WE2.1

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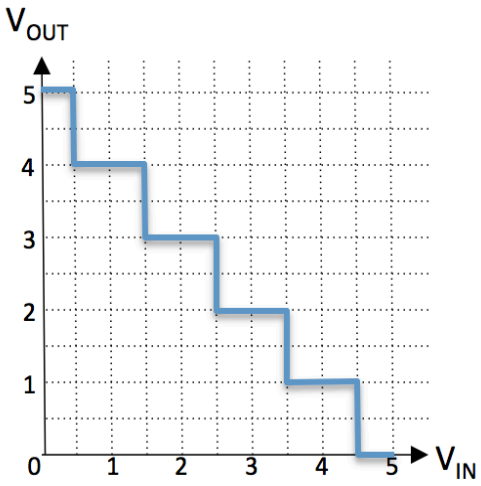
The Static Discipline

3/3 points (ungraded)

Ivan Idea, a resident of Chelyabinsk who's been watching the 6.004 videos on YouTube, was inspired to attach electrodes to opposite ends of a meteor fragment that came through his roof and produce a voltage transfer curve (VTC) of the resulting device, which is shown below.



Amazingly all the "corner points" of the VTC fall on the 0.5V grid.

Ivan is hoping he can sell his device as the world's only extraterrestrial combinational inverter and has provided the table below suggesting possible voltage thresholds to achieve 0.3V noise margins. He's happy to report that for any input voltage, the output voltage becomes stable within 1ns of the application of a new, stable input voltage. For each proposed specification please select "YES" if the device obeys the static discipline and "NO" if it does not.

	V_{OL}	V_{IL}	V_{IH}	V_{OH}	**Obeys Static Discipline**
Specification #1	0.1	0.4	4.6	4.9	Yes ✔ Answer: Yes
Specification #2	0.6	0.9	4.1	4.4	No ✔ Answer: No
Specification #3	1.1	1.4	3.6	3.9	Yes ✔ Answer: Yes

Explanation

In order to satisfy the static discipline, all valid inputs must produce valid outputs. For inverters, that means that for all input voltages $\leq V_{IL}$, the output voltage produced must be $\geq V_{OH}$. Conversely, for all input voltages $\geq V_{IH}$, the output voltage produced must be $\leq V_{OL}$.

Specification #1: For all input voltages $\leq V_{IL} = \mathbf{0.4}$ the VTC produces an output voltage of 5 which is $\geq V_{OH} = \mathbf{4.9}$. For all input voltages $\geq V_{IH} = \mathbf{4.6}$ the VTC produces an output voltage of 0 which is $\leq V_{OL} = \mathbf{0.1}$. So Specification #1 satisfies the static discipline.

Specification #2: For input voltages $\leq V_{IL} = \mathbf{0.9}$ the VTC produces an output voltage of either 4 or 5 depending on the input voltage. However, 4 is not $\geq V_{OH} = \mathbf{4.4}$. So Specification #2 does not satisfy the static discipline.

Specification #3: For all input voltages $\leq V_{IL} = \mathbf{1.4}$ the VTC produces an output voltage of 4 or 5 depending on the input voltage. Both 4 and 5 are $\geq V_{OH} = \mathbf{3.9}$. For all input voltages $\geq V_{IH} = \mathbf{3.6}$ the VTC produces an output voltage of 0 or 1 depending on the input voltage. Both 0 and 1 are $\leq V_{OL} = \mathbf{1.1}$. So Specification #3 satisfies the static discipline.

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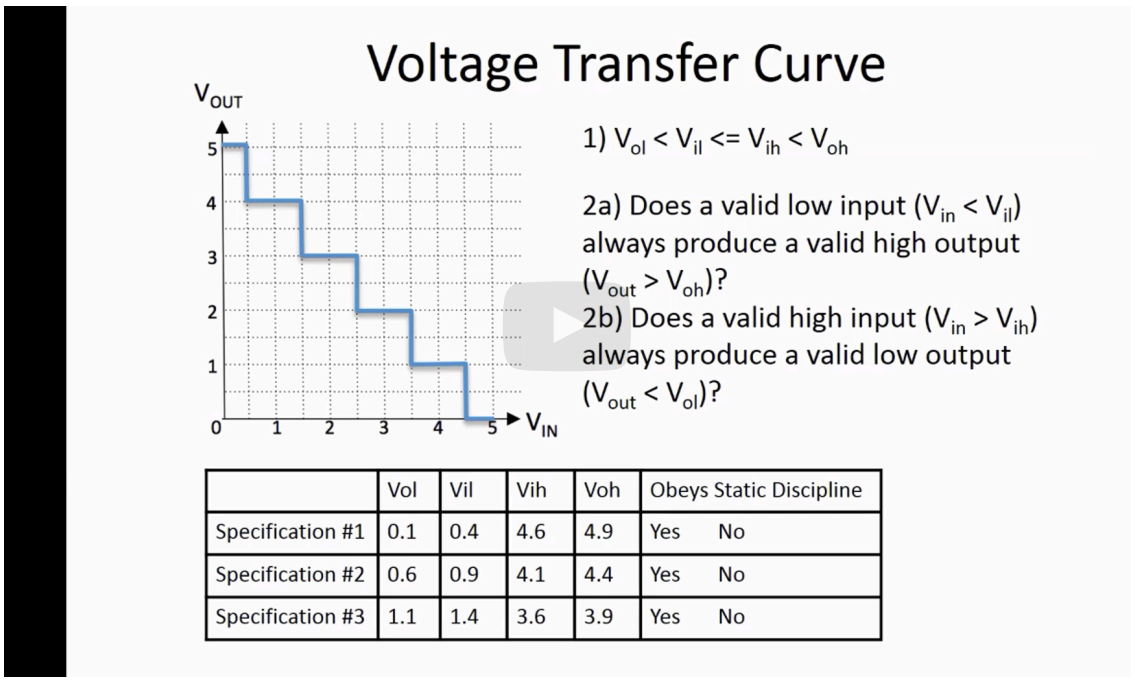
Answers are displayed within the problem

The Static Discipline

shown here.

For each specification, we need to check the following two constrain

Calculator



	Vol	Vil	Vih	Voh	Obeys Static Discipline
Specification #1	0.1	0.4	4.6	4.9	Yes No
Specification #2	0.6	0.9	4.1	4.4	Yes No
Specification #3	1.1	1.4	3.6	3.9	Yes No

▶ 3:05 / 5:39 1.0x

1) Is $V_{ol} < V_{il} <= V_{ih} < V_{oh}$ - satisfying this constraint guarantees that the outputs produced are better in quality than the inputs.

The second constraint is: Does a valid input produce a valid output?

Since this curve shows an inverting function, this translates to:

a) Does a valid input (where $V_{in} < V_{il}$) always produce a valid high output (where $V_{out} > V_{oh}$)?

And b) Does a valid high input (where $V_{in} > V_{ih}$) always produce a valid low output (where $V_{out} < V_{ol}$)?

If all of these constraints are satisfied, then that specification obeys the static discipline.

If not, it doesn't.

For all three specifications, we see

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- Specification 3 : wrong solution and also wrong explanation — 3
  For specification 3: VIL < 1.4 Volt, the output voltage can be 3 or 4 Volt, NOT 4 or 5, so does not comply the static discipline, becau...
- Are you confused? — 2
  Go to the notes it's better explained there https://computationstructures.org/notes/digitalabstraction/notes.html

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