

Vivado Design Suite Quick Reference

Project Mode vs Non-Project Mode

The Vivado Design Suite supports two design flows: Project Mode and Non-Project Mode. This table highlights the main differences between these two modes.

Flow Element	Project Mode	Non-Project Mode
Flow Navigation	Guided	Manual
Project Management	Automatic	Manual
Flow Customization	Limited	Unlimited
Reporting	Automatic	Manual
GUI Operation	Non-blocking	Blocking
Analysis Stages	Designs only	Designs and checkpoints

For details, refer to the *Vivado Design Suite User Guide: Design Flows Overview* ([UG892](#))

UCF to XDC Mapping

The following table gives the mapping from UCF constraints to XDC commands.

UCF Constraint	XDC Command
TIMESPEC PERIOD	create_clock
OFFSET IN	set_input_delay
OFFSET OUT	set_output_delay
TIG	set_false_path
FROM/THRU/TO	set_multicycle_path set_max_delay/set_min_delay
TNM	No direct equivalent, multiple commands may be needed
net "reset" SLEW = SLOW	set_property SLEW SLOW [get_ports reset]

In general, all physical constraints turn into properties on the respective objects. Refer to the *Vivado Design Suite User Guide: Using Constraints* ([UG903](#)).

Getting Help

For the most up-to-date information on every command available in the Vivado Design Suite use the built-in help system. At the Tcl prompt type:

```
> help
```

This will list all the categories of commands available in the Vivado tool. You can then query the specific command category of interest to get a list of the commands in that category. For example, if you want to see the list of XDC commands you would type:

```
> help -category XDC
```

See the *Vivado Design Suite Tcl Command Reference Guide* ([UG835](#)) for more information.

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Vivado IDE Launch Modes

When launching Vivado from the command line there are three modes:

- GUI Mode** – The default mode. Launches the Vivado IDE for interactive design.
Usage: vivado OR vivado -mode gui
- Tcl Shell Mode** - Launches the Vivado Design Suite Tcl shell for interactive design.
Usage: vivado -mode tcl
Note: Use the start_gui and stop_gui Tcl commands to open and close the Vivado IDE from the Tcl shell.
- Batch Process Mode** - Launches the Tcl shell, runs a Tcl script, and exits the tool.
Usage: vivado -mode batch -source <file.tcl>

Vivado Command Options:

```
-mode          Invocation mode: gui, tcl, and batch. Default: gui
-init          Source vivado.tcl file during initialization.
-source        Source the specified Tcl file. Required for batch mode.
-nojournal     Do not write a journal file.
-appjournal    Append to the journal file instead of overwriting it.
-journal       Journal file name. The default is vivado.jou.
-nolog         Do not write a log file.
-applog        Append to the log file instead of overwriting it.
-log           Log file name. The default is vivado.log.
-ise           ISE Project Navigator integration mode.
-m32           Run 32-bit binary version
-m64           Run 64-bit binary version
-version       Output version information and exit
-tclargs       Arguments passed on to Tcl argc argv
-tempDir       Temporary directory name
-verbose       Suspend message limits during command execution
<project>]    Load specified project file (.xpr) or Design Check Point (.dcp)
```

Main Reporting Commands

The Vivado Design Suite includes many reporting commands which provide different levels of information as the design progresses through the design flow.

Category	Purpose	Examples
Timing	Design goals	report_timing check_timing report_clocks report_clock_interaction
Performance	Measurement against design goals	report_timing report_timing_summary report_power report_min_pulse_width
Resource Utilization	Logical to physical resource mapping	report_utilization report_clock_util report_io report_control_sets report_ram_configuration
Design Rule Checks	Physical verification	report_drc report_ssn report_sso
Design Data	Project-specific settings	report_param report_config_timing report_ip_status

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Design Object Query Commands

Command	Description
get_cells	Get logic cell objects based on name/hierarchy or connectivity
get_pins	Get pin objects based name/hierarchy or connectivity
get_nets	Get net objects by name/hierarchy or connectivity
get_ports	Get top-level netlist ports by name or connectivity
all_inputs	Return all input ports in the current design
all_outputs	Return all output ports in the current design
all_ffs	Return all flip flops in current design
all_latches	Return all latches in current design
all_dsps	Return all DSP cells in the current design
all_rams	Return all ram cells in the current design

