PLD PROGRAMMING

ELEC 391 - Electrical Engineering Design Studio

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Objectives

- Introduction to PLD’s and their functionality
- Introduction to WinCupl 5.0
- Xeltek Superpro model 610p
- **Bonus:** common practices for digital electronics implementation

PLD's – What are they?

Programmable Logic Devices

- PROMs
- PALs
- **GALs**
- **PLAs**
- Complex PLDs
- FPGAs

Figure 1-1. Elementary PROM architecture

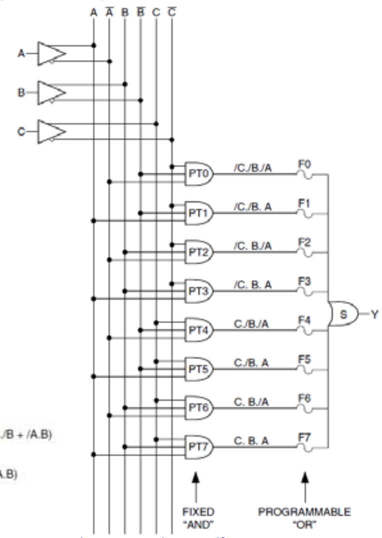
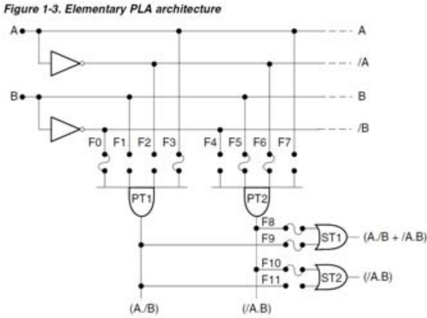


Figure 1-3. Elementary PLA architecture



From: "ATMEL – WinCUPL USER'S MANUAL" http://www.atmel.com/Images/doc0737.pdf

Design problem: 3-bits multiple of 3 indicator

#	B2	B1	B0	X = mult of 3?
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0

Multiple of 2:

$$Y = \overline{B0}$$

Multiple of 4:

$$Z = \overline{B0} \cdot \overline{B1}$$

Multiple of 3?

Design problem: 3-bits multiple of 3 indicator

#	B2	B1	B0	X = mult of 3?
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	0
6	1	1	0	1
7	1	1	1	0

Multiple of 3:

$$X = \overline{B2} \cdot B1 \cdot B0 + B2 \cdot B1 \cdot \overline{B0}$$

One step further:

$$X = B1 \cdot (\overline{B2} \cdot B0 + B2 \cdot \overline{B0})$$

If this is the minimum expression,

the solution requires 3 ICs

Design problem: 3-bits multiple of 3 indicator

Can we make it with 1 IC?

$$X = B1 \cdot (\overline{B2} \cdot B0 + B2 \cdot \overline{B0})$$

Yes, here is what we are going to need

- 1 IC: ATMEL ATF16V8B or similar (in stock)
- Software: WinCupl 5.0
  https://www.microchip.com/design-centers/fpgas-and-plds/splds-cplds/pld-design-resources
- Programming station: Xeltek Superpro model 610p
  (in MCLD 306)

WinCupl installation

- Use serial number **60008009**
- Use any organization name

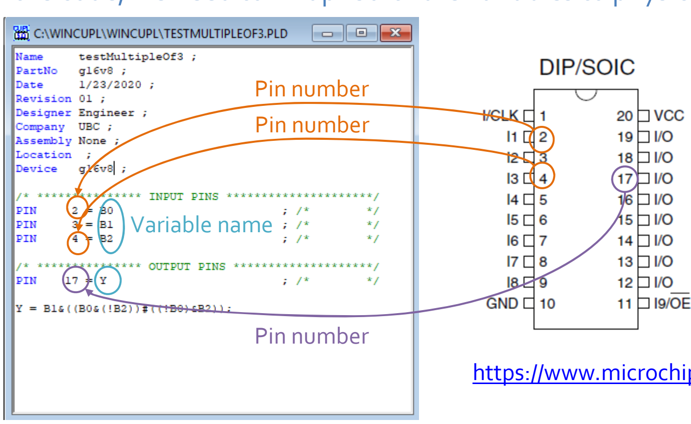
WinCupl

- Create a new project, give it a name, specify the device as g16v8
- Specify # of inputs and outputs (leave pinnodess at 0)
- Go to "Options"-> "Devices", and pic the actual device part number (Atmel ATF16V8B)
- Go to "Options"-> "Compiler", and make sure the following boxes are ticked:
  - In "Output Files" tab: "JEDEC", "Fuse Plot", "Equations", "Absolute", "List", "PDIF", and "PLA"
  - In "General" tab: "Simulate" and "JEDEC name = PLD name"

