# White Paper
# FUJITSU Server PRIMERGY
# Performance Report PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5

This document provides an overview of benchmarks executed on the FUJITSU Server PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5.

Explains PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 performance data in comparison to other PRIMERGY models. In addition to the benchmark results, the explanation for each benchmark and benchmark environment are also included.

| Version |
| --- |
| 1.2 |
| 2022/07/05 |

# Contents

# Document history

### Version 1.0 (2022/02/18)

New:

- Technical data
- SPECcpu2017, STREAM
  Measured and calculated with Intel Xeon E-2300 processor family / Intel Pentium Gold G6405
- SPECpower_ssj2008
  Measured with Intel Xeon E-2356G / Intel Xeon E-2388G
- Disk I/O
  Measured with 2.5" and 3.5" storage media

### Version 1.1  (2022/05/23)

Update:

- Minor corrections

### Version 1.2  (2022/07/05)

Update:

- Minor corrections

# Technical data

## PRIMERGY TX1310 M5



## PRIMERGY TX1320 M5



## PRIMERGY TX1330 M5

Decimal prefixes according to the SI standard are used for measurement units in this white paper (e.g. 1 GB = $10^9$ bytes). In contrast, these prefixes should be interpreted as binary prefixes (e.g. 1 GB = $2^{30}$ bytes) for the capacities of caches and memory modules. Separate reference will be made to any further exceptions where applicable.

| Model | PRIMERGY TX1310 M5 | PRIMERGY TX1320 M5 | PRIMERGY TX1330 M5 |
|---|---|---|---|
| Form factor | Tower server | | Tower / Rack server |
| Chipset | Intel C256 | | |
| Number of sockets | 1 | | |
| Number of processors orderable | 1 | | |
| Processor type | Intel Xeon E-2300 processor family / Intel Pentium Gold G6405 | | |
| Number of memory slots | 4 | | |
| Maximum memory configuration | 128 GB | | |
| Onboard HDD controller | Controller with RAID (0/1, or 5/6) function | | |
| PCI slots | PCI-Express 4.0 (x16 lane):　1 (Full height)　PCI-Express 3.0 (x1 lane):　1 (Full height)　PCI-Express 3.0 (x4 lane):　2 (Full height) | PCI-Express 4.0 (x8 lane):　2 (Low profile)　PCI-Express 3.0 (x4 lane):　1 (Low profile) | PCI-Express 4.0 (x8 lane):　2 (Full height)　PCI-Express 3.0 (x4 lane):　1 (Full geight) |
| Max. number of internal storage | 4 x 3.5 inches | 8 x 2.5 inches or 2 x 3.5 inches | 24 x 2.5 inches or 12 x 3.5 inches |

| Processor model | Number of cores | Number of threads | Cache [MB] | Rated frequency [GHz] | Maximum turbo frequency [GHz] | Maximum memory frequency [MHz] | TDP [W] |
|---|---|---|---|---|---|---|---|
| Xeon E-2388G[*1] | 8 | 16 | 12 | 3.2 | 5.1 | 3200 | 95 |
| Xeon E-2386G[*1] | 6 | 12 | 12 | 3.5 | 5.1 | 3200 | 95 |
| Xeon E-2378G[*1] | 8 | 16 | 16 | 2.8 | 5.1 | 3200 | 80 |
| Xeon E-2378[*1] | 8 | 16 | 16 | 2.6 | 4.8 | 3200 | 65 |
| Xeon E-2374G | 4 | 8 | 8 | 3.7 | 5.0 | 3200 | 80 |
| Xeon E-2356G | 6 | 12 | 12 | 3.2 | 5.0 | 3200 | 80 |
| Xeon E-2336[*1] | 6 | 12 | 12 | 2.9 | 4.8 | 3200 | 65 |
| Xeon E-2334[*1] | 4 | 8 | 8 | 3.4 | 4.8 | 3200 | 65 |
| Xeon E-2324G | 4 | 4 | 8 | 3.1 | 4.6 | 3200 | 65 |
| Xeon E-2314[*1] | 4 | 4 | 8 | 2.8 | 4.5 | 3200 | 65 |
| Pentium Gold G6405 | 2 | 4 | 4 | 4.1 | - | 2666 | 58 |

*1 not supported by TX1310 M5

All processors that can be ordered with PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 support Intel Turbo Boost Technology 2.0. This technology allows you to operate the processor with higher frequencies than the rated frequency. The "maximum turbo frequency" listed in the processor list above is the theoretical maximum frequency when there is only one active core per processor. The maximum frequency that can actually be achieved depends on the number of active cores, current consumption, power consumption, and processor temperature.

As a general rule, Intel does not guarantee that maximum turbo frequencies will be achieved. This is related to manufacturing tolerances, and the performance of each individual processor model varies from each other. The range of difference covers the range including all of the rated frequency and the maximum turbo frequency.

The turbo function can be set in the BIOS option. Generally, Fujitsu always recommends leaving the [Turbo Mode] option set at the standard setting [Enabled], as performance is substantially increased by the higher frequencies. However, the Turbo Mode frequency depends on the operating conditions mentioned above and is not always guaranteed. The turbo frequency fluctuates in applications where AVX instructions are used intensively and the number of instructions per clock is large. If you need stable performance or want to reduce power consumption, it may be beneficial to set the [Turbo Mode] option to [Disabled] to disable the turbo function.

| Memory modules | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Capacity [GB] | Number of ranks | Bit width of the memory chips | Frequency [MHz] | 3DS | Load Reduced | Registered | NVDIMM | ECC |
| 8 GB (1x   8 GB) 1Rx8 DDR4-3200 U ECC | 8 | 1 | 8 | 3200 | | | | | ✔ |
| 16 GB (1x  16 GB) 1Rx8 DDR4-3200 U ECC | 16 | 1 | 8 | 3200 | | | | | ✔ |
| 16 GB (1x  16 GB) 2Rx8 DDR4-3200 U ECC | 16 | 2 | 8 | 3200 | | | | | ✔ |
| 32 GB (1x  32 GB) 2Rx8 DDR4-3200 U ECC | 32 | 2 | 8 | 3200 | | | | | ✔ |

| Power supplies | Maximum number | | |
|---|---|---|---|
| | TX1310 M5 | TX1320 M5 | TX1330 M5 |
| Standard PSU 250W | 1 | 1 | -- |
| Standard PSU 300W | -- | -- | 1 |
| Modular PSU 500 W platinum | -- | 2 | 2 |
| Modular PSU 900 W platinum | -- | -- | 2 |

Includes components that will be supported after the system release. Also, some components may not be available in all countries or sales regions.

Detailed technical information is available in the data sheet of PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5.

# SPECcpu2017

## Benchmark description

SPECcpu2017 is a benchmark which measures the system efficiency with integer and floating-point operations. It consists of an integer test suite (SPECrate 2017 Integer, SPECspeed 2017 Integer) containing 10 applications and a floating-point test suite (SPECrate 2017 Floating Point, SPECspeed 2017 Floating Point) containing 14 applications. Both test suites are extremely computing-intensive and concentrate on the CPU and the memory. Other components, such as Disk I/O and network, are not measured by this benchmark.

SPECcpu2017 is not tied to a special operating system. The benchmark is available as source code and is compiled before the actual measurement. The used compiler version and their optimization settings also affect the measurement result.

SPECcpu2017 contains two different performance measurement methods. The first method (SPECspeed 2017 Integer or SPECspeed 2017 Floating Point) determines the time which is required to process a single task. The second method (SPECrate 2017 Integer or SPECrate 2017 Floating Point) determines the throughput, i.e. the number of tasks that can be handled in parallel. The performance per watt can also be measured by monitoring the system power using a power meter and an external controller system during performance measurements.

Both methods are also divided into two measurement runs, "base" and "peak." They differ in the use of compiler optimization. When publishing the results, the base values are always used and the peak values are optional.

| Benchmark | Number of single benchmarks | Arithmetic | Compiler optimization | Measurement result | |
|---|---|---|---|---|---|
| SPECspeed2017_int_peak | 10 | Integer | Aggressive (peak) | Speed | Performance |
| SPECspeed2017_int_energy_peak | | | | | Power efficiency |
| SPECspeed2017_int_base | 10 | | Conservative (base) | | Performance |
| SPECspeed2017_int_energy_base | | | | | Power efficiency |
| SPECspeed2017_int_peak | 10 | | Aggressive (peak) | Throughput | Performance |
| SPECspeed2017_int_energy_peak | | | | | Power efficiency |
| SPECspeed2017_int_base | 10 | | Conservative (base) | | Performance |
| SPECspeed2017_int_energy_base | | | | | Power efficiency |
| SPECspeed2017_int_peak | 10 | Floating point | Aggressive (peak) | Speed | Performance |
| SPECspeed2017_int_energy_peak | | | | | Power efficiency |
| SPECspeed2017_int_base | 10 | | Conservative (base) | | Performance |
| SPECspeed2017_int_energy_base | | | | | Power efficiency |
| SPECspeed2017_int_peak | 13 | | Aggressive (peak) | Throughput | Performance |
| SPECspeed2017_int_energy_peak | | | | | Power efficiency |
| SPECspeed2017_int_base | 13 | | Conservative (base) | | Performance |
| SPECspeed2017_int_energy_base | | | | | Power efficiency |

The measurement results are the geometric average from normalized ratio values which have been determined for individual benchmarks. The geometric average - in contrast to the arithmetic average - means that there is a weighting in favor of the lower individual results. "Normalized" means that the measurement is how fast is the test system compared to a reference system. For example, value "1" was defined for the SPECspeed2017_int_base, SPECrate2017_int_base, SPECspeed2017_fp_base, and SPECrate2017_fp_base results of the reference system. A SPECspeed2017_int_base value of 2 means that the measuring system has handled this benchmark twice as fast as the reference system. A SPECrate2017_fp_base value of 4 means that the measuring system has handled this benchmark about 4/[# base copies] times faster than the reference system. "# base copies" specifies how many parallel instances of the benchmark have been executed.

Not every SPECcpu2017 measurement is submitted by Fujitsu for publication at SPEC. This is why the SPEC web pages do not have every result. As Fujitsu archives the log files for all measurements, it is possible to prove the correct implementation of the measurements at any time.

# Benchmark environment

| System Under Test (SUT) | |
|---|---|
| **Hardware** | |
| Model | PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 |
| Processor | Intel Xeon E-2300 processor family / Intel Pentium Gold G6405 |
| Memory | 2 x 16 GB 2Rx8 PC4-3200AA-E |
| **Software** | |
| BIOS settings | FAN Control = Full [*1]<br><br>SPECspeed2017_int:<br>   Energy Efficient Turbo = Disabled<br>   SA GV High Gear = Gear1<br>SPECSpeed2017_fp:<br>   Hyper Threading = Disabled<br>   Package C-State un-demotion = Enabled<br>   REFRESH_2X_MODE = 2- Enabled HOT only<br>SPECrate2017_int:<br>   Adjacent Cache Line Prefetch = Disabled<br>   Package C-State limit = C6<br>   Per Core P State OS control mode = Disabled<br>SPECrate2017_fp:<br>   Hyper Threading = Disabled<br>   C-States Auto Demotion = Disabled<br>   C-States Un Demotion = Disabled<br>   DDR Speed Control = Auto<br>   DMI Gen3 ASPM = ASPM L0s<br><br>*1 except energy metrix |
| Operating system | SUSE Linux Enterprise Server 15 SP3 5.3.18-57-default |
| Operating system settings | Stack size set to unlimited using "ulimit -s unlimited"<br><br>SPECspeed2017_int, SPECrate2017_int:<br>   cpupower -c all frequency-set -g performance<br>SPECrate2017_fp:<br>   echo madvise > /sys/kernel/mm/transparent_hugepage/enabled |
| Compiler | Fortran: Version 2021.1 of Intel Fortran Compiler for Linux<br><br>SPECspeed2017_fp:<br>   C/C++: Version 2021.1 of Intel C/C++ Compiler for Linux<br>SPECspeed2017_int, SPECrate:<br>   C/C++: Version 2021.1 of Intel oneAPI DPC++/C++ Compiler for Linux |

Some components may not be available in all countries or sales regions.

