

**Business Computers Ltd / Business Computer (Systems) Plc:
The Molecular 18 minicomputer.**

Contents.

1. General introduction.
2. Models and Machine Versions
3. Delivery List and Applications
4. Systems Architecture
 - 4.1. Instruction Set and Timings
 - 4.2. Hardware and system interconnections
5. Software and Sample Programs
6. The Company History
7. List of references

1. General introduction.

The BCL Molecular 18 is an 18-bit minicomputer designed in England in 1970 and first sold in 1972. Initially the typical system comprised a Molecular 18 processor, one disk drive, one printer, one terminal, and a paper tape punch/reader station. Later systems included a Molecular 18 processor, at least one disk drive and up to 24 terminals and printers in total.

The architecture of the processor design remained little changed until production stopped in the early 1990s: the basic word length was 17bits - the machine's name took into account an 18th bit reserved for parity checking.

BCL sold systems primarily to wholesale distribution companies, tool merchants, builders' merchants, and wholesale paper merchants. In almost all cases, the system software and application software was also provided by BCL.

Business Computers Ltd. (BCL) was founded in 1969. The company's roots can be traced back to three earlier companies: Unex Ltd. (established in the late 1930s), Lows Calculators (1939) and Systemation Ltd. (1961). Unex and Lows designed electro-mechanical calculators and Systemation designed electronic calculators, the earlier ones being special-purpose and the later ones general-purpose. The full business history of BCL, its origins and its eventual demise, is given in section 6 below.

2. Models and Machine Versions

Several variants of the Molecular 18 were produced between 1970 and 1986. These are summarised below.

Mk 1 1970

First production model designed by Colin Chapman & Ian Miller 1.6 μ sec. Cycle Time; 850nanosec. core memory.

Mk 2 1973

A new processor design, but not compatible with the Mk 1. Given the volume of software already produced for the Mk 1 this was not a commercial success and was not pursued.

Mk 3 1974

Also known as, and generally marketed as, the 6/ME. This is a Mk 2 processor modified to support the Mk 1 instruction set.

Mk 4 1978

Physically a new design using the same processor as the Mk 3. This was also the first model to use a semiconductor store.

Mk 5 1984

Re-engineered Mk 3 or 6ME processor, designed to remove redundant stack logic and reduce the build to 3 boards. Hardware was re-designed by Keith A. Howlett of Systemation Development Ltd. Features of the original processor such as base and limit registers, a stack pointer and auto-increment and auto-decrement registers were removed.

Distributor 1986

Same processor, memory and IO cards as Mk 5, but new case.

Distributor / EP (Extended Processor)

As the 1986 Distributor but with a software control panel, integrated modem for remote support and device handlers for standard SCSI hard disks.

Systemation Amigo

A brand new design of the processor, including new peripheral controllers. Much use made of modern microprocessors to emulate the Molecular 18 instruction set. Amigo ran an operating system called Swift which was compatible with that produced and sold by BC(S). This was later subject to much legal wrangle from the new owners of BC(S) and was withdrawn from sale.

3. Delivery List and Applications

No definitive list of customers or delivery-dates has yet come to light. However, a survey of available minicomputers was conducted by *Computing* magazine in 1973. The Molecular 18 was reported as having 85 commercial users, 5 in education, and 10 in communications. A survey in *Computing* in 1973 reported the following software available for the Molecular 18: Assembler, macro-processor, multi-programming operating system, RPG 11, and applications. In

reality, there is no evidence that an assembler or macro-processor or RPG11 was available. Systems were supplied with a limited set of common routines and customers developed their bespoke applications systems themselves.

After 1976 there were five primary markets for the Molecular 18 systems: Distribution Companies, Builders Merchants, Tool Merchants, Sheet material merchants and Livestock markets. A standard Purchase & Nominal ledger system and a payroll were available and common to almost all sites. The primary package, for which the system was typically bought, was a stock control and sales order processing system.

