ADVANTAGES OF HAPTIC TRACKPADS

How Haptics Will Improve Next-Gen Computers

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HAPTIC TRACKPAD

Trackpads are often an overlooked component when selecting a new computer. Very few customers base their next computer purchase decision solely on the trackpad quality, but some are starting to notice better implementation of those important piece of hardware. Apple gets a lot of praise for their larger trackpads in tech reviews, Microsoft really improved PC user experience with their precision touchpad driver update in 2017 and Lenovo explored a new trackpad form factor with their Yoga 9i laptop. Trackpads are a very important part of a laptop computer user experience and OEMs are investing more resources to improve them.

While trackpads look like simple pieces of technology, they can pack some serious technology, since they can use different types of design and hardware to help you interact with your computer. You can find static touchpads, that doesn't move. It is also common to see mechanical trackpads, which consist of moving parts and buttons. The newest trend to get traction within the industry is using haptic trackpads to let you interact

with your laptop computer. The technology OEMs choose mainly depend on various internal goals, like designing slimmer Ultrabooks, reaching a price target, improving the user experience, etc. Let's see the biggest reasons that motivate computer OEMs to switch over to haptic trackpads, just like Apple did in 2015 when they launched their 12-inch MacBook with the first Force Touch trackpad.

Haptic Trackpads Are Thinner

The biggest motivation computer OEMs have to move from more common mechanical trackpads to one that uses haptics is to slim down the whole module size. Mechanical trackpads thickness normally goes up to 4 mm. Haptic trackpads can go from 3 mm to as low as 1.8 mm depending on which haptic technology the OEM is using. While saving 1 mm does not seem like a huge deal, it does in Ultrabooks that are less than 15 mm thick. It's also important to take a look at what is happening below the trackpad to understand the value of a slim module.

There is another very important piezo of hardware that sits just below the trackpad in a laptop design, the battery. Since batteries and trackpads fight for the same real estate, this means that a slimmer trackpad allows more space for a bigger battery. This can have a significant impact on the overall computer battery life if the OEM wants to design a larger trackpad. A large and thick trackpad will steal precious space that would have been otherwise used by the battery.

Haptic Trackpads Enables a Better User Experience

Mechanical trackpads use a hinge design to move. The hinge is normally attached somewhere in the upper third of the trackpad so it can rotate around and click. This means that the trackpads have “dead zones” where it cannot click (normally at the top). It also means that you need space to let the trackpad move freely and that the click feeling might not be constant across the whole surface. This provides a subpar user experience and waste space since you can’t use the whole trackpad surface to interact with the computer. It’s not surprising computer OEMs are looking for better ways to build compelling trackpads!

This is another advantage for haptic trackpads. They provide a consistent click feel on the whole trackpad surface. The user will never be in a “dead zone”. Plus, having a computer-generated click also means that designers can leverage the technology to customize the user experience. Depending on context, the click effect could be different. Take for example how Apple uses the Taptic Engine in the iPhone to communicate different types of notifications to the user (Success, Warning and Error). Designers can use the same approach with a haptic trackpad to share information within the computer and the user with the sense of touch.

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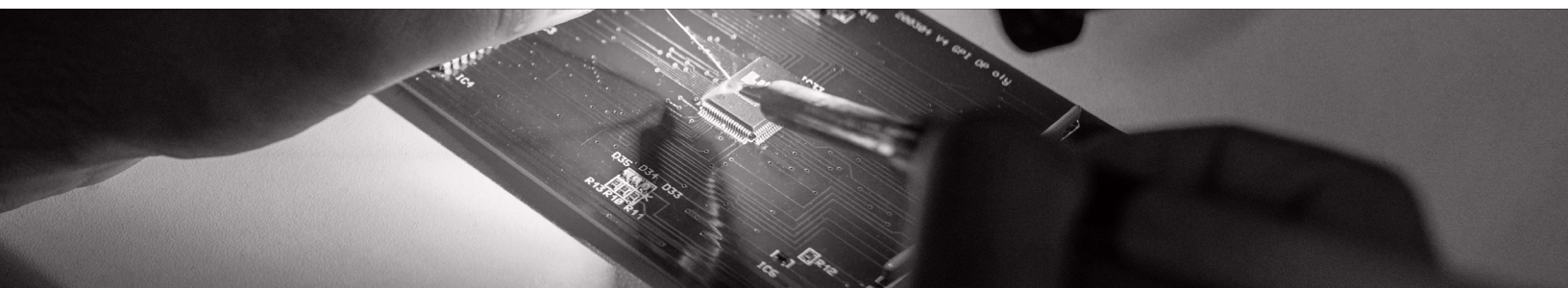
Haptic Trackpad Modules Can Include Force Sensors

A great feature that haptic trackpad can bring to laptop computers is the ability to sense the level of force applied to the surface. Since the trackpad does not move (at least very little), you can mount the trackpad on force sensors and detect how much force the user is applying on the device. This allows you to trigger different types of events with different force levels input.

