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IQC – IBIS QUALITY CHECKER

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Overview

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- **Motivation**
  - **SIG ➔ „Siemens“ IBIS Group**
  - **Improve the quality of the IBIS files**
- **Characteristics of the Quality Checker**
  - **begin with the most important tests**
  - **modular structure**
  - **improvements – step-by-step**
- **Example of an IQC**
- **Summary**

SIG – SIEMENS IBIS GROUP

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- **SIG ➔ „Siemens“ IBIS Group**

  ➔ The goal we had ➔

  - **On the SIEMENS WEB-PAGE for ALL to use http://ibis.siemens.com/home**

    ➔ „…define the desired quality level but also explain in detail what we need, and why we need it.”

    ➔ “ ...we expect from our IC vendors high IBIS model availability and quality …”

    ➔ “…hints and examples for IBIS modeling…”

  - **All the results of the SI / EMC – tools are ➔ as good as the models are!**

  - **SIG-Members: ➔SIEMENS ➔ Continental ➔ Nokia Siemens Networks ➔ Fujitsu-Siemens ➔ INFINEON**

IBIS Quality Task Group

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IBIS Quality Task Group – Chairman: Mike LaBonte

- **EXCEL-sheet with quality issues listed (each model ca. 80 lines)**
- **Very extensive and time consuming checks**
- **EXCEL-sheet should be part of the model**
- **Low acceptance, if made by hand**
- **Feasible, only if at least in major parts automated**
- **20-FEB-2008: The IBIS Quality Specification 1.1 is currently under review**
- ***Excerpt from the EXCEL-sheet :***

```
|IQ
|IQ  In column B below mark each item PASS, FAIL, or N/A. The IQ level is the highest level number for which all checks PASS. The
|IQ  IQ level is FAIL if no level completely passes. See IQ_specification.txt for complete descriptions of the checks.
|IQ                          4.1.1      LEVEL 0     [Model] parameters have correct typ/min/max order
|IQ                          4.1.2      LEVEL 0     [Model] Model_type
|IQ                          4.1.3      LEVEL 0     [Model] C_comp is reasonable
|IQ                          4.1.4      LEVEL 1     [Model] C_comp is correct
|IQ                          4.1.5      LEVEL 2a    [Model] C_comp SPICE correlation
|IQ                          4.1.6      LEVEL 2b    [Model] C_comp laboratory correlation
|IQ                          4.1.7      LEVEL 1     [Temperature Range] is reasonable
|IQ                          4.1.8      LEVEL 1     [Voltage Range] or [* Reference] is complete
```

Quality inside a IBIS model

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- **Advantages for all:**
  - **increased confidence of the model**
  - **better comparability between different models**
- **Disadvantages for the :**
  - **VENDOR → very time consuming**
  - **USER → restricted consistency checks only**
    - **→ NO possibility to prove the quality info**
    - **→ vendor „specific“ doing → time consuming**

Conclusion: → **uncertain cost-value ratio**

Remedy: Automation

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- **Old idea**
  - **every company has it‘s own scripts,**
    ➔ for testing of different kind of quality issues

- **Better idea:**
  - **to have the same quality-check for all available**
  - **to improve the quality only once, at the origin (vendor)**
  - **to use all the possible synergy effects**
  - **if the checker is for free,**
    ➔ more acceptance and dissemination will be gained

