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Broadband Versus Narrowband Driver/Power Amplifier: A Spectral Purity Comparison

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March 1990

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16. Abstract

The very high frequency (VHF) and ultra high frequency (UHF) series communications transmitters used in the field by the Federal Aviation Administration (FAA) Technical Center were originally equipped with narrowband amplifiers designed specifically for their respective frequency ranges. However, systems manufactured after August 1983 were provided with a new broadband VHF/UHF driver/power amplifier module. This unit was designed to unify the previously separate functions performed by the individual VHF and UHF narrowband driver/power amplifiers.

This report describes spectral purity tests performed at the FAA on two each GRT-21 (VHF) and one GRT-22 (UHF) series 10-watt communication transmitters. The purpose of this investigation was to determine if the new driver/power amplifier module generates noise levels sufficient to desensitize nearby receivers.

Test measurements show no significant difference in the spectral purity of the old (narrowband) driver/power amplifier and the new (broadband) driver/power amplifier.

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
Purpose	1
Background	1
DISCUSSION	1
Problem Definition	1
Equipment Description	2
Test Procedure	2
TEST RESULTS	2
CONCLUSIONS	3

LIST OF ILLUSTRATIONS

Figure		Page
1	Test Setup	4
2	Signal Received From a VHF Test Transmitter Equipped With the Old (Narrowband) Amplifier	5
3	Signal Received From a VHF Test Transmitter Equipped With the New (Broadband) Amplifier	6
4	Noise Floor Environment About Received Signal Using the VHF Test Transmitter Equipped With the Old (Narrowband) Amplifier	7
5	Noise Floor Environment About Received Signal Using the VHF Test Transmitter Equipped With the New (Broadband) Amplifier	8
6	Signal Received From a UHF Test Transmitter Equipped With the Old (Narrowband) Amplifier	9
7	Signal Received From a UHF Test Transmitter Equipped With the New (Broadband) Amplifier	10
8	Noise Floor Environment About Received Signal Using the UHF Test Transmitter Equipped With the Old (Narrowband) Amplifier	11
9	Noise Floor Environment About Received Signal Using the UHF Test Transmitter Equipped With the New (Broadband) Amplifier	12

INTRODUCTION

PURPOSE.

The purpose of this study was to investigate the spectral purity of the new very high frequency (VHF)/ultra high frequency (UHF) broadband versus the old and separate VHF and UHF narrowband driver/power amplifier modules for the GRT-21/22 series communications transmitters.

BACKGROUND.

Originally, the VHF and UHF transmitters used in the field were equipped with amplifiers designed specifically for their respective frequency ranges. However, systems manufactured after August 1983 were provided with a new broadband VHF/UHF driver/power amplifier module developed by International Telephone and Telegraph Corporation (ITT). This unit is a broadband device designed to unify the previously separate functions performed by the individual VHF and UHF narrowband driver/power amplifiers.

Recent reports of noise interference at one of the Federal Aviation Administration's (FAA) Remote Communication Outlets (RCO) were attributed to the new VHF/UHF driver/power amplifier. Technical support personnel investigating this problem maintain that this radiated noise energy is sufficient to degrade the performance of ground receivers operating on nearby adjacent channels. In this case, replacing the new VHF/UHF driver/power amplifier module with the old VHF-only driver/power amplifier unit eliminated the desensitization problem in the VHF equipment. From an equipment availability standpoint, this could not be considered to be a viable solution even if supported by technical evidence.

The Spectrum Engineering Division, ASM-500, requested that the FAA Technical Center perform spectral purity measurements and compare the old and new driver/power amplifiers.

DISCUSSION

PROBLEM DEFINITION.

The output power of a transmitter is confined mostly within the narrow band of frequencies about its assigned channel. If this frequency bandwidth is broadened, an increase in the power radiated at other frequencies above and below the carrier frequency results. This undesired radiation is known as "transmitter noise."

The front end of a typical radio receiver is receptive to a broadband of frequencies about its tuned center frequency. Whenever strong "off-frequency" carrier power (e.g., transmitter noise) is received, its performance is degraded.

This investigation seeks to determine if the new driver/power amplifier module generates noise levels sufficient to desensitize nearby receivers.

EQUIPMENT DESCRIPTION.

Two each GRT-21 (VHF) and one GRT-22 (UHF) series 10-watt communication transmitters were aligned within specifications and configured as shown in figure 1. The Hewlett Packard 3311A Function Generator was used as an external modulating source. External manual attenuators were used to control the signal strength applied to the spectrum analyzer. These attenuators were Hewlett Packard Model 335C and 335D, 0-12 decibel (dB) in 1-dB steps and 0-120 dB in 10-dB steps, respectively. Two each Antenna Products DPV-35 (single VHF) and two each Antenna Products DPV-37 (single UHF) antennas were used for these tests. The Hewlett Packard 8568B Spectrum Analyzer was used to monitor the radiated signals.

TEST PROCEDURE.

Baseline data were collected by the following test sequence: (1) external attenuators were adjusted to insure acceptable signal levels at the spectrum analyzer, i.e., less than minus 10 decibels above 1 milliwatt (dBm), (2) the transmitter was keyed and modulated 90 percent with a 1-kilohertz (kHz) tone, and (3) the external attenuators were adjusted to produce minus 10-dBm reference level at the spectrum analyzer. This sequence protects the spectrum analyzer from excessive input power.

Once the maximum amplitude of the incoming signal was established for a given driver/power amplifier configuration, the spectrum analyzer was adjusted for maximum sensitivity. An extremely long sweep time was chosen (1500 seconds) thereby, permitting measurements of signals down to approximately minus 120 dBm.

