



Intel[®] Management Engine

Intel[®] Quiet System Technology (QST) Tools User's Guide for Intel[®] 5 Series Chipset Based Platforms

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Revision History

Revision Number	Description	Revision Date
0.2	Initial release (with preliminary information for testing purposes)	January 2009
0.3	Updated to provide information about additional tools included and additional tool parameters	February 2009
0.5	Updated illustrated figures of the Configuration Wizard	April 2009
0.7	Removed requirement of DOS4GW.EXE for DOS based tools Updated Qstcply usage options in Section 2.3.1 Miscellaneous corrections throughout the doc	July 2009
0.75	Added Sensor Base Specification DTS RPM Control screen descriptions	July 2009



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1 Introduction

1.1 About This User’s Guide

This document is intended for Original Equipment Manufacturers (OEM) and System Integrators. It introduces and provides details on the use of the various configuration and tuning support tools for Intel® Quiet System Technology (Intel® QST). The tools are included in the various Intel® Management Engine (Intel® ME) firmware kits provided by Intel. These tools are provided to facilitate the configuration and fine tuning of the Intel® QST subsystem.

For additional information on Intel® QST configuration and fine tuning, refer to the latest version of the Intel® Quiet System Technology Configuration and Tuning Manual.

1.2 Terminology

Term	Description
Intel® QST	Intel® Quiet System Technology
Intel® ME	Intel® Management Engine; an embedded processor located within the PCH
Firmware (FW)	Embedded firmware running on the Intel® ME
ATX	Advanced Technology eXtended form factor.
BTX	Balanced Technology eXtended form factor.
Graphic User Interface (GUI)	A visual framework that allows the user to interact with an application through direct manipulation of graphics objects.
DTS	Digital Thermal Sensor reports a relative die temperature as an offset from TCC activation temperature.



2 Tools Overview

Intel provides this collection of tools and utilities to enhance the ease-of-use of the configuration and tuning processes for Intel® QST. The tools and utilities provided include:

1. **Configuration Management Tools** – A collection of tools that are used by OEM/ODM and System Integrators to create, edit, install and extract Intel® QST configuration files. Individually, they are used as follows:
 - a. **QSTCT_GUI.exe** – Windows executable for the Intel® QST Configuration GUI, a tool that supports the editing of QST Configuration (INI) files. See xxxx for more information on the use of this tool.
 - b. **QstConfigurationWizard.msi** – Installation package for the QST Configuration Wizard, which provides support for creating new QST Configuration (INI) files with a minimum of user input.
 - c. **QstCfgD.exe/QstCfg.exe** – Dos and Windows executables, respectively, for a tool that supports either the immediate installation of a QST Configuration (INI) file or the creation of a file containing a QST Binary Configuration Payload that can be subsequently installed (included in ME (SPI) flash images).
 - d. **QstINID.exe/QstINI.exe** – DOS and Windows executables, respectively, for a tool that supports the extraction of the currently-installed QST Payload and the reconstitution of a QST Configuration (INI) file from it.
 - e. **QstCfgATXIP.ini** – Default Intel® QST Configuration (INI) file for Intel® 5 Series Chipset based platforms. It is configured for the hardware that is present on the Customer Reference Board (CRB). It is provided as a starting point for the derivation of customer versions.
2. **Configuration Tuning Tools** – A collection of tools that are used by OEM/ODM and System Integrators to support both manual and automated fine tuning of Intel® QST configurations. Individually, they are used as follows:
 - a. **QstTuningWizard.msi** – Installation package for the QST Tuning Wizard, which automatically tunes the Fan Weighting Matrix and assists with the tuning of the Processor Temperature Response coefficients.
 - b. **QstLog.exe** – Windows executable for a command-line tool that is used to display and collect (log) readings from the fan speed controllers and the temperature, fan speed and (optionally) voltage and current sensors. The comma-delimited log files produced can be input to various tools, including Microsoft* Excel, for subsequent analysis.
 - c. **QstCtrl.exe** – Windows executable for an interactive command-line tool that can be used to manually control fan speed, display sensors/controller readings/settings and have Intel® QST perform fan redetection.



- d. **QstStaDt.exe/QstStat.exe** – DOS and Windows executables, respectively, for a command-line tool that is used to obtain a report of the status of the Intel® QST Subsystem and the sensors and fan speed controllers being managed by it.
 - e. **QstDtsD.exe/QstDts.exe** – DOS and Windows executables for a command-line tool that is used to test specific sets of parameters, before they are committed into a BIOS, for the new, DTS-based thermal management control capability utilized with the latest Intel processors.
3. **Compliance Test Tool** – This executable (QstCply.exe) is used to check the readiness of an Intel® QST-based system.
 4. **System Tools** – These tools facilitate the Intel® QST configuration process. Individually, they are used as follows:
 - a. **Fitc.exe** – This tool is used to combine individual images – the BIOS firmware, the Intel® QST (Management Engine) firmware and Intel® QST Configuration Payload – into a single image for the SPI flash.
 - b. **Fpt.exe** – This tool is used to write an image to SPI flash or update an image in the SPI flash device.

Note: This document does not cover how to use the system tools. For details on how to use the system tools (Fitc and Fpt), refer to the System Tools User's Guide included in the Management Engine firmware kit.

2.1 Configuration Management Tools

This collection of tools provides support for the creation, edit, installation and extraction of Intel® QST Configuration (INI) files. The use of these tools is documented in the subsequent sections. The QST Configuration GUI is documented separately in Chapter 3 and the QST Configuration Wizard is documented separately in Chapter 4.

2.1.1 QstCfgD.exe/QstCfg.exe

QstCfgD.exe: Pure DOS command line tool. The tool is supported on Free DOS and Windows 98 DOS.

QstCfg.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.



2.1.1.1 Usage

The Configuration Tool can be utilized to achieve different goals, including:

- 1) Initially configuring the Intel® QST subsystem: The Configuration Tool can generate a binary payload from an INI file containing initial control parameters. The binary payload can then be programmed into the SPI flash to configure Intel® QST subsystem.
- 2) Tuning Intel® QST subsystem: after initially configuring the Intel® QST subsystem, the parameters in the INI file can be modified and optimized, based upon specific system design and thermal characteristics, to achieve optimum performance of the Intel® QST Subsystem. The Configuration Tool can be used to deliver INI files with optimized settings to the ME for subsequent storage in the SPI flash. The Configuration Tool can be easily integrated into the factory floor tool/application to automatically store the final settings into the SPI flash of production systems in manufacturing line processes.
- 3) Intel® QST testing and validation: during testing, validation and tuning of the Intel® QST subsystem, control parameters may need to be changed often, in order to optimize Intel® QST performance. The Configuration Tool provides an easy way to update the settings of the Subsystem.

2.1.1.2 Invocation

The primary environments for the execution of the Configuration Tool is the Windows* O/S and DOS. The Configuration Tool takes an INI file containing configuration settings and generates a binary payload from it. This Payload can be sent directly to the Management Engine, for immediate application, or written to a file, for subsequent application. Binary payload files so produced can be included in SPI flash images. A system configured this way will have this configuration applied immediately after the system is powered up for the first time.

The Configuration Tool will execute from the command line. Its operation is defined as follows:

1. The Tool will parse the configuration contained within the specified INI file and verify its contents. If an error is detected, a report will be generated and the program's execution terminated.
2. If the Tool successfully parses the configuration, it will prepare a binary payload and either deliver it to the ME or write it to a file. If it is delivered to the ME, the results of the ME's processing of this payload will be output. If the payload is rejected by the ME, information about the parameter that caused it to be rejected will be displayed.

Note: The Tool directs its output (status updates, error messages, etc.) to the standard output stream (STDOUT; normally the console). If the command line redirects the program's output to a (log) file, the program will also duplicate its output to the standard error stream (STDERR; always the console). This ensures that the operator always sees the results of the operation, even if it is also written to a (log) file.



The syntax for the tool is defined as follows:

QstCfgD [<INI File Path>] [{-d | {-w | -o} [<Binary File Path>]]

QstCfg [<INI File Path>] [{-d | {-w | -o} [<Binary File Path>]]

Where:

INI File Path	Specifies the pathname for the INI file.
-d	Specifies that the tool is to wait (delay termination) until QST has completed its fan detection process.
-w [<Binary File Path>]	Specifies that the payload is to be written to a file. If this file already exists, the tool will request confirmation before overwriting it.
-o [<Binary File Path>]	Specifies that the payload is to be written to a file. If the file already exists, it will be overwritten.

Note:

- If the optional **INI File Path** is not specified, the default pathname for the INI file will be "**QstCfg.ini**".
- If the optional **Binary File Path** is not specified, the default pathname for the Payload file will be "**QstCfg.bin**".
- The **"-d"** parameter and the **"-w"/"-o"** parameters are mutually exclusive. If **"-w"** or **"-o"** is specified, **"-d"** cannot be specified.
- The **"-w"** parameter and the **"-o"** parameter are mutually exclusive. Only one of them may be specified.
- The tool also supports two additional parameters, **"-e"** and **"-c"**, that are used for testing purposes. Customers should not use these parameters.

2.1.1.3 Examples

1. **"qstcfg"**: Specifies that the configuration contained within file "Qstcfg.ini" will be parsed and, if no errors are detected, delivered to the ME for processing.
2. **"qstcfg config.ini -d"**: Specifies that the configuration contained within file "config.ini" will be parsed and, if no errors are detected, delivered to the ME for processing. The tool will wait to terminate until the fan detection process is completed.
3. **"qstcfg -o"**: Specifies that the configuration contained within file "qstcfg.ini" will be parsed and, if no errors are detected, written to file "qstcfg.bin". If file "qstcfg.bin" already exists, it will be overwritten.
4. **"qstcfg config.ini -o config.bin"**: Specifies that the configuration contained within file "config.ini" will be parsed and, if no errors are detected, written to file "config.bin". If file "config.bin" already exists, it will be automatically overwritten.



2.1.2 QstINID.exe/QSTINI.exe

This tool provides support for a level of post-mortem analysis of the Intel® QST Subsystem configuration. It provides the ability to reconstitute an INI file from a binary configuration payload. This payload may be read from a file (created previously using QstCfg.exe/QstCfgD.exe) or it may be obtained from the Intel® QST Subsystem. Once an INI file has been reconstituted, it can be compared to other INI files, in order to determine whether any differences are present or, in the latter case, to verify that the configuration in use by the Intel® QST Subsystem is as expected.

QstINID.exe: Pure DOS command line tool. The tool is supported on Free DOS and Windows* 98 DOS.

QstINI.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.

2.1.2.1 Invocation

The tool is an executable file for either the Windows or DOS environment. It executes in from the command line. Its command line syntax is defined as follows:

QstINID [-P <Payload-Path>] [-I <INI-Path>]

QstINI [-P <Payload-Path>] [-I <INI-Path>]

Where:

- | | |
|--------------------------------|---|
| -P <Payload-Path> | Specifies the pathname for a Binary Payload File. If one is specified, the INI file will be reconstituted from its contents. If no path is specified, the current Configuration Payload will be obtained from the Intel® QST Subsystem and used to reconstitute the INI file. |
| -I <INI-Path> | Specifies the pathname for the resulting INI file. If no pathname is specified, default pathname "QstCfg.ini" will be used. |

2.1.2.2 Examples

1. **"QstINI"**: Specifies that the current configuration payload is to be retrieved from the Intel® QST Subsystem and written to an INI file named "QstCfg.ini".
2. **"QstINI -I Config.ini"**: Specifies that the current configuration payload is to be retrieved from the Intel® QST Subsystem and written to an INI file named "Config.ini".
3. **"QstINI -P Config.bin"**: Specifies that the configuration payload contained within file "Config.bin" is to be retrieved and written to an INI file named "QstCfg.ini".
4. **"QstINI -P Config.bin -I Config.ini"**: Specifies that the configuration payload contained within file "Config.bin" is to be retrieved and written to an INI file named "Config.ini".



2.2 Configuration Tuning Tools

This collection of tools provides support for the fine tuning of Intel® QST Configurations. It allows the user to determine the best way to map sensors to fans and to determine the weighting of each fan response. They can be used with any system form factor and any number of fans and sensors.

The Intel® QST Tuning Wizard is the primary tool for the tuning of Intel® QST configurations; the other tools support subsequent monitoring and analysis of the tuned configuration. The QST Tuning Wizard is separately documented in Chapter 5; the following sections detail the usage of the other tools.

Note: For more information on the fine-tuning process, refer to the latest Intel® Quiet System Technology Configuration and Tuning Manual. Contact your Intel representative to obtain a copy of this document.

2.2.1 QstLog.exe – Reading/Setting Logging Tool

This tool provides support for the periodic collection of readings from the Temperature and Fan Speed Sensors and duty cycle values from the Fan Speed Controllers. Optionally, voltage and current sensor readings may be collected as well. The tool will sample the available Sensors and Controllers once per second and output the readings and settings both to the log file and to the display.

QstLog.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.

2.2.1.1 Invocation

The tool is an executable file working in Windows environment. It executes in from the command line. Its command line syntax is defined as follows:

QstLog [-L <Log-Path>] [-M] [-T <Samples>] [-V] [-C]

Where:

- L <Log-Path>** Specifies the pathname for the log file. This file will be overwritten. No warning of overwrite will be provided. Note: If no Pathname is provided, the default pathname will be "QstLog.txt"
- M** Specifies that the sample set collected in each one-second period is to be output to the console on a separate display line.
- T <Samples>** Specifies that the program is to terminate after logging the specified number of sampled reading sets.
- C** Specifies that readings from current sensors are to be included in the data displayed and logged. By default, only temperatures, fan speeds and fan duty cycles are collected, displayed and logged.



- V Specifies that readings from voltage sensors are to be included in the data displayed and logged. By default, only temperatures, fan speeds and fan duty cycles are collected, displayed and logged.

Example: "C:\Program Files\Qst\QstLog.exe" -L "C:\QstLog.txt"

This command will display the readings of temperatures, fan speeds and fan duty cycles of the available sensors and fan controllers. Also, the readings will be saved in file QstLog.txt in the root directory of drive C.

2.2.1.2 Operation

1. The tool will first verify that the Intel® QST Subsystem is configured. If it is not, operation cannot continue.
2. The tool will enumerate the supported sensors and controllers. Labels describing the usage for the sensors will be output to the log file (in the same order that readings/settings will be output). As well, terse labels will also be output to the console window.
3. Readings will be sampled from all available Sensors and Duty Cycle values will be sampled from all available Fan Speed Controllers. The readings will be output to the log file as well as to the console display. A sequence number is also included in the log file data.
4. Step 4 will be repeated, once per second, until a key press is detected or until the specified number of sample sets has been collected.
5. When a key is pressed, the log file will be closed. A summary, providing minimum, maximum and average readings and duty cycle values will be output to the console.
6. The tool will wait for the <enter> key to be pressed before terminating. This will provide the operator with an opportunity to peruse the summary information generated.



2.2.2 QstCtrl.exe – Manual Fan Control Tool

This tool provides support for manually specifying the (duty cycle) settings for the Fan Speed Controllers. It also provides support for the display of configuration and reading/setting information for Temperature, Voltage, Current and Fan Speed Sensors and for Fan Speed Controllers.

QstCtrl.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.

2.2.2.1 Commands

The tool runs in interactive mode, providing a command prompt and allowing the operator to perform multiple operations. Operation will continue until the operator enters an **exit** command. QstCtrl will be initiated from the command line. It has no command-line parameters.

QstCtrl will support the following internal commands:

A <ctrl>	Requests that the specified Fan Speed Controller be placed in automatic control mode. The Intel® QST Subsystem will determine the Duty Cycle values to be utilized. (Example: "A 1" – put Fan Speed Controller #1 in automatic mode.)
C	Requests the display of information about all Fan Speed Controllers.
E	Requests that the tool terminate.
M <ctrl> <duty>	Requests that the Duty Cycle output of the specified Fan Speed Controller be manually set to the specified value. For example, command "M 1 50" requests that Fan Controller 1 be operated at 50% duty cycle. (Example: "M 2 50" – Fan speed controller #1 is manually set to 50% duty cycle.)
R	Requests that a fan redetection operation is to be performed.
S	Requests the display of information about all Sensors.
SC	Requests the display of information about all Current Sensors.
SF	Requests the display of information about all Fan Speed Sensors.
ST	Requests the display of information about all Temperature Sensors.
SV	Requests the display of information about all Voltage Sensors.



