



AR benchmark testing

Industrial PCs

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I Publishing Information

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II Versions

Version	Date	Comment	Edited by
1.0	12/01/2011	First Edition	PMA
1.1	05/08/2013	Benchmark tests with APC910	MIK
1.2	07/04/2013	Benchmark enhancements with APC910 + 5PC900.TS77-09 and 5PC900.TS77-10	MIK
1.3	11/14/2014	Benchmark enhancements with APC2100/PPC2100	MIK
1.4	10/04/2016	Benchmark enhancements with APC2100/PPC2100 equipped with 2x4GB DRAM (5xPC2100.BY48-00x)	MIK
1.5	06/21/2017	Benchmark enhancements with APC910 + 5PC900.TS17-00, -01 and -02	MIK
1.6	01/29/2018	- Switched to new Corporate Design - Benchmark enhancements with X20CPx58x (only in the general overview) - Benchmark enhancements with xPC3100 - Benchmark enhancements with APC910 + 5PC900.TS17-04	MIK
1.7	20.05.2019	Benchmark enhancements with xPC2200	MIK

Table 1: Versions

III Distribution

This Application Note is intended for technically qualified staff.

IV Safety Notices

Safety notices in this document are organized as follows:

Safety notice	Description
Danger!	Disregarding the safety regulations and guidelines can be life-threatening.
Warning!	Disregarding the safety regulations and guidelines can result in severe injury or heavy damage to material.
Caution!	Disregarding the safety regulations and guidelines can result in injury or damage to material.
Information:	Important information used to prevent errors.

Table 2: Safety notices

V Test Locations

No.	Company	Street	Post Code	Place	Phone	Contact
1	B&R Industrial Automation	B&R Straße 1	A-5142	Eggelsberg	+43/7748/6586-0	

Table 3: Test locations

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1 Introduction

The purpose of this document is to illustrate how the various B&R Industrial PCs relate to each other with regard to performance. A benchmark program specially developed by B&R was run on the tested systems with Automation Runtime.

The test was structured as follows:

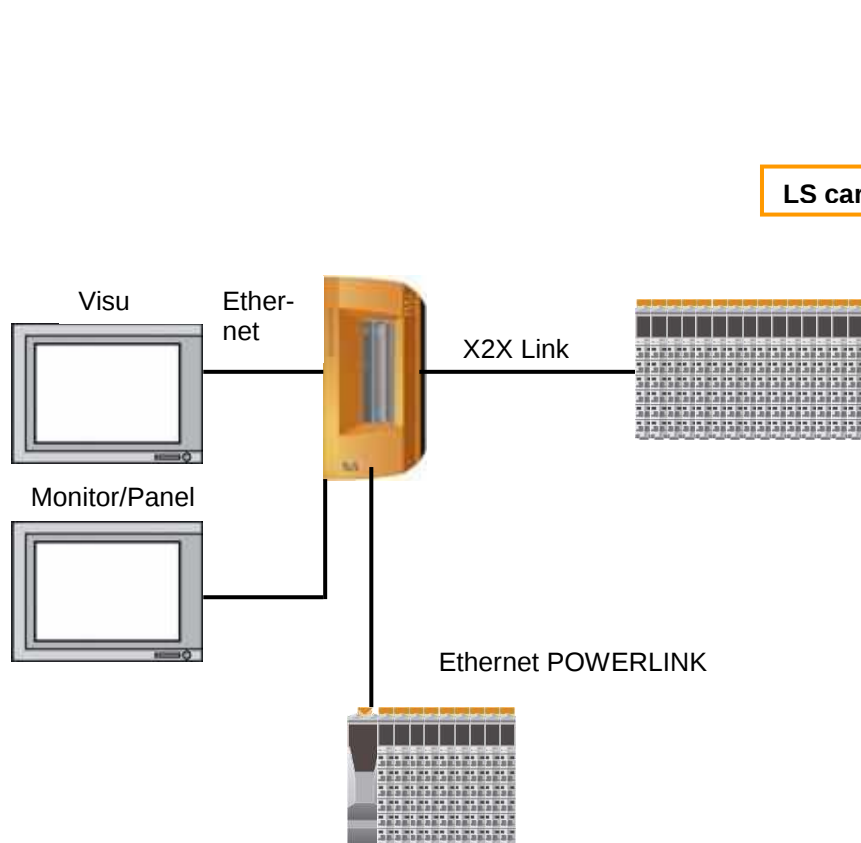


Figure 1: Basic test structure

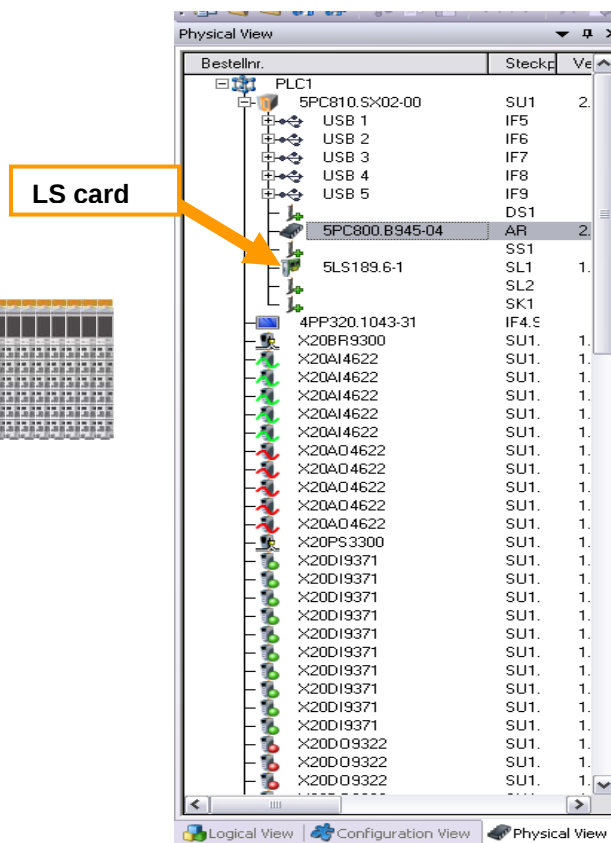


Figure 2: Physical View in Automation Studio

As can be seen in the images, the test always involved connecting one device under testing (DUT) to POWERLINK and X2X modules via an LS card or to POWERLINK modules via an IF card as an additional load. Each DUT was also connected via Ethernet to a PowerPanel 300, which displayed the GUI for the benchmark program. Additionally, an Automation Panel 900 was connected to each DUT to visualize the status of the PC and of Automation Runtime.

Tests were performed with various arrangements of peripheral devices.

2 Hardware

The following hardware was used for the benchmark tests:

2.1 Devices under test (DUT)

No.	Model number	CPU	VGA controller	Manufacturer
X20 CPU				
1	X20CP3484-1	X20 CPU Celeron 266, PLK V1/V2, 3x IF		B&R
2	X20CP1485-1	X20 CPU Celeron 400, PLK V1/V2, 1x IF		B&R
3	X20CP3486-1	X20 CPU Celeron 650, PLK V1/V2, 3x IF		B&R
4	X20CP3583	X20 CPU ATOM, 0.3GHz, PLK, 3x IF	-	B&R
5	X20CP3584	X20 CPU ATOM, 0.6GHz, PLK, 3x IF	-	B&R
6	X20CP3585	X20 CPU ATOM, 1.0GHz, PLK, 3x IF	-	B&R
7	X20CP3586	X20 CPU ATOM, 1.6GHz, PLK, 3x IF	-	B&R
Power Panel 300/400 consisting of: - 4PP420.0573-75 (PP420 TFT C VGA 5.7" T 1aPCI) - 3IF789.9-1 (aPCI IF 1x POWERLINK V1/V2, 1x X2X-LINK) - 5CFCRD.0512-04 (CompactFlash 512 MB B&R)				
8	AMD Geode LX800-500	Geode LX800 500MHz 128 kB cache	AMD Geode LX800 4 MB	B&R
Power Panel 500 consisting of: - 5PP520.0573-00 (PP520 TFT C VGA 5.7" T IF) - 5MMDDR.1024-01 (SO-DIMM DDR2 RAM 1024 MB PC2-5300) - 5PP5IF.FPLM-00 (PP500 IF POWERLINK MN 2-port SRAM) - 5CFCRD.0512-04 (CompactFlash 512 MB B&R)				
9	5PP5CP.US15-00	Intel Atom Z510 1.1GHz/400MHz FSB 512 kB cache	Intel US15W	B&R
10	5PP5CP.US15-01	Intel Atom Z520 1.33GHz/533MHz FSB 512 kB cache	Intel US15W	B&R
11	5PP5CP.US15-02	Intel Atom Z530 1.6GHz/533MHz FSB 512 kB cache	Intel US15W	B&R
APC620 with INTEL 855GME chipset consisting of: • 5PC600.SX02-01 (System 2PCI 1DD) • 5MMDDR.0512-00 (SO-DIMM DDR-SDRAM 512 MB PC2700) • 5AC600.HS01-01 or 5AC600.HS01-02 (APC620 heat sink 855GME 12.8 mm or APC620 heat sink 855GME 28 mm) • 5CFCRD.1024-04 (CompactFlash 1 GB B&R) • 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
12	5PC600.E855-00 / 5PC600.X855-00	Intel Pentium M 1100 MHz/400 MHz FSB 1 MB cache	Intel 82855 GME graphics controller 64 MB	B&R
13	5PC600.E855-01 / 5PC600.X855-01	Intel Pentium M 1600/400MHz FSB 1 MB cache	Intel 82855 GME graphics controller 64 MB	B&R
14	5PC600.E855-02 / 5PC600.X855-02	Intel Pentium M 1400/400MHz FSB 2MB cache	Intel 82855 GME graphics controller 64 MB	B&R
15	5PC600.E855-03 / 5PC600.X855-03	Intel Pentium M 1800/400MHz FSB 2MB cache	Intel 82855 GME graphics controller 64 MB	B&R
16	5PC600.E855-04 / 5PC600.X855-04	Intel Celeron M 600/400 MHz FSB 512 kB cache	Intel 82855 GME graphics controller 64 MB	B&R
17	5PC600.E855-05 / 5PC600.X855-05	Intel Celeron M 1000/400 MHz FSB 512 kB cache	Intel 82855 GME graphics controller 64 MB	B&R
APC620 with Intel 945GME chipset + Intel Atom N270 consisting of: • 5PC600.SX02-01 (System 2PCI 1DD) • 5MMDDR.1024-01 (SO-DIMM DDR2 RAM 1024 MB PC2-5300) • 5AC600.HS01-03 (APC620 heat sink 945GME 12.8mm)				

