Maximizing dynamic range by optimizing the input attenuator setting

The attenuator of the IDA 2

The input attenuator of the Interference and Direction Analyzers IDA 2 can be set in 1 dB steps, allowing unusually fine adjustment. The dynamic range can therefore be optimized to match the desired measurement task.

In densely populated inner city areas, it is not uncommon to experience interference in the many different forms of RF communications services: Radio and TV broadcasts (AM, FM, DAB, DVB-T), mobile telephony (GSM-900, GSM-1800, UMTS, CDMA, W-CDMA, LTE) and other wireless communications (WiFi, WLAN, WiMAX, DECT, ZigBee, Bluetooth). All these RF services have to meet exacting requirements. For one thing, the communications networks must be able to cope with high utilization levels. It is also essential that other services are not impaired by them, and last but not least, they should not interfere with each other. The limits of what can feasibly be measured are quickly reached in such environments. To avoid incorrect measurements, the dynamic range of the measuring instrument must be optimized to match the measurement conditions.

Figure 1: Various RF services in a built-up area.

Example: Measuring in the 1800 MHz mobile phone band

The dynamic range of a measuring instrument is the range between the smallest and largest measurable level. As the level increases, the dynamic range is limited by saturation: non-linearity in the active components leads to compression, harmonic distortions, and intermodulation. As an example, let us take a measurement above the 1800 MHz mobile phone band (Figure 2). The measurement is made using a directional antenna and internal preamplification. Apparent interference can be seen above the mobile phone band, the causes of which need to be determined.

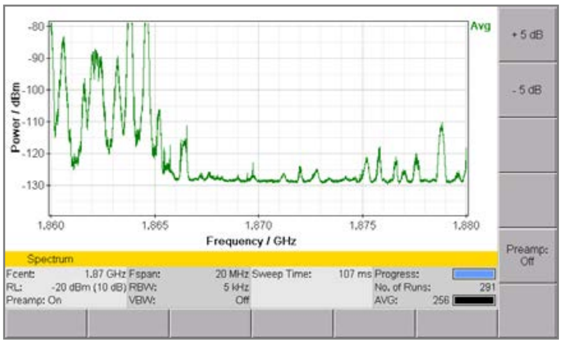

Figure 2: There appear to be several interferers present above the 1800 MHz mobile phone band. They are actually intermodulation products caused by non-linearities due to the input attenuation being too low.

Increasing the attenuation of the input attenuator reduces saturation of the input stage and with it the intrinsic distortion of the instrument. The noise level does increase, but this is not significant when measuring large signals (Figure 3). However, when measuring signals at low levels, this limitation in the dynamic range caused by the intrinsic noise of the analyzer is a nuisance. In such situations, the input attenuation is reduced in order to achieve as low a noise level as possible.

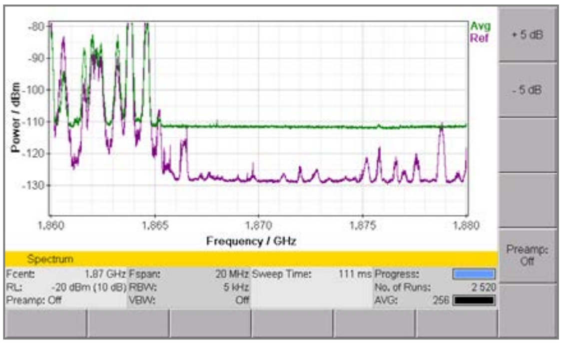

Figure 3: High input attenuation causes increased noise (green). The spectrum shown in Figure 2 was saved as a reference (violet).

How, though, can you measure small signals in the presence of much larger ones? On the one hand, the large signals need to be attenuated sufficiently to ensure that the measurement is not falsified by saturation or distortion. On the other hand, the attenuation needs to be low enough to stop the noise level from rising too far to allow the wanted signal to be detected, measured, and analyzed. This requires exact adjustment of the attenuation setting to match the measurement conditions. The optimum setting can be found by adjusting the attenuator stepwise using the smallest step. In the example, the attenuation was first increased in 1 dB steps and then decreased until it could be seen which signals were "real" and which were intrinsic impairments (Figure 4). The signal at 1876 MHz does not change amplitude when the attenuator is altered, so it is "real". Instruments with fine adjustment capability have a distinct advantage in such situations.

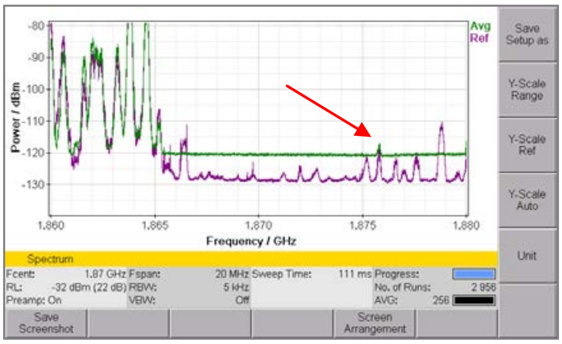

Figure 4: The ideal balance between noise and intermodulation is achieved with 22 dB input attenuation (green). This allows you to distinguish intermodulation from the true measurement signal (red arrow). The spectrum from Figure 2 is again used as reference (violet).

Rapid detection of intrinsic impairments by altering the attenuator setting

The two top softkeys of the IDA 2 can be used to quickly change the input attenuator setting in 5 dB steps (Figure 5). The Y axis remains fixed so that level changes can be seen more easily.

Using this ±5 dB offset makes it easy to distinguish a signal that is actually present from an intermodulation product. The "real" signal always indicates the same level value, regardless of the input attenuation, as long as there is no compression due to saturation. In contrast, the indicated level of an intermodulation product will change every time the input attenuator setting is altered.

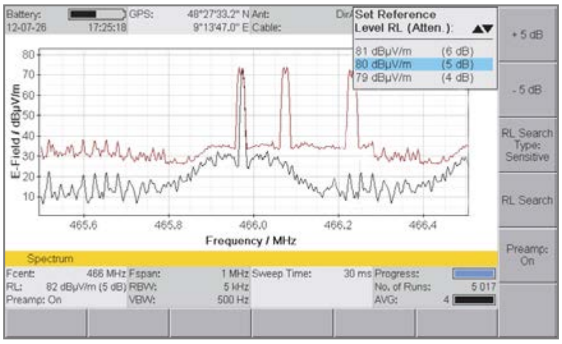

Figure 5: Using the ±5 dB offset makes it easy to distinguish between the actual signal and an intermodulation product.
The reference level also determines the input attenuation.

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