

Sampler in a Full-Duplex System and Method of Sampling Received Signal

IITM Technology Available for Licensing

Problem Statement

- Wireless communication demands have driven the development of **full-duplex systems sharing the same RF spectrum** for transmission & reception.
- **Self-interference**, where the transmitter's signal disrupts the receiver's signal, **poses a significant issue**, especially in the same channel full-duplex scenarios.
- Current **self-interference cancellation method**, often based on electrical balance, **struggle** with a **trade-off** between transmitter and receiver signal quality, **particularly in high-power systems**.
- **Using magnetic components** for self-interference cancellation results in **larger chip sizes** and **limited bandwidth**, making them **less suitable for modern communication systems**.
- **Time-selective sampling** is a proposed solution to **recover a clean RF signal** in the presence of **strong interference**.
- However, **direct sampling** of the **RF signal** faces implementation challenges, including issues like **charge injection**, **clock interference**, and **signal bleed-through**.
- Designing a sampler for **narrowband carrier-modulated signals** is particularly **complex**, especially when it must have a tracking bandwidth greater than the carrier frequency.
- Hence there is a need of the present patent that discloses a **Method and Apparatus for Passive Mixing of Multiphase** to address critical challenges in full-duplex communication systems as mentioned above and improve their performance.

Technology Category/ Market

Categories: Information & Communication Technologies (ICT) | Internet of Things (IoT)

Industry: Telecommunications and Wireless Communication Industry, RF (Radio Frequency), Wireless Broadband, Consumer Electronics

Applications: Wireless Telecommunications & Broadband, Defense and Military Communications, Satellite Communication, Consumer Electronics, driven by the need to address self-interference and enhance the quality and performance of wireless communication systems across various sectors.

Market: RF transceiver Market size was **US\$ 11.41 Bn in 2022** and is expected to reach **US\$ 25.22 Bn by 2029**, at a **CAGR of 12%** during the forecast period from **2022 to 2029**.

Technology

This present patent disclosure involves a sampler in a full-duplex transceiver system and a method for sampling received signals. this invention introduces a sampler and a method for sampling received signals in a full-duplex system, addressing self-interference and improving signal quality for more efficient wireless communication.

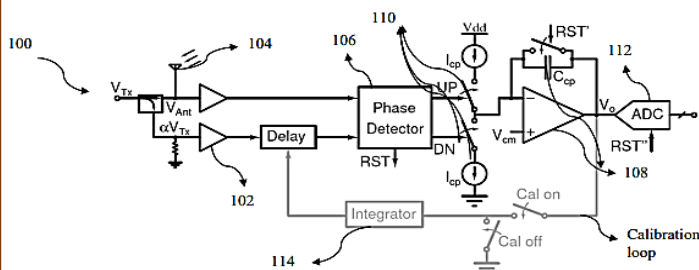
Invention Description:

1. The Sampler:

This is a component in a full-duplex transceiver system, includes the following key elements:

- **Buffer:** Captures amplitude information from both transmitter signal (Tx) and voltage at antenna port.
- **Phase Detector:** Measures the time delay between the buffered transmitter signal and the voltage at the antenna port.
- **Calibration Loop:** Controls the delay offset between the transmitter signal & antenna voltage.
- **Current Integrator:** Generates sampled output.
- **Charge Pump:** Manages current adjustments.
- **Analog to Digital Converter (ADC):** Digitizes the sampled output to create the final received signal.

FIG. 1 shows block diagram of a sampler at Tx zero-crossing



2. Sampling Process:

- The phase detector performs time-delay sampling at radio frequency using a conversion method.
- The conversion method might involve a voltage-to-delay conversion.

3. Calibration and Reset:

- The calibration loop includes a calibration loop integrator, and the current integrator is reset before each sampling instance.
- A switch and self-biased inverters are used for calibration to match path delays between the antenna port and the Tx signal paths.

