MDT50

VIDEO DISPLAY TERMINAL

SERVICE MANUAL

MORROW

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5 -- MAINTENANCE

INTRODUCTION

Scope of this Manual

This Manual presents details of the circuitry and data paths of the Morrow MDT50 Video Display Terminal, along with information on typical waveforms and signal levels, to allow service personnel to troubleshoot and repair the terminal, as needed. Familiarity with the Morrow MDT50 User's Manual is assumed.

While every effort has been made to assure that the information contained herein is accurate and up to date, Morrow Designs, Inc. reserves the right to make engineering changes and appropriate parts substitutions without prior notice in the interests of increased and improved performance.

> > > > WARNING < < < <

CRITICAL COMPONENT WARNING:

SERVICEMAN WARNING: This product contains components which are critical for X-Radiation Safety. See Service Manual for proper replacement. Normal 2nd Anode Voltage is 12 KV at Zero beam current, AC 120V input, and must NOT exceed 13 KV under any operating conditions. To measure 2nd Anode Voltage, use High Impedance meter. Connect (-) to chassis, use a High Voltage lead from (+) to 2nd Anode.

Components of the Morrow MDT50 Terminal

External

From an outside viewpoint, the Morrow MDT50 consists of two units: The Monitor Unit, containing the CRT, power supply, and control circuits; and the Keyboard Unit, containing the physical keyboard, its decoding circuitry, and circuits for communicating with the Monitor Unit.

The Keyboard and Monitor Units are connected by a coiled telephone handset cord with 7,62 mm (0.3 in) male plugs at each end. Power is supplied via a 3-wire grounded cord, terminated by a U.S. NEMA standard plug (which may be replaced to suit local power system requirements).

Communications with a Host computer or modem and a printer are provided via asynchronous RS-232 communication via two female DB-25 receptacles on the rear of the Monitor Unit. Controls are provided on the Monitor Unit for Power ON/OFF, Contrast, and setting operating parameters.

Internal

Internally, the Morrow MDT50 consists of:

➔ A Transformer and Voltage Selector Switch for converting 115V or 230V AC mains power to 10.5V AC, 16.7V AC, and 21.3V AC.

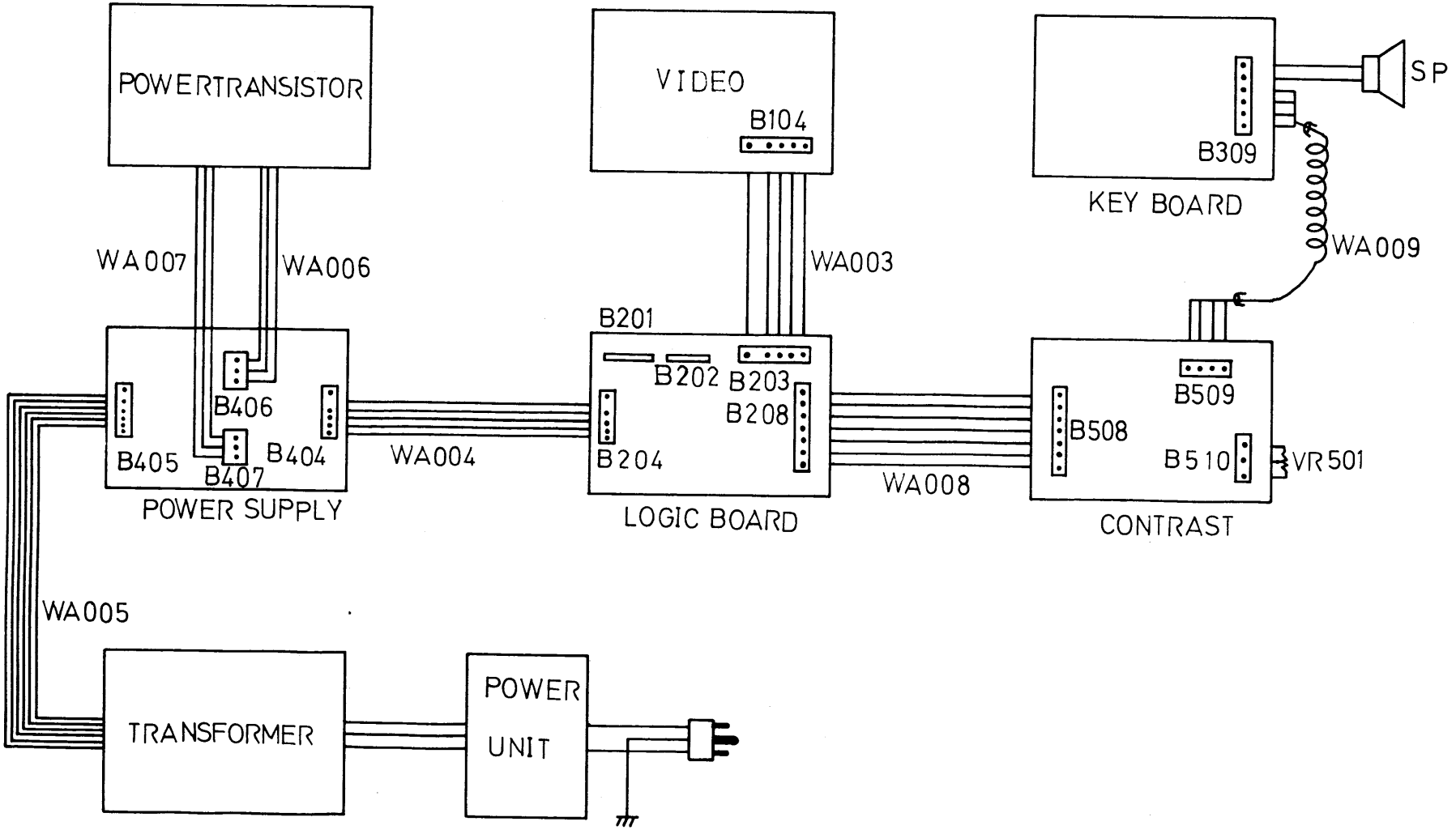
➔ A Power Supply board, with rectifiers and voltage regulators, to produce +5V, +15V, and -12V DC [regulated to ±10%].

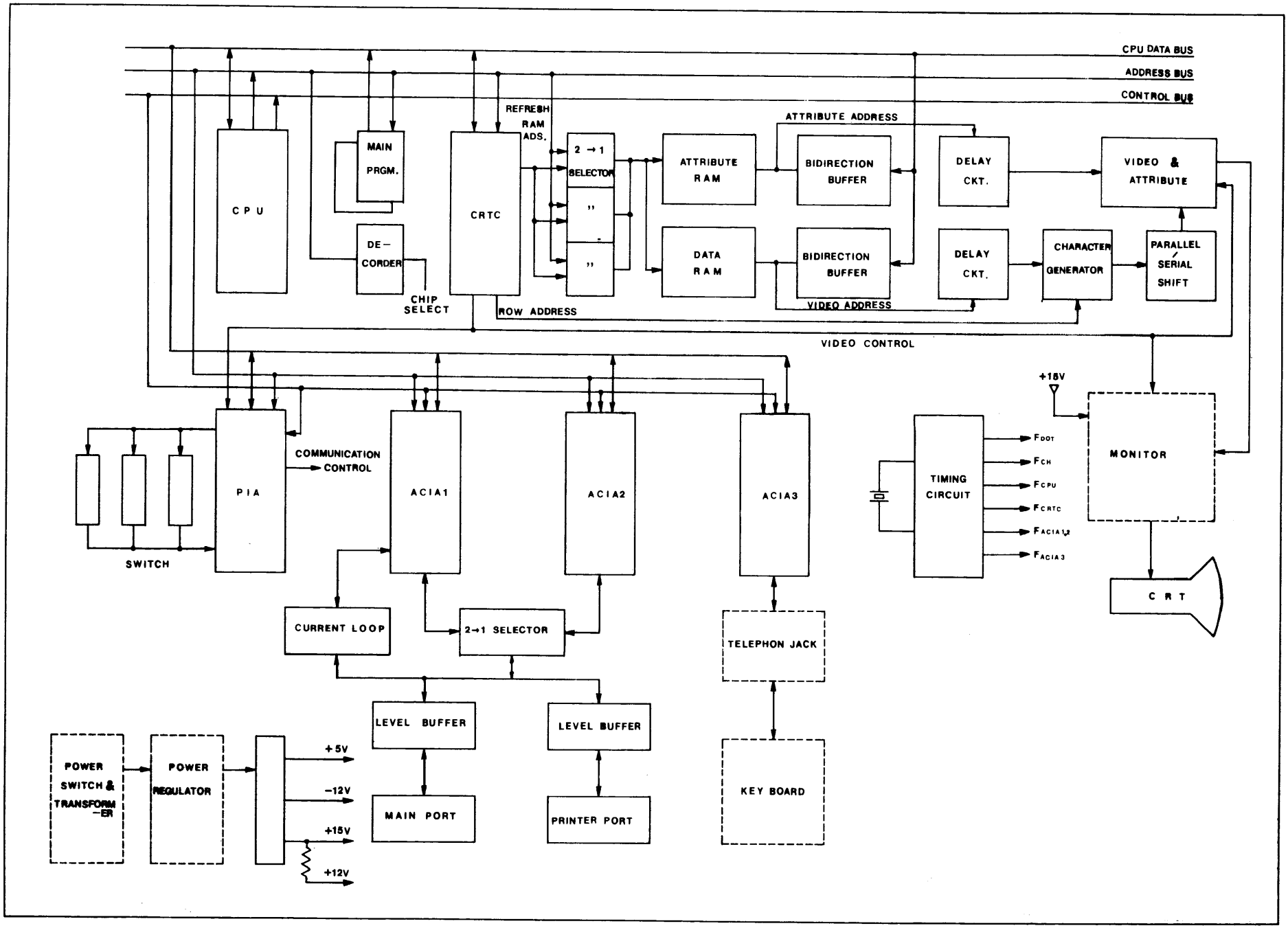
➔ A Main Logic Board, with a 68A02 Microprocessor, 16k of EPROM-resident firmware, 2k of character storage RAM, 4k of attribute and control storage RAM, a 68A45 CRT Controller, a 68A21 PIA, one 6850 and two 6851 ACIAs for Keyboard, Host and Printer communications, respectively, as well as miscellaneous control and sequencing logic.

➔ A Video Control board, to convert Horizontal and Vertical synch pulses to the proper waveforms for controlling CRT raster scan, and circuitry to control pixel display. Connection is made via cables to a 12" diagonal CE745129 VRA tube (or equivalent) for actual display.

