Advantages of CY25701 Programmable Spread Spectrum Crystal Oscillator in EMI Sensitive Applications

AN45324

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Software Version: None
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Application Note Abstract
The CY25701 is a programmable crystal oscillator with spread spectrum output capability. The CY25701 is available in a 5.0 x 3.2 mm LCC package in commercial and industrial temperature ranges. This application note discusses the various applications in which the CY25701 SSXO can be used in place of a standard crystal oscillator to prevent or solve system EMI issues.

Introduction
The CY25701 programmable spread spectrum crystal oscillator is a valuable tool to optimize EMI performance. The CY25701 is offered in an industry standard package and pinout. It can replace a traditional fixed-frequency crystal oscillator and provide flexibility and security if there are any EMI issues or unexpected system frequency marginality.

Figure 1. CY25701 in 5.0 mm x 3.2 mm 4 Pin LCC Package

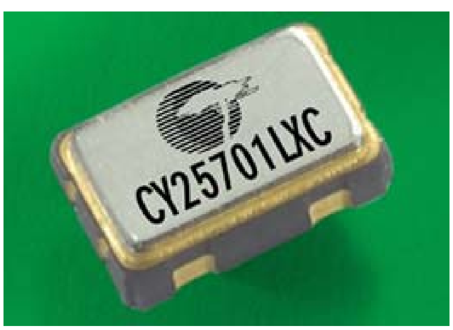


Table 1: Programmable Features of CY25701 SSXO

Programmable Feature	Range
Output Frequency	10–166 MHz
Spread Percentage	Down Spread: up to -4% Center Spread: up to ±2%
Modulation Rate	30.1, 31.5, or 32.9 kHz

CY25701 vs Crystal Oscillators
Standard crystal oscillators, which are commonly found in consumer electronics, have several limitations when compared to PLL based timing solutions. One notable disadvantage is that the output frequency of the oscillator is limited in range. Low cost quartz crystals are manufactured to operate with a fundamental frequency of up to around 50 MHz, before blank thinness becomes a concern. Above 50 MHz, the complexity of the crystal oscillator design increases, in turn raising the cost. The CY25701 uses an internal crystal to generate a reference for the PLL, allowing output frequencies up to 166 MHz. It also provides almost any frequency in that range with minimal synthesis error (less than 10 ppm) and in most cases no synthesis error at all. This is in contrast to crystal oscillators, which have long lead times and higher prices for non standard frequencies.

Programmability is another attribute that distinguishes the CY25701 from other crystal oscillators. If there is a change in the required clock frequency or if the spread percentage needs to be increased or reduced for EMI or stability purposes, the CY25701 can be quickly reprogrammed as needed. A fixed frequency oscillator requires ordering a new device, potentially delaying the project for weeks. Similarly, emission testing may cause significant delays if the amount of EMI reduction cannot be easily modified. Essentially, the programmability of the CY25701 gets the design started faster and keeps it moving forward should any unforeseen EMI or timing issues arise.

Spread spectrum capability is the feature that sets the CY25701 apart from most other crystal oscillators. When an oscillator is used to provide the system clock, a majority of the data and clock signals throughout the system switch at some multiple of that rate. This causes significant EMI at odd harmonics of the system frequency. By having the ability to modulate the system clock frequency, the peak energy of fundamental frequency and odd harmonics can be dispersed over a wider frequency range. Thus, peak energy in those frequency bands are reduced significantly. Early in the design phase it is difficult to predict the EMI produced by the overall system. A spread spectrum clock suppresses EMI during later stages of development—particularly during EMC compliance testing—and saves a lot of time and re-design effort.

Due to these advantages, the CY25701 is used in several different applications, including set top boxes, HDTVs, multifunction printers, car audio systems, medical devices, network switches, and a variety of specialty applications.

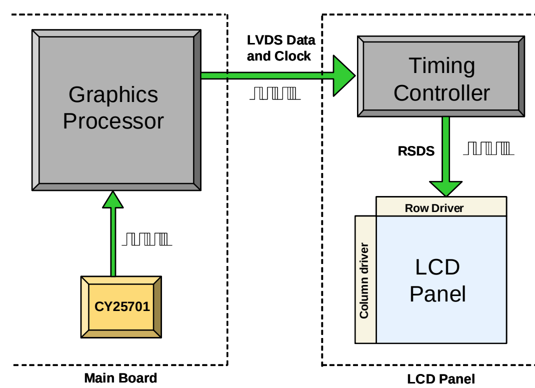
Common EMI Reduction Applications

As consumer electronics become smaller, faster, and increasingly more complex, the system designer must consider the most efficient techniques to minimize the resultant rise in EMI. A wide range of consumer products use spread spectrum clocking as a simple and cost effective way to reduce system EMI to desired levels.

