CARACTERIZACION DE CONVERTIDORES DE POTENCIA CON OSCILOSCOPIOS DIGITALES

Ing. Luigi Lorusso
Luigi.Lorusso@rohde-schwarz.com

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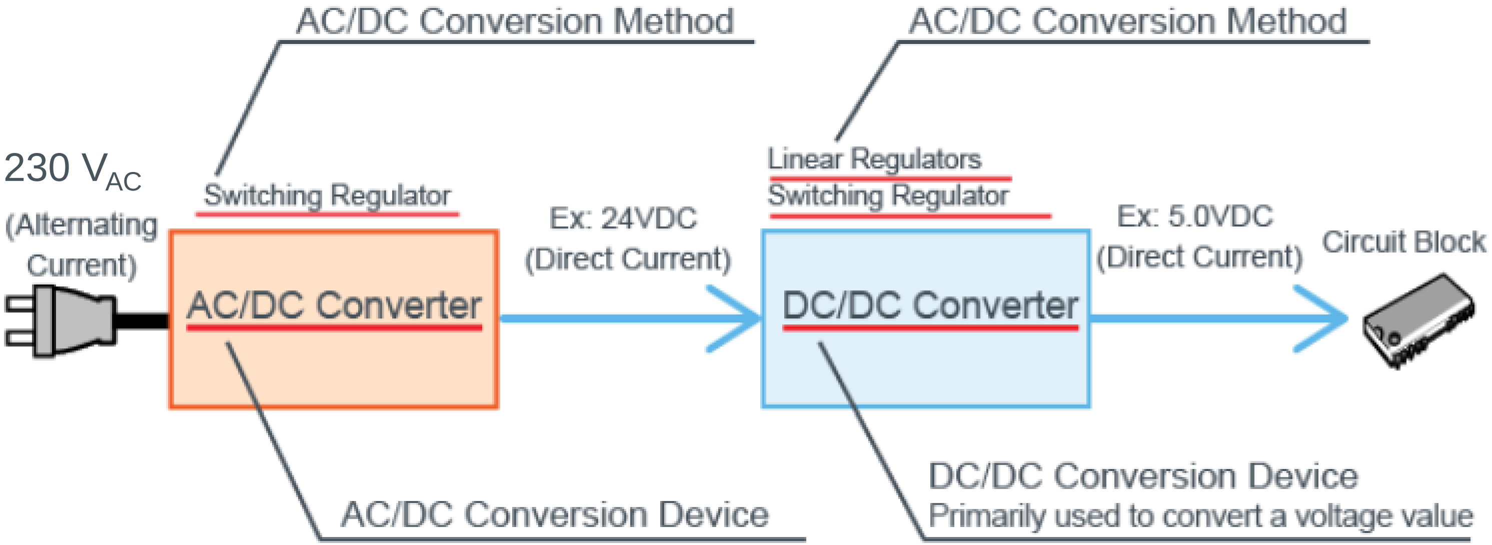
Make ideas real

WHAT'S A DC-DC CONVERTER?



12 V →

→ 3.3 V

BUCK

5 V →

→ 12 V

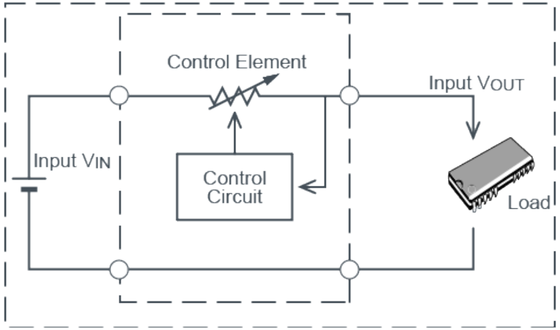
BOOST

A DC/DC converter that stabilizes the voltage is often referred to as a voltage regulator.

Two types of regulators exist, classified by a conversion method: linear or switching.

Linear Regulator

As its name suggests, a linear regulator is one where a linear component (such as a resistive load) is used to regulate the output. It is also sometimes called a series regulator because the control elements are arranged in series between the input and output.



Advantages	Disadvantages
•Simple circuit configuration •Few external parts •Low noise	•Relatively poor efficiency •Considerable heat generation •Only step-down (buck) operation

