Q'n Apps #E45

Q: Can I measure for pin-to-pin continuity?

Pin-to-pin Continuity

The standard HiLevel continuity test simply tests for the protect diode on the DUT pins by forcing a voltage and observing the current (and vice-versa). But this may not always detect a pin-to-pin short, because if two device pins are shorted together, the net current through each diode does not change. Twice as much current is forced through the parallel combination of two diodes. Therefore the shorted circuit configuration will result in the expected voltage drop across each diode, yielding a passing continuity test. The problem can be solved by performing a continuity test on each pin while grounding the remaining pins, as illustrated below.

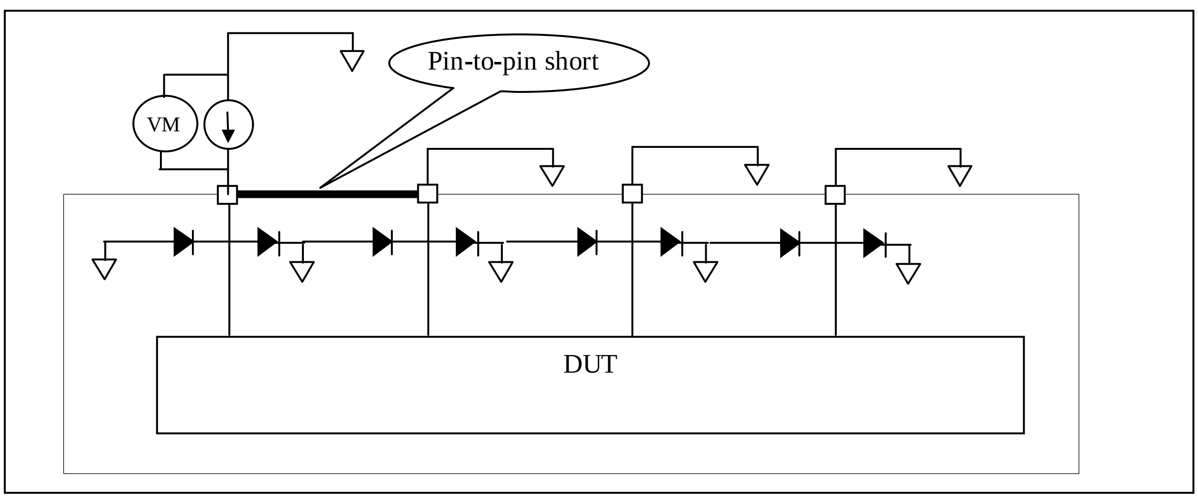

Figure 1. Pin-to-pin short testing

By forcing current and measuring the voltage drop, a complete continuity test results can be done. A simple combination of set files and DC tests can implement this test technique for HiLevel test systems. First, create a set file with all DUT pins defined as "DUT Output" pins. All the pins may be placed in one or many groups; you can use an existing set file and just change the pin direction for every group to ñOutputò. Next, for all groups switch on the programmable loads feature with the commutation voltage set to 0V. The Programmable load current for both IOL and IOH should be set at the same value. This value is typically in the range of 800uA to 5mA, depending on DUT protective diode characteristics and the leakage current specs. It should be no less than 5 times the continuity test force current. By using programmable loads, the grounding circuit for all pins is created. Make sure to set all power supplies to 0V.

Use the DC PMU window to define the pin-to-pin continuity test. Set the test type to ñForce Current Measure Voltageò, give the test a name, and define the pin group for the test so that it contains all the device pins. Define the test conditions as ñRun To Vector 0ò and ñDUT Power offò. Set the force current at least twice the highest leakage current from all DUT pins, but no less than 100uA (actual current value depends on protective diodes characteristic). Set the Limit to 1V and pass condition to ñPass if above 200mVò. Then save set file and the corresponding vector file, with only one vector included. The current settings rule is as follows:

$$I_{\text{Prog. Loads}} >> I_{\text{Force}} >> I_{\text{max. leakage}}$$

The example set file and test results for a 74161 device is shown below:

```
$SetFile 'C:\ ETSusb\74F161\74f161.set'
$VectorFile  'C:\ETSusb\74F161\74f161.TRN'
$ProgramFile  (none specified)
$ScanFile  (none specified)

;SysCh  Pin#     Name       Grp  Type(IOBS)
  10      7      CEP         1      O   ; C= 25.00
  11      6       D3         1      O   ; C= 25.00
  12      5       D2         1      O   ; C= 25.00
  13      4       D1         1      O   ; C= 25.00
  14      3       D0         1      O   ; C= 25.00
  15      2      CLK         1      O   ; C= 25.00
  16      1       MR         1      O   ; C= 25.00
  25      9       PE         1      O   ; C= 25.00
  26     10      CET         1      O   ; C= 25.00
  27     11       Q3         1      O   ; C= 25.00
  28     12       Q2         1      O   ; C= 25.00
  29     13       Q1         1      O   ; C= 25.00
  30     14       Q0         1      O   ; C= 25.00
  31     15       TC         1      O   ; C= 25.00

$PowerSupply 1  0.000 V
$PowerSupply 2  0.000 V
$PowerSupply 3  0.000 V
$SequenceMode Sequencing ;
$StopMode Halt ;
$BreakOnMode Vector ;
$DisplayMode Decimal ;
$StopVector 90
$LastVector 90
$DualThreshold  OFF
$ShortForce -0.300 V
$OpenForce  -1.200 V
$Frequency  10.000 MHz

$TimeForPass   2000

$MultiSiteMode  OFF
$TimingStrobe 1  25.000% ; 25.0 ns
$TimingStrobe 2  25.000% ; 25.0 ns
```

```
$TimingStrobe 3  0.000% ; 0.0 ns
$TimingStrobe 4  0.000% ; 0.0 ns
$TimingStrobe 5  0.000% ; 0.0 ns
$TimingStrobe 6  12.000% ; 12.0 ns
$TimingStrobe 7  20.000% ; 20.0 ns
$TimingStrobe 8  0.000% ; 0.0 ns
$TimingStrobe 9  30.000% ; 30.0 ns
$TimingStrobe 10  0.000% ; 0.0 ns
$TimingStrobe 11  0.000% ; 0.0 ns
$TimingStrobe 12  0.000% ; 0.0 ns
$TimingStrobe 13  0.000% ; 0.0 ns
$TimingStrobe 14  0.000% ; 0.0 ns
$TimingStrobe 15  0.000% ; 0.0 ns
$TimingStrobe 16  0.000% ; 0.0 ns
$TimingStrobe 17  0.000% ; 0.0 ns
$TimingStrobe 18  0.000% ; 0.0 ns
$TimingStrobe 19  0.000% ; 0.0 ns
$TimingStrobe 20  0.000% ; 0.0 ns
$TimingStrobe 21  0.000% ; 0.0 ns
$TimingStrobe 22  0.000% ; 0.0 ns
$TimingStrobe 23  0.000% ; 0.0 ns
$TimingStrobe 24  0.000% ; 0.0 ns
$TimingStrobe 25  0.000% ; 0.0 ns
$TimingStrobe 26  0.000% ; 0.0 ns
$TimingStrobe 27  0.000% ; 0.0 ns
$TimingStrobe 28  0.000% ; 0.0 ns
$TimingStrobe 29  0.000% ; 0.0 ns
$TimingStrobe 30  0.000% ; 0.0 ns
$TimingStrobe 31  0.000% ; 0.0 ns
$TimingStrobe 32  0.000% ; 0.0 ns

$Group 1
GroupName  'ALLPINS'
Display  BINARY
HeaderMode  PinName
PinFormat Output
StimFormat NRZ
StimStrobe         5;  0.0ns
TrailingStimStrobe 5;  0.0ns
InhibitStrobe      5;  0.0ns
CompareStrobe      1;  25.0ns
LowLogic   0% Of 1 # 0.000 V ;
HighLogic  0% Of 1 # 4.800 V ;
Threshold  0% Of 1 # 2.000 V ;
Hi_Threshold  0% Of 1 # 0.000 V ;
ProgrammableLoad  ON
IOL mA       5.000
IOH mA       5.000
CommutationVoltage 0% Of 1 # 0.000 V ;
ParallelLoad  OFF
TerminationVoltage 0% Of 1 # 0.085 V ;

$DcParameters ;    Parameters pertaining to the DC PARAMETRIC UNIT

TEST 1: ptopcont  ShowMeasurementDetails ;
      ForceCurrentMeasureVoltage    PowerOff    RunToVector 0 (dec) ;
      ForceValue = 600.000  uA ;
      Limit = 1.000 V ;
      PassRange Between 0.400 V and 8.000 V  ;
      DcPinGroup   all_pins ;
TEST 2:    ; Undefined
```

```
TEST 3:     ; Undefined
TEST 4:     ; Undefined
TEST 5:     ; Undefined
TEST 6:     ; Undefined
TEST 7:     ; Undefined
TEST 8:     ; Undefined
TEST 9:     ; Undefined
TEST 10:     ; Undefined
TEST 11:     ; Undefined
TEST 12:     ; Undefined
TEST 13:     ; Undefined
TEST 14:     ; Undefined
TEST 15:     ; Undefined
TEST 16:     ; Undefined
$DcPinGroups
all_pins     10 11 12 13 14 15 16 25 26 27 28 29 30 31 ;
output       27 28 29 30 31 ;
$NullPinGroup  3 4 5 6 7 8 9 10 11 12 13 14 15 16 ; PinGroups with 'null
name'

$EndDcParameters

$End
```

