```
1  ----------------------------------------------------------------------------------
2  -- Company:
3  -- Engineer: Professor Jim Plusquellic
4  --
5  -- Create Date:
6  -- Design Name:
7  -- Module Name:    DataTypes_pkg - Behavioral
8  -- Project Name:
9  -- Target Devices:
10 -- Tool versions:
11 -- Description:
12 --
13 -- Dependencies:
14 --
15 -- Revision:
16 -- Revision 0.01 - File Created
17 -- Additional Comments:
18 --
19 ----------------------------------------------------------------------------------
20
21 library IEEE;
22 use IEEE.STD_LOGIC_1164.ALL;
23 use IEEE.NUMERIC_STD.all;
24
25 package DataTypes_pkg is
26
27 -- We represent numbers in FIXED-POINT format, with 12-bit integer portion of the
   16-bit number stored in the PN BRAM.
28 -- The fractional component is given by 'PRECISION' and the sum is PN_SIZE_NB.
   PN_SIZE_LB needs to be able to count
29 -- to PN_SIZE_NB.
30    constant PN_INTEGER_NB: integer := 12;
31    constant PN_PRECISION_NB: integer := 4;
32    constant PN_SIZE_LB: integer := 4;
33    constant PN_SIZE_NB: integer := PN_INTEGER_NB + PN_PRECISION_NB;
34
35    constant BYTE_SIZE_LB: integer := 3;
36    constant BYTE_SIZE_NB: integer := 8;
37
38    constant WORD_SIZE_LB: integer := 4;
39    constant WORD_SIZE_NB: integer := 16;
40
41 -- BRAM SIZES: PNL is currently 8192 bytes with 16-bit words.
42    constant PNL_BRAM_ADDR_SIZE_NB: integer := 13;
43    constant PNL_BRAM_DBITS_WIDTH_LB: integer := PN_SIZE_LB;
44    constant PNL_BRAM_DBITS_WIDTH_NB: integer := PN_SIZE_NB;
45    constant PNL_BRAM_NUM_WORDS_NB: integer := 2**PNL_BRAM_ADDR_SIZE_NB;
46
47 -- Total number PNs loaded into region 4096 to 8192 is 2^12 = 4096.
48    constant NUM_PNS_NB: integer := 12;
49    constant NUM_PNS: integer := 2**NUM_PNS_NB;
50
51 -- Largest positive (signed) value for PNs is 1023.9375 which is in binary
   0011111111.1111, BUT AS a integer binary value with no
52 -- decimal place, it is 16383 (0011111111111111) (note, we have 16-bit for the
   word size now).
53    constant LARGEST_POS_VAL: integer := 16383;
54
55 -- My largest negative value is -1023.9375 or 110000000000.0001, AND as a integer
   binary value, -16383
56    constant LARGEST_NEG_VAL: integer := -16383;
57
58 -- We store the raw data in the upper half of memory (locations 4096 to 8191).
59    constant PN_BRAM_BASE: integer := PNL_BRAM_NUM_WORDS_NB/2;
```

Data Types VHD

_LB = log or exponent

_NB = natural #'s pos 1 → +∞

fractional up to 1/16 precision

"precision" fractions: 1/2, 1/4, 1/8, 1/16 → 8, 4, 2, 1 / 16, 16, 16, 16 → Σ = 1/16

Sum: 0.5, 0.75, 0.875, 0.9375

understand fixed vs floating type intergers i.e. 'precision' 'fraction' etc..

address size in (N) = 13

12+16-1 = 27

18+16-1 = 28

11+16-1 = 26

LB vs NB ??

int portion (12) + prec param (4)

? length of Block ?

? number of Blocks ?

?? _LB = exponent ??

2^3 = 8, 2^4 = 16

important

PNS ??

?? not 1/16 ths

LB ?? exponent.

NB/2 ? number Blocks ??

```
60      constant PN_UPPER_LIMIT: integer := PNL_BRAM_NUM_WORDS_NB;
61
62  -- The histogram starts at the mid-point in the lower half of the BRAM (2048 to
    4095)
63      constant HISTO_BRAM_SIZE_NB: integer := 11;
64      constant HISTO_BRAM_BASE: integer := (PNL_BRAM_NUM_WORDS_NB/2)/2;
65      constant HISTO_BRAM_UPPER_LIMIT: integer := (PNL_BRAM_NUM_WORDS_NB/2);
66
67  -- Max range can never exceed the number of words we allocated in histo memory
    which is 2048. NOTE: WE NEED 12 bits to store
68  -- the value 2048!
69      constant HISTO_MAX_RANGE_NB: integer := HISTO_BRAM_SIZE_NB+1;
70      constant HISTO_MAX_RANGE: integer := 2**HISTO_BRAM_SIZE_NB;
71
72  -- Use 4 here for histo LV and HV bounds of 6.25% and 93.75%. With a total count
    across histo cells of 4096, the bounds become
73  -- 256 and 3840.
74      constant HISTO_BOUND_PCT_SHIFT_NB: integer := 4;
75
76  end DataTypes_pkg;
77
```

÷ 2 twice?

÷ 2

Copy idea to PND_BRAM ....