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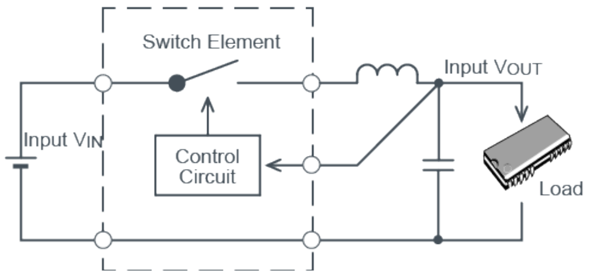
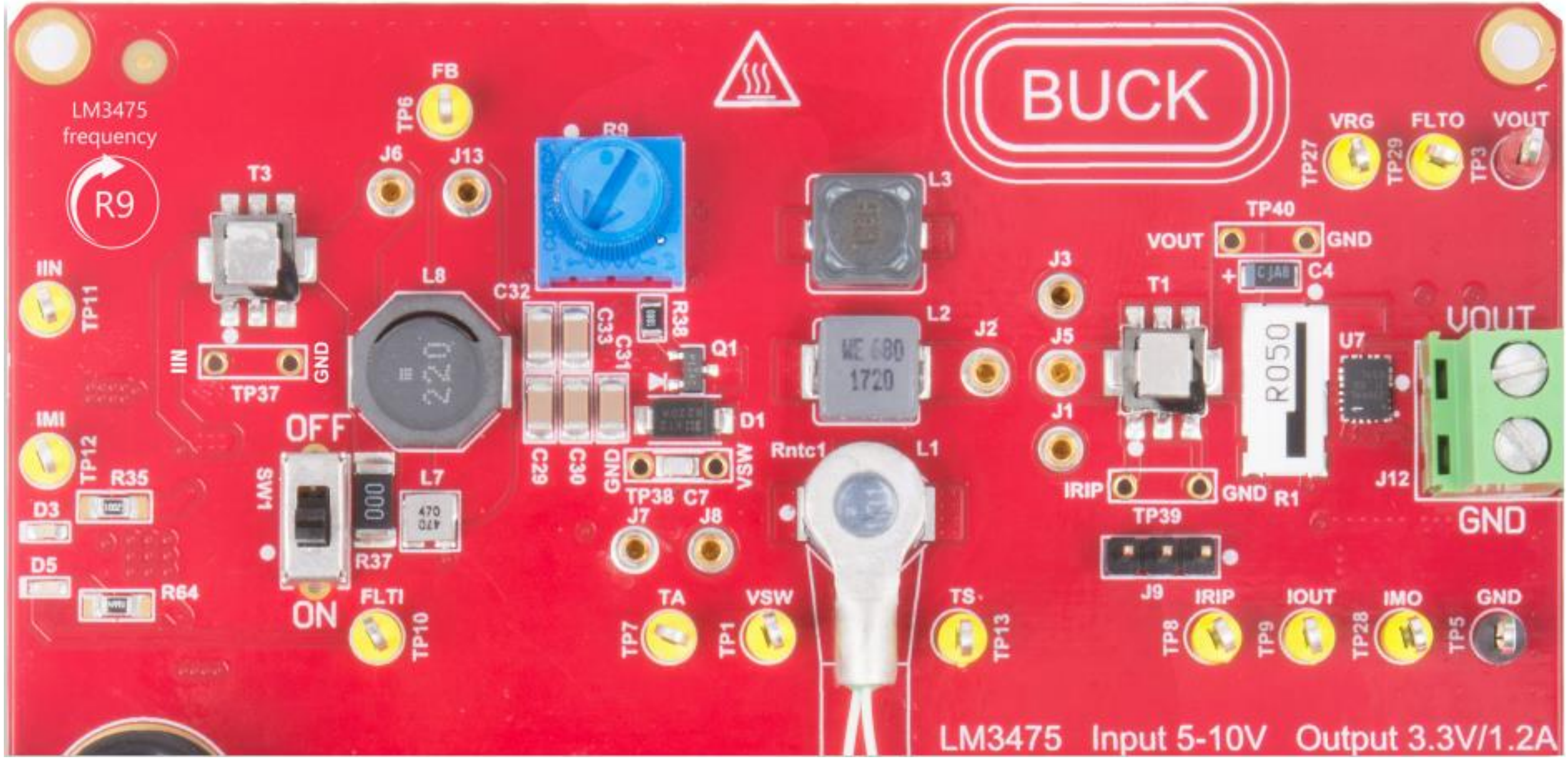
Switching Regulator

A switching regulator is a voltage regulator that uses a switching element to transform the incoming power supply into a pulsed voltage, which is then smoothed using capacitors, inductors, and other elements.
Power is supplied from the input to the output by turning ON a switch (MOSFET) until the desired voltage is reached.
Once the output voltage reaches the predetermined value the switch element is turned OFF and no input power is consumed.
Repeating this operation at high speeds makes it possible to supply voltage efficiently and with less heat generation.

