High-Frequency Low-Distortion Two-Tone Signal Generation Using Arbitrary Waveform Generator

Tomonori Yanagida, Shohei Shibuya, Koji Asami, Haruo Kobayashi
Gunma University 1-5-1 Tenjin-cho, Kiryu 376-8515 Japan e-mail: t161d096@gunma-u.ac.jp

This paper describes algorithms and simulation results of low-distortion two-tone signal generation methods with harmonics and image cancellation using an arbitrary waveform generator. We show high-frequency two-tone signal generation with IMD3 suppression. With this method distortion components close to the signal are suppressed simply by changing the DSP program—AWG nonlinearity identification is not required—and spurious components, generated far from the signal band, are relatively easy to remove using an analog filter.

Two-tone signal testing is frequently used in ADC testing (Fig.1) for such as communication applications. When the 3rd order nonlinearity is dominant in the AWG, IMD3 components are serious because they are close to the signals and are difficult to remove with an analog filter. Suppose that the AWG has 3rd-order distortion. Suppose the following:

$$Y(nT_s) = a_1 D_{in} + a_3 D_{in}^3 \qquad (1)$$

For the direct method, we use

$$D_{in} = A\sin(2\pi f_1{}' nT_s) + B\sin(2\pi f_2{}' nT_s) \qquad (2)$$

Simulation conditions are as follows:

$$f_1/f_s = 31/1024, \quad f_2/f_s = 43/1024 \quad f_1'/f_s = (f_s/2 - f_1)/f_s = 481/1024$$
$$f_2{}'/f_s = (f_s/2 - f_2)/f_s = 469/1024 \quad A = 1, B = 1, a_1 = 1, a_3 = -0.1.$$

Then the output spectrum is shown in Fig.3 (a). On the other hand, let us consider the high-frequency two-tone phase switching algorithm:

$$D_{in} = \begin{cases} X_0 = A\sin(2\pi f_1 nT_s + \varphi_0) + A\sin(2\pi f_2 nT_s - \varphi_0) & n\text{: even} \\ X_1 = A\sin(2\pi f_1 nT_s - \varphi_0) + A\sin(2\pi f_2 nT_s + \varphi_0) & n\text{: odd} \end{cases} \qquad (3)$$

The output power spectrum is shown in Fig. 3 (b), and we see that the IMD3 components around output signals are cancelled.

We have proposed high-frequency low-distortion two-tone signal generation algorithms with an AWG using the phase switching technique. It does not need the AWG nonlinearity identification, but need only a simple analog HPF. Simulation results show their effectiveness.

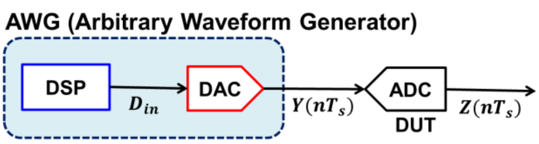


Fig.1 ADC linearity testing system

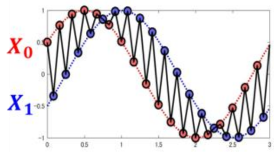
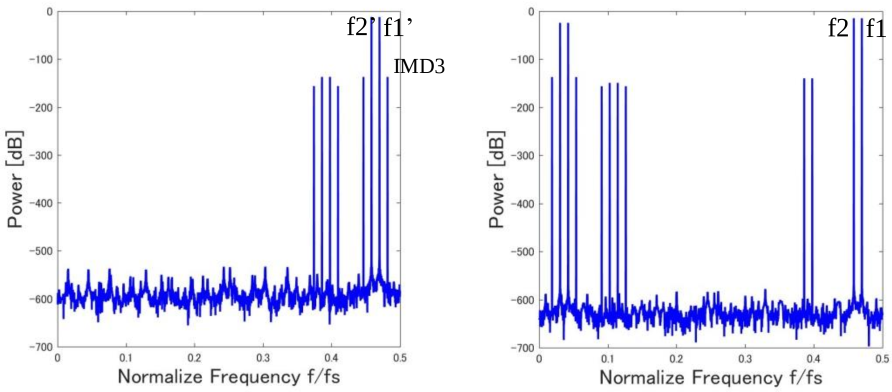


Fig.2 Phase switching signal



(a) conventional direct signal (b) phase switching signal

Fig.3 $Y(nT_s)$ spectrum with the high-frequency two-tone signal generation method with 3rd order harmonics.