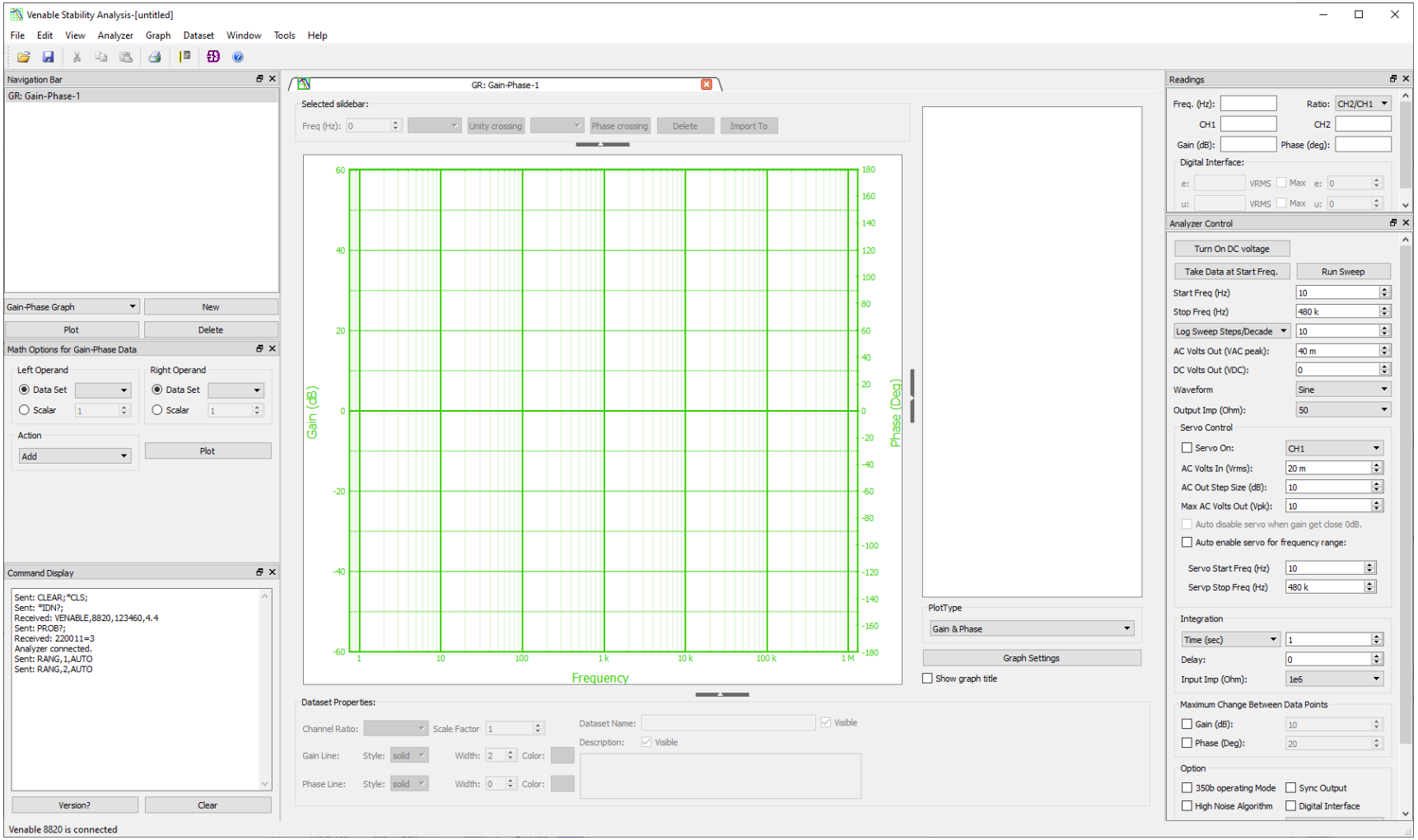
Venable Instruments
Training Session

Stabilizing Power Supply Control Loops

Venable 7.0 Stability Analysis Software



Version 7 Stability Analysis Software

- Python based: platform independent and fewer lines of code
- Docking windows and tabbed structure
- Multiple graphs with multiple plots can be saved in one file
- Software uses Windows ® USB driver
- Plug and play with easy connection to the analyzer
- Compatible with Windows® 7, 8, 8.1, 10 and 11

