Feedback

Computer Assisted Learning

Electricity & Electronics

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Test & Measurement

Single Conveyor & Workcell Systems
34-001 to 34-004

Technology Training for tomorrow's world

Single Conveyor
&
Workcell Systems

34-001 to 34-004

Feedback

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Notes

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The equipment, when used in normal or prescribed applications within the parameters set for its mechanical and electrical performance, should not cause any danger or hazard to health or safety if normal engineering practices are observed and they are used in accordance with the instructions supplied.

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DANGER

Refer to accompanying documents

CAUTION -
RISK OF
ELECTRIC SHOCK

CAUTION -
ELECTROSTATIC
SENSITIVE DEVICE

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COMPONENT REPLACEMENT

Where components are of a ‘Safety Critical’ nature, i.e. all components involved with the supply or carrying of voltages at supply potential or higher, these must be replaced with components of equal international safety approval in order to maintain full equipment safety.

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1. Equipment type
2. Component value
3. Component reference
4. Equipment serial number

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1 Introduction

1.1 Description of the Workcell Systems

This section gives a general description and overview of the Series 34 PLC applications systems available from Feedback Instruments Ltd. The Single Conveyor Systems and the dual-conveyor Workcell Systems are described, as applicable for Mitsubishi PLCs, or for use with other manufacturers' units.

1.1.1 The Systems

It is intended that the Workcell Systems 34-003 and 34-004 be used as applications equipment with which students may study the use and programming of Programmable Logic Controllers (PLCs). Both are dual-conveyor systems, comprising an upper and a lower conveyor, with various sensors and actuators interfaced to a PLC. The 34-003 Workcell System is supplied with a Mitsubishi PLC pack and the 34-004 Workcell System with an Allen-Bradley PLC with similar capabilities.

Variations of the above Systems are available. The 34-001 Single Conveyor System and the 34-002 Single Conveyor System have only the upper conveyor. The 34-001 is Mitsubishi PLC-based and the 34-002 is Allen-Bradley PLC-based. The Systems are also supplied without PLCs, for those wishing to use their own units. These are the 34-100 Single Conveyor PLC Application and the 34-120 PLC Workcell (dual conveyor).

This manual is for use with all of the above equipment. Obviously, if the system in use has only a single conveyor, some of the sections relating to the double-conveyor system are not relevant. Also, if a PLC other than those described is used the PLC manufacturer's data should be used in conjunction with the instructions given.

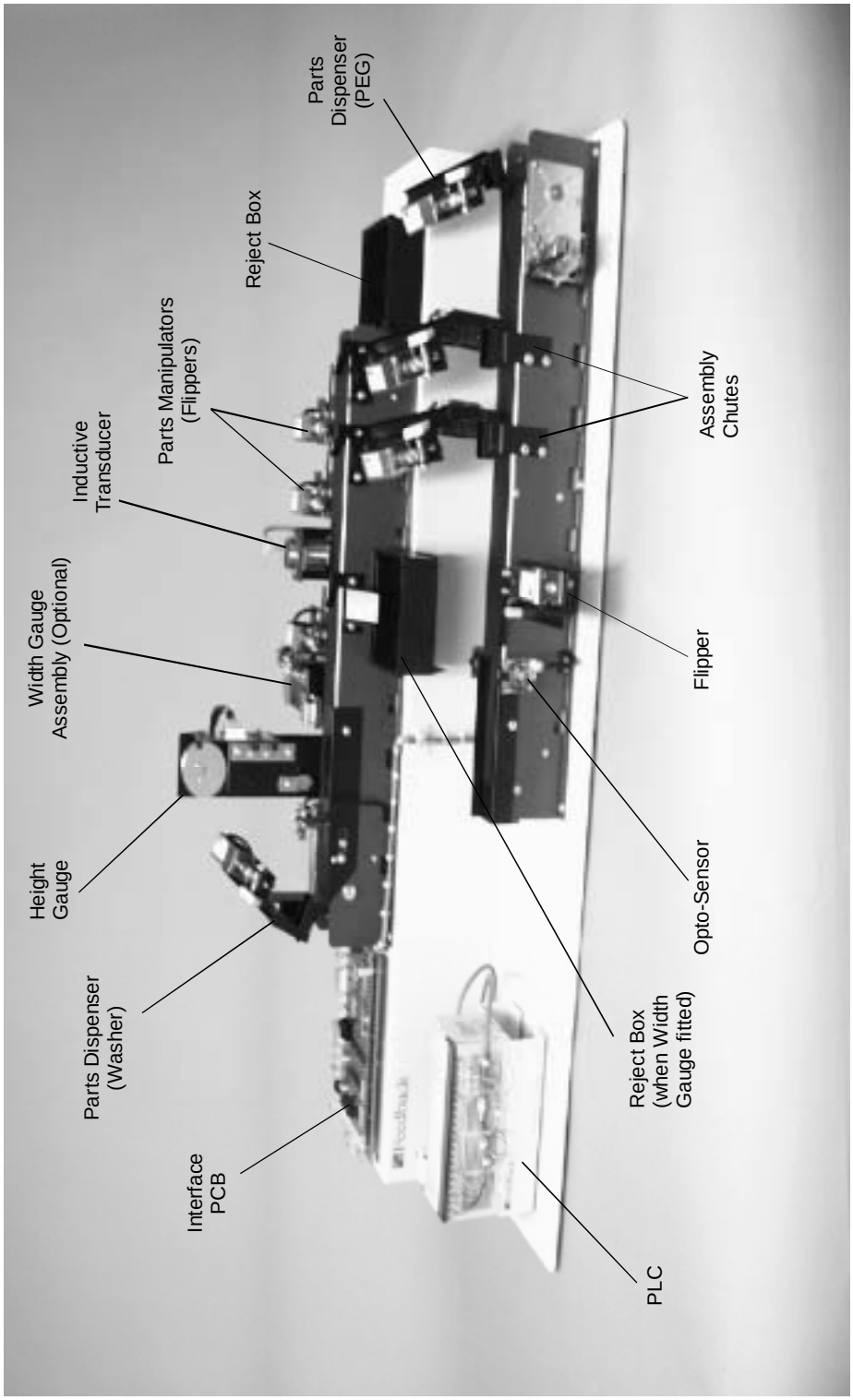


Figure 1-1: A Workcell System

1.1.2 The Workcell Systems 34-003 and 34-004

These are both dual-conveyor systems, supplied with PLCs. The conveyors, the PLC, the power supply and interface circuitry are all mounted on a baseplate. A typical set-up is shown in Figure 1-1.

The Workcell provides a vehicle with which students may investigate how typical sensors and actuators are connected and used with a PLC. Also, how to program the PLC to dispense, select, process and assemble parts, as an example application of an industrial process under PLC control.

1.1.2.1 Supplies and Interface

The power supplies for the conveyors, sensors and actuators are housed in the section to the rear of the baseplate, under the upper conveyor. Interconnection between the PLC and the sensors and actuators on the Workcell requires interface circuits. These are to be found on the printed circuit board (PCB) to the left of the upper conveyor.

The power for the PLC is fed using a separate power lead, from the PLC mains power outlet at the left-hand side of the baseplate.

1.1.2.2 Parts for assembly

The components (parts) for use in the various applications tasks are of two types: a 'base' part with a spigot (peg) onto which a 'washer' type part may be assembled. Figure 1-2 shows the two types of part.

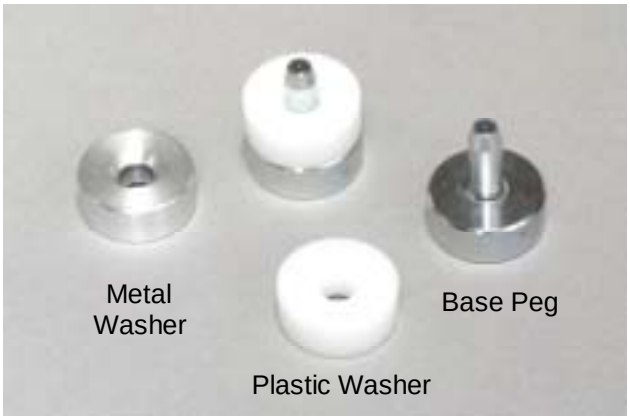


Figure 1-2: The parts used for assembly

The 'washer' may be either metal or plastic and may have different heights (thickness) and diameters (width). Tasks associated with the System select the required type and size of 'washer' and assemble it correctly onto a 'base'.

The table below gives the sizes of the parts supplied:

Part	Height (thickness)	Diameter (width)
Standard, correct	8 mm	20 mm
Wrong height	7 mm and 9 mm	20 mm
Wrong width	8 mm	19 mm and 21 mm

Note:

The Width Detector is an optional assembly and may not be present on all Workcells. If it is not present, 'wrong width' (diameter) parts will NOT be supplied.

1.1.2.3 Conveyors

The Workcell has two conveyor assemblies used for the transport of the parts. DC motors that drive through 600:1 gearboxes power these conveyors. The motors are under the control of the PLC, via the interface circuitry.

1.1.2.4 Parts dispensers

The parts dispensers in the System use solenoid actuators and have been designed to handle the two types of components used in the assembly task. A parts dispenser is shown in Figure 1-3.

There are two dispensers: one for the 'base' part, the other for the 'washer'. The dispensers are under the control of the PLC, via the interface circuitry.

Figure 1-3: A parts dispenser

1.1.2.5 Sensors

The Workcell has a number of opto-detectors to sense components at different parts of the system. Opto-reflective type Infra Red devices are used. The status of each opto-detector is shown by an integral LED fitted to the PCB of that detector (see Figure 1-4).

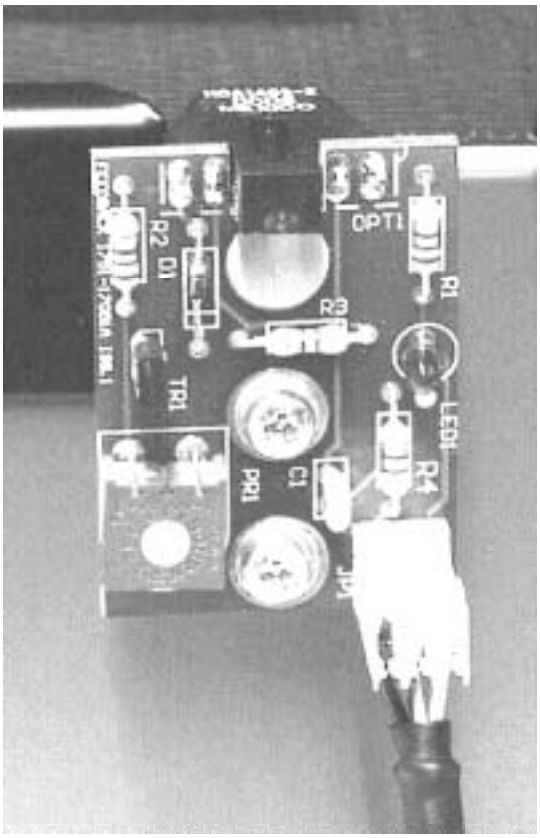


Figure 1-4: An opto-detector and PCB

Note:

This equipment has been designed to be used in conditions of normal laboratory lighting.

Do not use in direct sunlight or intense artificial light, as the infrared opto- sensors may not operate correctly.

The Workcell is also fitted with an inductive device that is used in conjunction with an opto-sensor to provide a simple detector to detect the difference between plastic and metal components (see Figure 1-5)

Figure 1-5: The inductive sensor

1.1.2.6 Height and Width Detectors

These detectors allow the height (thickness) and width (diameter) of the 'washer' components to be determined.

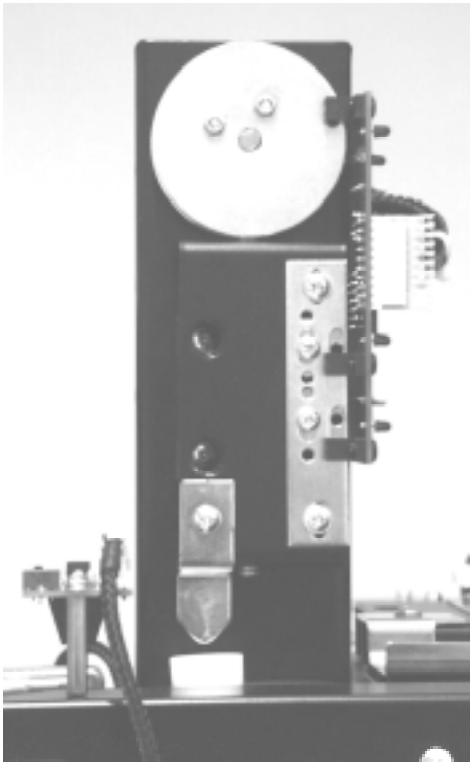


Figure 1-6: The height detector

They use opto-detectors that can be adjusted to give an output when a correct sized component is detected. Under and oversized components are rejected. The status of the detectors fitted to the size gauges are monitored by LED's fitted to the units.

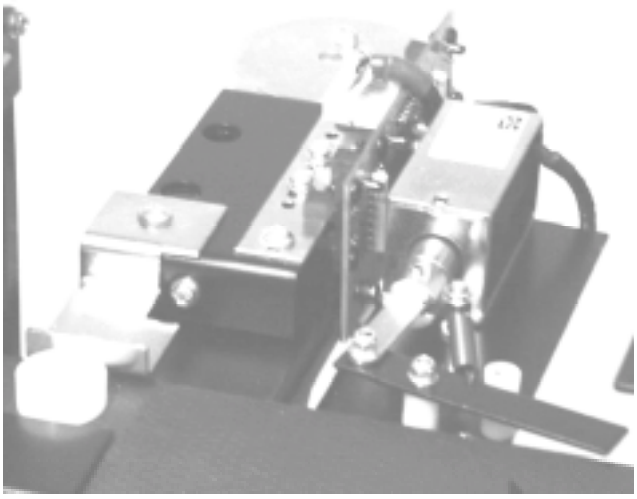


Figure 1-7: The width detector

Note:
The Width Detector is an optional assembly and may not be present on all Workcells

1.1.2.7 Parts manipulators

To move parts from one conveyor to the other, solenoid-operated ‘flippers’ are provided. These operate and force a component to move across the conveyor, either to be ejected or stored in a particular place.

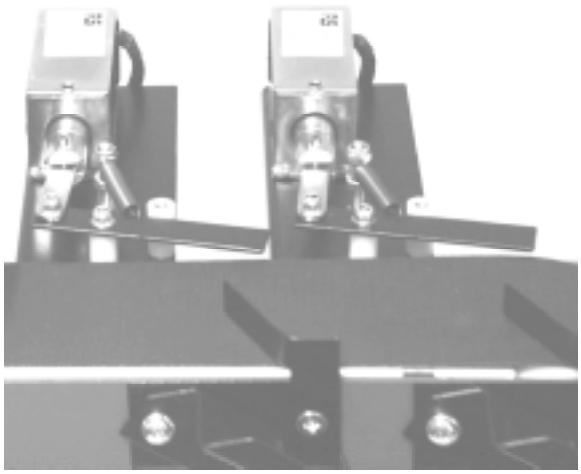


Figure 1-8: Parts manipulators (flippers)

1.1.3 The Workcell process

The sequence of operations that can be performed by a Workcell is as follows.

- Firstly, the conveyor belt is started.
- Next, the 'washer' component is dispensed onto the conveyor by actuating the first dispenser solenoid.
- The 'washer' then travels a short distance along the belt until its presence is detected by the first opto-sensor.
- After a period of time (determined by the PLC programming) the conveyor is stopped with the 'washer' under the height detector.
- The height detector now determines if the 'washer' is within the prescribed height (thickness) limits.
- The conveyor is restarted, causing the 'washer' to move on.

What happens next is determined by whether the width detector is fitted, or not.

1.1.3.1 With width detector fitted

- A similar procedure is followed for width (diameter) determination as for height described above.
- The conveyor is restarted, causing the 'washer' to move on.
- If the 'washer' has been determined to be out of the allowable range of diameters the first flipper, associated with the width detector, is actuated, forcing the component to exit the conveyor into the associated side bin.
- If the 'washer' has been determined to be within the allowable range of diameters the component proceeds along the conveyor to the inductive detector.

1.1.3.2 With the width detector not fitted

- As the flipper mentioned above in 1.1.3.1 is not fitted, the 'washer' will proceed directly along the conveyor to the inductive detector.

1.1.3.3 The inductive detector

Irrespective of the fitting, or otherwise, of the width detector, the process now continues to the inductive detector. The purpose of this sensor is to determine whether the 'washer' is made of metal or plastic. The process continues as follows:

- The presence of a part in front of the inductive detector is determined by the second opto-sensor. When this happens the conveyor is stopped.

- The inductive sensor is activated to determine whether the part is made of metal or plastic.
- The conveyor is restarted and the part is moved on.

1.1.3.4 The flippers

After the inductive detector there are two further flippers. One of these may be programmed to operate if the part was determined to be metal, the other if the part was determined to be plastic. However, this should only happen if the part has passed the first height test. If the 'washer' failed the initial height test, neither flipper should operate and the part should continue to the end of the conveyor and be dumped into the end bin.

When one of the flippers is operated the part is forced off the conveyor into the associated chute and is held ready for the assembly phase of the process.

1.1.3.5 The assembly phase

This uses the lower conveyor in the Workcell. If yours is a single conveyor system, this part of the description will not be relevant. The process continues as follows:

- Firstly, the lower conveyor belt is started.
- Next, one of the 'washer' chutes is actuated and a washer is dropped to the bottom, ready for assembly. The availability of a 'washer' so ready is registered by one of the opto-sensors mounted at the bottom of the chutes.
- When a 'washer' is ready, the 'base' component is dispensed onto the conveyor by actuating the second dispenser solenoid.
- The 'base' part moves along the conveyor, picks up the available 'washer', which is then assembled onto it.
- The resulting assembly moves towards the end of the conveyor where the last opto-sensor/flipper determines which of the exit guides the assembly takes. One is for metal parts, the other for plastic.

1.1.4 The Single Conveyor Systems 34-001 and 34-002

The above description of operation is for a dual-conveyor Workcell System. The equipment is available as a single conveyor option: either with a Mitsubishi or an Allen-Bradley PLC. These options are designated Single Conveyor System 34-001 and 34-002, respectively.

The description of operation given in the sections of 1.1.3 is relevant up to section 1.1.3.5, which should be ignored. However, instead of the flippers (described in 1.1.3.4) forcing the 'washer' down chutes to the lower conveyor, the 'washers' are forced from the conveyor into bins held on brackets mounted on the side of the conveyor.

The assembly phase is not available with a Single Conveyor System.

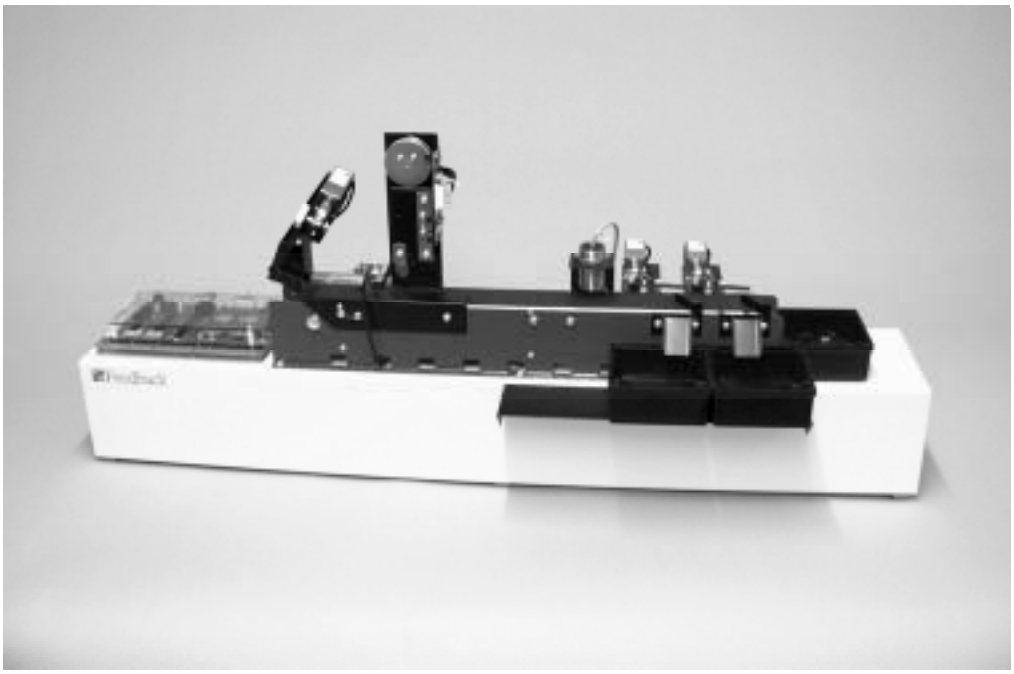


Figure 1-9: A Single Conveyor system

1.1.5 Using your own PLC

The Feedback 34 Series equipment for PLC applications has been designed as generic equipment suitable for the use with many manufacturers' PLC units. The Assignments, flow diagrams, ladder logic, etc are relevant to PLCs, in general. However, this instruction manual only supports in detail Mitsubishi PLCs. If you are using a PLC of any other type you **MUST** connect and operate the PLC as instructed in the manufacturer's data.

1.2 Initial set-up of the equipment

1.2.1 Mechanical assembly

1.2.1.1 The dual-conveyor Workcell System

Workcell systems are supplied fully assembled and tested. All that is needed is that the reject boxes be placed in their positions (see Figure 1-1). These boxes have magnetic bases that hold them firmly in place.

1.2.1.2 The width gauge

If the Diameter Gauging Unit (34-110) (the width gauge option) has been ordered with the Workcell it will also have been factory-fitted and no further mechanical assembly is required.

If the gauge has been ordered subsequently to the main system, then reference must be made to the fitting instructions supplied with the gauge.

1.2.1.3 The Single Conveyor System

Single Conveyor systems are also supplied fully assembled and tested. The reject boxes must be placed in their positions (see Figure 1-9).

1.2.2 Connecting the PLC

Whichever PLC is used with the equipment, it must be connected to the interface printed circuit board (located to the left of the upper conveyor) using normal, stranded, insulated equipment wire (not provided).

Although it is not mandatory to follow the connection instructions given below, they **ARE recommended** if you wish to use any of the pre-programmed examples supplied with the equipment.

All of the connections to the PLC are to be found along the front edge of the board. You will need a small screwdriver to make the connections.

The connections and their descriptions are given in Table 1-1 and the physical positions of the input and output devices to which the pin names refer are shown in Figs 1.10 and 1.11.