2.2.3 QstStatD.exe/QstStat.exe – Status Tool

This tool generates a report detailing the status of the Intel® QST Subsystem. Based upon the command-line parameters specified, both terse and verbose reports can be produced:

- The terse report includes a status summary for the Intel® QST Subsystem and status and current readings/settings for each sensor and fan speed controller that is presently enabled in the Intel® QST configuration.
- The verbose report includes a detailed breakdown of the status of the Intel® QST Subsystem and a detailed display of the configuration parameters and current status and readings/settings for each sensor and fan speed controller that is presently enabled in the Intel® QST configuration. The detailed status breakdown for the Intel® QST Subsystem includes information about the revision and capabilities of the Intel® QST firmware and the configuration that was specified by the BIOS, including Lock Mask settings, the configuration update for each processor present and any fan configuration updates that were specified.

QstStatD.exe: Pure DOS command line tool. The tool is supported on Free DOS and Windows 98 DOS.

QstStat.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.

2.2.3.1 Invocation

The tool is an executable file for either the Windows or DOS environment. It executes in from the command line. Its command line syntax is defined as follows:

QstStatD [-V]

QstStat [-V]

Where:

-V Specifies that a verbose report is desired.



2.2.3.2 Sample Reports

This section provides samples of the typical reports produced by the QstStat tool. These samples were collected on the Intel CRB board.

Sample report when run in the normal (non-verbose) mode:

```

Intel (R) Quiet System Technology Status Display v2.0.2.9906
Copyright (C) 2006-2009, Intel Corporation. All Rights Reserved.

The QST Subsystem is configured and operational

Sensor Configuration/Status Summary:

Processor Temperature                Normal          49.48
Peripheral Controller Hub (PCH) Temper... Normal          44.00
Motherboard Temperature              Normal          29.18

Processor Fan                        Normal          973

+12 Volts                           Normal         11.991
+5 Volts                             Normal          5.030
+3.3 Volts                           Normal          3.307
Memory Controller Hub Vcc            Normal          1.058
Processor Vcc                        Normal          1.045

Fan Speed Controller Configuration/Status Summary:

Processor Fan Controller              Normal          20.00%
Chassis Inlet Fan Controller         Normal          20.00%
Chassis Outlet Fan Controller        Normal          20.00%
Chassis Outlet Fan Controller        Normal          20.00%
    
```

Sample report when run in the verbose mode:

```

Intel (R) Quiet System Technology Status Display v2.0.2.9906
Copyright (C) 2006-2009, Intel Corporation. All Rights Reserved.

QST Subsystem Information:

Firmware Revision:                   6.0.0.9290

Firmware Capabilities:

Max Temperature Sensors:             12
Max Fan Speed Sensors:                8
Max Voltage Sensors:                 8
Max Current Sensors:                 0
Max Temperature Response:            12
Max Fan Speed Controllers:           8

The QST Subsystem is configured and operational

Current Lock Mask:

Configuration:                       Unlocked
Health Thresholds:                   Unlocked
Manual Fan Control:                   Unlocked
SST Bus Resources:                   Read-Write
Chipset Resources:                   Read-Write

Successful configuration attempt recorded

Configuration Update for CPU 1:

Reading Format:                       Absolute
MCH Temperature Supported:           False
Tcontrol Value:                       89.00
Correction Offset:                    0.00
    
```



Correcti on Slo pe:	1.00
Temperature Response:	
Proportional Gain:	0.00
Integral Gain:	0.00
Integral Time Window:	0
Derivative Gain:	0.00
Derivative Time Window:	0
No CPU DTS Configuration Updates Received	
No Fan Configuration Updates Received	
Sensor Configuration/Status Summary:	
Temperature Sensor 1:	
Health:	Normal
Usage:	Processor Temperature
Temp:	49.46
NonCrit:	95.00
Crit:	97.00
NonRecov:	99.00
Temperature Sensor 3:	
Health:	Normal
Usage:	Peripheral Controller Hub (PCH) Temperature
Temp:	45.00
NonCrit:	113.00
Crit:	117.00
NonRecov:	121.00
Temperature Sensor 5:	
Health:	Normal
Usage:	Motherboard Temperature
Temp:	29.39
NonCrit:	80.00
Crit:	85.00
NonRecov:	90.00
Fan Speed Sensor 1:	
Health:	Normal
Usage:	Processor Fan
Speed:	1003
NonCrit:	300
Crit:	250
NonRecov:	200
Voltage Sensor 1:	
Health:	Normal
Usage:	+12 Vol ts
Vol ts:	11.992
NonCrit Low:	11.400
Crit Low:	11.100
NonRecov Low:	10.800
NonCrit High:	12.600
Crit High:	12.900
NonRecov High:	13.200
Voltage Sensor 2:	
Health:	Normal
Usage:	+5 Vol ts
Vol ts:	5.031



NonCrit Low:	4.750
Crit Low:	4.625
NonRecov Low:	4.500
NonCrit High:	5.250
Crit High:	5.375
NonRecov High:	5.500
Voltage Sensor 3:	
Health:	Normal
Usage:	+3.3 Vol ts
Vol ts:	3.306
NonCrit Low:	3.135
Crit Low:	3.053
NonRecov Low:	2.970
NonCrit High:	3.465
Crit High:	3.548
NonRecov High:	3.630
Voltage Sensor 4:	
Health:	Normal
Usage:	Memory Controller Hub Vcc
Vol ts:	1.059
NonCrit Low:	1.000
Crit Low:	0.950
NonRecov Low:	0.900
NonCrit High:	1.100
Crit High:	1.150
NonRecov High:	1.200
Voltage Sensor 5:	
Health:	Normal
Usage:	Processor Vcc
Vol ts:	1.047
NonCrit Low:	0.646
Crit Low:	0.546
NonRecov Low:	0.446
NonCrit High:	1.246
Crit High:	1.346
NonRecov High:	1.446



```
Fan Speed Controller Configuration/Status Summary:

Fan Speed Controller 1:

Health: Normal
Usage: Processor Fan Controller
Control: Automatic
Duty: 20.00

Fan Speed Controller 2:

Health: Normal
Usage: Chassis Inlet Fan Controller
Control: Automatic
Duty: 20.00

Fan Speed Controller 3:

Health: Normal
Usage: Chassis Outlet Fan Controller
Control: Automatic
Duty: 20.00

Fan Speed Controller 4:

Health: Normal
Usage: Chassis Outlet Fan Controller
Control: Automatic
Duty: 20.00

End of Report
```

2.3 QstDtsD.exe/QstDts.exe – Process DTS Configuration Test

This tool allows the user to configure parameters of the Intel® QST Subsystem relating to the DTS-based thermal management specification. The command-line parameters allow the user to install settings from an INI file or extract the current settings to an INI file or the display. An option to create binary files that can be used by the System BIOS to configure the Intel® QST Subsystem can also be generated. This tool only operates on the *UpdateCPUConfiguration* and *UpdateDTSConfiguration* command data.

QstDtsD.exe: Pure DOS command line tool. The tool is supported on Free DOS and Windows* 98 DOS.

QstDts.exe: Windows command line tool. The tool is supported on Windows 2000 SP4, Windows XP SP1, Windows XP SP2, Windows XP 64, Windows Vista and Windows 7.

2.3.1.1 Invocation

The tool is an executable file for either the Windows or DOS environment. It executes in from the command line. Its command line syntax is defined as follows:

QstDtsD [<FileName>] {-I|-E|-D|-B|-T} [-V]

QstDts [<FileName>] {-I|-E|-D|-B|-T} [-V]



Where:

FileName	This parameter specifies the INI file name that should be used for input or output. Depending on the type of operation being performed the file extension may be modified. If this parameter is excluded "QstDts.ini" will be used as the default file name.
-I	This option is used to install settings to the Intel® QST Subsystem based on the values in the input INI file. The INI file can be specified using the FileName parameter.
-E	This option is used extract the current settings from the Intel® QST Subsystem and write them to an INI file. The INI file can be specified using the FileName parameter. Any existing file will be overwritten.
-D	This option displays the current DTS settings of the Intel® QST Subsystem.
-B	This option generates a set of binary files that contain the BIOS command data used to configure the Intel® QST Subsystem with the values in the input INI file. The output files are based off of the FileName parameter. CPU updates will have the file name format of " FileName_CPU#.bin " and DTS updates will have the file name format of " FileName_DTS#.bin ".
-T	This option is used to generate a template INI file. The INI file can be specified using the FileName parameter.
-V	This option allows for additional information to be displayed for a specific operation. Not all operations provide additional output.

2.3.1.2 Examples

1. "**QstDts -T**": Specifies that a template INI file should be generated as a file named "QstDts.ini".
2. "**QstDts -I Dts.ini**": Specifies that the values in the file "Dts.ini" should be installed on the Intel® QST Subsystem.
3. "**QstDts -D**": Specifies that the current values used by the Intel® QST Subsystem should be displayed on the screen.
4. "**QstDts -E**": Specifies that the current settings used by the Intel® QST Subsystem should be extracted and written to a file named "QstDts.ini".
5. "**QstDts -B Dts.ini**": Specifies that the settings in the file "Dts.ini" should be converted into the files "Dts_CPU1.bin" and "Dts_DTS1.bin". This assumes that the input INI file contains an enabled entries for both CPU1ConfigUpdate and Processor1DTSUpdate. These binary files contain the commands to be sent by the



System BIOS to configure the Intel® QST Subsystem as expressed in the input INI file.

2.3.2 MAXPower

The MAXPower tools run the processor at designated loads. There is a separate MAXPower tool (.exe execution file) for each processor. Make sure that the right version(s) of the tool are installed for the target processor(s).

After installing the MAXPower program (double click on the .exe file), the desired load can be set by choosing: Options → Workload Configuration.

Note: It is recommended that the MAXPower tools be installed to their default installation folders.

2.4 Intel® QST Compliancy Test Tool

This tool checks the readiness of the QST-enabled platform by performing the following tests: General Chipset tests, Intel® Management Engine Interface Device tests, Chipset Thermal device tests, Intel® Management Engine Interface tests, Intel® Management Engine Firmware tests and Intel® QST tests.

At the end of the test, the tool will output PASS/FAIL results for each area tested.

QstCply.exe: Pure DOS command line tool. The tool is supported on Free DOS and Windows* 98 DOS.

2.4.1 Invocation

The tool is executed in pure DOS and support Free DOS and Windows 98. Its command line syntax is defined as follows:

QstCply [/?] [/a] [/d] [/p] [/t] [/verbose] [/Exp]
(Ex : QstCply /a /t)

Where:

- /?** Display help
- /a** Dump Intel® QST Update Command Data
- /d** Dump Intel® Management Engine Interface PCI Configuration Space.
- /p** Dump all PCI Configuration Space
- /t** Run Intel® QST Compliance test suite (Default)
- /Verbose** Display Debug Information
- /Exp** Display Example Usage of the Tool



2.5 INI Files

The package provides a single example configuration file named "QstCfgATXIP.ini". This file configures Intel® QST to monitor and control the sensors and fan speed controllers that are available on the Customer Reference Board (CRB).

This INI file can be used as the starting point of the configuration process. Most of the control parameters can be used as they are, except for certain hardware-dependent parameters. Those hardware-dependent parameters need to be modified by the designer to reflect specific hardware implemented on the platform. For example, device address of a sensor, how many fan headers implemented on the mother board, etc.

Note: the Configuration Creation Wizard, which is also included in the ME firmware kit, can be used to easily create an initial INI file for a specific platform without using one of these initial INI files and modifying needed parameters. Refer to section 3.8 for more details.

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3 Using the Intel® QST Configuration GUI

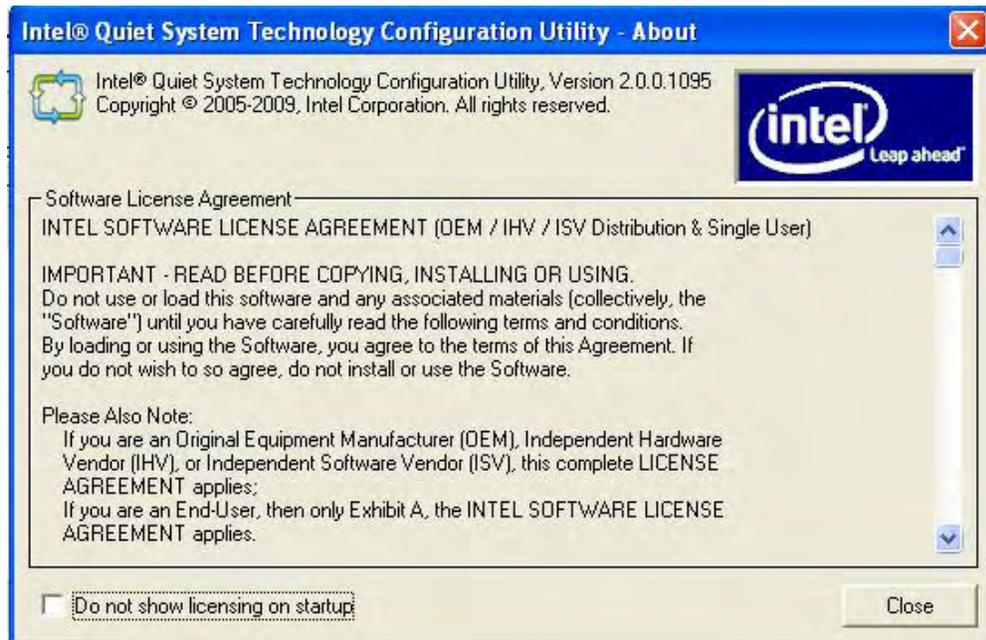
This is a Graphical User Interface (GUI) used to edit Intel® QST Configuration (INI) files. It is a Win32 executable file. Via the traversable structure it presents, the configuration variables included in a INI file may be edited and then saved.

Note: For Window* 2000 SP4 OS, the tool requires Microsoft MSVCP60.dll. Make sure MSVCP60.dll is installed on the system.

The following sections describe in detail how to use the Configuration GUI.

3.1 Start Up - License Agreement

When the program is started, Intel's license agreement is shown in a scrollable frame:



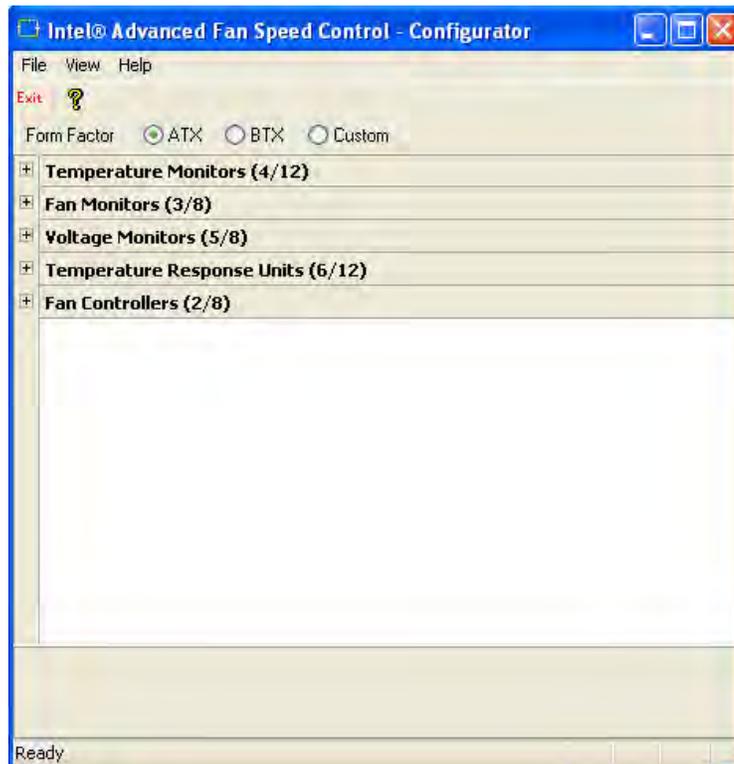
Clicking "I Agree" will open the main program. Clicking "I Disagree" causes the program to exit. Checking "Do not show licensing on startup" before clicking on "I Agree" will disable the display of the License Agreement during subsequent invocations of the program.



