
IHP

SG13G2

SG13G2 DC CV NMOS LV RF

Rev. 1.2 (190924)

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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
W0u15_L0u14_S546_4	150 m	140	101 m	101 m	1.3 4	1.3 4	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
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

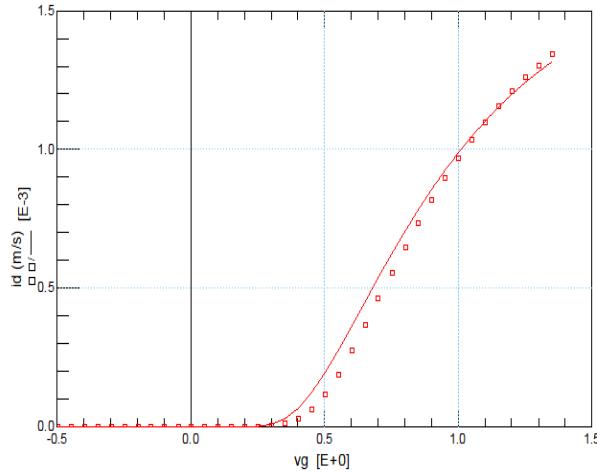
3.1.4 W = 150.0n, L = 10.00u, NF = 1

	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

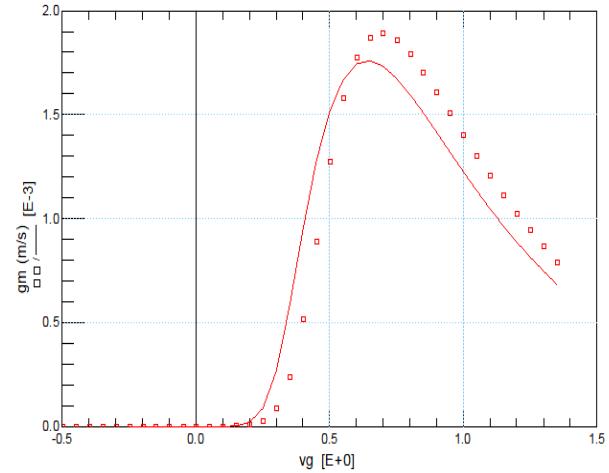
4 RF Transistors

4.1 NF04_WF05u0_L0u18_S453A_22

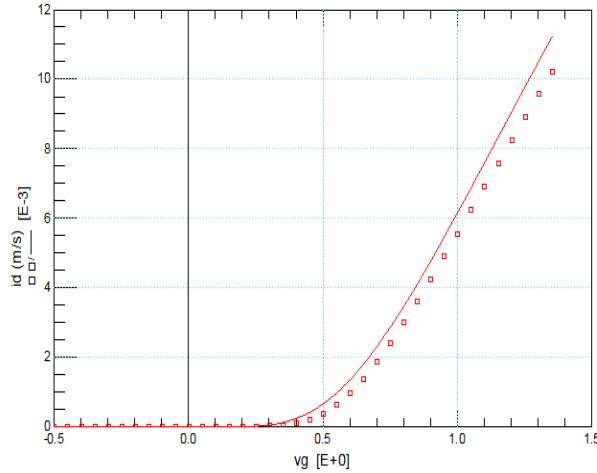
$IdVg$, $T = 27^\circ\text{C}$



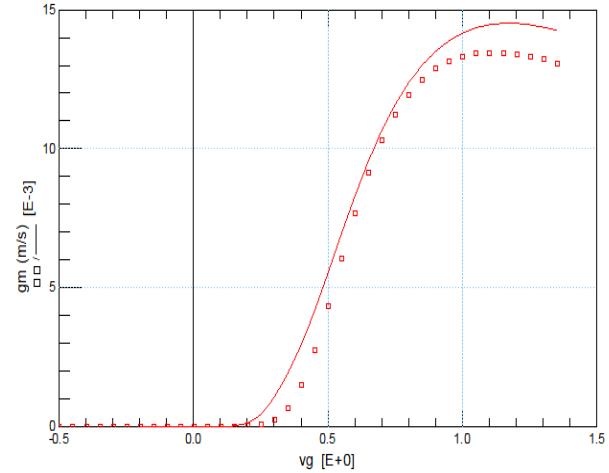
$$Id = f(Vg) @ Vd = 0.05\text{V}$$



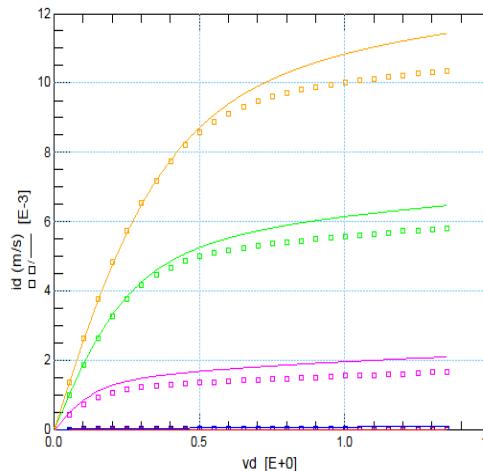
$$gm = f(Vg) @ Vd = 0.05\text{V}$$



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

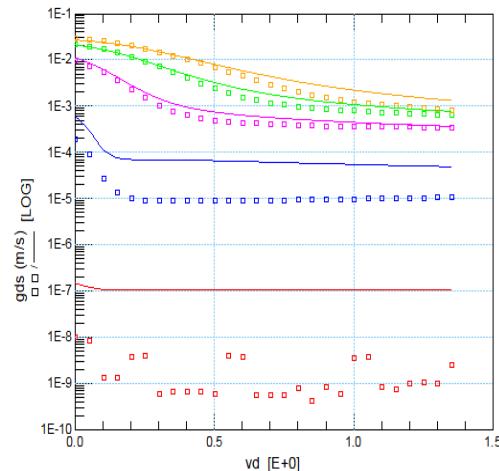


$$gm = f(Vg) @ Vd = 1.2\text{V}$$

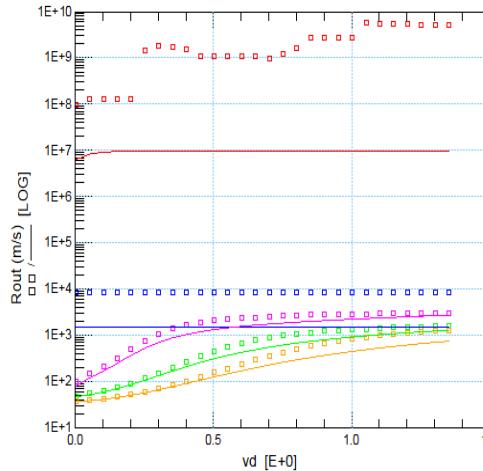
IdVd, T = 27°C

$$Id = f(Vd)$$

INDEX=1.000
vg(V)
0.000
337.5m
675.0m
1.013
1.350

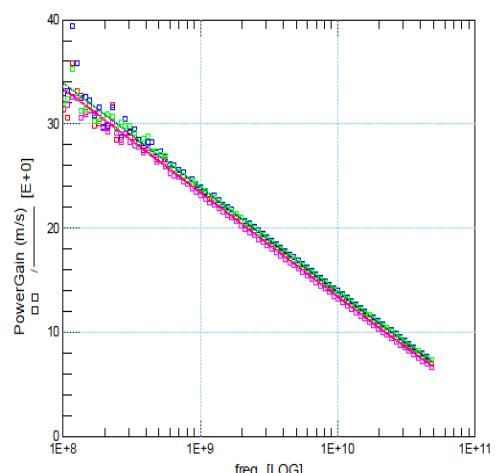


$$gds = f(Vd)$$

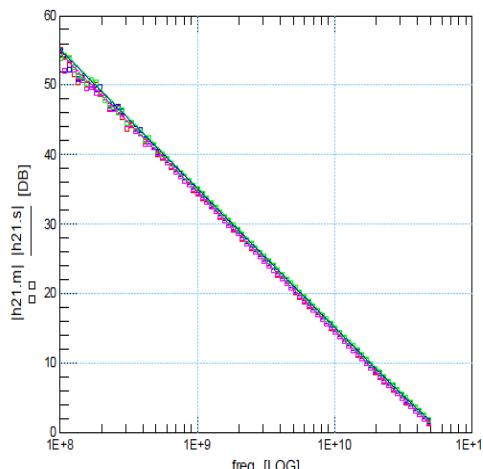


$$Rout = f(Vd)$$

INDEX=1.000
vg(V)
0.000
337.5m
675.0m
1.013
1.350

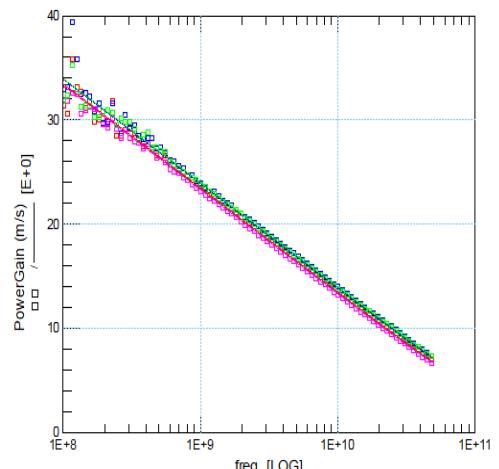


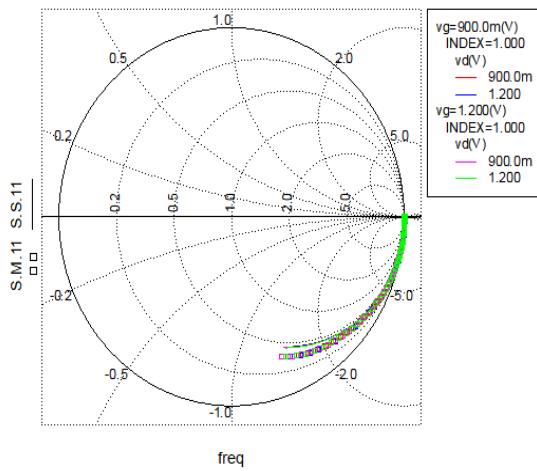
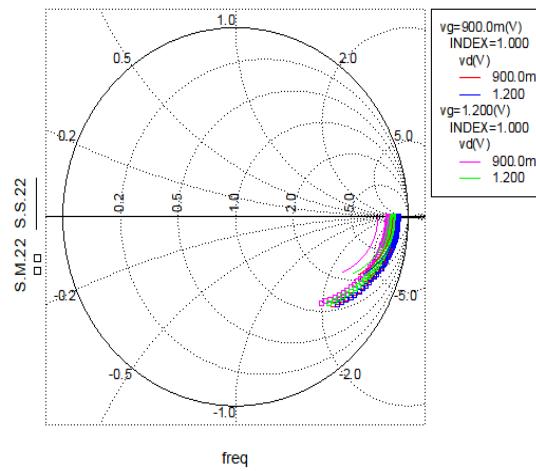
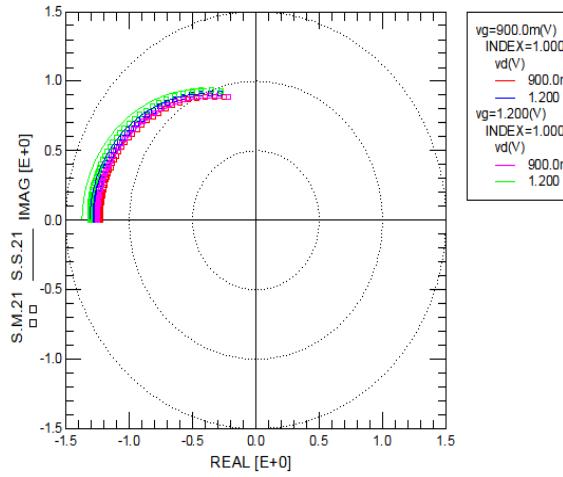
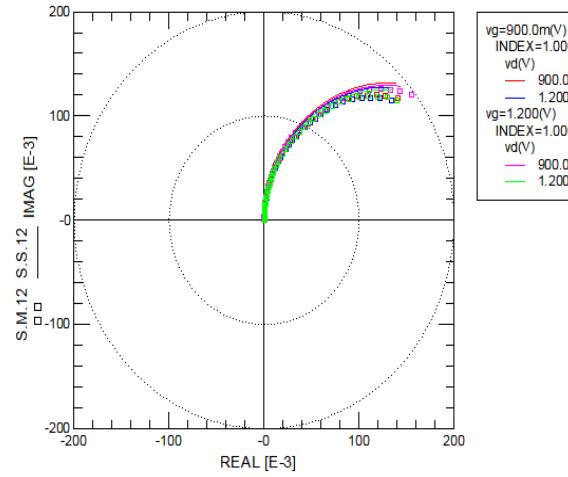
$$MSG/MAG = f(Vg,Vd)$$

S-Parameter, T = 27°C

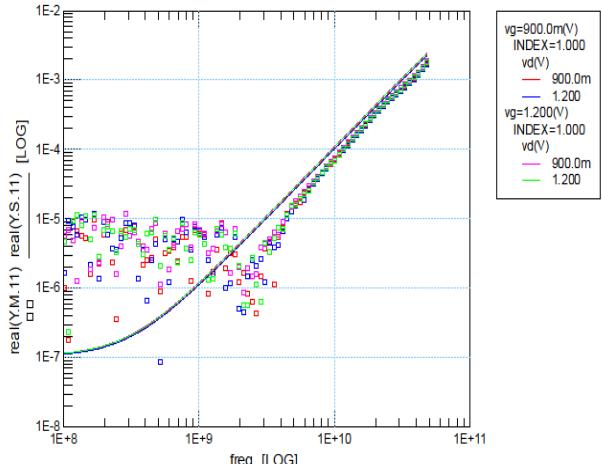
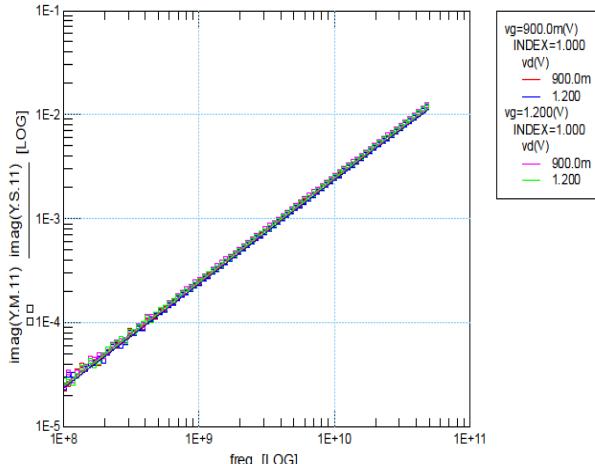
$$|h21| = f(Vg,Vd)$$

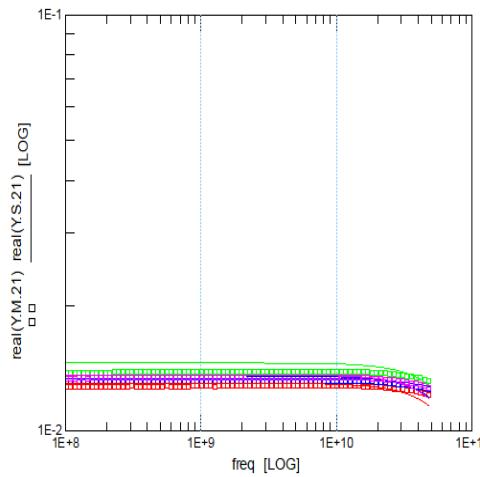
vg=900.0mV
INDEX=1.000
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=1.000
vd(V)
900.0m
1.200



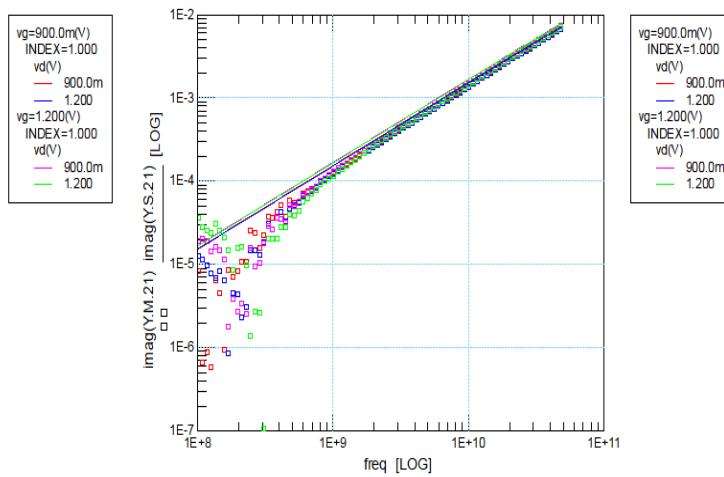
 $S_{11} = f(Vg, Vd)$  $S_{22} = f(Vg, Vd)$  $S_{21} = f(Vg, Vd)$  $S_{12} = f(Vg, Vd)$

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

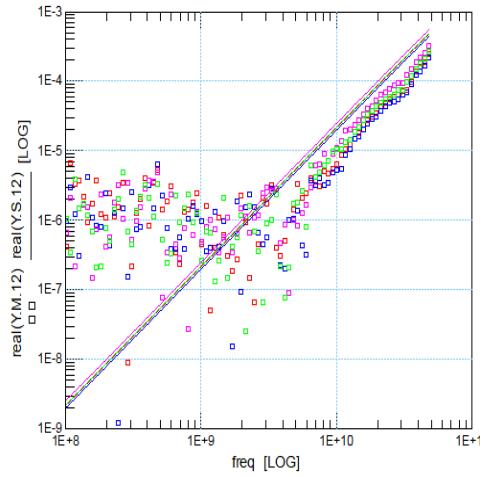
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



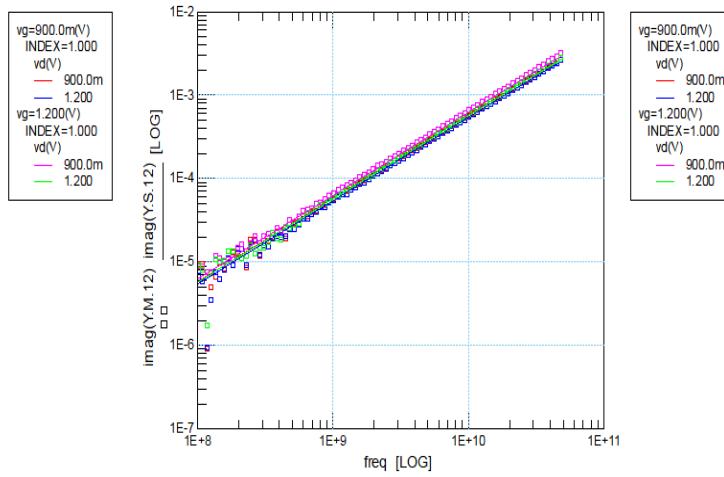
re(Y21) = f(Vg,Vd)



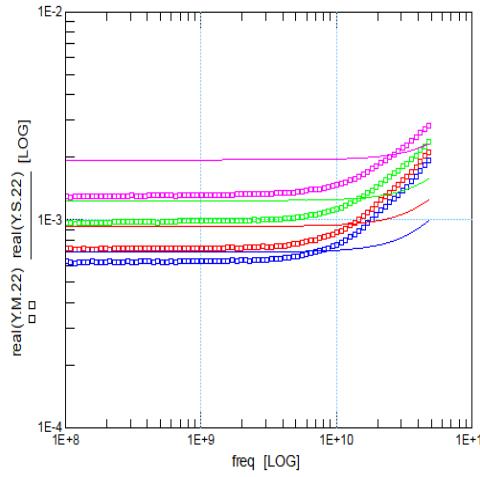
im(Y21) = f(Vg,Vd)



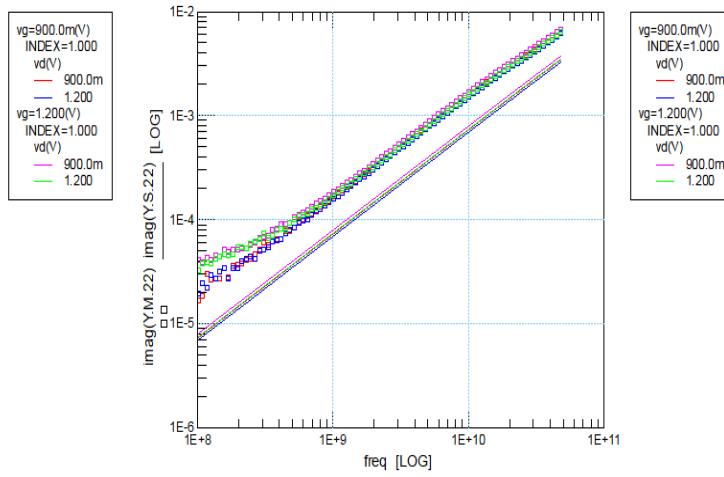
re(Y12) = f(Vg,Vd)



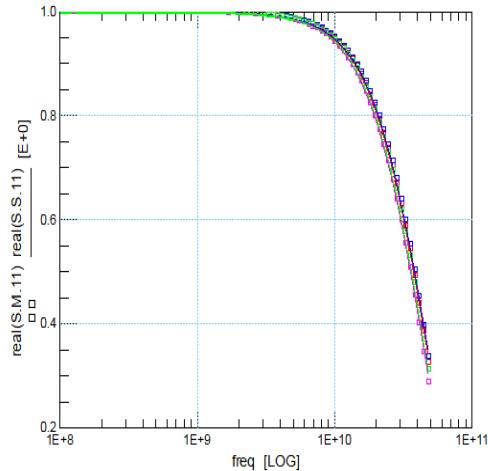
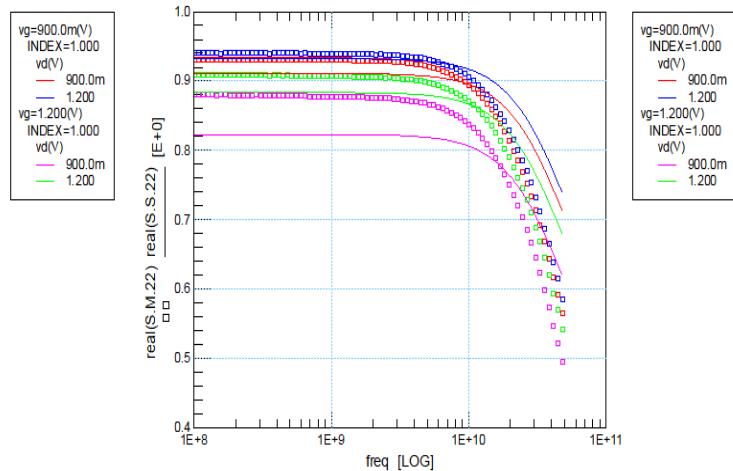
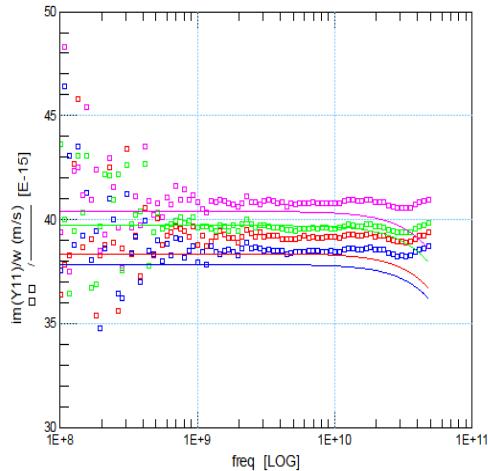
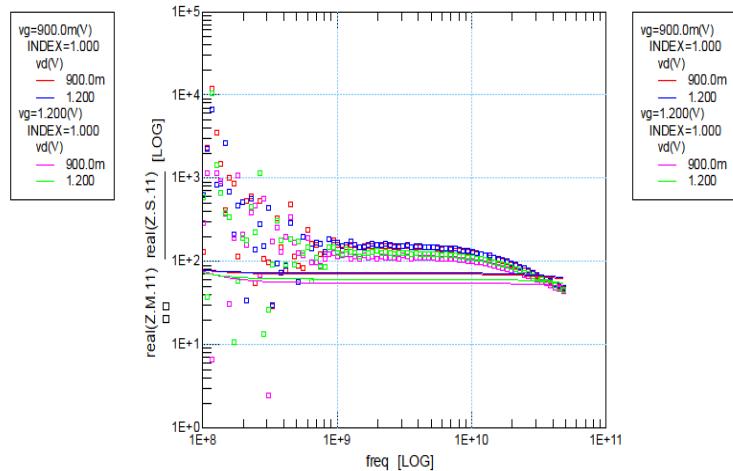
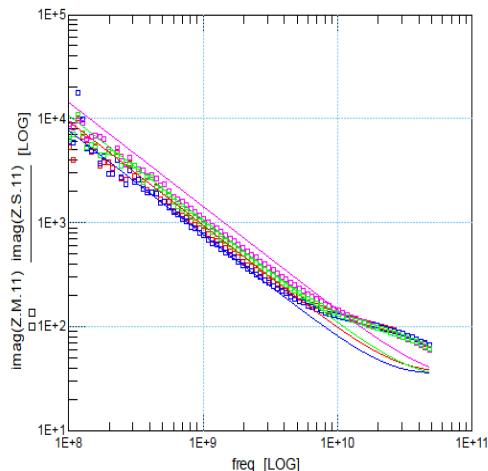
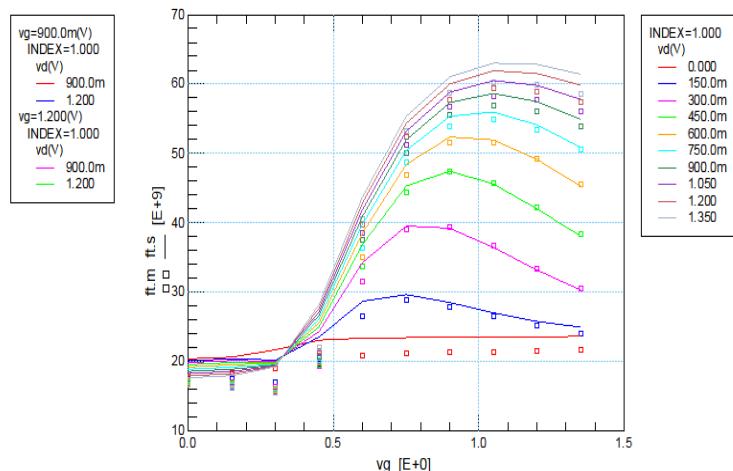
im(Y12) = f(Vg,Vd)

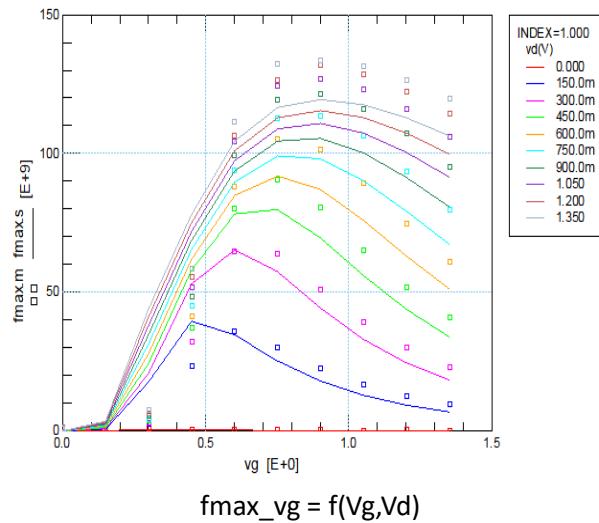


re(Y22) = f(Vg,Vd)



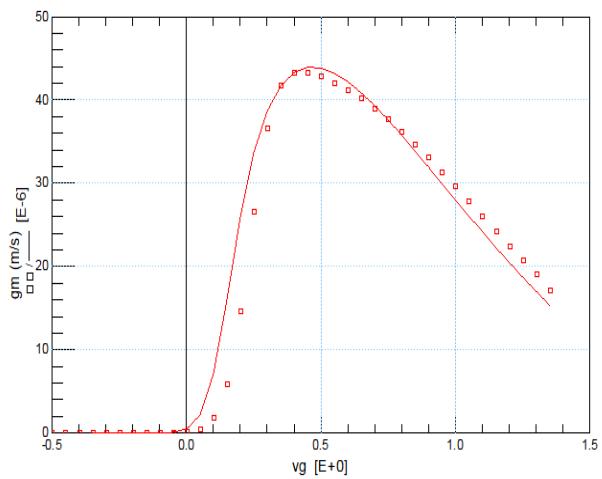
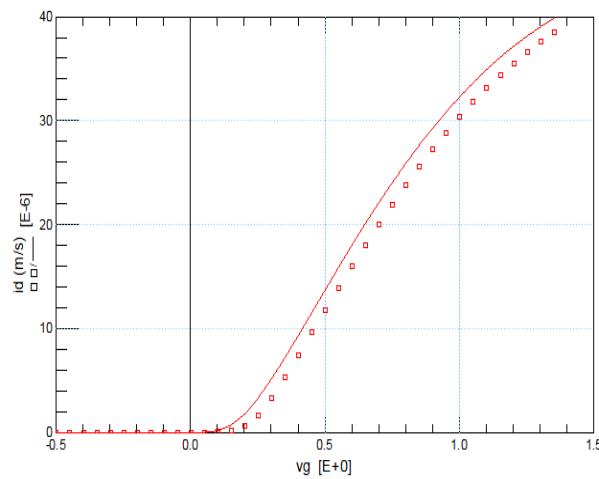
im(Y22) = f(Vg,Vd)

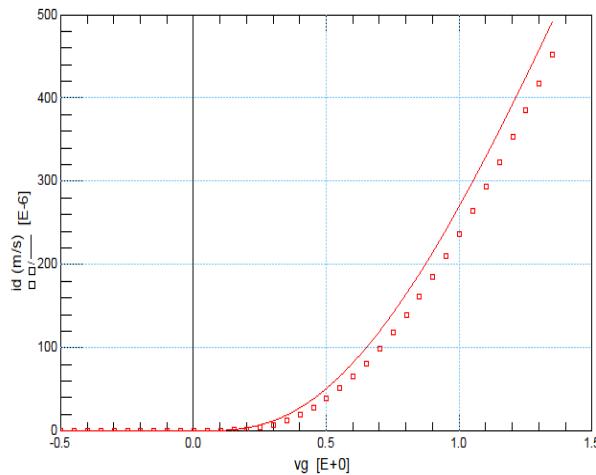
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



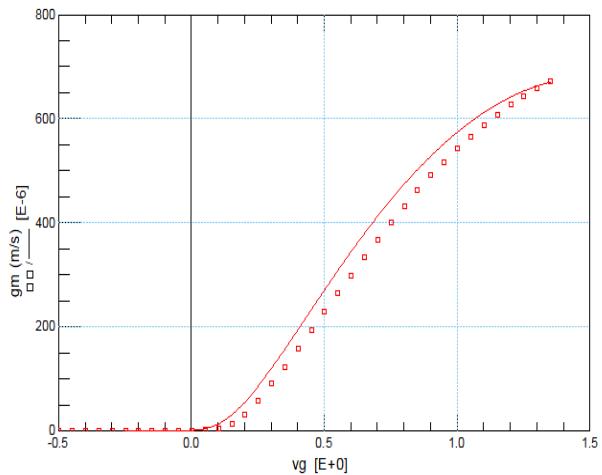
4.2 NF04_WF05u0_L10u0_S453A_10

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



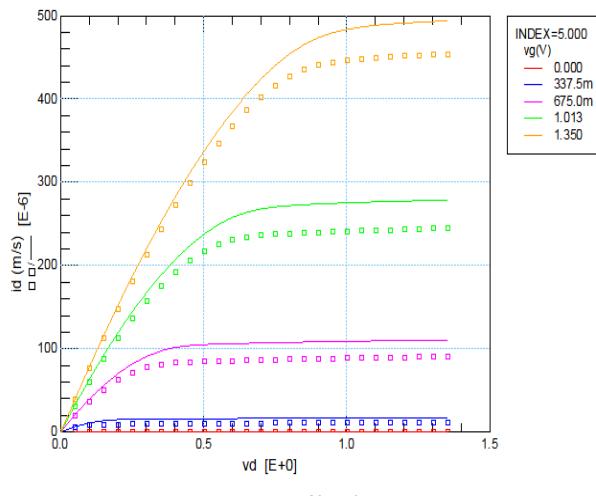


$$Id = f(Vg) @ Vd = 1.2V$$

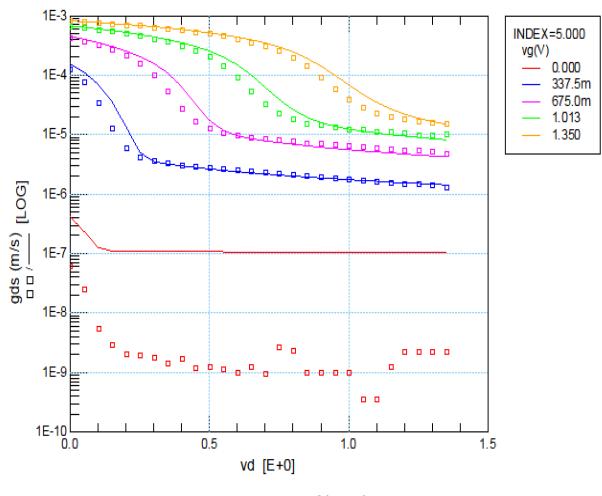


$$gm = f(Vg) @ Vd = 1.2V$$

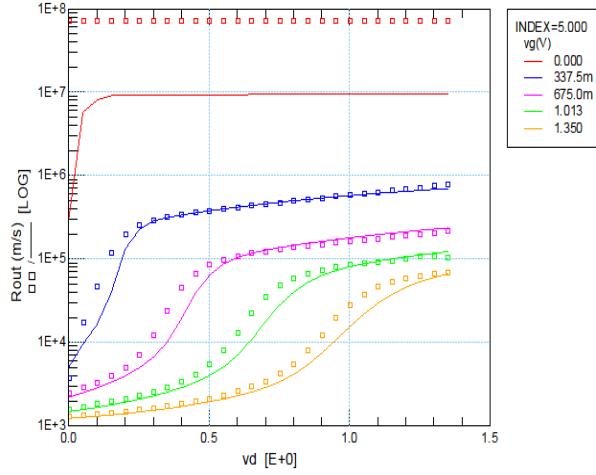
$IdVd, T = 27^\circ C$



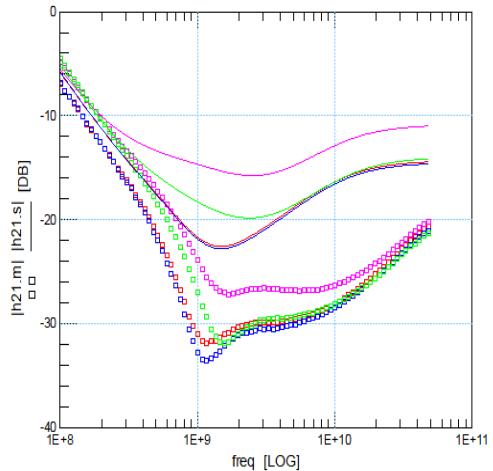
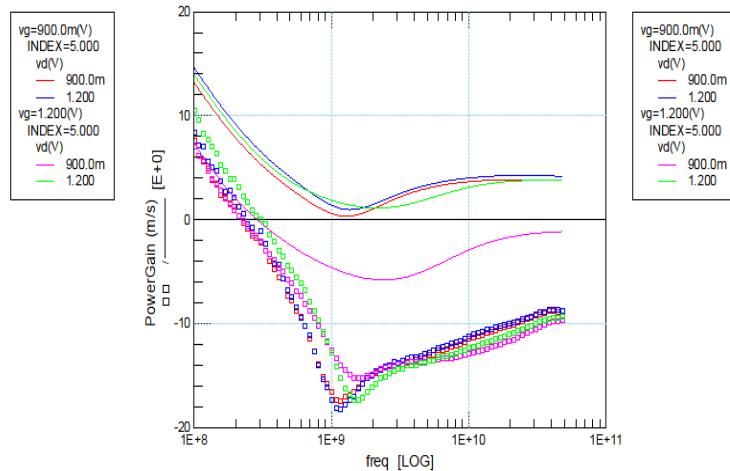
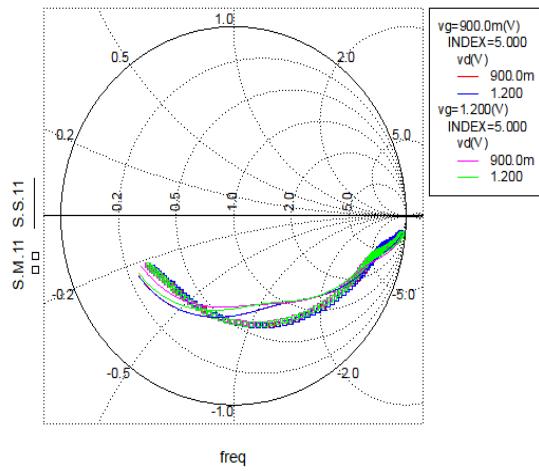
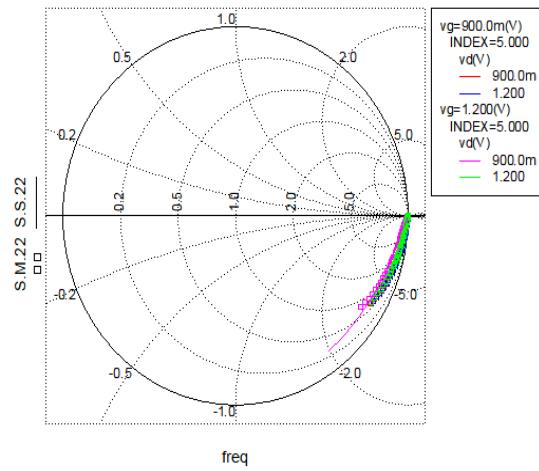
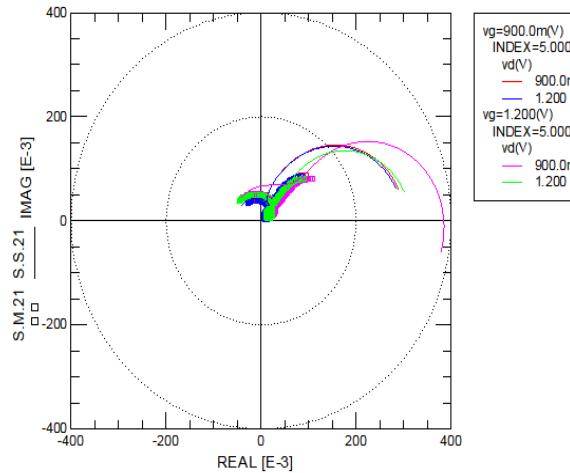
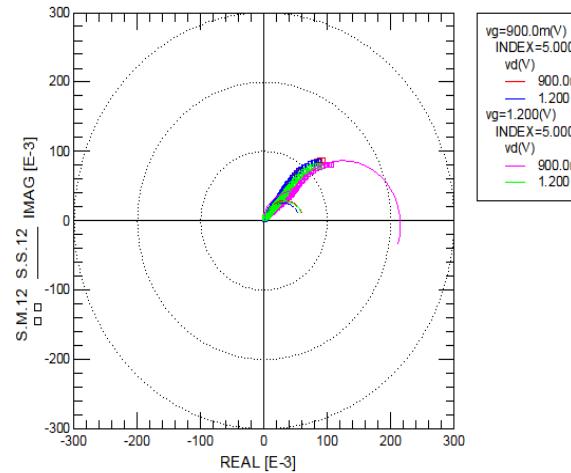
$$Id = f(Vd)$$



