The most important features of

MULBY 3 at a glance

The most important features of MULBY 3

This brochure shall provide a quick survey about the MULBY 3 central processor unit, standard peripherals and standard software. For more detailed information several software and hardware manuals are available.

The system engineering division of Krantz Computer is also able to connect other peripherals than those described in this brochure to the MULBY 3. Especially it is prepared to deliver software system support up to complete tailor-made key-turn systems.

Central Processor Unit

Main frame architecture	Central bus, all logical units like CPU, memory, data chanels and couplers communicate with each other via a common 16 bit bus.
Word length	8 bit, 16 bit, 32 bit (floating point). All word lengths may be used in any sequence. The MULBY 3 appears — as operand word length is concerned — as a 8 bit, a 16 bit and a 32 bit computer all in one. All word lengths are processed in parallel.
Address modes	Real two-address machine! Therefore a very powerful command structure. Each address is 16 bit long (no paging). Any instruction can also be executed immediately in the memory without using one of the 16 general purpose registers. All usual address modes available.
Instruction repertoire	130 basic instructions. Multiplication and division for fix point (16 bit) and floating point (32 bit). Powerful bit processing instructions. Numerous branch possibilities. Complex shift instructions. 8 bit instruction status register to store the status of the result after each instruction execution (overflow, equals zero, negative etc.).
Interrupt system	8 to 128 hardware interrupt levels. Controlled by hardware priority. Interrupting each other. Automatic storage of the contents of intruction counter and status register and jump into interrupt program. Interrupt also during instruction execution: respond time about 2 us. Buffering of interrupt requests, that means several users at one interrupt level possible. Each level can be switched on and off and activated under program control. Status of each level can be read out. All levels can be disabled temporarily.
Core memory	16 k to 64 k byte. Cycle time 750 ns. Access 8 bit or 16 bit in parallel.
Memory protect	Additional bit per 16 bit word. Change of the contents of protected memory locations only possible, if the instruction has been read from a protected location. Can be disabled from the oparator panel.

Memory parity	Permanent check of the correct operation of the core memory.
Firmware	ROM memory area with undistructable programs for power fail and restart, front panel operation, absolute program loaders from different peripheral devices.
Time clock	Two independent time clocks. Interrupt triggering can be switched on and off under program control. One time clock constant every 10 ms (is used by the operating system for the real-time-program). The other time interval can be selected between 100 us and 6.5 s. Both time clocks are quartz-controlled.
TTY interface	Interface for the operator unit: Teletypewriter 110 bd, typewriter 300 bd or keyboard of display unit 300 bd. Full duplex, potential isolated, line current 40 mA.
Hardware error detection	Permanent automatic check of the correct operation of the CPU hardware: Power fail, restart, memory protect, memory parity, false addressing, undefined instruction code. Error interrupt with reporting of the erroneous address. Very effective security provision.

Input/Output System

Operating modes	Basicly two operating modes, as far as possible, for all input/output units: 1. Under program control by the two-address instructions READ and WRITE. 2. Direct memory access (DMA). In both cases data transfer via central bus. DMA very fast, since memory access possible after 750 ns, worst case; hardware priority controlled. Transferred word lengths 8 bit and/or 16 bit in parallel.
Coupler	Translates electronic signals and the timing of peripherals devices, data communication interfaces and process control interfaces into internal signals and timing of the central bus. Data transfer fully buffered. Additional status input and output registers. Automatic error detection.
Multiplex chanel	Enables four couplers to perform DMA-operation. Two types available which differ only in speed: 160 k byte/s and 800 k byte/s.
High speed chanel	Application as interface for disc units, as a fast computer-computer linkage or as general purpose interface for very high transfer rates (up to 20 mio. bit/s). Two independent parts: 1. DMA, choice of 16 bit or 8 bit word length. 2. Under program control 16 bit word length. Interface two bi-directional TTL buses. DMA part equipped with FIFO buffer 16 by 16 bit.

