ADC10D1000
Thermal Diode Measurements and Theory

Diode I/V Curves versus Temperature

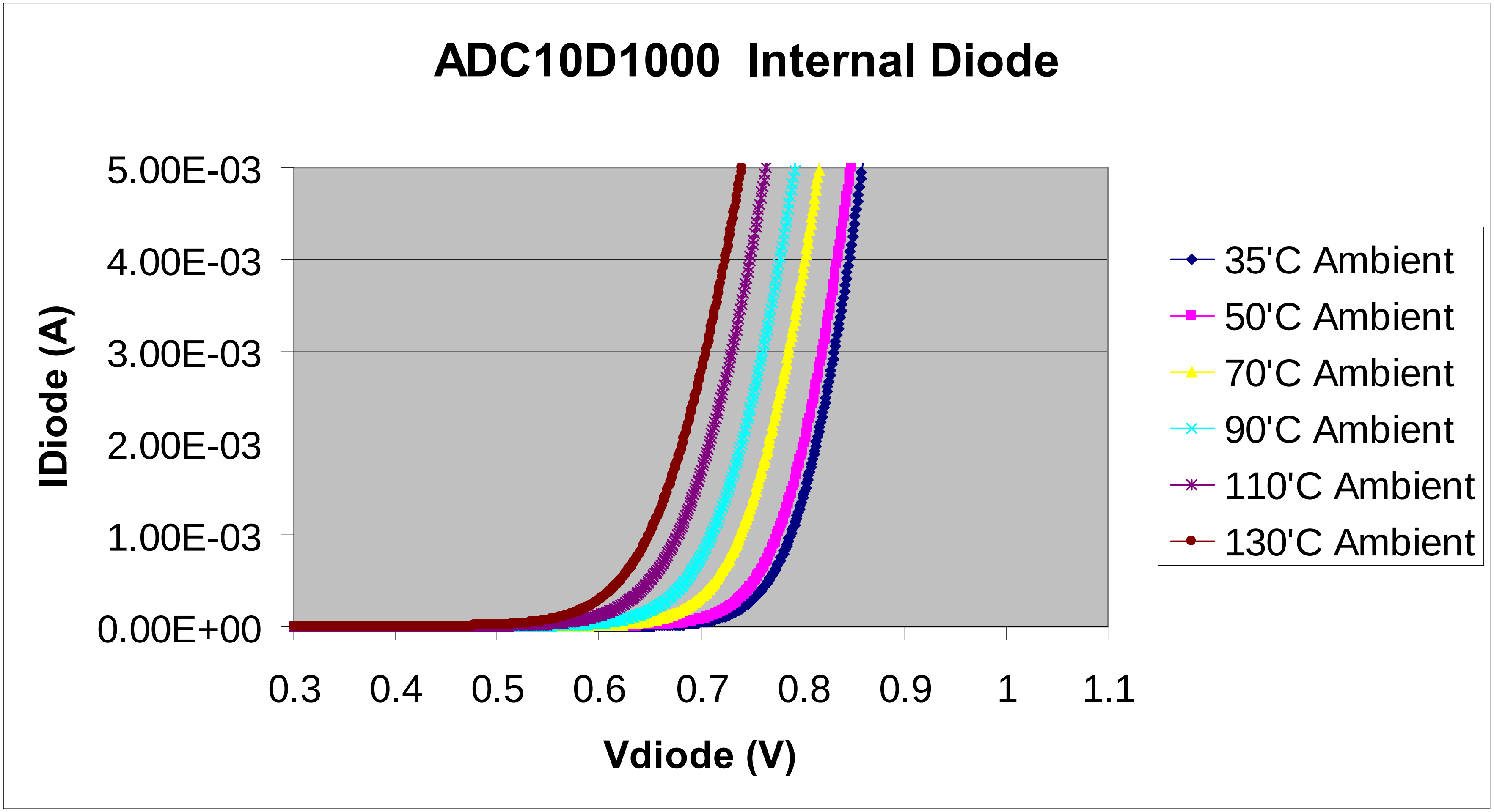
Internal Diode Current vs. Diode Voltage @ Different Ambient Temperatures

+1.9V supply, f_{CLK} = 1.0 Ghz, both channels powered- DOWN

- Note we have only characterized one ADC10D1000 internal diode therefore part to part mismatch is not compensated for, therefore, any dispersion in diode characteristics (the ideality factor) is not compensated. For our purposes the measurements provide accurate enough results to help establish the junction temperatures.
- Characterization curves shown for the ADC10D1000 internal diode were recorded by sweeping the voltage across the diode between 0 and 1V and measuring the resultant diode current at different ambient temperatures. Note the part is in power down mode to remove any self heating effect. Therefore by allowing stabilization time at each temperature we expect the junction temperature to equal the ambient temperature.
- Characterization curves allowed us to create the ADC10D1000 diode equation which can be used to estimate the actual junction temperature during normal operation.

