

**BM873**  
**restart/loader**

**pdp11**

**digital**



**BM873**  
**restart/loader**

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# CHAPTER 1

## DESCRIPTION

### 1.1 INTRODUCTION

This manual describes the operation and theory of the BM873 Restart/Loader. This option is intended for use with the PDP-11 family of processors. The BM873

- serves as general purpose loader for processors of the 11 family,
- contains bootstrap loaders for all common devices,
- provides the capability of loading with a "hidden console",
- permits starting from several sources e.g., pushbutton, Watchdog Timer, MODEM control, power fail, etc.,
- gives PDP-11 systems an initial program load capability,
- contains at least four starting addresses, and
- permits the calling of a special user ROM program.

It is assumed that the reader is thoroughly familiar with the operation of the PDP-11 processor with which this option is used.

### 1.2 GENERAL DESCRIPTION

The BM873 option is contained on a quad-height, extended length module that plugs into a small peripheral controller (SPC) slot. There are four versions of the BM873: YA, YB, YC, and YD. They are described in Table 1-1.

The programs contained in the BM873 can be loaded either from the processor console (Load Address and Start), by a JMP instruction in the program, or by an external contact closure or voltage level. An 8-pin Mate-N-Lok connector is used for the external interface. BM873 specifications are listed in Table 1-2.

### 1.3 FUNCTIONAL DESCRIPTION

The BM873 consists of two basic sections: the Restart Sequencer and the ROM.

Figure 1-1 shows the remote start timing. The Restart Sequencer takes contact closures or voltage levels and, after filtering and delaying, sets one of four Start Address Select flip-flops. The setting of one of the flip-flops causes the Begin Load Sequence flip-flop to set; this, in turn, initiates two one-shots to create a BUS AC LO/BUS DC LO

**Table 1-1**  
**Description of BM873 Versions**

<b>Version Designation</b>	<b>ROM Size</b>	<b>Description</b>
BM873-YA	128 words (256 words optional)	Contains bootstrap loader programs for several peripheral devices (RF11, RK11, TC11, etc.).
BM873-YB	256 words	Contains bootstrap loader programs for the devices contained in the YA version, plus programs for the Massbus devices.
BM873-YC	256 words	Contains bootstrap loader programs for the devices contained in the YA version, plus the program for the DU11 Synchronous Interface.
BM873-YD	256 words	Contains bootstrap loader programs for the TC11 DECTape, RH11/RP04 Disk, and the DTE20 10/11 Interface.

**Table 1-2**  
**BM873 Specifications**

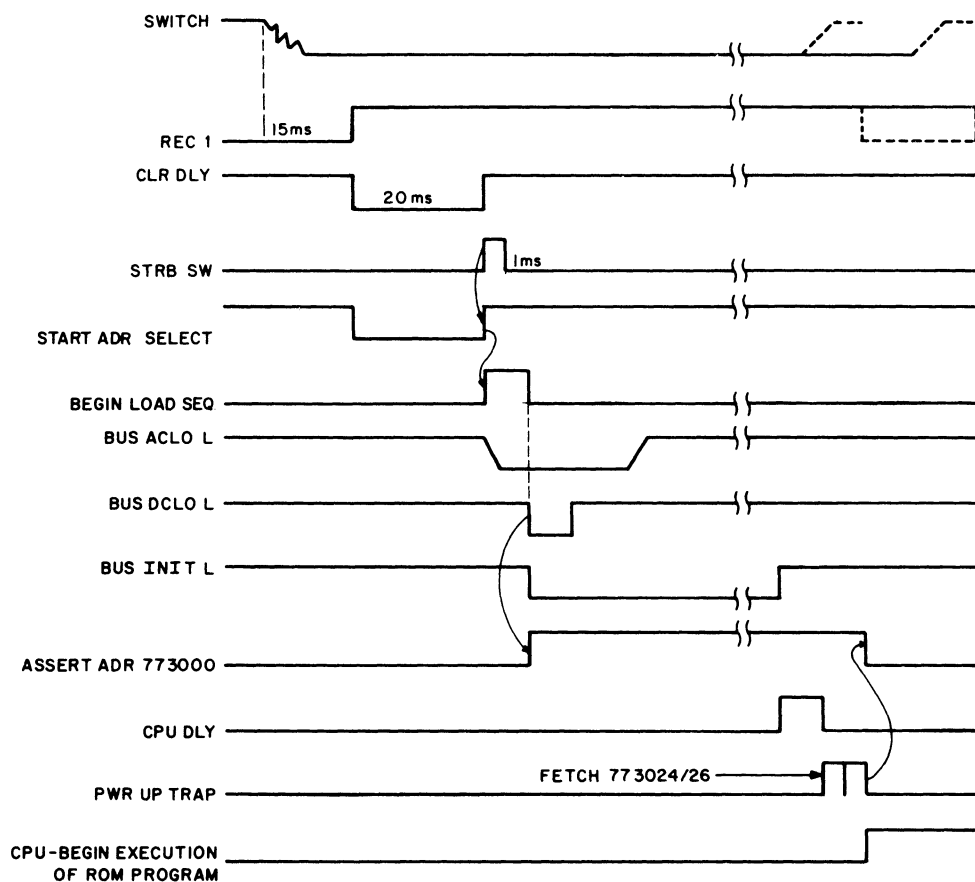
Capacity	
BM873-YA	128 words, read only (256 words optional)
BM873-YB, YC, YD	256 words, read only
Word length	16 bits
ROM cycle time	500 ns
Voltage requirements	+5 V $\pm$ 5% -15 V $\pm$ 5%
Current requirements	1.0 A max @ +5 V 2.0 mA max @ -15 V
Operating temperature	10° to 50° C
Humidity	20% to 95%