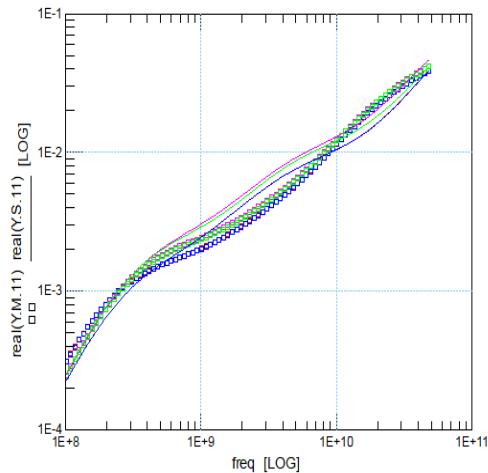
$$gds = f(Vd)$$



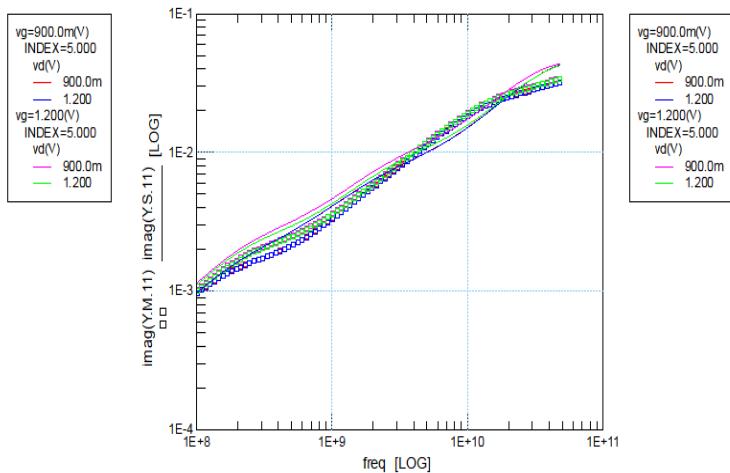
$$Rout = f(Vd)$$

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

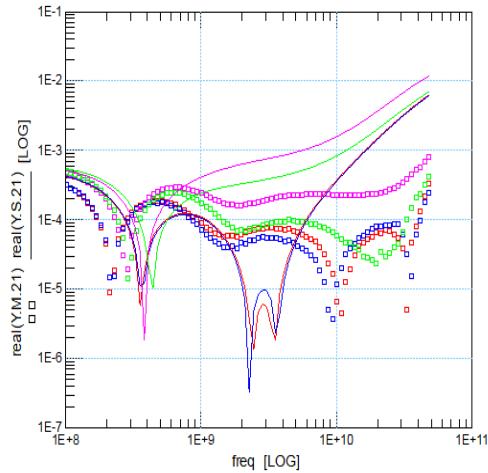
Y-Parameter, T = 27°C



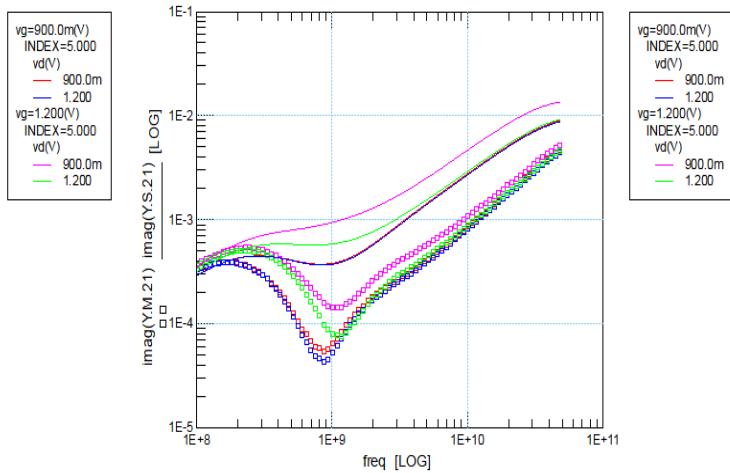
$$\text{re}(Y11) = f(Vg, Vd)$$



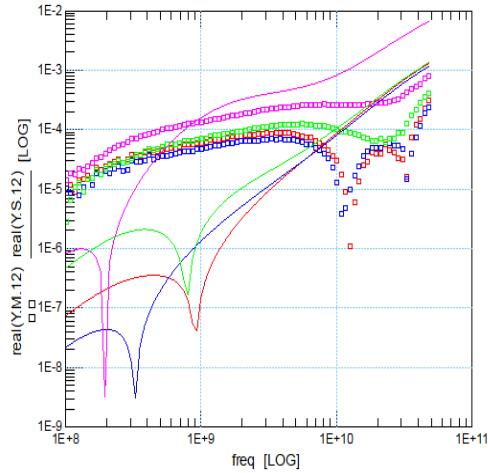
$$\text{im}(Y11) = f(Vg, Vd)$$



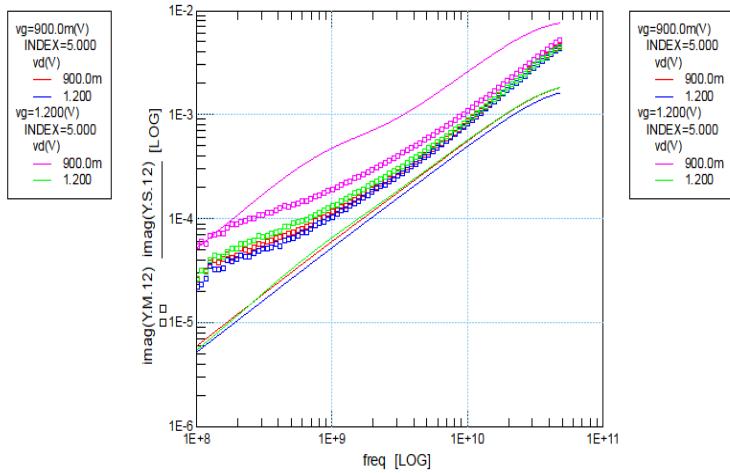
$$\text{re}(Y21) = f(Vg, Vd)$$



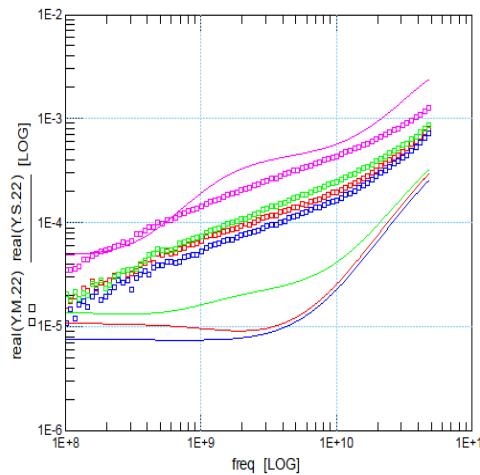
$$\text{im}(Y21) = f(Vg, Vd)$$



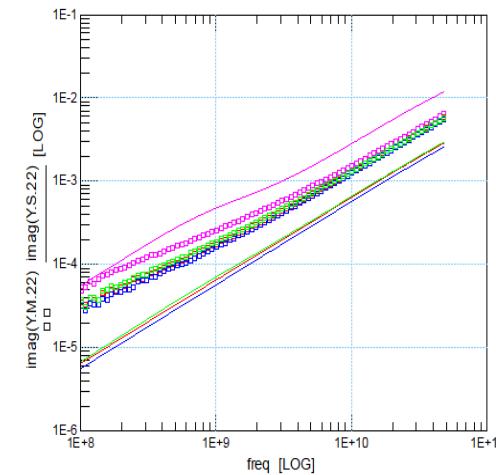
$$\text{re}(Y12) = f(Vg, Vd)$$



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

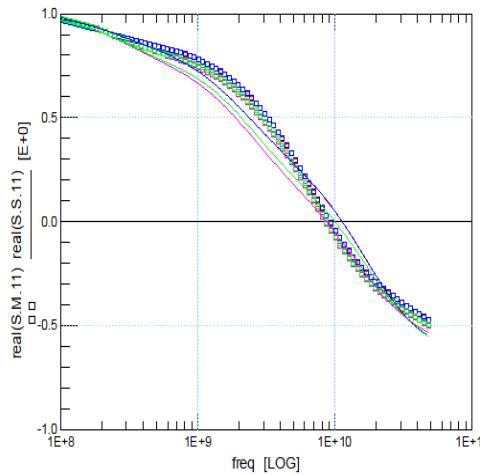


$$\text{re}(Y22) = f(Vg, Vd)$$

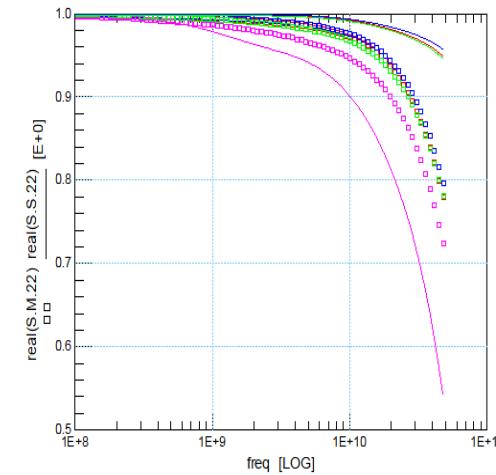


$$\text{im}(Y22) = f(Vg, Vd)$$

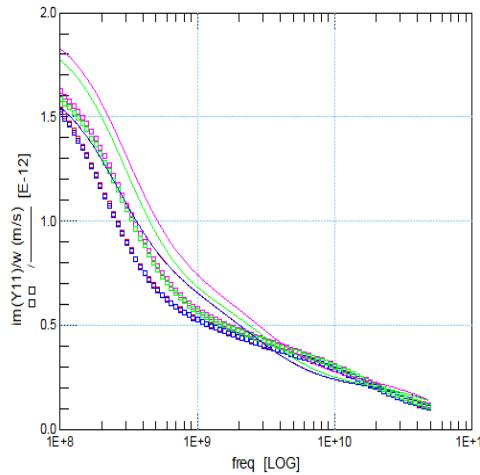
Verify Plots, T = 27°C



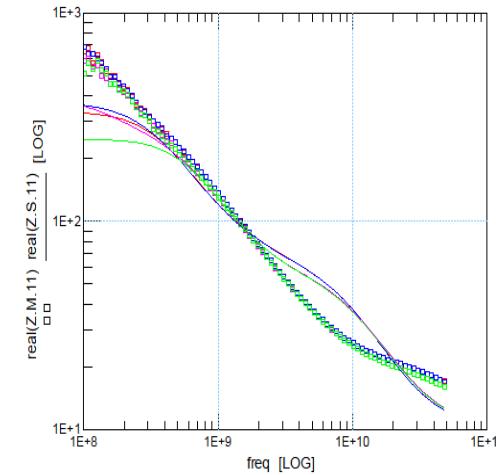
$$\text{re}(S11) = f(Vg, Vd)$$



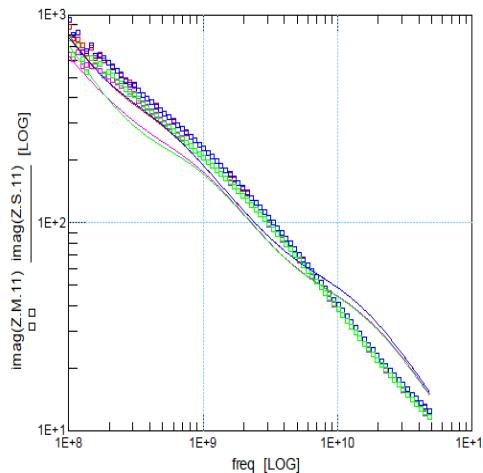
$$\text{re}(S22) = f(Vg, Vd)$$



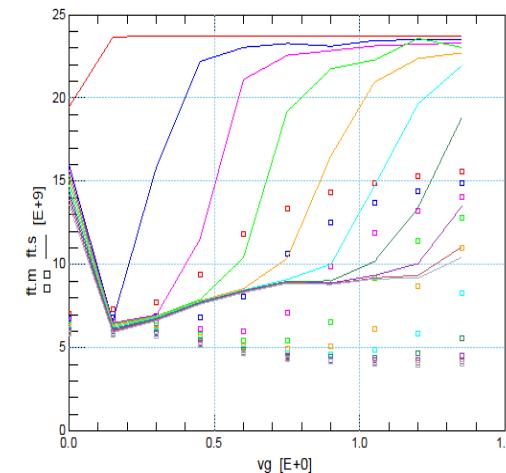
$$\text{im}(Y11) \text{ divided by } \omega$$



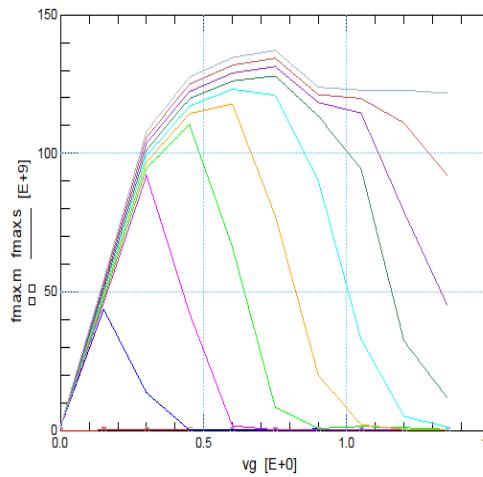
$$\text{re}(Z11) = f(Vg, Vd)$$



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



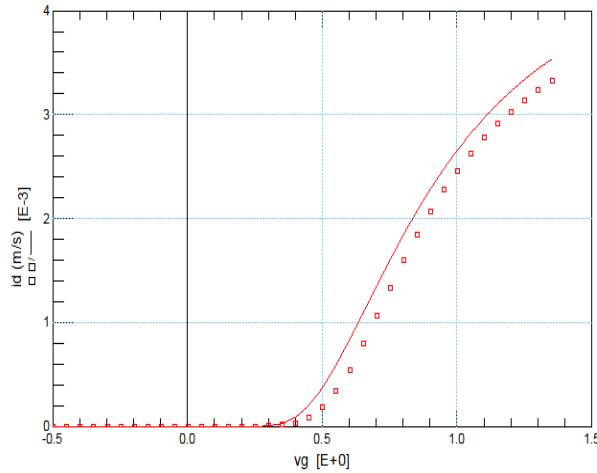
$$fT_{vg} = f(V_g, V_d)$$



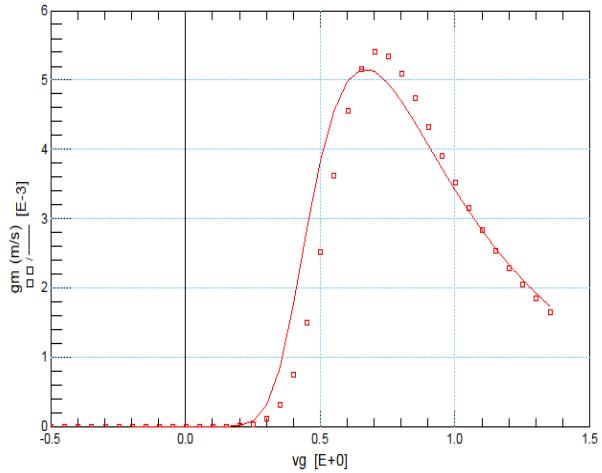
$$f_{\max,vg} = f(V_g, V_d)$$

4.3 NF05_WF10u0_L0u13_S453A_41

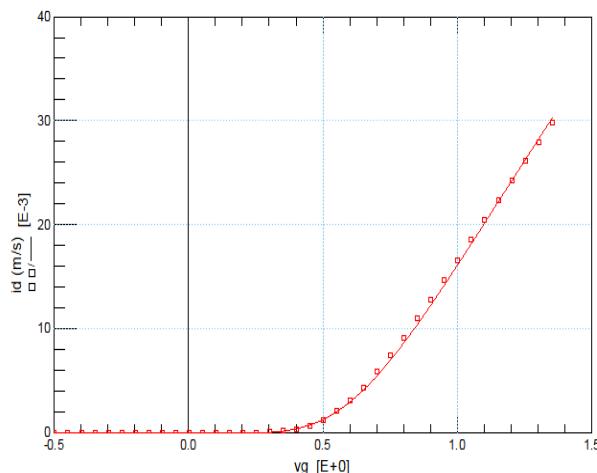
$IdVg$, $T = 27^\circ\text{C}$



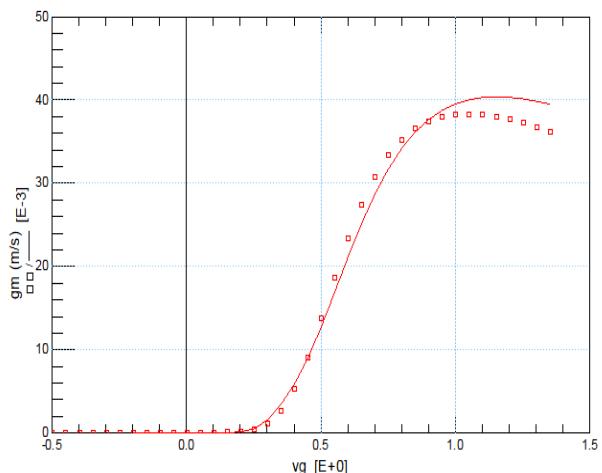
$Id = f(Vg)$ @ $Vd = 0.05\text{V}$



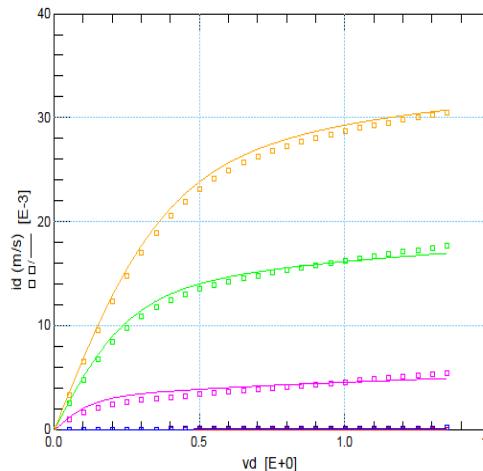
$gm = f(Vg)$ @ $Vd = 0.05\text{V}$



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

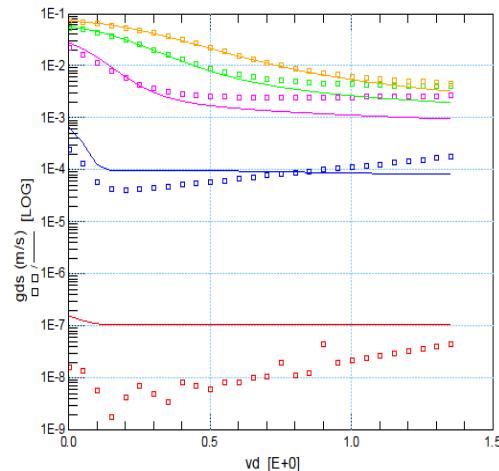


$gm = f(Vg)$ @ $Vd = 1.2\text{V}$

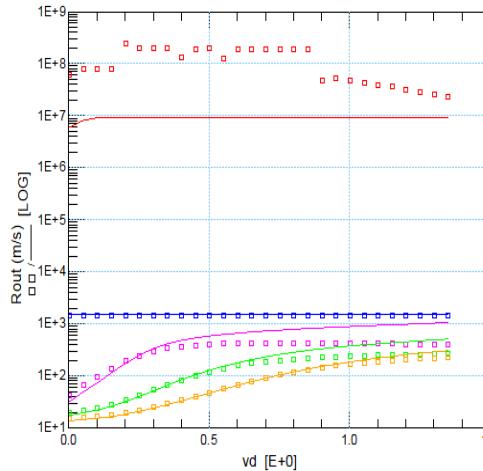
IdVd, T = 27°C

$$Id = f(Vd)$$

INDEX=9.000
vg(V)
0.000
337.5m
675.0m
1.013
1.350

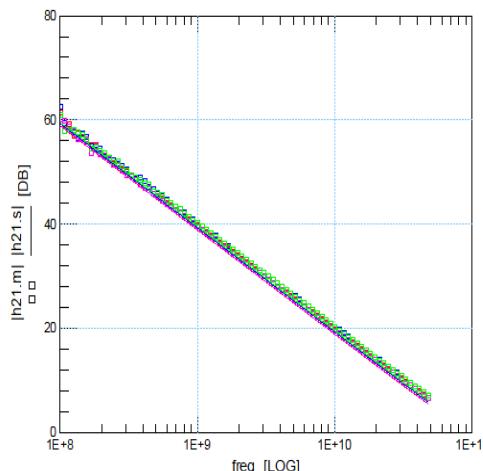


$$gds = f(Vd)$$



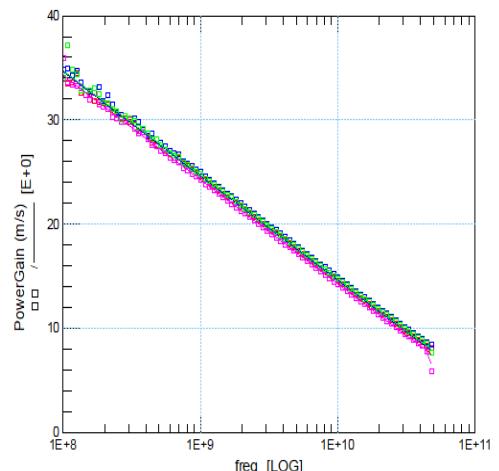
$$Rout = f(Vd)$$

INDEX=9.000
vg(V)
0.000
337.5m
675.0m
1.013
1.350

S-Parameter, T = 27°C

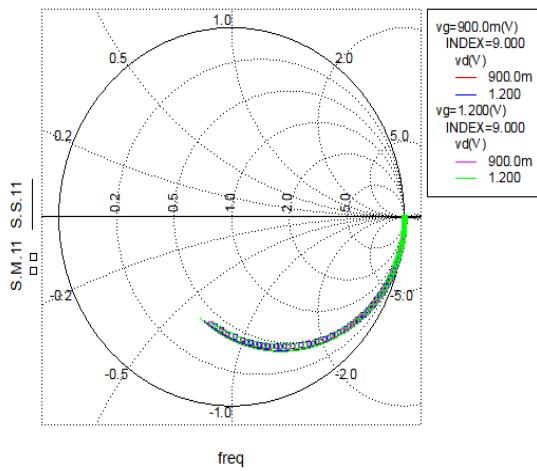
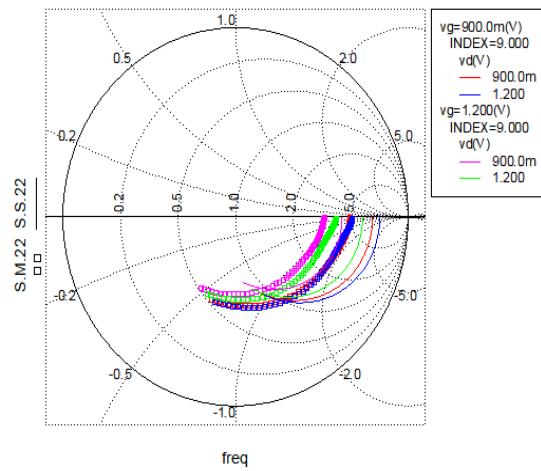
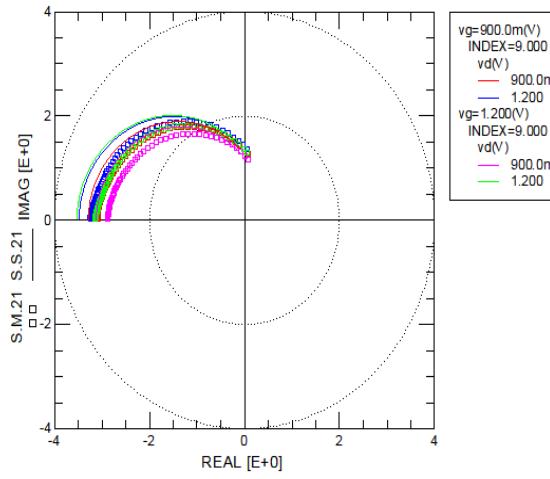
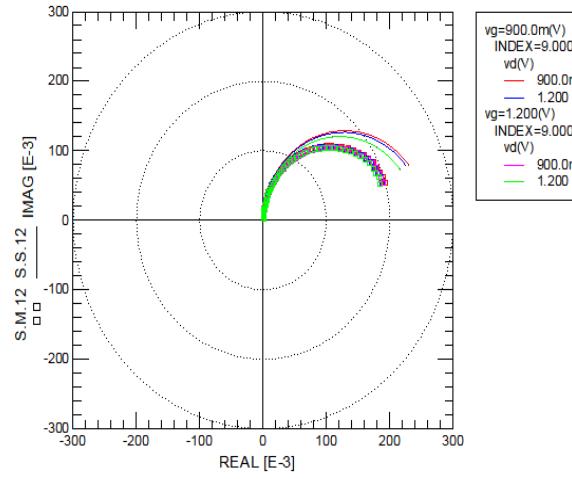
$$|h21| = f(Vg, Vd)$$

vg=900.0mV
INDEX=9.000
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=9.000
vd(V)
900.0m
1.200

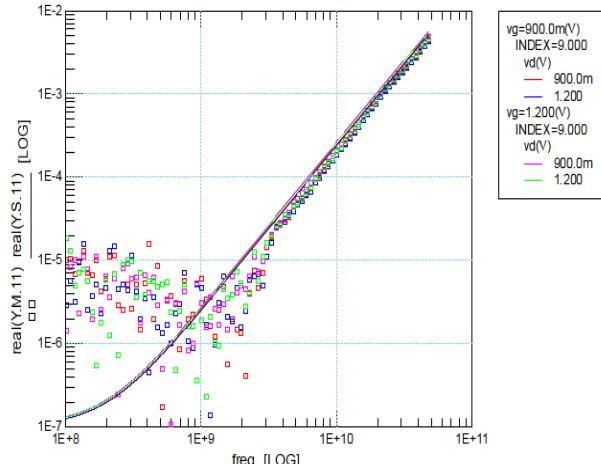
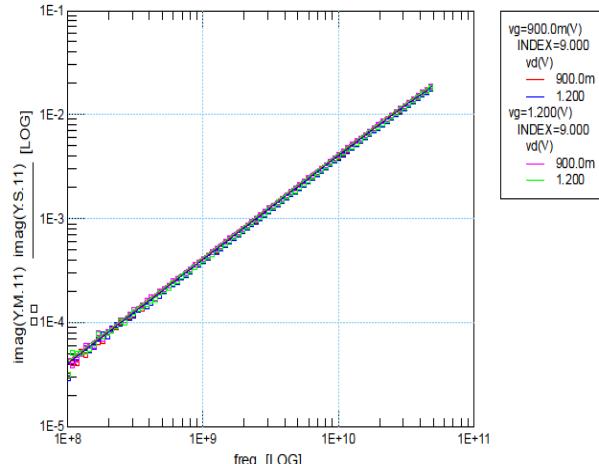


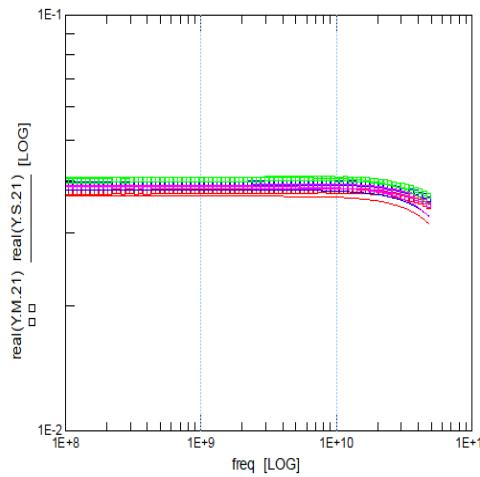
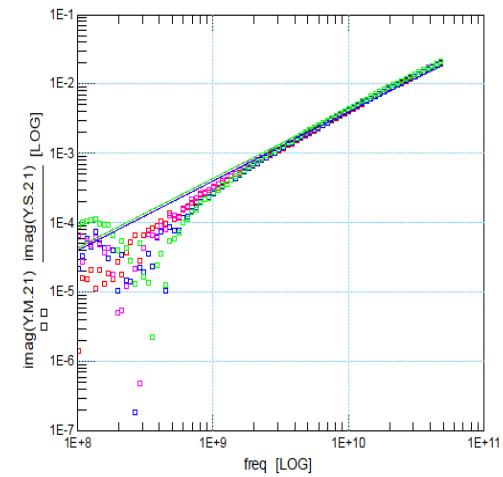
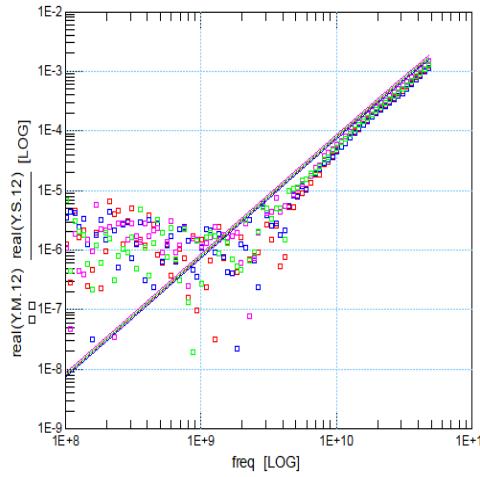
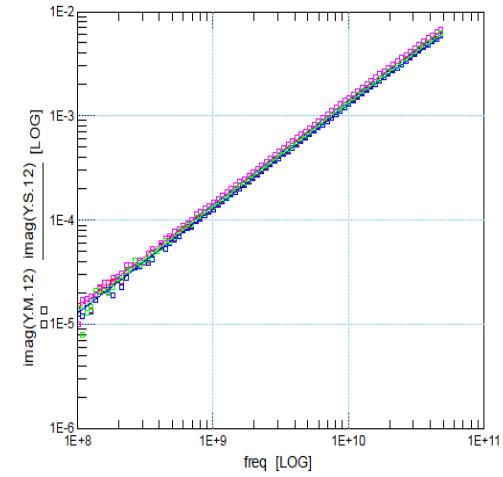
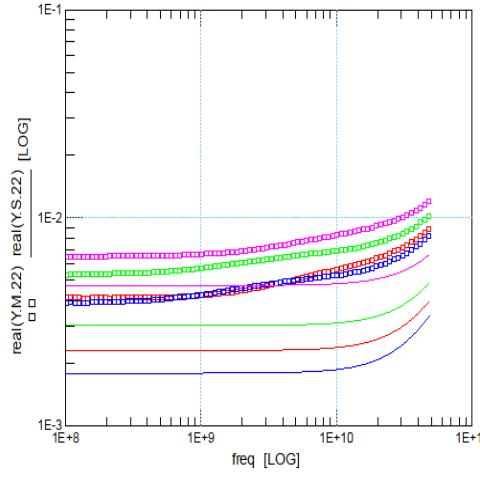
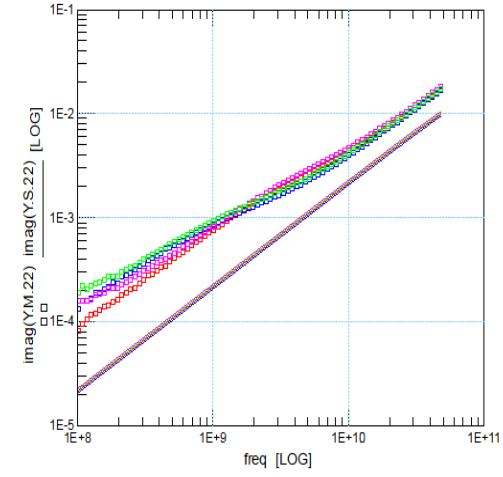
$$MSG/MAG = f(Vg, Vd)$$

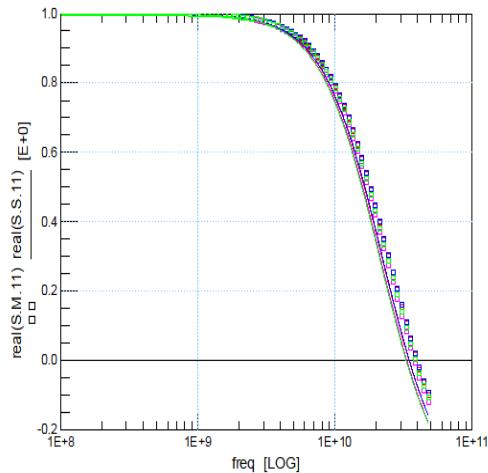
vg=900.0mV
INDEX=9.000
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=9.000
vd(V)
900.0m
1.200

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

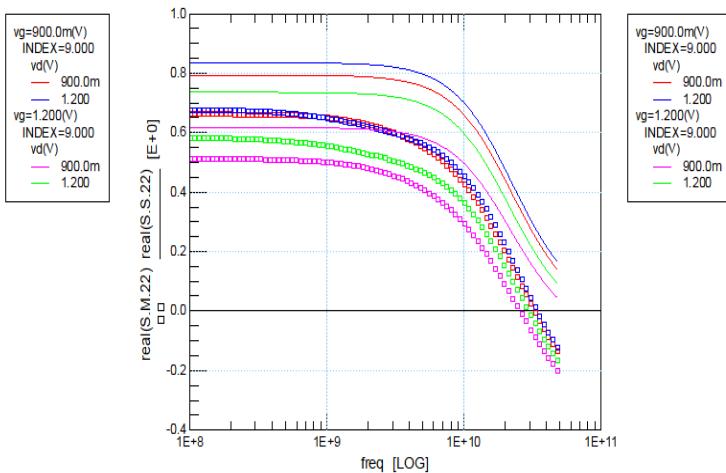
Y-Parameter, $T = 27^\circ\text{C}$

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

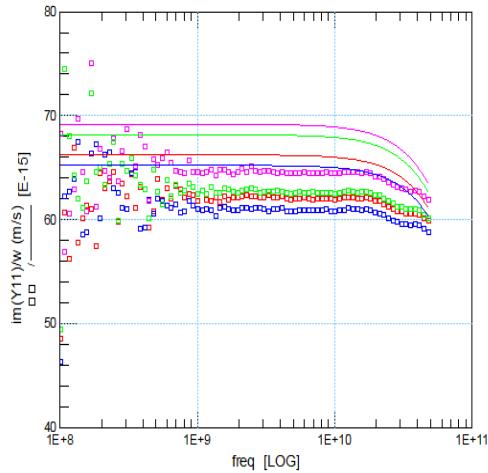
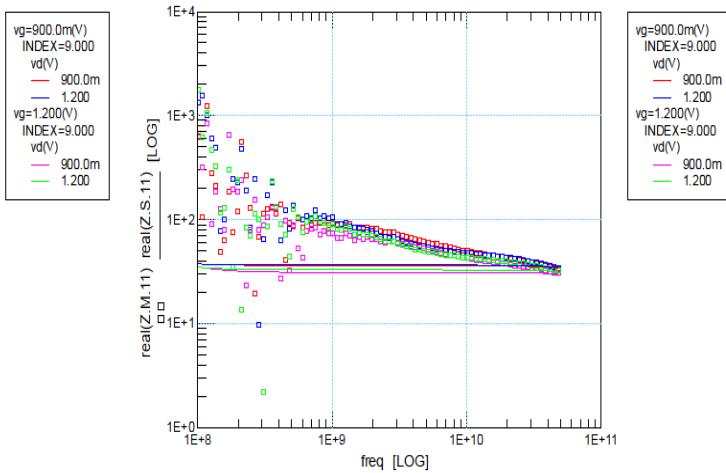
re(Y₂₁) = f(V_g, V_d)im(Y₂₁) = f(V_g, V_d)re(Y₁₂) = f(V_g, V_d)im(Y₁₂) = f(V_g, V_d)re(Y₂₂) = f(V_g, V_d)im(Y₂₂) = f(V_g, V_d)

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

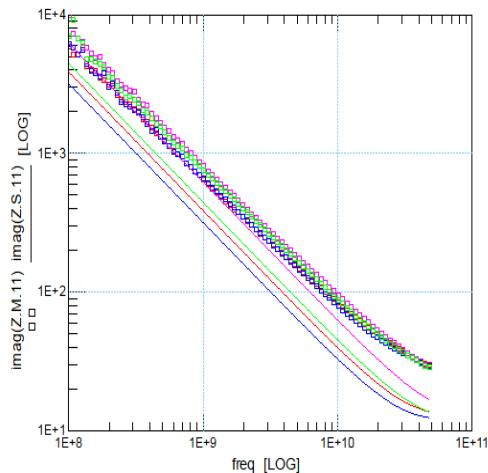
re(S11) = f(Vg, Vd)



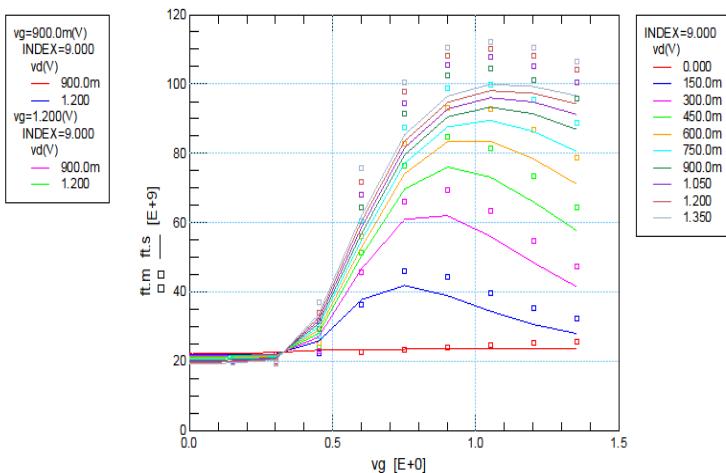
re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

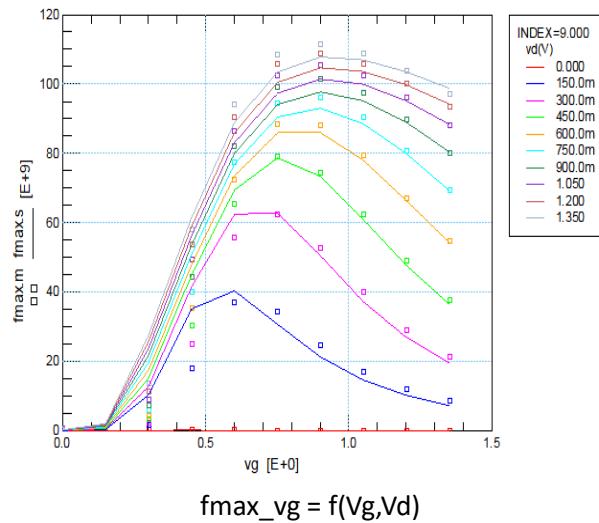
re(Z11) = f(Vg, Vd)



im(Z11) = f(Vg, Vd)

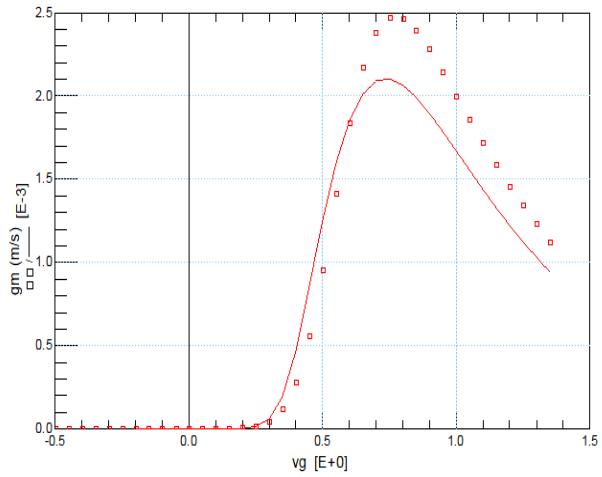
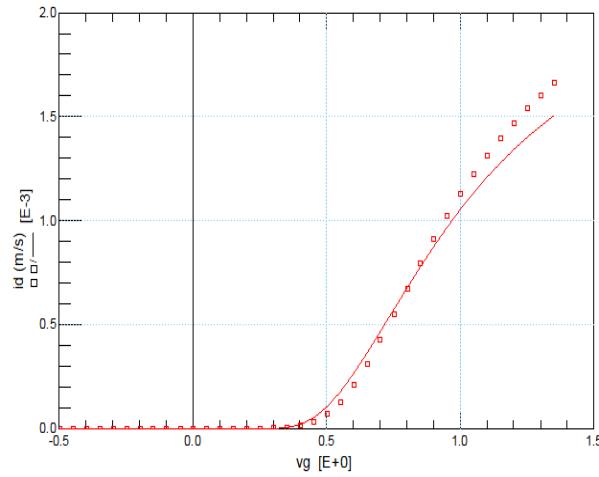


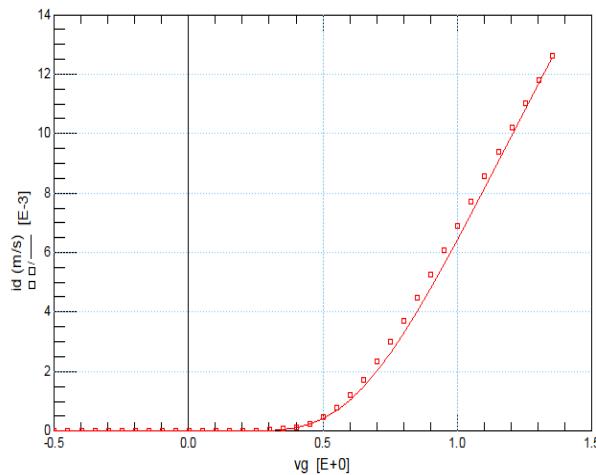
fT_vg = f(Vg, Vd)



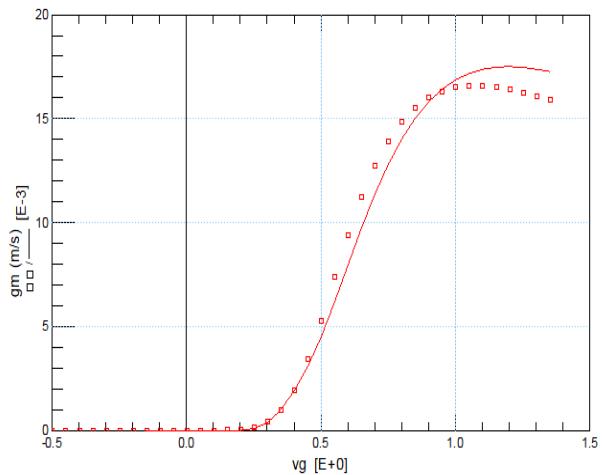
4.4 NF08_WF02u5_L0u13_S453A_34

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



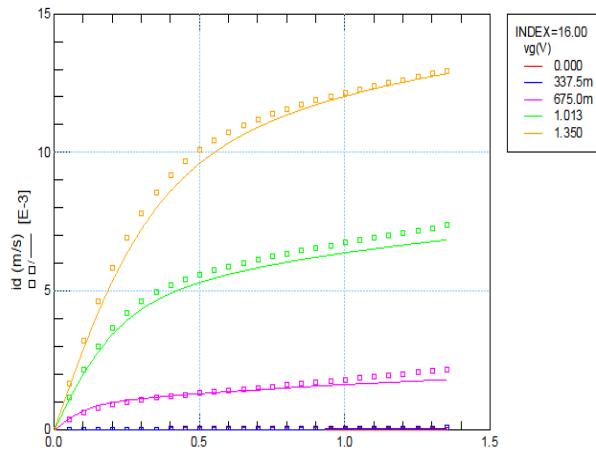


$$Id = f(Vg) @ Vd = 1.2V$$

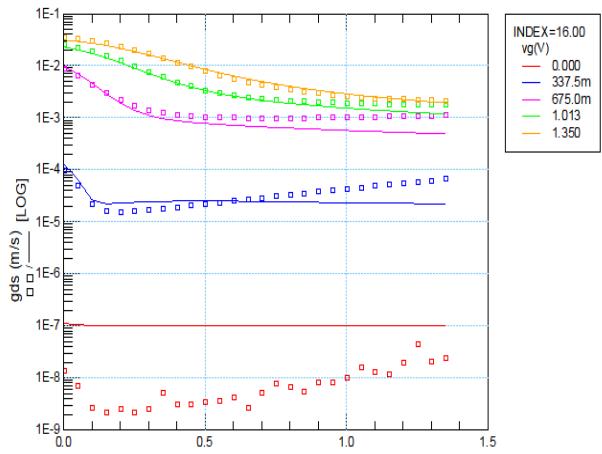


$$gm = f(Vg) @ Vd = 1.2V$$

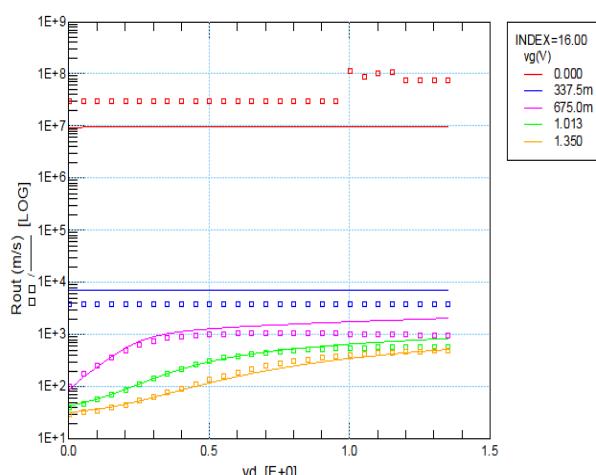
IdVd, T = 27°C



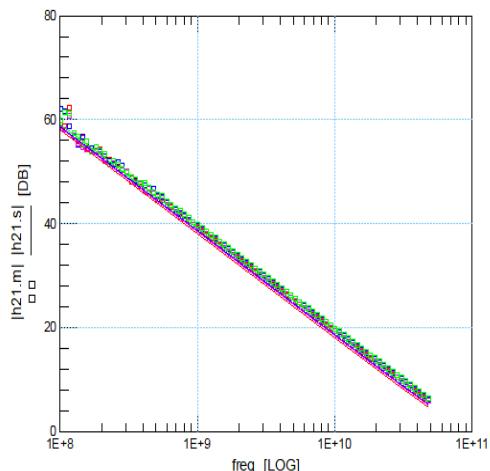
$$Id = f(Vd)$$



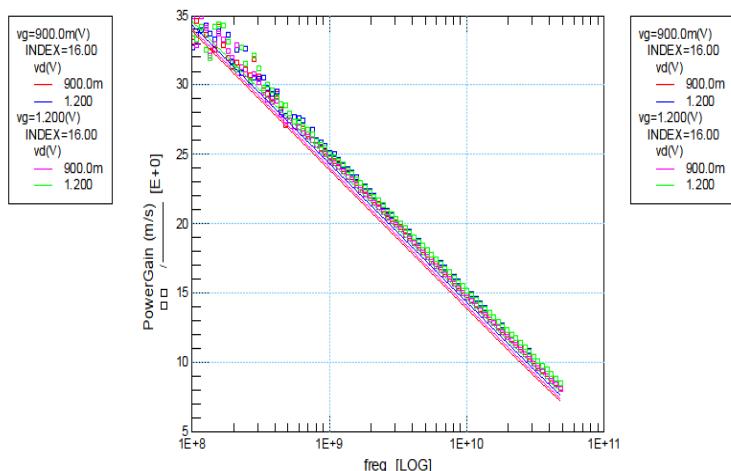
$$gds = f(Vd)$$



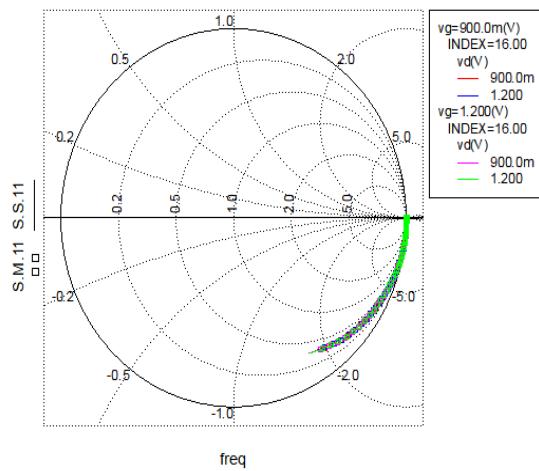
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

