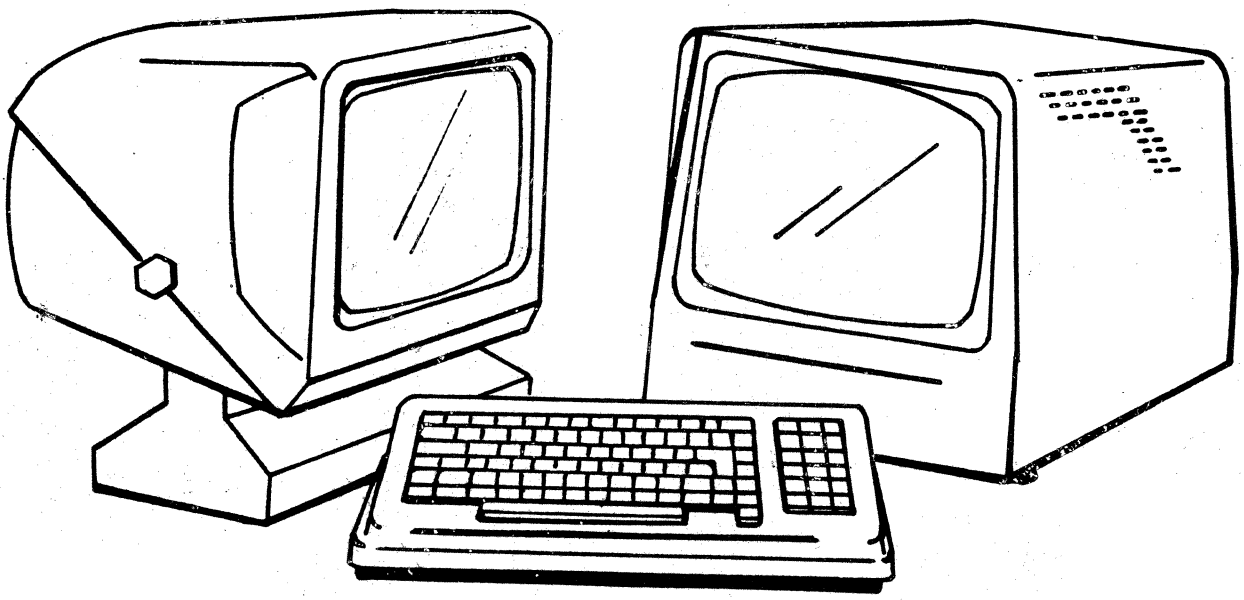
TELERAY

MODEL 100

CRT DATA TERMINAL



REFERENCE MANUAL

RESEARCH INC
BOX 24064 MINNEAPOLIS, MINNESOTA USA 55424
PHONE (612) 941-3300 • TWX 910-576-2837 • TELEX 29-0502

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March 1981

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A059469

TABLE OF CONTENTS

Section I

GENERAL INFORMATION

The Teleray Model 100 consists of four modules: monitor module, power supply module, keyboard module and logic module. The second section of the Model 100 Reference Manual defines the organization of these four modules into the Teleray as a block diagram. The remaining four sections of the manual give detailed information on each of the four modules. Each section consists of a theory of operation, schematic diagram and parts list.

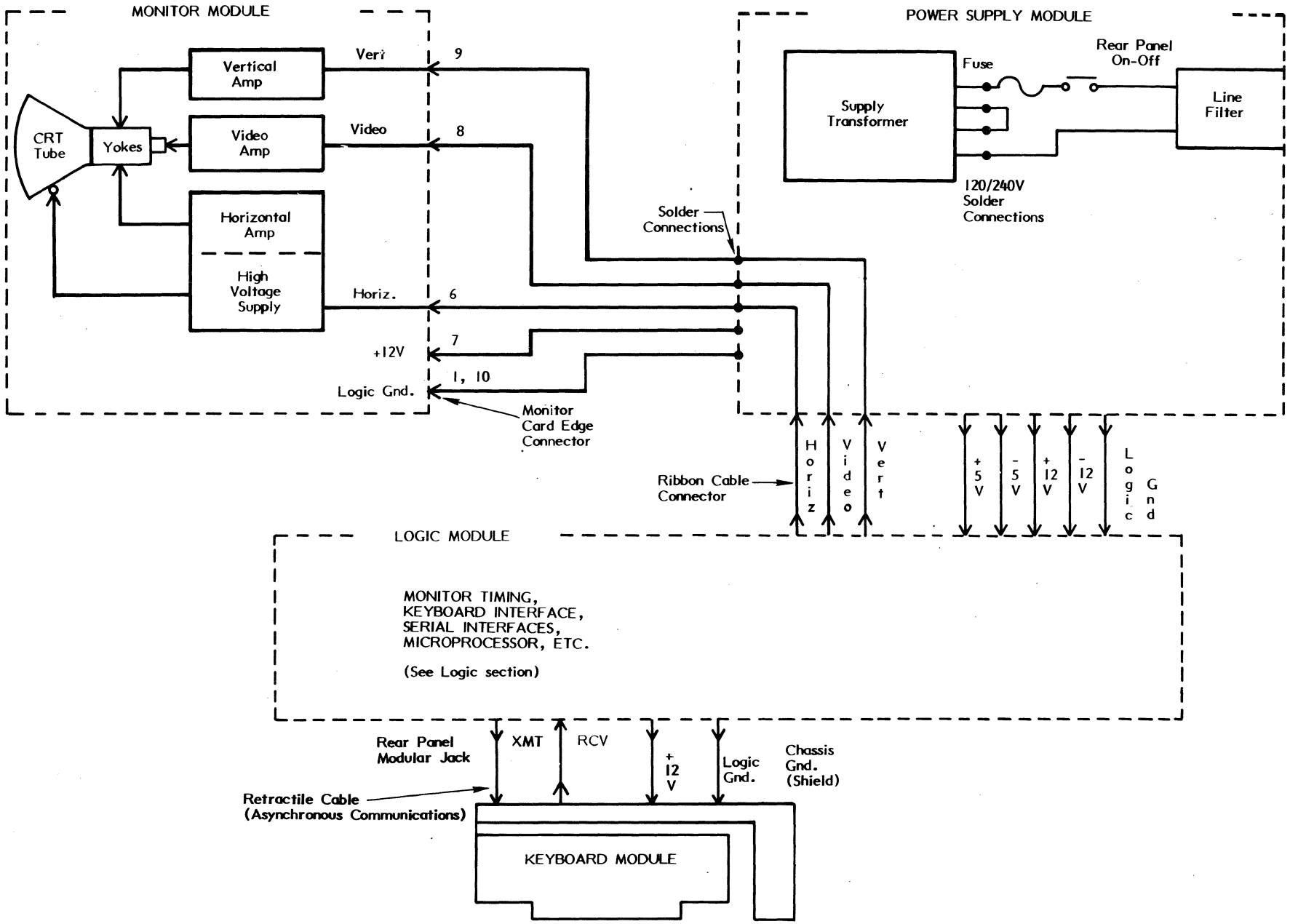
Once any Teleray module has been determined to have a malfunction, the specific section for that module should be used to troubleshoot and repair the module. The connections between modules that are detailed in Section 2 will, in most cases, provide enough information to determine which of the four modules has malfunctioned and needs repair. Some malfunctions in the logic module may be determined without the use of sophisticated testing equipment by using the Teleray self-test feature. The Teleray Model 100 Instruction Manual should be obtained and read as a prerequisite for using the Model 100 Reference Manual.

Section 2

MACHINE ORGANIZATION

The Teleray consists of a display cabinet and an optional detached keyboard module (except on "T" style). The display cabinet contains a monitor module, power supply module and logic module. These modules are accessible without using tools for exchange and/or repair. The Teleray Instruction Manual graphically illustrates module replacement.

The Module Signal Flow and Cabling Diagram describes the signal flow between modules. All connectors are keyed to prevent incorrect insertion. The ribbon cable used is symmetrical; the cable may be reversed end-to-end. Pin numbers on the cable are provided in each section.



