

X2. Systems architecture. First give a couple of sentences describing the machine and its intended applications areas, so as to fix its position in the market relative to other machines designed at the same time. Include a brief note on the CPU and memory technologies employed. Then give: (a) a register-level description (possibly including a simple diagram) of the CPU; (b) a system-level diagram which illustrates the interconnections and main characteristics of the memory and input/output equipment, plus an indication of configuration options; (c) where appropriate, operating system versions with overall characteristics. For (a), (b) and (c), use the original terminology and also provide notes that allow a modern reader to understand what's happening. Give accurate references to the sources of all information – see X5 below. (Contributes to blocks B1 and D4 of the final *Our Computer Heritage* database).



E5X2. Elliott 900 Series: Systems Architecture.

Series Overview.

The Elliott 900 Series computers were introduced by Elliott Automation during the 1960s, and continued in production through the 1970s. They were transistorised machines with ferrite core memory and parallel arithmetic.

The majority used 18-bit words, but there were some cut-down 13-bit and 12-bit versions. The hardware implementation evolved over time, and the machines were packaged differently for three primary market environments: Military, Office, and Industrial.

The 18-bit machines in historical order were:

- 901
- 920A
- 920B, 903, ARCH 9000
- 920M
- 920C, 905, ARCH 9050
- 920ATC & MC1800

The Cut-Down machines were:

- 13-bit: ARCH 102,
contemporary with *920A or 920B?*
- 12-bit: 902, 102C, ARCH 105,
also known as Minim or 12/12,
contemporary with 920C, 905, ARCH 9050.

To quote a sales brochure of the era, “Elliott-Automation 900 Series Small Low-cost Computers” [1]:

“The Series was introduced by the 920A computer, which is in service with the Royal Navy, the Army and the Royal Air Force. 920A machines are controlling

road traffic in Germany, directing interceptor aircraft in Holland and are mounted in Land Rovers and aircraft.”

“The 920B followed the 920A and with it the first big reduction in cost was achieved. The civil version of the 920B, the 903, is the successor in title to the highly successful Elliott 803, in its day the most popular and widely applied of all British designed computers. For teaching computing in schools and technical colleges the 903 is unsurpassed and it equips the world’s first mobile computing classroom. It is ideal for many scientific, design and engineering applications.”

“The 920B and the 903 established themselves in less than a year as the most generally useful computers ever designed. Their versatility created a new dimension in computing. The demand for them is so great that they are now being manufactured from quantity-produced modular assemblies.”

“The rapid development of microelectronics, with production line manufacture of components and sub-assemblies, has led to the design of the 920M – M standing for Microminiature. The 920M is one of the first computers ever designed for quantity production from prefabricated component modules.”

“As each new version has been introduced so has performance been increased. Already an even faster yet equally rugged computer is in production: the 920C, eight times faster than the 920B, which is itself two or three times faster than the 920A.” *In fact, although the 920B’s multiply and divide were 2.4 times faster than the 920A’s, most other instructions were only around 30% faster. Remember that this is a sales brochure.*

“Close on the heels of the 920C have come simplified, lower cost derivatives offering the same high performance capacity over a less extreme temperature range. These are the 902 and 905, and their “Arch” equivalents, assembled from a range of standard rack-mounting units to form highly competitive computer systems for commercial and industrial applications.”

“Newest of all is the microminiature 102C, functionally similar to the 902 but even further scaled down in size to suit military (air, sea and land) mobile installations.”

“This family of computers is unique.”

18-bit machines.

901.

I’m not sure if this belongs in the “900 Series”. Was it 18-bit, transistor, core, parallel? It’s before my time. I only know about it from some notes recently sent to me.

920A.

I don't think that I've got any literature about the physical aspects of the 920A. The 920A CPU with an 18-bit 8192-word store was housed in a substantial casting, painted olive green, which was not that much larger than a 920B. The one we had in Rochester ran off a very noisy 400 Hz power supply.

The maximum store size was 8192 words. Reference [2] makes it clear that extra store was never available. *However, reference [3] suggests that 8192 words was not the only store size used, so were there 4096-word 920As? CCS member Peter Lawrence suggests that this could have been just a design option that was never been implemented.*

920B, 903, ARCH 9000.

The following information is mainly taken from the 920B and 903 Facts Cards, [5] & [6], and from "Elliott 900 Technical Manual, Volume 4, Engineering Maintenance, Part 6, Logic Elements", [29].

The 920B CPU with an 18-bit 8192-word store was available:

- in a sealed military pack, measuring 81.2 x 47.3 x 21.3 cm and weighting 41 kg, or
- for a 19" rack mounting, measuring 80.0 x 48.3 x 22.6 cm and weighting 34 kg.