No.	Model number	CPU	VGA controller	Manufacturer
5CFCRD.1024-04 (CompactFlash 1 GB B&R) 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
18	5PC600.X945-00	CPU 945GME Intel Atom N270 1600/533 MHz 512 kB	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
APC810 with Intel 945GME chipset consisting of: 5PC810.SX02-00 (APC810 system 2CS 2SI 1LS) 2x 5MMDDR.1024-01 (SO-DIMM DDR2 RAM 1024 MB PC2-5300) 5AC801.HS00-00 or 5AC801.HS00-01 or 5AC801.HS00-02 (APC810 heat sink 945GME or APC810 heat sink 945GME T7400, GM45 or APC810 heat sink 945GME N270) 5CFCRD.1024-04 (CompactFlash 1 GB B&R) 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
19	5PC800.B945-00/ 5PC800.B945-10	CPU 945GME CD L2400 1660/667 MHz 2 MB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
20	5PC800.B945-01/ 5PC800.B945-11	CPU 945GME C2D L7400 1500/667 MHz 4 MB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
21	5PC800.B945-02/ 5PC800.B945-12	CPU 945GME C2D U7500 1060/533 MHz 2 MB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
22	5PC800.B945-03/ 5PC800.B945-13	CPU 945GME CM 423 1060/533 MHz 1 MB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
23	5PC800.B945-04/ 5PC800.B945-14	CPU 945GME C2D T7400 2160/667 MHz 4 MB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
24	5PC800.B945-05	CPU 945GME Atom N270 1600/533 MHz 512 kB cache	Intel Graphics Media Accelerator 950 max. 224 MB	B&R
APC810 with Intel GM45 chipset consisting of: 5PC810.SX02-00 (APC810 system 2CS 2SI 1LS) 2x 5MMDDR.2048-02 (SO-DIMM DDR3 2048 MB PC3-8500 256Mx64) 5AC801.HS00-01 (APC810 heat sink 945GME T7400, GM45) 5CFCRD.1024-04 (CompactFlash 1 GB B&R) 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
25	5PC800.BM45-00	CPU GM45 C2D T9400 2530/1066 MHz 6 MB cache	Intel Graphics Media Accelerator 4500MHD (Intel GM45)	B&R
26	5PC800.BM45-01	CPU GM45 C2D P8400 2260/1066 MHz 3 MB cache	Intel Graphics Media Accelerator 4500MHD (Intel GM45)	B&R
APC910 with Intel QM77/HM76 chipset consisting of: 5PC910.SX01-00 (APC910 System 1CS 1SI) 2x 5MMDDR.2048-03 (SO-DIMM DDR3 PC3-12800 2048MB) 5AC901.BX01-00 (APC910 Bus 1PCI) 5AC901.HS00-00 (APC910 heat sink active) 5AC901.FA01-00 (APC910 Fan Kit 1CS) 5CFAST.2048-00 (CFast 2GB) 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
27	5PC900.TS77-00	CPU QM77 i7-3615QE 4C 2.3/1.6GHz 6MB 45W	Intel HD Graphics 4000 (QM77)	B&R
28	5PC900.TS77-01	CPU QM77 i7-3612QE 4C 2.1/1.6GHz 6MB 35W	Intel HD Graphics 4000 (QM77)	B&R
29	5PC900.TS77-02	CPU QM77 i7-3555LE 2C 2.5/1.6GHz 4MB 25W	Intel HD Graphics 4000 (QM77)	B&R
30	5PC900.TS77-03	CPU QM77 i7-3517UE 2C 1.7/1.6GHz 4MB 17W	Intel HD Graphics 4000 (QM77)	B&R
31	5PC900.TS77-04	CPU QM77 i5-3610ME 2C 2.7/1.6GHz 3MB 35W	Intel HD Graphics 4000 (QM77)	B&R
32	5PC900.TS77-05	CPU QM77 i3-3120ME 2C 2.4/1.6GHz 3MB 35W	Intel HD Graphics 4000 (QM77)	B&R

No.	Model number	CPU	VGA controller	Manufacturer
33	5PC900.TS77-06	CPU QM77 i3-3217UE 2C 1.6/1.6GHz 3MB 17W	Intel HD Graphics 4000 (QM77)	B&R
34	5PC900.TS77-07	CPU HM76 C-847E 2C 1.1/1.3GHz 2MB 17W	Intel HD Graphics (HM76)	B&R
35	5PC900.TS77-08	CPU HM76 C-827E 1C 1.4/1.3GHz 1.5MB 17W	Intel HD Graphics (HM76)	B&R
36	5PC900.TS77-09	CPU HM76 C-1020E 2C 2.2/1.6GHz 2MB 35W	Intel HD Graphics (HM76)	B&R
37	5PC900.TS77-10	CPU HM76 C-1047UE 2C 1.4/1.6GHz 2MB 17W	Intel HD Graphics (HM76)	B&R
APC2100 with Intel Bay Trail consisting of: 5ACCLI01.SDL0-000 (HMI Link01 SDL) 5ACCIF01.FPLS-000 (HMI IF01 FRAM PLK RS232) 5CFAST.2048-00 (CFast 2GB)				
38	5APC2100.BY01-000	E3815 1C 1.46GHz 512kB 5W 1GB	Intel HD Graphics (Bay Trail)	B&R
39	5APC2100.BY11-000	E3825 2C 1.33GHz 1MB 6W 1GB	Intel HD Graphics (Bay Trail)	B&R
40	5APC2100.BY22-000	E3826 2C 1.46GHz 1MB 7W 2GB	Intel HD Graphics (Bay Trail)	B&R
41	5APC2100.BY34-000	E3827 2C 1.75GHz 1MB 8W 4GB	Intel HD Graphics (Bay Trail)	B&R
42	5APC2100.BY44-000	E3845 4C 1.91GHz 2MB 10W 4GB	Intel HD Graphics (Bay Trail)	B&R
43	5APC2100.BY48-000	E3845 4C 1.91GHz 2MB 10W 8GB	Intel HD Graphics (Bay Trail)	B&R
APC910 with Intel QM170/HM170 chipset consisting of: 5PC910.SX02-00 (APC910 System 2CS 1SI) 2x 5MMDDR.4096-04 (SO-DIMM DDR4-2133 4096MB) 5AC901.BX02-01 (APC910 Bus 1PCI 1PCle.x8 1SI) 5AC901.HS00-00 (APC910 heat sink active) 5AC901.FA02-00 (APC910 Fan Kit 2CS) 5CFAST.2048-00 (CFast 2GB) 5LS189.6-1 (Logic Scanner POWERLINK V1/V2, X2X, SRAM)				
44	5PC900.TS17-00	CPU QM170 i5-6440EQ 4C 2.7GHz 6MB 45W	Intel HD Graphics 530	B&R
45	5PC900.TS17-01	CPU HM170 i3-6100E 2C 2.7GHz 3MB 35W	Intel HD Graphics 530	B&R
46	5PC900.TS17-02	CPU HM170 C-G3900E 2C 2.4GHz 2MB 35W	Intel HD Graphics 510	B&R
47	5PC900.TS17-04	CPU QM170 i7-6820EQ 4C 2.8GHz 8MB 45W	Intel HD Graphics 530	B&R
xPC3100 with Intel Kaby Lake U chipset consisting of: 2x 5MMDDR.4096-04 (SO-DIMM DDR4-2133 4096MB) 5CFAST.2048-00 (CFast 2GB) 5AC901.IPLK-00 (IF POWERLINK SRAM)				
48	5APC3100.KBU0-000	APC3100 C-3965U 2C 2.2/2.1GHz 2MB 15W	Intel HD Graphics 610	B&R
49	5APC3100.KBU0-001	APC3100 i3-7100U 2C 2.4/2.1GHz 3MB 15W	Intel HD Graphics 620	B&R
50	5APC3100.KBU0-002	APC3100 i5-7300U 2C 2.6/2.1GHz 3MB 15W	Intel HD Graphics 620	B&R
51	5APC3100.KBU0-003	APC3100 i7-7600U 2C 2.8/2.1GHz 4MB 15W	Intel HD Graphics 620	B&R
xPC2200 with Intel Apollo Lake consisting of: 5ACCLI01.SDL0-000 (HMI Link01 SDL) 5ACCIF01.FPLS-001 (HMI IF01 512kB nvSRAM PLK RS232) 5CFAST.2048-00 (CFast 2GB)				
52	5APC2200.AL02-000	APC2200 E3930 2C 1.30GHz 2MB 6.5W 2GB	Intel HD Graphics 500	B&R
53	5APC2200.AL04-000	APC2200 E3930 2C 1.30GHz 2MB 6.5W 4GB	Intel HD Graphics 500	B&R
54	5APC2200.AL14-000	APC2200 E3940 4C 1.60GHz 2MB 9.5W 4GB	Intel HD Graphics 500	B&R
55	5APC2200.AL18-000	APC2200 E3940 4C 1.60GHz 2MB 9.5W 8GB	Intel HD Graphics 500	B&R

