Noise Assessment with the J2180A Preamplifier

In this first measurement, a J2180A is connected to a 50Ω oscilloscope and displayed using the spectrum function. The spurs at 28kHz, 60kHz and 85kHz are approximately -97dBm at the preamp output as seen in Figure 1.

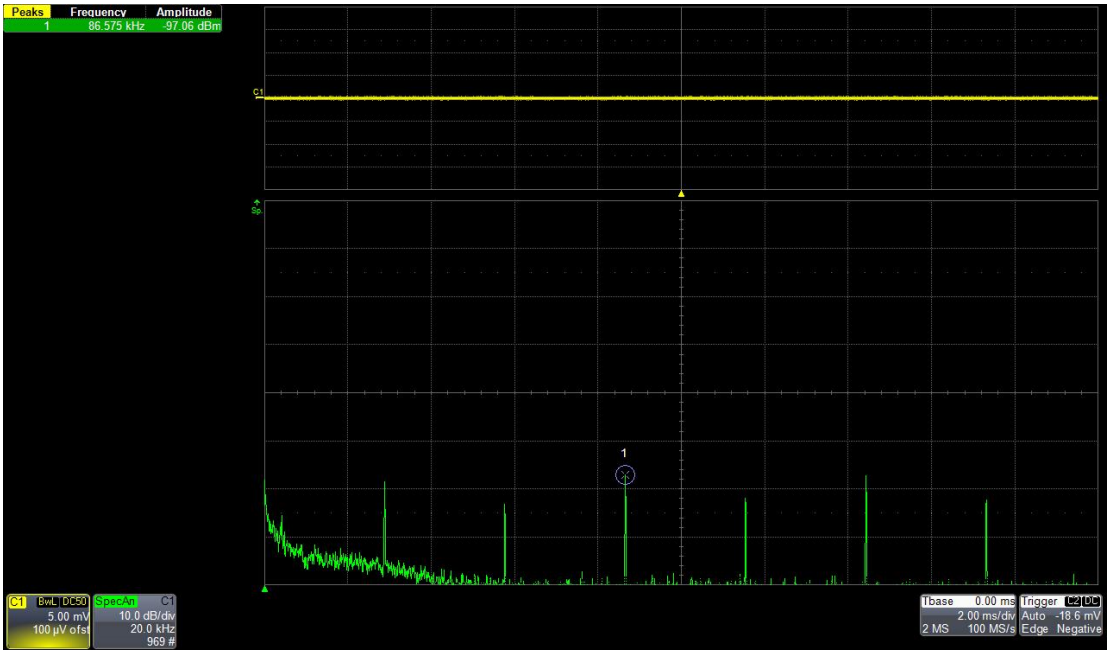

Figure 1 Oscilloscope measurement of J2180A output with no input signal (50 Ohm terminated).

The 28kHz spurious noise is due to the switching power supply internal to the J2170A. While the J2170A also includes a very high PSRR regulator, the resulting 28kHz noise spur is due to approximately 1mVrms residual switching frequency noise at the output of the regulator. Inserting a Picotest J2102B common model coaxial transformer between the J2180A output and the RSA510XA spectrum analyzer as shown in Figure 2. It is good to have several of these transformers on hand, especially for very low-level measurements. This coaxial transformer maintains the 50Ω connection integrity to greater than 200 MHz while providing excellent common mode rejection. This is not only true for making noise measurements but for low level measurements on all instruments.

Figure 2 J2180A connected to J2102B common mode coaxial transformer.

Inserting the J2102B common node coaxial transformer between the J2180A output and the oscilloscope removes the common mode signal between the two instruments as seen in Figure 3. This indicates that the higher frequency noise is common mode noise between the instruments.

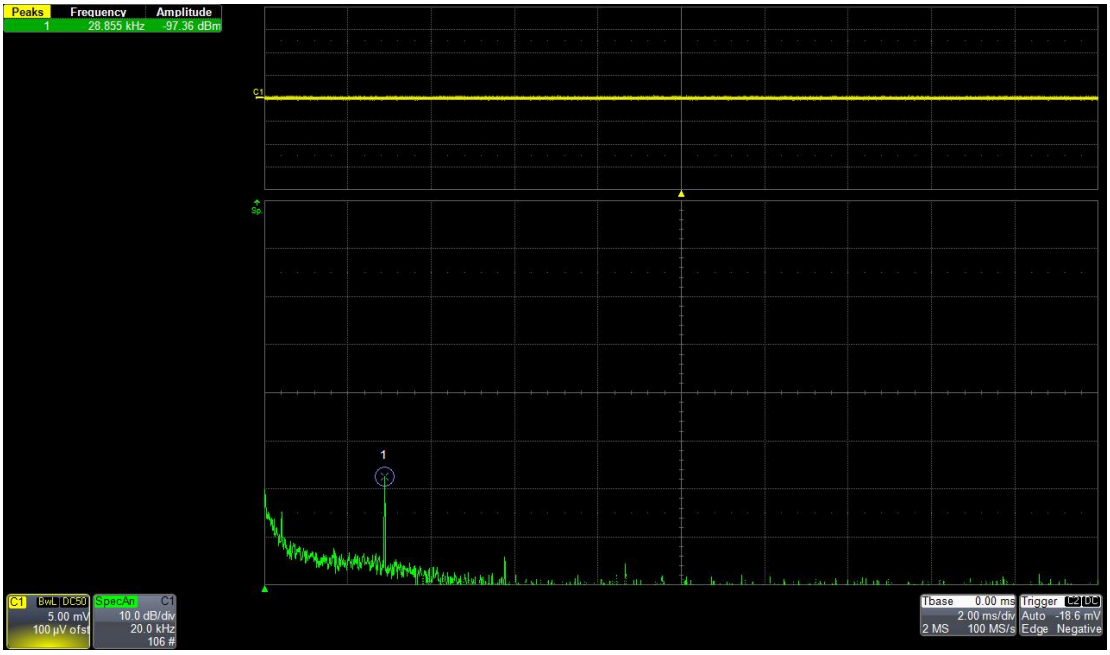

Figure 3 Inserting a J2102B common mode coaxial transformer between the J2180A and the oscilloscope eliminates most of the noise, which is common mode.