TEST RESULTS

It was necessary to externally attenuate the incoming 127.375 (megahertz) MHz signal, modulated 90 percent with a 1-kHz tone, by 22 dB. This setup positioned the peak amplitude of the trace on the minus 10-dBm calibrated reference line of the spectrum analyzer. This attenuation level was used for both the VHF narrowband and VHF broadband driver/power amplifier configurations. It should be noted that the spectrum analyzer's internal input attenuator was set for 0 dB for all tests.

Figure 2 illustrates the received signal from a VHF test transmitter equipped with the old (narrowband) amplifier. Figure 3 illustrates the received signal from the same VHF test transmitter when equipped with the new (broadband) amplifier.

The minimum "noise floor" level attainable, for all VHF and UHF test configurations, was approximately minus 120 dBm. These levels were monitored and plotted prior to each transmission. Figures 4 and 5 represent the same VHF signals, respectively, plotted in figures 2 and 3. Both figures indicate a clean environment, void of any signals strong enough to break the standard FAA receiver squelch threshold setting of minus 103 dBm.

The measurement techniques used for VHF testing were also performed on the UHF test transmitter, with similar results. The external attenuation needed to position the peak amplitude of the 363.725 MHz signal, modulated 90 percent with a 1-kHz tone on the minus 10-dBm calibrated reference line of the spectrum analyzer, was 12 dB.

Figures 6 and 7 show the signal strengths appearing at the input port of the spectrum analyzer for the narrowband and broadband driver/power amplifier transmitter configurations, respectively.

Figures 8 and 9 indicate the noise floor/signal sidebands environment existing about their respective transmitted signals. Once again, no adjacent signals having amplitudes approaching the minus 103 dBm receiver squelch threshold level specification were observed.

Another VHF test transmitter (127.370 MHz) was aligned within specifications and run through the same test scenario performed on transmitter (127.375 MHz) above for purposes of repeatability. Different VHF (narrowband) and VHF/UHF (broadband) driver/power amplifier modules were tested in both the above VHF test transmitters. No significant deviations from the original test results were found.

CONCLUSIONS

1. There was no significant difference measured in the spectral purity of the old (narrowband) driver/power amplifier and the new (broadband) driver/power amplifier.

2. While the number of units sampled was small, it is believed that their performance is representative of operational units. Therefore, the test results do not support the view that field interference problems can be attributed to the new (broadband) driver/power amplifier.

