



SpyGlass[®]-CDC

Industry Most Comprehensive, Practical,
and Powerful CDC Solution



Among the many verification challenges confronting system-on-chip (SoC) designers these days, clock domain crossings (CDCs) rank near the top in difficulty. Today's SoCs have dozens or sometimes even hundreds of clock domains, many of them difficult to verify using conventional simulation or static timing analysis (STA). For these bugs to be detected in simulation, it requires long simulation runs and a chance encounter and STA does not check for asynchronous clock domains. As a consequence, CDCs have become a leading cause of design errors. Such errors can add significant time and expense to the design-and-debug cycle, and may even find their way into silicon, necessitating costly re-spins.

The Problem

The success of static CDC verification tools is determined by two critical measures—the time taken to signoff and the completeness of CDC verification. Conventional CDC analysis tools fall short in both areas. They generate large amounts of noise (false violations)—extending the verification cycle—and provide poor coverage of complex CDC synchronization schemes.

Two particularly troublesome CDC-related issues involve FIFO- and handshake-based

synchronization mechanisms. Both can be difficult or impossible to accurately verify using simulation. And conventional static CDC analysis tools do too little and too much at the same time, simultaneously overlooking real design errors and over-reporting large numbers of false violations. As a result the user is forced into an endless bug-hunting process, which often discourages the designer and leaves real bugs undetected.

The Atrenta Solution – SpyGlass-CDC

- Supports widest variety of synchronizers and produces the least amount of false violations
- Automatically recognizes and formally verifies complex handshake and FIFO synchronization schemes
- Formally verifies data stability
- Automatically recognizes and formally verifies gray-code logic in re-convergent signals
- Works without the manual effort to supplement CDC testing with simulation vectors and writing assertions
- Integrates with Atrenta SpyGlass capabilities targeted for RTL like constraints, constraints and DFT
 - > Easy to ramp up and begin productive use within half a day, even for non-experts
 - > A structured methodology enables quick adoption by engineers and constraints optimized designs

SpyGlass-CDC Methodology

- Provides easy-to-use and a comprehensive method for solving CDC problems at RTL to avoid costly silicon re-spins
 - Provides methodology documentation and rule-sets as part of the product software installation
 - Walks users through a series of recommended steps to analyze CDC problems at block and chip level - the steps include design setup, setup checks, design-unit integration chip level CDC verification, report review and CDC verification sign-off
- User-guided CDC sub-methodology flow results
- in fewer but meaningful violations, thus saving time for the RTL designer

The Atrenta Difference

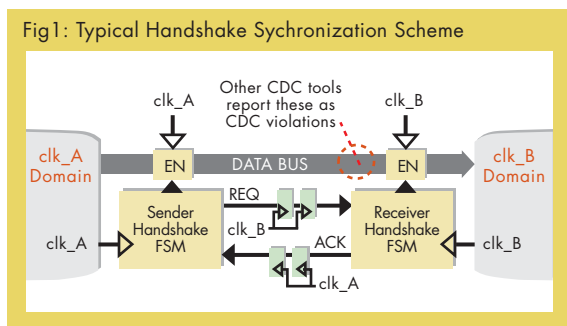
Separating True From False Violations

In order to isolate real clock domain crossing issues, it is necessary to detect various synchronization schemes—not just basic two-flop or multi-flop synchronizers, but more complex mechanisms, such as handshakes and FIFO-based schemes. Once detected, these synchronizers need to be verified as working correctly.

Both detection and verification have their own set of challenges, but when done properly, one can confidently claim correctness of these clock domain crossings. This knowledge can be used to filter out false violations, which typically result when a tool fails to recognize properly synchronized crossings and instead reports them as unsynchronized. Many tools lack the ability to detect and functionally verify handshake structures. Given that it is now commonplace to find up to 80 percent of CDCs controlled by handshakes in large design modules, false violations can be numbering in the hundreds. These false violations make designers give up on CDC verification with conventional tools in the market. Similar problems arise with FIFO synchronizers as well.

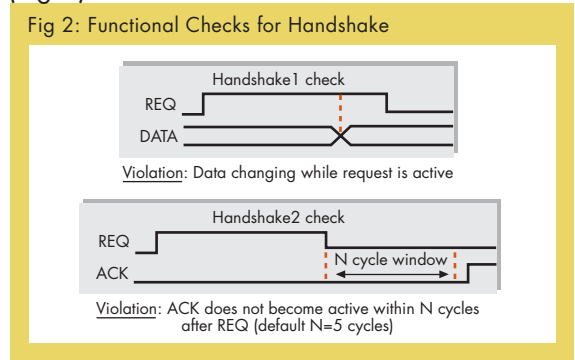
Verifying Handshake Synchronizers

Fig 1 shows a typical handshake synchronization scheme. Traditional CDC tools that look only for a double-flop synchronizer will report these crossings as unsynchronized, resulting in a large number of false violations.



The SpyGlass-CDC solution automatically identifies such handshake schemes, and can thus eliminate a large number of false violations. However, the crossing cannot be considered safe until its functionality is proven to be correct.

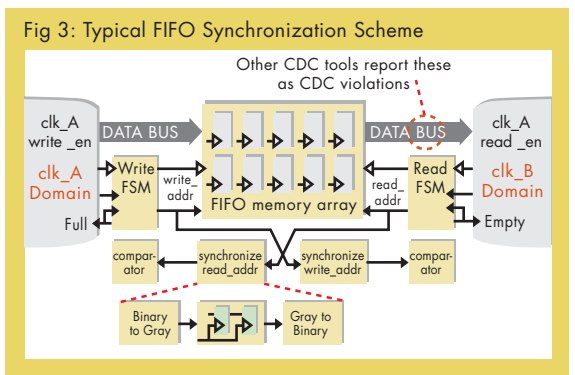
The SpyGlass-CDC solution also formally verifies to see if the following conditions can be violated (Fig 2).



Verifying FIFO Synchronizers

FIFOs are commonly used to transfer data generated by a source to a destination where the source and destination are clocked at different or variable rates. Very often the source and destination reside in different clock domains, in which case an asynchronous FIFO is needed.

Asynchronous FIFOs involve multiple clock domain crossings for empty and full flag calculation as well as data read to the destination domain. In a FIFO, these crossings are not always synchronized using traditional synchronization methods. Again, other CDC tools are unable to recognize such FIFO scheme (Fig 3), and will report these crossings as unsynchronized, resulting in a large number of false violations.



The SpyGlass-CDC solution not only automatically identifies the above FIFO scheme but also performs formal checking for data stability (on double-flop synchronizers), and re-convergence signals (from the gray encoder).



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