Removable disc unit	Up to 4 drives per controller. Drive: one fixed and one removable disc, 2.5 mio. byte each. Average access time 55 ms. The removable disc is used for quick loading of programs and data. Therefore no additional program loading device necessary.
Fixed head disc unit	Up to 4 drives per controller. Capacity 768 k byte per drive. Average access time 8.5 ms.
Diskette memory	Up to 8 drives per controller. Each drive one removable disc (floppy disc or diskette) with a capacity of 250 k byte. Average access time 500 ms. Format IBM-compatible, therefore also useful as inexpensive off-line data carrier.
Magnetic tape unit	Format IBM-compatible. 9 tracks, 800 bpi NRZ, 7 inches reels, 12.5 ips, read-after-write. Application as off-line data carrier.
Card reader	Standard IBM format. 400 cards/min. 500 Cards supply stack. Selfcontained desk top model.
Paper tape input/ output unit	Input and output in one unit. Reader: 0 to 300 ch/s. 5 to 8 chanels also 6 chanel TTS. Punch: 0 to 75 ch/s, choice of 8 chanels or 6 chanel TTS. Independent motor-driven take-up reel.
Printer	Serial printer, 180 ch/s, 0 to 132 ch/line, choice of 64 or 128 different characters. Up to 4 copies.
Teletype- writer	KSR 33. 100 bd, 10 ch/s respectively. 64 different characters. Mostly used as operator unit.
Typewriter	Printing mechanism: dot matrix. 300 bd, 30 ch/s respectively. 0 to 80 ch/line. Very silent operation. Standard ASCII keyboard. Mostly used as comfortable operator unit. Selfcontained desk top model.
Display unit	Unusual operation principal: The core memory is used as image refresh memory. A digital-to-video converter translates permanently the contents of a part of the core memory area into a standard video signal that triggers a tv-monitor. A change of the contents of this visible area of the memory is displayed on the monitor without delay. The keyboard operates completely separated from the monitor with a 300 bd TTY interface. Interpretation of typed-in characters under program control. That means extremely versatile operational functions, which can be ideally adapted to any application.

1536 characters on the screen in 24 lines, each of which with 64 columnes. Choice of 64 or 128 different characters. Very large screen (20 inches diameter) with very good readability. |

Alpha-numeric keyboard with 128 different characters; 36 additional
general purpose function keys, 16 lamps and a attention horn
which can be switched on and off under program control.
Automatic repeat function for each key.

These outstanding features of the Krantz display unit make even
very sophisticated applications be realized very easily. Very
effective manual operation of the system as well as generation
and test of user software.

Numeric terminal

Decimal keyboard with 10 additional function keys. Decimal
display of 12 numbers. 16 lamps for dialog control. Automatic
repeat function for each key. 300 bd TTY interface, full duplex
Selfcontained desk top model.

Digital input/ output

16 input and 16 output lines per coupler. Interface either relais
or opto-coupler. 8 active interrupt lines. Several couplers can be
tied together to form one logic unit. Using an external matrix
circuit up to 256 contacts can be read out by only one coupler.

General purpose coupler

Input/output of bytes with TTL interface, fully buffered.
Additional 8 bit status input and 8 bit status output registers.
By simple selection of short circuit adapters timing and signal
direction can be widely adapted to the interfaces of special
peripheral devices.

Analog input unit

16 multiplexed inputs per coupler. Input voltage $\pm$ 10 V, 12 bit
accuracy, 30 us conversion time. Sample & hold amplifier.

Analog output unit

6 independent, static outputs per coupler. Output voltage $\pm$ 10 V,
12 bit accuracy, 10 us conversion time.

TTY interface

4 independent interfaces per coupler, full duplex, 300 bd, automatic
line current check

Communication interface

Data transfer either synchronous or asynchronous, up to 19.200
bd. Half duplex or full duplex. Automatic control character
recognition. Byte and block parity generation and check or CRC.
Saves CPU time by versatile hardware functions.

Standard Software

Disc operating system	Real-time multiprogramming disc operating system with the following basic features: Control and synchronization of up to 128 user programs by each other or by absolute or relative time intervals, priority controlled availability of the CPU, core memory management, automatic loading of user programs from disc into core, memory program management for disc and core, file management for disc with direct and sequential access, control of data transfer to and from all input/output units, preparation of real-time and calender and utilities like COPY and DUMP.

By using logical device names, standardized formats and codes independency from physical peripheral devices, data communication interfaces and process control interfaces. Alignment of logical and physical devices during run time.

