Liberty Files

- Definition
- Format
- Header, Cell Level, Pin Level
- Cell Rise/Fall
- Rise/Fall Transition

What are Liberty Files?

Library Header

```
 *
 * Generated by Liberty NCX vD-2010.06-SP2 on Tue Feb 11 15:51:07 2014
 *
 */
library ("scs8hd_ss_1.60v_-40C") {
        define(switching_power_split_model,library,string);
        define(driver_model,library,string);
        define(leakage_sim_opt,library,string);
        define(default_constraint_arc_mode,library,string);
        define(min_pulse_width_mode,library,string);
        define(default_arc_mode,library,string);
        define(def_sim_opt,library,string);
        define(simulator,library,string);
        define(violation_delay_degrade_pct,timing,string);
        define(sim_opt,timing,string);
        technology("cmos");
        delay_model : "table_lookup";
        bus_naming_style : "%s[%d]";
        in_place_swap_mode : "match_footprint";
        library_features("report_delay_calculation");
        switching_power_split_model : "true";
        simulation : true;
        revision : "1.0000000";
        driver_model : "ramp";
        leakage_sim_opt : "runlvl=5 accurate=1 method=bdf kcltest=1 gmin=1E-15
1 gmin=1E-15 runlvl=5 accurate=1 method=bdf kcltest=1 gmin=1E-15";
        input_threshold_pct_rise : 50.000000;
        input_threshold_pct_fall : 50.000000;
        output_threshold_pct_rise : 50.000000;
        output_threshold_pct_fall : 50.000000;
        slew_lower_threshold_pct_fall : 20.000000;
        slew_lower_threshold_pct_rise : 20.000000;
        slew_upper_threshold_pct_fall : 80.000000;
        slew_upper_threshold_pct_rise : 80.000000;
        slew_derate_from_library : 1.000000;
        time_unit : "1ns";
        voltage_unit : "1V";
        current_unit : "1mA";
        leakage_power_unit : "1nW";
        pulling_resistance_unit : "1kohm";
        capacitive_load_unit(1.000000, \
          "pf");
[iptguser@beazly PVT]$
```

Definition

Liberty Files are a IEEE Standard for defining:

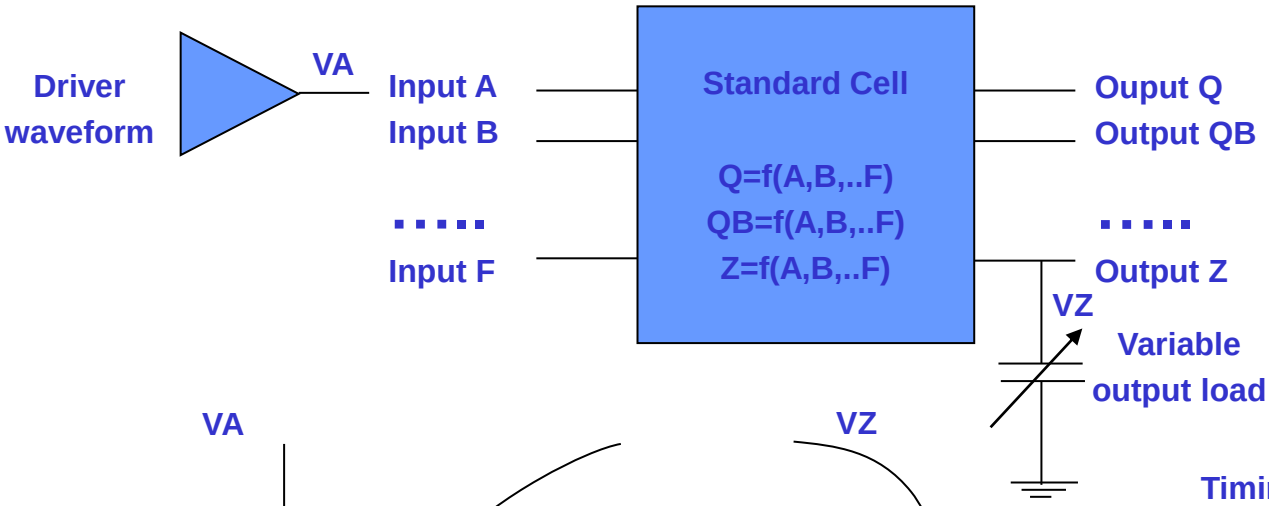
- PVT Characterization
- Relating Input and Output Characteristics
- Timing
- Power
- Noise

