

Fan Electrical performance requirements

Requirement	Value
Peak fan current draw	1.5 A
Average fan current draw	1.1 A
Fan start-up current draw	2.2 A
Fan start-up current draw maximum duration	1.0 second
Fan header voltage	12 V \pm 10%
Tachometer output	2 pulse per revolution

- Mechanical wear out represents the highest risk reliability parameter for fans. The capability of the functional mechanical elements (ball bearing, shaft, and tower assembly) must be demonstrated to a minimum useful lifetime of 50,000 hours.
- In addition to passing the environmental reliability tests described in Section 5.2, the fan must demonstrate adequate performance after 7,500 on/off cycles with each cycle specified as 3 minutes on, 2 minutes off, at a temperature of 70 °C.

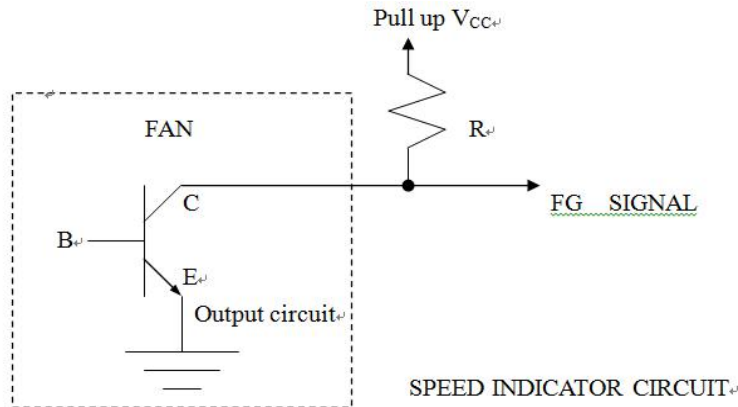
Fan speed indicator Circuit output (Option)

Most WANHANG-ELECTRONICS fans may build in an additional output intended for monitoring the speed of rotation. This signal can also be used to indicate that the fan is not turning. The signal takes the form of an open collector output.

These specifications must be observed;

$$I_{CE} = 5 \text{ mA (MAX) } \quad V_{CC} = +26.4\text{V(MAX) } , R \geq V_{CC}/I_{CE}$$

$$V_{CE(\text{sat})} = 0.5\text{V MAX}$$



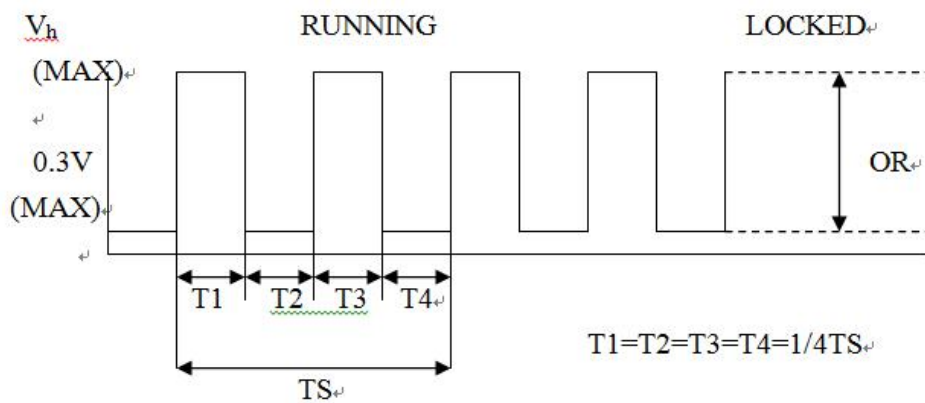
Fan Frequency Generation OUTPUT SIGNAL

When the fan is turning the output will take the form of a train of square wave.

When the fan motor is locked the output will be a DC signal either high or low.