➔ A small Contrast control and connector board, having a rotating potentiometer for contrast control, and a female RJ-11 receptacle for the Keyboard connector cord.

➔ A Keyboard, with a 93-key switch-matrix keyboard, decoded by an 8035 stand-alone microcomputer, which generates RS-232 signals by toggling one output line under the control of on-chip software, and receives RS-232 data via software use of interrupts.





Theory of Operation

Terminal Operation

The Morrow MDT50 CRT Terminal is designed to be an inexpensive and convenient data-entry and console device for a wide range of computer and data applications.

The Morrow MDT50 will normally be connected to a Host computer system, either directly or via MODEM, by asynchronous RS-232 or 20ma current loop, through the Host connector on the rear of the Monitor Unit. The terminal's on-board firmware allows it to communicate with the Host in Full or Half Duplex, or strictly Local mode (no outside communication). Communication rates range from 110 to 19,200 baud.

A subsidiary Printer port, also located on the rear of the Monitor Unit, allows the Morrow MDT50 to be connected to any ASCII printer with an RS-232 serial interface. Baud rates from 100 to 19,200 are available. The terminal provides two basic modes for printer operation:

Simultaneous Mode -- all characters transmitted from the Host are displayed on the monitor, and also sent to the Printer

Buffer Mode -- characters from the Host are buffered internally in the Morrow MDT50, and sent to the Printer without being displayed on the monitor

The Morrow MDT50's 16k of on-board firmware provides 93 basic commands, as well as numerous options, for setting operating parameters. These commands can be sent by the operator from the Keyboard, or by the Host through the Host port. The commands and their effects are documented in the Morrow MDT50 User's Manual.

Data Paths

The Morrow MDT50's Main Logic Board receives serial Asynchronous RS-232C character data from either the Host Port or the Keyboard. This character data is stored in a 2k-byte Display RAM. Character data from the display RAM is sent continuously to the Video display circuitry, where it is processed by a Character generating ROM, combined with attribute data from a separate 2k-byte Attribute RAM, and sent to the CRT for display.

If the Morrow MDT50 is in Full Duplex Mode, all character data received from the keyboard is immediately transmitted to the Host hrough the Host Port, but is not displayed on the CRT.

If it is in Half Duplex Mode, character data received from the keyboard is displayed on the CRT in addition to being transmitted to the Host.

In either Mode, XON/XOFF protocols are used in communicating with the Host.

If it is in Simultaneous (Transparent) Print Mode, character data received from either the Host or the Keyboard is displayed on the CRT and transmitted to the Printer Port.

If it is in Buffered Print Mode, character data received from the Host is transmitted directly to the Printer Port (with XON/XOFF handshaking) **without** being displayed on the CRT.

Quick Check-out

To check out the operation of the Morrow MDT50 quickly, and isolate problems:

1) Check for 115V AC or 230V AC on the primary (input) leads of the Power Transformer.

a) If found, go to Step 3.

b) Check the fuse, power switch, and power select switch.

2) Check the secondary (output) leads for 10.6V AC on blue, 21.3V AC on white, and 16.7V AC on brown.

a) If OK, go to Step 2.

b) Replace power transformer.

3) Disconnect cable from Power Supply to Main Logic Board (B404 <--> B204). Check B404 for:

Pin 1	-	-12V DC ±0.5V
Pin 2	-	+15V DC ±0.5V
Pin 3	-	+5V DC ±0.25V
Pins 4 & 5	-	Ground

a) If OK, replace cable to Main Logic Board (B404 <--> B204). Go to step 5.

4) Disconnect cable to power transistors (B406, 407). Check connectors for:

B406	Pin 1	-	15.1V DC
	Pin 2	-	29.8V DC
	Pin 3	-	29.9V DC
B407	Pin 1	-	5.1V DC
	Pin 2	-	14.3V DC
	Pin 3	-	14.4V DC

a) If OK, check U401 through U403 and capacitor.

b) Check Bridge Rectifiers BR401, BR402, BR403, and transistors Q401 and Q403.

5) Check voltage on B404 again.

a) If OK, go to Step 7.

6) Check Power Transistor voltages:

Q402	Base	-	10.6V DC
	Collector	-	5.1V DC
	Emitter	-	11.4V DC

Q404 Base	-	24.6V DC
Collector	-	15.1V DC
Emitter	-	25.2V DC

a) If OK, check U401 through U403 and capacitor.

b) Replace transistor(s).

7) Disconnect cable from Main Logic Board to Video Board (B203 <--> B104). Check signal levels and typical waveforms on Connector B203.

a) If OK, reconnect cable (B203 <--> B104) and run Monitor Check Subroutine (hit **ESC M** on keyboard) for software problems. Check/replace ROMs, if necessary.

b) Go to Step 8.

8) Disconnect cable to Contrast Board (B208 <--> B508). Check signal levels and typical waveforms on Connector B208.

a) If OK, Reconnect cable to Contrast Board (B208 <--> B508), go to Step 9.

b) Check all test points on Main Logic Board for proper signal levels and typical waveforms, then isolate and replace defective parts.

9) Disconnect cable connecting Keyboard to Contrast Board (B509 <--> B309). Check Contrast Board for defective parts and broken traces.

a) If OK, reconnect cable to Keyboard connector (B509 <--> B309) and go to Step 10.

b) Replace Contrast Board.

10) Check signal levels and typical waveforms at B309 on Keyboard PC board.

a) If OK, check all test points on Keyboard for signal levels and typical waveforms. Isolate and replace defective components.

b) Replace coiled telephone handset cord.

11) END.

The Video Board

Theory of Operation

Video Signal

The Video Signal is essentially an ON/OFF signal, which determines whether a particular pixel position on the face of the CRT will be illuminated or not by the scanning electron beam. It is generated by the video circuitry on the Main Logic Board, and received via Pin 3 of Connector B103 on the Video Board. It is amplified and pulse-formed by Transistors TR101 and TR102, and fed to the gate of the CRT tube through Pin 1 of Connector B101.

Vertical Synch

The Vertical Synchronization signal is generated by the CRT Controller chip on the Main Logic Board, and reaches the Video Board via Pin 4 of Connector B103. It is used by IC101 (muPC 1031 H2) to reset the beam of the CRT to the top of the screen in preparation for a scan. After pulse-shaping by IC101, it is used to control the Vertical Deflection Yoke (Y101) to position the beam correctly.

Horizontal Synch

The Horizontal Synchronization Signal is also generated by the CRT Controller chip on the Main Logic Board, and reaches the Video Board via Pin 6 of Connector B103. It controls the rate at which the beam scans the face of the CRT from side to side. After being amplified and pulse-shaped by TR103 and TR104, it is fed to the Horizontal Yoke and the Fly-Back Transformer (T102) to produce scan lines on the face of the CRT tube.

Miscellaneous Controls

Variable Resistors (Potentiometers) are provided to control:

Vertical Hold
Vertical Size
Vertical Linearity
Focus
Brightness

Troubleshooting

Components

I) Make sure that the power is **OFF.** Look at the Video Board, and check for obvious physical problems:

Broken Wires
Loose connectors
Broken connector parts
Dirt or dust
Overheated or burned parts

Correct problems and recheck before going on.

II) Remove the Video Board from the Morrow MDT50 and give it a thorough look, both front and back.

A) Are you **sure** the power is off? Turn it **OFF.**

B) **CAREFULLY** ground the Anode lead from the CRT tube. A heavy jumper from the Anode lead connection at the Flyback Transformer to chassis ground is the best bet -- the Anode may be at any voltage up to 12kV!

C) Disconnect the Anode lead.

D) Disconnect B104 (connector to Main Logic Board)

E) Disconnect B101 (connector to CRT tube)

F) Disconnect B102 (connector to small PCB on CRT tube)

G) Disconnect B103 (CRT tube grounding strap)

H) Remove the screws which hold it in the Monitor Unit.

I) Lift out the board, carefully.

J) Check all of the components for burns, overheating, leaks, etc.

K) Check for broken or missing components.

L) Check for cracked or broken traces, solder bridges or cold solder joints.

M) Carefully re-install Video Board, remembering to put the holding screws back in, and tighten them down.

N) Re-connect B101, B102, B103, B104, and the CRT Anode lead.

O) Turn ON power, wait for the CRT tube to warm up.

P) Enter a random assortment of letters and numbers via the keyboard. (If nothing happens, check Keyboard and Main Logic Board)

Q) Adjust:

Contrast,
Brightness,
Focus,
Horizontal Hold,
Vertical Hold,
Vertical Linearity, and
Vertical Size

III) Malfunctions

A) **No Video Signal**

1) Check that the Contrast control knob at the front of the Monitor Unit is turned up (clockwise).

2) Check for +15V on Pin 1, Connector B104, and at base of TR101. If not found, check Main Logic Board and Power Supply.

3) Check for Video Signal at TP101 (base of TR102). If not found, check Pin 3 of Connector B104.

a) If signal found, check VR101 (contrast control pot on small PCB at front of Monitor Unit) and R102. Replace as necessary.

b) If not found, check Main Logic Board.

4) Check for Video signal at TP102. If found, go to Step 9.

5) Check collector of TR102 for 6.4V, base for 0.4V, and emitter for 0.3V.

a) If signal found, go to Step 5.

b) If not found, isolate collector to check for pin being pulled down.

c) Check R103, R104, C103. Replace as necessary.

d) Check/replace TR102.

6) Check TP102 (collector of TR101) for 6.5V, base for 6.9V, and emitter for 6.4V.

a) If signal found, go to Step 6.

b) Check R101, C101, D101, C102. Replace as necessary.

c) Isolate collector to check for pull-down. If no signal, check/replace TR101.

d) Check L101, R105, C104, D102, and Brightness circuitry connected to Pins 3, 4, & 5 of Flyback Transformer. Replace as necessary.

7) Check Pin 1 of Connector B101.

a) If signal found, go to step 6).

b) Check R106. Replace as necessary.

8) Check R107 and C118 for short, open or solder bridges. Replace/repair as necessary.

9) Check circuitry connected to Pin 2 of Flyback Transformer -- D103, C129, R118, R119, R122, C132, C133, VR106. Replace/repair as necessary.

10) Check CRT tube for open circuit in Cathode. Replace as necessary.

B) **No Vertical Deflection**

1) Is the power **ON**? Turn it on.

2) Check connection between R111 and R101 for +15V relative to ground. If not found, check Pin 1, Connector B104 for +15V. If not found, check Main Logic Board and Power Supply Board.

3) Are all of the connectors from the Video Board to the Main Logic board and the CRT tube actually connected? Wiggle them to make sure.

