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Appendix

1. Matlab program for DDFS

(1).findrom.m

```

%*****/
% M-file      :   findrom.m      *
% VERSION    :   1.0            *
% DATE       :   Jul. 1 2003    *
% AUTHOR     :   Cheng Hen Shan *
% DESCRIPTION :   This m-file is used for the following purpose *
%             (1). Verify the algorithm of proposed DDFS *
%             (2). Find value of coarse and fine ROM for the proposed DDFS *
%             (3). Calculate the SFDR and plot the approximate sine wave form *
%*****/

parameter_store = 1;
for i=1:1024
    rel_amp(i) = sin(pi*i/(2*2^10)-0.0005);
    quarter_phase(i) = pi*i/(2*2^10)-0.0005;
    app_amp1(i) = fix(i/2);
    if(i<511)
        app_amp2(i)= fix(i/8);
    else
        app_amp2(i) = 128 - fix(i/8);
    end
end
app_amp = (app_amp1 + app_amp2)/512;
abits = 2;
bbits = 4;
cbits = 4;
%-----*
if (parameter_store == 1)
    [fine_amp,fine_value,temp_error] = errortable(quarter_phase,app_amp,abits,bbits,cbits);
end
%-----*
%           Use for calculating the coarse and fine error correct value *
%-----*
% ----- Store the error correct table to file -----*

```



```

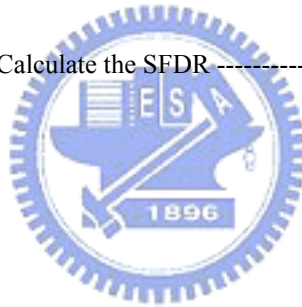
if (parameter_store == 1)
    errortablesave(fine_value,temp_error,'simufloat','simuint','simuhex',9);
end
[fine_amp,fine_hex,coarse_hex,app_amp] = errorlookuptable1(app_amp,quarter_phase,abits,bbits,cbits);
% ----- store the error correct table to file -----*
for i=1:4096
    rel_amp(i) = sin(pi*i/(2*2^10)-0.0005);
    phase(i) = pi*i/(2*2^10)-0.0005;
end
% ----- Calculate the second quantaure sin amplitude -----*
quarter_phase = phase(find(phase > 0.5*pi & phase <= pi));
quarter_phase = pi - quarter_phase;
for i = length(quarter_phase):-1:1
    sec_quarter_phase(length(quarter_phase)-i+1) = quarter_phase(i);
end
[temp_amp_quad2,fine_hex,coarse_hex,temp_second_quad] =
errorlookuptable1(app_amp,sec_quarter_phase,abits,bbits,cbits);
for i = length(temp_second_quad):-1:1
    amp_quad2(length(temp_second_quad)-i+1) = temp_amp_quad2(i);
    second_quad(length(temp_second_quad)-i+1) = temp_second_quad(i);
end
% ----- Calculate the third quantaure sin amplitude -----*
quarter_phase = phase(find(phase > pi & phase <= 1.5*pi));
third_quarter_phase = quarter_phase - pi;
[amp_quad3,fine_hex,coarse_hex,third_quad] =
errorlookuptable1(app_amp,third_quarter_phase,abits,bbits,cbits);
amp_quad3 = -1.*amp_quad3;
third_quad = -1.*third_quad;
% ----- Calculate the forth quantaure sin amplitude -----*
quarter_phase = phase(find(phase > 1.5*pi & phase <= 2*pi));
quarter_phase = 2*pi - quarter_phase ;
for i = length(quarter_phase):-1:1
    forth_quarter_phase(length(quarter_phase)-i+1) = quarter_phase(i);
end
[temp_amp_quad4,fine_hex,coarse_hex,temp_forth_quad] =
errorlookuptable1(app_amp,forth_quarter_phase,abits,bbits,cbits);
for i = length(temp_forth_quad):-1:1
    amp_quad4(length(temp_forth_quad)-i+1) = temp_amp_quad4(i);