Connector #	Connector name	Pin name	Pin description
J27	PLC1 outputs	sol3	Solenoid for 2nd chute
		sol2	Solenoid for 1st chute
		sol1	Width (diameter) reject solenoid
		hmdrv	Height (thickness) motor drive
		disp1	Washer dispenser
		conv1	Top conveyor motor
J28	PLC2 outputs	chut2	Dispense 2nd washer chute
		chut1	Dispense 1st washer chute
		sol4	Exit guide solenoid
		conv2	Bottom conveyor motor
		disp2	Base dispenser
		wmdrv	Width (diameter) motor drive
J26	PLC1 inputs	24pc1	24V supply input
		0vpc1	0V supply input
		stop	Stop button
		spr1	Spare
		hbdc	Height (thickness) gauge bottom dead centre
		htdc	Height (thickness) gauge top dead centre
		hght	Height (thickness) OK
		opt1	Pre-height gauge opto sensor
		opt2	Inductive detector opto sensor
		ind	Inductive sensor
J11		dmx	Diameter>maximum
		dmn	Diameter<minimum
J25	PLC2 inputs	24pc2	24V supply input
		0vpc2	0V supply input
		spr2	Spare
		wdth	Width (diameter) OK
		opt6	Exit guide 1 opto sensor
		opt5	Exit guide 2 opto sensor
		opt4	2nd chute opto sensor
		opt3	1st chute opto sensor
		dbdc	Width (diameter) gauge bottom dead centre
		dtdc	Width (diameter) gauge top dead centre
J10		start	Start button
		hmax	Height (thickness)>maximum
		hmin	Height (thickness)<minimum

Table 1-1: Interface Board Connections

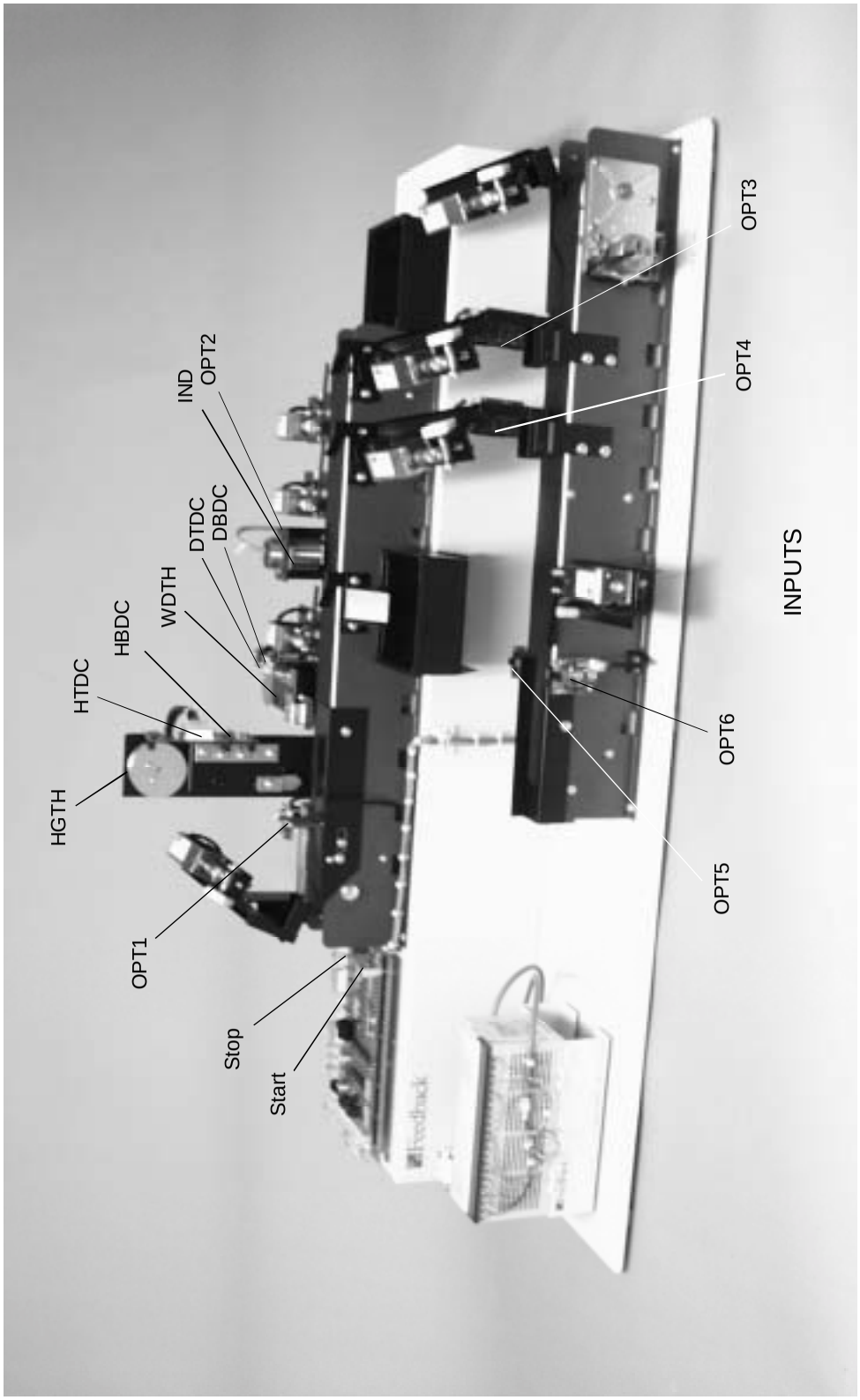


Figure 1-10: The PLC input devices

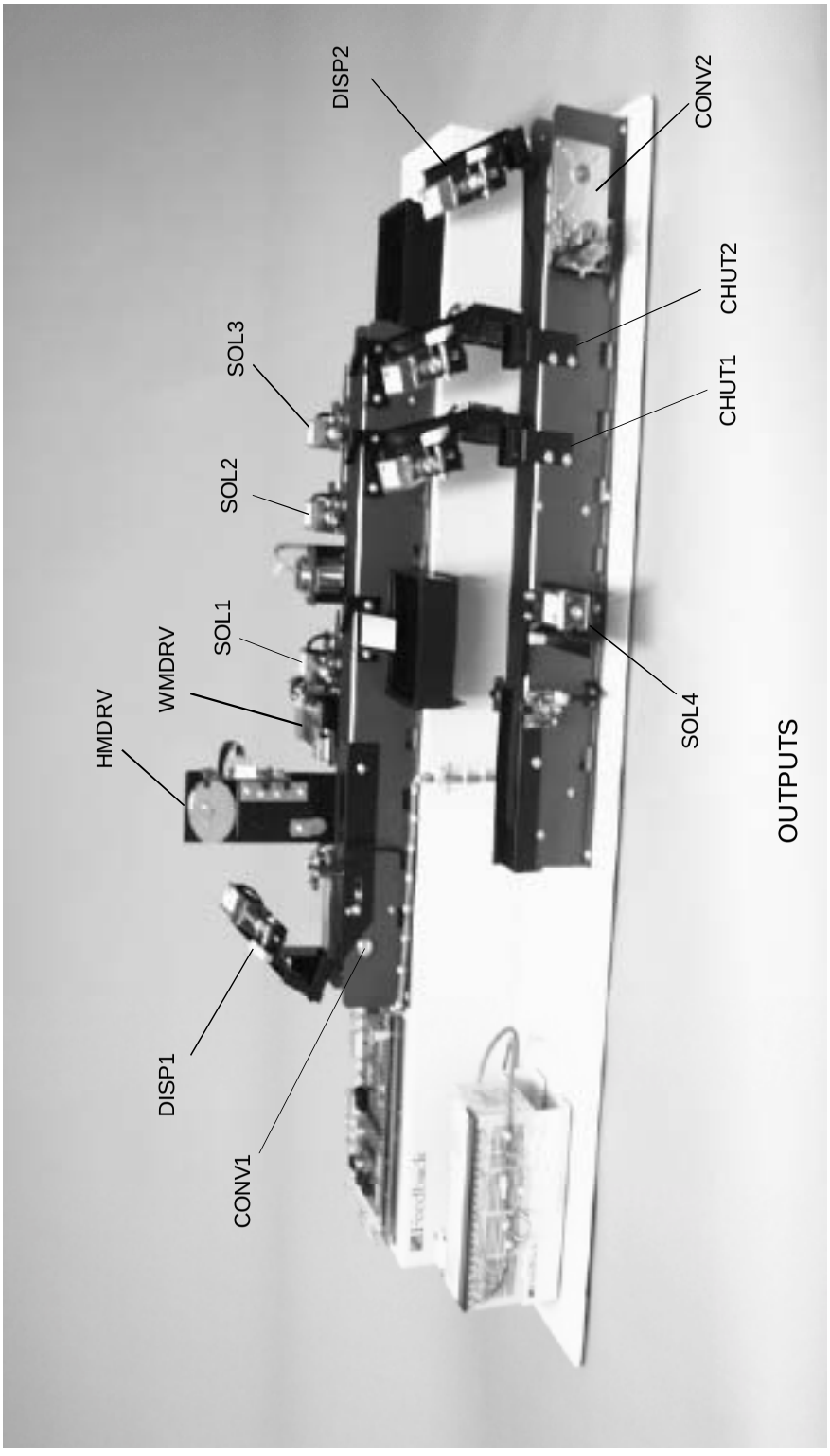


Figure 1-11: The PLC output devices

1.2.2.1 The Mitsubishi FX1s-30MR-DS PLC

A suggested connection scheme that will correspond with the example programs provided with the equipment is given in Table 1-2.

Connector #	Connector name	Pin name	Connected to on FX1s-30MR-DS PLC
J27	PLC1 outputs	sol3	Y0
		sol2	Y1
		sol1	Y5
		hmdrv	Y4
		displ	Y2
		conv1	Y3
J28	PLC2 outputs	chut2	Y10
		chut1	Y11
		sol4	Y15
		conv2	Y12
		disp2	Y13
		wmdrv	Y14
J26	PLC1 inputs	24pc1	24V
		0vpc1	0V
		stop	X0
		hbdc	X1
		htdc	X2
		hght	X3
		opt1	X4
		opt2	X5
		ind	X6
J25	PLC2 inputs	24pc2	24V
		0vpc2	0V
		spr2	NC
		wdth	X16
		opt6	X15
		opt5	X14
		opt4	X11
		opt3	X12
		dbdc	X13
		dtdc	X10
J10		start	X7

Table 1-2: Mitsubishi FX1s-30MR-DS PLC Connections

In addition to the connections in the table, the S/S input on the PLC should be connected to 24 V and the COM0 – COM4 inputs should be connected together and to 24 V. All other connections on the PLC are to be left open circuit. Figure 1-12 shows these connections diagrammatically.

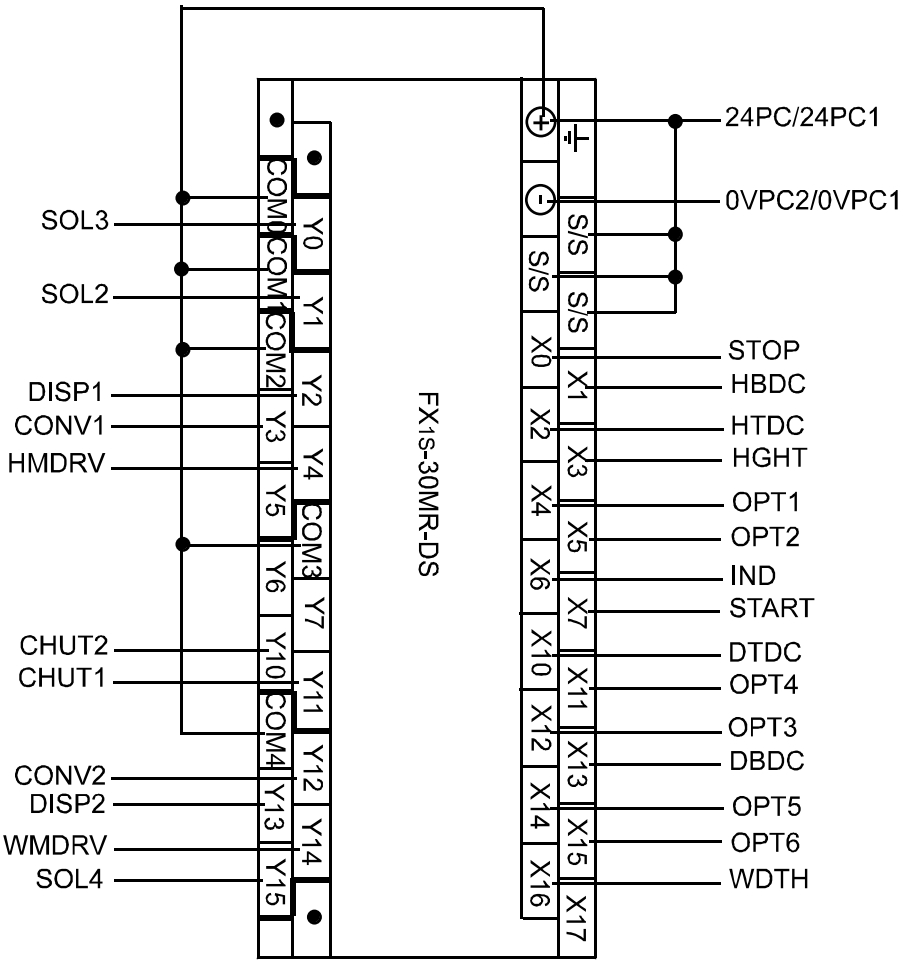


Figure 1-12: The PLC connections

1.2.2.2 Other PLCs

If it is desired to operate the Workcell with a PLC other than the Mitsubishi FX1s-30MR-DS, you **MUST** refer to the relevant manufacturer's handbook(s) for the PLC to be used. Although much of the content of this manual is generic, it is your responsibility to ensure correct connection, programming and operation for the PLC chosen. Feedback Instruments Ltd does not support the operation of the equipment with a PLC other than that supplied with the equipment.

1.2.3 Running the system

Raise the small lid on the top of the PLC and ensure that the slide switch below is in the off position. Plug in the Conveyor/Workcell and the PLC to the mains supply and switch on.

To ascertain whether the inputs are connected correctly, pass a component, or your finger, in front of each opto sensor and see if the corresponding LED on the PLC changes (the Inductive Sensor input will need a metal washer passed in front of it to operate the LED). Also, the 'start' and 'stop' buttons on the printed circuit board should be pressed to see if the corresponding LED's change.

1.2.3.1 The test program

The test program below will exercise all of the outputs associated with the Workcell.

If you have a hand-held programming pod follow the manufacturer's instructions as to how to enter the program.

If you have the Mitsubishi FXGPWIN, or similar, PC-based software this can be used to download the program. The test program is 'test1.pmw' on the supplied disk. Follow the manufacturer's instructions as to how to enter and download the program.

The green 'start' button on the printed circuit board starts the program. Ensure that you have the PLC slide switch set to 'run' for the program to operate.

The test program will operate each of the output devices, in turn. Observe that this happens.

An alternative way of testing that the output devices are functioning correctly is to connect one end of a piece of equipment wire to the 24V output terminal of the PLC and touch briefly the other end of the wire, in turn, to each of the device output terminals on the PLC (Y0 to Y15). Each device should operate as required.

Note:
It is NOT good practice to let output devices remain energised for long periods of time. Ensure that your testing or programming does not allow this to happen.

Test Program (test1.pmw):

```
0     LD      X007
1     SET     M10
2     LD      M10
3     SET     M11
4     OUT     Y002
5     LD      M11
6     OUT     T1      K15
9     LD      T1
10    SET     M12
11    OUT     Y003
12    RST     M10
13    LD      M12
14    OUT     T2      K15
17    LD      T2
18    SET     M13
19    OUT     Y004
20    RST     M11
21    LD      M11
22    OUT     T3      K15
25    LD      T3
26    SET     M14
27    OUT     Y014
28    RST     M12
29    LD      M14
30    OUT     T4      K15
33    LD      T4
34    SET     M15
35    OUT     Y005
36    RST     M13
37    LD      M15
38    OUT     T5      K15
41    LD      T5
42    SET     M16
43    OUT     Y001
44    RST     M14
45    LD      M16
46    OUT     T6      K15
49    LD      T6
50    SET     M17
51    OUT     Y000
52    RST     M15
53    LD      M17
54    OUT     T7      K15
```

57	LD	T7	
58	SET	M18	
59	OUT	Y013	
60	RST	M16	
61	LD	M18	
62	OUT	T8	K15
65	LD	T8	
66	SET	M19	
67	OUT	Y012	
68	RST	M17	
69	LD	M19	
70	OUT	T9	K15
73	LD	T9	
74	SET	M20	
75	OUT	Y011	
76	RST	M18	
77	LD	M20	
78	OUT	T10	K15
81	LD	T10	
82	SET	M21	
83	OUT	Y010	
84	RST	M19	
85	LD	M21	
86	OUT	T11	K15
89	LD	T11	
90	SET	M22	
91	OUT	Y015	
92	RST	M20	
93	LD	M22	
94	OUT	T12	K15
97	LD	T12	
98	RST	M21	
99	END		

The Ladder Diagram for the test program is given in Appendix A, towards the end of this manual.

2 The Assignments

2.1 Assignment Contents

The Assignment work covered in this manual is as follows:

Assignment 1	Familiarisation
Assignment 2	Workcell Initialisation and Parts Dispensing
Assignment 3	Gauging the Height
Assignment 4	Gauging the Diameter
Assignment 5	Selecting Parts by Material
Assignment 6	The Lower Conveyor–Dispensing Parts and Pegs
Assignment 7	The Lower Conveyor–Sorting Assembled Parts
Assignment 8	Stopping the System
Assignment 9	Suggested Additional Exercises

2.2 Equipment Required

To perform the Assignments requires:

Either

A Workcell 34-003 (Mitsubishi PLC)
or Workcell 34-004 (Allen-Bradley PLC)

or

A Single Conveyor System 34-001 (Mitsubishi PLC)
or Single Conveyor System 34-002 (Allen-Bradley PLC)

These systems are supplied with hand-held programming units as standard, thus enabling the programs listed in the Assignments to be loaded and run, as desired. PC-based software for developing and downloading PLC programs is also supplied with full systems. Although all of the Assignments may be performed using the hand-held programmers, the use of such PC-based software will speed up the programming and downloading and may also aid the learning process.

Alternatively, both the Single Conveyor application and the dual conveyor Workcell may be supplied without PLC, thus enabling the use of any manufacturer's PLC unit. If this is the case, the relevant manufacturer's information must be consulted to be able to perform the Assignments.

Note:

Although the Assignment instructions in this manual are relatively general, specific instructions and sample programs are only given for Mitsubishi PLCs. Some interpretation will be required if another manufacturer's PLC is used.

OBJECTIVES

1 To become familiar with the Workcell.

2 Learn how to connect the PLC to the Workcell.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

None

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read and thoroughly understood all of Chapter 1, Introduction, in this manual.

Have read Chapter 1 of the book 'Programmable Logic Controllers and their Engineering Applications'

Read carefully through Chapter 1, Introduction and ensure that you know with which variation of the System you have to work.

Identify each part of the system described in Section 1.1.2.

Ensure that you understand the Workcell process, as described in Section 1.1.3 (or 1.1.4 or 1.1.5, if relevant).

Ensure that the system is assembled mechanically correctly, as described in Section 1.2.1.

Identify each input and output on the Interface printed circuit board, as given in Table 1 in Section 1.2.2.

Ensure that the PLC is correctly connected to the Interface board. A sample connection scheme is given in Section 1.2.2.1, though you are free to use your own scheme. However, **note that if you use a scheme other than those in the above sections the sample programs provided might not run correctly**.

When you have satisfied yourself that the PLC is connected correctly, switch on the supplies to the Workcell and the PLC.

To ascertain whether the inputs are connected correctly, pass a component, or your finger, in front of each opto sensor and see if the corresponding LED on the PLC changes (the Inductive Sensor input will need a metal washer passed in front of it to operate the LED). Also, the 'start' and 'stop' buttons on the printed circuit board should be pressed to see if the corresponding LED's change.

To of test that the output devices are functioning correctly connect one end of a piece of equipment wire to the 24V output terminal of the PLC and touch briefly the other end of the wire, in turn, to each of the device output terminals on the PLC (Y0 to Y15). Each device should operate as required.

Note:

It is NOT good practice to let output devices remain energised for long periods of time. Ensure that your testing or programming does not allow this to happen.

If you have the Mitsubishi FXGPWIN, or similar, PC-based software this can be used to download a test program. The test program is 'test1.pmw' on the supplied disk. Follow the manufacturer's instructions as to how to enter and download the program.

If you do not have PC-based software available to download the test program you can load the program using the hand-held programmer supplied. This will take some time, as there are nearly one hundred steps – so this is an optional exercise at this stage. You will need to follow the manufacturer's instructions as to how to use the hand-held pod to enter the program.

The test program listing is given in Section 1.2.3.1 of this manual.

When entered, run the program. The green 'start' button on the printed circuit board starts the program. Ensure that you have the PLC slide switch set to 'run' for the program to operate.

Observe that the test program exercises in turn all of the outputs associated with the Workcell.

The cycle can be repeated by pressing the start button again.

Notes

OBJECTIVES

1 To initialise the Workcell.

2 Learn how to get the PLC to operate outputs.

3 Have an introduction to ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 1, Familiarisation.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Ensure that you understand the sequence of actions required for the Workcell to operate correctly by reading Section 1.1.3 of this manual.

Workcell initialisation

It is quite likely that when the top conveyor of the Workcell was stopped at the end of its last period of operation the 'plunger' of the height (thickness) gauge was not at its highest position. On pressing the 'start' button and before any other action takes place the plunger must be driven to its highest position (referred to as 'height gauge top dead centre') so that any component travelling down the conveyor does not hit the plunger.

To do this the height gauge motor must be turned on and the gauge driven until the top dead centre position is reached. The motor must then be stopped.

A flow diagram for this sequence of operations is shown in Figure 2-2-1.

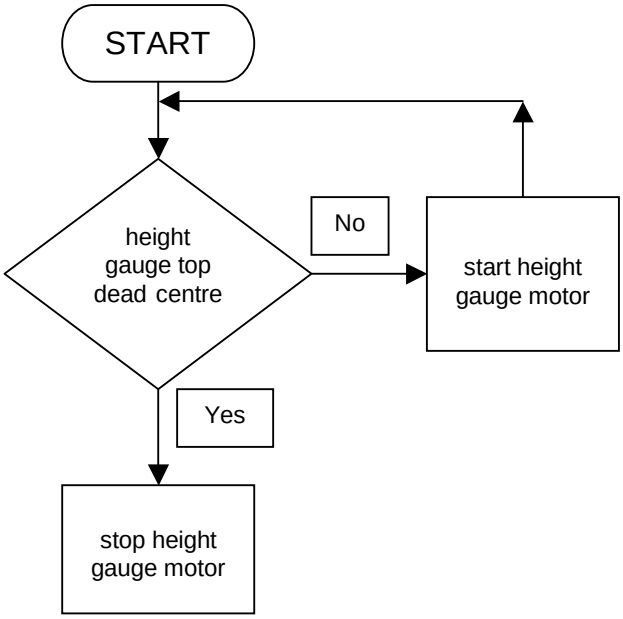


Figure 2-2-1: Height Gauge initialisation flow diagram

Ensure that you have read the PLC manufacturer's instructions on how to use the hand-held programming pod and that you are reasonably familiar with the IEC symbols used in PLC ladder programming.

The Interface Board connections that are relevant to the height gauge are shown in Section 1.2.2, Table 1-1. They are:

Height motor drive	hmdrv	(an output)
Height gauge top dead centre	htdc	(an input)
Start button	start	(an input)

If you have used the PLC connection scheme suggested in Section 1.2.2.1, these will correspond to:

hmdrv	Y4
htdc	X2
start	X7

Running the height motor

Ensure that you have read how to operate the hand-held programming pod and then load the following program:

```
0     LD      X007
1     OUT     Y004
2     END
```

This corresponds to the ladder diagram in Figure 2-2-2.

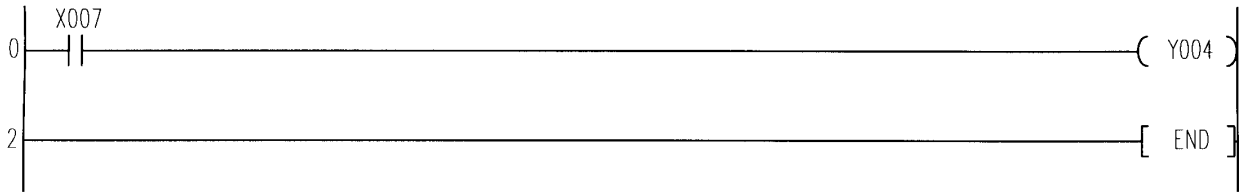


Figure 2-2-2: Ladder diagram

Run this program and see what happens.

Latching the motor

Obviously the above program is not satisfactory, as the motor will only run whilst the start button is depressed. This is quite logical, as the ladder diagram can be read as: “when X7 is true (the start button pressed) output Y4 (drive the height motor)”.

What is needed is for the motor drive to be latched, so that the motor stays on until it is required to be turned off. This is achieved by setting a ‘flag’ in the program and then using this flag to determine whether the motor is on, or off.

Try the program shown in the ladder diagram Figure 2-2-3 and see what happens.

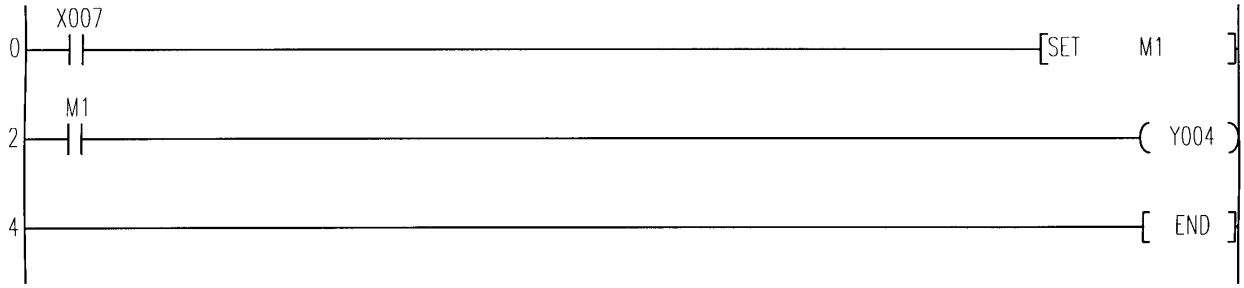


Figure 2-2-3: Motor latching

The internal flag M1 now represents the 'height motor flag'. Whenever it is 'set' the motor will be driven on; when it is 'reset' (RST) the motor will be turned off.

Detecting 'top dead centre'

The height motor must be turned off when the top dead centre position is reached.

There is an optical (LED) detector associated with the height gauge that produces a negative-going signal when this position is reached. This is used to reset the height motor flag.

Because the LED produces a negative-going signal, the 'load inverse' (LDI) command must be used.

Try the program shown in the ladder diagram of Figure 2-2-4.

