Pass Transistor Circuits

Dr DC Hendry

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Outline I

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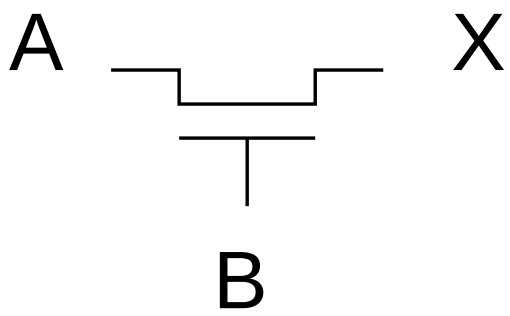
- When used as a pass transistor the device may conduct current in either direction.

Pass Transistor Truth Table



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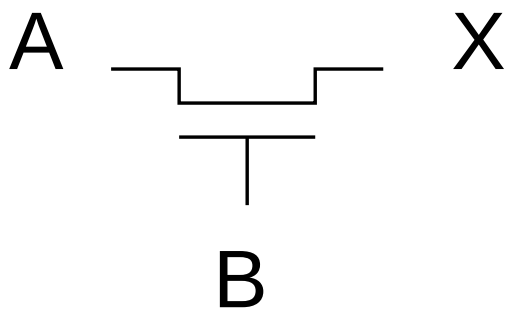

A	B	X
0	0	Z

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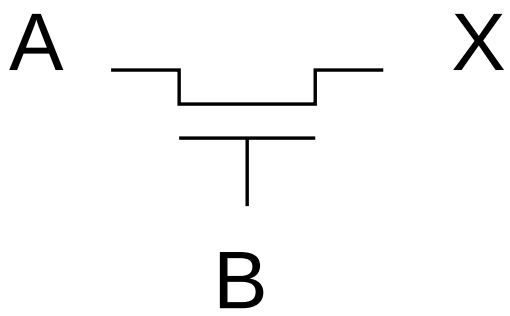

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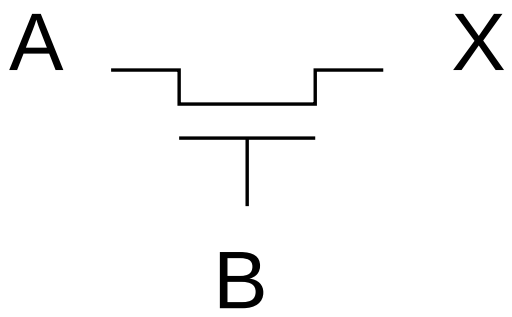

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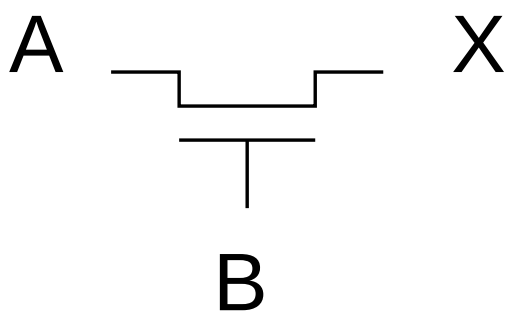

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Properties of Pass Transistors

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4. This reduction in output voltage makes cascading of pass transistor circuits difficult.

