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## ACCURACY OF TIME MEASUREMENT IN CALIBRATED COMPUTER SYSTEMS

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## INTRODUCTION

Even with the most careful programming it is not possible to create a program that measures time with a high degree of precision in any computer configuration. The measurement difference between different configurations can be up to 12 msec or more (Chroust, Schuhfried 2006: Die Genauigkeit der Zeitmessung verschiedener psychologischer Testprogramme [The accuracy of time measurement of different psychological test programs]). For more precise measurements it is necessary to calibrate the monitor – computer – response panel system for each individual configuration.

In the forthcoming version of the Vienna Test System (Version 6.46, release date April 2007) a calibration function has been added to the hardware test program. The calibration process takes about a minute; an optical sensor, which is connected to the response panel, checks the system's handling of time and makes adjustments if any deviations are found. This calibration should be carried out when the Vienna Test System is installed and whenever the configuration is changed (e.g., when additional programs are installed, even if these programs are not active during a test session).

This study aims to evaluate the effectiveness of this calibration function. As in earlier studies, an “electronic respondent” is used. The start of the stimulus is detected by means of a very fast and highly sensitive photo diode. The signal is amplified and transformed into a digital signal using a threshold value detector. This triggers a highly precise delay circuit, which after a pre-set interval closes a circuit, causing a button to be depressed.

The variation in the measurement results of such a calibrated setup is in the range -2 to +3msec. In percentage terms this amounts to a fluctuation of just under +/-1. Such systems measure with a high degree of precision. The remaining measurement inaccuracy results from stochastic errors in the running of Windows programs, for which it is not possible to compensate.

Initial trials with Windows Vista lead one to fear that Vista gives rise to significantly higher measurement inaccuracies than Windows XP.

## PRODUCT A: RT-S9 (VTS VERS.: 6.36.0.0) $PR_{TARGET} = 33$

The “electronic respondent” was set to have a reaction time of precisely 244 msec. According to the norm score table, this corresponds to a percentile rank of 33.

**Table 1: Measured reaction time at a delay of 244 msec, (percentile rank 33)**

System	PC	Monitor	Measured value	PR
1	Desktop PC 800MHz 128MBRam WinXP	Sony 446XS CRT 85Hz 1280x1024	244	33
2	Desktop PC 1500MHz 512 MBRam Win2000	Nokia 920C CRT 85Hz 1024x768	244	33
3	Desktop PC 2400MHz 512MB Ram WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	244	33
4	Desktop PC 800MHz 128MB Ram WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	245	32
5	Desktop PC 800MHz 480MB Ram WinXP	Samsung SyncMaster 193P 75Hz 1280x1024	243	34
6	IBM Thinkpad R51 Laptop 1500Mz 512 MB Ram WinXP	TFT 60Hz 1400x1500	243	34
7	Acer Travelmate 517TE Laptop 366MHz 64MBRam Win98	TFT 60Hz 1024x768	244	33
8	Acer Travelmate 722TX Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	246	32
9	Acer Travelmate 525TX Laptop 700MHz 128MBRam Win Millenium	TFT 60Hz 1024x768	244	33
10	IBM Thinkpad 600E Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	243	34
11	IBM Thinkpad 600 Laptop 500MHz 160MBRam Win98	TFT 60Hz 800x600	243	34

Depending on the computer configuration used, the reaction times reported by the test program range between 243 and 246 msec; the percentile ranks obtained are between  $PR = 32$  and  $PR = 34$ . The difference between the measured and the set time is in the range  $-1 / +2$ msec.

The reaction times quoted represent the mean of the measured reaction times from 28 items. The individual measurements vary in an equally distributed manner by  $\pm$  half of the reciprocal screen refresh rate.

**PRODUCT A: RT-S9 (VTS VERS.: 6.36.0.0) PR<sub>TARGET</sub> = 20**

The “electronic respondent” was set to have a reaction time of precisely 268 msec. According to the norm score table, this corresponds to a percentile rank of 20.

**Table 2: Measured reaction time at a delay of 268 msec, (percentile rank 20)**

System	PC	Monitor	Measured value	PR
1	Desktop PC 800MHz 128MBRam WinXP	Sony 446XS CRT 85Hz 1280x1024	268	20
2	Desktop PC 1500MHz 512 MBRam Win2000	Nokia 920C CRT 85Hz 1024x768	267	21
3	Desktop PC 2400MHz 512MB Ram WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	267	21
4	Desktop PC 800MHz 128MBRam WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	267	21
5	Desktop PC 2800MHz 480MB Ram WinXP	Samsung SyncMaster 193P 75Hz 1280x1024	266	21
6	IBM Thinkpad R51 Laptop 1500Mz 512 MB Ram WinXP	TFT 60Hz 1400x1500	268	20
7	Acer Travelmate 517TE Laptop 366MHz 64MBRam Win98	TFT 60Hz 1024x768	267	21
8	Acer Travelmate 722TX Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	269	20
9	Acer Travelmate 525TX Laptop 700MHz 128MBRam Win Millenium	TFT 60Hz 1024x768	271	19
10	IBM Thinkpad 600E Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	269	20
11	IBM Thinkpad 600 Laptop 500MHz 160MBRam Win98	TFT 60Hz 800x600	269	20

Depending on the computer configuration used, the reaction times reported by the test program range between 266 and 271 msec; the percentile ranks obtained are between PR = 19 and PR = 21. The difference between the measured and the set time is in the range -2 / +3msec.

The reaction times quoted represent the mean of the measured reaction times from 28 items. The individual measurements vary in an equally distributed manner by +/- half of the reciprocal screen refresh rate.

**PRODUCT A: RT-S9 (VTS VERS.: 6.36.0.0) PR<sub>TARGET</sub> = 16**

The “electronic respondent” was set to have a reaction time of precisely 285 msec. According to the norm score table, this corresponds to a percentile rank of 16.

**Table 3: Measured reaction time at a delay of 285 msec, (percentile rank 16)**

System	PC	Monitor	Measured value	PR
1	Desktop PC 800MHz 128MBRam WinXP	Sony 446XS CRT 85Hz 1280x1024	285	16
2	Desktop PC 1500MHz 512 MBRam Win2000	Nokia 920C CRT 85Hz 1024x768	284	17
3	Desktop PC 2400MHz 512MBRam WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	286	16
4	Desktop PC 800MHz 128MBRam WinXP	Samsung SyncMaster 192v 70Hz 1280x1024	286	16
5	Desktop PC 2800MHz 480MB Ram WinXP	Samsung SyncMaster 193P 75Hz 1280x1024	284	17
6	IBM Thinkpad R51 Laptop 1500Mz 512 MBRam WinXP	TFT 60Hz 1400x1500	285	16
7	Acer Travelmate 517TE Laptop 366MHz 64MBRam Win98	TFT 60Hz 1024x768	287	16
8	Acer Travelmate 722TX Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	284	17
9	Acer Travelmate 525TX Laptop 700MHz 128MBRam Win Millenium	TFT 60Hz 1024x768	287	16
10	IBM Thinkpad 600E Laptop 500MHz 64MBRam Win98	TFT 60Hz 1024x768	284	17
11	IBM Thinkpad 600 Laptop 500MHz 160MBRam Win98	TFT 60Hz 800x600	286	16

Depending on the computer configuration used, the reaction times reported by the test program range between 284 and 287 msec; the percentile ranks obtained are between PR = 16 and PR = 17. The difference between the measured and the set time is in the range -1 / +2msec.<0}

The reaction times quoted represent the mean of the measured reaction times from 28 items. The individual measurements vary in an equally distributed manner by +/- half of the reciprocal screen refresh rate.