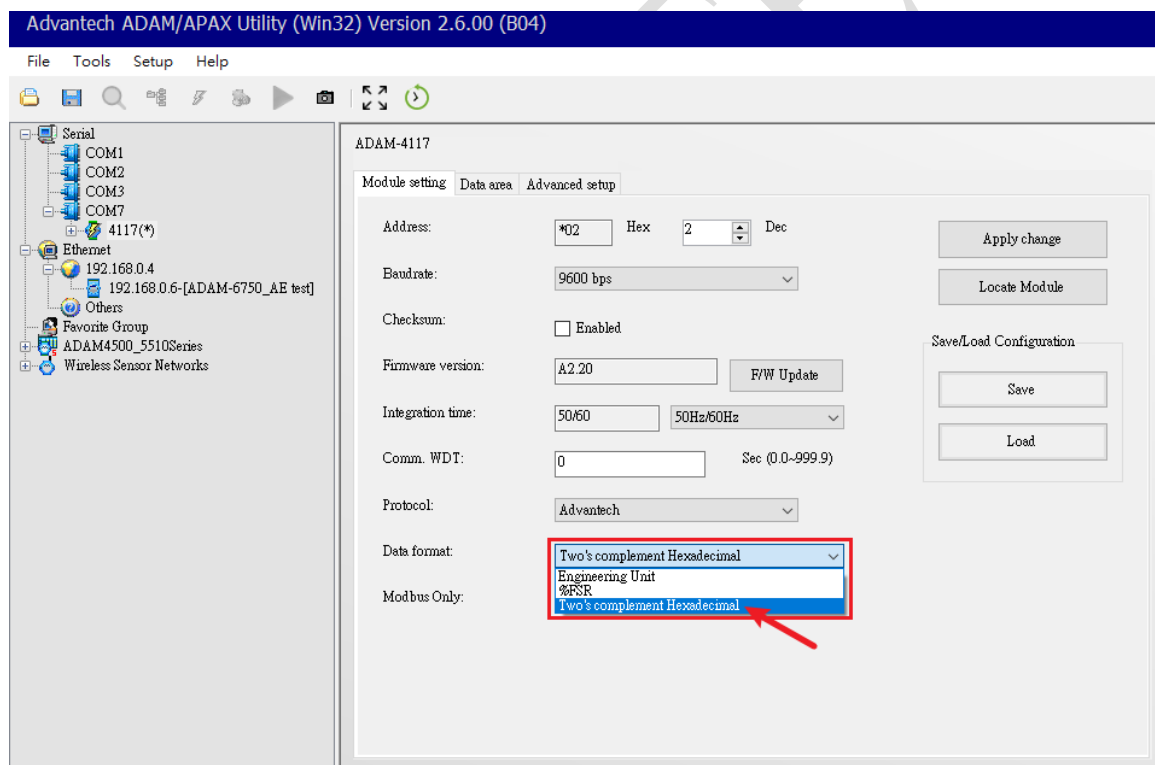


## Advantech AE Technical Share Document

<b>Date</b>	2021/01/06	<b>SR#</b>	1-4406253781
<b>Category</b>	■FAQ □SOP	<b>Related OS</b>	N/A
<b>Abstract</b>	How to calculate the data value from Engineering unit to Two's Complement Hexadecimal?		
<b>Keyword</b>	ADAM, data format		
<b>Related Product</b>	ADAM-4000 series, ADAM-4100 series		

### ■ Problem Description:

Users could utilize different types of data format of AI data via Adam/Apax .NET Utility, such as below.



And this document will only explain how to scale data value from engineering unit to Two's Complement Hexadecimal.

### ■ Solution:

Two's Complement Hexadecimal is a special data format for specific users to acquire, it is known for its own unique representation that doesn't have to notate polarity in data value.

And there is one thing that has to be mentioned which is the resolution, the resolution of ADC for either ADAM-4000 or ADAM-4100 is generally 16-bit. But when users would like to acquire data value in Two's Complement Hexadecimal format, the resolution of data value users receive will decrease 1 bit which means there is only **15-bit** resolution for this specific data format.

The reason for lower resolution while receiving data in this specific data format is that, Two's Complement Hexadecimal uses 1 bit to represent polarity in data, as below picture.

0	1	1	1	1	1	1	1	= 127
0	0	0	0	0	0	1	0	= 2
0	0	0	0	0	0	0	1	= 1
0	0	0	0	0	0	0	0	= 0
1	1	1	1	1	1	1	1	= -1
1	1	1	1	1	1	1	0	= -2
1	0	0	0	0	0	0	1	= -127
1	0	0	0	0	0	0	0	= -128

Figure1. Two's Complement Hexadecimal format

And following up content will explain how to transform data from engineering unit to Two's Complement Hexadecimal.

