

ZVxPlus Application: Transistor Characterization, Reliability and Model Verification

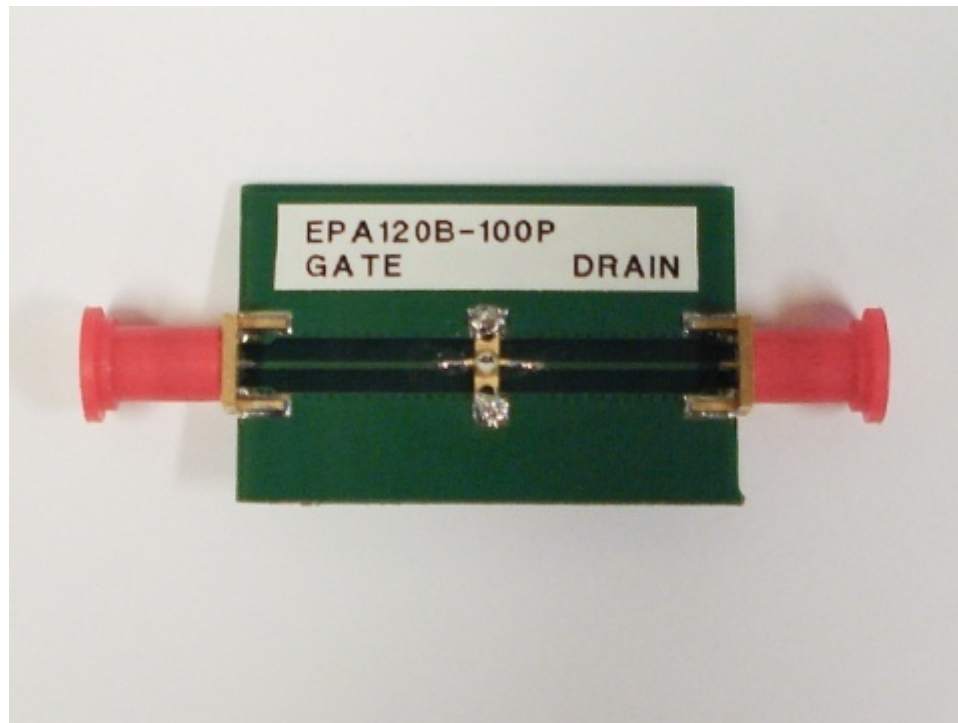


Outline

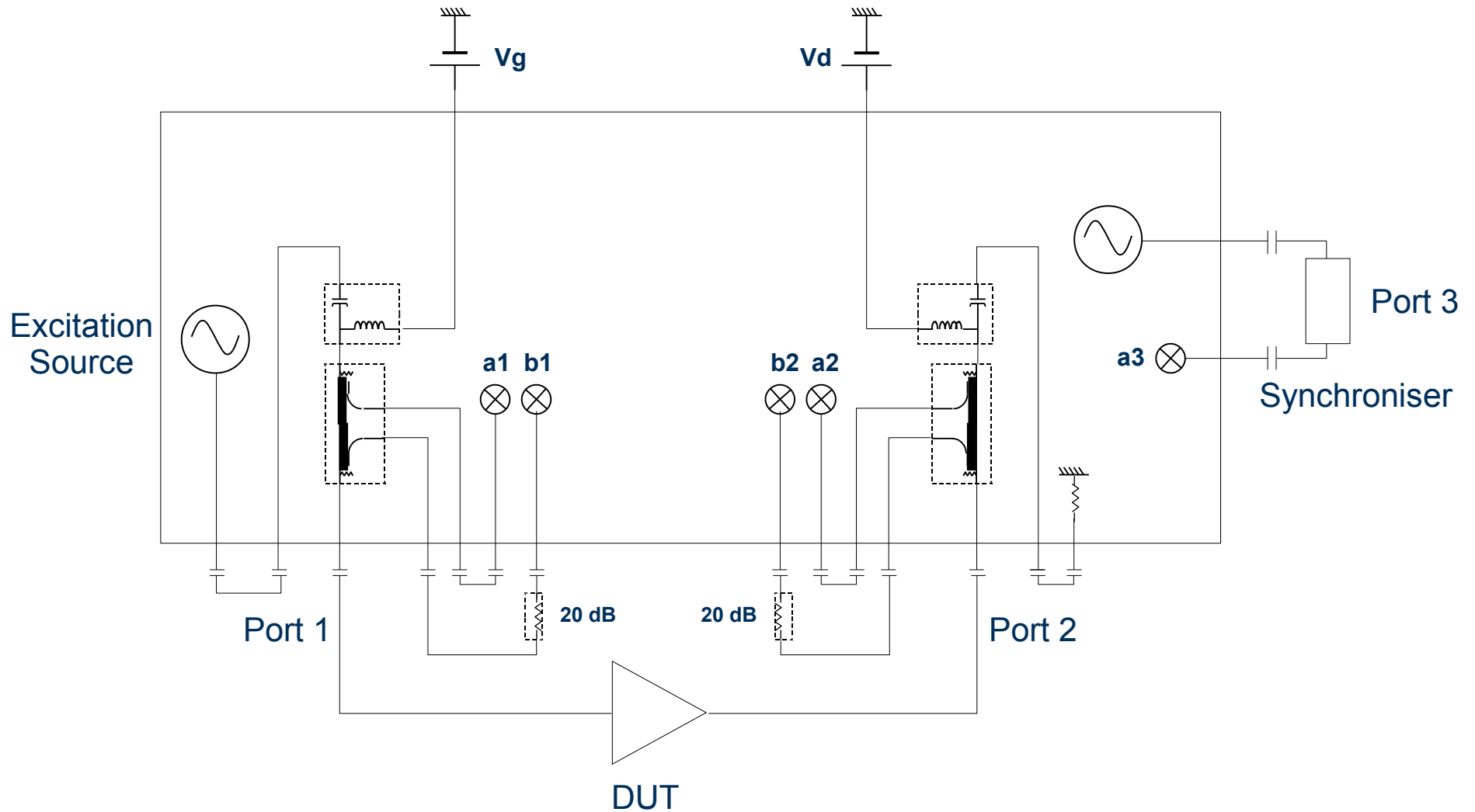
- The Device Under Test (DUT): EPA120B-100P
- Measurement Setup
- “Fire and Go...”
- Calibration and Deembedding Process
- DC IV Application
- DC+RF Measurement
 - Frequency Domain
 - Time Domain
 - Terminating Impedances
- Advanced Display: Dynamic lines
- Model Verification
- Conclusions

EPA120B-100P

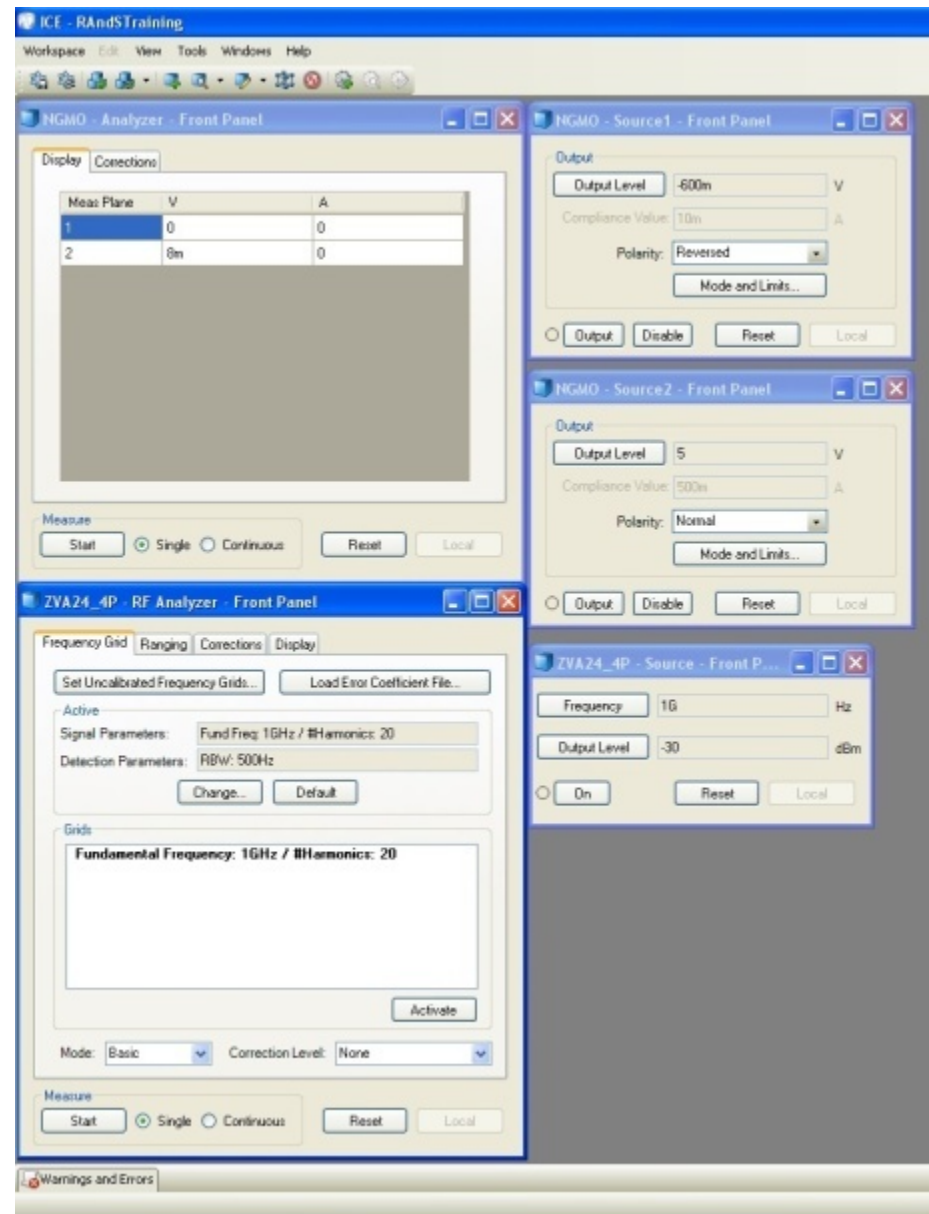
- EPA120B-100P
 - high efficiency heterojunction power FET
 - power output: + 29.0dBm typ.
 - power gain: 11.5dB typ. @ 12 GHz



