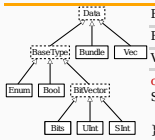
Spinal CheatSheet - Core

v0.1

Basic Types



Bool	
Bits/UInt/SInt([x bits])	
Vec(dataType:Data, size:Int)	

```
object myEnum extends SpinalEnum([encoding]){
  val IDLE, STATE1 = newElement()
}
```

Encoding Type for Enum are native, binarySequencial, binaryOneHot

Literal

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--"

Assignments

x := y	VHDL, Verilog <=
x <> y	uartCtrl.io.uart <> io.uart //Automatic connection
x \= y	VHDL :=, Verilog =
x.assignFromBits(Bits)	Can be used to assign enum to Bits
x.assignFromBits(Bits,hi:Int,lo:Int), bitCount:BitCount)	x.assignFrom(Bits, offset:Int,

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(default -> true)
```

Register

val r = Reg(DataType)	val r = RegInit(U"010")
val r = RegNext(signal)	val r = RegNextWhen(signal,cond)

Function : .set(), .clear(), .setWhen(cond), .clearWhen(cond), .init(value), .randBoot()

Conditional

```
when(cond1){
  //when cond1 is true
}.elsewhen(cond2){
  //when (not cond1) and cond2
}.otherwise{
  //when (not cond1) and (not cond2)
}
```

```
switch(x){
  is(value1){
    //when x === value1
  }
  is(value2){
    // when x === value2
  }
  default{
    //default code
  }
}
```

```
val res = cond ? whenTrue | whenFalse
```

```
val res = Mux(cond,whenTrue,whenFalse)
```

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

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

Assertion

```
assert(
  assertion = cond1,
  message = "My message",
  severity = ERROR // WARNING, NOTE, FAILURE
)
```

Units

Hz, kHz, MHz, GHz, THz	val freq:BigDecimal = 1 kHz
fs, ps, ns, us, ms, s, mn, hr	val time:BigDecimal = 2 ms
Bytes, Byte, KiB, MiB, GiB, TiB	val size:BigInt = 4 MiB
bits, bit	val myBits:BitCount = 3 bits
exp	val myExp:ExpNumber = 5 exp
pos	val myPos:PosCount = 2 pos

Operator

	!x	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 && y x || y	x ## y	x @@ y
Bool	✔			✔		✔		✔	✔	
SInt/UInt		✔	✔	✔						✔
Bits				✔	✔	✔	✔		✔	

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

in/out, master/slave

```
in/out Bool, in/out Bits/UInt/SInt[(x bits)], in/out(T) // Create input/output
```

```
master/slave Stream/Flow[T], master/slave(T) // Provide by the spinal.lib
```

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(MyType)
  val c = out UInt(32 bits)
}
```

```
class Bus(val config: BusConfig) extends Bundle {
  val addr = UInt(config.addrWidth bits)
  val dataWr, dataRd = Bits(config.dataWidth bits)
  val cs,rw = Bool
  def asMaster(): this.type = {
    out(addr, dataWr, cs, rw)
    in(dataRd)
  }
  def asSlave(): this.type = this.asMaster().flip() //Flip reverse all in out
}
val io = new Bundle{
  val masterBus = Bus(BusConfig).asMaster()
  val slaveBus = Bus(BusConfig).asSlave()
}
```

!! Thanks to the Lib this code can be written different (cf master/slave interface on Lib Sheet) !!

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
}
```

Area

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

ClockDomain

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

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

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

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

```
ClockDomain.current.frequency.getValue//Return frequency of the clock domain
```

Fixed Point

UFix/SFix(peak, resolution)	val q1= SFix(8 exp, -2 exp)
UFix/SFix(peak, width)	val q0 = SFix(8 exp,11 bits)
Operator :	
sub, add, multiplication	x+y, x-y, x*y
shift	x<<y, x>>y, x>|y, x<|y
Comparaison	x>y, x<y, x>=y, x<=y

Cast : myUFix.toUInt, mySFix.toSInt, myUInt.toUFix, mySInt.toSFix

Function : .maxValue, .minValue, .resolution

BlackBox

```
class CurstomRam(_wordWidth: Int) extends BlackBox {
  val generic = new Generic {
    val wordWidth = _wordWidth
  }
  val io = new Bundle {
    val clk = in Bool
    val wr = new Bundle {
      val en = in Bool
      ...
    }
  }
  mapClockDomain(clock=io.clk)
}
val ram = new CurstomRam(16) //Use as a component
```

Cast

myBool.asBits/asUInt/asSInt	
myBits.asBool/asUInt/asSInt	
myUInt.asBool/asBits/asSInt	
mySInt.asBool/asBits/asUInt	

Attribute

addAttribute(name)	
addAttribute(name.value)	

RAM

Declaration	val myRAM = Mem(type,size:Int) // RAM val myROM = Mem(type,initialContent : Array[Data]) // ROM
Write access	mem(address) := data mem.write(address, data, [mask])
Read access	myOutput := mem(x) mem.readAsync(address,[readUnderWrite]) mem.readSync(address,[enable],[readUnderWrite], [clockCrossing])

BlackBoxing	mem.generateAsBlackBox() //Explicitly set a memory to be a blackBox
	def main(args: Array[String]) {
	SpinalConfig()
	.addStandardMemBlackboxing(blackboxAll) //Option: blackboxAll,
	//blackboxAllWhatsYouCan, blackboxRequestedAndUninferable
	// blackboxOnlyIfRequested
	.generateVhdl(new TopLevel)
	}

readUnderWrite	dontCare, readFirst, writeFirst
Technology	mem.setTechnology(auto) // auto, ramBlock, distributedLut, registerFile
Mixed width RAM	mem.writeMixedWidth(address, data, [readUnderWrite]) mem.readAsyncMixedWidth(address, data, [readUnderWrite]) mem.readSyncMixedWidth(address, data, [enable], [readUnderWrite], [clockCrossing]) mem.readWriteSyncMixedWidth(address, data, enable, write, [mask], [readUnderWrite], [crossClock])

HDL Generation

```
SpinalVhdl(new MyTopLevel()) // Generate VHDL file
SpinalVerilog(new MyTopLevel()) // Generate Verilog file
```

SpinalConfig : mode, debug, defaultConfigForClockDomains, onlyStdLogicVectorAtTopLevelIo, defaultClockDomainFrequency, targetDirectory, dumpWave, globalPrefix, device, genVhdlPkg, phasesInserters, transformationPhases, memBlackBoxers

```
SpinalConfig(
  mode = Verilog, // VHDL
  targetDirectory="temp/myDesign",
  defaultConfigForClockDomains = ClockDomainConfig(clockEdge=RISING, resetKind=ASYNC),
  defaultClockDomainFrequency = FixedFrequency(50 MHz),
  OnlyStdLogicVectorAtTopLevelIo = true
).generate(new myComponent())
```

```
SpinalConfig(dumpWave = DumpWaveConfig(depth = 0)).generateVhdl(new MyComp()) //Gen wave file
```

```
SpinalConfig(globalPrefix="myPrefix_").generateVerilog(new MyTopLevel()) // Add a prefix to the package
```

```
SpinalVhdl(new myTopLevel()).printPruned() // Print all signals not used
```

```
def main(args: Array[String]): Unit = {
  SpinalConfig.shell(args)(new UartCtrl()) // Config from shell
    // Option : --vhdl, --verilog, -o, --targetDirectory
}
```

Template

```
import spinal.core._ // import the core
class MyTopLevel() extends Component { //Create 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
roundUp(that : BigInt, by : BigInt)	Return the first by multiply from that (included)
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 register counter
```

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