Data Formats and I/O Ranges

B

B.1 Analog Input Formats

The ADAM analog input modules can be configured to transmit data to the host in one of the following data formats:

-Engineering Units

-Percent of FSR

-Twos complement hexadecimal

-Ohms

B.1.1 Engineering Units

Data can be represented in engineering units by assigning bits 0 and 1 of the data format/checksum/integration time parameter the value 00.

This format presents data in natural units such as degrees, volts, millivolts and milliamps. The engineering format is readily parsed by the majority of computer languages, because the total data string length, including sign, digits and decimal point, does not exceed seven characters.

Input Range	Resolution
±15 mV, ±50 mV	**1 μV (three decimal places)**
±100 mV, ±150 mV, ±500 mV	**10 μV (two decimal places)**
±1 V, ±2.5 V, ±5 V	**100 μV (four decimal places)**
±10 V	**1 mV (three decimal places)**
±20 mA	**1 μA (three decimal places)**
Type J and T thermocouple	**0.01° C (two decimal places)**
Type K, E, R, S and B thermocouple	**0.01° C (one decimal place)**

Data is grouped into a plus (+) or minus (-) sign, followed by five decimal digits and a decimal point. The input range which is employed determines the resolution or the number of decimal places used as illustrated in the following table:

Example 1

The input value is -2.65 and the corresponding analog input module is configured for a range of ±5 V. The response to the Analog Data In command is:

-2.6500 (cr)

Example 2

The input value is 305.5° C. The analog input module is configured for a type J thermocouple whose range is (0° C to 760° C). The response to the Analog Data In command is:

+305.50 (cr)

Example 3

The input value is +5.653 V. The analog input module is configured for a ±5 V range. When the engineering units format is used, the ADAM Series analog input modules are configured so that they automatically provide an overrange capability. The response to the Analog Data In command in this case is:

+5.6530 (cr)

B.1.2 Percent of FSR

This mode is used by setting bits 0 and 1 of the data format/checksum / integration time parameter to 01. The format used in Percent of FSR consists of a Plus (+) or minus (-) sign followed by five decimal digits including a decimal point. The maximum resolution possible is 0.01%. The decimal point is fixed.

Data is given as the ratio of the input signal to the value of the full-scale range.

Example 1

The input value is +2.0 V. The input module is configured for a range of ±5 V. The response to the Analog Data In command is as follows:

+040.00 (cr)

The full calibrated voltage range ranges from -100% to 100% as voltage input ranges are always bipolar. A ±5 V input would range from -5 V (-100%) to 5 V (100%).

In this example the input is represented by +40% of the full-scale range which equals (+(40/100) x 5 V = +2.0 V) the actual input value.

Example 2

The input value is 652.5°C. A type K thermocouple (0°C to 1000°C) is configured in the analog input module. The response to the Analog Data In command is:

+065.25 (cr)

The result shows that the value of the input (652.5°C) is 65.25% of the value of the calibrated full-scale range (1000°C).

Thermocouple input ranges are always assumed to be bipolar with zero being the point of symmetry. This holds true regardless of the specified range of operation. For example, when using a type J thermocouple (0°C to 760°C) 760°C corresponds to +100% and 0°C corresponds to 0%. Even if 0°C lies outside the specified range of operation for the thermocouple, zero will remain the point of symmetry. For instance, a type B thermocouple is specified for operation from +500°C to +1800°C. In this case +1800°C corresponds to + 100% and 500°C corresponds to +27.77%.

The percentage is related to the full span of the configured range. If for instance a nickel RTD is specified for -80°C to +100°C then the lower value of -80°C equals 0% of span and the upper value of +100°C equals 100% of span.

When in the FSR mode, if a value exceeds the uppermost value of the input range, an overrange feature is automatically invoked by the ADAM analog input modules. Take, for instance, an analog module which is configured for a ±5 V range but one of the values read is + 5.5V. The resulting value would then be 110%.

The readings must fall within the input range to be guaranteed of accuracy. Although they are typically linear readings which fall between the ±100% and ±115% limits are not accurate, but still generally linear. Readings beyond these limits are neither accurate nor linear.

B.1.3 Twos complement hexadecimal

Easily transferred to integer format the Twos Complement Hexadecimal format represents the data in ASCII hexadecimal form providing rapid communication, high resolution and easy conversion to computer-compatible integer format.

To indicate twos complement hexadecimal bits 0 and 1 of the data format/checksum/integration time parameter must be set to 10. This format displays data in the form of a 4-character hexadecimal string. This string represents a 16-bit twos complement binary value. Positive full scale is denoted as 7FFF (+32,767) while negative full scale is represented by the value 8000 (-32,768). The resolution is one least significant bit (LSB) of 16 bits.

