HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

12616A

HIGH-SPEED INPUT/OUTPUT CHANNEL ACCESSORY KIT

(FOR THE 2114B COMPUTER)

Card Assembly
12616-60001, Rev 1005

Note

This manual should be retained with the Installation and Maintenance Manual (part no. 02114-90399) for the HP 2114B Computer.

12616-90001

HEWLETT-PACKARD COMPANY
11000 WOLFE ROAD, CUPERTINO, CALIFORNIA, U.S.A.

Printed: APRIL 1970

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This operating and service manual covers general information, installation, programming, theory of operation, maintenance, and replaceable parts for the HP 12616A High-Speed Input/Output Channel Accessory Kit. (See figure 1-1.)

1-3. GENERAL DESCRIPTION.

1-4. High-speed channel is used with the HP 2114B Computer. The high-speed channel card is a single printed-circuit card which plugs into a prewired slot in the computer. The 12616A Accessory Kit contains the following items:

a. 12616-60001 High-Speed Channel Card.

b. 12616-60002 Input Test Connector.

c. 12616-60003 Output Test Connector.

d. 02116-4001 Hood.

e. 1251-0335 48-Pin Connector.

f. 0642-0096 Tapping Screw (2).

g. 3030-0143 Setscrew.

h. 02116-4003 Cable Clamp.

i. 12616-90001 Operating and Service Manual.

j. HP 20546A High-Speed I/O Channel Rate Test Diagnostic Tape.

Note

The part number of the program tape is followed by a letter which identifies a particular revision of the tape. The first issue of a tape is identified by the letter A. Subsequent revisions are identified in sequence as B, C, D, etc. If a revision of a tape requires changes to associated documentation, an updating supplement for the documentation is supplied when the new tape is furnished. Always use the latest revision of a program tape, even if different from that specified in this manual, together with all updating documentation.

1-5. The high-speed channel card is used with the HP 12595A Multiplexed Input/Output Computer Accessory Kit and a user-designed controller. The multiplexed input/output computer accessory kit allows the computer to interface with the user's controller and to directly address up to 56 different devices from the computer. The addition of the high-speed channel accessory kit makes it possible to have direct high-speed data transfer between the computer and the high-speed devices in the system. Data transfer between the computer and the slower devices can then be accomplished under program control. For additional information on the multiplexed input/output computer acces-

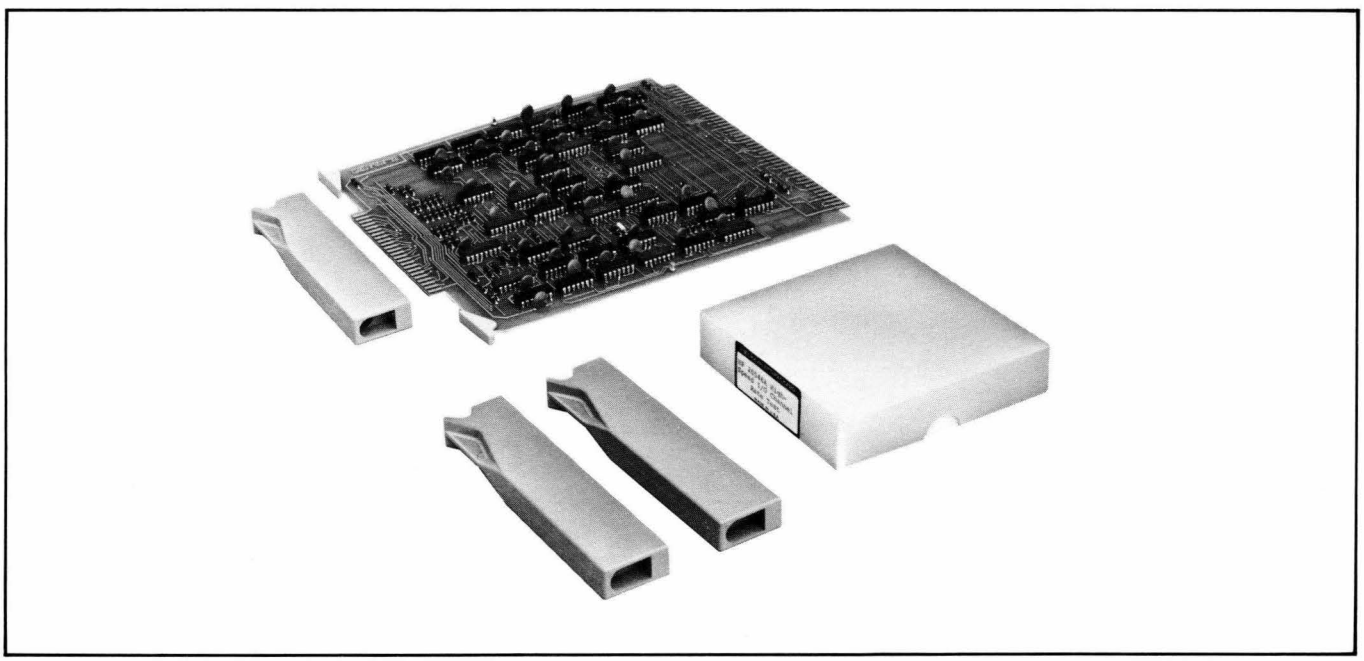


Figure 1-1. HP 12616A High-Speed Input/Output Channel Accessory Kit

sory kit, refer to the Operating and Service Manual for the kit, part number 12595-9001. Information contained in "A Pocket Guide to Interfacing HP Computer," part number 5950-8718, will aid in the design of a suitable controller.

1-6. The high-speed channel accessory kit enables the computer to transfer data directly between memory and external devices at a rate of 500,000 16-bit words per second in block lengths of 1 to 8192 words. Word transfer time is 2.0 microseconds for a 16-bit word. No character packing hardware is provided on the card; when using byte (eight-bit) oriented devices, character packing and unpacking may be accomplished with software, before or after data transfer.

1-7. The high-speed channel accessory kit can be used for either random or block data transfers. For random data transfers, a memory address must be provided for each 16-bit word transfer. For block data transfers, a starting address in memory must be provided as well as a word count block length. The memory address register on the high-speed channel card is then incremented automatically after each word transfer. The word count register is incremented with each word transfer and supplies an interrupt when the complete block of data has been transferred.

1-8. During operation, the high-speed channel card generates a special phase-5 memory cycle to read or write a word directly into or out of the predetermined memory location. During this phase 5 cycle, the high-speed channel card has control of the central processor unit and input/output section of the computer. The card generates the necessary control signals to accomplish the data transfer. A new phase 5 cycle is generated each time a cycle is requested by the user's controller.

1-9. IDENTIFICATION.

1-10. Printed-circuit card revisions are identified by a letter, a date code, and a division code stamped on the board (e.g., A-1055-22). The letter code identifies the version of the etched trace pattern on the unloaded board. The date code (four middle digits) refers to the electrical characteristics of the loaded board. The division code (last two digits) identifies the Hewlett-Packard division that manufactured the board. If the date code stamped on the printed-circuit board does not agree with the date code shown on the title page of this manual, there are differences between your board and the board described in this manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office.

1-11. SPECIFICATIONS.

1-12. Specifications for the high-speed channel card are listed in table 1-1.

1-13. TEST EQUIPMENT REQUIREMENTS.

1-14. The only test equipment required is an HP 180A Oscilloscope (or equivalent), which is used to troubleshoot the high-speed channel card.

Table 1-1. High-Speed Channel Card Specifications

16-bit word transfer time:	2.0 microseconds.
Maximum time from cycle request to completion of phase 5 cycle:	5.0 microseconds.
Data transfer rate (maximum):	500,000 16-bit words per second.
Data block length:	1 to 8192 16-bit words.
Addressing:	Random access to any core location or sequential access from a specified starting address (up or down).
Signal interfacing:	All signals are TTL and DTL compatible.
Power Requirements:	+5 volts at 1.8 amperes. -2 volts at 0.47 amperes.

SECTION II
INSTALLATION AND PROGRAMMING

2-1. INTRODUCTION.

2-2. This section contains installation and programming information for the high-speed channel accessory kit.

2-3. UNPACKING AND INSPECTION.

2-4. If the shipping carton is damaged upon receipt, request that the carrier's agent be present when the accessory kit is unpacked. Inspect the accessory kit for damage (cracks, broken parts, etc.). If the accessory kit is damaged and fails to meet specifications, notify the carrier and the nearest HP Sales and Service Office immediately. (Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The HP Sales and Service Office will arrange for the repair or replacement of the damaged kit without waiting for any claims against the carrier to be settled.

2-5. INSTALLATION.

CAUTION

Make certain that power is off at the computer before installing the high-speed channel accessory kit, or damage to the computer may result.

2-6. The high-speed channel card may be factory or field installed in the computer by plugging the card into slot XA16 in the computer mainframe. To complete the installation, a cable must be fabricated in the field to connect the 48-pin connector on the card to the user's controller. Table 2-1 lists the 48-pin connector kit parts, and figure 2-1 illustrates the proper assembly of the parts. The cable must be furnished by the user. Tables 2-2 and 2-3 list the connector pin functions for the 48-pin and 86-pin connectors on the high-speed channel card. Refer to table 2-2 when fabricating the cable that connects the controller to the card.

Table 2-1. 48-Pin Connector Kit Parts List

ITEM	QUANTITY	DESCRIPTION	PART NO.
1	1	Hood	02116-4001
2	2	Tapping Screw	0642-0096
3	1	Connector, 48-pin	1251-0335
4	1	Setscrew	3030-0143
5	1	Cable Clamp	02116-4003

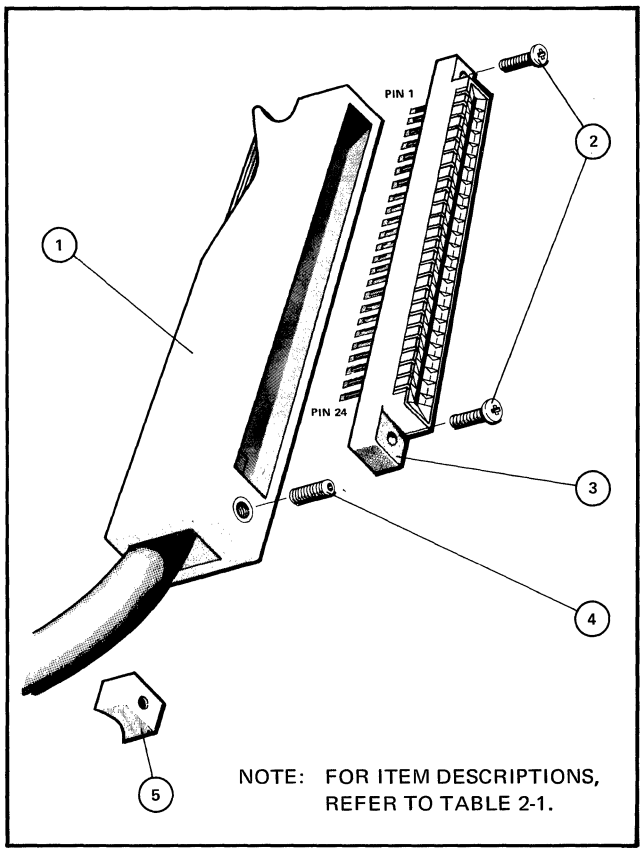


Figure 2-1. Connector Kit Assembly Diagram

2-7. After the high-speed channel accessory kit has been installed, perform the High-Speed I/O Channel Rate Test procedure, part number 12616-90003, contained in the Manual of Diagnostics to ensure proper operation of the high-speed channel card.

2-8. PROGRAMMING.

2-9. The high-speed channel card is programmed using HP assembler language. In order for the card to operate, however, certain control signals from the user's controller must be present in addition to the program words. The following is a listing of program instructions to which the high-speed channel card will respond:

a. STC 06: Sets the control bit to enable interrupts and sets the Transfer Enable flip-flop, which effectively turns on the card.

b. CLC 06: Clears the control bit, which inhibits interrupts. A CLC 06 instruction does not reset the Transfer Enable flip-flop on the card and thus does not inhibit data transfers.

