4th Generation Intel® Core™ and Intel® Celeron® Processor Mobile Series

Supporting 4th Generation Intel® Core™ Processor based on Mobile M-Processor and H-Processor Lines

Supporting Mobile Intel® Celeron® Processor Family

Application Power Guidelines Addendum For Intelligent Systems

March 2014

Order Number: 329023-004US

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Revision History

Date	Revision	Description
March 2014	004	Updated APG addendum with the Intel® Core™ i5-4410E, Intel® Core™ i5-4422E, and Intel® Core™ i3-4112E processors
December 2013	003	Updated APG addendum with Intel® Celeron® 2000E processor
August 2013	002	Updated APG addendum with Intel® Core™ i7-4860EQ and Intel® Core™ i7-4850E processors
June 2013	001	Initial release

§

1 Introduction

This document provides power data for the 4th Generation Intel® Core™ and Intel® Celeron® Processor Mobile Series while running real-life applications. This document is complementary to the specifications published in the product datasheet.

The Application Power Guidelines should be used for reference only. The power data provided in this document are not design points or specifications and should not be used as such.

Additional information about Application Power Guidelines is provided in the Table 1 Related Documents. Refer to the documents in Table 2 for supplemental information.

1.1 Related Documents

Table 1. Related Documents

Document Title	Document Number/Location
Embedded Application Power Guidelines	http://www.intel.com/content/dam/www/public/us/en/documents/white-papers/embedded-appl-power-guideline-paper.pdf

1.2 Reference Documents

Table 2. Reference Documents

Document Title	Document Number/Location
Mobile 4th Generation Intel® Core™ Processor Family Mobile - External Design Specification (EDS) – Volume 1 of 2	487246
4th Generation Intel® Core™ Processor Desktop, 4th Generation Intel® Core™ Processor Mobile, and Intel® Xeon® Processor E3-1200 v3 Product Family - External Design Specification (EDS) – Volume 2 of 2	487247
Haswell Mobile Platform - Design Guide	486713
[Haswell-M] Processor – Mobile 4th Gen. Intel® Core™ Platform Thermal Mechanical Design Guide	496203

NOTE: Contact the local Intel representative for the most recent revision of these documents.

1.3 Terminology

Table 3. Terminology

Term	Description
APG	Application Power Guidelines
CABAC	Context-Adaptive Binary Arithmetic Coding
DAQ	Dara Acquisition
ECC	Error-Correcting Code
eDRAM	Embedded Dynamic Random Access Memory
SKU	Stock Keeping Unit
TDP	Thermal Design Power

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2 Application Power Guidelines

The Application Power Guidelines (APG) data listed in this document are intended to reflect the typical use conditions. Factors such as temperature, platform configuration, and other variables can influence power usage. Specific information about the platforms and test configurations is provided in this document to enable a repeatable power measurement.

2.1 Intel® Core™ i7-4700EQ Processor Application Power Guidelines

Figure 1 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i7-4700EQ Processor with a 47W TDP specification.

Figure 1. Intel® Core™ i7-4700EQ Processor Application Power Guidelines

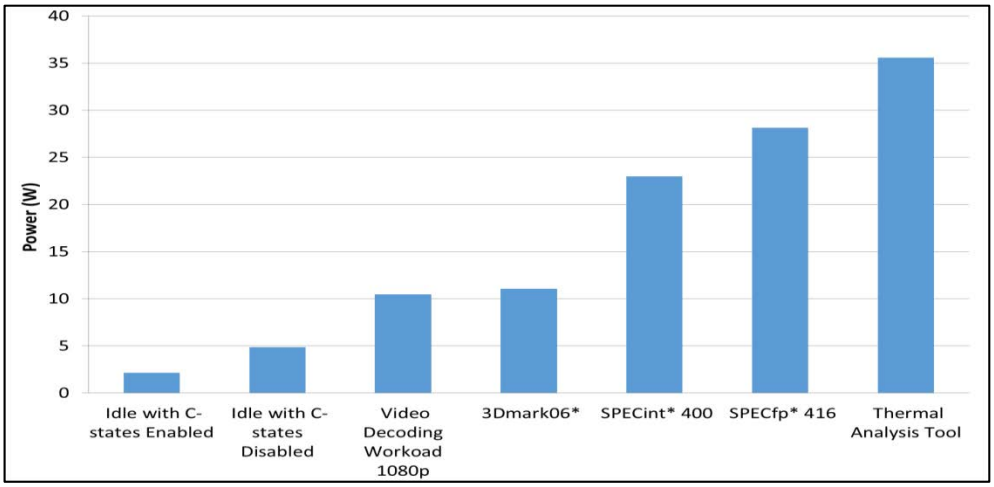

Table 4. Intel® Core™ i7-4700EQ Processor Application Power Guidelines

Application/Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.1	38
Idle with C-states Disabled	4.8	41
Video Decoding Workload 1080p	10.5	42
3DMark06*	11.1	42
SPECint* 400	23.0	55
SPECfp* 416	28.1	60
Thermal Analysis Tool	35.6	69

