SIEMENS DIGITAL INDUSTRIES SOFTWARE

Stop waiting for GDSII layouts to finish loading—switch to the OASIS format

Executive summary

File size and layout loading time have become increasingly important concerns as process technology advances and designs become larger and more complex. The OASIS file format has been around for more than 15 years, is accepted by every major foundry, and is supported by all major EDA tools. Switching to the OASIS file format and utilizing features such as CBLOCKs and strict mode can provide users with dramatically smaller file sizes and faster loading times, with no loss of data integrity.

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Contents

Introduction

As foundries advance their process technology, layout designers have the ability to deliver more functionality in the same chip area. As more content goes into a layout, the file size also increases, which creates a difficult challenge: dealing with full-chip graphic data system (GDSII) layouts that are hundreds of gigabytes, or even terabytes, in size. Although additional storage can be purchased relatively inexpensively, storage availability still becomes an increasingly larger concern.

Electronic design automation (EDA) tools also struggle with these larger layouts, resulting in longer loading times that can frustrate designers and impact aggressive tape-out schedules. This particular problem arises throughout the design process: when creating or modifying a layout, when checking timing, when running simulations, when running physical verification, or even just when viewing a layout.

Layout designers often try to address the file size problem by zipping their GDSII layouts. This approach reduces file sizes but can increase loading times, as tools must unzip the file before they can access the data. A better solution is to switch to the Open Artwork System Interchange Standard (OASIS®) format, which can reduce both file sizes and loading times. The OASIS format has been available for more than 15 years [1] and is accepted by every major foundry. It is also supported by all major commercial EDA tools [2].

The OASIS format has several features that help reduce file size compared to the GDS format.

- OASIS data represents numerical values with variable byte lengths, whereas the GDS format uses fixed byte lengths.
- OASIS functionality can also recognize complex patterns within a layout and store them as repetitions, rather than as individual instances or geometry objects.
- The OASIS CBLOCK feature applies Gzip compression to the individual cells within a layout. Because this compression is internal to the file, tools do not need to create a temporary uncompressed file, which is often necessary with normal Gzip compression. Additionally, unzipping a Gzip file is typically a single-threaded process, whereas CBLOCK files can be uncompressed in parallel.
- Strict mode OASIS layouts contain an internal lookup table that can tell a reader the location of different cells within the file. This information allows the reader to more efficiently parallelize the loading of the layout and can offer significant loading time

improvement.

Although features such as CBLOCK compression and strict mode are not required, it is highly recommended that layout designers utilize both to realize the fastest loading times in their tools while maintaining small file sizes.

What's wrong with GDS.GZ?

Many layout designers have resorted to zipping their GDSII layouts, which in measured testcases reduced file sizes by an average of 85%. Beyond cell placements, though, designs can contain a lot of repetition that is not recognized by the GDS format. As a result, much of a GDSII file is redundant information, which is why zipping a GDSII layout can achieve such significant compression ratios. However, the OASIS format natively recognizes this repetition and stores this information more compactly. Additionally, taking advantage of OASIS CBLOCK compression reduced file sizes by an additional 80% from the zipped GDSII layouts and by almost 97% from the uncompressed GDSII layouts. Figure 1 shows the file size reduction that can be achieved by using the OASIS format instead of a zipped GDSII layout.

