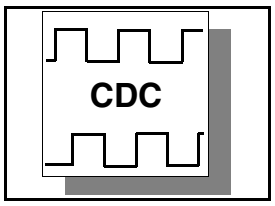
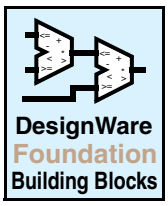


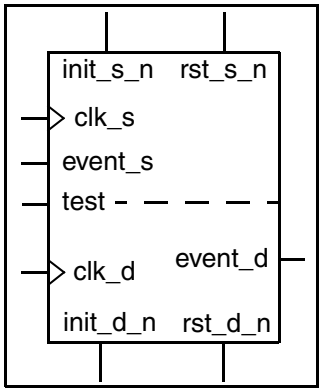


DW_pulse_sync

Dual Clock Pulse Synchronizer

Version, STAR and Download Information: IP Directory

Features and Benefits



- Fully tested cross clock domain
- Fully parameterized
- Able to use both positive and negative clock edge for sending clock domain
- Provides for both combinatorial and registered output, via parameter

Description

DW_pulse_sync provides a low-risk method for transmitting single clock cycle pulses between two different clock domains. This component uses clock-domain-crossing techniques to safely transfer pulses between logic operating on different clocks. The *pulse_mode* parameter determines the type of pulse that is transmitted; choices are toggle, rising edge, falling edge, or the default single source clock cycle pulse.

Simulation models are available in Verilog and VHDL. Synthesizable source is available in Verilog.

Table 1-1 Pin Description

Pin Name	Width	Direction	Function
clk_s	1	Input	Source clock
rst_s_n	1	Input	Asynchronous source reset
init_s_n	1	Input	Synchronous source reset
event_s	1	Input	Input pulse
clk_d	1	Input	Destination clock
rst_d_n	1	Input	Asynchronous destination reset
init_d_n	1	Input	Synchronous destination reset
event_d	1	Output	Output pulse
test	1	Input	Scan test mode select input

Table 1-2 Parameter Description

Parameter	Values	Description
reg_event	0 or 1 Default: 1	0: No register on output 1: Register `event_d` output
f_sync_type	0 to 4 Default: 2	0: Single clock design `clk_d` = `clk_s` 1: Neg-edge to pos-edge sync 2: Pos-edge to pos-edge sync 3: Three pos-edge flops in dest domain 4: Four pos-edge flops in dest domain
tst_mode	0 to 2 Default: 0	0: No test latch insertion 1: Hold latch using neg-edge flop 2: Hold latch using active low latch
verif_en	0 to 4 Default: 1	Verify enable control 0: No sampling errors inserted 1: Sampling errors are randomly inserted with 0 or up to 1 destination clock cycle delays 2: Sampling errors are randomly inserted with 0, 0.5, 1, or 1.5 destination clock cycle delays 3: Sampling errors are randomly inserted with 0, 1, 2, or 3 destination clock cycle delays 4: Sampling errors are randomly inserted with 0 or up to 0.5 destination clock cycle delays
pulse_mode	0 to 3 Default: 0	Selects the type of pulse presented to the input. 0: Single source domain clock cycle pulse transmitted to destination domain 1: Rising transition detect transmitted as single cycle pulse in the destination domain 2: Falling transition detect transmitted as single clock cycle pulse in the destination domain 3: Toggle of rising followed by falling separated by any number of clock cycles transmitted as a single-cycle pulse in the destination domain

Table 1-3 Synthesis Implementations

Implementation Name	Function	License Feature Required
rtl	Synthesis model	DesignWare

Table 1-4 Simulation Models

Model	Function
DW03.DW_PULSE_SYNC_SIM	Architectural name for VHDL simulation with missampling disabled.
DW03.DW_PULSE_SYNC_SIM_MS	Architectural name for VHDL simulation with missampling enabled. (See "Simulation Methodology" below for details.)