4) Check Test Point TP103 for Vertical Synch signal from the Main Logic Board. If no signal, check Main Logic Board.

a) If signal found, go to Step 5.

b) Check C105, C106, and R108. Replace as necessary.

5) Check TP104 for Vertical deflection signal from IC101. If no signal, test or replace IC101.

6) Check Vertical Yoke (Y101) for broken wires. If found to be open circuit, replace Yoke.

7) Check cathode of CRT tube for open circuit.

8) If all of the above are OK, check diodes, resistors, potentiometers, and capacitors in the vertical timing circuit for shorts, broken wires, or internal open circuits.

C) **No Horizontal Deflection**

1) Check connection between R116 and L102 for +15V relative to ground. If not found, check Pin 1, Connector B104 for +15V. If not found, check Main Logic Board and Power Supply Board.

2) Check TP105 for Horizontal Synch signal from Main Logic

Board. If no signal, check Main Logic Board. If signal does not agree with illustration of typical signal, check R114, and check TR103 for 0.35V on base, 14V on collector, and Ground on emitter.

3) Check TP106 (collector of TR103)

a) If signal found, go to Step 3).

b) Check collector of TR103.

c) If signal found, isolate collector of TR103 to see if signal is being pulled down by R116, R117, C121, or C122. Also check T101. Replace as necessary.

d) Test/replace TR103

4) Check TP107 (collector of TR104)

a) If signal found, go to Step 5).

b) Check base of TR104 for -0.1V, collector for 18V, and emitter for ground. Also check T101. Replace as necessary.

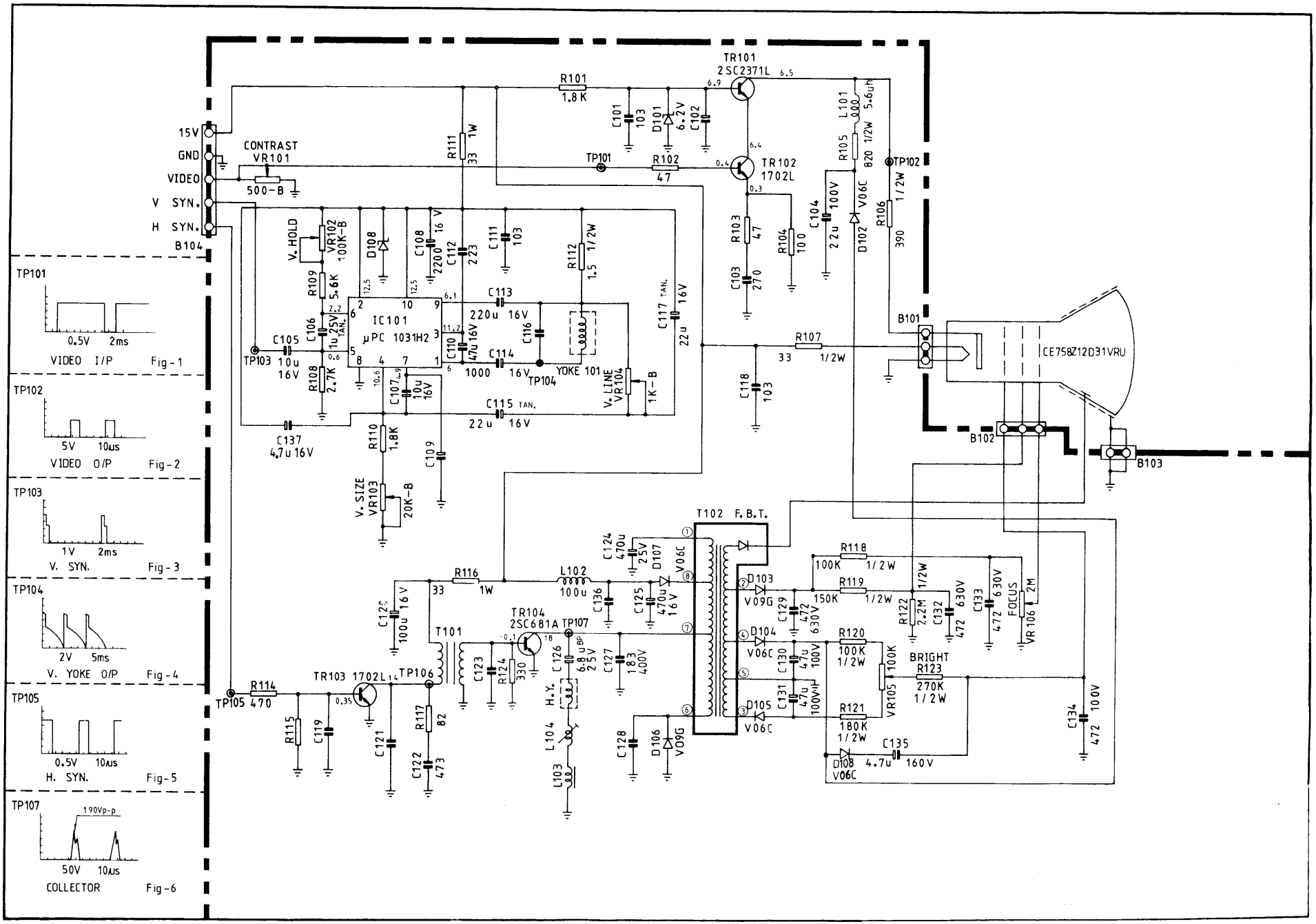
c) If signal found, isolate collector of TR104 to see if signal is being pulled down. Replace components as necessary.

d) Test/replace TR104.

5) Check for open circuit between Horizontal Yoke and ground. Check Horizontal Yoke, L103, L104 (adjustable), C127 and C126. Replace as necessary.

6) If all of above are OK, check all components in Horizontal Deflection circuitry, including connections to the Flyback Transformer, for shorts, opens, or corroded wires.

7) Check CRT Tube, replace as necessary.



THIS SCHEMATIC OR SPECIFICATION IS SUBJECT TO CHANGE
WITHOUT PRIOR WRITTEN NOTICE.

The Main Logic Board

Theory of Operation

Serial character data from the Host reaches the Main Logic board via Pin 3 of Connector B201, and is directed to Pin 12 (RXD) of U228 (6551 ACIA).

Serial data from the keyboard reaches the Main Logic Board via Pin 4 of Connector B208, and is directed to Pin 2 (RxD) of U218 (68A50 ACIA).

The ACIAs convert the serial data to 8-bit parallel data on their output pins (D0 - D7) which are connected to Lines D0 - D7 of the CPU Data Bus.

The 68A02 Microprocessor accepts the data and re-transmits it on the Data Bus to the display memory, U212 (2k x 8 RAM). From the memory, it is later transmitted via U223 (Octal Transciever) to U224 (Octal Latch). It is then ready for transmission to U225 (2732 Character Generator EPROM).

If the Freedom 100 is in Full Duplex Mode, the character data is also sent to U228 (ACIA) for transmission to the Host via Pin 2 of Connector B201. In Half Duplex, Block and Local Modes, data is not transmitted to the Host.

U209 (68A45 CRT Controller) controls Display refresh, as it withdraws character data from the Character Generator EPROM (U225). It also takes care of painting the cursor on the CRT screen.

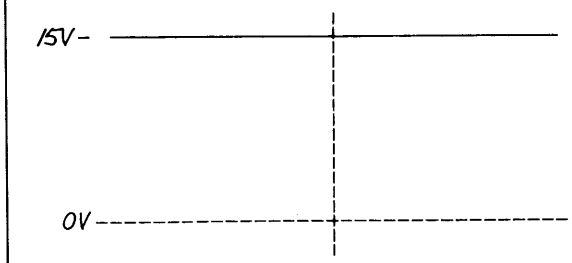
Output from the Character Generator goes to U236 (74LS166 Shift Register), where it is converted into a serial bit stream. This serial bit stream represents the sequence of pixels which must be turned ON to display one line on the CRT screen. Morrow MDT50 characters are displayed in a 7 x 9 dot block within a 9 x 12 dot matrix.

The serial data from U233 is combined at U229 (74LS74 Dual D Flip-FLop) with Attribute data from U211 (2k x 8 DRAM) gated through U221 & U222 (Octal Latches) to produce the Video Data output signal, which is transmitted on Pin 3 of Connector B203 to the Video Board.

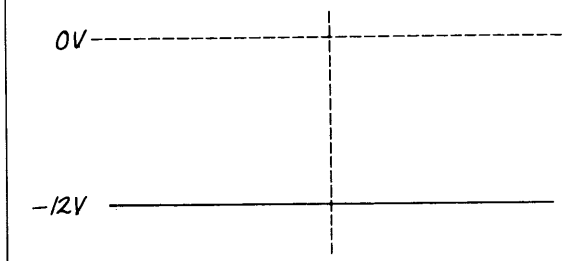
Test Points, Typical Waveforms, & Signal Levels

See the attached drawings and schematics

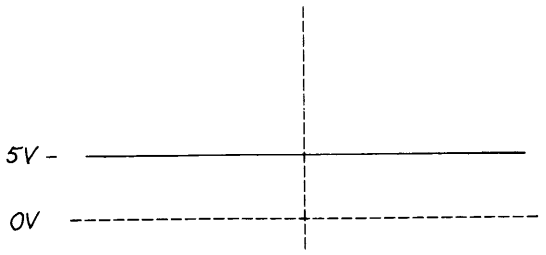
TP201	B203 Pin 1
+15V Power	
15V ± 0.5V	



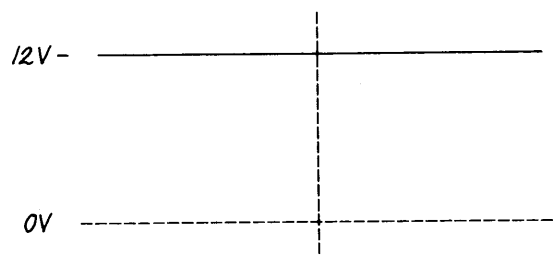
TP202	B204 Pin 1
-12V Power	
-12V ± 0.5V	



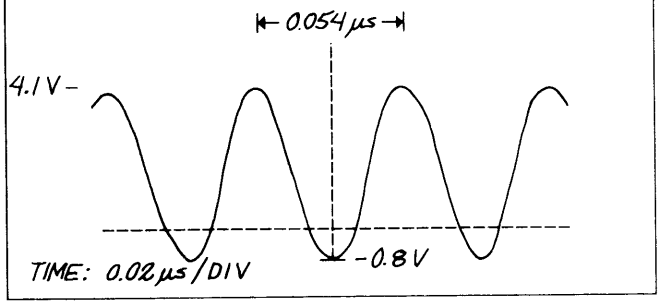
TP203	B204 Pin 3
+5V Power Input	
5V ± 0.2V	