Venable 7440

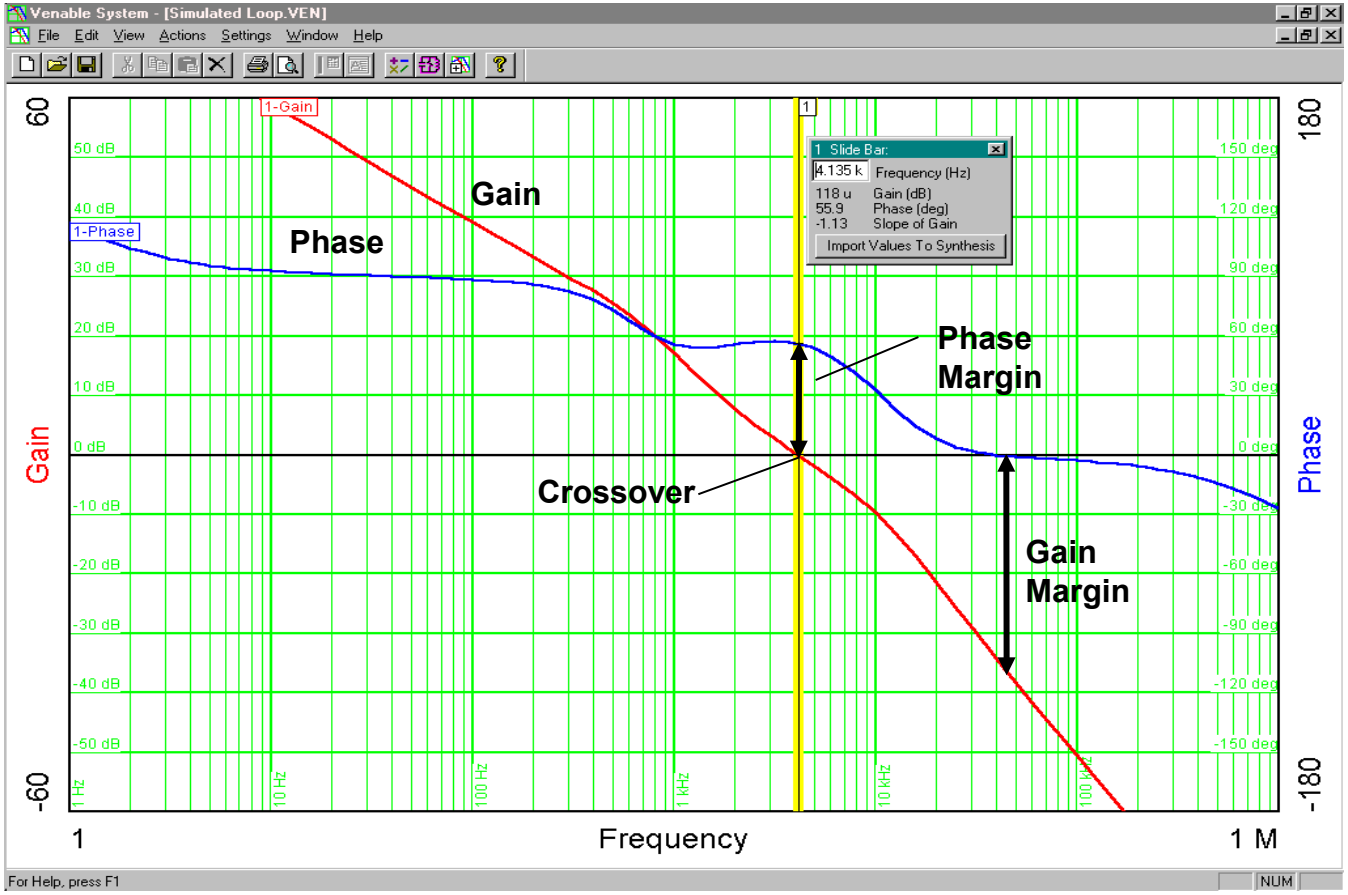
Specifications

- 10 **μ**Hz to 5/20/40 MHz
- 2, 3, or 4 Input channels
- 10mVpk-500Vpk input range
- Generator and channels isolated to 600 Vpk
- Can measure absolute phase referred to the generator
- IEEE 488 and USB 2.0 are standard interfaces

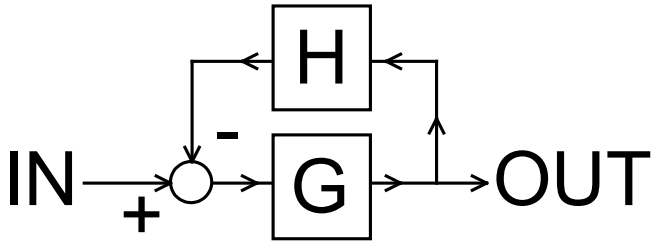
Loop Gain Measurements

- Stability Criteria
- Loop Gain Measurements
- Stabilizing Feedback Loops

Closed Loop Circuit Bode Plot of Loop Gain



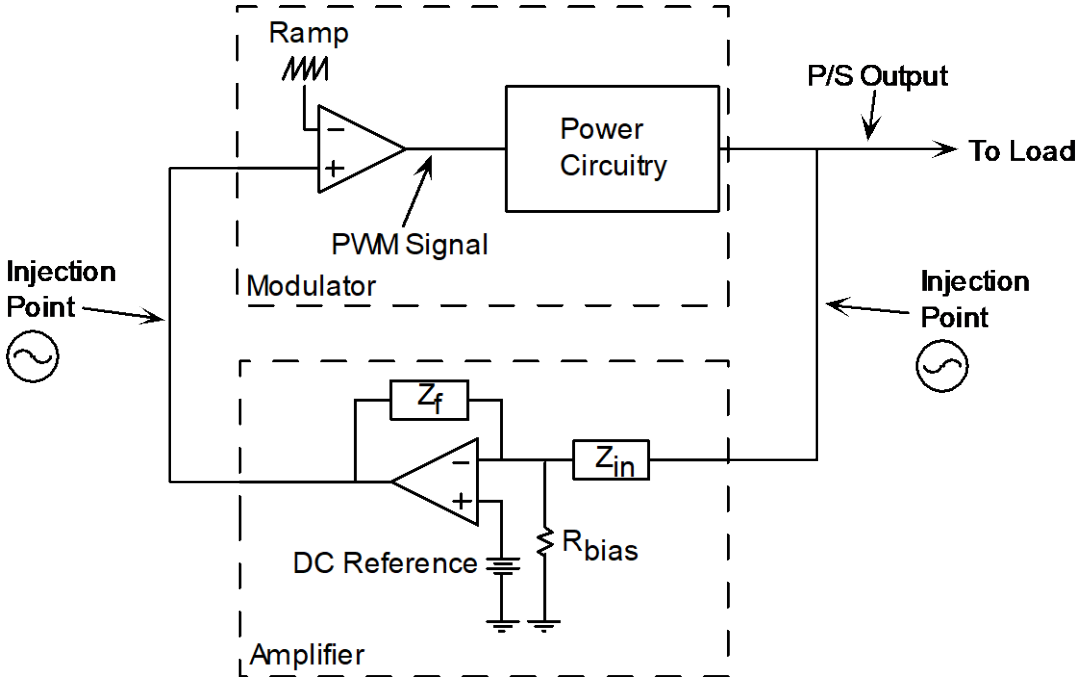
A LITTLE BIT ABOUT SIGNALS



$$G_{a} = \frac{G}{1+G} \qquad G_{a} = \frac{1}{H} \times \frac{G\,H}{1+G\,H}$$

Loop gain is <u>not</u> GH. Loop gain <u>is</u> -GH.