Table 4: Devices under test (DUT)

2.2 Removable storage device

No.	Name	Storage capacity	Purpose	Manufacturer
CompactFlash cards				
1	5CFCD.0512-04	512 MB	Visualization	B&R
2	5CFCD.1024-04	1 GB	Devices under test (DUT)	B&R
3	5CFAST.2048-00	2 GB	Devices under test (DUT)	B&R

Table 5: Hard drive / exchangeable media used

2.3 Peripherals

No.	Name	Description	Number used	Manufacturer
X2X modules used for load test				
1	X20BR9300	X20 bus receiver, supply feed 24V bus supply	1	B&R
2	X20PS3300	X20 supply, 24V, bus supply	1	B&R
3	X20AI4622	X20 analog 4x I, +/- 10V/0..20 mA, 12-bit	5	B&R
4	X20AO4622	X20 analog 4x O, +/- 10V/0..20 mA, 12-bit	5	B&R
5	X20DI9371	X20 digital 12x I, 24V, sink, 1 wire	10	B&R
6	X20DO9322	X20 digital 12x O, 24V 0.5A, source, 1 wire	10	B&R
POWERLINK modules used for load test				
7	X20BC0083	X20 bus controller POWERLINK V1/V2	5	B&R
8	X20PS9400	X20 BC supply, 24V, bus supply	5	B&R
9	X20AI4622	X20 analog 4x I, +/- 10V/0..20 mA, 12-bit	10	B&R
10	X20AO4622	X20 analog 4x O, +/- 10V/0..20 mA, 12-bit	10	B&R
11	X20DI9371	X20 digital 12x I, 24V, sink, 1 wire	10	B&R
12	X20DO9322	X20 digital 12x O, 24V 0.5A, source, 1 wire	10	B&R
Other peripheral devices				
13	4PP320.1043-31	PP320 TFT C VGA 10.4" T	1	B&R
14	5AP920.1505-01	AP920 C TFT XGA 15" T	1	B&R

Table 6: X2X-PL hardware for load testing

3 Software

The following software products were used for the tests:

3.1 Benchmark programs

No.	Name	Manufacturer	WEB link
1	Benchmark test	B&R	-

Table 7: Benchmark programs used and the corresponding WEB links

3.2 Operating system

The operating system used on the DUTs was Automation Runtime Embedded (ARemb).

As an integral component of Automation Studio™, Automation Runtime is the software kernel that allows applications to run on a target system (e.g. AP8xx).

No.	Name	Devices under test (DUT)
1	ARemb V3.08	1, 2, 3, 8, 12, 13, 14, 15, 16, 17
2	ARemb V4.00	9, 10, 11, 18, 19, 20, 21, 22, 23, 24, 25, 26
3	ARemb Q4.02	27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
4	ARemb I4.06	4, 5, 6, 7
5	ARemb B4.10	38, 39, 40, 41, 42
6	ARemb N4.10	43
7	ARemb A4.34	44, 45, 46, 47
8	ARemb E4.34	48, 49, 50, 51
9	ARemb B4.62	52, 53, 54, 55

Table 8: Operating system versions used

Information:

On multi-core processors ARemb only uses one core.

4 Results

Due to the varying performance of the APCs, they were grouped into 4 performance classes. In the following diagram, the results from each of the performance classes were extrapolated to provide a general overview of the range of performance across the product spectrum.

