Kevin M. Daugherty

A Practical Approach

Conversion

Analog-to-Digital
Figure 1. Typical data acquisition system.

When a data acquisition system is designed, there are often options to consider. By looking at the complete picture, it should be possible to decide which basic system to use. Typically, the goals are to provide a readable output and to ensure that the measurement process is straightforward.
Sample-and-Hold (S/H): It is not built into the A/D converter, must be added before the multiplexer allows for better synchronization of the input signals. The performance of the S/H stage is dependent on the hold time, which are the time constants for this function. Placing the S/H before the multiplexer allows for better synchronization of the input signals. However, there are trade-offs for this function. A longer hold time results in a slower system response, while a shorter hold time results in a faster system response.

Multiplexers are an option when more channels are required than the A/D converter can handle. This can be a cost-effective solution between a lower-cost discrete or fully integrated design.

Prevent aliasing or remove system transients from the signal by putting a filter stage in the output path of the A/D converter. Filters are often required to attenuate the out-of-band noise to prevent aliasing where multiple inputs must be measured as quickly as possible.

The input signals are commonly used in analog or digital data processing. The multiplexer reduces the number of channels from 8 to 1, allowing easier data processing. By using a single multiplexer instead of multiple ones, the signal processing is significantly simplified. In this example, there are two multiplexers feeding a single FET multiplexer.

Figure 1.1: Quad Multiplier

Figure 1.2: Quad Multiplier Crossbar

The crossbar configuration is defined as the ability to switch between the input channels. This allows for multiple channels to be processed simultaneously. The crossbar configuration is used in many applications, such as audio and video processing.
instruments, and the control, feedback, and decision making systems need to be considered.

When choosing an A/D converter, the following considerations are important:

1. Resolution:
   - The required resolution determines the A/D converter selection.
2. Speed:
   - Higher-speed A/D converters are necessary for high-speed applications.
3. Power Consumption:
   - Power consumption is a critical factor in battery-operated systems.
4. Cost:
   - Cost is a significant factor in selecting an A/D converter.

Figure 1.4 illustrates two options for A/D converters. The right-hand block diagram illustrates a single-channel A/D converter, while the left-hand block diagram illustrates a multiple-channel A/D converter. The single-channel A/D converter is suitable for applications requiring high resolution and speed, while the multiple-channel A/D converter is suitable for applications requiring multiple simultaneous measurements.

In conclusion, selecting the right A/D converter is crucial for successful data acquisition and processing. Careful consideration of the requirements and constraints of the application is necessary to ensure optimal performance.
and varying the duty cycle of a two-phase bridge. By using a fixed period of operation, the average voltage output of the two phases is the same as the average voltage output when the duty cycle of each phase is varied. This method is known as a voltage modulation converter. It is widely used in inverters and DC-DC converters. Although this method is not very efficient, it is relatively simple and can be implemented using simple electronic components.

The main limitation of this method is that the output voltage is not very linear, and the efficiency is low. However, it is widely used in inverters and DC-DC converters due to its simplicity and low cost.

The second method is known as current modulation. In this method, the average current output of the converter is varied, and the average voltage output is not very linear. This method is widely used in DC-DC converters and is known as a current modulation converter.

The main limitation of this method is that the output voltage is not very linear, and the efficiency is low. However, it is widely used in DC-DC converters due to its simplicity and low cost.

The third method is known as hybrid modulation. In this method, both the average voltage and current output of the converter are varied. This method is widely used in inverters and is known as a hybrid modulation converter.

The main limitation of this method is that the output voltage is not very linear, and the efficiency is low. However, it is widely used in inverters due to its simplicity and low cost.

In conclusion, the choice of modulation method depends on the application and the desired output characteristics. It is important to note that each method has its own unique advantages and disadvantages, and the choice of method should be based on the specific requirements of the application.
The next comparison is of speed versus resolution. Note, in most cases, that the speed is proportional to the lower oscillator frequency.

<table>
<thead>
<tr>
<th>Resolution measurement terms</th>
<th>Lowest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved PWM (same cell as standard)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>PWM (pulse width modulation)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>i-PWM (includes noise)</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>i-PWM (includes noise)</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>i-PWM (includes noise)</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>i-PWM (includes noise)</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td>i-PWM (includes noise)</td>
<td>64</td>
<td>128</td>
</tr>
<tr>
<td>Bit stream</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Maximum accuracy, this type of A/D converter</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

**Characteristics of Key A/D Converter**

In making a comparison of the available types of A/D converter, and this is helpful code and the selected resolution. The first comparison is of cost versus accuracy, and this is helpful due to the nature of operation (co-processor). Improvement may occur in the highness of operation (co-processor), or the current OP/UN. The next comparison is that either an adder or a sum of errors exists of those key requirements. Keep in mind that these are resolution, accuracy, speed, and cost. The following comparisons are of the available approaches. The most important characteristics include: speed, accuracy, cost, and quality of A/D converter. Generally, some key requirements can be used to quickly select a converter with the lowest effective number of bits for use. The desired resolution is practical only for the shortest signals of low peak-to-peak voltage. Fast data is usually recognized by the unknown input voltage.
The highest weighting factor of the output

**MSB (most significant bit)** then 1 LSB = 1/1024 = 0.976

For example, with 4-bit scale, 0 and resolution = 10 bits.

1 LSB (least significant bit) 1 LSB = (full-scale input voltage/resolution) - Intermodulation distortion (IMD)

When two different-frequency signals

shown in Fig. 7.7.

ideal voltage, expressed in least significant bits (LSB), (I/q).

This is also called the full-scale error, and it refers to the

Gain error.

Thus the output (V_out) decreases by 3 dB (V_out has dropped by 0.5 LSB)

Noise (V_NOISE) in the full-scale range is equal to the signal-to-

full-power bandwidth. This is defined as the frequency where the

\[
\text{ENOB} = \frac{\text{SINAD} - 1.76}{6.02}
\]

Dynamic nonlinearity.

The resolution of the analog-to-digital converter.

Effective number of bits (ENOB).

The ENOB, expressed in decibels,

are defined as the dynamic specification.

These refer to the performance/evaluation of the signal.

Dynamic nonlinearity.

This is the same as nonlinearity but

Maximum sampling rate instead of a direct-current (dc) input.

Phase of the signal must be sampled at a rate

Bandwidth-limited to below 1/2 of the Nyquist frequency.

Previous level, there would be 1 LSB differential error. When the DN