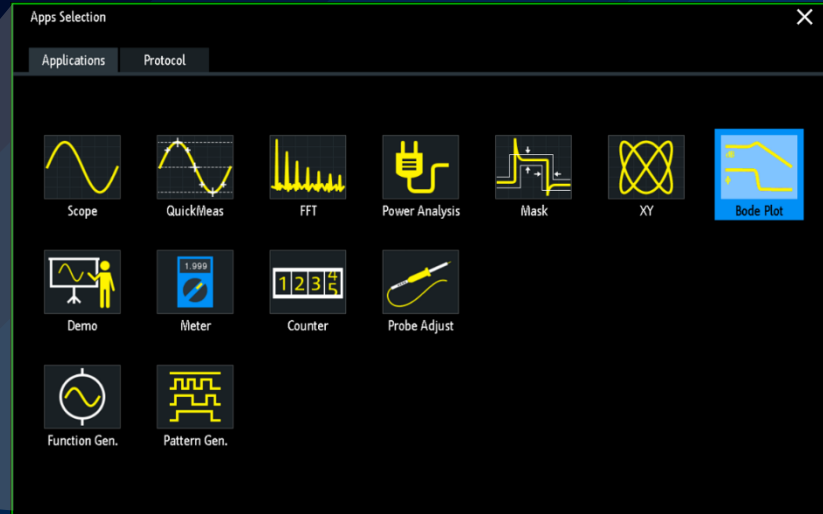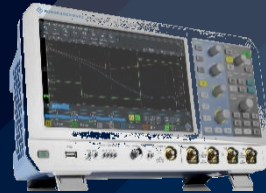# R&S® Frequency Response Analysis Option(K36) Perform Control Loop Response Measurements using Oscilloscopes

Tommy, ITMS AE

ROHDE&SCHWARZ

Make ideas real

POWER SUPPLY BASICS

Power Supply Description:

Efficiently produce well-regulated and low-noise DC power from an input rail

Types of Power Supplies

Linear (series-pass) and Switching mode (SMPS)

Linear

Operates within the transistor's linear region

+ Low noise

+ Low filtering requirements

- Always step down in nature

- Poor efficiency

Switching Mode

Switching transistor ON/OFF/ON/OFF, usually at a rate between 20 – 200 kHz

+ Highly efficient

+ Higher power in a smaller package

+ Variety of topologies

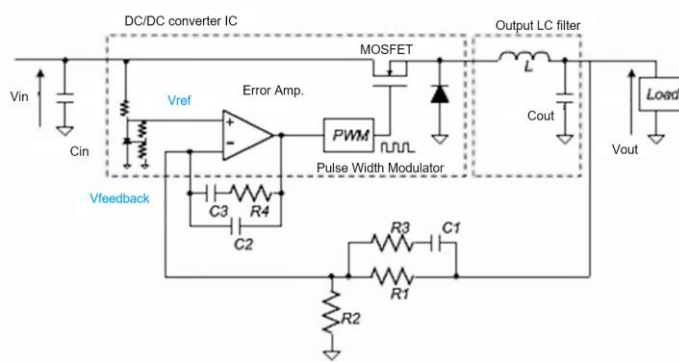**-** Moderate to high in noise and ripple

SWITCHING POWER SUPPLY
TRENDS

Design Optimization

► Improve efficiency

► Increase power density

► Increase reliability

► Control EMI, compliance to EMC regulations

► Improve output power rail integrity

► Decrease thermals

► Reduce cost

SWITCHING POWER SUPPLY
DC-DC CONVERTER BLOCK DIAGRAM SIMPLIFIED

► Error Amplifier compares the reference voltage (Vref) and the feedback voltage (Vfeedback)

► C1, C2, C3, R1, R2, R3, R4 adjusts the gain and phase delay of the error amplifier to improve the feedback loob stability

