

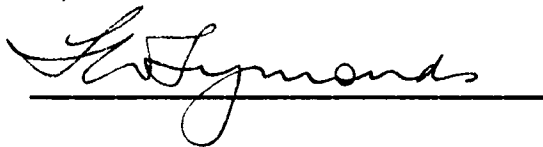
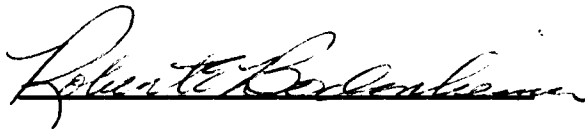
To the Graduate Council:

I am submitting herewith a thesis written by Simon S. Chung entitled "Standardized Computer Communication: An Effective Alternative for the Manufacturing Environment." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Electrical Engineering.



Asa O. Bishop, Jr., Major Professor

We have read this thesis
and recommend its acceptance:



Accepted for the Council:



Vice Provost

and Dean of The Graduate School

**STANDARDIZED COMPUTER
COMMUNICATION:
AN EFFECTIVE ALTERNATIVE
FOR THE MANUFACTURING
ENVIRONMENT**

A Thesis
presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Simon Sauyee Chung
May 1990

DEDICATION

This thesis is dedicated to my family, especially, my mother and my late father, who taught me about the importance of higher education and inspired me through our lives on three continents. The sacrifice they made for the whole family to immigrate to The United States of America was an important factor for me to realize my potential.

ACKNOWLEDGMENTS

I would like to thank the following organizations for sponsoring the project and providing state of the art equipments: Martin Marietta Corporation, and Allen Bradley Company, Incorporated. I would also like to thank the College of Engineering of The University of Tennessee/Knoxville for awarding a graduate assistantship for me to work at the Center of Computer Integrated Engineering and Manufacturing (CCIEEM), and to thank the Department of Electrical and Computer Engineering (ECE) for the awarding of a graduate research assistantship for me while I was studying for my Master's degree.

I especially like to express my sincere appreciation to Dr. Asa O. Bishop, Jr., Professor of ECE and chair-person of my thesis committee, who obtained both research assistantships for me. His valuable experience, and close advice are also deeply appreciated. I also like to thank Dr. Robert E. Bodenheimer, Professor of ECE, and Dr. Frederick W. Symonds, Professor of ECE, for their assistance and for serving as members of my thesis committee. Finally, I would like to thank Mr. Jason Hartman, Manager of the MAP Research Network, for his many valuable suggestions, assistance, and Library Functions.

ABSTRACT

The effectiveness of Computer Integrated Manufacturing (CIM) depended on the communication capabilities among the computers in the manufacturing facility. To analyze this effectiveness, standard communication protocol was used. Two CIM concepts, the Computer Aided Manufacturing (CAM) and the Flexible Manufacturing System (FMS), were employed for this purpose. With CAM, five ladder logic programs were tested and implemented to control the five workstations of the Manufacturing Model Factory of the Department of Electrical and Computer Engineering. A sixth ladder program was tested and implemented for the control of the 24 cell Automated Storage/Retrieval System (ASRS). Following the concept of FMS, communication between the Plant Host, an existing node in the Manufacturing Automation Protocol (MAP) Research Network of the Department of the Electrical and Computer Engineering, and the Area Manager of the Manufacturing Model Factory was established. A MAP Network Interface Unit was used to interface the Area Manager to the MAP network. Using a third MAP node, the Order Entry Point, inventory messages were sent between the 3 nodes. An off-the-shelf data base was used to track the transactions.

Comparing the use of proprietary computer network, this thesis has successfully proved that using a computer communication standard provided a feasible and effective alternative for CIM.

TABLE OF CONTENTS

CHAPTER	PAGE
1. INTRODUCTION	1
1.1 CAM and FMS	1
1.2 Factory communication	2
1.3 Network Standards and The Manufacturing Automation Protocol	3
1.4 Communication for the Model Factory and the MAP Network	6
2. THE MODEL FACTORY	8
3. THE CONTROL OF THE MODEL FACTORY	14
3.1 Introduction	14
3.2 Control Hardware	14
3.3 Control Software	25
4. THE COMMUNICATION OF THE MODEL FACTORY	48
4.1 Introduction	48
4.2 The CIM Model	48
4.3 Factory Communication Strategy	49
5. RESULTS AND CONCLUSION	55
5.1 Results	55
5.2 Conclusion	58
5.3 Future	58

CHAPTER	PAGE
LIST OF REFERENCES	61
APPENDICES	64
APPENDIX A WIRING LIST	65
APPENDIX B ASRS LADDER PROGRAM	75
APPENDIX C PUNCH PRESS LADDER PROGRAM	200
APPENDIX D DRILL PRESS LADDER PROGRAM	223
APPENDIX E VERTICAL MILLING LADDER PROGRAM	236
APPENDIX F HORIZONTAL MILLING LADDER PROGRAM	249
APPENDIX G 2-AXIS ROBOT LADDER PROGRAM	263
VITA	287

LIST OF FIGURES

FIGURE	PAGE
1.1 The Control and Communication Layout of the Factory	7
2.1 Top View of the Layout of the Manufacturing Model	9
3.1 The 62-Pin and the 9-Pin D-shells	18
3.2 Wiring scheme for bidirectional DC motor	21
3.3 Wiring scheme for the Output Module	22
3.4 Bit or integer elements that represent registers or flags	28
3.5 ASRS Flowchart	32
3.6 Punch Press Flowchart	37
3.7 Drill Press Flowchart	39
3.8 Vertical Milling Machine Flowchart	40
3.9 Horizontal Milling Machine Flowchart	43
3.10 Assembly Station Flowchart	45

CHAPTER 1

INTRODUCTION

Due to the rapid advancement in Very Large Scale Integrated (VLSI) technologies, computer processing power has increased while the cost for computer hardware has decreased. Many manufacturers are modernizing their production facilities with intelligent devices like computers and robots in order to implement strategies that are constrained to the Computer Integrated Manufacturing (CIM) concept [1]. Some of these strategies are known as:

- Computer Aided Manufacturing (CAM)
- Flexible Manufacturing Systems (FMS)

1.1 CAM and FMS

The concept of CAM embraces a broad range of manufacturing process designs and implementations. The main idea behind CAM can be described as the utilization of computers and robots to facilitate any activity that is related to manufacturing. However, the use of the computers cannot be optimized unless computer communication is effectively implemented throughout the factory. That is, the intelligent devices inside the manufacturing facility must be able to communicate with each other.

The idea of FMS calls for a manufacturing system that has the ability to be modified with a minimum loss of production time. This flexibility allows the manufacturer to have a minimum amount of part inventory. Once an order is received, a part order is then placed while the production for the present product is continued. The line is reconfigured by either updating or modifying the present processes when the new parts arrive. The production line is usually capable of producing many products with different parts and different operations. Information concerning the part and its location is exchanged over the network. This information is generally exchanged between the Order Entry Point, the Plant Host, the Area Manager and the Cell Controller. An effective computer network is required to coordinate such effort. Some of the advantages for CAM and FMS are:

- Reduction in labor cost
- Reduction in inventory cost
- Reduction in process design time
- Reduction in response time due to processes changes

1.2 Factory Communication

The main idea behind CIM is the effective use of computers in manufacturing to achieve maximum productivity. The optimal use of computers in the factory environment can only be accomplished with flexible and reliable computer communication. In general, two

options are available for computers to exchange information. First, point-to-point communication connects each computer on site to every other computer. Second, the use of a Local Area Network (LAN) allows a computer to interface to the network with a single connection in order to communicate with any computer that is attached to the LAN. Due to the increased number of connections in the point-to-point method, the first option is generally not used. As a result, LANs have become the preferred method for implementing communication networks in manufacturing facilities.

1.3 Network Standards and The Manufacturing Automation Protocol

Manufacturing engineers confronted with the use of computers in the factory are required to understand the integration of such computers and their applications into the existing computer network of the manufacturing facility. The need for integration arises because data is sent from one department to another within the organization. Many times, different departments have computers or intelligent devices from different vendors with no direct way of permitting these computers to communicate with one another because of vendor non-standard proprietary network protocols. One vendor usually provides all the communication network facilities and services. However, no one vendor can supply all the computer needs of a large organization because different applications dictate the use of intelligent devices manufactured by other vendors. If different

computer network vendors are used, then a great amount of time and resources are required to meet the interface design requirements of vendor specific protocols. Interoperability is not guaranteed with this type of solution.

Thus, the proprietary network will have to be replaced by a network that adheres to recognized network standards. Many organizations as well as user groups are committed to the standardization efforts. The most prominent organizations are:

- The International Standardization Organization (ISO)
- The International Consultative Committee on Telegraph and Telephony (CCITT)
- The American National Standards Institute (ANSI)
- The Institute of Electrical and Electronics Engineers (IEEE)
- The Manufacturing Automation Protocol/Technical and Office Protocol (MAP/TOP) User group

The International Standardization Organization - Open Systems Interconnection (ISO-OSI) Seven Layer Reference Model is a suite of protocols or rules that specify certain requirements and procedures in accordance with accepted standards in the design of LAN that consists of layered protocols [2]. The ISO-OSI Seven Layer Model consists of the following layers, beginning with the top-most layer:

- The Application Layer
- The Presentation Layer
- The Session Layer
- The Transport Layer
- The Network Layer
- The Data Link Layer
- The Physical Layer

Services are provided from the bottom-most layer to the top-most layer. For example, the network layer must serve the transport layer as well as all the other layers above it, but it does not serve any layer below such as the data link layer or the physical layer [3]. While the ISO-OSI Model specifies only the functions that are included in each layer, this model does not define the protocol to be used or whether the protocol must adhere to published standards. The Manufacturing Automation Protocol (MAP) 3.0 Specification is an implementation of the ISO-OSI Reference Model and specifies a subset of the ISO standards [4]. For example, MAP 3.0 follows the ISO-OSI Model, and its protocols are implemented with standards such as the IEEE-802 published by the IEEE 802 Committee [5]. As a result, two nodes on a network that follow the ISO-OSI Model with different protocol implementations may not necessarily communicate with each other, but two MAP nodes can communicate.

1.4 Communication for the Model Factory and the MAP Network

In order to study problems faced by Computer Integrated Manufacturing in an academic environment, an economically feasible manufacturing factory model and LAN with a standardized protocol like MAP were used. The purpose of this thesis was to establish communication between the manufacturing factory model and a node of the MAP network to illustrate CIM concepts like CAM and FMS. See Figure 1.1. For example, an order entry node transmitted an order to the Plant Host. Information was retrieved from the data base in the Plant Host to the Area Manager in response to the order. The information contained in the database consisted of the locations of raw material parts and finished products in the warehouse as well as the locations for empty bins. Once the Area Manager received the required information, the operator transmitted the data to the Programmable Logic Controller, PLC-5, and the part was then retrieved from the warehouse and placed on the assembly line by the retrieval system of the warehouse. The Area Manager would send a request to the Plant Host for an empty bin to store the part. Before the data was passed to the Area Manager from the Plant Host, the data base updated the transaction. After the data was passed to the Area Manager from the Plant Host, the operator transmitted the data to the PLC-5 which controlled the storage system of the warehouse, and the part was moved to the designated bin in the warehouse.

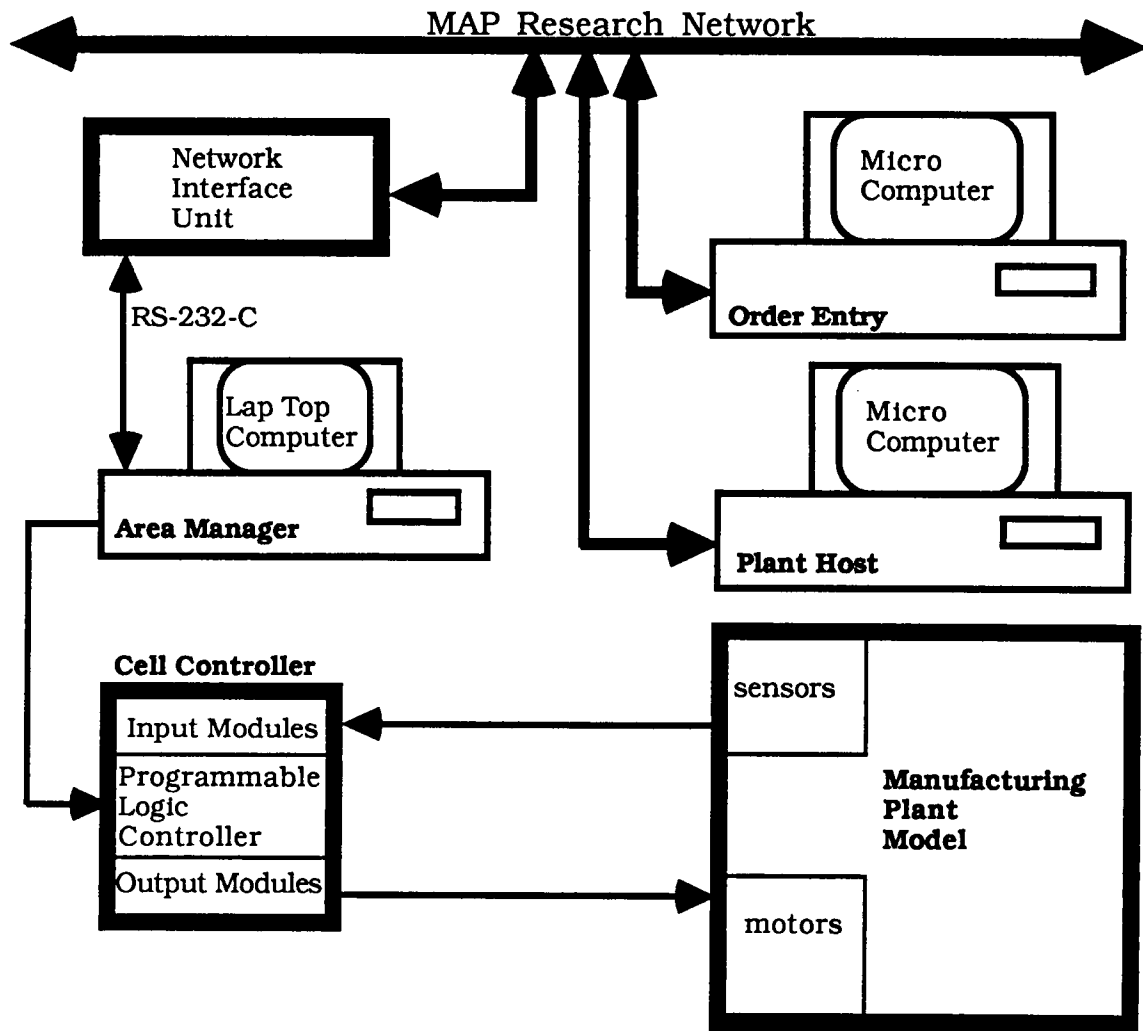


Figure 1.1. The Control and Communication Layout of the Factory

CHAPTER 2

THE MODEL FACTORY

The Fishertechnik model factory housed in the Department of Electrical and Computer Engineering of the University of Tennessee, Knoxville had the following functional facilities (see Figure 2.1):

- a 24 cell Automated Storage/Retrieval System (ASRS)
- a 10 track independent conveyor system
- a punch press workstation
- a drill press workstation
- a vertical mill workstation
- a horizontal mill workstation
- a 2-axis robot assembly workstation

The model factory had a footprint of 156 cm by 54 cm with the highest part of the model, which was the elevator, reaching a height of 48 cm. There were 34 direct current (DC) motors in the factory model. Seventeen of the 34 DC motors were bidirectional motors. Sixty sensors in the factory model provided the control elements for the computer interface. The sixty sensors consisted of 49 contact or limiting switches, 5 proximity switches, and 6 pairs of infrared emitting detecting sensors.

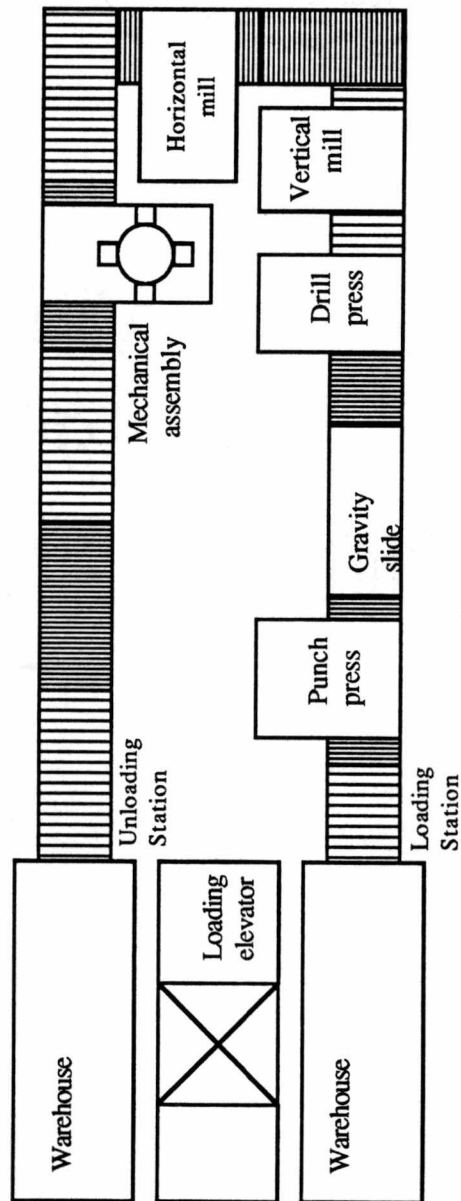


Figure 2.1. Top View of the Layout of the Manufacturing Model

The ASRS spanned the whole width of the footprint, 54 cm, and extends almost half of the 156 cm length. It was the most visible part in the whole model and was equipped with a warehouse that was made up of two storage structures, an elevator and its carriage, a telescopic transfer table, and the loading/unloading stations. (See Figure 2.1)

Each half of the warehouse had 12 storage cells, forming a 3 row by 4 column matrix. Each cell used a pallet to provide a movable base for storing material. The two parts of the ASRS were parallel to each other.

The elevator car was strategically located between the two halves of the warehouse structure. The elevator could be moved to any one of the 12 storage cells that were located on either side of the car. Inside the elevator, the telescopic transfer table mechanism was used to load/unload the pallet onto the elevator. The telescopic transfer table could extend to either half of the warehouse to load/unload a part from any one of the 24 cells. Additionally, the telescopic transfer table could extend to either the loading or unloading station.

The loading/unloading inspection stations served as an interface between the warehouse and the five workstations. Thus, these stations were attached to the ends of their respective halves of the warehouse structure and faced each other.

At the beginning of the conveyor system, the first inspection station used 3 pairs of infrared emitting/detecting sensors and one proximity switch to determine the part from the warehouse. The loading station had a space reserved for the future installation of a bar code reader. The unloading station had no inspection capability. A video camera based inspection station was planned for the future.

Once a part was loaded on the conveyor, the first workstation was the punch press. A proximity switch was used to detect the presence of the part. Three rams were used to position the object. The first ram, the forward ram, was used to remove the part from the conveyor belt. The second ram, the side ram, was then used to push the part into a well that had a lift table in the bottom for the punch operation. The third ram, the back ram, was used to return the part to the conveyor system after the punch process had been completed and the lift table had been moved into the up position. Both the punch press and the lift table formed the integral part of this workstation. Each was driven by two hydraulic pumps. The pumps were classified as the transmitting cylinder and the receiving cylinder.

After the punch process was completed, the part was transported to the drill press. The conveyor system and the gravity slide were used as the transport at this point. The slide was required because of the difference in elevations of the working surfaces of the punch press and the other workstations. Next, a proximity switch was used to detect the presence of a part which contained

metal. Once the part was in place, the drill head was lowered to the part and then raised to the home position.

The next workstation was the vertical mill. The mill had a chuck or turret with three different sizes of bits. A proximity switch was used to detect the presence of the part under the head of vertical mill. Once the part was in place, the chuck was rotated to the selected bit. The chuck was lowered to the part. When the bit was in the selected position, the driving motor was energized. After the milling operation was completed, the chuck was raised to the home position.

The horizontal mill was the next workstation. Once again, a proximity switch was used to detect the presence of the part. When the part was in place, the cutting head was lowered into position. The head was then moved across the part to simulate the milling operation. Upon completion of the milling operation, the head was raised to the home position.

Finally, the part was moved by the conveyor belt to the 2-axis robot assembly workstation before it was returned to the warehouse by the elevator for storage. This workstation provided a simulation of placing parts together for a product. In this case, 3 trays of colored washers were used as parts. The electromagnetic lift, located at the end of the robot arm, picked up the washers from the specified tray. From the most distant tray to the dropping point on the conveyor belt, an angle of approximately 180 degrees was swept by the robot arm. The washers were placed in a hole of a part located on the

conveyor belt. An essential requirement was that the washer was dropped vertically from the lift to maintain the required accuracy for part assembly. The distance between the inside diameter of the cylinder and the outside diameter of the washer represented a combined tolerance that was less than one thousandth of an inch.

There was great flexibility and economy offered by the model factory in the CIM study. Control programs for the ASRS, and the five workstations were designed, tested and implemented. These programs along with the MAP network were used to illustrate the CAM concept. The FMS inventory scheme was implemented with the use of the ASRS, the two inspection stations, and the conveyor system. Inventory messages were sent between the area manager and the Plant Host using the MAP network.

CHAPTER 3

THE CONTROL OF THE MODEL FACTORY

3.1 Introduction

This chapter described the control mechanisms that were used for the model factory. The implemented mechanisms were divided into two categories, hardware and software. Hardware included all the physical equipment that was used for the control of the project. Software included the algorithms and programs that were implemented for the control of the factory.

3.2 Control Hardware

The manufacturing environment included

- an Allen Bradley Programmable Logic Controller (PLC), the PLC-5/15
- an Allen Bradley T45 Portable Terminal with a 1784-KL Communication Interface Module
- an Allen Bradley 1771-A4B 16 Slot I/O (Input/Output) Chassis
- Allen Bradley 1771-OW Selectable Contact Output Modules
- Allen Bradley 1771-IG TTL Input Modules

- an Allen Bradley 1771-P7 120/220 V 16 A Power Supply
- a 5.0 V DC 6 A power supply
- a 7.5 V DC 1 A power supply
- 150 Ω resistors
- 200 Ω potentiometer
- cable (4-conductors)

The PLC-5. The main functions of the PLC-5 were to read inputs, to solve logic, and to energize outputs [6]. In order for the PLC-5 to perform its functions properly, 4 sets of Dual In-line Package (DIP) switches were set [7]. DIP switches 1, 2, 3 were located in the PLC-5, and the fourth DIP switch was on the backplane of the chassis. For this thesis, the DIP switches were set to the following configurations

- Switch 1: 1-on, 2-on, 3-on, 4-on, 5-on, 6-on, 7-off, 8-off
- Switch 2: 1-off, 2-off, 3-on, 4-on, 5-on, 6-on, 7-on, 8-on
- Switch 3: 1-on, 2-on, 3-off, 4-off
- Switch 4: 1-off, 2-off, 3-off, 4-off, 5-off, 6-on, 7-off, 8-off

For Switch 1, the first six positions were used to select the Peer Communication Link (PCL) station number for the PLC. For this case, the station number was set to zero. Position 7 was normally turned off. Position 8 was used to select either the scanner or the adapter mode. Scanner mode was selected for this thesis.

Switch 2 was only important when the processor was in the adapter mode. However, position 1 was always turned off. The rest of the positions were configured in such a way that would not give any meaning to the processor under scanner mode.

Switch 3 was used to connect terminators to the processor when it was an end device. Position 1 determined if the processor was an end device in the remote I/O link. Since the processor was used as an end device in the remote I/O link, that position was turned on in order to connect a terminator to the processor. Position 2 determined whether the processor was an end device in the peer link. Since the processor was used as an end device in the peer link, a terminator was connected to the processor by turning position 2 on. Positions 3 and 4 were not used.

Switch 4 selected numerous processor functions. Position 1 controlled the last state of the outputs. When this position was on, all outputs of the respective chassis remained at their last states after the time-out of a certain timer occurred. Thus, position 1 was turned off in order to reset the last states of all the outputs once the watchdog timer time-out had occurred. Positions 2 and 3 were not used, and were turned off. Positions 4 and 5 worked together to select addressing mode. Both 4 and 5 were turned off to select the 2 slot addressing mode. Positions 6 and 7 were on and off, respectively. These selections determined the absence of an

EEPROM module. Position 8 was turned off to unprotect the Random Access Memory (RAM) so that a new program could be loaded to the RAM.

Once the switches were properly configured, the PLC-5 could solve logic that was programmed from the T45 terminal, read field inputs that were received from the terminals of the TTL Input Modules, and energize field outputs that were attached to the terminals of the Selectable Output Modules.

The T45 Portable Industrial Terminal. The T45 Portable Industrial Terminal was one of the possible programming devices for the PLC-5 [8]. The Industrial Terminal was equipped with a 1784-KL Communication Interface Module. The interface module provided a port for communication with the Peer Communication Port of the PLC-5. A multi-conductor cable with two D-shell connectors physically connected the T45 to the PLC-5. Only three pins were active in the 62-pin D-shell of the 1784-KL module. These pins were pin 34, pin 35, and pin 36. The corresponding pins on the 9-pin D-shell of the Peer Communication Port of the PLC-5 were pin 5, pin 7, and pin 1, respectively (see Figure 3.1). The T45 had two other ports. These ports were the parallel printer port and the RS-232C/RS-422 serial port. The T45 was also used for documentation. The on-line programming feature added yet another function to the project, the console function. This function provided a point for entering data to the PLC, as well as giving read outs of certain results.

This function provided the operator of the model factory with the ability to interact with the PLC on-line. Therefore, controllability and observability of internal registers were achieved.

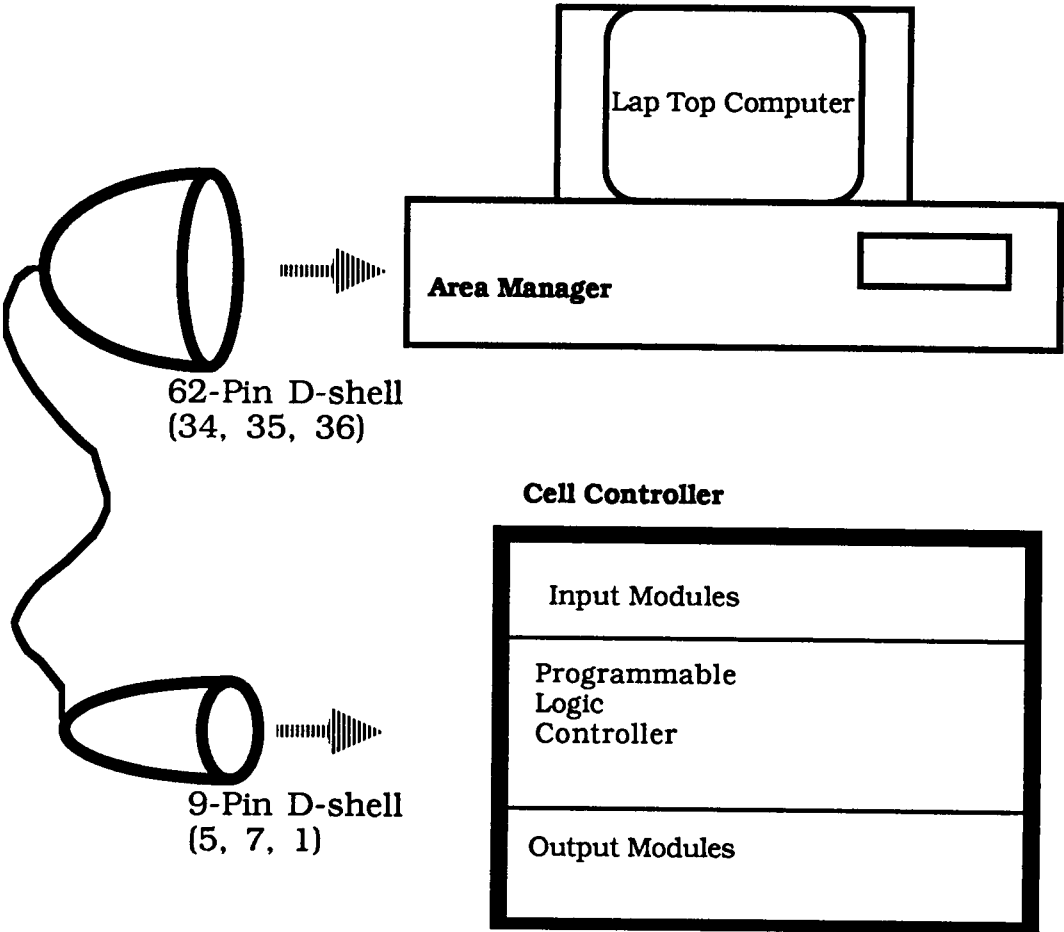


Figure 3.1. The 62-Pin and the 9-Pin D-shells

The I/O chassis and the P7 power supply. The Allen Bradley 1771-A4B 16 Slots I/O Chassis was used to house the PLC-5 and the I/O modules [9]. The 16 I/O slots were grouped in groups of 2. Each group was assigned a number. The group numbers started with 0 and ended with 7 (using octal numbering system) for a total of 8 groups in each chassis. As mentioned, the chassis also housed the PLC-5. The only place that the PLC could be installed was the end of the chassis next to I/O group 0.

The Allen Bradley 1771-P7 120/220 V 16 A Power Supply was used to supply power to the PLC-5 and the backplane of the chassis [10]. The P7 power supply was mounted on the outside of the chassis, and was located on the same side of the chassis as the PLC-5.

The output module and the 7.5 V power supply. The Allen Bradley 1771-OW Selectable Contact Output Module served as the interface between the PLC-5 and the motors of the model factory [11]. Each output module was plugged directly into the backplane of the chassis in order to interface with the PLC. To interface with the field outputs of the factory, the output module provided 12 terminals. The terminals were divided into 2 types, relay terminal and shared common terminal. Internally, each shared common terminal was connected to 2 adjacent relay terminals by means of 2 respective relays. Thus, the 12 output terminals were divided into 4 sets of terminals with each set containing 2 relay and 1 shared common terminals. The four sets of terminals were given as:

- Set 1 - terminals 1, 2, 3

- Set 2 - terminals 4, 5, 6
- Set 3 - terminals 7, 8, 9
- Set 4 - terminals 10, 11, 12

Terminals 2, 5, 8, and 11 were shared common terminals, and the rest were relay terminals.

Within each set, any signal that was presented to the shared common terminal externally could be selected simultaneously by the two relay terminals. On the other hand, when each of the two relays had its own external signal, then those signals must be selected by the shared common terminal mutually exclusively, that is, never energize both relay terminals of the same set simultaneously. This was important for controlling bidirectional DC motors.

To control motors in one direction, the connections were relatively simple. The connections required 1 set of terminals for each single directional motor. First, one of the two relay terminals was connected to the positive (+) terminal of the 7.5 V power supply, and the other relay terminal was connected to the negative (-) terminal of the power supply. Second, the "designated (+) terminal" of the motor was connected to the shared common terminal of the set, and the "designated (-) terminal" of the motor was then connected directly to the relay terminal which was connected to the (-) terminal of the power supply. In order to turn the motor on, only the relay that was connected to +7.5 V terminal of the power supply was energized.

To control a bidirectional motor, the connections were slightly more complex. See Figure 3.2. Two sets of terminals were required for each bidirectional motor. First, one relay terminal was taken from each set, and connected to the +7.5 V terminal of the power supply. The remaining relay terminal of each set was connected to the (-) terminal of the power supply. Second, one terminal from the bidirectional motor was connected to the shared common terminal

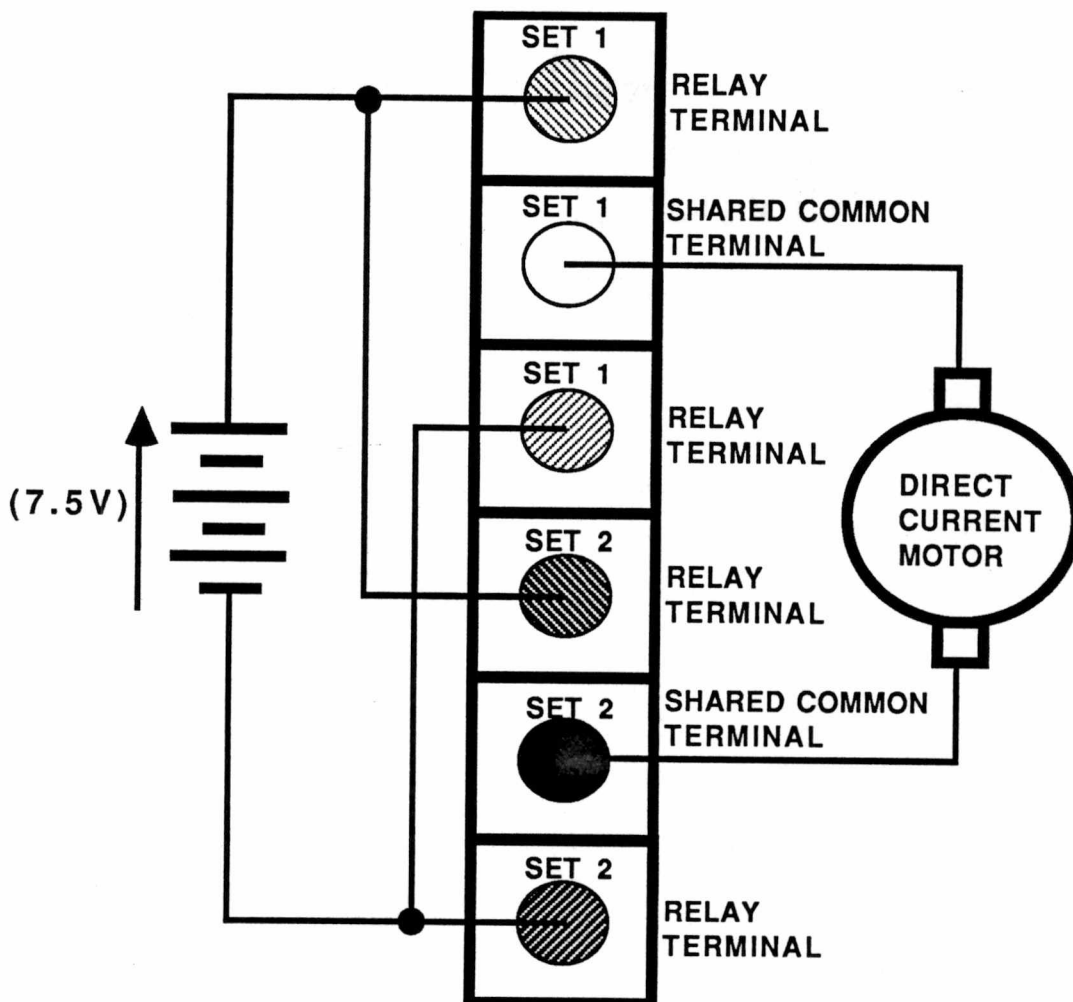


Figure 3.2. Wiring scheme for bidirectional DC motor

of one set. The other terminal of the bidirectional motor was connected to the shared common terminal of the other set.

For the motor to turn in one of the two directions, the (+) relay terminal of set one and the (-) relay terminal of set two were energized. To reverse the motor direction, the (-) relay terminal of set one and the (+) relay terminal of set two were energized. One had to remember not to energize both relay terminals of the same set simultaneously because the power supply would be shorted, and had to make sure that the relays controlling one direction were off before energizing the relays controlling the opposite direction.

After observing the 2 different connections for the single directional and the bidirectional motors, relay terminals 1, 4, 7, 10 were connected to the +7.5 V terminal of the power supply. Also, relay terminals 3, 6, 9, 12 were connected to the negative terminal of the power supply. See Figure 3.3 and Appendix A.

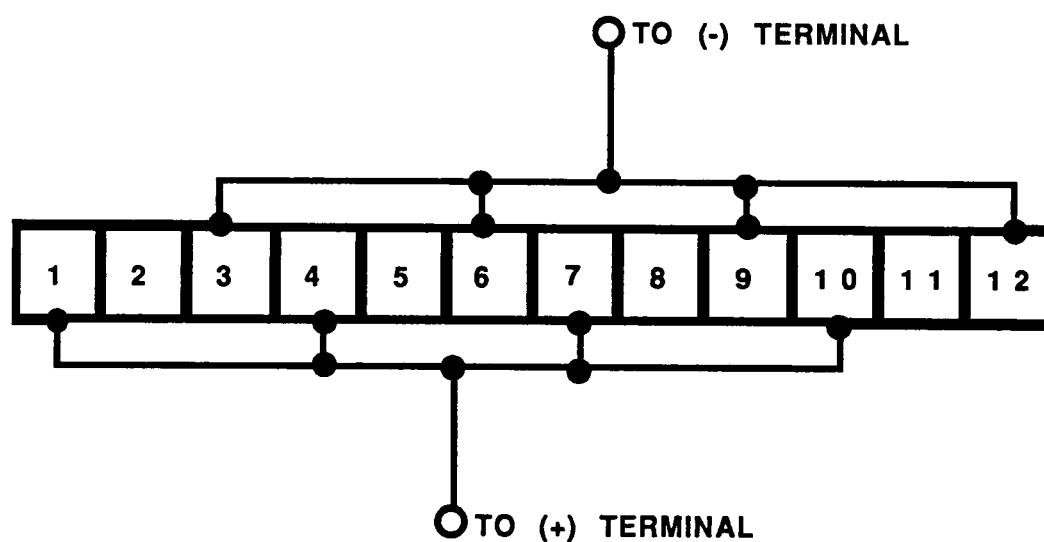


Figure 3.3. Wiring scheme for the Output Module

The input module and the 5 V power supply. The Allen Bradley 1771-IG TTL (Transistor Transistor Logic) Input Module provided the interface between the PLC and the switches and sensors of the model factory [12]. To interface with the PLC, the input module was directly plugged into the backplane of the chassis. To interface with the field inputs, eight input terminals (numbered from 0 to 7) were provided, and 8 Light Emitting Diodes (LEDs) were used to indicate the presence of a true signal in the terminals. Because the module worked with TTL signals, a 2 position DIP switch was provided to select either positive logic, High = True, or negative logic, Low = True. For this thesis, negative logic was selected by setting position 2 of the switch to the off position. Position 1 was also selected to the off position. This would turn a ninth LED in the module off to remind the user that negative logic was selected. Two other terminals were used to connect the +5 V power supply in order to supply the TTL inputs of the module. One terminal was labeled "A", and it was connected to the (+) terminal of the power supply. The other terminal was labeled "B", and it was connected to the (-) terminal of the power supply.

To connect a limit switch of the model factory to the terminal of the module, two wires were used. One wire was used to connect the (+) terminal of the 5 V power supply to the pole that was labeled +5 of the switch. The other pole of the switch was connected directly to the terminal of the input module with the second wire.

This terminal was also connected to the B terminal with a $150\ \Omega$ resistor to provide a pull-up for the switch when it was mated. Thus, the LED indicator for the terminal would go off when the switch was mated - a high voltage was presented in the terminal. The LED indicator would be on when the switch was open: a low voltage was presented in the terminal.

