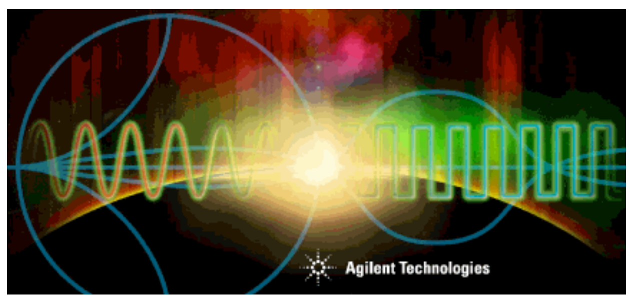
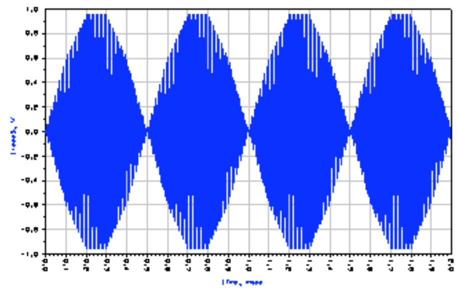
Topic 8:

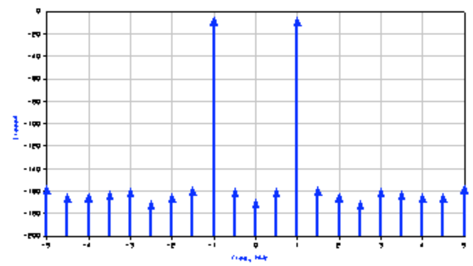
Circuit Envelope Simulation



What is Circuit Envelope ?

- Time samples the modulation envelope (not carrier)
- **Compute the spectrum at each time sample**
- **Output a time-varying spectrum**
- **Use equations on the data**
- **Faster than HB or Spice in many cases**
- **Integrates with System Simulation & Agilent Ptolemy**





Next, what tests can it perform?

Test circuits with realistic signals

GSM, CDMA, GMSK, pi/4DQPSK, QPSK, etc.

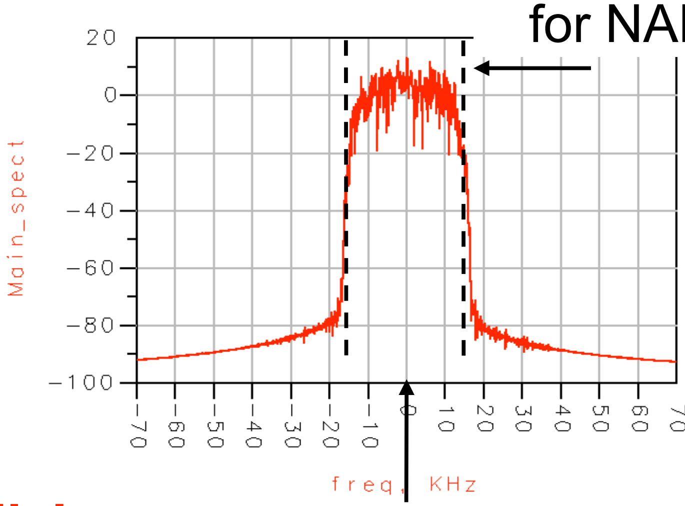
Simulations can include:

- Adjacent Channel Power Ratio
- Noise Power Ratio
- Error Vector Magnitude
- Power Added Efficiency
- Bit Error Rate

2-tone tests and linearized models do not predict this behavior as easily!

Example CE results:

32.8 kHz BW for NADC

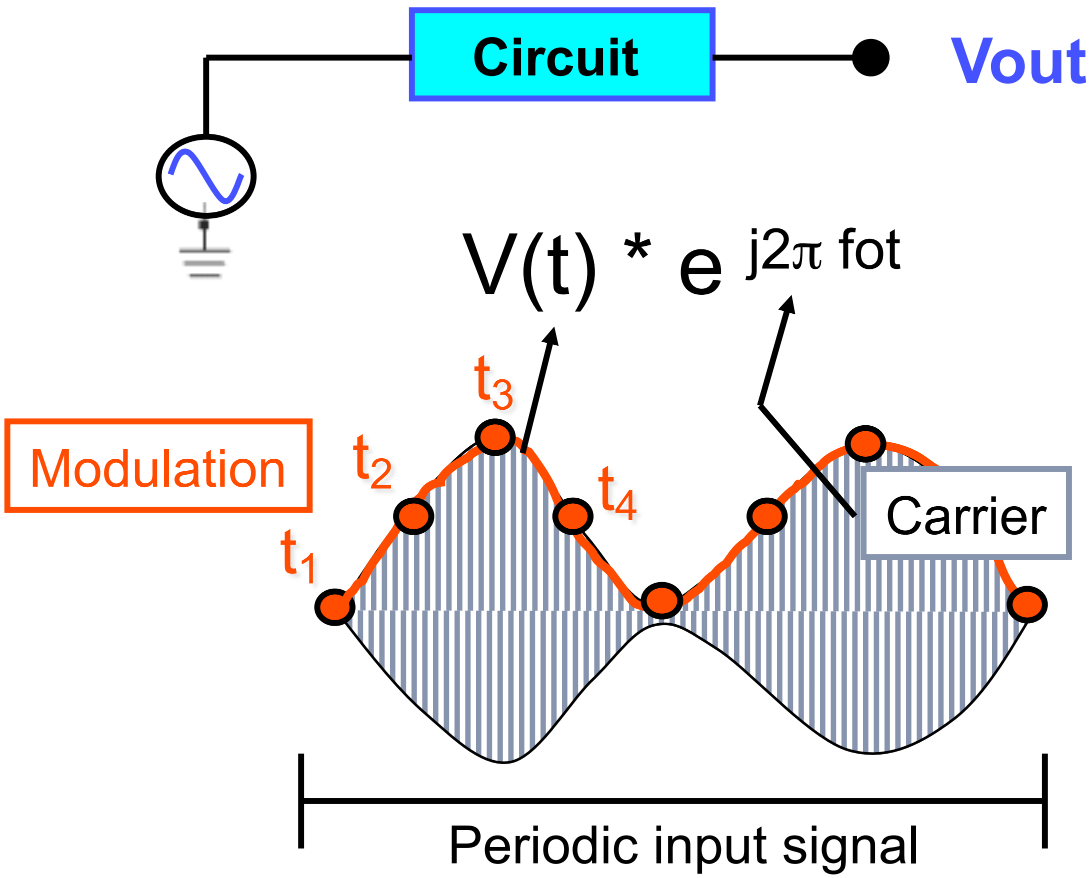


890 MHz carrier

Also, Envelope can be used for PLL simulations: lock time, spurious signals, modulation in the loop.

