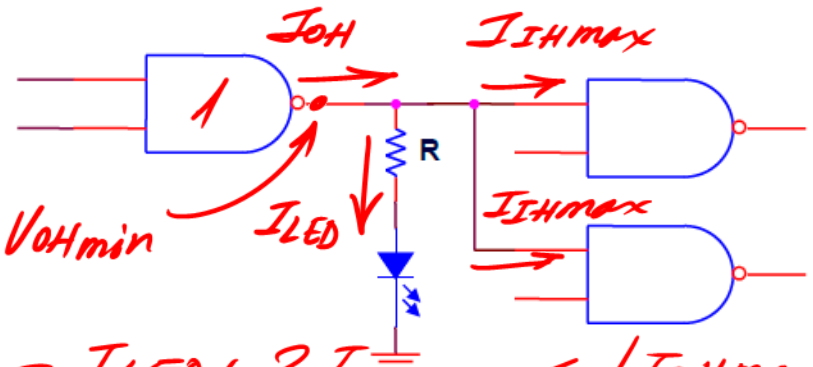
UNIT 3. LOGIC FAMILIES

23. The LED of figure with a resistor R of 50 Ω, is inserted in the digital circuit to display an internal variable. Taking into account the specifications of the logic gates as detailed in the following table, and $V_{\gamma(LED)}$=1.8V, a) Is this connection correct? If it is correct, how many inputs can be connected in total? If not, what is the value of R which allows connecting up to four inputs?



I_{OH} I_{IHmax} I_{IHmax} V_{OHmin} I_{LED}

Led on when gate 1 to High level

$I_{LED} = \frac{V_{OHmin} - V_{LED}}{R} = \frac{2.3 - 1.8}{50}$

$= 0.01A = 10mA$

$I_{OH} = I_{LED} + 2I_{IHmax} \leq |I_{OHmax}|$

V_{IHmin}	V_{ILmax}	V_{OHmin}	V_{OLmax}
2.5V	0.8 V	2.3 V	0.2 V
I_{IHmax}	I_{ILmax}	I_{OHmax}	I_{OLmax}
1 mA	-3.5 mA	-16 mA	25 mA

$I_{LED} + 2I_{IHmax} = 12mA$

as $|I_{OHmax}| = 16mA > 12mA$

⇒ Correct connection

How many inputs?

$|I_{OHmax}| \geq I_{LED} + n \cdot I_{IHmax}$

$16 \geq 10 + n \cdot 1 \Rightarrow n \leq 6$

UNIT 3. LOGIC FAMILIES

25. We want to connect the outputs of 2 standard components of a logic family with a voltage supply of 5V, to 3 inputs of components of the same family. The specifications of the family are shown in the following table:

V_{IHmin}	V_{ILmax}	V_{OHmin}	V_{OLmax}
2 V	0.8 V	2.4 V	0.4 V
I_{IHmax}	I_{ILmax}	I_{OHmax}	I_{OLmax}
40 µA	-1.6 mA	-400uA	16 mA

Voltage:

$V_{OHmin} \geq V_{IHmin}$? $\Rightarrow$ OK

2.4 ≥ 2

$V_{OLmax} \leq V_{ILmax}$? $\Rightarrow$ OK

0.8 ≤ 0.4

Voltage compatible

To make correctly this connection:

[A] We do not need to add anything more.

[B] It should be added a pull-up resistor between the output and the voltage supply, with a range of possible values between 0.41 kΩ and 8,12 kΩ.

[C] It cannot be done the connection of the outputs, since it would cause an undetermined voltage and the degradation of the output transistors.

[D] It should be added a pull-up resistor between the output and the voltage supply, with a range of possible values between 0,41 kΩ and 11,82 kΩ.

Currents:

$I_{OLmax} \geq 3|I_{ILmax}|$? $\Rightarrow$ OK

16 ≥ 3 · 1.6

$|I_{OHmax}| \geq 3 I_{IHmax}$? $\rightarrow$ OK

400µ ≥ 3 · 40µ

$\Rightarrow$ Current compatib.

