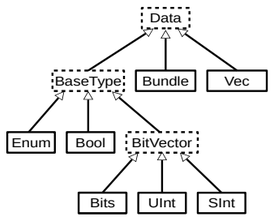
SpinalHDL CheatSheet – Core

Basic Types



Bool

Bits/UInt/SInt(x bits)

Vec(dataType:Data, size:Int)

```
object State extends SpinalEnum{
  val IDLE, S0,S1,S2 = newElement()
}
```

Literals

Bool(boolean)	val myBool = Bool(4 < 2)
True, False	val myBool = True
B/U/S(value:Int[,x bits])	val myUInt = U(13, 32 bits)
B/U/S"[[size']base]value"	val myBits = B"8'hA3" // h,d,b,x,o
B/U/S"binaryNumber"	val myBits = B"0110"
M"binaryNumber"	val itMatch = myBits === M"00--10--"

Register

val r = Reg(UInt(8 bits)	val r = Reg(UInt(8 bits)) init(0)
val r = RegNext(signal)	val r = RegNextWhen(signal,cond)
val r = RegInit(U"010")	

Assignements

x := y	VHDL, Verilog <=
x <> y	uartCtrl.io.uart <> io.uart //Automatic connection
x \= y	VHDL :=, Verilog =

Cast

asBits / asUInt / asSInt / asBool

x.assignFromBits(y : Bits)	Can be used to assign a Bits into something else.

```
x.assignFromBits(y : Bits,hi:Int,lo:Int)
x.assignFromBits(y : Bits, offset:Int, bitCount:BitCount)
```

Range

myBits(7 downto 0) //8 bits	myBits(0 to 5) //6 bits
myBits(0 until 5) // 5 bits	myBits(5) //bit 5
myUInt := (default -> true)	myUInt := (myUInt.range -> true)
myUInt := (3 -> true, default -> false)	myUInt := ((3 downto 1) -> true, default -> false)

```
val myBool = myUInt === U(myUInt.range -> true)
```

Units

Hz, kHz, MHz, GHz, THz	val freq: HertzNumber = 1 kHz
fs, ps, ns, us, ms, s, mn, hr	val time: TimeNumber = 2 ms
Bytes, Byte, KiB, MiB, GiB, TiB	val size: BigInt = 4 MiB
bits, bit	val myBits:BitCount = 3 bits

Basetype Functions

Bool	.set, .clear, .rise, .fall, .setWhen(cond), .clearWhen(cond)
Bits Sint UInt	resize(y:Int), .resized, .range, .high, x(hi,lo), x(offset,width bits), x(index), .msb, .lsb, xorR, .orR, .andR, .clearAll, .setAll, .setAllTo(Boolean),
	setAllTo(Bool)

Conditional / Mux

```
myBits.mux(
  0       -> (io.src0 & io.src1),
  1       -> (io.src0 | io.src1),
  default -> (io.src0)
)
```

```
when(cond1){
} elsewhen(cond2){
} otherwise{
}
```

```
switch(x){
  is(value1){
  }
  is(value2){
  }
  default{
  }
}
```

```
cond ? whenTrue | whenFalse
```

```
Select(
  cond1  -> value1,
  cond2  -> value2,
  default -> value3
)
```

```
Mux(cond,whenTrue,whenFalse)
```

Basetype Operators

	x + y x – y x * y	x < y x > y x <= y x >= y	x === y x =/= y	x >> y x << y x |<< y x |>> y	X & y x | y x ^ y	X && y x || y	!x	~x	@@	##
Bool			√		√	√	√	√		√
Bits			√	√	√			√		√
SInt UInt	√	√	√	√	√			√	√	

(##, @@ for concatenation) (|>>, |<< shift without resizing)

Bundle

```
case class RGB(width:Int) extends Bundle{
  val red, green, blue = UInt(width bits)
  def isBlack =
    red === 0 & green === 0 & blue === 0
}
```

```
val io = new Bundle{
  val a = in Bits(32 bits)
  val b = in(Rgb(config))
  val c = out UInt(8 bits)
}
```

```
class Bus(val config: BusConfig) extends Bundle with IMasterSlave{
  val addr = UInt(config.addrWidth bits)
  val dataWr, dataRd = Bits(config.dataWidth bits)
  val cs,rw = Bool
  def asMaster(): Unit = {
    out(addr, dataWr, cs, rw)
    in(dataRd)
  }
}
val io = new Bundle{
  val masterBus = master(Bus(BusConfig))
  val slaveBus  = slave(Bus(BusConfig))
}
```