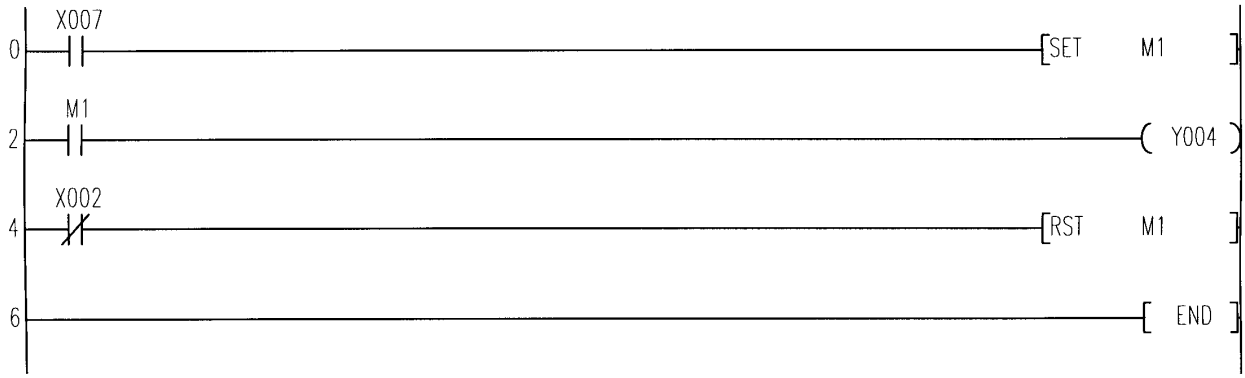


Figure 2-2-4: Top dead centre

This corresponds to the listing below:

0	LD	X007
1	SET	M1

2	LD	M1
3	OUT	Y004
4	LDI	X002
5	RST	M1
6	END	

The Diameter (width) Gauge

Note:

The Width Gauge is an optional assembly and may not be present on all Workcells

In just the same way as the height gauge must be out of the way before a part is dispensed onto the conveyor, the diameter (width) gauge (if fitted) must also be clear of the conveyor. This is achieved in a similar way as for the height gauge.

The Interface Board connections that are relevant to the width (diameter) gauge are shown in Section 1.2.2, Table 1-1. They are:

Width motor drive	wmdrv	(an output)
Width gauge top dead centre	dtdc	(an input)
Start button	start	(an input)

If you have used the PLC connection scheme suggested in Section 1.2.2.1, these will correspond to:

wmdrv	Y14
dtdc	X10
start	X7

When the Start button is pressed, you will need to set a flag (M4) for the width motor drive and then detect when the width (diameter) gauge has reached its top dead centre position. The width motor should then be stopped.

Incorporate these steps into your program and test that both the gauges move out of the way.

Dispensing a part

The next operation required is to dispense a part (washer) onto the conveyor and then to start the conveyor belt running.

As before, to be able to turn the dispenser and the top conveyor on and off, internal flags need to be set for these operations.

The outputs associated with the parts dispenser and the top conveyor can be seen from

Section 1.2.2, Table 1-1. They are:

Parts dispenser	disp1
Top conveyor motor	conv1

If you have used the PLC connection scheme suggested in Section 1.2.2.1, these will correspond to:

disp1	Y2
conv1	Y3

Flags for these can be set either right at the start or after the height motor has reached top dead centre. The flags used can be:

M2	disp1 flag
M3	conv1 flag

When these have been set they can be used to activate the dispenser and the top conveyor.

An example of this can be seen in the ladder diagram of Figure 2-2-5.

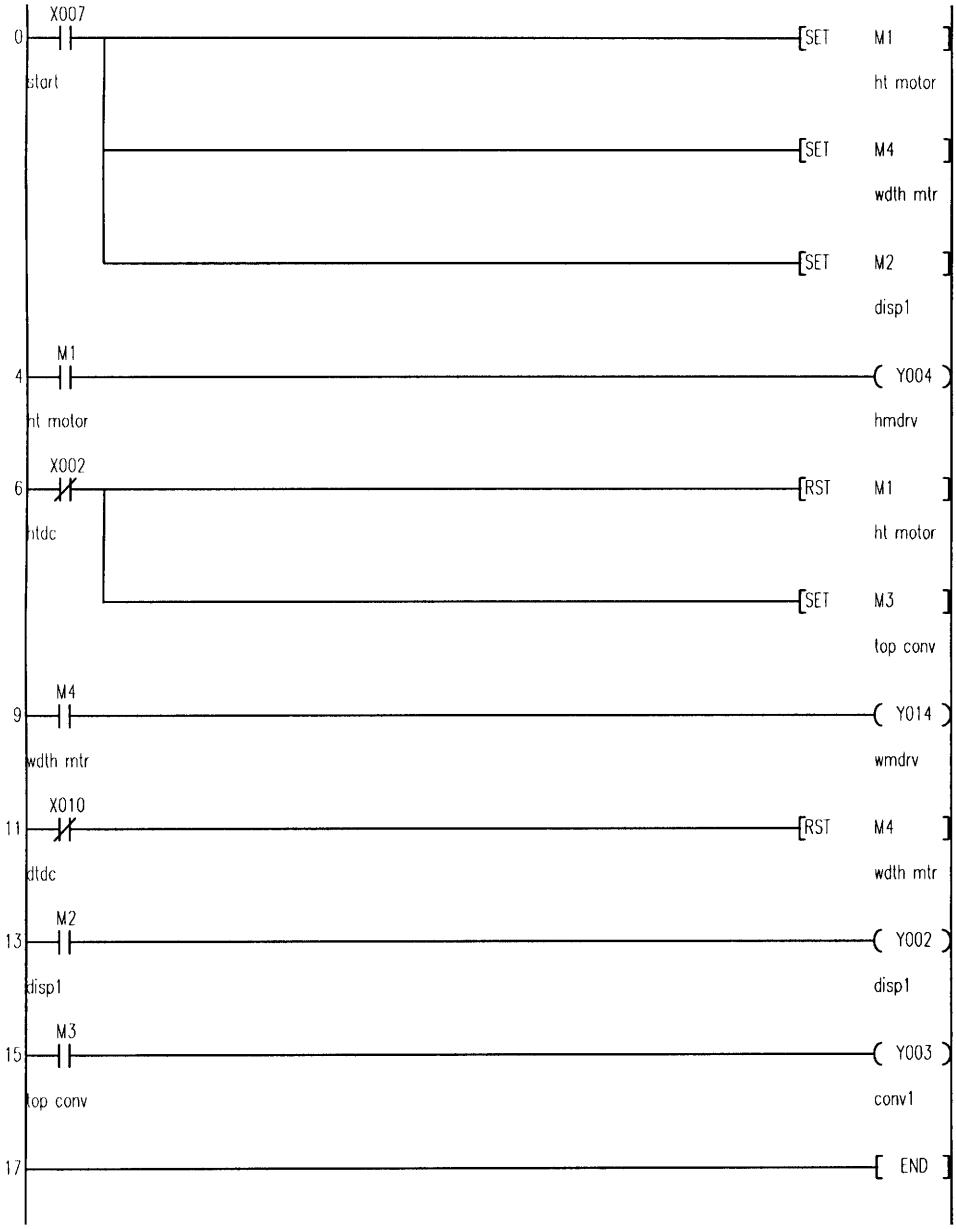


Figure 2-2-5: Initialisation sequence

Notes

OBJECTIVES

1 To program the PLC to operate the height gauge.

2 Learn how to get the PLC to use time delays.

3 Have an introduction to ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

After the initialisation sequence investigated in Assignment 2 has been followed and a part dispensed, the part should travel along the conveyor until sensed by the first opto-sensor, located just before the height gauge.

The requirement is for the part to stop at this sensor and then, after a short period, move on until it is under the height gauge. The part is then to stop again and the height gauge is to operate and determine whether the part is of the correct thickness, or too thick, or too thin. After this, the part is to move on to the next step in the process.

The flow diagram of this part of the process is given in Figure 2-3-1.

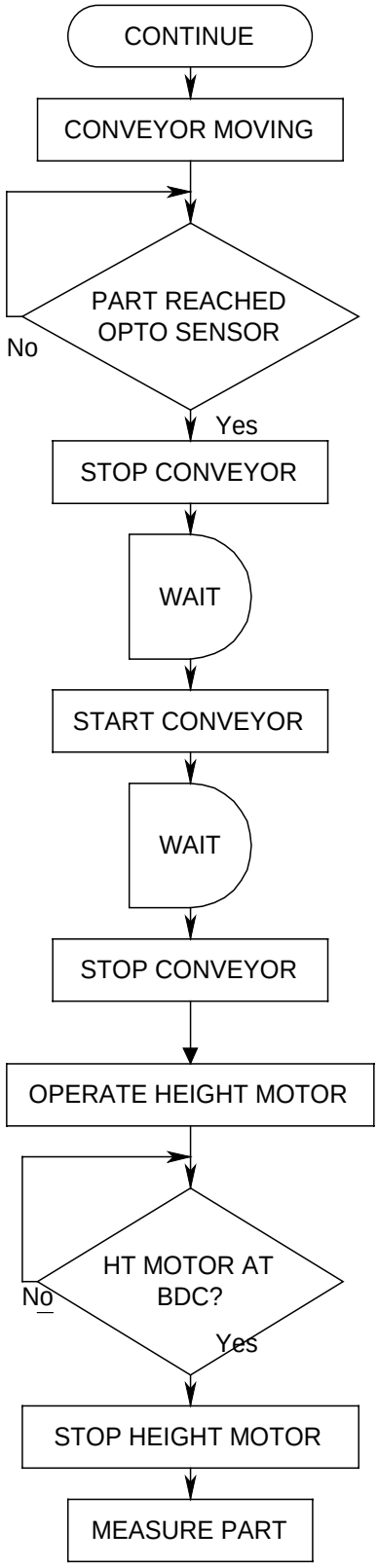


Figure 2-3-1: Height Gauge Flow Diagram

Sensing with the Opto-Sensor

The opto-sensor is a reflective infrared type sensor that detects the presence of a part by directing a beam of infrared light across the conveyor and detecting the reflections of the light as a part comes in front of it.

The signal from the sensor to the input of the PLC is designated ‘opt1’ (the pre-height opto-sensor) and is connected to input X4. It is a negative-going signal when a part is present.

To stop the conveyor when this sensor detects a part, the flag associated with the conveyor (M3) must be reset.

Add this line to the instructions from Assignment 2 to stop the part in front of the sensor.

Resetting the Dispenser

This is also a convenient point to reset the dispenser, ready for the dispensing of the next part.

The dispenser flag is M2. Incorporate this in your program.

Setting Timers

Once the presence of a part has been detected by the opto-sensor, the conveyor can be started and run for a time sufficient to position the part under the height gauge.

If this period is chosen correctly, the conveyor may be stopped with the part exactly under the height gauge.

To initiate a timer, a timer flag needs to be set. This flag is then loaded to start the timer, which, on completion of its timing period, starts the conveyor again.

At this point, another timer must be initiated which will stop the conveyor when the part is in the correct position directly under the height gauge.

The additional programming needed for the above functions is given in Figure 2-3-2.

Enter and run the program and investigate its operation.

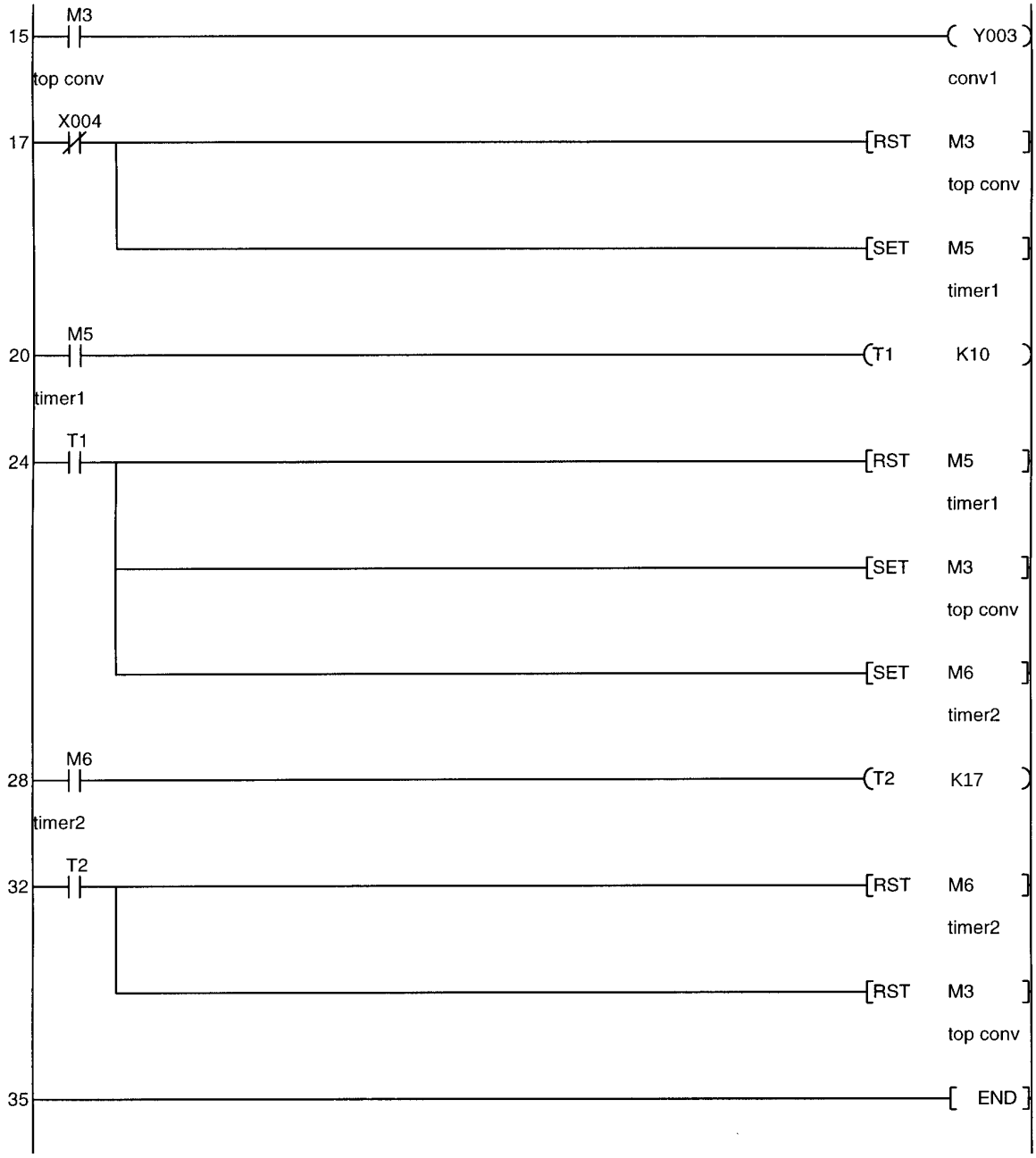


Figure 2.3.2: Timer Programming

2.3 Gauging the Part

The part now should be positioned directly under the height gauge. The blade of the height gauge should be above the flat section of the part (if it is over the centre, or if it is towards the edge, the gauge will not measure the correct thickness). If the part has not stopped in the correct position adjust the timer period to make it do so.

The gauge motor must now be run and stopped at bottom dead centre. It should dwell here for a short time whilst a thickness (height) flag is set, then it should continue up to top dead centre again.

Use the timer T2 to set the height motor flag (M1) and use this to drive the motor to bottom dead centre. Bottom dead centre is given by the negative-going input X1. When this occurs, the height motor should be stopped (reset) and a new timer flag should be set and run (M7, timer3).

On running timer3, the M7 flag should be reset, and, if the height of the part is within specification, a 'height ok' flag should be set. The height motor should then run again until top dead centre is reached, when it should stop and the conveyor should start once more.

This is shown in the flow diagram of Figure 2-3-1.

Construct a ladder diagram to perform the required program steps and program the PLC.

Run the program and verify that you have programmed the PLC correctly.

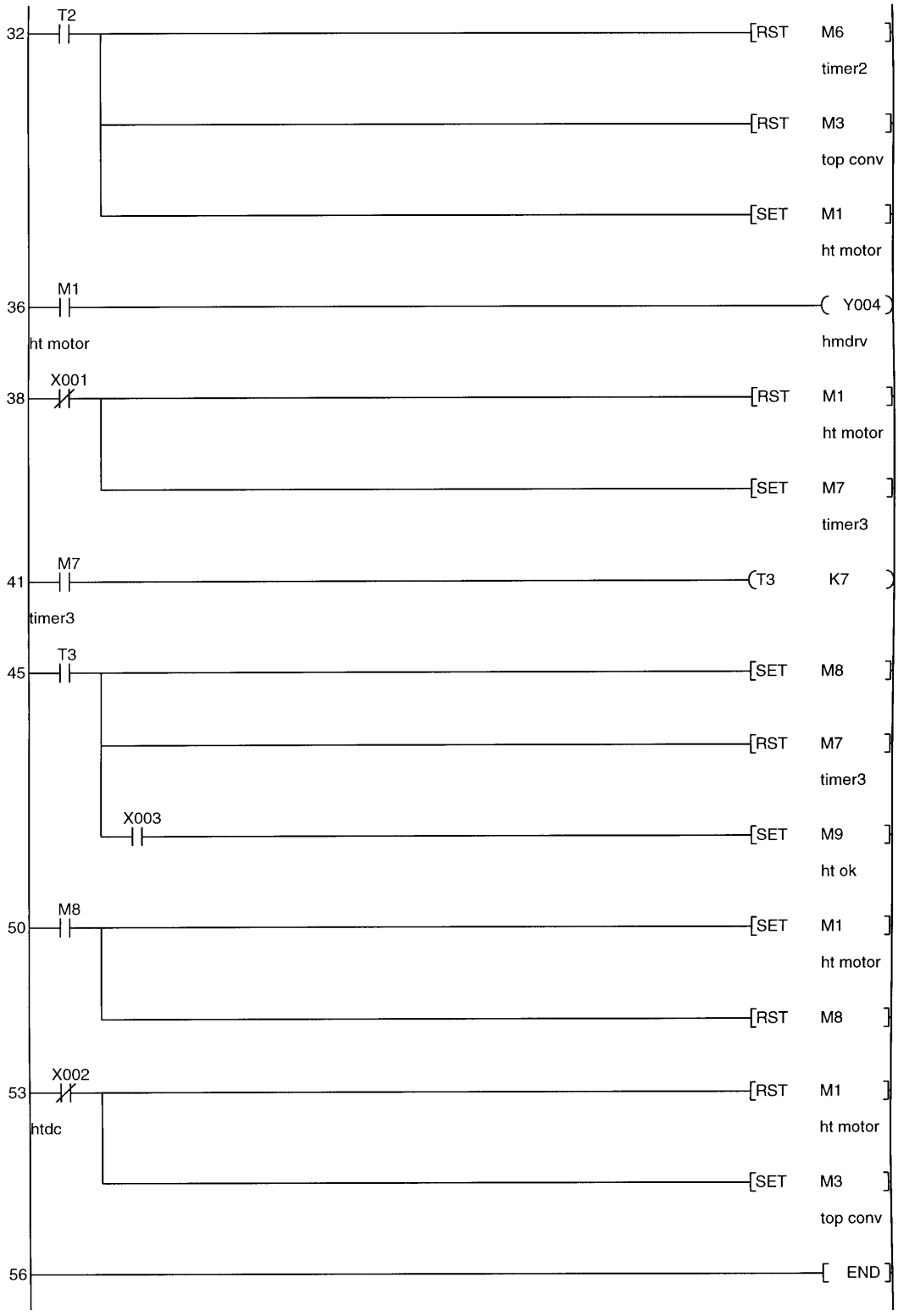


Figure 2.3.3: Additional Ladder Logic required

Notes

OBJECTIVES

1 To program the PLC to operate the width (diameter) gauge.

2 Have further practice in ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell with optional Width Gauge attached (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Note

This Assignment requires you to have the optional Width (diameter) Gauge attached to the Workcell. If you do not have this option fitted, you will not be able to do this Assignment.

If the Width Gauge is fitted to the upper conveyor of the Workcell, the next stage is to gauge the diameter of the part. The Width Gauge works in a similar way to that already investigated for the Height Gauge.

Gauging the Diameter (Width)

With the program that has been developed so far, the Width Gauge is out of the way whilst the height of the part is being determined. When this has been done, the conveyor must move for the time period required to position the part in front of the Width Gauge. The shape of the end-part of the gauge is such that the positioning of the part is not too critical.

Thus, another timer is required for the time to travel from the Height Gauge to the Width Gauge (T4). When this time has elapsed, the conveyor (M3) must be stopped.

Once the part has stopped in the correct place, the Width Gauge should move (M4) until bottom dead centre is reached (X13), where there should be a time dwell (T5) whilst the diameter measurement is read (X16). Then the gauge should move back to top dead centre (X10) and the conveyor started again (M3).

The flow diagram for this part of the process is shown in Figure 2-4-1.

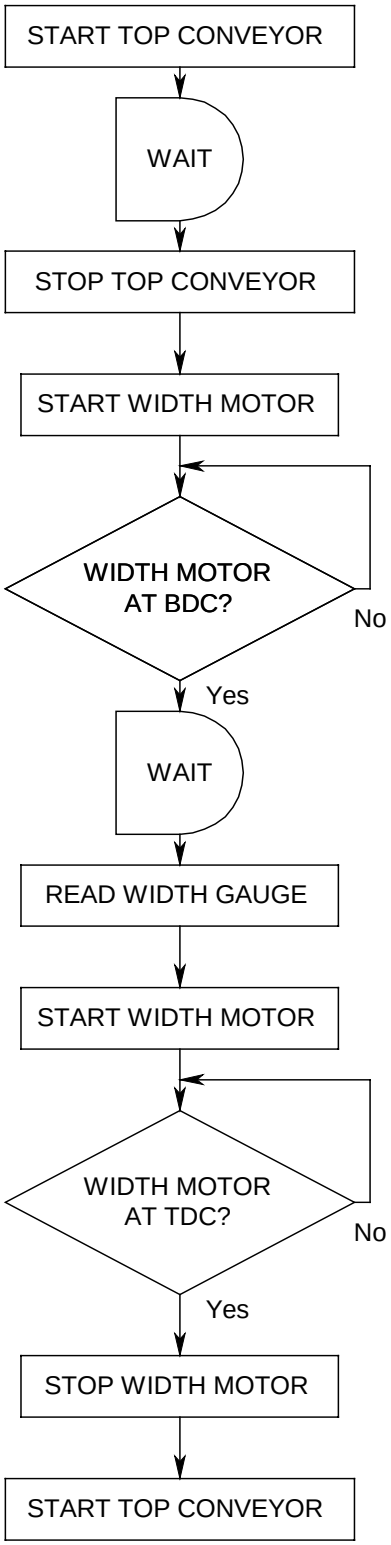


Figure 2-4-1: Width Gauge flow diagram

Construct a ladder diagram to perform the required program steps and program the PLC. Run the program and verify that you have programmed the PLC correctly.

