
PTX105R NFC Reader IC for IoT Applications

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Abstract

In this time of smart homes, cities, and industries, NFC technology is broadly accepted as an enabler of convenience and simplicity by providing a secure, low-power data exchange between devices. Consumers have enthusiastically adopted the technology for applications such as access control, home automation, authentication, and contactless payment because of its convenience.

In this White Paper, we will outline the challenges in implementing NFC in IoT applications, highlight the limitation of the conventional architecture of NFC readers. We will also introduce the core features of Renesas' PTX105R NFC Reader IC and explain its use in different IoT applications across industries.

Challenges in NFC-enabled IoT Applications

The use of NFC technology in IoT applications offers many benefits, including simplicity, security, and energy efficiency. However, it also comes with some challenges that need to be addressed:

Interoperability: For IoT applications, NFC antennas come in various sizes and designs, each optimized for specific use cases. Antenna variations in geometries, dimensions, and characteristics impact the effective communication range and signal shape, making it challenging for NFC-enabled devices to consistently communicate with one another.

Integration complexity: Integrating NFC functionality into IoT devices requires adding special software and hardware components into the existing system. Adding an NFC IC, antenna, and sometimes additional peripherals physically on the device's PCB demands careful design, layout, and considerations for signal interference. Integration of firmware and software also needs to be done carefully to provide an intuitive and reliable end user experience.

Power Requirement: Since many of the IoT devices are battery powered, having a power efficient solution not only for the NFC component but also for the complete system becomes extremely important.

Additionally, standard compatibility, cost, and time to market are all important aspects of IoT applications.

Limitations of conventional NFC controller architecture

As shown in Figure 1, conventional NFC Reader architecture typically employs a push-pull output stage which generates square-wave at the Transmitter output pins. While being rather easy to implement on the silicon, this kind of structure also has some fundamental limitations.

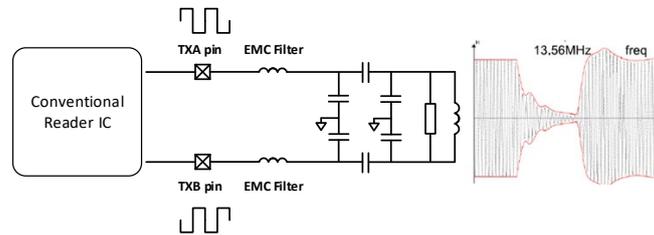


Figure 1: Conventional architecture of NFC controllers

EMC filter

Having a square-wave at the output of the transmitter requires the EMC filter to remove the additional frequency components before the signal can be applied to the antenna. One of the shortcomings of EMC filters is the additional resonant frequency introduced to the system. This additional resonant frequency makes the matching much more complicated and the system becomes much sensitive to detuning.

The inductors in the EMC filter are directly in the signal path, which introduces additional losses since they are not ideal. Variation introduced by the EMC filter components also needs to be considered in the system design.

Supply and Output power

Another issue of the conventional push-pull stage is current spikes on the supply. Since the output stage is basically switching between low and high (voltage level defined by the supply) and needs low impedance so that sufficient current can be provided to the antenna, the transition between these two states often creates spike currents in the 27.12MHz frequency range. Without careful handling, these spikes can be coupled into the system supply and disturb other electrical components.

Limited by the matching impedance (including EMC filter) and the transmitter output current, higher output power is achieved in conventional architecture by having higher a supply voltage of the output stage. This typically requires an additional power management unit such as a DC-DC booster, on chip or off chip, which makes the system more complicated and introduces additional losses.

Waveshape

Since the square wave output of the transmitter first needs to be filtered by the EMC filter and then applied to the antenna, conventional architectures have no direct control over the antenna signal shape. When different power levels or signal shapes are needed on the antenna, a push-pull stage only has two parameters to adjust: voltage level (defined by the power supply), or the pulse width. Either way the output power of the transmitter is adjusted, hoping to be 'translated' correctly by the EMC filter and achieve the desired waveshape on the antenna.

This lack of control on the antenna signal together with the extra vulnerability of detuning caused by dual resonating circuits composed by EMC filter and antenna, often leads to over-/undershoot and other signal shaping issues, resulting in poor interoperability and bad customer experiences.

All-new architecture features sine-wave output

Tailored to the specific needs of the IoT market, the PTX105R NFC Reader IC aims at providing effective solutions for these challenges by offering an all-new, patented architecture featuring a sine-wave output based on a Switch Capacitor Power Amplifier (SCPA) driver.

