

Morphing IBS to EMD and IBISx

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IBIS-ATM
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Overview

- Demonstrate an approach to package modeling that satisfies the needs of the industry
- Propose a syntax that is an incremental change to IBIS
- Demonstrate how IBIS can morph into .emd and .ibs
- Demonstrate how ibs can morph into .ibsx

Example Real IBIS File

- This is based on real 6Gbps part
- Size reduced from 220 differential channels to 3 Tx and 3 Rx differential channels
- legacy.ibs
 - Legacy IBIS commented with package requirements
- incremental.ibs
 - Legacy IBIS with new IBIS style package syntax
 - Legacy IBIS with Tstonefile On-Die models
- package.emd
 - Package represented in EMD syntax
- bare_die.ibsx
 - Bare-Die from legacy.ibs represented in .ibsx format
- Only snippets shown in this presentation
 - Complete files posted <[Link](#)>

legacy.ibs (Highlights)

```
[Pin]  signal_name      model_name      R_pin  L_pin  C_pin
|
AW10 RX[0]_N Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01755
AV10 RX[0]_P Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01755
AW13 RX[1]_N Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01565
AV13 RX[1]_P Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01565
AW8  RX[10]_N Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01785
AV8  RX[10]_P Rx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01785

AR10 TX[0]_N Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01375
AP10 TX[0]_P Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01375
AR13 TX[1]_N Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01165
AP13 TX[1]_P Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01165
AR8  TX[10]_N Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01340
AP8  TX[10]_P Tx NA NA NA | Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01340

[Model] Tx
...
| On-Die Tstonefile Tx_typ.s4p Tx_min.s4p Tx_max.s4p
| Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.02
| Diff_Package_Coupled pkg_cpl_{Corner}.mod pkg_cpl_{Corner} Length=0.02

[Model] Rx
| On-Die Tstonefile Rx_typ.s4p Rx_min.s4p Rx_max.s4p
| Diff_Package pkg_{Corner}.mod pkg_{Corner} Length=0.01
| Diff_Package_Coupled pkg_cpl_{Corner}.mod pkg_cpl_{Corner} Length=0.01
```


incremental.ibs

```
[Model] Tx
Model_type Differential_Output
C_comp 0.5p 0.5p 0.5p
Cref = 0
Vref = 0.5
Rref = 50
Vmeas = 0.5

[Temperature_Range] 25 100 0
[Voltage Range] 1.0 0.9 1.1
[Tstonefile] Tx_typ.s4p Tx_min.s4p Tx_max.s4p
|[Tstonefile] ami_file.ami(Tstonefile)
[Tstonefile Ports] Buffer+ Buffer- Pad+ Pad-
[Pulldown]
-2.50000E+00 -5.00000E-02 NA NA
 0.00000E+00  0.00000E-02 NA NA
 2.50000E+00  5.00000E-02 NA NA
[Pullup]
-2.50000E+00  5.00000E-02 NA NA
 0.00000E+00  0.00000E-02 NA NA
 2.50000E+00 -5.00000E-02 NA NA
[Ramp]
dV/dt_r .3/60p .27/1p .33/1p
dV/dt_f .3/60p .27/1p .33/1p
```

```
[Pin_Package_IBIS-ISS]
AW10 Pkg Length=0.01755
AV10 Pkg Length=0.01755
AW13 Pkg Length=0.01565
AV13 Pkg Length=0.01565
AW8  Pkg Length=0.01785
AV8  Pkg Length=0.01785
```

```
AR10 Pkg Length=0.01375
AP10 Pkg Length=0.01375
AR13 Pkg Length=0.01165
AP13 Pkg Length=0.01165
AR8  Pkg Length=0.01340
AP8  Pkg Length=0.01340
```

```
[End_Pin_Package_IBIS-ISS]
```

```
[Model_Package_IBIS-ISS]
Tx Pkg L=0.02
Rx Pkg L=0.01
Tx Pkg_Coupled Length=0.02
Rx Pkg_Coupled Length=0.01
[End_Model_Package_IBIS-ISS]
```

