

## Summary - AD9361 ADC

Name	ad9361_adc
Worker Type	Device
Version	v1.5
Release Date	4/2019
Component Library	ocpi.assets.devices
Workers	ad9361_adc.hdl
Tested Platforms	<ul style="list-style-type: none"> <li>• Agilent Zedboard/Analog Devices FMCOMMS2 (Vivado only)</li> <li>• Agilent Zedboard/Analog Devices FMCOMMS3 (Vivado only)</li> <li>• x86/Xilinx ML605/Analog Devices FMCOMMS2</li> <li>• x86/Xilinx ML605/Analog Devices FMCOMMS3</li> <li>• Ettus E310 (Vivado only, application for testing exists in e310 project)</li> </ul>

## Functionality

The AD9361 ADC device worker outputs a single RX channel's data from the AD9361 IC[1] via an iqstream output port. Up to two instances of this worker can be used to provide each AD9361 RX channel data stream in an independent, non-phase-coherent fashion.

## Worker Implementation Details

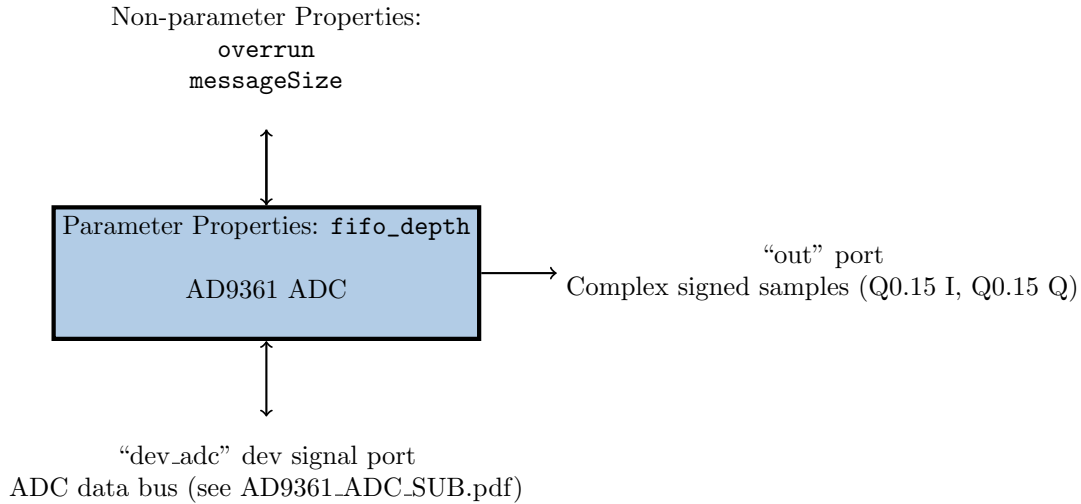
### ad9361\_adc.hdl

The ad9361\_adc.sub.hdl subdevice worker supports the ad9361\_adc.hdl device worker. The ad9361\_adc.sub.hdl subdevice sends a data bus containing 24-bit parallel I/Q data in the AD9361's DATA\_CLK\_P pin clock domain via the dev\_adc dev signal port. Either of data streams from the two AD9361 RX channels may be sent to an instance of ad9361\_adc.hdl. Which RX channel data stream is sent is determined within the ad9361\_adc.sub.hdl subdevice worker. The Q0.15 I/Q values on the ad9361\_adc.hdl output port are sign extended from the AD9361's 12-bit I/Q ADC bus. For more information see [3].

The ad9361\_adc.hdl worker passes data from the dev\_adc dev signal bus through an asynchronous First-In-First-Out (FIFO) buffer to achieve clock domain crossing. The FIFO's output side is in the HDL container's control clock domain. Note that the HDL container's control clock rate is platform-specific. The FIFO's depth in number of samples is determined at build-time by the fifo\_depth parameter property. An overrun property indicates when samples have been dropped due to the FIFO being full, which is possible when backpressure overcomes the ADC sample rate for long enough to fill up the FIFO. The output data port generates messages whose length in bytes is determined at runtime by the messageSize property.

