

Change bellows - An XT becomes an AT

The AT-Board Hirt-286S is an exchange motherboard that turns a slow XT compatible personal computer into an AT computer. A small modification and you are ready to go with a 80286 microprocessor clocked below 10 MHz.

There are three ways to speed up a slow XT-compatible personal computer.

1. you install a small add-on board in the socket of the 8284A clock frequency device. It contains two 8284A clock generators and a 24 MHz crystal that provides the higher system clock ($24 \text{ MHz}/3 = 8 \text{ MHz}$). The clock frequencies of the system bus 14.318 MHz on B30 and the timer IC 8253A with 1.19 MHz are retained. The processor clock can be switched between 4.77 and 8 MHz. This is a quite cheap but very problematic solution. All devices in the PC/XT are only designed for 5 MHz and the achievable speed advantages are moderate. Rarely the additional hardware is installed on a separate card.

2. one installs in an expansion slot an additional card to an independent processor system 8086 or 80286, which takes over the functions of the existing 8088 CPU. The 8088 CPU is demoted to an input/output processor or must be removed completely because the add-on card requires a ribbon cable connection to the motherboard CPU socket. This solution is of course much more expensive, the probability of being incompatible with the industry standard is very high.

3. remove the old motherboard and replace it with a new 80286 motherboard. The result is an AT-compatible system, which does not need to shy away from a comparison, often even outperforming original ATs. This solution offers, without compromises, the best price/performance ratio.

AT motherboard for XT computers

The core of such retrofit boards is usually the IC set from the Californian company Chips and Technologies. These are highly integrated components. They form the heart of the board. The 80286 CPU, the 8254 timer, the 8237 DMA controller etc. are grouped around them. On the hardware side, this suggests full compatibility with the original and brings a considerable price advantage with high reliability. The BIOS usually comes from Phoenix or from Awards Software Inc. Both work very closely with Chips and Technologies. I replaced the motherboard in an XT-compatible personal computer with the Hirt-286S AT-Turbo motherboard and was speechless. The old XT was unrecognizable. Pleasantly surprised was the high quality of the multilayer board. Not a single subsequent correction with wire-wrap was to be discovered. With some, also renowned manufacturers, one finds whole wire harnesses. Oscillograms of the address and data signals on the DRAMs confirmed the external impression. The board is delivered with a small English brochure. It is rather vague in some points, so that some tact is necessary for the installation of the new system board. The motherboard is fixed to the computer case with two screws. It has to be moved sideways. Several plastic nipples run in guide rails. These nipples are removed and used for the new board. Before, of course, all additional cards had to be removed. One should be very careful to note the attachment of the cables and their orientation. Small colored stickers on connectors and boards are very helpful. Power supply, hard disk(s) and floppy drives remain in the system. Following the instructions provided, check the various jumpers on the new board. After 30 to 60 minutes the system can be switched on again. It is advantageous to build and test a floppy system first. I will mention the reasons later. At full satisfaction the hard disk adapter is installed. This is hardly more time consuming, but much safer. A wrong input at the hard disks is very easily interpreted as a hardware error. With most AT systems, the user has to enter information about his hardware with a SETUP program. The values are stored in a battery-buffered RAM area and used in the POST check, in the BIOS tests, at power-on. This utility is not part of the standard scope of delivery. However, it is absolutely necessary for the use of the board. The setup program can either be purchased from the board's distributor, or more conveniently, the board can be ordered directly customized to the hardware used. The setup program asks the user for the number of installed hard disks. The answer must be 0. This means the drives which are addressed by the hard disk BIOS on the motherboard via an ATCombo adapter. Entering a type number (e.g. for ST 238 = 2) causes the system to crash. Reason: An XT hard disk adapter contains its own BIOS in an EPROM. A conflict situation arises during system boot. Both HD routines are initialized, the routine on the motherboard because a type number in the CMOS RAM, the routine in the XT adapter EPROM because in the address range from C8000H the EPROM is found. The whole disk/hard disk system becomes unusable. Removing the EPROM from the XT adapter is not a solution. The remedy is: remove the XT hard disk adapter from the system, perform a new SETUP, specify the number of hard disks as 0, switch off the system, install the XT