Next, how it works...

Circuit Envelope Technology



Time sample the envelope and then perform Harmonic Balance on the samples!

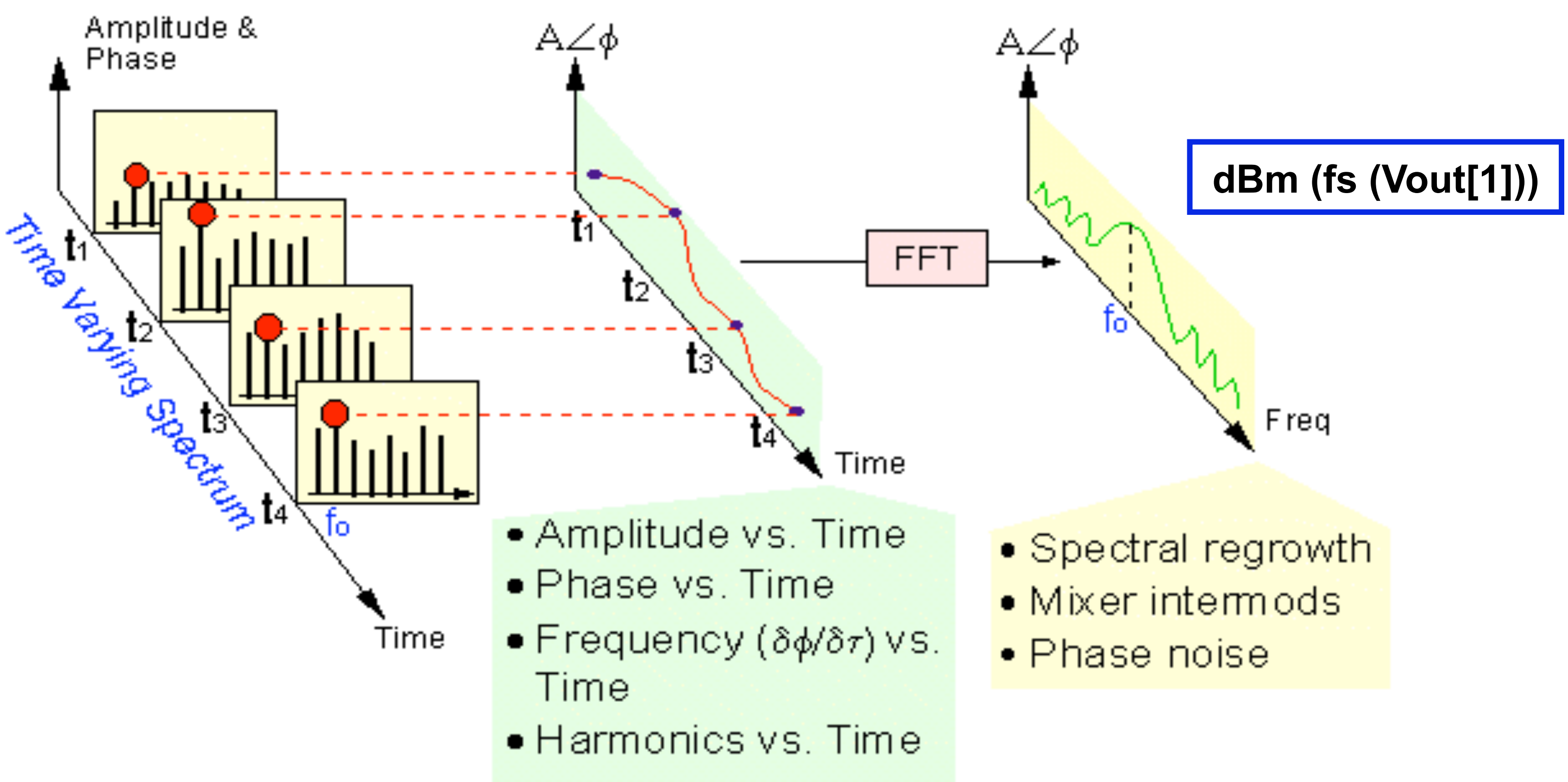
More...

NOTE: V(t) can be complex - am or fm or pm

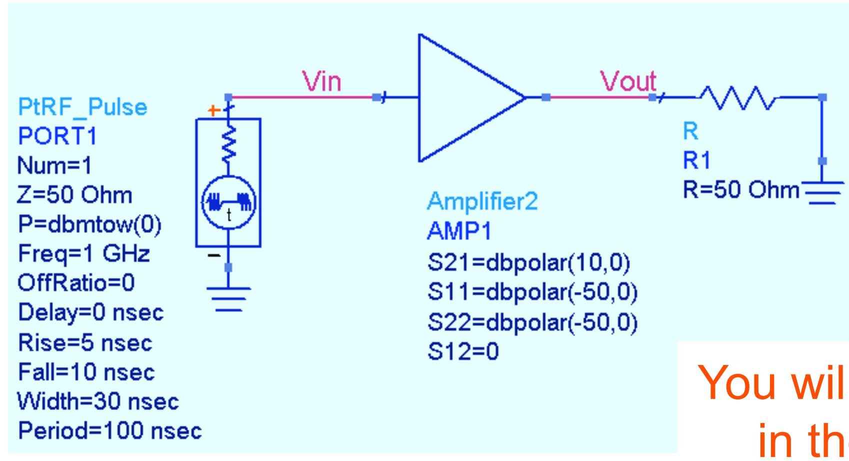
…more on CE Technology

Next, an example…

Captures time and frequency characteristics:



Example: AMP with RF pulse

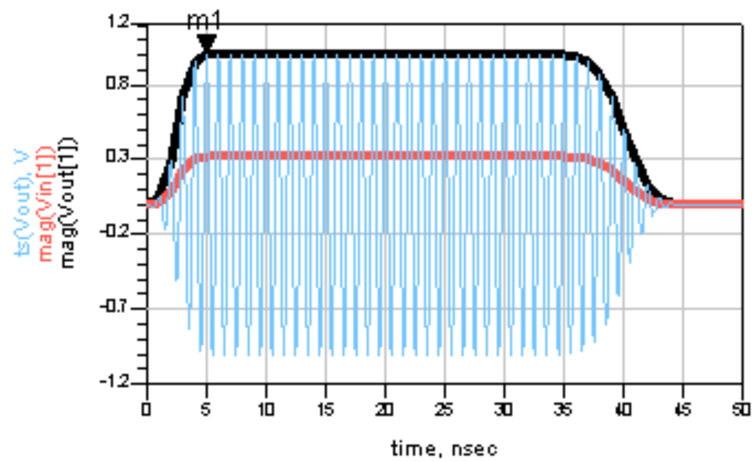


You will do this in the lab!

Step time is critical for sampling the envelope: rise, fall, and modulation rate. Therefore, Step (sample time) is NOT the same as Transient.

- **mag of Vout [1]: envelope**
- **mag of Vin [1]: envelope**
- **ts of Vout: signal**

...where [1] is the carrier: Freq[1].



Next, the controller setup...

Envelope Setup tab in the controller

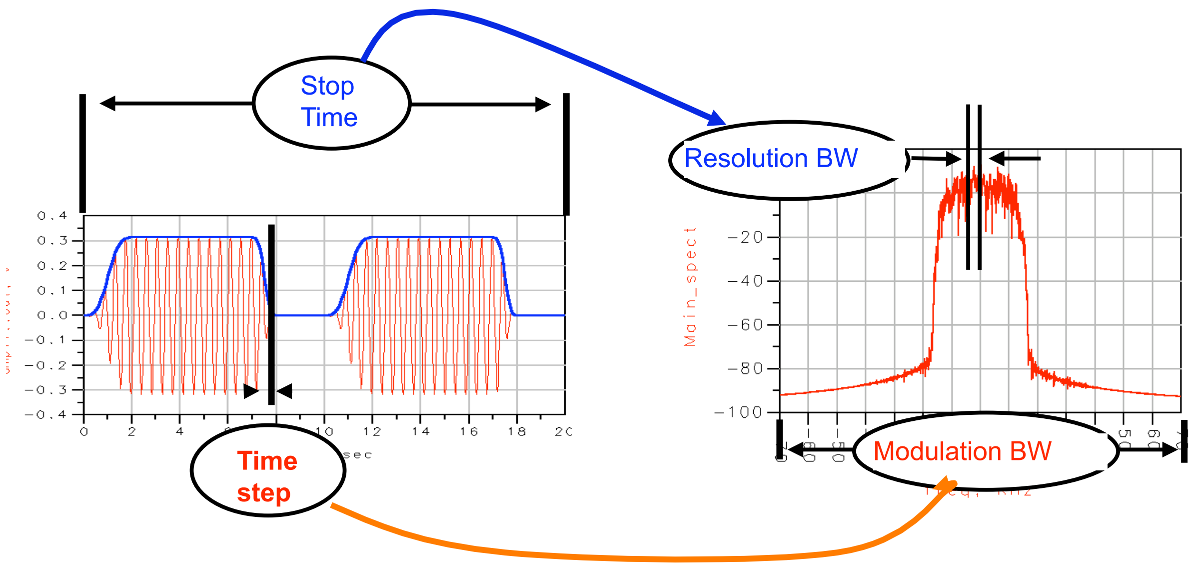
Example setup: one tone with 3 harmonics

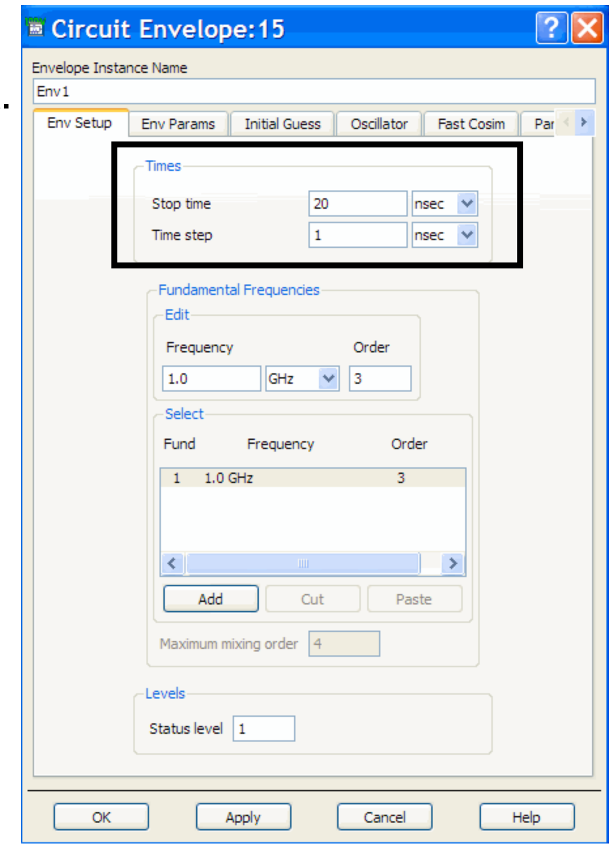
Stop time

- Determines resolution bandwidth of spectrum.
- Large enough to resolve spectral components of interest.

Time step

- Determines modulation bandwidth of the spectrum.
- Small enough to capture highest modulation frequency.



