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Enabling Cross Connected Differential Tx-Rx System Using IBIS [Series_switch]

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Agenda

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3 Solution

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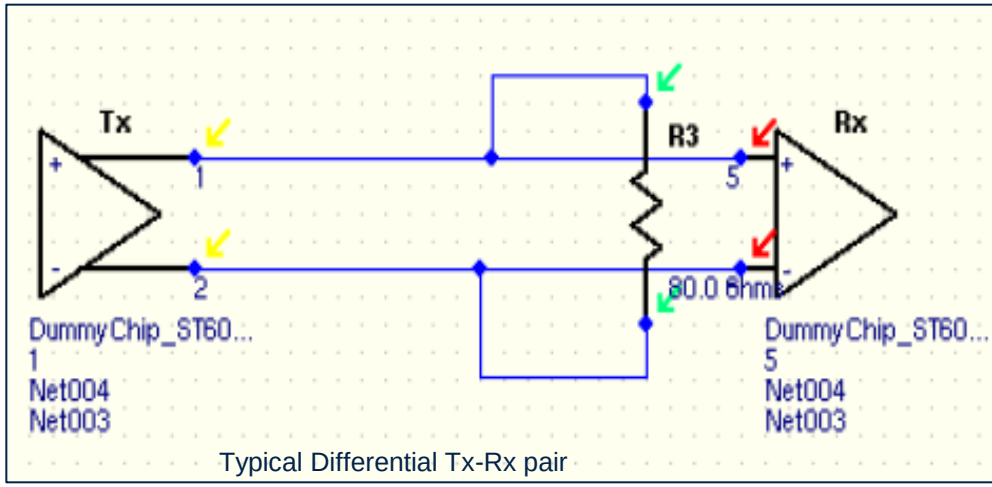
Introduction

Conventional Tx-Rx Pair using IBIS model:

- Typically, a differential system has a Tx-Rx connected pair.
- The On termination between Rx pad is described using a Series Model.
- Using Series Pin Mapping the Series model is connected between appropriate pad.
- **[R Series]** works fine with such system.
- Once Tx is off complete system will be off.
- The above system does not have any control over termination.

This modelling strategy using Series Model poses challenge when used with cross-connected differential pairs.



Typical Differential Tx-Rx pair

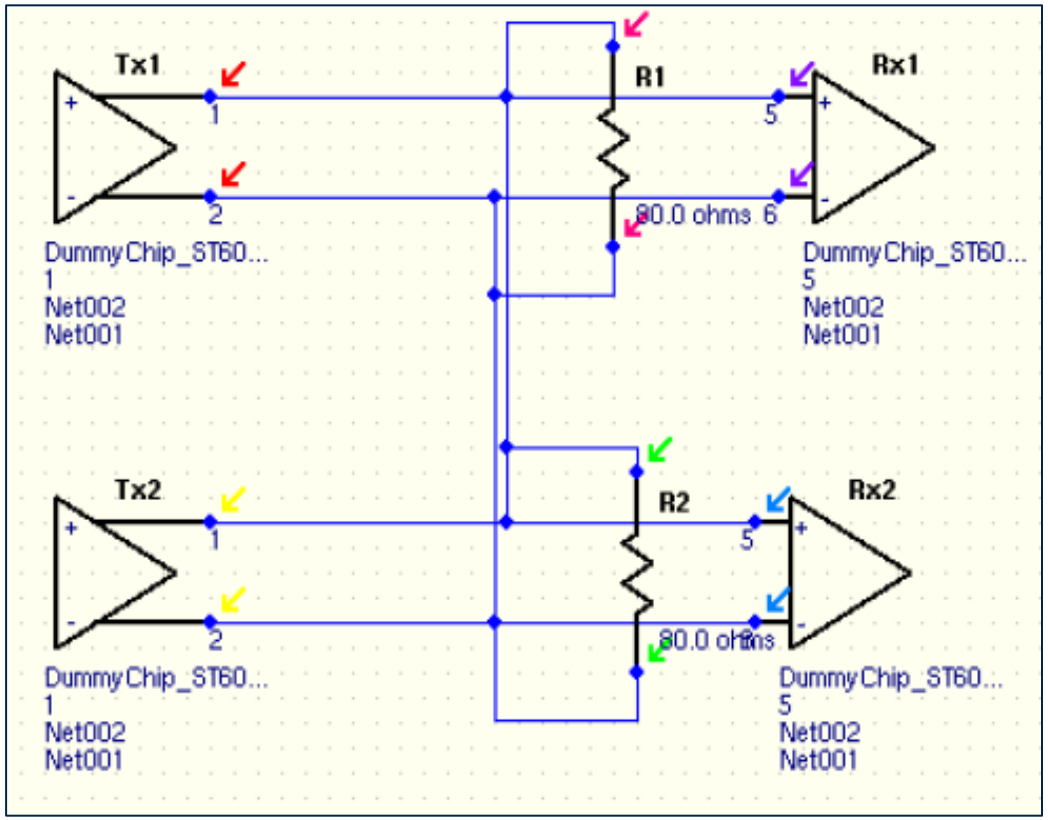
```
[Model]   SER_MOD
Model_type   Series
Polarity   Non-Inverting
C_comp   0pF   0pF   0pF
|
| variable        typ    min    max
[Voltage Range]  1.2V  1.14V  1.26V
|
| variable R(typ)  R(min)  R(max)
[R Series]  72.8Ohm   59.2Ohm  89.3Ohm
|
|[End]
```

