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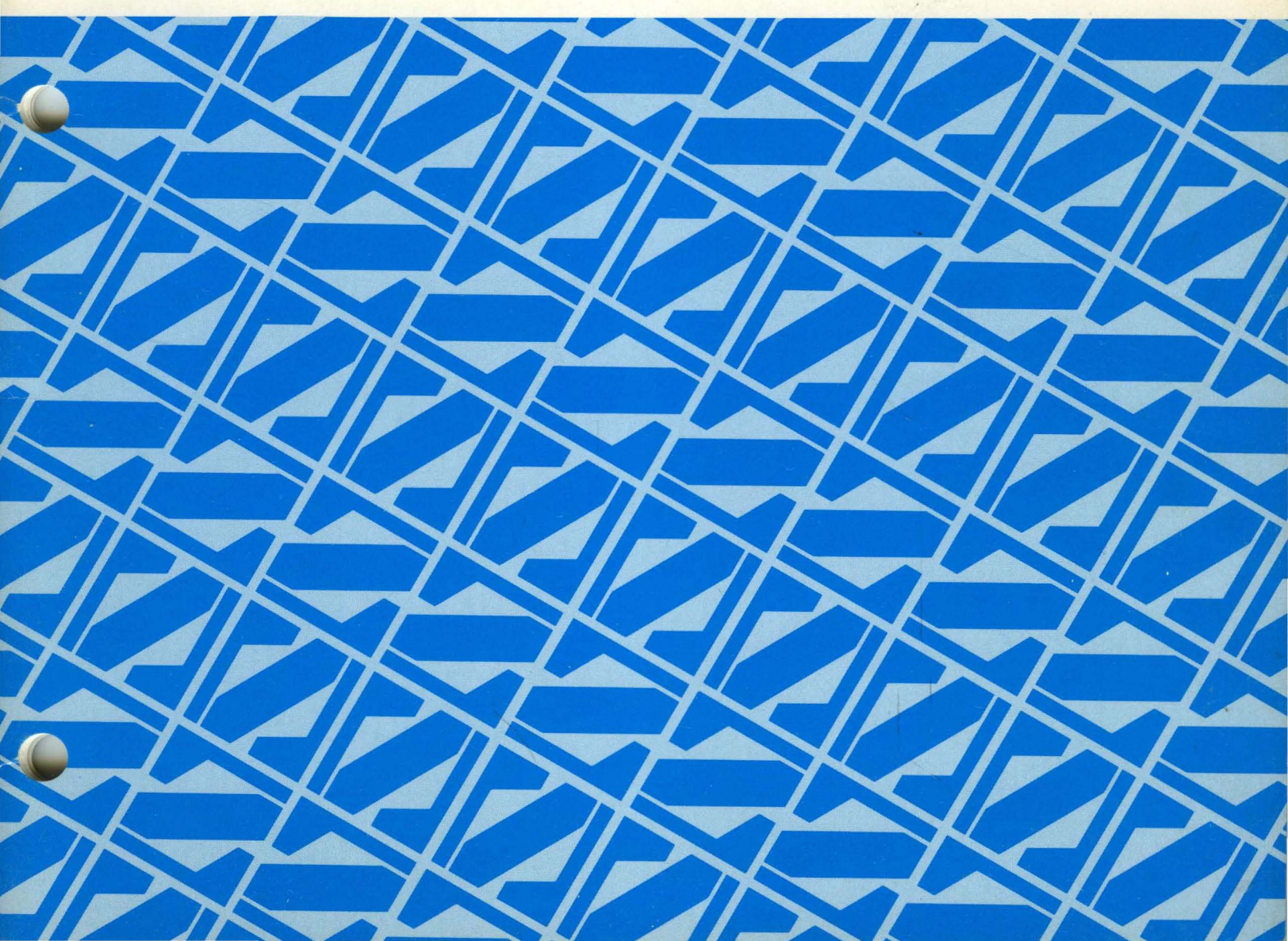
IMP-16 PROM Programmer Reference Manual



Integrated MicroProcessor
IMP-16

Publication No. 4200055A
Order No. IMP-16P/955A

IMP-16

PROM

PROGRAMMER

REFERENCE MANUAL

JULY 1974

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PREFACE

This publication provides the information necessary to use the IMP-16 PROM Programmer software package with IMP-16L or IMP-16P Microcomputers.

The PROM Programmer may be used to program either National Semiconductor MM4203/5203 or MM4204/5204 PROMs.

The information in this manual is for information purposes only and is subject to change without notice.

Copies of this and other National Semiconductor publications may be obtained from the sales office listed on the back cover.

CAUTION

Do not power up or remove power from the system with a PROM in either of the two programming sockets. This may destroy the contents of the last word of the PROM.

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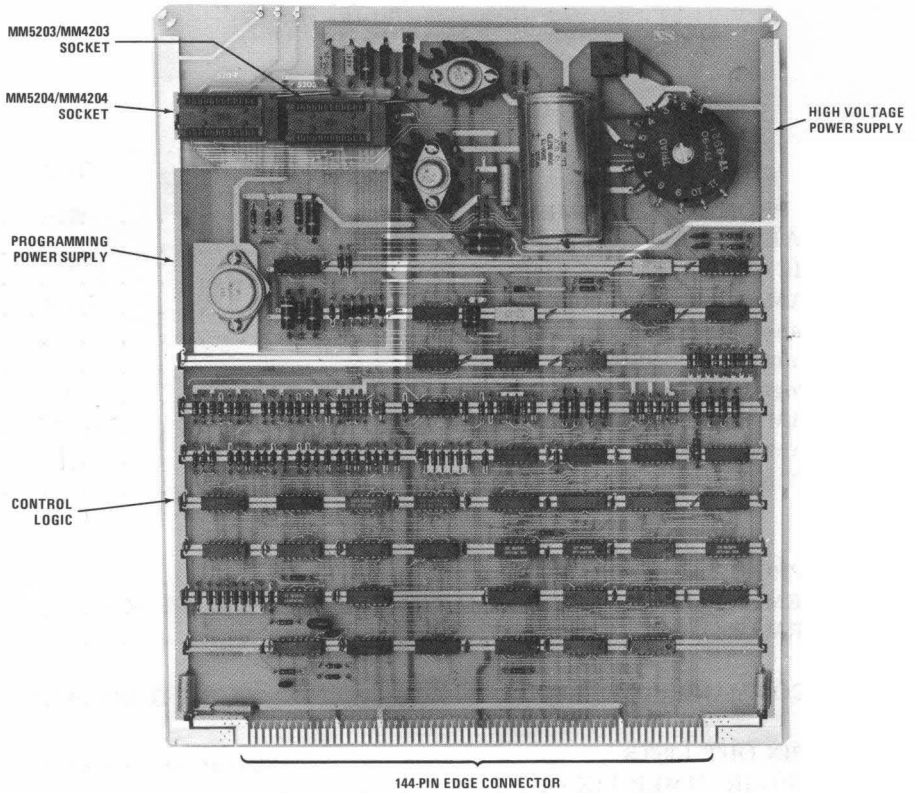
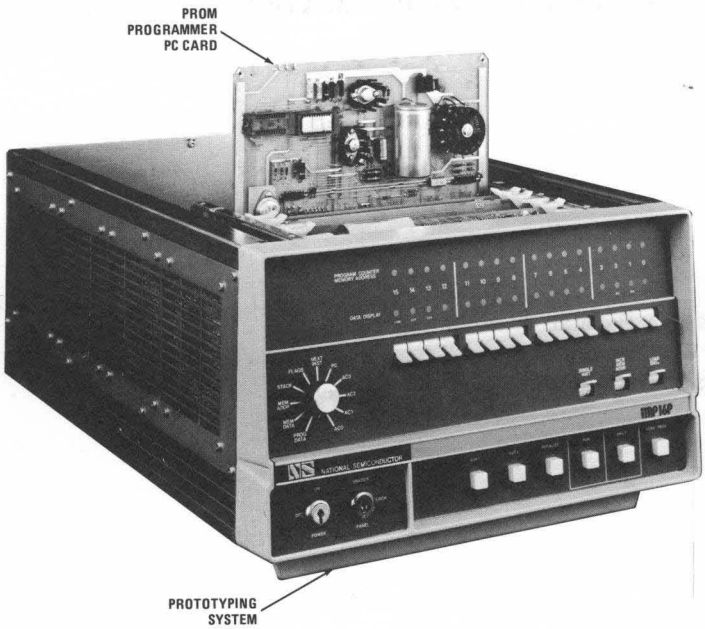

MM5203/MM4203
SOCKET
MM5204/MM4204
SOCKET
PROGRAMMING
POWER SUPPLY
CONTROL
LOGIC
HIGH VOLTAGE
POWER SUPPLY
144-PIN EDGE CONNECTOR


PROM
PROGRAMMER
PC CARD
PROTOTYPING
SYSTEM

Chapter 1

GENERAL INFORMATION

1.1 INTRODUCTION

The PROM Programmer is packaged on a 13-1/2 by 11-inch printed circuit card inserted in the IMP-16 Microcomputer. Two low-insertion force 24-pin sockets are provided. One accepts the National Semiconductor MM4203/5203 PROM and the other accepts the MM4204/5204 PROM. The PROM Programmer PC card contains all the logic and high-voltage power supplies necessary to program either PROM.