Early application suites were typically named after the first customer the suite was written for and included Thompson Toys, Philip Harris and Elliott-Baxter. These were a soft toy distributor, a pharmaceutical wholesaler, and a paper-merchant respectively. Subsequent customer sales used these systems as a basis for bespoke development, so for example a later furniture wholesaler's system was a toy reseller's system at heart.

By the mid 1980s these widely different systems had become too difficult to support and maintain, and two sophisticated applications were produced to include all the functionality in the older systems. The Birmingham office produced MCMB (Multi-Company, Multi-Branch) and the London (later Milton Keynes) office produced the London Package. Again these systems grew from what was deemed to be the best of what was currently available.

4. Systems Architecture

4.1. Instruction Set and Timings

The Molecular 18 has the following 17 bit registers:

- Program Counter
- Memory Address
- Register A
- Register B.

Operation codes 2 through to 26 - Memory reference instructions. These instructions operate on either the current page or on page zero. All of these instructions could operate indirectly.

Instruction words are organized as follows:

```
|17|16|15|14|13|12|11|10| 9| 8| 7| 6| 5| 4| 3| 2| 1|
|          | |          |
|Op-Code  |I|Z| | ---- Memory Address ---- |
```

I = Indirection Flag Z = Zero Page Flag

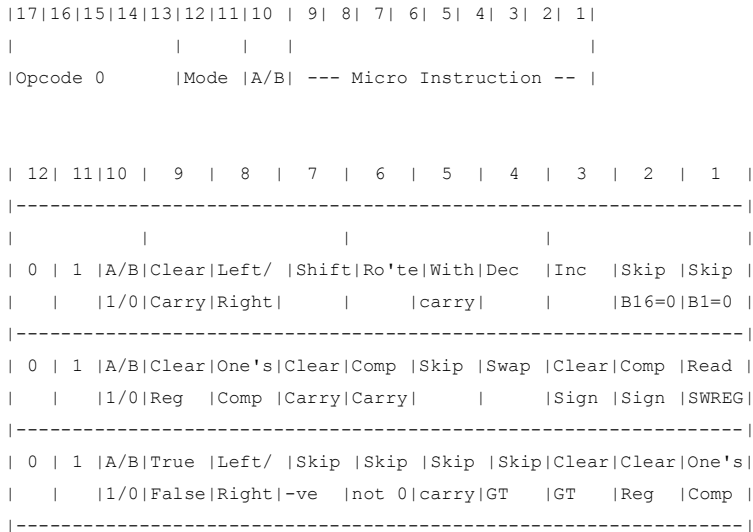
02 - JUMP	Jump to address	15 - ADAC	Add to Reg A with carry
03 - JSBR	Jump to subroutine	16 - ADBC	Add to Reg B with carry
04 - INSZ	Increment and skip on zero	17 - SFAC	Subtract from Reg A with carry
05 - DESZ	Decrement and skip on zero	20 - SFBC	Subtract from Reg B with carry
06 - ANDA	Logical AND	21 - LDA	Load Reg A
07 - IORA	Logical OR	22 - LDB	Load Reg B
10 - XORA	Logical Exclusive OR	23 - CMPA	Compare with Reg A
11 - ADA	Add to Reg A	24 - CMPB	Compare with Reg B
12 - ADB	Add to Reg B	25 - STA	Store Reg A
13 - SFA	Subtract from Reg A	26 - STB	Store Reg B
14 - SFB	Subtract from Reg B		

The CMPA and CMPB and other skip instructions conditionally skip the next instruction in sequence. The INSZ and DESZ instructions were commonly used to increment or decrement a loop counter and skip if done, and it is also used as an general increment instruction, either followed by a no-op or in contexts where it is known that the result will never be zero.