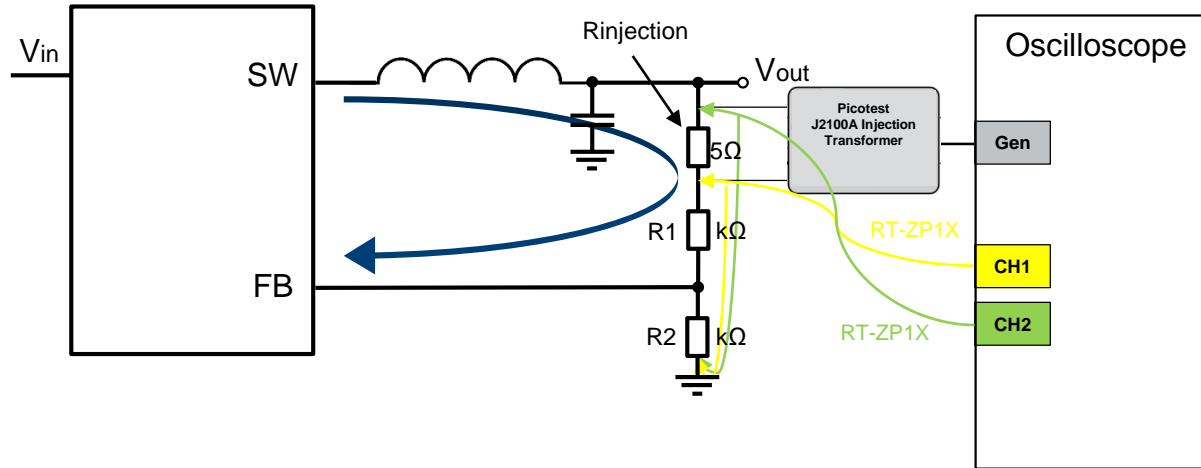► DC-DC converter can be regarded as a negative feedback control system

MEASUREMENT SETUP
SELECTING THE INJECTION POINT
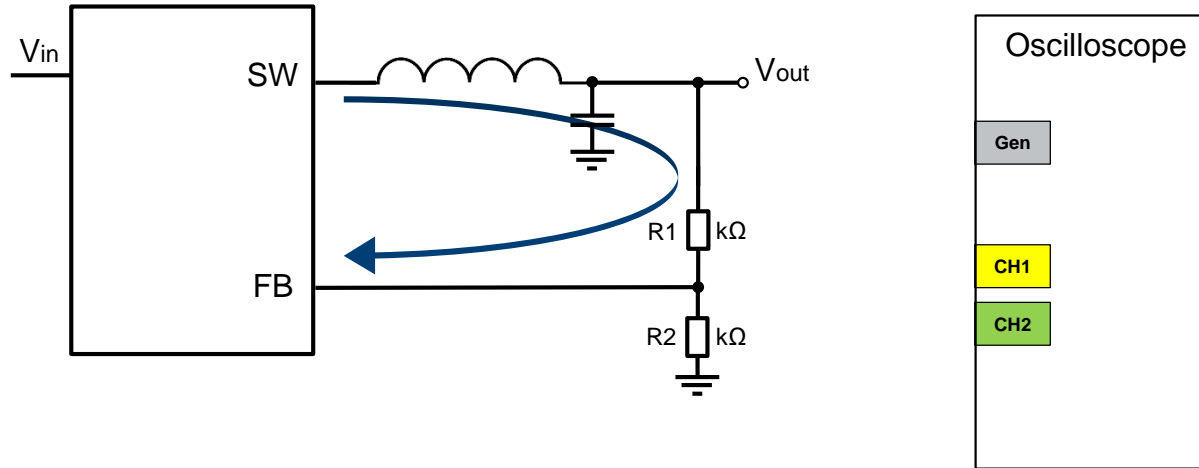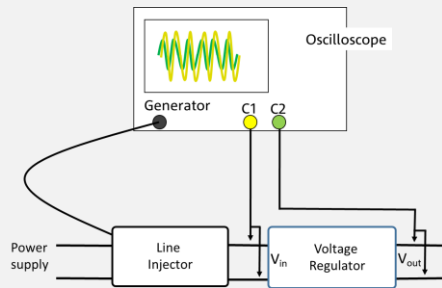
MEASUREMENT SETUP
SELECTING THE INJECTION POINT