This publication provides a user all the information necessary to program a National Semiconductor MM4203/5203 or MM4204/5204 PROM on either the IMP-16L or the IMP-16P Microcomputers.

Provisions are available to accomplish the following:

- Duplicate an existing PROM.
- Verify a previously programmed PROM.
- Read a paper tape in either P/N, complemented binary, or absolute LM format into memory.
- Read a card deck in absolute LM format into memory.
- Program a PROM from memory.

For additional information on the PROM Programmer the user is referred to Chapter 4 (Hardware-PROM Programmer) of this manual and to the publications listed in appendix D. Physical descriptions of the IMP-16 Microcomputer and its peripherals are contained in the IMP-16 users manuals (see appendix D, Reference System Publications). Detailed descriptions of the hardware/software environment is beyond the scope of this document.

1.2 SYSTEM CONFIGURATION

The basic operating environment requires the PRMSFT software package and the following hardware components:

- IMP-16L or IMP-16P Microcomputer
- PROM Programmer PC board
- Teletype with paper tape reader
- Card reader (optional) to read LM card decks

1.3 LIMITATIONS

Two types of PROMs may be programmed: National Semiconductor MM4203/5203 and MM4204/5204. The sockets are <u>not</u> interchangeable. Only the MM5203 may be plugged into the MM5203 socket, and only the MM5204 may be plugged into the MM5204 socket. If a PROM is plugged into the wrong socket, either the PROM or the PROM Programmer may be damaged. It may be advisable to put tape over the unused socket.

CAUTION

Power should always be turned off before the PROM Programmer board is inserted or removed from the system. When turning off power, make sure no PROMs are plugged in as some locations in the PROM may inadventently be programmed.

The programming time is dependent upon the temperature of the PROM. The hotter it is, the longer the PROM takes to program. A fan may be employed to cool the PROM for faster programming. Typically, the MM5203 may be programmed in less than 5 minutes.

1.4 CONVENTIONS

The following notation is used for command descriptions and examples in this manual:

- Mixed upper/lower-case characters indicate notes and comments.
- Nonunderlined characters, numbers, and symbols indicate computer-generated output.
- Underlined characters, numbers, and symbols indicate user-generated input; lower-case represents the general format, and upper-case represents the specific case.
- Circled, upper-case characters represent the operation of Teletype keys which do not generate a printed character.

The basic elements of the PRMSFT commands are defined as follows:

<a> specifies an operand 'a' of a command.

[a] indicates the operand 'a' is optional.

The following meaning is assigned to the term used in the general case form of the command:

<hex number> is defined as from one to four digits from the hexadecimal set. Leading zeros are suppressed.

Chapter 2

SOFTWARE

2.1 GENERAL

PRMSFT is a supervisory program used to program either the National Semiconductor MM4203/5203 or the MM4204/5204 PROMs. The PRMSFT software starts at location X'0000 and uses less than 2K of memory. A fixed Buffer Area is used to read from and write to the PROM. The Buffer Area is from X'0E00 to X'0FFF. For the MM5203 PROM, only the lower buffer is used (X'0E00 to X'0EFF).

2.2 COMMUNICATIONS

The user communicates with PRMSFT through the Teletype. When PRMSFT takes control, it types a question mark (?) to indicate it is ready to accept a command. The user may then enter PRMSFT commands. All commands must be terminated by a carriage return (CR). To abort a command before execution, the (ALT MODE) key may be pressed at anytime before the (CR). There are several error messages that may be generated during the command execution process. These conditions are discussed in relation to the relevant command.

During the processing of certain commands, PRMSFT continuously checks for keyboard input during the output process. If any input character is detected, the printing is terminated and the user is prompted for a new command. This feature is particularly useful for terminating excessive or undesirable output.

2.3 COMMAND DESCRIPTIONS

2.3.1 SET MODE Command

? S (CR)

This command sets the mode of operation for the type of PROM being programmed, either National Semiconductor MM4203/5203 or the MM4204/5204. After the command is issued, a message is typed explaining the options. If other than the requested inputs are typed, the message is repeated. If more than one hexadecimal digit is typed only the last digit is used. The default mode after PRMSFT software initialization is for the MM5203. The following examples illustrate the use of the SET MODE command.

1. This example sets the mode for MM5203.

```
? S (CR)
MM5204  4K PROM. TYPE 4  (CR).
MM5203  2K PROM. TYPE 2  (CR).
2 (CR)
MM5203  2K PROM.
?
```

2. Error, operator terminates command.

```
? S 0 (ALT MODE)
?
```

Bad input.

3. This example sets the mode for MM5204.

```
? S (CR)
MM5204  4K PROM. TYPE 4 (CR)
MM5203  2K PROM. TYPE 2 (CR)
3 (CR)  <-------------- Bad input.

MM5204  4K PROM. TYPE 4  (CR).
MM5203  2K PROM. TYPE 2  (CR).

1234 (CR)  <---------- Only the last digit is used.
MM5204  4K PROM.
?
```

2.3.2 CHECK MODE Command

```
? <--
```

This command is used to check the mode of operation being used. The following examples illustrate the CHECK MODE command.

1. In this example the mode is previously set for MM5203.

```
? <--
MM5203  2K PROM.
?
```

2. In this example the mode is previously set for MM5204.

```
? <--
MM5204  4K PROM.
 ?
```

2.3.3 READ PROM Command

```
? H (CR)
```

This command is used to read from an existing PROM into the Buffer Area. After the command is entered, a message is sent to the Teletype requesting the operator to insert the PROM into the socket and to type a space (SP) when ready. The data words are read into memory and then read again for verification. If the read is correct, the checksum of the PROM is typed out. If the PROM and memory Buffer Area do not agree, the data read from the PROM are typed out followed by the data from the Buffer Area and the addresses which do not agree. The following examples illustrate the use of the READ PROM command.

1. In this example the PROM is read correctly.

```
? H (CR)
PUT PROM IN SOCKET.
HIT SPACE WHEN READY. (SP)

CKSM = FE61

DATA IN MEMORY CORRECTLY.
TYPE P OR Y TO PROGRAM PROMS.
?
```

2. In this example memory and the PROM are not in agreement at address X'010.

```
? H (CR)
PUT PROM IN SOCKET,
HIT SPACE WHEN READY. (SP)

00FF  0010  BAD PROM AT ADDRESS 0010
DONE.
?
```

Data read from PROM is X'FF. Data is Buffer Area is X'10.

2.3.4 READ BINARY Command

```
? I (CR)
```

This command reads a complemented binary paper tape into the Buffer Area. The operator loads the tape and types the command. PRMSFT responds with a message to load the tape and hit space when ready. The routine reading the tape assumes a rubout character immediately precedes the data. If there is no rubout character at the beginning of the tape, the tape may be positioned to the first record and then a rubout typed before turning on the tape reader. A total of 256 or 512 8-bit words are read into the Buffer Area, depending upon which mode is selected. When the tape is read into memory, the checksum is typed out, and the operator is given the option of reading again to verify the tape. The following examples illustrate the use of the READ BINARY command.

