4. Measurement Procedures

4.1 List of Test Equipment and Accessories

1. PC with FCC.exe software for activating continuous transmission mode
2. TUTT accessories test box
3. Spectrum Analyzers
   - HP8563E spectrum analyzer
   - HP8593EM spectrum analyzer
4. Leader regulated DC power supply

4.2 Measurement Procedures

4.2.1 Conducted RF Power Output

Definition - The output power rating of the transmitter is the power available at the output terminal of the antenna cable when the terminal is connected to the normal load.

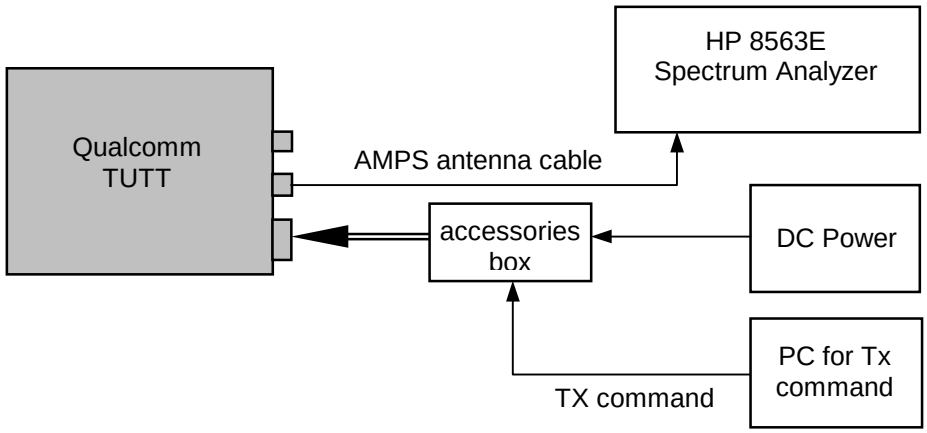

Figure 4–1. Measurement setup for conducted RF power

Method of Measurement - The transmitter output carrier power with SAT+ST modulation was measured using an HP 8563E spectrum. The measurement setup diagram is shown in Fig. 4-1.

Minimum Standard - The transmitter output power shall be maintained within range of –4dB to 2dB.

4.2.2 Radiated RF Power Output

Refer to TUV Product Service Test Report for test method and setup for radiated RF power output.

4.2.3 Occupied Bandwidth

Definition –The occupied bandwidth is defined as the spectrum noise produced at discrete frequency separations from the carrier due to all sources of unwanted noise within the transmitter in a modulated condition.

Method of Measurement – Pursuant to CFR 47 session 22.917(h), use a HP 8593EM spectrum analyzer to measure the bandwidth under SAT+ST condition. The measurement setup diagram is shown in Fig. 4-2.

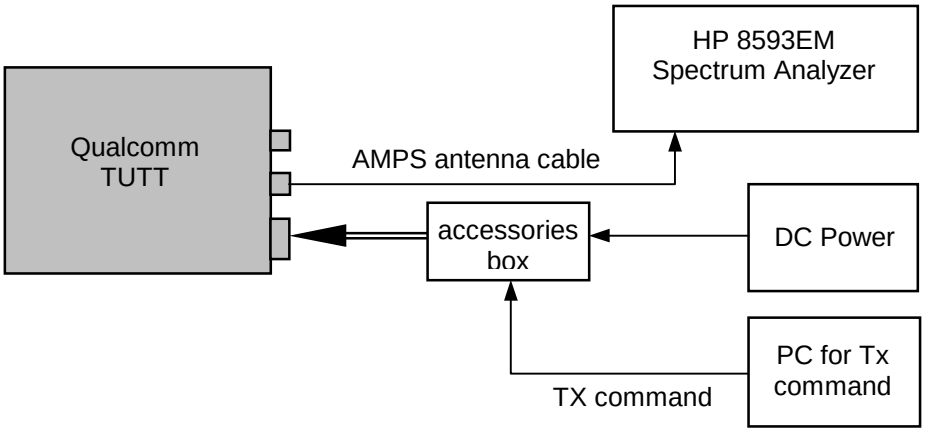

Figure 4–2. Measurement setup for Occupied Bandwidth

Minimum Standard - The mean power of emissions from the transmitter with modulated carrier shall be attenuated below the mean power of the non-modulated carrier in accordance with CFR 47 session 22.917(d).

4.2.4 Conducted Spurious Emissions

Definition - The conducted harmonic and spurious emissions are emissions at the antenna terminals at a frequency or frequencies that are outside the authorized bandwidth of the transmitter.

Method of Measurement - The transmitter shall be modulated with SAT, ST, and SAT+ST. The measurement was made with a HP 8563E spectrum analyzer from the lowest radio frequency generated in the equipment to the 10th harmonic of the carrier. The measurement setup diagram is shown in Fig. 4-3.

Minimum Standard - Conducted harmonic and spurious emissions shall be attenuated below the level of emissions of the carrier in accordance with CFR 47 session 22.917(d).

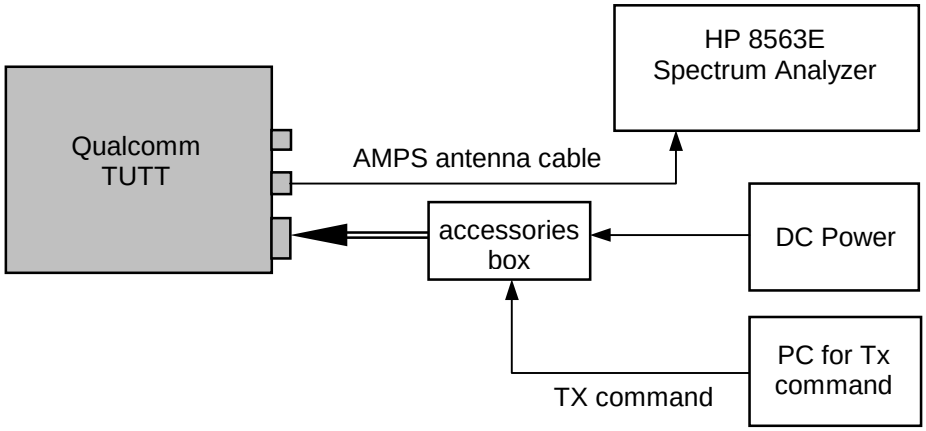

Figure 4–3. Measurement setup for conducted spurious emissions

4.2.5 Radiated Spurious emissions

Definition - The radiated spurious emissions are emissions from the TUTT unit with the attached antenna assembly. The radiated spurious emissions include those emissions radiated from the attached antenna as well as the equipment cabinet and attached cables.

Method of Measurement - The radiated emission measurement shall be conducted at a FCC certified lab test site with a search antenna, which is movable vertically and rotatable 90 degrees for vertically and horizontally polarized signals. Refer to TUV Product Service Test Report for detailed measurement setup

Minimum Standard - Radiated spurious emissions shall be attenuated below the maximum level of emission of the carrier by at least $43+10\log(P)$ dB, in which, P is mean output power in Watts.

4.2.6 Frequency Stability

Definition - The frequency stability is the ability of the transmitter to maintain an assigned carrier frequency against variation in ambient temperature and power supply.

Method of Measurement - Use the spectrum analyzer to sample the transmitter RF output signal and measure its frequency under each specific temperature and power supply condition. Vary the ambient temperature from -30 to +60 °C, and also vary the DC supply voltage to the equipment from 9.6 to 14.4 V at each temperature. The measurement setup is shown in Fig. 4-4.

Minimum Standard - The transmitter carrier frequency shall be maintained within ± 2.5 ppm.

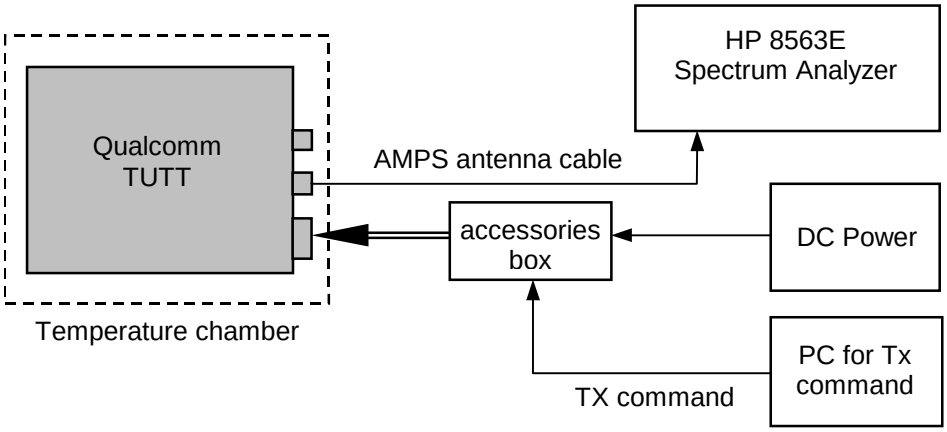

Figure 4–4. Measurement setup for frequency stability

5. Measurement Results

5.1 Transmitter RF Power Output

5.1.1 Conducted RF Power Output

The conducted RF power output is tested per Part 2.1046(a). The RF output power was measured using a HP 8563E Spectrum Analyzer. The antenna cable of the equipment is terminated to a 50 ohms resistive load of the Spectrum Analyzer. The nominal power from the CMM 8600 modem module (FCC ID: APV0896) manufactured by Standard Communication Corporation is 1.2W. The power level measured represents the actual power at the antenna port. Table 5-1 shows the measured conducted power output at carrier mode.

Table 5–1. Conducted RF power output at antenna port

Transmission Channel	Carrier frequency (MHz)	RF power (W)	
		Carrier	SAT+ST
991	824.04	0.961	0.681
380	836.40	1.258	0.851
799	848.97	0.631	0.430

5.1.2 Radiated RF Power Output

The maximum effective radiated power of the TUTT integrating CMM 8600 modem module is calculated using the following equations

$$P_{ERP} = \frac{EIRP}{1.64} = \frac{d^2}{1.64 \times 30} E_{\max}^2 \qquad (5\text{-}1)$$

where P represents the ERP output in ST mode. $E_{\max}$ is measured maximum electric field strength. d is the distance of 3 meters between the EUT source and measurement antenna. Table 5-2 gives the maximum ERP power level pursuant to equation (5-1). Refer to TUV Product Service Test Report for the measured maximum electric field strength under different orientations.

Table 5–2. Radiated RF power output from whip antenna

Channel	FREQ (MHz)	Max electric field (dBuV/m)	Max ERP (W)
991	824.04	127.5	1.029
380	836.40	128.2	1.209
799	848.97	125.4	0.634

5.2 Occupied Bandwidth

Occupied Bandwidth of the equipment was tested pursuant to FCC Part 2.1049. The measurement was conducted using HP 8593EM spectrum analyzer under SAT+ST mode. The measured data is shown in Table 5-3 and Fig.5-1 through Fig.5-3. Referring to FCC ID APV0896 Report, the necessary and emission bandwidth data modulation (F1D) is 40 kHz.

