



Usage of a transistor configured as diode

Asked 11 years, 9 months ago Modified 1 year, 10 months ago Viewed 44k times



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I faced lots of circuits that has transistors connected as diodes (gate connected to the drain). I know some of these circuits employ such transistor for safety reason but I couldn't figure out the reasons of others.



My question: Is there any reason behind connecting the transistors as diodes other than the one I mentioned? Some of my colleagues suggest that they may be used to realize high resistance but I think connecting the transistor in such configuration ($V_g = V_d$) will force the transistor to work in saturation region, **not** in linear region. Am I right?



transistors

diodes

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edited Dec 27, 2016 at 13:32



try-catch-finally

1,276 3 19 37

asked Dec 5, 2012 at 16:22



Bio_man

109 1 1 3

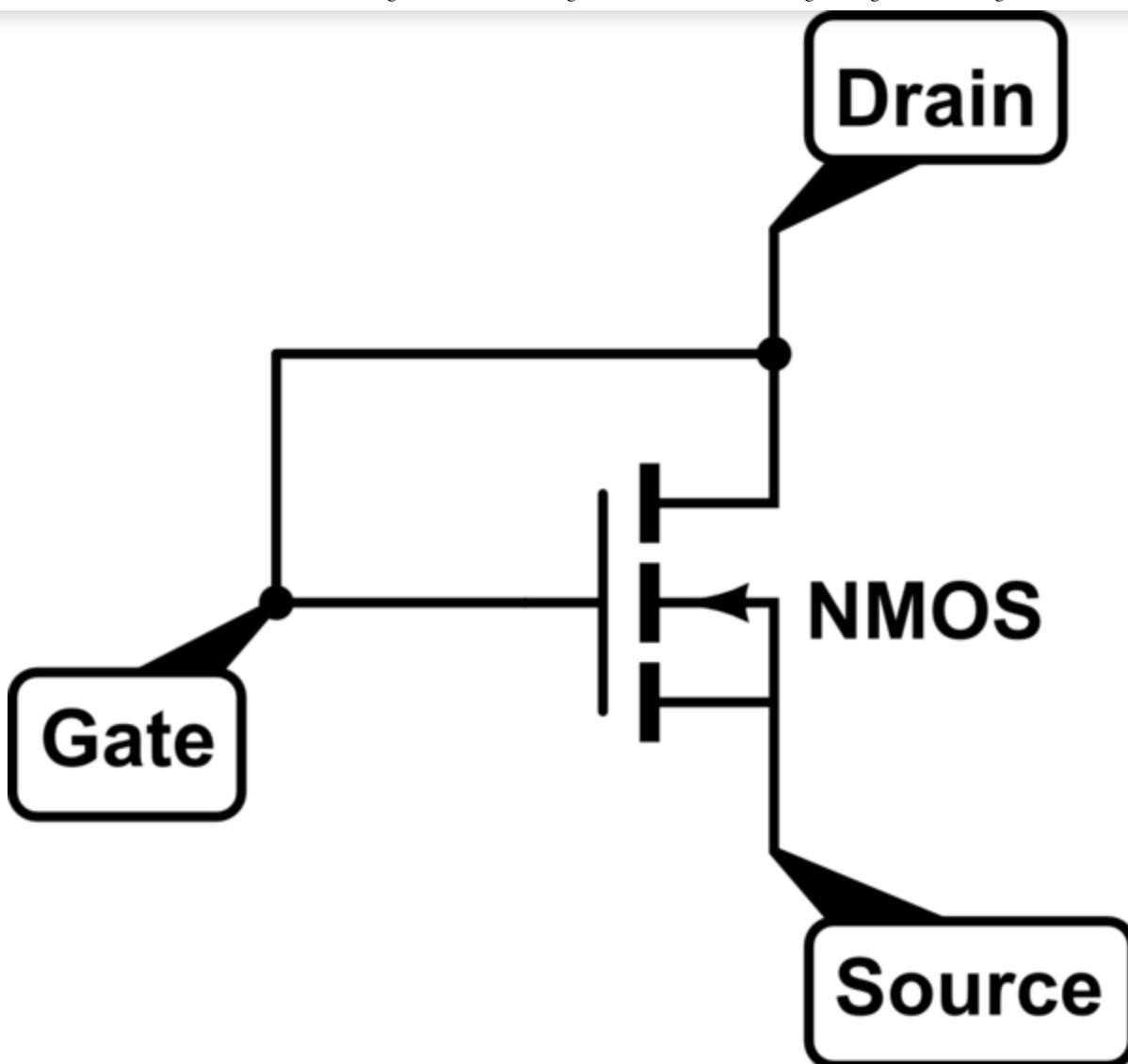
- 1 What kind of transistors are these? All the ones I know with a saturation region don't have gates or drains. – user16324 Dec 5, 2012 at 17:03
- 2 Can you show us a diagram and part number? You are confusing FET and BJT somewhere. – jippie Dec 5, 2012 at 17:24
- 4 I was taught that the 3 regions in MOSFETs are cut-off, triode, and saturation, and the 3 regions for BJTs are cut-off, saturation, and active. What other terminology is used for my FET's saturation region (where it's current doesn't depend upon V_{ds}). – Shamtam Dec 5, 2012 at 21:03