Internal Diode Current vs. Diode Voltage @ Different Ambient Temperatures

+1.9V supply, f_{CLK} = 1.0 Ghz, both channels powered- DOWN



- **Characterization curves show that the forward diode voltage decreases with temperature as expected.**

Internal Diode Current vs. Diode Voltage @ Different Ambient Temperatures

+1.9V supply, f_{CLK} = 1.0 Ghz, both channels powered- DOWN

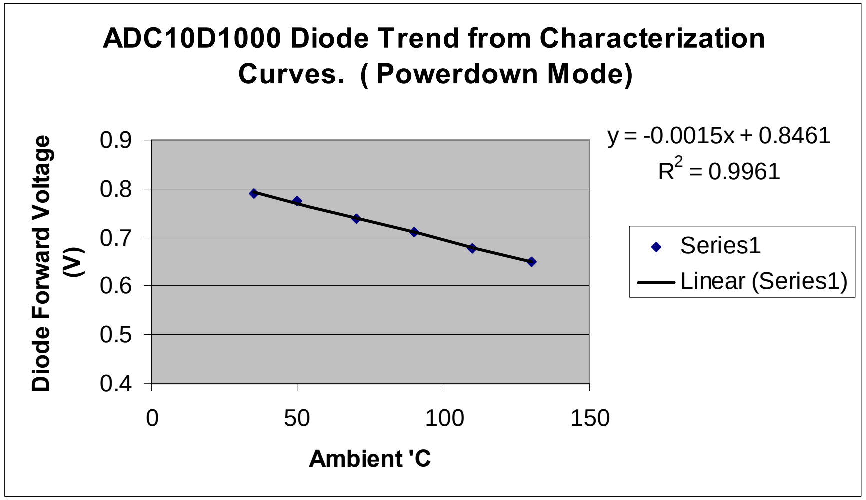
- **Using 1mA as the excitation current, the forward diode voltage on the ADC10D1000 diode measured at the listed ambient temperatures below . In this case ambient = junction since the ADC10D1000 is in powerdown mode.**

Ambient/Junction Temperature (C)	Vbe @ 1mA excitation current
35	0.789
50	0.776
70	0.739
90	0.711
110	0.677
130	0.65

Internal Diode Current vs. Diode Voltage @ different Ambient Temperatures

+1.9V supply, f_{CLK} = 1.0 Ghz, both channels powered- DOWN

- The plot shows the same data as shown in slide 4, however we now plot diode voltage vs. temperature at a constant diode current. The slope of the line plotted is the K factor, which shows that forward diode voltage decreases 1.5mV/'C when the forward current is a constant 1mA.



TEXAS INSTRUMENTS

Internal Diode Equation based on Characterization

$$V_D = -1.5\,\frac{mV}{'C} \times T_J + 0.8461$$ (for 1mA diode current)

Thus,

$$T_J = \frac{V_D - 0.8461}{-1.5\,\frac{mV}{'C}}$$

Substituting V_D for 0.65V (forward diode voltage)

$$T_J = \frac{0.65 - 0.8461}{-1.5\,\frac{mV}{'C}}$$ therefore , T_J = 130'C

Oven Temperature
vs.
Temperature measured using an accurate thermo-couple
vs.
Temperature measured using LM95221 temperature sensor