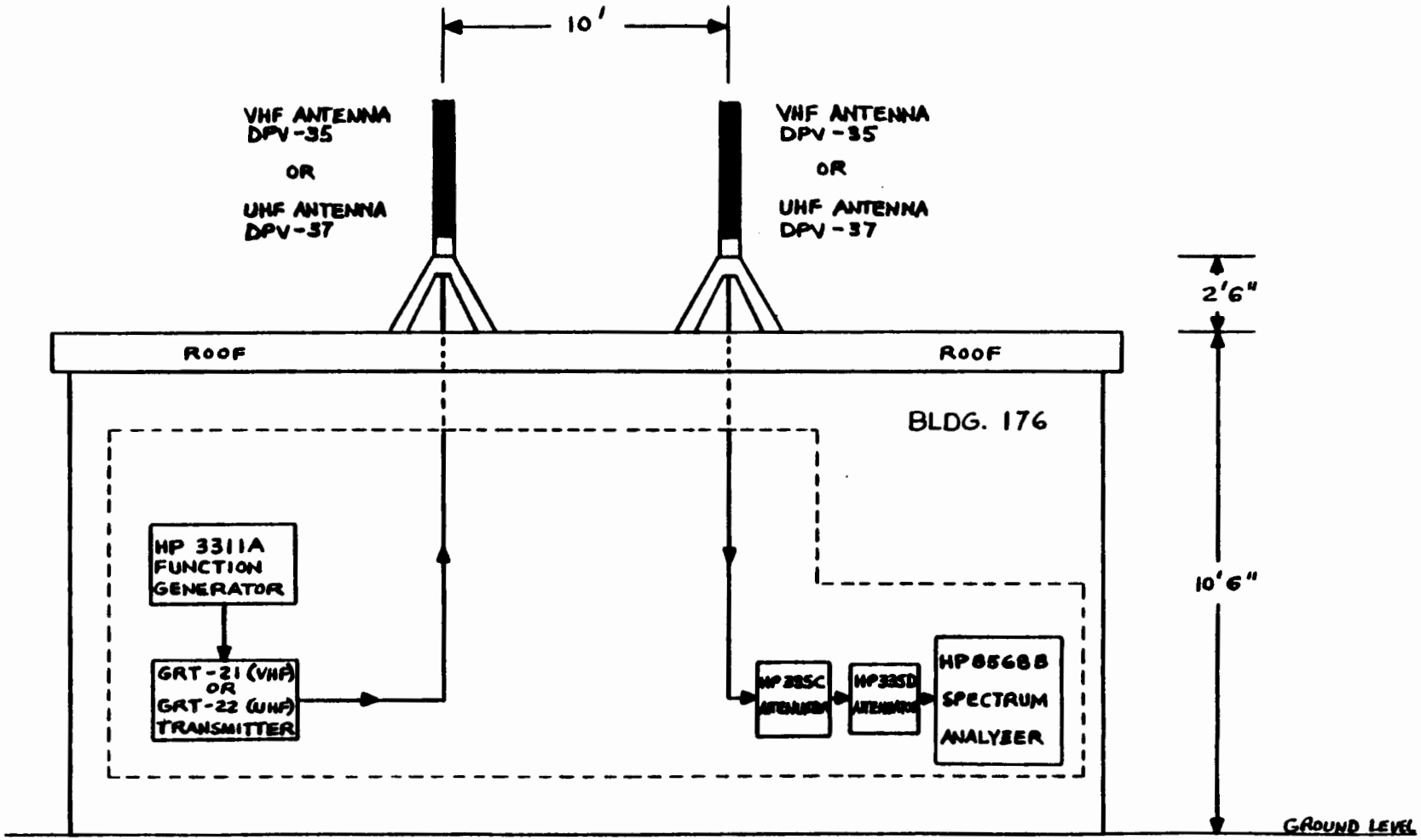

FIGURE 1. TEST SETUP

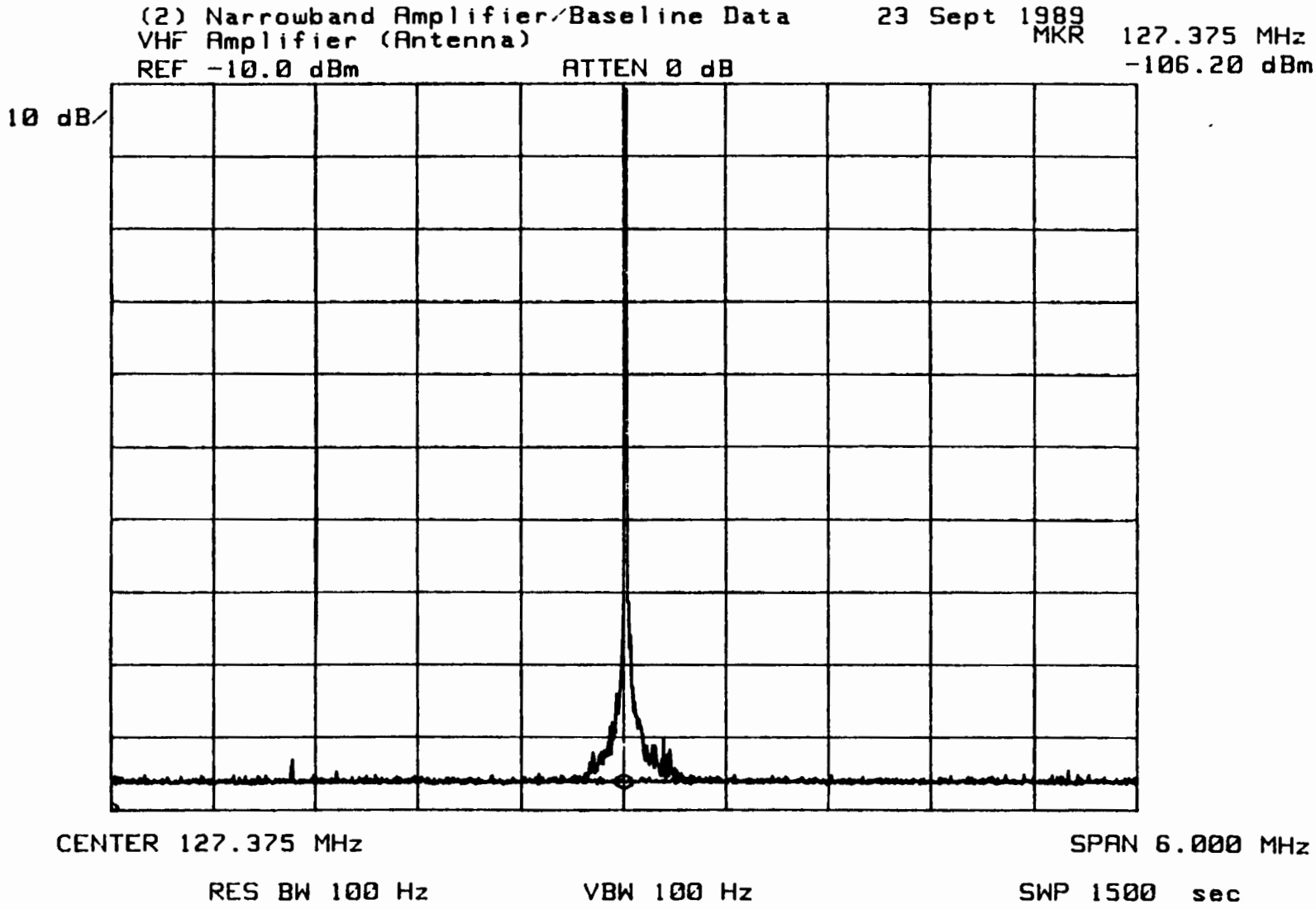

FIGURE 2. SIGNAL RECEIVED FROM A VHF TEST TRANSMITTER EQUIPPED WITH