Table 5–3. Occupied Bandwidth (99%)

Transmission Channel	Carrier frequency (MHz)	Occupied bandwidth (kHz)
991	824.04	39
380	836.40	38.44
799	848.97	39.56

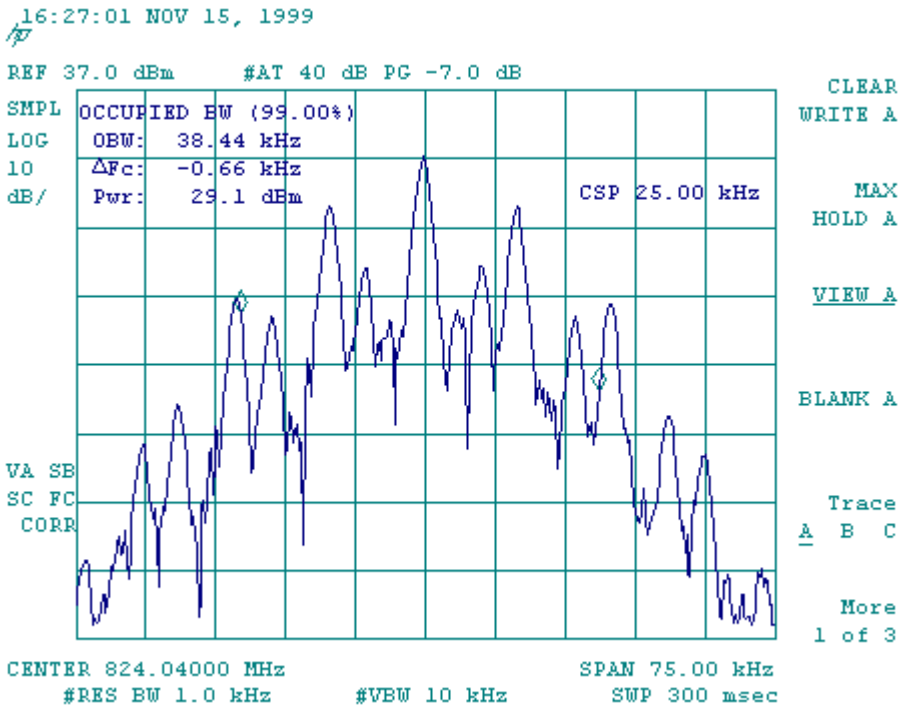

Figure 5–1. Occupied bandwidth on channel 991

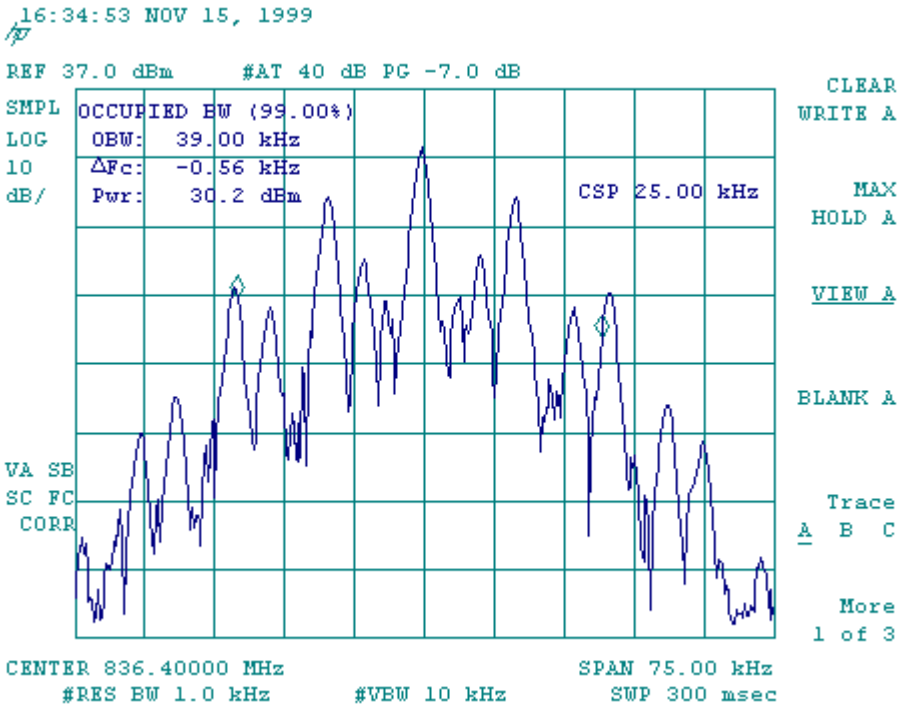

Figure 5–2. Occupied bandwidth on channel 380

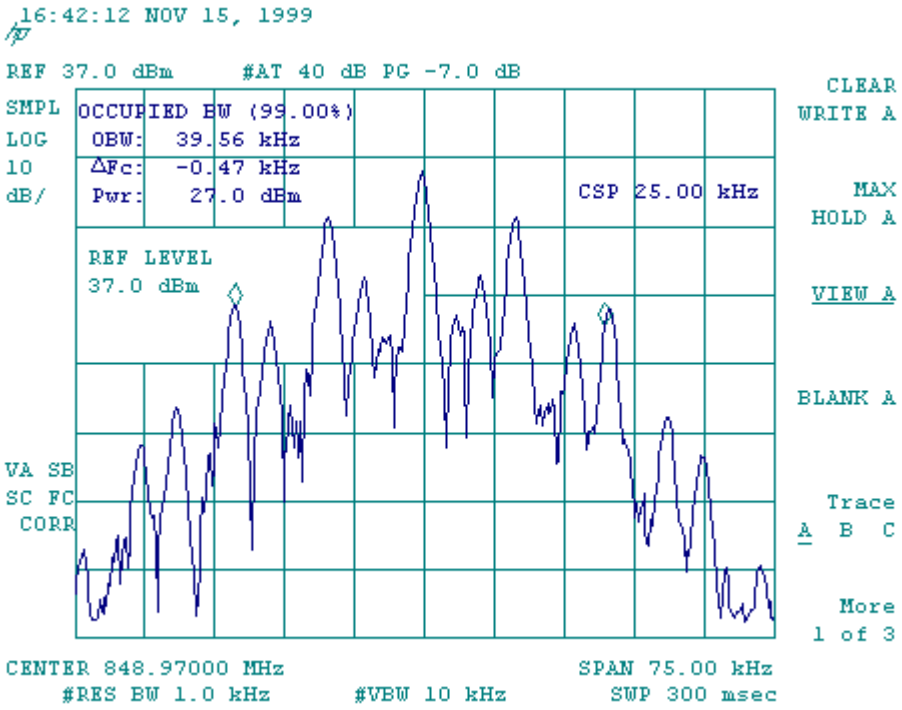

Figure 5–3. Occupied bandwidth on channel 799

5.3 Conducted Spurious Emission

Conducted emission from the equipment was tested pursuant to CFR 47 session 2.1046 and 22.917(d). Measurement was conducted using HP 8563E spectrum analyzer and CW, SAT, ST and SAT+ST modes were measured. An actual 6 feet antenna cable was used to connect the equipment RF output port to the analyzer, which has 50 ohm coaxial resistive load. The measurement results are shown in the Table 5-4 through Table 5-8. Waveforms at each channel for different modes are shown in Fig.5-4 through Fig.5-21.

Table 5–4. Conducted spurious emission mask relative to carrier F_0 with ST

Frequency	Limit (dBc)	Spurious emission (dBc)
$(F_0 + 45\,\text{kHz}) \geq f > (F_0 + 20\,\text{kHz})$ $(F_0 - 20\,\text{kHz}) > f \geq (F_0 - 45\,\text{kHz})$	-26	<-45
$(F_0 + 90\,\text{kHz}) \geq f > (F_0 + 45\,\text{kHz})$ $(F_0 - 45\,\text{kHz}) > f \geq (F_0 - 90\,\text{kHz})$	-45	<-60
$(F_0 + F_0) \geq f > (F_0 + 90\,\text{kHz})$	-44	<-70

Table 5–5. Conducted spurious emission in the receiver critical band

Frequency	Limit (dBm)	Spurious emission (dBm)
869 – 894 MHz	-80	<-85

Table 5–6. Conducted spurious emission by low-band channel (991)

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm)	Measurement attenuation (dB)
1	824.04	28.3		40.00
2	1648.08	-55.2	-13.0	10.00
3	2472.12	-62.4	-13.0	10.00
4	3296.16	-49.7	-13.0	10.00
5	4120.20	-57.1	-13.0	10.00
6	4944.24	-66.4	-13.0	10.00
7	5768.28	-67.3	-13.0	10.00
8	6592.32	<-75.0	-13.0	10.00
9	7416.36	<-75.0	-13.0	10.00
10	8240.40	<-75.0	-13.0	10.00

Table 5–7. Conducted spurious emission by mid-band channel (380)

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm)	Measurement attenuation (dB)
1	836.40	29.3		40.0
2	1672.80	-53.7	-13.0	10.0
3	2509.20	-61.9	-13.0	10.0
4	3345.60	-43.5	-13.0	10.0
5	4182.00	-50.5	-13.0	10.0
6	5018.40	-67.8	-13.0	10.0
7	5854.80	<-75.0	-13.0	10.00
8	6691.20	<-75.0	-13.0	10.00
9	7527.60	<-75.0	-13.0	10.00
10	8364.00	<-75.0	-13.0	10.00

Table 5–8. Conducted spurious emission by high-band channel (779)

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm)	Measurement attenuation (dB)
1	848.97	26.3		40.00
2	1697.94	-63.0	-13.00	10.00
3	2546.91	-53.0	-13.00	10.00
4	3395.88	-54.8	-13.00	10.00
5	4244.85	-57.5	-13.00	10.00
6	5093.82	-60.6	-13.00	10.00
7	5942.79	<-75.0	-13.00	10.00
8	6791.76	<-75.0	-13.00	10.00
9	7640.73	<-75.0	-13.00	10.00
10	8489.70	<-75.0	-13.00	10.00