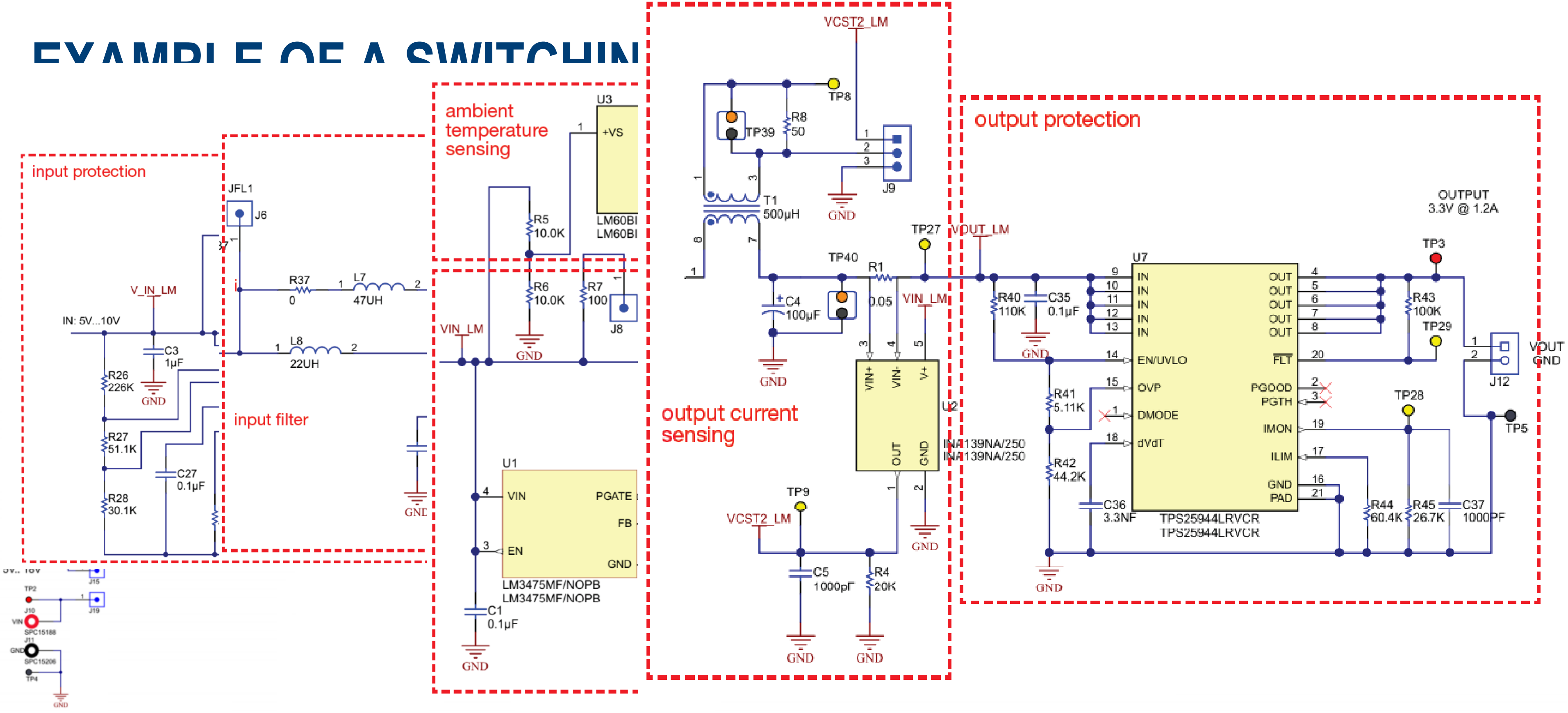


Advantages	Disadvantages
•High efficiency •Low heat generation •Boost/buck/negative voltage operation possible	•More external parts required •Complicated design •Increased noise