Cascaded Pass Transistors

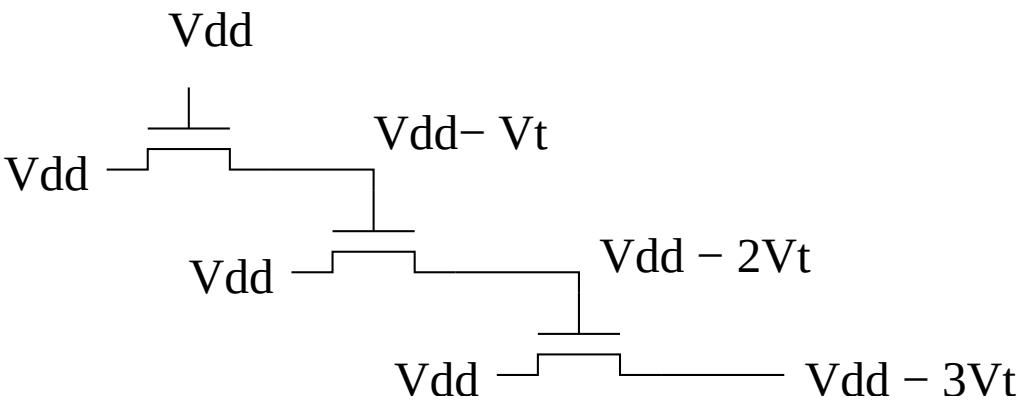

Figure: Cascaded pass transistors

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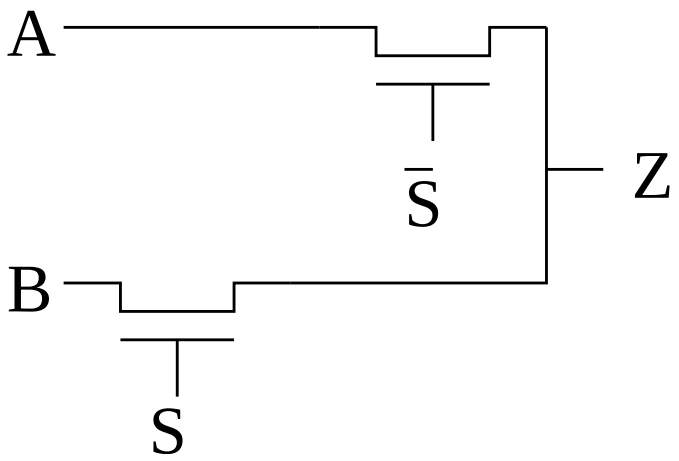
2. Similar circuits with a p-channel device "degrade" (by increasing) a logic zero by one V_t.
3. So such circuits are normally confined to the internal circuitry of a gate.
4. Full logic levels can be regenerated with an inverter at the output of the gate.

Two-to-One Mux



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- Note that the connection made is *bidirectional*

The CMOS Transmission Gate

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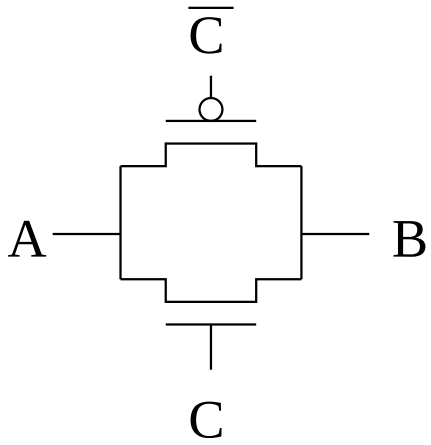

Figure: CMOS Transmission Gate Circuit

When C = 1, A and B are connected, both logic zero and logic one

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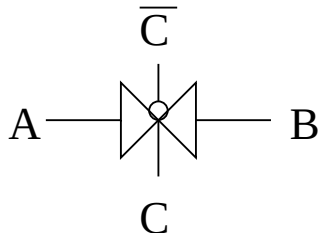

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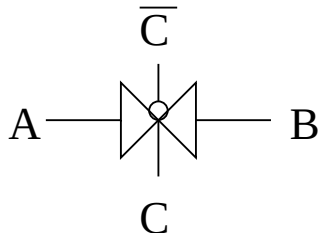
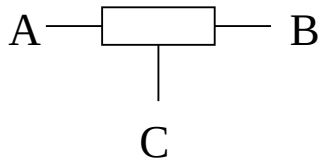


- The most commonly used symbol is simply:



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$$f = AS_2\overline{S_1} + B\overline{S_2}.\overline{S_1} + \overline{S_2}S_1$$

This may be rewritten as (the reason will become clear later):

$$f = AS_2\overline{S_1} + B\overline{S_2}.\overline{S_1} + 1.\overline{S_2}S_1 + 0.S_2S_1$$

Transmission Gate Implementation:

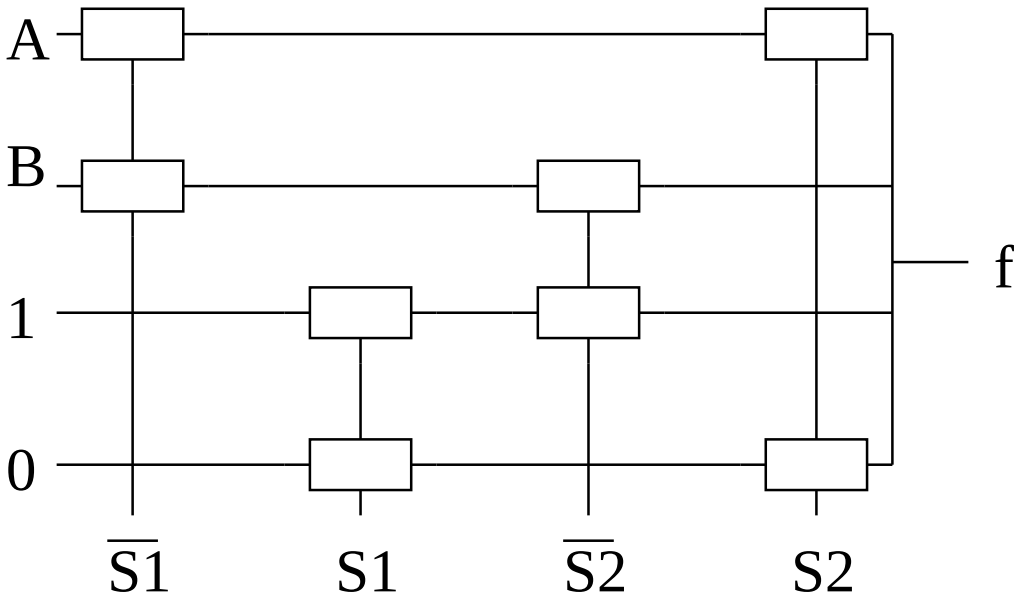

Figure: Implementation with Transmission Gates

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3. Where lines connect only to logic 1 the nMOS devices may be omitted.
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5. nMOS and pMOS devices may be grouped to minimise the number of wells required.