## Block Diagrams

### Top level



## Source Dependencies

### ad9361\_adc.hdl

- assets/hdl/devices/ad9361\_adc.hdl/ad9361\_adc.vhd
- core/hdl/primitives/util/adc\_fifo.vhd
- core/hdl/primitives/util/sync\_status.vhd
- core/hdl/primitives/util/util\_pkg.vhd
- core/hdl/primitives/bsv/imports/SyncFIFO.v
- core/hdl/primitives/bsv/imports/SyncResetA.v
- core/hdl/primitives/bsv/imports/SyncHandshake.v
- core/hdl/primitives/bsv/bsv\_pkg.vhd

## Component Spec Properties

Name	Type	SequenceLength	ArrayDimensions	Accessibility	Valid Range	Default	Usage
messageSize	Long	-	-	Initial, Readable	Standard	-	Number of bytes in output message
overrun	Bool	-	-	Writable, Volatile	Standard	-	Flag set when ADC tries to load a sample and the ADC FIFO is full. Once high, this flag is not cleared (i.e. set low) until the property is written to again (the flag clears regardless of write value, i.e. writing true or false both result in a value of false, also note that a property write happens on reset).

## Worker Properties

### ad9361\_adc.hdl

Scope	Name	Type	SequenceLength	ArrayDimensions	Accessibility	Valid Range	Default	Usage
SpecProperty	messageSize	Long	-	-	Initial,Readable	Standard	8192	Number of bytes in output message
SpecProperty	overrun	Bool	-	-	Writable,Volatile	Standard	0	Flag set when ADC tries to load a sample and the ADC FIFO is full. Once high, this flag is not cleared (i.e. set low) until the property is written to again (the flag clears regardless of write value, i.e. writing true or false both result in a value of false, also note that a property write happens on reset).
Property	fifo_depth	ULong	-	-	Parameter	Standard	0	Depth in number of samples of the ADC-to-control clock domain crossing FIFO.

## Component Ports

Name	Producer	Protocol	Optional	Advanced	Usage
out	true	iqstream_protocol	true	-	Complex signed samples (Q0.15 I, Q0.15 Q).

# Worker Interfaces

## ad9361\_adc.hdl

Type	Name	DataWidth	Advanced	Usage
StreamInterface	out	32	-	Complex signed samples (Q0.15 I, Q0.15 Q). This port generates data and obeys backpressure. Because both backpressure from the out port and forward pressure from the dev_adc data bus exists, it is possible for samples to be dropped in the clock domain-crossing FIFO, i.e. seen on the dev_adc data bus but never make it to the output port. This event is monitored via the overrun property.

Type	Name	Count	Optional	Master	Signal	Direction	Width	Description
DevSignal	dev_adc	1	False	True	present	Output	1	Value is 1 if a worker is connected to this devsignal port.
					adc_data_I	Input	12	Signed Q0.11 I value of ADC sample corresponding to RX channel 1.
					adc_data_Q	Input	12	Signed Q0.11 Q value of ADC sample corresponding to RX channel 1.
					adc_clk	Input	1	Clock for adc_data_I, adc_data_Q, and adc_give.
					adc_give	Input	1	Indicates that the adc_data_I and adc_data_Q are valid and should be latched on the next rising edge of adc_clk.

## Control Timing and Signals

The `ad9361_adc.hdl` device worker contains two clock domains: the clock from the Control Plane, and the `adc_clk` clock from the dev signal.

The latency from the dev signal data bus to the output port is non-deterministic due to data flowing through an asynchronous FIFO with each side in a different clock domain. This non-determinism exists even in the absence of backpressure. In the presence of backpressure, the latency increases in an amount directly proportional to the degree to which the FIFO is full.

