4-Wire Pulse Width Modulation (PWM) Controlled Fans

Specification

July 2004

Revision 1.2

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Revision History

Revision Number	Description	Revision Date
0.5	Initial Release.- Internal Only	June 2003
1.0	Initial Release Public	Nov 2003
1.1	Corrected Tachometer input signal, added definitions to operating modes	Dec 2003
1.2	Corrected Section 2.4 PWM input parameter	July 2004

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1   *Introduction*

1.1   Overview

This specification defines the intended operation of a fan that implements the Pulse Width Modulation (PWM) control signal on the 4-wire fan interface. The introduction of 4 wire PWM controlled fans is a means to reduce the overall system acoustics. The expectation is a 4 wire PWM controlled fan when properly implemented will be significantly quieter than a similar 3 wire fan.

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2   *Electrical Specifications*

2.1   Voltage

Fan operating voltage shall be within the range 12 V ±1.2 V.

2.2   Current

Peak fan current draw during start-up operation (with 13.2 V applied, with fan operating in the free stream condition) shall not exceed 2.0 A.

Fan current spike during start-up operation (with 13.2 V applied, with fan operating in the free stream condition) shall be allowed to exceed 1.0 A for a duration of no greater than 1.0 sec.

2.3   Tachometer Output Signal

Fan shall provide tachometer output signal with the following characteristics:

- Two pulses per revolution
- Open-collector or open-drain type output
- Motherboard will have a pull up to 12V, maximum 13.2V

2.4   PWM Control Input Signal

The following requirements are measured at the PWM (control) pin of the fan cable connector:

PWM Frequency: Target frequency 25 kHz, acceptable operational range 21 kHz to 28 kHz

Maximum voltage for logic low: $V_{IL} = 0.8$ V

Absolute maximum current sourced: $I_{max} = 5$ mA (short circuit current)

Absolute maximum voltage level: $V_{Max} = 5.25$ V (open circuit voltage)

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3 *Fan Speed Control*

3.1 Maximum Fan Speed Requirements

The maximum fan speed shall be specified for the fan model by the vendor and correspond to 100% duty cycle PWM signal input.

3.2 Minimum Fan Speed Requirements

The vendor shall specify the minimum RPM and the corresponding PWM duty cycle. This specified minimum RPM shall be 30% of maximum RPM or less. The fan shall be able to start and run at this RPM. To allow a lower specified minimum RPM, it is acceptable to provide a higher PWM duty cycle to the fan motor for a short period of time for startup conditions. This pulse should not exceed 30% maximum RPM and should last no longer than 2 seconds. See Figure 1.

Figure 1 Minimum Fan Speed Requirements: Start Pulse
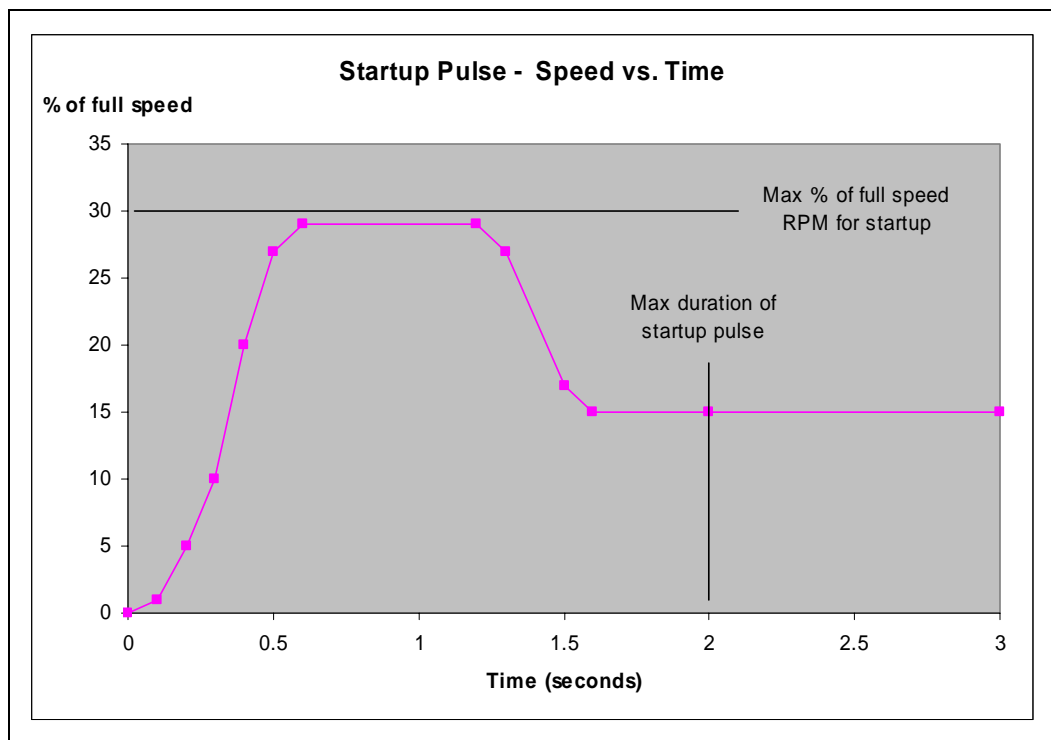
3.3   Fan Speed Response to PWM Control Input Signal

