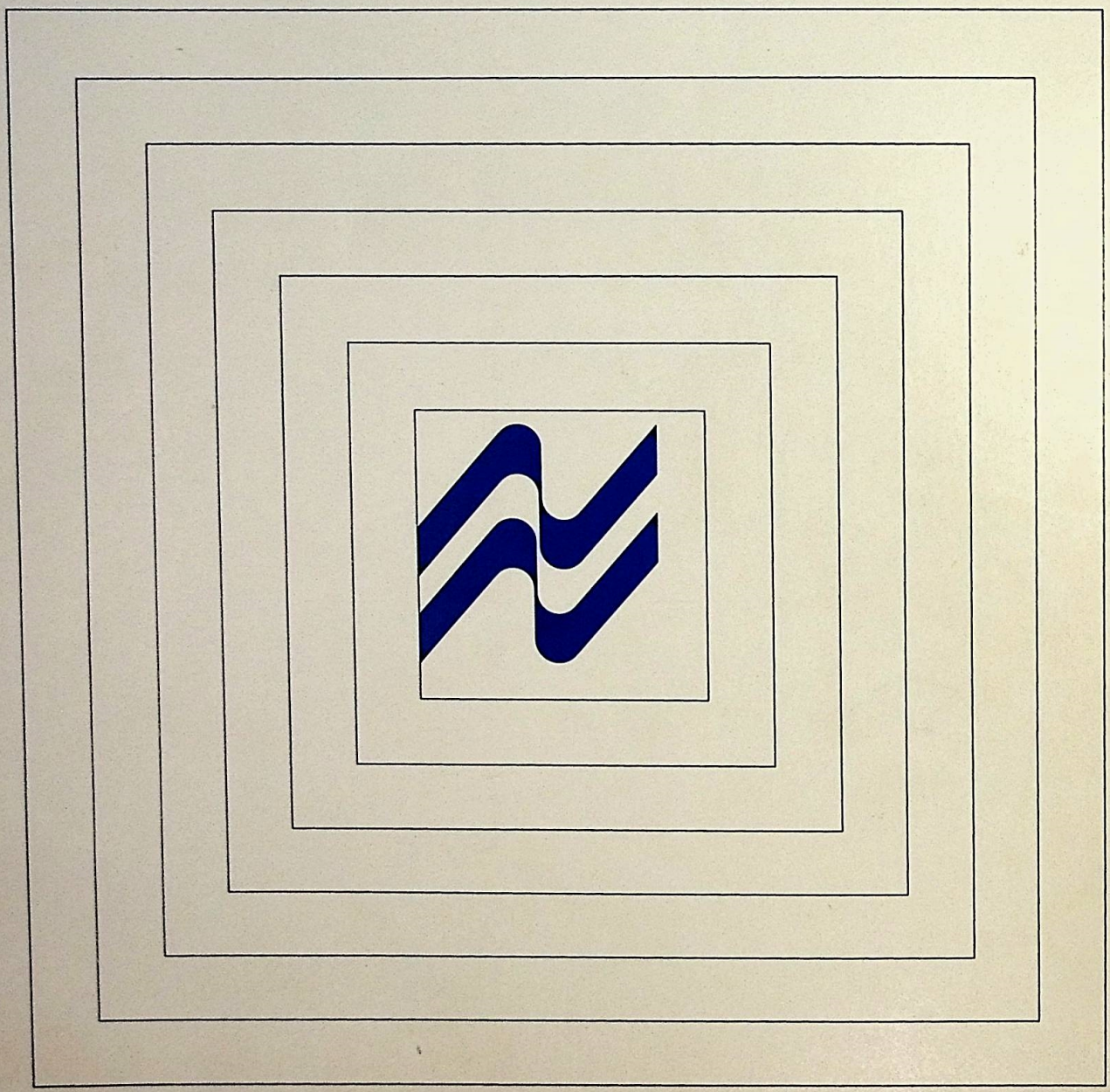
Users Manual

SC/MP Keyboard Kit

National Semiconductor



Publication Number 420305228-001B

SC/MP Keyboard Kit
Users Manual

December 1976

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Santa Clara, California 95051

PREFACE

This manual provides instructions for construction of the SC/MP Keyboard Kit using the SC/MP Kit or the SC/MP INTROKIT, a keyboard and display unit, and additional integrated circuits. Included are an operational description and an overview of SCMPKB (SC/MP Keyboard Kit Program). An understanding of computer machine language programming is required; refer to the SC/MP Programming and Assembler Manual. Construction procedures assume familiarity with basic electronic assembly techniques and tools.

This manual is to be used with either the SC/MP Kit Users Manual, Publication Number 4200113, or the SC/MP INTROKIT Users Manual, Publication Number 420305276-001, as appropriate.

Listed below are other sources of interfacing and programming information supplied with the SC/MP Kit or the SC/MP INTROKIT.

- SC/MP Technical Description, Publication Number 4200079 or SC/MP Technical Description (European), Publication Number 420305283-001
- SC/MP Programming and Assembler Manual, Order Number ISP-85/994Y
- SC/MP Data Sheet ISP-8A/500D

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Chapter 1

INTERRELATION OF THE SC/MP KIT OR SC/MP INTROKIT AND SC/MP KEYBOARD KIT

A hand-held Keyboard and Display Unit may be interfaced to a National Semiconductor Corporation SC/MP Kit or the European SC/MP INTROKIT. This marriage has produced the SC/MP Keyboard Kit; refer to figure 1-1 for a simplified functional diagram of the address/data flow between the SC/MP Kit or the SC/MP INTROKIT and the SC/MP Keyboard Kit, and to figures 2-1, 2-2, and 2-6 for schematic diagrams of the SC/MP Keyboard Kit, SC/MP Kit, and SC/MP INTROKIT, respectively. Chapter 3 contains a detailed description of the functions and operation of the SC/MP Keyboard.

The SC/MP Keyboard and Display Unit replaces the Teletype® (TTY) that is presently required as an input/output device for the SC/MP Kit or the SC/MP INTROKIT. Interconnection between the SC/MP Kit or the SC/MP INTROKIT and the SC/MP Keyboard Kit is via a 21-pin "umbilical cord" cable assembly. The SC/MP Keyboard Kit provides initialization, input/output operating capability, and address/data display.

Minor modifications to the SC/MP Kit and the SC/MP INTROKIT are required and are discussed in chapters 2 and 3. In addition, a read-only memory (ROM) MM5214 device is supplied as a replacement for the SC/MP Kit ROM or the SC/MP INTROKIT ROM; the replacement ROM allows the user to operate the SC/MP Keyboard and Display Unit. This ROM contains SCMPKB (SC/MP Keyboard Kit Program); SCMPKB is discussed in chapter 3. Briefly, SCMPKB allows the user to read *or* modify memory and to execute any routine in memory. The user-accessible SC/MP Keyboard Kit Input/Output Routine can be called as a subroutine by the user's program; this routine is described in chapter 3.

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NOTE

The reader should be familiar with the contents of the users manual for the SC/MP Kit (pub. No. 420113) or the SC/MP INTROKIT (pub. no. 420305283-001) as a prerequisite for using this manual. Also, review the preface and the table of contents of this manual before proceeding to the ensuing chapters.

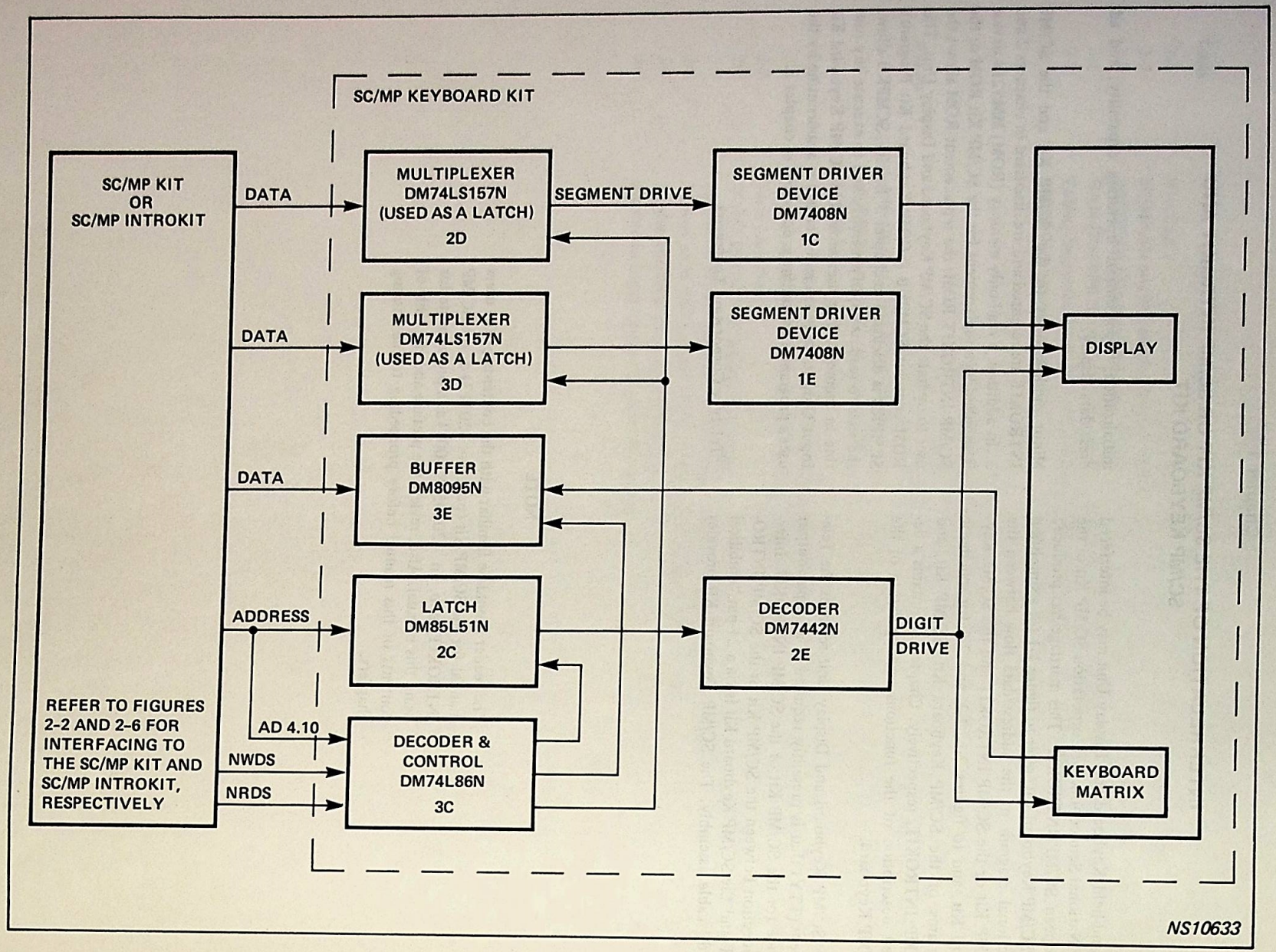

Figure 1-1. Address Data Flow Block Diagram

Chapter 2

REQUIRED ALTERATIONS TO THE SC/MP KIT AND SC/MP INTROKIT

2.1 INTRODUCTION

The SC/MP Keyboard Kit includes the integrated circuits and the discrete components that interface to the SC/MP Kit and the SC/MP INTROKIT. The SC/MP Keyboard Kit includes the following items:

- A Keyboard and Display Unit that connects to the SC/MP Kit or the SC/MP INTROKIT.
- An 8-bit TRI-STATE® Buffer between the memory outputs of the memory devices and the SC/MP chip inputs.
- Interface circuits to provide proper level conversions and drive requirements for a multiplexed input/output interface to the SC/MP Keyboard and Display Unit.
- 512 bytes of read-only memory (ROM) that contains SCMPKB (SC/MP Keyboard Kit Program).
- A Cambion wire-wrap tool and 125 5-inch pieces of special precut wire.
- All required discrete components.

When the user receives the SC/MP Keyboard Kit, he must first verify that all components specified in the Parts List (in appendix A) are included. An understanding of the information provided in the SC/MP Kit or INTROKIT Users Manual is a prerequisite to the material in this manual.

CAUTION

Any MOS device (SC/MP, RAM, or ROM) can be damaged by contact with an electrostatic or high-voltage charge. To guard against this, the following handling precautions are recommended.

- MOS devices should be stored or transported in conductive material so that all exposed leads are shorted together. Styrofoam or plastic trays must not be used.
- A grounded bench surface should be used, and soldering equipment or any other apparatus used in assembling the kit should be grounded.
- Nylon clothing should not be worn while handling MOS devices, and a user should ground himself before handling the devices.

The SC/MP Keyboard Kit is a valuable aid for developing and entering small programs into memory via the SC/MP Keyboard and Display Unit. The programs then can be executed and their operation is monitored by SCMPKB. SCMPKB and a functional description of the circuits and operation of the SC/MP Keyboard are discussed in chapter 3. For detailed descriptions of SC/MP, its various system configurations, and the SC/MP computer programming language and instruction set, refer to the SC/MP Technical Description and the SC/MP Programming and Assembler Manual.

Figure 2-1 schematically illustrates how the SC/MP Keyboard Kit is used to interface with the SC/MP Kit and the SC/MP INTROKIT; interconnections are indicated in the figure. The interface logic uses standard components and is capable of full hexadecimal (0-F) display.

2.2 MODIFICATIONS OF THE SC/MP KIT

In general, the following SC/MP Kit modifications are performed:

(1) The J3/J4 trace cut
(2) The initial soldering
(3) Placement of additional components
(4) Specific wiring requirements
(5) Memory addressing
(6) Backplane pinouts

NOTE

SC/MP INTROKIT modifications are discussed in 2.3.

