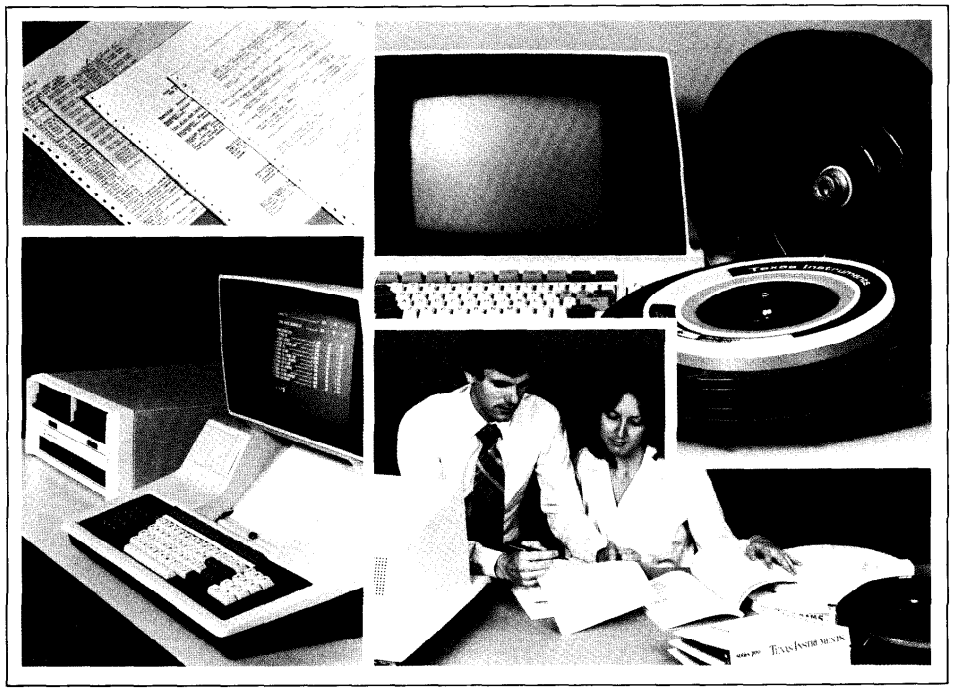
Model 990 Computer
Universal ROM Loader
User's Guide



Part No. 2270534-9701 **
15 April 1980

TEXAS INSTRUMENTS

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MANUAL REVISION HISTORY

Model 990 Universal ROM Loader User's Guide (2270534-9701)

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Preface

This manual describes the operation of the universal ROM loader for the Model 990/5, Model 990/10, and Model 990/12 Computers. The manual is directed to the operator (or person performing the operator function) who loads an operating system using the ROM loader.

The manual consists of the following sections:

Section

1 Introduction — Describes the universal ROM Loader.

2 Operation — Describes procedures for loading a system using the loader.

3 Errors — Describes the error displays provided by the loader.

The following Model 990 Computer manuals contain information related to the universal ROM loader:

Title	Part Number
Model 990/5 Computer Hardware User's Manual	946294-9701
Model 990/10 Computer System Field Maintenance Manual	945402-9701
Model 990/12 Computer Hardware User's Manual	226444-9701

The following Model 990 Computer manuals contain information about devices from which the universal ROM loader loads the system:

Title	Part Number
Model DS31/32 Disk System Installation and Operation	945260-9701
Model DS10 Cartridge Disk System Installation and Operation	946261-9701
DS25/DS50 Disk Systems Installation and Operation	946231-9701
Model DS200 Disk System Installation and Operation	949615-9701
Model FD1000 Flexible Disk System with International Chassis Installation and Operation	2250698-9701

Title	Part Number
Model 979A Magnetic Tape System Installation and Operation	946229-9701
Model FD800 Floppy Disk System Installation and Operation	945253-9701
Model 733 ASR/KSR Data Terminal Installation and Operation	945259-9701

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1

Introduction

The universal ROM loader is a replacement for several types of ROM loaders that were provided with Model 990 Computers. The loader consists of a set of ROM integrated circuits that contain a loader, a self-test routine, and the front panel routine for a Model 990/5, Model 990/10, or Model 990/12 Computer.