For example, Apple's Force Touch trackpad uses force sensing to trigger a submenu in Mac OS. Designers can leverage this technology to add features to their apps.

Plus, if you select piezo actuators to build your trackpad module, you can leverage the piezoelectric effect to use the actuator both for haptic and force sensing.



Different Haptic Technologies Are Available, but You Need to Choose Carefully

There are different technologies available to build haptic trackpads. Computer OEMs can then select the technology that better fits what they are trying to achieve. The two main options are Linear Resonant Actuators (LRA) and piezo actuators.

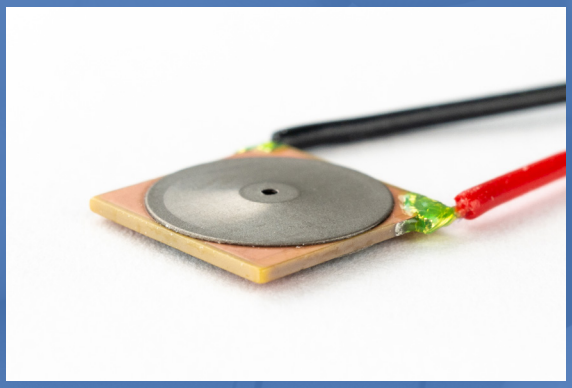
LRAs can be used to create haptic feedback on trackpads. While they use a custom LRA design for their needs, this is the technology Apple is currently using in their MacBook's Force Touch trackpads. It's also the same technology (same principles) as the vibration motors used in high-end smartphones.

While this option is the cheapest for haptic trackpads, it also has a couple of downsides. First, LRA based trackpads are not as thin as trackpads using piezo haptics. Second, LRAs cannot fully replicate the exact click feel of mechanical trackpads. They can get close, but they are not as convincing and immersive has piezo haptics. Finally, LRA consumes more power than piezo haptic enabled trackpads.

Piezoelectric actuators are the next generation of haptic motors available for trackpads. They offer many advantages over LRAs. First, they enable thinner trackpad designs. Second, they have faster and stronger haptic feedback than LRAs, resulting in sharper clicks. A piezo haptic click is invisible to the user, meaning the effect is so good, the user won't notice the difference with a real mechanical click. Being invisible to the user when clicking is probably the biggest compliment you can make to a haptic trackpad. Users notice haptics when they are bad, because it feels "off" and weird.

Finally, coupled with Boréas Technologies' drivers and our proprietary CapDriveTM technology, piezo actuators consume up to 10 times less power than LRAs.

PIEZO VS LRA HAPTIC COMPUTER TRACKPADS



VS

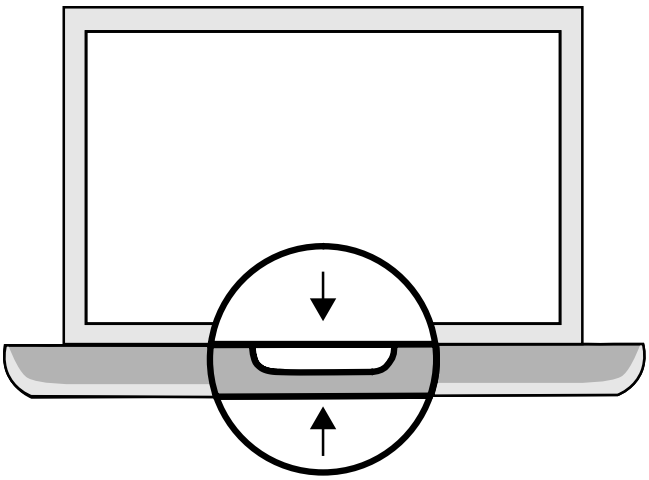
Which technology should you select?

Haptic computer trackpads have many advantages over traditional designs. Please read this article if you'd like to learn more about why the future of trackpad is haptic. You'll learn why computer OEMs are starting to replace mechanical trackpads with haptic hardware and their benefits.