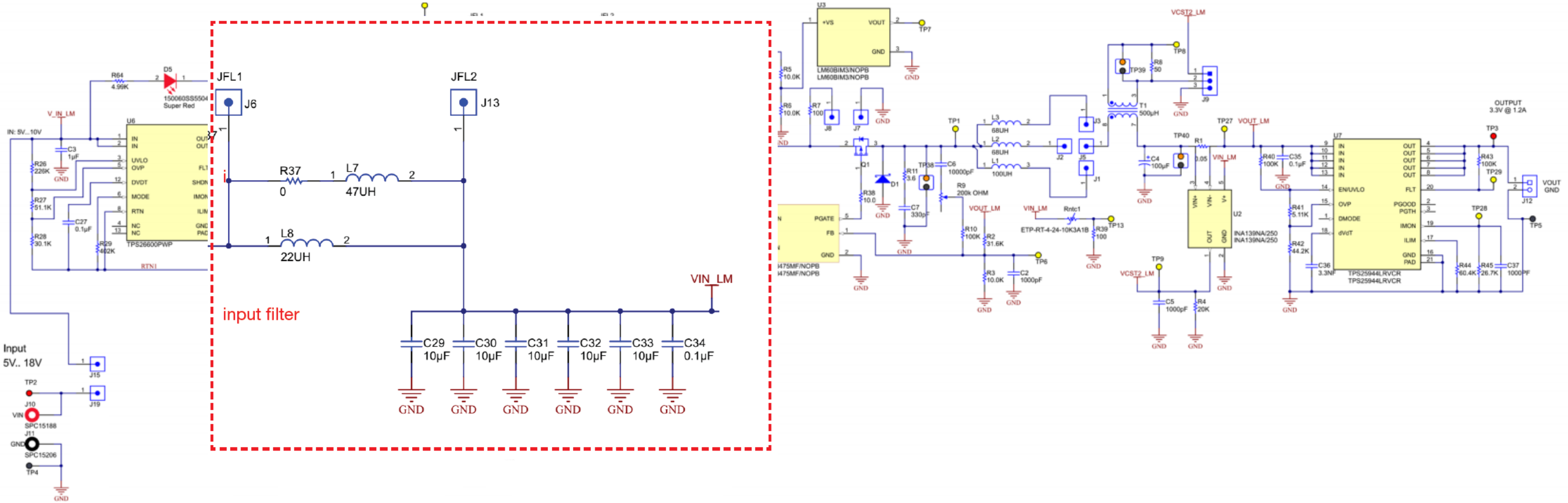
EXAMPLE OF A SWITCHING BUCK REGULATOR



EXAMPLE OF A SWITCHIN



IMPACT OF AN INPUT FILTER ON CURRENT RIPPLE



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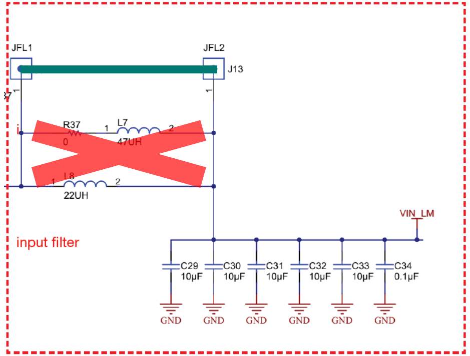