MODULE SIGNAL FLOW AND CABLING DIAGRAM

Section 3

MONITOR MODULE

Zenith DTI

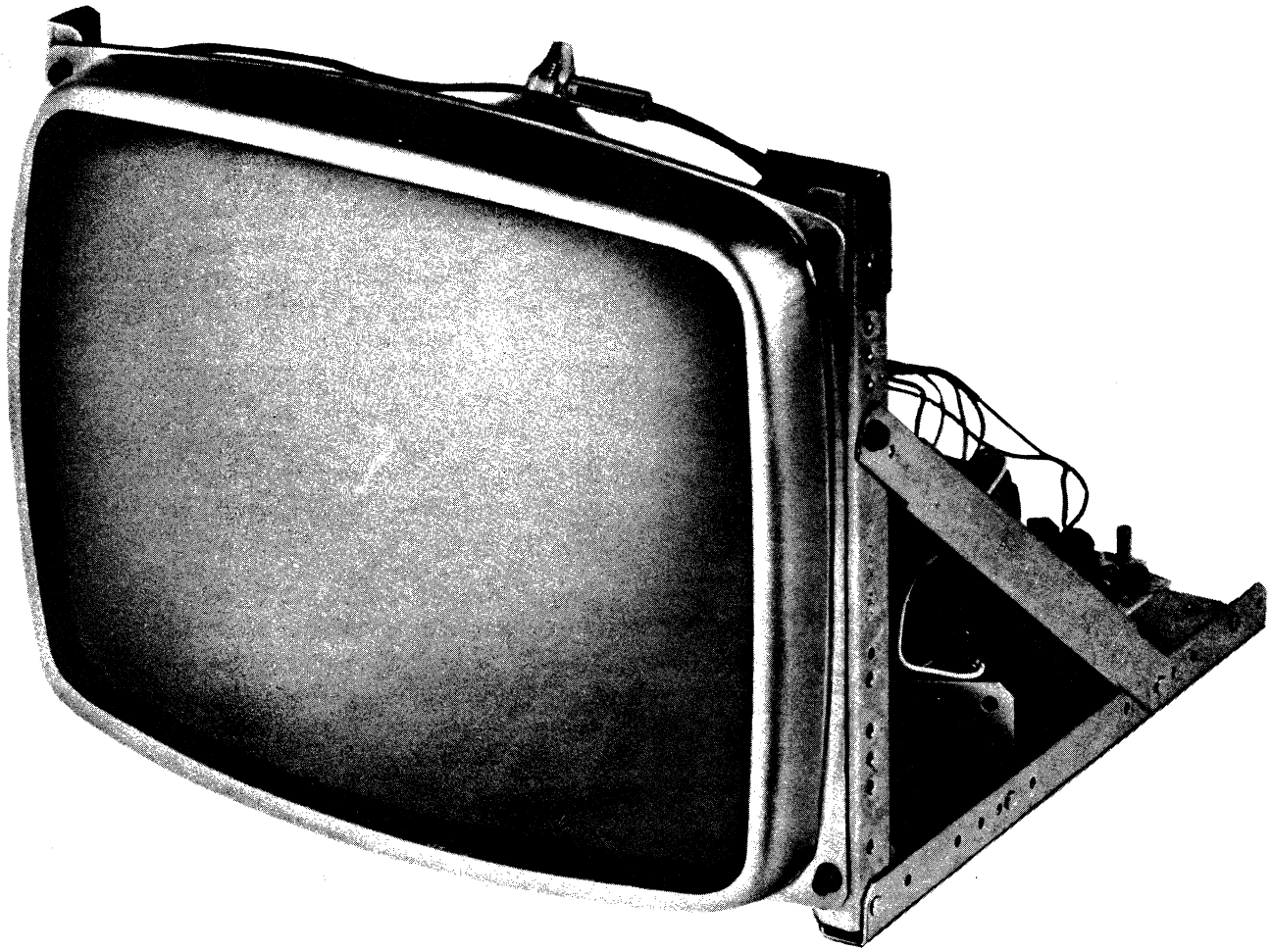
- Servicing Guidelines
- Theory of Operation
- Adjustments
- Schematics
- Parts Lists

DT1

DT1

ZENITH®

SERVICE MANUAL



DT1

D12 SERIES DATA DISPLAY TERMINALS

ZENITH RADIO CORPORATION

1000 MILWAUKEE AVENUE, GLENVIEW, ILLINOIS 60025

DT-1
5CRR

PRINTED IN U.S.A.
NOV., 1978

$2.00
923-924

PRODUCT SAFETY SERVICING GUIDELINES FOR ZENITH DATA DISPLAY TERMINALS

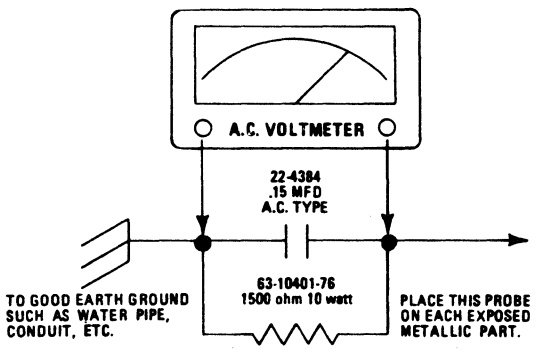
CAUTION: No modification of any circuit should be attempted. Service work should be performed only after you are thoroughly familiar with all of the following safety checks and servicing guidelines. To do otherwise increases the risk of potential hazards and injury to the user.

SAFETY CHECKS

After the original service problem has been corrected, a check should be made of the following:

SUBJECT: FIRE & SHOCK HAZARD

1. Be sure that all components are positioned in such a way to avoid possibility of adjacent component shorts. This is especially important on those chassis which are transported to and from the repair shop.
2. Never release a repair unless all protective devices such as insulators, barriers, covers, shields, strain reliefs, and other hardware have been reinstalled per original design.
3. Soldering must be inspected to uncover possible cold solder joints, frayed leads, damaged insulation, solder splashes or sharp solder points. Be certain to remove all loose foreign material.
4. Check "across-the-line" capacitor (if used) and other components for physical evidence of damage or deterioration and replace if necessary. Follow original layout, lead length and dress.
5. No lead or component should touch a resistor rated at 1 watt or more. Lead tension around protruding metal surfaces must be avoided.
6. All critical components (shaded on the schematic diagram and parts lists) such as: fuses, flameproof resistors, capacitors, etc., must be replaced with exact Zenith types. Do not use replacement components other than those specified or make unrecommended circuit modifications.
7. After re-assembly of the terminal always perform an AC leakage test on all exposed metallic parts of the cabinet and screws to be sure the terminal is safe to operate without danger of electrical shock. DO NOT USE A LINE ISOLATION TRANSFORMER DURING THIS TEST. Use an AC voltmeter having 5000 ohms per volt or more sensitivity in the following manner: Connect a 1500 ohm 10 watt resistor (63-10401-76), paralleled by a 0.15 mfd., 150V AC type capacitor (22-4384) between a known good earth ground (water pipe, conduit, etc.) and the exposed metallic parts, one at a time. Measure the AC voltage across the combination 1500 ohm resistor and 0.15 mfd. capacitor. Reverse the AC plug and repeat AC voltage measurements for each exposed metallic part. Voltage measured must not exceed 0.75 volts RMS. This corresponds to 0.5 milliamp AC. Any value exceeding this limit constitutes a potential shock hazard and must be corrected immediately.



SUBJECT: IMPLOSION PROTECTION

1. All Zenith picture tubes are equipped with an integral implosion protection system, but care should be taken to avoid damage during installation. Avoid scratching the tube.
2. Use only Zenith replacement tubes.

SUBJECT: X-RADIATION

1. Be sure procedures and instructions to all service personnel cover the subject of X-radiation. The only potential source of X-rays is the picture tube. However, this tube does not emit X-rays when the HV is at the factory-specified level. It is only when the HV is excessive that X-radiation can be generated. The basic precaution which must be exercised is to keep the HV at the factory-recommended level. Refer to the X-ray Precaution Label which is located inside each terminal for the correct high voltage. The proper value is also given in the schematic diagram. Operation at higher voltages may cause a failure of the picture tube or high voltage supply and, also, under certain circumstances, may produce radiation in excess of desirable levels.
2. Only Zenith-specified CRT anode connectors must be used.
3. It is essential that the serviceman has available at all times an accurate high voltage meter. The calibration of this meter should be checked periodically against a reference standard.
4. When the high voltage circuitry is operating properly there is no possibility of an X-radiation problem. Every time a chassis is serviced, the brightness should be run up and down while monitoring the high voltage with a meter to be certain that the high voltage does not exceed the specified value and that it is regulating correctly. We suggest that you and your service organization review test procedures so that voltage regulation is always checked as a standard servicing procedure, and that the reason for this prudent routine be clearly understood by everyone.
5. When trouble shooting and making test measurements in a terminal with a problem of excessive high voltage, do not operate the chassis longer than is necessary to locate the cause of excessive voltage.

IMPORTANT NOTE: DAG GROUNDING.

Each unit provides for grounding of the main P.C. Board and CRT socket board to the dag of the CRT through the dag grounding spring.

The ground wires are connected to the shell bond or T-band through a terminal lug. Upon installing the Video Display in a terminal, this grounding procedure should be followed to provide adequate high voltage filtering and arc protection. This especially pertains to mounting the video display as a kit version.

CAUTION

NO WORK SHOULD BE ATTEMPTED ON ANY EXPOSED MONITOR CHASSIS BY ANYONE NOT FAMILIAR WITH SERVICING PROCEDURES AND PRECAUTIONS.

GENERAL INFORMATION

This service manual introduces the Zenith D12 series of Video Displays. The series includes three basic forms: the D12-PF which is complete with power supply and frame, the D12-NF without power supply, the D12-NK in kit form which comes without frame or power supply.

The D12 series incorporate precision CRT's which provide uniformity of display and controlled spot size and geometry. The display may be operated from a standard 15 volt D.C. supply (or optional 12 V.D.C.) or from 120 volts A.C.

Input and output connections for the displays are made through a 10 pin edge connector on the main circuit board. Provision has been made for an optional remote brightness control. Schematic reference numbers are printed on the circuit board to aid in the location and identification of components for servicing.

Vertical and horizontal linearity is maintained within specifications without the use of linearity controls or adjustable devices. Excellent vertical linearity is assured by the extensive use of current feedback and horizontal linearity is achieved with a fixed saturable reactor.

Vertical and horizontal deflection systems sustain scan even in the absence or interruption of synchronizing signals. Vertical and horizontal synchronization is automatic and stable throughout the entire specified operating frequency range.

SPECIFICATIONS

CATHODE RAY TUBE

12'' diagonal measure, 90° deflection, 12.5 KV nominal high voltage at 50 μA. beam current. Available with bonded anti-reflective face plate option. P4 phosphor is standard and other EIA phosphors are available.

NOMINAL DISPLAY AREA

51 sq. in. defined by a rectangle 8½"x6" centered on the CRT. (Other display dimensions optional.)

INPUT SIGNALS (TTL LEVEL)

HORIZONTAL
4 to 40 μsec. duration (positive going standard).
VERTICAL
50 to 1400 μsec. duration (negative going standard).
VIDEO
1.0V to 2.5V P-P (user supplies 500 ohm contrast control for higher input levels).
Positive polarity for white characters. (Other polarities are available for horizontal and vertical sync.)

POWER SUPPLY

120V ± 10% or 240V ± 10%
(customer strappable) 47 to 63 Hz., or
15V DC at 800 ma. max., or
12V DC at 1100 ma. max.

BRIGHTNESS CONTROL

Internal or Customer supplied 100 KΩ potentiometer (accessible at pins 2, 3 and 4 of edge connector).

