



Pontifícia Universidade Católica do Rio Grande do Sul

Faculdade de Engenharia

Programa de Graduação em Engenharia da Computação



TF – Layout da Função Complexa F2

Micro2: Maiki Buffet e Marcelo Pereira

Professor: Fernando Gehm Moraes

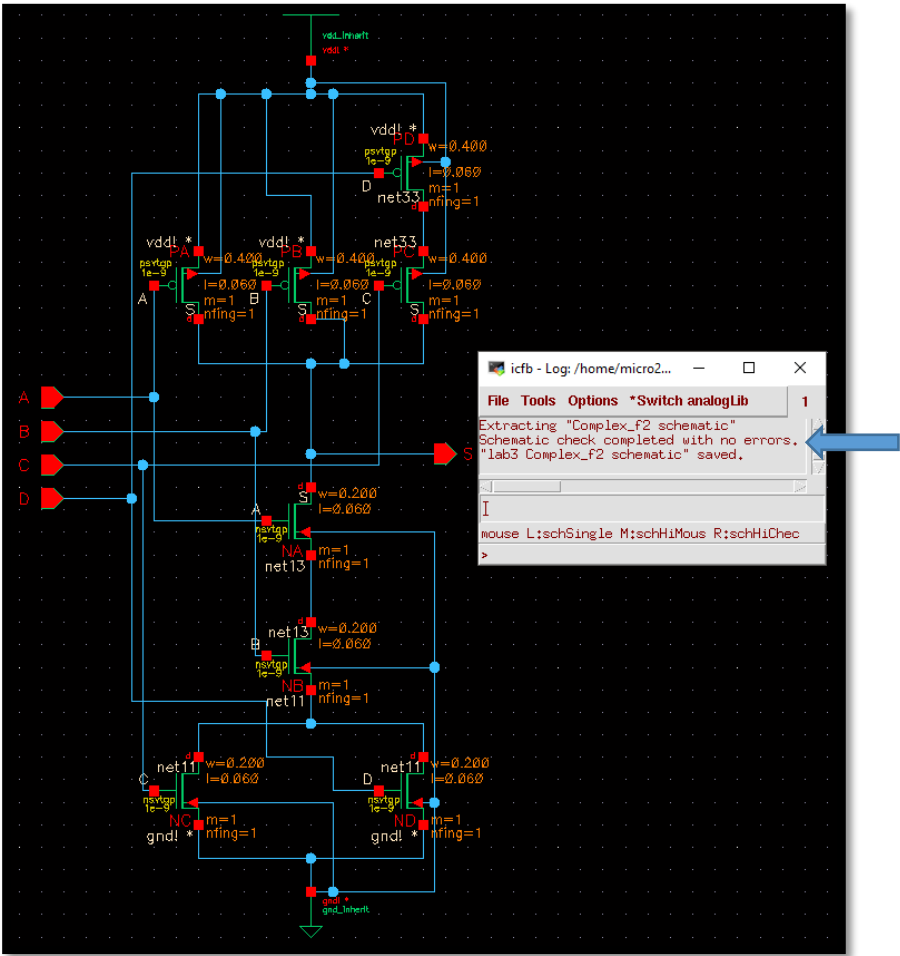
Porto Alegre

Novembro, 2016

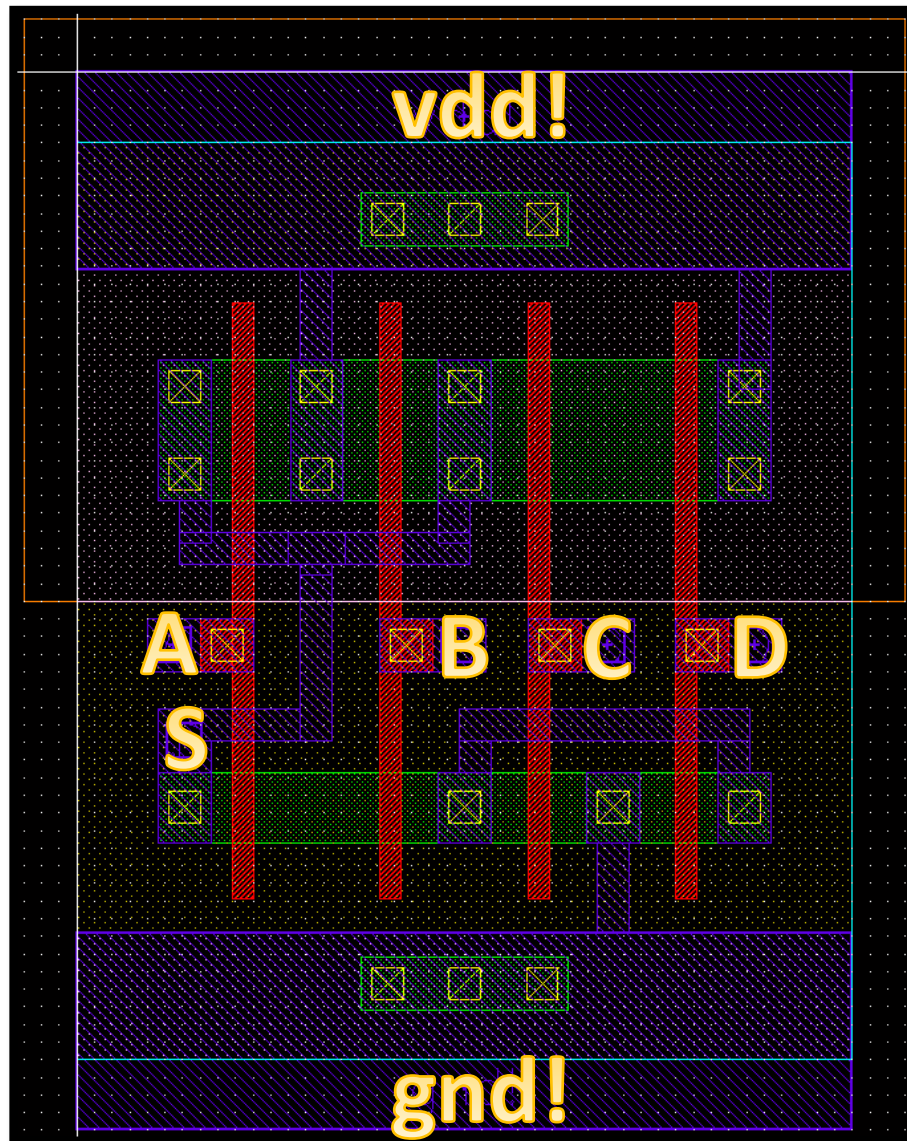
0) Tabela Verdade

A	B	C	D	$\sim(A\wedge B\wedge(C\vee D))$
1	1	1	1	0
1	1	1	0	0
1	1	0	1	0
1	0	1	1	1
0	1	1	1	1
0	0	0	1	1
0	0	1	0	1
0	1	0	0	1
1	0	0	0	1
0	0	0	0	1
1	1	0	0	1
0	0	1	1	1
1	0	0	1	1
0	1	1	0	1
1	0	1	0	1
