# Nonlinearity Factorization for Up-Conversion Mixer Linearity Analysis

Tech ID: 29667 / UC Case 2018-629-0

## ABSTRACT

Researchers at the University of California, Davis have developed a nonlinearity factorization scheme/method to fully characterize the time-varying behavior of switching stages with low intermediate frequency (IF).

## FULL DESCRIPTION

Up-conversion mixers modulate baseband signals to further broadcast through space or other media. The mixers should not constrain overall transmitter linearity, and their nonlinearities could be generated in many ways during the frequency translation. This makes analyzing the mixer difficult. Current methods of analyzing mixers use time-varying Volterra series or simulator-based analysis to address nonlinearity concerns but these methods overload the analysis, making it difficult, inefficient and costly to provide design insights with even greater analysis complexity when cascading nonlinear stages together.

Researchers at the University of California, Davis have developed a harmonic-based nonlinearity factorization scheme/method to fully characterize the time-varying behavior of the up-conversion mixer switching stages with low intermediate frequency (IF). This partitions the switching stage behaviors into different harmonics. The harmonics to represent their vicinity frequencies and closed-form formulas are derived to fully characterize the linearity performance of the up-conversion mixers with low IF. Key nonlinearity contributors are identified with intuitive interpretations. Additionally, the scheme/methodology can be employed with computer aided design (CAD) and electronic design automation (EDA) tools to enhance the analysis capabilities of nonlinearities in time-varying systems. This scheme/method can also remove the linearity performance degradation caused by even harmonics.

## APPLICATIONS

- Analyzing linearity of up-mixers

## FEATURES/BENEFITS

- Memory effects imposed by reactive components are greatly simplified
- Systemic, closed-form steps
- Removes linearity performance degradation caused by even harmonics
- Effectiveness of scheme/method has been validated with analytical predictions, simulations and measurement results
- Can be used as design guidelines to optimize development of commercial products
- Can be used as kernel for CAD/EDA tools

## PATENT STATUS

| Country | Type | Number | Dated | Case |
|---|---|---|---|---|
| United States Of America | Issued Patent | 10/700,640 | 06/30/2020 | 2018-629 |

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Passive Wideband Interferometer Enabled Error Feedback Transmitter
- High-Efficiency Broadband Doubler
- Hybrid SPST Switch Delivers High Isolation Over an Ultra-wide Bandwidth
- Passive Coupling Balance Scheme for Long Traveling Complex Differential Signals
- Frequency Discriminator-based Phase Noise Filter (PNF) for Ultra-Clean LO/Clock

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## OTHER INFORMATION

### KEYWORDS

harmonic analysis, linearity, up-conversion, mixers, time-varying systems, harmonic nulling, switching stages, low intermediate frequency, IF

### CATEGORIZED AS

- **Communications**
  - Other
- **Computer**
  - Other

### RELATED CASES

2018-629-0

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