UNIT 3. LOGIC FAMILIES

31. We want to connect a TTL open collector output with an input of a CMOS logic circuit powered to + 9V. Indicate the CORRECT answer:

Family A (TTL open collector)			Family B (CMOS +9V)			
V_{OLmax}	$I_{OHmax\ (fugas)}$	I_{OLmax}	V_{IHmin}	V_{ILmax}	I_{IHmax}	I_{ILmax}
0.4 V	100 µA	16 mA	6.3 V	2.7 V	0.1 µA	-0.1 µA

↳ leackage

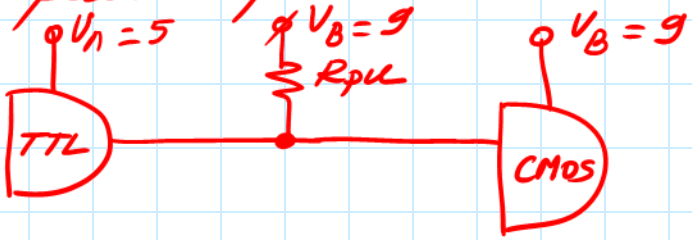
[A] It is necessary to connect a pull-up resistor between the output and the power supply. of + 9V. The value of the resistance must be between 0.54KΩ and 26.97KΩ.

[B] We can connect both famílies directly.

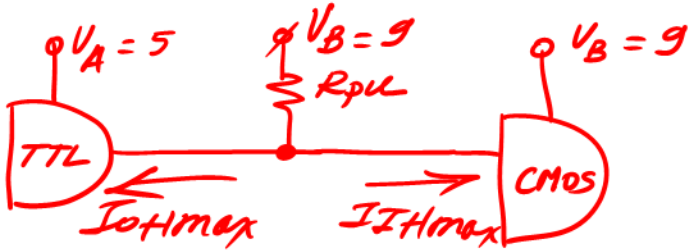
[C] It is necessary to insert a TTL buffer to make the current compatible at low level.

[D] It is necessary to connect a pull-up resistor between the output and the power supply. of + 9V. The value of the resistance must be between 2.1KΩ y 41.4KΩ.

TTL is open collector ⇒ Need a pull-up resistor



a) High level

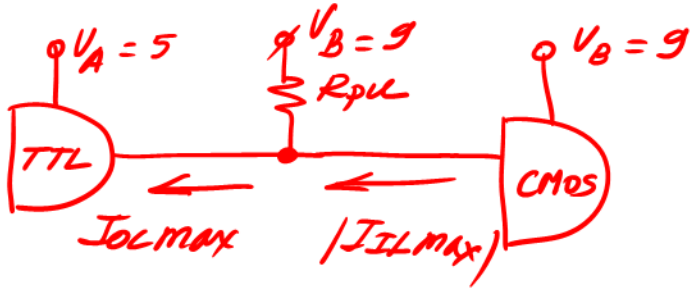


$$R_{pu} \leq \frac{V_B - V_{IHmin}}{I_{OHmax} + I_{IHmax}} = \frac{9 - 6.3}{0.1 + 0.0001}$$

$$R_{pu} \leq 26.97K$$

(No noise margin)

b) Low level



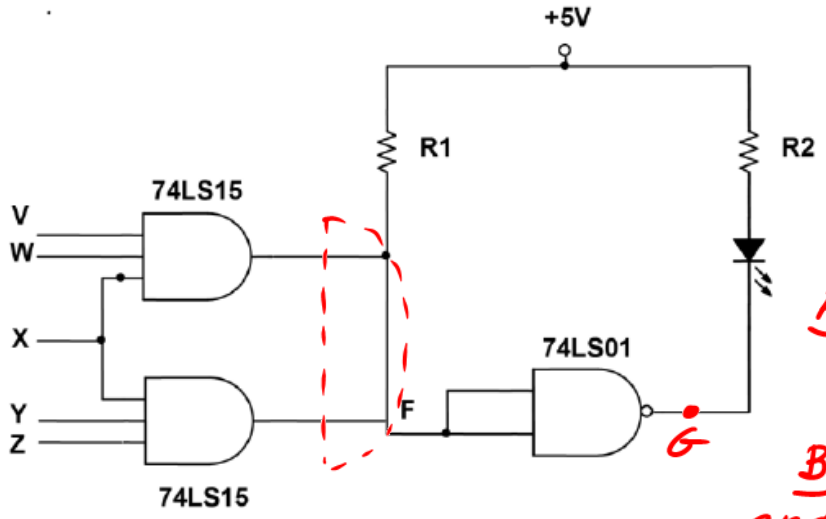
$$R_{pu} \geq \frac{V_B - V_{OLmax}}{I_{OLmax} - |I_{ILmax}|}$$

$$R_{pu} \geq \frac{9 - 0.4}{16 - 0.0001} = 0.538K$$

$$\boxed{0.538K \leq R_{pu} \leq 26.97K}$$

UNIT 3. LOGIC FAMILIES

32. The following circuit uses logic gates with open collector output (within the 74LS01 and 74LS15 integrated circuits) to implement a "wired AND", and to activate the LED output.



