Up/Down Interface

Description

Many modern control circuits use the value from a digital counter to directly determine a setting or position. Manipulating this value under computer control is not difficult, but when one has to interface with a human operator, several other factors must be considered. Human interfaces often require that the circuit respond to changes in a setting – up or down, left or right, clockwise or counterclockwise. These controls need a simple interface, which the ELM415 provides.

This 8 pin integrated circuit contains all the timing and logic that is necessary to interface two pushbuttons to most counter type interfaces. It reads the position of the switches and translates that into an appropriate signal for a counter to either increment or decrement, which in turn controls the output variable. Logic to filter out contact bounce, to sense when both keys are pressed simultaneously, to invert the count output, and to provide continuous pulses if an input pushbutton stays pressed are all included.

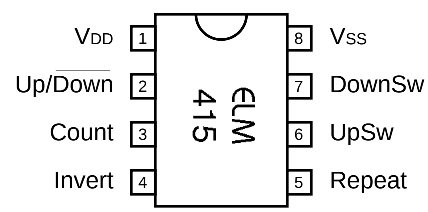
Applications

- Digital audio potentiometer controls
- Variable voltage or temperature circuits
- Motor positioning controls
- Single-stepping control circuits
- Reset circuits

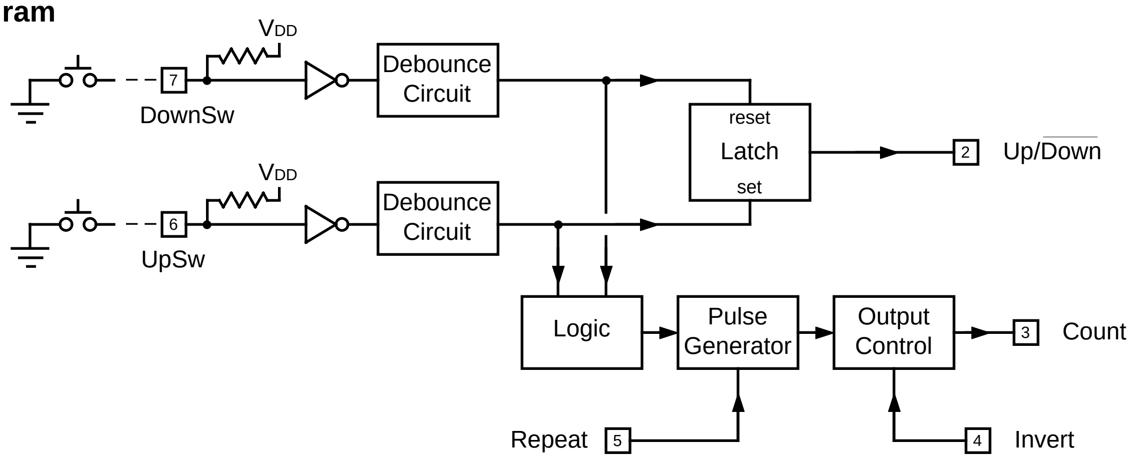
Features

- Low power CMOS design – typically 1mA at 5V
- Wide supply range – 3.0 to 5.5 volt operation
- Fully debounced switch inputs
- Internal pullup resistors provided
- Protection from simultaneous key presses
- High current drive outputs – up to 25 mA
- User selectable automatic repeat function
- Selectable Count output polarity

Connection Diagram
PDIP and SOIC
(top view)



Block Diagram



Pin Descriptions

V_{DD} (pin 1)

This pin is the positive supply pin, and should always be the most positive point in the circuit. Internal circuitry connected to this pin is used to provide power on reset of the microprocessor, so an external reset signal is not required. Refer to the Electrical Characteristics section for further information.

Up/$\overline{\text{Down}}$ (pin 2)

This is the count direction output, which changes state depending on which pushbutton is being pressed. If it is the Up pushbutton, this output will be at a high level, while a Down results in it being at a low level. The output remains at a level until the alternate pushbutton is pressed. When it does change, it does so approximately 1 msec prior to an active pulse appearing on Count.

