**Lab 2: Transient Analysis of Bandgap (BG) Voltage Reference**

Background:

Start-up circuit is needed in order to ensure the proper operation of Bandgap Voltage Reference. Most of the circuit block also has a shunt-down pin designed. This allows the circuit block to be power down to save power when necessary. Transient analysis is needed to simulate the proper operation of the start-up circuit and shunt-down pin.

Objectives:

* Familiarisation with transient simulation for a BG Voltage Reference Circuit
* Understanding of the operation of start-up circuit for BG Voltage Reference
1. Transient Simulation
	1. In Library Manager, double-click **BG\_OPAMP/BG\_test\_TRAN**. This is the test bench to test the start up and shut down performance of the circuit.
	2. In BG\_test\_TRAN schematic, click **Launch>ADE\_L**.
	3. In ADE, click **session>Load\_State**. Check ‘**cellview**’ and select **BG\_OPAMP/BG\_test\_TRAN/spectre-state1**. Click OK.
	4. Launch the simulation.
2. Result of transient simulation



Figure 1: Result of transient simulation

* 1. Create a new subwindow and drag /V1/PLUS to it. /V1/PLUS is the supply current of the circuit.
	2. Click on the left subwindow to select it. Click on ‘**Strip\_chart\_mode’**.
	3. Click on the trace /V1/PLUS of right subwindow. Click **Marker>Place>Track\_Marker** and click on the trace /V1/PLUS, to place the marker. It is observed that the current consumption is <1nA when the circuit is shut-down.
	4. More simulation, with different conditions, such as different VDD, process corners, temperatures, risetime of VDD and etc., should be performed to ensure that the design is robust.
	5. As an exercise, please identify the start-up circuit of the bandgap and understand its operating principle.