QX-16

DESKTOP COMPUTER

TECHNICAL MANUAL

M-TM-QX16

Epson Corporation
Nagano, Japan

FCC COMPLIANCE STATEMENT

This equipment uses and generates radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with limits for a Class B computing device in accordance with Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

* reorient the receiving antenna
* relocate the computer with respect to the receiver
* move the computer away from the receiver
* plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C., 20402. Stock No. 004-000-00345-4.

You can determine whether your computer is causing interference by turning it off. If the interference stops, it was probably caused by the computer or its peripheral devices. To further isolate the problem, disconnect the peripheral devices and their input/output cables one at a time. If the interference stops, it was caused by either the peripherial device or its I/O cable.

These devices usually require shielded cables. For Epson peripheral devices, you can obtain the proper shielded cable from your dealer. For non-Epson devices, contact the manufacturer or dealer for assistance.

Epson Corporation, Nagano, Japan

PRECAUTIONS

Precautionary notations throughout the text are categorized relative to 1) personal injury, and 2) damage to equipment:

DANGER   Signals a precaution which, if ignored, could result in serious or fatal personal injury. Great caution should be exercised in performing procedures preceded by DANGER headings.

WARNING   Signals a precaution which, if ignored, could result in damage to equipment.

The precautionary measures itemized below should always be observed when performing repair/maintenance procedures.

DANGER

1. ALWAYS DISCONNECT THE PRODUCT FROM BOTH THE POWER SOURCE AND PERIPHERAL DEVICES BEFORE PERFORMING ANY MAINTENANCE OR REPAIR PROCEDURE.

2. NO WORK SHOULD BE PERFORMED ON THE UNIT BY PERSONS UNFAMILIAR WITH BASIC SAFETY MEASURES AS DICTATED FOR ALL ELECTRONICS TECHNICIANS IN THEIR LINE OF WORK.

3. WHEN PERFORMING TESTING AS DICTATED WITHIN THIS MANUAL, DO NOT CONNECT THE UNIT TO A POWER SOURCE UNTIL INSTRUCTED TO DO SO. WHEN THE POWER SUPPLY CABLE MUST BE CONNECTED, USE EXTREME CAUTION IN WORKING ON POWER SUPPLY AND OTHER ELECTRONIC COMPONENTS.

WARNING

1. Repairs on Epson product should be performed only by an Epson certified repair technician.

2. Make certain that the source voltage is the same as the rated voltage, listed on the serial number/rating plate. If the Epson product has a primary AC rating different from available power source, do not connect it to the power source.

3. Always verify that the Epson product has been disconnected from the power source before removing or replacing printed circuit boards and/or individual chips.

4. In order to protect sensitive microprocessors and circuitry, use static discharge equipment, such as anti-static wrist straps, when accessing internal components.

5. Replace malfunctioning components only with those components recommended by the manufacturer; introduction of second-source ICs or other nonapproved components may damage the product and void any applicable Epson warranty.

PREFACE

This manual describes the theory of operation of the QX-16 microcomputer system, and includes troubleshooting, repair. and maintenance procedures for servicing system subassemblies. The text is divided into six chapters:

CHAPTER 1. PRODUCT DESCRIPTION — Describes the features and specifications of the computer, illustrates system components, and lists the logic configuration of the primary circuit boards.

CHAPTER 2. PRINCIPLES OF OPERATION — Details the functional organization of the logic circuitry.

CHAPTER 3. TROUBLESHOOTING — Provides instructions for isolating computer malfunctions.

CHAPTER 4. DISASSEMBLY AND ASSEMBLY — Describes system disassembly for replacement of malfunctioning subassemblies.

CHAPTER 5. ADJUSTMENT AND MAINTENANCE - Lists the necessary adjustments for unit assembly and servicing.

CHAPTER 6. DIAGRAMS AND REFERENCE MATERIALS — Describes option board specifications and I/O port addresses, illustrates IC pin configurations. and provides exploded, circuit board layout, and schematic diagrams for use in conjunction with the text.

Subsequent product modifications will be brought to your attention via Service Bulletins; please revise the text as bulletins are received.

This document is subject to change without notice.

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PRODUCT DESCRIPTION

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1.1 FEATURES

The EPSON QX-16 desktop computer system includes a 12-inch monochrome monitor and two SD-543 double-sided, quad-density floppy disk drives. Dual processors in the main memory unit allow the system to operate with 8-bit, Z-80A compatible or 16-bit, 8088 compatible operating systems, making the computer suitable for use with a wide variety of software. Standard equipment includes the multifunction keyboard, with eighteen programmable function keys, an EPSON parallel printer port, an RS-232C serial port, and three option slots on the main memory board for system expansion. The APX-ICRT video board, which enables the system to emulate the IBM video memory map, is also included as a standard feature.

1.2 SPECIFICATIONS

The specifications below apply to the entire system: sections following itemize specifications by major subassembly. (All weights include packaging materials.)