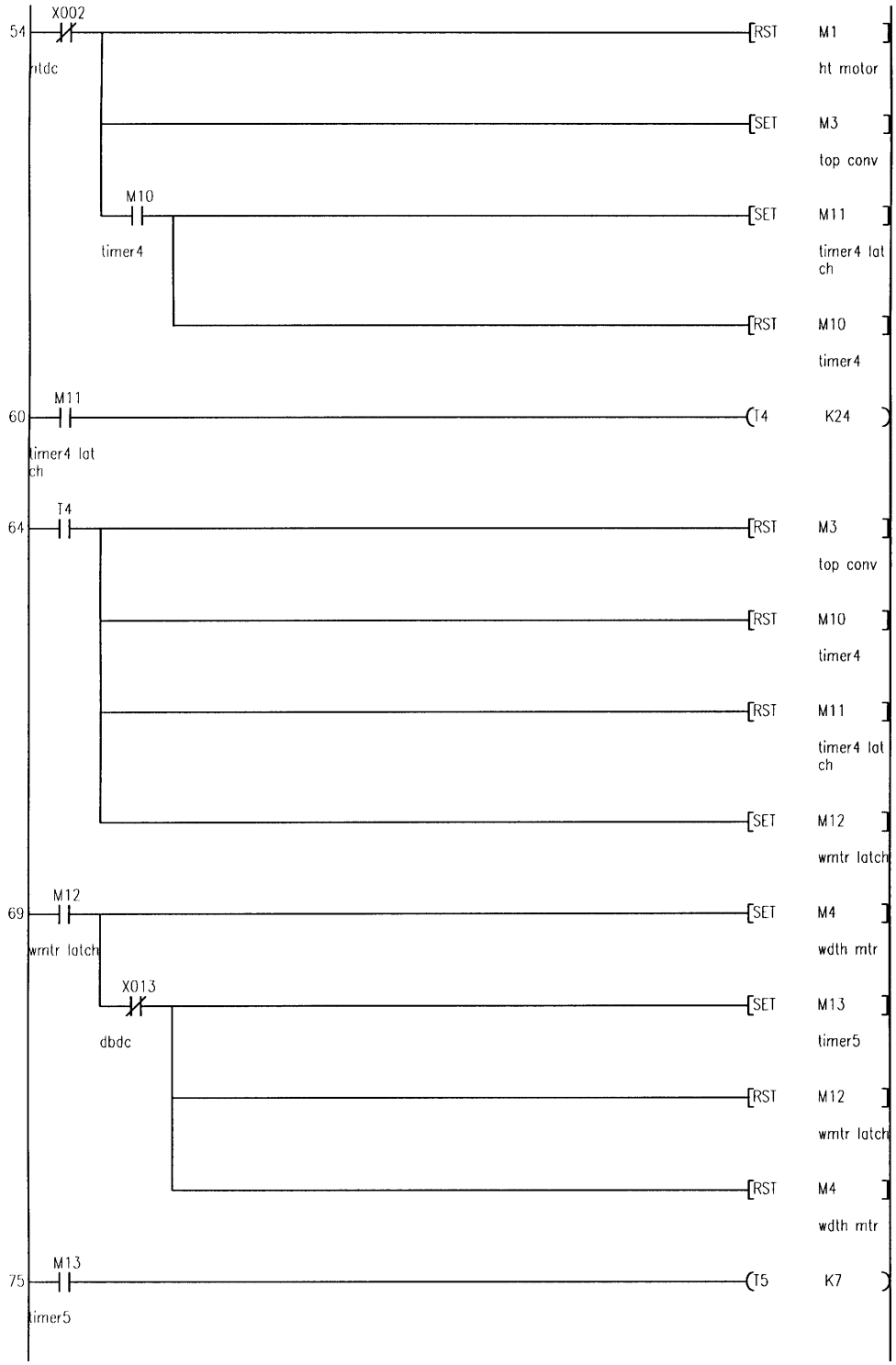


Figure 2-4-2(a): Extra programming steps required (cont'd over)

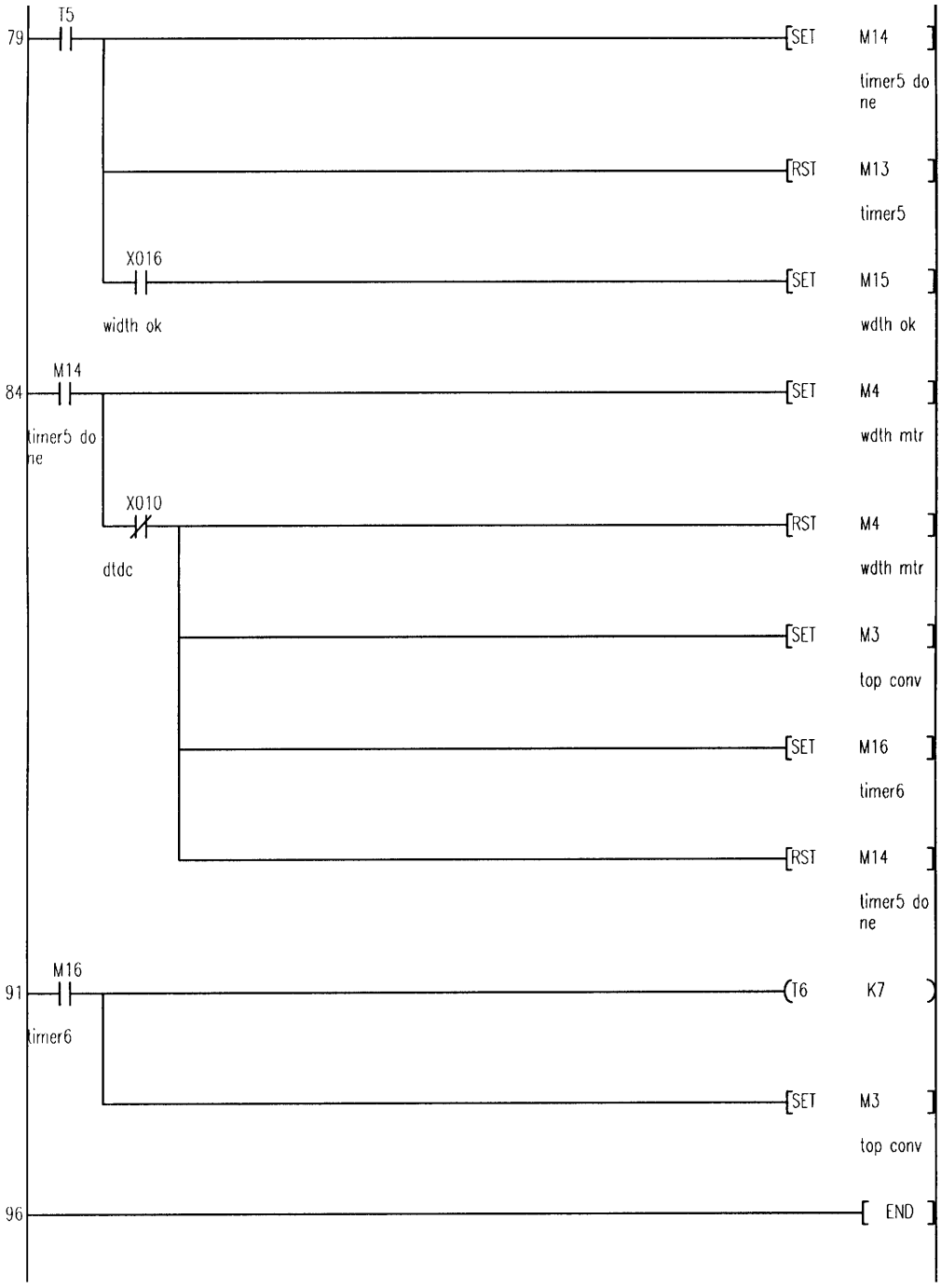


Figure 2-4-2(b): Extra programming steps required (cont'd)

Rejecting faulty diameter parts

If the part has been measured to be of the correct diameter, it should move along the conveyor until it is stopped in front of the inductive sensor.

However, if the part has been measured to be of the wrong diameter it should be rejected. This is achieved by operation of the first 'flipper' along the conveyor. When this operates, any part travelling along the conveyor will be forced off the side of the conveyor, down the chute and into the 'rejects' box.

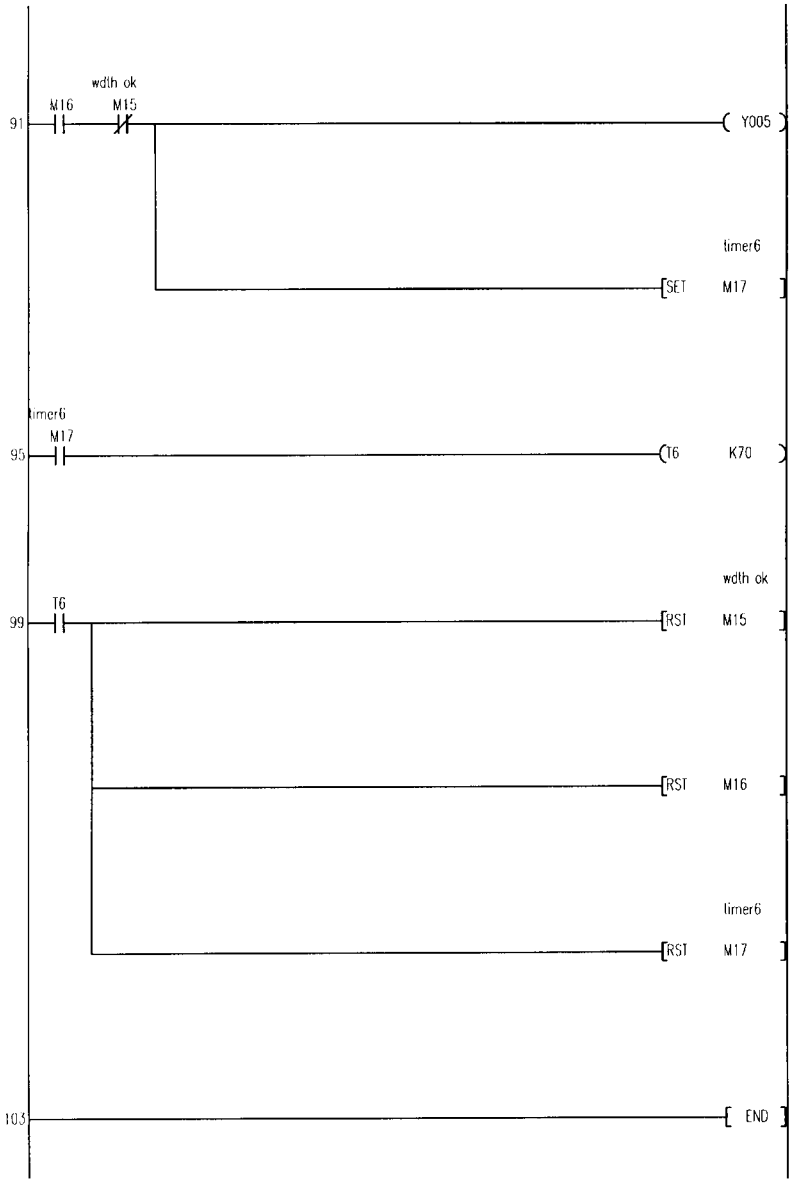


Figure 2-4-3: Reject program steps

OBJECTIVES

1 To program the PLC to select whether parts are metal or plastic and to direct them to the correct chute for future assembly.

2 Have further practice in ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell with optional Width Gauge attached (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Description of the procedure required

After the height (and the diameter – if the width gauge is fitted) has been determined, the next stage in the process is to determine whether the part is made of metal, or plastic.

An inductive transducer does this.

Identify the inductive transducer (see Figure 1-5). It is the cylindrical, threaded object mounted on a bracket about half-way along the conveyor.

On the rear of the conveyor, directly behind this transducer is a second opto-sensor. The conveyor must be stopped whenever a part comes in front of this sensor. There must then be a delay whilst the inductive transducer output is read. The conveyor should then restart.

If the height of the part had been found previously to be incorrect (M9 not set) the part should continue to the end of the conveyor and then fall into the reject box.

If the height of the part had been found previously to be correct (M9 set) and the part has been identified as plastic, the part should continue on the conveyor, the first flipper after the inductive sensor should operate and the part directed down the first chute.

If the height of the part had been found previously to be correct (M9 set) and the part has been identified as metal, the part should continue on the conveyor, the second flipper after the inductive sensor should operate and the part directed down the second chute.

Determining if metal or plastic

This requires sensing when the part reaches the opto-sensor, stopping the conveyor for a time to allow the output of the inductive transducer to be read and then starting the conveyor, again.

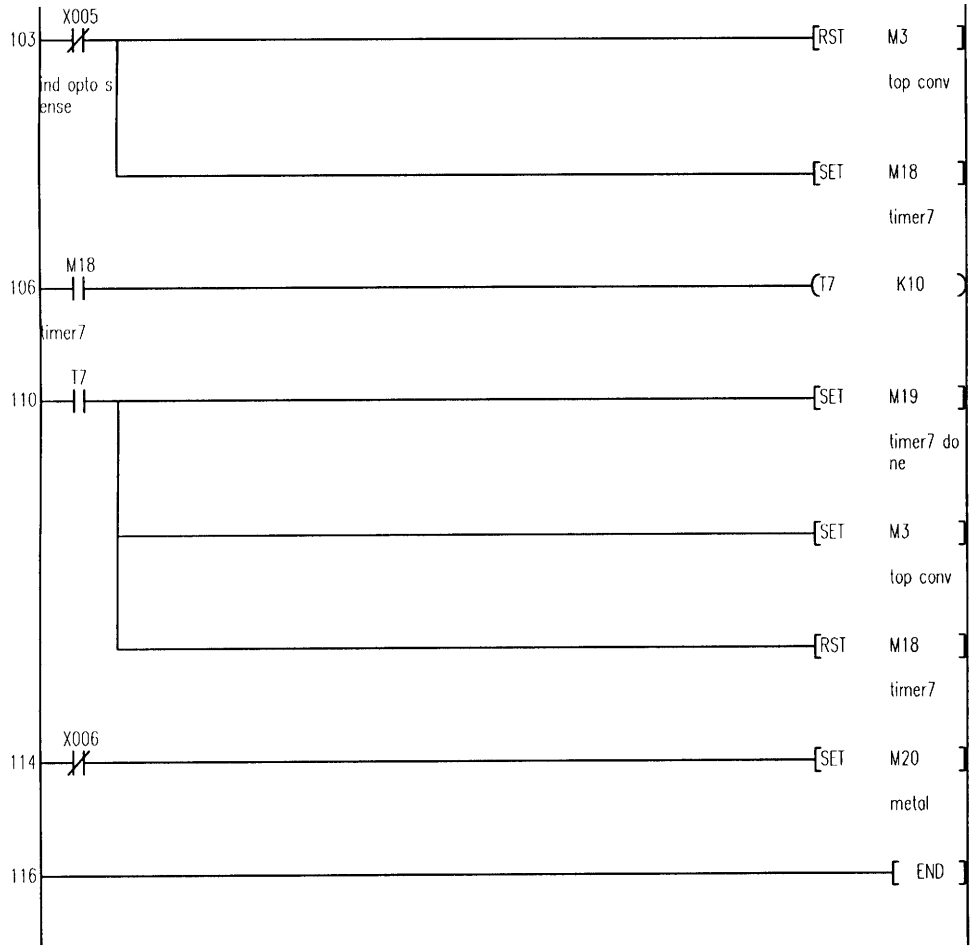


Figure 2-5-1: Inductive transducer opto sensor program

Selecting the correct chute

If the part has passed both height and width tests, on determining whether it is metal or plastic, it should proceed along the conveyor and the relevant flipper should actuate and deflect the part towards the correct material chute.

If the part did not pass the height test, the conveyor should continue to operate until the part falls off the end of the conveyor into a reject parts bin.

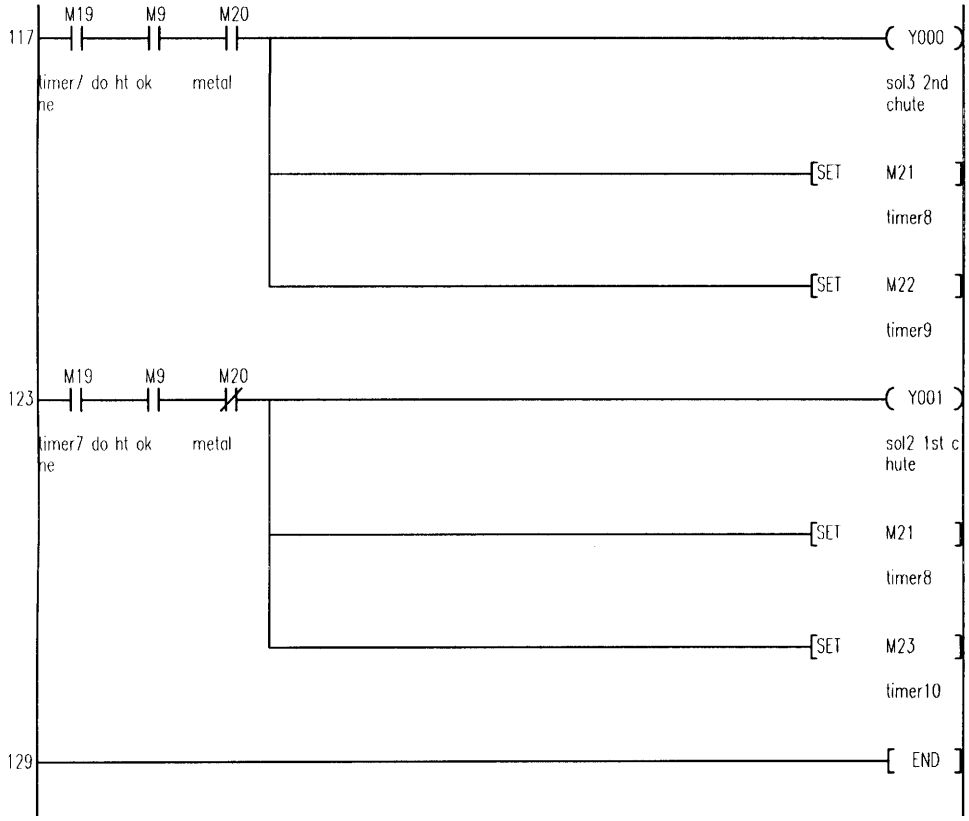


Figure 2-5-2: Operating the flippers for the chutes

Resetting the flippers and dispensing further parts

Once the part has been directed to the correct chute (or off the end of the conveyor if a reject), the relevant flipper must be reset and a further part dispensed onto the conveyor. The process should then recycle.

OBJECTIVES

1 To program the PLC to make a part available at the bottom of the relevant chute and to dispense a peg and start the lower conveyor.

2 Have further practice in ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell with optional Width Gauge attached (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Note

This Assignment requires you to have a full Workcell, including the lower conveyor. If you do not have this fitted, you will not be able to do this Assignment.

Description of the procedure required

The operation of one of the chute flippers on the upper conveyor is an indication that, after a suitable time delay, there will be a part available in the corresponding chute. That part must be dispensed to the bottom of the chute by the operation of the chute solenoid.

The lower conveyor can then be started and, when there is a part available at the bottom of either chute, a peg dispensed onto the conveyor.

The peg then travels along the conveyor to be mated with the available part.

The flow diagram for this part of the process is given in Figure 2-6-1

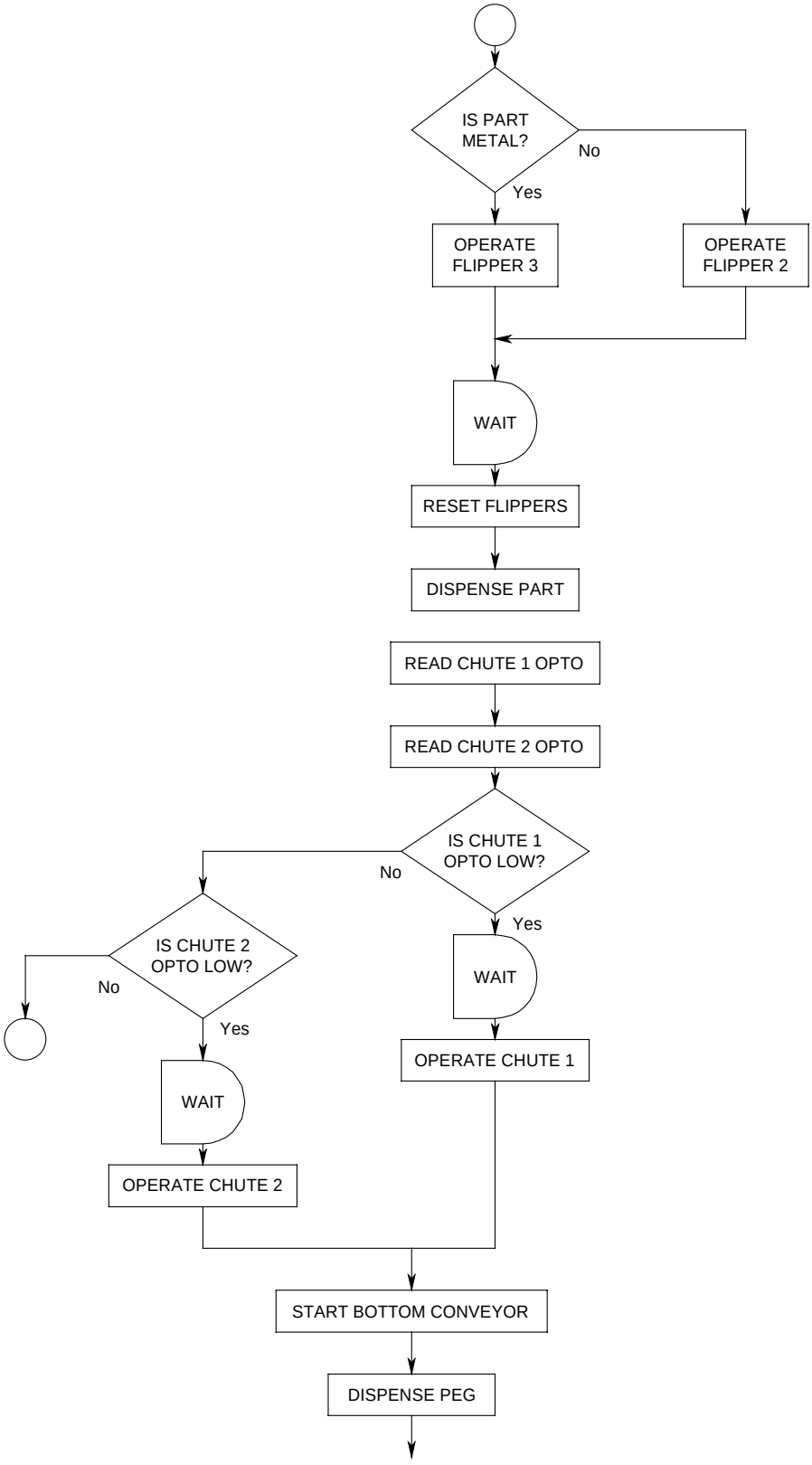


Figure 2-6-1: Flow Diagram

Operation of the chutes

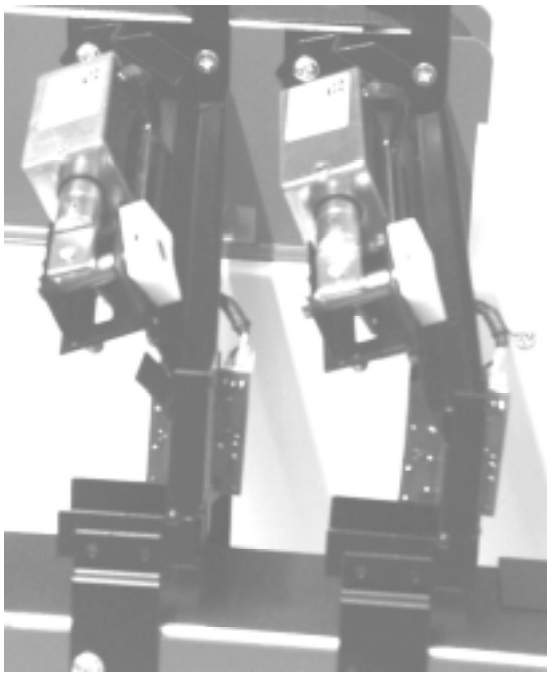


Figure 2-6-2: The parts chutes

The outputs that control the chute flippers are Y0 for the metal parts chute and Y1 for the plastic parts chute. These need to be operated whenever a corresponding part has been deemed to be of the correct height and diameter. Parts that are of the incorrect diameter have already been ejected; therefore the conditions for the flippers to operate are if the part height is correct and the decision as to whether it is metal or plastic has been made.

Also, a timer needs to be set to allow the flippers to be reset and to dispense the next part onto the top conveyor.

The ladder diagram for this is given in Figure 2-6-3.

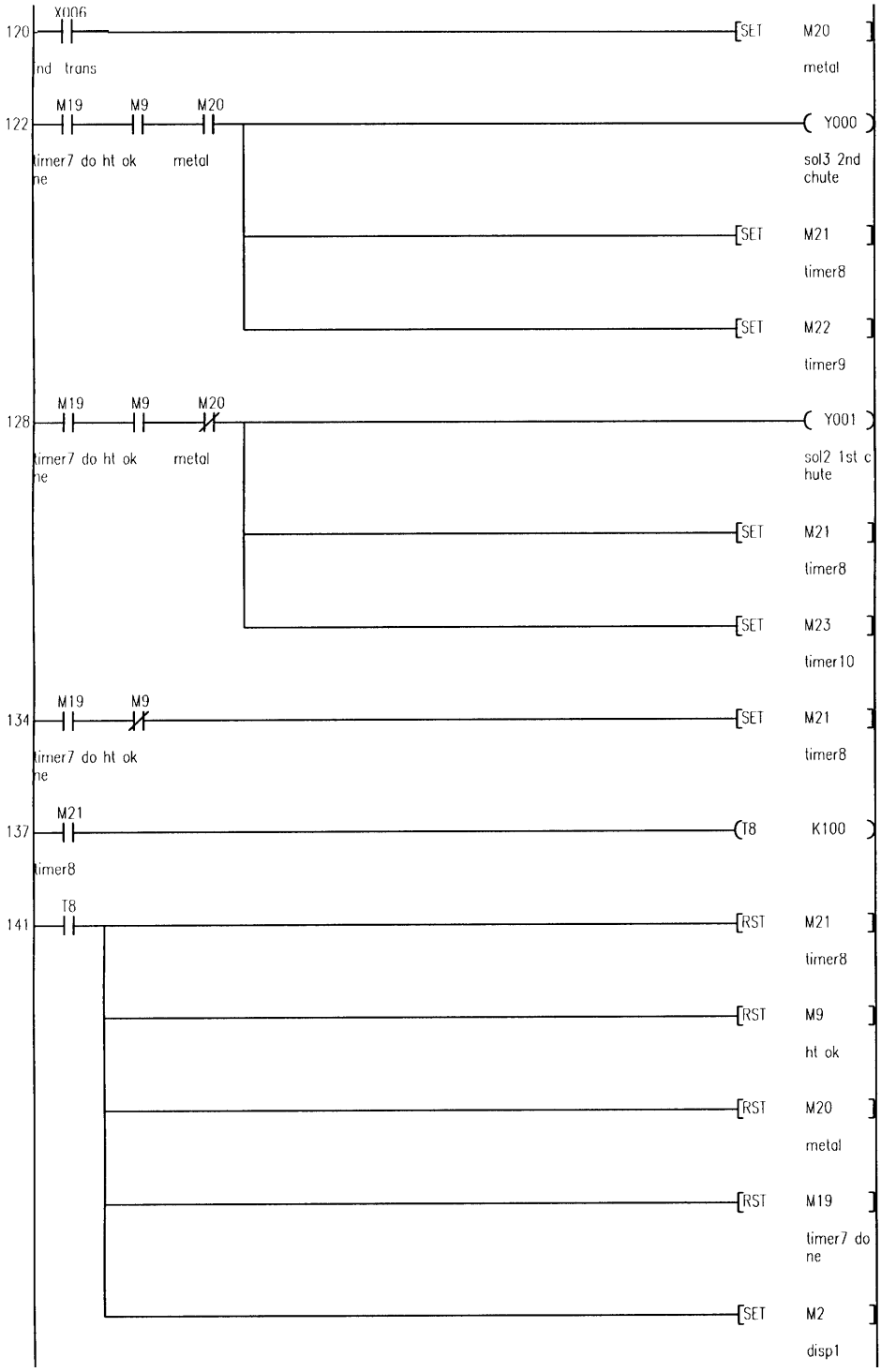


Figure 2-6-3: Ladder diagram

Dispensing a peg and starting the lower conveyor

Once the chute flippers have operated and sufficient time has elapsed to allow the part to be guided off the conveyor and into the required chute, the part is now available to be mated with a 'peg'.