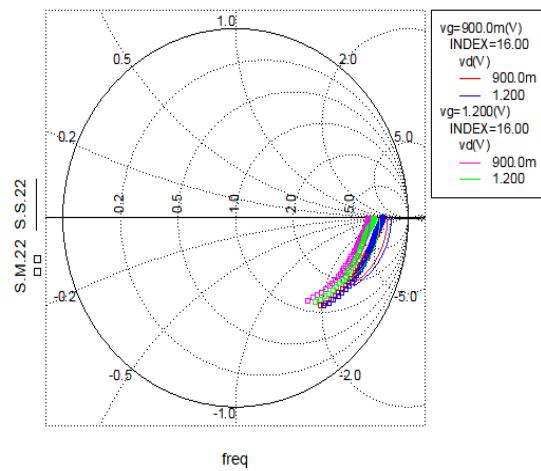
$$|h21| = f(Vg, Vd)$$



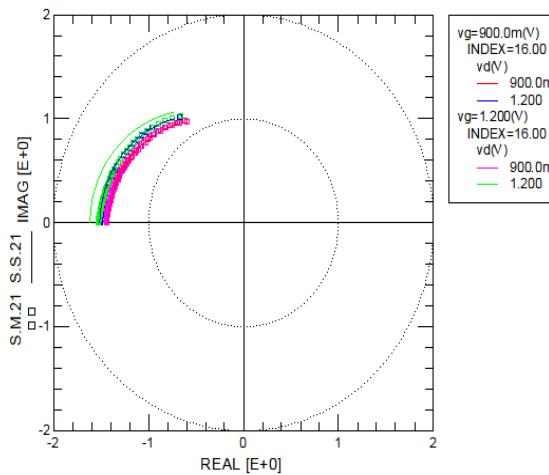
$$MSG/MAG = f(Vg, Vd)$$



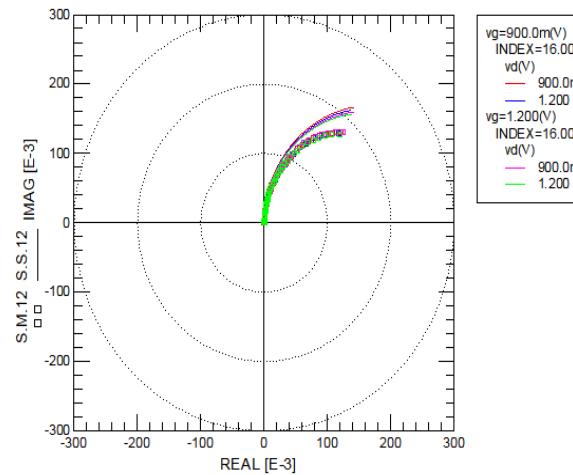
$$S11 = f(Vg, Vd)$$



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

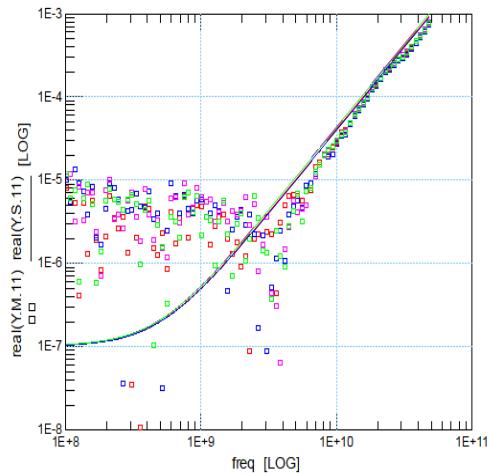


$$S21 = f(Vg, Vd)$$

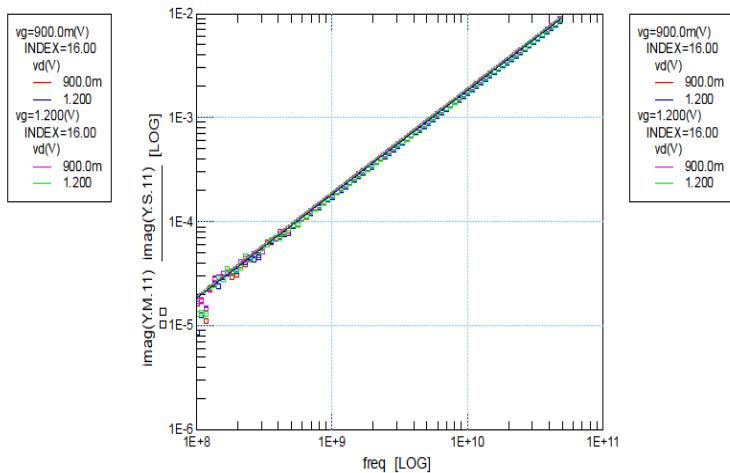


$$S12 = f(Vg, Vd)$$

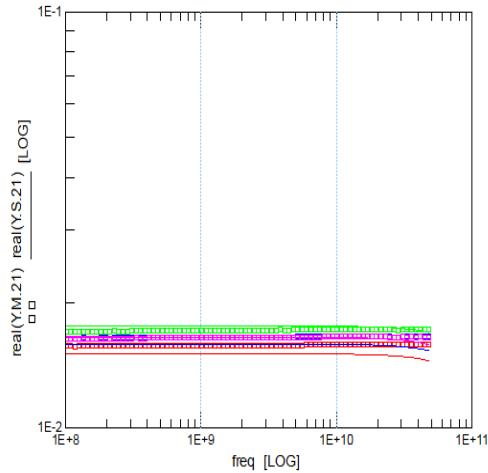
Y-Parameter, T = 27°C



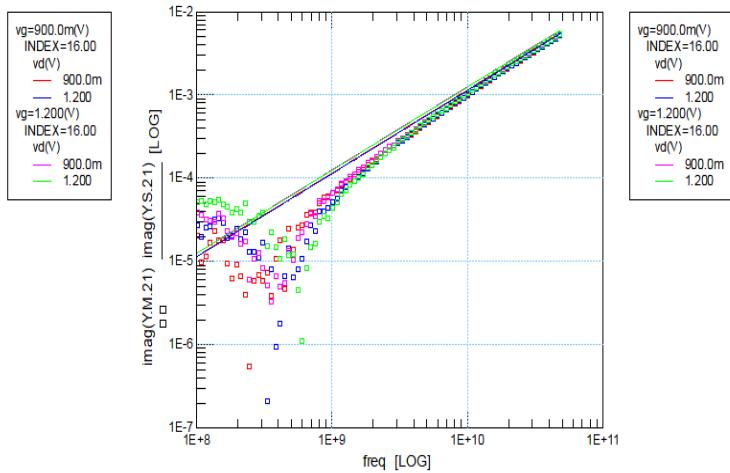
$$\text{re}(Y11) = f(Vg, Vd)$$



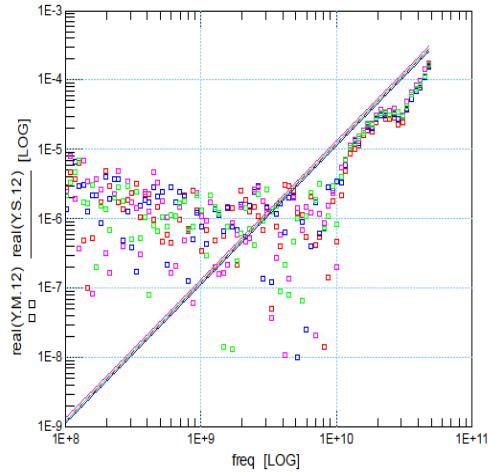
$$\text{im}(Y11) = f(Vg, Vd)$$



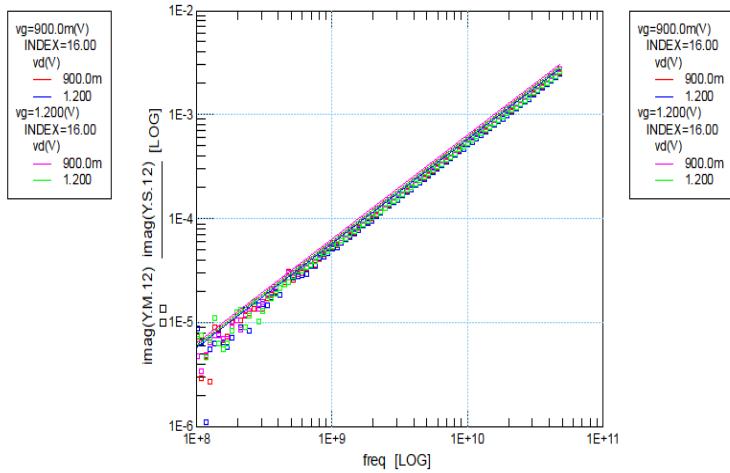
$$\text{re}(Y21) = f(Vg, Vd)$$



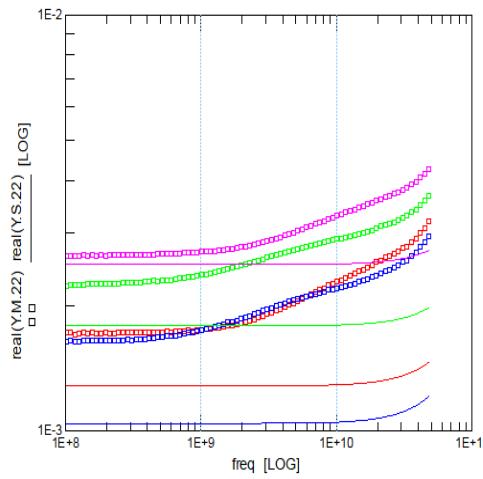
$$\text{im}(Y21) = f(Vg, Vd)$$



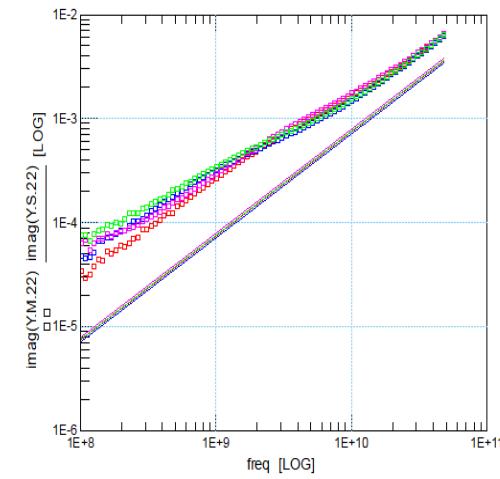
$$\text{re}(Y12) = f(Vg, Vd)$$



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

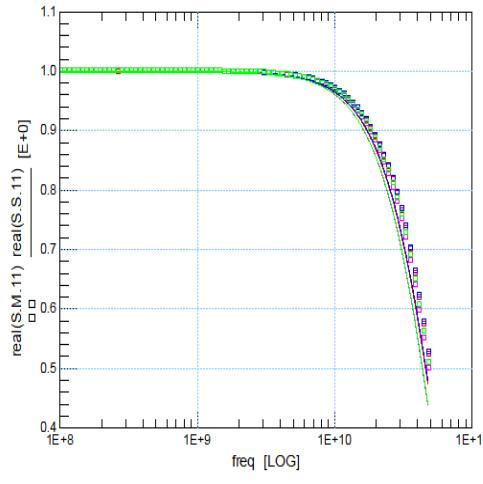


re(Y22) = f(Vg, Vd)

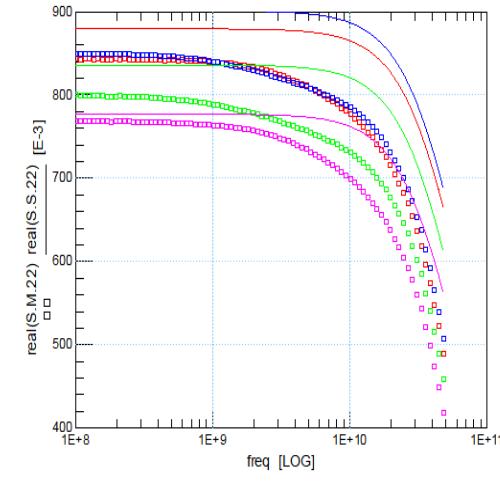


im(Y22) = f(Vg, Vd)

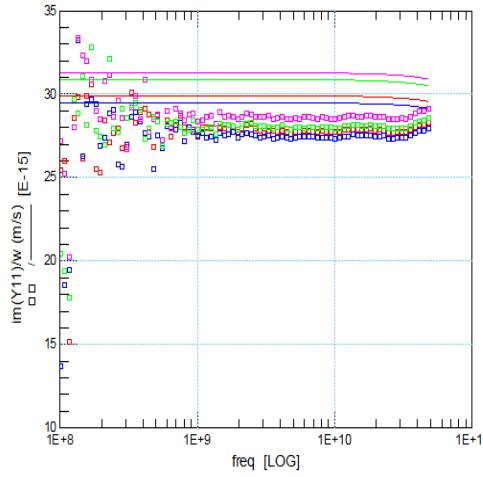
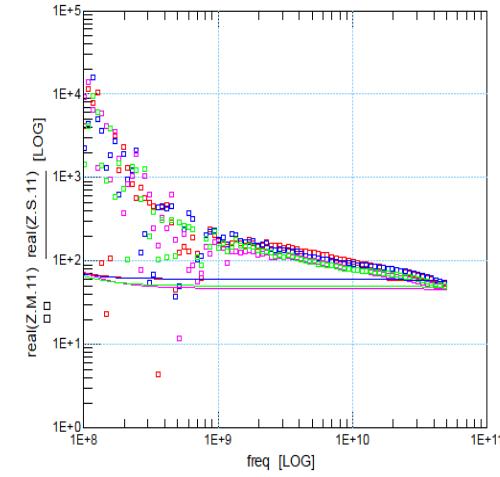
Verify Plots, T = 27°C



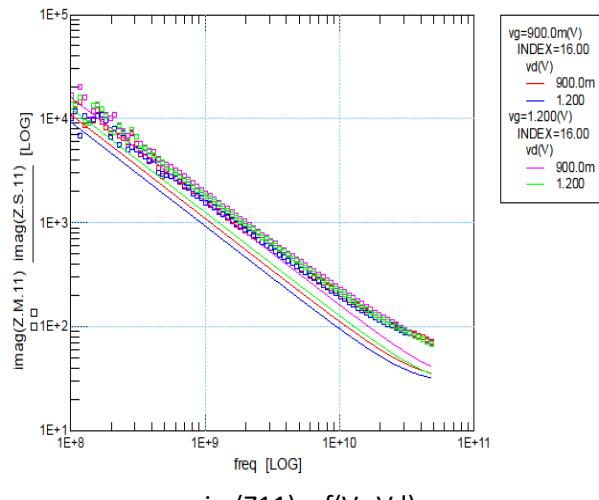
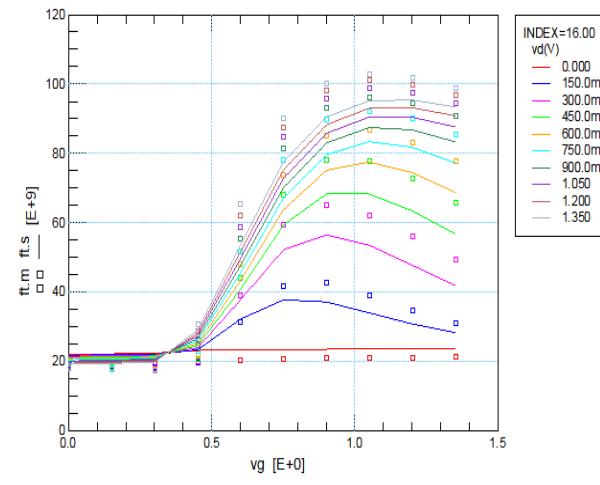
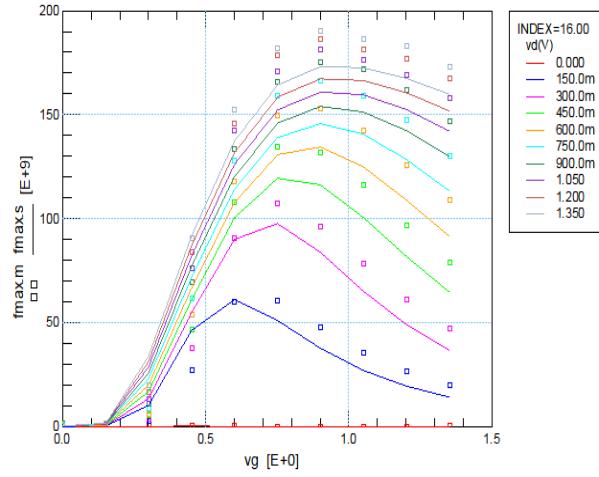
re(S11) = f(Vg, Vd)



re(S22) = f(Vg, Vd)

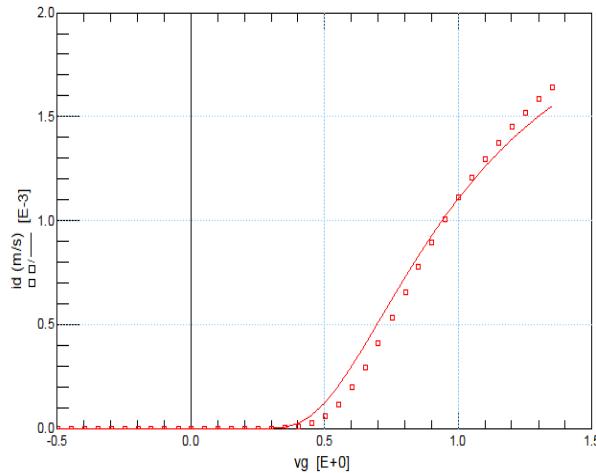
im(Y11) divided by ω 

re(Z11) = f(Vg, Vd)

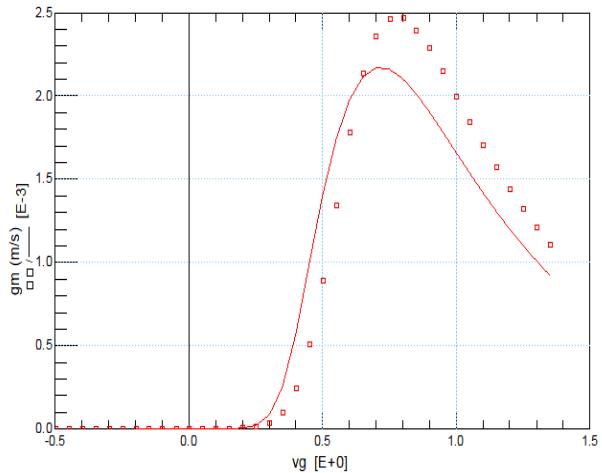
 $\text{im}(Z_{11}) = f(V_g, V_d)$  $fT_{vg} = f(V_g, V_d)$  $f_{\text{max}}_{vg} = f(V_g, V_d)$

4.5 NF04_WF05u0_L0u13_post_03

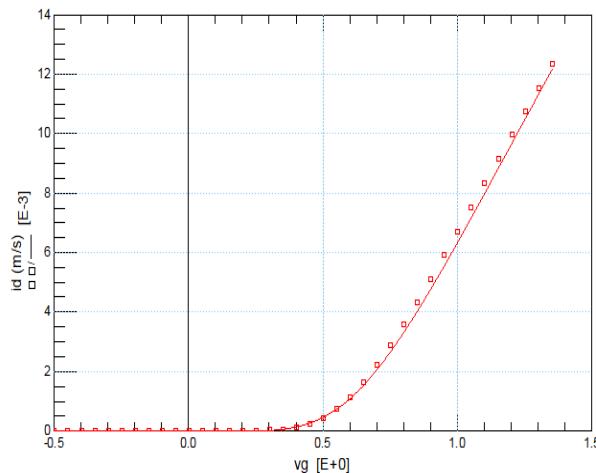
$IdVg$, $T = 27^\circ\text{C}$



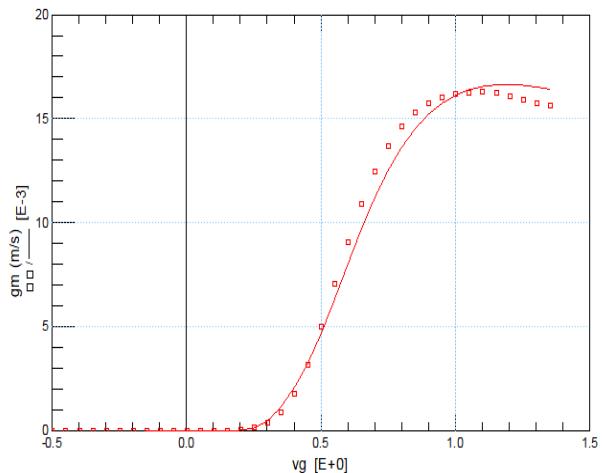
$$Id = f(Vg) \text{ @ } Vd = 0.05\text{V}$$



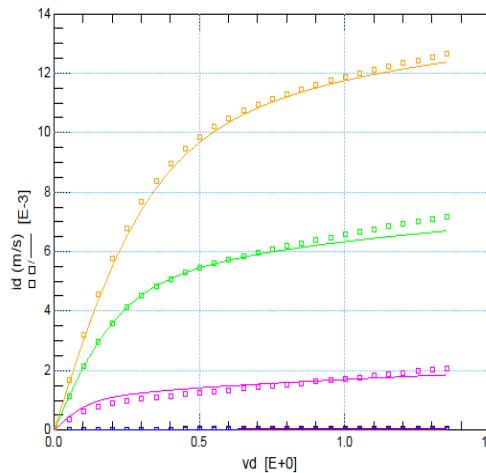
$$gm = f(Vg) \text{ @ } Vd = 0.05\text{V}$$



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

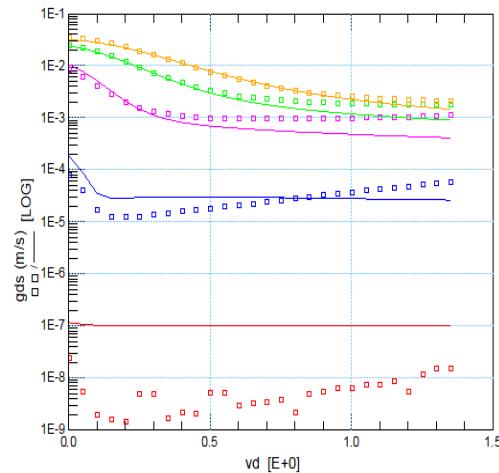


$$gm = f(Vg) \text{ @ } Vd = 1.2\text{V}$$

IdVd, T = 27°C

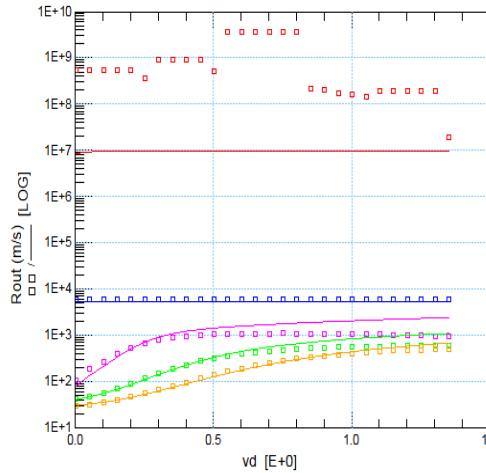
$$Id = f(Vd)$$

INDEX=36.00
vg(V)
0.000
337.5m
675.0m
1.013
1.350



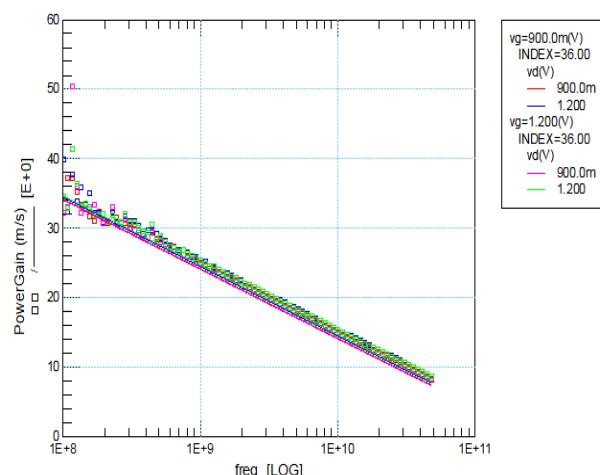
$$gds = f(Vd)$$

INDEX=36.00
vg(V)
0.000
337.5m
675.0m
1.013
1.350

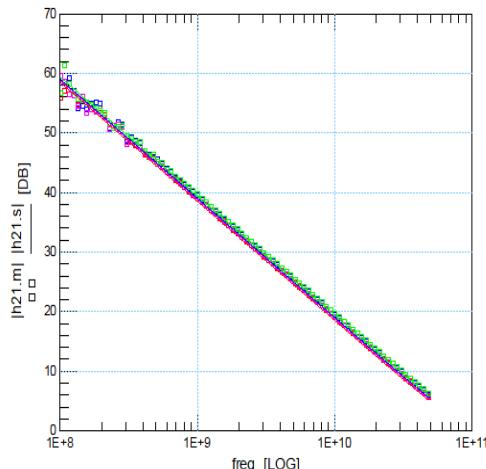


$$Rout = f(Vd)$$

INDEX=36.00
vg(V)
0.000
337.5m
675.0m
1.013
1.350

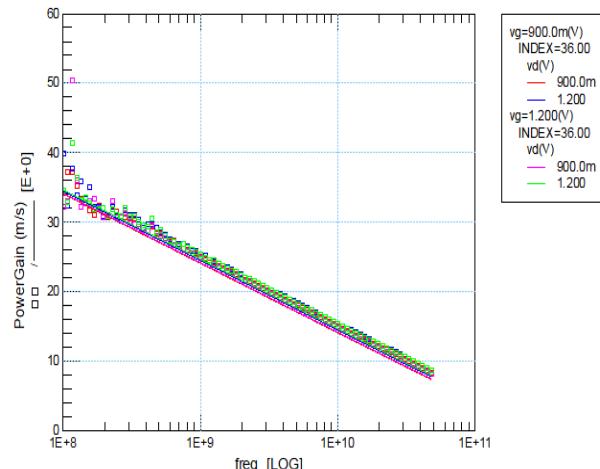


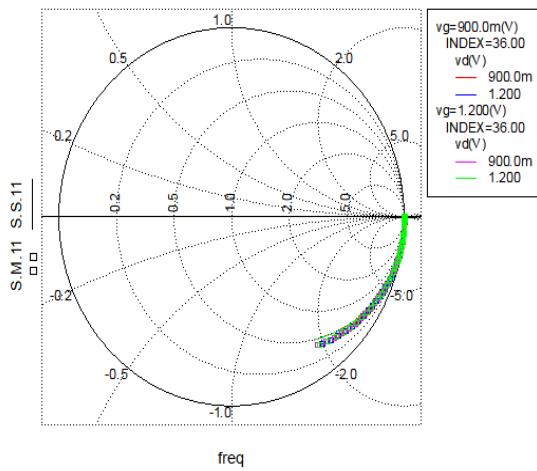
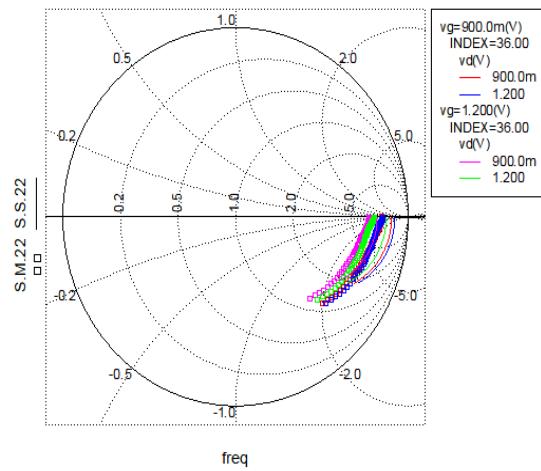
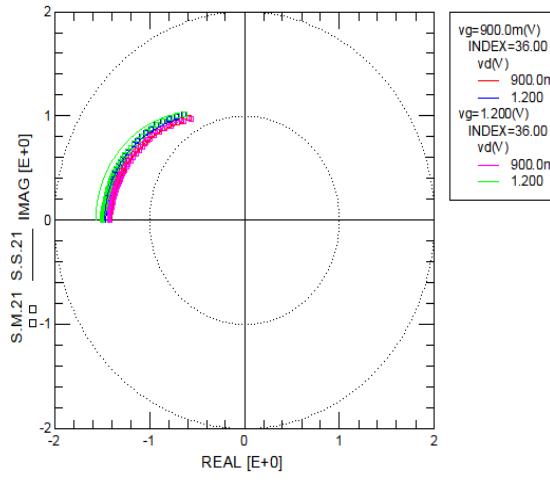
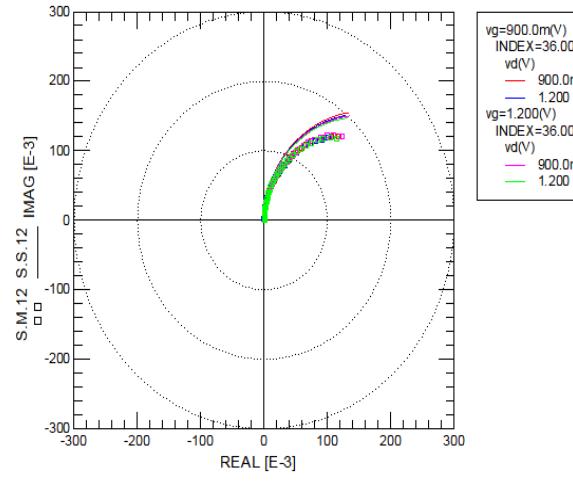
$$MSG/MAG = f(Vg,Vd)$$

S-Parameter, T = 27°C

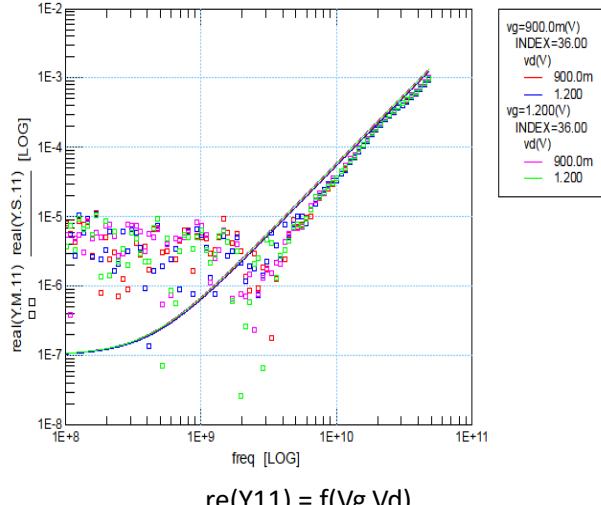
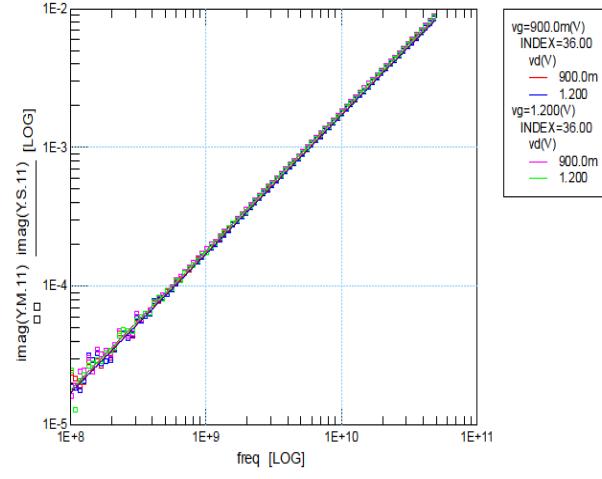
$$|h21| = f(Vg,Vd)$$

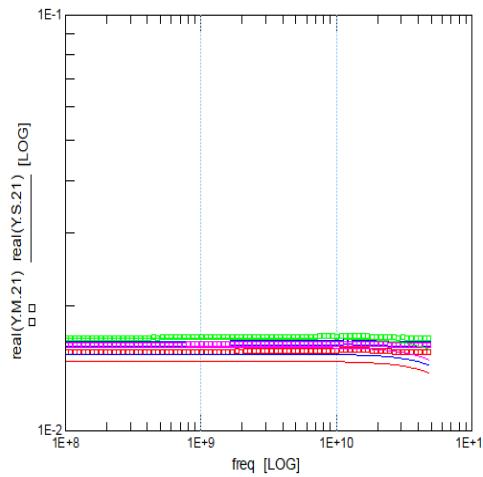
vg=900.0mV
INDEX=36.00
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=36.00
vd(V)
900.0m
1.200



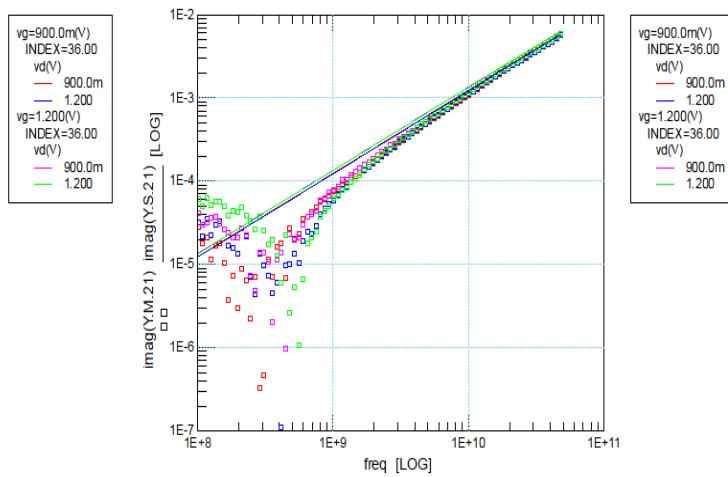
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

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

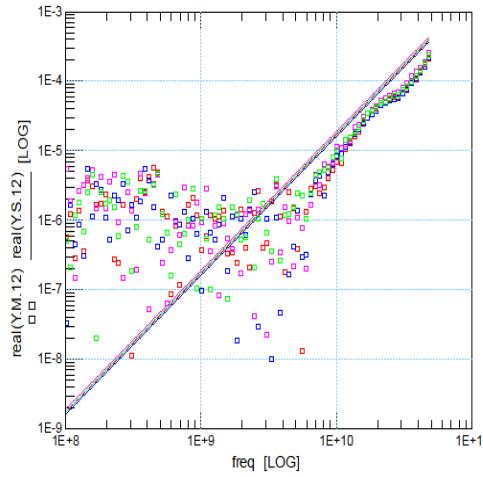
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



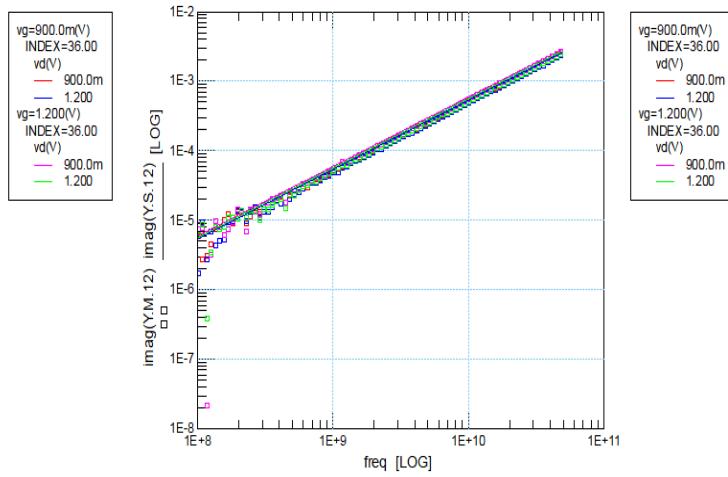
re(Y21) = f(Vg, Vd)



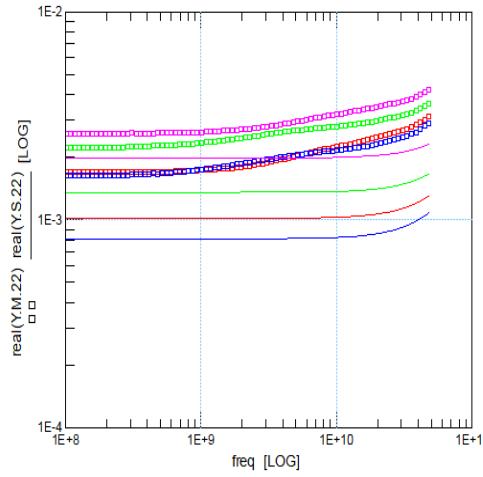
im(Y21) = f(Vg, Vd)



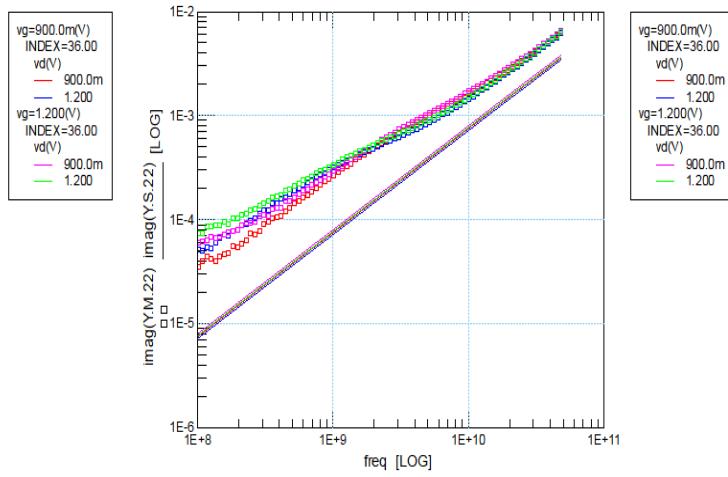
re(Y12) = f(Vg, Vd)



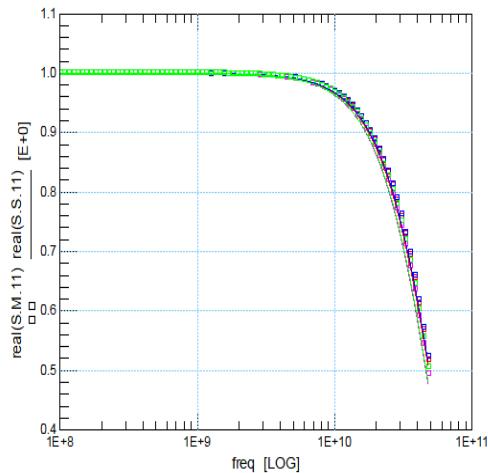
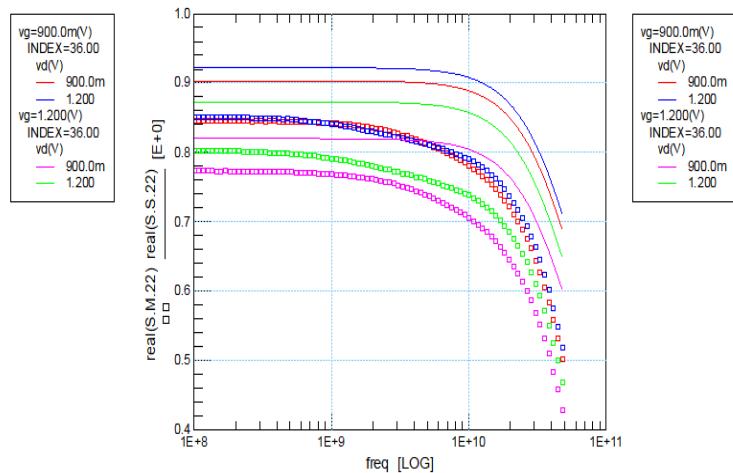
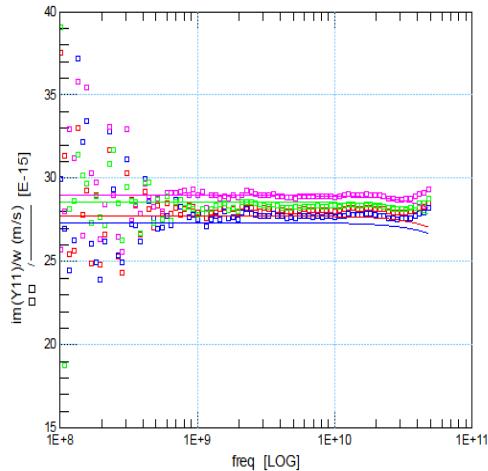
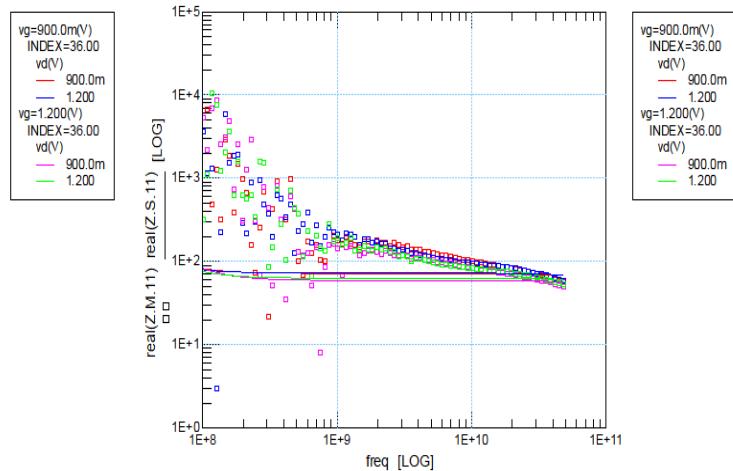
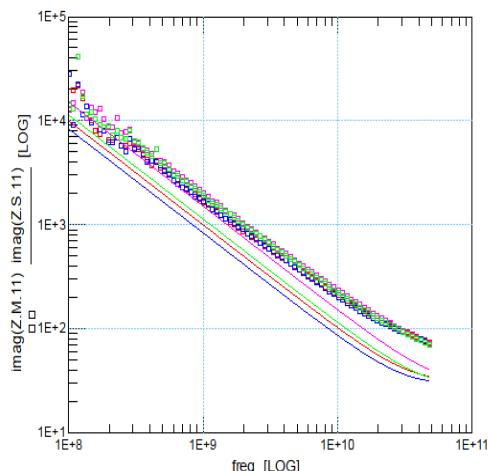
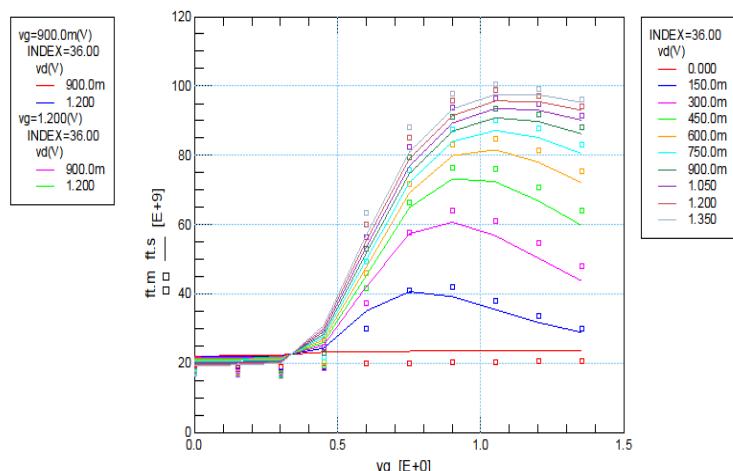
im(Y12) = f(Vg, Vd)

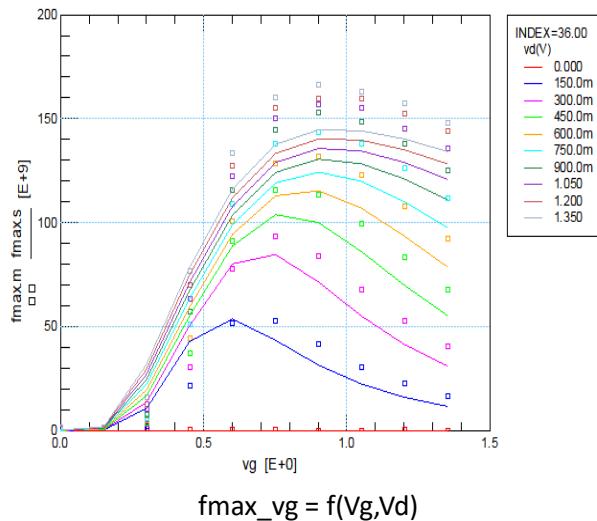


re(Y22) = f(Vg, Vd)



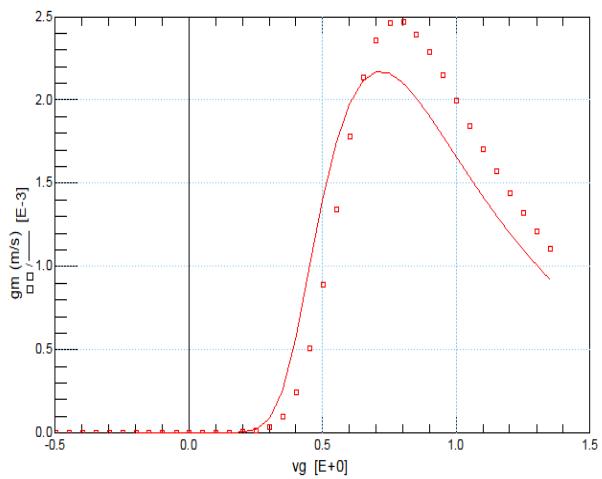
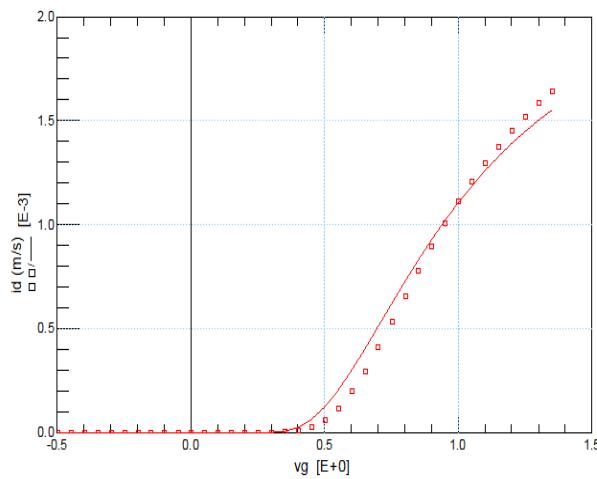
im(Y22) = f(Vg, Vd)

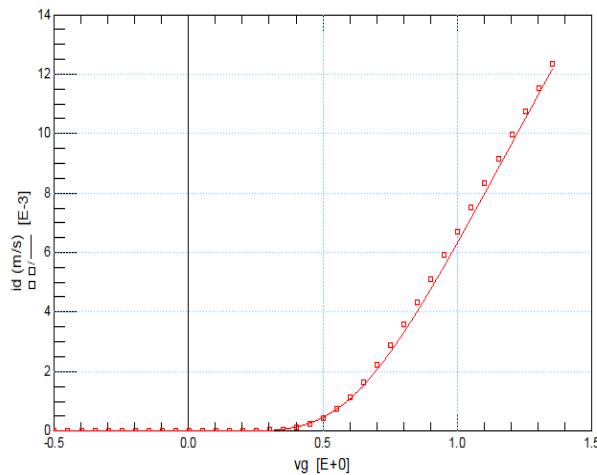
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