The connections for the infrared and the proximity switches were similar to that of the limit switch with minor differences. For the infrared emitter and detector pairs, only the output of the detector was connected to the terminal of the input module. A $150\ \Omega$ resistor was also used to connect the input terminal and terminal B of the module. Thus, when the light path was blocked by a part, the input to the terminal was a low voltage, and the LED indicator for this terminal would turn on. When the light path was free, the input to the terminal was a high voltage, and the LED indicator for this terminal would go out. To supply the emitter, terminals A and B were connected to the +5 V and ground terminals respectively of the sensor.

For the proximity switch connection, the output was connected directly to the input terminal of the module. The input terminal was also connected to the terminal B of the module by a $200\ \Omega$ potentiometer. The potentiometer was used because variable and non-standard resistance values were used by the different proximity switches. When a metallic part passed in front of the proximity switch, a low voltage was presented to the terminal of the

input module, and the LED indicator would turn on. When non-metallic part or no part passed by the proximity switch, a high voltage was presented in the terminal, and the LED indicator for such terminal would remain off.

3.3 Control Software

In order to program the PLC to perform the desired control functions, a computer language was selected. For this thesis, ladder logic, the programming language of the PLC, was used throughout for the control of the model factory. As mentioned in the hardware section, the T45 industrial terminal was used to provide on/off line programming and documentation. The operating system used for the terminal was the MSTM*-DOS. The Allen Bradley 6200 Series Software was used to create the ladder logic, to produce documentations, and to provide the console function.

The ladder logic and the sequential function chart. The basic principle of ladder logic was that the rung, like a rung in a ladder, was used to connect all the necessary input conditions to the desired outputs. In general, for the PLC to perform the desired output functions, all input conditions associated with that rung must logically become true before the outputs were activated. Two categories of input/output were identified for this project. First, actual inputs were received from the wired field sensors and

* MSTM is a trademark of Microsoft, INC.

switches. Similarly, actual outputs would energize wired field devices like motors. Second, logical inputs were conditions that were created by the program itself to inform the PLC certain events had occurred. Logical outputs were functions that were performed by the PLC to manipulate its data.

Once the ladder program was loaded to the PLC, the PLC was switched to the run mode to execute the program. The functions of the PLC were reduced to scanning the input and output image tables, and scanning the ladder program sequentially to solve the logic of the intended functions. The logic solving process was a continuous one; and the scanning of the input and output image tables, ladder logic was viewed as the processes of a cycle. This cycle repeated itself periodically until either a power failure occurred or until run mode was changed to program mode.

From time to time, a race condition in the logic solving process was created. When this occurred, the intended sequential functions of the ladder logic were destroyed. To overcome this, a function provided by the 6200 Series Software was used. This was the so called Sequential Function Chart (SFC). With SFC, the original program was subdivided to several smaller programs called step files. These step files were then combined into a chart sequentially according to their functions, not file numbers. All of the logic of the initial step file was solved before the logic of the next consecutive step file was scanned and solved. For each of the step

files, a transition file was created and assigned. The purpose of the transition file was to insure that all logic of the respective step file was solved, and to tell the PLC that it was ready to scan the next step file.

With SFC, a top down programming concept was achieved, and the logic for each rung was made much simpler. Also, the race condition was eliminated. Six ladder logic programs were tested and implemented for this project. The algorithmic flowcharts and programming strategies are discussed below. The ladder programs are provided in Appendixes B through G.

The programming of the ASRS. In programming the ASRS, an objective was defined, and it was divided into four sub-objectives because of its complexity.

- The elevator car was able to reach to any bin on either side of the warehouse to pick up a pallet that was specified by the operator at any time.
- Once the elevator was in position, the telescopic transfer table was used to pick up a pallet inside the bin, and the part on the pallet was loaded to the conveyor system.
- Once on the conveyor, the part was identified.
- The part was returned to the warehouse by using the conveyor, the elevator car, and the telescopic transfer table.

To accomplish the first sub-objective, eight registers were used. See Figure 3.4. These registers were the Comparison

Register, the Input Register, the Data Registers, the Row Flag, and the Column Flag. These 4 data registers were selected based on the matrix nature of the warehouse structures. Because the two structures were parallel to each other, one order pair was assigned to two opposing bins. Thus, (1, 2) represented the identification of a bin (row 1, column 2) in one structure, and an opposing bin (also row 1, column 2) in the other structure. Then, all the elements of a three row by four column matrix were used as the data base for making the decision of moving the elevator and the carriage car to the desired row and column, respectively.

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19

Figure 3.4. Bit or integer elements that represent registers or flags

With this in mind, the usage of the registers became apparent. First, the Comparison Register was set to 0 at all times. Second, the Input Register was used to store the operator's input from the keyboard. Third, if the contents of both the Comparison and the Input Register were identically 0, then no action was taken; if the contents of these two registers were different, then the contents of the Input Register were copied to all four Data Registers. Fourth, the contents of the Data Registers were compared with the stored data base determining the desired row and column coordinates. Fifth,

the Row Flag was set to either 1, 2, or 3; and the Column Flat was set to either 1, 2, 3, or 4. These flags were used as input conditions to energize the motors that were used to move the elevator and the carriage car. An important point to make here was that the Input Register and the Data Registers were initialized to a known state by setting them to any one of the valid data of the database when the program was executed for the first time or powered up. Also, when the input was not valid, it was cleared from the input register manually to avoid unpredictable outputs.

To accomplish the second sub-objective, a new flag was introduced. This was the Action Flag. The flag was used to implement a concept that was borrowed from linear systems. The causality of a system, stated briefly, is that the output of a system will not precede that of the input. In this program, the telescopic transfer table, the unloading ram, and the conveyor system could not be energized unless valid input was presented at the proper point. Thus, a logical way of setting the Action Flag was using the Row and Column Flags. Thus, the Action Flag was used as an extra input condition before these outputs was energized.

The third sub-objective was relatively easy. Three flags were used to identify the parts. To set these flags, the Double Height Flag, the Single Height Flag, and the Cylinder Flag; three pairs of infrared sensor and a proximity switch were used.

The fourth sub-objective was accomplished in a way that was similar to that of the second sub-objective. A Return Flag was used as

an extra input condition. Thus, the elevator would not move to the storage bin while the part was still on the conveyor system. The Return Flag was raised only when the lifted section of the conveyor was lowered to the home position.

The algorithms of this program are given in Figure 3.5. The ladder programs are given in Appendix B.

The programming of the Punch Press. The Punch Press was one of the more complex workstations, but it has enough switches to simplify the programming. No register was used in this program. The SFC kept the logic moderate. The concern for this program was that the front ram and the side ram used in moving the part must not be both moving out simultaneously (see Figure 3.6). The ladder program is provided in Appendix C.

The programming of the Drill Press. In contrast to the Punch Press, the Drill Press was the most simple workstation to program. This workstation also provided enough switches to make the logic simple. The SFC was employed to facilitate top down design (see Figure 3.7). The ladder program is given in Appendix D.

The programming of the Vertical Milling Machine. Although this machine generates much action, the programming was not too complicated. Again, SFC was used to maintain the top down design concept. One draw back for this machine was that only one switch was installed to control the rotation of the chuck. A software switch called the Bit Flag was created to overcome this difficulty. When the Bit Flag was set, the chuck would rotate. While the chuck was

rotating, the Bit Flag was cleared to avoid over rotation. When the cutter was aligned with the real position switch, the chuck would be stopped. The flowcharts are given in Figure 3.8. The ladder program is given in Appendix E.

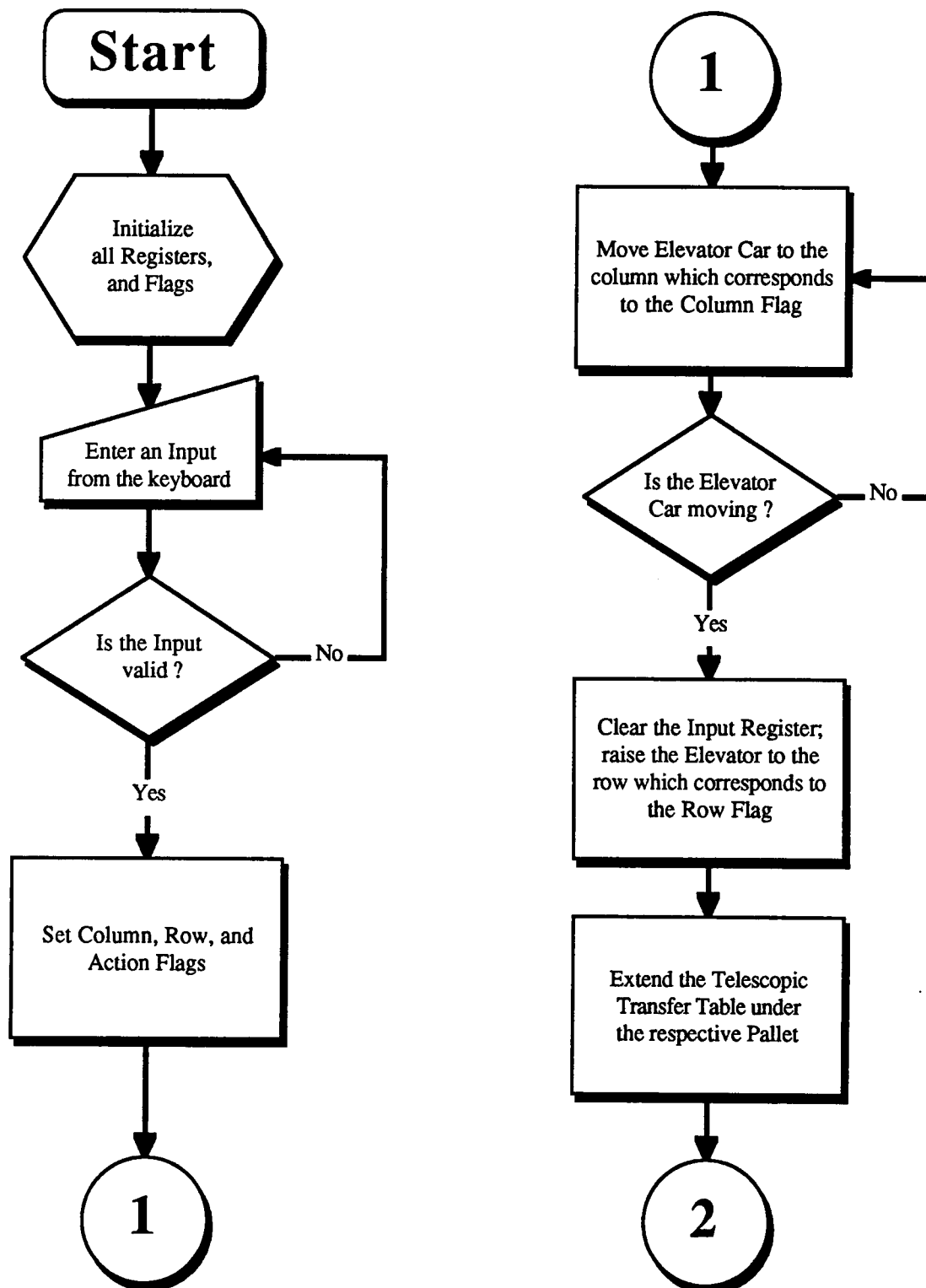


Figure 3.5. ASRS Flowchart

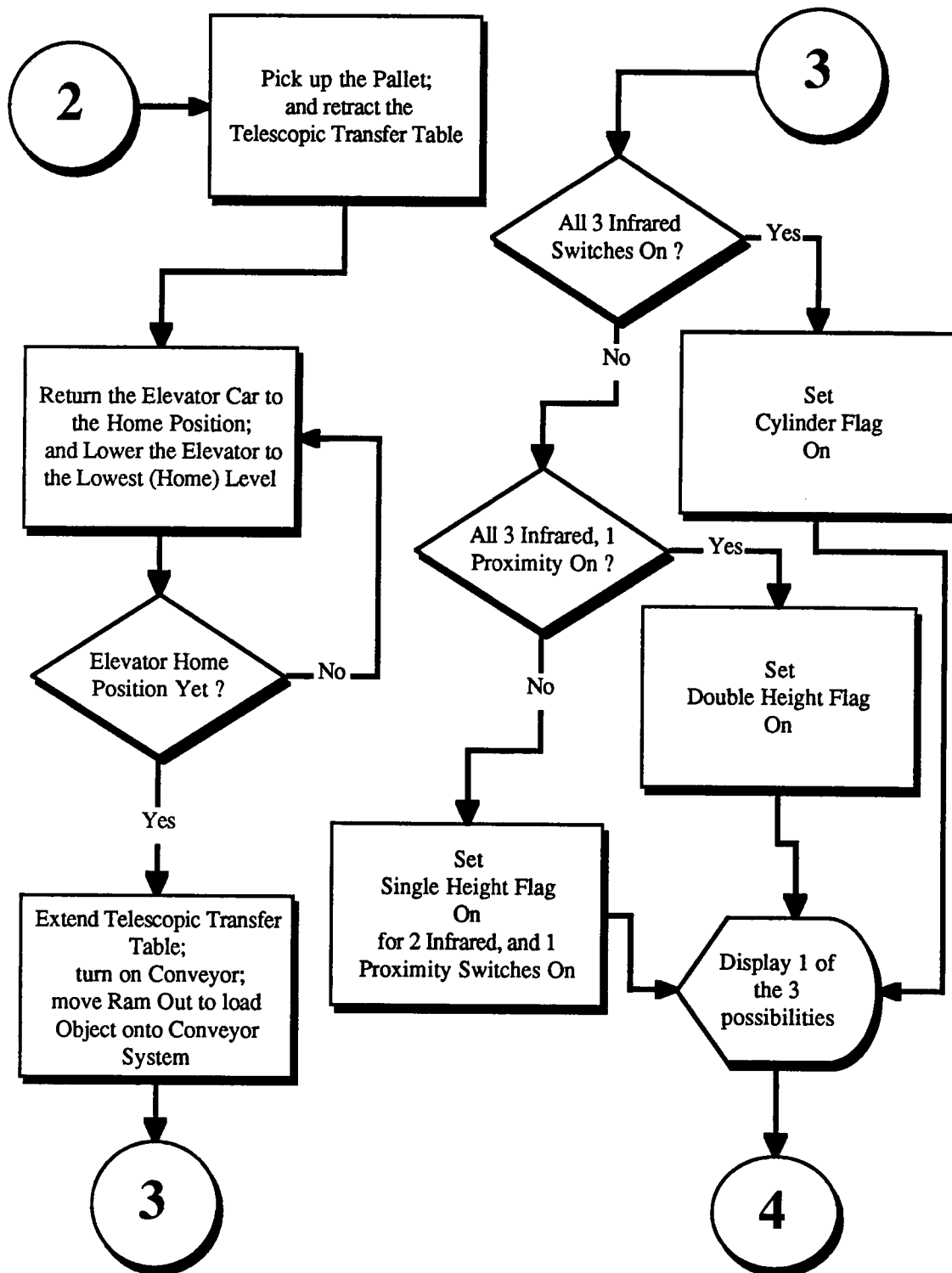


Figure 3.5. Continued

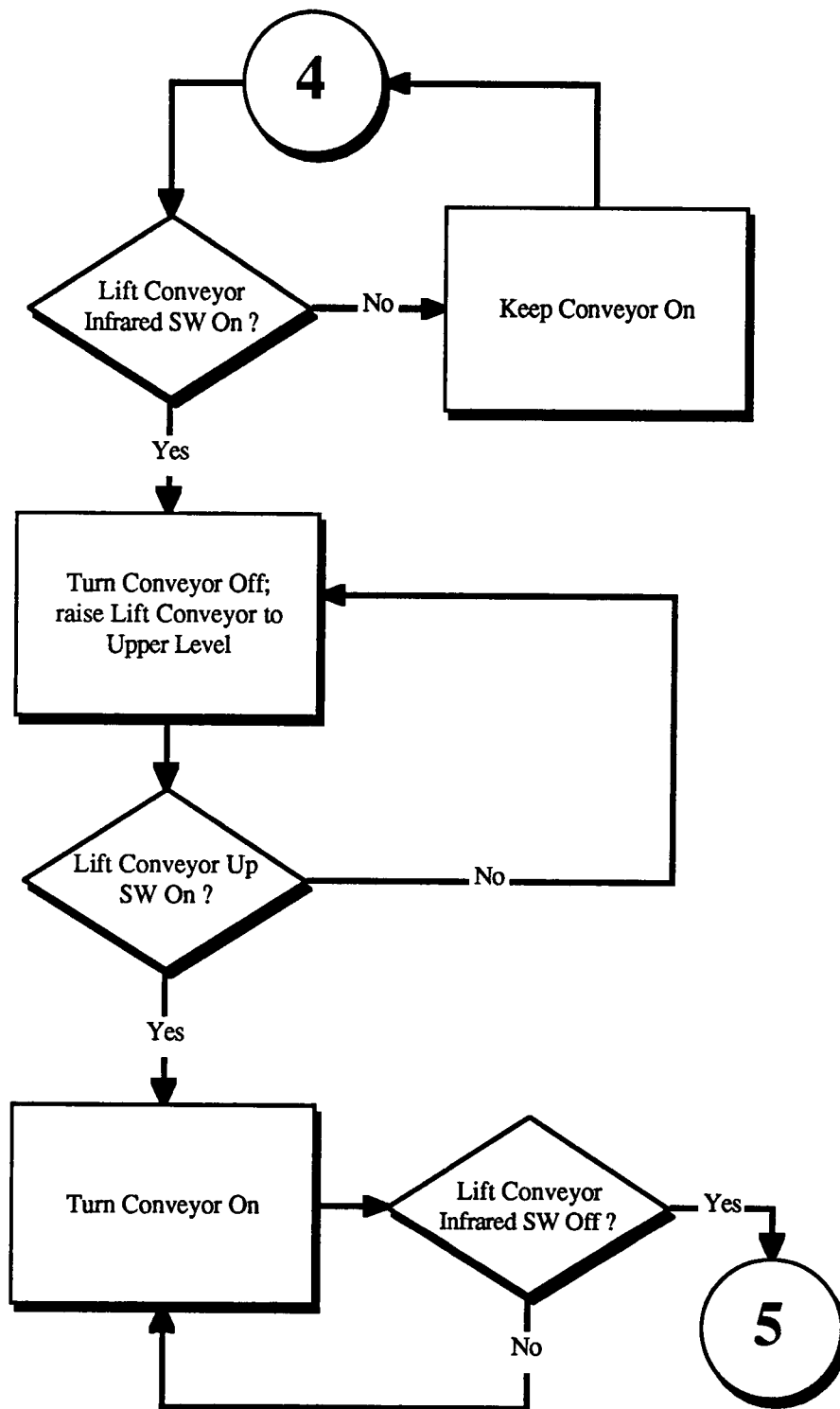


Figure 3.5. Continued

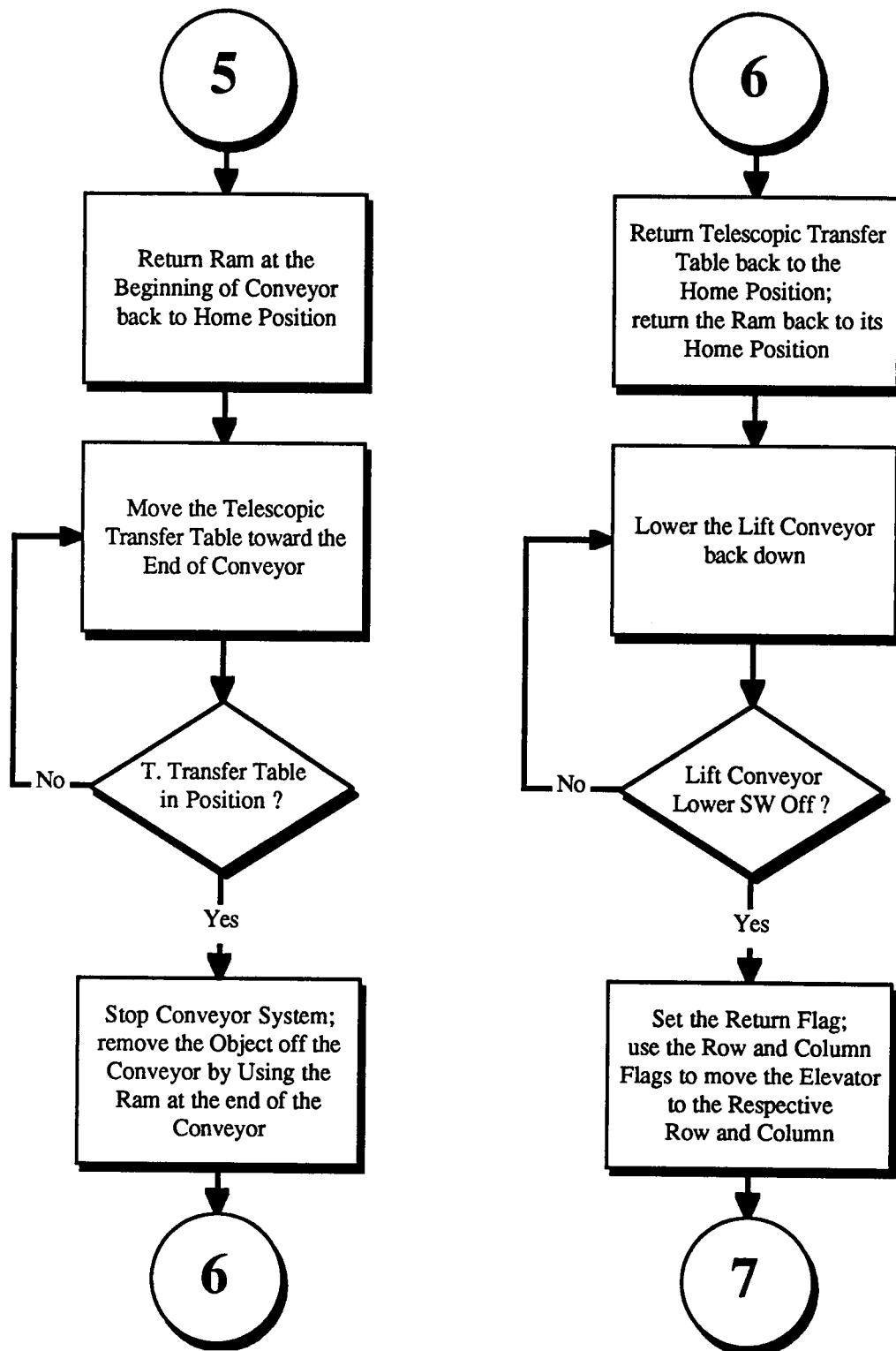


Figure 3.5. Continued

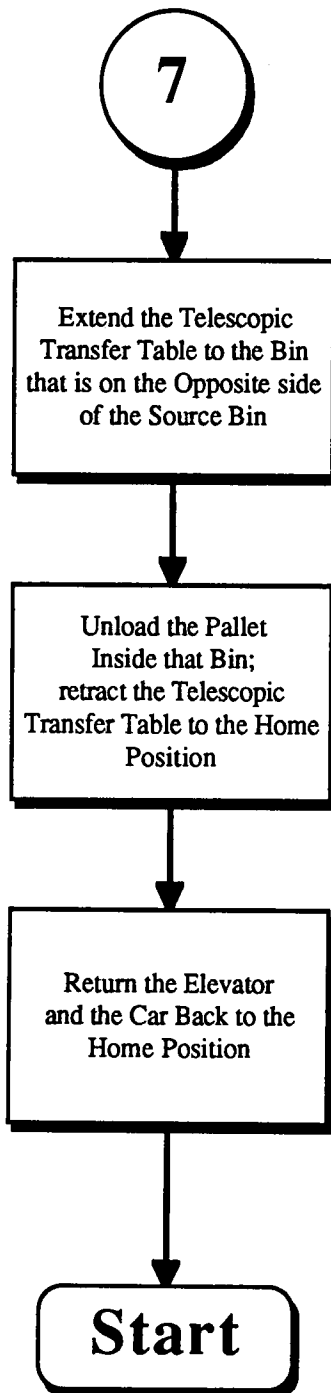


Figure 3.5. Concluded

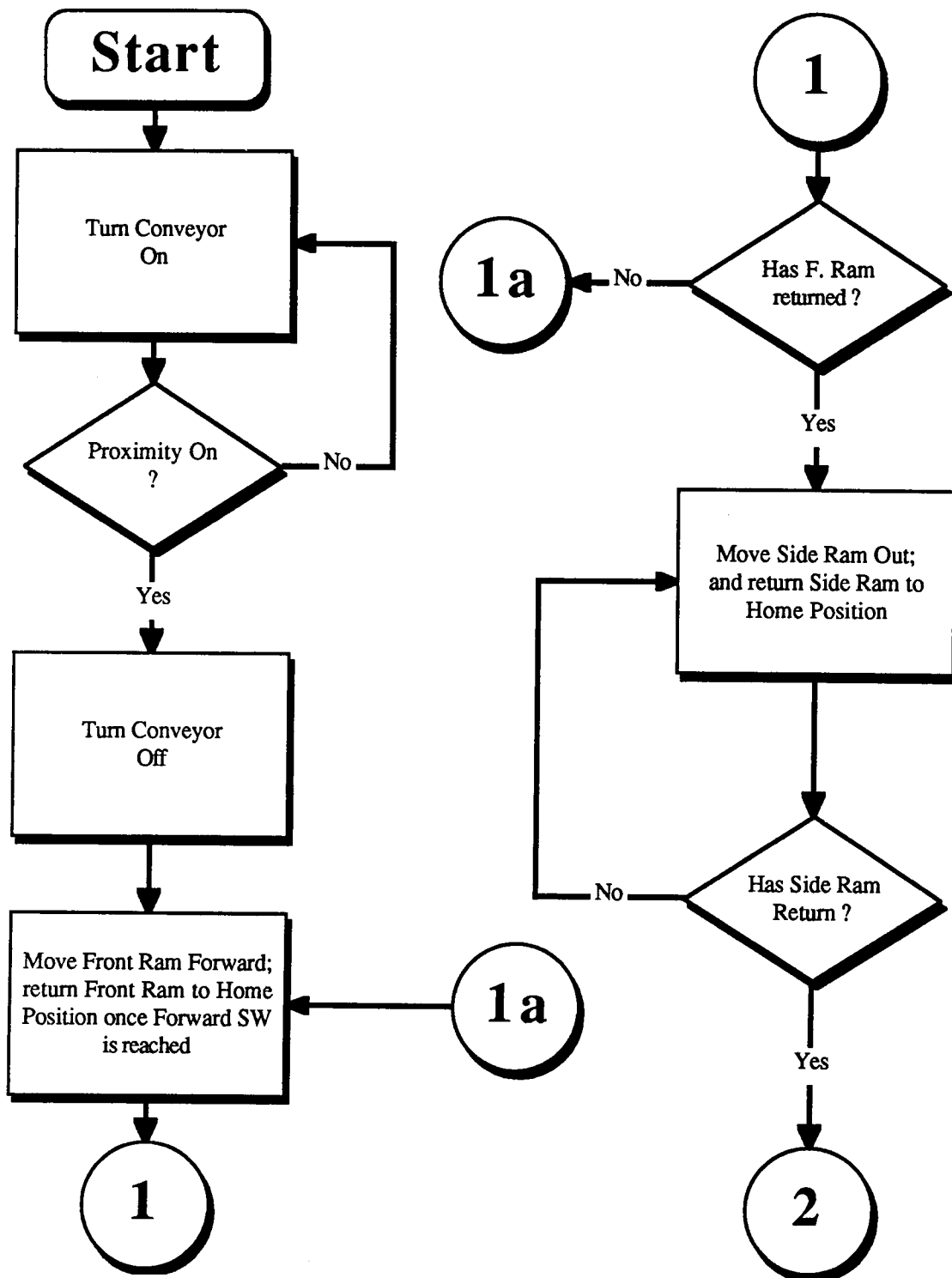


Figure 3.6. Punch Press Flowchart

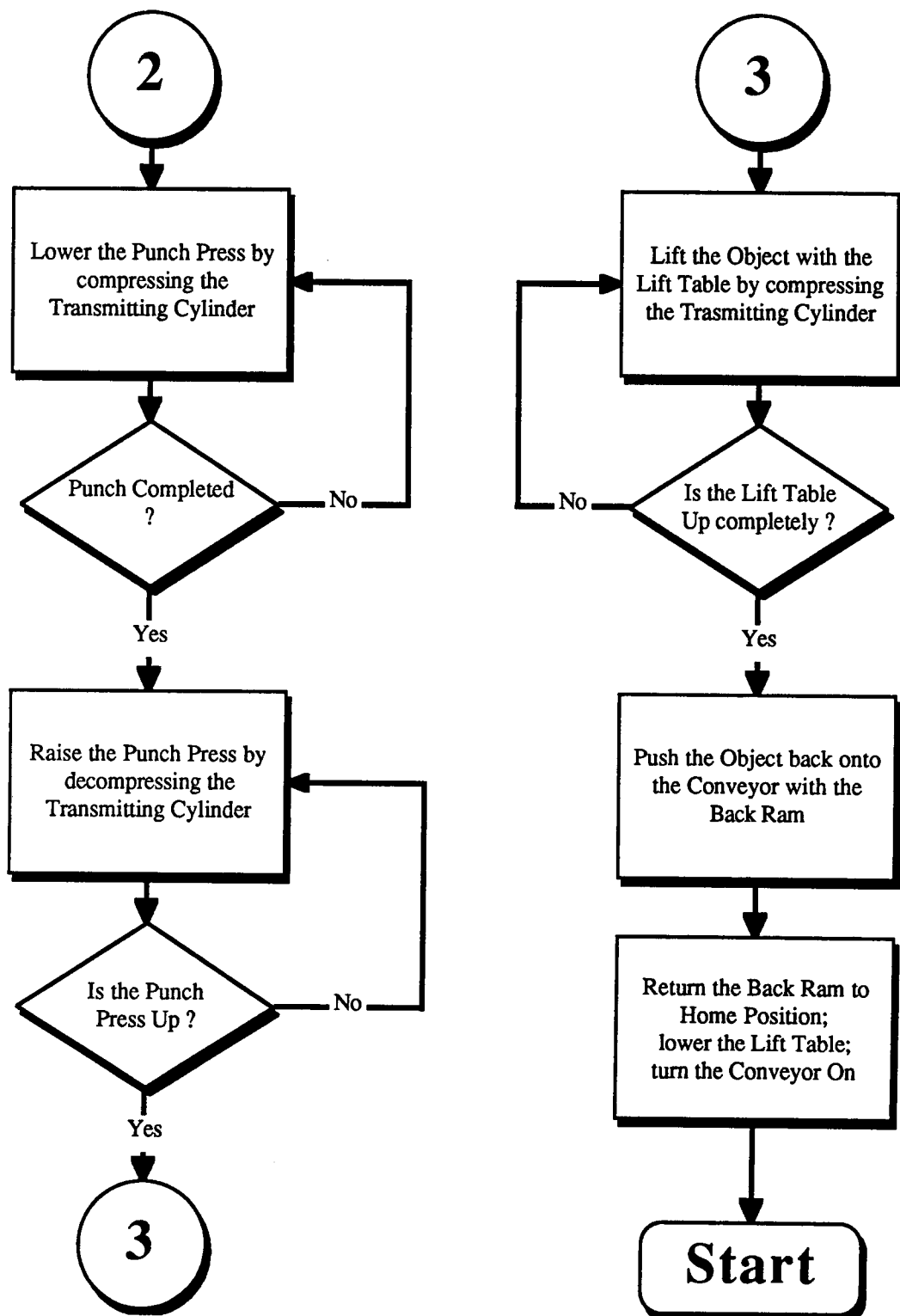


Figure 3.6. Concluded

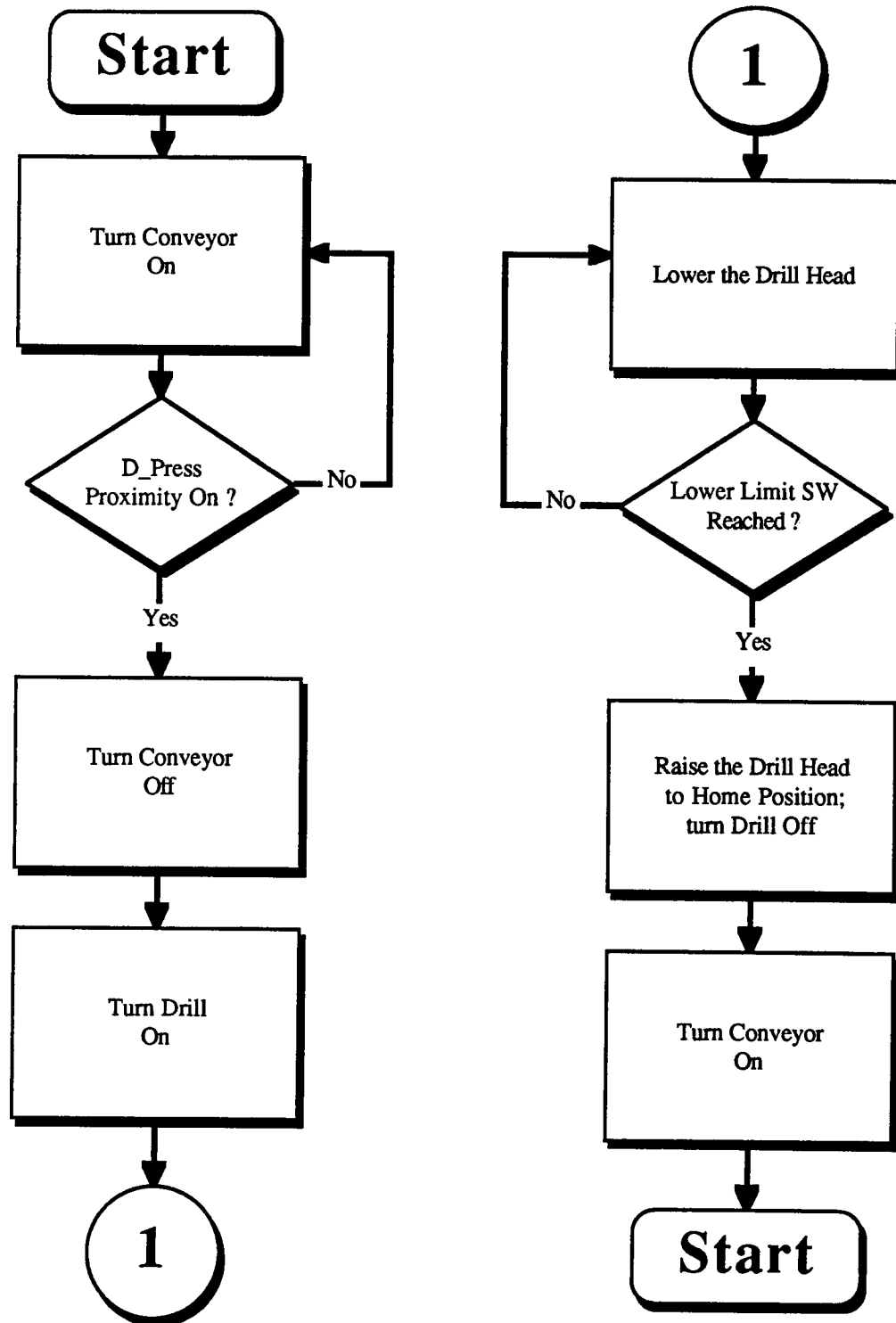


Figure 3.7. Drill Press Flowchart

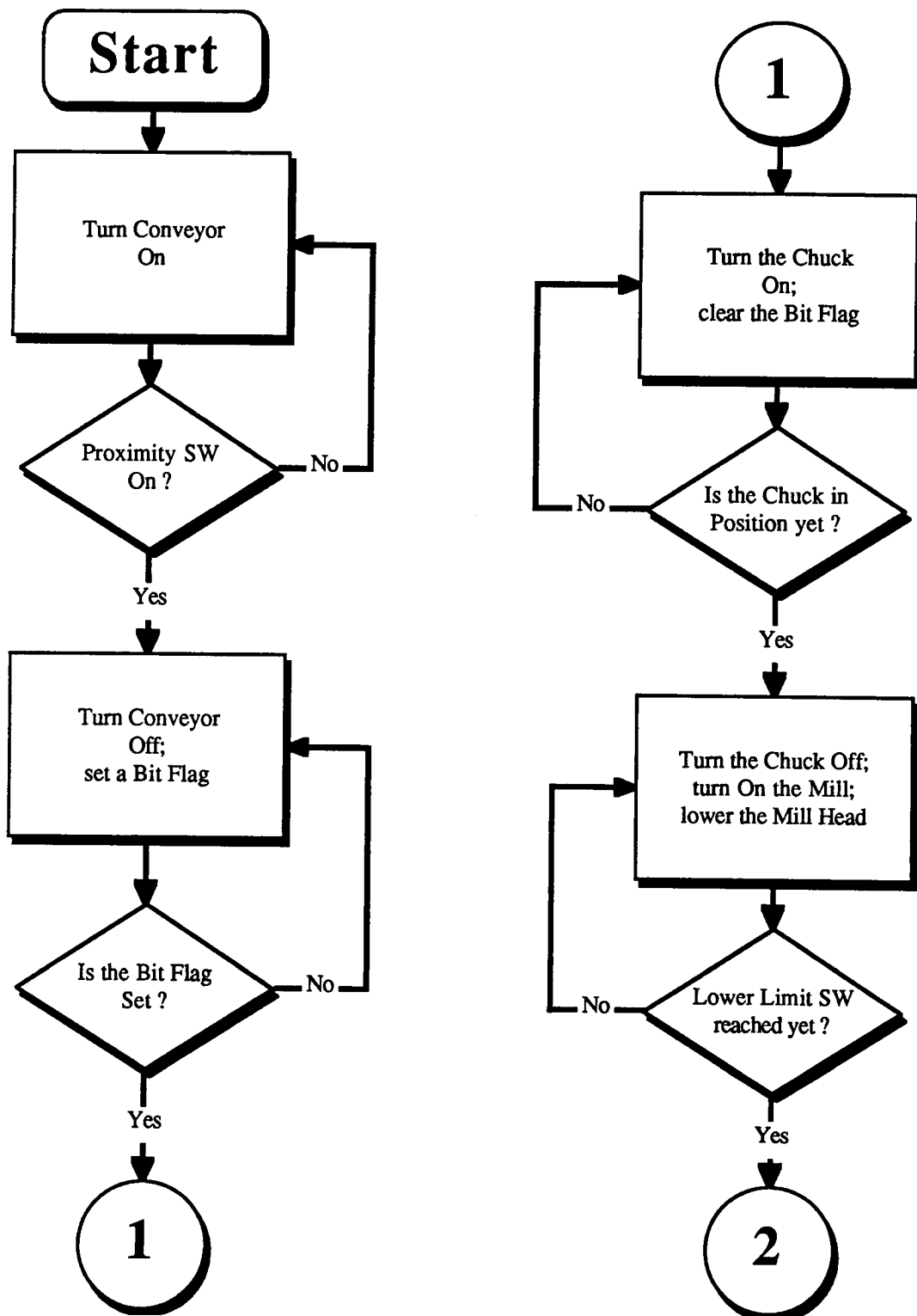


Figure 3.8. Vertical Milling Machine Flowchart

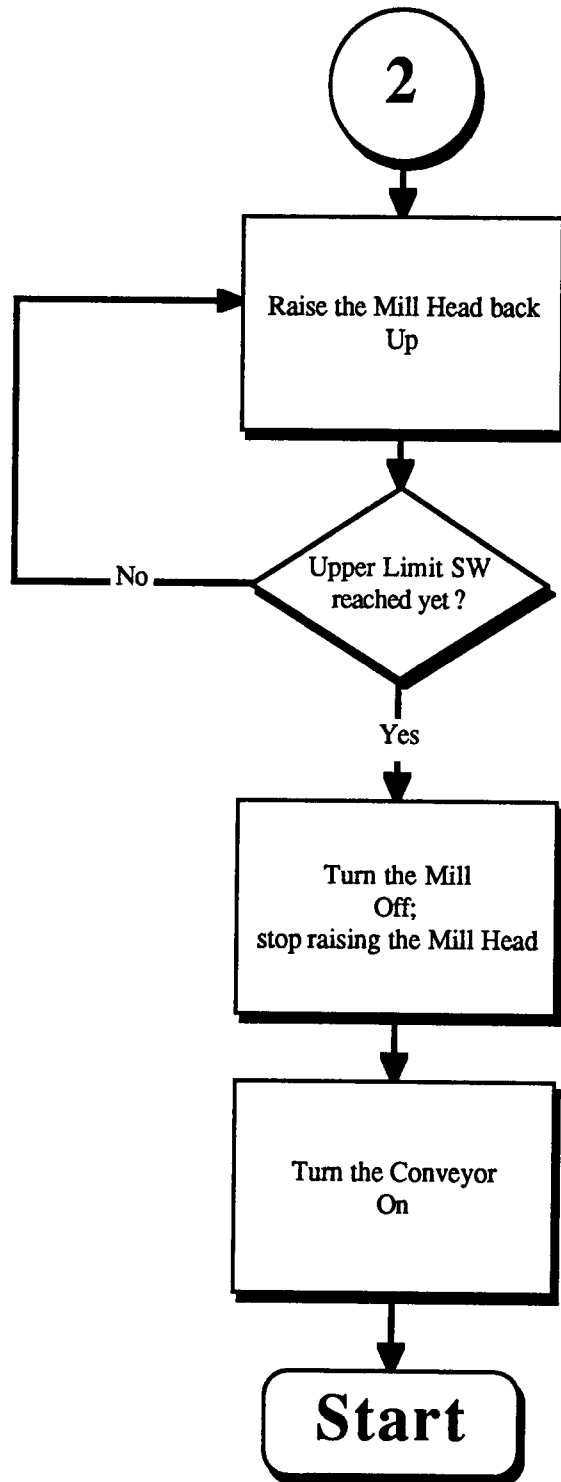


Figure 3.8. Concluded

The programming of the Horizontal Milling Machine. The required movements here were in between the Vertical Milling Machine and the Drill Press in complexity. No flag and register were used. The drill of the Drill Press was turned on before lowering the drill head. The cutter of the Horizontal Milling Machine was turned off while lowering the head. The SFC was used to maintain the top down style of programming. The ladder logic is in Appendix F (see Figure 3.9).