INTERCONNECT TO CUSTOMER SYSTEM

Via standard 10-pin edge connector.
VIKING #25V10S/1-2
AMP #225-21031-101
CINCH #250-10-30-170

RESOLUTION

900 vertical lines minimum at center of display and 700 vertical lines at the corners. Pulse rise time less than 20 nanoseconds, for 30V rise at CRT. Bandwidth is within 3db from 10 Hz. to 18 MHz.

GEOMETRY

NOTE: Measurements made with an input of 1.0-2.5V P-P and with the display adjusted to 6" highx8½" wide.
VERTICAL
a. Height of display at left side shall be within ± 2.0 percent of height at right side.
b. Top and bottom pincushion or barrel shall be within 1.25% of the average height.

HORIZONTAL
a. Width of display at top shall be within ± 2.5 percent of width at bottom.
b. Side pincushion or barrel shall be within 1.0% of the average width.

LINEARITY

No character shall vary in width or height by more than ± 10% of the average width or height of all the characters in a row or column respectively. No specific character shall vary in width or height more than ± 10% of an adjacent character.

SYNCHRONIZATION

HORIZONTAL
15.75 ± 0.5KHz.
18.60 ± 0.5KHz. (Optional)
Horizontal Blanking
10.0 μ sec. min.
Horizontal Phasing Control
10.0 μ sec. min. adjustment
VERTICAL
47 to 63 Hz.
VERTICAL RETRACE TIME
850 μ sec. max.

STORAGE

55° C. max. with bonded anti-reflective faceplate.
65° C. max. for plain faced CRT's.

ENVIRONMENT

Operating temperature
55° max. (free air temperature of display electronics).
Altitude
40,000 ft. + storage & shipment.
10,000 ft. max. operating.

WEIGHT

11.5 lbs. max. without optional power supply.
13.5 lbs. max. with optional power supply.
9.0 lbs. max. without frame.

THEORY OF OPERATION

POWER SUPPLY

Power Transformer TX201 is designed for use with 120V or 240V A.C. source. The secondary provides power to bridge rectifier (CR501, CR502, CR503 and CR504). The positive output of the bridge rectifier (junction of CR503 and CR504), forms the raw B+ supply (~ 20VDC).

Voltage regulation is accomplished in the negative leg of the power supply through a feedback network consisting of transistors QX501 and QX502 and their associated circuitry. The emitter voltage of QX501 is maintained by diodes CR505, CR506 and CR507. The base voltage is provided by potentiometer RX506.

If B+ increases, diodes CR505, CR506 and CR507 will draw more current to maintain the emitter voltage of QX501. Additionally, the voltage developed across RX506 will increase, resulting in a higher positive voltage at the base of QX501 which will result in less conduction. This reduces the base current of QX502 since QX501 provides the emitter/base current path for QX502. When QX502 conducts less, the voltage drop across Q502 is increased thus lowering B+.

If B+ decreases, diodes CR505, CR506 and CR507 will reduce conduction to maintain the emitter voltage of QX501. Additionally, the base voltage provided by RX506 will decrease. Less voltage on the base of QX501 will cause it to increase conduction, resulting in a greater emitter/base current flow in QX502. With this condition the voltage drop for Q502 is less and B+ is increased.

HORIZONTAL

The low-level horizontal section, which consists of transistors Q101 and Q102 (and associated circuitry), functions as a variable time delay monostable multivibrator. The input trigger for this circuit is provided by the horizontal drive pulse. The pulse is injected into the base or emitter (for either positive or negative pulse respectively) of Q101 through injection network C101, C111, R101, R110 and CR101. By varying the recovery time of the multivibrator, potentiometer R104 adjusts video information position (with respect to raster scan). Output of the monostable multivibrator, derived at the collector of Q102, is injected through a coupling network consisting of C110 and CR103. The resulting "Lock" signal is rereceived by one side of a precision astable multivibrator at the emitter of Q103. The astable multivibrator circuit is completed through Q104 and associated circuitry. This circuit will act as a free running oscillator until the "Lock" signal is received from the previous stage. Once locked, an output pulse is formed at the emitter of Q104 which is then D.C. coupled to the base of the horizontal driver transistor, Q105.

Remainder of the horizontal circuit is straightforward. Features to be noted are: Width and Linearity Coils LX102 and LX101 in series with the yoke (TX202). Linearity is fixed and an adjustable coil is provided for width. The linearity coil has a magnetically biased core which makes the inductance of the coil dependent upon its current. Pincushion and geometric corrections are made at the factory by the addition of rubber magnets around the plastic ring of the yoke. D.C. operation of 12 volts is accomplished by the (optional) addition of a boost circuit at the horizontal sweep transformer.

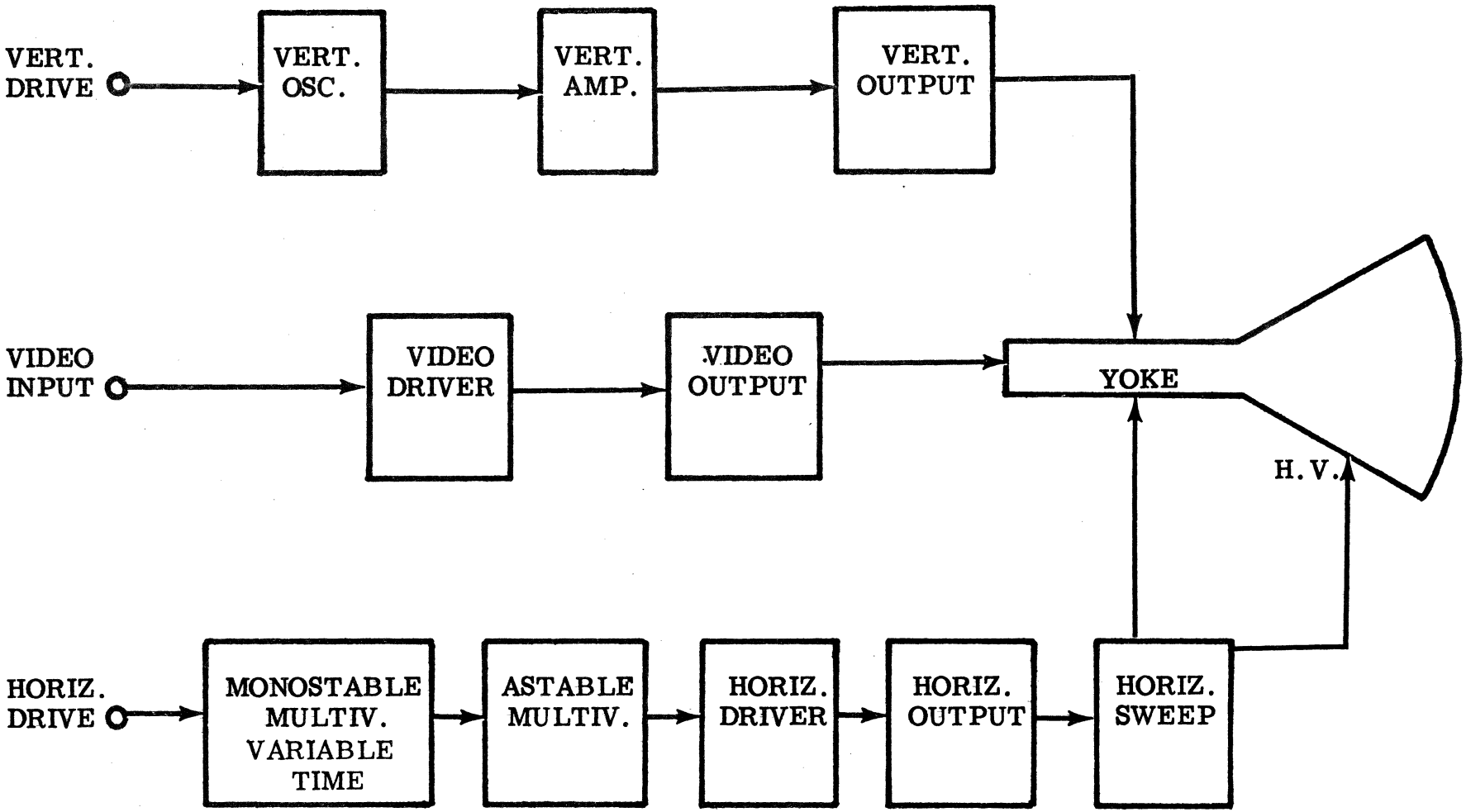
VERTICAL

The vertical circuit includes an oscillator consisting of transistors Q301 and Q302 and associated circuitry. Amplification is provided by transistors Q303 and Q304 with the emitter of Q304 feeding the base of the vertical driver Q305. The vertical output transistors, Q306 and Q307 are wired in the standard push-pull configuration. One feature of this vertical circuit is the addition of transistor Q308. This transistor doubles B+ during retrace, thus maintaining less than 800μ sec. of retrace time.

VIDEO

The video amplifier circuit consists of transistors Q401 and Q402 and associated circuitry. The circuit comprises a cascode amplifier which is triggered by a positive pulse at pin 8 of the edge connector. Upon receiving the input pulse, conduction is initiated and the collector voltage of Q402 is lowered. Amplification of low frequency voltage gain is fixed by the ratio of R407 and R408. Gain is maintained to 18 MHz by the bandwidth enhancing components R406, C403, and L401. Resistors R402 and R403 provide bias for the amplifier.

The collector output of Q401 is D.C. coupled to the cathode of the C.R.T. through resistor R201. Raster cut-off is adjusted with the brightness control R114 which is connected to G1 of the C.R.T.

