Appendix I

The contents of this appendix is not meant for the public, as it is controlled by a non-disclosure agreement signed with Cree, Inc.

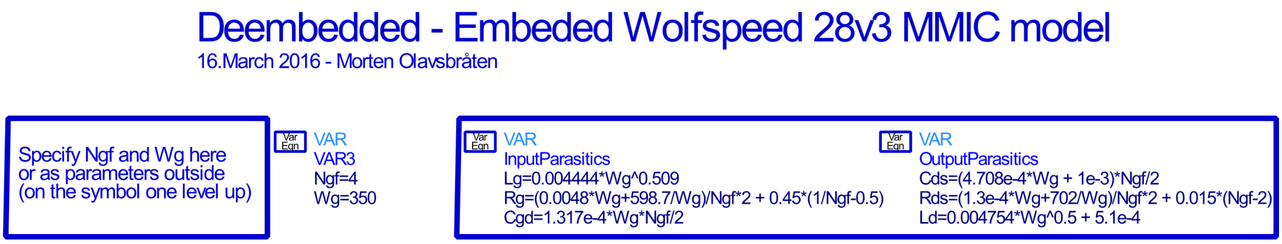

Figure 1: Olavsbråten transistor model equations

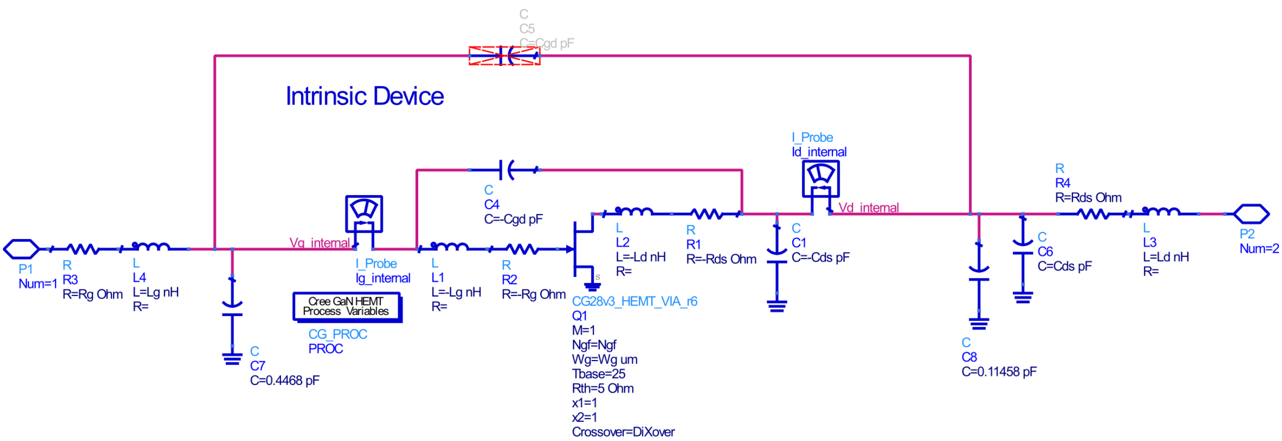

Figure 2: The transistor model with equations

Figure 1 and 2 shows the transistor model supplied by Morten Olavsbråten with the equations used to calculate the sizes of the parasitics. These values were used in the output network design.

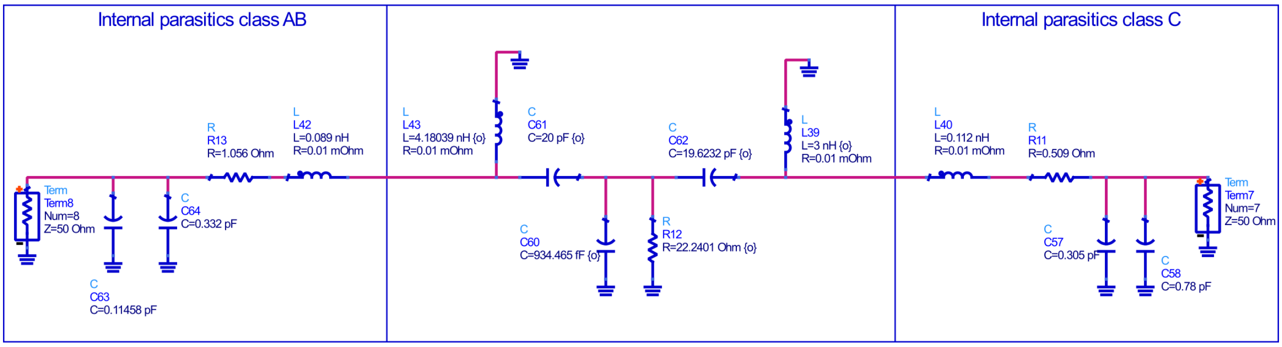

Figure 3: The output network with values.

Figure 3 shows the output network designed, with the internal parasitics of each transistor. The component values were calculated with the equations shown in figure 1. Ngf=4, and Wg=350 was used for the AB amplifier, while Ngf=6 and Wg=550 was used for the Class C amplifier.

2.5.2 Metal Film Resistor

Figure	Description	Dimension	Dimension Tolerance
2.5.2.1	Thin Film Resistor Layout Rules		
2.5.2.1a	- Minimum width (A)	8 µm	±0.5 µm
2.5.2.1a	- Minimum distance to edge of METAL1 (B)	1 µm	
2.5.2.1a	- Minimum overlap of RESISTOR and METAL1 (C)	5 µm	
2.5.2.1b	- Minimum length of resistor (D)	8 µm	
2.5.2.1c	- Minimum separation (E)	8 µm	
2.5.2.2	- Serpentine RESISTOR structures are not permitted		

(a) Dimension restrictions for thin film resistors.

