovens #10 & #11, Oven Variability Tests.

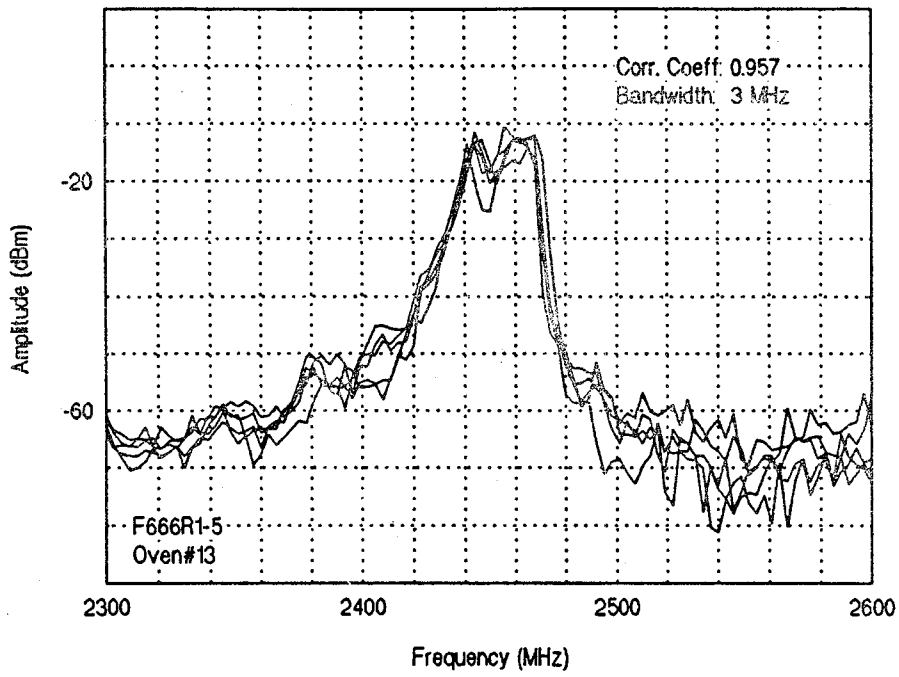


Figure D-6. Oven #13, Oven Variability Tests.

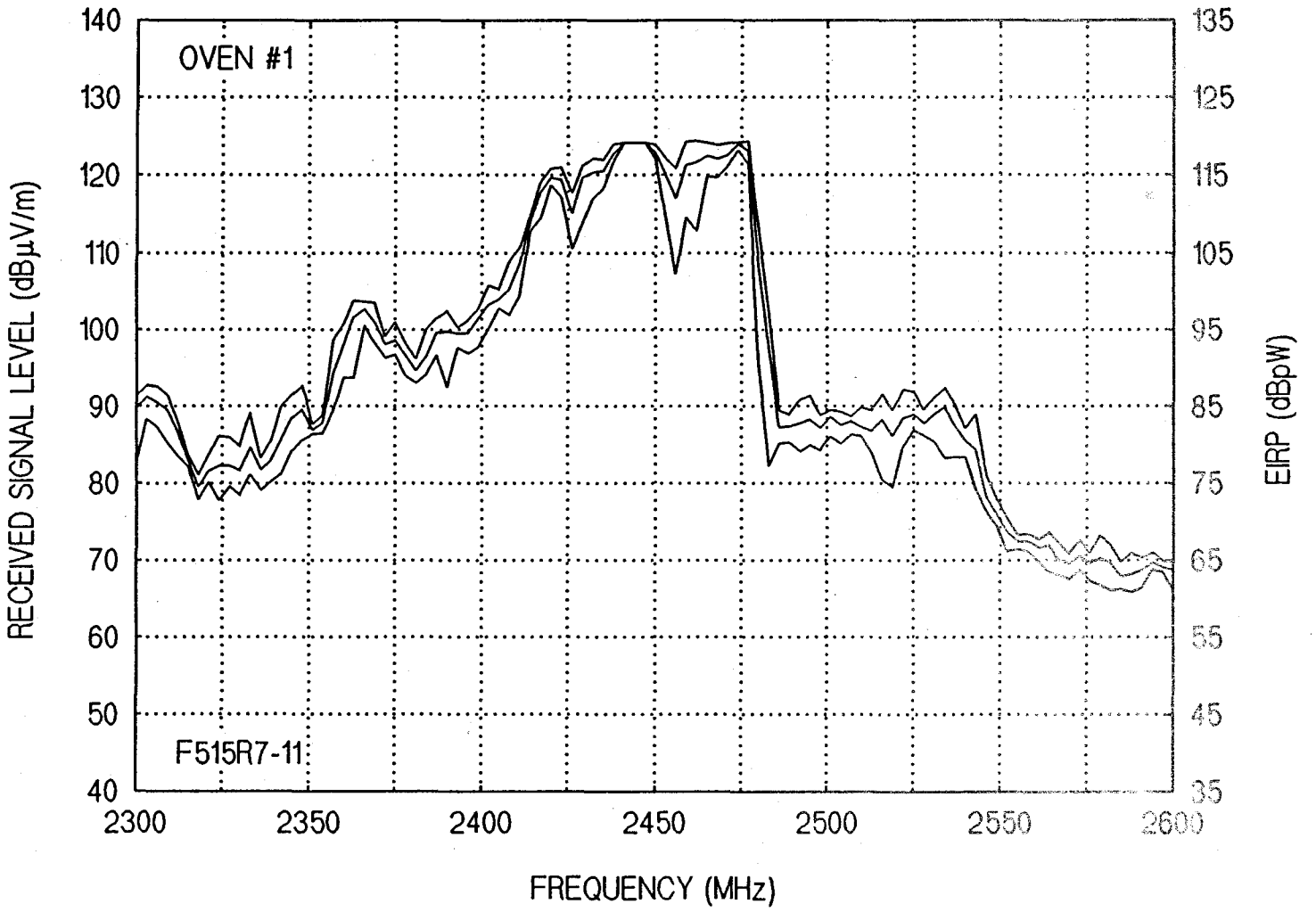


Figure D-7. Oven #1, Variability: Max, Mean, Min for Five Measured Spectra.

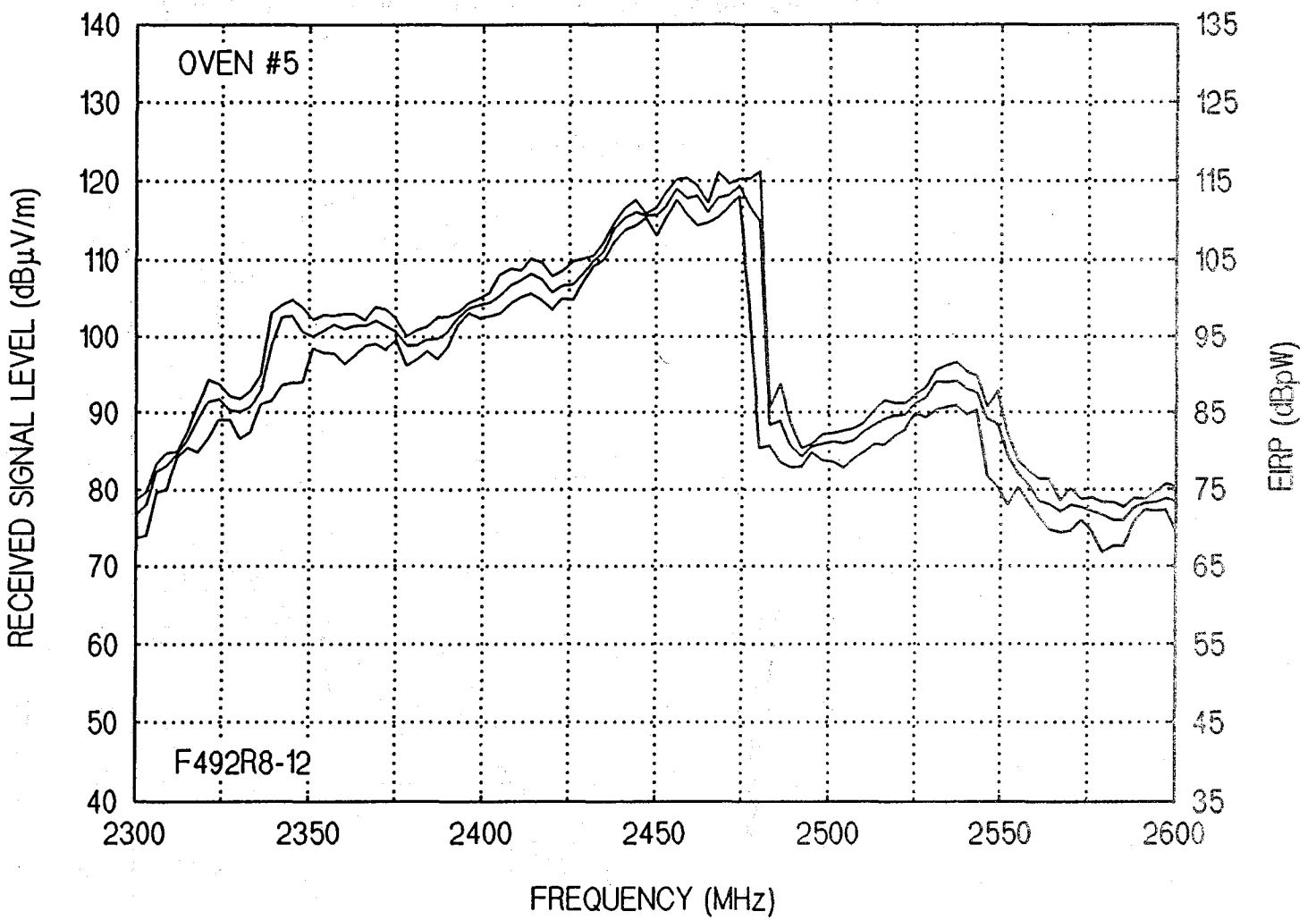


Figure D-8. Oven #5, Variability: Max, Mean, Min for Five Measured Spectra.