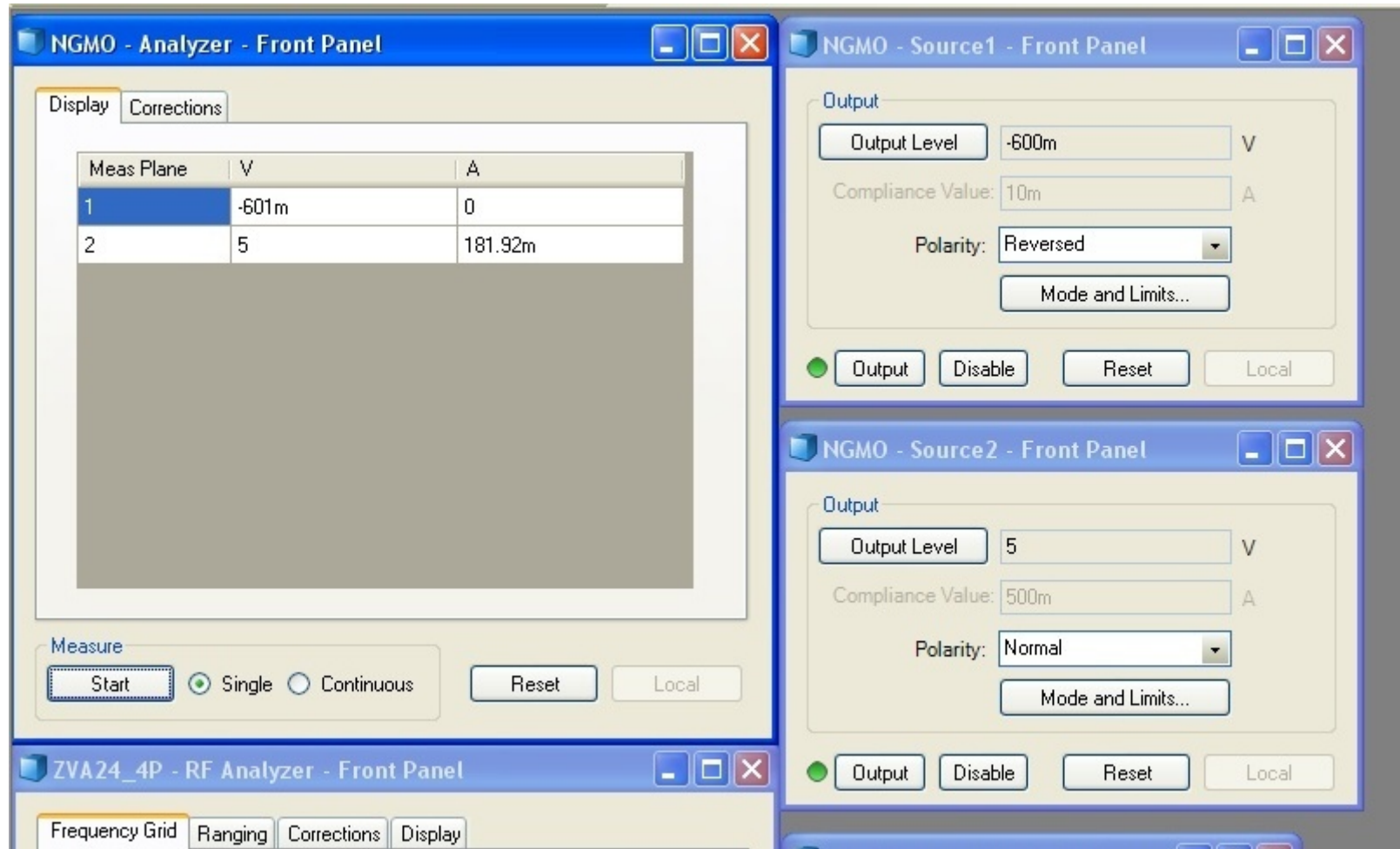
Measurement Setup



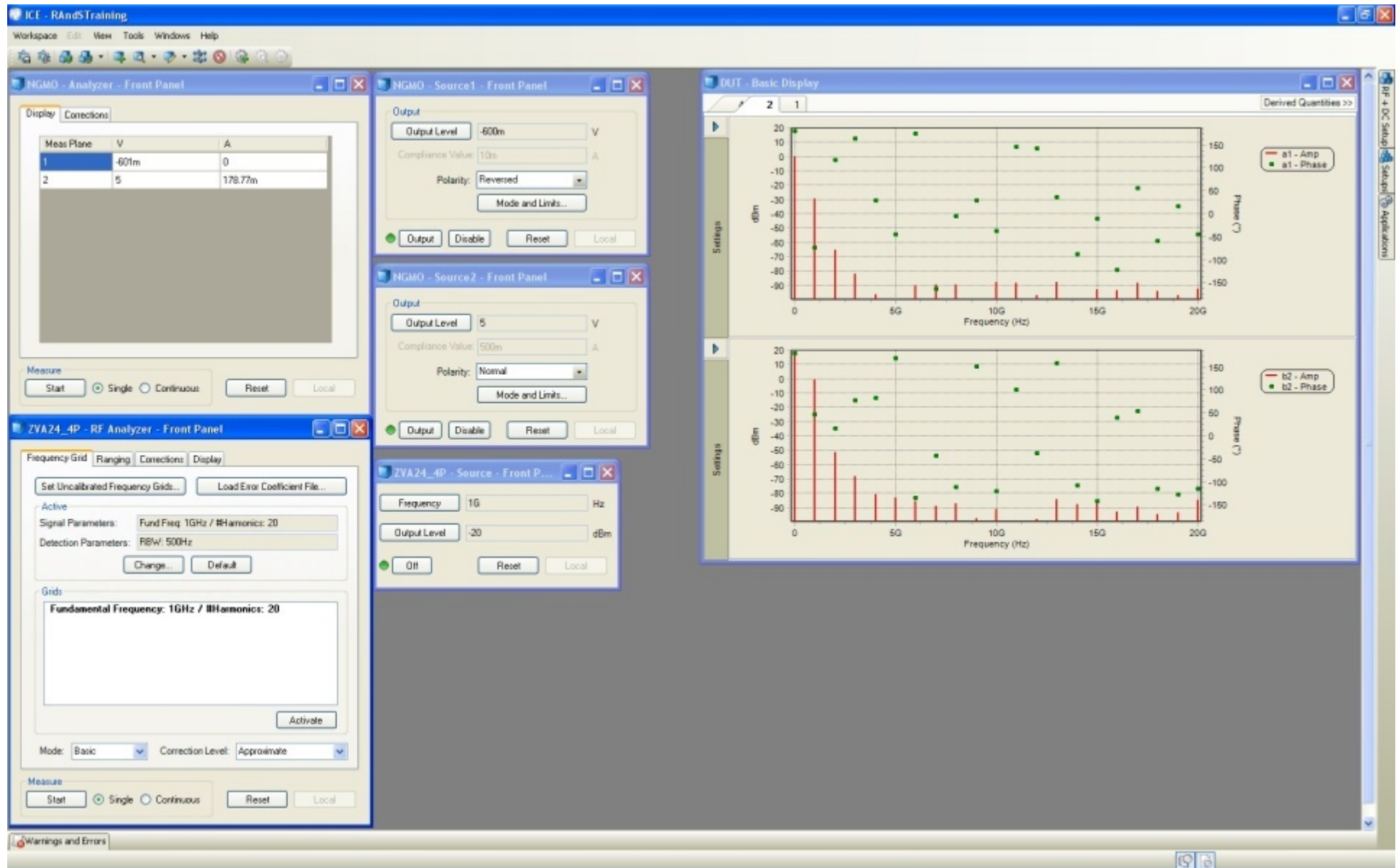
“Fire and Go...”



DUT properly working? (1)



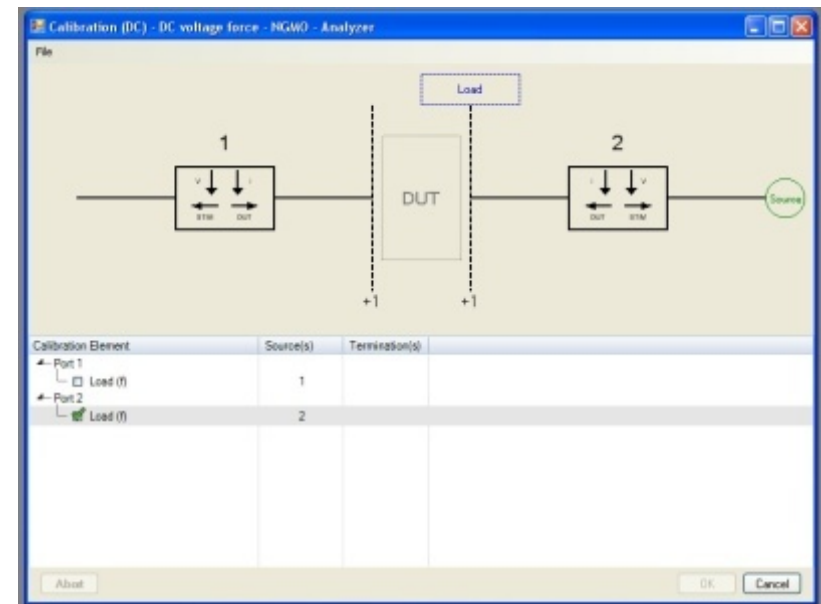
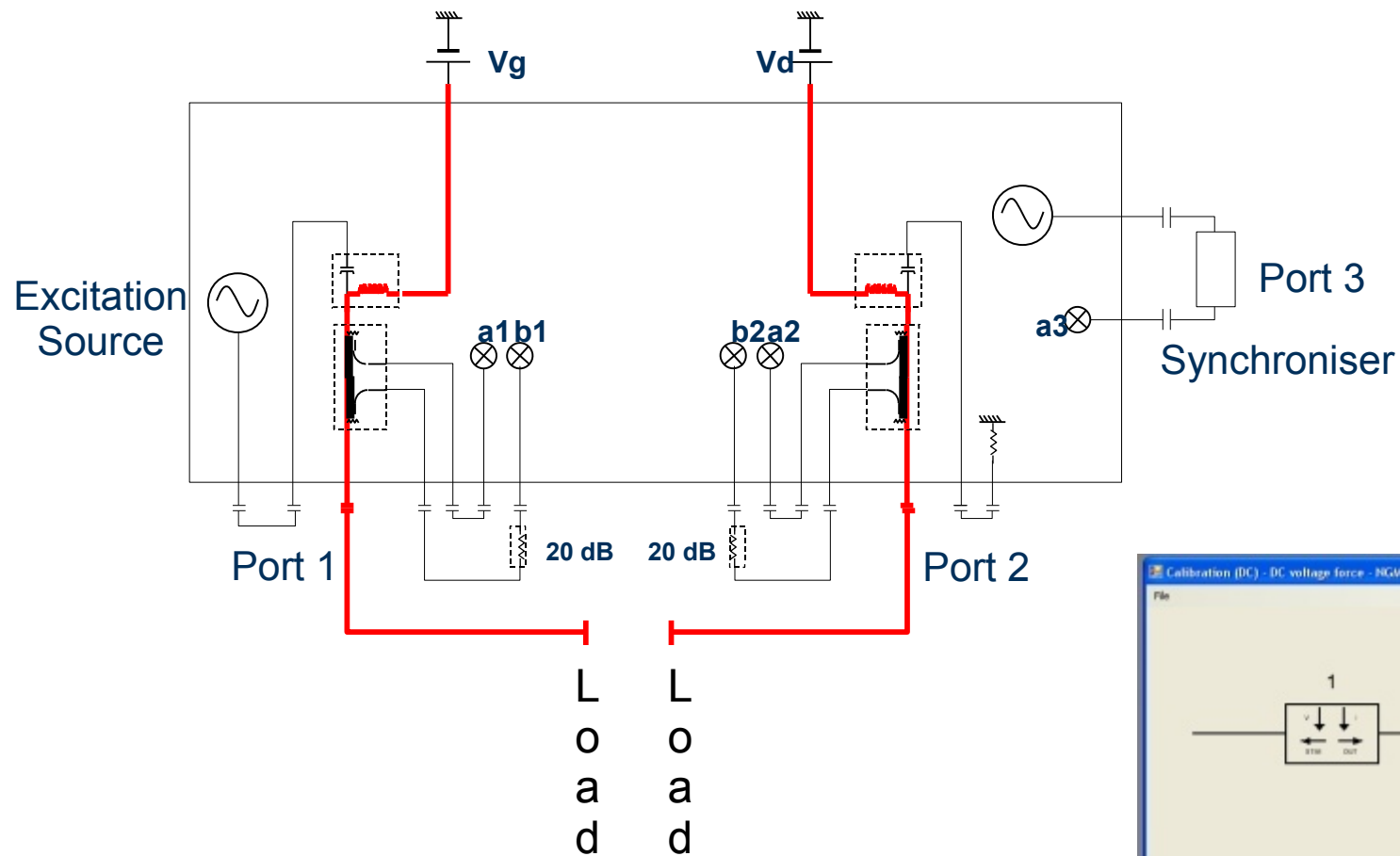
DUT properly working? (2)