The programming of the 2-Axis Robot Assembly Station. The movements here were as complex as one can imagine. However, a moderate algorithm was implemented. The 2-Axis Robot was programmed to pick up 3 different washers from 3 respective trays in the assembly process to the part, a cylinder. No register and flag were used, and the logic was kept to a minimum with SFC (see Figure 3.10). The ladder program is given in Appendix G.

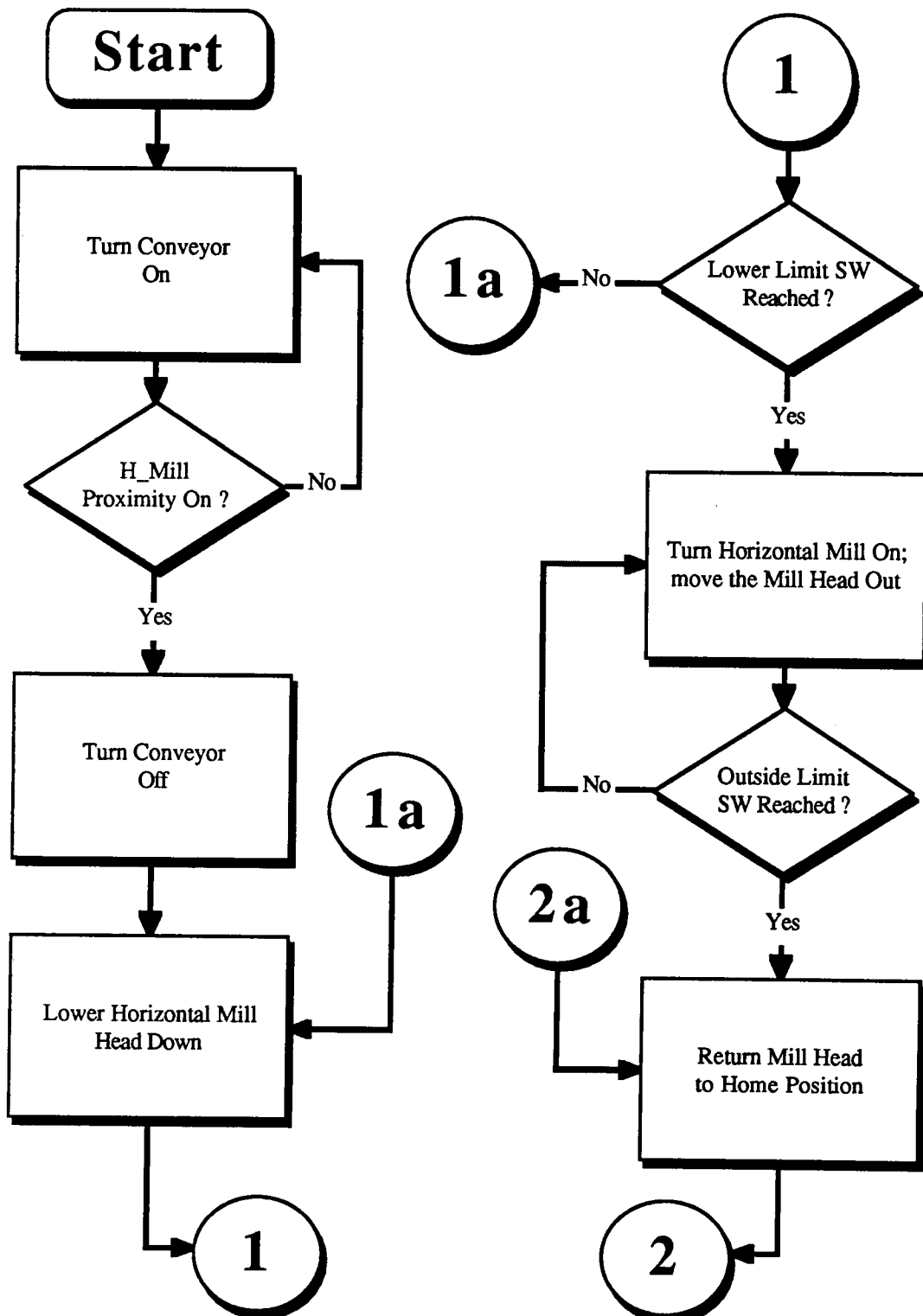


Figure 3.9. Horizontal Milling Machine Flowchart

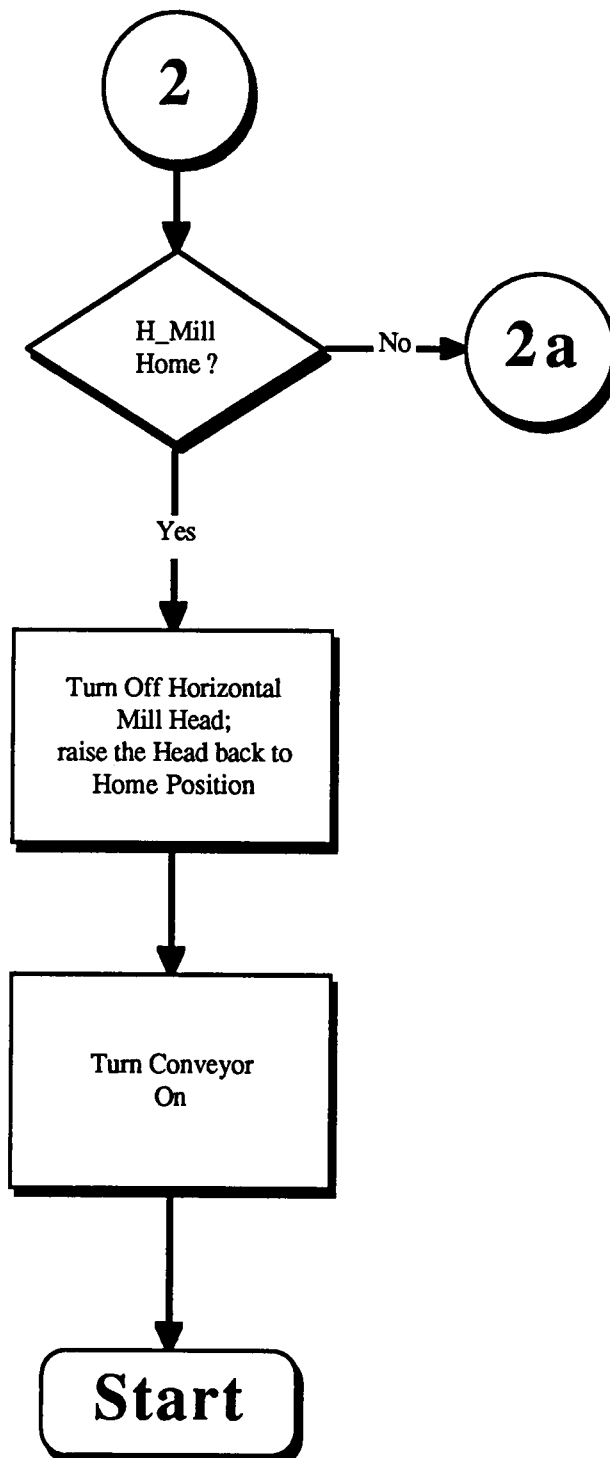


Figure 3.9. Concluded

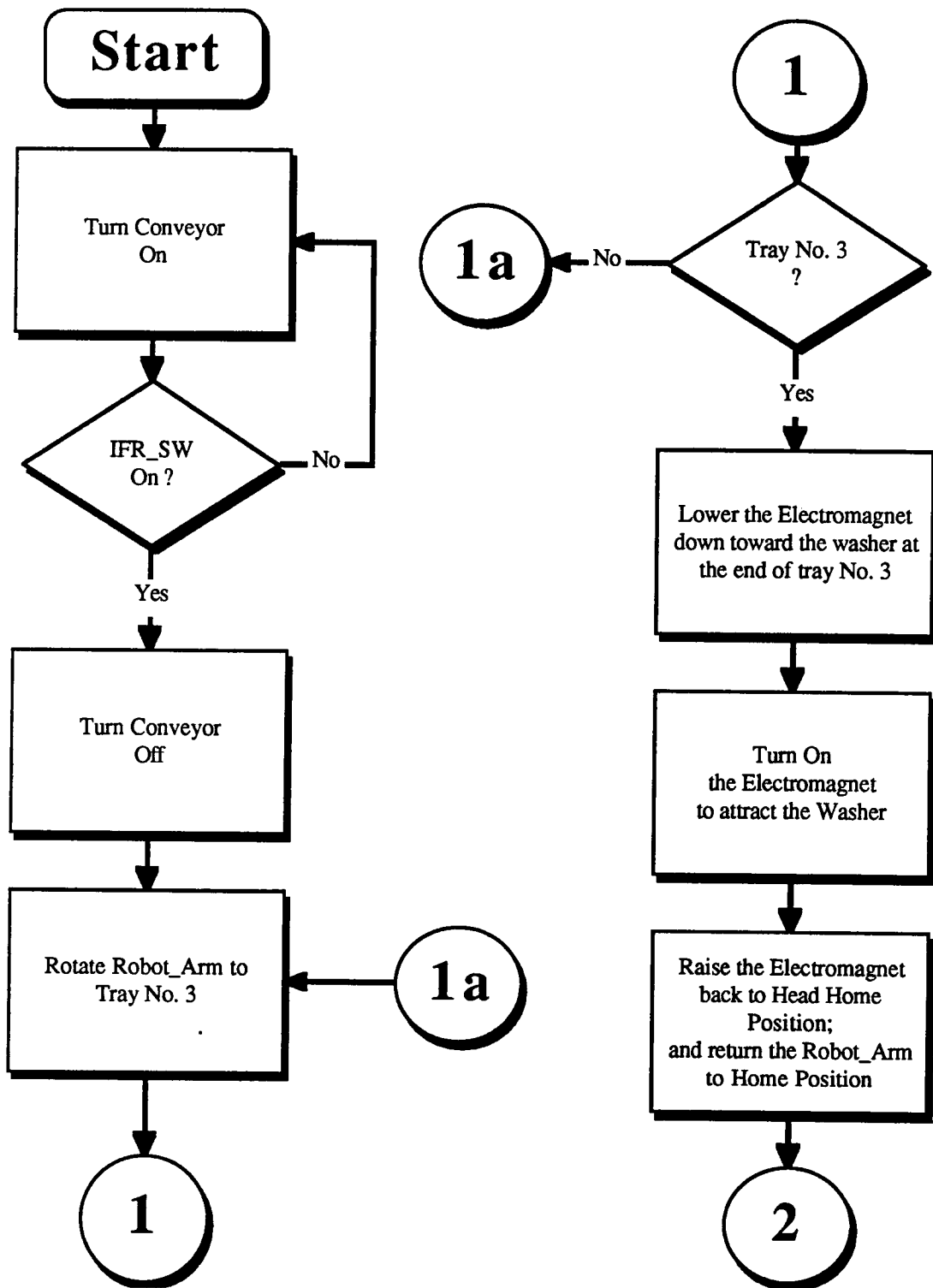


Figure 3.10. Assembly Station Flowchart

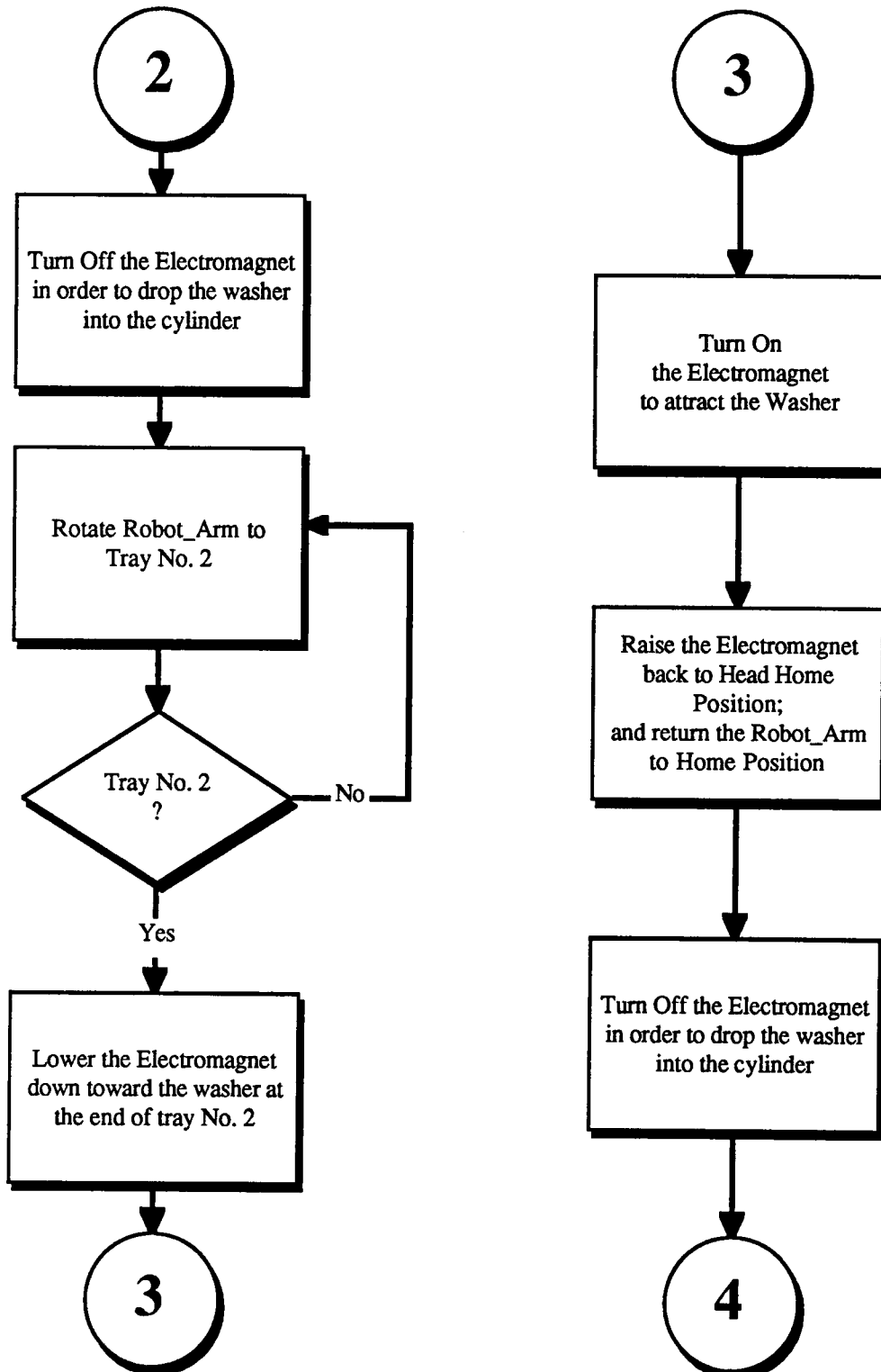


Figure 3.10. Continued

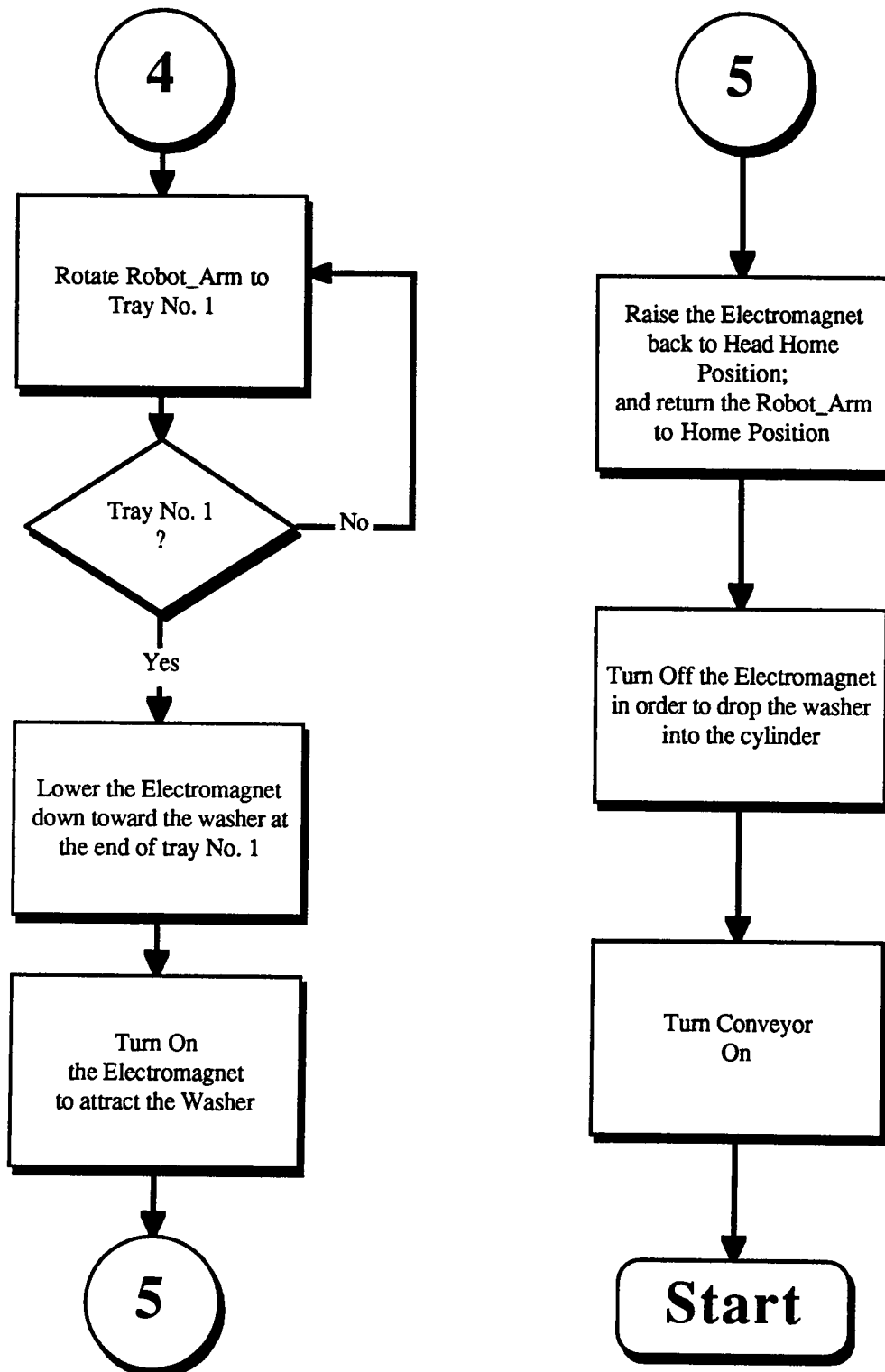


Figure 3.10. Concluded

CHAPTER 4

THE COMMUNICATION OF THE MODEL FACTORY

4.1 Introduction

As explained in chapter 1, the effectiveness in using computers and intelligent devices in the manufacturing environment requires the integration of such devices. Usually, the task of integrating the computers in a production facility is done with a LAN. In order to simplify the network and to insure interoperability for all computers, computer communication standards must be used. To demonstrate this idea, the MAP Research Network and the Manufacturing Model at the Department of Electrical and Computer Engineering of the University of Tennessee/Knoxville were used. In the following sections, the communication between the Model and a node of the MAP Research Network will be explained.

4.2 The CIM Model

In a CIM environment, a hierarchical layered structure exists for classifying the computers used [13]. This way, computer communication can be directed in an orderly fashion and a certain

level of efficiency of the network can be achieved. For example, in a four layers CIM model, the following hierarchy exists:

- The Plant Host
- The Area Manager
- The Cell Controller
- The Workstation

The data was distributed from the Plant Host to the different Area Managers. Upon receiving the data, each of the Area Managers then provided the data to their respective Cell Controllers. After acquiring the data, the cell controller determined the action taken on the Workstation.

In this thesis, a four layer CIM model was used. A micro-computer was used as the Plant Host, and it was a node on the MAP network. The T45 Portable Industrial Terminal and the PLC-5/15 were used as the Area Manager and the Cell Controller, respectively. The ASRS of the Model Factory was used as the Workstation. In addition to the CIM model, a MAP node was used as the Order Entry Point.

4.3 Factory Communication Strategy

Since both the Plant Host and the Order Entry Point were existing MAP nodes, no interfacing was required. To interface the T45 to the MAP network, a Network Interface Unit (NIU) was used. A RS-232-C 25-pin D-type Connector and a terminal emulation

program were implemented to interface the T45 to the NIU. Once this was accomplished, data communication between the Area Manager and the Plant Host were made possible. However, communication was established from the Plant Host to the Area Manager.

Area Manager communication with the Plant Host was required to access information in the data base residing in the Plant Host. This data base stored information about the inventory in the warehouse. Such information was used not only to track parts, but also to provide working information for the Cell Controller via the Area Manager. Upon receiving the location of the part from the Plant Host, coordinate input to the Area Manager was sent to the PLC-5 that was used to control the ASRS. Then the ASRS retrieved and placed the part to the assembly line. Similar procedures were used to place the finished part back to the warehouse of the ASRS. Before the part returned to the ASRS for storage, the location and process status were updated in the data base.

As a result, message formats was predetermined. For the Order Entry Node to place an order to the Plant Host, a sign integer with 8 significant places was used to represent the parts. The set of numbers containing ± 00000001 to ± 00000004 was used to identify 4 unprocessed parts. To represent the processed or finish products, the set of numbers containing ± 00000005 to ± 00000008 was used. Although only 4 parts were used, the data base worked well with part

codes from ± 00000001 to ± 99999999 . The (+) and (-) signs were used to identify operations. To store a part, the (+) sign was used. To retrieve a part, the (-) sign was used.

For the Area Manager to receive the location of the part from the Plant Host, 24 numbers were used to represent the location. The set of numbers containing 1 to 24 was used to represent the 24 bins of the warehouse. Again, the (+) and (-) signs were used to represent the operation. Locations +1 to +24 were used to identify the 24 empty bins, and locations -1 to -24 were used to identify the bins where the parts were stored. Also, +0 was used to indicate the no vacancy condition in the warehouse, and -0 was used to indicate the absence of a part.

The order of sending these numbers was important. Upon establishing the connection from the Plant Host to the Order Entry Point and the Area Manager, the Order Entry Point operator was prompted with a message ([+/-]Part Number ? :). The operator entered the part code with the described format. The Plant Host made a search in its data base. When the first location containing the requested part was found in the search, the Plant Host sent the number that represented the location to the Area Manager. The operator of the Area Manager then translated the location code into coordinate that the Cell Controller would understand. The Cell Controller then initiated the control of the ASRS to retrieve the part from the warehouse and placed it to the assembly line.

After completing a trip on the assembly line, the part was returned to the warehouse for storage. To store a processed part, similar communication procedures and format were used. This time, the Area Manager would request an empty bin for the processed part. Thus, the data base would search for an empty bin. Once the location was found, the data base would update the empty bin in the data base as a filled bin with the appropriate part code. The location of the empty bin was then sent to the the Area Manager. The location code was once again translated into coordinate and was sent to the Cell Controller. The mentioned procedures could also be used to store newly arrived parts. To this end, the data base was able to provide the most up-to-date inventory. Most off the shelf data base packages provide such capability. For this thesis, dBASE III PLUSTM* was used.

As mentioned, only 4 part codes were used in this thesis. The four parts were

- The cylinder
- The 30 mm by 30 mm by 30 mm cube
- The 15 mm by 30 mm by 45 mm block (single height)
- The 30 mm by 30 mm by 45 mm block (double height)

Thus, for the unprocessed parts, number 00000001 was assigned to represent the single height block, number 00000002 was assigned to represent the double height block, number 00000003 was assigned to represent the cube, and number 00000004 was assigned

* dBASE III PLUS is a trademark of Ashton-Tate, INC.

to represent the cylinder. For the finished or processed parts, number 00000005 was assigned to represent the cylinder, number 00000006 was assigned to represent the cube, number 00000007 was assigned to represent the single height block, and number 00000008 was assigned to represent the double height block.

In order to assign the 24 numbers to the bins in the warehouse, the matrix nature of the warehouse was used. Each half of the warehouse was considered as a 3 by 4 matrix, and 12 of the 24 numbers were assigned to its elements. For example, twelve numbers were assigned to the half of warehouse that was attached to the beginning of the conveyor system. The other 12 numbers were assigned to the remaining half of the warehouse. The numbers were assigned to the coordinates of the elements of each matrix so that minimum time was spent by the elevator and its carriage when retrieving and storing the part. For example, location 1 was the closest bin to the home position of the elevator and its carriage, and location 24 was the farthest bin from the home position of the elevator and its carriage. Thus, for half of the warehouse that was next to the beginning of the conveyor, the set of numbers (1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23) was assigned to its set of coordinates [(1,1); (2,1); (1,2); (2,2); (3,1); (3,2); (1,3); (2,3); (3,3); (1,4); (2,4); (3,4)], respectively, with the bottom row as the first row of the matrix and the column that was next to the elevator's home position as the first column. For the other half of the warehouse, the set of numbers (2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24) was assigned to

its set of coordinates [(1,1); (2,1); (1,2); (2,2); (3,1); (3,2); (1,3); (2,3); (3,3); (1,4); (2,4); (3,4)], respectively, also with the bottom row as the first row of the matrix and the column that was next to the elevator's home position as the first column. As a result, a part was retrieved/stored as soon as possible since the bin was reached by the elevator as the location was searched by the data base.

CHAPTER 5

RESULTS AND CONCLUSION

5.1 Results

Factory Control Results. All the ladder programs were given in the appendixes. These programs were tested and the results are described in chapter 3. The only exception was the program that controlled the ASRS. The part of the program that would identify the parts on the line was not implemented. Also, minor modifications were implemented. Four additional flags were used. They were the following:

- The TAKE_OUT flag
- The PUT_BACK flag
- The B_SIDE flag
- The E_SIDE flag

The first two flags determined the operation of the ASRS. For example, the ASRS either retrieved or stored a part, but it would never perform both operations at the same time. The second two flags determined the side which the transfer table would move. For example, the B_SIDE flag was used to represent the side of the warehouse that was next to the beginning of the conveyor system, and the E_SIDE flag represented the other side of the warehouse. To select the flags and to enter an input coordinate, the N7 file,

integer file, was used. Therefore, all flag conditions could be observed from the N7 file as well.

Once inside the N7 file, the following sequential procedures were used to enter data and to set flags in the N7 file:

- Enter coordinate into the INPUT_REG
- Set one of the side flags with a 1
- Set one of the operation flags with a 1

Factory Communication Results. The factory communication setup was tested and the results were found satisfactory. Network library functions were used to implement the factory communication specifications. The following key sequences were used to establish the connections among the Plant Host Node, the Area Manager Node, and the Order Entry Node:

- Go to the following subdirectory of the Area Manager system:

IPDS\ARCH\PLC5

- Execute the following program once inside the IPDS\ARCH\PLC5 directory [14]:

FACTDBN.EXE*

- Enter the following once inside the FACTDBN.EXE program:

C

- In the Plant Host, go to the following directory:

DBN

- Execute the following in the Plant Host:

* Nabajyoti Barkakati, MS-DOS Papers (Indianapolis: Howard W. Sams & Company, 1988), pp. 477-533.

factwork -S

- Execute the following in the Order Entry:

factwork

- When prompted, enter the following in the Plant Host:

INI002760_dBase_Server

- When prompted by the Plant Host after entering the last command, enter the following:

dBase_Factory

- Next, enter the following in the Order Entry upon receiving a prompt:

INI001F01_dBase_Client

- To complete the connection procedure, enter the following in the Order Entry when prompted:

INI002760_dBase_Server

Once all connections were established, a part code was entered from the Order Entry Node to the Plant Host. The Order Entry terminal operator must press the RETURN key on the following prompt. The data base in the Plant Host initiated the search, and stopped the search when the first requested part was found. The location was then transmitted to the Area Manager. The operator translated this location into the corresponding coordinate by pressing the F4 function key and entering the location number. The conversion was showed on the screen and printed on a parallel printer that was attached to the Area Manager. The operator then entered the on-line environment of the T45 by pressing the F5

function key. Once inside the on-line environment, the operator entered the data to the N7 file for the ASRS program. To return to the communication environment, the operator pressed the F10 function key after exiting the on-line environment, then pressed 0 at the next menu. After returning into the communication environment, the Area Manager operator sent a request to the Plant Host for an empty bin to store the part by pressing the F2 function key. When the Plant Host returned the location, the operator of the Area Manager used the F4 and F5 function keys as described above.

5.2 Conclusion

This thesis proved that using communication standards, instead of proprietary network, for data communication provided a feasible alternative for CIM. Additionally, communication was established between the Factory Model and a node in the MAP Research Network.

5.3 Future

The thesis served as a stepping stone for future projects. More problems can be solved with the Factory Model and the MAP Research Network. As mentioned before, the control programs for the workstations were implemented individually due to the limited amount of equipment and time. The automation of the Factory Model

calls for a number of algorithms that work with different operations and different parts. Also, the communication process can be automated. Thus, the Area Manager operator could be eliminated.

To solve the automation problem, the part code and a bar code reader may be used. Recall that only 4 parts were used, and only 1 out of 8 digits were used in the part code. The other 7 digits were used to represent the operations. Furthermore, each digit was represented by 4 bits. Thus, each workstation had the flexibility to provide up to 16 operations. The following steps provide a guide to approach the problem:

- Make copy of each ladder program and use one as the working copy
- Make necessary change of addresses in the working copy to match the new I/O addresses
- Test the working copy
- If all programs work well after the change, incorporate the programs for the workstations into the ASRS program
- Use Bit Flags or Integer Flags as extra input conditions in order to manipulate different operation for each workstation

These steps were possible because CAM provides the capabilities for updates and modifications.

To attack the communication automation problem, two possibilities may be investigated. The first one involves the use of the Allen Bradley's BASIC module [15]. Either the interface between BASIC and the Allen Bradley's 6200 Software, or a RS-232-C port

must be available. The second option requires the interface of the communication program, which was written in C, to the source code of the Allen Bradley's 6200 Software.

LIST OF REFERENCES

LIST OF REFERENCES

- [1] Jones, Vincent C., MAP/TOP Networking, McGraw-Hill, New York, N.Y., 1988.
- [2] Schwartz, Mischa, Telecommunication Networks: Protocols, Modeling and Analysis, Addison-Wesley, Reading, Mass., 1987.
- [3] Tanenbaum, Andrew S., Computer Networks, Prentice-Hall, Englewood Cliffs, N.J., 1988.
- [4] MAP Specification Versions 2.1.A, 2.2 & 3.0, General Motors Technical Center, Michigan, 1986, 1988.
- [5] Stallings, William, Handbook of Computer-Communications Standards, Macmillan Publishing Company, New York, N.Y., 1987.
- [6] PLC-5 Family Programmable Controllers Processor Manual, Allen-Bradley Company, Cleveland, Ohio, 1987.
- [7] PLC-5 Family Programmable Controllers Assembly and Installation Manual, Allen-Bradley Company, Cleveland, Ohio, 1989.
- [8] Portable Terminal (Cat. No. 1784-T45) User's Manual, Allen-Bradley Company, Cleveland, Ohio, 1988.
- [9] Allen-Bradley Universal I/O Chassis (Publication 1771-2.49), Allen Bradley Company, Cleveland, Ohio, March, 1987.

- [10] AC (120/220) 16 A Power Supply (Publication 1771-2.93), Allen Bradley Company, Cleveland, Ohio, April, 1986.
- [11] Allen-Bradley Selectable Contact Output Module (Publication 1771-2.110), Allen Bradley Company, Cleveland, Ohio, November, 1987.
- [12] TTL Input Module (Publication 1771-2.9), Allen Bradley Company, Cleveland, Ohio, May, 1986.
- [13] The MAP Book: An Introduction to Industrial Networking, Industrial Networking Incorporated, Santa Clara, CA, 1987.
- [14] Barkakati, Nabajyoti, MS-DOS Papers, Howard W. Sams & Company, Indianapolis, Indiana, 1988.
- [15] BASIC Module User's Manual, Allen-Bradley Company, Cleveland, Ohio, 1987.

APPENDICES

APPENDIX A

WIRING LIST

Cable #1: Punch Press

N.C. *			E1	Brown
Back Ram Forward Position	Group-1	I/Terminal-0	E2	Red
Back Ram Home Position	Group-1	I/Terminal-1	E3	Orange
Part Lift Home Position	Group-1	I/Terminal-2	E4	Yellow
+5V			Unused	Green
Side Ram Home Position	Group-1	I/Terminal-3	E5	Blue
Side Ram Forward Position	Group-2	I/Terminal-0	E6	Violet
Infrared Sensor Part In Place	Group-2	I/Terminal-6	E7	Gray
Front Ram Forward Position	Group-2	I/Terminal-1	E8	White
Front Ram Home Position	Group-2	I/Terminal-2	E9	Black
Proximity Switch (Punch)	Group-2	I/Terminal-0	E10	Brown
+5V		I/Terminal-A	+5	Red
Front Ram Forward +	Group-1	O/Terminal-2	M1	Orange
Front Ram -	Group-1	O/Terminal-5	M1	Yellow
Conveyor Punch Press -	Group-1	O/Terminal-9	M2	Green
Conveyor Punch Press +	Group-1	O/Terminal-11	M2	Blue
Side Ram Forward +	Group-2	O/Terminal-2	M3	Violet
Side Ram -	Group-2	O/Terminal-5	M3	Gray
Back Ram Forward +	Group-2	O/Terminal-8	M4	White
Back Ram -	Group-2	O/Terminal-11	M4	Black

* N.C. means Not Connected.

