

Case Study: IBM 15Gb IBIS-AMI Model using Dependency Tables

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The IBM 15Gb Chip-to-Chip (C2C) Core

- Chip-chip only (lower cost)
- Cu032 technology
- 15.0 Gb operation (12.5Gb for 1.05v termination voltage)
- 3 FFE taps
- 1 DFE tap
- AGC
- Dynamic Peaking (15 filter settings)

The IBM 15Gb Chip-to-Chip (C2C) Core – User settings

- 4 Corners
 - Nominal, Best, Worst, Extreme
- Termination Voltage (2 settings)
 - 1.20V or 1.05V operation
- NEGZ control (2 settings)
 - Switches in a stronger level of peaking
- H1Limit (4 settings)
 - DFE limit algorithm
- FC1667 noise integration bandwidth (2 settings)
 - Uses different Rx RJ parameters
- Tx coupling (2 settings)
 - AC or DC
- Gain (3 settings)
 - Reflects characteristics of AGC gain, different on-die S-parameters and peaking profile
- Tx power setting
- **140 support files covering all combinations**

AMI configuration - conventional

- 2 versions of "Corner" mapping
 - (Nom, Best, Worst) & (Nom, Best, Extreme)
- 2 versions for VTT/VTR
 - 1.05V and 1.20V
- 2 versions for NEGZ control
- 3 versions for "gain" settings
 - mid, min, max
- 4 versions for H1Limit
- 2 versions for RJ version

Perhaps **192** AMI configuration files to choose from, e.g.

"VTR1_05NEGZ0midH10FC0W.am1"

Dependency Tables

- Allow parameter values to be dependent on user selection of other variables
- Resolved by the EDA tool before simulation
- Expands the number of corners that may be simulated
- Dependent conditions can have multiple effect
 - i.e. more than one variable can be dependent
- Variable substitution can reduce table entries
- Drastically reduces the number of configuration files required
- Was BIRD 124

AMI Configuration using Dependency Tables: User Variables

```
(txcorner
  (Usage Info)
  (Type String)
  (Description "Tx Corners")
  (List "nc" "wc" "bc" "ec"))
(cmode
  (Usage Info)
  (Type String)
  (Description "Coupling mode")
  (List "ac" "dc"))
(VTT
  (Usage Info)
  (Type Float)
  (Description "Transmitter terminal
voltage")
  (List 1.05 1.20))
(txpow
  (Usage Info)
  (Type Integer)
  (Description "Tx power register")
  (Range 60 32 64))
```

```
(rxcorner
  (Usage Info)(Type String)
  (Description "Corners")
  (List "nc" "wc" "bc" "ec"))
(gain
  (Usage Info)(Type String)
  (Description "S-parameter gain settings")
  (List "mid" "min" "max"))
(negz
  (Usage Info)(Type Integer)
  (Description "NEGZEN bit")
  (List 0 1))
(VTR
  (Usage Info)(Type Float)
  (Description "Receiver terminal voltage")
  (List 1.05 1.20))
(H1limit
  (Usage Info)(Type Integer)
  (Description "DFE H1 Limit")
  (Range 3 0 7))
(Fc1667
  (Usage Info)(Type Integer)
  (Description "Fc/1667 (6Mz) noise integration
bandwidth")
  (List 0 1))
```

IBM 15G C2C Dependencies

- Transmitter Voltage level
 - PWL relationship to TXPOW user setting
- SJ magnitude
 - Corner, mode, VTT/VTR
- On-die S-parameters (Tx/Rx)
 - Corner, gain, NEGZ, VTT/VTR
- Peaking Filters
 - Corner, gain, VTR, NEGZ
- AGC
 - Corner, VTR
- Rotator Linearity
 - Corner, VTR, baud rate

AGC Dependency Table example

```
(Rx_AGC_Dependency_Table
  (Usage Info)
  (Type String Float Float Float Float Float)
  (Table
    (Labels "rxcorner In" "VTR In" "RX_Receiver_Sensitivity Out_Range"
      "agcmax Out_Range" "agcmin Out_Range" "agclev Out_Range")
    ("ec" 1.05 0.018 1.460 0.293 0.247)
    ("wc" 1.05 0.016 1.490 0.285 0.260)
    ("nc" 1.05 0.013 1.338 0.258 0.264)
    ("bc" 1.05 0.015 1.220 0.241 0.281)
    ("ec" 1.20 0.019 1.567 0.292 0.216)
    ("wc" 1.20 0.018 1.607 0.292 0.226)
    ("nc" 1.20 0.016 1.464 0.271 0.245)
    ("bc" 1.20 0.012 1.330 0.256 0.260)
  )
)
```