2.2.1 J3/J4 Trace Cut

Since the SC/MP Keyboard Kit requires external control of the data buffer (DM81LS95), refer to figures 2-1 and 2-2, the address space of the two RAMs (MM2101) and the ROM (MM5214) must be reduced to allow addressing of

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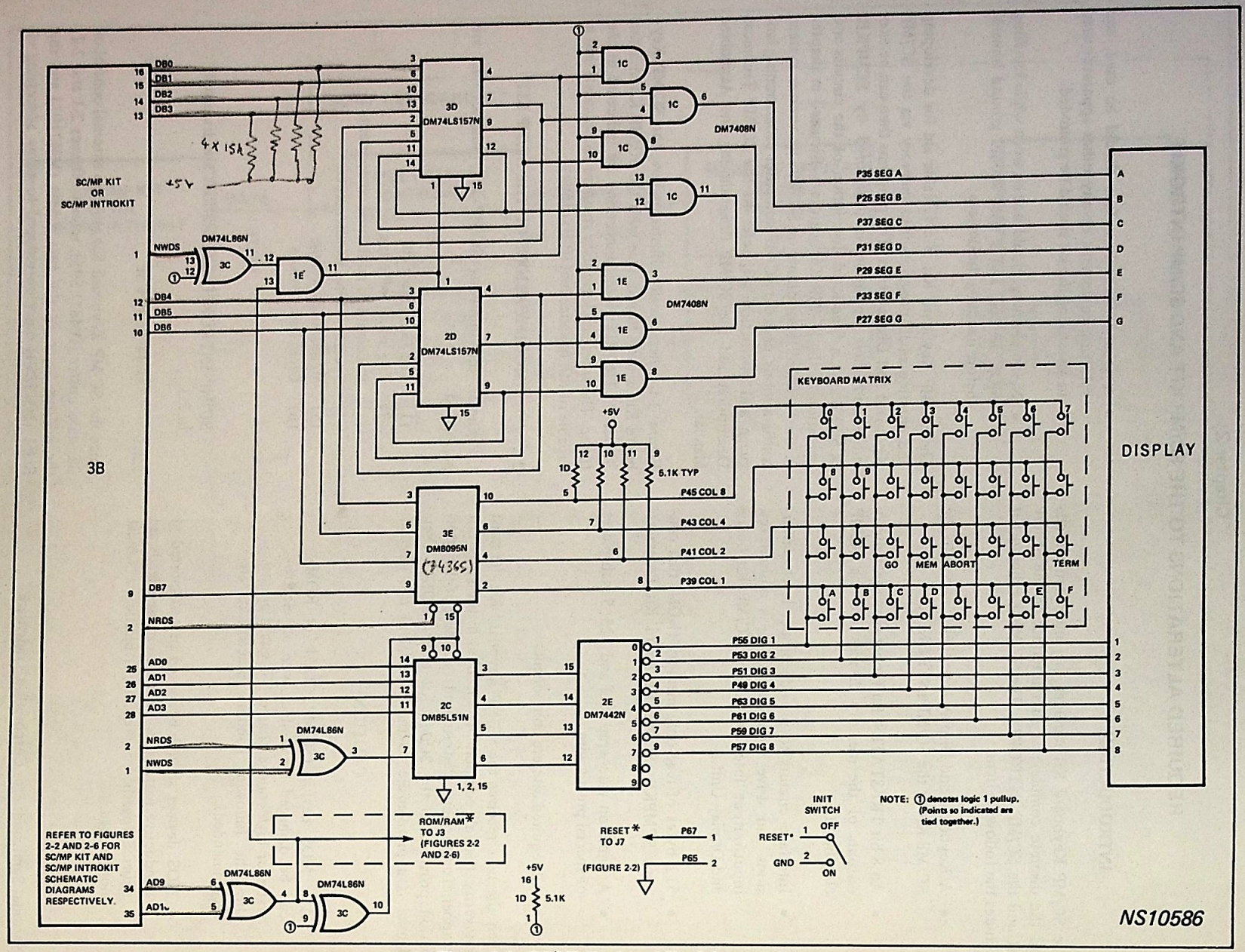


Figure 2-1. SC/MP Keyboard Kit Schematic Diagram

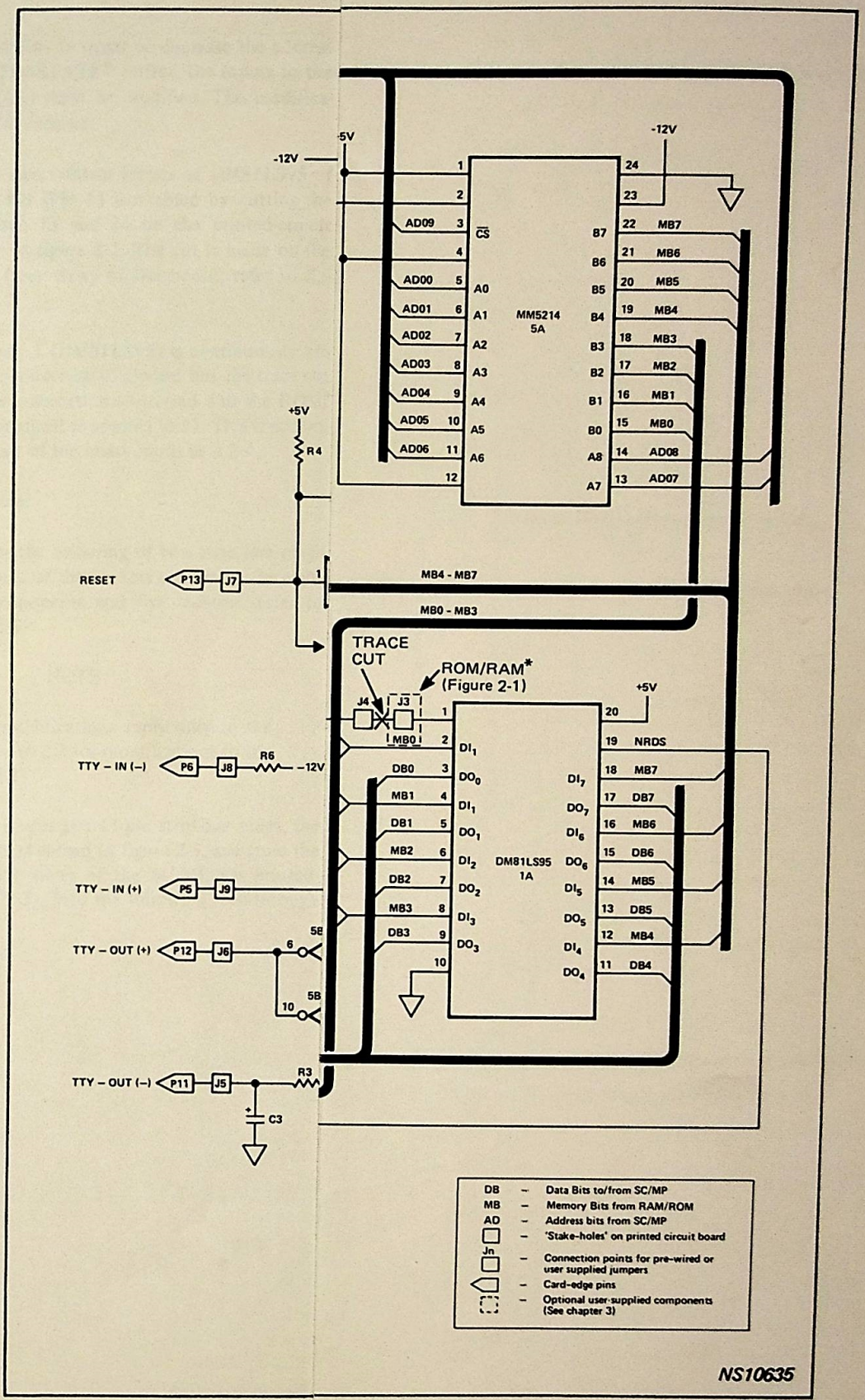


Figure 2-2. SC/MP Kit Schematic Diagram

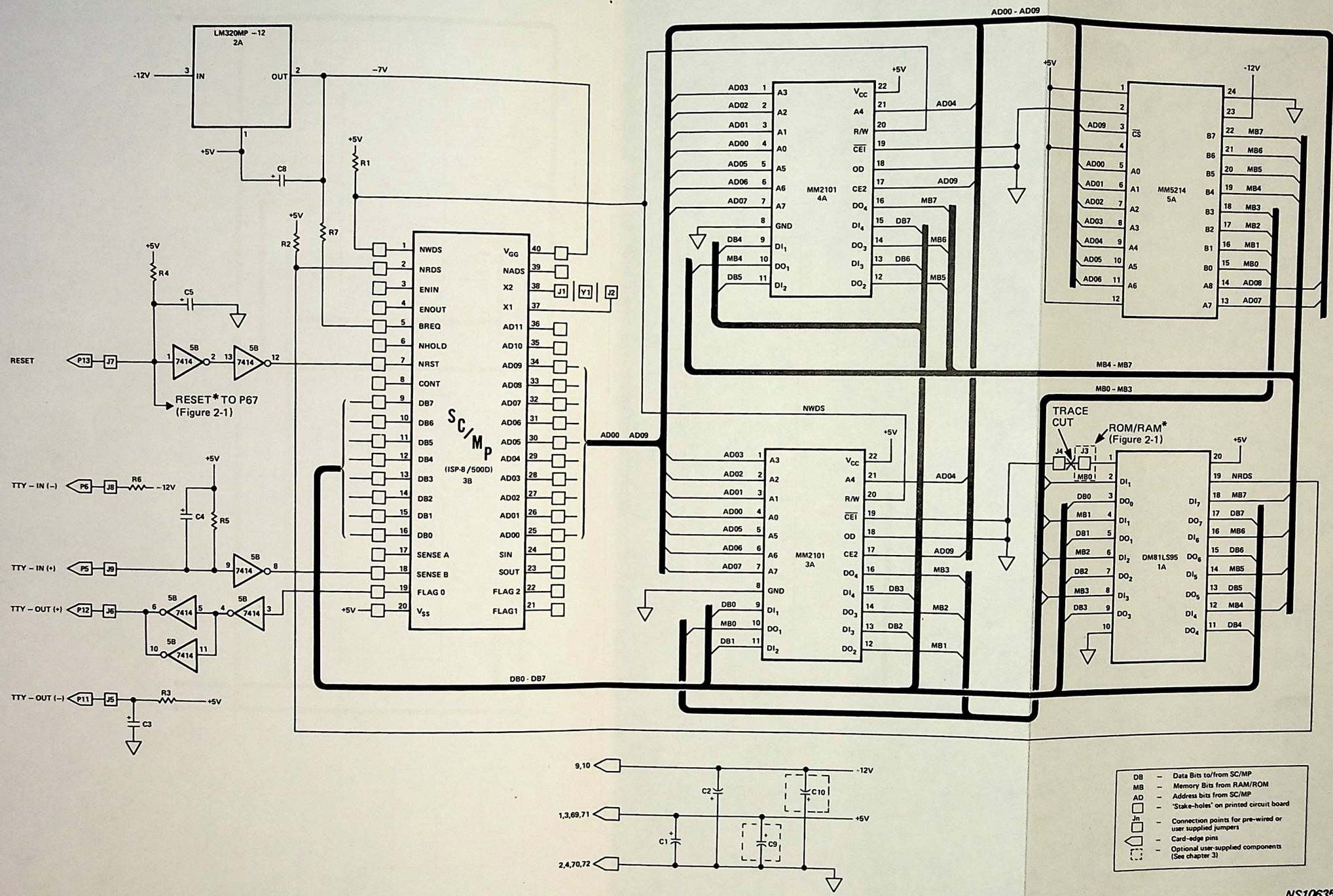
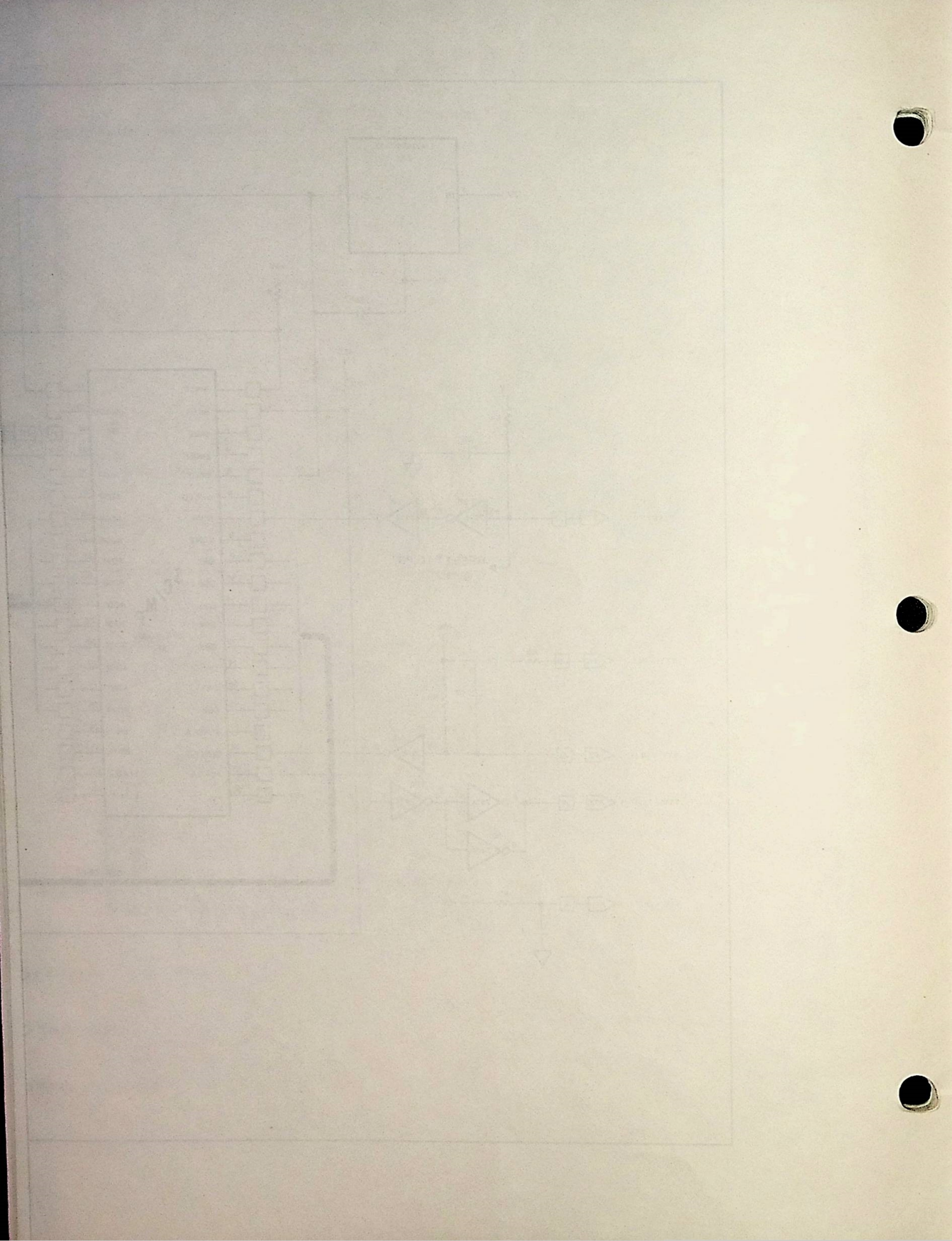


Figure 2-2. SC/MP Kit Schematic Diagram



the SC/MP Keyboard Kit. In order to decrease the address space on the 8-bit TRI-STATE® buffer, the inputs to the DM81LS95 device (1A) must be modified. This modification is accomplished as follows:

1. One of the two control inputs of DM81LS95 of the SC/MP Kit (Pin 1) is enabled by cutting the trace between J3 and J4 on the printed-circuit board, refer to figure 2-2. The cut is made on the solder side (rear view) of the board, refer to figure 2-4.