Cable #2: Punch Press & Drill Press

Lift Table Hyd. Down Switch	Group-1	I/Terminal-4	E1	Brown
Lift Table Hyd. Up Switch	Group-1	I/Terminal-5	E2	Red
Punch Ram Hyd. Up	Group-1	I/Terminal-6	E3	Orange
Punch Ram Down	Group-1	I/Terminal-7	E4	Yellow
+5V		I/Terminal-A	+5	Green
Punch Up	Group-2	I/Terminal-3	E5	Blue
Punch Down	Group-2	I/Terminal-4	E6	Violet
N.C.			E7	Gray
Drill Press Up (Home)	Group-0	I/Terminal-0	E8	White
Drill Press Down	Group-0	I/Terminal-1	E9	Black
Proximity Switch Drill Press	Group-0	I/Terminal-7	E10	Brown
+5V		I/Terminal-A	+5	Red
Drill Press Conveyor +	Group-0	O/Terminal-2	M1	Orange
Drill Press Conveyor -	Group-0	O/Terminal-12	M1	Yellow
Drill Press Head Down -	Group-0	O/Terminal-8	M2	Green
Drill Press Head Down +	Group-0	O/Terminal-11	M2	Blue
Lift Table Up +	Group-3	O/Terminal-2	M3	Violet
Lift Table Up -	Group-3	O/Terminal-5	M3	Gray
Punch Ram Down +	Group-3	O/Terminal-8	M4	White
Punch Ram -	Group-3	O/Terminal-11	M4	Black

Cable #3: Vertical Mill

N.C.			E1	Brown
N.C.			E2	Red
N.C.			E3	Orange
N.C.			E4	Yellow
+5V		I/Terminal-A	+5	Green
N.C.			E5	Blue
N.C.			E6	Violet
Vertical Head Rotate Position	Group-3	I/Terminal-1	E7	Gray
Vertical Head Home Position	Group-3	I/Terminal-2	E8	White
Vertical Head Down Position	Group-3	I/Terminal-3	E9	Black
Proximity Switch Vertical Mill	Group-3	I/Terminal-0	E10	Brown
+5V		I/Terminal-A	+5	Red
Conveyor Vertical Mill -	Group-3	O/Terminal-9	M1	Orange
Conveyor Vertical Mill +	Group-3	O/Terminal-5	M1	Yellow
Vertical Head Down -	Group-3	O/Terminal-8	M2	Green
Vertical Head +	Group-3	O/Terminal-11	M2	Blue
Vertical Head Rotate +	Group-4	O/Terminal-2	M3	Violet
Vertical Head Rotate -	Group-4	O/Terminal-9	M3	Gray
Vertical Mill Cutter +	Group-4	O/Terminal-5	M4	White
Vertical Mill Cutter -	Group-4	O/Terminal-9	M4	Black

Cable #4: Horizontal Mill

N.C.			E1	Brown
N.C.			E2	Red
N.C.			E3	Orange
N.C.			E4	Yellow
+5V		I/Terminal-A	+5	Green
N.C.			E5	Blue
Horiz. Head Down Position	Group-0	I/Terminal-0	E6	Violet
Horiz. Head Home Position	Group-0	I/Terminal-1	E7	Gray
Horiz. Head Out Position	Group-0	I/Terminal-2	E8	White
Horiz. Head In (Home)	Group-0	I/Terminal-3	E9	Black
Proximity Switch Horiz. Mill	Group-0	I/Terminal-7	E10	Brown
+5V		I/Terminal-A	+5	Red
Conveyor Horiz. Mill +	Group-1	O/Terminal-2	M1	Orange
Conveyor Horiz. Mill -	Group-1	O/Terminal-9	M1	Yellow
Horiz. Head Down -	Group-0	O/Terminal-2	M2	Green
Horiz. Head +	Group-0	O/Terminal-5	M2	Blue
Horiz. Head Out +	Group-0	O/Terminal-8	M3	Violet
Horiz. Head -	Group-0	O/Terminal-11	M3	Gray
Horiz. Mill Cutter +	Group-1	O/Terminal-5	M4	White
Horiz. Mill Cutter -	Group-1	O/Terminal-9	M4	Black

Cable #5: Conveyor A, Conveyor Assemble & Conveyor B

N.C.			E1	Brown
N.C.			E2	Red
N.C.			E3	Orange
N.C.			E4	Yellow
+5V		I/Terminal-A	+5	Green
N.C.			E5	Blue
N.C.			E6	Violet
N.C.			E7	Gray
N.C.			E8	White
N.C.			E9	Black
N.C.			E10	Brown
+5V		I/Terminal-A	+5	Red
N.C.			M1	Orange
N.C.			M1	Yellow
Conveyor B -	Group-1	O/Terminal-3	M2	Green
Conveyor B +	Group-1	O/Terminal-2	M2	Blue
Conveyor Assemble +	Group-1	O/Terminal-2	M3	Violet
Conveyor Assemble -	Group-1	O/Terminal-3	M3	Gray
Conveyor A +	Group-1	O/Terminal-2	M4	White
Conveyor A -	Group-1	O/Terminal-3	M4	Black

Cable #6: Assemble Station

Ground		I/Terminal-B	E1	Brown
N.C.			E2	Red
N.C.			E3	Orange
Infrared Sensor	Group-0	I/Terminal-6	E4	Yellow
+5V		I/Terminal-A	+5	Green
Station #3	Group-0	I/Terminal-5	E5	Blue
Station #2	Group-0	I/Terminal-4	E6	Violet
Station #1	Group-0	I/Terminal-0	E7	Gray
Assem. Station Conveyor Pos.	Group-0	I/Terminal-1	E8	White
Assemble Head Down	Group-0	I/Terminal-2	E9	Black
Assemble Head Home	Group-0	I/Terminal-3	E10	Brown
+5V		I/Terminal-A	+5	Red
Electromagnet	Group-1	O/Terminal-5	M1	Orange
Electromagnet	Group-1	O/Terminal-6	M1	Yellow
Assemble Head Down -	Group-0	O/Terminal-2	M2	Green
Assemble Head +	Group-0	O/Terminal-5	M2	Blue
Assemble Rotate +	Group-0	O/Terminal-8	M3	Violet
Assemble Rotate -	Group-0	O/Terminal-11	M3	Gray
Drill Press Drill Motor +	Group-0	O/Terminal-5	M4	White
Drill Press Drill Motor -	Group-0	O/Terminal-3	M4	Black

Cable #7: Warehouse Elevator Car

N.C.			E1	Brown
Level 3 Upper Limit	Group-3	I/Terminal-7	E2	Red
Level 2 Upper Limit	Group-3	I/Terminal-6	E3	Orange
Level 1 Upper Limit	Group-3	I/Terminal-5	E4	Yellow
+5V		I/Terminal-A	+5	Green
Level 1 Lower Limit	Group-2	I/Terminal-5	E5	Blue
Level 2 Lower Limit	Group-2	I/Terminal-4	E6	Violet
Level 3 Lower Limit	Group-2	I/Terminal-3	E7	Gray
Table Unload Position	Group-2	I/Terminal-2	E8	White
Table Load Position	Group-2	I/Terminal-1	E9	Black
Table Home Position	Group-2	I/Terminal-0	E10	Brown
+5V		I/Terminal-A	+5	Red
Transfer Table Unload -	Group-3	O/Terminal-11	M1	Orange
Transfer Table	Group-3	O/Terminal-8	M1	Yellow
Transfer Cage Car Right -	Group-3	O/Terminal-5	M2	Green
Transfer Cage Car +	Group-3	O/Terminal-2	M2	Blue
Elevator Up +	Group-2	O/Terminal-2	M3	Violet
Elevator -	Group-2	O/Terminal-5	M3	Gray
N.C.			M4	White
N.C.			M4	Black

Cable #8: Warehouse

Ground		I/Terminal-B	E1	Brown
N.C.			E2	Red
Upper Infrared Sensor	Group-3	I/Terminal-4	E3	Orange
Loading Ram Home Position	Group-4	I/Terminal-3	E4	Yellow
+5V		I/Terminal-A	+5	Green
Loading Ram Home Position	Group-4	I/Terminal-2	E5	Blue
Unloading Ram Out Position *	Group-4	I/Terminal-1	E6	Violet
Unloading Ram Home Position	Group-4	I/Terminal-0	E7	Gray
Infrared Sensor #1	Group-3	I/Terminal-3	E8	White
Proximity Switch	Group-3	I/Terminal-0	E9	Black
Infrared Sensor #2	Group-3	I/Terminal-2	E10	Brown
+5V		I/Terminal-A	+5	Red
Unloading Conveyor +	Group-1	O/Terminal-8	M1	Orange
Unloading Conveyor -	Group-1	O/Terminal-11	M1	Yellow
Unloading Part Ram Out +	Group-4	O/Terminal-2	M2	Green
Unloading Part Ram -	Group-4	O/Terminal-5	M2	Blue
Loading Conveyor +	Group-1	O/Terminal-8	M3	Violet
Loading Conveyor -	Group-1	O/Terminal-11	M3	Gray
Part Reload Ram Forward -	Group-4	O/Terminal-11	M4	White
Part Reload Ram +	Group-4	O/Terminal-8	M4	Black

* This wire has been disabled and changed to cable No. 9, wire M3.

Cable #9: Warehouse

Station Home Load/Unload	Group-1	I/Terminal-7	E1	Brown
Station #1	Group-1	I/Terminal-6	E2	Red
Station #2	Group-1	I/Terminal-5	E3	Orange
Station #3	Group-1	I/Terminal-4	E4	Yellow
+5V		I/Terminal-A	+5	Green
Station #4	Group-1	I/Terminal-3	E5	Blue
N.C.			E6	Violet
N.C.			E7	Gray
Lifting Conveyor Down Pos.	Group-1	I/Terminal-2	E8	White
Lifting Conveyor Up Pos.	Group-1	I/Terminal-1	E9	Black
Lifting Conveyor Infrared Sens.	Group-1	I/Terminal-0	E10	Brown
+5V		I/Terminal-A	+5	Red
Lifting Conveyor +	Group-1	O/Terminal-8	M1	Orange
Lifting Conveyor -	Group-1	O/Terminal-11	M1	Yellow
Lifting Conveyor Up +	Group-2	O/Terminal-8	M2	Green
Lifting Conveyor -	Group-2	O/Terminal-11	M2	Blue
Unloading Ram Out Pos. Switch*	Group-4	I/Terminal-1	M3	Violet
N.C.			M3	Gray
N.C.			M4	White
N.C.			M4	Black

* See cable No. 8.

APPENDIX B

ASRS LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

ASRS

Processor Address: 000 octal
3 August 1989 - 15:06

ASRS

3 August 1989 Page 2

SFC Listing

Up=(-,-) Down=(1,0) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|004|

+--++

+

005

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

|010|

+--++

+

011

|

+--++

|012|

+--++

+

013

|

+--++

|014|

+--++

+

015

|

```

+-+--+
|016|
+-+--+
+
017
|
+-+--+
|018|
+-+--+
+
019
|

```

ASRS

3 August 1989 Page 3

SFC Listing Up=(0,0) Down=(2,0) Left=(-,-) Right=(-,-) Quadrant (1,0)

```

+-+--+
|020|
+-+--+
+
021
|
+-+--+
|022|
+-+--+
+
023
|
+-+--+
|028|
+-+--+
+
029
|
+-+--+
|030|
+-+--+
+
031
|
+-+--+
|032|
+-+--+
+
033
|
+-+--+
|034|
+-+--+

```

```

+-
035
|
+-+-+
|036|
+-+-+
+-
037
|
+-+-+
|038|
+-+-+
+-
039
|
+-+-+
|040|
+-+-+
+-
041
|
+-+-+
|042|
+-+-+

```

ASRS

3 August 1989 Page 4

SFC Listing Up=(1,0) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (2,0)

```

+-
043
|
+-+-+
|044|
+-+-+
+-
045
|
+-+-+
END

```

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
002 -----	step	(0,0) - 1
003 -----	transition	(0,0) - 1
004 -----	step	(0,0) - 1
005 -----	transition	(0,0) - 1
006 -----	step	(0,0) - 1
007 -----	transition	(0,0) - 1
008 -----	step	(0,0) - 1
009 -----	transition	(0,0) - 1
010 -----	step	(0,0) - 1
011 -----	transition	(0,0) - 1
012 -----	step	(0,0) - 1
013 -----	transition	(0,0) - 1
014 -----	step	(0,0) - 1
015 -----	transition	(0,0) - 1
016 -----	step	(0,0) - 1
017 -----	transition	(0,0) - 1
018 -----	step	(0,0) - 1
019 -----	transition	(0,0) - 1
020 -----	step	(1,0) - 1
021 -----	transition	(1,0) - 1
022 -----	step	(1,0) - 1
023 -----	transition	(1,0) - 1
028 -----	step	(1,0) - 1
029 -----	transition	(1,0) - 1
030 -----	step	(1,0) - 1
031 -----	transition	(1,0) - 1
032 -----	step	(1,0) - 1
033 -----	transition	(1,0) - 1
034 -----	step	(1,0) - 1
035 -----	transition	(1,0) - 1
036 -----	step	(1,0) - 1
037 -----	transition	(1,0) - 1
038 -----	step	(1,0) - 1
039 -----	transition	(1,0) - 1
040 -----	step	(1,0) - 1
041 -----	transition	(1,0) - 1
042 -----	step	(1,0) - 1
043 -----	transition	(2,0) - 1
044 -----	step	(2,0) - 1
045 -----	transition	(2,0) - 1

ASRS

3 August 1989 Page 6

SFC Listing

Processor Address: 000 octal

Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

ASRS

3 August 1989 Page 7

SFC Listing

Processor Address: 000 octal

Summary

SFC LAYOUT: Quadrants (0,0) - (2,0)

```
+-----+
| (0,0) |
| Pg 02 |
+-----+
| (1,0) |
| Pg 03 |
+-----+
| (2,0) |
| Pg 04 |
+-----+
```

ASRS

3 August 1989 Page 8

SFC Listing

Processor Address: 000 octal

Summary

SEQUENTIAL FUNCTION CHART STATISTICS

Start of Program (SOP):	PAGE 2, QUADRANT (0,0)
Number of Rows:	3
Number of Columns:	1
Total Number of Quadrants:	3
Number of Steps:	20
Number of Transitions:	20
Number of Simultaneous Branches:	0
Number of Selection Branches:	0
Number of Label Definitions:	0
Number of Label References:	0

ASRS

3 August 1989 Page 9

Ladder Listing

Processor Address: 000 octal

Rung 2:0

Rung 2:0

This rung is used to initialize the operation, and side flags.

+EQU-----+	+CLR-----+	
+--+EQUAL	+-----+CLEAR	+-----+
Source A INPUT_REG	Dest TAKE_OUT	
0	0	
Source B COMP_REG	+-----+	
0		
+-----+		
	+CLR-----+	
	+-----+CLEAR	+-----+
	Dest PUT_BACK	
	0	
	+-----+	
	+CLR-----+	
	+--+CLEAR	+--+
	Dest B_SIDE	
	0	
	+-----+	
	+CLR-----+	
	+--+CLEAR	+--+
	Dest E_SIDE	
	0	
	+-----+	

N7:0 INPUT_REG
 COP- 6:8 36:5
 EQU- 2:0 2:1
 FAL- 4:0
 NEQ- 4:0

N7:5 TAKE_OUT
 CLR- 2:0
 EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
 6:20 6:21 6:22

N7:6 PUT_BACK
 CLR- 2:0
 EQU- 36:0 36:5

N7:7 B_SIDE
 CLR- 2:0
 EQU- 8:1 12:0 12:1 38:0 42:1

N7:8 E_SIDE
 CLR- 2:0
 EQU- 8:0 12:2 12:3 38:1 42:0

COMP REG

NEO- 4:0

Rung 2:1

This rung will initialize the four data registers that are used to determine the row and the column of the warehouse. i.e. dat 1, dat 2, dat 3, dat 4.

INPUT REG

NEQ- 4:0

DAT 1

FAL- 4:0

DAT 2

EQU- 2:2 6:1 6:1 6:1 6:13 6:14 6:15

This rung is used to clear the action flag.

N7:10 COMP REG

N7:11 ROW FLAG

N7:12 COL FLAG

N7:20 ACT FLAG

ASRS

3 August 1989 Page 13

Ladder Listing

Processor Address: 000 octal

Rung 2:3

N7:21 RET FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5

```

42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

Rung 2:4

+EQU-----+	+CLR-----+	
+--+EQUAL	+-----+CLEAR	+-----+
Source A ACT_FLAG	Dest F_IFR_FLAG	
0	0	
Source B COMP_REG	+-----+	
0		
+-----+		
	+CLR-----+	
	+--+--CLEAR	+-----+
	Dest PROX_FLAG	
	0	
	+-----+	
	+CLR-----+	
	+--+--CLEAR	+-----+
	Dest T_IFR_FLAG	
	0	
	+-----+	
	+CLR-----+	
	+--+CLEAR	+--+
	Dest B_IFR_FLAG	
	0	
	+-----+	

N7:10 COMP_REG
COP- 6:8 36:5
EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6
NEQ- 4:0

N7:20 ACT_FLAG
CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

N7:26 F_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:2

N7:27 PROX_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:3

N7:28 B_IFR_FLAG
 CLR- 2:4
 EQU- 18:6 18:7 18:8
 MOV- 18:4

N7:29 T_IFR_FLAG
 CLR- 2:4
 EQU- 18:6 18:7 18:8
 MOV- 18:5

Rung 2:5

+EQU-----+	+CLR-----+	
+--+EQUAL	+-----+CLEAR	+--+
Source A ACT_FLAG	Dest CYL_FLAG	
0	0	
Source B COMP_REG	+-----+	
0		
+-----+		
	+CLR-----+	
	+--+CLEAR	+--+
	Dest S_H_FLAG	
	0	
	+-----+	
	+CLR-----+	
	+--+CLEAR	+--+
	Dest D_H_FLAG	
	0	
	+-----+	

N7:10 COMP_REG
 COP- 6:8 36:5
 EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6
 NEQ- 4:0

N7:20 ACT_FLAG
 CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

N7:30 CYL_FLAG
 CLR- 2:5
 MOV- 18:6

N7:31 S_H_FLAG

```

N7:32      D_H_FLAG
           CLR- 2:5
           MOV- 18:8

```

```

Rung 2:6
| +EQU-----+                                     C5:1 |
+--EQUAL      +-----+-----+-----+-----+ (RES) +--
| |Source A  ACT_FLAG|                                     |
| |              0|                                     |
| |Source B  COMP_REG|                                     |
| |              0|                                     |
| +-----+-----+                                     |

```

```

N7:10      COMP_REG
            COP- 6:8 36:5
            EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6
            NEQ- 4:0

```

```
Rung 2:7
|
+-----[END OF FILE]-----+
|
```

89

Rung 3:0

```
|
|-----[EOT]-----+
|
```

Rung 3:1

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 17

Ladder Listing

Processor Address: 000 octal

Rung 4:0

Rung 4:0

This rung will write non-zero value from the input register to all four data registers.

+NEQ-----+	+FAL-----+	
+--+NOT EQUAL	+-----+FILE ARITH/LOGICAL+--(EN)--+	
Source A INPUT_REG	Control R6:10	
0	Length 4--(DN)	
Source B COMP_REG	Position 0	
0	Mode ALL+--(ER)	
+-----+	Dest #DAT_1	
	0	
	Expression	
	INPUT_REG	
	+-----+	

N7:0

INPUT_REG

COP- 6:8 36:5

EQU- 2:0 2:1

FAL- 4:0

NEQ- 4:0

N7:1

DAT_1

CLR- 2:1

EQU- 2:2 6:0 6:0 6:0 6:13 6:14 6:15

FAL- 4:0

N7:10

COMP_REG

COP- 6:8 36:5

EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6

NEQ- 4:0

R6:10

FAL- 4:0

Rung 4:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 18

Ladder Listing

Processor Address: 000 octal

Rung 5:0

Rung 5:0

```
|
+-----[EOT]--+
|
```

Rung 5:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 19

Ladder Listing

Processor Address: 000 octal

Rung 6:0

Rung 6:0

```
|      +EQU-----+      +MOV-----+ |
+--+--EQUAL      +--+-----+MOVE      +--+
| | |Source A    DAT_1| | |Source      1| |
| | |           0| | |           | |
| | |Source B    11| | |Dest      COL_FLAG| |
| | |           | | |           0| |
| | +-----+ | +-----+ |
| | +EQU-----+ | +-----+ |
| | +--+EQUAL      +--+-----+ |
| | |Source A    DAT_1| | |Source      1| |
| | |           0| | |           | |
| | |Source B    21| | |           | |
| | |           | | |           | |
| | +-----+ | +-----+ |
| | +EQU-----+ | +-----+ |
| | +--+EQUAL      +--+-----+ |
| | |Source A    DAT_1| | |Source      1| |
| | |           0| | |           | |
| | |Source B    31| | |           | |
| | |           | | |           | |
| | +-----+ | +-----+ |
```

```
N7:12      COL_FLAG
           CLR- 2:2
           EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
                36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
           MOV- 6:0 6:1 6:2 6:3
```

+EQU-----+				+MOV-----+			
+--+--EQUAL				+--+-----+MOVE			
		Source A	DAT_2			Source	2
			0				
		Source B	12			Dest	COL_FLAG
							0
		+-----+				+-----+	
		+EQU-----+					
	+--+--EQUAL	+--+--					
		Source A	DAT_2				
			0				
		Source B	22				
		+-----+					
		+EQU-----+					
	+--+EQUAL	+--+					
		Source A	DAT_2				
			0				
		Source B	32				
	+-----+						

```

N7:2          DAT_2
               CLR- 2:1
               EQU- 2:2 6:1 6:1 6:1 6:13 6:14 6:15

```

92

+EQU-----+				+MOV-----+			
+---+---+EQUAL				+---+---+MOVE			
		Source A	DAT_3			Source	3
			0				
		Source B	13			Dest	COL_FLAG
							0
		+-----+				+-----+	
		+EQU-----+					
	+--+	EQUAL	+--+				
		Source A	DAT_3				
			0				
		Source B	23				
		+-----+					
		+EQU-----+					
	+--+	EQUAL	+--+				
		Source A	DAT_3				
			0				
		Source B	33				
		+-----+					

CLR- 2:1
EQU- 2:2 6:2 6:2 6:2 6:13 6:14 6:15

```
CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

Rung 6:3

```

|      +EQU-----+
+-+---+EQUAL      +---+-----+MOVE-----+ |
| | |Source A      DAT_4| | |Source      4| |
| | |              0| | |              | |
| | |Source B      14| | |Dest      COL_FLAG| |
| | |              | | |              0| |
| | +-----+ | | +-----+ |
| | +EQU-----+ | |
| +-+---+EQUAL      +-+---+
| | |Source A      DAT_4| |
| | |              0| |
| | |Source B      24| |
| | |              | |
| | +-----+ |
| | +EQU-----+ |
| +-+---+EQUAL      +-+---+
| | |Source A      DAT_4| |
| | |              0| |
| | |Source B      34| |
| | |              | |
| | +-----+ |

```

N7:4 DAT_4

CLR- 2:1

EQU- 2:2 6:3 6:3 6:3 6:13 6:14 6:15

N7:12 COL_FLAG

CLR- 2:2

EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22
36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9

MOV- 6:0 6:1 6:2 6:3

Rung 6:4

The following rung is used to test the data for column selection.

```

|                                     COL_1SW  LFM1  LFM2          RTM1  |
| +EQU-----+ +EQU-----+ I:001  O:003  O:003          O:003  |
+--+EQUAL      +--+EQUAL      +---]  [---]/[---]/[-----+--(L)---+
| |Source A  TAKE_OUT| |Source A  COL_FLAG|    16    01    02    |    00  | |
| |              0| |              0|              |          | |
| |Source B      1| |Source B      1|              |          | |
| |              | |              |              |          | |
| +-----+ +-----+              |          | |
|                                     |          | |
|                                     | RTM2  | |
|                                     | O:003  | |
|                                     +--(L)---+ |
|                                     03      |

```

```

I:001/16      COL_1SW
               ] [- 6:4 36:1
               ]/[- 6:9 36:6

```

ASRS

3 August 1989 Page 22

Ladder Listing

Processor Address: 000 octal

Rung 6:4

```

N7:5          TAKE_OUT
               CLR- 2:0
               EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
                   6:20 6:21 6:22

```

```

N7:12         COL_FLAG
               CLR- 2:2
               EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
                   36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
               MOV- 6:0 6:1 6:2 6:3

```

```

O:003/00      RTM1
               ] [- 6:8 36:5
               ]/[- 7:0 14:0 37:0 44:0
               (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
               (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

```

O:003/01      LFM1
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

```

```

O:003/02      LFM2
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

```

O:003/03 RTM2

```
    ] [- 6:8 36:5
    ]/[- 7:0 14:0 37:0 44:0
    (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
    (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 6:5

The following rung is used to test the data for column selection.

```

|                                     COL_2SW  LFM1  LFM2          RTM1  |
| +EQU-----+ +EQU-----+ I:001  O:003  O:003          O:003  |
+-+EQUAL          +-+EQUAL          +---] [---]/[---]/[-----+---(L)---+
| |Source A  TAKE_OUT| |Source A  COL_FLAG|    15    01    02    |    00  | |
| |           0| |           0|           |           | |
| |Source B      1| |Source B      2|           |           | |
| |           | |           |           |           | |
| +-----+ +-----+           |           | |
|                                     | RTM2  | |
|                                     | O:003  | |
|                                     +---(L)---+ |
|                                     03      |
```

I:001/15 COL_2SW

```
    ] [- 6:5 36:2
    ]/[- 6:10 36:7
```

N7:5 TAKE_OUT

```
CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
      6:20 6:21 6:22
```

ASRS

3 August 1989 Page 23

Ladder Listing

Processor Address: 000 octal

Rung 6:5

N7:12 COL_FLAG

```
CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

O:003/00 RTM1

```
    ] [- 6:8 36:5
    ]/[- 7:0 14:0 37:0 44:0
    (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
    (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/01 LFM1

```
    ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
    (L)- 14:0 44:0
    (U)- 14:1 44:1
```

```
O:003/02      LFM2
                ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
                (L)- 14:0 44:0
                (U)- 14:1 44:1
```

```
O:003/03      RTM2
                ] [- 6:8 36:5
                ]/[- 7:0 14:0 37:0 44:0
                (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
                (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 6:6

The following rung is used to test the data for column selection.

```

|                                     COL_3SW  LFM1  LFM2          RTM1  |
| +EQU-----+ +EQU-----+ I:001  O:003  O:003          O:003  |
+--+EQUAL      +--+EQUAL      +---] [---]/[---]/[-----+---(L)---+
| |Source A  TAKE_OUT| |Source A  COL_FLAG|    14    01    02    |    00  | |
| |          0| |          0|          |          | |
| |Source B      1| |Source B      3|          |          | |
| |          | |          |          |          | |
| +-----+ +-----+          |          | |
|                                     | RTM2  | |
|                                     | O:003  | |
|                                     +---(L)---+ |
|                                     03      |

```

```
I:001/14      COL_3SW
                ] [- 6:6 36:3
                ]/[- 6:11 36:8
```

```
N7:5          TAKE_OUT
                CLR- 2:0
                EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
                    6:20 6:21 6:22
```

ASRS
Ladder Listing

3 August 1989 Page 24
Processor Address: 000 octal Rung 6:6

```
N7:12          COL_FLAG
                CLR- 2:2
                EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
                    36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
                MOV- 6:0 6:1 6:2 6:3
```

```
O:003/00      RTM1
                ] [- 6:8 36:5
                ]/[- 7:0 14:0 37:0 44:0
                (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
```

O:003/01 LFM1

```

J[/- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

O:003/02 LFM2

```
J/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

O:003/03 RTM2

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

Rung 6:7

The following rung is used to test the data for column selection.

[illegible]

I:001/13 COL 4SW

$$\frac{\begin{bmatrix} -6 & 7 & 36 \\ 4 \end{bmatrix}}{\begin{bmatrix} -6 & 12 & 36 \\ 9 \end{bmatrix}}$$

N7:5 TAKE OUT

```
CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
      6:20 6:21 6:22
```

ASRS

3 August 1989 Page 25

Ladder Listing

Processor Address: 000 octal

Rung 6:7

N7:12 COL FLAG

CLR- 2:2
 EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9

MOV- 6:0 6:1 6:2 6:3

O:003/00 RTM1

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
 (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
 (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

O:003/01 LFM1

] /[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
 (L)- 14:0 44:0
 (U)- 14:1 44:1

O:003/02 LFM2

] /[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
 (L)- 14:0 44:0
 (U)- 14:1 44:1

O:003/03 RTM2

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
 (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
 (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

Rung 6:8

This rung is used to clear the input register.

RTM1		RTM2			
	+EQU-----	O:003	O:003	+COP-----	
+--+EQU		+--]	[---]	+COPY FILE	+--+
	Source A TAKE_OUT	00	03	Source #COMP_REG	
		0		Dest #INPUT_REG	
	Source B	1		Length	1
				+-----	
	+-----				

N7:0 INPUT_REG

COP- 6:8 36:5
 EQU- 2:0 2:1
 FAL- 4:0
 NEQ- 4:0

N7:5 TAKE_OUT

CLR- 2:0
 EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
 6:20 6:21 6:22

N7:10 COMP_REG

COP- 6:8 36:5
 EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6

NEQ- 4:0

ASRS

3 August 1989 Page 26

Ladder Listing

Processor Address: 000 octal

Rung 6:8

O:003/00 RTM1

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 6:9

The following rung will unlatched the motor once the cloumn is selected.

	COL_1SW	RTM1
+EQU-----+ +EQU-----+ I:001		O:003
+--+EQUAL	+--+EQUAL	+---]/[-----+--(U)---+
Source A TAKE_OUT Source A COL_FLAG 16		00
0 0		
Source B 1 Source B 1		
+-----+ +-----+		
		RTM2
		O:003
		+--(U)---+
		03

I:001/16 COL_1SW

```
] [- 6:4 36:1
]/[- 6:9 36:6
```

N7:5 TAKE_OUT

```
CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
6:20 6:21 6:22
```

N7:12 COL_FLAG

```
CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

O:003/00 RTM1

```
] [- 6:8 36:5
```

```

]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/03 RTM2

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

ASRS

3 August 1989 Page 27

Ladder Listing

Processor Address: 000 octal

Rung 6:10

Rung 6:10

The following rung will unlatched the motor once the cloumn is selected.

				COL_2SW		RTM1	
	+EQU-----+	+EQU-----+		I:001		O:003	
+	---EQUAL	---EQUAL		----]/[-----		---(U)---+	+
	Source A	TAKE_OUT	Source A	COL_FLAG	15	00	
		0		0			
	Source B	1	Source B	2			
	-----+	-----+					
						RTM2	
						O:003	
						---(U)---+	
						03	

I:001/15 COL_2SW

```

] [- 6:5 36:2
]/[- 6:10 36:7

```

N7:5 TAKE_OUT

```

CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
      6:20 6:21 6:22

```

N7:12 COL_FLAG

```

CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3

```

O:003/00 RTM1

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/03 RTM2

```
    ] [- 6:8 36:5
    ]/[- 7:0 14:0 37:0 44:0
    (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
    (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 6:11

The following rung will unlatched the motor once the cloumn is selected.

				COL_3SW				RTM1	
	+EQU-----	+EQU-----		I:001				O:003	
+-+EQUAL		+-+EQUAL		+	---	]/[	-----	+(U)---+	+
	Source A	TAKE_OUT	Source A	COL_FLAG	14			00	
		0		0					
	Source B	1	Source B	3					
	+	-----	+	-----					
								RTM2	
								O:003	
								+(U)---+	
								03	

ASRS

3 August 1989 Page 28

Ladder Listing

Processor Address: 000 octal

Rung 6:11

I:001/14 COL_3SW

```
    ] [- 6:6 36:3
    ]/[- 6:11 36:8
```

N7:5 TAKE_OUT

```
    CLR- 2:0
    EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
          6:20 6:21 6:22
```

N7:12 COL_FLAG

```
    CLR- 2:2
    EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
          36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
    MOV- 6:0 6:1 6:2 6:3
```

O:003/00 RTM1

```
    ] [- 6:8 36:5
    ]/[- 7:0 14:0 37:0 44:0
    (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
    (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/03 RTM2

```
    ] [- 6:8 36:5
    ]/[- 7:0 14:0 37:0 44:0
```

(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
 (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

Rung 6:12

The following rung will unlatched the motor once the cloumn is selected.

				COL_4SW		RTM1	
	+EQU-----	+EQU-----		I:001		O:003	
+--EQUAL		+--EQUAL		+---]/[-----		+(U)---+	
	Source A	TAKE_OUT	Source A	COL_FLAG	13		00
		0		0			
	Source B	1	Source B	4			
	+-----	+-----					
							RTM2
							O:003
						+--(U)---+	
						03	

I:001/13 COL_4SW
] [- 6:7 36:4
]/[- 6:12 36:9

N7:5 TAKE_OUT
 CLR- 2:0
 EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
 6:20 6:21 6:22

N7:12 COL_FLAG
 CLR- 2:2
 EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
 MOV- 6:0 6:1 6:2 6:3

ASRS
 Ladder Listing Processor Address: 000 octal 3 August 1989 Page 29
 Rung 6:12

O:003/00 RTM1
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
 (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
 (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

O:003/03 RTM2
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
 (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
 (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

This rung will be used to select the rows.

```

N7:1          DAT_1
              CLR- 2:1
              EQU- 2:2 6:0 6:0 6:0 6:13 6:14 6:15
              FAL- 4:0

```

```

N7:2          DAT_2
               CLR- 2:1
               EQU- 2:2 6:1 6:1 6:1 6:13 6:14 6:15

```

```

N7:3          DAT_3
              CLR- 2:1
              EQU- 2:2 6:2 6:2 6:2 6:13 6:14 6:15

```

```
ASRS                                     3 August 1989   Page 30
Ladder Listing           Processor Address: 000 octal           Rung 6:13
```

```

N7:4      DAT_4
          CLR- 2:1
          EQU- 2:2 6:3 6:3 6:3 6:13 6:14 6:15

```

```

N7:11      ROW_FLAG
           CLR- 2:2
           EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
                10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                40:0 40:1 40:2 40:3 40:4 40:5
           MOV- 6:13 6:14 6:15

```

Rung 6:14

This rung will be used to select the rows.

+EQU-----+				+MOV-----+			
+-----+EQUAL				+-----+MOVE			
		Source A	DAT_1			Source	2
			0				
		Source B	21			Dest	ROW_FLAG
							0
		+-----+				+-----+	
		+EQU-----+					
		+-----+EQUAL					
		Source A	DAT_2				
			0				
		Source B	22				
		+-----+					
		+EQU-----+					
		+-----+EQUAL					
		Source A	DAT_3				
			0				
		Source B	23				
		+-----+					
		+EQU-----+					
		+-----+EQUAL					
		Source A	DAT_4				
			0				
		Source B	24				
		+-----+					

```

N7:1      DAT_1
           CLR- 2:1
           EQU- 2:2 6:0 6:0 6:0 6:13 6:14 6:15
           FAL- 4:0

```

```

N7:2      DAT_2
           CLR- 2:1
           EQU- 2:2 6:1 6:1 6:1 6:13 6:14 6:15

```

```

N7:3      DAT_3

```

CLR- 2:1
 EQU- 2:2 6:2 6:2 6:2 6:13 6:14 6:15

ASRS 3 August 1989 Page 31
 Ladder Listing Processor Address: 000 octal Rung 6:14

N7:4 DAT_4

CLR- 2:1
 EQU- 2:2 6:3 6:3 6:3 6:13 6:14 6:15

N7:11 ROW_FLAG

CLR- 2:2
 EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
 10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
 40:0 40:1 40:2 40:3 40:4 40:5
 MOV- 6:13 6:14 6:15

Rung 6:15

This rung will be used to select the rows.

	+EQU-----+					+MOV-----+				
	+-----+EQUAL					+-----+MOVE				
			Source A	DAT_1				Source	3	
				0						
			Source B	31				Dest	ROW_FLAG	
									0	
		+-----+				+-----+				
		+EQU-----+								
	+-----+EQUAL					+-----+				
			Source A	DAT_2						
				0						
			Source B	32						
		+-----+								
		+EQU-----+								
	+-----+EQUAL					+-----+				
			Source A	DAT_3						
				0						
			Source B	33						
		+-----+								
		+EQU-----+								
	+-----+EQUAL					+-----+				
			Source A	DAT_4						
				0						
			Source B	34						
		+-----+								

N7:1 DAT_1

```

N7:2          DAT_2
               CLR- 2:1
               EQU- 2:2 6:1 6:1 6:1 6:13 6:14 6:15

```

```
ASRS                                     3 August 1989   Page 32
Ladder Listing      Processor Address: 000 octal      Rung 6:15
```

```

N7:11      ROW_FLAG
           CLR- 2:2
           EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
                10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                40:0 40:1 40:2 40:3 40:4 40:5
           MOV- 6:13 6:14 6:15

```

		LL1SW DM1 DM2			UM1
+EQU-----+ +EQU-----+ I:002 O:002 O:002					O:002
+--+EQUAL	+--+EQUAL	+--] [---]/[---]/[-----+--(L)---+--			
Source A TAKE_OUT Source A ROW_FLAG	15 01 02			00	
0 0					
Source B 1 Source B 1					
+-----+ +-----+					
				UM2	
				O:002	
				+--(L)---+--	
					03

```
N7:5      TAKE_OUT
          CLR- 2:0
          EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
              6:20 6:21 6:22
```



```

N7:5      TAKE_OUT
          CLR- 2:0
          EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
              6:20 6:21 6:22

N7:11     ROW_FLAG
          CLR- 2:2
          EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
              10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
              40:0 40:1 40:2 40:3 40:4 40:5
          MOV- 6:13 6:14 6:15

O:002/00   UM1
          ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
          (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
          (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01   DM1
          ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
              45:0
          (L)- 14:2 40:0 40:1 40:2 44:2
          (U)- 14:3 40:3 40:4 40:5 44:3

ASRS
Ladder Listing
Processor Address: 000 octal
Rung 6:17
3 August 1989 Page 34

O:002/02   DM2
          ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
              45:0
          (L)- 14:2 40:0 40:1 40:2 44:2
          (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03   UM2
          ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
          (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
          (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 6:18

	LL3SW	DM1	DM2	UM1
+EQU-----+ +EQU-----+ I:002 O:002 O:002				O:002
+--+EQUAL	+--+EQUAL	+--+	[---]/[---]/[---]	(L)---+--
Source A TAKE_OUT Source A ROW_FLAG	13	01	02	00
	0			
Source B	1	Source B	3	
+-----+ +-----+				
				UM2
				O:002
				+--(L)---+
				03

```

I:002/13      LL3SW
               ] [- 6:18 40:2
               ]/[- 6:21 40:5

N7:5          TAKE_OUT
               CLR- 2:0
               EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
                   6:20 6:21 6:22

N7:11         ROW_FLAG
               CLR- 2:2
               EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
                   10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                   40:0 40:1 40:2 40:3 40:4 40:5
               MOV- 6:13 6:14 6:15

O:002/00      UM1
               ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
               (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
               (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01      DM1
               ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                   45:0
               (L)- 14:2 40:0 40:1 40:2 44:2
               (U)- 14:3 40:3 40:4 40:5 44:3

ASRS
Ladder Listing
Processor Address: 000 octal
3 August 1989   Page 35
Rung 6:18

O:002/02      DM2
               ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                   45:0
               (L)- 14:2 40:0 40:1 40:2 44:2
               (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03      UM2
               ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
               (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
               (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 6:19

This rung is used to unlatched the up-motor once the row is selected.

			LL1SW		UM1	
	+EQU-----	+EQU-----	I:002		O:002	
+--+EQU		+--+EQU		+--]/[-----	+(U)---+	
	Source A TAKE_OUT	Source A ROW_FLAG	15		00	
		0	0			
	Source B	1	Source B	1		
	+-----	+-----				
					UM2	
					O:002	
					+--(U)---	
					03	

I:002/15 LL1SW

] [- 6:16 14:2 40:0 44:2
]/[- 6:19 14:3 40:3 44:3

N7:5 TAKE_OUT

CLR- 2:0
 EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
 6:20 6:21 6:22

N7:11 ROW_FLAG

CLR- 2:2
 EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
 10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
 40:0 40:1 40:2 40:3 40:4 40:5
 MOV- 6:13 6:14 6:15

O:002/00 UM1

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
 (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
 (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/03 UM2

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
 (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
 (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

This rung is used to unlatched the up-motor once the row is selected.

				LL2SW		UM1	
	+EQU-----+	+EQU-----+		I:002		O:002	
	+--+EQUAL	+--+EQUAL		+--]/[-----		(U)---+	
	Source A	TAKE_OUT	Source A	ROW_FLAG	14	00	
		0		0			
	Source B	1	Source B	2			
	+-----+	+-----+					
						UM2	
						O:002	
						+--(U)---+	
						03	

I:002/14 LL2SW

] [- 6:17 40:1
]/[- 6:20 40:4

N7:5 TAKE_OUT

CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
6:20 6:21 6:22

N7:11 ROW_FLAG

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

O:002/00 UM1

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/03 UM2

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

Rung 6:21

This rung is used to unlatched the up-motor once the row is selected.