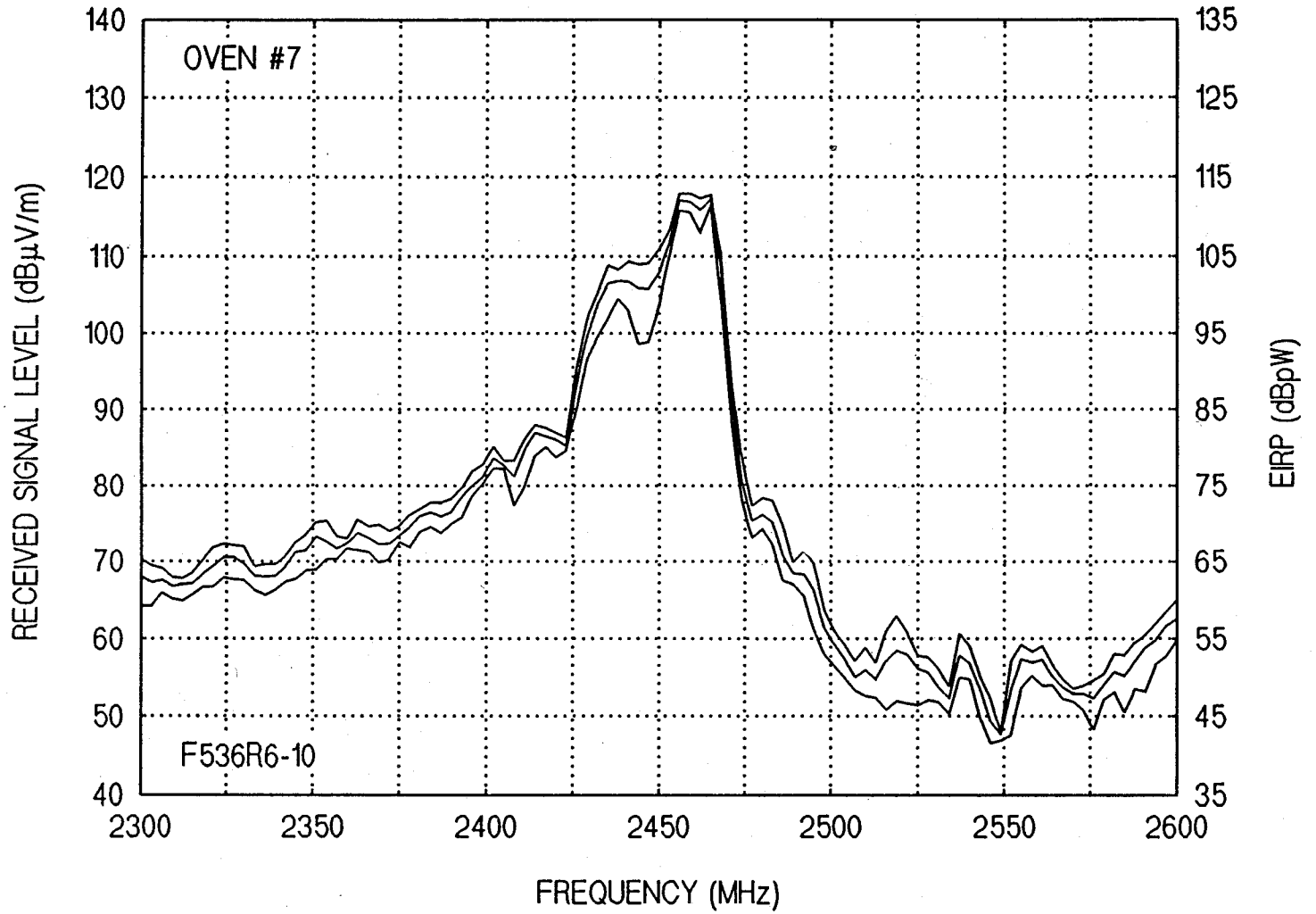


Figure D-9. Oven #7, Variability: Max, Mean, Min for Five Measured Spectra.

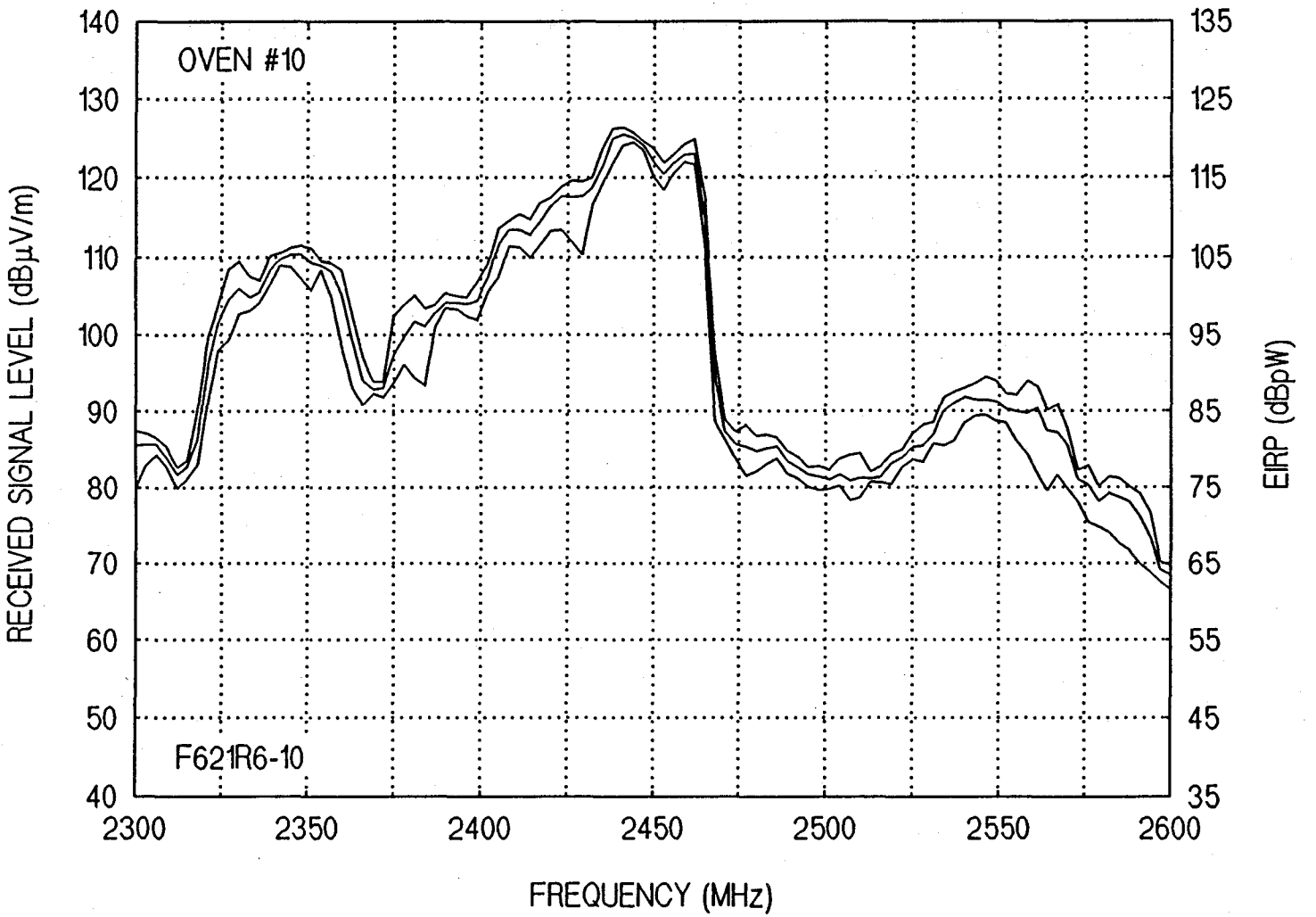


Figure D-10. Oven #10, Variability: Max, Mean, Min for Five Measured Spectra.

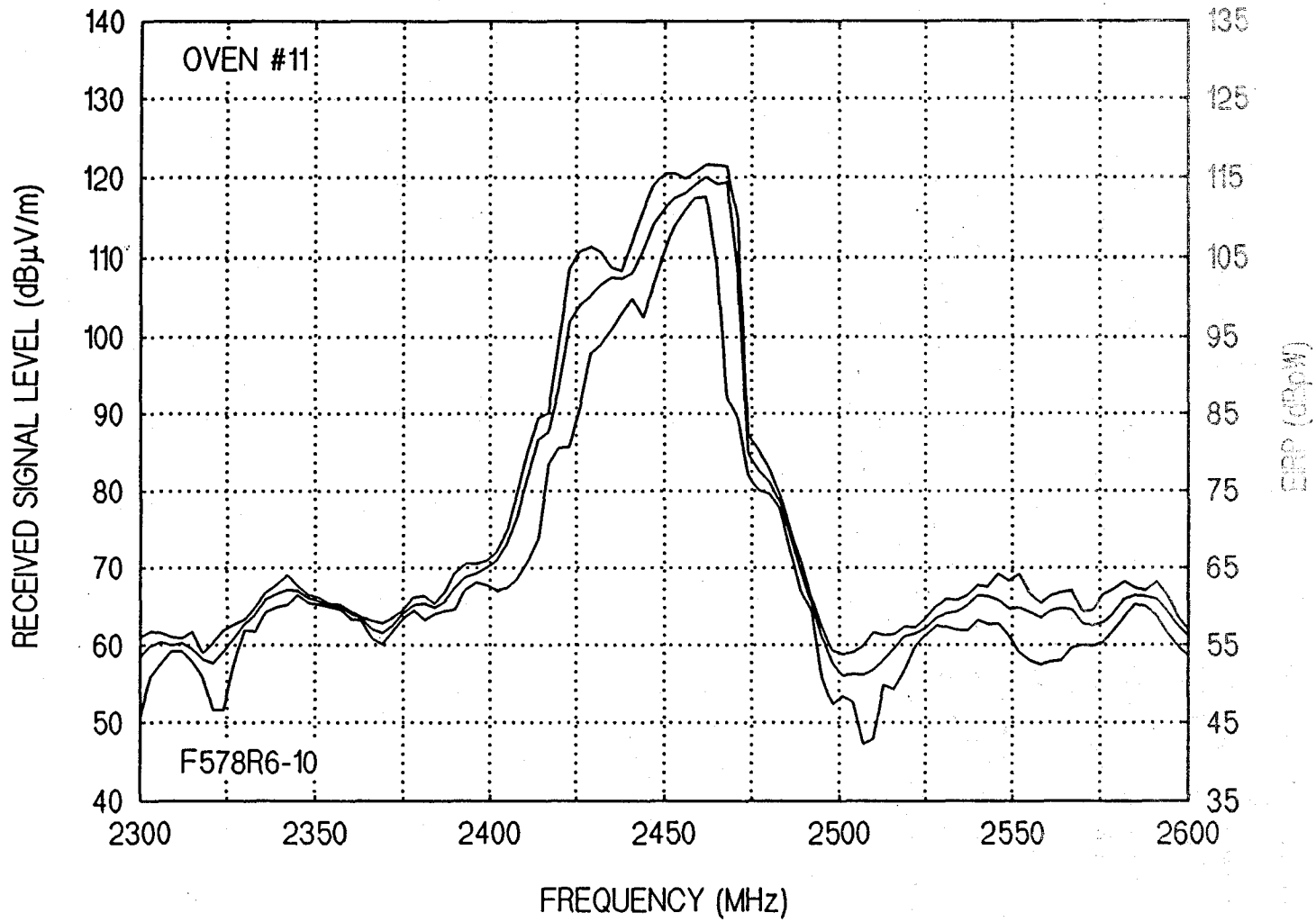


Figure D-11. Oven #11, Variability: Max, Mean, Min for Five Measured Spectra.

