A Stable and Low-Cost Site Source for Conducted- and Radiated-Emission Consistency Confirming and Daily Checking of Test Sites

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***Abstract*—In this paper, a new and low-cost design of site source with long-term stability is proposed. The site source is especially suitable for the daily site checking and the consistency confirming at different test sites. For these applications, the site source is highly required to be stable due to various test sites and long-term usage. Two crystal driven oscillators together with well-designed circuits, powered by AC, can generate fast and stable periodic trapezoidal waveforms, resulting in harmonic signals ranging from 150 kHz to 1 GHz. This indicates that the site source can be applied not only for the radiated-emission (RE) test from 30 MHz to 1 GHz but also for the conducted-emission (CE) test from 150 kHz to 30 MHz. For demonstration, the site-source prototype was created and measured. The measurement was performed inside a standard 10-m semi-anechoic chamber to show the attractive performance of frequency accuracy, output-power stability and radiation symmetry of the newly developed site source.**

Keywords—site source; EMI; conduction emission; radiation emission.

I. Introduction

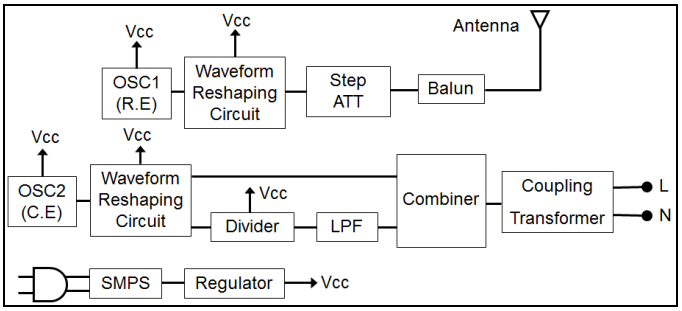
Site sources [1]-[3] are widely demanded and applied in certified EMI test laboratories. The site sources should generate harmonic reference signals spanning through the whole test spectrum of interest. The site sources may be used for the characterization and calibration of test sites. This is specifically required for the test at anechoic or semi-anechoic chambers due to the unwanted reflections from the absorbing walls and imperfect grounds. In addition, the sources may be used for daily site checking and consistency confirming at different test sites. For daily site checking, the radiated-emission (RE) and conducted-emission (CE) test instrument and procedures should be made sure to work normally and accurately every day. As a result, the site sources employed should have stability in really long term. For consistency confirming, the RE and CE test results measured at one site should be repeatable at the other sites. Therefore, the site sources used should be stable at different test sites with various environmental conditions. For these two applications, the stability of site source is thus the main issue for the site-source design.

In this paper, a new and stable low-cost site source is for the first time introduced. This site source uses two crystal driven oscillators combined with auxiliary circuits to generate fast periodic trapezoidal waveforms. The generated signals are then fed into a wideband omni-directional antenna for the sake of RE test. Innovatively, this antenna is not only for the purpose of signal radiation but also for the casing of the site source. By further cooperating with a frequency dividing circuit, the site source can also generate harmonic signals for CE test. The proposed site source is powered by AC. This is more stable than those powered by DC, especially in long term, since the unavoidable decay of battery. Consequently, the site source using the crystal-driven oscillator and the intended AC powering is easy to meet the requirement of source stability at various site environments. In order to demonstrate the site-source performance, the prototype was created and measured. This site-source prototype is measured according to the standard RE and CE setup at a 10-m certified semi-anechoic chamber. The measured results indeed show the outstanding performance of the newly proposed site source.

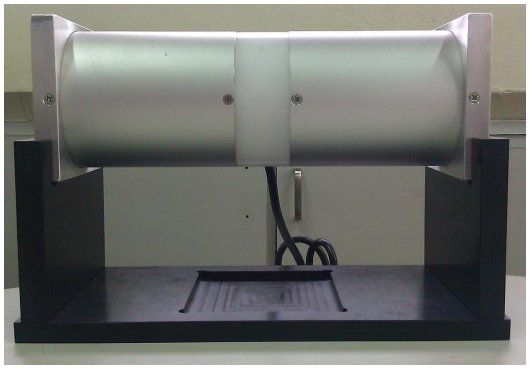
II. Site Souce Design and Its Performance

The block diagram and the prototype photo of the proposed site source are shown in Figs. 1(a) and 1(b), respectively. As the block diagram shows, both the CE- and RE-related parts of the site source are powered by AC, being stable for various test sites and times. After the AC-powered switching power supply, a twelve DC voltage is transferred by the regulator to a five DC voltage. This DC voltage, namely Vcc, is then used to supply the 16-MHz and 1-MHz crystal oscillators with following circuits for generating the RE and CE test signals, respectively. The crystal oscillators adopted here are stable in long term and insensitive to environmental temperature.

