```
****************************************************************************
****************************************************************************
```

BIRD ID#:   Analog
ISSUE TITLE: IBIS-AMI New Reserved Parameters for Analog Modeling
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DATE SUBMITTED: October 20, 2010
DATE REVISED: April 1, 2011
DATE ACCEPTED BY IBIS OPEN FORUM:

```
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STATEMENT OF THE ISSUE:

Model developers and EDA vendors building IBIS-AMI models using the IBIS 5.0
specification have come across a number of modeling issues that are not
addressed in IBIS 5.0. In order to deliver models and EDA tools that meet
end-user demands for model accuracy and functionality, EDA vendors have
defined "extensions" to add new capabilities to IBIS-AMI models.
Unfortunately, EDA vendors have had to use proprietary (and different) syntax
to add these capabilities to models, limiting model portability between
different EDA tools.

This BIRD proposes new syntax for the .ami control file that improves model
functionality and accuracy. Including this syntax in the IBIS standard will
allow creation of accurate, compliant IBIS-AMI models that are readily
portable between commercial EDA simulators.

The parameters defined in this document are to be added in Section 6c of the
IBIS 5.0 specification as new Reserved_Parameters.

> **Broadband Analog Buffer Model**
> > ISS_Buffer_File, ISS_Buffer_Subckt, ISS_Buffer_Arguments, Tx_Voh,
> > Tx_Vol, Tx_Trf
>
> **Broadband Analog Package Model**
> > ISS_Package_File, ISS_Package_Subckt, ISS_Package_Arguments

Note that all of the parameters defined in this BIRD **may** be declared in the
Model_Specific section of the .ami file to allow the use of some legacy
models. However, using these parameters in the Model_Specific section of the
.ami file is considered legacy use and will likely be deprecated in IBIS
versions beyond 5.1.

This BIRD also proposes new syntax for the .ibs file that enables this same
functionality within the IBIS file for both legacy IBIS models in addition to
AMI models. The new IBIS keywords are

> **Broadband Analog Buffer Model**
> > [External Analog], [End External Analog], ISS_Buffer_File,
> > **ISS_Buffer_Subckt ISS_Buffer_Arguments**, Tx_Voh, Tx_Vol, Tx_Trf 0
>
> **Broadband Analog Package Model**
> > ISS_Package, [ISS_Packages], [End ISS Packages], [ISS Package],
> > [End ISS Package], **ISS_Package_Subckt**, **ISS_Package_Arguments**

```
****************************************************************************
```
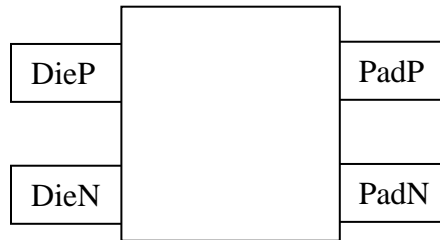
General Schema for Defining Analog Models

The usage of both Buffer Models and Package Models is the same. Three keywords are used to specify the file name, subckt name, and calling arguments. The parameters ISS_Buffer_File and ISS_Package_File specify the file name containing the subckt specified by **ISS_Buffer_Subckt** and **ISS**_Package_**Subckt**. **ISS_Buffer_Arguments** and **ISS**_Package_**Arguments** are used to define the order of the ports of the subckt, and parameters that are passed to the subckt.

The ISS_Buffer parameters may be defined in either the .ami file or in the [Model] section of a .ibs file.

The ISS_Package parameters may be define in the [Component] section, [Pin] section and/or [Model] section of a .ibs file. The Package defined in the [Pin] section takes precedence over the one defined in the [Model] section, which takes precedence over the one defined in the [Component] section.

Analog Buffer Model

The AMI parameters listed below are of Type String and Usage Info. They
define the name of the file containing the ISS Buffer Subckt and how the
subckt is defined.