APPENDIX E

HARMONIC EMISSION LEVEL MEASUREMENTS

This appendix contains the measurements of harmonic amplitude levels in dBμV/m and dBpW for Ovens #1, #2, #6, #7, and #8. The harmonic frequencies were measured out to the 7th harmonic range: 4800-5000 MHz, 7200-7500 MHz, 9600-10000 MHz, 12.0-12.5 GHz, 14.4-15.0 GHz, and 16.8-17.5 GHz.

In measurements of oven data, there were several levels that represent the measurement noise floor adjusted for the gain of the measurement antenna and not actual emission levels: Oven #1, 7th harmonic range between 17.4 and 17.5 GHz (see Figure E-7); Oven #6, 5th harmonic range between 12.38 and 12.42 GHz (see Figure E-19); Oven #6, 7th harmonic range between 17.4 and 17.5 GHz (see Figure E-21); Oven #8, 5th harmonic range between 12.38 and 12.44 GHz (see Figure E-33); Oven #8, 7th harmonic range between 17.4 and 17.5 GHz (see Figure E-36). At those frequencies ranges the harmonic levels fell below that system noise and these figures do not show the actual emission levels.

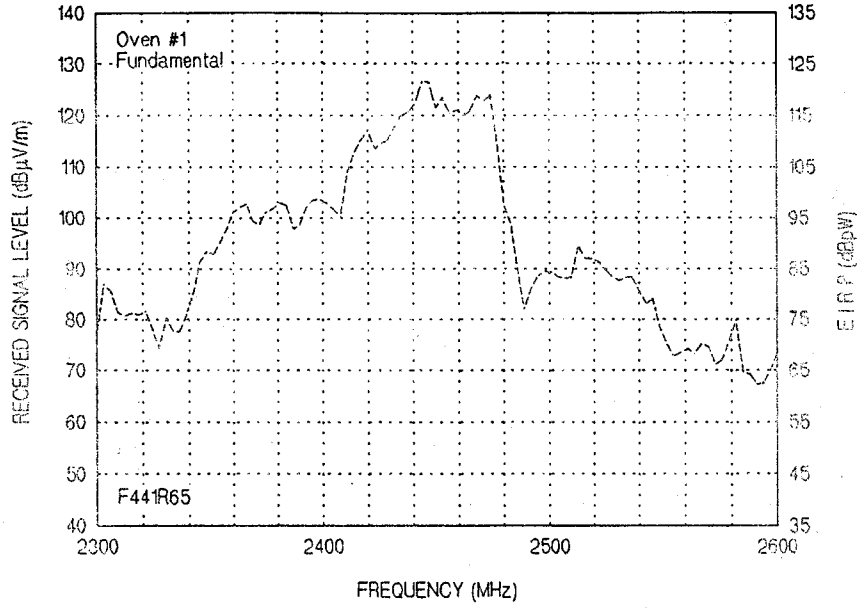


Figure E-1. Oven #1, Fundamental frequency range vs. amplitude.

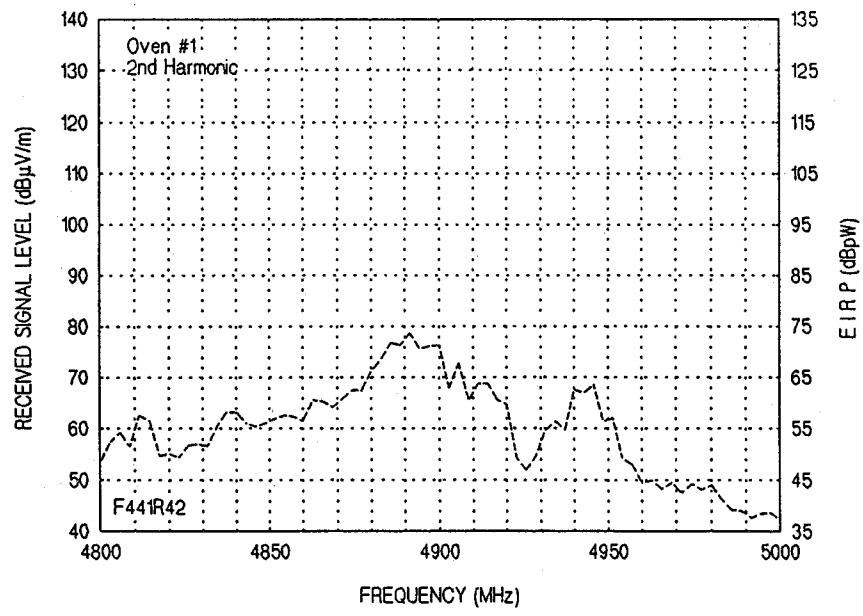


Figure E-2. Oven #1, 2nd Harmonic frequency range vs. amplitude.

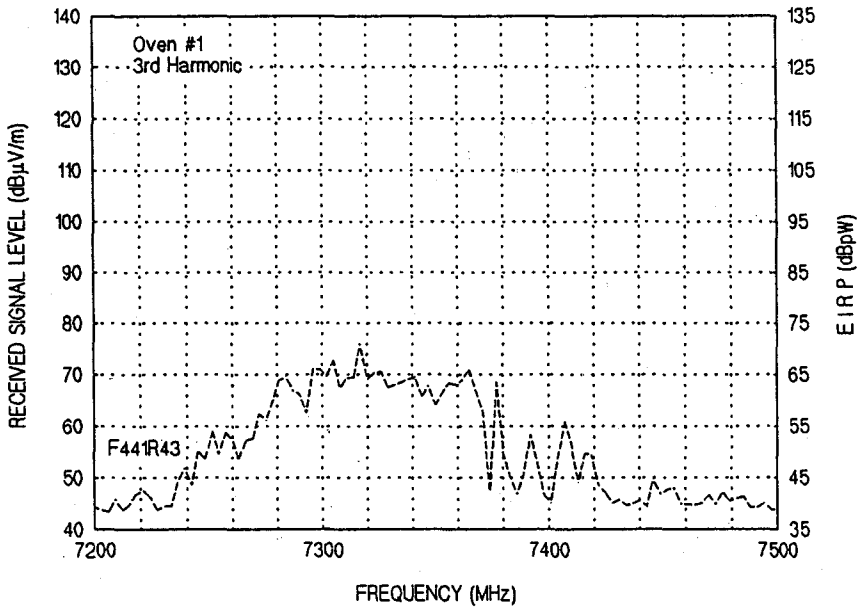


Figure E-3. Oven #1, 3rd Harmonic frequency range vs. amplitude.

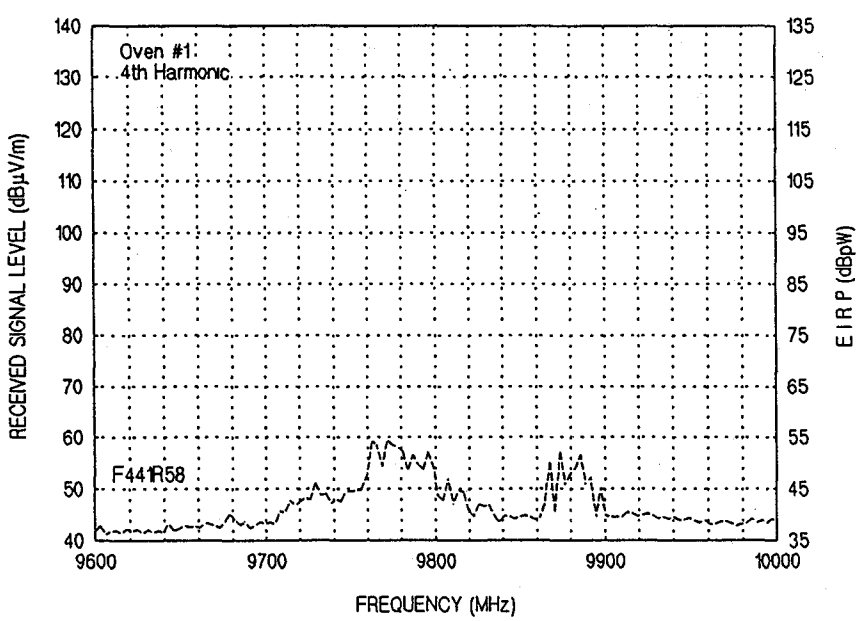


Figure E-4. Oven #1, 4th Harmonic frequency range vs. amplitude.

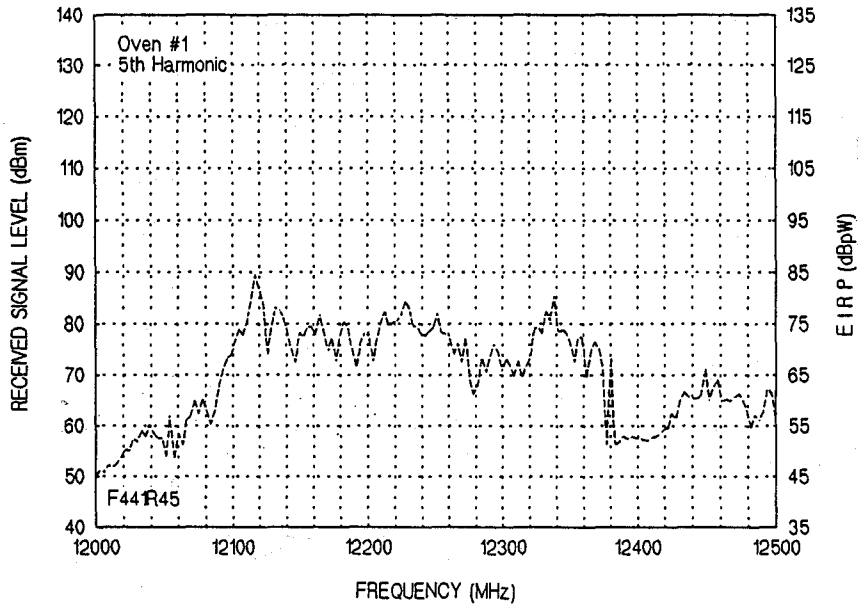


Figure E-5. Oven #1, 5th Harmonic frequency range vs. amplitude.