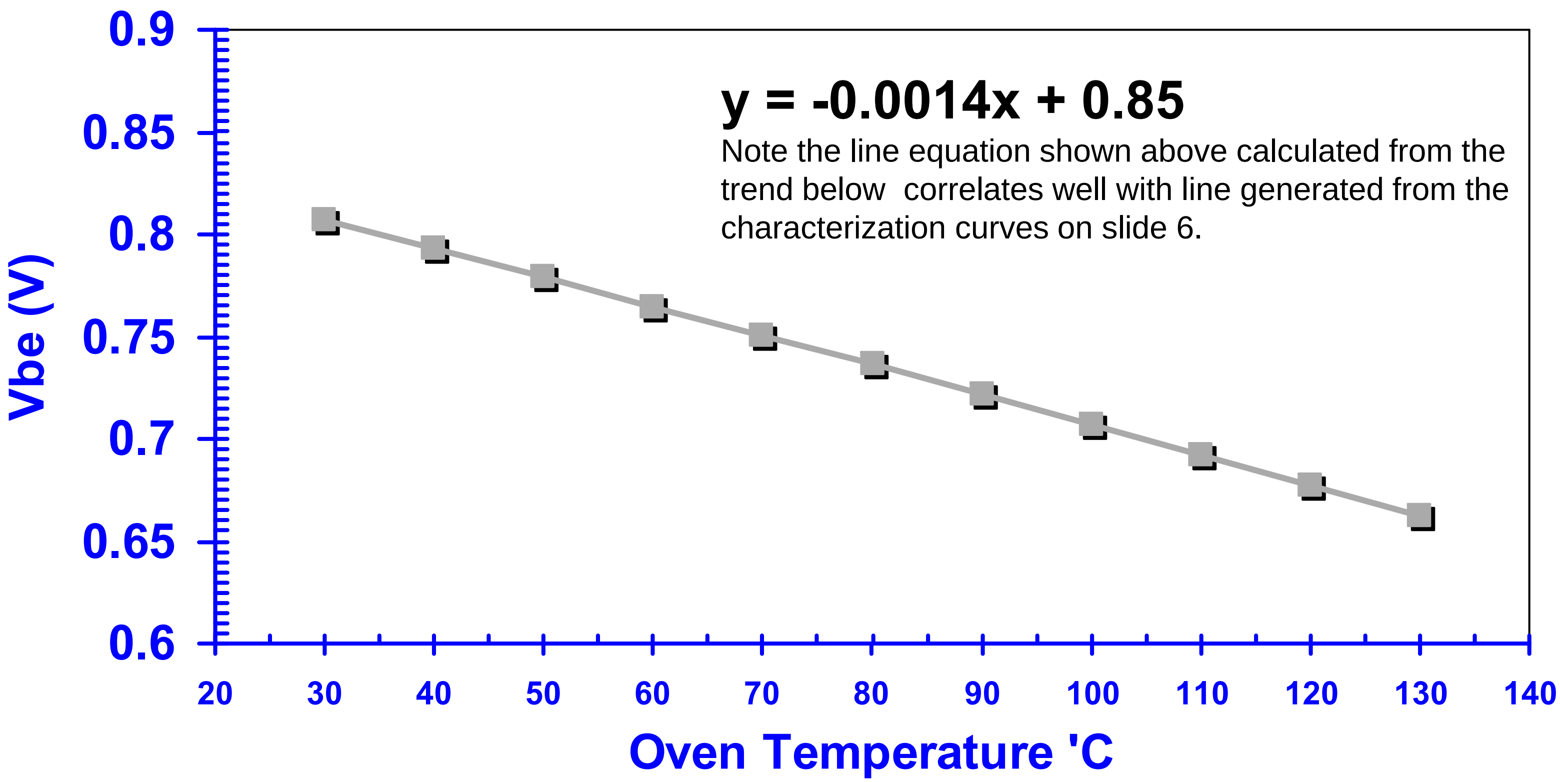
Diode VBE vs. Oven Temperature (Measured)

+1.9V supply, f_{CLK} = 1.0 Ghz, Fin = 247.47Mhz
Non-DES mode, FSR = High,
both channels powered- DOWN

Oven	Vbe	Thermo couple Measurement	LM95221 Junction
30	0.80658	30	31.25
40	0.793	39.9	41.625
50	0.77889	49.7	51.125
60	0.76468	59.8	62.125
70	0.75028	69.8	71.125
80	0.73638	79.3	81.375
90	0.72148	89.3	91.675
100	0.70678	99.7	101.5
110	0.6918	110.3	111.25
120	0.6768	121.3	121.5
130	0.66266	132.2	131.125

Diode VBE vs. Oven Temperature

+1.9V supply, f_{CLK} = 1.0 Ghz, Fin = 247.47Mhz
Non-DES mode, FSR = High,
both channels powered- DOWN



