

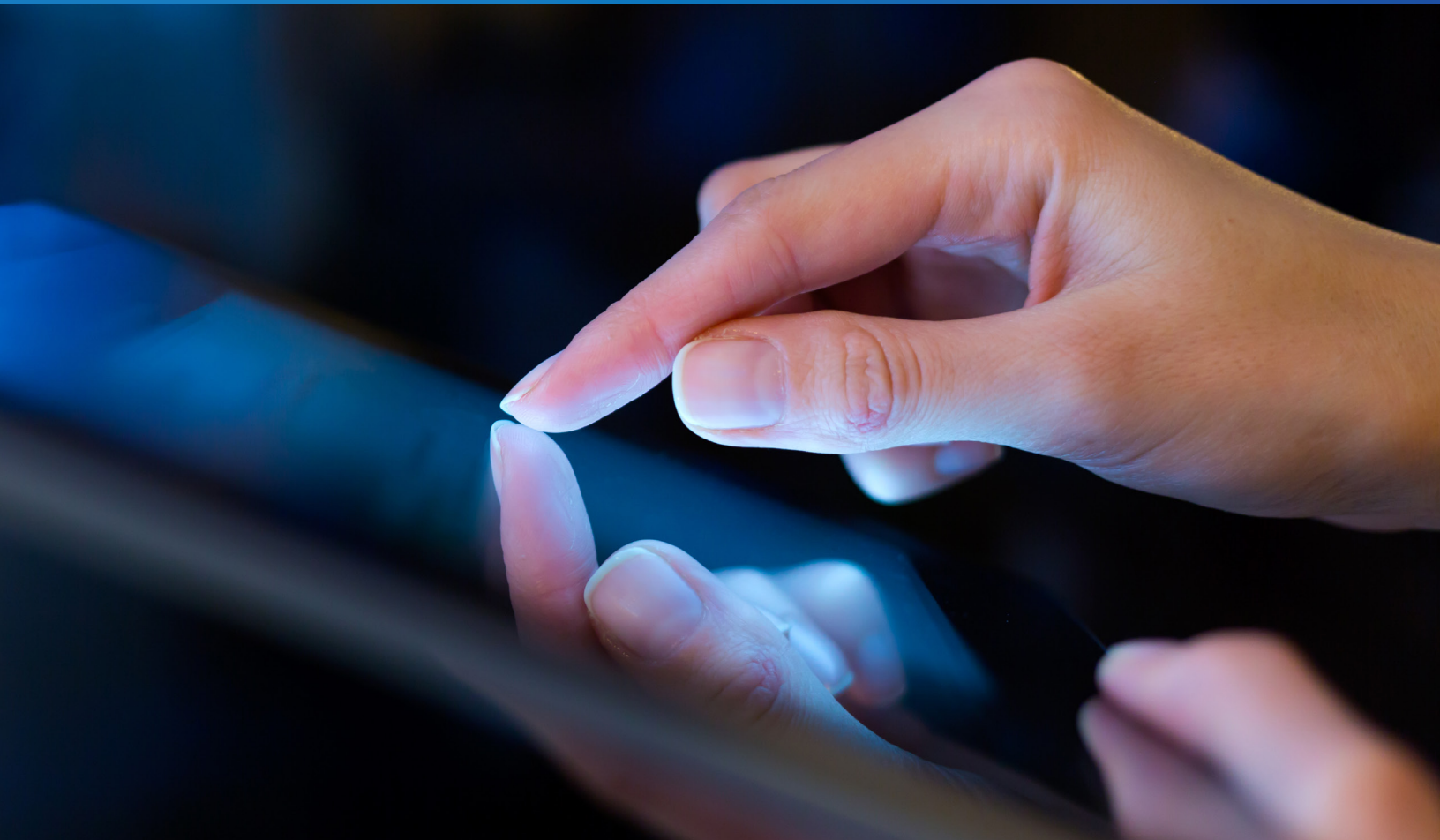


Whitepaper

Touching the Future

How Multi-Frequency-Region Parallel Sensing unlocks the next generation of display innovation

April 2025



Cutting through the noise

As device manufacturers continue their relentless pursuit towards thinner, lighter, and more responsive designs, engineers and system architects face escalating challenges in touch-display integration. Nowhere is this more evident than in the development of large-format and foldable OLED touch displays.

The trend toward thinner panels means that touch sensors are increasingly situated closer to sources of electromagnetic noise, such as display drivers and power circuits. This proximity significantly degrades signal quality, reducing the signal-to-noise ratio (SNR) and jeopardizing touch performance.