The small spur from the switching power supply is still seen at 28kHz and cannot be eliminated at the output of the J2180A. The spur can be removed by using an external linear (not switching) bench power supply. While we do not generally recommend this solution to our customers, it will eliminate the spur in this application.

The measurement in Figure 4 shows the spurious response with the J2170A replaced by a precision linear bench power supply (+/-12V 60mA). In this measurement using the precision linear bench power supply and the J2102B the spurs are removed as seen in Figure 4.

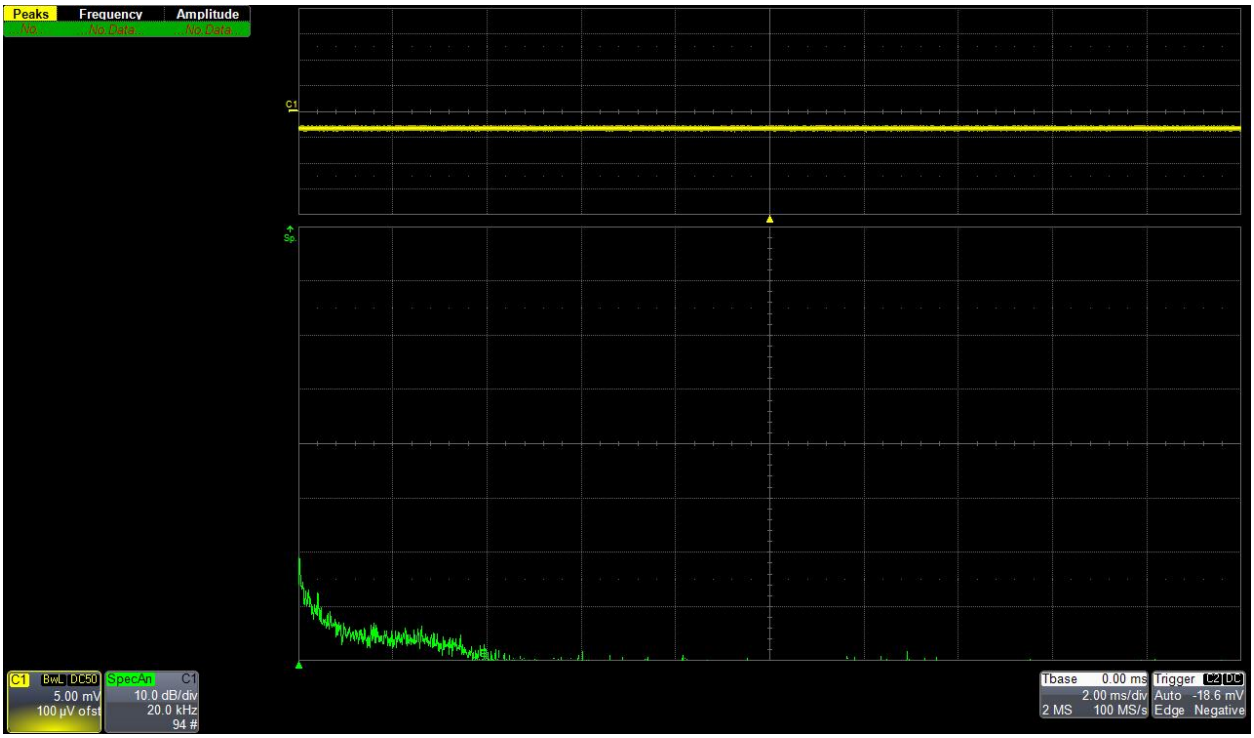

Figure 4 The J2180A output noise with a precision linear power supply replacing the J2170A and J2102B at the output.

At these very low noise levels it is also important to characterize ambient noise sources, since they can easily be picked up in wiring and by being absorbed through the instrument cases. The picture in Figure 5 shows a very small H-field probe connected to the input of the J2180A and placed in front of an active LCD display. Similar noise can be radiated from computer monitors, fluorescent lights and from the modulation of wireless routers.

Figure 5 A small H-field probe is placed in front of an active LCD screen.

The resulting noise spurs from the LCD screen are shown in Figure 6.

