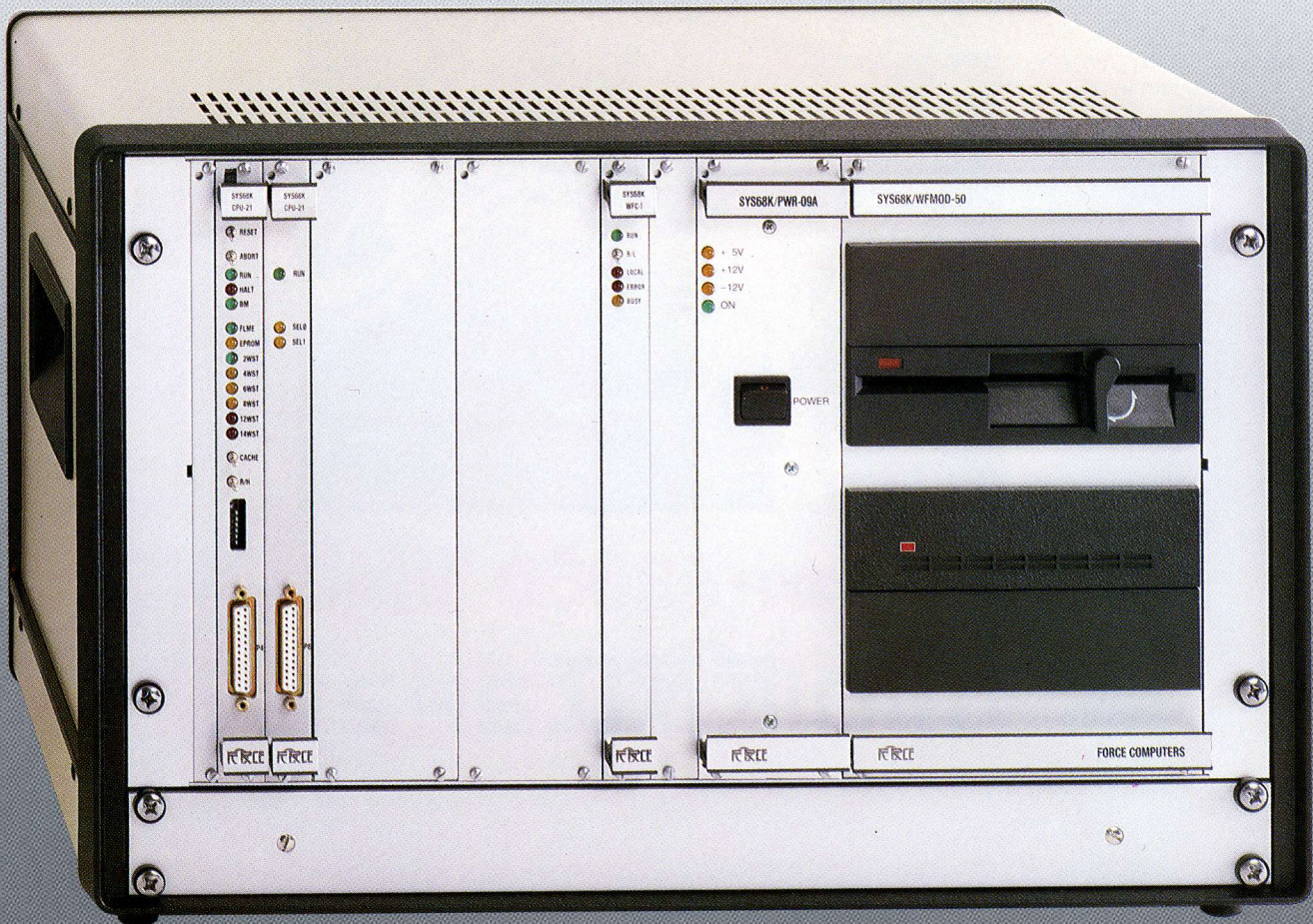# System 68000 VME

miniFORCE 2P21

Photo of miniFORCE 2P21

General Description

The miniFORCE 2P21 multi-user development/target system for realtime applications is a high performance system at low cost based on the VMEbus.