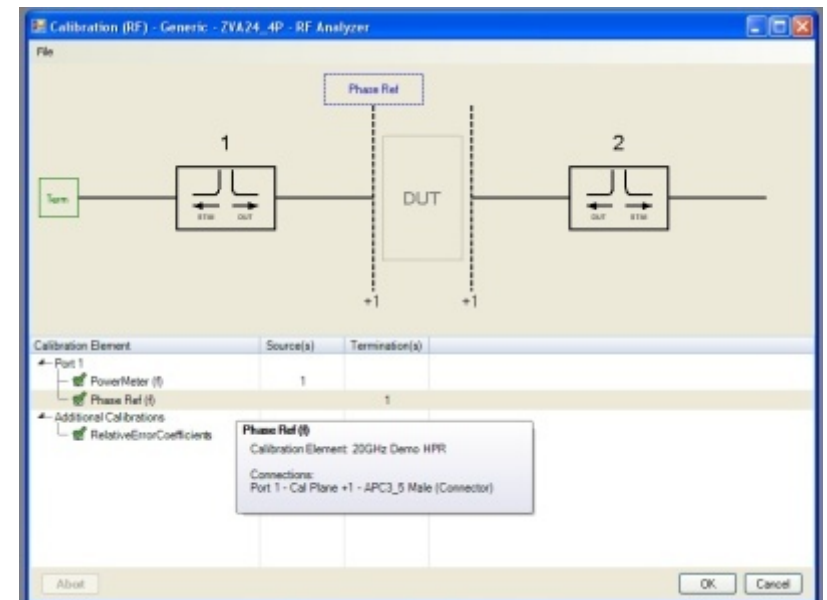
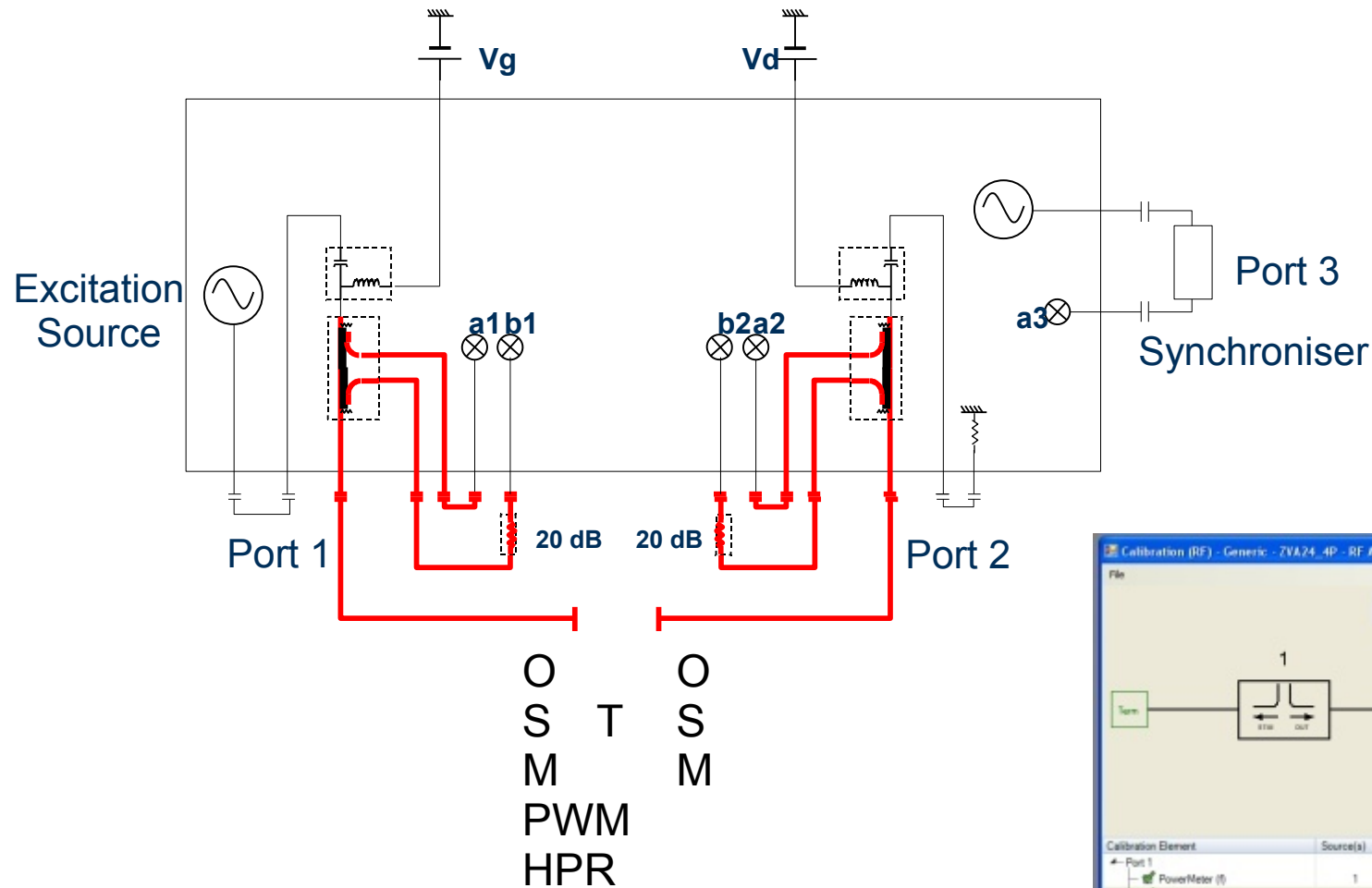
Next Step?

