Intel® IXP42X Product Line of Network Processors and IXC1100 Control Plane Processor: Spread-Spectrum Clocking to Reduce EMI

Application Note

July 2004

Document Number: 254028-002

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Revision History

Date	Revision	Description
July 2004	002	Updated Intel® product branding.
September 2003	001	Initial release of this document.

1.0 Overview

Electromagnetic interference (EMI) is a concern for board designers. The United States and other countries regulate the amount of EMI an electronic device may emit to ensure that electronic devices do not interfere with each other.

Because the Intel® IXP42X Product Line of Network Processors and IXC1100 Control Plane Processor typically go into consumer or residential applications, the Federal Communications Commission (FCC) regulations, regarding EMI, are more stringent. The FCC's Class A regulations pertain to industrial applications and Class B applies to residential or consumer applications. Hardware engineers designing with the IXP42X product line and IXC1100 control plane processors are often concerned with passing FCC Class-B regulations.

Many techniques are employed by engineers to reduce EMI. The first and most-effective method is board-layout techniques. With the proper care put into the board layout and termination, a hardware engineer can generally avoid further measures.

A hardware engineer may choose to use shielding in the box. This solution, however, is very expensive — particularly for high-volume products.

Another, popular technique is called "spread-spectrum clocking." By "spreading" the frequency slightly, the energy is spread out as well. This reduces the maximum peak energy seen, when measuring EMI. The total amount of energy is the same, but the peak values are reduced.

Since FCC Class A and Class B regulations concern the "peak" energy emissions, the spread-spectrum-clocking solution helps products meet FCC regulations.

This approach doesn't *guarantee* — in and of itself — that a board will meet FCC requirements, but spread-spectrum clocking is one of the techniques that a board designer can use to help meet those regulations.

Spread-spectrum clocking requires a special, spread-spectrum oscillator — that is more costly than an inexpensive crystal. But, the clocking technique may eliminate the need for more-expensive shielding — which more than offsets the cost of an oscillator.

Of the three discussed solutions to the EMI issue, the best one, obviously, is proper board design and layout.

2.0 Clocks and Spread-Spectrum Clocking

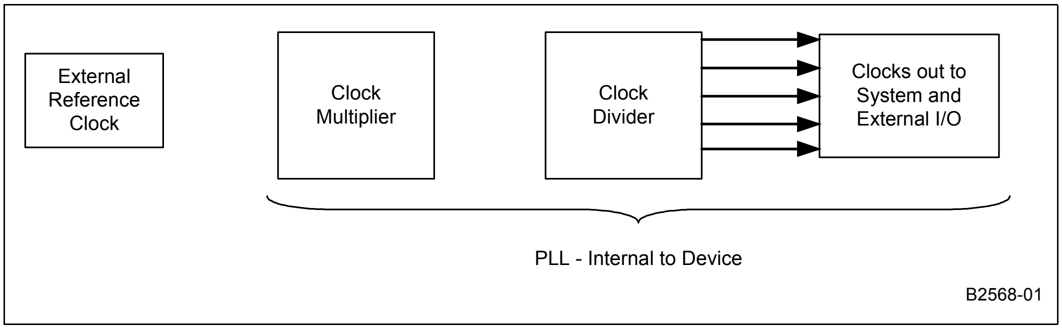
2.1 Clocks

In the IXP42X product line and IXC1100 control plane processors, all of the internal system clocks — and several of the external interface clocks — are generated by a Phase-Locked Loop (PLL) that is synchronized to an external reference clock. The external reference clock can be generated by a crystal oscillator or can be supplied directly from a clock generator.

The IXP42X product line and IXC1100 control plane processors' specification on the input clock is 33.33 MHz +/- 50 ppm.

The clock generation scheme is shown in Figure 1.

Figure 1. Clock-Generation Scheme



The Clock Multiplier is used to generate a high-frequency clock that is a common multiple for all internally generated clocks. This clock is divided down to produce the system and I/O clocks required by the device.

Since the clock multiplication and division is a linear operation, any change to the external reference clock period is directly translated to change in the output clock periods. (For example, a 1% change in external reference clock period creates a 1% change in the internally generated clock periods.)

This effect will be observed on any interface in which the IXP42X product line and IXC1100 control plane processors generate the clock for the interface.

Some interfaces have very tight specifications on the I/O clock and data transmission. If the external reference clock period is not within the specified range, it is up to the customer to ensure that the interfaces are operating within specifications.

These interfaces all run off of clocks generated internally:

- SDRAM
- GPIO clocks generated for external systems
- HSS - This interface generates a configurable clock that is divided down from the internal clock.
- UART(s)
- MDIO interface
- USB

Note: If you are using the spread-spectrum solution, *do not* use the USB interface. (See "USB Clocking Considerations" on page 7.)

2.2 Spread-Spectrum Clocking

Using a spread-spectrum clock generator, with the IXP42X product line and IXC1100 control plane processors, can help reduce EMI. In implementing this solution, however, the peripheral clocks need to be taken into account.

To ensure proper operation of the device, do not exceed the parameters in Table 1.

Table 1. Spread-Spectrum Clocking Parameters for Processors

Spread-Spectrum Conditions	Min	Max	Notes
Frequency deviation from 33.33 MHz as a percent.	-2.0%	+0.0%	Characterized and guaranteed by design, but not tested. Do not over-clock the PLL input. The A.C. timings will not be guaranteed if the device exceeds 33.33 MHz.
Modulation frequency		50 KHz	Characterized and guaranteed by design, but not tested

2.3 USB Clocking Considerations

The USB is very sensitive to clock deviations. The USB-1.1 specification lists a tolerance of 500 ppm or 0.05%.

If the clock deviates from the 33.33-MHz frequency, the USB is not be guaranteed to work correctly.

Therefore, if you choose to do spread-spectrum clocking in your design, *do not use* the USB.

3.0 Summary

Since the IXP42X product line and IXC1100 control plane processors often go into consumer electronics, strict EMI regulations must be met. One of the techniques that can help meet these requirements is spread-spectrum clocking.

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