

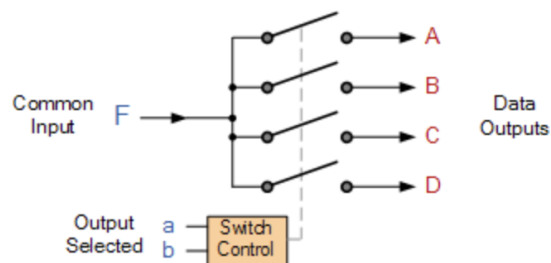
# The Demultiplexer

The demultiplexer is a combinational logic circuit designed to switch one common input line to one of several separate output line

The data distributor, known more commonly as the demultiplexer or “Demux” for short, is the exact opposite of the Multiplexer we saw in the previous tutorial.

The *demultiplexer* takes one single input data line and then switches it to any one of a number of individual output lines one at a time. The **demultiplexer** converts a serial data signal at the input to a parallel data at its output lines as shown below.

## 1-to-4 Channel De-multiplexer



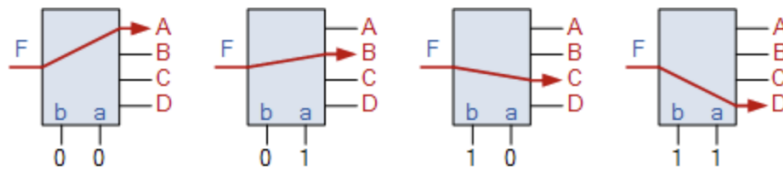
Output Select		Data Output Selected
b	a	
0	0	A
0	1	B
1	0	C
1	1	D

The Boolean expression for this 1-to-4 **Demultiplexer** above with outputs A to D and data select lines a, b is given as:

$$F = \overline{a}\overline{b}A + \overline{a}bB + a\overline{b}C + abD$$

The function of the **Demultiplexer** is to switch one common data input line to any one of the 4 output data lines A to D in our example above. As with the multiplexer the individual solid state switches are selected by the binary input address code on the output select pins “a” and “b” as shown.

### Demultiplexer Output Line Selection



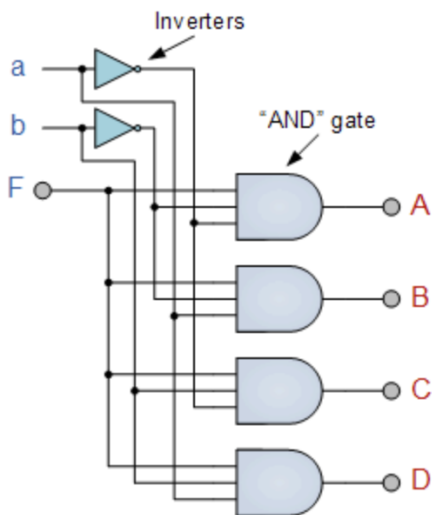
As with the previous multiplexer circuit, adding more address line inputs it is possible to switch more outputs giving a 1-to- $2^n$  data line outputs.

Some standard demultiplexer IC's also have an additional “enable output” pin which disables or prevents the input from being passed to the selected output. Also some have latches built into their outputs to maintain the output logic level after the address inputs have been changed.

However, in standard decoder type circuits the address input will determine which single data output will have the same value as the data input with all other data outputs having the value of logic “0”.

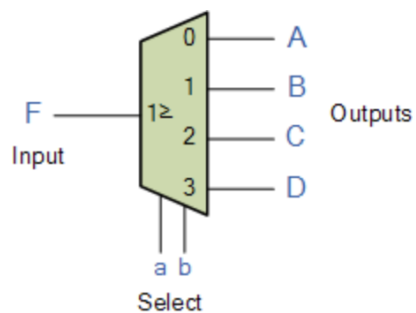
The implementation of the Boolean expression above using individual logic gates would require the use of six individual gates consisting of AND and NOT gates as shown.

## 4 Channel Demultiplexer using Logic Gates



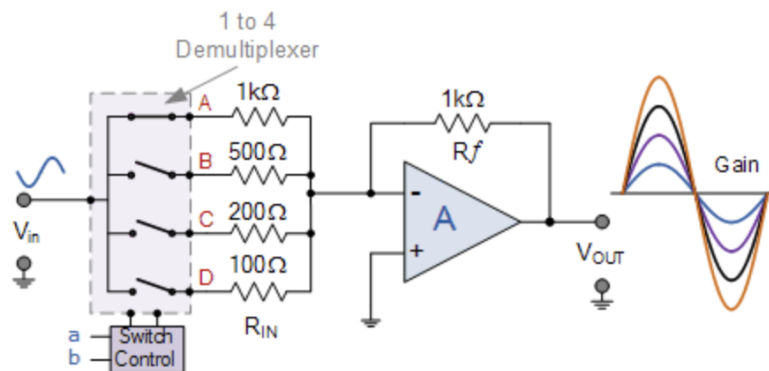
The symbol used in logic diagrams to identify a demultiplexer is as follows.

### The Demultiplexer Symbol



Again, as with the previous multiplexer example, we can also use it to digitally control the gain of an operational amplifier as shown.

## Digitally Adjustable Amplifier Gain



The circuit above illustrates how to provide digitally controlled adjustable/variable op-amp gain using a demultiplexer. The voltage gain of the inverting operational amplifier is dependent upon the ratio between the input resistor,  $R_{IN}$  and its feedback resistor,  $R_f$  as determined in the Op-amp tutorials.

The digitally controlled analogue switches of a demultiplexer selects an input resistor to vary the value of  $R_{in}$ . The combination of these resistors will determine the overall voltage gain of the amplifier, ( $A_v$ ). Then the voltage gain of the inverting operational amplifier can be adjusted digitally simply by selecting the appropriate input resistor combination.

Standard **Demultiplexer** IC packages available are the TTL 74LS138 1 to 8-output demultiplexer, the TTL 74LS139 Dual 1-to-4 output demultiplexer or the CMOS CD4514 1-to-16 output demultiplexer.

Another type of demultiplexer is the 24-pin, 74LS154 which is a 4-bit to 16-line demultiplexer/decoder. Here the individual output positions are selected using a 4-bit binary coded input. Like multiplexers, they can also be cascaded together to form higher order devices.

Unlike demultiplexers which convert a single data line into multiple output lines, or the multiplexer which can transfer multiple input lines into one single data line, there are also logic devices available which can switch data to and from multiple input and output lines depending on their data select control inputs.