THE OLD (NARROWBAND) AMPLIFIER

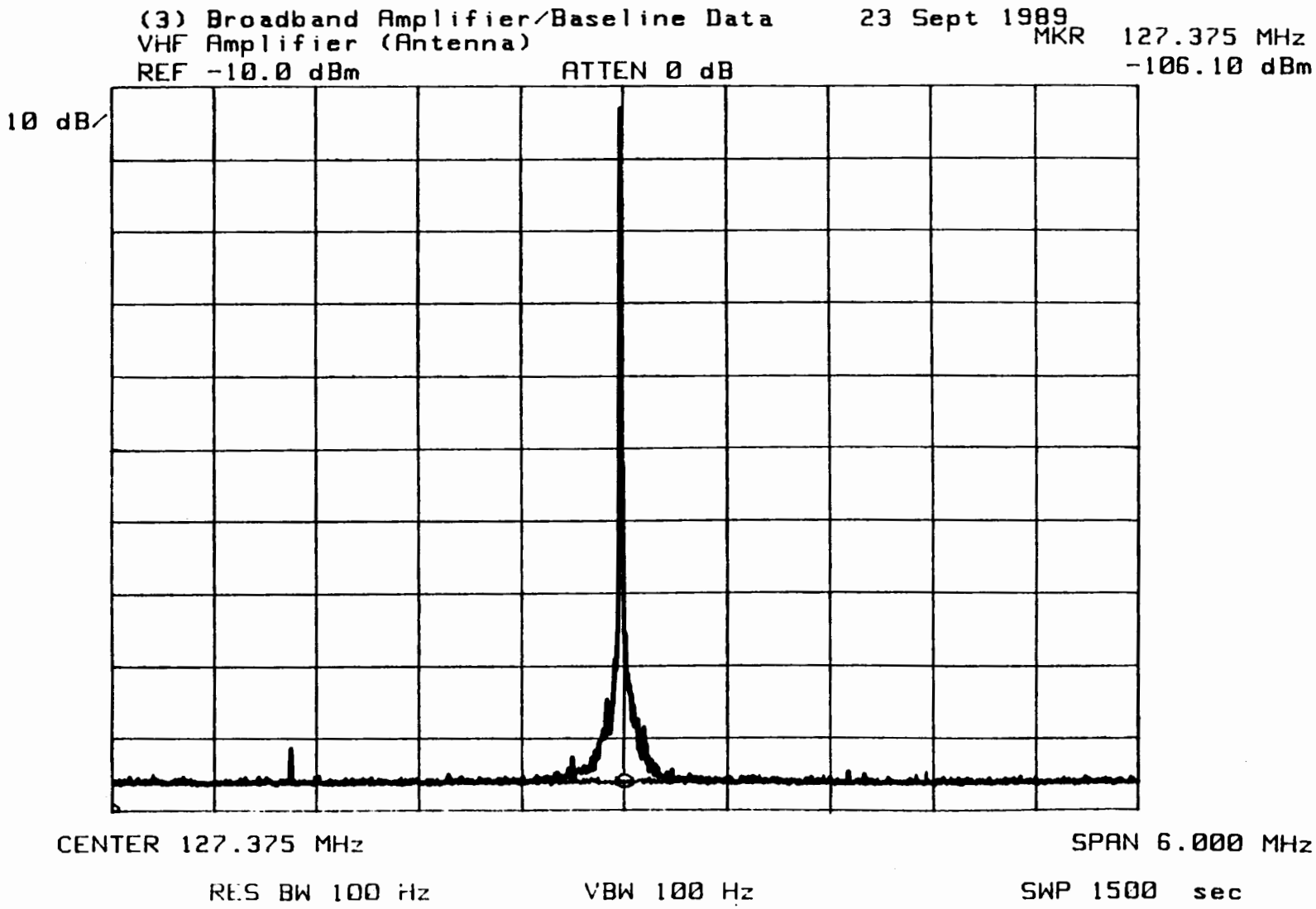

FIGURE 3. SIGNAL RECEIVED FROM A VHF TEST TRANSMITTER EQUIPPED WITH THE NEW (BROADBAND) AMPLIFIER

