

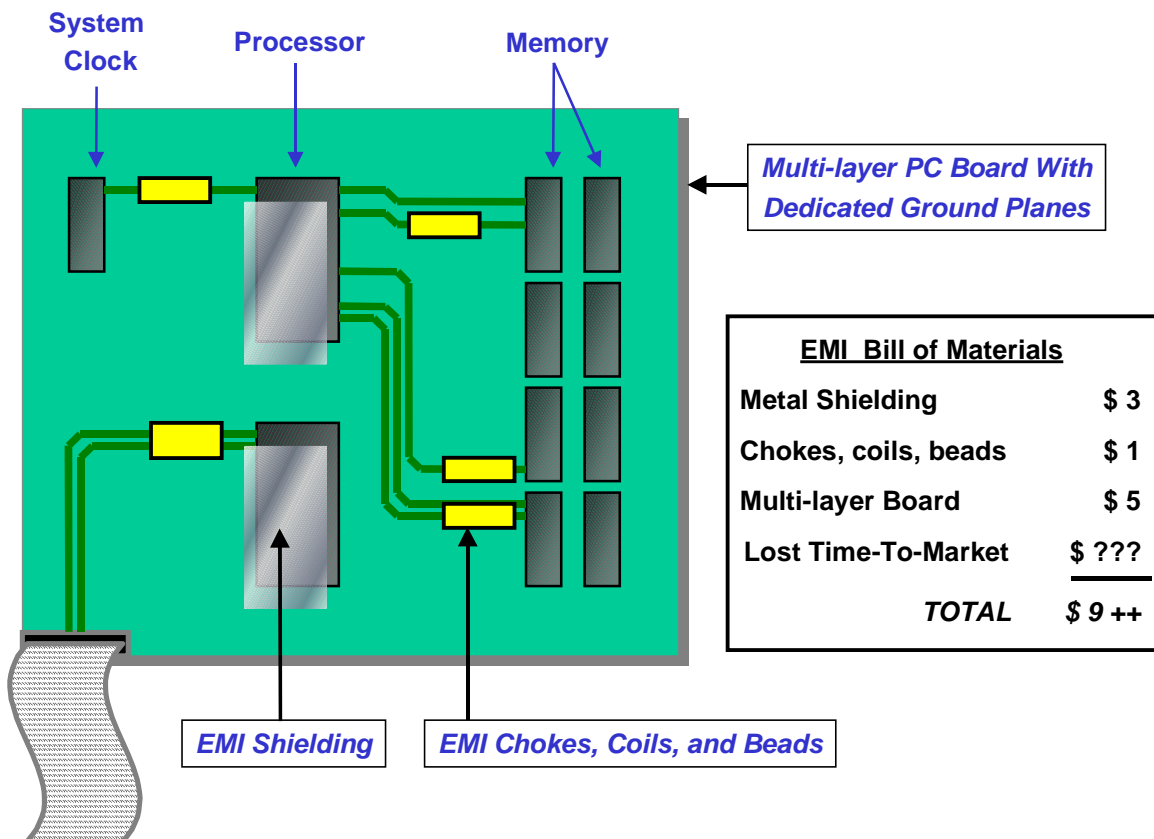
## EMI Reduction Using Spread Spectrum Techniques

### Background – The EMI Problem

Electromagnetic Interference (EMI) is caused by the generation and radiation of unwanted radio frequency signals that pollute carefully managed radio spectrum. EMI is the electronic equivalent of automotive smog and is emitted by any electronic system that has changing voltages and currents. In the United States, the Federal Communications Commission (FCC) has stringent rules about the maximum amount of EMI that a system may emit. These regulations address peak emissions (rather than average emissions) at a particular frequency. Similar regulatory bodies exist in other countries. A system that does not comply with FCC-type EMI standards cannot be used.

As system operating frequencies, data path widths, and output drive requirements increase, guaranteeing EMI compliance is becoming a difficult task for design engineering and manufacturing. As shown in Figure 1, the conventional methods used to meet EMI standards require metal shielding, multi-layer printed circuit boards, special casing, and passive components. As a result, the system's bill of materials and manufacturing costs increase but no value is added to the product in terms of features and competitiveness. In addition, using conventional methods of reducing system EMI requires a "trial and error" approach and results in longer time to market. In the worst case, a system must be entirely redesigned in order to satisfy EMI requirements.