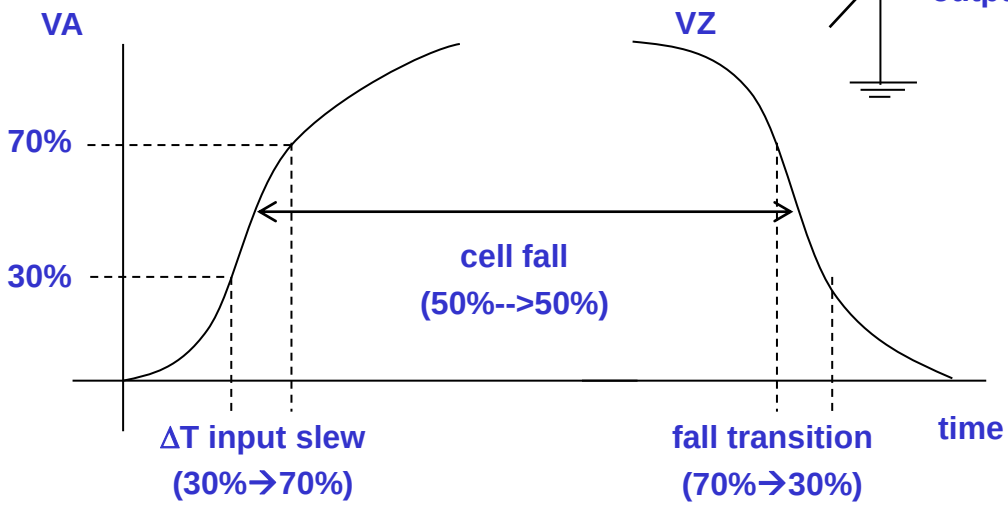
Cell Level Data

```
cell ("scs8hd_inv_1") {
  area : 3.753600;
  cell_footprint : "inv";
  cell_leakage_power : 2.706431e-04;
  driver_waveform_rise : "ramp";
  driver_waveform_fall : "ramp";
  pg_pin (vpwr) {
    voltage_name : "vpwr";
    pg_type : "primary_power";
  }
  pg_pin (vnb) {
    pg_type : "primary_ground";
    voltage_name : "vnb";
  }
  pg_pin (vpb) {
    pg_type : "primary_power";
    voltage_name : "vpb";
  }
  pg_pin (vgnd) {
    voltage_name : "vgnd";
    pg_type : "primary_ground";
  }
  leakage_power () {
    value : "0.0005316";
    when : "A";
  }
  leakage_power () {
    value : "9.6979784e-06";
    when : "!A";
  }
```

Pin Level Data

```
pin (Y) {
  related_ground_pin : "vgnd";
  related_power_pin : "vpwr";
  direction : "output";
  power_down_function : "(!vpwr + vgnd)";
  function : "(!A)";
  max_capacitance : 0.091563;
  max_transition : 1.509138;
  internal_power () {
    related_pin : "A";
    rise_power ("power_outputs_1") {
      index_1("0.01, 0.02305058, 0.05313293, 0.1224745, 0.2823108, 0.6507428, 1.5");
      index_2("0.0005, 0.001191502, 0.002839354, 0.006766192, 0.01612386, 0.03842323, 0.0915627");
      values("0.0062518, 0.0071946, 0.0093343, 0.0143461, 0.0263688, 0.0547859, 0.1220088", \
        "0.0061020, 0.0070752, 0.0092633, 0.0143412, 0.0261788, 0.0544311, 0.1225570", \
        "0.0059729, 0.0069235, 0.0090820, 0.0142317, 0.0261841, 0.0543833, 0.1217514", \
        "0.0058913, 0.0068043, 0.0089347, 0.0139982, 0.0260642, 0.0539628, 0.1222910", \
        "0.0058219, 0.0067152, 0.0088069, 0.0138386, 0.0258450, 0.0540244, 0.1209942", \
        "0.0057802, 0.0066865, 0.0088272, 0.0138701, 0.0255203, 0.0536239, 0.1216766", \
        "0.0054982, 0.0063917, 0.0085146, 0.0136795, 0.0257738, 0.0538937, 0.1201546");
    }
    fall_power ("power_outputs_1") {
      index_1("0.01, 0.02305058, 0.05313293, 0.1224745, 0.2823108, 0.6507428, 1.5");
      index_2("0.0005, 0.001191502, 0.002839354, 0.006766192, 0.01612386, 0.03842323, 0.0915627");
      values("-0.0013610, -0.0021930, -0.0042534, -0.0092393, -0.0211963, -0.0497384, -0.1177492", \
        "-0.0014876, -0.0022924, -0.0043280, -0.0092829, -0.0212175, -0.0497474, -0.1177583", \
        "-0.0016649, -0.0024628, -0.0044496, -0.0093735, -0.0212551, -0.0497668, -0.1177417", \
        "-0.0018531, -0.0026585, -0.0046184, -0.0095065, -0.0213462, -0.0498007, -0.1177699", \
        "-0.0018987, -0.0027040, -0.0047664, -0.0096715, -0.0214666, -0.0498750, -0.1178269", \
        "-0.0019755, -0.0028221, -0.0048465, -0.0097467, -0.0216451, -0.0500093, -0.1178971", \
        "-0.0020241, -0.0028843, -0.0049160, -0.0098884, -0.0217408, -0.0501701, -0.1180006");
    }
  }
```





