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Analog Electronics Lab #3 – Design of VCVS, VCCS, CCVS and CCCS using LM741

Objectives

To design the following four topologies using LM741 OPAMP

1. Voltage Controlled Voltage Source (VCVS)
2. Current Controlled Voltage Source (CCVS)
3. Voltage Controlled Current Source (VCCS)
4. Current Controlled Current Source (CCCS)

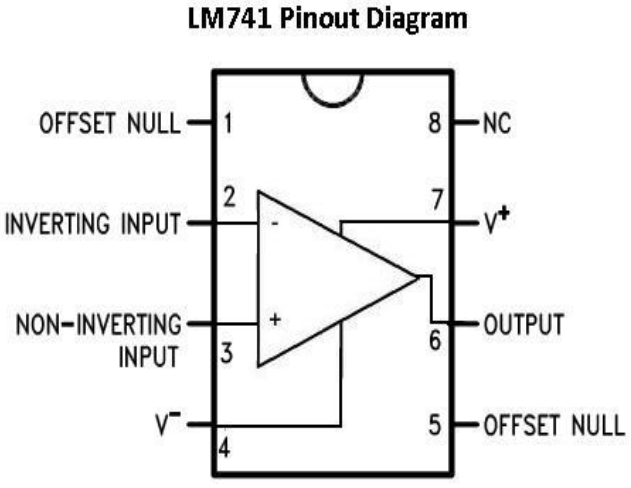
and find

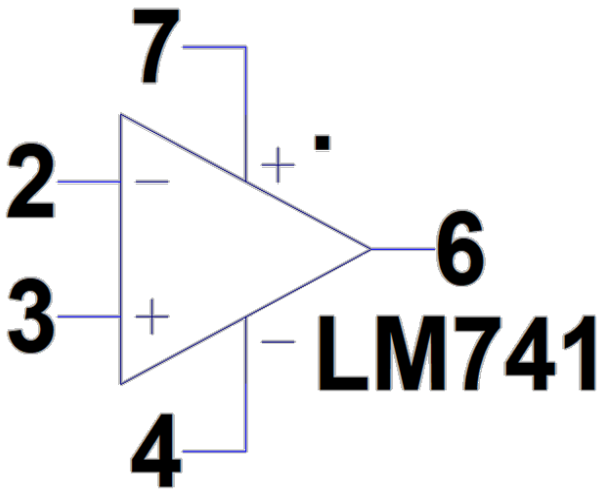
Simulated values of voltage gain (A_v) by
a) Varying R_L with constant source
b) Varying source with constant R_L

Compare the results from simulation with the theoretical values of A_v.

IC LM-741

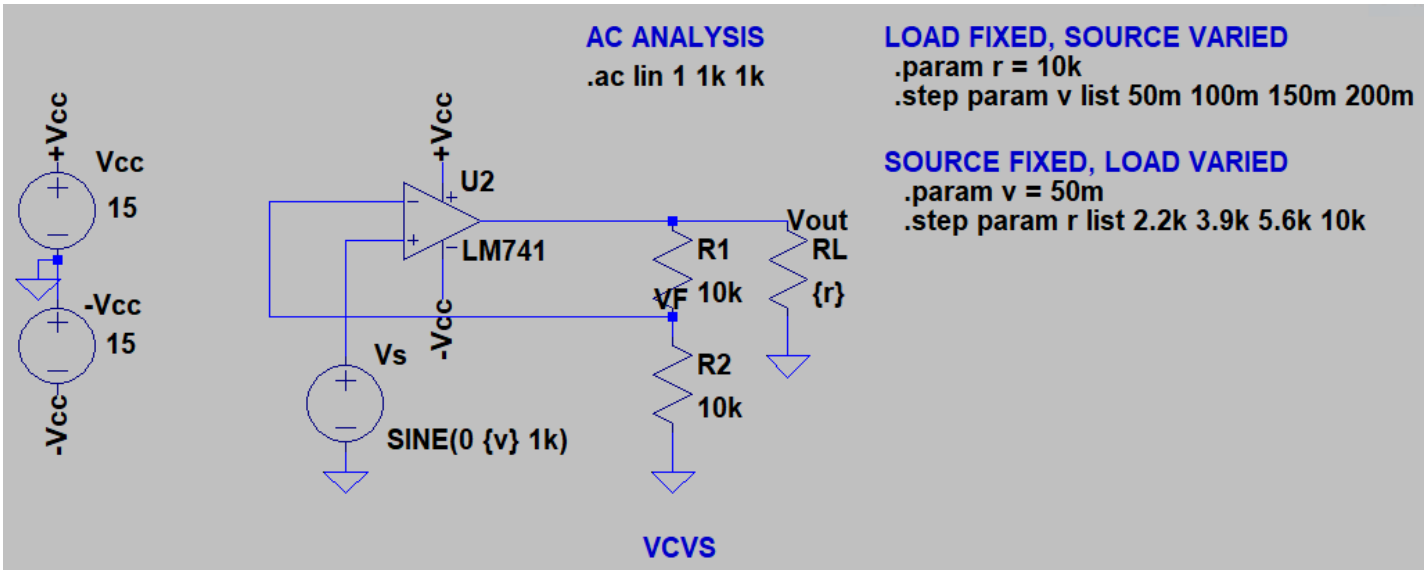
- LM741 operational amplifier is a DC-coupled high gain electronic voltage amplifier.
- It has only one op-amp inside.
- An operational amplifier IC is used as a comparator, which compares the two signal, the inverting and non-inverting signal.
- The main function of this IC is to do mathematical operation in various circuits.
- Op-amps have large gain and usually used as Voltage Amplifier.
- The LM741 can operate with a single or dual power supply voltage.