A 16.7MHz 68020 CPU is used on the SYS68K/CPU-21 offering a real computing power of 2.5 to 3.5 MIPS running without wait states out of the 512 Kbyte on board static RAM.

The powerful multi-tasking real time operating system PDOS* allows efficient and fast software development, as well as the testing of the used hard and software in the same environment without the overhead of an emulator and a host computer.

The FORTRAN 77 and the C-compiler allow easy software development in conjunction with the macro assembler.

1.0 Hardware

The miniFORCE 2P21 is housed in a 19″ enclosure which includes three quiet fans for cooling and a noise filter (RFI filter) for the fans and the power supply.

For easy installation in 19″ cabinets, the complete hardware consisting of power supply, motherboards and mass storage drives, is mounted in a 19″ rack. The major functions of the different hardware parts are described below:

1.1 Power Supply PWR-09A

The PWR-09A is used to power the VME boards, as well as the disk drives. The 280W power supplies drive up to 9 VME boards and offers a maximum drive capacity of 36 Amps at +5V.

1.2 Motherboard MOTH-09A and MOTH-E09A

The VMEbus motherboard allows the interconnection of up to 9 VMEbus-based boards 8, 16 and 32 bit data transfers are supported.

1.3 Mass Memory WFMOD-50

The Winchester Floppy module includes a high speed, half height winchester (35 ms average access time) as well as half height 1 Mbyte floppy disk. All drives (5 1/4″) are included in a cassette which is mounted in the 19″ rack near to the power supply.

The following table lists the features of the WFMOD-50 module.

	WFMOD-50
Winchester capacity	
unformatted	51.0 Mbyte
formatted	39.2 Mbyte
Average Access Time including head settling Time	35 ms
MTBF	11000 h
Floppy capacity	
unformatted	1.0 Mbyte
formatted	0.8 Mbyte
MTBF	10000 h

1.4 The CPU-board CPU-21

The powerful SYS68K/CPU-21 is used as the processor board in the miniFORCE 2P21. Zero wait state operation at 16.7MHz is performed using the 512 Kbyte static RAM. The computing power is in the range of 2.5 to 3.5 MIPS.

The on-chip cache of the 68020 CPU is fully supported in the real time operating system and peaks the throughput at cache only cycles to as much as 5 MIPS.

A Floating Point Co-Processor with 16.7MHz clock frequency is provided on the board to allow efficient execution of user supplied programs.

Features of the SYS68K/CPU-21

- 68020 CPU with a clock frequency of 16.7MHz

- 68881 Floating Point Co-Processor (16.7MHz)

- Two 68561 Multi-Protocol Communication Controllers for Serial I/O (one RS232 and one RS232/RS422 compatible interface)

- 68230 Parallel Interface and Timer for local control, interrupt level control and timer function

- 68153 Bus Interrupter Module for all local interrupts

- 512 Kbyte of zero wait state static RAM via the FLME interface (jumper selectable access address)

- 4 Sockets for EPROMs (32-bit wide) for 8K x 8 to 64K x 8 organised devices.

- 4 Sockets for EPROMs/SRAMs (32-bit wide) for 8K x 8 to 64K x 8 organized devices.

- Maximum capacity:

EPROM	SRAM	Comment
512 Kbyte	0	only EPROM
256 Kbyte	128 Kbyte	EPROM and SRAM

- Fully buffered local address data and control bus

- VMX Primary Master Interface (32-bit wide)

- VME/P1014 interface supporting unaligned transfer (32-bit)

- Single level bus arbiter

- Software selectable bus release functions (6)

- Interrupt handler (1-7 static)

- Bus Timer for BERR generation on local bus, VME/P1014 bus and VMXbus

- Power Fail Detector and RESET generator

- RESET and ABORT switch

- RUN/HALT switch

- CACHE enable/disable switch

- RUN/HALT/Bus Master/SRAM Access and Wait State indication LEDs

- 68020 Debugger Firmware called FORCEbug with Macro facility and Assembler/Disassembler included

1.5 Mass Memory Interface WFC-1

The WFC-1 board controls the winchester as well as the floppy disk drive (5 1/4 "). It contains an error detection and correction circuit as well as a 2 Kbyte sector buffer. The sector buffer allows the usage of the system as a real time target system because data can not be lost during transfers to/from the WFC-1. Full asynchronous operation is performed through the flexible interrupt scheme on the board.