SCPA Architecture

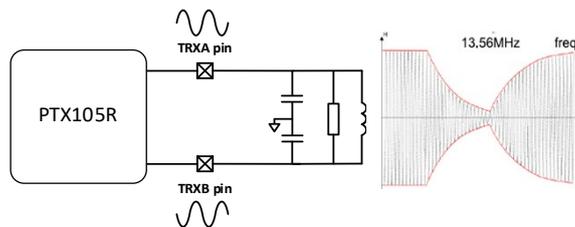


Figure 2: SCPA architecture implemented in PTX105R

As shown in Figure 2, PTX105R generates a sine-wave signal on the transmitter output which can be directly applied to the antenna (Direct Antenna Connection, DiRAC). By eliminating the EMC filter, the antenna matching becomes a lot simpler. Issues related to the inductors such as additional power loss or current limiting factor can also be avoided.

Significantly reducing the matching components does not only reduce BOM cost and PCB area, it also helps to achieve consistent RF performance with minimal variation since the variations introduced by these components are omitted.

Having direct sine-wave output also allows much finer wave shaping on the antenna signal, reducing overshoots and under-shoots. The same mechanism is also used for output power regulation, providing relatively stable power over the complete operating volume and avoiding saturation even when the counter device is very close to the reader antenna.

All these features lead to a much more stable RF performance and better interoperability across diverse antenna form factors.

Receiver Sensitivity

Different than the conventional receiver which typical includes voltage division, the sine-wave architecture provides a direct connection between the antenna and the PTX105R receiver input stage, allowing usage of the full signal dynamic range. With receiver sensitivity as high as -80dB, applications in noisy environment, such as below low-cost display, can be enabled.

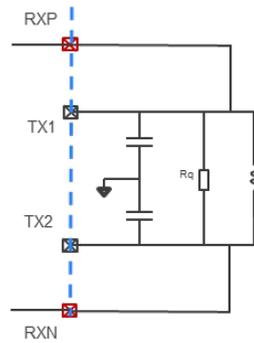


Figure 3: PTX105R DiRAC Antenna matching

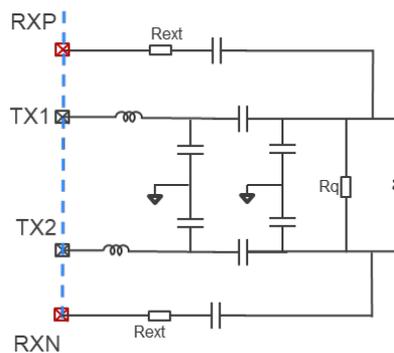


Figure 4: Conventional Antenna matching

Split-Stack Software

PTX105R offers a Split-Stack software solution where time-critical operations are running on the on-chip MCU. This on-chip handling of the low-level protocol tremendously reduces the package exchange on the Host Interface and frees up the resource of the Host Controller. In this way the usage of a cost-effective MCU becomes possible, which is especially attractive for IoT applications.

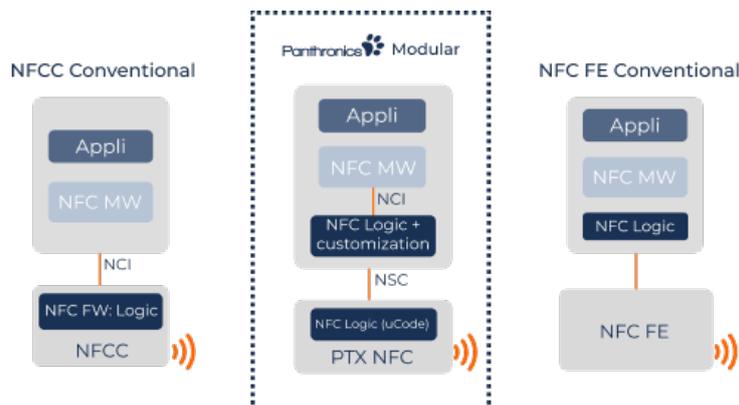


Figure 5: Split-Stack SW architecture vs conventional

Recap

As this article shows, conventional NFC controllers have found themselves trapped by a silicon architecture that makes it difficult to provide one solution seamlessly interacting with diverse counter devices.

By introducing an all-new sine-wave architecture in the PTX105R NFC Reader IC, Renesas is providing an innovative solution which offers higher RF performance and optimal interoperability, while enabling the usage of a smaller antenna in challenging operating environments. With its simplified antenna matching and easy software integration, PTX105R is the perfect fit for the fast expanding IoT market.

Reference Materials

Datasheet & App Notes:

<https://www.renesas.com/eu/en/products/wireless-connectivity/nfc/ptx105r-mid-power-multi-protocol-nfc-forum-compliant-reader>

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