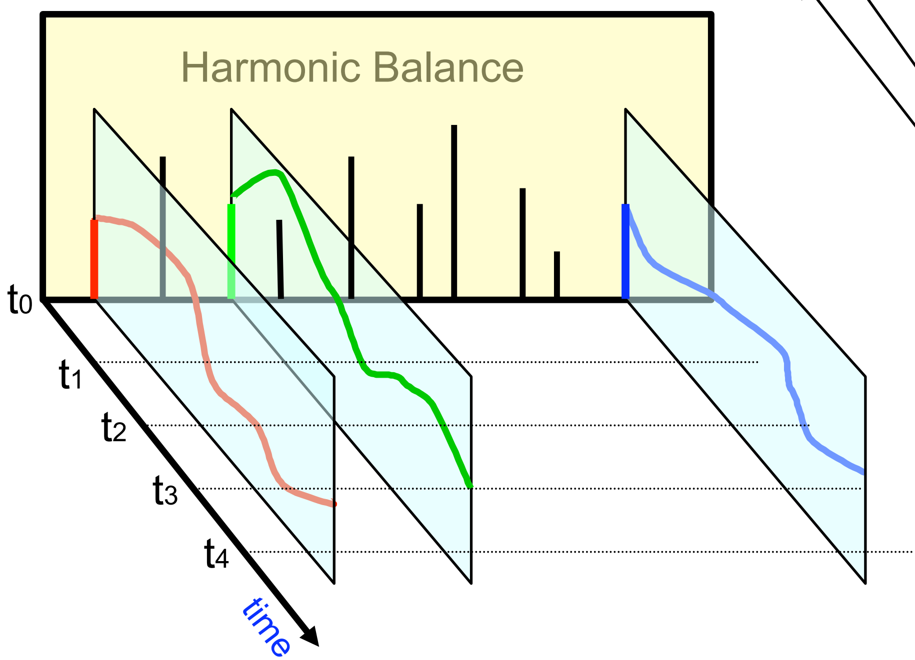


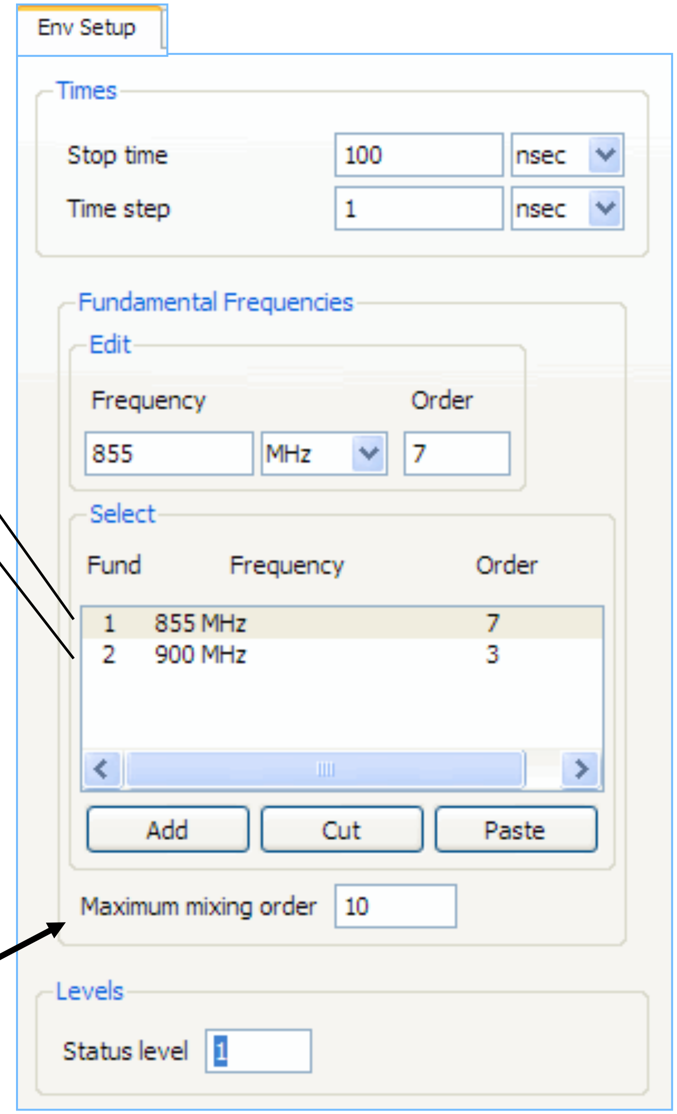
more

Envelope Setup tab (continued)

Another example: 2 tone analysis

7 Harmonics of Fundamental: Freq [1]
3 Harmonics of Fundamental: Freq [2]

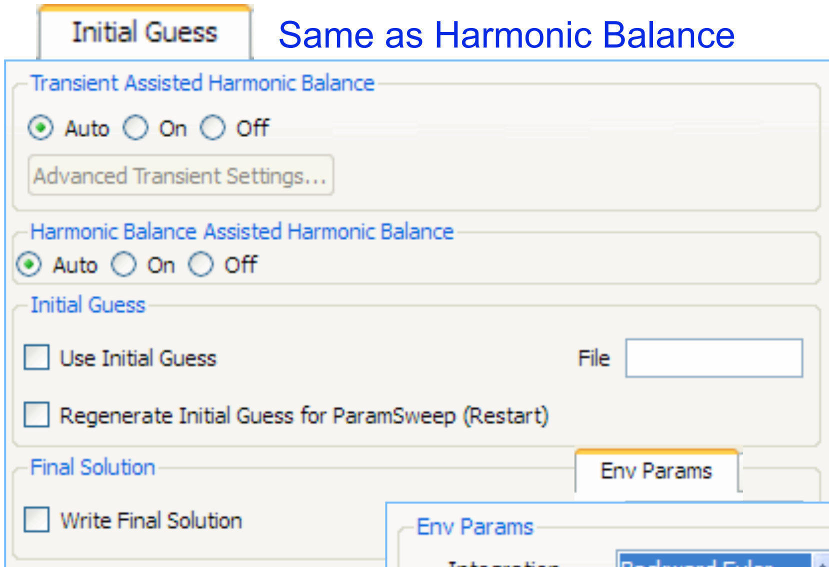


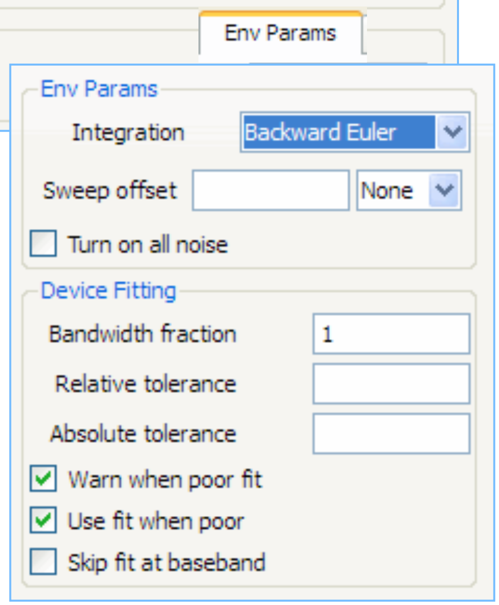


Same as HB: mixing products
If 2 or more tones.