The JSBR instruction stores the return address in word zero of the subroutine, with execution starting at word one. Subroutine return is done with an indirect JUMP through the return address. Subroutines commonly increment their return addresses to index through inline parameter lists or to perform conditional skips over instructions following the call. This is exactly the same as the PDP8

Operation code 0 - Register Instructions

No memory reference in this group, so they execute in one machine cycle. Micro-instructions could be combined, but only if from the same group.



Mode 00 - Various instructions

0	NOP	No Operation
1	HALT	Halt Processor
2	MASK	Interrupt disable flags
3	ACKI	Acknowledge Interrupt
4	ION	Interrupts On
5	IOFF	Interrupts Off
6	SION	Skip if Interrupts On
7	SIOFF	Skip if interrupts Off
10	SMOF	Skip if Mains Fail interrupt
11	SMON	Skip if mains on interrupt
12	PRTY	Skip if parity interrupt
13	PRCT	Skip if memory protect interrupt
14	BNDY	Skip if memory boundary interrupt
15	MASW	Skip if MA=SR(Switch Reg)
16	CONT	Skip if Continuous Interrupt switch on
17	RSTN	I/O Reset

Mode 01 - Shift and Rotate (Applies to Reg B also if bit 10 not set)

2400	CLC	Clear Carry (Wrong group?)
3001	ALSB	Skip if LSB of Reg A set
3002	AMSB	Skip if MSB of Reg A set
3004	INCA	Increment Reg A
3010	DECA	Decrement Reg A
3300	LSA	Left Shift Reg A (into carry)
3100	RSA	Right shift Reg A
3040	RRA	Rotate right Reg A
3260	LRAC	Left rotate Reg A with carry
3060	RRAC	Right rotate Reg A with carry

Mode 10 - Clear and Complement (Applies to Reg B also if bit 10 not set)

5400	CLA	Clear Reg A
5200	CPLA	Complement Reg A
4100	CLC	Clear carry flag
4040	CMPC	Complement carry flag
4020	SKIP	Skip next instruction
5010	SWPA	Swop top and bottom half of Reg A
5004	CLSA	Clear sign (Bit 17) of Reg A
5002	CPSA	Complement sign bit if Reg A
5001	ESRA	Enter Switches in to Reg A

Mode 11 - Alter/Skip

7200	APOS	2	Skip if Reg A +ve (i.e. Bit 17 not set)
7100	A=0	2	Skip if Reg A is zero
7002	CLA	-	ClearReg A
7001	CPLA	-	ComplementReg A (NOT twos complement)
6040	SKNC	2	Skip if carry not set
6010	SNGT	2	Skip if not greater than set
6004	CLGT	-	Clear greater than flag
7600	ANEG	1	Skip if Reg A is -ve (i.e.Bit 17 not set)
7500	AN0	1	Skip if Reg A is not zero
6440	SK=C	1	Skip if carry flag set
6410	S=GT	1	Skip if greater than flag set

Instructions in the same group may not be combined.

Operation code 1 - Input / Output instructions

12	11	10	9	8	7	6	5	4	3	2	1

A/B	Function			--	Mode	--	----- Device Address -----				

1/0	0	0	Device Reg								
No Operation			1, 2 or 3								

	0	1	Device Reg								
Set Busy /			1, 2, or 3								
Clear Done											

	1	0	Device Reg								
Clear Busy/			1, 2, or 3								
Clear Done											

	1	1	Read/	Device Reg	Read or Write transfer to device						
Input/Output			Write	1, 2, or 3	register. Action depends on the						
Pulse			actual device								

	0	0	1	1	1						
Skip if Busy			Skip Mode			No data transfer during					
Skip not Busy			Skip Mode			skip mode instructions.					
	1	0	1	1	1						
Skip if Done			Skip Mode								
	1	1	1	1	1						
Skip not Done			Skip Mode								

Disk drives were assigned device codes from 70 to 77. Terminals and Printers were assigned device codes from 47 up to 67. Although a console as such wasn't needed, a terminal attached to device code 47 was necessary.

Each attached device, in fact the device driver circuits, had up to three registers. The actual function of the registers depended on the attached device.