```

```

    forth_quad(length(temp_forth_quad)-i+1) = temp_forth_quad(i);
end
amp_quad4 = -1.*amp_quad4;
forth_quad = -1.*forth_quad;
% ----- Combine four quantaure sin amplitude -----*
roY = [ fine_amp amp_quad2 amp_quad3 amp_quad4];
approx_amp = [app_amp second_quad third_quad forth_quad];
% ----- Calculate the DFT to measure spur -----*
iN = length( roY );
roPsd = abs( fft( roY ) );
fiFloor = -160;
%----- Find the possible zeros and replace it with the fiFloor [dB] constant (10^(fiFloor/20)) -----*
    Min = 10^(fiFloor/20);
    roPsd = (2/iN) .* roPsd;
    roPsd(1) = 1/2 * roPsd(1);    % Adjust the DC
    roPsd( find( roPsd < Min ) ) = Min;
    roPsd = 20 .* log10( roPsd );
%----- Calculate the SFDR -----*
    temp_psd = roPsd;
    [maxsign,index] = max(roPsd);
    temp_psd(index) = 20 * log10( Min );
    [max_noise,index] = max(temp_psd);
    temp_psd(index) = 20 * log10( Min );
    [max_noise,index] = max(temp_psd);
    spur = maxsign - max_noise;
    spur;
%----- Plot the approximate Sine wave for-----*
figure;
plot(phase/pi,rel_amp,'-',phase/pi, roY,'-');
xlabel('phase accumulator □');ylabel('Sine Amplitude');
figure;
plot(phase/pi,rel_amp,'-',phase/pi,approx_amp,'-');
xlabel('phase accumulator □');ylabel('Sine Amplitude');

```



(2). errortable.m

```
%*****/
% M-file      :   errortable.m                               *
% VERSION    :   1.0                                         *
% DATE       :   Jul 20, 2003                                 *
% AUTHOR     :   Cheng Hen Shan                             *
% DESCRIPTION:   This m-file is used for the following purpose *
%                                                     Subroutine was used for finding value of coarse and fine ROM for the *
%                                                     proposed DDFS                                     *
%*****/
function [fine_signal,fine_value,temp_error] = errortable(quarterphase,approx_signal,abits,bbits,cbits)
% ----- Calculate the first quanta sine amplitude -----*
origin_amp = sin(quarterphase);
%----- Coarse interval for phase -----*
coarsetheta = pi/(2^(abits+bbits+1));
%----- Fine interval for phase e -----*
finetheta = coarsetheta/(2^cbits);
% ----- Calculate the coarse error amplitude -----*
number_coarse = 2^(abits+bbits);
number_fine = 2^cbits;
temp_signal = [];
for i = 1: number_coarse
    range_index = find(quarterphase > (i-1)*coarsetheta & quarterphase <= i*coarsetheta);
    origin_amp = sin(quarterphase(find(quarterphase > (i-1)*coarsetheta & quarterphase <= i*coarsetheta)));
    temp_amp = approx_signal(find(quarterphase > (i-1)*coarsetheta & quarterphase <= i*coarsetheta));
    temp_error(i) = min(origin_amp - temp_amp);
    temp_amp = temp_amp + temp_error(i);
    temp_signal = [temp_signal temp_amp];
end
gross_error_max = max(temp_error);
% ----- Calculate the fine error amplitude -----*
num_b = 2^bbits;
fine_signal = [];
for i = 1:2^abits
    for k = 1:2^bbits
        for j = 1:2^cbits
            origin_amp = sin(quarterphase(find(quarterphase >
            (((i-1)*num_b+k-1)*coarsetheta+(j-1)*finetheta) & quarterphase
```

```

<=(((i-1)*num_b+k-1)*coarsetheta+j*finetheta)));
    temp_amp = temp_signal(find(quarterphase > (((i-1)*num_b+k-1)*coarsetheta+(j-1)*finetheta)
& quarterphase <= (((i-1)*num_b+k-1)*coarsetheta+j*finetheta)));
    temp_error2(k,j) = median(origin_amp - temp_amp);
end
end
fine_value(i,:) = median(temp_error2,1);
for k = 1:2^bbits
    for j = 1:2^cbits
        temp_amp = temp_signal(find(quarterphase > (((i-1)*num_b+k-1)*coarsetheta+(j-1)*finetheta)
& quarterphase <= (((i-1)*num_b+k-1)*coarsetheta+j*finetheta)));
        temp_amp = temp_amp + fine_value(i,j);
        fine_signal = [fine_signal temp_amp];
    end
end
end
end
temp_error_max = max(fine_value);
fine_error_max = max(temp_error_max);

