Nassau Community College
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ELT-214

Offset Binary Signed Numbers

Most of this material is condensed from https://en.wikipedia.org/wiki/Offset_binary

Offset binary, also referred to as biased representation, is a digital coding scheme where all-zero corresponds to the minimal negative value and all-one to the maximal positive value. There several standards for offset binary, but the one we will use uses the offset (K) for an n-bit binary word is $K = 2^{n-1}$. For example: for an 8-bit word (n=8), the offset $K= 2^7 = 128 = 1000\ 000_{binary}= 80_{hex}$.

In use a signed value has the offset added to it so that all signed numbers become positive running from zero to 2^n-1. This has the consequence that the "zero" value is represented by a 1 in the most significant bit and zero in all other bits. It also has the consequence that in a logical comparison operation, one gets the same result as with a true form numerical comparison operation, whereas, in two's complement notation a logical comparison will agree with true form numerical comparison operation if and only if the numbers being compared have the same sign. Otherwise the sense of the comparison will be inverted, with all negative values being taken as being larger than all positive values.

Offset binary is often used in digital signal processing (DSP). Most analog to digital (A/D) and digital to analog (D/A) chips are unipolar, which means that they cannot handle bipolar signals (signals with both positive and negative values). A simple solution to this is to bias the analog signals with a DC offset equal to half of the A/D and D/A converter's range. The resulting digital data then ends up being in offset binary format. Most standard computer CPU chips cannot handle the offset binary format directly and signals from hardware have to be converted to the proper format by the programmer.

Offset Binary notation and 2's compliment signed binary notation are related by being the same except their MSB is inverted. Thus one method of converting a signed number into 2's compliment signed binary notation is to first put it into offset binary and then inverting the MSB. Similarly, to convert out of 2's compliment signed binary notation, you can invert the MSB and then convert out of offset binary.

Rules:
To convert a signed decimal number into n-bit offset binary:

1. Calculate the offset, $K = 2^{n-1}$
2. Add the offset K to the signed number
3. Convert to binary

To convert an offset binary number into a regular signed number:

1. Calculate the offset, $K = 2^{n-1}$
2. convert the binary number into decimal
3. Subtract the offset K to get the signed decimal number

A chart comparing various signed number systems is available at:
http://www.donwade.us/214/Binary_codes_5.pdf

A Wikipedia article on the general signed number representations is at:
https://en.wikipedia.org/wiki/Signed_number_representations.

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