Calibration

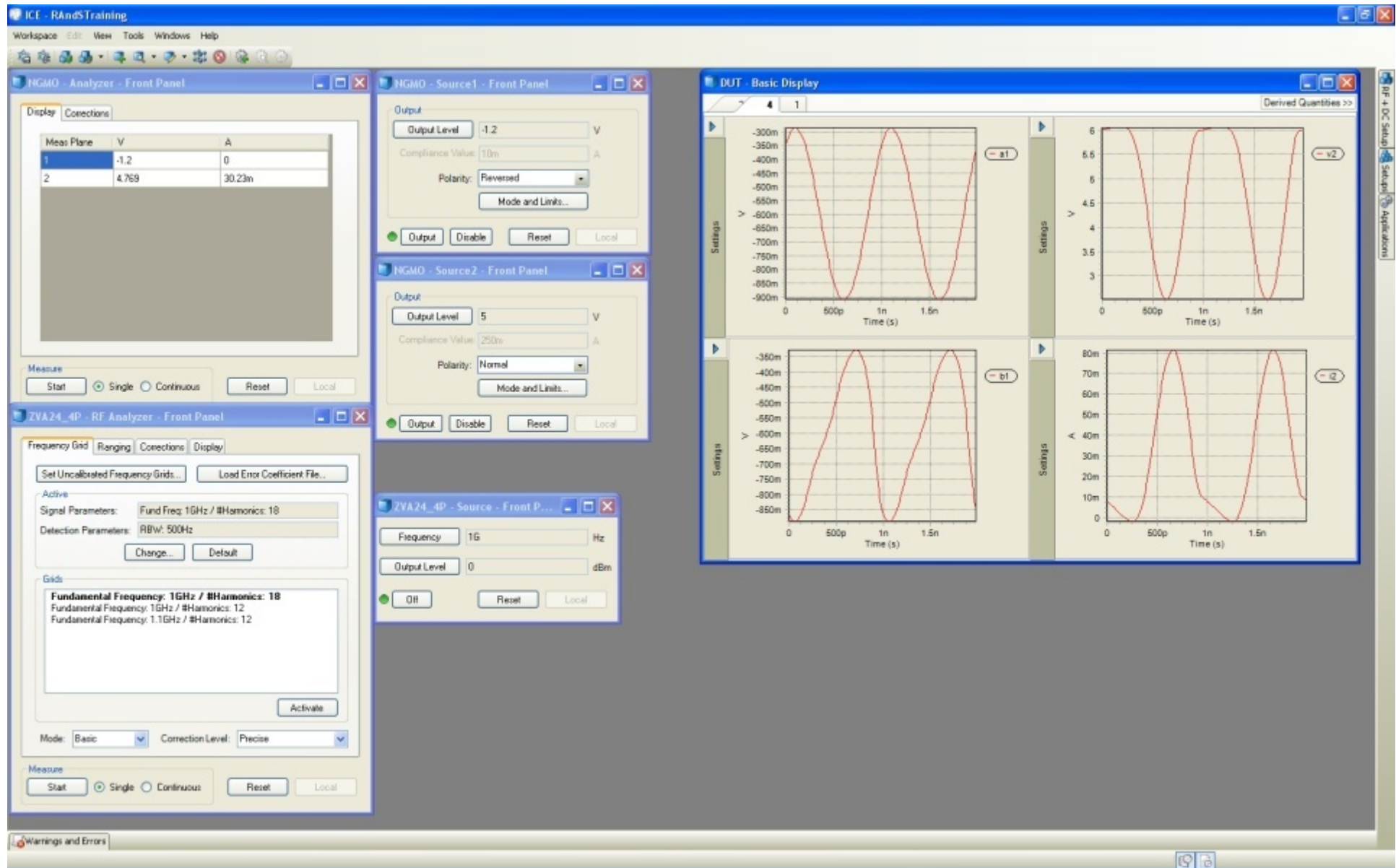
DC Calibration



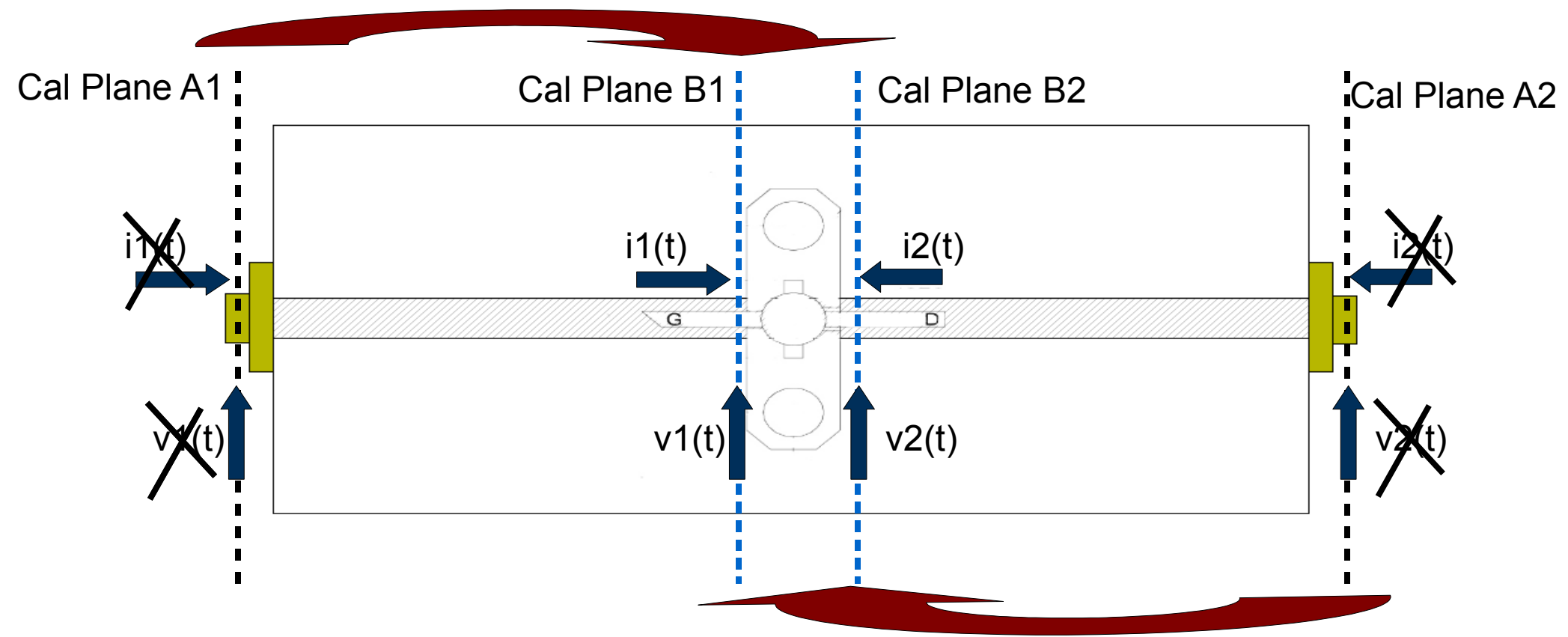
RF Calibration



DUT in pinch off?



Some words about deembedding

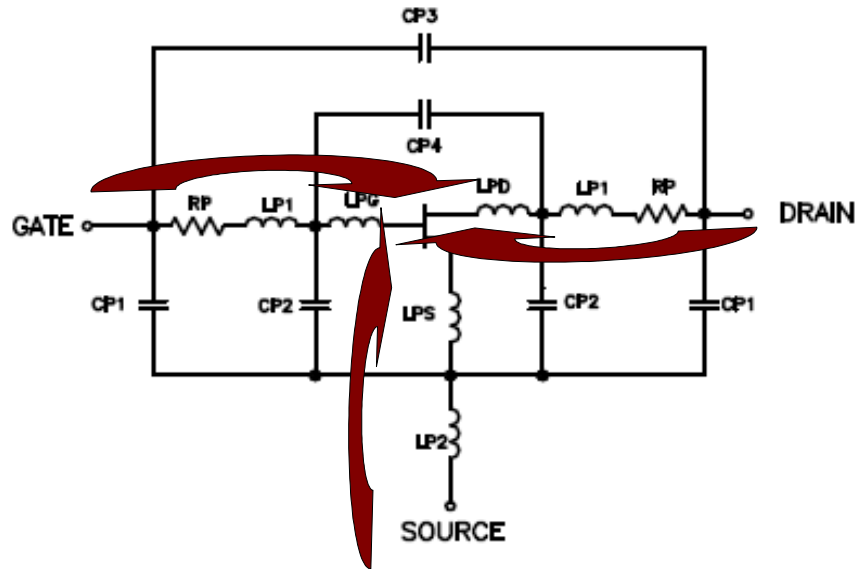


The DUT is placed on a PCB

- using calibration plane A1 and A2 we measure the behaviour of the DUT **AND** PCB
- using Multiline TRL (thru-reflect-line) we move the calibration plane to the DUT we measure the behaviour **ONLY** of the DUT

Some words about deembedding

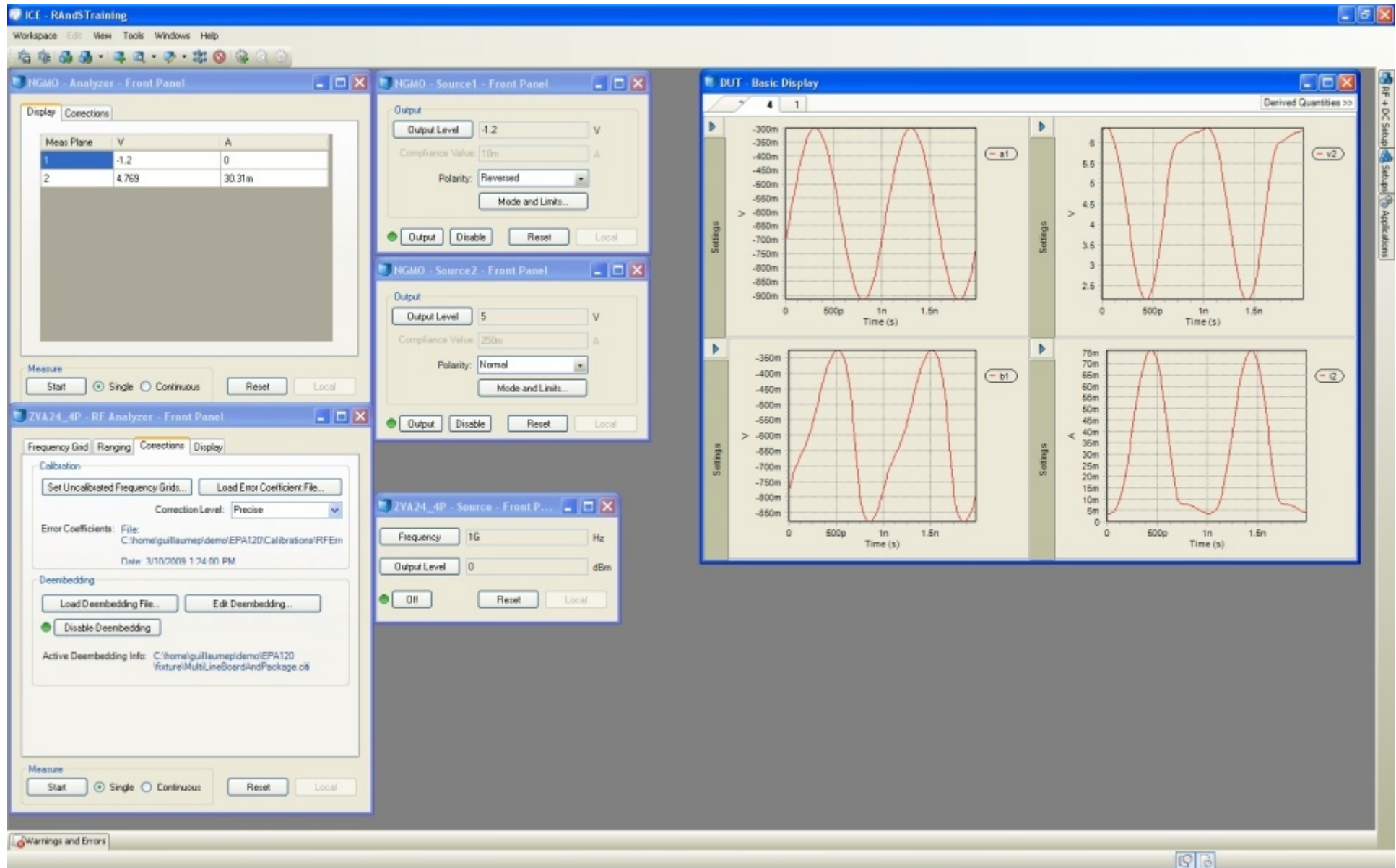
- Include package



PACKAGED FET MODEL

Using the FET Model,
provided by the manufacturer
the package can be included

DUT in pinch off (with deembedding)