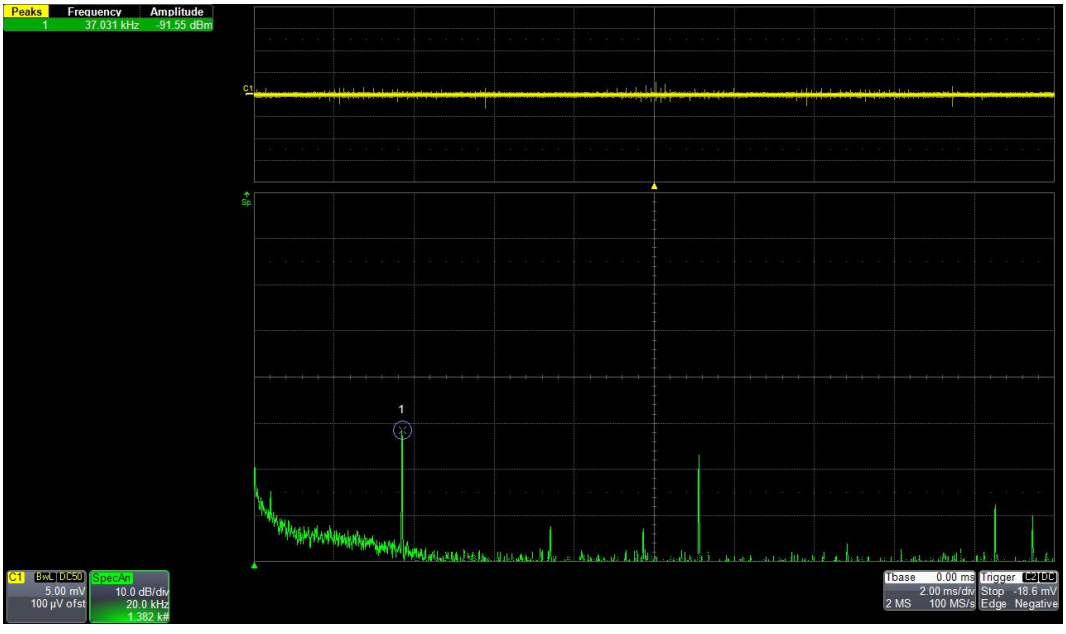

Figure 6 Noise spurs from the LCD screen radiation

Finally the measurement setup is confirmed by connecting a -30dBm, 100kHz sine wave to the preamplifier through a Picotest J2140A 40dB attenuator as shown in Figure 7.

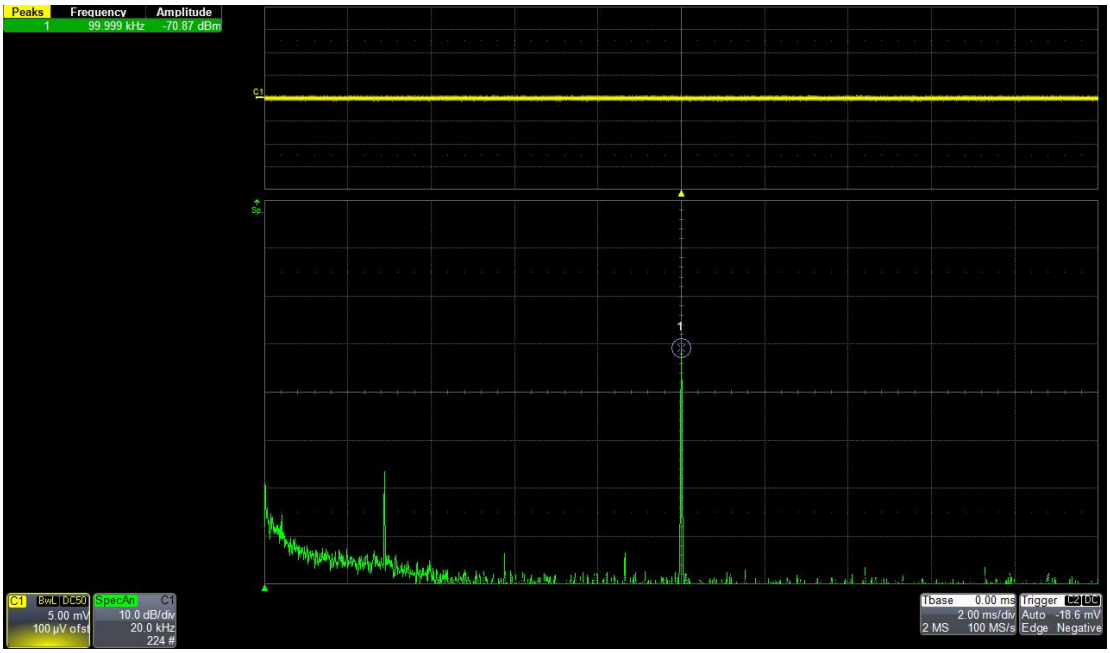

Figure 7 -30dBm signal measured through a Picotest J2140A attenuator.

These same noise management techniques also apply when measuring the noise with a spectrum analyzer, such as the Tektronix RSA5106A.