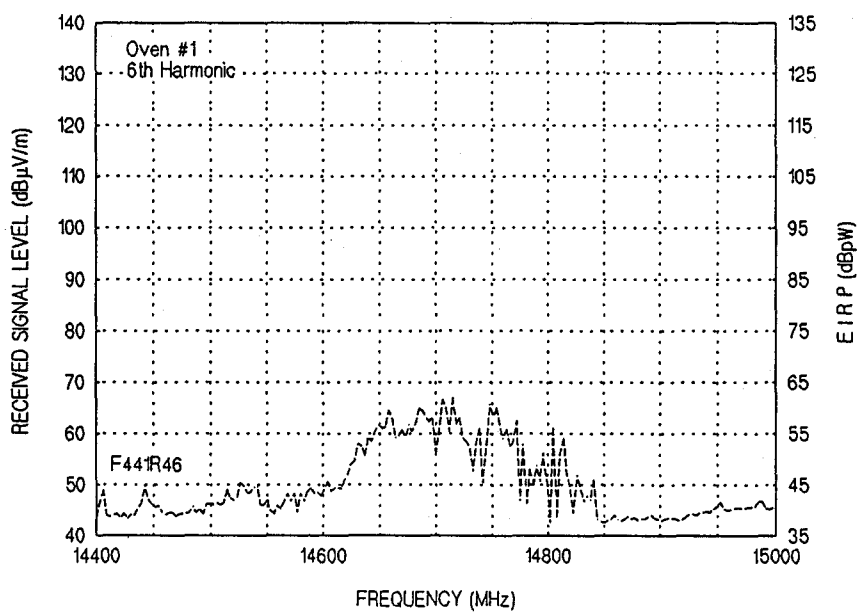


Figure E-6. Oven #1, 6th Harmonic frequency range vs. amplitude.

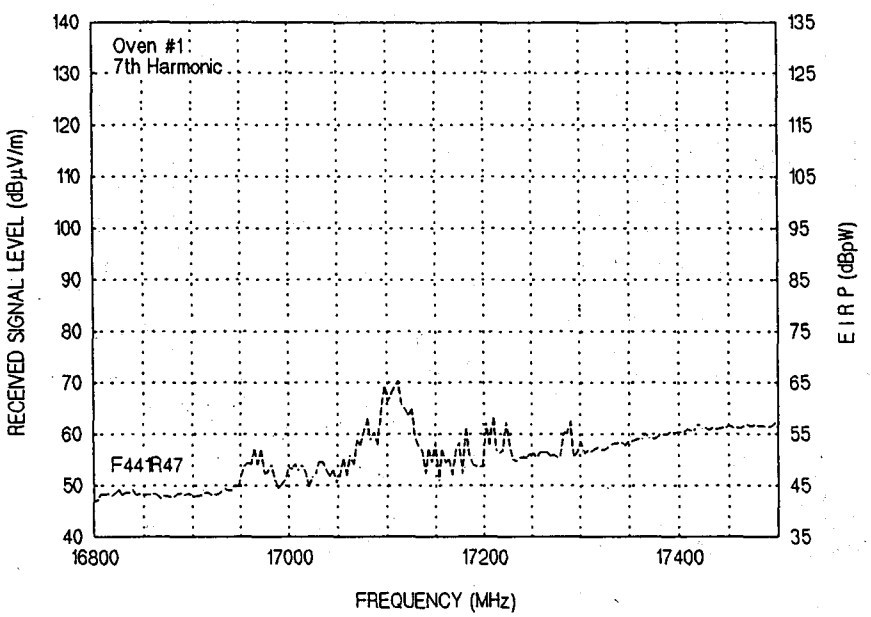


Figure E-7. Oven #1, 7th Harmonic frequency range vs. amplitude.

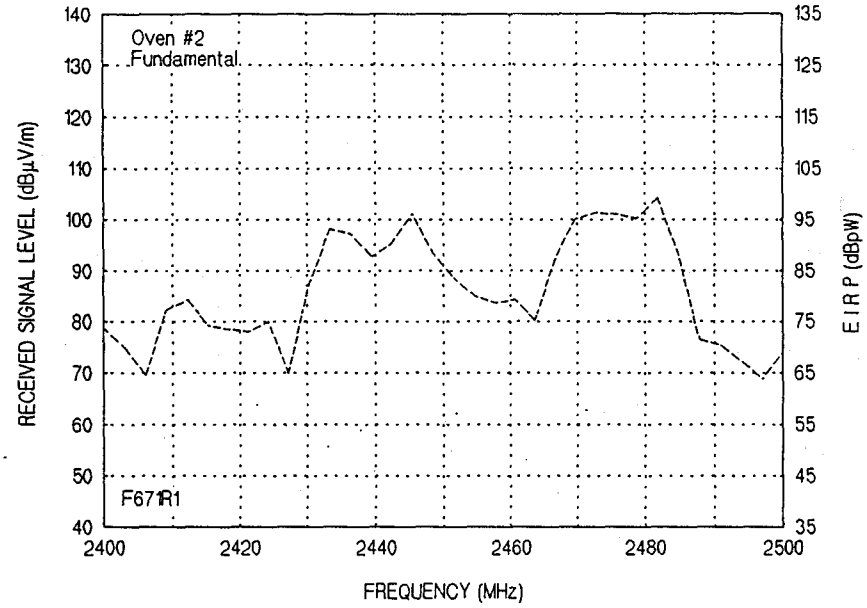


Figure E-8. Oven #2, Fundamental frequency range vs. amplitude.

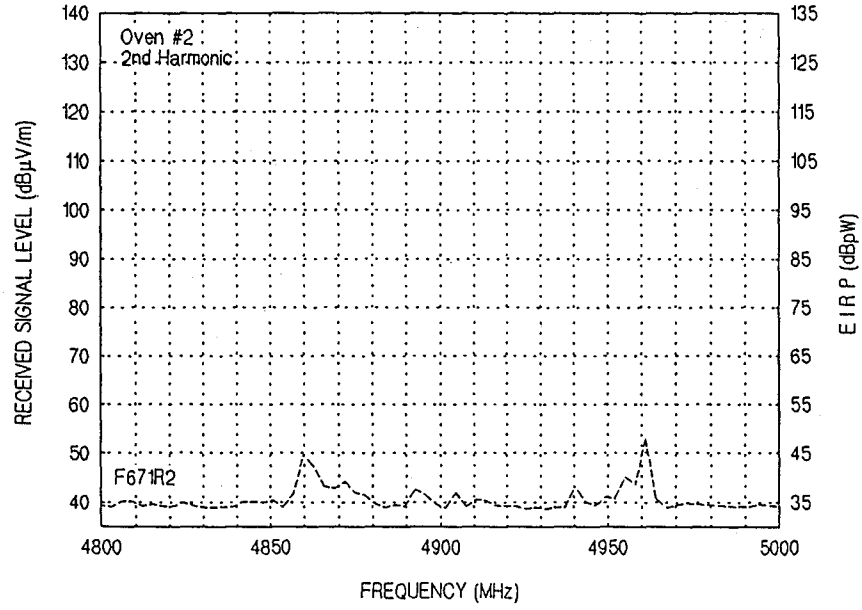


Figure E-9. Oven #2, 2nd Harmonic frequency range vs. amplitude.

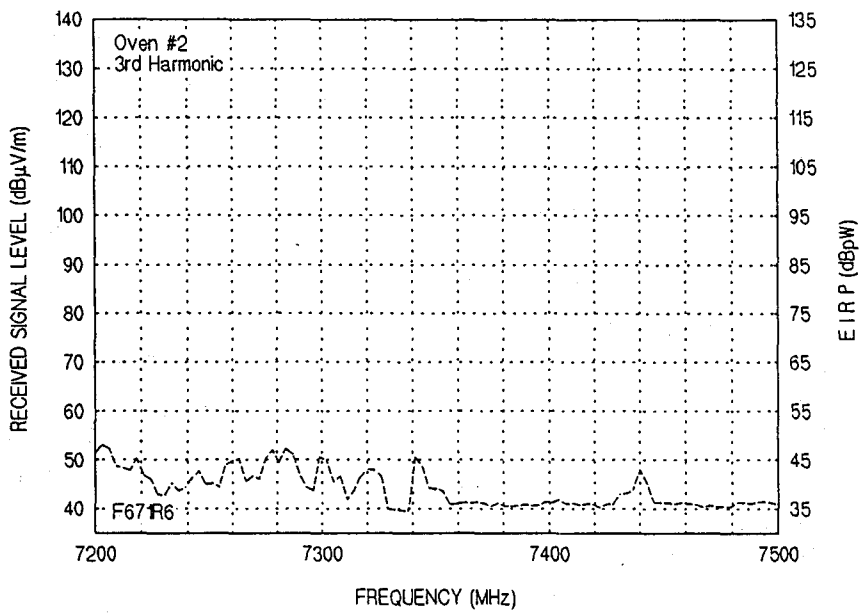


Figure E-10. Oven #2, 3rd Harmonic frequency range vs. amplitude.

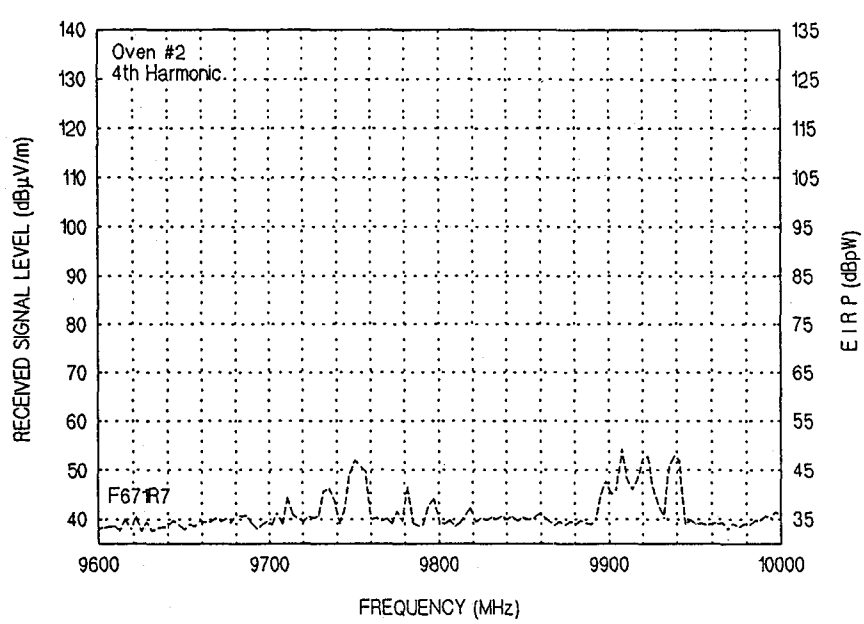


Figure E-11. Oven #2, 4th Harmonic frequency range vs. amplitude.