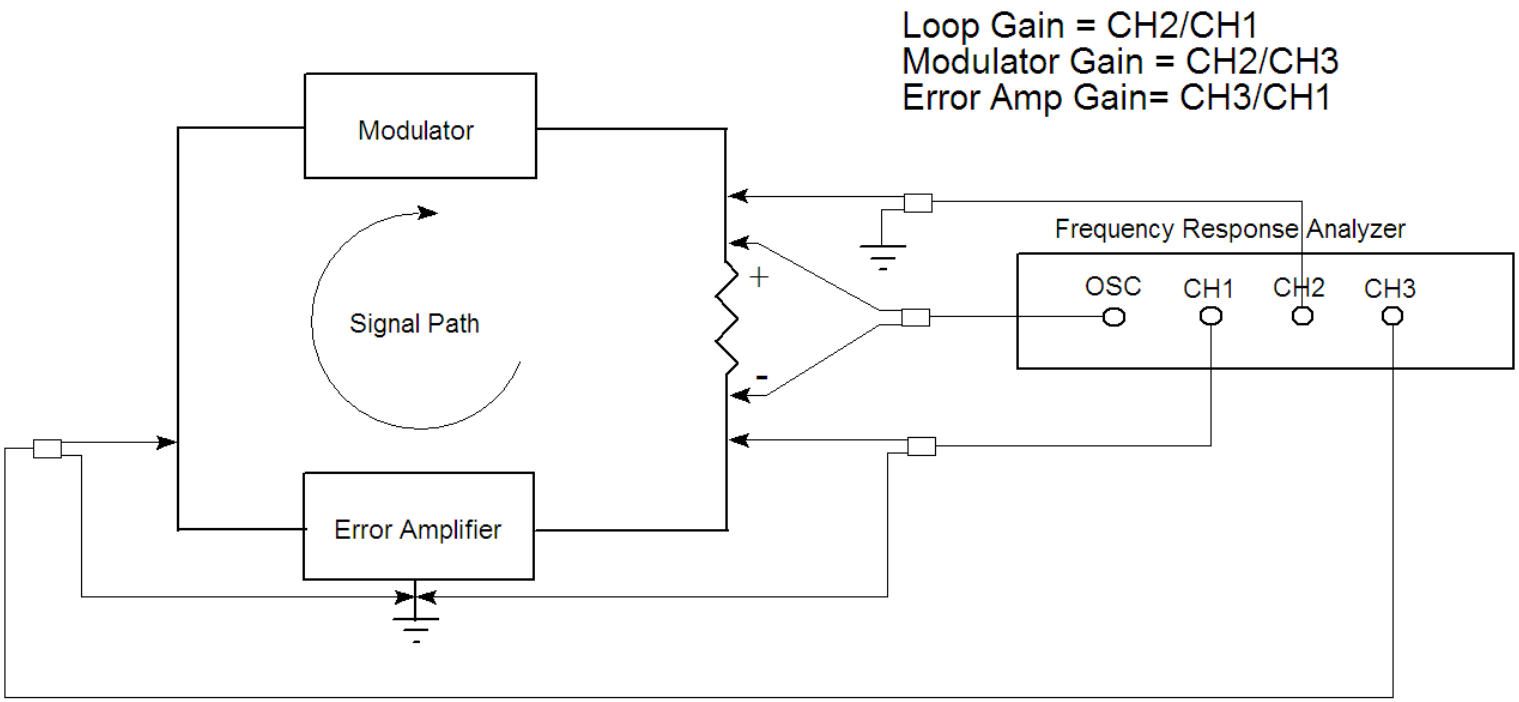
Closed Loop Circuit



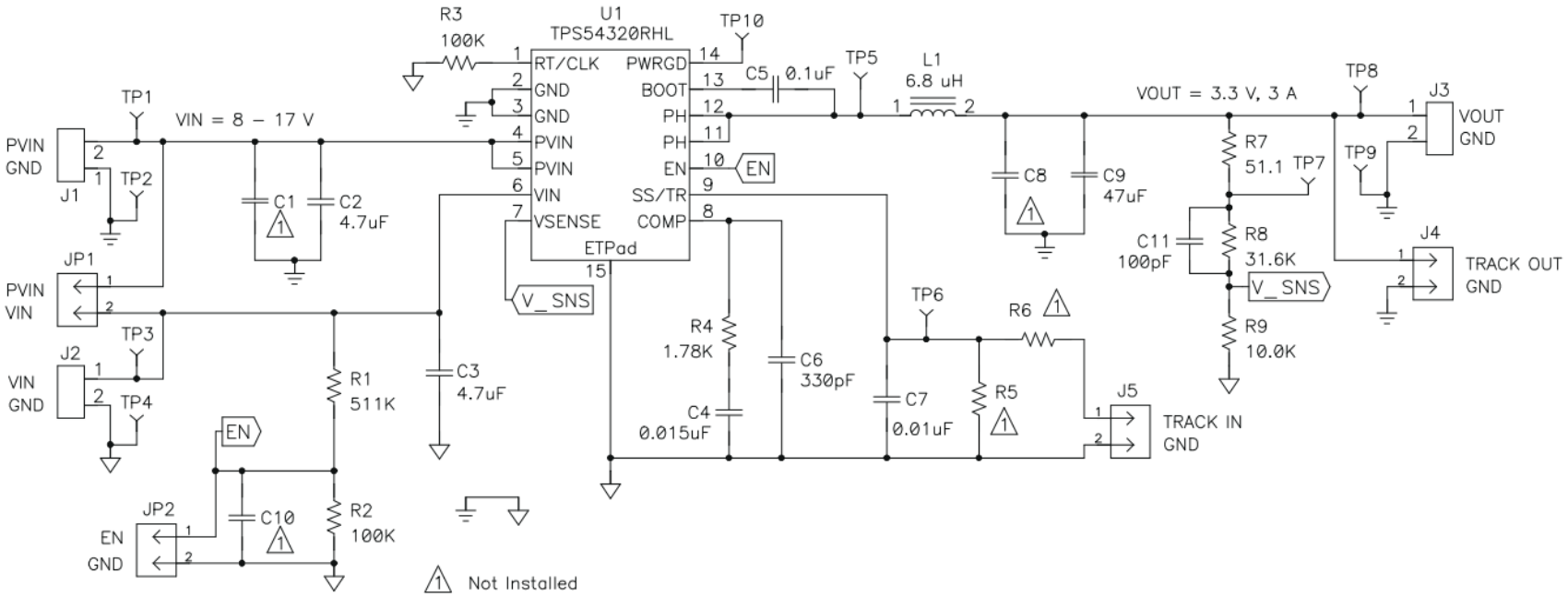
Measuring Loop Gain with the Loop Closed

- Select a point in the feedback loop where the loop is confined to a single path
- A low impedance is driving into a high impedance

