Protecting the Integrated Circuit from Over Powering

Application Note

Background

Powering-up a board under test on the *Medalist* i3070 Series 5 in-circuit tester is the pre-condition before the execution of any digital tests on the integrated circuit (IC). ICs on boards may be internally powered by on-board regulators. The on-board regulators can be affected during the testing or debugging procedures, which may cause the regulators to switch off unintentionally due to interference to its enable pins.

This increases the potential difference between the driven signal pins and the internal voltage rail of the IC and thus, can potentially cause damage to the IC pins (protection circuit), as driving continues without power on the voltage rails. The IC will be electrically stressed if testing continues under this “over voltage” condition.

This will incur a lot of rework, manpower and material cost if the IC malfunctions.

Agilent Technologies

Introduction

The *Medalist* i3070 Series 5 in-circuit test system offers a new safety feature called the power monitoring circuit (PMC) that will monitor and react to the above conditions. The objective is to save cost for manufacturers, without compromising test coverage or capabilities.

The PMC is a new safety feature to enable real-time monitoring of the power nodes of the IC to prevent any overdrive current to the pins of the IC if the power to the IC is accidentally turned off. Testing will stop and a failure message will be displayed when the power drops below a user-defined threshold. This feature can be enabled during debugging as well as during mass production.

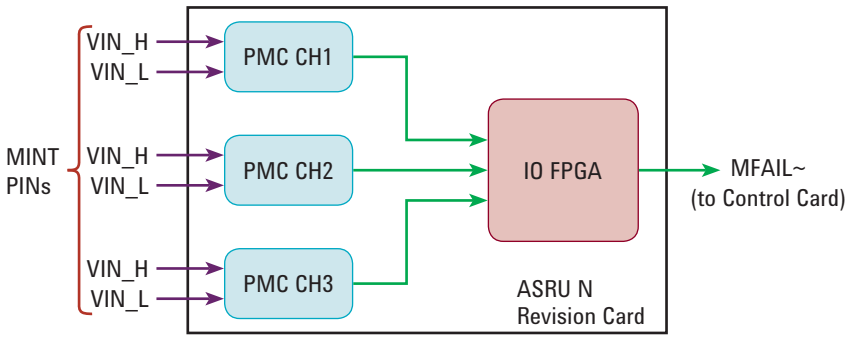

Figure 1. Power monitoring circuit (PMC) block diagram

Figure 1 above shows the PMC that is available in the analog stimulus response unit (ASRU) revision N card. Up to three devices under test (DUT) power supply voltages can be monitored during digital testing per ASRU revision N card. Different voltage limits can be set for each channel. Digital tests such as boundary scan, digital in circuit and mixed test will be halted upon the detection of a power failure during test, to prevent the back-drive current that can cause damage to ICs.

Prior to the availability of PMC in the market, the industry practice was to use powered analog test.

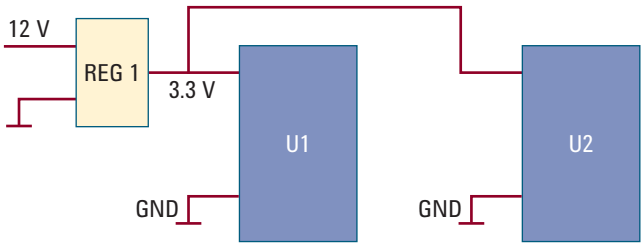

Figure 2. Simple circuit

Figure 2 shows an example whereby the 3.3 V power node output from the voltage regulator is tested through a powered analog test. This test only checks the voltage at the particular instant after powering up. There isn't any concurrent real time power voltage monitoring on the PCBA voltage regulator during digital testing of U1 and U2. The regulator can be affected during testing or debugging and will switch off unintentionally due to unexpected reasons like shorts or noises on its enable pins.

Applying PMC Monitoring On Power Rails

To detect voltage failure of "3.3 V" power node

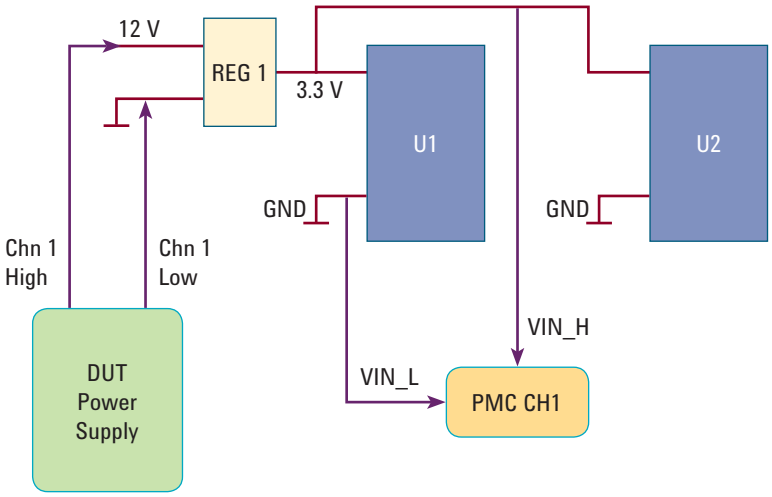

Figure 3. PMC connection to detect voltage failure

The following example is based on the assumption of using PMC Channel 1 on the ASRU revision N card:

1. With reference to Figure 3, connect "3.3 V" node to "Vin_H" of PMC channel 1. Mint pin/personality pin location is 213173.
2. Connect "GND" node to "Vin_L" of PMC channel 1 (Mint pin/personality pin location is 213174).