2. Normally, pin 1 (DM81LS95) is continuously enabled by a connection-to-ground but the trace cut removes the connection-to-ground and the ROM/RAM* input signal is applied to J3. This is accomplished as part of the instructions in 2.2.4.

2.2.2 Initial Solder

Initial Solder includes the soldering of two strip line plugs and all four corner pins of the sockets containing the eight integrated circuit components and five resistors; refer to figures 2-3, 2-4, and 2-5.

NOTE

The following modifications apply only to the SC/MP Kit; refer to 2.3 for modifications to the SC/MP INTROKIT.

Before soldering the 10-pin and 11-pin strip-line plugs, the user must insert them as shown in figure 2-5, and from the component side (front view) of the SC/MP Kit printed-circuit board (figure 2-3), into the following feed-through holes.

- The 10-pin strip-line plug is inserted and soldered into the feed-through holes on Pins 49, 51, 53, 55, 57, 59, 61, 63, 65, and 67.

- The 11-pin strip-line plug is inserted and soldered into the feed-through holes on Pins 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, and 45.

CAUTION

Do not solder from the component side; once the pins are inserted into the proper holes, turn the printed circuit board over and fill the pad with molten solder. *Do not* trim the excess lead length after soldering because the leads allow wire wrapping to the edge pins and also provide a means for attaching the cable to the SC/MP Keyboard Kit (Keyboard and Display Unit).

Sockets are used instead of soldering the eight integrated circuit components and five resistors directly to the printed-circuit board. The sockets are the "wire-wrap" type and must be soldered to the boards in the same positions as the components would have occupied. The most important function of a socket is to allow the use of wire wrapping (instead of soldering) the additional wires required in the wiring list; refer to table 2-1. Using the sockets for mounting the components and resistors also permits the easy insertion, removal, and replacement of the components and resistors without the resoldering of connections.

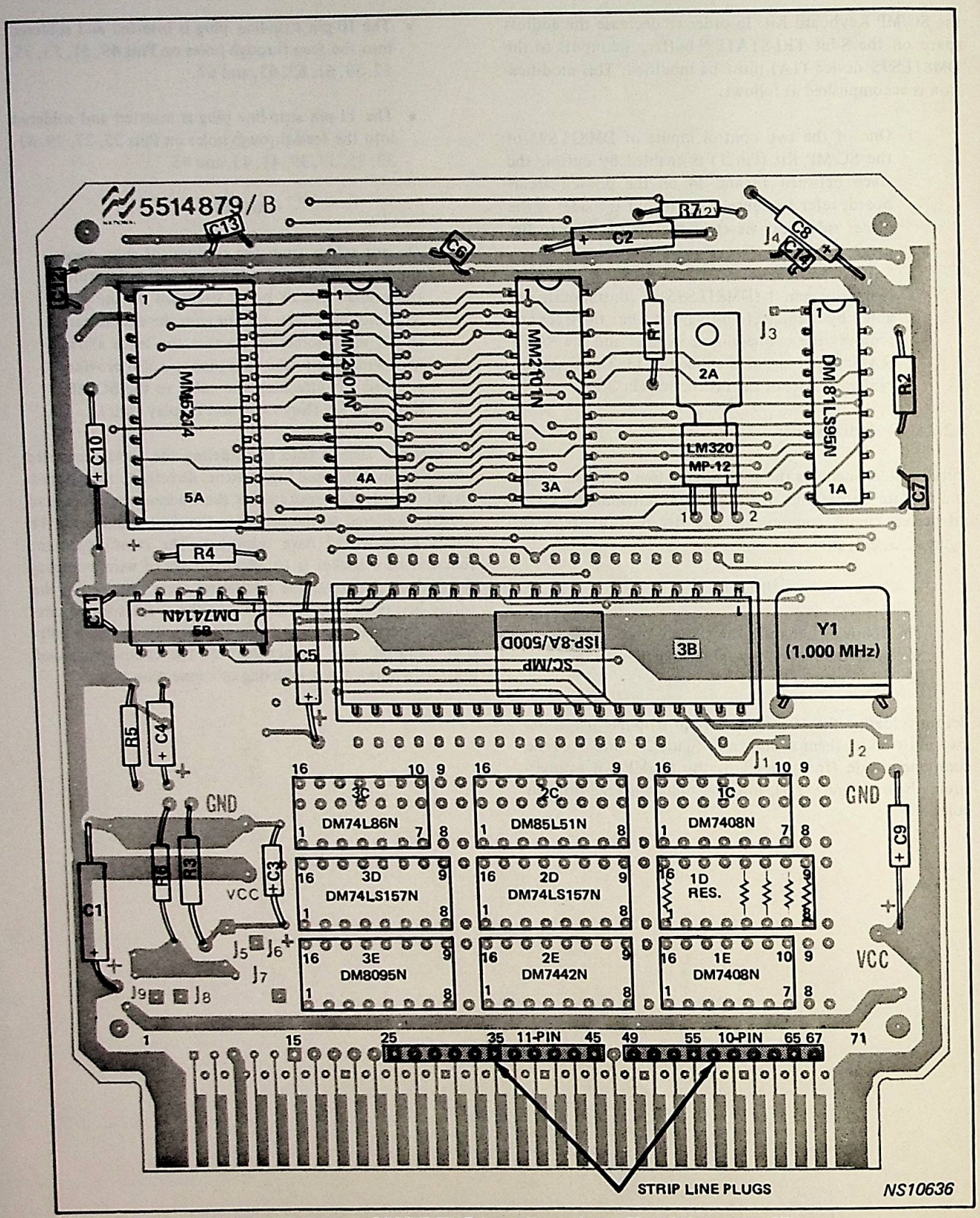


Figure 2-3. Layout of SC/MP Kit Printed Circuit Board (Front) Component View

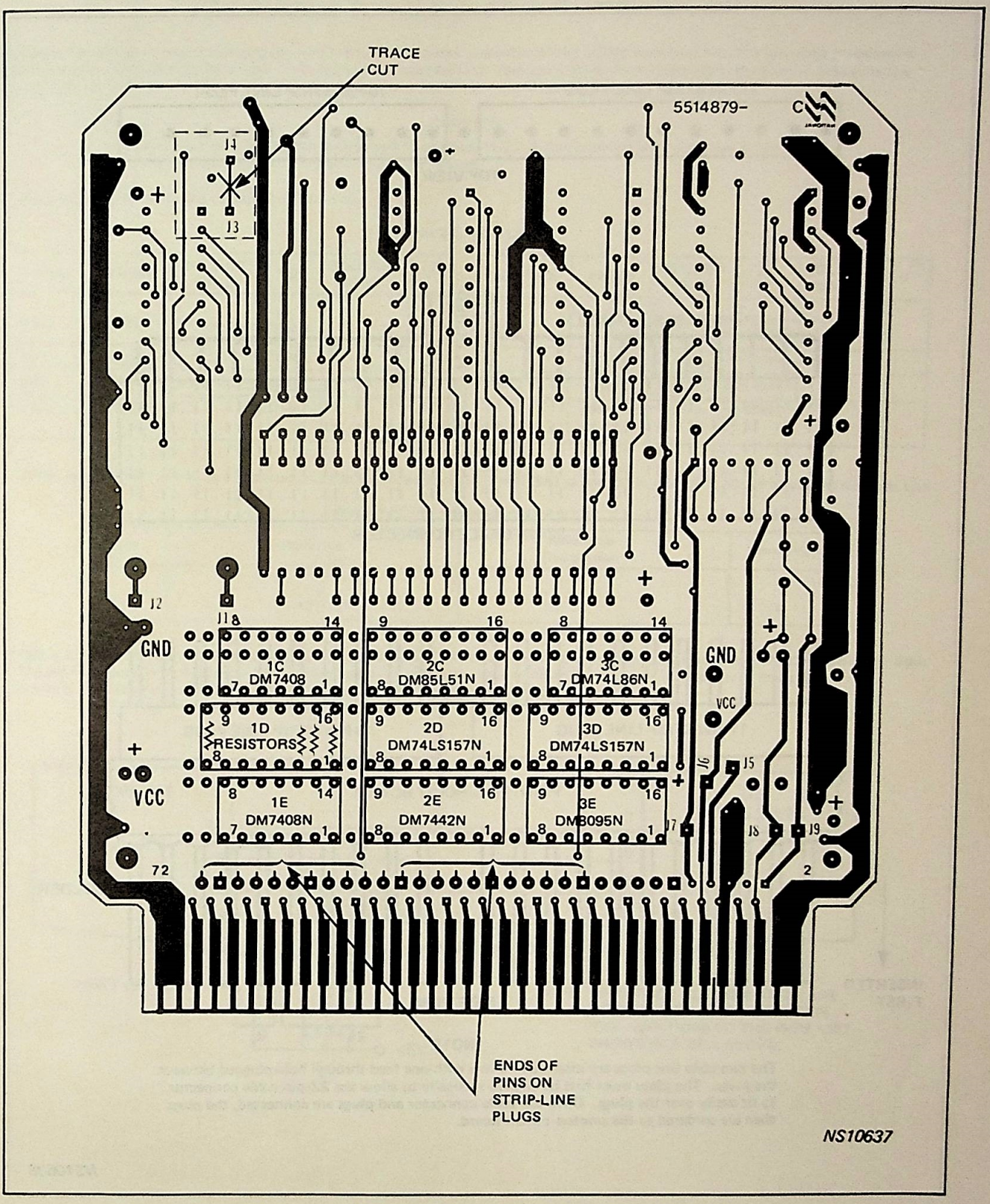
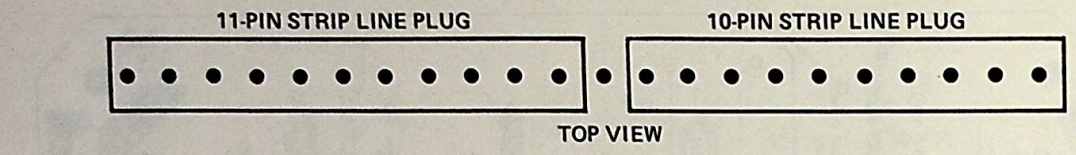
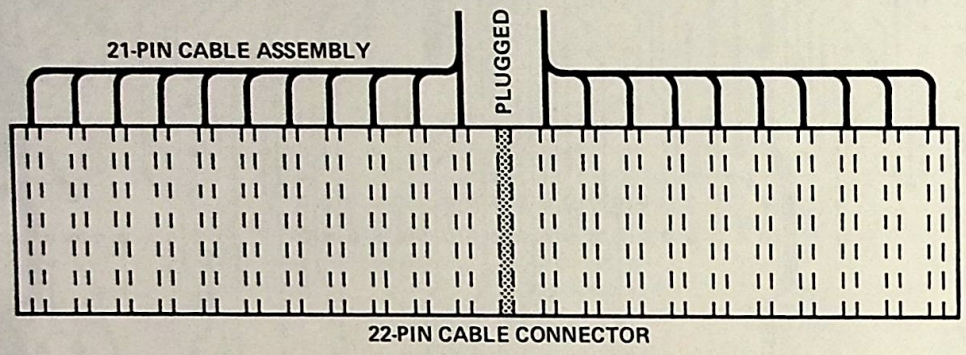
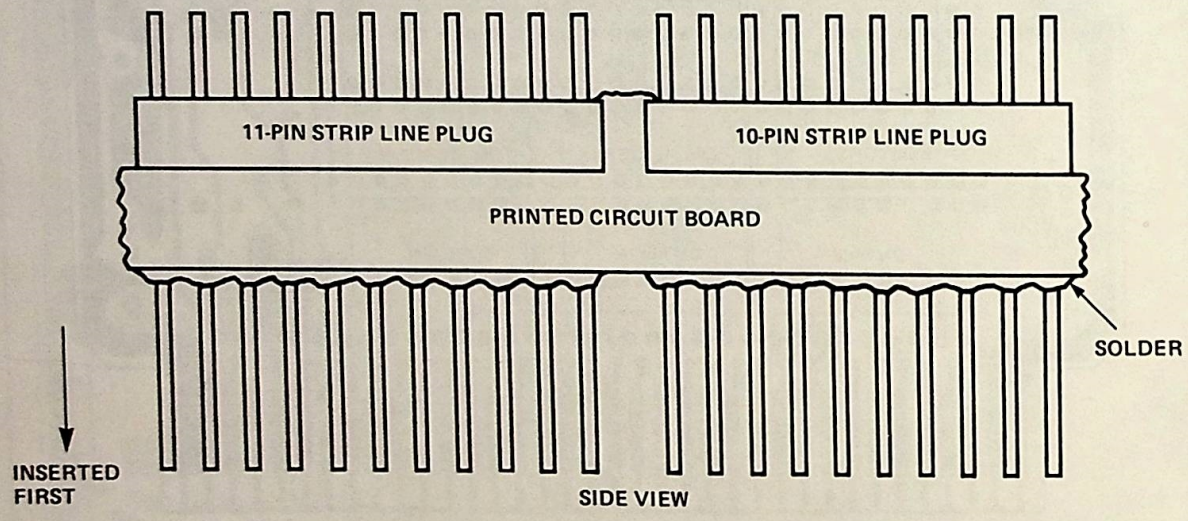


Figure 2-4. Layout of SC/MP Kit Printed Circuit Board (Rear) Solder View







NOTE

The two strip line plugs are inserted in a row with one feed-through hole plugged between the plugs. The plugs must first be aligned vertically to allow the 22-pin cable connector to fit easily over the plugs. Once the cable connector and plugs are connected, the plugs then are soldered to the printed-circuit board.