Generally well switched points:
1. Output of a voltage source
2. Input of an operational amplifier
3. Output of an operational amplifier

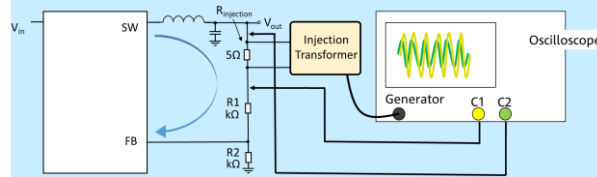# R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION
PRIMARY APPLICATIONS

PSRR
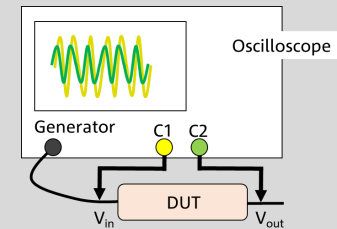
Measuring power supply rejection ratio
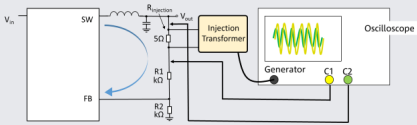
CLR

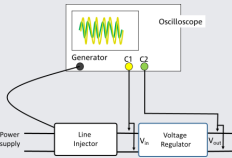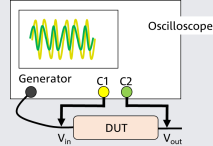Control loop response stability testing

Frequency response

Characterization of passive components

APPLICATIONS
REQUIRED EQUIPMENT

	Control Loop Response – CLR	Power Supply Rejection Ratio – PSRR	Frequency response – FRA
Field of Interest:	Power Supplies: ▪ Ensure stability of voltage regulators and switched mode power supplies	Power Supplies: ▪ Surveys of Power delivery device ▪ Indicate the power supply's output stability	Characteriziation of passive components: ▪ Passive Filters ▪ Amplifier Circuits ▪ Audio Systems
Description & Setup:			
Measurement:	20Log(Vout/Vin)	20Log(Vin/Vout)	20Log(Vout/Vin)
Additionally required:	Injection Transformer ▪ Picotest J2100A line injector	Injection Transformer ▪ Picotest J2120A line injector	-
Probing:	Input: 1:1 passive probes Output: 1:1 passive probes RT-ZP1X 38 MHz passive probes	Input: 10:1 passive probes Output: 1:1 passive probes RT-ZP1X 38 MHz passive probes	Mainly BNC cables