## Worker Configuration Parameters

### `ad9361_adc.hdl`

Table 1: Table of Worker Configurations for worker: `ad9361_adc`

Configuration	<code>ocpi_debug</code>	<code>ocpi_endian</code>	<code>fifo_depth</code>
0	false	little	64

## Performance and Resource Utilization

### `ad9361_adc.hdl`

The FPGA resource utilization and Fmax are included for this worker. Fmax refers to the maximum allowable clock rate for any registered signal paths within a given clock domain for an FPGA design. Fmax in the table below is specific only to this worker and represents the maximum possible Fmax for any OpenCPI bitstream built with this worker included. Note that the Fmax value for a given clock domain for the final bitstream is often worse than the Fmax specific to this worker, even if this worker is the only one included in the bitstream. Note also that the `DATA_CLK_P` devsignal's rate will only ever go as high as 245.76 MHz<sup>[2]</sup>.

Table 2: Resource Utilization Table for worker: `ad9361_adc`

Configuration	OCPI Target	Tool	Version	Device	Registers (Typ)	LUTs (Typ)	Fmax (MHz) (Typ)		Memory/Special Functions
							control plane clock	dev_adc.adc_clk clock	
0	<code>zynq</code>	Vivado	2017.1	<code>xc7z020clg484-1</code>	188	133	202 <sup>1</sup>	339 <sup>1</sup>	RAMB18: 1
0	<code>stratix4</code>	Quartus	17.1.0	<code>EP4SGX230KF40C2</code>	187	185	N/A	N/A	N/A
0	<code>virtex6</code>	ISE	14.7	<code>6vlx240tff1156-1</code>	208	258	335.373	369	RAM64M: 8

<sup>1</sup>These measurements were the result of a Vivado timing analysis which was different from the Vivado analysis performed by default for OpenCPI worker builds. For more info see Appendix 2

## Test and Verification

No unit test for this component exists. However, a hardware-in-the-loop application (which is NOT a unit test) exists for testing purposes (see `assets/applications/ad9361_adc_test`).

## References

- [1] AD9361 Datasheet and Product Info  
<https://www.analog.com/en/products/ad9361.html>
- [2] AD9361 Reference Manual UG-570  
`AD9361_Reference_Manual_UG-570.pdf`
- [3] AD361 ADC Sub Component Data Sheet  
[http://opencpi.github.io/releases/1.5.0/assets/AD9361\\_ADC\\_Sub.pdf](http://opencpi.github.io/releases/1.5.0/assets/AD9361_ADC_Sub.pdf)

# 1 Appendix 1 - AD9361 ADC Data Fidelity / Delay Setting Verification

## 1.1 FCOMMS3 on ML605 FMC-LPC slot

A custom script was run to report bit error rate vs. on-AD9361 RX data-clock delay settings. The following confirms both the ability of the ML605/FMCOMMS3 to have 100% data fidelity up to the maximum data rate and the experimental range of valid delay settings. Each entry in the table below represents bit error rate in percent.

```

FIR enabled      : 0
Data port config : 1R1T
sample rate      : 2.083334e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
  0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  11.1165 32.5526 38.0768 38.888 38.739 38.7141 38.7461 38.9165 error 38.7726 38.6963 38.887 38.8316 38.8514 38.8423 38.8295
1  0.175476
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15 0
FIR enabled      : 0
Data port config : 1R1T
sample rate      : 25e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
  0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  10.0082 32.0424 37.6495 38.6719 38.5193 38.267 38.6541 39.18 38.913 39.1368 38.7884 37.9674 37.9908 38.7934 38.827 37.885
1  0.0223796
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15 0
FIR enabled      : 0
Data port config : 1R1T
sample rate      : 40e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
  0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  10.0683 32.1218 37.4532 39.2014 39.1764 38.8275 37.9369 38.6688 38.5096 38.9964 38.5442 37.9761 38.4176 37.973 37.9934 38.9781
1  0.00101725
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15 0
FIR enabled      : 0
Data port config : 1R1T
sample rate      : 61.44e6 sps
rx_data_clock_delay  rx_data_delay->
|