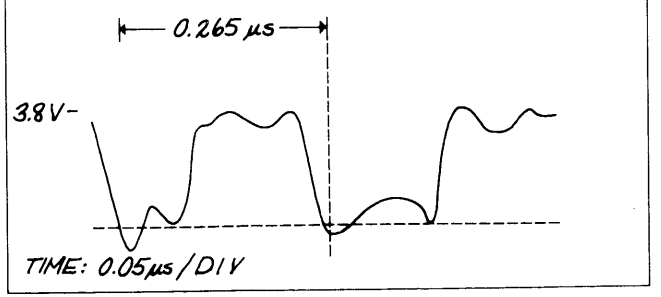
TP204	B212
Monitor	
12V ± 0.5V	



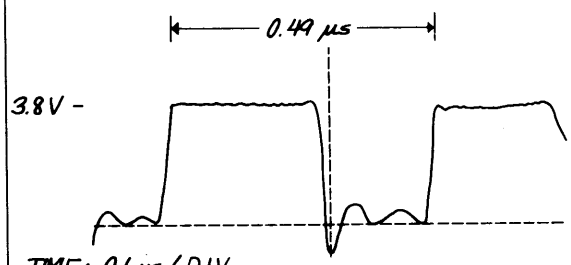
TP205	U267 Pin 8
Dot Frequency	
4.1V ± 0.5V	



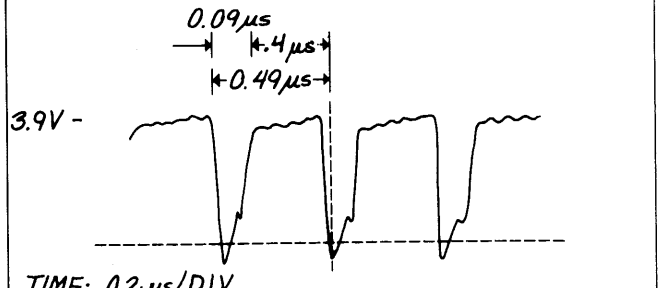
T206	U246 Pin 2
CPU Clock	
3.8V ± 0.5V	



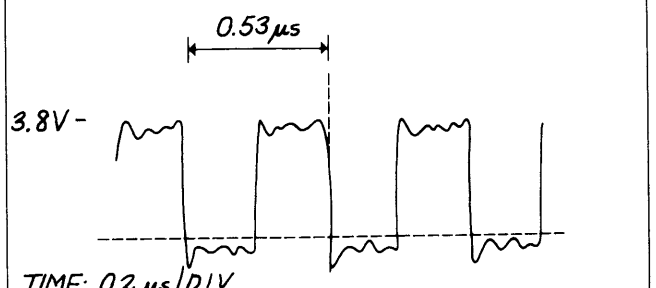
TP207	U268 Pin 6
CRTC Clock	
3.8V ± 0.5V	



TP208	U246 Pin 7
Character Clock	
3.9V ± 0.5V	

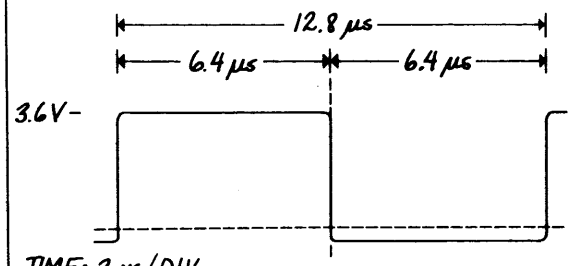


TP209	U267 Pin 10
ACIA Clock (RS232 Print Baud Rate)	
3.8V ± 0.5V	

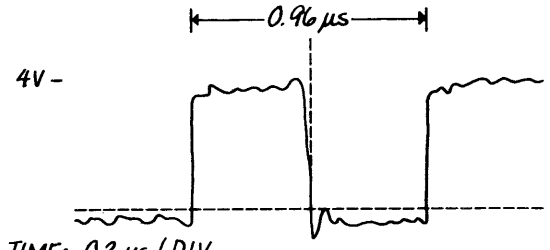


Logic Board Test Points

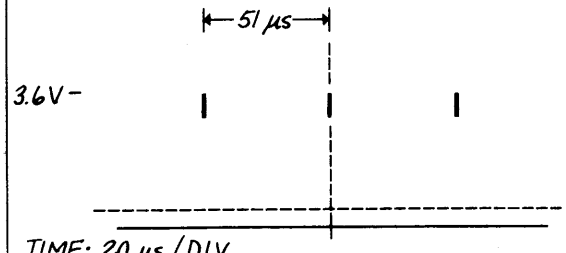
TP210	U243 Pin 3
Keyboard Interface Clock	
3.6V ± 0.5V	



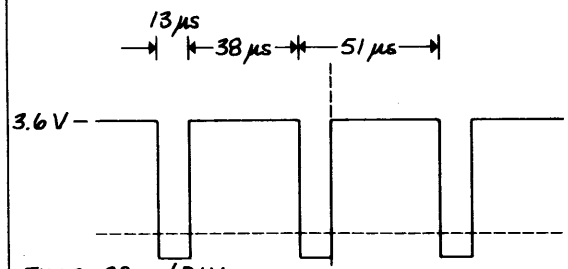
TP211	U218 Pin 16
MPU Enable External Chip Signal	
4V ± 0.5V	



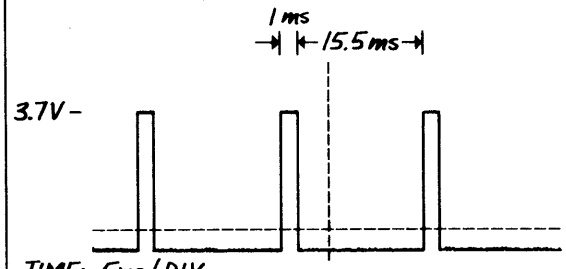
TP212	U232 Pin 7
CRTC Cursor Control Signal	
3.6V ± 0.5V	



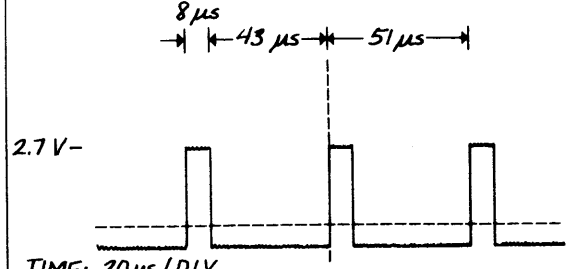
TP213	U232 Pin 3
CRTC Display Enable Output Signal	
3.6V ± 0.5V	



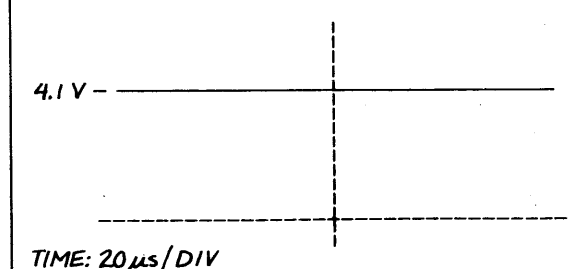
TP214	U209 Pin 40	60 Hz
CRTC Vertical Output Signal		
3.7V ± 0.5V		



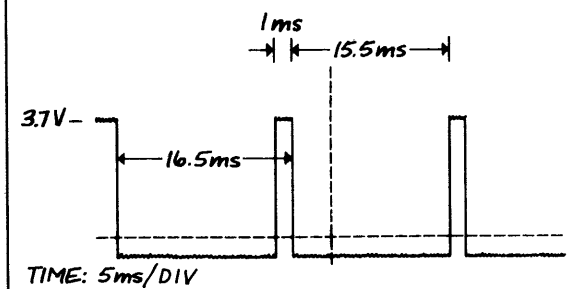
TP215	U209 Pin 39
CRTC Horizontal Output Signal	
2.7V ± 0.5V	



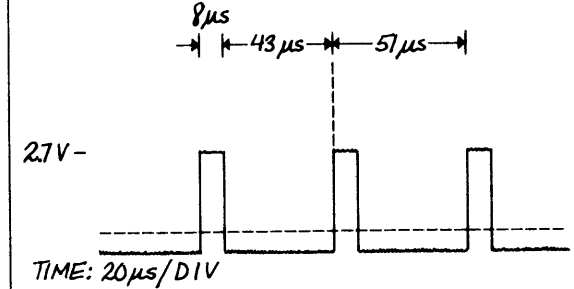
TP216	U206 Pin 2
System Reset Signal	
4.1V ± 0.5V	



TP217	B203 Pin 5	60 Hz
Vertical Synchronous Output		
3.7V ± 0.5V		



TP218	B203 Pin 4
Horizontal Synchronous Output	
2.7V ± 0.5V	



Logic Board Test Points

The Keyboard

Theory of Operation

The Morrow MDT50 Keyboard consists of an 8 x 12 matrix, 89 nodes of which are actually connected to key switches, decoded under software control by an 8035 Microprocessor with a crystal-controlled clock frequency of 3.58 MHz.

The <SHIFT>, <CTRL>, <CAPS LOCK> and <BLOCK> keys are separately decoded by Input Pins T0, T1, P15, & P10, respectively.

All 8 rows of the matrix are normally pulled up to +5V by 10k resistors, and are connected to the inputs of a 74LS244 inverting Octal Buffer. When a key is pressed, the Row line is connected to one of 12 Column lines connected to Input Pins 21 - 24, 28 - 31, and 35 - 38 of the 8035 (P 11 - 14 & P 20 - 27).

To read a key, the 8035 strobes data onto its data bus by bringing RD (Pin 8) **low**, enabling the Octal Buffer. Rows 0 - 7 are mapped to D0 - D7 (Pins 12 - 19). The 8035 then reads Column Data from the Input Pins to determine which key has been depressed.

The 8035 uses external Program Memory, stored in a 2k x 8 UV EPROM (2716). It uses a multiplexed Address/Data Bus, first putting the Address on the bus, then strobing the address data into an Octal Latch (U304, 74LS373) with a 1 microsecond pulse on the ALE line (Pin 11). The outputs of the Octal Latch are connected to the address inputs of the EPROM. The 8035 then strobes the EPROM by bringing PSEN (Pin 9) low for 1.6 microsec. One byte of program data is then put onto the Data Bus.

