

Buckle Up, 5G is Almost Here!

By Nick Stephen
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What comes to your mind when you hear “5G?” Well, before I got myself into the electronics industry, I would’ve guessed 5 grams. In fact, when I asked a few of my friends who are not in the industry, each replied with equally bad guesses, like 5 grand, 5 gigahertz, and more. The term “5G” actually stands for 5th generation! Before we dive into 5G, it would be beneficial to talk about what came before.

Cellular mobile communications began in the 1980s. When the technology emerged, the first-generation network carried voice only. In the 1990s, we started text messaging between devices; this was called 2nd generation. In early 2000s, 3G technology was born. With 3G came the ability to make calls, send texts, and surf the web from a “smart” wireless device. We currently have 4G, which includes all the functions of 3G, plus the ability to easily download or upload video and audio files.

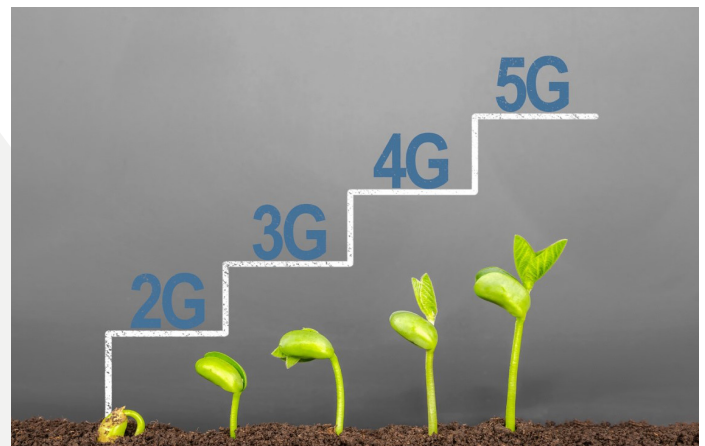
It’s obvious that the mobile and wireless technologies have come a long way, but what’s coming up next? What can we expect from 5G? How much of an impact will 5G have on the future? How does KEMET play a role in 5G? If you’re asking yourself all these questions, then you are in luck! I have all those answers, so keep on reading.

I’M GRATEFUL FOR 4G... BUT...

A couple of weeks ago, I was catching a last-minute flight and I wanted to download a movie to watch. Of course, I had procrastinated and waited until I was on the plane to start my download. Unsurprisingly, the download didn’t finish before takeoff, so I

was stuck staring out the window and contemplating life for two hours. I wouldn’t say it was a complete waste of two hours though. I had plenty of time to think about why my movie was taking so long to download.

The download speed of 4G networks range from 10-100mbps, and the frequencies below 6GHz and the 4G towers are non-directional. This means that the 4G towers are firing data in all directions. As you can imagine, this is a wasting a lot of power and energy by beaming radio waves to locations that are not requesting internet access. With all these factors combined, it’s safe to say I would need at least 10-20 minutes to download my full length, high definition movie.



OUT WITH THE OLD... IN WITH THE NEW

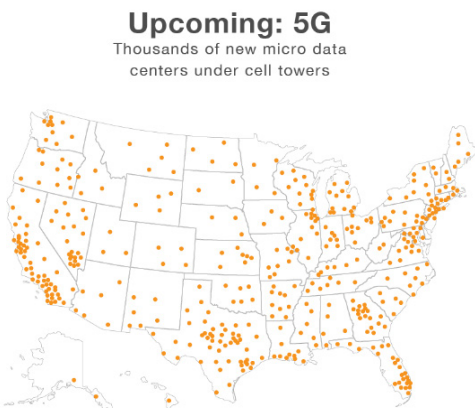
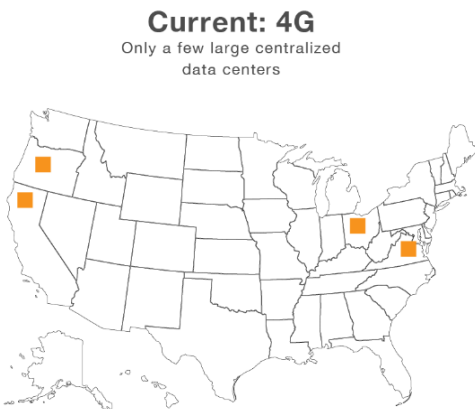
Can you imagine clicking the download button and seeing your movie become ready to view within seconds? Probably not. That’s because it’s not possible with the 4G networks we have. On 5G, the time it takes for two devices to communicate with one another is expected to be 50 times faster than on 4G. Download time for a high definition, full length movie will be seconds, not minutes.