sequence. The processor responds to the sequence by performing its normal power-down and power-up trap routines. Prior to the power-up sequence, however, the BM873 option asserts 773000 on the Unibus Address Lines. As a result, when the Program Counter (PC) and Processor Status Word (PSW) are restored, the data is taken from locations 773024/26 (nonvolatile memory systems) or from locations 773224/26 (volatile memory systems). Both of these addresses are locations within the BM873 option. The data from 773\*24 is 173000; the data from 773\*26 is 340, establishing a priority level of 7.

The data read from 773\*24 (173000) will have an offset address ORed onto Offset Address bits 8 through 1, giving a range of 173000 to 173776. The offset address bits are enabled by one of the four Start Address Select flip-flops via a diode matrix (Paragraph 2.1.1). Each bootstrap loader program has its own starting address, and it is this address that is selected via the offset address bits.

In the BM873-YB, some of the bootstrap loader programs have two starting addresses. The first address automatically selects unit zero and the second address selects the unit specified in the switch register. See Appendix A for device starting addresses for all versions.



11-2408

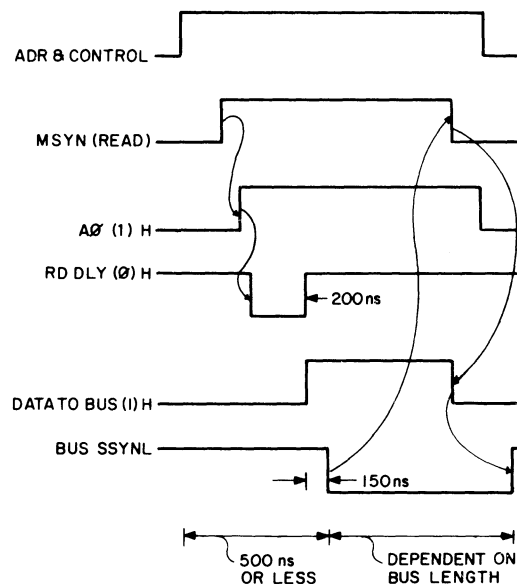
Figure 1-1 Remote Start Timing

The following sequence of operations would be typical:

- Close external switch and wait for switch filter delay.
- Assert AC LO; wait 6 ms.
- Assert DC LO for 6 ms; then wait 8 ms.
- Drop AC LO and assert address 773000.
- Wait for INIT to finish.
- The processor enters power-up routine.
- The BM873 option recognizes the fetch of address 773024 or 773224 and asserts 173XXX plus the 8-bit offset address to the data lines.
- The processor reads location 773026 or 773226 which is always 000340 (priority level 7).
- The processor fetches the next instruction from the ROM in address range 773000–773776. From this point, the bootstrap loader program contained in the ROM has control. (In the PDP-11/35 and PDP-11/40 systems, the PSW is fetched before the PC.)

If an actual power fail occurs in a nonvolatile memory system, the BM873 option does nothing, and the power-down and power-up traps work in the normal manner. If an actual power fail occurs in a volatile memory system, the power-up jumpers in the processor are set for 173224. During power-up the processor will fetch from 173224; the combination of address 773224 and no external lines asserted will cause the BM873 option to assert line 1 as a default case. Thus, in this case, the offset address selected for line 1 becomes the bootstrap loader call for power fail.

Data is read from the ROM in two bytes. Address bits 7 through 1 are present at all times via the bus receivers. Address bit 0 is generated on the module. A0 is always clear prior to a read cycle. The setting of A0 clocks the first byte into a holding register and simultaneously changes the address to gate the second byte to the output drivers. After a delay of about 200 ns, the output gates are enabled and the ROM data is placed on the Unibus. SSYN is asserted about 150 ns later, completing the read cycle. Figure 1-2 illustrates memory read timing.



11-2407

Figure 1-2 Memory Read Timing

# CHAPTER 2

## INSTALLATION AND CHECKOUT

### 2.1 INSTALLATION

Normally the BM873 Restart/Loader is installed at the factory and no further installation is required. However, if this option is added to an existing system, it may be necessary to add wiring to make the AC LO and DC LO signals available. These signals are provided on the PDP-11/05 and PDP-11/45 processors, and on the DD11-B. On the PDP-11/15, PDP-11/20, PDP-11/35, PDP-11/40, and the DD11-A it is necessary to ensure that the SPC slot containing the BM873 has BUS AC LO and BUS DC LO wiring available as follows:

Pin CV1 to B01F1 or B04F1 (BUS AC LO)

Pin CN1 to B01F2 or B04F2 (BUS DC LO)

If the wiring is not present, it must be added by hand-wiring, using a wire color different from that of the existing backplane wiring.