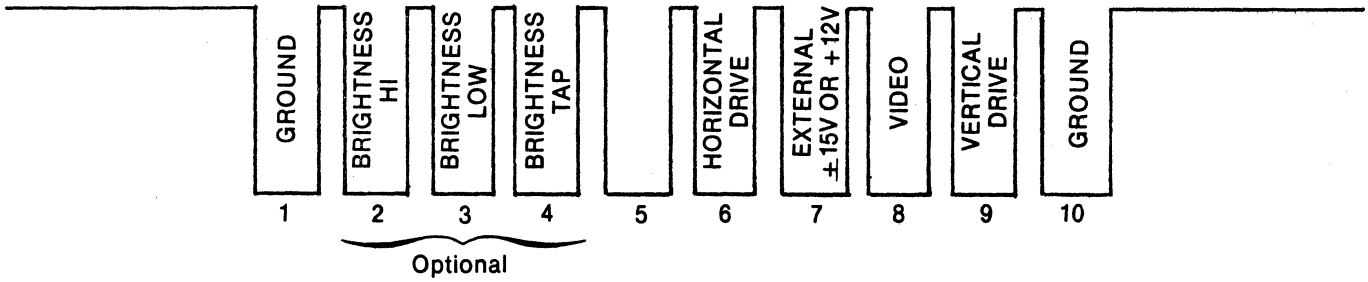

VERT.
DRIVE
VERT.
OSC.
VERT.
AMP.
VERT.
OUTPUT
VIDEO
INPUT
VIDEO
DRIVER
VIDEO
OUTPUT
YOKE
H.V.
HORIZ.
DRIVE
MONOSTABLE
MULTIV.
VARIABLE
TIME
ASTABLE
MULTIV.
HORIZ.
DRIVER
HORIZ.
OUTPUT
HORIZ.
SWEEP

ADJUSTMENT PROCEDURES FOR D12 VIDEO DISPLAY

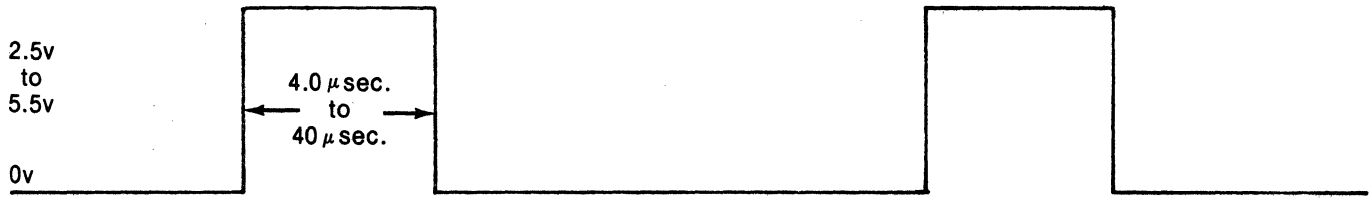
1. External power is applied to the monitor through an AC line cord or a 4 pin molex connector. The unit is wired for 120 VAC 50/60 Hz operation. (240 VAC 50/60 Hz optional)

2. INPUT SIGNALS: Input signals are connected to the display board through a 10 pin edge connector.

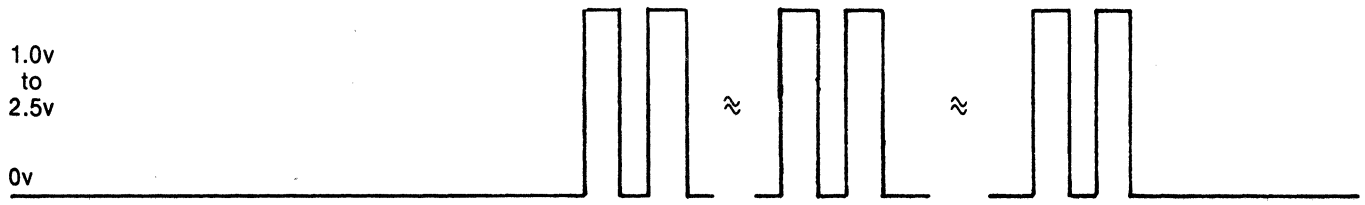
Component Side of Display Board



A. Horizontal drive signal — 15750 Hz ± 500 Hz

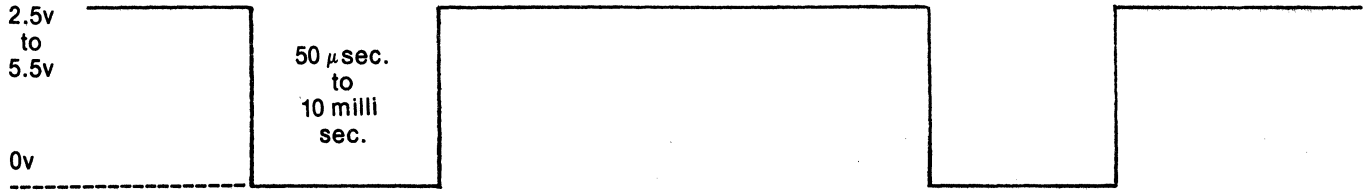


B. Video drive signal



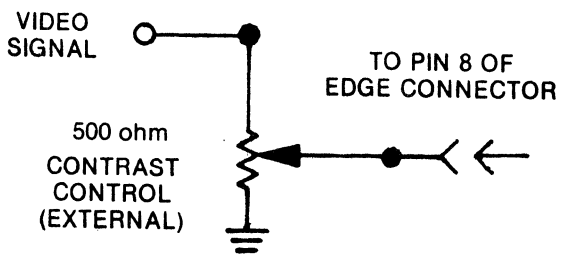
At a horizontal frequency of 15.7KHZ the video drive signal should start 11 microseconds ±5 μsec. after the leading edge of horizontal sync, and 900 microseconds or greater after the leading edge of vertical sync.

C. Vertical drive signal — 47 Hz to 63 Hz



In normal operation the horizontal and vertical drive signals and signal ground are connected to the edge connector through a cable assembly. If this is not the case connect pins 1 & 10 together with a jumper wire at the edge connector.

Should the video drive level exceed the 2.5 volts specified, an external contrast control must be provided. The video drive signal is connected to the top end of the 500Ω pot, the bottom end is grounded and the wiper arm connects to the video input of the edge connector as shown.



3. Once power is applied to the display and the input signals connected, adjust the brightness control until the edges of the raster are visible.

4. Depending on the requirements for height and width of the video presentation, the vertical size control and width coil should be adjusted accordingly.

5. The power supply board also has a control to adjust the regulated B+ of the monitor to +15V. Check for proper adjustment.

6. Adjust the phase control to center the video information within the raster. (The contrast control may have to be adjusted to obtain a display of the video information.)

7. Adjust brightness control for visual cutoff of the raster.

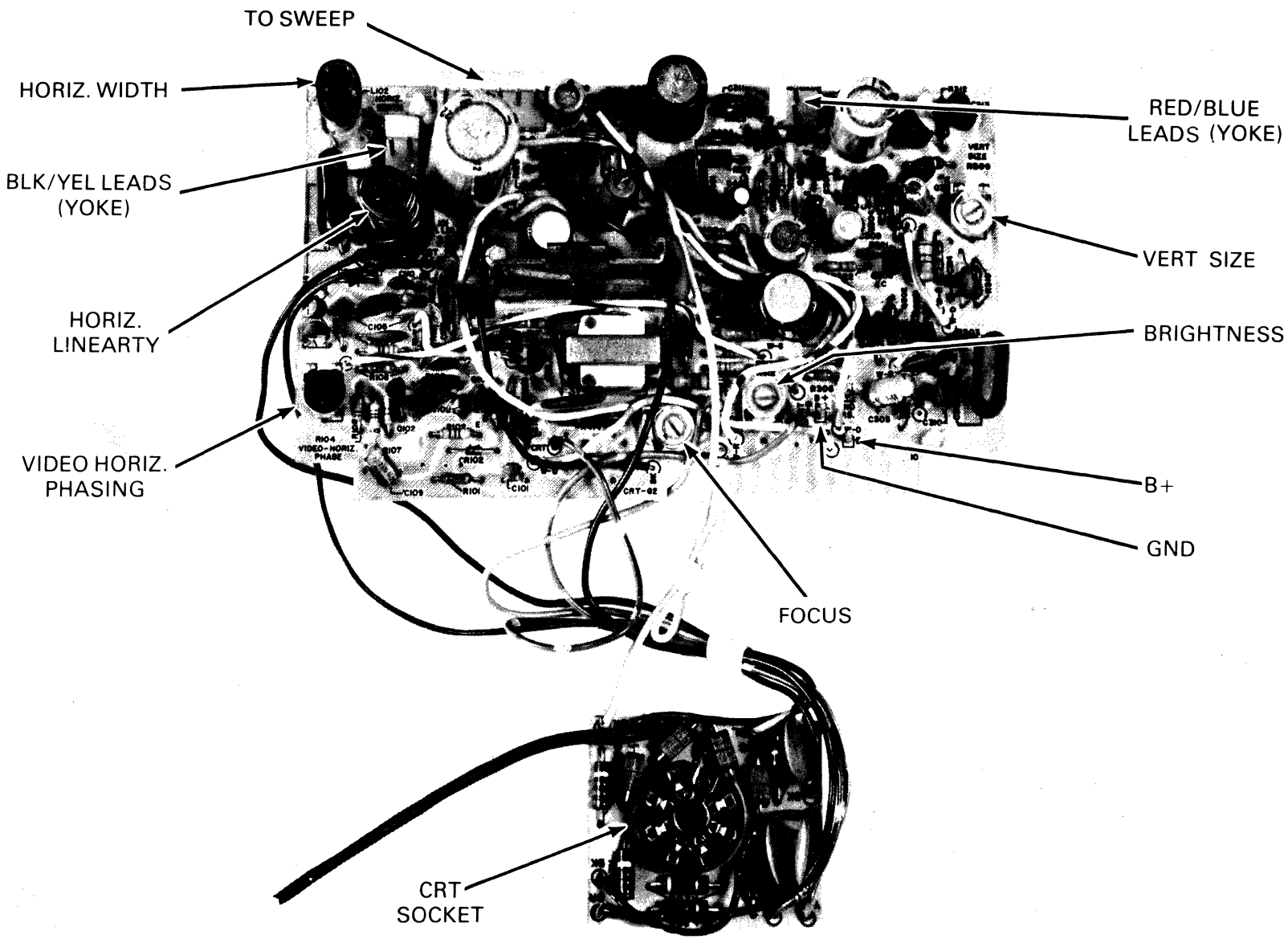
8. Adjust external contrast control for desired luminance.

