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/*
*****
*   File Name: w25p243a.v
*   Product:   W25P243A
*   Features:  64k x 64 burst pipelined SRAM
*               access time: 4.5ns
*               pipelined data output capability
*               2T/1T mode Signal cycle deslected mode
*               Intel burst mode & linear burst mode selection (LBO)
*               Packaged in 128-pin QFP and TQFP
*
*   Date : March 2, 1999
*           Written by Lin, Hung-Hsueh
*           Email Address : hhlin@winbond.com.tw
*
*   Verilog model for 64kx64 Burst Pipelined SRAM
*   (Tested on Verilog-XL 2.2.27)
*
*
*   Memory Product Dept.(PM20)
*   Winbond Electronics Crop.
*
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*   All right reserved
*
*   -----
*   Version 1.0 March 2 , 1999
*****
*/

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```

`timescale 1ns/100ps
module pbsram (addr, io, clk, ce_1, ce2, ce_3, gw, bwe, bw1, bw2, bw3, bw4, bw5,
bw6, bw7,bw8, oe, adv, adsc, adsp, zz, ft, lbo);

parameter maxDepth = 65536;    //64k
parameter maxAddr = 16;       //Address
parameter maxOut = 64;        //IO
parameter maxbyte = 8;        //Byte Number

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parameter reg_delay = 0.3;

inout [maxOut-1:0] io;
input [maxAddr-1:0] addr;

input clk, ce_1, ce2, ce_3;
input adv, adsc, adsp;
input gw, bwe, bw1, bw2, bw3, bw4, bw5, bw6, bw7, bw8, oe;
input zz , ft, lbo;

reg enable, pipe_enable;
reg wr_reg_out1, wr_reg_out2, wr_reg_out3, wr_reg_out4;
reg wr_reg_out5, wr_reg_out6, wr_reg_out7, wr_reg_out8;

reg [1:0] count;
reg [maxAddr-1:0] addr_reg_in;
reg [maxOut-1 :0] dout, data_out;
reg [maxOut-1:0]   din;
reg [(maxOut/4-1):0] array_quad1 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad2 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad3 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad4 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad5 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad6 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad7 [0:maxDepth];
reg [(maxOut/4-1):0] array_quad8 [0:maxDepth];

wire en_int = (~ce_1 & ce2 & ~ce_3);
wire ce_adsp = (~adsp & ~ce_1);
wire load = (ce_adsp | ~adsc) ;
wire addbit1, addbit0;
wire [maxAddr-1:0] addr_reg_out;

wire bw_en1 = (bw1 | bwe) & gw;
wire bw_en2 = (bw2 | bwe) & gw;
wire bw_en3 = (bw3 | bwe) & gw;
wire bw_en4 = (bw4 | bwe) & gw;

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wire bw_en5 = (bw5 | bwe) & gw;
wire bw_en6 = (bw6 | bwe) & gw;
wire bw_en7 = (bw7 | bwe) & gw;
wire bw_en8 = (bw8 | bwe) & gw;
wire wr_reg_or = wr_reg_out1 | wr_reg_out2 | wr_reg_out3 | wr_reg_out4 |
wr_reg_out5 | wr_reg_out6 | wr_reg_out7 | wr_reg_out8 ;
wire oe_en;
wire [maxOut-1:0] io;
wire [maxOut-1:0] io_int;

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integer i;

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initial

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begin
    enable =0;
    $timeformat(-9,1,"ns",10);
    for (i=0; i<=maxDepth; i=i+1)
        begin
            array_quad1[i] =8'b0;
            array_quad2[i] =8'b0;
            array_quad3[i] =8'b0;
            array_quad4[i] =8'b0;
            array_quad5[i] =8'b0;
            array_quad6[i] =8'b0;
            array_quad7[i] =8'b0;
            array_quad8[i] =8'b0;
        end
end

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end

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// address register

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always @(posedge clk)
begin
    if (load)
        addr_reg_in <= #0.2 addr;
end

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// burst counter

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always @(posedge clk)

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begin
    if (~lbo & load)
        count <= 2'b00;
    else
        if (lbo & load)
            count <= addr [1:0];
        else
            if (~adv & ~load)
                count = count + 1;
end

assign addbit1 = lbo ? count[1] : (count[1]^addr_reg_in[1]) ;
assign addbit0 = lbo ? count[0] : (count[0]^addr_reg_in[0]) ;
assign addr_reg_out = {addr_reg_in[maxAddr-1:2], addbit1, addbit0};

// write register
always @(posedge clk)
begin
    wr_reg_out1 <= #0.2 ~(ce_adsp || bw_en1);
    wr_reg_out2 <= #0.2 ~(ce_adsp || bw_en2);
    wr_reg_out3 <= #0.2 ~(ce_adsp || bw_en3);
    wr_reg_out4 <= #0.2 ~(ce_adsp || bw_en4);
    wr_reg_out5 <= #0.2 ~(ce_adsp || bw_en5);
    wr_reg_out6 <= #0.2 ~(ce_adsp || bw_en6);
    wr_reg_out7 <= #0.2 ~(ce_adsp || bw_en7);
    wr_reg_out8 <= #0.2 ~(ce_adsp || bw_en8);
end