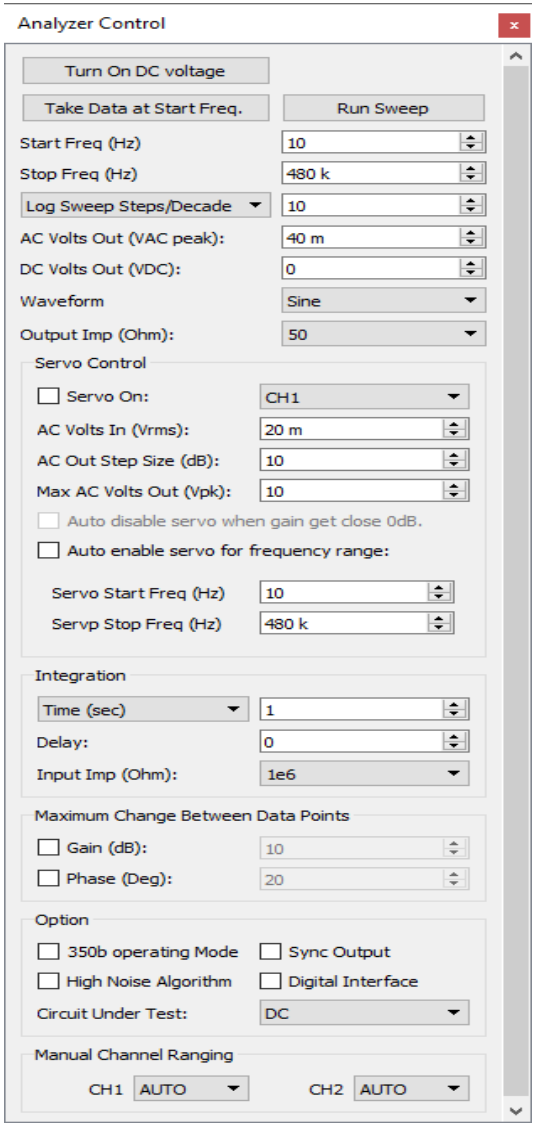
Injection Method



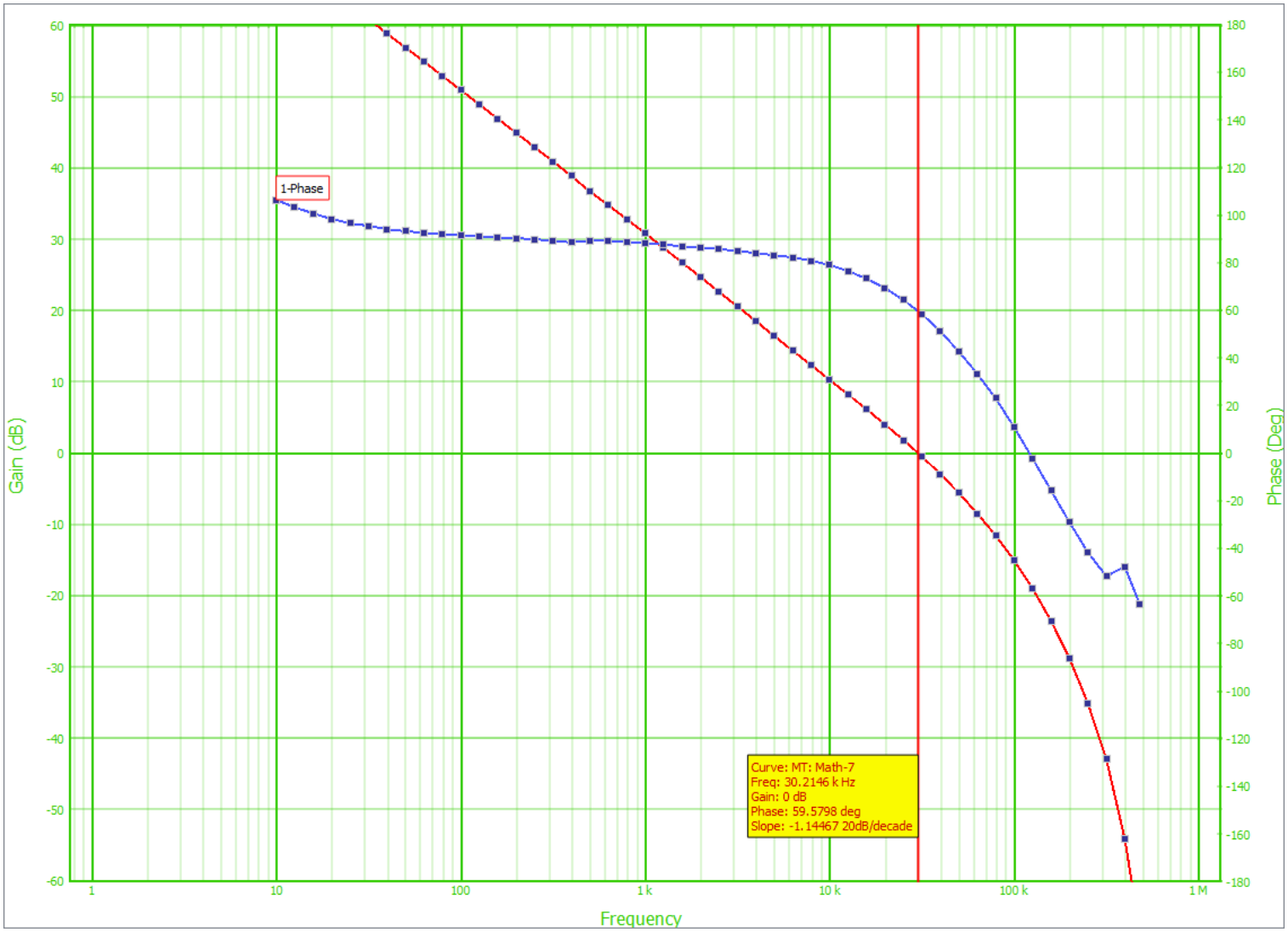
Loop Design Example – TPS54320 Synchronous Buck



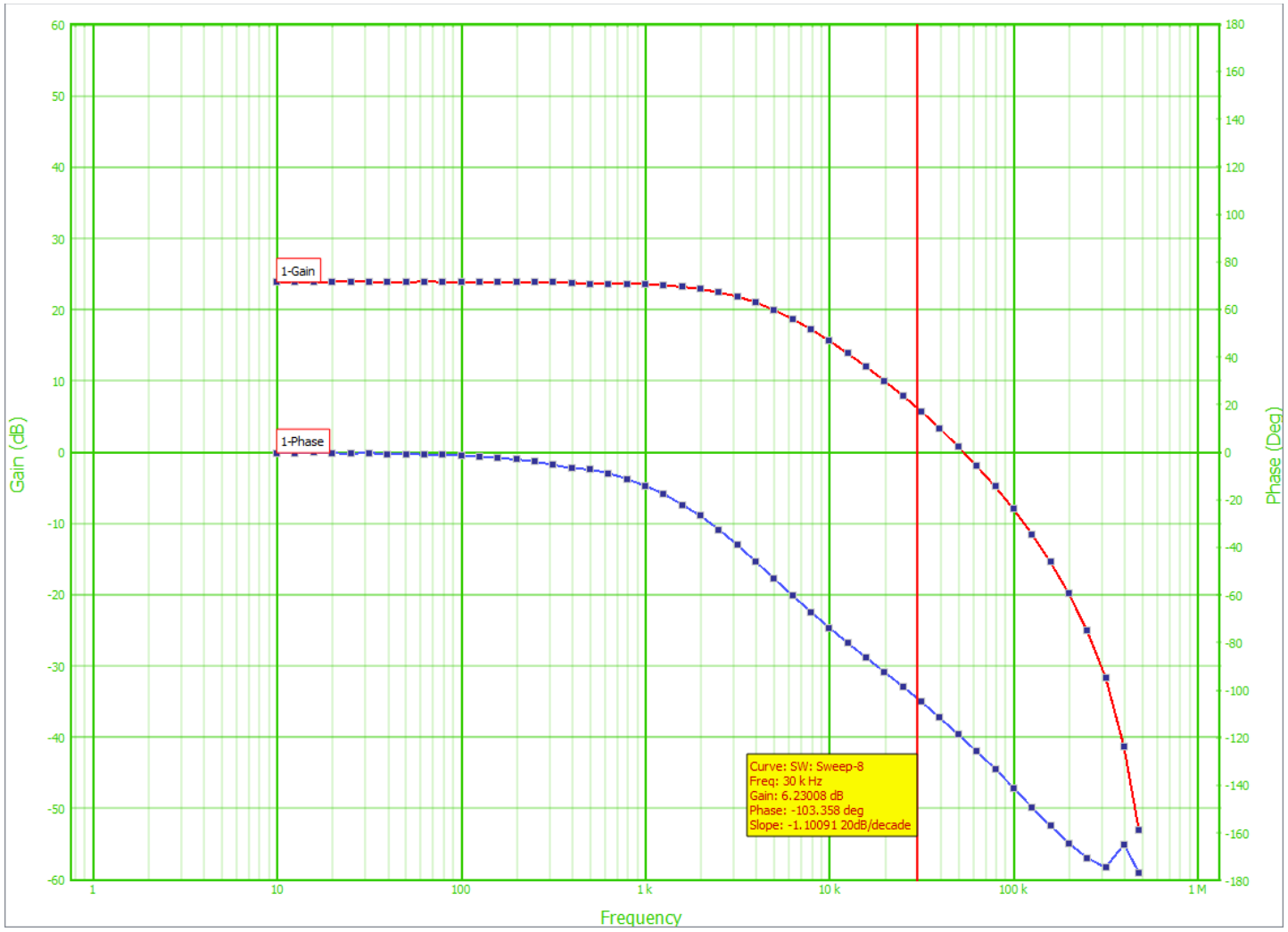
Analyzer Setup



Loop Gain Bode Plot



Modulator (Control-to-Output) Bode Plot



HOW TO COMPENSATE A LOOP

- Measure/model the control-to-output transfer function.

$$G(s)$$

- Decide on an overall loop bandwidth and phase margin.