Table 2-2. Pin Index for 48-Pin Connector

PIN	MNEMONIC	SIGNAL NAME	PIN	MNEMONIC	SIGNAL NAME
1	GND	Ground	A	GND	Ground
2	WC0	Word Count Bit 0	B	MA0	Memory Address Bit 0
3	WC1	Word Count Bit 1	C	MA1	Memory Address Bit 1
4	WC2	Word Count Bit 2	D	MA2	Memory Address Bit 2
5	WC3	Word Count Bit 3	E	MA3	Memory Address Bit 3
6	WC4	Word Count Bit 4	F	MA4	Memory Address Bit 4
7	WC5	Word Count Bit 5	H	MA5	Memory Address Bit 5
8	WC6	Word Count Bit 6	J	MA6	Memory Address Bit 6
9	WC7	Word Count Bit 7	K	MA7	Memory Address Bit 7
10	WC8	Word Count Bit 8	L	MA8	Memory Address Bit 8
11	WC9	Word Count Bit 9	M	MA9	Memory Address Bit 9
12	WC10	Word Count Bit 10	N	MA10	Memory Address Bit 10
13	WC11	Word Count Bit 11	P	MA11	Memory Address Bit 11
14	WC12	Word Count Bit 12	R	MA12	Memory Address Bit 12
15	WC13	Word Count Bit 13	S	MA13	Memory Address Bit 13
16	WC14	Word Count Bit 14	T	MODE	Mode
17	$\overline{\text{LWCR}}$	"Not" Load Word Count Register	U	DIR	Direction
			V	INT	Interrupt
18	IAK	Interrupt Acknowledge	W	REQ	Request
19	TEST	Test	X	$\overline{\text{INS}}$	"Not" Inhibit Step Word Count Register
20	Not Used				
21	$\overline{\text{CAK}}$	"Not" Cycle Acknowledge	Y	STEP	Step
22	IST	Input Strobe	Z	LOAD	Load
23	REN	Request Enable	AA	OST	Output Strobe
24	GND	Ground	BB	GND	Ground

c. STF 06: Sets the flag bit on the card.

d. CLF 06: Clears the flag bit on the card.

e. SFS 06: Causes the next program instruction to be skipped if the flag bit on the card is set.

f. SFC 06: Causes the next program instruction to be skipped if the flag bit on the card is clear.

g. LIA 02 (or LIB 02): Loads the contents of the word count register on the card into the A-register (or B-register) of the computer.

h. MIA 02 (or MIB 02): Merges ("inclusive or") the contents of the word count register on the card with the contents of the A-register (or B-register) of the computer.

i. CLC 00: Resets the Interrupt Channel Control flip-flop and the Transfer Enable flip-flop on the card to prevent the card from generating either an interrupt or a phase 5 cycle.

2-10. Table 2-4 lists the program sequence to operate the high-speed channel card. Note that the table lists instructions and signals from both the computer and the controller. Where reference is made to signal lines at the controller, refer to table 2-2 for the corresponding pin on the high-speed channel card 48-pin connector.

Table 2-3. Pin Index for 86-Pin Connector

PIN	MNEMONIC	SIGNAL NAME	PIN	MNEMONIC	SIGNAL NAME
1	GND	Ground	39	+5V	+5 Volts
2	GND	Ground	40	+5V	+5 Volts
3	PRL6	Priority Low on Select Code 6	41	IOB2	I/O Bus Bit 2
4	FLG0	Flag 0	42	IOB4	I/O Bus Bit 4
5	SFC	Skip if Flag Clear	43	Not Used	—
6	IRQ6	Interrupt Request 6	44	Not Used	—
7	CLF	Clear Flag	45	IOB3	I/O Bus Bit 3
8	IEN	Interrupt Enable	46	ENF	Enable Flag
9	STF	Set Flag	47	-2V	-2 Volts
10	IAK	Interrupt Acknowledge	48	-2V	-2 Volts
11	XMR2	External Memory Register Bit 2	49	Not Used	—
			50	Not Used	—
12	SKF	Skip on Flag Signal	51	IOB5	I/O Bus Bit 5
13	CRS	Control Reset to I/O	52	IOB7	I/O Bus Bit 7
14	SCM0	Select Code Most Significant Octal Digit 0	53	IOB6	I/O Bus Bit 6
			54	IOB8	I/O Bus Bit 8
15	IOG	Input/Output Group	55	IOB11	I/O Bus Bit 11
16	SCL2	Select Code Least Significant Octal Digit 2	56	IOB9	I/O Bus Bit 9
			57	IOB12	I/O Bus Bit 12
17	POPIO	Power On Pulse to I/O	58	IOB10	I/O Bus Bit 10
18	XMR1	External Memory Register Bit 1	59	XMR12	External Memory Register Bit 12
19	XMR0	External Memory Register Bit 0	60	T7	Time Period 7
			61	IOB13	I/O Bus Bit 13
20	IOO	I/O, Output	62	EDT	End of Data Transfer
21	CLC	Clear Control	63	Not Used	—
22	STC	Set Control	64	Not Used	—
23	PRH6	Priority High on Select Code 6	65	IOB14	I/O Bus Bit 14
24	IOI	I/O, Input	66	Not Used	—
25	SFS	Skip if Flag Set	67	Not Used	—
26	XMR3	External Memory Register Bit 3	68	Not Used	—
			69	$\overline{\text{SWST}}$	"Not" Switch Store in T-Register
27	XMR5	External Memory Register Bit 5	70	IOCO	I/O Control, Output
			71	Not Used	—
28	XMR4	External Memory Register Bit 4	72	PRL4	Priority Low on Select Code 4
			73	ISG	Interrupt Strobe Generator
29	XMR6	External Memory Register Bit 6	74	Not Used	—
			75	Not Used	—
30	XMR7	External Memory Register Bit 7	76	Not Used	—
			77	$\overline{\text{XPH4}}$	"Not" External Phase 4
31	XMR8	External Memory Register Bit 8	78	T3T4	Time Periods 3 and 4
			79	XMR13	External Memory Register Bit 13
32	XMR11	External Memory Register Bit 11	80	T4T5	Time Periods 4 and 5
			81	PH4	Phase 4
33	XMR10	External Memory Register Bit 10	82	$\overline{\text{HIS}}$	"Not" Hold Interrupt System
			83	$\overline{\text{PH5}}$	"Not" Phase 5
34	SCL6	Select Code Least Significant Octal Digit 6	84	$\overline{\text{XRTS}}$	"Not" External Read T onto S-Bus
35	IOB0	I/O Bus Bit 0	85	GND	Ground
36	XMR9	External Memory Register Bit 9	86	GND	Ground
37	Not Used	—			
38	IOB1	I/O Bus Bit 1			

Table 2-4. High-Speed Channel Card Operation

INITIALIZE CARD FOR OPERATION

a. Load starting address onto appropriate lines at controller. Include mode bit (logic 1 = count up) and direction bit (logic 1 = an input transfer).

b. Clock information from step "a" into the memory address register by setting the Step signal at the controller to a logic 0 and the Load signal to a logic 1. Once the starting address has been loaded, the Load signal should be set to a logic 0, and the Step signal should be set to a logic 1.

Note

Steps "c" and "d" are not required for random transfers (a data block length of one word).

c. Load the two's complement of the block length of data to be transferred onto appropriate lines at controller.

d. Clock information from step "c" into the word count register by setting the $\overline{\text{LWCR}}$ signal at the controller to a logic 0. Once the two's complement of the block length has been loaded, the $\overline{\text{LWCR}}$ signal should be set to a logic 1.

e. Turn on high-speed channel card with an STC 6,C instruction and turn on the device involved in the transfer. The high-speed channel card is now initialized and ready to begin the data transfer.

HIGH-SPEED CHANNEL DATA TRANSFER

a. When the controller receives the Request Enable signal from the high-speed channel card, a Request signal should be sent back to the card from the controller. The Request signal should be held at a logic 1 level for consecutive transfer cycles. The controller should also address the device involved in the data transfer.

b. The high-speed channel card will now generate the necessary control signals to transfer data between the computer and the controller.

DATA TRANSFER COMPLETION

a. At the end of the data transfer, the phase 5 cycle is disabled and an interrupt to location 06 will occur through the interrupt system. For random transfers, a logic 0 signal on the INS line from the controller will prevent this end-of-transfer interrupt until the INT line goes to a logic 1. Then a normal interrupt to a service subroutine will occur.

b. The high-speed channel card is now ready to be initialized for additional data transfers.

SECTION III
THEORY OF OPERATION

3-1. INTRODUCTION.

3-2. This section contains a brief functional description and a detailed circuit description for the high-speed channel accessory kit.

Note

For a description of abbreviations (mnemonics) used in the section, refer to table 4-1.

3-3. FUNCTIONAL DESCRIPTION.

3-4. The high-speed channel accessory kit requires a fifth phase in addition to the basic four-phase capability of the computer. Phase 5 is a special memory cycle that requires one machine timing cycle (T0 through T7). Once initiated by a Request signal from the controller, phase 5 operation is automatic and independent of program control. Each phase 5 cycle permits one input or output word to be exchanged between an external device (tape reader, disc memory, magnetic tape unit, etc.) and computer memory. See figure 3-1.

3-5. Before data transfer begins, the high-speed channel card is initialized for a particular transfer by inputs from the controller. The block length of data to be transferred is loaded into the word count register, and the starting address in computer memory is loaded into the memory address register on the high-speed channel card. The card is also set up for either an input transfer or an output transfer, and the memory address register is set to either count up or count down.

3-6. The high-speed channel card now waits for a Request signal from the controller. The Request signal causes a phase 5 cycle to be generated, suspending the main computer program for at least one machine cycle to achieve data transfer (one 16-bit word per phase 5 cycle). While the program is suspended, the high-speed channel card generates the necessary control signals to achieve data transfer. The select code addressing to the device involved in the transfer must be done by the controller. If the Request signal from the controller is held in a true state, consecutive phase 5 cycles will occur until the complete block of data has been transferred. At the end of the transfer, the word count register generates a Word Count Rollover signal and a normal interrupt to a service subroutine occurs.

3-7. The high-speed channel card may also be used to implement random data transfers between computer memory and input/output devices. For these single-word transfers, an Inhibit Step Word Count Register signal is used to prevent the word count register from counting and generating a Word Count Rollover signal. This prevents the high-speed channel completion interrupt from being generated after each of these random transfers. After all of the random transfers have been accomplished, an interrupt can be requested by the controller and the computer will interrupt to the normal completion subroutine.

3-8. The HP 12595A Multiplexed Input/Output Computer Accessory Kit allows the computer to directly address up to 56 different I/O devices. The addition of the high-speed channel accessory kit makes it possible to have a direct high-speed data transfer between the computer and the high-speed devices in the system. Data transfer between the computer and the slower devices can then be accomplished under program control.

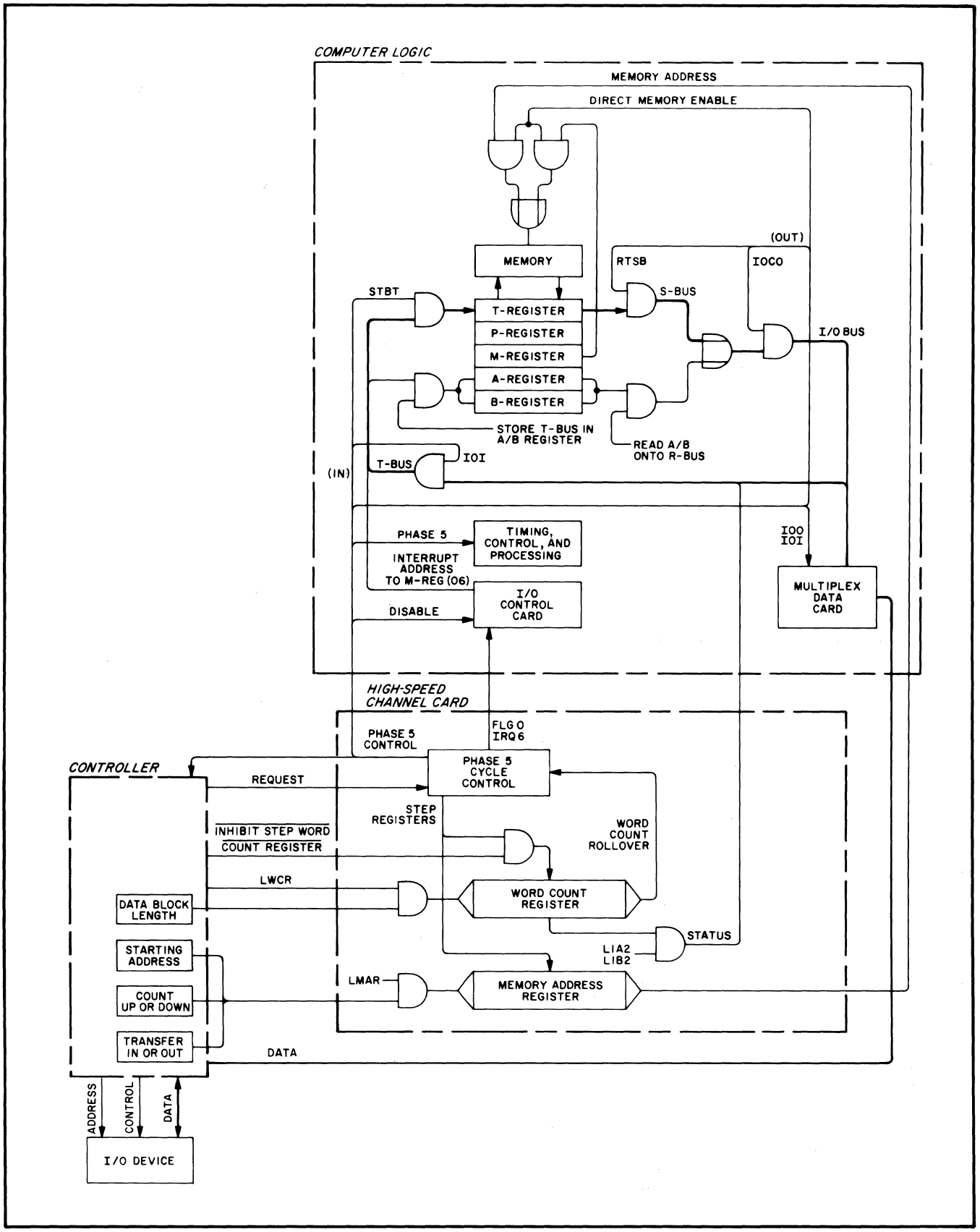
3-9. DETAILED CIRCUIT DESCRIPTION.