The PWM input shall be delivered to the fan through the control signal on Pin 4 (see Section 2.4). Fan speed response to this signal shall be a continuous and monotonic function of the duty cycle of the signal, from 100% to the minimum specified RPM. The fan RPM (as a percentage of maximum RPM) should match the PWM duty cycle within ±10%. If no control signal is present the fan shall operate at maximum RPM. See Figure 2.

Figure 2 Fan Speed Response to PWM Control Input Signal
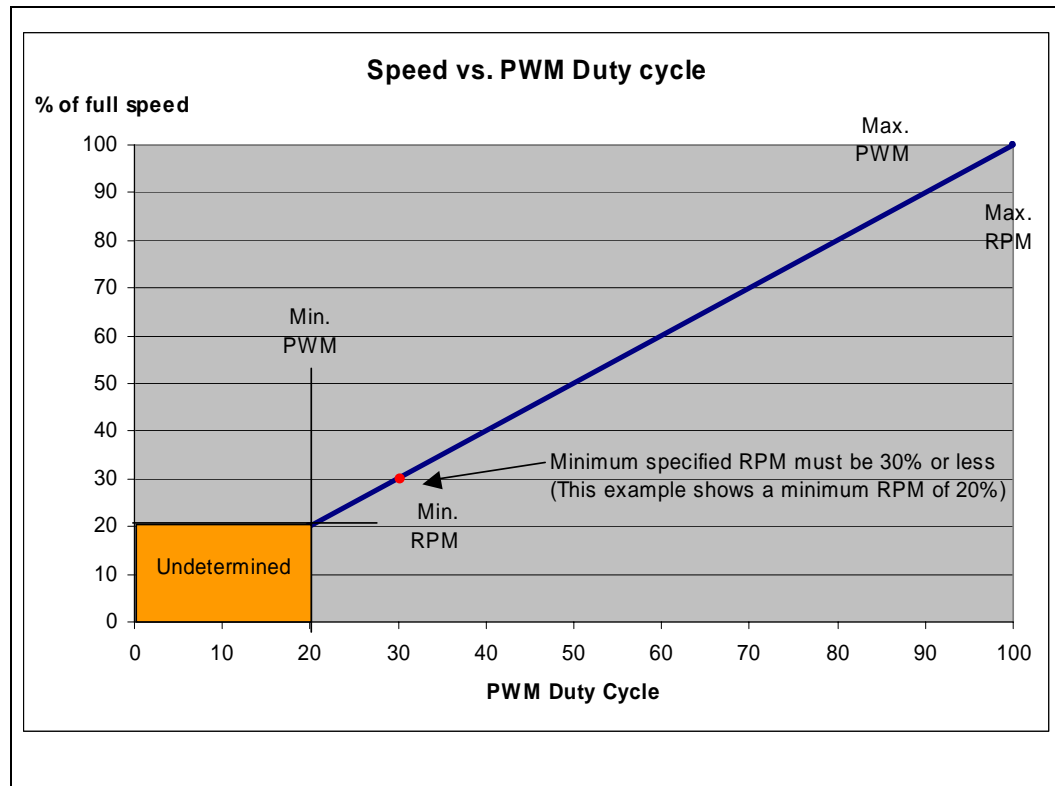
3.4   Operation below Minimum RPM

For all duty cycles less than the minimum duty cycle, the RPM shall not be greater than the minimum RPM. The following graphs and definitions show three recommended solutions to handle PWM duty cycles that are less than the minimum operational RPM, as a percentage of maximum.