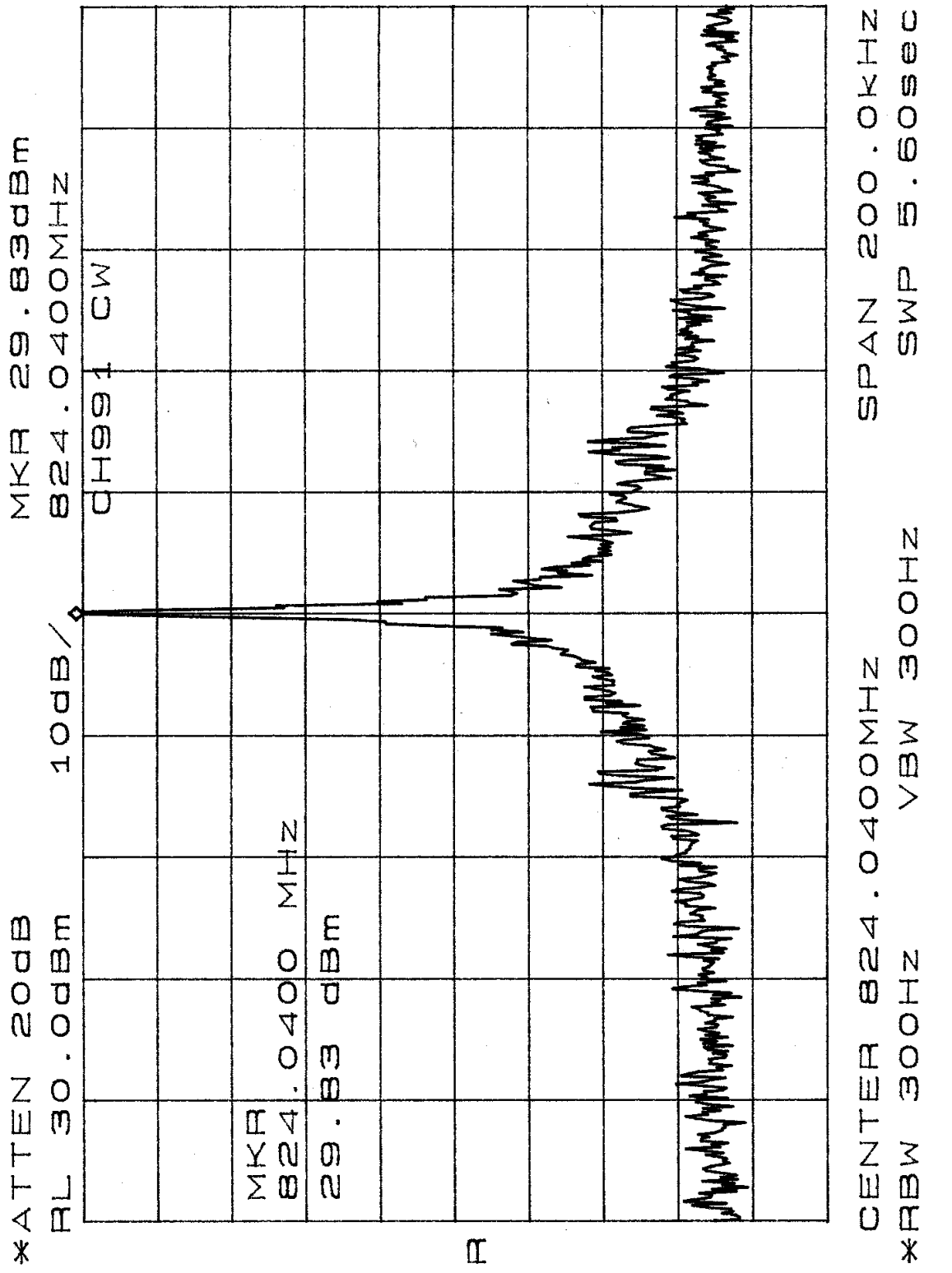

Figure 5–4. CW on low-band channel 991

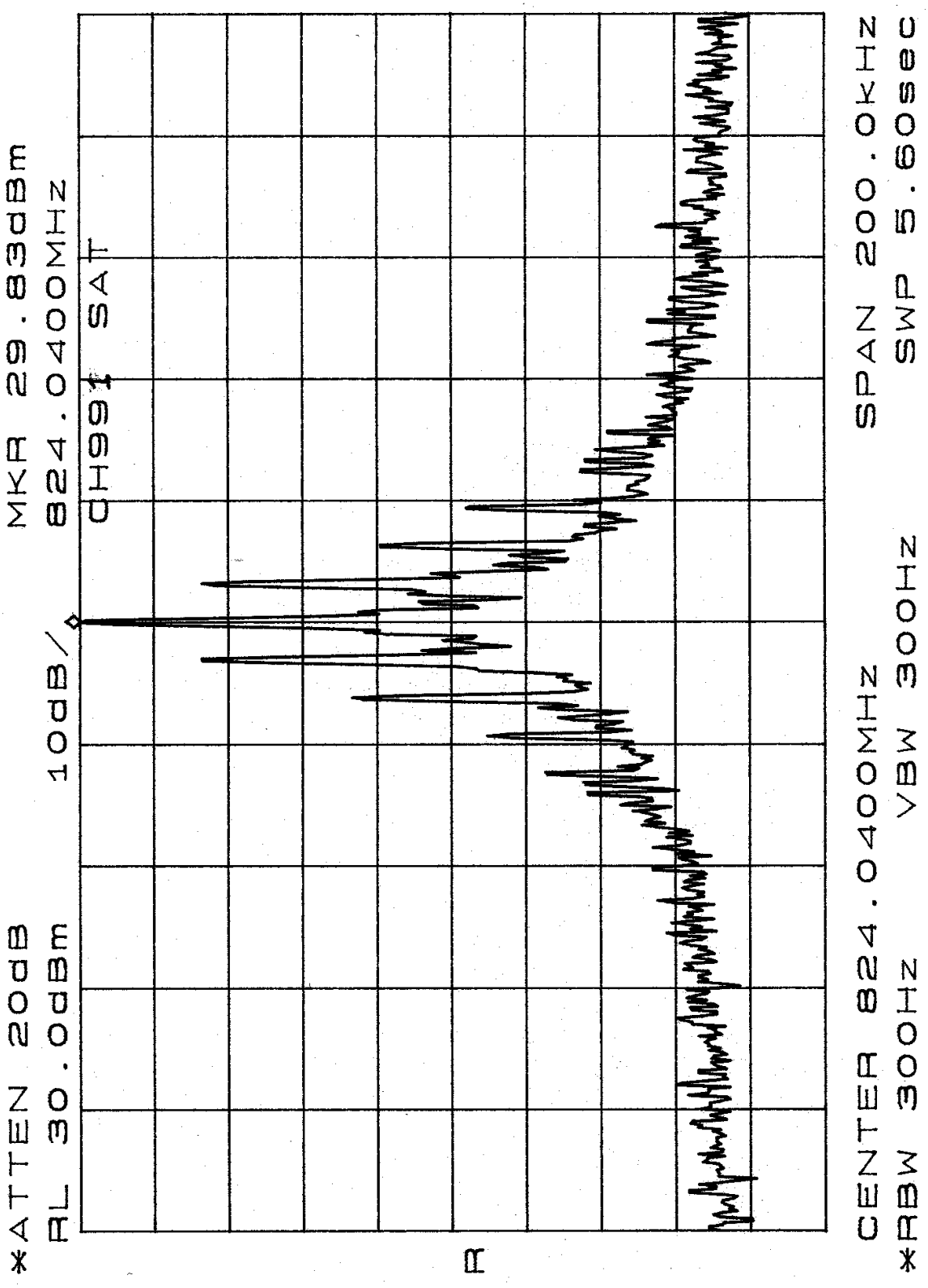

Figure 5–5. SAT mode on low-band channel 991

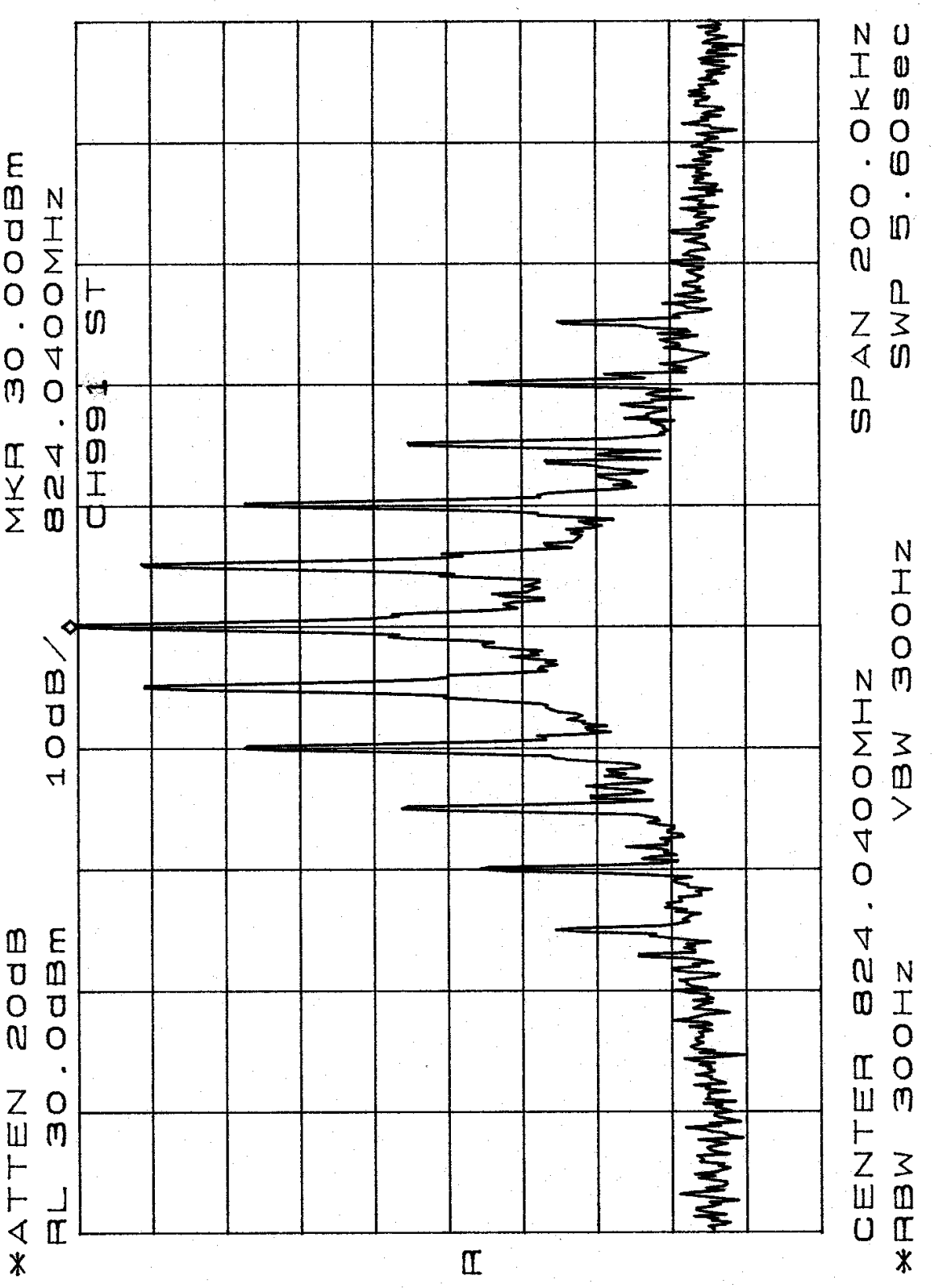

Figure 5–6. ST mode on low-band channel 991

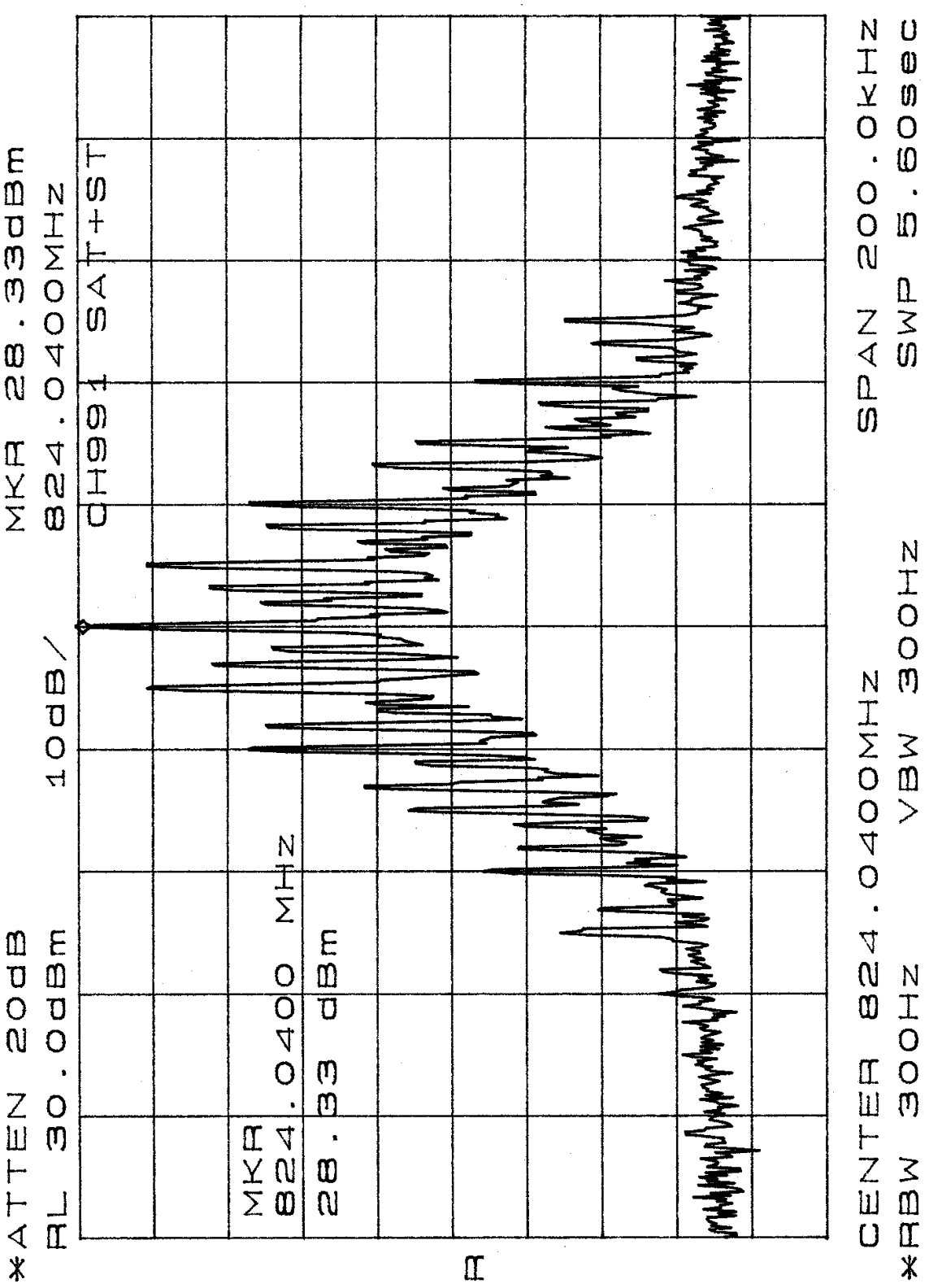