3-10. The following paragraphs contain a detailed circuit description for the high-speed channel accessory kit. The description covers initialization, generation of a phase 5 signal, data input and output operations, register stepping and device turn-off, and high-speed channel completion interrupt. See the schematic diagram for the high-speed channel card (figure 4-2) whenever referencing this circuit description.

3-11. INITIALIZATION.

3-12. To initialize the high-speed channel card, the starting address in computer memory is first loaded into the memory address register along with mode and direction bits. The starting address is placed on lines MA0 through MA13 at the controller. A true signal on the MODE line causes the memory address register to count in the up direction (positive) and a false signal causes the register to count in the down direction. After the desired information is on the lines from the controller, a false $\overline{\text{LMAR}}$ signal loads the information into the memory address register. The false $\overline{\text{LMAR}}$ signal on the high-speed channel card is brought up as a result of a logic 0 STEP signal and a logic 1 LOAD signal from the controller. These signals cause "nand" gate U92B to output a logic 0 level which loads the memory address register. Once the register has been loaded, the $\overline{\text{LMAR}}$ signal is returned to a logic 0 level by changing either the Step signal or the Load signal from the controller.

3-13. The second step in the initialization process is to load the word count register with the number of words in the block of data to be transferred. In reality, the word count register is loaded with the two's complement of the



2082-3

Figure 3-1. High-Speed Channel Card Functional Block Diagram

number representing the data block length. Since this will be a negative number, the register then counts in a positive direction (one count for each 16-bit word transferred) until there are all zero's in the register. To load the word count register, the two's complement of the data block length is loaded onto lines WC0 through WC14 at the controller. A logic 0 level on the $\overline{\text{LWCR}}$ line from the controller then loads the word count register. Once the register has been loaded, the $\overline{\text{LWCR}}$ line is set to a logic 1 level.

3-14. If the high-speed channel card is being used for random transfers (that is, data block lengths of one word), then it is not necessary to load the word count register. The $\overline{\text{INS}}$ line from the controller must be held at a logic 0 level for random transfer to prevent the word count register from being stepped after each word transfer.

3-15. The last step in the initialization process consists of setting the Control FF and clearing the Flag FF on the high-speed channel card and on the device interface card to or from which data is to be transferred. This is done by STC,C instructions in the main program to the select code of the device and to select code 6 (the high-speed channel card select code). On the high-speed channel card, the STC,6 instruction sets the Interrupt Channel Control FF and the Transfer Enable FF. The CLF instruction resets the Flag Buffer and Flag FFs.

3-16. GENERATION OF A PHASE 5 SIGNAL.

3-17. When the I/O device is ready to transfer a word and the controller has received an REN signal from the high-speed channel card, an REQ signal should be generated by the controller. The REQ signal and the set output of the Transfer Enable FF make "nand" gate U83C output a logic 0. The logic 0 signal resets the Cycle Request FF at T4T5. The reset output of the Cycle Request FF sets the Phase 5 FF at the end of T7 of the same machine cycle, generating the PH5 signal.

3-18. When the PH5 signal is generated, central processor operation is suspended for one machine cycle. To accomplish data transfer, the high-speed channel card must generate control signals that would normally be generated within the central processor unit. During the phase 5 cycle, the following control signals are generated by the card:

a. A $\overline{\text{PH5}}$ signal at pin 83 is generated by inverting the PH5 signal in U106A. During phase 5, this signal inhibits the enable phase gate on the computer timing generator card and prevents the computer from going into phase 1, 2, 3, or 4 until phase 5 is complete.

b. An ISG signal is generated for a memory input operation by combining the PH5 and IN signals in U105A. A true ISG signal inhibits the Memory Strobe Time (MST) signal from being generated on the computer timing generator card.

c. IOI and $\overline{\text{SWST}}$ signals are generated to implement memory input operations.

d. IOCO and $\overline{\text{XRTS}}$ signals are generated to implement memory output operations.

e. An $\overline{\text{XPH4}}$ signal is generated by the Update Interrupt Address FF during T7 of cycles that follow a phase 4 cycle. This causes a phase 4 signal to be generated at the timing generator card during T7 to store M-register bits 0 through 5.

f. The $\overline{\text{PH5}}$ and CRFF signals cause U83D to output a true signal during phase 5. This, in turn, generates an HIS signal to the I/O control card which prevents interrupt requests from other devices from being serviced during phase 5.

g. An IOG signal is generated for an input transfer by the PH5 signal. The IOG signal, along with the select code of the device (provided by the controller) and the IST signal, gates the data from the device interface card onto the IOB lines.

h. At the end of T7, a CAK signal is generated by "nand" gate U74D to let the controller know that a phase 5 cycle has been initiated.

3-19. DATA INPUT OPERATION.

3-20. The PH5 signal and the IN signal are "anded" in U94D of the high-speed channel card to provide the IST signal to the controller. The IST signal is used by the controller to clock the first data word out of the device registers onto the IOB lines. (See figure 3-2.) The PH5 and IN signals are combined in "and" gate U105A. The true output of U105A combines with ENF (T2 of current machine cycle) to generate SWST and IOI signals. The IOI signal gates the IOB bits onto the T-bus in the central processor. The SWST signal is decoded by the instruction decoder in the computer. The STBT signal, which results from the SWST signal being decoded, clocks the T-bus bits into the T-register. The T-register output is then routed directly into computer memory and the data transfer for the first word is complete. This process is repeated for each word to be transferred into memory.

3-21. DATA OUTPUT OPERATION.

3-22. The DIR bit from the controller will be a logic 0 for an output operation. After initialization, pin 7 on U75 of the memory address register is at a logic 0 level to reflect the output transfer. The logic 0 causes inverter U85C to output a true OUT signal. The OUT signal and the PH5 signal are "anded" with T3T4 in U102B to generate the OST signal to the controller. The OST signal prepares the device input register to receive the first data word. At T4T5, "nand" gate U92C generates a true XRTS signal and "and" gate U96B outputs a true IOCO signal. (See figure 3-3.) The XRTS signal and the RTS signal from the computer instruction decoder card combine to generate the RTSB signal. The RTSB signal gates the T-register bits onto the S-bus. The S-bus bits are inverted and are gated onto the IOB lines by the IOCO signal. The IOB bits are then transferred by the controller to the I/O device, and a single word transfer is complete. This process is repeated until all words in the data block have been transferred.

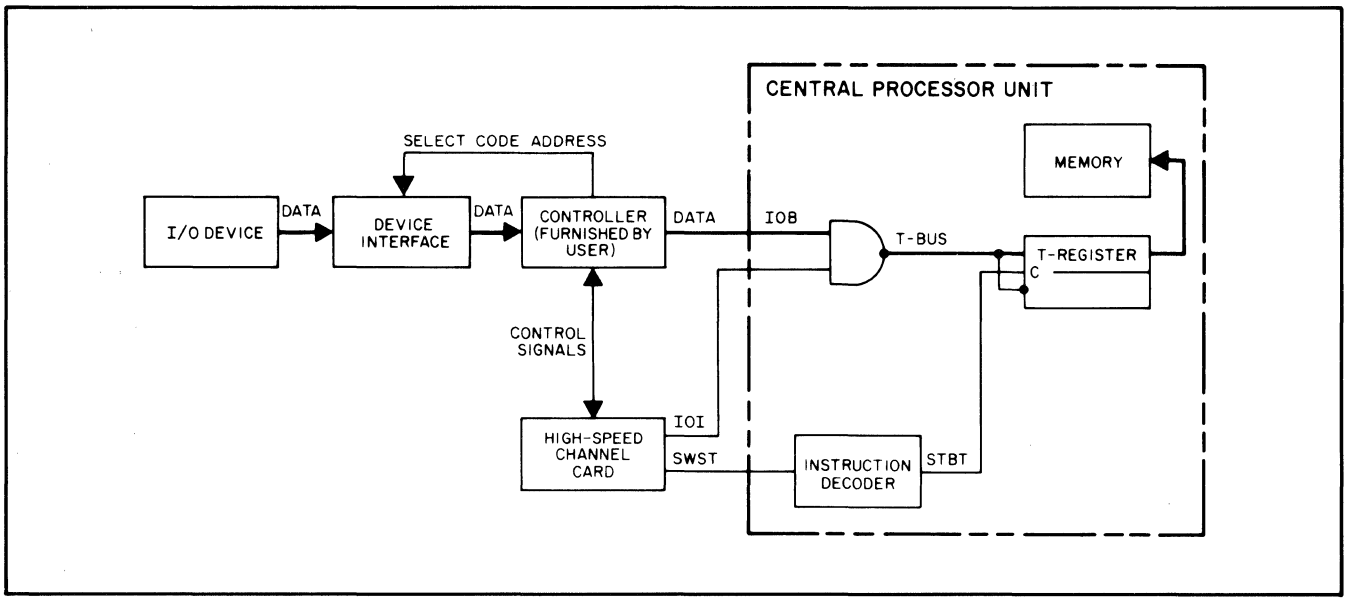


Figure 3-2. Transferring Data from an External Device to Memory

3-23. REGISTER STEPPING AND DEVICE TURN-OFF.

3-24. At the end of T4T5, the T6 FF on the high-speed channel card is reset. The reset output is "anded" with the PH5 signal in U102A to provide a true SMAR signal. The SMAR signal is applied to "nand" gates U74B and U74C. If the memory address register has been initialized to count in the up direction, the UP signal will be true. The true UP signal and the true SMAR signal cause "nand" gate U74B to output a negative pulse during T6, which advances the memory address register by one count. If the memory address register has been initialized to count in the down direction, the UP signal is false. This means that "nand" gate U74C will output a negative pulse during T6, and the register will count backwards or in the down direction. In either case, the register is now set to the memory location involved in the next data transfer.

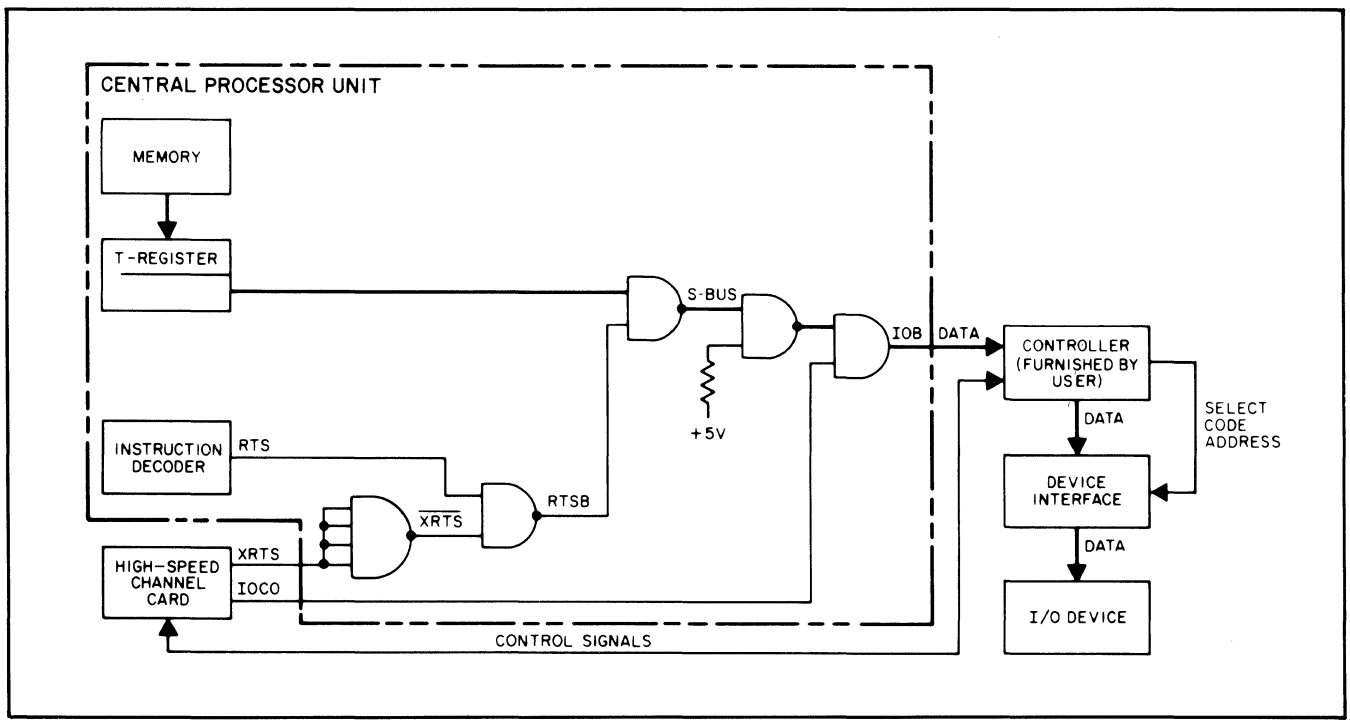


Figure 3-3. Transferring Data from Memory to an External Device

3-25. At T7 immediately before the phase 5 cycle, all inputs to "nand" gate U92A will normally be true and the gate outputs a true SWCR signal. The SWCR signal advances the word count register by one count. A logic 0 INS signal from the controller prevents the word count register from being stepped after each word transfer. The INS signal is for use with random data transfers only.