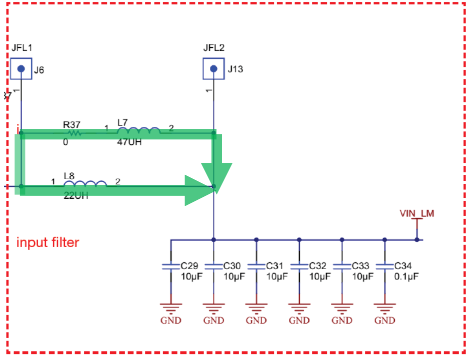
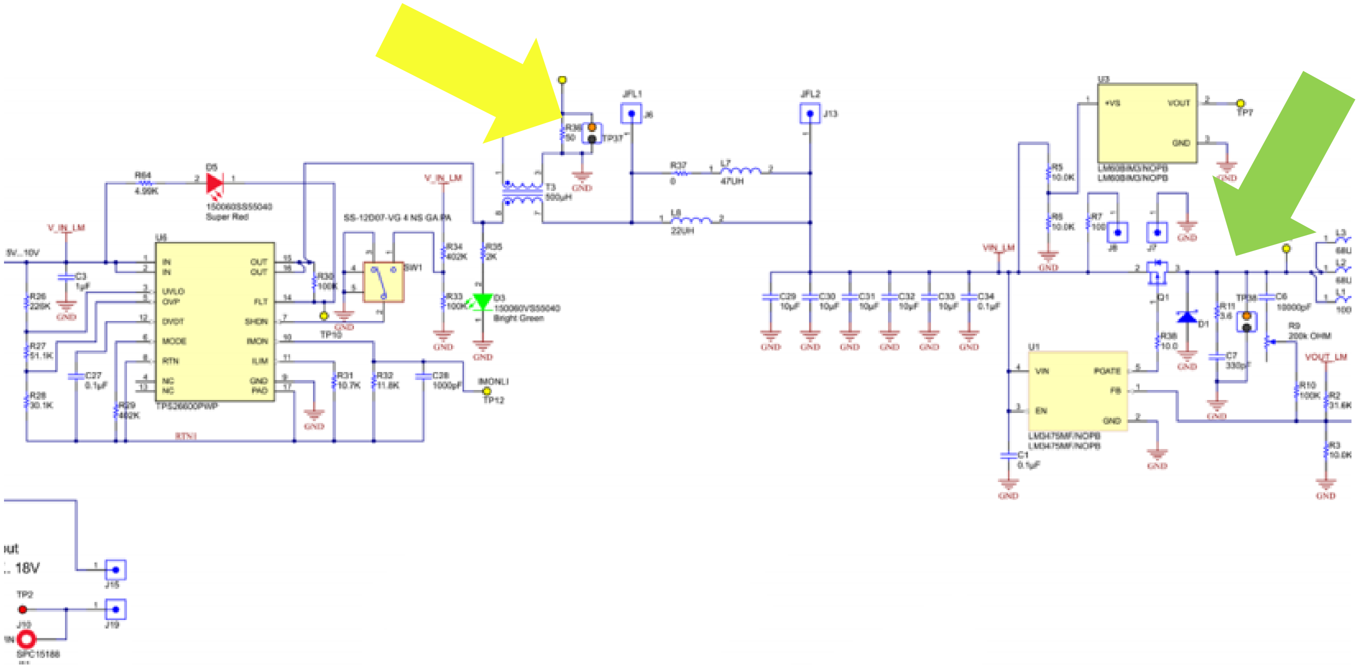






EQUIVALENT CIRCUIT FOR FILTER DIMENSIONING

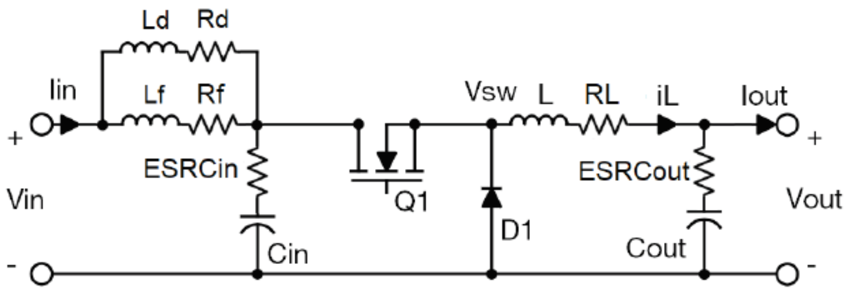
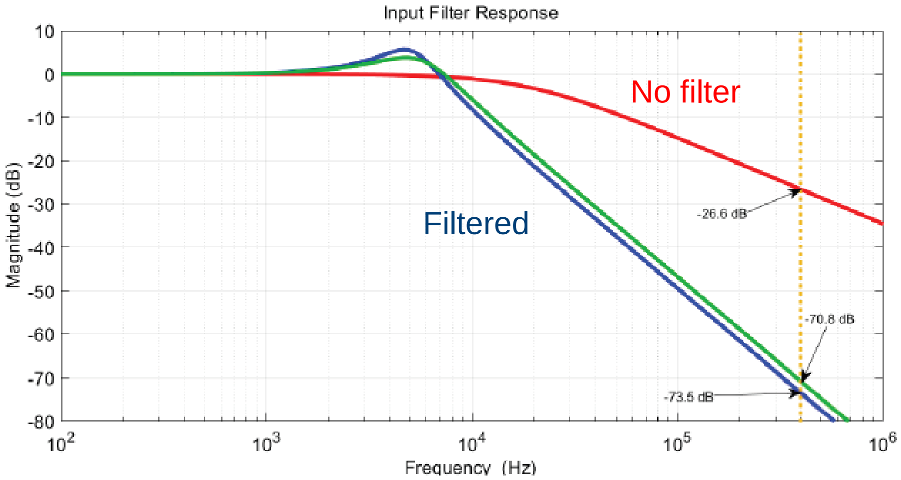
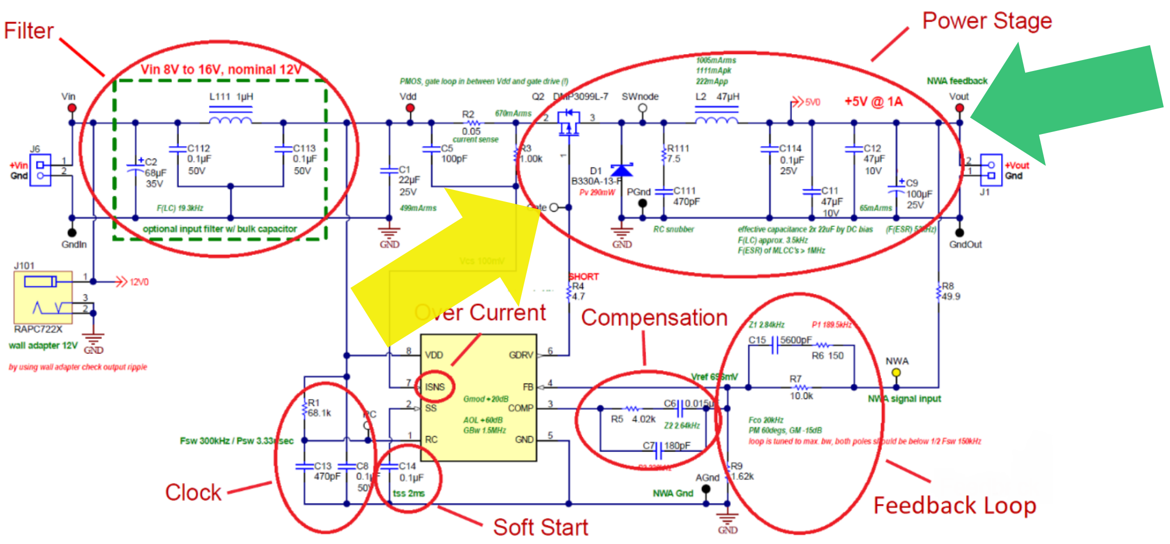


