Definitions:
Continuous time signal – A signal which is a function of time and has a value defined for every point in time.
Continuous amplitude signal – A signal whose amplitude is defined such that any amplitude between some minimum and a maximum is possible.
Discrete time signal – A signal which is a function of time but has a value defined only for discrete points in time. These discrete points are usually at regular intervals.
Discrete amplitude signal – A signal whose amplitude is defined in terms of discrete points between some minimum and maximum.
Analog Signal – A signal which is continuous in both time and amplitude.
Discrete Signal – A signal which is discrete in both time and amplitude. This is also commonly referred to as a digital signal.
Analog to Digital Converter – (A/D) A circuit, usually on one chip, which has an analog signal as an input and produces an binary number as an output. The binary output is proportional to the amplitude of the analog input. For example, an 8-bit A/D could accept analog signals in the range of 0 to 10 volts and produce 8-bit numbers in a register output in the range of 00000000 to 11111111 (0 to 255). In this case all zeros stands for 0 volts and all ones stands for 10 volts and each one-bit increment represents $10/255 = 0.0392$ volts.
Digital to Analog Converter – (D/A) A circuit, usually on one chip, which has a binary number as an input and produces a discrete amplitude voltage level as an output. For example, an 8-bit D/A might accept 8-bit binary number from 00000000 to 11111111 (0 to 255) as inputs and produce outputs in the range 0 to 10 volts. An input of all zeros would produce 0 volts, an input of $10000000 = 128$ would produce $5.0196$ volts, etc. Each increase of one-bit on the input would increase the output voltage by $10/255 = 0.0392$ volts.

Analog to Digital Converters
There are numerous methods of converting an analog input signal to a digital output signal and A/D converters come in a variety of forms. The most common place where we encounter A/D conversion is in the conversion of sound (usually something resembling music) to a digital form. Sound is picked up by a microphone which produces an analog output voltage. To make a CD, this analog signal is converted to a 16-bit binary number by an A/D converter and stored in digital form on a compact disk. When you play the CD, a D/A converter changes the digital binary numbers back to analog form which is used to drive a speaker.

For the Lego boards the A/D converter is used to read the voltage from the light sensors which serve as the eyes for the vehicle. A block diagram for the converter is shown in Figure 1 below.
To use the converter the processor write a control word to the control register which tells the converter which of the 8 channels to convert. The write line starts the conversion process which takes about 40 \( \mu \)sec. When the conversion is done the "done" bit is set. This bit is connected to bit 5 on port 3 of the processor. The processor can then read the converted data from the 8-bit output register. Note that the A/D converter is enabled by address line A13. The address bus has 16 bits and bit A13 must be a 0 to enable the converter. Bits A14 and A15 must be one. The complete address is then 0C000H as shown below.

<table>
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<th>A15</th>
<th>A14</th>
<th>A13</th>
<th>A12</th>
<th>A11</th>
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