POWER SUPPLY
Input Voltage	115 V ± 20% (USA)
	230 ± 20% (Europe)
Frequency	50/60 Hz
Power Consumption	Approximately 55W
Input Surge Current	30A for 20 ms maximum

INSULATION STRENGTH
100 - 120V Units	1KV for 1 minute between AC power supply and case
220 - 240V Units	1.25KV for 1.25 minutes between AC power supply and case

INSULATION RESISTANCE	10M ohms for 500VDC minimum
STANDARD INTERFACES	Centronics-compatible parallel printer interface port
	RS-232C serial interface port

OPTIONAL INTERFACES (3 option slots)
RS-232C interface
IEEE-488 interface
A-D/D-A converter
Fiber optic interface
Universal interface
Multi-font character generator interface

ENVIRONMENTAL CONDITIONS	Operation	Storage
Temperature	5°C to 40°C	−30°C to 70°C
Humidity (no condensation)	10 - 80%	10 - 90%
Shock Resistance (maximum)	1 G, 1 msec	5 G, 1 msec
Vibration Resistance (maximum)	0.25 G, 5-50 Hz	3 G, 5-50 Hz

1.2.1 Main Unit Specifications

PROCESSORS	Z-80A (4 MHz)/8088 (5.3 MHz)
MAIN MEMORY	256K bytes (eight 256K-bit DRAMs) Expandable to 512K bytes
IPL	2764 EPROM for Z-80A mode
BIOS	2764 EPROM for 8088 mode
CLOCK	CMOS real-time clock (battery backed)

DMA . . . .   6 channels (two μPD8237AC-5)

INTERRUPT LEVELS . . . .   13 (two μPD8259AC)

COUNTER TIMER . . . .   6 channels (two μPD8253AC)

VIDEO MEMORY

   APX-IGGS Video Board . . . .   128K bytes (four 64K x 4 DRAMs)

   APX-ICRT Video Emulator Board . . . .   32K bytes (four 16K x 4 DRAMs)

DIMENSIONS (w x d x h) . . . .   508 x 340 x 114 mm
(20 x 13.4 x 4.5 inches)

WEIGHT . . . .   11.3 Kg (24.8 lbs)

1.2.2 Keyboard Specifications

LAYOUT . . . .   QWERTY keyboard with multiple, programmable function keys, edit/cursor keypad, and numeric keypad

KEYBOARD CONTROLLER . . . .   μPD8049 (11 MHz)

TRANSFER RATE . . . .   Synchronous transfer between the keyboard and main unit at 1200 BPS

DIMENSIONS (w x d x h) . . . .   438 x 210 x 35.5 mm
(17.2 x 8.3 x 1.4 inches)

WEIGHT . . . .   1.6 Kg (3.5 lbs)

1.2.3 Monitor Specifications

DISPLAY SIZE . . . .   12" (diagonal)

PHOSPHOR . . . .   green

RESOLUTION . . . .   640 x 400 pixels

HORIZONTAL SYNC . . . .   18.87 KHz (TTL compatible)

VERTICAL SYNC . . . .   45.36 KHz (TTL compatible)

VIDEO SIGNAL . . . .   62.5 nsec (1.6 MHz)

DIMENSIONS (w x d x h) . . . .   310 x 310 x 280 mm
(12.25 x 12.25 x 11.0 inches)

WEIGHT . . . .   8.5 Kg (18.7 lbs)

1.2.4 Floppy Disk Drive Specifications

DRIVE SIZE . . . . 5.25 inch drives (two)

RECORDING METHOD . . . . MFM

STORAGE CAPACITY
    Unformatted . . . . 1000 K bytes
    Formatted (16 sectors/track) . . . . 565 K bytes

NUMBER OF TRACKS . . . . 160 (80 per side)

TRACK DENSITY . . . . 96 TPI

RECORDING DENSITY (side 1, track 79) . . . . 5876 BPI (double density)

TRACK RADIUS
    Innermost Track (TK 79) . . . . Side 0: 36.25 mm
                                           Side 1: 34.13 mm
    Outermost Track (TK 00) . . . . Side 0: 57.15 mm
                                           Side 1: 55.03 mm

TRANSFER RATE . . . . 250K bits per second

AVERAGE ROTATIONAL DELAY . . . . 100 msec

ACCESS TIME
    Track-to-Track . . . . 3 msec
    Average . . . . 96 msec
    Settling Time . . . . 15 msec

READ/WRITE HEAD
    Type . . . . Tunnel erase head with gimbal support
    Positioning System . . . . Stepper motor

DRIVE MOTOR . . . . Direct drive spindle motor
    Start-up Time . . . . 0.5 sec or less
    Speed . . . . 300 rpm

SENSORS . . . . Index, track 00, and write protect

POWER REQUIREMENT
    + 12V Read Current . . . . 0.6A typical, 1.5A maximum
                                           250mVpp maximum ripple
    + 5V Read/Write Current . . . . 0.15A typical, 0.4A maximum
                                           100mVpp maximum ripple

POWER DISSIPATION . . . . 8.0 W typical during operation

DIMENSIONS (w x d x h) . . . . 146 x 195.5 x 41 mm
                                           (5.7 x 7.7 x 1.6 inches)

WEIGHT . . . . 1.4 Kg (3.0 lbs)