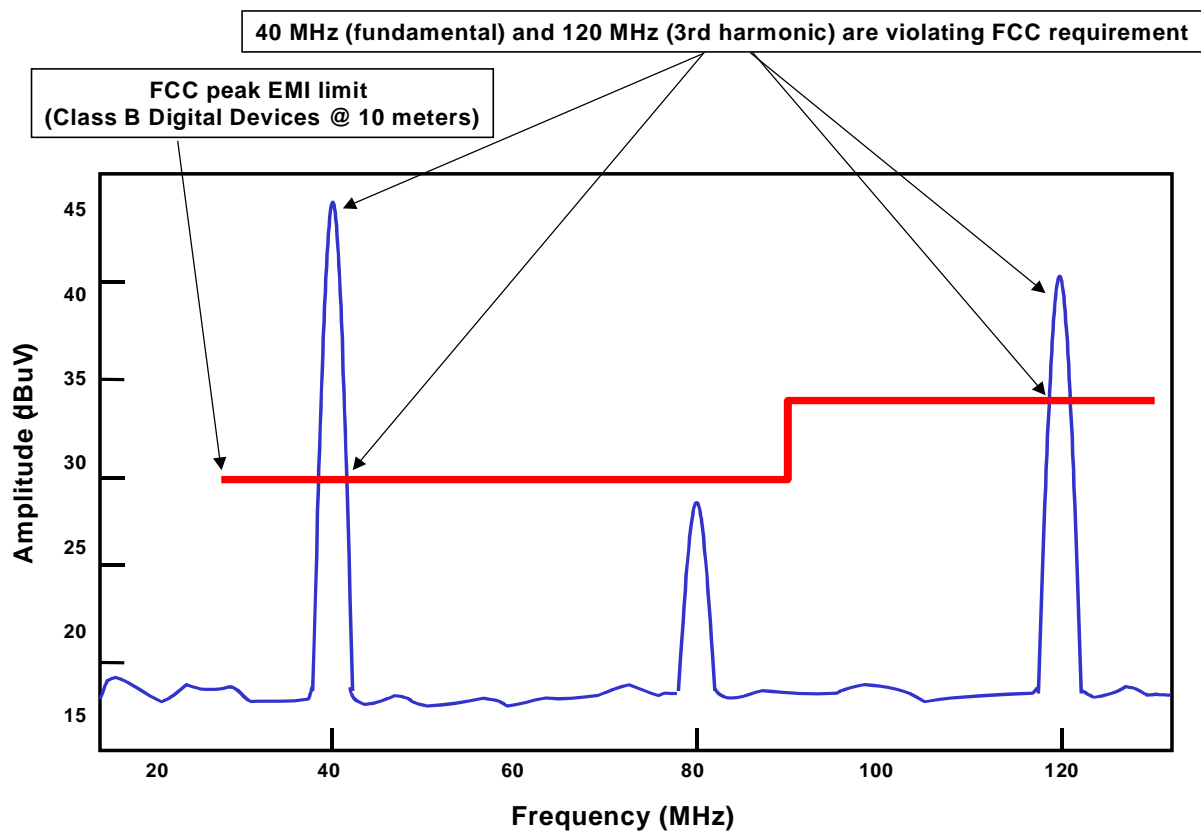
**Figure 1 – Conventional Techniques to Reduce System EMI**



## EMI Reduction Using Spread Spectrum Techniques

Figure 2 shows the EMI frequency spectrum of a typical electronic system with a clock frequency of 40 MHz. The fundamental frequency is 40 MHz and harmonics are present at 80 MHz, 120 MHz, ... The heavy black line indicates the peak EMI emission that the FCC allows. If any EMI emitted by this system exceeds the allowable FCC limit, the product cannot be shipped or used. In this particular case, the frequency components at 40 MHz and 120 MHz are exceeding FCC limits and this problem must be solved before the system can be shipped.