3.2 Main Program

The main frame of the GUI contains collapsible trees for each entity type. There are five entity types, categorized by functionality: Temperature Monitors, Fan Monitors, Voltage Monitors, Temperature Response Units, and Fan Controllers.

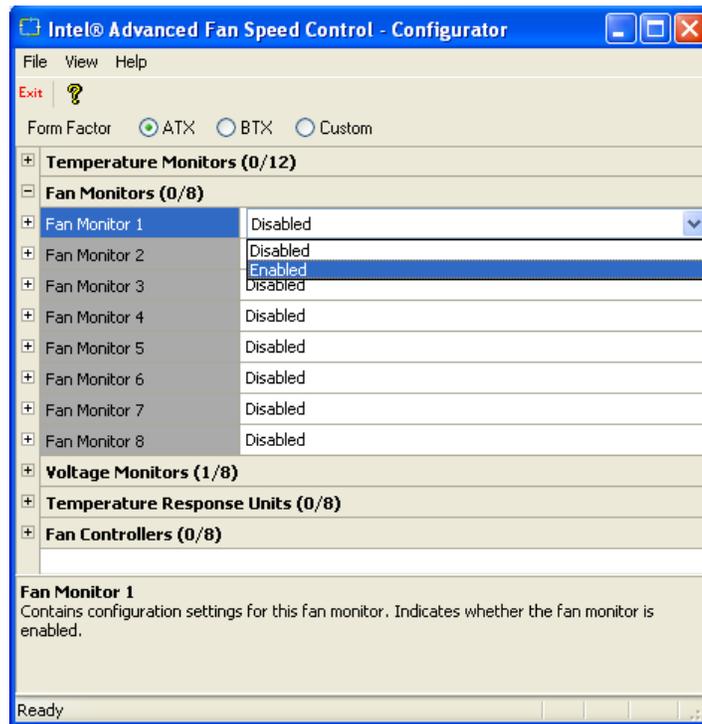
Under each entity type is a collection of entities. There is an indication of how many entities are supported and how many of them are enabled. For example, (4/12) after the Temperature Monitors entity type in the figure below indicates that there are a total of 12 temperature monitors and that 4 of them are currently enabled.



3.3 Accessing Entities within an Entity Type

Each entity type, when expanded by clicking on the [+] symbol, will show all the entities available of that type. Each entity can be enabled or disabled by clicking on the white bar next to it and choosing an appropriate option from the pull-down list.

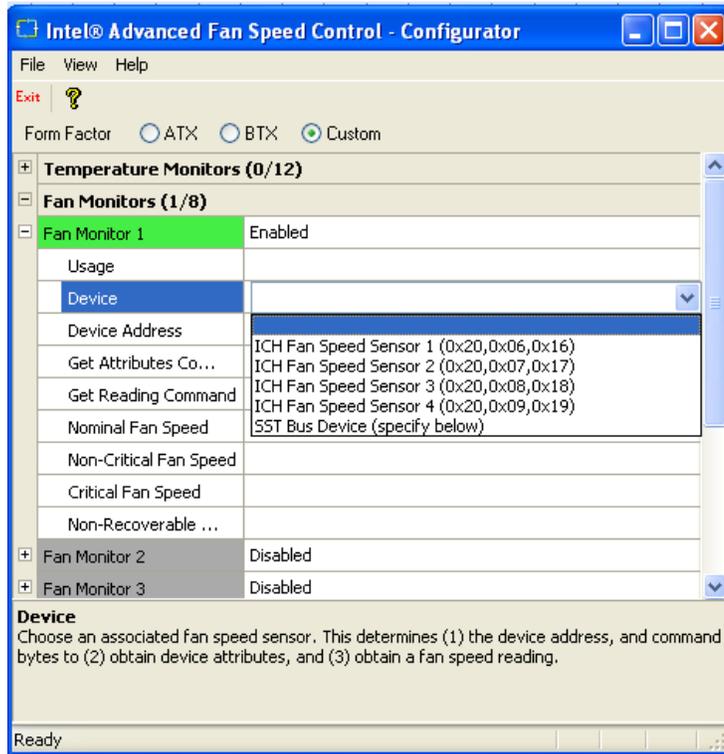
As illustrated in the figure below, after expanding the Fan Monitors type, 8 Fan Monitor entities can be accessed. Each entity can be enabled or disabled through the pull-down list.



3.4 Editing Parameters

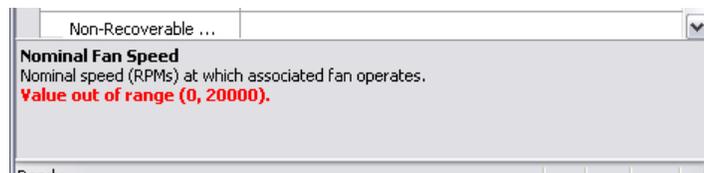
When an entity is enabled, the parameters for that entity can be accessed by clicking on the [+] symbol. To edit the parameter, left-click into an edit bar and either enter or choose a new value from the pull-down list.

Note that if an entity is disabled, the parameters for that entity cannot be edited.



3.5 Help Area

The help area at the bottom of the main window conveys information about the selected entity or parameter. Information is provided in standard black text and status messages are provided in red.



3.6 Menu Bar



The menu bar of the GUI includes File, View, and Help.

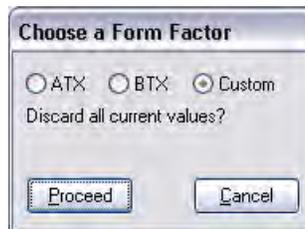
This section covers each menu option. A brief description for each menu item can also be seen in the status bar as the mouse cursor hovers over it.



File → New

Values present in the various entities will be wiped (the user will be prompted to save these values if he has not done so) and replaced with a default set of values. Three types of default values exist (categorized by the form factor of the system being configured):

- **ATX:** Set of Intel recommended defaults for ATX
- **BTX:** Set of Intel recommended defaults for BTX
- **Custom:** All fields are blank

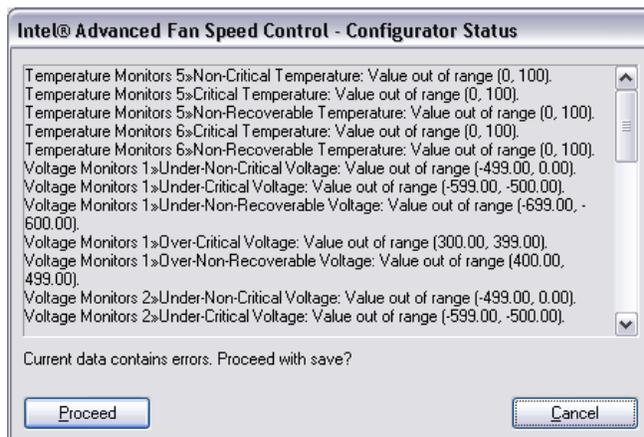


File → Load INI File...

Values present in the entity records will be wiped (the user will be prompted to save these values if he has not done so) and replaced with values from an INI file chosen by the user. A popup will ask which form factor is desired.

File → Save INI File...

This option saves current values in the entity records to an INI file of the user's choice. A popup box will be displayed if the Configurator finds issues with any field values (see figure below). The user has the option to Cancel in order to make edits before saving, or to Proceed and save with errors.

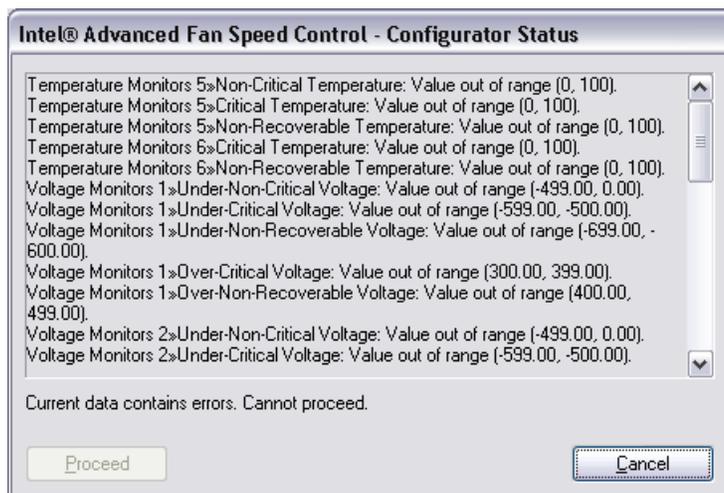




If an existing INI file is chosen, parameters will only be saved to it if they are changed. Comments in an existing INI file are preserved unless they are on line along with a parameter that is changed.

File → Generate Configuration Payload...

This option saves current values in the fields to a binary payload file (.BIN) of the user's choice. A popup box will be displayed if the Configurator finds issues with any parameter values (see figure below). In this case, the user will have only the option to Cancel the Save operation, in order to make corrections before saving. The Configurator will only enable the option to proceed if the user's data is error-free.



File → Send Configuration to Firmware...

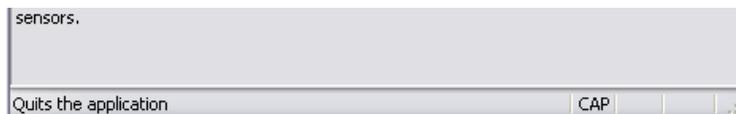
This option sends the parameters directly to the firmware. As with “File → Generate Configuration Payload”, the user cannot deliver data to firmware if errors are found by the Configurator.

File → Exit

Choose this option to exit the program.

View → Status Bar

Toggles the visibility of the status bar at the bottom of the window



View → Toolbar

This option toggles the visibility of the toolbar right under the menu bar.



View → Expand All

This option expands all tree nodes so that every parameter is made directly available. The scrollbar at the right of the window can be used to access parameters that are not immediately visible.

View → Collapse All

This option collapses all tree nodes so that only the root Entity Types are directly available. Clicking on the **[+]** symbol that marks a collapsible tree will expand the tree.

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4 Using the Intel® QST Configuration Wizard

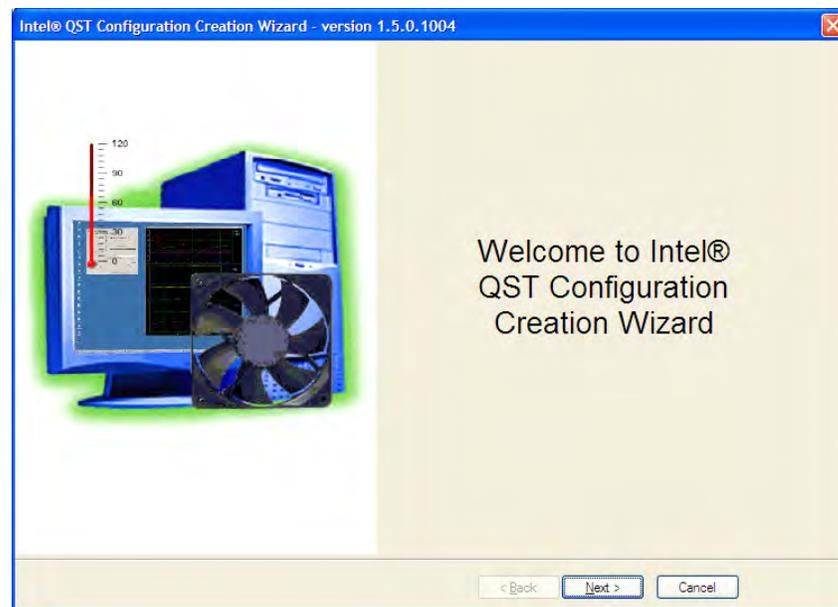
The Intel® QST Configuration Wizard is a tool that facilitates the configuration of the Intel® QST INI file. The tool aids the user in establishing the initial control settings and connecting sensor addresses to variables used by Intel® QST. The usage of this tool will primarily be by motherboard manufacturers or engineers responsible for configuring firmware within the motherboard. This tool does not provide system level tuning, which is facilitated by the Intel® Quiet System Technology (QST) Tuning Tool available from the ME Firmware Kit.

4.1 Installation

To install the Intel® QST Configuration Wizard, initiate QstConfigurationWizard.msi and follow the step-by-step installation instructions. It is recommended that you install the Intel® QST Configuration Wizard to the default directory.

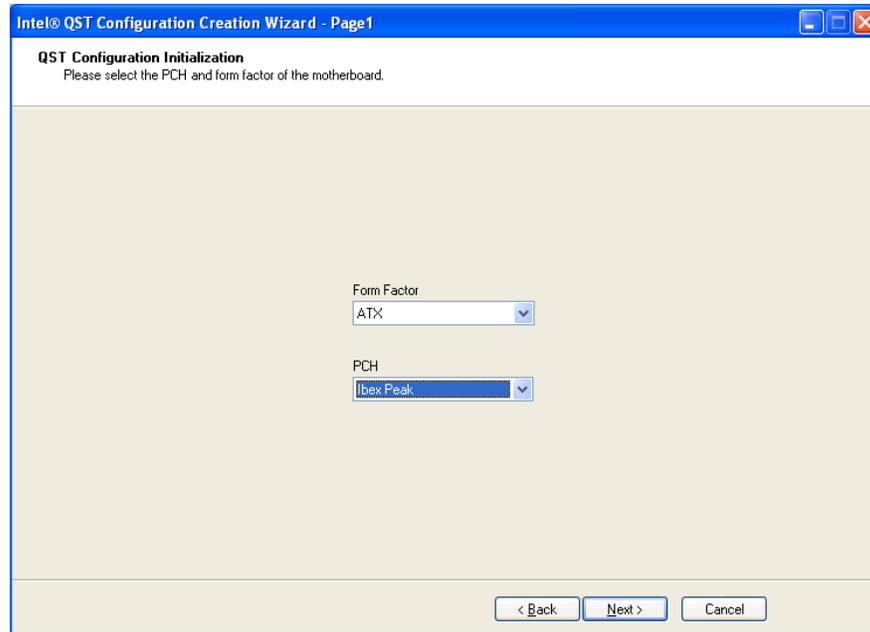
4.2 Invocation

The tool generates the INI file containing control parameters for a specific platforms based upon inputs from the board designers. This INI file includes device addresses and commands used to read sensors and control fans. The following screen images walk the reader through the usage of the wizard.



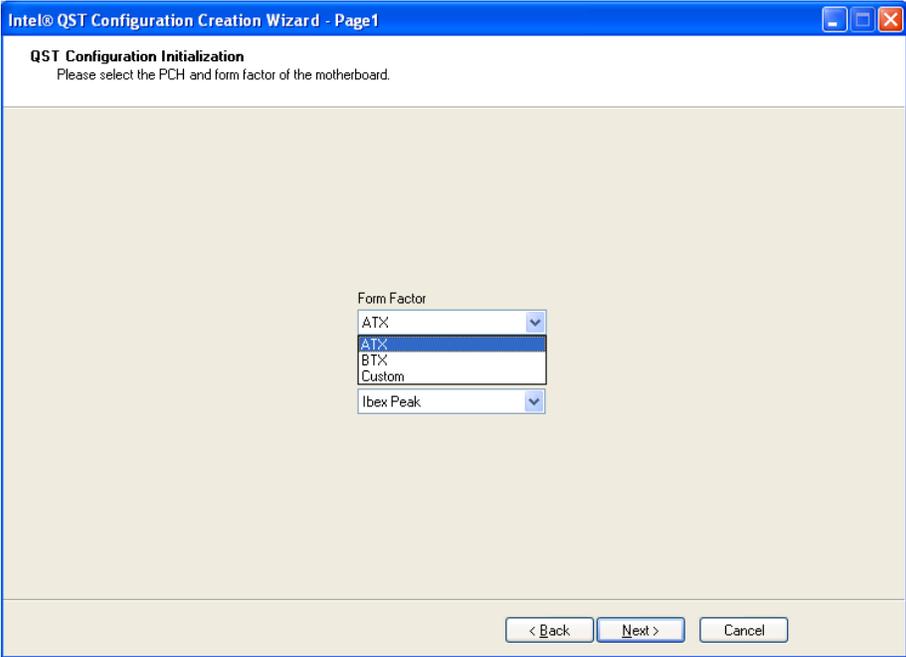


The Welcome screen will be the first screen the user will see once the Configuration Creation Wizard is started. The next screen prompts the user to select the PCH and form factor of the board through the drop down windows.