```

|                                     LL3SW                                     UM1 |
| +EQU-----+ +EQU-----+ I:002                                     O:002 |
+--+EQUAL      +--+EQUAL      +--]/[-----+--(U)---+
| |Source A  TAKE_OUT| |Source A  ROW_FLAG|    13                      | 00 | |
| |              0| |              0|                      |   | |
| |Source B      1| |Source B      3|                      |   | |
| |              | |              |                      |   | |
| +-----+ +-----+                      |   | |
|                                     | UM2 | |
|                                     | O:002 | |
|                                     +--(U)---+ |
|                                     03 |

```

ASRS

3 August 1989 Page 37

Ladder Listing

Processor Address: 000 octal

Rung 6:21

I:002/13 LL3SW

```

] [- 6:18 40:2
]/[- 6:21 40:5

```

N7:5 TAKE_OUT

```

CLR- 2:0
EQU- 6:4 6:5 6:6 6:7 6:8 6:9 6:10 6:11 6:12 6:16 6:17 6:18 6:19
      6:20 6:21 6:22

```

N7:11 ROW_FLAG

```

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

```

O:002/00 UM1

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

O:002/03 UM2

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 6:22

+EQU-----+>	+EQU-----+>	+EQU-----+>
+--+EQUAL	+--+--EQU	+--+--EQU
Source A TAKE_OUT	Source A ROW_FLAG	Source A COL_FLAG
0	0	0
Source B 1	Source B 1	Source B 1
+-----+>	+-----+>	+-----+>
	+EQU-----+>	+EQU-----+>
	+--+--EQU	+--+--EQU
	Source A ROW_FLAG	Source A COL_FLAG
	0	0
	Source B 2	Source B 2
	+-----+>	+-----+>
	+EQU-----+>	+EQU-----+>
	+--+--EQU	+--+--EQU
	Source A ROW_FLAG	Source A COL_FLAG
	0	0
	Source B 3	Source B 3
	+-----+>	+-----+>
	+EQU-----+>	+EQU-----+>
	+--+--EQU	+--+--EQU
	Source A COL_FLAG	Source A COL_FLAG
	0	0
	Source B 4	Source B 4
	+-----+>	+-----+>

ASRS

Ladder Listing

3 August 1989 Page 38

Processor Address: 000 octal

Rung 6:22

<	+MOV-----+>	
<-----+>	+MOVE	+--+
<	Source 1	
	Dest ACT_FLAG	
	0	
	+-----+>	
<		
<-----+>		
<		
<		
<+--+>		
<		

Ladder Listing

Processor Address: 000 octal

Rung 7:0

Rung 7:0

```
| RTM1 RTM2 UM1 UM2 |
| O:003 O:003 O:002 O:002 |
+---]/[---]/[---]/[---]/[-----[EOT]--+
| 00 03 00 03 |
```

O:002/00 UM1

```
] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:002/03 UM2

```
] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:003/00 RTM1

```
] [- 6:8 36:5
] /[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/03 RTM2

```
] [- 6:8 36:5
] /[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 7:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 41

Ladder Listing

Processor Address: 000 octal

Rung 8:0

Rung 8:0

This rung will move the transfer table toward the side of the ending conveyor.

					PB_SW	PUM1	PUM2		PBM1	
	+EQU-----+	+EQU-----+			I:002	O:003	O:003		O:003	
+--+EQUAL		+--+EQUAL			+++]/[---]/[---]/[---]				---()---+	
	Source A	E_SIDE	Source A	ACT_FLAG	12	04	07		05	
		0		0						
	Source B	1	Source B	1						
	+-----+	+-----+								
									PBM2	
									O:003	
									---()---+	
									06	

I:002/12 PB_SW

] [- 28:0
]/[- 8:0 22:0 22:2 38:1

N7:8 E_SIDE

CLR- 2:0
EQU- 8:0 12:2 12:3 38:1 42:0

N7:20 ACT_FLAG

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

O:003/04 PUM1

] /[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
()- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

O:003/05 PBM1

] /[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/06 PBM2

] /[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/07 PUM2

```

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

```

ASRS

3 August 1989 Page 42

Ladder Listing

Processor Address: 000 octal

Rung 8:1

Rung 8:1

This rung will cause the transfer table to move toward the side of the beginning of the conveyor.

			PU_SW	PBM1	PBM2				PUM1	
	+EQU-----+	I:002	O:003	O:003	+EQU-----+				O:003	
	+--EQUAL		+--]/[---]/[---]/[---]		+--EQUAL				+---()---+	
	Source A	B_SIDE	11	05	06	Source A	ACT_FLAG		04	
		0					0			
	Source B	1				Source B	1			
	+-----+					+-----+				
									PUM2	
									O:003	
									+--()---+	
									07	

I:002/11 PU_SW

```

] [- 18:1
]/[- 8:1 16:0 38:0

```

N7:7 B_SIDE

```

CLR- 2:0
EQU- 8:1 12:0 12:1 38:0 42:1

```

N7:20 ACT_FLAG

```

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
      22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

```

O:003/04 PUM1

```

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

```

O:003/05 PBM1

```

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( )- 8:0 22:2 38:1 42:1

```

(L)- 12:0
(U)- 12:1

O:003/06 PBM2

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/07 PUM2

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
()- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

ASRS

3 August 1989 Page 43

Ladder Listing

Processor Address: 000 octal

Rung 8:2

Rung 8:2

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 44

Ladder Listing

Processor Address: 000 octal

Rung 9:0

Rung 9:0

```
| PBM1 PBM2 PUM1 PUM2
| O:003 O:003 O:003 O:003
+---]/[---]/[---]/[---]/[-----[EOT]-+
| 05 06 04 07
```

O:003/04 PUM1

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
()- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

O:003/05 PBM1

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/06 PBM2

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0

```
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1
```

O:003/07 PUM2

```
]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3
```

Rung 9:1

```
|
|-----[END OF FILE]-----
|
```

ASRS

3 August 1989 Page 45

Ladder Listing

Processor Address: 000 octal

Rung 10:0

Rung 10:0

```
|
|                                     UL1SW DM1  DM2          UM1  |
| +EQU-----+ +EQU-----+ I:003 O:002 O:002          O:002 |
+--+EQUAL      +--+EQUAL      +---] [---]/[---]/[-----+--(L)---+
| |Source A  ACT_FLAG| |Source A  ROW_FLAG|   15   01   02      | 00 | |
| |              0| |              0|              |  |  |
| |Source B      1| |Source B      1|              |  |  |
| |              | |              |              |  |  |
| +-----+ +-----+              |  |  |
|                                     |  UM2  | |
|                                     | O:002 | |
|                                     +--(L)---+ |
|                                     03  |
```

I:003/15 UL1SW

```
] [- 10:0 36:10
]/[- 10:3 36:13
```

N7:11 ROW_FLAG

```
CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15
```

N7:20 ACT_FLAG

```
CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
```

22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

O:002/00 UM1

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01 DM1

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/03 UM2

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

ASRS

3 August 1989 Page 46

Ladder Listing

Processor Address: 000 octal

Rung 10:1

Rung 10:1

				UL2SW	DM1	DM2		UM1	
	+EQU-----	+EQU-----		I:003	O:002	O:002		O:002	
	+-+EQUAL	+-+EQUAL		+-+]	[---]	[---]		+(L)---+	
	Source A	ACT_FLAG	Source A	ROW_FLAG	16	01	02		00
		0		0					
	Source B	1	Source B	2					
	+-----	+-----							
									UM2
									O:002
								+-+ (L) ---	
								03	

I:003/16 UL2SW

] [- 10:1 36:11
]/[- 10:4 36:14

N7:11 ROW_FLAG

CLR- 2:2

```

EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

```

```

N7:20      ACT_FLAG
          CLR- 2:3
          EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
          MOV- 6:22

```

```

O:002/00    UM1
          ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
          (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
          (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

O:002/01    DM1
          ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                45:0
          (L)- 14:2 40:0 40:1 40:2 44:2
          (U)- 14:3 40:3 40:4 40:5 44:3

```

```

O:002/02    DM2
          ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                45:0
          (L)- 14:2 40:0 40:1 40:2 44:2
          (U)- 14:3 40:3 40:4 40:5 44:3

```

```

O:002/03    UM2
          ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
          (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
          (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

ASRS                      3 August 1989   Page 47
Ladder Listing            Processor Address: 000 octal      Rung 10:2
Rung 10:2

```

		UL3SW	DM1	DM2	UM1
	+EQU-----+ +EQU-----+ I:003 O:002 O:002				O:002
+--+EQUAL	+--+EQUAL	+++]	{---	/[---	/[-----+--(L)---+--
Source A ACT_FLAG	Source A ROW_FLAG	17	01	02	00
	0		0		
Source B	1 Source B	3			
+-----+ +-----+					
					UM2
					O:002
					+--(L)---+
					03

```

I:003/17    UL3SW
              ] [- 10:2 36:12
              ]/[- 10:5 36:15

N7:11       ROW_FLAG
              CLR- 2:2
              EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
                   10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                   40:0 40:1 40:2 40:3 40:4 40:5
              MOV- 6:13 6:14 6:15

N7:20       ACT_FLAG
              CLR- 2:3
              EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                   12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                   22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
              MOV- 6:22

O:002/00    UM1
              ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
              (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
              (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01    DM1
              ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                   45:0
              (L)- 14:2 40:0 40:1 40:2 44:2
              (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02    DM2
              ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                   45:0
              (L)- 14:2 40:0 40:1 40:2 44:2
              (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03    UM2
              ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
              (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
              (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

ASRS

Ladder Listing

3 August 1989 Page 48

Processor Address: 000 octal

Rung 10:3

Rung 10:3

This rung is used to unlatched the up-motor once the row is selected.

	UL1SW			UM1	
	+EQU-----+	+EQU-----+	I:003	O:002	
+--+EQUAL	+--+EQUAL	+--]/[-----+--(U)---+--			
	Source A ACT_FLAG	Source A ROW_FLAG	15		00
		0	0		
	Source B	1	Source B	1	
	+-----+	+-----+			
					UM2
					O:002
				+--(U)---+	
				03	

I:003/15 UL1SW

] [- 10:0 36:10
]/[- 10:3 36:13

N7:11 ROW_FLAG

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

N7:20 ACT_FLAG

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

O:002/00 UM1

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/03 UM2

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

This rung is used to unlatched the up-motor once the row is selected.

ASRS

3 August 1989 Page 49

Ladder Listing

Processor Address: 000 octal

Rung 10:4

I:003/16 UL2SW

N7:11	ROW FLAG
-------	----------

N7:20 ACT FLAG

O:002/00 UM1

0:002/03 UM2

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 10:5

This rung is used to unlatched the up-motor once the row is selected.

	UL3SW				UM1	
	+EQU-----+ +EQU-----+ I:003				O:002	
+--+EQUAL		+--+EQUAL		+---]/[-----+---(U)---+---		
	Source A	ACT_FLAG	Source A	ROW_FLAG	17	00
		0		0		
	Source B	1	Source B	3		
	+-----+ +-----+					
						UM2
						O:002
						+---(U)---+
						03

```

I:003/17    UL3SW
              ] [- 10:2 36:12
              ]/[- 10:5 36:15

```

ASRS 3 August 1989 Page 50
 Ladder Listing Processor Address: 000 octal Rung 10:5

```

N7:11      ROW_FLAG
            CLR- 2:2
            EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
                  10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                  40:0 40:1 40:2 40:3 40:4 40:5
            MOV- 6:13 6:14 6:15

```

```

N7:20      ACT_FLAG
            CLR- 2:3
            EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                  12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                  22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
            MOV- 6:22

```

```

O:002/00    UM1
              ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
              (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
              (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

O:002/03    UM2
              ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
              (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
              (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 10:6

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 51

Ladder Listing

Processor Address: 000 octal

Rung 11:0

Rung 11:0

```
| UM1  UM2
| O:002 O:002
|---]/[---]/[-----[EOT]--+
| 00  03
```

O:002/00 UM1

```
] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:002/03 UM2

```
] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

Rung 11:1

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 52

Ladder Listing

Processor Address: 000 octal

Rung 12:0

Rung 12:0

These rungs will return the transfer table to home position.

```
|
| TH_SW PUM1 PUM2 PBM1 |
| +EQU-----+ +EQU-----+ I:002 O:003 O:003 O:003 |
| +-+EQUAL +-+EQUAL +-+ ] [---]/[---]/[-----+--(L)---+
| |Source A B_SIDE| |Source A ACT_FLAG| 10 04 07 | 05 | |
| | 0 | 0 |
| |Source B 1| |Source B 1|
| | 1 | 1 |
| +-----+ +-----+
|
| PBM2 |
| O:003 |
| --- (L) --- |
| 06 |
```

```

I:002/10    TH_SW
              ] [- 12:0 12:2 30:0 42:0 42:1
              ]/[- 12:1 12:3 32:0

N7:7        B_SIDE
              CLR- 2:0
              EQU- 8:1 12:0 12:1 38:0 42:1

N7:20       ACT_FLAG
              CLR- 2:3
              EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                   12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                   22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
              MOV- 6:22

O:003/04    PUM1
              ]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
              ( )- 8:1 16:0 30:0 38:0 42:0
              (L)- 12:2
              (U)- 12:3

O:003/05    PBM1
              ]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
              ( )- 8:0 22:2 38:1 42:1
              (L)- 12:0
              (U)- 12:1

O:003/06    PBM2
              ]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
              ( )- 8:0 22:2 38:1 42:1
              (L)- 12:0
              (U)- 12:1

O:003/07    PUM2
              ]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
              ( )- 8:1 16:0 30:0 38:0 42:0
              (L)- 12:2
              (U)- 12:3

```

ASRS

Ladder Listing

3 August 1989 Page 53

Processor Address: 000 octal

Rung 12:1

Rung 12:1

				TH_SW		PBM1	
	+EQU-----+	+EQU-----+		I:002		O:003	
+	+EQU						
+	+EQU						
+	----	+	+	]/[-----		(U)---	+
	Source A	B_SIDE	Source A	ACT_FLAG	10	05	
		0		0			
	Source B	1	Source B	1			
	+-----+	+-----+					
						PBM2	
						O:003	
						+(U)---	
						06	

I:002/10 TH_SW
] [- 12:0 12:2 30:0 42:0 42:1
]/[- 12:1 12:3 32:0

N7:7 B_SIDE
 CLR- 2:0
 EQU- 8:1 12:0 12:1 38:0 42:1

N7:20 ACT_FLAG
 CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

O:003/05 PBM1
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/06 PBM2
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

Rung 12:2

				TH_SW	PBM1	PBM2		PUM1	
	+EQU-----+	+EQU-----+		I:002	O:003	O:003		O:003	
	+--EQUAL	+--EQUAL	+--]	[---]/[---]/[-----				(L)---+	
	Source A	E_SIDE	Source A	ACT_FLAG	10	05	06	04	
		0		0					
	Source B	1	Source B	1					
	+-----+	+-----+							
								PUM2	
								O:003	
								---(L)---+	
								07	

ASRS

3 August 1989 Page 54

Ladder Listing

Processor Address: 000 octal

Rung 12:2

I:002/10 TH_SW

] [- 12:0 12:2 30:0 42:0 42:1
]/[- 12:1 12:3 32:0

N7:8 E_SIDE

CLR- 2:0
 EQU- 8:0 12:2 12:3 38:1 42:0

N7:20 ACT_FLAG

CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

O:003/04 PUM1

] /[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
 ()- 8:1 16:0 30:0 38:0 42:0
 (L)- 12:2
 (U)- 12:3

O:003/05 PBM1

] /[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/06 PBM2

] /[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

Rung 12:3

		TH_SW		PUM1	
	+EQU-----+	+EQU-----+	I:002	O:003	
	+-+EQUAL	+-+EQUAL	+-+]/[-----	+(U)---+	
	Source A	E_SIDE	Source A	ACT_FLAG	10
		0		0	
	Source B	1	Source B	1	
	-----+	-----+			
				PUM2	
				O:003	
				---(U)---+	
				07	

I:002/10 TH_SW

```
] [- 12:0 12:2 30:0 42:0 42:1
]/[- 12:1 12:3 32:0
```

ASRS

3 August 1989 Page 55

Ladder Listing

Processor Address: 000 octal

Rung 12:3

N7:8 E_SIDE

```
CLR- 2:0
EQU- 8:0 12:2 12:3 38:1 42:0
```

N7:20 ACT_FLAG

```
CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22
```

O:003/04 PUM1

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
```

(U) - 12:3

Rung 12:4

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 56

Ladder Listing

Processor Address: 000 octal

Rung 13:0

Rung 13:0

```
| PUM1 PUM2 PBM1 PBM2
| O:003 O:003 O:003 O:003
+--]/[---]/[---]/[---]/[-----[EOT]--+
| 04 07 05 06
```

O:003/04 PUM1

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

O:003/05 PBM1

```
] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( ) - 8:0 22:2 38:1 42:1
(L) - 12:0
(U) - 12:1
```

O:003/06 PBM2

```
] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( ) - 8:0 22:2 38:1 42:1
(L) - 12:0
(U) - 12:1
```

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

Rung 13:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 57

Rung 14:0

The following rungs will return the elevator car back to home position.

```

|               EHSW  RTM1  RTM2               LFM1  |
| +EQU-----+ I:001 O:003 O:003               O:003  |
+-+EQUAL      +--] [---]/[---]/[-----+---(L)---+
| |Source A  ACT_FLAG| 17   00   03           | 01 | |
| |           0|           |           | |
| |Source B    1|           |           | |
| |           |           |           | |
| +-----+           |           | |
|               |           | LFM2 | |
|               |           | O:003 | |
|               |           +---(L)---+
|               |           02  |

```

I:001/17 EHSW

```

] [- 14:0 44:0
]/[- 14:1 18:0 18:1 44:1

```

N7:20 ACT_FLAG

```

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
      22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

```

O:003/00 RTM1

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/01 LFM1

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

O:003/02 LFM2

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

O:003/03 RTM2

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4

```

(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

ASRS

3 August 1989 Page 58

Ladder Listing

Processor Address: 000 octal

Rung 14:1

Rung 14:1

```
|
|           EHSW                               LFM1 |
| +EQU-----+ I:001                           O:003 |
+--+EQUAL      +--]/[-----+---(U)---+
| |Source A  ACT_FLAG| 17                       | 01 | |
| |                0|                          |   | |
| |Source B      1|                          |   | |
| |                |                          |   | |
| +-----+                                     |   | |
|                                           | LFM2 | |
|                                           | O:003 | |
|                                           +---(U)---+ |
|                                           02   |
```

I:001/17 EHSW

```
] [- 14:0 44:0
]/[- 14:1 18:0 18:1 44:1
```

N7:20 ACT_FLAG

```
CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
      22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22
```

O:003/01 LFM1

```
]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

O:003/02 LFM2

```
]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

Rung 14:2

	LL1SW	UM1	UM2		DM1	
	+EQU-----	I:002	O:002	O:002	O:002	
	+--EQU	+--]	[--]/[--]/[	-----	+(L)---+	
	Source A	ACT_FLAG	15	00	03	
		0				
	Source B	1				
	+-----					
					DM2	
					O:002	
					---(L)---	
					02	

I:002/15 LL1SW

] [- 6:16 14:2 40:0 44:2
]/[- 6:19 14:3 40:3 44:3

ASRS

3 August 1989 Page 59

Ladder Listing

Processor Address: 000 octal

Rung 14:2

N7:20

ACT_FLAG

CLR- 2:3

EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2

MOV- 6:22

O:002/00

UM1

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
 (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
 (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01

DM1

] /[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02

DM2

] /[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03

UM2

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
 (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
 (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

Rung 14:3

	LL1SW	DM1	
	+EQU-----+ I:002	O:002	
+--+EQU	+--]/[-----+ (U)---+ +		
	Source A ACT_FLAG 15	01	
	0		
	Source B 1		
	+-----+		
		DM2	
		O:002	
		+--(U)---+	
		02	

I:002/15 LL1SW

] [- 6:16 14:2 40:0 44:2
]/[- 6:19 14:3 40:3 44:3

N7:20 ACT_FLAG

CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

ASRS

3 August 1989 Page 60

Ladder Listing

Processor Address: 000 octal

Rung 14:3

O:002/01 DM1

] /[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

] /[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

Rung 14:4

+-----	[END OF FILE]	-----+

ASRS

3 August 1989 Page 61

Ladder Listing

Processor Address: 000 octal

Rung 15:0

Rung 15:0

```
| LFM1 LFM2 DM1 DM2 |
| O:003 O:003 O:002 O:002 |
+---]/[---]/[---]/[---]/[-----[EOT]--+
| 01 02 01 02 |
```

O:002/01 DM1

```
]/{- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

O:002/02 DM2

```
]/{- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

O:003/01 LFM1

```
]/{- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

O:003/02 LFM2

```
]/{- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

Rung 15:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

Ladder Listing

3 August 1989 Page 62

Processor Address: 000 octal

Rung 16:0

Rung 16:0

This rung will cause the transfer table to move toward the side of the beginning of the conveyor.

	PU_SW	PBM1	PBM2		PUM1	
	+EQU-----	I:002	O:003	O:003		
++EQU		+++]/[---]/[---]/[-----			+()--++	
	Source A ACT_FLAG	11	05	06		04
		0				
	Source B	1				
	+-----					
						PUM2
						O:003
					++()--+	
						07

I:002/11 PU_SW
] [- 18:1
]/[- 8:1 16:0 38:0

N7:20 ACT_FLAG
 CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

O:003/04 PUM1
]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
 ()- 8:1 16:0 30:0 38:0 42:0
 (L)- 12:2
 (U)- 12:3

O:003/05 PBM1
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/06 PBM2
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/07 PUM2
]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
 ()- 8:1 16:0 30:0 38:0 42:0
 (L)- 12:2

(U) - 12:3

Rung 16:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 63

Ladder Listing

Processor Address: 000 octal

Rung 17:0

Rung 17:0

```
| PUM1 PUM2
| O:003 O:003
+---]/[---]/[-----[EOT]--+
| 04 07
```

O:003/04 PUM1

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

Rung 17:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 64

Ladder Listing

Processor Address: 000 octal

Rung 18:0

Rung 18:0

This rung will turn all conveyors on.

WARNING: The output CON2 should only be used when the conveyor motor of the Mechanical Assembly Workstation (2-Axis Robot) is connected to the output terminal O:001/00.

	LIFT_IF	LCUSW	EHSW		CON_M	
+EQU-----+ I:001 I:001 I:001					O:001	
+--+EQUAL	+---]/[---]	[---]/[---			---()---+	
Source A ACT_FLAG	10	11	17		04	
	0					
Source B	1					
+-----+						
					CON2	
					O:001	
					---()---+	
					00	


```

I:001/10    LIFT_IF
              ] [- 20:0
              ]/[- 18:0 22:1 34:0

I:001/11    LCUSW
              ] [- 18:0 20:0

I:001/17    EHSW
              ] [- 14:0 44:0
              ]/[- 14:1 18:0 18:1 44:1

N7:20       ACT_FLAG
              CLR- 2:3
              EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                   12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                   22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
              MOV- 6:22

O:001/00    CON2
              ]/[- 19:0
              ( )- 18:0

O:001/04    CON_M
              ] [- 18:1
              ]/[- 19:0 23:0 34:0
              ( )- 18:0 22:0

```

Rung 18:1

This rung will load object on to the conveyor belt.

```

|          BROW SW PU_SW CON_M BRHM1 BRHM2          BROM1 |
| +EQU-----+ I:004 I:001 I:002 O:001 O:004 O:004      O:004 |
+--+EQUAL      +---] [---]/[---] [---] [---]/[---]/[-----+---( )---+
| |Source A  ACT_FLAG|    11    17    11    04    01    02      | 00 | | | |
| |          0|          |          |          |          | |
| |Source B    1|          |          |          |          | |
| |          |          |          |          |          | |
| +-----+          |          |          |          | |
|          |          | BROM2 | |
|          |          | O:004 | |
|          |          +---( )---+
|          |          03  |

```

ASRS

3 August 1989 Page 65

Ladder Listing

Processor Address: 000 octal

Rung 18:1

```

I:001/17      EHSW
                ] [- 14:0 44:0
                ]/[- 14:1 18:0 18:1 44:1

I:002/11      PU_SW
                ] [- 18:1
                ]/[- 8:1 16:0 38:0

I:004/11      BROW SW
                ] [- 18:1

N7:20         ACT_FLAG
                CLR- 2:3
                EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                    12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                    22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
                MOV- 6:22

O:001/04      CON_M
                ] [- 18:1
                ]/[- 19:0 23:0 34:0
                ( )- 18:0 22:0

O:004/00      BROM1
                ]/[- 19:0 22:1
                ( )- 18:1

O:004/01      BRHM1
                ]/[- 18:1 23:0
                ( )- 22:1

O:004/02      BRHM2
                ]/[- 18:1 23:0

```

()- 22:1

O:004/03 BROM2

] / [- 19:0 22:1

()- 18:1

THE FOLLOWING RUNGS WERE USED FOR EXPERIMENTAL
PURPOSE ONLY: RUNG 18:2 TO 18:8 and they can be deleted
without affecting the function of the program as stayed in
Chapter 5.

Rung 18:2

```
| F_IFRSW |
| I:003 | +MOV-----+ |
+---] [-----+MOVE +--+
| 12 | |Source 1| |
| | | | |
| | |Dest F_IFR_FLAG| |
| | | 0 | |
| | +-----+ |
```

I:003/12 F_IFRSW
] [- 18:2

N7:26 F_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:2

ASRS 3 August 1989 Page 66
Ladder Listing Processor Address: 000 octal Rung 18:3

Rung 18:3

```
| PROX_SW |
| I:003 | +MOV-----+ |
+---] [-----+MOVE +--+
| 10 | |Source 1| |
| | | | |
| | |Dest PROX_FLAG| |
| | | 0 | |
| | +-----+ |
```

I:003/10 PROX_SW
] [- 18:3

N7:27 PROX_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8

MOV- 18:3

Rung 18:4

B_IFRSW	
I:003	+MOV-----+
+---] [-----	+MOVE +--+
13	Source 1
	Dest B_IFR_FLAG
	0
	+-----+

I:003/13 B_IFRSW
] [- 18:4

N7:28 B_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:4

Rung 18:5

T_IFRSW	
I:003	+MOV-----+
+---] [-----	+MOVE +--+
14	Source 1
	Dest T_IFR_FLAG
	0
	+-----+

I:003/14 T_IFRSW
] [- 18:5

N7:29 T_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:5

ASRS

Ladder Listing

3 August 1989 Page 67

Processor Address: 000 octal

Rung 18:6

Rung 18:6

+EQU-----+ +EQU-----+ +EQU-----+ >			
+-+EQUAL	+-+EQUAL	+-+EQUAL	+-+----->
Source A PROX_FLAG	Source A F_IFR_FLAG	Source A B_IFR_FLAG	>
0	0	0	
Source B 0	Source B 1	Source B 1	
+-----+ +-----+ +-----+ +			

<+EQU-----+ +MOV-----+		
<+EQUAL	+-+MOVE	+-+
< Source A T_IFR_FLAG	Source 1	
0		
Source B 1	Dest CYL_FLAG	
	0	
+-----+ +-----+ +		

N7:26 F_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:2

N7:27 PROX_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:3

N7:28 B_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:4

N7:29 T_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:5

N7:30 CYL_FLAG
CLR- 2:5
MOV- 18:6

Rung 18:7

+EQU-----+ +EQU-----+ +EQU-----+ >	
+-+EQUAL +-+EQUAL +-+EQUAL +----->	
Source A T_IFR_FLAG	Source A F_IFR_FLAG Source A PROX_FLAG >
0	0 0
Source B 0	Source B 1 Source B 1
+-----+ +-----+ +-----+ >	

ASRS

3 August 1989 Page 68

Ladder Listing

Processor Address: 000 octal

Rung 18:7

<+EQU-----+ +MOV-----+	
<+EQUAL +-+MOVE +-+	
< Source A B_IFR_FLAG	Source 1
0	
Source B 1	Dest S_H_FLAG
	0
+-----+ +-----+ >	

N7:26 F_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:2

N7:27 PROX_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:3

N7:28 B_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:4

N7:29 T_IFR_FLAG
CLR- 2:4
EQU- 18:6 18:7 18:8
MOV- 18:5

N7:31 S_H_FLAG
CLR- 2:5
MOV- 18:7

Rung 18:8


```

|
|
ASRS                                     3 August 1989   Page 70
Ladder Listing                         Processor Address: 000 octal   Rung 19:0
Rung 19:0
|  CON2 CON_M BROM1 BROM2
|  O:001 O:001 O:004 O:004
+--]/[---]/[---]/[---]/[---]-----[EOT]--+
|    00    04    00    03
|

```

```

O:001/00    CON2
              ]/[- 19:0
              ( )- 18:0

O:001/04    CON_M
              ] [- 18:1
              ]/[- 19:0 23:0 34:0
              ( )- 18:0 22:0

O:004/00    BROM1
              ]/[- 19:0 22:1
              ( )- 18:1

O:004/03    BROM2
              ]/[- 19:0 22:1
              ( )- 18:1

```

```

Rung 19:1
|
+-----[END OF FILE]-----+
|

```

```

ASRS                                     3 August 1989   Page 71
Ladder Listing                         Processor Address: 000 octal   Rung 20:0

```

```

Rung 20:0
This rung will lift the conveyor to a higher level.

```

```

|                LIFT_IF LCUSW LCDM1 LCDM2                LCUM1 |
| +EQU-----+ I:001 I:001 O:002 O:002                O:002 |
+-+EQUAL          +---] [---] [---]/[---]/[---]-----+-( )--+
| |Source A  ACT_FLAG|    10    11    05    06                | 04 | |
| |                0|                |                | |
| |Source B      1|                |                | |
| |                |                |                | |
| +-----+                |                | |
|                |                | LCUM2 | |
|                |                | O:002 | |
|                |                +--( )--+ |
|                |                07  |

```

```

I:001/10    LIFT_IF
              ] [- 20:0
              ]/[- 18:0 22:1 34:0

I:001/11    LCUSW
              ] [- 18:0 20:0

N7:20       ACT_FLAG
              CLR- 2:3
              EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                   12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                   22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
              MOV- 6:22

O:002/04     LCUM1
              ]/[- 21:0 34:0
              ( )- 20:0

O:002/05     LCDM1
              ]/[- 20:0 35:0
              (L)- 34:0
              (U)- 34:2

O:002/06     LCDM2
              ]/[- 20:0 35:0
              (L)- 34:0
              (U)- 34:2

O:002/07     LCUM2
              ]/[- 21:0 34:0
              ( )- 20:0

```

Rung 20:1

```

|
+-----[END OF FILE]-----+
|
|

```

ASRS

3 August 1989 Page 72

Ladder Listing

Processor Address: 000 octal

Rung 21:0

Rung 21:0

```

| LCUM1 LCUM2
| O:002 O:002
+---]/[---]/[-----[EOT]-+
| 04 07
|

```

```
O:002/04      LCUM1
                ]/[- 21:0 34:0
                ( )- 20:0
```

```
O:002/07      LCUM2
                ]/[- 21:0 34:0
                ( )- 20:0
```

Rung 21:1

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 73

Ladder Listing

Processor Address: 000 octal

Rung 22:0

Rung 22:0

This rung will turn conveyor on.

```
|          LCDSW PB_SW          CON_M |
| +EQU-----+ I:001 I:002          O:001 |
|--+EQUAL      +--] [---]/[----- ( )--+
| |Source A  ACT_FLAG|   12   12          04 |
| |          0|
| |Source B    1|
| |          |
| +-----+
|
```

```
I:001/12      LCDSW
                ] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
                ]/[- 34:1
```

```
I:002/12      PB_SW
                ] [- 28:0
                ]/[- 8:0 22:0 22:2 38:1
```

```
N7:20      ACT_FLAG
            CLR- 2:3
            EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                  12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                  22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
            MOV- 6:22
```

```
O:001/04      CON_M
                ] [- 18:1
                ]/[- 19:0 23:0 34:0
                ( )- 18:0 22:0
```

This rung will return the beginning ram back to the home position.

```
I:001/10      LIFT_IF
                ] [- 20:0
                ]/[- 18:0 22:1 34:0
```

```
I:001/12      LCDSW
                ] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
                ]/[- 34:1
```

```
I:004/10      BRHSW
                ] [- 22:1
                ]/[- 22:2
```

```

0:004/00      BROM1
                ]/[- 19:0 22:1
                ( )- 18:1

```

```
O:004/02      BRHM2
                ]/[- 18:1 23:0
                ( )- 22:1
```

O:004/03 BROM2

] / [- 19:0 22:1
() - 18:1

Rung 22:2

This rung will move the transfer table toward the side of the ending conveyor.

```
|          BRHSW PB_SW LCDSW PUM1 PUM2          PBM1 |
| +EQU-----+ I:004 I:002 I:001 O:003 O:003          O:003 |
| ++EQUAL      +--]/[---]/[---] [---]/[---]/[-----+---( )---++
| |Source A  ACT_FLAG|  10   12   12   04   07          | 05 | |
| |           0|          |          | |
| |Source B    1|          |          | |
| |           |          |          | |
| +-----+          |          | |
|                   | PBM2 | |
|                   | O:003 | |
|                   +---( )---+ |
|                   06 |
```

I:001/12 LCDSW

] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
] / [- 34:1

I:002/12 PB_SW

] [- 28:0
] / [- 8:0 22:0 22:2 38:1

I:004/10 BRHSW

] [- 22:1
] / [- 22:2

ASRS

3 August 1989 Page 75

Ladder Listing

Processor Address: 000 octal

Rung 22:2

N7:20 ACT_FLAG

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

O:003/04 PUM1

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
() - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

O:003/05 PBM1

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0

```

( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

```

O:003/06 PBM2

```

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

```

O:003/07 PUM2

```

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

```

Rung 22:3

```

|
+-----[END OF FILE]-----+
|

```

ASRS

3 August 1989 Page 76

Ladder Listing

Processor Address: 000 octal

Rung 23:0

Rung 23:0

```

| CON_M BRHM1 BRHM2 PBM1 PBM2
| O:001 O:004 O:004 O:003 O:003
+---]/[---]/[---]/[---]/[---]/[-----[EOT]--+
| 04 01 02 05 06
|

```

O:001/04 CON_M

```

] [- 18:1
]/[- 19:0 23:0 34:0
( )- 18:0 22:0

```

O:003/05 PBM1

```

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

```

O:003/06 PBM2

```

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

```

```
O:004/01    BRHM1
              ]/[- 18:1 23:0
              ( )- 22:1
```

```
O:004/02    BRHM2
              ]/[- 18:1 23:0
              ( )- 22:1
```

Rung 23:1

```
|
+-----[END OF FILE]-----+
|
```

```
ASRS                      3 August 1989   Page 77
Ladder Listing             Processor Address: 000 octal      Rung 24:0
```

```
NO RUNGS IN FILE 24
NO RUNGS IN FILE 25
NO RUNGS IN FILE 26
NO RUNGS IN FILE 27
```

```
ASRS                      3 August 1989   Page 78
Ladder Listing             Processor Address: 000 octal      Rung 28:0
```

Rung 28:0

This rung will be used to load object back to the transfer table from the conveyor.

```
|          LCDSW PB_SW EROSW ERHM1 ERHM2          EROM1 |
| +EQU-----+ I:001 I:002 I:004 O:004 O:004      O:004 |
+--EQUAL          +--] [---] [---] [---]/[---]/[---]+--( )--+
| |Source A  ACT_FLAG|   12   12   12   05   06      | 04 | | |
| |              0|      |              |      | |
| |Source B      1|      |              |      | |
| |              |      |              |      | |
| +-----+      |      |              |      | |
|                  |      | EROM2 | |
|                  |      | O:004 | |
|                  |      +--( )--+ |
|                  |      07  | |
```

```
I:001/12    LCDSW
              ] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
              ]/[- 34:1
```

```
I:002/12    PB_SW
              ] [- 28:0
              ]/[- 8:0 22:0 22:2 38:1
```

I:004/12 EROSW

] [- 28:0
]/[- 30:0

N7:20 ACT_FLAG

 CLR- 2:3
 EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
 12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
 22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
 MOV- 6:22

O:004/04 EROM1

]/[- 29:0 32:0
 ()- 28:0

O:004/05 ERHM1

]/[- 28:0 33:0
 ()- 32:0

O:004/06 ERHM2

]/[- 28:0 33:0
 ()- 32:0

O:004/07 EROM2

]/[- 29:0 32:0
 ()- 28:0

Rung 28:1

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 79

Ladder Listing

Processor Address: 000 octal

Rung 29:0

Rung 29:0

```
| EROM1 EROM2 |
| O:004 O:004 |
+--]/[---]/[---[EOT]--+
| 04 07 |
```

O:004/04 EROM1

]/[- 29:0 32:0
 ()- 28:0

O:004/07 EROM2

```

]/[- 29:0 32:0
( )- 28:0

```

Rung 29:1

```

|
+-----[END OF FILE]-----+
|

```

ASRS

3 August 1989 Page 80

Ladder Listing

Processor Address: 000 octal

Rung 30:0

Rung 30:0

This rung will cause the transfer table to move toward the side of the beginning of the conveyor.

```

|          LCDSW EROSW TH_SW PBM1 PBM2          PUM1 |
| +EQU-----+ I:001 I:004 I:002 O:003 O:003      O:003 |
+--+EQUAL      +--] [---]/[---] [---]/[---]/[-----+--( )--+
| |Source A  ACT_FLAG| 12  12  10  05  06          | 04 | |
| |              0|                                |  | |
| |Source B      1|                                |  | |
| |              |                                |  | |
| +-----+                                         |  | |
|                                                     | PUM2 | |
|                                                     | O:003 | |
|                                                     +--( )--+ |
|                                                     07  |

```

I:001/12 LCDSW

```

] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
]/[- 34:1

```

I:002/10 TH_SW

```

] [- 12:0 12:2 30:0 42:0 42:1
]/[- 12:1 12:3 32:0

```

I:004/12 EROSW

```

] [- 28:0
]/[- 30:0

```

N7:20 ACT_FLAG

```

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
      22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

```

O:003/04 PUM1

```

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

```

O:003/05 PBM1

```

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( ) - 8:0 22:2 38:1 42:1
(L) - 12:0
(U) - 12:1

```

O:003/06 PBM2

```

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( ) - 8:0 22:2 38:1 42:1
(L) - 12:0
(U) - 12:1

```

ASRS

3 August 1989 Page 81

Ladder Listing

Processor Address: 000 octal

Rung 30:0

O:003/07 PUM2

```

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

```

Rung 30:1

```

|
+-----[END OF FILE]-----+
|

```

ASRS

3 August 1989 Page 82

Ladder Listing

Processor Address: 000 octal

Rung 31:0

Rung 31:0

```

| PUM1 PUM2
| O:003 O:003
+---] / [---] / [-----[EOT]---+
| 04 07
|

```

O:003/04 PUM1

```

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

```

O:003/07 PUM2

```

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

```

Rung 31:1

```

|
+-----[END OF FILE]-----+
|

```

ASRS

3 August 1989 Page 83

Ladder Listing

Processor Address: 000 octal

Rung 32:0

Rung 32:0

This rung will return the ending ram to the home position.