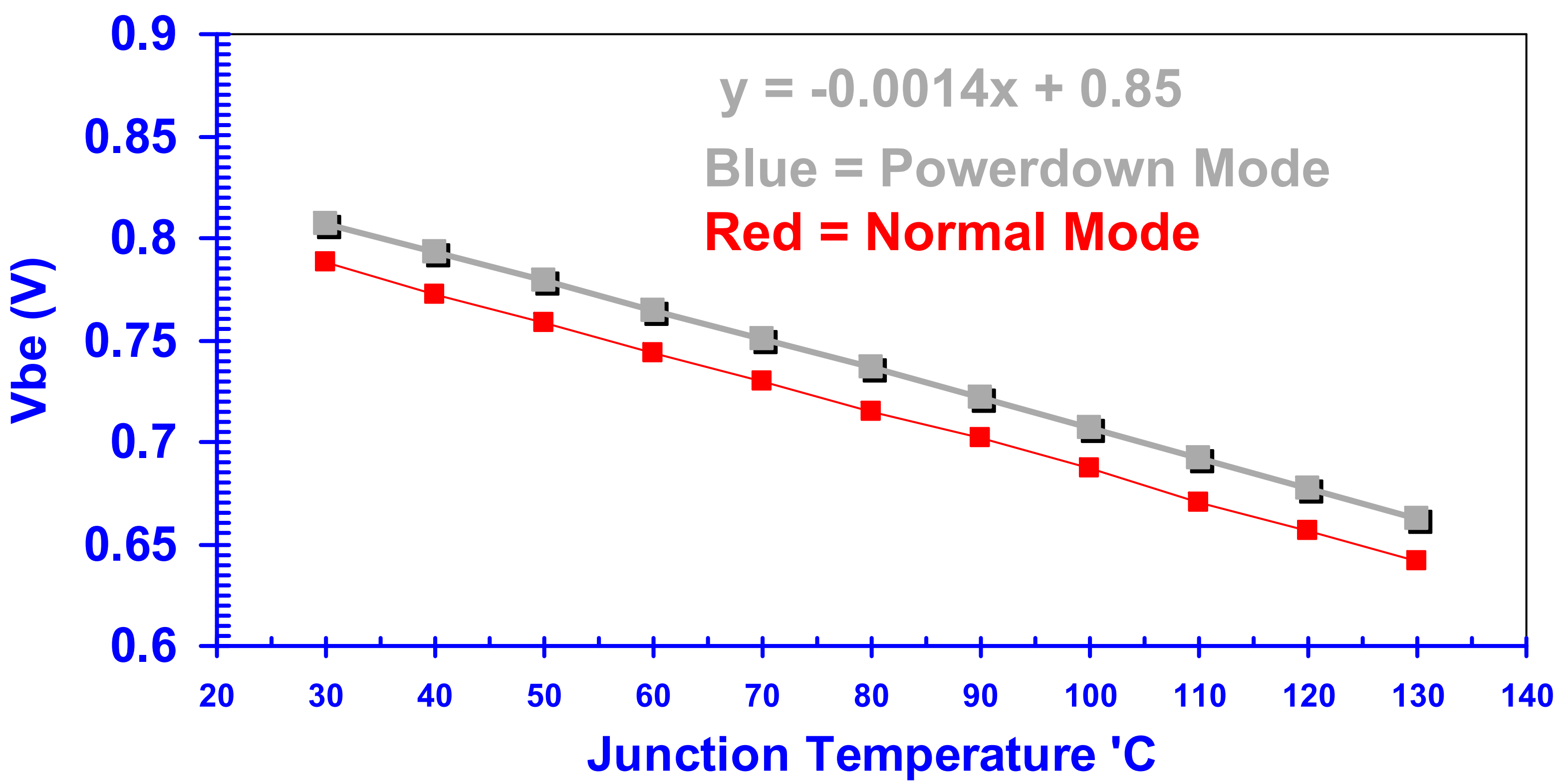
Diode VBE vs. Oven Temperature + Self Heating (Measured)

+1.9V supply, f_{CLK} = 1.0 Ghz, Fin = 247.47Mhz
Non-DES mode, FSR = High,
both channels powered- UP

Oven	Vbe	Thermo couple measurement	LM95221 Junction
30	0.78779	30.2	45.875
40	0.77254	40	57
50	0.758	50.4	67.25
60	0.74369	60.7	76.875
70	0.73010	71.3	86.375
80	0.71518	81.9	96.375
90	0.70188	90.1	105.25
100	0.6872	97.6	115.765
110	0.66998	109.3	126.75
120	0.65678	119.3	135
130	0.64137	130.5	146

