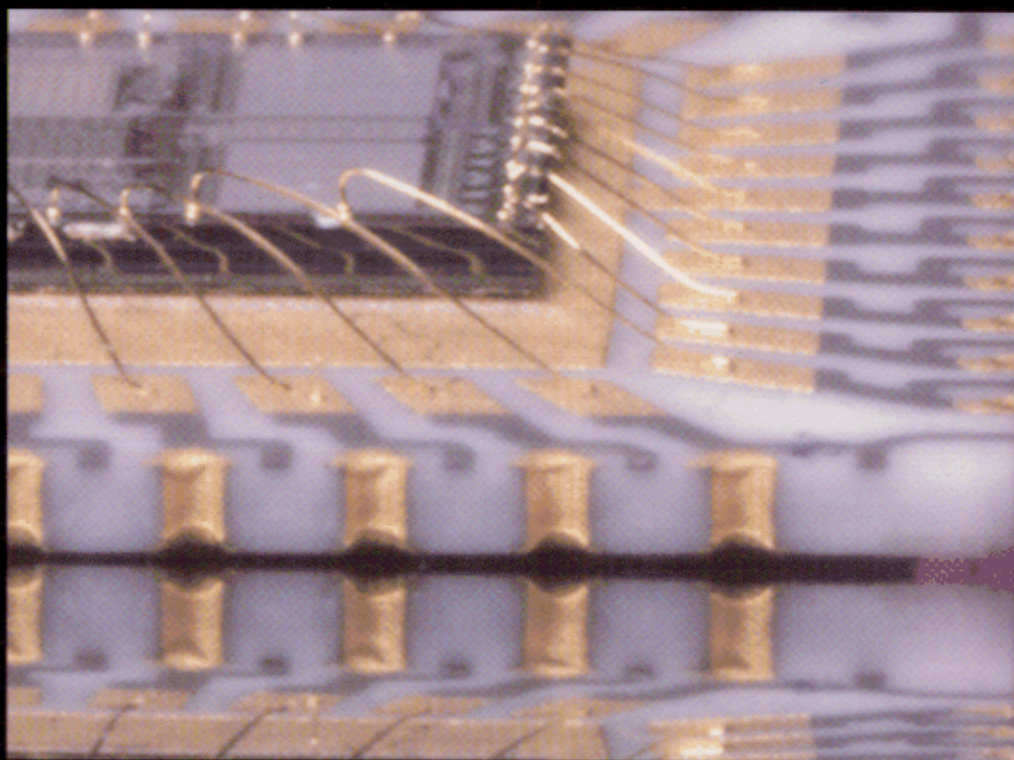


INTERNATIONAL EDITION

THE INTEL MICROPROCESSORS

8086/8088, 80186/80188, 80286, 80386, 80486, PENTIUM,
PENTIUM PRO PROCESSOR, PENTIUM II, PENTIUM III, PENTIUM 4
ARCHITECTURE, PROGRAMMING, AND INTERFACING

S E V E N T H E D I T I O N



Barry B. Brey

CONTENTS

CHAPTER 1	INTRODUCTION TO THE MICROPROCESSOR AND COMPUTER	1
	Introduction/Chapter Objectives, 1	
	1-1 A Historical Background, 2; 1-2 The Microprocessor-Based Personal Computer System, 16; 1-3 Number Systems, 27; 1-4 Computer Data Formats, 33; 1-5 Summary, 42; 1-6 Questions and Problems, 44	
CHAPTER 2	THE MICROPROCESSOR AND ITS ARCHITECTURE	49
	Introduction/Chapter Objectives, 49	
	2-1 Internal Microprocessor Architecture, 49; 2-2 Real Mode Memory Addressing, 55; 2-3 Introduction to Protected Mode Memory Addressing, 60; 2-4 Memory Paging, 65; 2-5 Summary, 68; 2-6 Questions and Problems, 70	
CHAPTER 3	ADDRESSING MODES	72
	Introduction/Chapter Objectives, 72	
	3-1 Data-Addressing Modes, 72; 3-2 Program Memory-Addressing Modes, 94; 3-3 Stack Memory-Addressing Modes, 96; 3-4 Summary, 99; 3-5 Questions and Problems, 101	
CHAPTER 4	DATA MOVEMENT INSTRUCTIONS	104
	Introduction/Chapter Objectives, 104	
	4-1 MOV Revisited, 105; 4-2 PUSH/POP, 113; 4-3 Load-Effective Address, 118; 4-4 String Data Transfers, 121; 4-5 Miscellaneous Data Transfer Instructions, 128; 4-6 Segment Override Prefix, 133; 4-7 Assembler Detail, 134; 4-8 Summary, 143; 4-9 Questions and Problems, 145	
CHAPTER 5	ARITHMETIC AND LOGIC INSTRUCTIONS	148
	Introduction/Chapter Objectives, 148	
	5-1 Addition, Subtraction, and Comparison, 148; 5-2 Multiplication and Division, 158; 5-3 BCD and ASCII Arithmetic, 163; 5-4 Basic Logic Instructions, 166; 5-5 Shift and Rotate, 172; 5-6 String Comparisons, 176; 5-7 Summary, 177; 5-8 Questions and Problems, 179	