Figure 5–7. SAT+ST modes on low-band channel 991

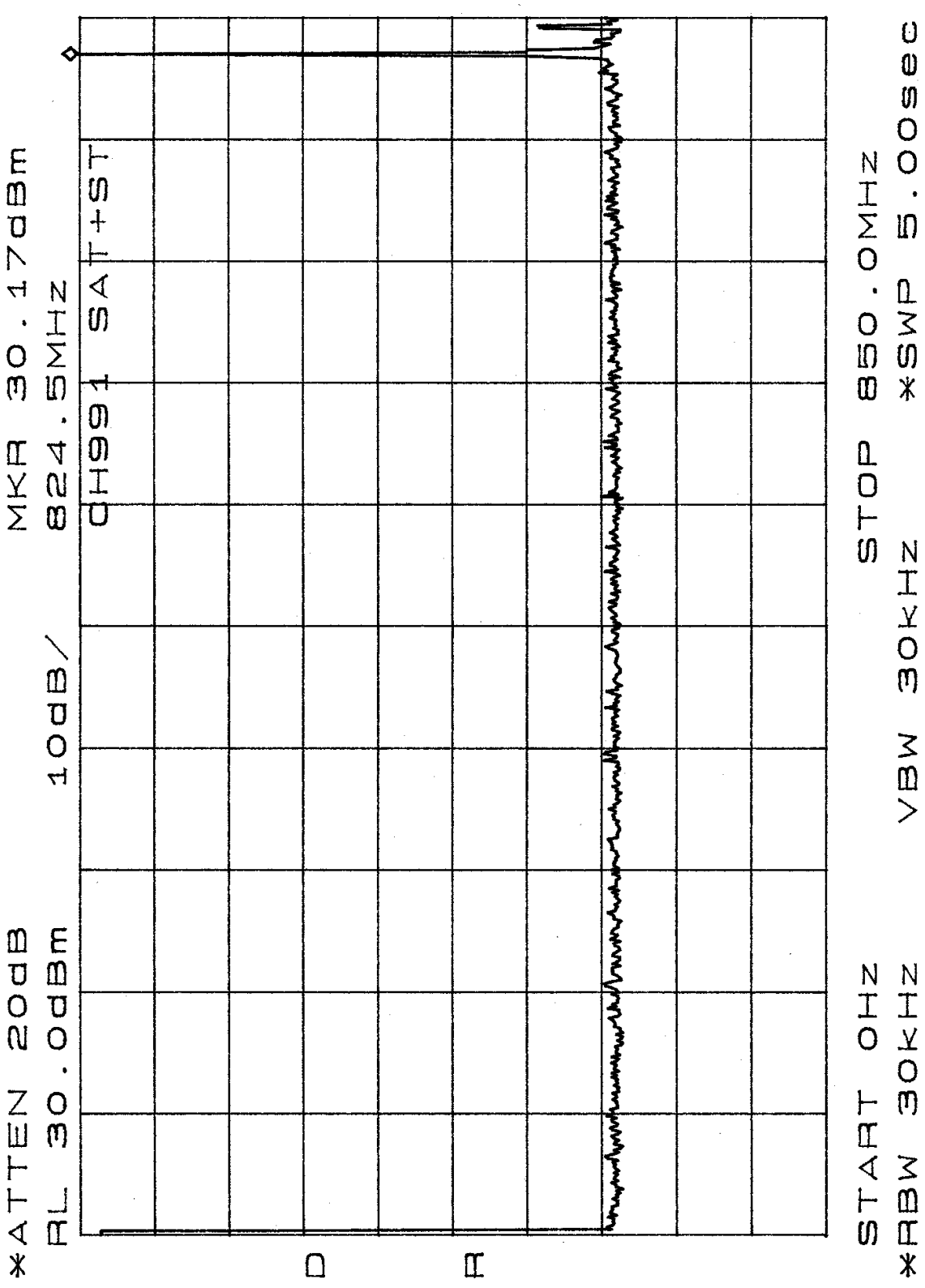

Figure 5–8. Out-of-band noise from low-band channel 991 (0-850 MHz)

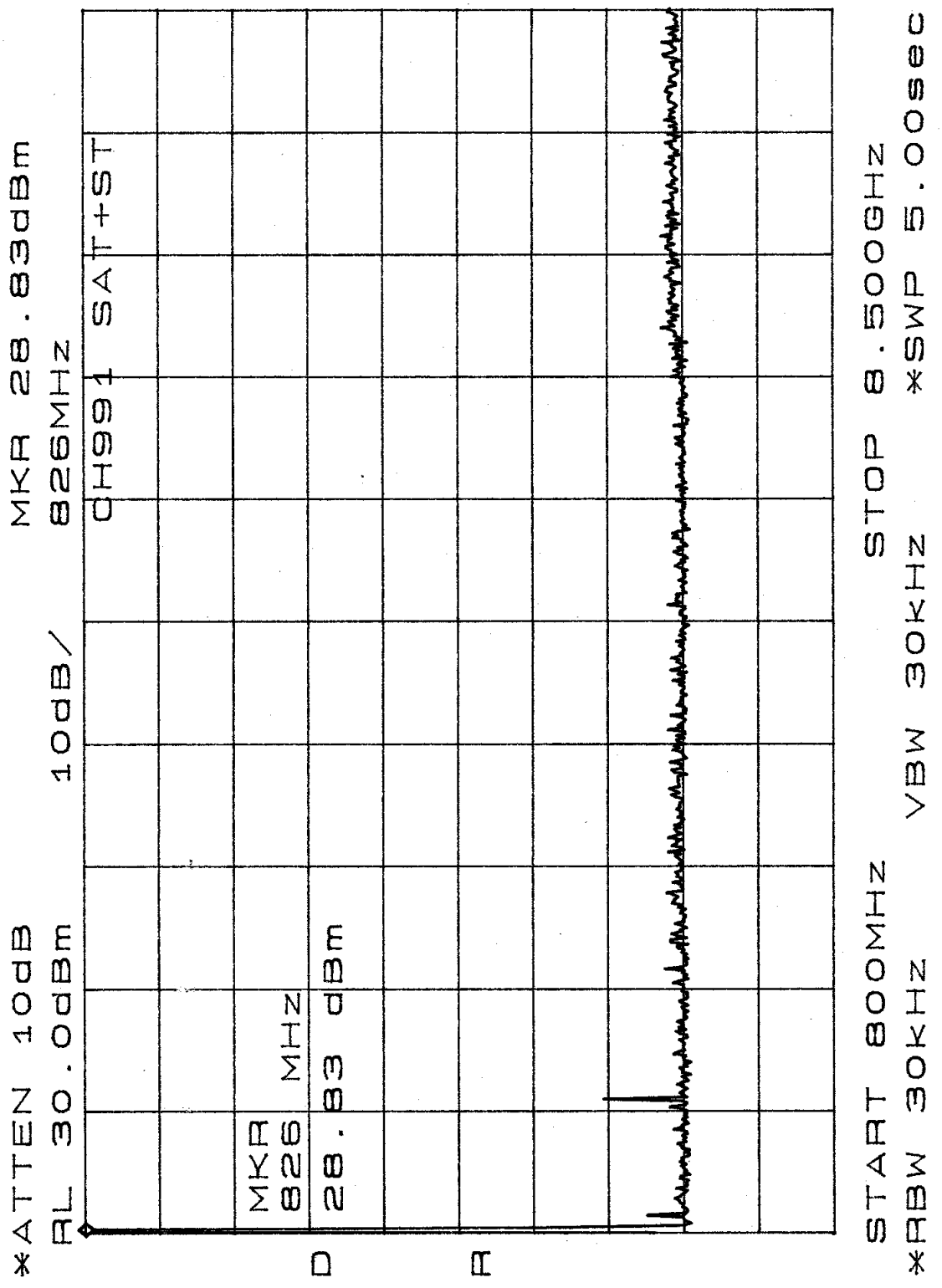

Figure 5–9. Out-of-band noise from low-band channel 991 (800-8500 MHz)