Table 1-4 Simulation Models (Continued)

Model	Function
dw/dw03/src/DW_pulse_sync_sim.vhd	VHDL simulation model source code (modeling RTL)
dw/sim_ver/DW_data_sync_1c.v	Verilog simulation model source code

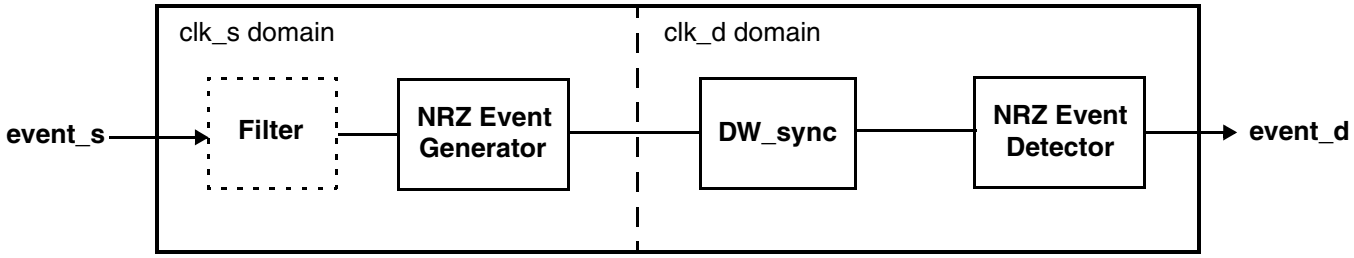
Simulation Methodology

The underlying pulse synchronization methodology implements a clock boundary missampling technique which allows for robust simulation of designs implementing this component. The Verilog model transparently uses missampling based on the parameters provided at compile/simulation time. The VHDL has a configuration which specifies the desired missampling model. For missampling to work with VHDL, the correct configuration must be selected at compile/run time.

Functional Description

The DW_pulse_sync synchronizer provides a method of passing event information from one clock domain to another. Using a Non-Return-to-Zero (NRZ) event generator (that is, a toggle register) triggered by the input, `event_s`, in the source clock domain, the destination domain synchronizes the NRZ event signal (using an instance of DW_sync) and then detects the NRZ event (that is, a toggle of the signal) and presents an active high output on `event_d` for once cycle of `clk_d` to signal the detected event.

Figure 1-1 DW_pulse_sync Dual-clock Pulse Synchronizer Block Diagram



The way in which the `event_s` input triggers events depends on the value of the parameter, *pulse_mode*.

Table 1-5 *pulse_mode* Parameter Trigger Method

pulse_mode	Trigger Method
0	Trigger an even for each clock cycle that `event_s` is high
1	Trigger an even for each clock cycle when `event_s` is high AND `event_s` was low for the previous clock (rising edge detect)
2	Trigger an even for each clock cycle when `event_s` is low AND `event_s` was high for the previous clock (falling edge detect)
3	Trigger an even for each clock cycle when `event_s` is different than it was for the previous clock (double edge detect)

Although there are no required clock frequency relationships between the source and destination clocks, the rate of events that the synchronizer can reliably pass is restricted by the frequency of the destination clock. The time between NRZ events between the domains must not approach one clock period of `clk_d` plus some adequate setup time of a synchronization register. To be safe, it's best to allow at least two periods of `clk_d` between any two consecutive events.

This module safely transmits a pulse between two clock domains, provided the frequency of the transmitted pulse train does not exceed 1/2 the frequency of the receiving clock domain. For pulses transmitted from a low-speed domain to a high-speed domain, the pulse is not lost despite the speed ratio. For pulses transmitted between asynchronous domains where the transmitting clock is faster, even if they are nearly the same frequency, the transmitting domain must not transmit a pulse more often than once every three cycles of the low-speed domain; that is, the pulse train frequency must be less than 1/2 of the low-speed clock domain frequency. For higher-speed transmitting domains, the maximum pulse frequency must be determined according to the frequency of the receiving domain.

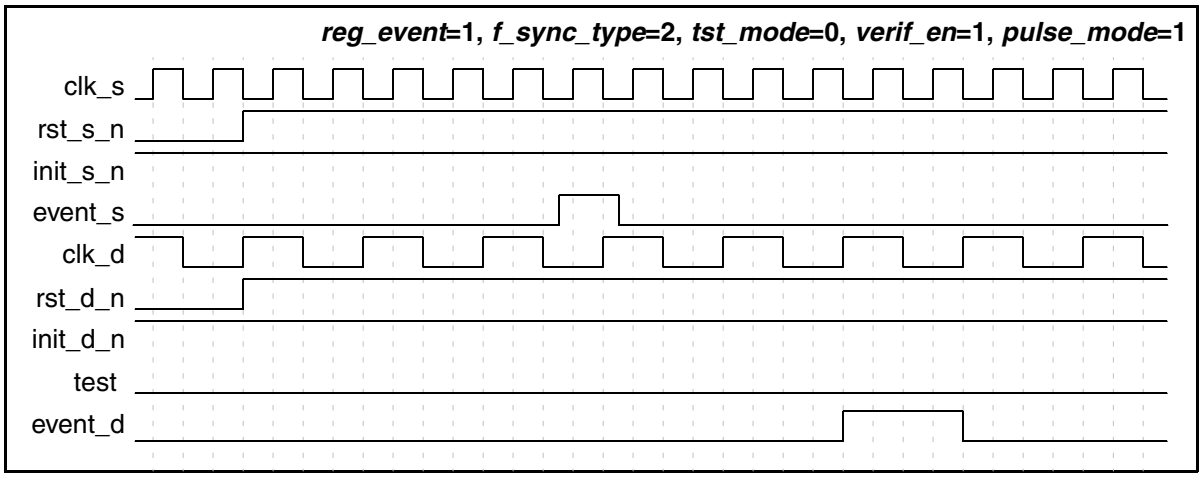
Because this block registers events across two time domains, if an odd number of events is passed to the source clock domain and then only the source domain reset is activated, the reset will cause an event in the receiving domain. The same is true if only the destination domain reset is applied.