```
            ┌──────────┐
    ┌─────┐ │          │ ┌─────┐
    │DieP │ │          │ │PadP │
    └─────┘ │          │ └─────┘
            │          │
    ┌─────┐ │          │ ┌─────┐
    │DieN │ │          │ │PadN │
    └─────┘ │          │ └─────┘
            └──────────┘
```

4 Port Analog Buffer ISS Circuit

ISS Buffer Analog Subckt Parameters in the AMI File

"**ISS_Buffer_File**": Name of file containing the ISS buffer subckt.
- This file shall in the same directory as the .ibs file.
- File may be contained in folders below this directory.

"**ISS_Buffer_Subckt**": The .subckt name defined the .subckt statement.
```
.subckt <name> <DieP|DieN|PadP|PadN> <DieP|DieN|PadP|PadN>
+ [<DieP|DieN|PadP|PadN> <DieP|DieN|PadP|PadN>]
+ [C_comp=AMI(Cc)Impedance=AMI(Rs)]
```

"**ISS_Buffer_Arguments**": The .subckt argumenta defined the subckt statement. The convention C_comp=AMI(Cc) indicates the value of the parameter C_comp shall be the value of the AMI parameter Cc.
```
.subckt <name> <DieP|DieN|PadP|PadN> <DieP|DieN|PadP|PadN>
+ [<DieP|DieN|PadP|PadN|> <DieP|DieN|PadP|PadN|>]
+ [C_comp=AMI(Cc)Impedance=AMI(Rs)]
```

AMI ISS Buffer Analog Subckt Parameters in the .ibs File

```
[Model]    tx
Model_type Output
[Algorithmic Model]
Executable Windows_VisualStudio5_32 tx.dll       Tx.ami
Executable Linux_gcc4.1.2_32        tx.linux.so   Tx.ami
[End Algorithmic Model]
[Temperature Range]  25 100 0
ISS_Buffer_File Intrinsic_Tx
ISS_Buffer_Subckt Intrinsic_Tx
ISS_Buffer_Arguments DieP DieN PadP PadN Cc=AMI(C_comp) Rs=AMI(Impedance)
Tx_Voh 1 .8 1.2
Tx_Vol 0
Tx_Trf 0
[End]
```

IBIS ISS Buffer Analog Subckt Parameters in the .ibs File

```
[Model]    tx
Model_type Output
C_comp 800f 750f 850f
Cref = 0
[Model Spec]
Vmeas .311 .287 .34
Vref .311 .287 .34
[Temperature Range]  25 100 0
[Voltage Range] .622 .574 .68
[External Analog]
ISS_Buffer_File Intrinsic_Tx
ISS_Buffer_Subckt Tx_Subckt
ISS_Buffer_Arguments IBIS([Voltage Range]) 0 StimP StimN DieP DieN PadP PadN Vref=IBIS(Vref)
[End External Analog]
[End]
```

AMI ISS Buffer Analog Subckt Parameters
in the .ami File

In Tx.ami

```
(Reserved_Parameters
  | Boilerplate Reserved_Parameters
  (ISS_Buffer_File (Usage Info)(Value "Tx_Analog.iss")(Type String)
      (Description "ISS subckt Tx_Analog found in file Tx_Analog.iss"))
  (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Tx_Analog")
      (Description "ISS subckt name"))
  (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "DieP DieN PadP PadN Cc=AMI(comp) Rs=AMI(Impedance)")
      (Description "Port Order and parameters of ISS subckt Tx_Analog"))
  (Tx_Voh (Corner 1 .8 1.2) (Usage Info) (Type Float)
        (Description "Voh to use to generate impulse response"))
  (Tx_Vol (Value 0) (Usage Info) (Type Float)
        (Description "Vol to use to generate impulse response"))
  (Tx_Trf (Value 0) (Usage Info) (Type Float)
)
(Model_Specific
        (Description "Rise time to use to generate impulse response"))
  (C_comp (Corner 1e-12 1.5e-12 .8e-12) (Usage Info) (Type Float)
        (Description "Buffer C_comp"))
  (Impedance (Range 50 45 55) (Usage Info) (Type Float)
        (Description "Single Ended Impedance"))
)
```

SPICE instance of Tx_Analog circuit

```
X1 DieH DieL PadH PadL Tx_Analog Rs=AMI(Impedance) Cc=AMI(C_comp)
```

File Tx_Analog.iss

```
.subckt Tx_Analog Die Die# Pad Pad# Rs=50 Cc=1p
E_H EDie 0 VCVS Die 0 1.
E_L Edie# 0 VCVS Die# 0 1.
R_Rs_H EDie Pad R='Rs'
R_Rs_L EDie# Pad# R='Rs'
C_Cc_H Pad 0 C='Cc'
C_CC_L Pad# 0 C='Cc'
R_ac Pad Nac R='Rac'
C_ac Pad# Nac C='Cac'
.ends Tx_Analog
```

In Rx.ami