For the RE test signals, the 16-MHz oscillator is then combined with the shaping inverter to generate an optimally fast periodic trapezoidal waveform. This waveform should be appropriately attenuated and fed into a wideband omni-directional antenna by a balun. For the CE test signals, the 1-MHz oscillator combined with the shaping inverter should provide an optimal waveform to the frequency divider. After frequency dividing and low-pass filtering, the CE test signals are finally appear at ports N and L. To protect the site source from surge damage, a coupling transformer is specially designed and located between the site-source circuits and these output ports.



(a)



(b)

Fig. 1. (a) Block diagram and (b) prototype photo of the newly proposed site source.

Fig. 2 shows the output harmonic signals of the site source for CE test. The signals are stable for long-term usage. According to our experience, the maximum deviation between different test sites and times is smaller than 1 dB. As mentioned before, the long-term stability is due to the adoption of crystal-driven oscillator and AC power.

Fig. 3 shows the radiated harmonic signals of the site source for RE test. Both vertical-polarized and horizontal-polarized radiation signals are measured. This measurement is performed at a certified 10-m semi-anechoic chamber as shown in Fig. 4. The site-source radiation patterns show stable and extremely omni-directional over the RE test frequency range from 30 MHz to 1000 MHz as shown in Fig. 5.

The wideband and omni-directional radiation merits of the site source are mainly resulted from the well designed, combined balun and antenna. The balun is bifilarly wire wound with ferrite core. As shown in Fig. 6(a), the balun can not only transform the unbalanced signal into the balanced signal but also provide an inductor for the equivalent resonator circuit for radiating. In addition, the antenna is an end-loaded dipole. As shown in Fig. 6(b), the antenna generate a capacitor and a resistor for the resonator circuit. By well designing the

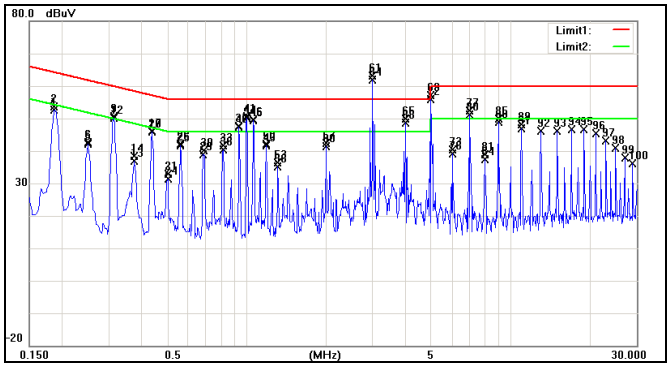
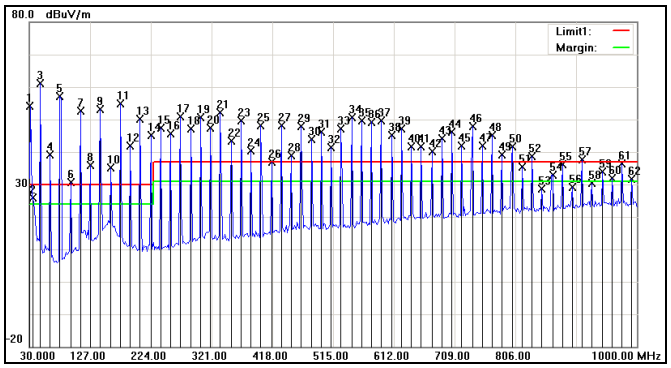
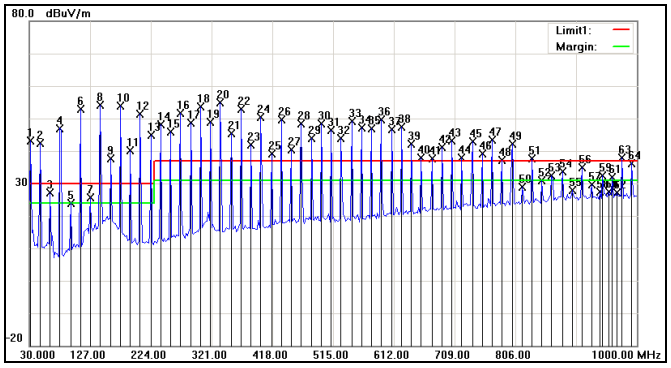