Count (pin 3)

This output provides a pulsing signal in response to one of the two pushbuttons being pressed. Simultaneous pressing of both switches is detected and results in no output. The width of the output pulse is fixed at approximately 1 msec, but the polarity can be changed depending on the level at the Invert input. This output is used to ‘clock’ the controlled counter circuit.

Invert (pin 4)

This input controls the quiescent level at pin 3 (the Count output). If low, the level at pin 3 will also normally be low, pulsing momentarily to a high level when a button is pressed. Setting this pin high causes pin 3 to rest at a high level, with the output pulses momentarily going low.

Repeat (pin 5)

This input controls the circuit response should one of the pushbuttons be continuously pressed. If this pin is at a low level, there will only be a single Count output generated, no matter how long the button stays pressed. If this pin is at a high level, a single pulse is output, then after a short delay, a continuous stream of pulses are generated for as long as the button is held.

UpSw (pin 6) and DownSw (pin 7)

The pushbuttons are connected to these pins. Internal pullup resistors are provided to bias the input when no button is pressed, simplifying the circuitry required. These are standard CMOS inputs, so the use of external delay components (capacitors, etc.) is not recommended.

V_{SS} (pin 8)

Circuit common is connected to this pin. This is the most negative point in the circuit.

Ordering Information

These integrated circuits are available in either the 300 mil plastic DIP format, or in the 200 mil SOIC surface mount type of package. To order, add the appropriate suffix to the part number:

300 mil Plastic DIP............................... ELM415P

200 mil SOIC.................................... ELM415SM

Absolute Maximum Ratings

Storage Temperature....................... -65°C to +150°C

Ambient Temperature with
Power Applied...................................-40°C to +85°C

Voltage on V_{DD} with respect to V_{SS}............0 to +7.5V

Voltage on any other pin with
respect to V_{SS}........................... -0.6V to (V_{DD} + 0.6V)

Note:

Stresses beyond those listed here will likely damage the device. These values are given as a design guideline only. The ability to operate to these levels is neither inferred nor recommended.

Electrical Characteristics

All values are for operation at 25°C and a 5V supply, unless otherwise noted. For further information, refer to note 1 below.

Characteristic	Minimum	Typical	Maximum	Units	Conditions
Supply voltage, V_{DD}	3.0	5.0	5.5	V	
V_{DD} rate of rise	0.05			V/ms	see note 2
Average supply current, I_{DD}		1.0	2.4	mA	V_{DD} = 5V, see note 3
Input low voltage	V_{SS}		0.15 V_{DD}	V	
Input high voltage	0.85 V_{DD}		V_{DD}	V	
Output low voltage			0.6	V	Current (sink) = 8.7mA
Output high voltage	V_{DD} - 0.7			V	Current (source) = 5.4mA
Internal pullup resistance	20	30	50	KΩ	Pins 6 & 7, see note 4
Debounce period		30		msec	see note 5
Up/Down setup time		1		msec	see note 6
Count output pulse width		1		msec	

Notes:

1. This integrated circuit is produced with a Microchip Technology Inc.'s PIC12C5XX as the core embedded microcontroller. For further device specifications, and possibly clarification of those given, please refer to the appropriate Microchip documentation.
2. This spec must be met in order to ensure that a correct power on reset occurs. It is quite easily achieved using most common types of supplies, but may be violated if one uses a slowly varying supply voltage, as may be obtained through direct connection to solar cells, or some charge pump circuits.
3. Pullup resistor currents are not included in this figure.
4. The value of the internal pullup resistance is both supply and temperature dependent.
5. The time for which the input must remain stable before it is considered valid by internal logic.
6. The Up/$\overline{\text{Down}}$ output will be stable for this time period before the output of a Count pulse.

