

IHP
SG13G2
SG13G2 RF NMOS LV

Rev. 1.2 (190924)

Date: February 4, 2023

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1 Documentation

1.1 Included Effects in Simulation Model

General	Date, Version	24.09.2019
	Processversion	SG13G2
	Simulator	ADS 2019, Spectre 18.1
	Simulation model	PSP 103.6
	Warning Boundaries	On

Statistic	Corner	x
	Process variations for Monte Carlo Simulation	e
	Mismatch	x
Transistor	DC behavior	x
	Drain diode	x
	Overlap cap.	x
	Junction cap.	x
	1/f Noise	x ₁
	HF / Thermal Noise	-
	Substrate resistance (RF)	x ₂
	Gate resistance (RF)	x ₂
Temperature	-40°C, 25°C, 70°C, 125°C	x

x measured and modelled

x₁ parameters taken from SG13

x₂ measurements are done from a different wafer run than DC model which leads to slight offsets

e estimated and modelled

o not included

- not applicable

1.2 Time range measurement

The verification of the time range measurements is done by the standard IHP verification procedure.

2 Setup

2.1 Measurement Conditions

2.1.1 Measurement Conditions for Transistors

	Sweep	Start[V]	Stop[V]	No. Points	List or f(Vth)
idvg	vg	-500m	1.35	38	
	vb	0	-1.2	5	
	vd	List		3	0.05, 0.6, 1.2
	vs	0		1	
idvd	vd	0	1.35	28	
	vg	Lin f(Vth)	1.35	5	Ref. Setup: idvg Idref: 100.0n Offset: 100.0m Resolution: 1.000m
	vb	0		1	
	vs	0		1	
idvd_vbmin	vd	0	1.35	28	
	vg	Lin f(Vth)	1.35	5	Ref. Setup: idvg Idref: 100.0n Offset: 100.0m Resolution: 1.000m
	vb	-1.2		1	
	vs	0		1	
idvd_vth	vd	0	1.35	28	
	vg	List f(Vth)		3	Ref. Setup: idvg Idref: 100.0n Offset: -200.0m Resolution: 1.000m Steps: 200.0m 200.0m
	vb	0		1	
	vs	0		1	
idvd_vth_vbmin	vd	0	1.35	28	
	vg	List		3	Ref. Setup: idvg

		f(Vth)			Idref: 100.0n Offset: -200.0m Resolution: 1.000m Steps: 200.0m 200.0m
	vb	-1.2		1	
	vs	0		1	
RF idvg	vg	-500m	1.35	38	
	vd	List		3	0.05, 0.6, 1.2
RF idvd	vd	0	1.35	28	
	vg	0	1.35	5	
RF sdut	freq	100MEG	47.6G	31	
	vd	0	1.35	10	
	vg	0	1.35	10	
spad	freq	100MEG	47.6G	31	
	Port1	0		1	
	Port2	0		1	

2.1.2 Measurement Conditions for Capacitance

	Sweep	Start[V]	Step[V]	Stop[V]	High Node	Low Node
Junction Bulk-Drain	1 VHI	-5	200m	200m	B	D
Junction Bulk-Source	1 VHI	-1	20m	300m	B	S
Oxide	1 VHI	1.35	-50m	-1.35	B	G
Overlap	1 VHI	-1.35	50m	1.35	G	D

2.2 Devices

2.2.1 Setup of DC Test Devices

Name	W[um]	L[um]	AD[um ²]	AS[um ²]	PD[um]	PS[um]	NRD	NRS	NF	Comment	Size Category
W10u0_L10u0_S541_5	10	10	3.4	3.4	20.7	20.7	0	0	1		Large
W0u15_L10u0_S547_3	150 m	10	101 m	101 m	1.34	1.34	0	0	1		Narrow
W10u0_L0u13_T356_S380_2	10	130 m	0	0	0	0	0	0	1		Short
W10u0_L0u13_S540_2	10	130 m	3.4	3.4	20.7	20.7	0	0	1		Short
W10u0_L0u13_S380_2	10	130 m	0	0	0	0	0	0	1		Short
W0u15_L0u13_S546_3	150 m	130 m	101 m	101 m	1.34	1.34	0	0	1		Small
W10u0_L0u18_S540_5	10	180 m	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L0u5_S541_1	10	500 m	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L1u2_S541_2	10	1.2	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L2u0_S541_3	10	2	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L5u0_S541_4	10	5	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L0u15_S540_4	10	150 m	3.4	3.4	20.7	20.7	0	0	1		L Scale
W10u0_L0u14_S540_3	10	140 m	3.4	3.4	20.7	20.7	0	0	1		L Scale
W0u3_L10u0_S545_2	300 m	10	102 m	102 m	1.28	1.28	0	0	1		W Scale
W0u18_L10u0_S546_1	180 m	10	103 m	103 m	1.34	1.34	0	0	1		W Scale
W05u0_L10u0_S542_3	5	10	1.7	1.7	10.7	10.7	0	0	1		W Scale
W02u0_L10u0_S543_1	2	10	680	680	4.6	4.6	0	0	1		W

			m	m	8	8					Scale
W0u6_L10u0_S544_1	600 m	10	204 m	204 m	1.8 8	1.8 8	0	0	1		W Scale
W0u3_L0u13_S544_2	300 m	130	102 m	102 m	1.2 8	1.2 8	0	0	1		LW Scale
W0u15_L0u5_S547_2	150 m	500	101 m	101 m	1.3 4	1.3 4	0	0	1		LW Scale
W05u0_L5u0_S542_2	5	5	1.7	1.7	10. 7	10. 7	0	0	1		LW Scale
W0u6_L0u18_S543_3	600 m	180	204 m	204 m	1.8 8	1.8 8	0	0	1		LW Scale
W0u3_L0u14_S544_3	300 m	140	102 m	102 m	1.2 8	1.2 8	0	0	1		LW Scale
W0u18_L0u14_S545_4	180 m	140	103 m	103 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u18_L0u13_S545_3	180 m	130	103 m	103 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u3_L0u15_S544_4	300 m	150	102 m	102 m	1.2 8	1.2 8	0	0	1		LW Scale
W02u0_L2u0_S542_5	2	2	680 m	680 m	4.6 8	4.6 8	0	0	1		LW Scale
W0u15_L0u15_S546_5	150 m	150	101 m	101 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u6_L0u5_S543_4	600 m	500	204 m	204 m	1.8 8	1.8 8	0	0	1		LW Scale
W0u18_L0u15_S545_5	180 m	150	103 m	103 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u3_L0u5_S545_1	300 m	500	102 m	102 m	1.2 8	1.2 8	0	0	1		LW Scale
W0u6_L0u13_S543_2	600 m	130	204 m	204 m	1.8 8	1.8 8	0	0	1		LW Scale
W0u15_L0u18_S547_1	150 m	180	101 m	101 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u6_L1u2_S543_5	600 m	1.2	204 m	204 m	1.8 8	1.8 8	0	0	1		LW Scale
W02u0_L0u13_S542_4	2	130	680 m	680 m	4.6 8	4.6 8	0	0	1		LW Scale
W0u15_L0u14_S546_4	150 m	140	101 m	101 m	1.3 4	1.3 4	0	0	1		LW Scale
W0u3_L0u18_S544_5	300 m	180	102 m	102 m	1.2 8	1.2 8	0	0	1		LW Scale

W05u0_L0u13_S542_1	5	130 m	1.7	1.7	10. 7	10. 7	0	0	1		LW Scale
W0u15_L0u12_S546_2	150 m	120 m	101 m	101 m	1.3 4	1.3 4	0	0	1		Addition al
W10u0_L0u12_S540_1	10	120 m	3.4	3.4	20. 7	20. 7	0	0	1		Addition al

2.2.2 Setup of CV Test Devices

Name	W[um]	L[um]	NF	AD[um ²]	AS[um ²]	PD[um]	PS[um]	Comment	Size Category
Junction Capacitance Bulk - Drain									
CJBDarea_S350B_1			1	37.5 K		850		B- High, S/D- Low	BD Area
CJBDperim_S350B_2			1	28.6 K		102K		B- High, S/D- Low	BD Perim
Junction Capacitance Bulk - Source									
CJBSarea_S350B_1			1	0		0		B- High, S/D- Low	BS Area
CJBSperim_S350B_2			1	0		0		B- High, S/D- Low	BS Perim
Oxide Capacitance									
Cox_S346K_3	160	250	1					B- High, G-Low	Oxide
Overlap Capacitance									
Cgds1_S350B_11	8K	130 m	80 0	1.52 K	1.52 K	8.32 K	8.32 K	G- High, S/D-	Overlap GDS

								Low, B+Sub -GND	
Cgdsb1_S350B_11	8K	130 m	80 0	1.52 K	1.52 K	8.32 K	8.32 K	G- High, S/D+B -Low	Overlap GDSB
Cgds2_S350B_12	6.6 K	250 m	66 0	1.26 K	1.26 K	6.87 K	6.87 K	G- High, S/D- Low, B+Sub -GND	Overlap 1 GDS
Cgdsb2_S350B_12	6.6 K	250 m	66 0	1.26 K	1.26 K	6.87 K	6.87 K	G- High, S/D+B -Low	Overlap 1 GDSB
Cgds3_S350B_13	400	10	40	79.8	79.8	436	436	G- High, S/D- Low, B+Sub -GND	Overlap 2 GDS
Cgdsb3_S350B_13	400	10	40	79.8	79.8	436	436	G- High, S/D+B -Low	Overlap 2 GDSB

3 Corner Devices

3.1 Target Values vs. Simulated Values

3.1.1 W = 10.00u, L = 130.0n, NF = 1

	Slow			Typic.			Fast		
	Target	Sim.	Error [%]	Target	Sim.	Error [%]	Target	Sim.	Error [%]
VT	550m	430m	21.88	500m	430m	14.07	440m	430m	2.35
Ron*W	-	-	-	650m	675m	3.72	-	-	-
Ion/W	380	488	-28.43	480	488	-1.67	580	488	15.86
log(Ioff/W)	-11.3	-9.66	3.65	-10.1	-9.66	2.58	-9.3	-9.66	2.16

3.1.2 W = 10.00u, L = 10.00u, NF = 1

	Slow			Typic.			Fast		
	Target	Sim.	Error [%]	Target	Sim.	Error [%]	Target	Sim.	Error [%]
VT	230m	147m	36.01	200m	147m	26.41	170m	147m	13.43
Ion/W	16.7	20.4	-22.16	18.1	20.4	-12.71	19.5	20.4	-4.62

3.1.3 W = 150.0n, L = 130.0n, NF = 1

	Slow			Typic.			Fast		
	Target	Sim.	Error [%]	Target	Sim.	Error [%]	Target	Sim.	Error [%]
VT	620m	453m	26.97	530m	453m	14.57	440m	453m	-2.9
Ion/W	420	5.18K	-1133.49	550	5.18K	-841.93	680	5.18K	-661.86

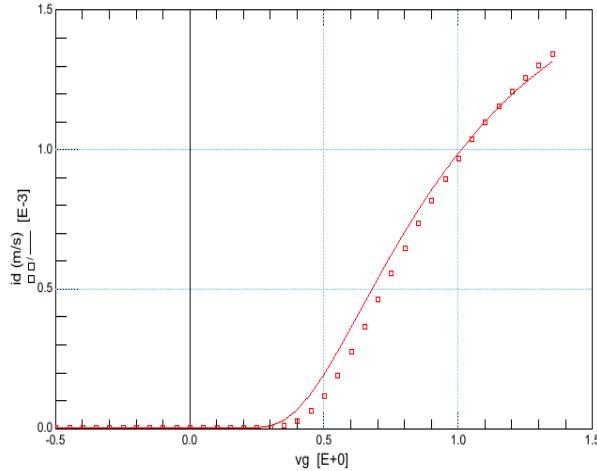
3.1.4 W = 150.0n, L = 10.00u, NF = 1

	Slow			Typic.			Fast		
	Target	Sim.	Error [%]	Target	Sim.	Error [%]	Target	Sim.	Error [%]
VT	270m	149m	44.86	200m	149m	25.56	130m	149m	-14.52
Ion/W	13	19.1	-47.24	15.5	19.1	-23.49	18	19.1	-6.34

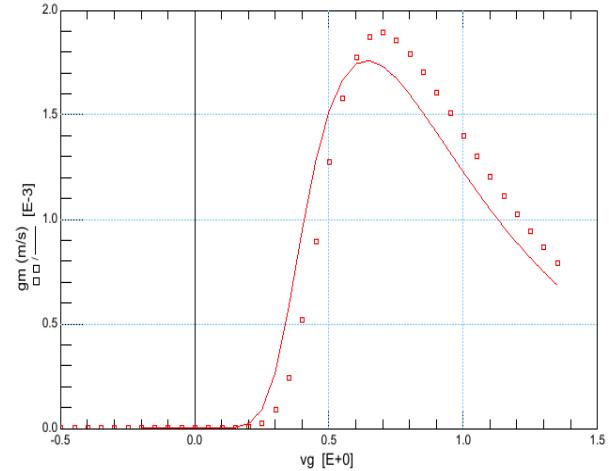
4 RF Transistors

4.1 NF04_WF05u0_L0u18_S453A_22

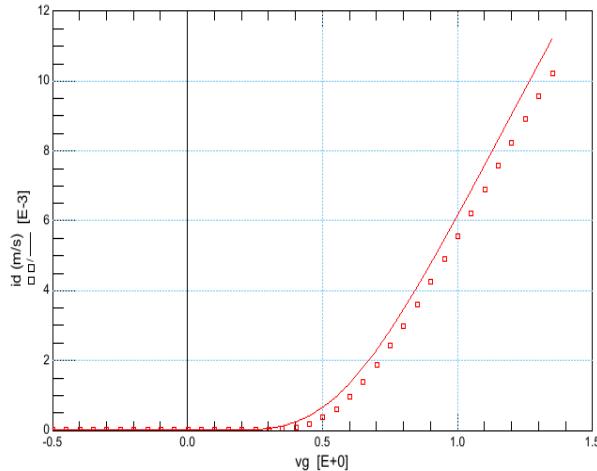
$IdVg$, $T = 27^\circ\text{C}$



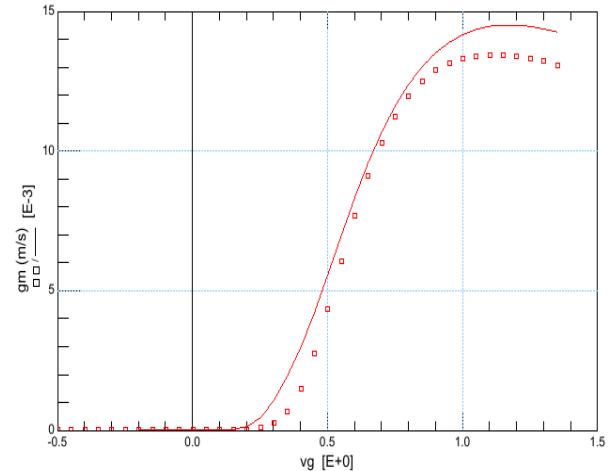
$$Id = f(Vg) @ Vd = 0.05\text{V}$$



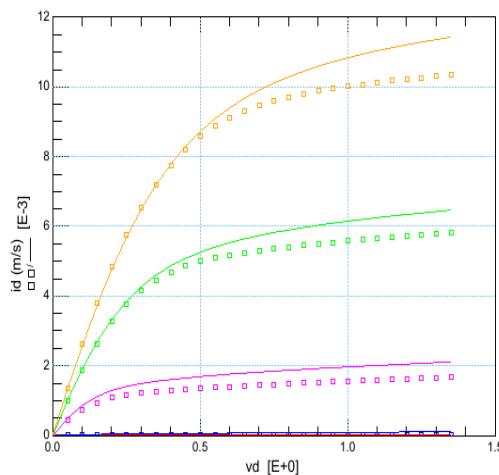
$$gm = f(Vg) @ Vd = 0.05\text{V}$$



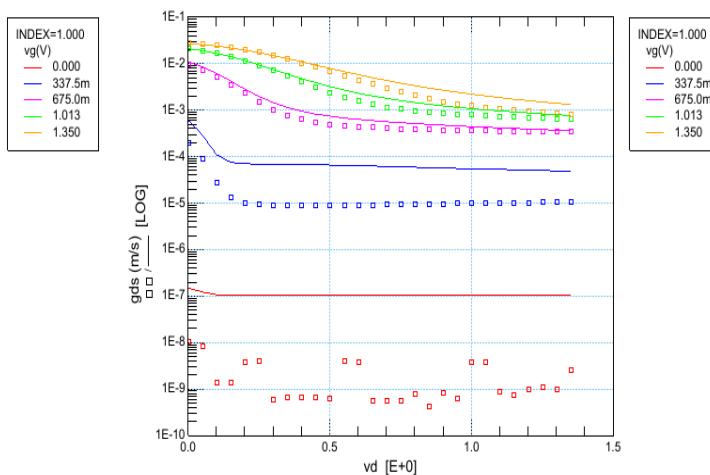
$$Id = f(Vg) @ Vd = 1.2\text{V}$$



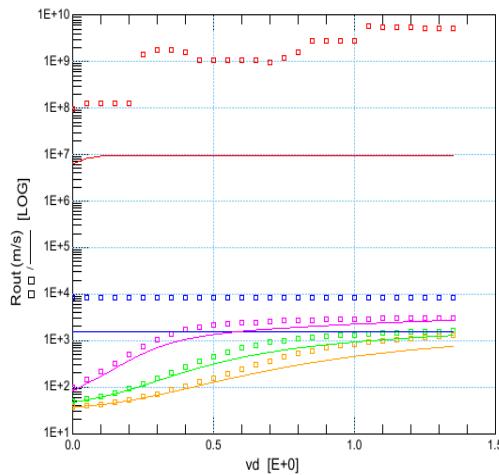
$$gm = f(Vg) @ Vd = 1.2\text{V}$$

IdVd, T = 27°C

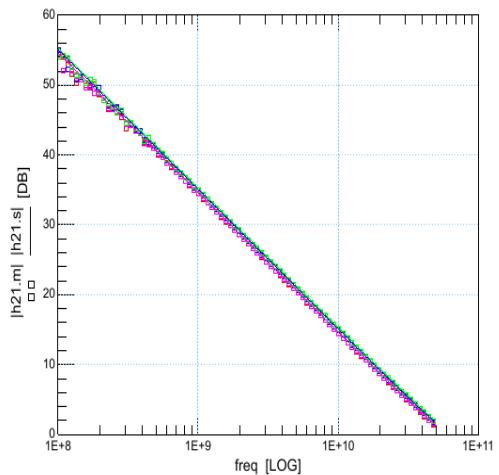
$$Id = f(Vd)$$



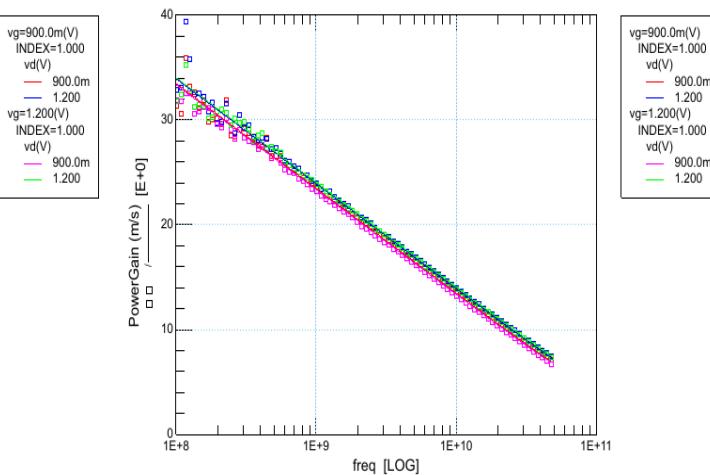
$$gds = f(Vd)$$



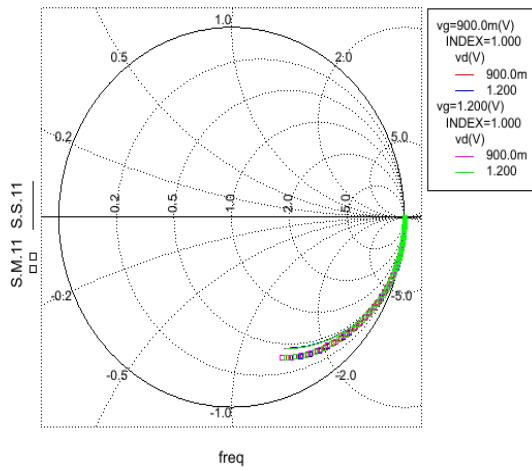
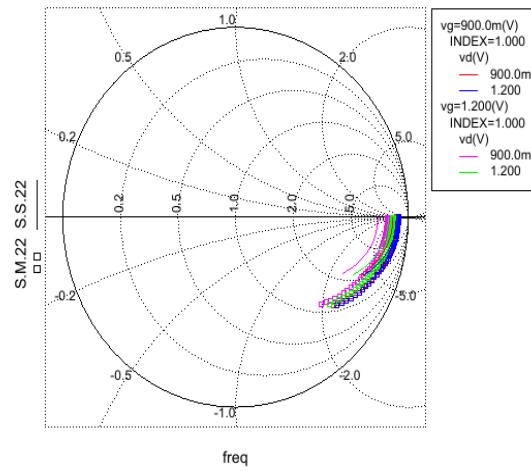
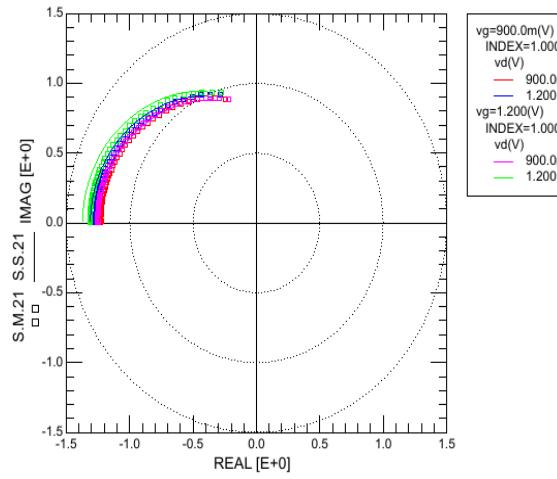
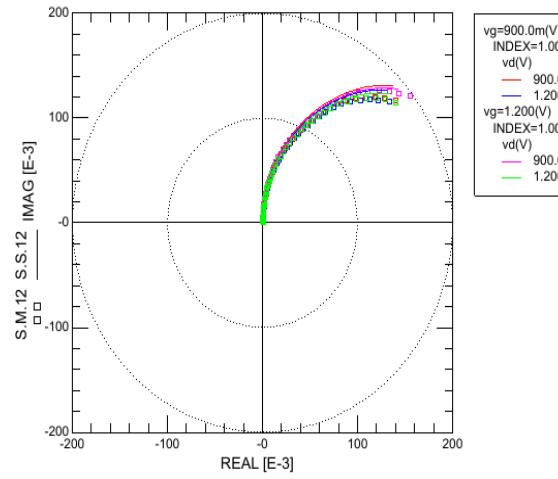
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

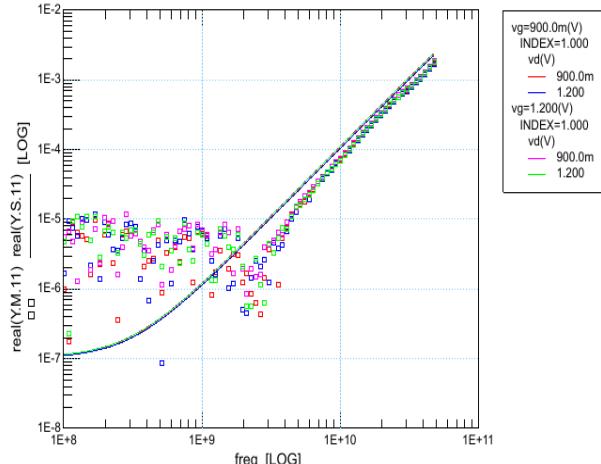
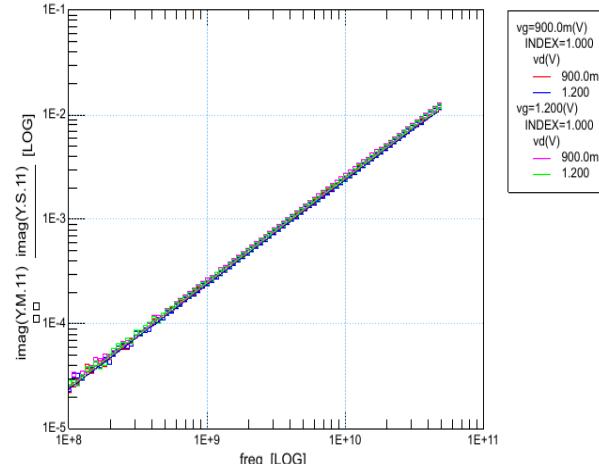
$$|h21| = f(Vg, Vd)$$

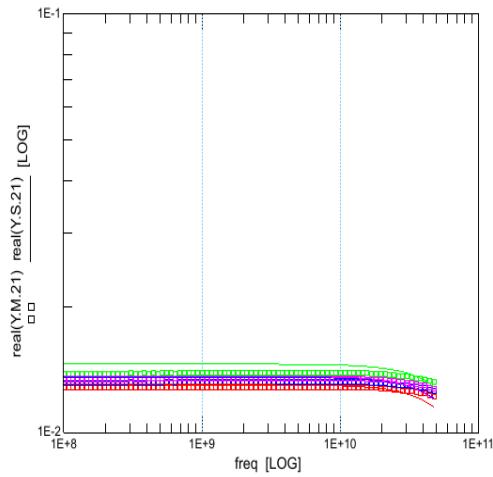


$$MSG/MAG = f(Vg, Vd)$$

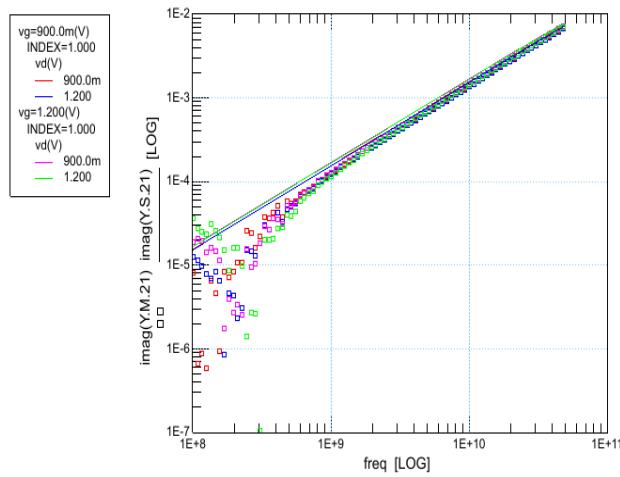
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

Y-Parameter, T = 27°C

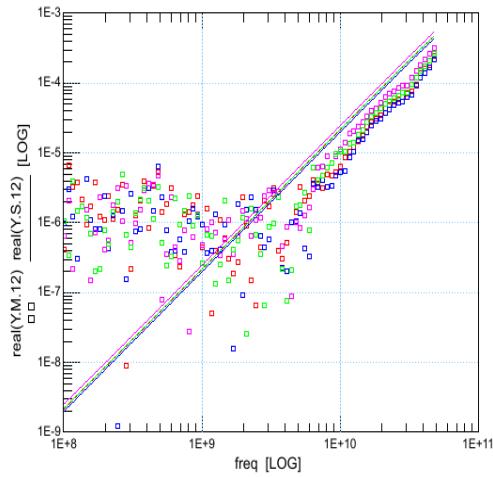
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



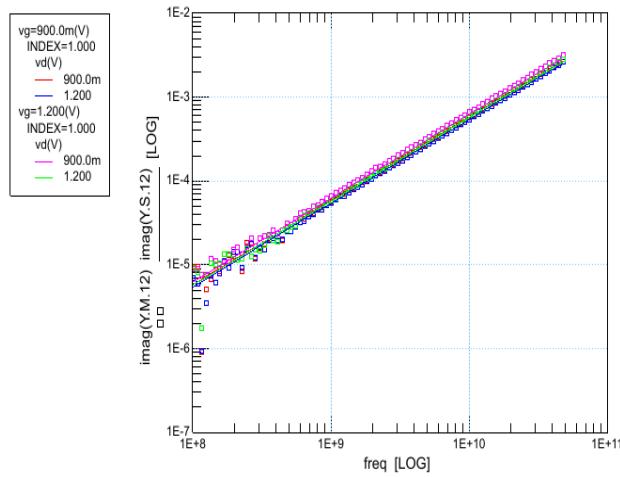
re(Y21) = f(Vg,Vd)



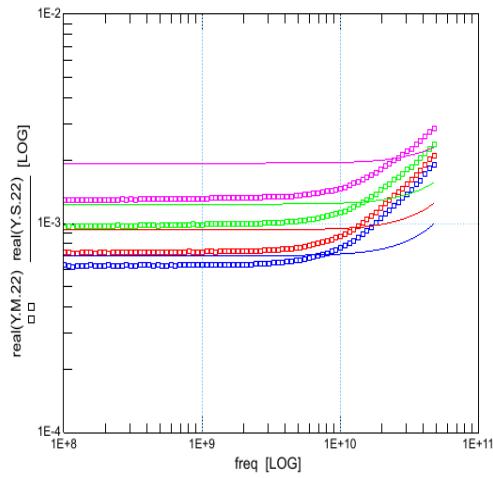
im(Y21) = f(Vg,Vd)



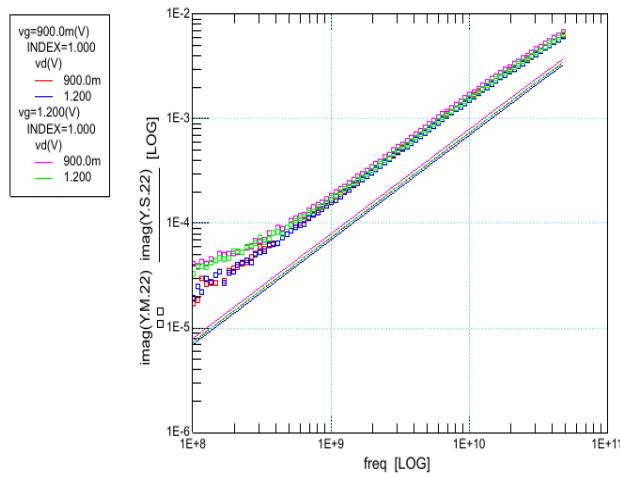
re(Y12) = f(Vg,Vd)



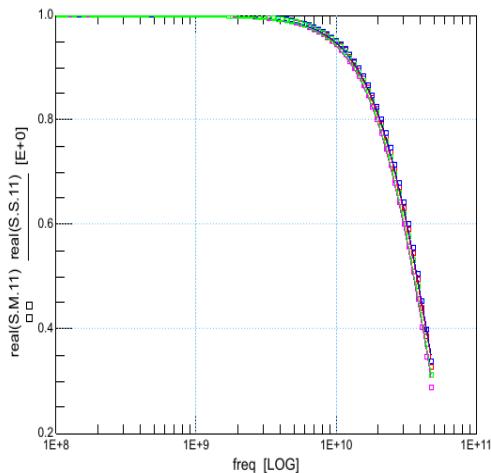
im(Y12) = f(Vg,Vd)



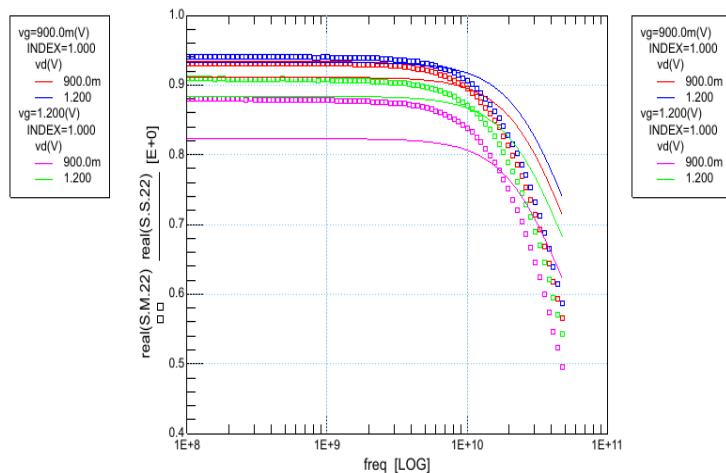
re(Y22) = f(Vg,Vd)



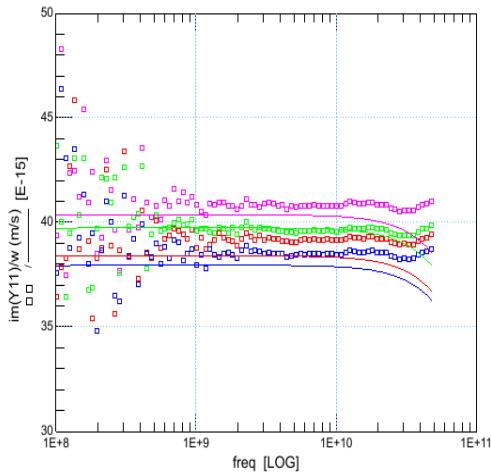
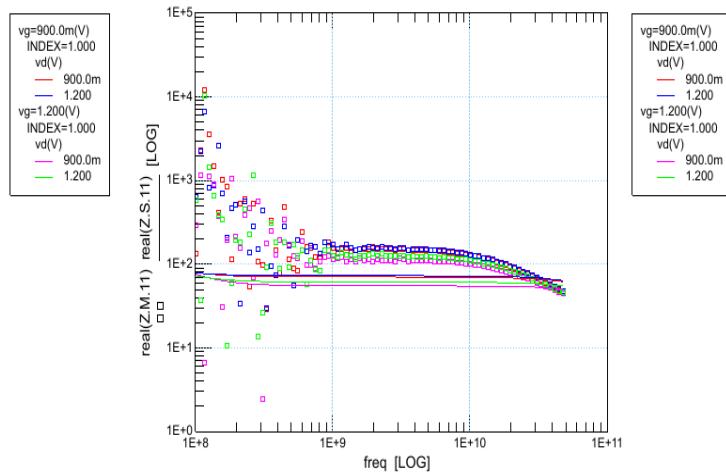
im(Y22) = f(Vg,Vd)

Verify Plots, $T = 27^\circ\text{C}$ 

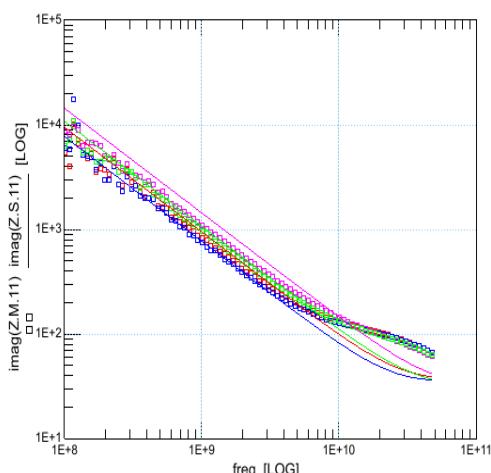
re(S11) = f(Vg, Vd)



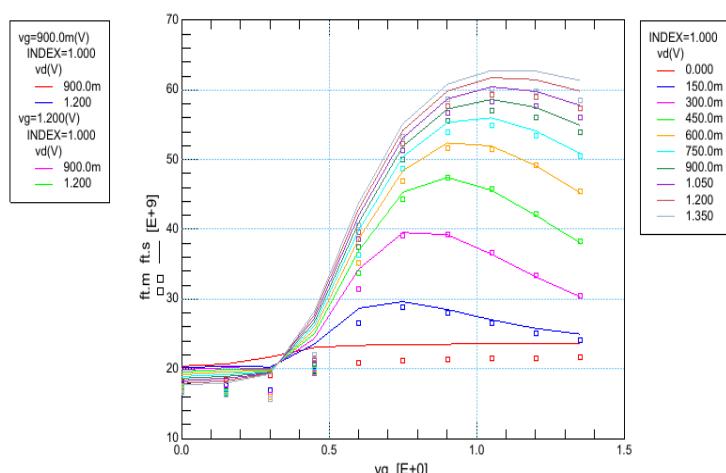
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

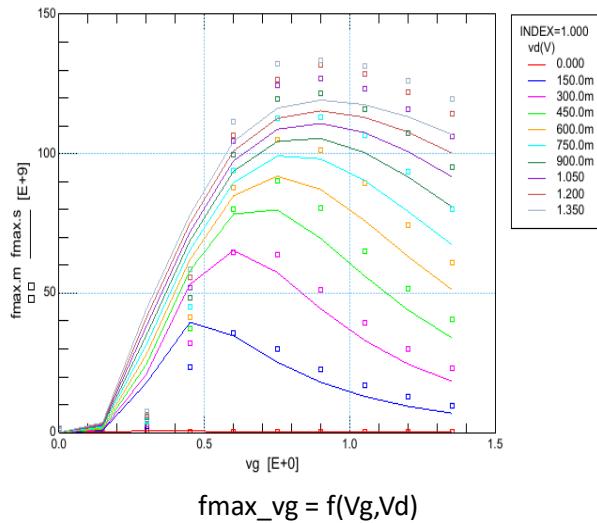
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

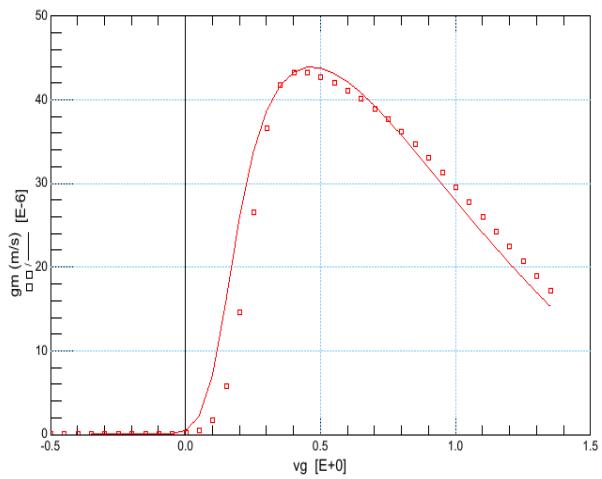
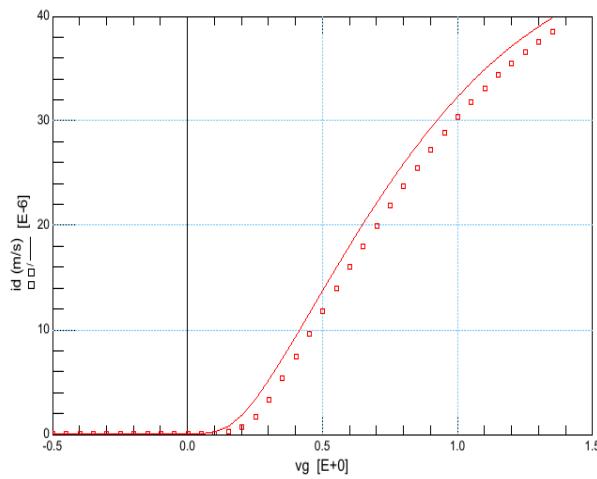


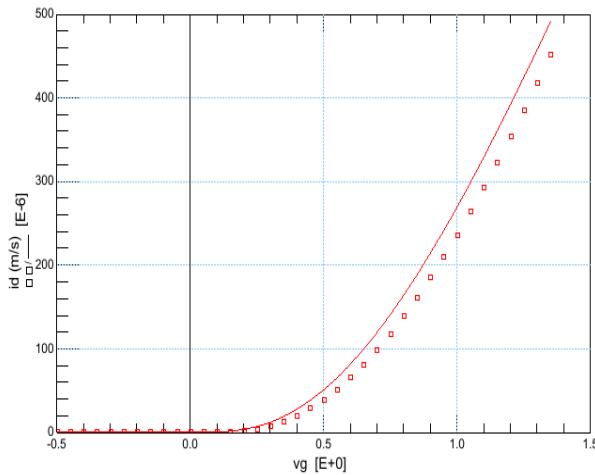
fT_vg = f(Vg, Vd)



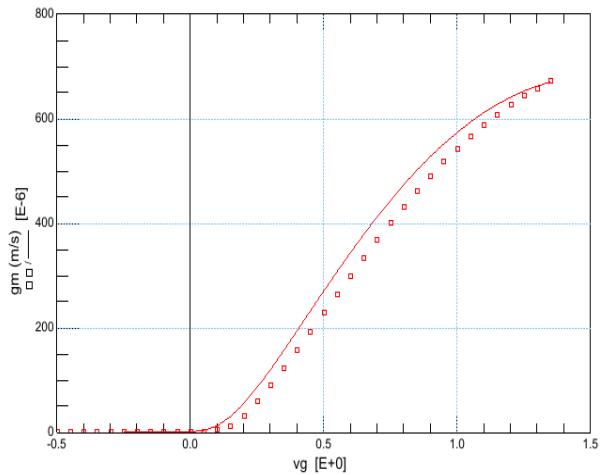
4.2 NF04_WF05u0_L10u0_S453A_10

IdVg, T = 27°C



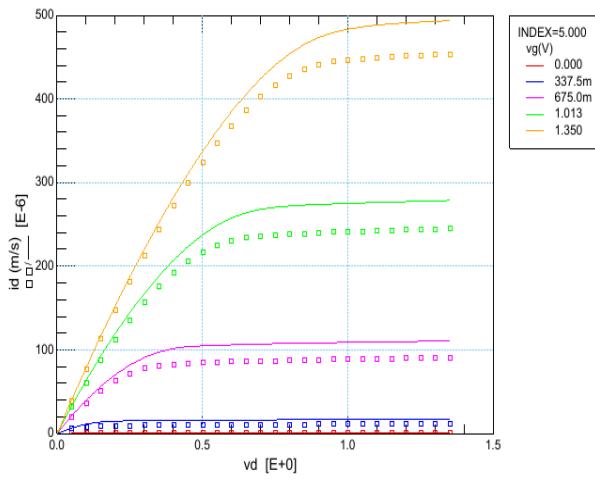


$$Id = f(Vg) @ Vd = 1.2V$$

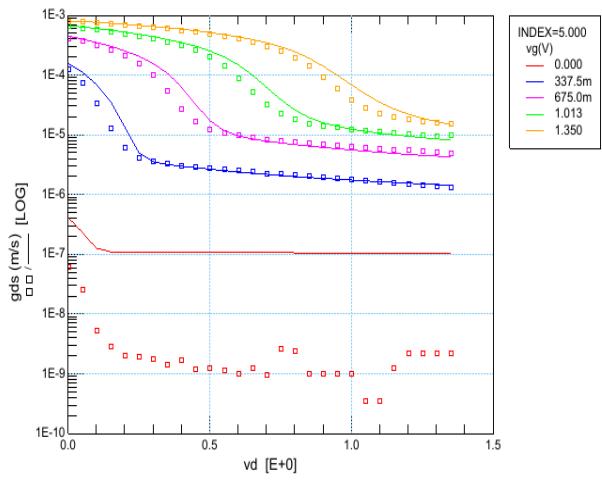


$$gm = f(Vg) @ Vd = 1.2V$$

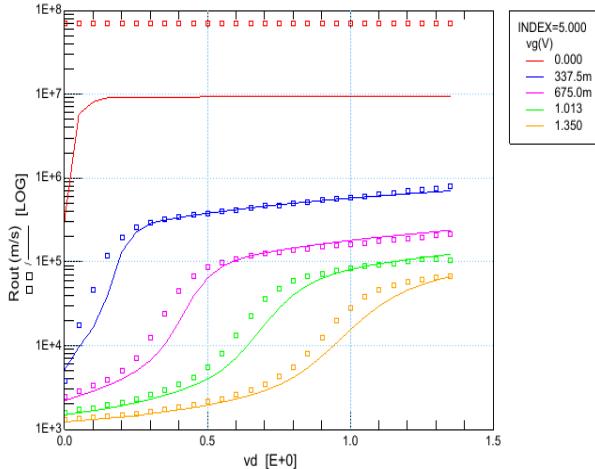
IdVd, T = 27°C



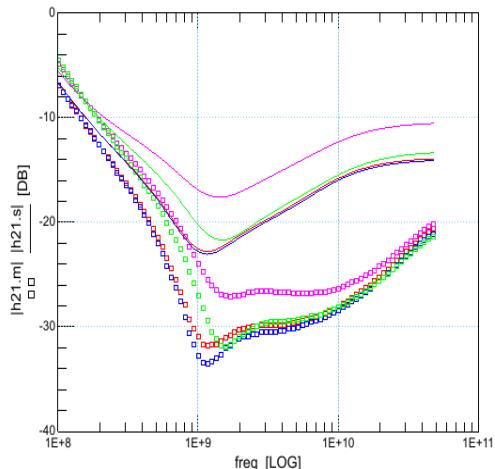
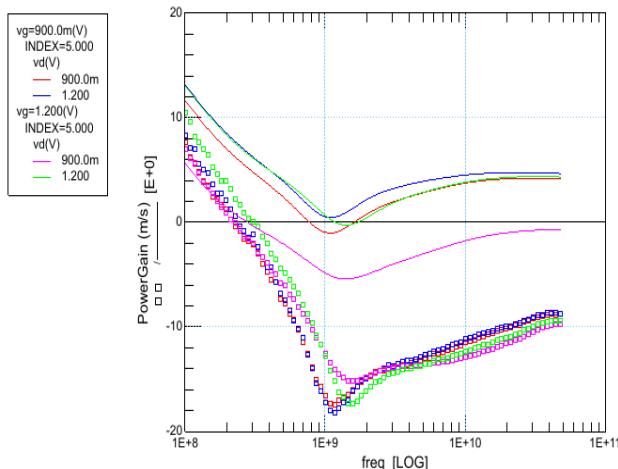
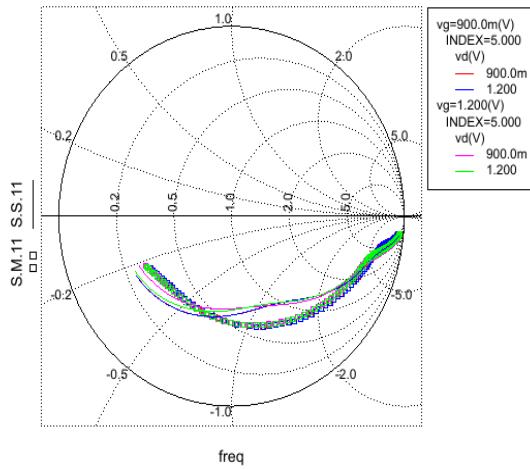
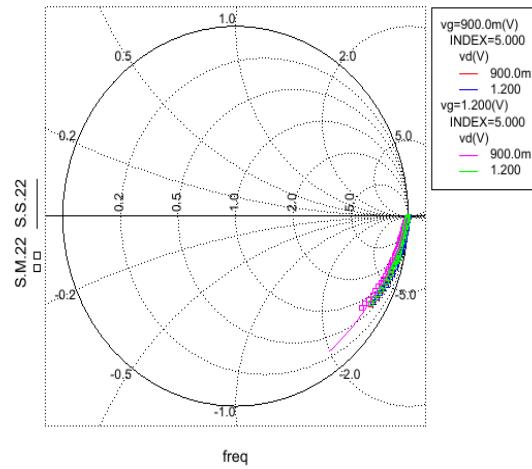
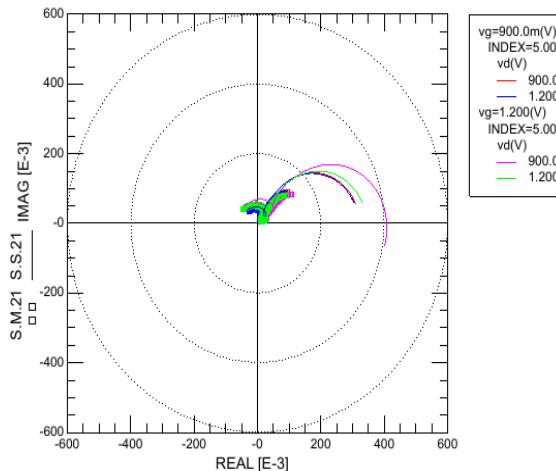
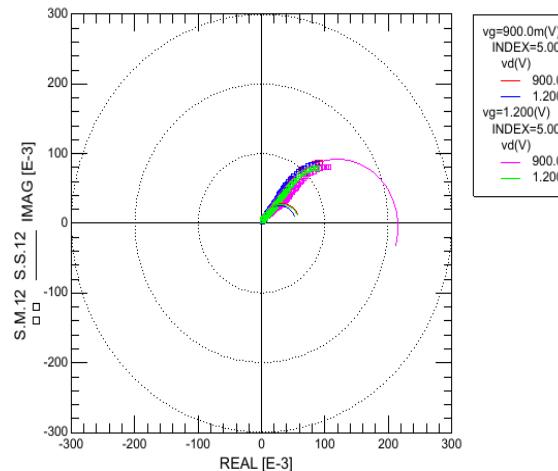
$$Id = f(Vd)$$