```
(Reserved_Parameters
  | Boilerplate Reserved_Parameters
  (ISS_Buffer_File (Usage Info)(Value "Rx_Analog.iss")(Type String)
      (Description "ISS subckt Rx_Analog found in file Rx_Analog.iss"))
  (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Rx_Analog")
      (Description "ISS subckt name"))
  (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "PadN PadP DieN DieP Cc=AMI(comp) Rd=AMI(Diff_Impedance)")
      (Description "Port Order and parameters of ISS subckt Rx_Analog"))
)
(Model_Specific
  (C_comp (Corner 1e-12 1.5e-12 .8e-12) (Usage Info) (Type Float)
          (Description "Buffer C_comp"))
  (Diff_Impedance (Range 100 90 110) (Usage Info) (Type Float)
          (Description "Differential Impedance"))
)
```

# SPICE instance of Rx_Analog circuit

```
X1 PadL PadH DieL DieH Rx_Analog Rd=AMI(Diff_Impedance) Cc=AMI(C_comp)
```

File Rx_Analog.iss

```
.subckt Rx_Analog Pad# Pad Die# Die Rd=100 Cc=1p
R_Rd Pad Pad# R='Rd'
C_Cc_H PadP 0 C='Cc'
C_CC_L PadN 0 C='Cc'
E_H Die 0 VCVS Pad 0 1.
E_L Die# 0 VCVS Pad# 0 1.
.ends Tx_Analog
```

ISS Package AMI Parameters

The AMI parameters listed below are of Type String and Usage Info. They
define the name of the file containing the ISS Subckt and how the subckt is
defined in the model.
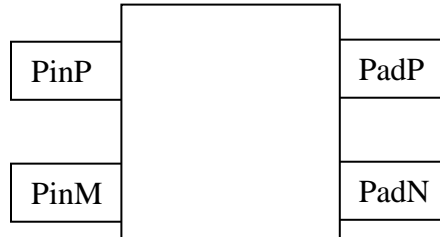
ISS Package Circuit

AMI Parameters to define the ISS Package Subckt usgae.

"**ISS_Package_File**": Name of file containing the ISS subckt.
   - This file shall in the same directory as the .ibs file.

"**ISS_ Package_Subckt**": The .subckt name defined the subckt call.
      .subckt <name> <PinP|PinN|PadP|PadN> < PinP|PinN|PadP|PadN>
      + [<PinP|PinN|PadP|PadN> < PinP|PinN|PadP|PadN>]
      + [Length=AMI(Length)Zo=AMI(Zo)]

"**ISS_Package_Arguments**": The .subckt argumenta defined the subckt call.
      .subckt <name> <PinP|PinN|PadP|PadN> < PinP|PinN|PadP|PadN>
      + [<PinP|PinN|PadP|PadN> < PinP|PinN|PadP|PadN>]
      + [Length=AMI(Length)Zo=AMI(Zo)]

Notes:
      ISS_Package_Arguments must have the following ports in any order
         PinP PinN PadP PadN

ISS Package Models in .ibs Files

```
[Component] my_ibis_component
ISS_Package my_package
[Pin]  signal_name     model_name    R_pin L_pin C_pin
1      rx1_p    rx           ISS_Package my_package Td=55ps Zo=47
2      rx1_n    rx           NA     NA     NA
3      rx2_p    rx           NA     NA     NA
4      rx2_n    rx           NA     NA     NA
...
18     tx5_n    tx           NA     NA     NA
|
[Diff Pin] inv_pin  vdiff tdelay_typ tdelay_min tdelay_max
...
|
[Model]    tx
Model_type Output
[Algorithmic Model]
Executable Windows_VisualStudio5_32 tx.dll       Tx.ami
Executable Linux_gcc4.1.2_32        tx.linux.so  Tx.ami
[End Algorithmic Model]
...
[Model]    rx
Model_type Input
...
[Algorithmic Model]
Executable Windows_VisualStudio5_32 rx.dll       Rx.ami
Executable Linux_gcc4.1.2_32        rx.linux.so  Rx.ami
ISS_Package my_package Td=AMI(Length) Zo=AMI(Zo)
[End Algorithmic Model]

...
[ISS_Packages]
[ISS Package] my_package
ISS_Package_File Package.iss
ISS_Package_Subckt Package
ISS_Package_Arguments PinP PinN PadP PadN Td=99ps Zo=51
[End ISS Package]
[End ISS Packages]
[End]
```

Example four port package subckt:

```
(Reserved_Parameters
  (ISS_Package_File (Usage Info)(Value "Package.iss")(Type String)
      (Description "ISS subckt Package found in file Package.iss"))
  (ISS_ Package_Subckt (Usage Info)(Type String) (Value "Package")
      (Description "ISS subckt name"))
  (ISS_ Package_Arguments (Usage Info)(Type String)
      (Value "PinP PinN PadP PadN Td=AMI(Length) Zo=AMI(Zo)")
      (Description "Port Order and parameters of ISS subckt Package"))
)
(Model_Specific
  (Length (Range 100e-12 50e-12 150e-12) (Usage Info) (Type Float)
      (Description "Length in seconds of package T-line"))
  (Zo (Corner 50 45 55) (Usage Info) (Type Float)
      (Description "Impedance of package T-line"))
)
```

Call to package subckt

```
X1 PinP PinN PadP PadN Package Td=AMI(Td) Zo=AMI(Zo)
```

Contents of Package.iss

```
.subckt Package PinP PinN PadP PadN Td=100p Zo=50.
TP PinP 0 PadP 0 Td='Td' Zo='Zo'
TN PinN 0 PadN 0 Td='Td' Zo='Zo'
.ends Package
```

Intrinsic Analog Buffer Model

If the value of ISS_Buffer_Subckt is Intrinsic_Tstonefile, Intrinsic_Tx, or Intrinsic_Rx the simulator shall use the following intrinsic subckt definitions.

Intrinsic_Tstonefile

In Tx.ami file

```
(Reserved_Parameters
  (ISS_Buffer_File (Usage Info)(Value "Intrinsic_Tstonefile")(Type String)
      (Description "Use intrinsic Tstonefile circuit"))
  (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Tx_Tstone")
      (Description "ISS subckt name"))
  (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "PadP PadN DieP DieN")
      (Description "Port Order of Intrinsic_Tstonefile subckt"))
  (Tx_Voh (Range 1 .8 1.2) (Usage Info) (Type Float)
        (Description "Voh to use to generate impulse response"))
  (Tx_Vol (Value 0) (Usage Info) (Type Float)
        (Description "Vol to use to generate impulse response"))
  (Tx_Trf (Value 0) (Usage Info) (Type Float)
        (Description "Rise time to use to generate impulse response"))
)
(Model_Specific
  (Tstonefile (Usage Info)(Type String) (Description "Touchstone File")
              (List "xwc.s4p" "wc.s4p" "nv.s4p" "bc.s4p" "xbc.s4p")
              (Description "Extreme Worst, Worst, Nominal, Best, Extreme Best
                            Touchstone File"))
)
```

SPICE instance of Tx_Tstone circuit

```
X1 DieH DieL PadH PadL Tx_Tstone
```

Virtual file Intrinsic_Tstonefile

```
.subckt AMI(ISS_Buffer_Subckt) 1 2 3 4
* Port order of Touchstone file is PadP PadN DieP DieN
S1 1 2 3 40 mname=A
.model A TSTONEFILE='AMI(Tstonefile)'
.ends AMI(ISS_Buffer_Subckt)
```

Model_Specific AMI parameters Tx_Vol, Tx_Voh, and Tx_Trf shall be used to determine the drive circuit used to generate the impulse response of the channel. TSTONEFILE shall be a Model_Specific parameter.

Intrinsic_Tx

Tx.ami file

```
(Reserved_Parameters
  (ISS_Buffer_File (Usage Info)(Value "Intrinsic_Tx")(Type String)
      (Description "Use intrinsic Tx circuit"))
  (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Tx_Subckt")
      (Description "ISS subckt name"))
  (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "DieP DieN PadP PadN Cc=AMI(C_comp) Rs=AMI(Impedance)")
      (Description "Port Order and parameters of ISS subckt Tx_Subckt"))
  (Tx_Voh (Range 1 .8 1.2) (Usage Info) (Type Float)
        (Description "Voh to use to generate impulse response"))
  (Tx_Vol (Value 0) (Usage Info) (Type Float)
        (Description "Vol to use to generate impulse response"))
  (Tx_Trf (Value 0) (Usage Info) (Type Float)
        (Description "Rise time to use to generate impulse response"))
)
(Model_Specific
  (C_comp (Corner 1e-12 1.5e-12 .8e-12) (Usage Info) (Type Float)
        (Description "Buffer C_comp"))
  (Impedance (Range 50 45 55) (Usage Info) (Type Float)
        (Description "Single Ended Impedance"))
)
```

The ISS subckt Call

```
X1 DieP DieN PadP PadN AMI(ISS_Buffer_Subckt)
+     Rs=AMI(Impedance) Cc=AMI(C_comp)
```

Virtual file Intrinsic_Tx