0	1	0	1	1

1) Esquemático:



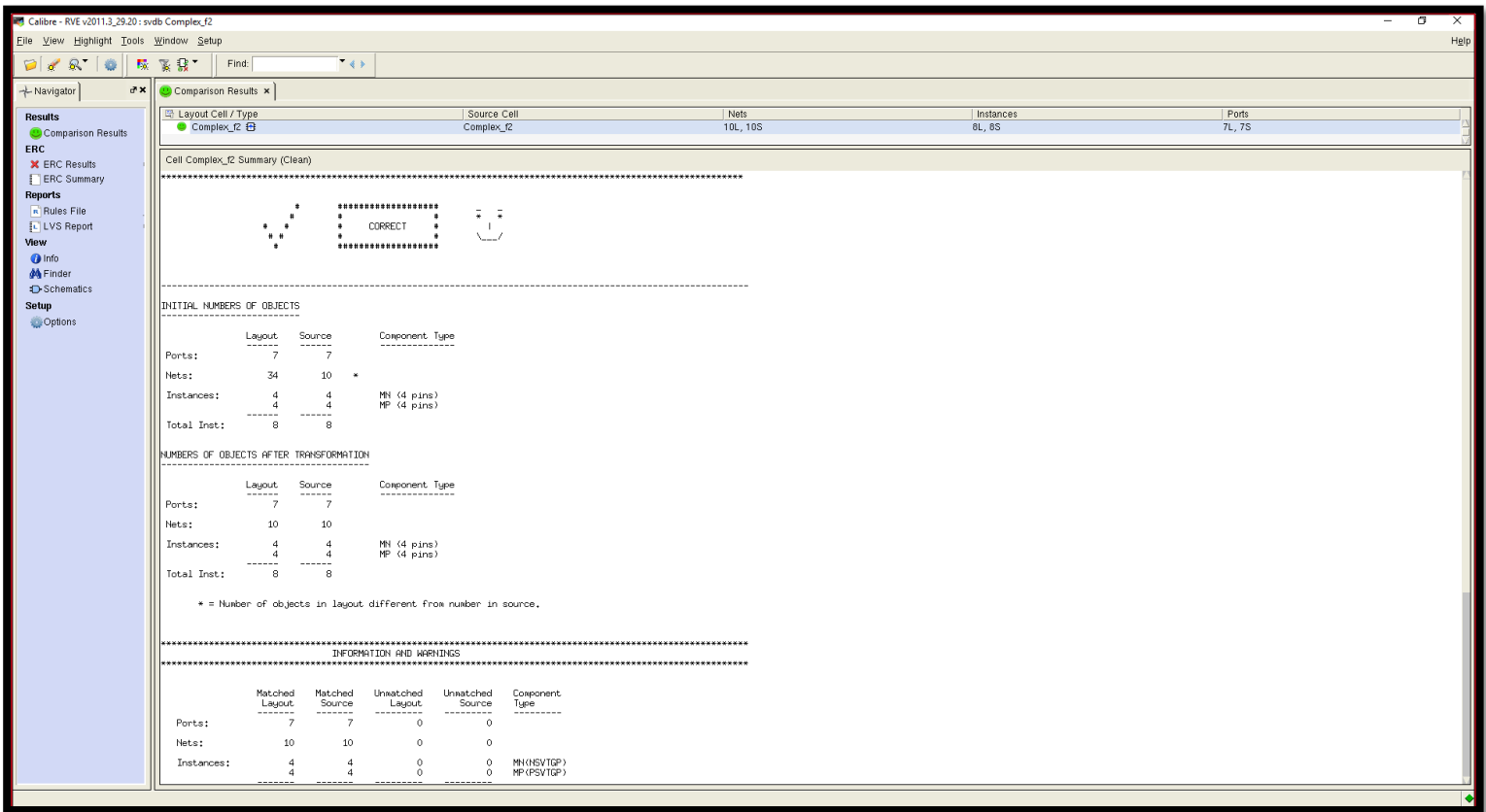
2) Layout:



3) Relatório do DRC:



4) Relatório do LVS:



No.	Layout Net	Source Net	R Count	C Total (F)	C+CC Total (F)
1	A	A	4	2.92312E-16	2.92312E-16
2	B	B	4	2.82479E-16	2.82479E-16
3	C	C	4	2.66154E-16	2.66154E-16
4	D	D	4	2.65397E-16	2.65397E-16
5	E	E	4	6.53551E-16	6.53551E-16
6	gnul	gnul	10	6.71329E-16	6.71329E-16
7	7	net11	9	2.53545E-16	2.53545E-16
8	vddl	vddl	17	4.66342E-16	4.66342E-16

☒ Find Nets:

Coupling to:  All Nets 

5) Relatório da Extração Elétrica e Simulação Elétrica:

- Complex_f2.pex.spi:

```
* File: Complex_f2.pex.spi
* Created: Tue Nov 29 22:47:43 2016
* Program "Calibre xRC"
* Version "v2011.3_29.20"
*
.include "Complex_f2.pex.spi.pex"
.subckt Complex_f2 A B C D S
*
* vdd! vdd!
* gnd! gnd!
* S S
* D D
* C C
* B B
* A A
XPA N_S_XPA_d N_A_XPA_g N_vdd!_XPA_s N_vdd!_X8_noxref_minus psvtgp L=0.06 W=0.4
+ NFING=1 M=1 AS=0.0744 AD=0.0864 PS=0.372 PD=0.832 P02ACT=0.3675 NGCON=1 lpe=3
XPB N_S_XPB_d N_B_XPB_g N_vdd!_XPA_s N_vdd!_X8_noxref_minus psvtgp L=0.06 W=0.4
+ NFING=1 M=1 AS=0.0744 AD=0.0744 PS=0.372 PD=0.372 P02ACT=0.7875 NGCON=1 lpe=3
XPC N_S_XPB_d N_C_XPC_g net33 N_vdd!_X8_noxref_minus psvtgp L=0.06 W=0.4 NFING=1
+ M=1 AS=0.0744 AD=0.0744 PS=0.372 PD=0.372 P02ACT=0.7875 NGCON=1 lpe=0
XPD net33 N_D_XPD_g N_vdd!_XPD_s N_vdd!_X8_noxref_minus psvtgp L=0.06 W=0.4
+ NFING=1 M=1 AS=0.0864 AD=0.0744 PS=0.832 PD=0.372 P02ACT=0.3675 NGCON=1 lpe=0
XNA N_S_XNA_d N_A_XNA_g net13 N_gnd!_X8_noxref_plus nsvtgp L=0.06 W=0.2 NFING=1
+ M=1 AS=0.0374 AD=0.0434 PS=0.374 PD=0.634 P02ACT=0.3675 NGCON=1 lpe=0
XNB net13 N_B_XNB_g N_net11_XNB_s N_gnd!_X8_noxref_plus nsvtgp L=0.06 W=0.2
+ NFING=1 M=1 AS=0.0374 AD=0.0374 PS=0.374 PD=0.374 P02ACT=0.7875 NGCON=1 lpe=0
XNC N_net11_XNB_s N_C_XNC_g N_gnd!_XNC_s N_gnd!_X8_noxref_plus nsvtgp L=0.06
+ W=0.2 NFING=1 M=1 AS=0.0374 AD=0.0374 PS=0.374 PD=0.374 P02ACT=0.7875 NGCON=1
+ lpe=3
XND N_net11_XND_d N_D_XND_g N_gnd!_XNC_s N_gnd!_X8_noxref_plus nsvtgp L=0.06
+ W=0.2 NFING=1 M=1 AS=0.0374 AD=0.0434 PS=0.374 PD=0.634 P02ACT=0.3675 NGCON=1
+ lpe=3
X8_noxref N_gnd!_X8_noxref_plus N_vdd!_X8_noxref_minus dnwps AREA=3.894 PJ=8.02
*
.include "Complex_f2.pex.spi.Complex_f2.pxi"
*
.ends
*
```

- Complex_f2.pex.spi.inv.pxi

```
* File: Complex_f2.pex.spi.Complex_f2.pxi
* Created: Tue Nov 29 22:47:43 2016
*
x_PM_Complex_f2_A N_A_XPA_g N_A_XNA_g A 0 PM_Complex_f2_A
x_PM_Complex_f2_B N_B_XPB_g N_B_XNB_g B 0 PM_Complex_f2_B
x_PM_Complex_f2_C N_C_XPC_g N_C_XNC_g C 0 PM_Complex_f2_C
x_PM_Complex_f2_D N_D_XPD_g N_D_XND_g D 0 PM_Complex_f2_D
x_PM_Complex_f2_S N_S_XNA_d S N_S_XPA_d N_S_XPB_d 0 PM_Complex_f2_S
x_PM_Complex_f2_gnd! N_gnd!_X8_noxref_plus gnd! N_gnd!_XNC_s 0
+ PM_Complex_f2_gnd!
x_PM_Complex_f2_net11 N_net11_XND_d N_net11_XNB_s 0 PM_Complex_f2_net11
x_PM_Complex_f2_vdd! N_vdd!_XPA_s N_vdd!_X8_noxref_minus vdd! N_vdd!_XPD_s 0
+ PM_Complex_f2_vdd!
```