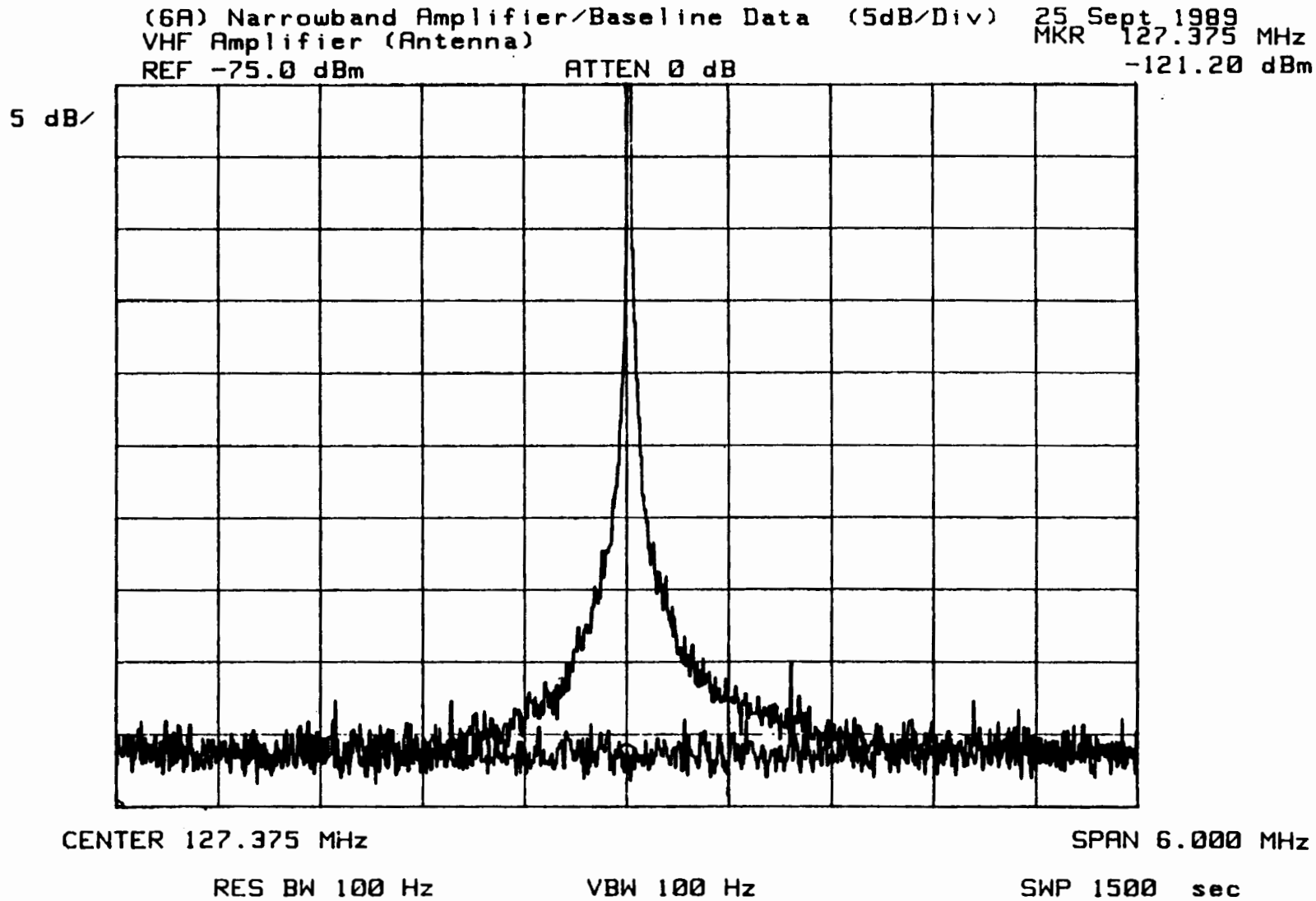

FIGURE 4. NOISE FLOOR ENVIRONMENT ABOUT RECEIVED SIGNAL USING THE VHF TEST TRANSMITTER EQUIPPED WITH THE OLD (NARROWBAND) AMPLIFIER