R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION
HOW DOES IT WORK?
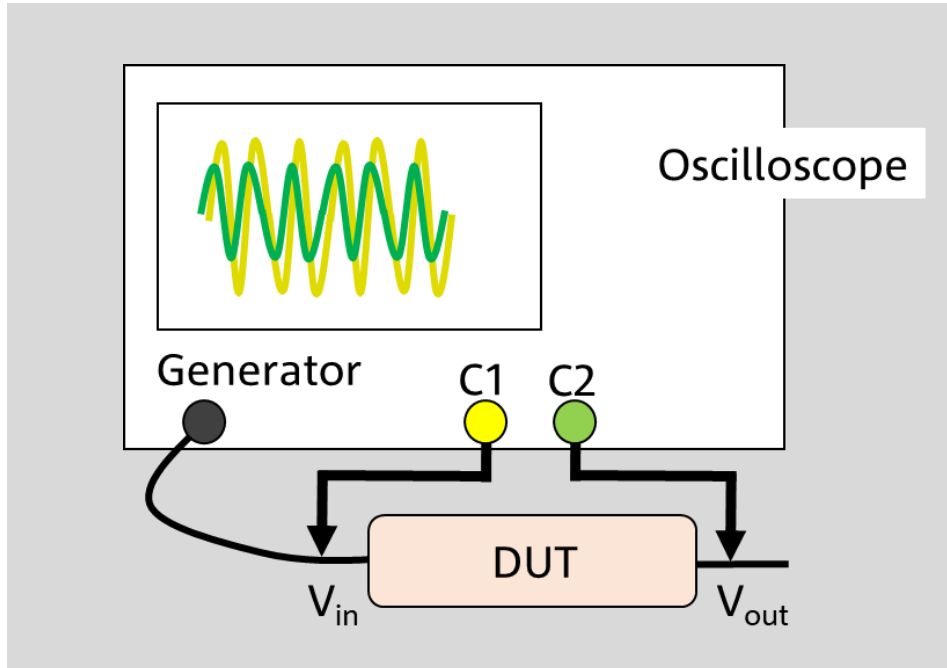
1. Internal signal generator provides swept stimulus (enables generator even is user hasn't purchased generator license)
2. Scope measures V_{in} and V_{out} amplitudes and phase at each frequency
3. Scope calculates and plots gain (logarithmically) and phase (linearly)

Supported oscilloscopes

RTB2000   RTM3000   RTA4000

R&S RTA4000 MIXED SIGNAL OSCILLO
WHAT HAVE WE HEARD FROM CUSTOMERS?
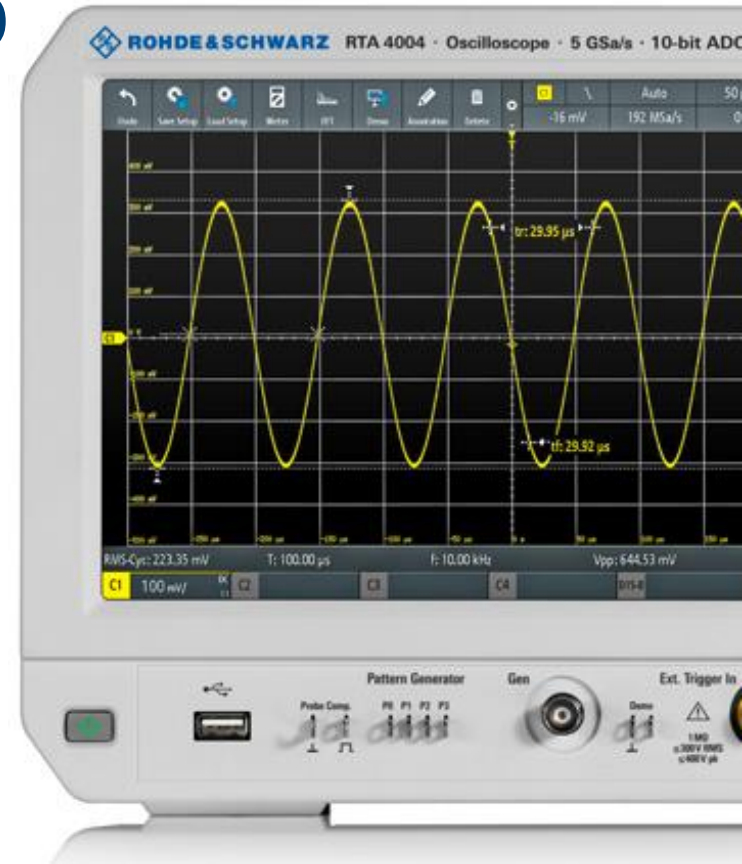
✔ Higher bit ADC