$$F_c = 30\ \text{kHz},\ \ \Phi_m = 60^\circ$$

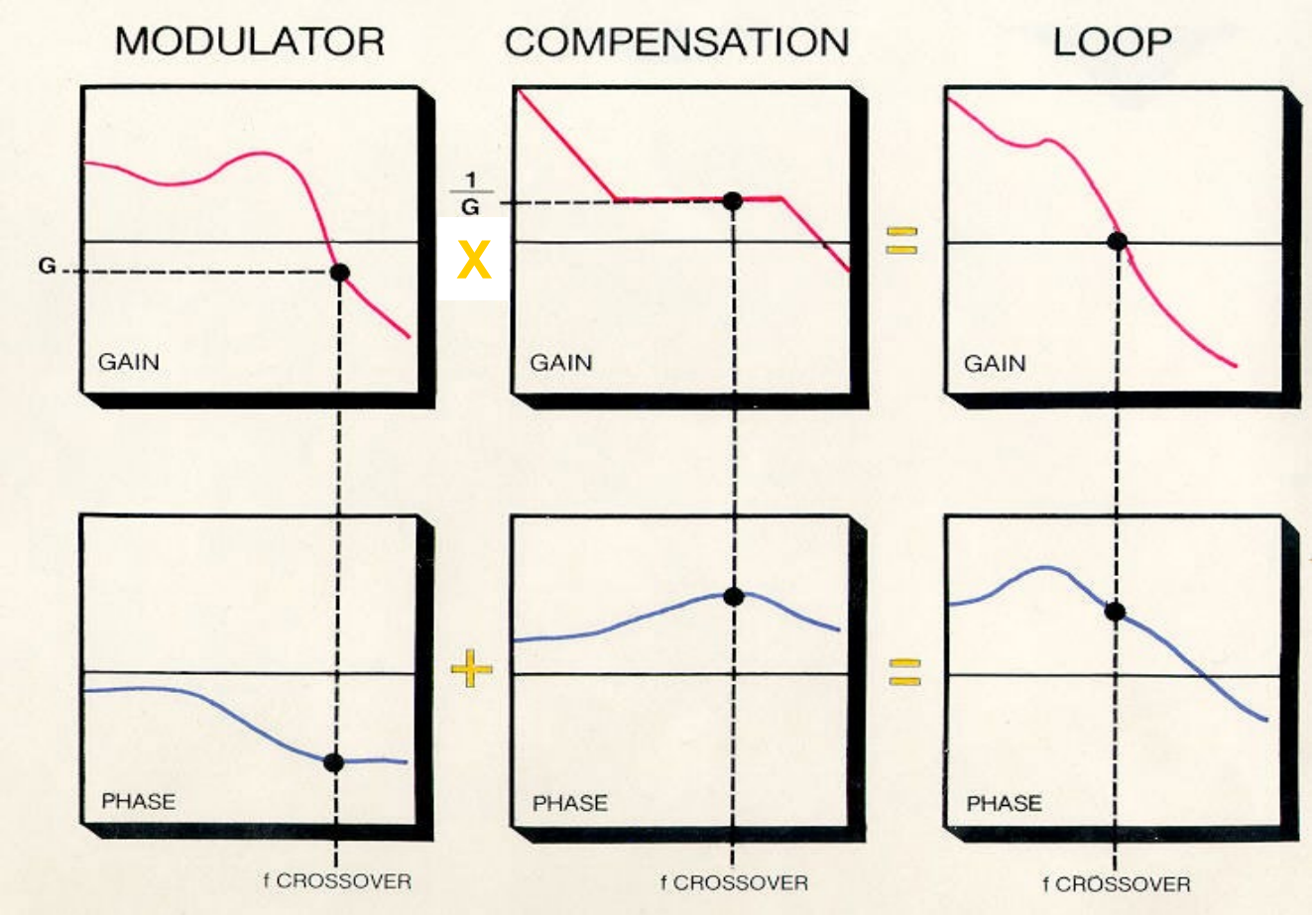
- Design the error amplifier gain at crossover, f_c.

$$Gc = 6.23008\ \text{dB}, \qquad H_c = 1/G_c = -6.23008\ \text{dB} = 0.4881$$

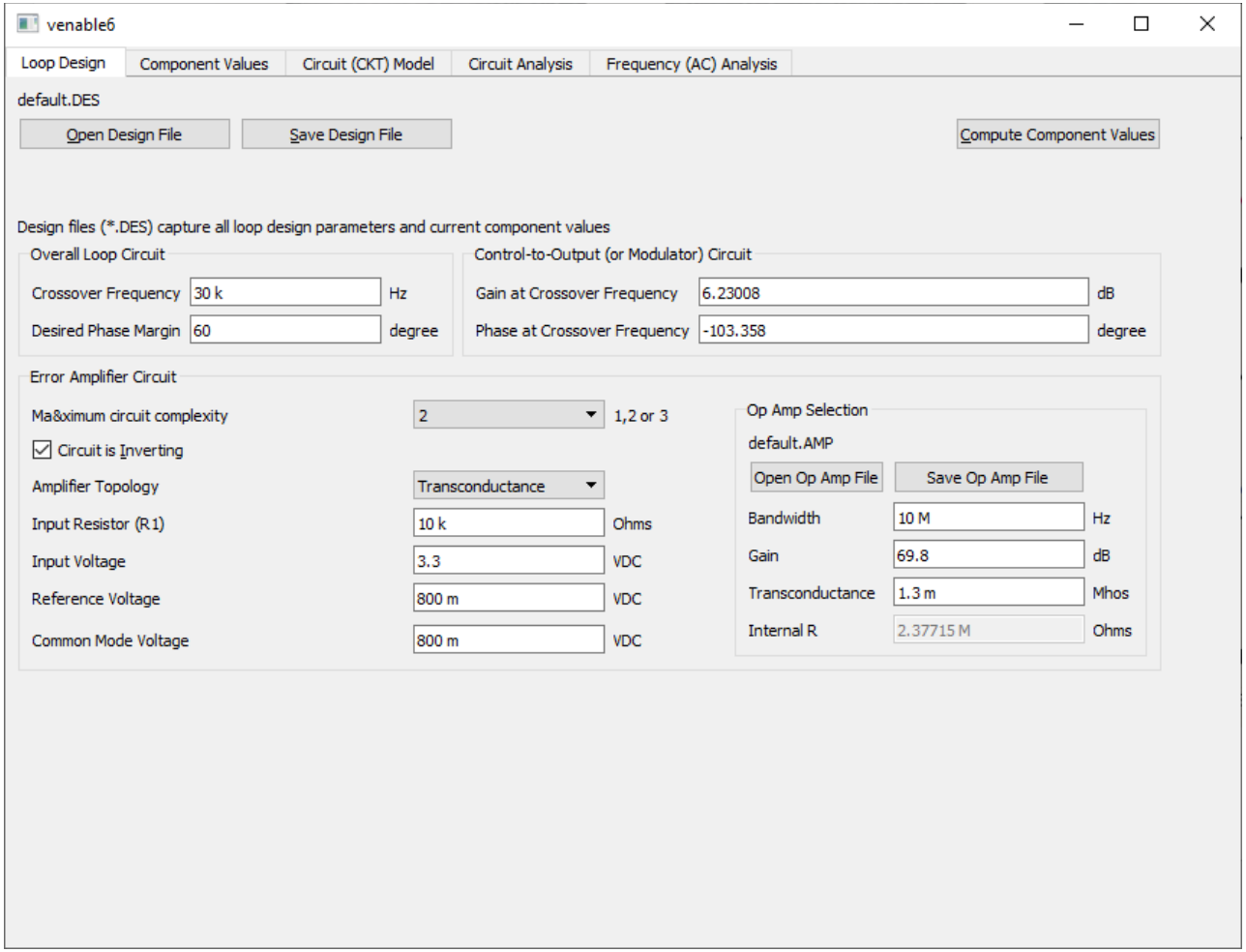
- Design the error amplifier phase boost at f_c.