At the same time, end-user expectations have never been higher. Whether in premium smartphones, tablets, automotive displays, or point-of-sale terminals, users demand high precision, fast response times, and flawless touch experiences—regardless of electrical noise. For designers and device manufacturers, achieving this level of performance at scale is both a technical and architectural hurdle.

Traditional approaches to touch sensing, especially in high-resolution OLED and ultra-thin displays, have begun to show their limits. Increasing the sensitivity of touch sensors alone is insufficient; mitigating noise and maintaining performance across varying display sizes and configurations require a fundamental shift in sensing strategy.

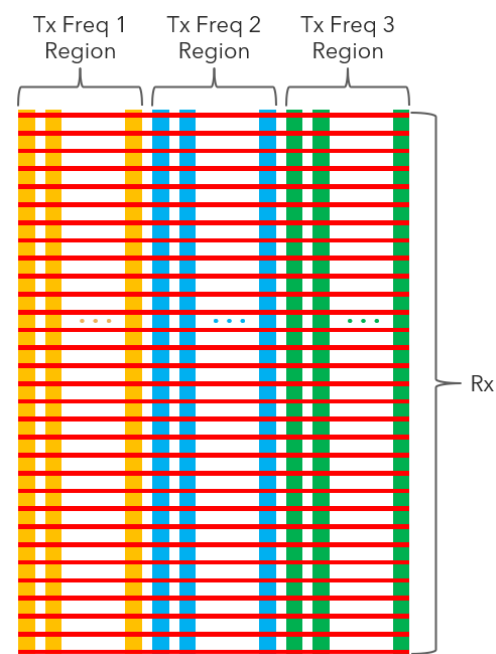
This whitepaper introduces Synaptics' patented Multi-Frequency-Region Parallel Sensing (MFRPS) technology, a leap forward in scalable touch controller architecture designed to overcome these exact challenges. Through a deep dive into the limitations of legacy designs, and a technical explanation of how MFRPS addresses the core issue of noise in thin-panel environments, we will show why this innovation represents a significant advancement for the industry.

What is MFRPS?

MFRPS is a patented approach at the heart of Synaptics' breakthrough that fundamentally reimagines how large touch sensors are scanned. Unlike conventional architectures that rely on sequential frequency bursts, MFRPS enables parallel scanning across multiple frequency regions. This innovation significantly reduces the duration of sensing bursts while boosting frame rates, delivering smoother, faster, and more responsive touch experiences, even on expansive or foldable displays.

Complementing this sensing innovation is Synaptics' Digital Analog Front End (dAFE). Unlike traditional AFEs, which can be bulky and costly, this fully digital design uses continuous-time sensing techniques coupled with advanced signal processing to deliver robust performance at a lower system cost. It's an architecture that scales easily and economically.

Another advancement comes in the form of Pseudo-Sine Wave Drive technology. By replacing conventional square-wave driving signals with smoother pseudo-sine waves, Synaptics reduces touch-to-display (T2D) distortion by up to 40%. This approach not only enhances visual clarity but also enables higher drive voltages with a low-voltage process, boosting the SNR and further improving touch accuracy in noisy environments.



Example of MFRPS with three frequency regions.

Lastly, Synaptics addresses power efficiency with Single-Burst Doze Mode Sensing. Traditional low-power sensing methods require two bursts to guarantee touch can be detected at any location and switch to active sensing mode. Synaptics, however, achieves equivalent results using just a single burst, cutting power consumption by up to 40% without sacrificing responsiveness. By leveraging MFRPS within this mode, devices can maintain a balance of performance and efficiency that's ideal for battery-sensitive applications.

Together, these innovations form a powerful architecture tailored for next-generation displays, offering OEMs a scalable, high-performance, and energy-efficient solution backed by Synaptics' deep expertise and patent portfolio.

Performance enhancements

Synaptics' MFRPS architecture is a technological breakthrough that delivers measurable, real-world performance improvements by redefining what's possible in touch and pen input systems.

One of the most critical advancements is improved noise immunity. By combining continuous time (CT) sensing with MFRPS, Synaptics narrows the sensing bandwidth, enabling more effective noise filtering and more accurate signal detection—even in electrically noisy environments like ultra-thin OLED displays or industrial settings.

The system also offers higher frame rates, thanks to MFRPS's ability to scan three frequency regions in parallel. This simultaneous scanning reduces overall panel sensing time, resulting in faster, more responsive touch interactions—essential for high-performance applications such as gaming and multitasking.

For users relying on stylus input, Synaptics delivers another leap forward with enhanced active pen accuracy. By supporting parallel in-phase (I) and quadrature (Q) demodulation of both the pen tip and ring signals, the system ensures greater stability and precision, yielding a smoother and more natural writing or drawing experience.