// enable register
always @(posedge clk)
begin
    if (load)
        enable = #0.2 en_int;
end

// pipelined enable
always @(posedge clk)
begin

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        pipe_enable <= #0.2 enable;
end

// memory array
always @(posedge clk)
begin
    if (en_int & ~adsc & adsp)
    begin
        #1.0
        if (~bw_en1) array_quad1[addr] <= din[7:0];
        if (~bw_en2) array_quad2[addr] <= din[15:8];
        if (~bw_en3) array_quad3[addr] <= din[23:16];
        if (~bw_en4) array_quad4[addr] <= din[31:24];
        if (~bw_en5) array_quad5[addr] <= din[39:32];
        if (~bw_en6) array_quad6[addr] <= din[47:40];
        if (~bw_en7) array_quad7[addr] <= din[55:48];
        if (~bw_en8) array_quad8[addr] <= din[63:56];
    end
    else if (enable & (adsc & (adsp | ce_1)))
    begin
        #1.0;
        if (~bw_en1) array_quad1[addr_reg_out] <= din[7:0];
        if (~bw_en2) array_quad2[addr_reg_out] <= din[15:8];
        if (~bw_en3) array_quad3[addr_reg_out] <= din[23:16];
        if (~bw_en4) array_quad4[addr_reg_out] <= din[31:24];
        if (~bw_en5) array_quad5[addr_reg_out] <= din[39:32];
        if (~bw_en6) array_quad6[addr_reg_out] <= din[47:40];
        if (~bw_en7) array_quad7[addr_reg_out] <= din[55:48];
        if (~bw_en8) array_quad8[addr_reg_out] <= din[63:56];
    end
end

end

// input register
always @(posedge clk)
begin
    din <= #0.3 io;
end
end

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```

// output register
always @(posedge clk)
begin
    #0.4;
    if ( ~wr_reg_or)
    begin
        dout[7 : 0] <= #0.2 array_quad1 [addr_reg_out];
        dout[15: 8] <= #0.2 array_quad2 [addr_reg_out];
        dout[23:16] <= #0.2 array_quad3 [addr_reg_out];
        dout[31:24] <= #0.2 array_quad4 [addr_reg_out];
        dout[39:32] <= #0.2 array_quad5 [addr_reg_out];
        dout[47:40] <= #0.2 array_quad6 [addr_reg_out];
        dout[55:48] <= #0.2 array_quad7 [addr_reg_out];
        dout[63:56] <= #0.2 array_quad8 [addr_reg_out];
    end

end

always @(posedge clk)
begin
    #0.2;
    if (wr_reg_or)
        data_out <= din ;
    else if ( ~wr_reg_or)
        data_out <= dout ;
end

assign io_int =  oe_en ? data_out : din ;

assign oe_en = (~oe & pipe_enable & enable & ~wr_reg_or);

//output driver
bufif1 #0.2 (io[0], io_int[0], oe_en);
bufif1 #0.2 (io[1], io_int[1], oe_en);
bufif1 #0.2 (io[2], io_int[2], oe_en);
bufif1 #0.2 (io[3], io_int[3], oe_en);
bufif1 #0.2 (io[4], io_int[4], oe_en);