#### NOTE

The BM873 option must be on the CPU side of any bus buffer.

#### 2.1.1 Start Address Selection

Each of the four external interface circuits has an associated address which must be specified for that circuit to be addressed. Each address consists of a fixed high-order portion (773XXX) and a low-order portion (bits 8 through 1) that is selected by adding or cutting diodes (Figure 2-1). With the diode in, a 1 is placed on the Unibus. With the diode out, a 0 is placed on the Unibus. When adding diodes, a low-wattage iron should be used and care should be taken with the plated mounting holes, so that the plating is not lifted from the laminate by the heat. The diodes (DEC type 664 or 1N3606) should be positioned so that their cathodes point toward the gold fingers of the module.

Appendix A lists starting addresses for various devices used with the BM873-YA, -YB, -YC and -YD Restart/Loaders. The three rightmost digits of the address represent the low-order portion to be selected via diodes.

The diagnostic program for this option contains a listing of the loader program in the comments portion of the Data Compare section. That diagnostic will be updated to contain the starting addresses and listing of future variations.

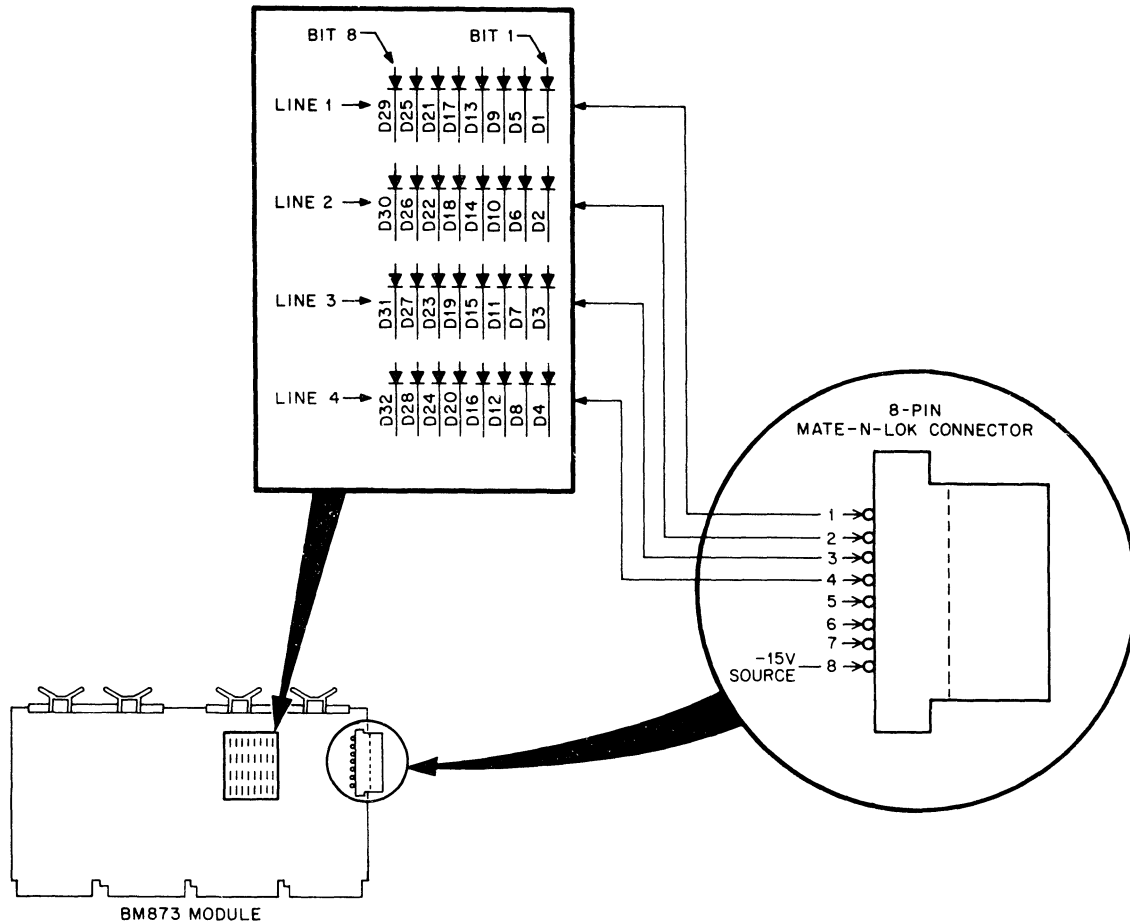


Figure 2-1 External Interface Circuit Diode Matrix

11-2406

### 2.1.2 Jumper Selection

The BM873 module contains three jumpers that are marked with the numerals 1, 2, and 3. Jumpers 1 and 2 are used to compensate for differences between the PDP-11/40 and 11/35 and all other PDP-11 family processors. Jumper 1 should be installed when the option is used with either the PDP-11/40 or the PDP-11/35. Jumper 2 should be installed for use with any other processor in the PDP-11 family. For the BM873-YD, jumper 1 is always installed and jumper 2 is always removed. Resistor R3 is also removed on the BM873-YD.

