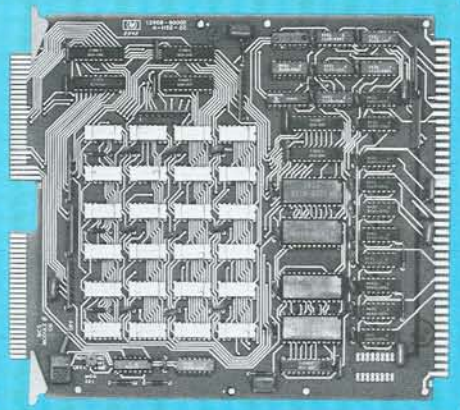
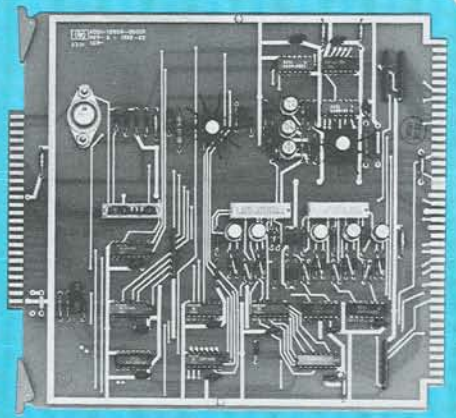
HEWLETT hp PACKARD

Microprogramming Accessories

For 2100 Series Minicomputers



12908B Writeable Control Store



12909A PROM Writer

WRITEABLE CONTROL STORE (WCS)

Features

- **Incorporates microprograms into computer hardware.**
- **256 24-bit word storage for microprograms.**
- **Enables access to six additional high-speed registers.**
- **196 nanosecond cycle time.**
- **Dynamically alterable.**
- **Read/Write capability from memory and disc.**

MICROPROGRAMMING

A microprogram is a computer program written with advanced, concise instructions that are stored in computer hardware rather than in memory. This makes it possible to execute microprograms from 5 to 10 times faster than ordinary software subroutines. In addition your subroutines can be coded using a fraction of the instruction words needed for conventional programming. Microprograms are expressed in 24-bit, 6 field format. These powerful instructions are executed in a mere 196 nanoseconds. All this not only saves vast memory space, but reduces execution time to a fraction of conventional computing time. Microprogramming enables you to use six additional high-speed registers for fast execution of arithmetic and logic functions and it provides your routines with the ultimate in security by storing them in the hardware.

Thus your own specific programming tasks are performed in the most efficient state-of-the-art manner in a fraction of the time formerly required. Computer applications that are unique to your needs can be added by microprograms to customize the 2100 to your own specific requirements. As your computer needs develop, the 2100 can be modified with different microprograms, thus extending the life and capability of your computer system.

WRITEABLE CONTROL STORE

The Writeable Control Store (WCS) Card contains semi-conductor random access memory for storage of microprograms. Each card contains 256 24-bit words. Up to three WCS cards can be inserted in the computer mainframe.

The instruction word format as stored on the WCS is:

Bits:	23-21	20-17	16-12	11-8	7-4	3-0
Field:	R-Bus	S-Bus	Function	Store	Special	Skip

You can even have your own library of microprograms on disc and transfer them to the WCS card as needed. After execution, the microprograms can be swapped with other microprograms on the disc or left on the WCS card.

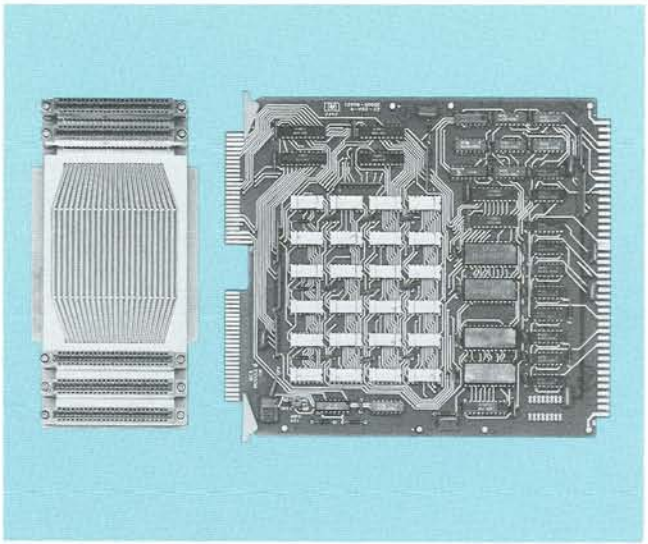
By such use of microprograms and disc files, you can dynamically alter the 2100 , configuring its power and speed to your specific purposes. The computer can thus be customized to entirely different system functions as quickly as microprograms can be transferred from disc files.