Rx IC and Peaking Dependency Table

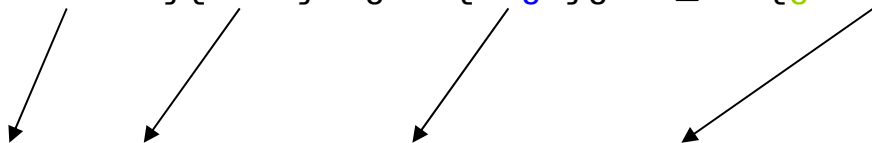
```
(rx_Dependency_Table
(Usage Info)
(Type String String Integer Float String String)
(Table
(Labels "rxcorner In" "gain In" "negz In" "VTR In" "Tstonefile Out_Range" "rxcte Out_Range")
("nc" "mid" 0 1.05 ".../ncAVTR1_05negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen0gain_dec255.cte.ami")
("nc" "mid" 0 1.20 ".../ncAVTR1_2negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen0gain_dec255.cte.ami")
("wc" "mid" 0 1.05 ".../wCAVTR1negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen0gain_dec255.cte.ami")
("wc" "mid" 0 1.20 ".../wCAVTR1_1negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen0gain_dec255.cte.ami")
("bc" "mid" 0 1.05 ".../bcAVTR1_08negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen0gain_dec255.cte.ami")
("bc" "mid" 0 1.20 ".../bcAVTR1_26negzen0gain_dec255peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen0gain_dec255.cte.ami")
("nc" "min" 0 1.05 ".../ncAVTR1_05negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen0gain_dec0.cte.ami")
("nc" "min" 0 1.20 ".../ncAVTR1_2negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen0gain_dec0.cte.ami")
("wc" "min" 0 1.05 ".../wCAVTR1negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen0gain_dec0.cte.ami")
("wc" "min" 0 1.20 ".../wCAVTR1_1negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen0gain_dec0.cte.ami")
("bc" "min" 0 1.05 ".../bcAVTR1_08negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen0gain_dec0.cte.ami")
("bc" "min" 0 1.20 ".../bcAVTR1_26negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen0gain_dec0.cte.ami")
("ec" "min" 0 1.05 ".../ecAVTR0_95negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ecAVTR0_95negzen0gain_dec0.cte.ami")
("ec" "min" 0 1.20 ".../ecAVTR1_05negzen0gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ecAVTR1_05negzen0gain_dec0.cte.ami")
("nc" "max" 0 1.05 ".../ncAVTR1_05negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen0gain_dec65535.cte.ami")
("nc" "max" 0 1.20 ".../ncAVTR1_2negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen0gain_dec65535.cte.ami")
("wc" "max" 0 1.05 ".../wCAVTR1negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen0gain_dec65535.cte.ami")
("wc" "max" 0 1.20 ".../wCAVTR1_1negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen0gain_dec65535.cte.ami")
("bc" "max" 0 1.05 ".../bcAVTR1_08negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen0gain_dec65535.cte.ami")
("bc" "max" 0 1.20 ".../bcAVTR1_26negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen0gain_dec65535.cte.ami")
("ec" "max" 0 1.05 ".../ecAVTR0_95negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ecAVTR0_95negzen0gain_dec65535.cte.ami")
("ec" "max" 0 1.20 ".../ecAVTR1_05negzen0gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ecAVTR1_05negzen0gain_dec65535.cte.ami")
("nc" "mid" 1 1.05 ".../ncAVTR1_05negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen1gain_dec255.cte.ami")
("nc" "mid" 1 1.20 ".../ncAVTR1_2negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen1gain_dec255.cte.ami")
("wc" "mid" 1 1.05 ".../wCAVTR1negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen1gain_dec255.cte.ami")
("wc" "mid" 1 1.20 ".../wCAVTR1_1negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen1gain_dec255.cte.ami")
("bc" "mid" 1 1.05 ".../bcAVTR1_08negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen1gain_dec255.cte.ami")
("bc" "mid" 1 1.20 ".../bcAVTR1_26negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen1gain_dec255.cte.ami")
("ec" "mid" 1 1.05 ".../ecAVTR0_95negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ecAVTR0_95negzen1gain_dec255.cte.ami")
("ec" "mid" 1 1.20 ".../ecAVTR1_05negzen1gain_dec255peak_dec0_norm.s4p" ".../ic_rx_ecAVTR1_05negzen1gain_dec255.cte.ami")
("nc" "min" 1 1.05 ".../ncAVTR1_05negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen1gain_dec0.cte.ami")
("nc" "min" 1 1.20 ".../ncAVTR1_2negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen1gain_dec0.cte.ami")
("wc" "min" 1 1.05 ".../wCAVTR1negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen1gain_dec0.cte.ami")
("wc" "min" 1 1.20 ".../wCAVTR1_1negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen1gain_dec0.cte.ami")
("bc" "min" 1 1.05 ".../bcAVTR1_08negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen1gain_dec0.cte.ami")
("bc" "min" 1 1.20 ".../bcAVTR1_26negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen1gain_dec0.cte.ami")
("ec" "min" 1 1.05 ".../ecAVTR0_95negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ecAVTR0_95negzen1gain_dec0.cte.ami")
("ec" "min" 1 1.20 ".../ecAVTR1_05negzen1gain_dec0peak_dec0_norm.s4p" ".../ic_rx_ecAVTR1_05negzen1gain_dec0.cte.ami")
("nc" "max" 1 1.05 ".../ncAVTR1_05negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_05negzen1gain_dec65535.cte.ami")
("nc" "max" 1 1.20 ".../ncAVTR1_2negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ncAVTR1_2negzen1gain_dec65535.cte.ami")
("wc" "max" 1 1.05 ".../wCAVTR1negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1negzen1gain_dec65535.cte.ami")
("wc" "max" 1 1.20 ".../wCAVTR1_1negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_wCAVTR1_1negzen1gain_dec65535.cte.ami")
("bc" "max" 1 1.05 ".../bcAVTR1_08negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_08negzen1gain_dec65535.cte.ami")
("bc" "max" 1 1.20 ".../bcAVTR1_26negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_bcAVTR1_26negzen1gain_dec65535.cte.ami")
("ec" "max" 1 1.05 ".../ecAVTR0_95negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ecAVTR0_95negzen1gain_dec65535.cte.ami")
("ec" "max" 1 1.20 ".../ecAVTR1_05negzen1gain_dec65535peak_dec0_norm.s4p" ".../ic_rx_ecAVTR1_05negzen1gain_dec65535.cte.ami")))
```