2.5.3 Bulk GaN Resistor[1]

Figure	Description	Dimension	Dimension Tolerance
2.5.3.1	Bulk GaN Resistor Layout Rules		
2.5.3.1a	- Minimum width (A)	10 µm	+0.1/-0.7 µm
2.5.3.1a	- Minimum length of resistor (B)	10 µm	
2.5.3.1b	- Minimum dimension of BGRCONTACT (C)	12 µm	
2.5.3.1b	- Inclusion of METAL1 within BGRCONTACT (D)	1 µm	
2.5.3.1b	- Extension of BGR1 beyond BGRCONTACT (E)	1 µm	
2.5.3.1b	- Extension of BGR2 beyond BGRCONTACT (E)	1 µm	
2.5.3.1c	- Extension of BGR1 beyond BGR2	0 µm	
	- Minimum BGR1 or BGR2 separation to VIA	10 µm	
	- Minimum separation of BGR1 or BGR2	10 µm	
	- BGR1 resistors require both BGR1 and coincident BGR2		
	- Typical size of BGR1/2 in BGR_END will be 4 µm larger than dimension "A"		

[1]Not recommend where accurate control of the resistance is required, or for RF portions of the circuit.

(b) Dimension restrictions for bulk resistors.

2.5.4 MIM Capacitor

Figure	Description	Dimension	Dimension Tolerance
2.5.4.1	MIM Capacitor Layout Rules		
2.5.4.1a	- Minimum width of CAPOPEN (A)	20 µm	±2 µm
2.5.4.1a	- Minimum inclusion of CAPOPEN within CAPTOP (B)	4 µm	
2.5.4.1a	- Minimum inclusion of CAPTOP within METAL1 (C)	6 µm	
2.5.4.1a	- Minimum radius in CAPOPEN corners (D)	10 µm	
	- Minimum distance: CAPTOP to RESISTOR	10 µm	
	- Minimum distance: CAPTOP to ACTIVE REGION[1]	20 µm	
	- Via is not permitted under MIM capacitor		

[1]Only required when using dielectric crossover processes

(c) Dimension restrictions for capacitors.

2.5.5 Rectangular Spiral Inductor

Figure	Description	Dimension	Dimension Tolerance
2.5.5.1	Rectangular Spiral Inductor Layout Rules		
2.5.5.1a,c	- Minimum separation of BRIDGE/METAL2 (A)	12 µm	
2.5.5.1a,c	- Minimum width of BRIDGE/METAL2 (B)	28 µm	
2.5.5.1a,c	- Maximum width of BRIDGE (B)[1]	40 µm[1]	
2.5.5.1a 2.5.5.1b 2.5.5.1c	- Maximum span of airbridge structure (C)[1]	120 µm[1]	
2.5.5.1b,c	- Minimum separation of METAL1 (D)	8 µm	
2.5.5.1d	- Minimum radius in corners of POST (E)	10 µm	
	- Reinforcement not permitted in air bridge process		

[1]Rule only applies when using air bridge crossover process

(d) Dimension restrictions for inductors.

Figure 4: Component restrictions.

Figure 4 show the minimum and maximum dimension restrictions of the components.

1.3 Material Characteristics and Maximum Ratings+

MATERIAL	Characteristic	MIN	TYP	MAX
SiC	Dielectric Constant	9.9	10	10.1
	Dielectric Tan-Delta	-	.001	-
	Thickness (μm)	90	100	110
Resistor Metal	Sheet Resistance (Ω/□)	10.5	12.0	13.5
	DC Current (mA/μm)			1
	Operating Temperature (ºC)			175
Gate Metal	Sheet Resistance (mΩ/□)		47	
	DC Current (mA/μm)			2
Metal1	Sheet Resistance (mΩ/□)	7.3	8.3	9.3
	DC Current (mA/μm)			15
Metal2	Sheet Resistance (mΩ/□)	7.3	8.3	9.3
	DC Current (mA/μm)			15
Capacitor Dielectric	Capacitance (pF/mm^2)	162	180	198
	Voltage, DC+RF @ 85 ºC (volts)			100
	Temperature Derating (volts/ºC)	0.14		
	Operating temperature (ºC)			225
	RF Current Density ($mA/\mu m^2$)			0.35
BGR1	Sheet Resistance (Ω/□)	45	70	110
	Peak Current (mA/μm)			0.2
	Maximum resistor temperature (ºC)			175
BGR2	Sheet Resistance (Ω/□)	375	415	455
	Peak Current (mA/μm)			0.2
	Maximum resistor temperature (ºC)			175
Airbridge crossover	Air space below crossover metal	5	7	15
	Maximum metal temperature (ºC)			225
Crossover dielectric	Dielectric Constant		3.3	
	Dielectric Thickness (μm)	3	4.2	6
	Dielectric Loss Tangent			0.01
	Thermal Conductivity (W/m ºK)		0.125	
	Maximum metal temperature (ºC)			225

+Not simultaneous

Figure 5: Foundry maximum ratings, and component values

Figure 5 shows the maximum ratings of the foundry components. The values in the table is used to calculate the component values, and ensure the components can handle the currents and voltages present in the circuit.