The microprograms that will not change can be permenently fused on read-only memory chips by the Programmable Read-Only Memory (PROM) Writer.

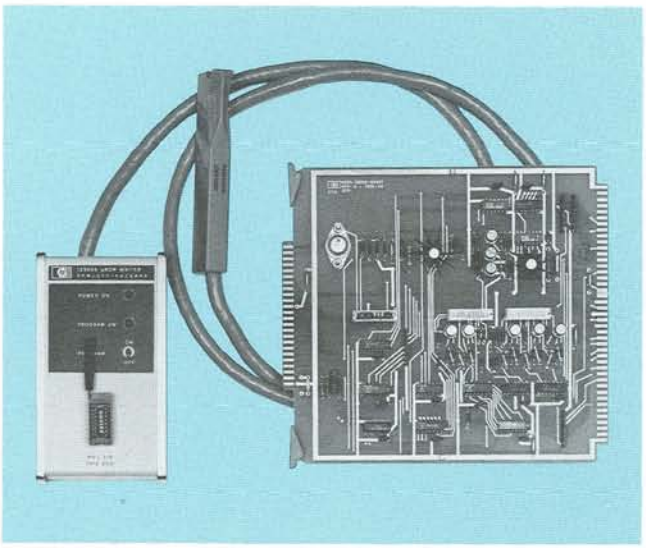
PROGRAMMABLE READ-ONLY MEMORY (PROM) WRITER

The Programmable Read-Only Memory Writer consists of one card that is temporarily inserted into a 2100 I/O slot and a small box in which the read-only memory chips are fused. Your microprograms can be transferred from memory to PROM chips by the PROM Writer.

The software provided with the PROM Writer enables the system operator to control the fusing. Microprogrammed chips are automatically verified and any missed bits are immediately fused.

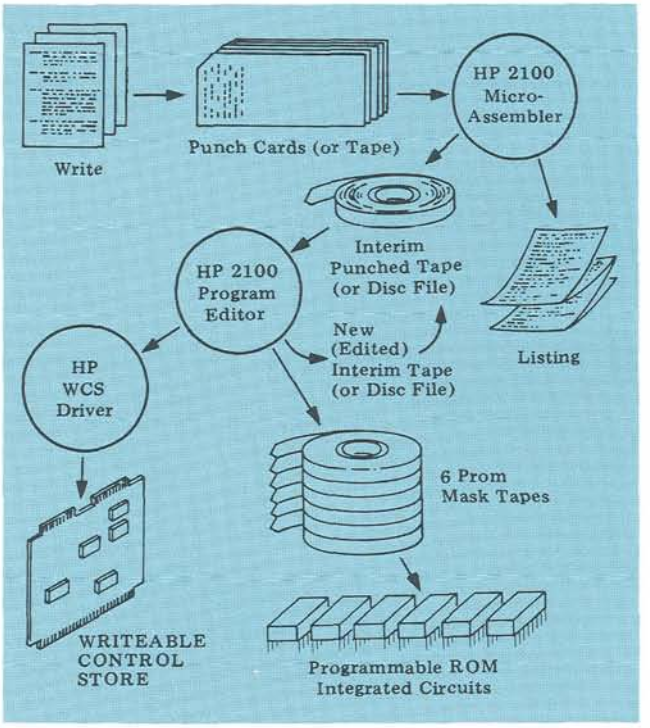


HP 12908B Writeable Control Store Interface Kit



HP 12909A Programmable Read-Only Memory Writer Interface Kit

The figure given below illustrates the sequence of microprogram implementation.



