COMX PL-80 Service Manual

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1st edition

1. Introduction

The PL-8Ø is a microcomputer based printer/plotter. It consists of an electronic circuit and a plotter mechanism.

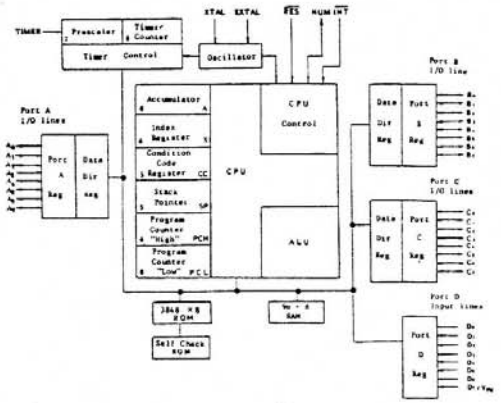
The electronic circuit carries out the interface and control functions and the mechanism implements the mechanical motions. Inside the electronic circuit, there is a microcontroller, CXØØ5, which controls the whole function of the PL-8Ø.

This manual describes the configuration of the CXØØ5 and operation theory of the electronic circuit and mechanism. Also, some trouble shooting concepts are included.

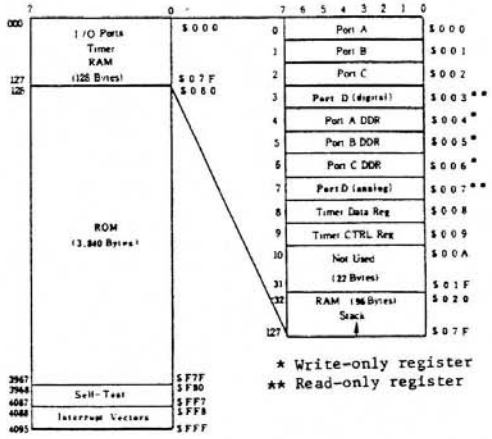
2. The CXØØ5

The CXØØ5 is the microcontroller of the PL-8Ø. It is a single chip microcomputer which consists of one 4K-byte programming area and four 8-bit input/output ports. The functions of the PL-8Ø, such as command receiving, decoding, motor control and LED indication are adopted by I/O ports. The functions of ports are controlled by the control program which is stored in the programming area of the CXØØ5.

The followings are the block diagram and memory configuration of the CXØØ5:



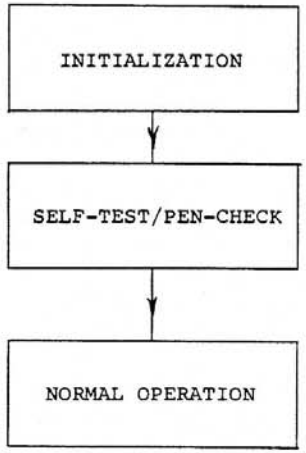
CX005 Block Diagram



Memory Configuration

3. Control Program

The CXØØ5 control program is mainly divided into three parts, the Initialization, Self-test/Pen-check and Normal Operation.



Flow-chart of Control Program

3.1 Initialization

During initialization, the CXØØ5 will do the following processes:

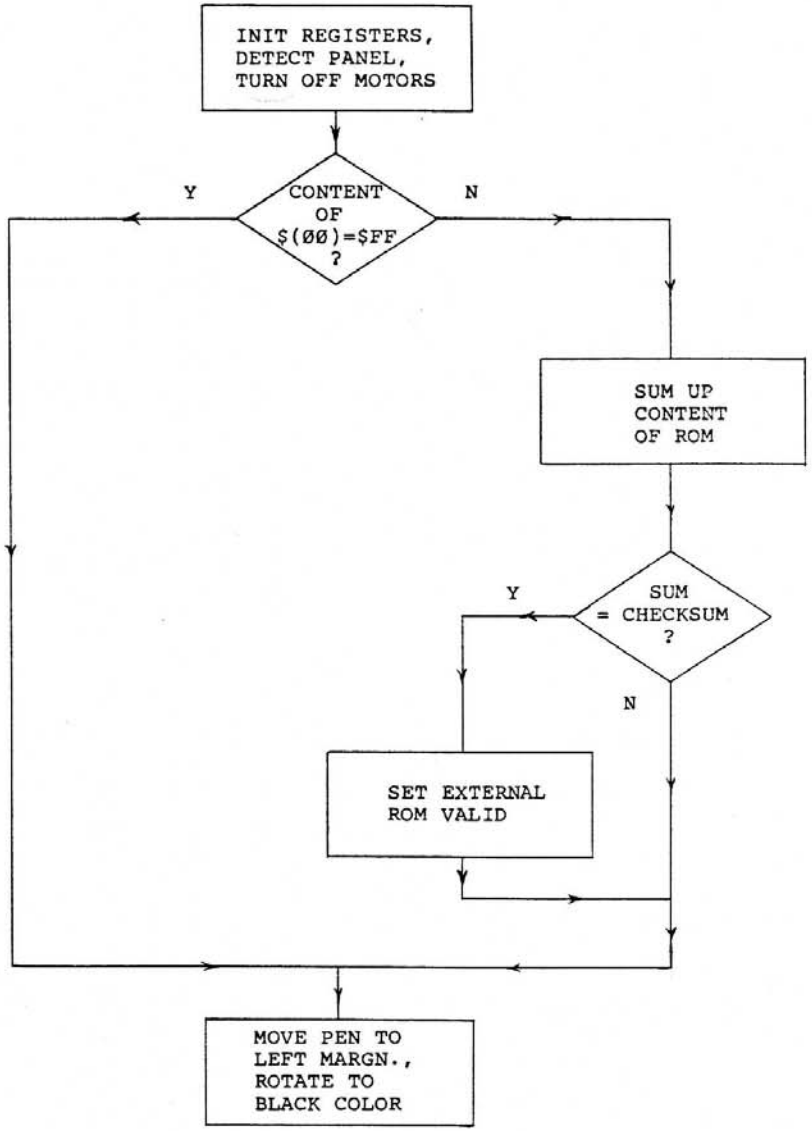
- Initialize the internal registers
- Detect and save the panel switches condition
- Turn off all motors
- Check the existance of External Character ROM
- Initialize X, Y and Z motor positions