```



(3). errortablesave.m

```

%*****
% M-file      :   errortablesave.m                               *
% VERSION    :   1.0                                           *
% DATE       :   Jul 20, 2003                                   *
% AUTHOR     :   Cheng Hen Shan                               *
% DESCRIPTION :   This m-file is used for the following purpose *
%             Subroutine was used for saving value of coarse and fine ROM for the *
%             proposed DDFS to file                             *
%*****
function errortablesave(fine_value,coarse_value,float_file,integ_file,hex_file,output_bit)
temp_coarse_max = max(coarse_value);
temp_error_max = max(fine_value);
temp_fine_max = max(temp_error_max);
i = 1;
% ----- Calculate the bit save for Coarse ROM -----*
while temp_coarse_max < 1/(2^i),
    i = i + 1;

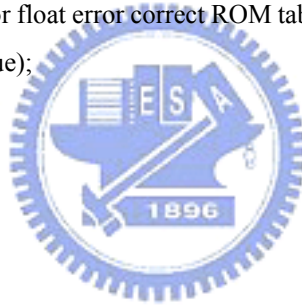
```



```

end
save_coarse_bit = i-1;
% ----- Calculate the bit save for Fine ROM -----*
i = 1;
while temp_fine_max < 1/(2^i),
    i = i + 1;
end
save_fine_bit = i-1;
actual_bit = output_bit - save_coarse_bit;
% ----- Converter integral number of coarse correct -----*
coarse_int = floor(coarse_value*(2^save_coarse_bit)*(2^actual_bit)+0.5);
coarse_hex = dec2hex(coarse_int);
% ----- Converter integral number of coarse correct -----*
actual_bit = output_bit - save_fine_bit;
fine_int = floor(fine_value*(2^save_fine_bit)*(2^actual_bit)+0.5);
fine_hex = dec2hex(fine_int);
%----- Save to file for float error correct ROM table -----*
[coarse_row,coarse_col] = size(coarse_value);
[fine_row,fine_col] = size(fine_value);
sub_name1 = '_coarse';
sub_name2 = '_fine';
temp_name1 = [float_file sub_name1];
temp_name2 = [integ_file sub_name1];
temp_name3 = [float_file sub_name2];
temp_name4 = [integ_file sub_name2];
temp_name5 = [hex_file sub_name1];
temp_name6 = [hex_file sub_name2];
fid1 = fopen(temp_name1,'w');
fid2 = fopen(temp_name2,'w');
fid3 = fopen(temp_name3,'w');
fid4 = fopen(temp_name4,'w');
fid5 = fopen(temp_name5,'w');
fid6 = fopen(temp_name6,'w');
fprintf(fid1,'%f\n',coarse_value);
fprintf(fid2,'%d\n',coarse_int);
%----- First write row and col numbers -----*
fprintf(fid3,'%u %u\n',fine_row,fine_col);
fprintf(fid4,'%u %u\n',fine_row,fine_col);

```



```

fprintf(fid3,'%f\n',fine_value);
fprintf(fid4,'%d\n',fine_int);
[row,column] = size(coarse_hex);
for i = 1:row
    temp_string = coarse_hex(i,1:column);
    fprintf(fid5,'%s\n',temp_string);
end
[row,column] = size(fine_hex);
for i = 1:row
    temp_string = fine_hex(i,1:column);
    fprintf(fid6,'%s\n',temp_string);
end
fclose(fid1);
fclose(fid2);
fclose(fid3);
fclose(fid4);
fclose(fid5);
fclose(fid6);

```



(4). errorlookuptable.m

```

%*****
% M-file      :      errorlookuptable      *
% VERSION    :      1.0                    *
% DATE       :      Aug 4, 2003            *
% AUTHOR     :      Cheng Hen Shan        *
% DESCRIPTION :      This m-file is used for the following purpose      *
%             :      Subroutine was used for loading fine and coarse error correct from file *
%             :      for the proposed DDFS                                  *
%*****
function [fine_signal,fine_hex,coarse_hex,approx_signal] = errorlookuptable(quarterphase,abits,bbits,cbits)
% ----- Load fine and coarse error correct from table -----*
[fine_value,coarse_value,fine_hex,coarse_hex] = loaderrortable('simufloat','simuint');
%----- First approximation for sin function - one line approximation -----*
app_amp1 = 2*quarterphase/pi;
%----- Second approximation for sin function - two line approximation-----*
app_amp2 = quarterphase(find(quarterphase <= 0.25*pi))/(2*pi);
app_amp3 = 0.25 - quarterphase(find(quarterphase > 0.25*pi & quarterphase <= 0.5*pi))/(2*pi);