$$\text{Boost} = \Phi m - \Phi(G_c) - 90^\circ, \qquad \Phi(Gc) = -103.36^\circ$$

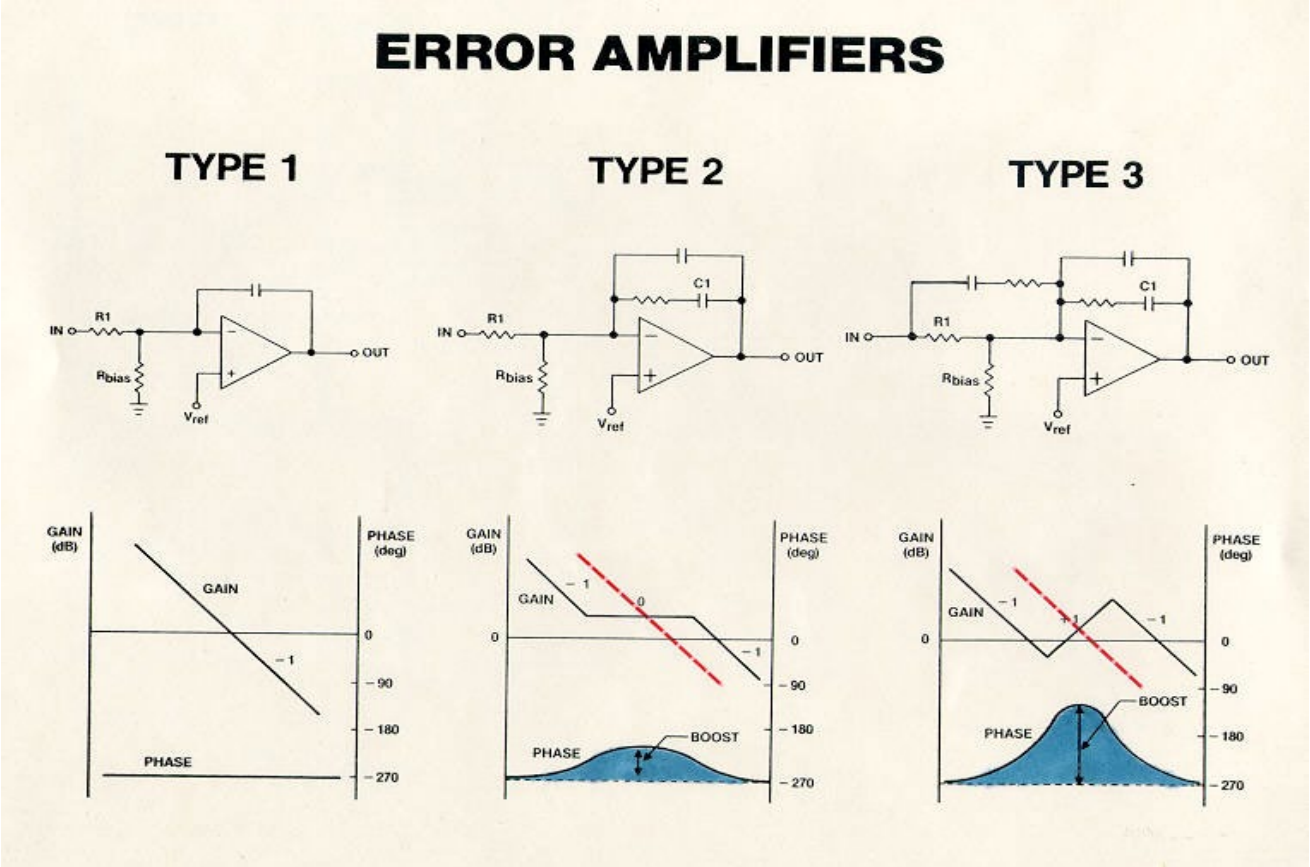
$$\text{Boost} = 73.36^\circ$$


MODULATOR
COMPENSATION
LOOP
G
GAIN
1
G
X
GAIN
=
GAIN