Timing Characteristics

- Cell Rise/Fall
- 50-50% time delay through cell

- Rise/Fall Transition
- Waveform transition, 30-70%

```
timing () {
  related_pin : "A";
  timing_type : "combinational";
  timing_sense : "negative_unate";
  cell_rise ("del_1_7_7") {
    index_1("0.01, 0.0230506, 0.0531329, 0.122474, 0.282311, 0.650743, 1.5");
    index_2("0.0005, 0.0011915, 0.00283935, 0.00676619, 0.0161239, 0.0384232, 0.0915627");
    values("0.0393913, 0.0481351, 0.0682676, 0.1148176, 0.2261336, 0.4902760, 1.1271604", \
      "0.0455350, 0.0543177, 0.0745882, 0.1219566, 0.2321275, 0.4960252, 1.1251990", \
      "0.0615748, 0.0702546, 0.0903614, 0.1380518, 0.2464881, 0.5123485, 1.1380734", \
      "0.0999742, 0.1085959, 0.1287553, 0.1756036, 0.2859632, 0.5432616, 1.1732209", \
      "0.1745766, 0.1895887, 0.2170584, 0.2652452, 0.3755799, 0.6386030, 1.2626264", \
      "0.3101955, 0.3368956, 0.3853594, 0.4625098, 0.5830301, 0.8453408, 1.4683126", \
      "0.5617597, 0.6087236, 0.6936649, 0.8289562, 1.0322970, 1.3284999, 1.9485167");
  }
  rise_transition ("del_1_7_7") {
    index_1("0.01, 0.0230506, 0.0531329, 0.122474, 0.282311, 0.650743, 1.5");
    index_2("0.0005, 0.0011915, 0.00283935, 0.00676619, 0.0161239, 0.0384232, 0.0915627");
    values("0.0291454, 0.0406597, 0.0668243, 0.1304383, 0.2795841, 0.6384314, 1.5091380", \
      "0.0292797, 0.0406510, 0.0676452, 0.1294254, 0.2814416, 0.6369616, 1.4898204", \
      "0.0293842, 0.0405772, 0.0673192, 0.1318008, 0.2833689, 0.6380833, 1.5070226", \
      "0.0353473, 0.0441388, 0.0677661, 0.1305581, 0.2815879, 0.6418293, 1.5074368", \
      "0.0603860, 0.0698299, 0.0871389, 0.1366998, 0.2825138, 0.6362187, 1.5013318", \
      "0.1081614, 0.1228129, 0.1486038, 0.1952778, 0.3050307, 0.6431969, 1.4902587", \
      "0.2026567, 0.2243255, 0.2683267, 0.3357463, 0.4515043, 0.6980425, 1.4977894");
  }
```

index_1: Input Waveform Rise Time (ns) (20-80%)

index_2: Output Load (pF)

cell_rise values: delay 50%-50% (ns)

rise_transition values: Output Waveform Rise Time (ns) (20-80%)

Liberty File Structure
Library Header

- **Library name and delay models.**
  - Table lookup is most predominate method. Hence massive number of matrices.
- **Nom_process – FF, SS, FS, SF, TT**
- **Nom_temperature – Simulation Temperature**
- **Nom_voltage – Simulation Voltage Reference**
- **Slew and Delay Threshold Points**
  - Low Slew – 10-20%
  - High Slew – 80-90%
  - Threshold – 50%
- **Sets Units (Voltage, Time, Current, Cap.)**

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Liberty File Structure
Cell Header

- **Cell Name**
- **Area**
  - Cell Area without units
- **Cell Leakage Power**
- **Cell Footprint**
  - Type of Cell (Shorthand)
    - Combinational (NAND, NOR, etc.)
    - Sequential (Flops)

Liberty File Structure
Pin Header

- **Direction -** Input, output, inout, internal
- **Clock Pin**
- **Function**
- **Max Capacitance -**Max output capacitance the output pin can drive.
- **Capacitance -** Input load capacitance
- **Sequential Cells – Flops**
  - Clocked on
  - Next state
  - Clear
  - Preset

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Liberty File Structure
Pin Paramters

- **Internal Power**
  - Output pins in combinational cells define rise_power and fall_power to related input pin. Input and clock pins also define this in sequential cells.
- **Timing**
  - Output pins in combinational cells define: rise_delay, fall_delay, rise_transition, and fall_transition.
  - Output pins in sequential cells define: rise_constraint, fall_constraint (Setup and Hold)