

```
1  --
  -----
2  --                               Modulador Digital
3  --
  -----
4  --  Título:                      Digital direct Synthetizer - DDS para
5  --  DAC
  -----
6  --  Autor:                       Jorge Tonfat
7  --
  -----
8  --  Descripción:
9  --
  -----
10 --  Señales de control:
11 --
  -----
12 --  Nombre:                      dds_dac
13 --
  -----
14 --  Fecha de creación:           01/11/2007
15 --  Última modificación:         01/11/2007
16 --
  -----
17
18
19 --
  -----
20 --  Declaración del paquete de componentes
21
22 library ieee;
23 use ieee.std_logic_1164.all;
24 use ieee.std_logic_arith.all;
25 use ieee.std_logic_unsigned.all;
26
27 entity DDS_DAC_8 is
28
29 generic (
30
31     ancho_palabra_in : natural := 16;
32     ancho_palabra_out : natural := 10;
33     bits_nousados : natural := 6
34
35 );
36 port (
37     clk:                in std_logic;
38     reset_n:            in std_logic;
39     delta_fase:         in std_logic_vector(ancho_palabra_in -1
downto 0);
```

```
40         salida:          buffer std_logic_vector(ancho_palabra_out
41         -1 downto 0);
42         LEDG :            out std_logic_vector(7 downto 0);
43         clk_dac, VGA_SYNC, VGA_BLANK :      out std_logic
44
45
46     );
47 end DDS_DAC_8;
48
49 architecture estructural of DDS_DAC_8 is
50
51     signal pre_rom_addr : std_logic_vector(ancho_palabra_in -
52     bits_nousados -1 downto 0);
53     signal acc_out : std_logic_vector(ancho_palabra_in -1 downto 0);
54     signal sel_inv_addr, sel_neg_rom : std_logic; -- se;ales para la
55     rom
56     signal new_rom, rom_addr : std_logic_vector(ancho_palabra_in -
57     bits_nousados -3 downto 0);
58     signal pre_salida, salida_reg : std_logic_vector(ancho_palabra_out
59     -1 downto 0);
60     signal clk_100: std_logic;
61
62
63     component VGA_PLL_150
64     PORT
65     (
66         areset      : IN STD_LOGIC := '0';
67         inclk0      : IN STD_LOGIC := '0';
68         c0          : OUT STD_LOGIC ;
69         c1          : OUT STD_LOGIC
70     );
71 end component;
72
73
74
75 begin
76
77     process(clk_100,reset_n)
78     begin
79         if reset_n ='0' then
80
81             acc_out<=(others=>'0');
82
83             elsif RISING_EDGE(clk_100) then
84
85                 acc_out <= delta_fase + acc_out;
86
87             end if;
88
89     end process;
90
91     pre_rom_addr <= acc_out(ancho_palabra_in -1 downto
92     ancho_palabra_in - bits_nousados - 4 ); -- addr antes de evaluar
```

```

93     sel_inv_addr <= pre_rom_addr(ancho_palabra_in - bits_nousados -2);
94     -- bit 2nd MSB que invierte addr.