```

```

approx_signal = app_amp1 + [ app_amp2  app_amp3];
%----- Coarse interval for phase -----*
coarsetheta = pi/(2^(abits+bbits+1));
%----- Fine interval for phase -----*
finetheta = coarsetheta/(2^cbits);
% ----- Calculate the coarse error amplitude -----*
number_coarse = 2^(abits+bbits);
number_fine = 2^cbits;
temp_signal = [];
for i = 1: number_coarse
    range_index = find(quarterphase > (i-1)*coarsetheta & quarterphase <= i*coarsetheta);
    if(size(range_index) > 0)
        temp_amp = approx_signal(find(quarterphase > (i-1)*coarsetheta & quarterphase <=
i*coarsetheta));
        temp_amp = temp_amp + coarse_value(i);
        temp_signal = [temp_signal  temp_amp];
    end
end
gross_error_max = max(coarse_value);
% ----- Calculate the fine error amplitude -----*
num_b = 2^bbits;
fine_signal = [];
for i = 1:2^abits
    for k = 1:2^bbits
        for j = 1:2^cbits
            range_index = find(quarterphase > (((i-1)*num_b+k-1)*coarsetheta+(j-1)*finetheta) &
quarterphase <= (((i-1)*num_b+k-1)*coarsetheta+j*finetheta));
            if(size(range_index) > 0)
                temp_amp = temp_signal(find(quarterphase >
(((i-1)*num_b+k-1)*coarsetheta+(j-1)*finetheta) & quarterphase <=
(((i-1)*num_b+k-1)*coarsetheta+j*finetheta));
                temp_amp = temp_amp + fine_value(i,j);
                fine_signal = [fine_signal temp_amp];
            end
        end
    end
end
temp_error_max = max(fine_value);

```



```
fine_error_max = max(temp_error_max);
```

(5). loaderrortable.m

```
%*****  
% M-file      :   loaderrortable.m      *  
% VERSION    :   1.0                  *  
% DATE       :   Aug 5, 2003          *  
% AUTHOR     :   Cheng Hen Shan      *  
% DESCRIPTION :   This m-file is used for the following purpose      *  
%           :   Subroutine was used for loading fine and coarse error correct from file *  
%           :   for the proposed DDFS, called by errorlookuptable.m *  
%*****  
/*****  
function [fine_value,coarse_value,fine_hex,coarse_hex] = loaderrortable(float_file,integ_file)  
%----- Load float error correct ROM table from file -----*  
sub_name1 = '_coarse';  
sub_name2 = '_fine';  
temp_name1 = [float_file sub_name1];  
temp_name2 = [integ_file sub_name1];  
temp_name3 = [float_file sub_name2];  
temp_name4 = [integ_file sub_name2];  
fid1 = fopen(temp_name1,'r');  
fid2 = fopen(temp_name2,'r');  
fid3 = fopen(temp_name3,'r');  
fid4 = fopen(temp_name4,'r');  
%----- Load coarse error correct value -----*  
coarse_value = fscanf(fid1,'%f',inf);  
coarse_int = fscanf(fid2,'%d',inf);  
coarse_hex = dec2hex(coarse_int);  
%----- Load fine error correct value -----*  
fine_unm_float = fscanf(fid3,'%u %u\n',2);  
fine_unm_int = fscanf(fid4,'%u %u\n',2);  
temp_value = fscanf(fid3,'%f',inf);  
temp_value = reshape(temp_value,fine_unm_float(2),fine_unm_float(1));  
fine_value = temp_value';  
temp_int = fscanf(fid4,'%d',inf);  
temp_int = reshape(temp_int,fine_unm_int(2),fine_unm_int(1));  
fine_int = temp_int';
```



```

fine_hex = dec2hex(fine_int');
fclose(fid1);
fclose(fid2);
fclose(fid3);
fclose(fid4);

```

2.Verilog code for digital modulator

(1). modulator.v

```

/*****
// MODULE      :    modeset.v                                *
// FILE NAME   :    modeset.v                                *
// VERSION    :    1.0                                        *
// DATE       :    OCT 1 2003                                *
// AUTHOR     :    Cheng Hen Shan                            *
// DESCRIPTION:    This module is used for setting modulation *
//                :    type                                  *
//                :    That is FSK DFSK BPSK QPSK according *
//                :    to the input parameter                *
*****/
// DEFINES
`define QUATER_PHASE_OUT_BITS    9    // amplitude out bits for quarter phase
`define PHASE_OUTPUT_BITS       10   // amplitude out bits for full phase
`define ACCUMU_BITS             20   // number of bits for accumulator
`define PHASE_TRUN_BITS        8    // number of bits for phase truncation
`define PHASE_INPUT_BITS       10   // number of bits for accumulator

// MODULE
module modulator(freqoffset,mode,data,symboltime,Clock, Reset, FCW,sinout,cosout,adcclock );
input    [11:0]    freqoffset;
input    [1:0]    mode;
input    [1:0]    data;
input    [7:0]    symboltime;
input    Clock, Reset;
input    [ `ACCUMU_BITS-1:0]    FCW;
output   [ `PHASE_OUTPUT_BITS-1:0]    sinout, cosout;
output   adcclock;

// SIGNAL DECLARATIONS
wire    [ `ACCUMU_BITS-1:0]    FCWOUT;

