

68000 MICROPROCESSOR TRAINER

FLT-68K



The system should be based on the industry standard Motorola 68000 processor.

The microprocessor board should be connected to the PC via RS232 connection for the downloading of programs written in assembly language and C.

Terminal emulation software should also be provided, enabling the system to be used in a target/development environment.

An applications board should also be supplied allowing interfacing and control principles to be taught.

Full CPU bus signals must be brought out to a 64 way DIN connector, and the following hardware features should be available:

68000 Microprocessor Board

- o 68K CPU 10Mhz.
- o Glue logic - CMOS includes two GAL's.
- o Full interrupt implementation as 68020.
- o Ten fault switches (6 open circuit, 4 shorts to ground).
- o Full CPU bus brought out to 64 way DIN connector.
- o EPROM standard 2 x 27256 (should also accept 27128, 27256, 27512).
- o RAM standard 16Kbytes, expandable to 512K.
- o 68230 PIT - 16 I/O lines
 - 8 user defined lines
 - 24 bit counter/timer
 - full interrupt support.
- o 68681 DUAL DUART - 2 x RS232 ports
 - 8 output lines
 - 3 input lines
 - counter timer.
- o Hardware reset.
- o 9v 1A Power supply included.
- o Sturdy book-style case.
- o RS232 connecting lead included.
- o Four additional manuals provided, plus one training manual.

Applications Board

This board should be designed to teach a wide variety of control experiments. Circuits provided must include:

- o Eight digital switches.
- o Temperature sensor.
- o Optical speed/position sensor.
- o Light sensor.
- o Potentiometer.
- o External analogue input.
- o DC motor.
- o Eight LED's.
- o Bargraph.
- o Heater.
- o Analogue output.

This board should include a power supply adapter, user's manual, and an experiment manual with eighteen easy to use programs specifically for use with the microprocessor board. The manual must also contain sixteen questions with fully worked answers.

Software

Professional Software Development System should be supplied providing 68000 cross assembler and C language cross compiler. Package should also include an editor/workbench environment, a terminal emulator, and on-line help specific to the 68000 processor.

System Overview

The Motorola MC68000 family of microprocessors is now widely recognized as an industry standard for industrial control and multi-user computer systems requiring the speed and power of an advanced 16/32-bit microprocessor. For this reason the 68000 is the number one choice for teaching microprocessor and control principles to students on electronic engineering and computing courses at all levels.

The 68000 may be used to teach advanced microprocessor principles, yet the orthogonal architecture and uniform addressing modes make it a very straightforward processor to learn. This, combined with the ease of use of the FLT-68K, make our system suitable for teaching microprocessors at introductory level through to advanced applications. The system makes an ideal platform both for the taught environment of the classroom and self-teach use by individual users. It also makes an ideal development/target board for control applications based on the MC68000.

All you need to start learning and developing 68000 applications is the FLT-68K and a personal computer with a serial port. The line assembler, monitor and debugging facilities built into the FLT-68K's firmware may then be used to enter, run and test your programs. A printer may be linked to the FLT-68K's second serial port to obtain hard copy output while EEPROMs may be inserted into auxiliary memory sockets to provide non-volatile storage for programs or data. Used in conjunction with our range of PC-based macro cross assembler and C compiler packages, the FLT-68K becomes a powerful target system allowing programs to be downloaded to it in the form of Motorola 'S' Format files.

Included in the package is the FLT-68K system board which is supplied housed in a sturdy book-style case, a power adapter, a PC serial link cable, PC-based terminal emulation and download software, a detailed user's manual and Motorola data books for the MC68000 microprocessor and MC68681 and MC68230 peripheral devices.



Hardware

The FLT-68K is based around the popular Motorola MC68000 microprocessor with its 16-bit data bus and 24-bit address bus. The system also incorporates a range of peripheral devices and is driven by a 10MHz clock.

The FLT-68K is supplied with 16K bytes of RAM, which is more than sufficient for most teaching requirements, but is expandable to a total of 512K bytes making it also suitable for larger scale applications. Two RAM memory sockets accept 6264 8K, 62256 32K, or 551001 128K static RAMs in pairs resulting in 16K, 64K and 256K bytes respectively. Two further auxiliary RAM sockets may also be used to accommodate these same devices resulting in a maximum RAM size of 512K bytes.

Also as standard, two 27256 32K EPROMs are fitted containing the FLT-68K's monitor firmware. These firmware routines may be replaced by, or incorporated into, the user's own firmware for turnkey applications. Also, two 27512 64K EPROMs may be used to expand the ROM memory to 128K bytes in total.

The MC68681 Dual Universal Asynchronous Receiver/Transmitter (DUART) provides two RS232 compatible serial ports, one for connection with a data terminal or host computer such as an IBM compatible PC, and the other for connection to a printer or for use by the user. Two male 9-way D-type connectors are provided.