Thoughts about an „Automatic“ Quality Check

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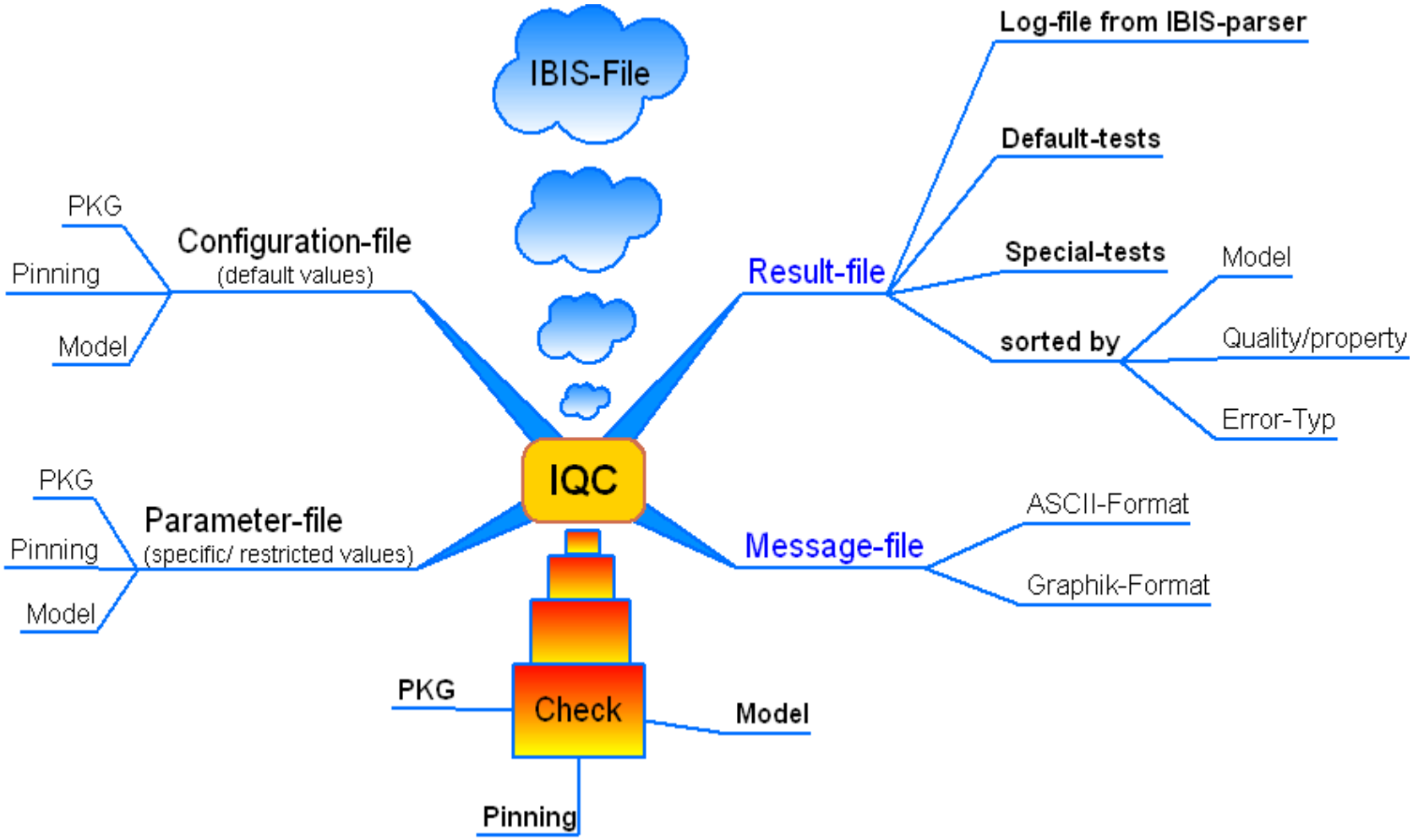
Based on

- ***EXCEL-sheet*** **summary of the** ***Quality Group Initiative***
- ***Needs*** **&** ***requests*** **from the** ***SIG-members***

One possible Proceeding

- **Concept of the Quality Checker**
  - **Priorities should be set by Pareto-principle (80/20)**
  - **A lot of constructive discussions needed**
- **Modular structure**
  - **new checks should be included as „plugins“**
  - **implementation can be distributed on different places/companies**
- **Transfer of the Quality Checker to the Quality Group**
  - **maximum usage for all model VENDORS & USERS**
  - **concentrating all activities at a central point of access**

Structure of the IBIS Quality Checker



What should the IQC do?

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- **Consistency checks for parameter and curves**
  - **inside the IBIS model**
  - **against Data Sheet**
  - **EBD / PKG / Pinning**
- **Curves evaluation and checks**
  - **Compare and find identical tables**
  - **Extract and compare the driver strength**
- **Statistics**
  - **Number of models / #pins w/o models**
  - **Parameter of interest**

Example of an IQC

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- **First step of an IQC was implemented by Dr. Christian Sporrer**

- **Presentation**
  - **Input files**
  - **Concept**
  - **Implementation of initial checks**
  - **Output processing**