Other CE tabs…

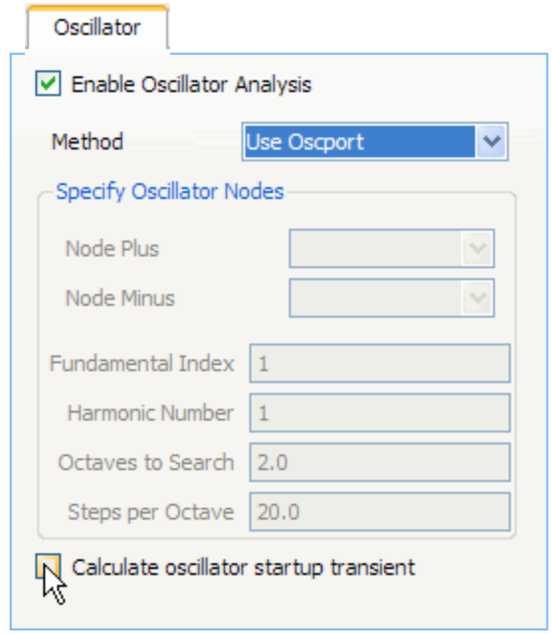
Same as Harmonic Balance



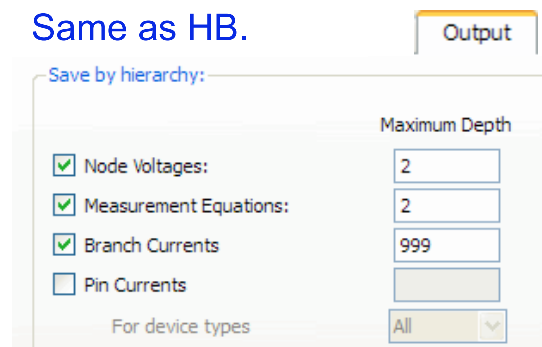


Env Params – Use for convergence issues.

Same as Harmonic Balance except for the bottom button: calculate startup transient instead of waiting for steady state.

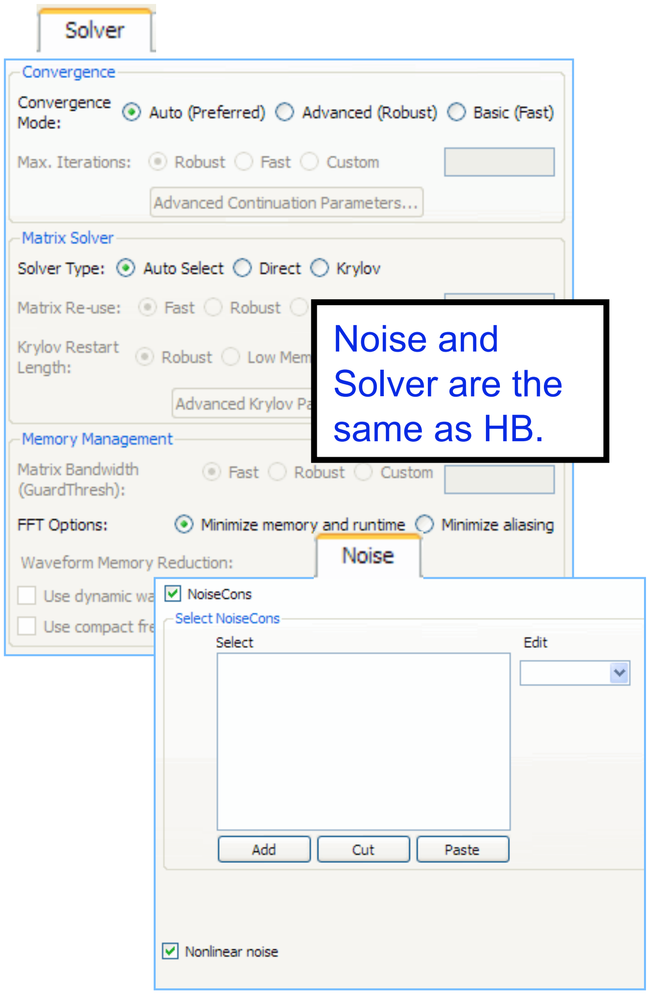


Same as HB.

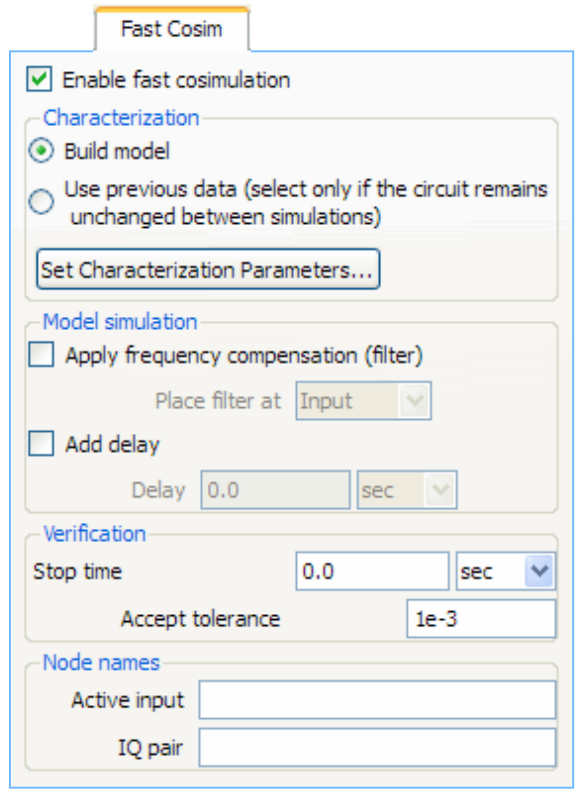


Other CE tabs (continued)

LAB



Noise and Solver are the same as HB.