Example Applications

Figure 1 shows the ELM415 used to interface two pushbutton switches to an ELM310 stepper motor controller, so that the motor position can be manually controlled. For simplicity, the stepper motor and its drive transistors are not shown in the diagram. Notice that pin 5 has been tied to V_{DD} in order to enable the automatic repeat function, allowing the motor to move 'continuously' if a button is held down. Also, because there are internal pullup resistors, the two pushbuttons have been connected directly to the inputs without further support circuitry.

Using the ELM310 to control a stepper motor has many advantages – low cost, low power, and ease of use, for example. The disadvantage, however, is that the integrated circuit is capable of responding very quickly to input signals. This could result in multiple steps of the motor, and perceived erratic motor operation, if the input were not 'debounced' by a circuit such as the ELM415.

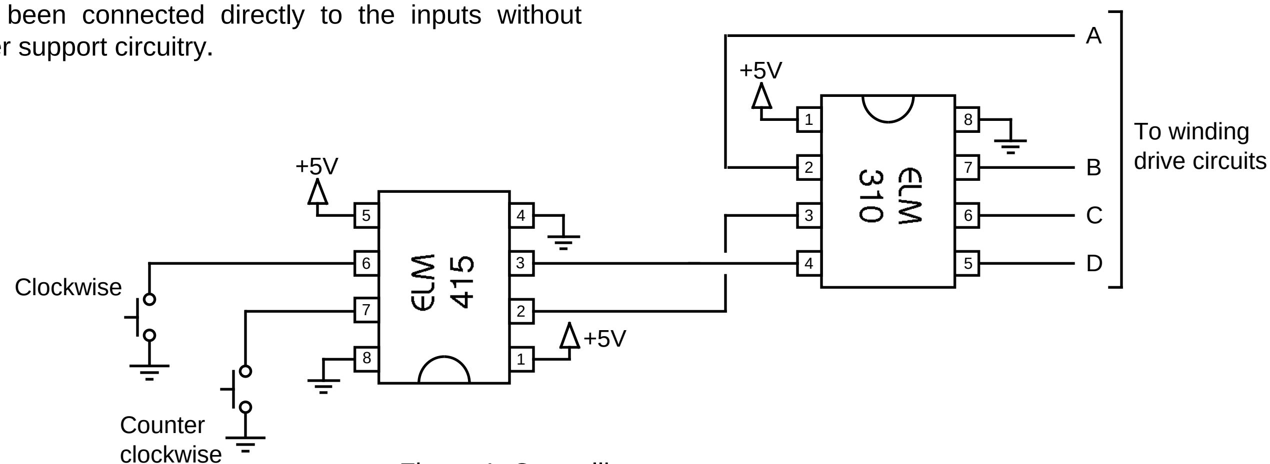


Figure 1. Controlling a stepper motor

The circuit of Figure 2 is very similar to the one above, but it uses an Analog Devices AD5220 Digital Potentiometer as the controlled device. The up and down buttons are used to 'move' the wiper between the two ends (pins 3 and 6). As shown, when stepped in the Up direction, the AD5220 moves the wiper towards the pin 3 end of the pot, while Down moves it towards pin 6.

The AD5220 expects to have a Count signal that is normally low, pulsing to a high level in order to change the resistance, so pin 4 is connected to a low (V_{SS}) level, as shown. Some devices, such as the Maxim MAX5160, require an inverted Count output, which can be provided by simply tying pin 4 to V_{DD} instead of V_{SS}.