IQC Implementation Overview

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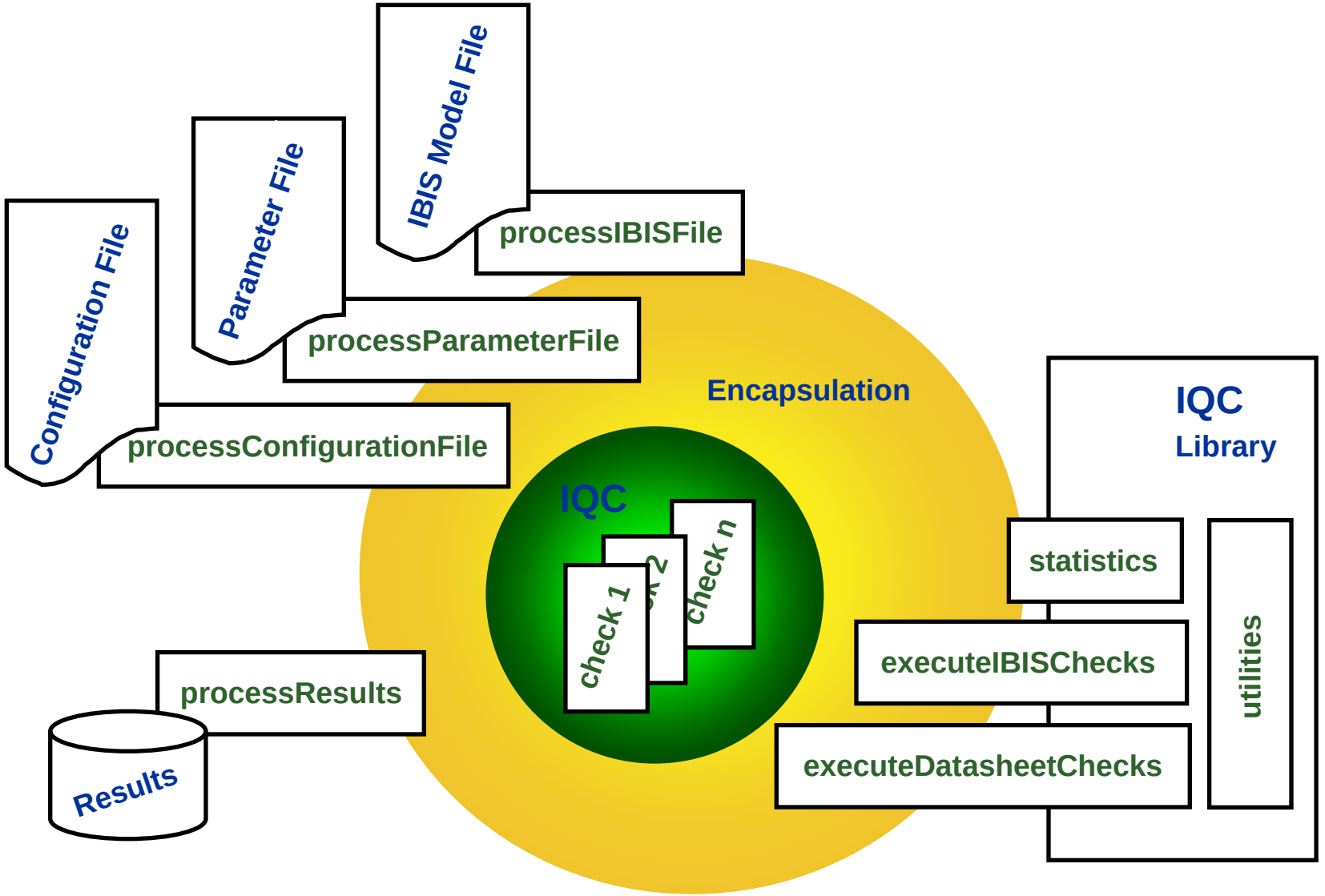

IQC Input Files (Syntax)

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- Same syntax for parameter and configuration files
- Grouped into sections: (@ section delimiter)

```
@A Package
@B Pin
@C Model (general)
@D Model specific information
        @D1 Model class 1
        @D2 Model class 2
@E Datasheet
```

- Parameter entry:

<keyword> :no of parameters: <parameter 1> <parameter 2> ….. # comment

<keyword> is every IBIS keyword (e.g. RAMP)
Non IBIS keywords are indicated with the prefix NI_ (e.g. NI_technology)
<parameter> is a number or string (e.g. cmos for NI_technology)

- Example:

```
@A Package
#=========
#              min    max    tolerance
R_pkg   : 3 :  0.5    1      0.1        # resistor range
L_pkg   : 3 :  2e-9   5e-9   0.1        # inductance range
C_pkg   : 3 :  2e-12  5e-12  0.1        # capacitance range
```