```

```
v
 0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  8.7087 31.222 36.0377 39.0559 38.7578 38.8687 38.5117 39.0518 38.8646 38.6719 38.3362 39.0422 38.4893 37.7355 39.0508 39.0106
1  0.161743
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15 0
FIR enabled      : 0
Data port config : 2R2T
sample rate      : 2.083334e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
 0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  error 31.9356 error 38.8067 38.7568 error error 38.6948 38.6612 38.8941 38.6012 38.7405 38.7589 38.9399 38.7741 38.8087
1  0
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15  error
FIR enabled      : 0
Data port config : 2R2T
sample rate      : 25e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
 0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  10.2153 31.5826 37.1175 38.8011 38.7777 38.7955 38.9638 39.1596 38.6841 39.1734 38.7619 38.6576 38.6983 38.9506 38.5905 38.9964
1  0
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 0
13 0
14 0
15 0
FIR enabled      : 0
Data port config : 2R2T
sample rate      : 40e6 sps
rx_data_clock_delay  rx_data_delay->
|
v
 0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0  19.9519 34.5505 38.4109 38.6759 38.8428 39.123 39.1123 38.7451 38.8947 37.7131 38.6642 38.6897 38.415 36.411 26.7649 11.1231
1  3.42967
2  0
3  0
4  0
5  0
6  0
7  0
8  0
9  0
10 0
11 0
12 3.35541
13 15.3783
```



```
14 34.4991
15 37.8092
FIR enabled : 0
Data port config : 2R2T
sample rate : 61.44e6 sps
rx_data_clock_delay rx_data_delay->
|
v
0 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 9.56268 30.2144 37.0743 39.0889 38.6958 38.6719 39.1861 38.9008 37.7182 34.2031 20.5037 5.95449 0 0 0 0
1 0.54067
2 0
3 0
4 0
5 0
6 0.18158
7 7.34151
8 23.8927
9 36.7589
10 38.9262
11 39.0381
12 38.886
13 38.8255
14 39.1647
15 38.3784
```

## 2 Appendix 2 - Vivado Timing Analysis

The Vivado timing report that OpenCPI runs for device workers may erroneously report a max delay for a clocking path which should have been ignored. Custom Vivado tcl commands had to be run for this device worker to extract pertinent information from Vivado timing analysis. After building the worker, the following commands were run from the assets project directory (after the Vivado settings64.sh was sourced):

```
cd hdl/devices/
vivado -mode tcl
```

Then the following commands were run inside the Vivado tcl terminal:

```
open_project ad9361_adc.hdl/target-zynq/ad9361_adc_rv.xpr
synth_design -part xc7z020clg484-1 -top ad9361_adc_rv -mode out_of_context
create_clock -name clk1 -period 0.001 [get_nets {ctl_in[Clk]}]
create_clock -name clk2 -period 0.001 [get_nets {dev_adc_in[adc_clk]}]
set_clock_groups -asynchronous -group [get_clocks clk1] -group [get_clocks clk2]
report_timing -delay_type min_max -sort_by slack -input_pins -group clk1
report_timing -delay_type min_max -sort_by slack -input_pins -group clk2
```

The following is the output of the timing reports. The Fmax for the control plane clock for this worker is computed as the maximum magnitude slack with a control plane clock of 1 ps plus 2 times the assumed 1 ps control plane clock period ( $4.933 \text{ ns} + 0.002 \text{ ns} = 4.935 \text{ ns}$ ,  $1/4.935 \text{ ns} = 202.63 \text{ MHz}$ ). The Fmax for the adc\_clk clock from the devsignal is computed as the maximum magnitude slack with adc\_clk of 1 ps plus 2 times the assumed 1 ps adc\_clk period ( $2.947 \text{ ns} + 0.002 \text{ ns} = 2.949 \text{ ns}$ ,  $1/2.949 \text{ ns} = 339.10 \text{ MHz}$ ).

```
Vivado% report_timing -delay_type min_max -sort_by slack -input_pins -group clk1
```