## Benchmark results

In terms of processors, the benchmark result depends primarily on the size of the processor cache, the support for Hyper-Threading, the number of processor cores, and the processor frequency. In the case of processors with Turbo mode, the number of cores, which are loaded by the benchmark, determines the maximum processor frequency that can be achieved. In the case of single-threaded benchmarks, which largely load one core only, the maximum processor frequency that can be achieved is higher than with multi-threaded benchmarks.

The results with "est." are the estimated values.

| Processor | Number of cores | SPECrate2017_int_base | | | SPECrate2017_fp_base | | |
|---|---|---|---|---|---|---|---|
| | | TX1310 M5 | TX1320 M5 | TX1330 M5 | TX1310 M5 | TX1320 M5 | TX1330 M5 |
| Xeon E-2388G | 8 | | **69.2** | **69.3** | | **60.0** | **60.0** |
| Xeon E-2386G | 6 | | 57.9 est. | 58.0 est. | | 53.7 est. | 53.7 est. |
| Xeon E-2378G | 8 | | 65.3 est. | 65.4 est. | | 57.7 est. | 57.7 est. |
| Xeon E-2378 | 8 | | 57.1 est. | 57.2 est. | | 53.4 est. | 53.4 est. |
| Xeon E-2374G | 4 | 42.9 est. | 42.3 est. | 42.4 est. | 44.2 est. | 43.8 est. | 43.8 est. |
| Xeon E-2356G | 6 | **56.5** | 55.7 est. | 55.8 est. | **52.8** | 52.4 est. | 52.4 est. |
| Xeon E-2336 | 6 | | 52.5 est. | 52.6 est. | | 50.6 est. | 50.6 est. |
| Xeon E-2334 | 4 | | 39.3 est. | 39.4 est. | | 41.8 est. | 41.8 est. |
| Xeon E-2324G | 4 | 34.8 est. | 34.3 est. | 34.3 est. | 42.5 est. | 42.2 est. | 42.2 est. |
| Xeon E-2314 | 4 | | 29.0 est. | 29.1 est. | | 38.5 est. | 38.5 est. |
| Pentium Gold G6405 | 2 | 8.95 est. | 16.2 est. | 16.3 est. | 17.2 est. | 17.1 est. | 17.1 est. |

| Processor | Number of cores | SPECspeed2017_int_base | | | SPECspeed2017_fp_base | | |
|---|---|---|---|---|---|---|---|
| | | TX1310 M5 | TX1320 M5 | TX1330 M5 | TX1310 M5 | TX1320 M5 | TX1330 M5 |
| Xeon E-2388G | 8 | | **15.8** | **15.8** | | **45.4** | **45.2** |
| Xeon E-2386G | 6 | | 15.2 est. | 15.2 est. | | 41.7 est. | 41.5 est. |
| Xeon E-2378G | 8 | | 15.6 est. | 15.6 est. | | 43.8 est. | 43.6 est. |
| Xeon E-2378 | 8 | | 14.8 est. | 14.8 est. | | 41.2 est. | 41.0 est. |
| Xeon E-2374G | 4 | 14.8 est. | 14.6 est. | 14.6 est. | 35.1 est. | 34.9 est. | 34.7 est. |
| Xeon E-2356G | 6 | **15.0** | 14.9 est. | 14.9 est. | **41.0** | 40.8 est. | 40.6 est. |
| Xeon E-2336 | 6 | | 14.4 est. | 14.4 est. | | 39.5 est. | 39.3 est. |
| Xeon E-2334 | 4 | | 14.0 est. | 14.0 est. | | 33.7 est. | 33.5 est. |
| Xeon E-2324G | 4 | 13.2 est. | 13.1 est. | 13.1 est. | 34.2 est. | 34.0 est. | 33.8 est. |
| Xeon E-2314 | 4 | | 12.7 est. | 12.7 est. | | 30.9 est. | 30.7 est. |
| Pentium Gold G6405 | 2 | 8.95 est. | 8.86 est. | 8.87 est. | 14.6 est. | 14.5 est. | 14.5 est. |

| Processor | Number of cores | TX1330 M5 | | | |
|---|---|---|---|---|---|
| | | SPECrate2017 int_energy_base | SPECrate2017 fp_energy_base | SPECspeed2017 int_energy_base | SPECspeed2017 fp_energy_base |
| Xeon E-2388G | 8 | **600** | **541** | **277** | **392** |

The following graph compares the throughput of PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 and its older model, PRIMERGY TX1310 M4/ TX1320 M4/ TX1330 M4, with maximum performance configurations.

**SPECrate2017: Comparison of PRIMERGY TX1320 M5 and PRIMERG TX1320 M5**
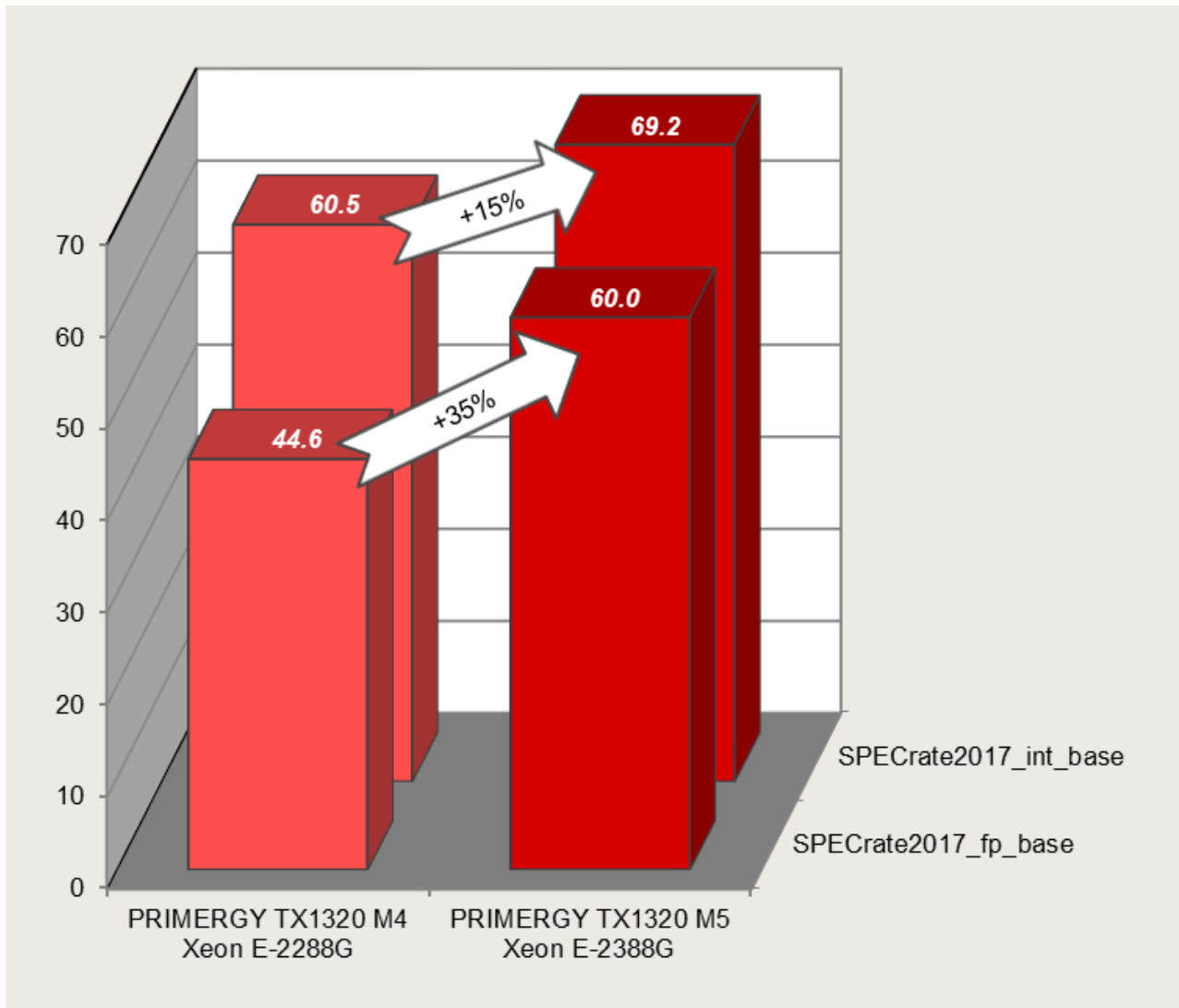
## SPECrate2017: Comparison of PRIMERGY TX1330 M5 and PRIMERG TX1330 M5
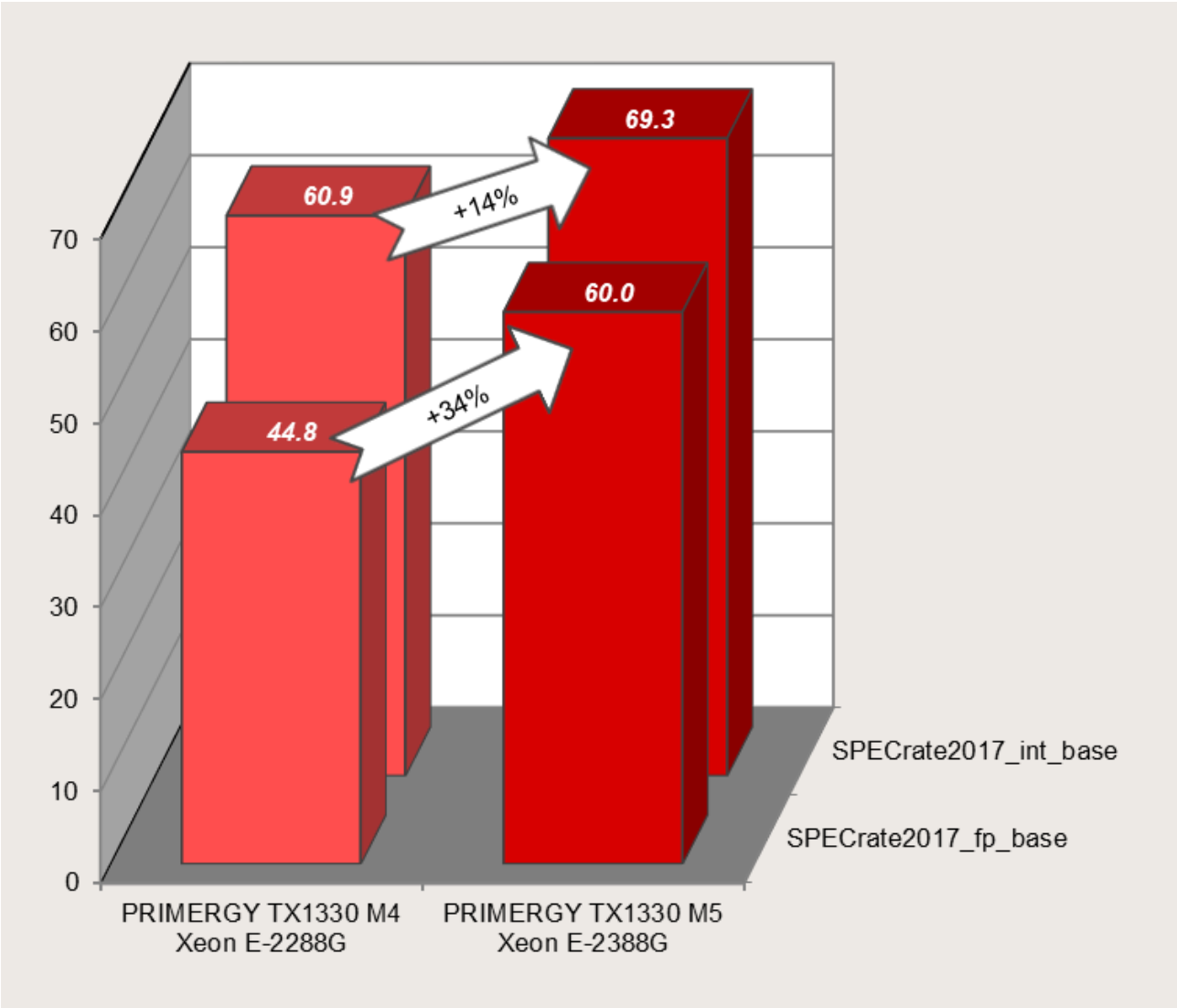
## Measurement results of SPECcpu 2017 (January 5, 2022)

On January 5th, 2022, PRIMERGY TX1320 M5 and TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECspeed2017_int_base benchmark.

