

Analysis and Measurement Technique for 1- dB Compression Point of Single Balanced RF Mixer

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Abstract

The present paper discusses the basic working and operation of RF Mixers being used broadly for communication purposes. In the present paper we have discussed various important parameters of Mixer and elaborately described the instrument setup and measurement techniques for measuring the most vital parameter for analyzing performance of mixer i.e., 1-dB Compression Point (P1dB). 1- dB compression point is very significant parameter as it indicates the power level that causes the gain to drop by 1 dB from its small signal value. In this paper we have described test set up for measuring this important parameter with various measuring instruments and has obtained good agreement between the predictions and experimental data.

Index Terms- Single diode mixers, 1 dB Compression Point (P1dB), Down Converter, VM-3 Receiver, Power meter, Attenuator

I INTRODUCTION

In Electronics, frequency mixer is a nonlinear electrical circuit that creates new frequencies from two signals applied to it. In its most common application, two signals at frequencies f_1 and f_2 are applied to a mixer, and it produces new signals at the sum $f_1 + f_2$ (Up conversion) and difference $f_1 - f_2$ (Down conversion) of the original frequencies. Other frequency components may also be produced in a practical frequency mixer. Mixers are widely used to shift signals from one frequency range to another, a process known as heterodyning, for convenience in transmission or further signal processing. Frequency mixers are also used to modulate a carrier frequency in radio transmitters.

They are used in a wide variety of applications including heterodyne receivers, radars of all types, electronic warfare, guided weapons, communication, instrumentation, transportation, radio astronomy etc [1].

Most down converting mixers [5] are three-port devices, as shown in Figure 1. They take two input and the output is a mixing product of these two inputs and is an intermediate frequency (IF) signal

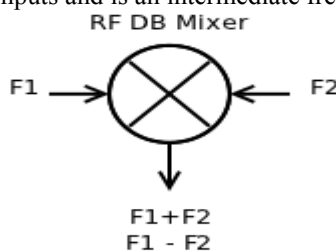


Fig 1. Basic Mixer Ports

II. MIXER PERFORMANCE METRICS

A RF Mixer has several parameters [6] and designs to evaluate its performances. These various designs cover different performance parameters of microwave mixer and an exact topology and mixing device selection is dictated by particular application requirements. Some of the important criteria by which to judge, and ultimately choose, a mixer are conversion loss [6], 1 dB compression point, Input Intercept Point (IIP3), Port Isolation, VSWR etc. Out of all these, **P1DB** is most important mixer metric to define the sensitivity and linearity of a radio frequency Mixer.

III. MEASUREMENT SET UP FOR 1-dB COMPRESSION POINT AND RESULTS

For measuring the 1-dB Compression point the basic set-up is given in Fig.2. To find 1-dB Compression point we have to find the region where mixer deviates 1dB at output from its linear region. At a fixed RF frequency, the RF power level is increased in steps and the corresponding power level at the IF port is measured. LO power is kept constant at +4dBm, +7dBm, and +10dBm respectively for finding out the effect of LO power on 1-dB compression point. A variable Attenuator is used at the RF Port to provide a continuously change in LO Power is

noted. For measuring the 1-dB is change in IF power is noted at constant LO Power. To find 1-dB Compression point [3] we have to find the region where mixer deviates 1dB at output from its linear region. At a fixed RF frequency, the RF power level is increased in steps and the corresponding power level at the IF port is measured. LO power is kept constant at +4dBm, +7dBm, and +10dBm respectively for finding out the effect of LO power on 1-dB compression point. A variable Attenuator is used at the RF Port to provide a continuously increasing power at constant frequency and the

IF port is measured using 30 MHz Receiver Model VM-3 [7], and Power meter - Model HP 438A being done in National Physical Laboratory (NPL), Delhi. VM-3 is a 30 MHz receiver,

For the measurement of parameter 1 dB Compression point, the basic set-up is as shown in figure 2. The LO power is kept at + 4.0 dBm and by changing the frequencies and power level at the IF port are measured. The similar exercise has been performed by keeping the LO power level +7dBm and +10dBm. Table 1.1 represents the observations taken during the measurement. The 1 dB compression point vs. RF frequency graph has been plotted in figures for various values of LO Power.