5 Answers

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[simulate this circuit](#) – Schematic created using [CircuitLab](#)

Since Gate and Drain are shorted, the following saturation condition always holds:

$$V_{DS} > V_{GS} - V_T$$

This means that once $V_{DS} > V_T$ the transistor both begins to conduct and enters saturation.

In saturation (after substitution $V_{GS} = V_{DS}$ for diode mode):



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However, this resistance is not constant - it depends on the applied bias. This is bad, but it is not that you have too many alternatives in integrated circuits (you can implement precision resistors by various techniques, but they are usually costly).

On the positive side - there are many application which do not require precision in resistances.

Can you implement a big resistor with diode connected transistor? Yes. There are two approaches:

- Long and narrow transistor
- Ensure that V_{DS} does not rise much over V_T

However, "big" resistor in integrated circuit is not the same as big resistor as discrete component - in integrated circuit all resistances are relatively low.

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edited Nov 18, 2016 at 9:25

answered Dec 1, 2013 at 23:29



Vasiliy

7,453 2 22 38



First, I am assuming that the poster is confusing drain with collector. If he is talking about MOSFETs or JFETs, then ignore the rest of this post.

12



It is a common practice in precision analog electronics to use Bipolar transistors as diodes. The purpose is to obtain a very low leakage diode. For example, a 3904 type transistor will have $<1\text{pA}$ of reverse leakage using the Base Emitter junction. However, it turns into a zener diode at around 6.8V. Works great for 5V and lower voltage logic circuits. Higher current and reverse voltage is achieved by using the Base as anode and the collector as the cathode. Still an excellent low leakage diode at around 10pA and now you get the voltage rating of the transistor and improved current. This will not be a high speed diode. Higher speed is achieved by shorting Collector to Base (Anode) and using the emitter as Cathode. However, reverse voltage must be limited to $<5\text{V}$.

The other purpose for using MOSFETs and other types of transistors as diode connected is for current mirror circuits, where a diode connected junction will track the active component's junction over temperature.



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In some cost sensitive products (cheap electronic novelty toys or games for instance) it may save \$0.01 per unit to replace a diode with a transistor in the following situation.

5



If you have 5 transistors and one diode in the circuit and there are no particularly exotic signal requirements then replacing the diode with an extra transistor means you have one less item (the diode) in your Bill of Materials and simply increase the quantity of the transistor by 1, which in large scale mass production can yield substantial cost savings (per unit) when buying parts in larger quantities.



There are secondary benefits to this also...

- The manufacturer can use fewer reels on their pick and place machines, which saves time, money and maintenance.
- Obsolescence is less of an issue with fewer parts in the product.

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answered Nov 18, 2016 at 9:55
user98663



2



I can't give you technical details but MOSFET's are used as clipping diodes in instrument effects pedals such as guitar distortion pedals. A search for the Mad Professor Fire Red fuzz schematic will show you how this is implemented. However, in the schematic it shows the drain and source tied together. That may just be an error by whomever traced the original circuit. But it should give you an idea of another way a MOSFET transistor is used as a diode.



Hope this helps a bit.



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answered Aug 3, 2014 at 20:04

 [chuckbuick](#)
21 1



The Mad Professor's schematic is not mistaken. Note that the transistors used in this schematic for clipping are JFETs, not MOSFETs. To connect a JFET as a diode, one should



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