95     sel_neg_rom <= pre_rom_addr(ancho_palabra_in - bits_nousados -1);
96     -- bit que invierte la salida de la rom
97     new_rom <= pre_rom_addr(ancho_palabra_in - bits_nousados -3 downto
98         0);
99
100
101     with sel_inv_addr select
102
103         rom_addr <= new_rom when '0',
104                     not(new_rom) when others;
105
106     with sel_neg_rom select
107
108         salida_reg <= (pre_salida + 512) when '0',
109                     (not(pre_salida) + '1' - 512 ) when others;
110
111
112
113     VGA_PLL_inst : VGA_PLL_150 PORT MAP (
114         areset    => not(reset_n),
115         inclk0    => clk,
116         c0        => clk_dac,
117         c1        => clk_100
118     );
119
120
121
122     VGA_SYNC <= '1';
123     VGA_BLANK <= '1';
124
125     LEDG <= salida(9 downto 2);
126
127
128     process (clk_100, reset_n)
129     begin
130         -- Reset whenever the reset signal goes low, regardless of
131         the clock
132         if (reset_n = '0') then
133             salida <= (others=>'0');
134         -- If not resetting, update the register output on the
135         clock's rising edge
136         elsif (rising_edge(clk_100)) then
137             salida <= salida_reg;
138         end if;
139     end process;
140
141
142     rom_block: process(clk_100) -- generado utilizando MATLAB
143         (rom_creation2.m)
144     begin
145         IF rising_edge (clk_100) THEN
146             case rom_addr is
```

```
146 when "00000000" => pre_salida <= "0000000000";
147 when "00000001" => pre_salida <= "0000000011";
148 when "00000010" => pre_salida <= "00000000110";
149 when "00000011" => pre_salida <= "00000001001";
150 when "00000100" => pre_salida <= "00000001100";
151 when "00000101" => pre_salida <= "00000001111";
152 when "00000110" => pre_salida <= "0000010010";
153 when "00000111" => pre_salida <= "0000010101";
154 when "00001000" => pre_salida <= "0000011001";
155 when "00001001" => pre_salida <= "0000011100";
156 when "00001010" => pre_salida <= "0000011111";
157 when "00001011" => pre_salida <= "0000100010";
158 when "00001100" => pre_salida <= "0000100101";
159 when "00001101" => pre_salida <= "0000101000";
160 when "00001110" => pre_salida <= "0000101011";
161 when "00001111" => pre_salida <= "0000101110";
162 when "00010000" => pre_salida <= "0000110010";
163 when "00010001" => pre_salida <= "0000110101";
164 when "00010010" => pre_salida <= "0000111000";
165 when "00010011" => pre_salida <= "0000111011";
166 when "00010100" => pre_salida <= "0000111110";
167 when "00010101" => pre_salida <= "0001000001";
168 when "00010110" => pre_salida <= "0001000100";
169 when "00010111" => pre_salida <= "0001000111";
170 when "00011000" => pre_salida <= "0001001010";
171 when "00011001" => pre_salida <= "0001001110";
172 when "00011010" => pre_salida <= "0001010001";
173 when "00011011" => pre_salida <= "0001010100";
174 when "00011100" => pre_salida <= "0001010111";
175 when "00011101" => pre_salida <= "0001011010";
176 when "00011110" => pre_salida <= "0001011101";
177 when "00011111" => pre_salida <= "0001100000";
178 when "00100000" => pre_salida <= "0001100011";
179 when "00100001" => pre_salida <= "0001100110";
180 when "00100010" => pre_salida <= "0001101001";
181 when "00100011" => pre_salida <= "0001101100";
182 when "00100100" => pre_salida <= "0001101111";
183 when "00100101" => pre_salida <= "0001110011";
184 when "00100110" => pre_salida <= "0001110110";
185 when "00100111" => pre_salida <= "0001111001";
186 when "00101000" => pre_salida <= "0001111100";
187 when "00101001" => pre_salida <= "0001111111";
188 when "00101010" => pre_salida <= "0010000010";