The detection of External Character ROM is described as follow:

The existance of the ROM is detected by reading the content of the address $ØØØØ. If the content is $FF, that means the ROM does not exist.

If the ROM exists, the CXØØ5 will check the contents of the ROM. Otherwise, it will enter the self-test routine.

The contents of the ROM is checked by summing up the data in the ROM. At the last address of the ROM, there is a checksum number which is the modulo-256 of the sum of the ROM data. If the checksum number is equal to the calculated sum, that means the ROM is good. Then, a ROM valid bit will be set for future use.



Flow-chart of Initialization

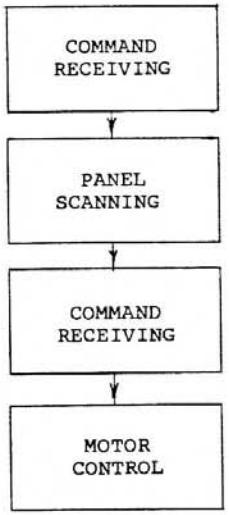
3.2 Self-test/Pen-check

In this procedure, the previously stored power-up panel status will be recalled. If some specified switches have been pressed, a self-test or pen-check routine will be executed. If no specified switch has been pressed, the CX005 will carry out the next procedure. (see PL-80 Operation Manual for self-test and pen-check details)

3.3 Normal Operation

The Normal Operation procedure contains three main routines:

- Command receiving routine
- Panel scanning routine
- Motor control routine



Flow-chart of Normal Operation Procedure

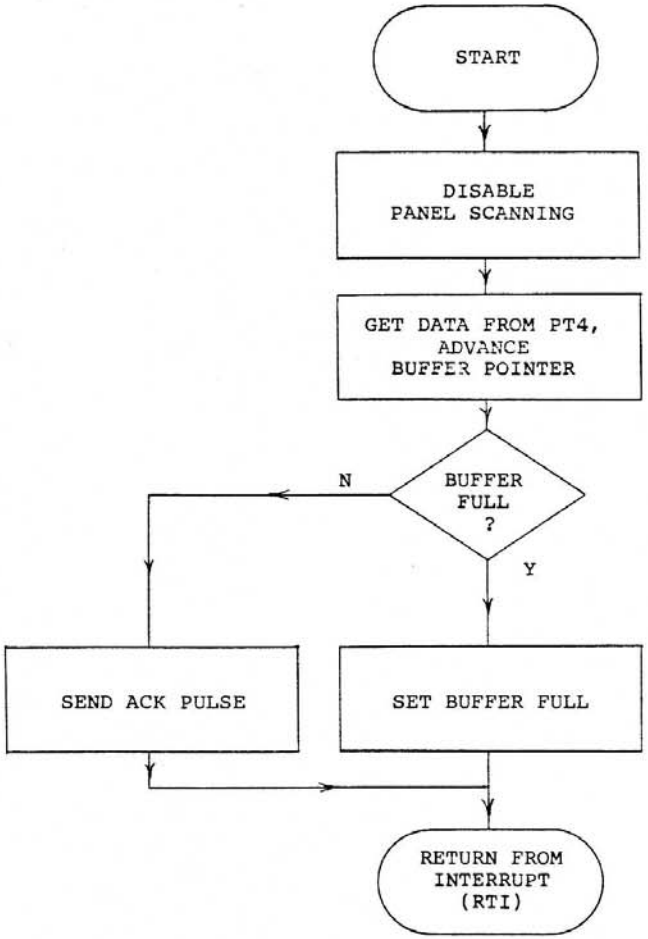
3.3.1 Command Receiving Routine

The CX005 receives commands from its input port D. The command existance is indicated by the INTERRUPT line. When a low level presents on the INTERRUPT line, the CX005 starts the interrupt service procedure. It will complete the current instruction, push the present internal status to the stack and enter the interrupt service routine. The starting address of the interrupt service routine is stored in the interrupt vector location, $FFA and $FFB.