1. In this example the tape is read correctly twice.

```
? I (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)

CKSM = 646B
VERIFY TAPE? Y OR N
Y (CR)
   VERIFY TAPE TO MEMORY.
   LOAD TAPE. AGAIN.
   HIT SPACE WHEN READY. (SP)
DATA IN MEMORY CORRECTLY.
TYPE P OR Y TO PROGRAM PROMS.
?
```

2. In this example the tape is read correctly once.

```
? I (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
CKSM = 646B
VERIFY TAPE?  Y OR N
N (CR)
TYPE P OR Y TO PROGRAM PROMS.
?
```

3. In this example the tape and memory are not correct.

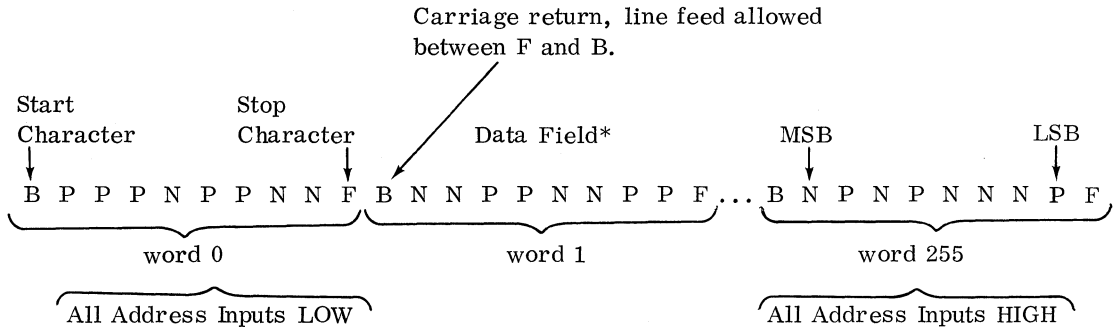
```
? I (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
CKSM = 64C1
VERIFY TAPE? Y OR N
Y (CR)
   VERIFY TAPE TO MEMORY.
   LOAD TAPE. AGAIN.
   HIT SPACE WHEN READY. (SP)
TAPE AND MEMORY NOT CORRECT TRY AGAIN.
?
```

2.3.5 READ P/N Command

```
? N (CR)
```

This command reads a paper tape in the P/N format into the Buffer Area. To load a tape, the operator enters the command. The system responds with a message to load the tape and hit space (SP) when ready. After the tape is read, the operator is given the option of reading again to verify the tape. Either 256 or 512 8-bit words are read, depending upon which mode is set. If an error is detected when verifying, an error message is sent to the Teletype. If the P/N tape contains any character other than P or N between the start and stop characters (B and F), the tape is bad and an error message is generated. The tape format is shown below.

Tape format for the MM5203 and MM5204.



*Data Field: Must have only Ps and Ns typed between B and F (no nulls or rubouts). Must have exactly eight P and N characters between the F stop character and the B start character. If an error is made preparing the tape, the entire word including the B and F start and stop characters must be rubbed out. Data for exactly 256 words must be entered, beginning with word 0, for the MM5203, and exactly 512 words for the MM5204. The P/N format stands for positive/negative voltage, with P = 1 or positive and N = 0 or negative.

The following examples illustrate the use of the READ P/N command.

1. This example shows correct operation reading the tape once.

```
? N (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
   P/N TAPE READ IN.
VERIFY TAPE? Y OR N
N (CR)
TYPE P OR Y TO PROGRAM PROMS.
?
```

2. This example shows correct operation reading the tape twice.

```
? N (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
   P/N TAPE READ IN.
VERIFY TAPE? Y OR N
Y (CR)
   VERIFY TAPE TO MEMORY.
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
DATA IN MEMORY CORRECTLY.
TYPE P OR Y TO PROGRAM PROMS.
?
```

3. In this example the P/N tape is read twice and memory does not agree.

```
? N (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
   P/N TAPE READ IN.
VERIFY TAPE? Y OR N
Y (CR)
   VERIFY TAPE TO MEMORY.
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
TAPE AND MEMORY NOT CORRECT TRY AGAIN.
?
```

4. This example shows bad data on the tape.

```
? N (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
P/N TAPE BAD.
?
```

2.3.6 READ LM Tape

```
? L (CR)
```

This command reads an absolute LM paper tape into the Buffer Area. The operator enters the command L (CR). A message is sent requesting that the operator load the tape and hit space when ready. The read routine assumes the tape is absolute and fits into 512 words of contiguous memory. The routine uses the lower 9 bits of the loading address to determine where to put the data in the Buffer Area. If bit 8 is a one, the data words are loaded into locations X'0F00 to X'0FFF. If bit 8 is zero, the data words are loaded into locations X'0E00 through X'0EFF. These two buffers are called the upper 256 (X'0F00-X'0FFF) and the lower 256 (X'0E00-X'0EFF). The operator is given the choice of programming from either the upper or lower 256 words and either the right or left 8 bits. All records are checked for checksum, and when an error is detected, a message is printed. The following examples illustrate the use of the READ LM TAPE command.

1. This example shows the correct reading of an absolute tape.

```
? L (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
U (CR) <-------------- Bit 8 of the data address = 1
LEFT BYTE TYPE L (CR)
RIGHT BYTE TYPE R (CR)
R (CR)
DONE.
?
```

2. This example shows an LM read with the operator typing the wrong inputs.

```
? L (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
H (CR) <-------------- Bad input
UPPER 256 U (CR)
LOWER 256 L (CR)
L (CR)
LEFT BYTE TYPE L (CR)
RIGHT BYTE TYPE R (CR)
L (CR)
DONE.
?
```

3. This example shows an LM read with a checksum error.

```
? L (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
CHECKSUM ERROR.
TRY AGAIN?  Y OR N
Y (CR)
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP) <------ Tape repositioned
UPPER 256 U (CR)
LOWER 256 L (CR)
U (CR)
LEFT BYTE TYPE L (CR)
RIGHT BYTE TYPE R (CR)
R (CR)
DONE.
?
```

2.3.7 READ LM CARDS

? J (CR)

This command reads absolute LM card deck into the Buffer Area. When the operator types the command, a message is returned to load the cards, ready the reader, and type a space (SP) when ready. The read routine assumes the load module (LM) is absolute and fits into 512 words of contiguous memory. The routine uses the least significant 9 bits of the loading address to determine where to load the data in the Buffer Area. If bit 8 is a one, the data words are placed in the upper buffer (X'0F00 to X'0FFF). If bit 8 is a zero, the data words are put in the lower buffer (X'0E00 to X'0EFF). The operator is given the choice of either the upper or the lower 256 words as well as the right and left byte. All records are checked for correct checksum, and an error message is typed if an incorrect checksum is found. The last card must contain an * in column 1. The following examples illustrate the use of the READ LM CARDS command.

1. This example shows the normal operation.

```
? J (CR)
MAKE CR READY.
HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
U (CR)
LEFT BYTE TYPE L (CR).
RIGHT BYTE TYPE R (CR).
L (CR)
DONE.
?
```

2. In this example the LM deck is greater than 512 words.

```
? J (CR)
MAKE CR READY.
HIT SPACE WHEN READY. (SP)
RLM TOO LARGE.
?
```

3. In this example an LM card is not correct.

```
? J (CR)
MAKE CR READY.
HIT SPACE WHEN READY. (SP)
INVALID CHAR.
?
```

4. In this example there is a transmission error.

```
? J (CR)
MAKE CR READY.
HIT SPACE WHEN READY. (SP)
TRANSMISSION ERROR.
?
```

5. This example shows a recovery from a bad checksum.

```
? J (CR)
MAKE CR READY.
HIT SPACE WHEN READY. (SP)
CHECKSUM ERROR.
TRY AGAIN?  Y OR N
Y (CR)
MAKE CR READY <---------- Put the bad card back in the card reader
HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
L (CR)
LEFT BYTE TYPE L (CR)
RIGHT BYTE TYPE R (CR)
L (CR)
DONE.
?
```

2.3.8 GO TO HEX Command

? G <hex address> (CR)

This command transfers control from the PRMSFT software to the hexadecimal address specified. This command is used to transfer control to a user's program. The following examples illustrate the use of the GO TO HEX command.

1. Jump to a user's program at X'4300.

   ? G 4300 (CR)

2. In this example the operand is missing.

```
? G (CR)
?
  <-- Control was not transferred.
```

2.3.9 MOVE DATA Command

? M [<hex number>] (CR)

This command moves data from the hex address specified to the Buffer Area (X'0E00). Either 256 or 512 words are moved depending on which mode is used. The address range wraps around memory; so if the starting address given is X'FF01 or greater, then, after word X'FFFF is moved, the next address is X'0000. If an address is not given, the move starts at zero. Either the left or right byte must be specified to be moved. The following example illustrates the use of the MOVE command.