On January 5th, 2022, PRIMERGY TX1320 M5 and TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECrate2017_fp_base benchmark.

On January 5th, 2022, PRIMERGY TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECspeed2017_int_energy_base benchmark.

On January 5th, 2022, PRIMERGY TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECspeed2017_fp_energy_base benchmark.

On January 5th, 2022, PRIMERGY TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECrate2017_int_energy_base benchmark.

On January 5th, 2022, PRIMERGY TX1330 M5 with an Intel Xeon E-2388G processor won first place in the 1-socket Intel Xeon category of the SPECrate2017_fp_energy_base benchmark.

# SPECpower_ssj2008

## Benchmark description

SPECpower_ssj2008 is the first industry-standard SPEC benchmark that evaluates the power and performance characteristics of a server. With SPECpower_ssj2008 SPEC has defined standards for server power measurements in the same way they have done for performance.

The benchmark workload represents typical server-side Java business applications. The workload is scalable, multi-threaded, portable across a wide range of platforms, and easy to run. The benchmark tests CPUs, caches, the memory hierarchy, and scalability of symmetric multiprocessor systems (SMPs), as well as the implementation of Java Virtual Machine (JVM), Just In Time (JIT) compilers, garbage collection, threads, and some aspects of the operating system.

SPECpower_ssj2008 reports power consumption for servers at different performance levels — from 100% to "active idle" in 10% segments — over a set period of time. The graduated workload recognizes the fact that processing loads and power consumption on servers vary substantially over the course of days or weeks. To compute a power-performance metric across all levels, measured transaction throughputs for each segment are added together and then divided by the sum of the average power consumed for each segment. The result is a figure of merit called "overall ssj_ops/watt". This ratio provides information about the energy efficiency of the measured server. The defined measurement standard enables customers to compare it with other configurations and servers measured with SPECpower_ssj2008. The diagram shows a typical graph of a SPECpower_ssj2008 result.
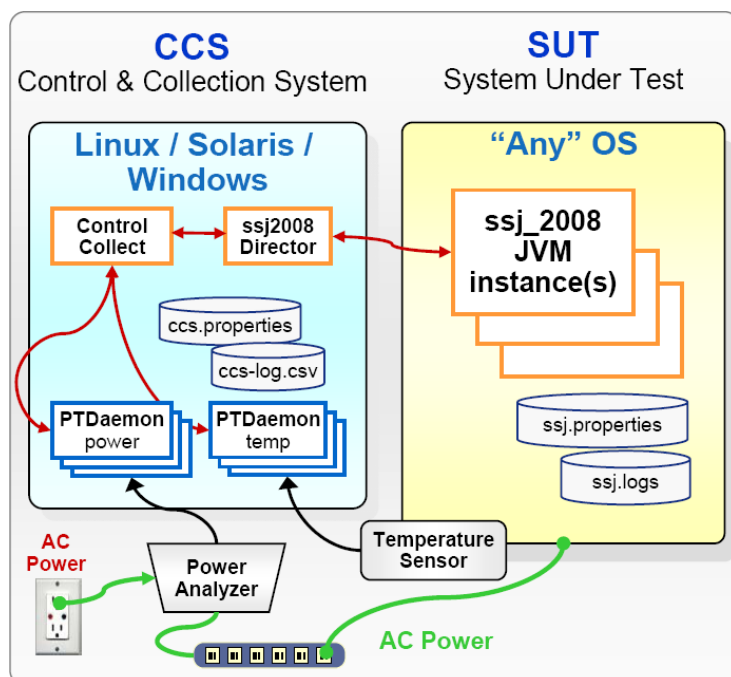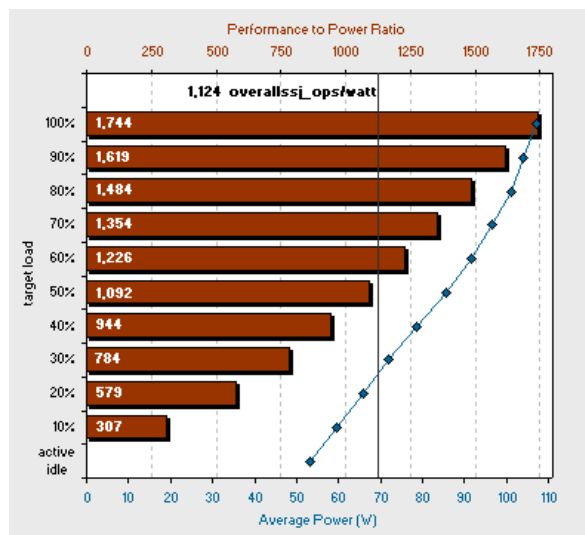
The benchmark runs on a wide variety of operating systems and hardware architectures, and does not require extensive client or storage infrastructure. The minimum equipment for SPEC-compliant testing is two networked computers, plus a power analyzer and a temperature sensor. One computer is the System Under Test (SUT) which runs one of the supported operating systems and the JVM. The JVM provides the environment required to run the SPECpower_ssj2008 workload which is implemented in Java. The other computer is a "Control & Collection System" (CCS) which controls the operation of the benchmark and captures the power, performance, and temperature readings for reporting. The diagram provides an overview of the basic structure of the benchmark configuration and the various components.

## Benchmark environment

| System Under Test (SUT) | |
| --- | --- |
| **For Linux OS measurement** | |
| **Hardware** | |
| Model | PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 |
| Processor | 1 x Intel Xeon E-2356G (TX1310 M5), 1 x Intel Xeon E-2388G (TX1320 M5 / TX1330 M5) |
| Memory | 2 x 8 GB 1Rx8 PC4-3200AA-ED2-11 |
| Network interface | 2 x Intel I210 Gigabit Network Connection (onboard) |
| Disk subsystem | 1 x SSD M.2 240GB, S26361-F5787-E240 |
| Power Supply Unit | 1 x 250 W, S26113-E591-V70-2 (TX1310 M5)<br>1 x 250 W, S26113-E564-V71-1 (TX1320 M5)<br>1 x 300 W, S26113-E581-V50-1 (TX1330 M5) |
| **Software** | |
| BIOS | R1.30.0 |
| BIOS settings | ASPM Support = Auto<br>Hardware Prefetcher = Disabled<br>Adjacent Cache Line Prefetch = Disabled<br>Intel Virtualization Technology = Disabled<br>Software Guard Extensions (SGX) = Software Controlled<br>DDR Speed Control = Auto<br>DMI Gen3 ASPM = Auto<br>DMI Link ASPM Control = Auto<br>SATA Controller Port0/1/2/3/4/6 = Disabled<br>Serial Port = Disabled<br>LAN2 Controller = Disabled |
| iRMC Firmware | 1.01S |
| Operating system | SUSE Linux Enterprise Server 15 SP3, 5.3.18-57-default |
| Operating system settings | kernel parameter: pcie_aspm=force pcie_aspm.policy=powersave intel_pstate=passive<br>Benchmark started via ssh.<br>modprobe cpufreq_conservative<br>cpupower frequency-set -g conservative<br>echo 3000000 > /sys/devices/system/cpu/cpufreq/conservative/sampling_rate<br>echo 92 > /sys/devices/system/cpu/cpufreq/conservative/up_threshold<br>echo 1 > /sys/devices/system/cpu/cpufreq/conservative/freq_step<br>echo 91 > /sys/devices/system/cpu/cpufreq/conservative/down_threshold<br>echo always > /sys/kernel/mm/transparent_hugepage/enabled<br>cpupower frequency-set -u 3200MHz (TX1310 M5)<br>cpupower frequency-set -u 2800MHz (TX1320 M5)<br>cpupower frequency-set -u 3300MHz (TX1330 M5)<br>sysctl -w kernel.nmi_watchdog=0<br>echo 0000:00:14:0 > /sys/bus/pci/drivers/xhci_hcd/unbind (TX1310 M5) |
| JVM | Oracle Java HotSpot 64-Bit Server VM 18.9 (build 11.0.9+7-LTS, mixed mode) |
| JVM settings | -server<br>-Xmn10500m -Xms12000m -Xmx12000m (TX1310 M5)<br>-Xmn11500m -Xms13000m -Xmx13000m (TX1320 M5 / TX1330 M5)<br>-XX:+UseHugeTLBFS -XX:+UseLargePages -XX:+UseTransparentHugePages -<br>XX:AllocatePrefetchDistance=256<br>-XX:AllocatePrefetchInstr=0 -XX:AllocatePrefetchLines=4 -XX:InlineSmallCode=3900<br>-XX:MaxInlineSize=270 -XX:ParallelGCThreads=8 -XX:SurvivorRatio=1<br>-XX:TargetSurvivorRatio=99 -XX:+UseParallelOldGC -XX:FreqInlineSize=2500<br>-XX:MinJumpTableSize=18 -XX:UseAVX=0 -XX:+UseBiasedLocking<br>-XX:-ThreadLocalHandshakes |

| **For Windows OS measurement** | |
|---|---|
| **Hardware** | |
| Model | PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 |
| Processor | 1 x Intel Xeon E-2356G (TX1310 M5), 1 x Intel Xeon E-2388G (TX1320 M5 / TX1330 M5) |
| Memory | 2 x 8 GB 1Rx8 PC4-3200AA-ED2-11 |
| Network interface | 2 x Intel I210 Gigabit Network Connection (onboard) |
| Disk subsystem | 1 x SSD M.2 240GB, S26361-F5787-E240 |
| Power Supply Unit | 1 x 250 W, S26113-E591-V70-2 (TX1310 M5)<br>1 x 250 W, S26113-E564-V71-1 (TX1320 M5)<br>1 x 300 W, S26113-E581-V50-1 (TX1330 M5) |
| **Software** | |
| BIOS | R1.30.0 |
| BIOS settings | ASPM Support = Auto<br>Hardware Prefetcher = Disabled<br>Adjacent Cache Line Prefetch = Disabled<br>Intel Virtualization Technology = Disabled<br>Software Guard Extensions (SGX) = Software Controlled<br>DMI Max Link Speed = Gen1<br>Turbo Mode = Disabled<br>DDR Speed Control = Auto<br>DMI Gen3 ASPM = Auto<br>DMI Link ASPM Control = Auto<br>SATA Controller Port0/1/2/3/4/6 = Disabled<br>Serial Port = Disabled<br>LAN2 Controller = Disabled |
| iRMC Firmware | 1.01S |
| Operating system | Microsoft Windows Server 2019 Standard |
| Operating system settings | Turn off hard disk after = 1 Minute<br>Turn off display after = 1 Minute<br>Minimum processor state = 0%<br>Maximum processor state = 100%<br>Using the local security settings console,<br>"lock pages in memory" was enabled for the user running the benchmark.<br>Benchmark was started via Windows Remote Desktop Connection. |
| JVM | Oracle Java HotSpot 64-Bit Server VM 18.9 (build 11.0.9+7-LTS, mixed mode) |
| JVM settings | -server<br>-Xmn10500m -Xms12000m -Xmx12000m (TX1310 M5)<br>-Xmn11500m -Xms13000m -Xmx13000m (TX1320 M5 / TX1330 M5)<br>-XX:SurvivorRatio=1 -XX:TargetSurvivorRatio=99 -XX:ParallelGCThreads=2<br>-XX:AllocatePrefetchDistance=256 -XX:AllocatePrefetchLines=4 -XX:LoopUnrollLimit=45<br>-XX:InitialTenuringThreshold=12 -XX:MaxTenuringThreshold=15 -XX:InlineSmallCode=3900<br>-XX:MaxInlineSize=270 -XX:FreqInlineSize=2500 -XX:+UseLargePages<br>-XX:+UseParallelOldGC -XX:UseAVX=0 -XX:-UseAdaptiveSizePolicy<br>-XX:-ThreadLocalHandshakes |

Some components may not be available in all countries or sales regions.