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of June 2013.
3. Platform: Intel® Core™ i7- 4700QE Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTS1.86C.0113.D00.1303081909.
5. Memory: 4x SODIMMs 2GB 1Rx8 EP3L-10600E-09-11-C1 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.0.030-generic).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.2 Intel® Core™ i5-4400E Processor Application Power Guidelines

Figure 2 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i5-4400E Processor with a 37W TDP specification.

Figure 2. Intel® Core™ i5-4400E Processor Application Power Guidelines

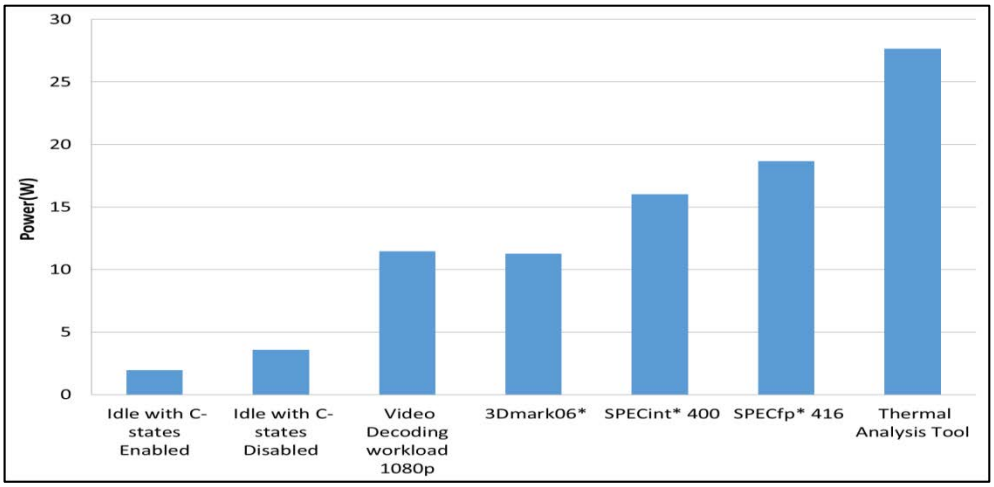

Table 5. Intel® Core™ i5-4400E Processor Application Power Guidelines

Application/Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	1.9	39
Idle with C-states Disabled	3.6	40
Video Decoding Workload 1080p	11.5	43
3DMark06*	11.3	45
SPECint* 400	16.0	51
SPECfp* 416	18.7	55
Thermal Analysis Tool	27.7	62

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of June 2013.
3. Platform: Intel® Core™ i5-4400E Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTS1.86C.0113.D00.1303081909.
5. Memory: 4x SODIMMs 2GB 1Rx8 EP3L-10600E-09-11-C1 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.0.030-generic).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.3 Intel® Core™ i5-4410E Processor Application Power Guidelines

Figure 3 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i5-4410E Processor with a 37W TDP specification.