SOFTWARE

A complete microprogramming software package is supplied with the WCS cards and PROM Writer. It includes the microprogram assembler, drivers, and Debug Editors for both the HP Basic Control System and HP Disc Operating System. Microprograms can be called from Assembly Language, FORTRAN II and IV, ALGOL, and HP Extended BASIC.

A detailed explanation of microprogramming methods and instructions is provided in **HP 2100 Computer Microprogramming Guide** (5951-3028) and **HP 2100 Computer Microprogramming Software** (02100-90133).

The calling sequences from Assembly Language and FORTRAN are given below as well as a sample microprogram.

Passing Control From An Assembly Language Program

There are two ways to pass control from an assembly language program to a microprogram. The first applies only if the RAM (Random Access Memory) pseudo-instruction is available; the second applies in any case. The two methods are illustrated below.

Passing Control From an Assembly Language Program to a Microprogram

```
Method 1:          RAM   SWB
                          .
                          .
                          .
                   SWB   EQU   xxxB
Method 2:          SWB   OCT   105xxx
```

The RAM pseudo-instruction automatically forms the 105xxx macro instruction using the constant supplied in the EQU statement (the 105xxx macro instruction replaces the RAM pseudo-instruction). In both cases, *xxx* is 000-377.

Passing Control From A Fortran Program

A FORTRAN program passes control to a microprogram indirectly by way of an assembly language program.

For example, the FORTRAN statement

```
CALL  XYZ (A,B)
```

generates the following calling sequence:

```
JSB   XYZ
DEF   *+3
DEF   address of the first parameter
DEF   address of the second parameter
```

When the above calling sequence is executed, control passes to the assembly language program named XYZ. XYZ replaces the JSB XYZ instruction in the above calling sequence with the 105xxx macro instruction and then passes control to the 105xxx macro instruction. The program XYZ is as follows:

```
      ENT   XYZ
XYZ   NOP
      LDA   XYZ
      ADA   =D—1
      LDB   105xxxB
      STB   0,I
      JMP   0,I
```

Block Move Microprogram

This sample microprogram moves a group of computer words from one place in core memory to another. When the microprogram receives control, it is assumed that:

- The number of words to be moved is in the A-register (in two's complement form).
- The FROM address is in the B-register.
- The TO address is in the core memory location pointed to by the P-register.

The HP assembly language calling sequence is as follows:

```
LDA   (number-of-words)
LDB   from-address
105xxx
DEF   to-address (cannot be indirect)
```

```
MOV     P     IOR  M    RW          GET 'TO' ADDRESS
        T     IOR  Q                PUT IT IN Q
-------------------------------------------------------------
LOOP  B  RRS  IOR  M    RW          READ A DATA WORD
         T    IOR  S1               PUT IT IN S1
-------------------------------------------------------------
        Q     IOR  S2               PUT 'TO' ADDRESS IN S2
        F  S2 DEC  M    CW   NMPV   ADDRESS THE 'TO' LOCATION
              JMP       OUT         (MEMORY PROTECT VIOLATION)
           S1 IOR  T                WRITE A DATA WORD TO MEMORY
-------------------------------------------------------------
        B     INC  B                INCREMENT THE 'FROM' ADDRESS
        Q     INC  Q                INCREMENT THE 'TO' ADDRESS
        A     INC  A         TBZ    DECREMENT AND TEST THE COUNTER
              JMP     LOOP          REPEAT THE MOVE LOOP
-------------------------------------------------------------
OUT     P     INC  P         EOP    INCREMENT THE P REGISTER
              IOR                   EXIT
```

Block Move Microprogram

Microinstruction Commentary

```
MOV     P    IOR  M   RW          GET 'TO' ADDRESS
        T    IOR  Q               PUT IT IN Q
```

Get the TO address and store it in the Q-register. The TO address cannot be indirect.

```
LOOP  B  RRS  IOR  M   RW          READ A DATA WORD
         T    IOR  S1              PUT IT IN S1
```

