ROHDE&SCHWARZ

Instruments Division

APPLICATION NOTE

Double frequency range for R&S Signal Generators

Products:

All Signal Generators

1G18-01-1193-e

Introduction

Leaving aside the microwave generators, the present line of Rohde & Schwarz products comprises signal generators

up to 1 GHz (SMX, SMG),
up to 2 GHz (SMH, SMGU),
up to 3 GHz (SME, SMT) and
up to 4.3 GHz (SMHU).

For applications at higher frequencies, all signal generators can also be operated with an **external passive frequency doubler** (Fig. 1).

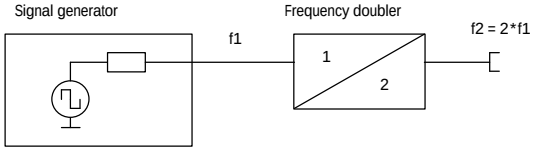

Fig. 1: Signal generator with frequency doubler

This extends the range of possible applications up to 8.6 GHz
Some degraded specs regarding level and modulation are described below.
For people using the frequency range 3 to 6 GHz, the low priced combination SMT plus frequency doubler will mainlybe interesting.
Signal generator SMHU is useful for the frequency range up to 8.6GHz. Especially the phase noise performance is excellent with this instrument.

Technical aspects - Signal Generator plus frequency doubler

Output level range

With an input level of 13dBm the recommended doublers produce an output power of about 0 dBm. By reducing the input level, output levels down to about -20dBm can be obtained. There is however no proportionality between input and output level, since frequency doubling is achieved by making use of a nonlinear diode characteristic.

Output spectrum

The typical output spectrum with an input level of 13 dBm at the doubler (input frequency f_1) is shown in figure 2:

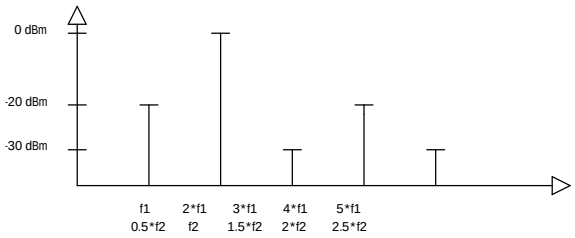

Figure 2: Output spectrum with doubler

In addition to the required output frequency f_2 , the input frequency f_1 and the harmonics thereof as well as the harmonics of the wanted signal occur as spurious products in this frequency spectrum. The odd-numbered multiples of the input frequency f_1, $3*f_1$, $5*f_1$ etc are referred to as subharmonics.
It should be noted that sub-subharmonics may occur if the input signal of the frequency doubler already contains subharmonics. This is the case with all three signal generator combinations proposed. The sub-subharmonics are however typically more than 50dBc below the required output signal.

It should also be pointed out that the residual FM and the SSB phase noise will be 6dB poorer as a result of frequency doubling.

Modulation transfer

1. Amplitude modulation

Amplitude-modulated signals can be transferred via a frequency doubler with losses in quality only. The AM distortion strongly increases with increasing modulation depth. The quality is however still sufficient for EMC applications.

2. Frequency and phase modulation

The FM quality is fully maintained on frequency doubling. It should be noted that the deviation will also be doubled. The signal generator therefore has to be set to half the value of the deviation desired.
When the SMT is used, peak deviations of 40 MHz (with FM) or 400 rad (with φM) are possible in the frequency range 3 to 6GHz!

3. Digital Modulation - IQ modulation

IQ-modulated signals can be doubled without any impairments, if they do not contain any AM components. This holds true for GMSK, for instance. It is only necessary to make the above correction of the deviation.
With QAM methods, however, vector errors are caused by the AM distortion described above.

4. Pulse modulation

Pulse-modulated signals are ideal for frequency doubling. Due to the nonlinear transfer characteristic of the frequency doubler, the edge steepness is even improved.

Recommended Combinations - Signal Generator plus Frequency Doubler

R&S Signal Generator	Extended frequency range	Recommended frequency doubler	Suppliers in Germany	Approx. price in DM
SMH 0.1 to 2000 MHz	4000 MHz	ANZAK D-5-4	Richardson Electronics 82178 Puchheim Tel 089/8002131	700,-
SME 0.005 to 3000 MHz SMT 0.005 to 3000 MHz	6000 MHz	NARDA 4453	Trans Tech, Munich Tel 089/843017	1100,-
SMHU 0.1 to 4300 MHz	8600 MHz	NARDA 4453	Trans Tech, Munich Tel 089/843017	1100,-

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