- Complex_f2.src.net

```
*****
* auCd1 Netlist:
*
* Library Name: lab3
* Top Cell Name: Complex_f2
* View Name: schematic
* Netlisted on: Nov 29 22:47:20 2016
*****

*.EQUATION
*.SCALE METER
*.MEGA
.PARAM

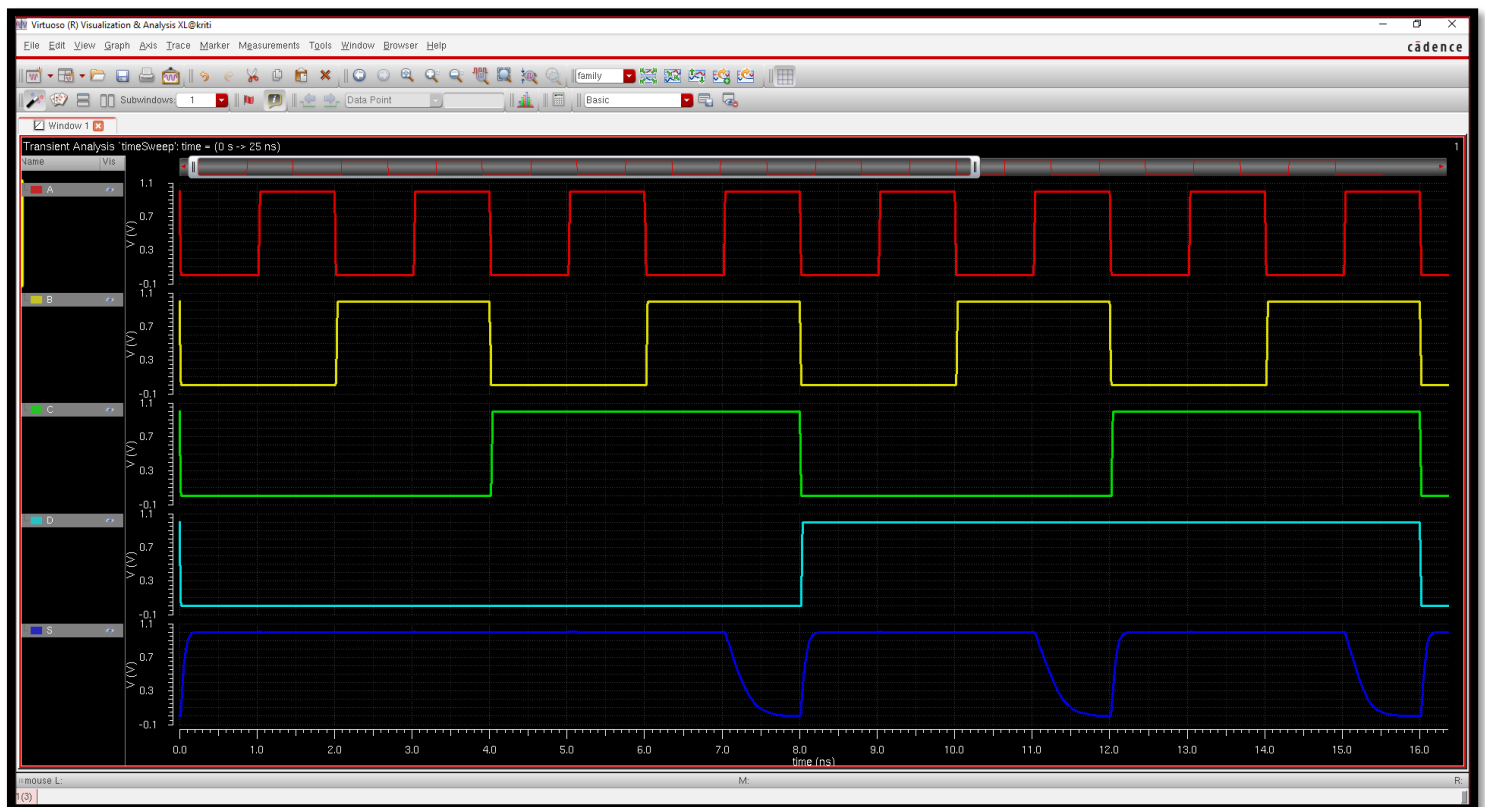
*.GLOBAL gnd!
+      vdd!

*.PIN gnd!
*+      vdd!

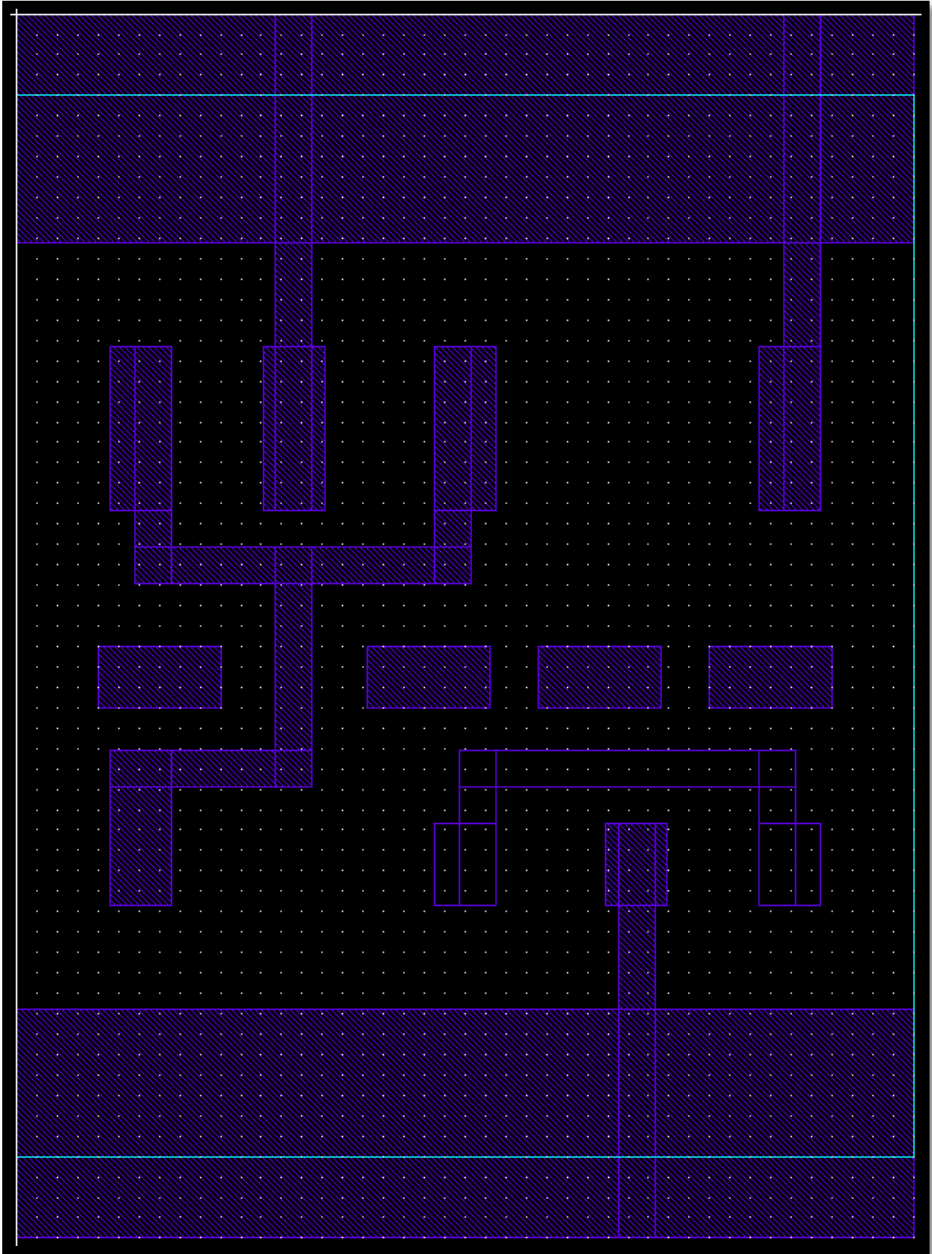
*****

* Library Name: lab3
* Cell Name: Complex_f2
* View Name: schematic
*****

.SUBCKT Complex_f2 A B C D S
*.PININFO A:I B:I C:I D:I S:0
MNA S A net13 gnd! nsvtgp w=0.2 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MNB net13 B net11 gnd! nsvtgp w=0.2 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MNC net11 C gnd! gnd! nsvtgp w=0.2 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MND net11 D gnd! gnd! nsvtgp w=0.2 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MPA S A vdd! vdd! psvtgp w=0.4 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MPB S B vdd! vdd! psvtgp w=0.4 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MPC S C net33 vdd! psvtgp w=0.4 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
MPD net33 D vdd! vdd! psvtgp w=0.4 l=0.06 nfing=1 sense=0 ngcon=1 m=1
+ accurateFlow=0
.ENDS
```