```

```

wire      [1:0]                sinphasebit,cosphasebit;
wire      sinmsbbit,cosmsbit,loadbit;
wire      sinms2bit,cosms2bit;
wire      [ `PHASE_OUTPUT_BITS-1:0]  sinout_wire, cosout_wire;
reg       [ `PHASE_OUTPUT_BITS-1:0]  sinout, cosout;
// MAIN CODE
// Instantiate
DDFS sinddfs(
    .Clock(Clock),
    .Reset(Reset),
    .phaseoffset(sinphasebit),
    .phaseload(loadbit),
    .FCW(FCWOUT),
    .ddfs_out(sinout_wire),
    .msbbit(sinmsbbit),
    .ms2bit(sinms2bit)
);
DDFS cosddfs(
    .Clock(Clock),
    .Reset(Reset),
    .phaseoffset(cosphasebit),
    .phaseload(loadbit),
    .FCW(FCWOUT),
    .ddfs_out(cosout_wire),
    .msbbit(cosmsbbit),
    .ms2bit(cosms2bit)
);

Modeset modeset(
    .freqoffset(freqoffset),
    .mode(mode),
    .data(data),
    .symboltime(symboltime),
    .msbbit(sinmsbbit),
    .msb2bit(sinms2bit),
    .Clock(Clock),
    .Reset(Reset),
    .FCW(FCW),

```



```

        .load_flag_pulse(loadbit),
        .sinphaseoff(sinphasebit),
        .cosphaseoff(cosphasebit),
        .FCWOUT(FCWOUT)
    );
assign adccclk = Clock;
always @(posedge adccclk)
begin
    cosout <= cosout_wire ;
    sinout <= sinout_wire ;
end
endmodule // end modeset

```

(2). ddfs.v

```

/*****
// MODULE      :    ddfs.v
// FILE NAME   :    ddfs.v
// VERSION    :    1.0
// DATE       :    Sep 1 2003
// AUTHOR     :    Cheng Hen Shan
// DESCRIPTION:    This module is for SCMF(sine/cosine mapping function)
//              :    This module defines a direct digit frequency synthesizer that is used for
//              :    generating the sin wave according to the frequency control word
*****/

// DEFINES
`define QUATER_PHASE_OUT_BITS    9        // amplitude out bits for quarter phase
`define PHASE_OUTPUT_BITS        10       // amplitude out bits for full phase
`define ACCUMU_BITS              20       // number of bits for accumulator
`define PHASE_TRUN_BITS          8        // number of bits for phase truncation
`define PHASE_INPUT_BITS         10       // number of bits for accumulator

// MODULE
module DDFS(Clock, Reset, phaseoffset, phaseload, FCW, ddfs_out,msbbit,ms2bit);
input                                Clock, Reset;
input      [1:0]                      phaseoffset;
input                                phaseload;
input      [`ACCUMU_BITS-1:0]         FCW;
output      [`PHASE_OUTPUT_BITS-1:0]  ddfs_out;

```

```

output                                     msbbit,ms2bit ; // MSB bit for phase address
// SIGNAL DECLARATIONS
wire    [`ACCUMU_BITS-1:0]                Acc_addr_Out;
wire    [`QUATER_PHASE_OUT_BITS-1:0]     quarter_ddfs_Out;
wire    [`PHASE_OUTPUT_BITS-1:0]         ddfs_out;
wire    [`PHASE_INPUT_BITS-1:0]          phase_input;
// Instantiate
Accumulator Accumu (
    .Clock(Clock),
    .Reset(Reset),
    .FCW(FCW),
    .phaseload(phaseload),
    .phaseoffset(phaseoffset),
    .Acc_Out(Acc_addr_Out)
);
PhaseToAmp amplitude (
    .phase(phase_input),
    .Amp_out(quarter_ddfs_Out)
);
assign ddfs_out =
    (Acc_addr_Out[`ACCUMU_BITS-1]) ? {1'b1 ,~quarter_ddfs_Out} : {1'b0 ,quarter_ddfs_Out};
assign phase_input =
    (Acc_addr_Out[`ACCUMU_BITS-2]) ? ~Acc_addr_Out[`ACCUMU_BITS-3:`PHASE_TRUN_BITS]:
    Acc_addr_Out[`ACCUMU_BITS-3:`PHASE_TRUN_BITS];
assign msbbit = Acc_addr_Out[`ACCUMU_BITS-1];
assign ms2bit = Acc_addr_Out[`ACCUMU_BITS-2];
endmodule // end DDFS