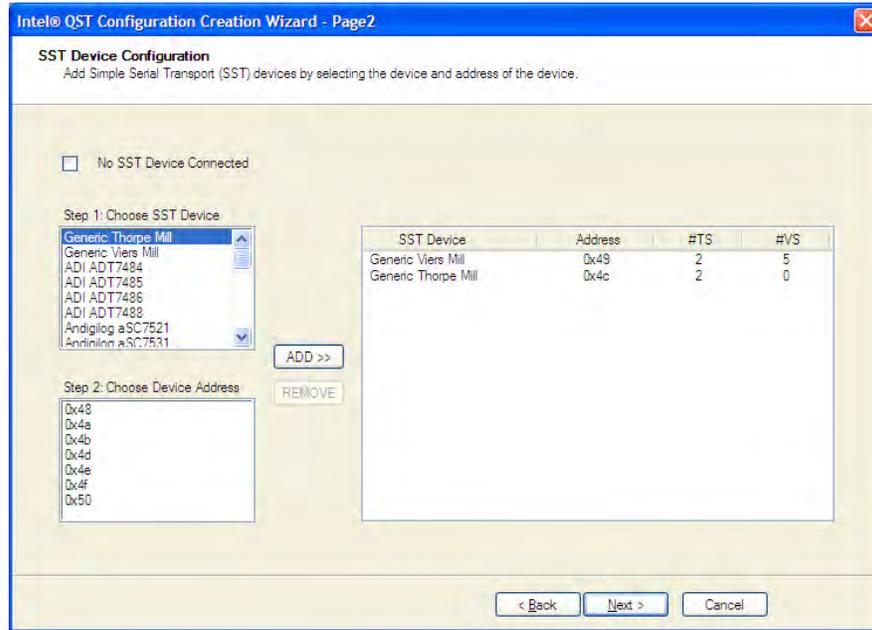


Two standard form factors, ATX and BTX, are available to select from the drop down shown in the next figure. These form factors encompasses all of the available sizes, such as micro-ATX. For nonstandard form factors, the “Custom” option would be selected. The form factor selection loads default settings that apply to the given form factor, such as PID settings.

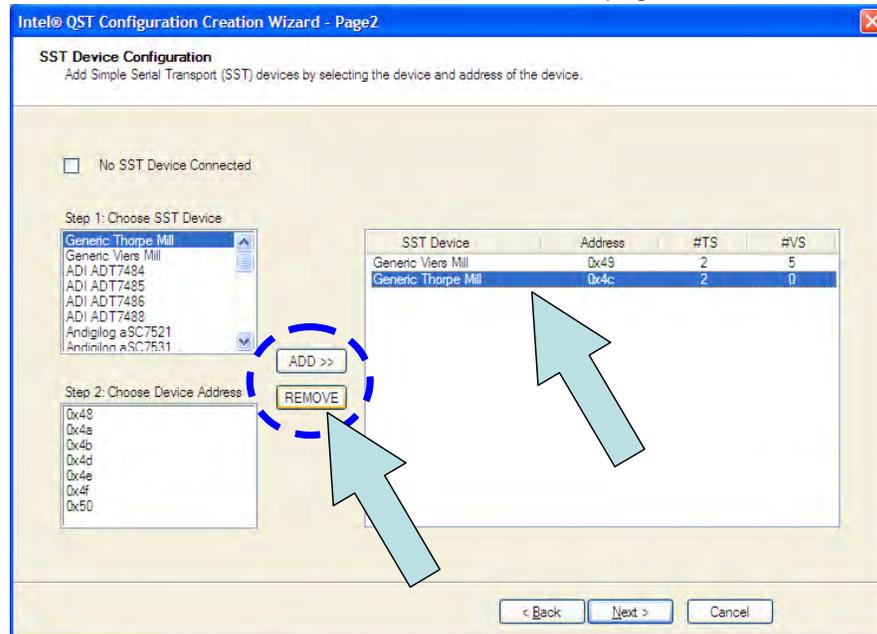




The following figure shows Page 2 of the Wizard. Page 2 prompts the user to add or remove SST devices. If no SST devices are available, checking the check box in the upper left hand corner will disable the page. On configurations where no prior ini file is loaded at the start of the wizard, the user will need to uncheck the check box to enable this page and add devices.

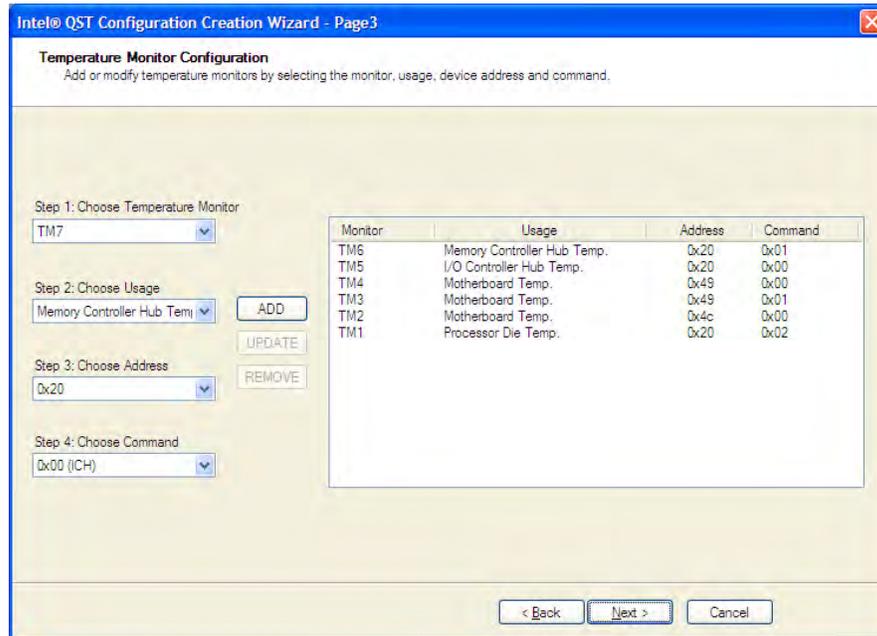


In order to remove a device, the user must first select the device in the list as shown in the following figure to enable the Remove button. Once the device is selected, pressing Remove will delete the device from the list and make the address available in the address window in the lower left hand corner of the page.

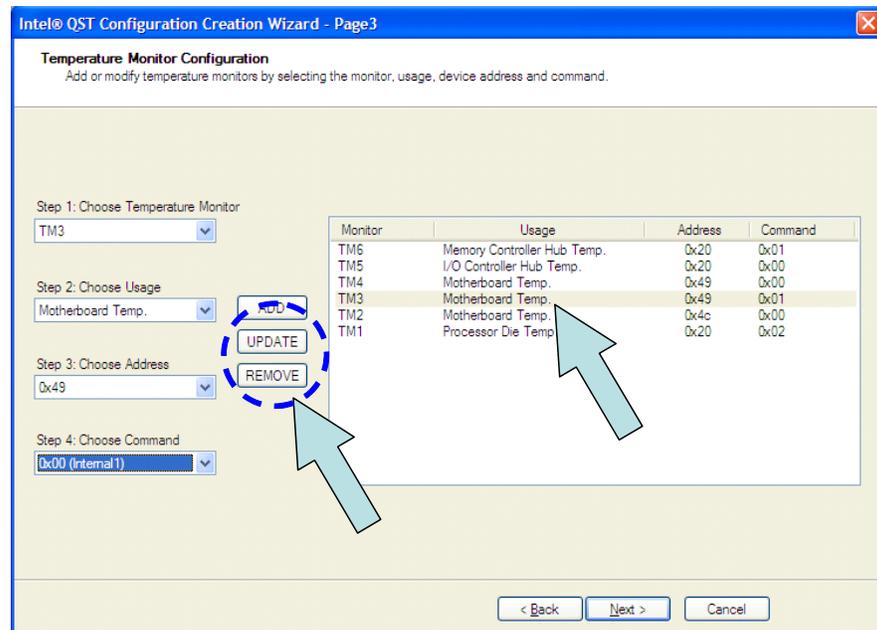




The next figure shows Page 3 of the Wizard. Page 3 configures the Temperature Monitors. Select the options from steps 1 through 4 on the screen and press the Add button to include additional Temperature Monitors. In the event of an error, the Temperature Monitor may be modified by selecting the monitor in the list, making the change, then pressing update.

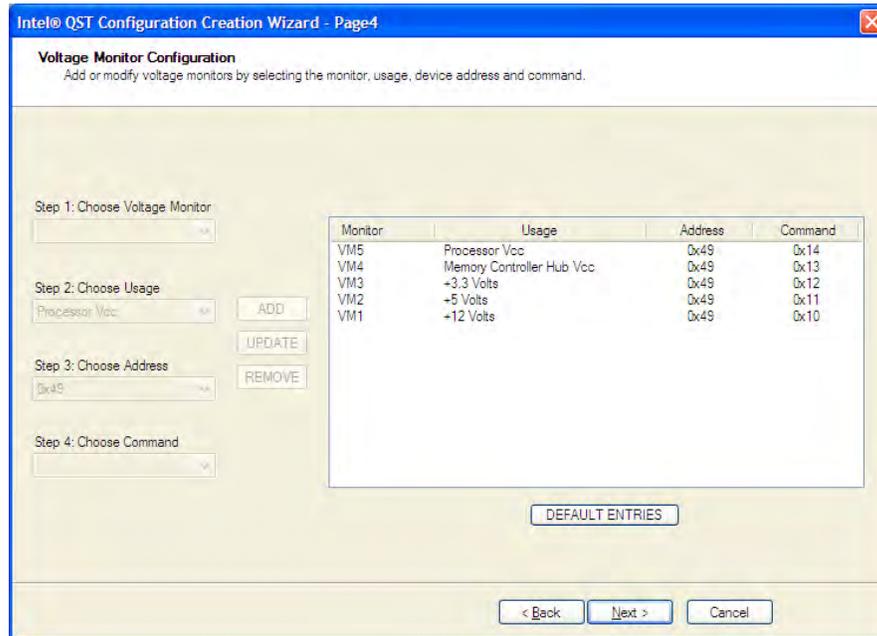


Note that the Update button will be disabled until a change has been made to the parameters. Likewise the Remove button is also disabled until a monitor is selected from the list.

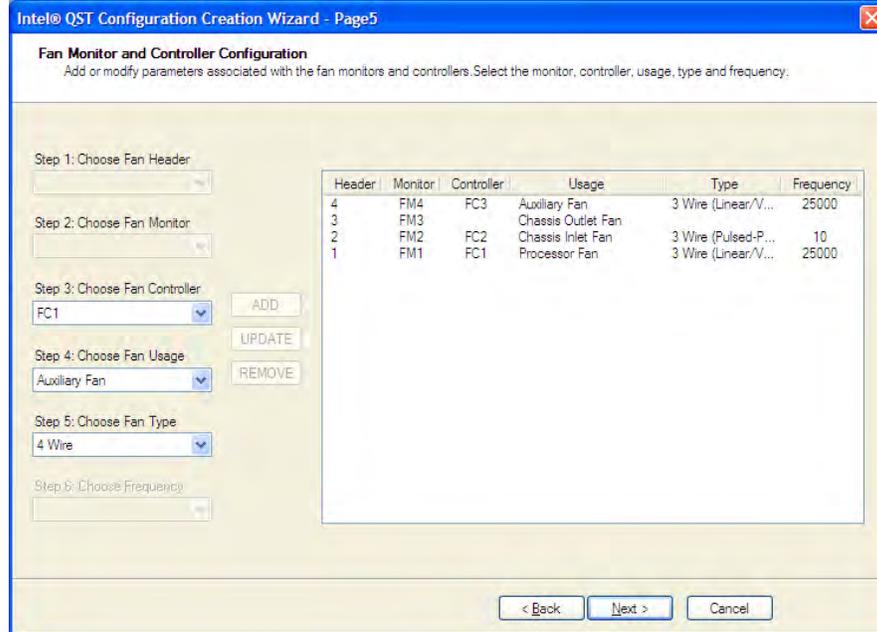




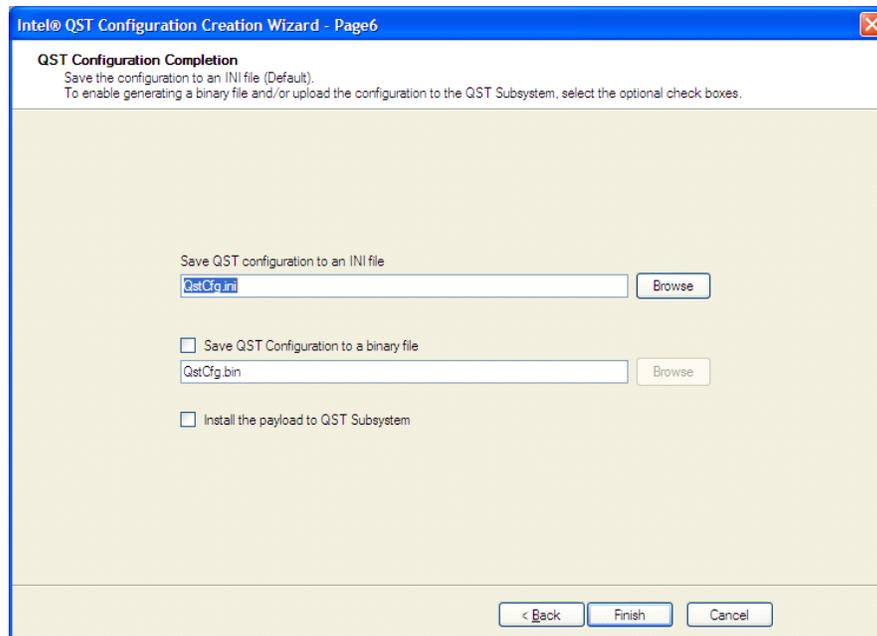
Page 4 of the Wizard is shown in the following figure and configures the voltage monitors. **Note that the Voltage Monitor page will not appear if no SST devices have been added on Page 2.** Adding, modifying, and removing Voltage Monitors are conducted in the same manner as described previously with the Temperature Monitors.



The following figure shows the Fan Monitor and Controller configuration. Note that this page may appear as Page 4 if no SST devices for voltage monitoring have been added. Interfacing with the page is similar to the previous pages. In order to enable the Update and Remove buttons, one of the monitors must be selected. Also a monitor must be available to configure in order for the Add button to be enabled.