ICE DC IV Application

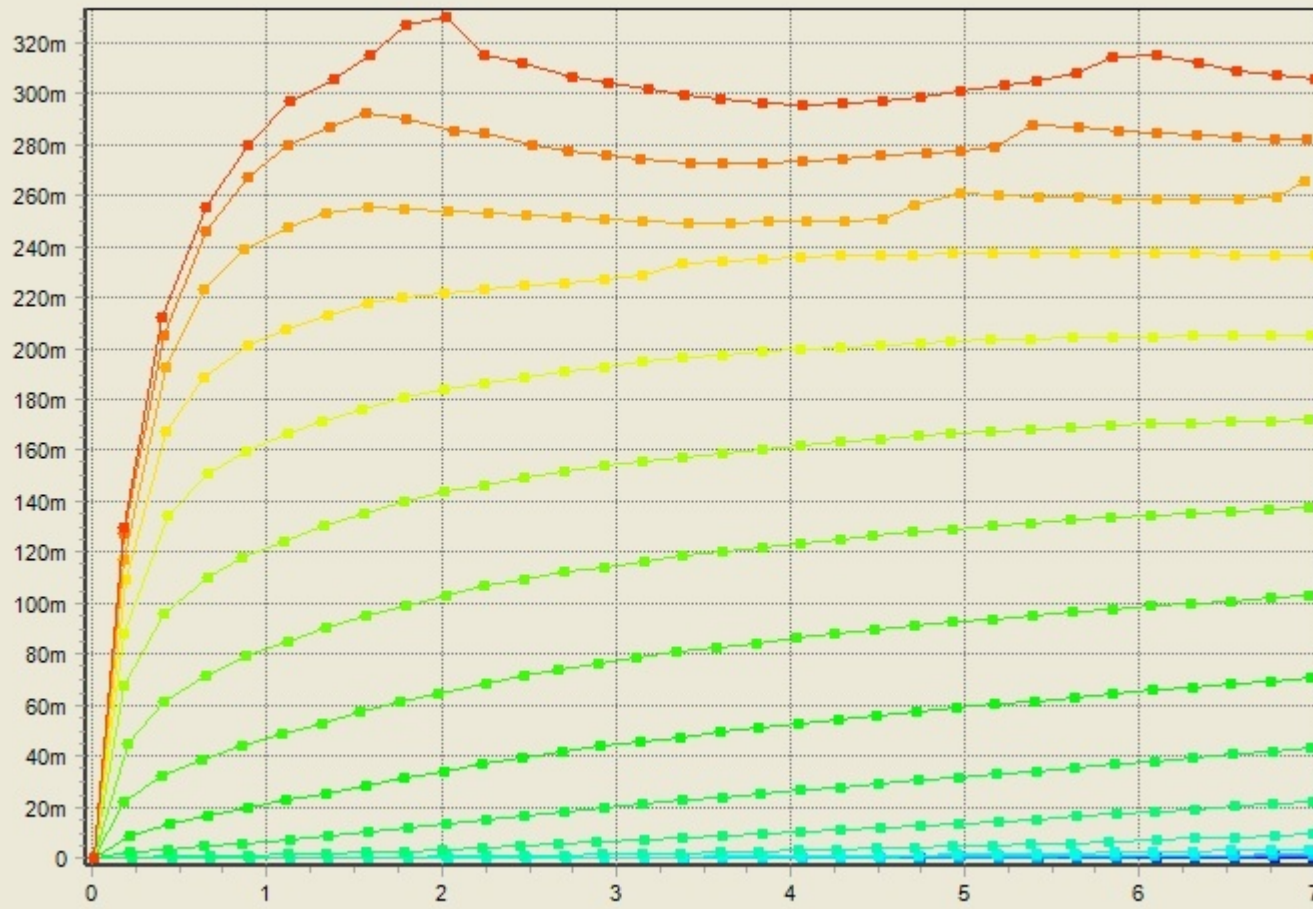
DC Sweep Parameters

Sweeps:

| | Min | Max | # Steps | Control Loop? | Max Diff | Max # Loops |
|--------|------|-------|---------|-------------------------------------|----------|-------------|
| Vgate | -1.8 | -100m | 18 | <input checked="" type="checkbox"/> | 10m | 10 |
| Vdrain | 0 | 7 | 29 | <input checked="" type="checkbox"/> | 10m | 20 |

Capability to force the control variables in the calibration plane

Defining limits at DC source and in calibration plane



DC Sweep Limits

Port: **Vdrain**

Source: **DI1**

Mode: **Voltage** Visualize...

| Voltage (V) | Current (A) |
|-------------|-------------|
| 0 | 500m |
| 15 | 500m |