A) $F=(V\cdot W\cdot X)\cdot(XYZ)=$
$VWXYZ$

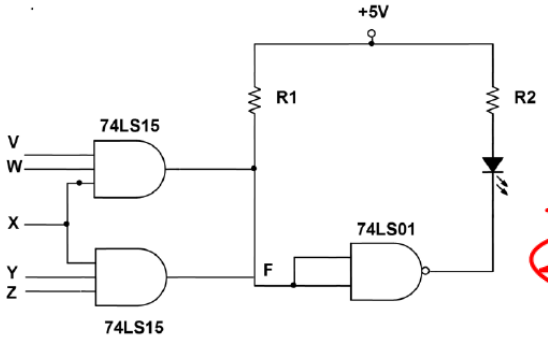
B) $F=1 \Rightarrow G=0 \Rightarrow V_G=V_{OL}$ and LED is ON, as cathode has a low voltage

A. Write a logical expression for the function implemented by the circuit in the signal F.
B. When F = '1 ', Is the LED on or off?.
C. Design R2, assuming that the current through the LED when it lights is $I_{LED\ (on)}= I_{OLmax}$ and $V_{LED\ (on)}= 1.2V$.
D. Taking into account the following features for 74LS01 and 74LS15 integrated circuits, calculate the range of values allowed for R1:

Vcc	V_{IHmin}	V_{ILmax}	V_{OLmax}	I_{IHmax}	I_{OHmax} (Leakage)	I_{OLmax}	I_{ILmax}
5 V	2.5V	0.8 V	0.5 V	20 µA	100 µA	7 mA	-0.36 mA

UNIT 3. LOGIC FAMILIES

32. The following circuit uses logic gates with open collector output (within the 74LS01 and 74LS15 integrated circuits) to implement a "wired AND", and to activate the LED output.



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5 V	2.5V	0.8 V	0.5 V	20 µA	100 µA	7 mA	-0.36 mA

C) $R_2 = \dfrac{5 - V_{OL_{max}} - V_{LED}}{I_{LED}}$

$\dfrac{5 - 0.5 - 1.2}{7} = 0.471K$ (471Ω)

D) $R_1 \geq$ (LOW)

$\dfrac{V_{CC} - V_{OLmax}}{I_{OLmax} - 2|I_{ILmax}|} = \dfrac{5 - 0.5}{7 - 2 \cdot 0.36}$

$R_1 \geq 0.717K$

(HIGH) No noise margin

$R_1 \leq \dfrac{V_{CC} - V_{IHmin}}{2 I_{OHmax} + 2 I_{IHmax}} = \dfrac{5 - 2.5}{2 \cdot 0.1 + 2 \cdot 0.02} = 10.417K$

$0.717K \leq R_1 \leq 10.417K$

UNIT 3. LOGIC FAMILIES

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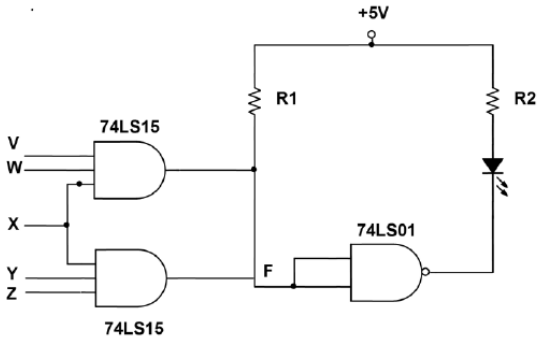

A. Write a logical expression for the function implemented by the circuit in the signal F.
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V_{cc}	V_{IHmin}	V_{ILmax}	V_{OLmax}	I_{IHmax}	I_{OHmax} (Leakage)	I_{OLmax}	I_{ILmax}
5 V	2.5V	0.8 V	0.5 V	20 µA	100 µA	7 mA	-0.36 mA