```
.subckt AMI(ISS_Buffer_Subckt) DieP DieN PadP PadN  Rt=1Meg Rs=1Meg Cc=0.
+ Vt=0. Cac=0. Rac=1Meg Rd=1Meg Cd=0.
E_H EDieP 0 VCVS DieP 0 1.
E_L EdieN 0 VCVS DieN 0 1.
R_Rs_H EDieP PadP R='Rs'
R_Rs_L EDieN PadN R='Rs'
R_Rd PadP PadN R='Rd'
C_Rd PadP PadN C='Cd'
R_Rt_H PadP Vt R='Rt'
R_Rt_H PadN Vt R='Rt'
V_Vt Vt 0 DC='Vt'
C_Cc_H PadP 0 C='Cc'
C_CC_L PadN 0 C='Cc'
R_ac PadP Nac R='Rac'
C_ac PadN Nac C='Cac'
.ends AMI(ISS_Buffer_Subckt)
```

Model_Specific AMI parameters Tx_Vol, Tx_Voh, and Tx_Trf shall be used to determine the drive circuit used to generate the impulse response of the channel. Rt, Rs, Cc, Vt, Rd, Cd, Cac, and Rac are Model_Specific AMI parameters.

Intrinsic_Rx Rx.ami file

```
(Reserved_Parameters
  (ISS_Buffer_File (Usage Info)(Value "Intrinsic_Rx")(Type String)
      (Description "Use intrinsic Rx circuit"))
  (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Rx_Subckt")
      (Description "ISS subckt name"))
  (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "DieP DieN PadP PadN Cc=AMI(C_comp) Rt=AMI(Impedance)")
      (Description "Port Order and parameters of ISS subckt Rx_Subckt"))
)
(Model_Specific
  (C_comp (Corner 1e-12 1.5e-12 .8e-12) (Usage Info) (Type Float)
        (Description "Buffer C_comp"))
  (Impedance (Range 50 45 55) (Usage Info) (Type Float)
        (Description "Buffer C_comp"))
      )
```

The ISS subckt call shall be

```
X1 DieP DieN PadP PadN AMI(ISS_Buffer_Subckt)
+                        Rt=AMI(Impedance) Cc=AMI(C_comp)
```

The ISS .subckt statement shall be

```
.subckt AMI(ISS_Buffer_Subckt) DieP DieN PadP PadN
+ Rt=1Meg Cc=0. Vt=0. Cac=0. Rac=1Meg Rd=1Meg Cd=0.
E_H DieP 0 VCVS PadP 0 1.
E_L DieN 0 VCVS PadN 0 1.
R_Rd PadP PadN R='Rd'
C_Rd PadP PadN C='Cd'
R_Rt_H PadP Vt R='Rt'
R_Rt_H PadN Vt R='Rt'
V_Vt Vt 0 DC='Vt'
C_Cc_H PadP 0 C='Cc'
C_CC_L PadN 0 C='Cc'
R_ac PadP Nac R='Rac'
C_ac PadN Nac C='Cac'
.ends AMI(ISS_Buffer_Subckt)
```

C_comp and Impedance are Model_Specific AMI parameters.

Example of a step response circuit for the following IBIS file and Tx and Rx AMI files

my_ibis.ibs

```
|**************************************************************************
|                 My_IBIS Transceiver IBIS-AMI Models
|**************************************************************************
|
[IBIS Ver]   5.1
[Disclaimer]
             THIS IBIS MODEL HAS BEEN CREATED BY THE SIGNAL
             INTEGRITY SOFTWARE SPICE WRAPPING PROCESS.
             THESE IBIS MODELS AREPROVIDED "AS IS" WITH NO
             WARRANTY WHATSOEVER AND SIGNAL INTEGRITY SOFTWARE
             SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OF
             MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE,
             OR AGAINST INFRINGEMENT.
|
[File Name]  my_ibis.ibs
|
[Date]       April 1, 2010
|
[File Rev]   1.0
|
[Source]     Signal Integrity Software
               6 Clock Tower Place, Suite 250
               Maynard, MA 01754
               support@sisoft.com
|
[Notes]      For correlation and AMI model usage information, see the
document:

               "my_ibis.pdf"