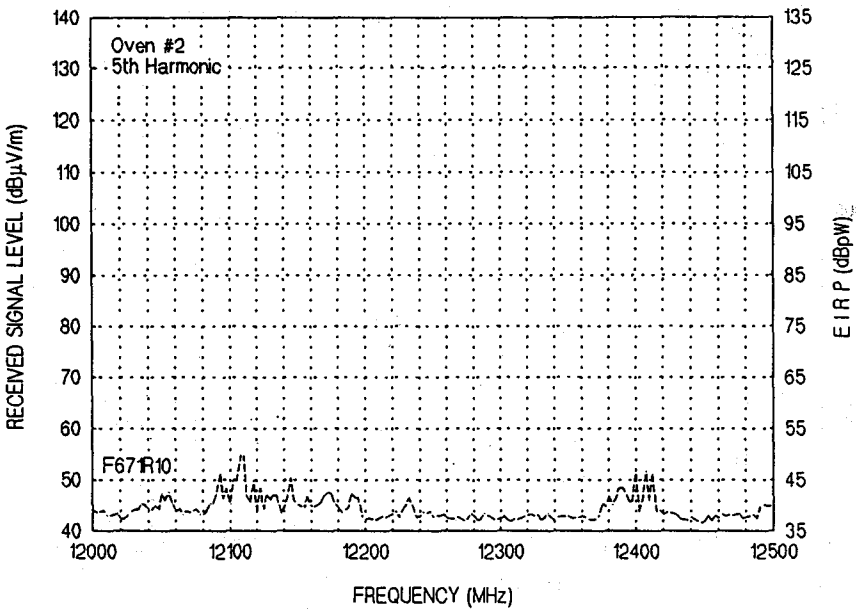


Figure E-12. Oven #2, 5th Harmonic frequency range vs. amplitude.

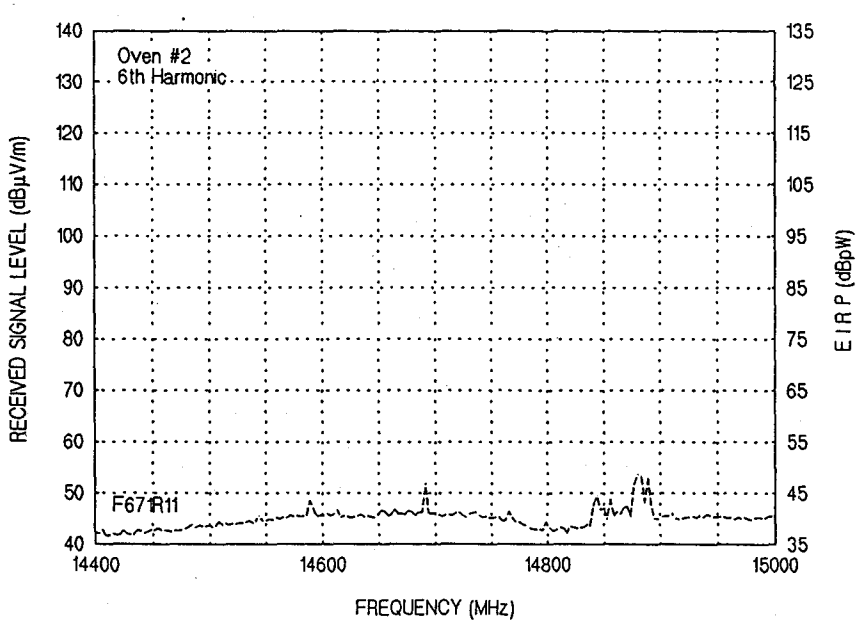


Figure E-13. Oven #2, 6th Harmonic frequency range vs. amplitude.

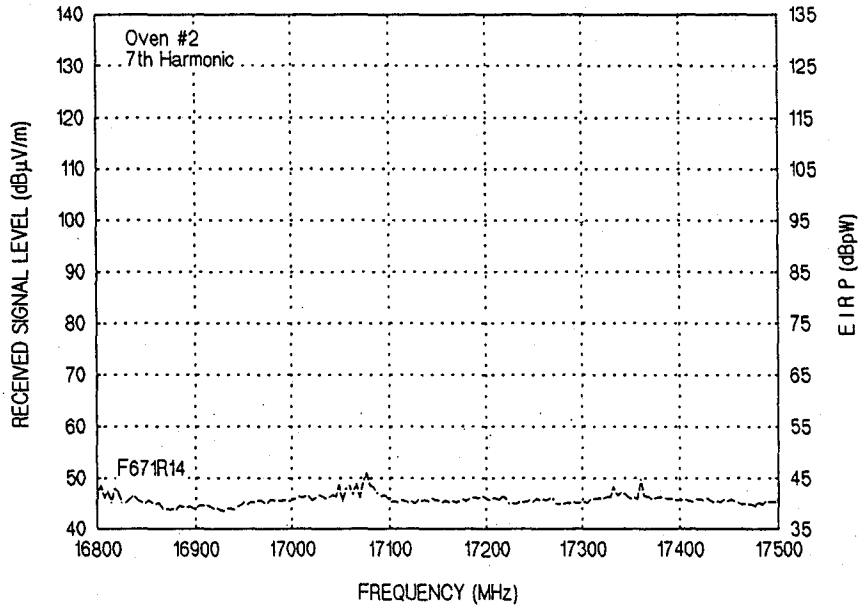


Figure E-14. Oven #2, 7th Harmonic frequency range vs. amplitude.

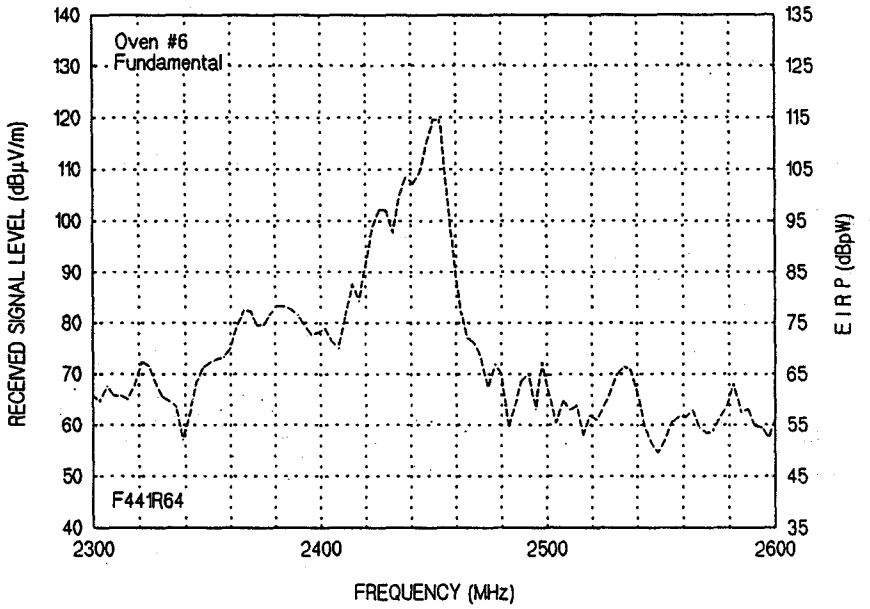


Figure E-15. Oven #6, Fundamental frequency range vs. amplitude.

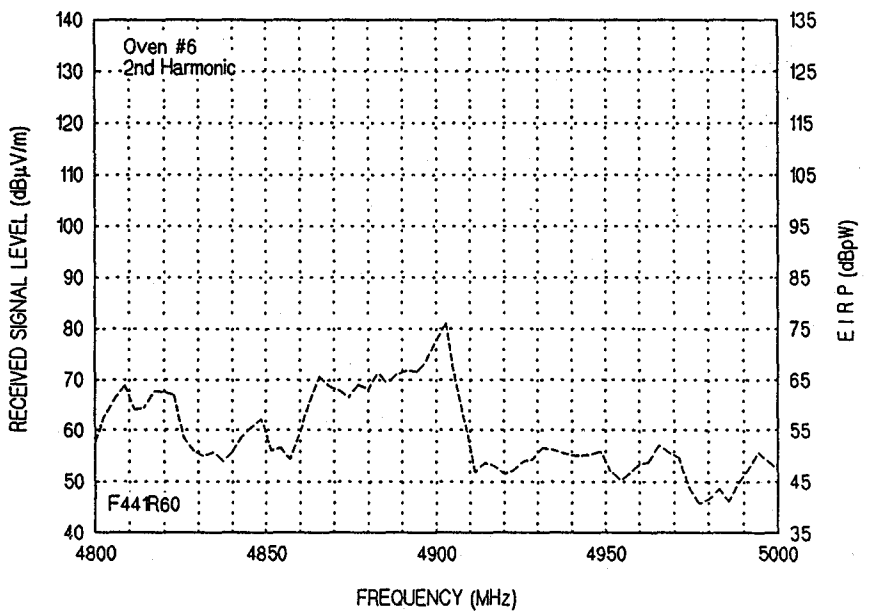


Figure E-16. Oven #6, 2nd Harmonic frequency range vs. amplitude.

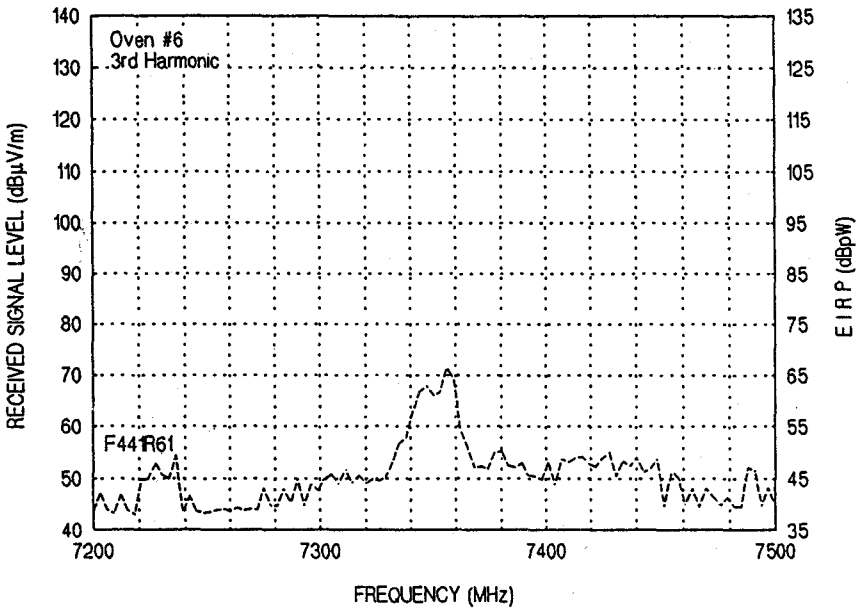


Figure E-17. Oven #6, 3rd Harmonic frequency range vs. amplitude.