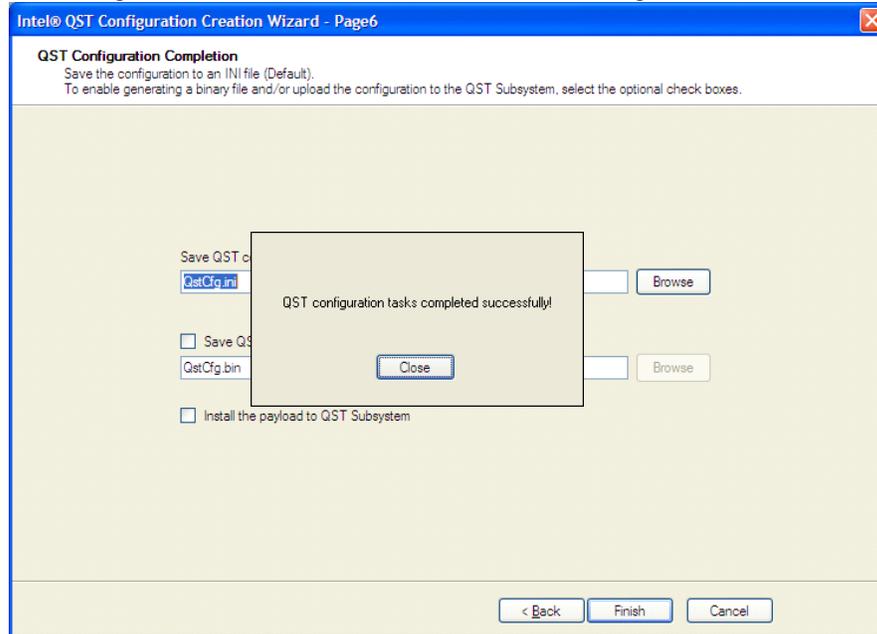


The following figure shows the final screen which may be page 5 or 6 depending upon whether there were voltage monitors for the configuration. The Wizard will automatically create an INI file named QstCfg.ini and save it to the root directory of the Wizard. Select the Browse button to change the destination directory. Two options for the configuration may be selected on this page. A binary image may be generated by selecting the check box. The binary file may be used to build a binary image for flash. If the configuration was conducted on the QST system, selecting the last check box will put the new configuration into the QST subsystem.





Once the destination files are selected, press the Finish button and the Wizard will notify the user of successfully completing the configuration. A dialog window will appear. Clicking Close will close the window and the Configuration Creation Wizard.



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5 Using the Intel® QST Tuning Wizard

5.1 Installation

In order to perform its tasks, the Intel® QST Tuning Wizard utilizes the services of a number of other facilities. As a result of these dependencies, the following installation process is necessary:

1. Install the pertinent version(s) of the Intel® MaxPower Program.
2. Install the Microsoft* .NET Framework.
3. Install the Intel® QST Tuning Wizard.

The Wizard requires Microsoft Windows XP (Service Pack 2), Windows Vista or Windows 7 operating system.

5.1.1 Installing the Intel® MaxPower Program

The Intel® MaxPower Program is used by the Intel® QST Tuning Wizard to place designated power loads on the processor. There are separate versions of this tool for each individual processor design. You should install versions for each and every processor design that you might utilize in your target systems. When you do so, it is required that you install them to their default installation folder (for example: C:\Program Files\Intel Corporation\Maximum Power Program for...); failing to do so will result in the Intel® QST Tuning Wizard being unable to locate and utilize their services.

The executables for installing the MaxPower Program are distributed using file names that specify the Intel internal code name of the target processor. Versions for the Lynnfield and Havendale processors are included in the Manageability Engine Firmware Kits. They are not included in the Intel® QST Tuning Wizard installation package, however.

5.1.2 Installing the Microsoft* .NET Framework

The Intel® QST Tuning Wizard requires that v3.0 of the Microsoft* .NET Framework be installed on the target system. Because of its size, this framework is not included in the Manageability Engine Firmware Kits. The redistributable package for the framework can be downloaded from <http://www.microsoft.com/downloads>. Alternatively, the framework is an optional install available via [Microsoft Update](#).



5.1.3 Installing the Intel® QST Tuning Wizard

Once you have the Microsoft* .NET Framework and appropriate version(s) of the Intel® MaxPower Program installed onto your target system, you can proceed with the installation of the Intel® QST Tuning Wizard.

To install the Intel® QST Tuning Wizard:

1. Initiate QstTuningWizard.msi.
2. Follow the step-by-step installation instructions. It is recommended that you install the Intel® QST Tuning Wizard to the default directory.

5.2 Usage

The Intel® QST Tuning Wizard is a simplified user interface that provides the ability to find and set optimal tuning parameters and related configuration parameters. The functionality does not completely replace the other available Intel® QST tools, but provides a tool that will satisfy the System Integrator's basic needs for finding the optimal parameter settings.

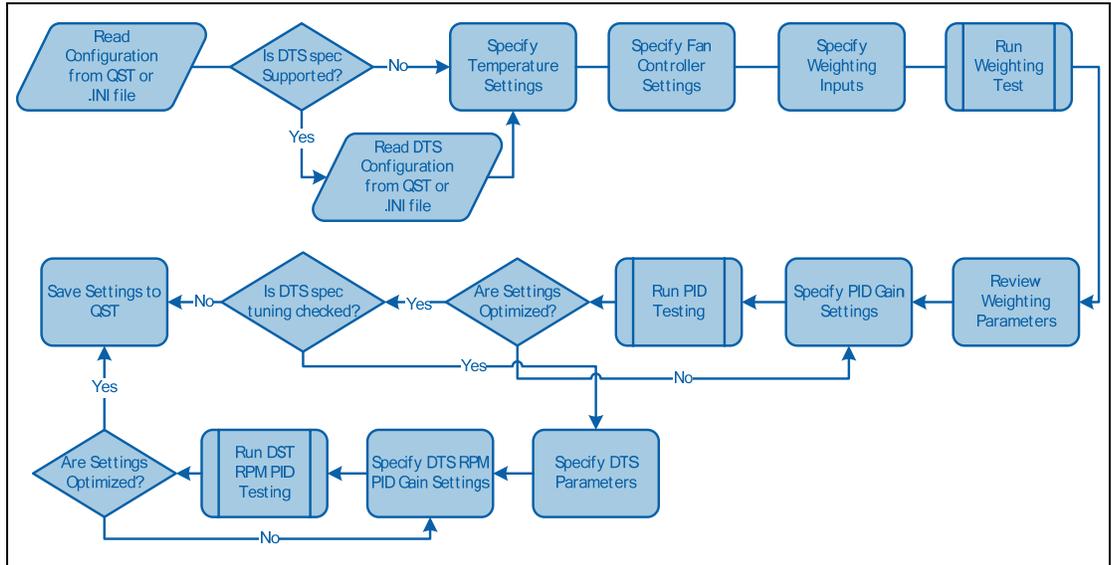
The Intel® QST Tuning Wizard is a simplified integration tool to be used by System Integrators to adjust the base configuration for their system designs and automate the tuning of the fan speed control solution. Specifically, it allows the Integrator to set temperature limits, specify fan control settings, specify acoustic information on fans, automatically test and determine temperature-sensor-to-fan-weight parameters, specify and test the PID gain settings for the CPU and deliver the new settings to the Intel® QST subsystem and (optionally) write them to an output (.INI) file. The Intel® QST Tuning Wizard also allows for the creation, alteration, and tuning of the parameters that implement the Sensor Based Specification for Neahlem based processors utilizing the Digital Temperature Sensor. Additionally the wizard allows these new settings to activate and/or deliver the new settings to the Intel® QST configuration and (optionally) write them to an output (.INI) file.



5.2.1 Usage Process

The process for using the Wizard and achieving the optimal settings for your system is visualized in Figure 1.

Figure 1: Flowchart for Wizard Process



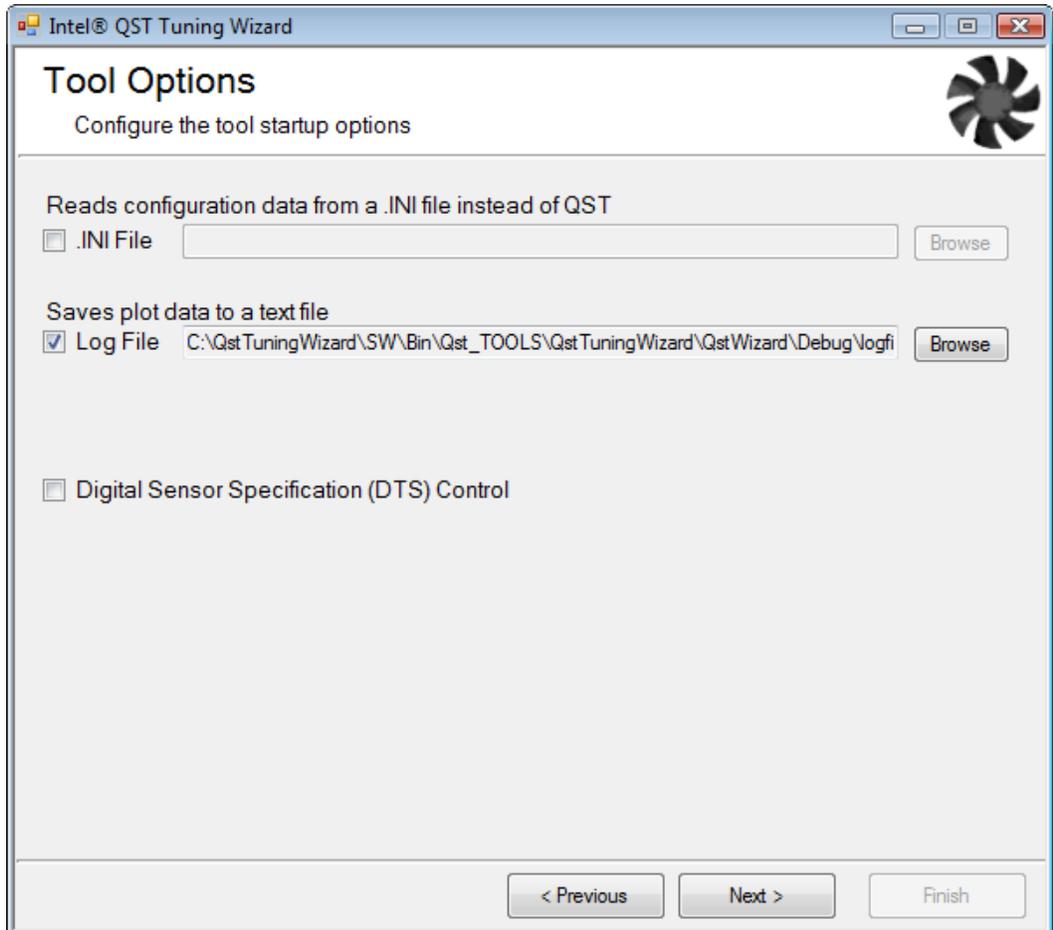


The Wizard steps through ten screens to complete the tuning process. Each screen and the options available are presented below. Additional screens and features are added for the implementation of the Sensor Based Specification for Nehalem based processors. These screens allow for the creation, alteration, and tuning of the Sensor Based specification using the Digital Temperature Sensor (DTS). If the system running the Intel® QST Tuning Wizard does not support the Sensor Based Specification these additional screens are not visible and are not part of the tuning process. The standard QST functionality for temperature based fan speed control has not changed in this generation. All associated .INI files and parameters have remained the same. The DTS, RPM control capability has been added for the processor fan and its parameters are stored in a separate .INI file. For more detailed information, see the Intel® QST Configuration and Tuning Manual.

1. **Welcome:** Start-up screen.
2. **Tool Options:** Screen used to specify initialization and data-recording parameters for the Wizard.
 - **.INI File:** By default, the active configuration is uploaded from QST and loaded into the current settings fields of the Intel® QST Tuning Wizard. Checking this checkbox allows the Integrator to use the File Open dialog to specify that an alternate configuration should be read from a particular .INI file and used in place of the current Intel® QST configuration.
 - **Log File:** By default, this checkbox is checked and the Intel® QST Tuning Wizard records data to the file "logfile.txt", located in the directory where the Wizard was installed. Clicking the 'Browse' button allows the Integrator to use the File Open dialog to choose the folder and specify the name of the log file that will receive test data (temperatures, duty cycles and fan speeds). Unchecking the checkbox disables the logging of test data.
 - **Digital Sensor Specification (DTS) Control:** If the platform that Wizard is operating on has the capability to implement the Sensor Based Specification then this check box will appear. If the DTS Control has NOT been configured nor enabled then the Tools Options screen appears as is show in Figure 2.



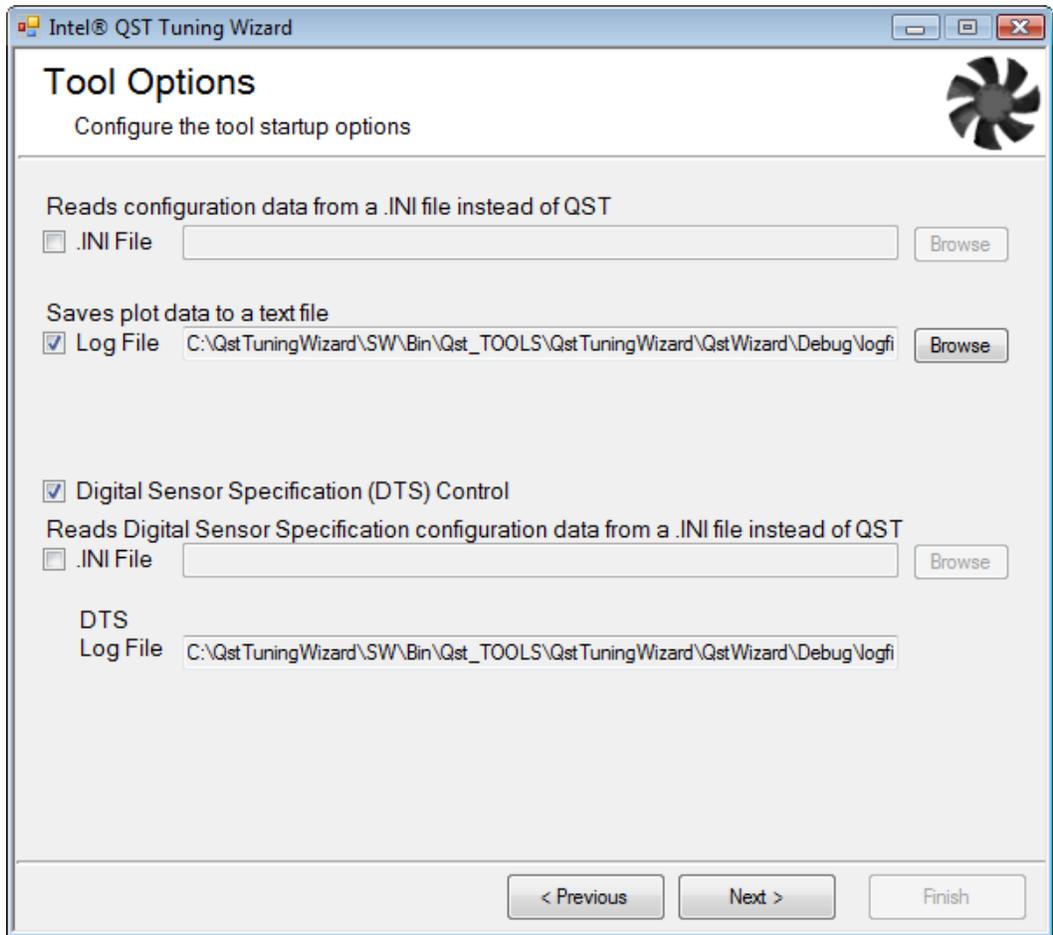
Figure 2: Tool Option Screen on System with DTS Control Capability but WITHOUT DTS Control Enabled



- **.INI FILE (Digital Sensor Specification (DTS) Control):** By default, the active DTS control configuration is uploaded from QST and loaded into the current settings fields of the Intel® QST Tuning Wizard. Checking this checkbox allows the Integrator to use the File Open dialog to specify that an alternate configuration should be read from a particular .INI file and used in place of the current Intel® QST DTS configuration (Figure 3).
- **Log File (Digital Sensor Specification (DTS) Control):** By default, this checkbox is checked and the Intel® QST Tuning Wizard records data to the file "logfileDTS.txt", located in the directory where the Wizard was installed. This logfile location is determined by the location of the log file path as inputted in the "Saves plot data to a text file" check box above. The path of this log file is altered to add a "DTS" to the end of the file name (Figure 3).



Figure 3: Tool Option Screen on System with DTS Control Configured and Loaded



3. **Temperature Settings:** Screen used to configure the temperature monitor usage and the associated limit temperature.