1. This example moves data from X'0120 through X'021F and uses the left byte.

```
? M 120 (CR)
LEFT BYTE TYPE L (CR).
RIGHT BYTE TYPE R (CR).
L (CR)
DONE.
?
```

2.3.10 FILL BUFFER Command

? W [<hex number>] (CR)

This command fills the Buffer Area with the last four digits of the hexadecimal number given. Either 256 or 512 words are filled depending on the mode used. The default is zero if the operand is missing. The following examples illustrate the use of the FILL BUFFER command.

1. In this example the left byte of the buffer is filled with X'FF.

```
? W FF (CR)
DONE.
?
```

2. In this example the buffer is filled with X'00.

```
? W (CR)          Defaults to X'00
DONE.
?
```

2.3.11 LIST PROM Command

? R [<hex address>] (CR)

This command reads a PROM and lists its contents starting at the given hexadecimal address within the PROM. If no address is given, the default address is zero. The format of the printout is the address followed by 8 hexadecimal words. The printout is either 256 or 512 words long, depending on the mode. Printing may be terminated by hitting any key on the keyboard. The following examples illustrate the use of the LIST PROM command.

1. This example shows a printout starting at address X'20.

```
? R 20 (CR)
0200 00FF 00FF 00FF 00FF 00FF 00FF 00FF 00FF
0028 00FF 00FF 00FF 00FF 00FF 00FF 00FF 00FF
                                          (SP)
?                          Operator hits
                           keyboard ----------^
```

2. In this example the PROM contents are listed starting at address X'00.

```
? R (CR)
0000 00FF 00FF 00FF 00FF    (SP) <---- Operator hits keyboard
```

2.3.12 LIST BUFFER Command

? T [<hex address>] (CR)

This command is used to type out any memory location starting at the hexadecimal address given. If the operand is missing, the Buffer Area is typed out. Either 256 or 512 words are typed out, depending on the mode. The listing may be terminated with a space (SP). The following examples illustrate the use of the LIST BUFFER command.

1. This example shows a listing starting at memory location X'E20.

```
? T E20 (CR)
0E20 0080 0000 004F 0081 0006 001C (SP) <---- Operator hits a space
?
```

2. In this example the write buffer is listed.

```
? T (CR)
0E00  004C  0000  0029  008D  0087  0065  0036  0083
0E08  0011  00D3  004B  004A  0021  008D  (SP) ←Operator hits a space
?
```

2.3.13 PROM CHECKSUM Command

```
? Q (CR)
```

This command computes and types out the checksum of the PROM. The following example illustrates the use of this command.

```
? Q (CR)
CKSM = FF00
?
```

2.3.14 BUFFER Checksum

```
? X (CR)
```

This command computes and types out the Buffer Area checksum. The following example illustrates the use of the command.

```
? X (CR)
CKSM = 4585
?
```

2.3.15 PROGRAM PROM Command

```
? Y [<hex address>] (CR)
```

This command is used to program a PROM starting at the hexadecimal address given. If the operand is missing, the default address is zero. In this mode the command does not check if the PROM is erased. On the IMP-16L, both the address being programmed and the data read from the PROM are displayed on the control panel. The address is displayed using the program counter memory address lights on the control panel. The data read from the PROM are displayed using the data display lights. On the IMP-16P, the operator may observe memory location X'0023 (the PROM address currently being accessed) to get a positive indication that the programmer is working. A message is printed at the start of programming. Hitting any key on the keyboard terminates programming, and a message is typed along with the last address programmed. If an address cannot be programmed, programming ceases and an error message is typed. This error message contains the data read from the PROM, and the data from the Buffer Area, along with the bad address. After the PROM is programmed, a message is typed to the operator along with ringing the TTY bell. If an error exists, an error message is typed. The following examples illustrate the use of the PROGRAM PROM command.

1. This example shows the correct operation starting at address X'00.

```
? Y (CR)
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = FF00
PROM IS CORRECT.
?
```

2. In this example the operator terminates the programming at X'0A.

```
? Y (CR)
PROGRAMMING NOW. (SP) <------Operator hits keyboard.
PROM AT ADDRESS 000A
?
```

3. Restart at X'0A.

```
? Y A (CR)
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = FF00
PROM IS CORRECT.
?
```

4. In this example the PROM could not be programmed at address X'02.

```
? Y (CR)
PROGRAMMING NOW.
   00FF  0002  BAD PROM AT ADDRESS 0002
?
```

2.3.16 CHECK AND PROGRAM Command

```
? P (CR)
```

This command programs a PROM starting at PROM location zero after checking to see if the PROM is erased. After the check, this command functions exactly as a PROGRAM command with no operand (starting address zero). The following examples illustrate the use of the CHECK AND PROGRAM command.

1. This example shows the correct operation.

```
? P (CR)
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = FF00
PROM IS CORRECT.
?
```

2. This example shows the PROM is not erased at address X'00.

```
? P (CR)
PROM NOT ERASED AT ADDRESS 0000
?
```

3. In this example the operator terminates programming with the keyboard.

```
? P (CR)
PROGRAMMING NOW. (SP)
PROM AT ADDRESS 0007
?
```

4. In this example the PROM could not be programmed at address X'02.

```
? P (CR)
PROGRAMMING NOW.
00FF  0002  BAD PROM AT ADDRESS 0002
?
```

Data read from PROM — Data in Buffer Area — PROM address

2.3.17 VERIFY Command

```
? V (CR)
```

This command is used to verify a PROM is written correctly. When the operator types the command, the contents of the PROM are compared with the contents of the Buffer Area. If the PROM and the Buffer Area agree, the checksum of the PROM is typed as well as a message. If the PROM and Buffer Area are not in agreement, an error message is output. All bad words are listed unless terminated by the operator hitting the space key. The following examples illustrate the use of the VERIFY command.

1. This example shows the correct operation.

```
? V (CR)
CKSM = FF00
PROM IS CORRECT.
?
```

2. In this example, there is a bad word at address X'02.

```
? V (CR)
00FF  0002  BAD PROM AT ADDRESS 0002
DONE.
?
```

Word read from PROM — Word in Buffer Area — PROM address

3. In this example, there are multiple bad addresses and operator terminates.

```
? V (CR)
00FF  0055  BAD PROM AT ADDRESS 0000
00FF  0055  BAD PROM AT ADDRESS 0001
00FF  0055  BAD PROM AT ADDRESS 0002    (SP) <---- Operator hits key
?
```

Chapter 3

OPERATION

3.1 INITIALIZATION

There are two ways of loading PRMSFT software, from paper tape or from cards. The paper tape initialization is the same for both the IMP-16P and the IMP-16L Microprocessors; however, the card deck initializations are different.

3.1.1 IMP-16 Paper Tape Initialization

The Absolute Paper Tape Loader (ABSPT) is resident in Read-Only Memory (ROM) on the IMP-16 Microprocessors. The procedure for loading from paper tape is as follows:

1. Press INIT on the IMP-16 panel.
2. Place the LM paper tape in the reader.
3. Press LOAD PROG on the IMP-16 panel.
4. Turn on paper tape reader.
5. Wait for tape to be read and processing to halt.
6. Press RUN to begin execution of PRMSFT.

3.1.2 IMP-16 Card Deck Initialization

In the IMP-16P the Absolute Card Reader Loader (ABSCR) is resident in ROM. In the IMP-16L it is resident in memory, starting at the location specified by the user. The procedure for loading the IMP-16P from cards is as follows:

1. Press INIT on the IMP-16P panel.
2. Set PC (program counter) to X'7F00.
3. Set display selector to PROG DATA.
4. Load card deck into card reader.
5. Press RESET on card reader.
6. Wait until green ready light is on.
7. Press RUN on the IMP-16P panel.

The procedure for loading the IMP-16L from cards is as follows:

1. Press INIT on the IMP-16L panel.
2. Put two CRBOOT cards in the card reader.
3. Put ABSCR card deck next.
4. Put PRMSFT card deck next.
5. Put a GO card at the end.
6. Press RESET on the card reader.
7. Wait until the green ready light is on.
8. Press AUX 1; one card is read in.
9. Press RUN on the IMP-16L panel.