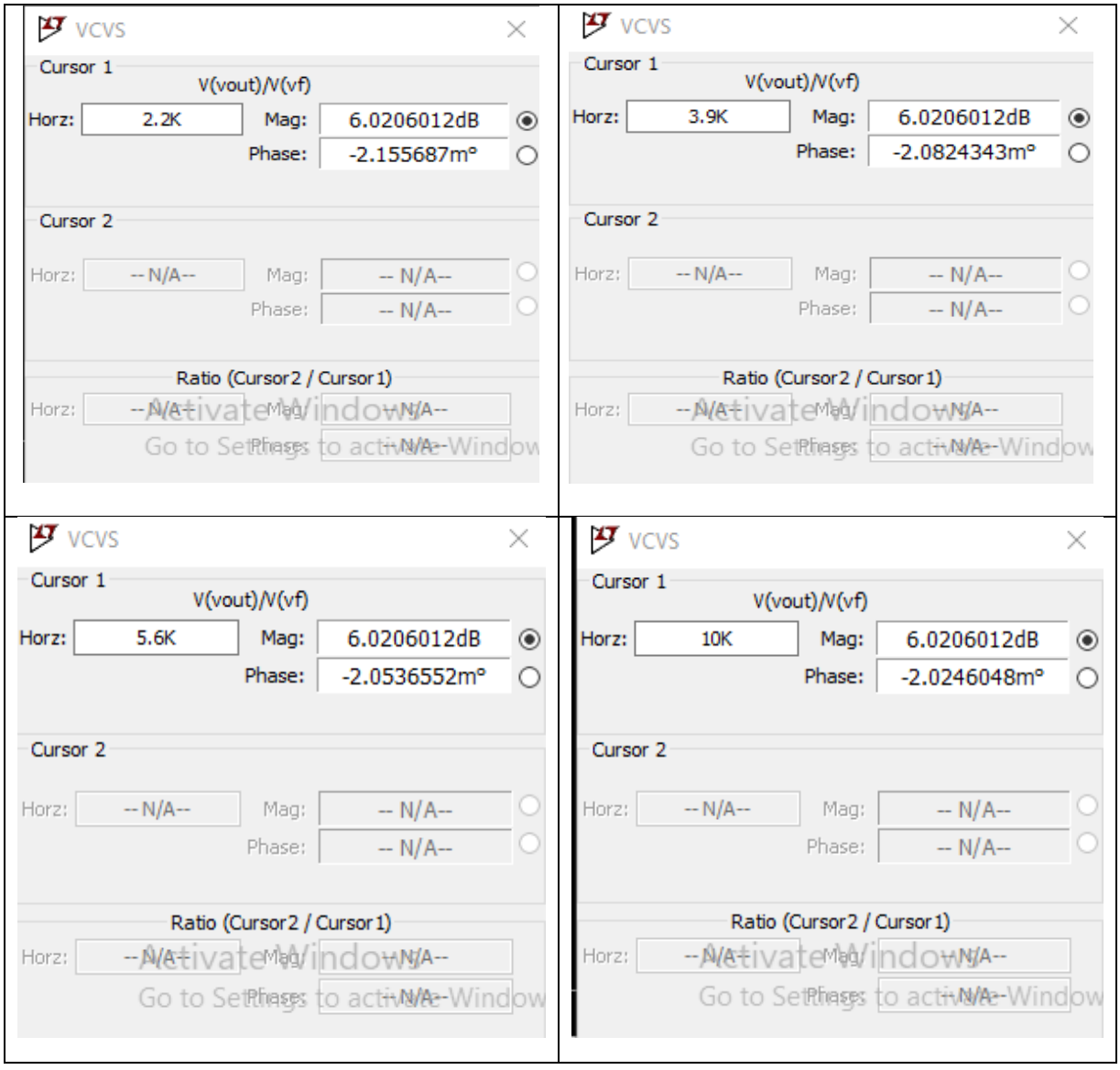


Voltage Controlled Voltage Source (VCVS)