**Figure 2 – EMI Measurements for a Typical 40 MHz System**



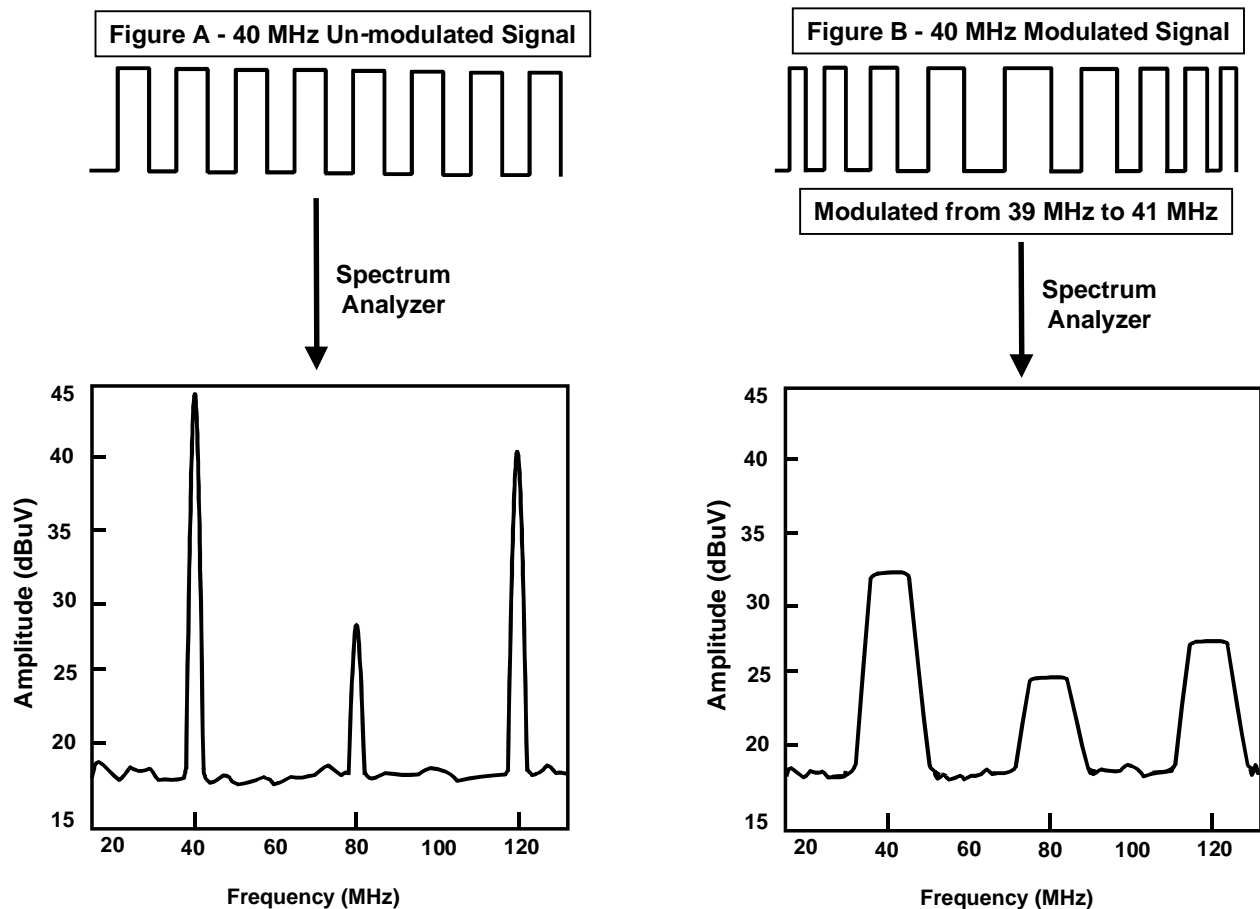
## EMI Reduction Using Spread Spectrum Techniques

### What is Spread Spectrum?

Spreading the spectrum of a frequency means distributing the energy that was originally concentrated at one frequency (or more accurately over a narrow band of frequencies) over a wider band, thereby reducing peak emissions. The energy is distributed by modulating the signal slowly between two frequency boundaries. The method of modulation dramatically influences the amount of EMI reduction.

Figure 3a shows the frequency spectrum of a 40 MHz reference frequency. If the 40 MHz signal were slightly modulated, for example from 39 MHz to 41 MHz, the total emitted energy would remain the same but would be “smeared” or distributed over 39 MHz to 41 MHz. This is shown in Figure 3b.

**Figure 3 – Spectrum of an Un-modulated and Modulated 40 MHz Signal**



Notice that the amplitudes in the frequency plot of the *modulated* 40 MHz signal (Figure 3b) are significantly reduced. This is because total emitted energy does not change if a signal is modulated. Rather, the energy gets “spread” over a wider frequency range thereby reducing *peak* emissions. This principle is used to reduce system EMI and is known as spread spectrum EMI suppression.

## EMI Reduction Using Spread Spectrum Techniques

### How Does Spread Spectrum EMI Suppression Reduce System EMI?

Most systems have at least one reference frequency (in other words, the system clock), usually from a crystal oscillator, phaselock loop (PLL), or external signal. This reference frequency sources all the ICs in the system. For example, if a system has a 40 MHz oscillator, then all address, data, and control signals will also switch at a multiple of 40 MHz. If the system reference frequency is modulated in a spread spectrum fashion, all clock-dependent outputs (such as address and data signals) will also exhibit this modulation. As a result, the cumulative EMI of the entire system will be reduced since each individual output signal's EMI level is reduced. Most importantly, this method of EMI suppression is approved by the FCC.