Point:
Voltage (V): **0** +
Current (A): **500m** ×

Interpolation Order: **0**

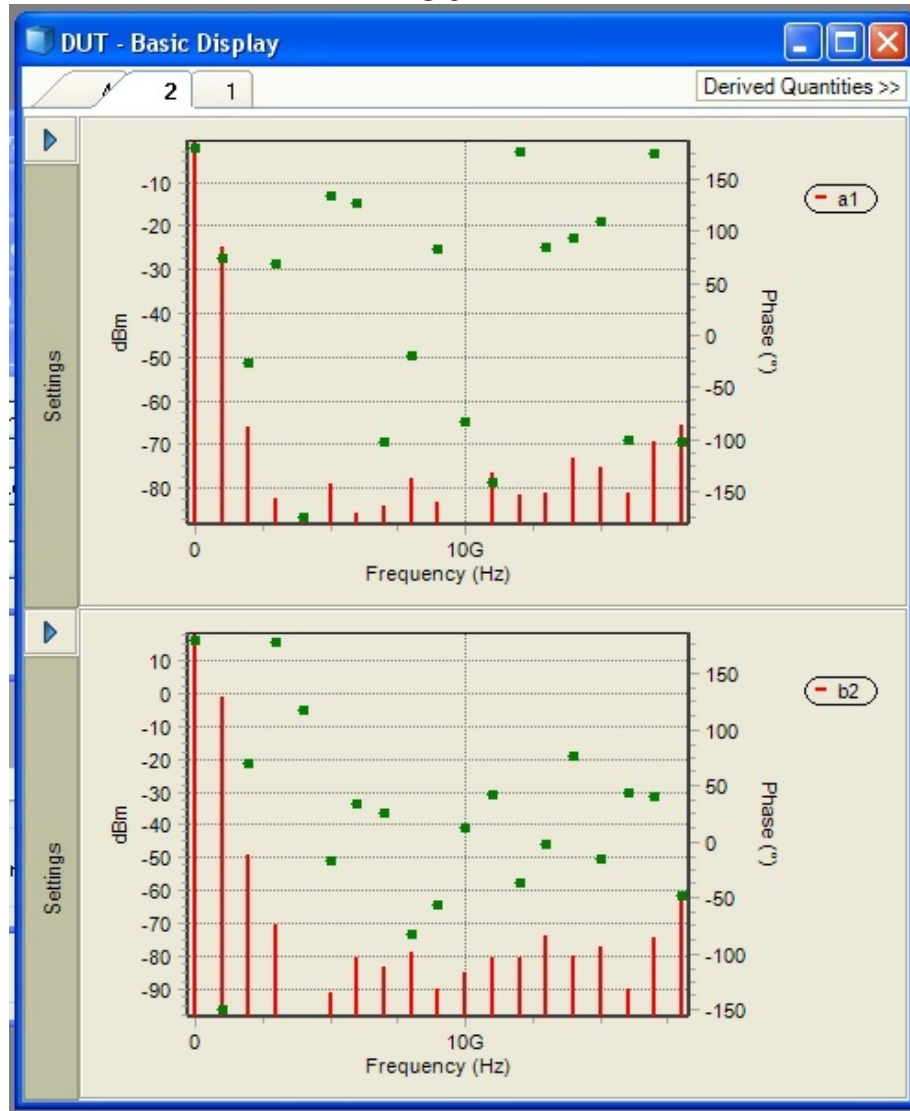
Max Power (W): **5**

OK Cancel

ZVxPlus: Frequency Domain Characterisation - Phase

$$V_{gs} = -0.6V, V_{ds} = 5V, f_0 = 1GHz$$

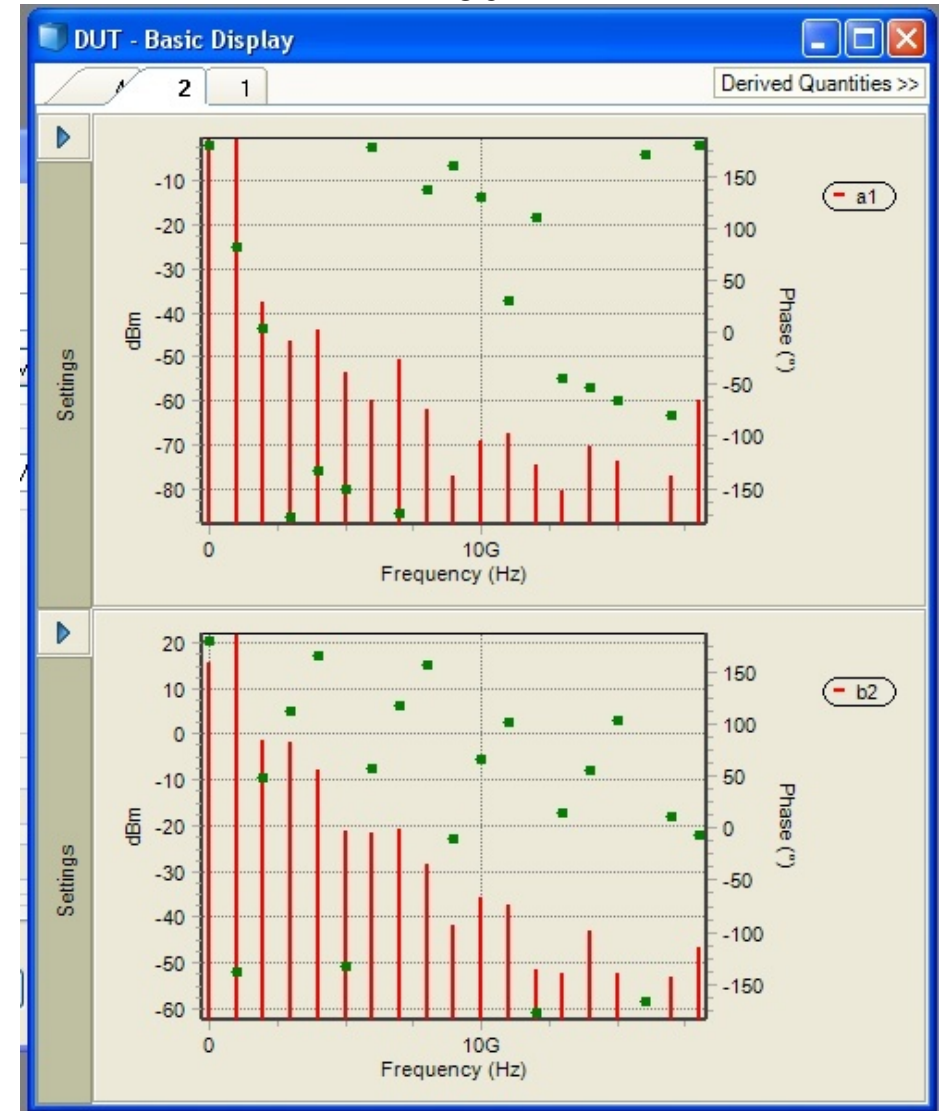
Pin = -25dBm



amplitude

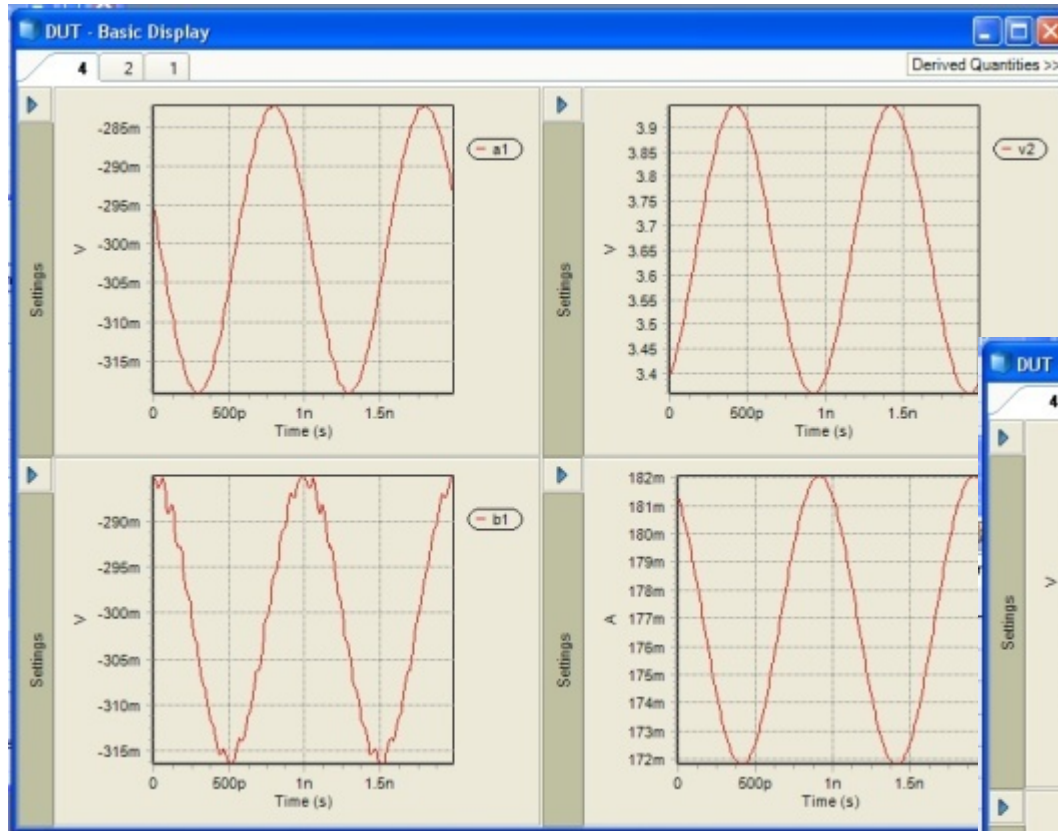
phase

Pin = 0dBm



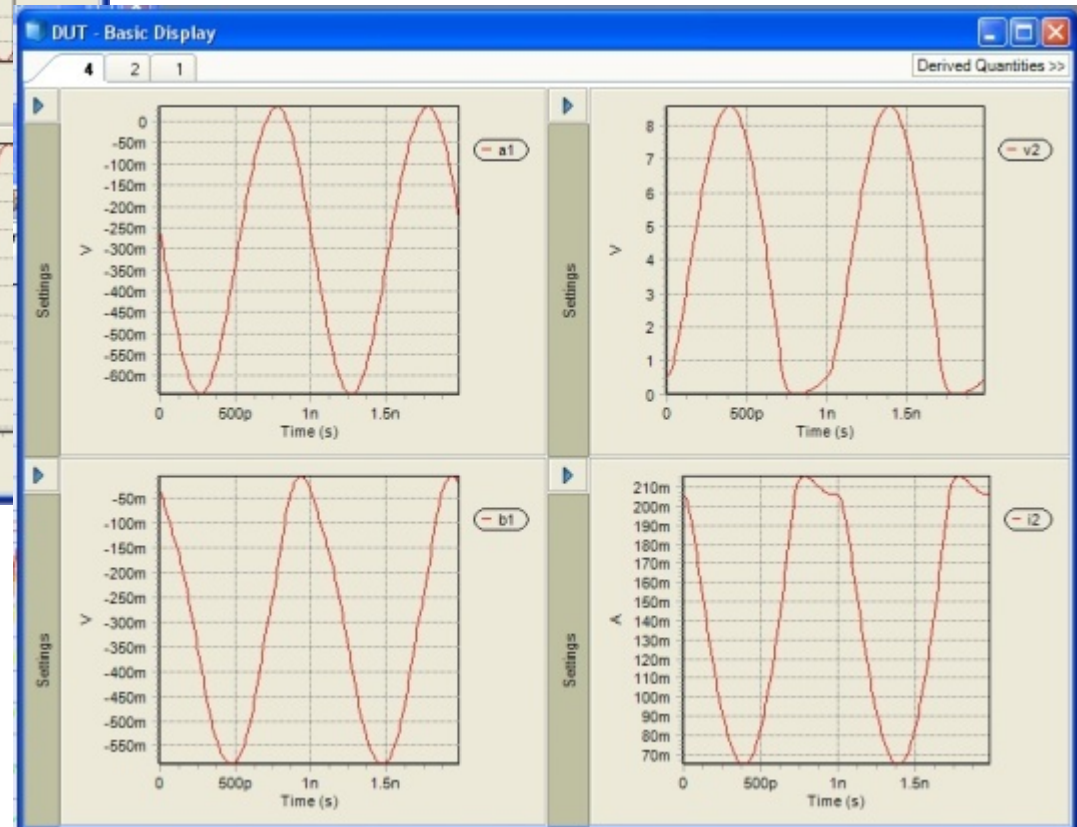
ZVxPlus: Time Domain Characterisation

$$V_{gs} = -0.6V, V_{ds} = 5V, f_0 = 1GHz$$



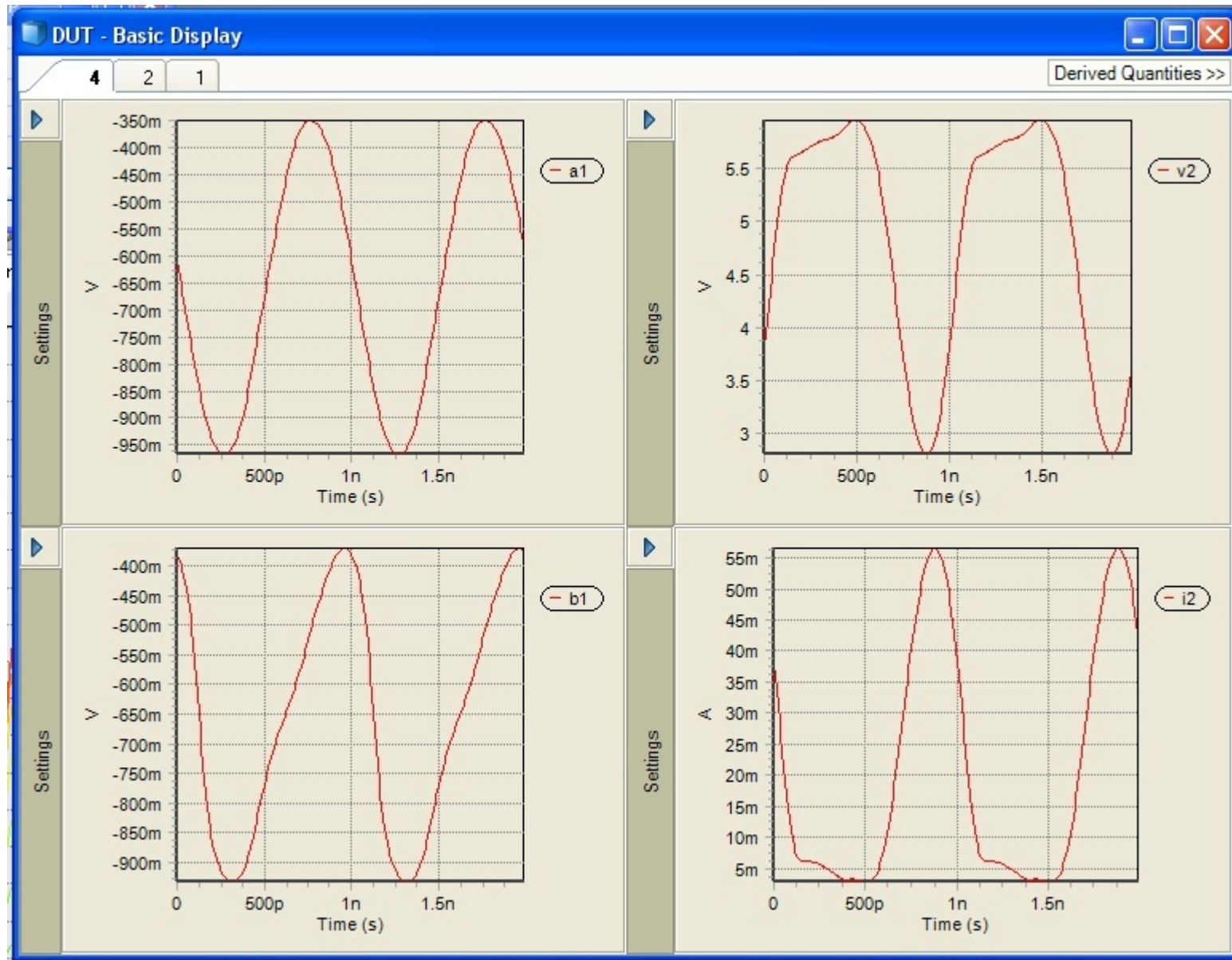
$P_{in} = 0dBm$