incremental.ibs (cont.)

```
[Package] Pkg_Coupled
  File pkg_coupled_{Corner}.mod
  Subckt pkg_coupled_{Corner}
  Type Coupled_Differential
  [Parameters]
    Length 0.02
  [End_Parameters]
  [Model_Ports]
    1 PadP
    2 PadM
    3 PinP
    4 PinM
    5 PadA1P
    6 PadA1M
    7 PinA1P
    8 PinA1M
    9 PadA2P
    10 PadA2M
    11 PinA2P
    12 PinA2M
  [End_Model_Ports]
  [End_Package]
[End_Package_IBIS-ISS]
```

```
[Package_IBIS-ISS]
```

```
[Package] Pkg
  File typ pkg_typ.mod
  Subckt typ pkg_typ
  Type Differential
  [Parameters]
    Length 0.02
  [End_Parameters]
  [Model_Ports]
    1 PadP
    2 PadM
    3 PinP
    4 PinM
  [End_Model_Ports]
[End_Package]
```

| Note indentation reflects legacy
| IBIS in a Parameter Tree without
| the rigor of a true Parameter Tree
| syntax

[Model] Requires IBIS-BSS

- IBIS-ISS supports only LTI behavior
- Using SPICE in [Model]s requires
 - PWL Voltage Controlled Sources
 - Threshold Detector
 - Time Function
- IBIS-BSS
 - IBIS-ISS plus requirements implemented as
 - Specific non-LTI HSPICE elements
 - Macro's that can be pre-processed for target SPICE simulator
- All that is required today is an On-Die Tstonefile
 - Users are requiring Tstonefile for >5 Gbps
 - IC Vendors are supplying Tstonefile for > 5Gbps

package.emd

```
(package
  (IBIS_Ver 6.0)
  (Disclaimer "THIS IBIS MODEL HAS BEEN CREATED BY SIGNAL INTEGRITY SOFTWARE")
  (File_Name package.emd)
  (File_Rev 1.0)
  (Date "Tue Aug 28 14:09:44 EDT 2012")
  (Source "Signal Integrity Software")
  (Notes "Note")
  (Copyright "No Copyright")
  (Manufacturer SiSoft)
  (Pin
    (AW10 (Signal RX[0]_N) (Package_Model Pkg) (Length 0.01755)(Class Rx)(Coupled_Class Rx_Coupled))
    (AV10 (Signal RX[0]_P) (Package_Model Pkg) (Length 0.01755)(Class Rx)(Coupled_Class Rx_Coupled))
    (AW13 (Signal RX[1]_N) (Package_Model Pkg) (Length 0.01565)(Class Rx)(Coupled_Class Rx_Coupled))
    (AV13 (Signal RX[1]_P) (Package_Model Pkg) (Length 0.01565)(Class Rx)(Coupled_Class Rx_Coupled))
    (AW8 (Signal RX[10]_N) (Package_Model Pkg) (Length 0.01785)(Class Rx)(Coupled_Class Rx_Coupled))
    (AV8 (Signal RX[10]_P) (Package_Model Pkg) (Length 0.01785)(Class Rx)(Coupled_Class Rx_Coupled))
    (AR10 (Signal TX[0]_N) (Package_Model Pkg) (Length 0.01375)(Class Tx)(Coupled_Class Tx_Coupled))
    (AP10 (Signal TX[0]_P) (Package_Model Pkg) (Length 0.01375)(Class Tx)(Coupled_Class Tx_Coupled))
    (AR13 (Signal TX[1]_N) (Package_Model Pkg) (Length 0.01165)(Class Tx)(Coupled_Class Tx_Coupled))
    (AP13 (Signal TX[1]_P) (Package_Model Pkg) (Length 0.01165)(Class Tx)(Coupled_Class Tx_Coupled))
    (AR8 (Signal TX[10]_N) (Package_Model Pkg) (Length 0.01340)(Class Tx)(Coupled_Class Tx_Coupled))
    (AP8 (Signal TX[10]_P) (Package_Model Pkg) (Length 0.01340)(Class Tx)(Coupled_Class Tx_Coupled))
```