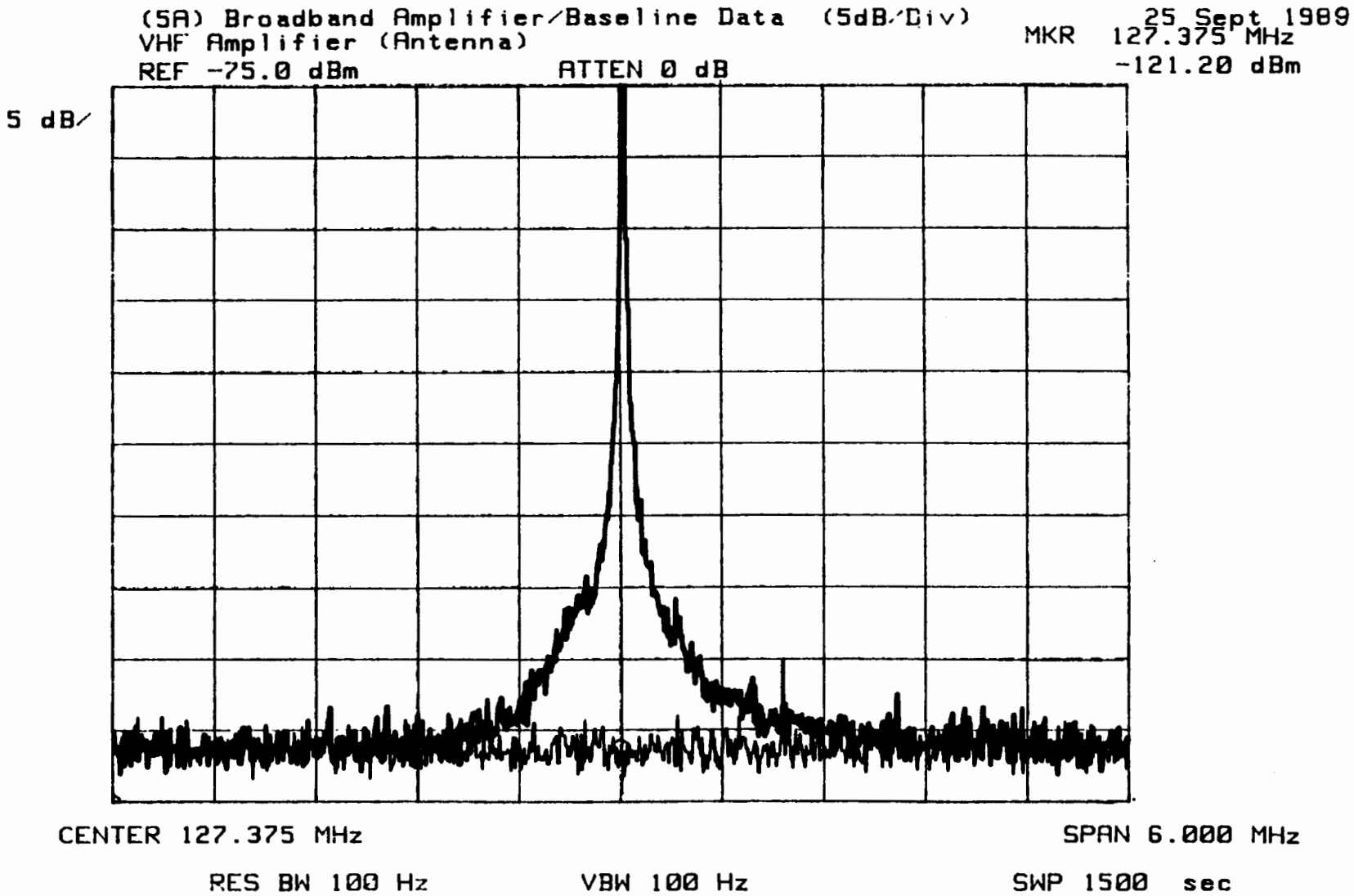

FIGURE 5. NOISE FLOOR ENVIRONMENT ABOUT RECEIVED SIGNAL USING THE VHF TEST TRANSMITTER EQUIPPED WITH THE NEW (BROADBAND) AMPLIFIER