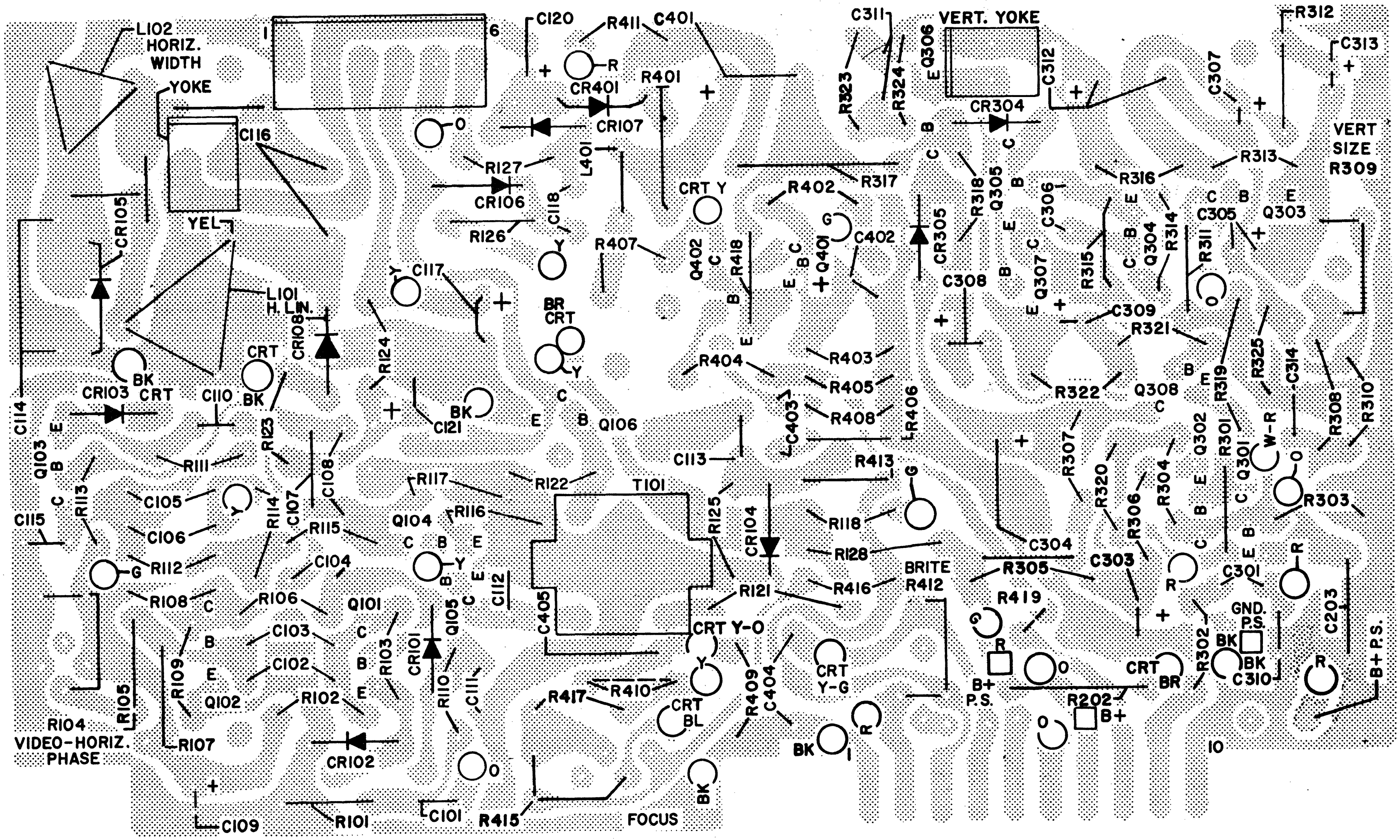
9. Adjust focus control for best possible overall focus.

IMPORTANT NOTE: DAG GROUNDING.

Each unit provides for grounding of the main P.C. Board and CRT socket board to the dag of the CRT through the dag grounding spring.

The ground wires are connected to the shell bond or T-band through a terminal lug. Upon installing the Video Display in a terminal, this grounding procedure should be followed to provide adequate high voltage filtering and arc protection. This especially pertains to mounting the video display as a kit version.


TO SWEEP
HORIZ. WIDTH
BLK/YEL LEADS (YOKE)
HORIZ. LINEARTY
VIDEO HORIZ. PHASING
RED/BLUE LEADS (YOKE)
VERT SIZE
BRIGHTNESS
B+
GND
FOCUS
CRT SOCKET



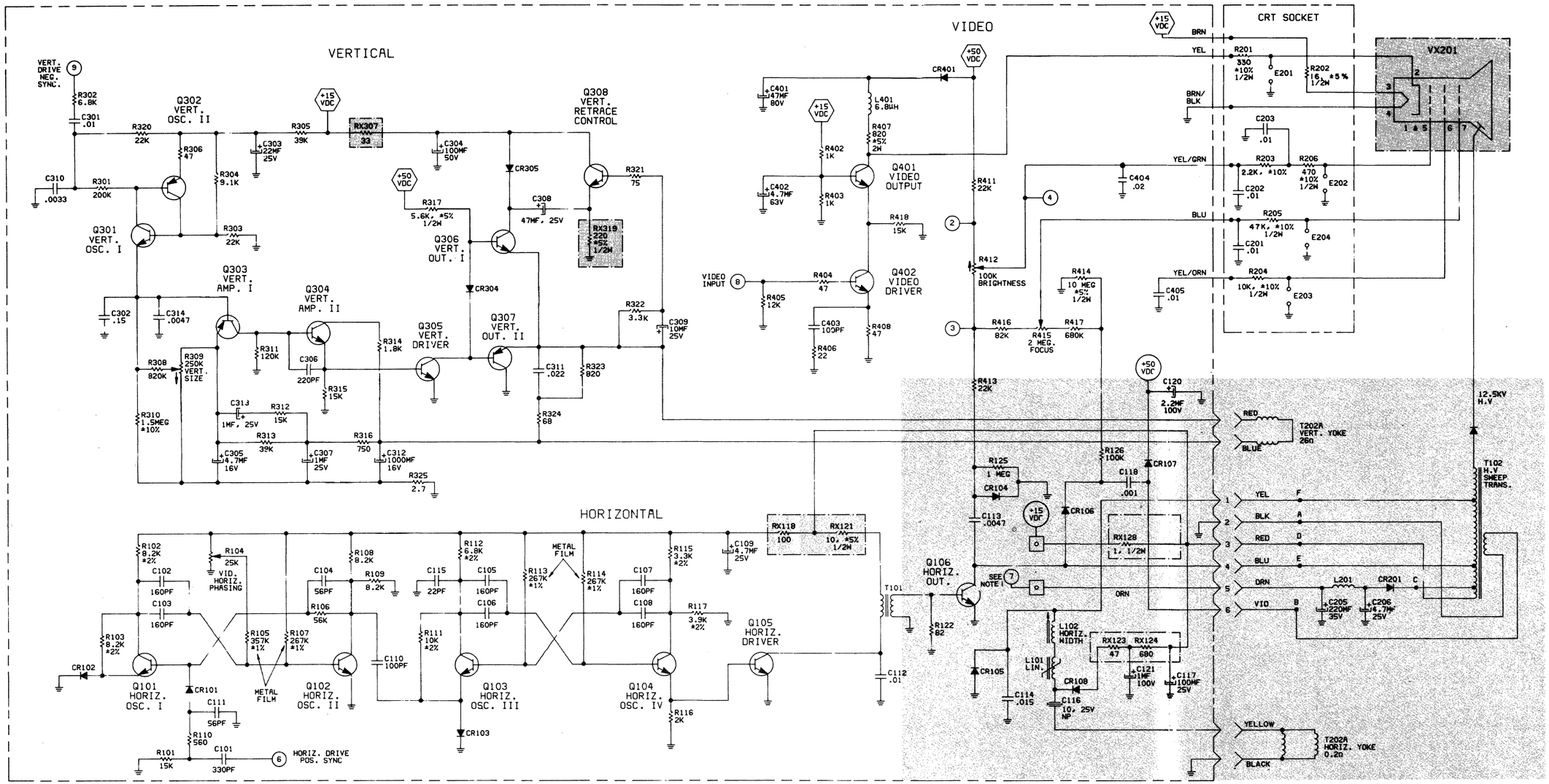
L102 HORIZ. WIDTH
YOKE
YEL
L101 H. LIN.
C120
R411
C401
CR401
R401
CR107
R127
CR106
R126
L401
C118
R407
CRT Y
C311
R323
R324
Q306
VERT. YOKE
C312
CR304
R312
C313
C307
VERT SIZE R309
R313
R316
Q303
C305
R317
R402
Q401
C402
CR305
R318
Q305
C306
Q304
R314
R315
Q307
R311
C308
C309
R321
R322
Q308
R319
R325
C314
R308
R310
C116
CR105
C114
CR103
CRT
BK
C110
CR108
C117
R124
BR CRT
Q402
R418
R404
R403
R405
R408
R406
C403
C121
Q106
Q103
R111
R123
C115
R113
C105
C106
R112
R108
R114
C107
C108
R115
R117
R116
R122
Q104
T101
C113
R413
R125
CR104
R118
R128
C304
R307
R320
R306
R304
Q302
R301
Q301
W-R
R303
C303
C301
R305
BRITE R412
R416
R121
R419
C104
R106
Q101
C103
C102
Q102
R102
R103
CR101
Q105
R110
C111
C112
C405
R109
R105
R104 VIDEO-HORIZ. PHASE
R107
CR102
C109
R101
C101
R415
FOCUS
R417
R410
CRT Y-O
CRT BL
R409
C404
CRT Y-G
B+ P.S.
R202
B+
CRT BR
R302
GND. P.S.
C310
C203
B+ P.S.
10