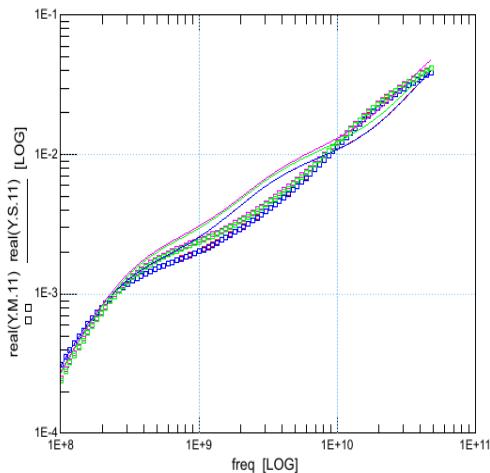
$$gds = f(Vd)$$



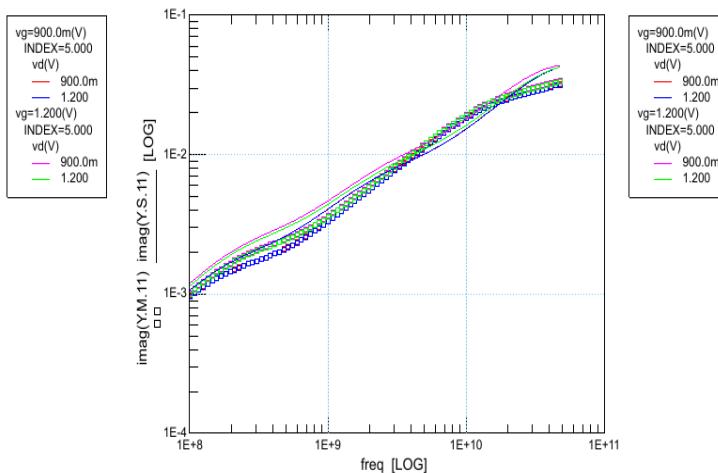
$$Rout = f(Vd)$$

S-Parameter, T = 27°C $|h21| = f(Vg, Vd)$  $MSG/MAG = f(Vg, Vd)$  $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

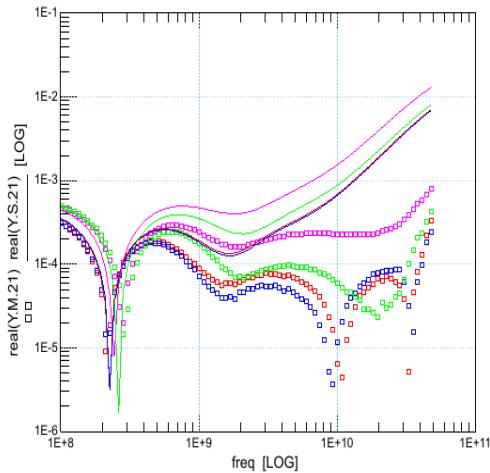
Y-Parameter, T = 27°C



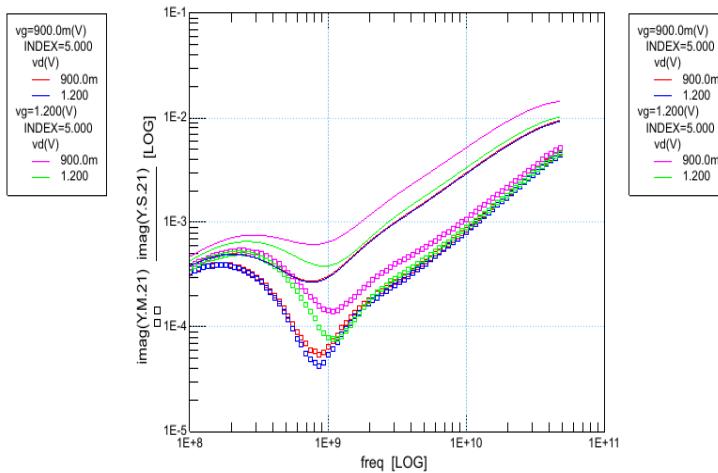
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



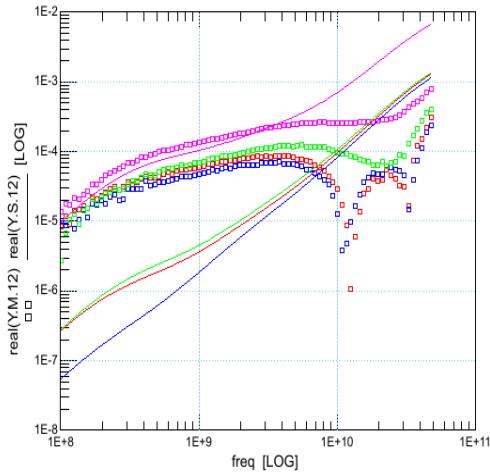
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



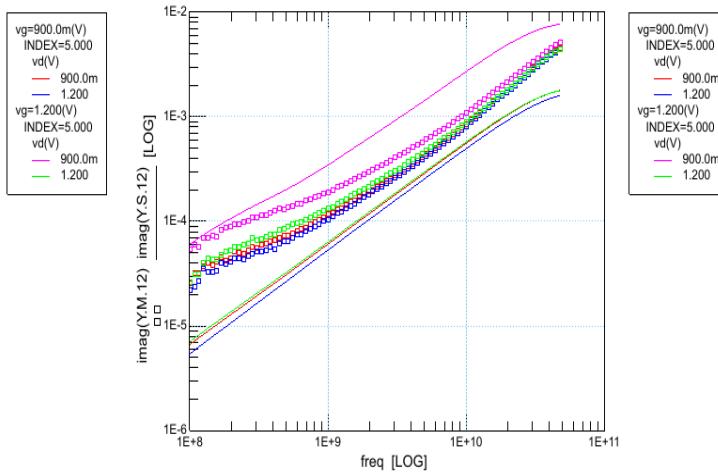
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



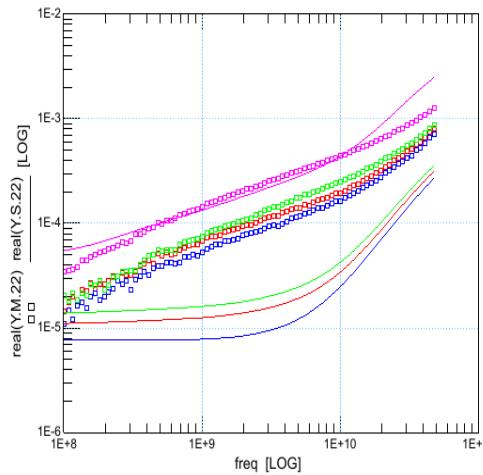
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



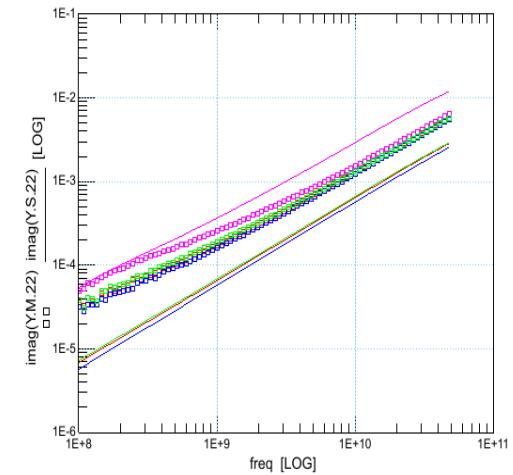
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



$$\text{im}(Y_{12}) = f(V_g, V_d)$$

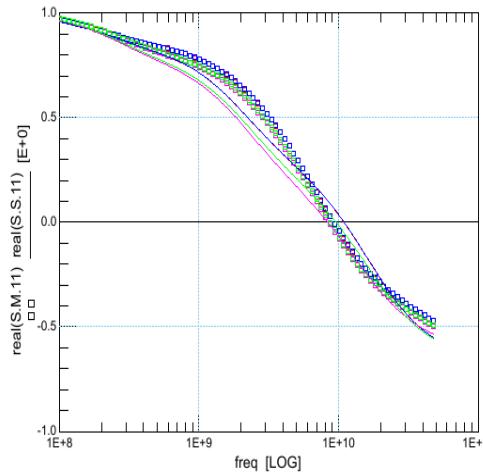


re(Y22) = f(Vg, Vd)

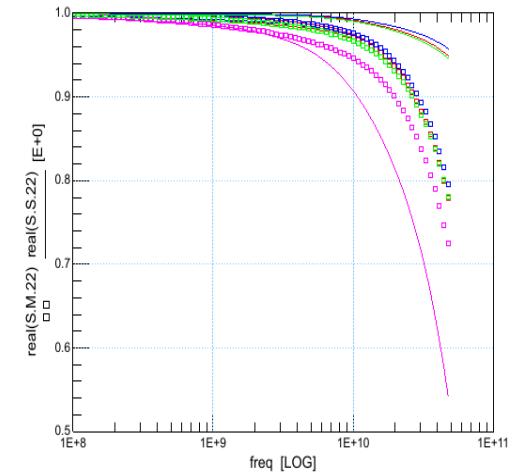


im(Y22) = f(Vg, Vd)

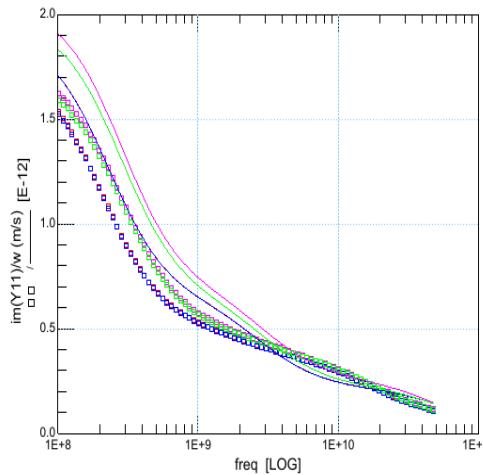
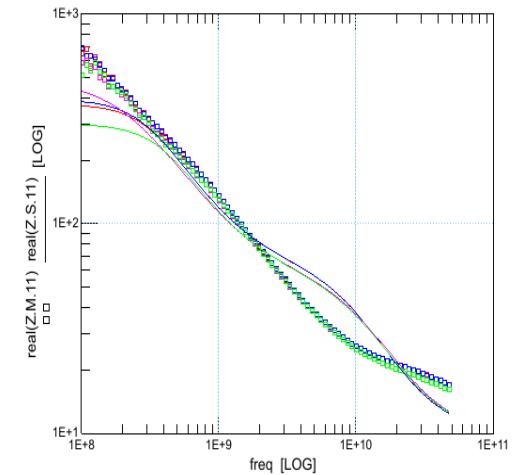
Verify Plots, T = 27°C



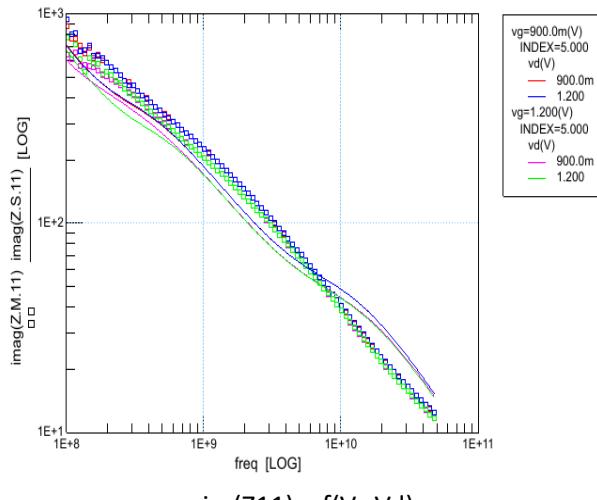
re(S11) = f(Vg, Vd)



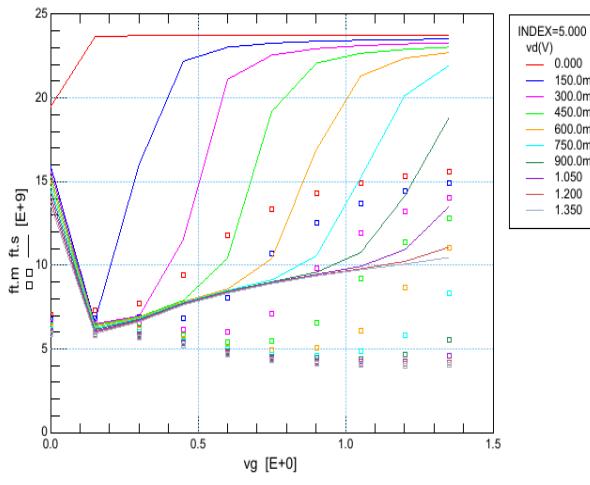
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

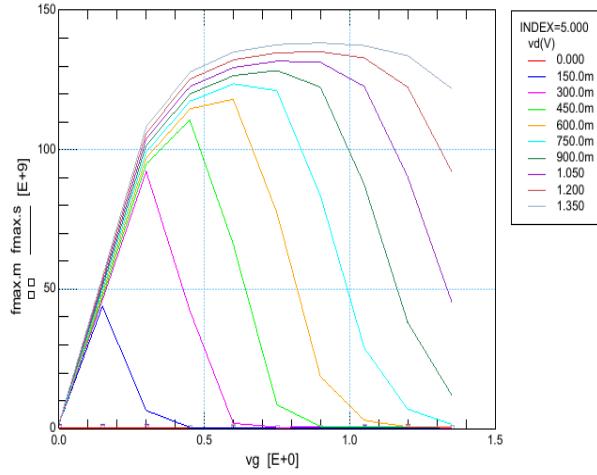
re(Z11) = f(Vg, Vd)



$$\text{im}(Z_{11}) = f(V_g, V_d)$$



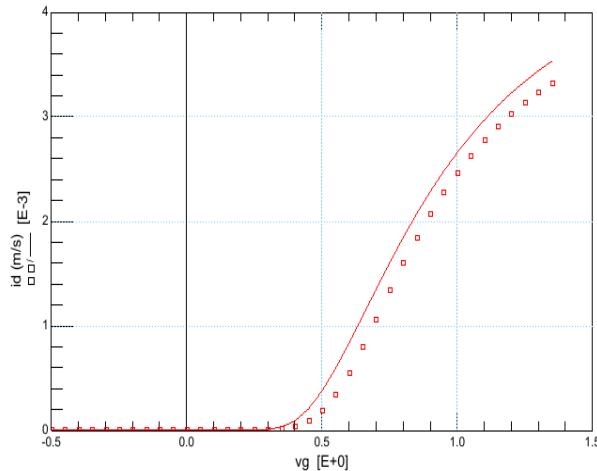
$$fT_{vg} = f(V_g, V_d)$$



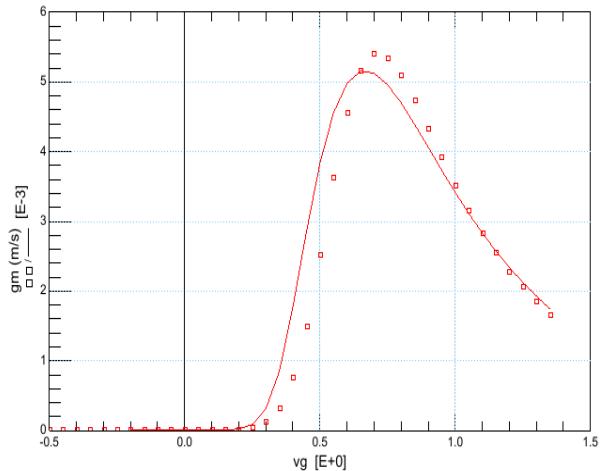
$$f_{\max,vg} = f(V_g, V_d)$$

4.3 NF05_WF10u0_L0u13_S453A_41

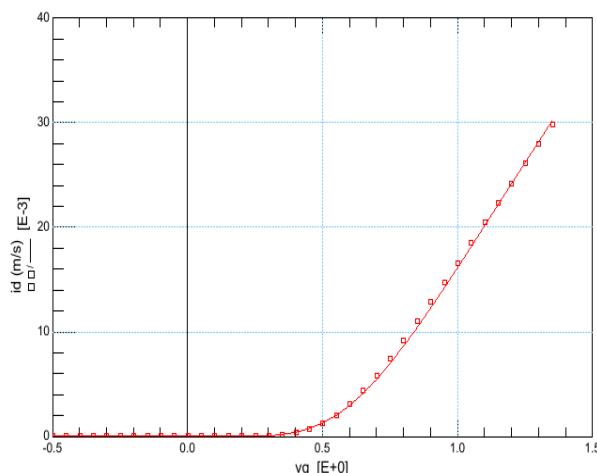
$IdVg$, $T = 27^\circ\text{C}$



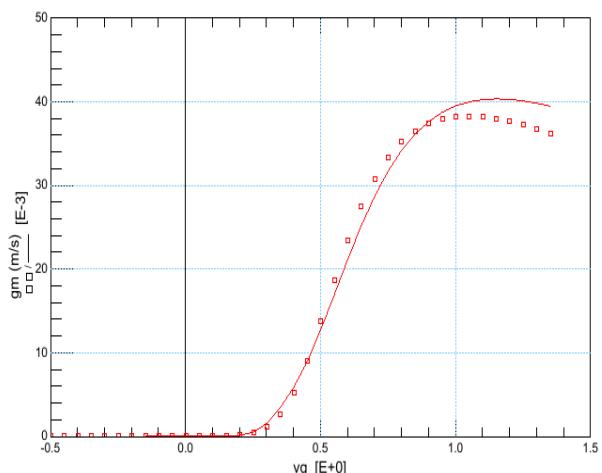
$Id = f(Vg)$ @ $Vd = 0.05\text{V}$



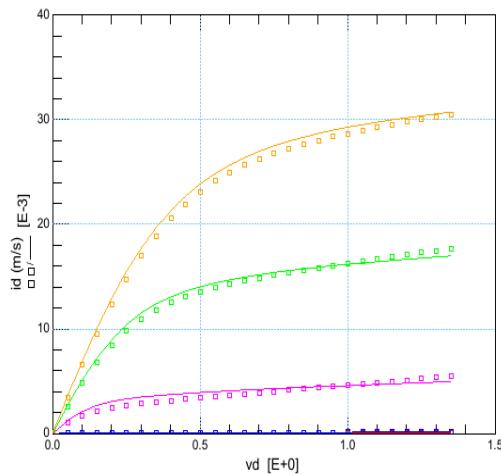
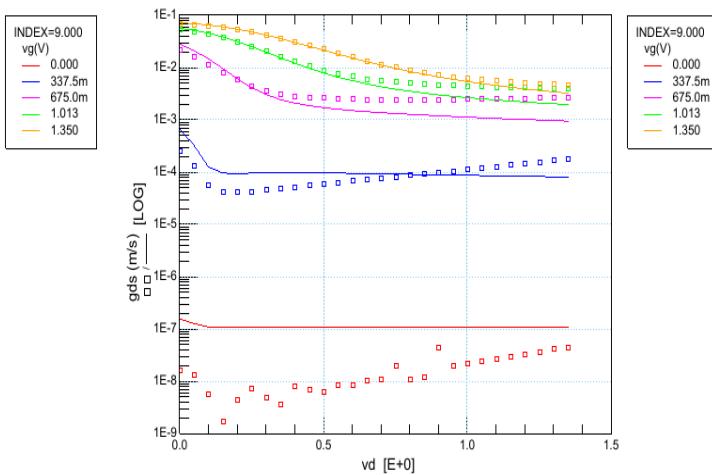
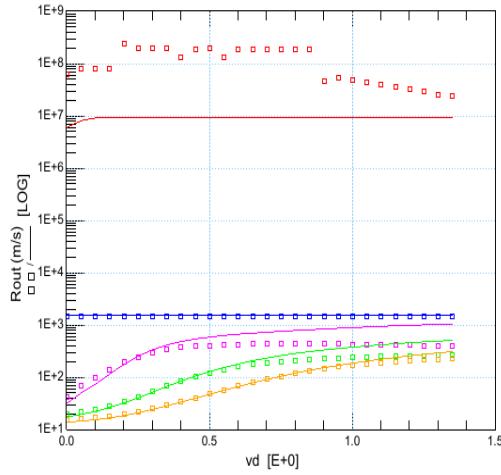
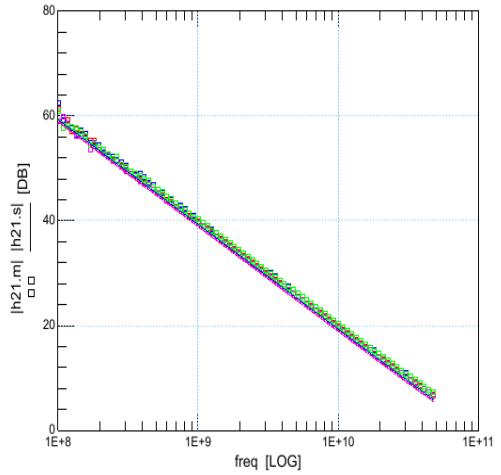
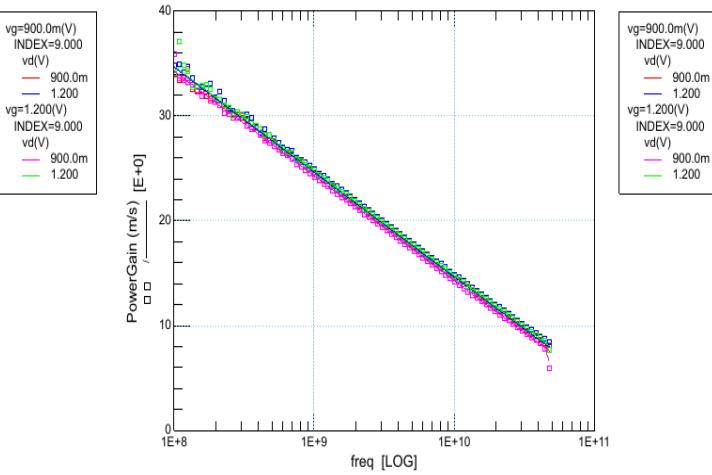
$gm = f(Vg)$ @ $Vd = 0.05\text{V}$

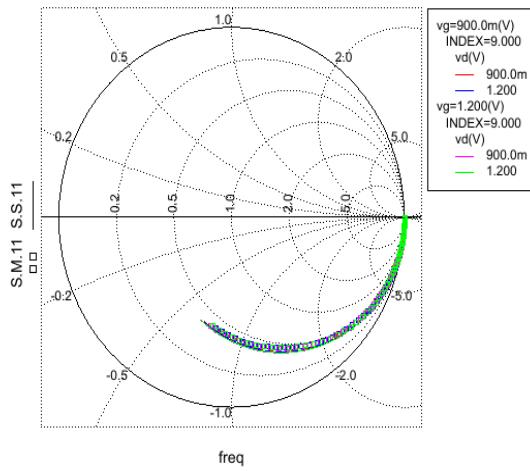
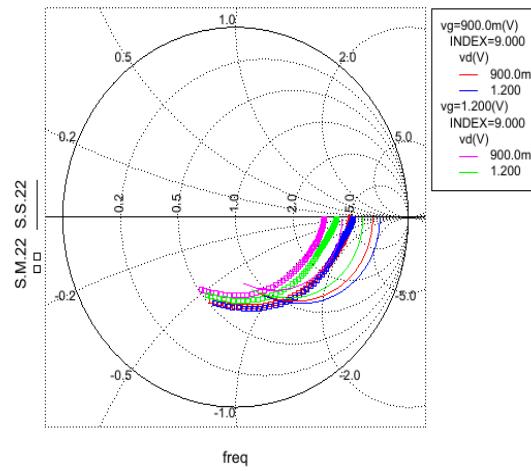
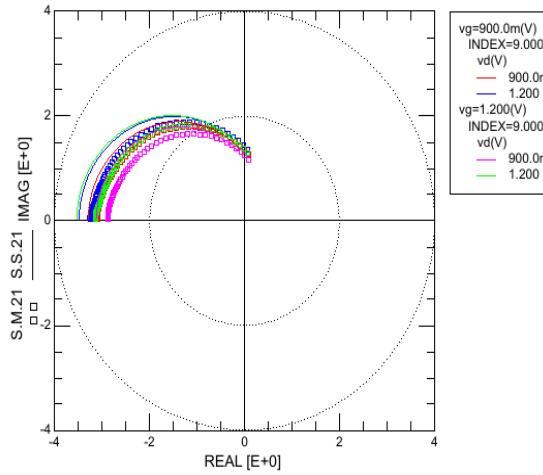
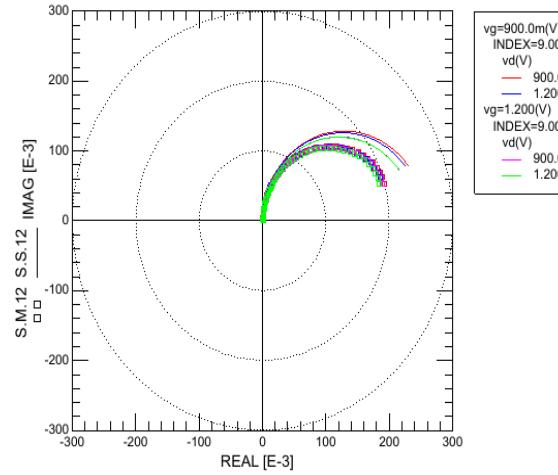


$Id = f(Vg)$ @ $Vd = 1.2\text{V}$

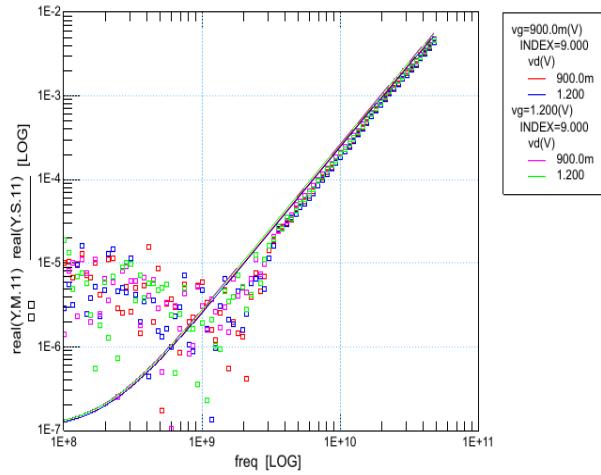
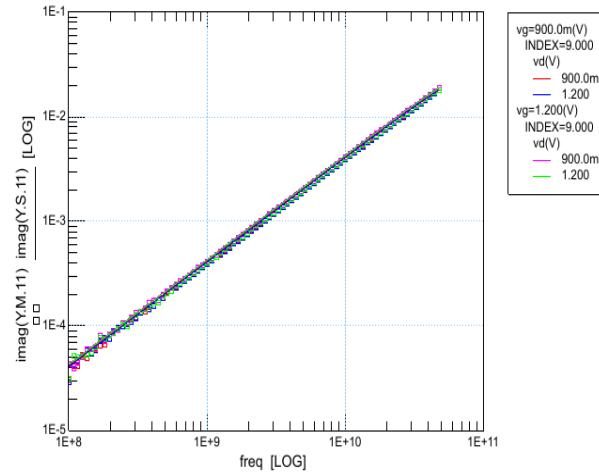


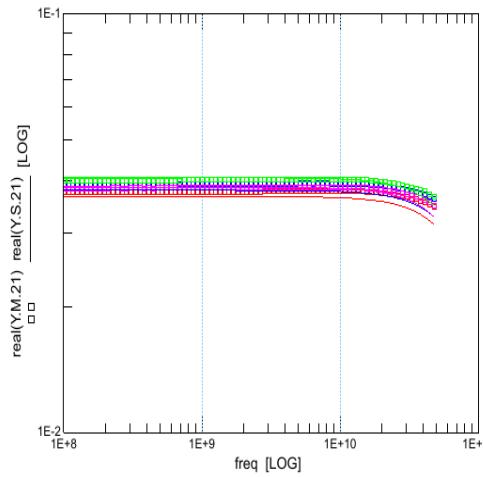
$gm = f(Vg)$ @ $Vd = 1.2\text{V}$

IdVd, T = 27°C $Id = f(Vd)$  $gds = f(Vd)$  $Rout = f(Vd)$ **S-Parameter, T = 27°C** $|h21| = f(Vg, Vd)$  $MSG/MAG = f(Vg, Vd)$

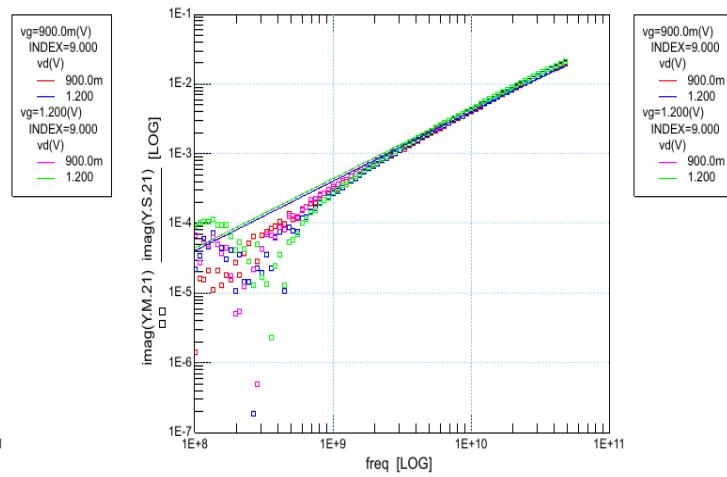
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

Y-Parameter, T = 27°C

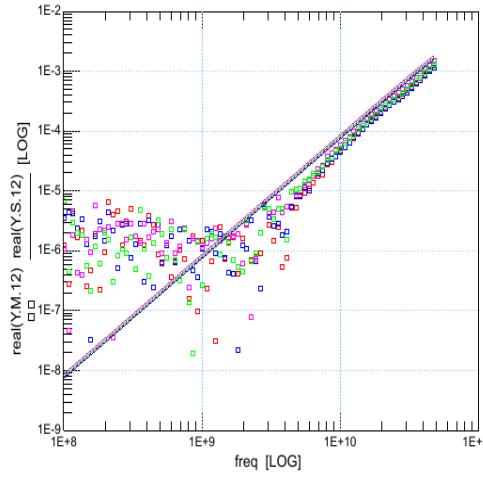
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



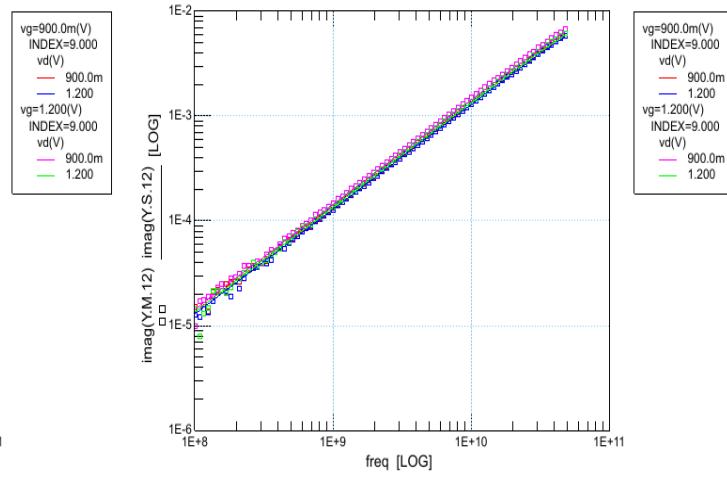
re(Y21) = f(Vg, Vd)



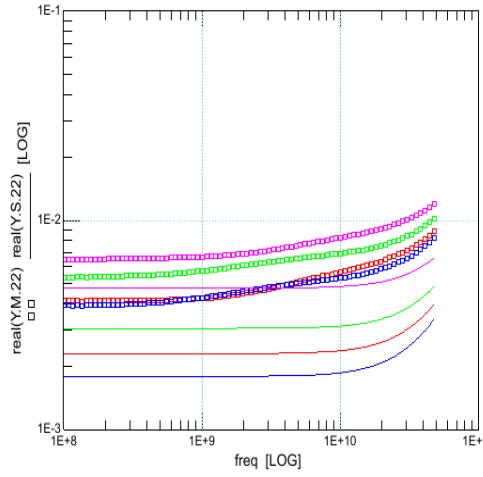
im(Y21) = f(Vg, Vd)



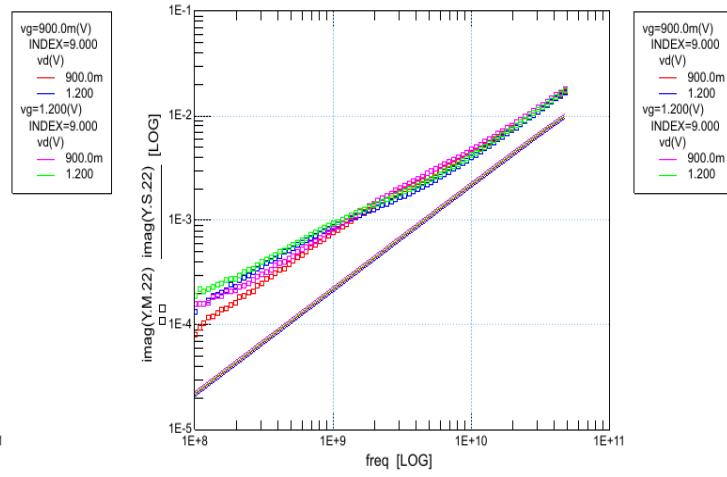
re(Y12) = f(Vg, Vd)



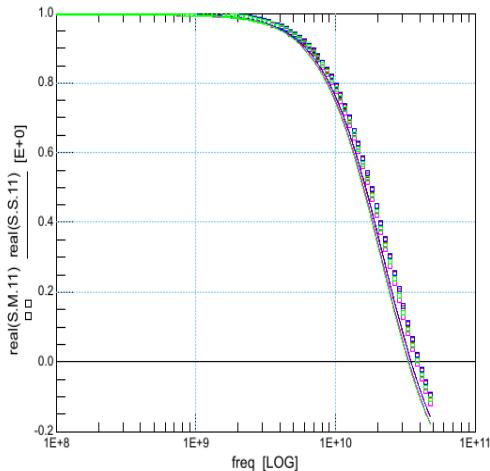
im(Y12) = f(Vg, Vd)



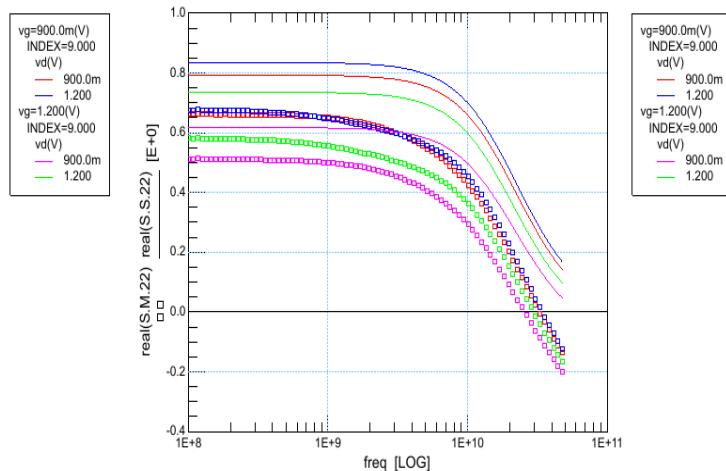
re(Y22) = f(Vg, Vd)



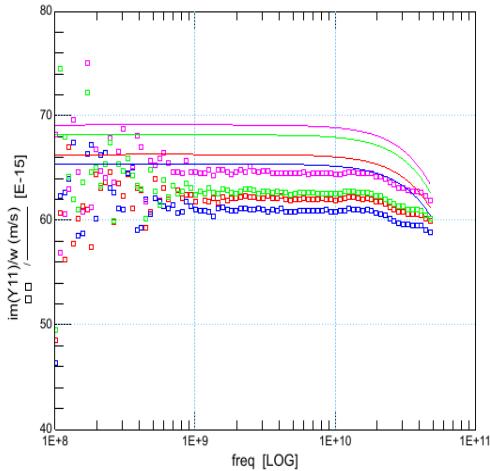
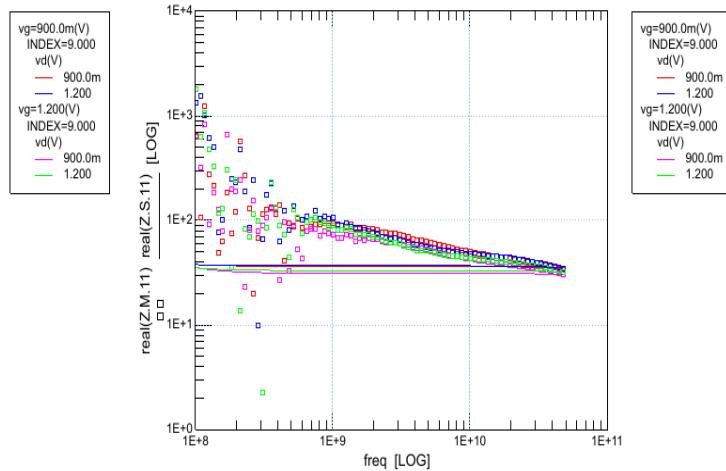
im(Y22) = f(Vg, Vd)

Verify Plots, $T = 27^\circ\text{C}$ 

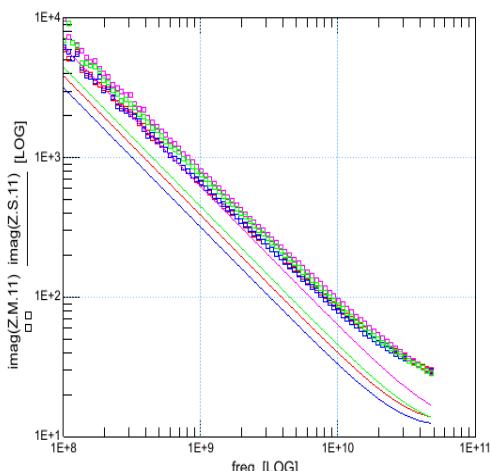
re(S11) = f(Vg, Vd)



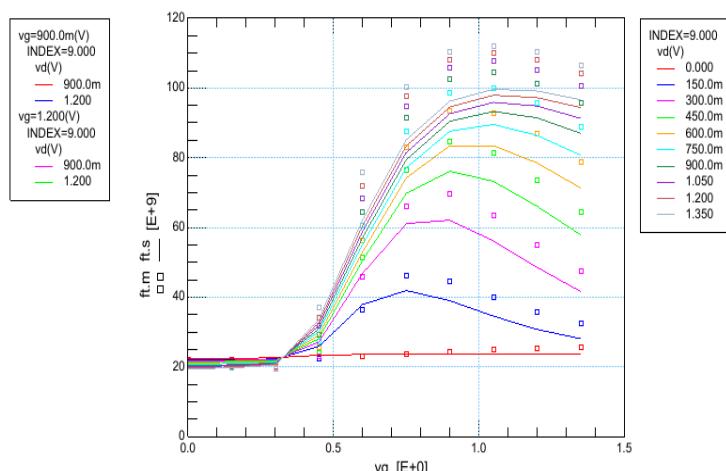
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

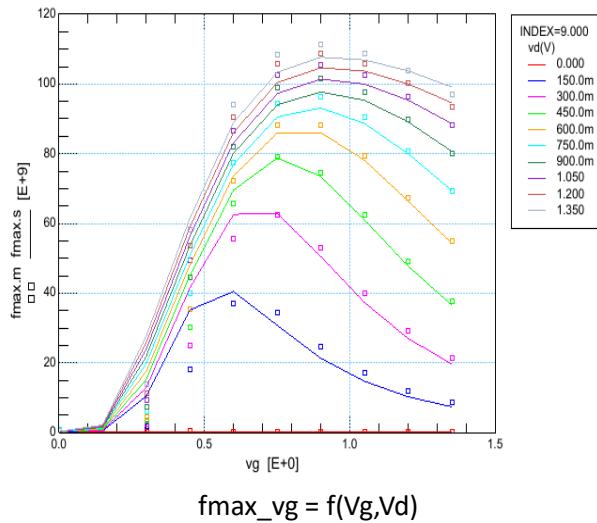
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

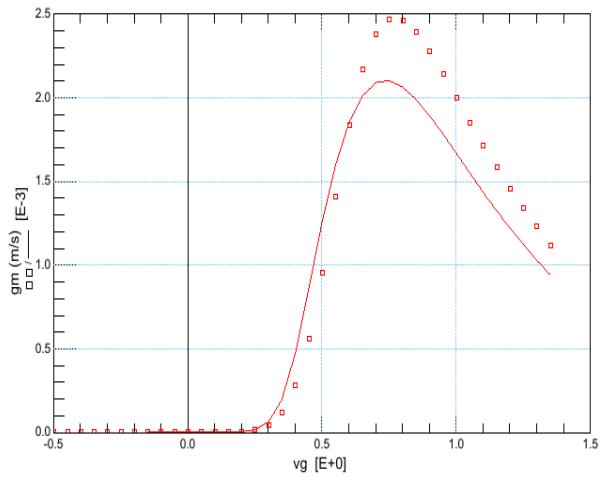
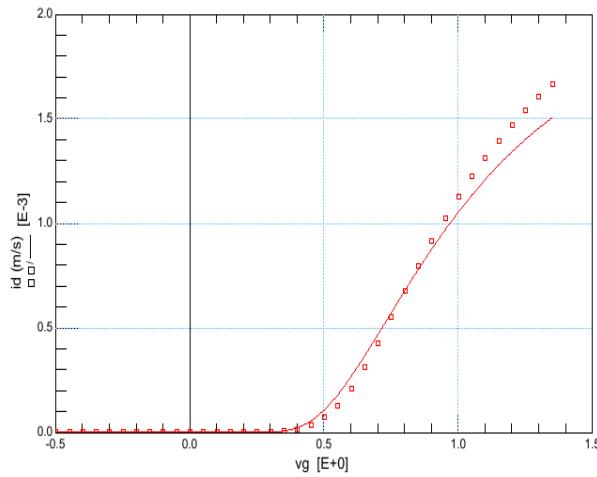


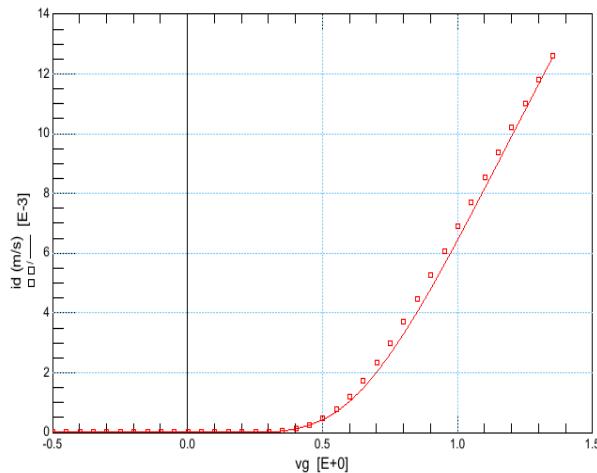
fT_vg = f(Vg, Vd)