- **Enabled Sensor:** Checkboxes allow the Integrator to disable the use of particular temperature inputs. The Processor, G/MCH and ICH temperatures are of prime importance and cannot be disabled.

Note: Disabling is a destructive process; if you exit from the Intel® QST Tuning Wizard, the configuration parameters for the temperature input will be lost and you will not be able to re-enable the temperature without directly modifying the .INI file and updating QST. See the Intel® QST Configuration and Tuning Manual for more information.

- **Usage:** Specifies the source of the temperature that is associated with a monitor. For specific devices (Processor, G/MCH and ICH), support for modifying the usage indicator is disabled. Usage for other sensors may be modified as appropriate.



- **Limit Temperature:** Specifies the limit, or target, temperature that Intel® QST should attempt to maintain at the associated temperature sensor.
4. **Fan Controller Settings:** Screen used to configure the fan controllers that are responsible for the determination of the duty cycle values that are sent to the fans.
- **Controller:** Indicates the available Fan Controllers, as specified in the current Intel® QST Configuration or the specified .INI file.
 - **Usage:** Specifies the purpose for the fan controllers. The Integrator may change the usage to reflect the most accurate purpose for each fan controller.
 - **Mode:** Specifies the mode of operation for each fan controller. Two modes are supported: **Min** and **Off**.
 - In **Min** Mode, if the necessary duty cycle falls below the specified **Min** duty cycle, the duty cycle is held at this minimum and the fan(s) will remain spinning.
 - In **Off** Mode, if the necessary duty cycle falls below the specified **Min** duty cycle, the duty cycle will be set to 0 (zero) and the fan(s) will be stopped. Once stopped, the fan(s) will remain stopped until the necessary duty cycle exceeds the specified **On** duty cycle.

Note: **Off** Mode is not supported by and is disabled for Fan Controller 1 (typically the processor fan controller).

- **Min Duty Cycle:** Specifies the minimum duty cycle allowed for the specified fan. The Integrator can change this value if the fans that they are using either do not spin reliably at the current minimum setting or do not meet the idle airflow requirements.
 - **On Duty Cycle:** Specifies the duty cycle above which, if the fans are stopped, they are restarted. This parameter is ignored (and disabled) if operating in **Min** Mode. Specifies the duty cycle at which, if the fans are stopped, they are restarted. The value must be some amount higher than the **Min** Duty Cycle. The difference should be at least 2%, in order to ensure that the fans are not rapidly oscillating between the on and off states.
 - **Max Duty Cycle:** Specifies the maximum duty cycle allowed for the fan controller. This is typically 100%, but may be set to a lower percentage if there is a duty cycle range in which the fan(s) produce significantly higher acoustics without providing any significant improvement in cooling.
 - **Signal Frequency:** Specifies the frequency of the PWM output signal from the fan speed controller. For 3-wire fans, values from 10-94 Hz are typical, though new circuit designs are available that use frequencies in the 22-30 KHz range. For 4-wire fans, 22-30 KHz is typical.
5. **Fan Monitor Settings:** Used to configure the operation of the fan monitors. The fan monitors are responsible for the determination of the health of the underlying fan sensor and the exposure of RPM readings from these sensors.
- **Fan:** Indicates the available fan monitors, as specified in the current Intel® QST Configuration or the specified Intel® QST .INI file.



- **Usage:** Specifies the purpose for the fan that is being monitored. The Integrator may change the usage to reflect the most accurate purpose of the fan monitor.
6. **Weighting Inputs:** Screen used to provide both required and optional data that is used in the weighting matrix optimization process. Fan acoustic data is included in the weighting matrix calculation in the next step. Intel® QST will de-prioritize louder and less-effective fans in favor of quieter and more-effective fans, respectively, to maintain the minimum system acoustic level.
- **Ambient Temperature:** Specifies the ambient temperature of the test room. This is a required parameter.
 - **Acoustic Units:** Specifies the acoustic units of the fan acoustic data, if available. Four choices are possible:
 - **No Acoustic Data:** No data is available to use in this process.
 - **Sound Power:** Acoustic data was measured in BA.
 - **Sound Pressure:** Acoustic data was measured in db.
 - **Relative Loudness:** While acoustic measurement is preferred, subjective evaluation is acceptable. Selecting this option opens the Intel® QST Tuning Wizard fan test window, which allows the Integrator to take the fan controllers to 100% duty cycle in succession, keeping all other fan controllers at their respective minimum duty cycle setting. The Integrator can then subjectively assign the loudest fan controller a 100% relative loudness value and the other fan controller(s) appropriately smaller relative loudness value(s).
 - **Acoustic Inputs:** Specifies the measured acoustic level associated with each fan controller (in units chosen above).
7. **Weighting Calculations:** Screen used to start the weighting calculation process.
- **Calculate Weights button:** This button starts the weighting calculation process. Once started, this button can also be used to abort the process (its label will change to depending on the program state). This test finds the optimal power setting, and then sequentially tests the effectiveness of each fan to each temperature sensor. This process can be skipped by clicking the next button. If skipped the user can manually enter the weighting values or skip to the PID tuning section of the Wizard if the weighting calculation has previously been performed. If the process is skipped the warning shown in Figure 4 will appear the weights stored in the QST subsystem will be loaded in the Weighting Calculation Results screen with a blue text color (Figure 5). If the weighting calculation is performed the text color in the Weighting Calculation Results screen is black.

Note: It is recommended to run the weighting calculation if it previously has not been performed.



Figure 4: Weighting Bypass Warning Message Box

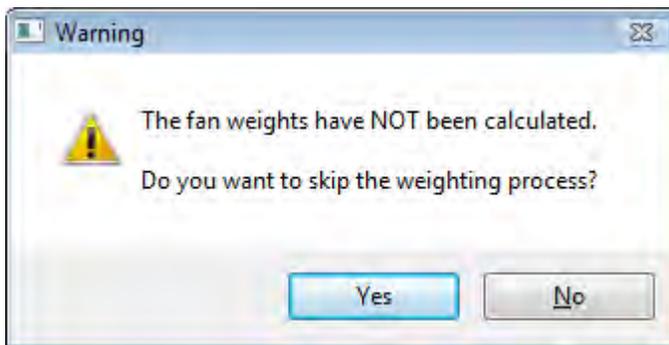
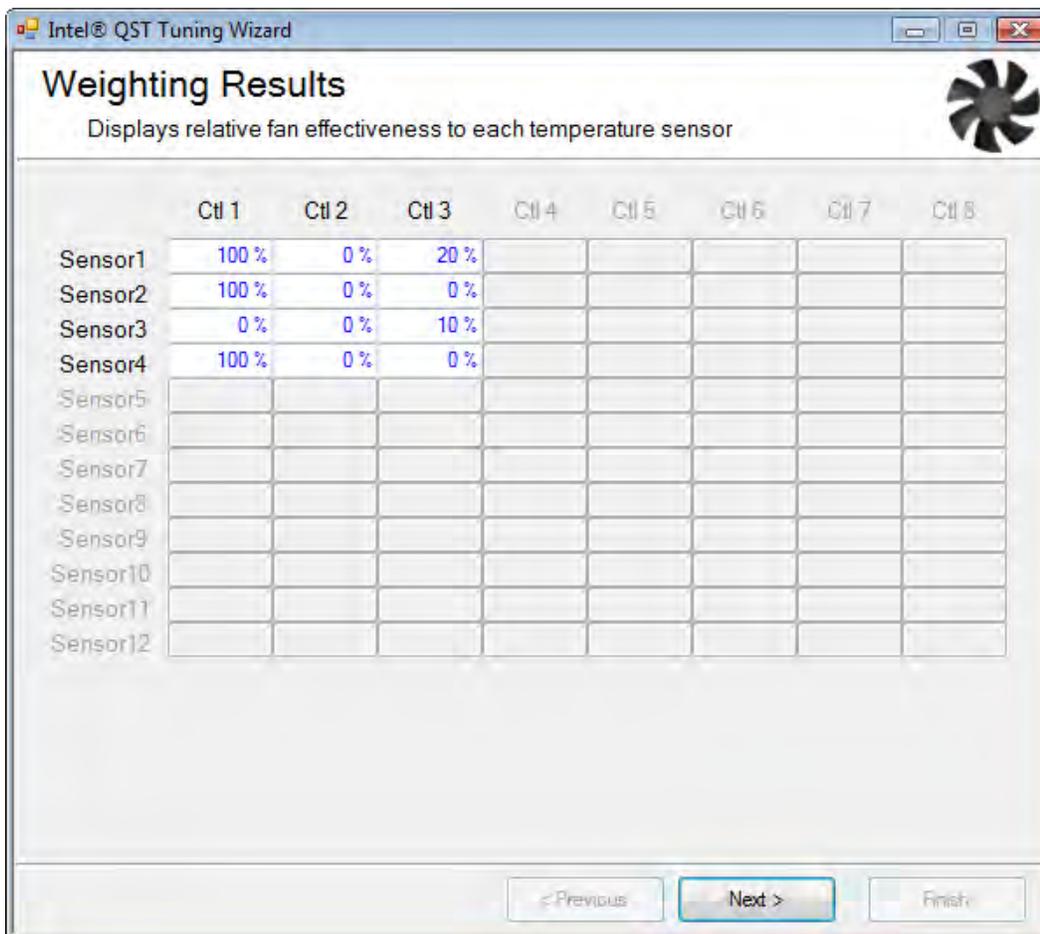


Figure 5: Weighting Calculation Results Screen After Skipping Process



Note: This process may take 20-30 minutes to complete, depending on the system configuration, number of fans, etc.



Note: For best results, the tests should be run with no other programs active. The results depend heavily upon seeing constant power levels, generated specifically by the MaxPower program, and additional CPU load may alter results.

Note: Some systems will either timeout or be over-temperature even at the lowest MaxPower setting. In the case of a timeout, it is recommended that the Integrator ignore the error and continue the test. If an over-temperature error is returned, the Integrator may choose to continue the test. If they do so, it is recommended that they monitor the system closely and abort the test if an excessive over-temperature situation occurs. In either case, the Integrator must ensure that each temperature monitor reaches steady-state for optimal weights to be calculated.

8. Weighting Calculation Results: Screen that allows user to view and modify the calculated weighting parameters. These parameters are presented in a matrix. The active cells of this matrix can be edited to change these values; however, it is recommended that the calculated values not be modified. Figure 5 shows the screen after the user has bypassed the weighting calculation process. Upon completion of this screen by the click of the "Next" button, the values are checked to determine if each of the temperature sensors (e.g. "Sensor3") has at least one fan controller (e.g. "Ctl 3") that is equal to 100%. If not the warning message in Figure 6 will appear. Typical this will not occur if the weighting calculation process is run and not bypassed but can occur if the user alters the values or a sensor is active but unresponsive during the process.

Figure 6: Warning Each Sensor Does Not Have At Least One Fan Controller with 100% Weighting

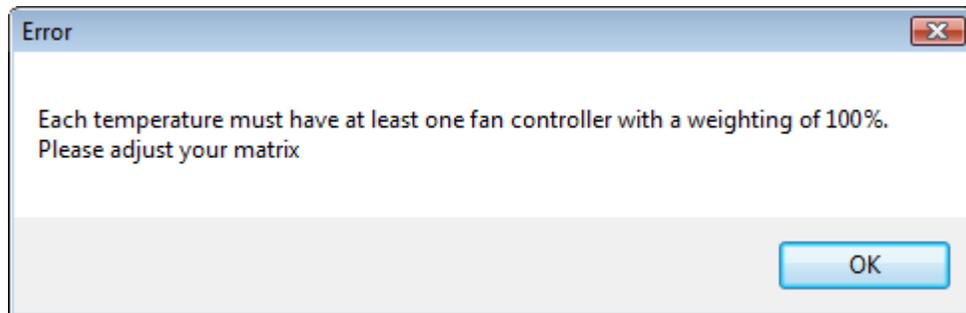
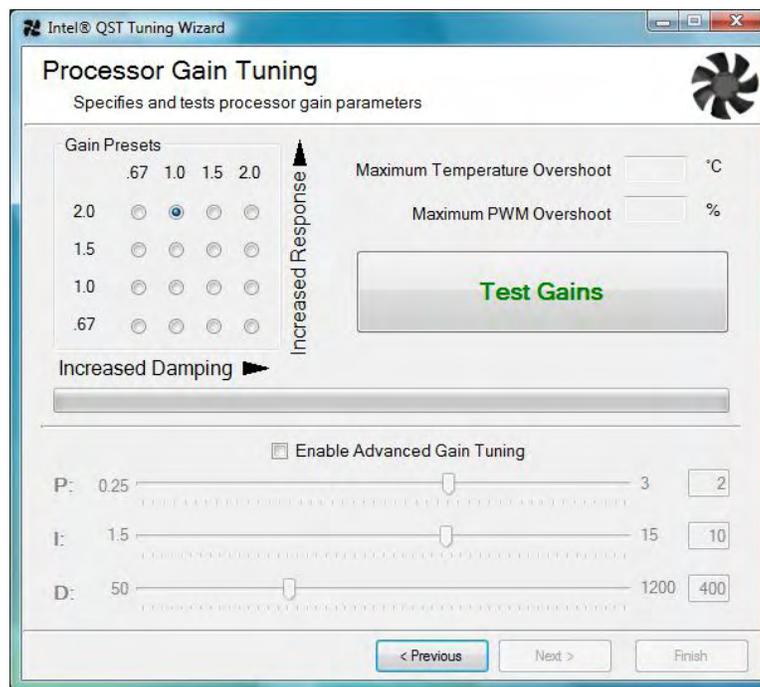




Figure 7: PID Gain Tuning Scene



9. **PID Gain Testing:** Screen used to set, adjust, test and retest the PID gain settings for the processor. The selection of the PID (K_p , K_i , K_d) gain settings is simplified using the Damping and Response parameter table. By analyzing the data created in this step, the gain settings can be adjusted to minimize the transient acoustics on your system. This step is iterative and will likely require the gain testing to be run multiple times.
 - **Gain Presets:** A pre-defined matrix of sets of PID gain settings that will provide good results across a broad range of systems. The default gain setting is (Damping = 1.0, Response = 1.0); this is the recommended settings for starting the test the first time. The corresponding P, I and D gain settings are displayed to the right of the slider bars below.
 - **Maximum Temperature Overshoot:** The maximum difference between the average steady-state condition and the peak across the response time domain. This parameter is displayed for the most recent gain test.
 - **Maximum PWM Overshoot:** The maximum difference between the average steady-state condition of the fan and its peak across the response time domain. This parameter is displayed for the most recent gain test.
 - **Test Gains:** Starts the gain testing routine, which takes the processor through three distinct power steps: from idle to high, from high to mid, and finally, from mid to high (see Figure 8). By analyzing the fan and temperature response at each of these power steps (marked by a gray vertical line on the plot), the gain settings can be adjusted to minimize the acoustics (see Section 5.2.2 for guidance on adjusting the gain settings).



- **Damping:** Damping and Response parameters are a simplified representation of the PID gain settings. In general, increasing the Damping will decrease fan oscillation and decrease temperature overshoot. However, too high of a Damping will cause fan overshoot, causing higher acoustics than are necessary to adequately cool the system.
- **Response:** Damping and Response parameters are a simplified representation of the PID gain settings. In general, increasing the Response causes the fans to react faster to a temperature change, thereby decreasing temperature overshoot. However, too high of a Response will cause fan overshoot and oscillation, causing higher acoustics than are necessary to adequately cool the system.
- **Enable Advanced Gain Tuning:** If selected, allows user specify K_p , K_i and K_D independent of the pre-defined ratios. If not selected, K_p , K_i and K_D gain settings are automatically set via the selected radio button in the Gain Presets. Selecting this option gives the user greater flexibility to both have a wider range of gains, as well as independently changing the ratios between the gains. If settings produce undesirable results, the user can easily select a Damping and Response setting from the pre-defined matrix.

Note: For more information on PID gain setting tuning, see Section 5.2.2.