Variable substitution

- Curly brackets indicate variable substitution
- Can save space where parameter filenames are logical
- Dependency tables can prepare variables for substitution

```
(Tstonefile
  (Usage Info)
  (Type String)
  (Value
    "hss15c2c/cu032/{rxcorner}{VTRV}negzen{negz}gain_dec{gain_dec}peak_dec0_norm.s
    4p"))
```

"hss15c2c/cu032/**ncAVTR1_05**negzen**0**gain_dec**255**peak_dec0_norm.s4p"



- Curly brackets banned from normal variable names

Example variable substitution

```
(VTRV (Usage Info) (Type String)
  (Description "AVTR name string")
  (List "AVTR0_95" "AVTR1" "AVTR1_05" "AVTR1_08" "AVTR1_1" "AVTR1_26" "AVTR1_2")
)
(VTRV_Dependency_Table (Usage Info)
  (Type String Float String )
  (Table
    (Labels "rxcorner In" "VTR In" "VTRV Out_Match")
    (
      { "nc" 1.05 "AVTR1_05" }
      { "bc" 1.05 "AVTR1_08" }
      { "wc" 1.05 "AVTR1" }
      { "ec" 1.05 "AVTR0_95" }
      { "nc" 1.20 "AVTR1_2" }
      { "bc" 1.20 "AVTR1_26" }
      { "wc" 1.20 "AVTR1_1" }
      { "ec" 1.20 "AVTR1_05" }
    ))
)
(gain_dec
  (Usage Info)
  (Type String)
  (Description "Gain value string")
  (List "0" "255" "65535"))
(gain_dec_Dependency_Table (Usage Info)
  (Type String String )
  (Table
    (Labels "gain In" "gain_dec Out_Match")
    (
      { "min" "0" }
      { "mid" "255" }
      { "max" "65535" }
    ))
)
(Tstonefile (Usage Info) (Type String)
  (Value
    "hss15c2c/cu032/{rxcorner}{VTRV}negzen{negz}gain_dec{gain_dec}peak_dec0_norm.s4p"))
```

Other "modern" parameters in IBM 15G C2C configuration file

- Tstonefile/RxIC
 - On-die s-parameters called up by ami config file
- DLLPath
 - Path to tx/rx DLL
- Supporting_Files
 - HSSCDR executables, data files
- DLLid
 - Allows multiple instances
- Labels
 - Gives extra information about user-selectable variables

Conclusions

- New models have outgrown simple AMI configuration – and it's only going to get more complicated:
 - IBM 15G backplane (BP)
 - IBM 28G BP
- Dependency tables allow selection based on other variables
- Variable substitution allows filenames to be automatically chosen
- Latest configuration parameters
- Alternative is 100+ .ami configuration files