## Benchmark results (Linux)

The PRIMERGY TX1310 M5 in SUSE Linux Enterprise Server 15 SP3 achieved the following result:

**SPECpower_ssj2008 = 9,993 overall ssj_ops/watt**
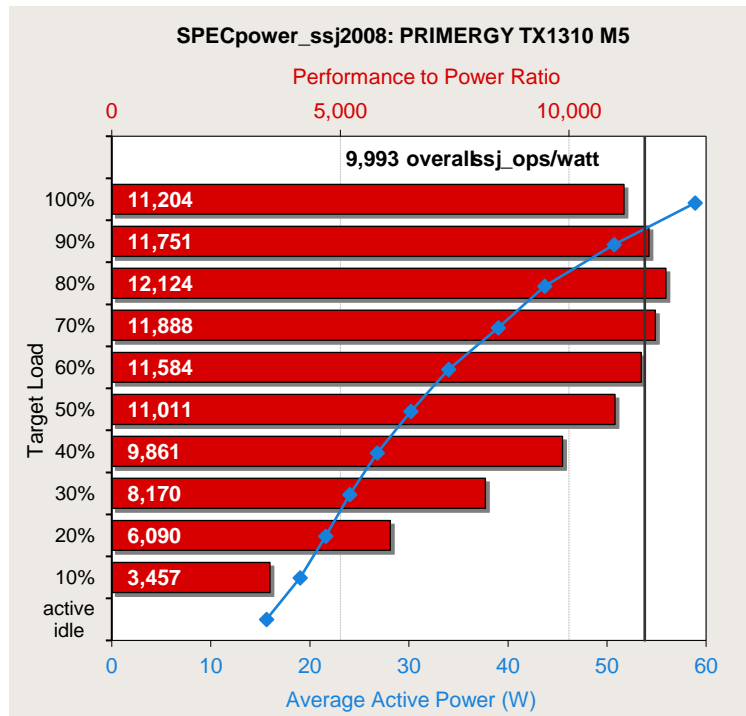


**SPECpower_ssj2008: PRIMERGY TX1310 M5**

The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 9,993 overall ssj_ops/watt for the PRIMERGY TX1310 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 659,394 | 58.9 | 11,204 |
| 90% | 595,196 | 50.7 | 11,751 |
| 80% | 529,513 | 43.7 | 12,124 |
| 70% | 463,722 | 39.0 | 11,888 |
| 60% | 393,761 | 34.0 | 11,584 |
| 50% | 332,000 | 30.2 | 11,011 |
| 40% | 264,032 | 26.8 | 9,861 |
| 30% | 196,303 | 24.0 | 8,170 |
| 20% | 131,513 | 21.6 | 6,090 |
| 10% | 65,719 | 19.0 | 3,457 |
| Active Idle | 0 | 15.6 | 0 |
| | | ∑ssj_ops / ∑power = 9,993 | |

The PRIMERGY TX1320 M5 in SUSE Linux Enterprise Server 15 SP3 achieved the following result:

**SPECpower_ssj2008 = 10,550 overall ssj_ops/watt**

**SPECpower_ssj2008: PRIMERGY TX1320 M5**

**Performance to Power Ratio**

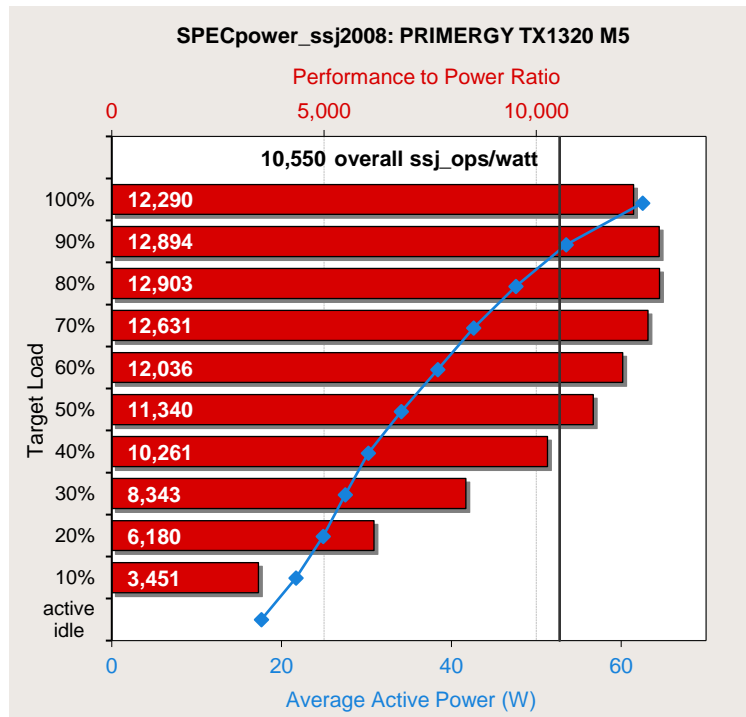| Target Load | ssj_ops/watt |
|---|---|
| 100% | 12,290 |
| 90% | 12,894 |
| 80% | 12,903 |
| 70% | 12,631 |
| 60% | 12,036 |
| 50% | 11,340 |
| 40% | 10,261 |
| 30% | 8,343 |
| 20% | 6,180 |
| 10% | 3,451 |

**10,550 overall ssj_ops/watt**

Average Active Power (W)

The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 10,550 overall ssj_ops/watt for the PRIMERGY TX1320 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 767,959 | 62.5 | 12,290 |
| 90% | 689,775 | 53.5 | 12,894 |
| 80% | 613,561 | 47.6 | 12,903 |
| 70% | 537,611 | 42.6 | 12,631 |
| 60% | 462,676 | 38.4 | 12,036 |
| 50% | 386,312 | 34.1 | 11,340 |
| 40% | 309,872 | 30.2 | 10,261 |
| 30% | 229,528 | 27.5 | 8,343 |
| 20% | 153,923 | 24.9 | 6,180 |
| 10% | 75,010 | 21.7 | 3,451 |
| Active Idle | 0 | 17.6 | 0 |
| | | **∑ssj_ops / ∑power = 10,550** | |

The PRIMERGY TX1330 M5 in SUSE Linux Enterprise Server 15 SP3 achieved the following result:
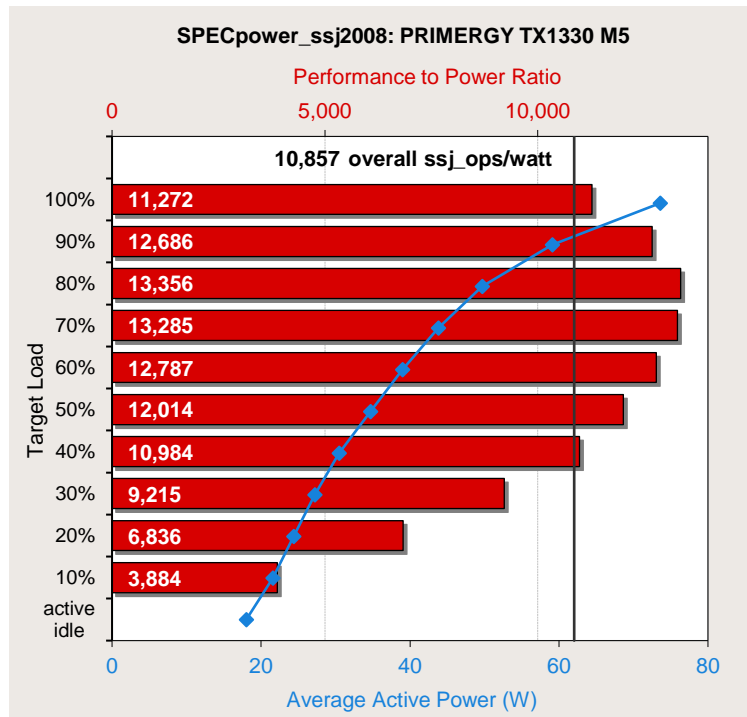
**SPECpower_ssj2008 = 10,857 overall ssj_ops/watt**



The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 10,857 overall ssj_ops/watt for the PRIMERGY TX1330 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 829,272 | 73.6 | 11,272 |
| 90% | 749,606 | 59.1 | 12,686 |
| 80% | 663,603 | 49.7 | 13,356 |
| 70% | 582,017 | 43.8 | 13,285 |
| 60% | 498,986 | 39.0 | 12,787 |
| 50% | 416,552 | 34.7 | 12,014 |
| 40% | 334,849 | 30.5 | 10,984 |
| 30% | 251,087 | 27.2 | 9,215 |
| 20% | 167,056 | 24.4 | 6,836 |
| 10% | 83,722 | 21.6 | 3,884 |
| Active Idle | 0 | 18.0 | 0 |
| | | | ∑ssj_ops / ∑power = 10,857 |

# Benchmark results (Windows)

The PRIMERGY TX1310 M5 in Microsoft Windows Server 2019 Standard achieved the following result:

**SPECpower_ssj2008 = 8,241 overall ssj_ops/watt**
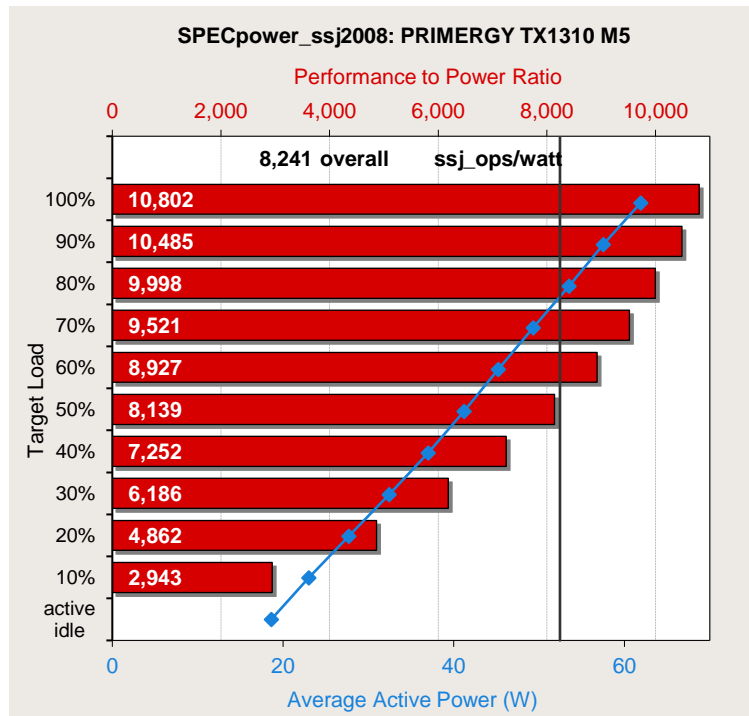


The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 8,241 overall ssj_ops/watt for the PRIMERGY TX1310 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 668,541 | 61.9 | 10,802 |
| 90% | 602,490 | 57.5 | 10,485 |
| 80% | 535,035 | 53.5 | 9,998 |
| 70% | 469,444 | 49.3 | 9,521 |
| 60% | 403,864 | 45.2 | 8,927 |
| 50% | 335,373 | 41.2 | 8,139 |
| 40% | 268,132 | 37.0 | 7,252 |
| 30% | 200,214 | 32.4 | 6,186 |
| 20% | 134,634 | 27.7 | 4,862 |
| 10% | 67,717 | 23.0 | 2,943 |
| Active Idle | 0 | 18.6 | 0 |
| | | ∑ssj_ops / ∑power = 8,241 | |

The PRIMERGY TX1320 M5 in Microsoft Windows Server 2019 Standard achieved the following result:

**SPECpower_ssj2008 = 8,212 overall ssj_ops/watt**

### SPECpower_ssj2008: PRIMERGY TX1320 M5

Performance to Power Ratio

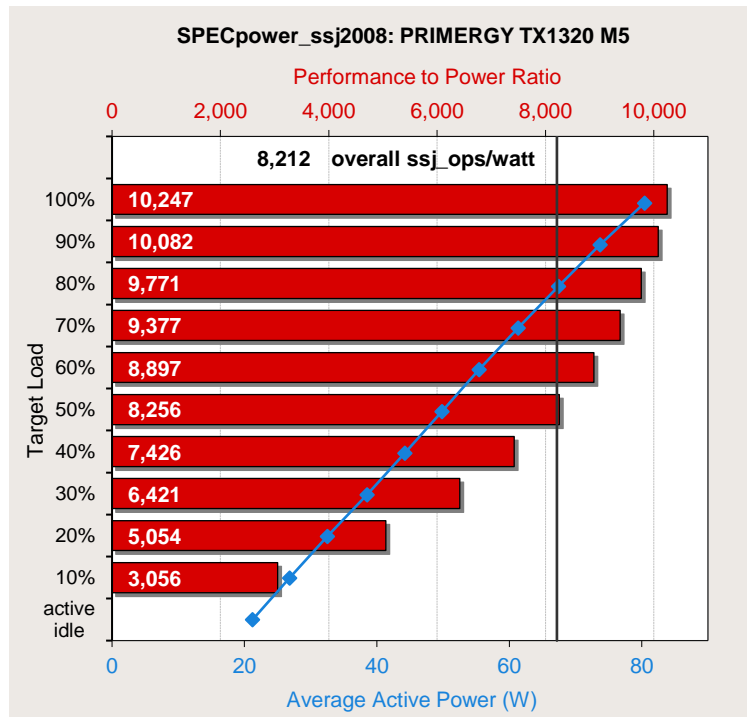| Target Load | Performance to Power Ratio |
|---|---|
| 100% | 10,247 |
| 90% | 10,082 |
| 80% | 9,771 |
| 70% | 9,377 |
| 60% | 8,897 |
| 50% | 8,256 |
| 40% | 7,426 |
| 30% | 6,421 |
| 20% | 5,054 |
| 10% | 3,056 |

8,212 overall ssj_ops/watt

Average Active Power (W)

The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 8,212 overall ssj_ops/watt for the PRIMERGY TX1320 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 823,469 | 80.4 | 10,247 |
| 90% | 742,859 | 73.7 | 10,082 |
| 80% | 658,398 | 67.4 | 9,771 |
| 70% | 574,969 | 61.3 | 9,377 |
| 60% | 493,150 | 55.4 | 8,897 |
| 50% | 411,162 | 49.8 | 8,256 |
| 40% | 328,474 | 44.2 | 7,426 |
| 30% | 247,149 | 38.5 | 6,421 |
| 20% | 164,036 | 32.5 | 5,054 |
| 10% | 81,790 | 26.8 | 3,056 |
| Active Idle | 0 | 21.2 | 0 |
| | | | ∑ssj_ops / ∑power = 8,212 |

The PRIMERGY TX1330 M5 in Microsoft Windows Server 2019 Standard achieved the following result:

**SPECpower_ssj2008 = 8,643 overall ssj_ops/watt**

**SPECpower_ssj2008: PRIMERGY TX1330 M5**

Performance to Power Ratio

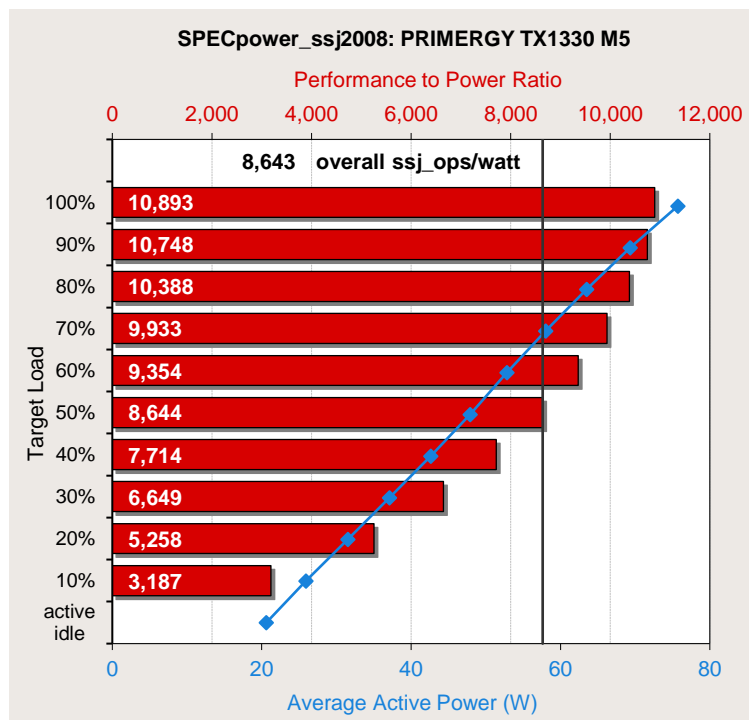| Target Load | Performance to Power Ratio (ssj_ops/watt) |
|---|---|
| 100% | 10,893 |
| 90% | 10,748 |
| 80% | 10,388 |
| 70% | 9,933 |
| 60% | 9,354 |
| 50% | 8,644 |
| 40% | 7,714 |
| 30% | 6,649 |
| 20% | 5,258 |
| 10% | 3,187 |

8,643 overall ssj_ops/watt

Average Active Power (W)

The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 8,643 overall ssj_ops/watt for the PRIMERGY TX1330 M5. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

| Performance | | Power | Energy Efficiency |
|---|---|---|---|
| Target Load | ssj_ops | Average Power (W) | ssj_ops/watt |
| 100% | 825,045 | 75.7 | 10,893 |
| 90% | 744,903 | 69.3 | 10,748 |
| 80% | 659,296 | 63.5 | 10,388 |
| 70% | 575,653 | 58.0 | 9,933 |
| 60% | 494,256 | 52.8 | 9,354 |
| 50% | 413,930 | 47.9 | 8,644 |
| 40% | 328,687 | 42.6 | 7,714 |
| 30% | 246,775 | 37.1 | 6,649 |
| 20% | 165,407 | 31.5 | 5,258 |
| 10% | 82,635 | 25.9 | 3,187 |
| Active Idle | 0 | 20.6 | 0 |
| | | **∑ssj_ops / ∑power = 8,643** | |

# Comparison with the predecessor

The following diagram shows for each load level (on the x-axis) the throughput (on the left y-axis) and the power consumption (on the right y-axis) of the PRIMERGY TX1320 M5 compared to the predecessor PRIMERGY TX1320 M4 with the JVM versions that affect the SPECpower_ssj2008 benchmark.

**SPECpower_ssj2008: PRIMERGY TX1320 M5 vs. PRIMERGY TX1320 M4**

| Load Level | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% | active idle |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Xeon E-2388G ssj_ops | 767,959 | 689,775 | 613,561 | 537,611 | 462,676 | 386,312 | 309,872 | 229,528 | 153,923 | 75,010 | 0 |
| Xeon E-2288G ssj_ops | 668,111 | 593,644 | 529,173 | 465,888 | 398,426 | 327,994 | 265,921 | 200,387 | 131,476 | 66,427 | 0 |
| Xeon E-2388G watt | 62.5 | 53.5 | 47.6 | 42.6 | 38.4 | 34.1 | 30.2 | 27.5 | 24.9 | 21.7 | 17.6 |
| Xeon E-2288G watt | 53.9 | 47.0 | 41.6 | 37.1 | 33.0 | 29.0 | 25.6 | 23.0 | 20.8 | 18.6 | 16.3 |
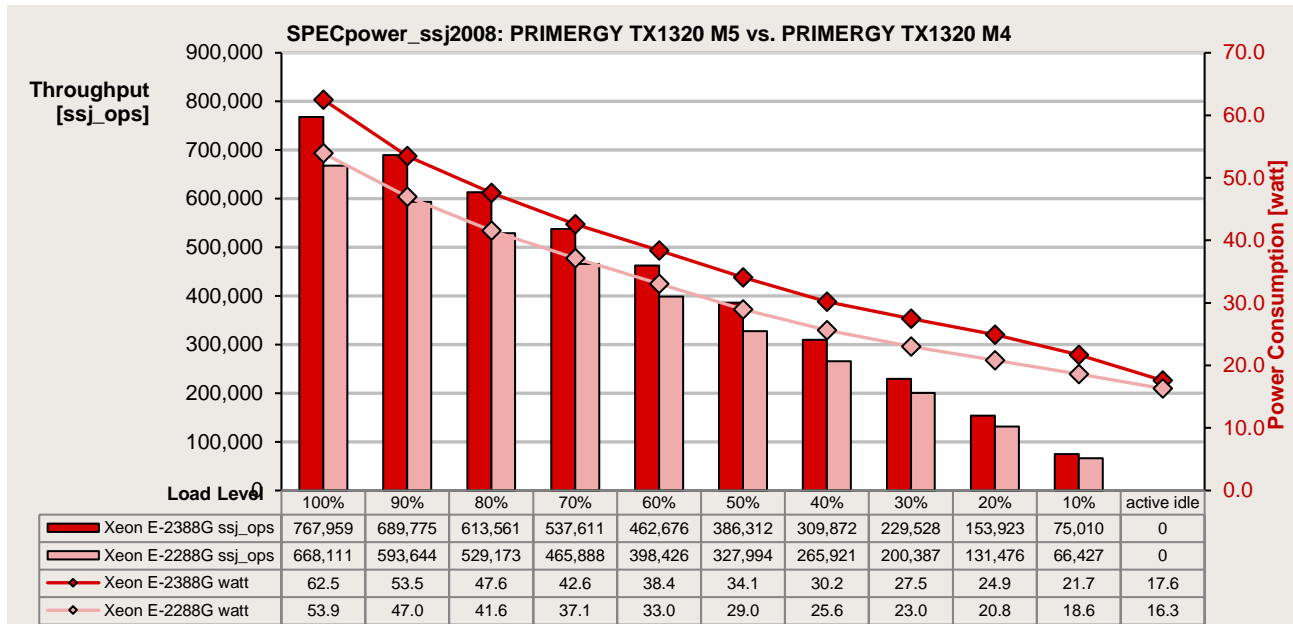
The total average throughput of the PRIMERGY TX1320 M5 is 4,226,227 ssj_ops, an improvement of 15.9% over the 3,647,448 ssj_ops of the PRIMERGY TX1320 M4.

On the other hand, the total average power consumption of the PRIMERGY TX1320 M5 is 401 W, which is 15.9% higher than the 346 W of the PRIMERGY TX1320 M4. The reason for the increased power consumption is the increased power consumption when idle. It was 16.3W on the PRIMERGY TX1320 M4, but it increased 1.08 times to 17.6W on the PRIMERGY TX1320 M5.

The overall energy efficiency of the PRIMERGY TX1320 M5 has improved by 0.104% due to a 15.9% increase in power consumption but a 15.9% improvement in performance.