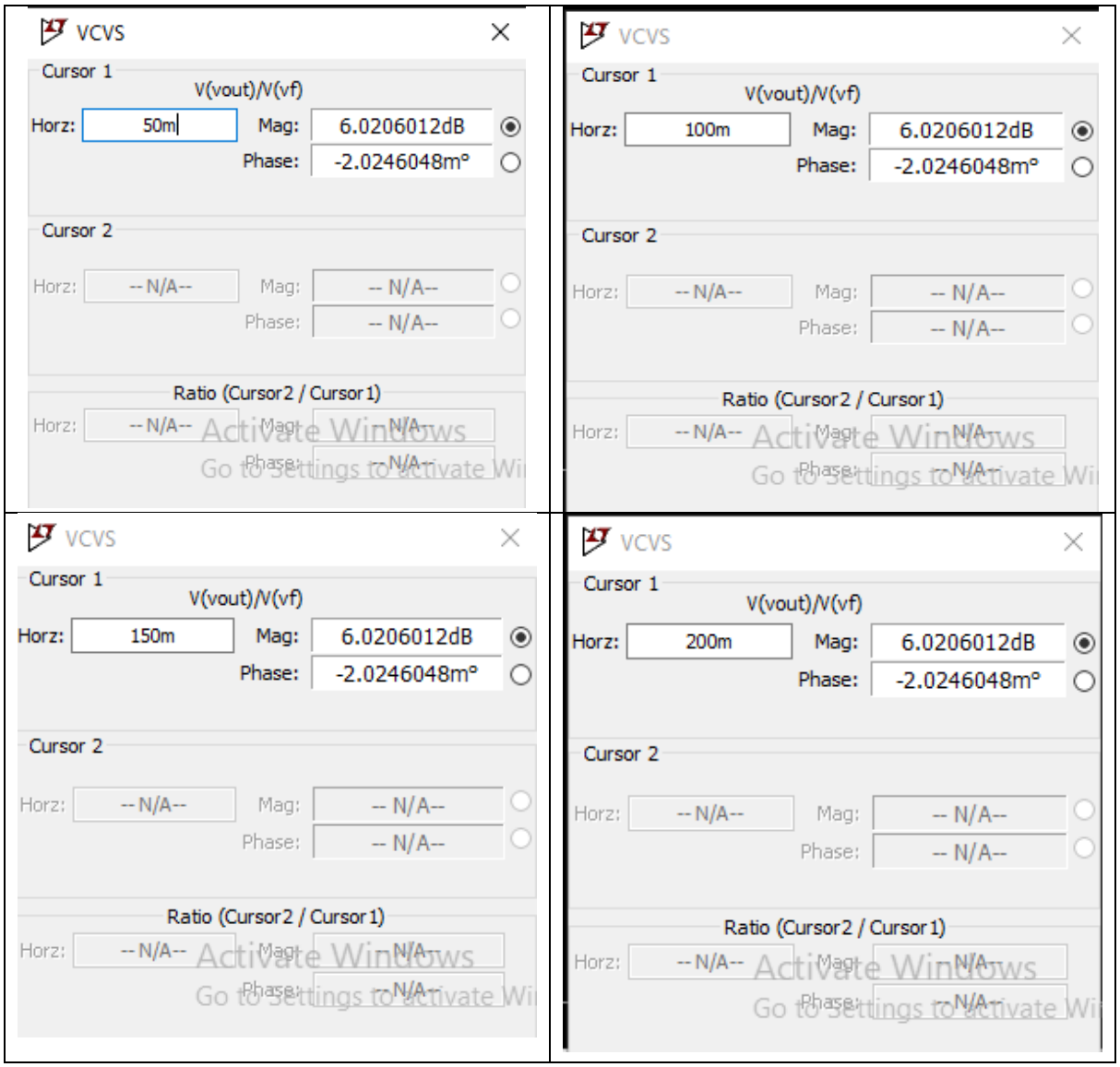
Schematic



Source V_s = 50mV and load varied



Load R_l = 10kΩ and source varied

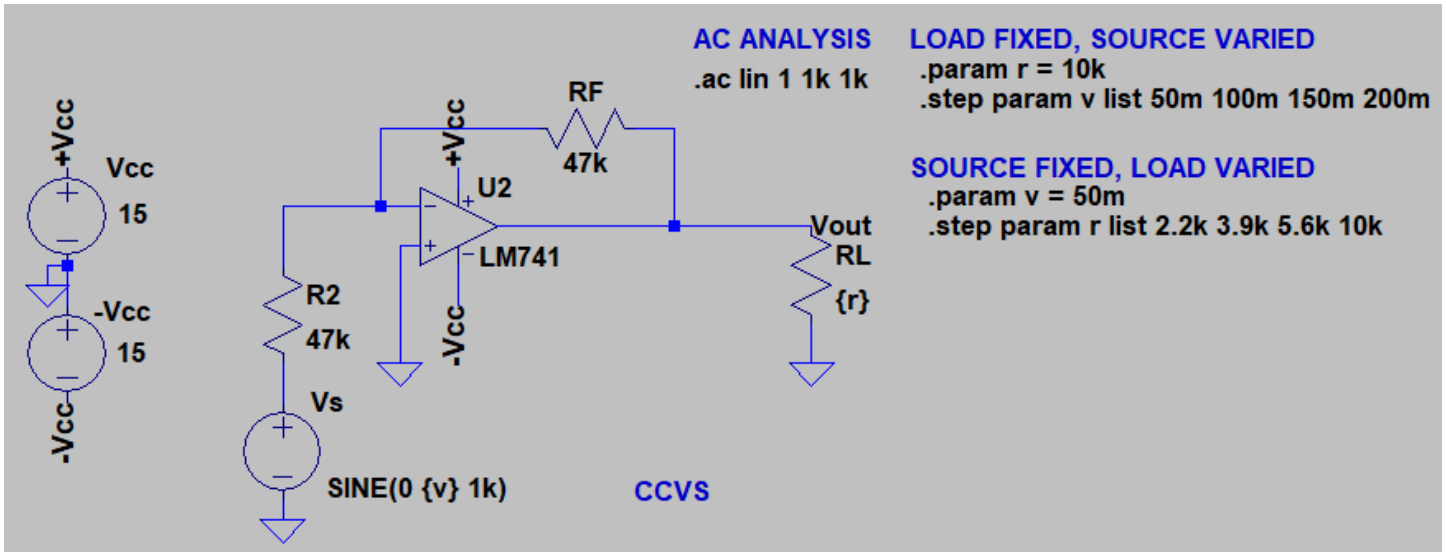


Comparison of simulated and theoretical values

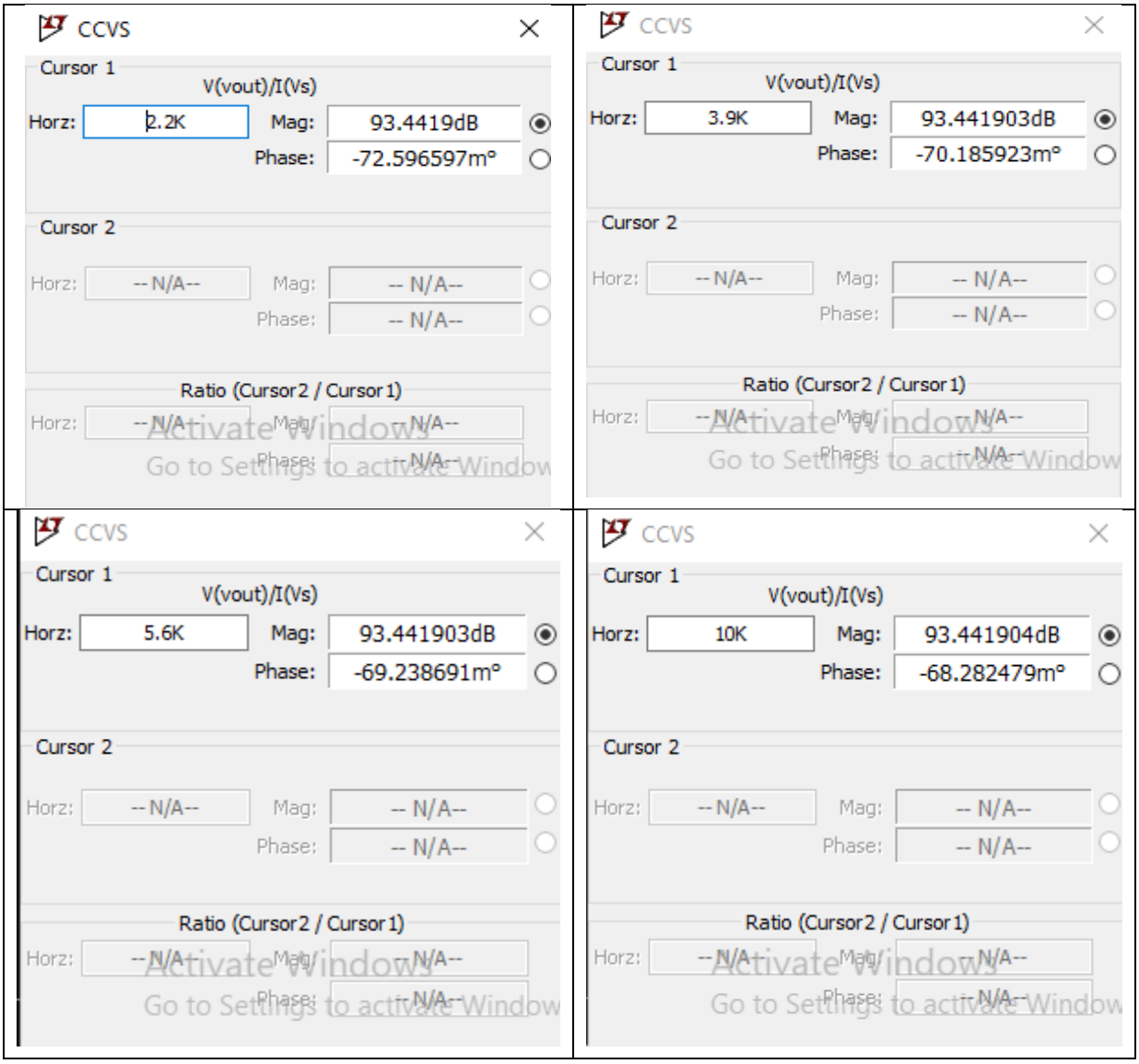
V_s (mV)	R_l (kΩ)	Simulated A_v	Theoretical $A_v = 1 + (R_1/R_2)$
50	2.2	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
50	3.9	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
50	5.6	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
50	10	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
50	10	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
100	10	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
150	10	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V
200	10	6.0206012 dB = 2 V/V	1 + (10kΩ/10kΩ) = 2 V/V

Current Controlled Voltage Source (CCVS)

