DS1221A Notch Filter and Demodulator

Analog filter and demodulator for electromagnetic (EMA-RF) and radio frequency analysis (RFA) on contactless solutions (ISO/IEC 14443)

Introduction

When testing for side channel leakage in a contactless solution, the reader's 13.56 MHz carrier wave introduces significant noise in the measurements. The DS1221A Notch Filter and Demodulator consists of analog filters that reduce the radio frequency (RF) signal while preserving the leakage signal from a contactless smartcard. This results in a reduction of the input voltage range of the digital oscilloscope, which then minimizes quantization error and consequently leads to a better signal-to-noise ratio. While the DS1221A Notch Filter and Demodulator is designed to be used with the Keysight High Precision Electromagnetic Probe or Microprocess MP300 TCL2 RF antenna for RFA, it can be used with any side channel test system.

KEYSIGHT

Key Features

- Dual-function analog device for RFA and EMA-RF measurements
- Significant reduction of quantization error
- Integrated power supply for High Precision Electromagnetic Probe

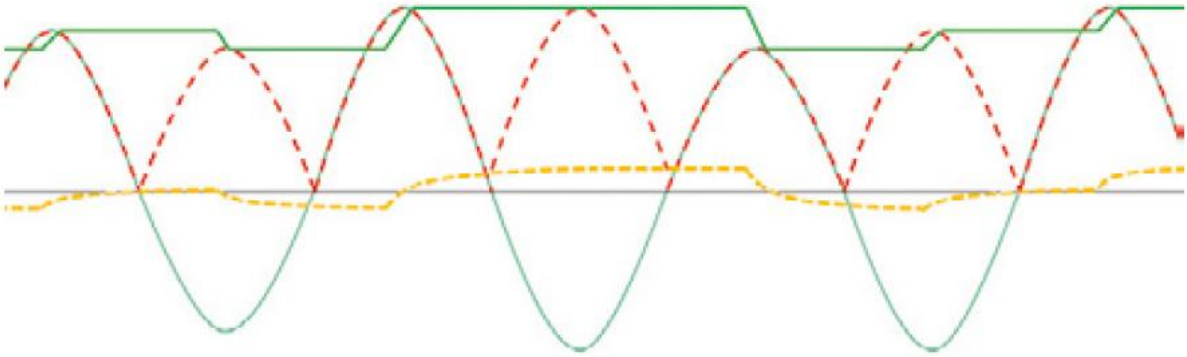

Figure 1. Simplified waveforms during the demodulation process: input (blue), rectified input (red), sampled (green), and filtered output (orange) waveforms

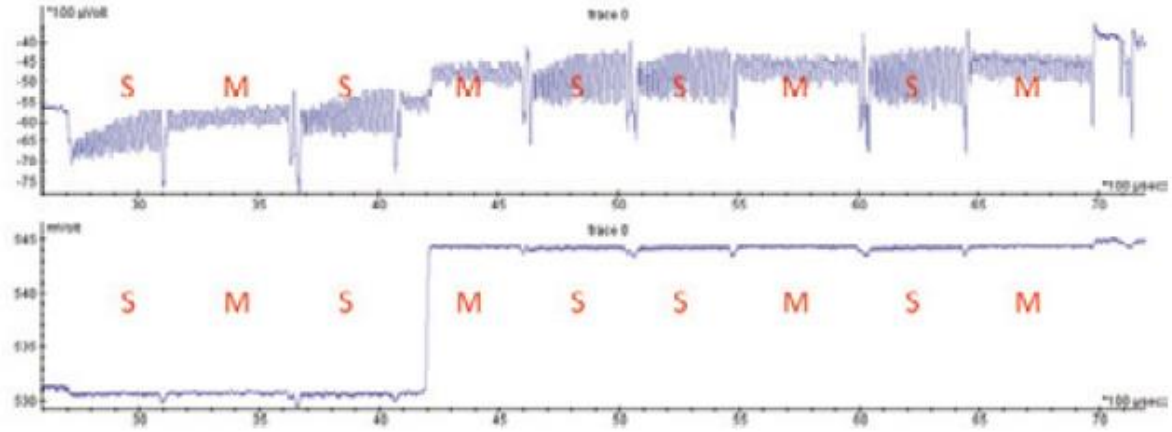

Figure 2. Simple power analysis (SPA) leakage of square and multiple operations in Rivest-Shamir-Adleman (RSA) encryption with the DS1221A Notch Filter and Demodulator based on 100 traces