```

|          LCDSW ERHSW TH_SW EROM1 EROM2          ERHM1 |
| +EQU-----+ I:001 I:004 I:002 O:004 O:004          O:004 |
+--EQUAL      +--] [---] [---]/[---]/[---]/[-----+--( )--+
| |Source A  ACT_FLAG| 12 13 10 04 07          | 05 | | |
| |          0|          |          |          |          |
| |Source B    1|          |          |          |          |
| |          |          |          |          |          |
| +-----+          |          |          |          |
|          |          | ERHM2 | |
|          |          | O:004 | |
|          |          +--( )--+
|          |          06 |

```

I:001/12 LCDSW

```

] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
]/[- 34:1

```

I:002/10 TH_SW

```

] [- 12:0 12:2 30:0 42:0 42:1
]/[- 12:1 12:3 32:0

```

I:004/13 ERHSW

```

] [- 32:0

```

N7:20 ACT_FLAG

```

CLR- 2:3
EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
      12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
      22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
MOV- 6:22

```

O:004/04 EROM1

] / [- 29:0 32:0
() - 28:0

O:004/05 ERHM1

] / [- 28:0 33:0
() - 32:0

O:004/06 ERHM2

] / [- 28:0 33:0
() - 32:0

O:004/07 EROM2

] / [- 29:0 32:0
() - 28:0

Rung 32:1

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 84

Ladder Listing

Processor Address: 000 octal

Rung 33:0

Rung 33:0

```
| ERHM1 ERHM2
| O:004 O:004
|---] / [---] / [-----[EOT]---+
| 05 06
```

O:004/05 ERHM1

] / [- 28:0 33:0
() - 32:0

O:004/06 ERHM2

] / [- 28:0 33:0
() - 32:0

Rung 33:1

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 85

Ladder Listing

Processor Address: 000 octal

Rung 34:0

Rung 34:0

The following rungs are used to return the conveyor one level down (home).

```

|          LCUM1 LCUM2 LCDSW CON_M LIFT_IF          LCDM1 |
| +EQU-----+ O:002 O:002 I:001 O:001 I:001          O:002 |
+--EQUAL      +--]/[---]/[---] [---]/[---]/[---] +--(L)---+
| |Source A  ACT_FLAG|    04    07    12    04    10          | 05 | |
| |              0|          |          | |
| |Source B      1|          |          | |
| |              |          |          | |
| +-----+          |          | |
|                      | LCDM2 | |
|                      | O:002 | |
|                      +--(L)---+ |
|                                06 |

```

```

I:001/10      LIFT_IF
              ] [- 20:0
              ]/[- 18:0 22:1 34:0

```

```

I:001/12      LCDSW
              ] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
              ]/[- 34:1

```

```

N7:20         ACT_FLAG
              CLR- 2:3
              EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
                  12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
                  22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2
              MOV- 6:22

```

```

O:001/04      CON_M
              ] [- 18:1
              ]/[- 19:0 23:0 34:0
              ( )- 18:0 22:0

```

```

O:002/04      LCUM1
              ]/[- 21:0 34:0
              ( )- 20:0

```

```

O:002/05      LCDM1
              ]/[- 20:0 35:0
              (L)- 34:0
              (U)- 34:2

```

```

O:002/06      LCDM2
              ]/[- 20:0 35:0
              (L)- 34:0
              (U)- 34:2

```

O:002/07 LCUM2

]/[- 21:0 34:0
()- 20:0

ASRS

3 August 1989 Page 86

Ladder Listing

Processor Address: 000 octal

Rung 34:1

Rung 34:1

```
| LCDSW |
| I:001 +EQU-----+ |
+---]/[--+EQUAL +-----+COUNT UP +- (CU)-+
| 12 |Source A ACT_FLAG| |Counter C5:1| |
| | | 0| |Preset 2+-(DN) |
| |Source B 1| |Accum 0| |
| | | | +-----+ |
| +-----+ |
```

C5:1

CTU- 34:1

RES- 2:6

I:001/12 LCDSW

] [- 22:0 22:1 22:2 28:0 30:0 32:0 34:0
]/[- 34:1

N7:20 ACT_FLAG

CLR- 2:3

EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0
12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0
22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2

MOV- 6:22

Rung 34:2

```
| | LCDM1 |
| C5:1 +EQU-----+ |
+---] [--+EQUAL +-----+ (U) ---+
| DN |Source A ACT_FLAG| | 05 | | |
| | | 0| | | |
| |Source B 1| | | |
| | | | | |
| +-----+ |
| | LCDM2 | |
| | O:002 | |
| +---(U)---+ |
| 06 |
```

C5:1.DN

] [- 34:2

N7:20

ACT_FLAG

CLR- 2:3

EQU- 2:4 2:5 2:6 8:0 8:1 10:0 10:1 10:2 10:3 10:4 10:5 12:0

12:1 12:2 12:3 14:0 14:1 14:2 14:3 16:0 18:0 18:1 20:0

22:0 22:1 22:2 28:0 30:0 32:0 34:0 34:1 34:2

MOV- 6:22

O:002/05

LCDM1

]/[- 20:0 35:0

(L)- 34:0

(U)- 34:2

ASRS

3 August 1989 Page 87

Ladder Listing

Processor Address: 000 octal

Rung 34:2

O:002/06

LCDM2

]/[- 20:0 35:0

(L)- 34:0

(U)- 34:2

Rung 34:3

|

+-----[END OF FILE]-----+

|

ASRS

3 August 1989 Page 88

Ladder Listing

Processor Address: 000 octal

Rung 35:0

Rung 35:0

| LCDM1 LCDM2

| O:002 O:002

+---]/[---]/[-----[EOT]---+

| 05 06

O:002/05

LCDM1

]/[- 20:0 35:0

(L)- 34:0

(U)- 34:2

O:002/06

LCDM2

]/[- 20:0 35:0

(L)- 34:0

(U)- 34:2


```

N7:12      COL_FLAG
           CLR- 2:2
           EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
                36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
           MOV- 6:0 6:1 6:2 6:3

N7:21      RET_FLAG
           CLR- 2:3
           EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
                36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
                42:0 42:1 44:0 44:1 44:2 44:3
           MOV- 36:0

ASRS
Ladder Listing      Processor Address: 000 octal      3 August 1989   Page 90
                                                           Rung 36:1

O:003/00      RTM1
               ] [- 6:8 36:5
               ]/[- 7:0 14:0 37:0 44:0
               (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
               (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

O:003/01      LFM1
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

O:003/02      LFM2
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

O:003/03      RTM2
               ] [- 6:8 36:5
               ]/[- 7:0 14:0 37:0 44:0
               (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
               (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

Rung 36:2

The following rung is used to test the data for column selection.

```

|                                     COL_2SW  LFM1  LFM2          RTM1  |
| +EQU-----+ +EQU-----+ I:001  O:003  O:003          O:003  |
+-+EQUAL          +-+EQUAL          +---] [---]/[---]/[---+---(L)---+
| |Source A  RET_FLAG| |Source A  COL_FLAG|    15    01    02    |    00  | |
| |          0| |          0|          |          |          |
| |Source B    1| |Source B    2|          |          |          |
| |          | |          |          |          |          |
| +-----+ +-----+          |          |          |
|                                     | RTM2  |
|                                     | O:003  |
|                                     +---(L)---+
|                                     03  |

```

I:001/15 COL_2SW

```

] [- 6:5 36:2
]/[- 6:10 36:7

```

N7:12 COL_FLAG

```

CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3

```

N7:21 RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

ASRS

3 August 1989 Page 91

Ladder Listing

Processor Address: 000 octal

Rung 36:2

O:003/00 RTM1

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/01 LFM1

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

O:003/02 LFM2

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0

```

(U)- 14:1 44:1

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 36:3

The following rung is used to test the data for column selection.

```
|
|          COL_3SW  LFM1  LFM2          RTM1  |
| +EQU-----+ +EQU-----+ I:001  O:003  O:003  O:003  |
+--+EQUAL      +--+EQUAL      +---] [---]/[---]/[-----+---(L)---+
| |Source A  RET_FLAG| |Source A  COL_FLAG|   14    01    02    |   00  | |
| |          0| |          0|          |          | |
| |Source B    1| |Source B    3|          |          | |
| |          | |          |          |          | |
| +-----+ +-----+          |          | |
|
|          |          |          |   RTM2  | |
|          |          |          |   O:003  | |
|          |          |          | +---(L)---+ |
|          |          |          |   03    | |
```

I:001/14 COL_3SW

```
] [- 6:6 36:3
]/[- 6:11 36:8
```

N7:12 COL_FLAG

```
CLR- 2:3
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

ASRS

3 August 1989 Page 92

Ladder Listing

Processor Address: 000 octal

Rung 36:3

O:003/00 RTM1

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

```
O:003/01      LFM1
                ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
                (L)- 14:0 44:0
                (U)- 14:1 44:1
```

```
O:003/02      LFM2
                ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
                (L)- 14:0 44:0
                (U)- 14:1 44:1
```

```
O:003/03      RTM2
                ] [- 6:8 36:5
                ]/[- 7:0 14:0 37:0 44:0
                (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
                (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 36:4

The following rung is used to test the data for column selection.

				COL_4SW	LFM1	LFM2		RTM1	
	+EQU-----+	+EQU-----+		I:001	O:003	O:003		O:003	
	+--+EQUAL	+--+EQUAL		+---]	[---]	[---]		[---+--(L)---+	
	Source A	RET_FLAG	Source A	COL_FLAG	13	01	02		00
		0		0					
	Source B	1	Source B	4					
	+-----+	+-----+							
									RTM2
									O:003
									+--(L)---+
									03

```
I:001/13      COL_4SW
                ] [- 6:7 36:4
                ]/[- 6:12 36:9
```

```
N7:12         COL_FLAG
                CLR- 2:2
                EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
                    36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
                MOV- 6:0 6:1 6:2 6:3
```

```
N7:21         RET_FLAG
                CLR- 2:3
                EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
                    36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
                    42:0 42:1 44:0 44:1 44:2 44:3
                MOV- 36:0
```

Ladder Listing

Processor Address: 000 octal

Rung 36:4

```

O:003/00      RTM1
               ] [- 6:8 36:5
               ]/[- 7:0 14:0 37:0 44:0
               (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
               (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

O:003/01      LFM1
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

O:003/02      LFM2
               ]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
               (L)- 14:0 44:0
               (U)- 14:1 44:1

O:003/03      RTM2
               ] [- 6:8 36:5
               ]/[- 7:0 14:0 37:0 44:0
               (L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
               (U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

Rung 36:5

This rung is used to clear the input register.

	RTM1	RTM2				
	O:003	O:003	+EQU-----+		+COP-----+	
+--]	[---]	[---+EQUAL		+-----+COPY FILE		+--+
	00	03	Source A PUT_BACK	Source	#COMP_REG	
				Dest	#INPUT_REG	
			Source B	Length	1	
				+-----+		
			+-----+			

```

N7:0          INPUT_REG
               COP- 6:8 36:5
               EQU- 2:0 2:1
               FAL- 4:0
               NEQ- 4:0

```

```

N7:6          PUT_BACK
               CLR- 2:0
               EQU- 36:0 36:5

```

```

N7:10         COMP_REG
               COP- 6:8 36:5
               EQU- 2:0 2:1 2:2 2:2 2:2 2:2 2:3 2:3 2:4 2:5 2:6
               NEQ- 4:0

```

O:003/00 RTM1

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

ASRS

3 August 1989 Page 94

Ladder Listing

Processor Address: 000 octal

Rung 36:5

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 36:6

The following rung will unlatched the motor once the cloumn is selected.

	COL_1SW	RTM1
+EQU-----+ +EQU-----+ I:001		O:003
+--+EQUAL	+--+EQUAL	+---]/[-----+--(U)---+
Source A RET_FLAG Source A COL_FLAG 16		00
0 0		
Source B 1 Source B 1		
+-----+ +-----+		
		RTM2
		O:003
		+--(U)---+
		03

I:001/16 COL_1SW

```
] [- 6:4 36:1
]/[- 6:9 36:6
```

N7:12 COL_FLAG

```
CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:003/00 RTM1

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/03 RTM2

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

ASRS

3 August 1989 Page 95

Ladder Listing

Processor Address: 000 octal

Rung 36:7

Rung 36:7

The following rung will unlatched the motor once the cloumn is selected.

				COL_2SW		RTM1	
	+EQU-----	+EQU-----	I:001			O:003	
+--+EQU		+--+EQU		+---]/[-----		(U)---+	
	Source A	RET_FLAG	Source A	COL_FLAG	15		00
		0		0			
	Source B	1	Source B	2			
	+-----	+-----					
							RTM2
							O:003
						+--(U)---	
						03	

I:001/15 COL_2SW

```

] [- 6:5 36:2
]/[- 6:10 36:7

```

N7:12 COL_FLAG

```

CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3

```

N7:21 RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

O:003/00 RTM1

```

] [- 6:8 36:5

```

```

]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

O:003/03 RTM2

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

```

ASRS

3 August 1989 Page 96

Ladder Listing

Processor Address: 000 octal

Rung 36:8

Rung 36:8

The following rung will unlatched the motor once the cloumn is selected.

	COL_3SW		RTM1	
+EQU-----+ +EQU-----+ I:001			O:003	
+--+EQUAL	+--+EQUAL	+---]/[-----+--(U)---+--		
Source A RET_FLAG Source A COL_FLAG 14		00		
0 0				
Source B 1 Source B 3				
+-----+ +-----+				
		RTM2		
		O:003		
		+--(U)---+		
		03		

I:001/14 COL_3SW

```

] [- 6:6 36:3
]/[- 6:11 36:8

```

N7:12 COL_FLAG

```

CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3

```

N7:21 RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

O:003/00 RTM1

```

] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0

```

```
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

ASRS

3 August 1989 Page 97

Ladder Listing

Processor Address: 000 octal

Rung 36:9

Rung 36:9

The following rung will unlatched the motor once the cloumn is selected.

				COL_4SW		RTM1	
	+EQU-----	+EQU-----		I:001		O:003	
+--+EQUAL		+--+EQUAL		+---]/[-----		(U)---+	
	Source A	RET_FLAG	Source A	COL_FLAG	13		00
		0		0			
	Source B	1	Source B	4			
	+-----	+-----					
							RTM2
							O:003
						+--(U)---	
						03	

I:001/13 COL_4SW

```
] [- 6:7 36:4
]/[- 6:12 36:9
```

N7:12 COL_FLAG

```
CLR- 2:2
EQU- 2:3 6:4 6:5 6:6 6:7 6:9 6:10 6:11 6:12 6:22 6:22 6:22 6:22
      36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9
MOV- 6:0 6:1 6:2 6:3
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:003/00 RTM1

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
```

(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 36:10

	UL1SW	DM1	DM2	UM1	
+EQU-----+ +EQU-----+ I:003 O:002 O:002				O:002	
+-+EQUAL	+-+EQUAL	+++] [---]/[---]/[-----		---(L)---	+
Source A RET_FLAG Source A ROW_FLAG	15	01	02	00	
0 0					
Source B 1 Source B 1					
+-----+ +-----+					

ASRS

3 August 1989 Page 98

Ladder Listing

Processor Address: 000 octal

Rung 36:10

	UM2	
	O:002	
	+++ (L)---	
	03	

I:003/15 UL1SW

```
] [- 10:0 36:10
]/[- 10:3 36:13
```

N7:11 ROW_FLAG

```
CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:002/00 UM1

```
] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:002/01 DM1

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

O:002/02 DM2

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

O:002/03 UM2

```
] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

ASRS

3 August 1989 Page 99

Ladder Listing

Processor Address: 000 octal

Rung 36:11

Rung 36:11

	UL2SW	DM1	DM2	UM1
+EQU-----+ +EQU-----+ I:003 O:002 O:002				O:002
+--+EQUAL	+--+EQUAL	+--]	[---]/[---]/[-----+--(L)---+--	
Source A RET_FLAG Source A ROW_FLAG	16	01	02	00
	0		0	
Source B	1	Source B	2	
+-----+ +-----+				
				UM2
				O:002
				+--(L)---+
				03

I:003/16 UL2SW

```
] [- 10:1 36:11
] / [- 10:4 36:14
```

N7:11 ROW_FLAG

CIR- 2:2

```
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
```

```

N7:21          RET_FLAG
                CLR- 2:3
                EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
                    36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
                    42:0 42:1 44:0 44:1 44:2 44:3
                MOV- 36:0

O:002/00      UM1

                ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
                (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
                (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01      DM1

                ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                    45:0
                (L)- 14:2 40:0 40:1 40:2 44:2
                (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02      DM2

                ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                    45:0
                (L)- 14:2 40:0 40:1 40:2 44:2
                (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03      UM2

                ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
                (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
                (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

RunG 36:12
|
|                                     UL3SW  DM1  DM2                                     UM1  |
| +EQU-----+ +EQU-----+ I:003 O:002 O:002                                     O:002 |
|++EQUAL          +-EQUAL          +--] [---]/[---]/[-----+--(L)---+
| |Source A  RET_FLAG| |Source A  ROW_FLAG|      17   01   02          |   00  | | |
| |              0| |              0|          |   |   | |
| |Source B      1| |Source B      3|          |   |   | |
| |              | |              |          |   |   | |
| +-----+ +-----+          |   |   | |
|                                     |   UM2  | |
|                                     | O:002  | |
|                                     +--(L)---+ |
|                                     03

```

```

I:003/17      UL3SW
                ] [- 10:2 36:12
                ]/[- 10:5 36:15

N7:11         ROW_FLAG
                CLR- 2:2
                EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
                    10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
                    40:0 40:1 40:2 40:3 40:4 40:5
                MOV- 6:13 6:14 6:15

N7:21         RET_FLAG
                CLR- 2:3
                EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
                    36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
                    42:0 42:1 44:0 44:1 44:2 44:3
                MOV- 36:0

O:002/00      UM1
                ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
                (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
                (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01      DM1
                ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                    45:0
                (L)- 14:2 40:0 40:1 40:2 44:2
                (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02      DM2
                ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
                    45:0
                (L)- 14:2 40:0 40:1 40:2 44:2
                (U)- 14:3 40:3 40:4 40:5 44:3

O:002/03      UM2
                ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
                (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
                (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 36:13

This rung is used to unlatched the up-motor once the row is selected.

	UL1SW		UM1	
	+EQU-----+ +EQU-----+ I:003		O:002	
	+--+EQUAL	+--+EQUAL	+--+]/[-----+--+ (U)---+--+	
	Source A RET_FLAG	Source A ROW_FLAG	15	
		0	0	
	Source B	1	Source B	1
	+-----+ +-----+			
			UM2	
			O:002	
			+--+ (U)---+--+	
			03	

I:003/15 UL1SW

] [- 10:0 36:10
]/[- 10:3 36:13

N7:11 ROW_FLAG

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

O:002/00 UM1

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/03 UM2

] /[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

Rung 36:14

This rung is used to unlatched the up-motor once the row is selected.

	UL2SW				UM1	
	+EQU-----+ +EQU-----+ I:003				O:002	
+-+EQUAL		+-+EQUAL		+-+]/[-----+--(U)---+ +		
	Source A	RET_FLAG	Source A	ROW_FLAG	16	00
		0		0		
	Source B	1	Source B	2		
	+-----+ +-----+ +					
						+++ +++

ASRS

3 August 1989 Page 102

Ladder Listing

Processor Address: 000 octal

Rung 36:14

		+++	+++
		UM2	
		O:002	
		+-+ (U) ---+	
		03	

I:003/16 UL2SW

] [- 10:1 36:11

] / [- 10:4 36:14

N7:11 ROW_FLAG

CLR- 2:2

EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1

10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15

40:0 40:1 40:2 40:3 40:4 40:5

MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3

EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12

36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5

42:0 42:1 44:0 44:1 44:2 44:3

MOV- 36:0

O:002/00 UM1

] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2

(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12

(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/03 UM2

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 36:15

This rung is used to unlatched the up-motor once the row is selected.

```

|                                     UL3SW                                     UM1 |
| +EQU-----+ +EQU-----+ I:003                                     O:002 |
+--+EQUAL      +--+EQUAL      +--]/[-----+---(U)---+
| |Source A  RET_FLAG| |Source A  ROW_FLAG|   17      |   00 | |
| |           0| |           0|           |           | |
| |Source B      1| |Source B      3|           |           | |
| |           | |           |           |           | |
| +-----+ +-----+           |           | |
|                                     | UM2 | |
|                                     | O:002 | |
|                                     +---(U)---+ |
|                                     03 |

```

I:003/17 UL3SW

```

] [- 10:2 36:12
]/[- 10:5 36:15

```

ASRS

3 August 1989 Page 103

Ladder Listing

Processor Address: 000 octal

Rung 36:15

N7:11

ROW_FLAG

```

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

```

N7:21

RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

O:002/00

UM1

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

O:002/03

UM2

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 36:16

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 104

Ladder Listing

Processor Address: 000 octal

Rung 37:0

Rung 37:0

```
|  UM1  UM2  RTM1  RTM2
| O:002 O:002 O:003 O:003
+---]/[---]/[---]/[---]/[-----[EOT]-+
|   00   03   00   03
|
```

O:002/00 UM1

```
] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:002/03 UM2

```
] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15
```

O:003/00 RTM1

```
] [- 6:8 36:5
] / [- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/03 RTM2

```
] [- 6:8 36:5
] / [- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

Rung 37:1

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 105

Ladder Listing

Processor Address: 000 octal

Rung 38:0

Rung 38:0

This rung will cause the transfer table to move toward the side of the beginning of the conveyor.

					PU_SW	PBM1	PBM2		PUM1	
	+EQU-----+ +EQU-----+ I:002 O:003 O:003							O:003		
+-+EQUAL			+-+EQUAL		+---]/[---]/[---]/[-----+--()--++					
	Source A	B_SIDE	Source A	RET_FLAG	11	05	06		04	
		0		0						
	Source B	1	Source B	1						
	+-----+ +-----+									
									PUM2	
									O:003	
								+--()--+		
									07	

I:002/11 PU_SW
] [- 18:1
]/[- 8:1 16:0 38:0

N7:7 B_SIDE
 CLR- 2:0
 EQU- 8:1 12:0 12:1 38:0 42:1

N7:21 RET_FLAG
 CLR- 2:3
 EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
 36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
 42:0 42:1 44:0 44:1 44:2 44:3
 MOV- 36:0

O:003/04 PUM1
]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
 ()- 8:1 16:0 30:0 38:0 42:0
 (L)- 12:2
 (U)- 12:3

O:003/05 PBM1
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/06 PBM2
]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
 ()- 8:0 22:2 38:1 42:1
 (L)- 12:0
 (U)- 12:1

O:003/07 PUM2

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
() - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

ASRS

3 August 1989 Page 106

Ladder Listing

Processor Address: 000 octal

Rung 38:1

Rung 38:1

This rung will move the transfer table toward the side of the ending conveyor.

				PB_SW	PUM1	PUM2		PBM1	
	+EQU-----	+EQU-----		I:002	O:003	O:003		O:003	
+	+EQU	+EQU		+	---	---	---	---	+
	Source A	E_SIDE		Source A	RET_FLAG	12	04	07	
		0			0				
	Source B	1		Source B	1				
	+	+		+	+				
								PBM2	
								O:003	
								+	
								06	

I:002/12 PB_SW

] [- 28:0
] / [- 8:0 22:0 22:2 38:1

N7:8 E_SIDE

CLR- 2:0
EQU- 8:0 12:2 12:3 38:1 42:0

N7:21 RET_FLAG

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

O:003/04 PUM1

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
() - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3

O:003/05 PBM1

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
() - 8:0 22:2 38:1 42:1

(L)- 12:0
(U)- 12:1

O:003/06 PBM2

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/07 PUM2

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
()- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

ASRS

3 August 1989 Page 107

Ladder Listing

Processor Address: 000 octal

Rung 38:2

Rung 38:2

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 108

Ladder Listing

Processor Address: 000 octal

Rung 39:0

Rung 39:0

```
| PUM1 PUM2 PBM1 PBM2
| O:003 O:003 O:003 O:003
+---]/[---]/[---]/[---]/[-----[EOT]-+
| 04 07 05 06
```

O:003/04 PUM1

]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
()- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

O:003/05 PBM1

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
()- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/06 PBM2

]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0

```
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1
```

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3
```

Rung 39:1

```
|
|-----[END OF FILE]-----
|
```

ASRS

3 August 1989 Page 109

Ladder Listing

Processor Address: 000 octal

Rung 40:0

Rung 40:0

				LL1SW	UM1	UM2		DM1	
	+EQU-----	+EQU-----		I:002	O:002	O:002		O:002	
	+--EQU	+--EQU		+--]	[---]	/[---]	/[-----	+--(L)---+	
	Source A	RET_FLAG	Source A	ROW_FLAG	15	00	03	01	
		0		0					
	Source B	1	Source B	1					
	+-----	+-----							
								DM2	
								O:002	
								+--(L)---+	
								02	

I:002/15 LL1SW

```
] [- 6:16 14:2 40:0 44:2
] / [- 6:19 14:3 40:3 44:3
```

N7:11 ROW_FLAG

CLR- 2:2

```
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
```

MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3

```
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:1 40:0 40:1 40:2 40:3 40:4 40:5
```

42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

O:002/00 UM1

] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01 DM1

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/03 UM2

] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

ASRS

3 August 1989 Page 110

Ladder Listing

Processor Address: 000 octal

Rung 40:1

Rung 40:1

	LL2SW	UM1	UM2	DM1
+EQU-----+ +EQU-----+ I:002 O:002 O:002				O:002
++EQU	++EQU	+	---	(L)---
Source A RET_FLAG Source A ROW_FLAG	14	00	03	01
	0		0	
Source B 1 Source B 2				
+-----+ +-----+				
				DM2
				O:002
				+(L)---+
				02

I:002/14 LL2SW

] [- 6:17 40:1
] / [- 6:20 40:4

N7:11 ROW_FLAG

CLR- 2:2

```

EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

```

```

N7:21      RET_FLAG
          CLR- 2:3
          EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
              36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
              42:0 42:1 44:0 44:1 44:2 44:3
          MOV- 36:0

```

```

O:002/00    UM1
            ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
            (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
            (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

O:002/01    DM1
            ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
              45:0
            (L)- 14:2 40:0 40:1 40:2 44:2
            (U)- 14:3 40:3 40:4 40:5 44:3

```

```

O:002/02    DM2
            ]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
              45:0
            (L)- 14:2 40:0 40:1 40:2 44:2
            (U)- 14:3 40:3 40:4 40:5 44:3

```

```

O:002/03    UM2
            ]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
            (L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
            (U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

```

ASRS                      3 August 1989   Page 111
Ladder Listing           Processor Address: 000 octal      Rung 40:2
Rung 40:2

```

		LL3SW	UM1	UM2	DM1
	+EQU-----+ +EQU-----+ I:002 O:002 O:002				O:002
+-+EQUAL	+-+EQUAL	+-+]	[- - -]	/ [- - -]	/ [- - - - - - - - - - (L) - - - +
Source A RET_FLAG	Source A ROW_FLAG	13	00	03	01
	0				
Source B 1	Source B 3				
+-----+ +-----+					
					DM2
					O:002
					+-- (L) --+
					02

I:002/13 LL3SW

] [- 6:18 40:2
]/[- 6:21 40:5

N7:11 ROW_FLAG

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
 10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
 40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
 36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
 42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

O:002/00 UM1

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

O:002/01 DM1

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

O:002/03 UM2

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

ASRS

3 August 1989. Page 112

Ladder Listing

Processor Address: 000 octal

Rung 40:3

Rung 40:3

				LL1SW		DM1	
	+EQU-----+	+EQU-----+	I:002			O:002	
+--+EQUAL		+--+EQUAL		+--]/[-----+--(U)---+--			
	Source A RET_FLAG	Source A ROW_FLAG	15			01	
		0	0				
	Source B	1	Source B	1			
	+-----+	+-----+					
						DM2	
						O:002	
						+--(U)---+	
						02	

I:002/15 LL1SW

] [- 6:16 14:2 40:0 44:2
]/[- 6:19 14:3 40:3 44:3

N7:11 ROW_FLAG

CLR- 2:2
 EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 10:0 10:1
 10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
 40:0 40:1 40:2 40:3 40:4 40:5
 MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3
 EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
 36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
 42:0 42:1 44:0 44:1 44:2 44:3
 MOV- 36:0

O:002/01 DM1

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

Rung 40:4

				LL2SW		DM1	
	+EQU-----+	+EQU-----+	I:002			O:002	
+-+EQUAL		+-+EQUAL	+-+]/[-----			-(U)---+	+
	Source A	RET_FLAG	Source A	ROW_FLAG	14		01
		0		0			
	Source B	1	Source B	2			
	+-----+	+-----+					
						+++	+++

ASRS

3 August 1989 Page 113

Ladder Listing

Processor Address: 000 octal

Rung 40:4

			+++	+++
			DM2	
			O:002	
			---(U)---	
			02	

I:002/14 LL2SW

] [- 6:17 40:1
]/[- 6:20 40:4

N7:11 ROW_FLAG

CLR- 2:2
 EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
 10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
 40:0 40:1 40:2 40:3 40:4 40:5
 MOV- 6:13 6:14 6:15

N7:21 RET_FLAG

CLR- 2:3
 EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
 36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
 42:0 42:1 44:0 44:1 44:2 44:3
 MOV- 36:0

O:002/01 DM1

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
 45:0
 (L)- 14:2 40:0 40:1 40:2 44:2
 (U)- 14:3 40:3 40:4 40:5 44:3

O:002/02 DM2

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

Rung 40:5

					LL3SW		DM1	
	+EQU-----	+EQU-----			I:002		O:002	
	+--+EQUAL	+--+EQUAL			+--]/[-----		-(U)---+	
	Source A	RET_FLAG	Source A	ROW_FLAG	13		01	
		0		0				
	Source B	1	Source B	3				
	+-----+	+-----+						
							DM2	
							O:002	
							---(U)---+	
							02	

I:002/13 LL3SW

```

] [- 6:18 40:2
] / [- 6:21 40:5

```

ASRS

3 August 1989 Page 114

Ladder Listing

Processor Address: 000 octal

Rung 40:5

N7:11

ROW_FLAG

```

CLR- 2:2
EQU- 2:3 6:16 6:17 6:18 6:19 6:20 6:21 6:22 6:22 6:22 10:0 10:1
      10:2 10:3 10:4 10:5 36:10 36:11 36:12 36:13 36:14 36:15
      40:0 40:1 40:2 40:3 40:4 40:5
MOV- 6:13 6:14 6:15

```

N7:21

RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

O:002/01

DM1

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

O:002/02

DM2

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0

```

(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

Rung 40:6

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 115

Ladder Listing

Processor Address: 000 octal

Rung 41:0

Rung 41:0

```
| DM1 DM2
| O:002 O:002
+--]/[---]/[-----[EOT]-+
| 01 02
```

O:002/01 DM1

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

O:002/02 DM2

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3
```

Rung 41:1

```
|
+-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 116

Ladder Listing

Processor Address: 000 octal

Rung 42:0

Rung 42:0

This rung will cause the transfer table to move toward the side of the beginning of the conveyor.

```

|                                     TH_SW PBM1 PBM2                PUM1 |
| +EQU-----+ +EQU-----+ I:002 O:003 O:003                O:003 |
+-+EQUAL          +-+EQUAL          +--] [---]/[---]/[-----+--( )--+
| |Source A      E_SIDE| |Source A  RET_FLAG| 10   05   06      | 04 | |
| |              0| |              0|              |      | |
| |Source B      1| |Source B      1|              |      | |
| |              | |              |              |      | |
| +-----+ +-----+              |      | |
|                                     | PUM2 | |
|                                     | O:003 | |
|                                     +--( )--+ |
|                                     07   |

```

```

I:002/10      TH_SW
               ] [- 12:0 12:2 30:0 42:0 42:1
               ]/[- 12:1 12:3 32:0

```

```

N7:8          E_SIDE
               CLR- 2:0
               EQU- 8:0 12:2 12:3 38:1 42:0

```

```

N7:21         RET_FLAG
               CLR- 2:3
               EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
                   36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
                   42:0 42:1 44:0 44:1 44:2 44:3
               MOV- 36:0

```

```

O:003/04      PUM1
               ]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
               ( )- 8:1 16:0 30:0 38:0 42:0
               (L)- 12:2
               (U)- 12:3

```

```

O:003/05      PBM1
               ]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
               ( )- 8:0 22:2 38:1 42:1
               (L)- 12:0
               (U)- 12:1

```

```

O:003/06      PBM2
               ]/[- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
               ( )- 8:0 22:2 38:1 42:1
               (L)- 12:0
               (U)- 12:1

```

O:003/07 PUM2

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

ASRS

3 August 1989 Page 117

Ladder Listing

Processor Address: 000 octal

Rung 42:1

Rung 42:1

This rung will move the transfer table toward the side of the ending conveyor.

```
|
| TH_SW PUM1 PUM2 PBM1 |
| +EQU-----+ +EQU-----+ I:002 O:003 O:003 O:003 |
+--EQUAL +--EQUAL +--] [---]/[---]/[-----+--( )---+
| |Source A B_SIDE| |Source A RET_FLAG| 10 04 07 | 05 | |
| | 0 | | 0 | | | |
| |Source B 1| |Source B 1| | | |
| | | | | | | |
| +-----+ +-----+ | |
| | | | | PBM2 | |
| | | | | O:003 | |
| | | | | +--( )---+ |
| | | | | 06 |
```

I:002/10 TH_SW

```
] [- 12:0 12:2 30:0 42:0 42:1
] / [- 12:1 12:3 32:0
```

N7:7 B_SIDE

```
CLR- 2:0
EQU- 8:1 12:0 12:1 38:0 42:1
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:003/04 PUM1

```
] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( ) - 8:1 16:0 30:0 38:0 42:0
(L) - 12:2
(U) - 12:3
```

O:003/05 PBM1

```
] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
( ) - 8:0 22:2 38:1 42:1
```

(L)- 12:0
(U)- 12:1

O:003/06 PBM2

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
() - 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/07 PUM2

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
() - 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

ASRS

3 August 1989 Page 118

Ladder Listing

Processor Address: 000 octal

Rung 42:2

Rung 42:2

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 119

Ladder Listing

Processor Address: 000 octal

Rung 43:0

Rung 43:0

```
| PBM1 PBM2 PUM1 PUM2
| O:003 O:003 O:003 O:003
|---] / [---] / [---] / [---] / [-----[EOT]---+
| 05 06 04 07
```

O:003/04 PUM1

] / [- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
() - 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3

O:003/05 PBM1

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0
() - 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1

O:003/06 PBM2

] / [- 8:1 9:0 12:2 13:0 16:0 23:0 30:0 38:0 39:0 42:0 43:0

```
( )- 8:0 22:2 38:1 42:1
(L)- 12:0
(U)- 12:1
```

O:003/07 PUM2

```
]/[- 8:0 9:0 12:0 13:0 17:0 22:2 31:0 38:1 39:0 42:1 43:0
( )- 8:1 16:0 30:0 38:0 42:0
(L)- 12:2
(U)- 12:3
```

Rung 43:1

```
|
|-----[END OF FILE]-----|
|
```

ASRS

3 August 1989 Page 120

Ladder Listing

Processor Address: 000 octal

Rung 44:0

Rung 44:0

The following rungs will return the elevator car back to home position.