WinCupl

- Define input and output pins, and assign variables to them

In the code, we need to "map" software variables to physical pins



Pin Configurations

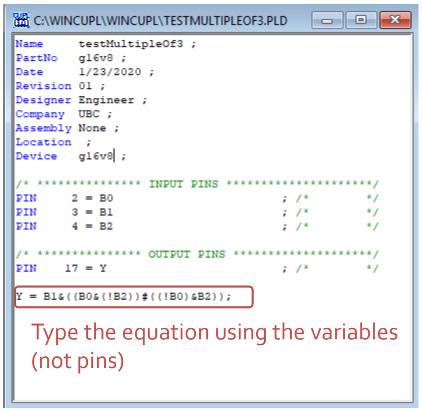
All Pinouts Top View

Pin Name	Function
CLK	Clock
I	Logic Inputs
I/O	Bi-directional Buffers
$\overline{OE}$	Output Enable
VCC	+5V Supply

https://www.microchip.com/wwwproducts/en/ATF16V8B

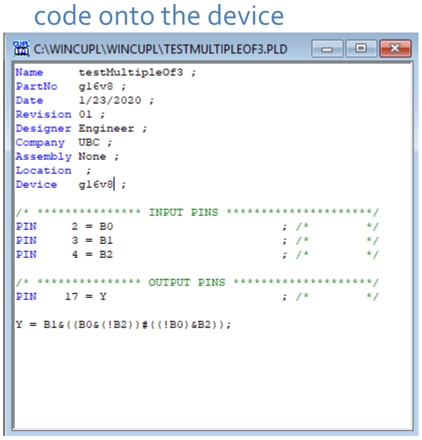
WinCupl

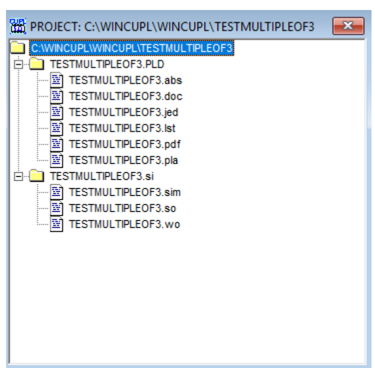
- Type in your equations (logic operators: NOT=!, AND=&, OR=#, XOR=$)



WinCupl

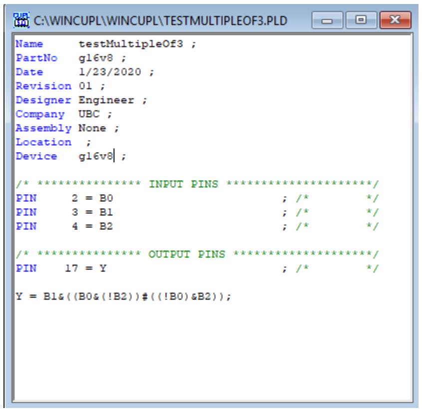
- Compile the project with "Run"-> "Device Dependent Compile"
- Make sure the file "ProjecName.JED" was created, you will need it to burn the code onto the device

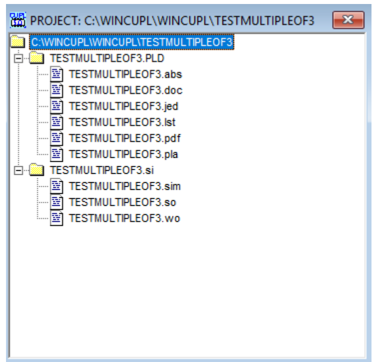




Simulate the circuit: WinSim (WinCupl code simulation)

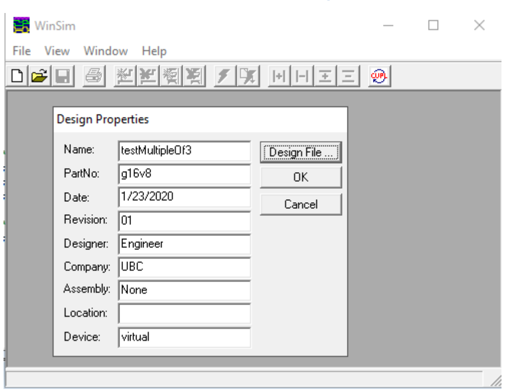
- Open WinSim on "Utilities"-> "WinSim"





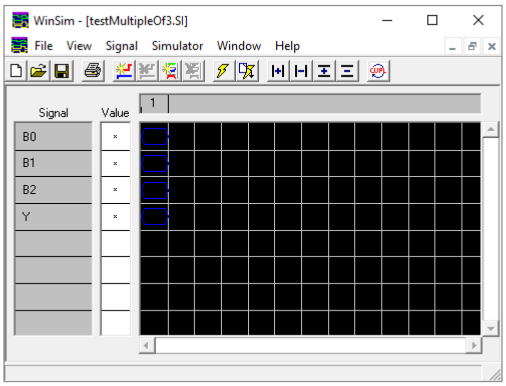
Simulate the circuit: WinSim (WinCupl code simulation)