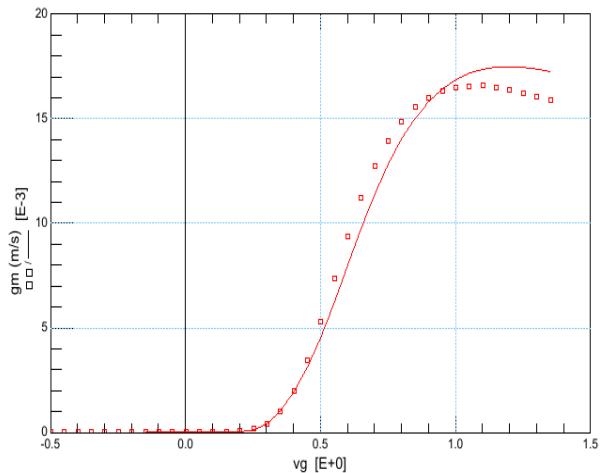
4.4 NF08_WF02u5_L0u13_S453A_34

$I_d V_g, T = 27^\circ C$



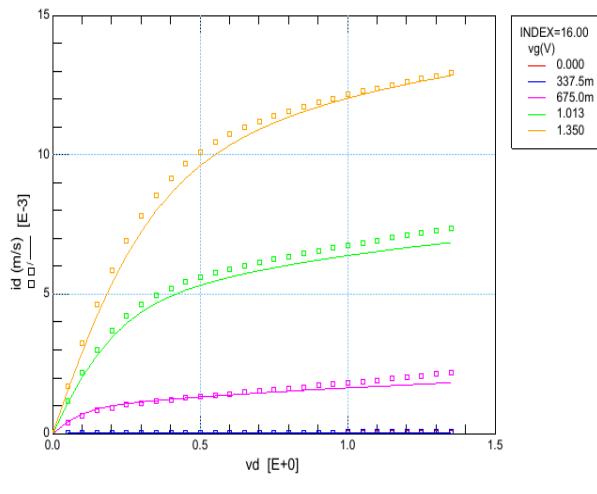


$$Id = f(Vg) @ Vd = 1.2V$$

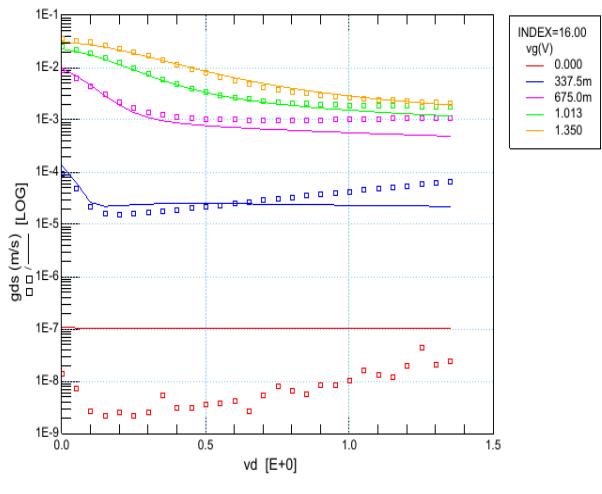


$$gm = f(Vg) @ Vd = 1.2V$$

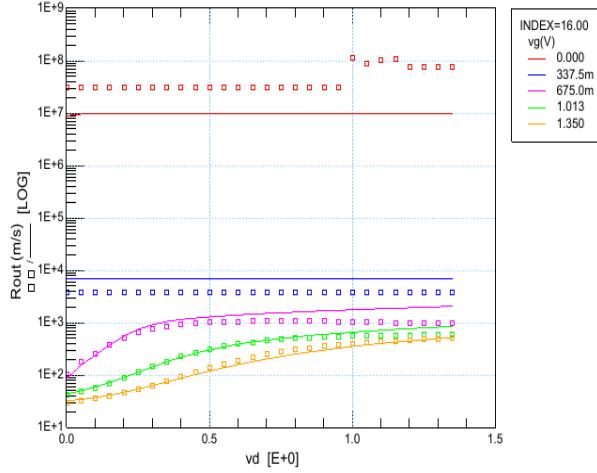
IdVd, T = 27°C



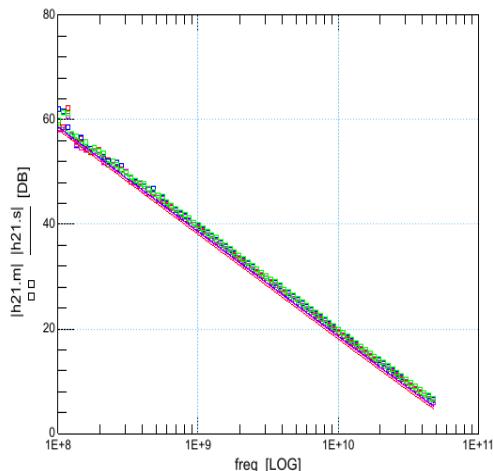
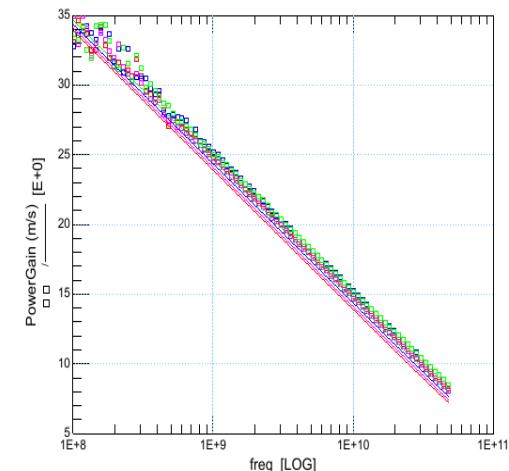
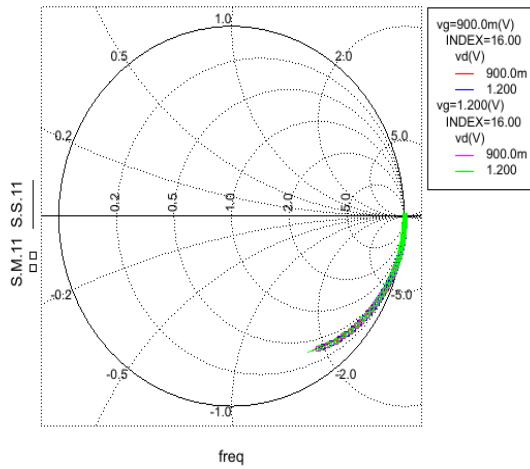
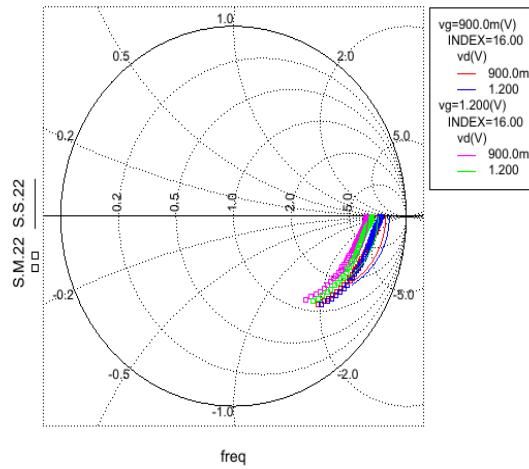
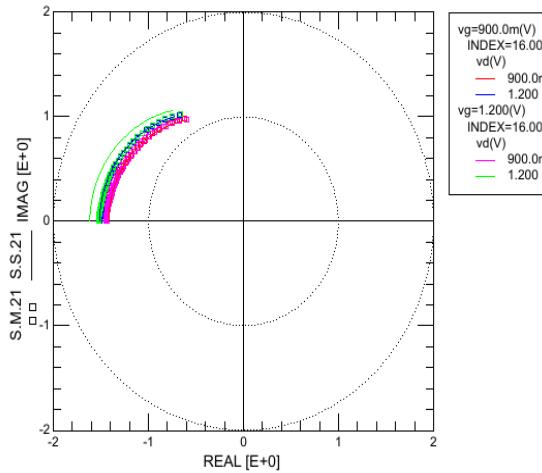
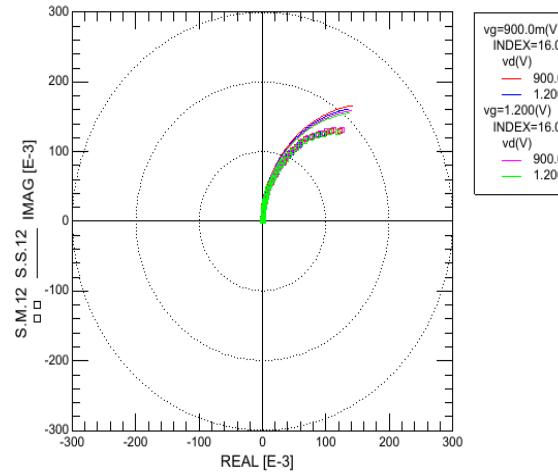
$$Id = f(Vd)$$



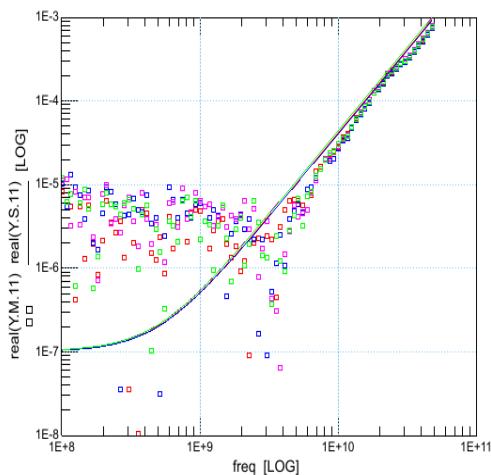
$$gds = f(Vd)$$



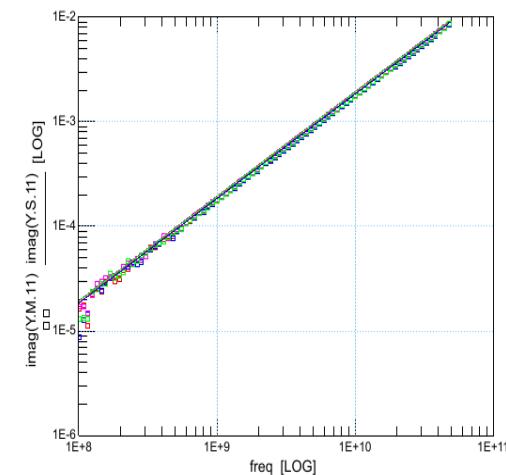
$$Rout = f(Vd)$$

S-Parameter, T = 27°C $|h21| = f(Vg, Vd)$  $MSG/MAG = f(Vg, Vd)$  $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

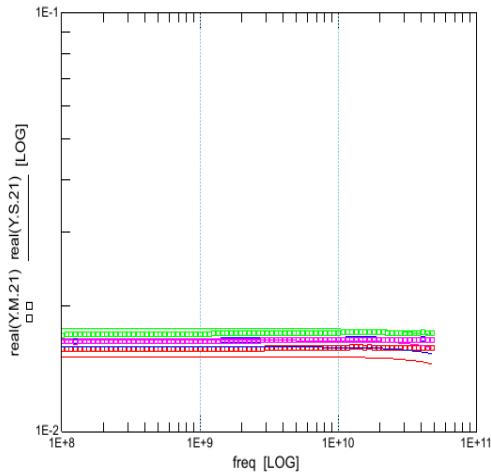
Y-Parameter, T = 27°C



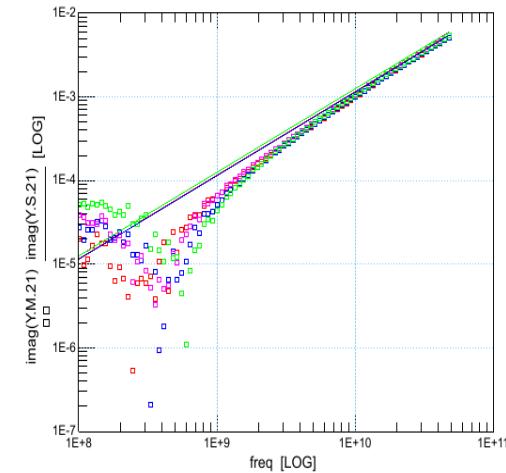
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



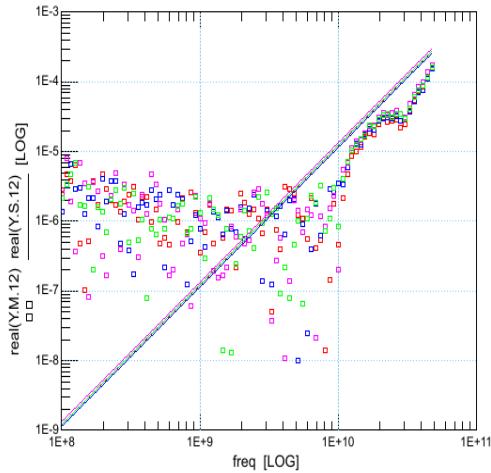
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



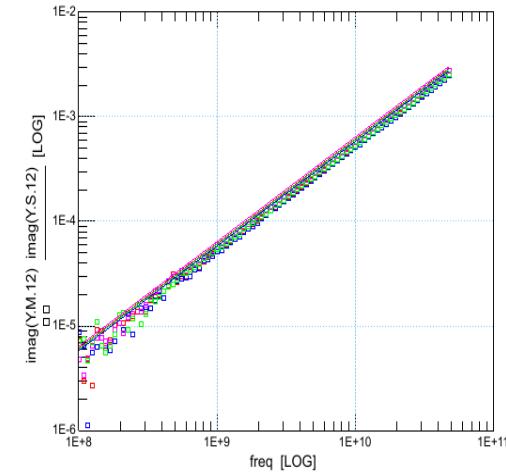
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



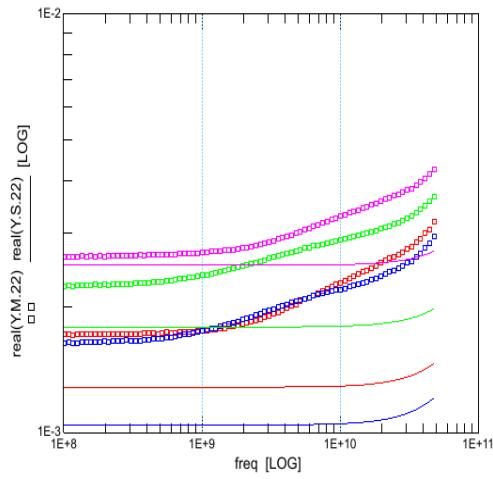
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



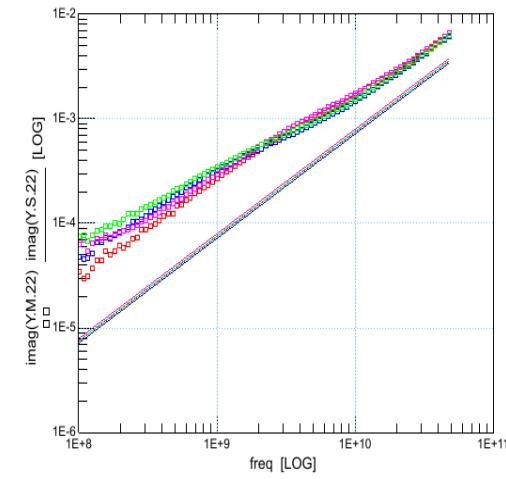
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



$$\text{im}(Y_{12}) = f(V_g, V_d)$$

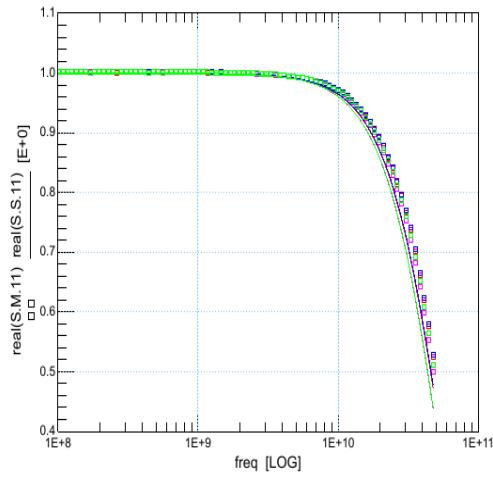


$$\text{real}(Y_{22}) = f(V_g, V_d)$$

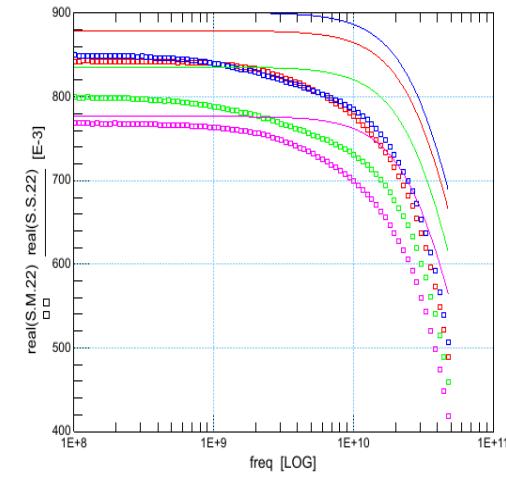


$$\text{imag}(Y_{22}) = f(V_g, V_d)$$

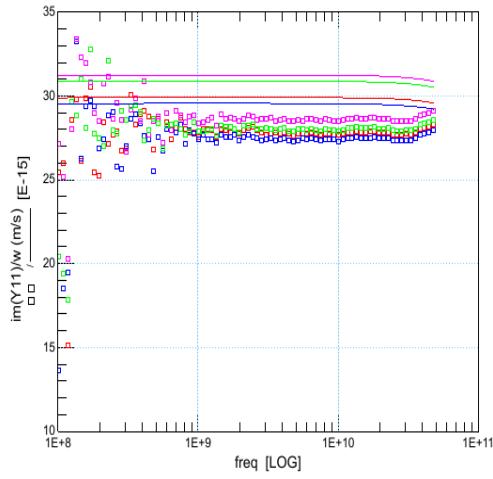
Verify Plots, $T = 27^\circ\text{C}$



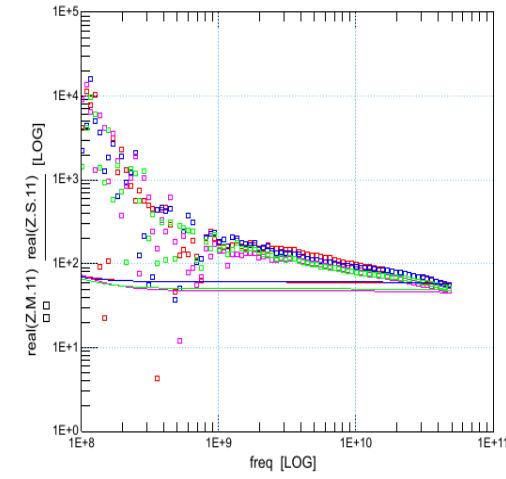
$$\text{real}(S_{11}) = f(V_g, V_d)$$



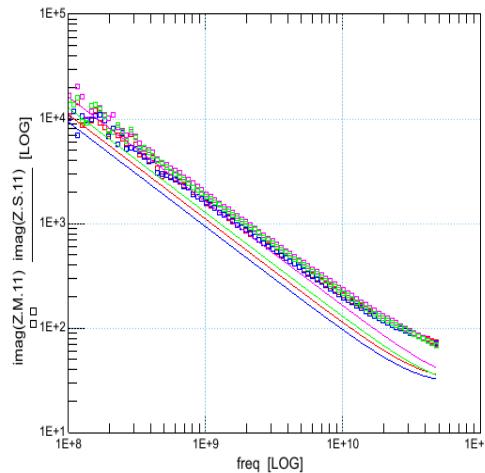
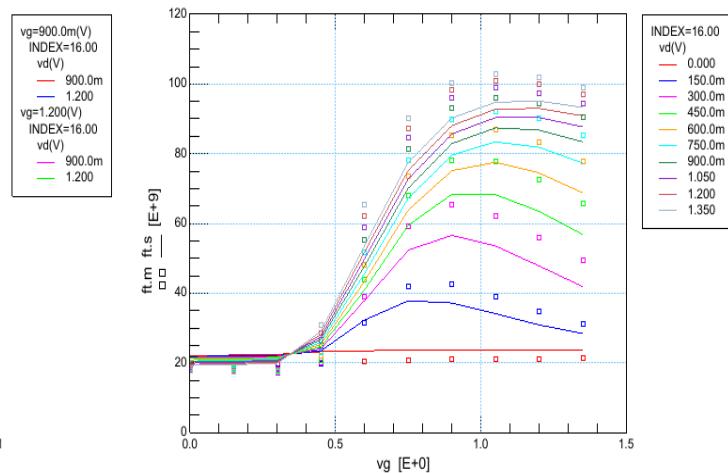
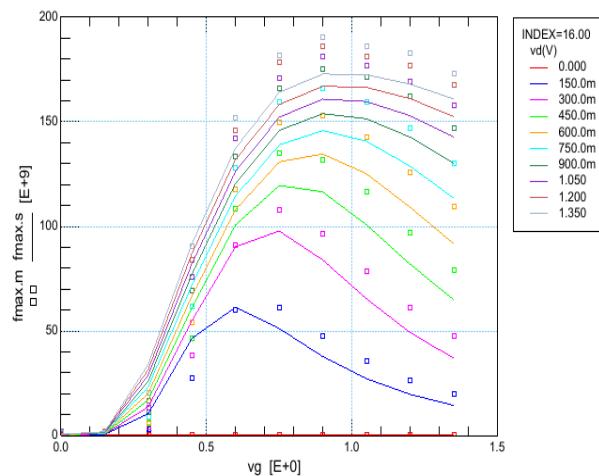
$$\text{real}(S_{22}) = f(V_g, V_d)$$



$$\text{im}(Y_{11}) \text{ divided by } \omega$$

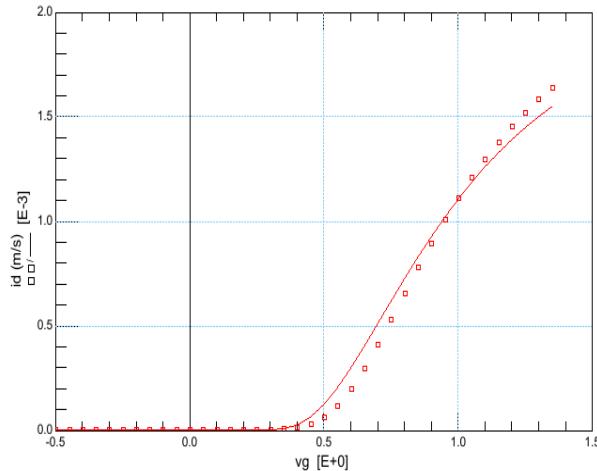


$$\text{real}(Z_{11}) = f(V_g, V_d)$$

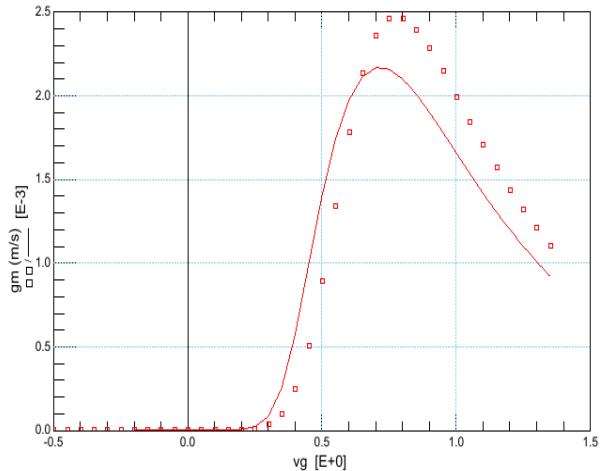
 $\text{im}(Z_{11}) = f(V_g, V_d)$  $f_T_{vg} = f(V_g, V_d)$  $f_{\text{max}}_{vg} = f(V_g, V_d)$

4.5 NF04_WF05u0_L0u13_post_03

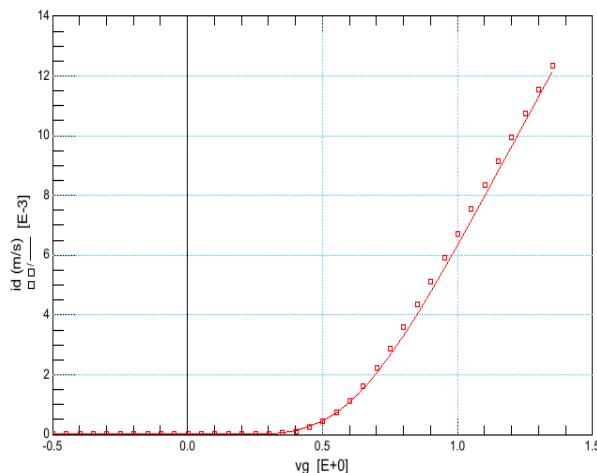
$IdVg$, $T = 27^\circ\text{C}$



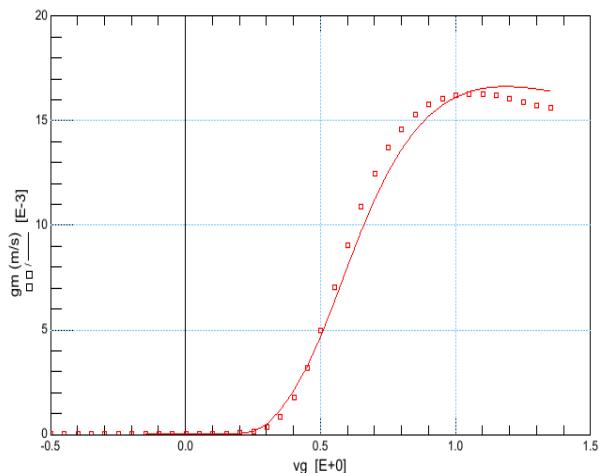
$Id = f(Vg)$ @ $Vd = 0.05\text{V}$



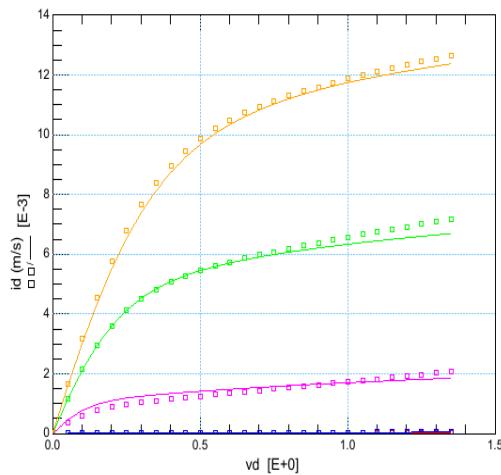
$gm = f(Vg)$ @ $Vd = 0.05\text{V}$



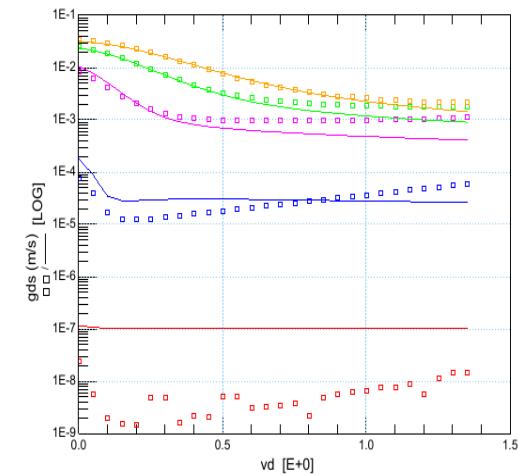
$Id = f(Vg)$ @ $Vd = 1.2\text{V}$



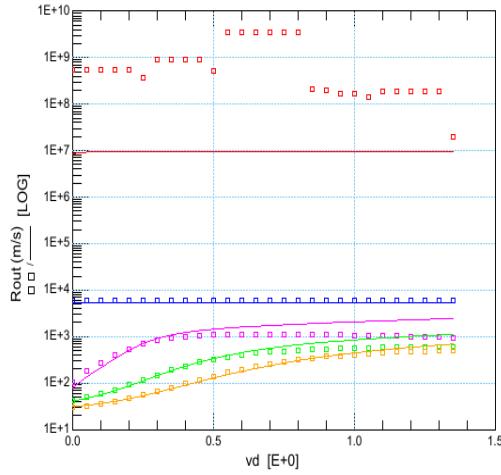
$gm = f(Vg)$ @ $Vd = 1.2\text{V}$

IdVd, T = 27°C

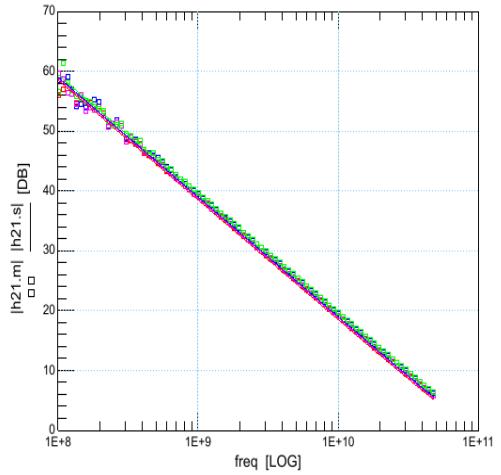
$$Id = f(Vd)$$



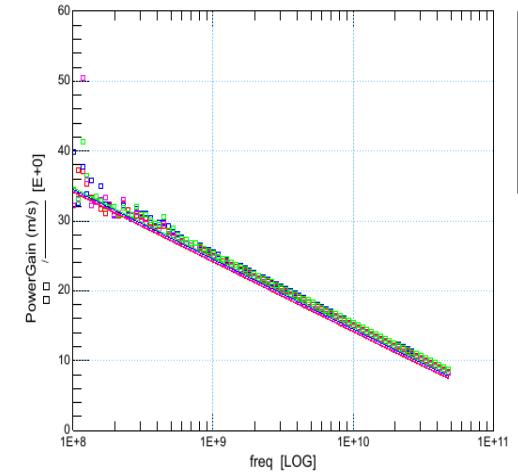
$$gds = f(Vd)$$



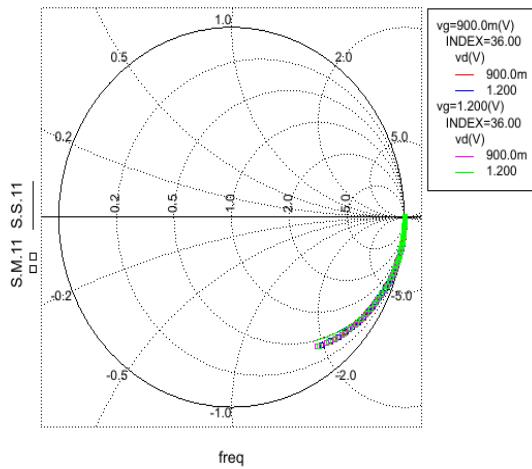
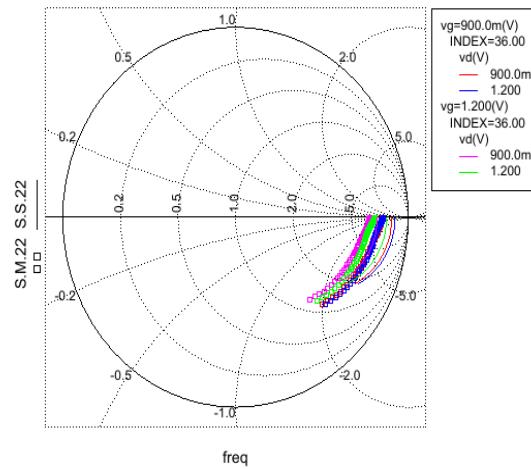
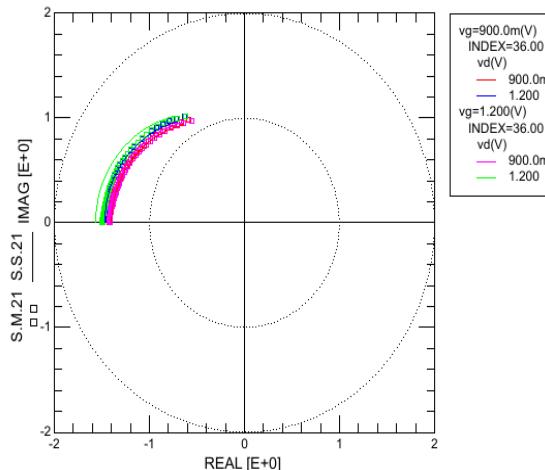
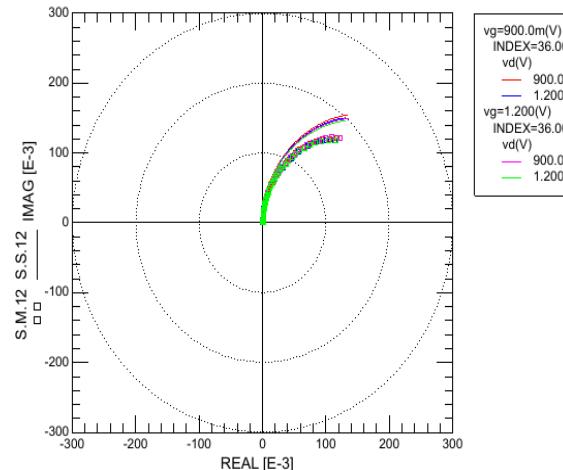
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

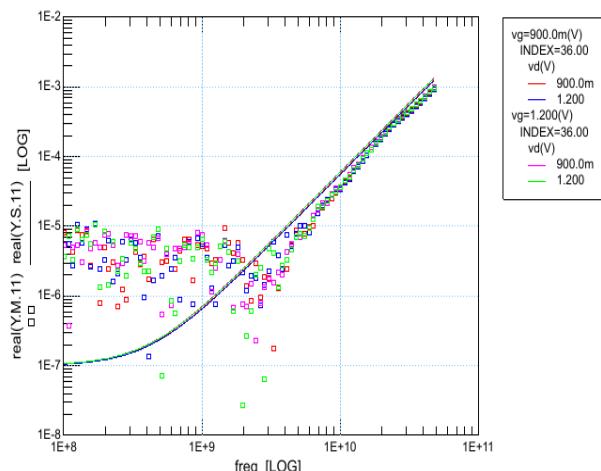
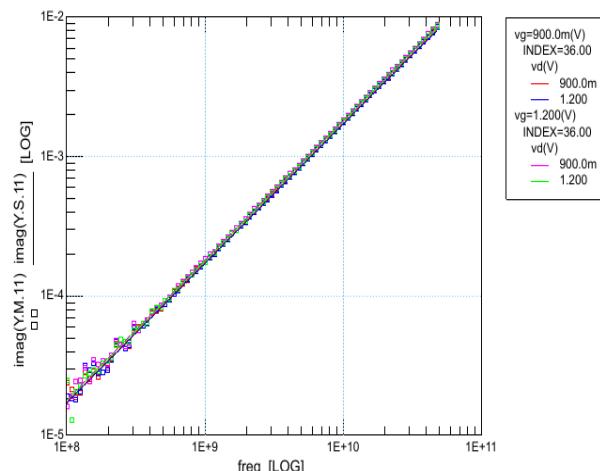
$$|h21| = f(Vg, Vd)$$

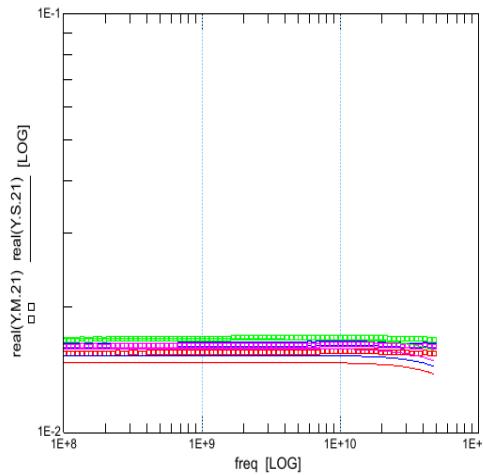


$$MSG/MAG = f(Vg, Vd)$$

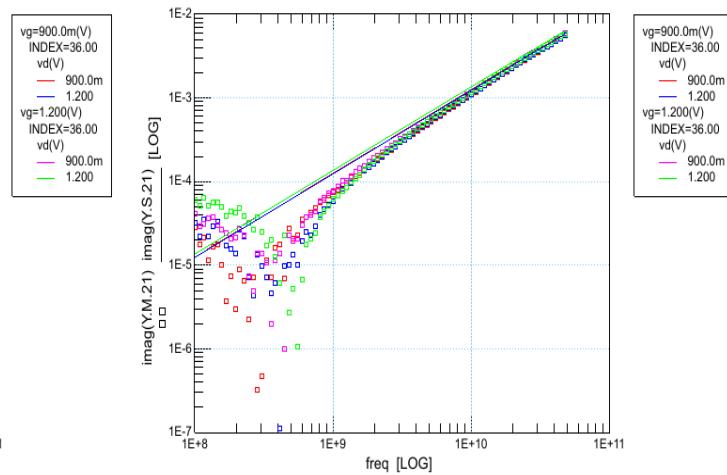
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

Y-Parameter, $T = 27^\circ C$

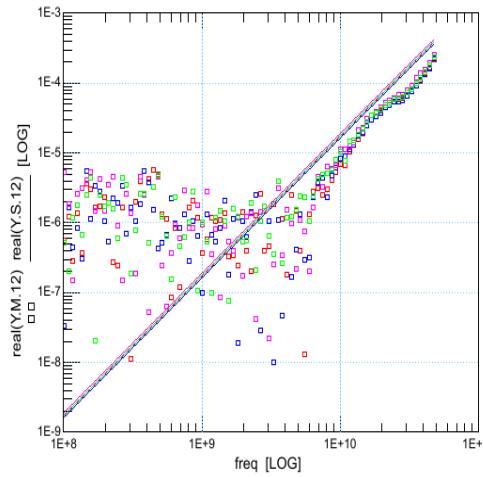
 $re(Y11) = f(Vg, Vd)$  $im(Y11) = f(Vg, Vd)$



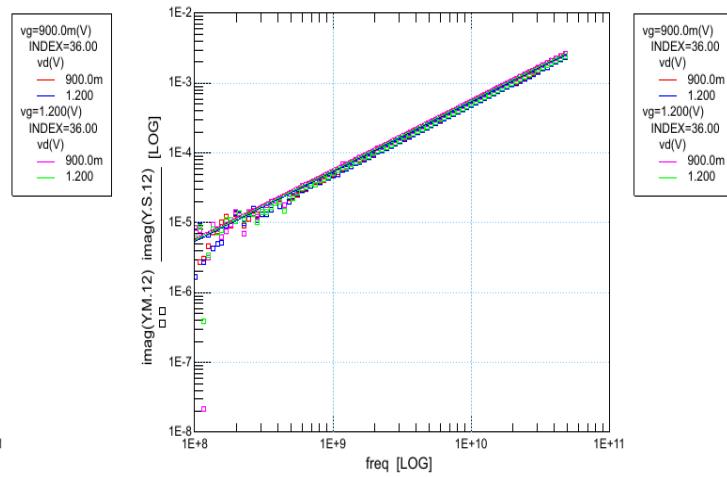
re(Y21) = f(Vg, Vd)



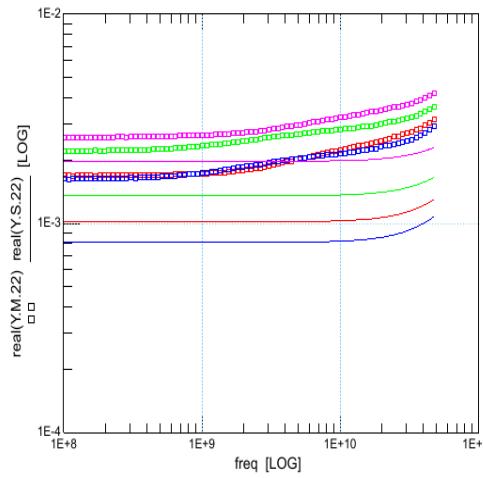
im(Y21) = f(Vg, Vd)



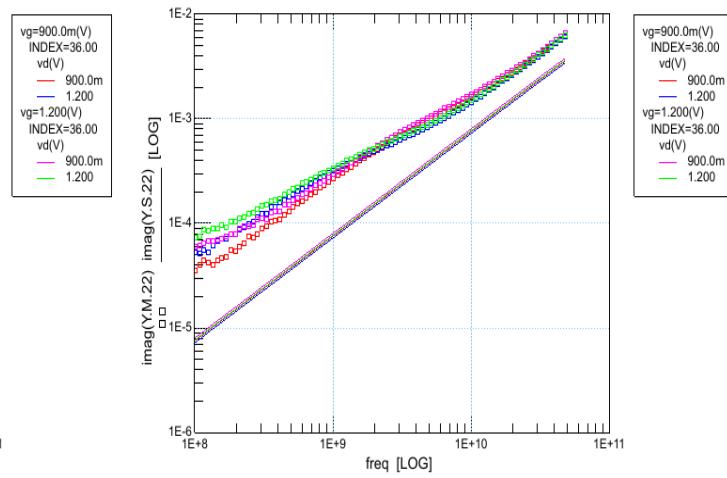
re(Y12) = f(Vg, Vd)



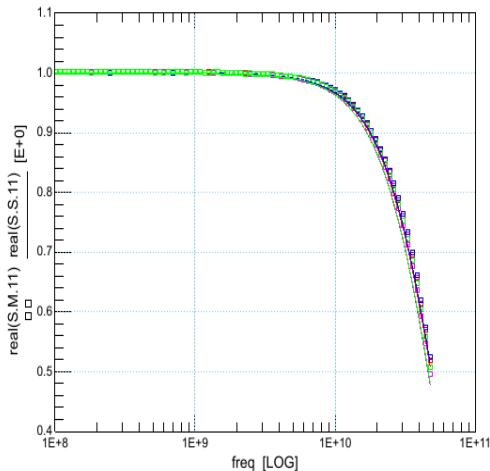
im(Y12) = f(Vg, Vd)



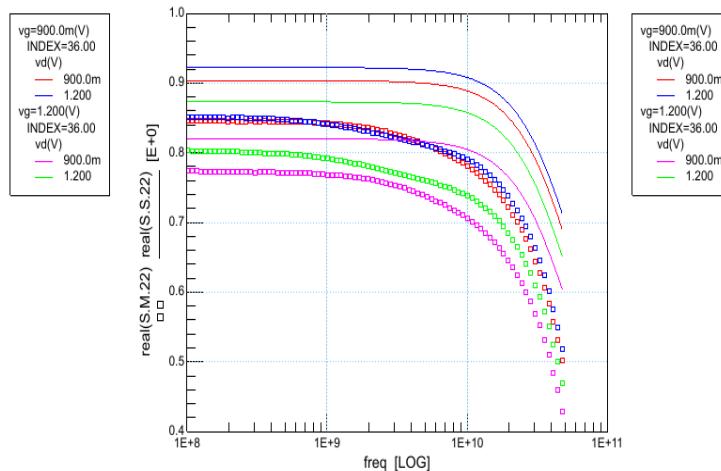
re(Y22) = f(Vg, Vd)



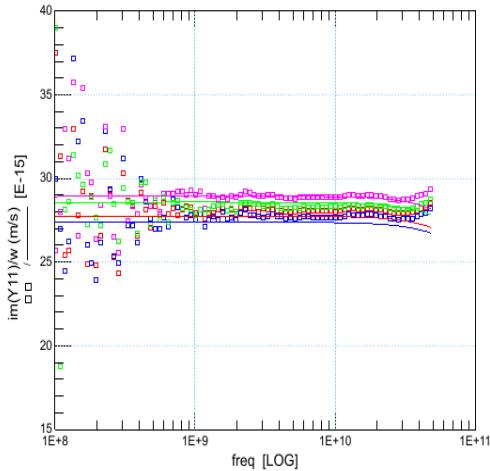
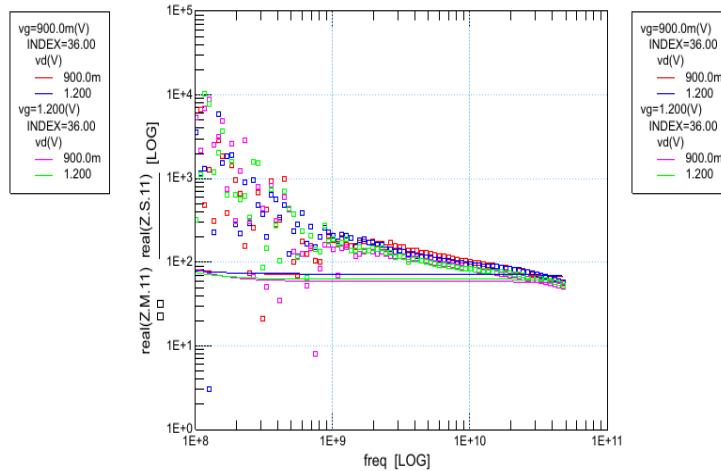
im(Y22) = f(Vg, Vd)

Verify Plots, $T = 27^\circ\text{C}$ 

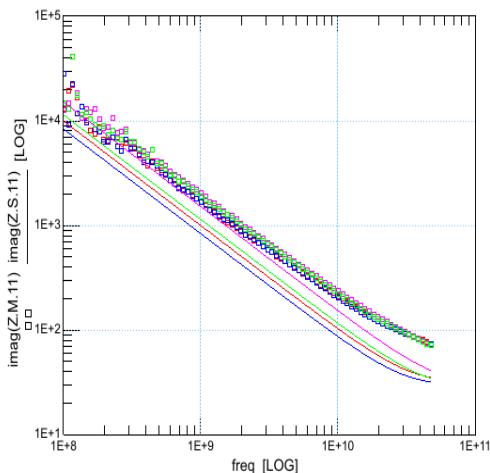
re(S11) = f(Vg, Vd)