### Timing Report

```
Slack (VIOLATED) :    -4.933ns (required time - arrival time)
Source:             wci/messageSize_property/value_reg[7]/C
                   (rising edge-triggered cell FDRE clocked by clk1 {rise@0.000ns fall@0.001ns period=0.001ns})
Destination:       worker/fifo/samplesInMessage_r_reg[0]/S
                   (rising edge-triggered cell FDSE clocked by clk1 {rise@0.000ns fall@0.001ns period=0.001ns})
Path Group:        clk1
Path Type:         Setup (Max at Slow Process Corner)
Requirement:       0.002ns (clk1 rise@0.002ns - clk1 rise@0.000ns)
Data Path Delay:   4.327ns (logic 2.025ns (46.799%) route 2.302ns (53.201%))
Logic Levels:     5 (CARRY4=3 LUT5=1 LUT6=1)
Clock Path Skew:  -0.049ns (DCD - SCD + CPR)
Destination Clock Delay (DCD): 0.924ns = ( 0.926 - 0.002 )
Source Clock Delay (SCD): 0.973ns
Clock Pessimism Removal (CPR): 0.000ns
Clock Uncertainty: 0.035ns ((TSJ^2 + TIJ^2)^1/2 + DJ) / 2 + PE
Total System Jitter (TSJ): 0.071ns
Total Input Jitter (TIJ): 0.000ns
Discrete Jitter (DJ): 0.000ns
Phase Error (PE): 0.000ns
```

Location	Delay type	Incr(ns)	Path(ns)	Netlist Resource(s)
	(clock clk1 rise edge)	0.000	0.000	r
		0.000	0.000	r ctl_in[Clk] (IN)
net (fo=155, unset)		0.973	0.973	wci/messageSize_property/ctl_in[Clk]
FDRE				r wci/messageSize_property/value_reg[7]/C

FDRE (Prop_fdre_C_Q)	0.518	1.491	r	wci/messageSize_property/value_reg[7]/Q
net (fo=2, unplaced)	0.976	2.467		wci/messageSize_property/Q[6]
			r	wci/messageSize_property/b_carry_i_3/I0
LUT6 (Prop_lut6_I0_D)	0.295	2.762	r	wci/messageSize_property/b_carry_i_3/0
net (fo=1, unplaced)	0.000	2.762		worker/fifo/S[1]
			r	worker/fifo/b_carry/S[1]
CARRY4 (Prop_carry4_S[1]_CO[3])				
	0.533	3.295	r	worker/fifo/b_carry/CO[3]
net (fo=1, unplaced)	0.009	3.304		worker/fifo/b_carry_n_0
			r	worker/fifo/b_carry__0/CI
CARRY4 (Prop_carry4_CI_CO[3])				
	0.117	3.421	r	worker/fifo/b_carry__0/CO[3]
net (fo=1, unplaced)	0.000	3.421		worker/fifo/b_carry__0_n_0
			r	worker/fifo/b_carry__1/CI
CARRY4 (Prop_carry4_CI_CO[2])				
	0.252	3.673	r	worker/fifo/b_carry__1/CO[2]
net (fo=3, unplaced)	0.470	4.143		wci/wci_decode/CO[0]
			r	wci/wci_decode/samplesInMessage_r[0]_i_1/I3
LUT5 (Prop_lut5_I3_D)	0.310	4.453	r	wci/wci_decode/samplesInMessage_r[0]_i_1/0
net (fo=32, unplaced)	0.847	5.300		worker/fifo/or
FDSE			r	worker/fifo/samplesInMessage_r_reg[0]/S
-----				
(clock clk1 rise edge)	0.002	0.002	r	
	0.000	0.002	r	ctl_in[Clk] (IN)
net (fo=155, unset)	0.924	0.926		worker/fifo/ctl_in[Clk]
FDSE			r	worker/fifo/samplesInMessage_r_reg[0]/C
clock pessimism	0.000	0.926		
clock uncertainty	-0.035	0.891		
FDSE (Setup_fdse_C_S)	-0.524	0.367		worker/fifo/samplesInMessage_r_reg[0]
-----				
required time		0.367		
arrival time		-5.300		
-----				
slack		-4.933		
Vivado% report_timing -delay_type min_max -sort_by slack -input_pins -group clk2				
Timing Report				
Slack (VIOLATED) :	-2.947ns (required time - arrival time)			
Source:	worker/fifo/fifo/sGenqPtr_reg[1]/C			
	(rising edge-triggered cell FDCE clocked by clk2 {rise@0.000ns fall@0.001ns period=0.001ns})			
Destination:	worker/fifo/fifo/sNotFullReg_reg/D			
	(rising edge-triggered cell FDCE clocked by clk2 {rise@0.000ns fall@0.001ns period=0.001ns})			
Path Group:	clk2			
Path Type:	Setup (Max at Slow Process Corner)			
Requirement:	0.002ns (clk2 rise@0.002ns - clk2 rise@0.000ns)			
Data Path Delay:	2.942ns (logic 1.061ns (36.064%) route 1.881ns (63.936%))			
Logic Levels:	3 (LUT4=1 LUT6=2)			
Clock Path Skew:	-0.049ns (DCD - SCD + CPR)			
	Destination Clock Delay (DCD): 0.924ns = ( 0.926 - 0.002 )			
	Source Clock Delay (SCD): 0.973ns			
	Clock Pessimism Removal (CPR): 0.000ns			
Clock Uncertainty:	0.035ns ((TSJ^2 + TIJ^2)^1/2 + DJ) / 2 + PE			
	Total System Jitter (TSJ): 0.071ns			
	Total Input Jitter (TIJ): 0.000ns			

```

Discrete Jitter      (DJ):  0.000ns
Phase Error          (PE):  0.000ns
    
```