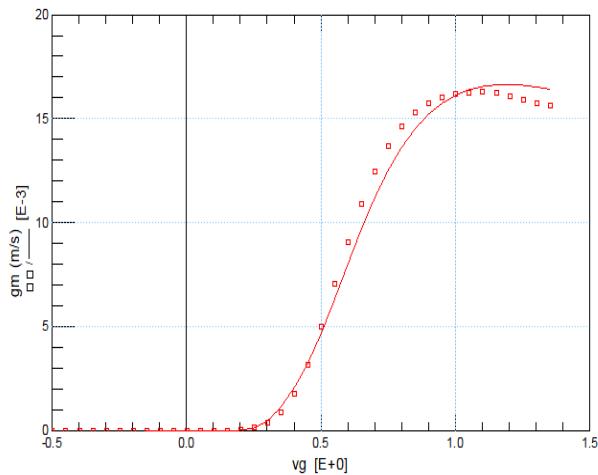
4.6 NF04_WF05u0_L0u13_S453A_03

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



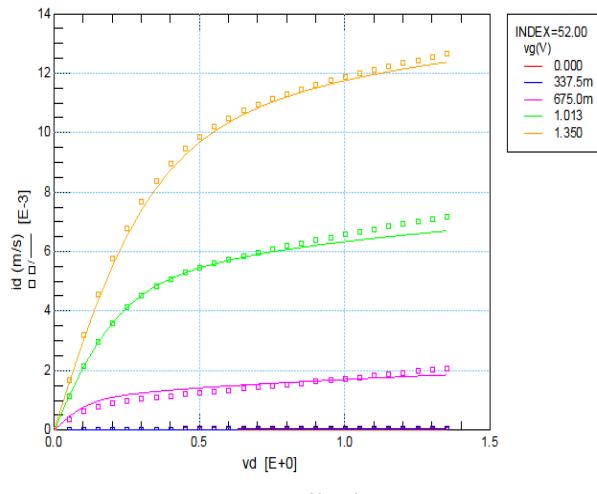


$$Id = f(Vg) @ Vd = 1.2V$$

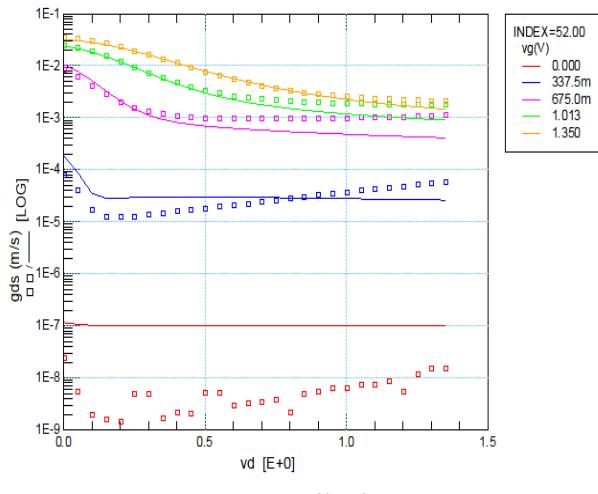


$$gm = f(Vg) @ Vd = 1.2V$$

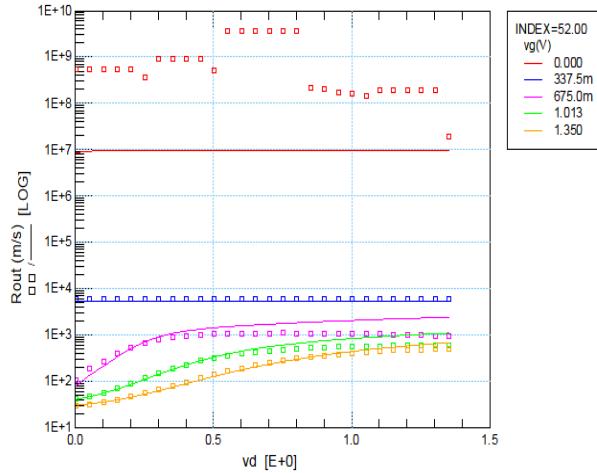
IdVd, T = 27°C



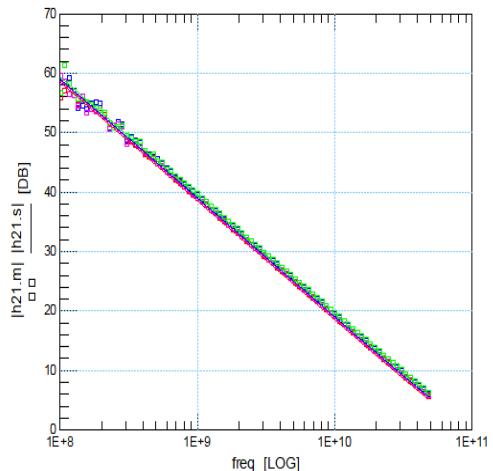
$$Id = f(Vd)$$



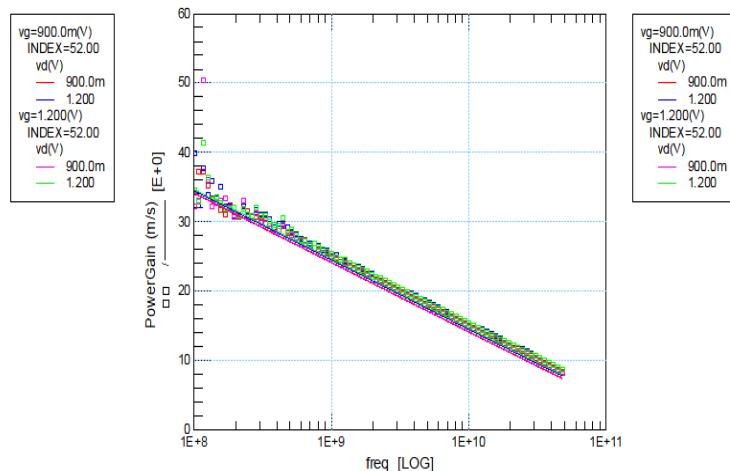
$$gds = f(Vd)$$



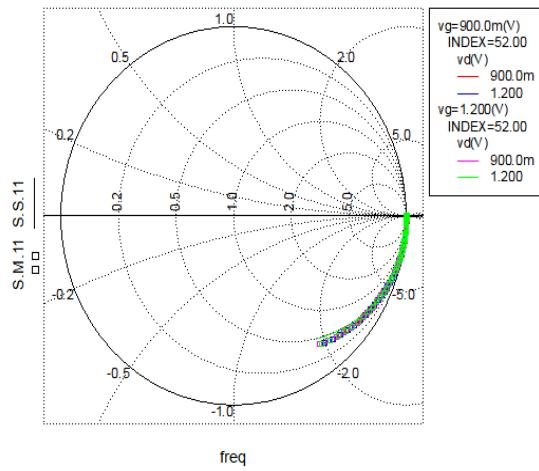
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

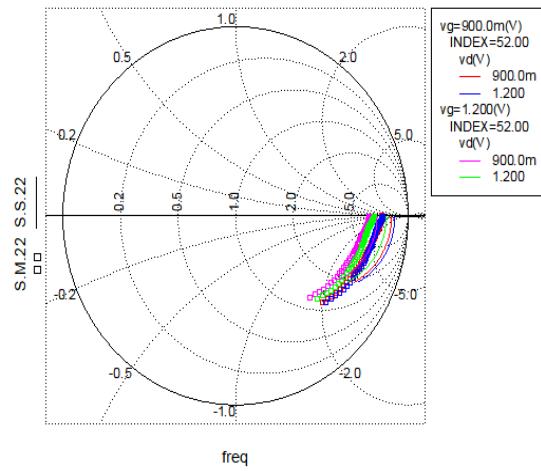
$$|h21| = f(Vg, Vd)$$



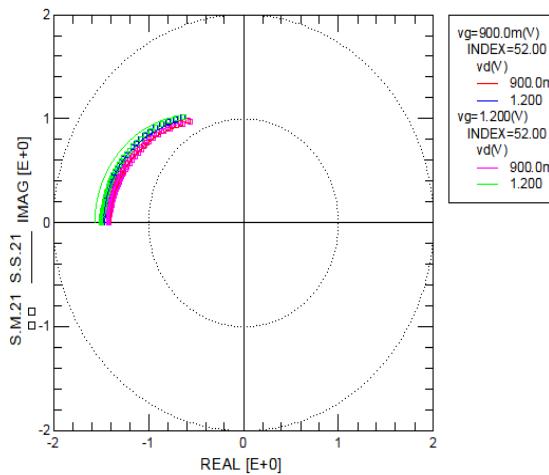
$$MSG/MAG = f(Vg, Vd)$$



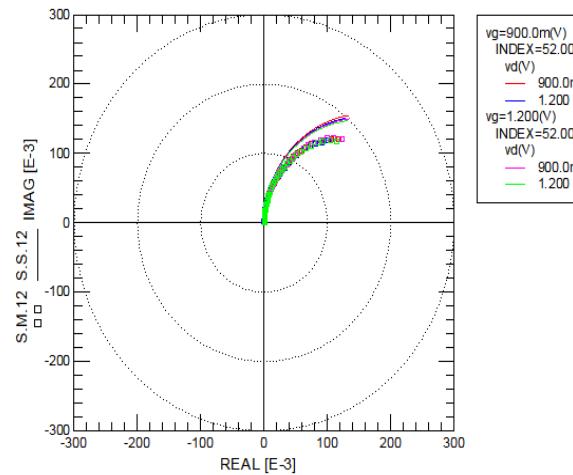
$$S11 = f(Vg, Vd)$$



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

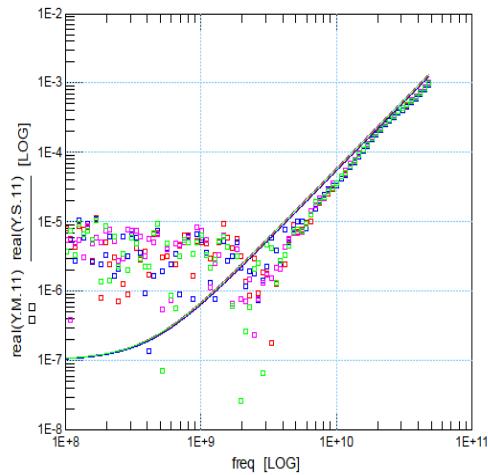


$$S21 = f(Vg, Vd)$$

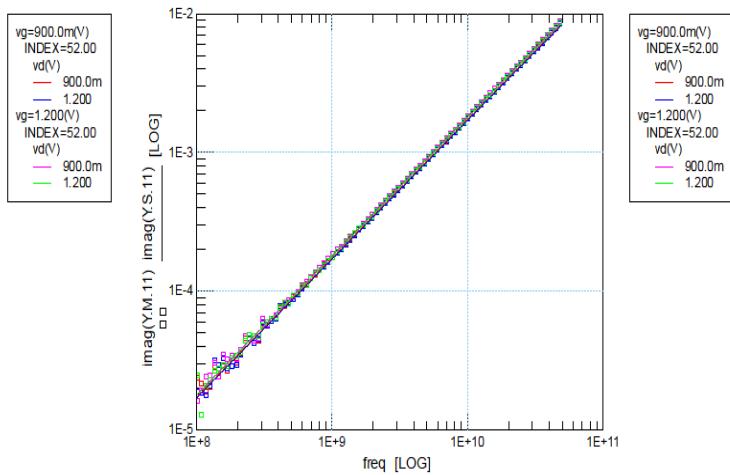


$$S12 = f(Vg, Vd)$$

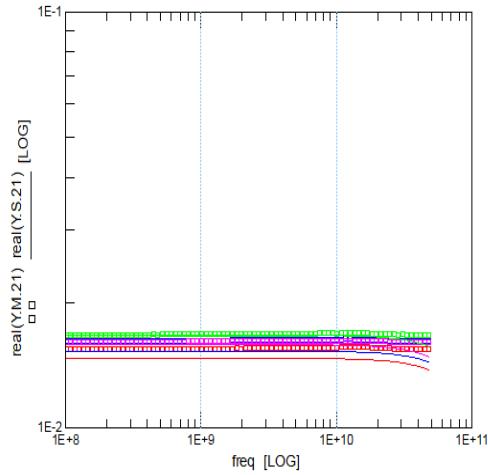
Y-Parameter, T = 27°C



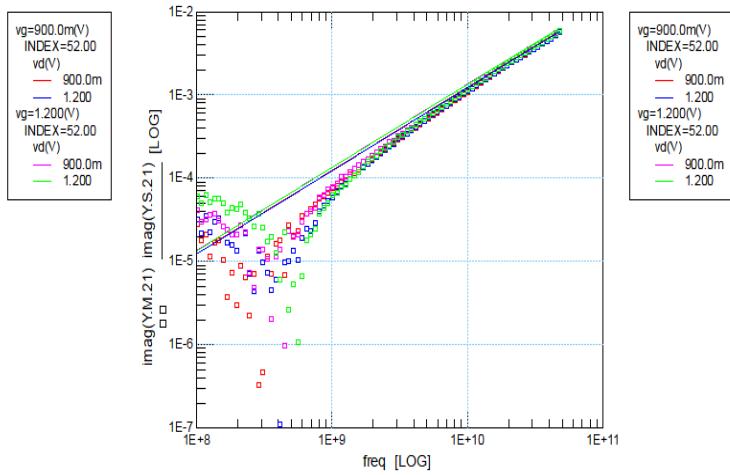
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



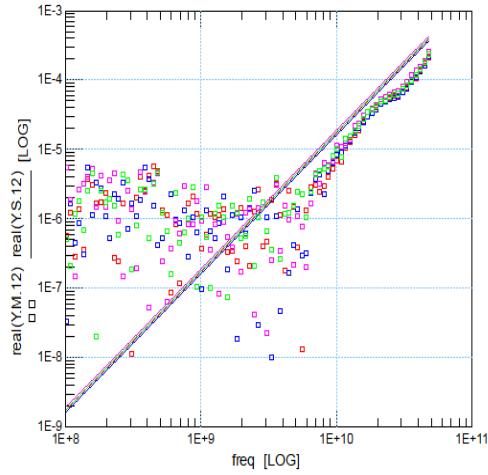
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



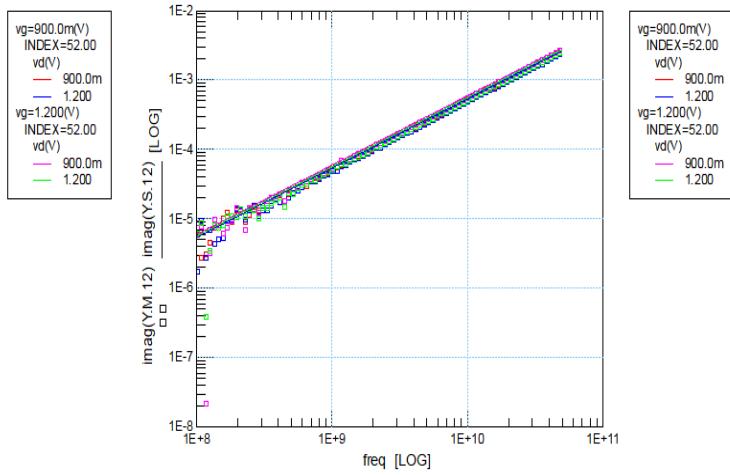
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



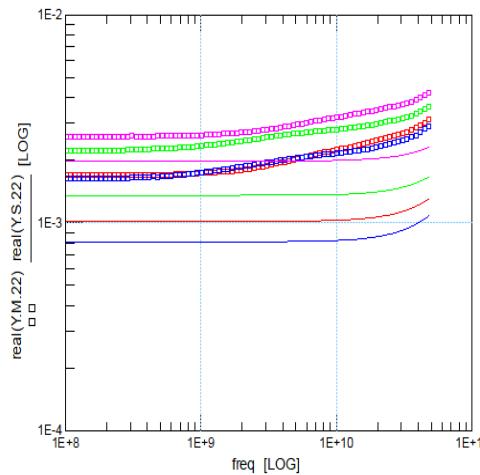
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



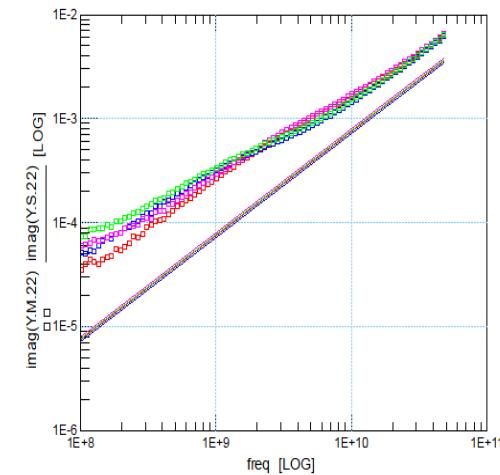
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



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

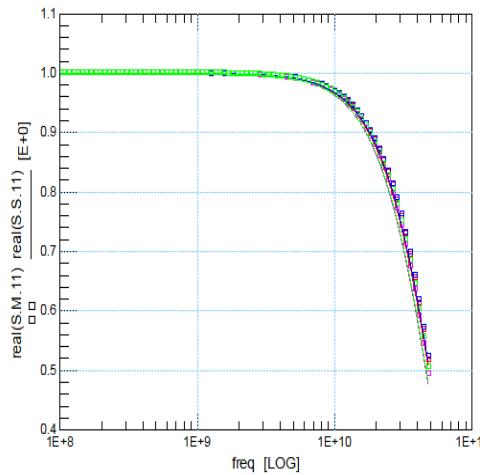


re(Y22) = f(Vg, Vd)

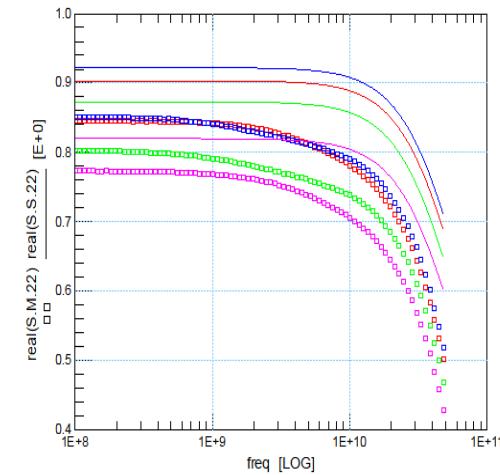


im(Y22) = f(Vg, Vd)

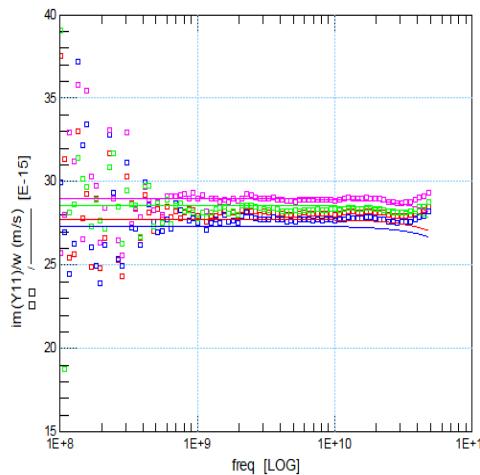
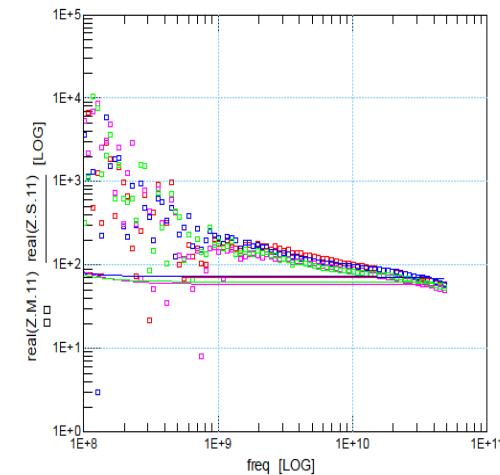
Verify Plots, T = 27°C



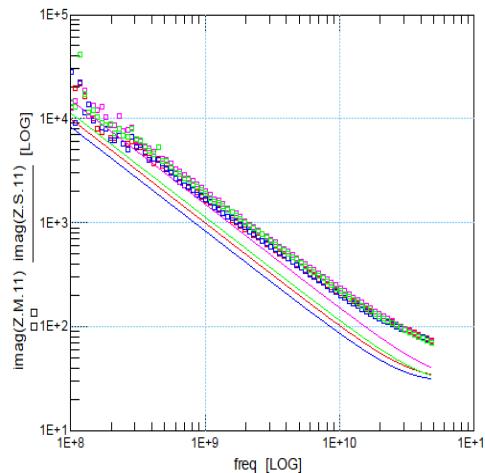
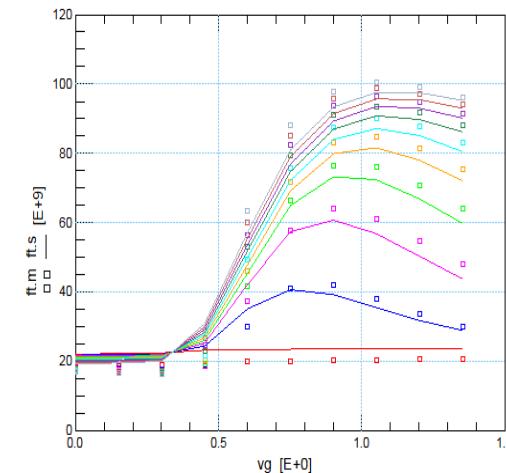
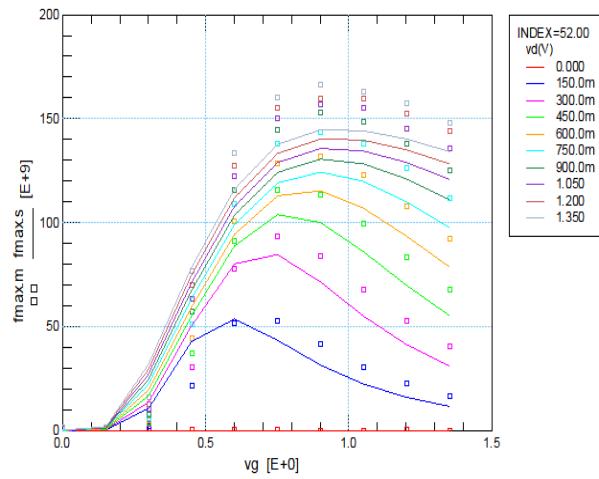
re(S11) = f(Vg, Vd)



re(S22) = f(Vg, Vd)

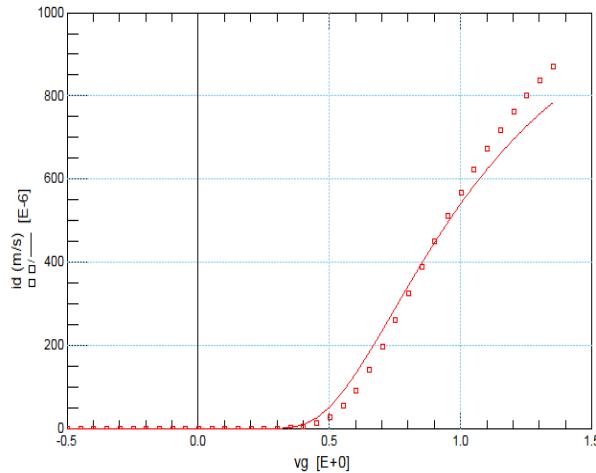
im(Y11) divided by ω 

re(Z11) = f(Vg, Vd)

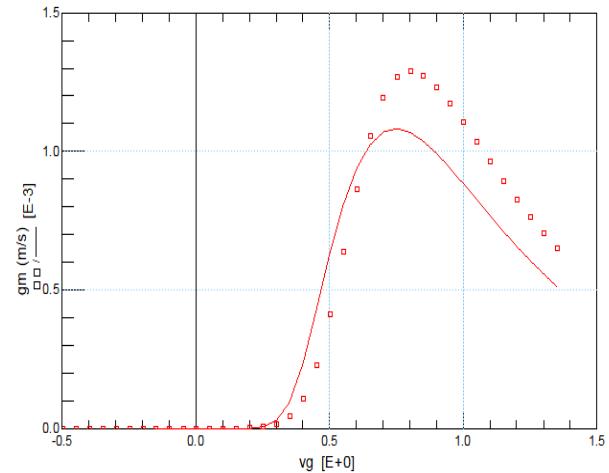
 $\text{im}(Z_{11}) = f(V_g, V_d)$  $fT_{vg} = f(V_g, V_d)$  $f_{\max, vg} = f(V_g, V_d)$

4.7 NF04_WF02u5_L0u13_S453A_24

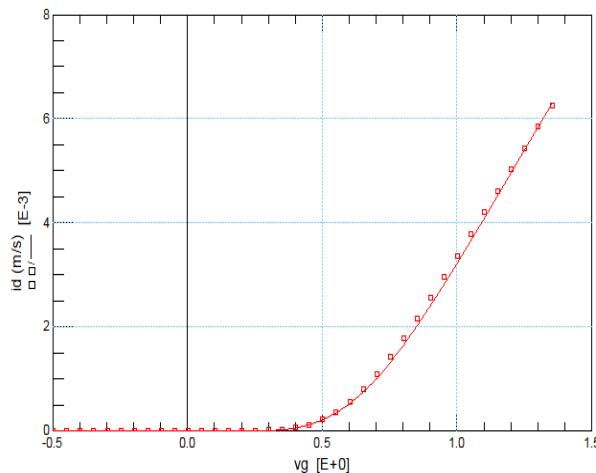
$IdVg$, $T = 27^\circ\text{C}$



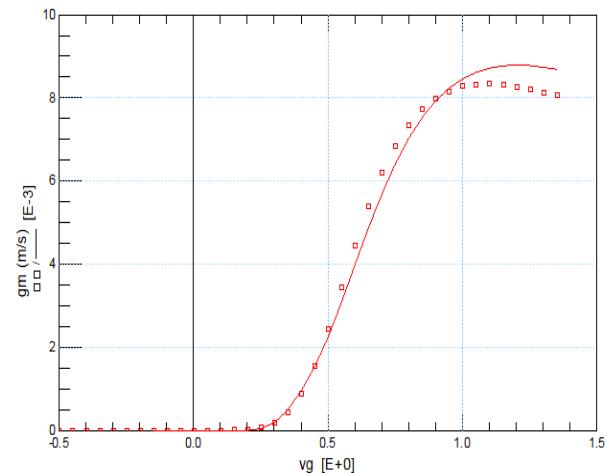
$Id = f(Vg)$ @ $Vd = 0.05\text{V}$



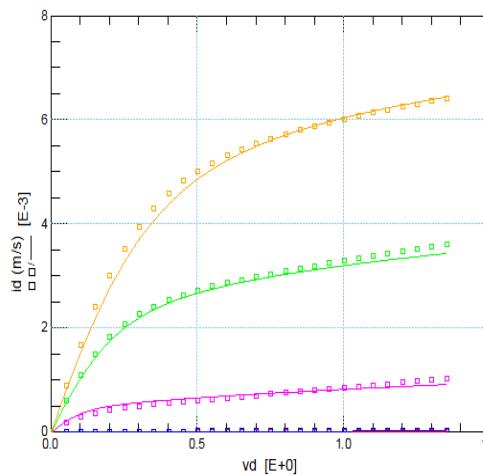
$gm = f(Vg)$ @ $Vd = 0.05\text{V}$



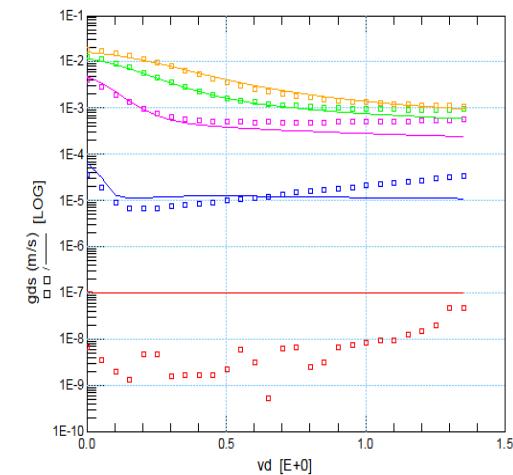
$Id = f(Vg)$ @ $Vd = 1.2\text{V}$



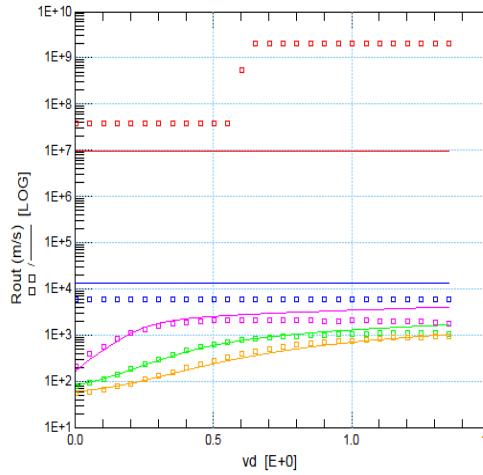
$gm = f(Vg)$ @ $Vd = 1.2\text{V}$

IdVd, T = 27°C

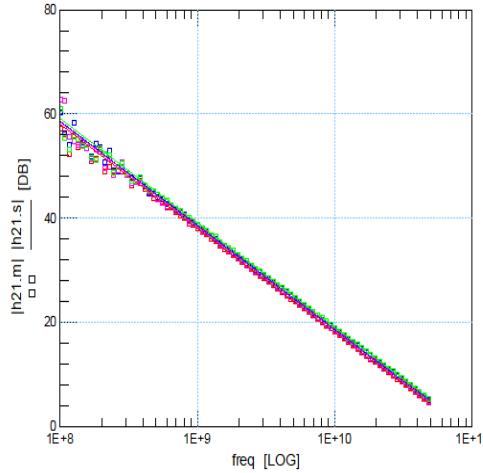
$$Id = f(Vd)$$



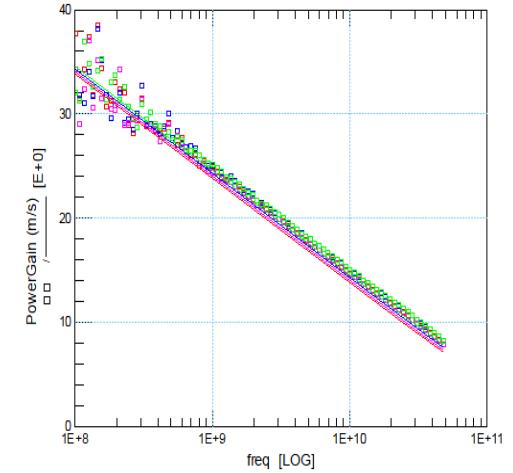
$$gds = f(Vd)$$



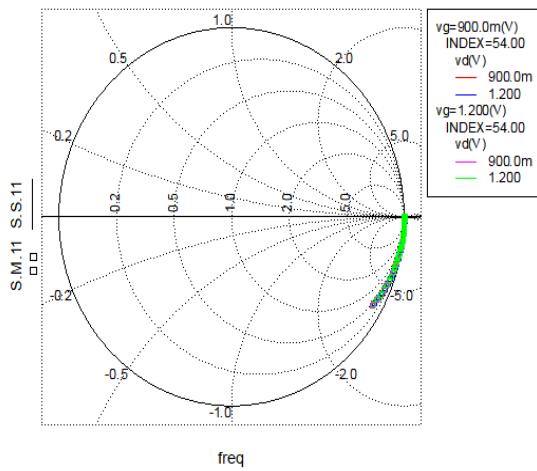
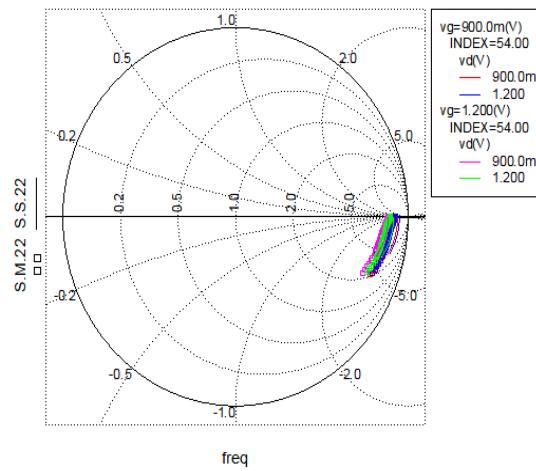
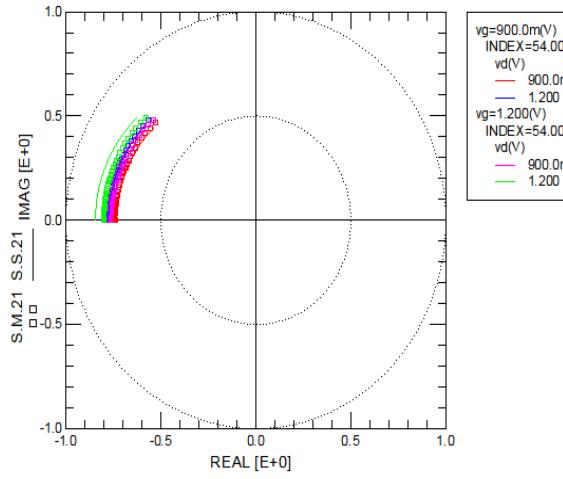
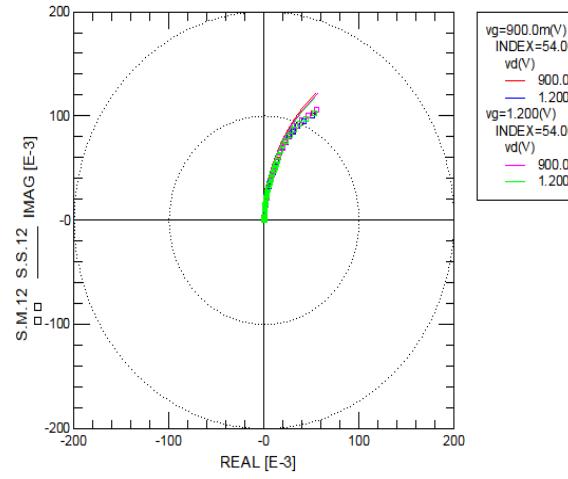
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

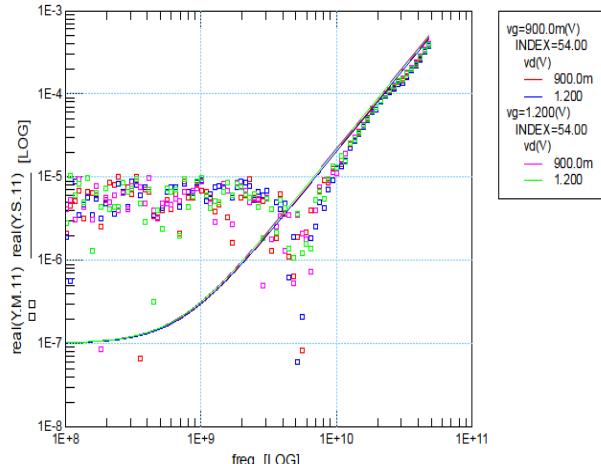
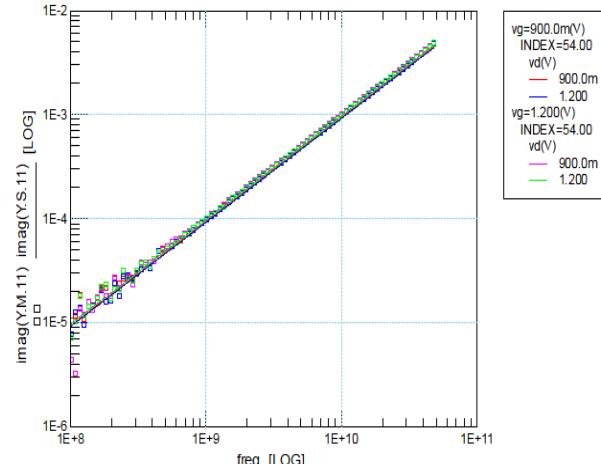
$$|h21| = f(Vg, Vd)$$

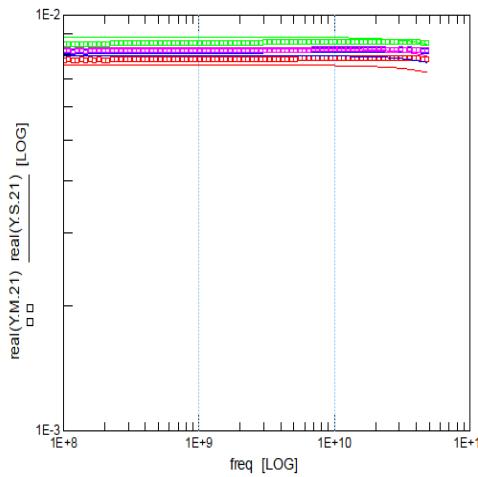


$$MSG/MAG = f(Vg, Vd)$$

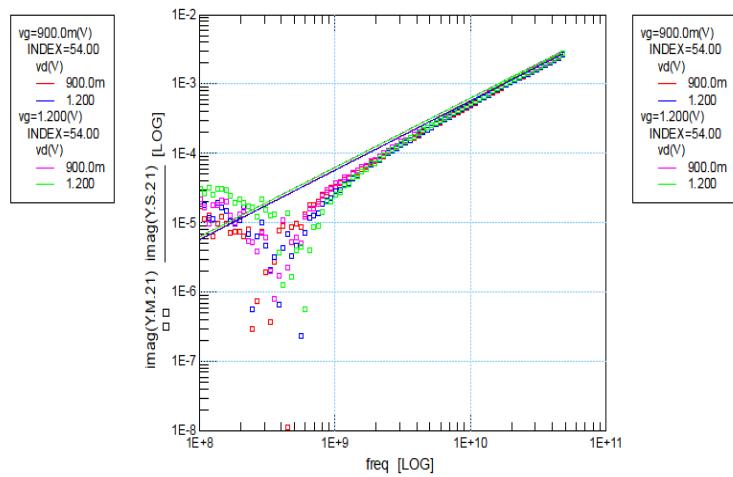
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

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

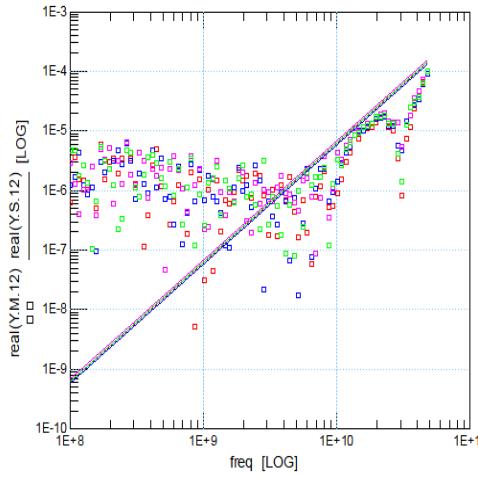
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



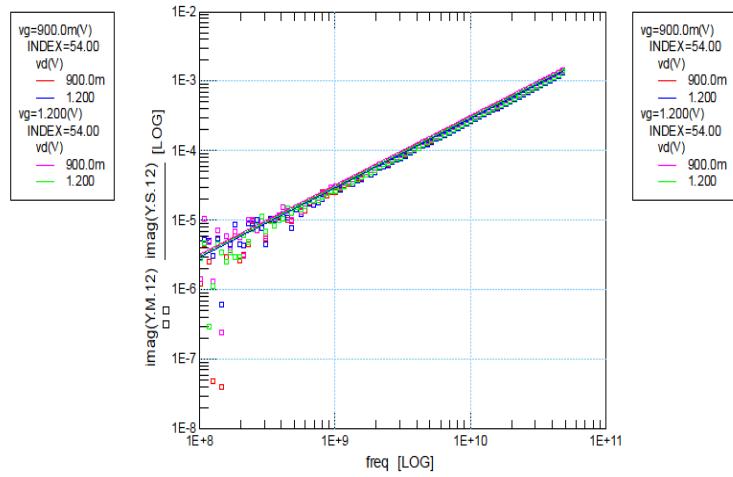
re(Y21) = f(Vg,Vd)



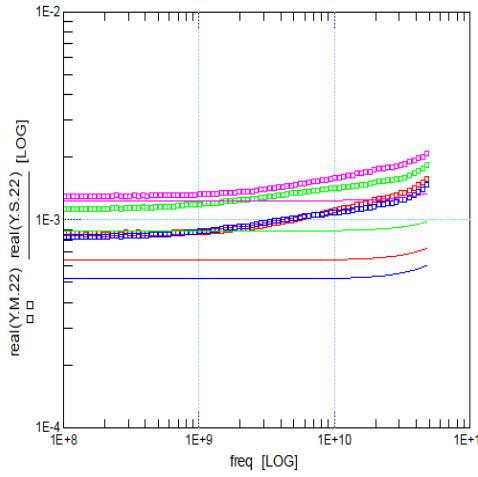
im(Y21) = f(Vg,Vd)



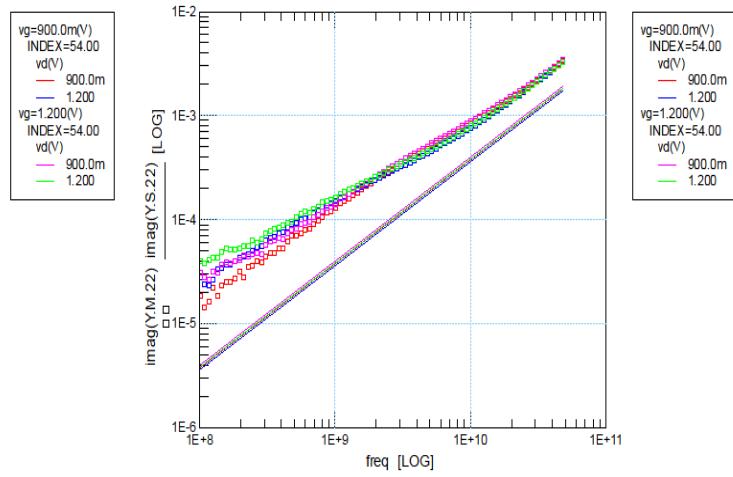
re(Y12) = f(Vg,Vd)



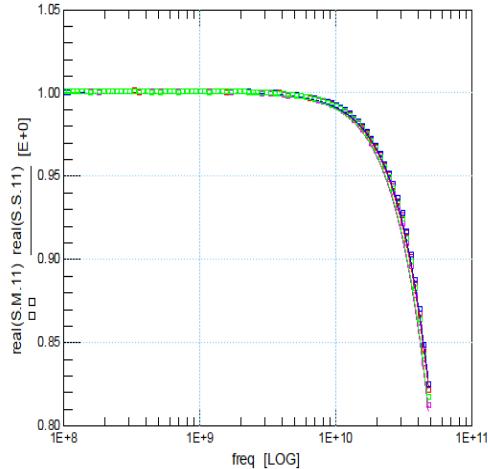
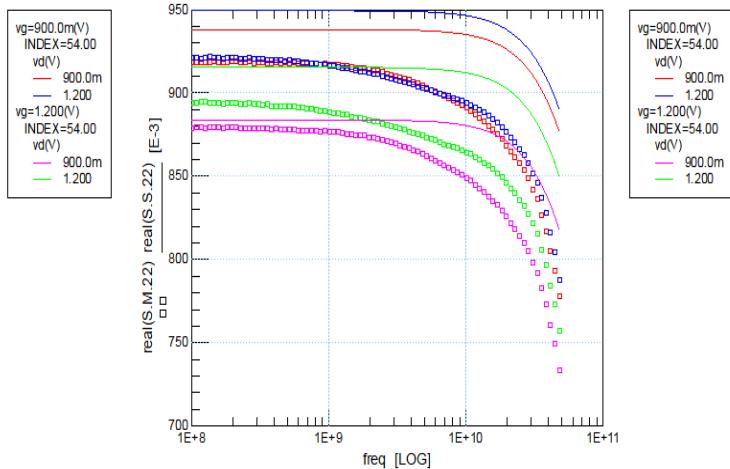
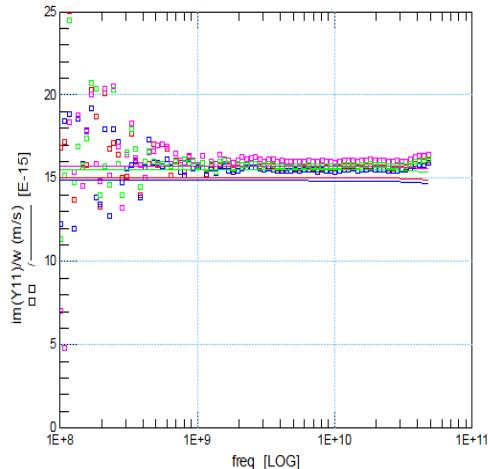
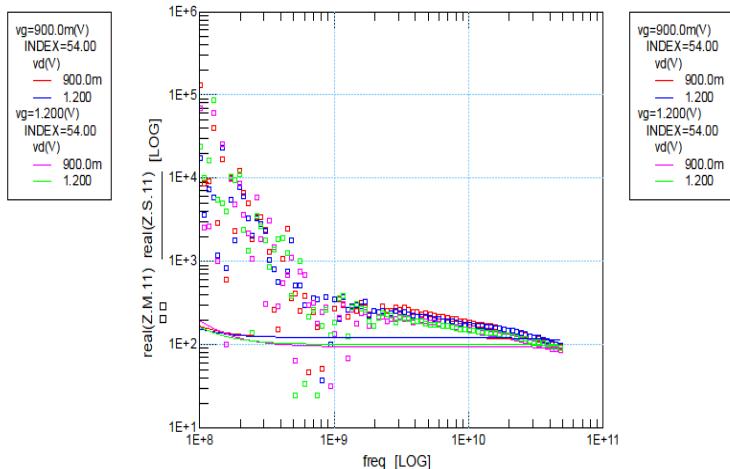
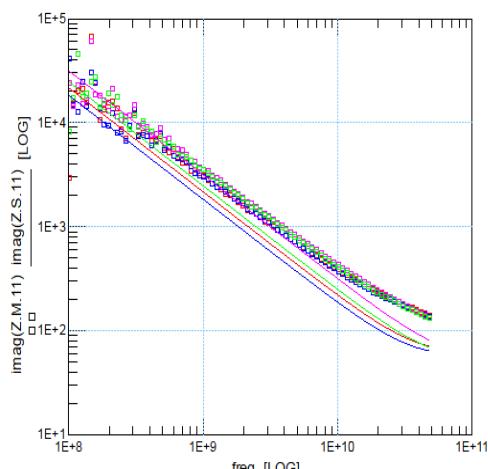
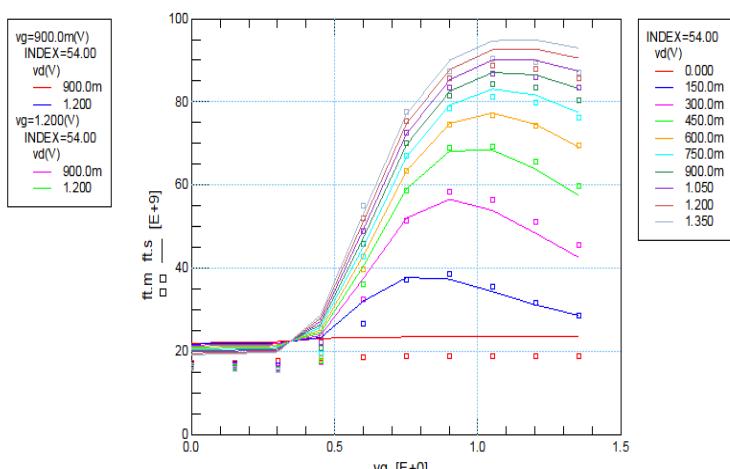
im(Y12) = f(Vg,Vd)

