Application Note

"Virtual Antenna"

Surface-Mount Chip Antenna and "Virtual Antenna" – The Facts

Some buzz arose in the market about antenna solutions sometimes referred to as "virtual antenna".[1] Proponents of "virtual antenna" cite a number of benefits for it, but essentially none of them hold up to serious scrutiny. This paper provides an overview of those claimed benefits and refutation of each, as compared to other surface-mount antenna technologies: printed circuit board (PCB) and ceramic chip. These technology approaches provide the same general benefits as "virtual antenna" and may require fewer tuning/matching components than "virtual antenna" solutions.

"Virtual antenna," PCB antennas and ceramic chip antennas have essentially the same total solution area and design process.

To provide the simple answer up front, most of the individual claims of "virtual antenna" are the same claims for all surface-mount chip-style antennas in an RF design: "virtual antenna", PCB antennas and ceramic chip antennas all use a ground plane and matching/tuning circuit to optimize performance in an RF solution, and all have essentially the same total area and design process. An example is provided following discussion of the itemized claims of "virtual antenna."

"Virtual Antenna" Claims

Many of the general claims of the proponents of "virtual antenna" products are factual, yet essentially all of them apply equally to other surface-mount (SMT) antenna solutions commonly available in the market. "Virtual antenna" and SMT antennas are like two children competing in a race that results in a tie with one child's parent exclaiming, "My child is the winner!" It is true apart from the omission that the same also applies for the other child.

Single SKU – Using a single antenna SKU (stock keeping unit – aka part number) for multiple protocols has limited procurement value at customers for whom a particular part performs effectively in multiple designs. The only possible benefits are line-item overhead and volume pricing in purchasing one SKU. This also comes at the expense of leveraging best-in-class product selection for each solution.

Design Reuse – Billed as "scalability," "versatility," and "modularity," design reuse is an extension of the single SKU claim. These claims mostly amount to "one product can be used in multiple designs." This is at best a procurement benefit, and only when the multiple designs require vastly different frequency ranges. If a common frequency range is used for a product, then most antennas will offer such design reuse. For example, if three designs need a WiFi antenna, then one SKU of any vendor's antenna will suffice.

No Customization Required – Any surface-mount antenna (and essentially any antenna solution) requires a matching network to tailor the antenna to the end product. "Virtual antenna" requires tuning just to find the right frequencies to test a design, and a ground plane is also required which may dictate design customizations. As for claims of being "off-the-shelf," essentially all SMT antennas are available off the shelf from the manufacturer and through major distribution channels like Digi-Key and Mouser. Antenna vendors not supplying through multiple channels have dubious claims to being "off-the-shelf."

Wide Frequency Range Capability – The only frequency range (bandwidth) needed for a design is what is needed for a design! "Extra" bandwidth is wasted and may allow unwanted signals to pass into the system. Tuning is required for "virtual antenna" just to gain basic functionality for a design and "virtual antenna" tuning does not allow random frequency band selection – there are constraints and limitations.

Additionally, sub-1 GHz performance tends to be weak in existing "virtual antenna" solutions. The

1. "Virtual antenna" has variably been claimed as an unregistered trademark (tm) by Ignion and ABI Research.[4] Linx Technologies makes no claim on a "virtual antenna" trademark but uses the term descriptively as opposed to describing an explicit real antenna.

result is that "virtual antenna" may suffer from "Jack of all trades, master of none" performance issues begging the questions, "What does a Jack-of-all-trades do best?" and "Which Jack-of-all-trades is better than another?"

A "Jack of all trades" provides wide-ranging mediocrity. An expert provides superior specific outcomes.

Software Driven – Antenna simulation software is widely available in the market and is used by all antenna providers to support customers in optimizing antenna matching and frequency tuning in their designs. The use of software in "virtual antenna" design may be highlighted because of the tuning that is *required* to select frequency bands as opposed to the inherent frequency band support of real antennas.

Small Size – Antenna size imparts limitations on any antenna, including "virtual antenna." Small size is exactly why "virtual antenna" proponents dance around "low frequency" (e.g. sub-1 GHz) performance. Even more importantly, "virtual antenna" solution area (including tuning network and ground plane) is often larger than competing solutions in which the antenna element is larger.

Multi-Feedline – Multi-feedline antennas (e.g. 2.4 GHz Bluetooth® & 915 MHz LPWA in one package) are possible with all surface-mount and other antenna types and have nothing to do with what supposedly makes "virtual antenna" special.

Total Cost of Development – There is nothing about "virtual antennas" that inherently lowers total cost of development. Product acquisition, matching/tuning effort (and number of components) and testing are all situational.