PHASE
+
PHASE
=
PHASE
f CROSSOVER
f CROSSOVER
f CROSSOVER

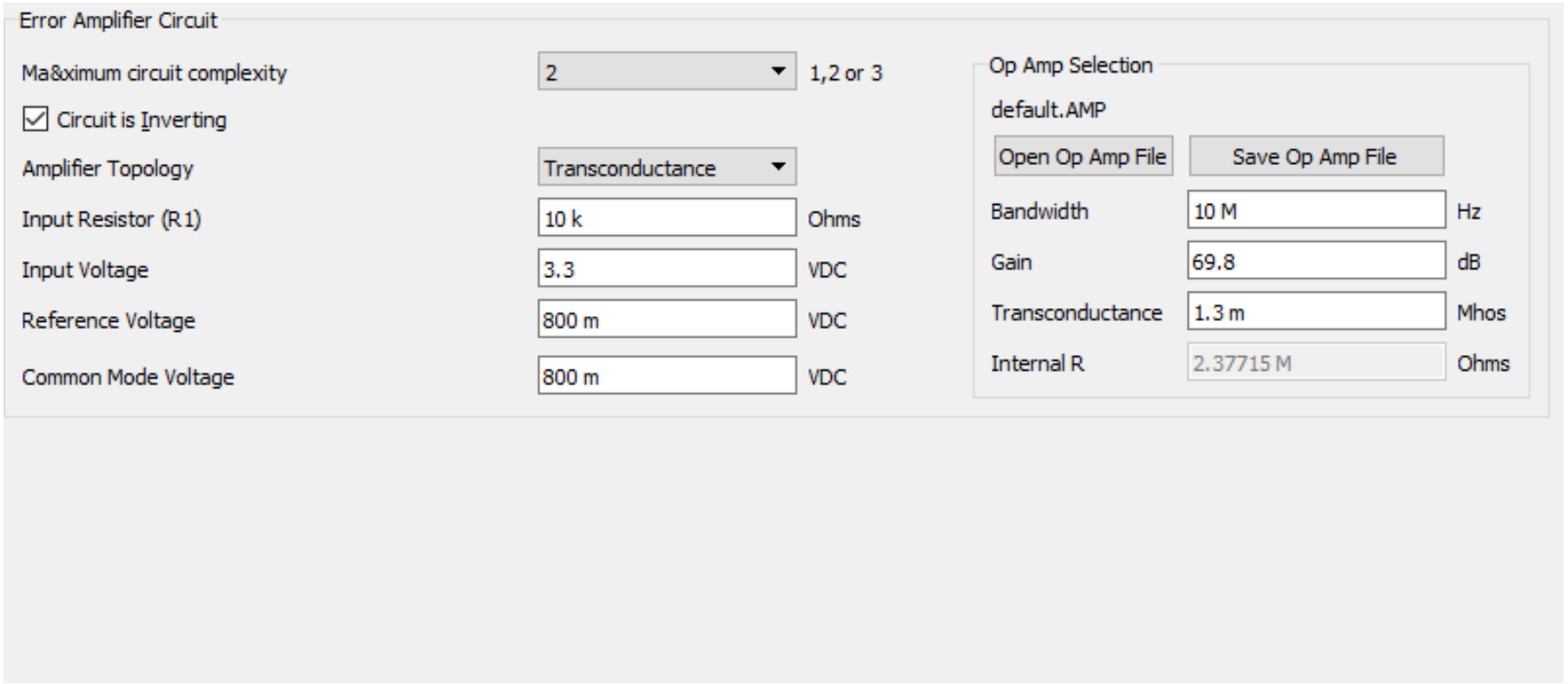
Circuit Analysis and Synthesis Menu



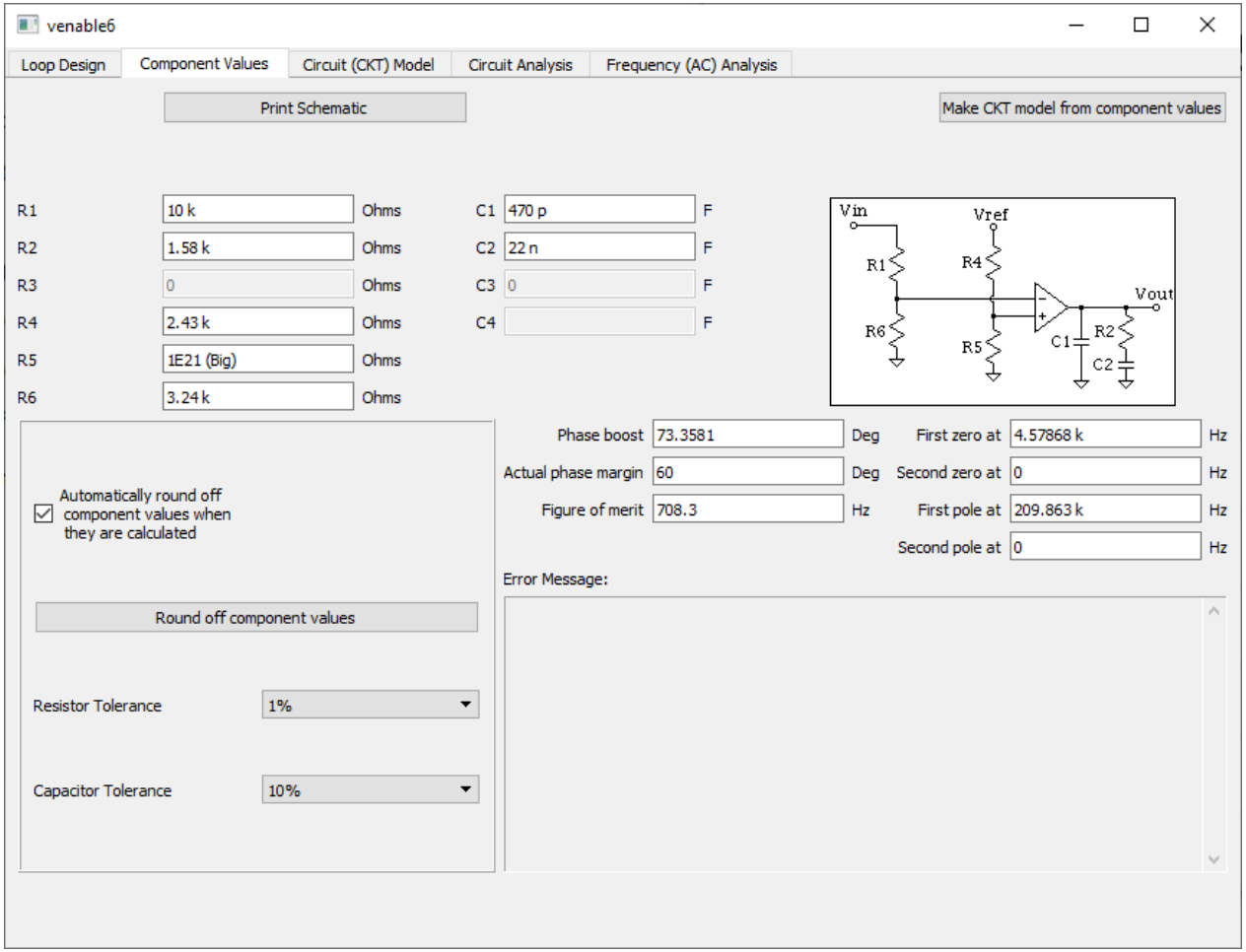
Choose an Amplifier Topology :



