

CONTROL DATA INSTITUTE
CONTROL DATA CORPORATION

MAGNETIC RECORDING EQUIPMENT TAPE

STUDENT MANUAL

FOREWORD

The Magnetic Recording Equipment Tape Student Manual is a training supplement for the study of magnetic tape equipment. It should be used in conjunction with your training manual as you progress through the course.

The knowledge you have gained already will be valuable for the study of magnetic recording. Try to establish connections between the operation of the mechanical and electrical components of the equipment. Remember that the laboratory sessions are of vital importance for a complete understanding of the material. Be sure to read the laboratory projects prior to attempting the laboratory. Have the objectives in mind, find out what is to be done and the purpose for it before you begin.

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INTRODUCTION TO MAGNETIC TAPE,
TAPE PATH, AND INTRODUCTION

INTRODUCTION

Every customer engineer will probably find himself responsible for the maintenance of a magnetic tape transport. Prevalence of the magnetic tape transport in the computer field as well as the number of transports per system assures the engineer many hours of experience. A good background in the basic principles of magnetic tape transports will make the equipment of any manufacturer an easier learning task. Review the introductory material on magnetic tape that was studied during the central processor portion of the course.

ASSIGNMENT

Prior to Day 2

Magnetic Tape Storage Training Manual: Pages 1-1-1 through 1-2-11, 2-1-1 through 2-1-13; questions 1 through 14 (page 2-5-50)

OBJECTIVES

Upon completion of this session you will be able to:

1. Define and describe the following terms.
 - a. Erasability
 - b. Accessibility
 - c. Capacity
 - d. Access time
 - e. Transfer rate
 - f. Frame
 - g. Record
 - h. File mark
 - i. Load-point marker
 - j. End-of-tape marker
2. Describe the basic magnetic principles that make magnetic recording possible.
3. Explain the concept of nonreturn to zero indiscrete (NRZI) recording.
4. Trace the process of the recording a block of data on magnetic tape.
5. List and describe the components along the tape path through the transport.
6. Describe tape motion through the transport.

OUTLINE

1. History and Purpose of Magnetic Tape
 - 1.1 History
 - 1.2 Definitions
2. Magnetic Theory and Tape Construction
 - 2.1 Basic magnetic principles
 - 2.2 Magnetic tape construction
3. Recording Schemes
 - 3.1 NRZI
 - 3.2 Double-frequency modulation
4. Recording Heads
 - 4.1 Introduction
 - 4.2 Types of heads
 - 4.3 Card and alignment of heads
5. Tape Formats
 - 5.1 Term definition
 - 5.2 Record layout
6. Tape Path Diagram
 - 6.1 Tape transport characteristics
 - 6.2 Tape motion and control
 - 6.3 Definition of tape movements
7. Demonstration of Operation

TAPE PATH DESCRIPTION AND FAMILIARIZATION

INTRODUCTION

The material for today is designed as a familiarization period. You will learn more about the specific components that process the magnetic tape through the transport, and then you will locate and identify a number of components within the transport. The last portion of the day is an introduction to the logic of the equipment. Each manufacturer uses different methods of logic construction, but the basic actions of the transport are fundamental. Learning one method will make the other methods much easier.

ASSIGNMENT

Prior to Day 3

Magnetic Tape Storage Training Manual: Pages 2-2-1 through 2-2-31, 2-5-48 and 2-5-49

OBJECTIVES

Upon completion of this session you will be able to:

1. Locate and identify any major component in the tape transport.
2. Demonstrate proper procedures when loading and unloading tape.
3. Correctly operate the operator control panel.
4. Describe the purpose of the pneumatic system and name the functional areas served by pressure and vacuum.

OUTLINE

1. Tape Path Description
 - 1.1 Tape motion and control
 - 1.2 Identification and description of components
 - 1.3 Pneumatic system
2. Laboratory, Component Location
 - 2.1 Instructions
 - 2.2 Student practice
3. Logic Introduction
 - 3.1 Signal interface
 - 3.2 Numbering system
 - 3.3 Overview

COMPONENT LOCATION LABORATORY

OBJECTIVES

Upon Completion of this laboratory session you will be able to:

1. Locate and identify any major component in the tape transport.
2. Demonstrate proper procedures when loading and unloading tape.
3. Correctly operate the operator control panel.

EQUIPMENT REQUIRED

Tape transport
Scratch tape

INSTRUCTIONS

1. For each of the components in Table 2.1, you are to:
 - a. Locate it and describe the location.
 - b. Define its function as a part of the machine.