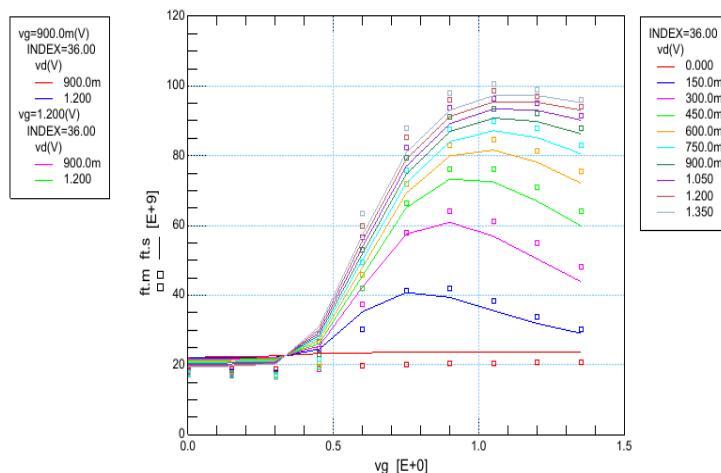
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

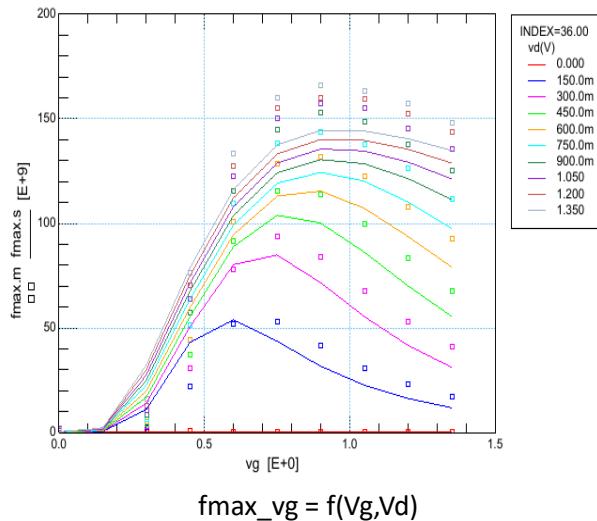
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

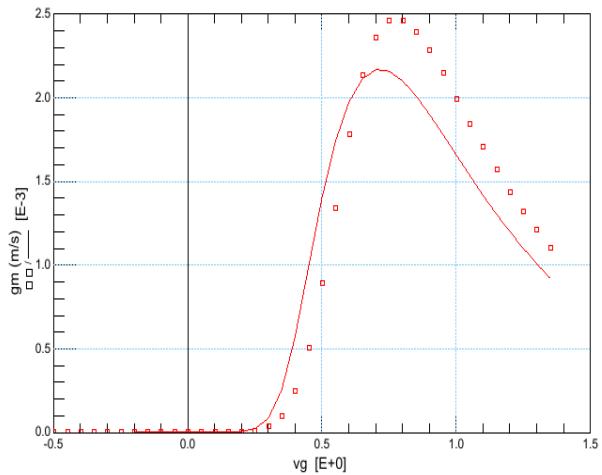
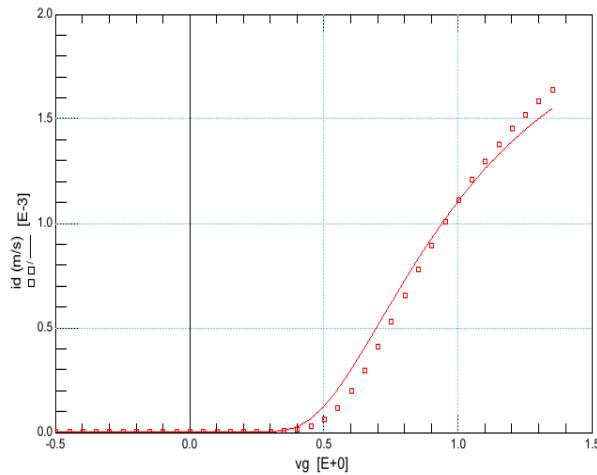


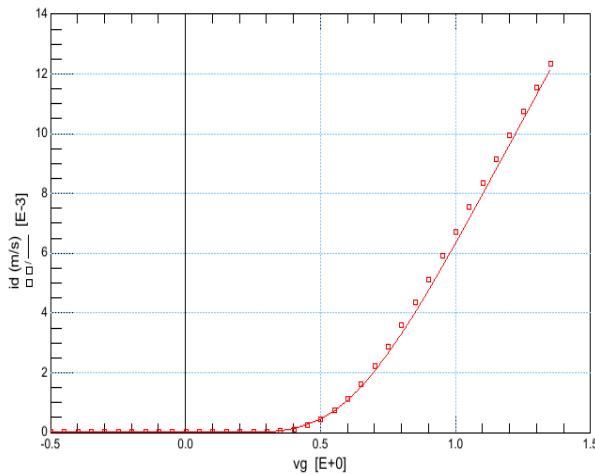
fT_vg = f(Vg, Vd)



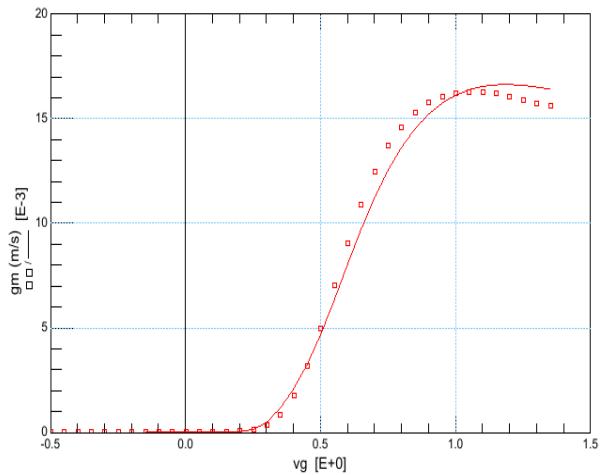
4.6 NF04_WF05u0_L0u13_S453A_03

I_d vs V_g , $T = 27^\circ\text{C}$



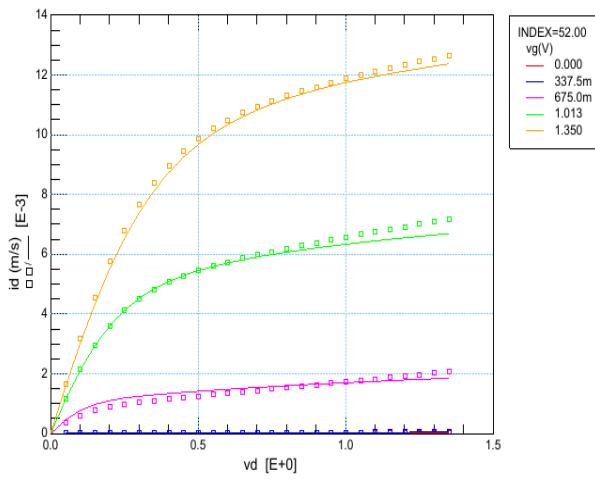


$$Id = f(Vg) @ Vd = 1.2V$$

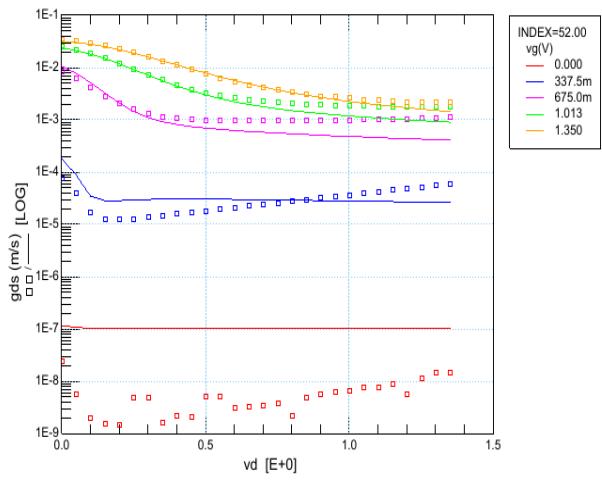


$$gm = f(Vg) @ Vd = 1.2V$$

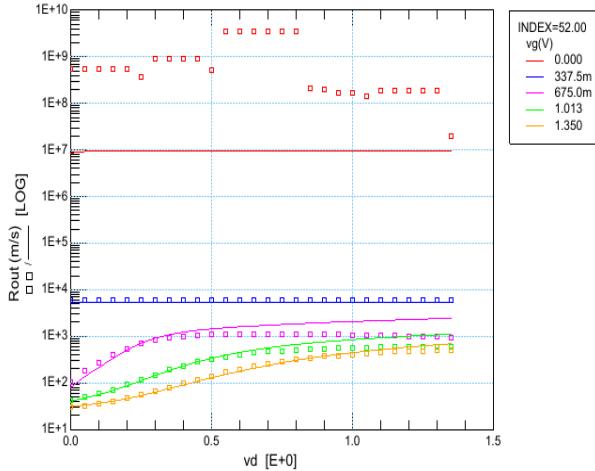
IdVd, T = 27°C



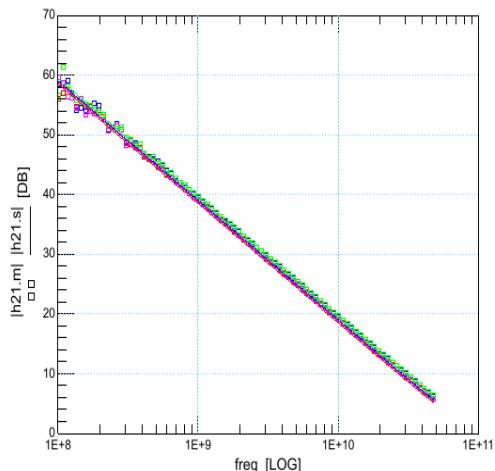
$$Id = f(Vd)$$



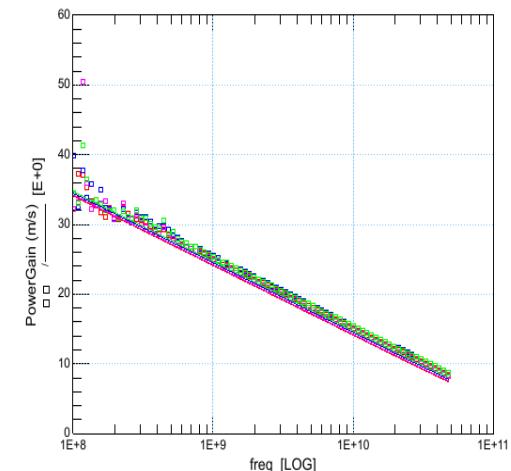
$$gds = f(Vd)$$



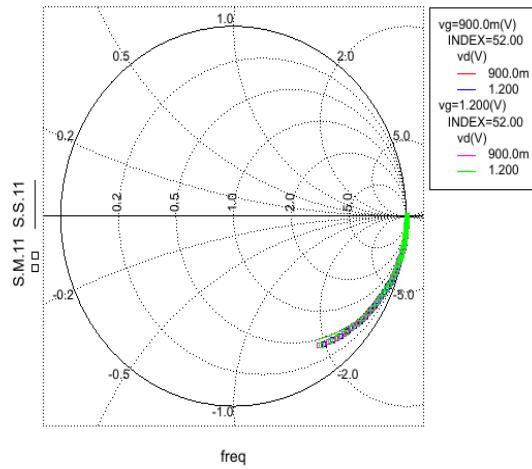
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

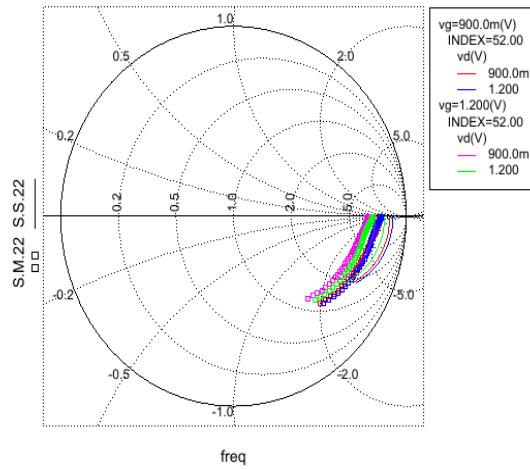
$$|h21| = f(Vg, Vd)$$



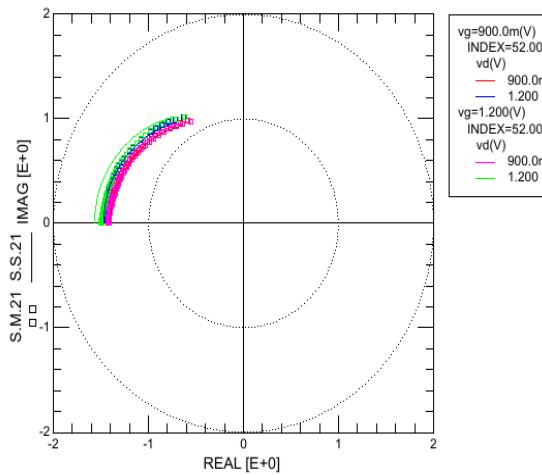
$$MSG/MAG = f(Vg, Vd)$$



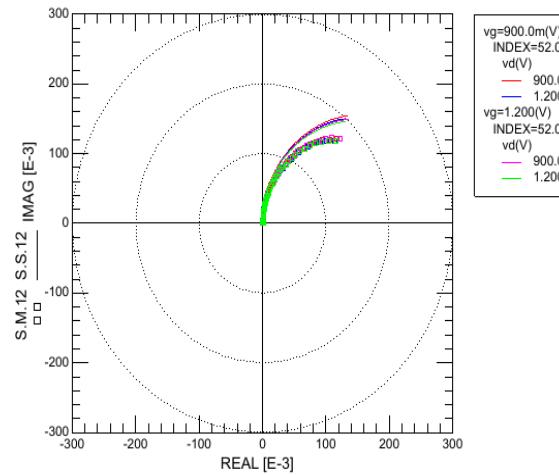
$$S11 = f(Vg, Vd)$$



$$S22 = f(Vg, Vd)$$

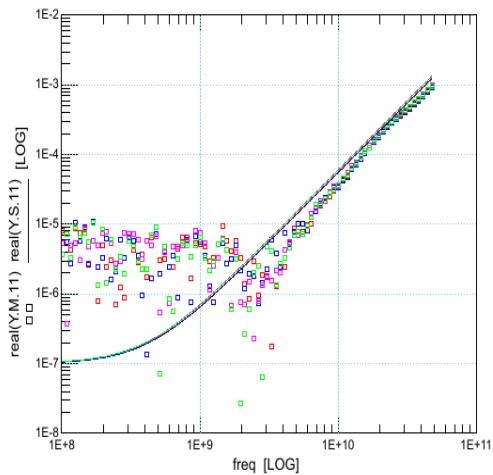


$$S21 = f(Vg, Vd)$$

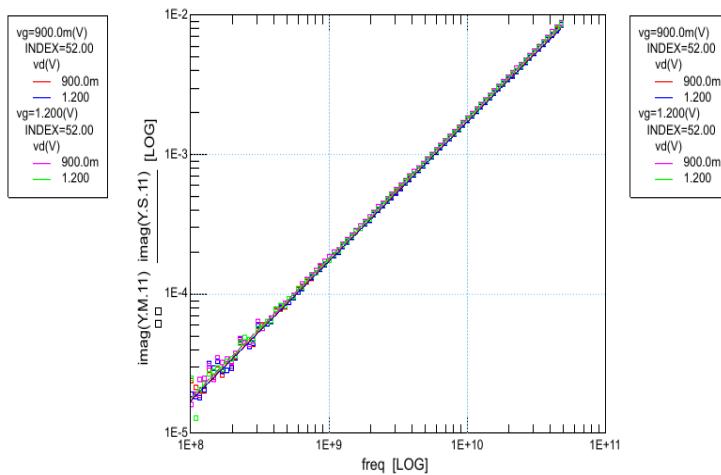


$$S12 = f(Vg, Vd)$$

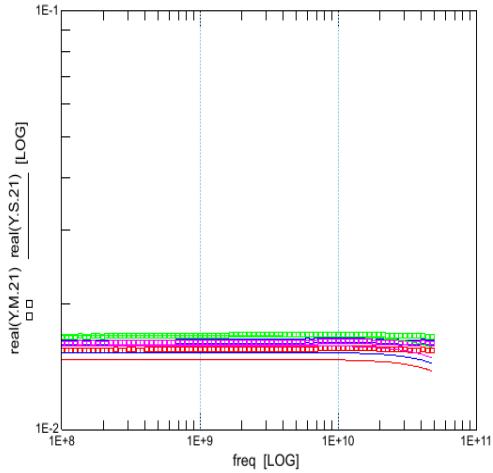
Y-Parameter, T = 27°C



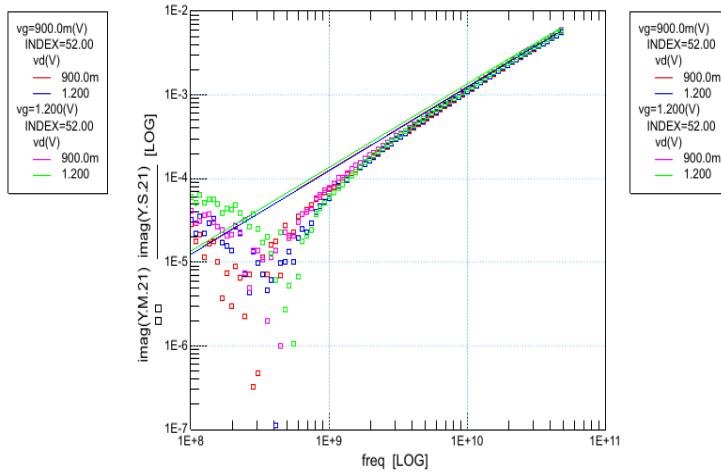
$$\text{re}(Y11) = f(Vg, Vd)$$



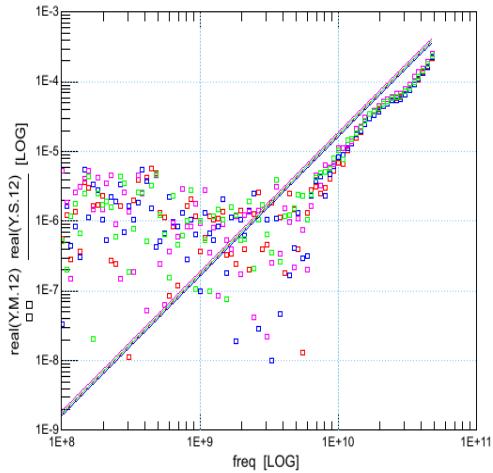
$$\text{im}(Y11) = f(Vg, Vd)$$



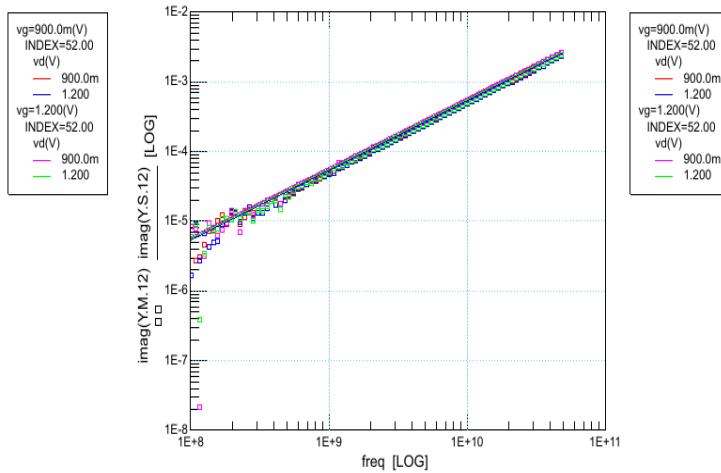
$$\text{re}(Y21) = f(Vg, Vd)$$



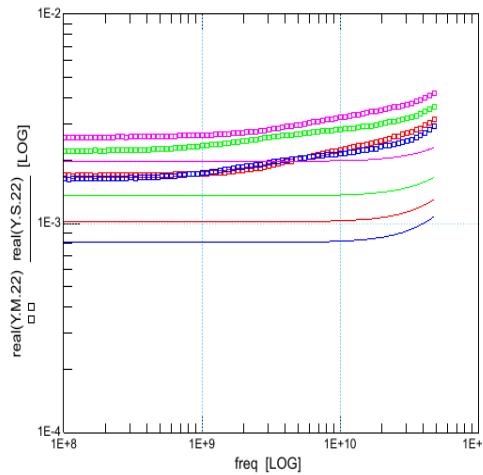
$$\text{im}(Y21) = f(Vg, Vd)$$



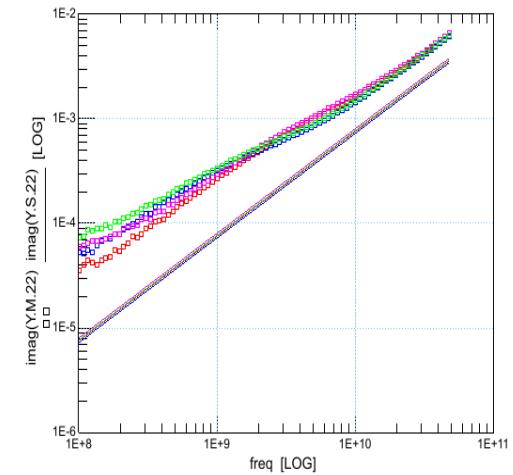
$$\text{re}(Y12) = f(Vg, Vd)$$



$$\text{im}(Y12) = f(Vg, Vd)$$

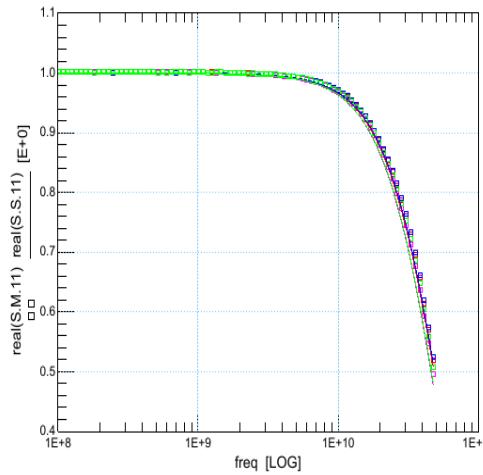


real(Y22) = f(Vg, Vd)

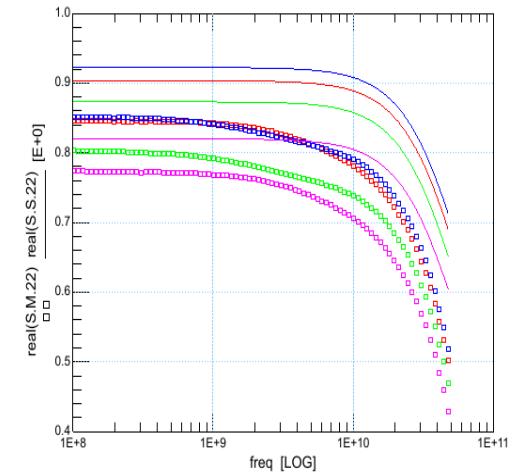


imag(Y22) = f(Vg, Vd)

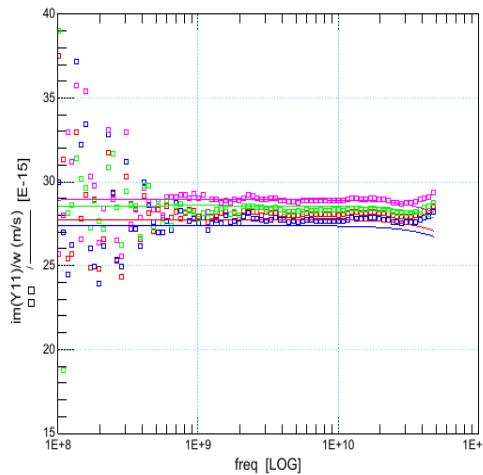
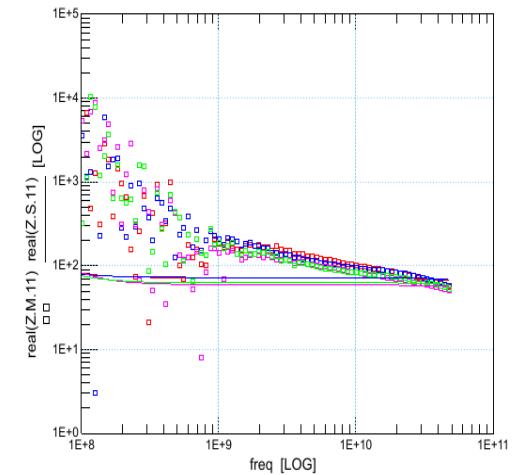
Verify Plots, T = 27°C



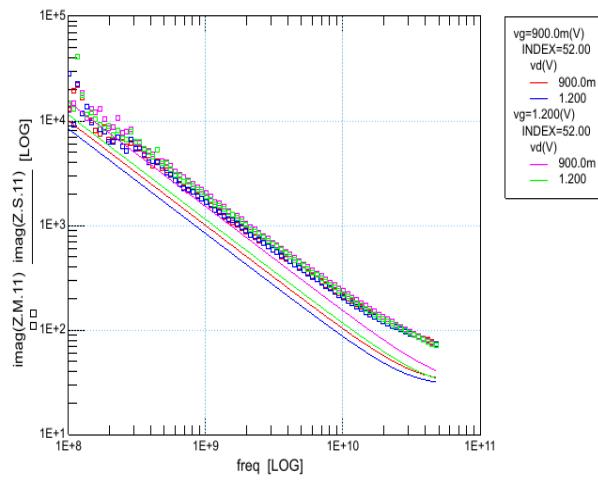
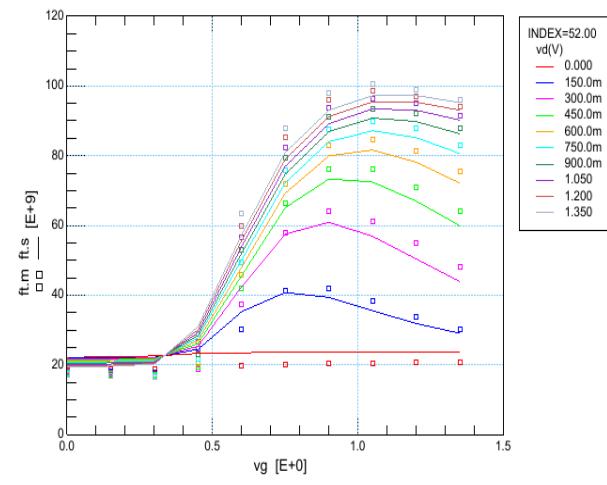
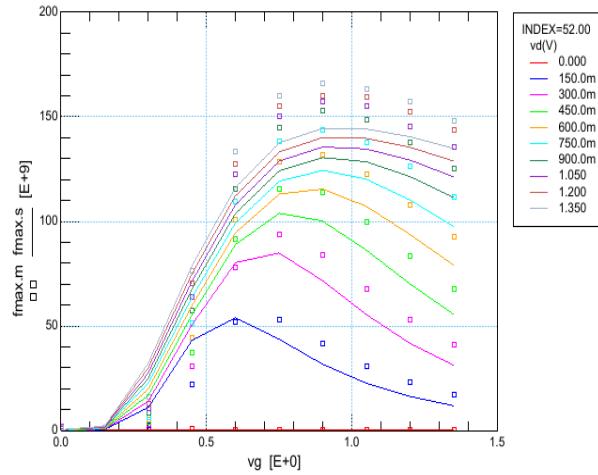
real(S11) = f(Vg, Vd)



real(S22) = f(Vg, Vd)

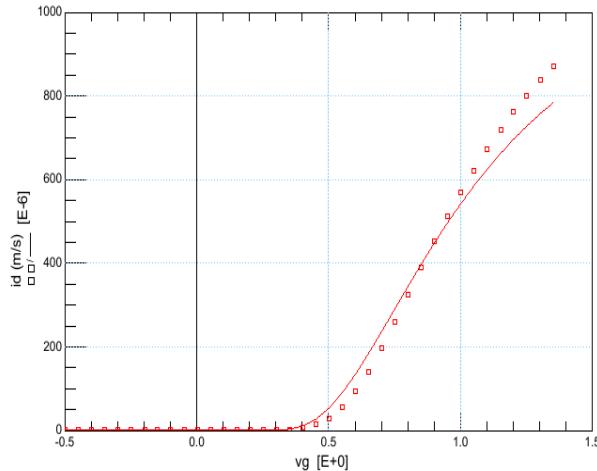
im(Y11) divided by ω 

real(Z11) = f(Vg, Vd)

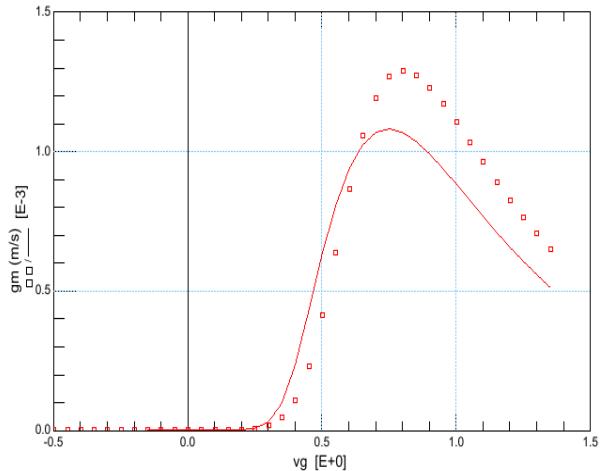
 $\text{im}(Z_{11}) = f(V_g, V_d)$  $fT_{vg} = f(V_g, V_d)$  $f_{\max, vg} = f(V_g, V_d)$

4.7 NF04_WF02u5_L0u13_S453A_24

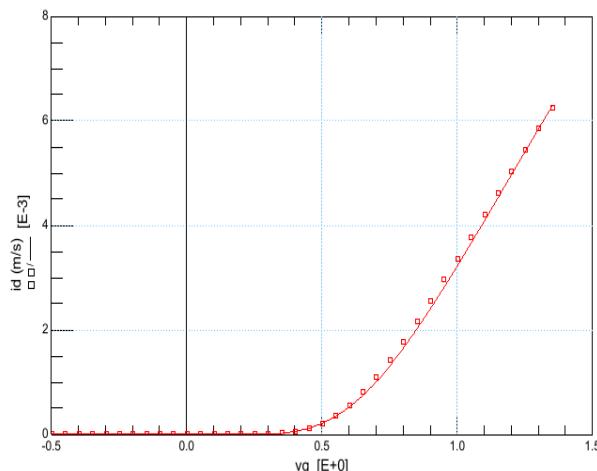
IdVg, T = 27°C



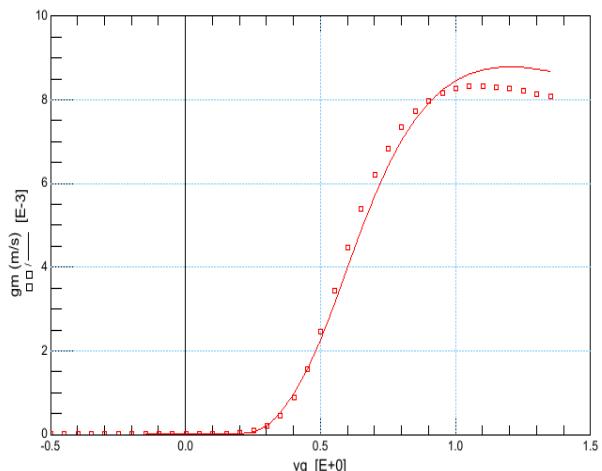
$Id = f(Vg)$ @ $Vd = 0.05V$



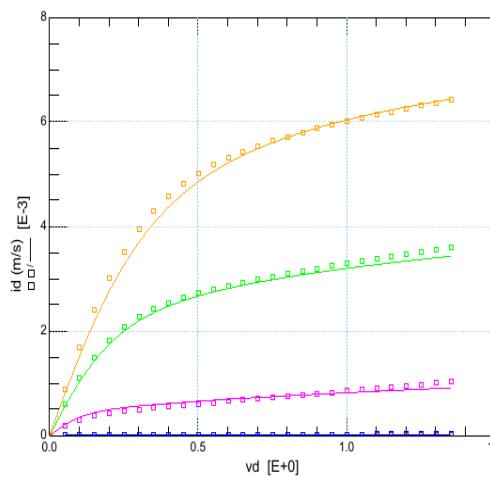
$gm = f(Vg)$ @ $Vd = 0.05V$



$Id = f(Vg)$ @ $Vd = 1.2V$

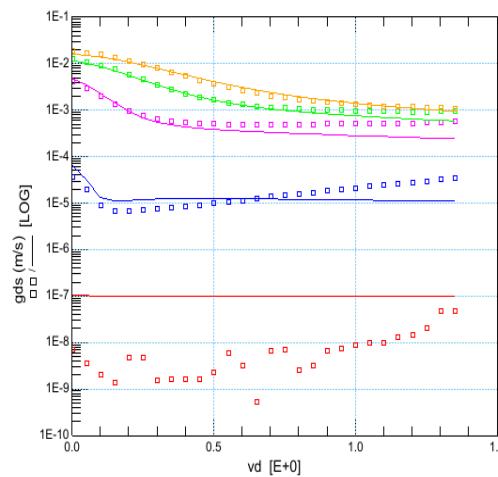


$gm = f(Vg)$ @ $Vd = 1.2V$

IdVd, T = 27°C

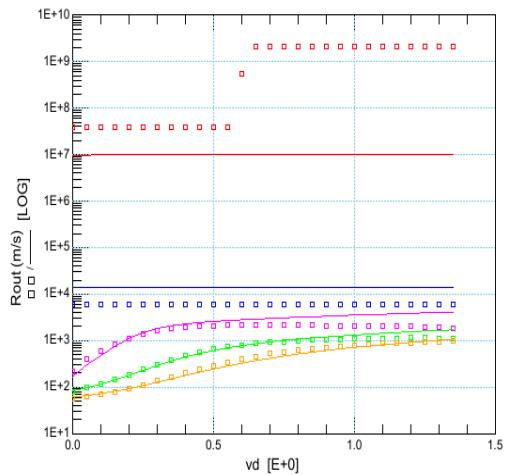
$$Id = f(Vd)$$

INDEX=54.00
 $Vg(V)$
 0.000
 337.5m
 675.0m
 1.013
 1.350



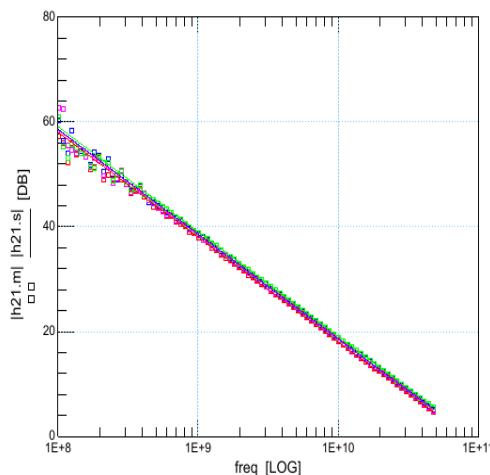
$$gds = f(Vd)$$

INDEX=54.00
 $Vg(V)$
 0.000
 337.5m
 675.0m
 1.013
 1.350



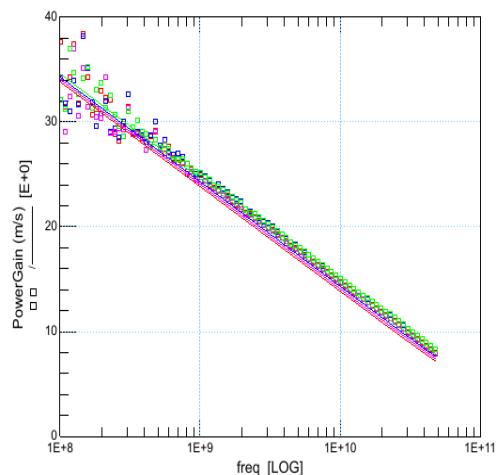
$$Rout = f(Vd)$$

INDEX=54.00
 $Vg(V)$
 0.000
 337.5m
 675.0m
 1.013
 1.350

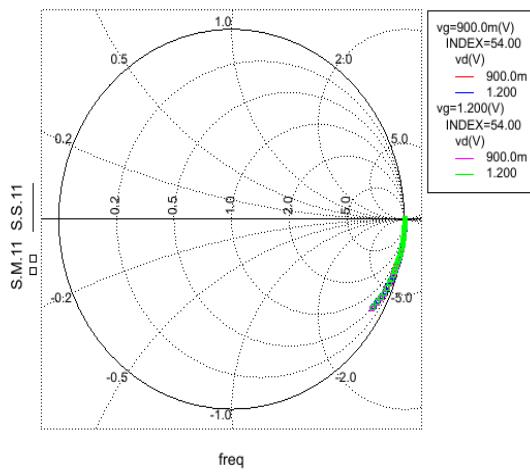
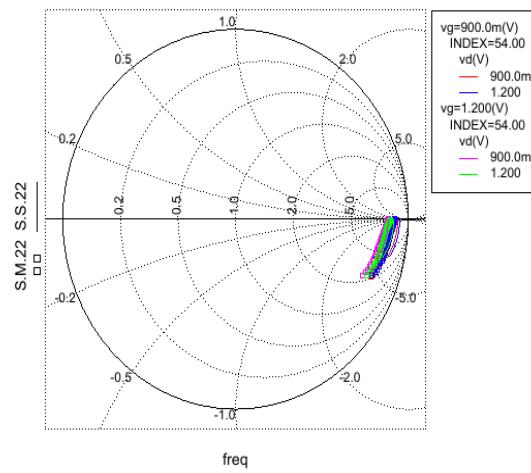
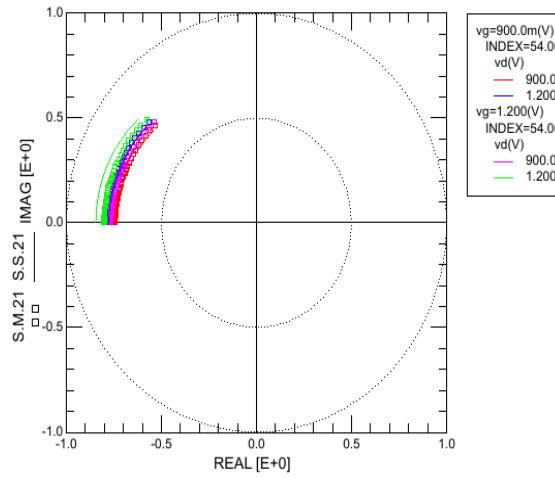
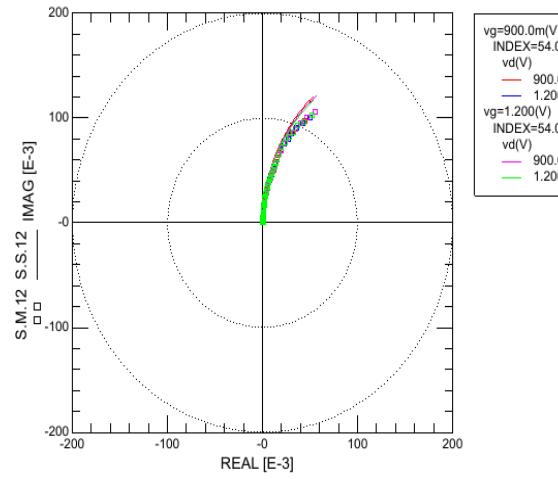
S-Parameter, T = 27°C

$$|h21| = f(Vg, Vd)$$

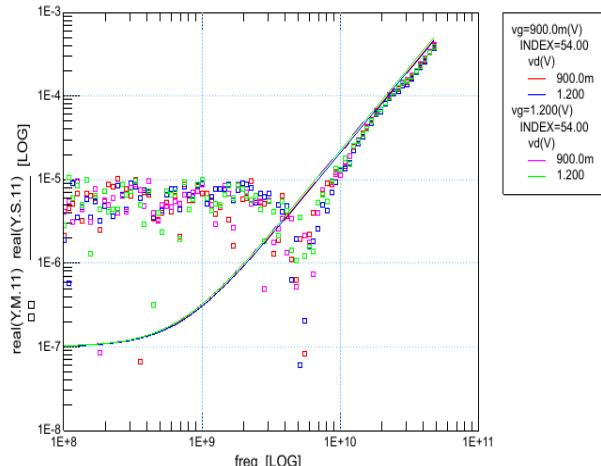
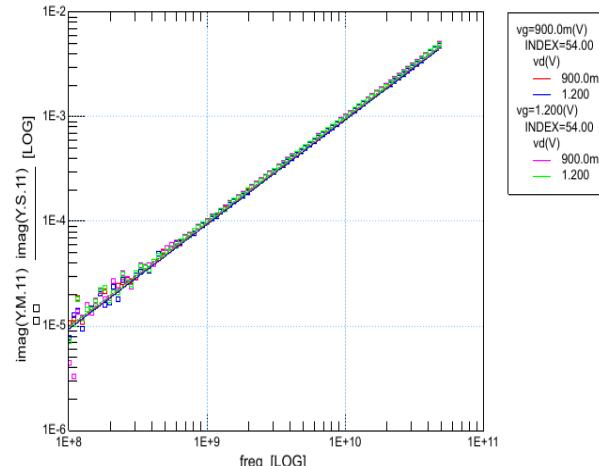
$Vg=900.0m(V)$
 INDEX=54.00
 $Vd(V)$
 900.0m
 1.200
 $Vg=1.200(V)$
 INDEX=54.00
 $Vd(V)$
 900.0m
 1.200

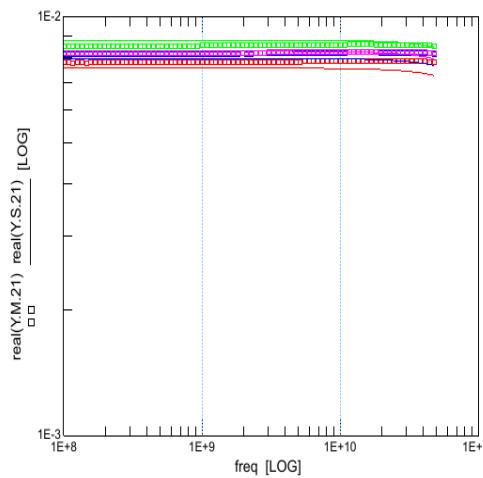


$$MSG/MAG = f(Vg, Vd)$$

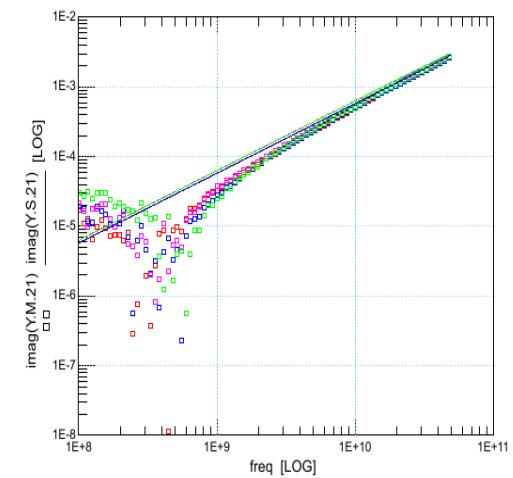
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

Y-Parameter, T = 27°C

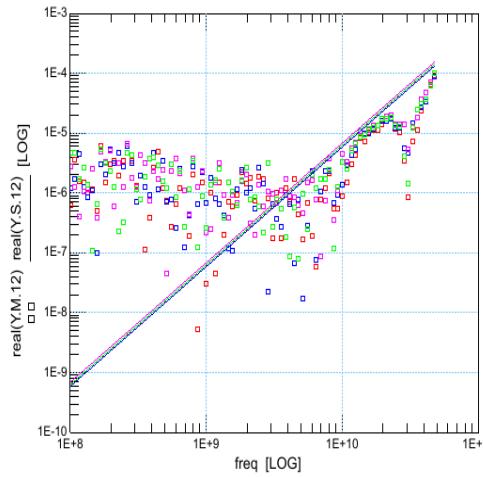
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



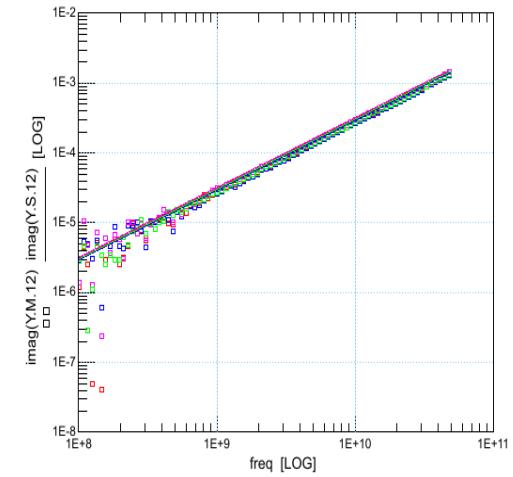
re(Y21) = f(Vg, Vd)



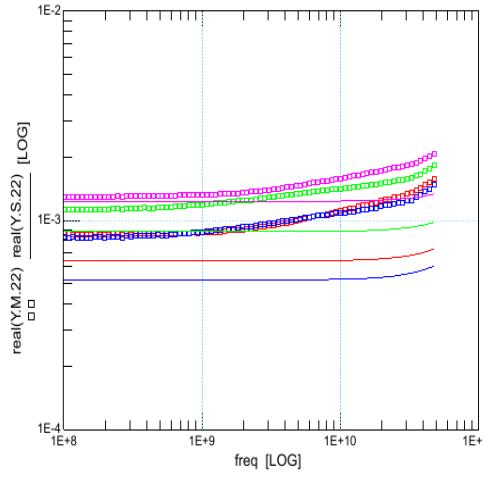
im(Y21) = f(Vg, Vd)



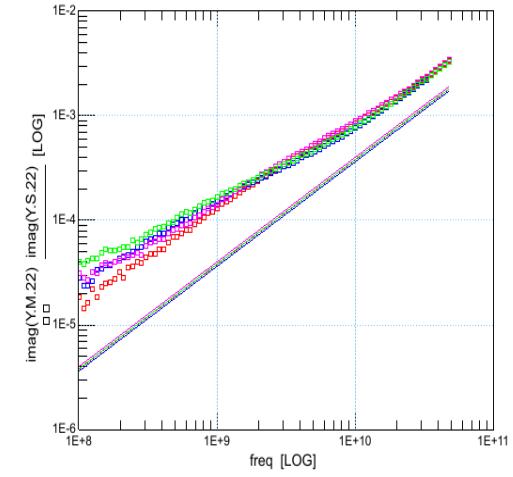
re(Y12) = f(Vg, Vd)