In a Type A implementation the fan will run at minimum RPM for all PWM duty cycle values less than minimum duty cycle. The minimum fan speed is controlled by design and can not be overridden by the external fan speed controller. See Figure 3.

Figure 3 Type A Operation, Minimum RPM, Stay on at Minimum RPM

Speed vs. PWM Duty cycle
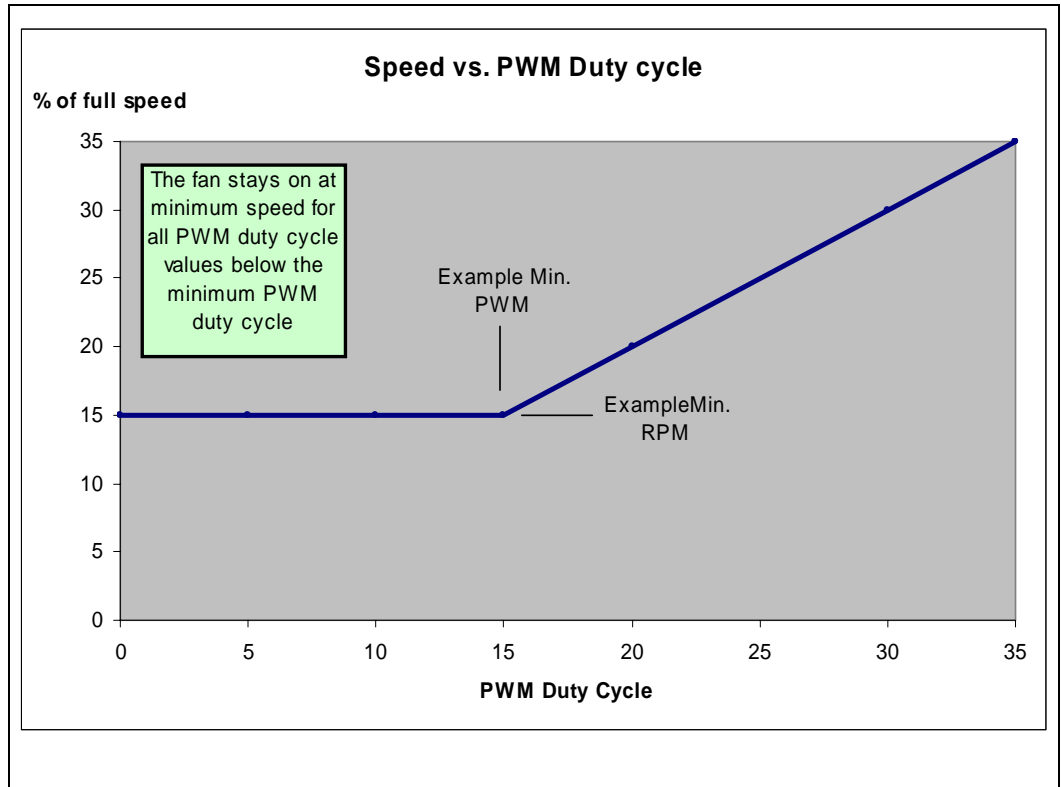
In a Type B implementation the fan will run at minimum RPM for all non-zero PWM duty cycle values less than minimum duty cycle and turn off the motor at 0% PWM duty cycle. See Figure 4.