Figure 3. Intel® Core™ i5-4410E Processor Application Power Guidelines

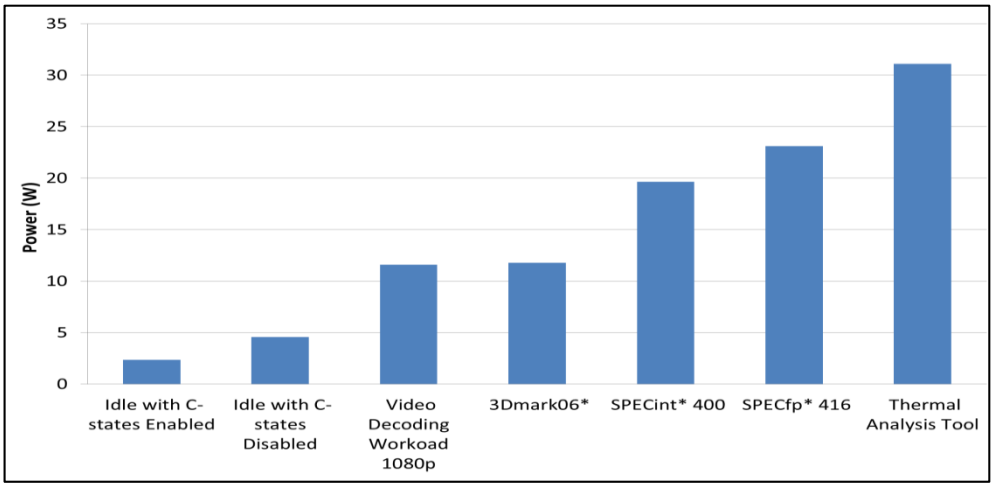

Table 6. Intel® Core™ i5-4410E Processor Application Power Guidelines

Application/Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.4	31
Idle with C-states Disabled	4.6	33
Video Decoding Workload 1080p	11.6	37
3DMark06*	11.8	39
SPECint* 400	19.7	50
SPECfp* 416	23.1	55
Thermal Analysis Tool	31.1	61

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of June 2013.
3. Platform: Intel® Core™ i5-4410E Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0118.R00.1303191744.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.4 Intel® Core™ i5-4422E Processor Application Power Guidelines

Figure 4 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i5-4422E Processor with a 25W TDP specification.

Figure 4. Intel® Core™ i5-4422E Processor Application Power Guidelines

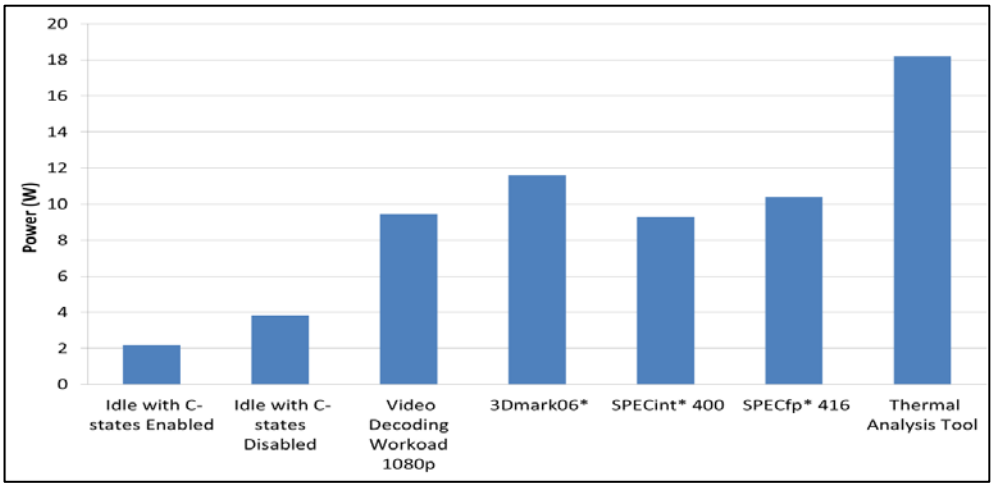

Table 7. Intel® Core™ i5-4422E Processor Application Power Guidelines

Application / Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.2	33
Idle with C-states Disabled	3.8	34
Video Decoding Workload 1080p	9.4	41
3DMark06*	11.6	41
SPECint* 400	9.3	39
SPECfp* 416	10.4	41
Thermal Analysis Tool	18.2	46

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of February 2014.
3. Platform: Intel® Core™ i5-4422E Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0135.R01.1311020052.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.5 Intel® Core™ i3-4112E Processor Application Power Guidelines

Figure 5 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i3-4112E Processor with a 25W TDP specification.