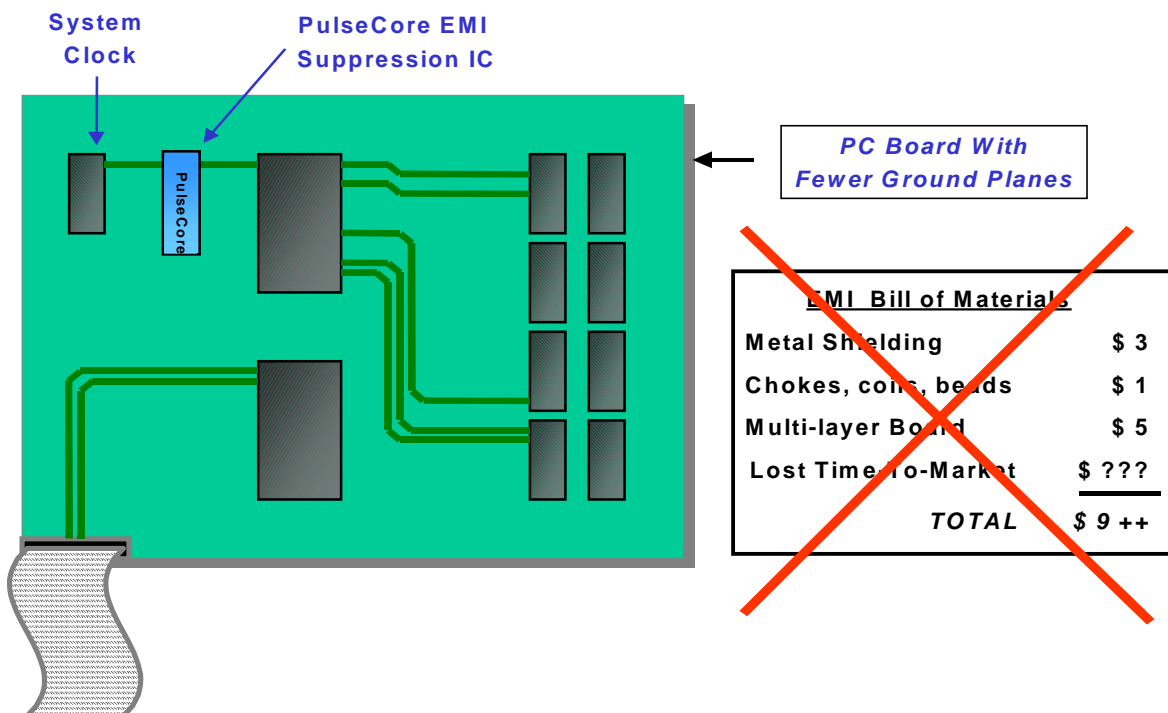
### How Do OEMs Benefit By Using Spread Spectrum?

Manufacturers of printers, fax machines, modems, multi-function products (MFP), scanners, graphics and video subsystems, digital cameras, DVD players, notebook LCD and flat panel displays, set-top boxes, Internet appliances, Personal Digital Assistants (PDA), and digital television sets can benefit in three ways by using spread spectrum techniques:

- 1) Reduce system EMI by up to 20 dB
- 2) Reduce costs by reducing bill of materials and complexity of printed circuit board
- 3) Reduce engineering resources needed in meeting EMI standards - resulting in faster time to market

Figure 4 illustrates how to use a spread spectrum EMI suppression IC, such as the PulseCore P2040. The P2040 would be placed in the path of the system clock thereby providing a modulated clock signal to the entire system. In conjunction with optimized PC board layout, using the P2040 would virtually remove the need for PC board dedicated ground planes, EMI shielding, special packaging, chokes, coils, and filters.

**Figure 4 – Using Spread Spectrum to Reduce System EMI**



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## EMI Reduction Using Spread Spectrum Techniques

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**Case Study: Laser Printer**

A leading U.S. OEM substituted conventional EMI suppression methodology with spread spectrum technology in its line of laser printers. Table 1 illustrates a “before and after” comparison. An overall cost saving of \$25 per system resulted from using spread spectrum technology. In addition, EMI testing time was reduced by 2 man months and this allowed significantly faster time to market.

**Table 1 – Case Study of a Standard Office Laser Printer**

	<b>BEFORE: (With Conventional Approach)</b>	<b>AFTER: (With Spread Spectrum)</b>	<b>Savings</b>
<b>Printed circuit board</b>	<b>6 layers</b> (8½” by 11” board)	<b>2 layers</b> (8½” by 11” board)	\$ 14
<b>EMI shielding and gaskets</b>	Extensively used	Virtually eliminated	\$ 10
<b>Miscellaneous components (chokes and filters)</b>	Used	Minimal usage	\$ 1
<b>EMI testing time</b>	3 man months	1 man month	2 man months
<b>TOTAL SAVINGS</b>			<b>\$ 25 ++</b>

**Product Information**

For information about PulseCore’s EMI suppression line of products, please contact PulseCore Marketing at [info@pulsecore.com](mailto:info@pulsecore.com) or visit our web site at [www.pulsecore.com](http://www.pulsecore.com).