Transistor Schematic

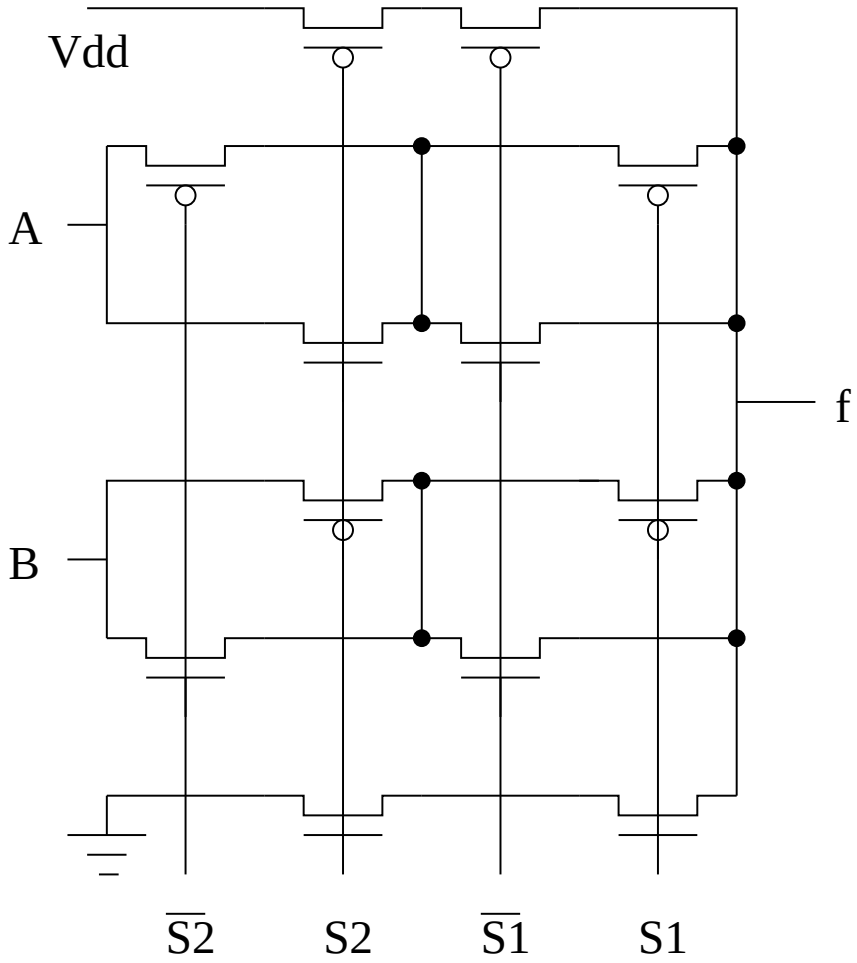

Figure: Transistor Level Schematic for Design

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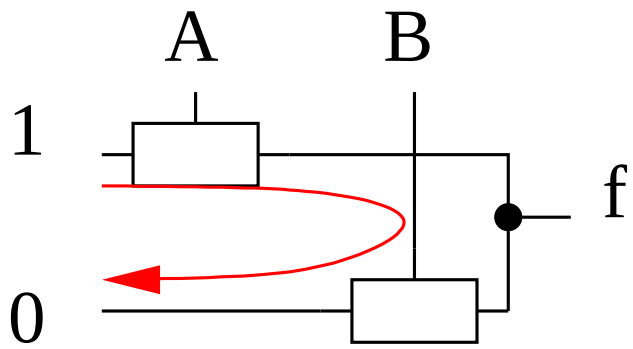
- The output is always driven to logic 1 or logic 0.
- There are no "sneak" paths, such as:



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- Plot variables on K-maps.
- Tabular methods such as modifications of Quine-McCluskey - not covered here.

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f	ab = 00	ab = 01	ab = 11	ab = 10
cd = 00	1	1	1	0
cd = 01	1	0	0	0
cd = 11	1	0	1	1
cd = 10	1	0	0	0

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	00	01	11	10
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Giving the Boolean expression for f as:

$$f = 1.\bar{a}\bar{b} + b\bar{c}\bar{d} + ac.d + a\bar{b}\bar{c}.0 + \bar{a}bc.0$$