DESCRIPTION

The Power MOSFET P-Channel NDP6020P is an Enhancement Mode MOSFET that can handle up to 20V @ 24A and is fully 5V and 3.3V logic compatible

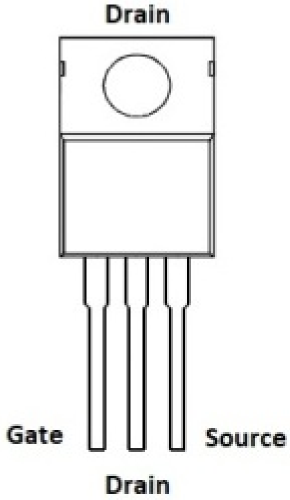
PACKAGE INCLUDES:

- Power MOSFET P-Channel NDP6020P

KEY FEATURES OF POWER MOSFET P-CHANNEL NDP6020P:

- P-Channel Power Enhancement Mode MOSFET
- Up to 20V and 24A power handling capability
- $R_{DS(on)} =$ 50mΩ at -4.5Vgs / 70mΩ @ -2.7V
- Fully 5V and 3.3V Logic Compatible

The NDP6020P is fully 5V and 3.3V logic compatible and is an excellent choice for use with uC.



MOSFET stands for Metal Oxide Semiconductor Field Effect Transistor which is why we just call it a MOSFET for short. Enhancement mode means that when the device has zero Gate voltage relative to the Source, the device is off. This is denoted by the schematic symbol with the broken line which indicates that it does not conduct when there is no Gate voltage.

Power MOSFETs are most often used a switches where they are turned fully ON or OFF to control a load such as a motor or high power LEDs. They are ideally suited for this because when the MOSFET is turned fully ON (Saturation Region), it has a very low resistance and can pass a lot of current without much power being dissipated in the device similar to a mechanical switch. When they are turned OFF (Cut-Off Region), they act as an open circuit much like a mechanical switch would when it is off.

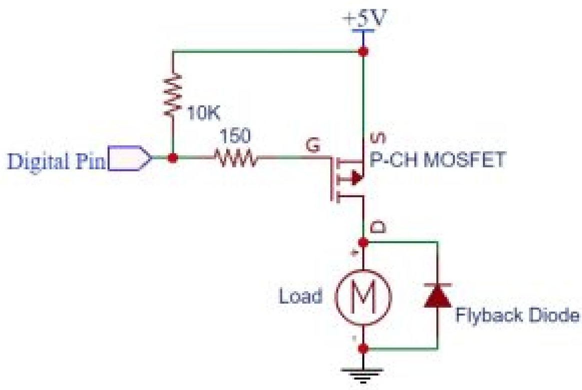
For some applications MOSFETs are also used in their Linear Region where they are are partially conducting, such as for an amplifier, analog fan speed controller or battery charger.

If using this device with a uC, it is possible to drive the MOSFET gate directly from an digital output pin as shown in the example circuit here.The very low 'ON' resistance means that there is very little voltage drop through the device and that also helps to keep power dissipation down.

When used for switching power to a load, P-Channel MOSFETs are typically used on the high side which means they are placed between the load and the power supply voltage.

Example Logic Controlled P-Channel Power MOSFET Circuits

P-Channel MOSFETs are typically connected with the Source of the device connected to the load power supply voltage and the drain connected to the load.



Typical Logic Level Drive Circuit for 5V load

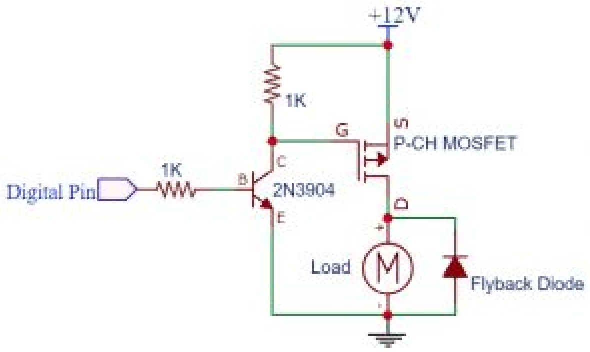
The MOSFET is turned ON by driving the gate LOW relative to the Source voltage and it is turned OFF by driving the gate toward the Source voltage. This limits its use to switching 5V if you are driving it directly from a 5V uC pin. An example circuit is shown to the right.