FAN RUNNING FOR 4 POLES

Two pulses per revolution

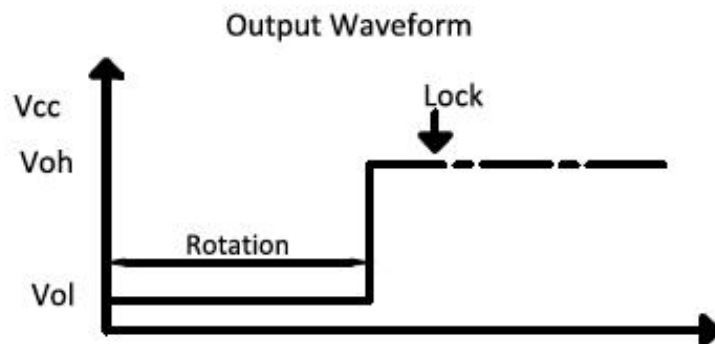
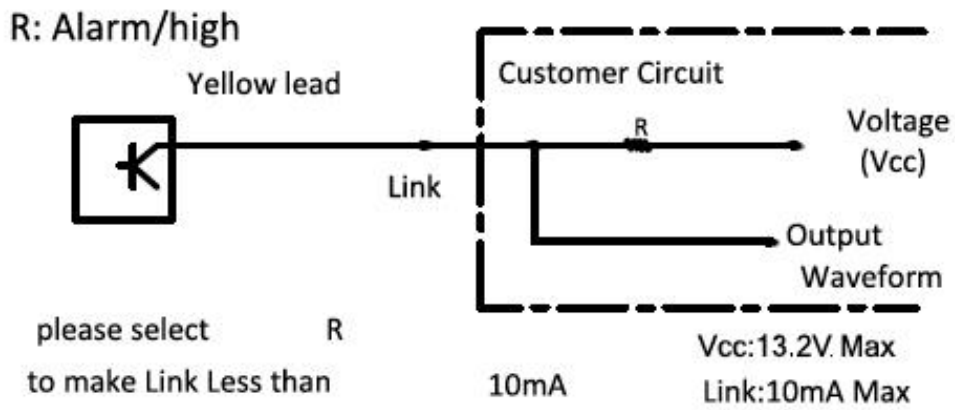