4.2. Hardware and system interconnections

...(to be continued ...)

5. Software and Sample Programs.

Operating Systems

Systems delivered prior to 1975 were supplied with a very basic set of routines to enable programs to be entered in octal machine code from a terminal and stored

in a specified sector on a physical disk. It was up to the customer to develop his or her own application software.

From 1976 onwards a general operating system was developed. LOS (Leicester Operating System) developed by Joe Templeman and Chris Green from the BCL Leicester offices was the first to allow the same program to be run in multiple different partitions. By 1978 it was in use 'at about three dozen installations'.

LOS was developed into OS during the 1980s, primarily by adding more sophisticated routines to develop programs and maintain the system. OS also supported the newer disk drives that became available, and later supported machines with more than 64K of memory by bank-switching the top 32K of memory.

Program Development

Programmers coded in a pseudo assembly language on pre-printed foolscap sheets. Each page represented a page in memory and held 100 (octal) steps. When the program was complete, it would be hand assembled by the programmer from his memory of op code and the occasional crib sheet and entered via a terminal in octal groups of 6 digits.

6. The Company History

BCL's roots can be traced back to three earlier companies: Unex Ltd. (established in the late 1930s), Lows Calculators (1939) and Systemation Ltd. (1961). Jewish refugees from continental Europe founded Unex in the late 1930s. They established a business selling and maintaining accounting machines –mainly those manufactured by Burroughs. After the war ended, they also had a reseller agreement with the German company Continental Wanderer, who manufactured electro-mechanical accounting machines. One of their biggest customers was Barclays Bank who used the 'Continental Class 900' machine extensively.

On 11th Dec 1939, Unex was bought by Mr. Thomas Low and re-incorporated as Lows Calculators Ltd., which then operated out of Unex's premises at 15 Holborn Viaduct, London EC2.

In 1962 Lows Calculators changed its name to Business Mechanisation Ltd. and moved to 180 Tottenham Court Road, London. At the Business Efficiency Exhibition (BEE) in Olympia, London, they exhibited an electro-mechanical invoicing machine built from an Adler electric typewriter and a Walther decimal printing calculator. At the exhibition, two engineers from Systemation Ltd, Bill Gannon and Gordon Clark, described to Business Mechanisation a purely electronic system they had designed that would perform a similar job albeit more reliably and faster. It was agreed that the new electronic system would be demonstrated to Bill Hesleton and Steve Brady from Business Mechanisation as

soon as it was complete. This happened several months later and Business Mechanisation subsequently cancelled development of their out-of-date product and agreed to take over the commercialisation of the new machine – subsequently named SADIE or Sterling and Decimal Invoicing Electronically.

Systemation had been formed in Hove, Sussex in 1961 by a group of six engineers who had worked previously in the aircraft industry. They quickly produced an electronic calculator called BETSIE that operated in Sterling and was used to calculate betting shop winnings. BETSIE sold well throughout the UK, and encouraged the team to build more complex electronic systems.

In 1965 Business Mechanisation Ltd became the sole agents for all of Systemation's products and sold over 85 SADIE systems in the first year.

SADIE was developed into a more general-purpose computer known as SUSIE – Stock Updating and Sales Invoicing Electronically. The major difference between these two machines was a magnetic drum store to enable records of stock levels to be maintained. In 1967 paper-tape stations were added to SADIE and SUSIE in accordance with the Ministry of Technology standard definition of a computer; this enabled purchasers to claim 20% tax relief on their investment.

In 1968 Business Mechanisation Ltd became BisMec Group Ltd. and a year later they acquired all of Systemation's assets and formed Business Computers Ltd or BCL. By then, the group had 13 sales branches throughout the UK and ROI. Typical SADIE systems sold for between £2,750 and £6,750 and SUSIE systems between £7,000 and £30,000.

In 1969, BCL offered shares to the public, issuing 700,000 ordinary 2/- shares at 21/- each. The share issue was over-subscribed by 40%.