Figure 2-6-4: A part (washer) and a peg

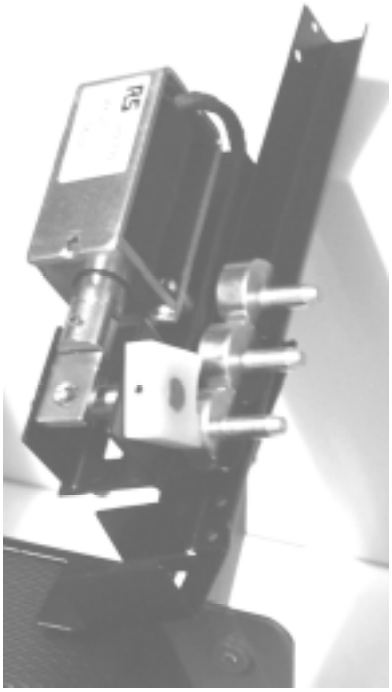


Figure 2-6-5: The peg dispenser

However, a peg should only be dispensed if there is a part available at the bottom of only one of the chutes. In a fault situation, where parts were present at the bottom of both chutes, a peg should not be dispensed.

The ladder diagram for this part of the process is given in Fig 2-6-6.

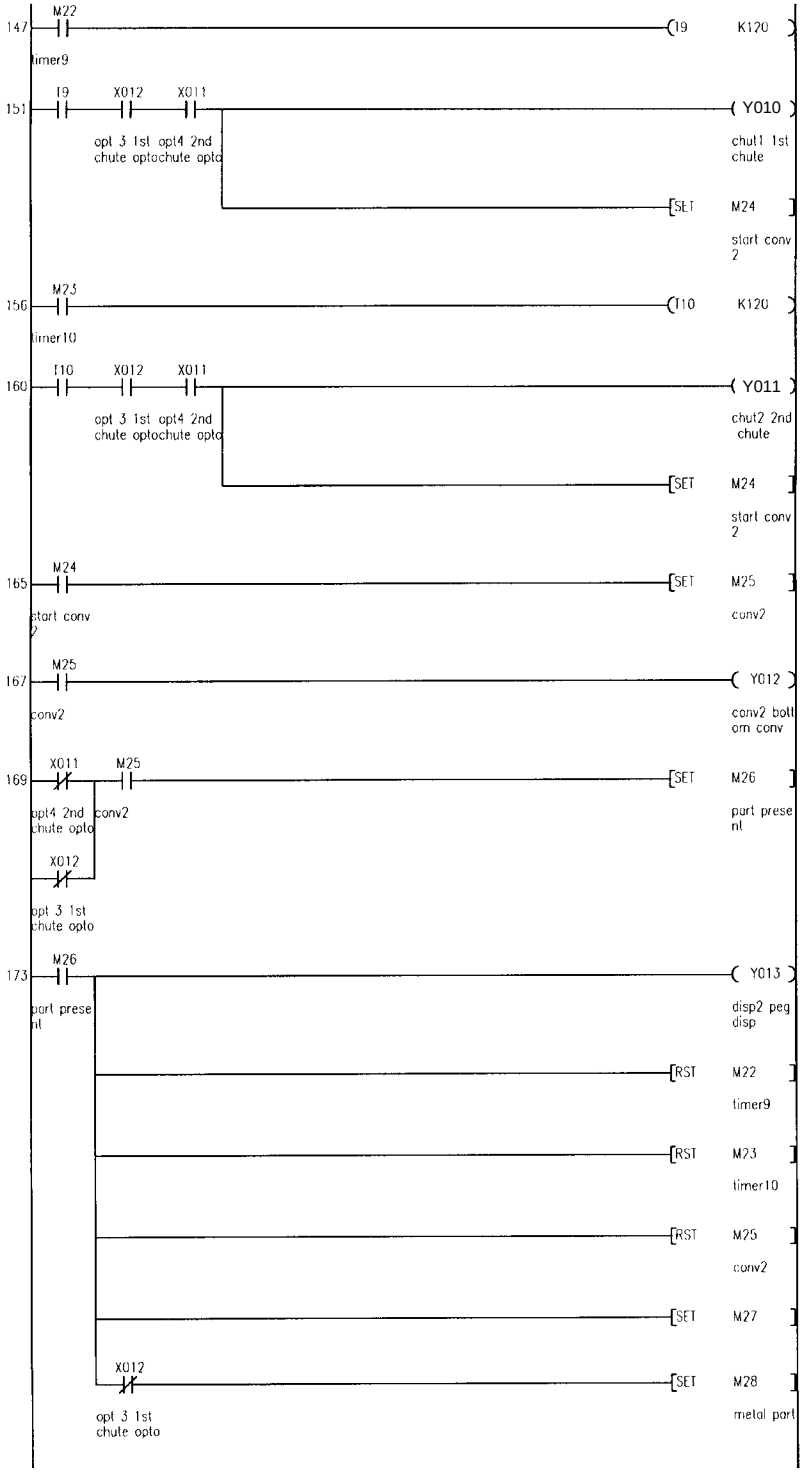


Figure 2-6-6: Chute operation

Notes

OBJECTIVES

1 To program the PLC to sort the assembled parts and pegs at the end of the lower conveyor by part material.

2 Have further practice in ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell with optional Width Gauge attached (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Note

This Assignment requires you to have a full Workcell, including the lower conveyor. If you do not have this fitted, you will not be able to do this Assignment.

Description of the procedure required

The final part of the process is directing the assembled units to the correct channel at the end of the conveyor.

If the part is metal, the assembled unit should be directed to one side of the divider (say, the far side). If the part is plastic, the assembled unit should be directed to the other side of the divider (the near side). This is accomplished by the operation of the final flipper.

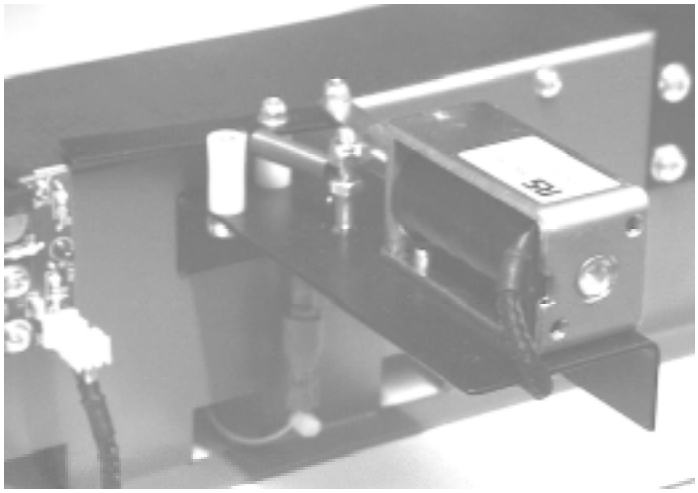


Figure 2-7-1: The parts sorting flipper

Opto-sensors determine when an assembly has been directed into a channel, and can be used to reset the flipper and dispense further parts and pegs.

The flow diagram for this final part of the process is given in Figure 2-7-2.

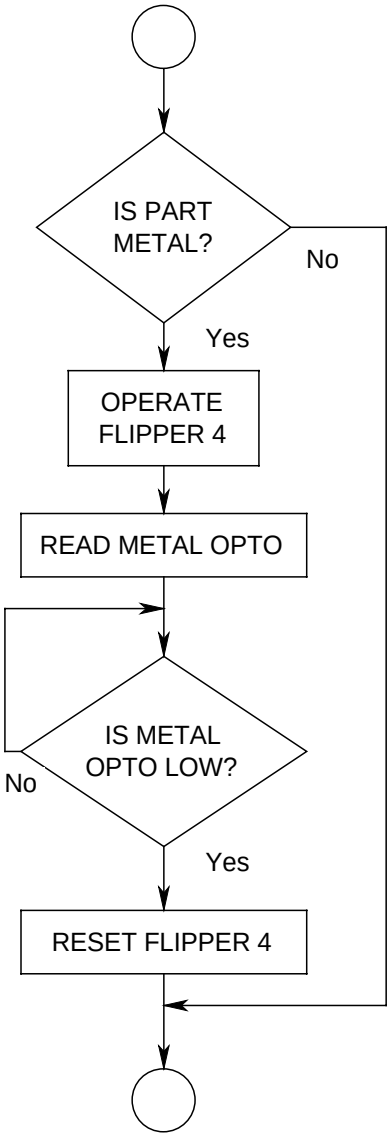


Figure 2-7-2: Flow Diagram

The corresponding program steps are given in Figure 2-7-3.

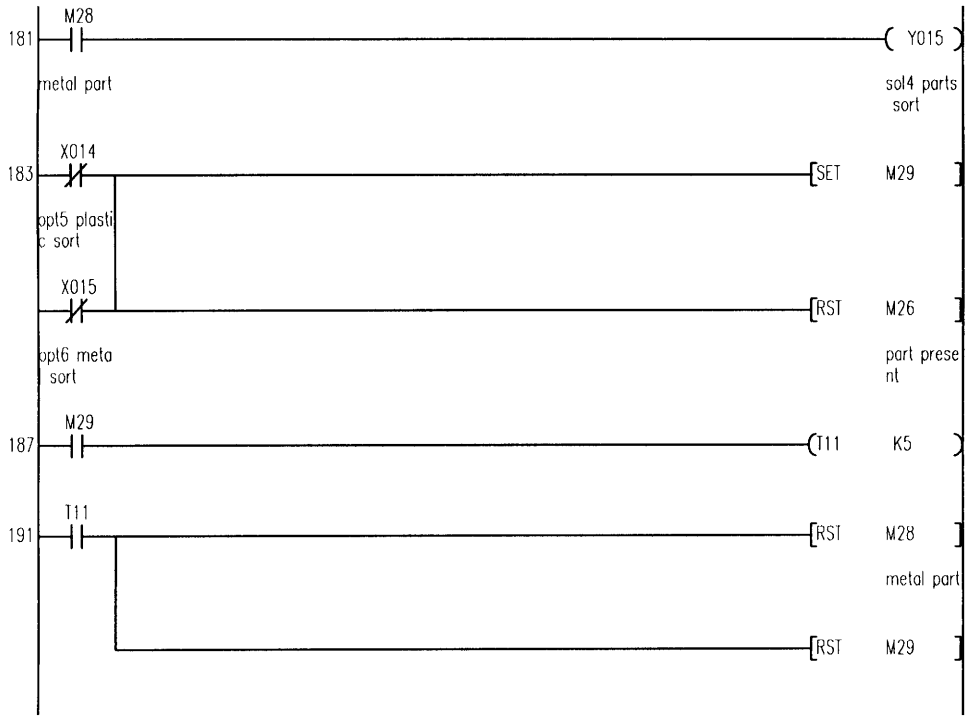


Figure 2-7-3: Ladder Diagram

OBJECTIVES

1 To program the PLC to stop the conveyor and reset the system.

2 Have further practice in ladder programming for PLCs and the IEC 1131-3 symbols.

EQUIPMENT REQUIRED

Qty	Apparatus
1	Workcell with optional Width Gauge attached (see Section 2.2 for alternatives)
	PLC manufacturer's data and instruction literature, as supplied with the PLC being used.
	Book: 'Programmable Logic Controllers and their Engineering Applications' by Alan J Crispin.

PREREQUISITE ASSIGNMENTS

Assignment 2, Workcell Initialisation and Parts Dispensing.

KNOWLEDGE LEVEL

Before working this assignment you should:

Have read Chapters 5 & 6 of the book 'Programmable Logic Controllers and their Engineering Applications'

Description of the procedure required

Some means of stopping and resetting the system is required.

The ‘Stop’ button is the red one on the printed circuit board by the top conveyor. When operated, at any time during the operation of the system, it should immediately stop the system and reset it such that pushing the green ‘Start’ button will commence the process once more.

To do this, the following must be done:

1. Stop the top and bottom conveyors
2. Stop the height motor
3. Stop the width motor
4. Reset the part dispenser
5. Reset the flippers

Figure 2-8-1 gives the ladder diagram for this.

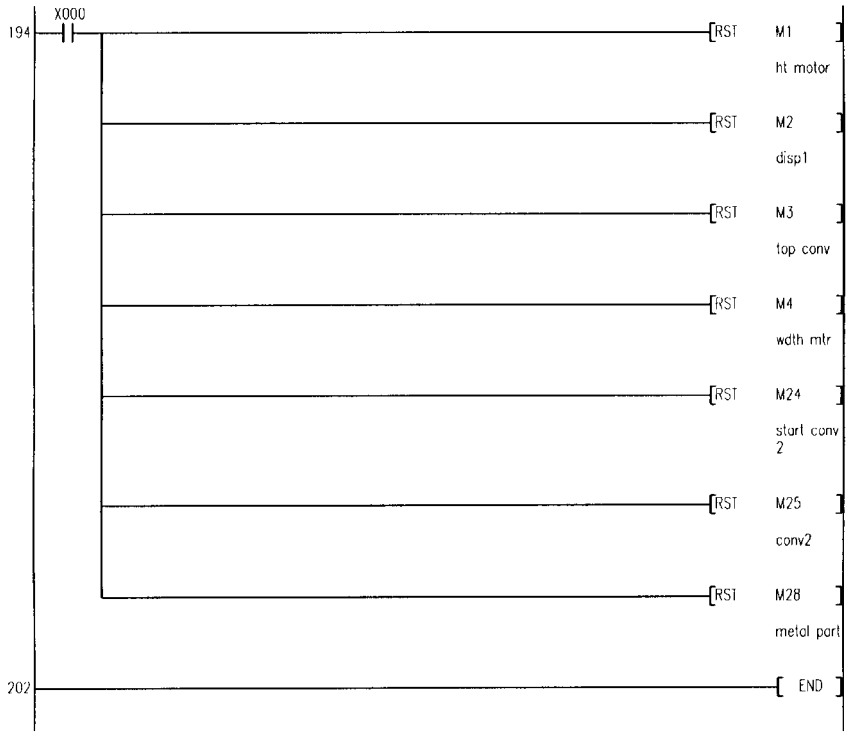


Figure 2-8-1: Ladder Diagram

The following are suggested additional exercises for those students that have mastered fully the preceding Assignments.

1. Use the signals that actuate the parts manipulator flippers (sol2 and sol3) to increment counters and those from the chute opto-sensors (opt3 and opt4) to decrement those counters, so that the number of washers held in each chute is known.
2. Use the information from 1, above, to stop the system if the number of washers in any chute fills it up.
3. Use the opto-sensors at the entrance to the final sorting channels (opt5 and opt6) to determine when a channel is full. Stop the system if this happens.

4. Set a timer after initial washer dispensing (disp1) so that, if the part does not reach the first opto-sensor (opt1) before this time has elapsed a fault is deemed to have occurred and the system is stopped.

Notes

3 Allen-Bradley MicroLogix 1000 PLC

3.1 Introduction

The Allen-Bradley PLC that is recommended for the Workcells (and is supplied as part of the 34-002 and 34-004 products) is the MicroLogix 1000, 1761-L32BWA.

The programming software used for this PLC is RSLogix 500. This is also supplied if the PLC Pack is purchased from Feedback.

Ensure that you have read Chapter 1, at least up to Section 1.2.1 before proceeding to connect up the PLC.

3.1.1 Connecting the PLC

Whichever PLC is used with the equipment, it must be connected to the interface printed circuit board (located to the left of the upper conveyor) using normal, stranded, insulated equipment wire (not provided).

Although it is not mandatory to follow the connection instructions given below, they **ARE recommended** if you wish to use any of the pre-programmed examples supplied with the equipment.

All of the connections to the PLC are to be found along the front edge of the board. You will need a small screwdriver to make the connections.

The connections and their descriptions are given in Table 1-1 and the physical positions of the input and output devices to which the pin names refer are shown in Figs 1.10 and 1.11 (these are in Chapter 1). The table is reproduced here as Table 3-1, for reference.

Connector #	Connector name	Pin name	Pin description
J27	PLC1 outputs	sol3	Solenoid for 2nd chute
		sol2	Solenoid for 1st chute
		sol1	Width (diameter) reject solenoid
		hmdrv	Height (thickness) motor drive
		disp1	Washer dispenser
		conv1	Top conveyor motor
J28	PLC2 outputs	chut2	Dispense 2nd washer chute
		chut1	Dispense 1st washer chute
		sol4	Exit guide solenoid
		conv2	Bottom conveyor motor
		disp2	Base dispenser
		wmdrv	Width (diameter) motor drive
J26	PLC1 inputs	24pc1	24V supply input
		0vpc1	0V supply input
		stop	Stop button
		spr1	Spare
		hbdc	Height (thickness) gauge bottom dead centre
		htdc	Height (thickness) gauge top dead centre
		hght	Height (thickness) OK
		opt1	Pre-height gauge opto sensor
		opt2	Inductive detector opto sensor
		ind	Inductive sensor
J11		dmx	Diameter>maximum
		dmn	Diameter<minimum
J25	PLC2 inputs	24pc2	24V supply input
		0vpc2	0V supply input
		spr2	Spare
		wdth	Width (diameter) OK
		opt6	Exit guide 1 opto sensor
		opt5	Exit guide 2 opto sensor
		opt4	2nd chute opto sensor
		opt3	1st chute opto sensor
		dbdc	Width (diameter) gauge bottom dead centre
		dtdc	Width (diameter) gauge top dead centre
J10		start	Start button
		hmax	Height (thickness)>maximum
		hmin	Height (thickness)<minimum

Table 3-1: Interface Board Connections

3.1.1.1 The Allen-Bradley MicroLogix 1000 1761-L32BWA PLC

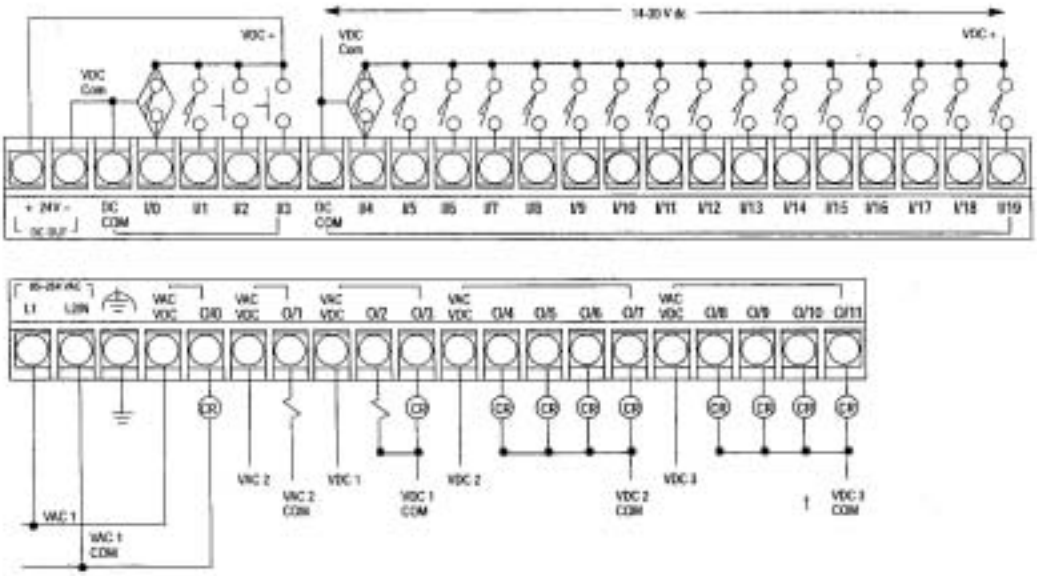
A suggested connection scheme that will correspond with the example programs provided with the equipment is given in Table 3-2.

Connector #	Connector name	Pin name	Connected to on 1761-L32BWA PLC
J27	PLC1 outputs	sol3	O-0
		sol2	O-1
		sol1	O-5
		hmdrv	O-4
		displ	O-2
		conv1	O-3
J28	PLC2 outputs	chut2	O-7
		chut1	O-8
		sol4	O-11
		conv2	O-9
		disp2	O-10
		wmdrv	O-6
J26	PLC1 inputs	24pc1	+24VDC OUT
		0vpc1	-24VDC OUT
		stop	I-0
		hbdc	I-1
		htdc	I-2
		hght	I-3
		opt1	I-4
		opt2	I-5
		ind	I-6
J25	PLC2 inputs	24pc2	+24VDC OUT
		0vpc2	-24VDC OUT
		spr2	NC
		wdth	I-16
		opt6	I-15
		opt5	I-14
		opt4	I-11
		opt3	I-12
		dbdc	I-17
		dtdc	I-18
J10		start hmin hmax	I-9 I-7 I-8

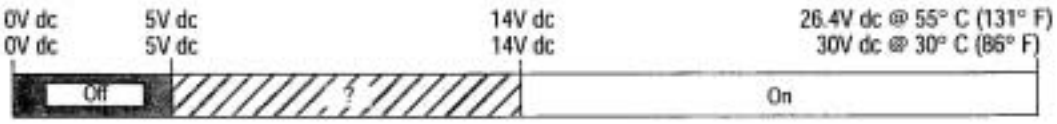
Table 3-2: Allen-Bradley MicroLogix 1000 1761-L32BWA PLC Connections

In addition to the connections in the table, the input DC COM terminals should be connected together and to the 24V DC OUT –ve terminal. The output VAC VDC terminals should all be connected together and to the 24V DC OUT +ve terminal. All other connections on the PLC are to be left open circuit. Figures 3-1 and 3-2 show these connections diagrammatically.

1761-L32BWA Wiring Diagram (Sinking Input Configuration)



1761-L32BWA Input Voltage Range



1761-L32BWA Output Voltage Range

Figure 3-1: The PLC connections and working voltage ranges

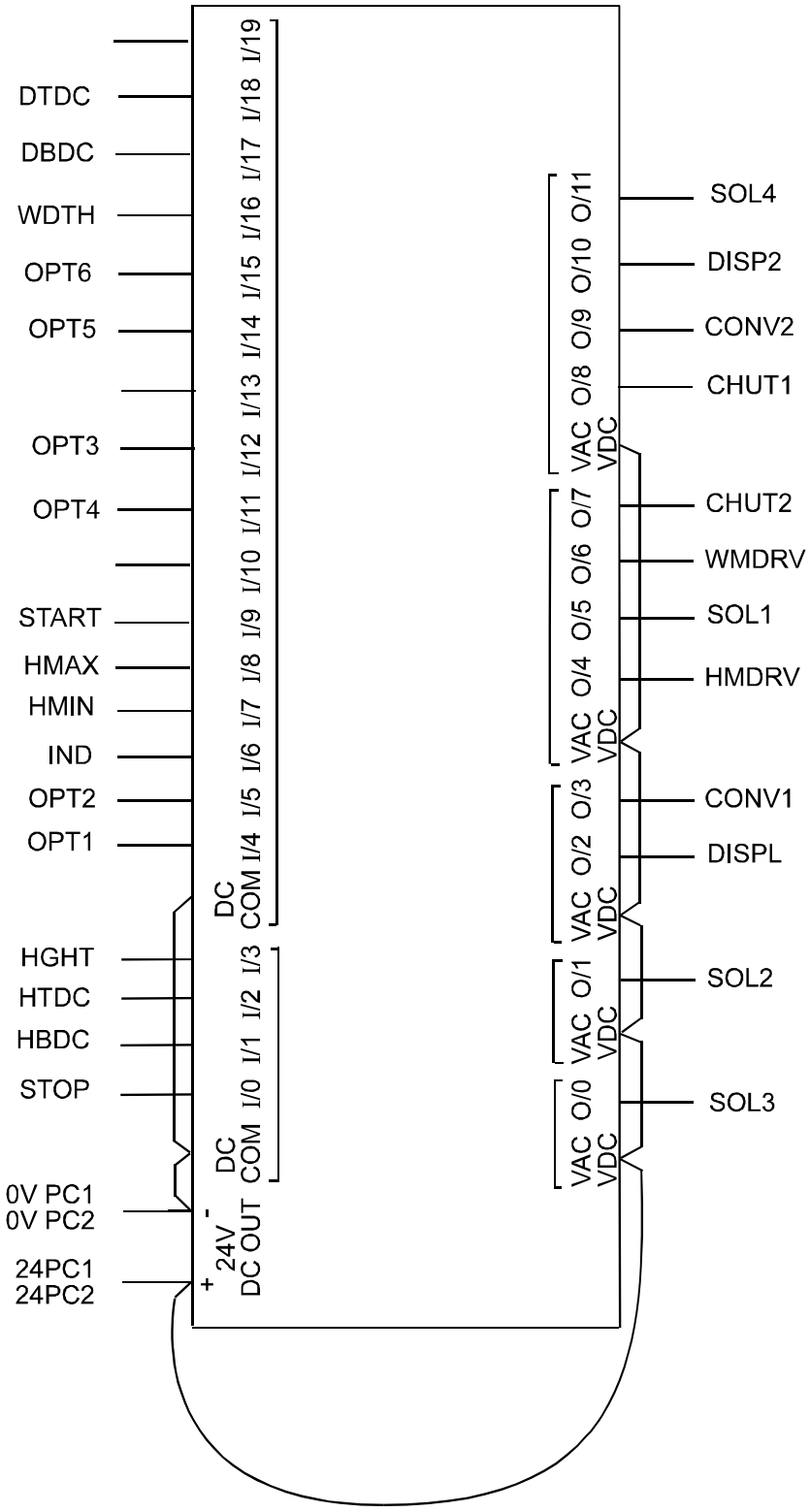


Figure 3-2: **The PLC Connections**

3.1.2 Running the system

Plug in the Conveyor/Workcell and the PLC to the mains supply and switch on.