Consumer printers, such as inkjet, have seen significant advances in resolution and throughput. These advances increase the number of signals used and printhead firing frequency. This in turn compels the designer to maintain an acceptable level of emissions. Previously, engineers took special care in routing signals to avoid EMI, requiring additional design time and often adding layers to the PCB. Additionally, ferrite beads, filters, and shielding were commonly used to mitigate the EMI problem. However, these solutions are marginalized with the introduction of spread spectrum clocking. By driving the system clock of the main processor or graphics ASIC of a printer with a spread spectrum enabled clock, all output signals from that device switch on the SS-enabled clock edges. This effectively suppresses EMI on all output signals. The CY25701 provides the unique advantage of allowing fine tuning of spread percentage and thus EMI reduction amount. During emission testing, the CY25701 can be programmed to several different SS percentages. Various spread percentages are tested until a setting is found that provides sufficient EMI reduction along with optimal system stability and jitter performance. The CY25701 provides fine tuning capability in the small steps of 0.25% spread to accomplish this goal. The spread spectrum profile and spectral plots in the Appendix illustrate the effect of SS percentage on EMI reduction.

Similar to printers, LCD panels have increased in resolution. Smaller displays may also have EMI issues unless preventive measures are taken during design. In applications using small LCD screens, space is almost always a primary concern. Adding ferrite beads or shielding for EMI reduction is unacceptable. This makes spread spectrum clocking the preferred solution. Using the CY25701 also allows the designer to save space by integrating the crystal into the small 5.0 mm x 3.2 mm LCC package. With the CY25701 as a SS clock source to the graphics processor, EMI is reduced on the LVDS data signals sent to the LCD panel. Most timing controllers also support an external SS clock input. This means that the RSDS outputs to the row drivers of the LCD also benefit from EMI reduction (Figure 2), offering a systemic solution to the LCD panel EMI problem.

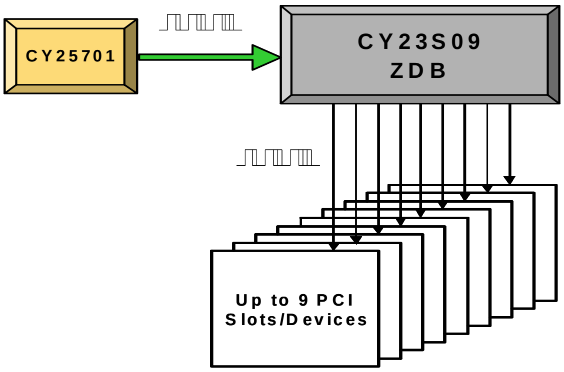
Figure 2. CY25701 Used in an LCD TV Application



Networking applications require a variety of clocks for different parts of the system. For example, data stream clocking has stringent jitter requirements often beyond the specifications of the CY25701. In these cases, Cypress offers Flexo high performance oscillators and clock generators with superior jitter performance. For other parts of a networking system, the CY25701 can be used for EMI reduction and signal integrity.

The CY25701 is a valuable replacement for a standard oscillator in PCI clocking. Typically, a reference clock is provided to a zero delay buffer (ZDB), which drives the multiple PCI slots. By combining the CY25701 as the reference clock with a spread-aware ZDB (see the CY23S0x product family), all of the PCI clocks generated benefit from the reduced EMI of the CY25701 output, as shown in Figure 3.

Figure 3. CY25701 Driving a Spread Aware ZDB



Many application processors and FPGAs in networking systems accept spread spectrum clock inputs. Thus, the internal PLLs and resulting output signals also maintain the spread, propagating low EMI signals throughout the system and drastically improving EMI performance. Another benefit in these networking applications is that the reduced EMI of the clock and data signals can benefit crosstalk, which is a major concern in such systems. Reducing crosstalk via spread spectrum helps ease the burden of signal routing by providing more noise margin. The CY25701 is an ideal solution for providing the input clock in these situations.