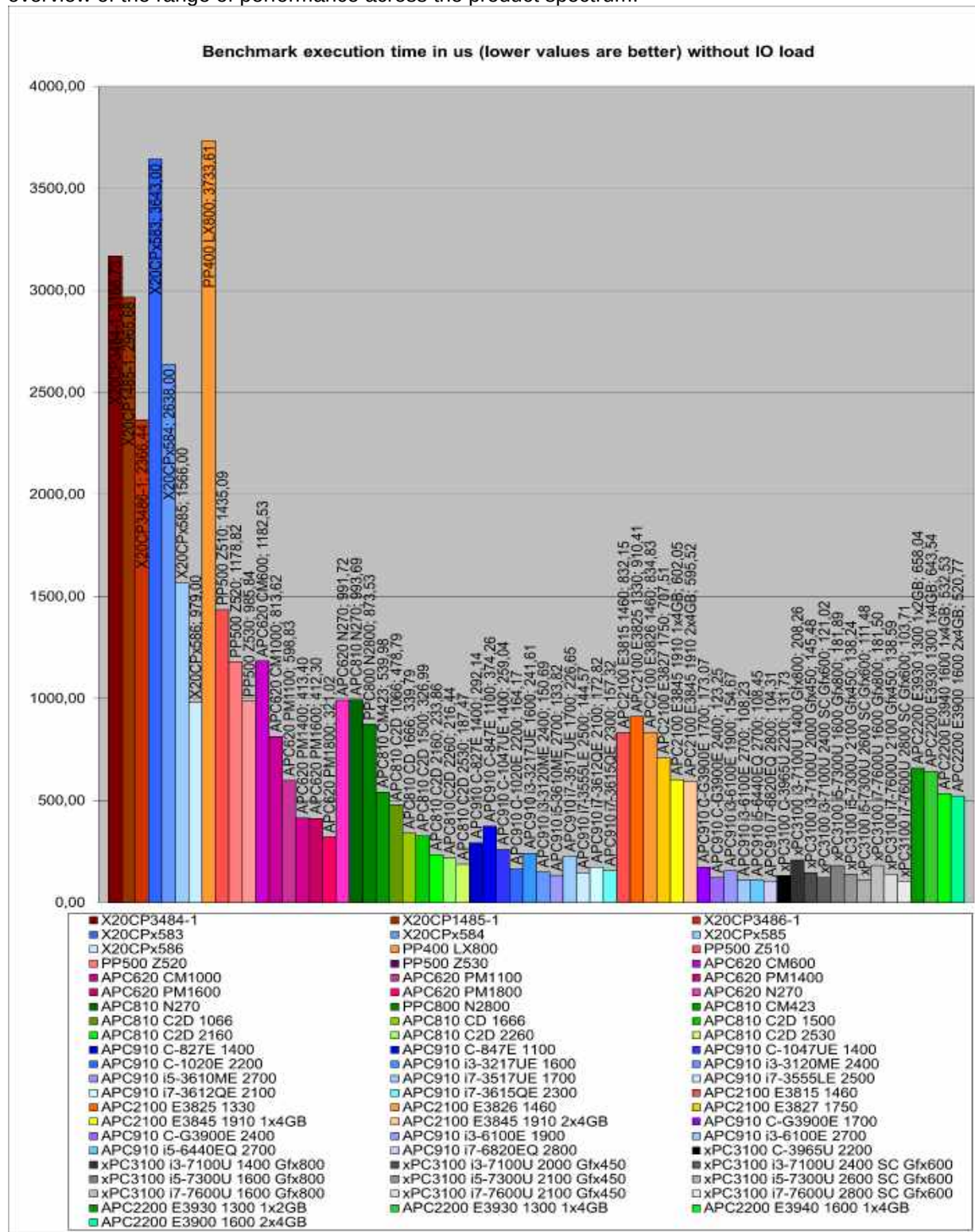


Figure 3: Distribution of performance across product range

4.1 Performance class 0

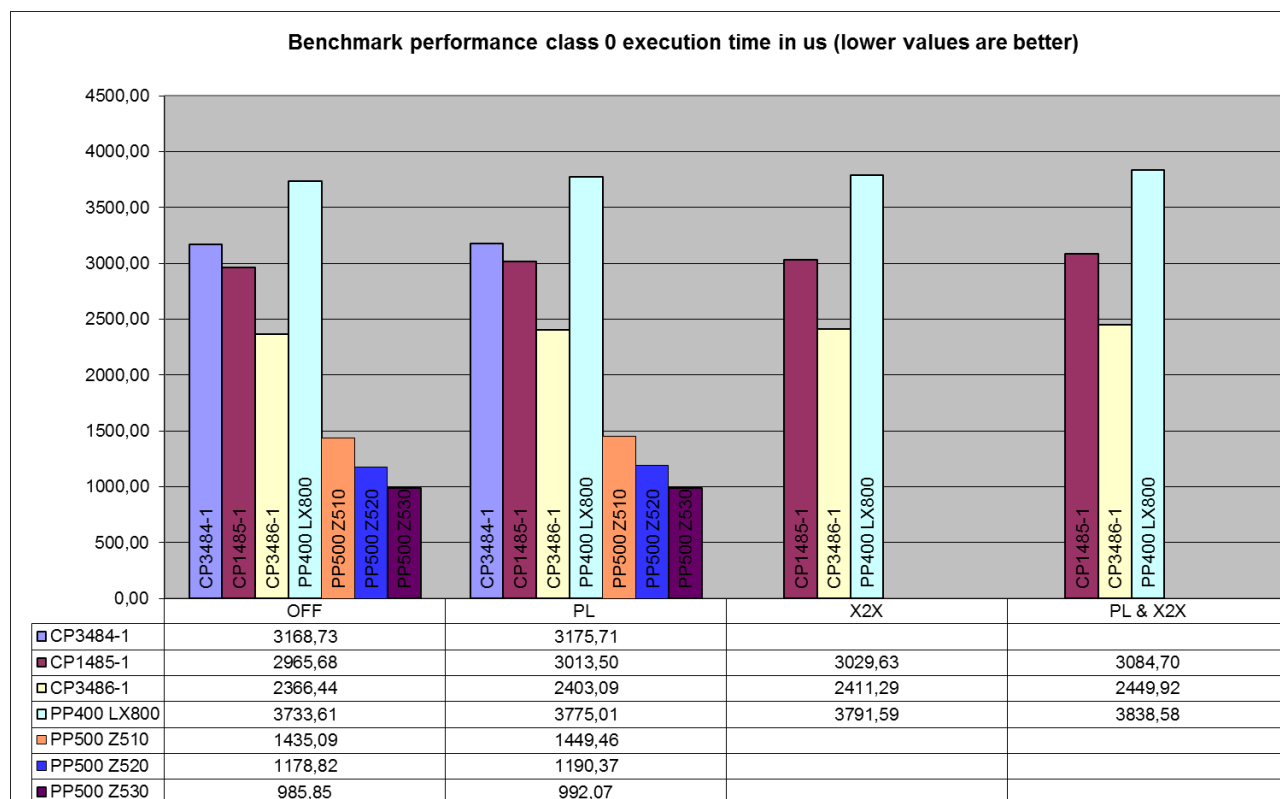


Figure 4: Test results - Execution time in µs - Performance class 0

Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

4.2 Performance class 1

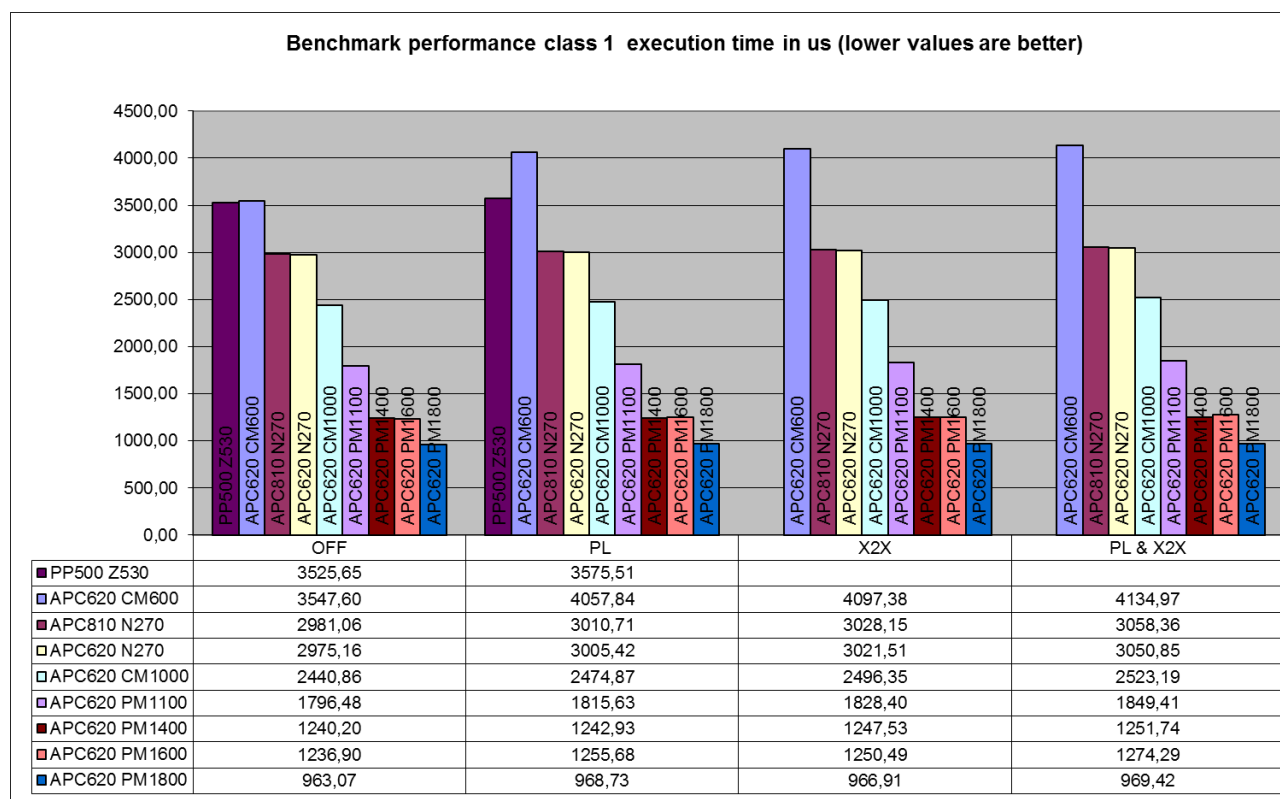


Figure 5: Test results - Execution time in µs - Performance class 1

Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

4.3 Performance class 2

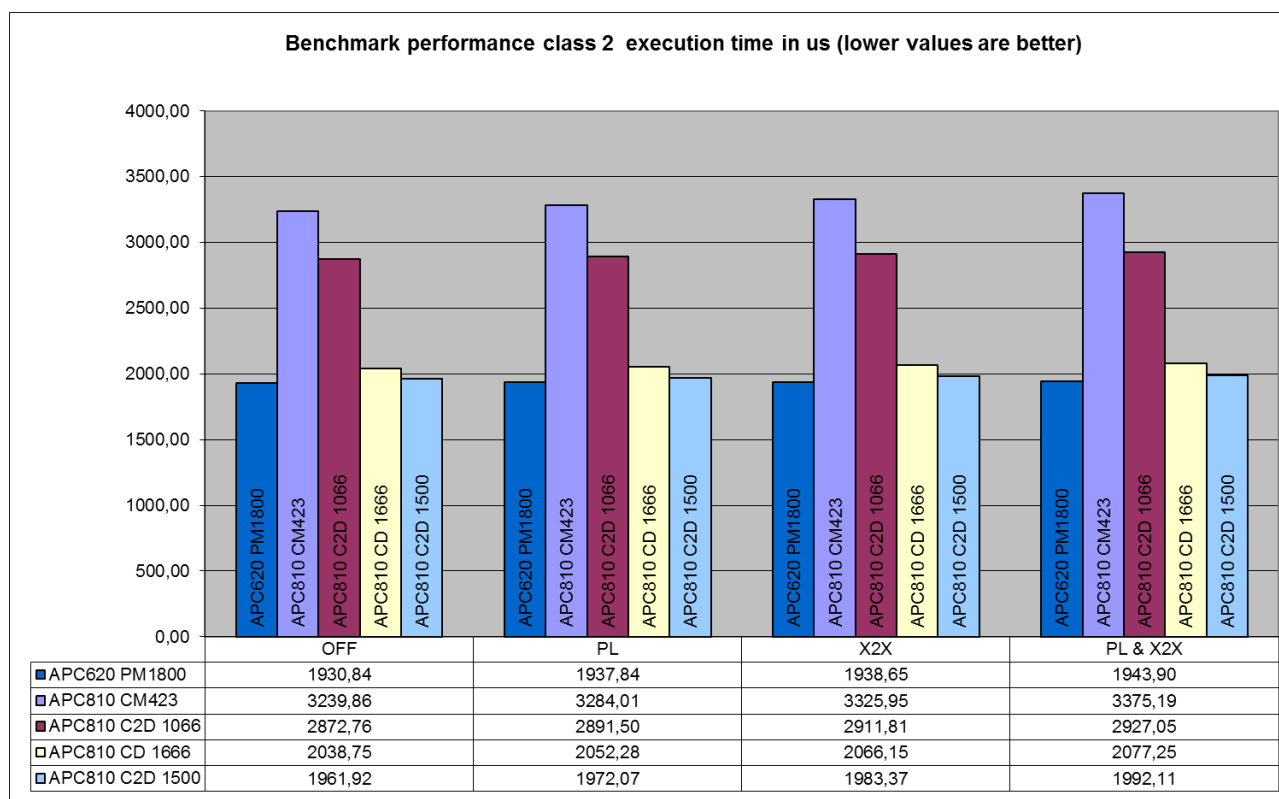


Figure 6: Test results - Execution time in µs - Performance class 2 – APC810

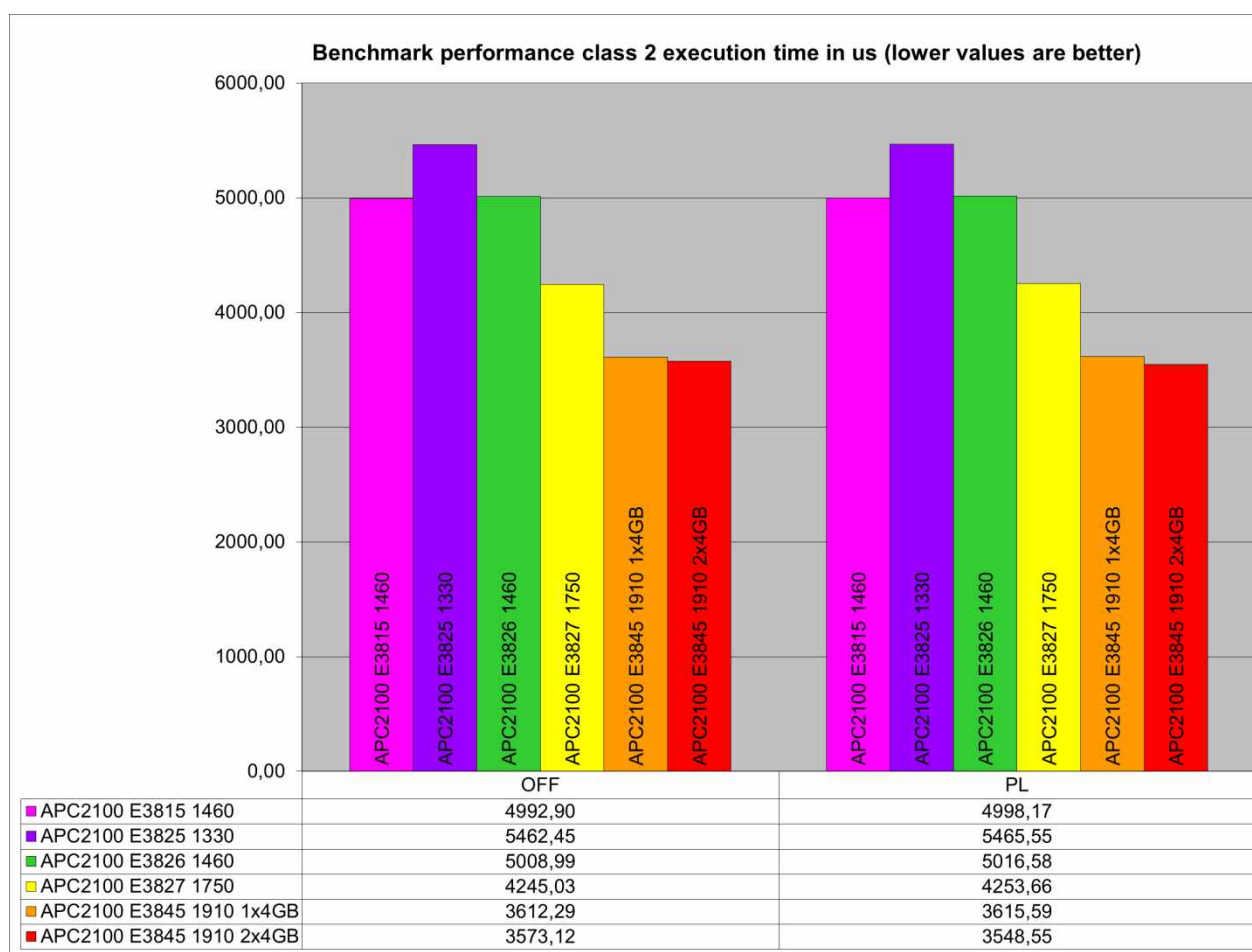
Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

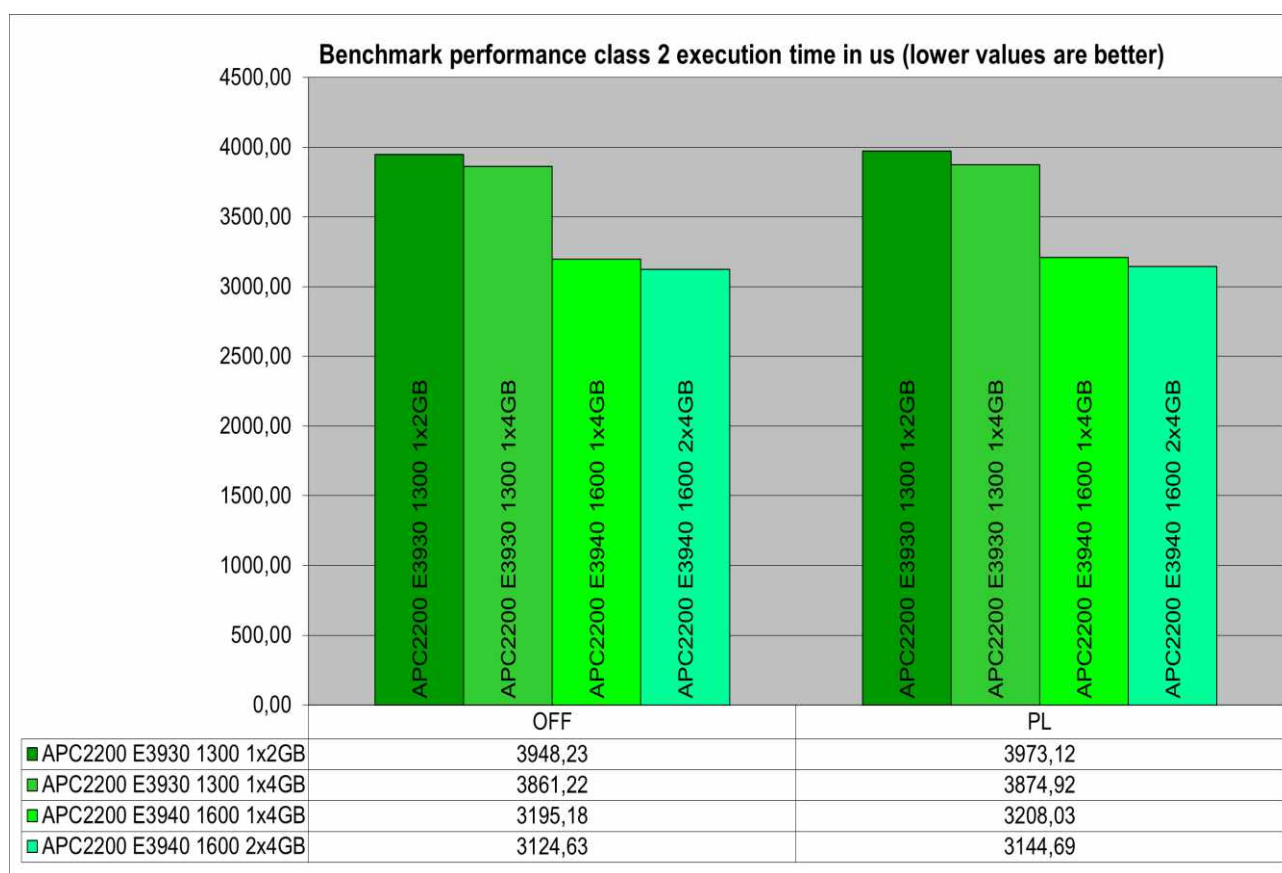
Figure 7: Test results - Execution time in μ s - Performance class 2 – APC2100 (Bay Trail)**Information about the graphic**