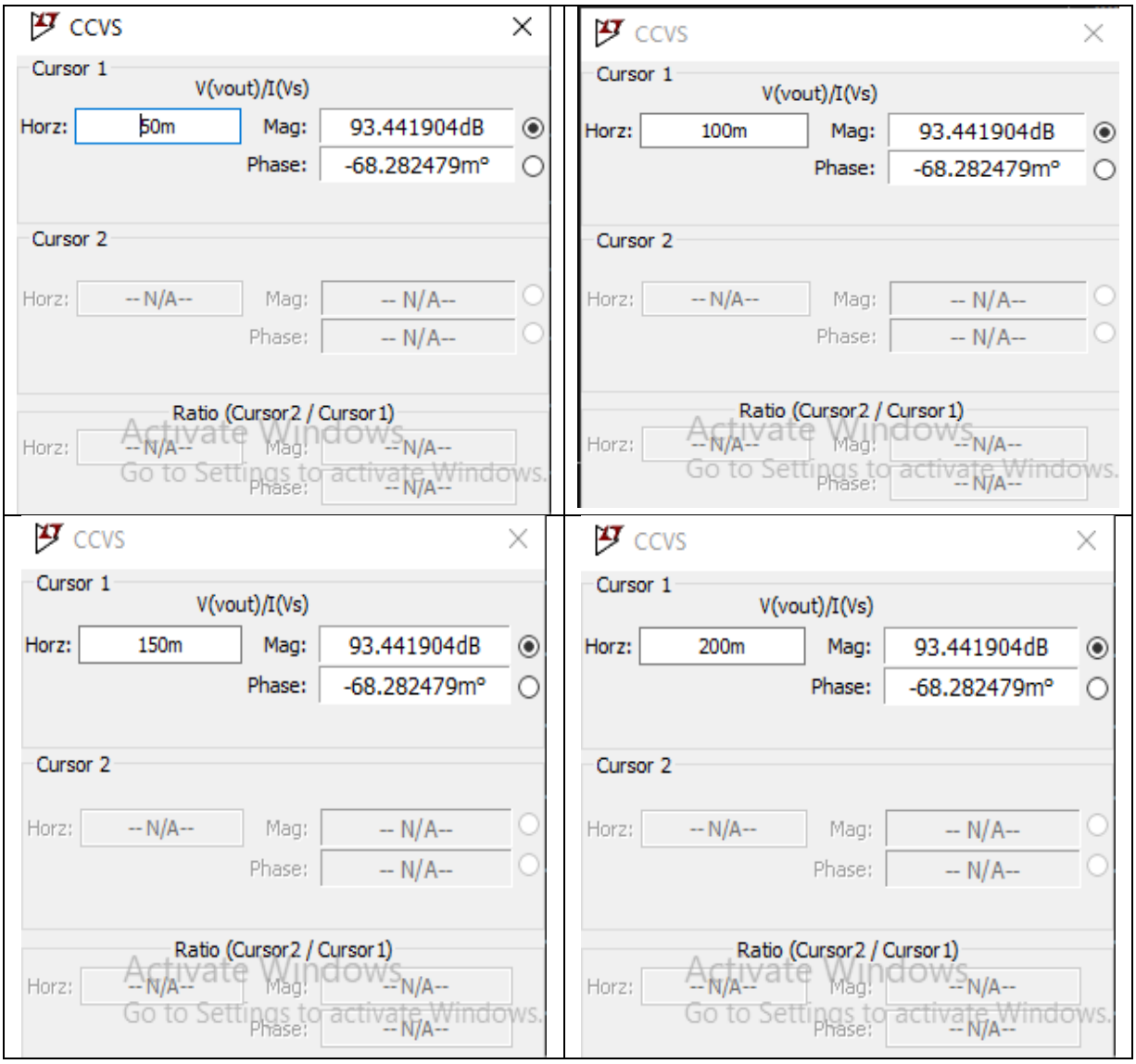
Schematic



Source V_s = 50mV and load varied



Load R_l = 10kΩ and source varied

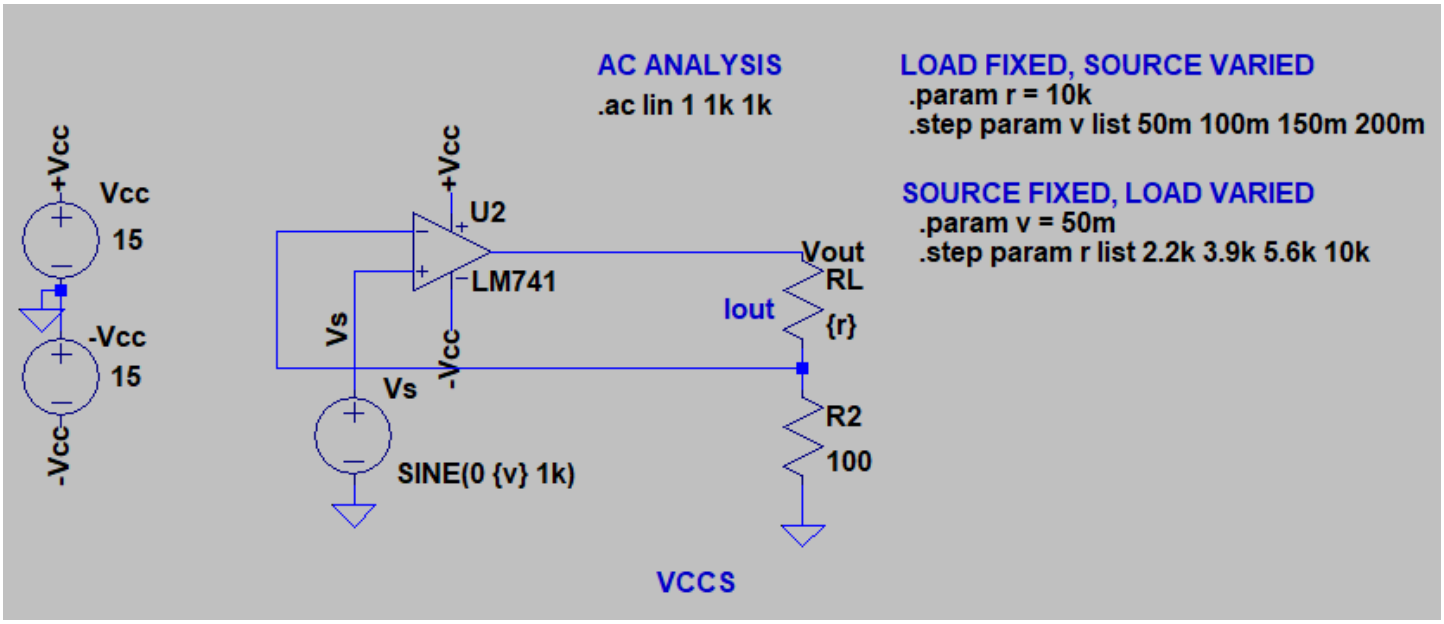


Comparison of simulated and theoretical values

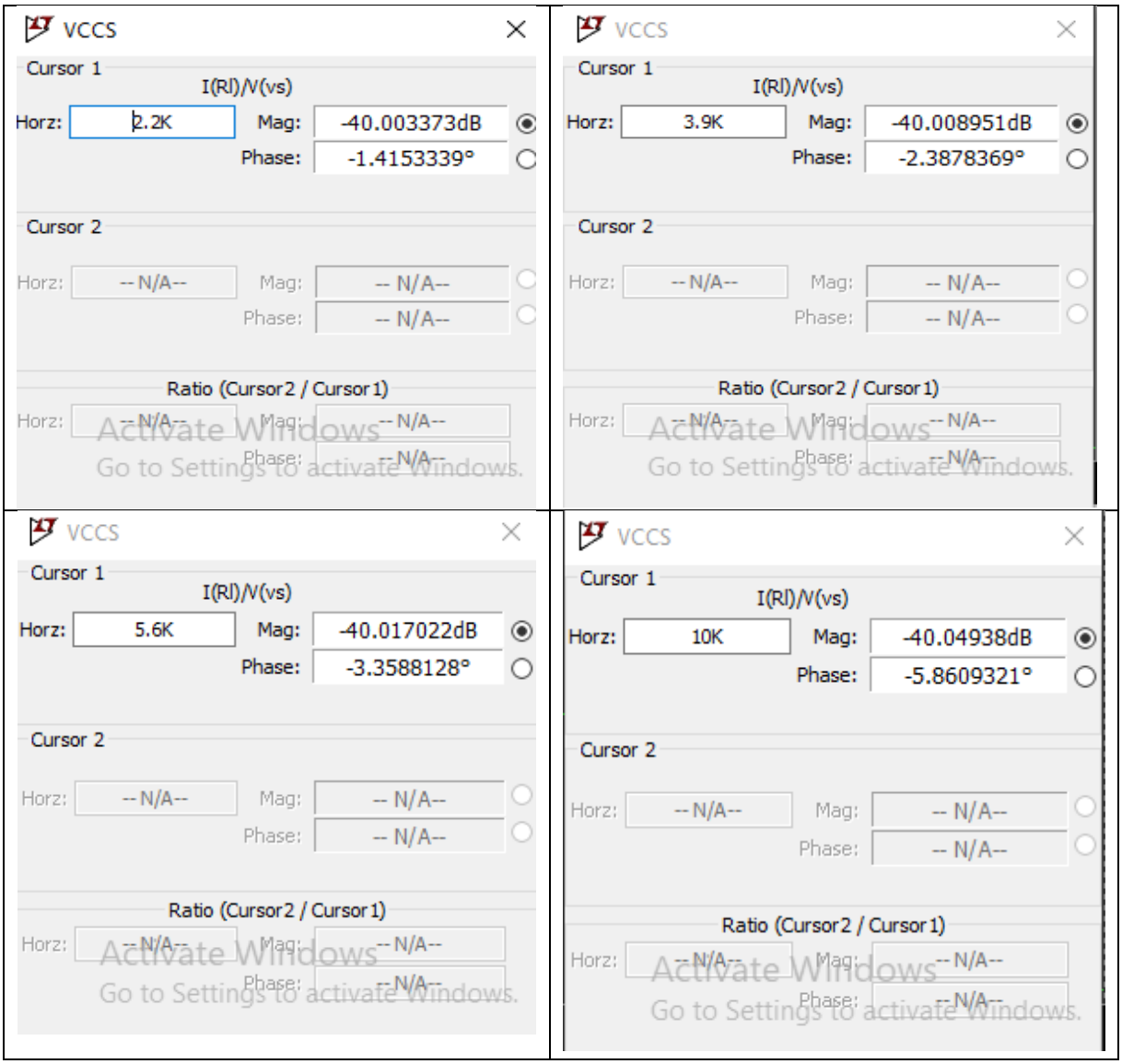
V_s (mV)	R_l (kΩ)	Simulated A	Theoretical A = R_F
50	2.2	93.4419 dB = 46.99969 kΩ	47 kΩ
50	3.9	93.441903 dB = 46.99971 kΩ	47 kΩ
50	5.6	93.441903 dB = 46.999707 kΩ	47 kΩ
50	10	93.441904 dB = 46.999712 kΩ	47 kΩ
50	10	93.441904 dB = 46.999712 kΩ	47 kΩ
100	10	93.441904 dB = 46.999712 kΩ	47 kΩ
150	10	93.441904 dB = 46.999712 kΩ	47 kΩ
200	10	93.441904 dB = 46.999712 kΩ	47 kΩ