The universal ROM loader is universal in that the set of devices from which an operating system may be loaded is the same for all three computers. The set of devices includes:

- Disk units
- FD1000 diskette unit
- FD800 diskette unit
- Cassette unit
- Magnetic tape unit
- Maintenance diagnostic unit (MDU) cassette

When loading from a hard disk or from a double-sided, double-density diskette, the loader loads memory image code. Track 0, sector 0 contains three parameters for the loader: the memory image track number, the entry point, and the length of the block of code (in bytes). The track number is in a word at byte address >0E relative to the start of sector 0, and also in a word at byte address >24. The entry point (the address in memory to which the loader transfers control) is at byte address >18. The length is in the following word, at byte address >1A.

The universal ROM loader offers an option when loading from a hard disk or from a double-sided, double-density diskette. An alternate program may be loaded one time by placing the loader parameters for the alternate program in track 0, sector 0. Place the alternate program memory image track number in a word at byte address >0E, the entry point of the alternate program in a word at byte address >1C, and the length of the alternate program in a word at byte address >1E. The contents of the words at byte addresses >18, >1A, and >24 (normal program load point, length, and track address, respectively) remain unaltered.

When loading from a single-sided diskette (on an FD800 unit), the loader loads memory image code from track 0. The last word of each sector is a flag, not code. When the last word of a sector is not equal to >FFFF, loading continues. When the last word of a sector is equal to >FFFF, the loader moves the device number into the load address, >A0, and transfers control to the instruction that has been loaded into address >A2.

When loading from magnetic tape or cassette (either from a 733 ASR or the MDU cassette unit), the loader loads object code.

Prior to loading, the loader executes a self-test routine appropriate for the computer. Then the loader stores the code from the load medium in the memory of the computer and transfers control to the code it has loaded.

2

Operation

2.1 OPTIONS

When the programmer panel is connected, the universal ROM loader loads a routine from disk unit 0 on the controller at TILINE* address >F800 by default. The user can alter the contents of addresses in memory to select another disk unit, to select a magnetic tape unit, or to select another device. When the specified disk unit or tape unit is not ready, the loader waits for the device to be made ready.

When the operator panel is connected, the loader attempts to load a routine from a magnetic tape unit on a controller at TILINE address >F880, or from a disk unit at TILINE address >F800. The sequence of units from which the loader attempts to load the system is:

1. The lowest-numbered ready tape unit, if any.
2. The lowest-numbered ready and write-protected disk unit, if any.
3. The lowest-numbered ready disk unit.

When no device is ready, the loader continues to attempt to locate a ready device. Mounting a tape or disk and making it ready causes the loader to load from the tape or disk.

The loader attempts to load a routine from the maintenance diagnostic unit (MDU) cassette unit whenever the MDU is connected. Operation of the MDU is described in the *Model 990/10 Computer System Field Maintenance Manual.*

In this manual, the device in which the load medium is mounted is referred to as the load device. The load medium is the disk, diskette, magnetic tape reel, or cassette that contains the software to be loaded. Load procedures for loading software using every device and option are described in the following paragraphs.

2.2 LOADING FROM A DISK

Before performing any of the following disk loading procedures, the load disk must be mounted and the load device must be ready. These procedures apply to double-sided, double-density diskettes, mounted in FD1000 diskette units connected to a TILINE controller, and to the various types of hard disks used with Model 990 computers.

The disk may be write-protected. However, the software being loaded often requires that write protection be off.

* TILINE is a registered trademark of Texas Instruments Incorporated.

2.2.1 Using the Programmer Panel

The switches on the programmer panel may select the load device and the indicators display any error codes issued by the self-test or the loader.

2.2.1.1 Default Disk Unit. The default disk unit is unit 0 of the disk controller at TILINE address >F800.

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.
2. Press the RESET switch.
3. Press the LOAD switch.