10. DTS Specification Parameter Inputs: Screen allows the user to create or adjust the parameters associated with the Sensor Based Specification. If the Sensor Based Specification of “DTS” control is active these values will be loaded from the Intel® QST configuration. If it is not the user can manually enter these values. Figure 8 shows this screen.

- **DTS Specification Parameters:** The values in this section are specific to the exact processor type and can be found in the processor specification. The performance target of the processor’s thermal solution in “Psi-ca” is determined based on the read DTS temperature of the processor and calculated based on a three parameter equation determined between Tcontrol (“DTS=Tcontrol”) and one degree below TCC activation (“DTS=-1”). This equation has a slope, intercept and maximum ambient temperature values (which is the same at both points). The exact equation and subsequent parameters can be found in the processor’s datasheet specifically in the Package Thermal Specification chapter in the Notes section of “Thermal Solution Performance above Tcontrol” table.

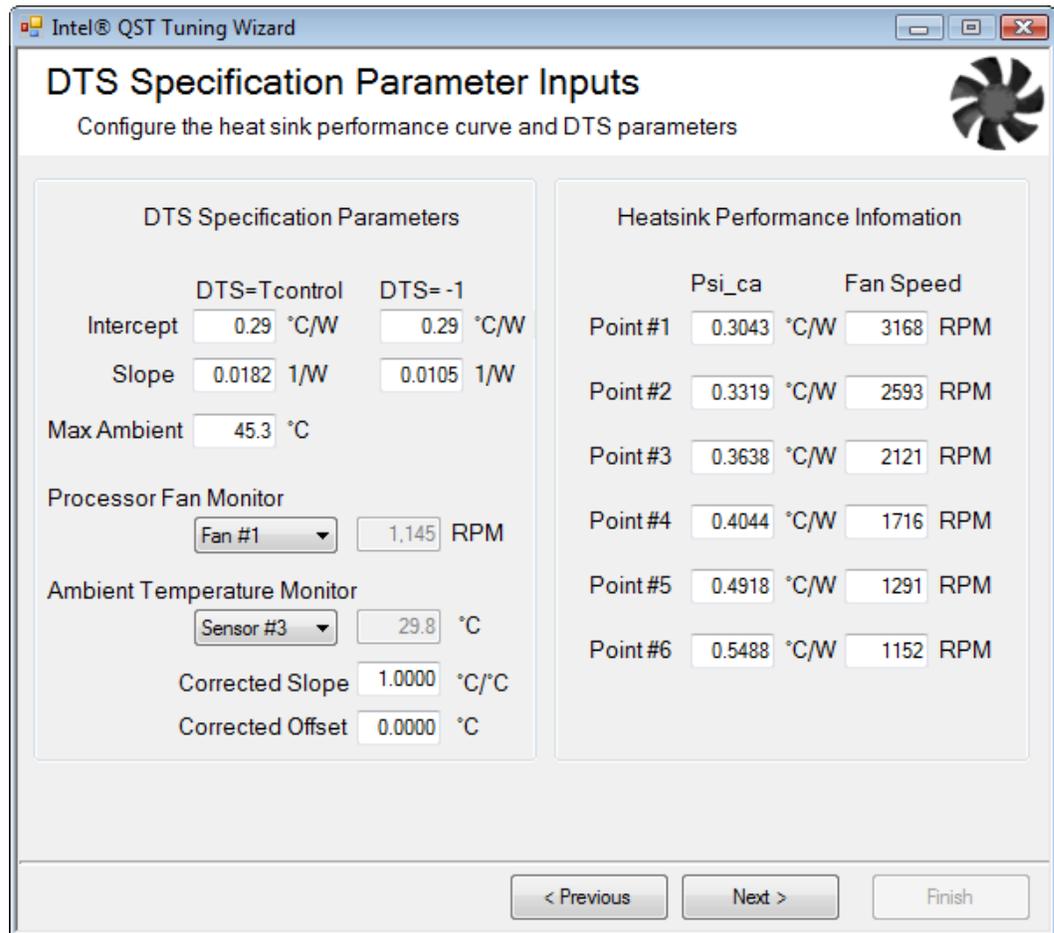
These parameters determine the Psi-ca “Target” for the processor when its DTS temperature is above Tcontrol.

- **Processor Fan Monitor:** Fan controller associated with the processor using the Sensor Based Specification and that will be controlled when DTS is above Tcontrol.
- **Ambient Temperature Monitor:** The Psi-ca Target varies as ambient temperature varies and as such a temperature monitor can be specified. It is assumed that the temperature monitor is immediately upstream of the processor’s thermal solution within the system. If there is ambient sensor available in the system then “No Sensor” can be selected and the specification will not vary with ambient temperature but will assume a constant 40 °C. Correction to the specific temperature sensor can be performed and the sensor’s slope and offset can be changed to adjust the sensor to represent the ambient temperature. The Temperature Sensor corrected slope and offset are parameters that are stored in the main QST subsystem and are not uniquely part of the Sensor Based Specification implementation.
 - **Corrected Slope:** Measured temperature value is read and multiplied by the corrected slope (in °C/°C). The corrected offset, if any, is then applied and the temperature is reported.
 - **Corrected Offset:** Measured temperature value adjusted by the addition of the corrected offset (°C) after corrected slope is applied and reported
- **Heatsink Performance Information:** This section contains the performance information for the active heatsink associated with the Processor Fan Monitor selected in the screen. Specifically six data points are inputted for the thermal solution’s thermal performance in “Psi-ca” (in degree Centigrade per Watt or “C/W”) at a specified thermal solution’s “Fan Speed” (in Revolutions per Minute or “RPM”). The thermal performance is determined with a Thermal Test Vehicle for which its specification is determined.



Please refer the processor’s datasheet and (specifically the Package Thermal Specification chapter) as well as the processor’s Thermal Mechanical Design Guide (specifically the Sensor Based Thermal Specification Design Guidance Chapter) for more details associated with the Sensor-Based Specification.

Figure 8: DTS Specification Parameter Inputs Screen



11. Processor DTS RPM Gain Tuning Screen: Similar to the “PID Gain Testing Screen” used to set, adjust, test and retest the PID gain settings for the processor when in temperature control or below Tcontrol this screen allows tuning of the RPM PID gain settings when the processor is above Tcontrol.

Note: To generate a temperature response that exceed the processors Tcontrol temperature testing may have to be performed at elevated temperatures. This need is dependant on the processor specification as well as it’s power dissipation.

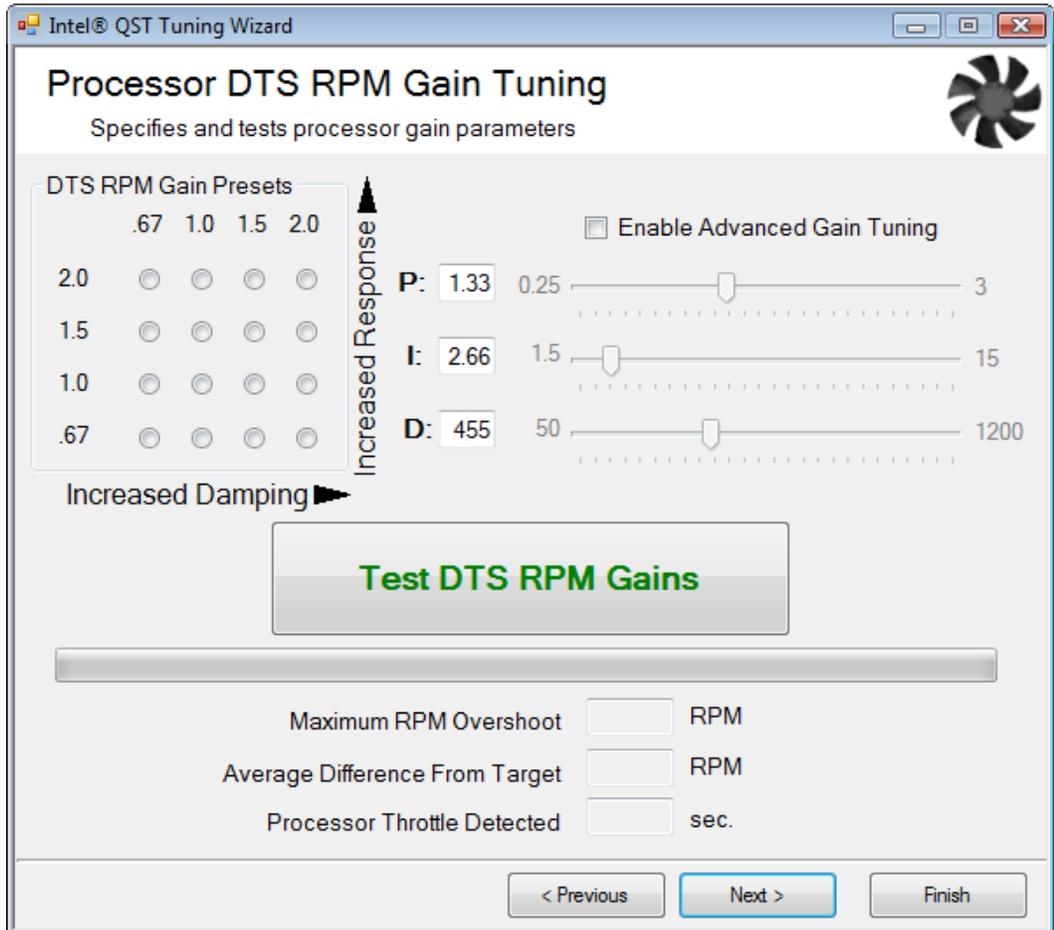


- **DTS RPM Gain Presets:** A pre-defined matrix of sets of PID gain settings similar to that of the temperature control PID gains may provide good results across a broad range of systems. It is specific to the thermal solution implemented and its speed range. The temperature control PID gains are a good place to start when testing DTS RPM control PID gains. Typically a well tuned system will require less responsiveness and dampening (0.75x to 0.5x) when above Tcontrol. The actual PID values are read from the QST configuration if the DTS specification has been implemented and is active. The corresponding P, I and D gain settings are displayed to the right of the DTS RPM Gain Presets section.
- **Enable Advanced Gain Tuning:** If selected, allows user specify P, I and D independent of the pre-defined ratios. If not selected, P, I, and D gain settings are automatically set via the selected radio button in the Gain Presets. Selecting this option gives the user greater flexibility to both have a wider range of gains, as well as independently changing the ratios between the gains. If settings produce undesirable results, the user can easily select a Damping and Response setting from the pre-defined matrix.
- **Damping:** Damping and Response parameters are a simplified representation of the PID gain settings. In general, increasing the Damping will decrease fan oscillation and decrease RPM overshoot. However, too high of a Damping will cause fan overshoot, causing higher acoustics than are necessary to adequately meet the sensor based specification.
- **Response:** Damping and Response parameters are a simplified representation of the PID gain settings. In general, increasing the Response causes the fans to react faster to a temperature change and a subsequent RPM target, thereby decreasing RPM overshoot. However, too high of a Response will cause fan RPM overshoot and oscillation, causing higher acoustics than are necessary to meet the sensor based specification.
- **Test DTS RPM Gains:** Starts the gain testing routine, which takes the processor through three distinct power steps: from idle to very high, from very high to high, and back to very high. By analyzing the fan and RPM response at each of these power steps, the gain settings can be adjusted to optimize the systems performance.
- **Maximum RPM Overshoot:** The maximum difference between the average steady-state condition of the fan and its peak across the response time domain. This parameter is displayed for the most recent gain test.
- **Average Difference From Target:** During the test a "Target RPM" is displayed along side the thermal solution's actual fan speed to compare how well the PID gains are controlling the thermal solution. If the DTS temperature is below Tcontrol it would be expected to see a Target RPM value above what the solution is actively spinning at. Above Tcontrol the control logic is seeking to meet the target RPM speed. This reports the average difference the fan speed is from the specification's targeted speed when the processor is above its Tcontrol.
- **Processor Throttle Detected:** Number of seconds a throttle or TCC event is detected during the test. The sensor based specification allows processor temperatures above Tcontrol which is an acoustic benefit to the end user but may place the processor closer to its Throttle or TCC activation temperature. If the PID values are implemented that don't not respond to DTS temperature



changes fast enough the processor may reach this throttle temperature. If significant throttle time is witness then increasing the responsiveness of the PID rpm gains is recommended.

Figure 9: Processor DTS RPM Gain Tuning Scene





12. Exit Screen: Screen allows user to save and implement settings. If the Digital Sensor Specification (DTS) Control check box is NOT checked in screen 2 then screens 10 and 11 are not show and this becomes screen 10

- **Update QST on exit:** Sends the final version of the configuration to QST for storage (overwriting previous settings). If the Sensor Based Specification DTS control has been activated and tuned then it parameters will be saved as well.
- **Update .INI on exit:** Writes settings to the .INI file that was specified in the "Tool Options" screen. If the Sensor Based Specification DTS control has been activated an additional .INI file is written as specified in the "Tool Options" screen.
- **Create new .INI on exit:** Writes settings to a new .INI file. The Integrator will specify the filename and directory in a File Open dialogue. If the Sensor Based Specification DTS control has been activated an additional File Open dialogue is seen to save the separate DTS .INI file.

5.2.2 PID Gain Setting Tuning

While much of the Wizard is automated, user input is required to find the optimal gain settings. The default gain settings may be adequate for many systems, but fine-tuning the gain settings to your particular system (and especially its processor cooling solution) can provide an additional acoustic benefit. This section describes the process for adjusting the PID gain settings in *Screen 9: PID Gain Testing*. Although these guidelines are focused on the temperature PID gains they also apply in general to the tuning of the DTS RPM control PID gains and should help guide the tuning of those PDI gains as well.

5.2.2.1 Determining the Quality of PID Gain Settings

Certain metrics can be used to measure the quality of your fan speed and temperature response to determine if you have optimized gain settings. Analyzing the fan speed and temperature response to multiple inputs can help you to determine (1) if your current gain settings are appropriate, and (2) how to change the gains to achieve better results. The Intel® QST Tuning Wizard automates both changes in processor power and data collection to enable the Integrator to assess the response quality to changes in power.

5.2.2.2 Assessing Response Quality

The first measures of response quality are indicated in the upper right corner of Figure 1: the Maximum Temperature Overshoot and the Maximum Fan Overshoot. If either of these values are large (>4 °C or > 5% PWM, respectively) then the user should change the gains and retest. See Table 1 for recommendations on changing the gain settings.



The second measure is analysis of the temperature and fan PWM response data from the PID gain settings test. Figure 11 - Figure 13 show the response of a relatively simple one fan, one sensor system while subjected to the series of changes in processor power shown in Figure 10. These power changes, moving from left to right, are as follows:

1. Start power at idle setting
2. Increase power to a high power setting
3. Reduce power to an intermediate power setting
4. Increase power to the high power setting again.

This series of power changes will stress the fan speed control subsystem and expose any problems with its dynamic control. In particular, the response at power steps 1-to-2 and 3-to-4 will provide the response data of interest. The results (Figure 11- Figure 13) can be used to illustrate how to measure the quality of fan and temperature response. Table 1 explains the metrics shown in Figure 11-Figure 13.