CHAPTER 6	PROGRAM CONTROL INSTRUCTIONS	182
	Introduction/Chapter Objectives, 182 6-1 The Jump Group, 182; 6-2 Controlling the Flow of the Program, 192; 6-3 Procedures, 197; 6-4 Introduction to Interrupts, 202; 6-5 Machine Control and Miscellaneous Instructions, 206; 6-6 Summary, 209; 6-7 Questions and Problems, 210	
CHAPTER 7	USING ASSEMBLY LANGUAGE WITH C/C++	213
	Introduction/Chapter Objectives, 213 7-1 Using Assembly Language with C++ for 16-Bit DOS Applications, 214; 7-2 Using Assembly Language with Visual C/C++ for 32-Bit Applications, 221; 7-3 Separate Assembly Objects, 230; 7-4 Summary, 235; 7-5 Questions and Problems, 236	
CHAPTER 8	PROGRAMMING THE MICROPROCESSOR	238
	Introduction/Chapter Objectives, 238 8-1 Modular Programming, 239; 8-2 Using the Keyboard and Video Display, 247; 8-3 Data Conversions, 260; 8-4 Disk Files, 268; 8-5 Example Programs, 279; 8-6 Summary, 285; 8-7 Questions and Problems, 285	
CHAPTER 9	8086/8088 HARDWARE SPECIFICATIONS	288
	Introduction/Chapter Objectives, 288 9-1 Pin-Outs and the Pin Functions, 288; 9-2 Clock Generator (8284A), 293; 9-3 Bus Buffering and Latching, 296; 9-4 Bus Timing, 301; 9-5 Ready and the Wait State, 306; 9-6 Minimum Mode versus Maximum Mode, 309; 9-7 Summary, 311; 9-8 Questions and Problems, 312	
CHAPTER 10	MEMORY INTERFACE	314
	Introduction/Chapter Objectives, 314 10-1 Memory Devices, 314; 10-2 Address Decoding, 326; 10-3 8088 and 80188 (8-Bit) Memory Interface, 335; 10-4 8086, 80186, 80286, and 80386SX (16-Bit) Memory Interface, 341; 10-5 80386DX and 80486 (32-Bit) Memory Interface, 348; 10-6 Pentium through Pentium 4 (64-Bit) Memory Interface, 351; 10-7 Dynamic RAM, 355; 10-8 Summary, 358; 10-9 Questions and Problems, 359	
CHAPTER 11	BASIC I/O INTERFACE	362
	Introduction/Chapter Objectives, 362 11-1 Introduction to I/O Interface, 362; 11-2 I/O Port Address Decoding, 372; 11-3 The Programmable Peripheral Interface, 380; 11-4 8254 Programmable Interval Timer, 406; 11-5 16550 Programmable Communications Interface, 416; 11-6 Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Converters, 424; 11-7 Summary, 430; 11-8 Questions and Problems, 431	
CHAPTER 12	INTERRUPTS	434
	Introduction/Chapter Objectives, 434 12-1 Basic Interrupt Processing, 434; 12-2 Hardware Interrupts, 442; 12-3 Expanding the Interrupt Structure, 448; 12-4 8259A Programmable Interrupt Controller, 451; 12-5 Interrupt Examples, 465; 12-6 Summary, 469; 12-7 Questions and Problems, 470	
CHAPTER 13	DIRECT MEMORY ACCESS AND DMA-CONTROLLED I/O	472
	Introduction/Chapter Objectives, 472 13-1 Basic DMA Operation, 472; 13-2 The 8237 DMA Controller, 474;	