I know it sounds too good to be true, but this is possible because 5G is expected to support up to 1 million connected devices per 0.38 square miles. This is compared to around 2,000 connected devices per 0.38 square miles with 4G. The 5G networks will



more easily understand the type of data being requested, so they will be able to switch into a lower power mode when not in use or when supplying low rates to specific devices. Then, they will switch to a higher-powered mode for things like HD video streaming.

The standards of 5G rely on high frequency band usage. This enables more concentrated, faster data relaying, but has certain limitations and penetration challenges that will affect “early 5G” deployment. These high frequencies are easily absorbed by humidity, rain, and other objects, meaning that they don’t travel as far. Initially, 5G coverage will be limited to outdoor, pedestrian-centric areas where frequencies can easily reach users. There will be an increased number of new towers in a variety of locations such as rooftops, small cell backhaul locations, and light poles.



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WHAT WILL IT TAKE?

In order to make 5G possible, many more towers and data centers will be built to support the higher frequencies, faster speeds, and lower latency. New technologies such as small cells, beam-forming, and full duplex to name a few, will be implemented.

Small cells are basically miniature cell phone towers that can be placed in inconspicuous places like light poles and the roofs of buildings. Small cells transmit data using millimeter waves, which get their name from their narrower than average wavelength. They occupy frequencies in the 30-300GHz range, which high enough to avoid interference from surrounding signals, but too high to pass through physical barriers.

I’M READY FOR A CHANGE. ARE YOU?

When we transitioned from 3G to 4G, it wasn’t much of a difference. Everything was pretty much the same. We still experience lags when video calling or streaming, and text messages still take some time to go through. The transition from 4G to 5G will be very significant. You will see plenty of changes in your everyday life.

<p>Movies and Video Calling</p>	<p>Sensors</p>
<p>Gaming</p>	<p>Vehicles</p>

Downloading videos and movies will be faster than before. Video calling will be clear and smooth, without the pauses currently experienced. More sensors will be implemented in cities to monitor and regulate traffic, trash collection, pollution, parking, noise, water pressure, and electricity.

The gaming industry will experience an interesting change! The industry will move away from consoles, to a cloud-based subscription service, offering more flexibility for the users. This is because they will be able to stream the game to any device, anywhere. Use of virtual reality for gaming is already significant. According to CNBC, [Disney](#) has partnered with [Lenovo](#) to create an augmented reality (AR) "Star Wars" game, which users play via their phone, a headset, and a lightsaber.



LET'S TALK AUTOMOTIVE

We can see the use of 4G in cars today with GPS, in-car WiFi, and connectivity to multiple devices. Some of the newer models even provide a traffic light service using the 4G LTE. When the vehicle approaches a connected traffic light, the driver sees a display of how many seconds until the light changes green. I'm not sure if this good or bad. I have many friends that are aggressive drivers and have no patience when the light turns green. Imagine if those aggressive drivers get to know how long until the light turns green!

When 3G and 4G networks were developed, the developers only had consumer voice and data in mind. Machine-to-machine communications are only recently becoming prominent. Therefore, 5G is being developed with machine-to-machine interface in mind, so there will be more connected devices and vehicles.

HOW WILL 5G IMPACT KEMET?

There will be a huge demand for parts in the automotive sector as vehicles become more automated. This means we would need more radio frequency (RF) and high frequency components, as well as sensors and magnetics for noise reduction. We also need to think of ways to load more power and memory capabilities into a smaller package. Higher capacitance, voltage (CV) parts, lower ESR/ESL, lower loss magnetics, high temperature components will all play a significant role within KEMET.



There are many KEMET products that will contribute to the advancement of 5G technologies. I talked about the usage of high frequency bands. This enables more concentrated, faster data relaying.

HIGH FREQUENCY PARTS?