IQC Input Files (Configuration File)

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Configuration File:

- Contains a set of ‚more general' parameters useful for the check of certain classes of IBIS models
- Defines default values to enable a first basic model check

Example:

```
@C Model
#=======
C_comp              : 2 :   10.0e-15   30.0e-12   # min_value  max_value
Voltage Range       : 2 :   1.0        6.0        # min_value  max_value
Temperature Range   : 2 :   0          150        # min_value  max_value
D_overshoot_high    : 1 :   9.0                   # max_value
D_overshoot_low     : 1 :   -3.0                  # min_value
D_overshoot_time    : 1 :   100e-9                # min_value
NI_short_current    : 2 :   1.0e-6     1.0        # min_value  max_value
#
# Ramp
dV/dt_r    : 2 :   3.0/0.2e-9     8.0/0.2e-9     # min_value  max_value
dV/dt_f    : 2 :   3.0/0.2e-9     8.0/0.2e-9     # min_value  max_value
```

IQC Input Files (Parameter File)

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Parameter File:

- Contains all parameters needed to check a specific IBIS model
- Refines most of the values of the configuration file
  (the parameter file overrules the configuration file)
- Can contain specific parameters not defined in the configuration file

Example:

```
@C Model
#=======
C_comp              : 2 :   0.1e-12    5.0e-12    # min_value  max_value
Voltage Range       : 2 :   1.4        1.6        # min_value  max_value
Temperature Range   : 2 :   0          90         # min_value  max_value
D_overshoot_high    : 1 :   4.6                   # max_value
D_overshoot_low     : 1 :   -1.0                  # min_value
D_overshoot_time    : 1 :   3.0e-9                # min_value
NI_technology       : 1 :   cmos                  # (cmos oder bip)
NI_short_current    : 2 :   1.0e-3     25.0e-3    # min_value  max_value
#
# Ramp
dV/dt_r     : 2 :   0.3/0.2e-9     0.8/0.2e-9     # min_value  max_value
dV/dt_f     : 2 :   0.3/0.2e-9     0.8/0.2e-9     # min_value  max_value
```

IQC Input Files (IBIS Model File)

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IBIS Model File:

- The IBIS model file contains the IBIS model to be checked

Example:

```
[Model]                 MODEL_GPIO
|
Model_type              3-state
Polarity                Inverting
|
|                       typ         min         max
C_comp                  2.00e-12    NA          NA
|
Vmeas = 0.750000
Cref  = 2.000000e-11
|
|                       typ         min         max
[Temperature range]     8.00e+01    1.25e+02    0.00e+00
|
|                       typ         min         max
[Voltage range]         1.50e+00    1.40e+00    1.60e+00
```

IQC Library (File IO)

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File IO Methods:

- **processConfigurationFile:**
  - readConfigurationFile()
  - getConfigurationVoltageTolerance()
  - getConfigurtaionTypVoltageRange()
  - getConfigurationTemperatureRange()
  - getConfigurationStepGradient()
  - getConfigurationNumberOfPins()
- **processParameterFile:**
  - readParameterFile()
  - getParameterPackageLimits()
  - getParameterDatasheetModels()
  - getParameterDatasheetPins()
  - getParameterTypVoltage()
- **processResults:**
  - print()
  - printf()
- **processIBISFile:**
  - readIBISFile()
  - getIBISPackage()
  - getIBISPinListPackageAvgMinMax()
  - getIBISPinList()
  - getIBISPinMapping()
  - getIBISModelList()
  - getIBISModel()
  - getIBISModelType()
  - getIBISModelVoltageRange()
  - getIBISModelTemperatureRange()
  - getIBISModelRamp()
  - getIBISModelTestLoad()
  - getIBISModelIVTable()
  - getIBISModelCurrentSum()

IQC Library (Computing)

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Computing Methods:

- **executeIBISChecks:**
  - compareValues()
  - valueSequence()
  - valueSequenceArray()
  - checkPinForModel()
  - checkIVTableOrder()
  - checkRampOrder()
  - checkStairStepping()
  - checkTestLoadCurrent()
- **executeDatasheetChecks:**
  - checkDatasheetModels()
  - checkDatasheetPins()
- **statistics:**
  - countPins()
  - countModels()
  - globalPackage()
  - filePackage()
- **utilities:**
  - file2string()
  - file2array()
  - interpolate()
  - mergeXAxis()

IQC Simple Checks for Demonstrator

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Checks implemented for the IQC Demonstrator:

- **Section A (Package):**
  - Range check for global package values
  - Compliance check for pinlist RLC values and global package
- **Section B (Pinning):**
  - Number of pins
  - Pins connected to model
- **Section D (Model):**
  - Voltage range
  - Temperature range
  - Ordering of ramp values
  - Ordering of IV tables
- **Section E (Datasheet):**
  - Comparison of model names
  - Comparison of pins

IQC Plug In

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How to create a new check ?