2.2.1.2 Specific Disk Unit. This procedure applies when the load device is a disk unit other than unit 0 on the disk controller at TILINE address >F800.

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.
2. Press the RESET switch.
3. Press the CLR switch.
4. Set the data switches to >0084.
5. Press the MA switch under ENTER.
6. Press the CLR switch.
7. Set the data switches to the select code shown in Table 2-1 for the load device.
8. Press the MDE switch.
9. Press the LOAD switch.

Table 2-1. Disk Unit Select Codes

Disk Unit	Select Code
0	>0800
1	>0400
2	>0200
3	>0100

2.2.1.3 Different Controller Address. This procedure is appropriate when the disk controller (or the one that controls the desired disk unit) is not at TILINE address >F800.

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.
2. Press the RESET switch.
3. Press the CLR switch.
4. Set the data switches to >0082.
5. Press the MA switch under ENTER.
6. Press the MDD switch.
7. Set the data switches to the TILINE address of the desired disk controller.
8. Press the MDE switch.
9. Press the MAI switch.
10. Set the data switches to the select code shown in Table 2-1 for the load device.
11. Press the MDE switch.
12. Press the LOAD switch.

2.2.2 Using the Operator Panel

The operator panel does not provide any means of selecting the load device. Therefore, selecting the disk unit requires that magnetic tape units and other disk units not be ready. Alternatively, the load device is the lowest-numbered write-protected disk unit. The software being loaded often attempts to write to the load device, however. The load device must be connected to the controller at TILINE address >F800.

To load a routine, perform the following steps:

1. Ensure that no magnetic tape unit connected to the controller at TILINE address >F880 is ready.
2. Ensure that no disk unit on the controller at TILINE address >F800 is write-protected, except the load device.
3. Ensure that no disk unit on the controller at TILINE address >F800 that has a number lower than that of the load device is ready.
4. Turn the key switch on the operator panel to the LOAD position and release.

2.3 LOADING FROM MAGNETIC TAPE

Before performing either of the magnetic tape load procedures, mount the load magnetic tape reel, position the tape at the load point, and make the tape unit ready.

2.3.1 Using the Programmer Panel

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.
2. Press the RESET switch.
3. Press the CLR switch.
4. Set the data switches to >0082.
5. Press the MA switch under ENTER.
6. Press the MDD switch.
7. Set the data switches to the TILINE address of the desired magnetic tape controller (typically, >F880).
8. Press the MDE switch.
9. Press the MAI switch.
10. Set the data switches to the select code shown in Table 2-2 for the load device.
11. Press the MDE switch.
12. Press the LOAD switch.

Table 2-2. Tape Unit Select Codes

Tape Unit	Select Code
0	>8000
1	>4000
2	>2000
3	>1000

2.3.2 Using the Operator Panel

The operator panel provides no means of selecting the load device. Therefore, selecting the load device requires that lower-numbered magnetic tape units not be ready. The load device must be connected to the controller at TILINE address >F880.

To load a routine, perform the following steps:

1. Ensure that all magnetic tape units on the controller at TILINE address >F880 that have numbers lower than that of the load device are not ready.

2. Turn the key switch on the operator panel to the LOAD position and release.

2.4 LOADING FROM SINGLE-SIDED DISKETTE

Before attempting to load from a diskette, verify that the diskette controller is installed at CRU address >0080, that the load diskette is mounted, and that the diskette unit is in the ready state. Diskette unit 0 must be the load device, or the units with numbers lower than that of the load device must not be ready.

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.

2. Press the RESET switch.

3. Press the CLR switch.

4. Set the data switches to >0080.

5. Press the MA switch under ENTER.

6. Press the MDE switch.

7. Press the LOAD switch.

2.5 LOADING FROM A CASSETTE

To load software into a Model 990/10 or Model 990/12 Computer from a cassette, the 733 ASR must be at CRU address >0000; to load software into a Model 990/5 Computer, the 733 ASR must be at CRU address >1700. The load cassette must be mounted in the playback cassette unit as determined by the position of the RECORD/PLAYBACK switch on the 733 ASR switch panel. The cassette tape must be positioned at the load point by rewinding to the beginning of the tape and pressing the LOAD switch for the cassette unit. The TAPE FORMAT switch on the switch panel must be set to the LINE position.