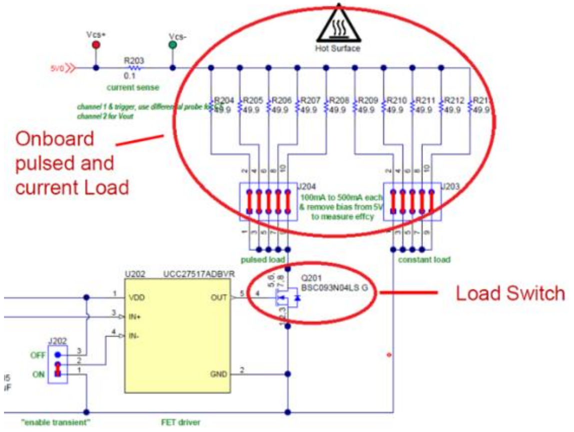
Figure 4.3. Buck converter with damped input filter



TRACK FUNCTION

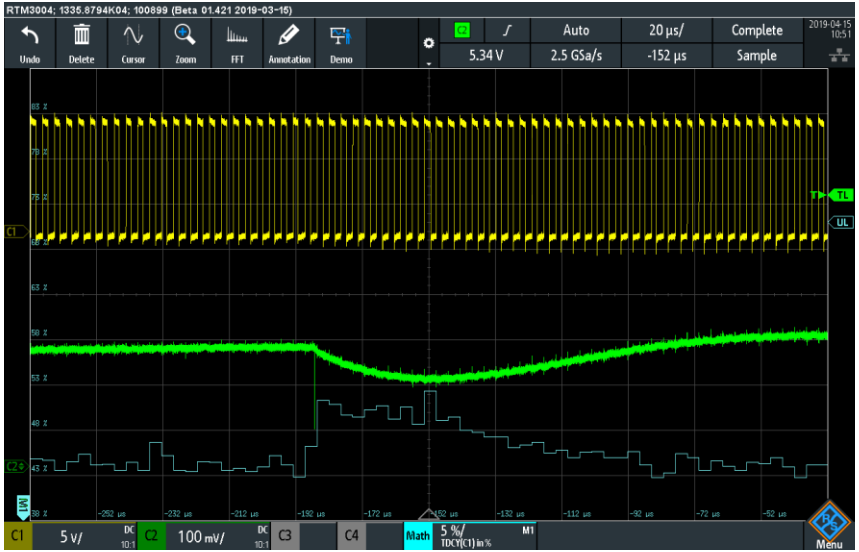


Load changes as
a square wave



TRACK FUNCTION

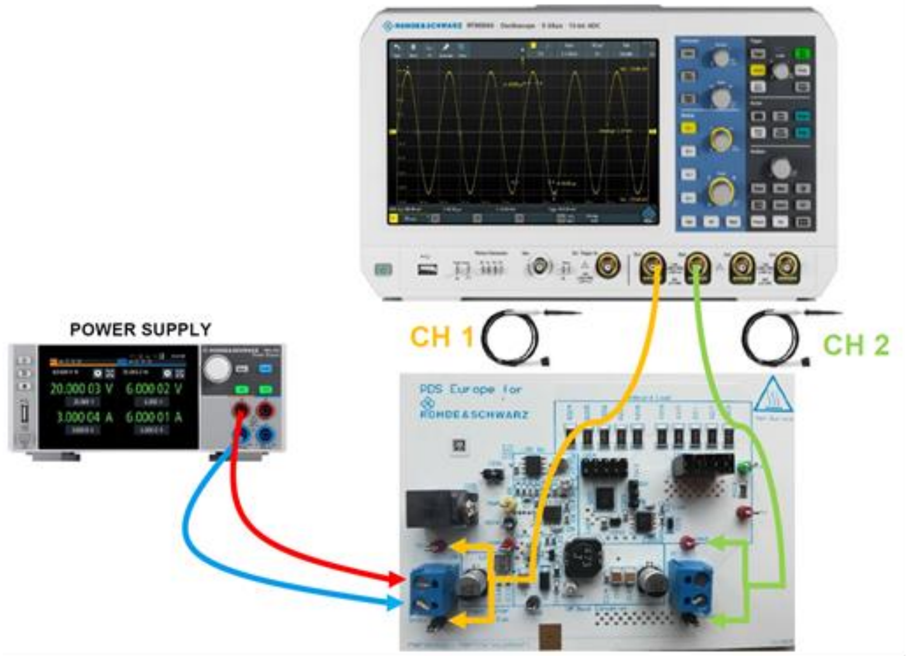
The track function is composed of measured values in the temporal order they were recorded during an acquisition. This analysis tool plots the results of any given value against time,

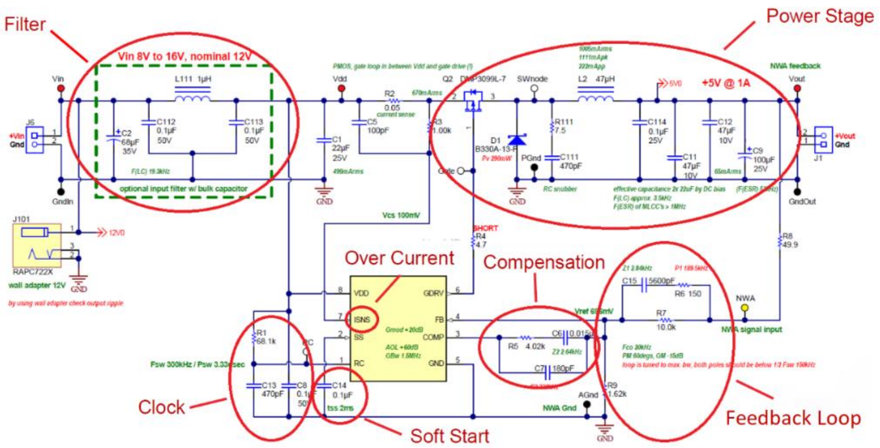


Use example:

PWM Modulation Analysis

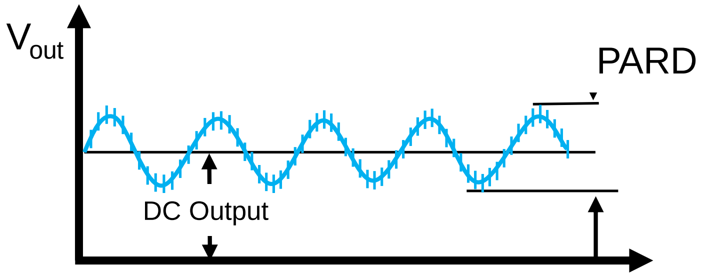
OUTPUT RIPPLE CHARACTERIZATION





WHAT IS RIPPLE?

- PARD = Periodic and Random Deviation
- Spurious AC components create ripple
  - Periodic: Ripple
  - Switching Noise
  - Load Step (Large)
  - LC Tank
  - Random: Noise
- Specified over a bandwidth
  - Typically 20 to 20 MHz
    - Careful, below 20 Hz is Output Drift



Examples

Rail Value	Tolerance	Need to measure
3.3 V	1%	33 mV_{pp}
1.8 V	2 %	36 mV_{pp}
1.2 V	2 %	24 mV_{pp}
1 V	1 %	10 mV_{pp}