TABLE 2.1. TAPE TRANSPORT COMPONENTS

COMPONENT	LOCATION	FUNCTION AND DEFINITION
1. Operator panel		
2. Magnetic head		
3. Pressure pad		
4. Brake port		

TABLE 2.1. TAPE TRANSPORT COMPONENTS (Cont)

COMPONENT	LOCATION	FUNCTION AND DEFINITION
5. Drive capstans		
6. Tape cleaners		
7. Tachometers		
8. Fault ports		
9. Overhead light		
10. Loop box lamps		
11. Loop box plenum		
12. Line vacuum gauge		

TABLE 2.1. TAPE TRANSPORT COMPONENTS (Cont)

COMPONENT	LOCATION	FUNCTION AND DEFINITION
13. Line pressure gauge		
14. Unit select light		
15. Maintenance panel		
16. Capstan motor		
17. Loop box blower		
18. Rotary pump system		
19. Power supply		
20. Cooling blower motor		

TABLE 2.1. TAPE TRANSPORT COMPONENTS (Cont)

COMPONENT	LOCATION	FUNCTION AND DEFINITION
21. Stripper		
22. Read logic chassis		
23. End-of-tape sensor		
24. Load-point sensor		
25. Differential pressure switch		
26. Valve panel		
27. Reel motors and brakes		

2. Refer to page 2-2-9 in the Magnetic Tape Storage Training Manual and follow the procedure for mounting the tape reel.
 - a. Mount the tape.
 - b. Perform the load operation.
 - c. Note the effect of the switches and indicators as listed on page 2-2-12 of the manual.

POWER SUPPLY AND LOGIC ANALYSIS OF CAPSTAN DRIVE AND
BRAKE CONTROL, TAPE MOTION LOGIC, AND SERVO CONTROL LOGIC

INTRODUCTION

The purpose of this session is to describe the way that the tape transport controls tape movement. Review the transport mechanics that control tape motion.

ASSIGNMENT

Prior to Day 4

Magnetic Tape Storage Training Manual: Pages 2-4-1 through 2-4-3, 2-5-1 through 2-5-14, 2-5-22 through 2-5-31, 2-3-1 through 2-3-19; questions 31 through 42 (page 2-5-53)

OBJECTIVES

Upon completion of this session you will be able to:

1. Explain the power-up and power-down sequences of the transport power supply.
2. Analyze the operation of the H switches that control vacuum and pressure for the capstans and pneumatic brake.
3. Describe the initiation of forward and reverse tape motion.
4. Describe the interaction of the photosensing circuits and the tachometer circuits as they control tape motion.
5. List the photosense light and dark indications required to drive, reverse, or brake each reel hub.

OUTLINE

1. Power Supply
 - 1.1 Simplified schematic
 - 1.2 Power supply diagram
 - 1.3 Power sequences
 - 1.4 Cable tracing
2. Capstan Drive and Brake Control
 - 2.1 Operation of the H switch
 - 2.2 Brake H switch
 - 2.3 Forward H switch
 - 2.4 Reverse H switch

- 3. Tape Motion Logic
 - 3.1 Forward motion
 - 3.2 Reverse motion
- 4. Servo Control Logic
 - 4.1 Purpose and description
 - 4.2 Logic analysis

MECHANICAL LABORATORY

INTRODUCTION

The purpose of mechanical laboratories such as the one scheduled for this session is to improve mechanical skills while providing an even greater familiarization with the equipment. Many of the alignments that will be done today, you may find yourself doing if you are assigned this piece of equipment for alignment in the field. With this in mind, follow the directions as closely as possible and begin now to do it right the first time.

ASSIGNMENT

Prior to Day 5

Magnetic Tape Storage Training Manual: Pages 2-3-1 through 2-3-19

OBJECTIVES

Upon completion of this session you will be able to:

1. Remove and replace the following components.
 - a. Capstan voice coils
 - b. Tachometers
 - c. Tape stripper
 - d. Capstan wheel
 - e. Pressure pad
2. Perform the following alignments.
 - a. Commutator
 - b. Capstan wheel
 - c. Tape stripper
 - d. Head
 - e. Pressure pad
 - f. Reel hub
 - g. Tape roller

OUTLINE

1. Laboratory Explanation and Demonstration
2. Mechanical Laboratory
 - 2.1 Student practice
 - 2.2 Critique

WRITE CONTROL, READ CONTROL,
AND ELECTRICAL LABORATORY

INTRODUCTION

The lecture for today is an analysis of the write and read logic of the tape transport. Review the fundamentals of writing and reading from previous equipment. The electrical laboratory is subdivided to give you laboratory material each day. Make sure that you understand the explanations given today since they will not be covered again before later laboratories.