3-26. The registers are stepped for each phase 5 cycle until all words in the data block have been transferred. Since the word count register is initially loaded with the two's complement of the number of words in the data block, the word count register will contain all zero's when all words have been transferred. The final SWCR signal sets all WCR bits to zero and causes pin 12 (the carry output) of U91 to go false. The false $\overline{\text{WCR}}$ signal makes "and" gate U101B output a false signal to set the Flag Buffer FF.

3-27. HIGH-SPEED CHANNEL COMPLETION INTERRUPT.

3-28. With the Flag Buffer FF set, "nand" gate U12D outputs a false signal at T2 (ENF) of the next machine cycle. This sets the Flag FF. At T5 of the cycle, all inputs to "nand" gate U27B are true, and the gate outputs a false signal. The false output sets the Interrupt Request FF, and IRQ6 and FLG0 signals are generated to the computer. The Flag Buffer FF also enables the generation of an EDT signal to signal the end of the data transfer.

3-29. At the I/O control card, the FLG0 and IRQ6 signals try to generate an interrupt, but the interrupt system is disabled for at least one phase to allow a main program instruction to be executed following a phase 5 operation. At the end of this cycle, the high-speed channel interrupts, causing the generation of a phase 4 cycle and forcing the high-speed channel trap cell location into the M-register. The next fetched instruction will be the call instruction for the high-speed channel completion subroutine. In the completion subroutine, the high-speed channel card is turned off and must be reinitialized before being placed in operation again.

3-30. For random transfers, the completion interrupt is handled differently. Since the word count register is not stepped for random transfers, a $\overline{\text{WCR}}$ signal is not generated to signal the end of a data block transfer. The interrupt must be requested by the controller as an INT signal. This INT signal causes the Flag Buffer FF to be set. The rest of the completion interrupt sequence is the same as for block data transfers. Since a completion interrupt is not requested until the INT signal is received from the controller, several independent random transfers may take place before the completion subroutine occurs.

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section contains maintenance information for the high-speed channel card, consisting of a diagnostic test procedure and troubleshooting information.

4-3. DIAGNOSTIC TEST.

4-4. The diagnostic program for the high-speed channel card consists of the HP 20456A High-Speed I/O Channel Rate Test Diagnostic Tape. Diagnostic test procedures for the card are contained in procedure number 12616-90003 in the Manual of Diagnostics. If malfunctions occur while the test is being run, refer to the troubleshooting information in paragraph 4-5.

Note

Due to the nature of the high-speed channel card, it is not possible to completely self test the card with software without using extensive test fixtures. Hewlett-Packard tests all functions of the card during the manufacturing process. However, to completely test the card in the field, an oscilloscope must be used to monitor the card signals while running the diagnostic test loop. (See figure 4-1.)

4-5. TROUBLESHOOTING.

4-6. Troubleshooting the high-speed channel card is accomplished by performing the diagnostic test procedure contained in the Manual of Diagnostics and analyzing the error halt messages and/or card signals that occur as the test is being run. While the card functions are being exercised by the diagnostic tests, most of the card signals may be monitored with an oscilloscope (HP 180A Oscilloscope, or equivalent). A timing diagram for the card is shown in figure 4-1. Table 4-1 contains a list of the card signals and logic equations as a further aid to troubleshooting the card. When troubleshooting the high-speed channel card, see the schematic and parts location diagrams for the card at the end of this section (figure 4-2). Complete integrated circuit pack diagrams and electrical characteristics are presented in Volume Two of the HP 2114B Installation and Maintenance Manual. Refer to Volumes Two and Three of the computer documentation for additional information on backplane wiring, signal data, etc., not included in this manual.

*DENOTES SIGNAL FROM THE CONTROLLER. (REFER TO NOTE 2.)

NOTES:

1. THESE SIGNALS MAY BE HIGH OR LOW, DEPENDING ON HOW THE CARD IS BEING INITIALIZED (COUNT UP OR COUNT DOWN, INPUT OR OUTPUT TRANSFER, THE STARTING ADDRESS, THE DATA BLOCK LENGTH, ETC.).
2. THE EXACT TIME THAT SIGNALS FROM THE CONTROLLER COME UP DEPENDS ON THE DESIGN OF THE CONTROLLER AND THE MANNER IN WHICH THE CONTROLLER IS UTILIZED. THE SIGNALS MUST COME UP IN THE CYCLE SHOWN, HOWEVER.
3. THESE SIGNALS ARE USED FOR INPUT DATA TRANSFERS ONLY.
4. THESE SIGNALS ARE USED FOR OUTPUT DATA TRANSFERS ONLY.
5. THIS SIGNAL IS USED TO GENERATE INTERRUPTS FOR RANDOM (SINGLE WORD) DATA TRANSFERS ONLY.

2082-4

Figure 4-1. High-Speed Channel Card Timing Diagram

Table 4-1. High-Speed Channel Card Signals and Equations

MNEMONIC	SIGNAL NAME	EQUATION
$\overline{CAK}$	"Not" Cycle Acknowledge	$\overline{CAK} = \overline{PH5B} + T7$
CR FF	Cycle Request FF	Data = $\overline{REQ}^* + \overline{TEFF}$ Clock = $\overline{T4T5}$
EDT	End of Data Transfer	EDT = FBFF · T4T5 · $\overline{CRFF}$
FB FF	Flag Buffer FF	Set = POPIO + (STF · SC6) + WCR + (INT* · $\overline{FLFF}$) Reset = (IAK · IRQFF) + (CLF · SC6)
FL FF	Flag FF	Set = FBFF · ENF Reset = CLF · SC6
FLG0	Flag 0	FLG0 = IRQFF
$\overline{HIS}$	"Not" Hold Interrupt System	$\overline{HIS} = \overline{PH5} + \overline{CRFF}$
IAK	Interrupt Acknowledge	IAK = IRQFF · (IAK from computer)
ICC FF	Interrupt Channel Control FF	Set = STC6 · SC6 Reset = (CLC · SC6) + (CRS + $\overline{PRL4}$)
IOCO	Input/Output Control Out	IOCO = OUT · T4T5 · PH5
IN	Data Input	IN = $\overline{LMAR}$ · DIR*
IST	Input Strobe	IST = IN · PH5
IRQ FF	Interrupt Request FF	Set = PRH6 · T5 · IEN · FLFF · ICCFF · FBFF Reset = ENF
IRQ6	Interrupt Request 6	IRQ6 = IRQFF
ISG	Interrupt Strobe Generator	ISG = PH5 · IN
$\overline{LMAR}$	"Not" Load Memory Address Register	$\overline{LMAR} = LOAD^* \cdot \overline{STEP}^* \cdot CAK^*$
$\overline{LWCR}$	"Not" Load Word Count Register	$\overline{LWCR} = \overline{LWCR}^*$
OST	Output Strobe	OST = PH5 · OUT · T3T4
OUT	Data Output	OUT = $\overline{IN}$
PH5	Phase 5	PH5 = PH5 FF

*Denotes signals that originate at the controller.

Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
PH5 FF	Phase 5 FF	Data = $\overline{CRFF}$ Clock = $\overline{T7}$
PH5B	Phase 5B	PH5B = PH5B FF
PH5B FF	Phase 5B FF	Data = $\overline{CRFF}$ Clock = T7
PRL6	Priority Low 6	PRL6 = PRH6 · $\overline{(IEN + FLFF + ICCFF)}$
REN	Request Enable	REN = ICCFF
RWCR	Read Word Count Register	RWCR = IOI · SC2
SC2	Select Code 2	SC2 = IOG · SCM0 · SCL2
SC6	Select Code 6	SC6 = IOG · SCM0 · SCL6
SKF	Skip on Flag Signal	SKF = (SFS · SC6 · FLFF) + (SFC · SC6 · $\overline{FLFF}$)
SMAR	Step Memory Address Register	SMAR = $\overline{Step}^*$ · PH5 · $\overline{T6}$
$\overline{SWCR}$	"Not" Step Word Count Register	$\overline{SWCR}$ = T7 · $\overline{CRFF}$ · $\overline{INS}^*$
SWST	Switch Store in T-Register	SWST = ENF · PH5 · IN
T6	Time Period 6	T6 = $\overline{T6\ FF}$
T6 FF	T6 FF	Clock = $\overline{T4T5}$ Data = Ground Direct Set = T7
TE FF	Transfer Enable FF	Set = STC · SC6 Reset = (FLFF · T4T5) + CRS + $\overline{PRL4}$
UIA FF	Update Interrupt Address FF	Set = PH4 Reset = $\overline{PH5}$ · ENF
$\overline{WCR}$	"Not" Word Count Rollover	$\overline{WCR}$ = $\overline{WCR0\ thru\ WCR14}$ · SWCR
WCR0	Word Count Register Bit 0	WCR0 = WCR0 FF

*Denotes signals that originate at the controller.

Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
WCR0 FF	Word Count Register Bit 0 FF	Clock = SWCR Direct Set = WC0* · LWCR Direct Reset = $\overline{WC0^*}$ · LWCR
WCR1	Word Count Register Bit 1	WCR1 = WCR1 FF
WCR1 FF	Word Count Register Bit 1 FF	Clock = SWCR · $\overline{WCR0}$ Direct Set = WC1* · LWCR Direct Reset = $\overline{WC1^*}$ · LWCR
WCR2	Word Count Register Bit 2	WCR2 = WCR2 FF
WCR2 FF	Word Count Register Bit 2 FF	Clock = SWCR · $\overline{WCR0}$ · $\overline{WCR1}$ Direct Set = WC2* · LWCR Direct Reset = $\overline{WC2^*}$ · LWCR
WCR3	Word Count Register Bit 3	WCR3 = WCR3 FF
WCR3 FF	Word Count Register Bit 3 FF	Clock = SWCR · $\overline{WCR0}$ thru $\overline{WCR2}$ Direct Set = WC3* · LWCR Direct Reset = $\overline{WC3^*}$ · LWCR
WCR4	Word Count Register Bit 4	WCR4 = WCR4 FF
WCR4 FF	Word Count Register Bit 4 FF	Clock = SWCR · $\overline{WCR0}$ thru $\overline{WCR3}$ Direct Set = WC4* · LWCR Direct Reset = $\overline{WC4^*}$ · LWCR
WCR5	Word Count Register Bit 5	WCR5 = WCR5 FF
WCR5 FF	Word Count Register Bit 5 FF	Clock = SWCR · $\overline{WCR0}$ thru $\overline{WCR4}$ Direct Set = WC5* · LWCR Direct Reset = $\overline{WC5^*}$ · LWCR
WCR6	Word Count Register Bit 6	WCR6 = WCR6 FF
WCR6 FF	Word Count Register Bit 6 FF	Clock = SWCR · $\overline{WCR0}$ thru $\overline{WCR5}$ Direct Set = WC6* · LWCR Direct Reset = $\overline{WC6^*}$ · LWCR

*Denotes signals that originate at the controller.

Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
WCR7	Word Count Register Bit 7	WCR7 = WCR7 FF
WCR7 FF	Word Count Register Bit 7 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR6}}$ Direct Set = WC7* · LWCR Direct Reset = $\overline{\text{WC7}}$* · LWCR
WCR8	Word Count Register Bit 8	WCR8 = WCR8 FF
WCR8 FF	Word Count Register Bit 8 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR7}}$ Direct Set = WC8* · LWCR Direct Reset = $\overline{\text{WC8}}$* · LWCR
WCR9	Word Count Register Bit 9	WCR9 = WCR9 FF
WCR9 FF	Word Count Register Bit 9 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR8}}$ Direct Set = WC9* · LWCR Direct Reset = $\overline{\text{WC9}}$* · LWCR
WCR10	Word Count Register Bit 10	WCR10 = WCR10 FF
WCR10 FF	Word Count Register Bit 10 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR9}}$ Direct Set = WC10* · LWCR Direct Reset = $\overline{\text{WC10}}$* · LWCR
WCR11	Word Count Register Bit 11	WCR11 = WCR11 FF
WCR11 FF	Word Count Register Bit 11 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR10}}$ Direct Set = WC11* · LWCR Direct Reset = $\overline{\text{WC11}}$* · LWCR
WCR12	Word Count Register Bit 12	WCR12 = WCR12 FF
WCR12 FF	Word Count Register Bit 12 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR11}}$ Direct Set = WC12* · LWCR Direct Reset = $\overline{\text{WC12}}$* · LWCR
WCR13	Word Count Register Bit 13	WCR13 = WCR13 FF
WCR13 FF	Word Count Register Bit 13 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR12}}$ Direct Set = WC13* · LWCR Direct Reset = $\overline{\text{WC13}}$* · LWCR

*Denotes signals that originate at the controller.

Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
WCR14	Word Count Register Bit 14	WCR14 = WCR14 FF
WCR14 FF	Word Count Register Bit 14 FF	Clock = SWCR · $\overline{\text{WCR0}}$ thru $\overline{\text{WCR13}}$ Direct Set = WCR14* · LWCR Direct Reset = $\overline{\text{WC14}}$* · LWCR
XMR0	External M-Register Bit 0	XMR0 = XMR0 FF
XMR0 FF	External M-Register Bit 0 FF	Clock = SMAR Direct Set = MA0* · LMAR Direct Reset = $\overline{\text{MA0}}$* · LMAR
XMR1	External M-Register Bit 1	XMR1 = XMR1 FF
XMR1 FF	External M-Register Bit 1 FF	Clock = SMAR · $\overline{\text{XMR0}}$ Direct Set = $\overline{\text{MA1}}$* · LMAR Direct Reset = MA1* · LMAR
XMR2	External M-Register Bit 2	XMR2 = XMR2 FF
XMR2 FF	External M-Register Bit 2 FF	Clock = SMAR · $\overline{\text{XMR0}}$ · $\overline{\text{XMR1}}$ Direct Set = MA2* · LMAR Direct Reset = $\overline{\text{MA2}}$* · LMAR
XMR3	External M-Register Bit 3	XMR3 = XMR3 FF
XMR3 FF	External M-Register Bit 3 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR2}}$ Direct Set = MA3* · LMAR Direct Reset = $\overline{\text{MA3}}$* · LMAR
XMR4	External M-Register Bit 4	XMR4 = XMR4 FF
XMR4 FF	External M-Register Bit 4 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR3}}$ Direct Set = MA4* · LMAR Direct Reset = $\overline{\text{MA4}}$* · LMAR
XMR5	External M-Register Bit 5	XMR5 = XMR5 FF
XMR5 FF	External M-Register Bit 5 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR4}}$ Direct Set = MA5* · LMAR Direct Reset = $\overline{\text{MA5}}$* · LMAR

*Denotes signals that originate at the controller.

Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
XMR6	External M-Register Bit 6	XMR6 = XMR6 FF
XMR6 FF	External M-Register Bit 6 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR5}}$ Direct Set = MA6* · LMAR Direct Reset = $\overline{\text{MA6*}}$ · LMAR
XMR7	External M-Register Bit 7	XMR7 = XMR7 FF
XMR7 FF	External M-Register Bit 7 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR6}}$ Direct Set = MA7* · LMAR Direct Reset = $\overline{\text{MA7*}}$ · LMAR
XMR8	External M-Register Bit 8	XMR8 = XMR8 FF
XMR8 FF	External M-Register Bit 8 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR7}}$ Direct Set = MA8* · LMAR Direct Reset = $\overline{\text{MA8*}}$ · LMAR
XMR9	External M-Register Bit 9	XMR9 = XMR9 FF
XMR9 FF	External M-Register Bit 9 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR8}}$ Direct Set = MA9* · LMAR Direct Reset = $\overline{\text{MA9*}}$ · LMAR
XMR10	External M-Register Bit 10	XMR10 = XMR10 FF
XMR10 FF	External M-Register Bit 10 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR9}}$ Direct Set = MA10* · LMAR Direct Reset = $\overline{\text{MA10*}}$ · LMAR
XMR11	External M-Register Bit 11	XMR11 = XMR11 FF
XMR11 FF	External M-Register Bit 11 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR10}}$ Direct Set = MA11* · LMAR Direct Reset = $\overline{\text{MA11*}}$ · LMAR
XMR12	External M-Register Bit 12	XMR12 = XMR12 FF
XMR12 FF	External M-Register Bit 12 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR11}}$ Direct Set = MA12* · LMAR Direct Reset = $\overline{\text{MA12*}}$ · LMAR

*Denotes signals that originate at the controller.

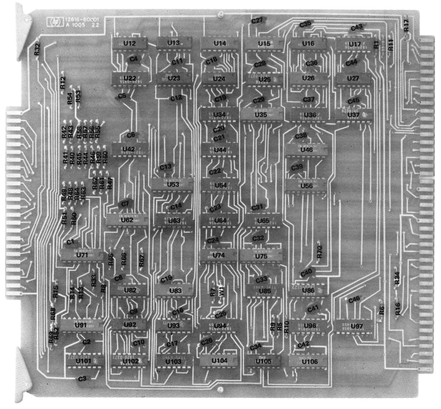
Table 4-1. High-Speed Channel Card Signals and Equations (Continued)

MNEMONIC	SIGNAL NAME	EQUATION
XMR13	External M-Register Bit 13	XMR13 = XMR13 FF
XMR13 FF	External M-Register Bit 13 FF	Clock = SMAR · $\overline{\text{XMR0}}$ thru $\overline{\text{XMR12}}$ Direct Set = $\overline{\text{MA13}}^*$ · LMAR Direct Reset = MA13* · LMAR
XPH4	External Phase 4	XPH4 = T7 · UIA FF
XRTS	External Read T to S-Bus	XRTS = OUT · T4T5 · PH5

*Denotes signals that originate at the controller.

Table 4-2. High-Speed Channel Card Replaceable Parts

REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.
C1 thru C29, C31 thru C46	0160-2055	Capacitor, Fxd, Cer, 0.01 uf, +80 -20%, 100 VDCW	91418	TA OBD
R1	0683-1015	Resistor, Fxd, Comp, 100 ohms, 5%, 1/4w	01121	CB 1025
R2,5,7,9,10,12,14,R40 thru R70	0683-4715	Resistor, Fxd, Comp, 470 ohms, 5%, 1/4w	01121	CB 4715
R6	0683-8215	Resistor, Fxd, Comp, 820 ohms, 5%, 1/4w	01121	CB 8215
R8,13,15	0683-1025	Resistor, Fxd, Comp, 1000 ohms, 5%, 1/4w	01121	CB 1025
R16,17	0683-3315	Resistor, Fxd, Comp, 330 ohms, 5%, 1/4w	01121	CB 3315
R32	0683-2415	Resistor, Fxd, Comp, 240 ohms, 5%, 1/4w	01121	CB 2415
R33	0683-1005	Resistor, Fxd, Comp, 10 ohms, 5%, 1/4w	01121	CB 1005
R34	0683-3915	Resistor, Fxd, Comp, 390 ohms, 5%, 1/4w	01121	CB 3915
U12,15,16,24,74,83,104	1820-0054	Integrated Circuit, TTL	01295	SN4342
U13,14,26,92	1820-0068	Integrated Circuit, TTL	01295	SN4343
U17,22,34,36,42,44,54,63,64,65, 94,96,97	1820-0956	Integrated Circuit, CTL	07263	SL3459
U23,105	1820-0141	Integrated Circuit, TTL	04713	SC7514PK
U25,101,102	1820-0372	Integrated Circuit, TTL	01295	SN4480
U27	1820-0069	Integrated Circuit, TTL	56289	USN7420A
U35,46,53,56,62,71,75,91	1820-0233	Integrated Circuit, TTL	01295	SN10625
U37	1820-0328	Integrated Circuit, TTL	01295	SN4467
U82,93	1820-0077	Integrated Circuit, TTL	56289	USN7474A
U85,103	1820-0132	Integrated Circuit, TTL	07263	U6A901659X
U86	1820-0327	Integrated Circuit, TTL	01295	SN4466
U106	1820-0071	Integrated Circuit, TTL	56289	USN7440A
W17	8159-0005	Jumper Wire	28480	8159-0005



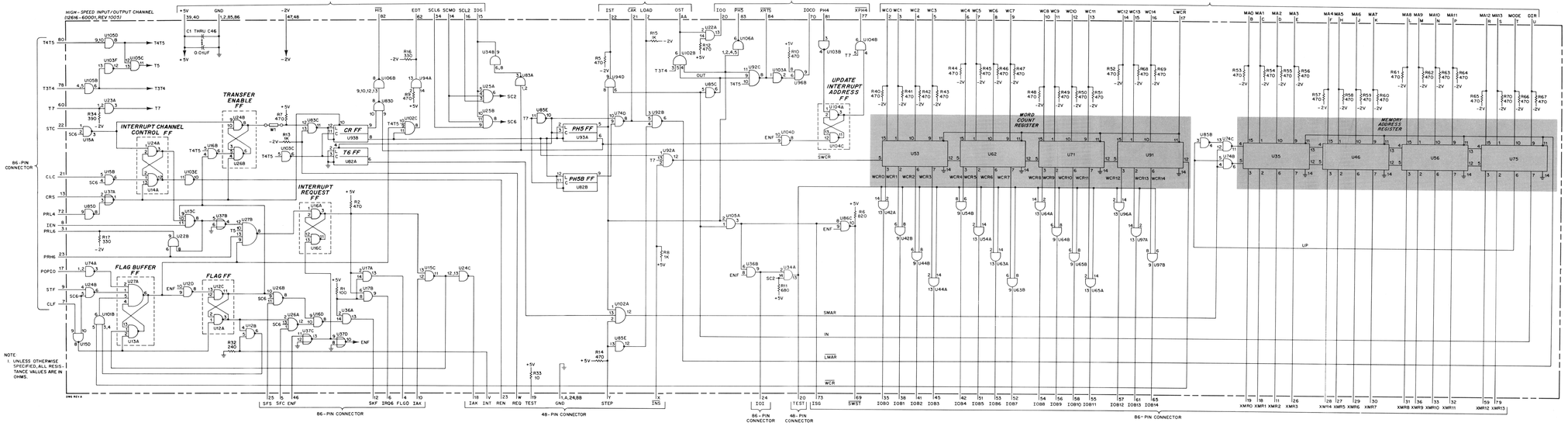


Figure 4-2. High-Speed Channel Card Schematic and Parts Location Diagrams

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION.

5-2. This section contains information for ordering replacement parts for the high-speed channel accessory kit. Table 5-1 lists parts in alphanumeric order of the HP stock numbers and lists the following information on each part:

a. Description of the part. (Refer to table 5-2 for an explanation of abbreviations and reference designations used in the DESCRIPTION column.)

b. Typical manufacturer of the part in a five-digit code; refer to list of manufacturers in table 5-3.

c. Manufacturer's part number.

d. Total quantity of each part used in the high-speed channel accessory kit.

5-3. A separate parts list is provided along with the parts location diagram for the high-speed channel card in section IV of this manual. This parts list lists the parts in alphanumeric order of reference designation.

5-4. ORDERING INFORMATION.

5-5. To order replacement parts, address the order or inquiry to the local Hewlett-Packard Sales and Service Office. (Refer to the list at the end of this manual for addresses.) Specify the following information for each part ordered:

a. Instrument model and serial number.
b. Hewlett-Packard stock number for each part.
c. Description of each part.
d. Circuit reference designation.