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Figure 2-5. Strip Line Plugs

ERRATA DATA
for
SC/MP Keyboard Kit Users Manual (Pub. No. 420305228-001B)

The changes described in these errata data are required to ensure proper operation of the SC/MP Keyboard Kit. The following procedure is keyed to pages in the SC/MP Keyboard Kit Users Manual and complements instruction given therein; therefore, the steps in this procedure should be understood before proceeding with instructions in the SC/MP Keyboard Kit Manual.

CAUTION

DO NOT CUT pins 8 and 9 for component 1C as stated in 2.2.3, Component Placement, page 2-10. Use of these pins are required in the procedure that follows.

1. *Page 2-9.* Add the following to table 2-1 (wire list).

Table 2-1. Wire List

SIGNAL	FROM	SOLDER WIRE	TO	SOLDER WIRE	√
DB0	3D3		1C (SP1)		
DB1	3D6		1D4		
DB2	3D10		1D3		
DB3	3D13		1D2		

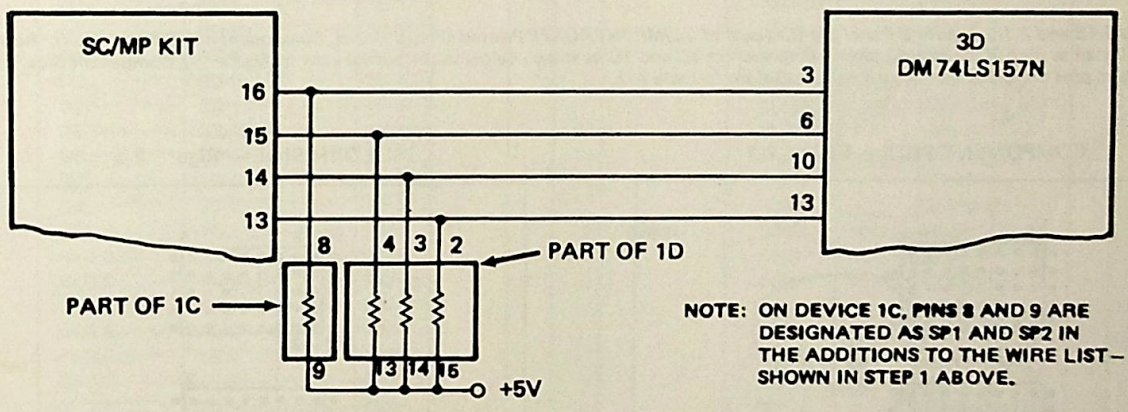
SIGNAL	FROM	SOLDER WIRE	TO	SOLDER WIRE	√
+5V	1C (SP2)		1D15		
	1D15		1D14		
	1D14		1D13		
	1D13		3D16		

2. Change quantity for item 16 to 133 pieces, and add four resistors (15K, 1/4W, 5%) as item 20 in table A-1, SC/MP Keyboard Kit Parts List.

Table A-1 SC/MP Keyboard Kit Parts List

Item	Description	Reference Designation	Quantity
20	Resistor, 15K, 1/4 W, 5%	1C, 1D	4

3. *Page 2-2, Figure 2-1 (SC/MP Keyboard Kit Schematic Diagram).* Add four resistors, as indicated, to signal lines DB0, DB1, DB2, and DB3. The physical location of these resistors are shown below in the partial view of figure 2-3 discussed in step 4 or in figure 2-7 in in step 5. The resistors to be used are listed as item 20 in the revised table A 1 (step 2 above).

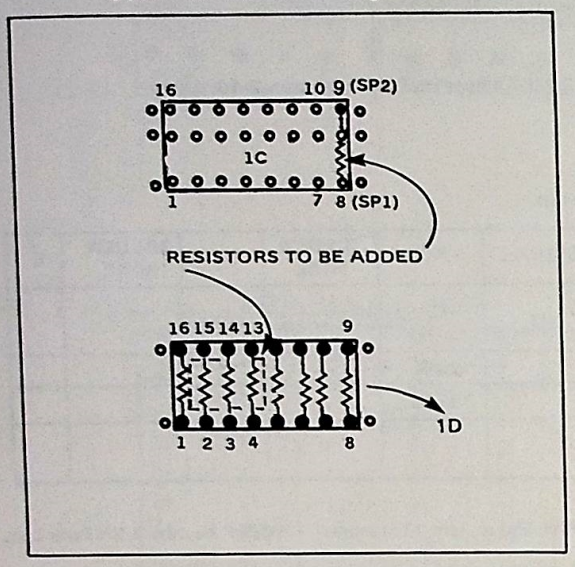


NOTE

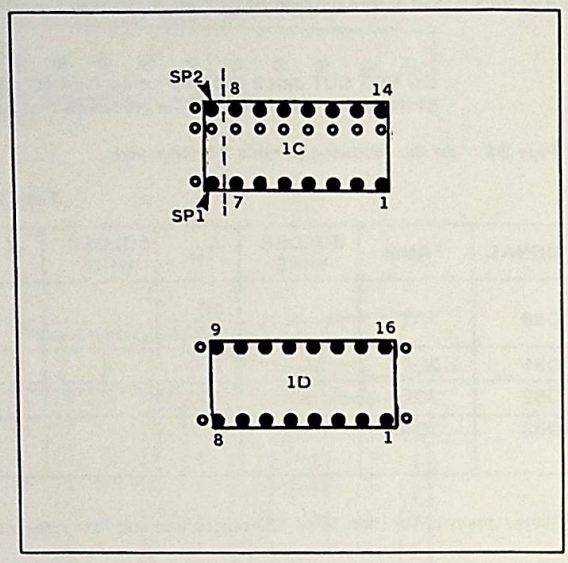
Follow instructions given in step 3 for the standard SC/MP Kit alterations. For SC/MP INTROKIT alterations, ignore instructions given in step 4 and follow instructions given in step 5.

4. *Pages 2-6 and 2-7, Figures 2-3 and 2-4 (Layouts of "Standard" SC/MP Printed Circuit Board, Component and Solder Views).* Add resistors listed as item 20 of revised table A-1 to sockets 1C and 1D as shown below in the partial view of figure 2-3, Component Side. Add wires to pins on solder side according to additions to table A-1 and following note.

COMPONENT SIDE — Figure 2-3



SOLDER SIDE — Figure 2-4



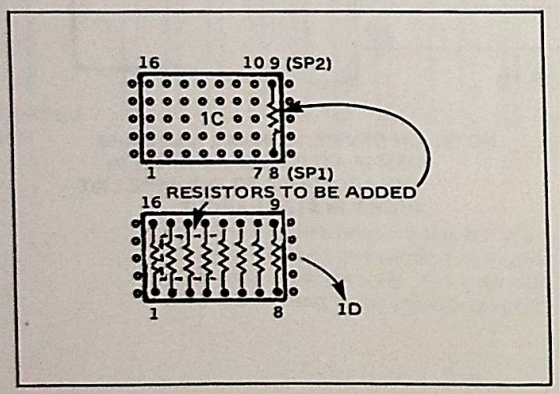
NOTES

a. Device 1C is a 16-pin socket, as shown in the view of the component side of the SC/MP printed circuit board. However, because instructions to cut off pins 8 and 9 of the socket were given in the SC/MP Keyboard Kit Users Manual, on the solder side of the printed circuit board only 14 pins would have been visible. For this reason, the pins were numbered from 1 through 14 — and the wire list (table 2-1) reflects this renumbering. The pins that were to be cut off, now, are going to be used and are designated as SP1 and SP2; the additions to the wire list (table 2-1) given in these errata data reflect the use of these designators (SP1 and SP2).

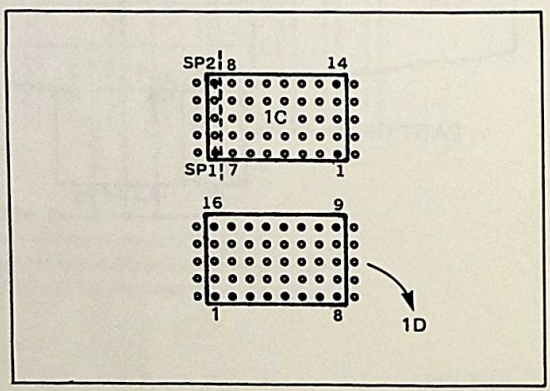
b. Device 1C is shown as a 16-pin device on the partial view of the solder side of the SC/MP printed circuit board. The broken line separating pins 7 and 8 from pins SP1 and SP2 is shown to indicate the demarcation of the lefthand side of 1C as shown in figure 2-4 of the SC/MP Keyboard Kit Users Manual.

5. *Pages 2-15 and 2-16, Figures 2-7 and 2-8 (Layouts of SC/MP INTROKIT Printed Circuit Board, Component and Solder Views).* Add resistors listed as item 20 of revised table A-1 to sockets 1C and 1D as shown below in the partial view of figure 2-7 Component Side. Add wires to pins on solder side according to additions to table A-1.

COMPONENT SIDE — Figure 2-7



SOLDER SIDE — Figure 2-8



NOTES

See notes "a" and "b" under step 4 above.

Table 2-1. Wire List

SIGNAL	FROM	Solder Wire	TO	Solder Wire	✓
NWDS	3B-1	S	3C-13		
NWDS	3C-13		3C-2		
NRDS	3B-2	S	3C-1		
NRDS	3C-1		3E-1		
AD09	3B-34	S	3C-6		
AD10	3B-35	S	3C-5		
DB0	3B-16	S	3D-3		
DB1	3B-15	S	3D-6		
DB2	3B-14	S	3D-10		
DB3	3B-13	S	3D-13		
DB4	3B-12	S	2D-3		
DB4	2D-3		3E-3		
DB5	3B-11	S	2D-6		
DB5	2D-6		3E-5		
DB6	3B-10	S	2D-10		
DB6	2D-10		3E-7		
DB7	3B-09	S	3E-9		
AD00	3B-25	S	2C-14		
AD01	3B-26	S	2C-13		
AD02	3B-27	S	2C-12		
AD03	3B-28	S	2C-11		
ROM/RAM*	1E-13		3C-4		
ROM/RAM*	3C-4		3C-8		
ROM/RAM*	3C-8		J3	S	
WDS	3C-11		1E-12		
WDSTB	2D-1		3D-1		
WDSTB	2D-1		1E11		
ROM/RAM	2C-9		2C-10		
ROM/RAM	2C-10		3C-10		
ROM/RAM	2C-9		3E-15		
R ± W	3C-3		2C-7		
D0	3D-4		3D-2		
D0	3D-2		1C-1		
D1	3D-7		3D-5		
D1	3D-5		1C-4		
D2	3D-9		3D-11		
D2	3D-11		1C-10		
D3	3D-12		3D-14		
D3	3D-14		1C-12		
D4	2D-4		2D-2		
D4	2D-2		1E-1		
SEG A	1C-3		P35		
SEG B	1C-6		P25		
SEG C	1C-8		P37		
SEG D	1C-11		P31		
SEG E	1E-3		P29		
SEG F	1E-6		P33		
SEG G	1E-8		P27		
DIG 1	2E-1		P55		
DIG 2	2E-2		P53		
DIG 3	2E-3		P51		
DIG 4	2E-4		P49		
DIG 5	2E-5		P63		
DIG 6	2E-6		P61		
DIG 7	2E-7		P59		

SIGNAL	FROM	Solder Wire	TO	Solder Wire	✓
DIG 8	2E-9		P57		
RESET*	J7	S	P67		
COL 1	P39		3E-2		
COL 1	3E-2		1D-5		
COL 2	P-41		3E-4		
COL 2	3E-4		1D-7		
COL 4	P-43		3E-6		
COL 4	3E-6		1D-6		
COL 8	P-45		3E-10		
COL 8	3E-10		1D-8		
D5	2D-7		2D-5		
D5	2D-5		1E-4		
D6	2D-9		2D-11		
D6	2D-9		1E-10		
A0	2C-3		2E-15		
A1	2C-4		2E-14		
A2	2C-5		2E-13		
A3	2C-6		2E-12		
"1"	1D-1		3C-9		
"1"	3C-9		3C-12		
"1"	3C-12		1E-9		
"1"	1E-9		1E-5		
"1"	1E-5		1E-2		
"1"	1E-2		1C-2		
"1"	1C-2		1C-5		
"1"	1C-5		1C-9		
"1"	1C-9		1C-13		
OUTGNG	GND	S	P65		
+5V	V_{CC}	S	1D-16		
	1D-16		1D-12		
	1D-12		1D-11		
	1D-11		1D-10		
	1D-10		1D-9		
	1D-9		2D-16		
	2D-16		3D-16		
	V_{CC}	S	3C-14		
	3C-14		2C-16		
	2C-16		1C-14		
	V_{CC}	S	1E-14		
	1E-14		2E-16		
	2E16		3E-16		
COMM	GND	S	1C-7		
	1C-7		2C-8		
	2C-8		2C-1		
	2C-1		2C-2		
	2C-2		2C-15		
	2C-15		3C-7		
	GND	S	3D-15		
	3D-15		3D-8		
	3D-8		2D-15		
	2D-15		2D-8		
	GND	S	3E-8		
	3E-8		2E-8		
	2E-8		1E-7		

2.2.3 Component Placement

Nine 16-pin sockets are included with the SC/MP Keyboard Kit; refer to the Parts List in appendix A. Although the nine sockets are 16-pin sockets, three of the components (3C, 1C, 1E) are only 14-pin components (refer to figure 2-3). The user must cut the leads on pins 8 and 9 of these three sockets before soldering the corner pins of the sockets. In addition, the five resistors (1D) are set in their socket as illustrated in figure 2-3 and the eight components are placed into the specified sockets with the proper pin orientation.

NOTE

The wire list (table 2-2) assumes the user knows which are 14-pin or 16-pin usable sockets.