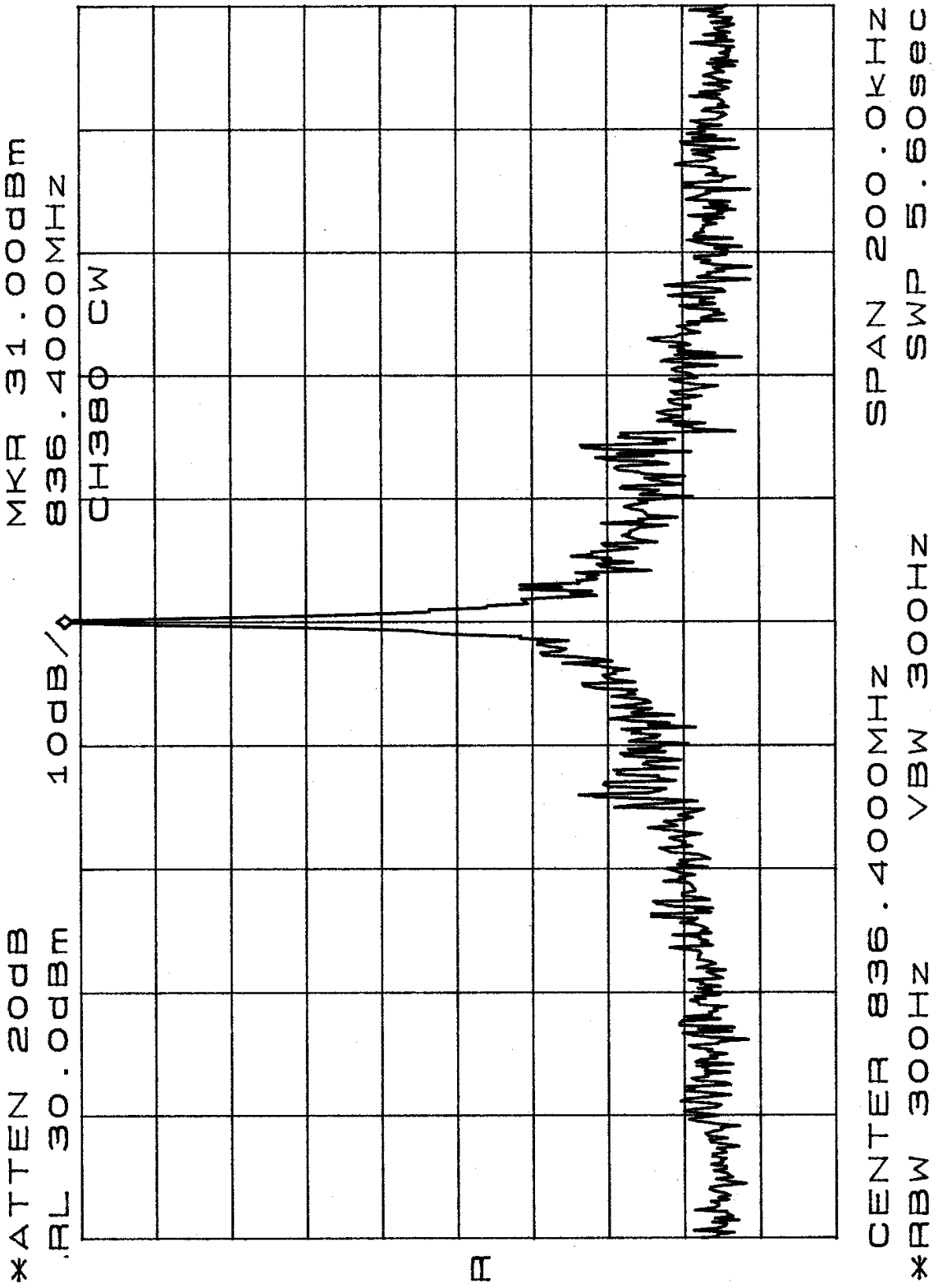

Figure 5–10. CW on mid-band channel 380

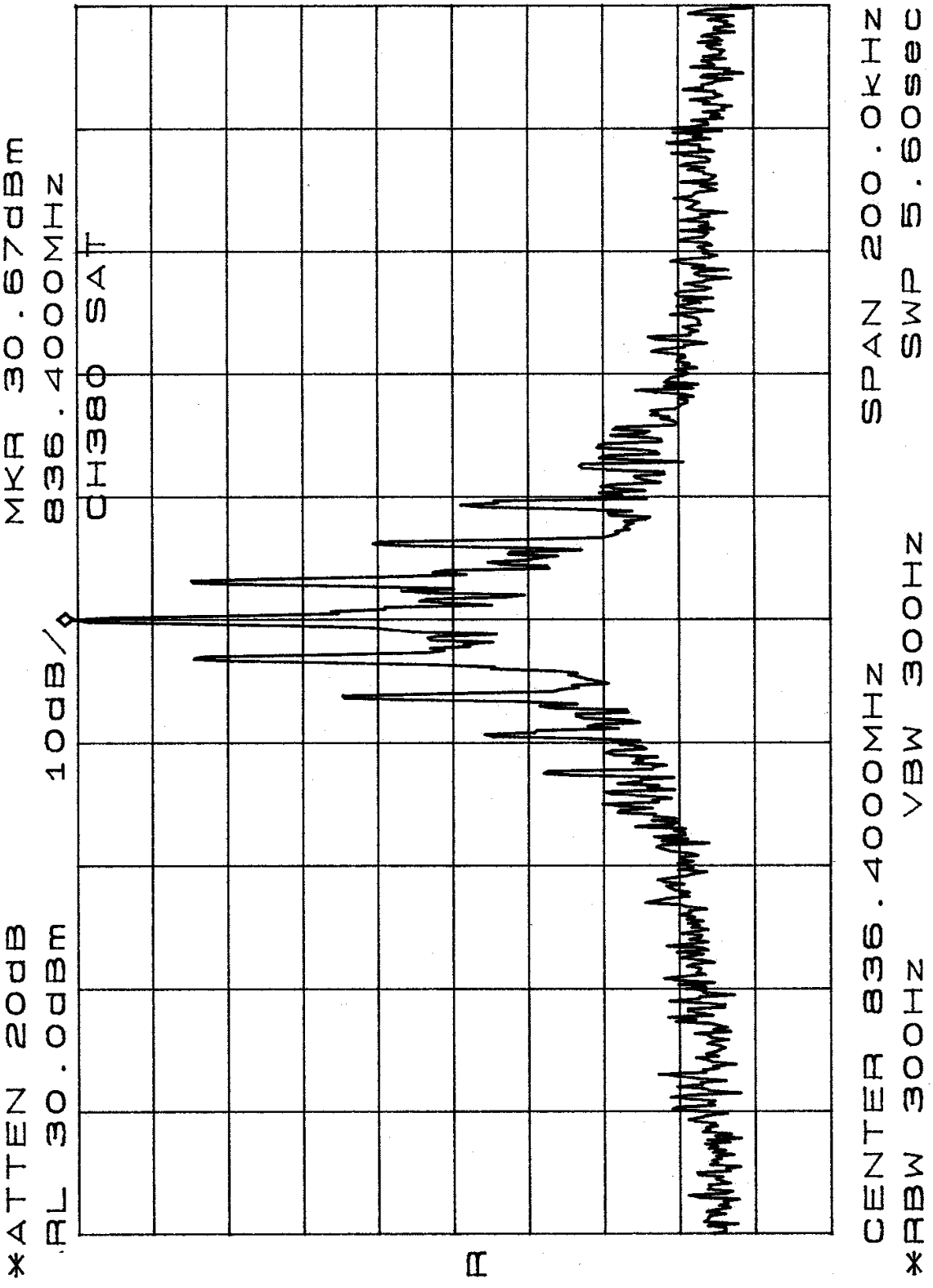

Figure 5–11. SAT mode on mid-band channel 380

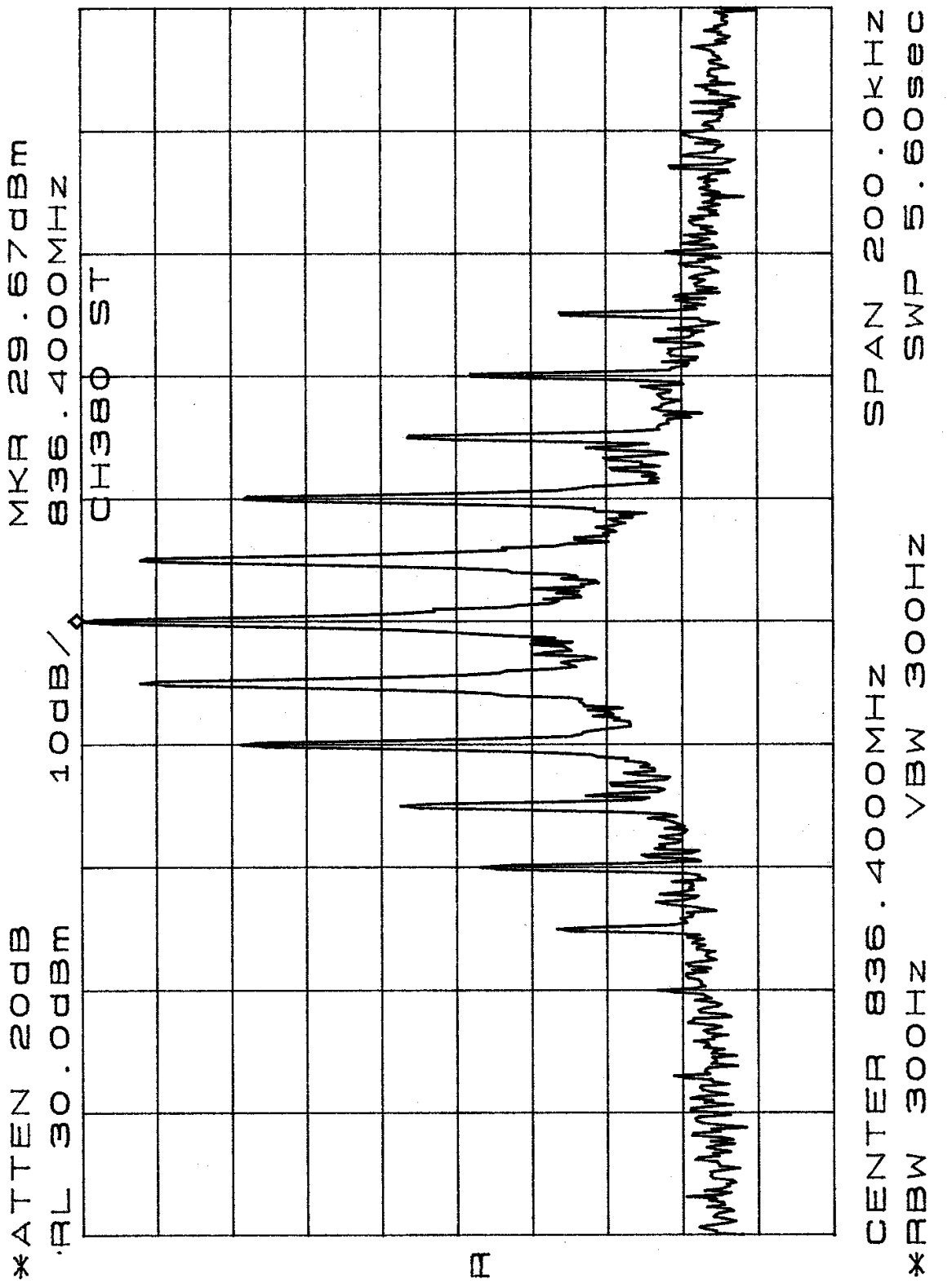

Figure 5–12. ST mode on mid-band channel 380

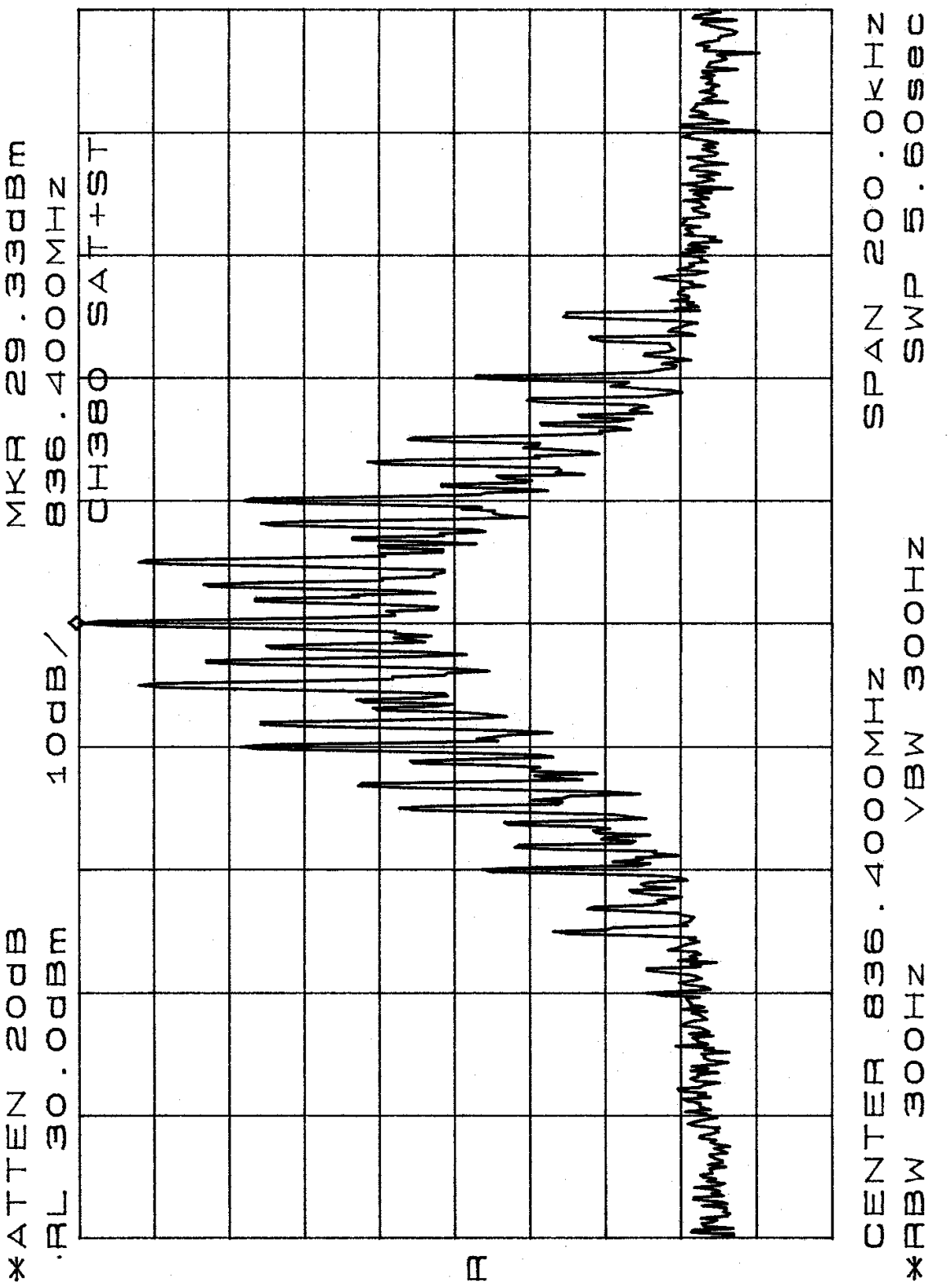