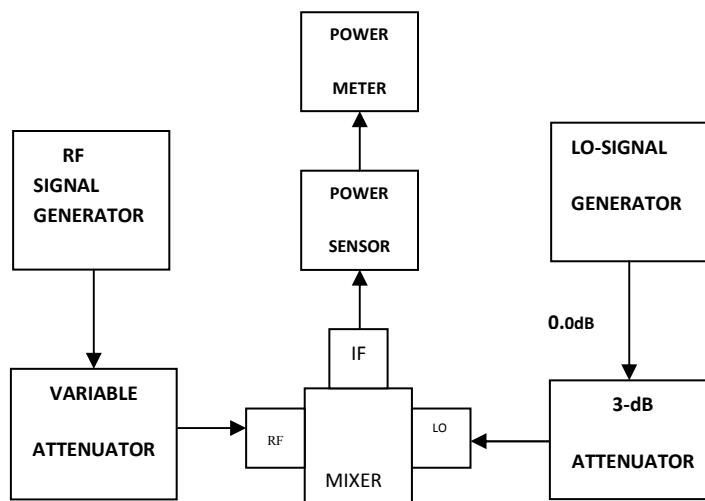


Fig. 2 Set-Up For 1 dB Compression Point Measurement

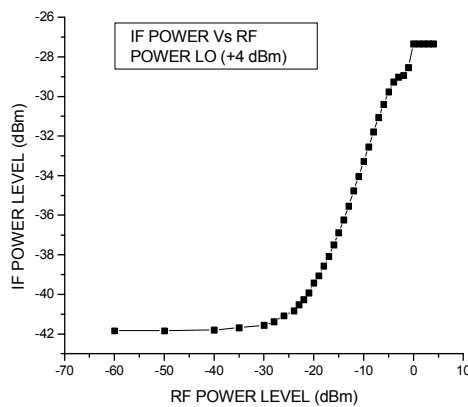


Fig. 3. 1 – dB Compression Point LO at +4 dBm

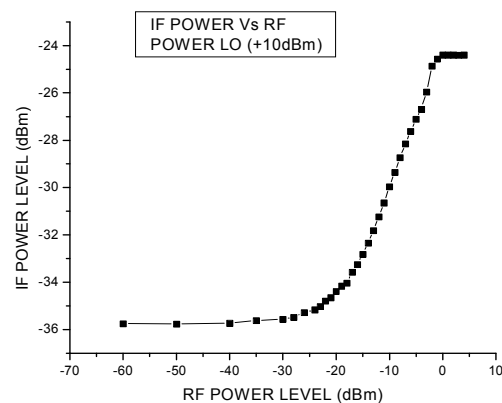


Fig.4. 1 – dB Compression Point LO at +10 dBm

V. REFERENCES

- [1] T. H. Oxley, "50 years development of the microwave mixer for heterodyne reception," IEEE Trans. Microwave Theory and Tech., Vol. MTT-50, No. 3, pp. 867-876, Mar. 2002.
- [2] S. A. Maas, Microwave Mixers, 2nd Edition. Norwood, MA, Artech House, 1993.
- [3] Introduction to Microwave Circuit by Robert .J.Weber, Wiley-IEEE Press (January 9, 2001)
- [4] Sze, SM. Physics of Semiconductor Devices. New York: Wiley Inter-science, 1969, p. 459.
- [5] Microwave Engineering by David M Pozar, Wiley Second Edition
- [6] Nitin Muchhal, Arun Patel, P S Negi," Study and Measurement technique of single diode Mixer for low conversion loss", National Conference on Recent Advances in Microwave Engineering, MITS Gwalior, 16-17 December 2011.
- [7] User Manual of VM-3 (A 30 MHz receiver and a Weinschel Engineering product)

IV CONCLUSION

In this paper we have discussed the various Microwave measuring instrument , set up for measuring the most important parameter i.e the 1 dB compression point of a microwave mixer and procedure to evaluate it. The constant value of LO power with changing RF power as shown in Table 1.1 shows the linearity and the better sensitivity of the Mixer.

Table 1.1: 1-dB Compression Point Measurement

POWER LEVEL AT RF PORT	IF POWER (dBm) LO (+4dBm)	IF POWER (dBm) LO (+7dBm)	IF POWER (dBm) LO (+10dBm)
-60	-41.833	-38.481	-35.747
-50	-41.833	-38.474	-35.759
-40	-41.800	-38.459	-35.735
-30	-41.561	-38.339	-35.560
-26	-41.077	-37.991	-35.279
-24	-40.821	-37.883	-35.165
-22	-40.258	-37.429	-34.784
-20	-39.424	-36.847	-34.389
-16	-37.502	-35.158	-33.240
-14	-36.233	-34.160	-32.339
-12	-34.768	-32.867	-31.237
-10	-33.268	-31.492	-29.952
-8	-31.790	-30.068	-28.726
-6	-30.385	-28.692	-27.616
-5	-29.765	-28.140	-27.098
-4	-29.259	-27.565	-27.680
-3	-29.016	-26.928	-25.947
-2	-28.933	-26.409	-24.859
-1	-28.535	-26.312	-24.561
0	-27.338	-26.215	-24.391
1	-27.335	-26.213	-24.392
2	-27.337	-26.215	-24.390
3	-27.338	-26.214	-24.393
4	-27.336	-26.216	-24.391