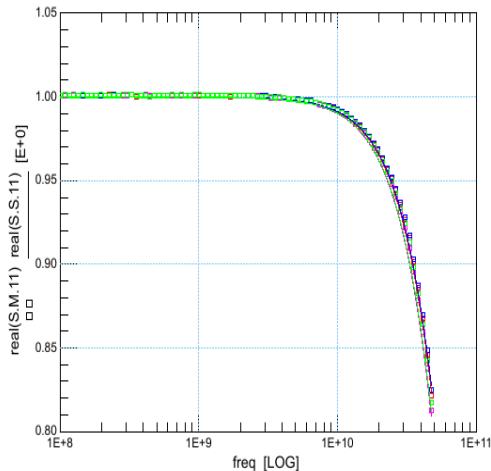
im(Y12) = f(Vg, Vd)



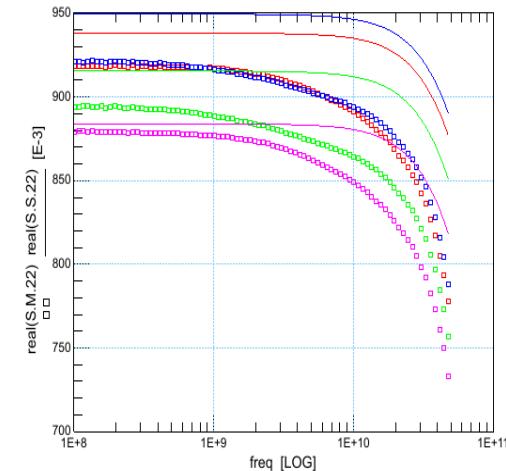
re(Y22) = f(Vg, Vd)



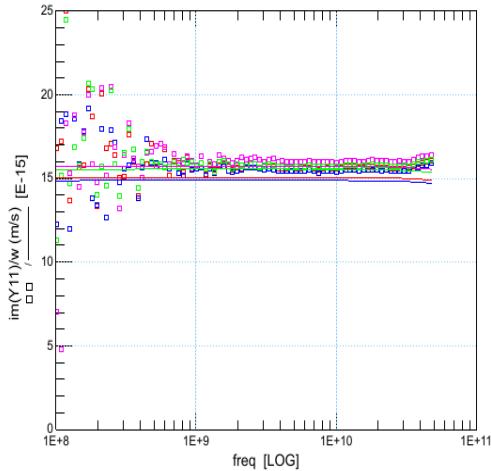
im(Y22) = f(Vg, Vd)

Verify Plots, $T = 27^\circ\text{C}$ 

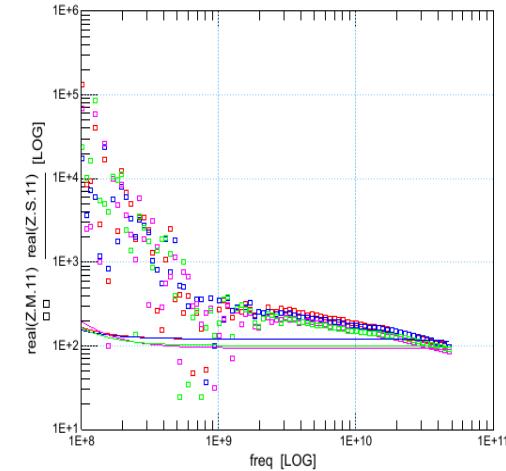
$$\text{re}(S11) = f(Vg, Vd)$$



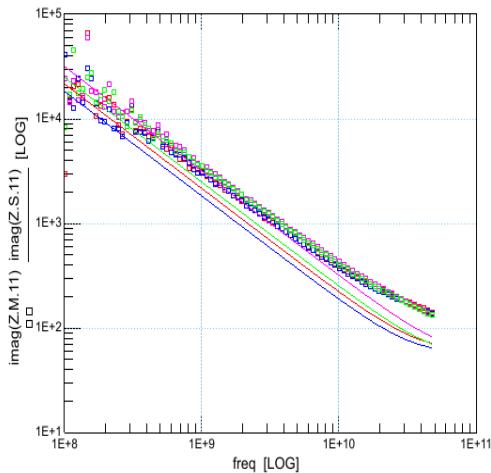
$$\text{re}(S22) = f(Vg, Vd)$$



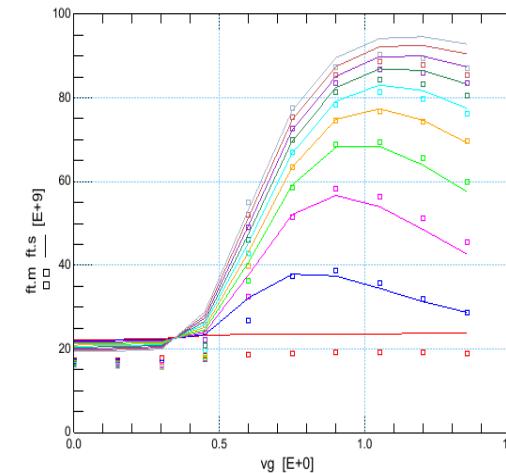
$$\text{im}(Y11) \text{ divided by } \omega$$



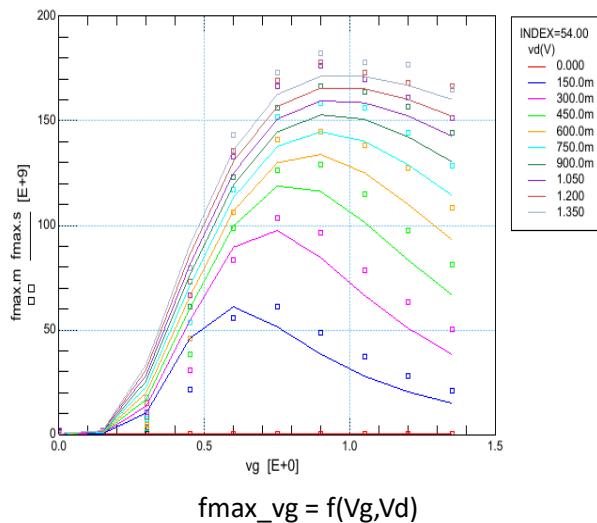
$$\text{re}(Z11) = f(Vg, Vd)$$



$$\text{im}(Z11) = f(Vg, Vd)$$

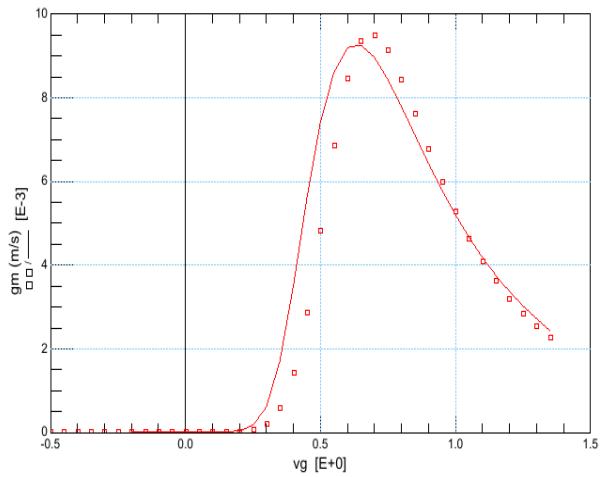
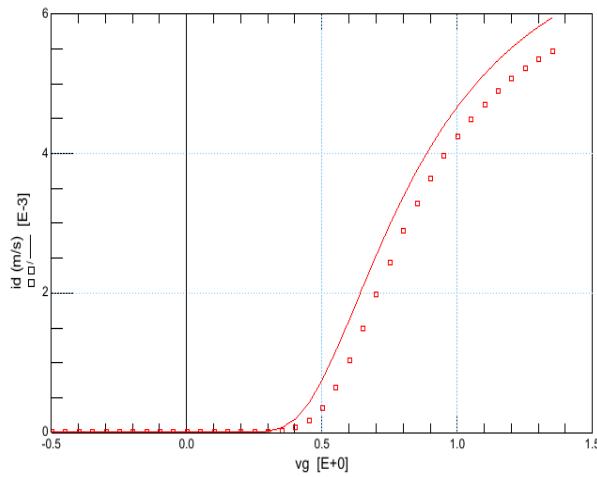


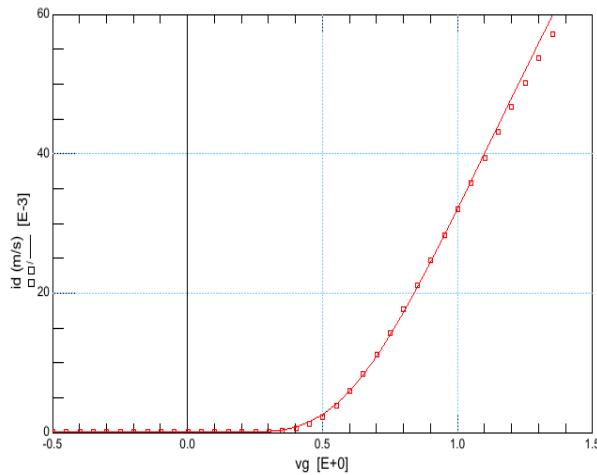
$$fT_{vg} = f(Vg, Vd)$$



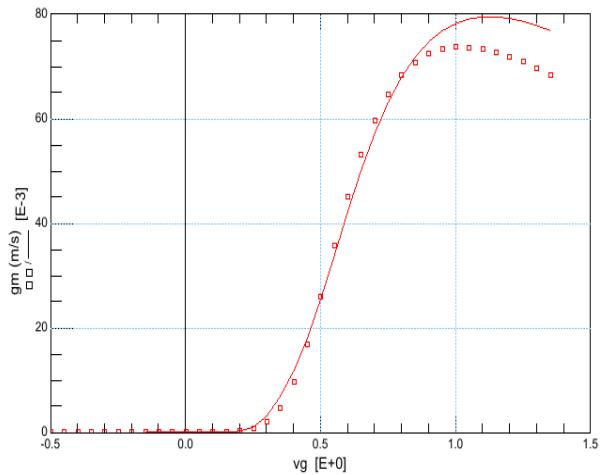
4.8 NF10_WF10u0_L0u13_S453A_00

$I_d V_g, T = 27^\circ C$



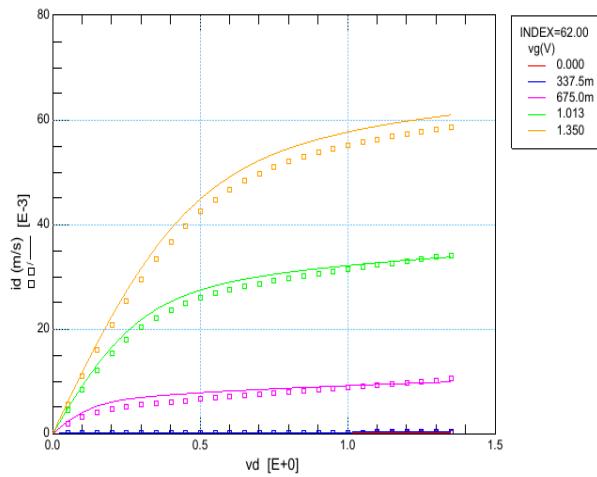


$$Id = f(Vg) @ Vd = 1.2V$$

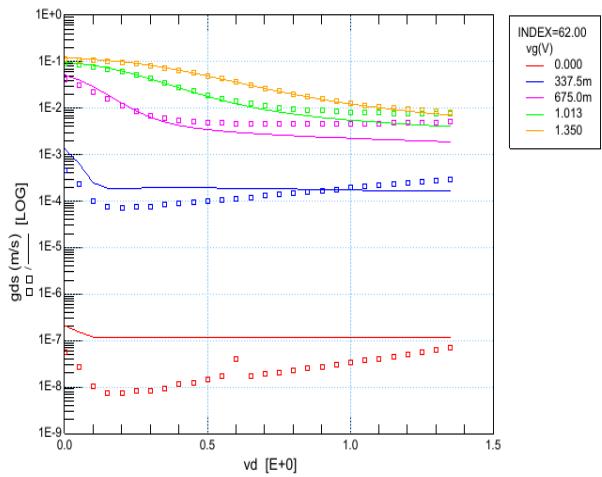


$$gm = f(Vg) @ Vd = 1.2V$$

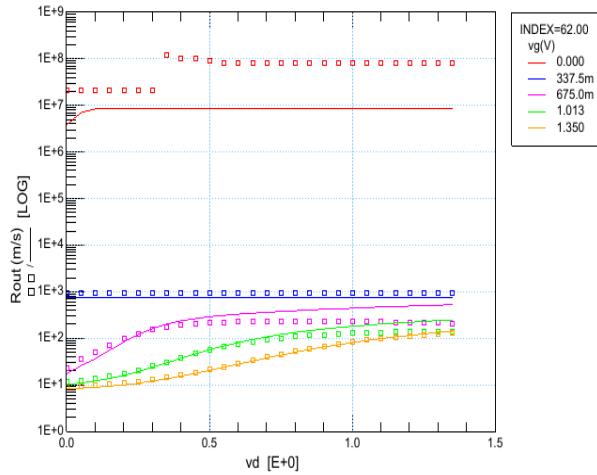
IdVd, T = 27°C



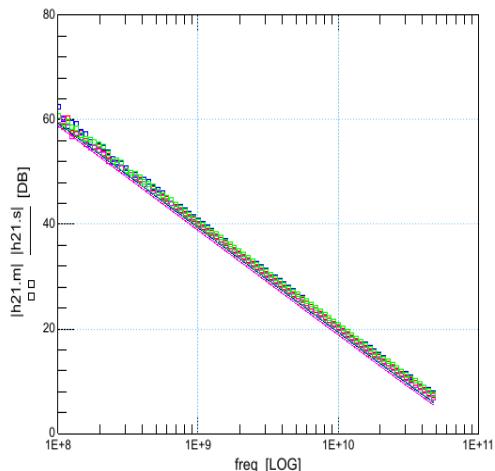
$$Id = f(Vd)$$



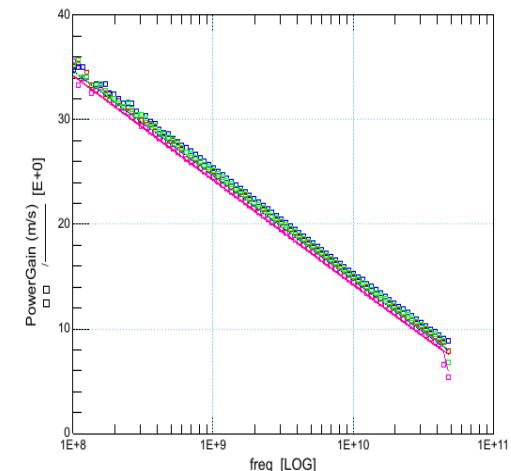
$$gds = f(Vd)$$



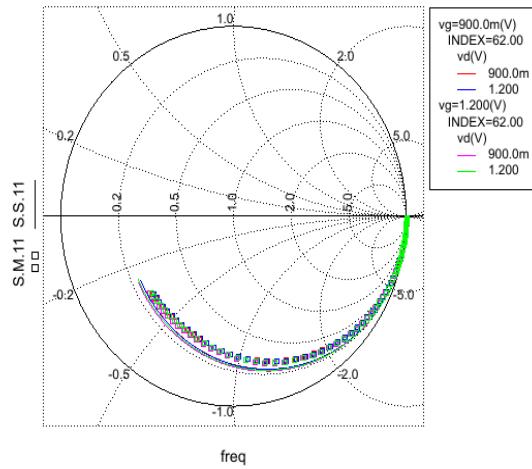
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

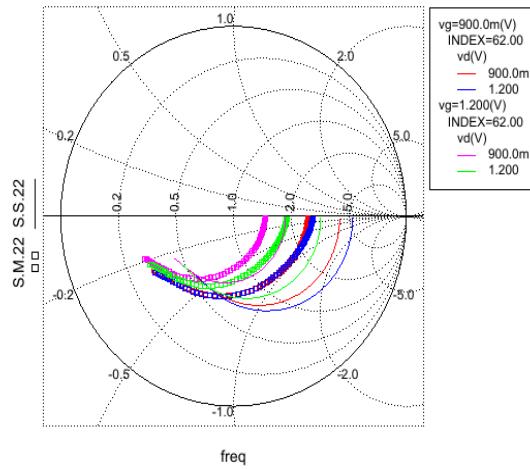
$$|h21| = f(Vg, Vd)$$



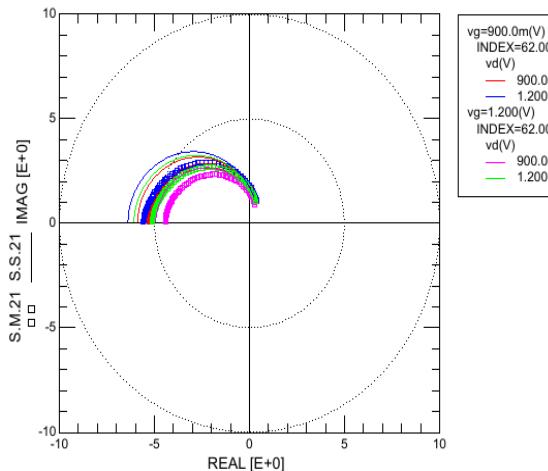
$$MSG/MAG = f(Vg, Vd)$$



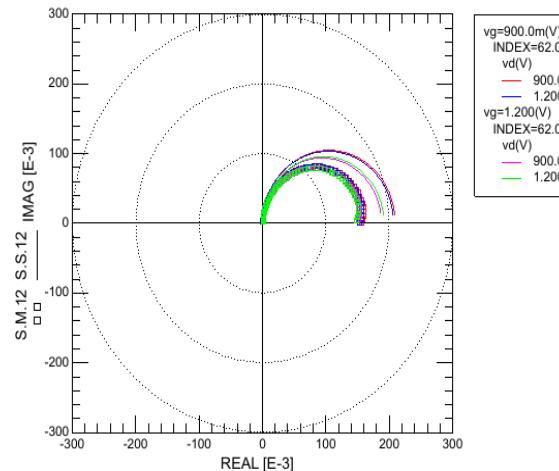
$$S11 = f(Vg, Vd)$$



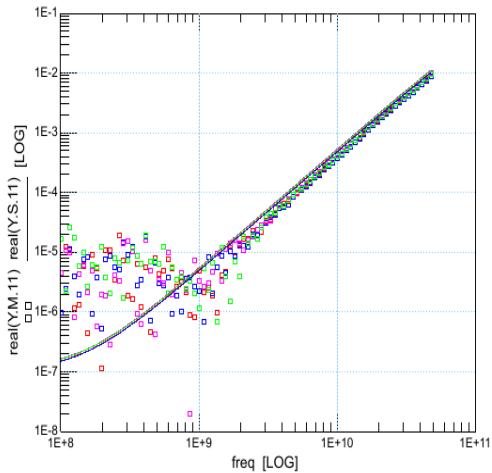
$$S22 = f(Vg, Vd)$$



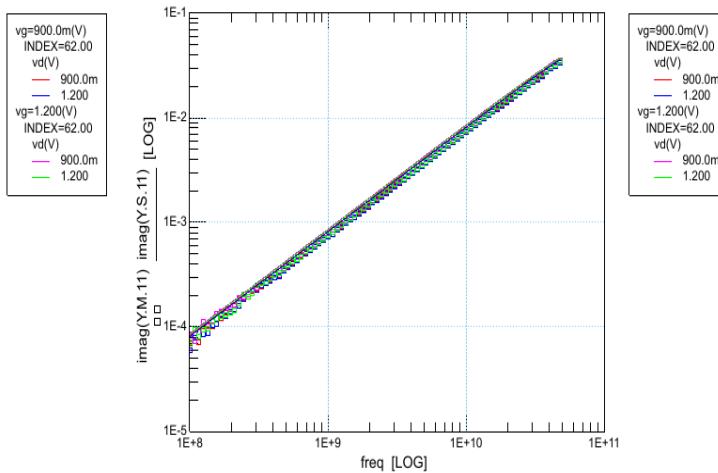
$$S21 = f(Vg, Vd)$$



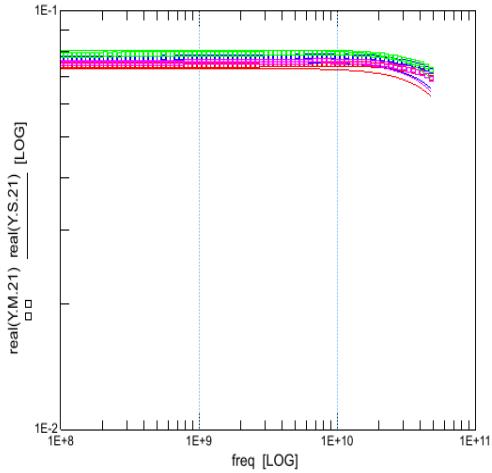
$$S12 = f(Vg, Vd)$$

Y-Parameter, T = 27°C

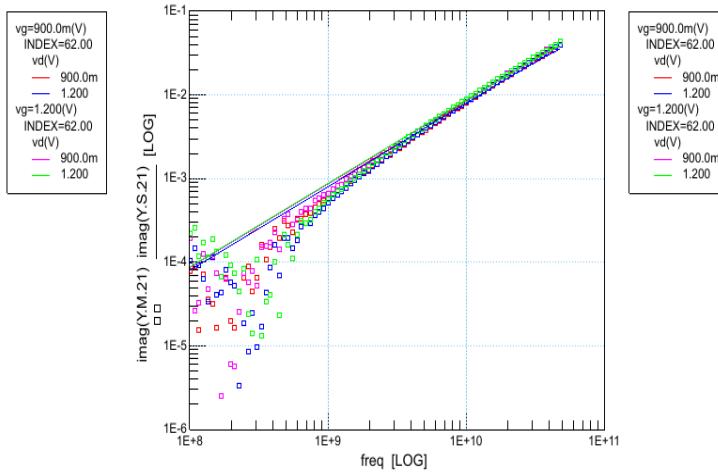
$$\text{re}(Y11) = f(Vg, Vd)$$



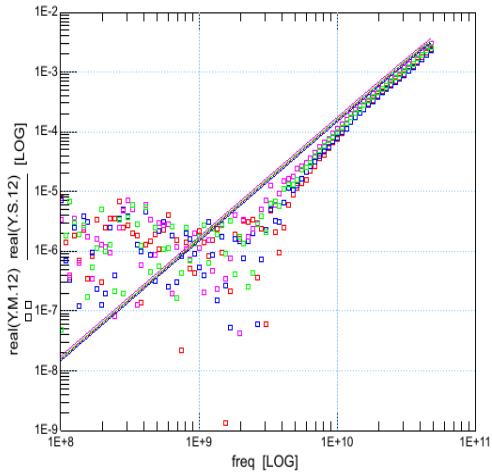
$$\text{im}(Y11) = f(Vg, Vd)$$



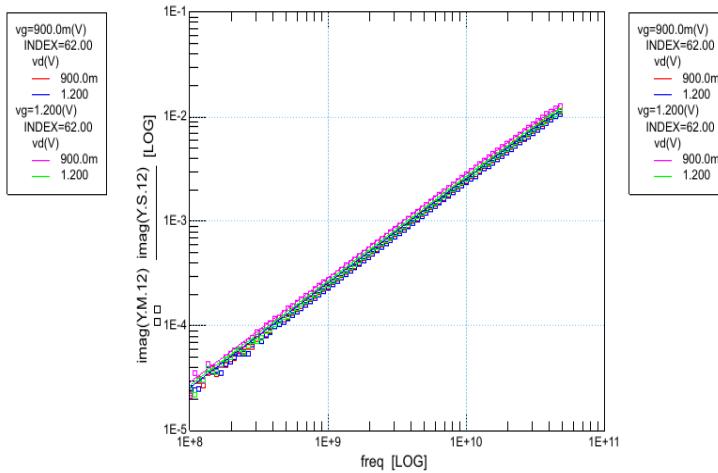
$$\text{re}(Y21) = f(Vg, Vd)$$



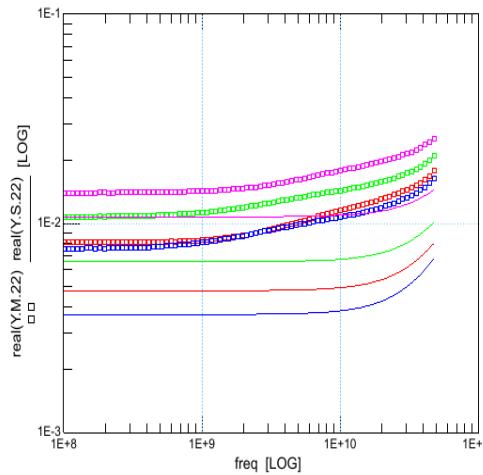
$$\text{im}(Y21) = f(Vg, Vd)$$



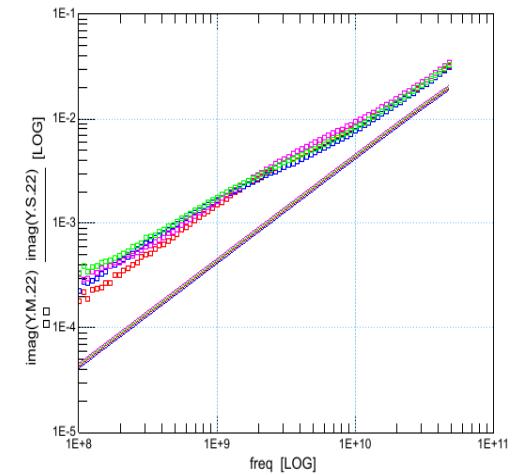
$$\text{re}(Y12) = f(Vg, Vd)$$



$$\text{im}(Y12) = f(Vg, Vd)$$

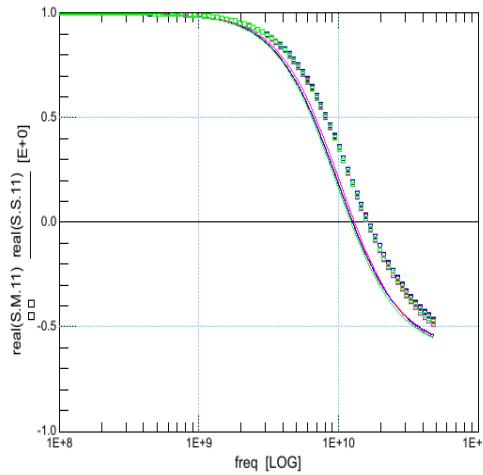


$$\text{real}(Y_{22}) = f(V_g, V_d)$$

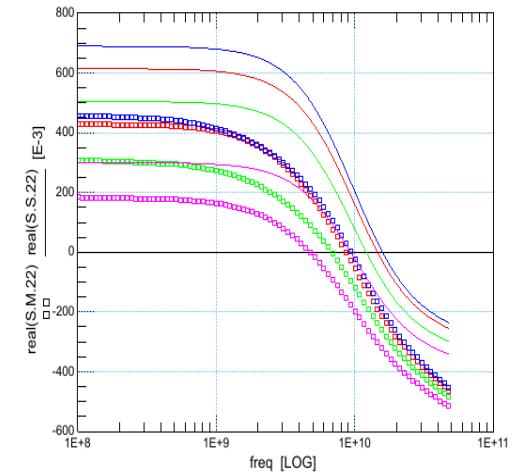


$$\text{imag}(Y_{22}) = f(V_g, V_d)$$

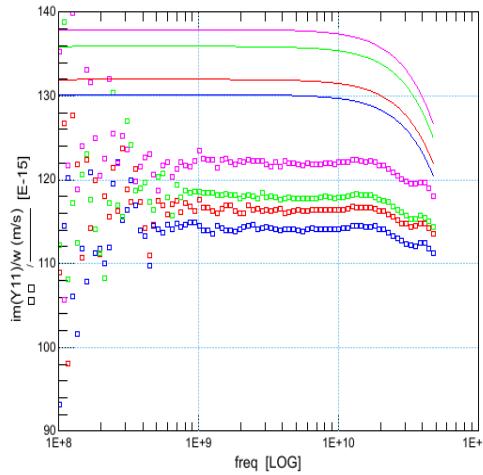
Verify Plots, $T = 27^\circ\text{C}$



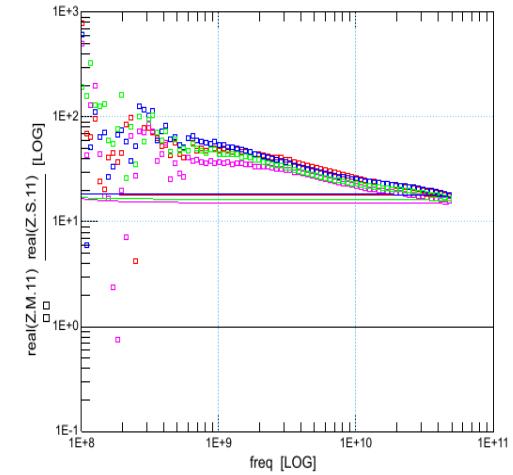
$$\text{real}(S_{11}) = f(V_g, V_d)$$



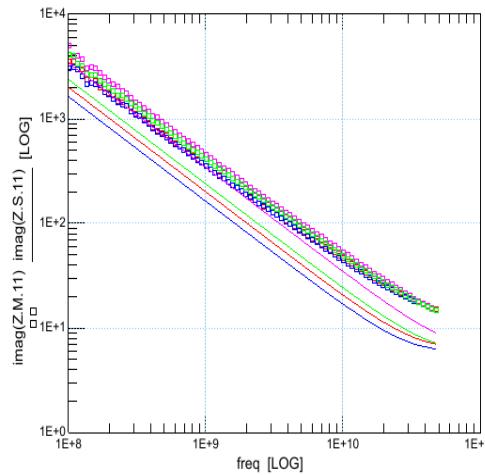
$$\text{real}(S_{22}) = f(V_g, V_d)$$



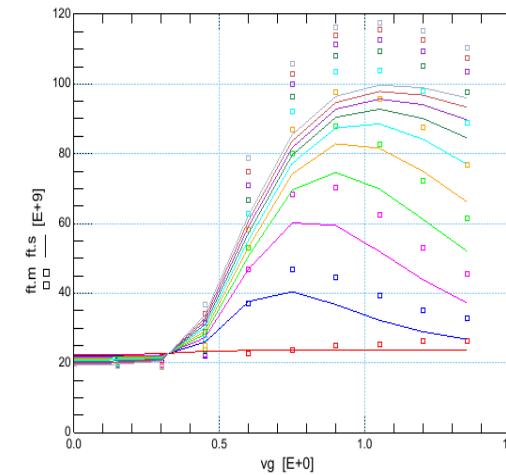
$$\text{im}(Y_{11}) \text{ divided by } \omega$$



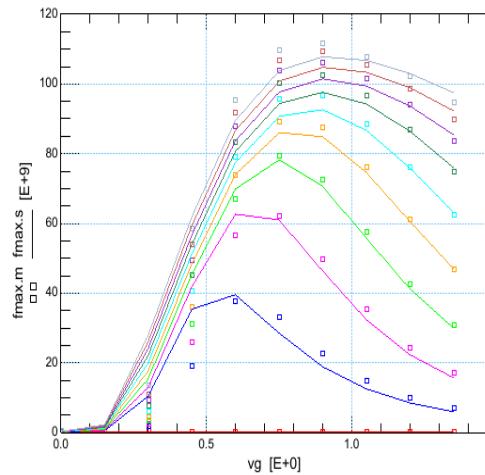
$$\text{real}(Z_{11}) = f(V_g, V_d)$$



$$\text{im}(Z_{11}) = f(V_g, V_d)$$



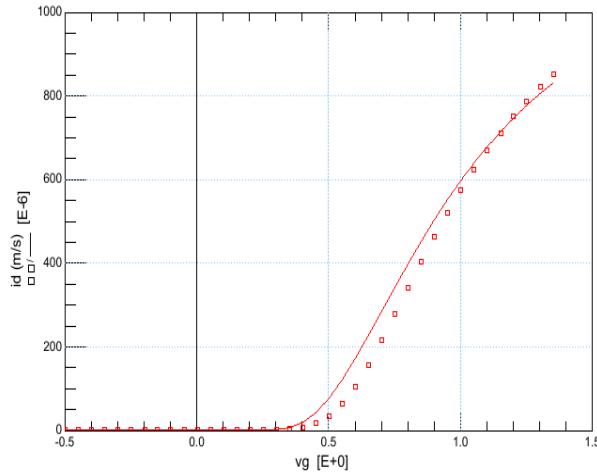
$$fT_{vg} = f(V_g, V_d)$$



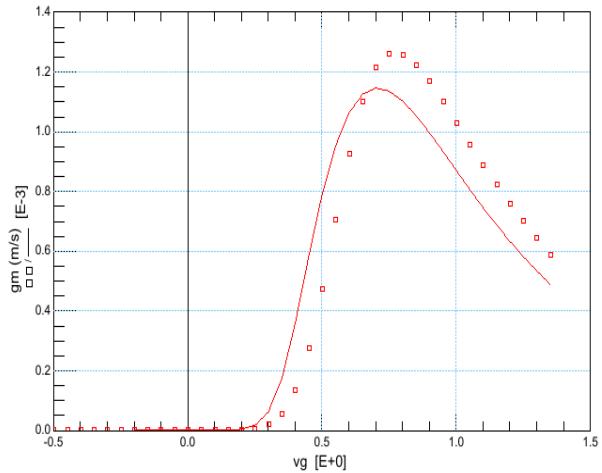
$$f_{\max_vg} = f(V_g, V_d)$$

4.9 NF01_WF10u0_L0u13_S453A_44

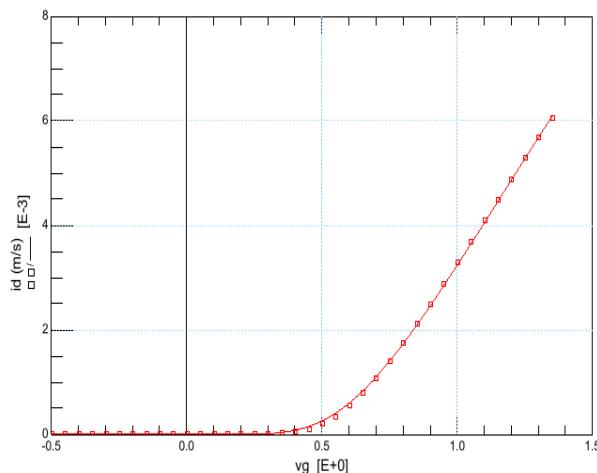
IdVg, T = 27°C



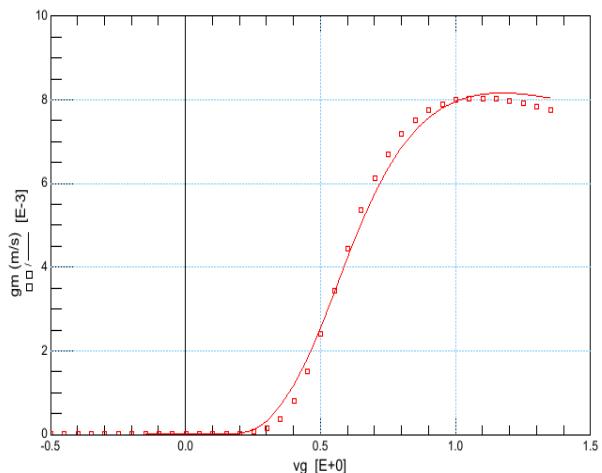
$Id = f(Vg)$ @ $Vd = 0.05V$



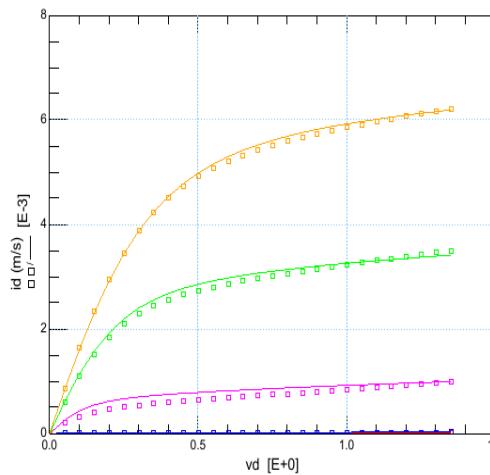
$gm = f(Vg)$ @ $Vd = 0.05V$



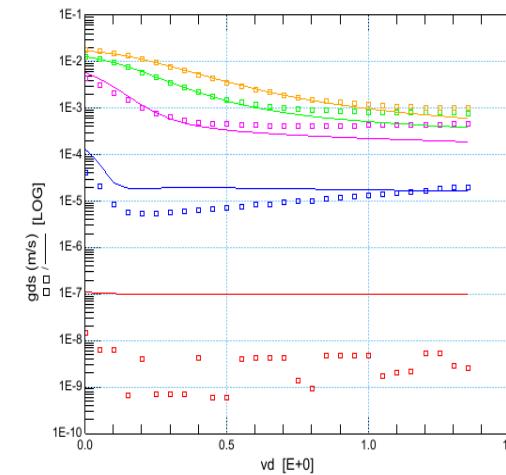
$Id = f(Vg)$ @ $Vd = 1.2V$



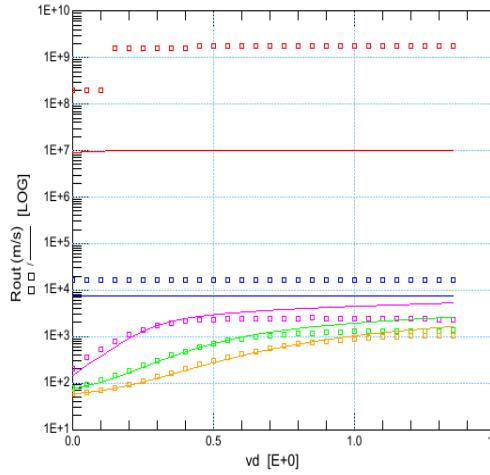
$gm = f(Vg)$ @ $Vd = 1.2V$

IdVd, T = 27°C

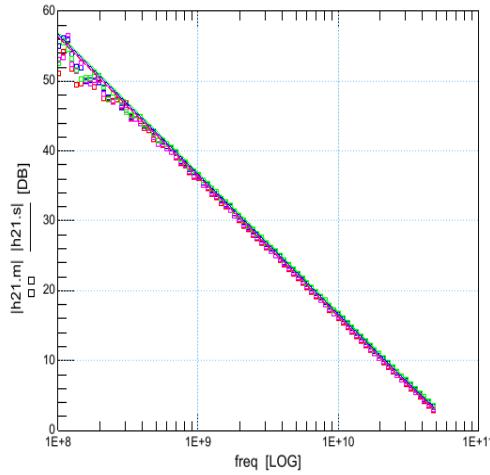
$$Id = f(Vd)$$



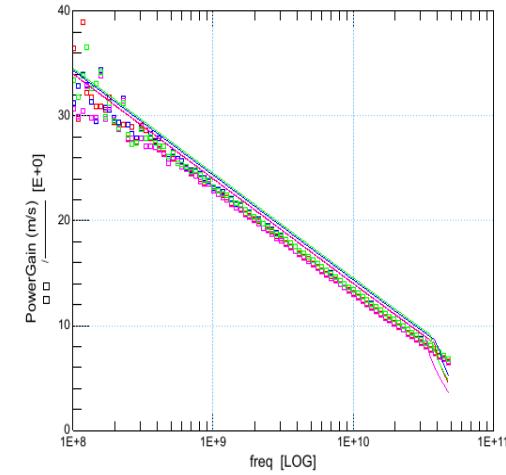
$$gds = f(Vd)$$



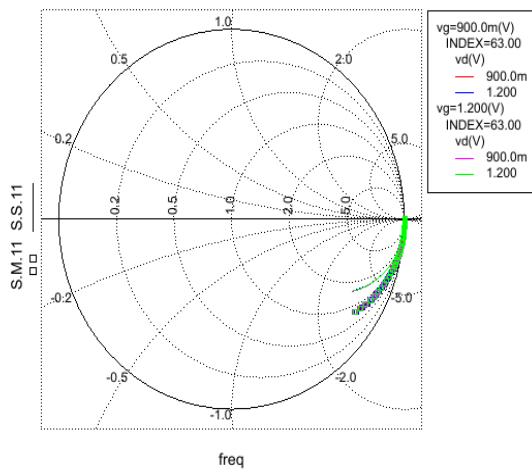
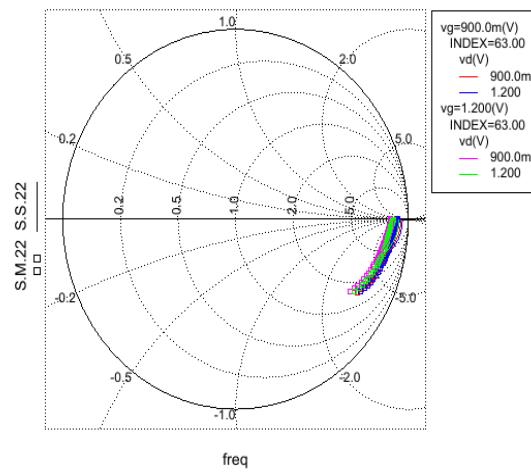
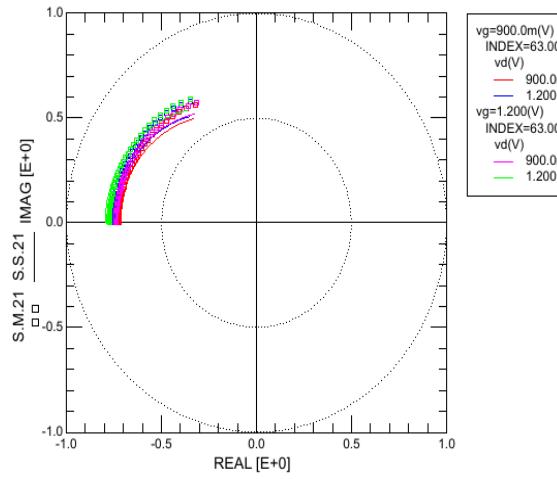
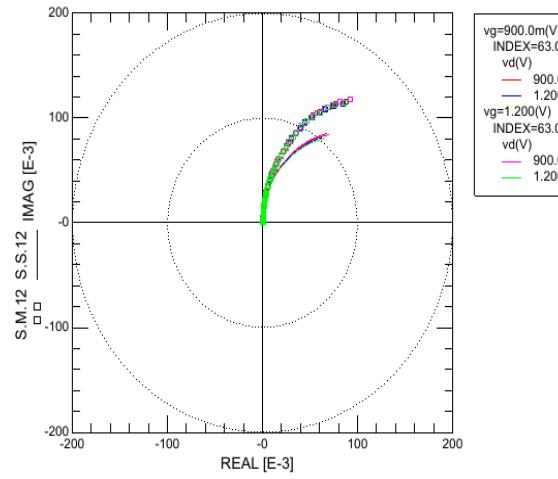
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

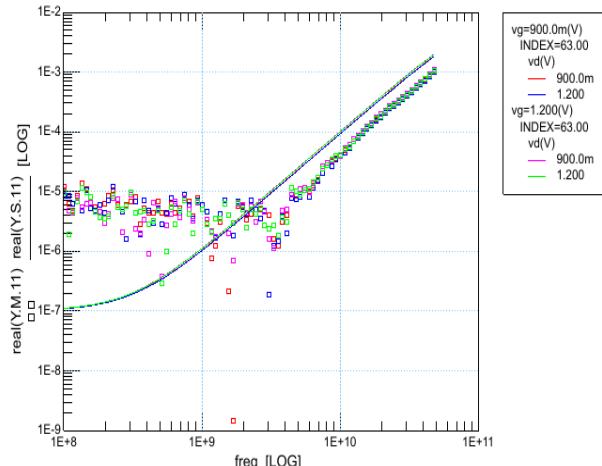
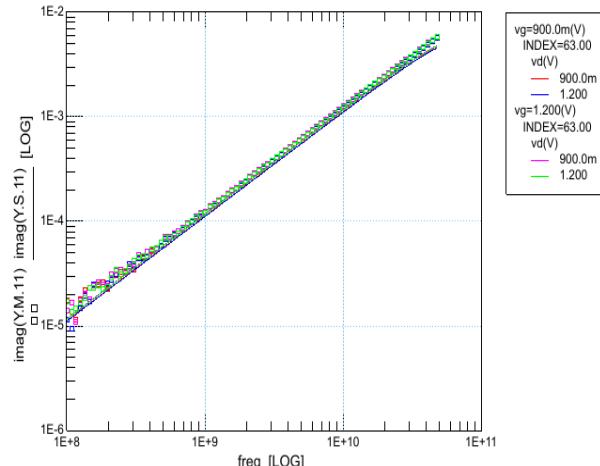
$$|h21| = f(Vg, Vd)$$