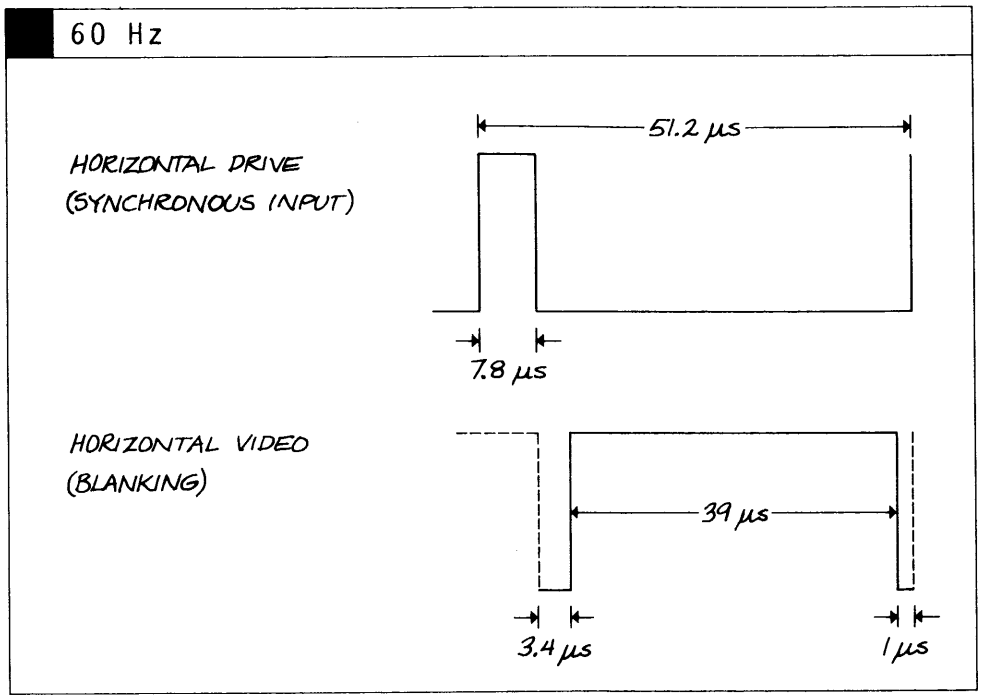
The 8035 can access a total of 8 256-byte pages in this way by specifying the page number on P20 - P22 (Pins 21 - 23). These pins are also used for keyboard decoding, but interference is precluded by adroit use of timing.

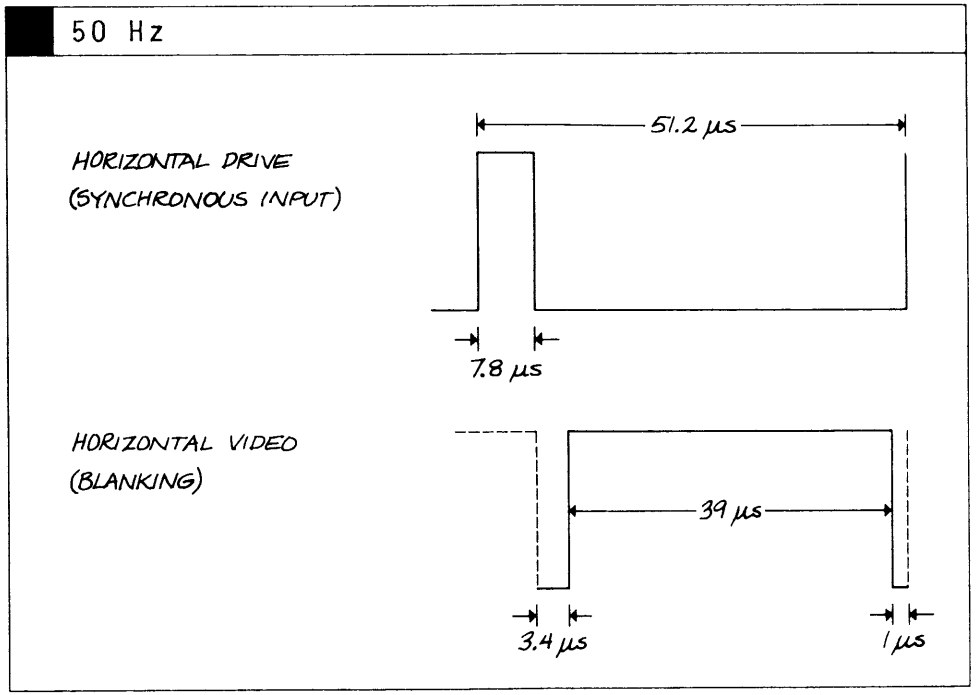
The Morrow MDT50 keyboard has an on-board 8-Ohm speaker for audio signalling (ASCII <BELL> character, operator attention, etc.) which is connected to the output of U308 (a NE 555 timer). The 555 puts out a 7 ms pulse, and is controlled by the 8035, which strobes P16 (Pin 33) under software control at a rate sufficient to produce either a high or low tone. The low tone is used in the key-click option to signal that a key has been pressed.

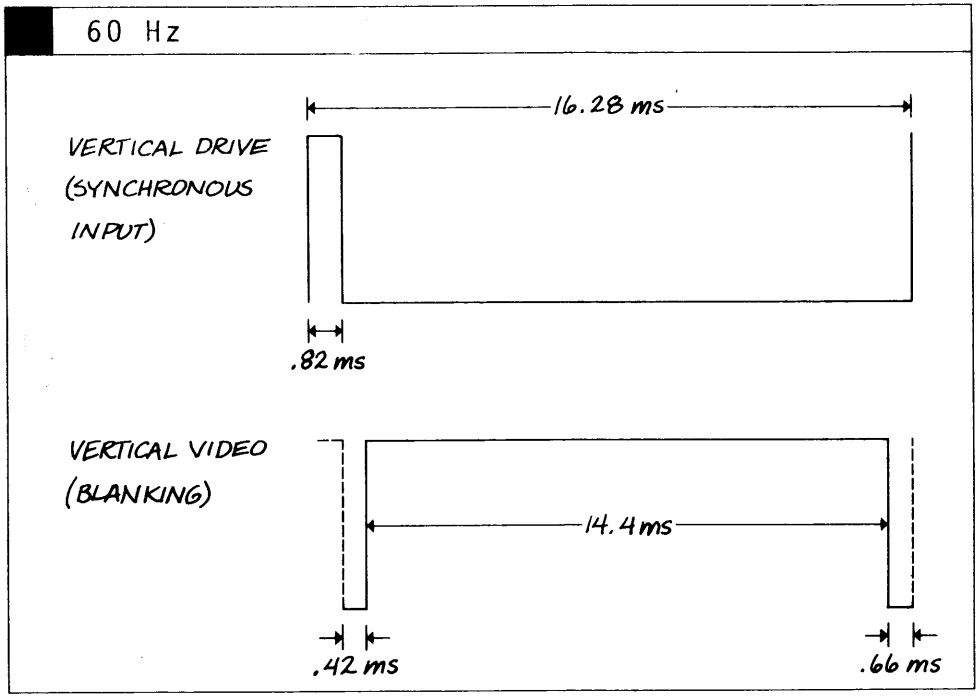
The keyboard also contains a 7805 Voltage Regulator to convert +12V power received from the Monitor Unit to +5V, which is used internally.

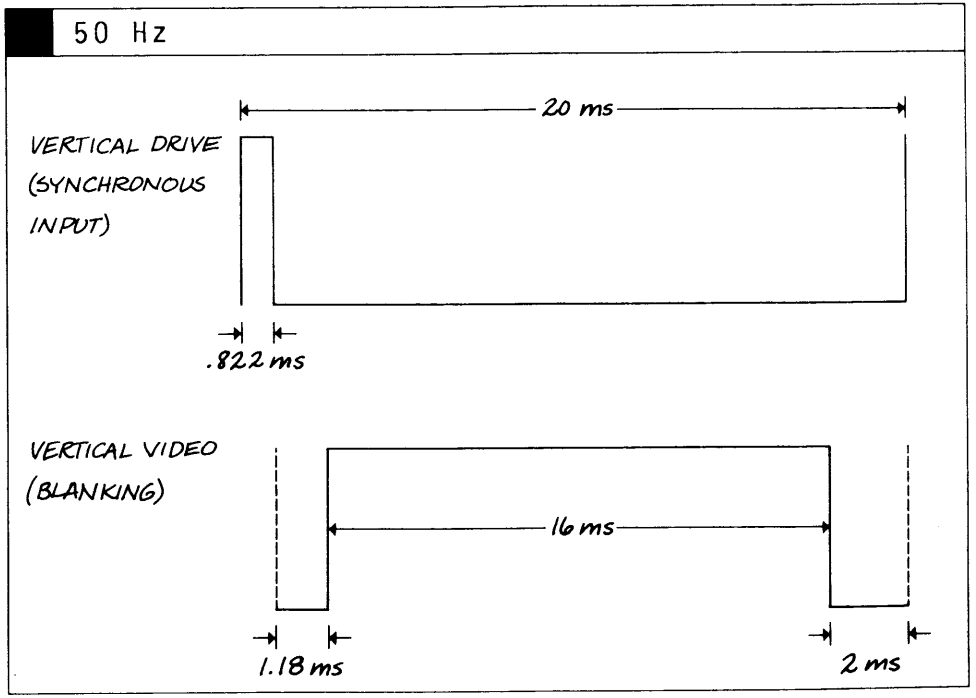
Test Points, Typical Waveforms & Signal Levels

See the attached drawings and schematics









Logic Board Output Timing

The Power Supply

Theory of Operation

The Morrow MDT50 Power Supply consists of a 3-wire grounded power cord, an ON/OFF switch, a fuseholder with a $\frac{1}{2}$ A fuse, a voltage level select switch ,a 115/230 V (Primary) transformer, whose 3 secondary windings produce: 10.6V AC, 21.3V AC, and 16.7V AC, as well as a power regulator board.

The Power Regulator Board gets 16.7V AC via Pins 1 & 2 of Connector P405, which is rectified to unfiltered -15.0V RMS by BR401 (Full-Wave Rectifier, W005M or equiv.), filtered and voltage limited to -12V DC, 1.5 A, by U403 (MC7912 or equiv.), which is output on Pin 1 of P404.

Pins 3 & 4 receive 21.3V AC, which is rectified to an unfiltered 19.2V RMS by BR402 (Full-wave rectifier, KBPC6005 or equiv.), voltage-limited by U402 (MC7815) to 15V DC, 1.5 A, and output on Pin 2 of P404. Pin 5 is the 0V reference ground for this power line.

Pins 5 & 6 receive 10.6V AC, which is rectified to an unfiltered 9.5V RMS by BR401 (KBPC6005 or equiv.), voltage limited to +5V DC, 1 A by U401 (MC7805 or equiv.) and output on Pin 3 of Connector P404. Pin 4 is the 0V reference ground for this power line.