LEGEND

ITEM NO.	PART NO.	DESCRIPTION
C101	22-7614-06A	330 PFD CAPACITOR 20% DISC 50V
C102	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C103	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C104	22-7622-28A	56 PFD CAPACITOR 10% DISC NPO 50V
C105	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C106	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C107	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C108	22-7619-39A	160 PFD CAPACITOR 5% DISC NPO 50V
C109	22-7152-03	4.7 MFD CAPACITOR +100%—10% ELEC 25V
C110	22-7613A	100 PFD CAPACITOR 10% DISC 50V
C111	22-7622-28A	56 PFD CAPACITOR 10% DISC 50V
C112	22-7613-24A	.01 MFD CAPACITOR 10% DISC 50V
C113	22-7440	.0047 MFD CAPACITOR 10% DISC 500V
CX114	22-7530-07	.015 MFD CAPACITOR 5% POLYESTER 400V
C115	22-7656-13A	22 PFD CAPACITOR 10% DISC 50V
C116	22-7313	10 MFD CAPACITOR 20% NP ELEC 25V
C117	22-7718-09	100 MFD CAPACITOR 20% ELEC 25V
CX118	22-3748	.001 MFD CAPACITOR 10% DISC 1KV
C119		
C120	22-7722-02	2.2 MFD CAPACITOR 20% ELEC 100V
C121	22-7722-01	1 MFD CAPACITOR 20% ELEC 100V
C201	22-4905-01	.01 MFD CAPACITOR +80%—20% 500V
C202	22-4905-01	.01 MFD CAPACITOR +80%—20% 500V
C203	22-4905-01	.01 MFD CAPACITOR +80%—20% 500V
C204		
CX205	22-7144-09	220 MFD CAPACITOR +100%—10% ELEC 35V
CX206	22-7142-03	4.7 MFD CAPACITOR +100%—10% ELEC 25V
C301	22-7613-24A	.01 MFD CAPACITOR 10% DISC 50V
C302	22-7548	.15 MFD CAPACITOR 10% POLYESTER 50V
C303	22-7152-05	22 MFD CAPACITOR +100%—10% ELEC 25V
C304	22-7720-09	100 MFD CAPACITOR 20% ELEC 50V
C305	22-7579-03	4.7 MFD CAPACITOR ELEC 16V
C306	22-7614-04A	220 PFD CAPACITOR 20% DISC 50V
C307	22-7389-02	1 MFD CAPACITOR 20% ELEC 25V
C308	22-7718-08	47 MFD CAPACITOR 20% ELEC 25V
C309	22-7152-04	10 MFD CAPACITOR +100%—10% ELEC 25V
C310	22-7614-18A	.0033 MFD CAPACITOR 20% DISC 50V
C311	22-7615-08A	.022 MFD CAPACITOR +80%—20% DISC 50V
C312	22-7579-04	1000 MFD CAPACITOR 10% ELEC 16V
C313	22-7389-02	1 MFD CAPACITOR 20% ELEC 25V
C314	22-7614-20A	.0047 MFD CAPACITOR 20% DISC 50V
C315		
C401	22-7722-08	47 MFD CAPACITOR 20% ELEC 100V
C402	22-7721-04	4.7 MFD CAPACITOR 20% ELEC 63V
C403	22-7613A	100 PFD CAPACITOR 10% DISC 50V
C404	22-7724	.02 MFD CAPACITOR +80%—20% DISC 500V
C405	22-3512	.01 MFD CAPACITOR +40%—10% DISC 1KV
R101	63-9922	15K OHM RESISTOR 5% FILM 1/4W
R102	63-9919-94	8.2K OHM RESISTOR 2% FILM 1/4W
R103	63-9919-94	8.2K OHM RESISTOR 2% FILM 1/4W
R104	63-10651-06	CONTROL 25K OHM (HORIZ PHASE)
R105	63-10533-05	357K OHM RESISTOR 1% METAL FILM 1/4W
R106	63-9922-14	56K OHM RESISTOR 5% FILM 1/4W
R107	63-10533-04	267K OHM RESISTOR 1% METAL FILM 1/4W
R108	63-9921-94	8.2K OHM RESISTOR 5% FILM 1/4W
R109	63-9921-94	8.2K OHM RESISTOR 5% FILM 1/4W
R110	63-9921-66	560 OHM RESISTOR 5% FILM 1/4W
R111	63-9919-96	10K OHM RESISTOR 2% FILM 1/4W
R112	63-9919-92	6.8K OHM RESISTOR 2% FILM 1/4W
R113	63-10533-04	267K OHM RESISTOR 1% METAL FILM 1/4W
R114	63-10533-04	267K OHM RESISTOR 1% METAL FILM 1/4W
R115	63-9919-84	3.3K OHM RESISTOR 2% FILM 1/4W
R116	63-9921-79	2K OHM RESISTOR 5% FILM 1/4W
R117	63-9919-86	3.9K OHM RESISTOR 2% FILM 1/4W
RX118	63-10559-48	100 OHM RESISTOR 5% FILM 1/4W
R119		
R120		
RX121	63-10565-24	10 OHM RESISTOR 5% FILM 1/2W
R122	63-9921-46	82 OHM RESISTOR 5% FILM 1/4W
RX123	63-10559-40	47 OHM RESISTOR 5% FILM 1/4W
RX124	63-10559-68	680 OHM RESISTOR 5% FILM 1/4W
R125	63-9922-44	1 MEGOHM RESISTOR 5% FILM 1/4W
R126	63-9922-20	100K OHM RESISTOR 5% FILM 1/4W
RX127		
RX128	63-10565	1 OHM RESISTOR 5% FILM 1/2W
R201	63-7763	330 OHM RESISTOR 5% CARBON COMP 1/2W
R202	63-7710	16 OHM RESISTOR 5% CARBON COMP 1/2W
R203	63-7799	2.2K OHM RESISTOR 10% CARBON COMP 1/2W
R204	63-7827	10K OHM RESISTOR 10% CARBON COMP 1/2W
R205	63-7855	47K OHM RESISTOR 10% CARBON COMP 1/2W
R206	63-7771	470 OHM RESISTOR 10% CARBON COMP 1/2W
R301	63-9922-27	200K OHM RESISTOR 5% FILM 1/4W
R302	63-9921-92	6.8K OHM RESISTOR 5% FILM 1/4W

ITEM NO.	PART NO.	DESCRIPTION
R303	63-9922-04	22K OHM RESISTOR 5% FILM 1/4W
R304	63-9921-95	9.1K OHM RESISTOR 5% FILM 1/4W
R305	63-9922-10	39K OHM RESISTOR 5% FILM 1/4W
R306	63-9921-40	47 OHM RESISTOR 5% FILM 1/4W
RX307	63-10559-36	33 OHM RESISTOR 5% FILM 1/4W
R308	63-9922-42	820K OHM RESISTOR 5% FILM 1/4W
R309	63-10651-08	CONTROL 250K OHM VERT SIZE
R310	63-9924-48	1.5 MEGOHM RESISTOR 10% FILM 1/4W
R311	63-9922-22	120K OHM RESISTOR 5% FILM 1/4W
R312	63-9922	15K OHM RESISTOR 5% FILM 1/4W
R313	63-9922-10	39K OHM RESISTOR 5% FILM 1/4W
R314	63-9921-78	1.8K OHM RESISTOR 5% FILM 1/4W
R315	63-9922	15K OHM RESISTOR 5% FILM 1/4W
R316	63-9921-69	750 OHM RESISTOR 5% FILM 1/4W
R317	63-7816	5.6K OHM RESISTOR 5% CARBON COMP 1/2W
R318		
RX319	63-10565-56	220 OHM RESISTOR 5% FILM 1/2W
R320	63-9922-04	22K OHM RESISTOR 5% FILM 1/4W
R321	63-9921-45	75 OHM RESISTOR 5% FILM 1/4W
R322	63-9921-84	3.3K OHM RESISTOR 5% FILM 1/4W
R323	63-9921-70	820 OHM RESISTOR 5% FILM 1/4W
R324	63-9921-44	68 OHM RESISTOR 5% FILM 1/4W
R325	63-9921-10	2.7 OHM RESISTOR 5% FILM 1/4W
R401		
R402	63-9921-72	1K OHM RESISTOR 5% FILM 1/4W
R403	63-9921-72	1K OHM RESISTOR 5% FILM 1/4W
R404	63-9921-40	47 OHM RESISTOR 5% FILM 1/4W
R405	63-9921-98	12K OHM RESISTOR 5% FILM 1/4W
R406	63-9921-32	22 OHM RESISTOR 5% FILM 1/4W
R407	63-10371-70	820 OHM RESISTOR 5% FILM 2W
R408	63-9921-40	47 OHM RESISTOR 5% FILM 1/4W
R409		
R410		
R411	63-9922-04	22K OHM RESISTOR 5% FILM 1/4W
R412	63-10651-05	CONTROL 100K OHM BRIGHTNESS
R413	63-9922-04	22K OHM RESISTOR 5% FILM 1/4W
R414	63-7952	10 MEGOHM RESISTOR 5% CARBON 1/2W
R415	63-10651-07	CONTROL 2 MEGOHM FOCUS
R416	63-9922-18	82K OHM RESISTOR 5% FILM 1/4W
R417	63-9922-40	680K OHM RESISTOR 5% FILM 1/4W
R418	63-9922	15K OHM RESISTOR 5% FILM 1/4W
R419		
L101	20-3906	COIL, RCF LINEARITY
LX102	20-3882	COIL, RCF TUNABLE WIDTH
LX201	20-3824	COIL, HORIZ FILTER
L401	20-3887-10C	COIL, RCF 6.8 uh
T101	95-3136-03	TRANSFORMER HORIZ DRIVER
TX102	95-3395-01	HV SWEEP TRANSFORMER
TX202 A,B	95-3397	DEFLECTION YOKE
CR101	103-142-01	DIODE
CR102	103-142-01	DIODE
CR103	103-142-01	DIODE
CR104	103-261-04A	DIODE
CR105	103-263A	DIODE
CR106	212-76	DIODE
CR107	103-298-04	DIODE
CR108	103-261-02A	DIODE
CR201	103-280-02	DIODE ALT: 103-263 (2) IN PARALLEL
CR301		
CR302		
CR303		
CR304	103-142-01	DIODE
CR305	103-261-02A	DIODE
CR401	103-295-02A	DIODE
Q101	121-975	TRANSISTOR #I HORIZ OSC
Q102	121-975	TRANSISTOR #II HORIZ OSC
Q103	121-975	TRANSISTOR #III HORIZ OSC
Q104	121-975	TRANSISTOR #IV HORIZ OSC
Q105	121-819	TRANSISTOR HORIZ DRIVER
QX106	121-1039	TRANSISTOR HORIZ OUTPUT
Q301	121-975	TRANSISTOR #I VERT OSC
Q302	121-699	TRANSISTOR #II VERT OSC
Q303	121-699	TRANSISTOR #I VERT AMP
Q304	121-975	TRANSISTOR #II VERT AMP
Q305	121-972	TRANSISTOR VERT DRIVER
Q306	121-819	TRANSISTOR VERT OUTPUT I
Q307	121-973	TRANSISTOR VERT OUTPUT II
Q308	121-819	TRANSISTOR VERT RETRACE CONTROL
Q401	121-1034	TRANSISTOR VIDEO OUTPUT
Q402	121-895	TRANSISTOR VIDEO DRIVER
E201	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)
E202	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)
E203	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)
E204	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)
VX201	100-684	12" CRT *OR*
	100-684-02	12" CRT