Refer to appendix B for a list, a description, and a truth table of each of the integrated circuit components.

2.2.4 Wiring List

The wiring list (in table 2-1) is a sequential listing of required wiring for the interconnection of specific components and electronic circuits of the SC/MP Kit and the SC/MP Keyboard Kit. A Cambion wire-wrap tool and 125 five-inch pieces of precut wire are supplied with the SC/MP Keyboard Kit; refer to the Parts List in appendix A. An "S" in the third or fifth columns of the Wiring List designates which end of the wire in the FROM (Column 2) or TO (Column 4) location must be soldered by the user.

2.2.5 Memory Addressing

Table 2-2 defines the address bits that are used in the SC/MP Kit and the SC/MP Keyboard Kit and the corresponding hexadecimal values for these addresses. Since all of the bits are *not* used, a particular memory location can be specified by several different 16-bit addresses. For example, Keyboard Display Select location $0DFF_{16}$ can also be addressed as $F4FF_{16}$, $25FF_{16}$, and so on.

Table 2-2. SC/MP Kit and SC/MP Keyboard Kit Memory Addressing

Address Bits		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
ROM Select		X	X	X	X	X	0	0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
	Hex Value	0-F				0,1,8, or 9				0-F				0-F			
RAM Select		X	X	X	X	X	1	1	X	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
	Hex Value	0-F				6,7,E, or F				0-F				0-F			
Keyboard/ Display Select		X	X	X	X	X	1	0	X	X	X	X	X	X	0/1	0/1	0/1
	Hex Value	0-F				4,5,C, or D				0-F				0-F			
Not Used WRITE to RAM Only		X	X	X	X	X	0	1	X	X	X	X	X	X	X	X	X
	Hex Value	0-F				2,3,A, or B				0-F				0-F			

X = Not used

2.2.6 Backplane Pinouts

Backplane pinouts (refer to table 2-3 and figure 2-3) are the 72 external pins on the SC/MP Kit printed-circuit board; they provide specific circuit functions. As an example, edge-connector pins are provided for connection of input power. The +5-volt power must be connected to edge pins 1, 3, 69, and 71. The -12-volt power must be connected to edge pins 9 and 10. The ground (common) connections for the printed-circuit board are edge pins 2, 4, 70, and 72.

Table 2-3. SC/MP Kit Backplane Pinouts

1	+5V	2	COMMON
3	+5V	4	COMMON
5	TTY IN (+)	6	TTY IN (-)
7	———	8	———
9	-12V	10	-12V
11	TTY OUT (-)	12	TTY OUT (+)
13	RESET*	•	•
•	•	•	•
•	•	•	•
25	SEG B	26	——
27	SEG G	28	——
29	SEG E	30	——
31	SEG D	32	——
33	SEG F	34	——
35	SEG A	36	——
37	SEG C	38	——
39	COL 1	40	——
41	COL 2	42	——
43	COL 4	44	——
45	COL 8	46	——
47	——	48	——
49	DIG 4	50	——
51	DIG 3	52	——
53	DIG 2	54	——
55	DIG 1	56	——
57	DIG 8	58	——
59	DIG 7	60	——
61	DIG 6	62	——
63	DIG 5	64	——
65	OUTGNG	66	——
67	RESET*	68	——
69	+5V	70	COMMON
71	+5V	72	COMMON

2.3 MODIFICATIONS OF THE SC/MP INTROKIT

In general, the following SC/MP INTROKIT modifications are performed in a manner similar to SC/MP Kit modifications outlined in 2.2.

(1) J3/J4 Trace Cut
(2) The initial soldering
(3) Placement of additional components
(4) Specific wiring requirements
(5) Backplane Connector Pinouts

2.3.1 The J3/J4 Trace Cut

The J3/J4 Trace Cut for both the SC/MP INTROKIT and SC/MP Kit is identical; refer to 2.2.1 and figures 2-7 and 2-8. The trace cut removes the connection-to-ground and the ROM/RAM* input signal is applied to J3.

2.3.2 Initial Solder

Initial solder includes the soldering of two strip line plugs and all four corners of the nine sockets; refer to figures 2-5 through 2-8.

Before soldering the 10-pin and 11-pin strip line plugs, the user must insert them as shown in figure 2-5, and from the component side (front view) of the SC/MP INTROKIT printed-circuit board as shown in figure 2-7.

The sockets allow the use of wirewrapping (instead of soldering) the additional wires required in the wiring list; refer to table 2-1.

2.3.3 Component Placing

The nine 16-pin sockets, integrated circuits, and resistors for both the SC/MP INTROKIT and the SC/MP Kit are identical, except for the pin locations because the printed-circuit boards are of different types; refer to 2.2.3 and figure 2-7.

2.3.4 Wiring List

The wiring list (refer to table 2-1) can be used for both the SC/MP Kit and the SC/MP INTROKIT. The only differences are as follows:

1. The RESET* Signal for the SC/MP Kit (as listed) is *FROM* J7 *TO* P67; the SC/MP INTROKIT is *FROM* 2E PIN 15 *TO* P67.

2. On the SC/MP INTROKIT, the 10-pin strip line-plug is inserted, soldered, and *must* be wire-wrapped (since there are no feed-through connections as on the SC/MP Kit; refer to 2.2.2) to pins 49, 51, 53, 55, 57, 59, 61, 63, 65, and 67 of the SC/MP Keyboard and Display Unit; the 11-pin strip line plug must be wire-wrapped to pins 25, 27, 29, 31, 33, 35, 37, 39, 41, 43 and 45; refer to figure 2-8.

2.3.5 Backplane Connector Pinouts

Connector pins are provided to the printed-circuit board for connection of input power. The +5-volt power must be connected to connector pins 1A and 1C. The –12-volt power must be connected to connector pins 3A and 3C. The recommended method of connecting power to the board is to use a standard 64-pin female connector socket. If two separate supplies are used, both must be referenced to a common ground. The ground connections for the printed-circuit board are connector pins 4A, 4C, 32A, and 32C.

CHANGE NOTICE NUMBER 1

June 6, 1977

Publication Number 420305228-001B SC/MP Keyboard Kit Users Manual

This change is effective immediately.

The display decoder/driver (reference 2E) has been changed from DM8842N to DM8845N. This change should be made to all references to this part as shown in Table 1.

Table 1

Page	Location	Change	
		From	To
1-2	Figure 1-1	DM8842N	DM8845N
2-2	Figure 2-1	DM8842N	DM8845N
2-6	Figure 2-3	DM8842N	DM8845N
2-7	Figure 2-4	DM8842N	DM8845N
2-15	Figure 2-7	DM8842N	DM8845N
2-16	Figure 2-8	DM8842N	DM8845N
3-1	Col. 1, Paragraph 3, Lines 2 and 4	DM8842N	DM8845N
A-1	Table A-1, Parts List	DM8842N	DM8845N
B-2	Col. 1, Paragraph 1, Line 1	DM8842N	DM8845N