- **More general functions which can be used for several checks should be implemented as method into the IQC library.**
  (High level of reuse, high level of modularity).
- **The check itself is implemented as a method call or a combination of method calls from the IQC library in the IQC main file.**
- **The processing of the results is done using methods from the output processor (not yet implemented).**

IQC Plug In (Example in PERL)

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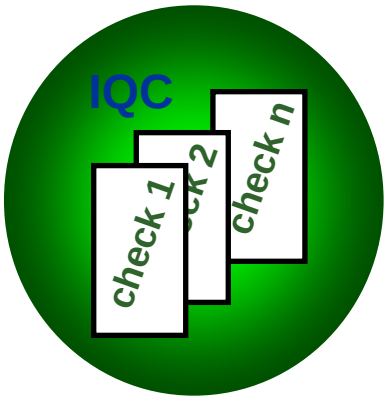
```
### Voltage Check  Plug In ###

# read typ supply voltage range and voltage tolerance from configuration file
my @configFile = $processConfigurationFile->readConfigurationFile($options{cfg}, $path, 'array');
my %vcc_typ_range = $processConfigurationFile->getConfigurationTypVoltageRange(\@configFile);
my %vcc_tolerance = $processConfigurationFile->getConfigurationVoltageTolerance(\@configFile);

# read IBIS voltage range
my @model = $processIBISFile->getIBISModel(\@ibisFile, $modelname);
my %voltage = $processIBISFile->getIBISModelVoltageRange(\@model);

# supply check
if($executeIBISChecks->compareValues($voltage{typ}, $vcc_typ, "=")){
   processResult->print("supply check:  ok    \n“);
}else{
   processResult->print("supply check:  error \n“);
}
# sequence check
if($executeIBISChecks->valueSequence($voltage{min}, $voltage{typ}, $voltage{max})){
   processResult->print("sequence check:  ok    \n“);
}else{
   processResult->print("sequence check:  error \n“);
}
# range check
if($executeIBISChecks->valueSequence($vcc_typ_range{min}, $voltage{typ}, $vcc_typ_range{max})){
    processResult->print("range check:  ok    \n“);
}else{
    processResults->print("range check:  error \n“);
}
```

IQC Library

IQC Library

IQC Library

IQC Library



IQC Output Processor

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Output processor:

- Basic print functionality
- Sophisticated output processing (not yet implemented)
  - Sorted by kind of test, error type, quality level, etc.
  - Configurable output formats

Example:

```
========================= Model Checks ==========================
+++++ Name: MODEL_3549_2411_7  Type: 3-state +++++
D.1 Voltage Checks:
  Correct ordering of IBIS voltage values:                    [x]
  Typical IBIS voltage is compliant to parameter file:        [x]
D.2 Temperature Checks:
  Correct ordering of IBIS temperature values (CMOS):                 [x]
  Typical IBIS temperature is in range of configuration file (CMOS):  [x]
D.4 Ramp Checks:
  Correct ordering of IBIS rising ramp values:      [x]
  Correct ordering of IBIS falling ramp values:     [x]
D.5 IV Table Checks:
  Correct ordering of IBIS I-V table values:
    Pulldown:           [x]
    GND_clamp :         [_]
    Pullup:             [x]
    POWER_clamp:        [_]
```

Summary

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- The success of the IBIS QUALITY TASK requires a commonly accepted procedure of automation
- The benefits of an IQC are indisputable, but no one will start, yet
- Large amount of work, to ímplement the tool, with "all" of the quality checks included at once
- Existing local solutions can be integrated into a powerful centralized solution to the benefit of the whole IBIS community
- If modular concept is used, a reasonable IBIS QUALITY CHECKER should be reachable, which is "self-improving" by use

IBIS QUALITY CHECKER

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Questions