Blackbox

```
class Ram(wordCount: Int) extends BlackBox{
  val io = new Bundle{
    val clk = in Bool
    val addr = in Uint(32 bits)
    ...
  }
  addGeneric("wordcount", wordCount)
  noIoPrefix() // remove io_ prefix
  mapClockDomain(clock=io.clk) // map to the current clockDomai
}
```

Component

```
class AndGate(width : Int) extend Component{
  val io = new Bundle{
    val value    = out Bits(width bits)
    val in1,in2 = in Bits(width bits)
  }
  io.value := io.in1 & io.in2
}
```

Directions

in/out(T)	in/out Bool/Bits/UInt/SInt(x bits)
master/slave(T)	master/slave Stream/Flow(T)

Area

```
val myCounter = new Area{
  val tick = Bool
  ...
}
io.output := myCounter.tick
```

ClockDomain

Configuration	val config = ClockDomainConfig(
	clockEdge = RISING, // FALLING
	resetKind = ASYNC, // SYNC, BOOT
	resetActiveLevel = LOW, // HIGH
	softResetActiveLevel = LOW, // HIGH
	clockEnableActiveLevel = LOW // HIGH
	)

Clock Domain	val myCD = ClockDomain(ioClock,ioReset, config)

Area	val coreArea = new ClockingArea(myCD){
	val myReg = Reg(UInt(32 bits)) // myCD clocked
	...
	}

External Clock	val myCD = ClockDomain.external("clockName")

```
ClockDomain.current // Get the current clock domain
ClockDomain.current.readClockWire // read current clock
```

Misc	ClockEnableArea, SlowArea, ResetArea

RAM

Declaration	val myRAM = Mem(type,size:Int) val myROM = Mem(type,initialContent : Array[Data])
Write	mem(address) := data mem.write(address, data, [mask])

Read	myOutput := mem(x) // Asyncronous read
	mem.readAsync(address,[readUnderWrite])
	mem.readSync(address,[enable],[readUnderWrite])

Read/Write	mem.readWriteSync(address,data,enable,write)

HDL Generation

SpinalVhdl(new MyTopLevel())	SpinalVerilog(new MyTopLevel())

```
SpinalConfig(
  mode = Verilog, // VHDL
  targetDirectory="temp/myDesign",
).generate(new myComponent())
```

```
val report = SpinalVhdl(new myTopLevel())
report.printPruned()
```

Template

```
import spinal.core._ // import the core
class MyTopLevel() extends Component { //Define a Component
  val io = new Bundle {
    val a,b = in Bool
    val c = out Bool
  }
  io.c := io.a & io.b
}
object MyMain {
  def main(args: Array[String]) {
    SpinalVhdl(new MyTopLevel()) //Generate a VHDL file
  }
}
```

Utils

log2Up(x : BigInt)	Number of bit needed to represent x
isPow2(x : BigInt)	Return true if x is a power of two
Cat(x: Data*)	Concatenate all arguments

Function

```
// Function to multiply an UInt by a scala Float value.
def coef(value : UInt,by : Float ) : UInt =
  (value * U((255*by).toInt,8 bits) >> 8)
```

```
def clear() : Unit = counter := 0 // Clear the counter
```

```
def sinus(size:Int, res:BitCount) = {
  (0 to size).map (i =>
    U(((Math.sin(i)+1) * Math.pow(2,res.value)/2).toInt)
  )
}
// memory initialised with a sinus
val mySinus = Mem(UInt(16 bits), sinus(1024, 16 bits))
```

Assertion

```
assert(
  assertion = cond,
  message = "My message",
  severity = ERROR  //WARNING, NOTE, FAILURE
)
```

Enum

```
object MyEnum extends SpinalEnum{
   val s0, s1, ..., sn = newElement
}
val state = RegInit(MyEnum.s0)
```