Figure 5–13. SAT+ST modes on mid-band channel 380

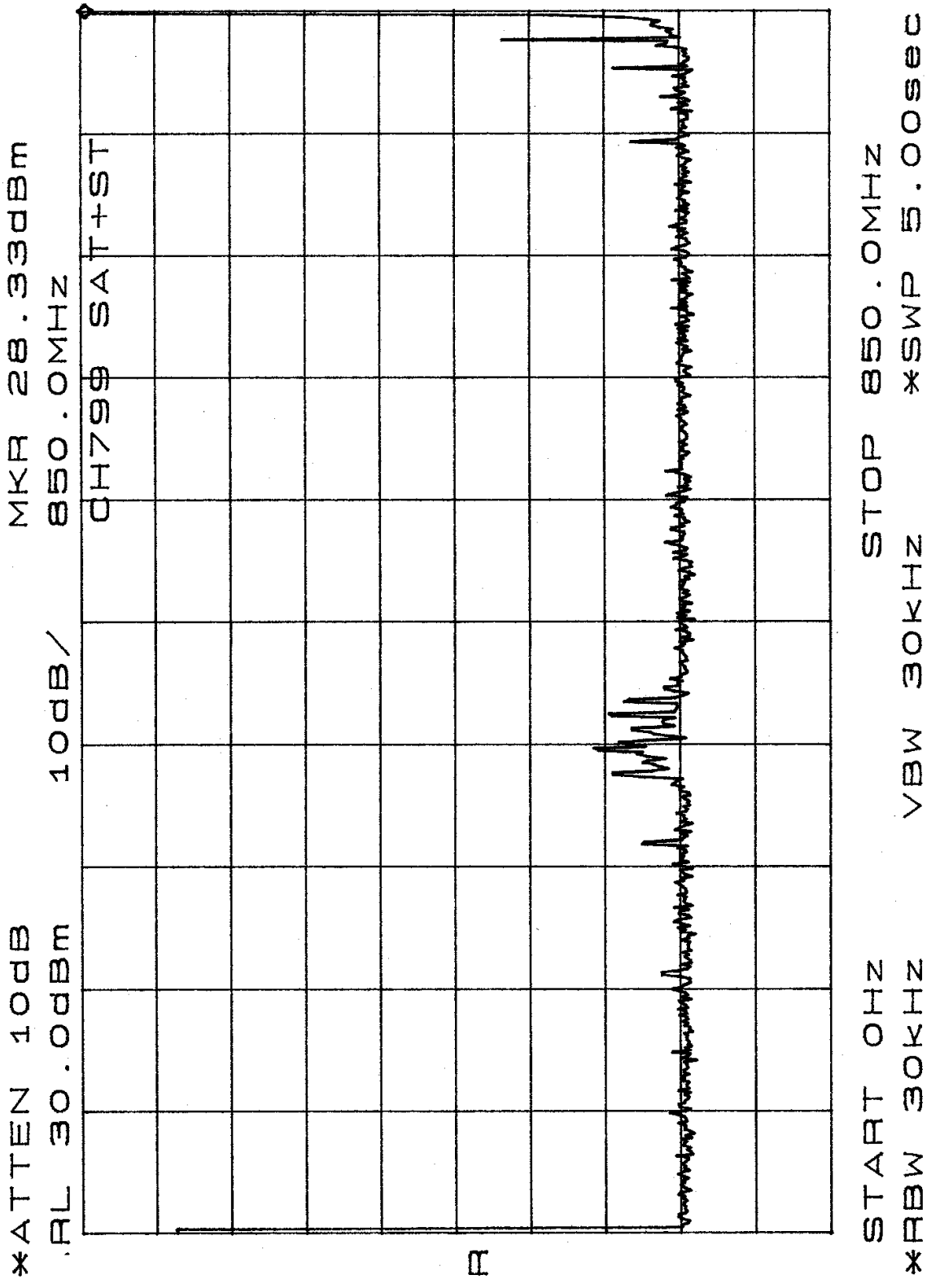

Figure 5–14. Out-of-band noise from mid-band channel 380 (0-850 MHz)

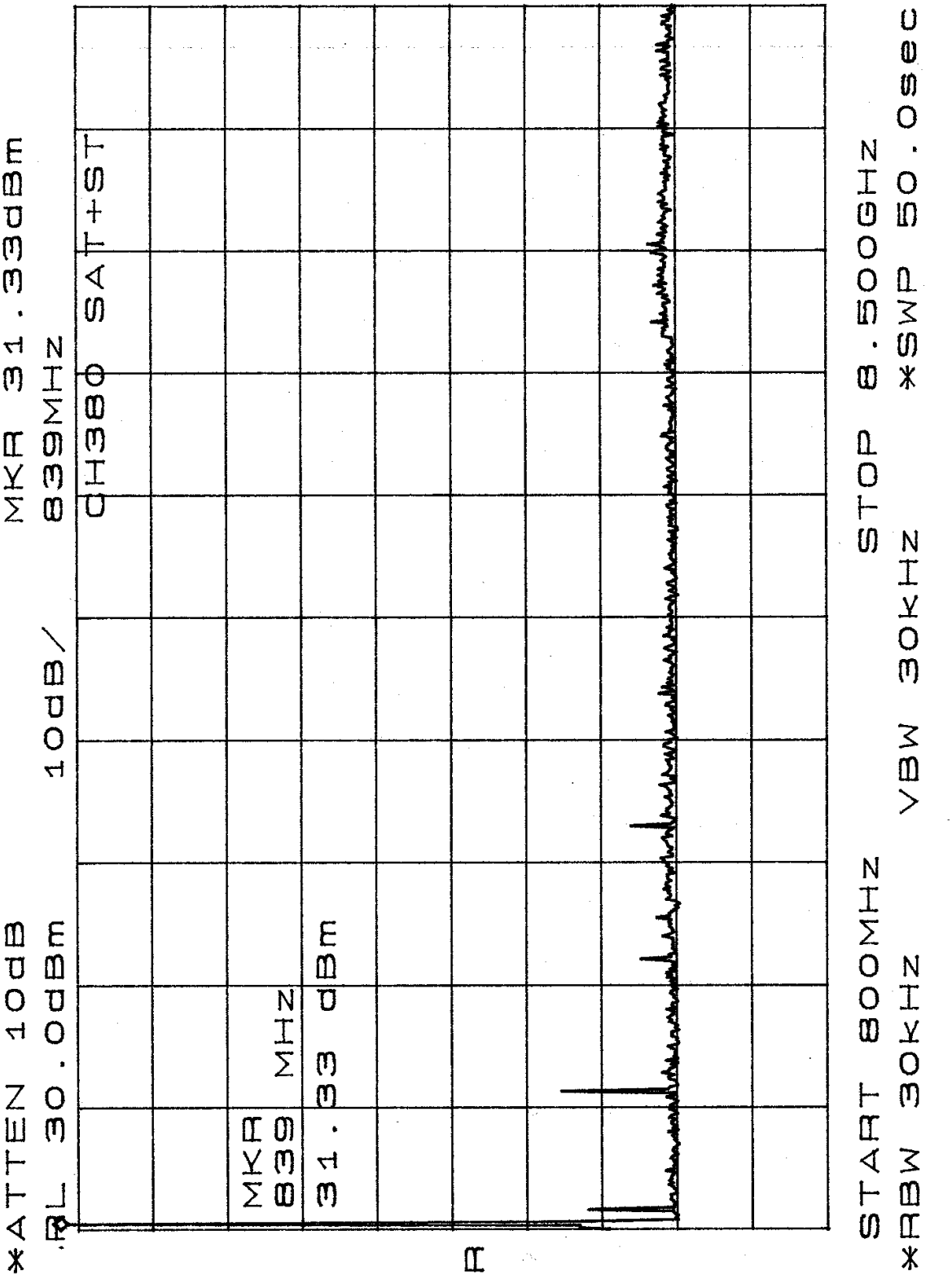

Figure 5–15. Out-of-band noise from mid-band channel 380 (800-8500 MHz)

