28 HOW TO BUILD AN IBM XT LOOKALIKE

28.1 IBM XT BUILDING BLOCKS

With the IBM PC expansion boards now available it is possible to configure a system that uses the minimum of IBM components. For example, if a PC, not the XT hard disk version, is obtained with only one floppy disk drive, 64 Kb of memory and the keyboard (even that does not have to be IBM) this configuration can be expanded to become a 64 Kb system with a hard disk, colour/graphics monitor, serial/parallel ports, clock/calendar and be fully compatible with the XT.

The expansion units for effecting this type of upgrade are, for example, currently provided by the Quadram Corporation of America, whose products are distributed in Europe by Interquadram. If a minimally configured PC is expanded to become an IBM XT lookalike, it will be significantly cheaper than an XT whilst still remaining 100 percent compatible because the IBM Bios is used, see Appendix 6.

However, one can go a stage further by constructing the equivalent of a minimally configured PC available from IBM dealers, and the purpose of this chapter is to show how this can be done and how it can be expanded to become a fully compatible IBM XT lookalike.

A minimal system from an IBM dealer consists of the main printed circuit board (or motherboard), disk drive and keyboard. The motherboard will contain the microprocessor, or microprocessors if the numerical chip is also used, 64 Kb of system RAM (expandable to 256 Kb on the motherboard), system ROM containing Bios and BASIC firmware support logic and the five expansion slots and connectors. Also included is the floppy disk controller, a printed circuit board that plugs into one of the five expansion slots on the PC.

When this configuration system is purchased from IBM one floppy disk drive is mandatory; this can be either 160 Kb or 320 Kb capacity, although normally one would select the larger unit. A system power supply (rated at 63 watts) is included, this also contains the A.C. mains supply, I/O sockets and the supply on/off switch.

All these items are mounted inside a metal enclosure that forms the IBM PC case. Note that the system loudspeaker is also fixed within this enclosure. The final item is the keyboard but, as mentioned above, this could be replaced with one of the IBM equivalents that are readily available, unless it is considered important to keep the IBM logo on at least one part of the configuration.

Thus the minimum PC configuration that IBM will supply is a 64 Kb machine with one floppy disk controller. In the UK this costs £1,131 and from this one can build up to an IBM XT lookalike. The question is can this minimally configured PC be built more cheaply? The rest of this chapter explores the issues in building an XT motherboard and of configuring the unit using standard add-in boards.

28.2 THE MEGA-BOARD

The items detailed above all are readily available from numerous sources, with the exception of the two printed circuit boards. Recently, however, Display Telecommunications of Dallas have introduced a single board computer, the Mega-Board, which is functionally compatible with the XT main printed circuit board. Given that the main printed circuit board is the heart of the system, the Mega-Board appears to be an attractive alternative board. The other printed circuit board, the floppy disk controller, can be readily obtained as a spares item from any IBM dealer.

In order to test the feasibility of utilising the Mega-Board as the main printed circuit board one was obtained from Display Telecommunications Corporation. It is a 10·5 inch x 13·5 inch double sided, plated through-hole, silk screen, solder mask printed circuit board. Its layout provides for eight expansion interface connectors plus a gold plated 62 way edge connector which is part of the board. This edge connector can be used to further expand the interface bus. Provision is made on the board for a reset switch; the switch can be fitted directly to the board or located remotely. The reset logic provides a system reset that results in a cold start when the switch is activated, this method is preferable when compared to IBM where, in order to obtain a cold start, the power unit has to be switched on and off.

The memory area of the board is divided in two sections: static memory and dynamic memory. The static area consists of five 28 way sockets, which is further divided into two groups, one of two sockets for ROM or EPROM and the other of three sockets for RAM, ROM, EPROM, or EEPROM. The first group can be configured by links on the board to accommodate memory integrated circuits whose capacity can range from 8 Kbs to 128 Kbs. The second set can be also configured for use with circuits with capacities ranging from 2 Kbs to 32 Kbs.

The dynamic memory section consists of four sets of nine sockets and, like the static memory area, is configurable for use with different types of memory circuits, e.g. 16 K, 64 K or 256 Kbs DRAMS. If one were to use the 256 Kbs circuits, then the on board memory capacity would be a full Mb.

There is also a small area of the board for wire wrap pins and sockets; this is to facilitate special custom applications. In all other respects the board offers the same capabilities as the XT main printed circuit board, even the options switch on the Mega-Board has the same settings.
One final point to note is that, although the power connector on the Mega-Board has the same pin out as the IBM connector, the type supplied by DTC is of a different style and would not mate with IBM power supply connections. This in itself is not a major problem for it is unlikely that an IBM power supply would be used in any final configuration since most OEM hard disk manufacturers use a separate power supply.