Figure 4 Type B Operation, Stay On at Minimum RPM, Off at 0% RPM
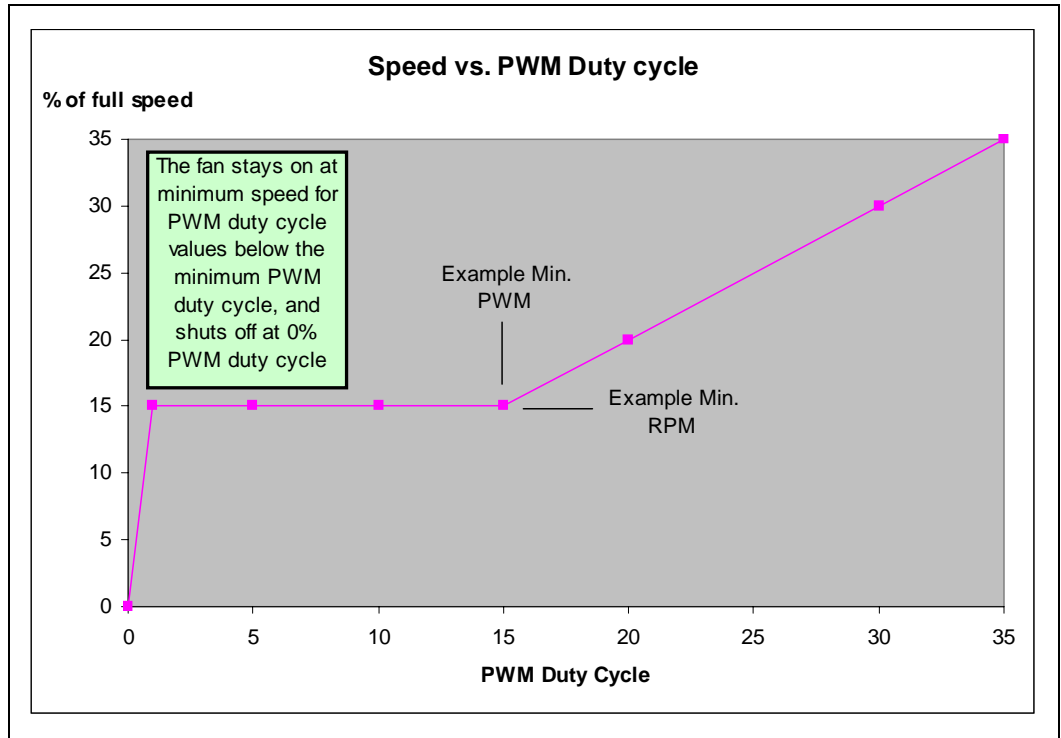
In Type C implementation the fan will stop running when the current provided to the motor windings is insufficient to support commutation. The fan should not be damaged from this. The fan would also turn off the motor at 0% PWM duty cycle input. See Figure 5.

Figure 5 Type C, Operation below Minimum RPM, Min, RPM = Starting RPM

Speed vs. PWM Duty cycle

% of full speed

Example Min. PWM

Example Min. RPM

The minimum fan speed specified is also the minimum fan starting speed. The fan may continue to run at speeds below the minimum speed, but will not start at that speed.

Fan speed as PWM duty cycle is being reduced

Fan speed as PWM duty cycle is being increased

PWM Duty Cycle

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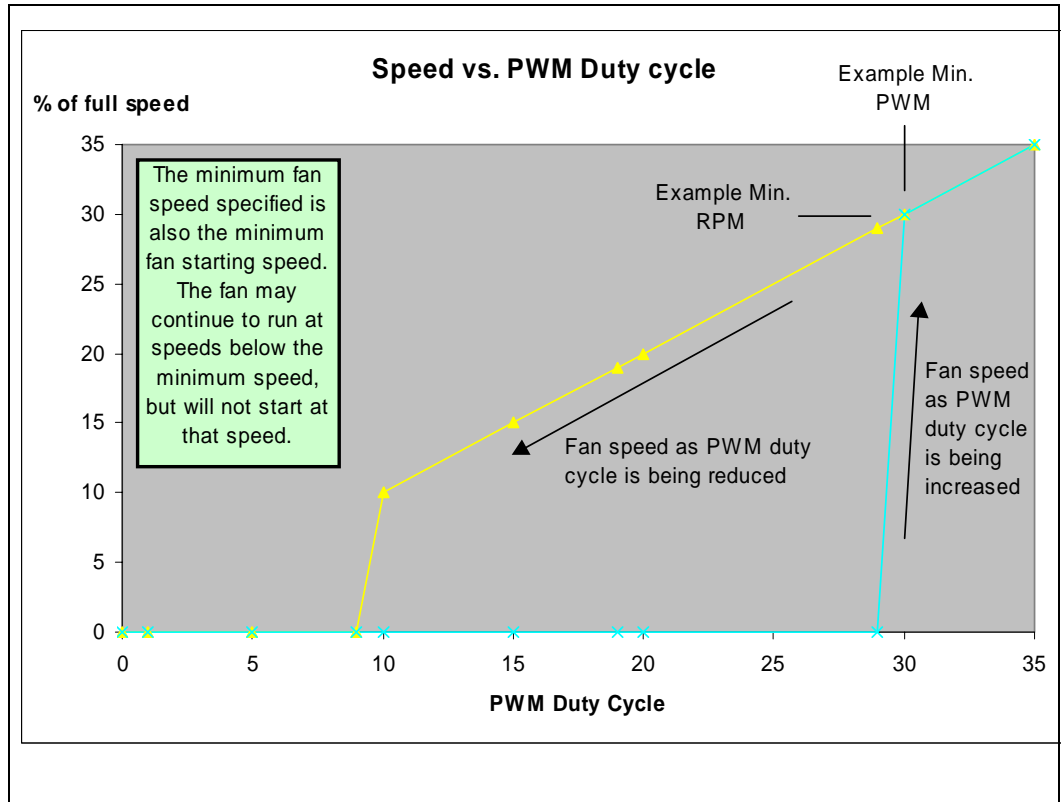
4   Required Features

4.1.1   Polarity Protection

Fan motor shall have polarity protection.