Table 5-1. High-Speed Channel Accessory Kit Replaceable Parts

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
0160-2055	Capacitor, Fxd, Cer, 0.01 uf, +80 -20%, 100 VDCW	91418	TA OBD	45
0642-0096	Tapping Screw	00000	OBD	2
0683-1005	Resistor, Fxd, Comp, 10 ohms, 5%, 1/4w	01121	CB 1005	1
0683-1015	Resistor, Fxd, Comp, 100 ohms, 5%, 1/4w	01121	CB 1015	1
0683-1025	Resistor, Fxd, Comp, 1000 ohms, 5%, 1/4w	01121	CB 1025	3
0683-2415	Resistor, Fxd, Comp, 240 ohms, 5%, 1/4w	01121	CB 2415	1
0683-3315	Resistor, Fxd, Comp, 330 ohms, 5%, 1/4w	01121	CB 3315	2
0683-3915	Resistor, Fxd, Comp, 390 ohms, 5%, 1/4w	01121	CB 3915	1
0683-4715	Resistor, Fxd, Comp, 470 ohms, 5%, 1/4w	01121	CB 4715	38
0683-6815	Resistor, Fxd, Comp, 680 ohms, 5%, 1/4w	01121	CB 6815	1
0683-8215	Resistor, Fxd, Comp, 820 ohms, 5%, 1/4w	01121	CB 8215	1
1251-0335	Connector, 48-Pin	71785	251-24-30-261	1
1820-0054	Integrated Circuit, TTL	01295	SN4342	7
1820-0068	Integrated Circuit, TTL	01295	SN4343	4
1820-0069	Integrated Circuit, TTL	56289	USN7420A	1
1820-0071	Integrated Circuit, TTL	56289	USN7440A	1
1820-0077	Integrated Circuit, TTL	56289	USN7474A	2
1820-0132	Integrated Circuit, TTL	07263	U6A901659X	2
1820-0141	Integrated Circuit, TTL	04713	SC7514PK	2
1820-0233	Integrated Circuit, TTL	01295	SN10625	8
1820-0327	Integrated Circuit, TTL	01295	SN4466	1
1820-0328	Integrated Circuit, TTL	18324	N7402N	1
1820-0372	Integrated Circuit, TTL	01295	SN4480	3
1820-0956	Integrated Circuit, CTL	07263	SL3459	13
3030-0143	Setscrew, No. 6-32, 1/2 in.	00000	OBD	1
8159-0005	Jumper Wire	28480	8159-0005	1
02116-4001	Hood	28480	02116-4001	1
02116-4003	Cable Clamp	28480	02116-4003	1
12616-60001	High-Speed Channel Card	28480	12616-60001	1
12616-60002	Input Test Connector	28480	12616-60002	1
12616-60003	Output Test Connector	28480	12616-60003	1
12616-90001	Operating and Service Manual	28480	12616-90001	1

Table 5-2. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A = assembly	J = receptacle connector	TB = terminal board
B = motor	K = relay	TP = test point
BT = battery	L = inductor	U = integrated circuit
C = capacitor	M = meter	V = vacuum tube, neon bulb, photocell, etc.
CP = coupler	MC = microcircuit	
CR = diode	P = plug connector	VR = voltage regulator
DL = delay line	Q = transistor	W = cable, jumper
DS = device signaling (lamp)	R = resistor	X = socket
E = misc hardware	RT = thermistor	Y = crystal
F = fuse	S = switch	Z = tuned cavity, network
FL = filter	T = transformer	

ABBREVIATIONS

A = amperes	IMPG = impregnated	P/O = part of
AC = alternating current	IN. = inch, inches	POLY = polystyrene
AFC = automatic frequency control	INCD = incandescent	PORC = porcelain
ALUM = aluminum	INCL = include(s)	POS = position(s)
AL-ELECT = aluminum electrolytic	INS = insulation(ed)	POT = potentiometer
ASSY = assembly	INT = internal	PP = peak-to-peak
	I/O = input/output	PT = point
BFO = beat frequency oscillator		PWV = peak working voltage
BE CU = beryllium copper	K = kilo = 1000	
BH = binder head		R = resistor
BP = bandpass	LH = left hand	RECT = rectifier
BRS = brass	LIN = linear taper	RF = radio frequency
BWO = backward wave oscillator	LK WASH = lock washer	RH = round head or right hand
	LOG = logarithmic taper	RMO = rack mount only
C = capacitor	LPF = low pass filter	RMS = root-mean square
CCW = counterclockwise		RWV = reverse working voltage
CER = ceramic	M = milli = 10^{-3}	
CMO = cabinet mount only	MEG = mega = 10^{6}	S-B = slow-blow
COEF = coefficient	MET FLM = metal film	SCR = screw
COM = common	MET OX = metal oxide	SE = selenium
COMP = composition	MFR = manufacturer	SECT = section(s)
COMPL = complete	MHz = megahertz	SEMICON = semiconductor
CONN = connector	MINAT = miniature	SI = silicon
CP = cadmium plate	MOM = momentary	SIL = silver
CRT = cathode-ray tube	MTG = mounting	SL = slide
CTL = capacitor-transistor logic	MY = Mylar	SPDT = single-pole, double-throw
CW = clockwise		SPG = spring
	N = nano (10^{-9})	SPL = special
DC = direct current	N/C = normally closed	SPST = single-pole, single-throw
DEPC = deposited carbon	NE = neon	SR = split ring
DPDT = double-pole, double-throw	NI PL = nickel plate	SST = stainless steel
DPST = double-pole, single-throw	NO. = number	STL = steel
DR = drive	N/O = normally open	
	NPN = negative-positive-negative	TA = tantalum
ELECT = electrolytic		TD = time delay
ENCAP = encapsulated	NPO = negative positive zero (zero temperature coefficient)	TGL = toggle
EXT = external		THD = thread
	NRFR = not recommended for field replacement	TI = titanium
F = farads		TOL = tolerance
FH = flat head	NSR = not separately replaceable	TRIM = trimmer
FIL H = fillister head		TTL = transistor-transistor logic
FXD = fixed	OBD = order by description	TWT = traveling wave tube
	OD = outer diameter	
G = giga (10^{9})	OH = oval head	U (μ) = micro = 10^{-6}
GE = germanium	OX = oxide	
GL = glass		VAR = variable
GND/GRD = ground(ed)	P = peak	VDCW = direct current working volts
	PC = printed circuit	
H = henries	PF = picofarads = 10^{-12} farads	W/ = with
HDW = hardware	PH = Phillips head	W = watts
HEX = hexagonal	PH BRZ = phosphor bronze	WIV = working inverse voltage
HG = mercury	PHL = Phillips	WW = wirewound
HR = hour(s)	PIV = peak inverse voltage	W/O = without
HZ = hertz	PNP = positive-negative-positive	
ID = inner diameter		
IF = intermediate frequency		

Table 5-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Ma.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.

Table 5-3. Code List of Manufacturers (Continued)

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
1804Z	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Speciality Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

00015-47
Revised: April, 1969

From: FSC. Handbook Supplements

Table 5-3. Code List of Manufacturers (Continued)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Simon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

00015-47
Revised: April, 1969

From: FSC. Handbook Supplements

HEWLETT • PACKARD SALES AND SERVICE

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

5737 East Broadway
Tucson 85716
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000

3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2220 Watt Ave.
Sacramento 95825
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
Tel: (305) 731-2020
TWX: 510-955-4099

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-224-4882

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 962-5000
TWX: 910-760-1670

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 265-3713
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

1120 Morse Road
Columbus 43229
Tel: (614) 846-1300

OKLAHOMA
2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

RHODE ISLAND
873 Waterman Ave.
East Providence 02914
Tel: (401) 434-5535
TWX: 710-381-7573

TEXAS
P.O. Box 1270
201 E. Arapaho Rd.
Richardson 75080
Tel: (214) 231-6101
TWX: 910-867-4723

P.O. Box 22813
6300 Westpark Drive
Suite 100
Houston 77027
Tel: (713) 781-6000
TWX: 910-881-2645

231 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

UTAH
2890 South Main Street
Salt Lake City 84115
Tel: (801) 487-0715
TWX: 910-925-5681

VERMONT
P.O. Box 2287
Kennedy Drive
South Burlington 05401
Tel: (802) 658-4455
TWX: 710-658-4712

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

***WEST VIRGINIA**
Charleston
Tel: (304) 768-1232

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

*Service Only

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd.
11745 Jasper Ave.
Edmonton
Tel: (403) 482-5561
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
1037 West Broadway
Vancouver 12
Tel: (604) 731-5301
TWX: 610-922-5059

MANITOBA
Hewlett-Packard (Canada) Ltd.
511 Bradford Ct.
St. James
Tel: (204) 786-7581
TWX: 610-671-3531

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd.
2745 Dutch Village Rd.
Suite 203
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
50 Galaxy Blvd.
Rexdale
Tel: (416) 677-9611
TWX: 610-492-4246

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-20607

FOR CANADIAN AREAS NOT LISTED:
Contact Hewlett-Packard (Canada) Ltd. in Pointe Claire, at the complete address listed above.

CENTRAL AND SOUTH AMERICA

ARGENTINA
Hewlett-Packard Argentina S.A.C.e.I
Lavalle 1171 - 3°
Buenos Aires
Tel: 35-0436, 35-0627, 35-0431
Telex: 012-1009
Cable: HEWPACKARG

BRAZIL
Hewlett-Packard Do Brasil I.e.C Ltda.
Rua Coronel: Oscar Porto, 691
Sao Paulo - 8, SP
Tel: 288-7111
Cable: HEWPACK Sao Paulo

Hewlett-Packard Do Brasil I.e.C. Ltda.
Avenida Franklin Roosevelt 84-grupo 203
Rio de Janeiro, ZC-39, GB
Tel: 232-9733
Cable: HEWPACK Rio de Janeiro

CHILE
Héctor Calcagni y Cia, Ltda.
Bustos, 1932-3er Piso
Casilla 13942
Santiago
Tel: 4-2396
Cable: Calcagni Santiago

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Kier Ltda.
Carrera 7 No. 48-59
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota
Telex: 044-400

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
Apartado Postal 1589
27 Avenida Norte 1133
San Salvador
Tel: 25-74-50
Cable: ELECTRONICA
San Salvador

GUATEMALA
Olander Associates Latin America
Apartado Postal 1226
Ruta 4, 6-53, Zona 4
Guatemala City
Tel: 63958
Cable: OLALA Guatemala City

JAMAICA
General Engineering Services, Ltd.
27 Dunrobin Ave.
Kingston
Tel: 42657
Cable: GENSERV

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Moras 439
Col. del Valle
Mexico 12, D.F.
Tel: 5-75-46-49

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Avenida Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 45-2335
Cable: FEPERU Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de Leon 154
Pda. 3-Pta. de Tierra
San Juan 00906
Tel: (809) 725-3342
Cable: SATRONICS San Juan
Telex: SATRON 3450 332

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard De Venezuela C.A.
Apartado 50933
Caracas
Tel: 71.88.05, 71.88.69, 71.99.30
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8461

E 4/70

HEWLETT • PACKARD SALES AND SERVICE

EUROPE

AUSTRIA
Unilabor GmbH
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33
Vienna A-1095
Tel: (222) 42 61 81, 43 13 94
Cable: LABORINSTRUMENT Vienna
Telex: 75 762

BELGIUM
Hewlett-Packard Benelux S.A.
348 Boulevard du Souverain
Brussels 1160
Tel: 72 22 40
Cable: PALOBEN Brussels
Telex: 23 494

DENMARK (May 70)
Hewlett-Packard A/S
Datavej 38
DK-3460 **Birkeroed**
Tel: (01) 81 66 40
Cable: HEWPACK AS
Telex: 66 40

EASTERN EUROPE
Hewlett-Packard S.A. Genf.
Korrespondenz Büro Für Ost-Europa
(Czechoslovakia, Hungary, Poland, DDR, Rumania, Bulgaria)
Innstrasse 23
Postfach
A-1204 Vienna, Austria
Tel: (222) 33 66 06
Cable: HEWPACK Vienna

FINLAND
Hewlett-Packard Oy
Bulevardi 26
P.O. Box 12185
Helsinki 12
Tel: 13-730
Cable: HEWPACKOY-Helsinki
Telex: 12-1563

FRANCE
Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
91 Orsay
Tel: 920 88 01
Cable: HEWPACK Orsay
Telex: 60048

Hewlett-Packard France
4 Quai des Etroits
69 **Lyon** 5ème
Tel: 42 63 45
Cable: HEWPACK Lyon
Telex: 31617

GERMANY
Hewlett-Packard Vertriebs-GmbH
Lietzenburgerstrasse 30
1 **Berlin** 30
Tel: (0811) 211 60 16
Telex: 18 34 05

Hewlett-Packard Vertriebs-GmbH
Herrenbergerstrasse 110
703 **Böblingen, Württemberg**
Tel: 07031-6671
Cable: HEPAG Böblingen
Telex: 72 65 739

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 **Düsseldorf** 1
Tel: 68 52 58/59
Telex: 85 86 533

Hewlett-Packard Vertriebs-GmbH
Berliner Strasse 117
6 **Nieder-Eschbach/Frankfurt 56**
Tel: (0611) 50 10 64
Cable: HEWPACKSA Frankfurt
Telex: 41 32 49

Hewlett-Packard Vertriebs-GmbH
Beim Strohhause 26
2 **Hamburg** 1
Tel: 24 05 51/52
Cable: HEWPACKSA Hamburg
Telex: 21 53 32

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13
8 **München** 9
Tel: 0811 69 59 71/75
Cable: HEWPACKSA München
Telex: 52 49 85

GREECE
Kostas Karayannis
18, Ermou Street
Athens 126
Tel: 230301,3,5
Cable: RAKAR Athens
Telex: 21 59 62 RKAR GR

IRELAND
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks, England
Tel: Slough 753-33341
Cable: HEWPIE Slough
Telex: 84413

ITALY
Hewlett-Packard Italiana S.p.A.
Via Amerigo Vespucci 2
20124 **Milano**
Tel: 6251 (10 lines)
Cable: HEWPACKIT Milan
Telex: 32046

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25
00144 **Rome** - Eur
Tel: 591 2544
Cable: HEWPACKIT Rome
Telex: 61514

NETHERLANDS
Hewlett-Packard Benelux, N.V.
Weerdestein 117
P.O. Box 7825
Amsterdam, Z 11
Tel: 020-42 7777
Cable: PALOBEN Amsterdam
Telex: 13 216