   Note: the BRC is set to 213173 and 213174 above, because the PMC channel uses ASRU revision N card in module 3. For complete listing of PMC associated BRC, please refer Appendix A.

3. Enable the PMC setting in the testplan.

```
sub Setup_Power_Supplies (Status_Code, Message$)
global PMC_On
    cps
    sps 1, 12.0, 2 optimize
    ....
    if PMC_On the
    spmc 1, 3.0 ! <PMC Channel Id >, <Voltage Trigger Limit>
    spmc interrupt on   !<on/off>
    ....
end if
subend
```

   Note: For a complete listing of new Bt-Basic PMC commands and their details, please refer to Appendix A.

4. The potential difference between "3.3 V" and "GND" is 3.3 volts. In this example, the PMC voltage trigger setting is 3.0 volts. If voltage on the "3.3 V" node drops below 3.0 V, PMC will be triggered to stop U1 and U2 digital tests.

Applying PMC Monitoring On Power Rails

To detect over voltage of "3.3 V" power node

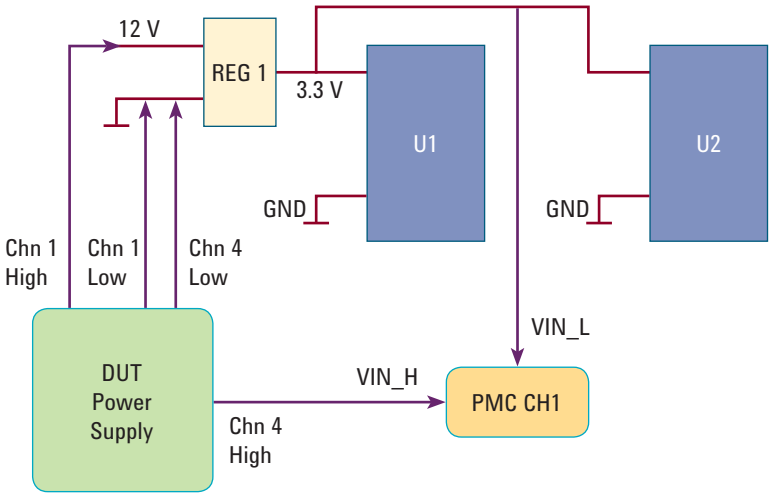

Figure 4. PMC connection to detect over voltage

1. With reference to Figure 4, select an unused[1] DUT power supply channel (example: channel 4) and connect the high output to "Vin_H" of PMC channel 1. Mint pin/personality pin location is 213173.

   Note 1: the BRC is set to 213173 and 213174 above, because PMC channel uses ASRU revision N card in module 3. For complete listing of PMC associated BRC, please refer Appendix A.

2. Connect the Low output of the DUT power supply to the board ground (GND node) so that both reference to the same potential.

3. Connect "3.3 V" node to "Vin_L" of PMC channel 1. Mint pin/personality pin location is 213174.

4. Enable the PMC and voltage setting in the testplan.

```
sub Setup_Power_Supplies (Status_Code, Message$)
global PMC_On
    cps
    sps 1, 12.0, 2; optimize
    sps 4, 5.0, 1; optimize
    ....
    if PMC_On the
    spmc 1, 1.5 ! <PMC Channel Id >, <Voltage Trigger Limit>
    spmc interrupt on   !<on/off>
    ....
end if
subend
```

   Note: For a complete listing of new Bt-Basic PMC commands and their details, please refer to Appendix A.

5. The potential difference between "sps 4" and regulator output ("3.3 V" node) is 1.7 volts for normal operation. If voltage at the "3.3 V" node rose to 3.6 volts such that the new potential difference between the "sps 4" and "3.3 V" is 1.4 volts, which is lower than the voltage trigger limit setting at 1.5 volts, the PMC will be triggered to stop the U1 and U2 digital tests.

Conclusion

The *Medalist* i3070 Series 5 in-circuit test system with its new PMC feature can prevent potential damage to the ICs from unexpected voltage failure or over voltage. It can also help users to identify causes of failures during debugging, such as whether digital tests failed are due to power-up or digital test issues.

The i3070 Series 5. Saves cost. No compromise.

Appendix A

Module	Channel	Vin_H	Vin_L
3	Channel 1	213173	213174
	Channel 2	213175	213176
	Channel 3	213177	213178
2	Channel 4	201173	201174
	Channel 5	201175	201176
	Channel 6	201177	201178
1	Channel 7	123173	123174
	Channel 8	123175	123176
	Channel 9	123177	123178
0	Channel 10	111173	111174
	Channel 11	111175	111176
	Channel 12	111177	111178

Command	Remark
spmc <channel>, <voltage limit>	Use PMC and set voltage limit for a channel
Example: spmc 2, 3.3	Use PMC on channel 2 and set a 3.3 V limit
spmc <channel>, off	Turns off PMC for a channel
Example: spmc 10, off	Turns off PMC channel 10
spmc <off/reset>	Turns off or reset failure flags for all channels
Example: spmc off	Turn PMC off for all channels
spmc interrupt <on/off>	Turns interrupt on/off for all channels
Example: spmc interrupt on	Turn interrupt on for all channels
rpmc <channel>, <flag>	Reads the failure flag for a channel
Example: rpmc 1, V_Flag	Read channel 1 failure flag and store in variable "V_Flag"

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