Figure 10: Power Level Changes for the PID Gain Settings Test

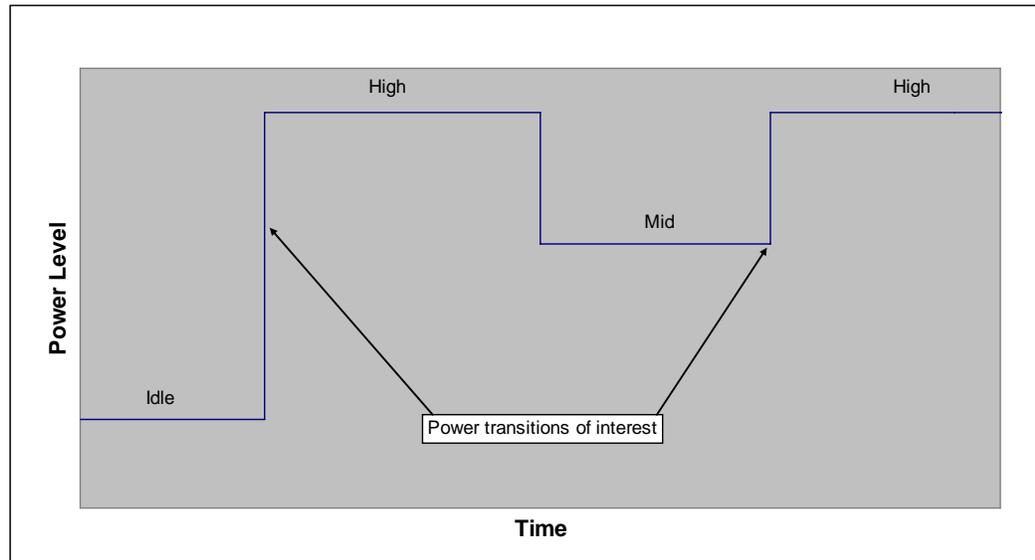


Figure 11-Figure 13 show response data from a real system with only one fan and the CPU temperature response shown. The indicators of poor PID Gain Settings are highlighted and an improvement path is suggested.



Figure 11: Fan Overshoot & Temperature Oscillation (Adjustment: Decrease Response)

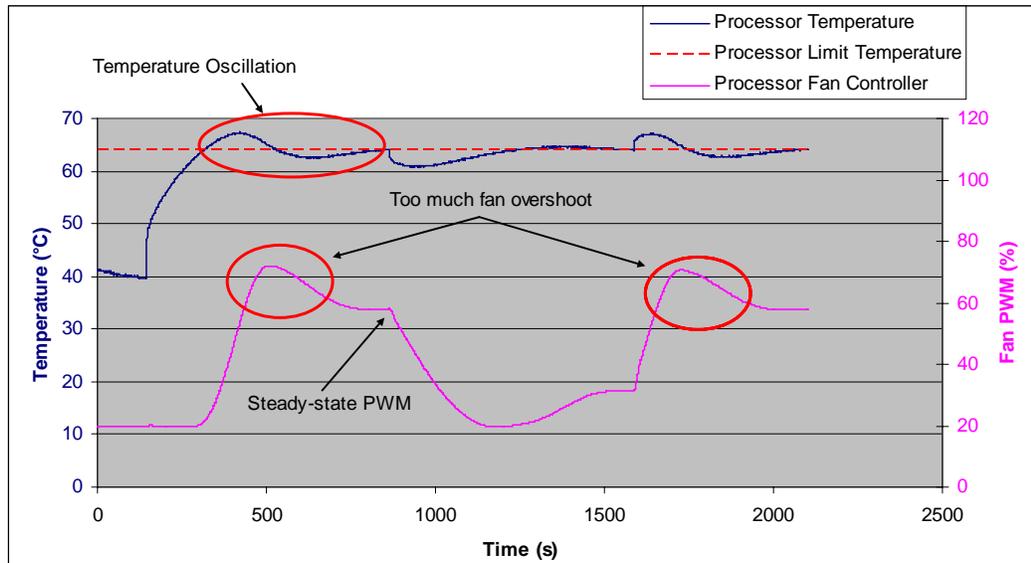


Figure 12: Temperature Overshoot (Adjustment: Increase Both Damping and Response)

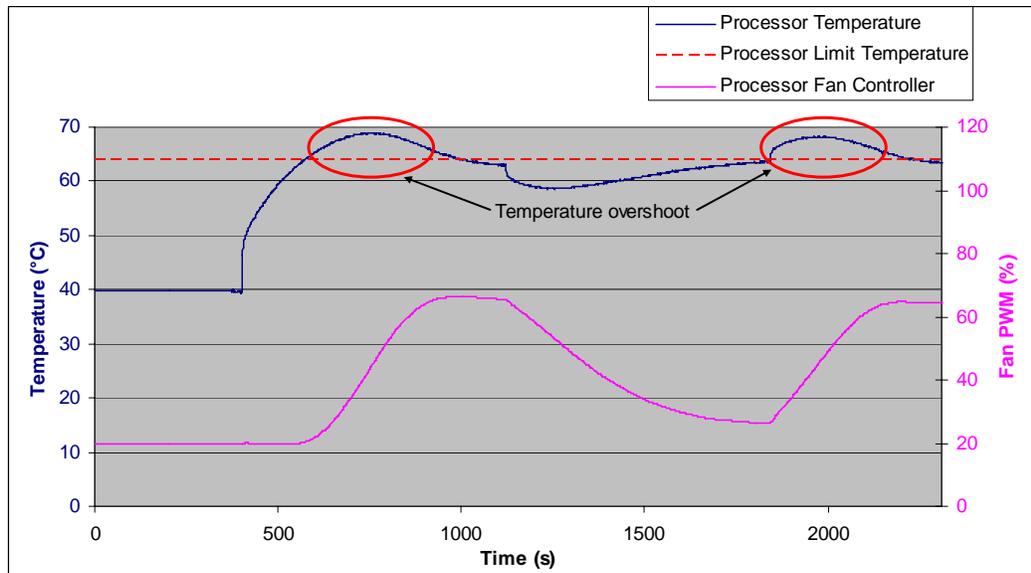




Figure 13: Fan Spike, Temperature and Fan Overshoot (Adjustment: Decrease Damping)

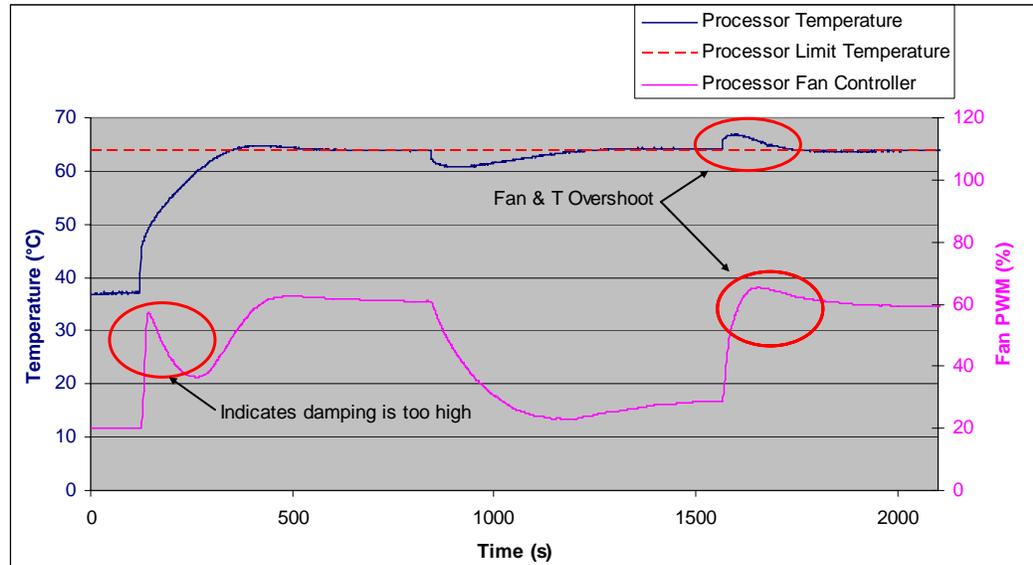


Table 1: PID Gain Setting Adjustment Guide

Metric	Description	How to Improve Problem
Fan and/or Temperature Oscillation	The fan or temperature response oscillates above and below its steady-state condition when the power is not changing	Decrease Response and Increase Damping
Fan Overshoot	The maximum delta between the average steady-state condition of the fan and its peak across the response time domain	Decrease Response and Damping
Temperature Overshoot	The maximum delta between the average steady-state condition of the temperature sensor and its peak across the response time domain	Increase Response and Damping
Fan and Temperature Overshoot	During certain power changes the fan speed increases above its steady state condition, but at other parts of the test, the temperature increases above its steady state condition	Increase Response and decrease Damping



5.2.2.3 Process for Adjusting the PID Gain Settings

Once the response data is analyzed and the problem areas identified, the Damping and Response parameters can be changed to improve performance. The process for tuning the gain settings is as follows:

1. Choose a set of gain values for initial testing from the Gain Preset table. The default settings are a good place to start.
2. Run the gain test on the Processor Gain Tuning screen.
3. Analyze the data and identify the key indicators as described in Section 5.2.2.2.
4. Use the information presented in Figure 11-Figure 14 and Table 1 to determine if the PID gain settings are adequate and, if not, how to adjust the Damping and Response to improve the results. For example, if the test was run using the default settings, and the results in Figure 12 were achieved, the temperature overshoot would need to be decreased. Referring to Figure 15, this response indicates moving both the Damping and Response parameters up and to the right is necessary (i.e. away from the 'Too Much Temperature Overshoot' corner). Thus, the button at (Damping = 1.5, Response = 1.5) should be selected. After making any change, the Gain Tests should be run again to verify the new settings.

Note: This method works for any starting point. Suppose a second test was run and the data indicated that there was too much fan oscillation. For fan oscillation, the plot recommends moving down and right. When the starting point is (1.5, 1.5), the next setting to test would be (2.0, 1.0), and so on. It is also acceptable to move horizontally or vertically on the chart if multiple indicators are found.

Repeat the test, analyze and adjust process (steps 1-4) until good Damping and Response settings are found. This is indicated by none of the symptoms described in Table 1 being present in the data, a temperature overshoot of $<4^{\circ}\text{C}$ and a fan overshoot of $<5\%$ PWM. Figure 14 shows the response of a well-tuned system.

Figure 14: Response from Tuned PID Gain Settings

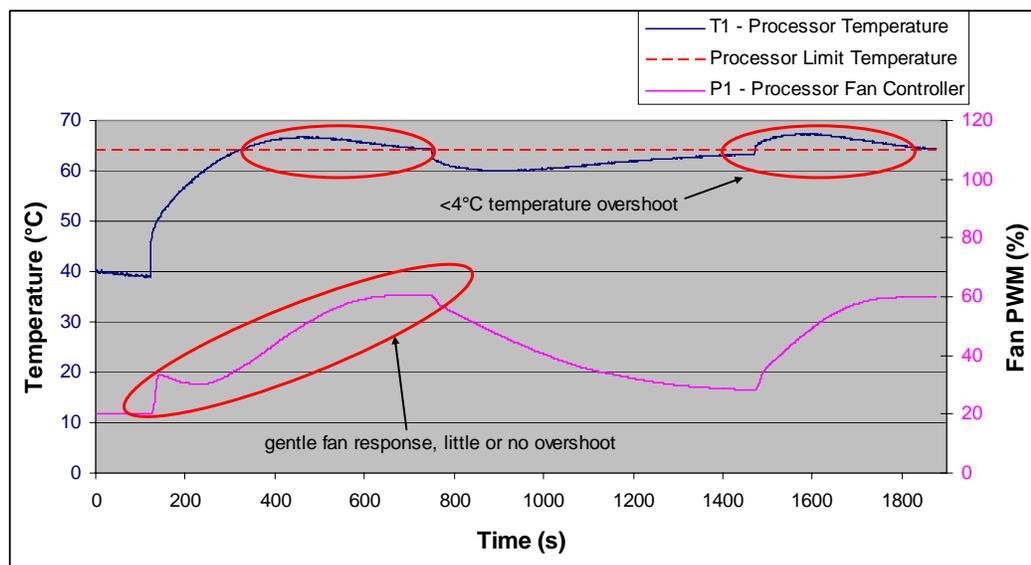
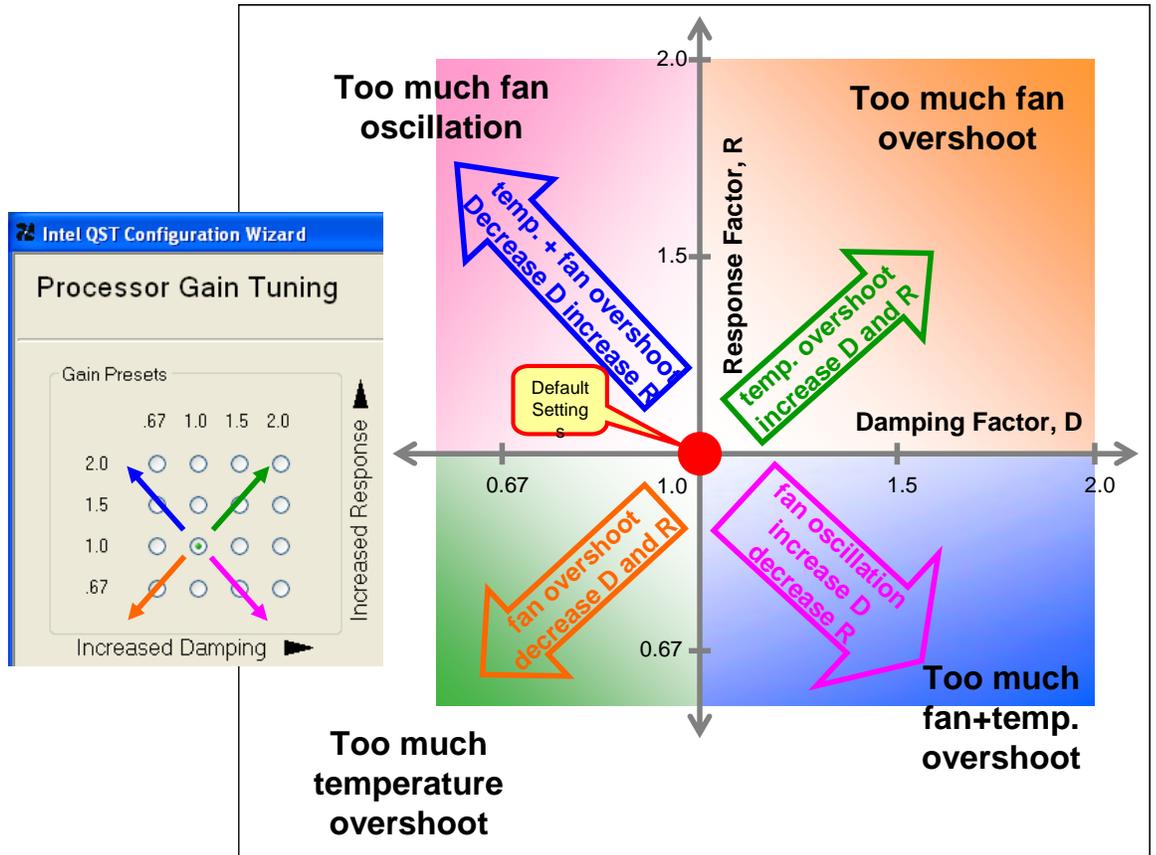




Figure 15: PID Gain Setting Adjustment Guide





5.2.3 Using the Plot Window

The QST Plot window offers several functions to help the user see the data as it is collected in real time and in a useful manner.

5.2.3.1 Plot Window Contents

The Plot Window shows three separate sets of data vs. time while the testing proceeds: 1) the temperature for each enabled temperature sensor, 2) the fan controller PWM, and 3) the fan monitor RPM. These are displayed top-to-bottom in the window. Figure 11-Figure 14 all represent examples of the contents of the temperature portion of the plot display.

5.2.3.2 Plot Window Options

The features enabled in the plot window are as follows:

- For both the x- and y-axis:
 - Can be panned by grabbing and dragging.
 - Right click context menu can enable/disable tracking and zoom to fit the data displayed.
- Zoom in on data. To zoom, click the 'Zoom On' button in the lower right side of the plot of interest, then select a rectangle around the data of interest. Cursor must start in the upper-right corner of the rectangle. Click the button again (now titled 'Zoom Off') to return to the full data set.
- Hide and unhide channels. Click on the channel of interest in the legend and answer 'Yes' in the dialogue box to hide a channel. Repeat process to unhide channel.
- 5. Clicking on 'No' when hiding or unhiding a channel will open a color selection dialogue to change the color of the channel.
- The window can be resized as desired. Each plot will take 1/3 of the height and the full width of the window.