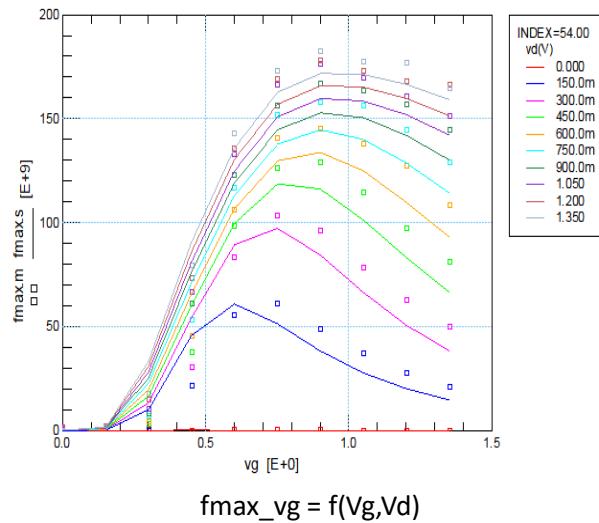


re(Y22) = f(Vg,Vd)



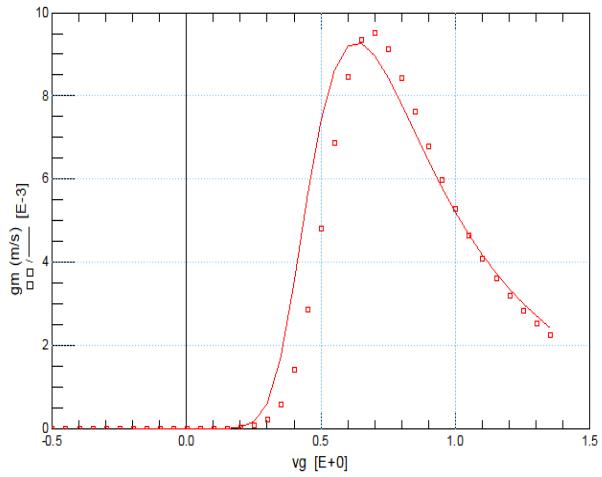
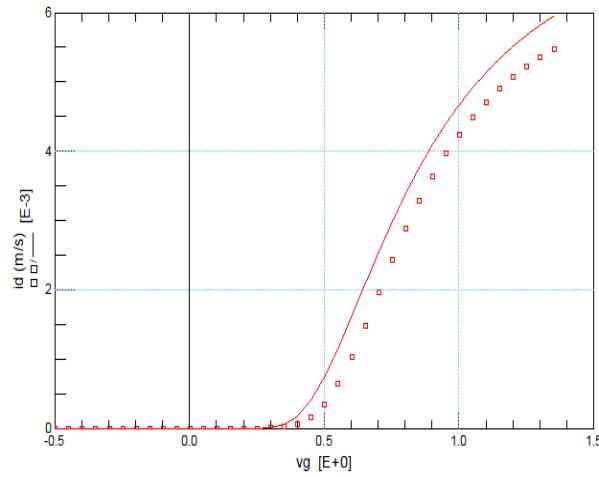
im(Y22) = f(Vg,Vd)

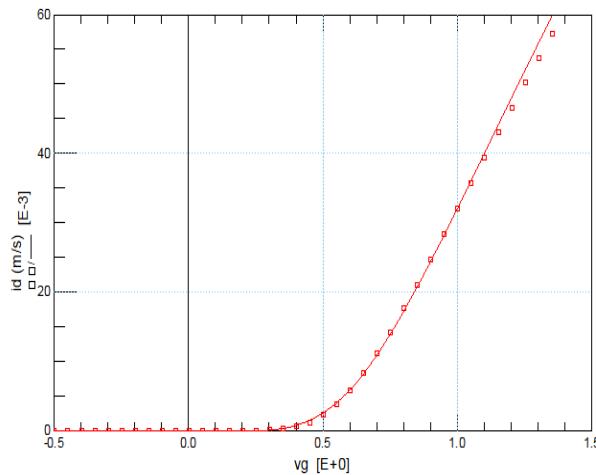
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



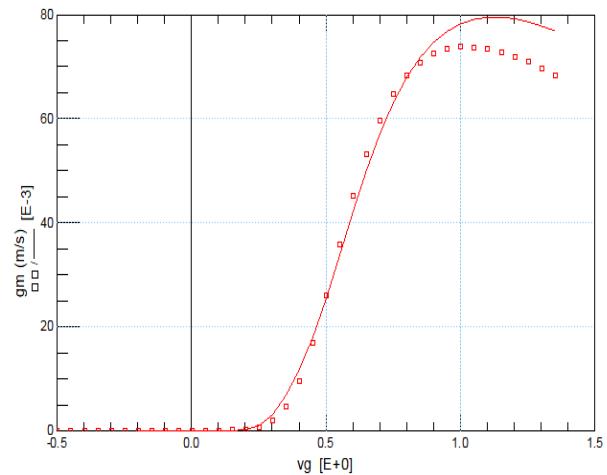
4.8 NF10_WF10u0_L0u13_S453A_00

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



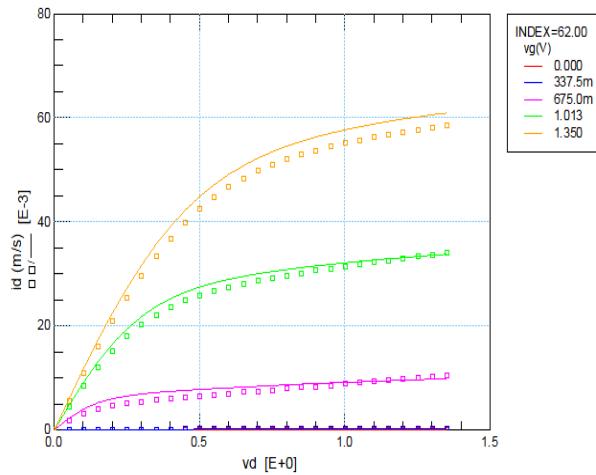


$$Id = f(Vg) @ Vd = 1.2V$$

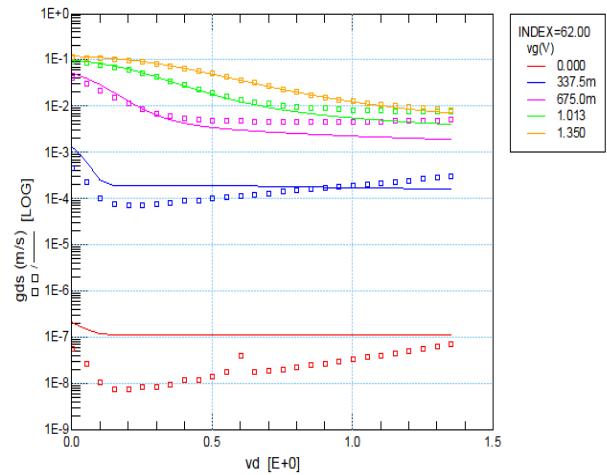


$$gm = f(Vg) @ Vd = 1.2V$$

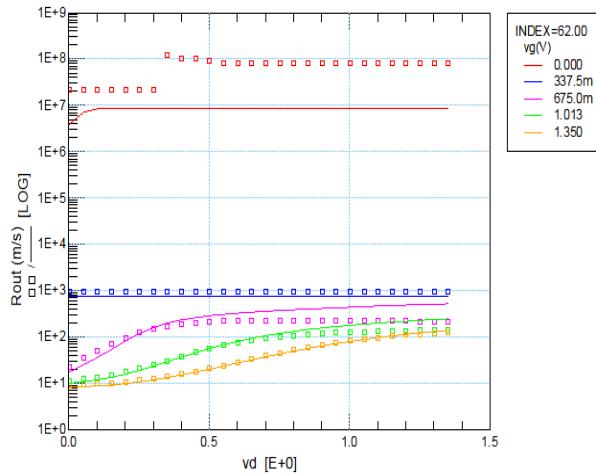
IdVd, T = 27°C



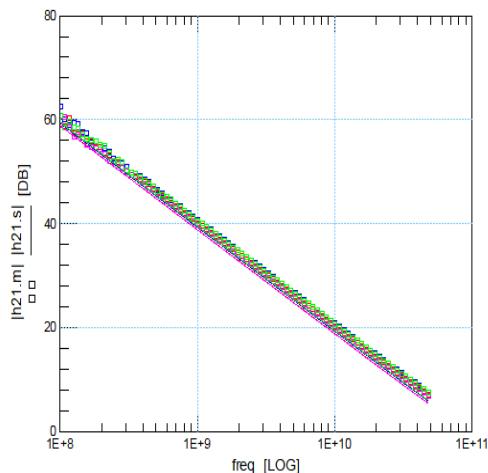
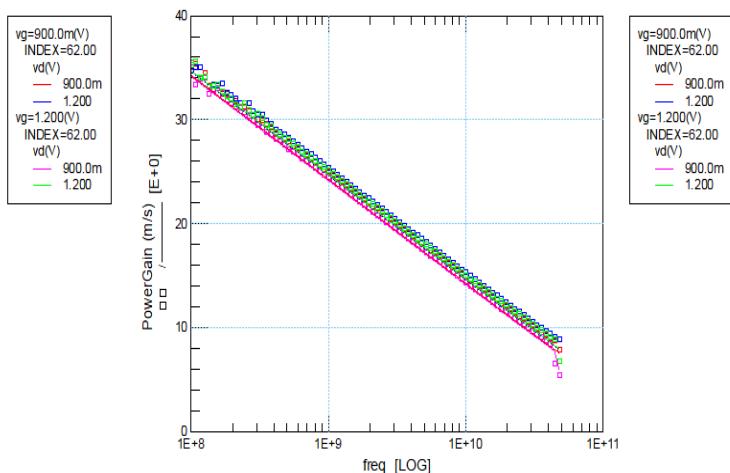
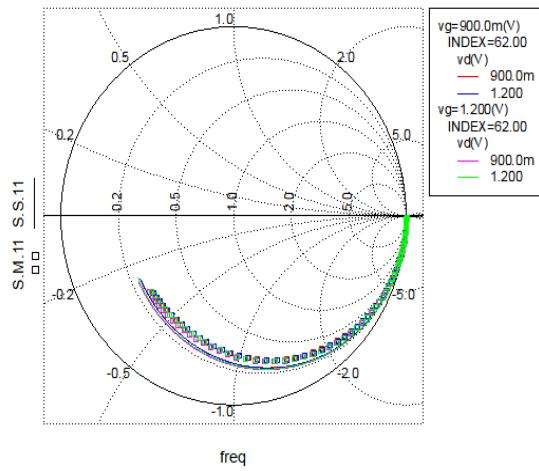
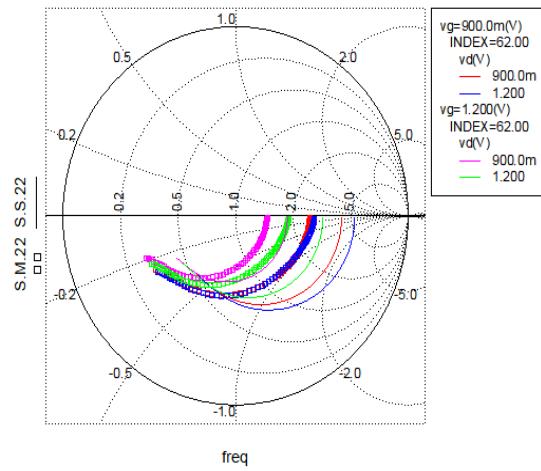
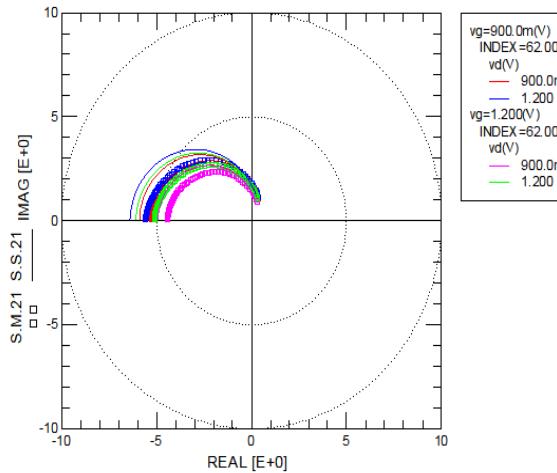
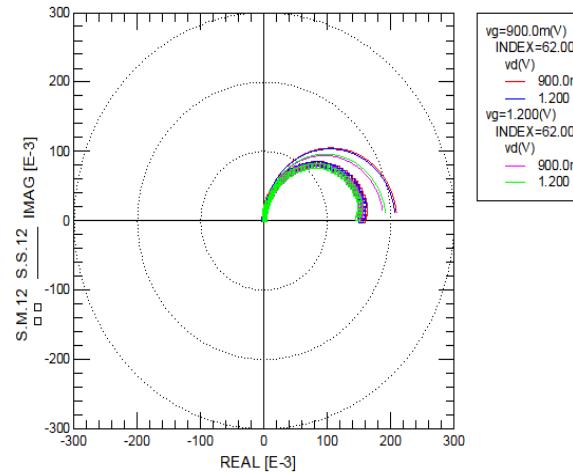
$$Id = f(Vd)$$



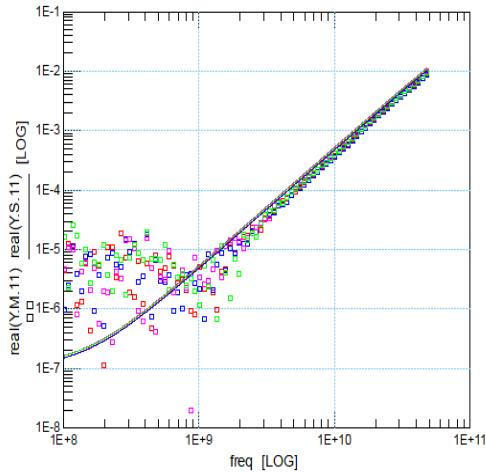
$$gds = f(Vd)$$



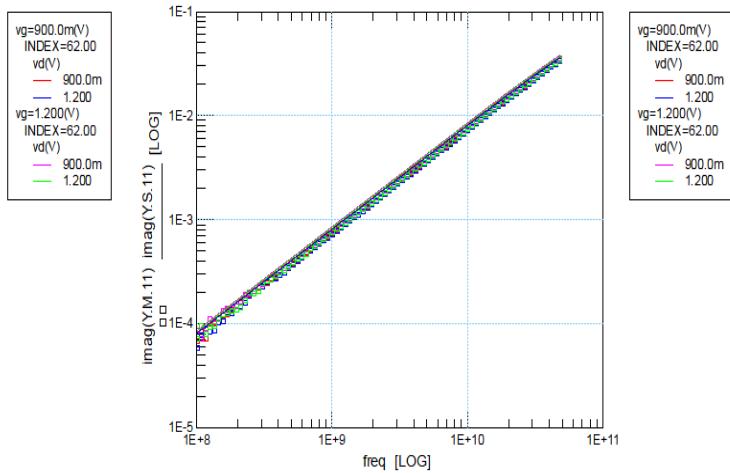
$$Rout = f(Vd)$$

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

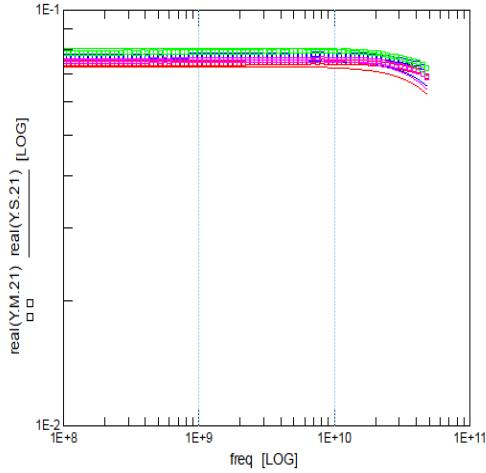
Y-Parameter, T = 27°C



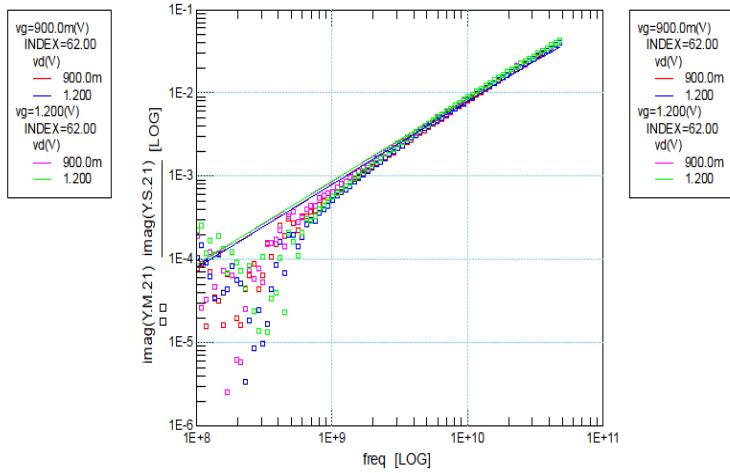
$$\text{re}(Y11) = f(Vg, Vd)$$



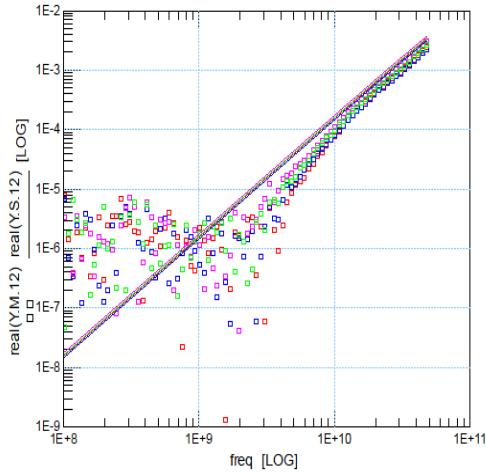
$$\text{im}(Y11) = f(Vg, Vd)$$



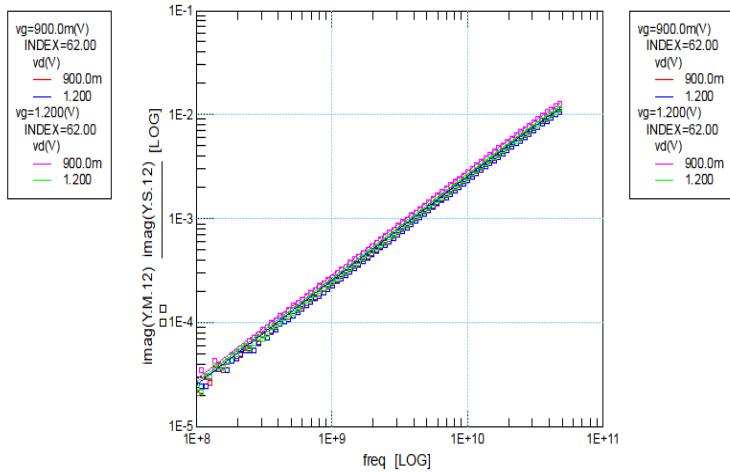
$$\text{re}(Y21) = f(Vg, Vd)$$



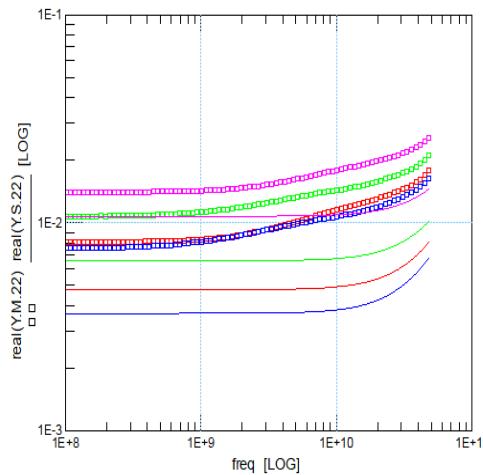
$$\text{im}(Y21) = f(Vg, Vd)$$



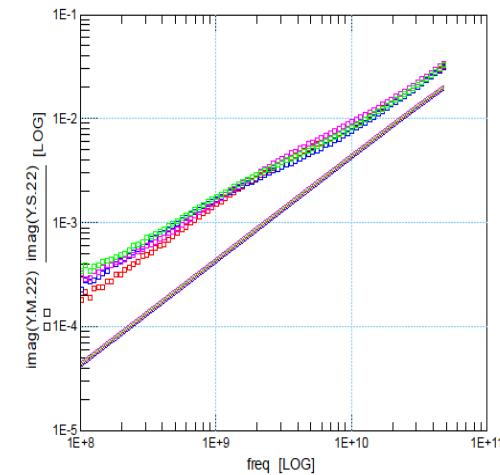
$$\text{re}(Y12) = f(Vg, Vd)$$



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

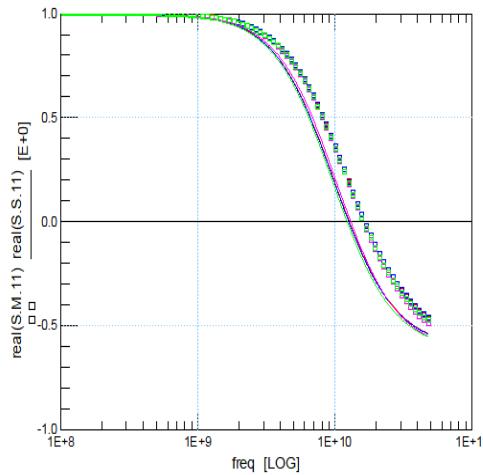


$$\text{re}(Y22) = f(Vg, Vd)$$

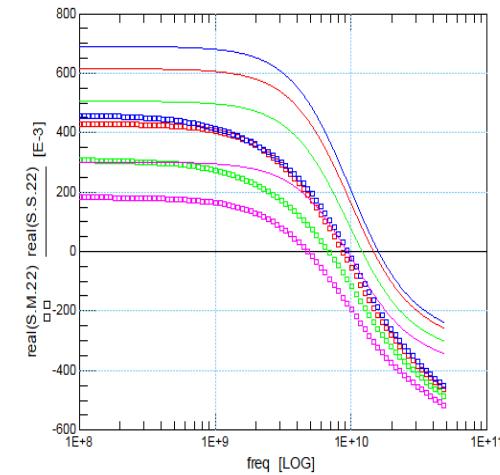


$$\text{im}(Y22) = f(Vg, Vd)$$

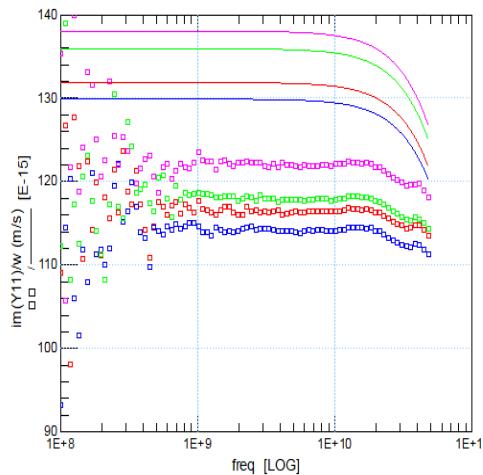
Verify Plots, T = 27°C



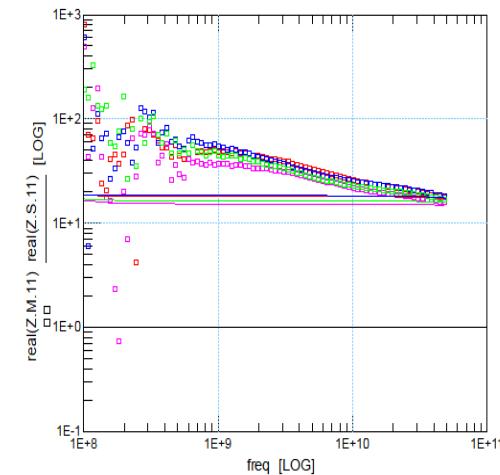
$$\text{re}(S11) = f(Vg, Vd)$$



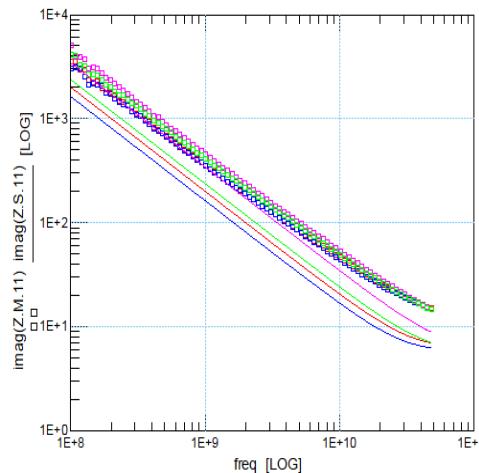
$$\text{re}(S22) = f(Vg, Vd)$$



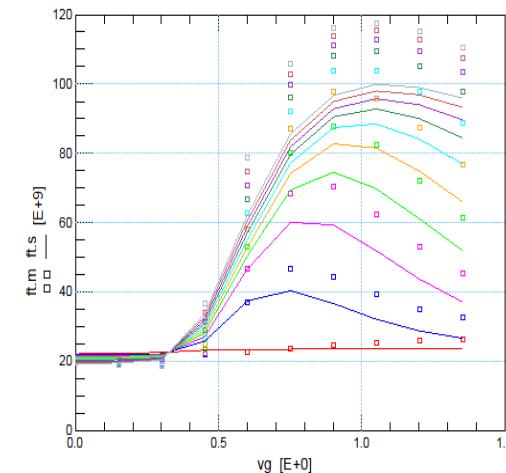
$$\text{im}(Y11) \text{ divided by } \omega$$



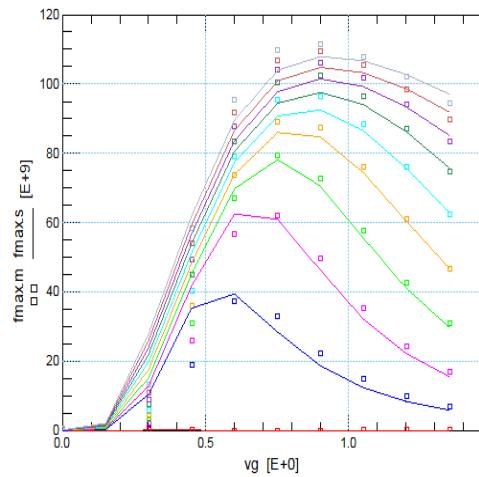
$$\text{re}(Z11) = f(Vg, Vd)$$



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



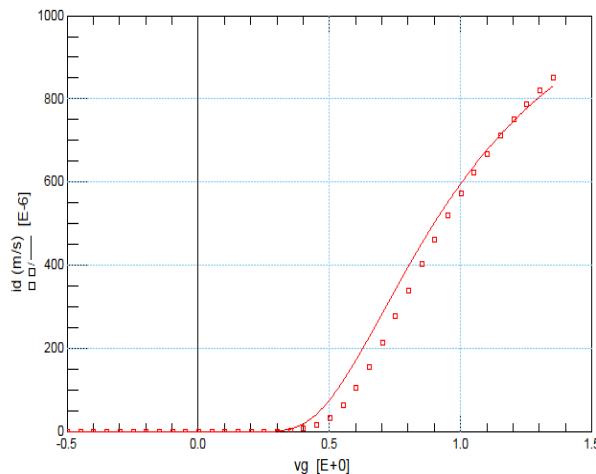
$$fT_{vg} = f(V_g, V_d)$$



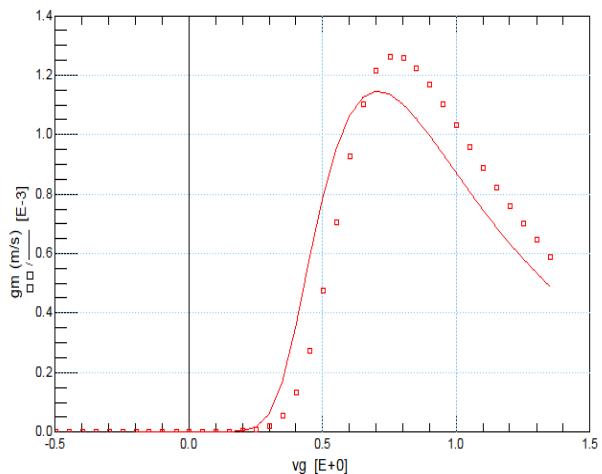
$$f_{\text{max}}_{vg} = f(V_g, V_d)$$

4.9 NF01_WF10u0_L0u13_S453A_44

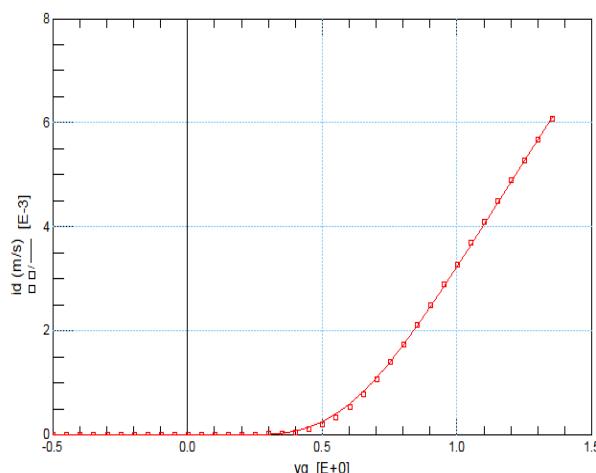
$IdVg$, $T = 27^\circ\text{C}$



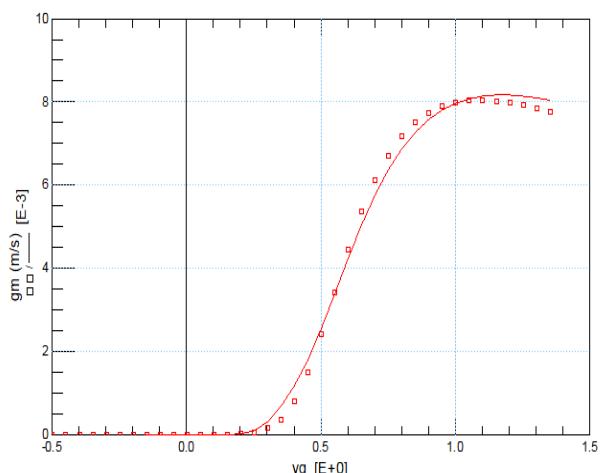
$Id = f(Vg)$ @ $Vd = 0.05\text{V}$



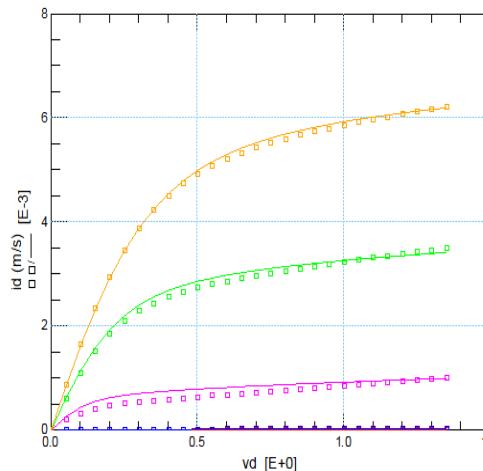
$gm = f(Vg)$ @ $Vd = 0.05\text{V}$



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

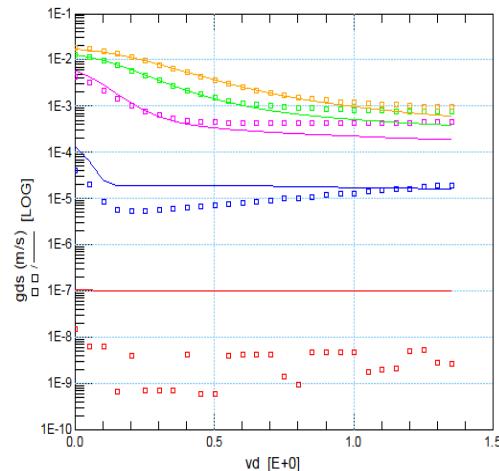


$gm = f(Vg)$ @ $Vd = 1.2\text{V}$

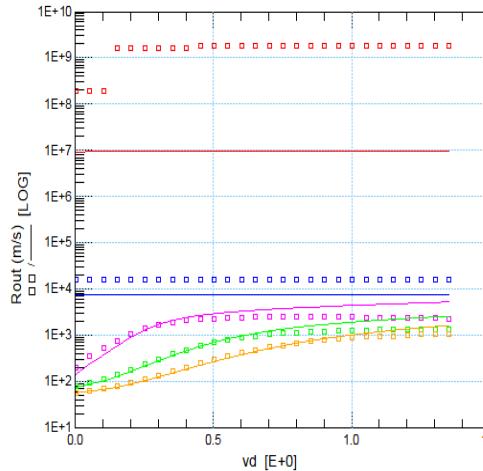
IdVd, T = 27°C

$$Id = f(Vd)$$

INDEX=63.00
vg(V)
0.000
337.5m
675.0m
1.013
1.350



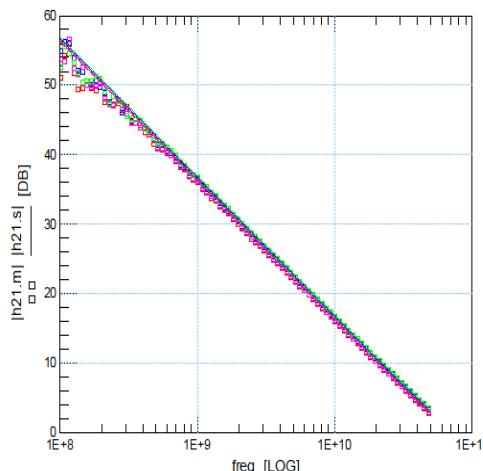
$$gds = f(Vd)$$



$$Rout = f(Vd)$$

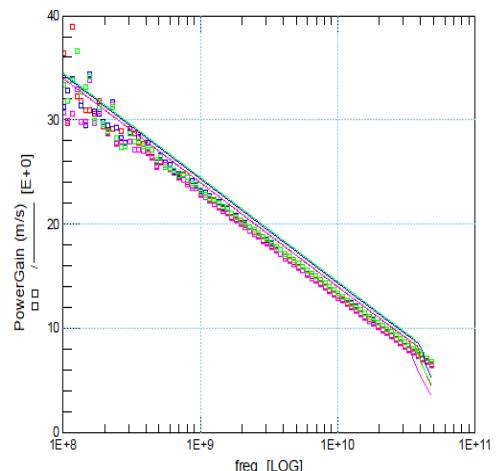
INDEX=63.00
vg(V)
0.000
337.5m
675.0m
1.013
1.350

$$Rout = f(Vd)$$

S-Parameter, T = 27°C

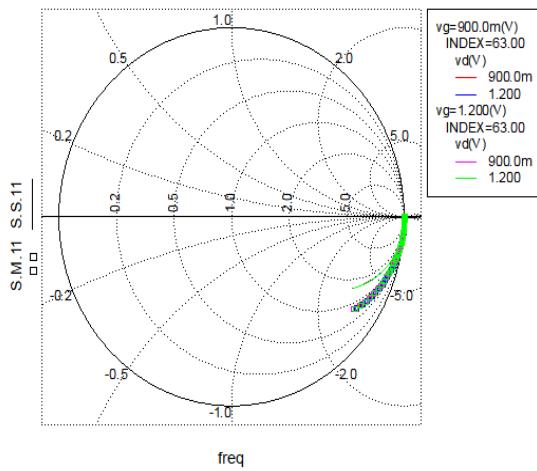
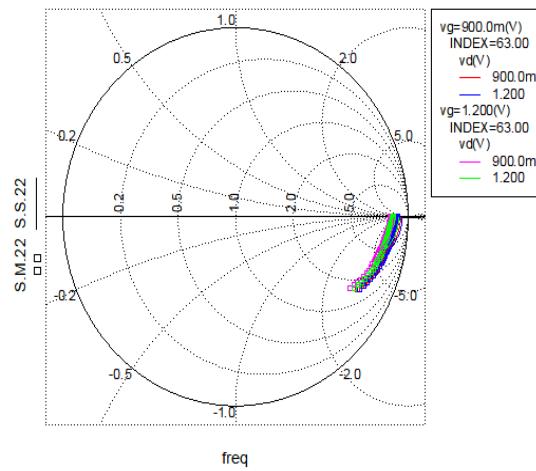
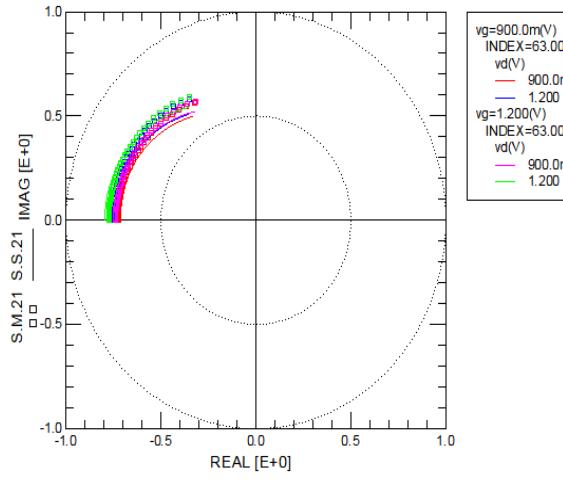
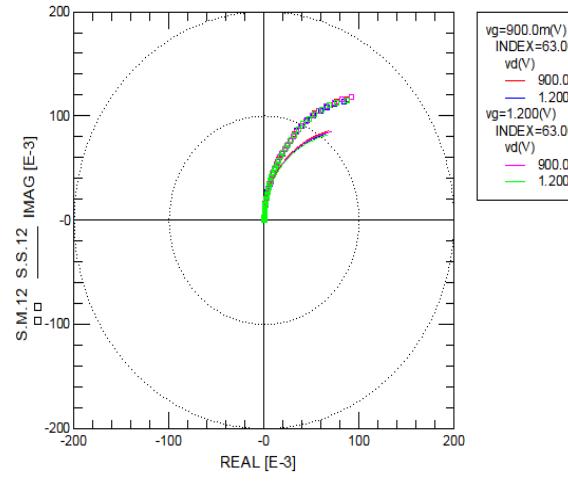
$$|h21| = f(Vg, Vd)$$

vg=900.0mV
INDEX=63.00
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=63.00
vd(V)
900.0m
1.200

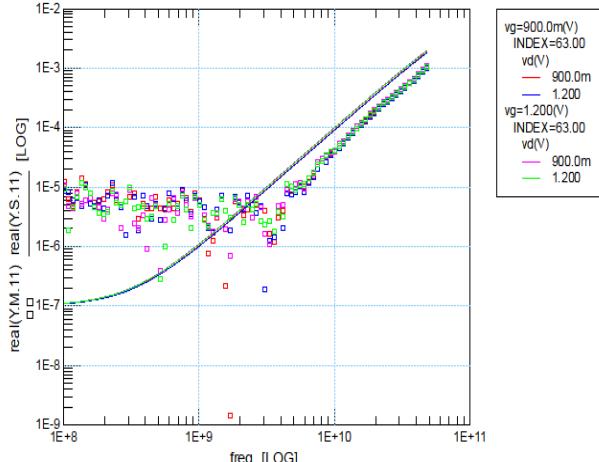
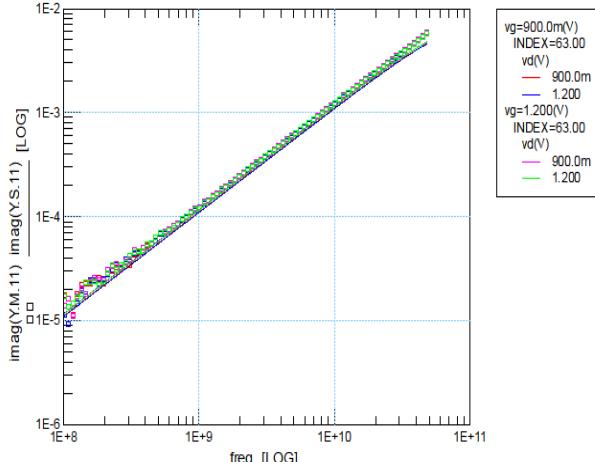


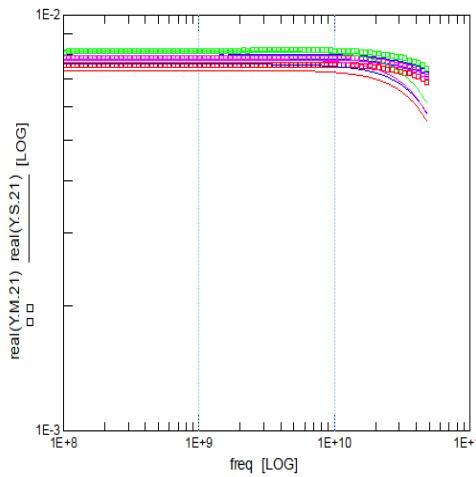
$$MSG/MAG = f(Vg, Vd)$$

vg=900.0mV
INDEX=63.00
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=63.00
vd(V)
900.0m
1.200

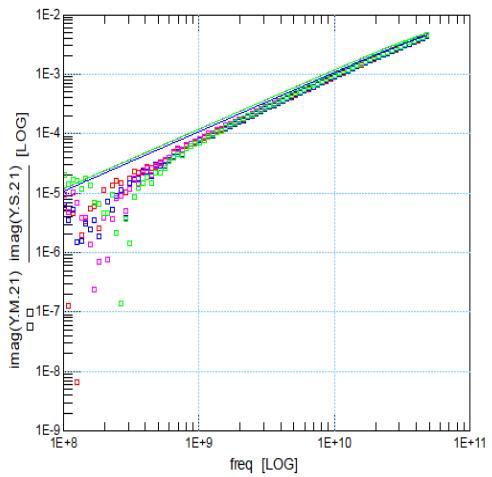
 $S_{11} = f(Vg, Vd)$  $S_{22} = f(Vg, Vd)$  $S_{21} = f(Vg, Vd)$  $S_{12} = f(Vg, Vd)$

Y-Parameter, T = 27°C

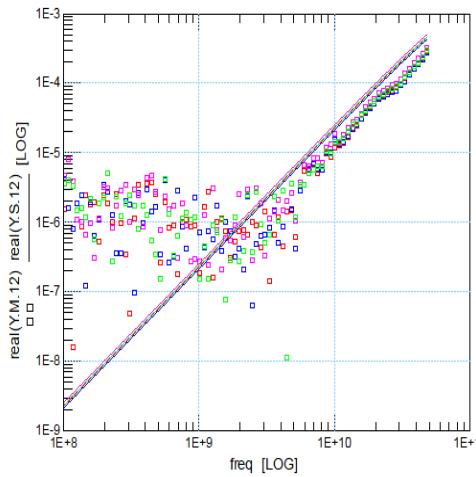
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



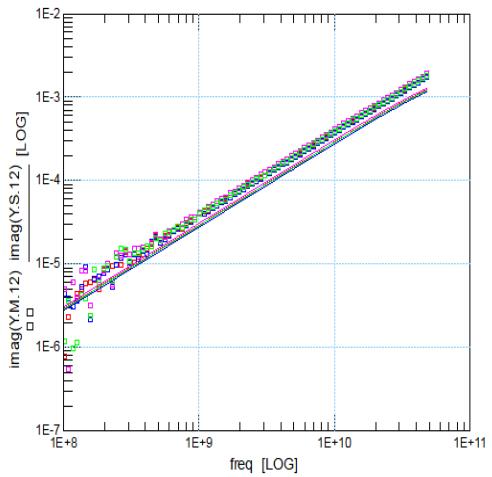
re(Y21) = f(Vg,Vd)



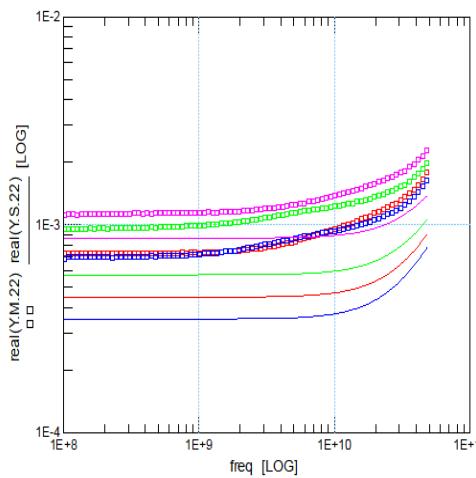
im(Y21) = f(Vg,Vd)



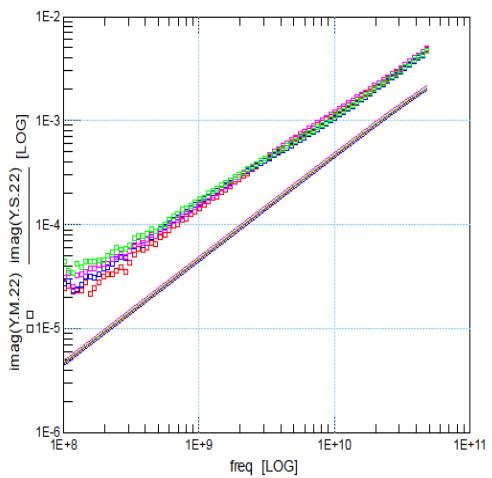
re(Y12) = f(Vg,Vd)