189 when "00101011" => pre_salida <= "0010000101";
190 when "00101100" => pre_salida <= "0010001000";
191 when "00101101" => pre_salida <= "0010001011";
192 when "00101110" => pre_salida <= "0010001110";
193 when "00101111" => pre_salida <= "0010010001";
194 when "00110000" => pre_salida <= "0010010100";
195 when "00110001" => pre_salida <= "0010010111";
196 when "00110010" => pre_salida <= "0010011010";
197 when "00110011" => pre_salida <= "0010011101";
198 when "00110100" => pre_salida <= "0010100000";
199 when "00110101" => pre_salida <= "0010100011";
200 when "00110110" => pre_salida <= "0010100110";
201 when "00110111" => pre_salida <= "0010101001";
202 when "00111000" => pre_salida <= "0010101100";
203 when "00111001" => pre_salida <= "0010101111";
204 when "00111010" => pre_salida <= "0010110010";
```

```
205 when "00111011" => pre_salida <= "0010110100";
206 when "00111100" => pre_salida <= "0010110111";
207 when "00111101" => pre_salida <= "0010111010";
208 when "00111110" => pre_salida <= "0010111101";
209 when "00111111" => pre_salida <= "0011000000";
210 when "01000000" => pre_salida <= "0011000011";
211 when "01000001" => pre_salida <= "0011000110";
212 when "01000010" => pre_salida <= "0011001001";
213 when "01000011" => pre_salida <= "0011001100";
214 when "01000100" => pre_salida <= "0011001111";
215 when "01000101" => pre_salida <= "0011010001";
216 when "01000110" => pre_salida <= "0011010100";
217 when "01000111" => pre_salida <= "0011010111";
218 when "01001000" => pre_salida <= "0011011010";
219 when "01001001" => pre_salida <= "0011011101";
220 when "01001010" => pre_salida <= "0011100000";
221 when "01001011" => pre_salida <= "0011100010";
222 when "01001100" => pre_salida <= "0011100101";
223 when "01001101" => pre_salida <= "0011101000";
224 when "01001110" => pre_salida <= "0011101011";
225 when "01001111" => pre_salida <= "0011101110";
226 when "01010000" => pre_salida <= "0011110000";
227 when "01010001" => pre_salida <= "0011110011";
228 when "01010010" => pre_salida <= "0011110110";
229 when "01010011" => pre_salida <= "0011111001";
230 when "01010100" => pre_salida <= "0011111011";
231 when "01010101" => pre_salida <= "0011111110";
232 when "01010110" => pre_salida <= "0100000001";
233 when "01010111" => pre_salida <= "0100000100";
234 when "01011000" => pre_salida <= "0100000110";
235 when "01011001" => pre_salida <= "0100001001";
236 when "01011010" => pre_salida <= "0100001100";
237 when "01011011" => pre_salida <= "0100001110";
238 when "01011100" => pre_salida <= "0100010001";
239 when "01011101" => pre_salida <= "0100010100";
240 when "01011110" => pre_salida <= "0100010110";
241 when "01011111" => pre_salida <= "0100011001";
242 when "01100000" => pre_salida <= "0100011011";
243 when "01100001" => pre_salida <= "0100011110";
244 when "01100010" => pre_salida <= "0100100001";
245 when "01100011" => pre_salida <= "0100100011";
246 when "01100100" => pre_salida <= "0100100110";
247 when "01100101" => pre_salida <= "0100101000";
248 when "01100110" => pre_salida <= "0100101011";
249 when "01100111" => pre_salida <= "0100101101";
250 when "01101000" => pre_salida <= "0100110000";
251 when "01101001" => pre_salida <= "0100110010";
252 when "01101010" => pre_salida <= "0100110101";
253 when "01101011" => pre_salida <= "0100110111";
254 when "01101100" => pre_salida <= "0100111010";
255 when "01101101" => pre_salida <= "0100111100";
256 when "01101110" => pre_salida <= "0100111111";
257 when "01101111" => pre_salida <= "0101000001";
258 when "01110000" => pre_salida <= "0101000100";
259 when "01110001" => pre_salida <= "0101000110";
260 when "01110010" => pre_salida <= "0101001000";