Upon successful completion of any of the appropriate loading procedures control is transferred to PRMSFT. PRMSFT outputs the program name, then a prompt character (question mark):

```
PRMSFT  05/01/74
?
```

To restart the system, the operator may push the initialize (INIT) and run (RUN) buttons.

3.2 PROM DESCRIPTION

The National Semiconductor MM4203/5203 is a 256-word by 8-bit PROM and is pin compatible with the National Semiconductor MM4213/5213 ROM. The National Semiconductor MM4204/5204 is a 512-word by 8-bit PROM and is pin compatible with the National Semiconductor MM4214/5214 ROM.

3.3 PROM HANDLING

A few rules must be adhered to when handling PROMs:

1. The PROM sockets are not interchangeable. If an MM4203/5203 is plugged into a 5204 socket or an MM4204/5204 is plugged into a 5203 socket, the PROM and/or the PROM Programmer may be damaged. Be careful to plug the PROM into the correct socket.

2. Never power-up or power-down the system with a PROM in the programmer. Such action alters the contents of the PROM.

3.4 PROM PROGRAMMING

3.4.1 General

This section is intended as a guide for programming the PROM. It is suggested the user familiarize himself with the PRMSFT commands before using the section. The examples given in the following sections are typical usage; they should not be construed to be the only usage of those commands.

3.4.2 Duplicating an existing PROM.

```
PRMSFT  05/01/74                    System initialization.
? S (CR)                            Set the mode for MM5203 PROM.
MM5204 4K PROM.  TYPE 4 (CR).
MM5203 2K PROM.  TYPE 2 (CR).
2 (CR)
MM5203 2K PROM.
? H (CR)                            Read PROM into Buffer Area.
PUT PROM IN SOCKET.
HIT SPACE WHEN READY. (SP)
CKSM = FE61
DATA IN MEMORY CORRECTLY.
TYPE P OR Y TO PROGRAM PROM.
? P (CR)                            Check if erased then program.
PROM NOT ERASED AT ADDRESS 0000     Forgot to change PROM.
? P (CR)                            New PROM to Program.
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = FE61
PROM IS CORRECT.
? V (CR)                            Verify the PROM is written correctly.
CKSM = FE61
PROM IS CORRECT.
?                                   Finished.
```

3.4.3 Programming from P/N paper tape.

```
? ←                                          Check the mode.
MM5203  2K PROM.
? S (CR)                                     Set the mode for MM5204 PROM.
MM5204  4K PROM.  TYPE 4 (CR).
MM5203  2K PROM.  TYPE 2 (CR).
4 (CR)
MM5204  4K PROM.
? N (CR)
   LOAD TAPE.                                Read in the tape.
   HIT SPACE WHEN READY. (SP)
   P/N TAPE READ IN.
VERIFY TAPE?  Y OR N
Y (CR)
   VERIFY TAPE TO MEMORY.                    Reload tape to verify.
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
DATA IN MEMORY CORRECTLY.
TYPE P OR Y TO PROGRAM PROMS.
? T (CR)                                     List the Buffer Area.
0E00  004C  0000  00FF  00FF  00FF  00FF  00FF  00FF
0E08  0011  00D3  00FF  008D  0087  0065  0036  00FF
0E10  00FF  00FF  (SP)                       Operator terminates listing.

? Y (CR)                                     Program the PROM.
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = F014
PROM IS CORRECT.
? G 4300 (CR)                                Go to the user's program.
```

3.4.4 Programming from complemented binary paper tape.

```
PRMSFT  05/01/74                             System initialization.
? S (CR)                                     Set the mode to 4K PROM.
MM5204  4K PROM.  TYPE 4 (CR).
MM5203  2K PROM.  TYPE 2 (CR).
4 (CR)
MM5204  4K PROM.
? I (CR)                                     Read binary tape.
   LOAD TAPE.
   HIT SPACE WHEN READY. (SP)
CKSM = 0203
VERIFY TAPE?  Y OR N
N (CR)
TYPE P OR Y TO PROGRAM PROMS.
? P (CR)                                     Program the PROM.
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = 0203
PROM IS CORRECT.
? V (CR)                                     Verify the PROM.
CKSM = 0203
PROM IS CORRECT.                             Finish..
?
```

3.4.5 Programming from LM paper tape.

```
? ←                                   Check the mode.
MM5203  2K PROM.
? L (CR)
   LOAD TAPE.                         Read the LM tape.
   HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
U (CR)
LEFT BYTE TYPE L (CR)
RIGHT BYTE TYPE R (CR)
R (CR)                                Program the PROM.
DONE.
? P (CR)
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = 0411
PROM IS CORRECT.
?                                     Finished.
```

3.4.6 Programming from LM cards.

```
? ←                                   Checks the mode.
MM5203  2K PROM.                      It's ok.
? J (CR)                              Read cards.
MAKE CR READY.
   HIT SPACE WHEN READY. (SP)
UPPER 256 U (CR)
LOWER 256 L (CR)
U (CR)
LEFT BYTE TYPE L (CR).
RIGHT BYTE TYPE R (CR).
R (CR)
DONE.
? X (CR)                              Print the buffer checksum.
CKSM = 061E                           Ok.
? Y (CR)                              Program the PROM.
PROGRAMMING NOW.
PROM PROGRAMMED.
CKSM = 061E
PROM IS CORRECT.
? W (CR)                              Zero the buffer.
DONE.                                 Finished.
?
```

3.5 HOW TO ERASE A PROM

PROMS with the quartz window may be erased using short-wave ultra-violet light of approximately 253.7 nanometers shining directly on the window for half an hour.

Chapter 4

HARDWARE — PROM PROGRAMMER

4.1 PHYSICAL DESCRIPTION

The PROM Programmer logic is packaged on a single 13-1/2 by 11-inch printed circuit card. Two low-insertion-force 24-pin sockets are provided; one accepts MM5203/4203 and the other accepts MM5204/4204 PROMs. This logic card contains all the logic and high voltage power supplies required to program the above PROMs. The high voltages needed to program a PROM are derived from its -12-volt power supply.

4.2 SPECIFICATIONS

Size of board:	13-1/2 inches by 11 inches
Two low-insertion-force 24-pin sockets	
Input power:	+5V at 1.3 amperes -12V at 1.5 amperes
Temperature:	Operating 0° to 50°C Storage -20° to 125° C
Humidity:	Maximum of 90% relative humidity without condensation
Interface characteristics:	4 user flags - 2 for data transmission 2 for controlling program voltages 1 user branch-on condition

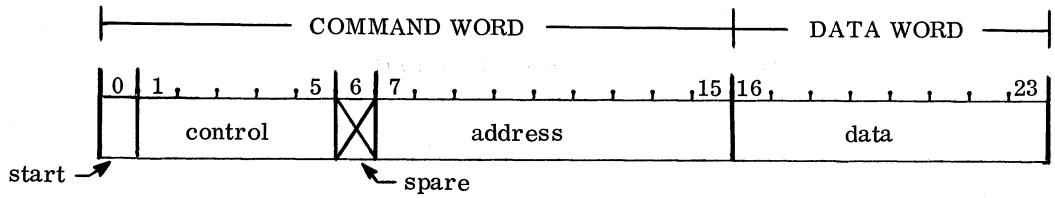
4.3 PROGRAM LOGIC CONTROL

All communication between the CPU and the PROM Programmer is accomplished with four user control flags and one user branch-on condition. The PROM Programmer hardware is compatible with all IMP microcomputers; only the software requirements are different. Table 4-1 shows the functions of the PROM Programmer.

Table 4-1. PROM Programmer Functions

Functions	Start Bit	Control Bits					Address Bits	Data Bits
		1 RD	2 EV	3 EP	4 ET	5 DV		
Read Data	1	1					Required	From PROM
Program PROM	1		1	1		1	Required	From memory
Overtemperature	1				1	1	Not Required	8 clock pulses to keep in sync

DATA TRANSMISSION FORMAT



COMMAND WORD FORMAT

First bit sent	0	Start Bit (SB)
5 control bits	1	Read Data command (RD)
	2	Enable Voltage (EV)
	3	Enable Program voltage (EP)
	4	Enable Temperature check (ET)
	5	Disable V_{BB} voltage (DV)
	6	Spare
9 address bits	7	Address bit 8 MSB for MM5204
	8	Address bit 7 MSB for MM5203
	9	Address bit 6
	10	Address bit 5
	11	Address bit 4
	12	Address bit 3
	13	Address bit 2
	14	Address bit 1
	15	Address bit 0 LSB of address

DATA WORD FORMAT

8 data bits	16	Data bit 7 MSB
	17	Data bit 6
	18	Data bit 5
	19	Data bit 4
	20	Data bit 3
	21	Data bit 2
	22	Data bit 1
Last bit sent	23	Data bit 0 LSB

Note: Data sent to program the MM5203 must be complemented.
Data words are not complemented for the MM5204.