During the interrupt routine, the following procedures will be done:

- Suspend panel scanning function
- Get the data from PT4
- Advance input buffer pointer

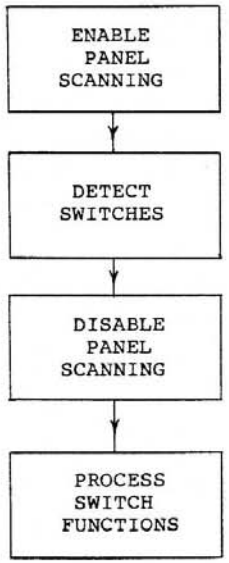
If after receiving a data, the buffer is full, the CX005 will leave the interrupt routine without sending the ACK pulse. Otherwise, the pulse will be sent to the host unit to indicate that the PL-80 is ready to receive another data.



Flow-chart of Interrupt Routine

3.3.2 Panel Scanning Routine

The panel scanning routine detects the depression of the panel switches and carries out the corresponding procedures defined by the switches.



Flow-chart of Panel Scanning Routine

3.3.3 Motor Control Routine

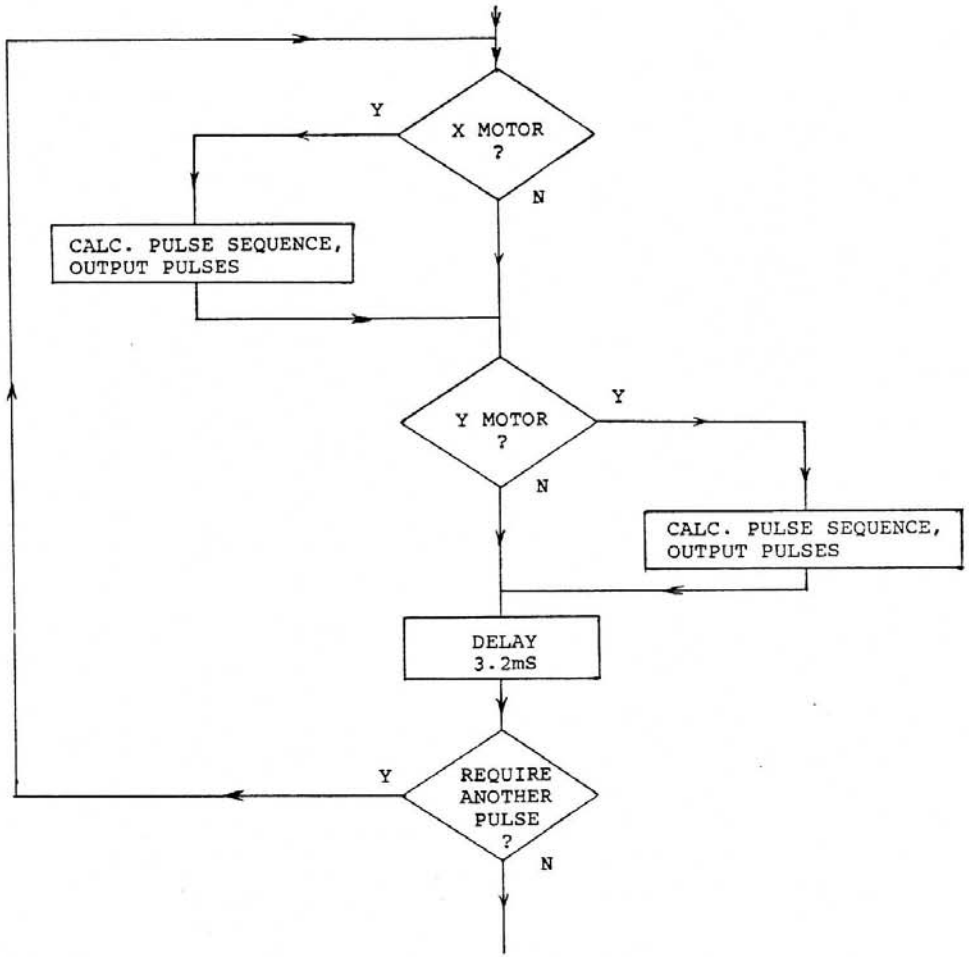
The plotting motion of the PL-80 is driven by three stepping motors which control the X, Y motion and pen control.

The moving direction of a motor is determined by the excitation sequence of the phases. At the motor control routine, the moving direction is determined by the comparision between the present location and the next location. After the steps and direction are determined, a sequence of pulse will be output to the motor. There is a delay of 3.2mS before the changing of pulse states. This is the set up time delay of a phase position.

Before the motors are turned off, a holding time of 9mS is required to stabilize the motors.

STEP NO.	A	B	C	D	MOTOR SHAFT ROTATION	DIRECTION Z AXIS
1	ON	OFF	OFF	ON	counter-clockwise	+ pen-down
2	OFF	ON	OFF	ON		
3	OFF	ON	ON	OFF		
4	ON	OFF	ON	OFF		

Motor Phases States Diagram



Flow-chart of Motor Control Routine

4. Hardware Descriptions

4.1 Mechanism

The main parts of the mechanism are three stepping motors. They drive different groups of mechanical systems. Each system controls a one-axis motion.

The X system is a pulley and wire system. The wire is connected to the pen carriage. It controls the left and right plotting function.