```



(3). modeset.v

```

/*****
// MODULE      :    modeset.v                               *
// FILE NAME   :    modeset.v                               *
// VERSION    :    1.0                                       *
// DATE       :    OCT 1 2003                                 *
// AUTHOR     :    Cheng Hen Shan                            *
// DESCRIPTION:    This module is used for setting modulation *
//              type that is FSK DFSK BPSK QPSK according to the input parameter *
*****/

```



```

// DEFINES
`define QUATER_PHASE_OUT_BITS 9 // amplitude out bits for quarter phase
`define PHASE_OUTPUT_BITS 10 // amplitude out bits for full phase
`define ACCUMU_BITS 20 // number of bits for accumulator
`define PHASE_TRUN_BITS 8 // number of bits for phase truncation
`define PHASE_INPUT_BITS 10 // number of bits for accumulator
`define FSKMODE 2'b00 // FSK mode
`define DFSKMODE 2'b01 // DFSK mode
`define BPSKMODE 2'b10 // BPSK mode
`define QPSKMODE 2'b11 // QPSK mode

// MODULE
module Modeset(freqoffset,mode,data,symboltime,msbbit,msb2bit,Clock, Reset, FCW,
              load_flag_pulse, sinphaseoff, cosphaseoff, FCWOUT );
input [11:0] freqoffset;
input [1:0] mode;
input [1:0] data;
input [7:0] symboltime;
input msbbit,msb2bit,Clock, Reset;
input [ `ACCUMU_BITS-1:0] FCW;
output load_flag_pulse;
output [ 1:0] sinphaseoff,cosphaseoff;
output [ `ACCUMU_BITS-1:0] FCWOUT;

// SIGNAL DECLARATIONS
wire [ `PHASE_INPUT_BITS-1:0] phase_input;
reg [ `ACCUMU_BITS-1:0] FCWOUT;
reg [1:0] prev_data;
reg [7:0] prev_symbol_time;
reg load_flag;
reg [7:0] count;
reg [1:0] sinphaseoff,cosphaseoff;
reg load_pulse,init_load,msb_pulse;
wire msb2_pulse_check ,delay_load;
reg load_flag_pulse ,rst,set;

// MAIN CODE
always @(Reset)
begin
    rst = 0;
    set = 1;

```

end

always @(posedge Clock)

begin

load_pulse <= load_flag;

msb_pulse <= msb2bit;

load_flag_pulse <= delay_load;

if (Reset) // reset

begin

init_load <= set; // reset output to zero

FCWOUT <= rst;

count <= rst;

load_flag <= rst;

sinphaseoff <= rst;

cosphaseoff <= set;

prev_data <= rst;

end

else if(delay_load || init_load)

begin

FCWOUT <= FCW;

case (mode)

FSKMODE :

begin

if(prev_data[0] == 1'b0)

FCWOUT <= FCW;

else

FCWOUT <= FCW + {8'b0, freqoffset};

sinphaseoff <= 2'b00;

cosphaseoff <= 2'b01;

end

DFS MODE :

begin

case(prev_data)

2'b00 : FCWOUT <= FCW;

2'b01 : FCWOUT <= FCW + {8'b0, freqoffset}>>8};

2'b10 : FCWOUT <= FCW + {8'b0, freqoffset}>>3};

2'b11 : FCWOUT <= FCW + {8'b0, freqoffset};



```

    endcase
        sinphaseoff <= 2'b00;
        cosphaseoff <= 2'b01;
end
`BPSKMODE :
begin
    if(prev_data[0] == 1'b0)
        begin
            sinphaseoff <= 2'b00;
            cosphaseoff <= 2'b01;
        end
    else
        begin
            sinphaseoff <= 2'b10;
            cosphaseoff <= 2'b11;
        end
    end
end
`QPSKMODE :
begin
    case(prev_data)
        2'b00 :
            begin
                sinphaseoff <= 2'b00;
                cosphaseoff <= 2'b00;
            end
        2'b01 :
            begin
                sinphaseoff <= 2'b10;
                cosphaseoff <= 2'b00;
            end
        2'b10 :
            begin
                sinphaseoff <= 2'b00;
                cosphaseoff <= 2'b10;
            end
        2'b11 :
            begin
                sinphaseoff <= 2'b10;
            end
    end
end

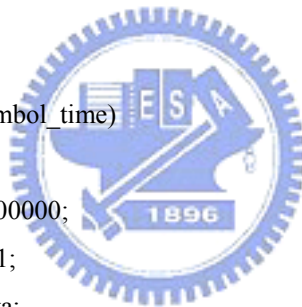
```



```

        cosphaseoff <= 2'b10;
    end
endcase
end
//default :
//begin
//end
endcase
init_load <= 1'b0;
end
else if(msb2_pulse_check)
begin
case (mode)
`BPSKMODE , `QPSKMODE :
begin
    if(prev_data[0] == 1'b0)
        if((~msbbit)&&(~msb2bit))
            begin
                if(count == prev_symbol_time)
                    begin
                        count <= 8'b00000000;
                        load_flag <= 1'b1;
                        prev_data <= data;
                        prev_symbol_time <= symboltime;
                    end
                else
                    begin
                        count <= count + 1;
                        load_flag <= 1'b0;
                    end
                end
            end
        else
            load_flag <= 1'b0;
        end
    else
        if(msbbit&&(~msb2bit))
            begin
                if(count == prev_symbol_time)
                    begin