Figure 4-1. Data Transmission Format

4.3.1 Data Transmission Flags

Two user flags transfer data between the processor and the PROM Programmer. User flag 1 is for data, and flag 2 is used as a clock for transferring the data. All data transfers are 24-bit serial; the first 16 bits are the command word and the last 8 bits are the data word. Data sent to program the MM5203 must be complemented; data words are not complemented for the MM5204. Initialization resets all transmission lines. The data transmission format and bit description are shown in figure 4-1.

4.3.2 User Branch-on Condition

When reading from the PROM Programmer, the user branch-on condition is used to determine if the received bit is a logic '1' or a logic '0'. A true on this line (a branch) corresponds to a logic '0' received. A true on the line is also used to indicate overtemperature on the PROM. After the received bit is determined to be a '1' or a '0',the clock flag is pulsed to receive the next bit. When monitoring overtemperature, the clock flag must be pulsed eight times, after the command word is received, to keep the hardware in synchronization (data word is not used for overtemperature).

4.3.3 User Program Voltage Control Flags

To program a PROM, two additional flags are needed to control the programming voltages. The command word enables the voltages to program the PROM. Flag 3 sets the correct voltage levels for V_{SS}, V_{LL} and V_{BB}. Flag 4 programs the PROM.

4.4 PROGRAM VOLTAGES

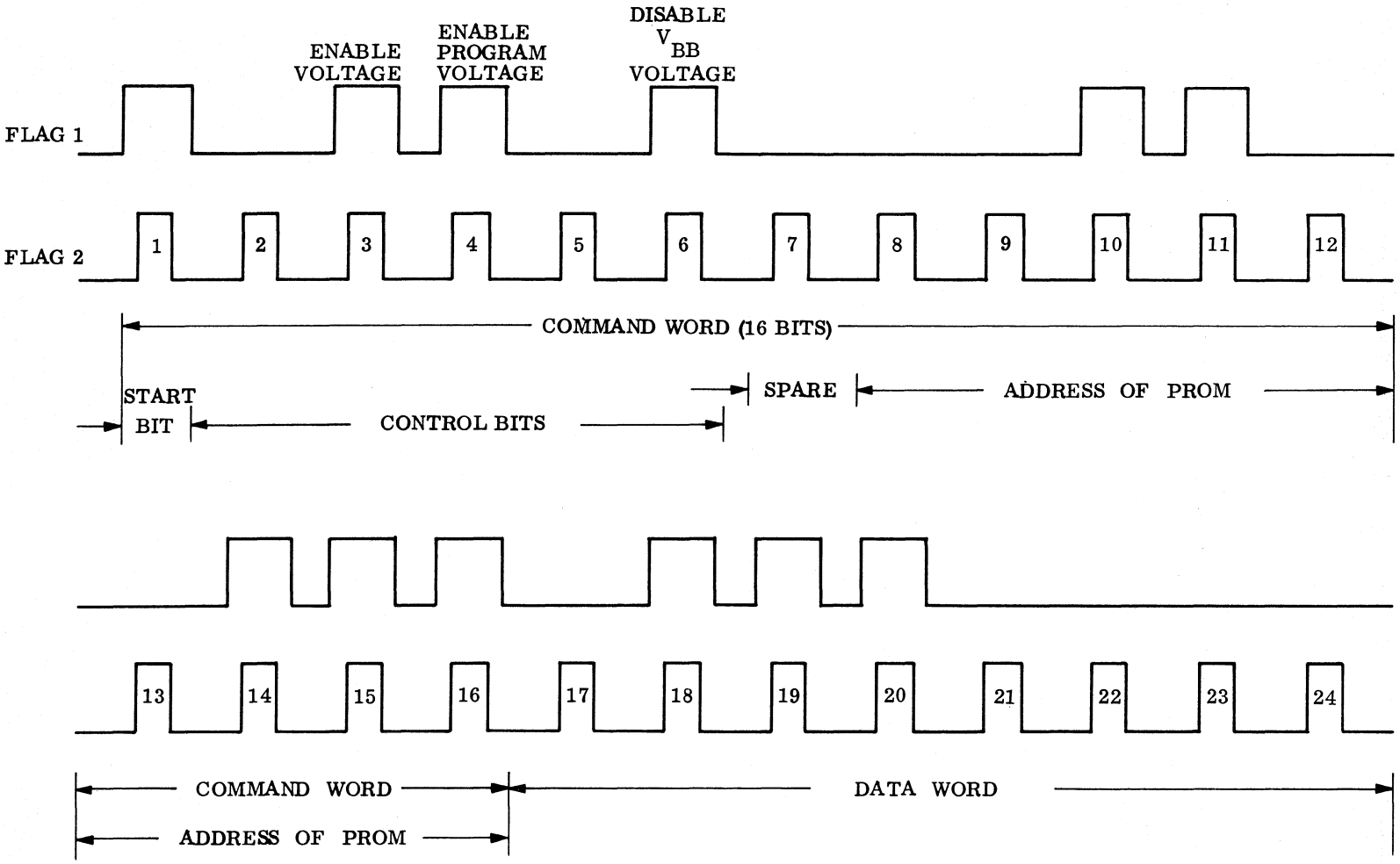
An inverter power supply powered from the -12V line generates the voltages to program the PROM. These voltages consist of a raw +70V at 200 milliamperes constant drain which can be pulsed to 600 milliamperes for 10 milliseconds with a 3-volt drop. From the +70V the V_{BB} voltage is derived +58V at 100 milliamperes. V_{SS} is derived using V_{BB} as a reference. V_{SS} is 11V less than V_{BB} during programming. The program voltage is 0V. Initialization resets all programming voltages. Figure 4-2 shows the relationship of programming voltages to user flags.

4.5 PROGRAMMING SEQUENCE

Figure 4-2 illustrates the relation of the control flags (USER 1 and USER 2) required to program PROM location X'67 with the value of X'70. Once the entire command word and data word sequence are transmitted to the programmer, the actual programming voltages must be delivered to the PROM. Figure 4-3 illustrates how user flags 3 and 4 are used for this function.