1.3 HARDWARE CONFIGURATION (Figure 1-1)

The computer is composed of the main CPU unit, which includes the power supply, controller, and graphics boards; the monitor; the keyboard; and two floppy disk drives.
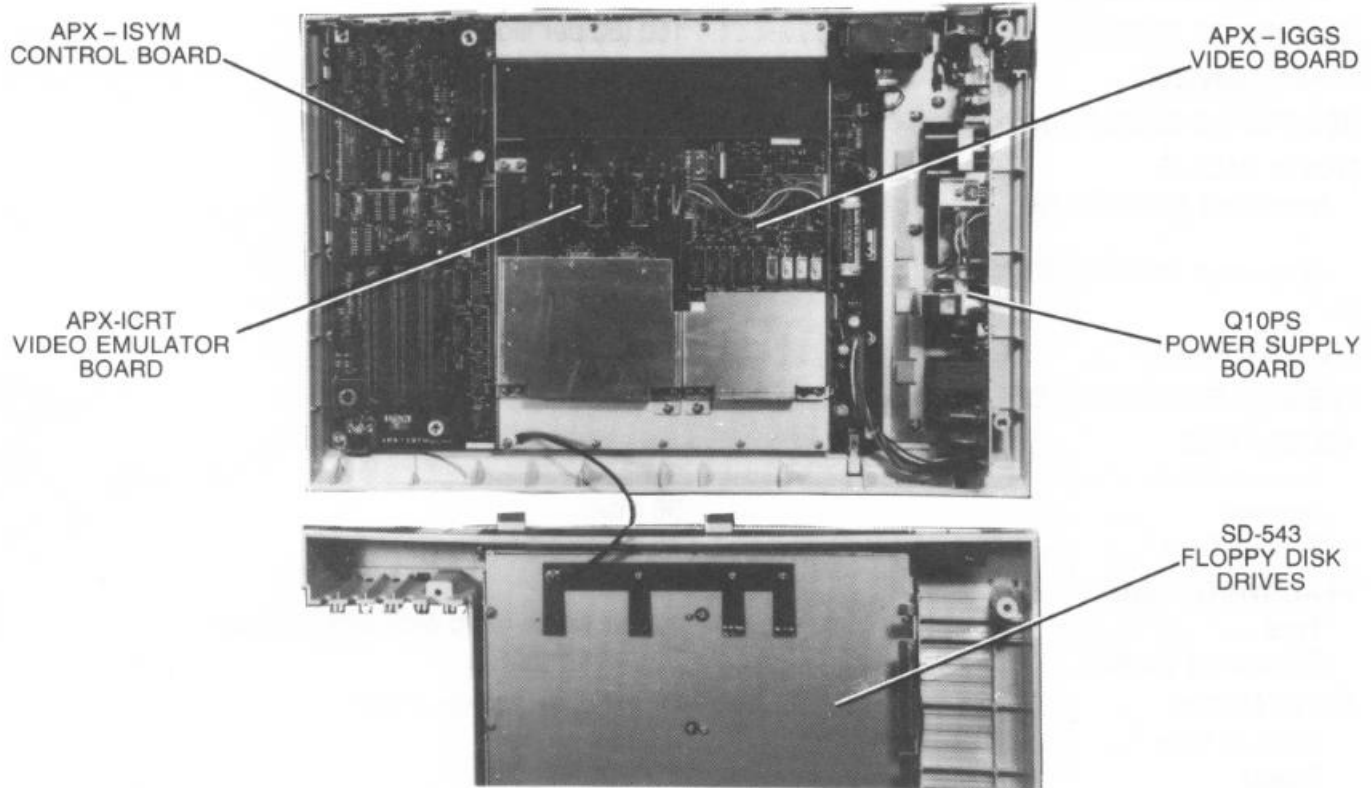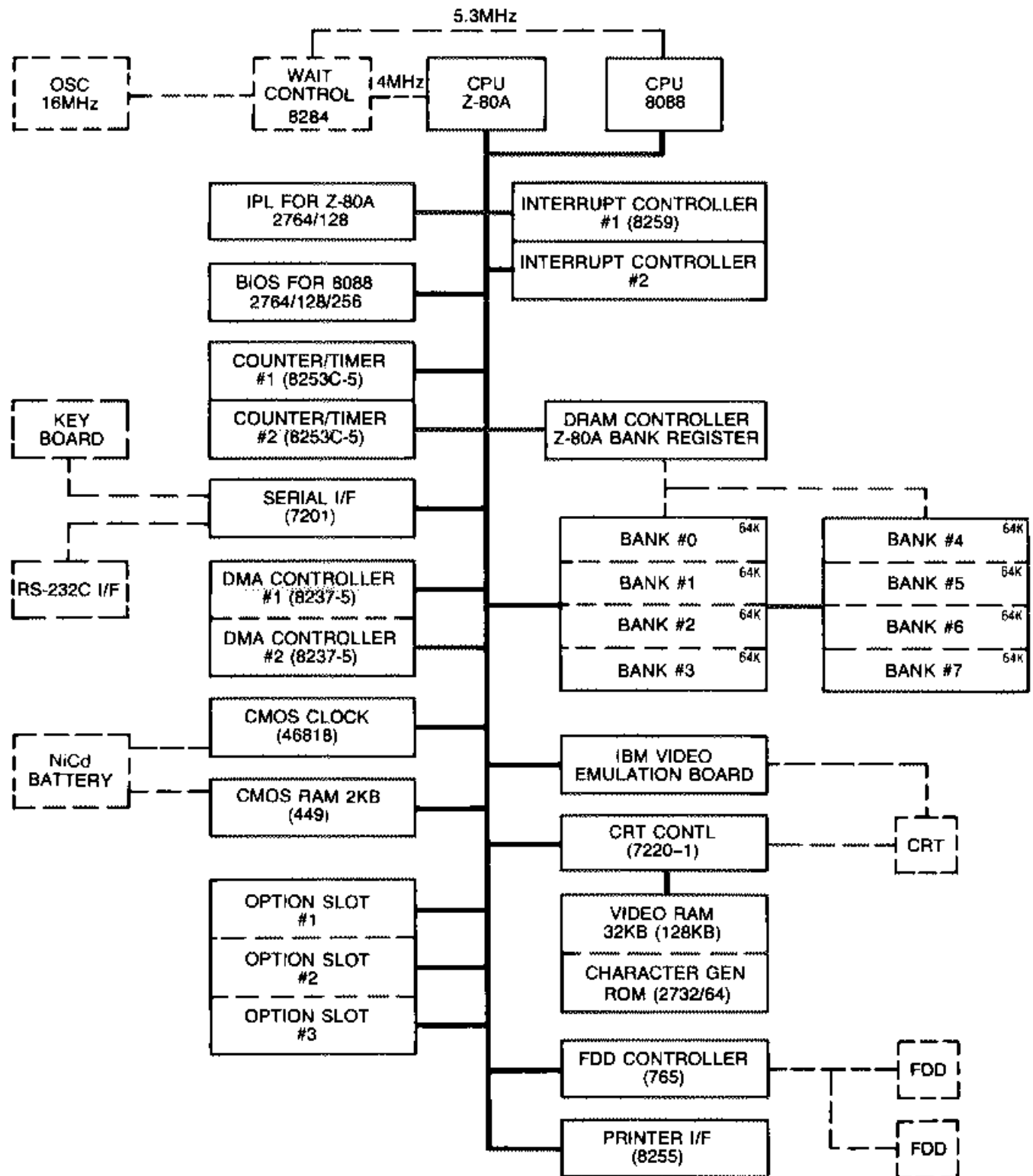
APX – ISYM
CONTROL BOARD