```

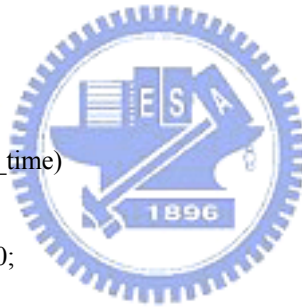


```

        count <= 8'b00000000;
        load_flag <= 1'b1;
        prev_data <= data;
    prev_symbol_time <= symboltime;
    end
    else
    begin
        count <= count + 1;
        load_flag <= 1'b0;
    end
end
else
    load_flag <= 1'b0;
end

default :
begin
    if((~msbbit)&&(~msb2bit))
    begin
        if(count == prev_symbol_time)
        begin
            count <= 8'b00000000;
            load_flag <= 1'b1;
            prev_data <= data;
        prev_symbol_time <= symboltime;
        end
        else
        begin
            count <= count + 1;
            load_flag <= 1'b0;
        end
    end
    else
        load_flag <= 1'b0;
    end
endcase
end
else

```



```

    init_load <= 1'b0;
end
assign delay_load = load_flag & ~load_pulse;
assign msb2_pulse_check = ~msb2bit & msb_pulse;
endmodule      // end modeset

```

(4). PhaseToAmp.v

```

/*****
// MODULE      :   PhaseToAmp.v                               *
// FILE NAME    :   PhaseToAmp.v                               *
// VERSION     :   1.0                                         *
// DATE        :   Sep 1 2003                                  *
// AUTHOR      :   Cheng Hen Shan                             *
// DESCRIPTION:   This module is for phase to amplitude       *
//               by approximation method using coarse rom and *
//               to compensate the approximation value         *
*****/
// DEFINES
`define ADDRESS_BITS      10 // Number of addition operations
`define COARSE_OUTPUT_BITS 6 // out bits for COARSE ROM
`define COARSE_ADDRESS_BITS 6 // address bits for COARSE ROM
`define FINE_OUTPUT_BITS  3 // out bits for FINE ROM
`define AMP_OUT_BITS      9 // Bit width of amplitude output
`define A_ADDR_BITS       2 // number of bits for A address
`define B_ADDR_BITS       4 // number of bits for B address
`define C_ADDR_BITS       4 // number of bits for C address
`define OUT_DIFF_BIT      `COARSE_OUTPUT_BITS-`FINE_OUTPUT_BITS
                          // Difference of bits for C address
`define COARSE_START_BIT  `ADDRESS_BITS-`A_ADDR_BITS-`B_ADDR_BITS
                          // Difference of bits for C address
`define FINE_START_BIT    `ADDRESS_BITS-`A_ADDR_BITS
// MODULE DEFINITION
module PhaseToAmp(Clock,phase,Amp_out);
input          Clock;
input  [ `ADDRESS_BITS-1:0] phase;
output  [ `AMP_OUT_BITS-1:0] Amp_out;

```

```

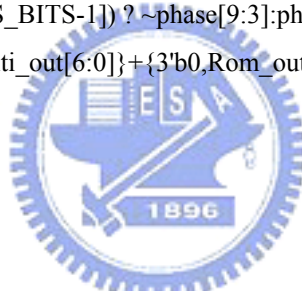
// SIGNAL DECLARATIONS
wire      [`COARSE_OUTPUT_BITS-1:0]      coarse_rom_out;
wire      [`FINE_OUTPUT_BITS-1:0]        fine_rom_out;
wire      [`AMP_OUT_BITS-1:0]            Amp_out;
wire      [`COARSE_OUTPUT_BITS-1:0]      Rom_out;
wire      [6:0]                           multi_out;

// Instantiate the adder
coarserom coarse_rom(
    .address(phase[`ADDRESS_BITS-1: `COARSE_START_BIT]),
    .q(coarse_rom_out)
);

finerom fine_rom(
    .address({phase[`ADDRESS_BITS-1: `FINE_START_BIT],phase[`C_ADDR_BITS-1:0]}),
    .q(fine_rom_out)
);

assign Rom_out = coarse_rom_out + {3'b0,fine_rom_out};
assign multi_out[6:0] = (phase[`ADDRESS_BITS-1]) ? ~phase[9:3]:phase[9:3];
assign Amp_out = phase[9:1]+ {2'b0,multi_out[6:0]}+{3'b0,Rom_out[5:0]};
endmodule // end PhaseToAmp