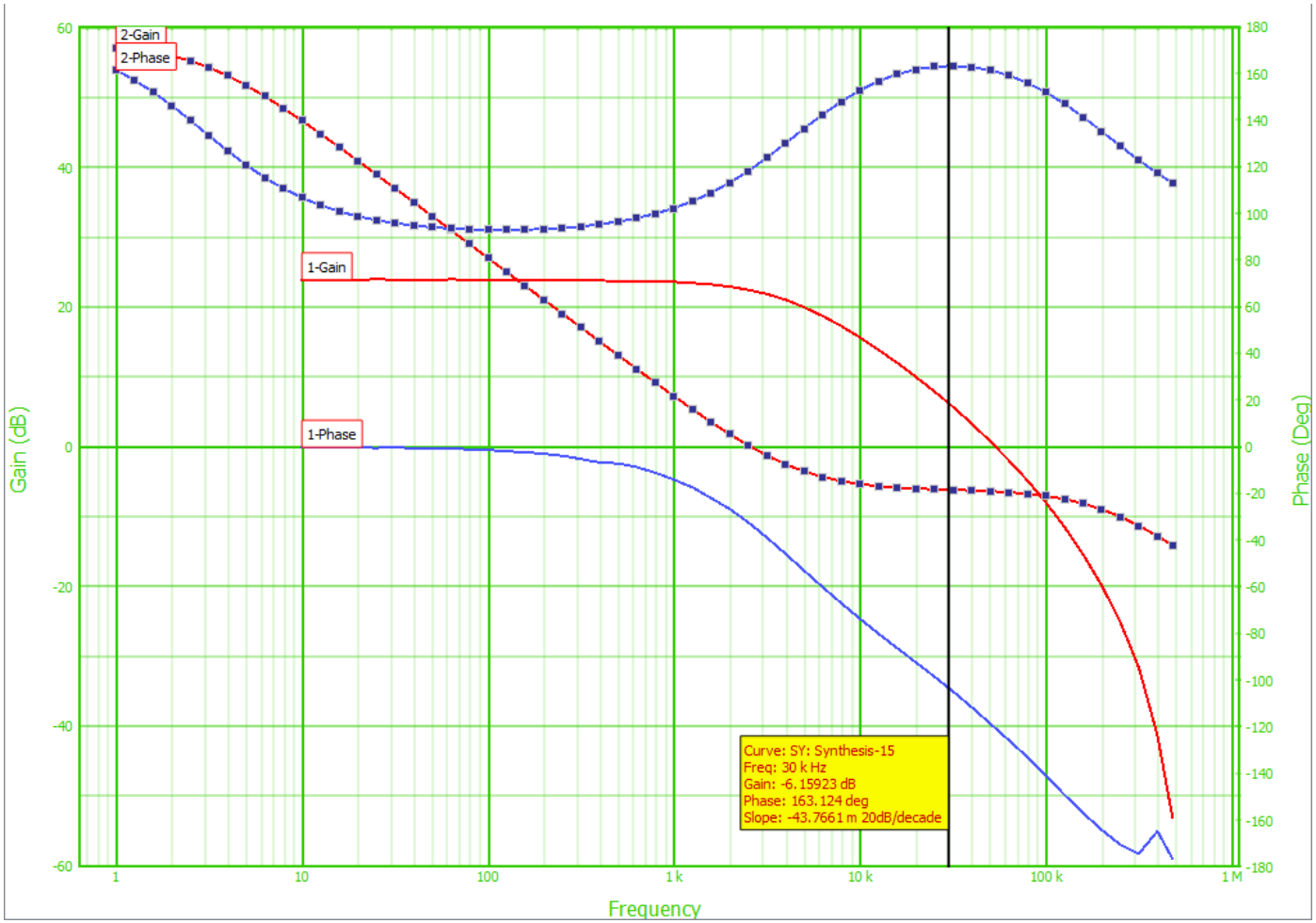
Error Amplifier Topology



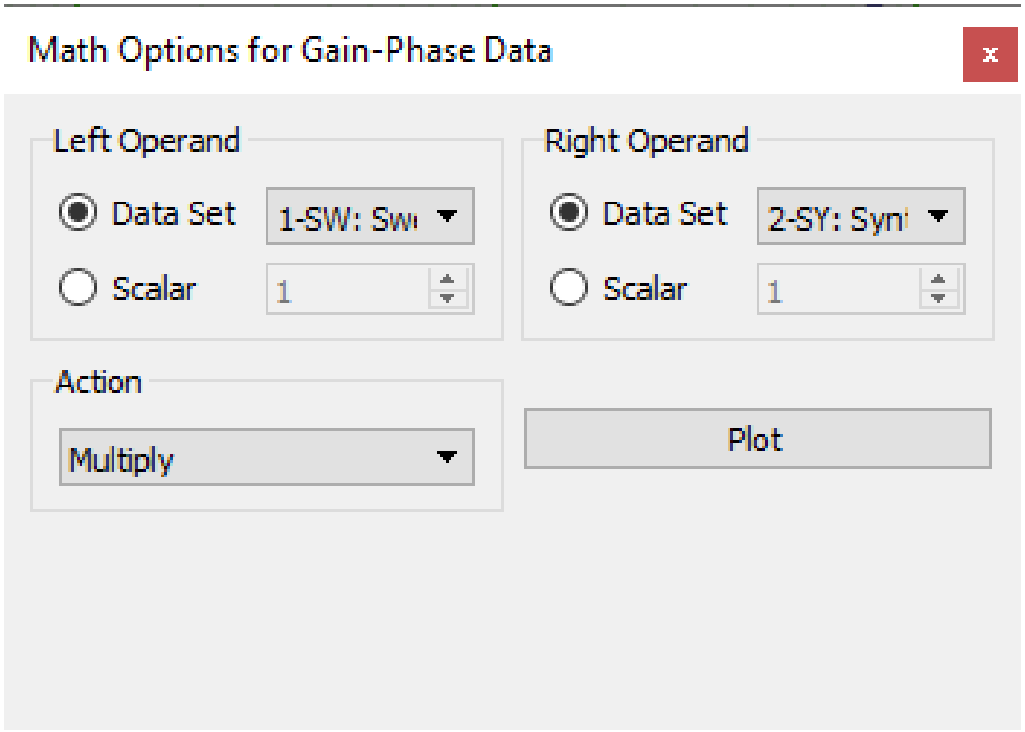
Error Amplifier Component Values



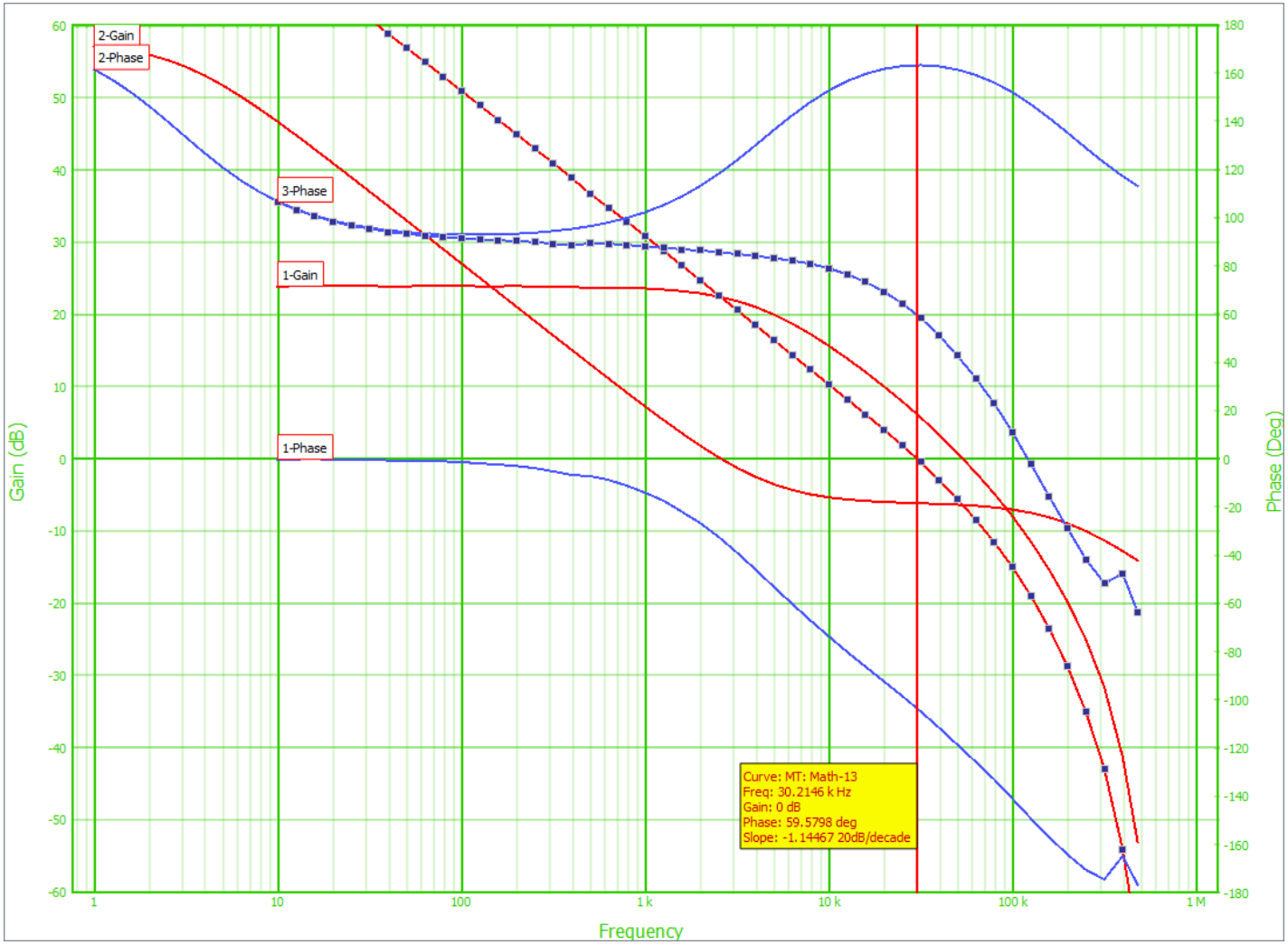
Synthesized Error Amplifier Transfer Function



Multiply Modulator by Error Amp Response



Predicted and Measured Loop Gain and Phase



Questions?

Thank You

Michael Gray, Sr. Staff Engineer

For more information on any Venable Frequency Response Analysis System, call 512-949-3144, or email info@venableinstruments.com