261 when "01110011" => pre_salida <= "0101001011";
262 when "01110100" => pre_salida <= "0101001101";
263 when "01110101" => pre_salida <= "0101010000";
```

```
264 when "01110110" => pre_salida <= "0101010010";
265 when "01110111" => pre_salida <= "0101010100";
266 when "01111000" => pre_salida <= "0101010111";
267 when "01111001" => pre_salida <= "0101011001";
268 when "01111010" => pre_salida <= "0101011011";
269 when "01111011" => pre_salida <= "0101011110";
270 when "01111100" => pre_salida <= "0101100000";
271 when "01111101" => pre_salida <= "0101100010";
272 when "01111110" => pre_salida <= "0101100100";
273 when "01111111" => pre_salida <= "0101100111";
274 when "10000000" => pre_salida <= "0101101001";
275 when "10000001" => pre_salida <= "0101101011";
276 when "10000010" => pre_salida <= "0101101101";
277 when "10000011" => pre_salida <= "0101101111";
278 when "10000100" => pre_salida <= "0101110010";
279 when "10000101" => pre_salida <= "0101110100";
280 when "10000110" => pre_salida <= "0101110110";
281 when "10000111" => pre_salida <= "0101111000";
282 when "10001000" => pre_salida <= "0101111010";
283 when "10001001" => pre_salida <= "0101111100";
284 when "10001010" => pre_salida <= "0101111110";
285 when "10001011" => pre_salida <= "0110000000";
286 when "10001100" => pre_salida <= "0110000010";
287 when "10001101" => pre_salida <= "0110000100";
288 when "10001110" => pre_salida <= "0110000111";
289 when "10001111" => pre_salida <= "0110001001";
290 when "10010000" => pre_salida <= "0110001011";
291 when "10010001" => pre_salida <= "0110001100";
292 when "10010010" => pre_salida <= "0110001110";
293 when "10010011" => pre_salida <= "0110010000";
294 when "10010100" => pre_salida <= "0110010010";
295 when "10010101" => pre_salida <= "0110010100";
296 when "10010110" => pre_salida <= "0110010110";
297 when "10010111" => pre_salida <= "0110011000";
298 when "10011000" => pre_salida <= "0110011010";
299 when "10011001" => pre_salida <= "0110011100";
300 when "10011010" => pre_salida <= "0110011110";
301 when "10011011" => pre_salida <= "0110011111";
302 when "10011100" => pre_salida <= "0110100001";
303 when "10011101" => pre_salida <= "0110100011";
304 when "10011110" => pre_salida <= "0110100101";
305 when "10011111" => pre_salida <= "0110100111";
306 when "10100000" => pre_salida <= "0110101000";
307 when "10100001" => pre_salida <= "0110101010";
308 when "10100010" => pre_salida <= "0110101100";
309 when "10100011" => pre_salida <= "0110101110";
310 when "10100100" => pre_salida <= "0110101111";
311 when "10100101" => pre_salida <= "0110110001";
312 when "10100110" => pre_salida <= "0110110011";
313 when "10100111" => pre_salida <= "0110110100";
314 when "10101000" => pre_salida <= "0110110110";
315 when "10101001" => pre_salida <= "0110110111";
316 when "10101010" => pre_salida <= "0110111001";
317 when "10101011" => pre_salida <= "0110111011";
318 when "10101100" => pre_salida <= "0110111100";
319 when "10101101" => pre_salida <= "0110111110";
320 when "10101110" => pre_salida <= "0110111111";
321 when "10101111" => pre_salida <= "0111000001";
322 when "10110000" => pre_salida <= "0111000010";
```

```
323 when "10110001" => pre_salida <= "0111000100";
324 when "10110010" => pre_salida <= "0111000101";
325 when "10110011" => pre_salida <= "0111000111";
326 when "10110100" => pre_salida <= "0111001000";
327 when "10110101" => pre_salida <= "0111001001";
328 when "10110110" => pre_salida <= "0111001011";
329 when "10110111" => pre_salida <= "0111001100";
330 when "10111000" => pre_salida <= "0111001101";
331 when "10111001" => pre_salida <= "0111001111";
332 when "10111010" => pre_salida <= "0111010000";