OFF – Results without peripheral load

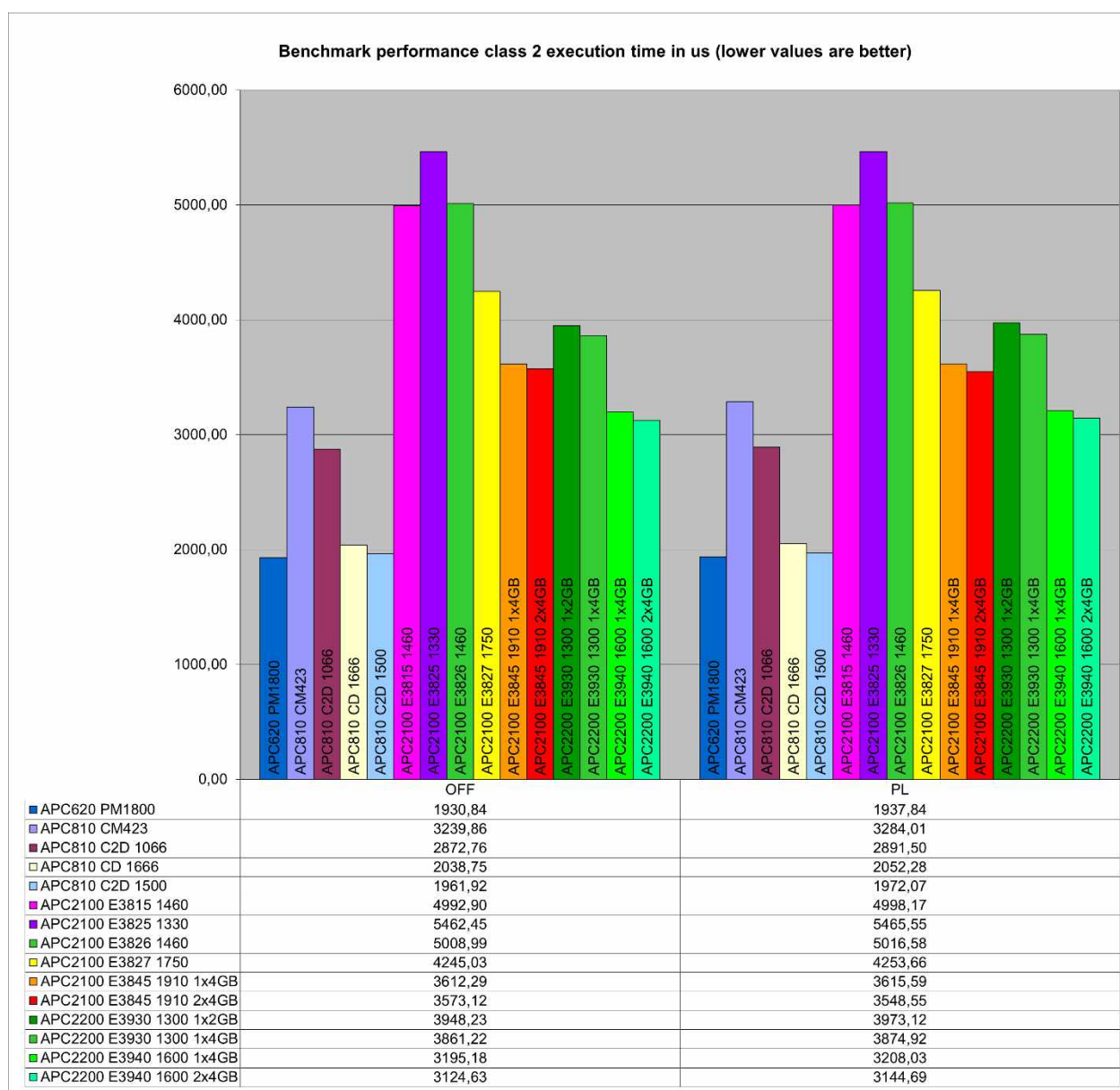
PL – Results with POWERLINK as load

Information about Automation Runtime operation

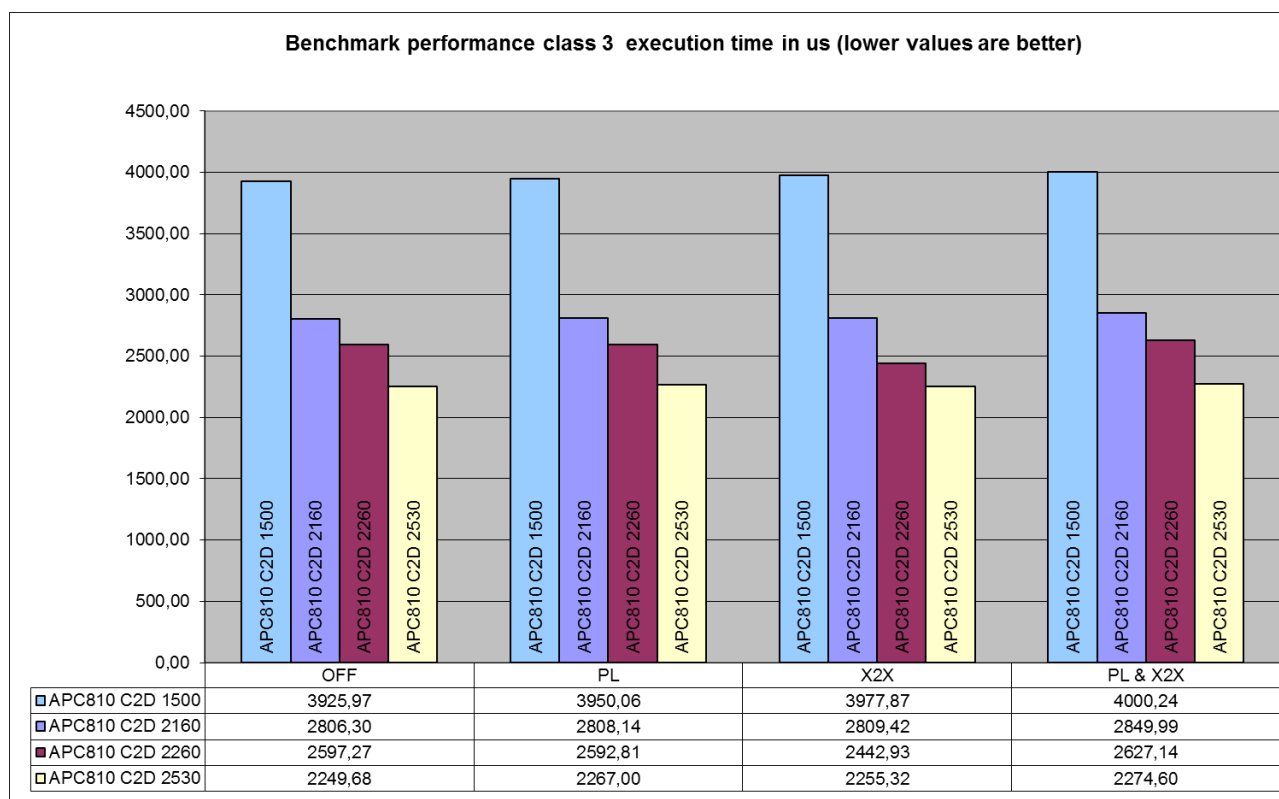
In order to use Automation Runtime (ARemb and ARwin), the BIOS setting *Advanced - Miscellaneous configuration - Realtime environment* must be set to *Enabled*.

Figure 8: Test results - Execution time in μ s - Performance class 2 – APC2200 (Apollo Lake)**Information about the graphic****OFF – Results without peripheral load****PL – Results with POWERLINK as load****Information about Automation Runtime operation**

In order to use Automation Runtime (ARemb), the BIOS setting *Advanced – OEM Features - Realtime environment* must be set to *Enabled*.

Figure 9: Comparison - Execution time in μ s - Performance class 2 (APC810 with APC2100 and APC2200)**Information about the graphic****OFF – Results without peripheral load****PL – Results with POWERLINK as load**

4.4 Performance class 3

Figure 10: Test results - Execution time in μ s - Performance class 3 (APC810)

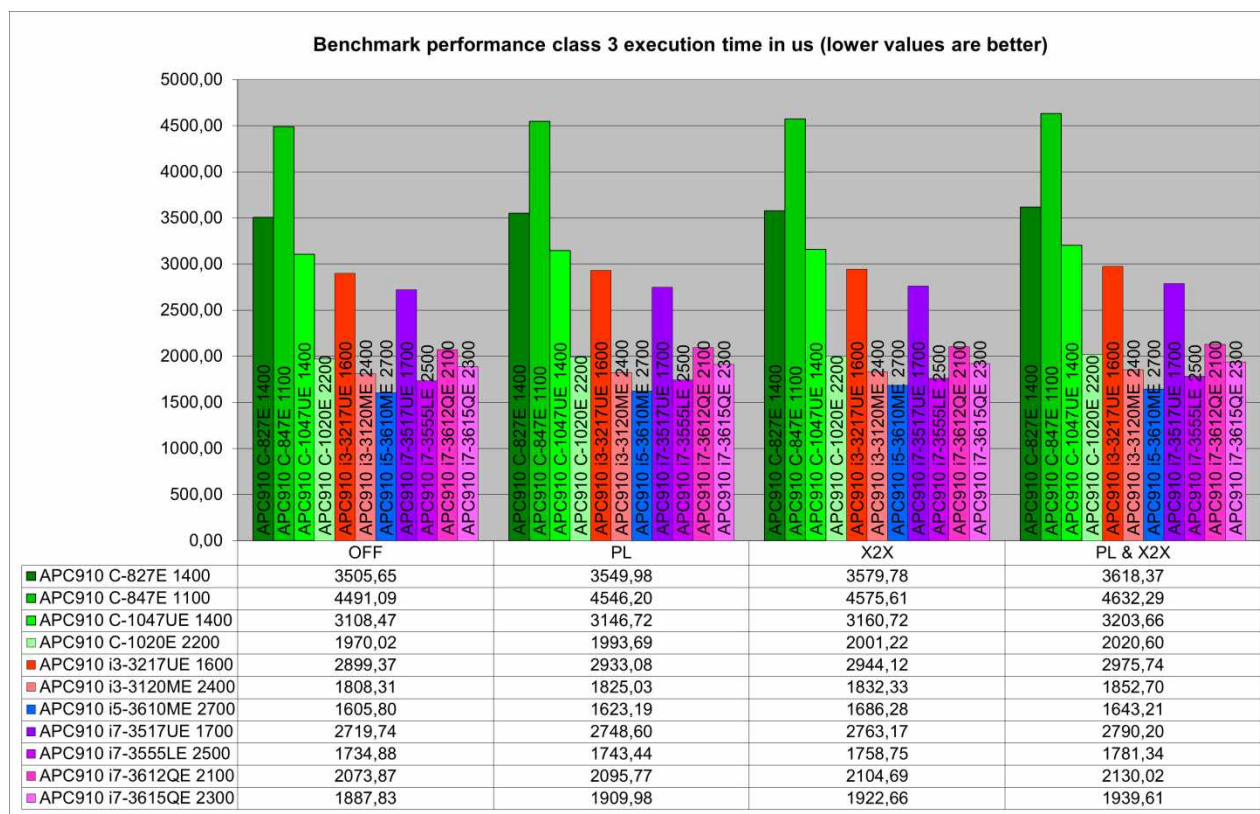
Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

Figure 11: Test results - Execution time in μ s - Performance class 3 (APC910 with QM77/HM76)

Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

Information about Automation Runtime operation

In order to use Automation Runtime (ARemb and ARwin), the BIOS setting *Advanced - OEM features - Realtime environment* must be set to *Enabled*.