$$N = \text{R.P.M.}$$

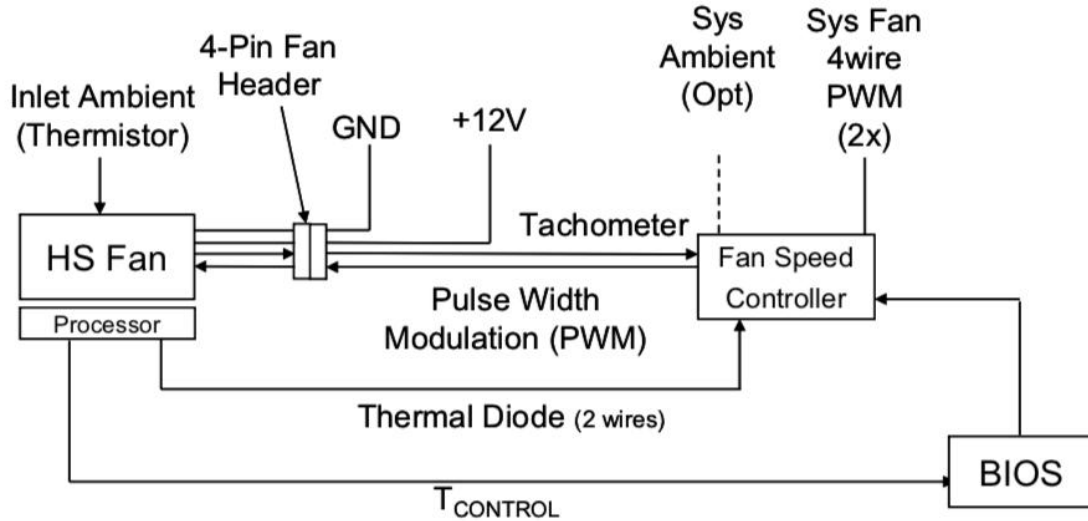
$$TS = 60/N(\text{SEC})$$

Fan Alarm Signal

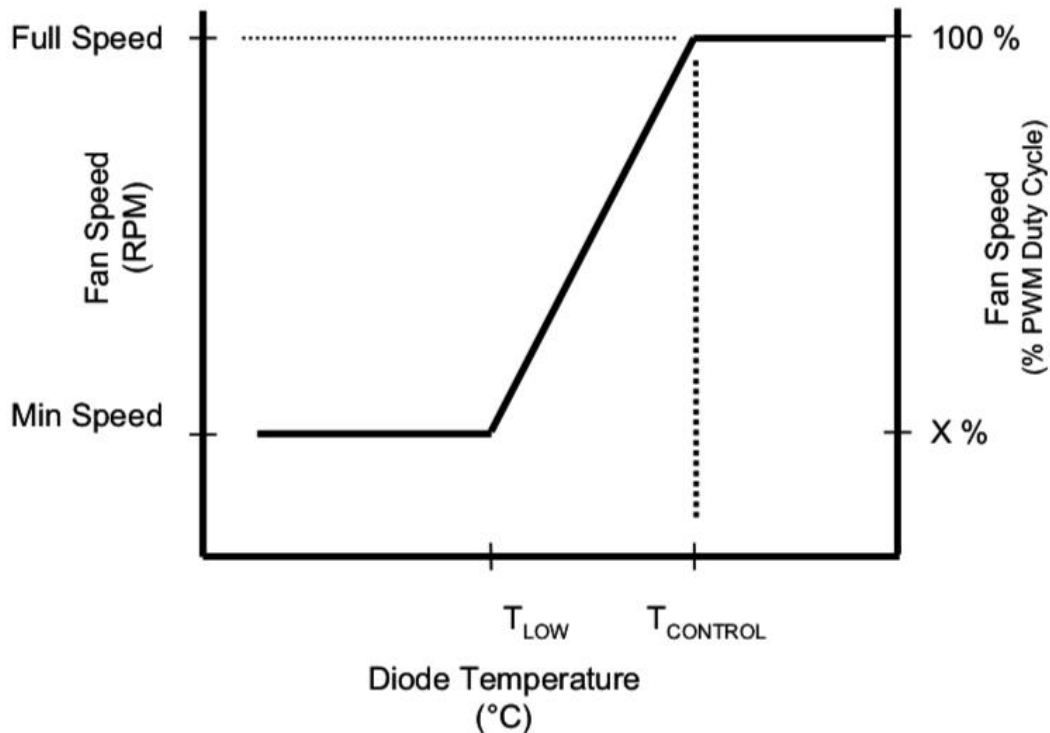
Signal Circuit System



Fan Speed Control Implementation



A number of major manufacturers have FSC components that include the necessary functionality to measure the temperature of the on-die thermal diode and output a PWM signal. These components can be a discrete device or a super I/O (SIO) with the functionality embedded. The following vendors currently have components that could be suitable: Analog Devices, ITE, Maxim, National Semiconductor, SMSC and Winbond. Consult their web sites or local sales representatives for a part suitable for your design. See Appendix E for further details on the motherboard requirements