- Create a new WinSim project, click "Design File" and select your WinCupl project



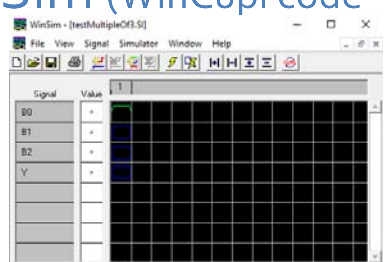
Simulate the circuit: WinSim (WinCupl code simulation)

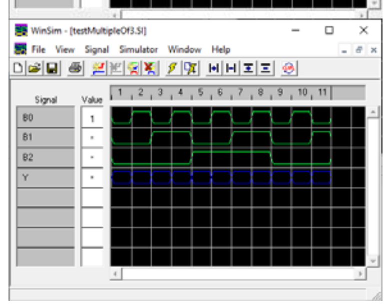
- Add all signals on "Signals"-> "Add Signal"



Simulate the circuit: WinSim (WinCupl code simulation)

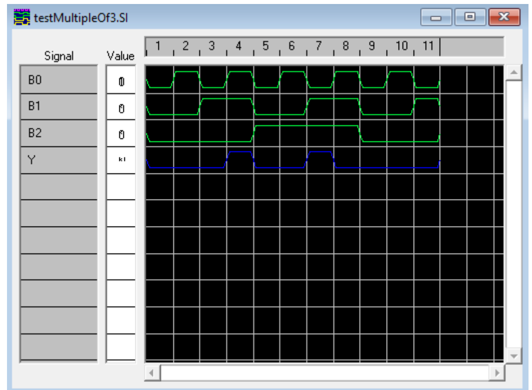
- Define High or Low states of the inputs
- To define the value of a signal: right click on the black cell and select "1" or "0" accordingly
- To add more test cases, right click next to the "1" in gray and click add more vectors (these are the test cases)





Simulate the circuit: WinSim (WinCupl code simulation)

- Simulate by clicking on "Simulator"-> "Run Simulator"



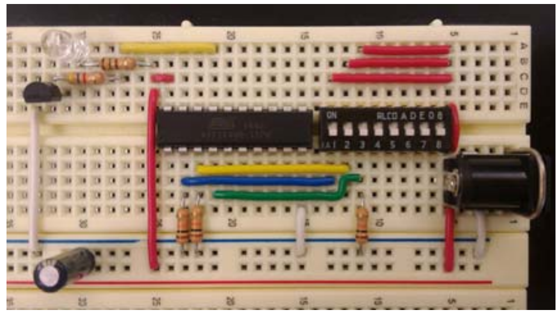
Does this match the design?

Superpro 610P

- Get to the programming station in MCLD 306 with your *.JED file
- Make sure the programmer is turned ON and connected to the USB port
- Mount your IC on to the programmer socket and lower the lever ensure all pins are making good contact
- Open the software "Superpro 610P & 611S series", it should recognize the programmer
- Select your device by clicking on "Device", and search for 16v8, find the "ATMEL ATF16V8B"
- To load your .JED file click on "File"-> "Load", and browse for your file
- Click on the following buttons respecting the sequence order: "Erase", "Blank Check", "Program", and "Verify", each operation should take a couple of seconds FP1
- If you find any errors, ask your TA for help/suggestions, if everything is OK remove your device and plug it into your circuit

How should I build the prototype?

- No flying wires!
- No flimsy connections!
- Solid, reliable built
- Color-coded wires for easier debugging
- Using an LED? Check current capability, add a buffer (transistor, gate, op-amp…)
- Using a switch? Add pull-down resistors
- Include a capacitor on the DC BUS

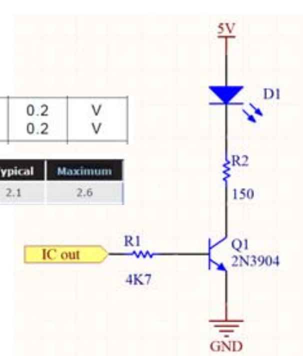


Transistor circuit as current buffer

- Q Vsat and LED Vf must be taken into account
- R2 determines the LED current
- R1 limits the base current

$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 10 mA I_C = 50 mA	I_B = 1 mA I_B = 5 mA				0.2 0.2	V V

Characteristics	Color	Symbol	Condition	Unit	Minimum	Typical	Maximum
Forward Voltage	Red/Amber	V_F	I_F = 20 mA	V		2.1	2.6



Pull-down resistors