NORWAY
Hewlett-Packard Norge A/S
Box 149
Nesveien 13
N-1344 **Haslum**
Tel: 53 83 60
Cable: HEWPACK Oslo
Telex: 6621

PORTUGAL
Telectra
Empresa Tecnica de Equipamentos
Electricos, S.a.r.l.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
Lisbon 1
Tel: 68 60 72
Cable: TELECTRA Lisbon
Telex: 1598

SPAIN
Ataio Ingenieros SA
Ganduxer 76
Barcelona 6
Tel: 211-44-66
Cable: TELEATAIO BARCELONA

Ataio Ingenieros SA
Enrique Larreta 12
Madrid, 16
Tel: 215 35 43
Cable: TELEATAIO Madrid
Telex: 2749E

SWEDEN
Hewlett-Packard (Sverige) AB
Hagakersgatan 9C
S 431 04 **Mölndal** 4
Tel: 031 - 27 68 00

Hewlett-Packard (Sverige) AB
Svetsarvägen 7
S171 20 **Solna** 1
Tel: (08) 98 12 50
Cable: MEASUREMENTS Stockholm
Telex: 10721

SWITZERLAND
Hewlett Packard (Schweiz) AG
Zurcherstrasse 20
8952 **Schlieren**
Zurich
Tel: (051) 98 18 21/24
Cable: HEWPACKAG Zurich
Telex: 53933

Hewlett Packard (Schweiz) A.G.
Rue du Bois-du-Lan 7
1217 Meyrin 2 **Geneva**
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 2 24 86

TURKEY
Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel: 49 40 40
Cable: TELEMATION Istanbul

UNITED KINGDOM
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks
Tel: Slough 33341
Cable: HEWPIE Slough
Telex: 84413

Hewlett-Packard Ltd.
The Graftons
Stamford New Road
Altrincham, Cheshire
Tel: 061 258-8626

USSR
Please Contact
Hewlett-Packard S.A.
Rue du Bois-du-Lan 7
1217 Meyrin 2 **Geneva**
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Switzerland
Telex: 2.24.86

YUGOSLAVIA
Belram S.A.
83 avenue des Mimosas
Brussels 15, Belgium
Tel: 34 33 32, 34 26 19
Cable: BELRAMEL Brussels
Telex: 21790

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard S.A.
Rue du Bois-du-Lan 7
1217 Meyrin 2 **Geneva**
Switzerland
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 2.24.86

AFRICA, ASIA, AUSTRALIA

ANGOLA
Telectra Empresa Técnica de Equipamentos Eléctricos SAR
Rua de Barbosa Rodrigues 42-1°
Box 6487
Luanda
Cable: TELECTRA Luanda

AUSTRALIA
Hewlett-Packard Australia Pty. Ltd.
22-26 Weir Street
Glen Iris, 3146
Victoria
Tel: 20.1371 (6 lines)
Cable: HEWPARD Melbourne
Telex: 31024

Hewlett-Packard Australia Pty. Ltd.
61 Alexander Street
Crows Nest 2065
New South Wales
Tel: 43.7866
Cable: HEWPARD Sydney
Telex: 21561

Hewlett-Packard Australia Pty. Ltd.
97 Churchill Road
Prospect 5082
South Australia
Tel: 65.2366
Cable: HEWPARD Adelaide

Hewlett Packard Australia Pty. Ltd.
2nd Floor, Suite 13
Casablanca Buildings
196 Adelaide Terrace
Perth, W.A. 6000
Tel: 21-3330

Hewlett-Packard Australia Pty. Ltd.
10 Woolley Street
P.O. Box 191
Dickson A.C.T. 2602
Tel: 49-8194
Cable: HEWPARD Canberra ACT

CEYLON
United Electricals Ltd.
P.O. Box 681
Yahala Building
Staples Street
Colombo 2
Tel: 5496
Cable: HOTPOINT Colombo

CYPRUS
Kypronics
19-19D Hommer Avenue
P.O. Box 752
Nicosia
Tel: 6282-75628
Cable: HE-I-NAMI

ETHIOPIA
African Salespower & Agency Private Ltd., Co.
P. O. Box 718
58/59 Cunningham St.
Addis Ababa
Tel: 12285
Cable: ASACO Addisababa

HONG KONG
Schmidt & Co. (Hong Kong) Ltd.
P.O. Box 297
1511, Prince's Building
10, Chater Road
Hong Kong
Tel: 240168, 232735
Cable: SCHMIDTCO Hong Kong

INDIA
Blue Star Ltd.
Kasturi Buildings
Jamshedji Tata Rd.
Bombay 20BR, India
Tel: 29 50 21
Telex: 2396
Cable: BLUEFROST

Blue Star Ltd.
Band Box House
Prabhadevi
Bombay 25DD, India
Tel: 45 73 01
Telex: 2396
Cable: BLUESTAR

Blue Star Ltd.
14/40 Civil Lines
Kanpur, India
Tel: 6 88 82
Cable: BLUESTAR

Blue Star, Ltd.
7 Hare Street
P.O. Box 506
Calcutta 1, India
Tel: 23-0131
Telex: 655
Cable: BLUESTAR

Blue Star Ltd.
Blue Star House,
34 Ring Road
Lajpat Nagar
New Delhi 24, India
Tel: 62 32 76
Telex: 463
Cable: BLUESTAR

Blue Star, Ltd.
96 Park Lane
Secunderabad 3, India
Tel: 7 63 91
Cable: BLUEFROST

Blue Star, Ltd.
23/24 Second Line Beach
Madras 1, India
Tel: 2 39 55
Telex: 379
Cable: BLUESTAR

Blue Star, Ltd.
1B Kaiser Bungalow
Dindli Road
Jamshedpur, India
Tel: 38 04
Cable: BLUESTAR

INDONESIA
Bah Bolon Trading Coy. N.V.
Djalah Merdeka 29
Bandung
Tel: 4915 51560
Cable: ILMU
Telex: 809

IRAN
Telecom, Ltd.
P. O. Box 1812
240 Kh. Saba Shomali
Teheran
Tel: 43850, 48111
Cable: BASCOM Teheran

ISRAEL
Electronics & Engineering Div. of Motorola Israel Ltd.
17 Aminadav Street
Tel-Aviv
Tel: 36941 (3 lines)
Cable: BASTEL Tel-Aviv
Telex: Bastel Tv 033-569

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Nisei Ibaragi Bldg.
2-2-8 Kasuga
Ibaragi-Shi
Osaka
Tel: 23-1641

Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, **Nagoya** City
Tel: 551-0215

Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
59 Yoyogi 1-chrome
Shibuya-ku, **Tokyo**
Tel: 370-2281/7
Telex: 232-2024YHP
Cable: YHPMARKET TOK 23-724

KENYA
R. J. Tilbury Ltd.
P. O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 68206, 58196
Cable: ARJAYTEE Nairobi

KOREA
American Trading Co., Korea, Ltd.
P.O. Box 1103
Dae Kyung Bldg.
107 Sejong Ro
Chongro Ku
Seoul
Tel: 75-5841 (4 lines)
Cable: AMTRACO Seoul

LEBANON
Constantin E. Macridis
Clemenceau Street
P.O. Box 7213
Beirut
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

MALAYSIA
MECOMB Malaysia Ltd.
2 Lorong 13/6A
Section 13
Petaling Jaya, **Selangor**
Cable: MECOMB Kuala Lumpur

MOZAMBIQUE
A. N. Goncalves, LDA.
4.1 Apt. 14 Av. D. Luis
P.O. Box 107
Lourenco Marques
Cable: NEGON

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
32-34 Kent Terrace
P.O. Box 9443
Wellington, N.Z.
Tel: 56-559
Cable: HEWPACK Wellington

PAKISTAN (EAST)
Mushko & Company, Ltd.
Zirat Chambers
31, Jinnah Avenue
Dacca
Tel: 280058
Cable: NEWDEAL Dacca

PAKISTAN (WEST)
Mushko & Company, Ltd.
Oosman Chambers
Victoria Road
Karachi 3
Tel: 511027, 512927
Cable: COOPERATOR Karachi

PHILIPPINES
Electromex Inc.
Makati Commercial Center
2129 Pasong Tamo
Makati, Rizal D 708
P.O. Box 1028
Manila
Tel: 89-85-01
Cable: ELEMEX Manila

SINGAPORE
Mechanical and Combustion Engineering Company Ltd.
9, Jalan Kilang
Singapore, 3
Tel: 642361-3
Cable: MECOMB Singapore

SOUTH AFRICA
Hewlett Packard South Africa (Pty.), Ltd.
Breecastle House
Bree Street
Cape Town
Tel: 3-6019, 3-6545
Cable: HEWPACK Cape Town
Telex: 5-0006

Hewlett Packard South Africa (Pty.), Ltd.
P.O. Box 31716
30 De Beer Street
Braamfontein, **Johannesburg**
Tel: 724-4172 724-4195
Telex: 0226 JH
Cable: HEWPACK Johannesburg

TAIWAN REP. OF CHINA
Hwa Sheng Electronic Co., Ltd.
P. O. Box 1558
Room 404
Chia Hsin Building
No. 96 Chung Shan North Road, Sec. 2
Taipei
Tel: 555211 Ext. 532-539
545936, 546076, 548661
Cable: VICTRONIX Taipei

TANZANIA
R. J. Tilbury Ltd.
P.O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206, 58196
Cable: ARJAYTEE Nairobi

THAILAND
The International Engineering Co., Ltd.
P. O. Box 39
614 Sukhumvit Road
Bangkok
Tel: 910722 (7 lines)
Cable: GYSOM
TLX INTENCO BK-226 Bangkok

UGANDA
R. J. Tilbury Ltd.
P.O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206, 58196
Cable: ARJAYTEE Nairobi

VIETNAM
Peninsular Trading Inc.
P.O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20.805
Cable: PENINSULA Saigon

ZAMBIA
R. J. Tilbury (Zambia) Ltd.
P.O. Box 2792
Lusaka
Zambia, Central Africa

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8461

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

12616A

PRELIMINARY SPECIFICATIONS

HIGH SPEED INPUT/OUTPUT CHANNEL

A. Single port to memory with external control.

B. Word transfer time -- 2.0 microseconds for 16-bit word. Maximum time from request to completed 1-word transfer -- 2.5 microseconds.

C. Data transfer rate -- 500,000 16-bit words/second.

D. Block transfer length -- 1 to 8192 16-bit words.

E. Single printed circuit card.

F. No character packing or bit manipulation provided on card.

G. Data input or output provided with multiplex data card, 12595A. External addressing of different devices can be accomplished from the I/O control card.

H. Field installable in 2114B.

I. Addressing -- Random access to any location in core or sequential access from a specific starting address. Address register is loaded externally. Random addressing is accomplished by supplying a new address for each transfer. Block transfers are accomplished by supplying a starting address, which is automatically indexed after each data transfer.

J. Word count -- ~~The word count register is set up with I/O Address 02.~~ The auto-indexing ~~may be~~ is controlled externally. Overflow of word count register will cause an interrupt to location 06.

K. Control lines are provided for:

Transfer Request
Transfer Request Enable
Transfer Acknowledge
Direction of Transfer
Step Memory Address (Level)
Load Memory Address
Step Word Count Register
Interrupt Request
Interrupt Acknowledge
Strobe Output Data
Strobe Input Data
Load Word Count Register

All signals are TTL or DTL compatible.

12616A SPECIFICATIONS

The 12616A is a high-speed input-output channel for use with the multiplexed I/O feature of the 2114B computer.

The multiplexed I/O (12595A) provides the capability of interfacing to a customer-built controller and directly addressing 56 different devices from the computer. The addition of 12616A makes it possible for a customer to have several high-speed devices in his system.

This option uses the same pre-wired slot as the 12607A in a 2114B computer. This provides a capability of DMA or high-speed I/O channel, but not both simultaneously.

The 12616A provides all the control lines and registers to implement a random access or sequential access data transfer. Random transfers can be accomplished by supplying a new address and an end-of-transfer interrupt for each data word.

Sequential transfers or block transfers can be accomplished by supplying a starting address and a word count. The memory address will be incremented automatically with each data word transfer. The word count register will increment with each word transferred and supply an interrupt when the block transfer is completed.

This system will be very useful to a customer who has a number of devices operating with multiplexed I/O. The fast devices can be controlled by the high-speed channel, while the slower devices can operate under program control.

Some of the uses for this option are linking several computers together in a multi-processing system; driving several displays that are updated at random times; direct memory increment system for waveform analysis; data acquisition systems with many devices of various speeds.

Summary

1. Single port to memory with external control.
2. Word transfer time: 2.0 microseconds for 16-bit word.
   Maximum time from request to completed 1-word transfer: 2.5 microseconds.
3. Data transfer rate: 500,000 16-bit words/second
4. Block transfer length: 1 to 8192 16-bit words.
5. Single printed circuit card.
6. No character packing or bit manipulation provided on card.
7. Data input or output provided with multiplex data card, 12595A. External addressing of different devices can be accomplished from the I/O control card.
8. Field installable in 2114B.
9. Addressing: Random access to any location in core or sequential access from a specific starting address. Address register is loaded externally.