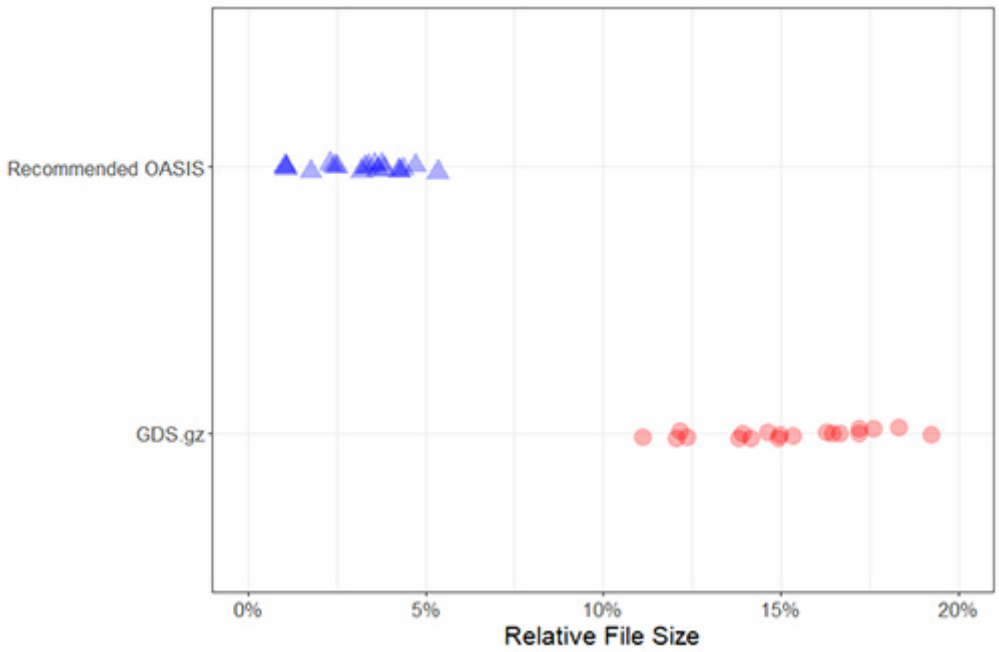

Figure 1. File sizes relative to the uncompressed GDSII layout (smaller is better). In all measured testcases, the recommended OASIS options delivered smaller file sizes than zipping the uncompressed GDS layout.

In addition, a zipped GDSII layout's file size reductions are usually offset by longer loading times, as tools must first unzip the layout. As seen in figure 2, the Calibre® nmDRC™ tool took, on average, 25% longer to load the zipped GDSII layout than the corresponding uncompressed GDSII layout. Not only were the corresponding recommended OASIS layouts smaller, the Calibre nmDRC tool was able to load them faster than the uncompressed GDSII layouts in all measured testcases, with improvements ranging from 65% to over 90%.