In this article, we'll cover how to select the best haptic solution for your design. There are two main technologies available to build haptic trackpad modules: Linear Resonant Actuators (LRA) and piezoelectric actuators. While they can both create haptic effects, they use very different actuating mechanisms that have significant impacts on how to integrate them and the level of performance they can offer.

Let's see which technology you should use and why.

Piezo Haptic Trackpad Modules Are Thinner

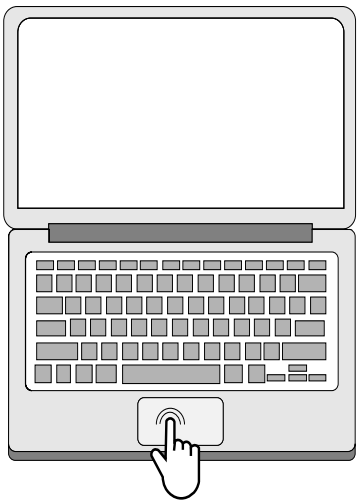


The biggest motivation for computer OEMs to pursue haptic trackpads is their thinness. Mechanical trackpads normally measure more than 3 mm thick. Haptic trackpads can measure below 3 mm. However, the technology you'll use in your design will have a direct impact on how thin you can go.

LRA module designs are normally around 3 mm thick. The thickest part of the module is the LRA itself. While you may find and use thinner LRA, you will do it at the expense of a huge trade-off in haptic feedback quality. Bad haptic feedback will result in weak and unrefined (soft) clicks. Poor quality haptics will irritate and annoy the user. The trackpad will feel off and weird. Obviously, this isn't the end goal, so you should be very careful when selecting your actuator. To have acceptable haptics, you will need to use a bigger LRA. An easy rule of thumb to help you: an LRA below 3 mm thick will not have an acceptable performance output for a computer trackpad module.

On the other hand, piezo actuators have different form factors. You can use different types of piezo actuators to build your trackpad module. Piezo actuators can be much thinner than LRAs. Building your trackpad module with piezo actuators offers the flexibility to go as thin as 1.8 mm!

Piezo Actuators Haptic Feedback Quality is Better



Another major difference between LRA and piezo haptics trackpad is the quality of haptic effects (clicks) they can generate. This is due to two main reasons; the vibration axis and the actuator rise time.
The only way to integrate an LRA to a trackpad module, and keeping the module thin, is with the actuator lying flat horizontally. This makes the actuator vibrates laterally, in the X or Y axis. This means your trackpad either moves left and right (X-axis) or back and forth from the user (Y-axis). While the movement is very fast, it doesn't create the most satisfying button click effects. This is because we are used to feeling buttons moving against our fingers, in the Z-Axis (vertically).

Piezo actuators that lay flat on a surface create haptic feedback in the Z-Axis. This means the trackpad module will force against your finger, just like a normal button. It simply feels more natural for the user.

LRA and piezo actuators uses very different properties to transform energy into movement and vibrations. LRA uses magnetism to move a mass back and forth at his resonant frequency. On the other hand, piezo actuators use the piezoelectric effect to create movement. Piezo actuators deform almost instantaneously under high-tension (voltage) electric current. This means the rise time – the time required for a pulse to rise from 10% to 90% of full amplitude - of piezo actuators is significantly faster than what LRA can achieve. This translates in a much sharper click effects. Since the LRA takes a little more time to reach its full amplitude, the haptic effect has unwanted noise at the beginning and the end of click effect. The unwanted noise is responsible for the click "softness" or lack of sharpness.

CapDriveTM Driven Piezo Actuators Consume Much Less Power Than LRA

A great feature of piezo actuators is their great power efficiency, but you need to very careful here. While the actuator itself is very efficient, it requires high-voltage current to generate significant haptic feedback. The piezo driver you will select to operate the actuator will have a significant impact on the module's power consumption.

Boréas Technologies piezo drivers are built from the ground-up for battery-powered mobile applications. Power efficiency is our man goal when we design our piezo drivers integrated circuits. Therefore, CapDriveTM piezo drivers use a state-of-the-art architecture that uses the capacitive nature of piezo actuators to recover and reuse the energy. This allows piezo haptic solutions, powered by CapDriveTM drivers, to consume much less power. Your solution could consume up to 10 times less power than the same piezo actuator, used with a competing piezo driver. The same applies for LRA-based solutions.