Power efficiency is also a cornerstone of the platform. Synaptics' single-burst doze mode sensing, powered by MFRPS, cuts doze mode power consumption by up to 40% compared to traditional two-burst approaches—making it ideal for battery-powered devices that still demand high responsiveness.

And finally, this performance doesn't come at the expense of scale. With native support for larger panels, MFRPS handles the increased capacitive load of large-format and foldable displays without compromising speed, accuracy, or efficiency—making it the perfect fit for today's increasingly complex design requirements.

A patently better solution

Synaptics' Multi-Frequency-Region Parallel Sensing features a number of recent patented innovations:

1. Multi-Frequency-Region Parallel Scan for Touch Sensor.
2. Touch Sensing Method to Mitigate Impulse and Burst Noise.
3. Inter-band Harmonics Interference Mitigation for Multi-Frequency-Region Parallel Scan.
4. Sensing Method to Reduce Doze Mode Power Consumption.
5. Zero Row Sum CDM Driving for Multi-Frequency Simultaneous Touch Sensing (pending).



Benefits to developers and OEMs

For developers and OEMs building next-generation devices, Synaptics' MFRPS technology delivers clear, strategic advantages across performance, design, and cost effectiveness.

First, it enables the creation of differentiated products that stand out in a crowded marketplace. With enhanced signal fidelity, faster frame rates, and best-in-class active pen accuracy, MFRPS empowers brands to deliver smoother, more responsive, and more intuitive user experiences—whether in foldables, tablets, automotive displays, or point-of-sale systems.

Second, the architecture helps drive lower overall system cost. By integrating key functions into a single chip and reducing the number of required external components, MFRPS streamlines hardware complexity. This not only reduces bill of materials (BOM) costs but also simplifies design and speeds time to market.

Third, MFRPS is purpose-built for the demands of fast response times and ultra-thin designs. Its robust noise immunity and high signal-to-noise ratio (SNR) maintain accuracy and responsiveness even as displays become thinner and touch sensors move closer to noisy display drivers—eliminating a major barrier to innovation in modern industrial design.

Finally, the solution is scalable across screen sizes and types, from compact mobile devices to large-format OLED and LCD panels. Developers can rely on a single architecture to support a wide range of applications, reducing engineering overhead and accelerating product development cycles.

With MFRPS, Synaptics delivers a forward-looking platform that aligns with the performance, efficiency, and flexibility needs of today's most ambitious device makers.

A world of applications

Synaptics' MFRPS architecture represents a breakthrough in capacitive touch sensing, delivering significant performance improvements for large panels and low-power devices.



Foldable smartphones



Laptops & tablets (OLED and LCD)



Automotive infotainment systems



Retail point-of-sale displays



Industrial control systems



Gaming consoles

Shaping what's next in touch technology

As touch-enabled devices evolve—becoming thinner, more responsive, and more immersive—the demands on sensing technology also evolve. Developers and OEMs must deliver high performance and low latency across a growing variety of screen sizes, form factors, and use cases, all while managing power efficiency and system cost.

Synaptics' MFRPS architecture is engineered to effectively meet these challenges. By combining innovations such as parallel multi-frequency scanning, continuous-time digital sensing, and single-burst low-power modes, MFRPS achieves superior noise immunity, faster frame rates, and exceptional signal fidelity. These performance gains translate directly into meaningful benefits for device makers—enabling differentiated products, reducing system complexity and cost, and scaling effortlessly across display technologies.

MFRPS represents more than a technical advance. It is a foundational platform for the next generation of touch-enabled experiences, offering OEMs and developers the tools they need to deliver more intuitive and engaging end-user experiences.

As the market evolves, Synaptics stands ready—with a proven architecture, a growing family of compatible chips, and a commitment to innovation that empowers our partners to push the boundaries of what's possible in human-machine interaction.

About Synaptics

Synaptics is leading the charge in AI at the Edge, bringing AI closer to end users and transforming how we engage with intelligent connected devices, whether at home, at work, or on the move. As the go-to partner for the world's most forward-thinking product innovators, Synaptics powers the future with its cutting-edge Synaptics Astra™ AI-Native embedded compute, Veros™ wireless connectivity, and multimodal sensing solutions. We're making the digital experience smarter, faster, more intuitive, secure, and seamless. From touch, display, and biometrics to AI-driven wireless connectivity, video, vision, audio, speech, and security processing, Synaptics is the force behind the next generation of technology enhancing how we live, work, and play.



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