**SPECpower_ssj2008 overall ssj_ops/watt: PRIMERGY TX1320 M5 vs. PRIMERGY TX1320 M4**

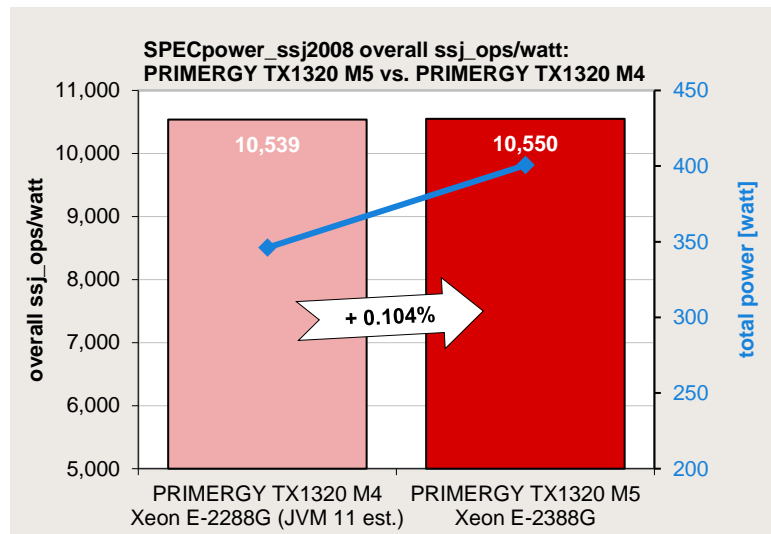| | PRIMERGY TX1320 M4 Xeon E-2288G (JVM 11 est.) | PRIMERGY TX1320 M5 Xeon E-2388G |
|---|---|---|
| overall ssj_ops/watt | 10,539 | 10,550 |

+ 0.104%

The following diagram shows for each load level (on the x-axis) the throughput (on the left y-axis) and the power consumption (on the right y-axis) of the PRIMERGY TX1330 M5 compared to the predecessor PRIMERGY TX1330 M4 with the JVM versions that affect the SPECpower_ssj2008 benchmark.
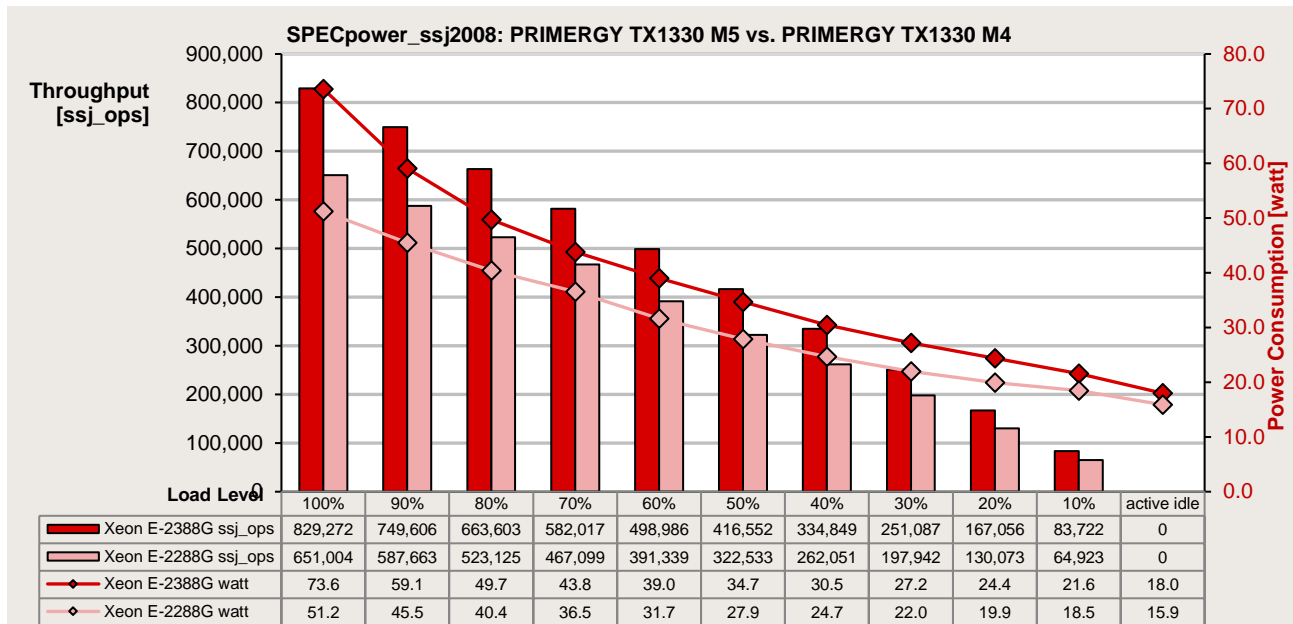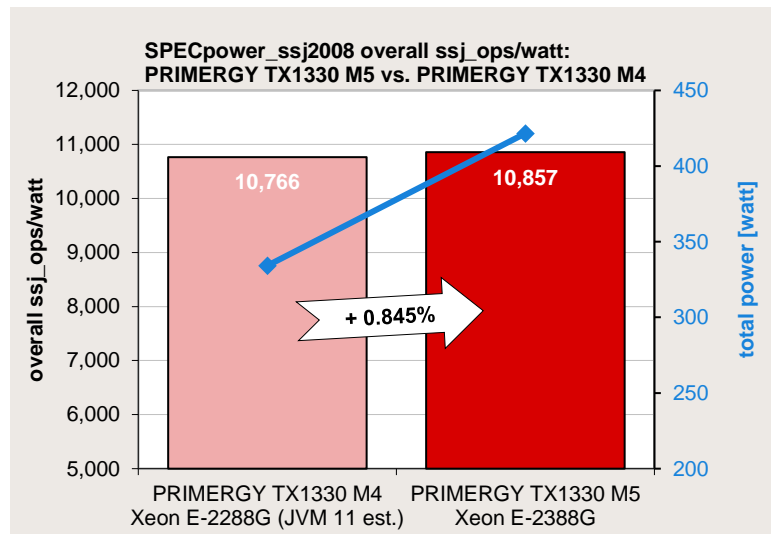
**SPECpower_ssj2008: PRIMERGY TX1330 M5 vs. PRIMERGY TX1330 M4**

| Load Level | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% | active idle |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Xeon E-2388G ssj_ops | 829,272 | 749,606 | 663,603 | 582,017 | 498,986 | 416,552 | 334,849 | 251,087 | 167,056 | 83,722 | 0 |
| Xeon E-2288G ssj_ops | 651,004 | 587,663 | 523,125 | 467,099 | 391,339 | 322,533 | 262,051 | 197,942 | 130,073 | 64,923 | 0 |
| Xeon E-2388G watt | 73.6 | 59.1 | 49.7 | 43.8 | 39.0 | 34.7 | 30.5 | 27.2 | 24.4 | 21.6 | 18.0 |
| Xeon E-2288G watt | 51.2 | 45.5 | 40.4 | 36.5 | 31.7 | 27.9 | 24.7 | 22.0 | 19.9 | 18.5 | 15.9 |

The total average throughput of the PRIMERGY TX1330 M5 is 4,576,750 ssj_ops, an improvement of 27.2% over the 3,597,752 ssj_ops of the PRIMERGY TX1330 M4.

On the other hand, the total average power consumption of the PRIMERGY TX1330 M5 is 422 W, which is 26.3% higher than the 334 W of the PRIMERGY TX1330 M4. The reason for the increased power consumption is the increased power consumption when idle. It was 15.9W on the PRIMERGY TX1330 M4, but it increased 1.13 times to 18.0W on the PRIMERGY TX1330 M5.

**SPECpower_ssj2008 overall ssj_ops/watt: PRIMERGY TX1330 M5 vs. PRIMERGY TX1330 M4**

| PRIMERGY TX1330 M4 Xeon E-2288G (JVM 11 est.) | PRIMERGY TX1330 M5 Xeon E-2388G |
|---|---|
| 10,766 | 10,857 |

+ 0.845%

The overall energy efficiency of the PRIMERGY TX1330 M5 has improved by 0.845% due to a 26.3% increase in power consumption but a 27.2% improvement in performance.

## Measurement results of SPECpower_ssj2008 (January 19, 2022)

### 10,857 SPECpower_ssj2008

On January 19, 2022, PRIMERGY TX1330 M5 with an Intel Xeon E-2388G processor achieved a performance value of 10,857 on the SUSE Linux Enterprise Server 15 SP3 in the SPECpower_ssj2008 benchmark, in the Linux division of Intel Xeon E-2300 processor family category and won first place in SPECpower_ssj2008 performance.

For the latest results of the SPECpower_ssj2008, see https://www.spec.org/power_ssj2008/results/.

# Disk I/O: Performance of storage media

## Benchmark description

Performance measurements of disk subsystems for PRIMERGY servers are carried out with a defined measurement method, which models the accesses of real application scenarios on the basis of specifications.

The essential specifications are as follows.

- Random access / sequential access ratio
- Read / write access ratio
- Block size (kB)
- Queue Depth (number of IO requests to issue at one time)

A given value combination of these specifications is known as "load profile." The following five standard load profiles can be allocated to typical application scenarios.

| Standard load profile | Access | Type of access | | Block size [kB] | Application |
|---|---|---|---|---|---|
| | | read | write | | |
| Filecopy | random | 50% | 50% | 64 | Copying files |
| Fileserver | random | 67% | 33% | 64 | Fileserver |
| Database | random | 67% | 33% | 8 | Database (data transfer) Mail server |
| Streaming | sequential | 100% | 0% | 64 | Database (log file), Data backup, Video streaming (partial) |
| Restore | sequential | 0% | 100% | 64 | Restoring files |

In order to model applications that access in parallel with a different load intensity the Queue Depth is increased from 1 to 512 (in steps to the power of two).

The measurements of this document are based on these standard load profiles.

The main measurement items are as follows.

- Throughput [MB/s]    Throughput in megabytes per second
- Transactions [IO/s]    Transaction rate in I/O operations per second
- Latency [ms]    Average response time in ms

The data throughput has established itself as the normal measurement variable for sequential load profiles, whereas the measurement variable "transaction rate" is mostly used for random load profiles with their small block sizes. Data throughput and transaction rate are directly proportional to each other and can be transferred to each other according to the following formula.

| *Data throughput [MB/s]* | *= Transaction rate [IO/s] x Block size [MB]* |
|---|---|
| *Transaction rate [IO/s]* | *= Data throughput [MB/s] / Block size [MB]* |

In this section, a power of 10 (1 TB = $10^{12}$ bytes) is used to indicate the capacity of the hard storage medium, and a power of 2 (1 MB / s = $2^{20}$ bytes) is used to indicate the capacity of other media, file size, block size, and throughput.

All the details of the measurement method and the basics of disk I/O performance are described in the white paper "Basics of Disk I/O Performance."

# Benchmark environment

All the measurement results discussed in this section apply for the hardware and software components listed below.

| System Under Test (SUT) | | |
|---|---|---|
| **Hardware** | | |
| TX1320 M5 / TX1330 M5 **3.5 inch model** | | |
| Controller:          PRAID EP540i | | |
| Storage media | Category | Drive name |
| HDD | SAS HDD(SAS 12Gbps, 15krpm)[512n] | ST300MP0006 |
| | | ST600MP0006 |
| | NL-SAS HDD (SAS 12Gbps, 7.2krpm)[512e] | ST6000NM029A |
| | | ST8000NM001A |
| | NL-SAS HDD (SAS 12Gbps, 7.2krpm)[512n] | ST2000NM003A |
| | | ST4000NM003A |
| | BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512e] | ST6000NM021A |
| | | ST8000NM000A |
| | BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512n] | ST2000NM000A |
| | | ST4000NM000A |
| SSD | SATA SSD(SATA 6Gbps, Mixed Use) | MTFDDAK240TDT |
| | | MTFDDAK480TDT |
| | | MTFDDAK960TDT |
| | | MTFDDAK1T9TDT |
| | | MTFDDAK3T8TDT |
| | SATA SSD(SATA 6Gbps, Read Intensive) | MTFDDAK240TDS |
| | | MTFDDAK480TDS |
| | | MTFDDAK960TDS |
| | | MTFDDAK1T9TDS |
| | | MTFDDAK3T8TDS |
| | | MTFDDAK7T6TDS |

| Controller: | Intel C256 Standard SATA AHCI controller | |
|---|---|---|
| Storage media | Category | Drive name |
| SSD | M.2 Flash module | MTFDDAV240TDS |
| | | MTFDDAV480TDS |

| TX1320 M5 / TX1330 M5 **2.5 inch model** | | |
|---|---|---|

| Controller: | PRAID EP540i | |
|---|---|---|
| Storage media | Category | Drive name |
| HDD | SAS HDD(SAS 12Gbps, 15krpm)[512n] | ST300MP0006 |
| | | ST600MP0006 |
| | SAS HDD(SAS 12Gbps, 10krpm)[512e] | AL15SEB18EQ |
| | | AL15SEB24EQ |
| | SAS HDD(SAS 12Gbps, 10krpm)[512n] | AL15SEB060N |
| | | AL15SEB120N |
| | BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512e] | ST1000NX0313 |
| | BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512n] | ST1000NX0423 |
| SSD | SAS SSD(SAS 12Gbps, Write Intensive) | XS400ME70084 |
| | | XS800ME70084 |
| | | XS1600ME70084 |
| | SAS SSD(SAS 12Gbps, Mixed Use) | XS800LE70084 |
| | | XS1600LE70084 |
| | | XS3200LE70084 |
| | SAS SSD(SAS 12Gbps, Read Intensive) | XS960SE70084 |
| | | XS1920SE70084 |
| | | XS3840SE70084 |
| | | XS7680SE70084 |
| | SATA SSD(SATA 6Gbps, Mixed Use) | MTFDDAK240TDT |
| | | MTFDDAK480TDT |
| | | MTFDDAK960TDT |
| | | MTFDDAK1T9TDT |
| | | MTFDDAK3T8TDT |
| | SATA SSD(SATA 6Gbps, Read Intensive) | MTFDDAK240TDS |
| | | MTFDDAK480TDS |
| | | MTFDDAK960TDS |
| | | MTFDDAK1T9TDS |
| | | MTFDDAK3T8TDS |
| | | MTFDDAK7T6TDS |
| | PCIe SSD(Mixed Use) | SSDPE2KE016T8 |
| | | SSDPE2KE032T8 |
| | | SSDPE2KE064T8 |
| | PCIe SSD(Read intensive) | SSDPE2KX010T8 |
| | | SSDPE2KX020T8 |
| | | SSDPE2KX040T8 |