The Y system is a gear system. It is connected to a platen which drives the paper motion. It controls the up and down plotting function.

The Z system is a cam system which is connected to the pen up-down bar. It controls the pen up-down and color changing function.

By controlling the X, Y and Z motions properly, color pictures can be plotted.

On the left of the mechanism, there is a small switch (CRSW). It detects the leftmost position of the pen carriage.

On the right of the mechanism, there is a paper release lever. It is used for paper adjustment.

In the middle of the mechanism, there is connector. It is connected to the motors and the CRSW. All signals are sent to the mechanism through this connector.

4.2 Power Supply

The power source of the PL-80 is a 10V AC-DC adaptor. The DC 10V voltage is regulated to lower voltage by the two regulators, T1 (7805) and T2 (7806).

C1, C2, and L1 composed a noise suppressor and C3 is a ripple filter. The regulator T1 provides a regulated 5V DC supply for the whole logic circuit. The ground pin of T2 is connected to a diode CR1 and then to ground. This is done to increase the output voltage of T2 from 6V to 6.7V. The 6.7V supply is used to drive the motors.

4.3 Microcontroller

The microcontroller PT6 (CX0005) is the heart of the circuit. It is a single chip microcomputer unit (MCU) with four 8-bit I/O ports. Port A to C are

input/output programmable but port D is an input port only.

Pin 5 and 6 are the clock input of the chip. A 4 MHz ceramic resonator (Y1) is used as the clock source. C13 and C14 are the loading capacitors. A quartz crystal can be used instead of the ceramic oscillator provided that C13 is removed.

Pin 2 is the RESET pin. It is connected to R20 and C15 to provide a power up reset. The reset delay time is about 100mS. The reset pin is also connected to pin 31 of the parallel connector through pin 6 and 15 of PT3 to provide an external reset.

The INTERRUPT pin, pin 3, is connected to pin 3 of PT1 as a data strobe input. The signal status are described in the "Data Input and Handshake Signals" section.

Pin 9 to 40 are the I/O ports. They control all the functions of the PL-80. Their functions and I/O status are summarized as follow:

PORT	DIR	FUNCTION	PORT	DIR	FUNCTION
PA0	O/P	Y motor phase A	PC0	O/P	ROM A0 /X motor phase A
PA1	O/P	Y motor phase B	PC1	O/P	ROM A1 /X motor phase B
PA2	O/P	Y motor phase C	PC2	O/P	ROM A2 /X motor phase C
PA3	O/P	Y motor phase D	PC3	O/P	ROM A3 /X motor phase D
PA4	O/P	ROM A12	PC4	O/P	ROM A4 /ACK
PA5	O/P	ROM CE /PT5 CK	PC5	O/P	ROM A5 /On-line LED
PA6	O/P	PT4 OE	PC6	O/P	ROM A6
PA7	O/P	SW & PE ENABLE	PC7	O/P	ROM A7
PB0	O/P	Z motor phase A	PD0	I/P	D0 /ROM D0 /DOWN SW
PB1	O/P	Z motor phase B	PD1	I/P	D1 /ROM D1 /PEN-SEL SW
PB2	O/P	Z motor phase C	PD2	I/P	D2 /ROM D2 /UP SW
PB3	O/P	Z motor phase D	PD3	I/P	D3 /ROM D3 /CRSW
PB4	O/P	ROM A8	PD4	I/P	D4 /ROM D4 /ON LINE SW
PB5	O/P	ROM A9	PD5	I/P	D5 /ROM D5 /PE Sensor
PB6	O/P	ROM A10	PD6	I/P	D6 /ROM D6 /RIGHT SW
PB7	O/P	ROM A11	PD7	I/P	D7 /ROM D7 /LEFT SW

4.4 Multiplexer

PT5 (74LS174) is a hex D-type FF. It multiplexes the port C of the MCU. Pin 9 of PT5 is the multiplex control pin. It is connected to pin 38 (PA5) of the MCU.

4.5 Data Input and Handshake Signals

The external input data is latched by the 8-bit data latch PT4 (74LS374). The clock input, pin 11 of PT4, is controlled by pin 11 of PT1 (74LSØØ) which is the BUSY signal.

The handshake signal is controlled by PT1. Pin 8, 9, 1Ø, 11, 12 and 13 composed a S-R flip-flop. The SET input (pin 13 of PT1) is connected to the STROBE pin (pin 1) of the parallel connector. The RESET input (pin 9 of PT1) is connected to the ACK pin (pin 1Ø) of the parallel connector through C9. The SET and RESET inputs are low active.