[R Series] Model

Challenge: cross-connected Tx-Rx Pairs (1/2)

Cross-connected Tx-Rx Pairs using IBIS model:

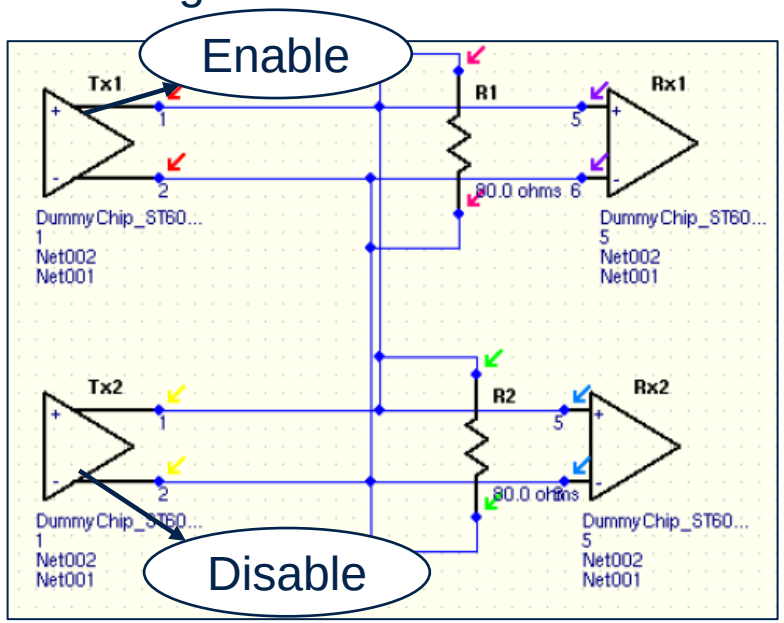
- Two Tx and Rx pair are cross connected for some applications.
- The application requires only one Tx and Rx pair to be active at a time.
- Due to always On termination on Rx, the active Tx will see equivalent termination of both the Rx.
- Also, current flowing from the Pad will be divided between both the Rx.
- It will give reduced and inaccurate Differential Swing between the output pads.

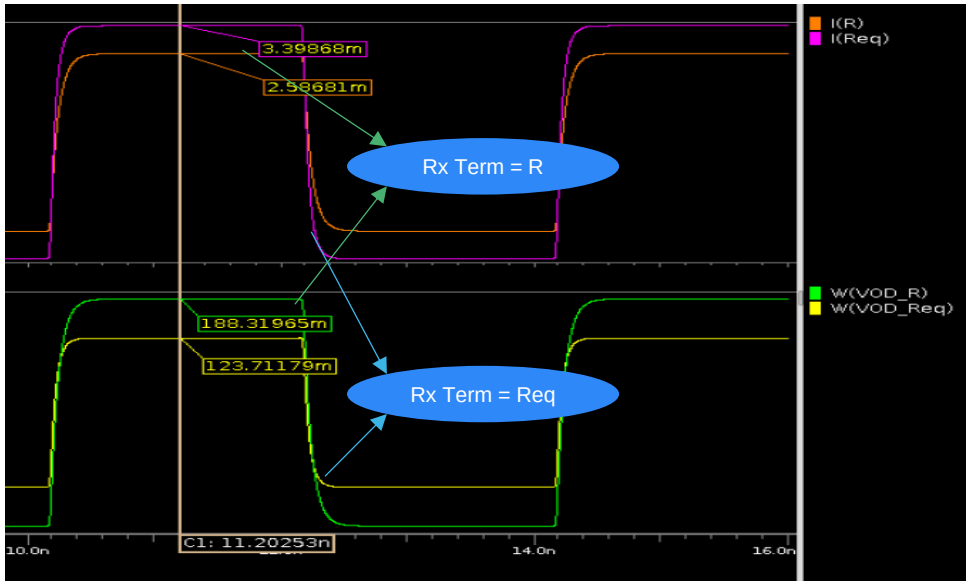


Cross- connected Tx-Rx pair

Challenge: cross-connected Tx-Rx Pairs (2/2)