APX – IGGS
VIDEO BOARD

APX-ICRT
VIDEO EMULATOR
BOARD

Q10PS
POWER SUPPLY
BOARD

SD-543
FLOPPY DISK
DRIVES

FIGURE 1-1. COMPONENT LOCATIONS

1.3.1 Main Unit Components (Figures 1-2 through 1-4)

The main unit houses the Q10PS power supply board, which includes the filter and switching regulator; the APX-ISYM control board, which includes the Z80A-compatible and 8088 processors and related logic components; the APX-IGGS video board, which includes the µPD7220 graphic display controller and VRAM for monitor control; and the APX-ICRT video emulation board, which enables IBM format video display.

Logic component relationships are diagrammed in Figure 1-2. Figure 1-3 and Table 1-1 describe layout and functions of the APX-ISYM board components, including the three option slots (refer to the Specifications for a list of available interfaces). Figure 1-4 and Table 1-2 describe the APX-IGGS board, and Figure 1-5 and Table 13 describe the APX-ICRT video emulator board. The power supply board is illustrated in Figure 1-6, with power supply voltages listed in Table 1-4.

The CPU unit also houses the two floppy disk drives; however, these are discussed separately throughout the text. (See Section 1.3.2.)

NOTE: *BANK 0-7 BECOMES 512K BYTE MEMORY SPACE IN 8088 MODE.*

FIGURE 1-2. LOGIC BLOCK DIAGRAM

TABLE 1-1. APX-ISYM BOARD COMPONENT DESCRIPTIONS

NAME	MODEL	IC LOCATION	QTY	FUNCTION
CPUs	µPD780-1 8088-2	18C 16C	1 1	8-bit CPU (4MHz) compatible with Z80A. 16-bit CPU (5.3MHz)
DMA Controller	8237AC-5	8F,10F	2	Provided with a total of 6 channels for FDD, monitor, and options.
Interrupt Controller	8259AC-2	8D,9D	2	Controls the interrupt priority with a total of 13 levels of interrupt including PWD output, keyboard interrupt, and options.
Counter/Timer	8253C-5	9C,10C	2	Controls the baud rate of the keyboard, clock, and RS-232C interface.
Serial Controller	7201C	1B	1	Allocates channel A to the keyboard and B to the RS-232C interface, and controls serial data transfer with the CPU.
Printer Controller	8255AC-5	16A	1	Provided with an 8-bit parallel port for interfacing with an Epson compatible printer.
Real Time Clock	146818P	18A	1	Clock with calendar functions.
Floppy Disk Controller	µPD765AC	13A	1	Controls SD-543 FDDs.
Gate Array for FDD Controller	GAFDDC	10A	1	Inserted between the FDC (µPD765) and the SD-543 drive, this device controls the FDDs.
VFO	SED9421	11B	1	Variable frequency oscillator for the FDD read circuit. Data separator.
I/O Selector	LS154	8C	1	Accesses each I/O port by decoding the 4-bit low order address (A2—A5) of the CPU.
Main Memory	µPD41257 (HM50256)	13H 20H 13J 20J	8 16	256K-byte system memory. 512K byte memory configuration
PROM	2764 2764/27128/27256	22C 24C	1 1	Z-80A initial program loader (IPL). 8088 basic input/output system (BIOS).
CMOS RAM	µPD449	25C	1	Stores the data (Backed by the NiCd battery.)