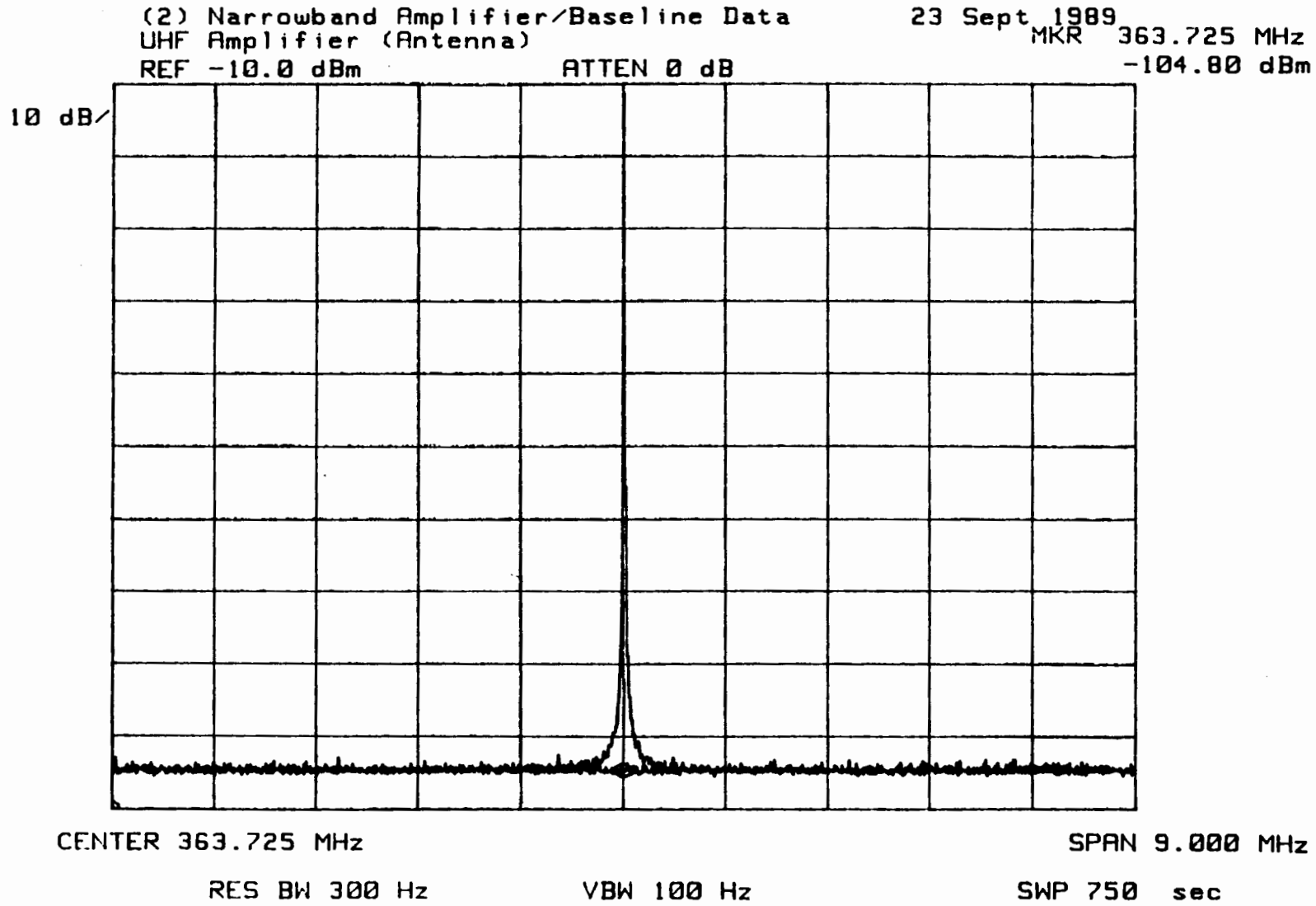

FIGURE 6. SIGNAL RECEIVED FROM A UHF TEST TRANSMITTER EQUIPPED WITH THE OLD (NARROWBAND) AMPLIFIER

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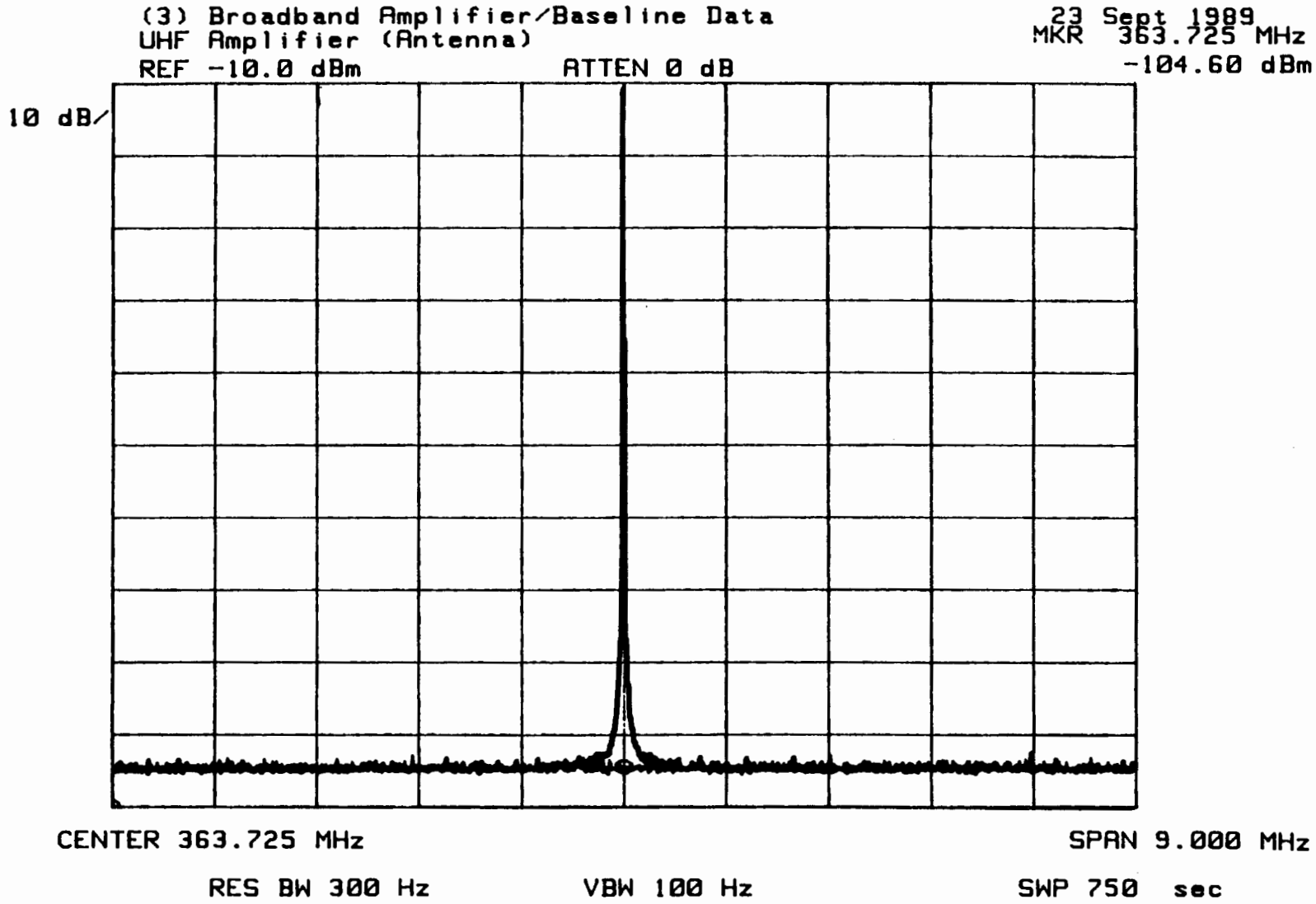