Location	Delay type	Incr(ns)	Path(ns)	Netlist Resource(s)
	(clock clk2 rise edge)	0.000	0.000	r
		0.000	0.000	r dev_adc_in[adc_clk] (IN)
	net (fo=33, unset)	0.973	0.973	worker/fifo/fifo/dev_adc_in[adc_clk]
	FDCE			r worker/fifo/fifo/sGenqPtr_reg[1]/C
	FDCE (Prop_fdce_C_Q)	0.518	1.491	r worker/fifo/fifo/sGenqPtr_reg[1]/Q
	net (fo=3, unplaced)	0.983	2.474	worker/fifo/fifo/p_0_in[0]
				r worker/fifo/fifo/sNotFullReg_i_6/I0
	LUT6 (Prop_lut6_I0_D)	0.295	2.769	r worker/fifo/fifo/sNotFullReg_i_6/0
	net (fo=1, unplaced)	0.449	3.218	worker/fifo/fifo/sNotFullReg_i_6_n_0
				r worker/fifo/fifo/sNotFullReg_i_4/I3
	LUT4 (Prop_lut4_I3_D)	0.124	3.342	r worker/fifo/fifo/sNotFullReg_i_4/0
	net (fo=1, unplaced)	0.449	3.791	worker/fifo/fifo/sNextNotFull__12
				r worker/fifo/fifo/sNotFullReg_i_1/I5
	LUT6 (Prop_lut6_I5_D)	0.124	3.915	r worker/fifo/fifo/sNotFullReg_i_1/0
	net (fo=1, unplaced)	0.000	3.915	worker/fifo/fifo/sNotFullReg_i_1_n_0
	FDCE			r worker/fifo/fifo/sNotFullReg_reg/D
	(clock clk2 rise edge)	0.002	0.002	r
		0.000	0.002	r dev_adc_in[adc_clk] (IN)
	net (fo=33, unset)	0.924	0.926	worker/fifo/fifo/dev_adc_in[adc_clk]
	FDCE			r worker/fifo/fifo/sNotFullReg_reg/C
	clock pessimism	0.000	0.926	
	clock uncertainty	-0.035	0.891	
	FDCE (Setup_fdce_C_D)	0.077	0.968	worker/fifo/fifo/sNotFullReg_reg
	required time		0.968	
	arrival time		-3.915	
	slack		-2.947	