TABLE 1-2. APX-IGGS BOARD COMPONENT DESCRIPTIONS

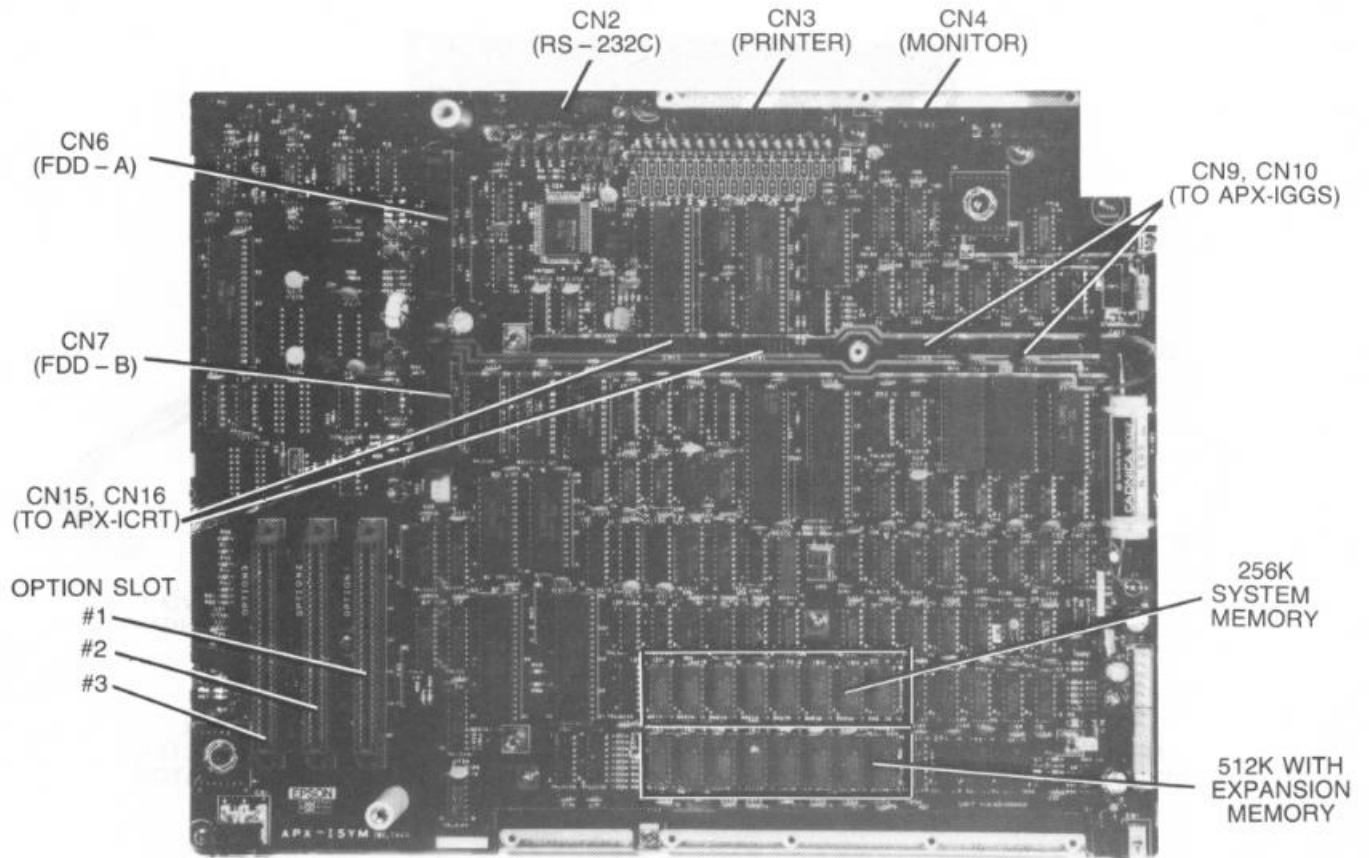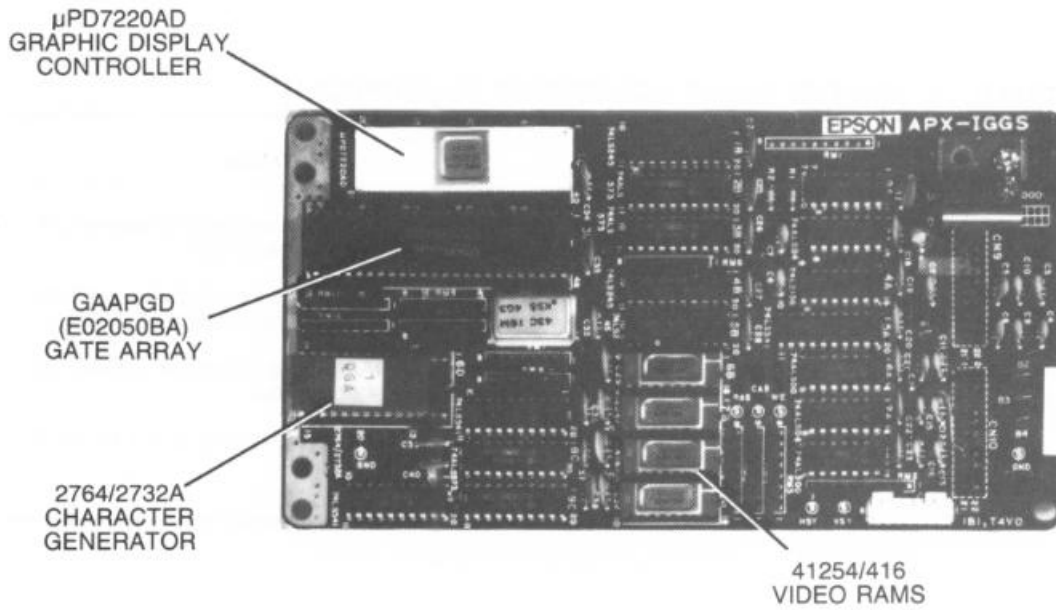| NAME	MODEL	IC LOCATION	QTY	FUNCTION
Graphic Display Controller	µPD7220AD	1C	1	Graphics display controller with video memory management.
Video RAM	41254/416	6B— 9B	4	Video memory.
Character Generator	2732A/64	6D	1	Character generator EPROM.
Gate Array	E02050BA	3C	1	Includes zoom, line count, and attribute circuit.