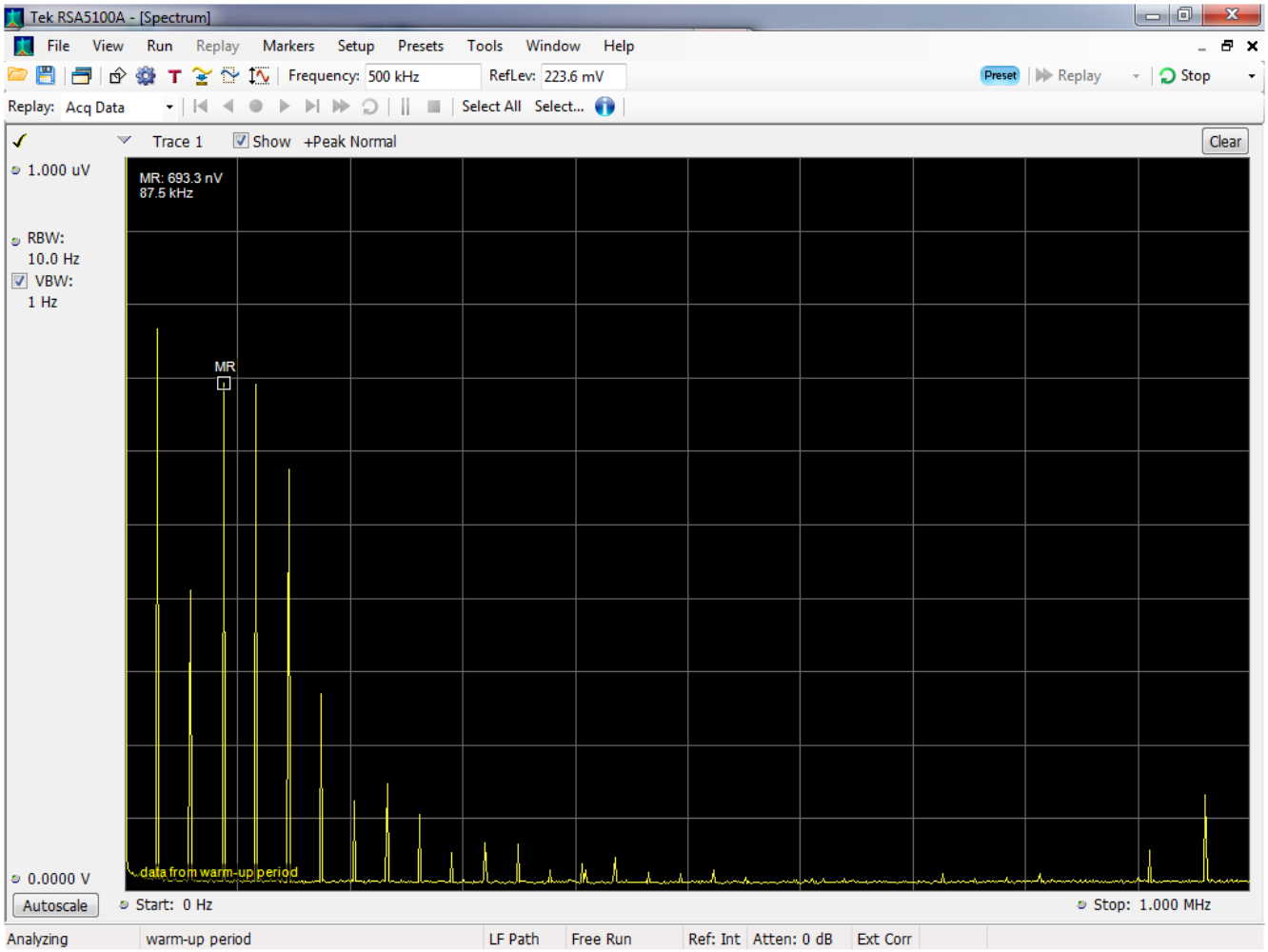

Figure 8 Noise measurement with J2180A powered by J2170A and without J2102B.