To avoid unwanted events, both domains should be reset.

Timing Diagrams

Figure 1-2 depicts pulse train timing from source domain to destination domain.

Figure 1-2 Post Reset Timing Diagram



Related Topics

- Memory – Registers Overview
- DesignWare Building Block IP Documentation Overview

HDL Usage Through Component Instantiation - VHDL

```
library IEEE,DWARE,dw03;
use IEEE.std_logic_1164.all;
use DWARE.DW_Foundation_comp.all;

entity DW_pulse_sync_inst is
      generic (
        inst_reg_event : NATURAL := 1;
        inst_f_sync_type : NATURAL := 2;
        inst_tst_mode : NATURAL := 0;
        inst_verif_en : NATURAL := 1;
        inst_pulse_mode : NATURAL := 1
        );
      port (
        inst_clk_s : in std_logic;
        inst_rst_s_n : in std_logic;
        inst_init_s_n : in std_logic;
        inst_event_s : in std_logic;
        inst_clk_d : in std_logic;
        inst_rst_d_n : in std_logic;
        inst_init_d_n : in std_logic;
        inst_test : in std_logic;
        event_d_inst : out std_logic
        );
    end DW_pulse_sync_inst;


architecture inst of DW_pulse_sync_inst is

begin

    -- Instance of DW_pulse_sync
    U1 : DW_pulse_sync
    generic map ( reg_event => inst_reg_event,
                  f_sync_type => inst_f_sync_type,
                tst_mode => inst_tst_mode,
                verif_en => inst_verif_en,
                pulse_mode => inst_pulse_mode )
    port map ( clk_s => inst_clk_s,
               rst_s_n => inst_rst_s_n,
             init_s_n => inst_init_s_n,
             event_s => inst_event_s,
             clk_d => inst_clk_d,
             rst_d_n => inst_rst_d_n,
             init_d_n => inst_init_d_n,
             test => inst_test,
             event_d => event_d_inst );
```

```
end inst;
-- pragma translate_off
library DW03;
configuration DW_pulse_sync_inst_cfg_inst of DW_pulse_sync_inst is
  for inst
  end for; -- inst
end DW_pulse_sync_inst_cfg_inst;
-- pragma translate_on
```

HDL Usage Through Component Instantiation - Verilog

```
module DW_pulse_sync_inst( inst_clk_s, inst_rst_s_n, inst_init_s_n, inst_event_s,
inst_clk_d,
          inst_rst_d_n, inst_init_d_n, inst_test, event_d_inst );

parameter reg_event = 1;
parameter f_sync_type = 2;
parameter tst_mode = 0;
parameter verif_en = 1;
parameter pulse_mode = 1;


input inst_clk_s;
input inst_rst_s_n;
input inst_init_s_n;
input inst_event_s;
input inst_clk_d;
input inst_rst_d_n;
input inst_init_d_n;
input inst_test;
output event_d_inst;

    // Instance of DW_pulse_sync
    DW_pulse_sync #(reg_event, f_sync_type, tst_mode, verif_en, pulse_mode)
      U1 ( .clk_s(inst_clk_s), .rst_s_n(inst_rst_s_n), .init_s_n(inst_init_s_n),
.event_s(inst_event_s), .clk_d(inst_clk_d), .rst_d_n(inst_rst_d_n),
.init_d_n(inst_init_d_n), .test(inst_test), .event_d(event_d_inst) );

endmodule
```

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Synopsys, Inc.
690 E. Middlefield Road
Mountain View, CA 94043

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