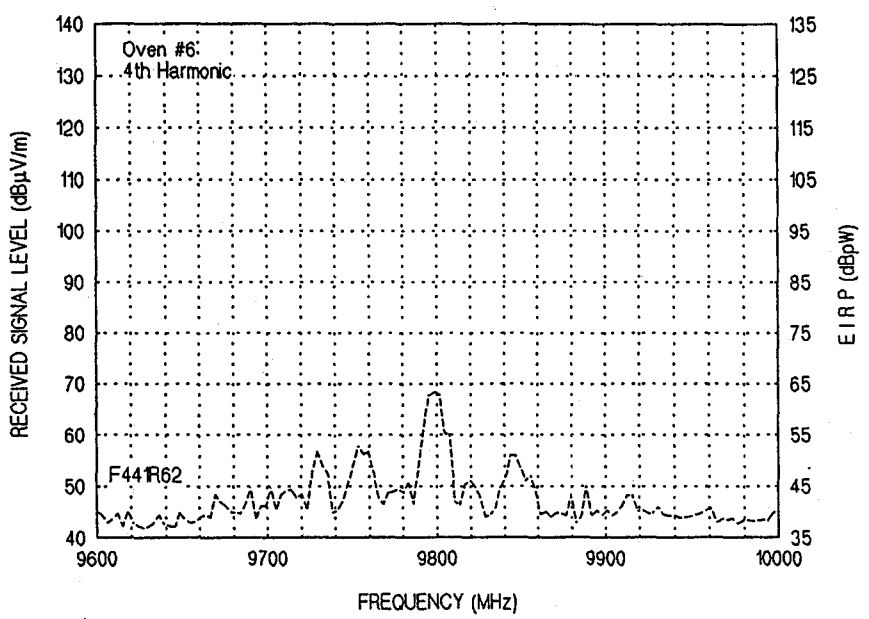


Figure E-18. Oven #6, 4th Harmonic frequency range vs. amplitude.

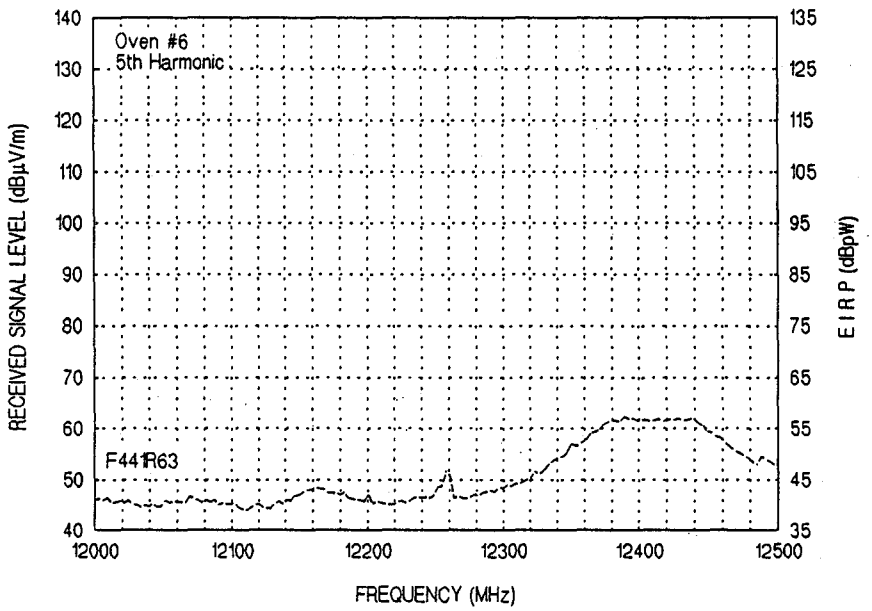


Figure E-19. Oven #6, 5th Harmonic frequency range vs. amplitude.

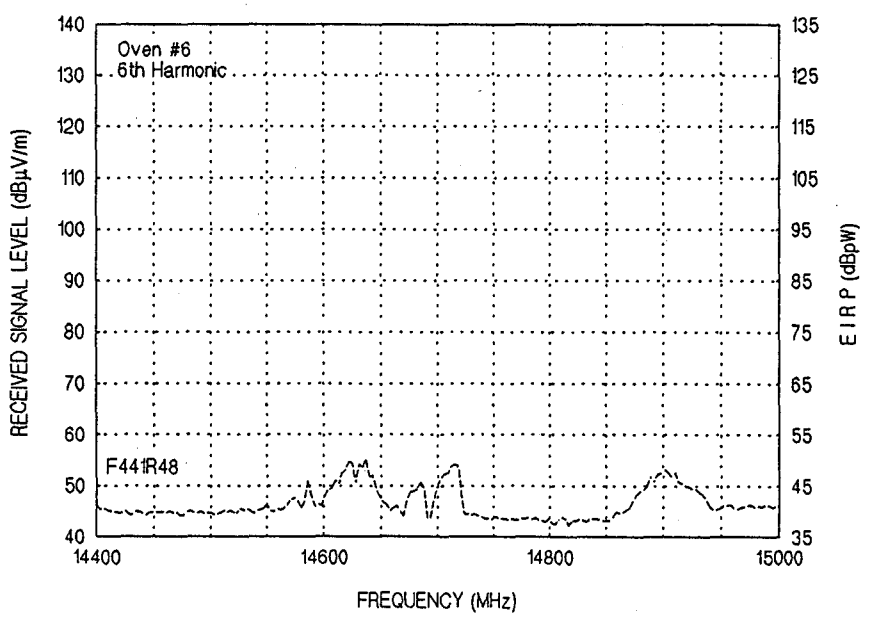


Figure E-20. Oven #6, 6th Harmonic frequency range vs. amplitude.

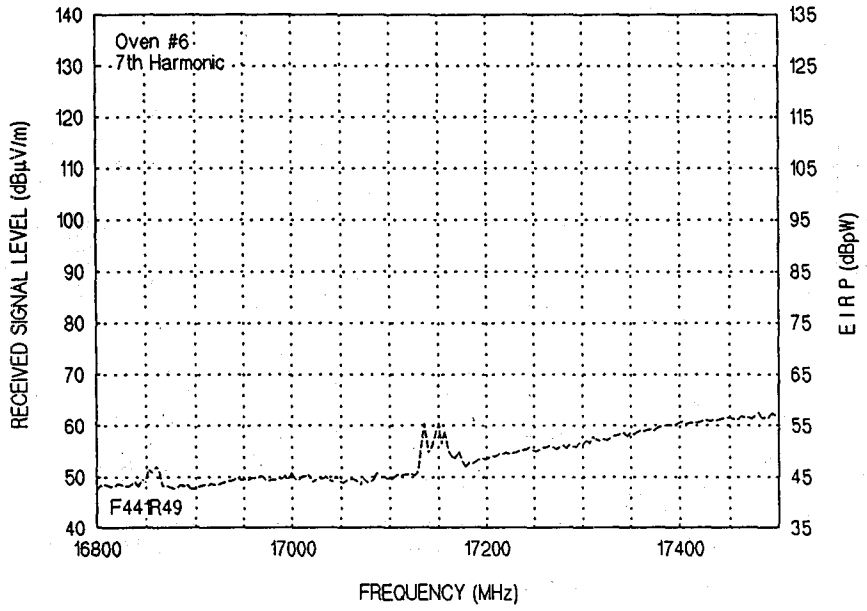


Figure E-21. Oven #6, 7th Harmonic frequency range vs. amplitude.

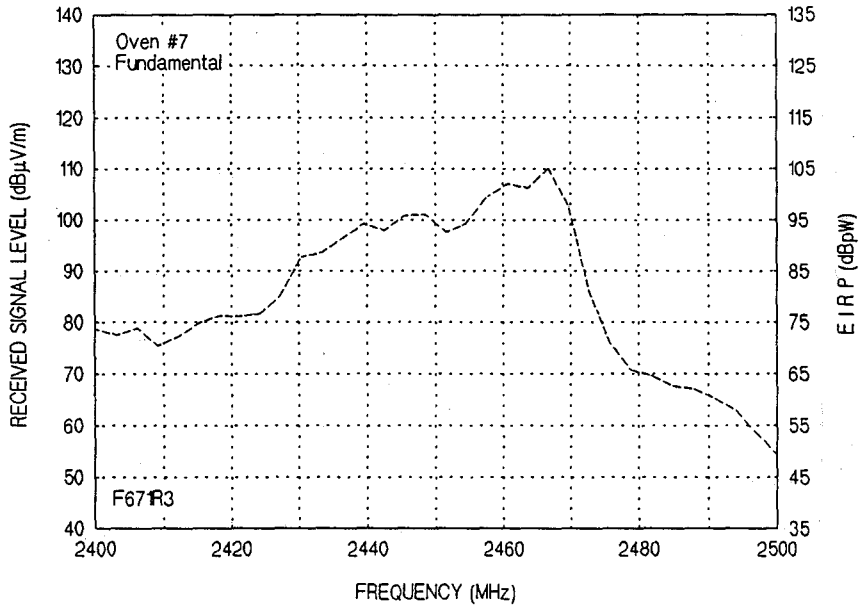


Figure E-22. Oven #7, Fundamental frequency range vs. amplitude.

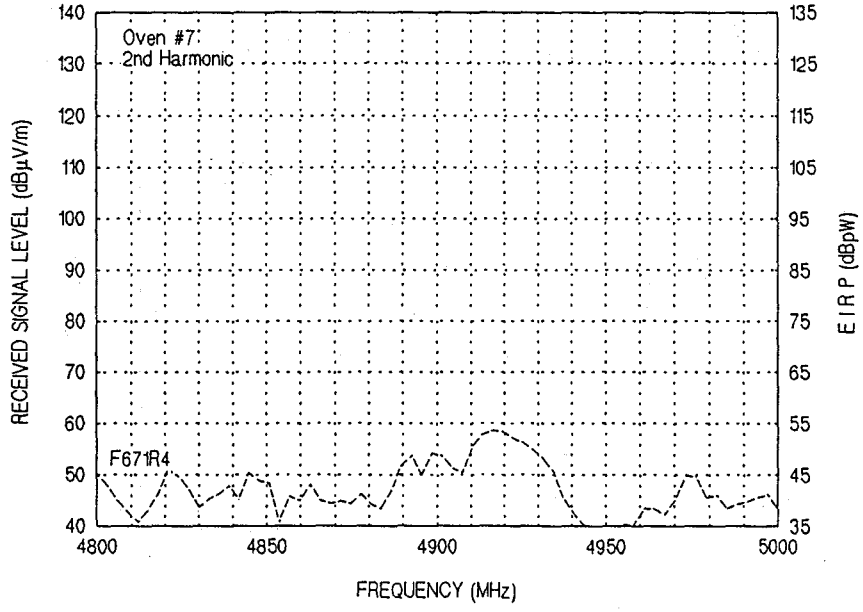


Figure E-23. Oven #7, 2nd Harmonic frequency range vs. amplitude.