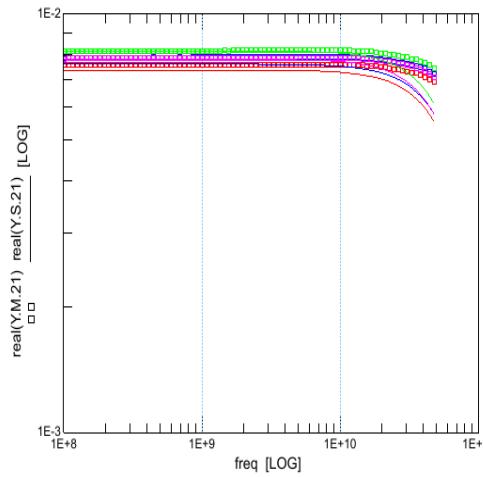
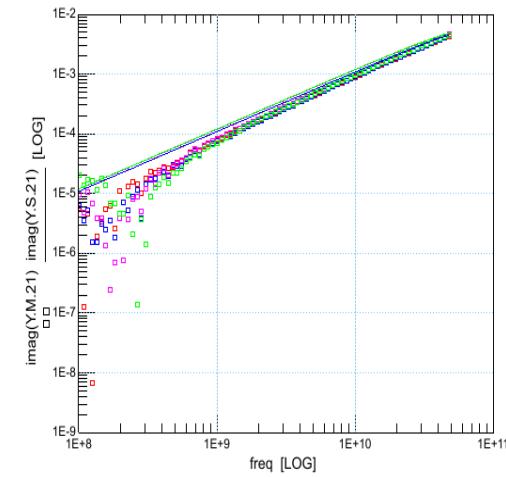
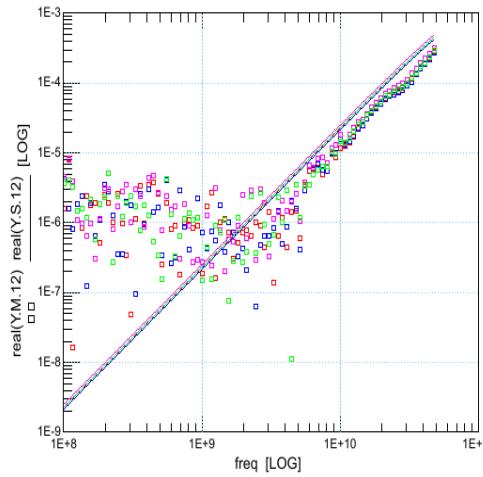
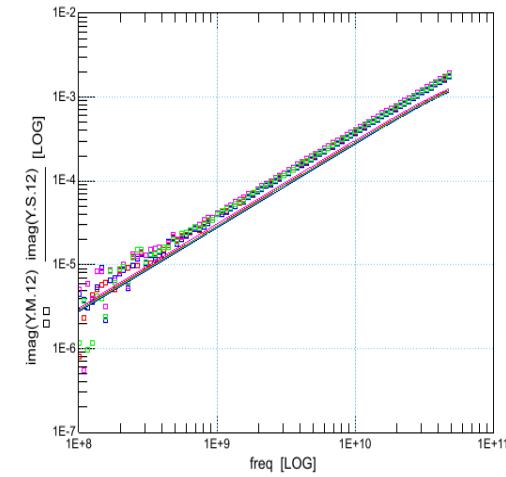
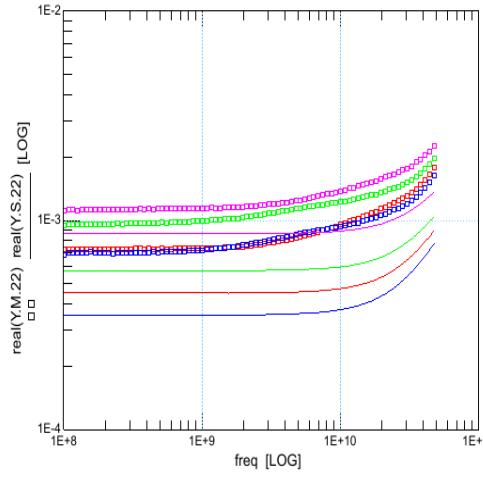
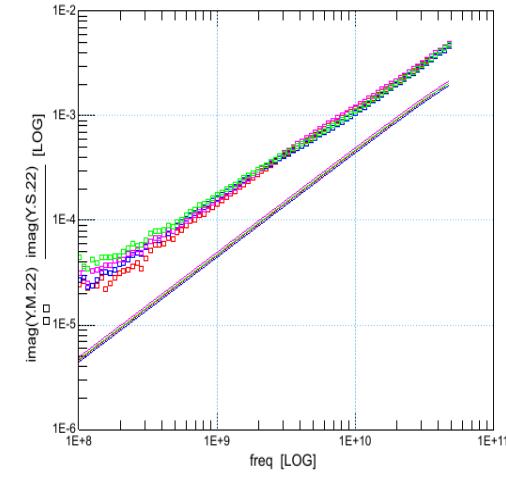


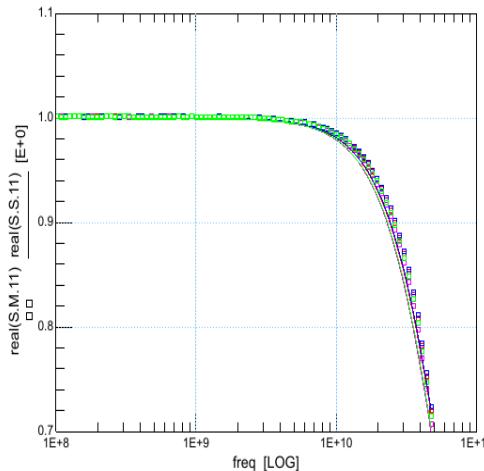
$$MSG/MAG = f(Vg, Vd)$$

 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

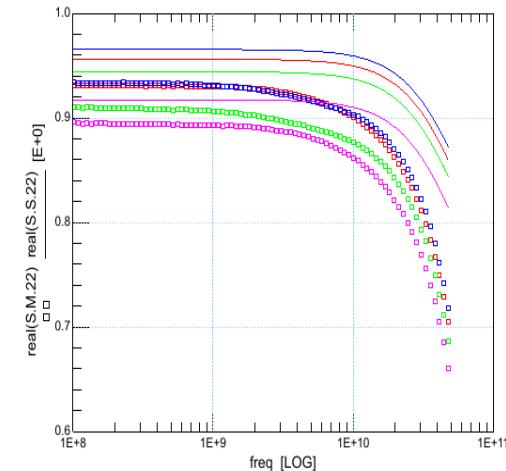
Y-Parameter, T = 27°C

 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$

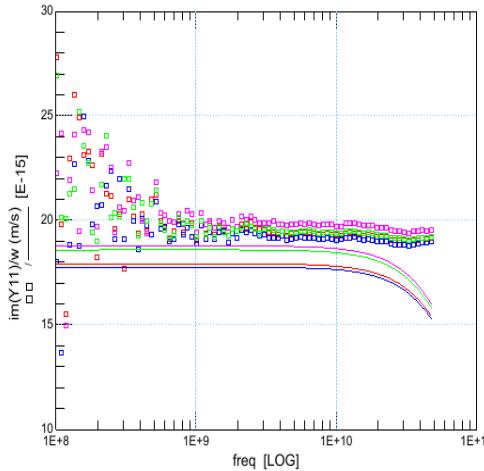
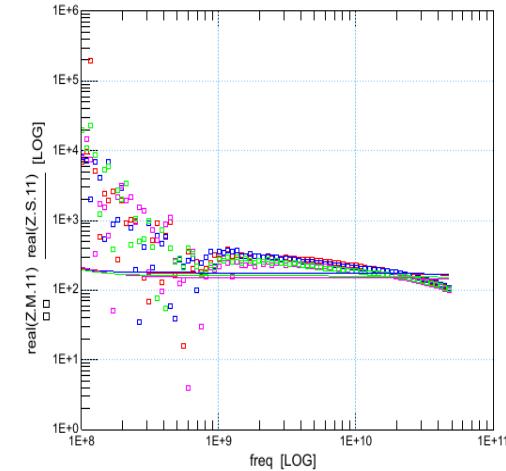
re(Y₂₁) = f(V_g, V_d)im(Y₂₁) = f(V_g, V_d)re(Y₁₂) = f(V_g, V_d)im(Y₁₂) = f(V_g, V_d)re(Y₂₂) = f(V_g, V_d)im(Y₂₂) = f(V_g, V_d)

Verify Plots, $T = 27^\circ\text{C}$ 

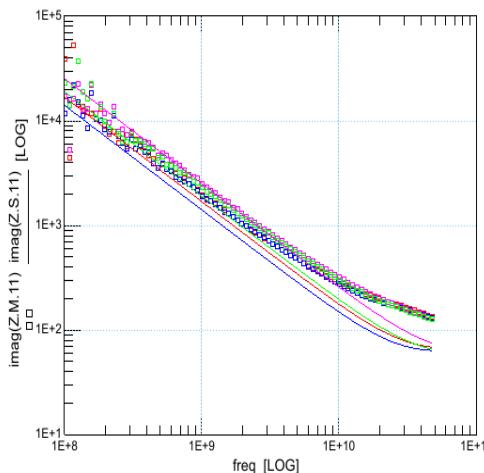
re(S11) = f(Vg, Vd)



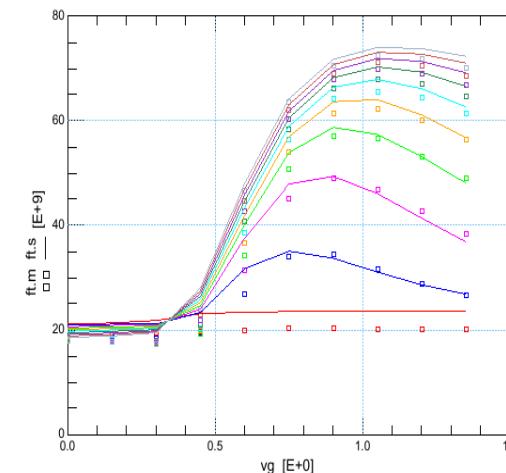
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

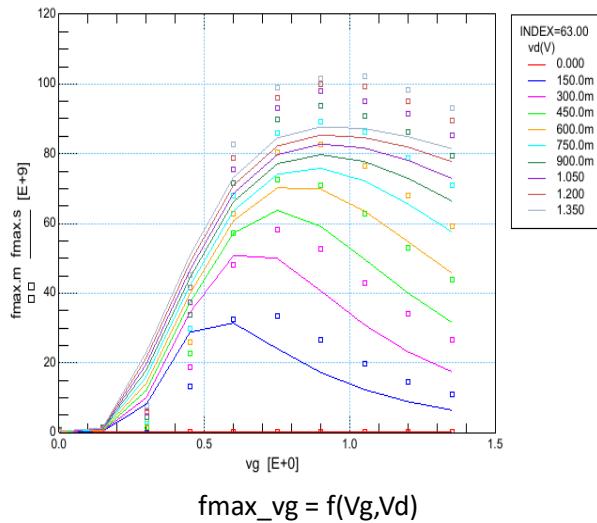
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

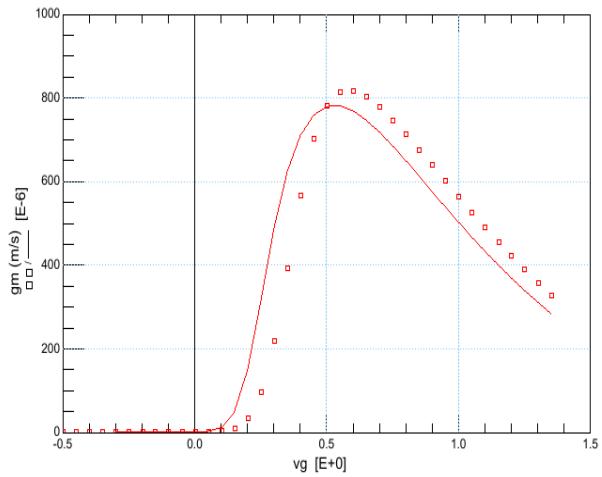
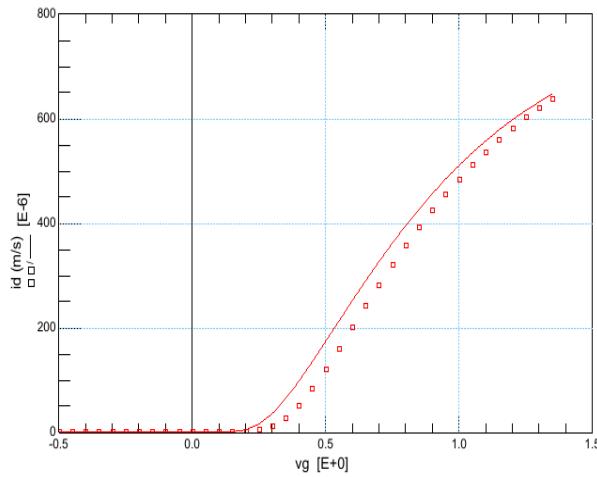


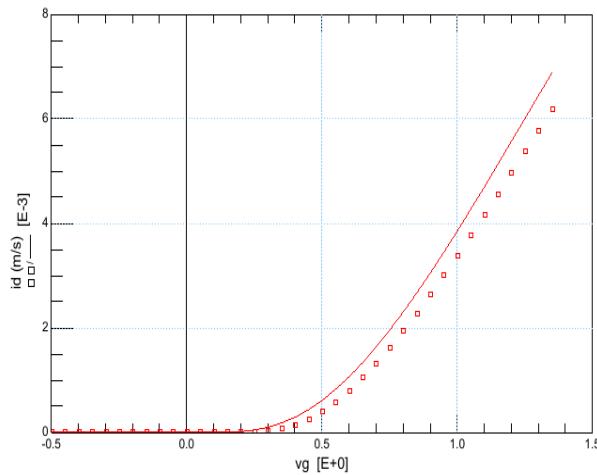
fT_vg = f(Vg, Vd)



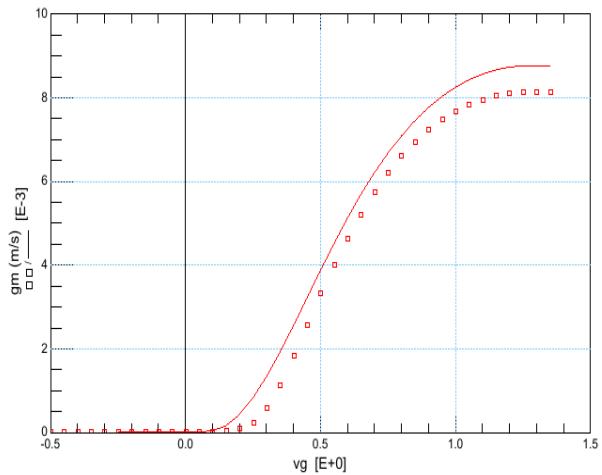
4.10NF04_WF05u0_L0u5_S453A_23

$I_d V_g, T = 27^\circ C$



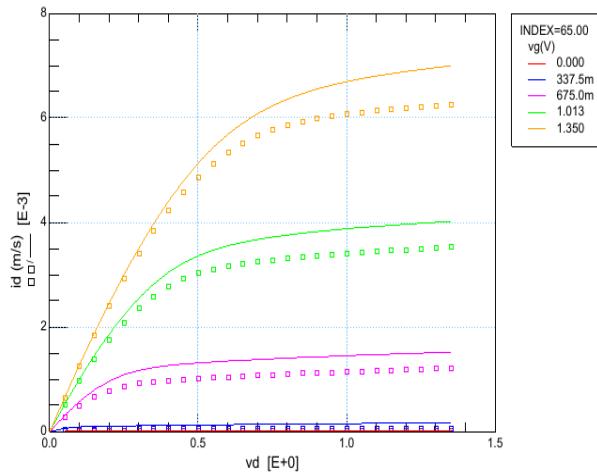


$$Id = f(Vg) @ Vd = 1.2V$$

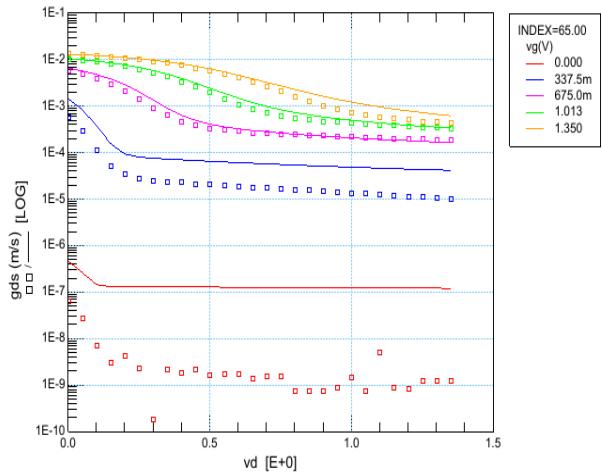


$$gm = f(Vg) @ Vd = 1.2V$$

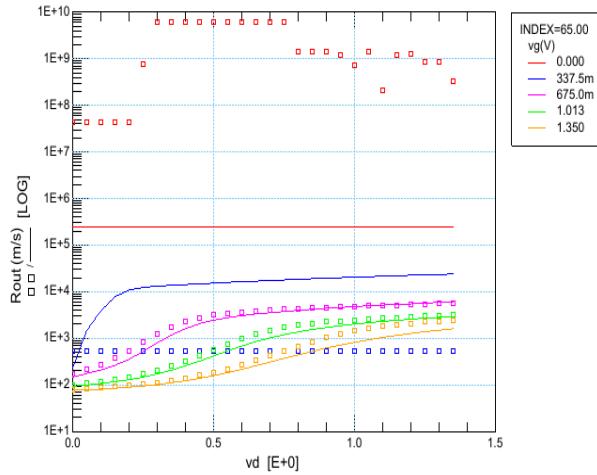
IdVd, T = 27°C



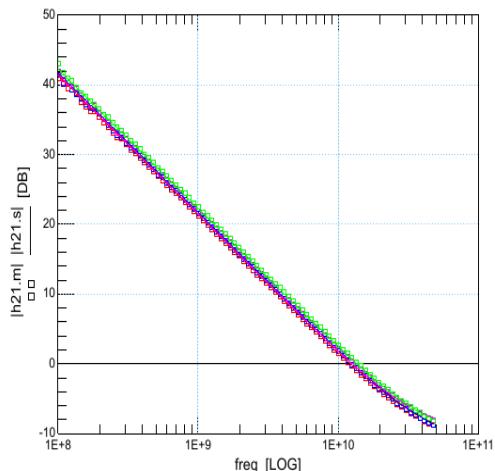
$$Id = f(Vd)$$



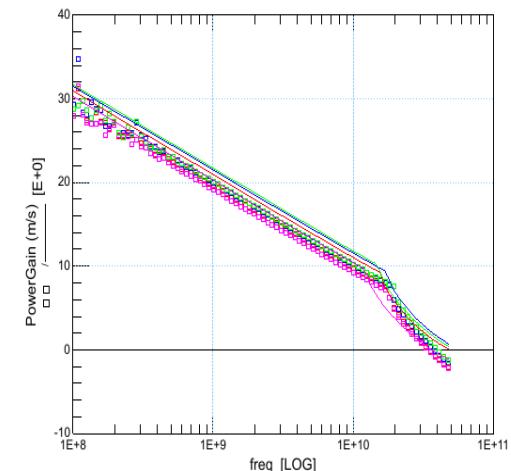
$$gds = f(Vd)$$



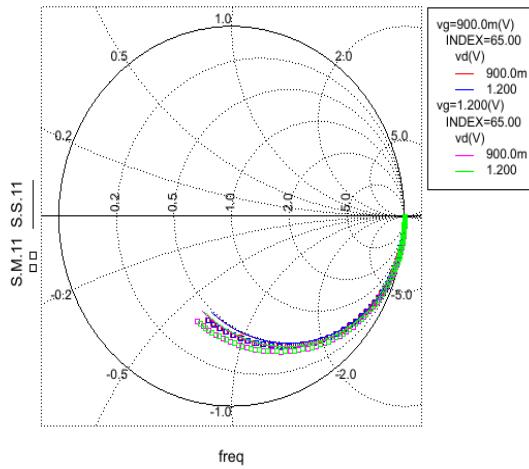
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

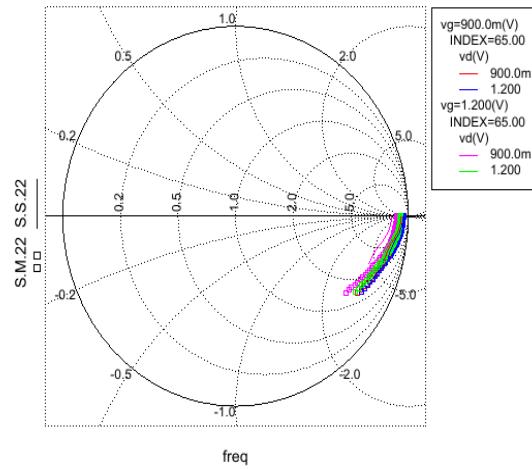
$$|h21| = f(Vg, Vd)$$



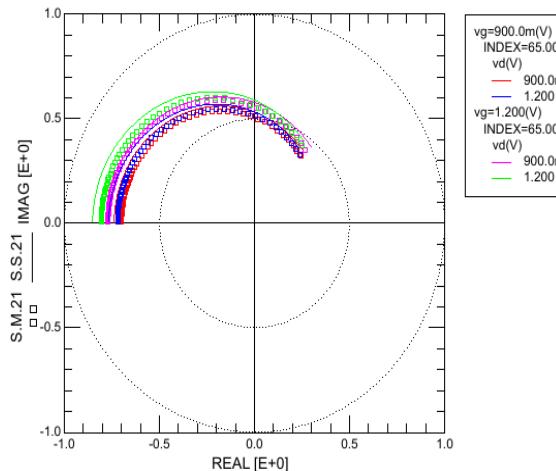
$$MSG/MAG = f(Vg, Vd)$$



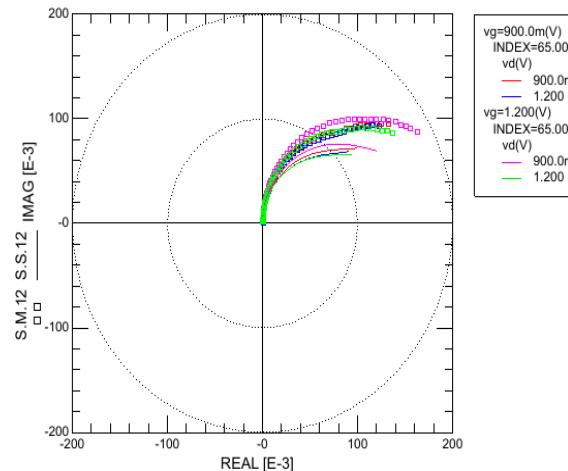
$$S11 = f(Vg, Vd)$$



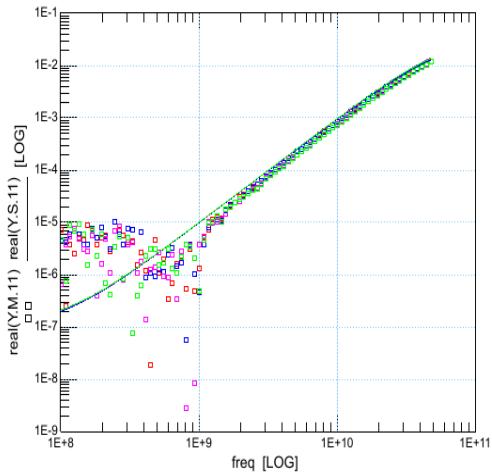
$$S22 = f(Vg, Vd)$$



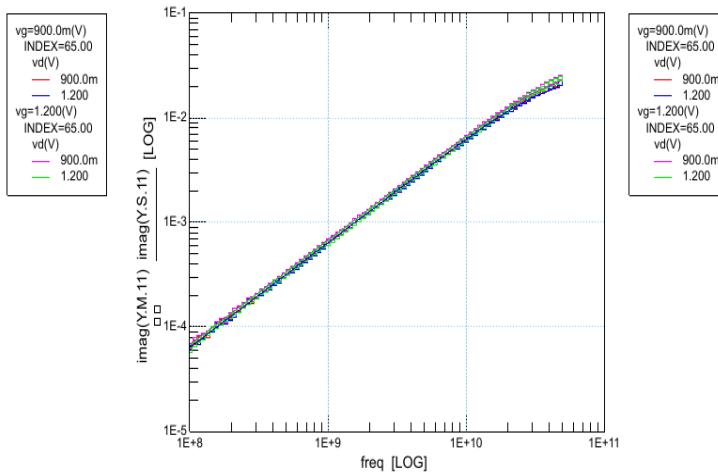
$$S21 = f(Vg, Vd)$$



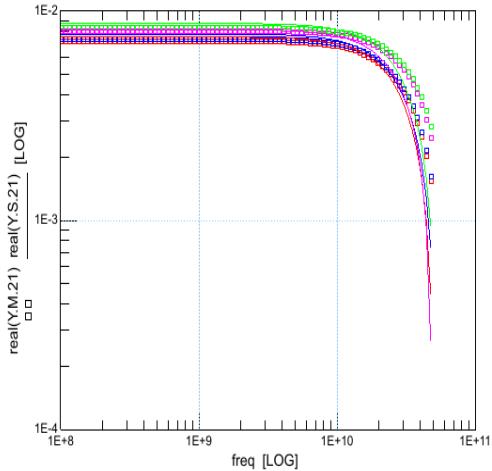
$$S12 = f(Vg, Vd)$$

Y-Parameter, T = 27°C

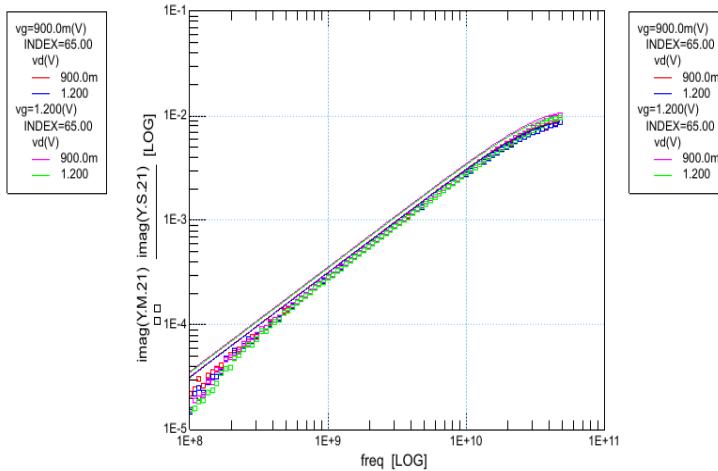
$$\text{re}(Y_{11}) = f(Vg, Vd)$$



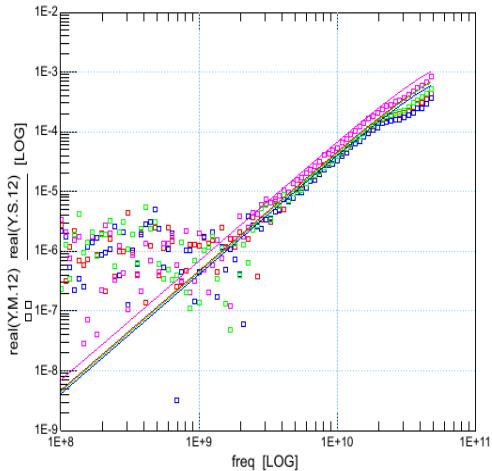
$$\text{im}(Y_{11}) = f(Vg, Vd)$$



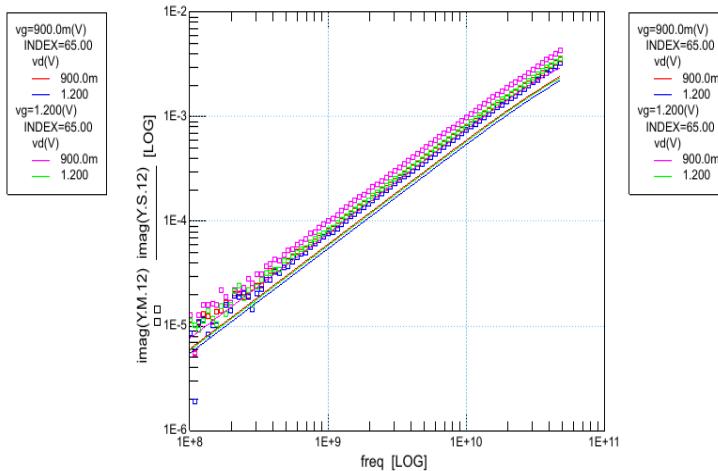
$$\text{re}(Y_{21}) = f(Vg, Vd)$$



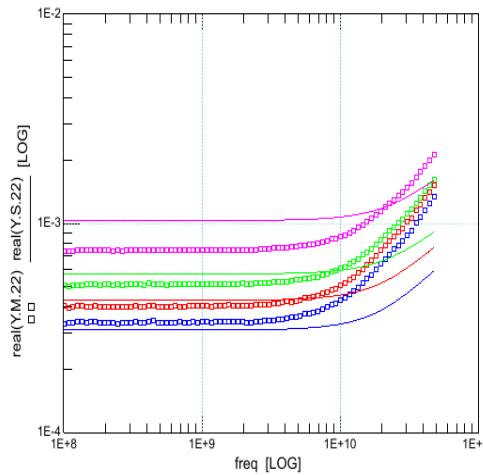
$$\text{im}(Y_{21}) = f(Vg, Vd)$$



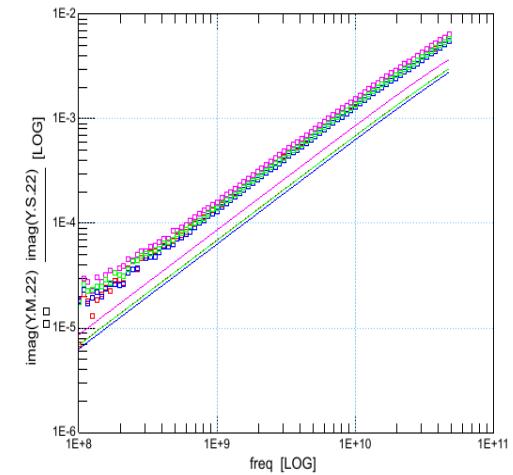
$$\text{re}(Y_{12}) = f(Vg, Vd)$$



$$\text{im}(Y_{12}) = f(Vg, Vd)$$

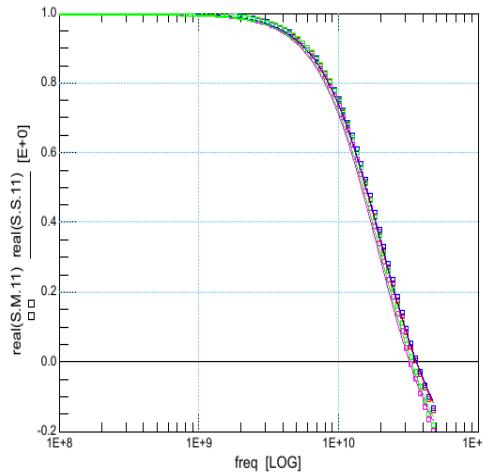


$$\text{real}(Y_{22}) = f(Vg, Vd)$$

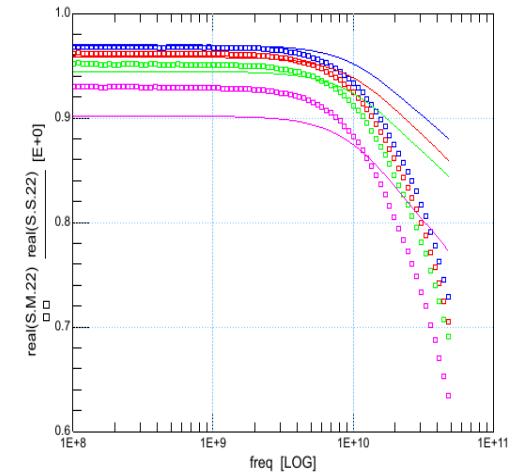


$$\text{imag}(Y_{22}) = f(Vg, Vd)$$

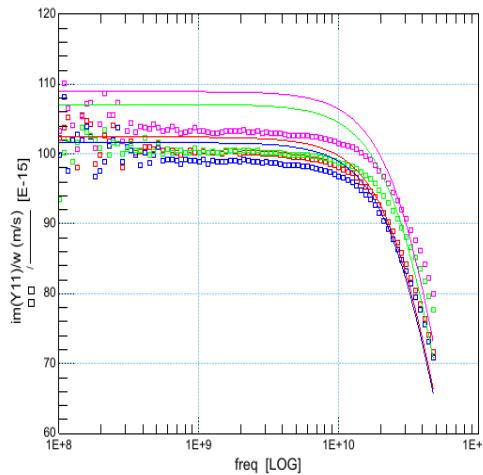
Verify Plots, $T = 27^\circ\text{C}$



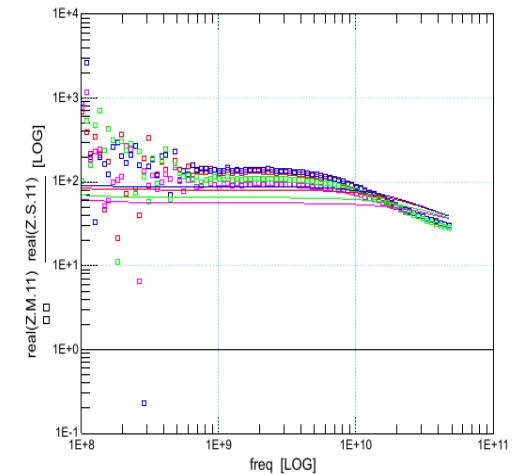
$$\text{real}(S_{11}) = f(Vg, Vd)$$



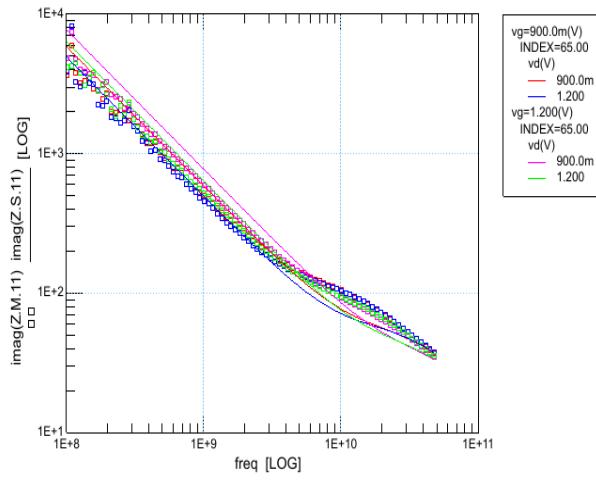
$$\text{real}(S_{22}) = f(Vg, Vd)$$



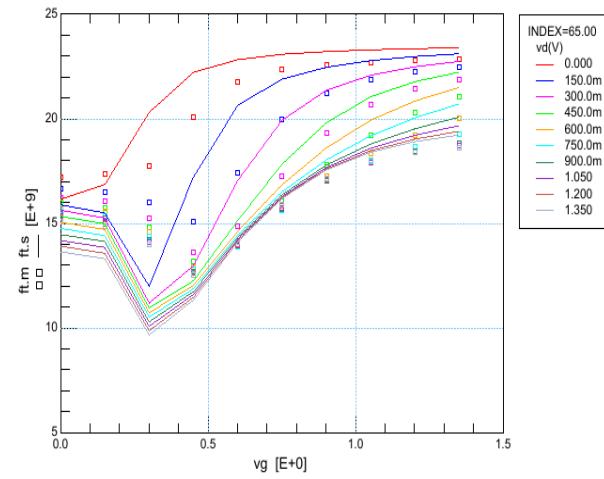
$$\text{im}(Y_{11}) \text{ divided by } \omega$$



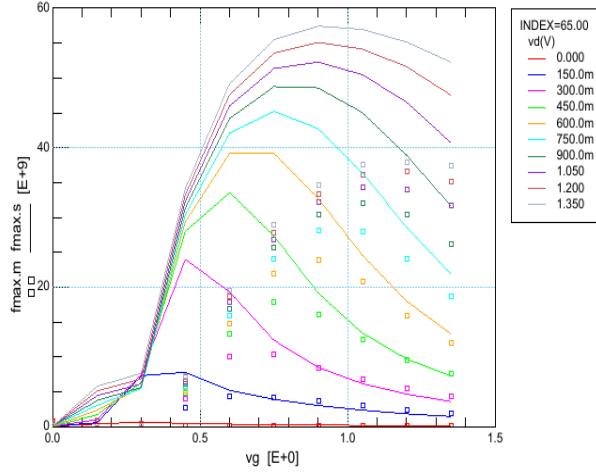
$$\text{real}(Z_{11}) = f(Vg, Vd)$$



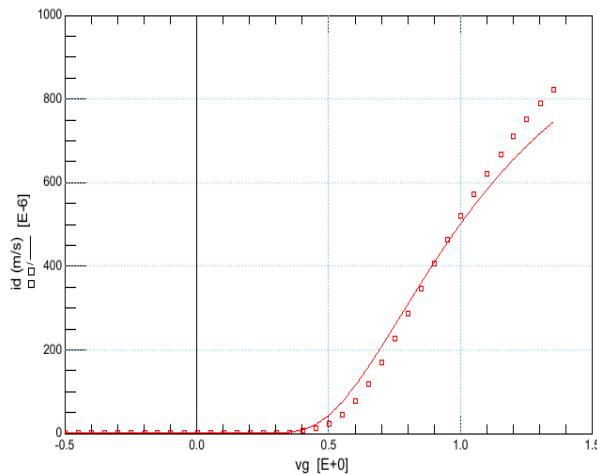
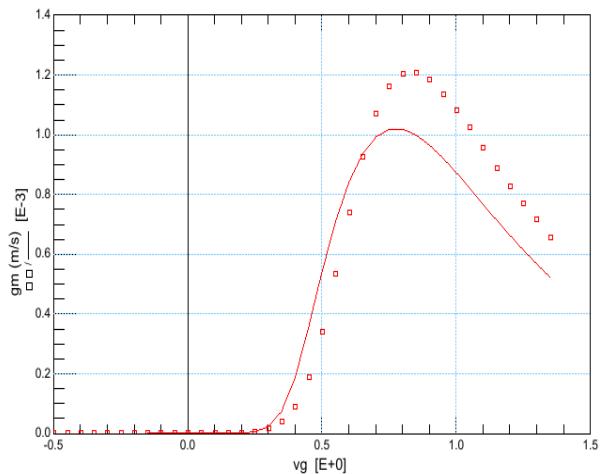
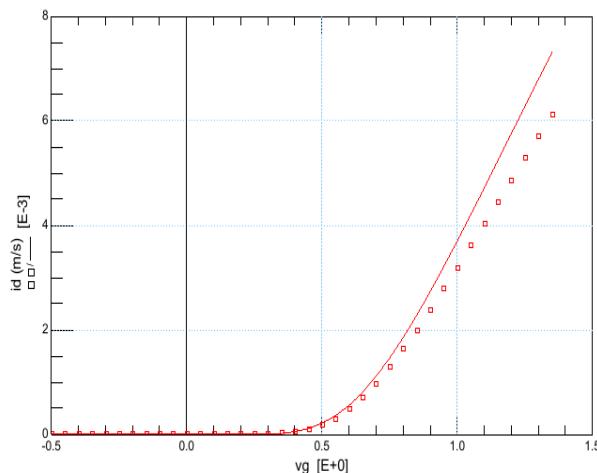
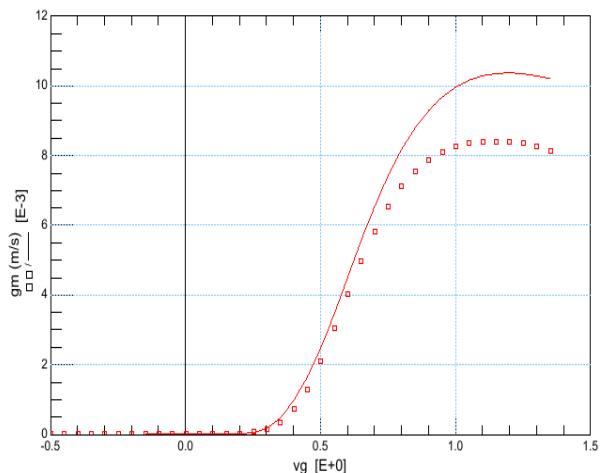
$$\text{im}(Z_{11}) = f(V_g, V_d)$$

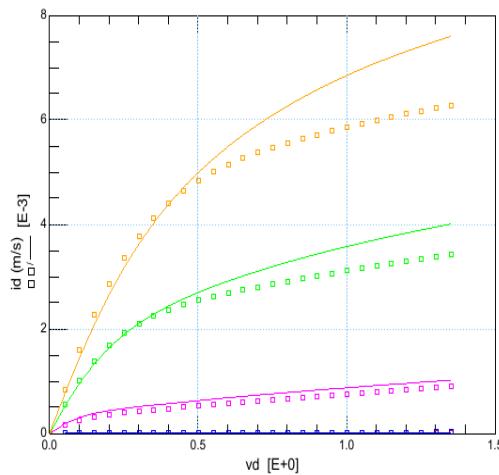


$$fT_{vg} = f(V_g, V_d)$$

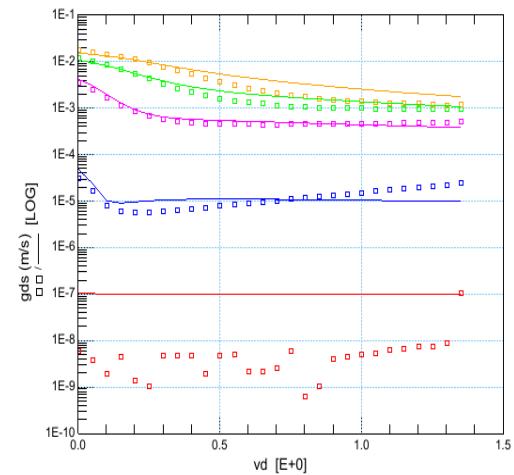


$$f_{\max,vg} = f(V_g, V_d)$$

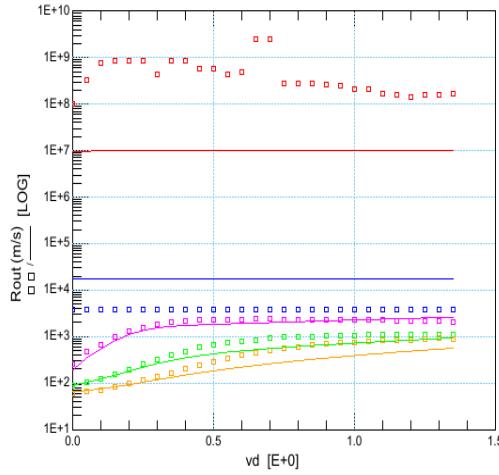
4.11 NF10_WF01u0_L0u13_S453A_51**IdVg, T = 27°C** $Id = f(Vg) @ Vd = 0.05V$  $gm = f(Vg) @ Vd = 0.05V$  $Id = f(Vg) @ Vd = 1.2V$  $gm = f(Vg) @ Vd = 1.2V$

IdVd, T = 27°C

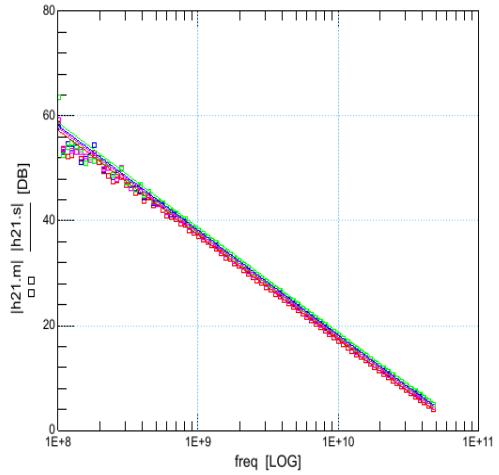
$$Id = f(Vd)$$



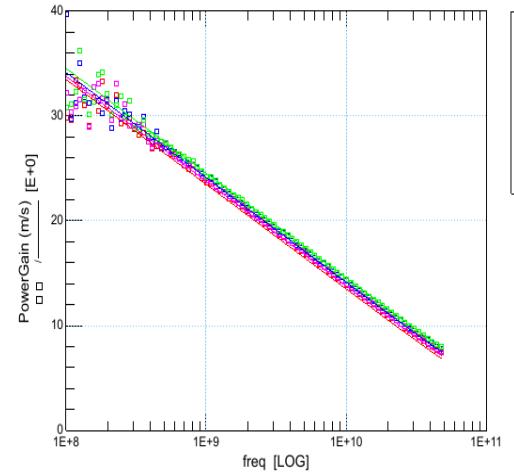
$$gds = f(Vd)$$



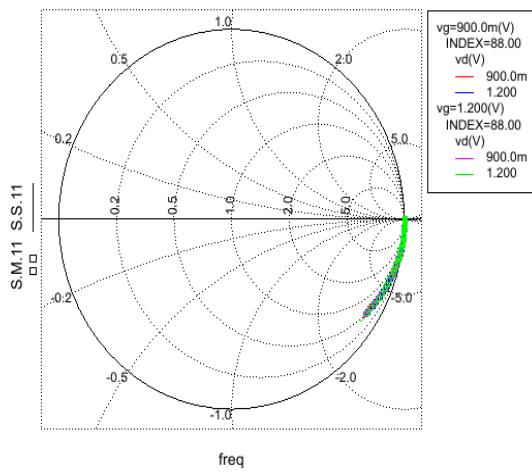
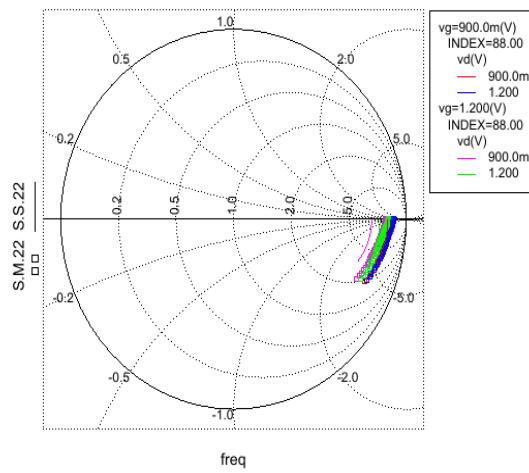
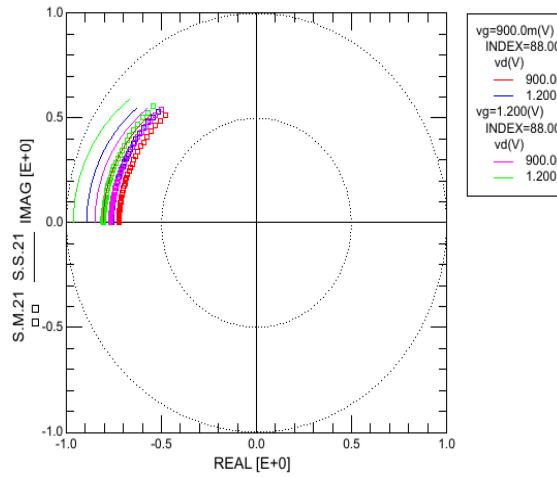
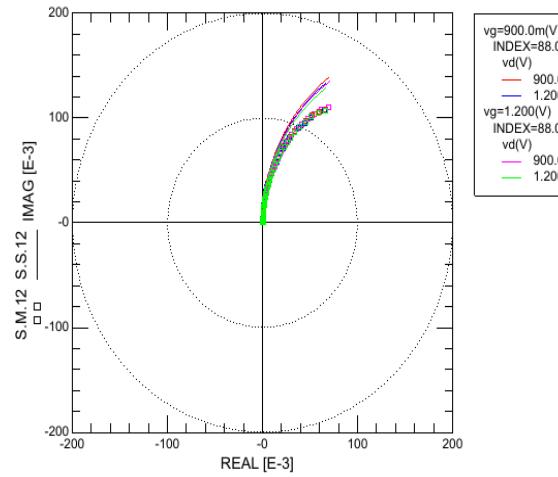
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