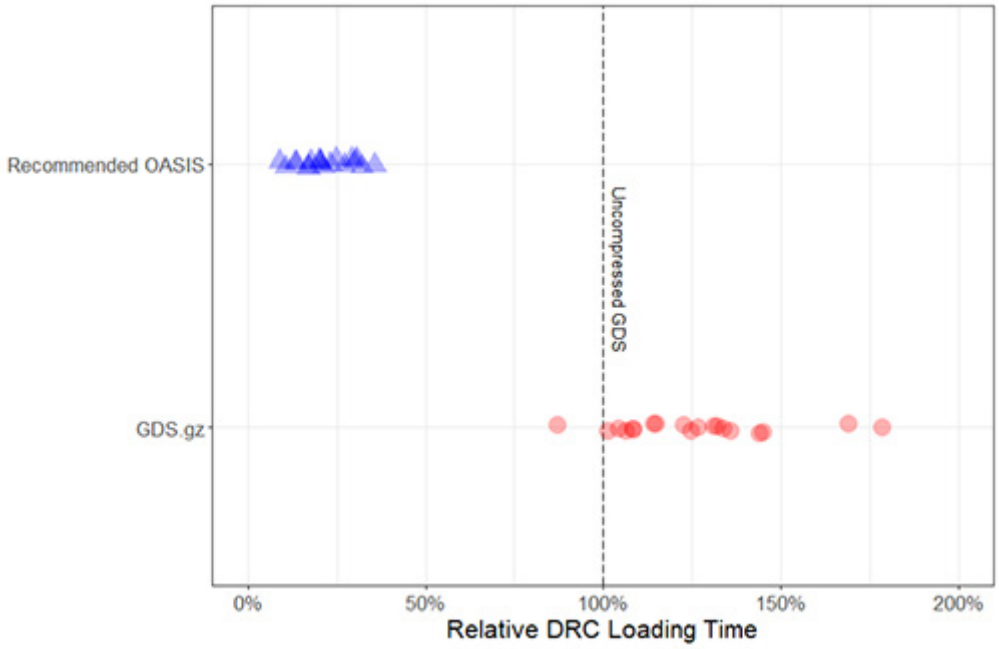

Figure 2. Calibre nmDRC loading times relative to the uncompressed GDSII layout (smaller is better). In all measured testcases, the recommended OASIS options delivered faster Calibre nmDRC loading times than zipping the uncompressed GDSII layout.

While figures 1 and 2 considered file sizes and loading times separately, the reality is that layout designers must deal with both together. As seen in figure 3, plotting both quantities on the same chart makes it even clearer that the recommended OASIS options deliver significant benefits in terms of both file size and loading time.

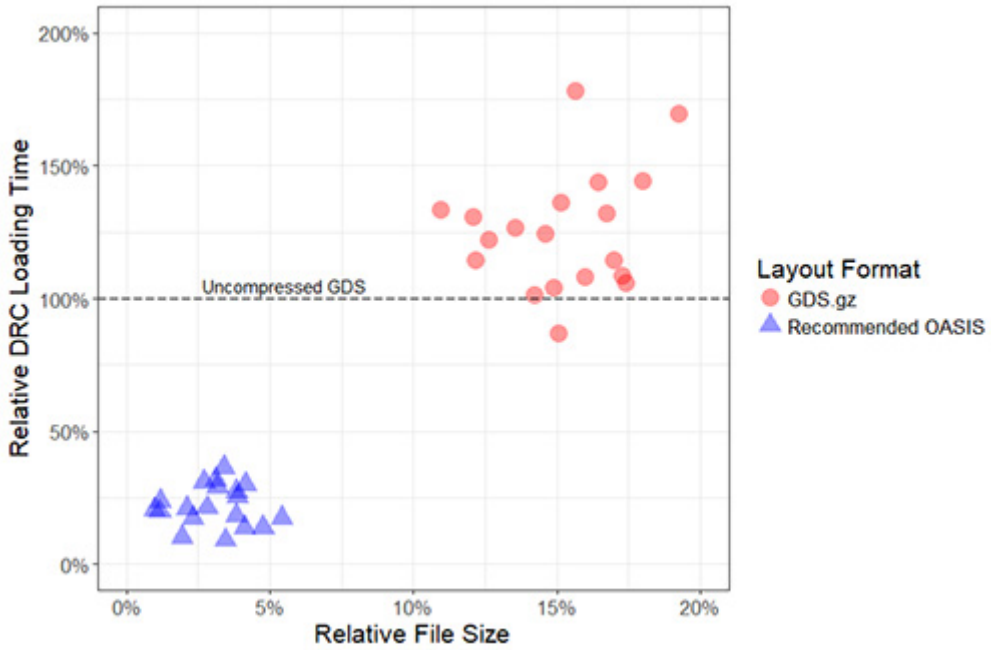

Figure 3. Calibre nmDRC load time and file size, both relative to uncompressed GDSII file. In all measured testcases, the recommended OASIS options delivered faster Calibre nmDRC load times and smaller file sizes than zipping the uncompressed GDSII layout.

Loading time costs are incurred throughout the design process every time a user runs the Calibre nmDRC tool or even just views a layout. The Calibre nmDRC tool is typically run in batch mode, where slow loading performance may not be as readily apparent. However, when viewing a layout, users must actively wait for the layout to load, which can be very frustrating. As seen in figure 4, viewing a zipped GDSII layout in the Calibre DESIGNrev™ viewer took up to 30% longer than viewing the uncompressed GDSII layout. In addition to the file size reduction of almost 80% (compared to the zipped GDSII layout), switching to the OASIS format with the recommended options reduced the loading time in the Calibre DESIGNrev viewer by an average of over 70%