The purpose of the electrical laboratory is to allow you to make alignments of a functional tape transport. You will use an exerciser identical to the one used by the customer engineer in the field to make the same alignments. The only difference between the two processes is that you will be making more alignments than are typically done at one time by the engineer.

ASSIGNMENT

Prior to Day 6

Magnetic Tape Storage Training Manual: Pages 2-5-32 through 2-5-38,
2-6-1 through 2-6-7; questions 15
through 30, 43 through 52 (page 2-5-53)

OBJECTIVES

Upon completion of this session you will be able to:

1. Explain the purpose and action of the file protect ring.
2. Tell how NRZI data is recorded on the surface of the tape.
3. Trace the flow of data as it is fed from the controller to the tape during a write operation.
4. Trace the flow of data from the read heads to the controller during a read operation.
5. Give the purpose of the level shift network.
6. Describe the circuit action of the read gate.

OVERALL ELECTRICAL LABORATORY OBJECTIVES

Upon completion of the laboratory you will be able to:

1. Connect and operate the 699 tape exerciser for the purpose of writing and reading test tapes and aligning the tape-handling capabilities of the transport.
2. Inspect and adjust for start-stop capabilities within the tolerances of the transport.
3. Perform the loop box photocell adjustment.
4. Adjust for mechanical and electrical tape skew.
5. Adjust for proper delay for the density-compensating delays.
6. Identify symptoms of improper operation, troubleshoot, and isolate malfunctions within the tape transport.

OUTLINE

1. Write Control
 - 1.1 NRZI generation
 - 1.2 Write select and enable
 - 1.3 Write operation
2. Read Control
 - 2.1 Read chain
 - 2.2 Read gate
3. Explanation and Demonstration of Electrical Laboratory
4. Electrical Laboratory

READ CONTROL, LOCAL CONTROL,
AND ELECTRICAL LABORATORY

INTRODUCTION

The lecture for today will complete the study of read control and introduce the local control circuits. The second half of the day will be a continuation of the electrical laboratory. Be sure to review the directions for the laboratory and be prepared to continue where you left off.

ASSIGNMENT

Prior to Day 7

Magnetic Tape Storage Training Manual: Pages 2-5-14 through 2-5-31,
2-5-38 through 2-5-40, 2-6-1 through 2-6-7

OBJECTIVES

Upon completion of this session you will be able to:

1. Describe the effect of density selection on the operation of the tape transport and its controller.
2. Explain the way in which the tape transport differentiates between an end-of-record and a file mark.
3. List the conditions required for the tape transport to send a ready indication to the controller.
4. Differentiate between the action of sensing end of tape under automatic and under local control.
5. Explain the operation of the fault circuits.
6. Give the function of the load-point circuit under different circumstances.

OUTLINE

1. Read Control
 - 1.1 Read timing
 - 1.2 Stop-on-file-mark circuit
 - 1.3 Select density
 - 1.4 Select read

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Magnetic Recording Equipment Tape

2. Local Control
 - 2.1 Ready circuit
 - 2.2 Sense end of tape
 - 2.3 Master clear and fault
 - 2.4 Sense load point
 - 2.5 Pad extend circuit
3. Electrical Laboratory

LOAD OPERATION, REWIND, REWIND
UNLOAD, AND ELECTRICAL LABORATORY

INTRODUCTION

This is the last session concerning logical analysis of the tape transport. The operations studied will be those under local control. Prepare for the lesson by reviewing the tape motion and control circuits and mechanics. This session also concludes the electrical alignments laboratory. Be sure that you have satisfied all the objectives of the laboratory.

ASSIGNMENTS

Prior to Day 8

Magnetic Tape Storage Training Manual: Pages 2-5-41 through 2-5-47;
questions 53 through 63 (page 2-5-62)

OBJECTIVES

Upon completion of this session you will be able to:

1. Describe the initiation of a load tape operation.
2. Trace the action within the transport during a load tape operation.
3. Differentiate between a rewind and a rewind-unload operation.
4. Explain the ways in which rewind and rewind-unload operations may be initiated.
5. Describe the action during a rewind and a rewind-unload operation.