$P_{in} = -25dBm$

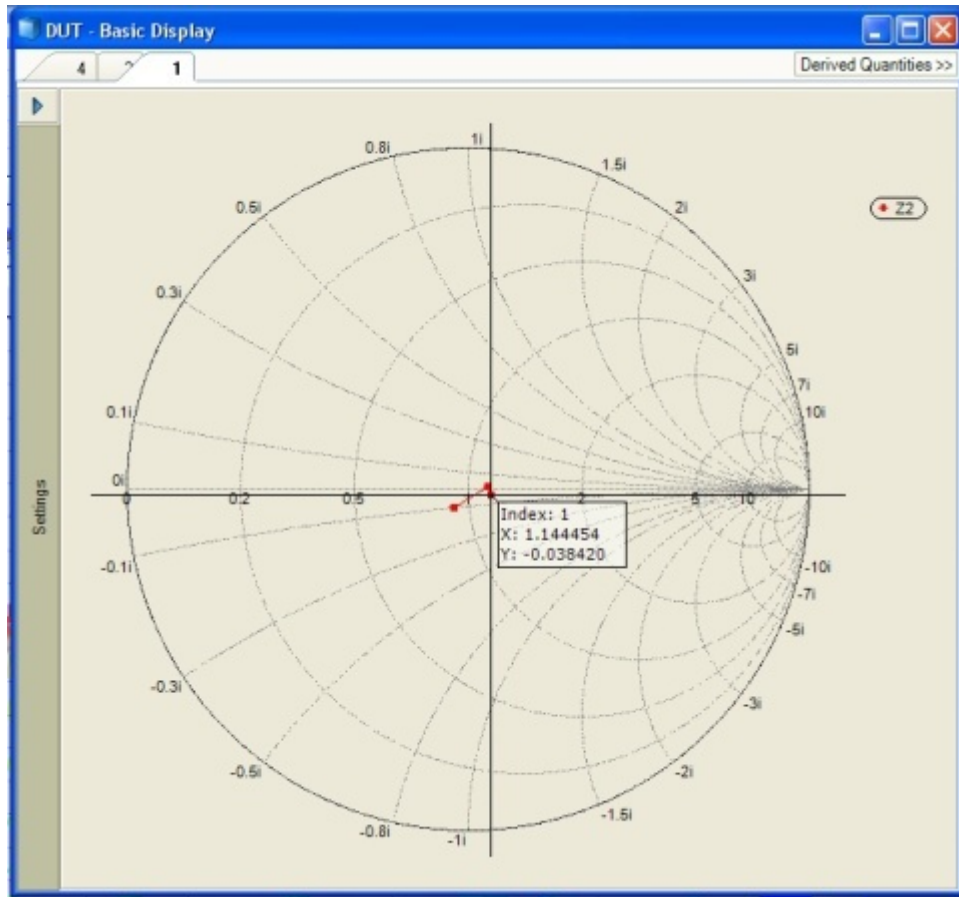


ZVxPlus: Time Domain Characterisation – Pinch Off

$$V_{gs} = -1.3V, V_{ds} = 5V, f_0 = 1GHz$$

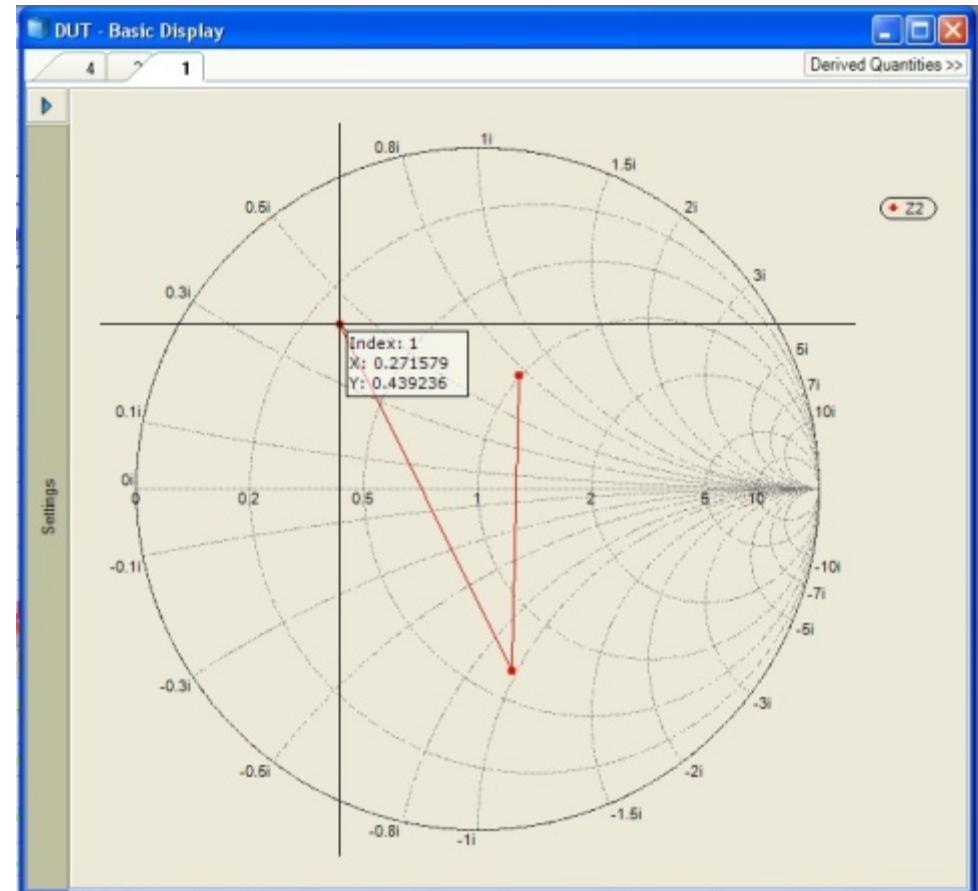


ZVxPlus: Terminating Impedances



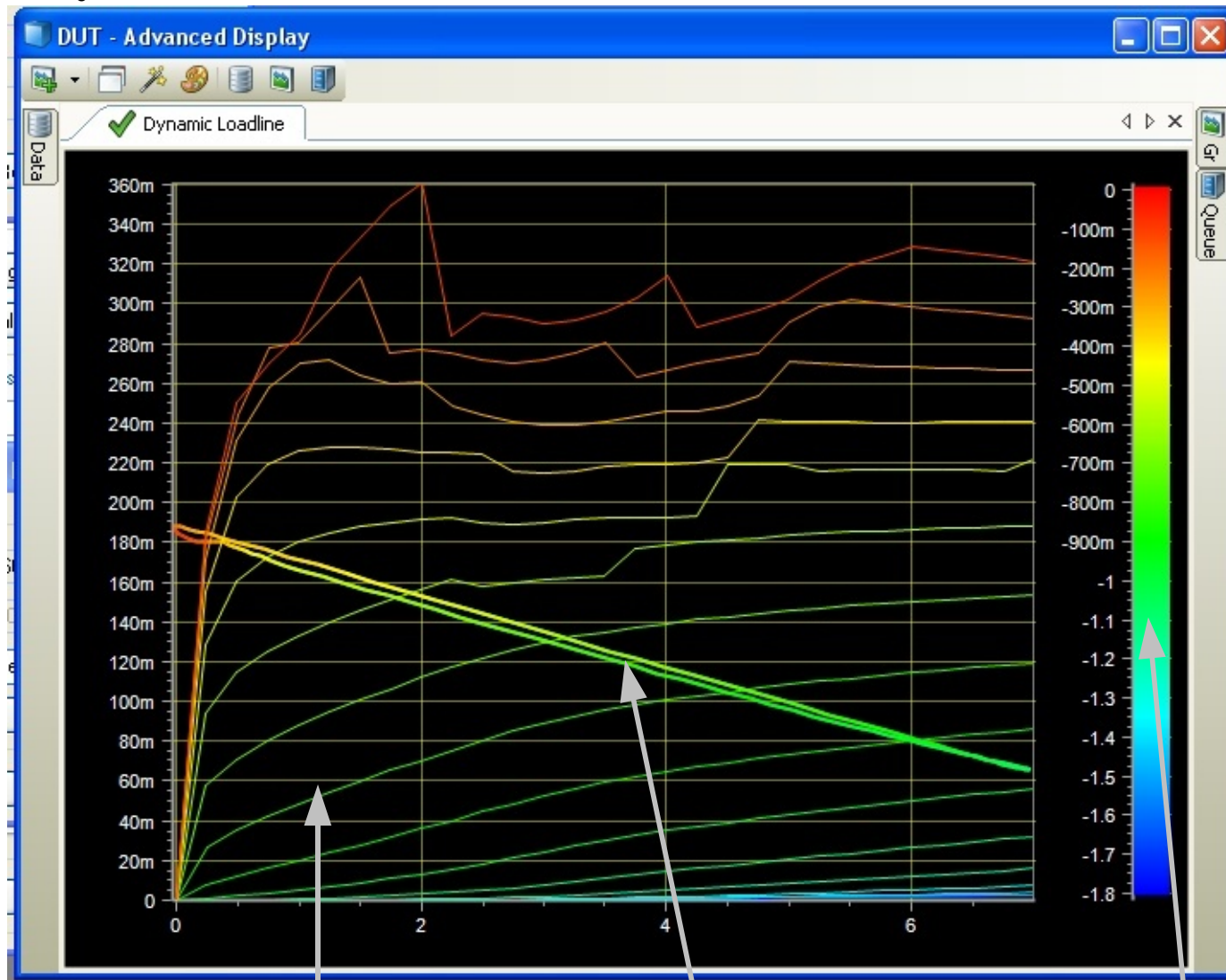
Output Impedance with 50 Ohm termination at fundamental and 2 harmonics

Output Impedance with Open termination at fundamental and 2 harmonics



ZVxPlus: Dynamic Loadline

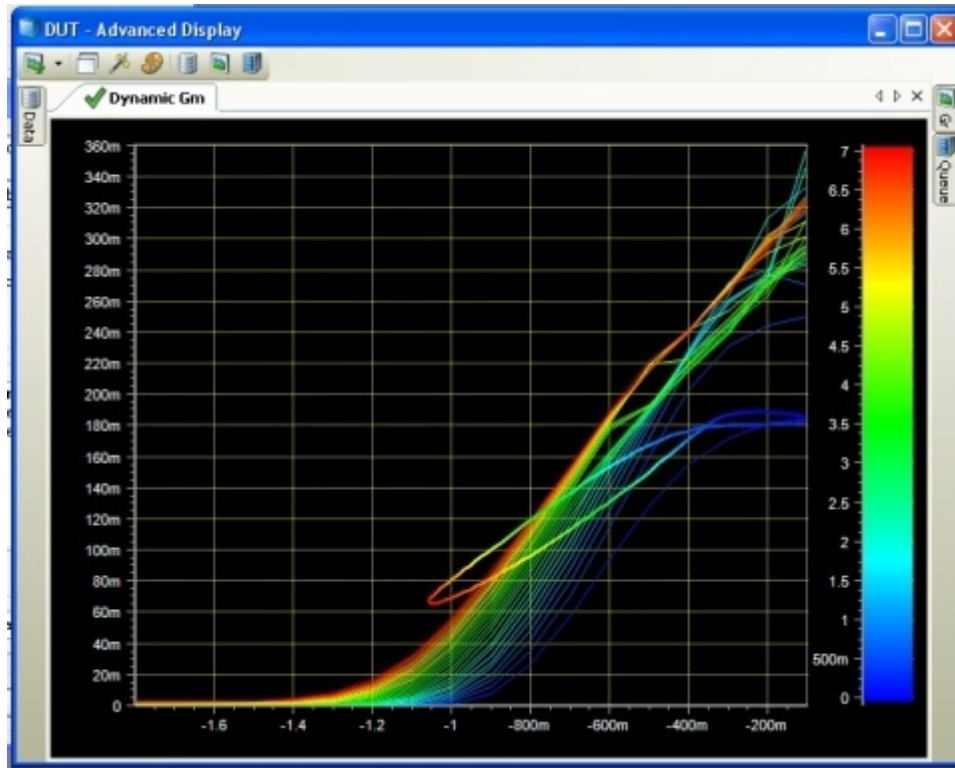
$V_{gs} = -0.6V$, $V_{ds} = 4V$ $f_0 = 1GHz$ $P_{in} = 0$ dBm