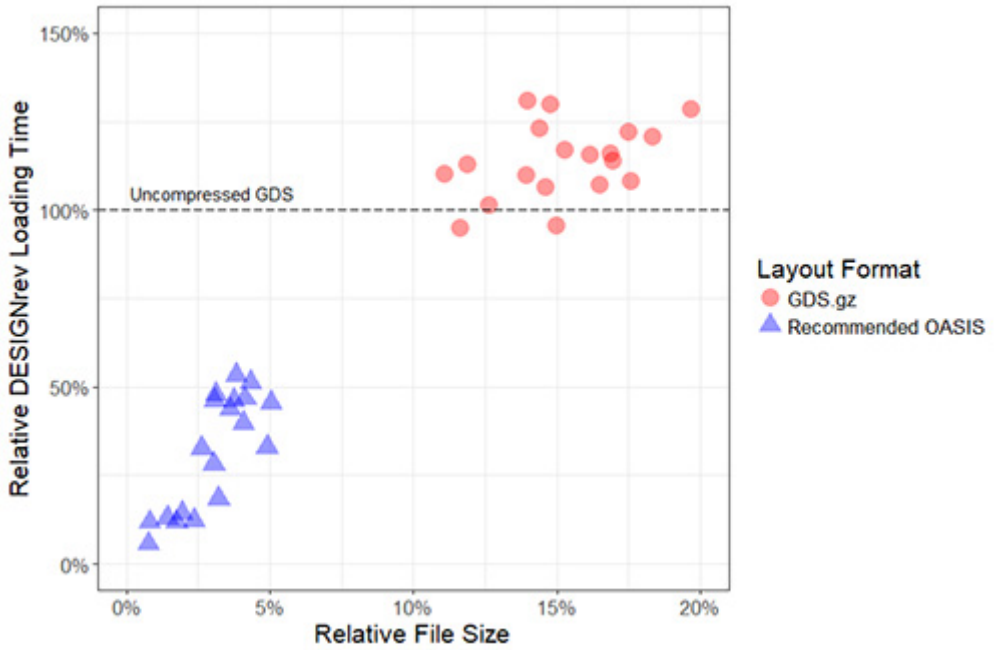

Figure 4. Calibre DESIGNrev loading time and file size, both relative to the uncompressed GDSII file. In all measured testcases, the recommended OASIS options delivered faster load times than zipping the uncompressed GDSII layout.

What about zipping an OASIS layout?

Layout designers may think that zipping an OASIS layout can provide additional file size reductions. However, CBLOCK and Gzip use similar compression algorithms, so using both compression methods typically provides only minimal file size reductions, while loading times actually increase because tools must uncompress the same file twice.

In a few cases, zipping an uncompressed OASIS layout may reduce file sizes more than using CBLOCK. However, layout readers cannot load a zipped OASIS layout in parallel without first unzipping the file, which leads to increased loading times. As seen in figure 5, the zipped OASIS layout had 6% smaller file sizes when compared to the recommended OASIS layout. However, Calibre nmDRC loading times increased by an average of over 60% to offset this benefit, and, in several cases, the loading time more than doubled.