Summary

The CY25701 integrates a crystal with a programmable spread spectrum PLL in a small, industry-standard oscillator package to provide a simple, powerful solution for various applications. The flexible EMI reduction capabilities and programmable output frequency enable system designers to save on component cost and development time. Data sheets and other information on the CY25701 and related timing solutions from Cypress are available on the web at http://www.cypress.com.

Appendix

The appendix contains plots of data taken from the CY25701 using a modulation domain analyzer and spectrum analyzer to show the effects of spread spectrum on EMI reduction. A 50 MHz output frequency is selected and center spread profiles of ±0.5%, ±1.0%, and ±2.0% spread are generated to compare how much spread percentage can benefit peak reduction. Figure 4 through Figure 7 show a sample of the profiles and EMI reduction provided by the CY25701 for fairly typical parameters. Performance may vary depending on the specific configuration details.

The data is taken at the fundamental frequency, 3rd harmonic (150 MHz), and 9th harmonic (450 MHz). Because the output generated is approximately a square wave, there is no even harmonic component. The odd harmonic amplitudes are attenuated by a factor of 1/N, where N is the number of the odd harmonic. Despite this, spread spectrum is often used for odd harmonic peak reduction because of different emission requirements in different frequency bands. The plots show that the CY25701 is effective at lowering the peak level of both fundamental and harmonic peaks.

The higher SS percentages provide superior EMI reduction. Applications that require significant EMI reduction can use higher SS percentage to meet emission standards depending on the system sensitivity to frequency deviation. More sensitive systems may use lower percentage spread (down to 0.5%) and still see the benefits of several dB peak reductions, as seen from the CY25701 spectral plots.

Figure 4. Spread Spectrum Profiles for 50 MHz Output, ±0.5%, ±1.0%, and ±2.0% Spread