Tx1 is driving both Rx1 & Rx2





Pad Current and Differential swing of a Tx-Rx pair and Cross connected Tx-Rx pair

	Actual Tx-Rx pair	Cross-connected Tx-Rx pair
Pad Current	2.58mA	3.39mA
Swing	188.32mV	123.71mV

Pad current and Differential swing comparison

- The impedance seen by Tx1 is $Req = \frac{R1*R2}{R1+R2}$.
- Current from Tx1 is divided between Rx1 and Rx2.
- Therefore, due to always On Rx termination, it leads to reduced, inaccurate Differential Output swing on Pad.

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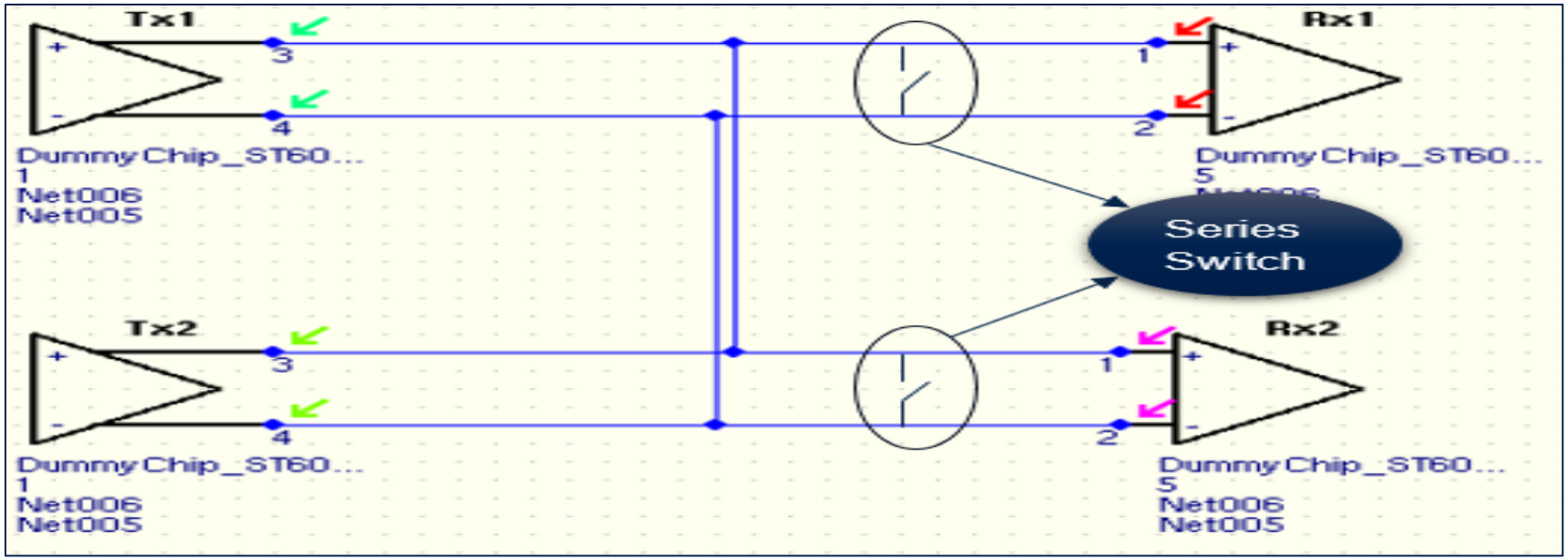
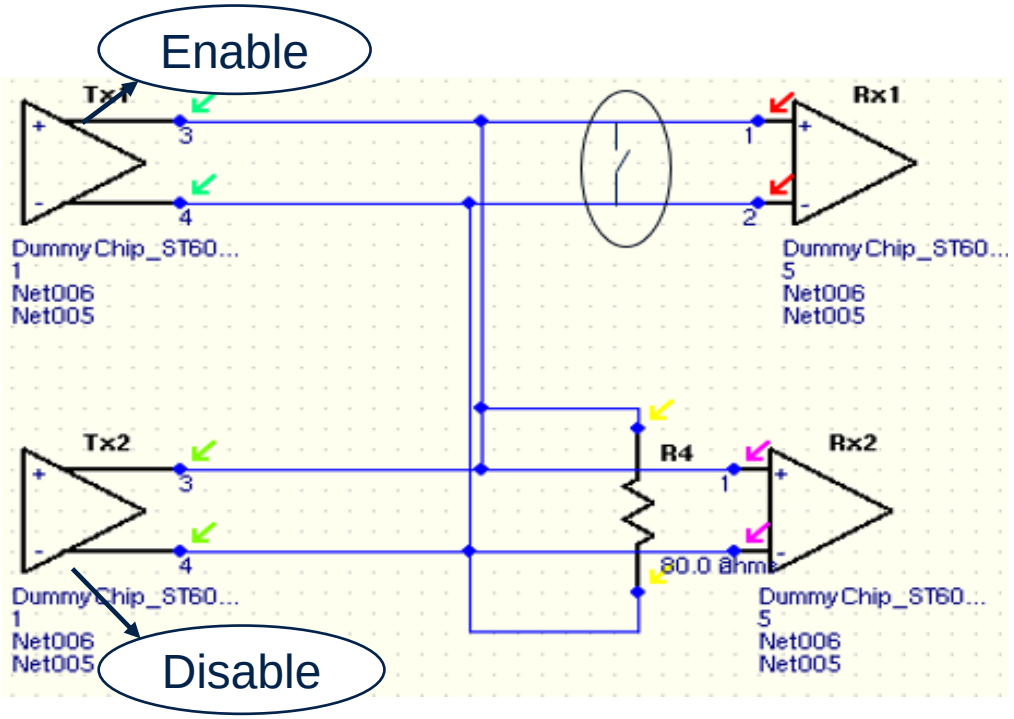
Proposed solution