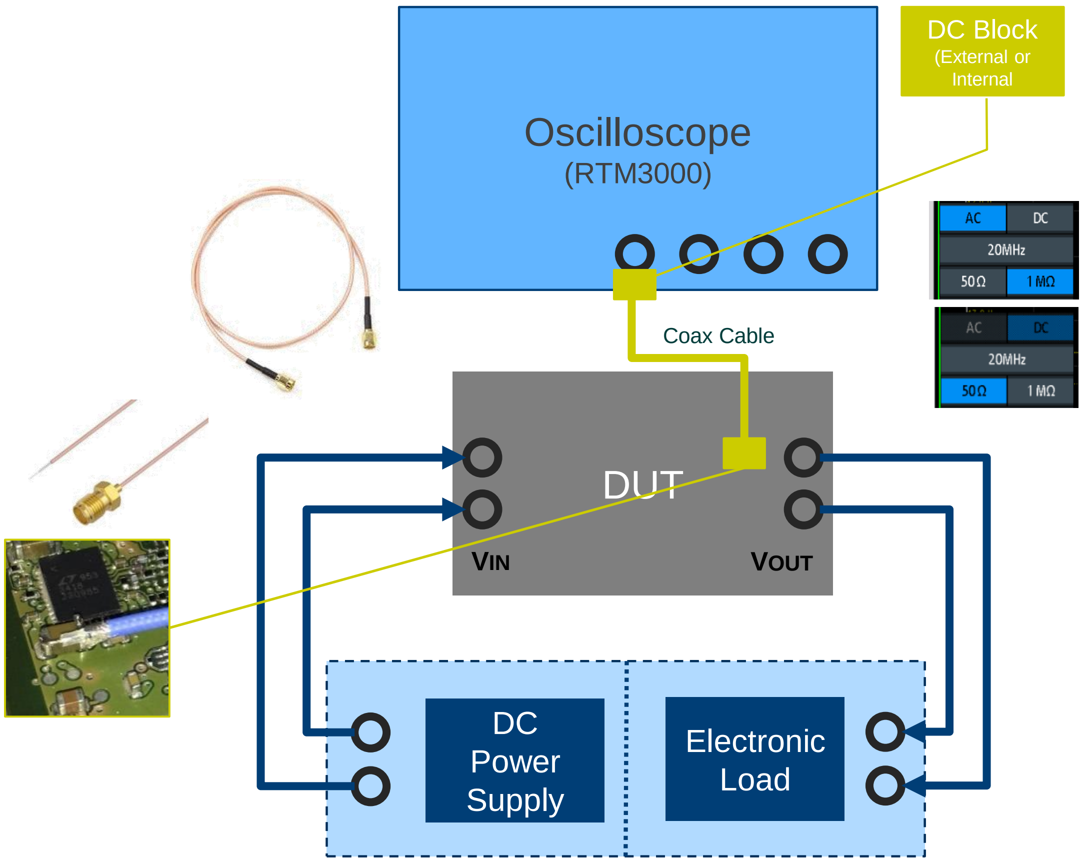
HOW TO MEASURE RIPPLE VOLTAGE METHOD #1 - DIRECT

Scope Setup

- Use Scope's 50 Ohm path
  - Rail must be below 5 V_{RMS}
- AC Coupling Remove DC Offset
  - (Not available with 50 Ohm)
  - External DC block is possible
  - Also creates high-pass filter
- Maximize V/div for no clipping
- Optional: Reduce Bandwidth

Load Setup

- Constant Resistance



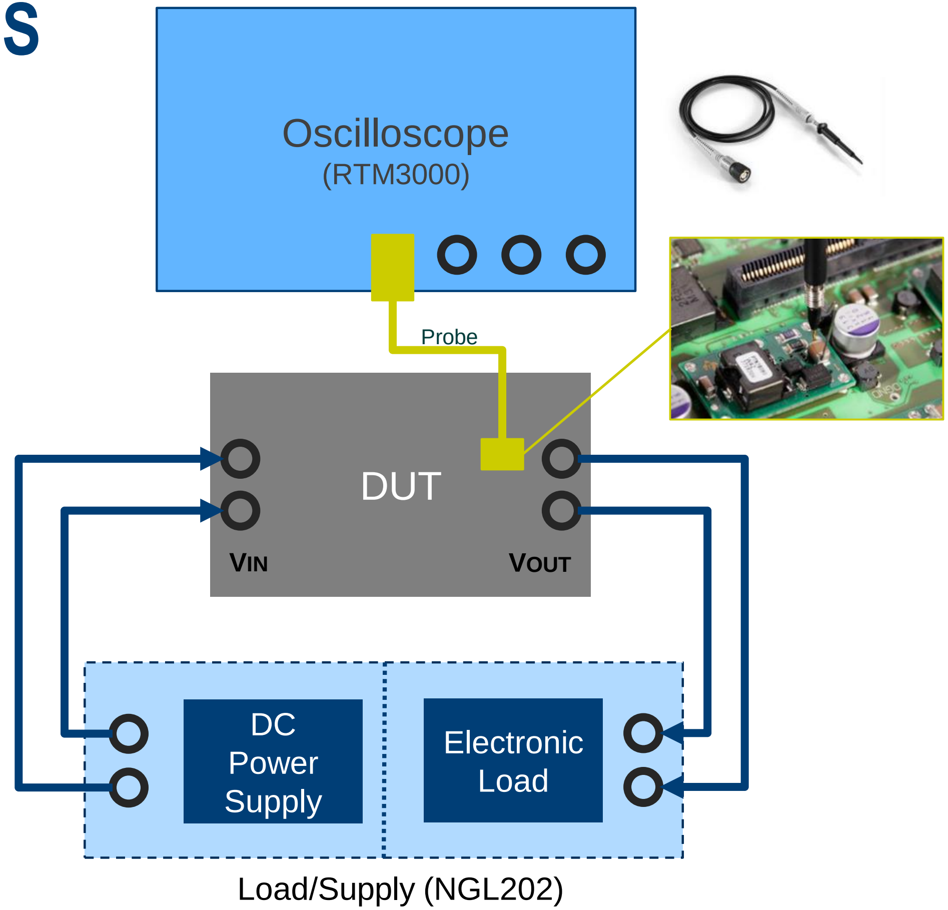
HOW TO MEASURE RIPPLE VOLTAGE METHOD #2 – PASSIVE PROBES

Scope Setup

- 500 MHz 10:1 Probe
  - Wide Voltage Range
  - Somewhat noisy
- 38 MHz 1:1 Probe (eg RT-ZP1X)
  - Lower noise, but lower BW
- 1 MOhm Path
- Can use built-in AC coupling