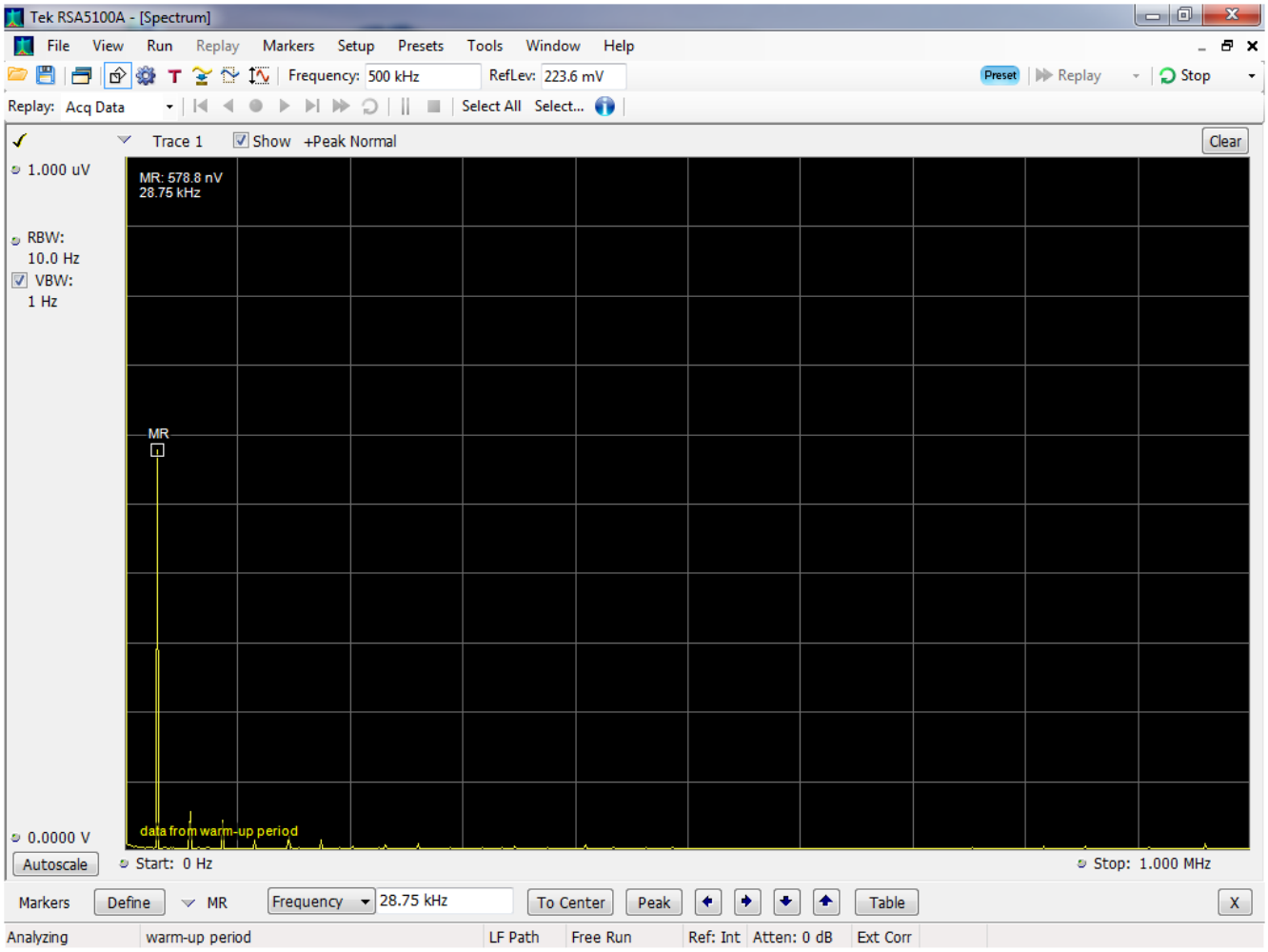

Figure 9 Noise measurement with J2180A and J2102B connected at the output again shows most of the spurs to be common mode and easily removed

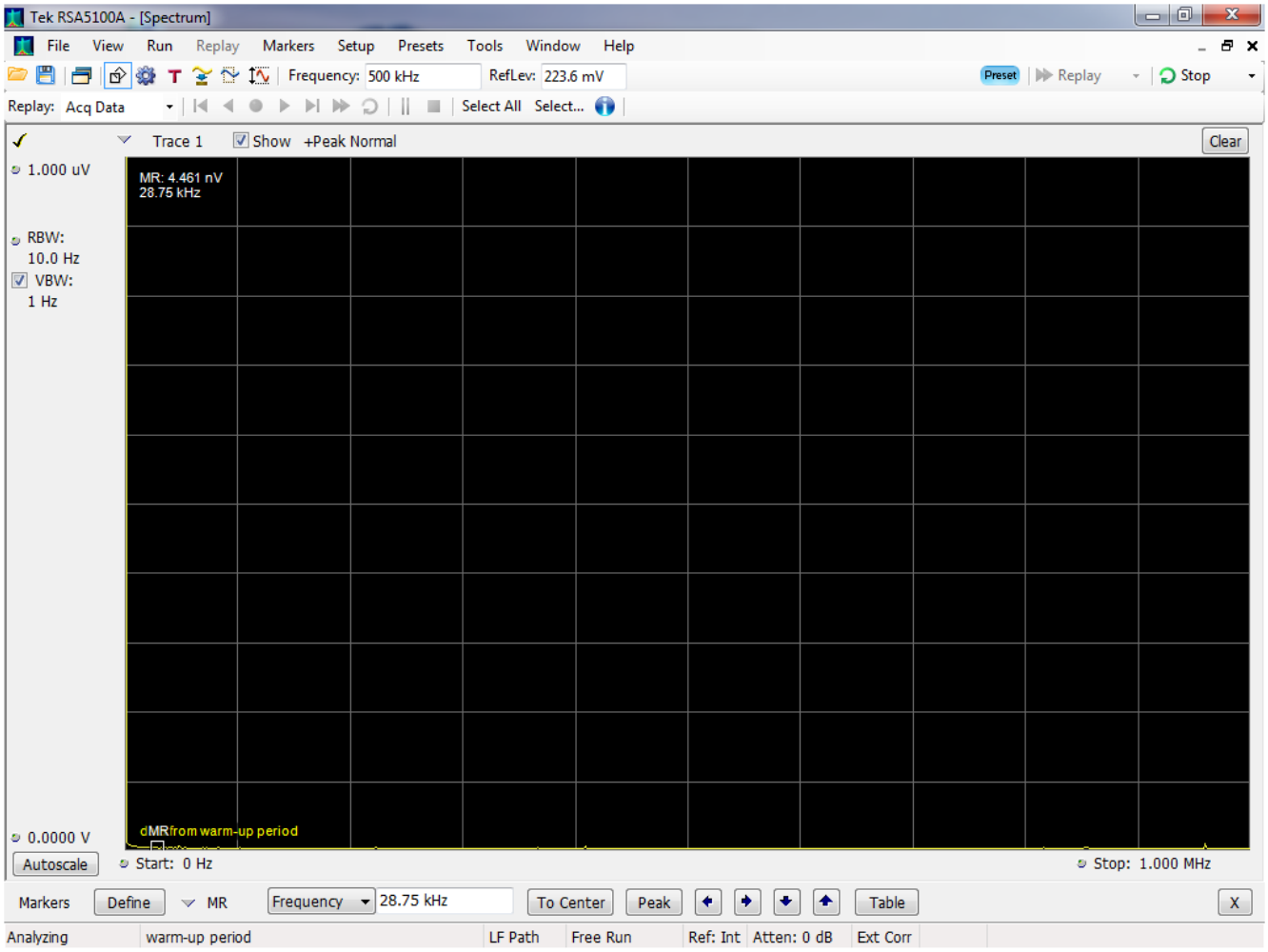

Figure 10 Noise measurement using precision linear bench power supply and J2102B eliminates all spurs