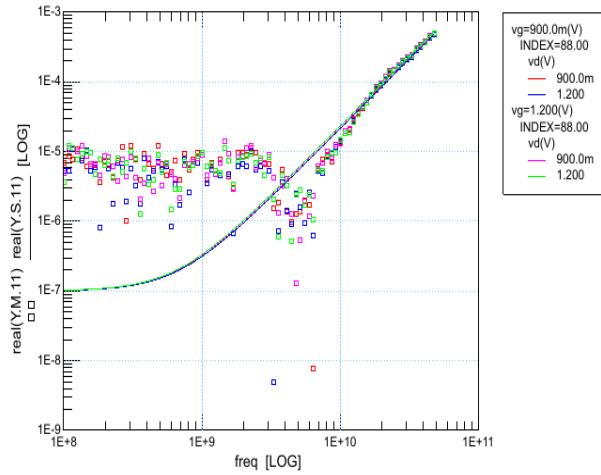
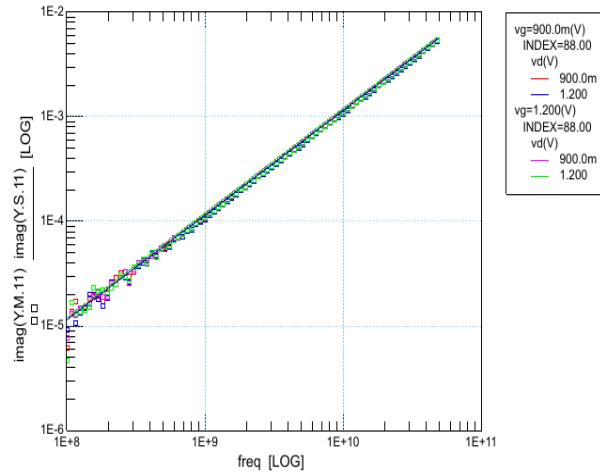
$$|h21| = f(Vg, Vd)$$

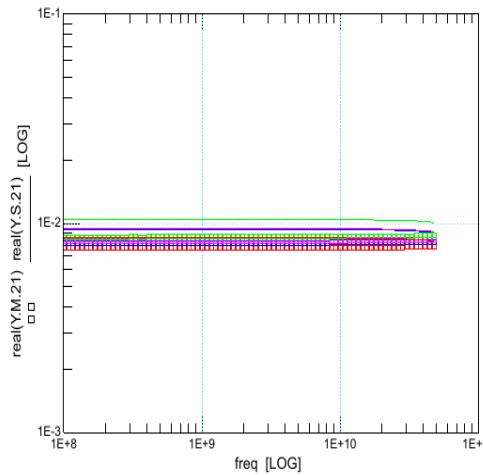
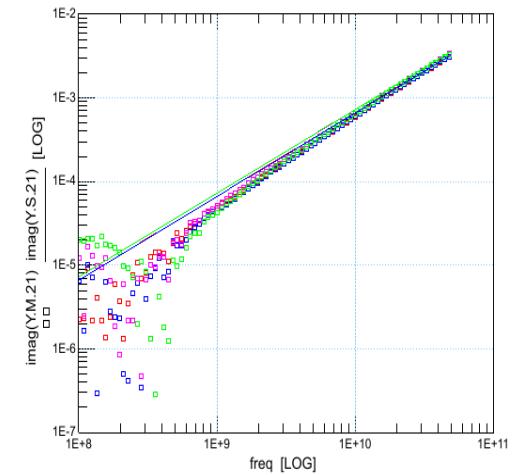
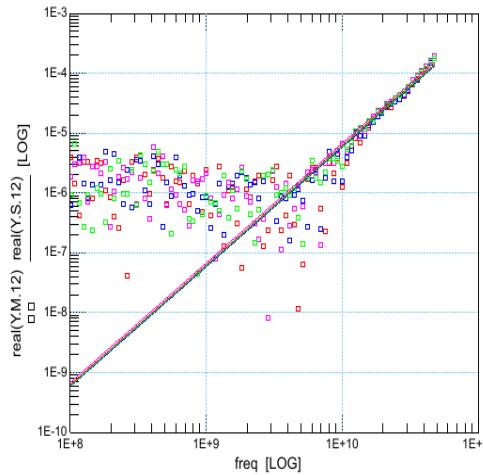
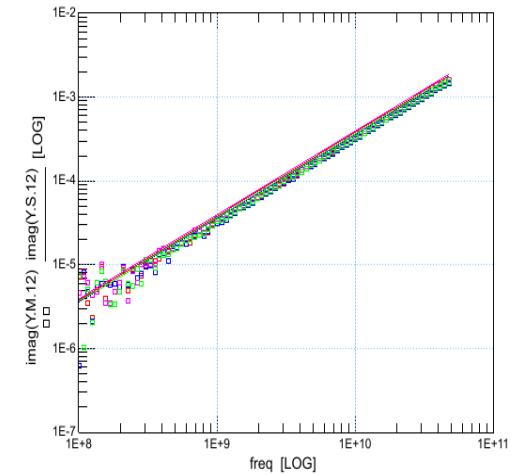
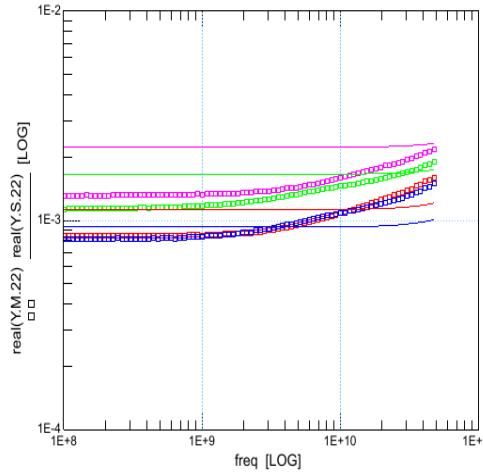
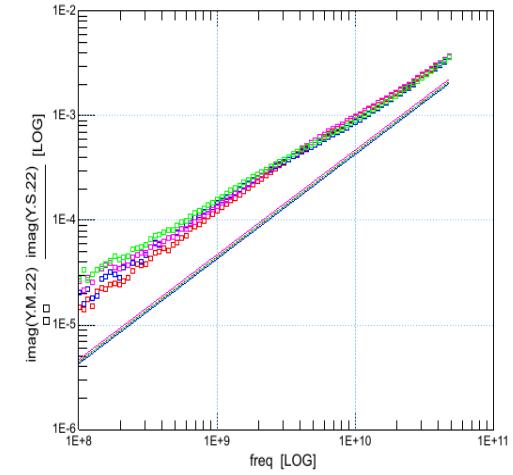


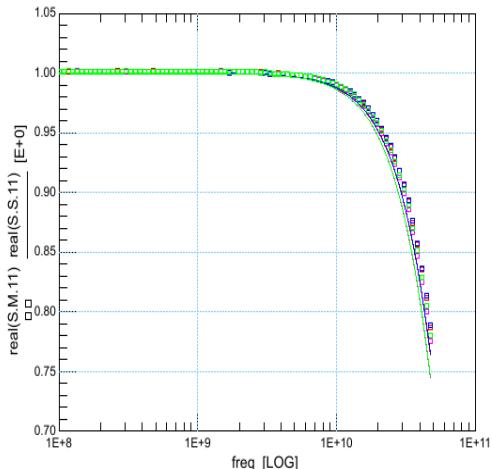
$$MSG/MAG = f(Vg, Vd)$$

 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

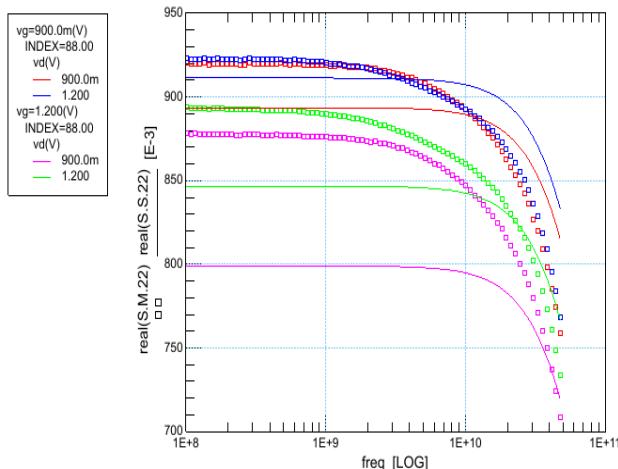
Y-Parameter, T = 27°C

 $\text{re}(Y_{11}) = f(Vg, Vd)$  $\text{im}(Y_{11}) = f(Vg, Vd)$

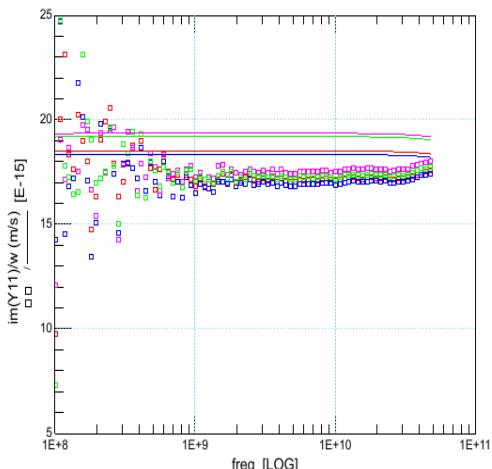
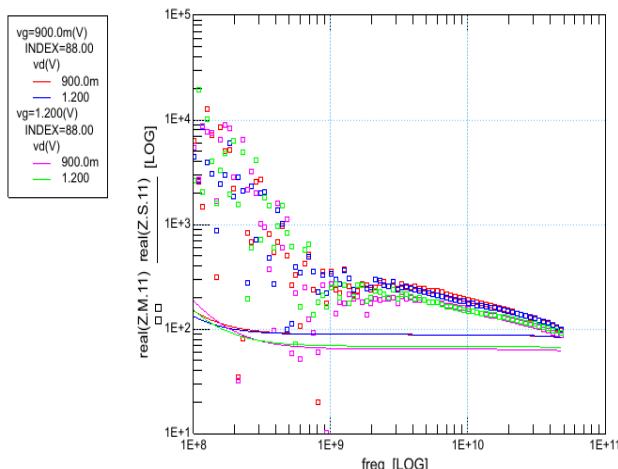
re(Y₂₁) = f(V_g, V_d)im(Y₂₁) = f(V_g, V_d)re(Y₁₂) = f(V_g, V_d)im(Y₁₂) = f(V_g, V_d)re(Y₂₂) = f(V_g, V_d)im(Y₂₂) = f(V_g, V_d)

Verify Plots, $T = 27^\circ\text{C}$ 

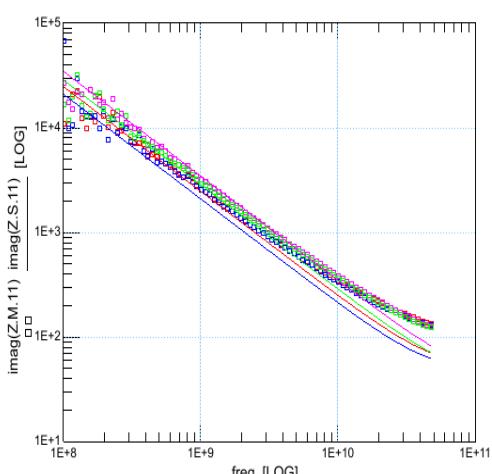
real(S11) = f(Vg,Vd)



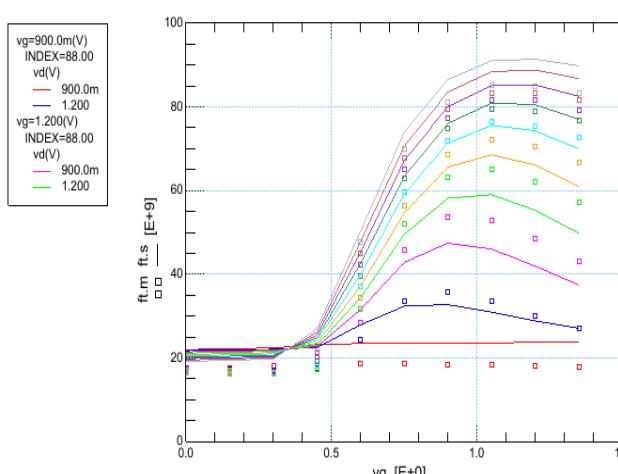
real(S22) = f(Vg,Vd)

im(Y11) divided by ω 

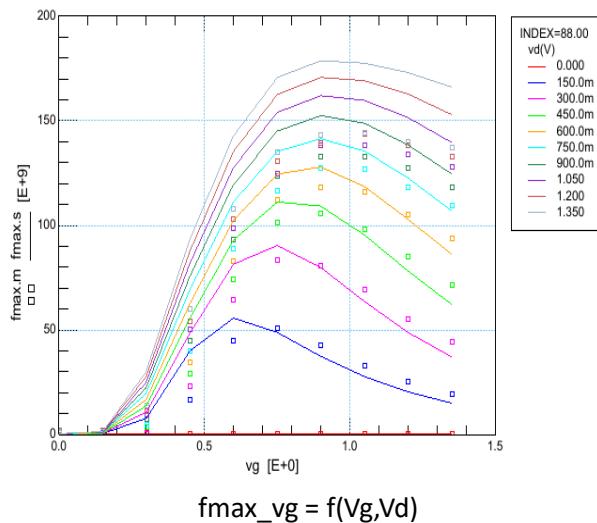
real(Z11) = f(Vg,Vd)



imag(Z11) = f(Vg,Vd)

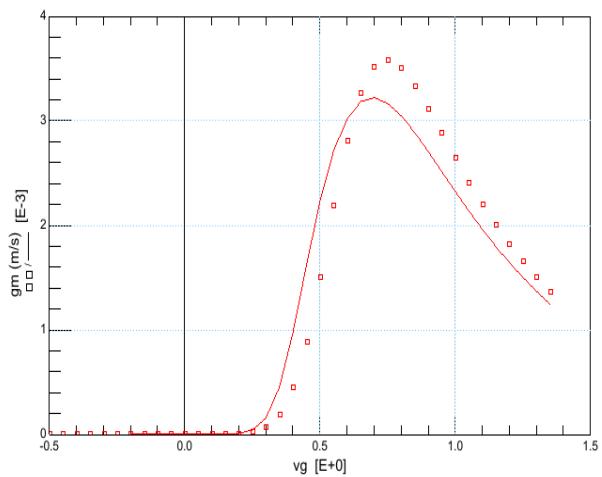
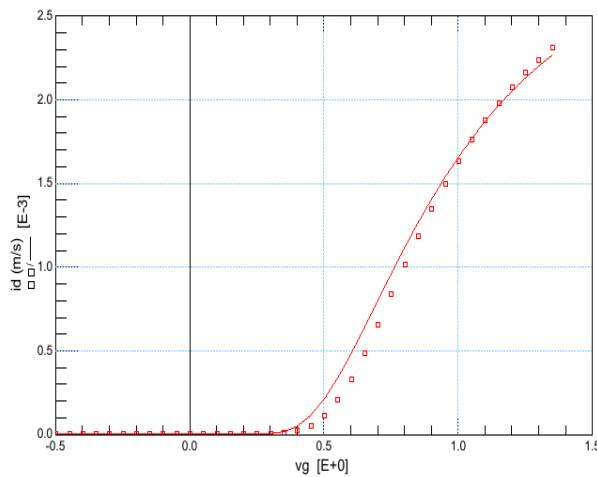


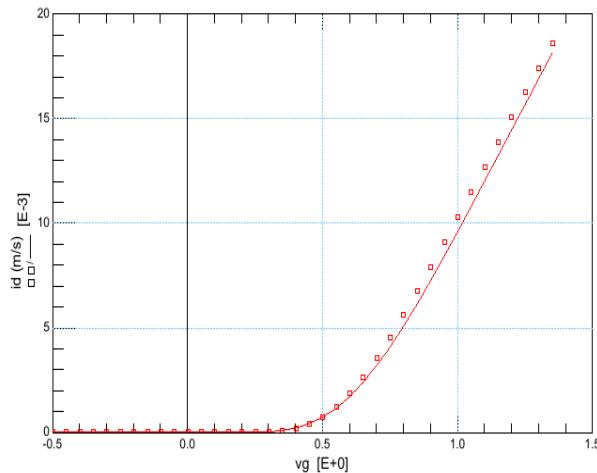
fT_vg = f(Vg,Vd)



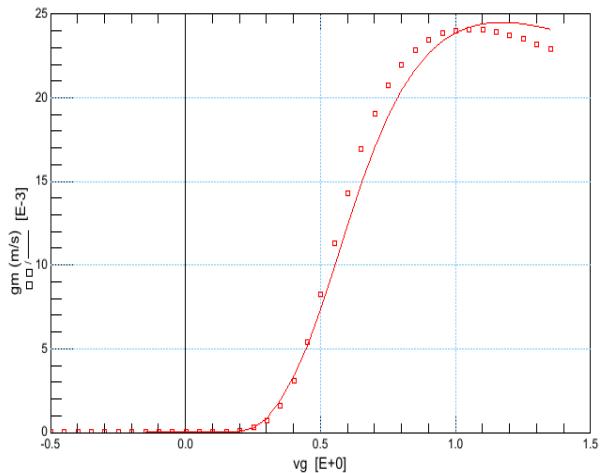
4.12 NF04_WF07u5_L0u13_S453A_31

I_d vs V_g , $T = 27^\circ\text{C}$



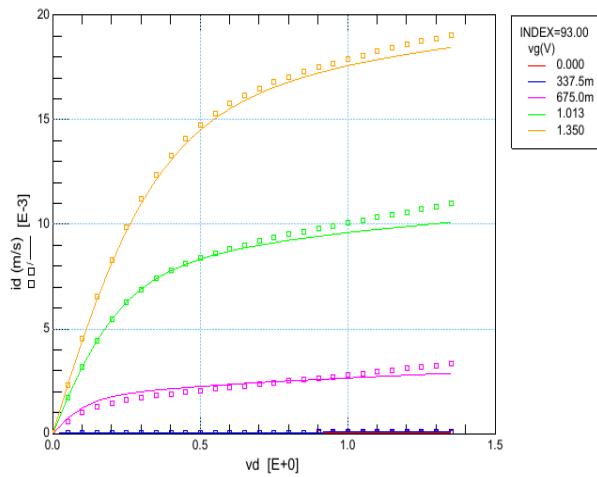


$$Id = f(Vg) @ Vd = 1.2V$$

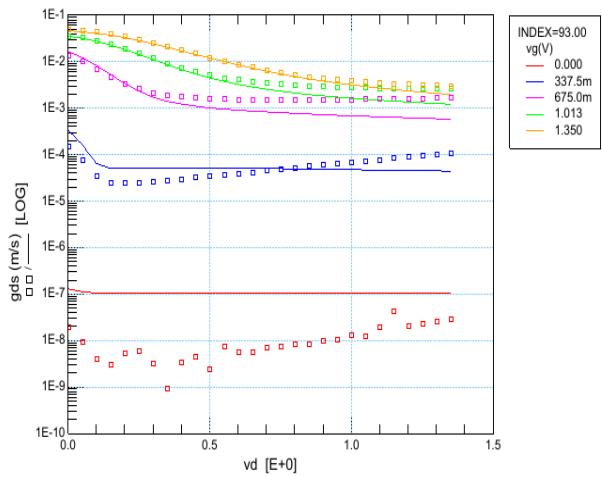


$$gm = f(Vg) @ Vd = 1.2V$$

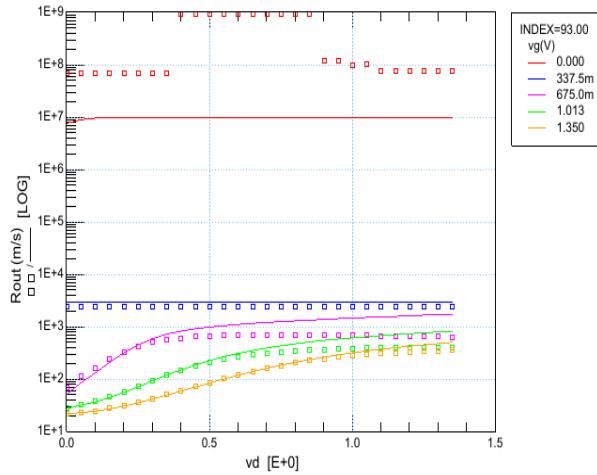
IdVd, T = 27°C



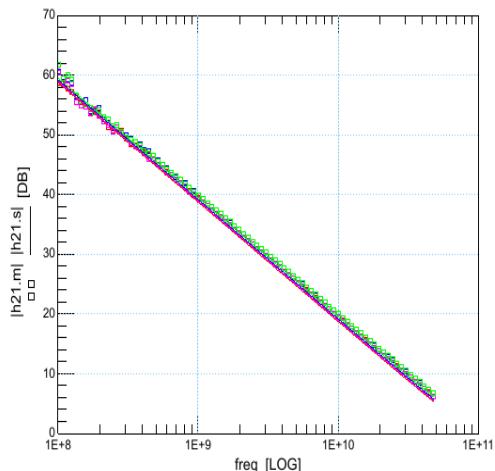
$$Id = f(Vd)$$



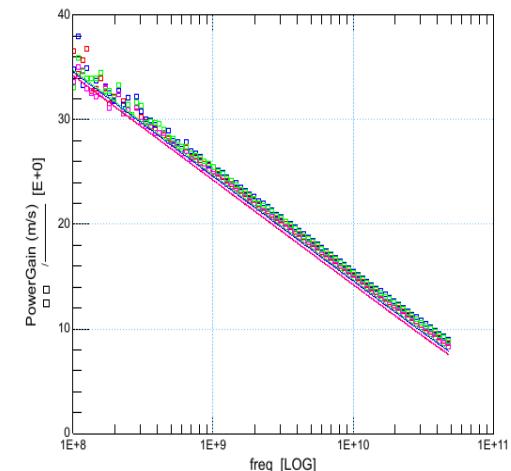
$$gds = f(Vd)$$



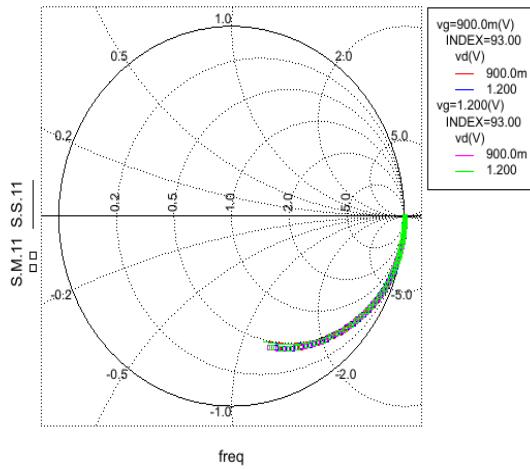
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

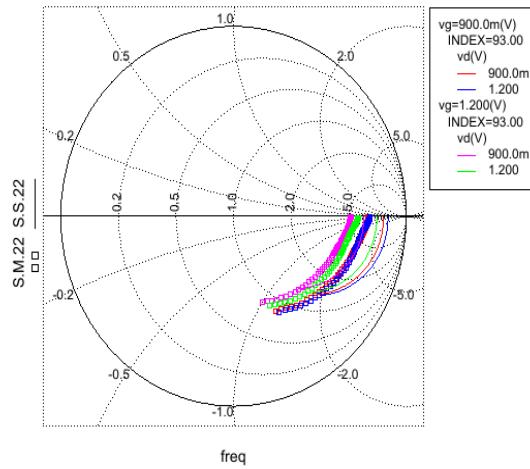
$$|h21| = f(Vg, Vd)$$



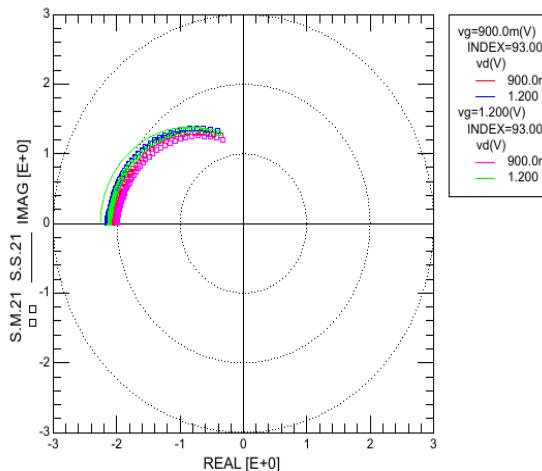
$$MSG/MAG = f(Vg, Vd)$$



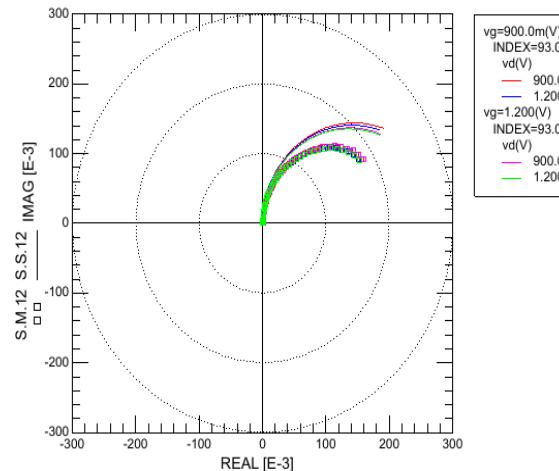
$$S11 = f(Vg, Vd)$$



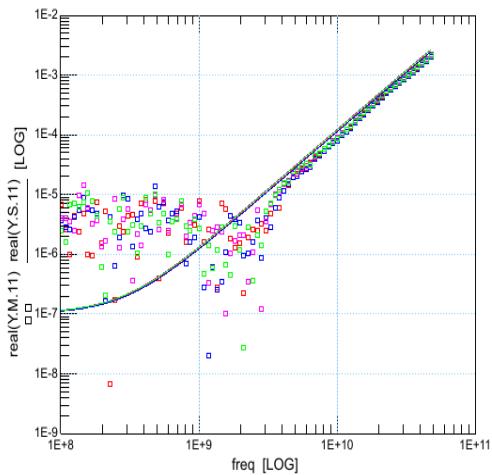
$$S22 = f(Vg, Vd)$$



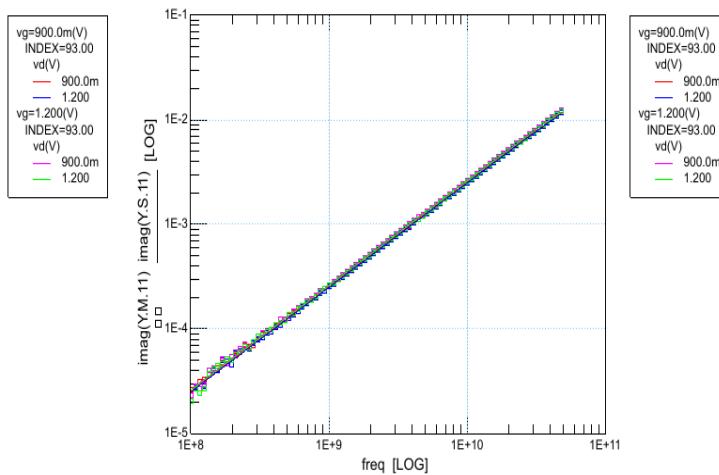
$$S21 = f(Vg, Vd)$$



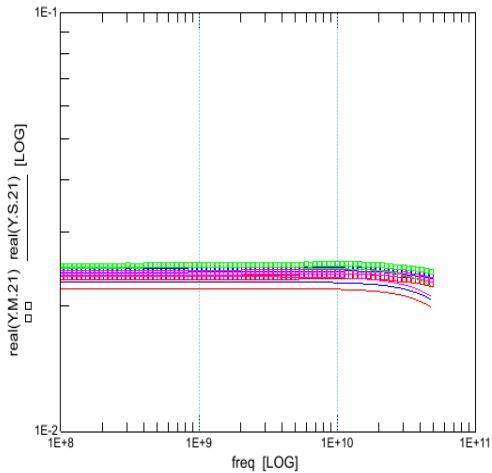
$$S12 = f(Vg, Vd)$$

Y-Parameter, T = 27°C

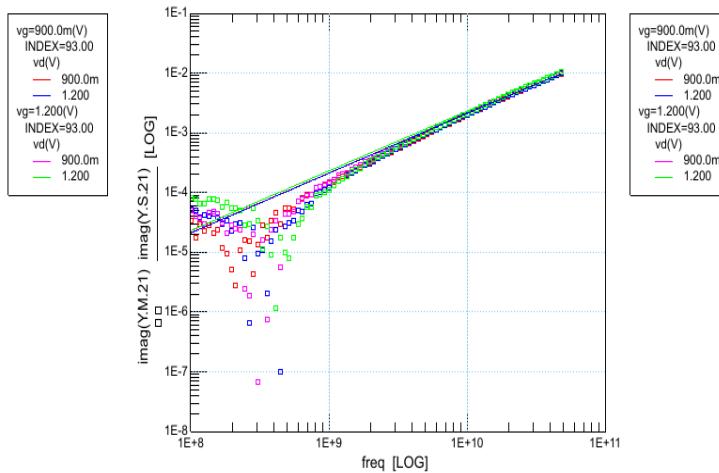
$$\text{re}(Y11) = f(Vg, Vd)$$



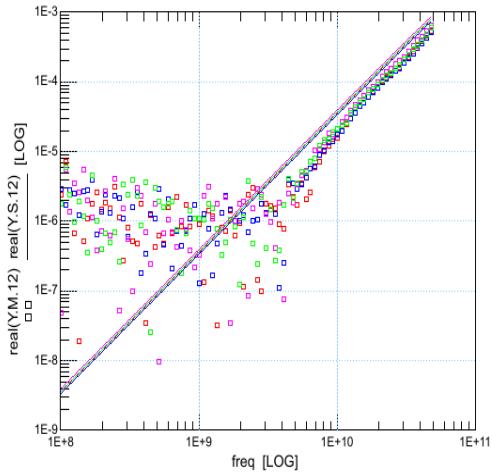
$$\text{im}(Y11) = f(Vg, Vd)$$



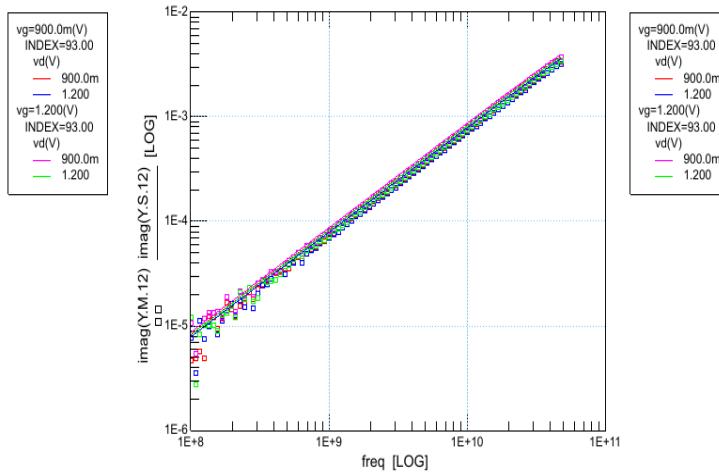
$$\text{re}(Y21) = f(Vg, Vd)$$



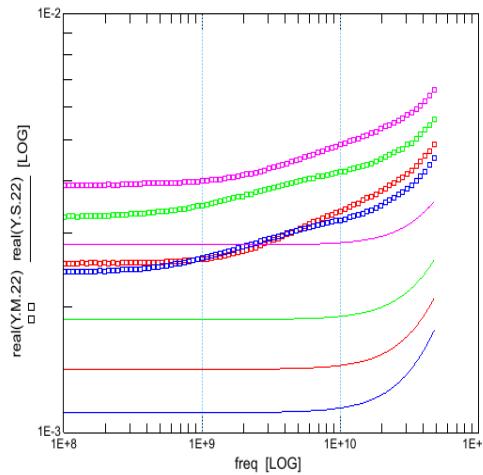
$$\text{im}(Y21) = f(Vg, Vd)$$



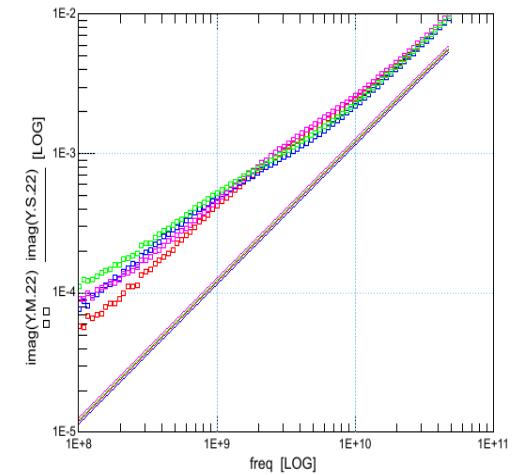
$$\text{re}(Y12) = f(Vg, Vd)$$



$$\text{im}(Y12) = f(Vg, Vd)$$

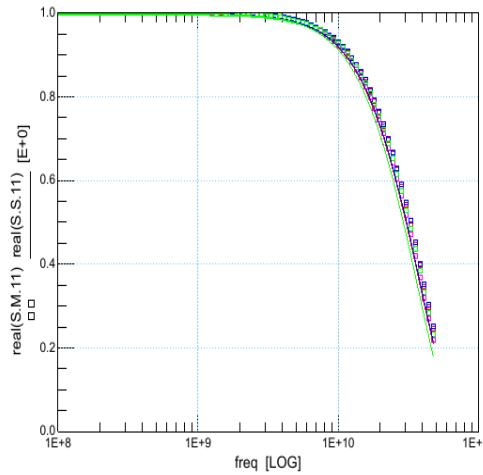


$$\text{real}(Y_{22}) = f(V_g, V_d)$$

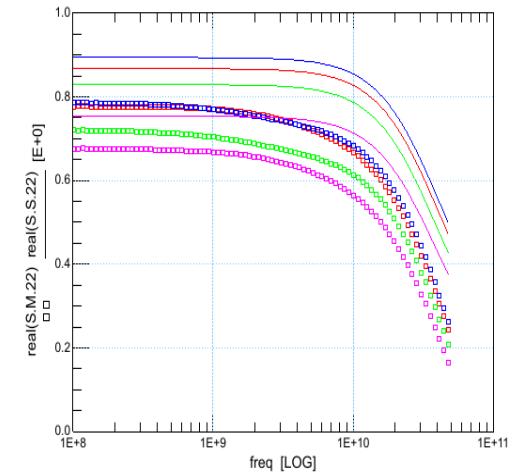


$$\text{imag}(Y_{22}) = f(V_g, V_d)$$

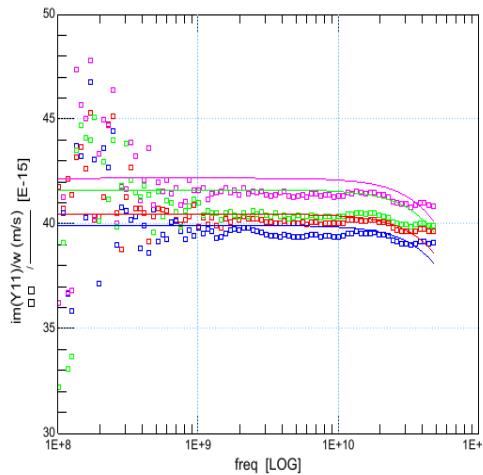
Verify Plots, $T = 27^\circ\text{C}$



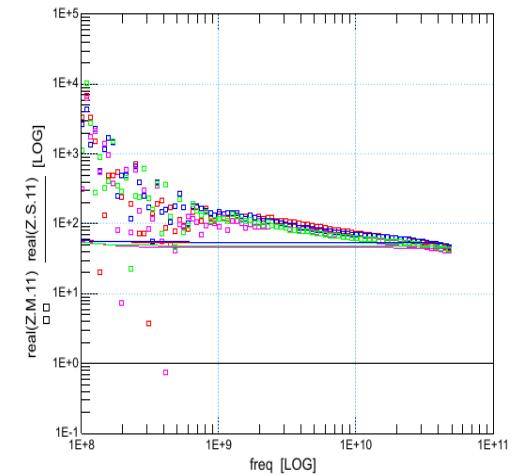
$$\text{real}(S_{11}) = f(V_g, V_d)$$



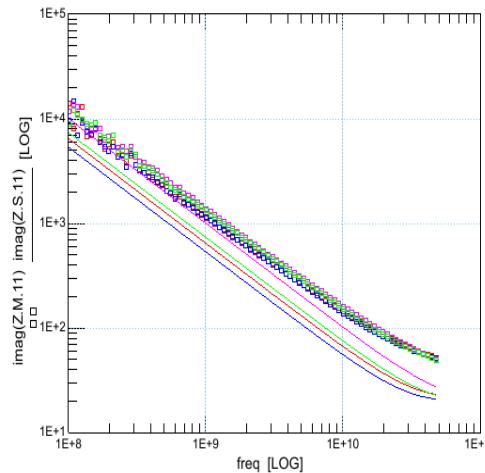
$$\text{real}(S_{22}) = f(V_g, V_d)$$



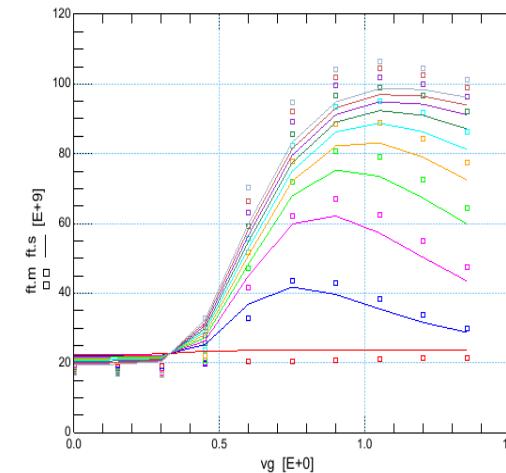
$$\text{im}(Y_{11}) \text{ divided by } \omega$$



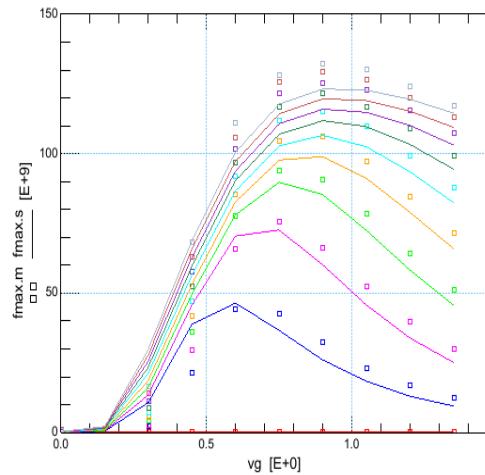
$$\text{real}(Z_{11}) = f(V_g, V_d)$$



im(Z11) = f(Vg,Vd)



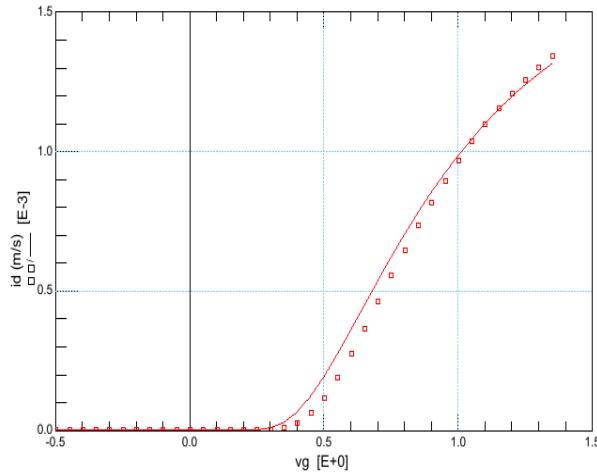
fT_vg = f(Vg,Vd)



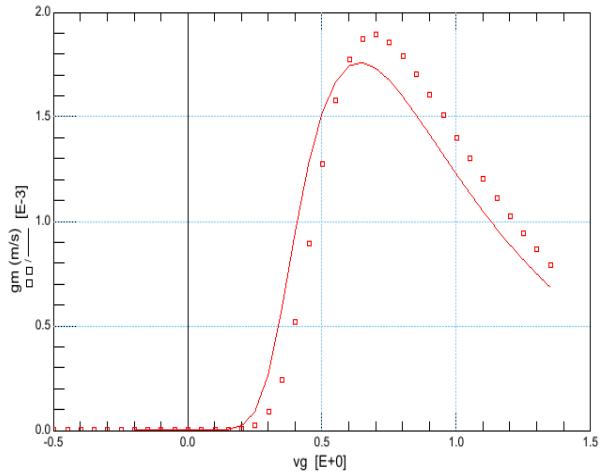
fmax_vg = f(Vg,Vd)

4.13NF04_WF05u0_L0u18_post_22

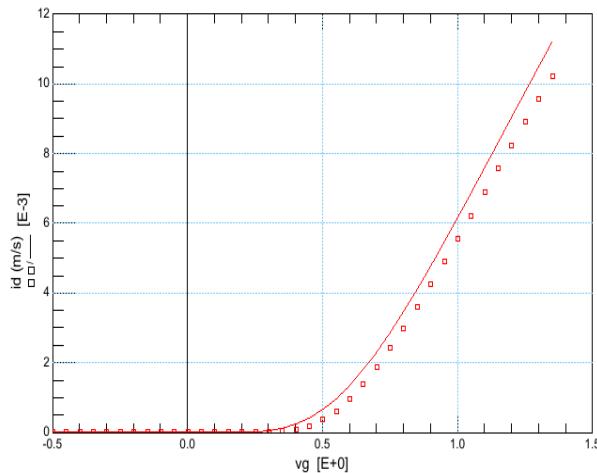
$IdVg$, $T = 27^\circ\text{C}$



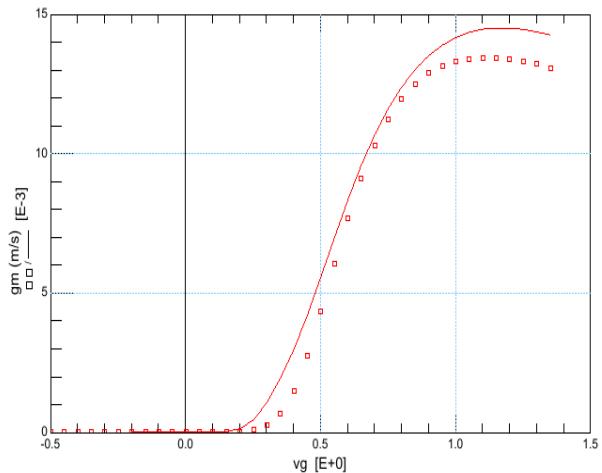
$Id = f(Vg)$ @ $Vd = 0.05V$



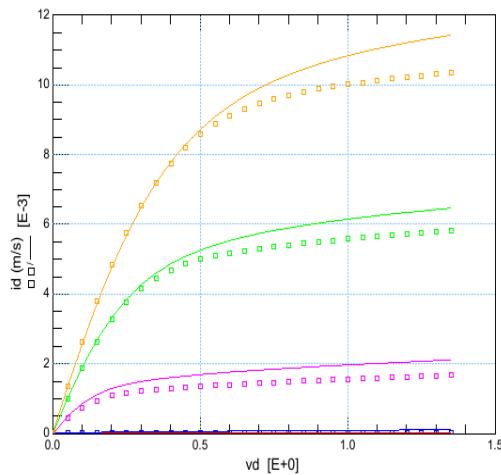
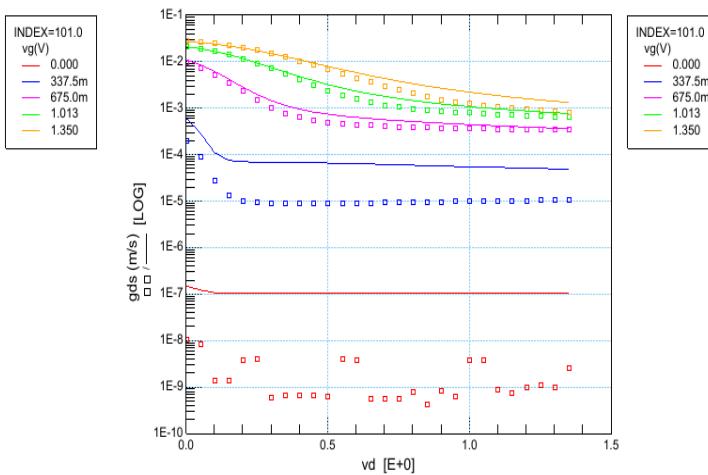
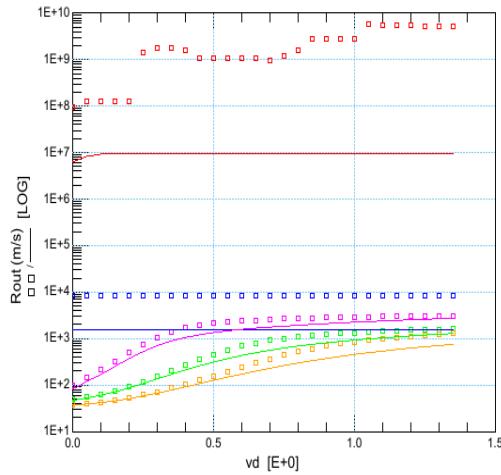
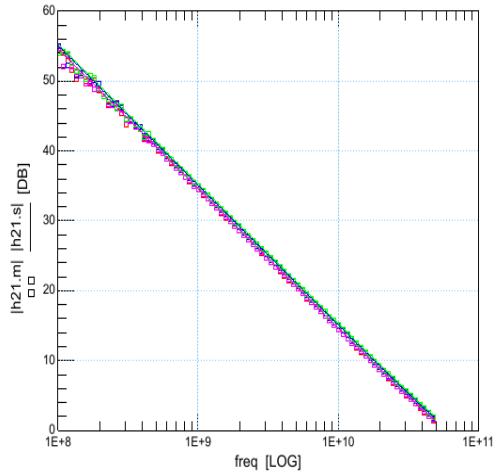
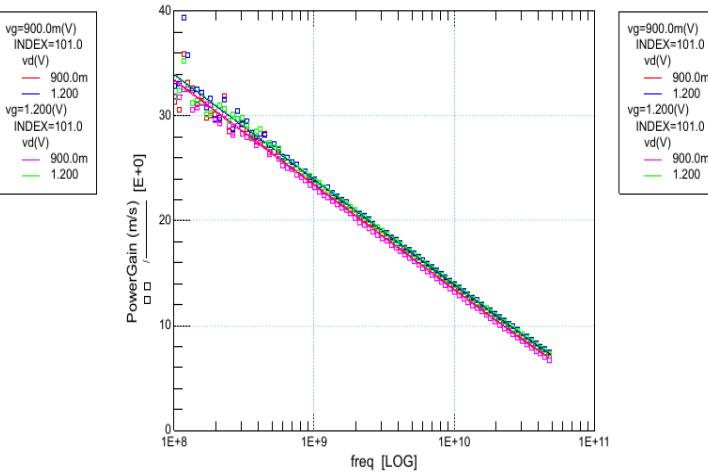
$gm = f(Vg)$ @ $Vd = 0.05V$