Figure 5. Intel® Core™ i3-4112E Processor Application Power Guidelines

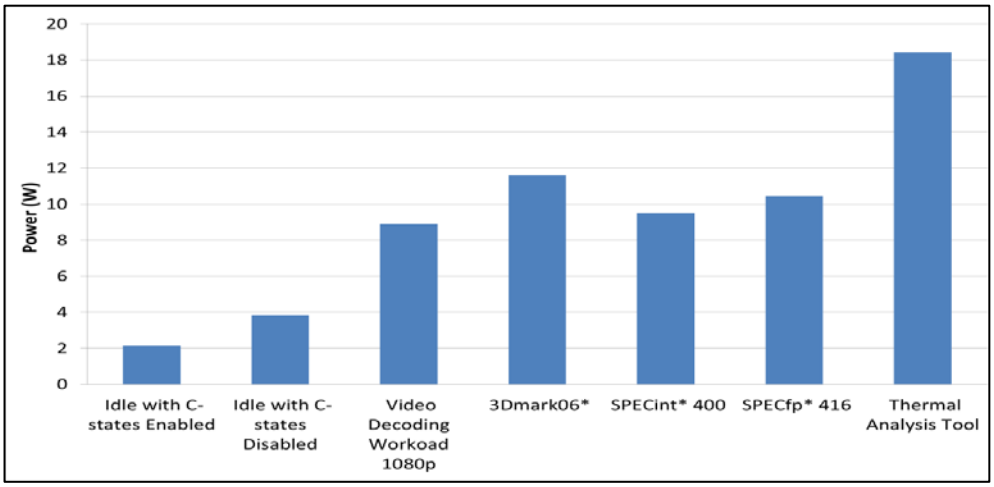

Table 8. Intel® Core™ i3-4112E Processor Application Power Guidelines

Application / Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.1	31
Idle with C-states Disabled	3.8	33
Video Decoding Workload 1080p	8.9	36
3DMark06*	11.6	40
SPECint* 400	9.5	38
SPECfp* 416	10.5	39
Thermal Analysis Tool	18.4	46

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of February 2014.
3. Platform: Intel® Core™ i3-4112E Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0135.R01.1311020052.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.6 Intel® Core™ i7-4860EQ Processor with Intel® Iris™ Pro graphics 5200 Application Power Guidelines

Figure 6 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i7-4860EQ Processor with a 47W TDP specification.

Figure 6. Intel® Core™ i7-4860EQ Processor Application Power Guidelines

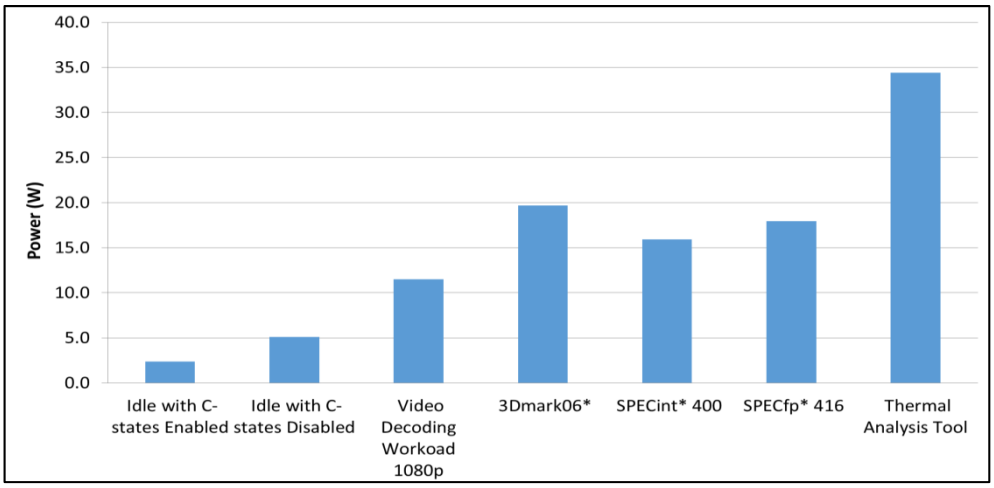

Table 9. Intel® Core™ i7-4860EQ Processor Application Power Guidelines

Application / Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.4	30
Idle with C-states Disabled	5.1	33
Video Decoding Workload 1080p	11.5	35
3DMark06*	19.7	41
SPECint* 400	15.9	44
SPECfp* 416	17.9	46
Thermal Analysis Tool	34.4	55

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of July 2013.
3. Platform: Intel® Core™ i7-4860EQ Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0131.R02.1307182148.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.7 Intel® Core™ i7-4850EQ Processor with Intel® Iris™ Pro graphics 5200 Application Power Guidelines

Figure 7 indicates the Application Power Guidelines for various embedded applications for the Intel® Core™ i7-4850EQ Processor with a 47W TDP specification.