Troubleshooting

Components

I) Visual Check.

A) Turn power **OFF** and disconnect power cord from mains socket.

B) Visually check all wiring and components for signs of heat, burning, leakage or breakage.

C) Using ohmmeter, check Power cord for open circuit (all 3 wires). Check ON/OFF switch for proper operation. Check fuse for open circuit. Check voltage selector switch for proper operation. Check transformer for open circuits (both primary and secondary windings).

D) Disconnect P405 (connector to transformer) and P406 (connector to Main Logic Board). Disconnect P402 (connector to Power Transistors on heat sink).

E) **CAREFULLY** discharge all capacitors on the Power Supply Board.

F) Carefully remove Power Supply Board, unscrewing and saving any holding screws.

G) Inspect both sides of Board for damaged or burnt components, broken or corroded wires, broken traces, solder bridges, cold solder joints, etc.

H) Carefully replace Power Supply Board, tightening down all holding screws. Replace Connectors P402, P404, and P405.

I) Plug in Unit and turn ON power.

J) Check secondary (output) leads for:

Blue lead	-	10.6V AC
White lead	-	21.3V AC
Brown lead	-	16.7V AC

Replace Power Transformer if necessary.

II) Voltage Problems

A) **No +5V DC**

1) Check Pins 5 & 6 of P405 for 10.6V AC. If not found, check transformer.

2) Check across C401 (electrolytic) for 15V DC. If not found, replace BR401 (full wave rectifier) and/or Capacitor C401.

3) Check for ground at Pin 4 of P404, Pin 2 of U401, and negative pole of C401, C402, C403, C405, and at C404. If not found, locate and repair broken trace.

4) Check capacitors for short circuit, check R401 and R402 for open circuit.

5) Remove and check Q402 (power transistor) using transistor checker. Replace or repair wiring as necessary.

6) Isolate and test Q401 with transistor checker. Replace as necessary.

7) Remove and test U401. Replace as necessary.

B) **No +12V DC**

1) Check Pins 3 & 4 of P405 for 21.3V AC. If not found, check transformer.

2) Check across C406 (electrolytic) for 30.1V DC. If not found, replace BR402 (full wave rectifier) and/or Capacitor C406.

3) Check for ground at Pin 5 of P404, Pin 2 of U402, and negative pole of C406, C407, C408, C410, and at C409. If not found, locate and repair broken trace.

4) Check capacitors for short circuit, check R403 and R404 for open circuit.

5) Remove and check Q404 (power transistor) using transistor checker. Replace or repair wiring as necessary.

6) Isolate and test Q403 with transistor checker. Replace as necessary.

7) Remove and test U402. Replace as necessary.

B) **No +15V DC**

1) Check Pins 1 & 2 of P405 for 16.7V AC. If not found, check transformer.

2) Check across C411 (electrolytic) for 15.0V DC. If not found, replace BR403 (full wave rectifier) and/or Capacitor C411.

3) Check for ground at Pin 1 of U403, and negative pole of C411, C412, C413, C415, and at C414. If not found, locate and repair broken trace(s).

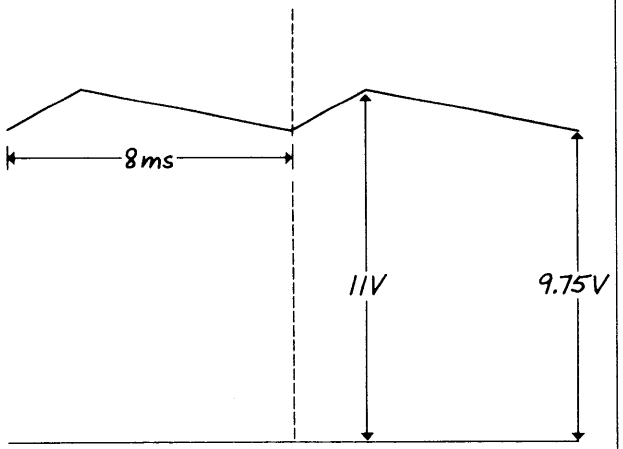
4) Check capacitors for short circuit.

5) Remove and test U403. Replace as necessary.

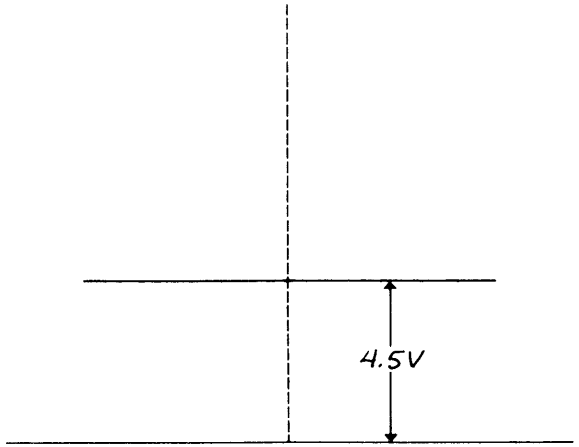
Test Points, Typical Waveforms, & Signal Levels

See the attached drawings and schematics

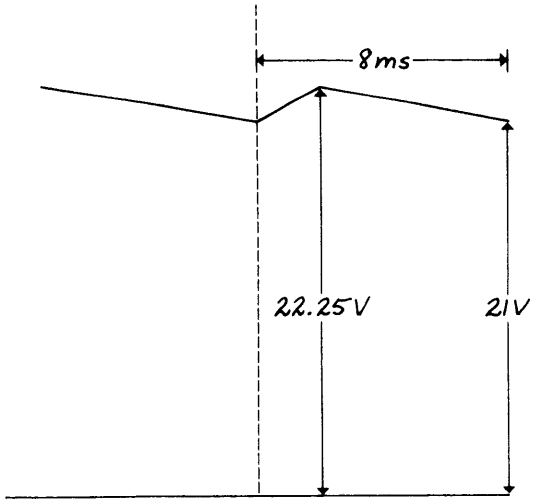
TP1



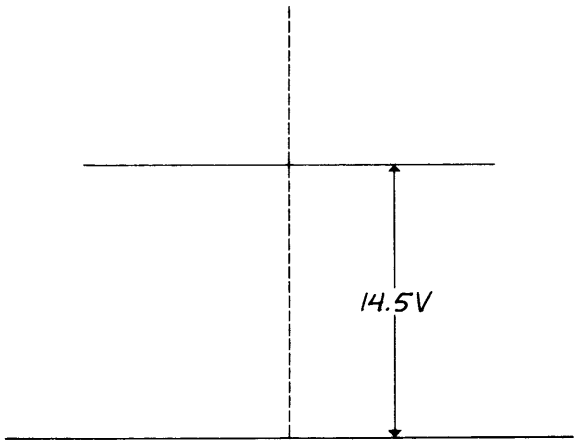
TP2



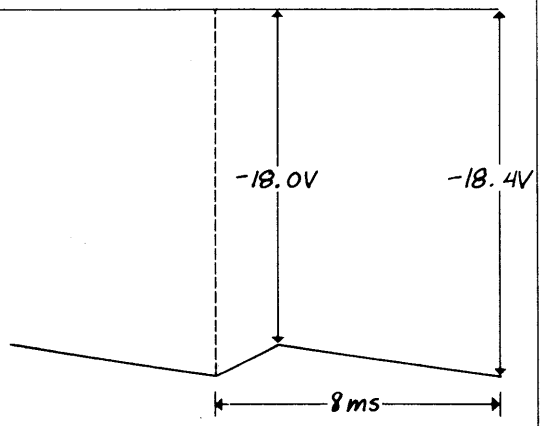
TP3



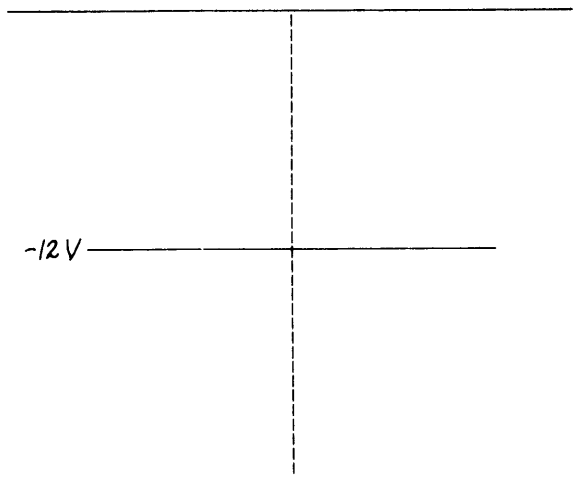
TP4



TP5

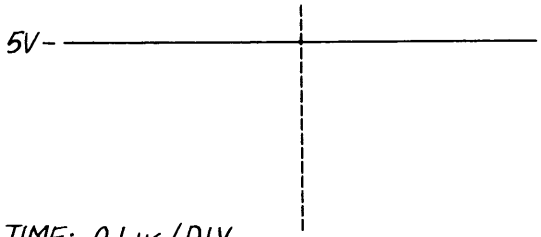


TP6

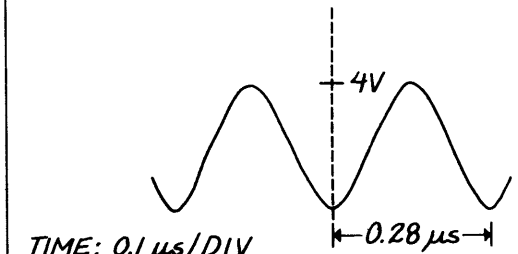


Power Supply Board (Loaded)

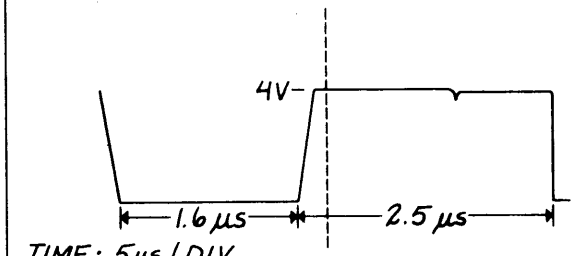
TP301 (TP1)	7805 (U309)
+5V	
5V ± 0.1V	



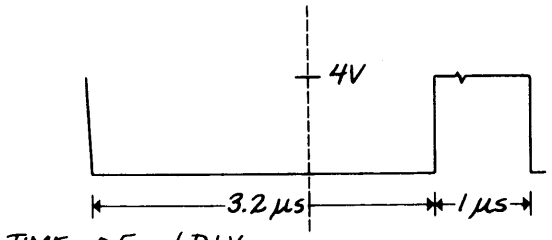
TP311 (TP2)	8035 (U301)
Clock Signal	
4V ± 0.5V	