FIGURE 1-3. APX-ISYM CONTROL BOARD
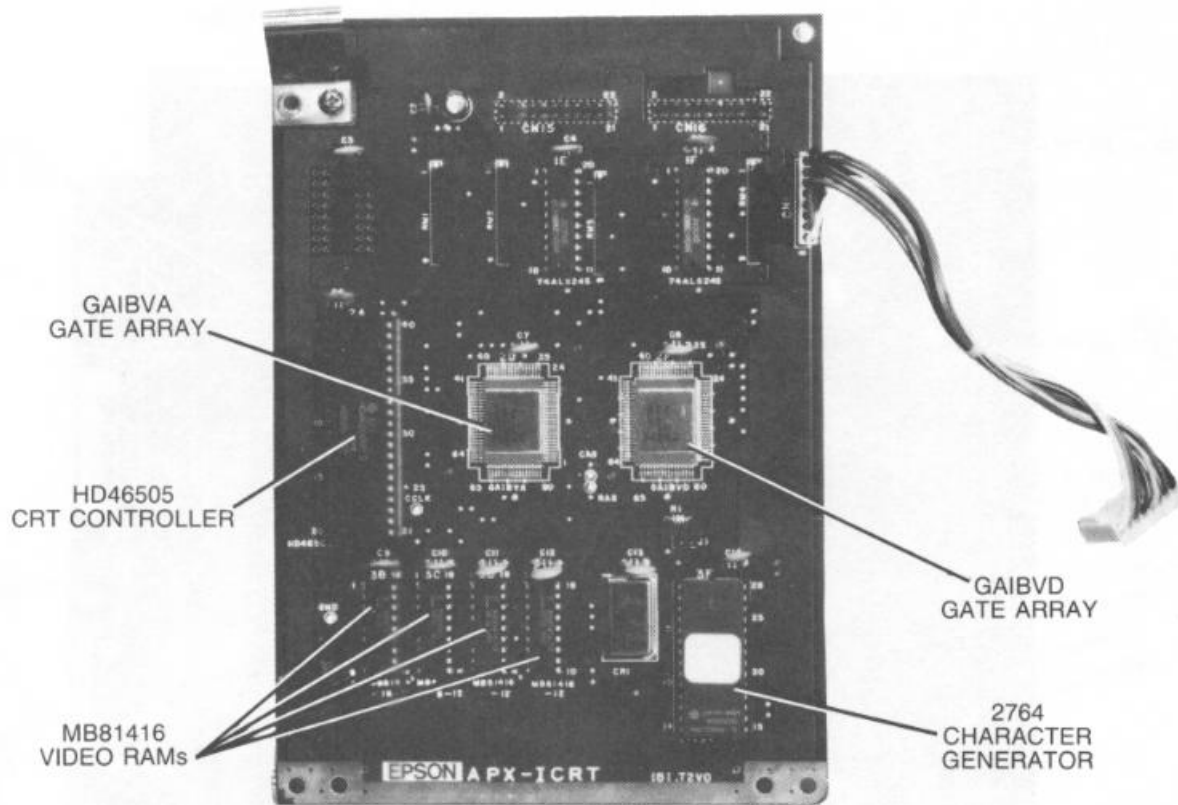

FIGURE 1-4. APX-IGGS VIDEO BOARD

FIGURE 1-5. APX-ICRT VIDEO EMULATOR BOARD

TABLE 1-3. APX-ICRT BOARD COMPONENT DESCRIPTIONS

NAME	MODEL	IC LOCATION	QTY	FUNCTION
CRT Controller	HD46505SP-2	2A	1	Controls VRAM and gate arrays to enable emulation of IBM PC display hardware.
Gate Arrays GAIBVA/GAIBVD	MB62H159/ MB63H137	2D, 2F	2	Controls memory addressing and converts VRAM data to video signals under control of 46505.
VRAMs	MB81416-10	3B-3E	4	32K bytes DRAM store graphics display or character and attribute data.
Character Generator	2764	3F	1	EPROM stores character patterns for 8×16, 7×7, or 5×7 fonts.