To ascertain whether the inputs are connected correctly, pass a component, or your finger, in front of each opto sensor and see if the corresponding LED on the PLC changes (the Inductive Sensor input will need a metal washer passed in front of it to operate the LED). Also, the 'start' and 'stop' buttons on the printed circuit board should be pressed to see if the corresponding LED's change.

3.1.2.1 The test program

The test program below will exercise all of the outputs associated with the Workcell.

If you have a hand-held programming pod follow the manufacturer's instructions as to how to enter the program.

If you have the RSLogix 500, or similar, PC-based software this can be used to download the program. The test program is **test.rss** on the supplied disk. Follow the manufacturer's instructions as to how to enter and download the program.

The green 'start' button on the printed circuit board starts the program. Ensure that you have the PLC slide switch set to 'run' for the program to operate.

The test program will operate each of the output devices, in turn. Observe that this happens.

An alternative way of testing that the output devices are functioning correctly is to connect one end of a piece of equipment wire to the 24V output terminal of the PLC and touch briefly the other end of the wire, in turn, to each of the device output terminals on the PLC (O-0 to O-15). Each device should operate as required.

Note:
It is NOT good practice to let output devices remain energised for long periods of time. Ensure that your testing or programming does not allow this to happen.

3.2 Performing the Assignments

All of the Assignments described in Chapter 2 are possible with the Allen-Bradley PLC. However, there are differences in some of the terminology and operational detail of the controllers.

The flow diagrams are controller-independent and can be used as a guide.

The program commands required will differ in some details. Consult your Allen-Bradley handbook to see the differences.

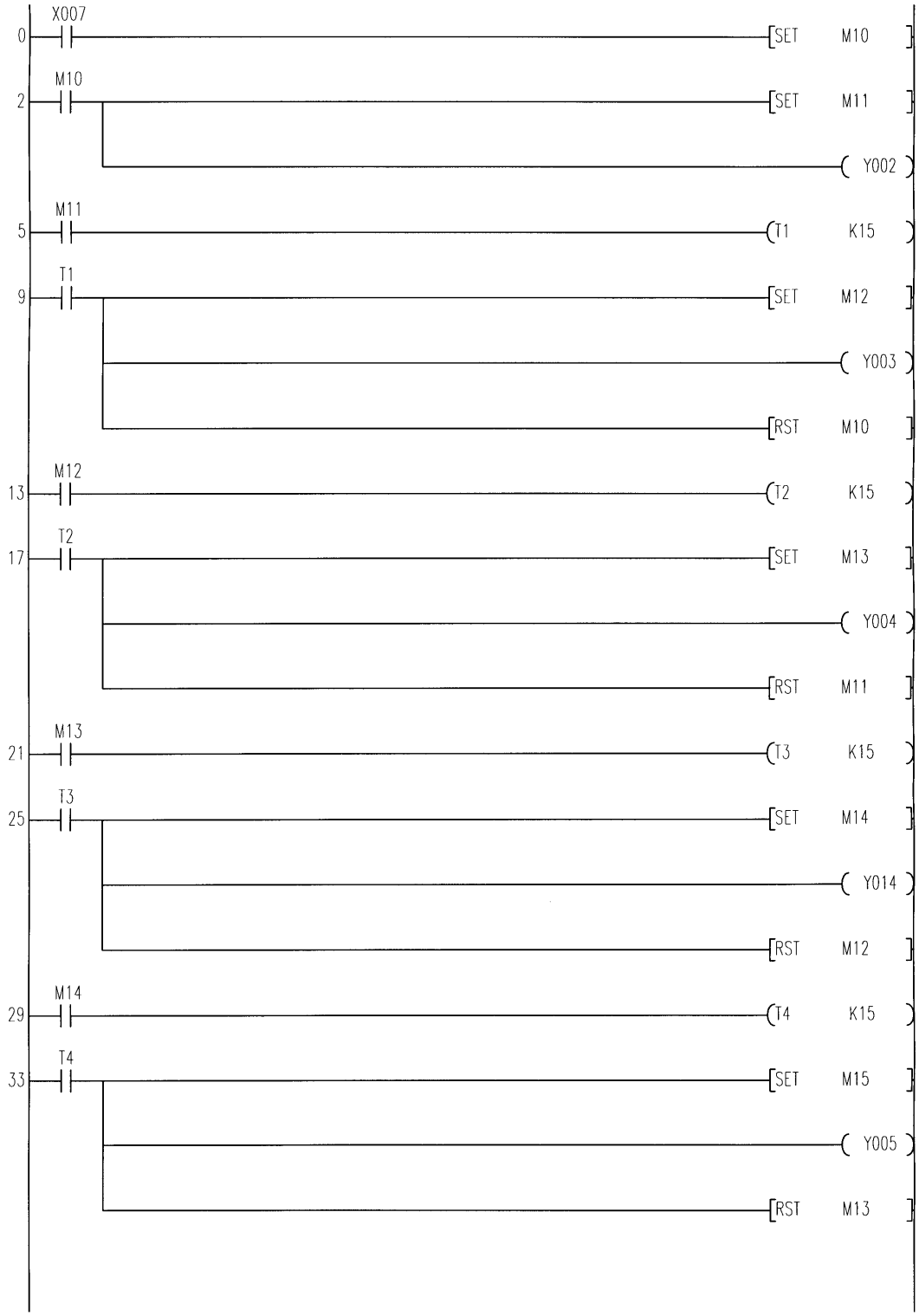
Some sample programs are supplied on the software disk with the system. These are listed in Appendix D. They are examples of operational programs and do not use all of the available features of the hardware. Additional programming exercises that use more of the features are suggested in Assignment 9.

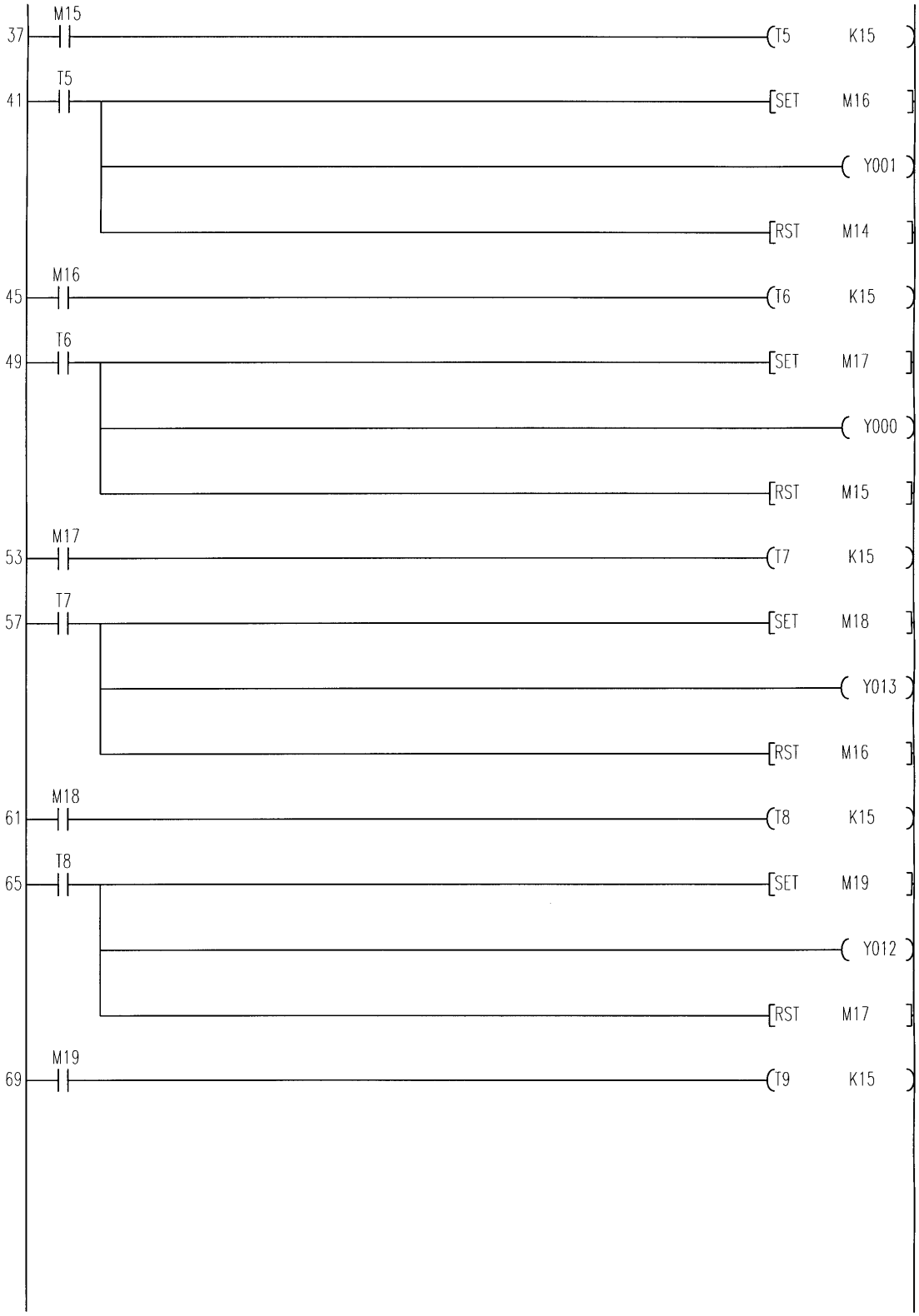
Notes

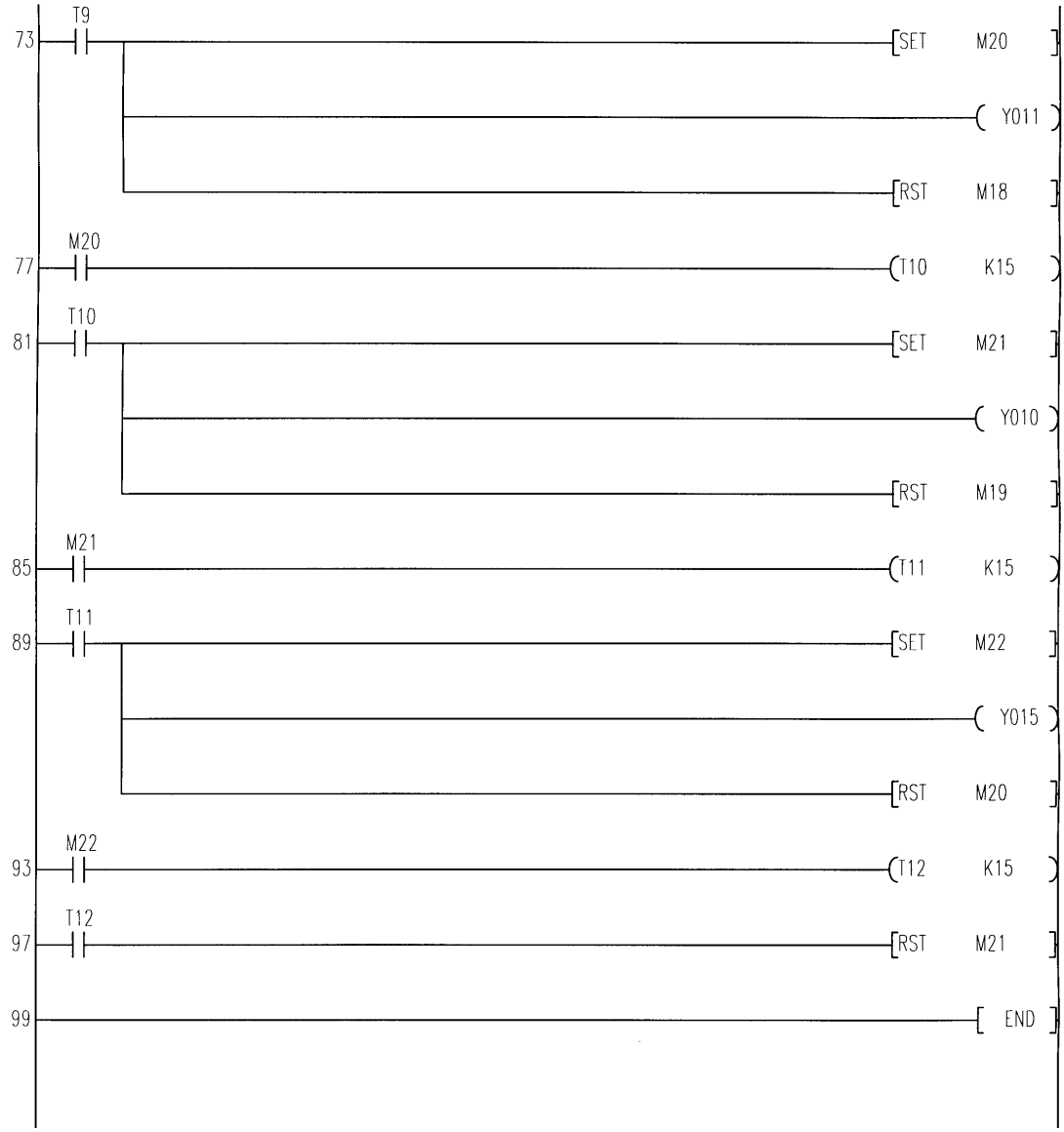
4 Appendices

Notes

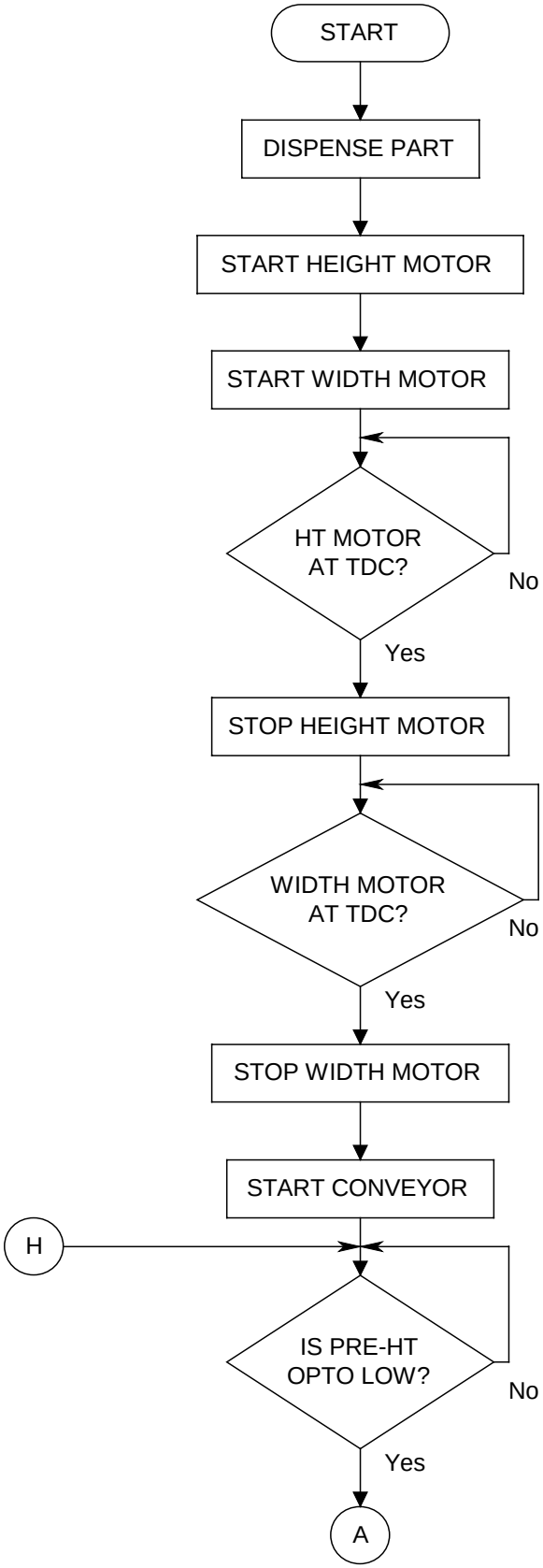
The ladder diagram for the test program (test1.pmw) is as follows:

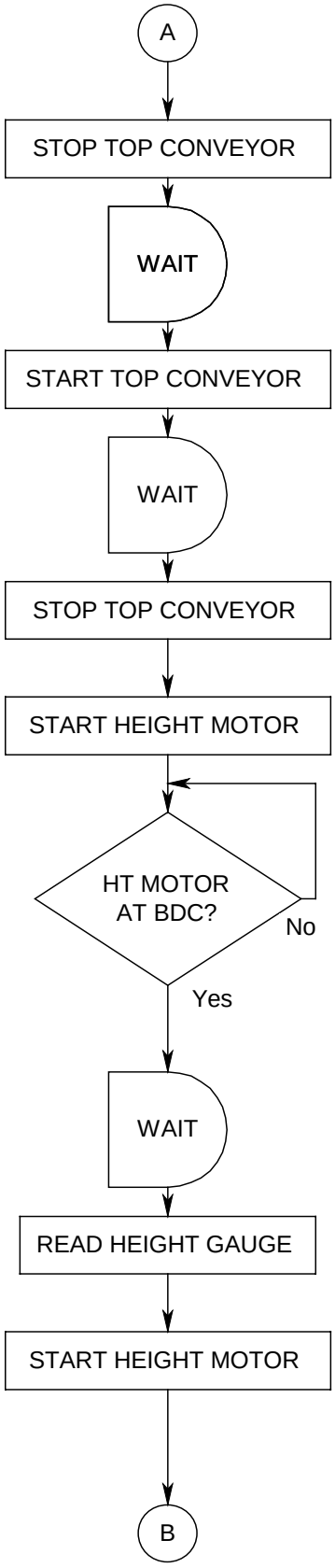


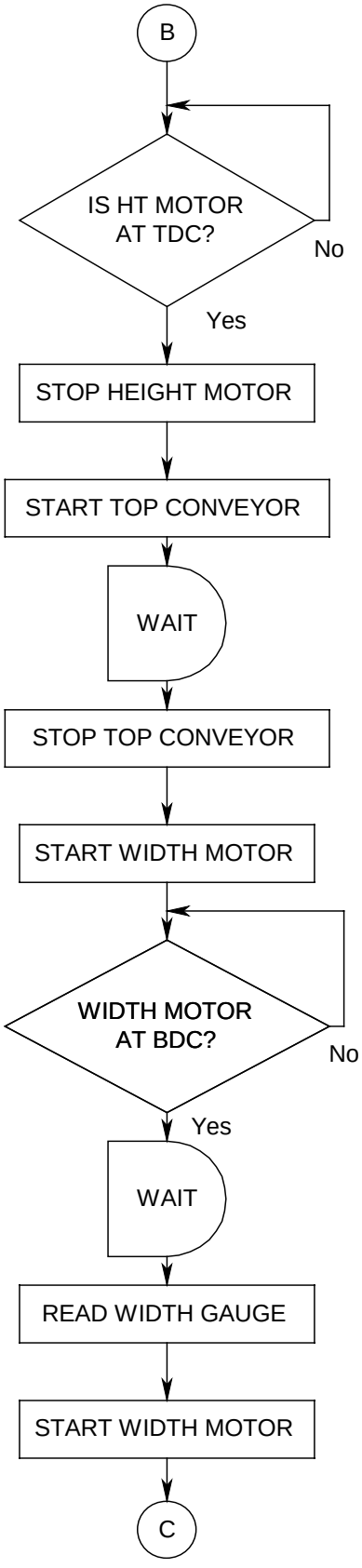

37 M15 T5 K15
41 T5 SET M16
Y001
RST M14
45 M16 T6 K15
49 T6 SET M17
Y000
RST M15
53 M17 T7 K15
57 T7 SET M18
Y013
RST M16
61 M18 T8 K15
65 T8 SET M19
Y012
RST M17
69 M19 T9 K15

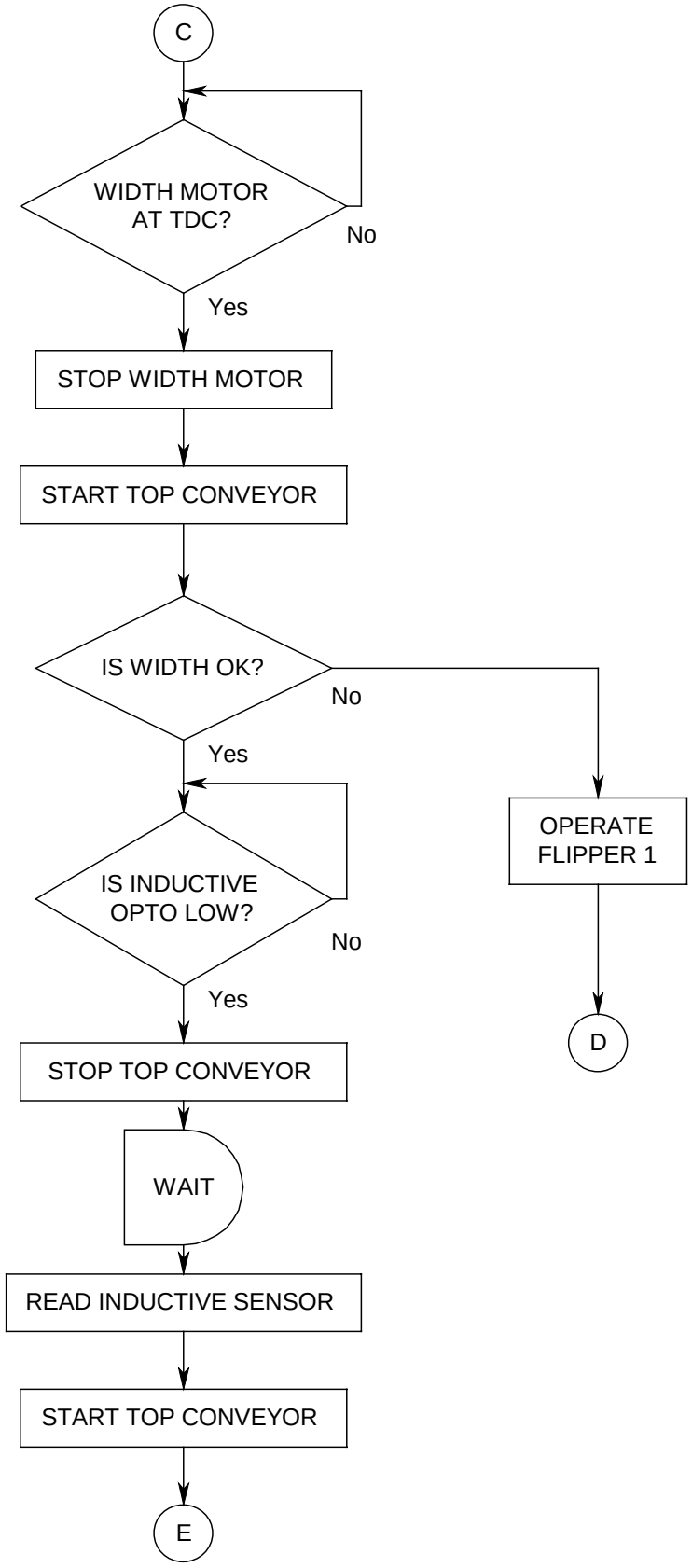

73
T9
SET M20
Y011
RST M18
77
M20
T10 K15
81
T10
SET M21
Y010
RST M19
85
M21
T11 K15
89
T11
SET M22
Y015
RST M20
93
M22
T12 K15
97
T12
RST M21
99
END