These calculations can be verified by replacing the `create_clock` lines above with the following values and rerunning the `report_timing` commands and observing a value of 0.000 ns for the slacks:

```

create_clock -name clk1 -period 4.935 [get_nets {ct1_in[Clk]}]
create_clock -name clk2 -period 2.949 [get_nets {dev_adc_in[adc_clk]}]
report_timing -delay_type min_max -sort_by slack -input_pins -group clk1
report_timing -delay_type min_max -sort_by slack -input_pins -group clk2
    
```

```

Vivado% report_timing -delay_type min_max -sort_by slack -input_pins -group clk1

Timing Report

Slack (MET) :          0.000ns (required time - arrival time)
Source:          wci/messageSize_property/value_reg[7]/C
                 (rising edge-triggered cell FDRE clocked by clk1 {rise@0.000ns fall@2.467ns period=4.935ns})
Destination:     worker/fifo/samplesInMessage_r_reg[0]/S
                 (rising edge-triggered cell FDSE clocked by clk1 {rise@0.000ns fall@2.467ns period=4.935ns})
Path Group:      clk1
Path Type:       Setup (Max at Slow Process Corner)
    
```

```

Requirement:      4.935ns (clk1 rise@4.935ns - clk1 rise@0.000ns)
Data Path Delay:  4.327ns (logic 2.025ns (46.799%) route 2.302ns (53.201%))
Logic Levels:    5 (CARRY4=3 LUT5=1 LUT6=1)
Clock Path Skew: -0.049ns (DCD - SCD + CPR)
  Destination Clock Delay (DCD): 0.924ns = ( 5.859 - 4.935 )
  Source Clock Delay (SCD): 0.973ns
  Clock Pessimism Removal (CPR): 0.000ns
Clock Uncertainty: 0.035ns ((TSJ^2 + TIJ^2)^1/2 + DJ) / 2 + PE
  Total System Jitter (TSJ): 0.071ns
  Total Input Jitter (TIJ): 0.000ns
  Discrete Jitter (DJ): 0.000ns
  Phase Error (PE): 0.000ns
    
```

Location	Delay type	Incr(ns)	Path(ns)	Netlist Resource(s)
	(clock clk1 rise edge)	0.000	0.000	r
		0.000	0.000	r ctl_in[Clk] (IN)
	net (fo=155, unset)	0.973	0.973	wci/messageSize_property/ctl_in[Clk]
	FDRE			r wci/messageSize_property/value_reg[7]/C
	FDRE (Prop_fdre_C_Q)	0.518	1.491	r wci/messageSize_property/value_reg[7]/Q
	net (fo=2, unplaced)	0.976	2.467	wci/messageSize_property/Q[6]
				r wci/messageSize_property/b_carry_i_3/I0
	LUT6 (Prop_lut6_IO_0)	0.295	2.762	r wci/messageSize_property/b_carry_i_3/0
	net (fo=1, unplaced)	0.000	2.762	worker/fifo/S[1]
				r worker/fifo/b_carry/S[1]
	CARRY4 (Prop_carry4_S[1]_CO[3])	0.533	3.295	r worker/fifo/b_carry/CO[3]
	net (fo=1, unplaced)	0.009	3.304	worker/fifo/b_carry_n_0
				r worker/fifo/b_carry__0/CI
	CARRY4 (Prop_carry4_CI_CO[3])	0.117	3.421	r worker/fifo/b_carry__0/CO[3]
	net (fo=1, unplaced)	0.000	3.421	worker/fifo/b_carry__0_n_0
				r worker/fifo/b_carry__1/CI
	CARRY4 (Prop_carry4_CI_CO[2])	0.252	3.673	r worker/fifo/b_carry__1/CO[2]
	net (fo=3, unplaced)	0.470	4.143	wci/wci_decode/CO[0]
				r wci/wci_decode/samplesInMessage_r[0]_i_1/I3
	LUT5 (Prop_lut5_I3_0)	0.310	4.453	r wci/wci_decode/samplesInMessage_r[0]_i_1/0
	net (fo=32, unplaced)	0.847	5.300	worker/fifo/or
	FDSE			r worker/fifo/samplesInMessage_r_reg[0]/S
	(clock clk1 rise edge)	4.935	4.935	r
		0.000	4.935	r ctl_in[Clk] (IN)
	net (fo=155, unset)	0.924	5.859	worker/fifo/ctl_in[Clk]
	FDSE			r worker/fifo/samplesInMessage_r_reg[0]/C
	clock pessimism	0.000	5.859	
	clock uncertainty	-0.035	5.824	
	FDSE (Setup_fdse_C_S)	-0.524	5.300	worker/fifo/samplesInMessage_r_reg[0]
	required time		5.300	
	arrival time		-5.300	
	slack		0.000	

