# Power Distribution Network Analysis

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## Introduction

The performance of power distribution networks (PDN) have becoming increasingly important in electronic system design. Existing methods and approaches in analyzing PDN requires some urgent improvement due to their shortcomings.

## Three Basic Components of PDN

Voltage regulator module (VRM), the passive distribution network and the ICs are the three components in a PDN system.

VRM and IC are sources/sinks of voltage and currents. The passive network connects them together.

## Component Models

IC power models are exclusively in RLC format. SO does VRM models. Passive interconnects are given in S or Z parameters.

## Algorithms and Tools

Most PDN analyses focus on obtaining and assessing the impedances of the PDN network. Little attention has been given to assessing the voltage noise budgets due to IC currents. Significant gaps exist in analyzing the PDN using rigorous approach.

## IC Power Model

As of today it is still quite difficult to obtain PDN models of ICs. The models available are largely inadequate for voltage noise analyses. Most models contain only one resistor and one capacitor. IC currents are non-exist in many models provided.

## VRM Model

VRMs are usually represented by a small resistor. The frequency dependent characteristics of the VRM output is often neither from VRM vendors nor from simulations.

## PDN Model

Mostly represented by S or Z parameters. The DC point usually does not exist, making it difficult to analyze the system in time domain. Passivity and causality of models.

## PDN Modeling Objectives

A new method of analyzing PDN noise has been developed by the authors and tested in matlab. This new method avoids the pitfalls of doing transient analysis in time-domain to obtain voltage noises at IC bumps and package BGAs.

A frequency-domain recursive modeling scheme has also been devised to extract the IC currents.

1. Extraction and MOR realization of on-die PDN impedances (UiMOR) , circuits and currents
2. Importation and processing of PCB layouts
3. Automated extraction of PDN network S/Z parameters
4. PDN voltage noise analysis, matlab and C++, comparison with results from commercial tools
5. PDN DC point analysis and incorporation in time-domain analysis
6. Integration of vector-fitting algorithms and codes in PDN analysis
7. VRM model development and analysis

References