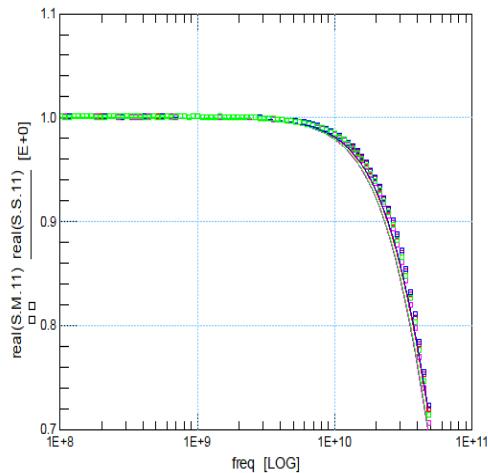
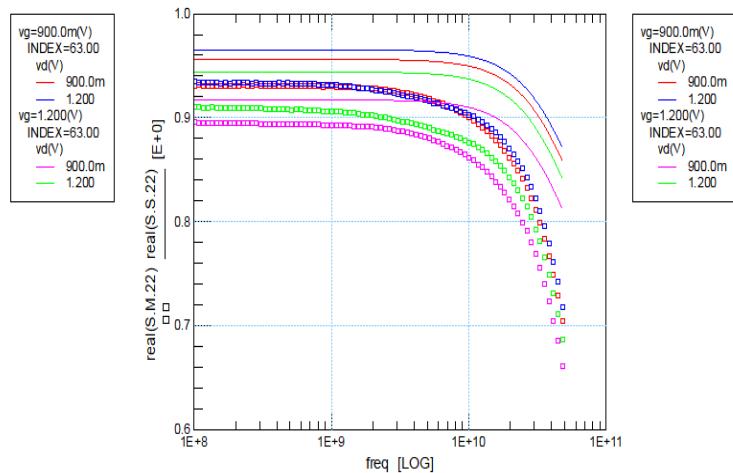
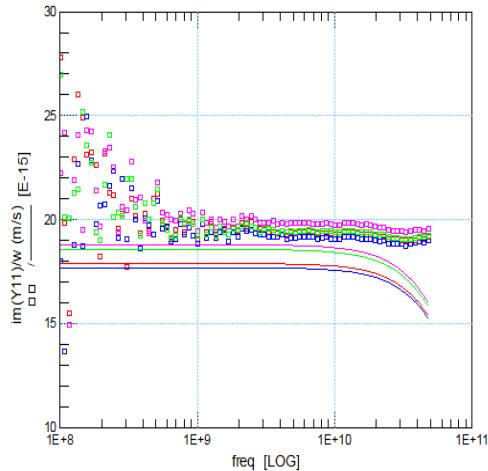
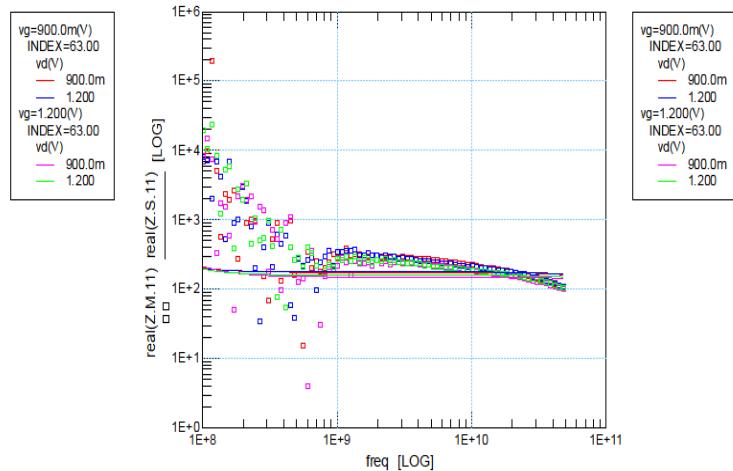
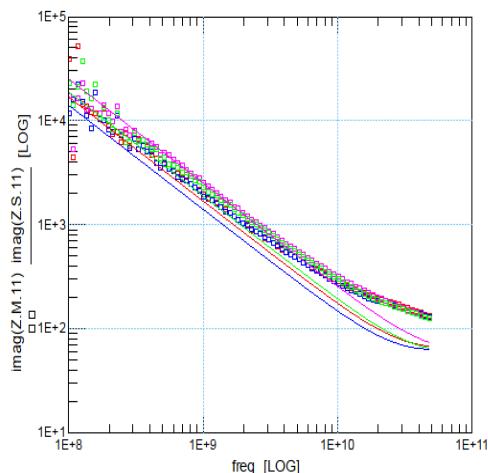
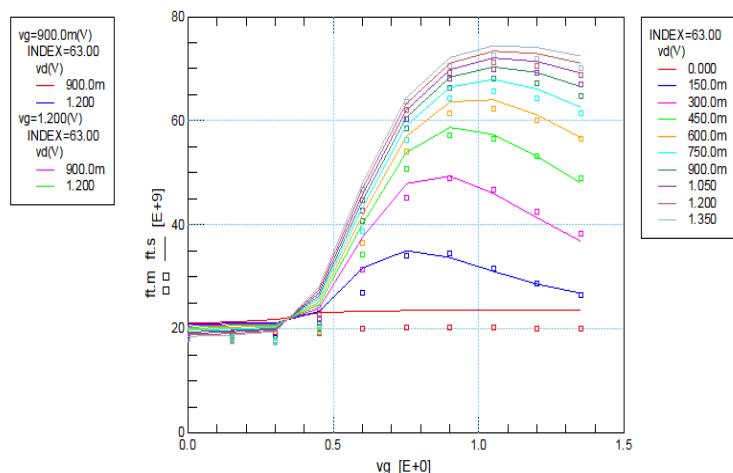
im(Y12) = f(Vg,Vd)

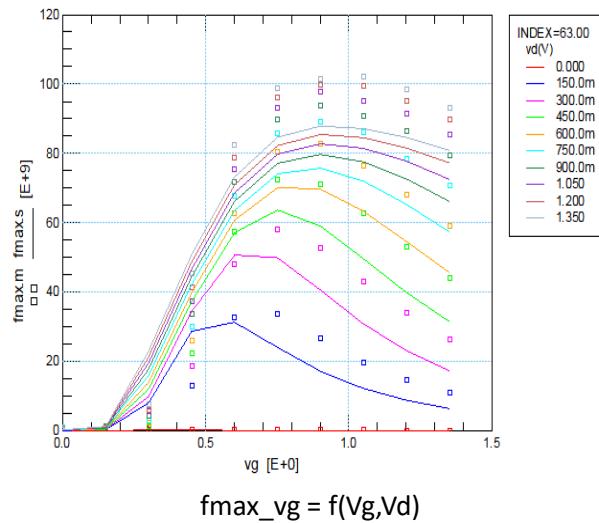


re(Y22) = f(Vg,Vd)



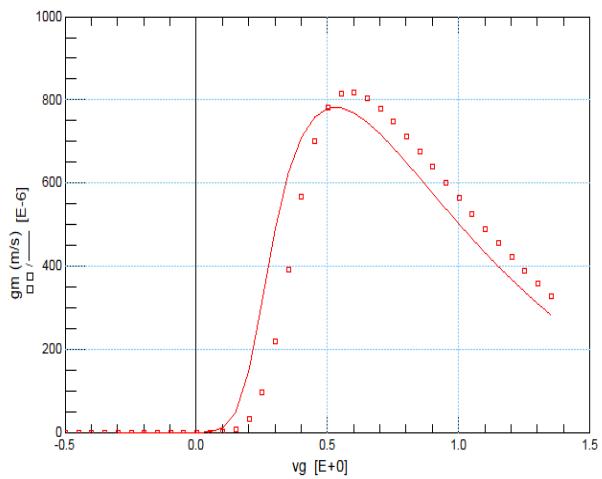
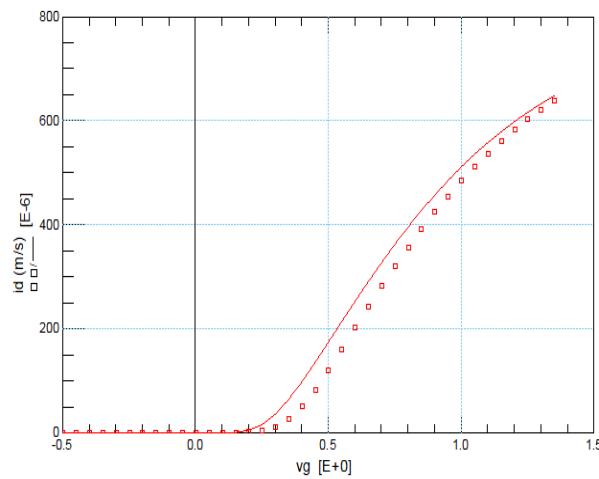
im(Y22) = f(Vg,Vd)

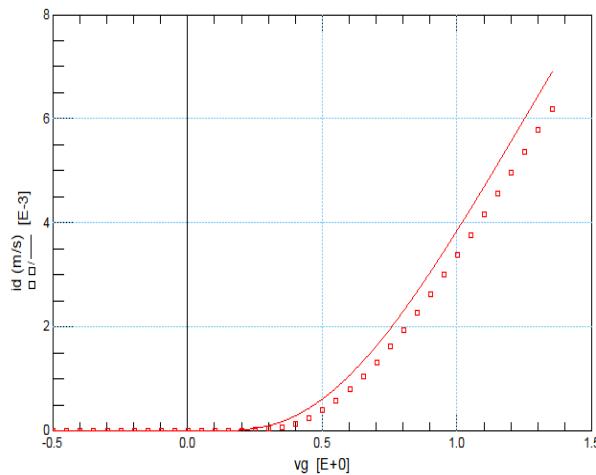
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



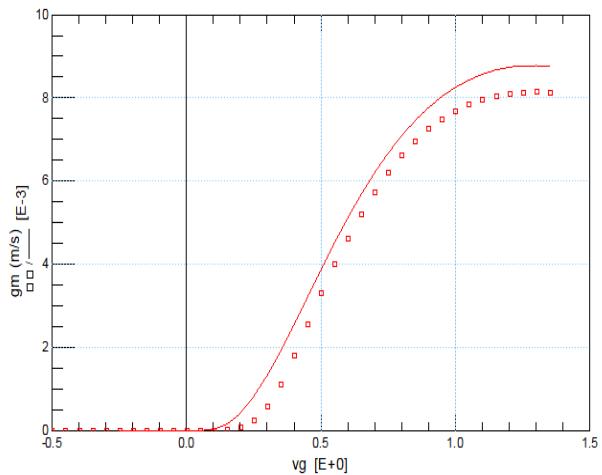
4.10NF04_WF05u0_L0u5_S453A_23

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



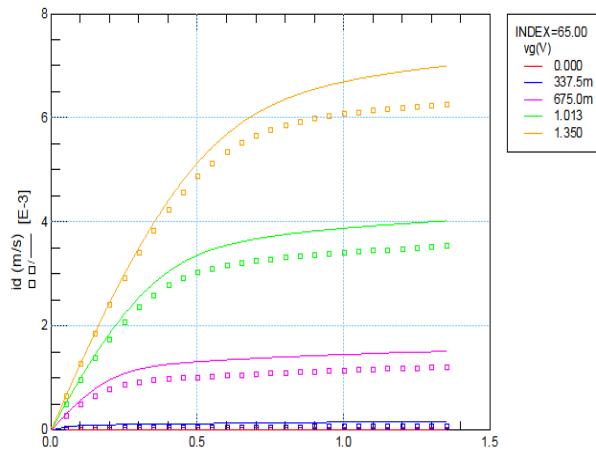


$$Id = f(Vg) @ Vd = 1.2V$$

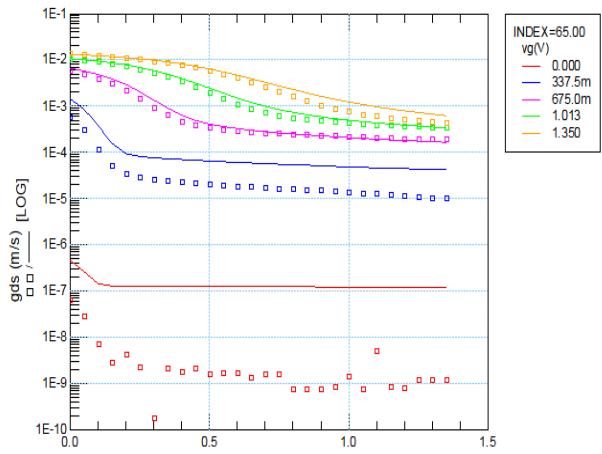


$$gm = f(Vg) @ Vd = 1.2V$$

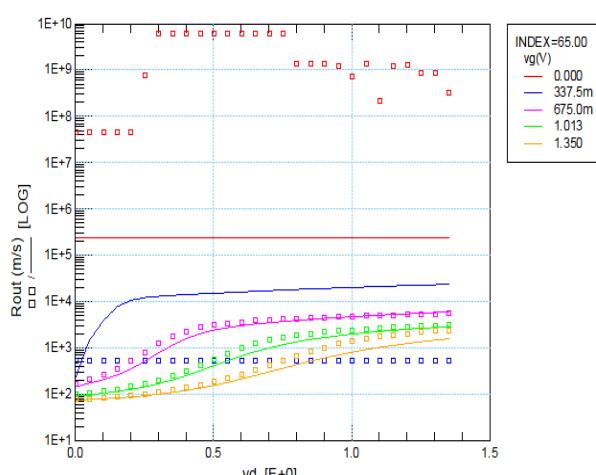
IdVd, T = 27°C



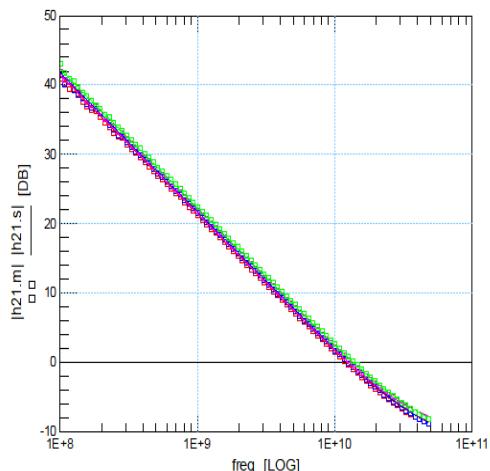
$$Id = f(Vd)$$



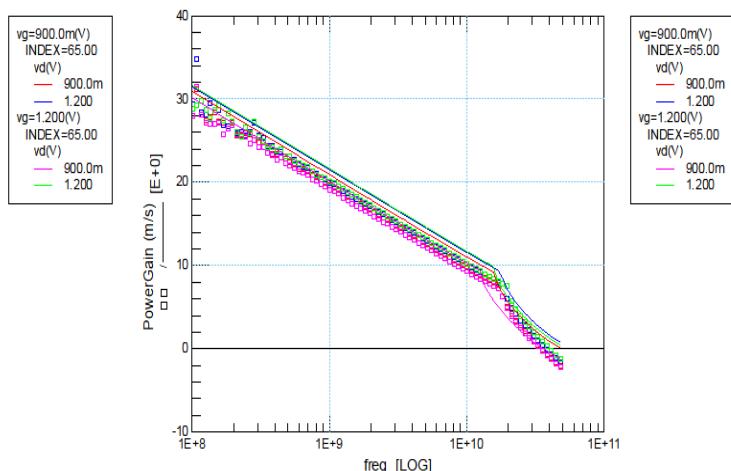
$$gds = f(Vd)$$



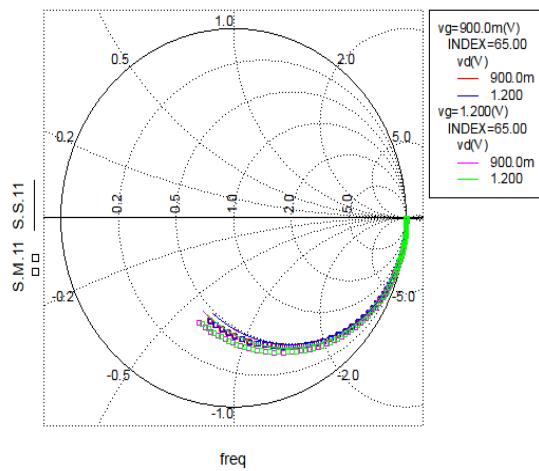
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

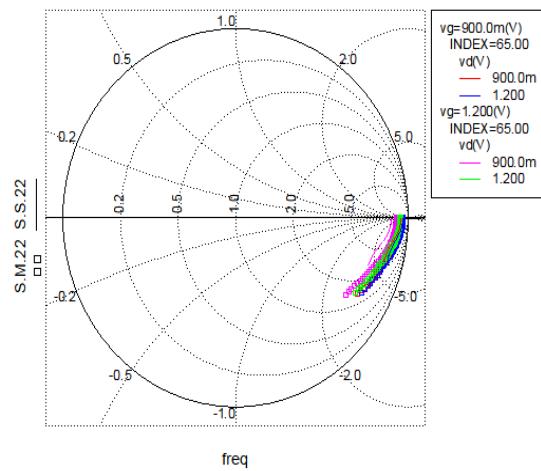
$$|h21| = f(Vg, Vd)$$



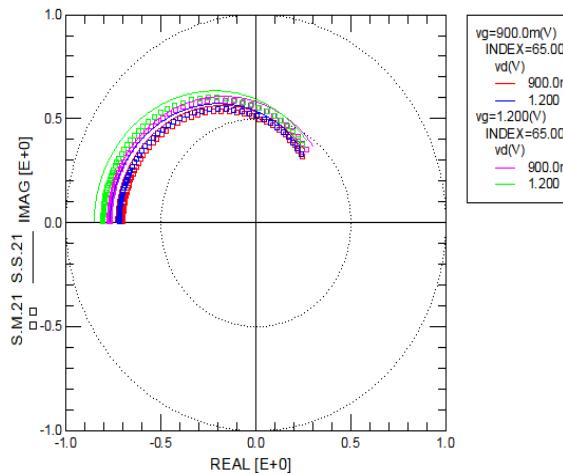
$$MSG/MAG = f(Vg, Vd)$$



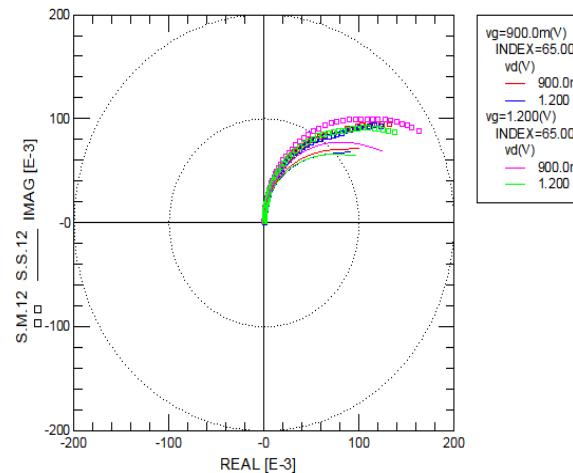
$$S11 = f(Vg, Vd)$$



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

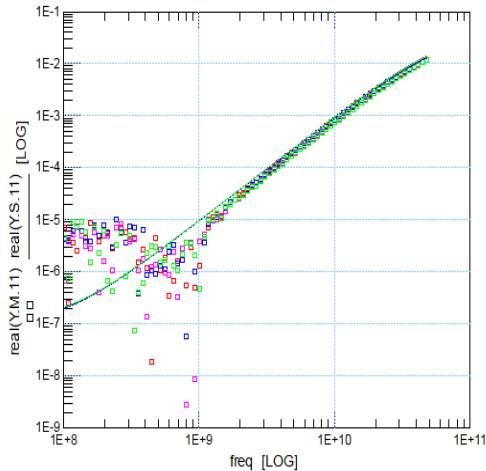


$$S21 = f(Vg, Vd)$$

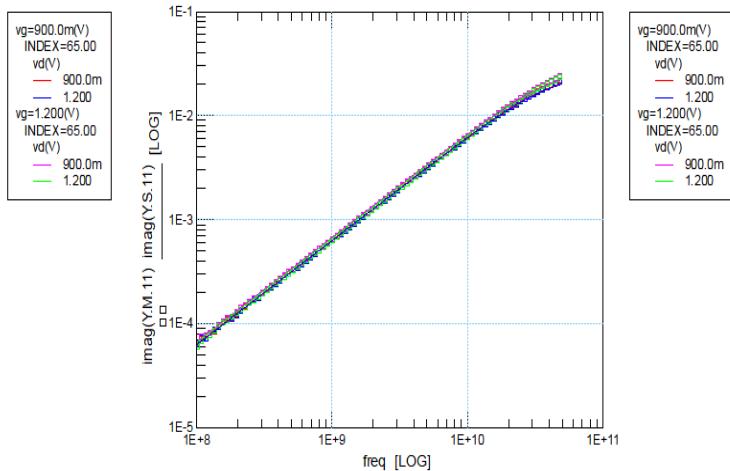


$$S12 = f(Vg, Vd)$$

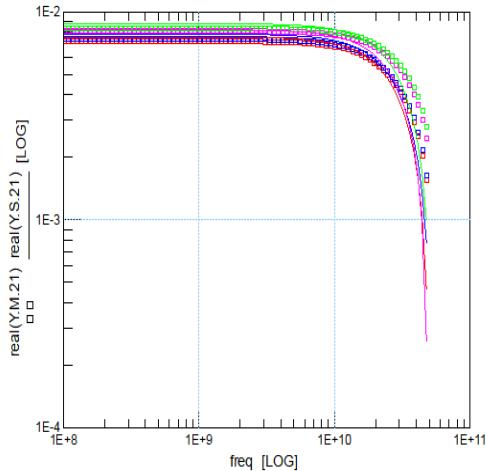
Y-Parameter, T = 27°C



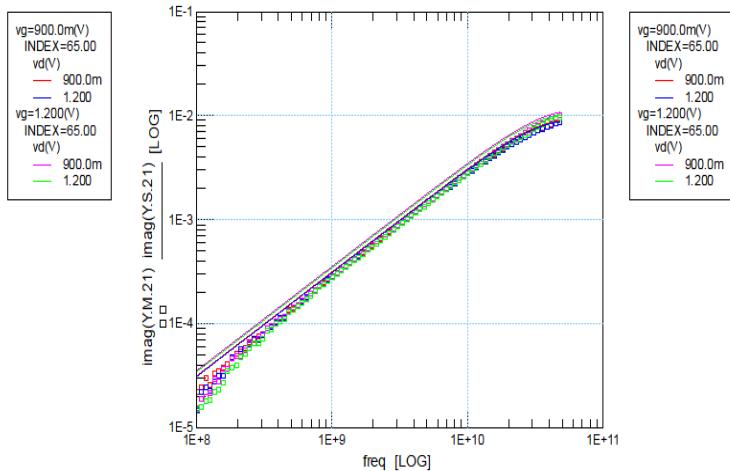
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



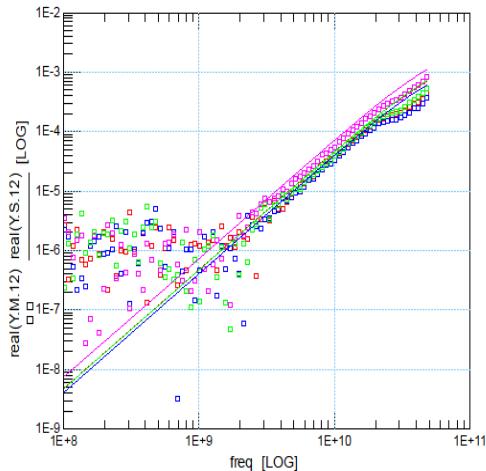
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



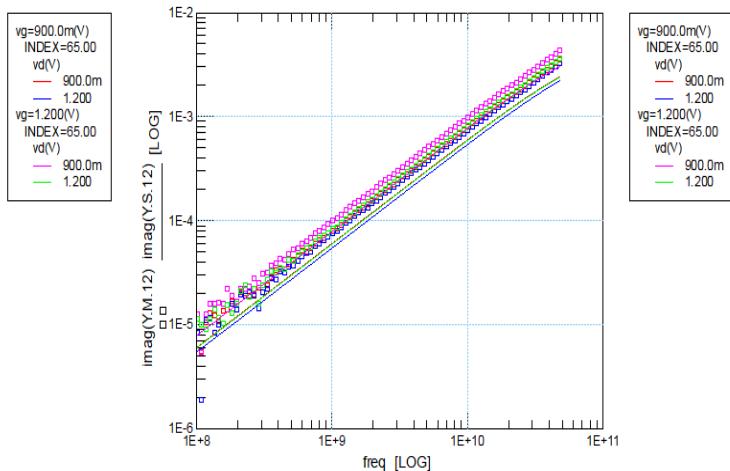
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



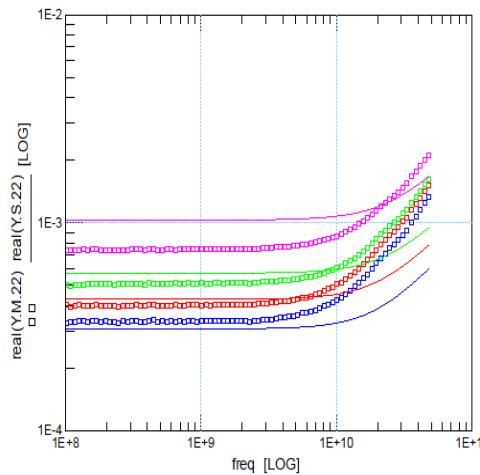
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



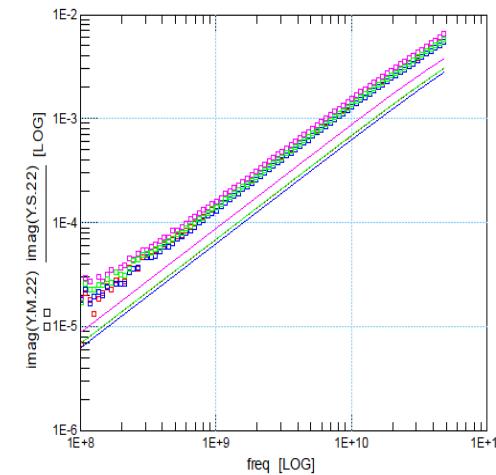
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



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

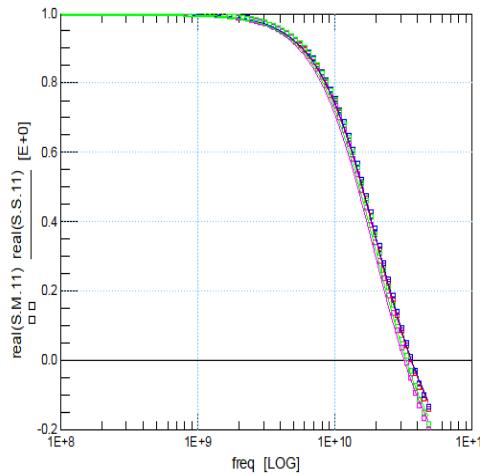


$$\text{re}(Y22) = f(Vg, Vd)$$

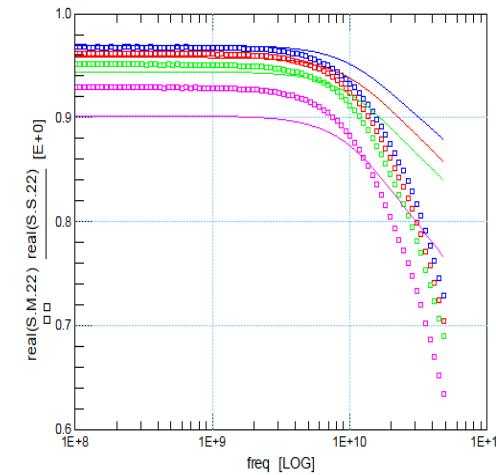


$$\text{im}(Y22) = f(Vg, Vd)$$

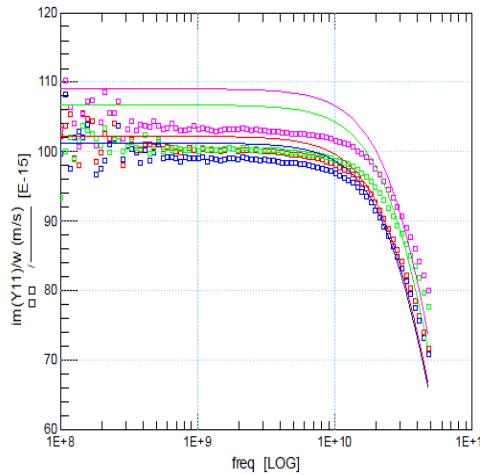
Verify Plots, T = 27°C



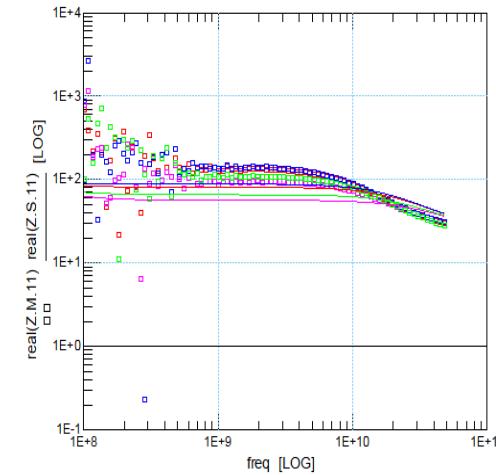
$$\text{re}(S11) = f(Vg, Vd)$$



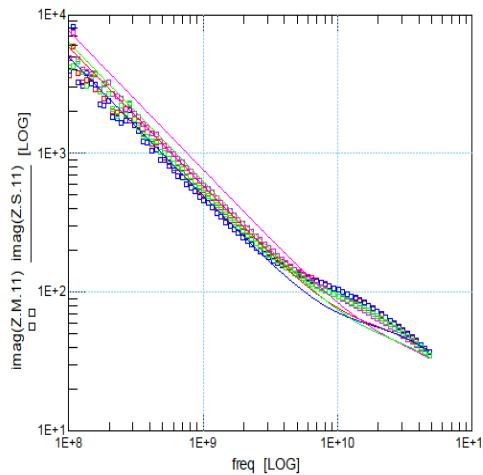
$$\text{re}(S22) = f(Vg, Vd)$$



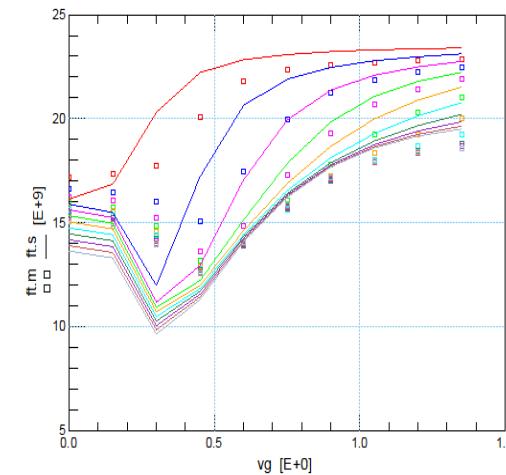
$$\text{im}(Y11) \text{ divided by } \omega$$



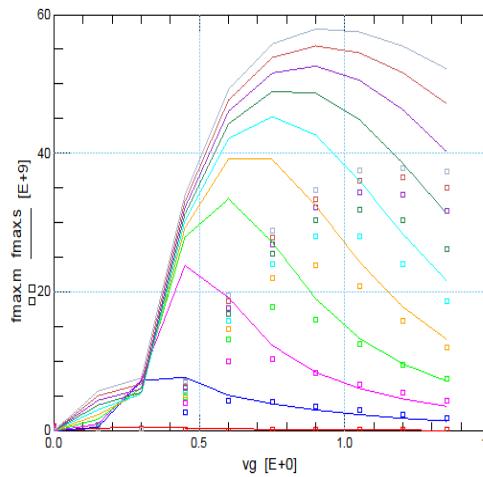
$$\text{re}(Z11) = f(Vg, Vd)$$



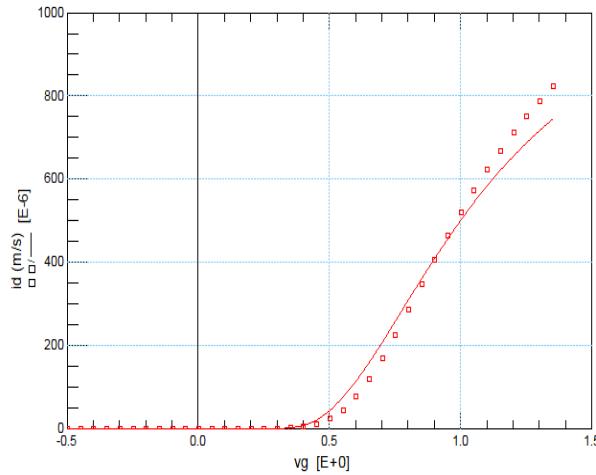
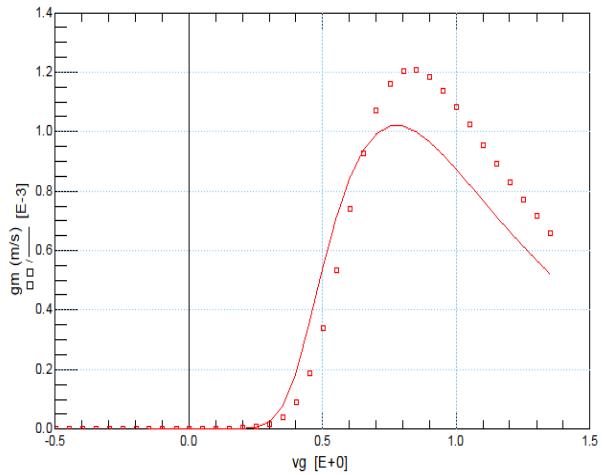
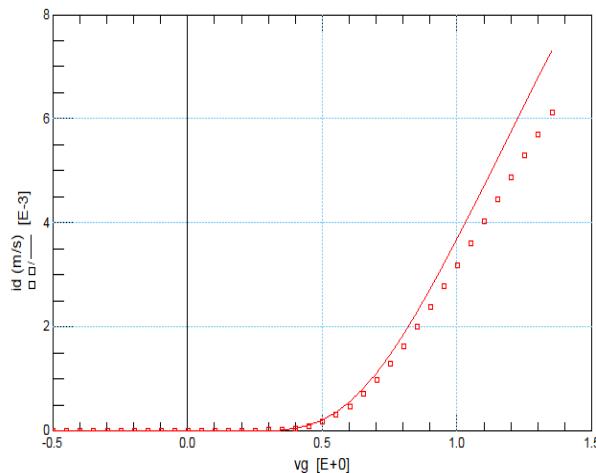
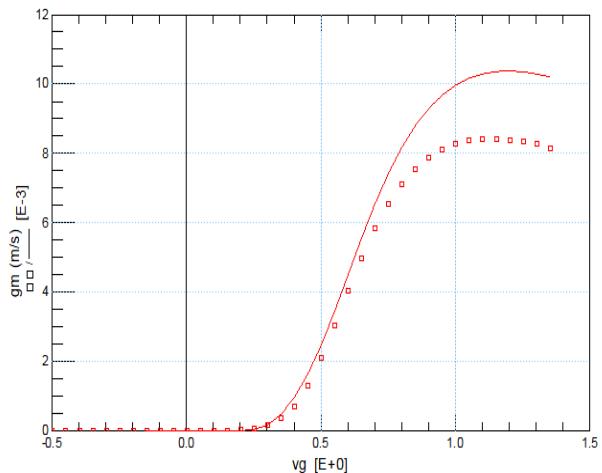
$$\text{im}(Z_{11}) = f(V_g, V_d)$$

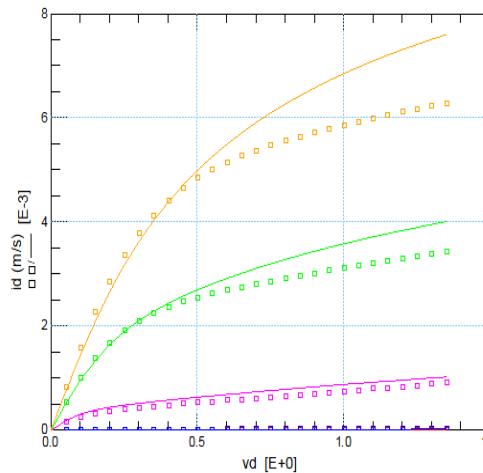
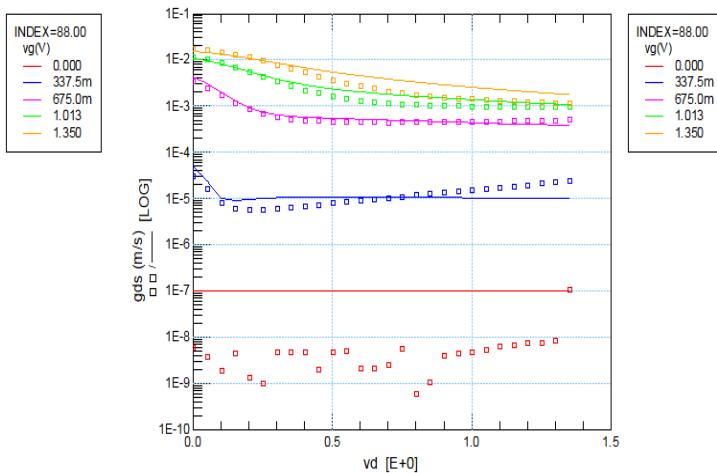
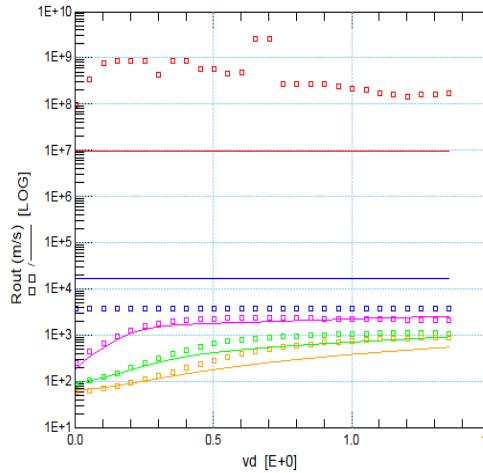
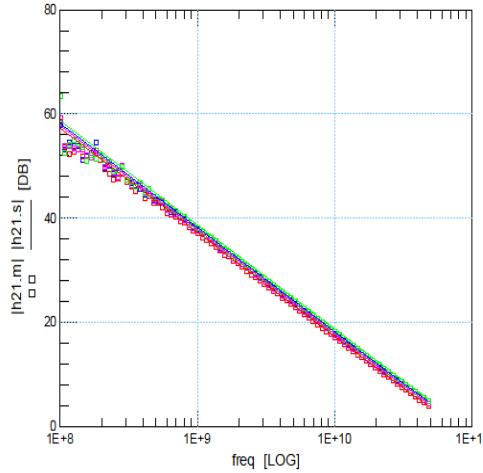
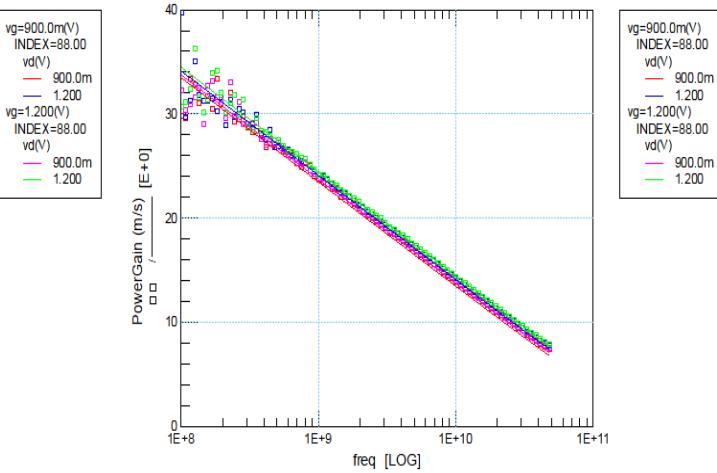


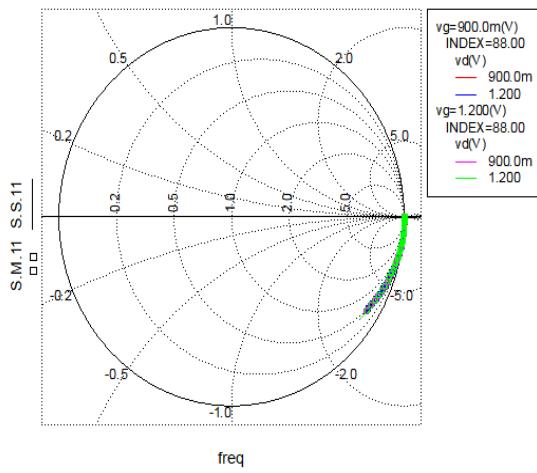
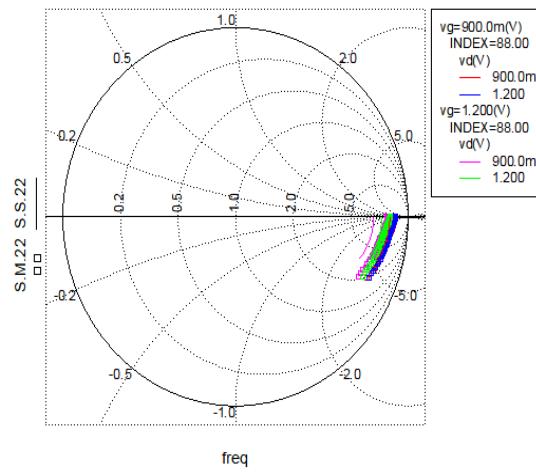
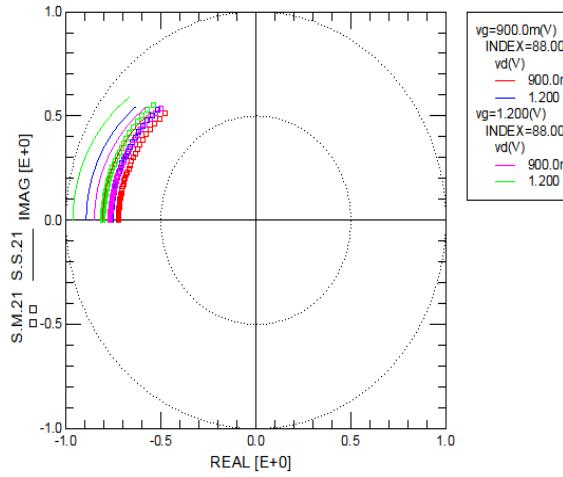
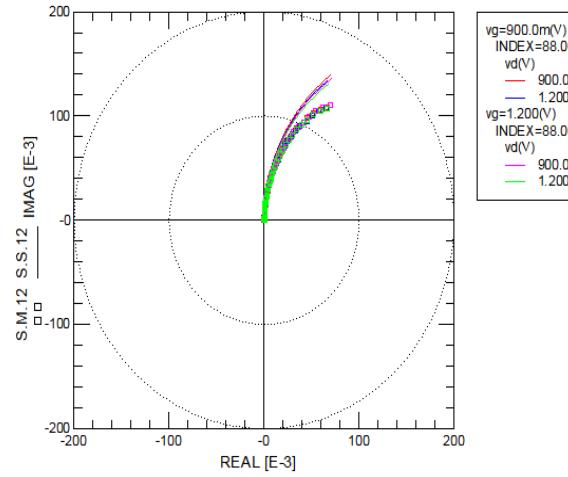
$$fT_{vg} = f(V_g, V_d)$$



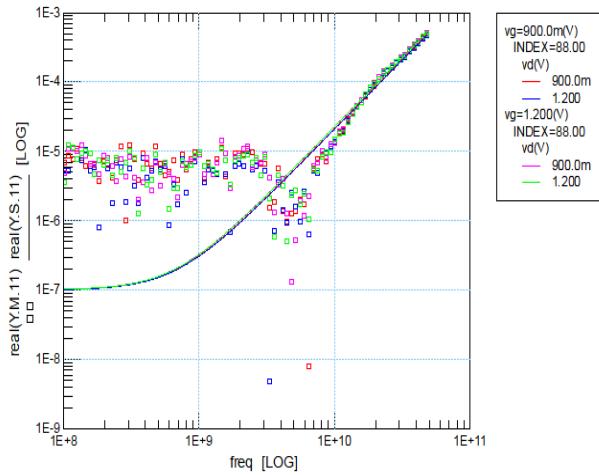
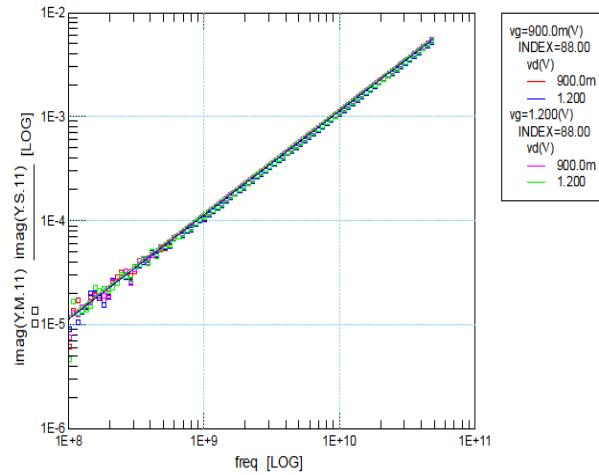
$$f_{\text{max},vg} = f(V_g, V_d)$$

