REEDHOLM

SUPPORT NOTE

SN-130

User Function Connection Methodology

Overview

Depending on connection and biasing methods, some things can cause device damage when testing sensitive devices:

- Narrow voltage spikes when connecting a DUT to the system resources.
- Voltage overshoot when applying power to a DUT with high capacitance.

Starting with RDS DOS 8.1 and RDS Intranet 1.21, instrumentation drivers and application test engines were modified to prevent such damage. This support note describes how to alter custom user functions for compliance with the new software.

Unexpected Spikes

During investigation of possible causes of device damage, it was learned that some spikes have been present since inception of the Reedholm test engine (1987). They were not isolated and addressed before now because damage could not be induced at Reedholm and because they seemed to be random events related to specific customer test structures.

Energy transfers to the DUT when it is connected after charge builds-up on the nodal backplane, matrix, or analog cabling due to leakage currents. If leakage current is high, or if the system is left idle for long periods, charge build-up can be quite large. On the other hand, charge buildup from leakage between tests is usually insignificant.

Another source of charging is inadvertent biasing of test structures due to sneak paths. For instance, a diode isolated test structure could be charged if voltage across the junction leads to avalanche breakdown or zener conduction.

If the DUT presents high impedance at time of contact, a voltage spike results. Since most DUT's are high impedance, or are enhancement mode devices requiring bias to become low impedance, most charging spikes appear as voltage. Of course, short duration current spikes also cause damage.

Charged Connections

There are several ways for a DUT to be connected when damaging charge is present:

- Probe needles touching down with a conducting path to ground through the chuck or directly from the probe card analog connector.
- Matrix pins being connected while the probe needles are in contact with the DUT, thereby discharging cabling that has been charged by sneak paths or connecting nodes that have charged while not being used.

Spikes Due to Range Changes

Instruments capable of supplying current (i.e., VF's, VFIF's, and DMM's in current mode) act something like an inductor when changing ranges by trying to keep current flowing, and thus creating what look like voltage spikes. Problems are generally eliminated with make before break switching, but that does not do much good when upranging from an overranged condition. In such cases, spikes can several volts.

Voltage Overshoot

Reedholm VF and VFIF supplies are designed to be as fast as possible with no overshoot. However, overshoot always happens if a supply goes into current limit while ramping to the target voltage. The amount and shape of overshoot is determined by:

- Capacitance load of DUT
- Current range and limit setting of PS

During the project to eliminate device damage, the largest overshoot seen with a VFIF was roughly 2V and several milliseconds wide. That is more than enough to damage sensitive DUT's or to cause latch-up on some DUT's.

Software Solutions

Overshoot and spike test issues were resolved by making following fundamental changes to both the instrumentation drivers and test engine.

A) VoltsRamp and VoltsRampAll

VoltsRamp and VoltsRampAll driver level routines were added. These ramp a supply to a target voltage and keep voltage overshoot <100mV for DUT's with <1000nF effective capacitance.

Restricted Auto Ranging for Supplies

Once a supply is biased to >|1V|, ranging is no longer permitted. Thus, user functions must be changed to always set appropriate voltage and current ranges initially.

Pins Left Grounded After Power Down

After a test has finished and power is removed, all test system pins are grounded to prevent voltage spikes as instrumentation is disconnected, no matter how unlikely that might be. Pins are left grounded to prevent charge build-up prior to the next test.

New Test Connection Scheme

The test engine calls the same power down code for standard routines and user functions. Thus, user functions need to be changed to unground critical pins. In addition, user functions need to avoid aborts due to new hot switching rules. Figure 1 is an RDS DOS user function with the new connection scheme.

Connection & Bias Steps

1) System pins are grounded if not already grounded. Wait 1ms for relays to close.
2) DMM and supplies set to 100µA
3) DMM (meter low first if applicable) and supplies connected. Wait 1ms for relays to switch and nodes to discharge.
4) DMM is switched to voltage mode if applicable.
5) Supplies set to target current and voltage ranges and fix ranged. Wait 1ms for relays to switch.
6) Pins are disconnected from ground and DUT pins are connected. Wait 1ms for relays.
7) VoltsRamp is called to apply voltage biases.
8) Rest of test is run.

```
CheckGroundPins(True);     (* Gnds pins, PSAzero if not already gnd'd *)
ConfigModsForCon;         (* Set modules to 100uA, includes 1msec dly *)
ConDev(PS,1,1,High);                  (* Connect Drain Supply         *)
ConDev(DMM,1,1,High);                 (* Connect DMM High             *)
ConDev(PS,2,2,High);                  (* Connect Gate Supply          *)
ConDev(PS,3,3,High);                  (* Connect Sub. Supply          *)
RI_Delay(1);                          (* Give time to discharge nodes *)

SetVFIFstoVFs(False);      (* PS 3&4 to 100mA - act like VFs if VFIFs *)
Vrange(DMM,1,DMM_Range);              (* Set Meter Starting Range     *)
FixRange(DMM,1);                      (* Stop Autoranging             *)
Arange(PS,2,PS2_Current);             (* Set Gate Current Range       *)
Vrange(PS,2,PS2_Voltage);             (* Set Gate Voltage Range       *)
Arange(PS,1,PS1_Current);             (* Set Test Current Range       *)
Vrange(PS,1,PS1_Voltage);             (* Set Drain Volt Range         *)
Vrange(PS,3,PS3_Voltage);             (* Set Sub. Voltage Range       *)
FixRange(PS,1);                       (* Fix range PS 1               *)
FixRange(PS,2);                       (* Fix range PS 2               *)
FixRange(PS,3);                       (* Fix range PS 3               *)
Amps(2,PS2_Current);                  (* Set Gate Current Compliance  *)
Amps(1,PS1_Current);                  (* Set Test Current             *)
RI_Delay(1);                     (* Settle PS's before connecting DUT *)

OpenPins;                            (* Only ground pins had been set *)
ConPin(0,LowPin);                     (* Connect Source Pin           *)
ConPin(1,HighPin);                    (* Connect Drain Pin            *)
ConPin(2,CtrlPin);                    (* Connect Gate Pin             *)
ConPin(3,BiasPin);                    (* Connect Sub. Pin             *)
RI_Delay(1);                           (* Give time for pins to close *)

VoltsRamp(2,PS2_Voltage,True);  (* Ramp to Gate Voltage, wait for I  *)
VoltsRamp(3,PS3_Voltage,True);        (* Set Sub. Voltage             *)
VoltsRamp(1,PS1_Voltage,False);   (* Ramp to V, don't wait for Ilmt  *)
RI_Delay(TimeOfDelay);                           (* Wait To Stabilize *)

                       (* REST OF TEST STARTS *)
```

Figure 1 – Example of User Function Connection & Bias Code