LTZ1000CH and LTZ1000ACH test, December 2015, chuckb

Overview -

This is a test of each component in the chip at different temperatures and bias currents. Each transistor, the Zener and the heater are all tested separately. The chip is inside a cardboard box which acts as protection from the winds inside the large commercial environmental chamber. The chip was verified to be at the same temperature as the environmental chamber before each test series.

LTZ1000CH Chip date code 1535. Fresh from the Linear tech / Dig key package. It was manufactured in the 35 week of 2015, pretty new!

LTZ1000ACH Chip date code 9616. It was manufactured in the 16^{th} week of 1996. It has been powered constantly for at least the last 5 years at a 95 deg C chip temp.

Setup -

The LTZ1000 leads were brought out of the chamber with 22 ga wires, 1 meter. I would estimate 0.1 ohm of wiring resistance. All testing was essentially a 2-wire measurement.

The transistors had the base shorted to the collector. In operation the base an collector voltages are the same so this is the easy way to simulate that. If you just look at Vbe with a constant current you do not know what base current to use because it depends on Beta, which depends on temperature and current.

A Keithley 2002 with August 2015 calibration was used to measure voltage. It was set to High Accuracy mode (8.5 digits and 10 NPLC).

An EDC 520 was used to supply the bias current. The output current was correct within 0.01% as verified by the K2002 before and after testing.

Transistors were tested at 50, 100, 200 and 1000ua. Q2 was not tested at 1000ua. Heater resistance was tested at 1ma. The zener was tested at 0.5, 1, 2, 4, 8, 10 ma. The 8 and 10 ma results are not shown because they were changing caused by chip heating.

Conclusions –

The chip will do what it's designed to do over a large range of temperatures and bias currents. The transistor biasing resistor (70k typ) needs to be stable but their initial values could be anywhere from 35k to 150k without affecting operation.

The two chips under test were built 20 years apart, one was fresh and the other was well aged and the characteristics that I measured were basically the same.

At 100ua collector current the Vbe of Q1 changes about -2.25 mV / deg C.

At 4 ma the Zener voltage changes about +3.14 mV / deg C. At 0.5ma it's about +2.6mV / deg C.

The zener resistance is about 35 ohms at 50 deg C. It has roughly a 4000 ppm / deg C temp co. This is not Kelvin sensed by Q1. Note the first graph under "Typical Performance Characteristics", page 3, in the LTZ1000 data sheet.

The heater resistance changes at +4000 ppm / deg C. That result indicates that it's an all metal (aluminum?) heater.

Testing the Zener element above a few ma heats the die and changes its temperature. The Zener voltage measurement needs to be performed with pulse techniques or with an actively temperature controlled chip.

When stable at a new ambient temperature, check the heater element and transistors before checking the Zener.

The substrate diode from pin 1 to pin 4 had less than 1pa of leakage at 15v reverse bias at room temperature. So the heater voltage will not directly affect the Zener current in pin 4.

Testing to do yet -

Do a pulse test of the Zener voltage at higher currents. Or run just the temperature control part of the chip while testing the Zener.

Understand the resistive components of each part of the chip.

Determine Zener resistance and temp co with Q1 acting as Kelvin sensing.

The first round of tests was in an environmental chamber over the -50 to +150C temperature range. This next round will be in a small TEC environmental chamber over the -30 to +100 deg C range. Chip temperature will be verified by Vbe voltage. Maybe the TEC will just run full cold and the chip temperature will be actively chip heater controlled.

Check several other chips to understand the distribution of the characteristics.