Timing-based Query Commands

Command	Description
all_clocks	Get a list of all defined clocks in the current design
get_clocks	Get clock objects by name or object traversed
get_generated_clocks	Get generated Clock objects
all_fanin	Get list of pins or cells in fanin of specified object in timing path
all_fanout	Get list of pins or cells in fanout of specified object in timing path
all_registers	Get list of all sequential / latched cells in the current design
get_path_groups	Path group objects
get_timing_paths	Timing path objects, equivalent to report_timing printout

Filtering

All get_* commands provide a -filter option. There is also an independent filter command. Filtering provides a mechanism to reduce lists of returned objects based on the object properties. For example, to filter on a LIB_CELL type you could do the following:

```
> get_cells -hier -filter {LIB_CELL == FDCE}
```

You can combine multiple filters together:

```
> get_ports -filter {DIRECTION == in && NAME == *clk*}
```

You can filter directly on Boolean properties:

```
> get_cells -filter {IS_PRIMITIVE && !IS_LOC_FIXED}
```

Valid operations are: ==, !=, ==, !=, <=, >=, >, < as well as && and || between filter patterns

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Tcl Examples

Tcl examples:

An iterative loop to display direction and IO standard for all ports:

```
foreach x [get_ports] {puts "$x \
    [get_property IOSTANDARD $x] \
    [get_property DIRECTION $x]"}
```

A simple procedure to give the short version of help on a command:

```
proc short cmdName {
    help -short $cmdName
}
```

Usage: short <command_name>

A procedure to return an array of unique prim/pinname count based on input pin object list:

```
proc countPrimPin {pinObjs} {
    array set count {}
    foreach pin $pinObjs {
        set primpinname [getPrimPinName $pin]
        if {[info exist count($primpinname)]} {
            incr count($primpinname)
        } else {
            set count($primpinname) 1
        }
    }
    return [array get count]
}
```

Usage: countPrimPin <pinObjs>

A procedure to return the primitive/libpinname of the pin:

```
proc getPrimPinName {pin} {
    set pinname [regsub {.*([A-Z]*)$} [get_property name $pin] {1}]
    set primname [get_property LIB_CELL [get_cells -of $pin]]
    return "$primname/$pinname"
}
```

Usage: getPrimPinName pin

A procedure to return the number of characters of the longest string in a list:

```
proc returnMaxStringLength {list} {
    set l [map {x {return [string length $x]}} [lsort -unique $list]]
    return [expr max([join $l .])]
}
```

Usage: returnMaxStringLength list

See the *Vivado Design Suite User Guide: Using Tcl Scripting (UG894)* for more information.

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Batch Mode Script Examples

Example scripts for both Project Mode and Non-Project Mode, using the BFT example design.

Non-Project Mode:

When working in Non-Project Mode, sources are accessed from their current locations and the design is compiled in memory. You are viewing the active design in memory, so changes are automatically passed forward in the design flow. You can save design checkpoints and create reports at any stage of the design process using Tcl commands. In addition, you can open the Vivado IDE at each design stage for design analysis and constraints assignment.

```
set outputDir ./Tutorial_Created_Data/bft_output
file mkdir $outputDir
# STEP#1: setup design sources and constraints
read_vhdl -library bftLib [ glob ./Sources/hdl/bftLib/*.vhd]
read_vhdl ./Sources/hdl/bft.vhdl
read_verilog [ glob ./Sources/hdl/*.v ]
read_xdc ./Sources/bft_full.xdc
# STEP#2: run synthesis, report utilization and timing estimates, write checkpoint design
synth_design -top bft -part xc7k70tfg484-2
write_checkpoint -force $outputDir/post_synth
report_utilization -file $outputDir/post_synth_util.rpt
report_timing -sort_by group -max_paths 5 -path_type summary \
    -file $outputDir/post_synth_timing.rpt
# STEP#3: run placement and logic optimization, report utilization and timing estimates
opt_design
power_opt_design
place_design
phys_opt_design
write_checkpoint -force $outputDir/post_place
report_clock_utilization -file $outputDir/clock_util.rpt
report_utilization -file $outputDir/post_place_util.rpt
report_timing -sort_by group -max_paths 5 -path_type summary \
    -file $outputDir/post_place_timing.rpt
# STEP#4: run router, report actual utilization and timing, write checkpoint design, run DRCs
route_design
write_checkpoint -force $outputDir/post_route
report_timing_summary -file $outputDir/post_route_timing_summary.rpt
report_utilization -file $outputDir/post_route_util.rpt
report_power -file $outputDir/post_route_power.rpt
report_drc -file $outputDir/post_imp_drc.rpt
write_verilog -force $outputDir/bft_impl_netlist.v
write_xdc -no_fixed_only -force $outputDir/bft_impl.xdc
# STEP#5: generate a bitstream
write_bitstream $outputDir/design.bit
```