333 when "10111011" => pre_salida <= "0111010001";
334 when "10111100" => pre_salida <= "0111010011";
335 when "10111101" => pre_salida <= "0111010100";
336 when "10111110" => pre_salida <= "0111010101";
337 when "10111111" => pre_salida <= "0111010110";
338 when "11000000" => pre_salida <= "0111011000";
339 when "11000001" => pre_salida <= "0111011001";
340 when "11000010" => pre_salida <= "0111011010";
341 when "11000011" => pre_salida <= "0111011011";
342 when "11000100" => pre_salida <= "0111011100";
343 when "11000101" => pre_salida <= "0111011101";
344 when "11000110" => pre_salida <= "0111011110";
345 when "11000111" => pre_salida <= "0111100000";
346 when "11001000" => pre_salida <= "0111100001";
347 when "11001001" => pre_salida <= "0111100010";
348 when "11001010" => pre_salida <= "0111100011";
349 when "11001011" => pre_salida <= "0111100100";
350 when "11001100" => pre_salida <= "0111100101";
351 when "11001101" => pre_salida <= "0111100110";
352 when "11001110" => pre_salida <= "0111100111";
353 when "11001111" => pre_salida <= "0111101000";
354 when "11010000" => pre_salida <= "0111101000";
355 when "11010001" => pre_salida <= "0111101001";
356 when "11010010" => pre_salida <= "0111101010";
357 when "11010011" => pre_salida <= "0111101011";
358 when "11010100" => pre_salida <= "0111101100";
359 when "11010101" => pre_salida <= "0111101101";
360 when "11010110" => pre_salida <= "0111101110";
361 when "11010111" => pre_salida <= "0111101111";
362 when "11011000" => pre_salida <= "0111110000";
363 when "11011001" => pre_salida <= "0111110001";
364 when "11011010" => pre_salida <= "0111110010";
365 when "11011011" => pre_salida <= "0111110011";
366 when "11011100" => pre_salida <= "0111110010";
367 when "11011101" => pre_salida <= "0111110011";
368 when "11011110" => pre_salida <= "0111110011";
369 when "11011111" => pre_salida <= "0111110100";
370 when "11100000" => pre_salida <= "0111110101";
371 when "11100001" => pre_salida <= "0111110101";
372 when "11100010" => pre_salida <= "0111110110";
373 when "11100011" => pre_salida <= "0111110110";
374 when "11100100" => pre_salida <= "0111110111";
375 when "11100101" => pre_salida <= "0111111000";
376 when "11100110" => pre_salida <= "0111111000";
377 when "11100111" => pre_salida <= "0111111000";
378 when "11101000" => pre_salida <= "0111111001";
379 when "11101001" => pre_salida <= "0111111001";
380 when "11101010" => pre_salida <= "0111111010";
381 when "11101011" => pre_salida <= "0111111010";
```

```
382     when "11101100" => pre_salida <= "01111111011";
383     when "11101101" => pre_salida <= "01111111011";
384     when "11101110" => pre_salida <= "01111111011";
385     when "11101111" => pre_salida <= "01111111100";
386     when "11110000" => pre_salida <= "01111111100";
387     when "11110001" => pre_salida <= "01111111100";
388     when "11110010" => pre_salida <= "01111111101";
389     when "11110011" => pre_salida <= "01111111101";
390     when "11110100" => pre_salida <= "01111111101";
391     when "11110101" => pre_salida <= "01111111101";
392     when "11110110" => pre_salida <= "01111111110";
393     when "11110111" => pre_salida <= "01111111110";
394     when "11111000" => pre_salida <= "01111111110";
395     when "11111001" => pre_salida <= "01111111110";
396     when "11111010" => pre_salida <= "01111111110";
397     when "11111011" => pre_salida <= "01111111110";
398     when "11111100" => pre_salida <= "01111111110";
399     when "11111101" => pre_salida <= "01111111110";
400     when "11111110" => pre_salida <= "01111111110";
401     when others => pre_salida <= "01111111110";

402         end case;
403     end if;
404 end process rom_block;
405
406 end;
```