Sample Set File for 74f161

Here is an example of test results for pins 10 and 11 shorted together. Note that the test fails for both of the pins (highlighted in green).

```
        ---- Device# 2 ----

Test 'ptopcont':    *** Failed ***
 LowLimit: 0.400 V,  HighLimit: 8.000 V,  Compliance: 1.000 V
 Chan    Pin     Name           Status          Forced          Measured
  10   7      CEP          Passed       600.000 uA   583.426 mV
  11   6      D3           Passed       600.000 uA   1.365 V
  12   5      D2           Passed       600.000 uA   1.360 V
  13   4      D1           Passed       600.000 uA   1.360 V
  14   3      D0           Passed       600.000 uA   1.360 V
  15   2      CLK          Passed       600.000 uA   811.098 mV
  16   1      MR           Passed       600.000 uA   1.360 V
  25   9      PE           Passed       600.000 uA   1.360 V
  26   10     CET          Failed       600.000 uA   29.096 mV
  27   11     Q3           Failed       600.000 uA   29.096 mV
  28   12     Q2           Passed       600.000 uA   835.845 mV
  29   13     Q1           Passed       600.000 uA   835.845 mV
  30   14     Q0           Passed       600.000 uA   835.845 mV
  31   15     TC           Passed       600.000 uA   835.845 mV
```

Test results for pins 10 and 11 shorted

System channels 26 and 27 (DUT pins 10 and 11) measure far less current than do the passing pins. On the next page, see test results in which all of the device pins are passing (no short).

Example result for all pins passing:

```
        ---- Device# 3 ----

Test 'ptopcont':    $ Passed $
 LowLimit: 0.400 V,  HighLimit: 8.000 V,  Compliance: 1.000 V
 Chan   Pin    Name            Status          Forced          Measured
  10   7      CEP           Passed       600.000 uA    578.477 mV
  11   6      D3            Passed       600.000 uA    1.360 V
  12   5      D2            Passed       600.000 uA    1.360 V
  13   4      D1            Passed       600.000 uA    1.365 V
  14   3      D0            Passed       600.000 uA    1.360 V
  15   2      CLK           Passed       600.000 uA    811.098 mV
  16   1      MR            Passed       600.000 uA    1.365 V
  25   9      PE            Passed       600.000 uA    1.360 V
  26   10     CET           Passed       600.000 uA    1.360 V
  27   11     Q3            Passed       600.000 uA    830.895 mV
  28   12     Q2            Passed       600.000 uA    835.845 mV
  29   13     Q1            Passed       600.000 uA    835.845 mV
  30   14     Q0            Passed       600.000 uA    835.845 mV
  31   15     TC            Passed       600.000 uA    835.845 mV
```

Test results with all pins passing

See also:
Q'nApp #E1 on the PinList function
Q'nApp #E35 on the Programmable Loads, DCPMU
Q'nApp #E51 on Fast Continuity
Q'nApp #E61 on Pin-to-pin resistance