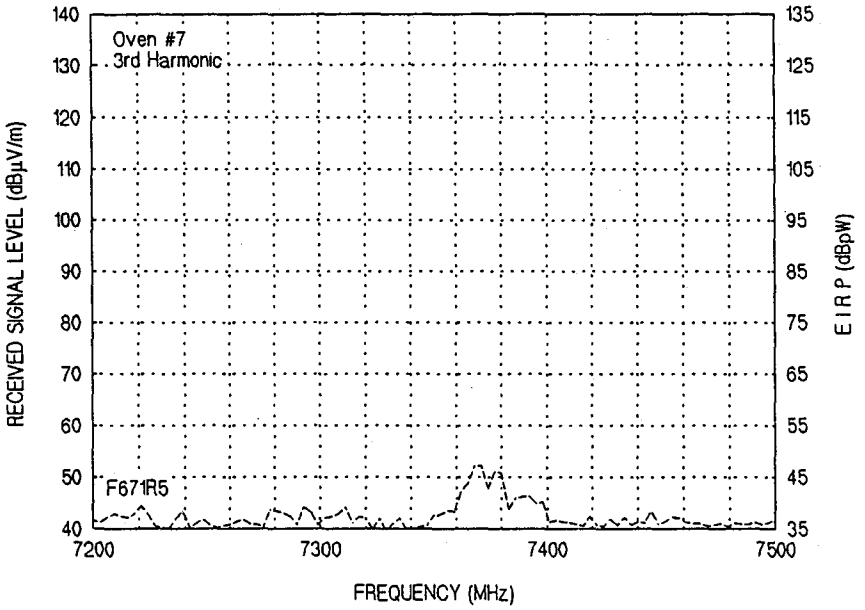


Figure E-24. Oven #7, 3rd Harmonic frequency range vs. amplitude.

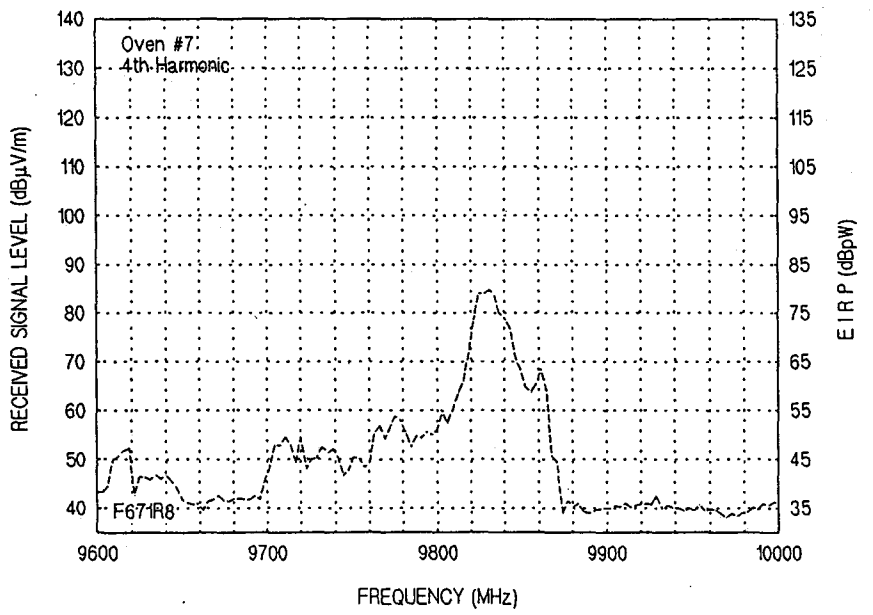


Figure E-25. Oven #7, 4th Harmonic frequency range vs. amplitude.

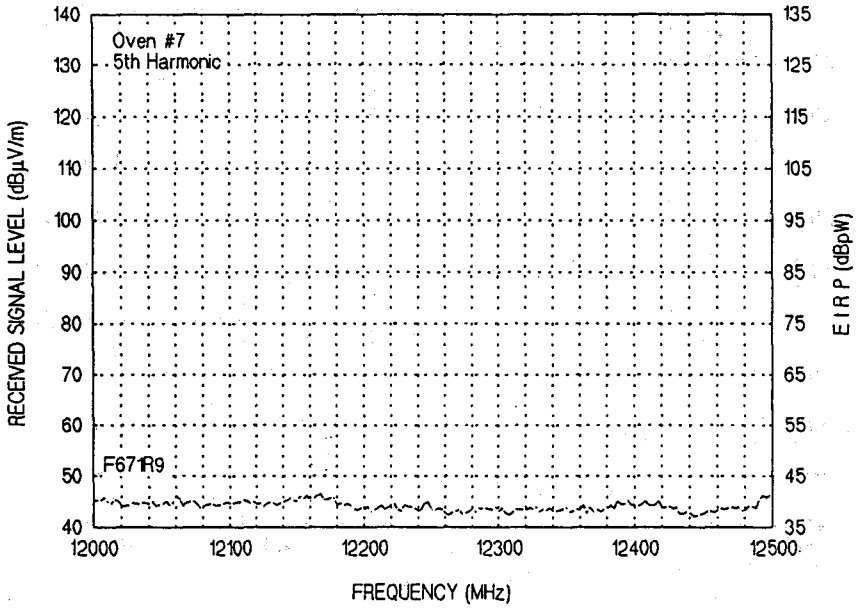


Figure E-26. Oven #7, 5th Harmonic frequency range vs. amplitude.

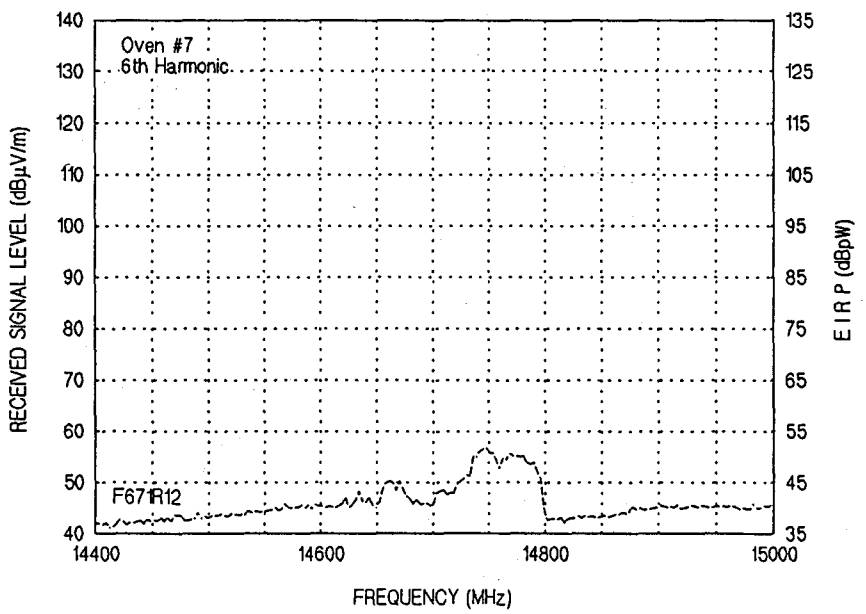


Figure E-27. Oven #7, 6th Harmonic frequency range vs. amplitude.

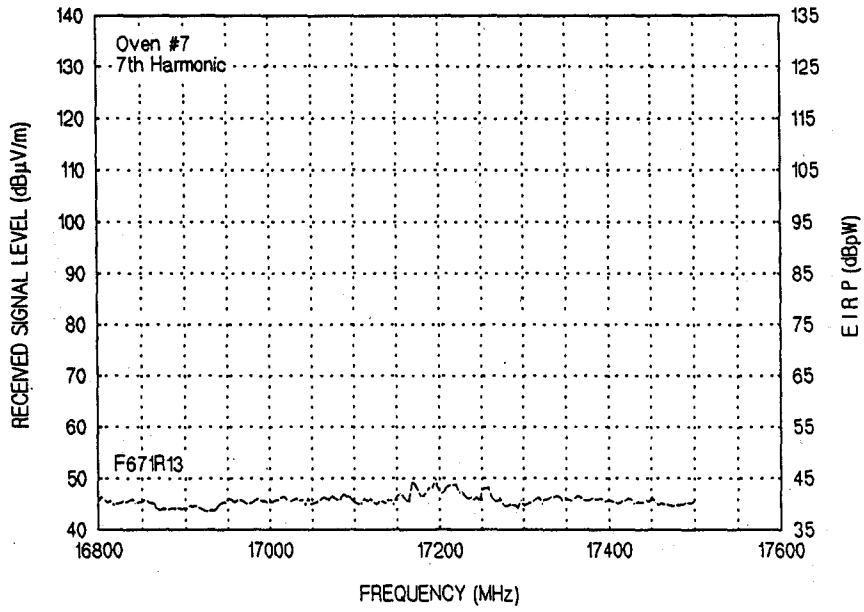


Figure E-28. Oven #7, 7th Harmonic frequency range vs. amplitude.

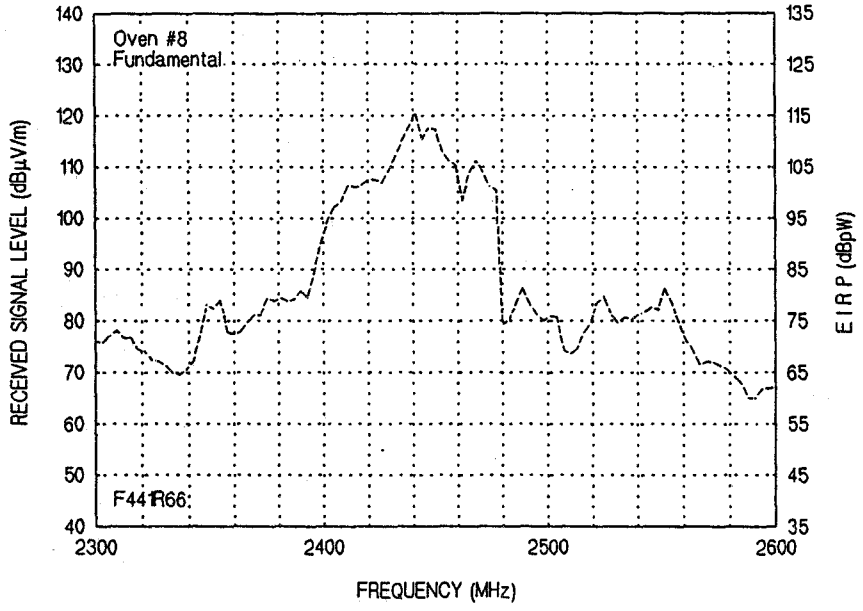


Figure E-29. Oven #8, Fundamental frequency range vs. amplitude.

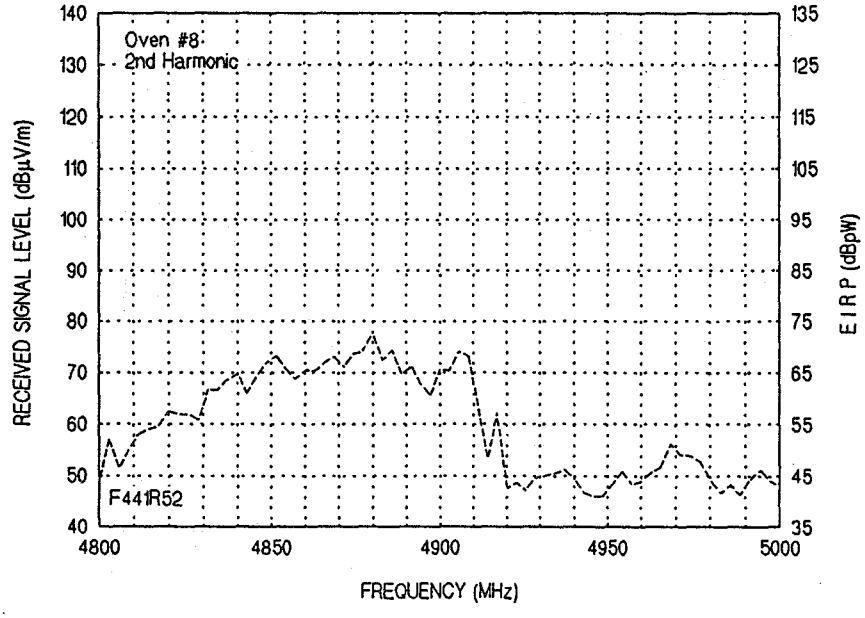


Figure E-30. Oven #8, 2nd Harmonic frequency range vs. amplitude.