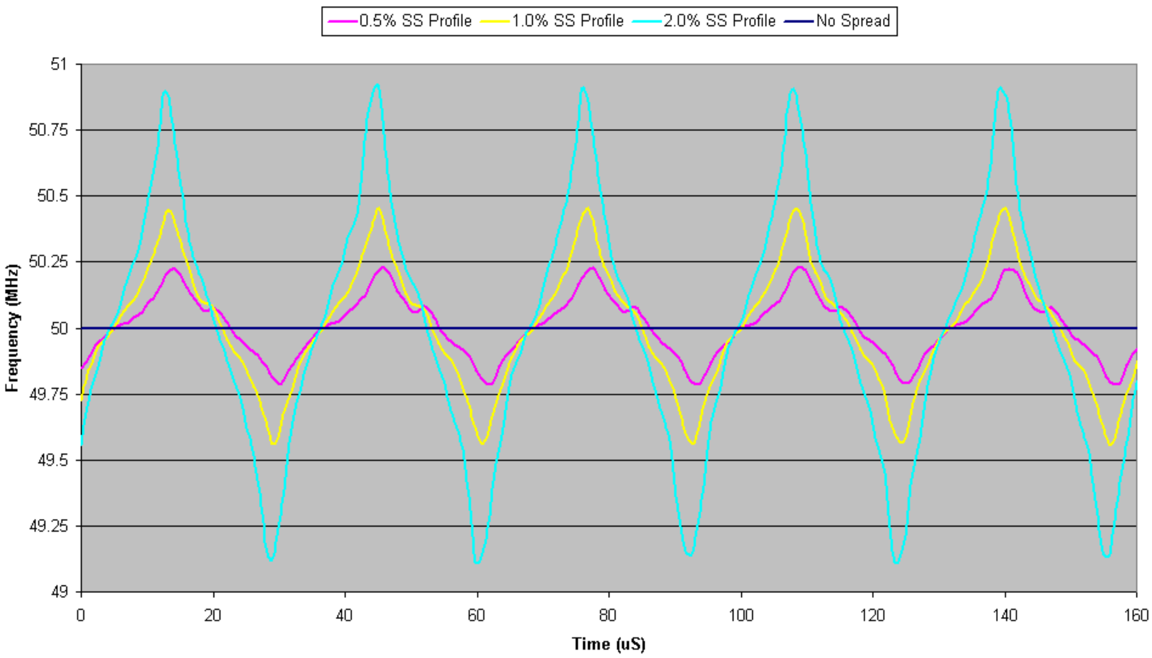


Figure 5. EMI Reduction at Fundamental (50 MHz), ±0.5%, ±1.0%, and ±2.0% Spread

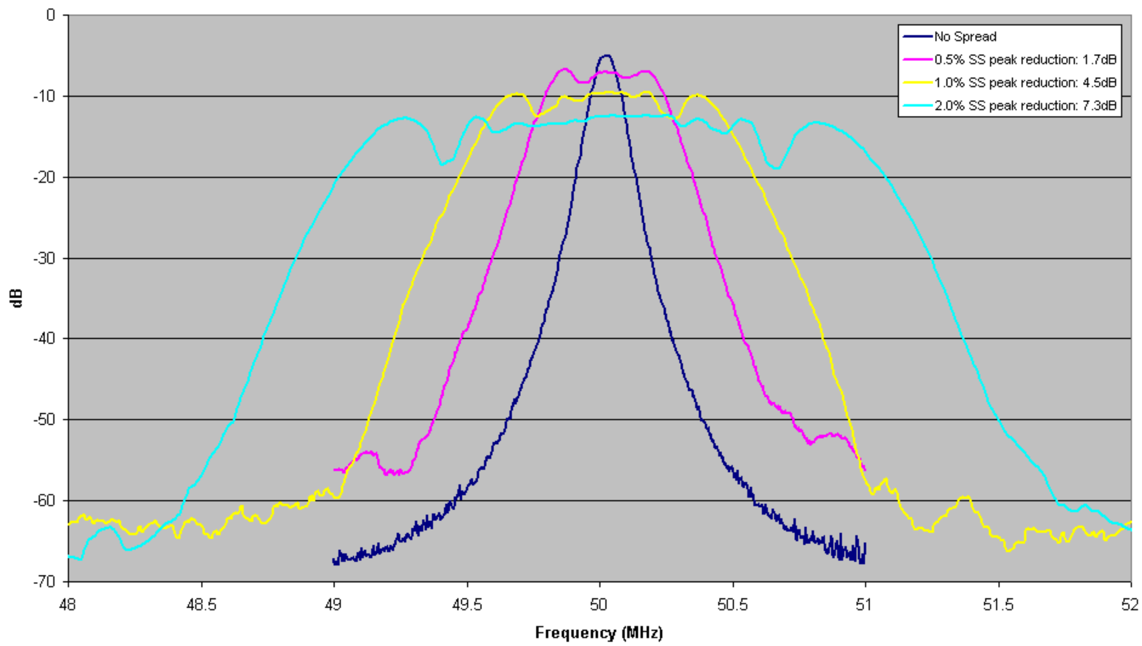


Figure 6. EMI Reduction at 3rd Harmonic (150 MHz), ±0.5%, ±1.0%, and ±2.0% Spread