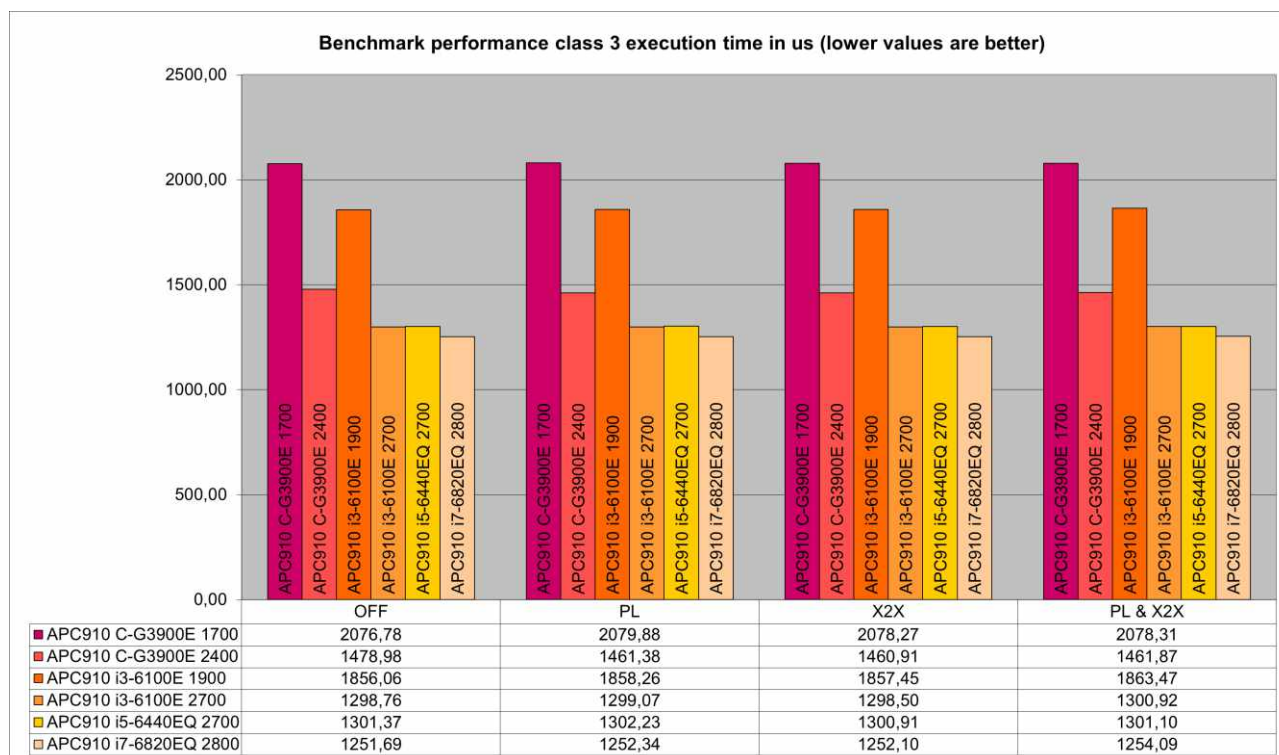


Figure 12: Test results - Execution time in µs - Performance class 3 (APC910 with QM170/HM170)

Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

X2X – Results with X2X Link as load

PL&X2X – Results with POWERLINK and X2X Link as load

Information about Automation Runtime operation

In order to use Automation Runtime Windows (ARwin), BIOS setting *Advanced - OEM features - Realtime environment* must be set to *Enabled*.

In order to use Automation Runtime Embedded (ARemb), BIOS settings *Advanced - OEM features - Realtime environment* must be set to *Enabled* and *Boot – Boot Option Sorting Method* must be set to *UEFI before Legacy*.

In situations where there is a heavy load on the CPU and GPU simultaneously, it is possible that the specified Thermal Design Power (TDP) of the CPU is exceeded. When this happens, the CPU's internal protective mechanisms will begin limiting the load to the TDP. This means that either the CPU frequency or the graphic frequency (GPU) will be reduced/controlled. In real-time applications, this can result in increased jitter and/or higher cycle times.

This behavior can be influenced by settings in BIOS. The maximum CPU frequency can be set in BIOS under *Advanced - CPU configuration* using option *Set boot freq ratio*. Option *Active processor cores* sets the number of cores being used.

In addition, the maximum frequency of the GPU (Gfx) can be limited in BIOS under *Advanced - Graphics configuration* using option *Max. GPU frequency*.

Limiting the CPU and/or GPU frequency reduces power consumption and prevents the TDP from being exceeded.

The optimal settings for real-time operation depend on several factors:

1. The CPU variant being used
 - If CPU C-G3900E is used, no further action (BIOS settings) are necessary. For pure ARemb operation, the limiting of active processor cores can be set to 1 in BIOS; this is otherwise recommended.
 - If CPU i3-6100E, i5-6440EQ or i7-6820EQ is used, see item 2. ARemb, ARwin or B&R Hypervisor mode.
2. ARemb, ARwin or B&R Hypervisor mode.
 - For pure ARemb operation, the active processor cores must be limited to 1 (see item 4 "Typical ARemb applications").
 - For ARwin or B&R Hypervisor operation, see item 3. Requirements of the respective application.
3. Requirements of the respective application:
 - If high CPU performance is desired, then it is recommended to limit the GPU to a minimum. Depending on the CPU variant used, it may also be necessary to somewhat limit the CPU frequency (see point 5 "Typical ARwin or B&R Hypervisor applications").
 - If high GPU performance is desired, then it is recommended to limit the CPU (minimum CPU frequency = 800 MHz). Depending on the CPU variant used, it may also be necessary to somewhat limit the GPU frequency (see point 5 "Typical ARwin or B&R Hypervisor applications").
 - If mid-level performance of the CPU and GPU is desired, then it is recommended to use a moderate limit for both the CPU and GPU (see item 5 "Typical ARwin or B&R Hypervisor applications").
4. Typical ARemb applications:
 - Limit the active processor cores to 1.
5. Typical ARwin or B&R Hypervisor applications:
 - High CPU performance:
 - i3-6100E with 2600 MHz CPU and 500 MHz GPU frequency.
 - i5-6440EQ with 2400 MHz CPU and 500 MHz GPU frequency.
 - i7-6820EQ with 2500 MHz CPU and 500 MHz GPU frequency.
 - High GPU performance:
 - i3-6100E with 2000 MHz CPU and maximum GPU frequency.
 - i5-6440EQ with 1900 MHz CPU and maximum GPU frequency.
 - i7-6820EQ with 2100 MHz CPU and maximum GPU frequency.
 - Mid-level CPU and GPU performance:
 - i3-6100E with 2300 MHz CPU and 800 MHz GPU frequency.
 - i5-6440EQ with 2200 MHz CPU and 800 MHz GPU frequency.
 - i7-6820EQ with 2300 MHz CPU and 800 MHz GPU frequency.

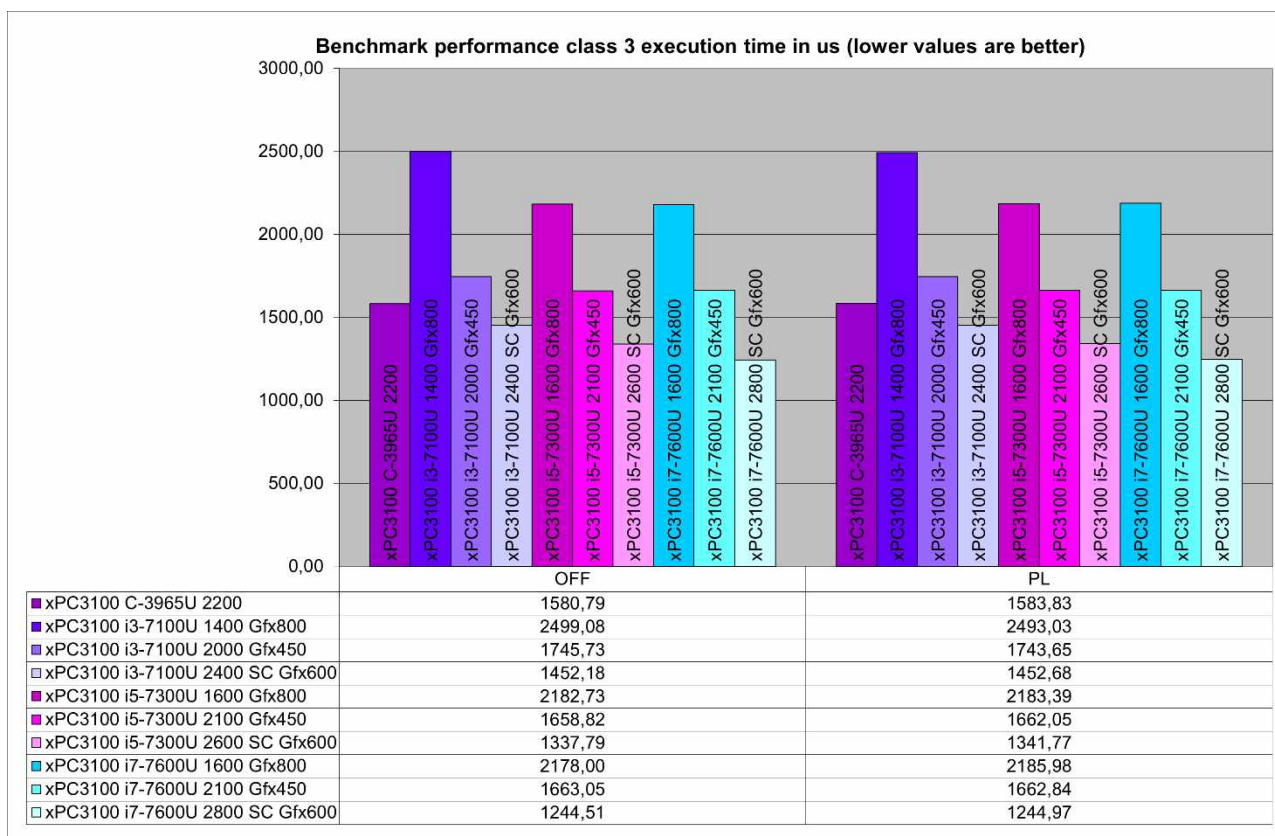


Figure 13: Test results - Execution time in µs - Performance class 3 (xPC3100 with Kaby Lake U)