4.6 PIN LIST AND BACK PANEL WIRE LIST

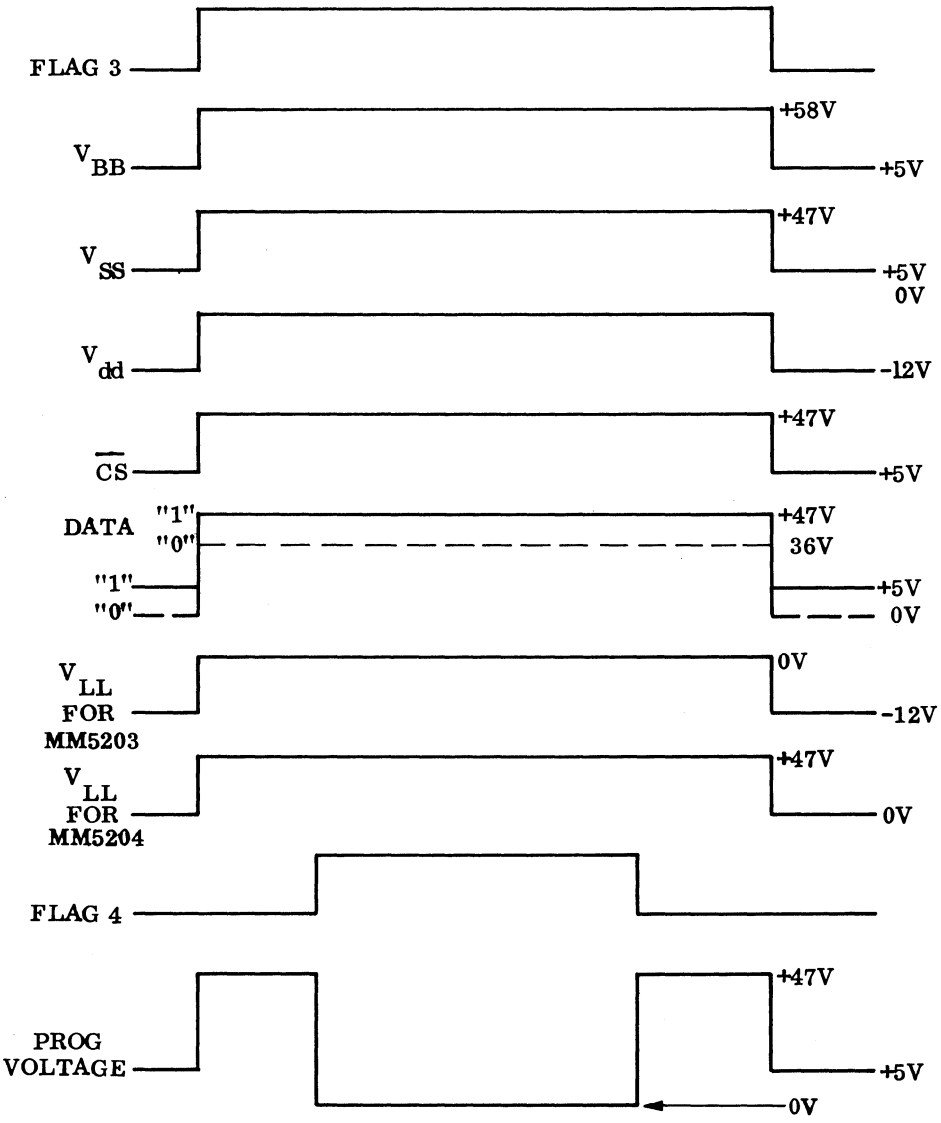
Refer to appendix C for the PROM Programmer edge connector pin list and IMP-16P system back panel wire list.



COMMAND WORD = x'B467 WHICH IS WRITE TO ADDRESS x'067

DATA WORD = x'70

Figure 4-2. Illustration of Writing to PROM



NOTE: LEVELS NOT DRAWN TO SCALE

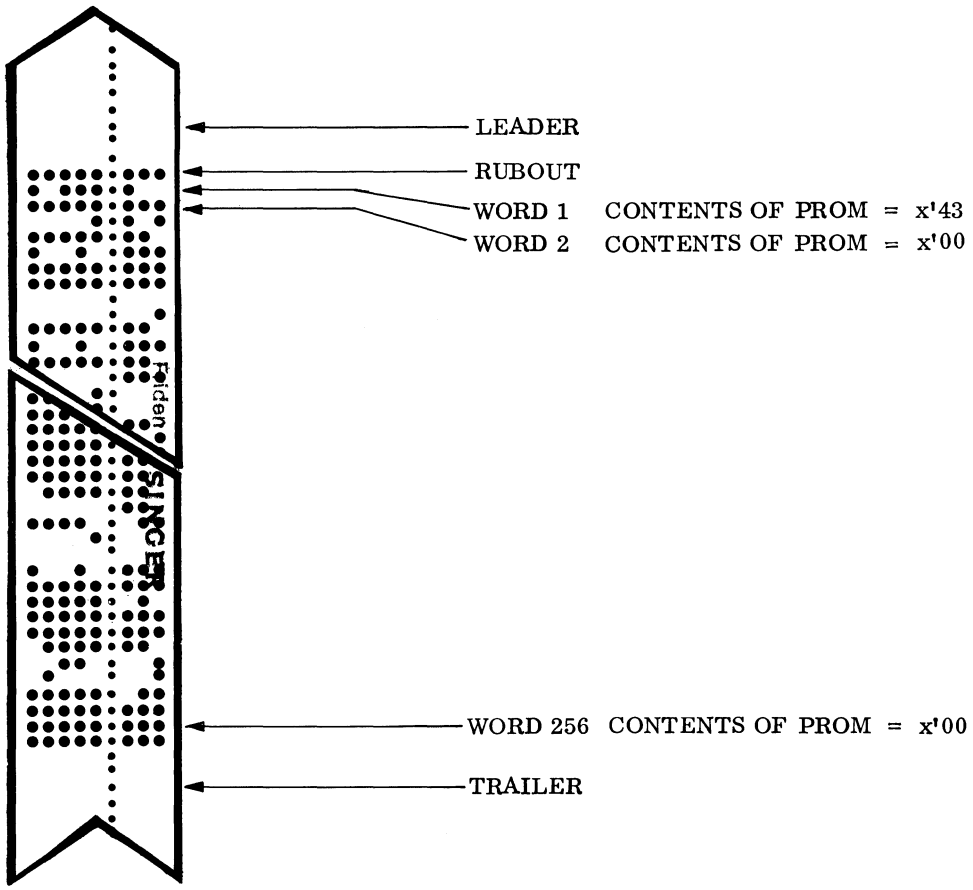
Figure 4-3. Typical Programming Voltages

Appendix A

PROM TAPE FORMATS

A.1 COMPLEMENTARY BINARY FORMAT

For each word in the PROM, there is one character on the paper tape. So for the MM5203 PROM there are 256 characters punched on the paper tape. The first character corresponds to location 000 in the PROM and the last character corresponds to decimal location 255. Since each word is specified by 8 bits of data, each character is used to fully define the data word. For this reason, there is no parity for each word. Also the character actually punched on the paper tape is the ones-complement of the data actually programmed into the PROM. The following paper tape is an example of a valid complementary binary PROM tape.



A.2 P/N FORMAT

For each word in the PROM, there are ten consecutive characters punched on the paper tape. The first character is a 'B' with the next eight being either a 'P' or an 'N'. Each 'P' stands for a logic '1' and each 'N' stands for a logic '0'. The most significant bit is the first character and the last character corresponds to the least significant bit of the data word. The eight data characters must then be followed by an 'F'. All other characters prior to the next 'B' are ignored.

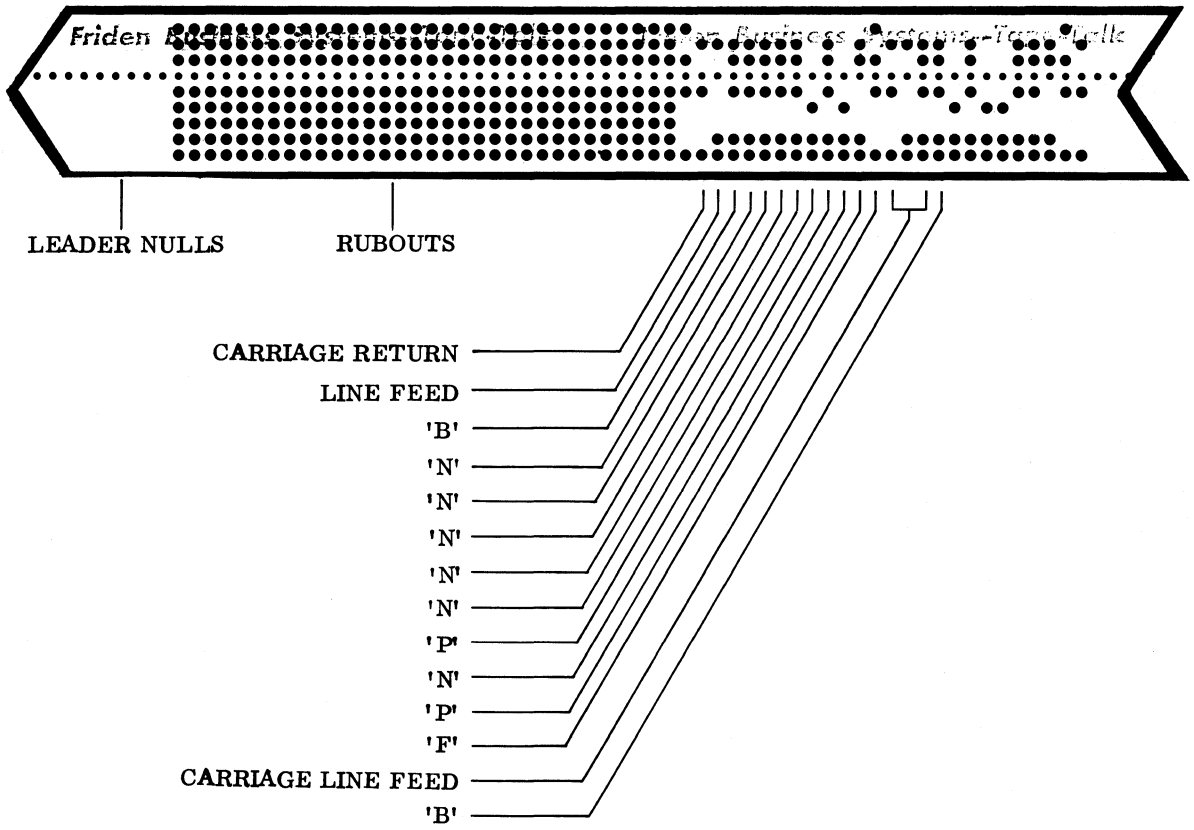
Each paper tape contains a leader section. This consists of an adequate number of nulls followed by 32 RUBOUT characters. The trailer is similar in that it consists of 32 RUBOUT characters followed by an adequate number of null characters.