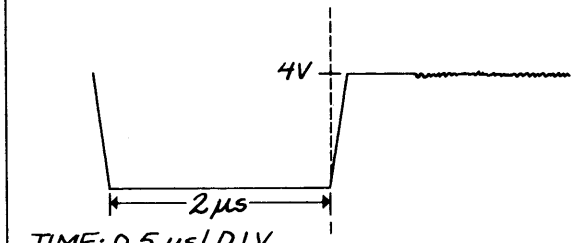
TP302 (TP3)	8035 (U301)
Enable	
4V ± 0.5V	



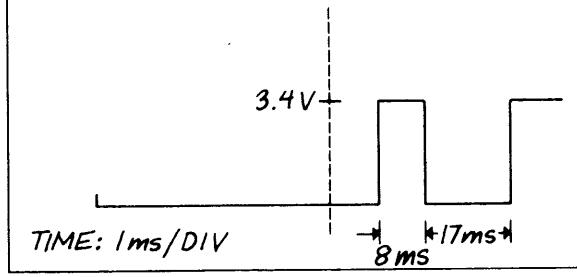
TP303 (TP4)	8035 (U301)
Address Latch Enable	
4V ± 0.5V	



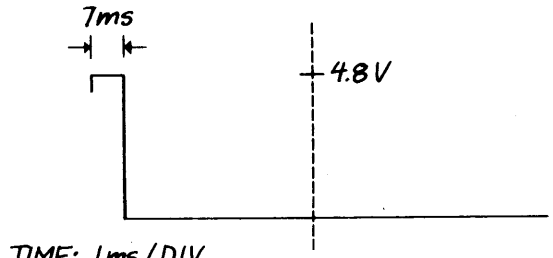
TP304 (TP5)	8035 (U301)
CPU Read	
4V ± 0.5V	



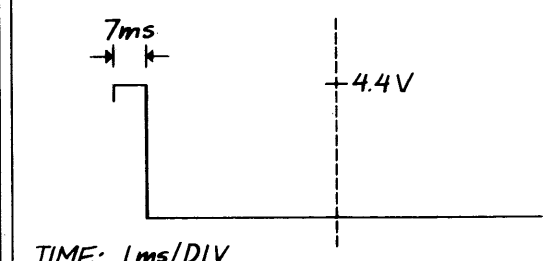
TP306 (TP6)	74LS14 (U306)
Data Terminal	
3.4V ± 0.5V	



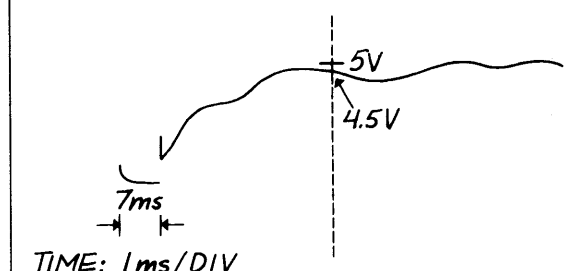
TP308 (TP7)	8035 33 (U301)
Data NE555	
4.8V ± 0.5V	



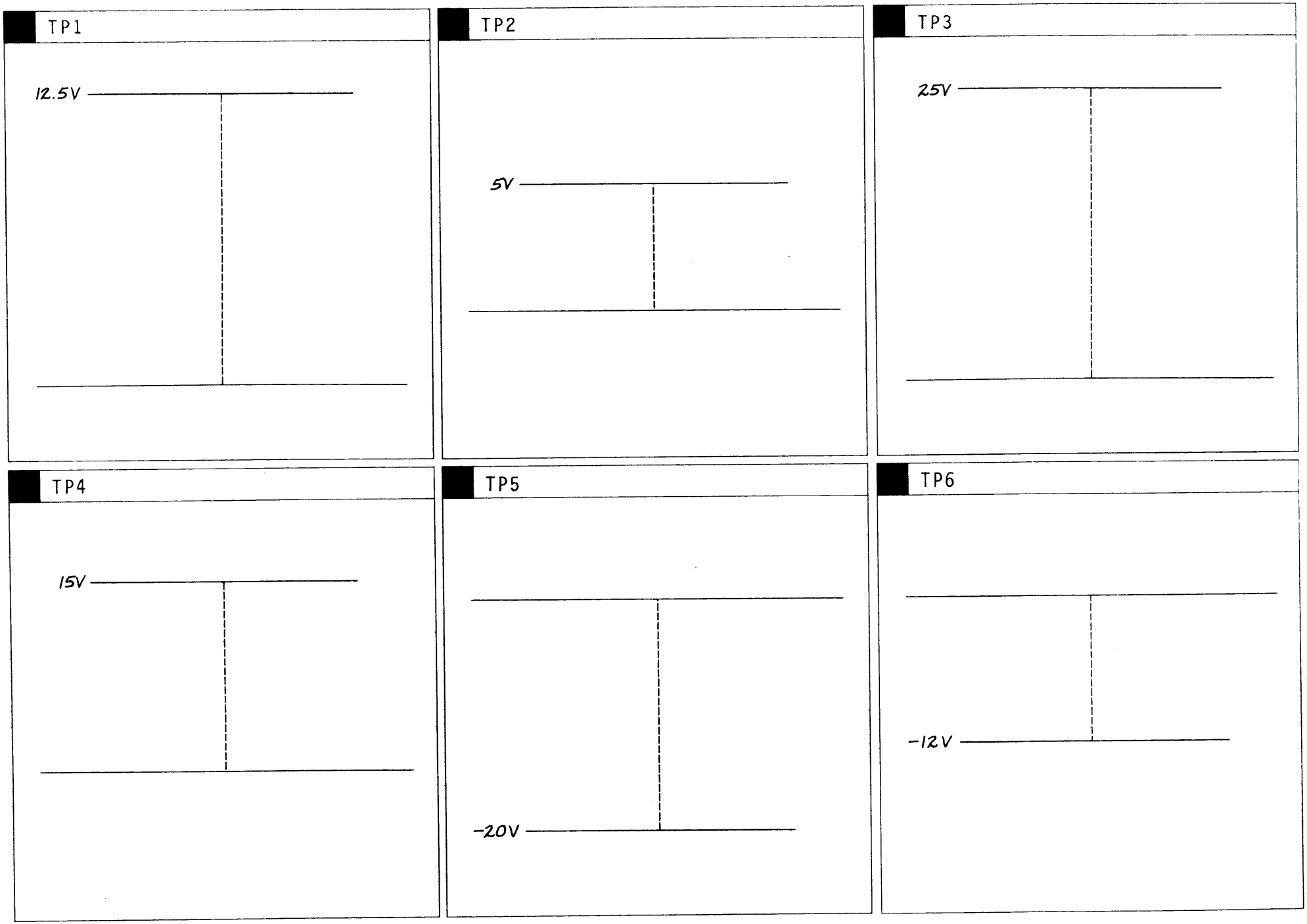
TP309 (TP8)	NE555 (U308)
NE555	
4.4V ± 0.5V	



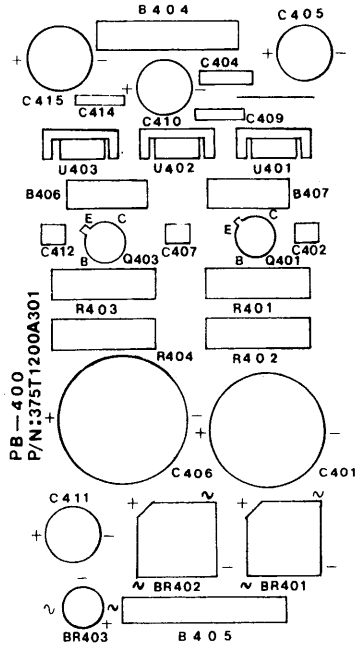
TP310 (TP9)	U307
Tone Signal at Speaker	
4.5V ± 0.5V	

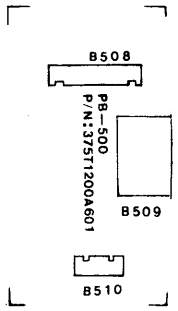


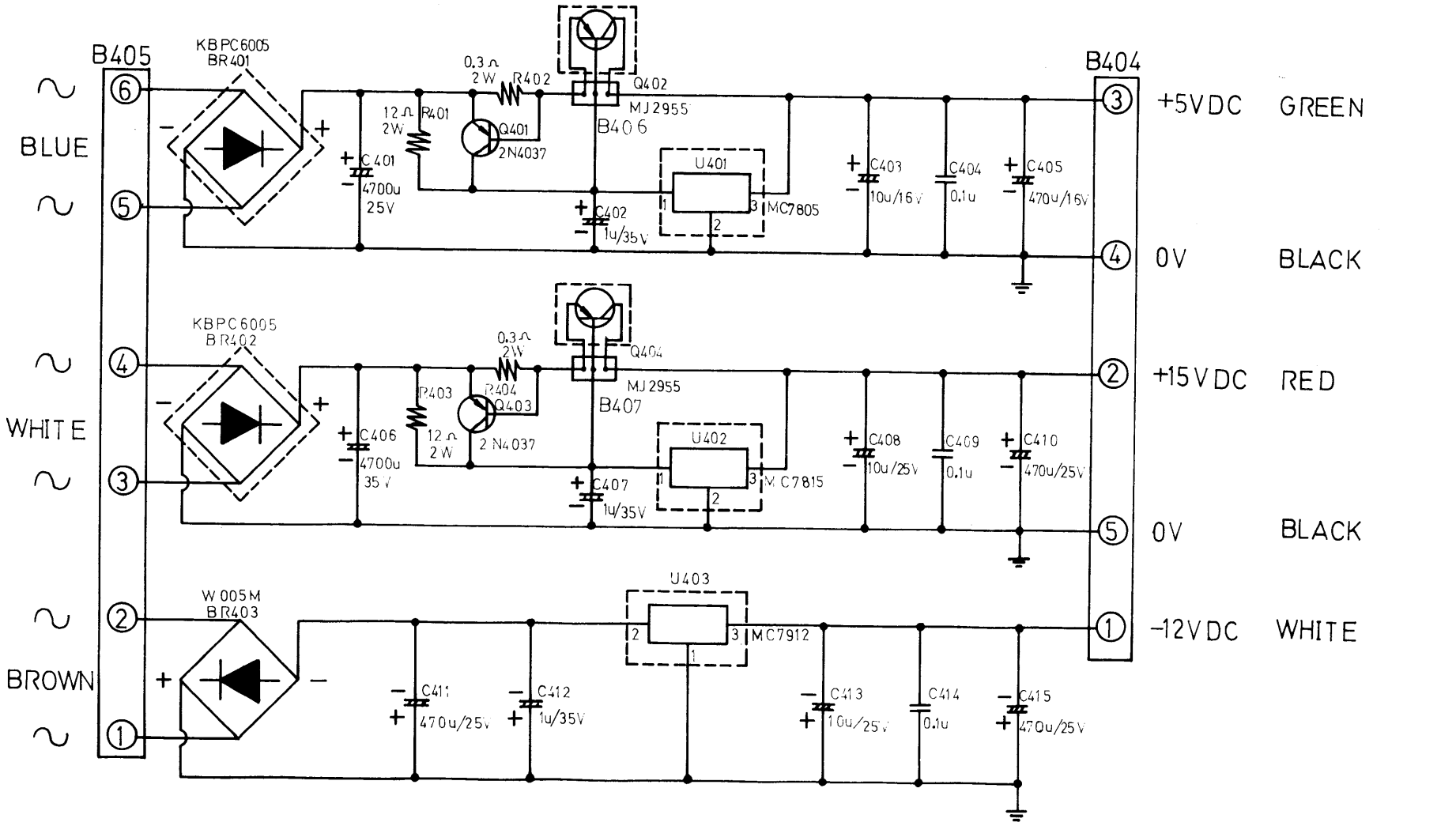
Keyboard Test Points



Power Supply Board (Unloaded)