28.3 POPULATING THE MEGA-BOARD

A bill of materials is supplied with DTC’s Mega-Board. This is equivalent to a parts list and it itemises all those parts necessary to component the blank board. A user’s manual was also obtained, this document describes the logic of the board but it gives only a brief description on how to construct it. The manual is definitely intended for users who are fully conversant with digital electronics and it is not a constructor’s manual as might be supplied with a kit computer. At the end of the manual there also is a full set of logic diagrams which, no doubt, will prove to be invaluable.

For the board to be equivalent to an XT, the Mega-Bios Read Only Memory is required. This part, when installed, provides a Bios that is compatible to the one used on the XT. Before the board could be assembled a kit of parts had to be made up utilising the information obtained from the bill of materials. All the items were listed by manufacturer’s part number and description together with the required quantity. The first items to be sourced were the sockets and connectors. Low profile turned-pin sockets were chosen for the Intel 8000 series and memory integrated circuits (the other integrated circuits were not socketed so as to ensure high reliability). There was no difficulty with the supply of these, but an initial enquiry for the 62 way connectors, used for expansion boards, resulted in delivery time of many months being quoted.

The next set of items that was considered to be a possible problem were the integrated circuits. These circuits were divided into two distinct sets. The first was the 8000 series, which consisted of the 8088 microprocessor support circuits; it was impossible to source all of these items on a reasonable delivery time. The second set was the 74LS and 74S general purpose integrated circuits and, after much difficulty, they were obtained from several different suppliers. It must be remembered that all this procurement was taking place during a world wide shortage of components.

The resistors, capacitors and resistor packs were easily obtained, their manufacturers were not the same as specified on the bill of materials but equivalents were found. It was obvious from the bill of materials that certain items would have to come directly from DTC; for example, the pre-programmed PROM used in the memory address decoding scheme. Other items such as the delay lines, the crystal and its trimming capacitor also had to come from DTC since they stocked components with the correct dimensions for use with the board. Fortunately DTC were able to provide items that were obtainable in the UK together with the special components and, at the same time, a listing of the Mega-Bios was ordered. With the kit of parts now completed, it was possible to start assembling the board.

The board is supplied with pre-printed component identifiers so that the destination of each item can be found. The first items to be inserted on the board were the capacitors, and care was taken to ensure that the polarity of the tantalum capacitors was correct. If these are reversed on insertion they can explode; once located they were carefully soldered. With regard to soldering, the board is a high quality product with a high component density and consequently the tracks and solder pads are finely dimensioned. Therefore a precision temperature controlled soldering iron was used.

Having completed the fitting of the capacitors, the connectors and sockets were installed and soldered. Sockets for integrated circuits were only installed where the integrated circuit was either one of the 8000 series or a memory circuit. This was done to improve reliability and at the same time allow sensitive or relatively high cost items to be easily changed. A reset switch was not fixed to the board where provided, this function was to be performed remotely. Resistor packs, resistors, delay lines, diode, crystal and its trimming capacitor concluded the componenting and soldering of the passive items. At this stage the components fitted so far were checked for correct orientation and type with respect to the information printed on the board. Integrated circuits that were to be soldered in were now fitted and checked for correct placement and orientation prior to soldering.

All that was now left was to trim the three metal busbars that were required on the board and the fitting of one dil switch. Information for trimming the busbars is supplied when they are obtained from DTC. It consists of a photocopy of already trimmed busbars and the individual busbar specification. There was no indication as to which way the busbars went but, on attempting to locate them, it was found that they would fit correctly in only one position. These items were duly fitted and soldered, then the 8000 series integrated circuits were inserted into their respective sockets, eighteen 64 K bit DRAMS into Row 0 and Row 1 to give a 128 Kb of memory and finally the Mega-Bios into socket J4. The fully populated board is shown in the photograph opposite. Having completed all this, the Mega-Board was now ready for testing and rectification of any possible faults.

28.4 CONFIGURING THE MEGA-BOARD

The final configuration for this project is the 128 Kb Mega-Board, Fujitsu 5·25 inch half height floppy disk drive, Quadram 6 Mb hard disk unit and controller, IBM floppy disk controller, Quadram ‘Quadvue’ expansion card, IBM keyboard, Monochrome display from Interquadram, ‘Total Access’ enclosure from Bicc-Vero and an 130W Boschert switching power supply.

The hard disk from Quadram is fully XT compatible and allows an operating system to be ‘booted’ from a cold start. The ‘Quadvue’ board controls the monochrome screen, provides both serial and parallel ports and supplies the system with a time of day.