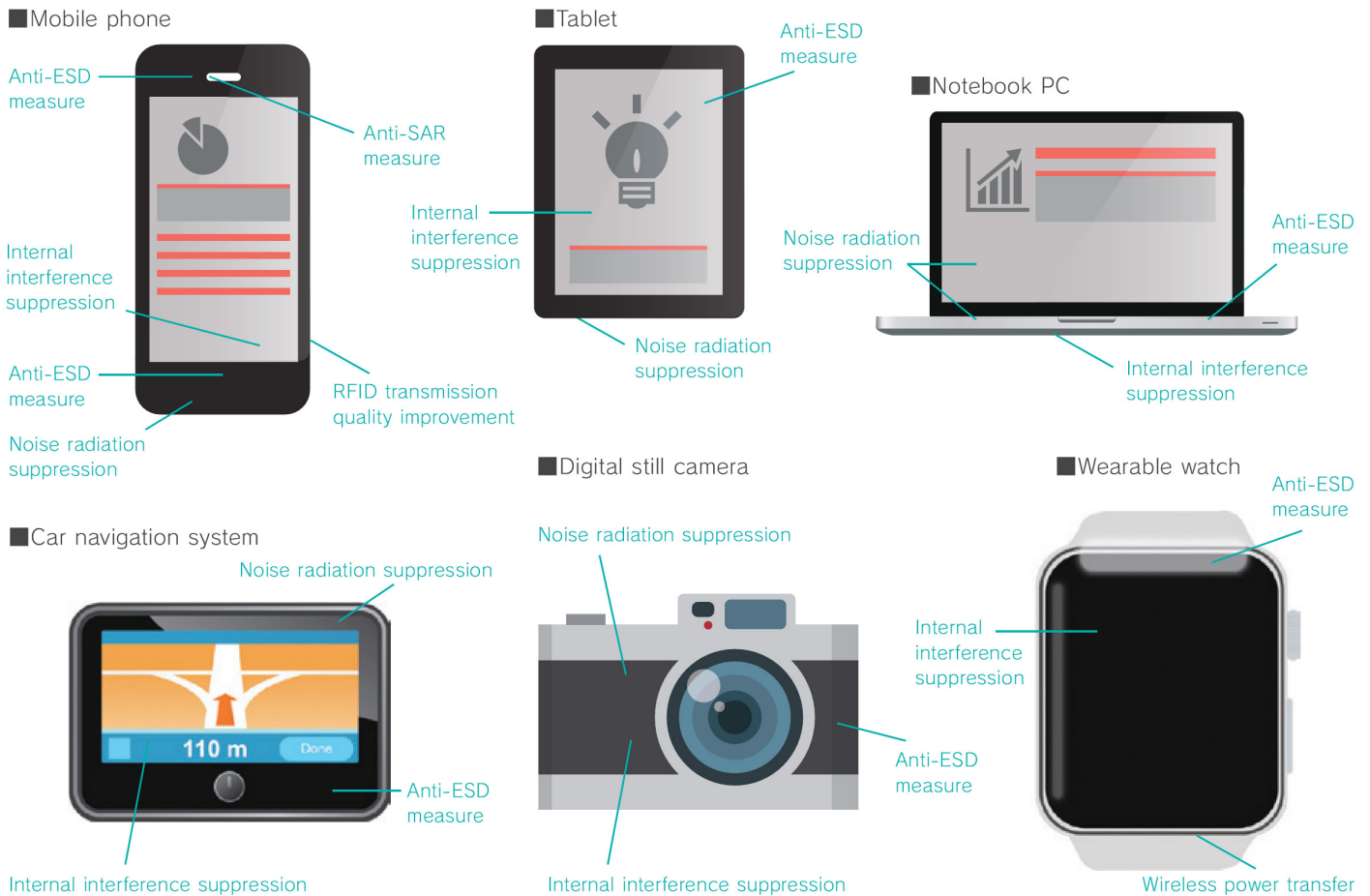
KEMET's [HiQ-CBR series](#) ceramics are a perfect fit for higher frequencies. Our CBR series MLCCs have a C0G dielectric, which is an ultra-stable dielectric. The materials are chosen, and the design is optimized, so the capacitors characteristics are well suited to the higher frequencies. These capacitors have a frequency range up to 50 GHz and are designed to have the lowest possible ESR. This allows for minimal power loss at RF frequencies. CBR Series devices are suitable for many circuit applications including RF power amplifiers, mixers, oscillators, low noise amplifiers, filter networks, antenna tuning, timing circuits, delay lines, and MRI imaging coils.



SUPPRESS YOUR NOISE!