The following is an example of the printout of a single word in P/N format:

BNPNPNPNPF

The PROM contents for this word is X'55.

The following is an example of the leader section of the paper tape along with its first data word:



Contents of PROM = X'05 at address X'00

Appendix B

COMMAND SUMMARY

Command	Symbol & Format	Description
Set Mode	S	Set mode for PROM type.
Check Mode	←	Check mode for PROM type.
Read PROM	H	Read from PROM to Buffer Area.
Read Binary	I (rubout first)	Read from complemented binary paper tape to Buffer Area.
Read P/N	N	Read from P/N paper tape to Buffer Area.
Read LM Tape	L	Read from LM paper tape to Buffer Area.
Read LM Cards	J	Read from LM cards to Buffer Area.
Go to Hex	G <hex address>	Go to hexadecimal address.
Move Data	M [<hex address>]	Move data starting at hexadecimal address.
Fill Buffer	W [<hex address>]	Fill Buffer Area with hexadecimal number.
List PROM	R [<hex address>]	Read and list PROM starting at hexadecimal address.
List Buffer	T [<hex address>]	List memory starting at hexadecimal address.
PROM Checksum	Q	Print PROM checksum.
Buffer Checksum	X	Print Buffer Area checksum.
Program PROM	Y [<hex address>]	Program PROM starting at hexadecimal address.
Check & Program	P	Check if PROM erased; then program.
Abort	(ALT MODE)	Terminate keyboard request.
Verify	V	Verify PROM to Buffer Area.

NOTE: Command terminator is carriage return (CR)

Appendix C

PIN OUT LISTS

C.1 PROM PROGRAMMER PIN OUT LIST

PINS	SIGNAL	FUNCTION
1-4	GND	All systems
5-8	+5v	All systems power
16	FLAG 7*	User with IMP-16L UFLAG B*
27	ENBL*	Used with IMP-8P for selective enable
28	WRSTR	Used with IMP-8P for selective enable
30	Ad0	Used with IMP-8P for selective enable I/O disable/enable
31-32	-12v	All systems
33	SYSENBLO	Buffered output of selective enable I/O enable/disable
41	FLAG 6	All systems user flag input enable voltages IMP-16P user flag F14 IMP-16L ground this pin IMP-8P user flag User 3
43	FLAG 7	All systems user flag input program pulse IMP-16 user flag F15 IMP-8P user flag User 4
49	FLAG 6*	Used with 16L UFLAGA*
53	SYSENBLO*	Selective enable output open collector I/O disable/enable
54	BOC*	Used with IMP-16L UJCNDA + user jump-on condition data branch if data 0, temperature branch if overtemp
57	FLAG 3	All systems user flag input data input for data transmission IMP-16P user flag F11 IMP-16L user flag FLAG 11 IMP-8P user flag User 1
59	INIT*	All systems
63	SYSENB	Selective enable input I/O enable/disable all flag inputs, run/stop inverter power supply

PINS	SIGNAL	FUNCTION
64	FLAG 0	All system user flag input used as a clock for data transmission
		IMP-16P user flag F8
		IMP-16L user flag FLAG 8
		IMP-8P user flag User 2
71-72	GND	All systems
99-100	-12v	All systems
111-112	-12v	All systems
120	BOC	Used with IMP-16P, IMP-8P user branch-on condition data branch if data 0, temperature branch if overtemp
		IMP-16 user jump-on cond JC 15
		IMP-8P user jump-on cond USER JC
137-140	+5v	All systems
141-144	GND	All systems

C.2 IMP-16 PIN OUT FOR PROM PROGRAMMER

C.2.1 IMP-16L Pin-Out for PROM Programmer

PIN	SIGNAL ON PROM PROGRAMMER	SIGNAL ON IMP-16L
1	GND	
2	GND	
3	GND	
4	GND	
5	+5V	
6	+5V	
7	+5V	
8	+5V	
16	FLAG 7*	UFLAGB*
31	-12V	
32	-12V	
41	FLAG 6	GND
43	FLAG 7	GND
49	FLAG 6*	UFLAGA*
54	BOC*	UJCONDB*
57	FLAG 3	FLAG 11
59	INIT*	INIT*
64	FLAG 0	FLAG 8
71	GND	

PIN	SIGNAL ON PROM PROGRAMMER	SIGNAL ON IMP-16L
72	GND	
99	-12V	
100	-12V	
111	-12V	
112	-12V	
137	+5V	
138	+5V	
139	+5V	
140	+5V	
141	GND	
142	GND	
143	GND	
144	GND	

C.2.2 IMP-16P Pin-Out for PROM Programmer

PIN	SIGNAL ON PROM PROGRAMMER	SIGNAL ON IMP-16P
1	GND	
2	GND	
3	GND	
4	GND	
5	+5V	
6	+5V	
7	+5V	
8	+5V	
31	-12V	
32	-12V	
41	FLAG 6	F14
43	FLAG 7	F15
57	FLAG 3	F11
59	INIT*	INIT*
64	FLAG 0	F8
71	GND	
72	GND	
99	-12V	
100	-12V	
111	-12V	

PIN	SIGNAL ON PROM PROGRAMMER	SIGNAL ON IMP-16P
112	-12V	
120	BOC	JC15
137	+5V	
138	+5V	
139	+5V	
140	+5V	
141	GND	
142	GND	
143	GND	
144	GND	

C.3 IMP-16 BACK PANEL WIRE-LIST OPTIONS REQUIRED

C.3.1 IMP-16L Wire List

SIGNAL	FROM	STA	TO	STA	COMMENTS
FLAG 7*	CPU-60	[1]	PRP-16	[2]	= UFLAGB*
FLAG 6	PRP-41		PRP-43		= GND (PP)
FLAG 7	PRP-43		PRP-71		= GND (PP)
FLAG 6*	CPU-59		PRP-49		= UFLAGA*
BOC*	CPU-54		PRP-54		= UJCNDB*
FLAG 3	CPU-57		PRP-57		= FLAG 11
INIT*	CPU-136		PRP-59		
FLAG 0	CPU-56		PRP-64		= FLAG 8
-12 VA	PRP-99		PRP-100		= -12V (PP)
-12 VA	PRP-100		PRP-111		= -12V (PP)

[1] "CPU" stands for the card position for the IMP-16L CPU

[2] "PRP" stands for the card position chosen for the PROM Programmer.

C.3.2 IMP-16P Wire List

SIGNAL	FROM	STA	TO	STA	COMMENTS
FLAG 6	CPU-134	[1]	PRP-41	[2]	= F14
FLAG 7	CPU-132		PRP-43		= F15
FLAG 3	CPU-133		PRP-57		= F11
FLAG 0	CPU-130		PRP-64		= F8
INIT*	CPU-16		PRP-59		
BOC	CPU-107		PRP-120		= JC15

[1] "CPU" stands for the card position for the IMP-16C card

[2] "PRP" stands for the card position for the PROM programmer card

NOTE: The ground wire on JC15 at the IMP-16C card before connecting the BOC.

Appendix D

REFERENCE SYSTEM PUBLICATIONS

Publication	Order Number	Description
IMP-16L Users Manual	IMP-16L/928X	Operation of the IMP-16L Microcomputer
IMP-16P Users Manual	IMP-16P/937	Operation of the IMP-16P Microcomputer
IMP-16 Programming and Assembler Manual	IMP-16S/102YB	Assemble Language Programming of IMP-16 Microcomputers

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