A choice of power supplies was available for DC, 50 Hz, or 400 Hz. The average dissipation of the CPU with an 8192-word store was 120 watts.

The store of a 920B or 903 was extensible in units of 8192 or 16384 words to a maximum of 65536 words. *I have seen a suggestion that some 920Bs or 903s only had a 4096-word store. I have no software or documentation which would support this view. Both I and CCS member Peter Lawrence (the main designer of the 920B?) believe that the minimum 920B/903 configuration was an 8192 word store.*

For program development, a 920B would be supplied to an Elliott division, with a Control Panel, usually with a neon register Display Unit, and with a paper-tape reader and punch, but usually with no on-line TeleType. Programs would be prepared on FlexoWriters.

When delivered to the end user, a 920B might well be connected to the application by a bespoke InterFace Unit (IFU), and with an "autostart" plug in lieu of the Control Panel. The binary program would be loaded from a Program Loading Unit (PLU) into Core memory, where it would remain, whether there was power on the system or not, until an update was required.

The 903 was supplied in a desk measuring 94cm high, 66cm deep, 109cm wide, housing two 19" racks, one for the CPU with an 8192-word store, the other for the CPU power supply, paper-tape and TeleType logic, and the paper-tape power supply. The Control Panel, and paper-tape reader and punch, stood on this. A TeleType was usually supplied, but not the neon register Display Unit.

Extra store for a 903 would be supplied in a second desk, which provided a power supply sufficient for 24576 words with space for an 8192-word store in one of the 19" racks, and space for a 16384-word store in the other 19" rack.

The CPU of a 920B/903 contains 75 circuit boards, measuring 8"x5" (20x13cm). Most of these are populated with "Logic Sub-Assemblies", typically 14 to a board. Each LSA can hold up to 3 transistors plus other components, and so can implement up to 3 "basic logic elements" using Diode-Transistor Logic. For example, LSA01 implements three 2-input NAND gates, LSA03 is a 4-input NAND gate and two NOT inverters.

920M.

The following information is mainly taken from the 920M Facts Card, [8], and from the brochure "Elliott-Automation 900 Series Small Low-cost Computers", [1].

The 920M "is constructed from about 450 inexpensive throw-away modules and includes a miniature 8192-word core store, all housed in three hinged segments, two containing logic and the other the store and its circuitry". "When closed up the 920M measures only 12.56" x 7.50" x 7.63" [30.8 x 18.4 x 18.7 cm]. This three-layer configuration in the form of a 3/4ATR package is ideal for the computer's aerospace applications".

"The 920M incorporates the latest micro-circuit forms of the well-proven DTL type of logic circuit which has proved so successful in previous 920 Series computers", but whereas the 920B is mostly discrete components, the 920M is mostly integrated circuits.

The power dissipation is 45 watts with the 8192-word 5μsec store, and 65 watts with the 8192-word 2μsec store. The 8192-word internal store is extendable to 32768 words by additional units.

920C, 905, ARCH 9050.

The following information is mainly taken from the 920C and 905 Facts Cards, [12] & [13], and from the brochure "Elliott MCS920C Microminiature High-speed Computer", [11].

The 920C CPU *with no internal store* measures 43.2 x 12.7 x 19.1 cm. "Store capacity consists of one or more external 8192 or 16384 word units, directly addressable, up to a maximum of 131072 words". An 8192-word store measures 43.2 x 25.4 x 10.2 cm. Power consumption with one 1μsec store is 150 watts.

The 905 was supplied as 19" rack-mounted units or in a desk measuring 91cm high, 61cm deep, 107cm wide. Store could be expanded using 8192-word modules to 65536 words or using 16384-word units to 131072 words.

Note that the wording differs for the 920C and 905. Was the 920C also limited to using 16384-word units to achieve 131072 words, because of a driver limitation; or did this limit only apply to a 905, because of a power supply or desk-size limitation?

The 920C/905 Control Panel featured a row of lights, and a multi-way switch, which enabled the contents of the registers to be inspected in turn. This replaced the optional neon register Display Unit, that some 920Bs and few if any 903s had.

920ATC & MC1800.

The 920ATC was built by Maritime Aircraft Systems Division, Airport Works, Rochester.

The MC1800 was built by Marconi Space and Defence Systems Limited, *Frimley or Stanmore?* “based upon the AMD 2901 bipolar, bit-sliced microprocessor”. See [30].

12/13-bit machines.

ARCH 102.

A 13-bit machine.
Contemporary with *920A or 920B?*

I'm not going to include this in the Pilot Study.

902, 102C, ARCH 105.

12-bit machines, also known as Minim or 12/12.
Contemporary with 920C, 905, ARCH 9050.

I'm not going to include these in the Pilot Study.

Terry Froggatt, April 2004.