Example

The input value is -1.234 V. An analog input module is configured for a ±5 V range. The value returned is:

E069 (cr)

This value is equivalent to the signed integer -8087.

Input ranges with voltage and milliamp values are used with the full calibrated voltage range from 8000 to 7FFF. For instance, an ADAM-4011 module is given a ±5 V input range. In this case -5 V is represented as 8000h and +5 V is denoted as 7FFFh.

When thermocouple input ranges are used, an input range which is bipolar

and symmetric about zero is assumed. The following table provides several examples.

Thermocouple Type	Temperature Range (Degrees)	Temperature Range (Hex)
J	0° C to 760° C	0000h - 7FFFh
T	-100° C to 400° C	E000h - 7FFFh
R	500° C to 1750° C	2492h - 7FFFh

The given span of the specified range is used to determine the RTD input ranges for twos complement hexadecimal values. As an example, if the nickel RTD is specified for the range -80°C to +100°C, the respective values in hexadecimal notation would be 8000h to 7FFFh.

B.1.4 Ohms

To indicate ohms, set bits 0 and 1 of the data format/checksum/integration time parameter to 11; this data format is only valid for ADAM-4013 analog input modules.

The ohms format allows you to read the value of the RTD resistance in ohms. It consists of a "+" or "-" sign followed by five decimal digits and a decimal point. The resolution (position of the decimal point) of Platinum-Nickel RTDs is 10 m Ω. (two decimal places).

For example, for a 100 Ω. platinum RTD specified for -100°C to +100°C, +100°C corresponds to +138.50 Ω. and -100°C corresponds to +060.60 Ω.

B.2 Analog Input Ranges

Range Code (hex)	Input Range Description	Data Formats	+F.S.	Zero	-F.S.	Displayed Resolution
00	± 15 mV	Engineering Unite	+15.000	±00.000	-15.000	1 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
01	± 50 mV	Engineering Unite	+50.000	±00.000	-50.000	1 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
02	± 100 mV	Engineering Unite	+100.00	±000.00	-100.00	10 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
03	± 500 mV	Engineering Unite	+500.00	±000.00	-500.00	10 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
04	± 1 V	Engineering Unite	+100.00	±0.0000	-1.0000	100.00 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
05	± 2.5 V	Engineering Unite	+2.5000	±0.0000	-2.5000	100.00 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
06	± 20 mV	Engineering Unite	+20.000	±00.000	-20.000	1 µv
		% of FSR	+100.00	±000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
07	not used					

Range Code (hex)	Input Range Description	Data Formats	+F.S.	Zero	-F.S.	Displayed Resolution
08	– 10 mV	Engineering Unite	+10.000	–00.000	-10.000	1 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
09	– 5 V	Engineering Unite	+5.0000	–0.0000	-5.0000	100.00 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
0A	– 1 V	Engineering Unite	+1.0000	–0.0000	-1.000	100.00 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
0B	– 500 mV	Engineering Unite	+500.00	–000.00	-500.00	10 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
0C	– 150 mV	Engineering Unite	+150.00	–000.00	-150.00	10 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]
0D	– 20 mV	Engineering Unite	+20.000	–00.000	-20.000	1 v
		% of FSR	+100.00	–000.00	-100.00	0.01%
		Twos Complement	7FFF	0000	8000	1 LSB[1]

Range Code (hex)	Input Range Description	Data Formats	Maximum Specitied Signal	Minimum Specitied Signal	Displayed Resolution
0E	Type J Thermocouple 0 C to 760 C	Engineering Unite	+760.000	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]

Range Code (hex)	Input Range Description	Data Formats	Maximum Specitied Signal	Minimum Specitied Signal	Displayed Resolution
0F	Type K Thermocouple 0 C to 1000 C	Engineering Unite	+1000.0	+0000.0	0.1 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
10	Type T Thermocouple -100 C to 400 C	Engineering Unite	+400.00	-100.00	0.01 C
		% of FSR	+100.00	-0.25.00	0.01%
		Twos Complement	7FFF	E000	1 LSB[1]
11	Type E Thermocouple 0 C to 1000 C	Engineering Unite	+1000.0	+0000.0	0.1 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
12	Type R Thermocouple 500 C to 1750 C	Engineering Unite	+1750.0	+0500.0	0.1 C
		% of FSR	+100.00	+028.57	0.01%
		Twos Complement	7FFF	2492	1 LSB[1]
13	Type R Thermocouple 500 C to 1750 C	Engineering Unite	+1750.0	+0500.0	0.1 C
		% of FSR	+100.00	+028.57	0.01%
		Twos Complement	7FFF	2492	1 LSB[1]
14	Type B Thermocouple 500 C to 1800 C	Engineering Unite	+1800.0	+0500.0	0.1 C
		% of FSR	+100.00	+027.77	0.01%
		Twos Complement	7FFF	2381	1 LSB[1]
20	100.00 W Platinum RTD a = .00385 -100 C to 100 C	Engineering Unite	+100.00	-100.000	0.1 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	8000	1 LSB[1]
		Ohms	+138.50	+060.60	10 mW
21	100.00 W Platinum RTD a = .00385 0 C to 100 C	Engineering Unite	+100.000	+000.00	0.1 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+138.50	+100.00	10 mW