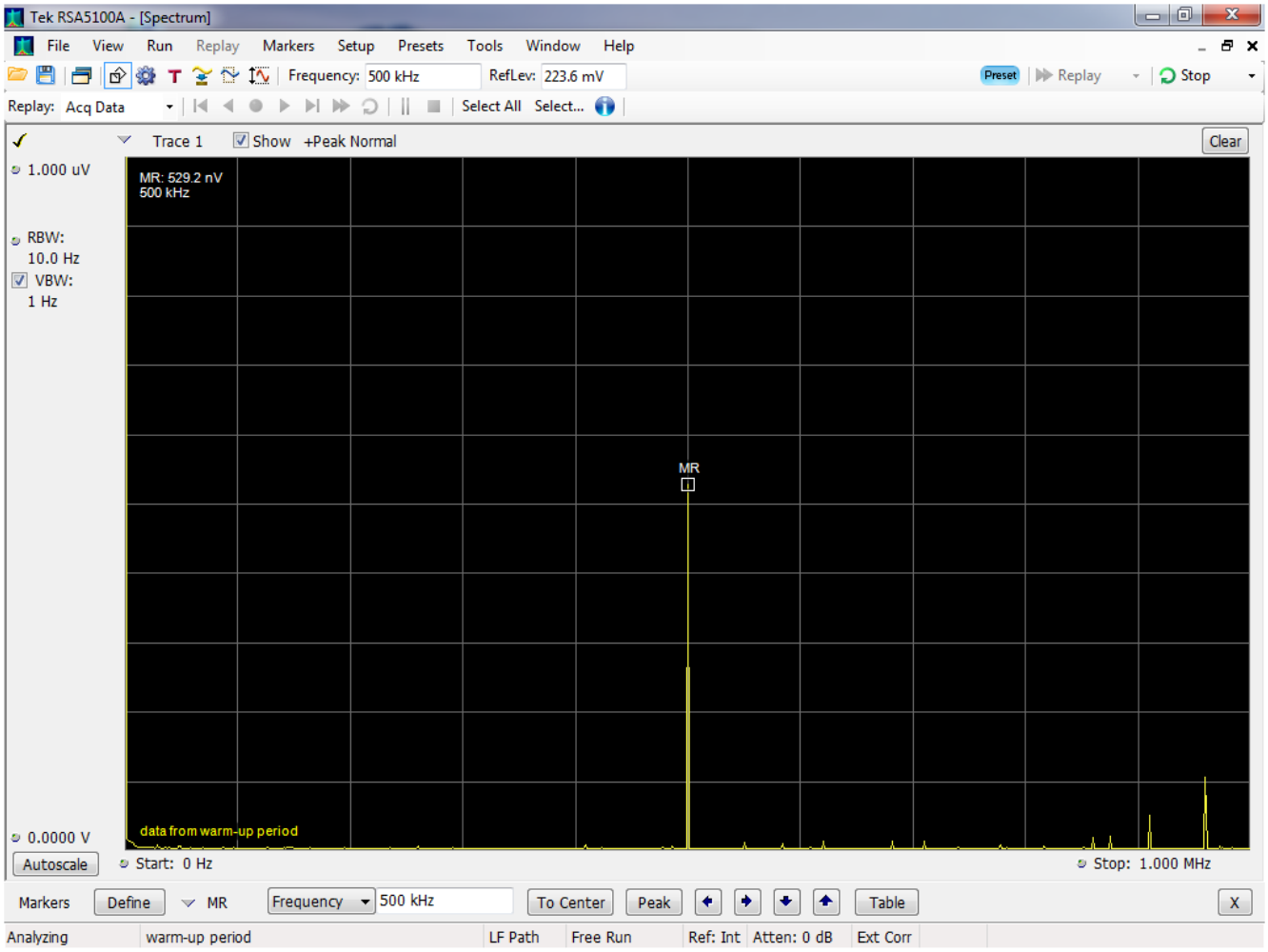

Figure 11 Verifying setup measuring a -100dBm 500kHz sine signal (-20dBm through two cascaded Picotest J2140A 40dB attenuators)