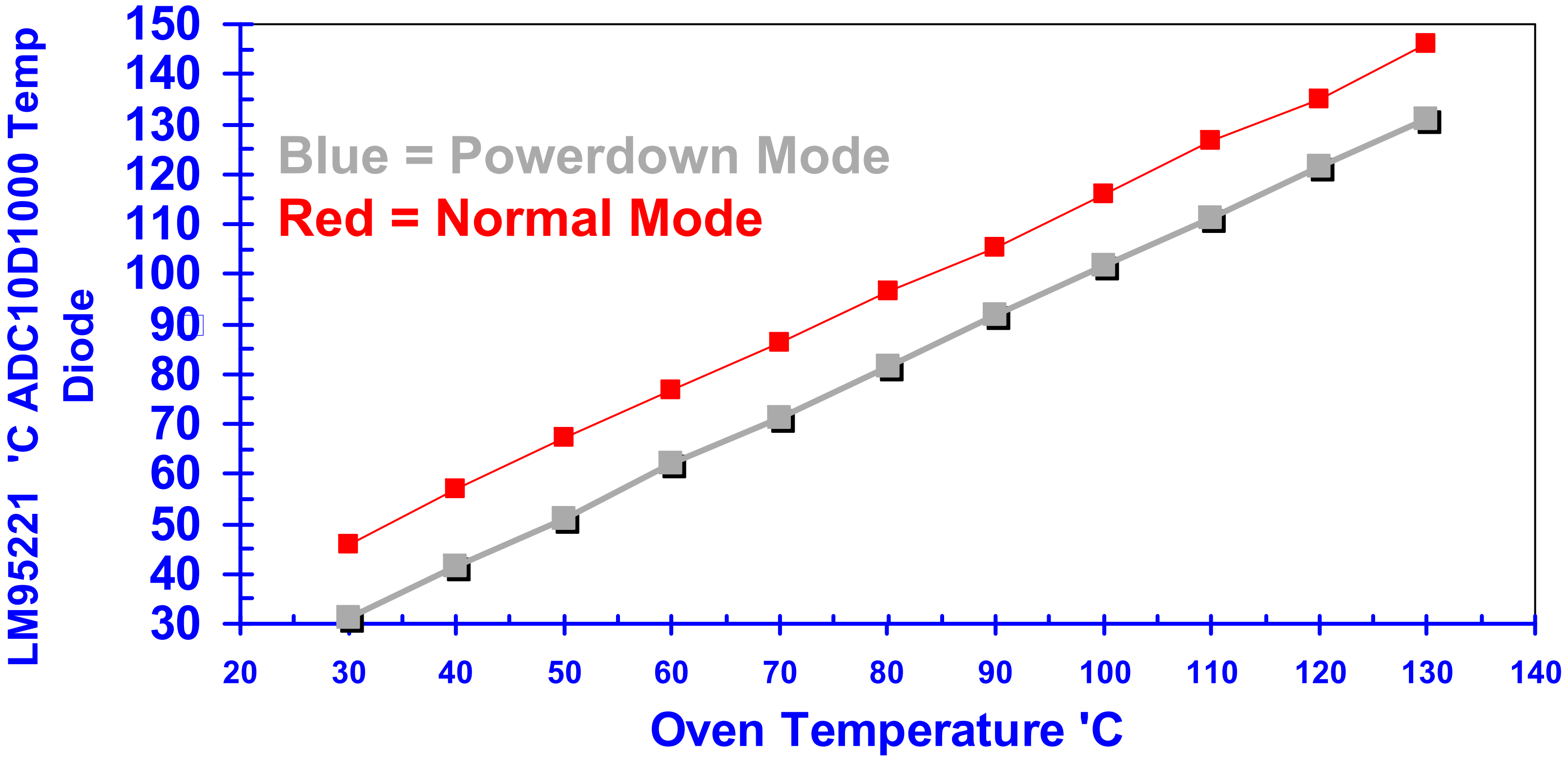
Diode VBE vs. Junction Temperature

+1.9V supply, f_{CLK} = 1.0 Ghz, Fin = 247.47Mhz
Non-DES mode, FSR = High,



LM95221 vs. Oven Temperature in both Powerdown and Normal Mode

+1.9V supply, f_{CLK} = 1.0 Ghz, Fin = 247.47Mhz
Non-DES mode, FSR = High,



Internal Temperature Diode Conclusion

- The diode characteristics are consistent with previous Giga-Sample ADC products.
- Basic diode I/V measurements vs. Temperature match well with oven and thermocouple measurements.
- **Note:** We have only characterized one ADC10D1000 internal diode therefore part to part mismatch is not compensated for, therefore, any dispersion in diode characteristics (the ideality factor) is not compensated. For our purposes the measurements provide accurate enough results to help establish the junction temperatures.