Jumper 3 controls access to an extra 128 words of ROM. When this jumper is cut, additional addresses from 773400 to 773776 become available. For the BM873-YB, -YC, and -YD versions, this jumper is always cut.

### 2.1.3 CPU Addressing with Volatile Memory

When this option is used in computers with volatile memory, the power fail trap address must be jumpered to 773224 if automatic reloading is desired.

For a PDP-11/45 CPU, install jumpers W6, W3, and W1 on the M8100 board. This will provide an address of 773224.

For a PDP-11/40 CPU, connect jumper W7 on the M7235 board for a binary 1. This jumper will provide an address of 7732XX. The last two digits are provided by jumpers 4 and 2.

## 2.2 CHECKOUT

The diagnostic program for the BM873 option is MAINDEC-11-DZBMD-D. This program starts with a dialogue and is self-explanatory. As new ROM programs are implemented, this diagnostic may be modified. However, the basic version may be used on all option variations as long as the user visually checks the ROM data following the first pass.

The diagnostic contains the instructions for its own operation. The opening dialogue establishes which option variation (-YA, -YB, etc.) is being tested.



# CHAPTER 3

## PROGRAMMING

This device is a Read-Only Memory and requires no programming. However, certain factors must be considered in system programming as the following paragraphs explain.

### 3.1 POWER FAIL PROGRAMMING

With the BM873 option installed, the power-down/power-up routines may require modification, depending on the bootstrap used. Use of the external interface causes the power-fail sequence in the CPU when AC LO is detected going low; the power-up trap program is not used, and, therefore, not restored.

This is not a problem when a bootstrap loads into core and overwrites location 24, because the new program will set up the power-fail routine. However, if the new program does not reload location 24, the next power-fail sequence (may be real) will find the power-up restore program instead of the power-down routine.

This condition can be resolved by the power-fail routine testing this option with any DATI instruction. The combination of this option and a real power-fail will cause the DATI to perform in a normal manner. The combination of this option and the external interface active (causing the AC LO and trap) will cause a nonexistent device trap (no SSYN) to location 4.

```
                MOV                #1S,@#4                ; TRAP CATCHER
                CLR                @#6
                TST                @#173000                ; DEV BLIND?
                NOP
2S:             MOV                #PWRUP,@#24            ; REAL PWR FAIL
                (SAVE ROUTINE)
1S:             HALT
```

#### Example 1

The above program works because this option goes “blind” (will not return SSYN) when it has been activated by an external interface signal. This condition continues from the assertion of AC LO until the release of DC LO.

### 3.2 REGISTER DESCRIPTION

There are no registers in this device. There are four flip-flops that can be loaded for diagnostic purposes but they cannot be read.





# CHAPTER 4

## OPTIONS

### 4.1 USER CUSTOM PROGRAM FOR THE BM873-YA

Two etched circuit positions on the BM873-YA board provide an extra 128 words of ROM. To add this extra memory capacity, Jumper 3 must be cut, permitting address recognition of all 256 words.

Figure 4-1 is a sample ROM program data sheet that can be helpful in programming the ROMs. Columns 1 and 2 contain the PDP-11 program listing. From the address data in column 1, the ROM starting address can be determined and the offset diodes cut (diode = 1; no diode = 0). The data in column 2 must be expressed in binary form as in columns 3 and 4. (Note that byte 1 is moved to the line below that of the original entry.) The eight binary digits for each byte are then shifted into columns 5 and 6 under the ROM B and ROM A headings, respectively. Columns 7 and 8 contain the resulting ROM address in binary and decimal form, respectively. Column 8 consists of four columns of decimal addresses, distinguished by the configuration of the 2 MSB of the binary address. Each program data sheet contains 64 ROM locations (32 words), hence four sheets are required to encode all 128 words. Therefore, only one of the four subcolumns of decimal addresses actually applies for each sheet, and the other three should be crossed out to avoid confusion. The 2-column checklist between columns 7 and 8 can be used for checkoff purposes, e.g., checking off ROMs as they are blasted.

A blank program data sheet is included in Chapter 6 to assist the user in programming the read-only memory of the BM873.

Customers who wish to create their own programs can purchase PROMs from integrated circuit vendors or distributors. Some distributors have programming capabilities so that programmed ROMs can be purchased. The following PROMs have been found acceptable:

Intersil type 5603A  
Monolithic Memories Inc. type 6300

The following PROMs have not been tested but according to the manufacturer's data should be acceptable. Any PROM that is specified to be "pin compatible with the 74187" should work in this application.

National Semiconductor type DM8573  
Signetics type 82S26

ROM Program Data Sheet - 32<sub>10</sub> Word Block

1 2 3 4  
 ↓ ↓ ↓ ↓  
 Address Bits 7 & 6

Choose one of four sheets. Cross out the other three address lists.