To load a routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.

2. Press the RESET switch.

3. Press the CLR switch.

4. Set the data switches to >0080.

5. Press the MA switch under ENTER.
6. Press the CLR switch.
7. Press the MDE switch.
8. Press the LOAD switch.

2.6 LOADING FROM THE MAINTENANCE DIAGNOSTIC UNIT

To load software from the maintenance diagnostic unit (MDU), verify that the MDU has been connected in place of the programmer panel or operator panel of the computer. Mount the load cassette in the MDU cassette unit.

To load from the MDU cassette, perform the following steps:

1. Press the RESET switch on the MDU.
2. Press the REWIND switch on the MDU.
3. Press the HALT/SIE switch on the programmer panel of the MDU.
4. Press the RESET switch on the programmer panel of the MDU.
5. Press the LOAD switch on the MDU — *not the MDU programmer panel.*

3

Errors

3.1 TYPES OF ERRORS

The universal ROM loader contains a self-test that is executed prior to executing the loader. The self-test exercises the computer to determine that it is sufficiently operational to load and execute software. If not, the self-test displays error indications and halts without performing the load operation. The error indications are displayed on the programmer panel and are supplemented by error indicators on the circuit boards of the computer. The tests, and therefore the errors, differ for each computer. The self-test errors are described in the paragraphs that immediately follow.

The paragraphs following those that describe the self-test errors list the loader errors. Loader error codes are displayed on the programmer panel.

3.2 SELF-TEST ERRORS

The self-test for the Model 990/5 Computer tests the following:

- The CPU
- Memory
- I/O ports
- ROM checksum

The CPU test exercises CPU instructions. The memory test checks all memory locations through >F7FE except for the workspace used by the self-test routine. The I/O port test exercises the TMS9902 and TMS9903 I/O ports in the test mode provided in the port circuitry. The ROM checksum test verifies the integrity of the contents of the universal ROM loader.

The self-test for the Model 990/10 Computer verifies the integrity of the contents of the universal ROM loader.

The self-test for the Model 990/12 Computer tests the following:

1. Microcode
2. Assembly language instructions
3. TILINE operation
4. Memory

5. Level 2 (internal) interrupt

6. Levels 3 through 15 (external) interrupts

The microcode test executes an Execute Micro Diagnostic (EMD) instruction to test the microcode. The assembly language instructions test exercises assembly language instructions. The TILINE operation test exercises the TILINE addressing and mapping circuitry. The memory test exercises locations >00000 through >000FE, >00120 through >0F7FE, and >10000 through >1FFFE. The internal interrupt test checks that an interrupt actually occurs for each internal error condition, and the interrupt sets the error interrupt status register correctly. The external interrupt test verifies that the interrupt priority is observed and that lower priority pending interrupts occur when higher priority interrupt processing has completed.

3.2.1 Model 990/5 Computer Self-Test Errors

When the CPU test fails, the computer enters a loop. The display on the programmer panel is undefined; the RUN and FAULT indicators are lit. The loader cannot be executed until the CPU has been repaired.

When the memory test fails, the self-test flashes the failing memory address on the programmer panel display. The address is displayed five times, with the FAULT indicator off. Then the IDLE, FAULT, and RUN indicators are lit. Press HALT and RUN to execute the loader.

To display the failing memory address (in register R7 of the self-test workspace), press the HALT/SIE switch and the MA switch under DISPLAY on the programmer panel.

When the I/O port test fails, the self-test flashes the CRU address of the failing I/O port on the programmer panel display five times, with the FAULT indicator lit. Then the IDLE and RUN indicators are lit also. Press HALT and RUN to execute the loader.