OUTLINE

1. Load Operation
 - 1.1 Flowchart
 - 1.2 Fault ports
 - 1.3 Logic analysis
2. Rewind and Rewind Unload
 - 2.1 Rewind flowchart
 - 2.2 Rewind operation
 - 2.3 Rewind-unload flowchart
 - 2.4 Rewind-unload operation
3. Electrical Laboratory

TROUBLESHOOTING PRINCIPLES AND
TROUBLESHOOTING LABORATORY

INTRODUCTION

Today is a session on troubleshooting. You will have a chance to use the tape transport to perform casualty analysis. Keep in mind that this is not a game but is a practice session of the skill that you will find most important when you work in the field.

ASSIGNMENT

Prior to Day 9

Written report on troubleshooting laboratory

Controller Training Manual: Pages 1-1 through 1-13, 2-1 and 2-2, 2-12 through 2-15

OBJECTIVES

Upon completion of this session you will be able to:

1. Describe the logical steps of proper troubleshooting procedure.
2. Recognize and describe electrical and mechanical malfunctions of the tape transport.
3. Isolate malfunctions to their source.
4. Remove and replace faulty components.

OUTLINE

1. Troubleshooting Principles
 - 1.1 Symptom recognition
 - 1.2 Trouble diagnosis
 - 1.3 Component replacement
2. Troubleshooting Laboratory

POWER	FWD	RVS	RWNO
WRITE	READ	LOW 220/536 DEN	H1 800 DEN
UNLOAD	LOAD	READY	CLEAR

BLOCK DIAGRAM ANALYSIS OF THE TAPE CONTROLLER

INTRODUCTION

The material presented in this session is a block diagram analysis of the tape transport controller. Although you will not study the actual circuits of the controller during the lecture, you should familiarize yourself with the logic as you study. Review the operation of basic read and write action of previous controllers as well as the connect and function operations.

ASSIGNMENTS

Prior to Day 10

Controller Training Manual: Pages 2-15 and 2-16, 2-21 through 2-35,
2-40 through 2-50, 2-52 through 2-65, 2-77 through 2-81

OBJECTIVES

Upon completion of this session you will be able to:

1. Name the functional components of the magnetic tape controller, using a block diagram.
2. Describe the action that takes place during a connect operation.
3. List the conditions required to begin writing on tape.
4. Explain the effect that tape speed and oscillator frequency have on the density of the recorded information.
5. Differentiate between the processes of 12-bit and 6-bit writing.
6. Trace the data flow during a read operation, using a block diagram.
7. Define and describe the process of read after write.
8. Show the difference between a 12-bit and a 6-bit read.
9. Describe a reverse read operation.
10. Indicate the conditions necessary to reply to or reject a function instruction.
11. Explain the purpose and trace the actions of the parity mode, density, backward, and release-clear functions.
12. Explain the action that occurs during a rewind-unload operation.
13. Define and describe the skip-bad-spot, write-file-mark, backspace, and search-file-mark instructions.

OUTLINE

1. Block Diagram Analysis of Tape Transport and Controller
 - 1.1 Review of interface signals and status
 - 1.2 Basic write operation
 - 1.3 Basic read operation
 - 1.4 Connect flowchart
2. Write Operation Block Diagram
 - 2.1 Description of write operation
 - 2.2 Block diagram analysis
 - 2.3 Write operation flowchart
3. Read Operation Block Diagram
 - 3.1 Description of read operation
 - 3.2 Block diagram analysis
 - 3.3 Read operation flowchart
 - 3.4 Read character
 - 3.5 Read reverse
 - 3.6 Read after write
4. Functions Block Diagram Analysis
 - 4.1 Nonmotion functions
 - 4.2 Motion functions

MAGNETIC RECORDING EQUIPMENT EXAMINATION 1

DAYS 1 THROUGH 9 (TAPE)

INTRODUCTION

This examination not only allows your instructor to evaluate your progress, but also gives you a chance to gain a more thorough understanding of the last 6 days of material.

Complete the following steps in each session area as a review for the test.

ASSIGNMENT

1. Read your class notes.
2. Scan your reading material.
3. Test yourself again on the session reviews.

OBJECTIVES

4. Read the session objectives. Remember that this is what you are expected to know.
5. List the properties of X on a piece of paper if the objective says, "You will be able to list the properties of X."

OUTLINE

6. Compare your notes to the outline. Have you recognized the main points? What are the main points? Recheck your objectives.

VOCABULARY

7. Review the vocabulary terms by:
 - a. Seeing if you can name the term that goes with a definition.
 - b. Choosing a term by defining it.

Knowing the meaning of several dozen terms without comprehending the way these terms are used will not make you an expert, but knowing all the principles and not being sure of the terms can cause a potential expert to fail both in his tests and his future goals.