Wan7com, Inc.

IP_3 Measurement of WHM0010AE 1-150 MHz Power Amplifier IC

1. Introduction

WHM0010AE amplifier is a low noise figure, wideband, and super high linearity amplifier IC with SMT package design. The amplifier offers typical P_{1dB} of 30 dBm and output IP_3 of 48 dBm at the frequency range from 1 MHz to 150 MHz. With WanTcom's advance technology, WHM0010AE has 18 dB differences between the IP_3 and P_{1dB}. The difference is in the 10 ~12 dB range for a traditional amplifier.

It becomes difficult to measure the IP_3 at 50 dBm range. Any device in the test system may contribute worse third order intermodulation than the amplifier itself. The correct calibration and setup of the IP_3 test system is essential to ensure the IMD_3 generated by the test system is lower than that of the device under test (DUT).

This application note examines the signal combiner, power level settings, and the setup of the IP_3 test system for the IP_3 measurement of WHM0010AE.

2. The IP_3 Test System

Figure 1 shows the block diagram of the test system. Two-tone signal is combined and fed to the DUT through a 3-dB fixed attenuator. The output of DUT is connected to a spectrum analyzer (HP8594E).

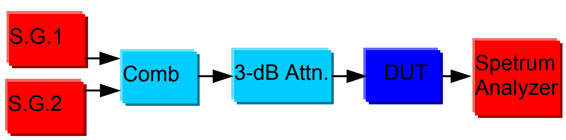

Fig. 1 The block diagram of the test system

Due to the difficult availability of isolators, the isolation between the two input ports of the combiner is critical. In order to maintain the good isolation, a fixed 3 dB coaxial attenuator is inserted between the output of the combiner and the input of the DUT, due to the fact that the input VSWR of the DUT may not be ideal. Also, the narrow band combiner is developed to ensure about 30 dB isolation between the two input ports.

Besides the combiner consideration, the spectrum analyzer settings are critical too to ensure the IMD_3 level generated by the spectrum analyzer is lower than that of the DUT itself.

a) Combiner

Figure 2 shows the 16 ~ 17 MHz special made combiner.

Figure 3 shows the measured frequency response of the combiner. The insertion loss is about 3.2 dB, return losses are better than 20 dB, and the isolation (S23) is better than 28 dB at the passband frequency of 16 – 17 MHz.

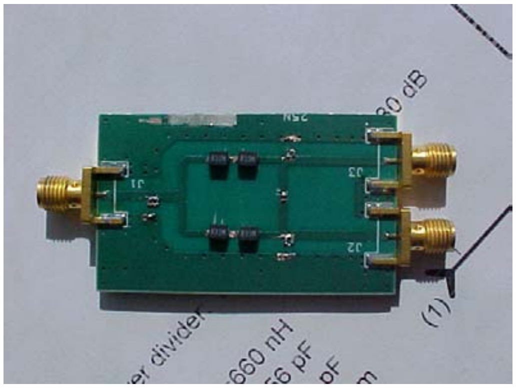

Fig. 2 The 16 ~ 17 MHz special made combiner

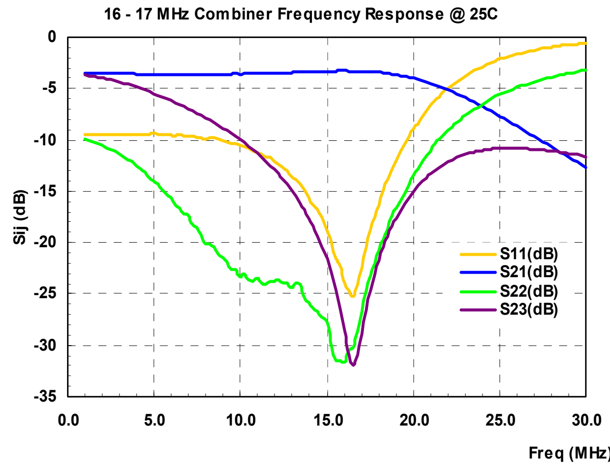

Figure 3 The measured frequency response of the combiner

Figure 4 shows the schematic of the combiner.

b) System Third Order Intermodulation without DUT

Set two-tone frequencies to be 16 MHz and 17 MHz, respectively. The each tone power level at the output of the combiner to be –4.0 dBm. Set the spectrum analyzer at the following settings:

Center frequency:	18 MHz	Attenuation:	30 dB
Span:	100 kHz	VID BW:	100 Hz
RES BW:	1.0 kHz	REF LEVEL:	-20 dBm

Without the 3 dB external attenuator and DUT, the measured IMD_3 is at – 85 dBm. This IMD_3 is believed from the interaction between the two signal sources due to the inefficient isolation of the combiner.

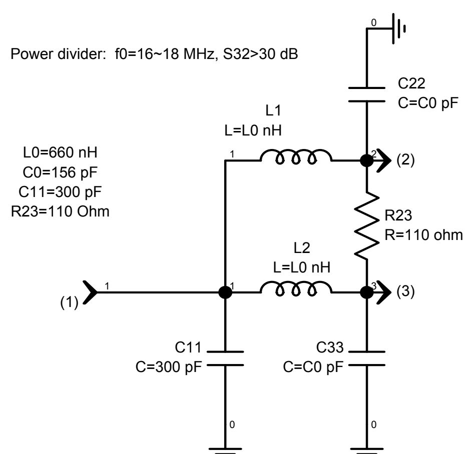

Figure 4 shows the schematic of the combiner

c) The System Limit

With the 3-dB attenuator between the DUT and the combiner, the signal levels before the DUT are as follows assuming the gain of DUT is 17 dB:

Each tone $P_{in,@DUT}$:	-7 dBm;
$P_{3,\ @DUT\ IN}$:	-86 dBm;
Each tone $P_{out,@DUT}$:	10.0 dBm;
$P_{3,\ @DUT\ OUT}$:	-69 dBm;

Thus, the best IP_3 limit that the system can detect is

$$[3 \times 10 - (-69)]/2 = 49.0 \text{ (dBm)}$$

The amount attenuation of the external attenuator is critical. Too less attenuation will give poor isolation of the combiner and thus the higher system IMD_3. Too high attenuation will result too low first order output power level, which will affect the measurement accuracy.

The input power level of each tone will affect the IP3 measurement. The power level should be set at the value so that the system IP_3 limit value the highest. Besides, the input power level should be optimized for the different gain of the amplifier. Otherwise, the measured IP_3 may be better in the lower gain (such as lower V_{dd} bias of 7 V for example) than that at the nominal gain (full V_{dd} bias of 10 V).

The measured IP_3 of WHM0010AE evaluation unit was 49.0 dBm with the described system with the mentioned parameter settings. Due to the limitation of the test system, IP_3 performance of WHM0010AE may be beyond 49.0 dBm. In order to truly measure the IP_3 performance, the following more advance test systems are desired:

i) Two isolators are added between the sources and the inputs of combiner with the existing system;

ii) Besides the added isolators, a duplexer and high linearity amplifier are insert between the output of the DUT and the spectrum analyzer. The receiving filter of the duplexer should have at least 30 dB attenuation to the two-tone signal while allows the IMD_3 component passes. A low intermodulation load is terminated at the transmitting filter for the load of the two-tone signal.

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