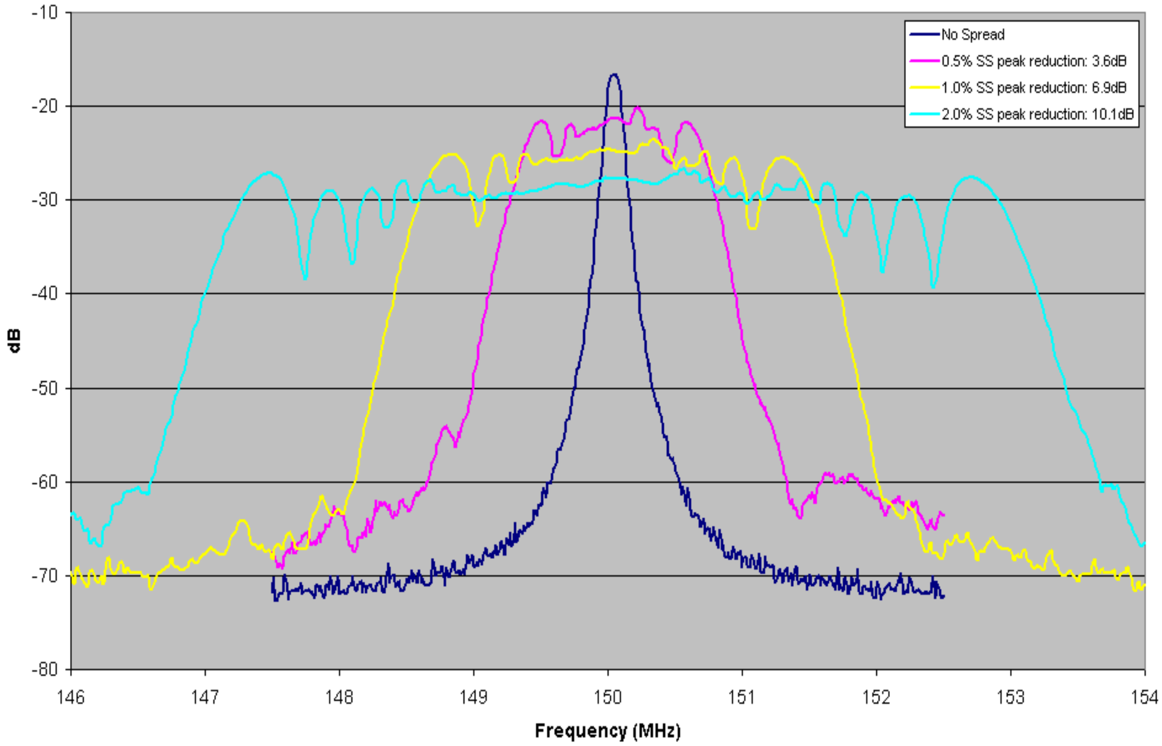
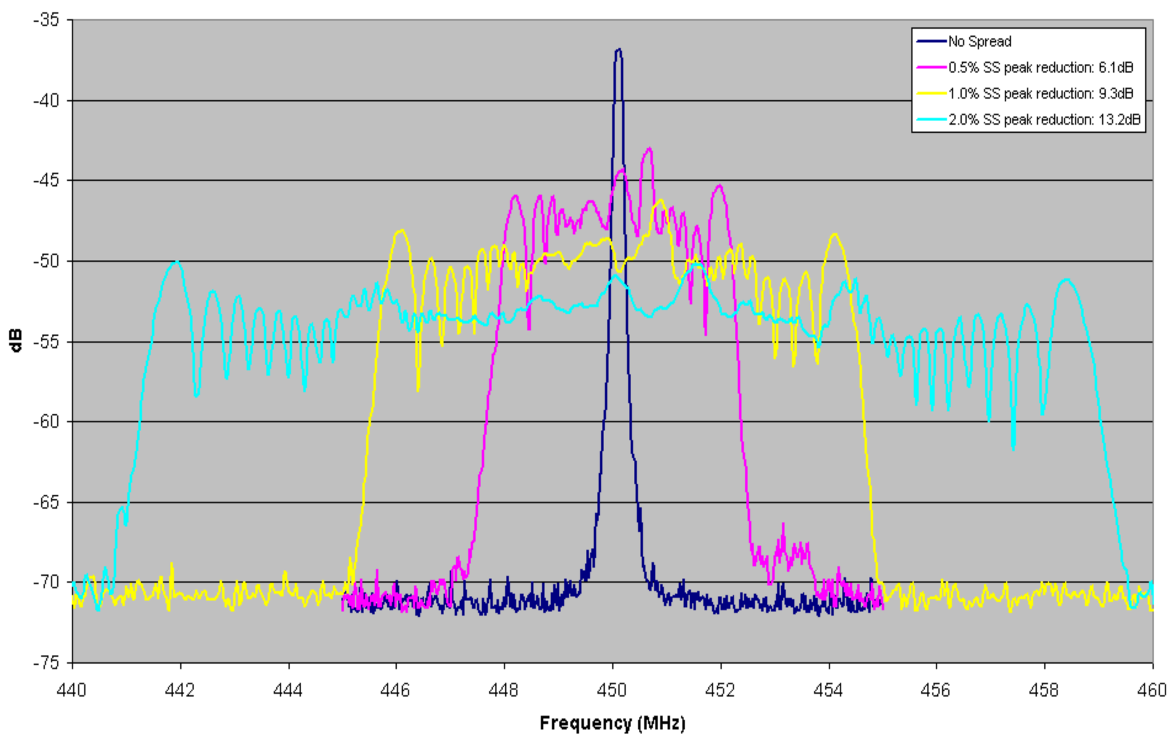


Figure 7. EMI Reduction at 9th Harmonic (450 MHz), ±0.5%, ±1.0%, and ±2.0% Spread



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