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Images

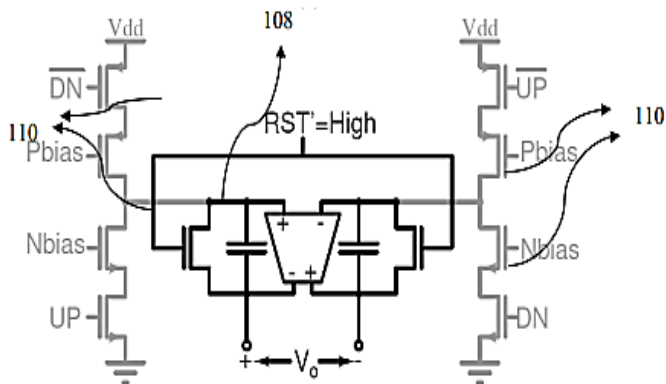


FIG. 2 shows a circuit of the differential charge-pump with the integrator, where the RST' is high

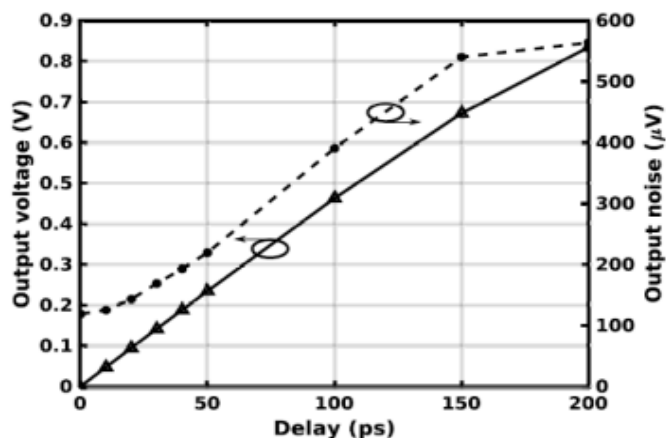


FIG. 3 is a graphical diagram illustrates a output voltage and an integrated output noise versus delay between a VAnt and a coupled VTx

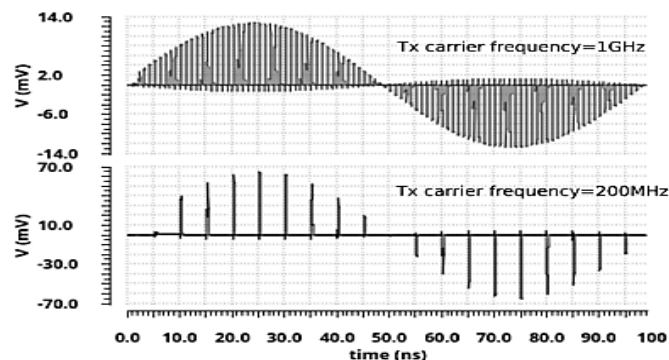


FIG. 4 is a transient simulation of a received signal in the presence of a VTx signal

Intellectual Property

IITM IDF Ref.: 1667

IN Patent No. 354604

PCT Application No.: PCT/IN2019/050204

US Application No.: 16968828

TRL (Technology Readiness Level)

TRL- 3, Proof of Concept

Research Lab

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Key Features / Value Proposition

Technical Perspective

- **Self-Interference Solution:** Solves self-interference for simultaneous, clear transmission and reception.
- **Better Signal Quality:** Improves signals for faster, reliable wireless communication.
- **Works well in the high-power systems, eliminates quality trade-offs.**
- **Efficient Spectrum Use:** Optimizes RF spectrum for efficient wireless communication.

Industrial Perspective

- **Enhanced Services:** Industries benefit from improved communication services, offering better connectivity and efficient data transfer.
- Reduces manufacturing costs by eliminating the need for bulky components.
- Provides a competitive advantage with superior, interference-free communication solutions.
- Critical in military and defense for secure, interference-free communication.

User Perspective

- **Clearer Calls:** Users enjoy improved call quality with reduced interference.
- **Faster Data:** Faster, reliable data transfer means quicker downloads and smoother streaming.
- **IoT Reliability:** Ensures reliable smart devices and sensors for IoT users.
- **Enhanced Security:** Improved security and privacy in communication experiences.

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