2.0 Preferred VMEbus Boards for system extension

The miniFORCE 2P21 is a full 32 bit VMEbus based system and provides the maximum throughput if the processor runs within the local SRAM. A memory extention of the 512 Kbyte RAM can be made via a SRAM-22 board or via global memory boards on the VMEbus.

For systems where global memory has to be used, a 32 bit memory board is the best solution to improve throughput and execution speed.

Additional memory is automatically detected and used by the PDOS operating system if it is continuous to the local memory.

Additional I/O channels are supported through the SIO-1 board as well as through the advanced system control unit ASCU-1/2.

3.0 PDOS* Operating System Overview

The SYS68K/PDOS* is a powerful multi-user, multi-tasking, Real Time Operating System (RTOS). PDOS* consists of a small real time kernel (4 Kbyte) which provides synchronisation and control of events occurring from the hardware using semaphores, events, messages, mailboxes and suspension primitives.

The file management module supports named file access with sequential, random and shared accesses. The details of the PDOS*functions are listed below:

3.1 PDOS KERNEL

PDOS* is written in assembly language for fast, efficient execution. The small kernel provides multi-tasking, Real-Time Clock, event processing, and memory management functions. Ready tasks are scheduled using a prioritized, round-robin method. The line A exception vector is used to interface over 74 system primitives to a user task.

Multi-Tasking execution environment: Tasks are the components comprising a real-time application. Each task is an independent program that shares the processor with other tasks in the system. Tasks provide a mechanism that allows a complicated application to be subdivided into

several independent, understandable, and manageable modules. Real-time, concurrent tasks are allocated in 2 Kbyte increments. The task system overhead for each task is only 1.25 Kbyte.

3.2 INTERTASK COMMUNICATION & SYNCHRONIZATION

Semaphores and events provide a low overhead facility for one task to signal another. Events can be used to indicate availability of a shared resource, timing pulses, or hardware interrupt occurrences. Messages and mailboxes are used in conjunction with system lock, unlock, suspend, and event primitives. PDOS* provides timing events that can be used in conjunction with desired events to prevent system outlocks. Other special system events signal character inputs and outputs.

3.3 MEMORY REQUIREMENTS

PDOS* is very memory efficient. The PDOS* kernel, file manager, and user monitor utilities require only 16 Kbyte of memory plus an additional 4 Kbyte for system buffers and stacks. Further memory reduction can be achieved by linking the user application to a 4 Kbyte PDOS* kernel for a small, ROMable, standalone, multi-tasking module.

3.4 FILE MANAGEMENT

The PDOS* file management module provides sequential, random, read only, and shared access to named files on a secondary storage device. These low overhead file primitives use a linked, random access file structure and a logical sector bit map for allocation of secondary storage. No file compaction is ever required. Files are time stamped with date of creation and last update. Up to 32 files can be simultaneously opened. Complete device independence is achieved through read and write logical sector primitives.

3.5 COMMAND LINE INTERPRETER

A resident command line interpreter allows multiple commands to be entered on a single line. Command utilities such as append, define, delete, copy, rename, and show file are also resident and can be executed without destroying current memory programs. Other functions resident in the PDOS * monitor include setting the baud rate of a port, checksumming memory, creating tasks, listing tasks, files and open file status, asking for help, setting file level, file attributes, interrupt mask, and system disk, and directing console output.

3.6 INTERRUPT MANAGEMENT

The PDOS* kernel handles user console, system clock, and other designated hardware interrupts. User consoles have interrupt driven character I/O with type ahead. A task can be suspended pending a hardware or software event. PDOS* will switch control to a task suspended on an external event within 100 microseconds after the occurrence of the event (provided the system mask is high enough). Otherwise, a prioritized round-robin scheduling of ready tasks occurs in 10 millisecond intervals.