Vivado% report\_timing -delay\_type min\_max -sort\_by slack -input\_pins -group clk2

Timing Report

Slack (MET) : 0.000ns (required time - arrival time)  
 Source: worker/fifo/fifo/sGenPtr\_reg[1]/C  
 (rising edge-triggered cell FDCE clocked by clk2 {rise@0.000ns fall@1.474ns period=2.949ns})  
 Destination: worker/fifo/fifo/sNotFullReg\_reg/D  
 (rising edge-triggered cell FDCE clocked by clk2 {rise@0.000ns fall@1.474ns period=2.949ns})  
 Path Group: clk2  
 Path Type: Setup (Max at Slow Process Corner)  
 Requirement: 2.949ns (clk2 rise@2.949ns - clk2 rise@0.000ns)  
 Data Path Delay: 2.942ns (logic 1.061ns (36.064%) route 1.881ns (63.936%))  
 Logic Levels: 3 (LUT4=1 LUT6=2)  
 Clock Path Skew: -0.049ns (DCD - SCD + CPR)  
 Destination Clock Delay (DCD): 0.924ns = ( 3.873 - 2.949 )  
 Source Clock Delay (SCD): 0.973ns  
 Clock Pessimism Removal (CPR): 0.000ns  
 Clock Uncertainty: 0.035ns ((TSJ<sup>2</sup> + TIJ<sup>2</sup>)<sup>1/2</sup> + DJ) / 2 + PE  
 Total System Jitter (TSJ): 0.071ns  
 Total Input Jitter (TIJ): 0.000ns  
 Discrete Jitter (DJ): 0.000ns  
 Phase Error (PE): 0.000ns

Location	Delay type	Incr(ns)	Path(ns)	Netlist Resource(s)
	(clock clk2 rise edge)	0.000	0.000	r
		0.000	0.000	r dev_adc_in[adc_clk] (IN)
net (fo=33, unset)		0.973	0.973	worker/fifo/fifo/dev_adc_in[adc_clk]
FDCE				r worker/fifo/fifo/sGenPtr_reg[1]/C
FDCE (Prop_fdce_C_Q)		0.518	1.491	r worker/fifo/fifo/sGenPtr_reg[1]/Q
net (fo=3, unplaced)		0.983	2.474	worker/fifo/fifo/p_0_in[0]
				r worker/fifo/fifo/sNotFullReg_i_6/I0
LUT6 (Prop_lut6_I0_D)		0.295	2.769	r worker/fifo/fifo/sNotFullReg_i_6/D
net (fo=1, unplaced)		0.449	3.218	worker/fifo/fifo/sNotFullReg_i_6_n_0
				r worker/fifo/fifo/sNotFullReg_i_4/I3
LUT4 (Prop_lut4_I3_D)		0.124	3.342	r worker/fifo/fifo/sNotFullReg_i_4/D
net (fo=1, unplaced)		0.449	3.791	worker/fifo/fifo/sNextNotFull__12
				r worker/fifo/fifo/sNotFullReg_i_1/I5
LUT6 (Prop_lut6_I5_D)		0.124	3.915	r worker/fifo/fifo/sNotFullReg_i_1/D
net (fo=1, unplaced)		0.000	3.915	worker/fifo/fifo/sNotFullReg_i_1_n_0
FDCE				r worker/fifo/fifo/sNotFullReg_reg/D
(clock clk2 rise edge)		2.949	2.949	r
		0.000	2.949	r dev_adc_in[adc_clk] (IN)
net (fo=33, unset)		0.924	3.873	worker/fifo/fifo/dev_adc_in[adc_clk]
FDCE				r worker/fifo/fifo/sNotFullReg_reg/C
clock pessimism		0.000	3.873	
clock uncertainty		-0.035	3.838	
FDCE (Setup_fdce_C_D)		0.077	3.915	worker/fifo/fifo/sNotFullReg_reg
required time			3.915	
arrival time			-3.915	

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slack	0.000
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