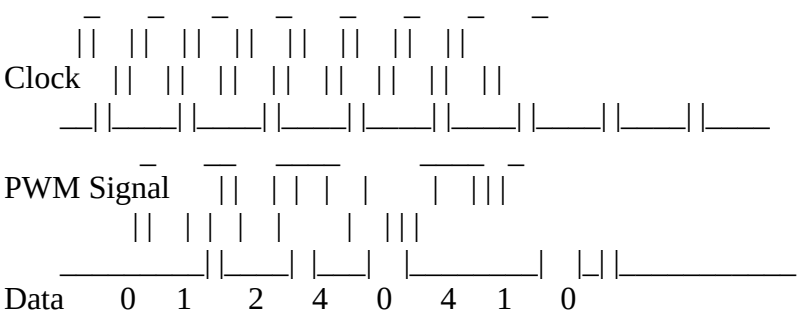
Applications of PWM

Applications

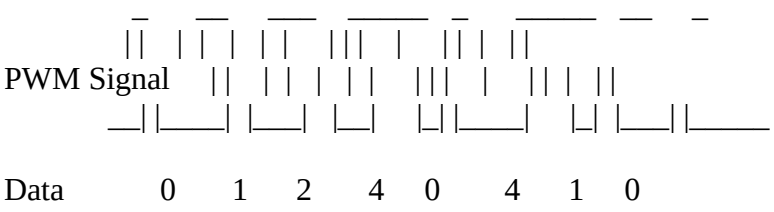
Telecommunications

In telecommunications, the widths of the pulses correspond to specific data values encoded at one end and decoded at the other.

Pulses of various lengths (the information itself) will be sent at regular intervals (the carrier frequency of the modulation).



The inclusion of a clock signal is not necessary, as the leading edge of the data signal can be used as the clock if a small offset is added to the data value in order to avoid a data value with a zero length pulse.



Power delivery

PWM can be used to adjust the total amount of power delivered to a load without losses normally incurred when a power transfer is limited by resistive means. The drawback are the pulsations defined by the duty cycle, switching frequency and properties of the load. With a sufficiently high switching frequency and, when necessary, using additional passive electronic filters the pulse train can be smoothed and average analog waveform recovered.

High frequency PWM power control systems are easily realisable with semiconductor switches. As has been already stated above almost no power is dissipated by the switch in either on or off state. However, during the transitions between on and off states both voltage and current are non-zero and thus considerable power is dissipated in the switches. Luckily, the change of state between fully on and fully off is quite rapid (typically less than 100 nanoseconds) relative to typical on or off times, and so the average power dissipation is quite low compared to the power being delivered even when high switching frequencies are used.

Modern semiconductor switches such as MOSFETs or Insulated-gate bipolar transistors (IGBTs) are quite ideal components. Thus high efficiency controllers can be built. Typically frequency converters used to control AC motors have efficiency that is better than 98 %. Switching power supplies have lower efficiency due to low output voltage levels (often even less than 2 V for microprocessors are needed) but still more than 70-80 % efficiency can be achieved.

Variable-speed fan controllers for computers usually use PWM, as it is far more efficient when compared to a potentiometer or rheostat. (Neither of the latter is practical to operate electronically; they would require a small drive motor.)

Light dimmers for home use employ a specific type of PWM control. Home-use light dimmers typically include electronic circuitry which suppresses current flow during defined portions of each cycle of the AC line voltage. Adjusting the brightness of light emitted by a light source is then merely a matter of setting at what voltage (or phase) in the AC halfcycle the dimmer begins to provide electrical current to the light source (e.g. by using an electronic switch such as a triac). In this case the PWM duty cycle is the ratio of the conduction time to the duration of the half AC cycle defined by the frequency of the AC line voltage (50 Hz or 60 Hz depending on the country).

These rather simple types of dimmers can be effectively used with inert (or relatively slow reacting) light sources such as incandescent lamps, for example, for which the additional modulation in supplied electrical energy which is caused by the dimmer causes only negligible additional fluctuations in the emitted light. Some other types of light sources such as light-emitting diodes (LEDs), however, turn on and off extremely rapidly and would perceivably flicker if supplied with low frequency drive voltages. Perceivable flicker effects from such rapid response light sources can be reduced by increasing the PWM frequency. If the light fluctuations are sufficiently rapid, the human visual system can no longer resolve them and the eye perceives the time average intensity without flicker (see flicker fusion threshold).

In electric cookers, continuously-variable power is applied to the heating elements such as the hob or the grill using a device known as a Simmerstat. This consists of a thermal oscillator running at approximately two cycles per minute and the mechanism varies the duty cycle according to the knob setting. The thermal time constant of the heating elements is several minutes, so that the temperature fluctuations are too small to matter in practice.

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