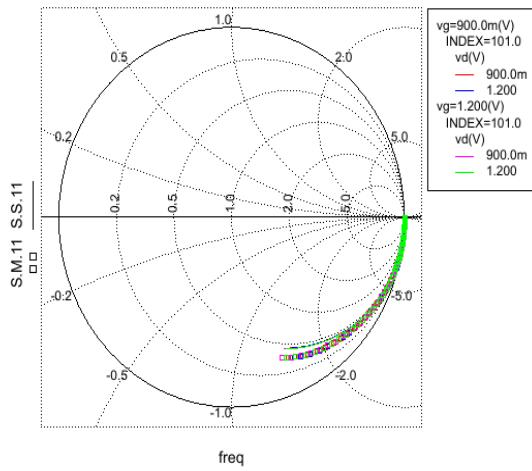
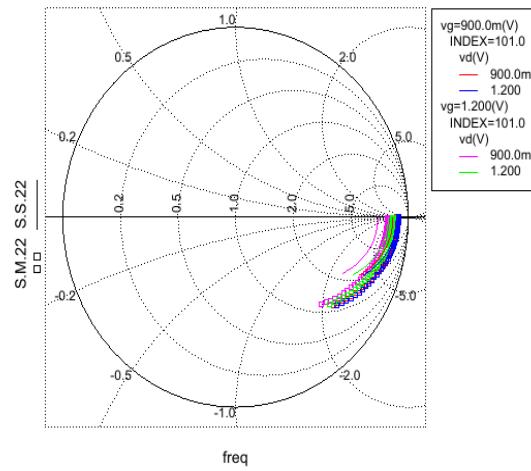
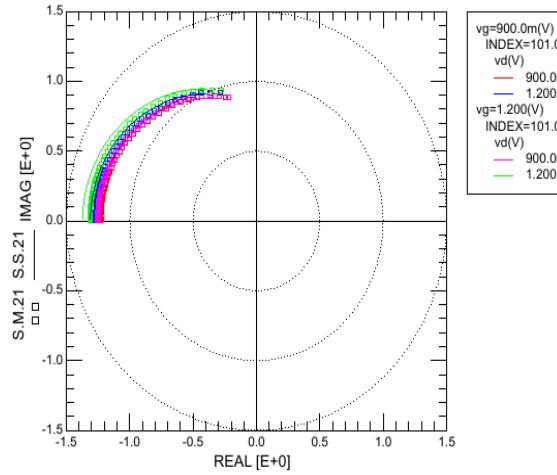
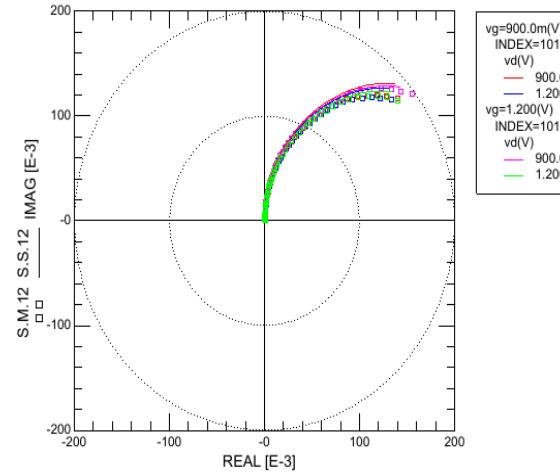


$Id = f(Vg)$ @ $Vd = 1.2V$

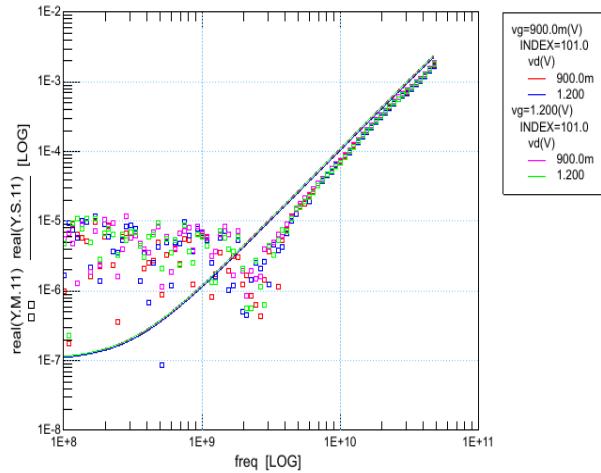
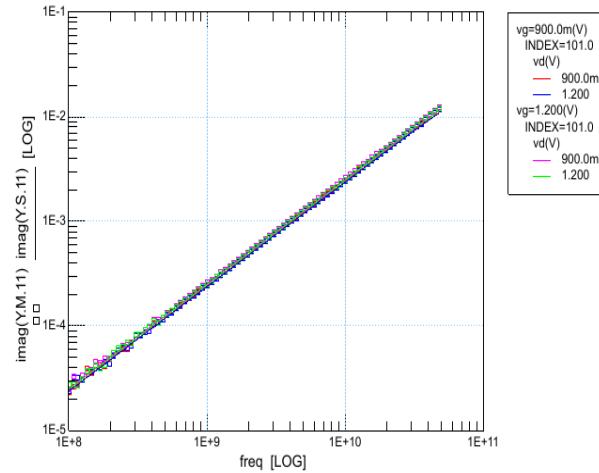


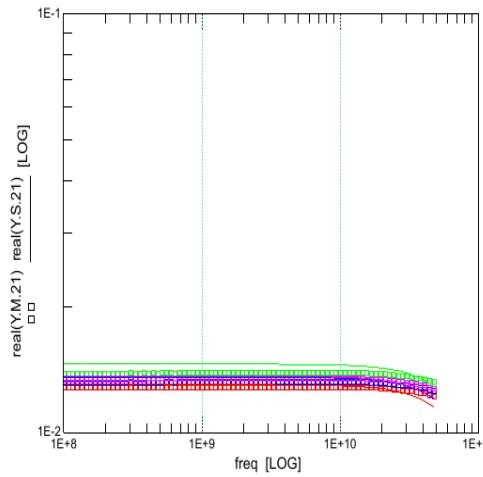
$gm = f(Vg)$ @ $Vd = 1.2V$

IdVd, T = 27°C $Id = f(Vd)$  $gds = f(Vd)$  $Rout = f(Vd)$ **S-Parameter, T = 27°C** $|h21| = f(Vg, Vd)$  $MSG/MAG = f(Vg, Vd)$

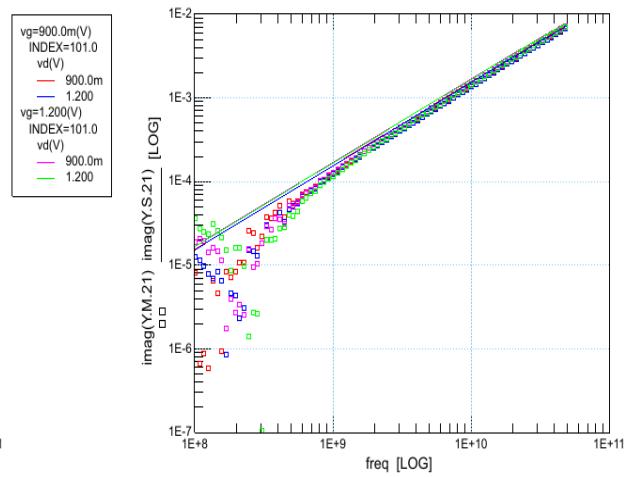
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

Y-Parameter, T = 27°C

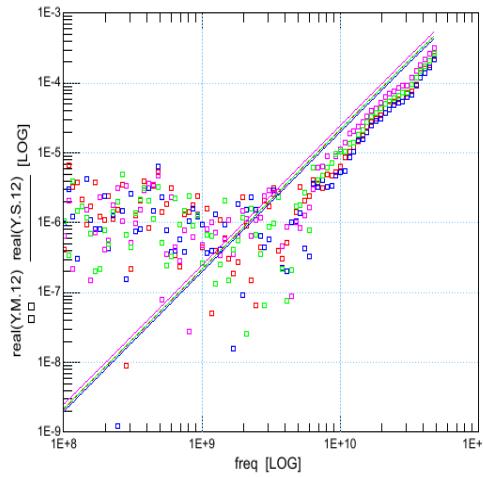
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



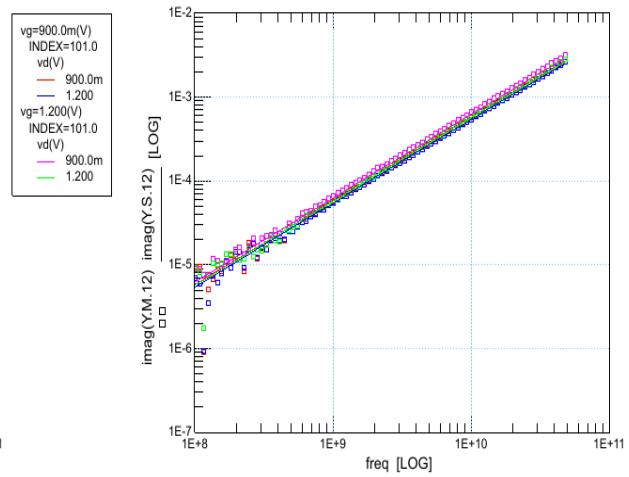
re(Y21) = f(Vg,Vd)



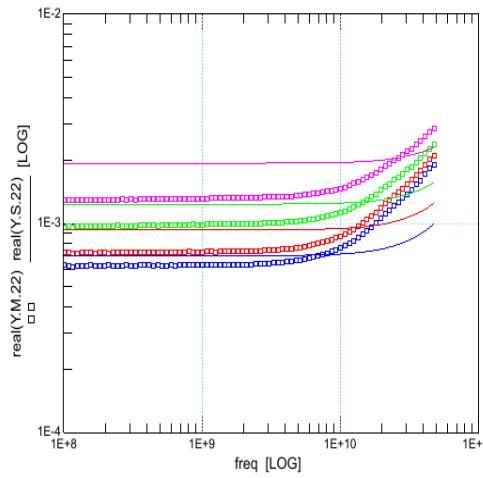
im(Y21) = f(Vg,Vd)



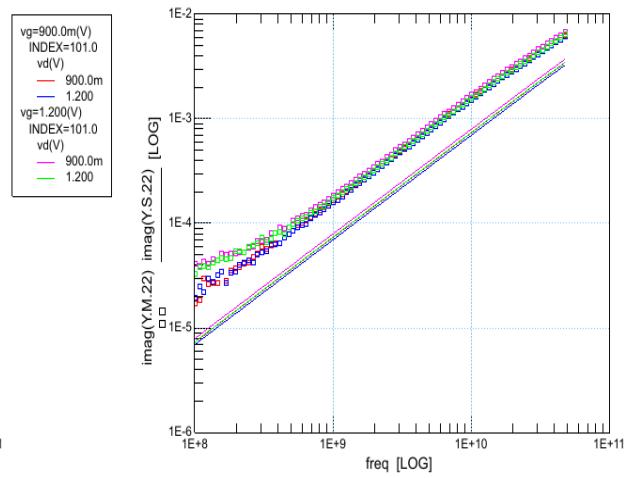
re(Y12) = f(Vg,Vd)



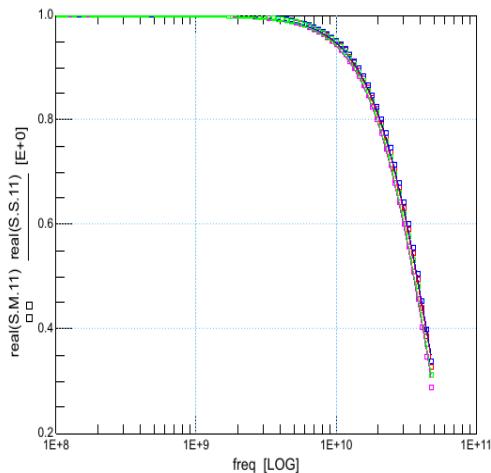
im(Y12) = f(Vg,Vd)



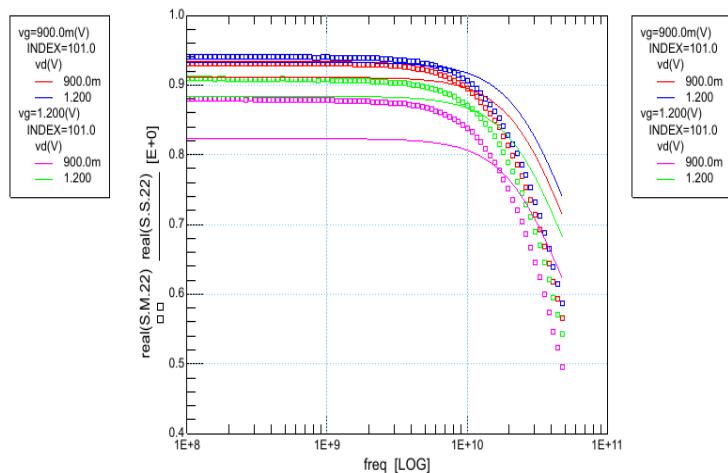
re(Y22) = f(Vg,Vd)



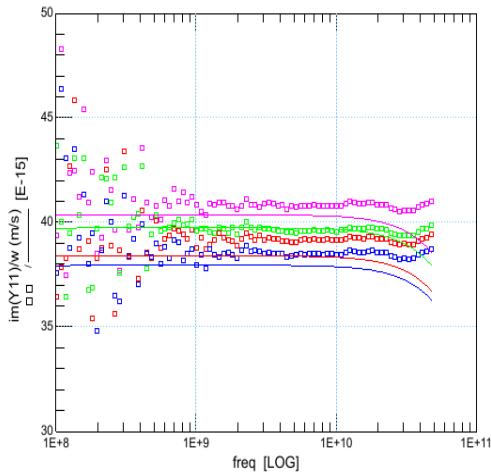
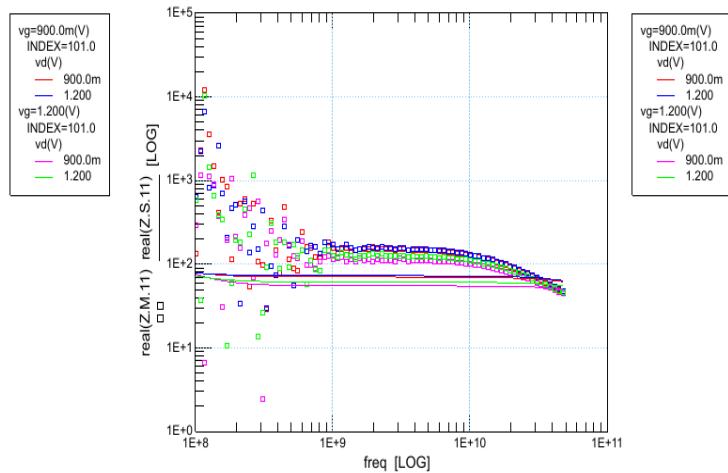
im(Y22) = f(Vg,Vd)

Verify Plots, $T = 27^\circ\text{C}$ 

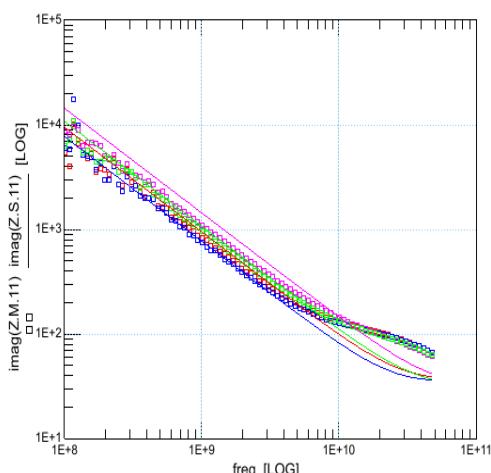
re(S11) = f(Vg, Vd)



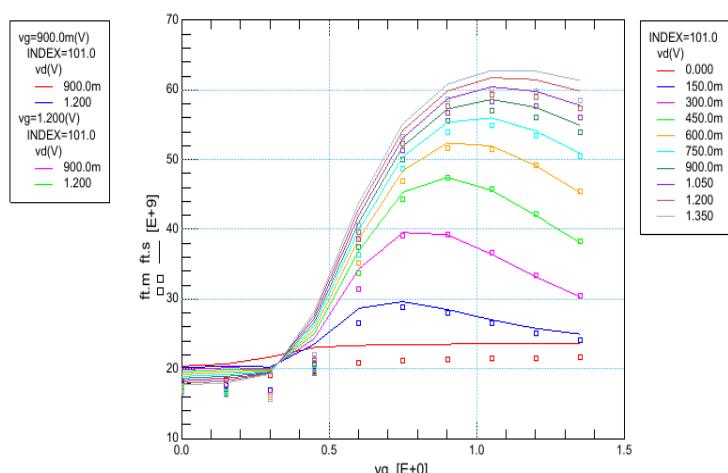
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

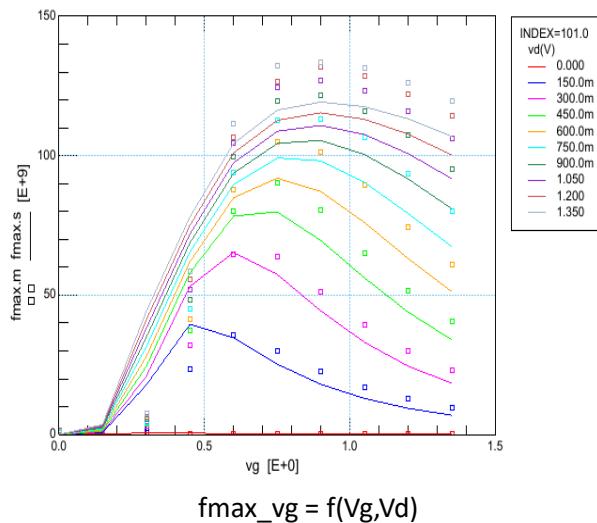
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

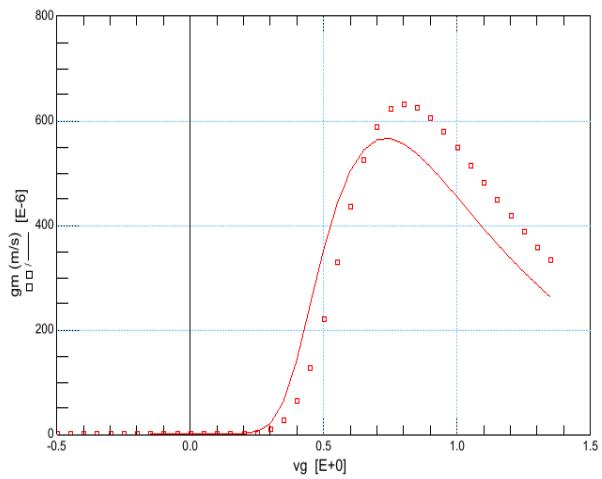
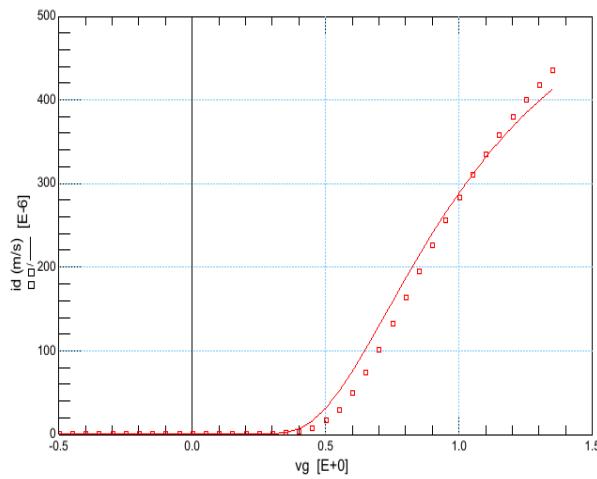


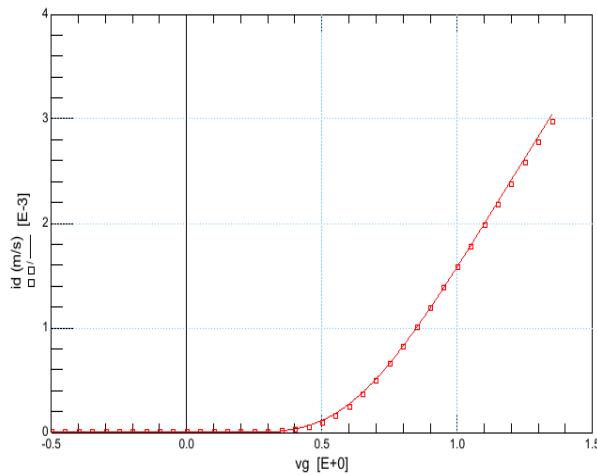
fT_vg = f(Vg, Vd)



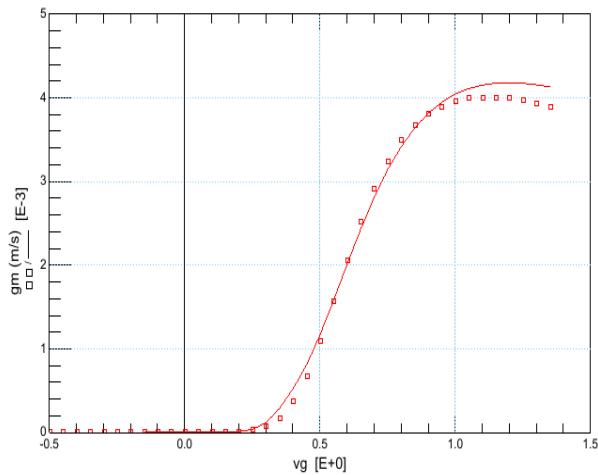
4.14 NF01_WF05u0_L0u13_S453A_54

$I_d V_g, T = 27^\circ C$



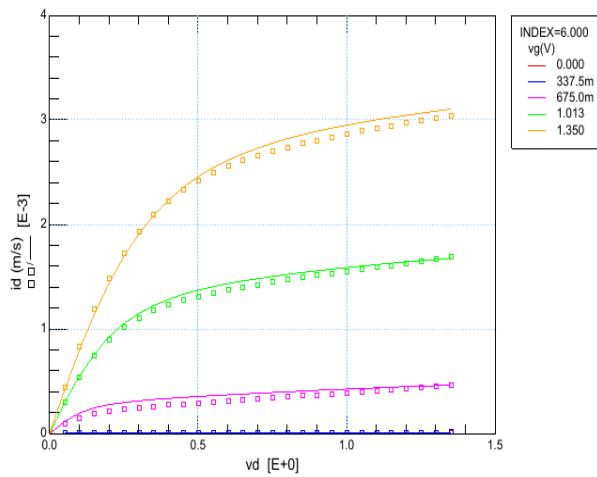


$$Id = f(Vg) @ Vd = 1.2V$$

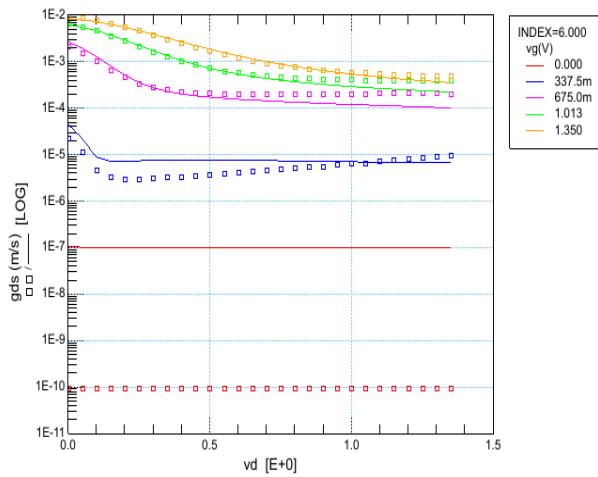


$$gm = f(Vg) @ Vd = 1.2V$$

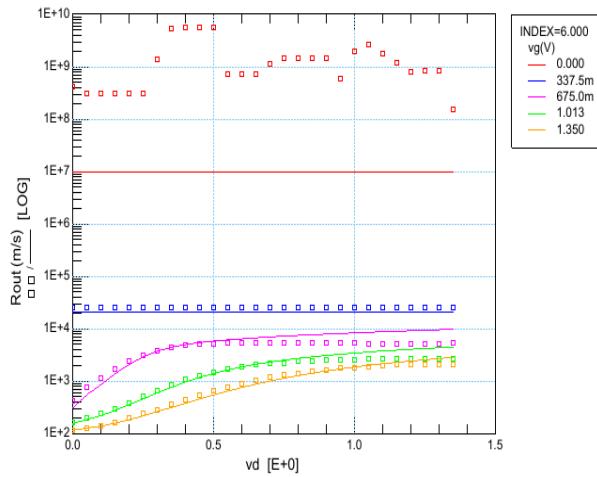
IdVd, T = 27°C



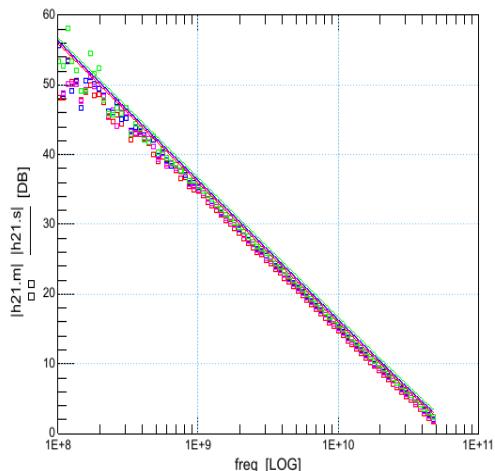
$$Id = f(Vd)$$



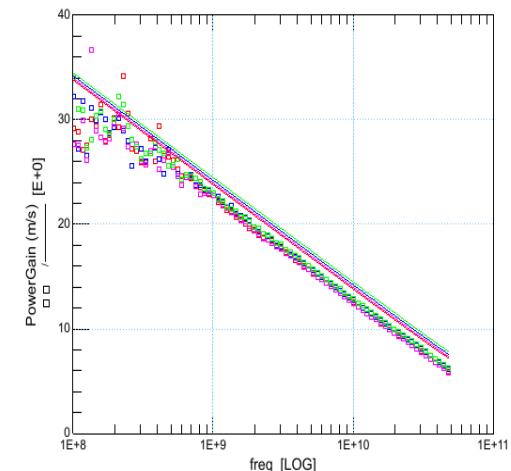
$$gds = f(Vd)$$



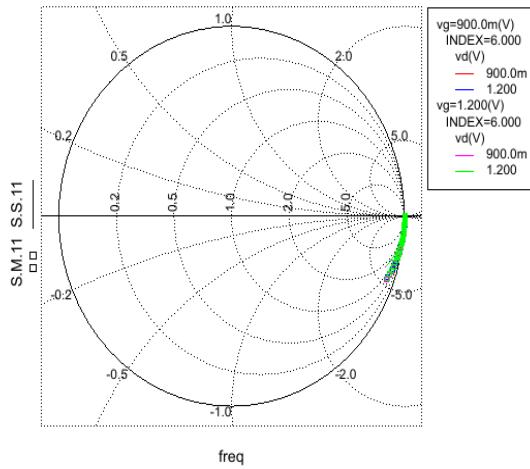
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

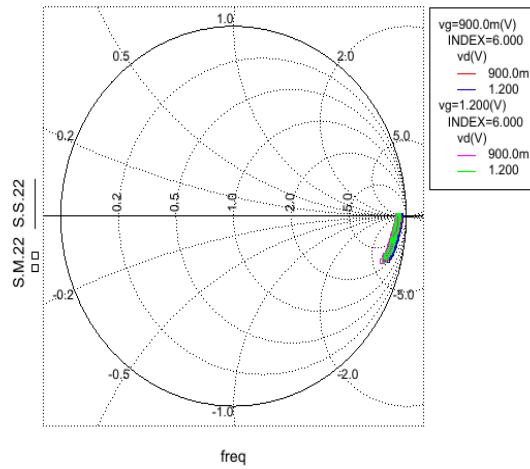
$$|h21| = f(Vg, Vd)$$



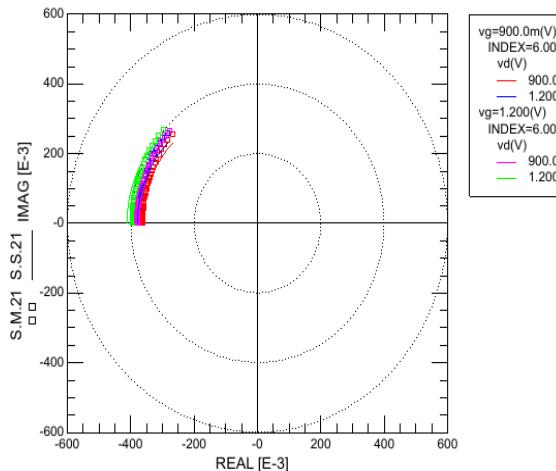
$$MSG/MAG = f(Vg, Vd)$$



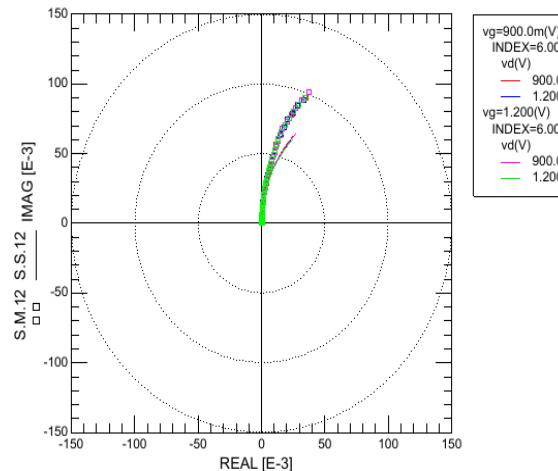
$$S11 = f(Vg, Vd)$$



$$S22 = f(Vg, Vd)$$

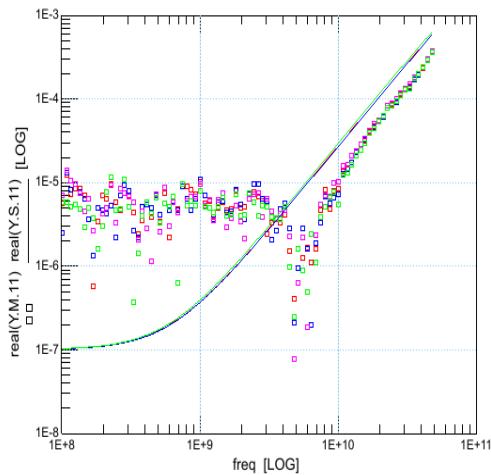


$$S21 = f(Vg, Vd)$$

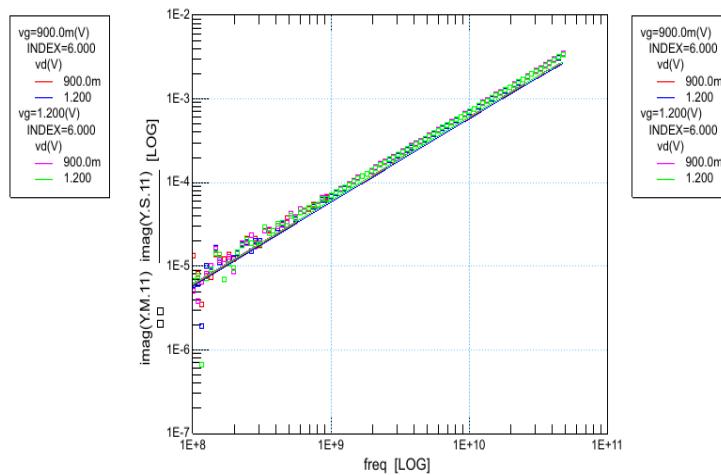


$$S12 = f(Vg, Vd)$$

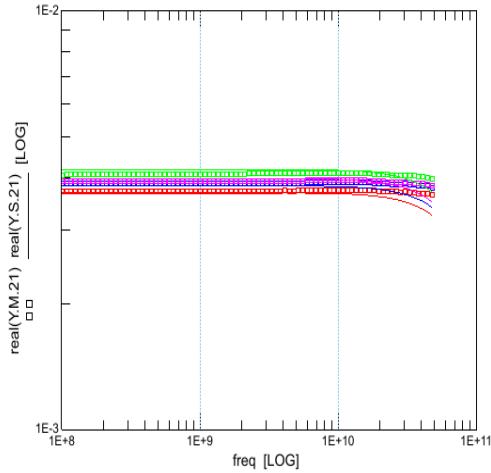
Y-Parameter, T = 27°C



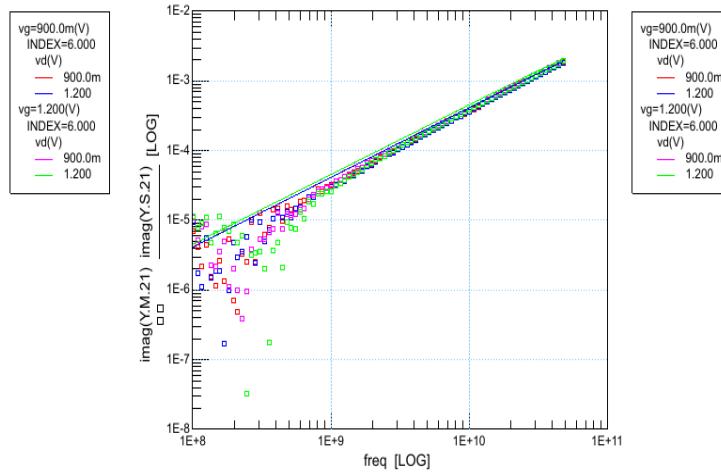
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



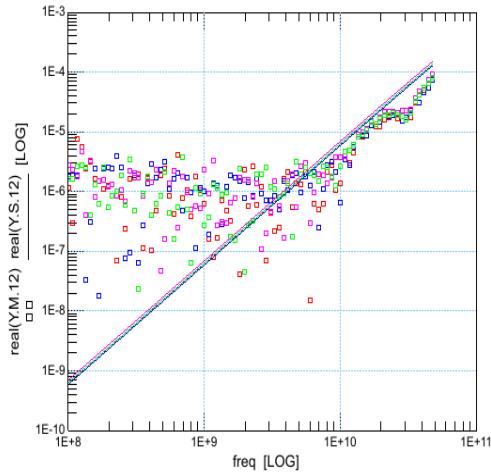
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



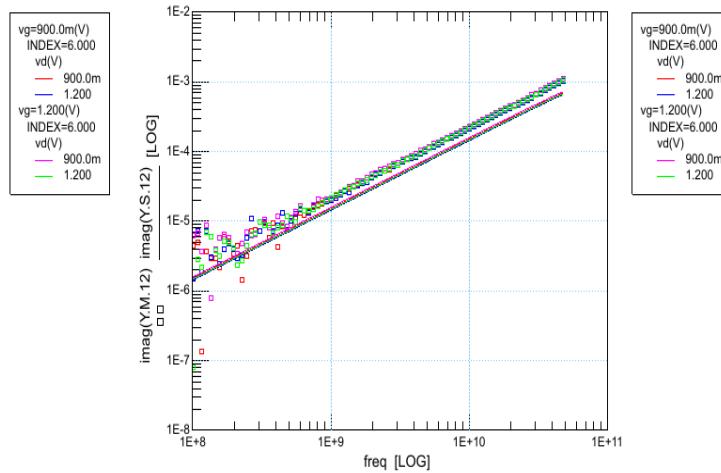
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



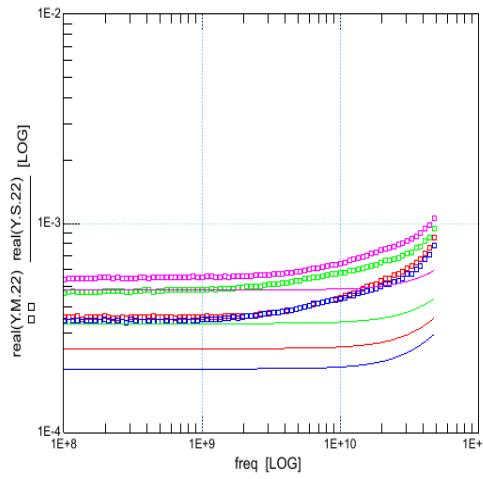
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



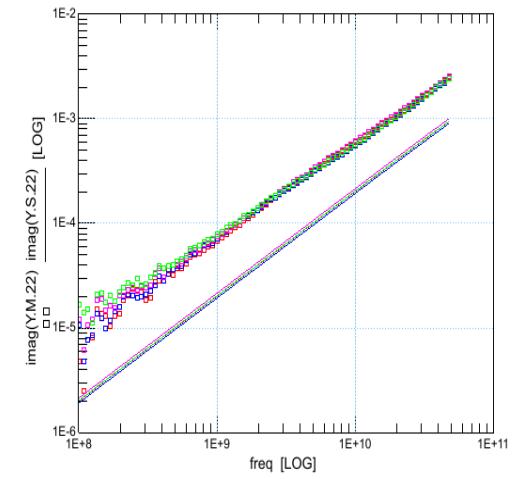
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



$$\text{im}(Y_{12}) = f(V_g, V_d)$$

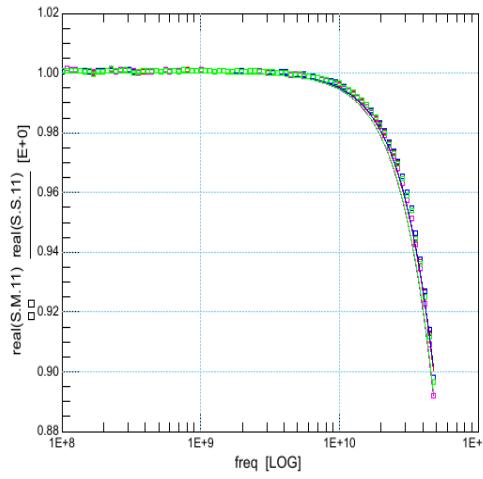


$$\text{re}(Y22) = f(Vg, Vd)$$

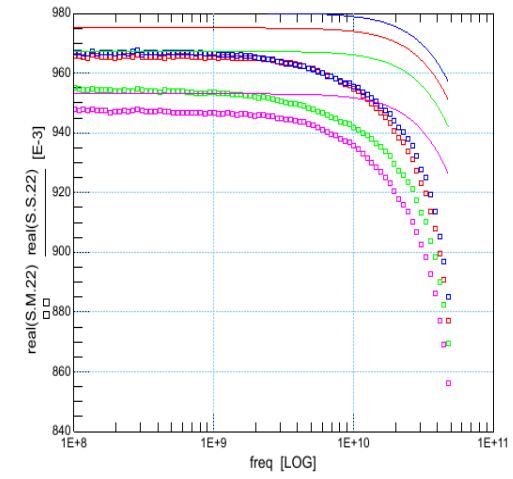


$$\text{im}(Y22) = f(Vg, Vd)$$

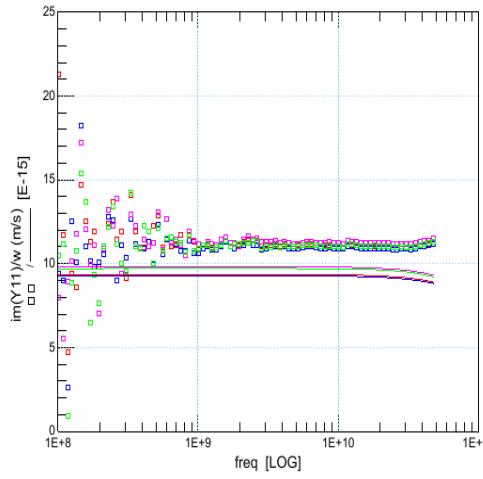
Verify Plots, T = 27°C



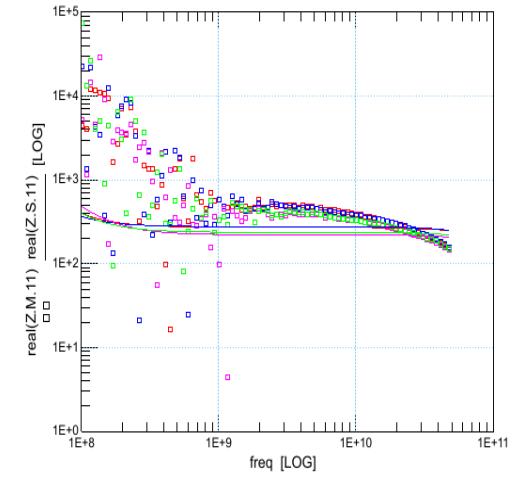
$$\text{re}(S11) = f(Vg, Vd)$$



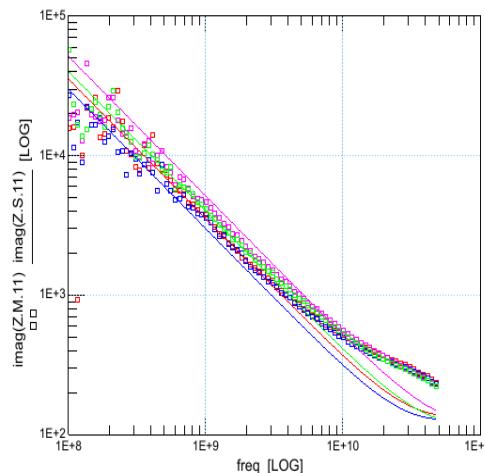
$$\text{re}(S22) = f(Vg, Vd)$$



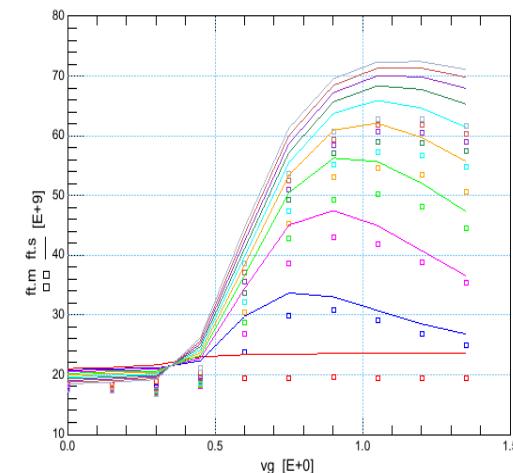
$$\text{im}(Y11) \text{ divided by } \omega$$



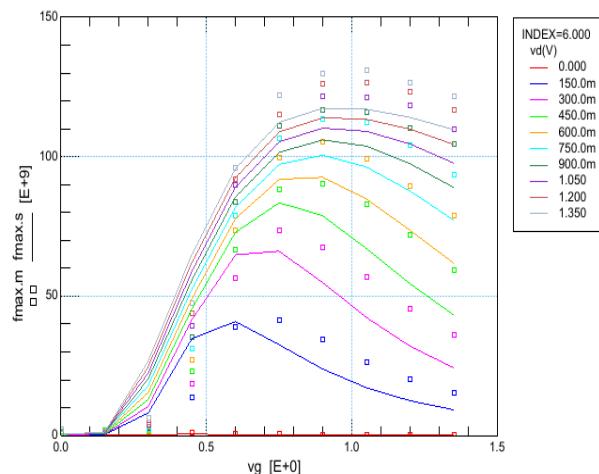
$$\text{re}(Z11) = f(Vg, Vd)$$



im(Z11) = f(Vg,Vd)



fT_vg = f(Vg,Vd)



fmax_vg = f(Vg,Vd)

5 Flicker Noise

Flicker noise model parameters are taken from the SG13 simulation models.

5.1 *Measurement Conditions*

Not defined as no flicker noise measurements are yet done on SG13G2 devices.

5.2 *Devices*

Not defined as no flicker noise measurements are yet done on SG13G2 devices.

6 Change History

Revision	Device	Changes
190606	All	Initial version
190730	All	Adjust temperature and RF behavior
190924	Summarized Results	Legend added