Fig. 2. Measured results for the CE test signals.



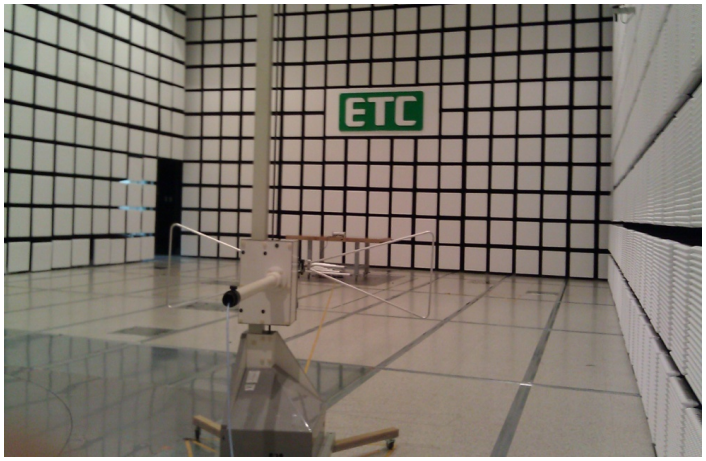
(a)



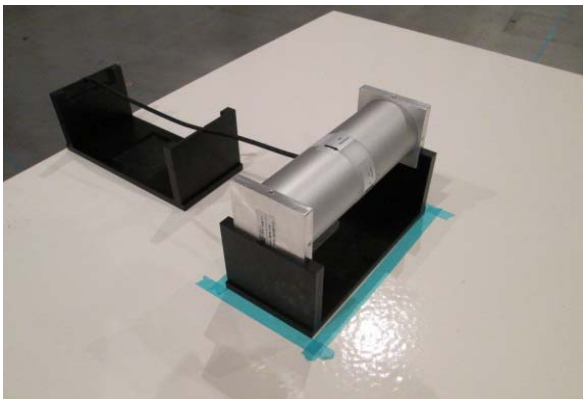
(b)

Fig. 3. Measured results for the RE test signals: (a) vertical polarization; (b) horizontal polarization.

corresponding equivalent components shown in Fig. 6, the antenna is therefore capable of radiating the wideband signals. It is worth mentioning that the antenna directly uses the metal casing of the site source. As a result, the cost of the site source can be further reduced and its compactness is enhanced.



(a)



(b)

Fig. 4. Testing setup at a 10-m certified semi-anechoic chamber: (a) whole scenario; (b) close view.

In order to obtain stable and repeatable site-source signals, the arrangement of site source for test is critical. Especially for the RE test, the proper ways to place the site source and its power core for the horizontally and vertically polarized radiation are shown in Figs. 7(a) and 7(b), respectively. The key point of this arrangement is that the site-source antenna and the power core should be orthogonal. Therefore, the coupling between the site source and the power core can be highly reduced. This is essential for the signals generated to be with minimum deviation between any two tests. For keeping the straightness of power core, a wooden fixture is specially created and also shown in Fig. 7. In addition, the power core should be properly filtered to suppressed the conducted noise.