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bufif1 #0.2 (io[5], io_int[5], oe_en);
bufif1 #0.2 (io[6], io_int[6], oe_en);
bufif1 #0.2 (io[7], io_int[7], oe_en);
bufif1 #0.2 (io[8], io_int[8], oe_en);
bufif1 #0.2 (io[9], io_int[9], oe_en);
bufif1 #0.2 (io[10], io_int[10], oe_en);
bufif1 #0.2 (io[11], io_int[11], oe_en);
bufif1 #0.2 (io[12], io_int[12], oe_en);
bufif1 #0.2 (io[13], io_int[13], oe_en);
bufif1 #0.2 (io[14], io_int[14], oe_en);
bufif1 #0.2 (io[15], io_int[15], oe_en);
bufif1 #0.2 (io[16], io_int[16], oe_en);
bufif1 #0.2 (io[17], io_int[17], oe_en);
bufif1 #0.2 (io[18], io_int[18], oe_en);
bufif1 #0.2 (io[19], io_int[19], oe_en);
bufif1 #0.2 (io[20], io_int[20], oe_en);
bufif1 #0.2 (io[21], io_int[21], oe_en);
bufif1 #0.2 (io[22], io_int[22], oe_en);
bufif1 #0.2 (io[23], io_int[23], oe_en);
bufif1 #0.2 (io[24], io_int[24], oe_en);
bufif1 #0.2 (io[25], io_int[25], oe_en);
bufif1 #0.2 (io[26], io_int[26], oe_en);
bufif1 #0.2 (io[27], io_int[27], oe_en);
bufif1 #0.2 (io[28], io_int[28], oe_en);
bufif1 #0.2 (io[29], io_int[29], oe_en);
bufif1 #0.2 (io[30], io_int[30], oe_en);
bufif1 #0.2 (io[31], io_int[31], oe_en);
bufif1 #0.2 (io[32], io_int[32], oe_en);
bufif1 #0.2 (io[33], io_int[33], oe_en);
bufif1 #0.2 (io[34], io_int[34], oe_en);
bufif1 #0.2 (io[35], io_int[35], oe_en);
bufif1 #0.2 (io[36], io_int[36], oe_en);
bufif1 #0.2 (io[37], io_int[37], oe_en);
bufif1 #0.2 (io[38], io_int[38], oe_en);
bufif1 #0.2 (io[39], io_int[39], oe_en);
bufif1 #0.2 (io[40], io_int[40], oe_en);
bufif1 #0.2 (io[41], io_int[41], oe_en);
bufif1 #0.2 (io[42], io_int[42], oe_en);

```

bufifl #0.2 (io[43], io_int[43], oe_en);
bufifl #0.2 (io[44], io_int[44], oe_en);
bufifl #0.2 (io[45], io_int[45], oe_en);
bufifl #0.2 (io[46], io_int[46], oe_en);
bufifl #0.2 (io[47], io_int[47], oe_en);
bufifl #0.2 (io[48], io_int[48], oe_en);
bufifl #0.2 (io[49], io_int[49], oe_en);
bufifl #0.2 (io[50], io_int[50], oe_en);
bufifl #0.2 (io[51], io_int[51], oe_en);
bufifl #0.2 (io[52], io_int[52], oe_en);
bufifl #0.2 (io[53], io_int[53], oe_en);
bufifl #0.2 (io[54], io_int[54], oe_en);
bufifl #0.2 (io[55], io_int[55], oe_en);
bufifl #0.2 (io[56], io_int[56], oe_en);
bufifl #0.2 (io[57], io_int[57], oe_en);
bufifl #0.2 (io[58], io_int[58], oe_en);
bufifl #0.2 (io[59], io_int[59], oe_en);
bufifl #0.2 (io[60], io_int[60], oe_en);
bufifl #0.2 (io[61], io_int[61], oe_en);
bufifl #0.2 (io[62], io_int[62], oe_en);
bufifl #0.2 (io[63], io_int[63], oe_en);

```

specify

```

specparam tCYC=10.0, //Clock Cycle time
    tKH=4,           //Colok High Pulse Width
    tKL=4,           //Colok Low Pulse Width
    tKQ=6,           //Clock to Output Valid
    tKX=2,           //Clock to Output Invalid
    tKHZ=4.5,        //Clock to Output High-Z
    tKLZ=0,          //Clock to Output Low-Z
    tOE=4.5, //Output Enable to Output Valid
    tOHZ=4.5,        //Output Enable to High-Z
    tOLZ=0,          //Output Enable to Low-Z
    tAS=2.0, //Add. Setup Time
    tADSS=2.0, //ADSP_, ADSC_, ADV_ Setup Time
    tCES=2.0, //CE_1_, CE2, CE_3_ Setup Time
    tWS=2.0, //GW_, BWE_ BWx_ Setup Time
    tDS=2.0, //Write Data Setup Time

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tAH=1.0, //Add. Hold Time
tADSH=1.0, //ADSP_, ADSC_, ADV_ Hold Time
tCEH=1.0, //CE_1_, CE2, CE_3_ Hold Time
tWH=1.0, //GW_, BWE_ BWx_ Hold Time
tDH=1.0; //Write Data Hold Time

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```

(oe *>io)=(tOE,tOE,tOHZ);
(clk *>io)=(tKQ,tKQ,tKHZ);

```

```

$width (posedge clk, tKH);
$width (negedge clk, tKL);
$period (posedge clk, tCYC);
$period (negedge clk, tCYC);
$setuphold(posedge clk, adsc, tADSS, tADSH);
$setuphold(posedge clk, adsp, tADSS, tADSH);
$setuphold(posedge clk, adv, tADSS, tADSH);
$setuphold(posedge clk, bw1, tWS, tWH);
$setuphold(posedge clk, bw2, tWS, tWH);
$setuphold(posedge clk, bw3, tWS, tWH);
$setuphold(posedge clk, bw4, tWS, tWH);
$setuphold(posedge clk, bw5, tWS, tWH);
$setuphold(posedge clk, bw6, tWS, tWH);
$setuphold(posedge clk, bw7, tWS, tWH);
$setuphold(posedge clk, bw8, tWS, tWH);
$setuphold(posedge clk, gw, tWS, tWH);
$setuphold(posedge clk, bwe, tWS, tWH);
$setuphold(posedge clk, ce_1, tCES, tCEH);
$setuphold(posedge clk, ce2, tCES, tCEH);
$setuphold(posedge clk, ce_3, tCES, tCEH);
$setuphold(posedge clk, addr, tAS, tAH);
endspecify

endmodule

```