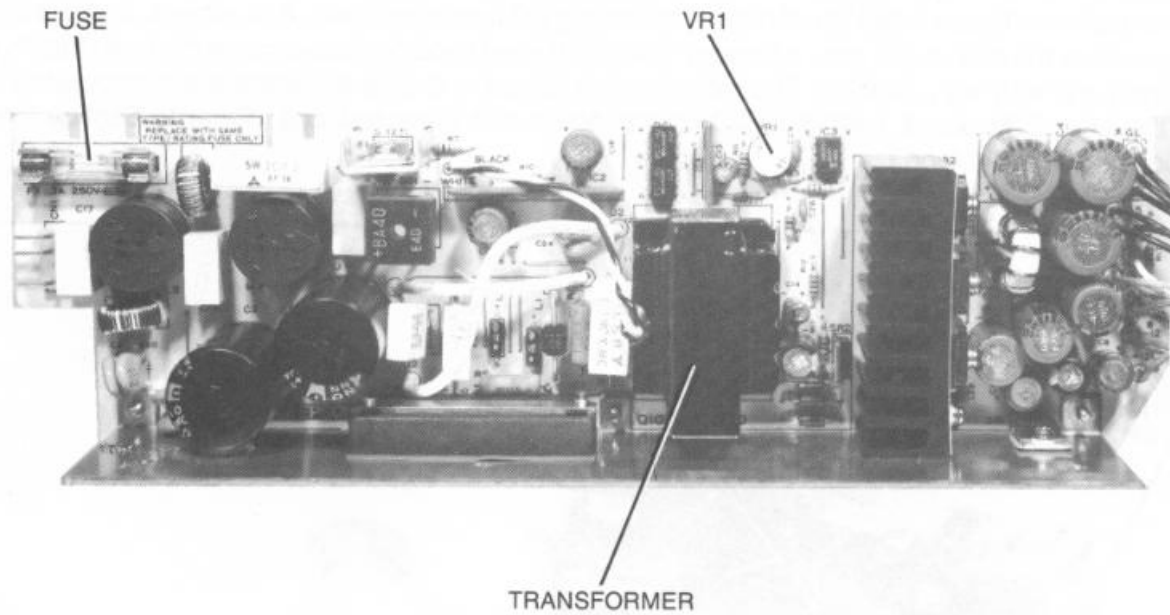FIGURE 1-6. Q10PS POWER SUPPLY BOARD

TABLE 1-4. Q10 PS BOARD OUTPUT VOLTAGES

OUTPUT VOLTAGE	USE	VOLTAGE LIMITS	NOMINAL CURRENT
+5	Logic circuit	5.0 to 5.1V	3.6A
+12(C)	Not used in QX-16	---	---
+12(F)	Floppy disk drive	11.4 to 12.6V	1.2A
+12(L)	Keyboard, RS-232C	11 to 13V	0.45A
-12	DRAM, RS-232C	-11 to -13V	0.02A

1.3.2 Floppy Disk Drive Components (Figure 1-7)

Two SD-543, 5 1/4 inch floppy disk drives are housed in the system CPU unit. The half-height (1.6 inch / 41 mm) drives perform double-sided, quad-density recording (80 tracks per side). A brushless, direct-drive spindle motor rotates the disk at 300 rpm; a stepper motor and steel band positioner move the head rapidly (3 ms access time) and with high reliability. The motor control circuit and data separator are incorporated in two LSIs on the APX-ISYM board, enabling FDD control board size to be reduced. (Refer to Section 2.6 for a description of FDD operation.)
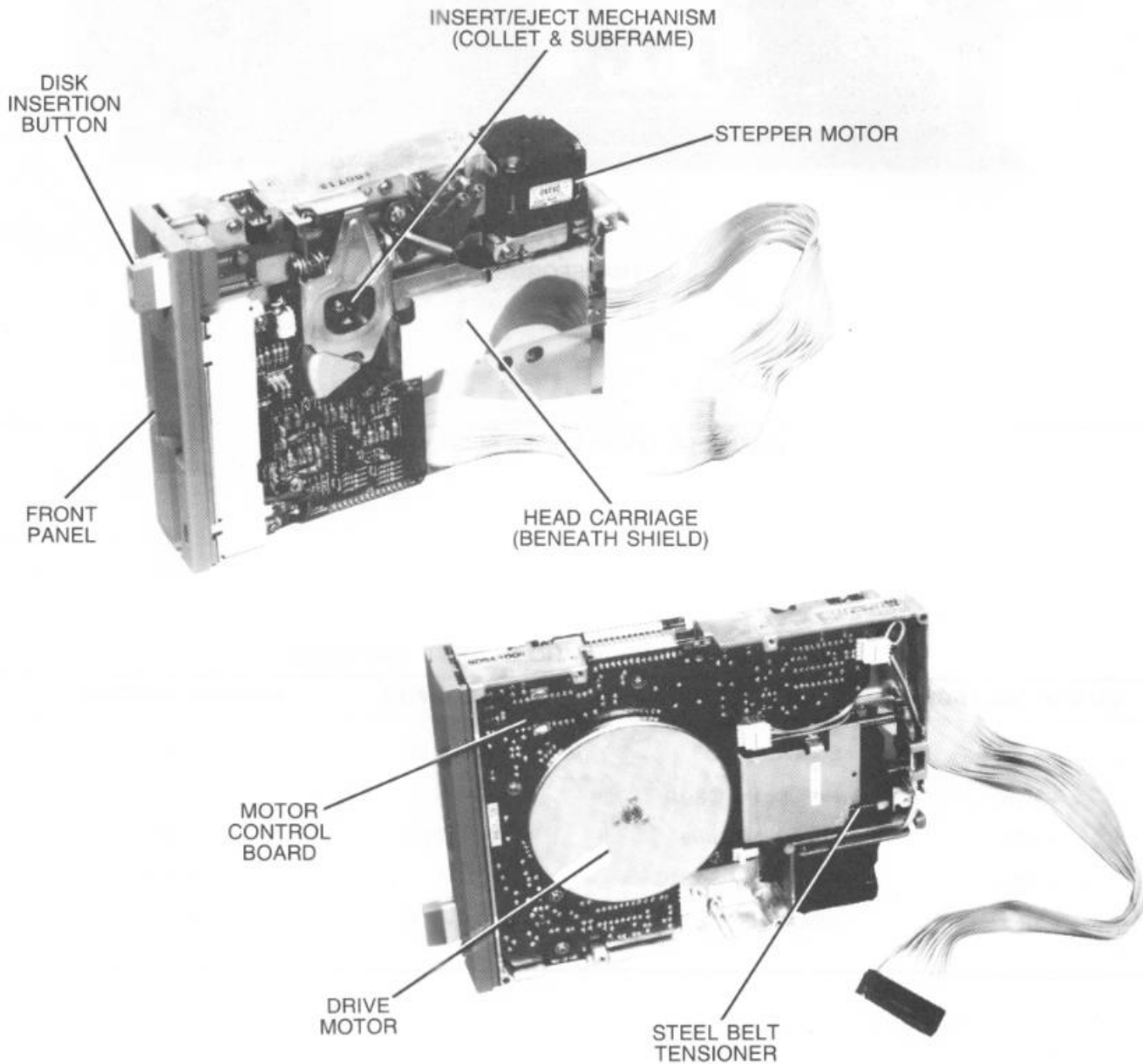

FIGURE 1-7. SD-543 FLOPPY DISK DRIVE COMPONENT LOCATIONS

1.3.3 Keyboard Components (Figure 1-8)

The desktop keyboard is a standard QWERTY keyboard with eighteen programmable function keys, an edit/cursor keypad, and a numeric keypad. The keyboard performs synchronous data transfer at 1200 BPS with the system CPU, using a custom keyboard controller IC. (Refer to Section 2.7 for a description of keyboard operation.)