To display the CRU address of the failing I/O port (in register R7 of the self-test workspace), press the HALT/SIE switch and the MA switch under DISPLAY on the programmer panel.

When the ROM checksum test fails, the computer enters a loop with >FFFF displayed on the programmer panel, the RUN indicator lit, and the FAULT indicator flashing.

3.2.2 Model 990/10 Computer Self-Test Errors

When the Model 990/10 Computer self-test fails, the computer enters a loop with >FFFF displayed on the programmer panel, the RUN indicator lit, and the FAULT indicator flashing.

3.2.3 Model 990/12 Computer Self-Test Errors

Errors in executing the Model 990/12 self-test are indicated on the programmer panel and on the fault indicators on the AU and SMI boards of the CPU. Table 3-1 lists the error codes displayed on the programmer panel and the number of the test, as shown in paragraph 3.2.

When an error occurs in a subtest, the FAULT indicator on the programmer panel is lit; additional indicators may be lit as shown in Table 3-1.

Table 3-1. Model 990/12 Computer Self Test Errors

Error Code (Hexadecimal)	RUN	AU Fault	SMI Fault	Lock-Up	Test
0000	Off	Off	Off	Yes	1
0000	Off	On	Off	Yes	1
0000	Off	Off	On	Yes	1
0100	On	Off	Off	Yes	2-6
0200	On	Off	Off	No	2-6
0400	On	Off	Off	No	2
0800	On	Off	Off	No	3
1000	On	Off	Off	No	4
2000	On	Off	Off	No	5
4000	On	Off	Off	No	6

When the load device is the MDU cassette, the RUN indicator on the programmer panel remains off; furthermore, the procedure (in a subsequent paragraph) for executing the loader without having successfully completed the self-test does not apply. The only recovery when loading from the MDU cassette is to repair the computer.

To repair the computer, notice the fault indicators on the AU and SMI boards. If the fault indicator on either board is lit, replace that board. If the fault indicators on both boards are lit, or if the indicators are both off, replace both boards.

Four of the errors leave the computer locked up. In the lock up condition, the computer is executing microcode without returning to the instruction level. The HALT/SIE switch on the programmer panel cannot transfer control to the programmer panel routine. That is, none of the switches on the programmer panel affect the operation of the computer. You must turn the AC power to the computer off, and then on, to recover from a lock-up. The AC power switch is at the rear of the computer chassis.

To load software when the self-test has failed, you may enter the loader routine at the starting address and execute the loader. The hardware failure that caused the self-test to fail may interfere with proper loading and/or execution of the software. The failure may also destroy the software being loaded, or other data on the medium from which the software is loaded. The following procedure does not apply when software is being loaded from the MDU cassette.

CAUTION

Do not attempt to execute the loader following a self-test failure without repairing the CPU unless you have a backup copy of the load medium.

To execute the loader routine, perform the following steps at the programmer panel:

1. Press the HALT/SIE switch.
2. Press the CLR switch.
3. Set the data switches to >0080.
4. Press the MA switch under ENTER.
5. Press the MDD switch to display the contents of address >0080.
   a. When loading from a disk, double-sided diskette, or magnetic tape, skip to step 8 if the display shows a negative number.
   b. When loading from a single-sided diskette, skip to step 16 if the display shows a positive number.
   c. When loading from a 733 ASR cassette, skip to step 16 if the display shows zero.
6. Perform the substep that applies to the loading device:
   a. When loading from a disk, double-sided diskette, or magnetic tape, set the data switches to >8000.
   b. When loading from a single-sided diskette, press the MA switch under DISPLAY.
   c. When loading from a 733 ASR cassette, press the CLR switch.
7. Press the MDE switch. When loading from a single-sided diskette or a 733 ASR cassette, skip to step 16.
8. Press the MAI switch.
9. Press the MDD switch to display the TILINE address of the loading device. The typical TILINE address is >F800 for disk or double-sided diskette, or >F880 for magnetic tape. *When the address is correct, skip to step 12.*
10. Set the data switches to the correct TILINE address.
11. Press the MDE switch.
12. Press the MAI switch.