Figure 7. Intel® Core™ i7-4850EQ Processor Application Power Guidelines

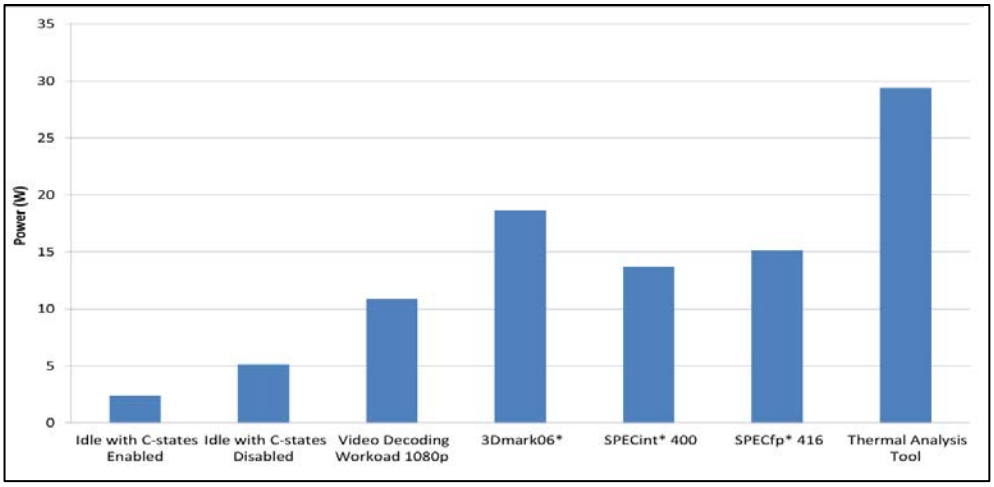

Table 10. Intel® Core™ i7-4850EQ Processor Application Power Guidelines

Application / Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.4	31
Idle with C-states Disabled	5.1	34
Video Decoding Workload 1080p	10.9	36
3DMark06*	18.7	45
SPECint* 400	13.7	40
SPECfp* 416	15.1	44
Thermal Analysis Tool	29.4	54

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of July 2013.
3. Platform: Intel® Core™ i7-4850EQ Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0131.R02.1307182148.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

2.8 Intel® Celeron® 2000E Processor Application Power Guidelines

Figure 8 indicates the Application Power Guidelines for various embedded applications for the Intel® Celeron® 2000E Processor with a 37W TDP specification.

Figure 8. Intel® Celeron® 2000E Processor Application Power Guidelines

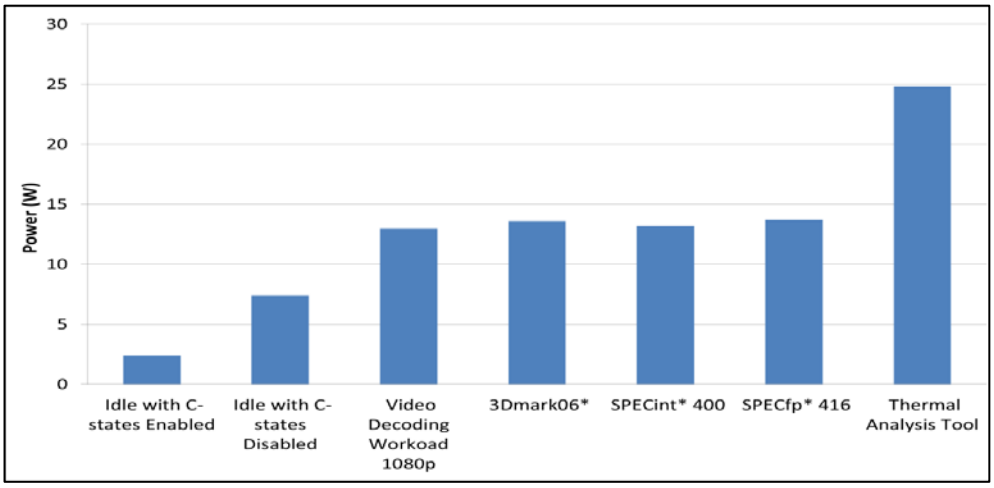

Table 11. Intel® Celeron® 2000E Processor Application Power Guidelines

Application / Benchmark	Processor Power (W)	Junction Temperature (°C)
Idle with C-states Enabled	2.4	31
Idle with C-states Disabled	7.4	34
Video Decoding Workload 1080p	13.2	36
3DMark06*	13.7	45
SPECint* 400	16	40
SPECfp* 416	15.1	44
Thermal Analysis Tool	29.4	54

NOTES:

1. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance.
2. Test Configuration: The results presented are from a single sample. The data was not post-processed to account for part-to-part variation. Intel internal testing as of November 2013.
3. Platform: Intel® Celeron® 2000E Processor with Intel® Series 8 Chipset Family.
4. BIOS Revision: HSWLPTU1.86C.0131.R02.1307182148.
5. Memory: 4x SODIMMs 4GB PC3L-12800-CL11 with ECC.
6. Operating System: Windows 7* x64 Service Pack 1 and Linux* Ubuntu* 11.10 (kernel 3.10.1).
7. Additional Configuration details are listed in Section 3. Configuration and Disclaimer.