Information about the graphic

OFF – Results without peripheral load

PL – Results with POWERLINK as load

SC – Single Core

Gfx – Grafik (GPU – Graphics Processor Unit)

Information about Automation Runtime operation

In order to use Automation Runtime (ARemb and ARwin), BIOS setting *Advanced - OEM features - Realtime environment* must be set to *Enabled*.

In situations where there is a heavy load on the CPU and GPU simultaneously, it is possible that the specified Thermal Design Power (TDP) of the CPU is exceeded. When this happens, the CPU's internal protective mechanisms will begin limiting the load to the TDP. This means that either the CPU frequency or the graphic frequency (GPU) will be reduced/controlled. In real-time applications, this can result in increased jitter and/or higher cycle times.

This behavior can be influenced by settings in BIOS. The setting of a permanent CPU frequency must be enabled in BIOS under *Advanced - CPU configuration* using option *CPU flex ratio override*. A maximum CPU frequency can then be set using option *CPU flex ratio settings*. Option *Active processor cores* sets the number of cores being used.

In addition, the maximum frequency of the GPU (Gfx) can be limited in BIOS under *Advanced - Power & Performance - GT power Management control* using option *Maximum GT frequency*.

Limiting the CPU and/or GPU frequency reduces power consumption and prevents the TDP from being exceeded.

The optimal settings for real-time operation depend on several factors:

1. The CPU variant being used

- If CPU C-3965U is used, no further action (BIOS settings) are necessary. For pure ARemb operation, the limiting of active processor cores can be set to 1 in BIOS; this is otherwise recommended.
- If CPU i3-7100U, i5-7300U or i7-7600U is used, see item 2. ARemb, ARwin or B&R Hypervisor mode.

2. ARemb, ARwin or B&R Hypervisor mode

- For pure ARemb operation, the active processor cores must be limited to 1 and the GPU frequency must be limited to an average value, see item 3. Typical ARemb applications.
- For ARwin or B&R Hypervisor operation, see item 4. Typical ARwin or B&R Hypervisor applications.

3. Typical ARemb applications:

The 3 operating modes per core-i CPU shown above in the benchmark diagram are meant to represent typical applications. With the Celeron variant of the xPC3100, limiting the CPU and/or GPU frequency is not necessary:

xPC3100 C-3965U 2200:	xPC3100 is operated with max. CPU and Gfx frequency (single-core operation is recommended).
xPC3100 i3-7100U 2400 SC Gfx600:	xPC3100 is operated as a single-core system with max. CPU frequency of 2400 MHz and Gfx frequency of 600 MHz.
xPC3100 i5-7300U 2600 SC Gfx600:	xPC3100 is operated as a single-core system with max. CPU frequency of 2600 MHz and Gfx frequency of 600 MHz.
xPC3100 i7-7600U 2800 SC Gfx600:	xPC3100 is operated as a single-core system with max. CPU frequency of 2800 MHz and Gfx frequency of 600 MHz.

4. Typical ARwin or B&R Hypervisor applications:

The 3 operating modes per core-i CPU shown above in the benchmark diagram are meant to represent typical applications. With the Celeron variant of the xPC3100, limiting the CPU and/or GPU frequency is not necessary:

xPC3100 C-3965U 2200:	xPC3100 is operated with max. CPU and Gfx frequency.
xPC3100 i3-7100U 1400 Gfx800:	xPC3100 is operated with a CPU frequency of 1400 MHz and Gfx frequency of 800 MHz.
xPC3100 i3-7100U 2000 Gfx450:	xPC3100 is operated with a CPU frequency of 2000 MHz and Gfx frequency of 450 MHz.
xPC3100 i5-7300U 1600 Gfx800:	xPC3100 is operated with a CPU frequency of 1600 MHz and Gfx frequency of 800 MHz.
xPC3100 i5-7300U 2100 Gfx450:	xPC3100 is operated with a CPU frequency of 2100 MHz and Gfx frequency of 450 MHz.
xPC3100 i7-7600U 1400 Gfx800:	xPC3100 is operated with a CPU frequency of 1600 MHz and Gfx frequency of 800 MHz.
xPC3100 i7-7600U 2100 Gfx450:	xPC3100 is operated with a CPU frequency of 2100 MHz and Gfx frequency of 450 MHz.

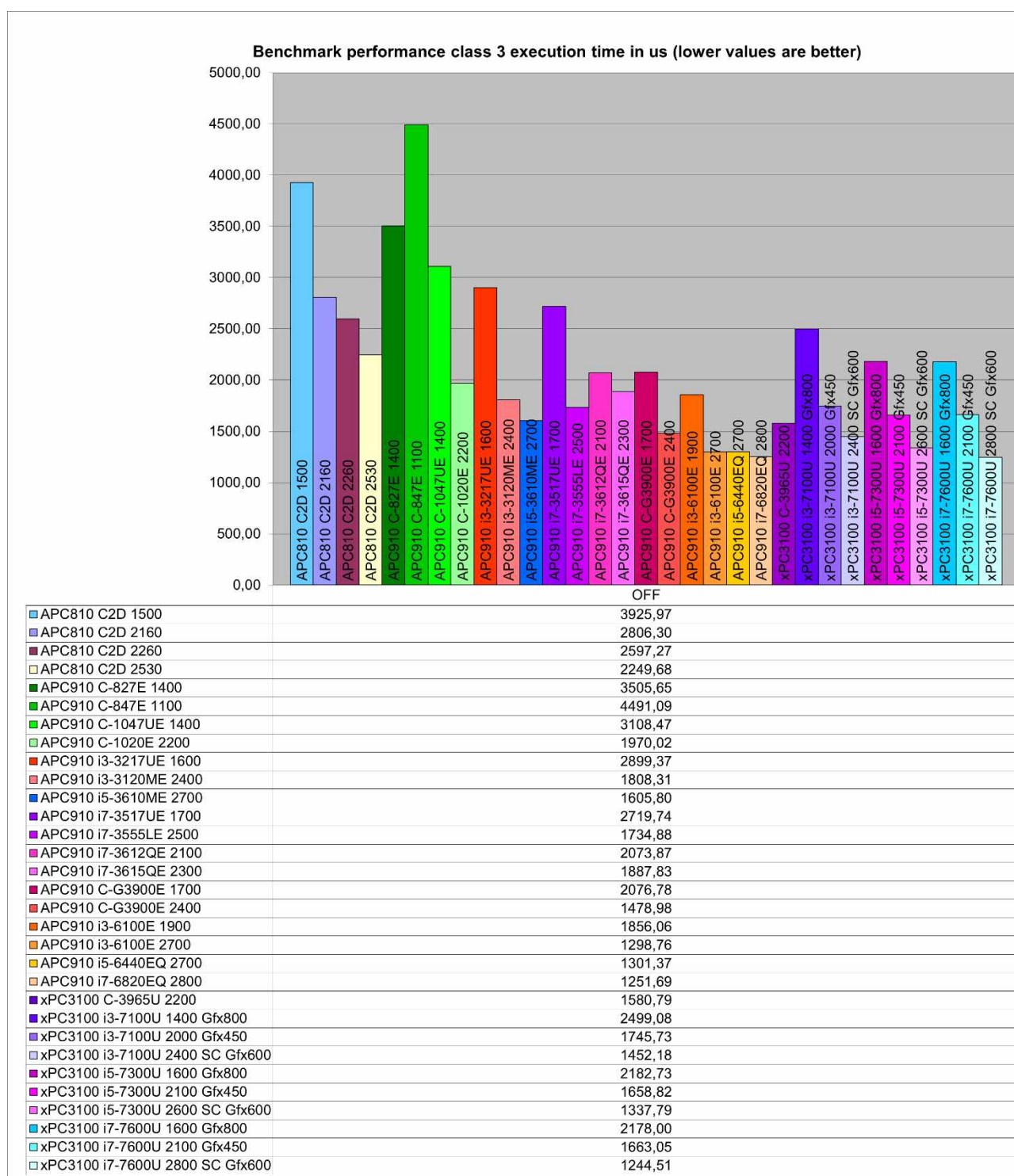


Figure 14: Comparison - Execution time in µs - Performance class 3 (APC810 with APC910 and xPC3100)

Information about the graphic

OFF – Results without peripheral load

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