             Revision 1.0 -- 4/1/2010
               Initial release


|
[Copyright]  Copyright 2010, Signal Integrity Software, Inc.,
             All Rights Reserved.
|
|**************************************************************************
|                    COMPONENT: my_ibis_component
|**************************************************************************
|
[Component] my_ibis_component
|
[Manufacturer]  SiSoft
|
[Package]
R_pkg        0.001m  NA NA
L_pkg        0.001nH NA NA
C_pkg        0.001pF NA NA
```

```
|
[Pin] signal_name   model_name      R_pin L_pin C_pin
1     rx1_p    rx              NA    NA    NA
2     rx1_n    rx              NA    NA    NA
3     rx2_p    rx              NA    NA    NA
4     rx2_n    rx              NA    NA    NA
5     rx3_p    rx              NA    NA    NA
6     rx3_n    rx              NA    NA    NA
7     rx4_p    rx              NA    NA    NA
8     rx4_n    rx              NA    NA    NA
|
11    tx1_p    tx              NA    NA    NA
12    tx1_n    tx              NA    NA    NA
13    tx2_p    tx              NA    NA    NA
14    tx2_n    tx              NA    NA    NA
15    tx3_p    tx              NA    NA    NA
16    tx3_n    tx              NA    NA    NA
17    tx4_p    tx              NA    NA    NA
18    tx5_n    tx              NA    NA    NA
|
[Diff Pin] inv_pin  vdiff tdelay_typ tdelay_min tdelay_max
1 2 0.025 na na na
3 4 0.025 na na na
5 6 0.025 na na na
7 8 0.025 na na na
11 12 0.025 na na na
13 14 0.025 na na na
15 16 0.025 na na na
17 18 0.025 na na na
|
|
|**************************************************************************
|         MODEL: tx
|**************************************************************************
|
[Model]    tx
Model_type Output
|
C_comp 800f 750f 850f
Cref = 0
[Model Spec]
Vmeas .311 .287 .34
Vref .311 .287 .34
[Temperature Range]  25 100 0
[Voltage Range] .622 .574 .68
[Algorithmic Model]
Executable Windows_VisualStudio5_32 tx.dll        Tx.ami
Executable Linux_gcc4.1.2_32       tx.linux.so   Tx.ami
[End Algorithmic Model]
|
[Temperature Range]  25 100 0
|
[Pulldown]
-2.500 -5.22030E-02 -4.99600E-02 -5.35217E-02
0.000 +0.00000E+00 +0.00000E+00 +0.00000E+00
2.500 +5.22030E-02 +4.99600E-02 +5.35217E-02
[Pullup]
```

```
-2.500 +5.22030E-02 +4.99600E-02 +5.35217E-02
0.000 +0.00000E+00 +0.00000E+00 +0.00000E+00
2.500 -5.22030E-02 -4.99600E-02 -5.35217E-02
[Ramp]
dV/dt_r .191/60f .172/60f .211/60f
dV/dt_f .191/60f .172/60f .211/60f
|
|*************************************************************************
|                    MODEL: rx
|*************************************************************************
|
[Model]    rx
Model_type Input
|
C_comp 0.55p 0.50p 0.60p
Vinh = 0.55
Vinl = 0.45
[Algorithmic Model]
Executable Windows_VisualStudio5_32 rx.dll        Rx.ami
Executable Linux_gcc4.1.2_32        rx.linux.so   Rx.ami
[End Algorithmic Model]
|
[Temperature_Range] 25 100 0
[Voltage Range] 1.0 0.9 1.1
[GND Clamp]
-2.5 -.05 -.05 -.05
0.00 +.00 +.00 +.00
2.50 +.05 +.05 +.05
|
[End]
```

Tx.ami file

```
(my_tx  (Description "Transmitter Model")
  (Reserved_Parameters
    (AMI_Version (Value "5.1") (Usage Info)(Type String))
    (Ignore_Bits(Usage Info)(Type Integer)(Value 3)
      (Description "Fill tapped delay line."))
    (Max_Init_Aggressors(Usage Info)(Type Integer)(Value 25)
      (Description "Maximum number of aggressors."))
    (Init_Returns_Impulse(Usage Info)(Type Boolean)(Value True)
      (Description "Both impulse and parameters_out returned."))
    (GetWave_Exists(Usage Info)(Type Boolean)(Value True)
      (Description "GetWave is provided."))