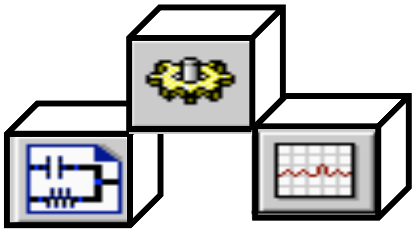
Cosim is for use with Ptolemy co-simulations. It builds a behavioral model (Automatic Verification Modeling) for single input/output RF circuits which runs faster than co-simulating with the device model.

What the lab is about ...

Lab 8:

Circuit Envelope Simulations

Steps in the Design Process

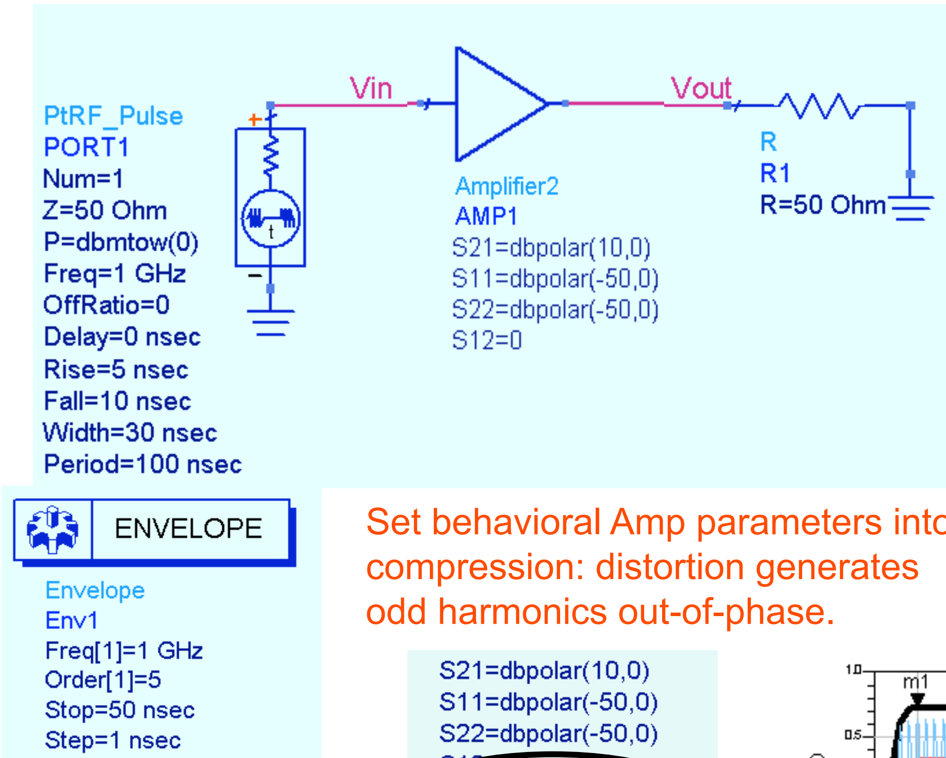


- Design the RF sys behavioral model receiver
- Test conversion gain, spectrum, etc.
- Start amp_1900 design – subckt parasitics
- Simulate amp DC conditions & bias network
- Simulate amp AC response - verify gain
- Test amp noise contributions – tune parameters
- Simulate amp S-parameter response
- Create a matching topology
- Optimize the amp in & out matching networks
- Filter design – lumped 200MHz LPF
- Filter design – microstrip 1900 MHz BPF
- Transient and Momentum filter analysis
- Amp spectrum, delivered power, Zin - HB
- Test amp comp, distortion, two-tone, TOI
- **CE basics for spectrum and baseband**
- **CE for amp_1900 with GSM source**
- Replace amp and filters in rf_sys receiver
- Test conversion gain, NF, swept LO power
- Final CDMA system test CE with fancy DDS
- Co-simulation of behavioral system

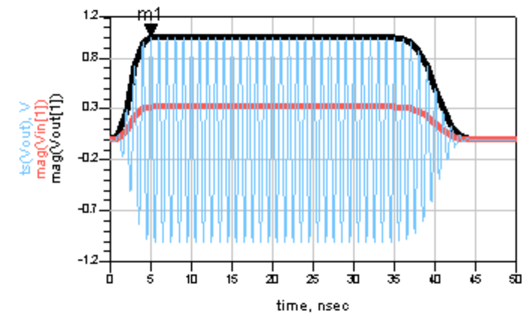
You are here: →

First, simulate using an RF pulse

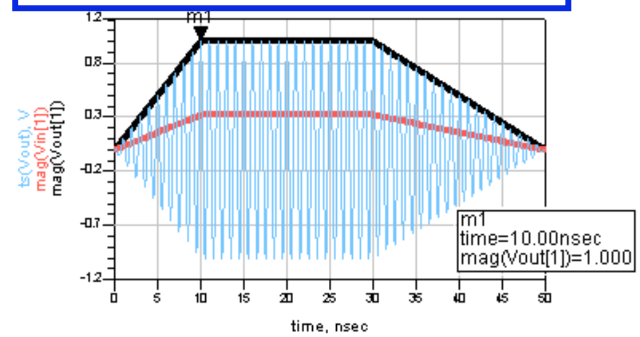
Behavioral amp and different time steps:



Vary step time.