```



(5). Accumulator.v

```

/*****
// MODULE      :   Accumulato.v                               *
// FILE NAME    :   Accumulato.v                               *
// VERSION      :   1.0                                       *
// DATE         :   Sep 1 2003                                 *
// AUTHOR       :   Cheng Hen Shan                             *
// DESCRIPTION:   This module defines an accumulator with synchronous clk and reset inputs. *
//               When the adder is synchronously reset, the outputs go to zero and proceed add *
//               at each clk period                             *
*****/

// DEFINES
`define ACC_BITS      20      // number of bits for accumulator
module Accumulator (Clock, Reset, FCW, phaseload, phaseoffset, Acc_Out);
input                Clock, Reset;
input                [`ACC_BITS-1:0] FCW;
input                phaseload;

```

```

input      [1:0]                phaseoffset;
output     [`ACC_BITS-1:0]      Acc_Out;
reg        [`ACC_BITS-1:0]      Acc_Out;
reg        [`ACC_BITS-1:0]      Acc_In;
reg        init_load;

always @(phaseoffset)
begin
    case(phaseoffset)
        2'b00 : Acc_In <= `ACC_BITS'b0000_0000_0000_0000;
        2'b01 : Acc_In <= `ACC_BITS'b0100_0000_0000_0000;
        2'b10 : Acc_In <= `ACC_BITS'b1000_0000_0000_0000;
        2'b11 : Acc_In <= `ACC_BITS'b1100_0000_0000_0000;
    endcase
end

always @(posedge Clock)
begin
    if (Reset) // reset
    begin
        Acc_Out <= 0; // reset output to zero
        init_load <= 1'b1;
    end
    else if(phaseload || init_load)
    begin
        Acc_Out <= Acc_In;
        init_load <= 1'b0;
    end
    else // ADD input Data_In to output
        Acc_Out <= Acc_Out + FCW;
end
endmodule

```

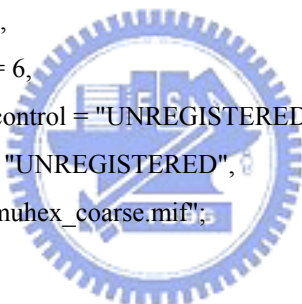


(6). coarserom.v

```

/*****
// MODULE      :   coarserom.v                               *
// FILE NAME   :   coarserom.v                               *
// VERSION    :   WM1.0                                       *
// DATE       :   Feb 1 2004                                   *
// AUTHOR     :   megafunction wizard: %LPM_ROM%             *
// DESCRIPTION:   megafunction generated by Quartet software for Rom
*****/

module coarserom (address, q);
input   [5:0]    address;
output  [5:0]    q;
wire    [5:0]    sub_wire0;
wire    [5:0]    q = sub_wire0[5:0];
lpm_rom  lpm_rom_component (.address (address), .q (sub_wire0));
defparam
    lpm_rom_component.lpm_width = 6,
    lpm_rom_component.lpm_widthad = 6,
    lpm_rom_component.lpm_address_control = "UNREGISTERED",
    lpm_rom_component.lpm_outdata = "UNREGISTERED",
    lpm_rom_component.lpm_file = "simuhex_coarse.mif";
endmodule
```



(7). finerom.v

```

/*****
// MODULE      :   finerom.v                                 *
// FILE NAME   :   finerom.v                                 *
// VERSION    :   WM1.0                                       *
// DATE       :   Feb 1 2004                                   *
// AUTHOR     :   megafunction wizard: %LPM_ROM%             *
// DESCRIPTION:   megafunction generated by Quartet software for Rom
*****/

module finerom (address, q);
input   [5:0]    address;
output  [2:0]    q;
wire    [2:0]    sub_wire0;
wire    [2:0]    q = sub_wire0[2:0];
endmodule
```

```
lpm_rom  lpm_rom_component (.address (address), .q (sub_wire0));
defparam
    lpm_rom_component.lpm_width = 3,
    lpm_rom_component.lpm_widthad = 6,
    lpm_rom_component.lpm_address_control = "UNREGISTERED",
    lpm_rom_component.lpm_outdata = "UNREGISTERED",
    lpm_rom_component.lpm_file = "simuhex_fine.mif";
endmodule
```



Autobiography

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