    (ISS_Buffer_File (Usage Info)(Value "Intrinsic_Tstonefile")(Type String)
      (Description "Use intrinsic Tstonefile circuit"))
    (ISS_Buffer_Subckt (Usage Info)(Type String)
      (Value "Intrinsic_Tstonefile")
      (Description "ISS subckt name"))
    (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "PadP PadN DieP DieN")
      (Description "Port Order of Intrinsic_Tstonefile subckt"))
    (Tx_Voh (Range 1 .8 1.2) (Usage Info) (Type Float)
        (Description "Voh to use to generate impulse response"))
    (Tx_Vol (Value 0) (Usage Info) (Type Float)
        (Description "Vol to use to generate impulse response"))
    (Tx_Trf (Value 0) (Usage Info) (Type Float)
        (Description "Rise time to use to generate impulse response"))
    (ISS_Package_File (Usage Info)(Value "Package.iss")(Type String)
      (Description "ISS subckt Package found in file Package.iss"))
    (ISS_Package_Subckt (Usage Info)(Type String) (Value "Package")
      (Description "ISS subckt name"))
    (ISS_Package_Arguments (Usage Info)(Type String)
      (Value "PinP PinN PadP PadN Td=AMI(Length) Zo=AMI(Zo)")
      (Description "Port Order and parameters of ISS subckt Package"))
  )
  (Model_Specific
    (Tx_Swing (Usage In)(Type Float)(Format Range 0. -.25 .25)
      (Description "Peak Differential Voltage"))
    (FFE
      (-1 (Usage In)(Type Tap)(Range 0. -.25 .25)
          (Description "Pre-cursor tap weight"))
      (0  (Usage In)(Type Tap)(Format Range 1. 0. 1.)
          (Description "Main tap weight"))
      (1  (Usage In)(Type Tap)(Format Range 0. -.5 .5)
          (Description "Post-cursor tap weight"))
    )
    (Tstonefile (Usage Info)(Type String)
        (List "xwc.s4p" "wc.s4p" "nv.s4p" "bc.s4p" "xbc.s4p")
        (Description
        "Extreme Worst, Worst, Nominal, Best, Extreme Best Touchstone File"))
    (Length (Range 100e-12 50e-12 150e-12) (Usage Info) (Type Float)
      (Description "Length in seconds of package T-line"))
    (Zo (Corner 50 45 55) (Usage Info) (Type Float)
      (Description "Impedance of package T-line"))
  )
)
```

Rx.ami file

```
(my_rx
  (Description "Receiver Model")
  (Reserved_Parameters

    (AMI_Version (Value "5.1") (Usage Info)(Type String))

    (Ignore_Bits(Usage Info)(Type Integer)(Value 6)
      (Description "Fill tapped delay line."))
    (Max_Init_Aggressors(Usage Info)(Type Integer)(Value 25)
      (Description "Maximum number of aggressors."))
    (Init_Returns_Impulse(Usage Info)(Type Boolean)(Value True)
      (Description "Both impulse and parameters_out returned."))
    (GetWave_Exists(Usage Info)(Type Boolean)(Value True)
      (Description "GetWave is provided."))

    (ISS_Buffer_File (Usage Info)(Value "Intrinsic_Rx")(Type String)
      (Description "Use intrinsic Rx circuit"))
    (ISS_Buffer_Subckt (Usage Info)(Type String) (Value "Intrinsic_Rx")
      (Description "ISS subckt name"))
    (ISS_Buffer_Arguments (Usage Info)(Type String)
      (Value "DieP DieN PadP PadN Cc=AMI(C_comp) Rt=AMI(Impedance)")
      (Description "Port Order and parameters of ISS subckt Rx_Subckt"))

    (ISS_Package_File (Usage Info)(Value "Package.iss")(Type String)
      (Description "ISS subckt Package found in file Package.iss"))
    (ISS_Package_Subckt (Usage Info)(Type String) (Value "Package")
      (Description "ISS subckt name"))
    (ISS_Package_Arguments (Usage Info)(Type String)
      (Value "PinP PinN PadP PadN Td=AMI(Length) Zo=AMI(Zo)")
      (Description "Port Order and parameters of ISS subckt Package"))


  )
  (Model_Specific
    (boost (Usage In)(Type String)(List "Off" "On")
      (Description "Sets the EQ Boost Off/On"))
    (my_corner (Usage In)(Type String)
      (List "Xslow" "Slow" "Typ" "Fast" "Xfast") (Default "Typ")
      (Description "Process corner to use"))
    (C_comp (Corner 1e-12 1.5e-12 .8e-12) (Usage Info) (Type Float)
      (Description "Buffer C_comp"))
    (Impedance (Range 50 45 55) (Usage Info) (Type Float)
      (Description "Buffer single ended impedance"))