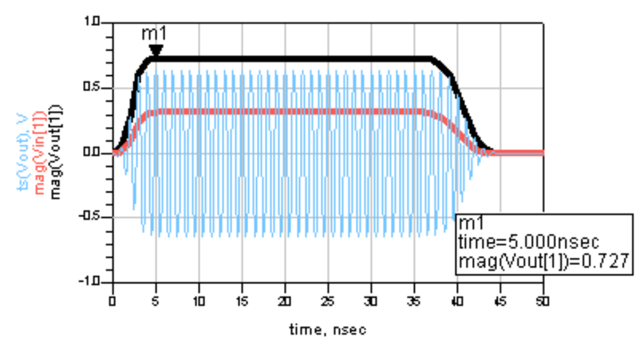


Time Step: 1 nsec vs 10 ns

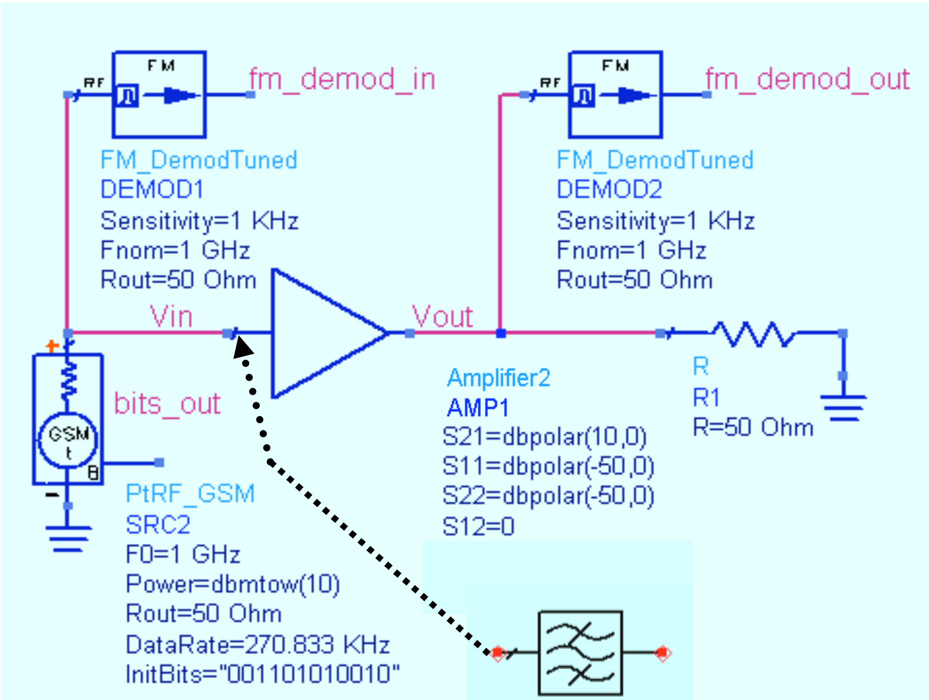


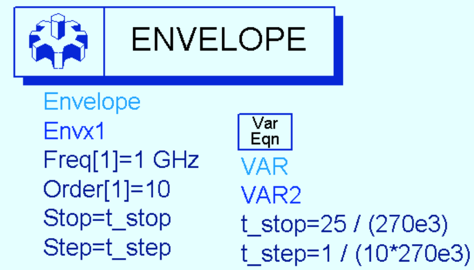
Set behavioral Amp parameters into compression: distortion generates odd harmonics out-of-phase.

S21=dbpolar(10,0)
S11=dbpolar(-50,0)
S22=dbpolar(-50,0)
S12=0.
GainCompPower=5
GainComp=1 dB