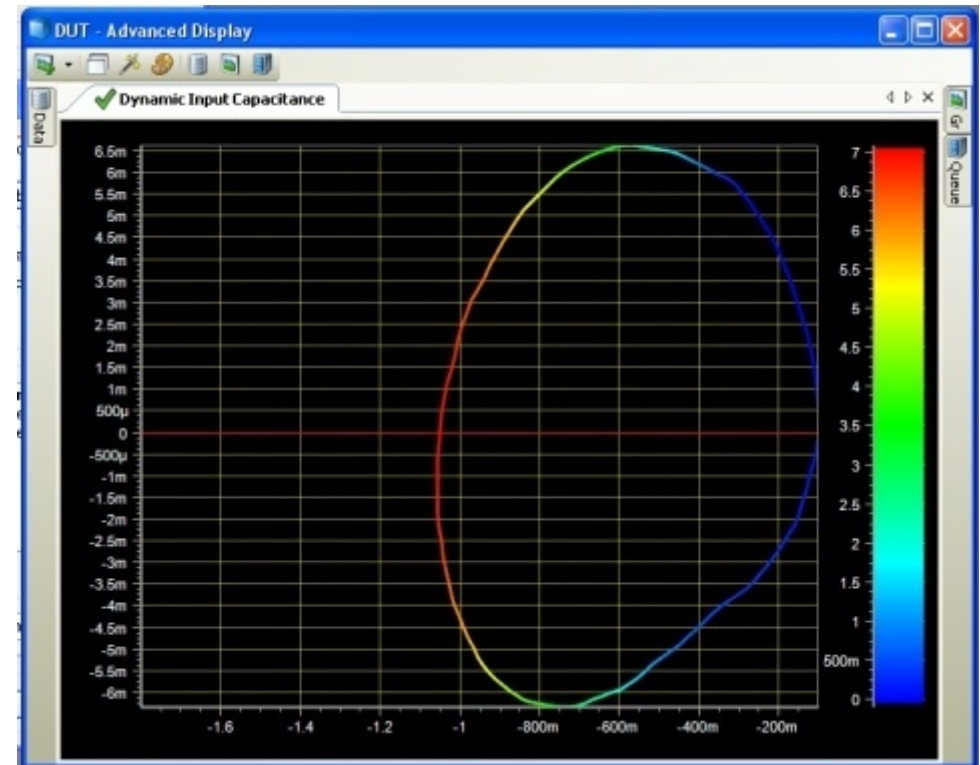
Compare the static V_{gate} with the dynamic V_{gate} through color Z-axis

ZVxPlus: Dynamic Gm and Input Capacitance

Dynamic Gm



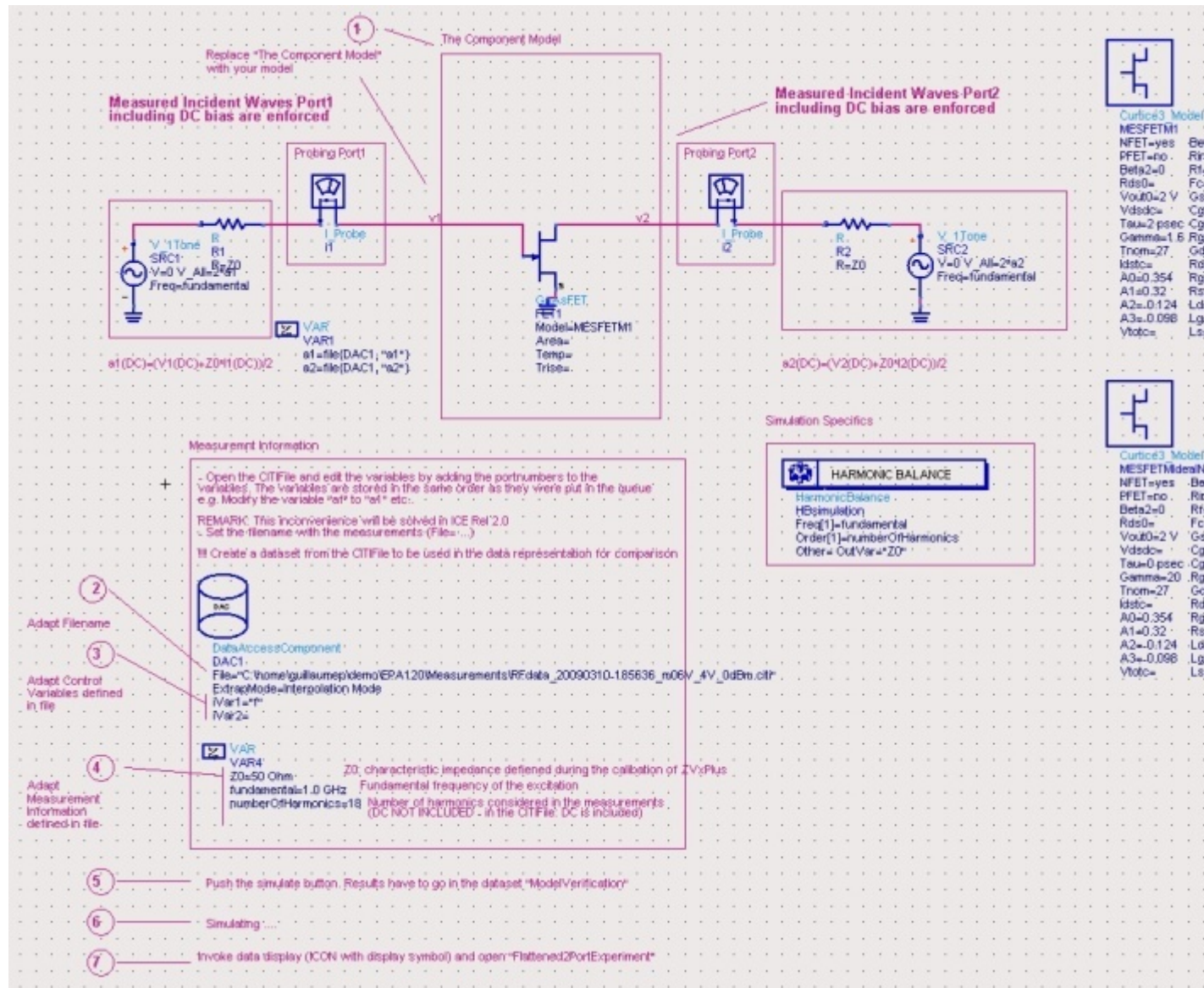
“Dynamic Input Capacitance”



Exporting Measurements



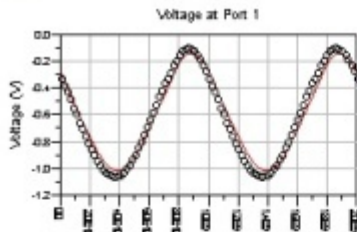
Model Verification in ADS



Measurement vs Simulation

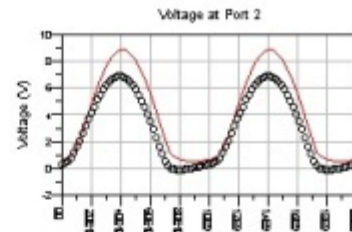
○ Measurements
— Simulations

Voltage and Current at both ports - Time Domain



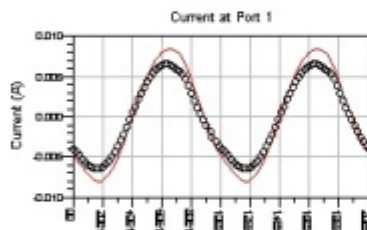
Time (s)
Simulated - Measured DC Voltage Port1

| | |
|-----------------|-----------------|
| -0.601 + j0.000 | -0.601 + j0.000 |
|-----------------|-----------------|



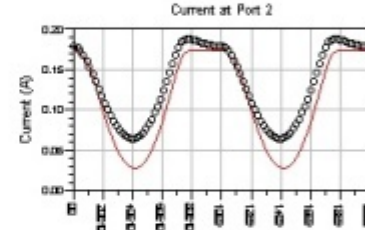
Time (s)
Simulated - Measured DC Voltage Port2

| | |
|----------------|----------------|
| 4.064 + j0.000 | 2.979 + j0.000 |
|----------------|----------------|



Simulated - Measured DC Current Port1

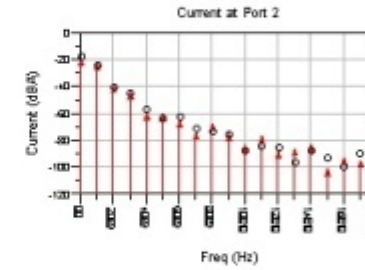
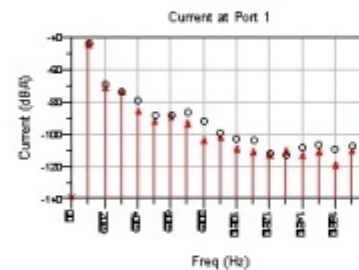
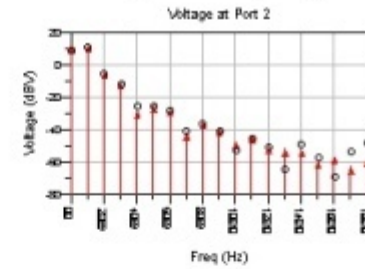
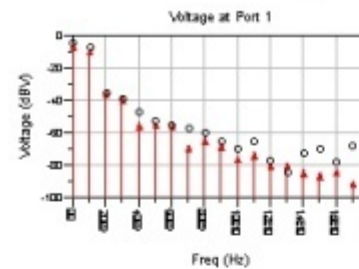
| | |
|----------------|----------------|
| 0.000 + j0.000 | 0.000 + j0.000 |
|----------------|----------------|



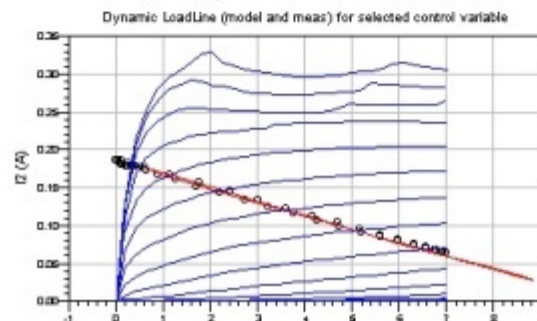
Simulated - Measured DC Current Port2

| | |
|----------------|----------------|
| 0.112 + j0.000 | 0.134 + j0.000 |
|----------------|----------------|

Voltage and Current at both ports - Frequency Domain



Dynamic Loadlines



Calculating the measured voltages / currents

Eqn v1meas=\$measurements..a1+\$measurements..b1

Eqn v2meas=\$measurements..a2+\$measurements..b2

REMARK: One needs to make sure that these equations i1meas and i2meas gets executed. Therefore, one must open the equation, change the variable name, close the equation and change it again.

Conclusions

- Prepare measurement setup and ICE
- Calibration steps
- Deembedding capability
- DC and RF Transistor Characterization
- Basic Displays
- Advanced Displays: Dynamic Lines
- Model Verification