| Controller: | Intel C256 Standard SATA AHCI controller | |
|---|---|---|
| Storage media | Category | Drive name |
| SSD | M.2 Flash module | MTFDDAV240TDS |
| | | MTFDDAV480TDS |

| TX1310 M5 | | | |
|---|---|---|---|
| Controller: | Intel C256 Standard SATA AHCI controller | | |
| | Storage media | Category | Drive name |
| | HDD | SATA HDD(SATA 6Gbps, 15krpm)[512n] | ST1000DM010 |
| | SSD | SATA SSD(SATA 6Gbps, Read Intensive) | MTFDDAK240TDS |
| | | | MTFDDAK480TDS |
| | | M.2 Flash module | MTFDDAV240TDS |
| | | | MTFDDAV480TDS |

| **Software** | | |
|---|---|---|
| Operating system | | Microsoft Windows Server 2016 Standard |
| Benchmark version | | 3.0 |
| RAID type | | Type RAID 0 logical drive consisting of 1 hard disk |
| Stripe size | | HDD: 256KB, SSD: 64 KB |
| Measuring tool | | Iometer 1.1.0 |
| Measurement area | HDD,SSD (other than M.2, E1.S) | RAW file system is used. The first 32GB of available LBA space is used for sequential access. The following 64GB is used for random access. |
| | SSD (M.2, E1.S) | NTFS file system is used. The first 32GB of available LBA space is used for sequential access. The following 64GB is used for random access. |
| Total number of Iometer worker | | 1 |
| Alignment of Iometer accesses | | Aligned to access block size |

Some components may not be available in all countries or sales regions.

# Benchmark results

The results shown here are intended to help you select the appropriate storage media under the aspect of disk-I/O performance. For this purpose, a single storage medium was measured in the configuration specified in the subsection "Benchmark environment."

## *Controller*

The measurements were made using controllers in the table below.

| Storage media | Controller name | Cache | Supported interfaces | | RAID levels |
|---|---|---|---|---|---|
| | | | host | drive | |
| SSD/HDD PCIe SSD 2.5" | PRAID EP540i | - | PCIe 3.0 x8 | SATA 6G SAS 12G PCIe x16 | 0, 1, 1E, 10, 5, 50 |
| M.2 Flash | C256 Standard SATA AHCI controller | - | DMI 3.0 x4 | SATA 6G | - |

## *Storage media*

When selecting the type and number of storage media you can move the weighting in the direction of storage capacity, performance, security or price. The following types of HDD and SSD storage media can be used for PRIMERGY servers.

| model | Storage media type | Interface | Form factor |
|---|---|---|---|
| 3.5 inch model | HDD | SAS 12G | 3.5 inch or 2.5 inch [1] |
| | | SATA 6G | 3.5 inch |
| | SSD | SATA 6G | 2.5 inch [1] or M.2 |
| 2.5 inch model | HDD | SAS 12G | 2.5 inch |
| | | SATA 6G | 2.5 inch |
| | SSD | SAS 12G | 2.5 inch |
| | | SATA 6G | 2.5 inch or M.2 |
| | | PCIe 3.0 | 2.5 inch |

1) *It is available with a 3.5 inch cage.*

HDDs and SSDs are operated via host bus adapters, usually RAID controllers, with a SATA or SAS interface. The interface of the RAID controller to the chipset of the systemboard is typically PCIe or, in the case of the integrated onboard controllers, an internal bus interface of the systemboard.

Of all the storage medium types SSDs offer by far the highest transaction rates for random load profiles as well as the shortest access times. In return, however, the price per gigabyte of storage capacity is substantially higher.

## *Cache settings*

In most cases, the cache of HDDs has a great influence on disk-I/O performance. It is frequently regarded as a security problem in case of power failure and is thus switched off. On the other hand, it was integrated by hard disk manufacturers for the good reason of increasing the write performance. For performance reasons it is therefore advisable to enable the hard disk cache. To prevent data loss in case of power failure you are recommended to equip the system with a UPS.

For the purpose of easy and reliable handling of the settings for RAID controllers and hard disks it is advisable to use the RAID-Manager software "ServerView RAID" that is supplied for PRIMERGY servers. All the cache settings for controllers and hard disks can usually be made en bloc - specifically for the application - by using the pre-defined mode "Performance" or "Data Protection." The "Performance" mode ensures the best possible performance settings for the majority of the application scenarios.

## *Performance values*

The performance values are summarized in the following tables. In each case specifically for a single storage medium and with various access types and block sizes. The established measurement variables, as already mentioned in the subsection "Benchmark description" are used here. Thus, transaction rate is specified for random accesses and data throughput for sequential accesses. To avoid any confusion among the measurement units the tables have been separated for the two access types.

The table cells contain the maximum achievable values. This means that each value is the maximum achievable value of the whole range of load intensities (number of Outstanding I/Os). In order to also visualize the numerical values each table cell is highlighted with a horizontal bar, the length of which is proportional to the numerical value in the table cell. All bars shown in the same scale of length have the same color. In other words, a visual comparison only makes sense for table cells with the same colored bars. Since the horizontal bars in the table cells depict the maximum achievable performance values, they are shown by the color getting lighter as you move from left to right. The light shade of color at the right end of the bar tells you that the value is a maximum value and can only be achieved under optimal prerequisites. The darker the shade becomes as you move to the left, the more frequently it will be possible to achieve the corresponding value in practice.

## Storage media

### TX1320 M5 / TX1330 M5 3.5 inch model

### HDDs

| Capacity [GB] | Stotage device | interface | Transactions [IO/s] | | | Throughput [MB/s] | |
|---|---|---|---|---|---|---|---|
| | | | Database | Fileserver | Filecopy | Streaming | Restore |
| 300 | ST300MP0006 | SAS 12G | 790 | 696 | 666 | 304 | 304 |
| 600 | ST600MP0006 | SAS 12G | 736 | 651 | 601 | 301 | 300 |
| 6,000 | ST6000NM029A | SAS 12G | 369 | 333 | 323 | 252 | 252 |
| 8,000 | ST8000NM001A | SAS 12G | 354 | 310 | 310 | 255 | 255 |
| 2,000 | ST2000NM003A | SAS 12G | 378 | 343 | 336 | 237 | 237 |
| 4,000 | ST4000NM003A | SAS 12G | 369 | 333 | 330 | 214 | 215 |
| 6,000 | ST6000NM021A | SATA 6G | 326 | 293 | 302 | 253 | 253 |
| 8,000 | ST8000NM000A | SATA 6G | 325 | 290 | 301 | 249 | 248 |
| 2,000 | ST2000NM000A | SATA 6G | 331 | 304 | 313 | 230 | 207 |
| 4,000 | ST4000NM000A | SATA 6G | 313 | 290 | 297 | 211 | 210 |

### SSDs

| Capacity [GB] | Stotage device | interface | Transactions [IO/s] | | | Throughput [MB/s] | |
|---|---|---|---|---|---|---|---|
| | | | Database | Fileserver | Filecopy | Streaming | Restore |
| 240 | MTFDDAK240TDT | SATA 6G | 46,406 | 5,989 | 6,121 | 508 | 370 |
| 480 | MTFDDAK480TDT | SATA 6G | 49,138 | 6,383 | 6,600 | 508 | 437 |
| 960 | MTFDDAK960TDT | SATA 6G | 50,488 | 6,970 | 7,136 | 508 | 486 |
| 1,920 | MTFDDAK1T9TDT | SATA 6G | 50,669 | 7,183 | 7,336 | 508 | 487 |
| 3,840 | MTFDDAK3T8TDT | SATA 6G | 49,490 | 7,115 | 7,208 | 493 | 474 |
| 240 | MTFDDAK240TDS | SATA 6G | 42,594 | 5,435 | 5,510 | 508 | 301 |
| 480 | MTFDDAK480TDS | SATA 6G | 47,577 | 6,109 | 6,310 | 508 | 401 |
| 960 | MTFDDAK960TDS | SATA 6G | 50,134 | 6,633 | 6,852 | 506 | 480 |
| 1,920 | MTFDDAK1T9TDS | SATA 6G | 50,638 | 7,078 | 7,286 | 508 | 488 |
| 3,840 | MTFDDAK3T8TDS | SATA 6G | 49,542 | 7,097 | 7,196 | 495 | 477 |
| 7,680 | MTFDDAK7T6TDS | SATA 6G | 47,200 | 7,134 | 7,563 | 508 | 487 |
| 240 | MTFDDAV240TDS | SATA 6G | 32,138 | 5,494 | 5,506 | 506 | 298 |
| 480 | MTFDDAV480TDS | SATA 6G | 39,970 | 6,373 | 6,541 | 508 | 395 |

## TX1320 M5 / TX1330 M5 2.5 inch model

### HDDs

| Capacity [GB] | Stotage device | interface | Transactions [IO/s] | | | Throughput [MB/s] | |
|---|---|---|---|---|---|---|---|
| | | | Database | Fileserver | Filecopy | Streaming | Restore |
| 300 | ST300MP0006 | SAS 12G | 790 | 696 | 666 | 304 | 304 |
| 600 | ST600MP0006 | SAS 12G | 736 | 651 | 601 | 301 | 300 |
| 1,800 | AL15SEB18EQ | SAS 12G | 767 | 631 | 624 | 255 | 249 |
| 2,400 | AL15SEB24EQ | SAS 12G | 754 | 620 | 617 | 264 | 260 |
| 600 | AL15SEB060N | SAS 12G | 698 | 586 | 600 | 232 | 232 |
| 1,200 | AL15SEB120N | SAS 12G | 732 | 604 | 615 | 230 | 226 |
| 1,000 | ST1000NX0313 | SATA 6G | 393 | 340 | 337 | 134 | 134 |
| 1,000 | ST1000NX0423 | SATA 6G | 399 | 344 | 346 | 134 | 134 |