Range Code (hex)	Input Range Description	Data Formats	Maximum Specitied Signal	Minimum Specitied Signal	Displayed Resolution
22	100.00 W Platinum RTD a = .00385 0 C to 200 C	Engineering Unite	+200.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+175.84	+100.00	10 mW
23	100.00 W Platinum RTD a = .00385 0 C to 600 C	Engineering Unite	+600.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+313.59	+100.00	10 mW
24	100.00 W Platinum RTD a = .00392 -100 C to 100 C	Engineering Unite	+00.00	-100.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	8000	1 LSB[1]
		Ohms	+139.16	+060.60	10 mW
25	100.00 W Platinum RTD9285 0 C to 100 C	Engineering Unite	+100.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+139.16	+100.00	10 mW
26	100.00 W Platinum RTD a = .00392 0 C to 200 C	Engineering Unite	+200.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+177.13	+100.00	10 mW
27	100.00 W Platinum RTD a = .00392 0 C to 600 C	Engineering Unite	+600.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+317.28	+100.00	10 mW
28	120 W Nickel RTD -80 C to 100 C	Engineering Unite	+100.000	-80.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	8000	1 LSB[1]
		Ohms	+200.64	+066.60	10 mW

Range Code (hex)	Input Range Description	Data Formats	Maximum Specitied Signal	Minimum Specitied Signal	Displayed Resolution
29	100.00 W Nickel RTD a = .00392 0 C to 100 C	Engineering Unite	+100.00	+000.00	0.01 C
		% of FSR	+100.00	+000.00	0.01%
		Twos Complement	7FFF	0000	1 LSB[1]
		Ohms	+200.64	+120.00	10 mW

NOTE: [1] Resolution is one LSB of 16 bits

B.3 Analog Output Formats

You can configure ADAM analog output modules to receive data from the host in one of the following data formats:

-Engineering Units

-Percent of FSR

-Twos complement hexadecimal

Data for ADAM modules can be used in any one of the following data formats:

B.3.1 Engineering Units

This format is chosen by setting bits 0 and 1 of the data format/slew rate/ checksum parameter to 00.

Data is presented in natural units such as milliamps. The Engineering Units format is readily parsed by most computer languages as the total data string length is fixed at six characters: two decimal digits a decimal point and three decimal digits. The resolution is 5 μA.

Example: An analog output module (address 01h) is configured for a 0 to 20 mA range. If the output value is + 4.762 mA the format of the Analog Data Out command would be #0104.762(cr).

B.3.2 Percent of Span

The Percent of Span format is employed by setting bits 0 and 1 of the data format/slew rate/checksum parameter to 01.

This format consists of a "+" or "-" sign, three decimal digits, a decimal point and two decimal digits. Data is presented as the value sent of the output signal relative to the span of the output (percent of span).

The maximum resolution is 0.2% of span (5 μA for the 0 to 20 mA output range) and the desired output value is 10 mA the format of the Analog Data Out command is as follows:

#01+050.00 (cr)

indicating that the output is at 50% of span. The decimal point is fixed.

B.3.3 Hexadecimal

This format is selected by setting bits 0 and 1 of the data format/slew rate/ checksum parameter to 10.

ASCII's condensed hexadecimal representation of data allows and provides high resolution, quick communication and easy conversion to computer-compatible integer format. The format consists of a 3-character hexadecimal string representing a 12-bit binary value. The resolution for the 0 to 20 mA output range equals .025% of span, which is 5 μA. The corresponding value for 000 is 0 mA; likewise, the value FFF corresponds to 20 mA.

B.4 Analog Output Ranges

Range Code (hex)	Input Range Description	Data Formats	Maximum Specitied Signal	Minimum Specitied Signal	Output Resolution
30	0 to 20 mA	Engineering Unite	20.000	00.000	5 A
		% of FSR	+100.00	+000.00	5 A
		Hexadecimal Binary	FFF	000	5 A
31	4 to 20 mA	Engineering Unite	20.000	04.000	5 A
		% of FSR	+100.00	+000.00	5 A
		Hexadecimal Binary	FFF	000	5 A
32	0 to 10 V	Engineering Unite	20.000	00.000	2.442 mA
		% of FSR	+100.00	+000.00	2.442 mA
		Hexadecimal Binary	FFF	000	2.442 mA