# Compass Heading

A magnetometer is used in a lot of robotic embedded systems in order to calculate their heading. It replaces the analogue compass. These sensors measure the magnetic field on 2 or 3 axes, from which the direction can be calculated. Given a 2-axes magnetometer, the direction can be calculated with the following formula:

$$\theta = tan^{-1}\left(\frac{a}{b}\right)$$

where a and b represent respectively the magnetic field intensity on Y and X axes.

This kind of sensor also needs a calibration step to perform without bias. It is required to design a digital circuit for implementing such operation for a digital magnetometer whose magnetic field is represented in **8-bit C2**. With the possibility to store bias values when requested by the user, and subtract them on the following calculus. The interface of the circuit to be designed is as follows:
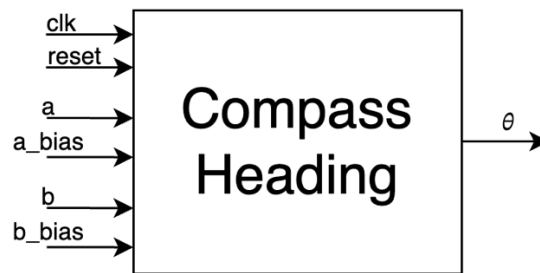
The resolution of the output can be chosen freely. Discuss which elements of the architecture it affects. The _bias signals are 1-bit inputs that indicate the value of the related axis must be stored internally as a bias.

You are requested to deal with the various possible error situations, documenting the choices made. In particular, it is necessary to take into consideration:
- Possible division errors during calculation

The final project report must contain:
- Introduction (circuit description, possible applications, possible architectures, etc.)
- Description of the architecture designed (block diagram, inputs/outputs, etc.)
- VHDL code (with detailed comments) to be attached to the report.
- Test strategy (Test-plan) and related Testbench for verification; a detailed, though not exhaustive, verification is required, including error situations and borderline cases of functioning
- Interpretation of the results obtained in the automatic synthesis/implementation on a Xilinx FPGA platform in terms of maximum clock frequency (critical path), elements used (slice, LUT, etc.) and estimated power consumption. Comment on any warning messages.
- Conclusions