controller, reboot. Voila, the racehorse gallops again. But now let's get a bit closer to the actual hardware of the AT-Turbo board. The motherboard uses the IC set from Chips and Technologies, which has been available for about a year. It consists of 5 CMOS or ALS-TTL gate arrays, which replace about 60 ICs of the ATS. This brings a lower load for the power supply and lower temperatures in the package. Truly not a disadvantage. The set is available in two versions, for 8 and 10 MHz system clock. Via a jumper, a switch can be installed, one selects a clock rate of 6 MHz or 10 MHz for the Hirt board. A display of the turbo mode with a light emitting diode is possible. Also during the operation of the computer this clock frequency can be changed with a switch, without causing a program crash with it. Due to the imprints on the components, we could determine that the manufacturers only guarantee a safe operating frequency of 8 MHz for two of the components used. 80286-CPU and the Chips and Technologies set were designed for 8 MHz. The external generation of two signals for RAM addressing (RAS+ALE) required for 10 MHz was available. Obviously, not enough large quantities of the 10 MHz versions are available yet. They can be replaced later. In the Chips and Technologies set, this is only one component, the P82C201 system controller in the P82C201-10 version. CPU and system controller are socketed. Faster dynamic RAMs with 100 ns access time would also be a great advantage. However, they are still relatively expensive at the moment. Interferences could not be determined in the 10 MHz mode without waitstates with 120 ns RAMs and 250 ns EPROMs, however. The tolerances of the components were probably quite high. The RAM of the Hirt board consists of four rows, i.e. two memory banks. 64-KBit and 256-KBit chips can be used. If 256-KBit chips are used (maximum 1 MByte), 512 KByte must be specified as basic memory and 512 KByte as extended memory (addresses above 100000H) in the SETUP program. The maximum PC DOS memory of 640 KByte can be reached with a mixed configuration. Bank-0 256-KBit and Bank-1 64-KBit chips. This is a feature of the chipset, which supports only 4 memory models in decoding. The motherboard contains 7 headers, four of which are designed in 16-bit and three in 8-bit technology. The XT compatible slots accommodate the screen adapter, the floppy adapter and the hard disk adapter after the conversion. The four AT strips are free for expansions. Additionally, the motherboard contains an asynchronous interface. A socket for an 80287 coprocessor is also not missing and programmers will welcome the connection option of a button for a hardware reset. The hard disk thanks this option with a longer lifetime. The timing of the ROM addressing has been optimized in the Chips and Technologies kit. Therefore slower EPROMs can be used. However, the ROM addressing on the Digicom board is not completely error-free. The BIOS is located in two 27128 (16 KByte each), at the addresses 0E8000 - 0EFFFFH and 0F8000 - 0FFFFFFH. However, this doesn't bother the user if the range 0E0000 to 0EFFFFH is left out. The technical manual for the IBM PC shows it as reserved. One can use the EPROM types 27128 and 27256. A jumper is set accordingly. The reason for the double addressing is an imperfect decoding in this area. The Chips and TechnologiesSatz supplies only a ROM CS signal (CS= chip select) for the range 0E0000H to 0FFFFFFH. A further link with the address line A16 was obviously forgotten or not considered necessary. This is the only shortcoming I could find during a test period of several weeks. On the positive side, the full system clock is passed on in the header via B20. You can install memory cards without waitstates as extended memory if they support the 10 MHz clock. I have examined three BIOS versions. Phoenix version 1.58 did not accept the XT keyboard. The system did not boot. You can use the BIOS from Awards Software INC. (tested versions 2.03 and 2.07). If you want to convert an original IBM PC with the new AT board, you have to give up your usual Basic. A ROM-Basic is not available with the exchange ROMs. BASIC.COM and BASICA.COM are therefore not executable. But Microsoft's GW-Basic eliminates this weakness. However, it does not belong to the scope of supply of the board, must be bought therefore additionally.

AT performance without limitations

After the rebuild, my system included a floppy controller with two YE-DATA 580 floppy drives, Western Digital's WD1002-WX1-(BIOS 62- 000094-031-) hard drive adapter with a Seagate ST238 hard drive, and a monochrome display adapter. Tests were run with this configuration. Since an 8-bit DMA transfer, which an XT hard disk system also performs on an ATBoard, is relatively slow, the tests were repeated with a PC Magazin PLUS No. 7/8 of June 16, 1987 combo adapter, which favors a 16-bit I/O transfer. The time advantages are considerable. Small time gains are achieved with a lower interleave factor. The recommended standard in the XT is 1:6 for the XEBEC adapter, only 1:3 for the WD1002-WX1. Small problems can occur in color systems. There is no possibility to adjust the 14.318 MHz oscillating circuit. The color burst signal is derived from it. In case of a deviation, color shifts occur. The board is incompatible with some utilities in 10 MHz mode. Switching to 6 MHz helps. Otherwise I couldn't recognize any incompatibilities. If 100 ns RAMs, a 10 MHz processor and a 10 MHz system controller

are used, the safety margins are also sufficient. A BIOS in faster EPROMs (170 ns) should also be thought of. An increase to a 12 MHz clock, which is possible according to the brochure by exchanging an oscillator, is not advisable in my opinion. Too many components are then outside their specified operating range, especially the system controller, which as a core component supplies the clock times. The safety margins shrink. The susceptibility to errors increases. In addition, 12 MHz would have to be run with a wait state. Compared to 10 MHz without wait-states, this results in a performance loss of around 20 percent. A 12 MHz system without wait states can only be implemented with more complex and expensive physical memory models such as cache memory. After the very positive tests, only one small drop of bitterness remains. In terms of hardware, some additions have obviously been realized by Digicom via the keyboard controller, and the additions are supported differently by the BIOS versions. For example, the Awards BIOS 2.03 and 2.07 accepts both AT and XT keyboards, but does not support a 640 KByte PC-DOS/ 384 KByte extended memory model. The Phoenix BIOS version 1.58, on the other hand, only accepts an AT keyboard, but, as I was told by the manufacturer in response to my queries, it should support a 640 KB PC-DOS/ 384 KB Extended Memory memory split. So there is obviously a lack of closer cooperation between the companies writing the BIOS and Digicom, the Taiwanese producer of the board, so I would advise to ask the dealer which keyboard can be used with the new AT system board. It might be necessary to do without the usual keyboard, which is not only a cost factor that should not be underestimated, but also the time needed to get used to the new keyboard. (Harold Milbradt/wg)

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