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3 Configuration and Disclaimer

Values presented represent a typical or average processor SKU and do not guarantee a customer will achieve these exact values for each silicon sample. These values are not intended to replace TDP, nor are they intended to be used for reliability assessments. Individual test results may vary.

Software and workloads used in performance tests may have been optimized for performance only on Intel processors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

3.1 APG Configuration

The results presented in this document are collected on a single sample. The data has not been post processed to account for part to part variation.

- Platforms:
  - Platform 1: Intel® Core™ i7- 4700QE Processor with Intel® Series 8 Chipset Family
  - Platform 2: Intel® Core™ i5- 4400E Processor with Intel® Series 8 Chipset Family
  - Platform 3: Intel® Core™ i5- 4410E Processor with Intel® Series 8 Chipset Family
  - Platform 4: Intel® Core™ i5- 4422E Processor with Intel® Series 8 Chipset Family
  - Platform 5: Intel® Core™ i3- 4112E Processor with Intel® Series 8 Chipset Family
  - Platform 6: Intel® Core™ i7- 4860EQ Processor with Intel® Series 8 Chipset Family
  - Platform 7: Intel® Core™ i7- 4850EQ Processor with Intel® Series 8 Chipset Family
  - Platform 8: Intel® Celeron® 2000E Processor with Intel® Series 8 Chipset Family
- Windows* Benchmarks: Video Decode Workload 1080P*, 3Dmark06*, Thermal Analysis Tool (TAT) (rev4.3).
- Linux* Ubuntu* Benchmarks: SPEC* CPU2006.1.2 (SPECint* 400 Perlbench, SPECfp* 416 Gamess).

- Video Decoding Workload 1080P: Digital Signage CityScape1Min_1080pMP4.mp4 (H264, High@L4, 30fps, 20mbps, no CABAC) was used to create a workload where multiple concurrent streams were decoded and displayed to the screen (VC+VO) with GFx frequency running at 600MHz for all platforms. Platforms 1, 2 and 3 ran 16 concurrent streams, platform 4 and 5 ran 15 concurrent streams, platforms 6 and 7 ran 13 concurrent streams, and platform 8 ran 10 concurrent streams.
- To provide deterministic CPU and Graphics frequencies when running all benchmarks including the TDP workload the Intel® Turbo Boost Technology graphics frequency was disabled in the Operating System graphics properties.
- A reference heat sink with fan was used while running these benchmarks.
- Measurement tool: Power Profiler 2.0 (National Instrument* USB-6255 DAQ with signal conditioning breakout board).
- Application Power Guidelines testing was conducted by Intel Corporation.
- For more information go to http://www.intel.com/performance/.

3.2 Additional Information

- In case of conflict the datasheet supersedes this document.
- Temperature values are mean temperatures measured through the duration of the test.
- The APG configuration is provided for repeatability of the test.
- SPEC* CPU2006 is an industrial standard benchmark designed to provide performance measurements that can be used to compare compute-intensive workloads on different computer systems. SPEC* CPU2006 test on Intel microprocessors are measured using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information; including system benchmarks to evaluate the performance of systems they are considering purchasing. For more information about SPEC* CPU2006 please visit www.spec.org/cpu2006/. The SPECint* benchmark used in this test is 400.Perlbench. The SPECfp* benchmark used in this test is 416.gamess.
- Power Thermal Utility tool (PTU) or Thermal Analysis tool (TAT) are developed by Intel to generate TDP like workloads on a system.
- 3DMark06* is a 3D graphics benchmark, designed for DirectX* 9.0. It includes four graphics tests, two CPU tests, and several feature tests. The CPU tests measures the contribution of the processor on 3D graphical while the graphics test measures game simulation performance. Power was measure while running Graphic Test 1: Return to Proxycon. For more information about 3Dmark06* please visit http://www.futuremark.com/benchmarks/3dmark/all. Player is an open source media player.
- The Idle Power reported above is while displaying the Windows* desktop screen.

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