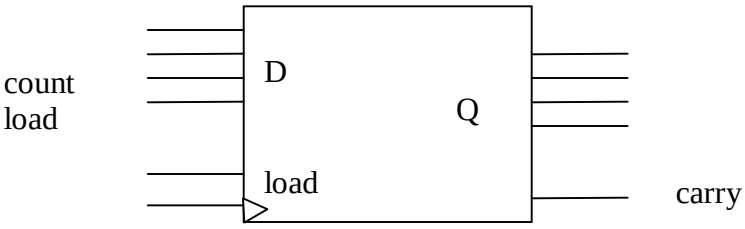
A counter in VHDL

- Counter: a register that can also increment
- The circuit (drawing)

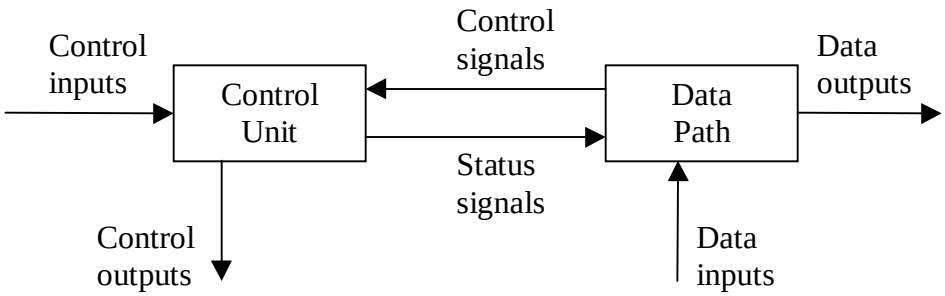


- The std_logic_unsigned library allows arithmetic operations to be done on std_logic_vector values
    - Values are treated as unsigned integers
    - Ie. 1111_2 is 15_{10} not -1_{10}
    - Operations defined: + - * shifts comparisons
- In VHDL, you can't read the value of an output port
    - Q_int will be an internal copy of Q that we can read
    - We need to read the value to increment it
- "here" was created for testing
    - it should be removed from the final model
- count_process handles parallel load & increment
    - dosen't update Q, just Q_int
    - line 34 does the increment.
    - Could also have been done other ways:
    - Q_int <= Q_int+
      conv_std_logic_vector (1,4)
      [convert 1 to a 4 bit value]
- Q_update process copies Q_int to Q when necessary.
- If the increment was above the "if", it would still work correctly

- Delta delay
    - Signal assignments with no "after…" part have a "delta delay
    - Any lines of code that follows run <u>before</u> the signal changes
    - Eg
      a<= '0'
      wait for 10 ns;
      a<= '1';
      b<=a;
    - At the end, b is '0'
    - Signal assignments happen at the end of each "simulation cycle"

Register Transfers

- The control & datapath make up the CPU
  - The data path performs operations on the data.
  - The control actives the operations in the datapath



- Operations that the datapath can do in one cycle are "micro operations"
  - Load, add, shift
- The control unit directs the datapath to do the right microop
- We will have a "register transfer language" to describe microops
  - Eg
  - R1 ← R2, R2 ← R1
    (swapping content at the same time)
- Common operations
  - + - * /
  - AND, OR, XOR, NOT
  - Shift right, shift left
  - || concatenation
  - eg.
    R1← "0000" || R0
    (extend R0 by 4 bits, put into R1)
  - R2← R0 + R1 + 1
    (two's compliment R0 –R1 into R2)
  - Cout ||R1 ← R0||Cin
    (shift R0 left into R1, with carry)