In 1970 BCL launched Multi-SUSIE, a multi-user accounting computer that was commercially very successful with over 1000 systems sold. The income thus generated funded the development of a general-purpose minicomputer to be known as the Molecular 18, launched in October 1971.

BCL grew very rapidly with sales offices opening around the UK and abroad and employing over 590 people at its peak, but went into receivership on 26th June 1974 - primarily due to cash flow issues associated with their rapid expansion.

BCL had insisted on selling complete systems including system and application software, but had hugely under-estimated the complexity of producing this on the Molecular 18. Their experience with SADIE and SUSIE did not scale well up to the multi-user systems on the Molecular 18, and their bankers eventually called in the large development loans taken out by the company.

In 1975, Computer Agencies Ltd, part of Computer World Trade (wholly owned by British Airways), bought what remained of BCL from the receivers, and renamed their company Business Computer (Systems) Ltd. A division of Computer World Trade called Computer Field Maintenance had contracts with many Molecular customers to provide hardware support and purchased the business to support their hardware maintenance business.

Early in 1976, ICL acquired the UK arm of Singer Business Machines, and shortly afterwards made a number of senior managers redundant. A small team of these managers, including Mike Munnely, Eric Gilliland and Martin Alcock, bought a controlling interest in BC(S) Ltd and Munnely was made Managing Director. The management team already had wide experience in selling the Singer System 10 computer, and saw the Molecular 18 as an alternative system to sell into the small businesses arena they knew well. The new managers quickly developed a reliable multi-user operating system and set standards for the development of application software. The new business grew rapidly and it went public in May 1981.

BC(S) Plc continued to develop the Molecular 18 operating system and application software with great success. However, another equally sized part of the business was heading for trouble.

BC(S) also sold small office accounting and stock control systems developed around a range of 8-bit Diablo microcomputers imported from Xerox in the USA. In 1978 BC(S) became sole UK distributor for these machines, and produced an extensive suite of application programs written in a proprietary language called DACL (Diablo Application Control Language), for which a compiler for the Diablo machines was available. In 1980 the contract was extended for another five years, but in 1984 Xerox decided to stop development and sales of these machines leaving BC(S) with no platform into which to sell their application systems. The loss of sales of these relatively high margin systems caused BC(S) severe cash flow problems and trading losses.