6) Layout da View Abstract:



- Complex_f2.lef

1

```

*****
# Preview export LEF
#
#   Preview sub-version 5.10.41_USR5.90.69
#
# REF LIBS: lab3
# TECH LIB NAME: cmos065
# TECH FILE NAME: techfile.cds
*****

VERSION 5.5 ;

NAMECASESENSITIVE ON ;

DIVIDERCHAR "/" ;
BUSBITCHARS "[]" ;

UNITS
    DATABASE MICRONS 1000 ;
END UNITS

MANUFACTURINGGRID    0.005000 ;
SITE CORE
    SYMMETRY Y ;
    CLASS CORE ;
    SIZE 0.200 BY 2.600 ;
END CORE

MACRO Complex_f2
    CLASS CORE ;
    FOREIGN Complex_f2 0 -2.8 ;
    ORIGIN 0.000 2.800 ;
    SIZE 2.200 BY 2.600 ;
    SYMMETRY X Y ;
    SITE CORE ;
    PIN S
        DIRECTION OUTPUT ;
        PORT
            LAYER M1 ;
            RECT 1.025 -1.215 1.175 -0.815 ;
            RECT 1.025 -1.395 1.115 -0.815 ;
            RECT 0.290 -1.395 1.115 -1.305 ;
            RECT 0.635 -1.895 0.725 -1.305 ;
            RECT 0.230 -1.895 0.725 -1.805 ;
            RECT 0.230 -1.215 0.380 -0.815 ;
            RECT 0.290 -1.395 0.380 -0.815 ;
            RECT 0.230 -2.185 0.380 -1.805 ;
        END
    END S
    PIN D
        DIRECTION INPUT ;
        PORT
            LAYER M1 ;
            RECT 1.700 -1.700 2.000 -1.550 ;
        END
    END D
    PIN C
        DIRECTION INPUT ;
        PORT
            LAYER M1 ;
            RECT 1.280 -1.700 1.580 -1.550 ;
        END
    END C
    PIN B

```

2

```

        DIRECTION INPUT ;
        PORT
            LAYER M1 ;
            RECT 0.860 -1.700 1.160 -1.550 ;
        END
    END B
    PIN A
        DIRECTION INPUT ;
        PORT
            LAYER M1 ;
            RECT 0.200 -1.700 0.500 -1.550 ;
        END
    END A
    PIN vdd!
        DIRECTION INOUT ;
        USE POWER ;
        SHAPE ABUTMENT ;
        PORT
            LAYER M1 ;
            RECT 0.000 -0.560 2.200 0.000 ;
            RECT 1.880 -1.215 1.970 0.000 ;
            RECT 1.820 -1.215 1.970 -0.815 ;
            RECT 0.605 -1.215 0.755 -0.815 ;
            RECT 0.635 -1.215 0.725 0.000 ;
        END
    END vdd!
    PIN gnd!
        DIRECTION INOUT ;
        USE GROUND ;
        SHAPE ABUTMENT ;
        PORT
            LAYER M1 ;
            RECT 0.000 -3.000 2.200 -2.440 ;
            RECT 1.445 -2.185 1.595 -1.985 ;
            RECT 1.475 -3.000 1.565 -1.985 ;
        END
    END gnd!
    OBS
        LAYER M1 ;
        RECT 1.025 -2.185 1.175 -1.985 ;
        RECT 1.820 -2.185 1.970 -1.985 ;
        RECT 1.085 -2.185 1.175 -1.805 ;
        RECT 1.820 -2.185 1.910 -1.805 ;
        RECT 1.085 -1.895 1.910 -1.805 ;
    END
END Complex_f2

END LIBRARY

```


7) Caracterização Elétrica:

inv_datasheet Library

Cell Groups

[COMPLEX_F2](#)

[INV](#)

COMPLEX_F2

inv_datasheet Cell Library: Process , Voltage 1.00, Temp 25.00

Truth Table

INPUT				OUTPUT
A	B	C	D	S
0	x	x	x	1
1	0	x	x	1
1	1	0	0	1
1	1	x	1	0
1	1	1	x	0

Pin Capacitance Information

Cell Name	Pin Cap(pf)				Max Cap(pf)
	A	B	C	D	S
Complex_f2	0.00107	0.00105	0.00109	0.00107	0.08000

Leakage Information

Cell Name	Leakage(nW)		
	Min.	Avg	Max.
Complex_f2	0.00000	16.89490	58.69550

Delay Information

Delay(ns) to S rising :

Cell Name	Timing Arc(Dir)	Delay(ns)		
		Min	Mid	Max
Complex_f2	A->S (RF)	0.01097	0.08406	0.37308
	B->S (RF)	0.01235	0.08590	0.37275
	C->S (RF)	0.02701	0.12987	0.63263
	D->S (RF)	0.02980	0.12244	0.61879

inv_datasheet Library

Cell Groups

[COMPLEX_F2](#)

