Conditional Control Proposal for IBIS and IBIS-ISS

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Agenda

- **Existing syntax and motivation**
- **Example of Param control**
- **[EMD Model] and [Interconnect Model] structures**
  - **Add Range for restricted continuous Param selections**
  - **Add List for restricted discrete Param selections**
- **Conditionals in IBIS-ISS add more .subckt execution flexibility**
- **Advantages, limitations**
- **Proposals and conclusion**

Param Syntax for IBIS [* Model]

```
| Param name   format value
Param abc      Value  2m                  | 2E-3 in IBIS
Param def      Value  4k                  | 4E3 in IBIS
Param ts_file  Value  "typ.s2p"           | file name string
                                          | passed into IBIS-ISS
```

Only format **Value** is supported, but the format column was added in anticipation of possible future expansion

([Model] with [C Comp Model] supports format **Corner** with typ/min/max columns, but corners are not relevant for Interconnect and EMD structures)

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[EMD Group] Example

[EMD Group] <group_name>

        <EMD Set1> (and NA or file name)

                [EMD Model] <model_name1> and Params

                [EMD Model] <model_name2> and Params

                ….

        <EMD Set2> (and NA or file name)

                [EMD Model] <model_name3> and Params

                [EMD Model] <model_name4> and Params

                ….

        Etc.

[End EMD Group]

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Motivation (1)

- **Param feature avoids redundant [* Model]s since one set of terminal connections and/or one IBIS-ISS model can use different parameter settings**

- **In [EMD Group] or [Interconnect Model Group], all scoped Param entries should be made available to the EDA tool and User for modification**

- **The model developer may have intended that only some Param entries be modified or be restricted to selected values or ranges**

- **Note, only one Param value is still passed to the IBIS-ISS .subckt**

Motivation (2)

- **Displaying all Param entries may be ok if few Param entries are used**
  - **There could be scoping confusion due to having several [* Sets] with embedded [* Model]s AND with identical names**
  - **There are still no modification constraints**
- **Are there other selection solutions?**
  - **Range**
  - **List**
- **Conditional statements in IBIS-ISS are explored**

Motivation (3)

- Add to IBIS Param **Range** <typ> <min> <max> for restricted continuous selections
- Add to IBIS Param **List** for restricted discrete selections
- Add to IBIS-ISS conditional statements (**.IF, .ELSEIF, .ELSE** and **.ENDIF**) for more IBIS-ISS interconnect options and even other usages, e.g.,
  - <u>Combination</u> of selected values (e.g., length, impedance, and Touchstone file selections)

Adding Range and List to Param

```
|  Param  name     format value/list
Param     Length  Range   3m 1m 5m | numeric (<typ> <min> <max>
Param     TS_sel  List    "ts1.ts" "ts2.ts" "ts3.ts" "ts4.ts"
          | fixed string selections showing what is supported
Param     Logic   List    1 2 3 4  | for logic control
```

Range and **List** would be new Param format choices for [EMD Model]s and [Interconnect Model]s

EDA Tools would need **Range** testing and **List** selection interfaces

[EMD Model] Example 1

```
|**************************************************
[EMD Set]          SET_1
| ...
[EMD Model]        MODEL_1
| Param name       format value(s)
Param    Length    Range  3m 1m 5m  | <typ> <min> <max>
|
File_IBIS-ISS      sample1.iss      Subckt_1
Number_of_terminals = 20
1  Pin_I/O          pin_name        A1
2  Pin_I/O          pin_name        A2
| ...
19 Pin_Rail         pin_name        P3
20 Pin_Rail         pin_name        P4
[End EMD Model]
[End EMD Set]
```

IBIS-ISS sample1.iss

default value

```
.SUBCKT Subckt_1 1 2 ... 19 20 Length = 3m
$ Common code or Xsubckt call uses parameter
$ Length
.ENDS
```

[EMD Model] Example 2

```
|*******************************************************
[EMD Set]         SET_2
| ...
[EMD Model]       MODEL_2
| Param name      format value(s)
Param    TS_sel   List    "ts1.ts" "ts2.ts" "ts3.ts" "ts4.ts"
|
File_IBIS-ISS     sample2.iss     Subckt_2
Number_of_terminals = 20
1  Pin_I/O        pin_name        A1
2  Pin_I/O        pin_name        A2
| ...
19 Pin_Rail       pin_name        P3
20 Pin_Rail       pin_name        P4
[End EMD Model]
[End EMD Set]
```

IBIS-ISS sample2.iss

default value

```
.SUBCKT Subckt_2 1 2 ... 19 20
+                       TS_sel = "ts1.ts"
$ Common code or Xsubckt call uses parameter
$ tsfile = str('TS_sel')
.ENDS
```

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Add IF-ELSE Syntax to IBIS-ISS

- Add **.IF, .ELSE, .ELSEIF, .ENDIF**
- **(Already documented in HSPICE)**
- **Would work with Param Range and List addition in [EMD Model] and [Interconnect Model] Syntax**
- **Nested conditional statements (conditionals within conditionals) can be supported**
  - **E.g., use conditionals for one or more combinations of Param entries**
  - **Supports more circuit analysis flexibility**

String Values Not Supported

- **.IF** and **.ELSEIF** syntax do not work for string values
- (However, a single string value can be passed into IBIS-ISS)
- A numeric alternative is possible for pseudo conditional string selections with the **.IF** and **.ELSEIF** statements and additional logic (such as changing *.ts files and multiplier combinations)

[EMD Model] Example 3

```
|*****************************************************************
[EMD Set]        SET_3
| ...
[EMD Model]      MODEL_3
| Param name      format value(s)
Param    TS_Sel   List    1 2 3 4    | String List work around
|
File_IBIS-ISS    sample_3.iss    Subckt_3
Number_of_terminals = 20
1  Pin_I/O       pin_name       A1
2  Pin_I/O       pin_name       A2
| ...
19 Pin_Rail      pin_name       P3
20 Pin_Rail      pin_name       P4
[End EMD Model]
[End EMD Set]
```

IBIS-ISS sample3.iss (for strings)

```
.SUBCKT Subckt_3 1 2 ... 19 20 TS_Sel = 1
.IF (TS_Sel == 1)
tsfile = str('ts1.ts')
.ELSEIF (TS_Sel == 2)
tsfile = str('ts2.ts')
.ELSEIF (TS_Sel == 3)
tsfile = str('ts3.ts')
.ELSEIF (TS_Sel == 4)
tsfile = str('ts4.ts')
.ELSE
$ Common Touchstone calling code using tsfile
.ENDIF
.ENDS
```

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Proposals and Conclusion

- **BIRD for IBIS [Interconnect Model] and [EMD Model] syntax to add Param Range and List**
  - EDA vendors would need interfaces to test for a single Param Range value or to pass on a single Param List selection
- **ISSIRD for IBIS-ISS conditional statements (already exists in HSPICE) for flexibility**