Project Mode:

When working in Project Mode, a directory structure is created on disk in order to manage design source files, run results, and track project status. A runs infrastructure is used to manage the automated synthesis and implementation process and to track run status.

```
create_project project_bft ./project_bft -part xc7k70tfg484-2
add_files {./Sources/hdl/FifoBuffer.v ./Sources/hdl/async_fifo.v ./Sources/hdl/bft.vhdl}
add_files [ glob ./Sources/hdl/bftLib/*.vhd]
set_property library bftLib [get_files [ glob ./Sources/hdl/bftLib/*.vhd]]
import_files -force -norecuse
import_files -fileset constrs_1 ./Sources/bft_full.xdc
set_property steps.synth_design.args.flatten_hierarchy full [get_runs synth_1]
launch_runs synth_1
wait_on_run synth_1
launch_runs impl_1
wait_on_run impl_1
launch_runs impl_1 -to_step write_bitstream
```

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Timing Constraints

create_clock: Create a clock object

```
create_clock -period <arg> [-name <arg>] [-waveform <args>] [-add]
    [-quiet][[-verbose] [<objects>]
```

If the <objects> is left out a virtual clock is created

create_generated_clock: Create a generated (derived) clock object

```
create_generated_clock [-name <arg>] -source <args> [-edges <args>] [-divide_by <arg>]
    [-multiply_by <arg>] [-combinational] [-duty_cycle <arg>] [-edge_shift <args>]
    [-add] [-master_clock <arg>] [-quiet] [-verbose] [<objects>]
```

set_input_delay / set_output_delay: Set input/output delay on ports

```
set_input/output_delay [-clock <args>] [-reference_pin <args>] [-clock_fall] [-rise] [-fall] [-max]
    [-min] [-add_delay] [-network_latency_included] [-source_latency_included]
    [-quiet] [-verbose] [<delay>] [<objects>]
```

set_false_path: Define false path

```
set_false_path [-setup] [-hold] [-rise] [-fall] [-reset_path] [-from <args>] [-rise_from <args>]
    [-fall_from <args>] [-to <args>][[-rise_to <args>] [-fall_to <args>]
    [-through <args>] [-rise_through <args>] [-fall_through <args>] [-quiet]
    [-verbose]
```

set_max_delay / set_min_delay: Specify maximum/minimum delay for timing paths

```
set_max/min_delay [-rise] [-fall] [-reset_path] [-from <args>] [-rise_from <args>]
    [-fall_from <args>] [-to <args>] [-rise_to <args>] [-fall_to <args>] [-through <args>]
    [-rise_through <args>] [-fall_through <args>] [-datapath_only*] [-quiet] [-verbose]
    [<delay>]
```

* datapath_only is only valid for set_max_delay

set_multicycle_path: Define multicycle path

```
set_multicycle_path [-setup] [-hold] [-rise] [-fall] [-start] [-end] [-reset_path] [-from <args>]
    [-rise_from <args>] [-fall_from <args>] [-to <args>] [-rise_to <args>]
    [-fall_to <args>] [-through <args>] [-rise_through <args>] [-fall_through <args>]
    [-quiet] [-verbose] [<path_multiplier>]
```

set_clock_groups: Set exclusive or asynchronous clock groups

```
set_clock_groups [-name <arg>] [-logically_exclusive] [-physically_exclusive]
    [-asynchronous] [-allow_paths] [-group <args>] [-quiet]
    [-verbose]
```

Exception Priority Rules:

set_false_path / set_clock_groups	Highest
set_max/min_delay	↓
set_multicycle_path	Lowest

Object Filter Priority Rules:

-from pin	Highest
-to pin	
-through pin	↓
-from clock	
-to clock	Lowest