Program Listing		Octal List		ROM "B"	ROM "A"	ROM Addr.			76	76	76	76	
Addr.	Data	Byte "1"	Byte "0"	3 2 1 0	3 2 1 0	5 4 3 2 1 0	A	B	00	01	10	11	
173000	010702		11 000 010	1 1 0 0	0 0 1 0	0 0 0 0 0 0	0	✓	✓	0	64	128	192
		0 001 000 1		0 0 0 1	0 0 0 1		1	✓	✓	1	65	129	193
173002	000455		00 101 101	0 0 1 0	1 1 0 1	0 0 0 0 1 0	0	✓	✓	2	66	130	194
		0 000 000 1		0 0 0 0	0 0 0 1		1	✓	✓	3	67	131	195
173004	177462		00 110 010	0 0 1 1	0 0 1 0	0 0 0 1 0 0	0	✓		4	68	132	196
		1 111 111 1		1 1 1 1	1 1 1 1		1	✓		5	69	133	197
173006	000005		00 000 101	0 0 0 0	0 1 0 1	0 0 0 1 1 0	0	✓		6	70	134	198
		0 000 000 0		0 0 0 0	0 0 0 0		1	✓		7	71	135	199
173010	010702		11 000 010	1 1 0 0	0 0 1 0	0 0 1 0 0 0	0	✓		8	72	136	200
		0 001 000 1		0 0 0 1	0 0 0 1		1	✓		9	73	137	201
173012	000451		00 101 001	0 0 1 0	1 0 0 1	0 0 1 0 1 0	0	✓		10	74	138	202
		0 000 000 1		0 0 0 0	0 0 0 1		1	✓		11	75	139	203
173014	177406		00 000 110	0 0 0 0	0 1 1 0	0 0 1 1 0 0	0	✓		12	76	140	204
		1 111 111 1		1 1 1 1	1 1 1 1		1	✓		13	77	141	205
				0 0 0 0	0 0 0 1					14	78		206
173066	000423		00 010 011	0 0 0 1		1 1 0 1 1 0	0	✓		55	118	182	246
		0 000 000 1		0 0 0 0	0 0 0 1		1	✓		56	119	183	247
173070	176716		11 001 110	1 1 0 0	1 1 1 0	1 1 1 0 0 0	0	✓		57	120	184	248
		1 111 110 1		1 1 1 1	1 1 0 1		1	✓		58	121	185	249
173072	000005		00 000 101	0 0 0 0	0 1 0 1	1 1 1 0 1 0	0	✓		59	122	186	250
		0 000 000 0		0 0 0 0	0 0 0 0		1	✓		60	123	187	251
173074	010702		11 000 010	1 1 0 0	0 0 1 0	1 1 1 1 0 0	0	✓		61	124	188	252
		0 001 000 1		0 0 0 1	0 0 0 1		1	✓		62	125	189	253
173076	000417		00 001 111	0 0 0 0	1 1 1 1	1 1 1 1 1 0	0	✓		63	126	190	254
		0 000 000 1		0 0 0 0	0 0 0 1		1	✓			127	191	255

4-2

Figure 4-1 Sample ROM Program Data Sheet

## CHAPTER 5

### INTERFACE

The external interface consists of four separate high-impedance receivers with 4.7-kilohm resistors in series with each one. A -15 V source is provided through 10 kilohms to facilitate the use of contact closures. The external interface also accepts single-ended voltage inputs. A signal of 0.5 mA at -4 V or greater will cause a Restart sequence. The maximum permissible input is  $\pm 25$  V.

These inputs are filtered with RC networks and Schmitt triggers and have a time delay of approximately 10 to 15 ms. The signal must remain for at least 150 ms. Only one external line may be active at a time; two or more active at the time of the sample will cause a race condition until one wins, but the result will be indeterminate.

The interface connector is an 8-pin male Mate-N-Lok (DEC Part Number 12-09340-01). Five pins (DEC Part Number 12-09378) are required for connection-placed as shown in Figure 2-1.