[INV](#)

Delay(ns) to S falling :

Cell Name	Timing Arc(Dir)	Delay(ns)		
		Min	Mid	Max
Complex_f2	A->S (RF)	0.02611	0.12939	0.65702
	B->S (RF)	0.02915	0.12366	0.64715
	C->S (RF)	0.02738	0.10823	0.61280
	D->S (RF)	0.03237	0.11549	0.62770

Power Information

Internal switching power(pJ) to S rising :

Cell Name	Input	Power(pJ)		
		min	mid	max
Complex_f2	A	0.00091	0.00124	0.00121
	B	0.00109	0.00145	0.00141
	C	0.00000	0.00000	0.00000
	C	0.00130	0.00156	0.00151
	D	0.00000	0.00000	0.00000
	D	0.00149	0.00168	0.00166

Internal switching power(pJ) to S falling :

Cell Name	Input	Power(pJ)		
		min	mid	max
Complex_f2	A	0.00021	0.00048	0.00043
	B	0.00022	0.00043	0.00040
	C	0.00000	0.00000	0.00000
	C	0.00024	0.00036	0.00036
	D	0.00000	0.00000	0.00000
	D	0.00034	0.00045	0.00044

Passive power(pJ) for A rising (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max

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inv_datasheet Library Da...

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Search

inv_datasheet Library

Cell Groups

[COMPLEX_F2](#)

[INV](#)

Passive power(pJ) for A rising (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	$(B * IC * ID * S)$	0.00000	0.00000	0.00000
	$(B * IC * ID * S)$	-0.00017	-0.00017	-0.00019
	$(!B * C * S)$	0.00000	0.00000	0.00000
	$(!B * C * S)$	-0.00019	-0.00019	-0.00020
	$(!B * IC * S)$	0.00000	0.00000	0.00000
	$(!B * IC * S)$	-0.00019	-0.00019	-0.00020

Passive power(pJ) for A falling (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	$(B * IC * ID * S)$	0.00000	0.00000	0.00000
	$(B * IC * ID * S)$	0.00021	0.00021	0.00021
	$(!B * C * S)$	0.00000	0.00000	0.00000
	$(!B * C * S)$	0.00021	0.00021	0.00021
	$(!B * IC * S)$	0.00000	0.00000	0.00000
	$(!B * IC * S)$	0.00021	0.00021	0.00021

Passive power(pJ) for B rising (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	$(A * IC * ID * S)$	0.00000	0.00000	0.00000
	$(A * IC * ID * S)$	-0.00017	-0.00017	-0.00017
	$(!A * C * S)$	0.00000	0.00000	0.00000
	$(!A * C * S)$	-0.00017	-0.00017	-0.00017
	$(!A * IC * D * S)$	0.00000	0.00000	0.00000
	$(!A * IC * D * S)$	-0.00017	-0.00017	-0.00017
	$(!A * IC * ID * S)$	0.00000	0.00000	0.00000
	$(!A * IC * ID * S)$	-0.00017	-0.00017	-0.00017

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Cell Groups

[COMPLEX_F2](#)

[INV](#)

Passive power(pJ) for B falling (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	$(A * IC * ID * S)$	0.00000	0.00000	0.00000
	$(A * IC * ID * S)$	0.00021	0.00021	0.00021
	$(!A * C * S)$	0.00000	0.00000	0.00000
	$(!A * C * S)$	0.00020	0.00018	0.00018
	$(!A * IC * D * S)$	0.00000	0.00000	0.00000
	$(!A * IC * D * S)$	0.00020	0.00018	0.00018
	$(!A * IC * ID * S)$	0.00000	0.00000	0.00000
	$(!A * IC * ID * S)$	0.00019	0.00018	0.00018

Passive power(pJ) for C rising (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	$(A * B * D * !S)$	0.00000	0.00000	0.00000
	$(A * B * D * !S)$	-0.00004	-0.00004	-0.00004
	$(A * !B * D * S)$	0.00000	0.00000	0.00000
	$(A * !B * D * S)$	-0.00022	-0.00022	-0.00022
	$(A * !B * ID * S)$	0.00000	0.00000	0.00000
	$(A * !B * ID * S)$	-0.00023	-0.00023	-0.00023
	$(!A * B * D * S)$	0.00000	0.00000	0.00000
	$(!A * B * D * S)$	-0.00022	-0.00022	-0.00022
	$(!A * B * ID * S)$	0.00000	0.00000	0.00000
	$(!A * B * ID * S)$	-0.00023	-0.00023	-0.00023
	$(!A * !B * D * S)$	0.00000	0.00000	0.00000
	$(!A * !B * D * S)$	-0.00022	-0.00022	-0.00022
	$(!A * !B * ID * S)$	0.00000	0.00000	0.00000
	$(!A * !B * ID * S)$	-0.00023	-0.00023	-0.00023

Passive power(pJ) for C falling (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max

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inv_datasheet Library

Cell Groups

COMPLEX_F2

INV

Passive power(pJ) for C falling (conditional):