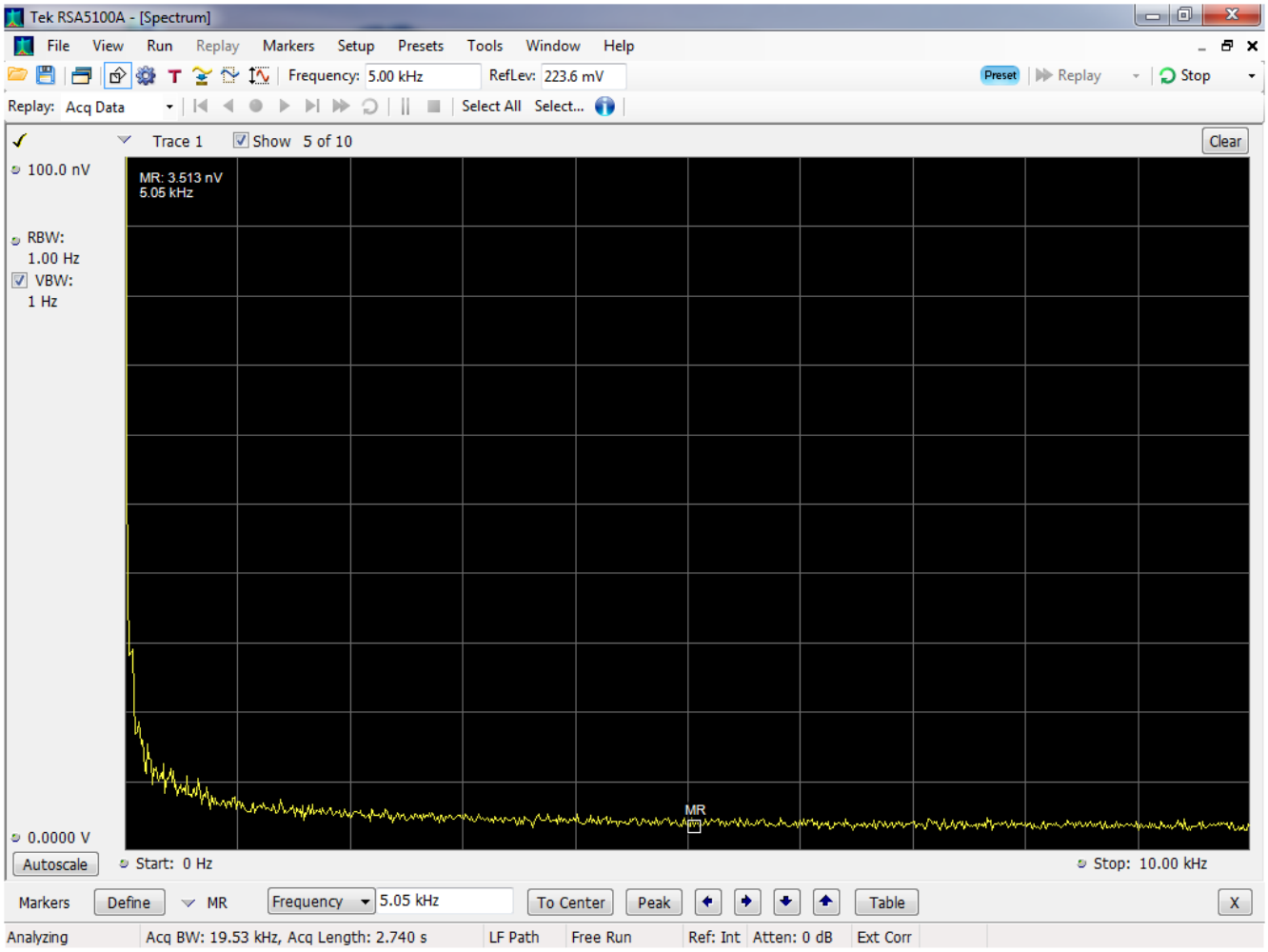

Figure 12 Noise density measurement with nothing connected to the RSA input.