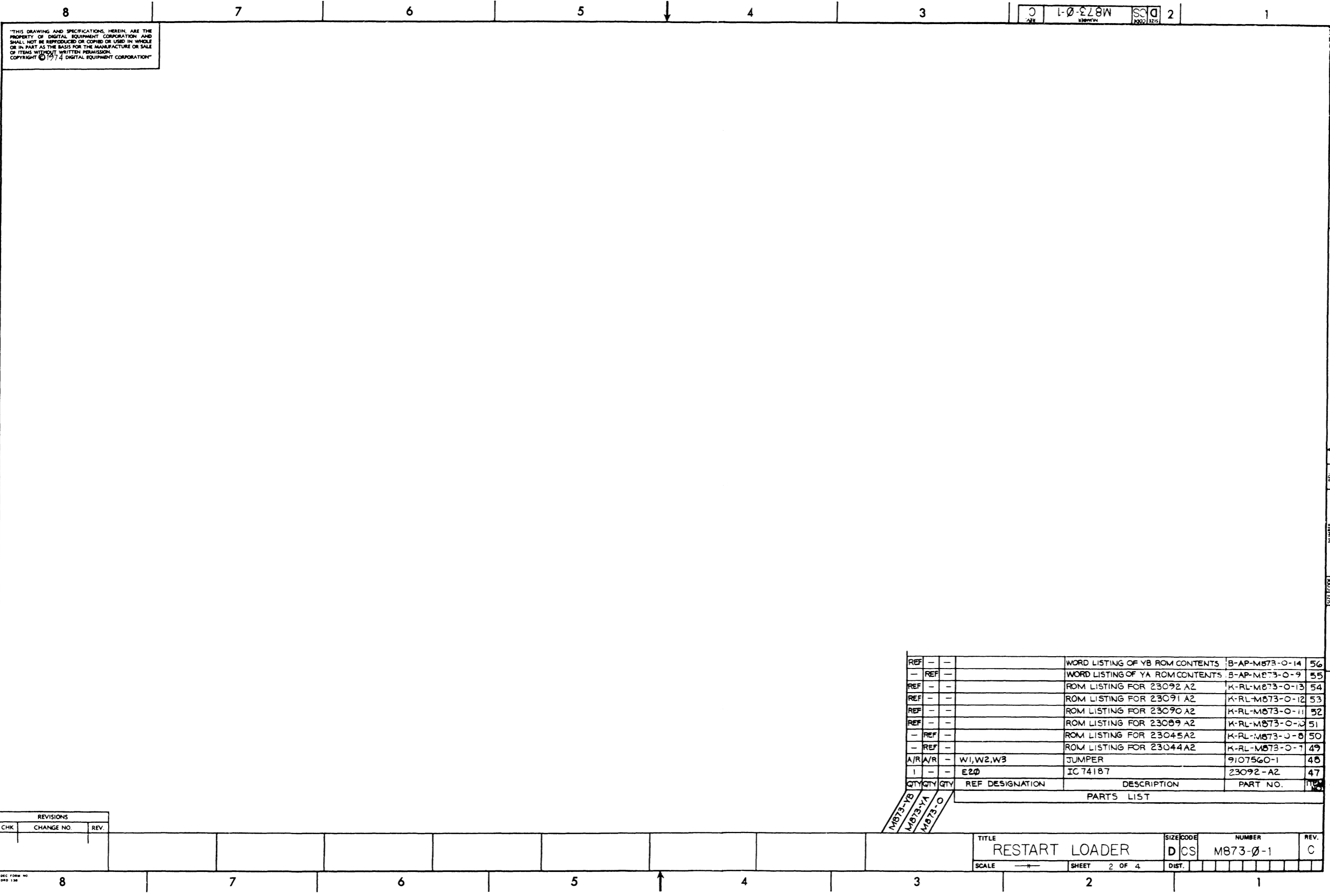
## CHAPTER 6

# ENGINEERING DRAWINGS

This chapter contains the 4-sheet engineering drawing of the BM873 (D-CS-M873-0-1) and a blank program data sheet for use in programming the read-only memory of this option. Use of these sheets is described in Chapter 4 of this manual.