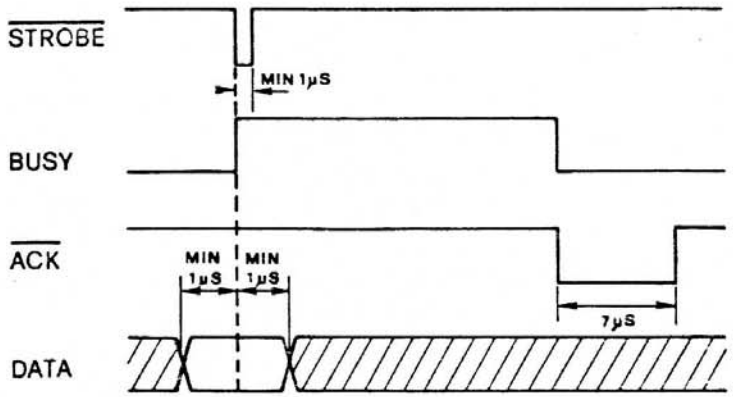
When the STROBE signal of the parallel connector goes low, a falling edge occurs in pin 13 of PT1. This falling edge sets pin 11 of PT1 to high. Since this pin is connected to the BUSY pin of the parallel connector and the clock input of PT4, the BUSY signal will become high and the external data will be clocked into PT4.

When the STROBE signal returns to high, the signal at pin 3 of PT1, which is a NAND output of pin 11 and the STROBE signal, will go low. This generates an interrupt signal to the MCU.

When the MCU is processing an interrupt signal, it sends a low pulse to its pin 39 (PA6), which is connected to pin 1 of PT4, to read the data.

After the data is read, the MCU will generate a low pulse to its pin 13 (PC4). This low pulse, after multiplexed by PT6, is passed to the ACK pin (pin 1Ø) of the parallel connector. This generates an acknowledge pulse to the host computer.

The acknowledge pulse is also used to reset the S-R flip-flop through pin 9 of PT1. This also causes the BUSY signal to return to low. The reset time is shortened by the differentiater composed by the C9 and R3.



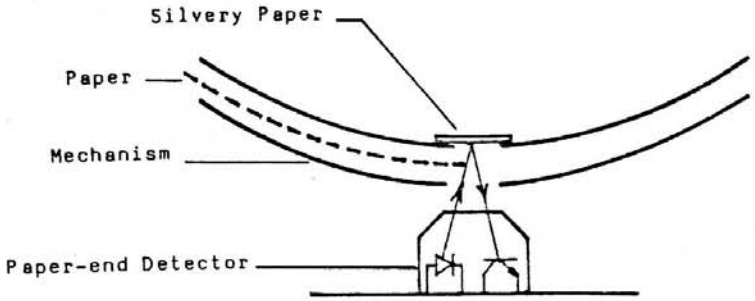
Handshake Signals Timing Diagram

4.6 Switches Detection

The switches are detected by the MCU through port D (PDØ-4, PD5-6). Since port D is also shared by the external input data and ROM pack data, the switches detection is multiplexed. PA7 (pin 4Ø) of the MCU controls the switches multiplexing through pin 4/5 and 6 of PT1. The switches input is enabled only when PA5 is high.

4.7 Paper-end Detection

The paper-end detector of the PL-8Ø is an optical sensor. It is mounted under the mechanism. The detector emits infra red light and senses back the reflection light. A silivery paper is sticked on the mechanism facing the detector. When no paper is inserted, the infra red light is reflected and the detector output a low signal. When a paper is inserted, the relfection is blocked and the detector output high signal.



Paper-end Detection

The detector output (pin 3 of P3) is connected to PD5 (pin 19) of the MCU. Similar to the switches detection, the detector is controlled by PA7 (pin 40) of the MCU. A high level in PA7 enables the paper-end detection.

Pin 1 and 2 of P3 are the emitter pins of the detector. They are connected to the power supply through the power LED.

Since the paper-end detection depends on the reflection of the silvery paper, the paper must be sticked properly. Any folding or misalignment of the paper will result in bad performance of paper-end detection.

4.8 Motor Driver

PT2 and PT3 are the two non-inverting motor drivers. PT2 drives the Y and Z motors and PT3 drives the X motor. The drivers provide a 6.7V phase voltage to each motor. The input of PT2 (pin 2-9) are connected to port A and B of the MCU. The input of PT3 (pin 2-5) are connected to PT6 which is the multiplexed output of port C.

Pin 1 of PT2 and PT3 are the input supply pins and are connected to 5V. Pin 11 and 20 are the output supply pins and are connected to 6.7V. Pin 12-19 of PT2 and pin 16-19 of PT3 are the outputs of the drivers. They are directly connected to the X, Y and Z motors.

The typical phase current of the motors are as follows:

X : 223 mA +/-10%
Y : 268 mA +/-10%
Z : 134 mA +/-10%

4.9 ROM-pack

The ROM pack contains an External Charater ROM. This ROM is connected to the 26-way edge-connector P6. The address lines are connected to port B (pin 29-32) and port C (pin 9-17) of the MCU. The data lines are connected to port D (pin 17-24). The CHIP ENABLE pin is connected to PA5 (pin 38). This pin will go low when the data of the ROM is read.

5. Trouble Shooting Concept

Before starting trouble shooting, we should know the power up procedure of the PL-80 first.

The power up procedure is as follow:

- The power indicator will be turned on.
- The X, Y and Z motor will move to their stand-by position. (If a ROM-pack is inserted, This procedure will be delayed about 2 seconds.)
- The ON-LINE indicator will be turned on. (It will blink if no paper is inserted.)

The followings are some faulty examples and their solutions:

5.1 The POWER indicator is not turned on after the power switch has been turned on.

Solution:

- Check the voltage of P1. If it is less than 9V, check the AC adaptor, C1, C2, C3 and L1.
- Check the output voltage of T1. If it is not 5V, T1 may be defective.