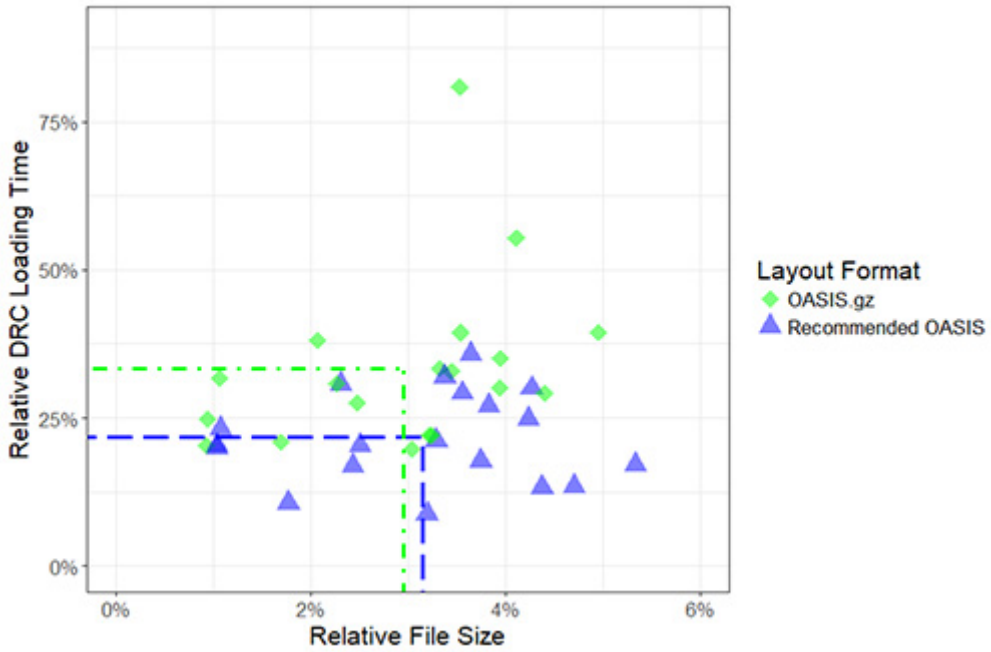

Figure 5. Calibre nmDRC load times and file size for OASIS and OASIS.gz files. The means of both file sets show the OASIS.gz provides a slightly smaller file size when zipping the uncompressed OASIS layout, but incurs a significant load time penalty.

What should I do next?

At 16 nm and smaller nodes, block-level and full-chip layouts should be in the OASIS format, specifically with strict mode and CBLOCK options. Moving flows to utilize these recommendations can provide dramatically smaller file sizes and faster loading times.

Maintaining data integrity is critical, so layout designers may want to first switch a previous project to the OASIS format to reduce risk and see firsthand the benefits of switching. They can also run the Calibre XOR function to convince themselves that no data is lost by switching to the OASIS format. Additionally, every time physical verification is run on an OASIS layout, it is another check that the layout is correct.

Layout designers can convert their layouts to the OASIS format using the Calibre DESIGNrev viewer. For best results, use the 2018.2 or later release and enable both CBLOCK and strict mode options when exporting the layout. These recommended options are also available when using the layout filemerge utility as part of a chip assembly flow. By setting the **-cblockmode 1**

and
-strictmode 1 options, users can reduce the loading time when running full-chip physical verification using the Calibre nmDRC tool.

Designers should use the 2017.4 or later release of the Calibre nmDRC tool to load OASIS layouts with the recommended options in parallel. Designers can confirm their layouts are loaded in parallel by searching for "STRICT PARALLELISM: ENABLED" in their Calibre nmDRC log files. Note: this parallelization is only enabled when running the Calibre nmDRC tool with the **-hyper** and **-turbo** options.

Conclusion

File size and layout loading time have become increasingly important concerns as process technology advances. While storage is relatively inexpensive, it is an unnecessary and avoidable cost. Longer layout loading times encountered throughout the design process are similarly preventable.

The OASIS format has been around for more than 15 years, is accepted by every major foundry, and is supported by all commercial EDA tools. Switching to the OASIS format using options such as CBLOCK compression and strict mode can provide designers with dramatically smaller file sizes and faster loading times, with no loss of data integrity.

References

1. “SEMI Standard P39 – Specification for OASIS® – Open Artwork System Interchange Standard,” SEMI. https://store-us.semi.org/products/p03800-semi-p39-specification-for-oasis%C2%AE-open-artwork-system-interchange-standard
2. Joseph C Davis, Steffen Schulze, Sai Fu, Yijun Tong, "Deployment of OASIS in the semiconductor industry: status, dependencies, and outlook," Proc. SPIE 7545, 26th European Mask and Lithography Conference, 75450B (15 May 2010); https://doi.org/10.1117/12.864158

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