Load Setup

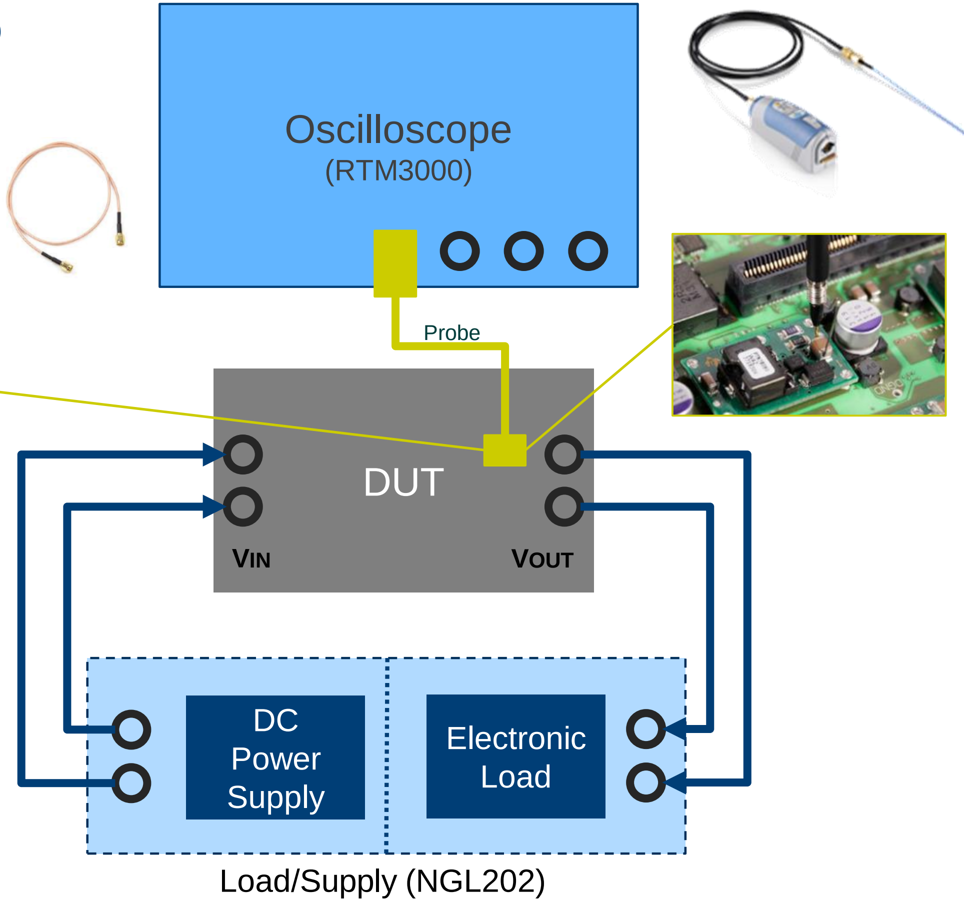
- Constant Resistance



HOW TO MEASURE RIPPLE VOLTAGE METHOD #3 – ACTIVE PROBES

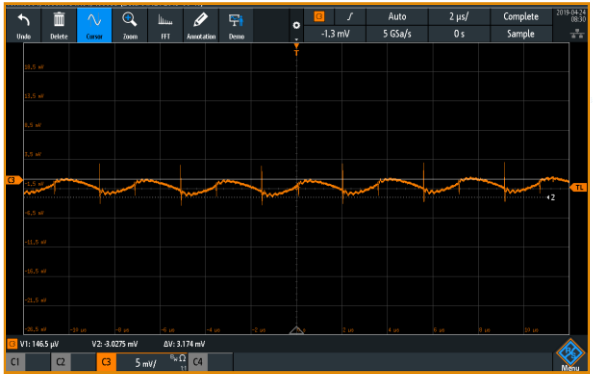
Scope Setup

- Power Supply Rail Probe (eg RT-ZPR20)
  - Purpose built probe
- Low Noise
  - 50 Ohm Path
- High DC Impedance
  - 50 kOhm @ DC
  - 50 Ohm >1 kHz
- High DC Offset
  - ± 60 V
- High Bandwidth
  - Up to 4 GHz



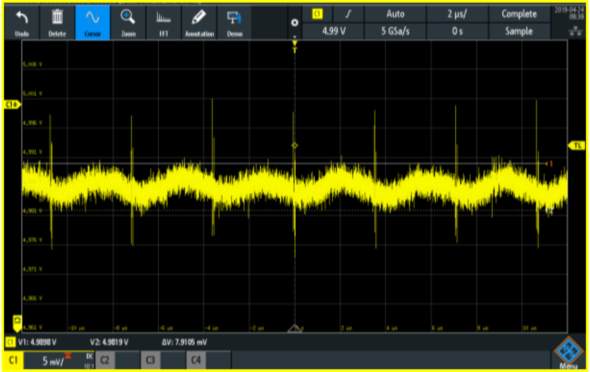
OUTPUT VOLTAGE RIPPLE COMPARISONS

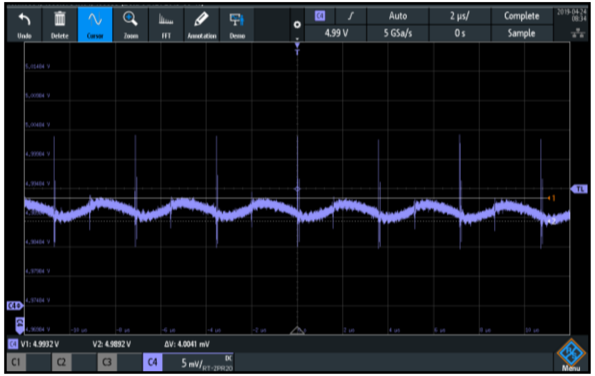
1:1 Passive



DC-Block

10:1 Passive





1:1 Active
Power Rail Probe