5.2 The POWER and the ON-LINE indicators are turned on but the X, Y and Z motors do not move. The panel switches and the paper-end detector do not function.

Solution:

- Check pin 5 (EXTAL) of PT6. There should be a 4 MHz Sine-wave. The upper peak of the wave should be not less than 2V and the lower peak should be not greater than 0.8V. If it is not the case, Y1, C13 or C14 may be defective.
- Check pin 2 (RESET) of the MCU. If it is not a high level, R20 or C15 may be defective.
- Check pin 15 and 6 of PT3. If they are of different logic level. PT3 may be defective.

5.3 The POWER indicator is turned on but the X, Y or Z motor does not move.

Solution:

- Check the output voltage of T2. If it is less than 6.6V or greater than 6.8V, T2 or CR1 may be defective.
- Check PT2 and PT3. Compare the input and output waveform. If they are the same, PT2 or PT3 may be

defective.
- If it is only the X motor does not move, check also PT5.

5.4 The panel switches do not function.

Solution:

- Check the panel assembly. See if there is any open-circuit or short-circuit.
- Check CR4-9.
- Check pin 6 of PT1, there should be a low level or low pulses. If it is not, compare the signals of pin 4/5 with pin 6 of PT1. If the signals are not of inverted shape, PT1 may be defective.

5.5 The paper-end detector does not function.

Solution:

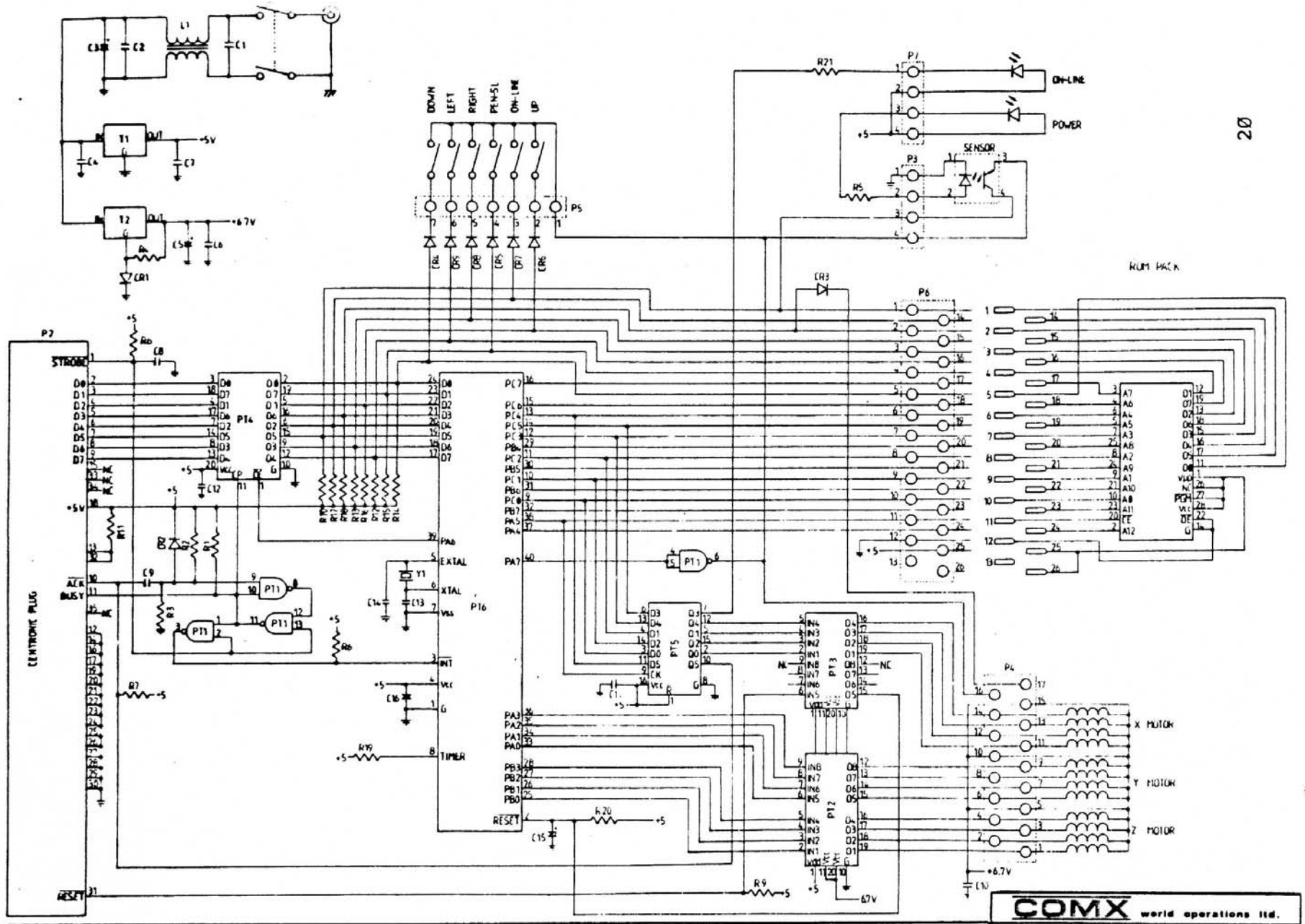
- Check the optical sensor.
- Check the signal in pin 6 of PT1. See section 5.3.
- Check the POWER indicator and related circuit.