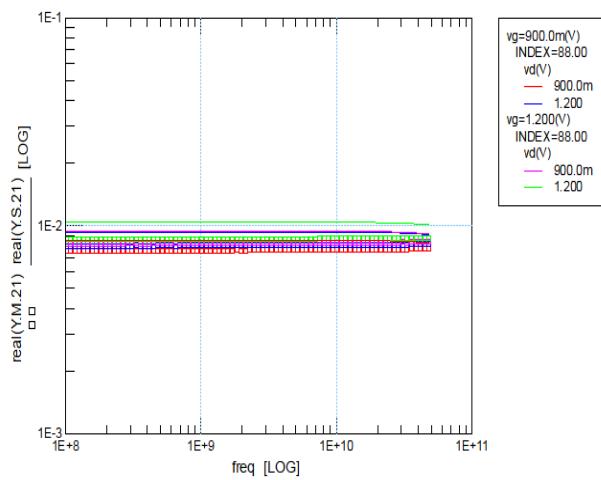
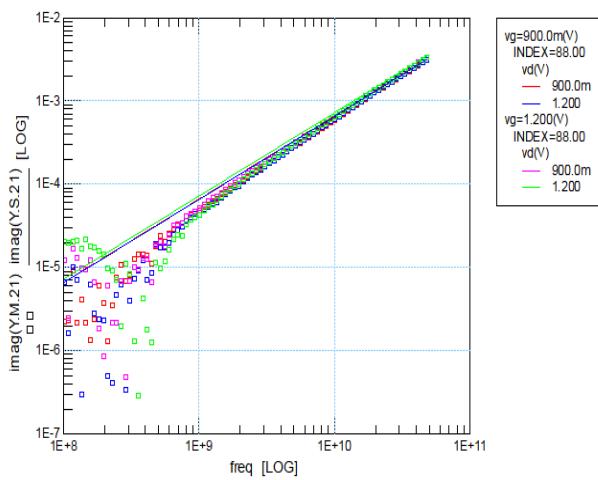
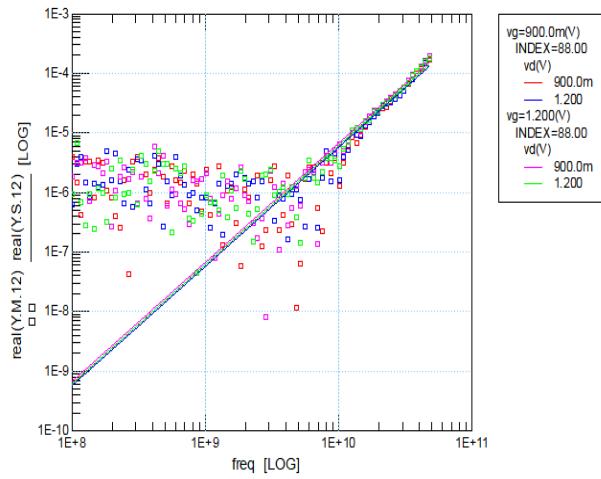
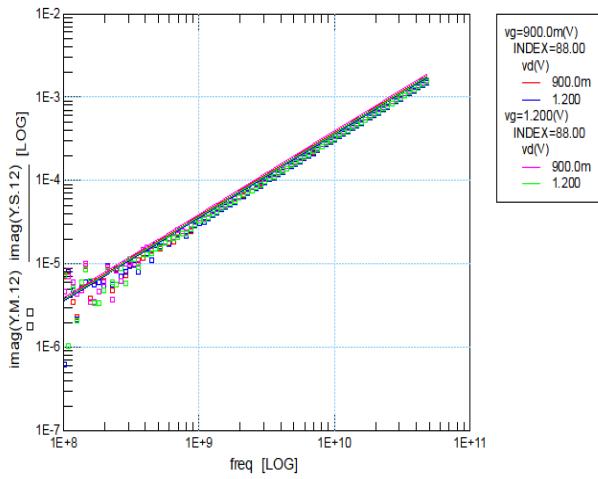
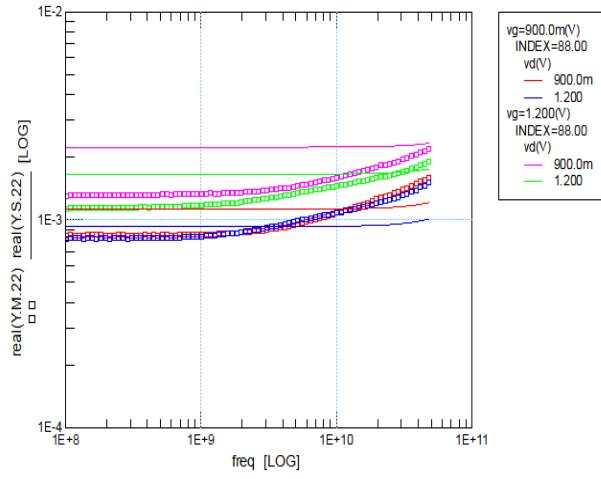
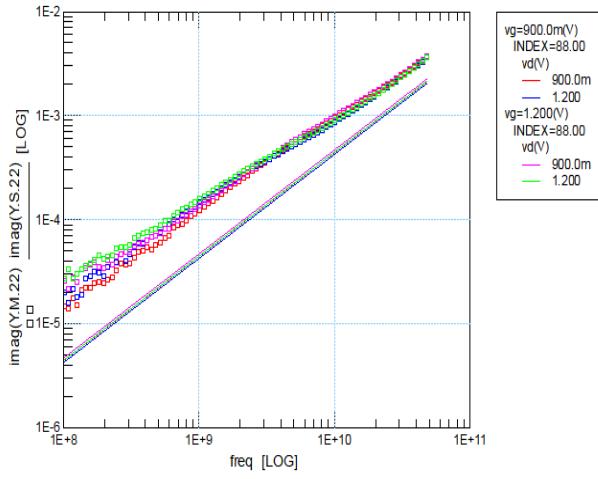
4.11 NF10_WF01u0_L0u13_S453A_51**IdVg, T = 27°C** $Id = f(Vg) @ Vd = 0.05V$  $gm = f(Vg) @ Vd = 0.05V$  $Id = f(Vg) @ Vd = 1.2V$  $gm = f(Vg) @ Vd = 1.2V$

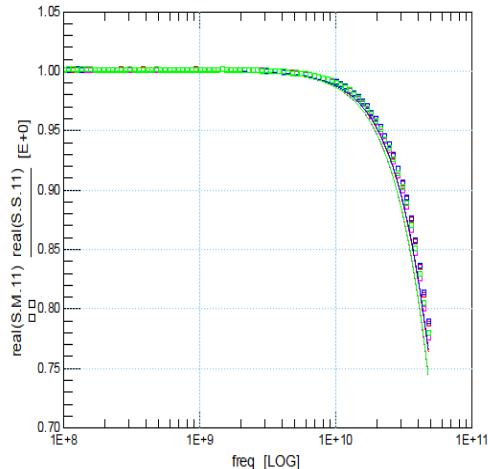
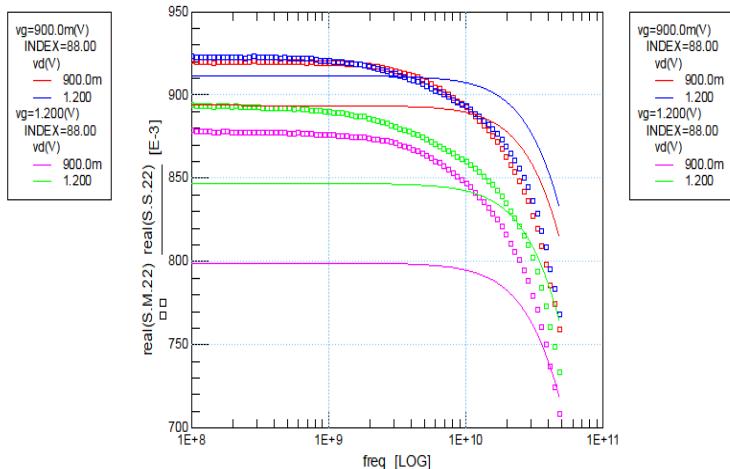
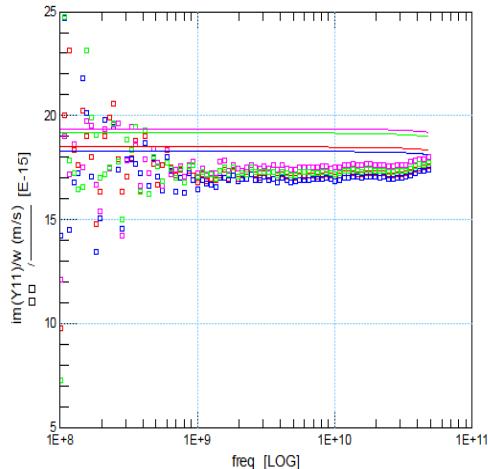
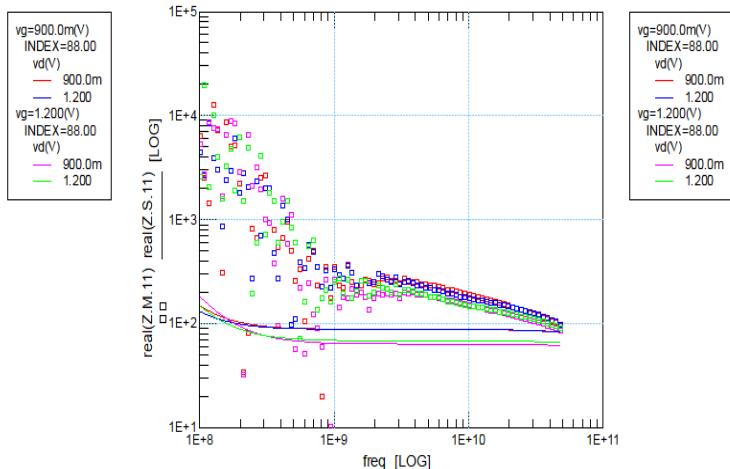
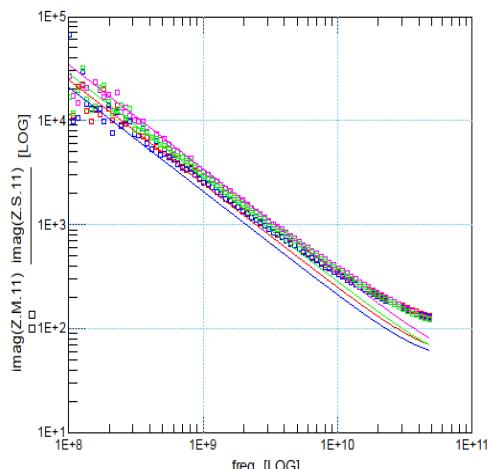
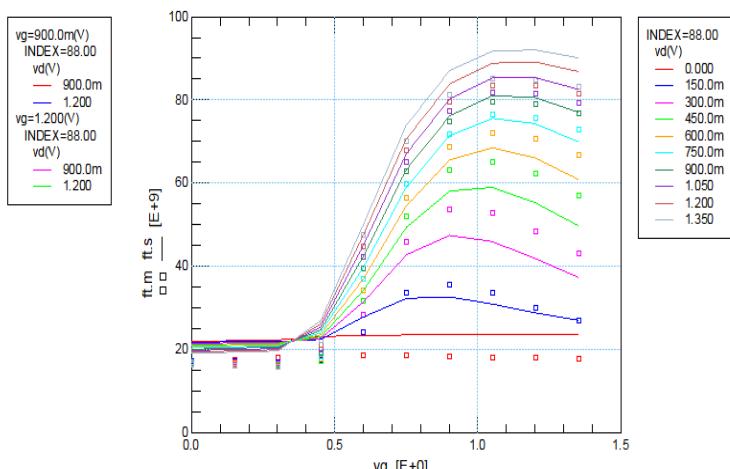
IdVd, T = 27°C $Id = f(Vd)$  $gds = f(Vd)$  $Rout = f(Vd)$ **S-Parameter, T = 27°C** $|h21| = f(Vg, Vd)$  $MSG/MAG = f(Vg, Vd)$

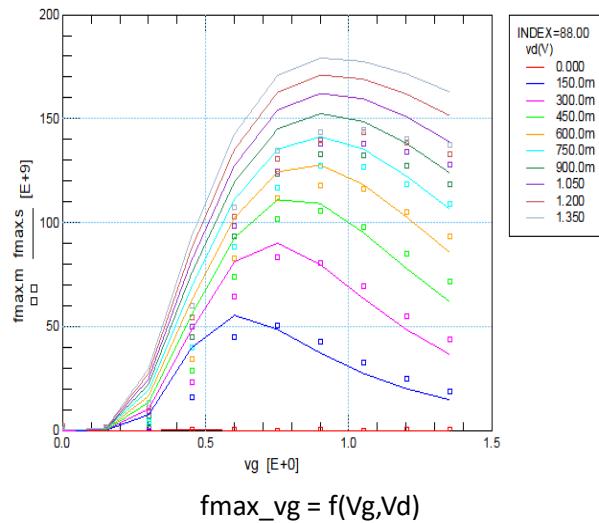
 $S11 = f(Vg, Vd)$  $S22 = f(Vg, Vd)$  $S21 = f(Vg, Vd)$  $S12 = f(Vg, Vd)$

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

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

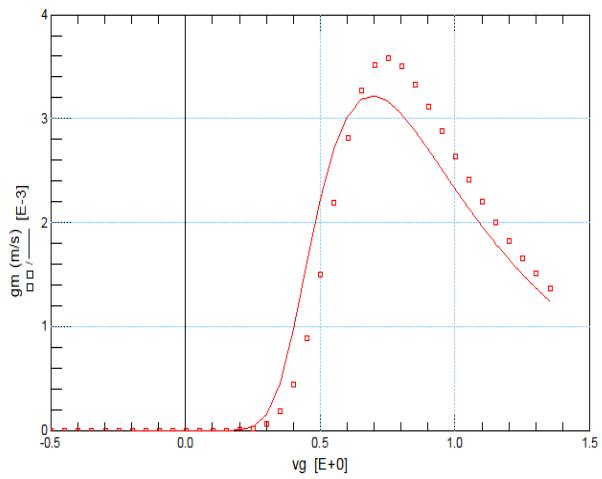
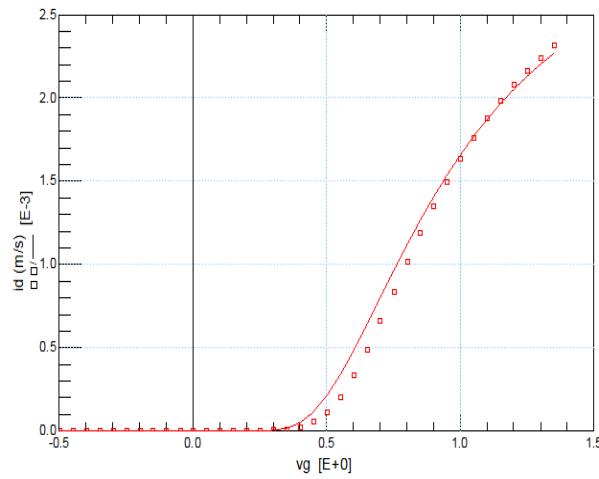
re(Y₂₁) = f(V_g, V_d)im(Y₂₁) = f(V_g, V_d)re(Y₁₂) = f(V_g, V_d)im(Y₁₂) = f(V_g, V_d)re(Y₂₂) = f(V_g, V_d)im(Y₂₂) = f(V_g, V_d)

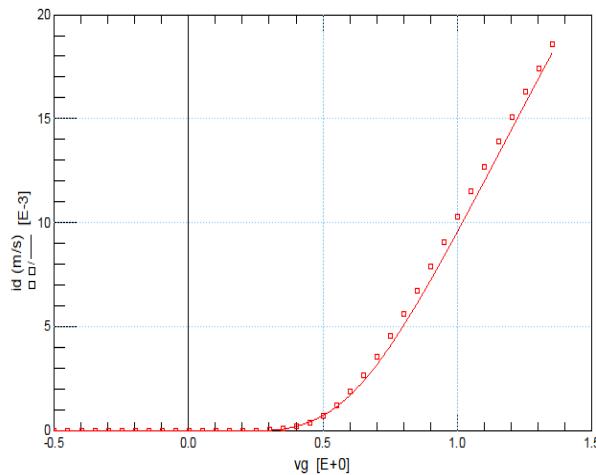
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



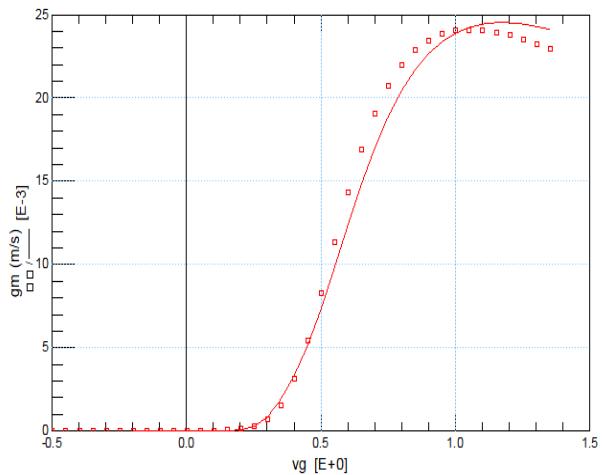
4.12 NF04_WF07u5_L0u13_S453A_31

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



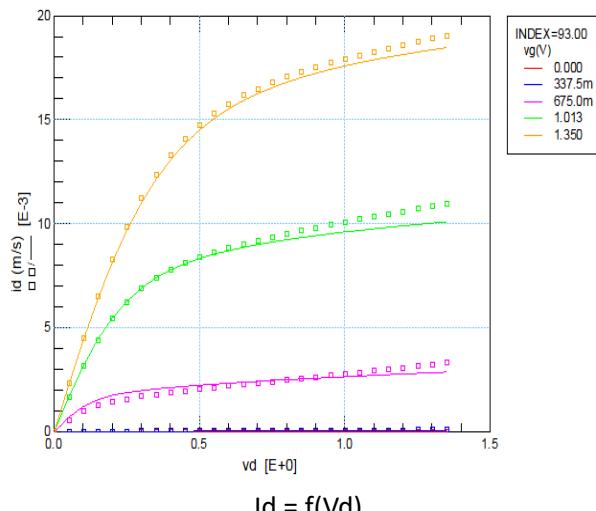


$$Id = f(Vg) @ Vd = 1.2V$$

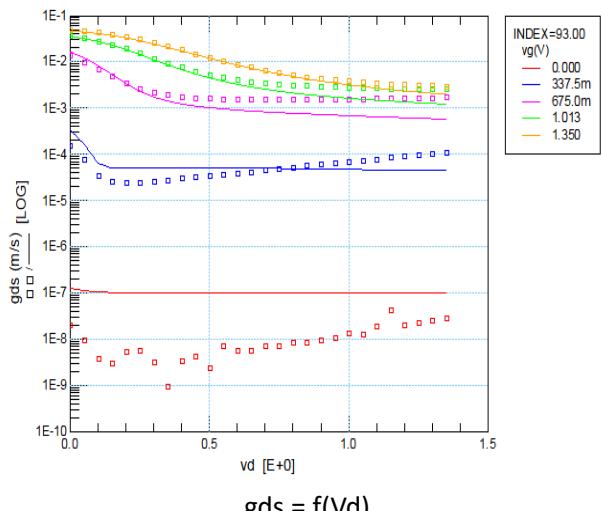


$$gm = f(Vg) @ Vd = 1.2V$$

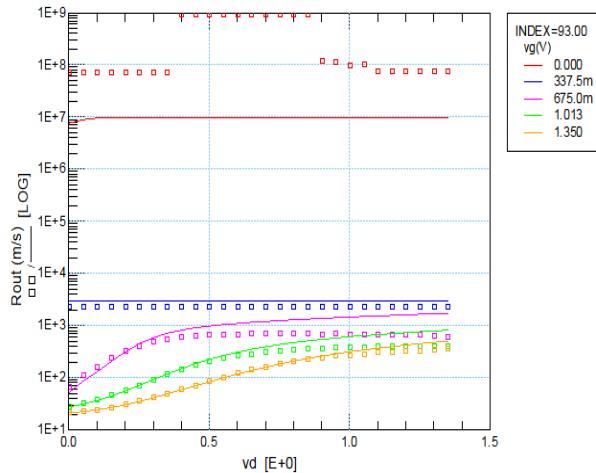
IdVd, T = 27°C



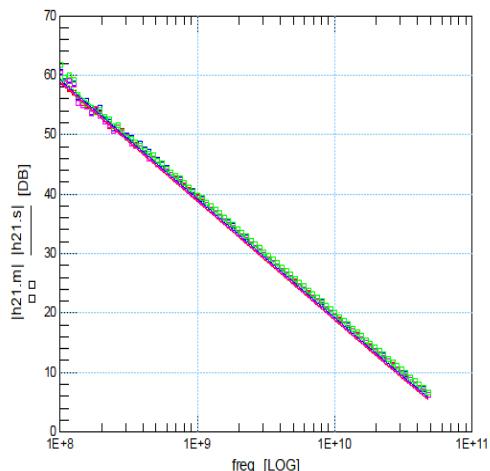
$$Id = f(Vd)$$



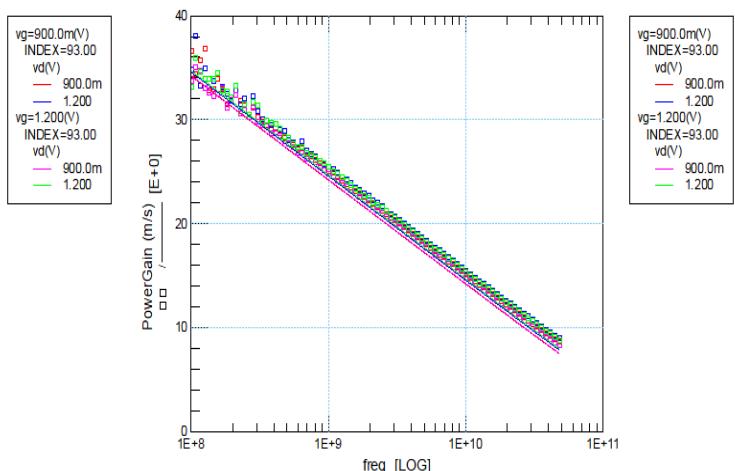
$$gds = f(Vd)$$



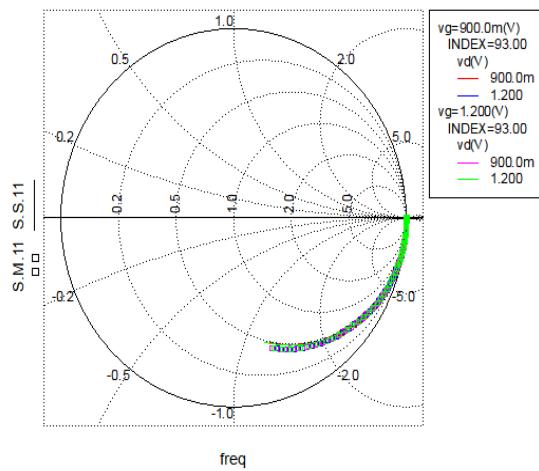
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

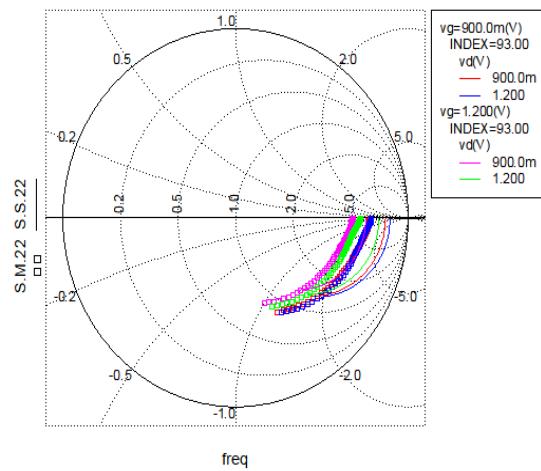
$$|h21| = f(Vg, Vd)$$



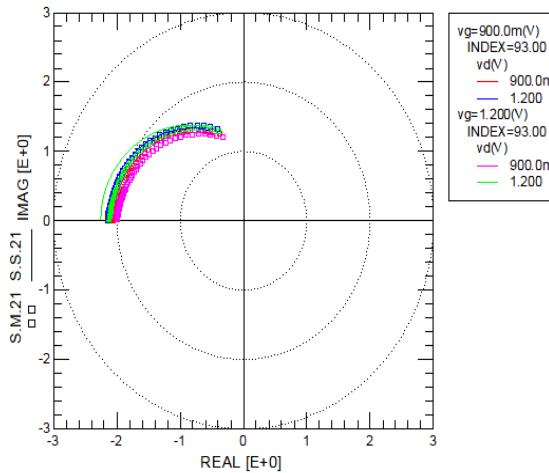
$$MSG/MAG = f(Vg, Vd)$$



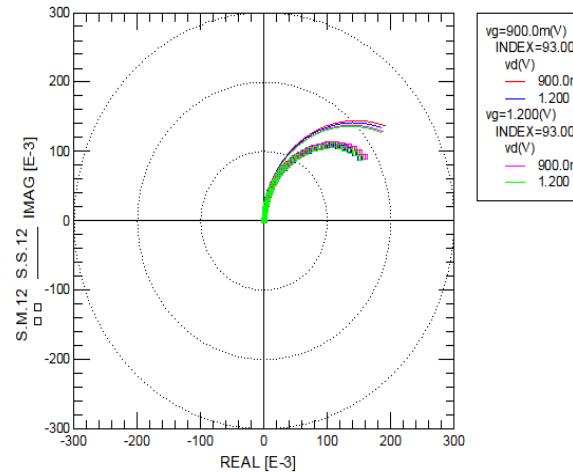
$$S11 = f(Vg, Vd)$$



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

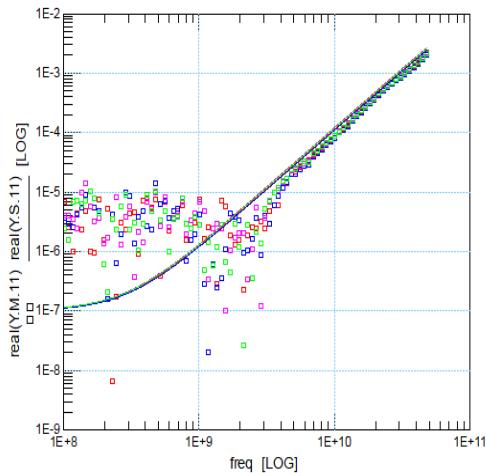


$$S21 = f(Vg, Vd)$$

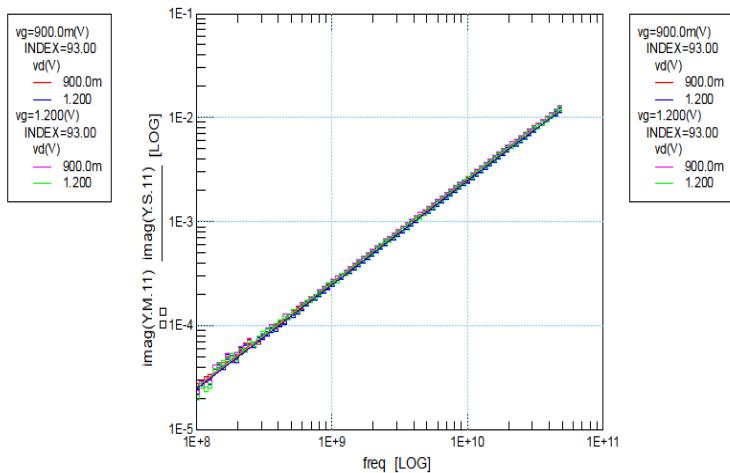


$$S12 = f(Vg, Vd)$$

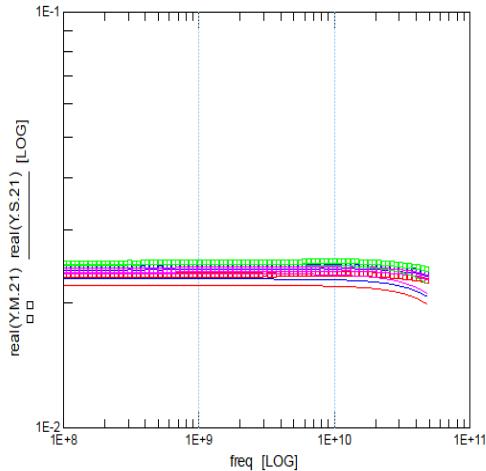
Y-Parameter, T = 27°C



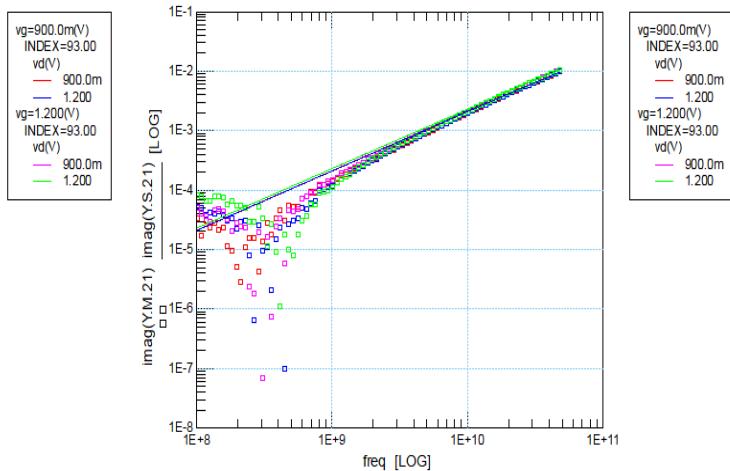
$$\text{re}(Y_{11}) = f(V_g, V_d)$$



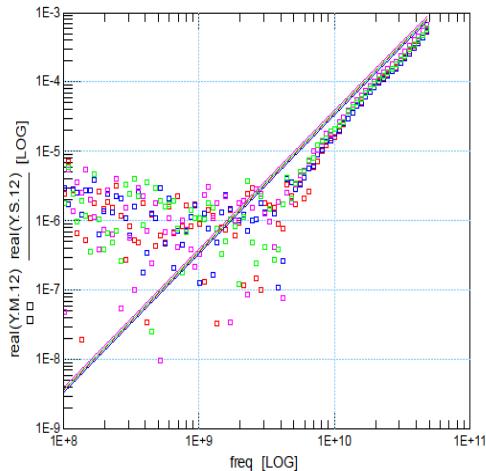
$$\text{im}(Y_{11}) = f(V_g, V_d)$$



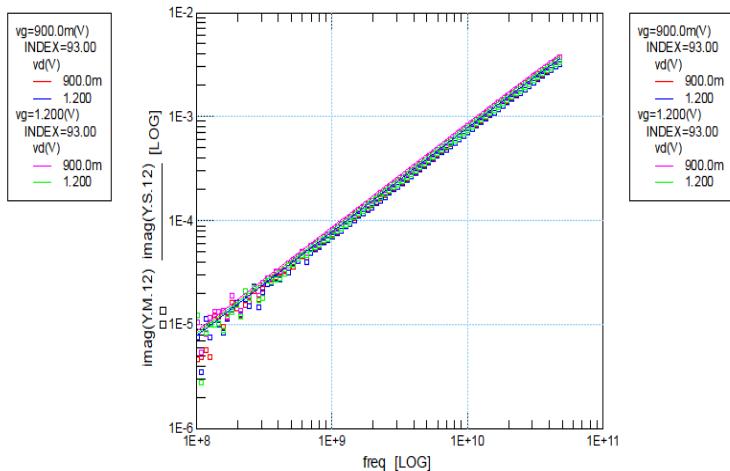
$$\text{re}(Y_{21}) = f(V_g, V_d)$$



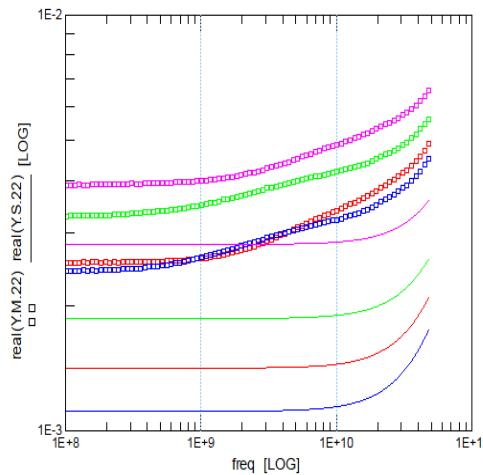
$$\text{im}(Y_{21}) = f(V_g, V_d)$$



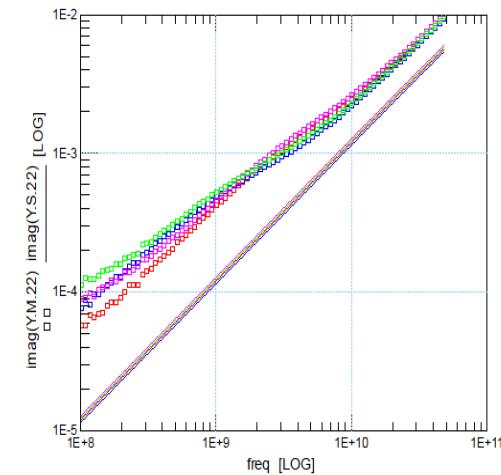
$$\text{re}(Y_{12}) = f(V_g, V_d)$$



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

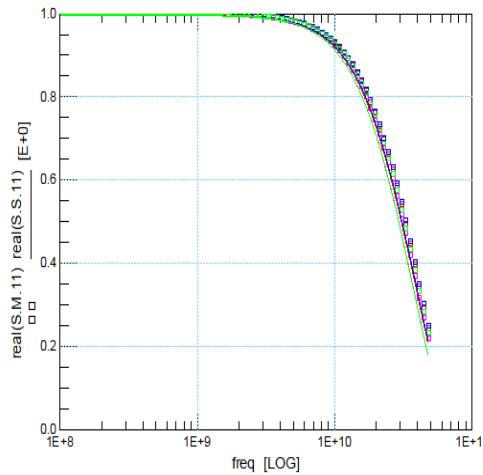


re(Y22) = f(Vg, Vd)

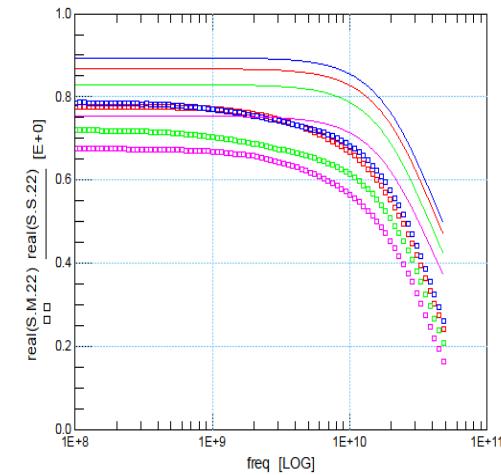


im(Y22) = f(Vg, Vd)

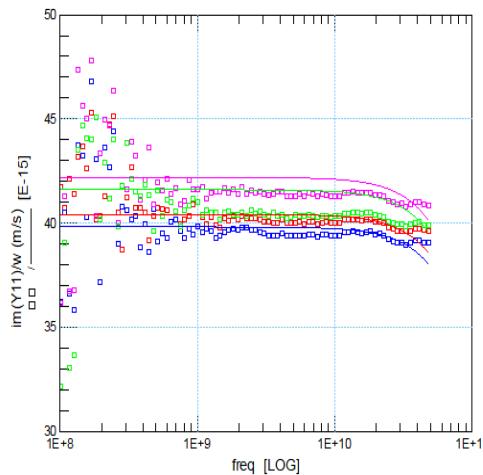
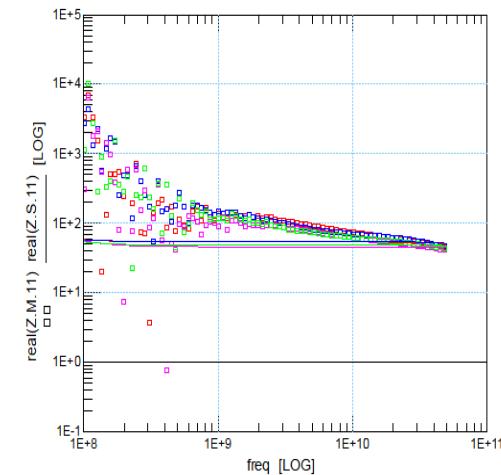
Verify Plots, T = 27°C



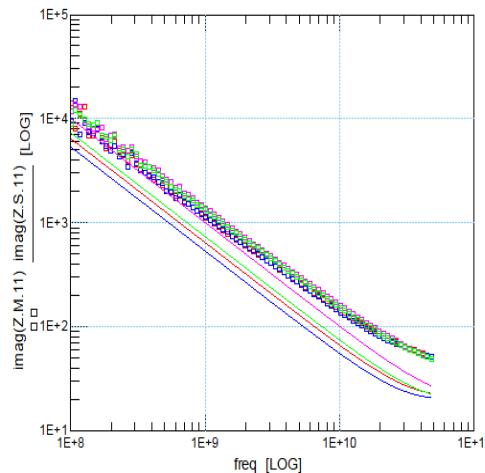
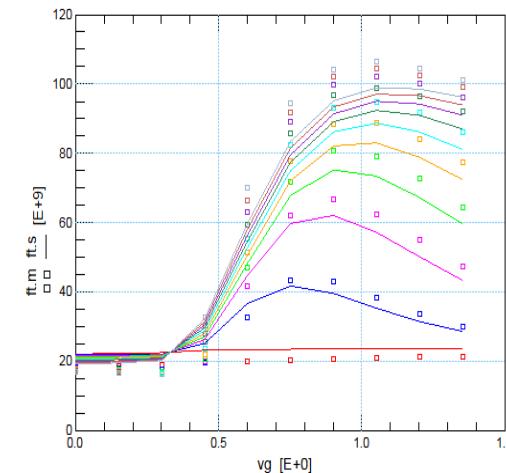
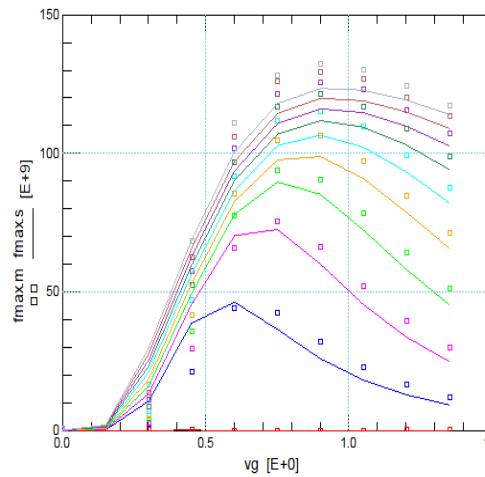
re(S11) = f(Vg, Vd)



re(S22) = f(Vg, Vd)

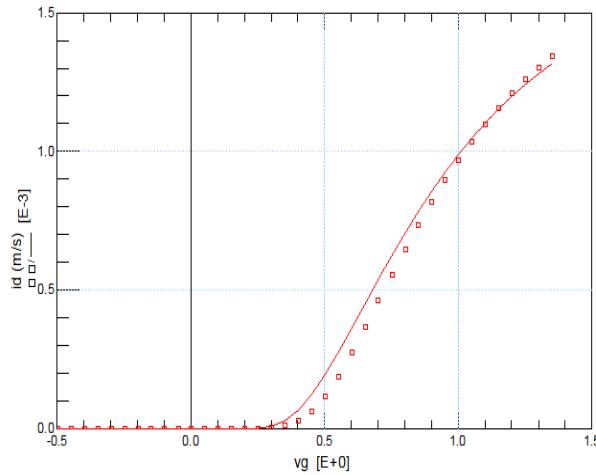
im(Y11) divided by ω 

re(Z11) = f(Vg, Vd)

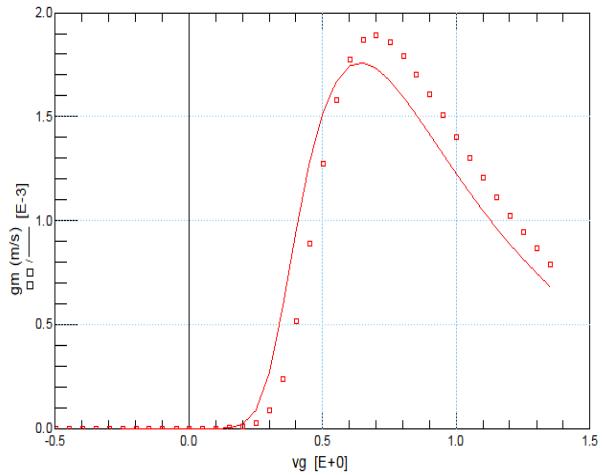
 $\text{im}(Z_{11}) = f(V_g, V_d)$  $fT_{vg} = f(V_g, V_d)$  $f_{\text{max}}_{vg} = f(V_g, V_d)$

4.13NF04_WF05u0_L0u18_post_22

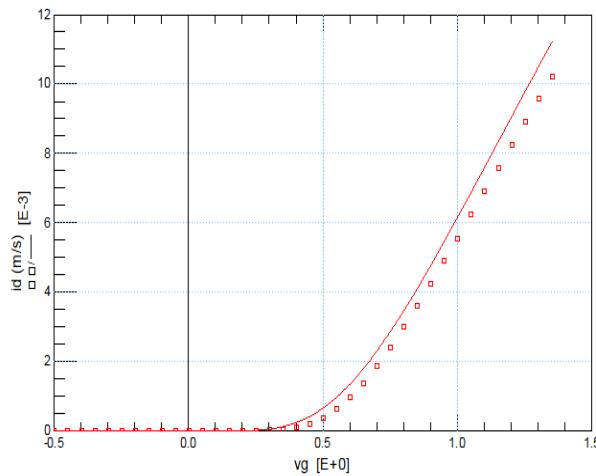
$IdVg$, $T = 27^\circ\text{C}$



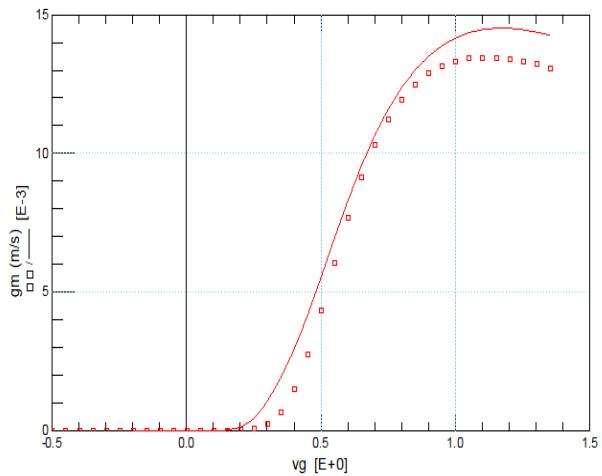
$$Id = f(Vg) \text{ @ } Vd = 0.05V$$



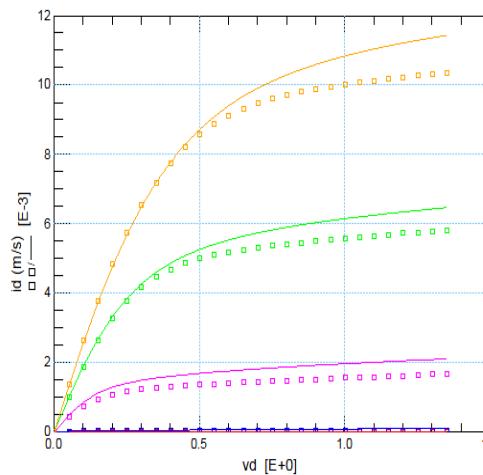
$$gm = f(Vg) \text{ @ } Vd = 0.05V$$



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

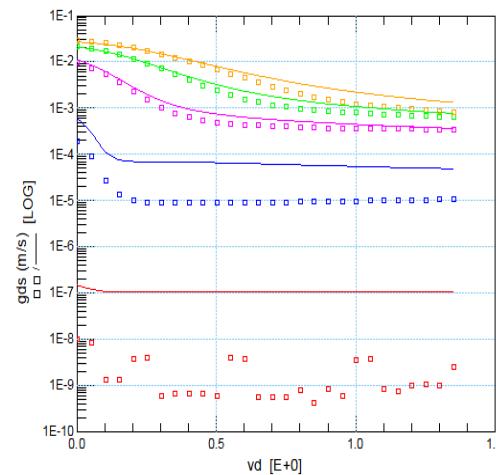


$$gm = f(Vg) \text{ @ } Vd = 1.2V$$

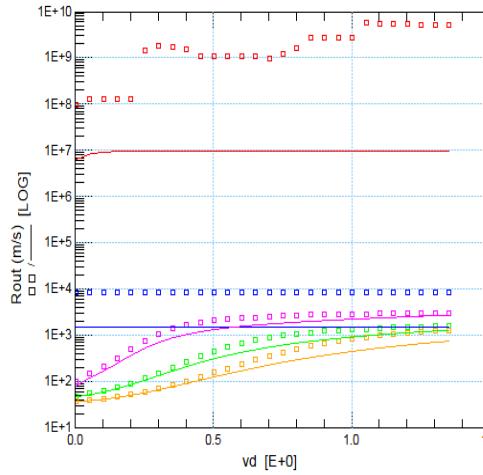
IdVd, T = 27°C

$$Id = f(Vd)$$

INDEX=101.0
vg(V)
0.000
337.5m
675.0m
1.013
1.350

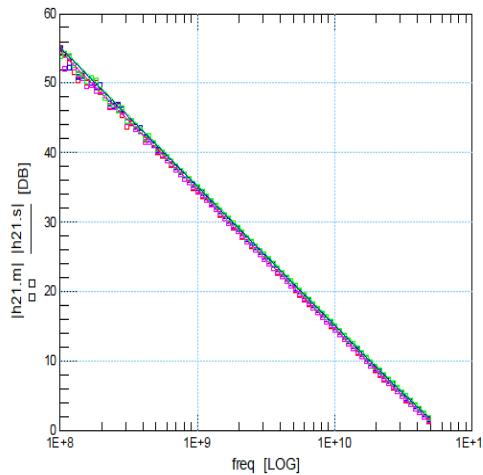


$$gds = f(Vd)$$



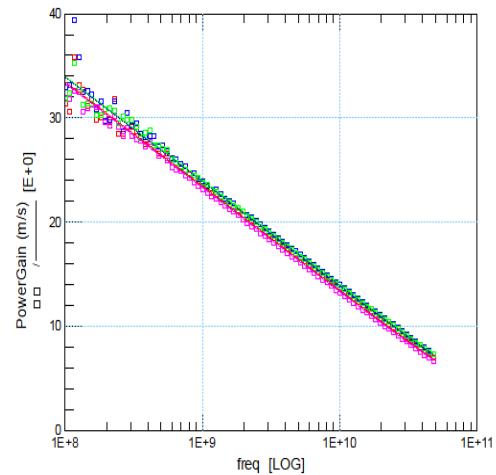
$$Rout = f(Vd)$$

INDEX=101.0
vg(V)
0.000
337.5m
675.0m
1.013
1.350

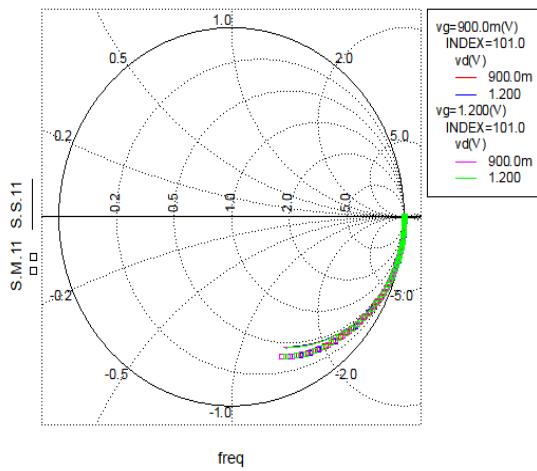
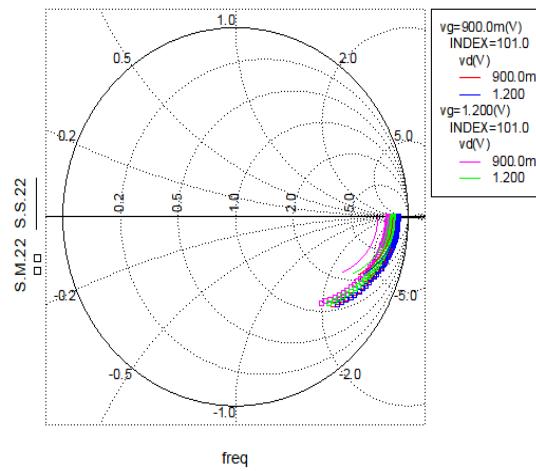
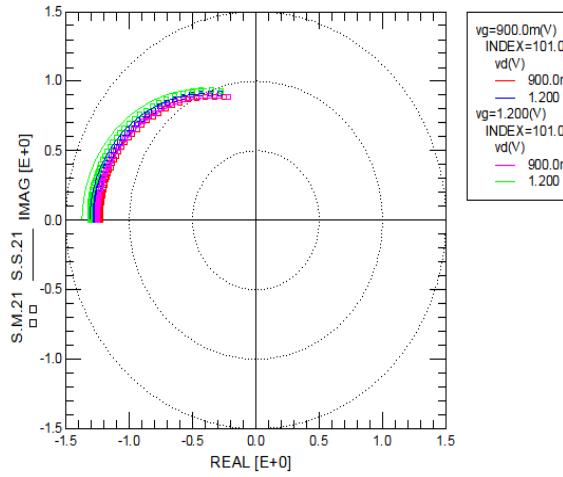
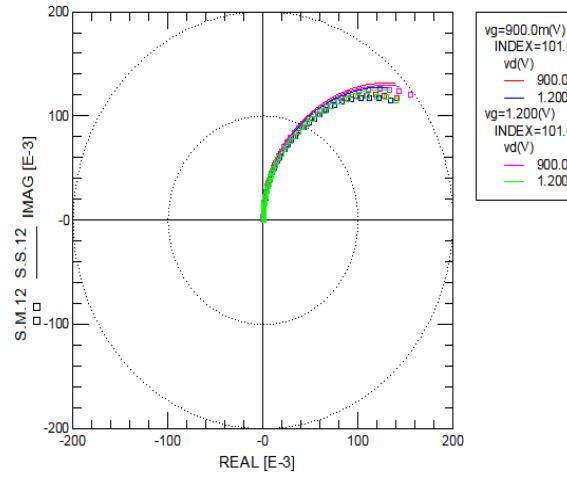
S-Parameter, T = 27°C