Voltage Controlled Current Source (VCCS)

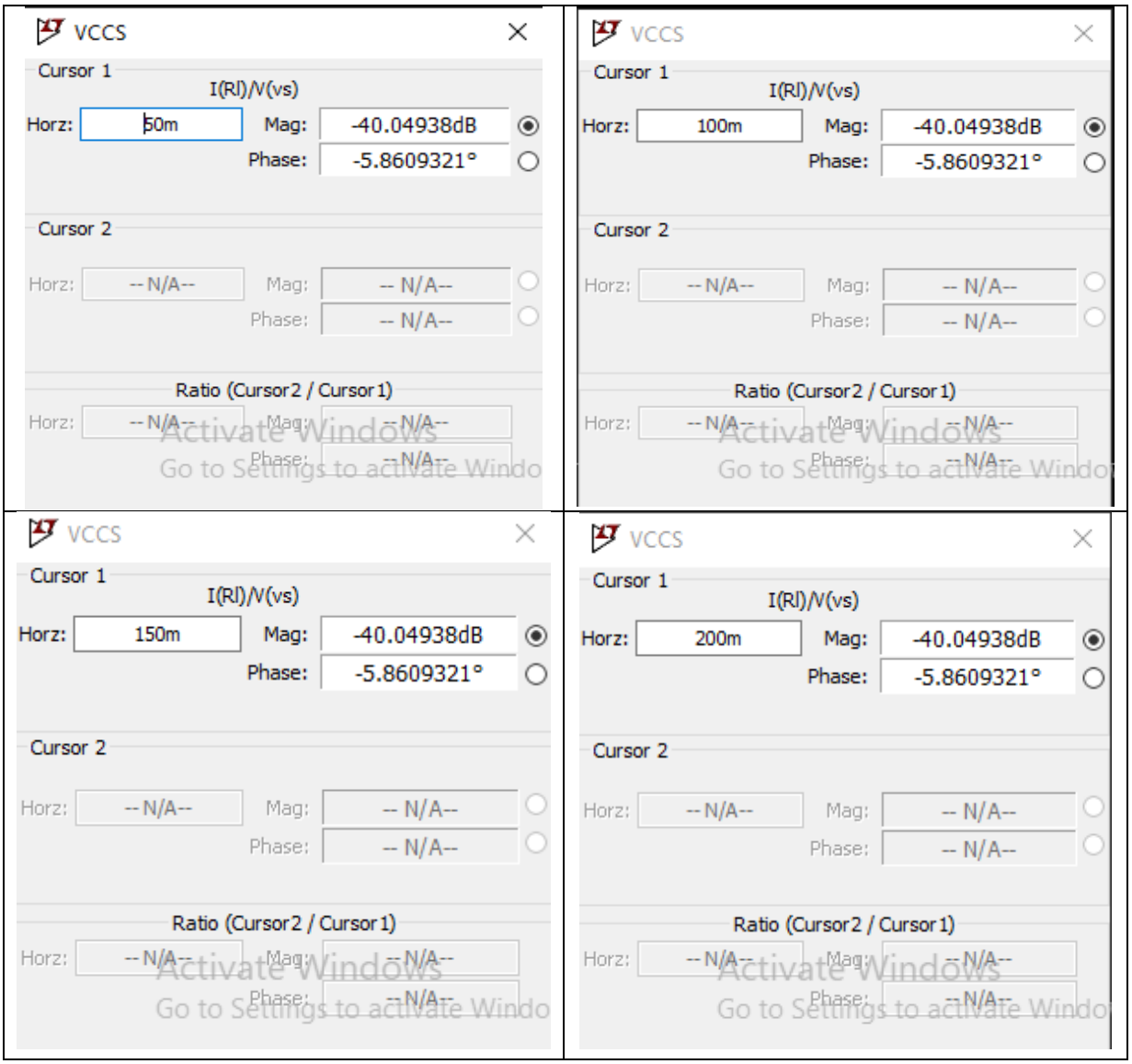
Schematic



Source V_s = 50mV and load varied



Load R_l = 10kΩ and source varied

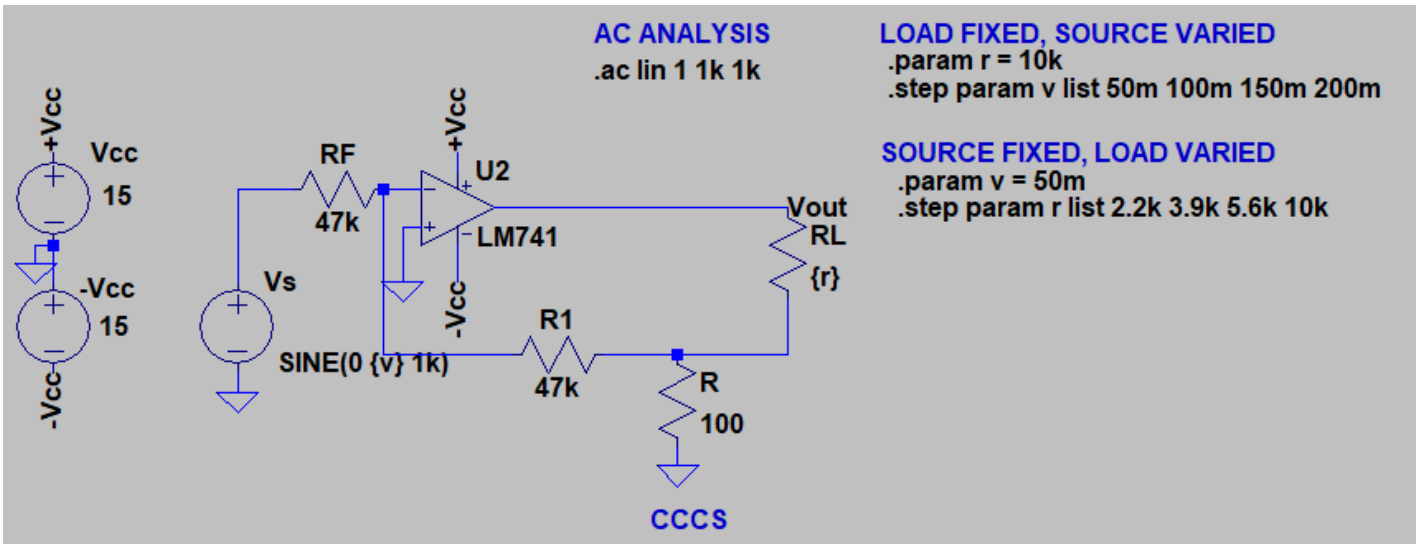


Comparison of simulated and theoretical values

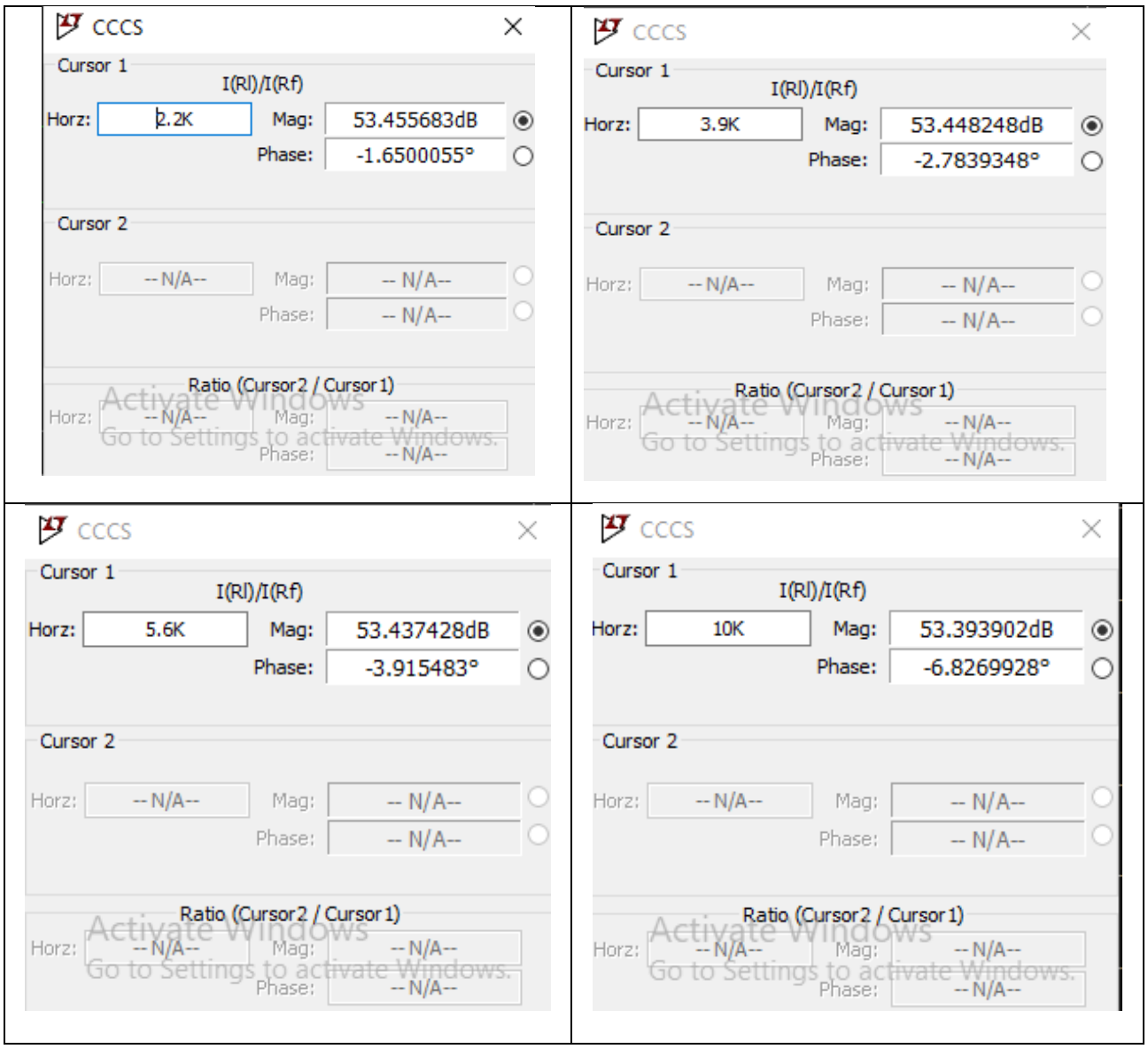
V_s (mV)	R_l (kΩ)	Simulated A	Theoretical A = $1/R_2$
50	2.2	-40.003373 dB = 0.009996 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
50	3.9	-40.008951 dB = 0.009989 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
50	5.6	-40.017022 dB = 0.009980 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
50	10	-40.04938 dB = 0.009943 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
50	10	-40.04938 dB = 0.009943 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
100	10	-40.04938 dB = 0.009943 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
150	10	-40.04938 dB = 0.009943 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}
200	10	-40.04938 dB = 0.009943 Ω^{-1}	$1/100\Omega$ = 0.01 Ω^{-1}