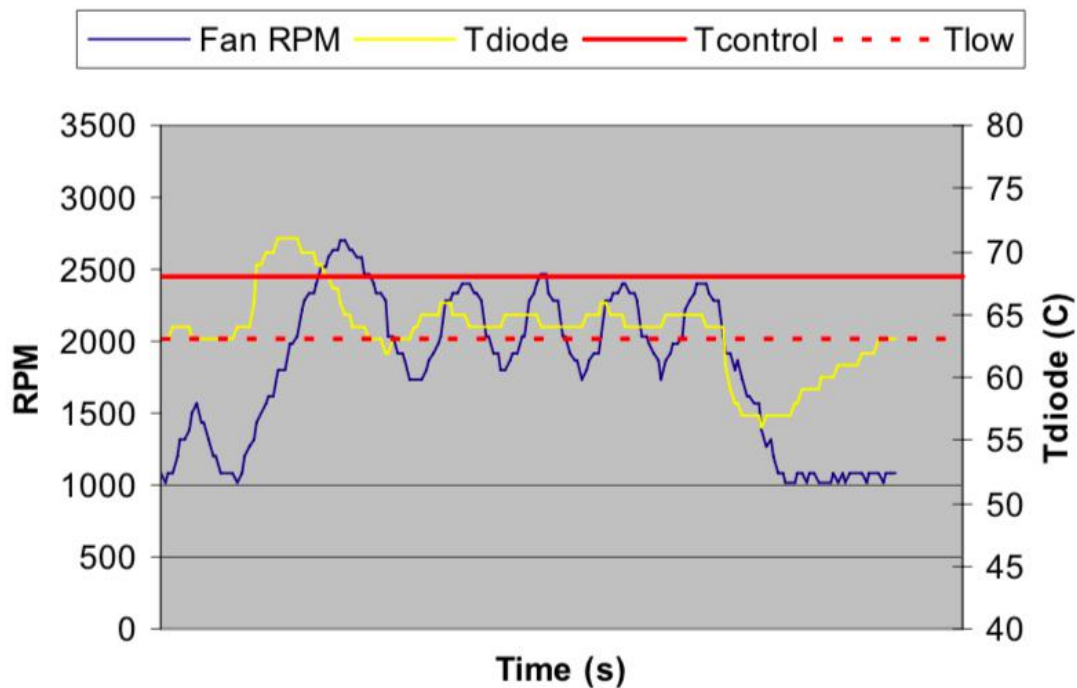
Temperature to begin fan acceleration

The first item to consider is the value for T_{LOW} . The FSC device needs a minimum temperature to set as the threshold to begin increasing PWM duty cycle to the fan.

The system designer might initially consider a small temperature range ($T_{CONTROL} - T_{LOW} = T_{RANGE}$), such as 5 °C to accelerate the fan. That would delay the fan accelerating for the longest period after an increase in T_{DIODE} . There are a number of issues that should be considered with this strategy:

- There is little granularity in the fan speeds. For each 1 °C of increase in diode temperature = 20% jump in PWM duty cycle %.
- Fan speed oscillation as the thermal solution chases the diode temperature.
- Having T_{DIODE} overshoot $T_{CONTROL}$ and the thermal profile causing the Thermal Control Circuit to activate to reduce the temperature.

The first two cases can create a poor acoustic response for the user. For the third case, the user could notice a drop in performance as the thermal control circuit reduces the power. Figure 19 is an example of this situation. The system begins at idle and a moderate workload is applied (less than TDP).



An alternate would be to consider a slightly larger value such as $T_{\text{RANGE}} = 10\text{ }^{\circ}\text{C}$. In this case the design is trading off the acoustic margin for thermal margin.

- There is increased granularity in the fan speeds.
- Fan speed oscillation are significantly reduced
- Maximum fan speed is lower

The rate of change of Ψ_{CA} vs. RPM is an exponential curve with a larger decrease at the beginning of the fan acceleration than as the maximum speed is approached. By having the fan start to accelerate at a lower T_{DIODE} reading the thermal solution can keep up with rate of change in processor power. The rate of change in acoustics (dBA) is more linear with RPM. When comparing these two metrics, the choice of a larger T_{RANGE} value becomes a more acceptable trade off. Figure 20 graphs the system at the same conditions as in Figure 19, but $T_{\text{RANGE}} = 10^{\circ}$.

Minimum PWM Duty Cycle

The final step in determining the FSC setting is to determine the minimum PWM Duty cycle. This is the fan speed for any $T_{\text{DIODE}} < T_{\text{LOW}}$. The selection of this value is dependent on:

- Acoustic target at system idle
- Voltage regulator cooling

For a motherboard design intending to use the Intel Boxed Pentium 4 Processor in 775–land LGA Package or the enabled reference thermal solution the recommended minimum PWM duty cycle is 30%.

Heater and Thermistor