3.7 SUPPORT TOOLS

Numerous support utilities including virtual screen editors, assembler, linker, macroprocessor, disk diagnostics, link, and recovery, disk cataloging are additional standard functions in the PDOS*. Single stepping, multiple break points, memory snap shots, save and restore task commands, and error trapping primitives are provided for program debugging.

3.8 LANGUAGE SUPPORT

The following languages are available under PDOS*:

Assembler:	A macro assembler with the full 68020 instruction set is included in the PDOS* system.
C:	A complete implementation of the C-language as defined by Kernigham and Ritchie is available as an option. Extensions include most of the PDOS primitives to support the real time features of PDOS. A 68020 version is under development and will be used instead of the 68000/68010 version if it becomes available.
FORTRAN77:	Full ANSI 77 Version of the FORTRAN language is available as an option. A 68020 version is under development and will be used instead of the 68000/68010 version if it becomes available.
PASCAL:	Full Jensen/Wirth implementation of the ISO PASCAL standard is under development.

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4.0 System Configuration

The basic configuration of a 32 bit development system is realised in the miniFORCE 2P21 Real Time System.

The miniFORCE 2P21 consists of 6 unused VME slots for application dependent I/O boards or memory expansion.

All 6 left open slots are supported from the included power supply with a maximum allowed current of 3A per slot.

Special configurations including additional boards are available on request.

System Configurations

	miniFORCE 2P21
Processor	68020
Frequency	16.7MHz
Floating Point CoProcessor	68881
Frequency	16.7MHz
Local RAM Type	SRAM
Capacity	512 Kbyte
No. of Wait States	0
Data Transfer Size	8, 16, 24 and 32 Bit
Serial I/O Channels	2
RS232	1 + 1
RS422	1
Winchester Disk unformatted	51 Mbyte
Floppy Disk unformatted	1 Mbyte
VMEbus Interrupt Handler	1-7 dyn.
Single Level Arbiter	Yes
Primary VMXbus Interface	A24:D8, D16, D24, D32
VMEbus Interface	A32:D8, D16, D24, D32
	A24:D8, D16, D24, D32
	A16:D8, D16, D24, D32
Used VME Boards	CPU-21
	WFC-1
	MOTH-09A
	MOTH-E09A
No of Free Slots	6
Power Supply	PWR-09A 36A at 5V
Mass Memory	WFMOD-50
Housing	19″
Weight	max 23kg (51 lbs)
Dimensions	344 mm x 520 mm x 400 mm
Operating Temperature	5–45°C
Relative Humidity	5–85 % (non condensing)

System Benchmarks

	miniFORCE 2P21
10.000.000 Nops	3.55 s
100.000 Context Switches	2.98 s
100.000 Read time of day	3.61 s
100.000 Set System event	3.65 s
100.000 Test System event	1.86 s
100.000 Resource allocations	7.70 s
100.000 Send and Receive 64 bytes	17.34 s
100.000 Task Synchronisations	15.55 s
100.000 Lock and Unlock file	6.94 s
100.000 10byte record rereads	9.57 s

The benchmarks are performed with CPU-21 at 16.7MHz processor clock frequency and cache enabled.

Ordering Information

System Configuration

miniFORCE 2P21 Part No. 620700	PDOS System with CPU-21 and documentation
SYS68K/PDOS-SUM/21 Part No. 800090	Software Users Manual for the PDOS Operating System.

Language support

SYS68K/PDOS-C020 Part No. 140031	C-Compiler for PDOS inclusive documentation
SYS68K/PDOS-FOR020 Part No. 140041	FORTRAN-77 Compiler for PDOS inclusive documentation
SYS68K/PDOS-PAS020 Part No. 140021	PASCAL Compiler for PDOS inclusive Documentation (Product under Development)

VMEbus Extensions

SYS68K/SRAM-22 Part No. 201000	Zero Wait State 512 Kbyte static RAM extention for CPU-20/21
SYS68K/DRAM-E3M1 Part No. 200004	1 Mbyte 32-bit VMEbus dynamic RAM board including documentation
SYS68K/SIO-1 Part No. 310000	6 channel serial I/O board including documentation
SYS68K/ASCU-2 Part No. 700007	System Control Unit including IEEE488, 1 serial I/O and one Parallel Interface. Documentation included

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