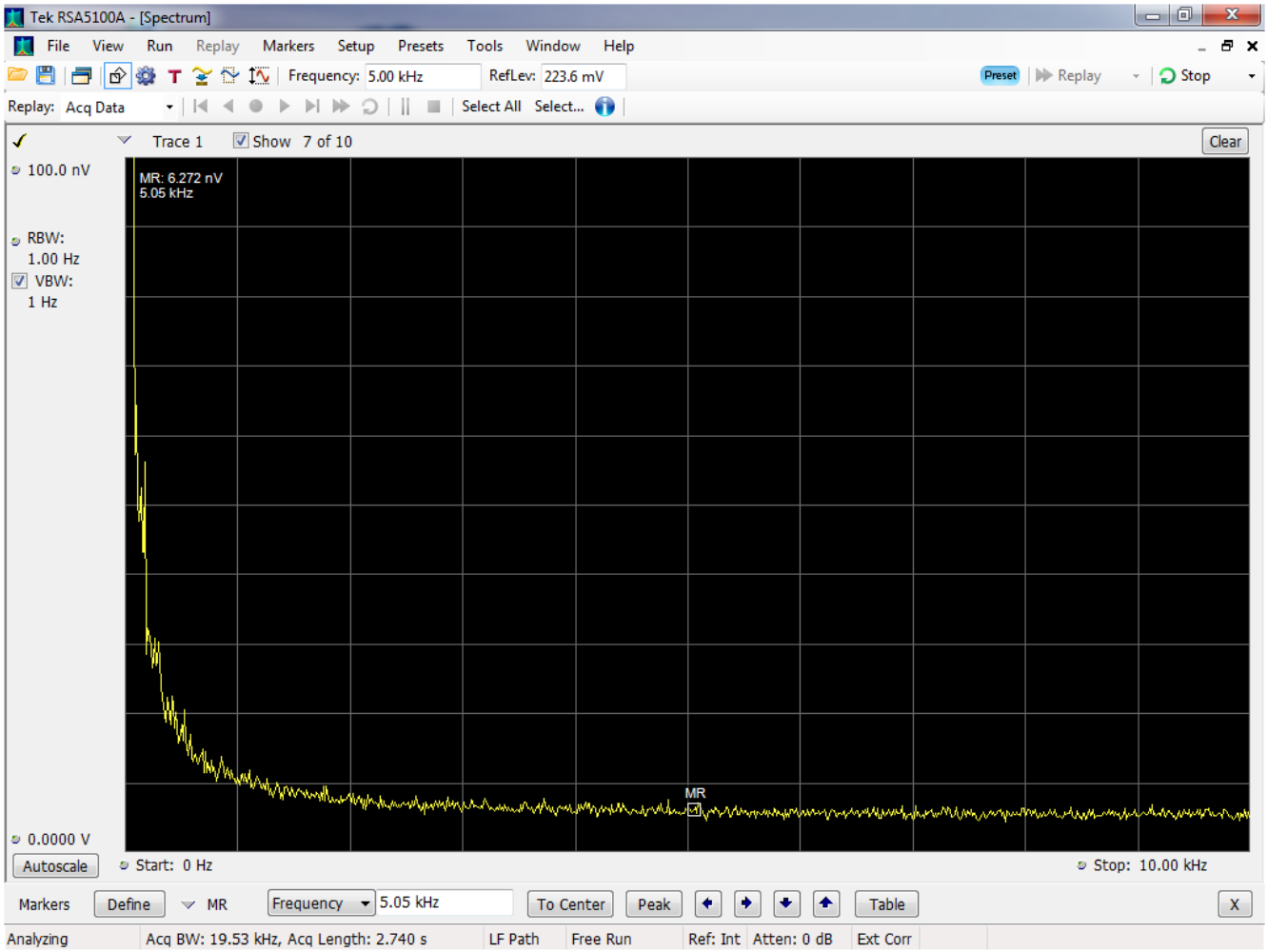

Figure 13 Noise density first J2180A preamp.

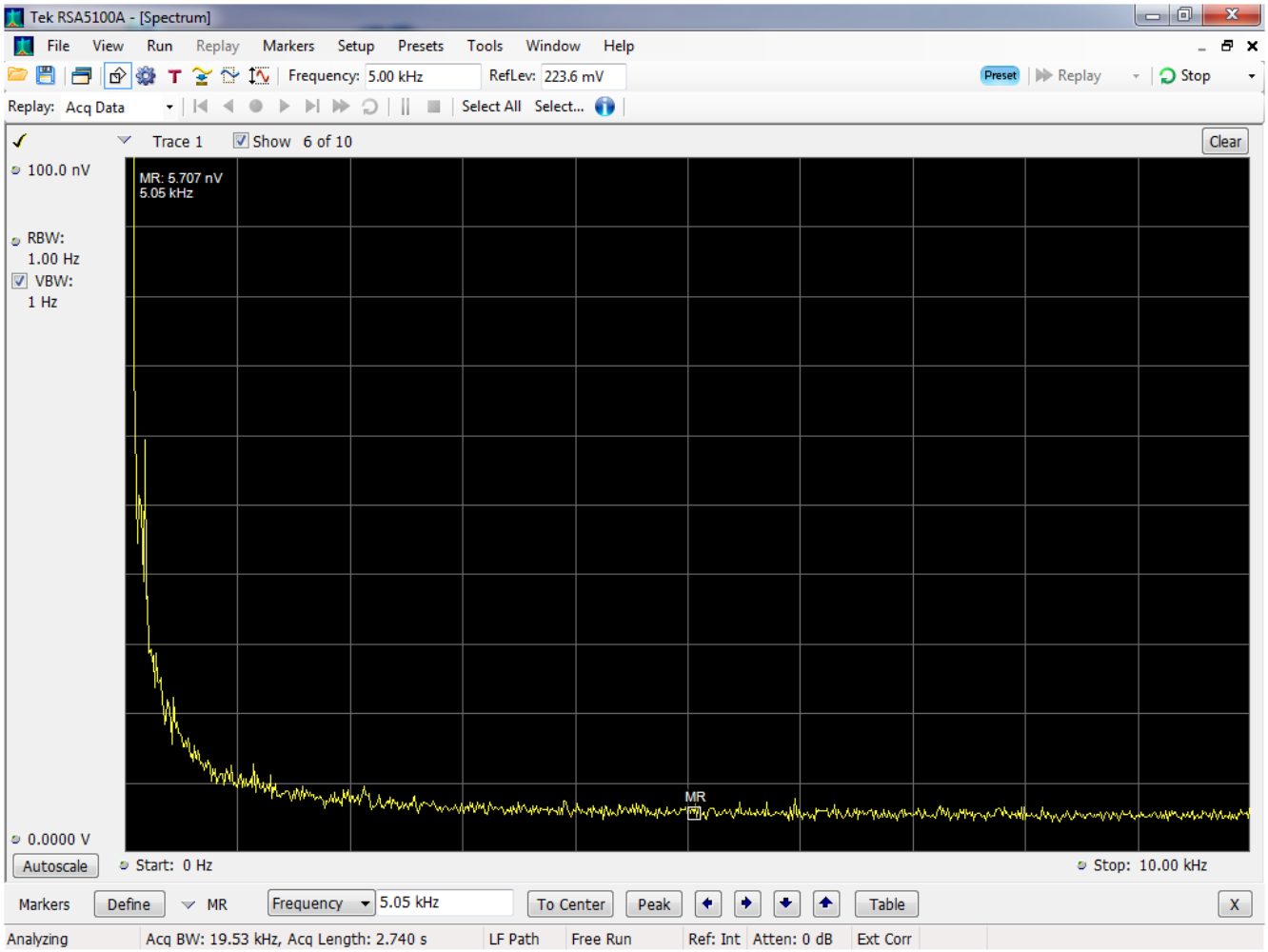

Figure 14 Noise density of a second J2180A preamp.