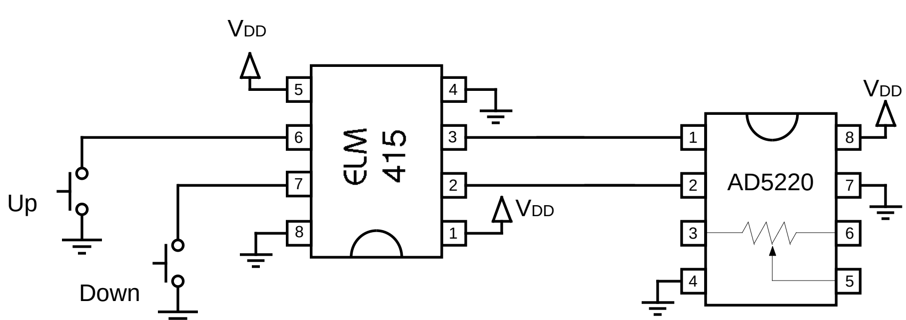


Figure 2. Controlling a digital potentiometer

Example Applications (cont'd)

A variation of Figure 2 is shown in Figure 3. It uses series resistors on the pushbutton inputs, and has also had its autorepeat function modified slightly.

This circuit assumes that the pushbuttons are to be mounted at a distance from the ELM415, which is why the series resistors have been added. This is a good practice to follow whenever working with CMOS circuits that might be exposed to electrostatically induced charges, as could be the case due to the extra wiring for the switches. The resistors help to limit induced currents which will flow through the IC's internal protection diodes during a discharge, and in doing so reduce the chance of latchup problems. Generally, we recommend that protection resistors be installed close to the IC whenever wiring is to extend from the circuit by more than about twelve inches.

The other difference between the circuits of Figures 2 and 3 is the connection between pins 5 and 6. This can best be explained by considering that in Figure 3, due to the internal pullup resistor on pin 6, pin 5 will normally be at V_{DD} (enabling the repeat function). When the Down button is pressed, the autorepeat function will remain enabled, and multiple pulses will be output. When the Up button is pressed, however, it will pull both pins 5 and 6 low, disabling the autorepeat and allowing only a single pulse to be generated. This is useful if one wants the user to explicitly press a button for each advance in one direction, but will allow a rapid transition to a 'safe' position when the other button is pressed. This may be a desireable feature if controlling the temperature in a heater circuit, for example.

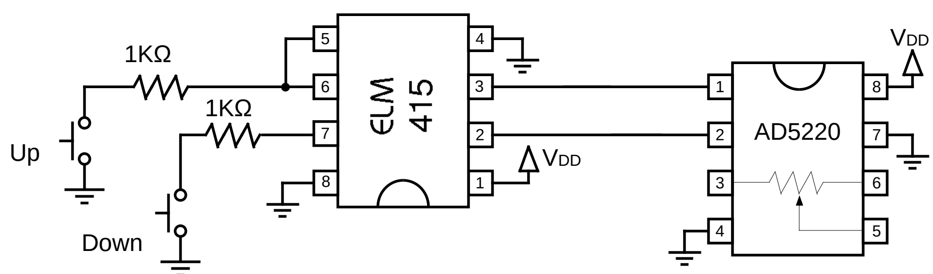


Figure 3. Controlling a digital potentiometer (with rapid down)

Our final example shows how easily one can use the ELM415 as a 'one-shot' or monostable multivibrator in a reset circuit. Often one has the need to reset a circuit using a pushbutton, but multiple resets due to bouncing switches would be an annoyance. Using the circuit of Figure 4, one can generate a single clean reset pulse whenever the pushbutton is pressed. If the circuit needs a negative-going pulse, simply connect pin 4 to V_{DD} rather than V_{SS}.

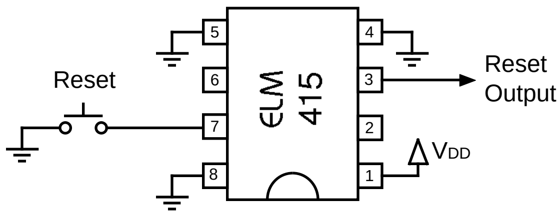


Figure 4. Manual reset circuit

Hopefully this has provided you with several ideas for using the ELM415 in your next project. Have you considered using it to reset a timer whenever a contact closes, or to count switch closures, or to determine an object's direction based on the order in which the two switches operated…