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0 1-0-328W SC D 2 1

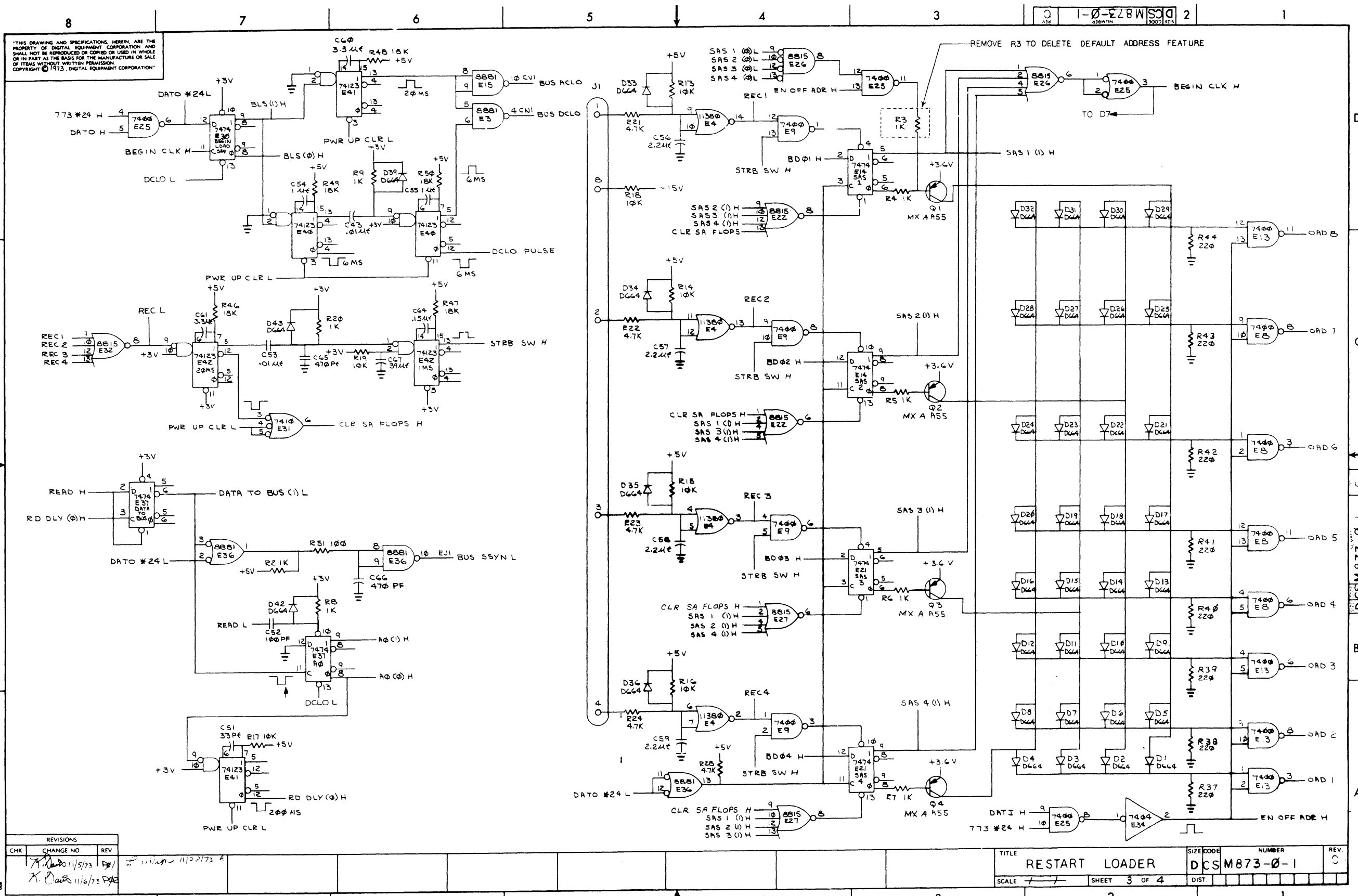
REF	-	-	WORD LISTING OF YB ROM CONTENTS	B-AP-M873-0-14	56	
-	REF	-	WORD LISTING OF YA ROM CONTENTS	B-AP-M873-0-9	55	
REF	-	-	ROM LISTING FOR 23092 A2	K-RL-M873-0-13	54	
REF	-	-	ROM LISTING FOR 23091 A2	K-RL-M873-0-12	53	
REF	-	-	ROM LISTING FOR 23090 A2	K-RL-M873-0-11	52	
REF	-	-	ROM LISTING FOR 23089 A2	K-RL-M873-0-10	51	
-	REF	-	ROM LISTING FOR 23045A2	K-RL-M873-0-8	50	
-	REF	-	ROM LISTING FOR 23044A2	K-RL-M873-0-7	49	
A/R	A/R	-	W1,W2,W3	JUMPER	9107560-1	48
1	-	-	E20	IC 74187	23092-A2	47
QTY	QTY	QTY	REF DESIGNATION	DESCRIPTION	PART NO.	REV.

M873-YB  
M873-YA  
M873-O

PARTS LIST			
TITLE	SIZE CODE	NUMBER	REV.
RESTART LOADER	D CS	M873-0-1	C
SCALE	SHEET	DIST.	
+	2 OF 4		

REVISIONS		
CHK	CHANGE NO.	REV.





REVISIONS		
CHK	CHANGE NO	REV
	1	11/5/73
	2	11/6/73

TITLE	RESTART LOADER	SIZE CODE	DCSM873-0-1	NUMBER		REV	C
SCALE	10	SHEET	3 OF 4	DIST			



ROM Program Data Sheet - 32<sub>10</sub> Word Block

1 2 3 4  
 ↓ ↓ ↓ ↓  
 Address Bits 7 & 6

Program Listing		Octal List		ROM "B"	ROM "A"	ROM Addr.			7 6	7 6	7 6	7 6
Addr.	Data	Byte "1"	Byte "0"	3 2 1 0	3 2 1 0	5 4 3 2 1 0	A	B	00	01	10	11
						0 0 0 0 0 0			0	64	128	192
							1		1	65	129	193
						0 0 0 0 1 0			2	66	130	194
							1		3	67	131	195
						0 0 0 1 0 0			4	68	132	196
							1		5	69	133	197
						0 0 0 1 1 0			6	70	134	198
							1		7	71	135	199
						0 0 1 0 0 0			8	72	136	200
							1		9	73	137	201
						0 0 1 0 1 0			10	74	138	202
							1		11	75	139	203
						0 0 1 1 0 0			12	76	140	204
							1		13	77	141	205
						0 0 1 1 1 0			14	78	142	206
							1		15	79	143	207
						0 1 0 0 0 0			16	80	144	208
							1		17	81	145	209
						0 1 0 0 1 0			18	82	146	210
							1		19	83	147	211
						0 1 0 1 0 0			20	84	148	212
							1		21	85	149	213
						0 1 0 1 1 0			22	86	150	214
							1		23	87	151	215
						0 1 1 0 0 0			24	88	152	216
							1		25	89	153	217
						0 1 1 0 1 0			26	90	154	218
							1		27	91	155	219
						0 1 1 1 0 0			28	92	156	220
							1		29	93	157	221
						0 1 1 1 1 0			30	94	158	222
							1		31	95	159	223
						1 0 0 0 0 0			32	96	160	224
							1		33	97	161	225
						1 0 0 0 1 0			34	98	162	226
							1		35	99	163	227
						1 0 0 1 0 0			36	100	164	228
							1		37	101	165	229
						1 0 0 1 1 0			38	102	166	230
							1		39	103	167	231
						1 0 1 0 0 0			40	104	168	232
							1		41	105	169	233
						1 0 1 0 1 0			42	106	170	234
							1		43	107	171	235
						1 0 1 1 0 0			44	108	172	236
							1		45	109	173	237
						1 0 1 1 1 0			46	110	174	238
							1		47	111	175	239
						1 1 0 0 0 0			48	112	176	240
							1		49	113	177	241
						1 1 0 0 1 0			50	114	178	242
							1		51	115	179	243
						1 1 0 1 0 0			52	116	180	244
							1		53	117	181	245
						1 1 0 1 1 0			54	118	182	246
							1		55	119	183	247
						1 1 1 0 0 0			56	120	184	248
							1		57	121	185	249
						1 1 1 0 1 0			58	122	186	250
							1		59	123	187	251
						1 1 1 1 0 0			60	124	188	252
							1		61	125	189	253
						1 1 1 1 1 0			62	126	190	254
							1		63	127	191	255