A 10K pull-up resistor on the gate will help to ensure that the MOSFET will be kept in the OFF state when the uC is powering up and the outputs are floating.

A series resistor of about 150 ohms between the uC and the gate helps to ensure any surge currents stay within safe limits of the uC. An example circuit to control a 5V load directly from a uC output pin is shown to the right.

If you want to switch a higher voltage load such as a 12V motor, you will need to use a small transistor, MOSFET driver or similar to switch the gate at the Source voltage of 12V to drive the MOSFET completely off.

An example of this type of circuit is shown to the right.



Typical Logic Level Drive Circuit for 12V Load

P-Channel MOSFET Theory of Operation

MOSFET spec sheets can look pretty complicated, but for many applications we just need to pay attention to a few key parameters that are explained here.

Note that because the device is typically hooked up with the Source connected to the positive voltage which is opposite of an N-Channel device, many of these are spec'd as a negative voltage or current because of the opposite point of reference.

V_{DS} : Drain-To-Source Voltage is the maximum voltage that the device can be used to switch. If you're switching 12V, you need a device with a **V_{DS}** > -12V and usually you want something with a fair amount of safety margin.

I_D : Continuous Drain Current is the maximum current that the device can handle. this will often be specified under several conditions such as at 25C room temperature and at 100C or similar high operating temperature. Achieving the maximum current through the device assumes that you are driving it fully on and that appropriate heat sinking is applied. If you have a device that draws 10A, you need an **I_D** > -10A. Generally the higher the **I_D** rating of the device compared to the amount of current you need to pass though it, the easier it will be to manage thermals.

V_{GS} : Gate Voltage is the negative voltage differential between the Gate and the Source which is how hard the MOSFET is being driven.

$V_{GS(th)}$: Gate Threshold Voltage is the voltage at which the MOSFET starts to conduct. Any voltage higher than this will drive the MOSFET to the OFF state known as the Cut-Off Region.

$R_{DS(on)}$: Static Drain-to-Source On-Resistance is the minimum resistance of the MOSFET when it is driven to the fully ON state known as the Saturation Region. The key to look for here is that **$R_{DS(on)}$** may be specified at one or a couple of **V_{GS}** voltages.

If it is spec'd at -10V only, the part is not logic compatible and needs something close to 10V to drive it into saturation. This means a MOSFET driver, transistor or some other means is required to drive the gate with something close to 10V.

If there are two voltages listed, the highest voltage will be the voltage at which the device is fully saturated and show the lowest resistance, often -10V. The lower voltage is often around -4.5V and shows the resistance if you were to drive it directly off of 5V logic. Having this specified implies that the device is at least partially 5V logic compatible even if it isn't being driven to full saturation.

Looking at the example spec sheet entry below, this is telling us that to drive the MOSFET to full saturation requires a **V_{GS}** voltage of -10V where max resistance is 3.4mOhm. If we were to drive it instead at -4.5V directly off of 5V logic, the resistance goes up to 5.2mOhm which is an increase of about 60%.

Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=-4.5V, I_D=-100A	-	4.0	5.2	mΩ
		V_{GS}=-10V, I_D=-100A	-	2.9	3.4	

A device like this can be driven directly off of 5V logic, but because its internal resistance has gone up, it will drop 60% more voltage and dissipate 60% more power/heat in the device for the same current. From a practical standpoint, this means it can handle about 60% the full rated current than it could handle if it was driven at -10V. I would consider this as being mostly 5V logic compatible. If you are using a 60A device to control a 20A load for instance, this will generally be fine. If you need 40A out of it, then you will need to drive it harder.

Notes:

1. *None*

TECHNICAL SPECIFICATIONS

Maximum Ratings		
V_{DSS}	Drain-Source Voltage	-20V
I_D	Drain Current	-24A
R_{DS}	Drain-Source On-Resistance	0.05Ω
P_D	Power Dissipation	60W (requires heat sink)
Package		TO-220
Package Type		Plastic Tab, 3-lead, through hole
Mfr		Fairchild / Onsemi
Datasheet		**NDP6020P**