✔ Touch screen

✔ More memory

✔ Multiple instruments in one oscilloscope

✔ Higher sensitivity

✔ Best Signal Integrity

COMPANY RESTRICTED

INTRODUCING THE RTA4000
UNRIVALED SIGNAL INTEGRITY AND DEEP

10 -bit   ADC

1,000 MSample   Memory

1/2 to 1/5th   Full Scale Noise
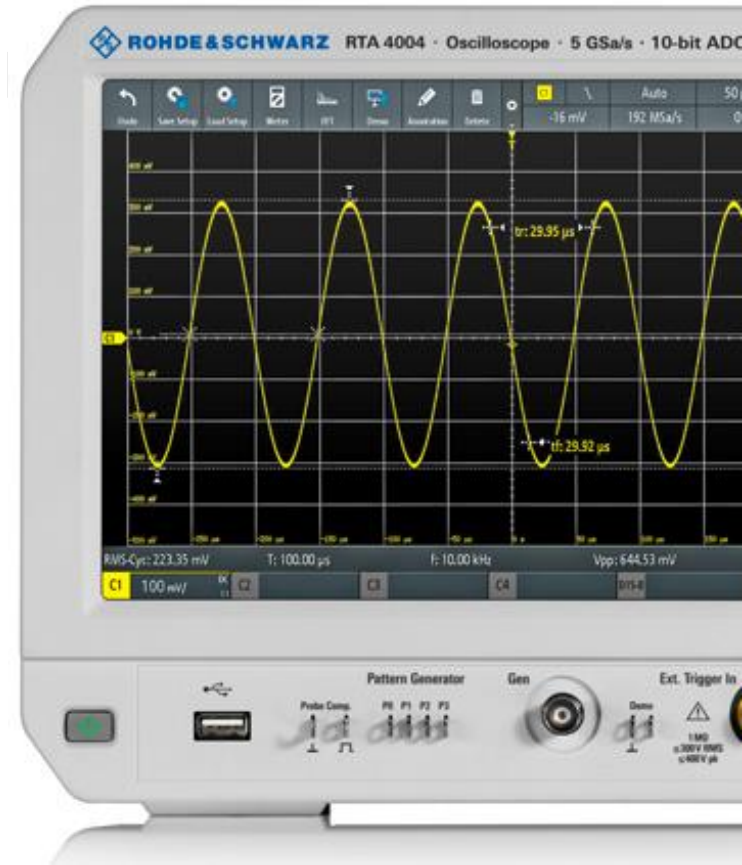
R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION
SPECIFICATIONS

Frequency range	10 Hz to 25 MHz
Dynamic range:	80 dB (typical)
Amplitude range	10 mV to 5 V (50 Ω load) 20 mV to 10 V (1MΩ load)
Amplitude modes	Fixed or custom profile
Points per decade	10 to 500 points
Plots	Logarithmic gain and linear phase
Analysis	Waveform cursors and tabular view of test results

R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION
USER INTERFACE

Use fields to adjust your setting

Use Horizontal Scale to adjust frequency window

Use the Vertical scale and position knobs to adjust Bode amplitude

Use knob to change the position of your markers

Touch support for Bode Application

REQUIRED EQUIPMENT
BEST PROBE TO PERFORM CONTROL LOOP RESPONSE

10:1 probe

RT-ZP05S/RT-ZP10

+ Supplied standard with oscilloscope

+ Provides up to 500 MHz bandwidth

+ Magnifies DC offset range by 10x

- Limits vertical sensitivity by 10x

- Magnifies oscilloscope's noise floor by 10x

1:1 probe

RT-ZP1X

+ Optimizes vertical sensitivity

+ Minimizes oscilloscope noise floor

- Limits bandwidth up to 38 MHz

- Limits DC offset

REQUIRED EQUIPMENT
WIDEBAND INJECTION TRANSFORMER

How to choose the right injection transformer:

► Isolation

► Bandwidth

► Gain flatness

► Primary to secondary capacitance

Our Recommondation for Control Loop Response (CLR)

► **Picotest J2100A Injecton** Transformer (1 Hz – 5 MHz)