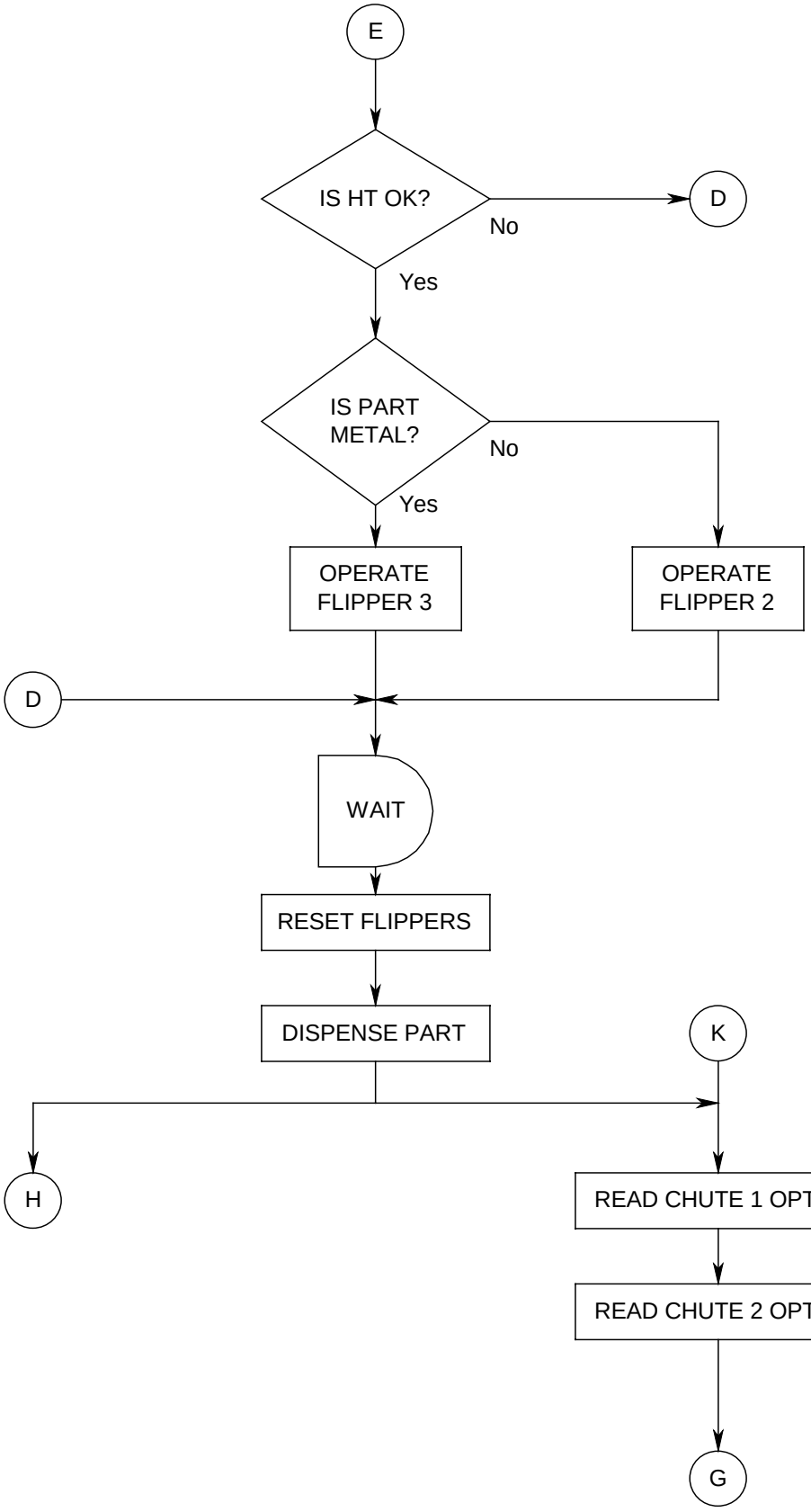
Notes

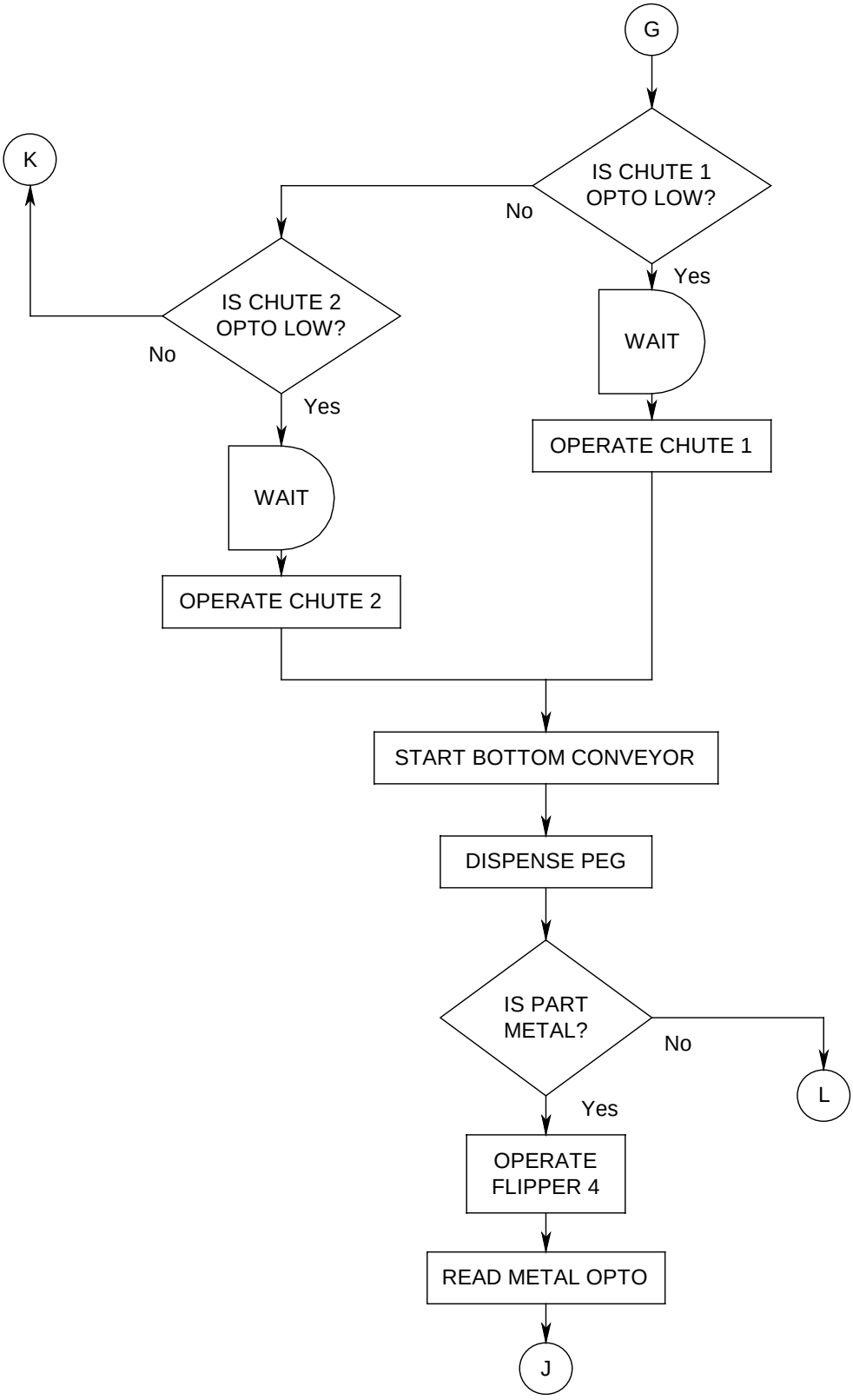

START
DISPENSE PART
START HEIGHT MOTOR
START WIDTH MOTOR
HT MOTOR
AT TDC?
No
Yes
STOP HEIGHT MOTOR
WIDTH MOTOR
AT TDC?
No
Yes
STOP WIDTH MOTOR
START CONVEYOR
H
IS PRE-HT
OPTO LOW?
No
Yes
A

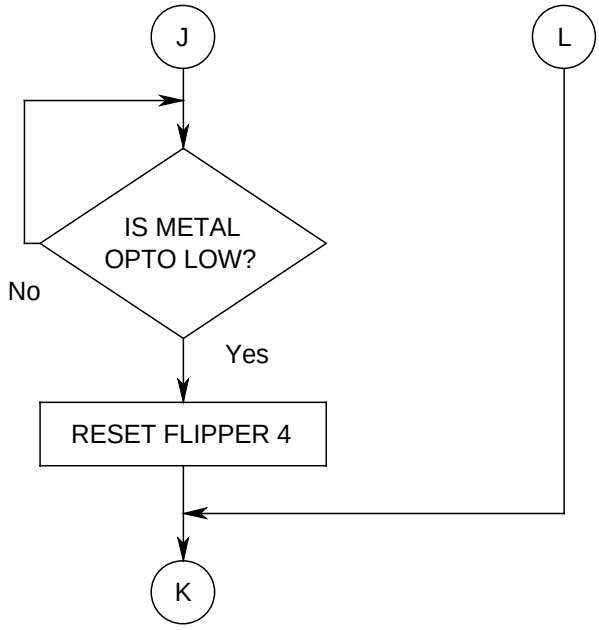

A
STOP TOP CONVEYOR
WAIT
START TOP CONVEYOR
WAIT
STOP TOP CONVEYOR
START HEIGHT MOTOR
HT MOTOR
AT BDC?
No
Yes
WAIT
READ HEIGHT GAUGE
START HEIGHT MOTOR
B


B
IS HT MOTOR AT TDC?
No
Yes
STOP HEIGHT MOTOR
START TOP CONVEYOR
WAIT
STOP TOP CONVEYOR
START WIDTH MOTOR
WIDTH MOTOR AT BDC?
No
Yes
WAIT
READ WIDTH GAUGE
START WIDTH MOTOR
C

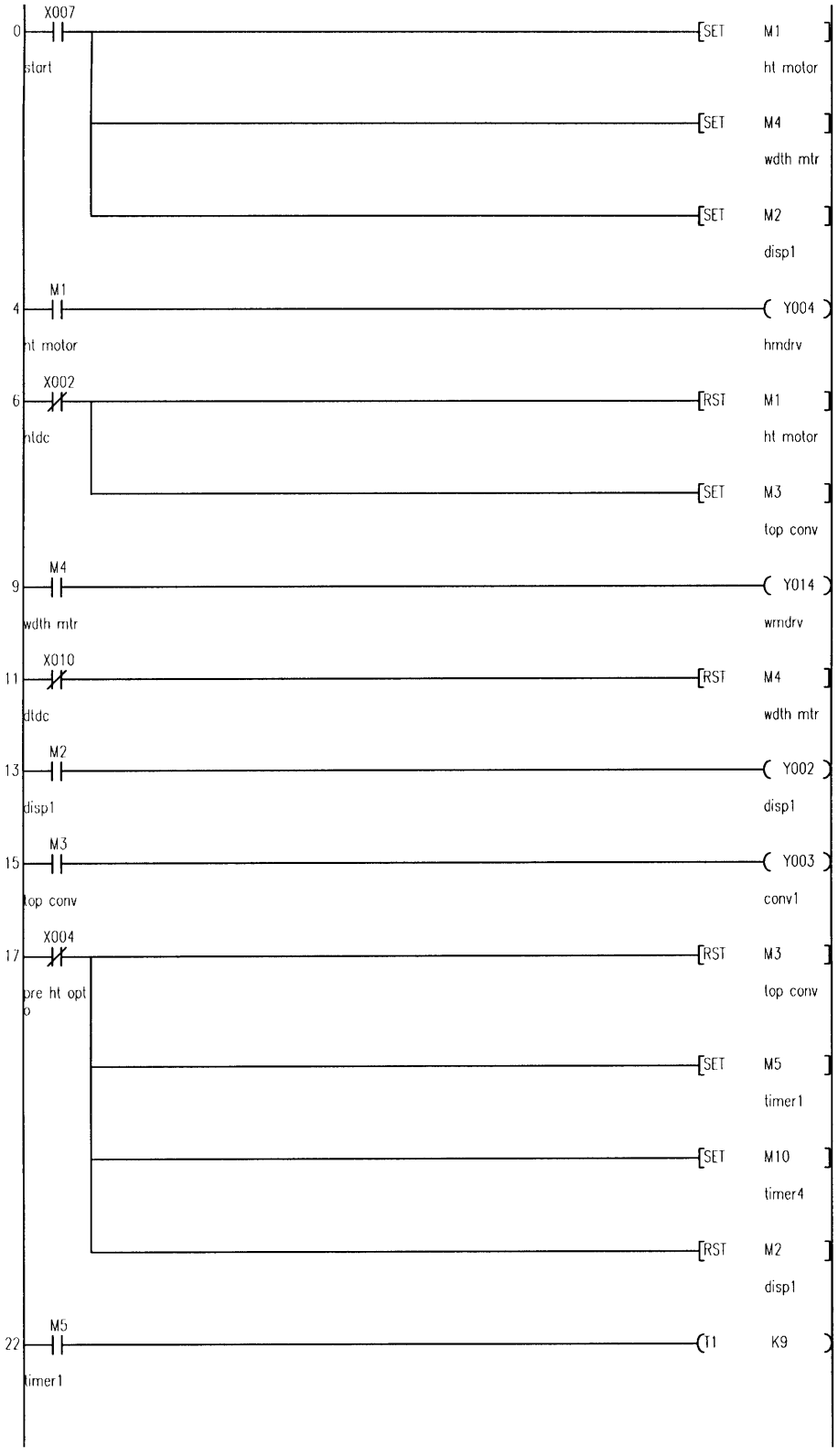

C
WIDTH MOTOR AT TDC?
No
Yes
STOP WIDTH MOTOR
START TOP CONVEYOR
IS WIDTH OK?
No
Yes
OPERATE FLIPPER 1
IS INDUCTIVE OPTO LOW?
No
Yes
D
STOP TOP CONVEYOR
WAIT
READ INDUCTIVE SENSOR
START TOP CONVEYOR
E

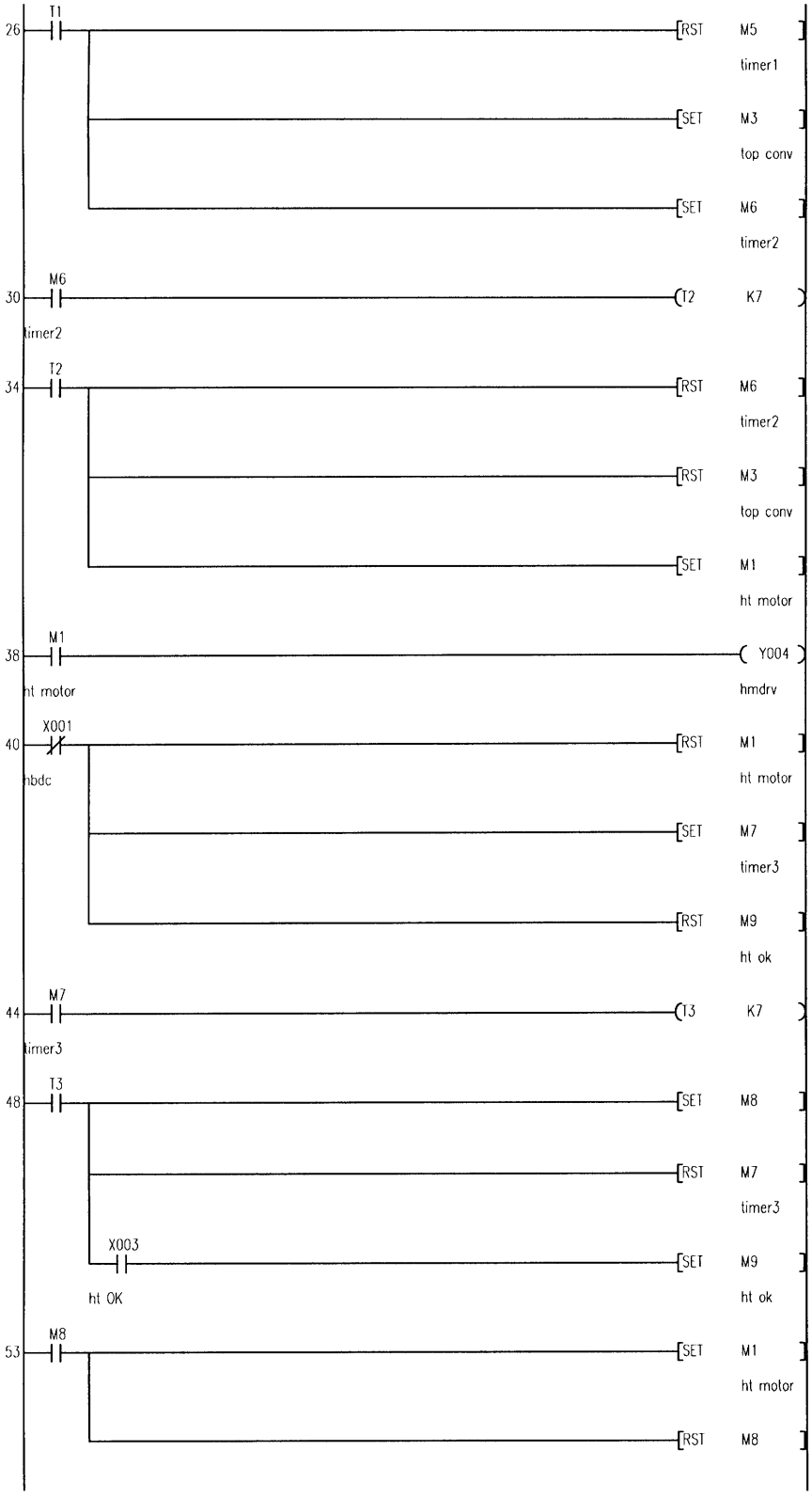

E
IS HT OK?
No
D
Yes
IS PART METAL?
No
Yes
OPERATE FLIPPER 3
OPERATE FLIPPER 2
D
WAIT
RESET FLIPPERS
DISPENSE PART
K
H
READ CHUTE 1 OPTO
READ CHUTE 2 OPTO
G

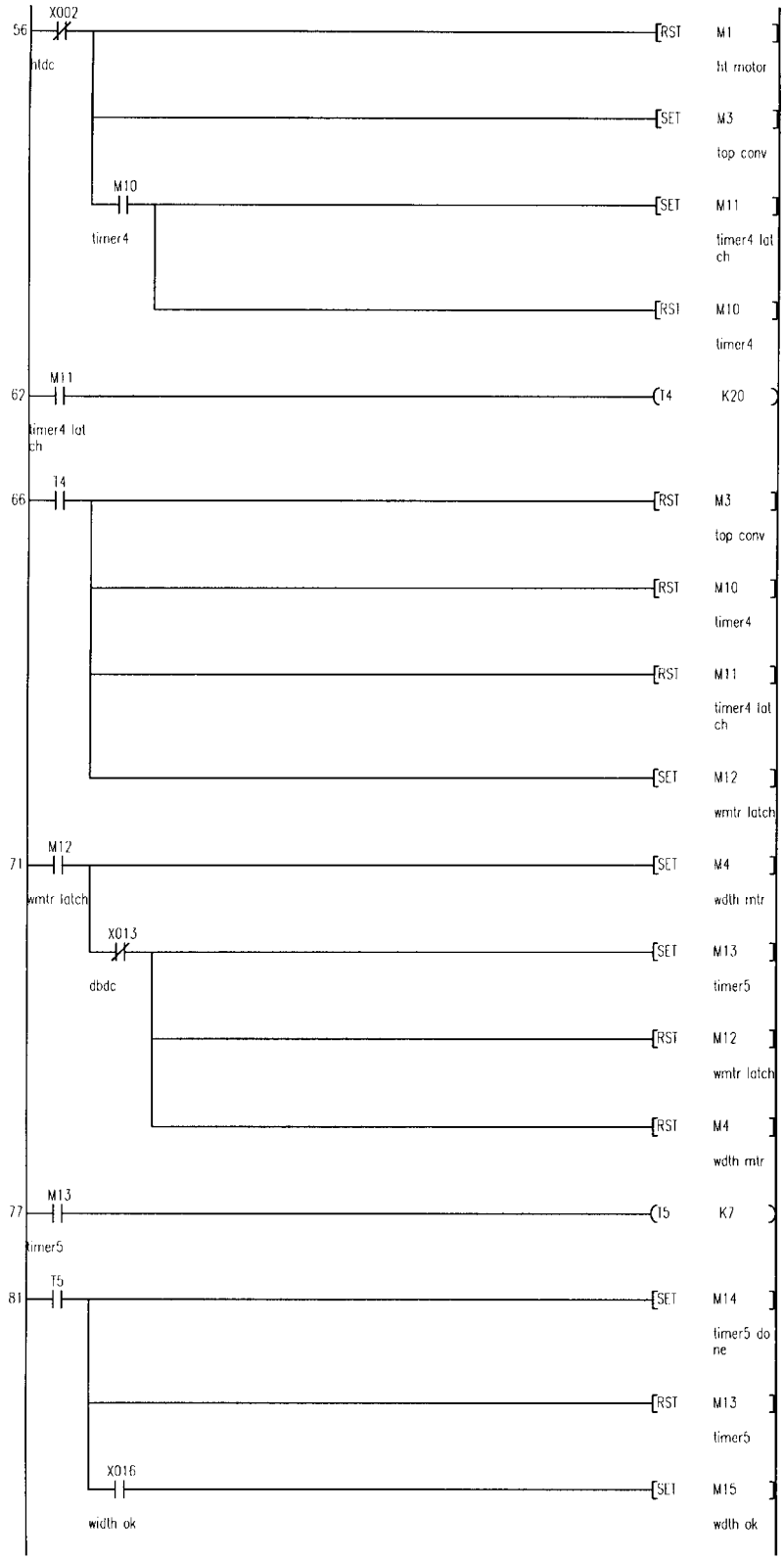

G
IS CHUTE 1
OPTO LOW?
No
Yes
K
IS CHUTE 2
OPTO LOW?
No
Yes
WAIT
OPERATE CHUTE 1
WAIT
OPERATE CHUTE 2
START BOTTOM CONVEYOR
DISPENSE PEG
IS PART
METAL?
No
L
Yes
OPERATE
FLIPPER 4
READ METAL OPTO
J