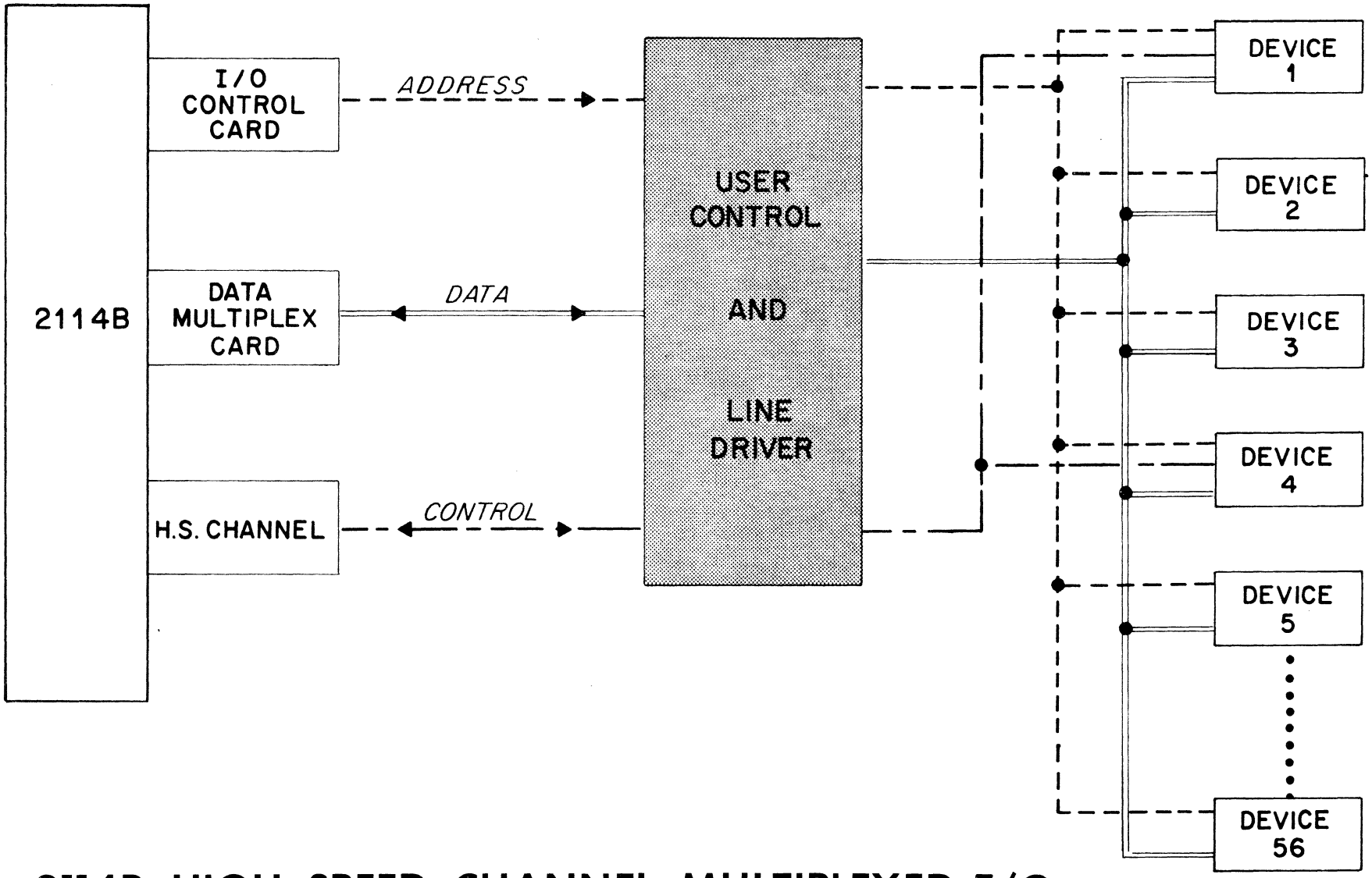
Random addressing is accomplished by supplying a new address for each transfer. Block transfers are accomplished by supplying a starting address, which is automatically indexed after each data transfer.

10. Word count: The word count register is loaded with the 2's complement of the number of words to be transferred. This register is incremented after each data transfer. The word count of zero will cause an interrupt to signal an end of transfer.

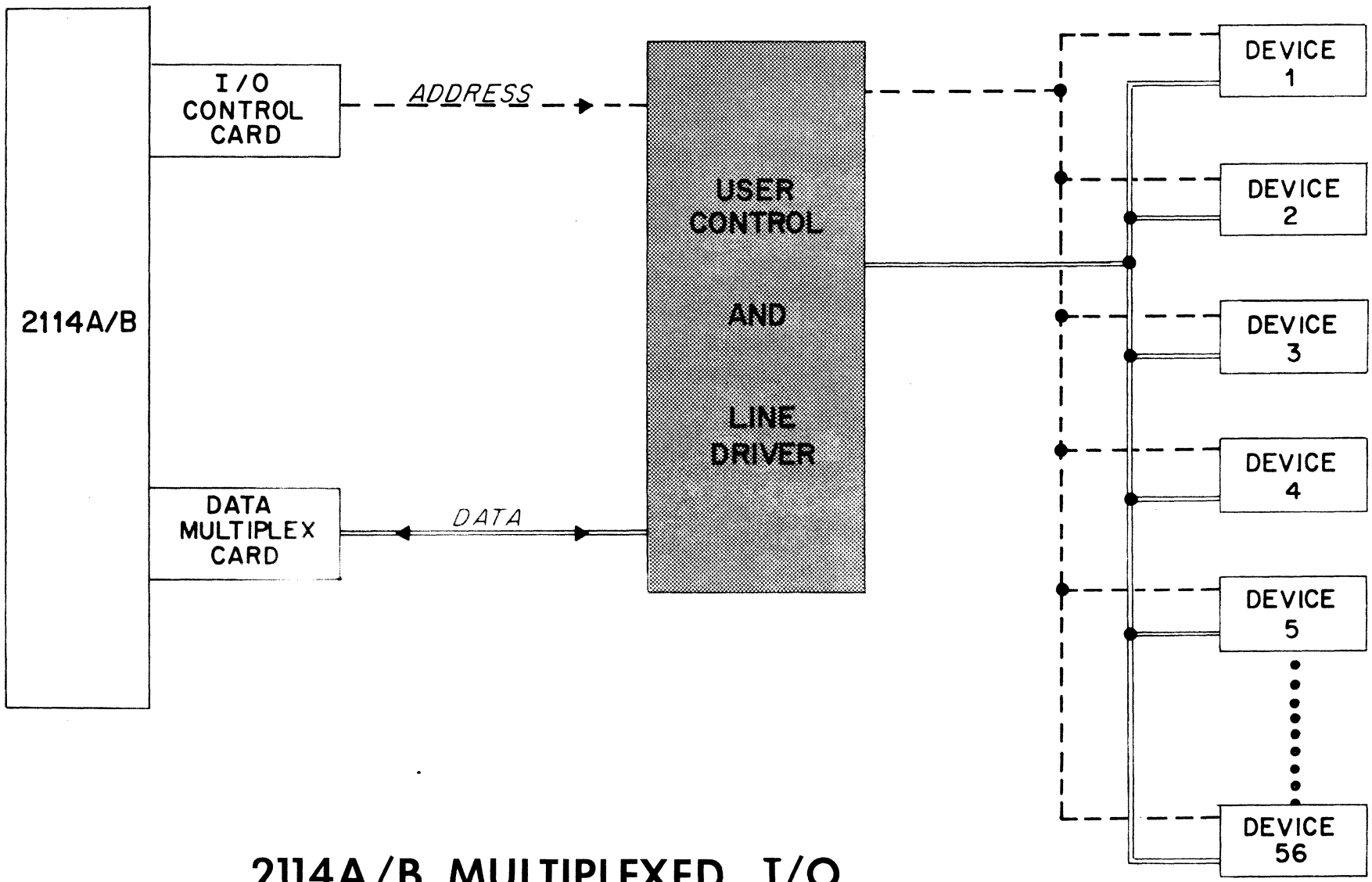
11. Control lines are provided for:

Transfer Request
Transfer Request Enable
Transfer Acknowledge
Direction of Transfer
Step Memory Address (Level)
Load Memory Address
Step Word Count Register
Interrupt Request
Interrupt Acknowledge
Strobe Output Data
Strobe Input Data
Load Word Count

All signals are TTL or DTL compatible.



2114B HIGH SPEED CHANNEL MULTIPLEXED I/O



2114A/B MULTIPLEXED I/O

HEWLETT PACKARD

DIGITAL COMPUTERS

HIGH-SPEED INPUT/OUTPUT CHANNEL

MULTIPLEXING AT HIGH DATA TRANSFER RATES FOR THE HP 2114B

FEATURES

- **EXTERNAL CONTROL**
  Permits direct data transfer to memory without software control.

- **INDEPENDENT CONTROL REGISTERS**
  Contains memory address and word count registers.

- **FAST**
  Completes each transfer in one machine cycle; performs block transfers at rates up to 500 KHz.

- **DTL/TTL COMPATIBLE**
  Provides proper logic levels for DTL/TTL on all signal lines.

- **FLEXIBLE**
  Performs sequential block or random transfers.

HP 12616A High-Speed I/O Option; requires
HP 12595A Multiplexed I/O Option

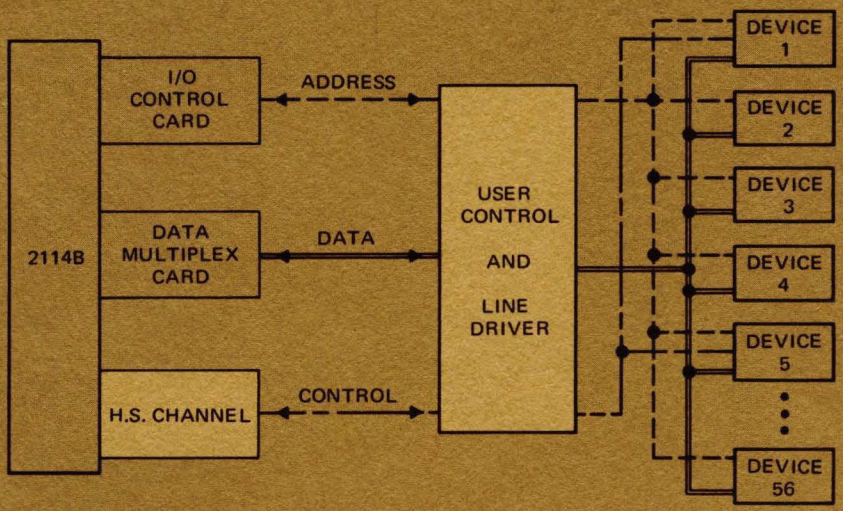
DESCRIPTION

The High-Speed Channel operates under control of the Multiplexer option to multiplex data at high transfer rates. Functionally, the Channel is similar to Direct Memory Access (DMA) and occupies the DMA slot of the 2114B Computer. I/O data is transferred via the Multiplex card directly to/from memory, rather than through the A or B Registers. The mode of transfer is "cycle-stealing"; only one machine cycle is required for the entire transfer. At the maximum transfer rate of 500 kHz, the option is capable of stealing every consecutive machine cycle until a block transfer is complete.

This system is very useful to the user who has a number of different devices operating with multiplexed I/O. The fast devices can be controlled by the high-speed channel, while the slower devices can operate under program control. Some of the uses for this option are:

- Linking several computers together in a multiprocessing system.
- Driving several displays that are updated at random times.
- Incrementing memory directly for waveform analysis.
- Data acquisition with many devices of various speeds.

The 12616A includes a word count register and a memory address register, which are used to specify how many words are to be transferred and where in memory the data should be transferred. These registers must be loaded externally (not by program) by the user's controller. Because the registers increment automatically after each transfer, the controller need not include logic for this purpose.



SPECIFICATIONS

Capacity: Single input/output channel (computer slot A16) for use with multiplexed I/O (Accessory No. 12595 – External addressing of 56 different devices through the 2114B I/O control card).

Maximum Data Transfer Rate: 500,000 16-bit words/second.

8-Bit Byte Transfer Time: 2 microseconds.

16-Bit Word Transfer Time: 2 microseconds (maximum of 2.5 microseconds from request to completed transfer).

Block Transfer Length: 1 to 8192 16-bit words.

Cycles Required to Initiate Block Transfer: 1

Cycles Stolen from Main Program per word transferred: 1

Memory Addressing: Random access to any location in core or sequential access from a specific starting address. Address register loaded externally.

Cost: $1,000.00

HEWLETT hp PACKARD

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 94303. In Europe, 1217 Meyrin-Geneva, Switzerland

Printed in U.S.A. 11/69

5952-4329