Choose one of four sheets. Cross out the other three address lists.



# APPENDIX A

## DEVICE STARTING ADDRESSES

**BM873-YA Starting Addresses**

Address	Device Type
773000	RF11 DECdisk
773010	RK11 Disk
773020	Transfer to address contained in switch register
773030	TC11 DECtape
773050	TM11 DECmagtape
773100	RP11 Disk Pack
773144	RC11 Disk
773210	KL11/DC11 Console TTY Reader
773230	TA11 Cassette
773312	PC11 Paper Tape Reader

**BM873-YB Starting Addresses**

Address	Device Type
773000	RH11/RS03/RS04 Disk (Unit zero)
773002	RH11/RS03/RS04 Disk (Unit specified in switch register)
773030	RK11 Disk (Unit zero)
773032	RK11 Disk (Unit specified in switch register)
773070	TC11 DECtape
773110	TM11 DECmagtape
773136	RF11 DECdisk
773150	RH11/TU16/TM02 Tape Drive
773212	RC11 Disk
773230	RH11 Device Combination (Unit zero)*
773231	RH11 Device Combination (Unit specified in switch register)
773320	RH11/RP04 Disk (Unit zero)
773322	RH11/RP04 Disk (Unit specified in switch register)
773344	Transfer to address contained in switch register
773350	RP11 Disk Pack (Unit zero)
773352	RP11 Disk Pack (Unit specified in switch register)
773510	KL11/DL11 Console TTY Reader
773524	TA11 Cassette (Unit zero)
773526	TA11 Cassette (Unit specified in switch register)
773620	PC11 Paper Tape Reader

\*If the TM02/TU16 is selected, the value in the console switch register is the position of the TM02 on the RH11, instead of the unit number on the TU16 drive. The slave unit number (number on TU16) should still be zero.

**BM873-YC Starting Addresses**

<b>Address</b>	<b>Device Type</b>
773000	RF11 DECdisk
773010	RK11 Disk
773020	Transfer to address contained in switch register
773030	TC11 DECTape
773050	TM11 DECmagtape
773100	RP11 Disk Pack
773144	RC11 Disk
773210	KL11/DC11 Console TTY Reader
773230	TA11 Cassette
773312	PC11 Paper Tape Reader
773400	DU11 Synchronous Interface

**BM873-YD Starting Addresses**

<b>Address</b>	<b>Device Type</b>
773000	Transfer to address contained in switch register
773014	TC11 DECTape
773304	RH11/RP04 Disk
773534	DTE20 10/11 Interface

# Reader's Comments

BM873 RESTART/LOADER  
EK-BM873-TM-004

Your comments and suggestions will help us in our continuous effort to improve the quality and usefulness of our publications.

What is your general reaction to this manual? In your judgment is it complete, accurate, well organized, well written, etc.? Is it easy to use? \_\_\_\_\_

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What features are most useful? \_\_\_\_\_

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What faults do you find with the manual? \_\_\_\_\_

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Does this manual satisfy the need you think it was intended to satisfy? \_\_\_\_\_

Does it satisfy *your* needs? \_\_\_\_\_ Why? \_\_\_\_\_

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Would you please indicate any factual errors you have found. \_\_\_\_\_

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Please describe your position. \_\_\_\_\_

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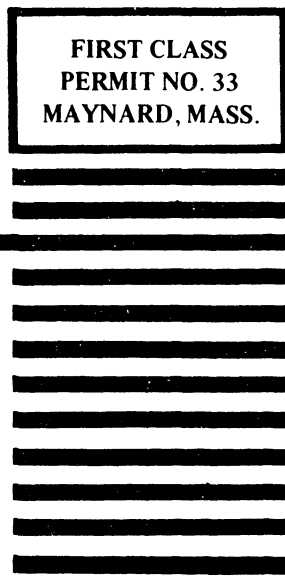
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