### SSDs

| Capacity [GB] | Stotage device | interface | Transactions [IO/s] | | | Throughput [MB/s] | |
|---|---|---|---|---|---|---|---|
| | | | Database | Fileserver | Filecopy | Streaming | Restore |
| 400 | XS400ME70084 | SAS 12G | 122,956 | 22,969 | 19,438 | 1,052 | 872 |
| 800 | XS800ME70084 | SAS 12G | 123,848 | 23,784 | 19,435 | 1,052 | 874 |
| 1,600 | XS1600ME70084 | SAS 12G | 123,277 | 23,725 | 19,270 | 1,051 | 884 |
| 800 | XS800LE70084 | SAS 12G | 121,914 | 23,707 | 19,257 | 1,052 | 871 |
| 1,600 | XS1600LE70084 | SAS 12G | 122,949 | 23,771 | 19,455 | 1,052 | 874 |
| 3,200 | XS3200LE70084 | SAS 12G | 123,090 | 22,816 | 19,418 | 1,051 | 872 |
| 960 | XS960SE70084 | SAS 12G | 123,014 | 23,678 | 19,424 | 1,052 | 870 |
| 1,920 | XS1920SE70084 | SAS 12G | 123,093 | 23,760 | 19,423 | 1,052 | 874 |
| 3,840 | XS3840SE70084 | SAS 12G | 122,810 | 22,949 | 19,406 | 1,051 | 871 |
| 7,680 | XS7680SE70084 | SAS 12G | 123,461 | 22,899 | 19,516 | 1,051 | 880 |
| 240 | MTFDDAK240TDT | SATA 6G | 46,406 | 5,989 | 6,121 | 508 | 370 |
| 480 | MTFDDAK480TDT | SATA 6G | 49,138 | 6,383 | 6,600 | 508 | 437 |
| 960 | MTFDDAK960TDT | SATA 6G | 50,488 | 6,970 | 7,136 | 508 | 486 |
| 1,920 | MTFDDAK1T9TDT | SATA 6G | 50,669 | 7,183 | 7,336 | 508 | 487 |
| 3,840 | MTFDDAK3T8TDT | SATA 6G | 49,490 | 7,115 | 7,208 | 493 | 474 |
| 240 | MTFDDAK240TDS | SATA 6G | 42,594 | 5,435 | 5,510 | 508 | 301 |
| 480 | MTFDDAK480TDS | SATA 6G | 47,577 | 6,109 | 6,310 | 508 | 401 |
| 960 | MTFDDAK960TDS | SATA 6G | 50,134 | 6,633 | 6,852 | 506 | 480 |
| 1,920 | MTFDDAK1T9TDS | SATA 6G | 50,638 | 7,078 | 7,286 | 508 | 488 |
| 3,840 | MTFDDAK3T8TDS | SATA 6G | 49,542 | 7,097 | 7,196 | 495 | 477 |
| 7,680 | MTFDDAK7T6TDS | SATA 6G | 47,200 | 7,134 | 7,563 | 508 | 487 |
| 1,600 | SSDPE2KE016T8 | PCIe3 x4 | 276,785 | 45,739 | 40,923 | 3,214 | 1,972 |
| 3,200 | SSDPE2KE032T8 | PCIe3 x4 | 306,446 | 53,059 | 50,093 | 3,220 | 2,461 |
| 6,400 | SSDPE2KE064T8 | PCIe3 x4 | 297,505 | 56,338 | 56,632 | 3,219 | 2,499 |
| 1,000 | SSDPE2KX01 | PCIe3 x4 | 153,263 | 25,891 | 21,942 | 2,799 | 1,109 |
| 2,000 | SSDPE2KX02 | PCIe3 x4 | 237,530 | 38,336 | 34,740 | 3,181 | 1,979 |
| 4,000 | SSDPE2KX04 | PCIe3 x4 | 242,546 | 39,242 | 38,151 | 2,905 | 2,417 |
| 240 | MTFDDAV240TDS | SATA 6G | 32,138 | 5,494 | 5,506 | 506 | 298 |
| 480 | MTFDDAV480TDS | SATA 6G | 39,970 | 6,373 | 6,541 | 508 | 395 |

## TX1310 M5

| Capacity [GB] | Stotage device | interface | Transactions [IO/s] | | | Throughput [MB/s] | |
|---|---|---|---|---|---|---|---|
| | | | Database | Fileserver | Filecopy | Streaming | Restore |
| 1,000 | ST1000DM010 | SATA 6G | 266 | 245 | 233 | 206 | 201 |
| 240 | MTFDDAK240TDT | SATA 6G | 33,340 | 5,566 | 5,583 | 508 | 302 |
| 480 | MTFDDAK480TDT | SATA 6G | 39,533 | 6,388 | 6,497 | 501 | 396 |
| 240 | MTFDDAV240TDS | SATA 6G | 32,138 | 5,494 | 5,506 | 506 | 298 |
| 480 | MTFDDAV480TDS | SATA 6G | 39,970 | 6,373 | 6,541 | 508 | 395 |

## TX1310 M5

# STREAM

## Benchmark description

STREAM is a synthetic benchmark that has been used for many years to determine memory throughput and was developed by John McCalpin during his professorship at the University of Delaware. Today STREAM is supported at the University of Virginia, where the source code can be downloaded in either Fortran or C. STREAM continues to play an important role in the HPC environment in particular. It is for example an integral part of the HPC Challenge benchmark suite.

The benchmark is designed in such a way that it can be used both on PCs and on server systems. The unit of measurement of the benchmark is GB/s, i.e. the number of gigabytes that can be read and written per second.

STREAM measures the memory throughput for sequential accesses. These can generally be performed more efficiently than accesses that are randomly distributed on the memory, because the processor caches are used for sequential access.

Before execution the source code is adapted to the environment to be measured. Therefore, the size of the data area must be at least 12 times larger than the total of all last-level processor caches so that these have as little influence as possible on the result. The OpenMP program library is used to enable selected parts of the program to be executed in parallel during the runtime of the benchmark. This provides optimal load distribution for the available processor cores.

In the STREAM benchmark, a data area consisting of 8-byte elements is continuously copied to four operation types. Arithmetic operations are also performed on operation types other than COPY.

| Arithmetics type | Arithmetics | Bytes per step | Floating-point calculation per step |
|---|---|---|---|
| COPY | a(i) = b(i) | 16 | 0 |
| SCALE | a(i) = q x b(i) | 16 | 1 |
| SUM | a(i) = b(i) + c(i) | 24 | 1 |
| TRIAD | a(i) = b(i) + q x c(i) | 24 | 2 |

The throughput is output in GB/s for each type of calculation. The differences between the various values are usually only minor on modern systems. In general, only the determined TRIAD value is used as a comparison.

The measured results primarily depend on the clock frequency of the memory modules. The processors influence the arithmetic calculations.

In this chapter, throughputs are indicated as a power of 10. (1 GB/s = $10^9$ Byte/s)

## Benchmark environment

| System Under Test (SUT) | |
|---|---|
| **Hardware** | |
| Model | PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5 |
| Processor | Intel Xeon E-2300 processor family / Intel Pentium Gold G6405 |
| Memory | 2 x 32 GB 2Rx8 PC4-3200AA-E |
| **Software** | |
| BIOS settings | FAN Control = Full |
| Operating system | SUSE Linux Enterprise Server 15 SP3 5.3.18-57-default |
| Operating system settings | Default |
| Compiler | C/C++: Version 2021.1 of Intel C/C++ Compiler for Linux |
| Benchmark | STREAM Version 5.10 |

Some components may not be available in all countries or sales regions.

## Benchmark results

The results with "est." are the estimated values.

| Processor | Memory frequency [MHz] | Maximum memory bandwidth [GB/s] | Number of cores | Rated frequency [GHz] | TRIAD [GB/s] | | |
|-----------|------------------------|---------------------------------|-----------------|-----------------------|--------------|--|--|
| | | | | | TX1310 M5 | TX1320 M5 | TX1330 M5 |
| Xeon E-2388G | 3200 | 51.2 | 8 | 3.2 | | 43.8    est. | **43.8** |
| Xeon E-2386G | 3200 | 51.2 | 6 | 3.5 | | 44.1    est. | **44.1** |
| Xeon E-2378G | 3200 | 51.2 | 8 | 2.8 | | 43.8    est. | **43.8** |
| Xeon E-2378 | 3200 | 51.2 | 8 | 2.6 | | 43.7    est. | **43.7** |
| Xeon E-2374G | 3200 | 51.2 | 4 | 3.7 | 43.2    est. | 43.2    est. | **43.2** |
| Xeon E-2356G | 3200 | 51.2 | 6 | 3.2 | 44.2    est. | 44.2    est. | **44.2** |
| Xeon E-2336 | 3200 | 51.2 | 6 | 2.9 | | 44.1    est. | **44.1** |
| Xeon E-2334 | 3200 | 51.2 | 4 | 3.4 | | 42.9    est. | **42.9** |
| Xeon E-2324G | 2933 | 51.2 | 4 | 3.1 | 43.0    est. | 43.0    est. | **43.0** |
| Xeon E-2314 | 3200 | 51.2 | 4 | 2.8 | | 43.1    est. | **43.1** |
| Pentium Gold G6405 | 3200 | 42.7 | 2 | 4.1 | 35.3    est. | 35.3    est. | **35.3** |

The following diagram illustrates the throughput of the TX1330 M5 in comparison to its predecessor, the TX1330 M4.

**STREAM TRIAD: Comparison of PRIMERGY TX1330 M5 and PRIMERGY TX1330 M4**
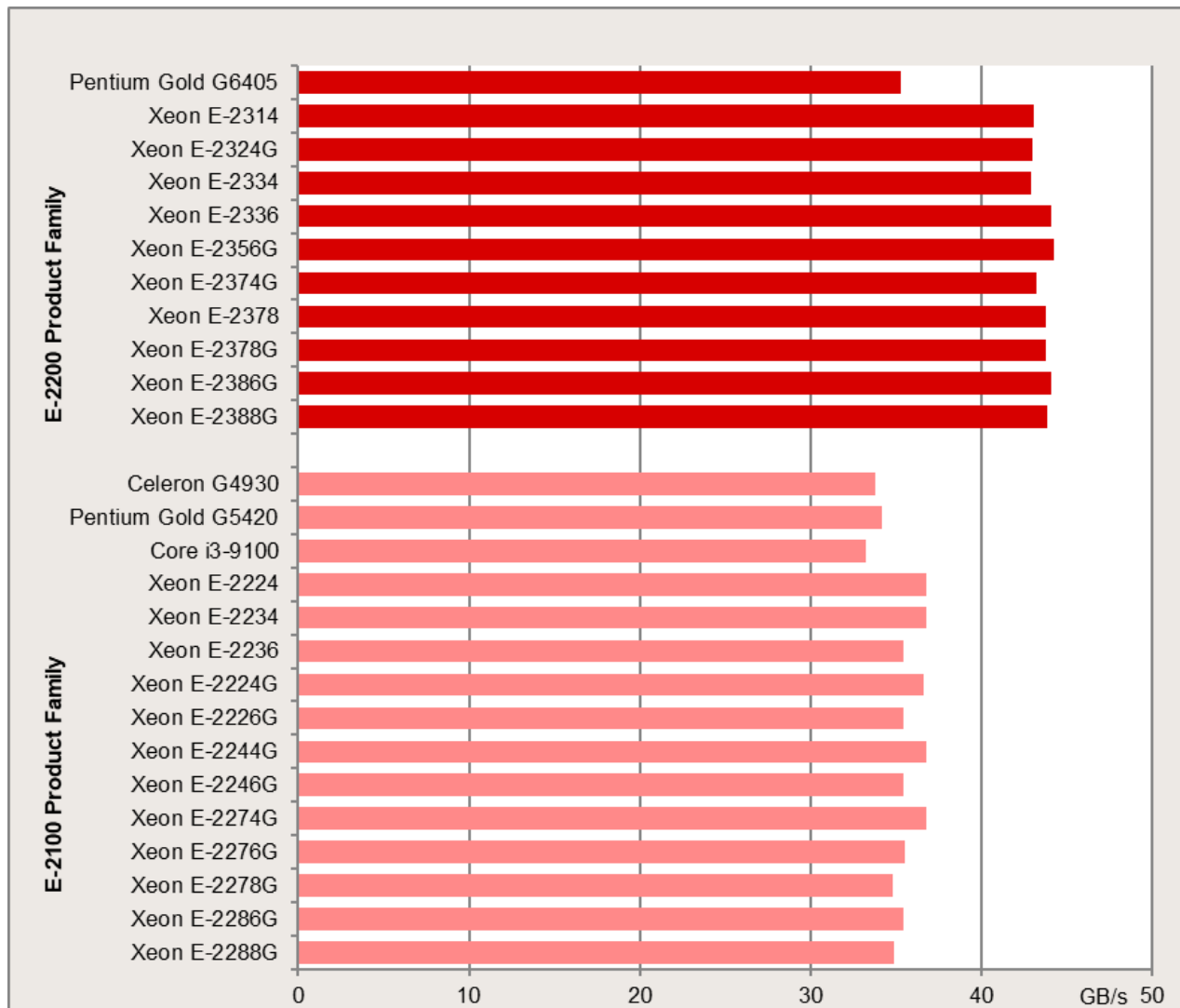
# Literature

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https://www.fujitsu.com/global/products/computing/servers/primergy/

**PRIMERGY TX1310 M5 / TX1320 M5 / TX1330 M5**

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Data sheet

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**STREAM**

https://www.cs.virginia.edu/stream/

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