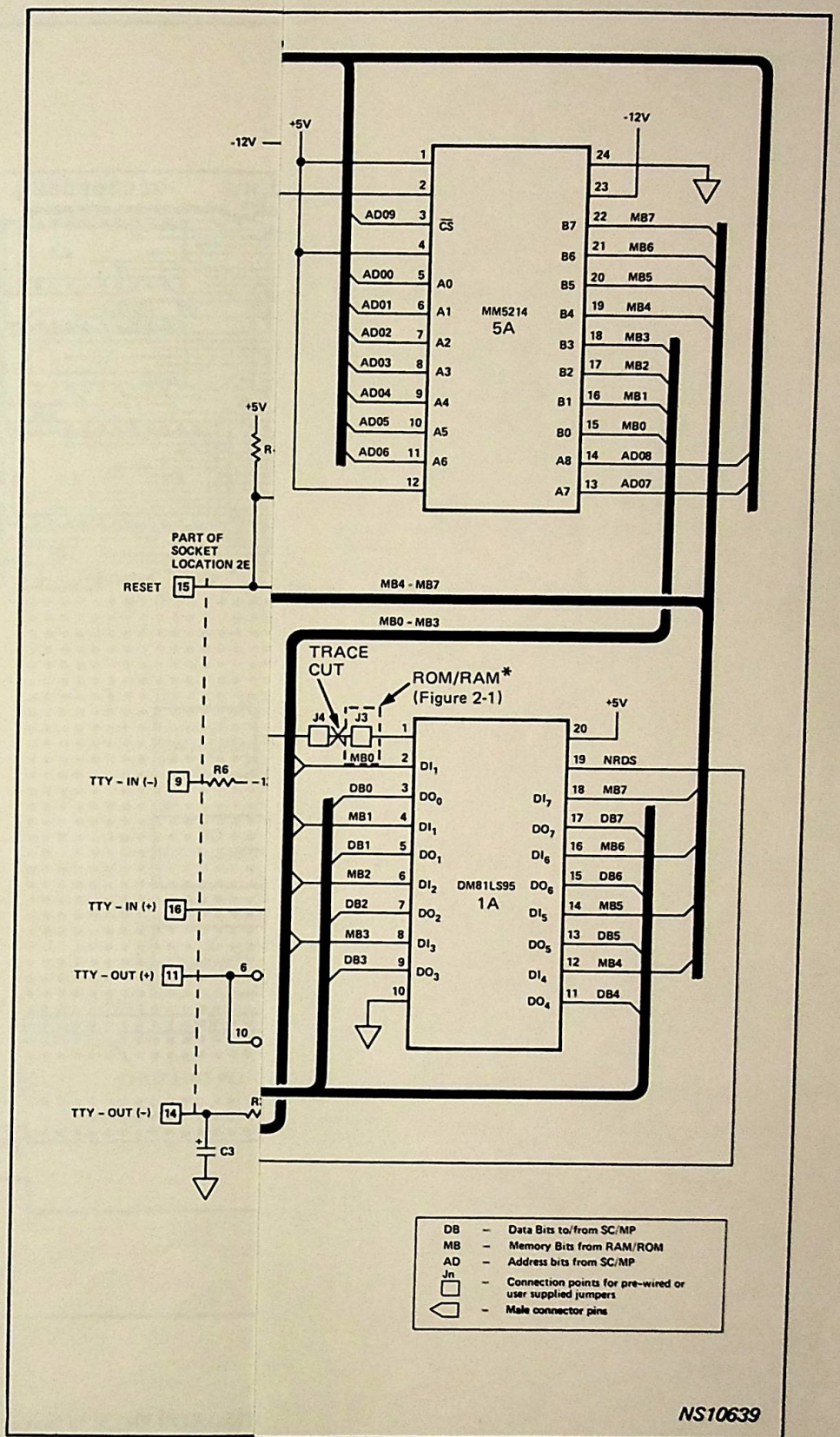


Figure 2-6. SC/MP INTROKIT Schematic Diagram

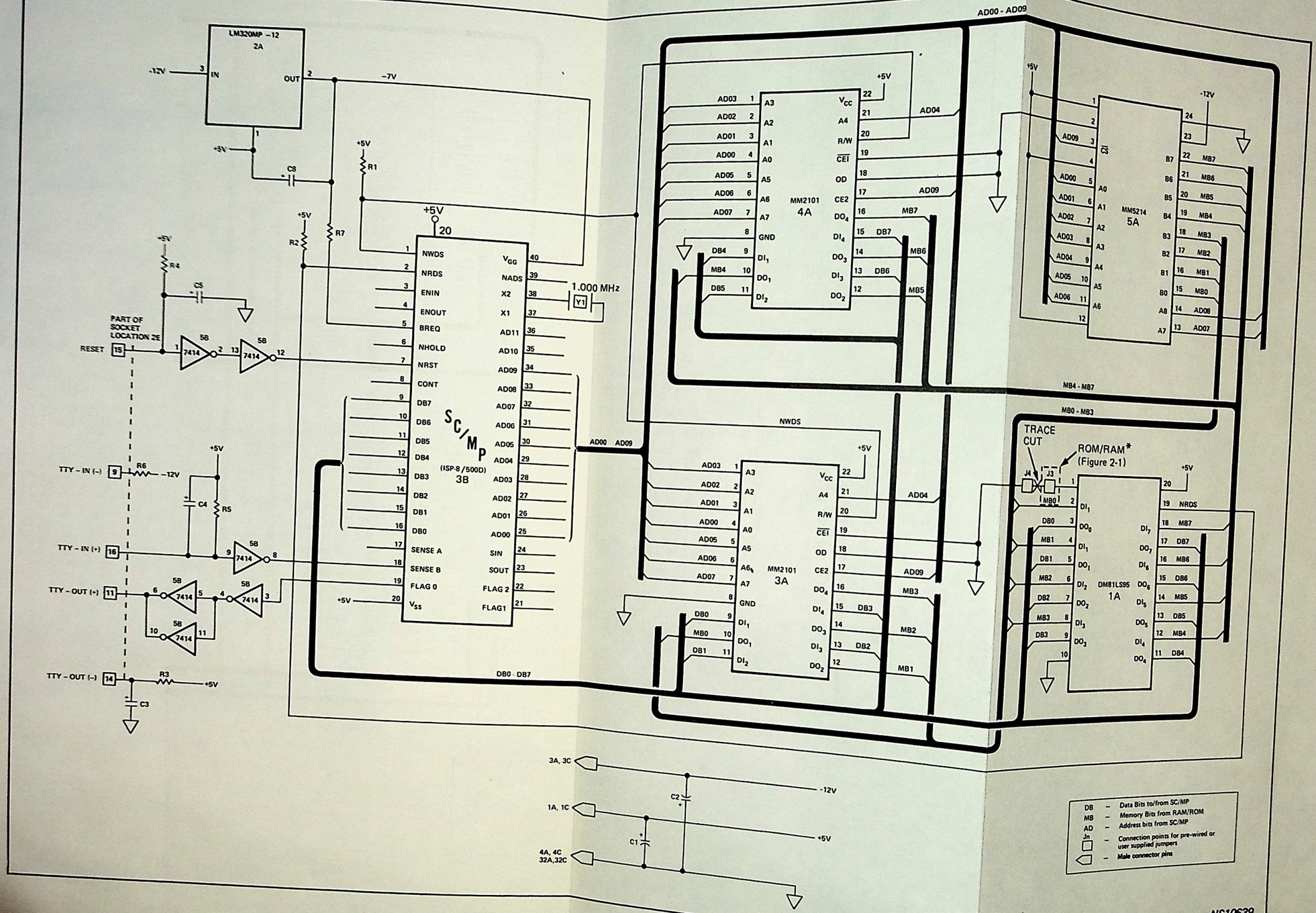


Figure 2-6. SC/MP INTROKIT Schematic Diagram

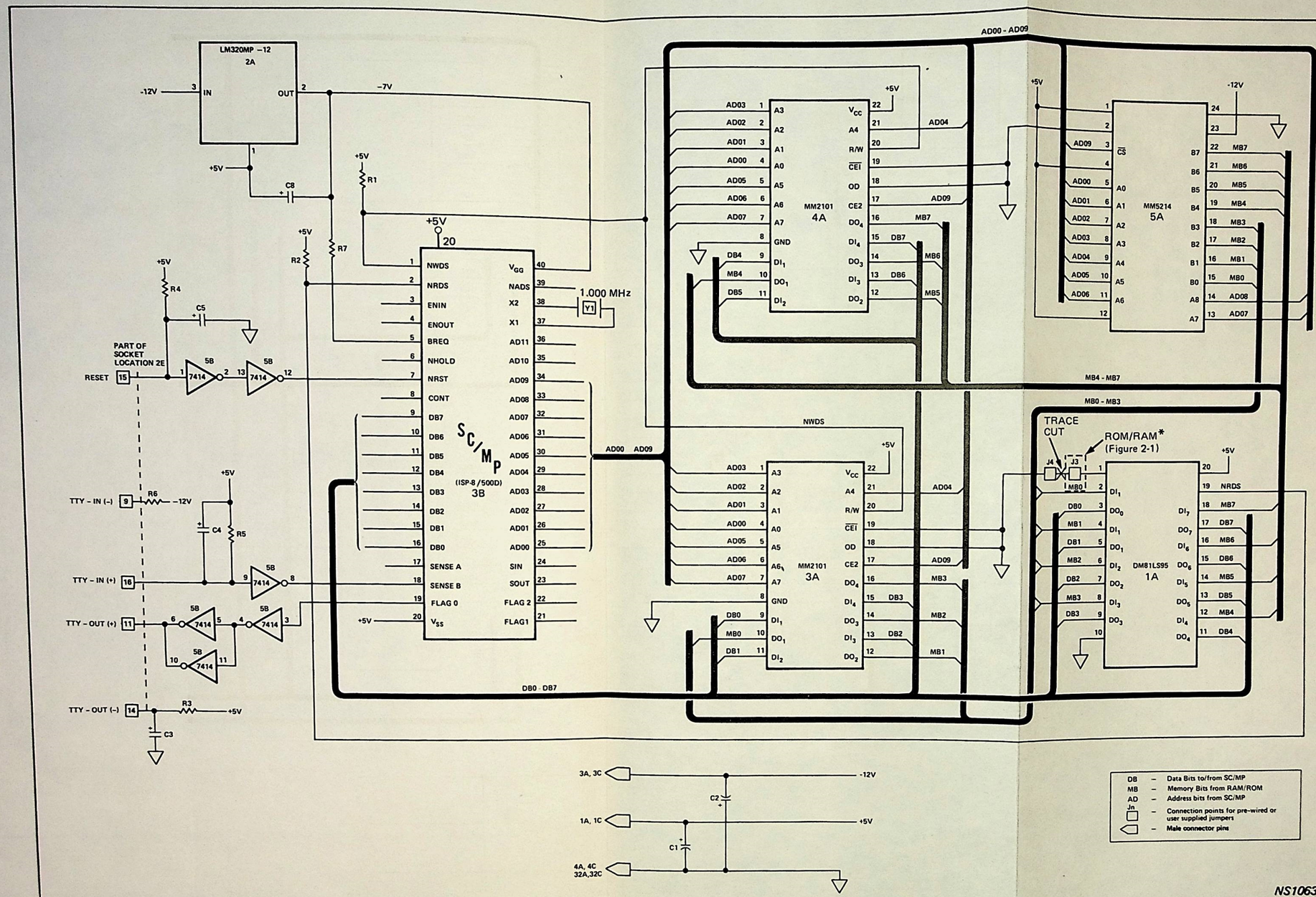
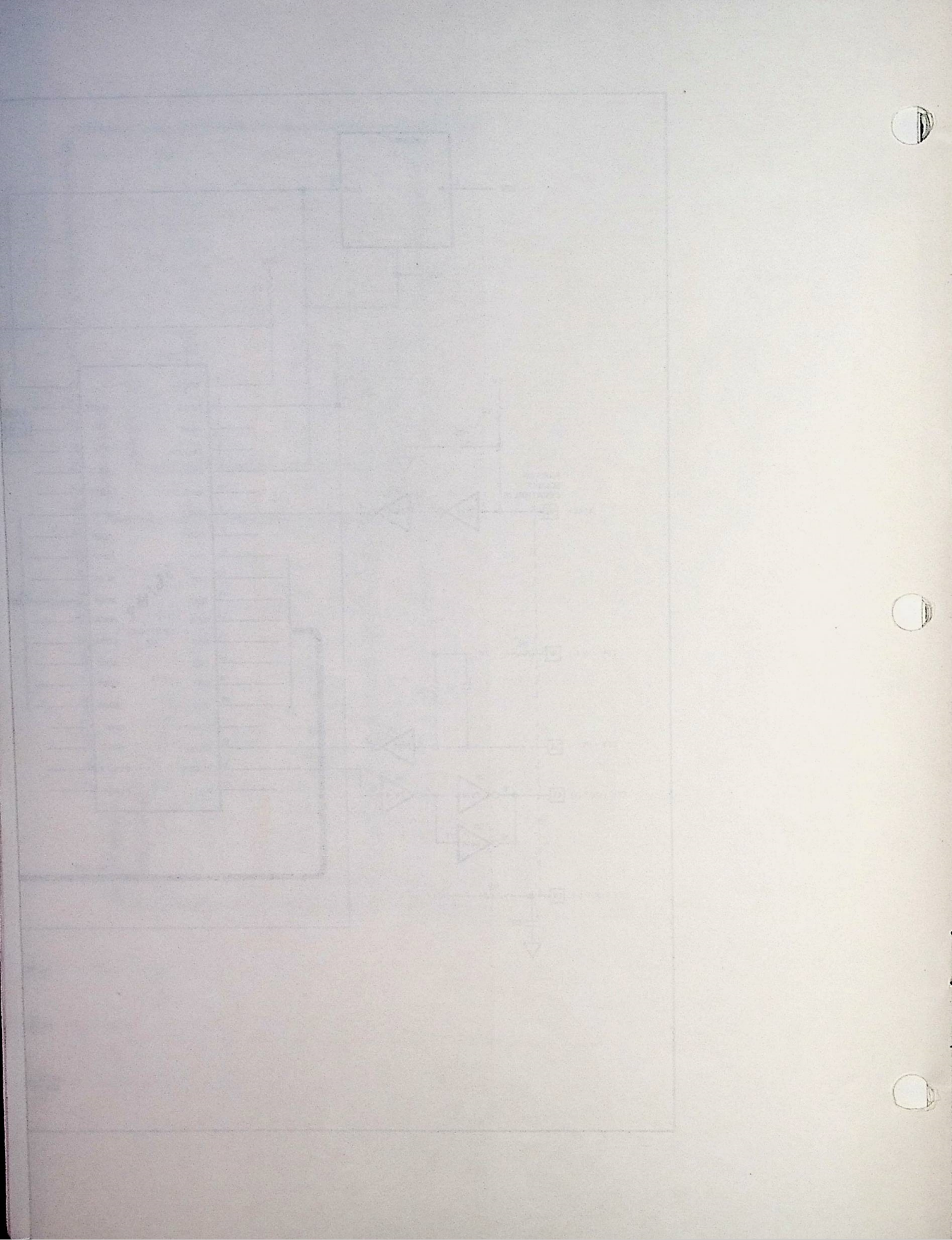


Figure 2-6. SC/MP INTROKIT Schematic Diagram



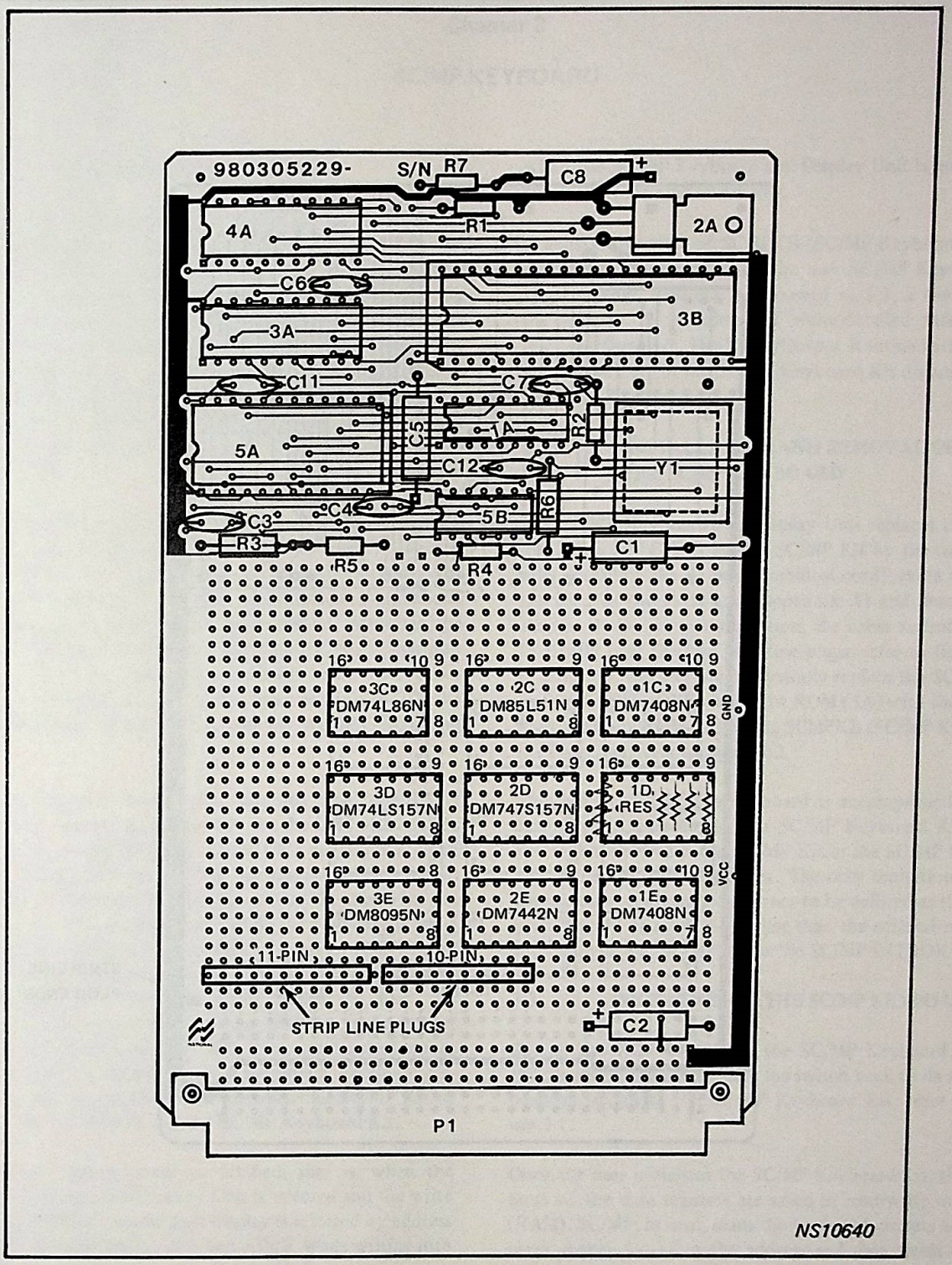


Figure 2-7. Layout of SC/MP INTROKIT Printed Circuit Board (Front), Component View

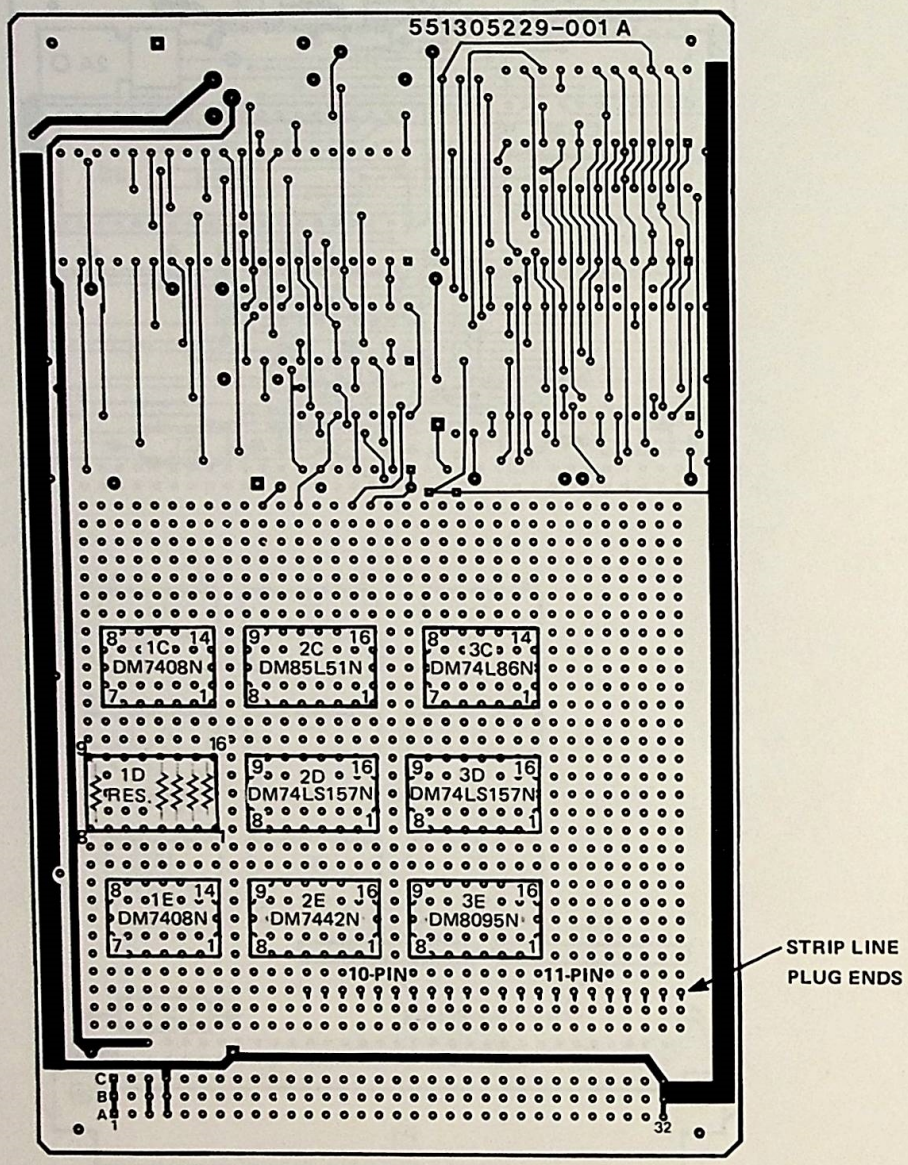


Figure 2-8. Layout of SC/MP Introkit Printed Circuit Board (Rear) Solder View.