5.6 The external input commands are not executed or executed wrongly.

Solution:

- Check pin 11 of PT4. If there is no low pulse during command input, check PT1.
- Compare the output data of PT4 with the input command. If they are different, PT6 may be defective.
- Check the STROBE, ACK and BUSY signals. If they do not follow the "Handshake Signal Timing Diagram" shown in section 4.5, PT1 may be defective.
- If the ACK signal is incorrect, PT5 may be also defective.

Appendix A
Circuit Diagram



PT1	74LS00	R1	4.7K	R8	4.7K	R15	10K	C1	0.1uF	C9	500PF
PT2	1247	R2	4.7K	P9	4.7K	R16	10K	C2	0.1uF	C10	0.1uF
PT3	1247	R3	10K	R10	10K	R17	10K	C3	2200uF 25V	C11	0.1uF
PT4	74LS374	R4	1K	R11	4.7K	R18	10K	C4	0.22uF	C12	0.1uF
PT5	74LS174	R5	120	R12	10K	R19	4.7K	C5	220uF 16V	C13	30PF
PT6	CX005	R6	4.7K	R13	10K	R20	10K	C6	0.1uF	C14	30PF
		R7	1K	R14	10K	R21	150	C7	0.1uF	C15	10UF 10V
								C8	0.0047uF	C16	1UF 10V

CR1-CR9 1N914

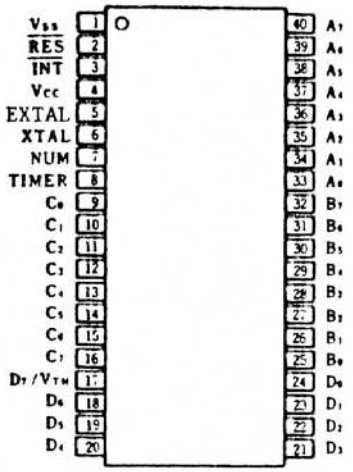
Y1 4MHZ

P6 TO ROM PACK

COMX world operations ltd.

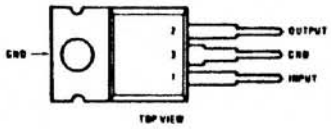
SYSTEM	PLOTTER	MODEL NO	F-003-PY-REV.0
SUBSYSTEM		DRAWING No	CC860227081
MATERIAL		UNIT	
FINISH		SCALE	
DESIGN		DRAWN	
CHECKED		CLASS	C
APPROVED		REV	1