► **Picotest J2101A Injection** Transformer 10Hz - 45MHz

Our Recommondation for Power Supply Rejection Ratio (PSRR)
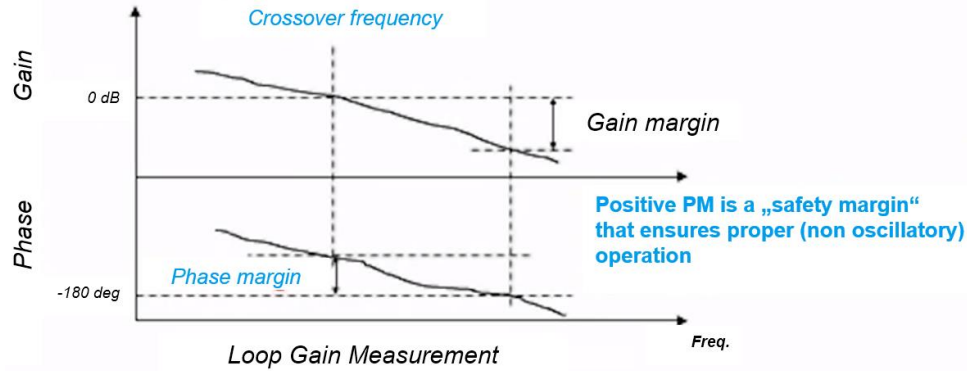
► **Picotest J2120A Line Injector** (10 Hz – 10 MHz)

R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION
CONTROLS AND SETTINGS

TYPICAL CLR MEASUREMENT
INTERPRET RESULTS

Loop Gain Measurement

- ► Higher 0 dB cross-over frequency = Faster response to load changes
- ► Higher phase margin (>45°) at 0 dB cross-over frequency = More stability
- ► Lower gain at higher frequencies = Better noise immunity (output ripple)
- ► Designer must optimize response speed and stability for their applications

R&S®K36 FREQUENCY RESPONSE ANALYSIS OPTION

Supported Instruments

RTB2000	RTM3000	RTA4000

▶ Uses the oscilloscope's built-in waveform generator

Frequency from 10 Hz up to 25 MHz

▶ No separate generator option B6 additionally required

Features & Functionalities

▪ **Amplitude Profile**
Profile the amplitude of the generator output.
Suppress the noise behavior of your DUT when performing a CLR

▪ **Improve resolution**
Choose the points per decade to setup and modify the resolution of your plot
(up to 500 points per decade)

▪ **Markers support**
Use markers to get single sample values

▪ **Result Table**
Use the table to get a list the measure samples.
Eaysily save your results
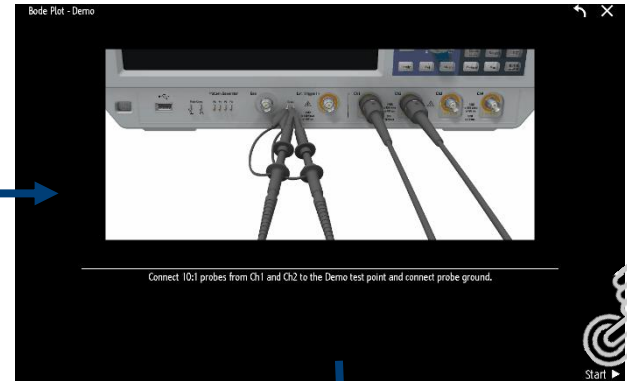
R&S®K36 BODE ANALYSIS OPTION
ORDERING INFORMATION

	RTB2000	RTM3000	RTA4000
RTx-K36	1335.8007.02 1335.8007.03	1335.9178.02 1335.9178.03	1335.7975.02 1335.7975.03
RTx-PK1	1333.1092.02 1333.1092.03	1335.8942.02 1335.8942.03	1335.7775.02 1335.7775.03
RTxx-COM2	1333.1005P97	1335.8794P97	
RTxx-COM4	1333.1005P99	1335.8794P99	1335.7700P99

BUILT-IN DEMO
TOOLBAR → DEMO → ADVANCED → "BODE PLOT- DEMO

THANK YOU FOR PAYING ATTENTION!