D12 VIDEO DISPLAY 15.7KHz



IMPORTANT SAFETY NOTICE

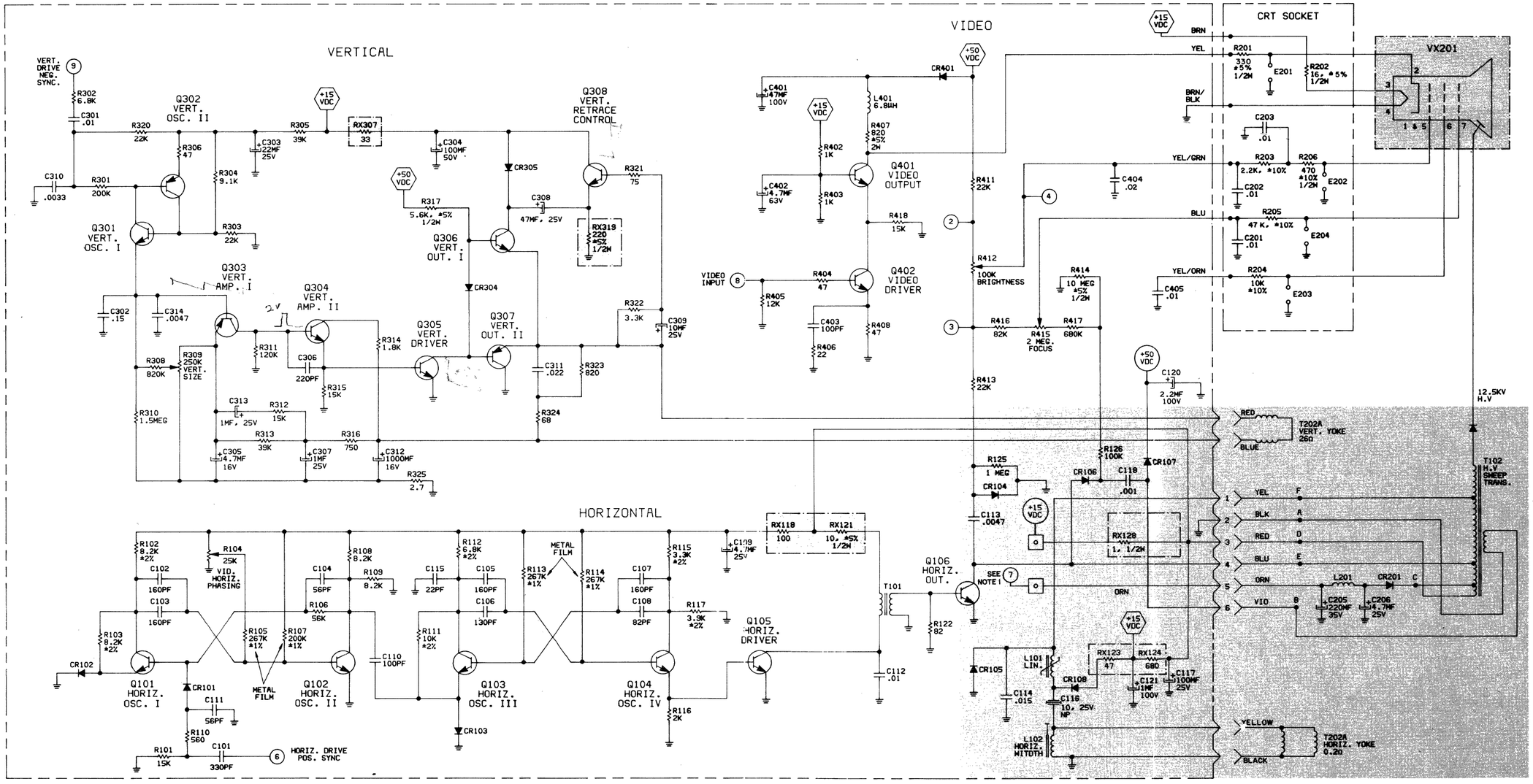
When servicing this chassis, under no circumstances should the original design be modified or altered without permission from the Zenith Radio Corporation. All components should be replaced only with types identical to those in the original circuit. Special components are used to prevent shock and fire hazard. These critical components are shaded on the schematic and parts list for easy identification.

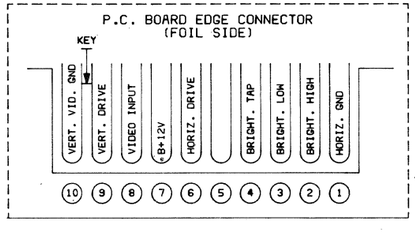
This circuit diagram may occasionally differ from the actual circuit used. This way, implementation of the latest safety and performance improvement changes into the set is not delayed until the new service literature is printed.

IMPORTANT SAFETY NOTICE

FOR X-RADIATION, FIRE OR SHOCK HAZARD PREVENTION, CERTAIN SPECIAL OR REDUNDANT PARTS ARE USED. USE ONLY EXACT REPLACEMENTS. DO NOT ALTER THE CIRCUIT OR DEFEAT THE FUSES. FAILURE TO COMPLY MAY BE UNLAWFUL.

D12 VIDEO DISPLAY 18.6KHz





= DC VOLTAGE SOURCE

= DC VOLTAGE APPLIED

NOTE: 1. CUSTOMER SUPPLIED EXTERNAL DC SOURCE ON PIN 7 EDGE CONNECTOR

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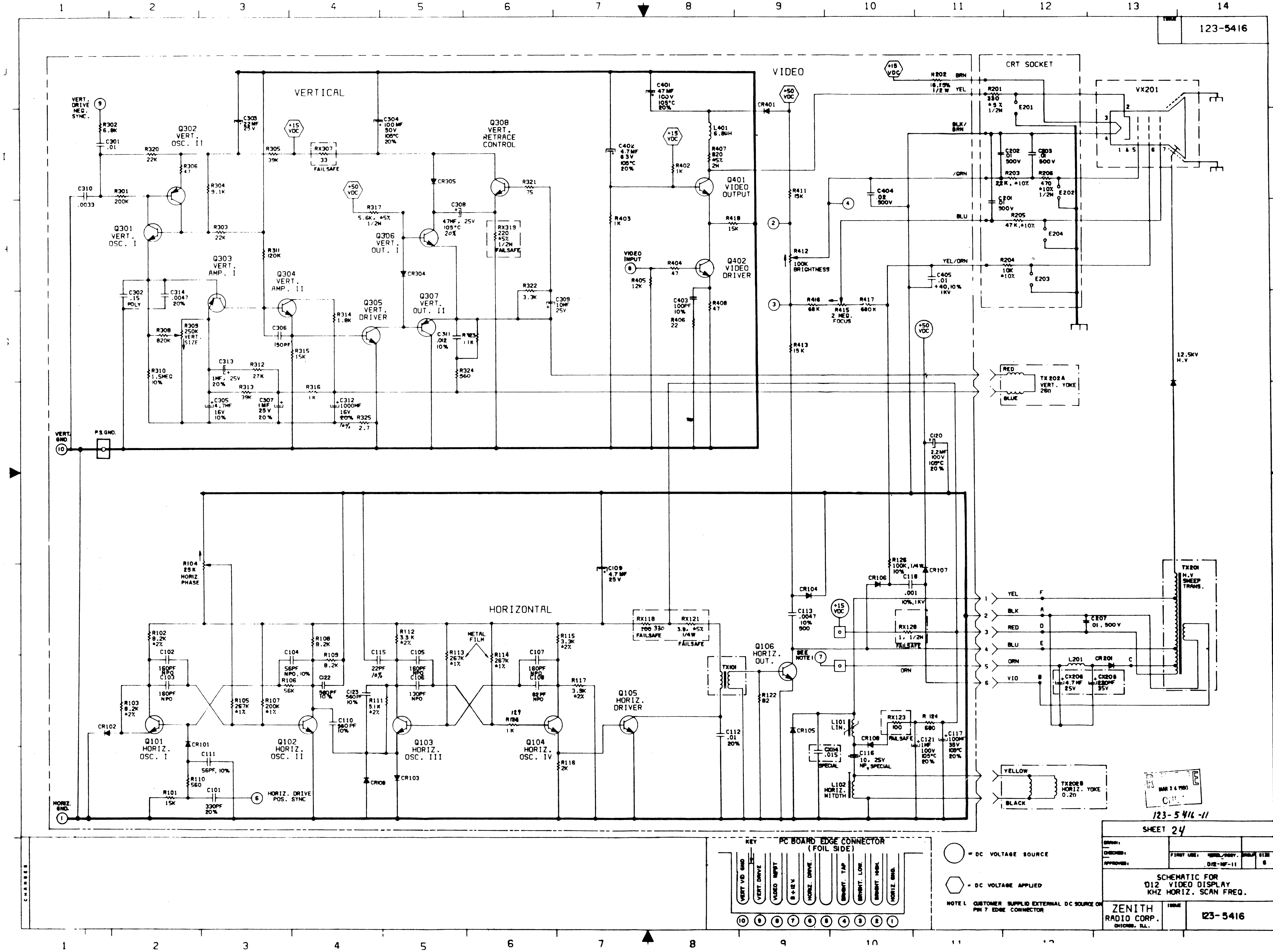