Manufacturability – "Virtual antenna" claims of replicability, consistency of quality, and speed of manufacturing apply equally well to all PCB chip antennas as well as many ceramic chip antennas. The same is true of the claim of being manufacturable using pick and place equipment and reflow soldering. Most SMT antennas are available in tape and reel packaging.

Case Study – Dual-Band WiFi

As an example of the weakness in the claims of "virtual antenna" versus real SMT antennas, use of the Ignion RUN mXTEND™[2] "virtual antenna" is compared to the Linx Technologies nanoSplatch® ANT-DB1-nSP250[3] PCB chip antenna for dual-band WiFi (2.4 GHz, 5 GHz).

Table 1 summarizes the parameters of the solutions. To view the VSWR and gain performance of these solutions please see the resources cited in this paper.

What immediately becomes clear is that, despite the smaller area of the "virtual antenna" "booster" element – which is still longer and taller than the Linx antenna, **the required ground plane area and total solution area are smaller for the Linx ANT-DB1-nSP250. As defined by the manufacturers, the "virtual antenna" total solution area is more than 3.6 times larger than the Linx solution**. With the total solution area being the limiting factor for the design, the small size of the "virtual antenna" booster may become a detriment to the design since it may force the use of more tuning components or limit potential performance because a less constrained antenna element will, in general, provide better performance in a given situation.

Also very clear is that the "virtual antenna" requires four tuning components just to function as a dual-band WiFi antenna, whereas the Linx ANT-DB1-nSP250 will support dual-band WiFi "out of the box." The single component that is visible on the Linx evaluation board is a zero-Ohm resistor used to directly pass the antenna signal while also allowing customers to add a tuning/matching network for evaluation purposes. Furthermore, the four-component dual-band WiFi tuning network of the "virtual antenna" must be found in a special application note rather than in the basic product datasheet. Otherwise, the manufacturer must be contacted to determine how to use the "virtual antenna."

2. Ignion. RUN mXTEND™ – Wi-Fi Dual Band. Retrieved May 27, 2021, from https://ignion.io/files/AN_NN02-224_WifiDualBand.pdf
3. Linx Technologies. nanoSplatch™ ANT-DB1-nSP250. Retrieved May 27, 2021, from https://linxtechnologies.com/wp/wp-content/uploads/ANT-DB1-nSP250-ds.pdf

Table 1. Solution Parameter Summary

	"Virtual Antenna"	Linx ANT-DB1-nSP250
Antenna Element		
Antenna Size	12 mm x 3 mm x 2.4 mm (36 sq mm)	9.6 mm x 8.4 mm x 1.1 mm (80.6 sq mm)
Tuning Components Required for Basic Use	4	0
Suggested Ground Plane	79.5 mm x 54 mm (4293 sq mm)	41 mm x 21 mm (828 sq mm)
Total Solution Area	86 mm x 54 mm (4644 sq mm)	40.6 mm x 31.6 mm (1283 sq mm)
Evaluation Board		

ABI Research's "Virtual Antenna" Whitepaper

It is worth noting that market research firm, ABI Research, released a whitepaper, "Rethinking IoT Device Development with Virtual Antenna Technology," in May of 2021. This paper was sponsored by Ignion.[4] While the general front-end material of the paper is reasonably unbiased, the "virtual antenna" treatement should be judged with a critical eye due to the compensated nature of the publication. The promotion of Ignion "virtual antenna" and lack of critical analysis is apparent. There is no data supporting "virtual antenna" claims, no direct comparison of a "virtual antenna" product with other SMT antennas, and no technical explanation of the "magic" that purportedly makes "virtual antenna" technically superior to other SMT antennas.

Conclusion

With a bit of research beyond the headlines and hashtags it becomes apparent that "virtual antenna" is more of a marketing term than a technology. There may be some peculiarities in the construction of some "virtual antenna" products, but they perform the same function as a real antenna in a solution comprising antenna/"booster," tuning/matching circuit, and ground plane.

Also, essentially all of the claims of benefit of "virtual antenna" accrue to PCB and ceramic chip surface-mount antennas. In fact, the example shown in this paper demonstrates that the PCB chip antenna can offer smaller total solution area and component count.

The one relevant claim of benefit for "virtual antenna" is the potential procurement benefit of purchasing only one product SKU for use in multiple, disparate, applications, targeting limited frequency band groups. In that corner case, "virtual antenna's" "Jack-of-all-trades" positioning may present value. With that, however, one must balance the ability of optimized real antennas to perform to each specific need. A "Jack of all trades" provides wide-ranging mediocrity. An expert provides superior specific outcomes.

4. ABI Research. Rethinking IoT Device Development with Virtual Antenna Technology. (D. Shey, Ed., & T. Taylor, Compiler) Oyster Bay, NY: ABI Research. Retrieved May 19, 2021

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