Read a data word from the core memory location pointed to by the FROM address and store the data word in Scratch Pad Register 1.

```
      Q       IOR  S2             PUT 'TO' ADDRESS IN S2
      F  S2   DEC  M   CW  NMPV    ADDRESS THE 'TO' LOCATION
              JMP      OUT         (MEMORY PROTECT VIOLATION)
         S1   IOR  T               WRITE A DATA WORD TO MEMORY
```

Put the TO address in Scratch Pad Register 2. Address the TO core memory location. Write the data word into the core memory location pointed to by the TO address. The F, DEC, and NMPV micro-orders in the "write into memory" microinstruction test the TO address to make sure it does not refer to a location in the protected portion of core memory. If a memory protect violation is detected, control passes to OUT (otherwise the "write into memory" operation is performed).

```
      B       INC  B               INCREMENT THE 'FROM' ADDRESS
      Q       INC  Q               INCREMENT THE 'TO' ADDRESS
      A       INC  A        TBZ    DECREMENT AND TEST THE COUNTER
              JMP     LOOP         REPEAT THE MOVE LOOP
```

Increment the FROM address. Increment the TO address. Increment and test the number of words (remember that the number of words is in two's complement form; consequently, the number is effectively decremented). If the number = 0, control passes to OUT. Otherwise, the move loop is repeated.

```
OUT     P    INC  P         EOP     INCREMENT THE P REGISTER
             IOR                    EXIT
```

Increment the P-register and exit.

Microprogram Mnemonics

R-bus	S-bus	Function	Store	Special	Skip
NOP	NOP	IOR	NOP	NOP	NOP
A	P	XOR	M	CNTR	EOP
B	S1	AND	T	CW	COUT
Q	S2	NOR	IR	ECYN	CTR
F	S3	LWF	A	ECYZ	CTRI
AAB	S4	ARS	B	IOG1	FLG
CAB	M	LGS	Q	L1	ICTR
CQ	T	CRS	F	R1	NEG
	ADR	JMP	P	RSS	NMPV
	CNTR	CJMP	S1	RW	ODD
	CL	JSB	S2	AAB	OVF
	CR	RSB	S3	ASG1	RPT
	CIR	ADD	S4	ASG2	TBZ
	IOI	ADDO	IOO	LEP	UNC
	RRS	SUB	AAB	SRG1	AAB
	COND	MPY	CAB	SRG2	NAAB
		DIV			
		DEC			
		INC			
		INCO			
		SOV			
		CLO			
		SFLG			
		CFLG			
		RFE			
		RFI			
		P1A			

SPECIFICATIONS

WRITEABLE CONTROL STORE CARD

PHYSICAL

Dimensions
- Width: 7-3/4 inches (196 millimeters)
- Height: 8-11/16 inches (22 millimeters)

CURRENT REQUIRED

+4.85 volts supply 4.6 amperes
+2.00 volts supply 0.15 amperes

EQUIPMENT SUPPLIED

12908B Writeable Control Store PCA (12908-60006)
Jumper Board Assembly (12908-60003)
Operating and Service Manuals (12908-90001)

PROGRAMMABLE READ ONLY MEMORY WRITER

PHYSICAL

- Width: 7-3/4 inches (196 millimeters)
- Height: 8-11/16 inches (222 millimeters)

Prom Writer Mounting Fixture
- Width: 3 inches (76. millimeters)
- Height: 5-3/4 inches (146 millimeters)
- Depth: 1-1/2 inches (38 millimeters)

CURRENT REQUIRED

+5 volt supply $\leqslant$ 0.500 amperes
-2 volt supply $\leqslant$ 0.040 amperes
+12 volt supply $\leqslant$ 0.250 amperes
+30 volt supply $\leqslant$ 0.250 amperes

EQUIPMENT SUPPLIED

12909A PROM Writer Printed-circuit Assembly (12909-60001)
PROM Writer Mounting Fixture (12909-60002)
Test ROM (1816-0250)
Operating and Service Manual (12909-90001)

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For more information, call your local HP Sales Office or East (201) 265-5000 Midwest (312) 677-0400 South (404) 436-6181 West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-ku, Tokyo, 151.

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