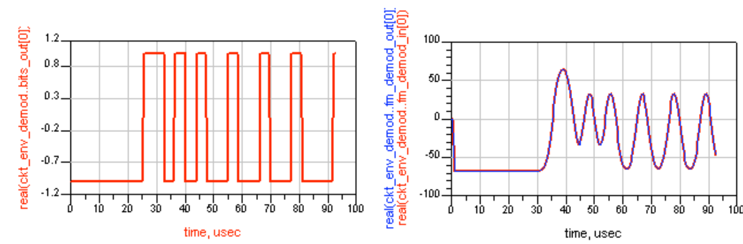


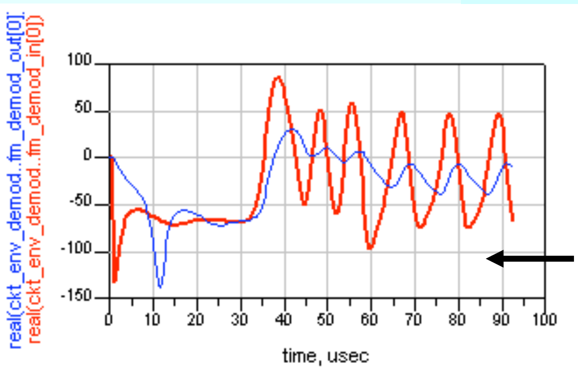
Next, use a GSM source and demodulators





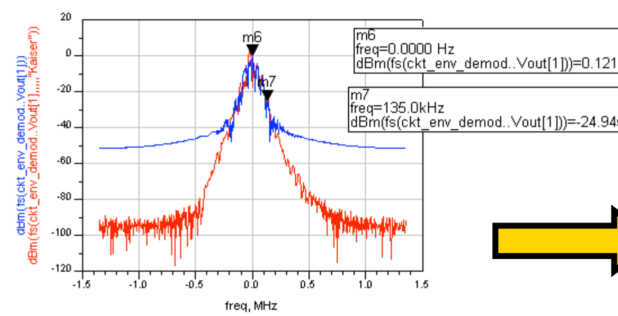
Plot: **bits_out** and **fm_demod**





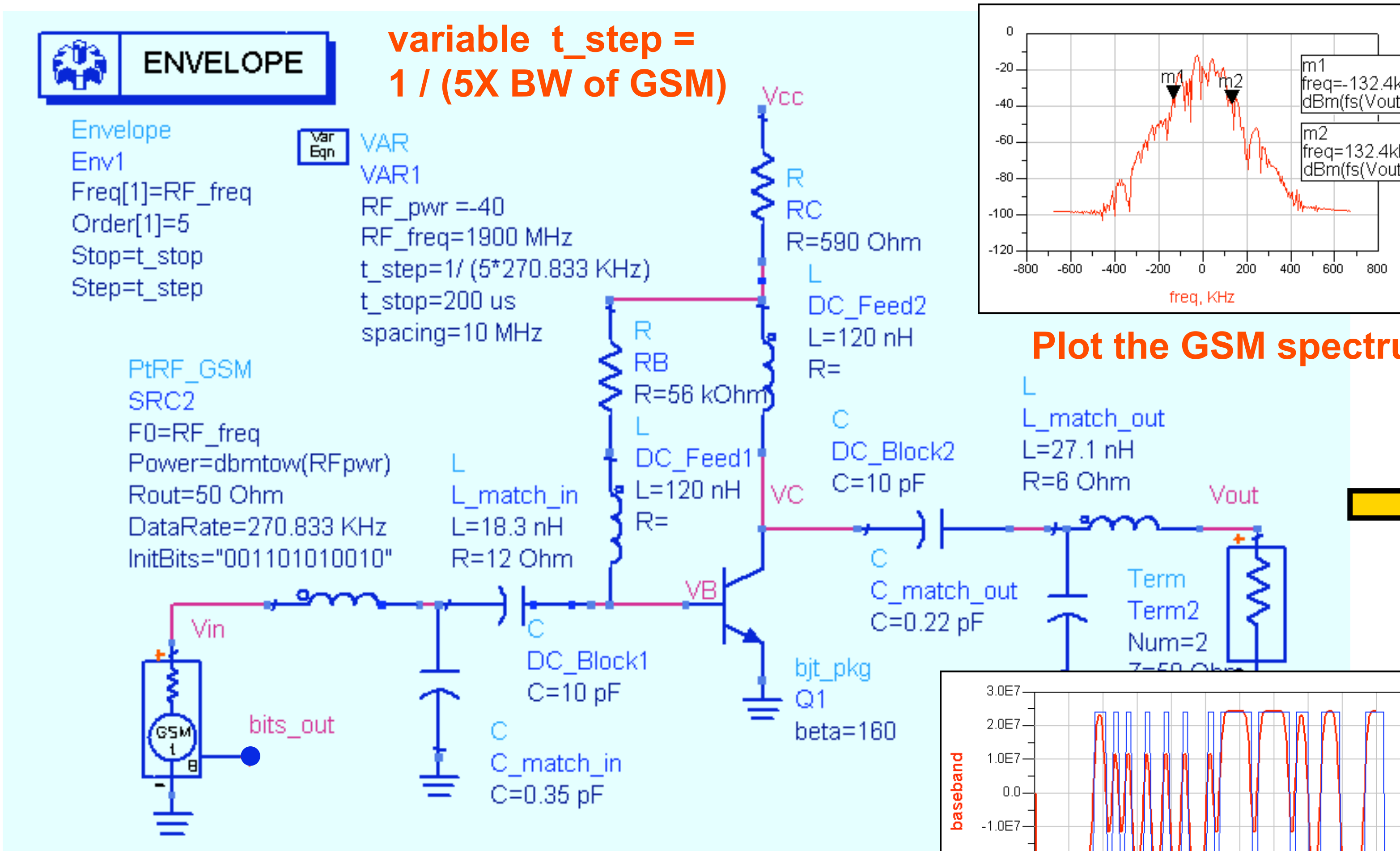
Also, insert a filter at **Vin** to alter the phase. See the difference at fm_demods.

Plot the GSM BW spectrum with with and without windowing.



Finally, use AMP_1900 with the GSM source

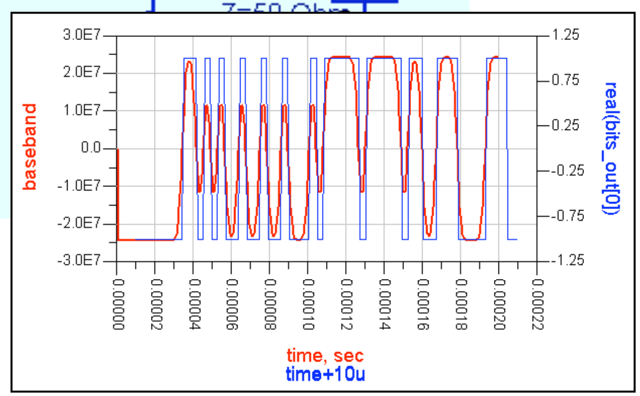
variable t_step = 1 / (5X BW of GSM)



Plot the GSM spectrum

Verify baseband integrity using an equation to demodulate the signal and compare bits.

Eqn baseband=diff (unwrap (phase (Vout [1])) / 360)



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Optional - channel power calculation

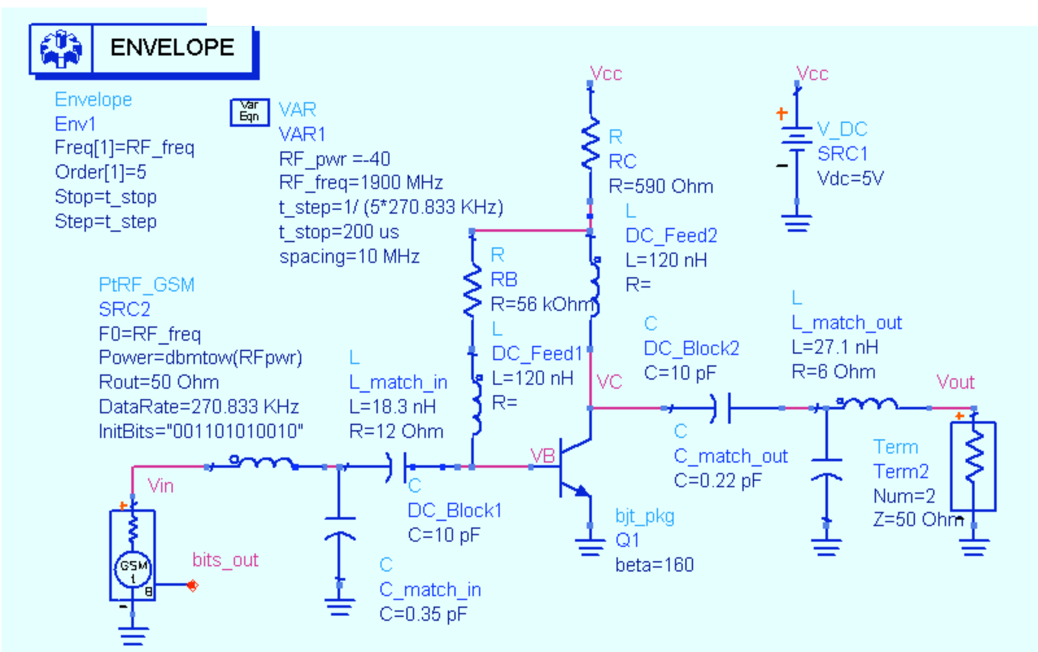
On a new page in DDS, write two equations:

Limits: **defines the bandwidth and**

channel_pwr: **calculates power in the channel.**

Eqn limits= {-(270KHz / 2), (270KHz / 2)}

Eqn channel_pwr=10*log(channel_power_vr (Vout[1], 50, limits, "Kaiser"))+30



No need to resimulate, use Vout[1] which is 1900 MHz!

channel_pwr
-4.886