```
|
|          EHSW RTM1 RTM2                      LFM1 |
| +EQU-----+ I:001 O:003 O:003                O:003 |
| +EQU-----+ +---] [---]/[---]/[-----+---(L)---+
| |Source A RET_FLAG| 17 00 03                    | 01 | |
| |          0|                                     |   | |
| |Source B      1|                                     |   | |
| |          |                                     |   | |
| +-----+                                         |   | |
|                                                     | LFM2 | |
|                                                     | O:003 | |
|                                                     +---(L)---+
|                                                     02  |
```

I:001/17 EHSW

```
] [- 14:0 44:0
]/[- 14:1 18:0 18:1 44:1
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:003/00 RTM1

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
```

```
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

O:003/01 LFM1

```
]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

O:003/02 LFM2

```
]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1
```

O:003/03 RTM2

```
] [- 6:8 36:5
]/[- 7:0 14:0 37:0 44:0
(L)- 6:4 6:5 6:6 6:7 36:1 36:2 36:3 36:4
(U)- 6:9 6:10 6:11 6:12 36:6 36:7 36:8 36:9
```

ASRS

3 August 1989 Page 121

Ladder Listing

Processor Address: 000 octal

Rung 44:1

Rung 44:1

	EHSW	LFM1	
+EQU-----+ I:001		O:003	
+--+EQUAL	+--]/[-----+--+	(U)---	+
Source A RET_FLAG 17		01	
0			
Source B 1			
+-----+			
		LFM2	
		O:003	
		+--(U)---	
		02	

I:001/17 EHSW

```
] [- 14:0 44:0
]/[- 14:1 18:0 18:1 44:1
```

N7:21 RET_FLAG

```
CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0
```

O:003/01 LFM1

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

O:003/02 LFM2

```

]/[- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L)- 14:0 44:0
(U)- 14:1 44:1

```

Rung 44:2

	LL1SW	UM1	UM2		DM1	
	+EQU-----	I:002	O:002	O:002		
+-+EQUAL		+-+]	[---]/[---]/[---		+--(L)---+	
	Source A RET_FLAG	15	00	03		01
		0				
	Source B	1				
	+-----					
						DM2
						O:002
					+--(L)---+	
						02

I:002/15 LL1SW

```

] [- 6:16 14:2 40:0 44:2
]/[- 6:19 14:3 40:3 44:3

```

ASRS

3 August 1989 Page 122

Ladder Listing

Processor Address: 000 octal

Rung 44:2

N7:21 RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

O:002/00 UM1

```

]/[- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

O:002/01 DM1

```

]/[- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

O:002/02 DM2

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

O:002/03 UM2

```

] / [- 7:0 11:0 14:2 37:0 40:0 40:1 40:2 44:2
(L)- 6:16 6:17 6:18 10:0 10:1 10:2 36:10 36:11 36:12
(U)- 6:19 6:20 6:21 10:3 10:4 10:5 36:13 36:14 36:15

```

Rung 44:3

	LL1SW	DM1	
+EQU-----+ I:002		O:002	
+--+EQU	+--] / [-	(U) --+ +	
Source A RET_FLAG 15		01	
0			
Source B 1			
+-----+			
		DM2	
		O:002	
		+-- (U) --+	
		02	

I:002/15 LL1SW

```

] [- 6:16 14:2 40:0 44:2
] / [- 6:19 14:3 40:3 44:3

```

N7:21 RET_FLAG

```

CLR- 2:3
EQU- 36:1 36:2 36:3 36:4 36:6 36:7 36:8 36:9 36:10 36:11 36:12
      36:13 36:14 36:15 38:0 38:1 40:0 40:1 40:2 40:3 40:4 40:5
      42:0 42:1 44:0 44:1 44:2 44:3
MOV- 36:0

```

ASRS

3 August 1989 Page 123

Ladder Listing

Processor Address: 000 octal

Rung 44:3

O:002/01 DM1

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

O:002/02 DM2

```

] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
      45:0
(L)- 14:2 40:0 40:1 40:2 44:2
(U)- 14:3 40:3 40:4 40:5 44:3

```

Rung 44:4

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 124

Ladder Listing

Processor Address: 000 octal

Rung 45:0

Rung 45:0

```
| LFM1 LFM2 DM1 DM2
| O:003 O:003 O:002 O:002
+---]/[---]/[---]/[---]/[-----[EOT]--+
| 01 02 01 02
```

O:002/01 DM1

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L) - 14:2 40:0 40:1 40:2 44:2
(U) - 14:3 40:3 40:4 40:5 44:3
```

O:002/02 DM2

```
] / [- 6:16 6:17 6:18 10:0 10:1 10:2 15:0 36:10 36:11 36:12 41:0
45:0
(L) - 14:2 40:0 40:1 40:2 44:2
(U) - 14:3 40:3 40:4 40:5 44:3
```

O:003/01 LFM1

```
] / [- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L) - 14:0 44:0
(U) - 14:1 44:1
```

O:003/02 LFM2

```
] / [- 6:4 6:5 6:6 6:7 15:0 36:1 36:2 36:3 36:4 45:0
(L) - 14:0 44:0
(U) - 14:1 44:1
```

Rung 45:1

```
|
|-----[END OF FILE]-----+
|
```

ASRS

3 August 1989 Page 125

Ladder Listing

Processor Address: 000 octal

Summary

REPORT OPTIONS SUMMARY

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
SFC Display Mode:	NORMAL
Include SFC Cross Reference:	YES
Right Power Rail:	YES
Address Comments:	YES
Symbols:	YES
Rung Comments:	YES
Cross References:	ALL
Starting Rung:	2:0
Ending Rung:	45:32767

APPENDIX C

PUNCH PRESS LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

PUNCH PRESS

Processor Address: 000 octal
3 August 1989 - 15:50

SFC Listing Up=(-,-) Down=(1,0) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|004|

+--++

+

005

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

|010|

+--++

+

011

|

+--++

|012|

+--++

+

013

|

+--++

|014|

+--++

+

015

|

```

+-++
|016|
+-++
+
017
|
+-++
|018|
+-++
+
019
|

```

3 August 1989 Page 3

SFC Listing Up=(0,0) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (1,0)

```

+-++
|020|
+-++
+
021
|
+-++
END

```

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 4

Program File 1

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
002 -----	step	(0,0) - 1
003 -----	transition	(0,0) - 1
004 -----	step	(0,0) - 1
005 -----	transition	(0,0) - 1
006 -----	step	(0,0) - 1
007 -----	transition	(0,0) - 1
008 -----	step	(0,0) - 1
009 -----	transition	(0,0) - 1
010 -----	step	(0,0) - 1
011 -----	transition	(0,0) - 1
012 -----	step	(0,0) - 1
013 -----	transition	(0,0) - 1
014 -----	step	(0,0) - 1
015 -----	transition	(0,0) - 1
016 -----	step	(0,0) - 1
017 -----	transition	(0,0) - 1
018 -----	step	(0,0) - 1
019 -----	transition	(0,0) - 1
020 -----	step	(1,0) - 1
021 -----	transition	(1,0) - 1

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 5

Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 6

Summary

SFC LAYOUT: Quadrants (0,0) - (1,0)

```

+-----+
| (0,0) |
| Pg 02 |
+-----+
| (1,0) |
| Pg 03 |
+-----+

```

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 7

Summary

SEQUENTIAL FUNCTION CHART STATISTICS

```

Start of Program (SOP):          PAGE 2, QUADRANT (0,0)

Number of Rows:                  2
Number of Columns:              1

Total Number of Quadrants:      2

Number of Steps:                10
Number of Transitions:          10
Number of Simultaneous Branches: 0
Number of Selection Branches:   0
Number of Label Definitions:     0
Number of Label References:     0

```

Ladder Listing

Processor Address: 000 octal

3 August 1989 Page 8

Rung 2:0

Rung 2:0

The following rungs are used to turn the conveyor of the punch press ON and OFF.

```

|          PPSW                      PUN_CONVY |
|  I:003                                O:001 |
+----]/[----- (L) -----+
|      10                                06 |

```

```

I:003/10    PPSW
            ] [- 2:1
            ]/[- 2:0

```

```

O:001/06    PUN_CONVY
            ]/[- 3:0
            (L) - 2:0

```

(U)- 2:1

Rung 2:1

```
| PPSW                                PUN_CONVY |
| I:003                                O:001 |
+---] {-----[-----[-----[-----[-----+
| 10                                06 |
```

```
I:003/10    PPSW
              } [- 2:1
              ]/[- 2:0
```

```
O:001/06    PUN_CONVY
              ]/[- 3:0
              (L)- 2:0
              (U)- 2:1
```

Rung 2:2

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 9

Ladder Listing

Processor Address: 000 octal

Rung 3:0

Rung 3:0

```
| PUN_CONVY                                |
| O:001                                |
+---]/[-----[-----[-----[-----[EOT]-+
| 06                                |
```

```
O:001/06    PUN_CONVY
              ]/[- 3:0
              (L)- 2:0
              (U)- 2:1
```

Rung 3:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 10

Ladder Listing

Processor Address: 000 octal

Rung 4:0

Rung 4:0

The rungs are used to move front ram forward.

PFH FFM21 FFM22	FFM11
I:002 O:001 O:001	O:001
+--]/[---]/[---]/[-----+---(L)---+	
12 01 02	00
	FFM12
	O:001
	+---(L)---+
	03

I:002/12 PFH
]/[- 4:0 6:1

O:001/00 FFM11
]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

O:001/01 FFM21
]/[- 4:0 7:0
(L)- 6:0
(U)- 6:1

O:001/02 FFM22
]/[- 4:0 7:0
(L)- 6:0
(U)- 6:1

O:001/03 FFM12
]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

Rung 4:1

PFF	FFM11
I:002	O:001
+--]/[-----+---(U)---+	
11	00
	FFM12
	O:001
	+---(U)---+
	03

I:002/11 PFF
]/[- 4:1 6:0

O:001/00 FFM11

```

]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

```

3 August 1989 Page 11

Ladder Listing Processor Address: 000 octal

Rung 4:1

O:001/03 FFM12

```

]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

```

Rung 4:2

```

|
+-----[END OF FILE]-----+
|

```

3 August 1989 Page 12

Ladder Listing Processor Address: 000 octal

Rung 5:0

Rung 5:0

```

| FFM11 FFM12
| O:001 O:001
+--]/[---]/[-----[EOT]-+
| 00 03
|

```

O:001/00 FFM11

```

]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

```

O:001/03 FFM12

```

]/[- 5:0 6:0
(L)- 4:0
(U)- 4:1

```

Rung 5:1

```

|
+-----[END OF FILE]-----+
|

```

3 August 1989 Page 13

Ladder Listing Processor Address: 000 octal

Rung 6:0

Rung 6:0

The following rungs pull the front ram backward.

PFF	FFM11	FFM12		FFM21	
I:002	O:001	O:001		O:001	
+---]/[---]/[---]/[---]				+---(L)---+	
	11	00	03		01
					FFM22
					O:001
				+---(L)---+	
				02	

I:002/11 PFF
]/[- 4:1 6:0

O:001/00 FFM11
]/[- 5:0 6:0
 (L)- 4:0
 (U)- 4:1

O:001/01 FFM21
]/[- 4:0 7:0
 (L)- 6:0
 (U)- 6:1

O:001/02 FFM22
]/[- 4:0 7:0
 (L)- 6:0
 (U)- 6:1

O:001/03 FFM12
]/[- 5:0 6:0
 (L)- 4:0
 (U)- 4:1

Rung 6:1

PFH		FFM21	
I:002		O:001	
+---]/[---		+---(U)---+	
	12		01
			FFM22
			O:001
		+---(U)---+	
		02	

I:002/12 PFH
]/[- 4:0 6:1

O:001/01 FFM21
]/[- 4:0 7:0

(L)- 6:0

(U)- 6:1

3 August 1989 Page 14

Ladder Listing

Processor Address: 000 octal

Rung 6:1

O:001/02 FFM22

]/[- 4:0 7:0

(L)- 6:0

(U)- 6:1

Rung 6:2

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 15

Ladder Listing

Processor Address: 000 octal

Rung 7:0

Rung 7:0

| FFM21 FFM22

| O:001 O:001

```
+---]/[---]/[-----[EOT]-+
| 01 02
```

O:001/01 FFM21

]/[- 4:0 7:0

(L)- 6:0

(U)- 6:1

O:001/02 FFM22

]/[- 4:0 7:0

(L)- 6:0

(U)- 6:1

Rung 7:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 16

Ladder Listing

Processor Address: 000 octal

Rung 8:0

Rung 8:0

The rungs will cause the side ram to move inward.

SHSW SIM31 SIM32	SIM13	
I:001 O:002 O:002	O:002	
+---]/[---]/[---]/[-----+---(L)---+---		
13 01 02	00	
	SIM23	
	O:002	
	+---(L)---+	
	03	

I:001/13 SHSW
]/[- 8:0 10:1

O:002/00 SIM13
]/[- 9:0 10:0
(L)- 8:0
(U)- 8:1

O:002/01 SIM31
]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

O:002/02 SIM32
]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

O:002/03 SIM23
]/[- 9:0 10:0
(L)- 8:0
(U)- 8:1

Rung 8:1

SISW	SIM13	
I:002	O:002	
+---]/[-----+---(U)---+---		
10	00	
	SIM23	
	O:002	
	+---(U)---+	
	03	

I:002/10 SISW
]/[- 8:1 10:0

O:002/00 SIM13
]/[- 9:0 10:0
(L)- 8:0

(U)- 8:1

3 August 1989 Page 17

Ladder Listing

Processor Address: 000 octal

Rung 8:1

O:002/03 SIM23

]/[- 9:0 10:0

(L)- 8:0

(U)- 8:1

Rung 8:2

```
|
|-----[END OF FILE]-----|
|
```

3 August 1989 Page 18

Ladder Listing

Processor Address: 000 octal

Rung 9:0

Rung 9:0

| SIM13 SIM23

| O:002 O:002

+--]/[---]/[-----[EOT]-+

| 00 03

O:002/00 SIM13

]/[- 9:0 10:0

(L)- 8:0

(U)- 8:1

O:002/03 SIM23

]/[- 9:0 10:0

(L)- 8:0

(U)- 8:1

Rung 9:1

```
|
|-----[END OF FILE]-----|
|
```

3 August 1989 Page 19

Ladder Listing

Processor Address: 000 octal

Rung 10:0

Rung 10:0

The rungs will pull the side ram out to home pos.

	SISW	SIM13	SIM23		SIM31	
	I:002	O:002	O:002		O:002	
+---]/[---]/[---]/[---]					(L)	---+
	10	00	03		01	
					SIM32	
					O:002	
					(L)	---+
					02	

I:002/10 SISW
]/[- 8:1 10:0

O:002/00 SIM13
]/[- 9:0 10:0
 (L)- 8:0
 (U)- 8:1

O:002/01 SIM31
]/[- 8:0 11:0
 (L)- 10:0
 (U)- 10:1

O:002/02 SIM32
]/[- 8:0 11:0
 (L)- 10:0
 (U)- 10:1

O:002/03 SIM23
]/[- 9:0 10:0
 (L)- 8:0
 (U)- 8:1

Rung 10:1

	SHSW		SIM31	
	I:001		O:002	
+---]/[-----]			(U)	---+
	13		01	
			SIM32	
			O:002	
			(U)	---+
			02	

I:001/13 SHSW
]/[- 8:0 10:1

O:002/01 SIM31

]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

3 August 1989 Page 20

Ladder Listing

Processor Address: 000 octal

Rung 10:1

O:002/02 SIM32

]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

Rung 10:2

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 21

Ladder Listing

Processor Address: 000 octal

Rung 11:0

Rung 11:0

```
| SIM31 SIM32
| O:002 O:002
+---]/[---]/[-----[EOT]---+
| 01 02
```

O:002/01 SIM31

]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

O:002/02 SIM32

]/[- 8:0 11:0
(L)- 10:0
(U)- 10:1

Rung 11:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 22

Ladder Listing

Processor Address: 000 octal

Rung 12:0

Rung 12:0

the rung causes the punch to come down.

```
| PDSW PUM41 PUM42                                PDM41 |
| I:001 O:003 O:003                                O:003 |
+--] [---]/[---]/[-----+--( )--+
|   17   05   06                                | 04 |
|                                                    | PDM42 |
|                                                    | O:003 |
|                                                    +--( )--+
|                                                    07 |
```

I:001/17 PDSW
] [- 12:0

O:003/04 PDM41
]/[- 13:0 14:0
 ()- 12:0

O:003/05 PUM41
]/[- 12:0 15:0
 ()- 14:0

O:003/06 PUM42
]/[- 12:0 15:0
 ()- 14:0

O:003/07 PDM42
]/[- 13:0 14:0
 ()- 12:0

Rung 12:1

```
|                                                    |
+-----[END OF FILE]-----+
|                                                    |
```

3 August 1989 Page 23

Ladder Listing

Processor Address: 000 octal

Rung 13:0

Rung 13:0

```
| PDM41 PDM42                                |
| O:003 O:003                                |
+--]/[---]/[-----[EOT]--+
|   04   07                                |
```

O:003/04 PDM41
]/[- 13:0 14:0

()- 12:0

O:003/07 PDM42

] / [- 13:0 14:0

()- 12:0

Rung 13:1

|

+-----[END OF FILE]-----+

|

|

|

3 August 1989 Page 24

Ladder Listing

Processor Address: 000 octal

Rung 14:0

Rung 14:0

This rung will pull the punch up.

| PUSW PDM41 PDM42

PUM41 |

| I:001 O:003 O:003

O:003 |

+--] [---]/[---]/[-----+--()--+

| 16 04 07

| 05 |

|

| PUM42 |

|

| O:003 |

|

+--()--+

|

06 |

I:001/16 PUSW

] [- 14:0

O:003/04 PDM41

] / [- 13:0 14:0

()- 12:0

O:003/05 PUM41

] / [- 12:0 15:0

()- 14:0

O:003/06 PUM42

] / [- 12:0 15:0

()- 14:0

O:003/07 PDM42

] / [- 13:0 14:0

()- 12:0

Rung 14:1

```
|
|-----[END OF FILE]-----+
|
```

3 August 1989 Page 25

Ladder Listing

Processor Address: 000 octal

Rung 15:0

Rung 15:0

```
| PUM41 PUM42
| O:003 O:003
+--]/[---]/[-----[EOT]--+
| 05 06
```

O:003/05 PUM41

```
] / [- 12:0 15:0
( ) - 14:0
```

O:003/06 PUM42

```
] / [- 12:0 15:0
( ) - 14:0
```

Rung 15:1

```
|
|-----[END OF FILE]-----+
|
```

3 August 1989 Page 26

Ladder Listing

Processor Address: 000 octal

Rung 16:0

Rung 16:0

This rung will cause the table to move up.

```
| TUSW TDM31 TDM32
| I:001 O:003 O:003
+--] [---]/[---]/[-----+--( )--+
| 15 01 02
|
| TUM31
| O:003
| TUM32
| O:003
+--( )--+
| 03
```

I:001/15 TUSW

```
] [- 16:0
```

```
O:003/00      TUM31
                ]/[- 17:0 20:0
                ( )- 16:0
```

```
O:003/01      TDM31
                ]/[- 16:0 21:0
                ( )- 20:0
```

```
O:003/02      TDM32
                ]/[- 16:0 21:0
                ( )- 20:0
```

```
O:003/03      TUM32
                ]/[- 17:0 20:0
                ( )- 16:0
```

Rung 16:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 27

Ladder Listing

Processor Address: 000 octal

Rung 17:0

Rung 17:0

```
| TUM31 TUM32
| O:003 O:003
+---]/[---]/[-----[EOT]-+
| 00 03
```

```
O:003/00      TUM31
                ]/[- 17:0 20:0
                ( )- 16:0
```

```
O:003/03      TUM32
                ]/[- 17:0 20:0
                ( )- 16:0
```

Rung 17:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 28

Ladder Listing

Processor Address: 000 octal

Rung 18:0

Rung 18:0

This rung will cause the back ram to move inward.

BFSW BOM41 BOM42	BIM41	
I:001 O:002 O:002	O:002	
+---] [---]/[---]/[-----+---()---+		
10 04 07	05	
	BIM42	
	O:002	
	+---()---+	
	06	

I:001/10	BFSW	]	[- 18:0
O:002/04	BOM41	]/[- 18:0 21:0	() - 20:1
O:002/05	BIM41	]/[- 19:0 20:1	() - 18:0
O:002/06	BIM42	]/[- 19:0 20:1	() - 18:0
O:002/07	BOM42	]/[- 18:0 21:0	() - 20:1

Rung 18:1

+-----[END OF FILE]-----+	

3 August 1989 Page 29

Ladder Listing

Processor Address: 000 octal

Rung 19:0

Rung 19:0

BIM41 BIM42	
O:002 O:002	
+---]/[---]/[-----[EOT]---+	
05 06	

```
O:002/05      BIM41
                ]/[- 19:0 20:1
                ( )- 18:0
```

```
O:002/06      BIM42
                ]/[- 19:0 20:1
                ( )- 18:0
```

Rung 19:1

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 30

Ladder Listing

Processor Address: 000 octal

Rung 20:0

Rung 20:0

This rung will cause the table to move down.

```
| TDSW TUM31 TUM32                                TDM31 |
| I:001 O:003 O:003                                O:003 |
+--] [---]/[---]/[-----+--( )--+
|   14   00   03                                | 01 | |
|                                                    | TDM32 | |
|                                                    | O:003 | |
|                                                    +--( )--+ |
|                                                    02  |
```

```
I:001/14      TDSW
                ] [- 20:0
```

```
O:003/00      TUM31
                ]/[- 17:0 20:0
                ( )- 16:0
```

```
O:003/01      TDM31
                ]/[- 16:0 21:0
                ( )- 20:0
```

```
O:003/02      TDM32
                ]/[- 16:0 21:0
                ( )- 20:0
```

```
O:003/03      TUM32
                ]/[- 17:0 20:0
                ( )- 16:0
```

Rung 20:1

This rung will cause the back to return to home posi.

BHSW BIM41 BIM42	BOM41
I:001 O:002 O:002	O:002
+---] [---]/[---]/[-----+---()---+	
11 05 06	04
	BOM42
	O:002
	+---()---+
	07

I:001/11 BHSW

] [- 20:1

O:002/04 BOM41

] / [- 18:0 21:0
() - 20:1

O:002/05 BIM41

] / [- 19:0 20:1
() - 18:0

O:002/06 BIM42

] / [- 19:0 20:1
() - 18:0

3 August 1989 Page 31

Ladder Listing

Processor Address: 000 octal

Rung 20:1

O:002/07 BOM42

] / [- 18:0 21:0
() - 20:1

Rung 20:2

+-----[END OF FILE]-----+	

3 August 1989 Page 32

Ladder Listing

Processor Address: 000 octal

Rung 21:0

Rung 21:0

TDM31 TDM32 BOM41 BOM42	
O:003 O:003 O:002 O:002	
+---]/[---]/[---]/[---]/[-----[EOT]---+	
01 02 04 07	

O:002/04 BOM41
]/[- 18:0 21:0
 ()- 20:1

O:002/07 BOM42
]/[- 18:0 21:0
 ()- 20:1

O:003/01 TDM31
]/[- 16:0 21:0
 ()- 20:0

O:003/02 TDM32
]/[- 16:0 21:0
 ()- 20:0

Rung 21:1

```

|
+-----[END OF FILE]-----+
|

```

3 August 1989 Page 33

Ladder Listing

Processor Address: 000 octal

Summary

REPORT OPTIONS SUMMARY

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
SFC Display Mode:	NORMAL
Include SFC Cross Reference:	YES
Right Power Rail:	YES
Address Comments:	YES
Symbols:	YES
Rung Comments:	YES
Cross References:	ALL
Starting Rung:	2:0
Ending Rung:	21:32767

APPENDIX D

DRILL PRESS LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

DRILL PRESS

Processor Address: 000 octal
3 August 1989 - 16:11

DRILL PRESS

3 August 1989 Page 2

SFC Listing Up=(-,-) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

|010|

+--++

+

011

|

+--++

END

DRILL PRESS

3 August 1989 Page 3

SFC Listing

Processor Address: 000 octal

Program File 1

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
002	----- step	(0,0) - 1
003	----- transition	(0,0) - 1
006	----- step	(0,0) - 1
007	----- transition	(0,0) - 1
008	----- step	(0,0) - 1

009	-----	transition	(0,0) - 1
010	-----	step	(0,0) - 1
011	-----	transition	(0,0) - 1

DRILL PRESS 3 August 1989 Page 4
 SFC Listing Processor Address: 000 octal Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

DRILL PRESS 3 August 1989 Page 5
 SFC Listing Processor Address: 000 octal Summary

SFC LAYOUT: Quadrants (0,0) - (0,0)

```
+-----+
| (0,0) |
| Pg 02 |
+-----+
```

DRILL PRESS 3 August 1989 Page 6
 SFC Listing Processor Address: 000 octal Summary

SEQUENTIAL FUNCTION CHART STATISTICS

Start of Program (SOP):	PAGE 2, QUADRANT (0,0)
Number of Rows:	1
Number of Columns:	1
Total Number of Quadrants:	1
Number of Steps:	4
Number of Transitions:	4
Number of Simultaneous Branches:	0
Number of Selection Branches:	0
Number of Label Definitions:	0
Number of Label References:	0

Rung 2:0

The rungs will turn the drill conveyor on.

```
| DPPSW                                DPCONV |
| I:000                                O:000 |
+---] / [----- (L) -----+
| 17                                00 |
```

```
I:000/17    DPPSW
              ] [- 2:1 3:0 10:0
              ] / [- 2:0 10:1 11:0
```

```
O:000/00    DPCONV
              ] / [- 3:0
              (L) - 2:0 10:0
              (U) - 2:1 10:1
```

Rung 2:1

```
| DPPSW                                DPCONV |
| I:000                                O:000 |
+---] [----- (U) -----+
| 17                                00 |
```

```
I:000/17    DPPSW
              ] [- 2:1 3:0 10:0
              ] / [- 2:0 10:1 11:0
```

```
O:000/00    DPCONV
              ] / [- 3:0
              (L) - 2:0 10:0
              (U) - 2:1 10:1
```

Rung 2:2

```
|
+----- [END OF FILE] -----+
|
```

3 August 1989 Page 8
Processor Address: 000 octal Rung 3:0

```
I:000/17      DPPSW
                ] [- 2:1 3:0 10:0
                ]/[- 2:0 10:1 11:0
```

```
Rung 3:1
|
+-----[END OF FILE]-----
|
```

NO RUNGS IN FILE 4
NO RUNGS IN FILE 5

Rung 6:0
The following rungs will turn drill motor on and lower the
drill head toward the object.

```
I:000/10      DPHSW
                ] [- 8:2
                ]/[- 6:0 8:1 9:0
```

O:000/02 DRILLM

] / [- 7:0 9:0 11:0
(L) - 6:0 8:0
(U) - 6:1 8:1

Rung 6:1

| DPDSW

DRILLM |

| I:000

O:000 |

+---] / [----- (U) ---+

| 11

02 |

I:000/11 DPDSW

] [- 6:2
] / [- 6:1 7:0 8:0

O:000/02 DRILLM

] / [- 7:0 9:0 11:0
(L) - 6:0 8:0
(U) - 6:1 8:1

Rung 6:2

| DPDSW DPHUM1 DPHUM2

DPHDM1 |

| I:000 O:000 O:000

O:000 |

+---] [---] / [----] / [----- +--- () ---+

| 11 04 07

| 05 | |

|

| DPHDM2 | |

|

| O:000 | |

|

+--- () ---+ |

|

06 |

I:000/11 DPDSW

] [- 6:2
] / [- 6:1 7:0 8:0

O:000/04 DPHUM1

] / [- 6:2 9:0
() - 8:2

O:000/05 DPHDM1

] / [- 7:0 8:2
() - 6:2

DRILL PRESS
Ladder Listing

Processor Address: 000 octal

3 August 1989 Page 11
Rung 6:2

O:000/06 DPHDM2
]/[- 7:0 8:2
 ()- 6:2

O:000/07 DPHUM2
]/[- 6:2 9:0
 ()- 8:2

Rung 6:3

```
|
|-----[END OF FILE]-----+
|
```

DRILL PRESS
Ladder Listing

Processor Address: 000 octal

3 August 1989 Page 12
Rung 7:0

Rung 7:0

```
| DRILLM DPHDM1 DPHDM2 DPDSW |
| O:000 O:000 O:000 I:000 |
+--]/[---]/[---]/[---]/[---[EOT]-+
| 02     05     06     11 |
```

I:000/11 DPDSW
] [- 6:2
]/[- 6:1 7:0 8:0

O:000/02 DRILLM
]/[- 7:0 9:0 11:0
 (L)- 6:0 8:0
 (U)- 6:1 8:1

O:000/05 DPHDM1
]/[- 7:0 8:2
 ()- 6:2

O:000/06 DPHDM2
]/[- 7:0 8:2
 ()- 6:2

Rung 7:1

```
|
+-----[END OF FILE]-----+
|
```

DRILL PRESS

3 August 1989 Page 13

Ladder Listing

Processor Address: 000 octal

Rung 8:0

Rung 8:0

The following rungs will turn drill motor on and raise the
drill head from the object.

```
| DPDSW DRILLM |
| I:000 O:000 |
+---]/[----- (L)---+
| 11 02 |
```

I:000/11 DPDSW

```
] [- 6:2
]/[- 6:1 7:0 8:0
```

O:000/02 DRILLM

```
] /[- 7:0 9:0 11:0
(L)- 6:0 8:0
(U)- 6:1 8:1
```

Rung 8:1

```
| DPHSW DRILLM |
| I:000 O:000 |
+---]/[----- (U)---+
| 10 02 |
```

I:000/10 DPHSW

```
] [- 8:2
]/[- 6:0 8:1 9:0
```

O:000/02 DRILLM

```
] /[- 7:0 9:0 11:0
(L)- 6:0 8:0
(U)- 6:1 8:1
```

Rung 8:2

DPHSW DPHDM1 DPHDM2	DPHUM1	
I:000 O:000 O:000	O:000	
+---] [---]/[---]/[-----+---()---++		
10 05 06	04	
	DPHUM2	
	O:000	
	+---()---+	
	07	

I:000/10 DPHSW
] [- 8:2
]/[- 6:0 8:1 9:0

O:000/04 DPHUM1
]/[- 6:2 9:0
 ()- 8:2

O:000/05 DPHDM1
]/[- 7:0 8:2
 ()- 6:2

DRILL PRESS

3 August 1989 Page 14

Ladder Listing

Processor Address: 000 octal

Rung 8:2

O:000/06 DPHDM2
]/[- 7:0 8:2
 ()- 6:2

O:000/07 DPHUM2
]/[- 6:2 9:0
 ()- 8:2

Rung 8:3

+-----[END OF FILE]-----+	

DRILL PRESS
Ladder Listing

3 August 1989 Page 15
Processor Address: 000 octal

Rung 9:0

```
Rung 9:0
| DPHSW DPHUM1 DPHUM2 DRILLM |
| I:000 O:000 O:000 O:000 |
+---]/[---]/[---]/[---]/[-----[EOT]--+
| 10 04 07 02 |
```

```
I:000/10 DPHSW
          ] [- 8:2
          ]/[- 6:0 8:1 9:0
```

```
O:000/02 DRILLM
          ]/[- 7:0 9:0 11:0
          (L)- 6:0 8:0
          (U)- 6:1 8:1
```

```
O:000/04 DPHUM1
          ]/[- 6:2 9:0
          ( )- 8:2
```

```
O:000/07 DPHUM2
          ]/[- 6:2 9:0
          ( )- 8:2
```

```
Rung 9:1
|
+-----[END OF FILE]-----+
|
```

DRILL PRESS
Ladder Listing

3 August 1989 Page 16
Processor Address: 000 octal

Rung 10:0

Rung 10:0
The rungs will turn the drill conveyor on.

```
| DPPSW DPCONV |
| I:000 O:000 |
+---] [----- (L) ---+
| 17 00 |
```

```

I:000/17      DPPSW
               ] [- 2:1 3:0 10:0
               ]/[- 2:0 10:1 11:0

```

```

O:000/00      DPCONV
               ]/[- 3:0
               (L)- 2:0 10:0
               (U)- 2:1 10:1

```

```

Rung 10:1
| DPPSW
| I:000
+---]/[-----DPCONV |
| 17                                     O:000 |
|                                     (U)---+
|                                     00  |

```

```

I:000/17      DPPSW
               ] [- 2:1 3:0 10:0
               ]/[- 2:0 10:1 11:0

```

```

O:000/00      DPCONV
               ]/[- 3:0
               (L)- 2:0 10:0
               (U)- 2:1 10:1

```

```

Rung 10:2
|
+-----[END OF FILE]-----+
|

```

```

DRILL PRESS
Ladder Listing
Processor Address: 000 octal
3 August 1989  Page 17
Rung 11:0

```

```

Rung 11:0
| DRILLM DPPSW
| O:000 I:000
+---]/[-----[EOT]---+
| 02 17

```

```

I:000/17      DPPSW
               ] [- 2:1 3:0 10:0
               ]/[- 2:0 10:1 11:0

```

O:000/02 DRILLM

]/[- 7:0 9:0 11:0

(L)- 6:0 8:0

(U)- 6:1 8:1

Rung 11:1

|
+-----[END OF FILE]-----+
|

DRILL PRESS

3 August 1989 Page 18

Ladder Listing

Processor Address: 000 octal

Summary

REPORT OPTIONS SUMMARY

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
SFC Display Mode:	NORMAL
Include SFC Cross Reference:	YES
Right Power Rail:	YES
Address Comments:	YES
Symbols:	YES
Rung Comments:	YES
Cross References:	ALL
Starting Rung:	2:0
Ending Rung:	11:32767

APPENDIX E

VERTICAL MILLING LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

VERTICAL MILL

Processor Address: 000 octal
3 August 1989 - 16:03

VERTICAL MILL

3 August 1989 Page 2

SFC Listing Up=(-,-) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|004|

+--++

+

005

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

END

VERTICAL MILL

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 3

Program File 1

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
----------------------------	------------	-------------------------

002	----- step	(0,0) - 1
003	----- transition	(0,0) - 1
004	----- step	(0,0) - 1
005	----- transition	(0,0) - 1
006	----- step	(0,0) - 1
007	----- transition	(0,0) - 1
008	----- step	(0,0) - 1
009	----- transition	(0,0) - 1

VERTICAL MILL

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 4

Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

VERTICAL MILL

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 5

Summary

SFC LAYOUT: Quadrants (0,0) - (0,0)

```
+-----+
| (0,0) |
| Pg 02 |
+-----+
```

VERTICAL MILL

SFC Listing

Processor Address: 000 octal

3 August 1989 Page 6

Summary

SEQUENTIAL FUNCTION CHART STATISTICS

Start of Program (SOP): PAGE 2, QUADRANT (0,0)

Number of Rows: 1

Number of Columns: 1

Total Number of Quadrants: 1

```

Number of Steps:          4
Number of Transitions:    4
Number of Simultaneous Branches: 0
Number of Selection Branches: 0
Number of Label Definitions: 0
Number of Label References: 0

```

VERTICAL MILL
Ladder Listing

Processor Address: 000 octal

3 August 1989 Page 7

Rung 2:0

Rung 2:0

This rung is used to turn on the vetical mill's conveyor.

```

| VPSW                                VP_CONVY |
| I:003                                O:003   |
+--]/[-----+-----+-----+-----+-----+ ( )-----+
| 10                                     02    |

```

```

I:003/10    VPSW
              ] [- 2:1 8:2
              ]/[- 2:0

```

```

O:003/02    VP_CONVY
              ]/[- 3:0 9:0
              ( )- 2:0 8:2

```

Rung 2:1

```

| VPSW                                |
| I:003                                +MOV-----+ |
+--] [-----+-----+-----+-----+-----+ +MOVE +--+
| 10                                     |Source      B3:0| |
|                                     | 0000000000000001| |
|                                     |Dest        B3:1| |
|                                     | 0000000000000000| |
|                                     +-----+ +--+

```

B3:0

```

EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

```

B3:1

```

CLR- 4:1
EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

```

$$\begin{bmatrix} -2 & 1 & 8 & 2 \\ -2 & 0 \end{bmatrix}$$

-----[END OF FILE]-----

Rung 3:0

```

| VP_CONVY
| O:003
+---]/[-----[EOT]---
|      02

```

]/[- 3:0 9:0
()- 2:0 8:2

-----[END OF FILE]-----

Rung 4:0

```

|                                     CHUCK |
| +EQU-----+                       O:004 |
| +--EQUAL          +-----+-----+ (L) +--
| |Source A      B3:0|               00 |
| |  0000000000000001|               |
| |Source B      B3:1|               |
| |  0000000000000000|               |
| +-----+

```

EQU- 4:0

MOV- 2:1
NEQ- 4:2 5:0

B3:1

CLR- 4:1
EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

O:004/00 CHUCK

]/[- 5:0 6:0 6:1
(L)- 4:0
(U)- 4:2

Rung 4:1

CHKSW		
I:003	+CLR-----+	
+--] [-----	+CLEAR	+--+
11	Dest B3:1	
	0000000000000000	
	+-----+	

B3:1

CLR- 4:1
EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

I:003/11 CHKSW

] [- 4:1
]/[- 4:2

Rung 4:2

	CHKSW	CHUCK
+NEQ-----+	I:003	O:004
+--+NOT EQUAL	+--]/[-----	(U) --+
Source A B3:0 11		00
0000000000000001		
Source B B3:1		
0000000000000000		
+-----+		

VERTICAL MILL
Ladder Listing

3 August 1989
Processor Address: 000 octal

Page 10
Rung 4:2

B3:0

EQU- 4:0
MOV- 2:1

NEQ- 4:2 5:0

B3:1

CLR- 4:1
EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

I:003/11 CHKSW

] [- 4:1
]/[- 4:2

O:004/00 CHUCK

]/[- 5:0 6:0 6:1
(L)- 4:0
(U)- 4:2

Rung 4:3

```
|
+-----[END OF FILE]-----+
|
```

VERTICAL MILL
Ladder Listing

3 August 1989 Page 11
Processor Address: 000 octal Rung 5:0

Rung 5:0

```
| CHUCK
| O:004 +NEQ-----+
+--]/[--+NOT EQUAL +-----[EOT]--+
| 00 |Source A B3:0|
| | 0000000000000001|
| |Source B B3:1|
| | 0000000000000000|
| +-----+
```

B3:0

EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

B3:1

CLR- 4:1
EQU- 4:0
MOV- 2:1
NEQ- 4:2 5:0

O:004/00 CHUCK

```

]/[- 5:0 6:0 6:1
(L)- 4:0
(U)- 4:2

```

Rung 5:1

```

|
+-----[END OF FILE]-----+
|

```

VERTICAL MILL
Ladder Listing

3 August 1989 Page 12
Processor Address: 000 octal Rung 6:0

Rung 6:0

```

| CHUCK VHDSW                                VCUT |
| O:004 I:003                                O:004 |
+---]/[---] [-----]------( )--+
|   00   13                                02 |

```

I:003/13 VHDSW

] [- 6:0 6:1

O:004/00 CHUCK

```

]/[- 5:0 6:0 6:1
(L)- 4:0
(U)- 4:2

```

O:004/02 VCUT

```

]/[- 7:0
( )- 6:0 8:0

```

Rung 6:1

```

| CHUCK VHDSW VHMU1 VHMU2                                VHMD1 |
| O:004 I:003 O:003 O:003                                O:003 |
+---]/[---] [---]/[---]/[-----]------( )--+
|   00   13   04   07                                | 05 | |
|                                                         | VHMD2 | |
|                                                         | O:003 | |
|                                                         +---( )--+ |
|                                                         06 | |

```

I:003/13 VHDSW

] [- 6:0 6:1

O:003/04 VHMU1

```

]/[- 6:1 9:0
( )- 8:1

```

```

O:003/05    VHMD1
              ]/[- 7:0 8:1
              ( )- 6:1

O:003/06    VHMD2
              ]/[- 7:0 8:1
              ( )- 6:1

O:003/07    VHMU2
              ]/[- 6:1 9:0
              ( )- 8:1

O:004/00    CHUCK
              ]/[- 5:0 6:0 6:1
              (L)- 4:0
              (U)- 4:2

```

Rung 6:2

```

|
+-----[END OF FILE]-----+
|

```

VERTICAL MILL
Ladder Listing

3 August 1989 Page 13
Processor Address: 000 octal Rung 7:0

Rung 7:0

```

| VHMD1 VHMD2 VCUT
| O:003 O:003 O:004
+--]/[---]/[---]/[-----[EOT]-+
| 05 06 02

```

```

O:003/05    VHMD1
              ]/[- 7:0 8:1
              ( )- 6:1

```

```

O:003/06    VHMD2
              ]/[- 7:0 8:1
              ( )- 6:1

```

```

O:004/02    VCUT
              ]/[- 7:0
              ( )- 6:0 8:0

```

Rung 7:1

```

|

```

```

+-----[END OF FILE]-----+
|
|

```

VERTICAL MILL
Ladder Listing

3 August 1989 Page 14
Processor Address: 000 octal Rung 8:0

Rung 8:0

```

| VHHSW
| I:003
+---] [-----+-----+-----+
| 12
|
|

```

```

VCUT |
O:004 |
( )--+
02 |

```

```

I:003/12    VHHSW
              ] [- 8:0 8:1
              ]/[- 8:2

```

```

O:004/02    VCUT
              ]/[- 7:0
              ( )- 6:0 8:0

```

Rung 8:1

This rung is used to bring the vertical head to home position.

```

| VHHSW VHMD1 VHMD2
| I:003 O:003 O:003
+---] [---]/[---]/[-----+-----+-----+
| 12 05 06
|
|
|
|
|
|

```

```

VHMU1 |
O:003 |
+---( )--+
| 04 | |
| VHMU2 | |
| O:003 | |
+---( )--+
07 |

```

```

I:003/12    VHHSW
              ] [- 8:0 8:1
              ]/[- 8:2

```

```

O:003/04    VHMU1
              ]/[- 6:1 9:0
              ( )- 8:1

```

```

O:003/05    VHMD1
              ]/[- 7:0 8:1
              ( )- 6:1

```

```

O:003/06    VHMD2
              ]/[- 7:0 8:1
              ( )- 6:1

```

O:003/07 VHMU2

]/[- 6:1 9:0
()- 8:1

Rung 8:2

This rung is used to turn on the vetical mill's conveyer.

```
| VHHSW  VPSW                                VP_CONVY |
| I:003 I:003                                O:003  |
+---]/[---] [-----]-----+ ( )-----+
|    12    10                                02    |
```

I:003/10 VPSW

] [- 2:1 8:2
]/[- 2:0

VERTICAL MILL

3 August 1989 Page 15

Ladder Listing

Processor Address: 000 octal

Rung 8:2

I:003/12 VHHSW

] [- 8:0 8:1
]/[- 8:2

O:003/02 VP_CONVY

]/[- 3:0 9:0
()- 2:0 8:2

Rung 8:3

```
|
|-----[END OF FILE]-----+
|
```

VERTICAL MILL

3 August 1989 Page 16

Ladder Listing

Processor Address: 000 octal

Rung 9:0

Rung 9:0

```
| VHMU1 VHMU2 VP_CONVY                                |
| O:003 O:003 O:003                                |
+---]/[---]/[---]/[-----]-----+ [EOT]-+
|    04    07    02                                |
```

O:003/02 VP_CONVY

]/[- 3:0 9:0

()- 2:0 8:2

O:003/04 VHMU1

]/[- 6:1 9:0

()- 8:1

O:003/07 VHMU2

]/[- 6:1 9:0

()- 8:1

Rung 9:1

```
|
+-----[END OF FILE]-----+
|
```

VERTICAL MILL

3 August 1989 Page 17

Ladder Listing

Processor Address: 000 octal

Summary

REPORT OPTIONS SUMMARY

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
SFC Display Mode:	NORMAL
Include SFC Cross Reference:	YES
Right Power Rail:	YES
Address Comments:	YES
Symbols:	YES
Rung Comments:	YES
Cross References:	ALL
Starting Rung:	2:0
Ending Rung:	9:32767

APPENDIX F

HORIZONTAL MILLING LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

HORIZONTAL MILL

Processor Address: 000 octal
3 August 1989 - 16:16

HORIZONTAL MILL

3 August 1989 Page 2

SFC Listing Up=(-,-) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|004|

+--++

+

005

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

|010|

+--++

+

011

|

+--++

END

HORIZONTAL MILL

3 August 1989 Page 3

SFC Listing

Processor Address: 000 octal

Program File 1

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
----------------------------	------------	-------------------------

002	----- step	(0,0) - 1
003	----- transition	(0,0) - 1
004	----- step	(0,0) - 1
005	----- transition	(0,0) - 1
006	----- step	(0,0) - 1
007	----- transition	(0,0) - 1
008	----- step	(0,0) - 1
009	----- transition	(0,0) - 1
010	----- step	(0,0) - 1
011	----- transition	(0,0) - 1

HORIZONTAL MILL

3 August 1989 Page 4

SFC Listing

Processor Address: 000 octal

Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

HORIZONTAL MILL

3 August 1989 Page 5

SFC Listing

Processor Address: 000 octal

Summary

SFC LAYOUT: Quadrants (0,0) - (0,0)

+-----+
| (0,0) |
| Pg 02 |
+-----+

HORIZONTAL MILL

3 August 1989 Page 6

SFC Listing

Processor Address: 000 octal

Summary

SEQUENTIAL FUNCTION CHART STATISTICS

Start of Program (SOP): PAGE 2, QUADRANT (0,0)

Number of Rows: 1

Number of Columns: 1

Total Number of Quadrants:	1
Number of Steps:	5
Number of Transitions:	5
Number of Simultaneous Branches:	0
Number of Selection Branches:	0
Number of Label Definitions:	0
Number of Label References:	0

HORIZONTAL MILL

3 August 1989 Page 7

Ladder Listing

Processor Address: 000 octal

Rung 2:0

Rung 2:0

The rungs are used to turn the horizontal mill conveyor on.