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	(A * B * D * !S)	0.00000	0.00000	0.00000
	(A * B * D * !S)	0.00009	0.00008	0.00008
	(A * !B * D * S)	0.00000	0.00000	0.00000
	(A * !B * D * S)	0.00023	0.00023	0.00023
	(A * !B * !D * S)	0.00000	0.00000	0.00000
	(A * !B * !D * S)	0.00024	0.00024	0.00024
	(!A * B * D * S)	0.00000	0.00000	0.00000
	(!A * B * D * S)	0.00023	0.00023	0.00023
	(!A * B * !D * S)	0.00000	0.00000	0.00000
	(!A * B * !D * S)	0.00024	0.00024	0.00024
	(!A * !B * D * S)	0.00000	0.00000	0.00000
	(!A * !B * D * S)	0.00023	0.00023	0.00023
	(!A * !B * !D * S)	0.00000	0.00000	0.00000
	(!A * !B * !D * S)	0.00023	0.00023	0.00023
Passive power(pJ) for D rising (conditional):				
Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	(A * B * C * !S)	0.00000	0.00000	0.00000
	(A * B * C * !S)	-0.00015	-0.00020	-0.00020
	(A * !B * !C * S)	0.00000	0.00000	0.00000
	(A * !B * !C * S)	-0.00023	-0.00023	-0.00023
	(!B * C * S)	0.00000	0.00000	0.00000
	(!B * C * S)	-0.00022	-0.00022	-0.00022
	(!A * B * C * S)	0.00000	0.00000	0.00000
	(!A * B * C * S)	-0.00022	-0.00022	-0.00022
	(!A * B * !C * S)	0.00000	0.00000	0.00000
	(!A * B * !C * S)	-0.00023	-0.00023	-0.00023
	(!A * !B * !C * S)	0.00000	0.00000	0.00000
	(!A * !B * !C * S)	-0.00023	-0.00023	-0.00023
	(!A * !B * !C * S)	0.00000	0.00000	0.00000

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inv_datasheet Library

Cell Groups

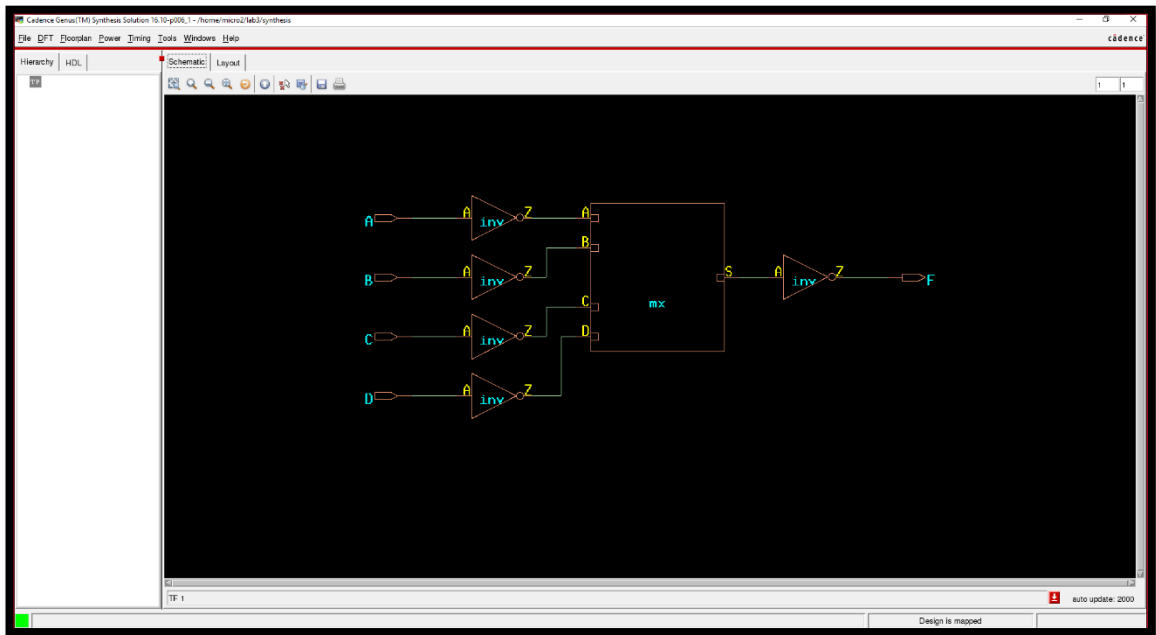
COMPLEX_F2

INV

Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	(A * B * C * !S)	0.00000	0.00000	0.00000
	(A * B * C * !S)	-0.00015	-0.00020	-0.00020
	(A * !B * !C * S)	0.00000	0.00000	0.00000
	(A * !B * !C * S)	-0.00023	-0.00023	-0.00023
	(!B * C * S)	0.00000	0.00000	0.00000
	(!B * C * S)	-0.00022	-0.00022	-0.00022
	(!A * B * C * S)	0.00000	0.00000	0.00000
	(!A * B * C * S)	-0.00022	-0.00022	-0.00022
	(!A * B * !C * S)	0.00000	0.00000	0.00000
	(!A * B * !C * S)	-0.00023	-0.00023	-0.00023
	(!A * !B * !C * S)	0.00000	0.00000	0.00000
	(!A * !B * !C * S)	-0.00023	-0.00023	-0.00023
	(!A * !B * !C * S)	-0.00023	-0.00023	-0.00023
Passive power(pJ) for D falling (conditional):				
Cell Name	When	Power(pJ)		
		min	mid	max
Complex_f2	(A * B * C * !S)	0.00000	0.00000	0.00000
	(A * B * C * !S)	0.00026	0.00026	0.00026
	(A * !B * !C * S)	0.00000	0.00000	0.00000
	(A * !B * !C * S)	0.00024	0.00024	0.00024
	(!B * C * S)	0.00000	0.00000	0.00000
	(!B * C * S)	0.00023	0.00023	0.00023
	(!A * B * C * S)	0.00000	0.00000	0.00000
	(!A * B * C * S)	0.00023	0.00023	0.00023
	(!A * B * !C * S)	0.00000	0.00000	0.00000
	(!A * B * !C * S)	0.00024	0.00024	0.00024
	(!A * !B * !C * S)	0.00000	0.00000	0.00000
	(!A * !B * !C * S)	0.00023	0.00023	0.00023
	(!A * !B * !C * S)	0.00023	0.00023	0.00023

Next (INV)

8) Síntese Lógica:

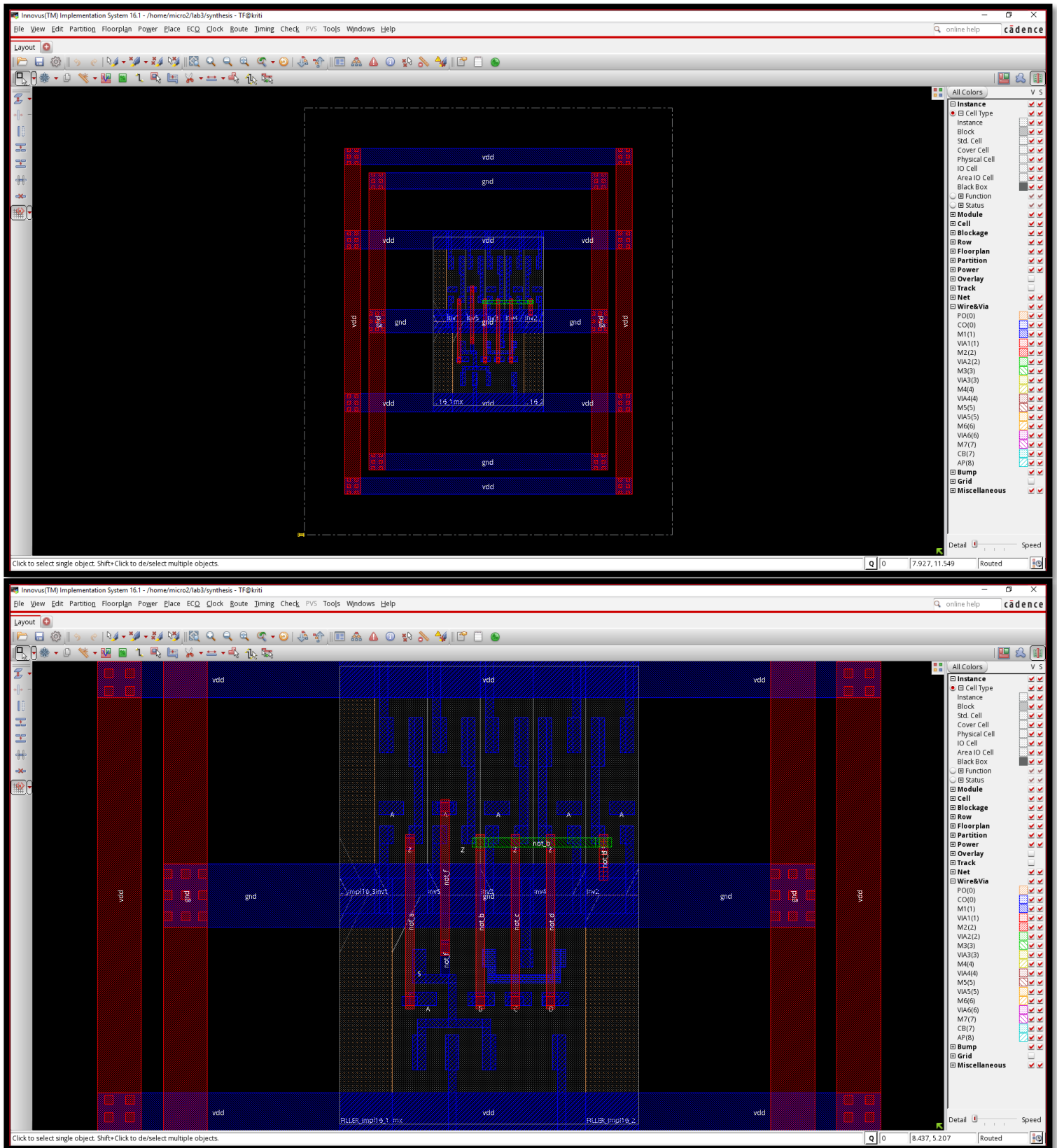


```
=====
Generated by:      Genus(TM) Synthesis Solution 16.10-p006_1
Generated on:      Nov 29 2016  11:16:19 pm
Module:            TF
Interconnect mode: global
Area mode:         physical library
=====
```

Gate	Instances	Area	Library
Complex_f2	1	5.356	inv
inv	5	7.800	inv
total	6	13.156	

Type	Instances	Area	Area %
inverter	5	7.800	59.3
logic	1	5.356	40.7
physical_cells	0	0.000	0.0
total	6	13.156	100.0

9) Síntese Física:



```

----- Design Statistics:
Number of Instances           : 9
Number of Non-uniquified Insts : 7
Number of Nets               : 17
Average number of Pins per Net : 1.18
Maximum number of Pins in Net  : 2

----- I/O Port summary
Number of Primary I/O Ports   : 5
Number of Input Ports         : 4
Number of Output Ports        : 1
Number of Bidirectional Ports : 0
Number of Power/Ground Ports  : 0
Number of Floating Ports      *: 0
Number of Ports Connected to Multiple Pads *: 0
Number of Ports Connected to Core Instances : 5

----- Design Rule Checking:
Number of Output Pins connect to Power/Ground *: 0
Number of Insts with Input Pins tied together ?: 0
Number of TieHi/Lo term nets not connected to instance's PG terms ?: 0
Number of Input/InOut Floating Pins           : 0
Number of Output Floating Pins                 : 0
Number of Output Term Marked TieHi/Lo         *: 0

Number of nets with tri-state drivers          : 0
Number of nets with parallel drivers           : 0
Number of nets with multiple drivers          : 0
Number of nets with no driver (No FanIn)      : 0
Number of Output Floating nets (No FanOut)    : 0
Number of High Fanout nets (>50)              : 0
Checking routing tracks.....
Checking other grids.....
Checking FINEFET Grid is on Manufacture Grid.....

Checking core/die box is on Grid.....

Checking snap rule .....

Checking Row is on grid.....

Checking AreaIO row.....
Checking routing blockage.....
Checking components.....
Checking IO Pins.....
Unplaced Io Pins = 5
Checking constraints (guide/region/fence).....
Checking groups.....

Checking Ptn Pins .....
Checking Ptn Core Box.....

Checking Preroutes.....
No. of regular pre-routes not on tracks : 0
Design check done.
Report saved in file checkDesign/TF.main.htm.ascii.
*** Message Summary: 0 warning(s), 0 error(s)

0

```

Depth	Name	#Inst	Area (um^2)
0	TF	6	13.52
1			