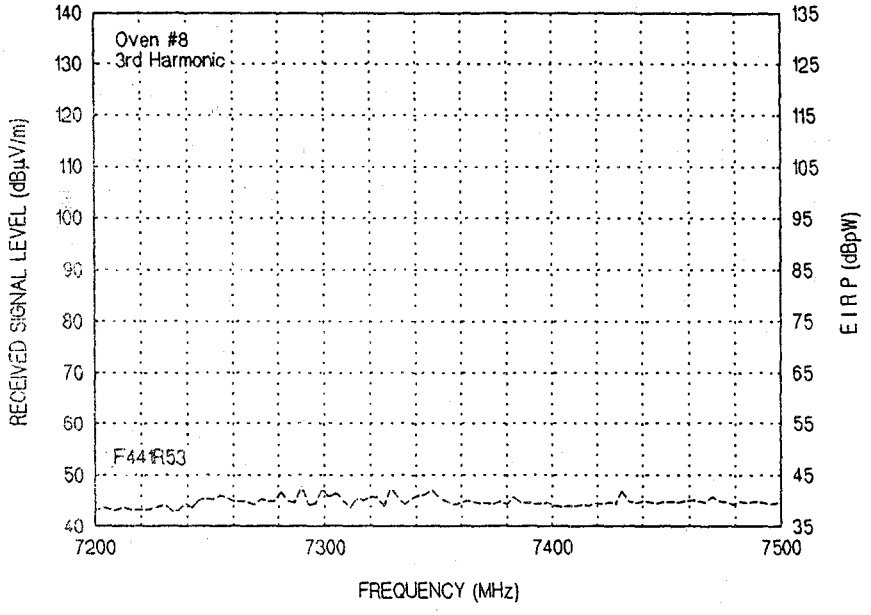


Figure E-31. Oven #8, 3rd Harmonic frequency range vs. amplitude.

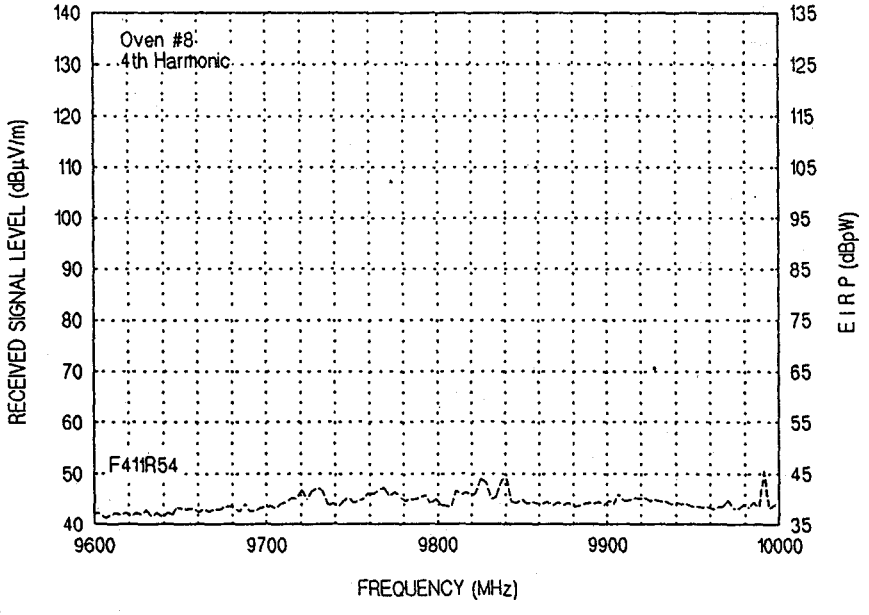


Figure E-32. Oven #8, 4th Harmonic frequency range vs. amplitude.

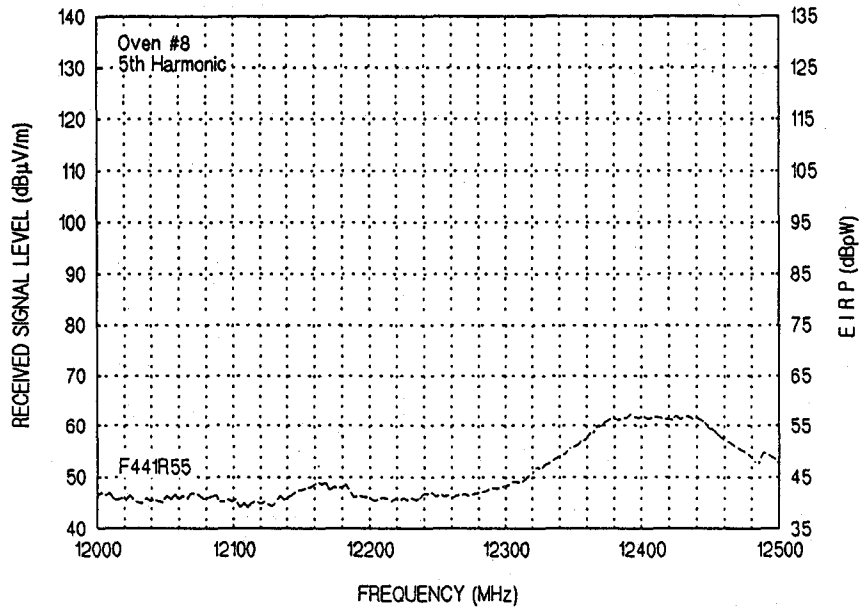


Figure E-33. Oven #8, 5th Harmonic frequency range vs. amplitude.

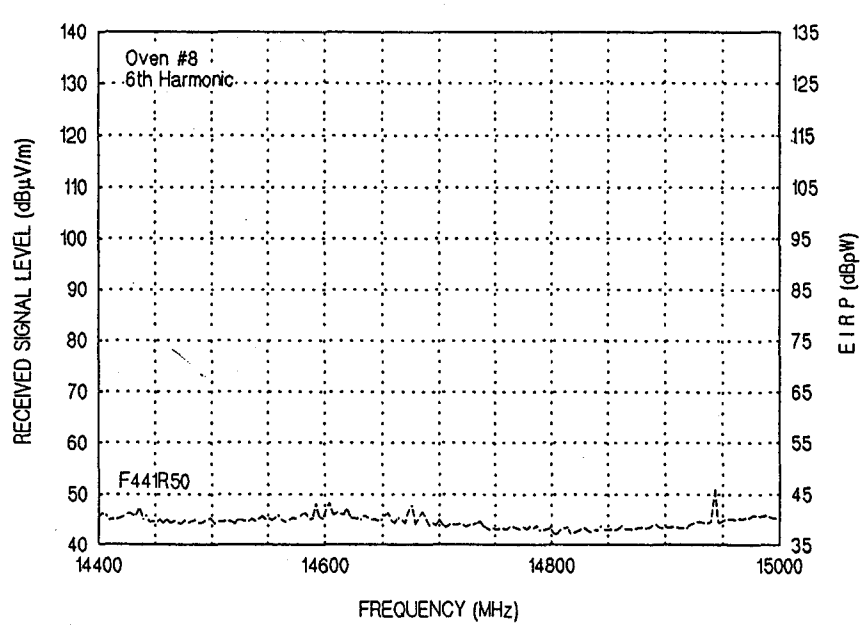


Figure E-34. Oven #8, 6th Harmonic frequency range vs. amplitude.

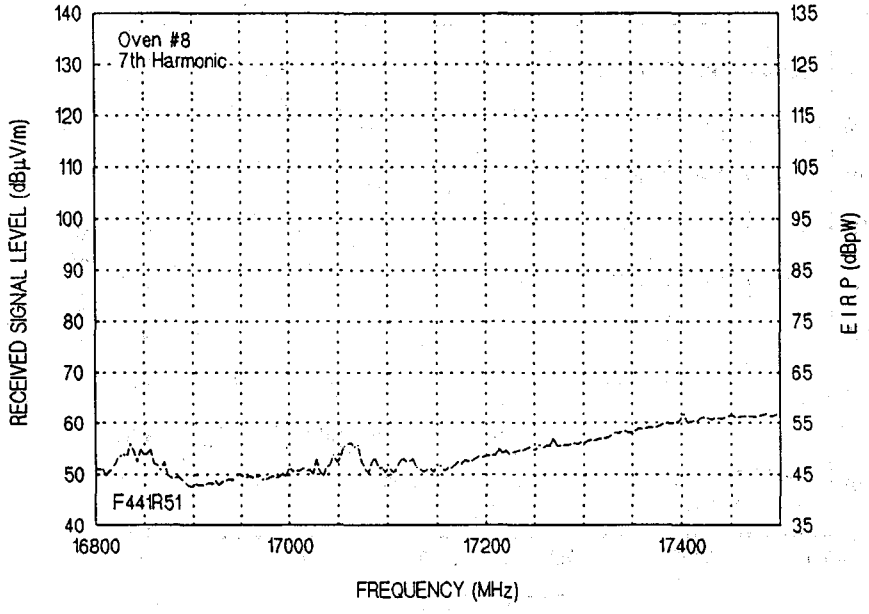


Figure E-36. Oven #8, 7th Harmonic frequency range vs. amplitude.

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14. SUPPLEMENTARY NOTES

15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This Volume 2 report provides the Appendices of the results of radio spectrum measurements of 13 individual microwave ovens performed at the Institute for Telecommunication Sciences (ITS). Appendix A is how NTIA understands the FCC informal compliance testing procedures. Appendix B contains the frequency domain measurements of the microwave emission spectra for all the ovens included in the NTIA tests. Appendix C contains the detailed time domain measurements of time waveforms and amplitude-probability distributions (APDs) curves that were derived from those waveforms. These ovens represent the ovens with the highest (#1, #5, and #10) and lowest (#7 and #11) emission spectrum characteristics for the ovens tested by NTIA/ITS. Appendix D contains the spectrum variability measurements which consist of the compilation of spectrum variation tests and the maximums, the minimums, and the means for those variation tests. Appendix E contains the harmonic suppression levels out to the 7th harmonic level for Ovens #1, #2, #6, #7, and #8.

16. Key Words *(Alphabetical order, separated by semicolons)*

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