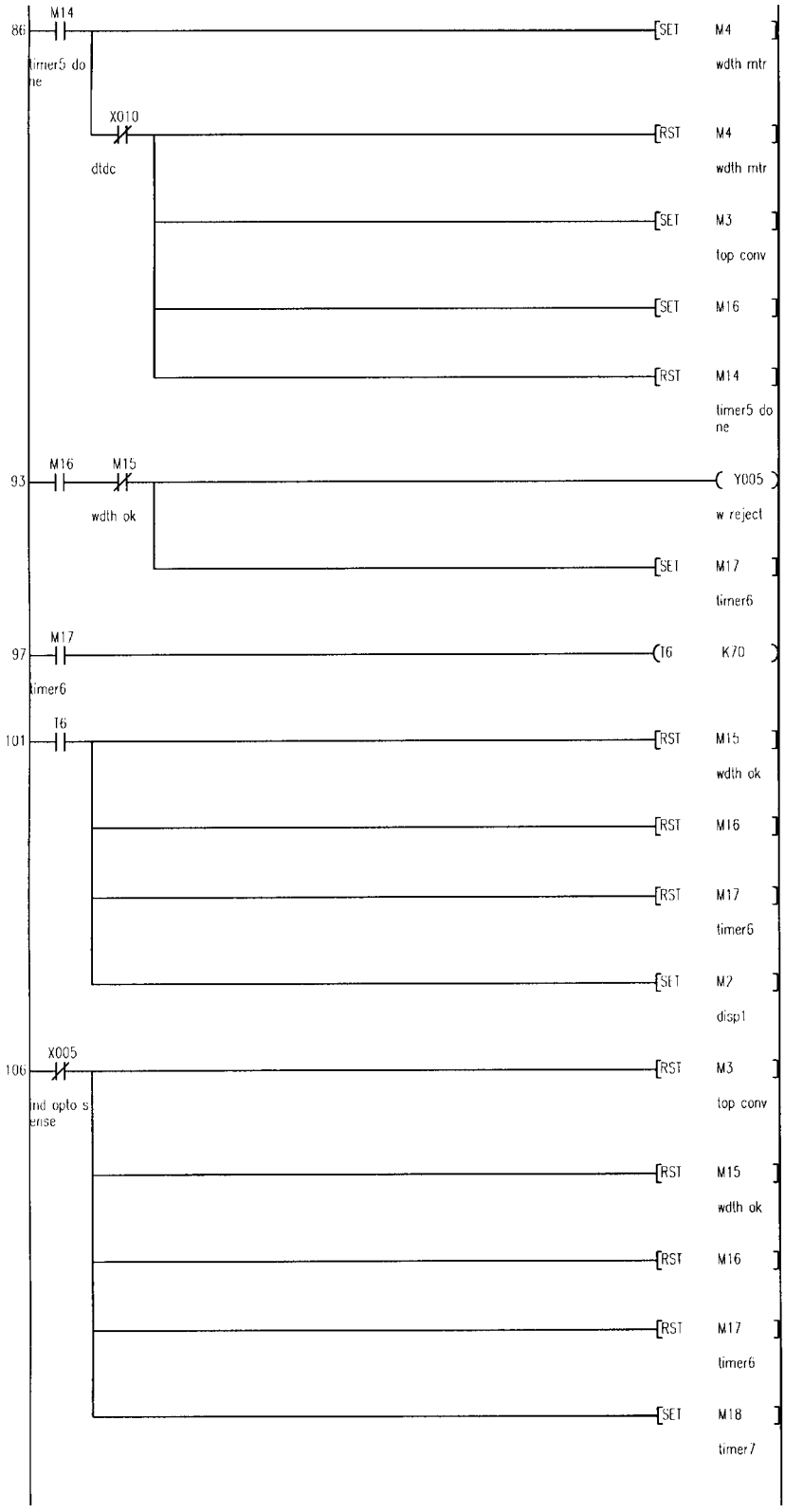

J
L
IS METAL
OPTO LOW?
No
Yes
RESET FLIPPER 4
K

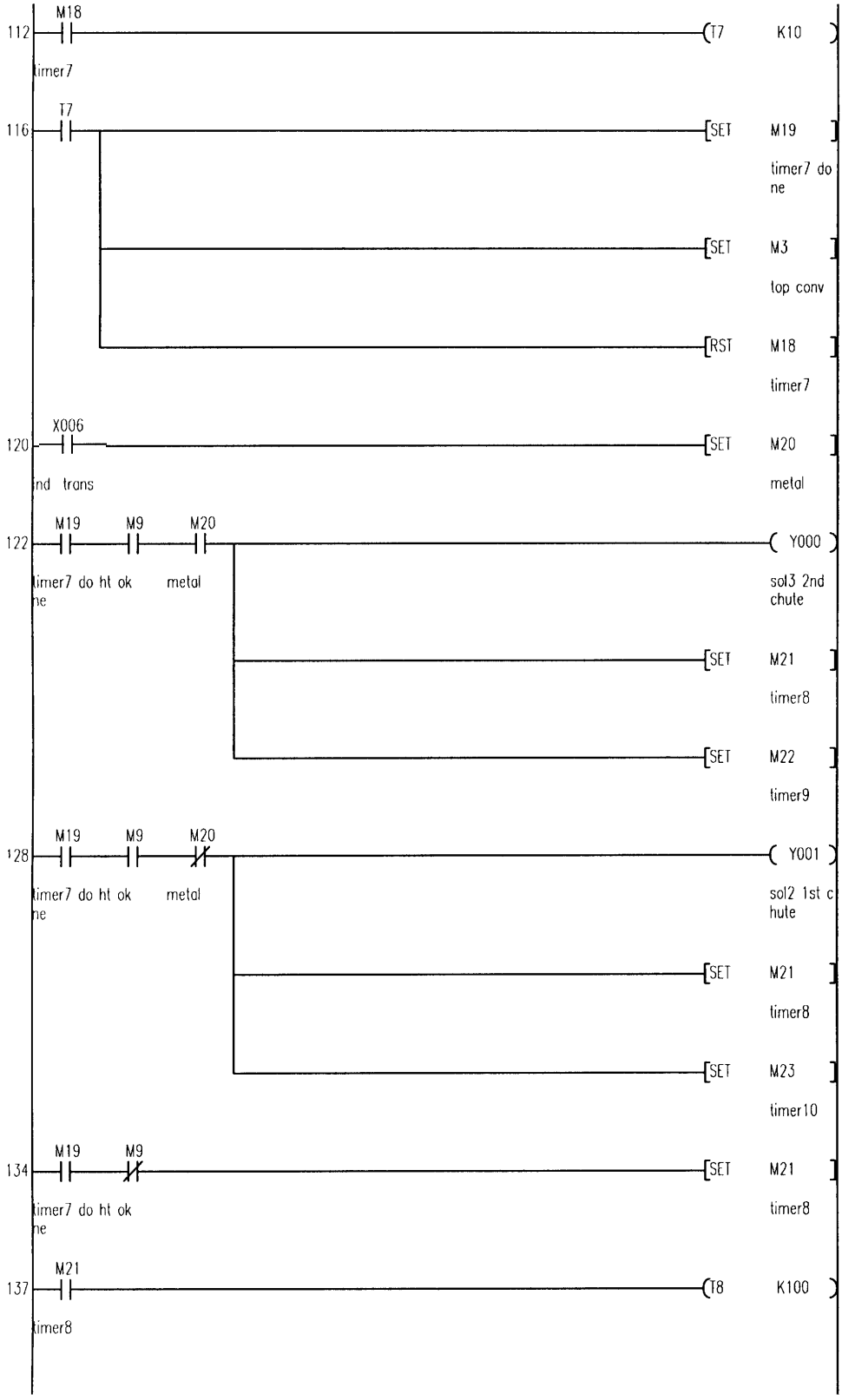
Notes

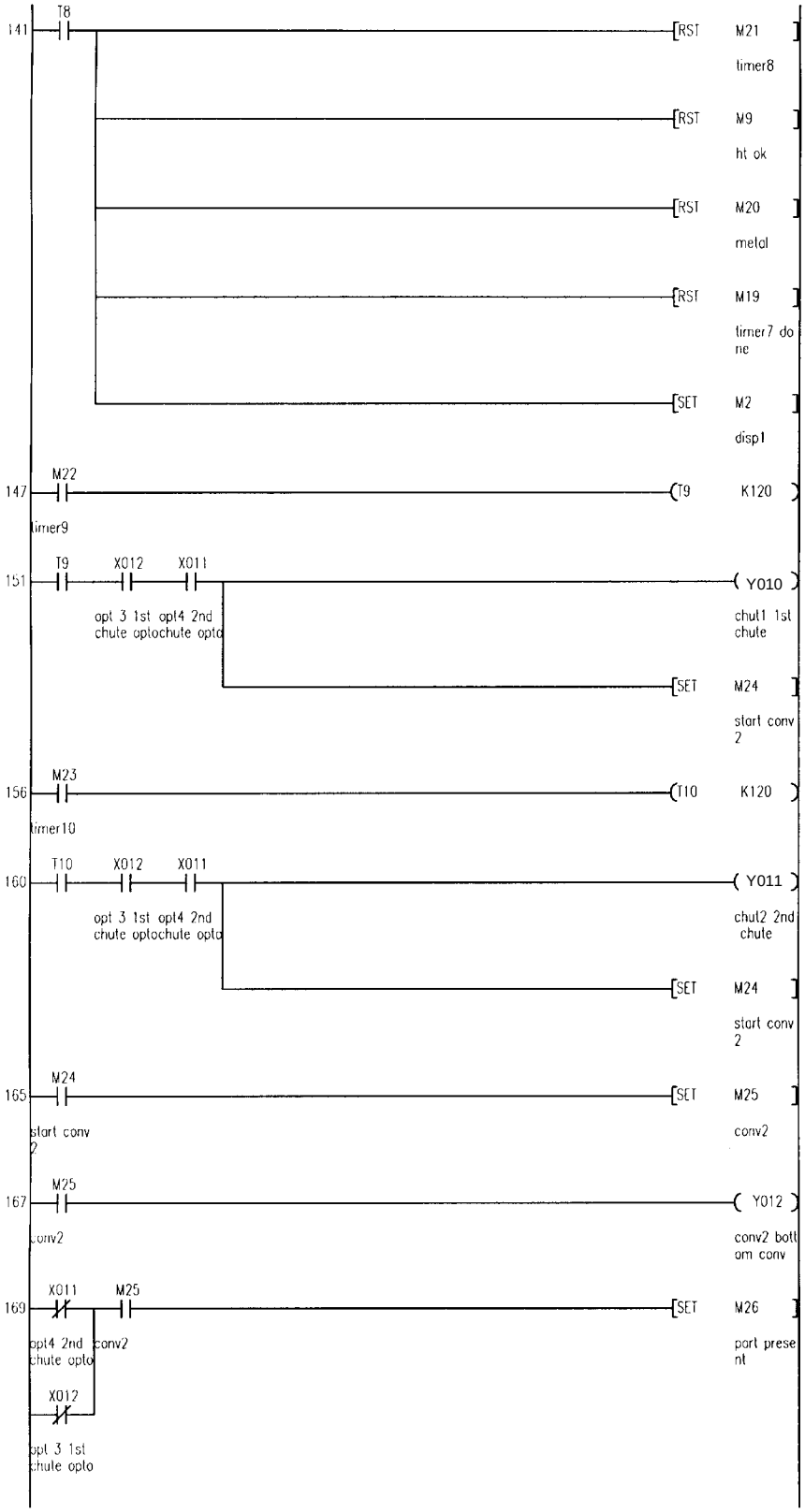

0
X007
start
SET M1
ht motor
SET M4
wdth mtr
SET M2
disp1
4
M1
ht motor
Y004
hmdrv
6
X002
htdc
RST M1
ht motor
SET M3
top conv
9
M4
wdth mtr
Y014
wmdrv
11
X010
dtdc
RST M4
wdth mtr
13
M2
disp1
Y002
disp1
15
M3
top conv
Y003
conv1
17
X004
pre ht opt
RST M3
top conv
SET M5
timer1
SET M10
timer4
RST M2
disp1
22
M5
timer1
T1
K9

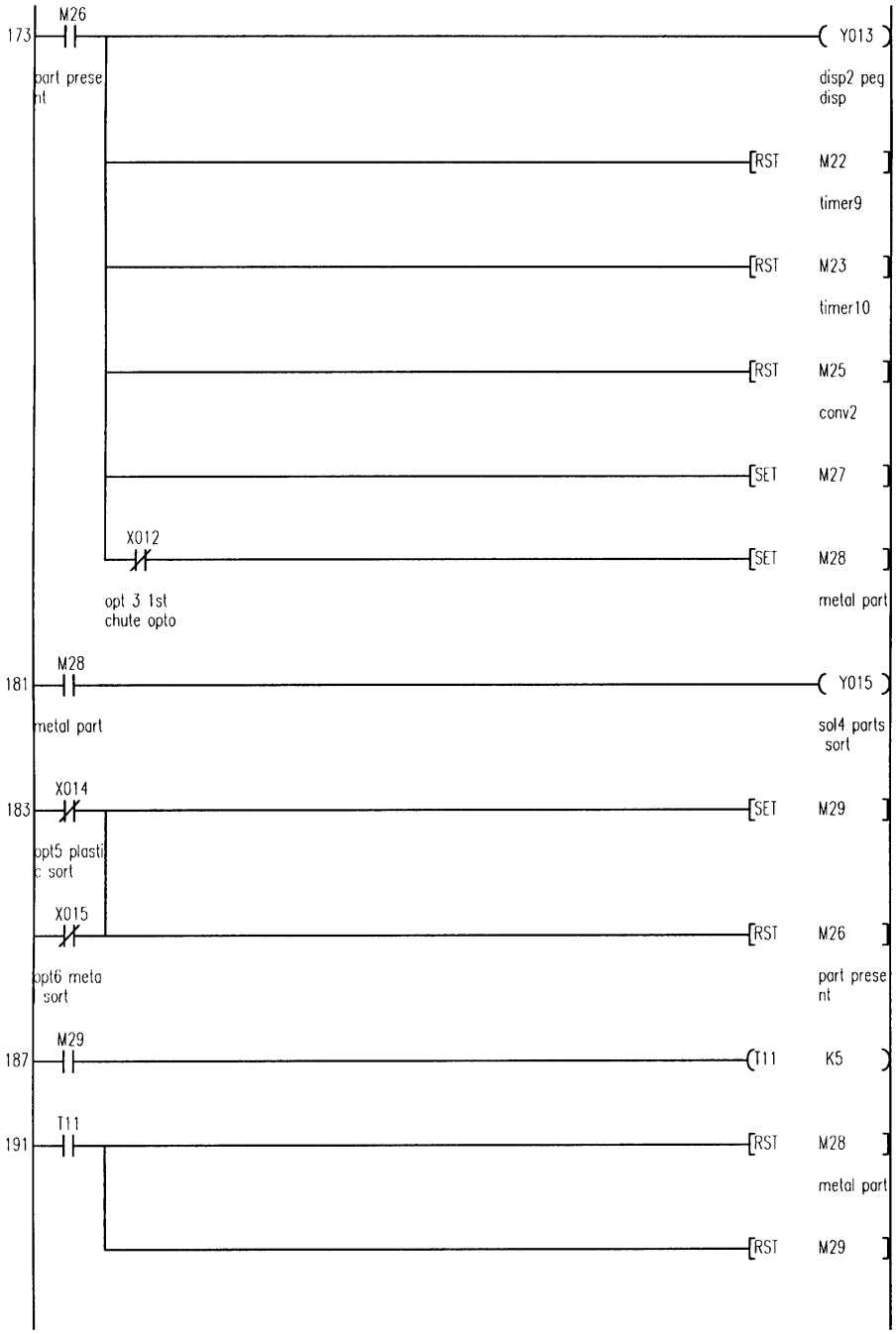

26
T1
RST M5
timer1
SET M3
top conv
SET M6
timer2
30
M6
T2 K7
timer2
34
T2
RST M6
timer2
RST M3
top conv
SET M1
ht motor
38
M1
Y004
ht motor
hmdrv
40
X001
RST M1
hbdc
ht motor
SET M7
timer3
RST M9
ht ok
44
M7
T3 K7
timer3
48
T3
SET M8
RST M7
timer3
X003
SET M9
ht OK
ht ok
53
M8
SET M1
ht motor
RST M8


56
X002
bldc
RST M1
bl motor
SET M3
top conv
M10
timer4
SET M11
timer4 lat ch
RST M10
timer4
62
M11
timer4 lat ch
T4 K20
66
T4
RST M3
top conv
RST M10
timer4
RST M11
timer4 lat ch
SET M12
wmtr latch
71
M12
wmtr latch
SET M4
wdth mtr
X013
dbdc
SET M13
timer5
RST M12
wmtr latch
RST M4
wdth mtr
77
M13
timer5
T5 K7
81
T5
SET M14
timer5 done
RST M13
timer5
X016
width ok
SET M15
wdth ok


86
M14
timer5 done
SET M4
wdth mtr
X010
dtdc
RST M4
wdth mtr
SET M3
top conv
SET M16
RST M14
timer5 done
93
M16
M15
wdth ok
Y005
w reject
SET M17
timer6
97
M17
timer6
T6 K70
101
T6
RST M15
wdth ok
RST M16
RST M17
timer6
SET M2
disp1
106
X005
ind opto sense
RST M3
top conv
RST M15
wdth ok
RST M16
RST M17
timer6
SET M18
timer7


112
M18
T7
K10
timer7
116
T7
SET
M19
timer7 do
ne
SET
M3
top conv
RST
M18
timer7
120
X006
SET
M20
nd trans
metal
122
M19
M9
M20
Y000
timer7 do ht ok
ne
metal
sol3 2nd
chute
SET
M21
timer8
SET
M22
timer9
128
M19
M9
M20
Y001
timer7 do ht ok
ne
metal
sol2 1st c
hute
SET
M21
timer8
SET
M23
timer10
134
M19
M9
SET
M21
timer7 do ht ok
ne
timer8
137
M21
T8
K100
timer8


141
T8
RST M21
timer8
RST M9
ht ok
RST M20
metal
RST M19
timer7 do
ne
SET M2
disp1
147
M22
T9 K120
timer9
151
T9 X012 X011
Y010
opt 3 1st opt4 2nd
chute optochute opto
chut1 1st
chute
SET M24
start conv
2
156
M23
T10 K120
timer10
160
T10 X012 X011
Y011
opt 3 1st opt4 2nd
chute optochute opto
chut2 2nd
chute
SET M24
start conv
2
165
M24
SET M25
start conv
2
conv2
167
M25
Y012
conv2
conv2 bott
om conv
169
X011 M25
SET M26
opt4 2nd conv2
chute opto
port prese
nt
X012
opt 3 1st
chute opto


173
M26
part prese
nt
Y013
disp2 peg
disp
RST M22
timer9
RST M23
timer10
RST M25
conv2
SET M27
X012
SET M28
opt 3 1st
chute opto
metal part
181
M28
metal part
Y015
sol4 parts
sort
183
X014
SET M29
opt5 plasti
c sort
X015
RST M26
opt6 meta
l sort
part prese
nt
187
M29
T11 K5
191
T11
RST M28
metal part
RST M29

Notes

The programs included on the disk that accompanies this equipment are:

Programs to work with **Mitsubishi FXGPWIN** software (Feedback s/w 34-901).

Test program	test1.pmw
Full Workcell (including width gauge)	fulcelw.pmw
Full Workcell (excluding width gauge)	fulcel.pmw
Single Conveyor System (including width gauge)	sconvw.pmw
Single Conveyor System (excluding width gauge)	sconv.pmw

Programs to work with **Allen-Bradley RSLogix 500** software (Feedback s/w 34-902).

Test program	test.rss
Full Workcell (including width gauge)	fulcelw.rss
Full Workcell (excluding width gauge)	fulcel.rss
Single Conveyor System (including width gauge)	sconvw.rss
Single Conveyor System (excluding width gauge)	sconv.rss

Note

These programs are example programs only. They are fully-functioning and may be used to run the systems. However, the program steps and labels may not correspond fully to the ladder diagrams shown in this manual.

Notes

The Height and Width Gauges have been factory-set and, in normal operation, should not need re-setting up. If, for any reason, they go out of alignment, the following procedure should be followed to reset them.

Setting up the Height Gauge

Slightly loosen the two ‘adjusting screws’ (see Figure E-1).

Position a correct thickness (8 mm) washer under the plunger of the height gauge so that the tip of the plunger will come down on a flat part of the washer’s surface.

Turn on the equipment, but do not run any program.

Manually, bring down the ‘plate’ until the plunger rests on the top of the washer.

Move the ‘adjustment plate’ so that both the ‘too big’ and the ‘too small’ LED’s are unlit.

Tighten the two adjusting screws.

Position a ‘too thick’ (9 mm) washer under the plunger of the height gauge so that the tip of the plunger will come down on a flat part of the washer’s surface.

Check that the ‘too big’ LED is on.

Position a ‘too thin’ (7 mm) washer under the plunger of the height gauge so that the tip of the plunger will come down on a flat part of the washer’s surface.

Check that the ‘too small’ LED is on.

If either of these last two checks fails, repeat the setting up procedure until correct.

Setting up the Width Gauge

A similar procedure to the above is used to set up the Width Gauge.

Use a 20 mm diameter washer as the correct size, a 19mm washer for ‘too small’ and a 21 mm washer for ‘too big’.

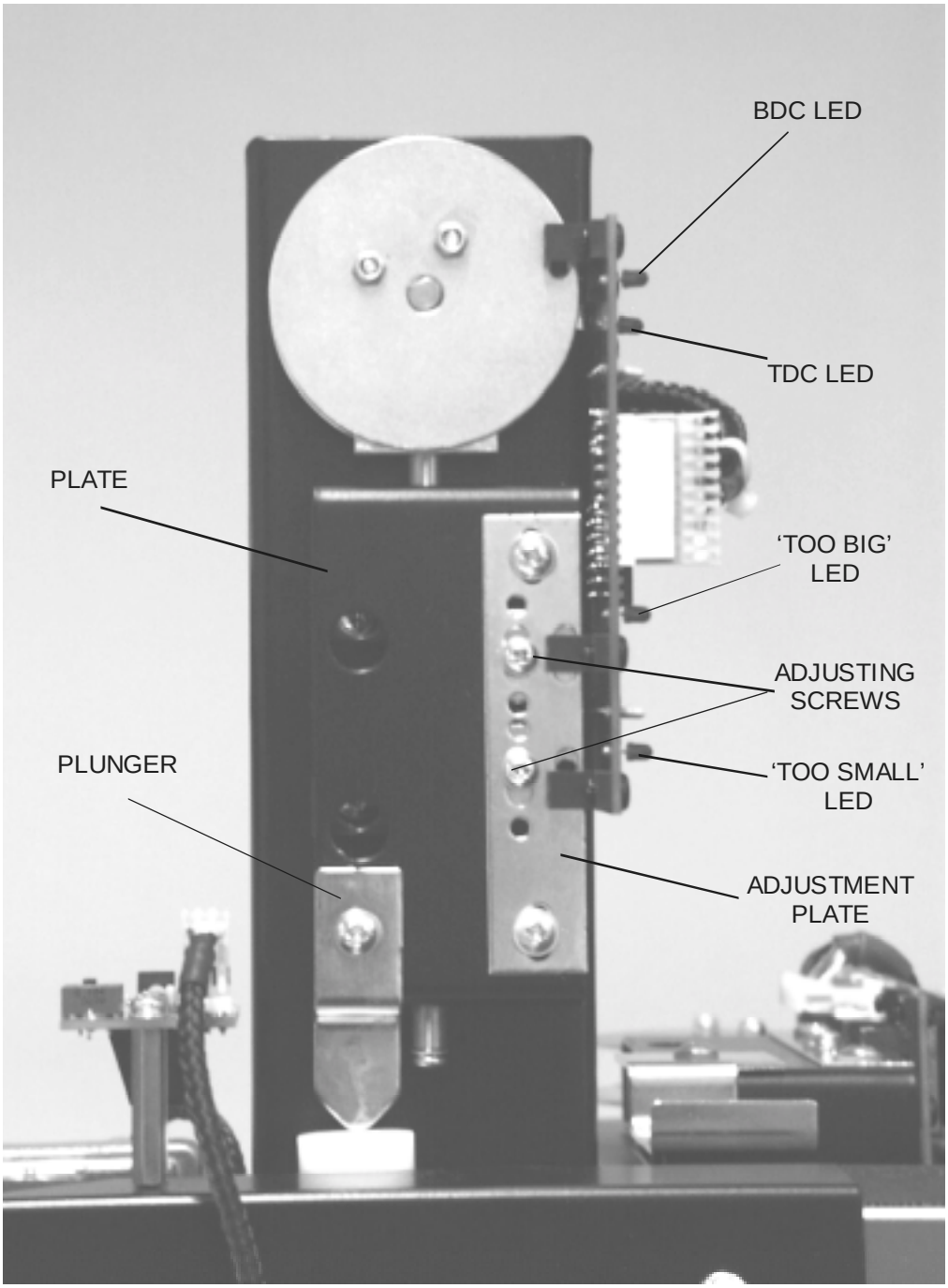
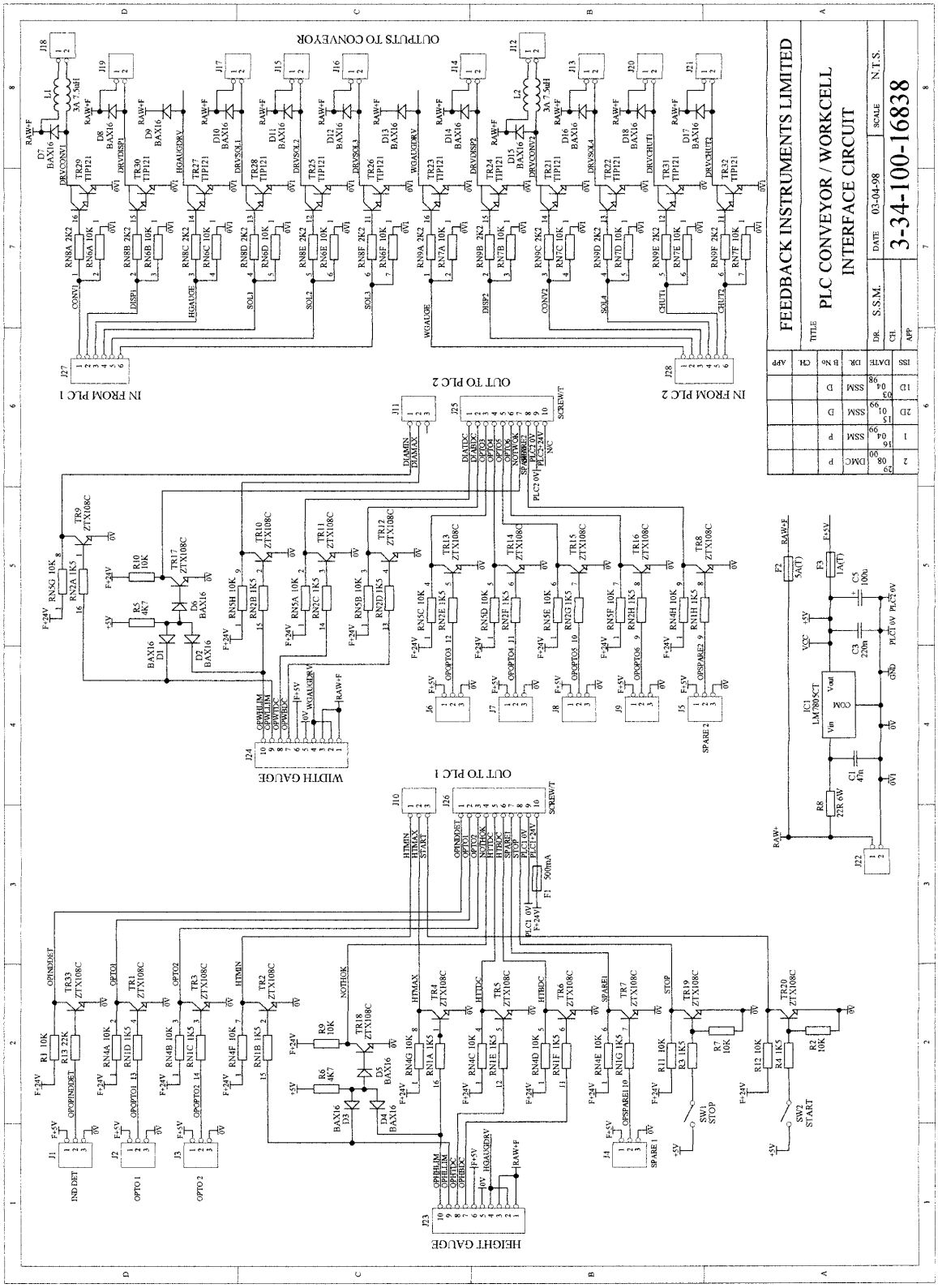


Figure E-1: Height Gauge


FEEDBACK INSTRUMENTS LIMITED
PLC CONVEYOR / WORKCELL
INTERFACE CIRCUIT
3-34-100-16838
OUTPUTS TO CONVEYOR
IN FROM PLC 1
IN FROM PLC 2
OUT TO PLC 2
OUT TO PLC 1
WIDTH GAUGE
HEIGHT GAUGE

Notes