Current Controlled Current Source (CCCS)

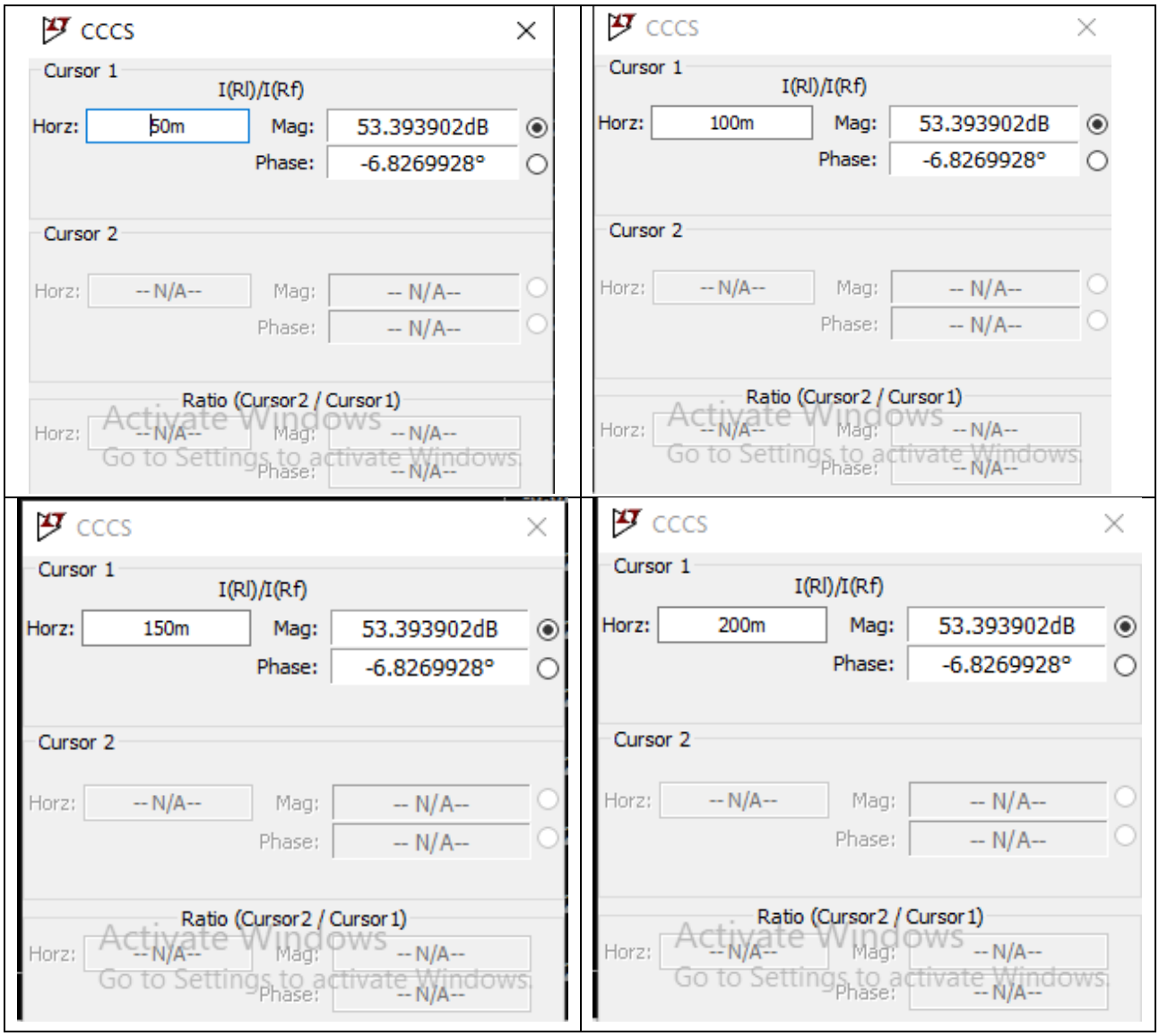
Schematic



Source V_s = 50mV and load varied



Load R_l = 10kΩ and source varied



Comparison of simulated and theoretical values

V_s (mV)	R_l (kΩ)	Simulated A_i	Theoretical $A_i = 1 + (R_1/R)$
50	2.2	53.455683 dB = 470.7433 A/A	1 + (47kΩ/100Ω) = 471 A/A
50	3.9	53.448248 dB = 470.3405 A/A	1 + (47kΩ/100Ω) = 471 A/A
50	5.6	54.437428 dB = 469.755 A/A	1 + (47kΩ/100Ω) = 471 A/A
50	10	54.393902 dB = 467.4069 A/A	1 + (47kΩ/100Ω) = 471 A/A
50	10	54.393902 dB = 467.4069 A/A	1 + (47kΩ/100Ω) = 471 A/A
100	10	54.393902 dB = 467.4069 A/A	1 + (47kΩ/100Ω) = 471 A/A
150	10	54.393902 dB = 467.4069 A/A	1 + (47kΩ/100Ω) = 471 A/A
200	10	54.393902 dB = 467.4069 A/A	1 + (47kΩ/100Ω) = 471 A/A