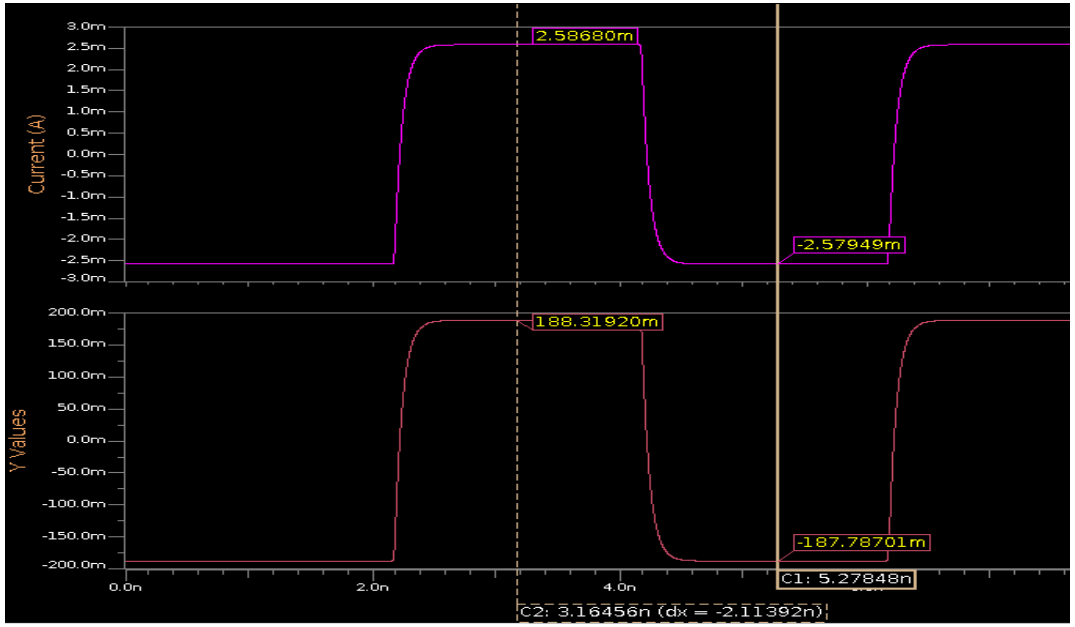


[Series_switch] for termination of receiver:

- The receiver controllability can be achieved using series switch for termination.
- Switch ON and OFF state V/I data will provide active state or high impedance termination to Rx.
- It will enable the system to switch between different Tx-Rx pair.

Validation





Cross connected Tx–Rx pair current and differential swing between pads.

- Series_switch is Off for Rx1 and On for Rx2.
- Tx1 is driving Rx2 only.
- Output Differential Swing between pad is +/- 188mV (matching with expected output).

Conclusion

- **Application specific configuration is gaining demand**
  - IBIS Model must be easy to use
  - Minimal modifications (instantiate and use)

- **Differential receiver's termination modeling**
  - Series model ([R series]) for Rx termination will not work in cross-connected multi-differential Tx-Rx pair.
  - Using [Series_switch] instead of any Series model is most suited option of termination modeling.
    - It can control the receiver's termination state from active to high impedance.
    - Flexible to use as only one time setup is required at customer end for unconventional multiple Tx-Rx pair.

- **[R series] vs [Series_switch] approach**
  - No difference in differential output voltage (V_{od}) is observed, in case of single(typical) Tx-Rx pair.

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