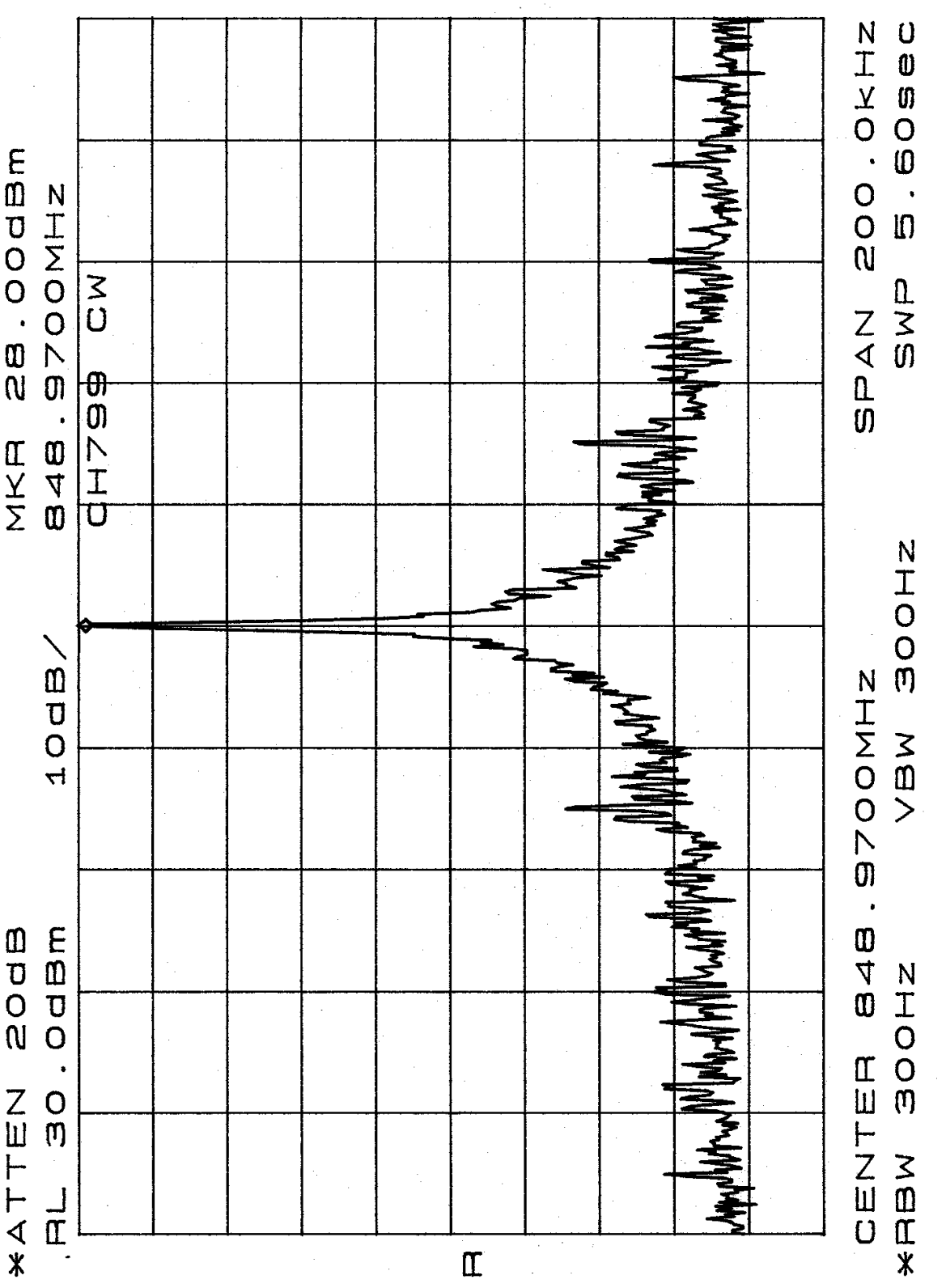

Figure 5–16. CW on high-band channel 799

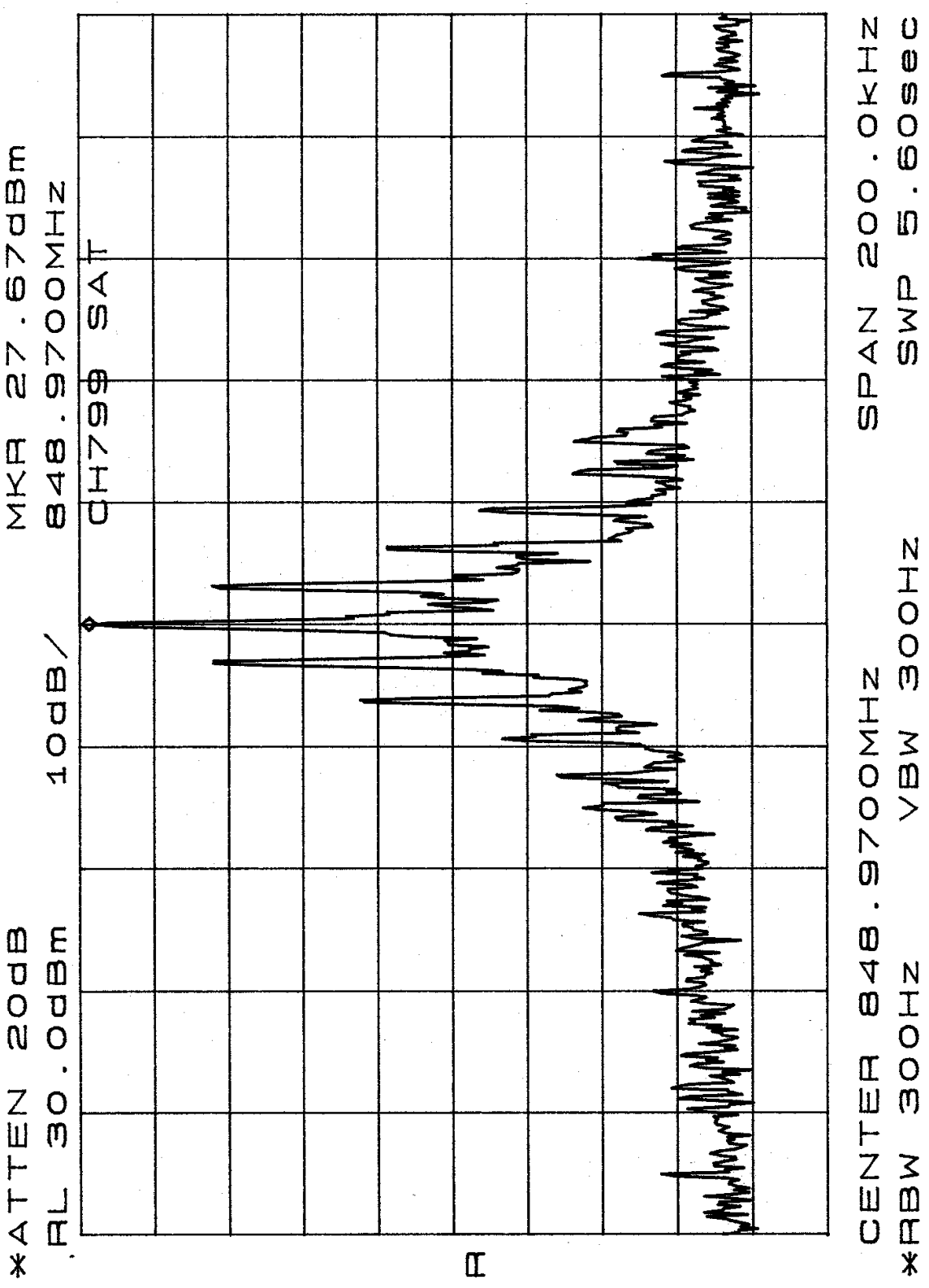

Figure 5–17. SAT mode on high-band channel 799

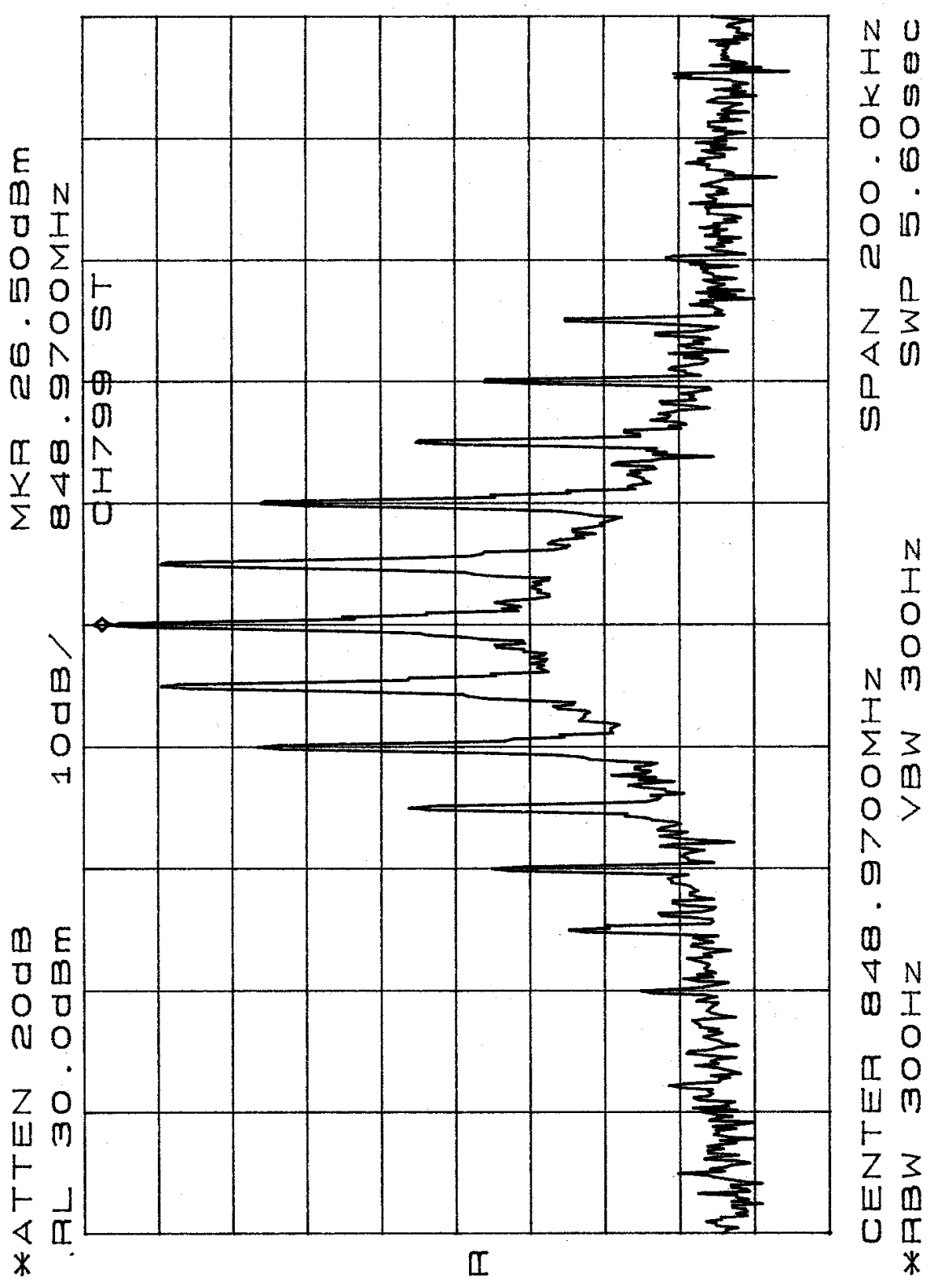

Figure 5–18. ST mode on high-band channel 799

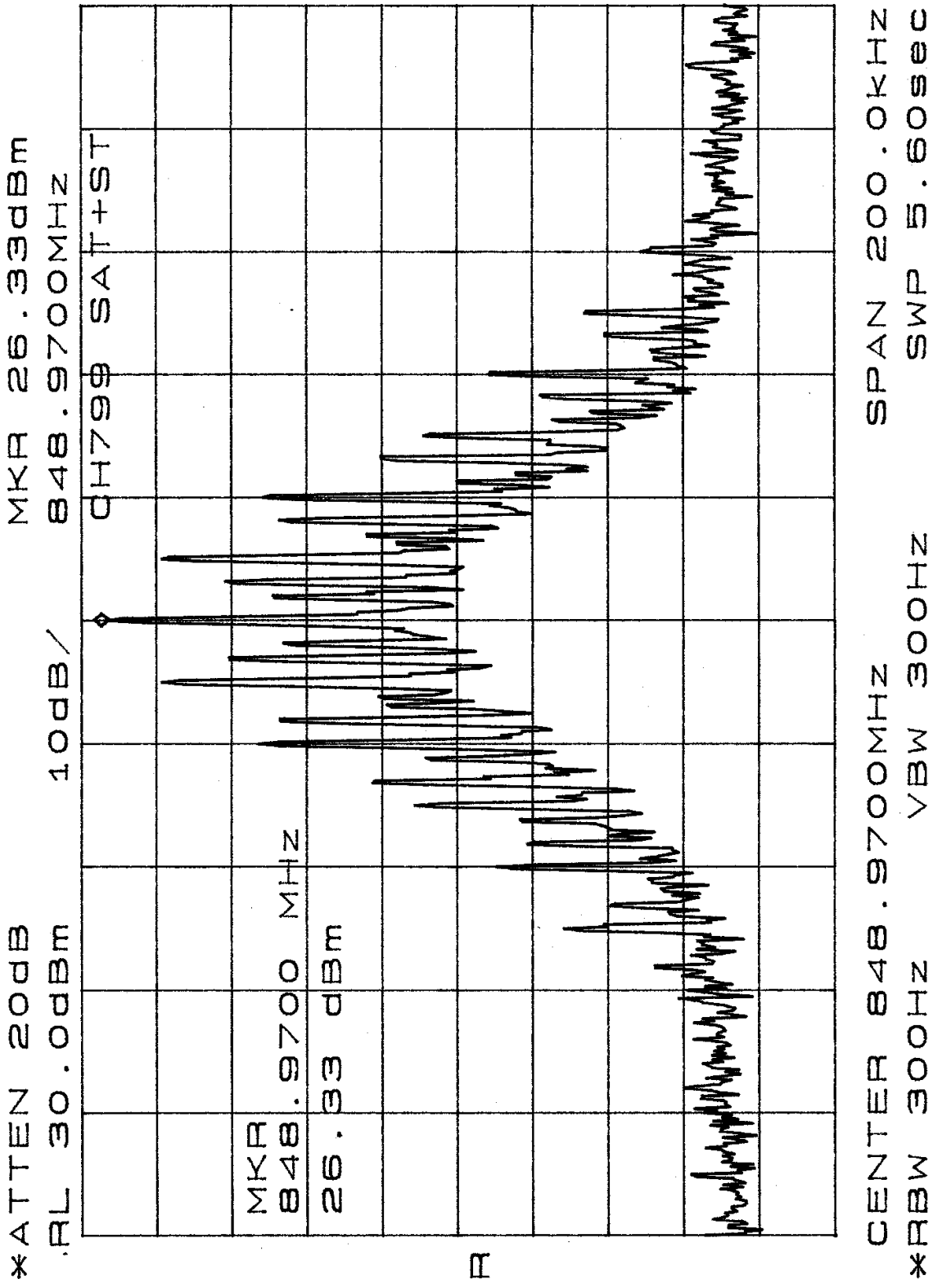

Figure 5–19. SAT+ST modes on high-band channel 799

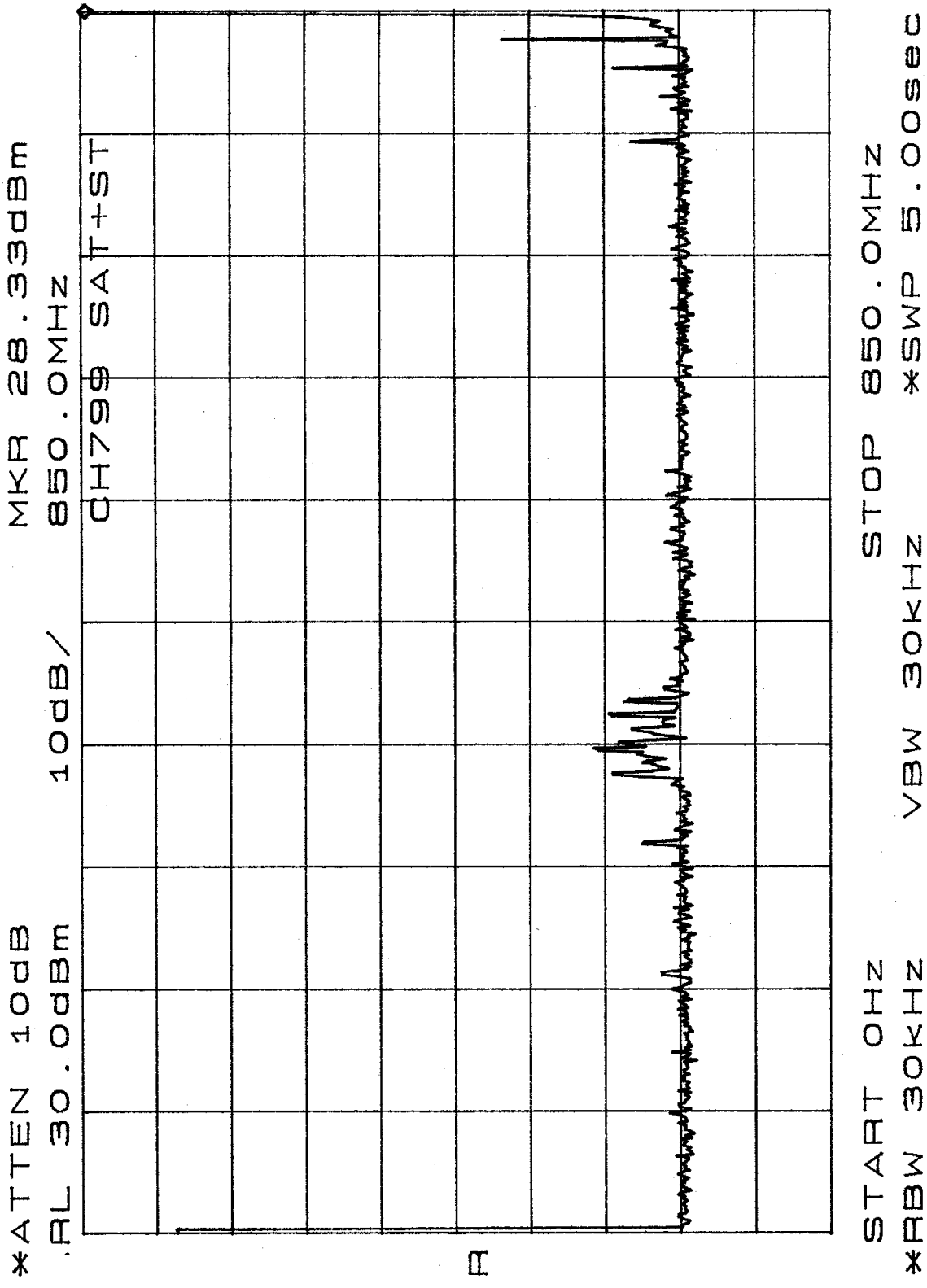

Figure 5–20. Out-of-band noise from high-band channel 799 (0-850 MHz)

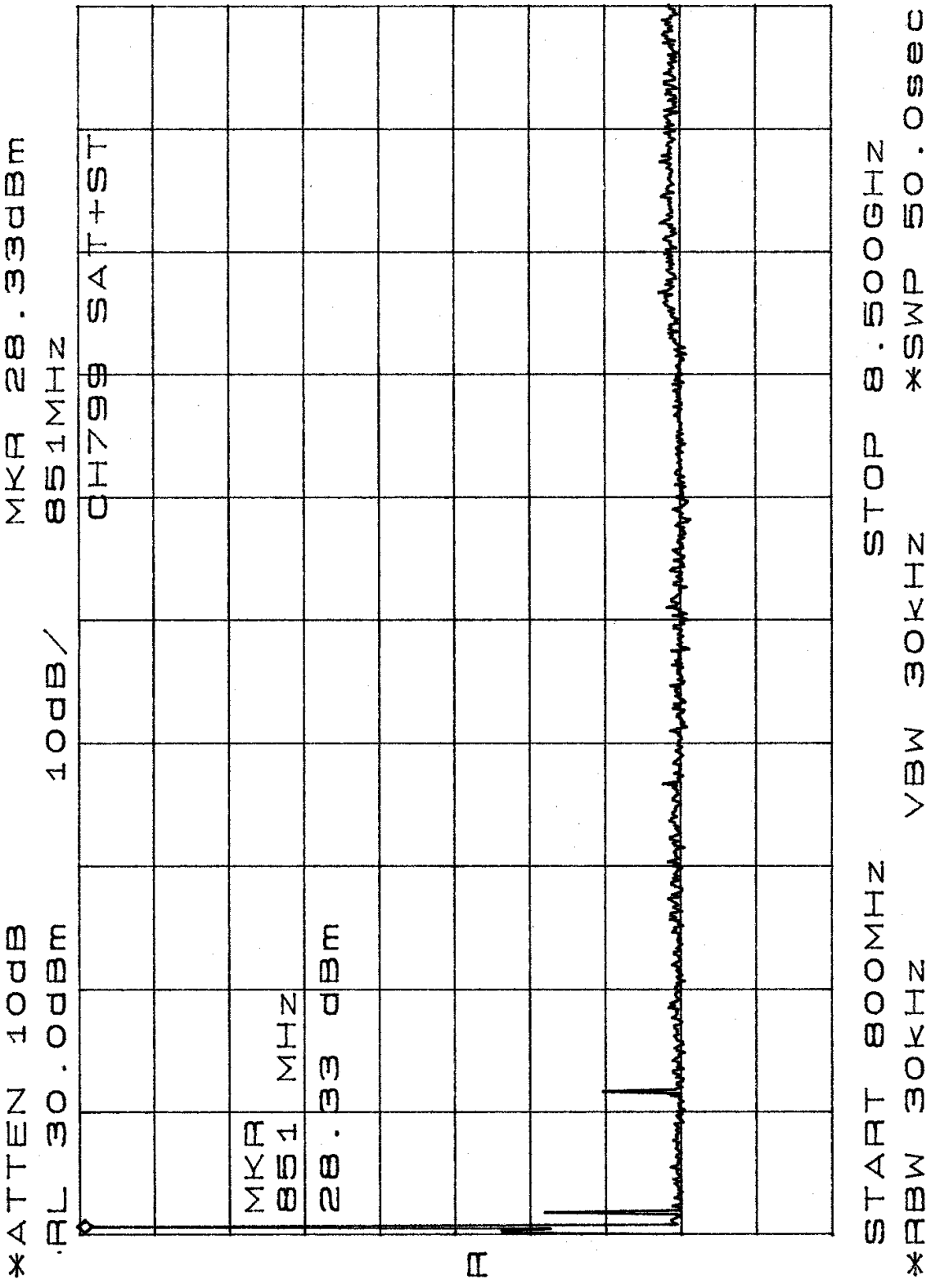

Figure 5–21. Out-of-band noise from high-band channel 799 (800-8500 MHz)

5.4 Radiated Spurious Emissions

Refer to TUV Product Service Test Report.

5.5 Frequency Stability

Frequency stability of the equipment versus temperature and power supply change was tested pursuant to FCC Part 2.1055. Measurement was conducted in mid-band channel 380 transmitting mode without modulation on the carrier frequency (836.40 MHz). CSZ Dimension Series 60 Chamber was used to stabilize a specific temperature and HP 8563E spectrum analyzer was used to monitor frequency stability. Table 5-9 shows the test results

Table 5–9. Frequency offset (Hz) from carrier frequency of channel 380

	External DC power supply (V)					
Temperature (°C)	**9.6**	**10.8**	**12 (Nom)**	**13.2**	**14.4**	**Specification (Hz)**
-30	153	187	177	203	230	± 2901
-20	157	153	177	193	207	± 2901
-10	110	127	123	130	130	± 2901
0	217	223	223	237	267	± 2901
10	290	283	280	267	263	± 2901
20	0	0	0	3	3	± 2901
30	-110	-100	-97	-93	-87	± 2901
40	-260	-263	-237	-240	-247	± 2901
50	-260	-260	-253	-250	-243	± 2901
60	323	300	280	260	240	± 2901