Piezo Actuators Can Both Sense Force and Create Haptic Feedback

The piezoelectric effect is a very interesting phenomenon that allows piezo elements to generate an electric charge when they are stressed. Which means you can measure the electric potential of the actuator to determine how much for is applied on it. This is the reason why force sensors often use piezo materials. The piezoelectric effect is also a reversible process, which means the actuator will deform itself when an electric charge is applied to it. This is how we generate haptic feedback with piezo actuators.

Piezo haptic trackpad modules can leverage both sides of the piezoelectric effect to create thin and efficient design, using the actuator to both generate high quality haptics and sense input force. Plus, when using one of our CapDriveTM piezo drivers, you don't even need additional electronics! Our piezo haptic drivers come with integrated force sensing out of the box, without additional hardware. Built-in sensing is an exclusive feature from our CapDriveTM architecture.

Our trackpad demo leverages the piezoelectric effect using only one piezo actuator to both sense and generate haptics across the whole trackpad surface.

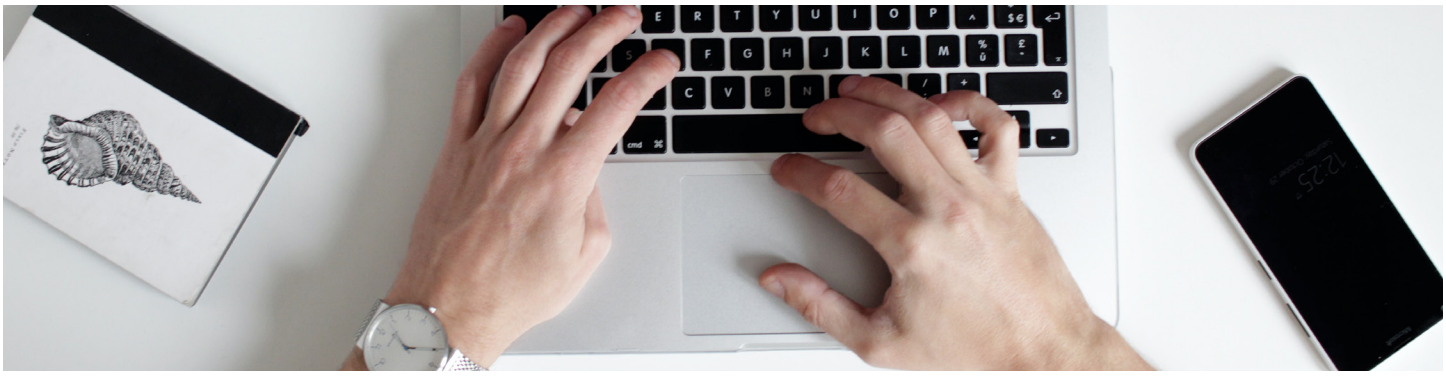
Be Careful: Your Mechanical Integration Has a Significant Impact

One very important thing that you need to consider when building a haptic trackpad is the mechanical integration of the actuator, and this stands for whichever technology you select. Integrating an LRA is very different than integrating a piezo actuator. Therefore, you should carefully select your actuator at the beginning of your project. Otherwise, you will have a hard time to switch your actuator in the middle of your project. It's important to design from the ground up for the appropriate actuator.

The reason we recommend taking a good hard look at your module design is simple; a bad mechanical integration can significantly impact the performance of your actuator. For example, a bad mechanical design with too much friction or rigidity can make you believe your actuator isn't strong enough. Avoiding simple mistake is important when you evaluate haptic technologies; otherwise you can select the wrong solution or lose considerable development time. Our team can help you kick-start your project by sharing best practices on how to evaluate our technology and create a convincing demonstration. Let us know how we can help!

Starting Your Piezo Haptic Trackpad Project

We firmly believe piezo haptic hardware builds the best trackpad modules. We obviously look biased since we design highly efficient piezo haptic drivers, but we are confident in our claims. Therefore, we built the BOS1901-Kit to help you and your team evaluate our technology and validate our claims.



The BOS1901-Kit is a low-cost evaluation kit that helps you rapidly test the haptic feedback quality and integrated force sensing features, measure the system power consumption, and accelerate your project development. The BOS1901-Kit is available worldwide on our website or at multiple distributors.

Haptic technologies are hard to compare without feeling and experiencing them for real, so the best decision you can make today to kickstart your haptic trackpad project is to order one of our BOS1901-Kit. We'll setup you up in no time with our onboarding program, specifically curated for building piezo haptic trackpads.

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