Summary of GPIO Pin states Output, Input with high impedance, and Input with pull-up.

When determining if a pin is output or input, the key is to look at human interaction.

If the circuit performs an action such as lighting an LED, or driving a DC motor, then the pin is output and will drive the load.

If the circuit allows the user/environment to trigger the program through a switch or sensor, then the pin is input. If it is input, then we need to know if the pin is connected to a power source or to ground.

The following diagrams summarize these states and the settings of the 3 port registers.

Output



In this circuit, the LED tells us that this is an output pin, i.e. we expect that the LED will be off when the pin is low (0), and on when the pin is high (1).

Since it is output the DDRX register must be set to a 1 for the pin position.

The PORTX register then controls the on/off state of the LED, where the LED is off when PORTX pin=0 and on when PORTX pin=1.

Note the PINX register has no bearing.

Input with high impedance



The switch tells us that the pin in this circuit is input, i.e. we expect that the switch will change the state of the pin, and we will detect that in our program.

Since current will flow from the voltage source, through the switch, and into the pin, then the pin must be kept low until the switch is closed.

Since it is input the DDRX register must be set to a 0 for the pin position.

The PORTX register is set to 0 for the pin to make it high impedance.

The PINX register will read 0 for the pin while the switch is open, and 1 when the switch is closed and current flows to the pin.

Example read for Port-B Pin-2:

in r0,PINB ; read Port-B input

if (r0 == 0b?????0??) then the switch is open

if (r0 == 0b?????1??) then the switch is closed

Note the ?’s mean we don’t care about those pin values for this circuit, just pin-2

Input with pull-up



The switch tells us that the pin in this circuit is input, i.e. we expect that the switch will change the state of the pin, and we will detect that in our program.

Since current will flow from the pin through the switch to ground, we expect that the pin is in a high state while the switch is open and will be pulled low when the switch is closed. The internal pull-up sources internal voltage to the pin to keep it high until the pin is connected to ground externally.

Since it is input the DDRX register must be set to a 0 for the pin position.

The PORTX register is set to 1 for the pin to engage the pull-up.

The PINX register will read 1 for the pin while the switch is open, and 0 when the switch is closed, and current is pulled to the external ground.

Example read for Port-B Pin-2:

in r0,PINB ; read Port-B input

if (r0 == 0b?????1??) then the switch is open

if (r0 == 0b?????0??) then the switch is closed

Note the ?’s mean we don’t care about those pin values for this circuit, just pin-2