package.emd (cont.)

```
(Reference_Designator_Map

    (U1 (IBIS_File legacy.ibs) (Component legacy))
| Or
    (U1 (IBISx_File bare_die.ibsx))
)

(Extended_Nets
    (RX[0]_N  AW10 U1.AW10)
    (RX[0]_P  AV10 U1.AV10)
    (RX[1]_N  AW13 U1.AW13)
    (RX[1]_P  AV13 U1.AV13)
    (RX[10]_N AW8  U1.AW8)
    (RX[10]_P AV8  U1.AV8)
    (TX[0]_N  AR10 U1.AR10)
    (TX[0]_P  AP10 U1.AP10)
    (TX[1]_N  AR13 U1.AR13)
    (TX[1]_P  AP13 U1.AP13)
    (TX[10]_N AR8  U1.AR8)
    (TX[10]_P AP8  U1.AP8))
```

package.emd (cont.)

```
(Interconnect
  (Pkg
    (File (Corner pkg_typ.mod pkg_min.mod pkg_max.mod))
    (Subckt (Corner pkg_typ pkg_min pkg_max))
    (Type Differential)
    (Parameters
      (Length 0.02)
    )
    (Model_Ports
      (1 PadP)
      (2 PadM)
      (3 PinP)
      (4 PinM)
    )
  )
)
```

bare_die.ibsx

```
(bare_die
  (IBIS_Ver 6.0)
  (Disclaimer "THIS IBIS MODEL HAS BEEN CREATED BY SiSoft")
  (File_Name bare_die.ibsx)
  (File_Rev 1.0)
  (Date      "Tue Aug 28 14:09:44 EDT 2012")
  (Source    "Signal Integrity Software")
  (Notes     "Note")
  (Copyright "No Copyright")
  (Manufacturer SiSoft)
  (Pad
    (AW10 (Signal RX[0]_N) (Model Rx))
    (AV10 (Signal RX[0]_P) (Model Rx))
    (AW13 (Signal RX[1]_N) (Model Rx))
    (AV13 (Signal RX[1]_P) (Model Rx))
    (AW8  (Signal RX[10]_N) (Model Rx))
    (AV8  (Signal RX[10]_P) (Model Rx))
    (AR10 (Signal TX[0]_N)  (Model Tx))
    (AP10 (Signal TX[0]_P)  (Model Tx))
    (AR13 (Signal TX[1]_N)  (Model Tx))
    (AP13 (Signal TX[1]_P)  (Model Tx))
    (AR8  (Signal TX[10]_N) (Model Tx))
    (AP8  (Signal TX[10]_P) (Model Tx)))
```

bare_die.ibsx (cont.)

```
(Tx      (Model_type Differential_Output)
(Thresholds
  (Cref 0)
  (Vref 0.5)
  (Rref 50)
  (Vmeas 0.5))
(Temperature_Range (Corner 25 100 0))
(Voltage_Range      (Corner 1.0 1.0 1.0))
(Legacy_IV/VT
  (C_comp 0p)
  (Tstonefile (Corner Tx_typ.s4p Tx_min.s4p Tx_max.s4p))
  (Tstonefile Ports Buffer+ Buffer- Pad+ Pad-)
  (Pulldown
    (-2.50000E+00 -5.00000E-02 NA NA)
    (-0.00000E+00 0.00000E-02 NA NA)
    ( 2.50000E+00 5.00000E-02 NA NA))
  (Pullup
    (-2.50000E+00 5.00000E-02 NA NA)
    ( 0.00000E+00 0.00000E-02 NA NA)
    ( 2.50000E+00 -5.00000E-02 NA NA))
  )
  (Ramp
    (dV/dt_r (Corner .3/60p .27/1p .33/1p))
    (dV/dt_f (Corner .3/60p .27/1p .33/1p))
  )
))
```


Conclusion

- Proposed packaging syntax
 - Can be implemented in legacy IBIS
 - Addresses need of this real exemplar
- IBIS can be morphed into both
 - EMD + Bare-Die Legacy IBIS
 - EMD + Bare-Die IBISx
- Changes made to Legacy IBIS should anticipate EMD and IBISx
- Next Steps
 - Apply this IBIS-ISS methodology to IC Vendor supplied package interconnect test cases
 - Should table [External Model] BIRDs until
 - IBIS-BSS is defined and approved
 - Industry requires On-Die models beyond Tstonefile