The MC68230 Peripheral Interface/Timer (PI/T) provides 24 parallel input/output lines plus a counter/timer. Access to these lines is by way of a 40-pin IDC header which is compatible with a range of development and educational peripherals such as our applications board, switch and lamp board, and 4mm interface module.

Further user expansion may be gained by way of the male 64 way DIN41612 connector, which provides access to all the MC68000 processor signals.

An on-board system reset switch is provided, as are status LEDs, and fault switches which allow the simulation of hardware faults for student fault-finding exercises.

Firmware A 64K byte firmware package is provided with the FLT-68K making the board a mini development system. It comprises a comprehensive monitor, a line-by-line assembler and a disassembler.

The monitor program has been made as simple as possible to use, with each of the 53 different commands available being invoked by simple two-letter codes. No further information has to be remembered as any additional parameters are requested by the monitor in a clear and verbose manner where required. The occasional user will benefit from the in-built help option which provides a brief description of each of the monitor commands. In most cases it will not be necessary to refer to the user's manual, once the detailed description of the commands has been studied.

The line-by-line assembler enables 68000 assembler language programs to be entered and assembled a line at a time making program entry simple and quick. For test and demonstration programs this method will be found faster and more convenient than using full cross-software facilities on a host computer.

68000 machine code anywhere in memory may also be disassembled with the resulting assembler source code being displayed on screen or printed out if a printer is connected. Other monitor commands allow code to be executed and single-stepped, allow breakpoints to be set, registers and memory contents to be displayed, and much more.

Demonstration routines for use with the Applications Board, and test programs to ensure the FLT-68K board is fully functional are also incorporated into the firmware.

Documentation

No matter how good a microprocessor board may be, for the user to be able to become familiar with it as quickly as possible and use it to its full potential it is vital that it is matched by equally good quality documentation. Consequently, much effort was given to ensuring that the user's manual supplied with the FLT-68K gives the user the best possible start. Not only is every aspect of the system described, but diagrams and example programs are given where possible.

The documentation leads the user through setting up the system and provides detailed information on its hardware and firmware. Monitor commands are described in detail, as are monitor system calls and the 68000 instruction set and addressing modes. The use of the MC68681 Dual Universal Asynchronous Receiver/Transmitter (DUART) and MC68230 Peripheral Interface/Timer (PI/T) is also described with examples, and full schematics are provided for the board.

Specifications

CPU	Motorola MC68000 microprocessor with 16-bit data bus and 24-bit address bus
System Clock	10MHz generated by a CMOS oscillator
RAM	16K bytes fitted as standard, expandable to 256K bytes RAM User RAM Address Range: 400400h-403FFFh (400400h-43FFFFh when expanded)
ROM	Two 27256 32K EPROMs containing the 64K bytes monitor program, expandable to 128K bytes with use of two 27512 64K EPROMs Monitor EPROM Address Range: 000000h-00FFFFh (000000h-01FFFFh when expanded)
Memory Expansion	Sockets for additional RAM up to 256K bytes On-board RAM Expansion Address Range: 440000h-47FFFFh
I/O Ports	MC68230 Peripheral Interface/Timer (PI/T) chip providing 16 digital I/O lines and a 24-bit wide counter with 5-bit prescaler, with full interrupt support Input/Output Address Range: 800001h-800035h MC68681 Dual Universal Asynchronous Receiver/Transmitter (DUART) providing two full specification RS232 serial ports with full interrupt support Input/Output Address Range: A00001h-A0001Fh Three interrupt sources (link selectable) Bus Expansion Connector offering access to all 64 lines of the 68000 CPU
Connectors	Two male 9-way D-type RS232 serial ports, one for connecting with display terminal or host PC, the other for connecting to a printer or for general use 40 way IDC header providing access to the MC68230 Peripheral Interface/Timer (PI/T) digital input/output and counter/timer lines 64 way male DIN41612 bus expansion connector offering access to all processor signals of the MC68000 CPU
Interrupts	Eight external user interrupt vectors, auto vectored interrupts, and eleven trap instructions available to the user
Switch Faults	Ten fault switches offer six open circuit and four short to ground faults
Power Supply	The board operates from a single 9V power supply and has a current consumption of 700mA A 110/120V 50/60Hz or 220/240V 50/60Hz power adapter is included (please specify which is required when ordering)
Physical Characteristics	Dimensions: 1575mm wide, 2230mm deep, 160mm high without case Weight: 1.41lb including case

Applications Board

The applications board has been designed to aid the teaching of microprocessor interfacing from simple switch and lamp input/output through to more complex closed-loop and open-loop control systems.

The new board layout enables students to easily understand each experiment section as it is worked upon. The wide array of features incorporated into the board include digital switches, traffic light color LED displays, temperature, light, and optical position/speed sensors, a heater, a DC motor, an LED bargraph, and a potentiometer. A screw terminal is also provided for external analog input.