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

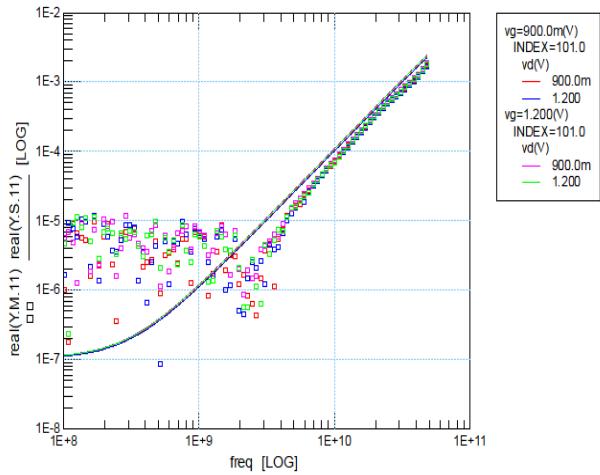
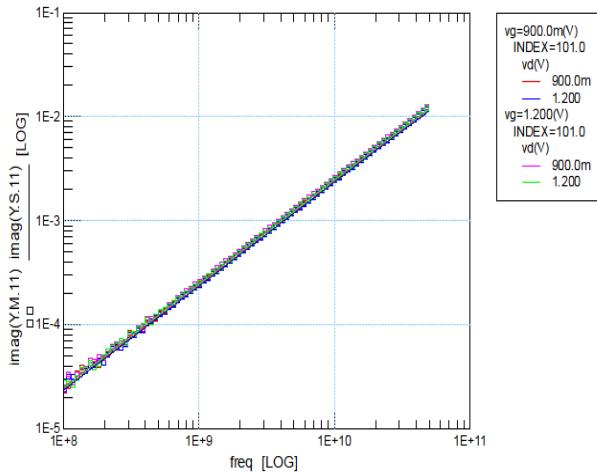
vg=900.0mV
INDEX=101.0
vd(V)
900.0m
1.200
vg=1.200(V)
INDEX=101.0
vd(V)
900.0m
1.200

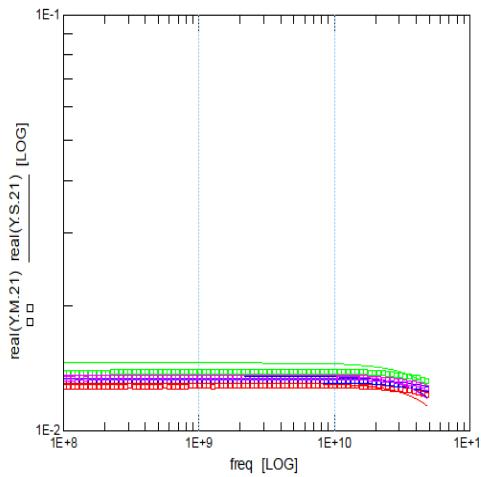


$$MSG/MAG = f(Vg, Vd)$$

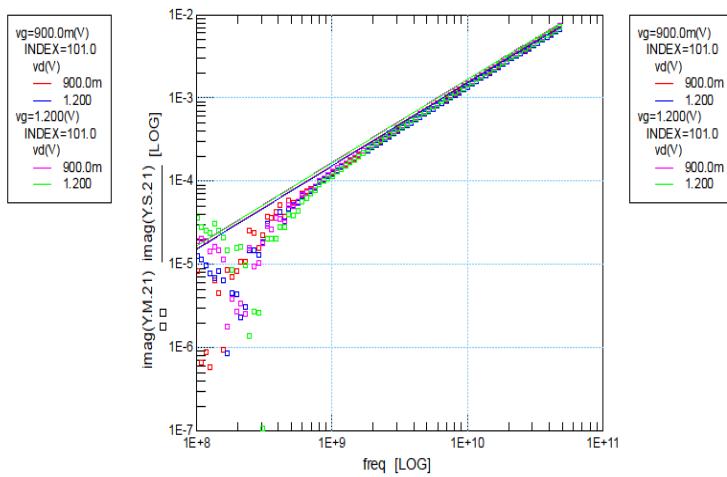
 $S_{11} = f(Vg, Vd)$  $S_{22} = f(Vg, Vd)$  $S_{21} = f(Vg, Vd)$  $S_{12} = f(Vg, Vd)$

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

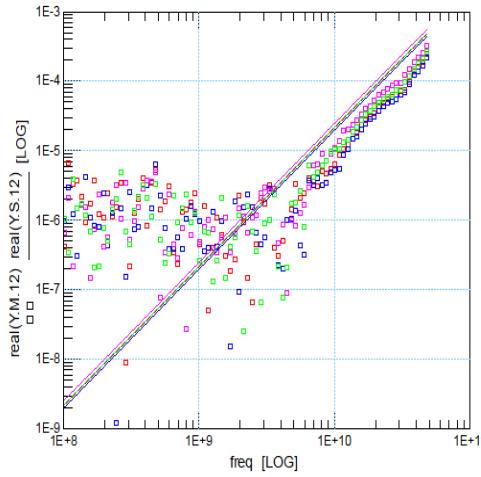
 $re(Y_{11}) = f(Vg, Vd)$  $im(Y_{11}) = f(Vg, Vd)$



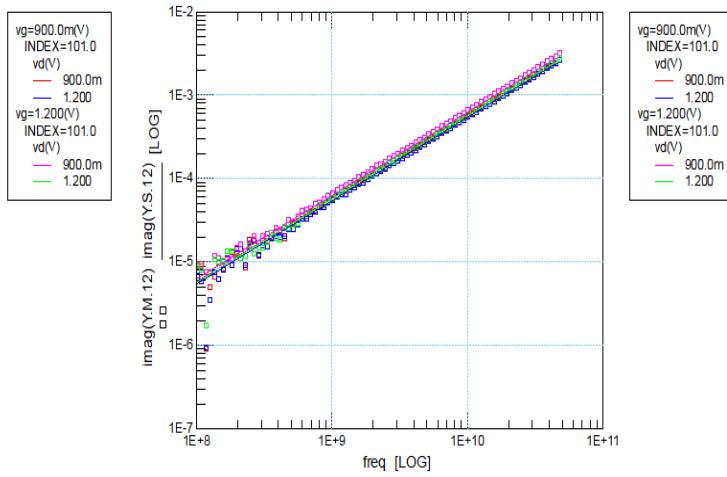
re(Y21) = f(Vg,Vd)



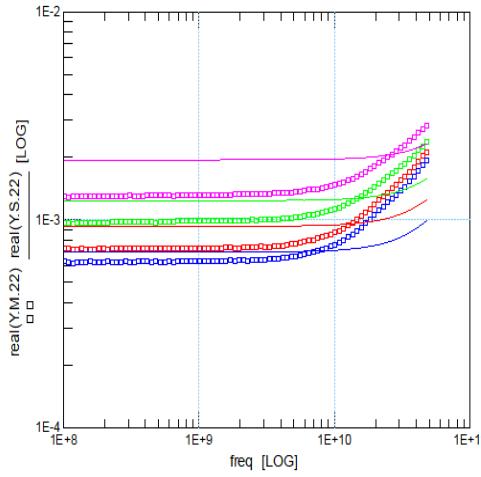
im(Y21) = f(Vg,Vd)



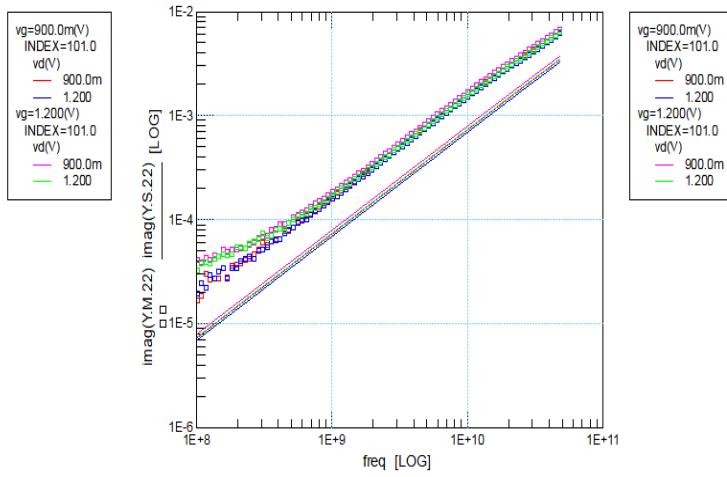
re(Y12) = f(Vg,Vd)



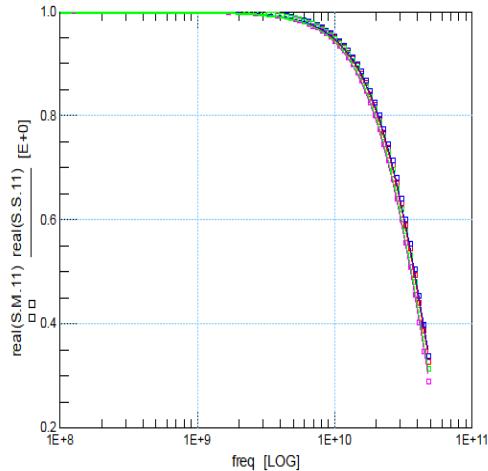
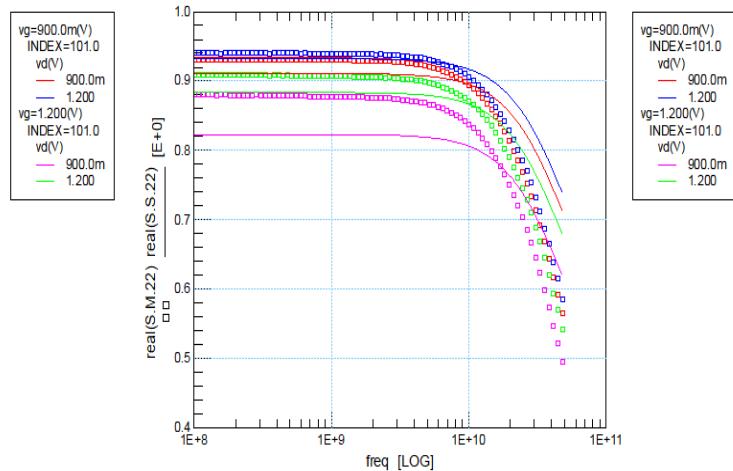
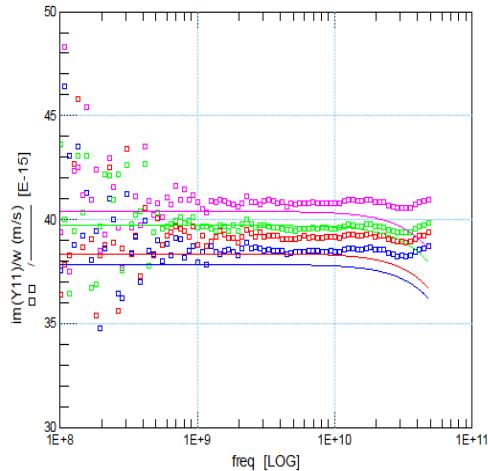
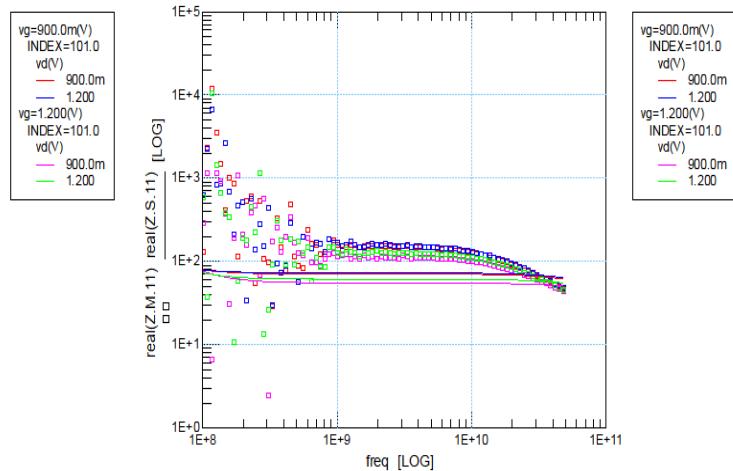
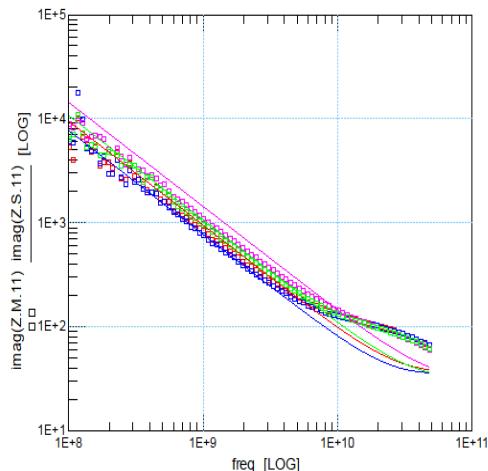
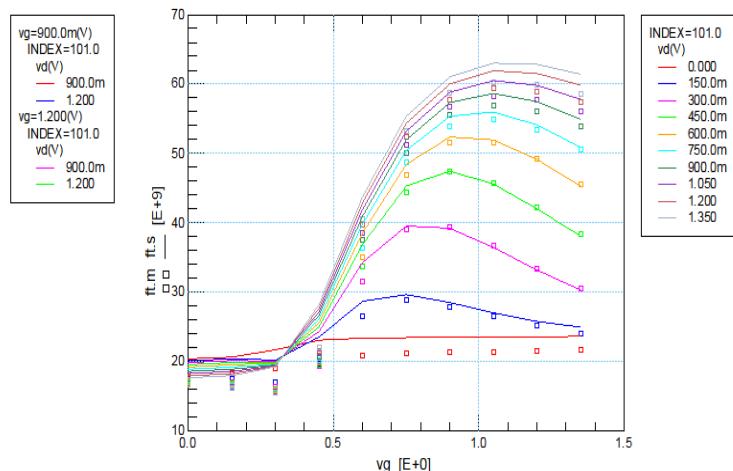
im(Y12) = f(Vg,Vd)

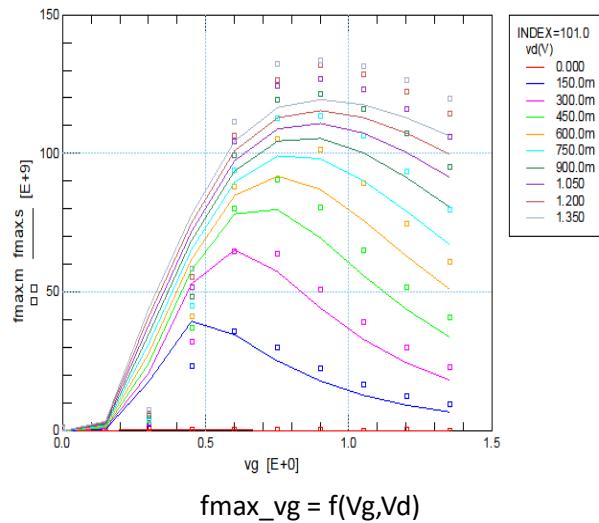


re(Y22) = f(Vg,Vd)



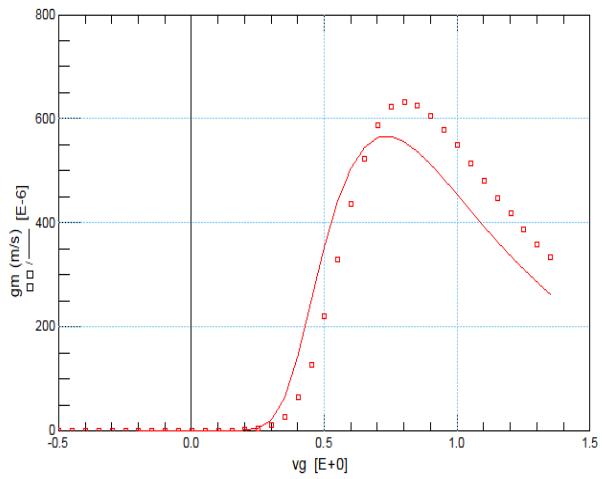
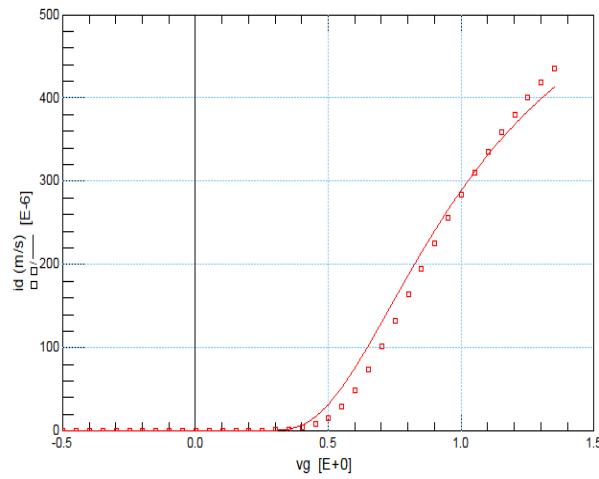
im(Y22) = f(Vg,Vd)

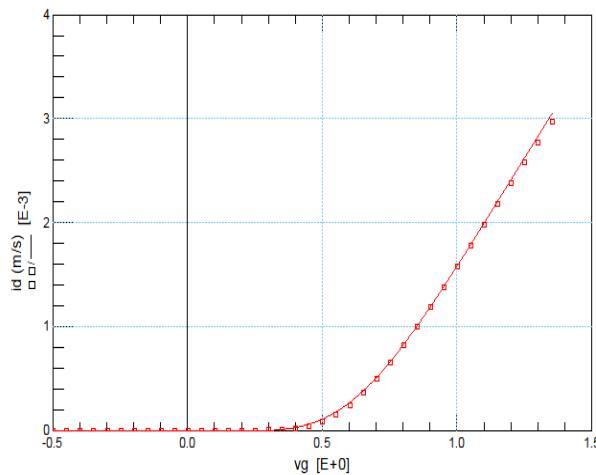
Verify Plots, $T = 27^\circ\text{C}$  $\text{re}(S11) = f(Vg, Vd)$  $\text{re}(S22) = f(Vg, Vd)$  $\text{im}(Y11) \text{ divided by } \omega$  $\text{re}(Z11) = f(Vg, Vd)$  $\text{im}(Z11) = f(Vg, Vd)$  $fT_{vg} = f(Vg, Vd)$



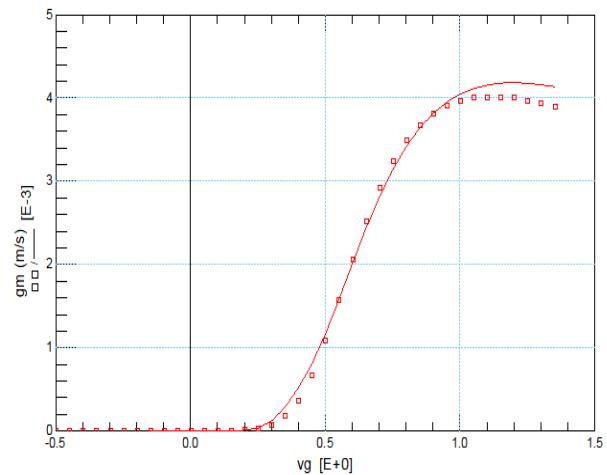
4.14 NF01_WF05u0_L0u13_S453A_54

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



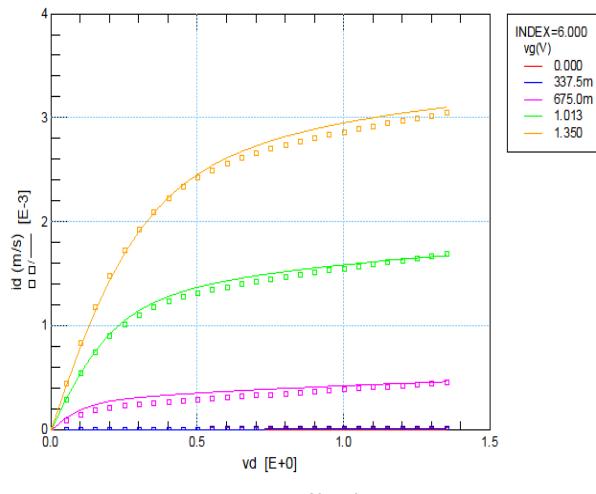


$$Id = f(Vg) @ Vd = 1.2V$$

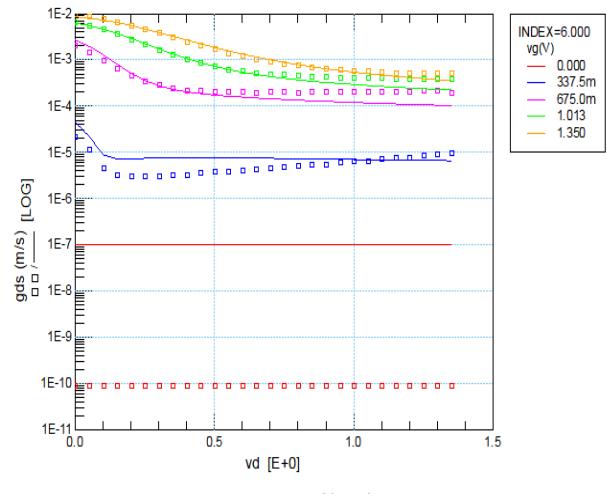


$$gm = f(Vg) @ Vd = 1.2V$$

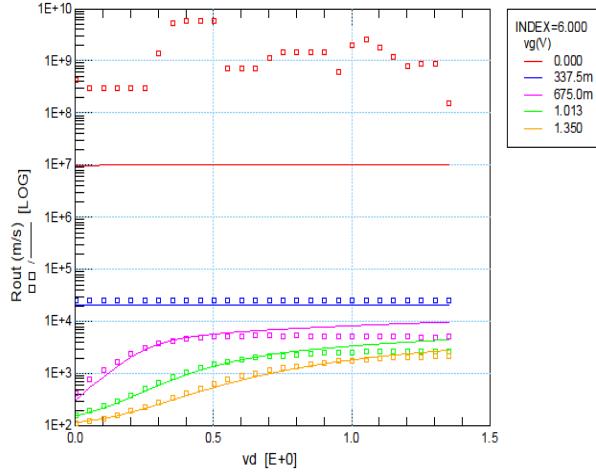
IdVd, T = 27°C



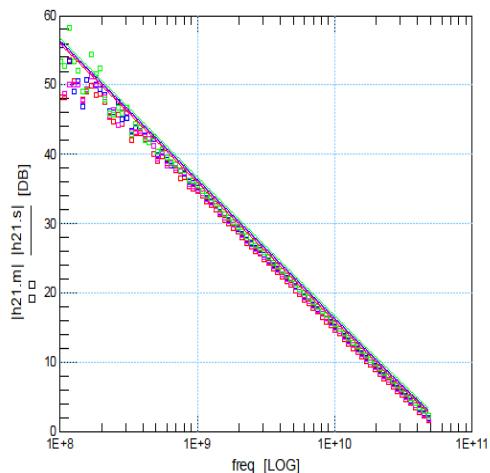
$$Id = f(Vd)$$



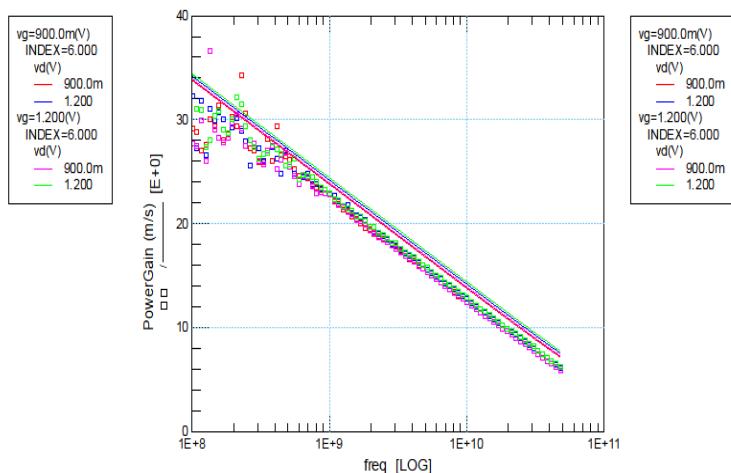
$$gds = f(Vd)$$



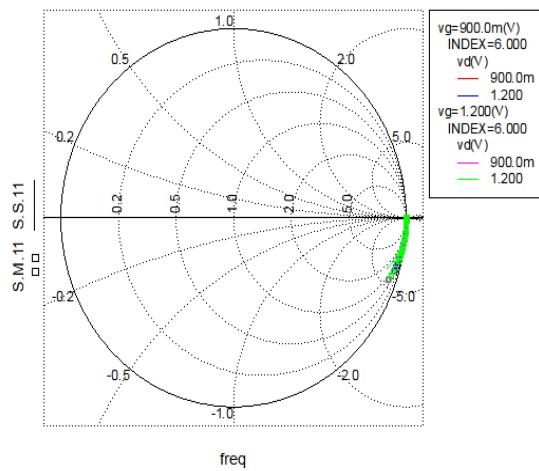
$$Rout = f(Vd)$$

S-Parameter, T = 27°C

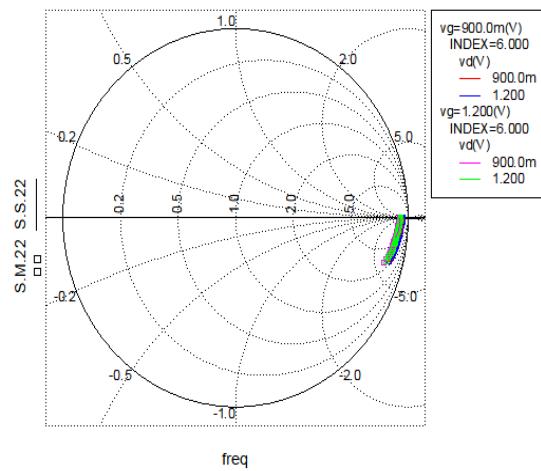
$$|h21| = f(Vg, Vd)$$



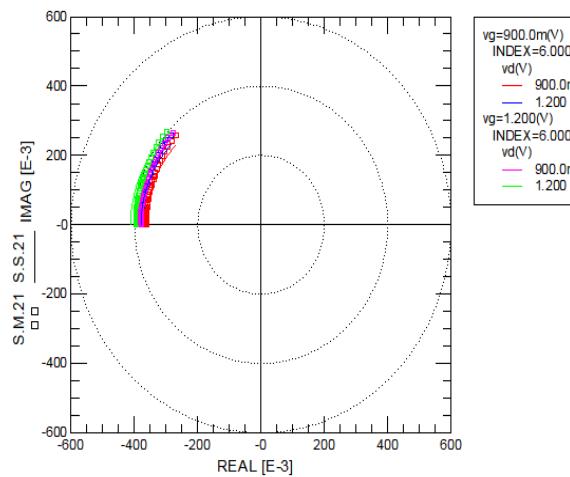
$$MSG/MAG = f(Vg, Vd)$$



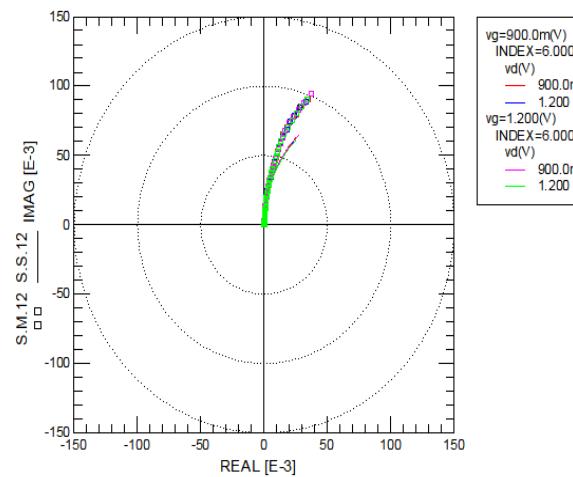
$$S11 = f(Vg, Vd)$$



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

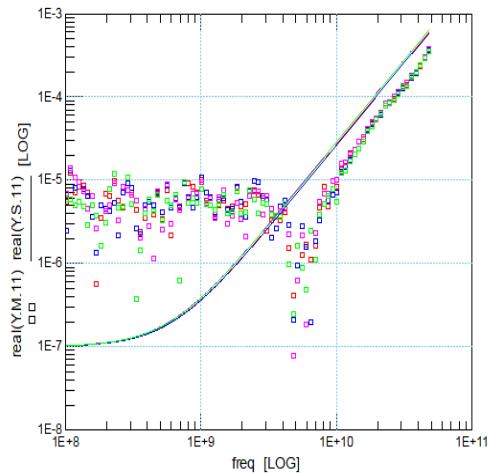


$$S21 = f(Vg, Vd)$$

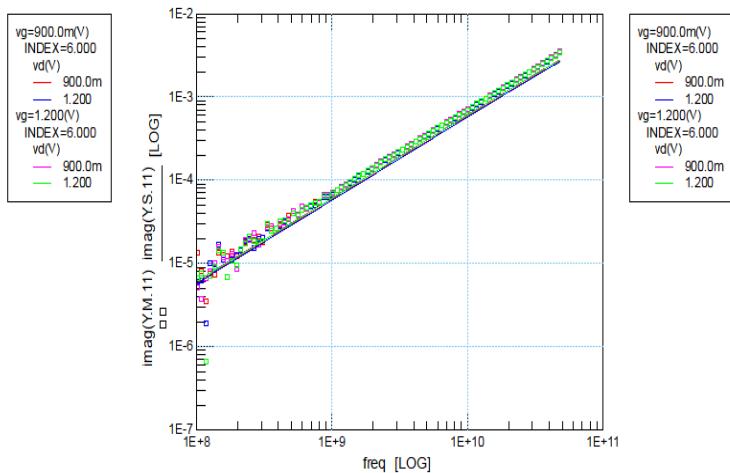


$$S12 = f(Vg, Vd)$$

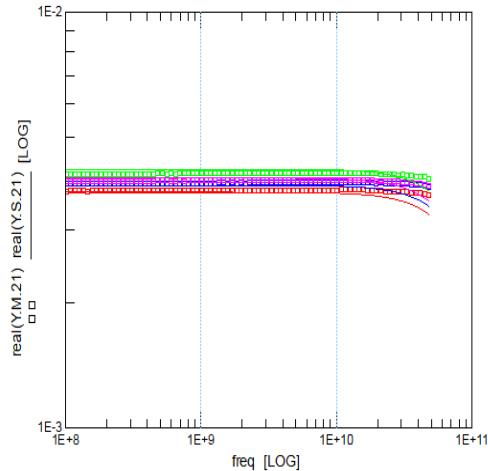
Y-Parameter, T = 27°C



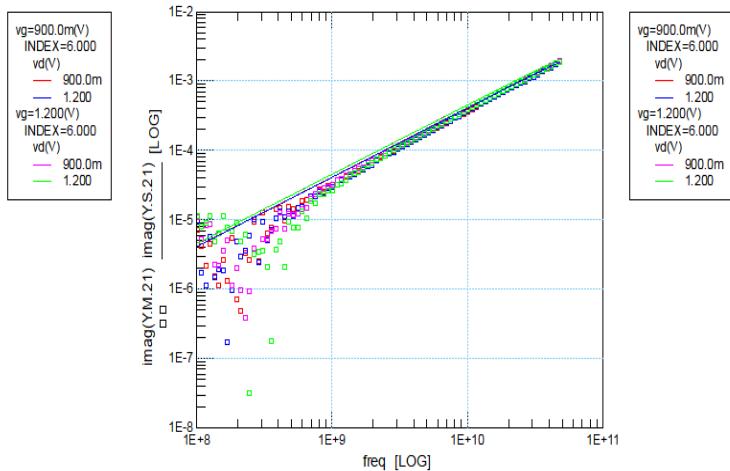
$$\text{re}(Y11) = f(Vg, Vd)$$



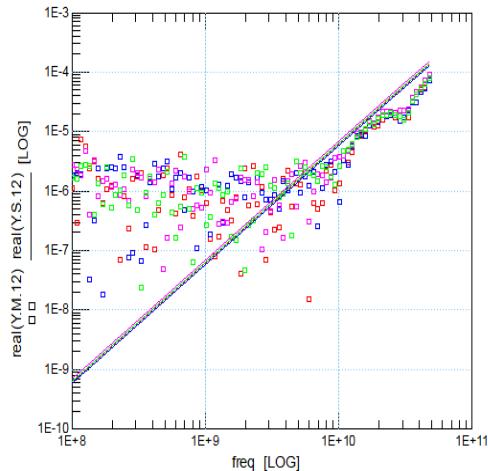
$$\text{im}(Y11) = f(Vg, Vd)$$



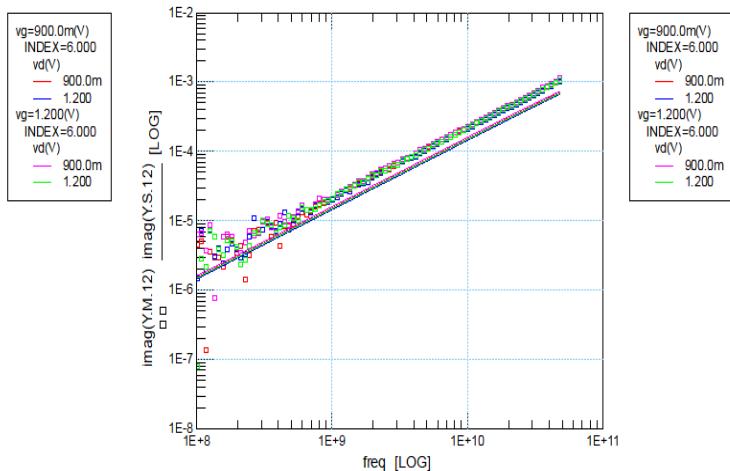
$$\text{re}(Y21) = f(Vg, Vd)$$



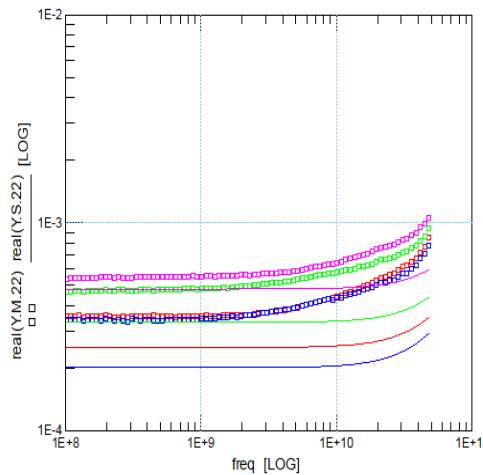
$$\text{im}(Y21) = f(Vg, Vd)$$



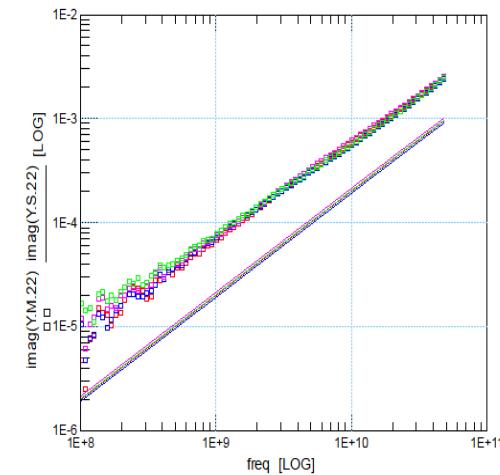
$$\text{re}(Y12) = f(Vg, Vd)$$



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

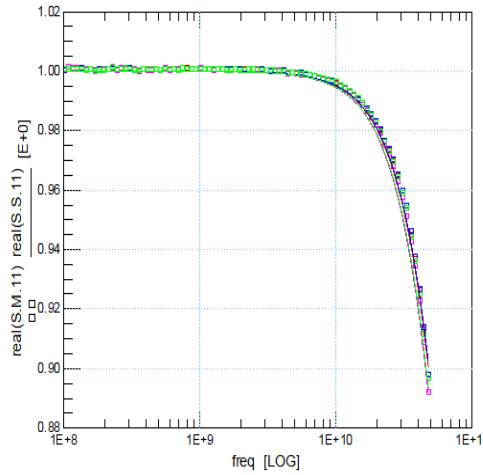


re(Y22) = f(Vg, Vd)

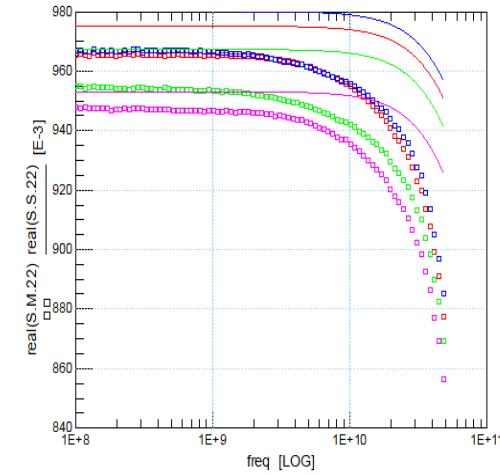


im(Y22) = f(Vg, Vd)

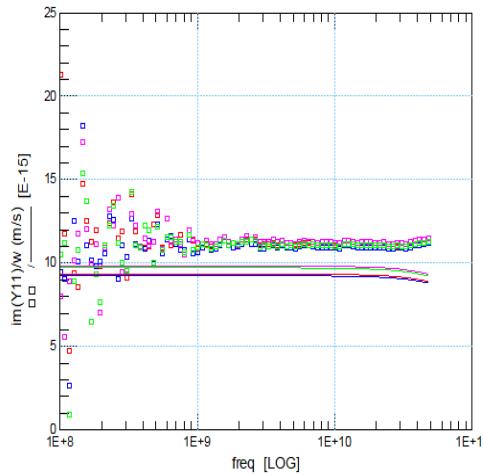
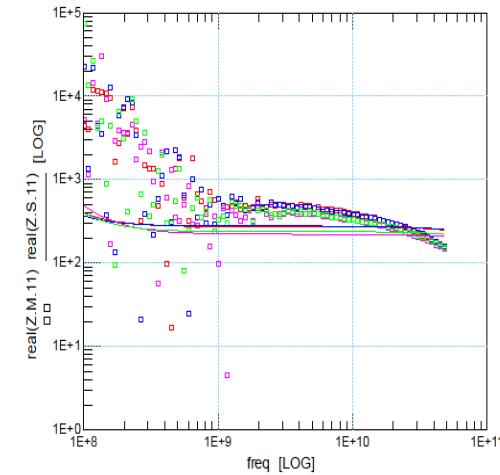
Verify Plots, T = 27°C



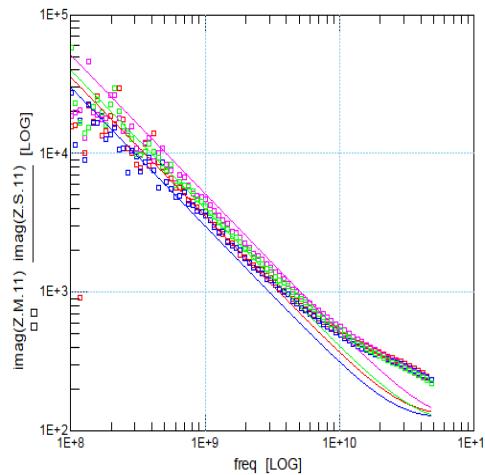
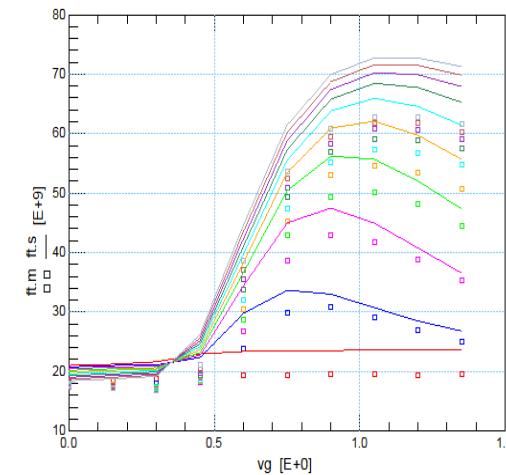
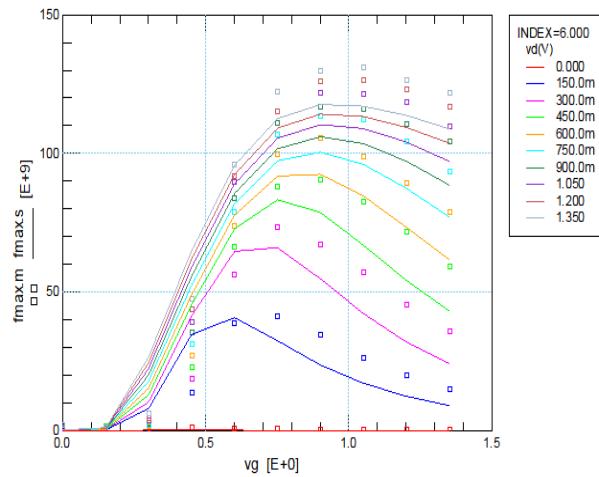
re(S11) = f(Vg, Vd)



re(S22) = f(Vg, Vd)

im(Y11) divided by ω 

re(Z11) = f(Vg, Vd)

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

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