HMPSW	HMCON
I:000	O:001
+-+]/[-----	(L) --+
17	00

I:000/17	HMPSW	
	] [- 2:1 3:0	
	]/[- 2:0	

O:001/00	HMCON	
	]/[- 3:0 11:0	
	(L)- 2:0 10:1	
	(U)- 2:1 10:2	

Rung 2:1

HMPSW	HMCON
I:000	O:001
+-+]/[-----	(U) --+
17	00

I:000/17	HMPSW	
	] [- 2:1 3:0	
	]/[- 2:0	

O:001/00	HMCON	
	]/[- 3:0 11:0	
	(L)- 2:0 10:1	
	(U)- 2:1 10:2	

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 8

Processor Address: 000 octal

Rung 3:0

```

| HMC0N HMP5W |
| O:001 I:000 |
+--]/[---] [-----[EOT]-+
| 00 17 |

```

$$\frac{\begin{bmatrix} -2 & 1 & 3 \\ 0 & 0 & 0 \end{bmatrix}}{\begin{bmatrix} -2 & 0 & 0 \end{bmatrix}}$$

```
]/[- 3:0 11:0
(L)- 2:0 10:1
(U)- 2:1 10:2
```

```
|
+-----[END OF FILE]-----+
|
```

3 August 1989 Page 9

Processor Address: 000 octal

Rung 4:0

This rung will move the horizontal mill head down.

```

| HHDSW HMHUM1 HMHUM2                                HMHDM1 |
| I:000 O:000 O:000                                O:000 |
+--| [---]/[---]/[-----]-----+--( )--+
|    10    00    03                                | 01 |
|                                                    | HMHDM2 |
|                                                    | O:000 |
|                                                    +--( )--+
|                                                    02 |

```

] [- 4:0

```

O:000/00      HMMUM1
                ]/[- 4:0 11:0
                ( )- 10:0

```

```

O:000/01      HMHDM1
                ]/[- 5:0 10:0
                ( )- 4:0

```

```

O:000/02      HMHDM2
                ]/[- 5:0 10:0
                ( )- 4:0

```

```

O:000/03      HMMUM2
                ]/[- 4:0 11:0
                ( )- 10:0

```

Rung 4:1

```

|
+-----[END OF FILE]-----+
|

```

HORIZONTAL MILL
Ladder Listing

3 August 1989 Page 10
Processor Address: 000 octal Rung 5:0

Rung 5:0

```

| HMMHDM1 HMMHDM2
| O:000 O:000
+--]/[---]/[-----[EOT]--+
| 01 02

```

```

O:000/01      HMHDM1
                ]/[- 5:0 10:0
                ( )- 4:0

```

```

O:000/02      HMHDM2
                ]/[- 5:0 10:0
                ( )- 4:0

```

Rung 5:1

```

|
+-----[END OF FILE]-----+
|

```

HORIZONTAL MILL
Ladder Listing

3 August 1989 Page 11
Processor Address: 000 octal Rung 6:0

Rung 6:0

The rungs will turn the horizontal cutter on and move the head out.

HMHOSW HHINM1 HHINM2	HHOM1	
I:000 O:000 O:000	O:000	
+--] [----]/[----]/[-----+--()--+		
12 05 06	04	
	HHOM2	
	O:000	
	+--()--+	
	07	

I:000/12 HMHOSW
] [- 6:0 6:1
]/[- 6:2 7:0

O:000/04 HHOM1
]/[- 7:0 8:0
 ()- 6:0

O:000/05 HHINM1
]/[- 6:0 9:0
 ()- 8:0

O:000/06 HHINM2
]/[- 6:0 9:0
 ()- 8:0

O:000/07 HHOM2
]/[- 7:0 8:0
 ()- 6:0

Rung 6:1

HMHOSW	HCUT	
I:000	O:001	
+--] [-----+--(L)--+		
12	02	

I:000/12 HMHOSW
] [- 6:0 6:1
]/[- 6:2 7:0

O:001/02 HCUT
]/[- 7:0 9:0
 (L)- 6:1 8:1
 (U)- 6:2 8:2

```

Rung 6:2
| HMHOSW                                     HCUT |
| I:000                                     O:001 |
+---]/[----- (U)---+
| 12                                     02 |

```

```

I:000/12    HMHOSW
              ] [- 6:0 6:1
              ]/[- 6:2 7:0

```

```

HORIZONTAL MILL                               3 August 1989   Page 12
Ladder Listing                               Processor Address: 000 octal   Rung 6:2

```

```

O:001/02    HCUT
              ]/[- 7:0 9:0
              (L)- 6:1 8:1
              (U)- 6:2 8:2

```

```

Rung 6:3
|
+-----[END OF FILE]-----+
|

```

```

HORIZONTAL MILL                               3 August 1989   Page 13
Ladder Listing                               Processor Address: 000 octal   Rung 7:0

```

```

Rung 7:0
| HHOM1 HHOM2 HCUT HMHOSW |
| O:000 O:000 O:001 I:000 |
+---]/[---]/[---]/[---]/[-----[EOT]---+
| 04 07 02 12 |

```

```

I:000/12    HMHOSW
              ] [- 6:0 6:1
              ]/[- 6:2 7:0

```

```

O:000/04    HHOM1
              ]/[- 7:0 8:0
              ( )- 6:0

```

```

O:000/07    HHOM2
              ]/[- 7:0 8:0
              ( )- 6:0

```

```

O:001/02    HCUT
              ]/[- 7:0 9:0
              (L)- 6:1 8:1

```

(U)- 6:2 8:2

Rung 7:1

```
|
|-----[END OF FILE]-----+
|
```

HORIZONTAL MILL

3 August 1989 Page 14

Ladder Listing

Processor Address: 000 octal

Rung 8:0

Rung 8:0

The rungs will move the horizontal head in and have the cutter on at the same time.

```
| HHINSW HHOM1 HHOM2                                HHINM1 |
| I:000 O:000 O:000                                O:000 |
+--] [----]/[---]/[-----+--( )---+
|   13    04    07                                | 05 | |
|                                                    | HHINM2 | |
|                                                    | O:000 | |
|                                                    +--( )---+ |
|                                                    06 |
```

I:000/13 HHINSW

```
] [- 8:0 8:1
]/[- 8:2 9:0
```

O:000/04 HHOM1

```
] /[- 7:0 8:0
( )- 6:0
```

O:000/05 HHINM1

```
] /[- 6:0 9:0
( )- 8:0
```

O:000/06 HHINM2

```
] /[- 6:0 9:0
( )- 8:0
```

O:000/07 HHOM2

```
] /[- 7:0 8:0
( )- 6:0
```

Rung 8:1

```
| HHINSW                                HCUT |
| I:000                                O:001 |
+--] [-----+--(L)---+
```

02 |

```
I:000/13      HHINSW
                ] [- 8:0 8:1
                ]/[- 8:2 9:0
```

```
O:001/02      HCUT
                ]/[- 7:0 9:0
                (L)- 6:1 8:1
                (U)- 6:2 8:2
```

Rung 8:2

```

| HHINSW | HCUT |
| I:000 | O:001 |
+---+ / {----- (U) -----+
| 13 | 02 |

```

```

HORIZONTAL MILL                                3 August 1989    Page 15
Ladder Listing                                Processor Address: 000 octal          Rung 8:2

```

```
I:000/13      HHINSW
                ] [- 8:0 8:1
                ]/[- 8:2 9:0
```

O:001/02 HCUT

]/[- 7:0 9:0
 (L)- 6:1 8:1
 (U)- 6:2 8:2

Rung 8:3

```

|
+-----[END OF FILE]-----+
|

```

```

HORIZONTAL MILL                                3 August 1989   Page 16
Ladder Listing                                Processor Address: 000 octal          Rung 9:0

```

Rung 9:0

```

| HHINM1 HHINM2 HCUT HHINSW                                     |
| O:000 O:000 O:001 I:000                                       |
+--]/[---]/[---]/[---]/[-----]-----[EOT]--+
|      05      06      02      13

```

```
I:000/13      HHINSW
                ] [- 8:0 8:1
                ]/[- 8:2 9:0
```

```
O:000/05      HHINM1
                ]/[- 6:0 9:0
                ( )- 8:0
```

```
O:000/06      HHINM2
                ]/[- 6:0 9:0
                ( )- 8:0
```

```
O:001/02      HCUT
                ]/[- 7:0 9:0
                (L)- 6:1 8:1
                (U)- 6:2 8:2
```

Rung 9:1

```
|
+-----[END OF FILE]-----+
|
```

HORIZONTAL MILL
Ladder Listing

3 August 1989 Page 17
Processor Address: 000 octal Rung 10:0

Rung 10:0

The rung is used to raise the horizontal head back to home position.

```
| HHSW HMHDM1 HMHDM2                      HMHUM1 |
| I:000 O:000 O:000                      O:000  |
+---] [---]/[---]/[-----+---( )---+
| 11 01 02                               | 00 | |
|                                         | HMHUM2 | |
|                                         | O:000  | |
|                                         +---( )---+ |
|                                         03  |
```

```
I:000/11      HHSW
                ] [- 10:0 10:1
                ]/[- 10:2 11:0
```

```
O:000/00      HMHUM1
                ]/[- 4:0 11:0
                ( )- 10:0
```

```
O:000/01      HMHDM1
                ]/[- 5:0 10:0
                ( )- 4:0
```

```
O:000/02      HMHDM2
                ]/[- 5:0 10:0
```

()- 4:0

O:000/03 HMHUM2

]/[- 4:0 11:0

()- 10:0

Rung 10:1

The rungs are used to turn the horizontal mill conveyor on.

| HHHSW

HMCON |

| I:000

O:001 |

+--] [----- (L) --+

| 11

00 |

I:000/11 HHHSW

] [- 10:0 10:1

]/[- 10:2 11:0

O:001/00 HMCON

]/[- 3:0 11:0

(L)- 2:0 10:1

(U)- 2:1 10:2

Rung 10:2

| HHHSW

HMCON |

| I:000

O:001 |

+--] [----- (U) --+

| 11

00 |

HORIZONTAL MILL

3 August 1989 Page 18

Ladder Listing

Processor Address: 000 octal

Rung 10:2

I:000/11 HHHSW

] [- 10:0 10:1

]/[- 10:2 11:0

O:001/00 HMCON

]/[- 3:0 11:0

(L)- 2:0 10:1

(U)- 2:1 10:2

Rung 10:3

|

|

+-----[END OF FILE]-----+

|

|

Rung 11:0

```

| HMMHUM1 HMMHUM2 HMCON HHHSW |
| O:000 O:000 O:001 I:000 |
+---]/[----]/[----]/[---]/[-----[EOT]-+
| 00 03 00 11 |

```

I:000/11 HHHSW

```

] [- 10:0 10:1
]/[- 10:2 11:0

```

O:000/00 HMMHUM1

```

]/[- 4:0 11:0
( ) - 10:0

```

O:000/03 HMMHUM2

```

]/[- 4:0 11:0
( ) - 10:0

```

O:001/00 HMCON

```

]/[- 3:0 11:0
(L) - 2:0 10:1
(U) - 2:1 10:2

```

Rung 11:1

```

|
+-----[END OF FILE]-----+
|

```

REPORT OPTIONS SUMMARY

Page Width:	80
Page Length:	66
Graphics Capabilities:	NO
SFC Display Mode:	NORMAL
Include SFC Cross Reference:	YES
Right Power Rail:	YES
Address Comments:	YES
Symbols:	YES
Rung Comments:	YES
Cross References:	ALL
Starting Rung:	2:0
Ending Rung:	11:32767

APPENDIX G

2-AXIS ROBOT LADDER PROGRAM

Allen-Bradley Co.
6200 Series Software
PLC-5 Programming Terminal Software
Release 2.22
Program Listing

ASSEMBLE

Processor Address: 000 octal
3 August 1989 - 15:41

ASSEMBLE

3 August 1989 Page 2

SFC Listing Up=(-,-) Down=(-,-) Left=(-,-) Right=(-,-) Quadrant (0,0)

START

+--++

+==+

#002#

+==+

+

003

|

+--++

|004|

+--++

+

005

|

+--++

|006|

+--++

+

007

|

+--++

|008|

+--++

+

009

|

+--++

|010|

+--++

+

011

|

+--++

|012|

+--++

+

013

|

+--++

|014|

+--++

+

015

|

+--++

END

ASSEMBLE
SFC Listing

Processor Address: 000 octal

3 August 1989 Page 3
Program File 1

PROGRAM FILE CROSS REFERENCE

Program File Number & Name	File Usage	Quadrant - Number Found
002 -----	step	(0,0) - 1
003 -----	transition	(0,0) - 1
004 -----	step	(0,0) - 1
005 -----	transition	(0,0) - 1
006 -----	step	(0,0) - 1
007 -----	transition	(0,0) - 1
008 -----	step	(0,0) - 1
009 -----	transition	(0,0) - 1
010 -----	step	(0,0) - 1
011 -----	transition	(0,0) - 1
012 -----	step	(0,0) - 1
013 -----	transition	(0,0) - 1
014 -----	step	(0,0) - 1
015 -----	transition	(0,0) - 1

ASSEMBLE
SFC Listing

Processor Address: 000 octal

3 August 1989 Page 4
Program File 1

LABEL CROSS REFERENCE

Label Number	Definition	Quadrants Referenced In
--------------	------------	-------------------------

** NO LABEL DEFINITIONS OR REFERENCES EXIST TO CROSS REFERENCE **

ASSEMBLE
SFC Listing

Processor Address: 000 octal

3 August 1989 Page 5
Summary

SFC LAYOUT: Quadrants (0,0) - (0,0)

+-----+
| (0,0) |
| Pg 02 |
+-----+

SEQUENTIAL FUNCTION CHART STATISTICS

Start of Program (SOP):	PAGE 2, QUADRANT (0,0)
Number of Rows:	1
Number of Columns:	1
Total Number of Quadrants:	1
Number of Steps:	7
Number of Transitions:	7
Number of Simultaneous Branches:	0
Number of Selection Branches:	0
Number of Label Definitions:	0
Number of Label References:	0

Rung 2:0

The following 2 rungs are used to turn the conveyor on until the infrared switch is on.

AIRS	ASB_CON
I:000	O:001
+---]/[------(L)---+	
16	00

I:000/16 AIRS
] [- 2:1 2:2 3:0 14:0
]/[- 2:0

O:001/00 ASB_CON
]/[- 3:0 15:0
 ()- 14:0
 (L)- 2:0
 (U)- 2:1

```

Rung 2:1
|  AIRS                                     ASB_CON |
|  I:000                                   O:001  |
+--] [----- (U)-----+
|    16                                     00  |

```

```

I:000/16      AIRS
               ] [- 2:1 2:2 3:0 14:0
               ]/[- 2:0

```

```

O:001/00      ASB_CON
               ]/[- 3:0 15:0
               ( )- 14:0
               (L)- 2:0
               (U)- 2:1

```

Rung 2:2

The following 2 rungs are used to turn the robot to tray 3 and to lower the robot head (the electromagnet lift).

```

|  AIRS TRAY3 RPBM1 RPBM2                 RPUM1  |
|  I:000 I:000 O:000 O:000                 O:000  |
+--] [---] [---]/[---]/[----- ( )-----+
|    16    15    05    06                 | 04  |
|                                           | RPUM2 |
|                                           | O:000 |
|                                           +-- ( )--+
|                                           07  |

```

```

I:000/15      TRAY3
               ] [- 2:2
               ]/[- 2:3

```

```

I:000/16      AIRS
               ] [- 2:1 2:2 3:0 14:0
               ]/[- 2:0

```

```

ASSEMBLE                                           3 August 1989   Page 8
Ladder Listing                                   Processor Address: 000 octal   Rung 2:2

```

```

O:000/04      RPUM1
               ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
               ( )- 2:2 6:1 10:1

```

```

O:000/05      RPBM1
               ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
               ( )- 4:0 8:0 12:0

```

```

O:000/06      RPBM2
                ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
                ( )- 4:0 8:0 12:0

```

```

O:000/07      RPUM2
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1

```

Rung 2:3

TRAY3 RHDSW RHUM1 RHUM2		RHDM1	
I:000 I:000 O:000 O:000		O:000	
+---]/[---] [---]/[---]/[-----+---()---++			
15 12 00 03		01	
		RHDM2	
		O:000	
		+---()---+	
		02	

```

I:000/12      RHDSW
                ] [- 2:3 6:0 10:0

```

```

I:000/15      TRAY3
                ] [- 2:2
                ]/[- 2:3

```

```

O:000/00      RHUM1
                ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
                ( )- 4:1 8:1 12:1

```

```

O:000/01      RHDM1
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0

```

```

O:000/02      RHDM2
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0

```

```

O:000/03      RHUM2
                ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
                ( )- 4:1 8:1 12:1

```

Rung 2:4

+-----[END OF FILE]-----+		

ASSEMBLE

3 August 1989 Page 9

Ladder Listing

Processor Address: 000 octal

Rung 3:0

```
Rung 3:0
| ASB_CON  AIRS  RPUM1  RPUM2  RHDM1  RHDM2          |
| O:001  I:000  O:000  O:000  O:000  O:000          |
+---]/[----] [---]/[---]/[---]/[---]/[-----] [EOT]-+
|      00      16      04      07      01      02          |
```

```
I:000/16      AIRS
                ] [- 2:1 2:2 3:0 14:0
                ]/[- 2:0

O:000/01      RHDM1
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0

O:000/02      RHDM2
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0

O:000/04      RPUM1
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1

O:000/07      RPUM2
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1

O:001/00      ASB_CON
                ]/[- 3:0 15:0
                ( )- 14:0
                (L)- 2:0
                (U)- 2:1
```

Rung 3:1

```
|
+-----[END OF FILE]-----+
|
```

Rung 4:0

The following rungs are used to pick up a washer in tray 3, to move the lift back up to the home position, to rotate the robot arm back to home position, and to drop the washer to the reciving cylinder.

RHHSW RH_SW RPUM1 RPUM2	RPBM1	
I:000 I:000 O:000 O:000	O:000	
+---]/[---] [---]/[---]/[-----+---()---+---		
13 11 04 07	05	
	RPBM2	
	O:000	
	+---()---+	
	06	

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0
  
```

```

I:000/13    RHHSW
              ] [- 4:1 8:1 12:1
              ]/[- 4:0 8:0 12:0
  
```

```

O:000/04    RPUM1
              ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
              ( )- 2:2 6:1 10:1
  
```

```

O:000/05    RPBM1
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0
  
```

```

O:000/06    RPBM2
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0
  
```

```

O:000/07    RPUM2
              ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
              ( )- 2:2 6:1 10:1
  
```

```

| RHHSW RHDM1 RHDM2                                RHUM1 |
| I:000 O:000 O:000                                O:000 |
+--| [---]/[---]/[-----]-----+--( )--+--+
|    13    01    02                                | 00 | |
|                                                    | RHUM2 | |
|                                                    | O:000 | |
|                                                    +--( )--+ |
|                                                    03

```

```
O:000/00      RHUM1
                }/[- 2:3 5:0 6:0 9:0 10:0 13:0
                ( )- 4:1 8:1 12:1
```

```
O:000/01      RHDM1
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0
```

```
O:000/02      RHDM2
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0
```

```
O:000/03      RHUM2
                ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
                ( )- 4:1 8:1 12:1
```

```

| RH_SW | ELEMG |
| I:000 | O:001 |
+---]/[------(U)---+
| 11 | 02 |

```

```

I:000/11      RH_SW      ] [- 4:0 4:3 8:0 8:3 12:0 12:3
                        ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

```

```

0:001/02      ELEMG
                ]/[- 5:0 9:0 13:0
                (L)- 4:3 8:3 12:3
                (U)- 4:2 8:2 12:2

```

```

Rung 4:3
| RH_SW                                ELEMG |
| I:000                                O:001 |
+---] [------(L)---+
| 11                                    02 |

```

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

```

```

O:001/02    ELEMG
              ]/[- 5:0 9:0 13:0
              (L)- 4:3 8:3 12:3
              (U)- 4:2 8:2 12:2

```

```

Rung 4:4
|
+-----[END OF FILE]-----+
|

```

```

ASSEMBLE                      3 August 1989   Page 12
Ladder Listing                 Processor Address: 000 octal   Rung 5:0

```

```

Rung 5:0
| RPBM2 RPBM1 RHUM2 RHUM1 RH_SW ELEMG      |
| O:000 O:000 O:000 O:000 I:000 O:001      |
+---]/[---]/[---]/[---]/[---]/[---]/[-----[EOT]---+
| 06 05 03 00 11 02                        |

```

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

```

```

O:000/00    RHUM1
              ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
              ( )- 4:1 8:1 12:1

```

```

O:000/03    RHUM2
              ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
              ( )- 4:1 8:1 12:1

```

```

O:000/05    RPBM1
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0

```

```

O:000/06    RPBM2
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0

```

ELEMG

```
] / [- 5:0 9:0 13:0
```

(L)- 4:3 8:3 12:3

(U) - 4:2 8:2 12:2

Rung 5:1

-----[END OF FILE]-----

ASSEMBLE

3 August 1989 Page 13

Ladder Listing

Processor Address: 000 octal

Rung 6:0

Rung 6:0

[illegible]

I:000/12 RHDSW

$$] \ [-2:3 \ 6:0 \ 10:0$$

I:000/14 TRAY2

] [- 6:1

$$\} / [- 6:0$$

0:000/00 RHUM1

```
] / [- 2:3 5:0 6:0 9:0 10:0 13:0
```

()- 4:1 8:1 12:1

O:000/01 RHDM1

```
]/[- 3:0 4:1 7:0 8:1 11:0 12:1
```

()- 2:3 6:0 10:0

0:000/02 RHDM2

$$]/[-\ 3:0\ 4:1\ 7:0\ 8:1\ 11:0\ 12:1$$

()- 2:3 6:0 10:0

0:000/03 RHUM2

1/[- 2:3 5:0 6:0 9:0 10:0 13:0

() - 4:1 8:1 12:1

Rung 6:1

The following 2 rungs are used to turn the robot to the respective tray 2 and to lower the robot head (the electromagnet lift).

```

| TRAY2 RPBM1 RPBM2                                RPUM1  |
| I:000 O:000 O:000                                O:000  |
+---] [---]/[---]/[-----+---( )---+
|   14   05   06                                | 04 | |
|                                                | RPUM2 | |
|                                                | O:000 | |
|                                                +---( )---+
|                                                07  |

```

I:000/14 TRAY2

```

] [- 6:1
]/[- 6:0

```

O:000/04 RPUM1

```

]/[- 3:0 4:0 7:0 8:0 11:0 12:0
( )- 2:2 6:1 10:1

```

ASSEMBLE

3 August 1989 Page 14

Ladder Listing

Processor Address: 000 octal

Rung 6:1

O:000/05 RPBM1

```

]/[- 2:2 5:0 6:1 9:0 10:1 13:0
( )- 4:0 8:0 12:0

```

O:000/06 RPBM2

```

]/[- 2:2 5:0 6:1 9:0 10:1 13:0
( )- 4:0 8:0 12:0

```

O:000/07 RPUM2

```

]/[- 3:0 4:0 7:0 8:0 11:0 12:0
( )- 2:2 6:1 10:1

```

Rung 6:2

```

|
+-----[END OF FILE]-----+
|

```

ASSEMBLE

3 August 1989 Page 15

Ladder Listing

Processor Address: 000 octal

Rung 7:0

Rung 7:0

```

| RPUM1 RPUM2 RHDM1 RHDM2                                |
| O:000 O:000 O:000 O:000                                |
+---]/[---]/[---]/[---]/[-----[EOT]---+
|   04   07   01   02                                |

```

```
O:000/01    RHDM1
              ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
              ( )- 2:3 6:0 10:0
```

```
O:000/02    RHDM2
              ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
              ( )- 2:3 6:0 10:0
```

```
O:000/04    RPUM1
              ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
              ( )- 2:2 6:1 10:1
```

```
O:000/07    RPUM2
              ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
              ( )- 2:2 6:1 10:1
```

Rung 7:1

```
|
+-----[END OF FILE]-----+
|
```

ASSEMBLE

3 August 1989 Page 16

Ladder Listing

Processor Address: 000 octal

Rung 8:0

Rung 8:0

The following rungs are used to pick up a washer in tray 2, to move the lift back up to the home position, to rotate the robot arm back to home position, and to drop the washer to the reciving cylinder.

```
| RHHSW RH_SW RPUM1 RPUM2                                RPBM1 |
| I:000 I:000 O:000 O:000                                O:000 |
+---]/[---] [---]/[---]/[-----+---( )---+
|   13   11   04   07                                | 05 | |
|                                                         | RPBM2 | |
|                                                         | O:000 | |
|                                                         +---( )---+
|                                                         06  |
```

```
I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0
```

```
I:000/13    RHHSW
              ] [- 4:1 8:1 12:1
              ]/[- 4:0 8:0 12:0
```

```
O:000/07      RPU2
```

```

| RHHSW RHDM1 RHDM2                                RHUM1 |
| I:000 O:000 O:000                                O:000 |
+--| [---]/[---]/[-----]-----+--( )--+--+
|   13    01    02                                | 00 |
|                                                    | RHUM2 |
|                                                    | O:000 |
|                                                    +--( )--+
|                                                    03

```

```
O:000/00      RHUM1

                ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
                { }- 4:1 8:1 12:1
```

```

Rung 8:2
| RH_SW                                     ELEMG |
| I:000                                     O:001 |
+---]/[----- (U) ---+
| 11                                     02 |

```

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

```

```

O:001/02    ELEMG
              ]/[- 5:0 9:0 13:0
              (L)- 4:3 8:3 12:3
              (U)- 4:2 8:2 12:2

```

```

Rung 8:3
| RH_SW                                     ELEMG |
| I:000                                     O:001 |
+---] [----- (L) ---+
| 11                                     02 |

```

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

```

```

O:001/02    ELEMG
              ]/[- 5:0 9:0 13:0
              (L)- 4:3 8:3 12:3
              (U)- 4:2 8:2 12:2

```

```

Rung 8:4
|
+-----[END OF FILE]-----+
|

```

```

ASSEMBLE                      3 August 1989   Page 18
Ladder Listing                 Processor Address: 000 octal   Rung 9:0

```

```

Rung 9:0
| ELEMG RH_SW RHUM1 RHUM2 RPB2 RPB1 |
| O:001 I:000 O:000 O:000 O:000 O:000 |
+---]/[---]/[---]/[---]/[---]/[---]/[-----[EOT]---+
| 02 11 00 03 06 05 |

```

```

I:000/11    RH_SW
              ] [- 4:0 4:3 8:0 8:3 12:0 12:3
              ]/[- 4:2 5:0 8:2 9:0 12:2 13:0

O:000/00    RHUM1
              ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
              ( )- 4:1 8:1 12:1

O:000/03    RHUM2
              ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
              ( )- 4:1 8:1 12:1

O:000/05    RPBM1
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0

O:000/06    RPBM2
              ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
              ( )- 4:0 8:0 12:0

O:001/02    ELEMG
              ]/[- 5:0 9:0 13:0
              (L)- 4:3 8:3 12:3
              (U)- 4:2 8:2 12:2

```

Rung 9:1

```

|
|-----[END OF FILE]-----|
|
|

```

ASSEMBLE

3 August 1989 Page 19

Ladder Listing

Processor Address: 000 octal

Rung 10:0

Rung 10:0

```

| TRAY1 RHDSW RHUM1 RHUM2                                RHDM1 |
| I:000 I:000 O:000 O:000                                O:000 |
+--]/[---] [---]/[---]/[---]-----+--( )--+
|   10   12   00   03                                | 01 | |
|                                                         | RHDM2 | |
|                                                         | O:000 | |
|                                                         +--( )--+
|                                                         02 |

```

I:000/10 TRAY1

```

      ] [- 10:1
      ]/[- 10:0

```

```

I:000/12      RHDSW
               ] [- 2:3 6:0 10:0

O:000/00      RHUM1
               ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
               ( )- 4:1 8:1 12:1

O:000/01      RHDM1
               ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
               ( )- 2:3 6:0 10:0

O:000/02      RHDM2
               ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
               ( )- 2:3 6:0 10:0

O:000/03      RHUM2
               ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
               ( )- 4:1 8:1 12:1

```

Rung 10:1

The following 2 rungs are used to turn the robot to the respective tray 1 and to lower the robot head (the electromagnet lift).

TRAY1 RPB1 RPB2	RPUM1
I:000 O:000 O:000	O:000
+--] [---]/[---]/[-----+--()--+	
10 05 06	04
	RPUM2
	O:000
	+--()--+
	07

```

I:000/10      TRAY1
               ] [- 10:1
               ]/[- 10:0

O:000/04      RPUM1
               ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
               ( )- 2:2 6:1 10:1

```

ASSEMBLE

3 August 1989 Page 20

Ladder Listing

Processor Address: 000 octal

Rung 10:1

```

O:000/05      RPB1
               ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
               ( )- 4:0 8:0 12:0

O:000/06      RPB2
               ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
               ( )- 4:0 8:0 12:0

```

```
O:000/07      RPUM2
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1
```

Rung 10:2

```
|
+-----[END OF FILE]-----+
|
```

ASSEMBLE

3 August 1989 Page 21

Ladder Listing

Processor Address: 000 octal

Rung 11:0

Rung 11:0

```
| RPUM1 RPUM2 RHDM1 RHDM2
| O:000 O:000 O:000 O:000
+---]/[---]/[---]/[---]/[-----[EOT]--+
| 04 07 01 02
```

```
O:000/01      RHDM1
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0
```

```
O:000/02      RHDM2
                ]/[- 3:0 4:1 7:0 8:1 11:0 12:1
                ( )- 2:3 6:0 10:0
```

```
O:000/04      RPUM1
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1
```

```
O:000/07      RPUM2
                ]/[- 3:0 4:0 7:0 8:0 11:0 12:0
                ( )- 2:2 6:1 10:1
```

Rung 11:1

```
|
+-----[END OF FILE]-----+
|
```

Rung 12:0

The following rungs are used to pick up a washer in tray 1, to move the lift back up to the home position, to rotate the robot arm back to home position, and to drop the washer to the reciving cylinder.

RHHSW RH_SW RPUM1 RPUM2	RPBM1	
I:000 I:000 O:000 O:000	O:000	
+---]/[---] [---]/[---]/[-----+---()---+---		
13 11 04 07	05	
	RPBM2	
	O:000	
	+---()---+	
	06	

I:000/11 RH_SW
] [- 4:0 4:3 8:0 8:3 12:0 12:3
]/[- 4:2 5:0 8:2 9:0 12:2 13:0

I:000/13 RHHSW
] [- 4:1 8:1 12:1
]/[- 4:0 8:0 12:0

O:000/04 RPUM1
]/[- 3:0 4:0 7:0 8:0 11:0 12:0
 ()- 2:2 6:1 10:1

O:000/05 RPBM1
]/[- 2:2 5:0 6:1 9:0 10:1 13:0
 ()- 4:0 8:0 12:0

O:000/06 RPBM2
]/[- 2:2 5:0 6:1 9:0 10:1 13:0
 ()- 4:0 8:0 12:0

O:000/07 RPUM2
]/[- 3:0 4:0 7:0 8:0 11:0 12:0
 ()- 2:2 6:1 10:1

Rung 12:1

RHHSW RHDM1 RHDM2		RHUM1	
I:000 O:000 O:000		O:000	
+--] [---]/[---]/[-----		+--()--+	
13 01 02		00	
		RHUM2	
		O:000	
		+--()--+	
		03	

I:000/13 RHHSW

] [- 4:1 8:1 12:1
]/[- 4:0 8:0 12:0

O:000/00 RHUM1

] /[- 2:3 5:0 6:0 9:0 10:0 13:0
 ()- 4:1 8:1 12:1

ASSEMBLE

3 August 1989 Page 23

Ladder Listing

Processor Address: 000 octal

Rung 12:1

O:000/01 RHDM1

] /[- 3:0 4:1 7:0 8:1 11:0 12:1
 ()- 2:3 6:0 10:0

O:000/02 RHDM2

] /[- 3:0 4:1 7:0 8:1 11:0 12:1
 ()- 2:3 6:0 10:0

O:000/03 RHUM2

] /[- 2:3 5:0 6:0 9:0 10:0 13:0
 ()- 4:1 8:1 12:1

Rung 12:2

RH_SW		ELEMG	
I:000		O:001	
+--]/[-----		(U)--+	
11		02	

I:000/11 RH_SW

] [- 4:0 4:3 8:0 8:3 12:0 12:3
]/[- 4:2 5:0 8:2 9:0 12:2 13:0

O:001/02 ELEMG

] /[- 5:0 9:0 13:0
 (L)- 4:3 8:3 12:3
 (U)- 4:2 8:2 12:2

Rung 12:3

```
| RH_SW | ELEM |
| I:000 | O:001 |
+---] [----- (L)---+
| 11 | 02 |
```

```
I:000/11 RH_SW
          ] [- 4:0 4:3 8:0 8:3 12:0 12:3
          ]/[- 4:2 5:0 8:2 9:0 12:2 13:0
```

```
O:001/02 ELEM
          ]/[- 5:0 9:0 13:0
          (L)- 4:3 8:3 12:3
          (U)- 4:2 8:2 12:2
```

Rung 12:4

```
| |
+-----[END OF FILE]-----+
| |
```

ASSEMBLE

3 August 1989 Page 24

Ladder Listing

Processor Address: 000 octal

Rung 13:0

Rung 13:0

```
| ELEM RH_SW RHUM1 RHUM2 RPBM1 RPBM2 |
| O:001 I:000 O:000 O:000 O:000 O:000 |
+---]/[---]/[---]/[---]/[---]/[-----[EOT]---+
| 02 11 00 03 05 06 |
```

```
I:000/11 RH_SW
          ] [- 4:0 4:3 8:0 8:3 12:0 12:3
          ]/[- 4:2 5:0 8:2 9:0 12:2 13:0
```

```
O:000/00 RHUM1
          ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
          ( )- 4:1 8:1 12:1
```

```
O:000/03 RHUM2
          ]/[- 2:3 5:0 6:0 9:0 10:0 13:0
          ( )- 4:1 8:1 12:1
```

```
O:000/05 RPBM1
          ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
          ( )- 4:0 8:0 12:0
```

```
O:000/06 RPBM2
          ]/[- 2:2 5:0 6:1 9:0 10:1 13:0
          ( )- 4:0 8:0 12:0
```

```
] / [- 5:0 9:0 13:0
(L) - 4:3 8:3 12:3
(U) - 4:2 8:2 12:2
```

```

|
+-----[END OF FILE]-----+
|

```

Rung 14:0

```

| AIRS | ASB_CON |
| I:000 | O:001 |
+--] [----- ( )--+
| 16 | 00 |

```

```
] [- 2:1 2:2 3:0 14:0
]/[- 2:0
```

```
]/[- 3:0 15:0
( )- 14:0
(L)- 2:0
(U)- 2:1
```

```
|
+-----[END OF FILE]-----+
|
```

Rung 15:0

```

| ASB_CON |
| O:001 |
+---] / [-----[EOT]--+
| 00 |

```

Rung 15:1

REPORT OPTIONS SUMMARY

286

VITA

VITA

Simon Sauyee Chung was born on May 4, 1958 in Canton, China. He had lived in Hong Kong and Venezuela, South America before coming to the United States of America. He became a U.S. citizen in August, 1980. He had worked in his family's business while completing his Bachelor of Science in Biology degree at the East Tennessee State University. He graduated with a Bachelor of Science degree in Electrical Engineering in August, 1987 at the University of Tennessee, Knoxville and continued to study for the Master of Science degree in the same field in September, 1987.

He co-oped at the International Business Machines Corporation (IBM) in Charlotte, North Carolina for over a year, and gained valuable experiences by working in the printer manufacturing, strategy and planning, and development areas. Since graduating with the M.S.E.E. degree, he is working for NASA, Langley Research Center in Hampton, Virginia. He is currently a member of the IEEE, Eta Kappa Nu Electrical Engineering Honor Society, and Kappa Mu Epsilon Math Honor Society.