Chapter 3

SC/MP KEYBOARD

3.1 FUNCTIONAL DESCRIPTION

The SC/MP Keyboard has an input matrix of 32 single-contact, normally open, pushbutton switches that are arranged in a 4-by-8 array (refer to figure 2-1); only 20 of the 32 switches are connected and therefore are active. The 20 switches are read sequentially only one row at a time to determine if any switches are closed. Reading of the matrix is accomplished by cycling through the 4 lower bits (0 through 3) of the desired address, and then performing a load from the SC/MP Keyboard and Display Unit. If there are no closed switches, the bits in the accumulator are all high (X'FF).

The SC/MP Keyboard and Display Unit contains a multiplexed 8-digit, 7-segment (A through G) display. Because each segment is independently controlled, not only the numbers (0 through 9) but also the hexadecimal-alphabetic characters (A through F) can be displayed. Although the SC/MP Keyboard contains a 4-by-8 matrix, for design purposes, only 20 keys are used. In addition to the 16 keys for the hexadecimal characters, four keys contain the GO, the MEMORY, the TERMINATE, and the ABORT command keys.

Segment data are sent over the data bus. The DM85L51N device (2C) latches the address bits for the DM7442N device (2E) while the DM74L86N device (3C) generates a clock for the DM85L51N device (2C). The DM7442N device (2E) is a BCD-to-Decimal Decoder that drives the digits for the Display and also is a row driver while the keyboard is being scanned. The Display is a standard calculator-type display and is driven directly by the two DM7408N segment-driver devices (1C, 1E). The DM7408N devices, in turn, are driven by two quad-two-lines to one-line multiplexers, DM74LS157N devices (2D, 3D), that are hooked up as latches. Refer to figure 1-1 for a simplified functional diagram of the address/data flow between the SC/MP Kit or the SC/MP INTROKIT and the SC/MP Keyboard Kit.

Once these segment data are latched, that is, when the SC/MP Keyboard and Display Unit is selected and the write strobe (NWDS) is low, the digit display is selected by address bits AD0 through AD3, AD9, and AD10. While writing into the display, no more than one digit line is low.

When a switch is closed, the data bit in the corresponding column is pulled down to a logic '0'. This signal is buffered by the DM8095N device (3E) and is read into the data bus when the SC/MP Keyboard and Display Unit is selected and the read strobe (NRDS) is low.

A general overview of SCMPKB (SC/MP Keyboard Kit Program) and a description of the user SC/MP Keyboard Kit Input/Output Routine is discussed in 3.3; a flowchart of the routine is included for more-detailed information; refer to figure 3-2. The Input/Output Routine listing is supplied separately in the SC/MP Keyboard Kit documentation package.

3.2 INSTALLATION AND REMOVAL OF THE SC/MP KEYBOARD

The SC/MP Keyboard and Display Unit replaces the use of the Teletype® (TTY) on the SC/MP Kit by the user physically installing the 21-pin "umbilical cord" cable assembly specified in the Parts List (appendix A) and described in chapter 2. For proper operation, the cable assembly must fit tightly over the two strip-line plugs; refer to figure 2-3. In addition, the user must physically replace the SC/MP Kit or SC/MP INTROKIT MM5214 ROM (5A) with the SC/MP Keyboard Kit ROM containing SCMPKB (SC/MP Keyboard Kit Program); refer to figure 2-2.

Removal of the SC/MP Keyboard is accomplished by the user physically removing the SC/MP Keyboard Kit ROM and replacing it with the SC/MP Kit or the SC/MP INTROKIT ROM for TTY operation. The only limitation is that the memory addressing continues to be defined as the modified spacing in table 2-2 rather than the original memory addressing of the SC/MP Kit or the SC/MP INTROKIT.

3.3 OPERATION OF THE SC/MP KEYBOARD

Sliding the INIT Switch on the SC/MP Keyboard to the INIT position and then sliding the switch back to its original position initializes the SC/MP Keyboard Kit; refer to figure 3-1.

Once the user initializes the SC/MP Keyboard Kit, the contents of the data registers are saved in read/write memory (RAM). SC/MP, in turn, scans the keyboard circuits and displays dashes (——) in the address and data fields of the SC/MP Keyboard and Display Unit. SC/MP now waits (a

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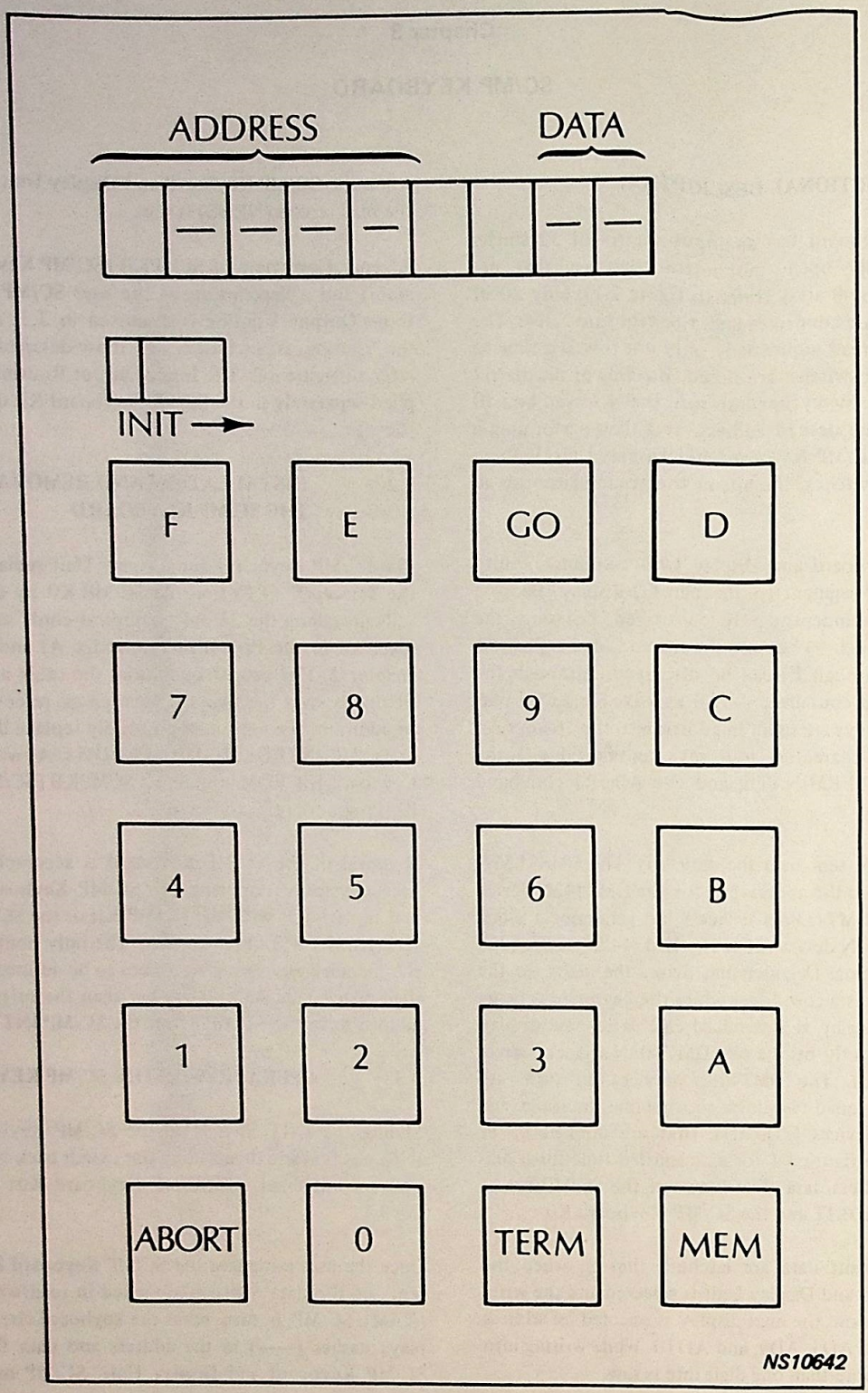

Figure 3-1. Keyboard and Display Unit (Top View)

WAIT loop) for the user to press either a GO or a MEMORY command key. If the user presses a TERMINATE or an ABORT command key, the operation is ignored completely by SC/MP. If the GO command key is pressed, the last referenced address is displayed and the data field is set to "dashes."

Next, either the hexadecimal (0 through F) keys *or* the TERMINATE command key is pressed. If the user presses any other key, 'ERROR' is displayed and SCMPKB returns to the WAIT loop. Once one of the 0 through F keys is pressed, the balance of the word is ZEROED. For an example, if execution is desired beginning with address X'0005, the user need only press the number 5, not 0005. If the user makes a mistake, he does not have to be concerned about how many times he has pressed the hexadecimal keys because only the digits of the last four keys pressed are saved by SCMPKB – but the user must ensure that the digits represented by the last four keys that are pressed represent the desired address.

The TERMINATE command key is pressed by the user when he wants to transfer program control to its specified address. When this command key is pressed and released, the P1, P2, A, E, and S Registers are loaded with data previously saved in memory; that is, the previous state of SC/MP is restored. The P3 Register contains the return address to SCMPKB. To return to SCMPKB, an XPPC P3 Instruction (Exchange Program Counter with P3) should be executed, and upon returning to SCMPKB, all of the registers are saved for subsequent examination in memory.

When the MEMORY command key is pressed by the user, the previous memory address and data are displayed in the address and data fields. If the MEMORY command key is pressed again, the next address and the data at that address are displayed. The MEMORY command key is pressed again to read the next address, and so on. In other words, pressing the MEMORY key increments the memory address by one and causes the newly incremented address and its data to be displayed.

To enter any address, the user presses any of the hexadecimal (0 through F) keys. The pressing of the first hexadecimal key zeroes the balance of the address field and displays the data at that address. Pressing the hexadecimal keys will continue to be interpreted as legitimate addresses until the user presses the TERMINATE command key. Once the TERMINATE command key is pressed, any subsequent hexadecimal key that is pressed represents data and the appropriate digit is displayed in the data field. Regardless of how many times the hexadecimal keys are pressed, only the digits represented by the last two keys pressed are the data used. Pressing the TERMINATE command key writes data to memory. After the data are written in memory, they are read back and displayed with the corresponding present address of the data.

The ABORT command key is pressed when the user wants to return immediately to the command mode.

3.4 PROGRAM FLOW OF THE USER-ACCESSIBLE ROUTINE

The purpose of the SC/MP Keyboard Input/Output Routine is to read the 20 active matrix switches (keys) and to display the proper information for the user's perusal. The routine is interleaved with the digit display; this technique allows that which is displayed to be recognized twice – once when the data segments are written and once when the keyboard is scanned by the SC/MP Keyboard Kit Input/Output Routine. Figure 3-2 is a flowchart of the SC/MP Keyboard Kit Input/Output Routine. This routine assumes that the data to be displayed are stored in the first eight bytes of read/write memory (RAM); digit 1 is the least significant digit. The address of this specific RAM is in the P2 Register and must be XXX0, where XXX is any legitimate RAM address. A total of 18 words of RAM is allocated for the SC/MP Keyboard Kit Input/Output Routine; refer to table 3-1.