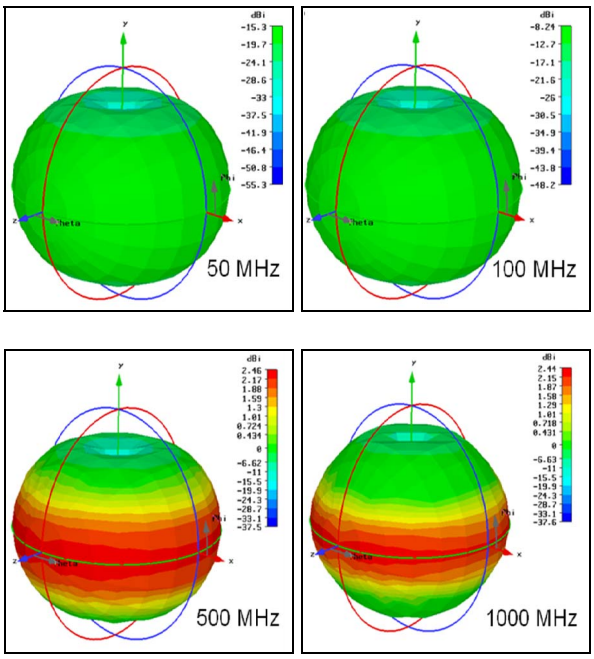
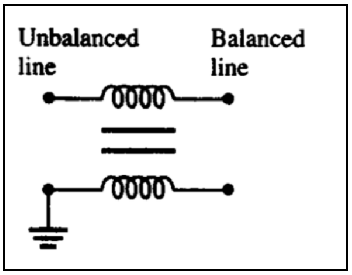
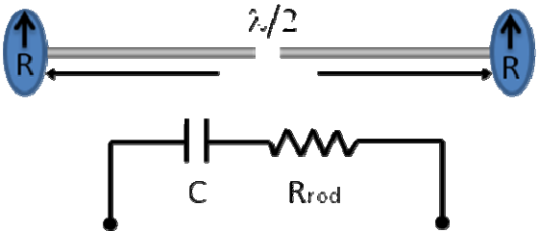


Fig. 5. Radiation patterns of the site source at 50 MHz, 100 MHz, 500 MHz, and 1000 MHz.

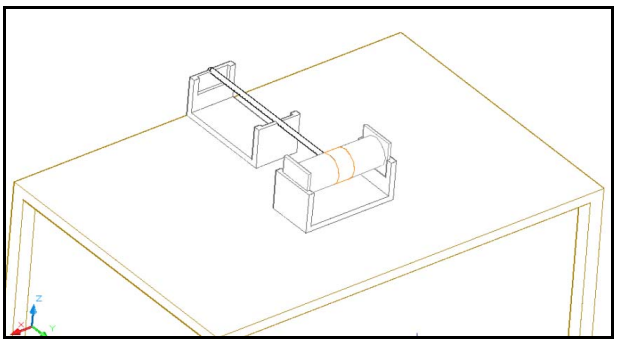


(a)

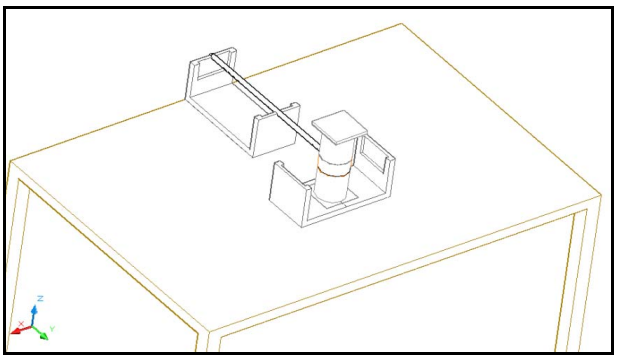


(b)

Fig. 6. The equivalent circuits of (a) the balun and (b) the wideband antenna.



(a)



(b)

Fig. 7. Placement and arrangement of the site source for the testing of (a) horizontal polarization and (b) vectical polarization.

III. Conclusions

A new and stable site source using crystal-driven oscillators and AC power is proposed for daily site checking and site consistency confirming. The proposed site source is with high stability and can be applied for both RE and CE test. The site-source prototype created indeed generates harmonic signals ranging from 150 kHz to 1 GHz. The signal deviation measured at different test sites and times can be smaller than 1 dB. Especially for the RE test, the measured radiation patterns of the site source show extremely omni-directional property. Therefore, the proposed sit source is promising and valuable for the practical applications.

Acknowledgment

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