    (Length (Range 100e-12 50e-12 150e-12) (Usage Info) (Type Float)
      (Description "Length in seconds of package T-line"))
    (Zo (Corner 50 45 55) (Usage Info) (Type Float)
      (Description "Impedance of package T-line"))

  )
)
```

User has selected

For Tx

```
Tstonefile=xwc.s4p
Length=150e-12
Z0=45
Tx_Voh=.8
Tx_Vol=0.
```

For Rx

```
C_Comp=1.5e-12
Impedance=45
Length=150e-12
Z0=45
```

SPICE Circuit to generate Impulse Response

```
* Step Response Circuit
.tran 20p 30n
.options post probe


* Stimulus
V_H_stim H_stim 0 DC=0. pwl( 0 0. 1n 0.  1.001n .8 100n .8)
V_L_stim L_stim 0 DC=.8 pwl( 0 .8 1n .8 1.001n 0. 100n 0.)


* Tx Buffer ISS Model
XTx TxPadP TxPadN H_Stim L_Stim Tx_Tstone
* Tx Buffer ISS Model


* Tx Package ISS Model
XTxPkg TxPinP TxPinN TxPadP TxPadN Package Td=150e-12 Zo=45


* The channel
W1 TxPinP TxPinN 0 RxPinP RxPinN 0 N=2 RLGCmodel=Channel_Wline L=0.5080


* Rx Packge ISS Model
XRxPkg RxPinP RxPinN RxPadP RxPadN Package Td=150e-12 Zo=45


* Rx Buffer ISS Model
X1 RxDieP RxDieN RxPadP RxPadN Package Rt=45 Cc=1.5e-12


* Probe the Rx at the Die
.probe tran v(RxDieP,RxDieN)
```

```
* Supporting subckts


* Tx Buffer ISS Model
.subckt Intrinsic_Tstone 1 2 3 4
* Port order of Touchstone file is PadP PadN DieP DieN
S1 1 2 3 40 mname=A
.model A TSTONEFILE='xwc.s4p'
.ends Intrinsic_Tstone

* Tx and Rx Package ISS Model
.subckt Package PinP PinN PadP PadN Td=100p Zo=50.
TP PinP 0 PadP 0 Td='Td' Zo='Zo'
TN PinN 0 PadN 0 Td='Td' Zo='Zo'
.ends Package

* Rx Buffer ISS Model
.subckt Intrinsic _Subckt DieP DieN PadP PadN
+ Rt=1Meg Cc=0. Vt=0. Cac=0. Rac=1Meg Rd=1Meg Cd=0.
E_H DieP 0 VCVS PadP 0 1.
E_L DieN 0 VCVS PadN 0 1.
R_Rd PadP PadN R='Rd'
C_Rd PadP PadN C='Cd'
R_Rt_H PadP Vt R='Rt'
R_Rt_H PadN Vt R='Rt'
V_Vt Vt 0 DC='Vt'
C_Cc_H PadP 0 C='Cc'
C_CC_L PadN 0 C='Cc'
R_ac PadP Nac R='Rac'
C_ac PadN Nac C='Cac'
.ends Intrinsic _Subckt

* Channel W-line Model
.model Channel_Wline W MODELTYPE=RLGC N=2
+ Ro = +1.02785E+01 +0.00000E+00 +1.02785E+01
+ Lo = +4.37200E-07 +9.24700E-08 +4.37200E-07
+ Co = +1.13200E-10 -2.39500E-11 +1.13200E-10
+ Rs = +1.64438E-03 +7.28589E-05 +1.64438E-03
+ Gd = +1.42300E-11 -3.01000E-12 +1.42300E-11
.end
```

```
****************************************************************************
****************************************************************************
```

ANALYSIS PATH/DATA THAT LED TO SPECIFICATION

The parameters defined in this BIRD came from commercial IBIS-AMI model
development efforts where new functionality was needed to meet customer
expectations for model functionality, accuracy and performance. The
parameters in this BIRD were defined by SiSoft and its semiconductor
partners. These parameters are being contributed to IBIS to ensure IBIS-AMI
model accuracy and portability.


```
****************************************************************************
```

ANY OTHER BACKGROUND INFORMATION:

This BIRD is being requested by the following IBIS users and model
developers, in conjunction with the authors:

        Cisco Systems: Upen Reddy, Doug White
        Ericsson: Anders Ekholm
        Broadcom: Yunong Gan
        IBM: Adge Hawes
        TI: Alfred Chong, Srikanth Sundaram


```
****************************************************************************
```