Appendix B
CXØØ5 Pins Assignment

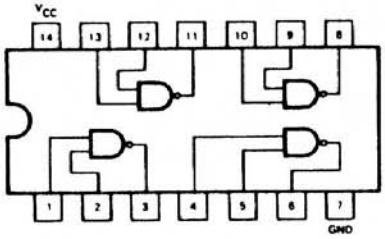


Appendix C
IC Logic Diagrams

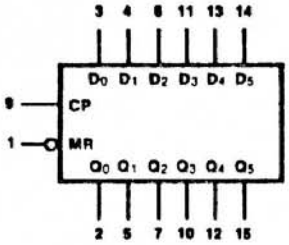
78M05, 7806



74LS00

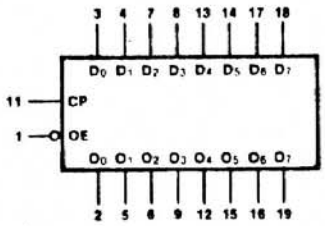


74LS174



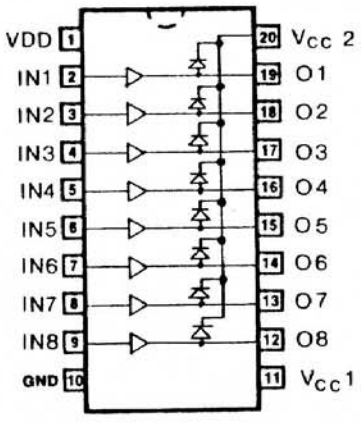
Vcc = Pin 16
GND = Pin 8

74LS374

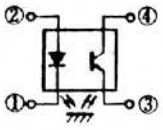


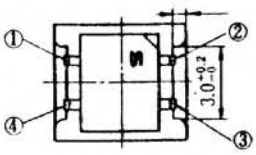
Vcc = Pin 20
GND = Pin 10

LB1247



GP2S05





① Cathode
② Anode
③ Emitter
④ Collector

Appendix D
Spare Parts List

ITEM	COMPONENT	DESCRIPTION	PART NO.
IC:			
1	PT1	74LS00,Quad 2-I/P NAND Gate	PL-I-74LS00
2	PT2	LB1247,Octal Motor Drivers	PL-I-LB1247
3	PT3	LB1247,Octal Motor Drivers	PL-I-LB1247
4	PT4	74LS374,Octal D Flip-Flop	PL-I-74LS374
5	PT5	74LS174,Hex D Flip-Flop	PL-I-74LS174
6	PT6	CX005,Microcontroller	PL-I-CX005
7	T1	78M05,5V Voltage Regulator (with mica sheet)	PL-I-78M05
8	T2	7806,6V Voltage Regulator	PL-I-7806
Resistors:			
9	R1	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
10	R2	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
11	R3	10K ohm +/-5% 1/4W	PL-R-10K-5-25
12	R4	1K ohm +/-5% 1/4W	PL-R-1K0-5-25
13	R5	100 ohm +/-5% 1/4W	PL-R-100-5-25
14	R6	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
15	R7	1K ohm +/-5% 1/4W	PL-R-1K0-5-25
16	R8	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
17	R9	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
18	R10	12K ohm +/-5% 1/4W	PL-R-12K-5-25
19	R11	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
20	R12-18	10K ohm +/-5% 1/4W	PL-R-10K-5-25
21	R19	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
22	R20	10K ohm +/-5% 1/4W	PL-R-10K-5-25
23	R21	150 ohm +/-5% 1/4W	PL-R-150-5-25
24	R22	100 ohm +/-5% 1/4W	PL-R-100-5-25
25	R23-30	4.7K ohm +/-5% 1/4W	PL-R-4K7-5-25
Capacitors:			
26	C1	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
27	C2	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
28	C3	2200uF,Elec,25VDC	PL-C-2200U-E-25
29	C4	0.22uF,Cer,+/-20%,25VDC	PL-C-0220N-C-25
30	C5	220uF,Elec,16VDC	PL-C-0220U-E-16
31	C6	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
32	C7	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
33	C8	0.001uF,Cer,+/-20%,50VDC	PL-C-0001N-C-50
34	C9	500pF,Mylar,+/-10%,25VDC	PL-C-0500P-M-25
35	C10	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
36	C11	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
37	C12	0.1uF,Cer,+/-20%,25VDC	PL-C-0100N-C-25
38	C13	30pF,Cer,+/-20%,50VDC	PL-C-0030P-C-50

39	C14	30pF,Cer,+/-20%,50VDC	PL-C-0030P-C-50
40	C15	10uF,Elec,10VDC	PL-C-0010U-E-10
41	C16	1uF,Elec,10VDC	PL-C-0001U-E-10
Diodes:			
42	CR1-9	1N914	PL-D-IN914
Zener Diode:			
43	CR10	5.6V, 500mW	PL-Z-5V6-500
Connection Accessories:			
44	P1	Power Adaptor Receptacle	PL-P-PWR
45	P2	Centronics Socket,36 ways	PL-P-CEN
46	P3(A)	4 pins Header	PL-P-PH4
47	P3(B)	4 ways Housing Asm. W/Wires	PL-P-HA4
48	P4	17 ways Housing Asm. W/Wires	PL-P-HA17
49	P5	7 ways Flex. PCB Connector	PL-P-FC7
50	P6	26 ways Edge Connector	PL-P-EC26
51	P7(A)	4 pins Header	PL-P-PH4
52	P7(B)	4 ways Housing Asm. W/Wires	PL-P-HA4
Others:			
53	Y1	Ceramic Resonator,4MHz	PL-Y-4M
54	L1	Noise Suppression Coil	PL-L
55	SW1	Power Switch	PL-S-PWR
Misc:			
56		Main Circuit Board Assembly	PL-BRDASM
57		Sensor Board Assembly	PL-SENASM
58		Panel Switches Assembly	PL-PNLASM
59		Plotter Mechanism	PL-MECHSM
60		Aluminium Foil Sticker	PL-ALMFOL
61		LED, Red, 5mm Dia.	PL-LED-R
62		LED, Green, 5mm Dia.	PL-LED-G
63		Heat Sink	PL-HETSNK
64		Power Adaptor (Standards: B,H,S,U,V)	AD-10-(B,H,S,U,V)
65		Ball Point Pens (4 colors)	PL-BP
66		Roll Paper Supporter - Left	PL-PARSPL
67		Roll Paper Supporter - Right	PL-PARSPR
68		ROM-pack Entrance Door Assembly	PL-ROMDOR
69		Transparent Cover	PL-TRNCOV
70		Screw Set (6 metal, 2 plastic)	PL-SCREW
71		Foot Rests (4 pcs)	PL-FOTRST
72		Paper Guide	PL-PARGUD
73		Operation Manual	PL-MANUAL
74		Circuit Diagram (A1 size)	PL-CIRDGM

Appendix E
Recommended Equipment for Trouble Shooting

Tooling :

1. Philips screw driver
2. Tweezer
3. Miniature soldering iron (25 W)
4. Desoldering tool /Copper wick
5. Cutter
6. Needle nose pliers
7. 60% tin resin core soldering wire

Equipment :

1. 10 MHz Oscilloscope
2. Multimeter
3. Computer with centronic parallel output
4. Function generator (0.2 ~ 1 MHz)

Others :

1. A4 /letter size blank paper (PL-CPA/PL-CPL)
2. Ballpoint pens (PL-BP)
3. Connector cleaning pads
4. Insulated copper wire
5. Clean cloth