Maintenance

The Monitor Unit

General

The exterior of the Monitor Unit should be cleaned periodically with a damp cloth to remove accumulated dirt and grime. Be careful, however, in cleaning the face of the CRT screen, since it is covered with a Nylon anti-glare screen. This screen is relatively fragile, and will not withstand heavy pressure or vigorous scrubbing motions.

Approximately every 6 months to 1 year, the housing of the Monitor Unit should be removed by a competent service technician, and the circuitry inspected for collected dust or particulate matter, possible corrosion, or loose connections. Vacuum as necessary, and replace or clean parts, and check signal levels before reassembling the case.

It is recommended that signal levels and waveforms at all defined Test Points be checked whenever the Monitor Unit case is opened.

Starting with the Power Supply, check signal levels at Connectors P405 and P404, then Test Points TP401 - TP406.

Next, test the Main Logic Board, beginning with P204, and continuing with TP201 through TP218, in order.

Next, test the Video Board, beginning with P103, and continuing with TP101 through TP107, in order.

Replacing the CRT tube

> > > > WARNING < < < <

CRITICAL COMPONENT WARNING:

SERVICEMAN WARNING: This product contains components which are critical for X-Radiation Safety. See Service Manual for proper replacement. Normal 2nd Anode Voltage is 12 KV at Zero beam current, AC 120V input, and must NOT exceed 13 KV under any operating conditions. To measure 2nd Anode Voltage, use High Impedance meter. Connect (-) to chassis, use a High Voltage lead from (+) to 2nd Anode.

The Keyboard Unit

Like the Monitor Unit, the Keyboard Unit should be cleaned periodically with a damp cloth to remove accumulated dirt and grime. Be careful not to get water on the keyboard itself, since this would cause electrical shorting and possible damage.

It is recommended that the Keyboard Unit be opened and the keys, PC board and case be vacuumed or blown out with oil- and moisture-free compressed air every 3 to 6 months, since it is exposed to environmental contamination -- dust, dirt, hair, cigarette ashes, spills, paper shreds and dust, etc.

While the Keyboard Unit is being cleaned, it is recommended that signal level and waveform checks on the circuitry be performed.

First check signal levels and waveforms on the pins of Connector 308, the proceed with Test Points TP301 through TP311, in order.

Variance of more than 15% in signal level, or significant deviations from the illustrated waveforms will indicate that detailed troubleshooting of the associated circuitry should be performed.

PARTS LIST

Appendix: PARTS LIST

Logic Board

Part #	Desc.	Generic Desc.	Component Location
231400000-0	CPU	68A02	U202
235240000-0	ACIA	68A50	U218
235200000-0	CRTC	68A45	U209
235400000-0	PIA	68A21	U201
235280000-0	ACIA	6551	U228,236
233240001-0	Static Ram	6116	U208,211,212
233280000-0	EPROM	2564	U203
233240000-0	EPROM	2732	U205,225
237140004-0		74LS00	U242
237140005-0		74LS04	U206,230,247
237140002-0		74LS08	U231,241
237140001-0		74LS32	U207,238,239
		74LS74	U229
237140003-0		74LS86	U240
		74LS90	U245
237140006-0		74LS92	U244
237140007-0		74LS107	U243
237160001-0		74LS138	U219
237160005-6		74S139	U220
237160003-0		74LS157	U213,214, 215,237
237160004-0		74LS166	U233
		74LS374	U221,222 224,232
237160000-0		74LS193	U246
23720000-0		74LS245	U210,223
235060001-0		4N33	U216,217
235140000-0		MC1488	U227,235
235140001-0		MC1489	U226,234
271140000-0		NE556	U204
3502-11804	Resistor	180HM2W.J	R212
	Resistor	5100HM 1/2 W.J	R217,218
3194-14753	Resistor	4.7M.1/4W.J	R206
3194-11753	Resistor	1.8M.1/4W.J	R204
3194-11053	Resistor	1M.1/4W.J	R205
3194-13323	Resistor	3.3K.1/4W.J	R201,202 207,208 209,211 213,214
3194-12743	Resistor	570K.1/4W.J	R203
3194-11223	Resistor	1.2K.1/4W.J	R210
3194-12213	Resistor	2200HM.1/4W.J	R219,220
3194-11013	Resistor	1000HM.1/4W.J	R215
42-T11331C	Capacitor	330uf/16v	C201
49-K11100C	Capacitor	10uf/16v	C203
	Capacitor	0.47uf/16v	C206
	Capacitor	0.1uf/50v	C231
	Capacitor	0.1uf/12v	C202,204 205,207

			208,209
			210,211
			212,213
			214,215
			216,217
			218,219
			220,221
			222,223
			224,225
			230,232
			233,234
			239,240
			241,242
			243,244
			246
			210,211
			212,213
			214,215
			216,217
			218,219
			220,221
			222,223
			224,225
			230,232
			233,234
			239,240
			241,242
			243,244
			246
	Capacitor	0.01uf/50v	C245
41-K234710	Capacitor	470pf/50v	C226,227
			228,229
			235,236
			237,238
41-K23680C	Capacitor	68pf/50v	C247
1120-00010	Diode	1N4148	D201-227
382GA00000001	Crystal	18.432MH2	X201
377410018001	Dip SW	8 pin piano type	SW201
37741001A001	Dip SW	10 pin piano type	SW202,203
3786125H001	D Connector	25 pin right angle	B201,202
1603-00004		5 pin RTB-1.5-5	B203,204
	Post Connector	MICRO 7 pin JST	B208
3781140P0001	IC Socket	40 pin	S201,204
3781128P001	IC Socket	28 pin	S202,203
3781124P001	IC Socket	24 pin	S205
	Jumper	62.5m/m	X.4
375T1200AL00	PCB		PB-200

Monitor Board

Keyboard

231400001-0	CPU	8035	U301
233240002-0	EPROM	2716	U305
237140000-0		74LS14	U306
237200000-0		74LS244	U302
237200001-0		74LS373	U304
237080000-0		SN75452	U307
271080000-0		NE555	U308
215030001-0	Regulator IC	7805	U309
3194-12233	Resistor	22K.1/4W.J	R307
3194-11033	Resistor	10K.1/4W.J	R302,303 304,305 317,318 319,320 321,322 323,324 325
3194-12223	Resistor	2.2K.1/4W.J	R306
3194-11023	Resistor	1K.1/4W.J	R301
3501-31014	Resistor	1000HM.1W.J	R308
	Capacitor	47uf/16v	C312,313
42-K12100C	Capacitor	10uf/16v	C309
	Capacitor	4.7uf/16v	C314
49-K11109D	Capacitor	1uf/16v	C303
	Capacitor	0.1uf/12v	C311
49-K11107C	Capacitor	0.01uf/50v	C305,306 C307,310 315
41-K23333C	Capacitor	0.033uf/50v	C308
41-K23331C	Capacitor	330Pf/50v	C304
41-J30220C	Capacitor	22Pf/50v	C301,302
1127-00002	Crystal	3.58MHZ	X301
1120-00010	Diode	1N4148	D301,302
3781140P0001	IC Socket	40 Pin	S301
3781124P001	IC Socket	24 Pin	S302
39A020R16801	Speaker	0.16W.8ohm	SP301
	Wafer	GPin Micro90 Degree JST	B309
377920040001	Keyboard	Key Top + Key SW. + Plate	KB301
375T1-200AK00	PCB		PB300

Power Supply

215030000-0	Regulator IC	7805	U401
215030001-0	Regulator IC	7815	U402
215030002-0	Regulator IC	7912	U403
131000000015B	Tr	2N40373	Q401,403

15100000008M	Tr	MJ2955	Q402,404
11200000015	BR	KBPCG005	BR401,402
11200000016G	BR	W005M	BR403
3402-31803	Resistor	18ohm.2W.J	R401,403
3402-30393	Resistor	0.3ohm.2W.J	R402,404
42-T11472D	Capacitor	4700uf/25v	C401
42-T11472E	Capacitor	4700uf/35v	C406
42-T11471C	Capacitor	470uf/16v	C405
42-T11471D	Capacitor	470uf/25v	C410,411 415
49-K11100C	Capacitor	10uf/16v	C403
49-K11100D	Capacitor	10uf/25v	C413,408
49-K11109E	Capacitor	1uf/35v	C402,412 413
41-K23104E	Capacitor	0.1uf/50v	C404,409 414
1603-00022	Wafer	GP-SVF Base	B405
1603-00004	Wafer	5P-SVF Base	B404
1603-00002	Wafer	3P-SVF Base	B406,407
1001-00015	Fuse	250V.1.5A FST	F401
37622S000001	Fuse Holder	Screw type	
377522261001	Power SW	2P2T B Type	SW401
412100A60001	Power Cord		PW401
377622260001	Power Select SW	B Type	SW402
39B121133001	Transformer	115v/230v	XF401
375T1200A300	PCB		PB-400

Contrast

1603-00029	Base	7 Pin Micro JST	B508
3791204P0001	Telephone Jack	PCB	B509
375T1200A600	PCB		PB500

Assembly Wire

3P Assembly Wire (Mini)	WA006,007
5P Assembly Wire (Mini)	WA004
6P Assembly Wire (Micro)	WA009
7P Assembly Wire (Micro)	QA008