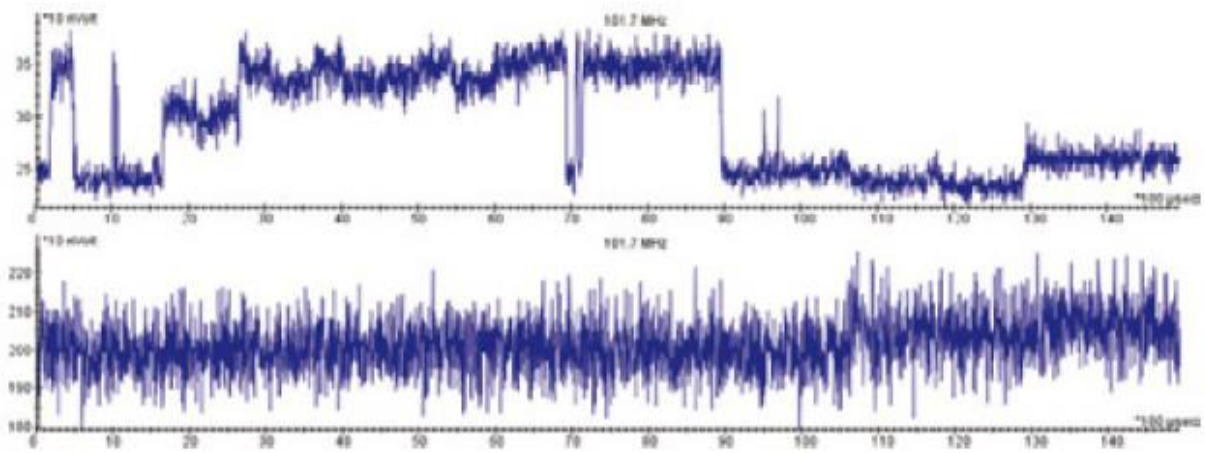

Figure 3. 101.64 MHz – 101.76 MHz (SNR -9 dB) traces based on a) 1,000 traces with the Notch Filter and Demodulator b) 1,000 traces without the Notch Filter and Demodulator

Technical Description

The DS1221A Notch Filter and Demodulator integrates two functions, a multi-notch filter and demodulator:

- The multi-notch filter attenuates the RF frequency components at 13.56 MHz, 27.12 MHz, 40.68 MHz, and 54.24 MHz in the electromagnetic (EM) signal coming from a contactless card. It improves the signal-to-quantization-noise ratio (SNR) by approximately 15 dB over the frequency range 0 – 50 MHz. The reduction in quantization error is especially important when the SNR of the unfiltered signal is below 15 dB. In this case, the required number of traces to perform EMA-RF can be reduced to 10 percent (or more).
- The demodulator samples the peak signal at 27.12 MHz to demodulate the RF signal coming from the reader antenna, improving the SNR of the RFA signal. The required number of traces to perform SRFA can be reduced to 10 percent (or less).

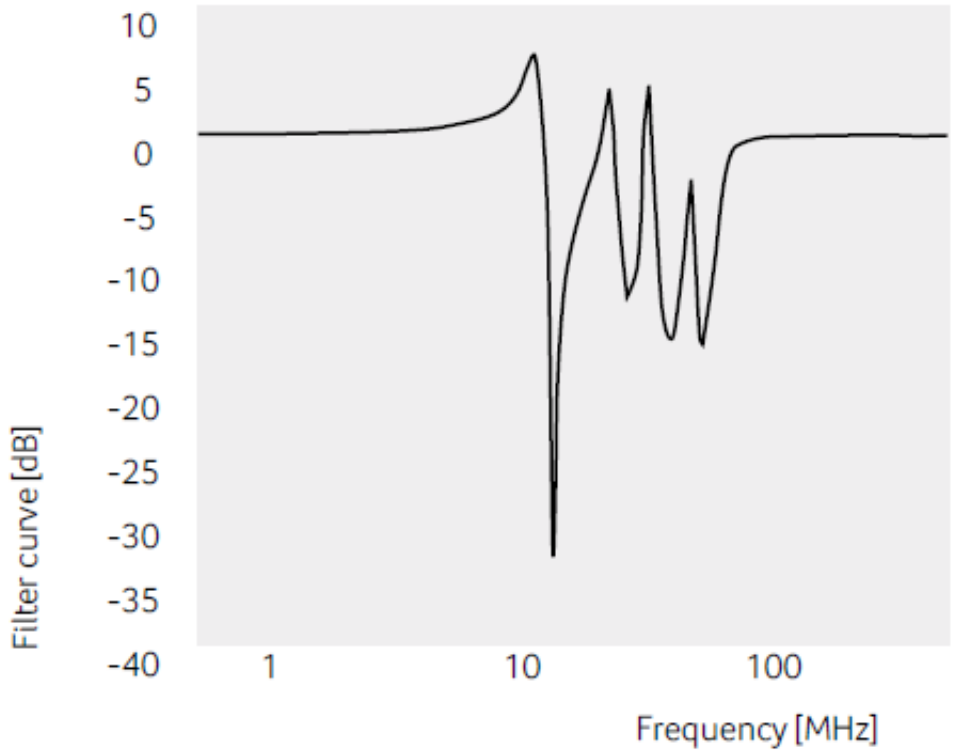

Figure 4. Frequency curve of the DS1221A Notch Filter and Demodulator

Technical Specifications

- Power: 15 V DC, 10 W max
- Green LED indicates power is on
- 1 V input connector: BNC, 50 Ohms impedance, AC-coupling, max voltage 2 V peak-to-peak
- 5 V input connector: BNC, 50 Ohms impedance, AC-coupling, max voltage 10 V peak-to-peak
- Red LED indicates overload of the 1 V or 5 V input
- Multi-notch filter output connector: BNC, 50 Ohms impedance, max 4 V peak-to-peak when terminated by 50 Ohms
- Gain of multi-notch filter/demodulator output connector: BNC, 50 Ohms impedance, max 2 V peak-to-peak when terminated with 50 Ohms

0 MHz	11 MHz	13.6 MHz	22.5 MHz	27.1 MHz	32.5 MHz	40.7 MHz	48 MHz	54.3 MHz	100 MHz
0 dB	+6 dB	-27 dB	+3 dB	-13 dB	+4 dB	-16 dB	-3 dB	-16 dB	0 dB

- Sample and hold interval of demodulator: 10 ns
- Sample frequency: 2 times fundamental frequency of RF carrier (depends on input signal, typically 27.12 MHz)