This is only a rough description of this very powerful operating system. More detailed information is given by the user's software manual.

The operating system is applied for three types of discs: fixed head disc, removable disc and diskette memory.

Core memory oriented operating system	This operating system is compatible with the disc operating system, that means a user program for this operating system will also run under the disc operating system. Most important difference: No external memory management. But less need of core memory capacity.
I/O routines	For all standard peripheral devices, data communication interfaces and process control interfaces I/O routines are available, which correspond to both operating systems. So the user has not to care for programming with interrupt levels, couplers and data chanels. He simply uses those standardized commands of the operating system.
Macro-assembler	Very powerful macro-assembler which enables the programmer to take full advantage of the multiple hardware features of the MULBY system. Runs as user program under both operating systems. Object code may be in absolute or relocating format.
Linkage editor	Links relocating object codes generated by the assembler. Runs as user program under both operating systems. New object code may be in absolute or relocating format. The latter can be linked again.
Relocating loader	Location independent program to load object codes with relocating format to any memory location. Part of the disc operating system.

Text editor	Program to type in and date up source programs for assembler and FORTRAN compiler. Runs as user program under both operating systems. Adapted to teletypewriter, typewriter and display unit.
Debugging system	Program to check out user programs, both dynamicly and staticly. Runs at both operating systems. Adapted to teletypewriter, typewriter and display unit.
Display package	Supports the following functions by taking full advantage of the special hardware features of the Krantz display unit: Generation and up-date of source programs, writing, reading and up-dating of data files, dynamic and static check out of user programs, general display I/O routine for user programs. Compared with the operation of a teletypewriter the display unit offers a considerable increase of operating comfort. This means a much more economic generation and check out of user programs.
FORTRAN IV compiler	Corresponds to standard ASA FORTRAN IV with the exception of complex numbers and double precision integer numbers. In return there are additional statements for logical functions and bit processing. Direct data exchange with all standard peripheral devices, data communication interfaces and process control interfaces. Insertion of assembler instructions and macros, respectively. FORTRAN generated user programs can run immediately under both operating systems. The compiler translates into a code level, which is identical with the assembler source code. Therefore FORTRAN generated code sequences can be used without modification in assembler programs. Moreover the FORTRAN library is a set of assembler macros, so that this mathematical library is available for assembler programming. The FORTRAN compiler runs as a user program under both operating systems, whereas the disc version offers a much higher comfort. For FORTRAN generated programs the floating point processor is recommended, but not necessary, because a software package is available which simulates the floating point instructions by software.
BASIC interpreter	Standard Dartmouth BASIC including all matrix operations. Additional statements for file handling. By these statements BASIC allows to transfer data to and from the disc and input/output operations with all standard peripheral devices, data communication interfaces and process control interfaces. These features extend considerably the application of BASIC, for data collection and processing in laboratories and for processing large data volumes via disc. The BASIC interpreter runs as a user program under both operating systems. Multi-user operation is possible only under the disc operation system.

Hardware test program	Check out program for the CPU, all standard peripheral units, data communication interfaces and process control interfaces. Runs as a user program under both operating systems. For data communication and process control interfaces test equipment is available, so that the tests can be executed up to the external cable connectors. Several operating modes, among them dynamic individual test of every single function.

Model Survey

MULBY 3/20	Smallest model of MULBY 3. Core memory up to 32 k, no hardware floating point instructions
MULBY 3/30	Medium scale model of MULBY 3. Core memory up to 64 k, no hardware floating point instructions (but as option available)
MULBY 3/35	Large scale model of MULBY 3. Core memory up to 64 k, built-in floating point instructions.
Standard computer systems	Complete computer systems including all standard software. Several basic configurations starting with MULBY 3/20 up to MULBY 3/35. Choice of diskette memory (very inexpensive) or removable disc unit. Further information by the brochure ,,Rechenanlagen''.
INTEXTA	Computer system for text processing by several display units. Including user software package with a very easy to learn, comfortable dialog language for text gathering, editing, management and processing in multi-user operation. Additionally a very powerful program for type setting. Application in printing industrie, editor's offices and documentation centers. Further information by the brochure ,,INTEXTA''.