### Representation of Negative Binary Numbers in Two’s Complement

In the following we will briefly look at the question of how negative binary numbers can be represented in a computer system. For the sake of simplicity, we will restrict ourselves to numbers without decimal places. There are several possibilities for this. The easiest to

tional symbols such as + and −. This has the advantage that no additional control logic is understand and most common is the two’s complement. This procedure offers the possibility to represent negative numbers in the binary system without having to resort to addirequired in digital circuits. The basic idea is as follows:

First you define a constant number of digits, which all binary numbers must have. In the 8-

used. If necessary, shorter numbers are then filled with leading zeros, i.e., bit two’s complement, for example, as the name suggests, numbers with eight digits aredisplayed as 0001 01102, for example. left, indicates whether the number is101102 is then

The most significant bit, i.e., the bit furthest to the negative or not. If this bit is 0, a non-negative number is present. With negative numbers this bit has the value 1.

In the 8-bit two’s complement, all numbers between are therefore non-negative numbers. All numbers between are negative.

The determination of the (decimal) value of numbers in two’s complement is slightly diftakes into account that the most significant bit represents the sign by giving the highestcomplement is calculated as follows:power a negative sign. The value b of an (n + 1) digit binary number bn . b0 in two’s ferent from that described above for general binary numbers. The calculation implicitly b = bn · −2n + ni = 0∑−1bi ·2i

The following table shows the value range of eight-digit binary numbers, once as an unsigned decimal number and once as an interpretation in the 8-bit two’s complement. As you can see, the largest positive number that can be displayed in the two’s complement is no longer 255, but only 127, although the negative numbers up to and including −128 can now also be displayed. The value range has thus shifted from 0 ... 255 to −128 ... 127 due to the use of the two’s complement. In general, it is therefore important to know how the value of a binary number should be interpreted.

It is easy to think about the fact that this method can be easily transferred to longer binary numbers, e.g., 32 bit or 64 bit.

Table 3: Value range of binary numbers in 8-bit two's complement

Source: Brückmann, 2013.