13–3 Shared-Bus Operation, 489; 13–4 Disk Memory Systems, 496; 13–5 Video Displays, 504;
13–6 Summary, 511; 13–7 Questions and Problems, 511

CHAPTER 14	THE ARITHMETIC COPROCESSOR, MMX, AND SIMD TECHNOLOGIES	513
	Introduction/Chapter Objectives, 513	
	14–1 Data Formats for the Arithmetic Coprocessor, 514; 14–2 The 80X87 Architecture, 518;	
	14–3 Instruction Set, 522; 14–4 Programming with the Arithmetic Coprocessor, 547;	
	14–5 Introduction to MMX Technology, 551; 14–6 Introduction to SSE Technology, 563;	
	14–7 Summary, 569; 14–8 Questions and Problems, 571	
CHAPTER 15	BUS INTERFACE	574
	Introduction/Chapter Objectives, 574	
	15–1 The ISA Bus, 574; 15–2 The Peripheral Component Interconnect (PCI) Bus, 584;	
	15–3 The Parallel Printer Interface (LPT), 592; 15–4 The Serial COM Ports, 595;	
	15–5 The Universal Serial Bus (USB), 597; 15–6 The Accelerated Graphics Port (AGP), 604;	
	15–7 Summary, 604; 15–8 Questions and Problems, 605	
CHAPTER 16	THE 80186, 80188, AND 80286 MICROPROCESSORS	607
	Introduction/Chapter Objectives, 607	
	16–1 80186/80188 Architecture, 607; 16–2 Programming the 80186/80188 Enhancements, 617;	
	16–3 80C188EB Example Interface, 635; 16–4 Real-Time Operating Systems (RTOS), 642;	
	16–5 Introduction to the 80286, 650; 16–6 Summary, 654; 16–7 Questions and Problems, 655	
CHAPTER 17	THE 80386 AND 80486 MICROPROCESSORS	657
	Introduction/Chapter Objectives, 657	
	17–1 Introduction to the 80386 Microprocessor, 658; 17–2 Special 80386 Registers, 672;	
	17–3 80386 Memory Management, 674; 17–4 Moving to Protected Mode, 682;	
	17–5 Virtual 8086 Mode, 692; 17–6 The Memory Paging Mechanism, 694;	
	17–7 Introduction to the 80486 Microprocessor, 698; 17–8 Summary, 706; 17–9 Questions and Problems, 707	
CHAPTER 18	THE PENTIUM AND PENTIUM PRO MICROPROCESSORS	709
	Introduction/Chapter Objectives, 709	
	18–1 Introduction to the Pentium Microprocessor, 710; 18–2 Special Pentium Registers, 718;	
	18–3 Pentium Memory Management, 720; 18–4 New Pentium Instructions, 722;	
	18–5 Introduction to the Pentium Pro Microprocessor, 727; 18–6 Special Pentium Pro Features, 736; 18–7 Summary, 737; 18–8 Questions and Problems, 738	
CHAPTER 19	THE PENTIUM II, PENTIUM III, AND PENTIUM 4 MICROPROCESSORS	739
	Introduction/Chapter Objectives, 739	
	19–1 Introduction to the Pentium II Microprocessor, 740; 19–2 Pentium II Software Changes, 748;	
	19–3 The Pentium III, 750; 19–4 The Pentium 4, 751; 19–5 Summary, 762;	
	19–6 Questions and Problems, 762	
	APPENDIXES	764
	Appendix A: The Assembler, Visual C++, and DOS, 764; Appendix B: Instruction Set Summary, 775; Appendix C: Flag-Bit Changes, 876; Appendix D: Answers to Selected Even-Numbered Questions and Problems, 878	
	INDEX	896