4.1.2   Rotor Lock Protection

Fan rotor shall have lock protection and auto-restart

4.1.3   Wire Length

To be specified in individual fan specification based on application

4.1.4   Wire Type

Wire type shall meet the following minimum qualifications: UL recognized appliance wiring, style UL1430, rated minimum 105C, 300V, 26 gauge.

4.1.5   Connector Housing

Wire shall be terminated with 4-pin connector housing, Wieson part number 2510C888-001, Molex 47054-1000 or equivalent. See Figure 6 for reference drawing

The intended mating header for this connector housing, is Wieson part number 2366C888-007 Molex 47053-1000, Foxconn HF27040-M1, Tyco 1470947-1 or equivalent See Figure 7 for reference drawing.

4.1.6   Fan Connector Pinout and Wiring Colors

Table 1 Connector Pinout

Pin	Function	Wire Color
1	GND	Black
2	12 V	Yellow
3	Sense	Green
4	Control	Blue

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Required Features

5   *Environmental and Reliability*

5.1.1   Operating Temperature

Fan shall be capable of sustaining normal operation over an ambient inlet temperature range of 0°C to 70 °C.

5.1.2   Non-operating Humidity

Fan shall be capable of sustaining normal operation at +55 °C / 85 %R.H.

5.1.3   Non-operating Thermal Cycling

Fan shall be capable of sustaining normal operation after being subjected to -5 °C to +70 °C for 1000 cycles; ramp = 20 °C/min; 10 min dwell.

5.1.4   Power Cycling

Fan shall be capable of sustaining normal operation after being subjected to 7,500 on/off cycles, each cycle specified as 3 minutes on, 2 minutes off at 70°C ambient temperature. The sample size is 12 units for this test.

5.1.5   Reliability

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.

The fan must pass the reliability test criteria with the fan operating at rated voltage in a high temperature environment. Readouts include RPM, Icc and Noise. No infant mortality defects allowed.

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6   *Reference Drawings*

The following pages contain reference drawings for the Connector Housing, and Baseboard Connector.

Figure 6 Connector Housing

NOTES:
1. MATERIAL: NYLON
2. COLOR: IVORY
3. FLAMMABILITY:FINISHED PART SHALL HAVE A MINIMUM UL FLAMMABILITY RATING OF UL94V-0
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M.

SECTION A-A

2X 6.08
0.7
8
2.18

4X 1.35
4X 1.35
5.08
10.8±0.3
5.34
0.13
1.85
1.59
3X 2.54
(7.62±0.2)
(COMBINED)

12.9

PIN ONE

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONS AND TOLERANCES
IN ACCORDANCE WITH ASME Y14.5M-1994
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
.X ± 0.5   Angles ± 0.5°
.XX ± 0.25
.XXX ± 0.025

PARTS LIST

	TOP		
-003	-002	-001	ITEM NO	PART NUMBER
QTY PER ASSY			

DESCRIPTION

DEPARTMENT

intel® CORP.   2200 MISSION COLLEGE BLVD.
P.O. BOX 58119
SANTA CLARA, CA 95052-8119

TITLE   4 PIN CONNECTOR

MATERIAL: -
FINISH:

SIZE   CAGE CODE   DRAWING NUMBER   REV
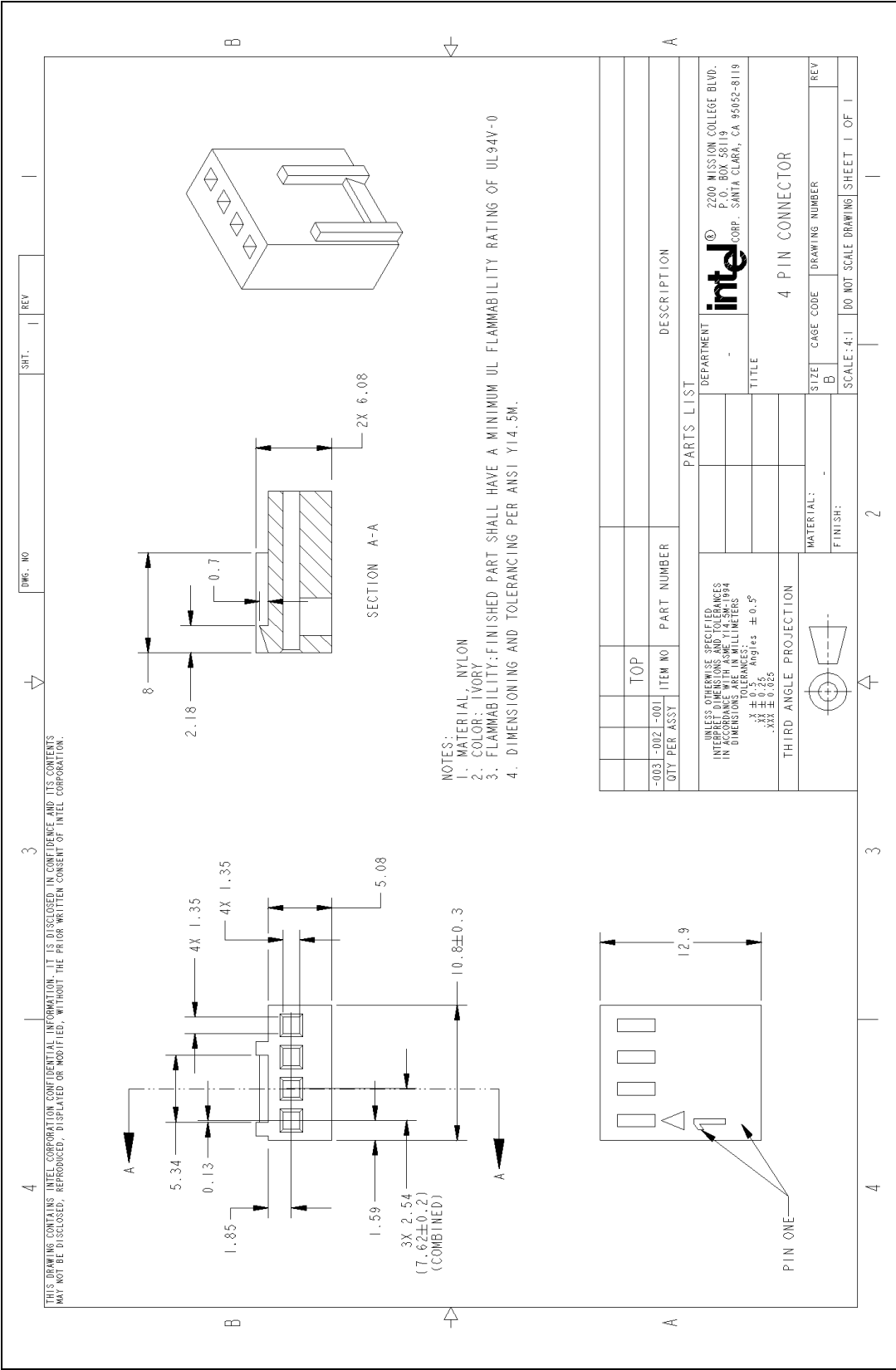B   -

SCALE: 4:1   DO NOT SCALE DRAWING   SHEET 1 OF 1

DWG. NO   SHT.   1   REV

Figure 7 Baseboard Connector

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NOTESNOTES:
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PIN 1

UNLESS OTHERWISE SPECIFIED
INTERPRET DIMENSIONS AND TOLERANCES
IN ACCORDANCE WITH ASME Y14.5M-1994
DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
.X ± 0.5   Angles ± 0.5°
.XX ± 0.25
.XXX ± 0.025

THIRD ANGLE PROJECTION

DEPARTMENT

intel ®
2200 MISSION COLLEGE BLVD.
P.O. BOX 58119
CORP. SANTA CLARA, CA 95052-8119

TITLE

4 PIN HEADER

SIZE CAGE CODE DRAWING NUMBER
B   4PINHEADER
SCALE:4:1 DO NOT SCALE DRAWING SHEET 1 OF 1

MATERIAL: -
FINISH:

PARTS LIST
DESCRIPTION
PART NUMBER
ITEM NO
-003 -002 -001
QTY PER ASSY
TOP

4PINHEADER SHT. 1 REV
DWG. NO