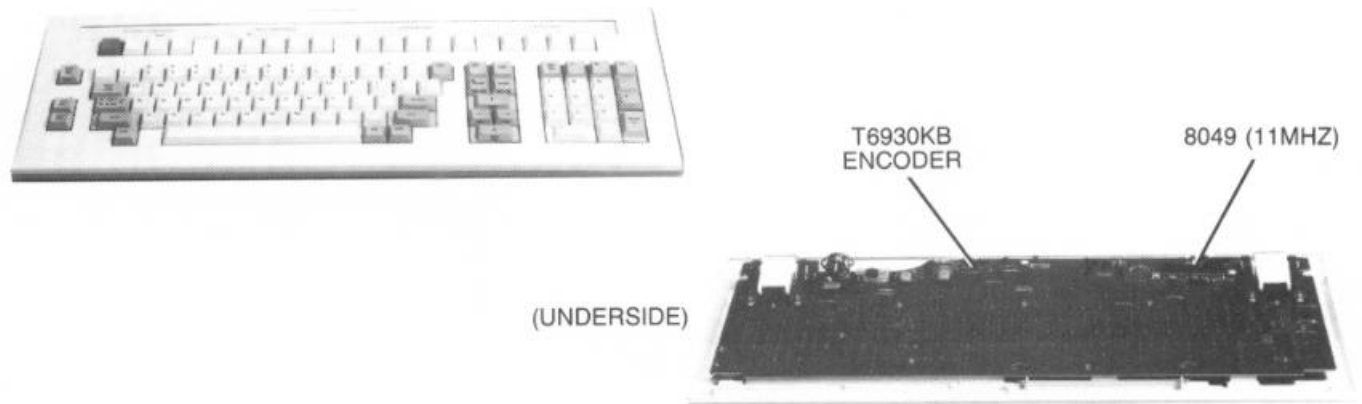T6930KB ENCODER   8049 (11MHZ)

(UNDERSIDE)

FIGURE 1-8. KEYBOARD COMPONENT LOCATIONS

1.3.4 Monitor Components (Figure 1-9)

The standard, non-glare green monitor has 640 x 400 line resolution, and uses TTL compatible horizontal and vertical sync signals. Figure 1-8 illustrates monitor component locations. (Refer to Section 2.8 for a description of monitor operation.)
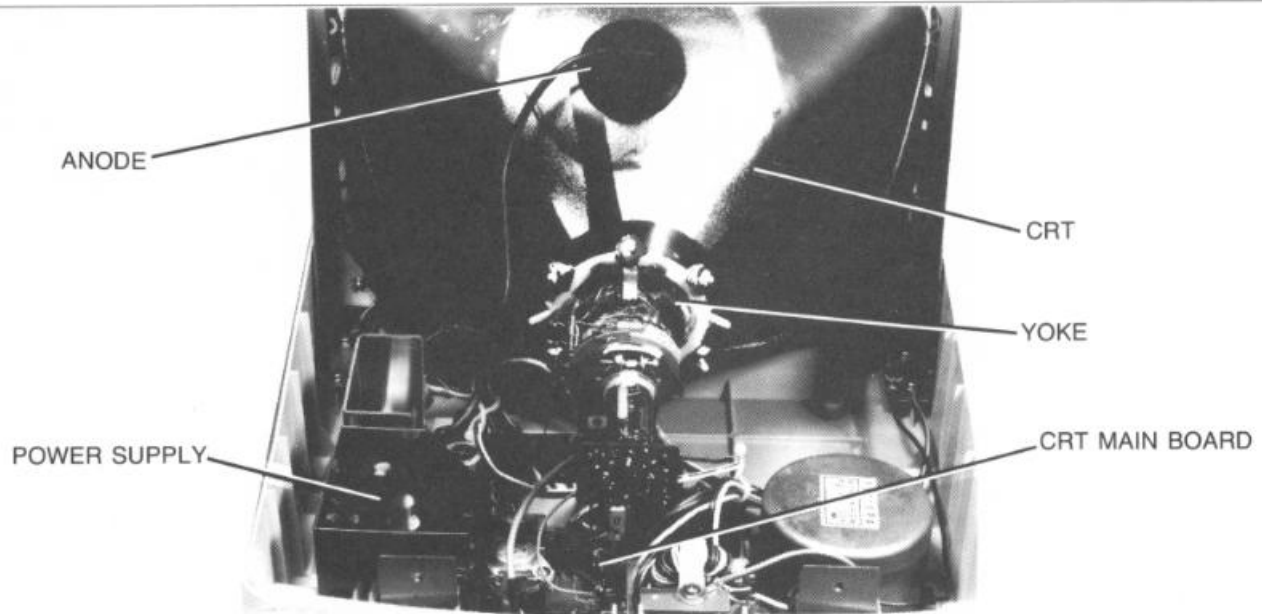

ANODE
CRT
YOKE
POWER SUPPLY
CRT MAIN BOARD

FIGURE 1-9. MONITOR COMPONENT LOCATIONS