GUVC-S10GD - Output Tension De-conversion Equation

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Resumo

The main objective of this document is to provide more documentation for GUVC-S10GD sensor users, about the equation proposed to reconvert the output tension in to sensor's output current. Because, the GUVC-S10GD's data-sheet only provides an equation to convert the output current in to UV-C Power.

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Sumário

1 Introduction

The GUVC-S10GD sensor, despite being an device that could be operated with simple ADC (Analog to Digital Conversion), doesn't work exactly as a common ADC. The reason is that it responses to changes in the "analysis parameter"(which is UVC radiation) with changes in output current, and not output tension as usually is expected. Also, another problem, was that the GUVC-S10GD's output-current was in the order of nano-amperes ($10^{-9}A$), which complicated more the situation.

So, to solve these "little hindrances", people from the Hardware Nucleus of Zenith's Embedded Systems Department developed a circuit to "translate"the output-current into out-put tension that could be read by the Blue-Pill (STM-32) ADC ports. This circuit is showed bellow:

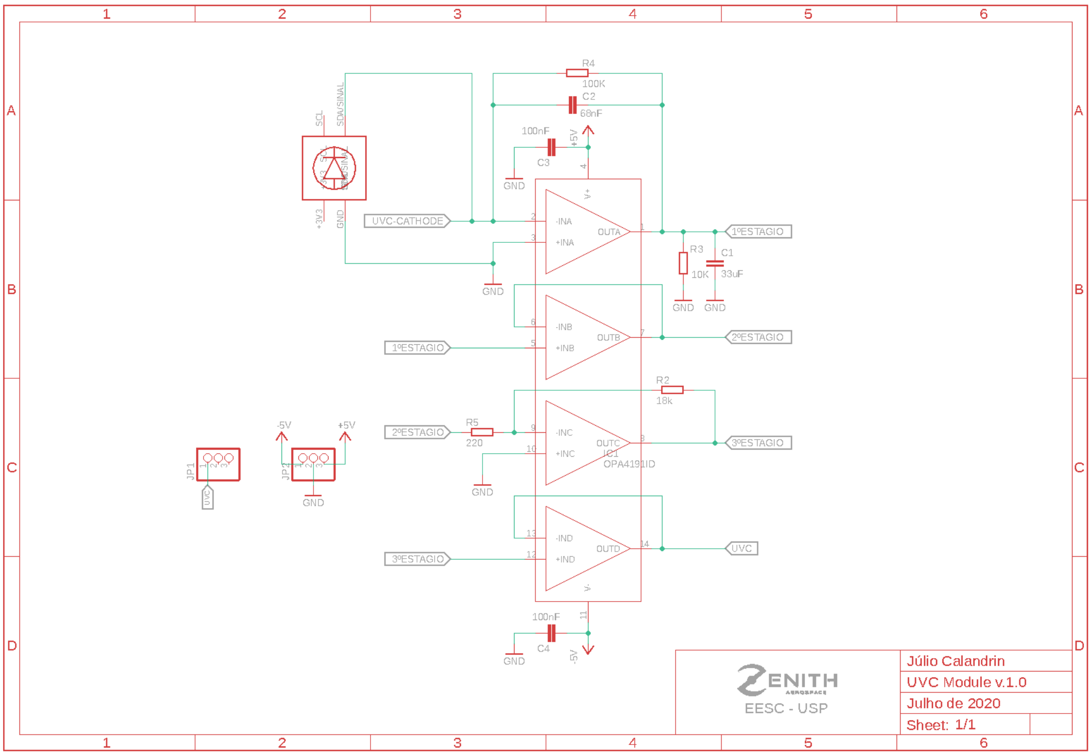

Figura 1: Sample of Circuit Diagram

Meanwhile, the circuit presented in Figure 1 could suffer changes until the final implementation. So, to avoid need to re-write the Sensor's "Driver"in response to small changes in the project, the Low-Level Nucleus decided to propose an generic equation to co-relate the output-current to the output-tension. This equation was based in the follow graphics, provided by the Hardware Nucleus, and is going to be explained in the next topic:

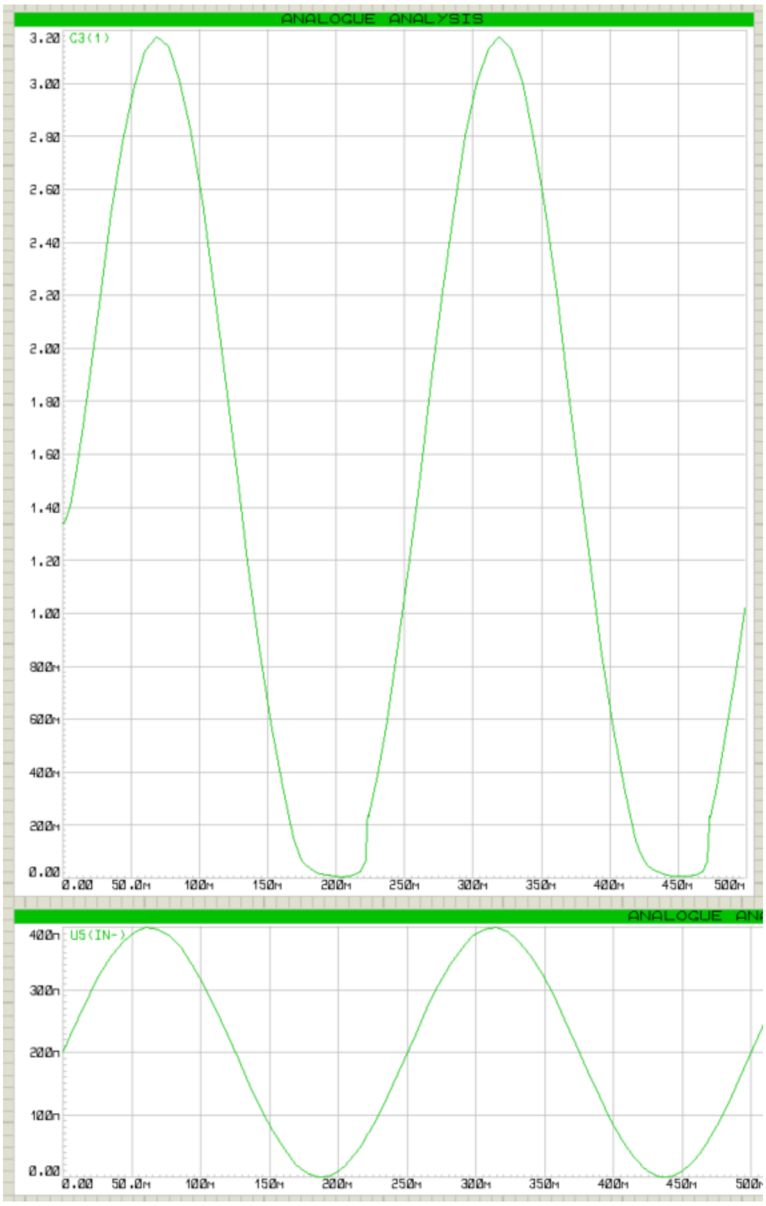

Figura 2: Calibration Graphic Sample

2 General Equation Deduction

Explaining the previous graphics provided by the Hardware Nucleus, the top graphic shows the output-tension (U_{out}) in the ADC Port of the Blue-Pill (STM-32) versus a generic abscissa, and the bottom one shows the output-current (i_{out}) at the GUVC-S10GD versus the same abscissa as the top graphic.

So, based on this information, the Low-Level Nucleus Team decided to took some parameters into account: the offset of both graphics (b_u and b_i)(distance between the graphic origin and the ordinate when the varying trigonometric term is equal to 0), the phase difference (ϕ) of both graphics (that in this pair of graphics it's close to zero, but not null) and the amplitude of both graphics (A_u and A_i).

OBS: Was made an assumption that the wave length is the same for each graphic pair, based that it is defined by the Oscilloscope used to plot the calibration curve.

$$\begin{gathered} U_{out} = A_u \cdot \sin(x) + b_u \\ i_{out} = A_i \cdot \sin(x + \phi) + b_i \end{gathered} \tag{1}$$

$$f(U_{out}) = i_{out} \tag{2}$$

$$i(x) = A_i \cdot (\sin(x) \cdot \cos(\phi) + \cos(x) \cdot \sin(\phi)) + b_i \tag{3}$$

$$\begin{gathered} \sin(x) = \frac{U_{out} - b_u}{A_u} \\ \cos(x) = \sqrt{\frac{{A_u}^2 - (U_{out} - b_u)^2}{{A_u}^2}} \end{gathered} \tag{4}$$

$$i_{out} = A_i \cdot (\frac{U_{out} - b_u}{A_u} \cdot \cos(\phi) + \sqrt{\frac{{A_u}^2 - (U_{out} - b_u)^2}{{A_u}^2}} \cdot \sin(\phi)) + b_i \tag{5}$$

Its important to notice that, besides well co-relating the U_{out} with i_{out}, the Equation 5 requires functions from the "math.h"library of C Programming Language, as "sqrt( )", "cos( )"and "sin( )". But, this means that the Blue-Pill would need to make operations using "double", which is a problem, because Blue-Pill is designed to work and make operations using integers, even using simple floating numbers "float"need some tricks that requires more processing-power from the board.

3 Special Cases

In other to "solve"/provide an outside way to calculate the output-current (i_{out}) requiring minimum quantity of processing-power from the Blue-Pill as possible. It was noticed that if the phase difference ϕ was presumed as $\phi = 0°$(same phase, $\lambda_{phase} = 1$) or $\phi = 180°$(opposition of phase $\lambda_{phase} = -1$), the expression becomes much more simple as showed bellow:

$$i_{out} = (\frac{A_i}{A_u}) \cdot (U_{out} - b_u) \cdot (\lambda_{phase}) + b_i \tag{6}$$

Notice that the only parameters in this case are the actual converse factor ($\frac{A_i}{A_u}$), the "offset values", (b_i and b_u), that shift both initial functions at Equation 1, the Output Tension U_{out}, and the λ_{phase}, that is equal to $\cos(\phi)$.

By the way, even that this equation covers only two specific cases, it is possible to use this "approximation"in other cases in order to only have an "idea"about the radiation at the system. So if the application doesn't need an "accurate"data about the radiation, the author recommends using this expression, because it would not "overload"the Blue-Pill in order to "nothing".

4 Conclusion

In order to deal with the extremely low output-current of the GUVC-S10GD, it was developed a circuit to ”translate”that current into tension that could be read by the Blue-Pill’s ADC Ports. However, this solution required an expression to ”de-convert”/discover the original current sent by the GUVC-S10GD, because the Data-sheet only provides an equation to relates the UV-C Power with that current. So, two equations was proposed, one more generic, but that requires a lot of power processing from the Blue-Pill, and other more simple, requiring less from the Blue-Pill, but that finds ”approximate results”.