KEMET also offers a very unique product called the [Flex Suppressor®](#). They are available in the GHz band, which makes them suitable for 5G applications. The Flex Suppressor is a polymer-based flexible sheet, blended with micron-sized magnetic powders dispersed throughout the material.

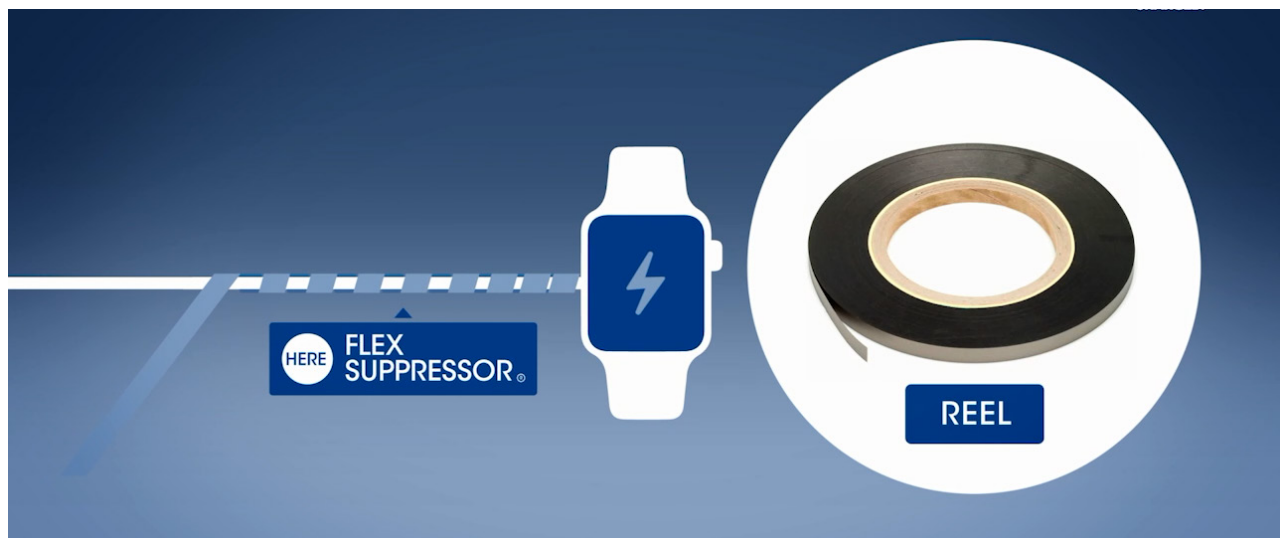
There is virtually no limitation on where it can be used. You can easily cut them into different shapes, so they can be used in portable equipment. The picture below will give you an idea of different application areas for KEMET's Flex Suppressor.



They are used for EMI suppression of radiated noise from CPU/ GPU, signal line, cable, and more. The flex suppressor can be used to improve de-sense. De-sense is the degradation in sensitivity due to noise sources. The wireless charging application is also a common use for our Flex Suppressor. Conversion efficiency is improved by using the Flex Suppressor. A lot of people have smart watches these days. Usually you will see a big bulky core around the charger cables, but the newer cables use a strip of Flex Suppressor, and it serves the same purpose but more efficiently.

HANG TIGHT, 5G IS ALMOST HERE!

The CBR series ceramics and flex suppressors are not the only products suitable for 5G applications. We have many other products that can be used in a wide variety of applications. We have tantalum polymers which will heavily contribute to autonomous driving and the electrification of vehicles. We have a line of sensor and actuator products which will be used for industrial and home automation.



Some companies launched 5G services in 2018, but it is not very significant yet—although, they have bragging rights! Most of the big changes will only happen years after the initial announcement. The first 4G cell phones were introduced in 2010, but revolutionary applications such as Airbnb, Uber, and Snapchat all came years after the announcement. 5G is an investment for the future. You can expect to see big things from 5G in the coming years. For now, take a seat, buckle up, and get ready, because 5G is almost here.

“By 2035, 5G will enable \$12.3 trillion of global economic output and support 22 million jobs worldwide. Much of that growth will come from the digitization of transportation, agriculture, manufacturing and other physical industries.”

– Ronan Dunne, Executive Vice President and Group President, Verizon Wireless

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For more information on our Hi-Q CBR series and Flex Suppressors, or to browse our library of products, be sure to visit [Component Edge](#).

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