Table 3-1. RAM (Read/Write Memory) Allocation for the SC/MP Keyboard Kit I/O Routine

Memory Address	Comments
F00	SEGMENT FOR DIGIT 1
F01	SEGMENT FOR DIGIT 2
F02	SEGMENT FOR DIGIT 3
F03	SEGMENT FOR DIGIT 4
F04	SEGMENT FOR DIGIT 5
F05	SEGMENT FOR DIGIT 6
F06	SEGMENT FOR DIGIT 7
F07	SEGMENT FOR DIGIT 8
F08	EXTRA LOCATION
F09	COUNTER
F0A	KEY PUSHED
F0B	CHAR READ
F0C	MEMORY ADDRESS LOW
F0D	MEMORY WORD
F0E	MEMORY ADDRESS HI
F0F	FIRST FLAG
F10	ROW COUNTER
F11	FLAG FOR NOW DATA
	USER'S PROGRAM RESIDES HERE
0FF9	P1: Pointer Register 1 (bits 8-15)
0FFA	P1: Pointer Register 1 (bits 0-7)
0FFB	P2: Pointer Register 2 (bits 8-15)
0FFC	P2: Pointer Register 2 (bits 0-7)
0FFD	AC: Accumulator
0FFE	EX: Extension Register
0FFF	SR: Status Register

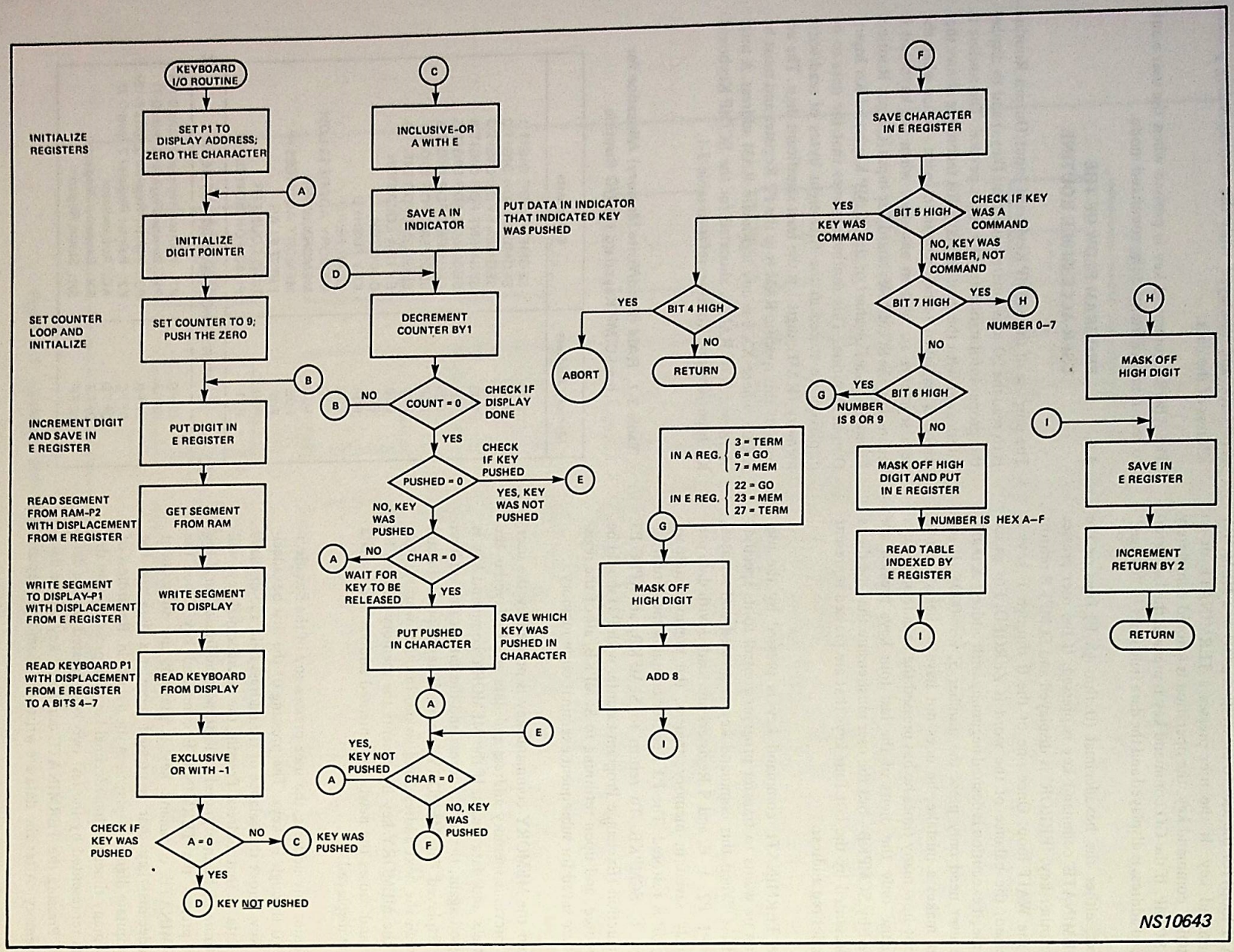

Figure 3-2. Keyboard Input/Output Routine Flowchart

The SC/MP Keyboard Kit Input/Output Routine is written as a callable subroutine so that the user has access to the subroutine during execution of his specific software program; refer to table 3-2.

This subroutine has three returns:

1. The first return indicates that a command (GO, MEMORY, and TERMINATE) key was pressed and the specific command key was defined by the user. (Return to XPPC 3 Instruction +1.)
2. The second return indicates that a hexadecimal (zero through F) key was pressed and the data are returned in the E Register. (Return to XPPC 3 Instruction +3.)
3. The third return indicates that the ABORT command key was pressed by the user and the return goes back to SCMPKB. (No return to user program.)

Table 3-2. Calling Sequence for the SC/MP Keyboard Kit I/O Routine

Nos.	Routine	Assembler Opcode Mnemonics	Assembler Operand	Comments
1	KYB	=	0185	;ADDRESS OF DISPLAY ROUTINE.
2	RAM	=	0F00	;ADDRESS OF RAM.
3		LDI	H<RAM>	;SET P2 TO ADDRESS OF RAM.
4		XPAH	2	
5		LDI	L<RAM>	
6		XPAL	2	
7		LDI	H<KYB>	;SET P3 TO ADDRESS OF ROUTINE.
8		XPAH	3	
9		LDI	L<KYB>-1	
10		XPAL	3	
11		XPPC	3	;GO TO ROUTINE.
12		JMP	CMND	;COMMAND KEY RETURN
13	NUM:			;NUMBER RETURN
•		•		;PROCESS NUMBER
•		•		
•		•		•
28	CMND:			;PROCESS COMMAND KEY
•		•		•
•		•		•
•		•		•

APPENDIX A

SC/MP KEYBOARD KIT PARTS LIST

Table A-1. SC/MP Keyboard Kit Parts List

Item	Description	Reference Designation	Quantity
1	Keyboard and Display Unit	- - -	1
2	Rubber Band	- - -	1
3	Plastic Bag, 4" x 6"	- - -	1
4	Plastic Bag, 4" x 5"	- - -	1
5	I. C. DM7408N	1C, 1E	2
6	I. C. DM7442N (Dec Decoder)	2E	1
7	I. C. DM74L86N (XOR)	3C	1
8	I. C. DM74LS157N (Multiplexer)	2D, 3D	2
9	I. C. DM8095N (TRI-STATE® Buffer)	3E	1
10	I. C. DM85L51N	2C	1
11	I. C. MM5214 (ROM) Refer to Note	5A	1
12	Resistor, 5.1KΩ, 1/4 W, 5%	1D	5
13	16-pin sockets, Wire Wrap	- - -	9
14	10-pin Strip Line Plug, Circuit Assembly	- - -	1
15	11-pin Strip Line Plug, Circuit Assembly	- - -	1
16	Wire, Precut, 5" Wire Wrap	- - -	125 pieces
17	Wire Wrap Tool, Cambion	- - -	1
18	Conductive Foam 2.5" x 3"	- - -	1
19	Skin Pack Back-up Card	- - -	1

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NOTE

ROM contains the SC/MP Keyboard Kit Program. MM5204 or MM5244 is substituted for MM5214 in some kits. These three devices are functionally equivalent and pin compatible.

APPENDIX B

ADDITIONAL SC/MP KIT INTEGRATED CIRCUIT COMPONENTS

A list of the eight required integrated circuit components that are added (with the five specified resistors) to the SC/MP Kit printed circuit board, and a description, location, and truth table of each component follow.

- (3C) DM74L86N – a quad 2-input EXCLUSIVE-OR gate integrated circuit device that utilizes TTL to provide four EXCLUSIVE-OR gates in one package.

Input		Output
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

H = High Level, L = Low Level, X = Don't Care

- (2D, 3D) DM74LS157N (Two) – A quad 2-input multiplexer integrated circuit component that consists of four 2-input multiplexers with common input select logic and common output disable circuits. It allows two groups of 4 bits each to be multiplexed to four parallel outputs providing a simple storage element known as latching. When the Enable input is at the logical '0' level, the outputs reflect information on the selected inputs. However, when a logical '1' is applied, the outputs assume the logic '0' level.

Inputs				Output
STROBE	SELECT	A	B	Y
H	X	X	X	L
L	L	L	X	L
L	L	H	X	H
L	H	X	L	L
L	H	X	H	H

H = High Level, L = Low Level, X = Don't Care

- (3E) DM8095N – A TRI-STATE® hexadecimal buffer that is used to convert standard TTL or DTL outputs to TRI-STATE outputs.

Inputs			Outputs
$\overline{G}1$	$\overline{G}2$	A	Y
H	X	X	HI-Z
X	H	X	HI-Z
L	L	H	H
L	L	L	L

H = High Level, L = Low Level, X = Don't Care
HI-Z = High Impedance

- (2C) DM85L51N – A TRI-STATE logic device that provides four D-type flip-flops in one package and is capable of driving highly capacitive or low-impedance loads.

Inputs					Output
		DATA ENABLE		DATA	
CLEAR	CLOCK	G1	G2	D	Q
H	X	X	X	X	L
L	L	X	X	X	Q_0
L	↑	H	X	X	Q_0
L	↑	X	H	X	Q_0
L	↑	L	L	L	L
L	↑	L	L	H	H

When either M or N (or both) is (are) high, the output is disabled to the high impedance state; however, sequential operation of the flip-flops is not affected.

H = High Level (Steady state), L = Low Level (Steady state), ↑ = low-to-high Level Transition, X = Don't Care (any input including transitions), Q_0 = the level of Q before the indicated steady state input conditions were established.

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- (2E) DM7442N – A BCD-to-Decimal Decoder that utilizes Series 54/74 compatible circuits to decode a 4-bit BCD number to 1 of 10 decimal outputs. These 10 decimal outputs are capable of driving each of 10 standard TTL loads.

No.	BCD Input				Decimal Output									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	H	L	H	H	H	H	H	H	H	H
2	L	L	H	L	H	H	L	H	H	H	H	H	H	H
3	L	L	H	H	H	H	H	L	H	H	H	H	H	H
4	L	H	L	L	H	H	H	H	L	H	H	H	H	H
5	L	H	L	H	H	H	H	H	H	L	H	H	H	H
6	L	H	H	L	H	H	H	H	H	H	L	H	H	H
7	L	H	H	H	H	H	H	H	H	H	H	L	H	H
8	H	L	L	L	H	H	H	H	H	H	H	H	L	H
9	H	L	L	H	H	H	H	H	H	H	H	H	H	L
INVALID	H	L	H	L	H	H	H	H	H	H	H	H	H	H
	H	L	H	H	H	H	H	H	H	H	H	H	H	H
	H	H	L	L	H	H	H	H	H	H	H	H	H	H
	H	H	L	H	H	H	H	H	H	H	H	H	H	H
	H	H	H	L	H	H	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = High Level, L = Low Level

- (1C, 1E) DM7408N (Two) – A quad 2-input AND gate that provides the non-inverting AND function in the quad 2-input pin configuration.

Input		Output
A	B	L
L	L	L
L	H	L
H	L	L
H	H	H

- (1D) Resistors (Five) – A 5.1KΩ, 1/4W, 5% device that is connected into an electrical circuit to introduce a specific resistance.

For further information pertaining to each specified comnent, refer to the *latest* data sheets for each component.

APPENDIX C

APPLICATION EXAMPLE

The following program is intended for use with the SC/MP Keyboard Kit. Using SCMPKB (SC/MP Keyboard Kit Program) and the Keyboard and Display Unit, the program is entered into memory using the MEMORY Command of SCMPKB, and then is executed using the GO Command. Following is a description of the key to be pushed, the resultant address and data displays, and comments.

Key to Push	Address Display	Data Display	Comments
INIT (POWER UP)	- - - -	- -	Waiting for Input
MEM	0 0 0 1	9 0	Read Memory
F	0 0 0 F	E b	Set Address to
F	0 0 F F	0 d	X'0FFB
b	0 F F b	0 0	
TERM	0 F F b	0 0	Move to Data Field
F	0 F F b	0 F	Set P2H to 0F
TERM	0 F F b	0 F	Write to RAM
MEM	0 F F C	0 0	Increment Memory
TERM	0 F F C	0 0	Move to Data Field
2	0 F F C	0 2	Set P2L to 20
0	0 F F C	2 0	
TERM	0 F F C	2 0	Write to RAM
F	0 0 0 F	E b	Set Address to
2	0 0 F 2	0 6	X'0F20
0	0 F 2 0	X X	
TERM	0 F 2 0	X X	Move to Data Field
5	0 F 2 0	0 5	
E	0 F 2 0	5 E	
TERM	0 F 2 0	5 e	Write to RAM
MEM	0 F 2 1	x x	Bump Address
TERM	0 F 2 1	X X	Move to Data Field
5	0 F 2 1	0 5	
C	0 F 2 1	5 C	
TERM	0 F 2 1	5 C	Write to RAM
MEM	0 F 2 2	X X	Bump Address
TERM	0 F 2 2	X X	Move to Data Field
5	0 F 2 2	0 5	
C	0 F 2 2	5 C	
TERM	0 F 2 2	5 C	Write to RAM
MEM	0 F 2 3	X X	Bump Address
TERM	0 F 2 3	X X	Move to Data Field
3	0 F 2 3	0 3	
D	0 F 2 3	3 d	
TERM	0 F 2 3	3 d	Write to RAM

Key to Push	Address Display	Data Display	Comments
MEM	0 F 2 4	X X	Bump Address
TERM	0 F 2 4	X X	Move to Data Field
0	0 F 2 4	0 0	
TERM	0 F 2 4	0 0	Write to RAM
MEM	0 F 2 5	X X	Bump Address
TERM	0 F 2 5	X X	Move to Data Field
5	0 F 2 5	0 5	
E	0 F 2 5	5 E	
TERM	0 F 2 5	5 E	Write to RAM
MEM	0 F 2 6	X X	Bump Address
TERM	0 F 2 6	X X	Move to Data Field
4	0 F 2 6	0 4	
TERM	0 F 2 6	0 4	Write to RAM
MEM	0 F 2 7	X X	Bump Address
TERM	0 F 2 7	X X	Move to Data Field
5	0 F 2 7	0 5	
E	0 F 2 7	5 E	
TERM	0 F 2 7	5 E	Write to RAM
MEM	0 F 2 8	X X	Bump Address
TERM	0 F 2 8	X X	Move to Data Field
0	0 F 2 8	0 0	
TERM	0 F 2 8	0 0	Write to RAM
MEM	0 F 2 9	X X	Bump Address
TERM	0 F 2 9	X X	Move to Data Field
0	0 F 2 9	0 0	
TERM	0 F 2 9	0 0	Write to RAM
GO	ERROR	– –	Try to Execute
GO	0 F 2 9	– –	Set Up to Execute
1	0 0 0 1	– –	at X'0185
8	0 0 1 8	– –	
5	0 1 8 5	– –	
TERM	d i d G o o d	– –	Display Data in Memory
MEM	– – – –	– –	Back to Wait
GO	0 1 F 2	– –	Read to Execute Again

The user *must* push the TERM Command before repeating the steps.

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Publication No. 420305228-001B