

Pycom Lopy 4 Non Linear ADC Investigation

adc_full := (0.000 1.000 1.334 1.995 3.548)

$$\text{zero_gain_cal} := \begin{pmatrix} 0 & 70 \\ 127 & 100 \\ 550 & 200 \\ 974 & 300 \\ 1820 & 500 \\ 2650 & 700 \\ 3510 & 900 \\ 3933 & 1000 \\ 4095 & 1044 \end{pmatrix}$$

adcv := zero_gain_cal i := 2..4

adcv^{*i*} := round(adcv⁽¹⁾ · adc_full_{0,i}, 1)

$$\text{adcv} = \begin{pmatrix} 0 & 70 & 93.4 & 139.7 & 248.4 \\ 127 & 100 & 133.4 & 199.5 & 354.8 \\ 550 & 200 & 266.8 & 399 & 709.6 \\ 974 & 300 & 400.2 & 598.5 & 1064.4 \\ 1820 & 500 & 667 & 997.5 & 1774 \\ 2650 & 700 & 933.8 & 1396.5 & 2483.6 \\ 3510 & 900 & 1200.6 & 1795.5 & 3193.2 \\ 3933 & 1000 & 1334 & 1995 & 3548 \\ 4095 & 1044 & 1392.7 & 2082.8 & 3704.1 \end{pmatrix}$$

converts an integer value into millivolts out

dca(x, gain) := interp(adcv⁽⁰⁾, adcv^(gain+1), x).mV

Non Linear ADC Calibration Assumption

dca(2595, 2) = 1.37V *<-- note correct voltage at atten = 2*

dca(2595, 3) = 2.437V $dca(2595, 2) + (adcv^{(2+1)})_0 \cdot mV = 1.51V$ *<-- 1.51 = 1.37 + 0.139 (zero offset at atten = 2)*

Vs @ battery terminals by DMM = 4.18 V

$$V_s := 4.18V \quad R_1 := 115 \cdot 10^3 \cdot \text{ohm} \quad R_2 := 56 \cdot 10^3 \cdot \text{ohm}$$

$$V_{\text{out}} := \frac{R_2}{R_1 + R_2} \cdot V_s \quad V_{\text{out}} = 1.369V$$

$$\frac{R_2}{R_1 + R_2} = 0.3275 \quad dca(2595, 2) \cdot \left(\frac{R_2}{R_1 + R_2} \right)^{-1} = 4.184V$$

Linear ADC Calibration Assumption (as per code)

$$\frac{2595}{4095} \cdot 2 \cdot V \cdot \left(\frac{R_2}{R_1 + R_2} \right)^{-1} = 3.87V \quad \frac{2595}{4095} \cdot 2 \cdot V = 1.267V$$

Full range values for LoPy4 gain settings

attn = 0 = ADC.ATTN_0DB = 0 dB gain = range 0-1V

attn = 1 = ADC.ATTN_2_5DB = 2.5 dB = range 0-1.334V

attn = 2 = ADC.ATTN_6DB = 6 dB = range 0-1.995V

attn = 3 = ADC.ATTN_11DB = 11 dB = range 0 - 3.548V

ADC calibration values from

<https://forum.pycom.io/topic/1690/correct-formula-for-batt-monitoring-on-expansion-board/7>

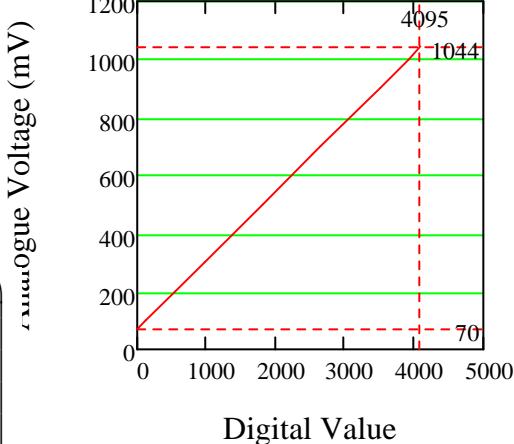
check of gain values

(See <http://www.engpiaudio.com/calculatorVoltagePower.htm>)

$$20 \cdot \log \left(\frac{1.334}{1} \right) = 2.503$$

$$20 \cdot \log \left(\frac{1.995}{1} \right) = 5.999$$

$$20 \cdot \log \left(\frac{3.548}{1} \right) = 11$$



The is a look up linear interpolation table of the calibration voltages multiplied by respective gains for 0, 2.5, 6 and 11db being 1, 1.334, 1.995 and 3.538.

Column 0 is digital integer values,
Columns 1 to 4 are millivolts for attn = 0, 1, 2 and 3

converts volts into an integer value

adc(x, gain) := round $\left(\text{interp} \left(adcv^{(gain+1)}, adcv^{(0)}, \frac{x}{mV} \right) \right)$

adc(1370 mV, 2) = 2595

agrees with DMM between P16 & GND @ 1.55V

<-- 1.51 = 1.37 + 0.139 (zero offset at atten = 2)