Let's take bipolar input range for example first, Two's Complement Hexadecimal divides the 16-bit data 65535 into two segments, one half for positive-polar value and another half for negative-polar value, this might sounds fuzzy to you, so please check below picture for better-understanding.

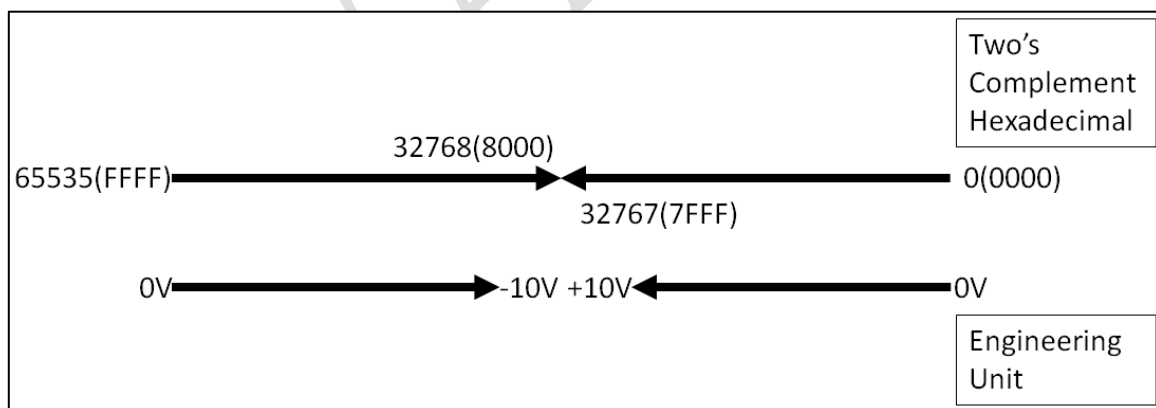


Figure2. The similarity between two different data formats

Now let us calculate the engineering unit 5V and -5V and transform them into Two's Complement Hexadecimal format.

5V to this specific format:

$$\frac{5V}{10V(maximal\ positive\ polar\ value)} \times 32767 = 16383.5(3FFF\ in\ Hex)$$

Hence, users will receive 3FFF while ADAM reads 5V.

-5V to this specific format:

$$65535 - \left( \frac{-5V}{-10V(\text{maximal negative polar value})} \right) \times 32767 = 49151(\text{BFFF in Hex})$$

Hence, users will receive BFFF while ADAM reads -5V.

And there is one special input range on Thermocouple modules, such as ADAM-4118 and ADAM-4018+. This special input range is Type T -100~400 °C. The firmware in Thermocouple modules will regard it as symmetric input range in order to unite the calculation methods in different input ranges. Thus, whenever it comes to Two's Complement Hexadecimal format, we can regard it as -400-400 °C input range. So, the -100 °C will be 57343(DFFF) instead of 65535(FFFF) in this specific format.

As you can see below, the red part is the valid part which means customer won't get values in black part.

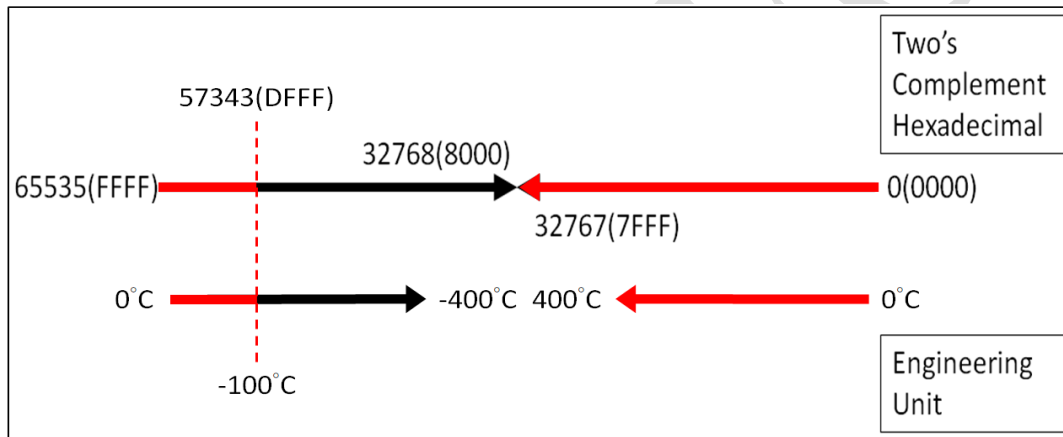


Figure3. The asymmetric input range Type T

Then, let's take unipolar input range for practice, this time we use 4-20mA as instance. As Figure 2 demonstrates, yet we only have to draw importance on the right half part which is positive polar segments.

Now let us calculate and transform 4mA into Two's Complement Hexadecimal format.

$$\frac{4mA}{20mA(\text{maximal postive polar value})} \times 32767 = 6553.4(\text{1999 in Hex})$$

Hence, users will receive 1999 instead of 0000 while ADAM reads 4mA.