13. Press the MDD switch to display the unit select code. The correct codes are:

Disk unit 0	>0800
Disk unit 1	>0400
Disk unit 2	>0200
Disk unit 3	>0100
Tape unit 0	>8000
Tape unit 1	>4000
Tape unit 2	>2000
Tape unit 3	>1000

When the unit select code is correct, skip to step 16.

14. Set the data switches to the correct unit select code.
15. Press the MDE switch.
16. Set the data switches to >FC1C.
17. Press the PC switch under ENTER.
18. Press the RUN switch.

3.3 LOADER ERRORS

Loader error indications are displayed on the programmer panel; the displays are the same for all computers, but different for different load devices.

When the load device is a disk or double-sided diskette unit, a loader error causes the RUN indicator to remain lit, the FAULT indicator to flash, and the display to contain a value other than >FFFF. The value is an error code listed in Table 3-2.

Table 3-2. Disk Loader Error Codes

Error Code (Hexadecimal)	Meaning
0XXX	Controller error. The status bits from the controller are represented by XXX.
XX00	Unit error. The unit status bits from the controller are represented by XX.
D001	The disk does not contain software on track 1 that the loader can load. The byte count in track 0, sector 0, is zero.

The controller status bits and unit status bits returned by the controller are described in the installation and operation manual for the specific disk or diskette unit. These manuals are listed in the Preface.

When the load device is a magnetic tape unit, a loader error causes the RUN indicator to remain lit, the FAULT indicator to flash, and the display to contain a value other than >FFFF. The value is an error code listed in Table 3-3.

Table 3-3. Tape Loader Error Codes

Error Code (Hexadecimal)	Meaning
0XXX	Controller error. The status bits from the controller are represented by XXX.
XX00	Unit error. The unit status bits from the controller are represented by XX.
XXXX	Error in reading record XXXX.

The controller status bits and unit status bits returned by the controller are described in the installation and operation manual for the tape unit, listed in the Preface.

When the load device is a cassette unit (733 ASR or MDU), a loader error causes the RUN indicator to remain lit, the FAULT indicator to flash, and the display to contain a value other than >FFFF. The value is the number of the record in the file being loaded in which the failure occurred.

When the load device is a single-sided diskette unit, a loader error causes the RUN indicator to remain lit, the FAULT indicator to flash, and the display to contain a value other than >FFFF. The value is the status word returned by the FD800 controller. The status word is described in the installation and operation manual for the diskette unit, listed in the Preface.

USER'S RESPONSE SHEET

Manual Title: Model 990 Computer Universal ROM Loader User's Guide (2270534-9701)

Manual Date: 15 April 1980 **Date of This Letter:** _____

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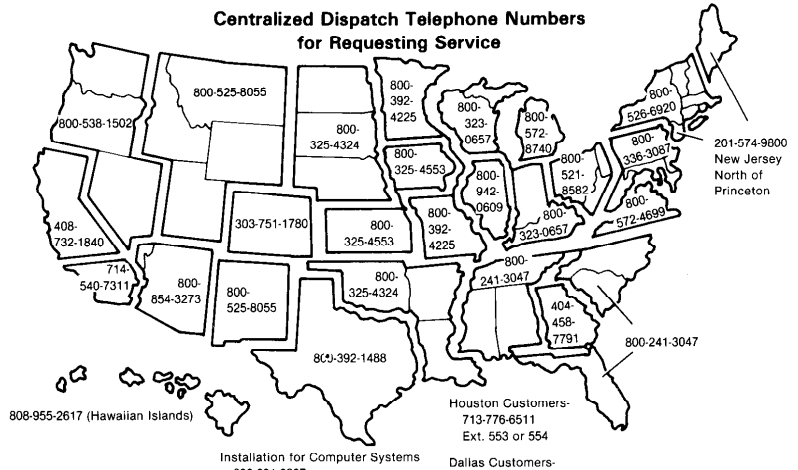

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