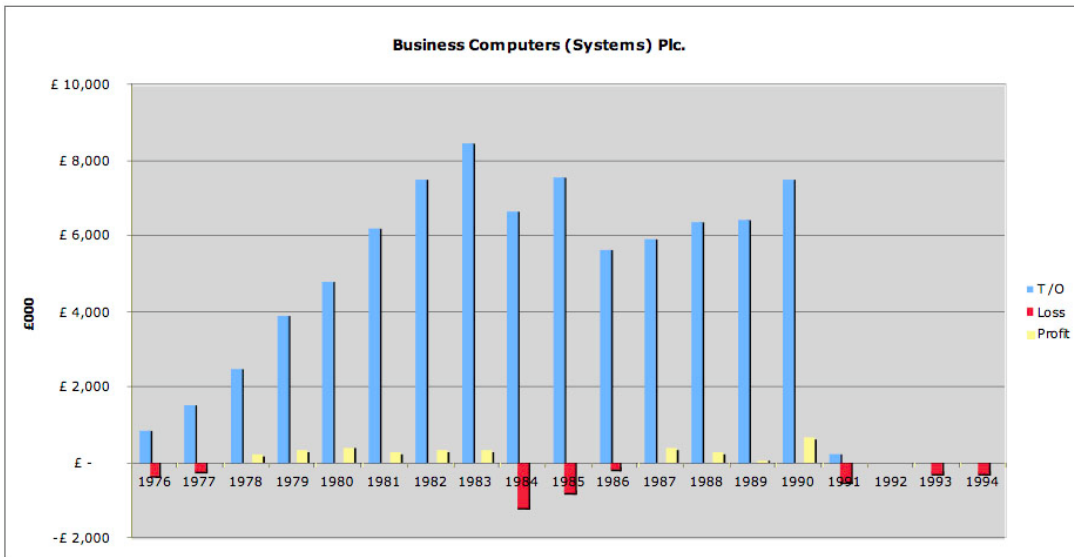
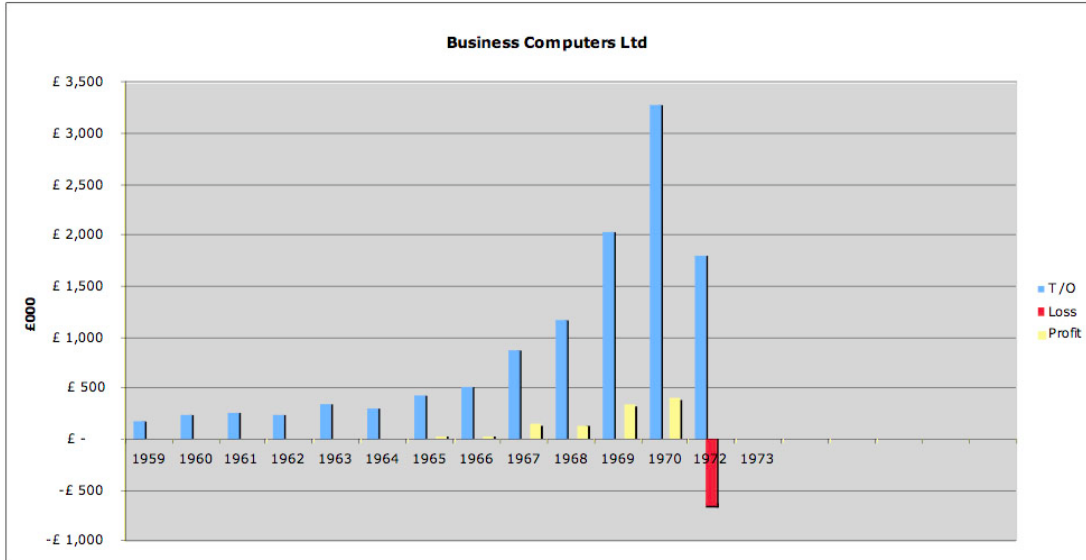
After struggling with growing losses, BC(S) Plc was bought by Electronic Data Processing Plc of Sheffield, UK in 1986. Customers using the Molecular systems and the Diablo systems were gradually moved to more modern platforms and development and support of the Molecular was stopped by the new company in the mid-1990s.

The antecedents of BCL and the company's eventual demise are summarised in the Table given on the next page.

Company	Founded	Wound up, merged, name-change, etc.	date	New name, or incorporated into
Unex Ltd	~ 1937	Bought by Low & re-named	1939	Lows Calculators Ltd.
Lows Calculators Ltd.	1939	Name change	1962	Business Mechanisation Ltd.
Systemation Ltd.	1961	Systemation's assets acquired by BisMec	1969	Business Computers Ltd.
Business Mechanisation Ltd.	1962	Name change	1968	BisMec Group
BisMec Group	1968	Name change & expansion by acquisition of Systemation Ltd.	1969	Business Computers Ltd.
Business Computers Ltd.	1969	Into receivership 1974; then bought up in 1975 by Computer Agencies Ltd.	1975	Business Computer (Systems) Ltd.
Business Computer (Systems) Ltd.	1975	Acquired by Electronic Data Processing Ltd.	1986	Electronic Data Processing Ltd.

Electronic Data Processing Ltd. continued to market the Molecular 18 until the mid-1990s.

Business Computers Ltd.'s year-on-year trading position from 1959 to 1972, and that of Business Computers (Systems) plc from 1976 to 1994, are illustrated in the graphs given on the next page.



7. List of references
... (to be continued ...)