FIGURE 7. SIGNAL RECEIVED FROM A UHF TEST TRANSMITTER EQUIPPED WITH THE NEW (BROADBAND) AMPLIFIER

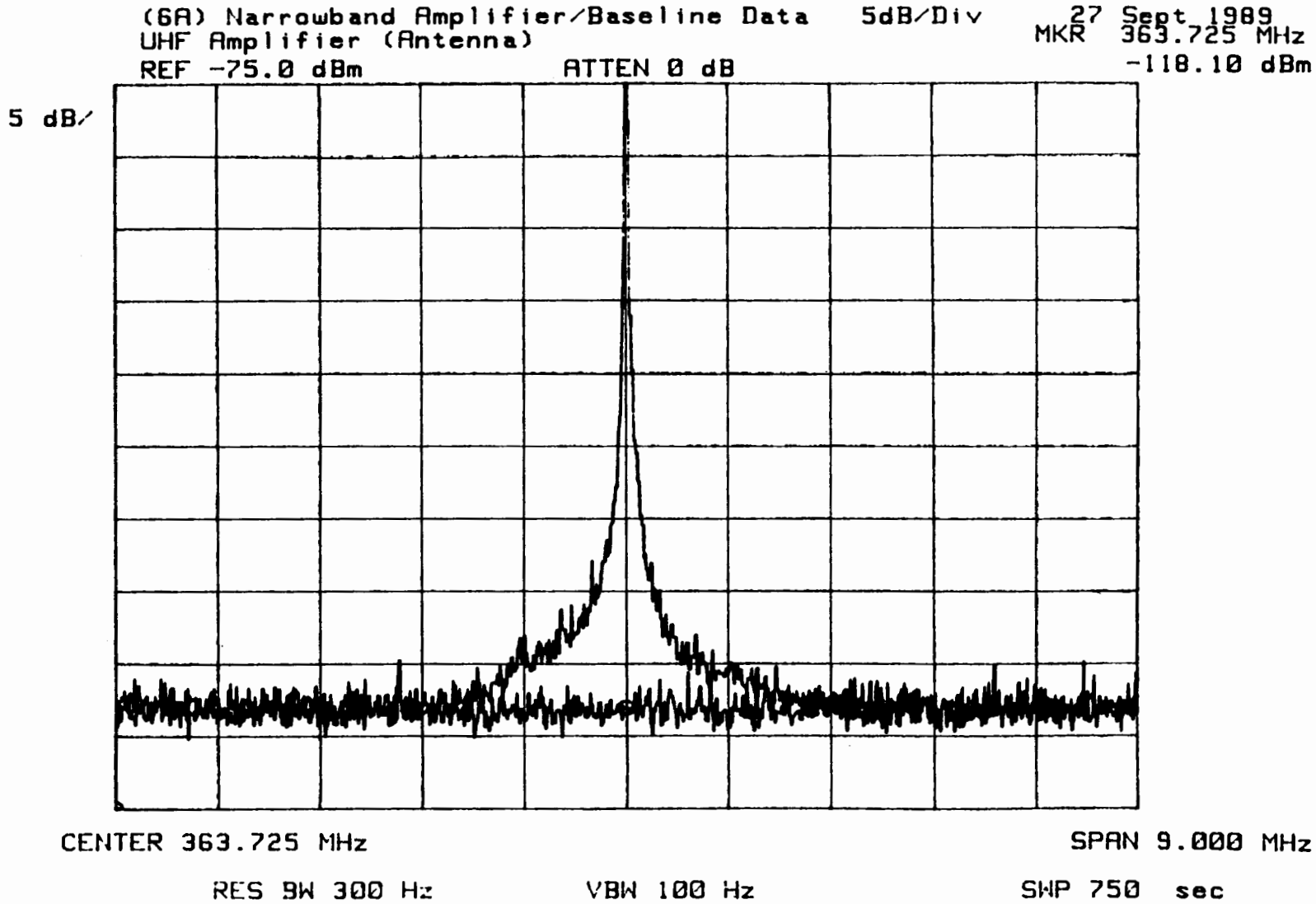

FIGURE 8. NOISE FLOOR ENVIRONMENT ABOUT RECEIVED SIGNAL USING THE UHF TEST TRANSMITTER EQUIPPED WITH THE OLD (NARROWBAND) AMPLIFIER

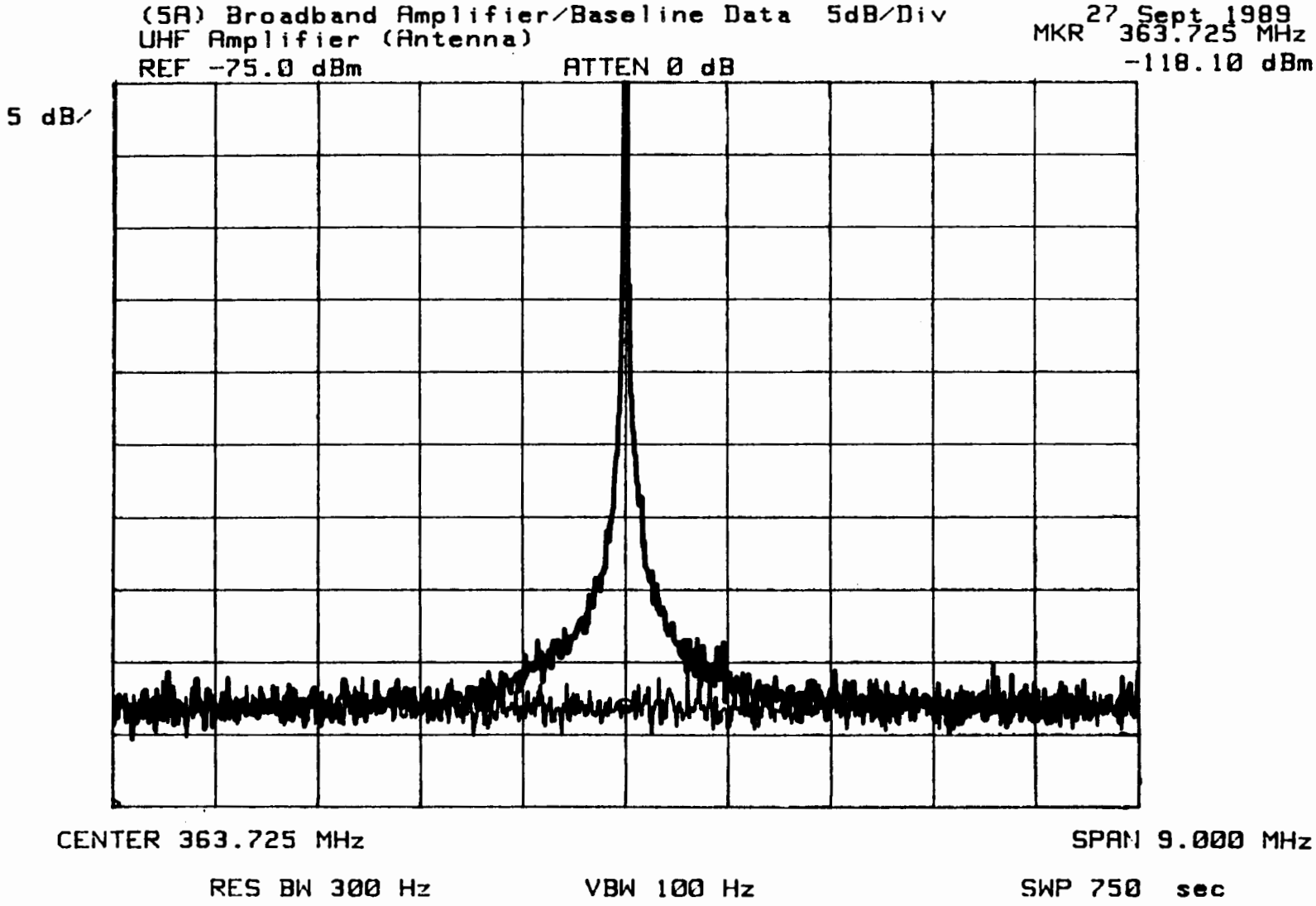

FIGURE 9. NOISE FLOOR ENVIRONMENT ABOUT RECEIVED SIGNAL USING THE UHF TEST TRANSMITTER EQUIPPED WITH THE NEW (BROADBAND) AMPLIFIER