



## Boundary Scan Ground Bounce Suppression

Boundary-Scan circuitry, while in the process of testing interconnections, can set up and excite current surges on a board. This in turn can cause "ground bounce", where the ground potential in some localized area of a circuit moves (bounces) with respect to that seen at some other area. This can have the effect of superimposing an unwanted clock pulse on the TCK line observed by one or more ICs in a Boundary-Scan chain.

An approach is to anticipate the surge and desensitize the circuit to the unwanted clock pulse at that point in time. This is also difficult to identify and not always possible. However, with Boundary-Scan tests we are fortunate to be able to do exactly this.

Consider the Boundary-Scan TAP state diagram. Transitions from either Update state (Update-xR) to Select-DR-Scan are those taken when TMS is held high when TCK goes 0-1. This is the path normally taken by Agilent 3070 software. If TMS were low during the rising TCK edge, the TAP would transition to Run-Test/Idle instead, and stay there for any additional TCKs, as long as TMS remains low.

Now consider what happens when a TAP is in Update-xR and TCK transitions from 1-0. This is the TCK edge that causes an update action to occur on device outputs, potentially causing a power surge and ground bounce. This bounce will occur some time after the falling edge. It occurs about 50 nsec after the edge, and lasts about 25 nsec. This can look like an extra TCK pulse. If TMS is high when this pulse occurs, the TAP will transition to Select-DR-Scan rather than staying in Update-xR. This ruins the synchronization of this TAP with others in the chain, and also with the 3070's expectation of the TAP state. As testing continues, the affected TAP proceeds out of synchronization and all subsequent test results are completely useless.

This is the expected trajectory: (pcf order TCK, TMS, TDI, TDO)

```
"11ZX" !Update-xR
"01ZX"
"11ZX" !Select-DR-Scan
"00ZX"
"10ZX" !Capture-DR
"00ZX"
```

This is the actual trajectory:

```
"11ZX" !Update-xR
"01ZX"
"11ZX" β Extra TCK cycle injected by ground bounce
"01ZX" β Tap Enters Select-DR-Scan early
"11ZX" !Select-DR-Scan β Tap is NOT HERE, but in Select-IR-Scan
"00ZX"
"10ZX" !Capture-DR β Tap is NOT HERE, but it Capture-IR"
```

```
"00ZX"
```

Now, consider what happens if TMS is low when this extra TCK is injected. Then, the TAP will proceed to Run-Test/Idle. This would also be a problem UNLESS we intended to be going there anyway. What saves our TAP synchronization is the fact that Run-Test/Idle has a self looping transition when TMS is low.

This is the expected trajectory:

```
"11ZX" !Update-xR
"10ZX" β while TCK is still high, switch TMS to 0
"00ZX" β falling edge triggers outputs to change
"10ZX" ! Run-Test/Idle
"01ZX"
"11ZX" !Select-DR-Scan
"00ZX"
"10ZX" !Capture-DR
"00ZX"
```

This is the actual trajectory:

```
"11ZX" !Update-xR
"10ZX" β while TCK is still high, switch TMS to 0
"00ZX" β falling edge triggers outputs to change
"10ZX" β Extra TCK cycle injected
"00ZX" β TAP enters Run-Test/Idle early
"10ZX" ! Run-Test/Idle β TAP stays in Run-Test/Idle
"01ZX"
"11ZX" !Select-DR-Scan
"00ZX"
"10ZX" !Capture-DR
"00ZX"
```

Now, if several devices are chained and one of them suffers the ground bounce induced TCK cycle, it will go to Run-Test/Idle early but wait there for the others to catch up! This maintains synchronization of the TAPs and testing can continue with meaningful results.

Workarounds:

**DISCLAIMER:** This is an undocumented feature at B.02.5x and B.02.7x. Support for this feature will be incorporated into the B.03.00 software release – it will be a selectable Global Option in Agilent Board Consultant and a button that can be clicked on in the SPD Interface.

Workaround 1: UNIX Environment Variable

This unix environment variable can be set up in any shell window by typing at a shell prompt:

```
$ set BSCAN_GROUND_BOUNCE_SUPPRESSION
$ BSCAN_GROUND_BOUNCE_SUPPRESSION=ON
$ export BSCAN_GROUND_BOUNCE_SUPPRESSION
```

NOTE: The unix environment variable will only be set for that particular shell window, so you would need to run Agilent Test Consultant or the SPD Interface from that shell window in order to get the ground bounce suppression for the boundary scan tests.

If you want this unix environment variable to be more global then you can add these lines, minus the shell prompt symbol (\$), to your .profile and/or your .vueprofile. You must do this for each user that wants this variable set up. Adding these lines to your .profile sets the unix environment variable in any shell window that you use as well as if you telnet/rlogin to that machine from a different machine. Adding these lines to your .vueprofile will set the unix environment variable in any GUI that is launched from the vue pop-up menus for that particular login on that machine.

You can type env at a shell prompt:

```
$ env
```

to display the environment information, which includes environment variables. This is an easy way to check whether you have set up the variable correctly.

An example of a .vueprofile with the unix environment variable added into it is provided at the end of this document. The .profile would look similar.

An easy way to check that you are getting ground bounce suppression in your boundary scan tests is to look for the comment:

```
!! Ground Bounce Suppression has been selected.
```

in the top of your vcl file generated from the SPD Interface or the Agilent Interconnect Plus software.

## Workaround 2: ITL Syntax

If you have already generated your boundary scan tests with the Agilent Interconnect Plus software you can still add ground bounce suppression to these tests. Add the following syntax into your ITL file(s) and recompile the test:

```
ground bounce suppression yes
```

Here is an example of where the syntax would go in an interconnect test:

```
!IPG: rev B.02.75 Fri April 24 12:08:43 1998
interconnect "u1_u4"
```

```
ground bounce suppression yes ! add the new syntax
```

```
chain "u1_u4"
tdi "TDI"
tdo "TDO"
tms "TMS"
tck "TCK"
```

```
.
.
end interconnect
```

An easy way to check that you are getting ground bounce suppression in your boundary scan tests is to look for the comment:

**!! Ground Bounce Suppression has been selected.**

in the top of your .vcl file generated from the Agilent Interconnect Plus software.