123-5416
VERTICAL
VIDEO
HORIZONTAL
CRT SOCKET
VX201
Q301 VERT. OSC. I
Q302 VERT. OSC. II
Q303 VERT. AMP. I
Q304 VERT. AMP. II
Q305 VERT. DRIVER
Q306 VERT. OUT. I
Q307 VERT. OUT. II
Q308 VERT. RETRACE CONTROL
Q401 VIDEO OUTPUT
Q402 VIDEO DRIVER
Q101 HORIZ. OSC. I
Q102 HORIZ. OSC. II
Q103 HORIZ. OSC. III
Q104 HORIZ. OSC. IV
Q105 HORIZ. DRIVER
Q106 HORIZ. OUT.
TX202A VERT. YOKE
TX202B HORIZ. YOKE
TX201 H.V. SWEEP TRANS.
12.5KV H.V.
R104 25K HORIZ. PHASE
R412 100K BRIGHTNESS
R415 2 MEG. FOCUS
R309 250K VERT. SIZE
VERT. DRIVE NEG. SYNC.
HORIZ. DRIVE POS. SYNC
VIDEO INPUT
VERT. GND
HORIZ. GND.
P.S. GND.
PC BOARD EDGE CONNECTOR (FOIL SIDE)
KEY
VERT VID GND
VERT. DRIVE
VIDEO INPUT
B+12V
HORIZ. DRIVE
HORIZ. GND.
BRIGHT. TAP
BRIGHT. LOW
BRIGHT. HIGH
= DC VOLTAGE SOURCE
= DC VOLTAGE APPLIED
NOTE 1. CUSTOMER SUPPLIED EXTERNAL DC SOURCE ON PIN 7 EDGE CONNECTOR
SHEET 24
SCHEMATIC FOR D12 VIDEO DISPLAY KHZ HORIZ. SCAN FREQ.
ZENITH RADIO CORP. CHICAGO, ILL.
123-5416
123-5416-11

SAMPLES OF NEW OR REVISED PART MUST BE APPROVED BY ZENITH RADIO CORPORATION BEFORE PROCEEDING WITH PRODUCTION UNLESS OTHERWISE SPECIFIED IN CHANGE COLUMN. AFTER APPROVAL MANUFACTURER SHALL NOT CHANGE THE DESIGN, PERFORMANCE, MATERIALS, OR MANUFACTURING SITE WITHOUT PRIOR NOTIFICATION AND APPROVAL BY ZENITH RADIO CORPORATION

ITEM NUMBER	PART NUMBER	DESCRIPTION	
C101	22-7814-08A	330 PFD. CAPACITOR ±20% DISC.	50V
C102	22-7818-30A	180 PFD. CAPACITOR ±5% DISC. NPO	50V
C103	22-7818-30A	180 PFD. CAPACITOR ±5% DISC NPO	50V
C104	22-7822-20A	56 PFD CAPACITOR ±10% DISC	50V
C105	22-7818-30A	180 PFD CAPACITOR ±5% DISC NPO	50V
C106	22-7818-37A	130 PFD CAPACITOR ±5% DISC NPO	50V
C107	22-7818-30A	180 PFD CAPACITOR ±5% DISC NPO	50V
C108	22-7819-32X	82 PFD CAPACITOR ±5% DISC NPO	50V
C109	22-7152-03	4.7 MFD CAPACITOR +100%-10% ELEC	25V
C110	22-7813-08A	560 PFD CAPACITOR ±10% DISC	50V
C111	22-7822-20A	56 PFD CAPACITOR ±10% DISC	50V
C112	22-7814-24A	.01 MFD CAPACITOR ± 20% DISC	50V
C113	22-7448	.0847 MFD CAPACITOR ±10% DISC	500V
C114	22-7536-07	.015 MFD CAPACITOR SPECIAL	
C115	22-7656-13A	22 PFD CAPACITOR ±10% DISC	50V
C116	22-7313	10 MFD CAPACITOR SPECIAL	25V
C117	22-7719-00	100 MFD CAPACITOR ±20% ELEC. 105°C	35V
C118	22-3748	.001 MFD CAPACITOR ±10% DISC	1KV
C119			
C120	22-7722-02	2.2 MFD CAPACITOR ±20% ELEC 105°C	100V
C121	22-7722-01	1 MFD CAPACITOR ±20% ELEC. 105°C	100V
C122	22-7813-00	560 PFD CAPACITOR ±10% DISC	50V
C123	22-7813-00	560 PFD CAPACITOR ±10% DISC	50V
C201	22-4005-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C202	22-4005-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C203	22-4005-01	.01 MFD CAPACITOR +80-20%DISC.	500V
C204			
CX205	22-7144-00	220 MFD CAPACITOR +100%-10% ELEC.	35V
CX206	22-7142-03	4.7 MFD CAPACITOR +100%-10% ELEC.	25V
C207	22-4005-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C301	22-7613-24A	.01 MFD CAPACITOR ±10% DISC	50V
C302	22-7547	.15 MFD.CAPACITOR ±10% POLYESTER	50V
C303	22-7152-05	22 MFD CAPACITOR +100-10% ELEC	25V
C304	22-7720-00	100 MFD CAPACITOR ±20% ELEC. 105°C	50V
C305	22-7578-03	4.7 MFD CAPACITOR ±10% ELEC.	16V
C306	22-7813-02A	150 PFD CAPACITOR ±10% DISC	50V
C307	22-7309-02	1 MFD CAPACITOR ±20% ELEC.	25V
C308	22-7718-00	47 MFD CAPACITOR ±20% ELEC. 105°C	25V
C309	22-7152-04	10 MFD CAPACITOR +100-10% ELEC.	25V
C310	22-7814-18A	.0033 MFD CAPACITOR ±20% DISC	50V
C311	22-7813-30A	.012 MFD CAPACITOR ±10% DISC.	50V
C312	22-7578-04	1000 MFD CAPACITOR ±10% ELEC.106°C	16V
C313	22-7309-02	1 MFD CAPACITOR ±20% ELEC.	25V
C314	22-7814-28A	.0047 MFD CAPACITOR ±20% DISC	50V
C401	22-7722-00	47 MFD CAPACITOR ±20% ELEC 105°C	100V
C402	22-7721-04	4.7 MFD CAPACITOR ±20% ELEC 105°C	63V
C403	22-7613A	100 PFD CAPACITOR ±10% DISC	50V
C404	22-7724	82 MFD CAPACITOR +80%-20% DISC.	500V
C405	22-3512	.01 MFD CAPACITOR +40-10% DISC	16V

ITEM NUMBER	PART NUMBER	DESCRIPTION	
R101	63-0822	15K OHM RESISTOR ± 5% FILM	1/4W
R102	63-0819-84	8.2K OHM RESISTOR ± 2% FILM	1/4W
R103	63-0819-84	8.2K OHM RESISTOR ± 2% FILM	1/4W
R104	63-10651-11	CONTROL 25K OHM (HORIZ. PHASE)	
R105	63-10533-84	267K OHM RESISTOR ± 1% (METAL FILM)	1/4W
R106	63-0822-14	56K OHM RESISTOR ± 5% FILM	1/4W
R107	63-10533-11	200K OHM RESISTOR ± 1% METAL FILM	1/4W
R108	63-0821-84	8.2K OHM RESISTOR ±5% FILM	1/4W
R109	63-0821-84	8.2K OHM RESISTOR ±5% FILM	1/4W
R110	63-0821-86	560 OHM RESISTOR ± 5%	1/4W
R111	63-10351-08	5.1K OHM RESISTOR ± 2% FILM	1/4W
R112	63-0819-84	3.3K OHM RESISTOR ±2% FILM	1/4W
R113	63-10533-84	267K OHM RESISTOR 1% METAL FILM	1/4W
R114	63-10533-84	267K OHM RESISTOR ± 1% METAL FILM	1/4W
R115	63-0818-84	3.3K OHM RESISTOR ±2%	1/4W
R116	63-0821-78	2K OHM RESISTOR 5% FILM	1/4W
R117	63-0819-86	3.9K OHM RESISTOR ± 2% FILM	1/4W
BRE118	63-10559-06	330 / 100 OHM RESISTOR ±5% FAILSAFE	1/4W
R119			
R120			
BRE121	63-10558-14	0.8 OHM RESISTOR ± 5% FAILSAFE	1/4W
R122	63-0821-46	82 OHM RESISTOR ± 5%	1/4W
BRE123	63-10558-48	100 OHM RESISTOR ± 5% FAILSAFE	1/4W
R 124	63-0321 48	680 OHM RESISTOR ±5% FILM	
R125			
R126	63-0804-20	100K OHM RESISTOR ± 5% CARBON COMP.	1/4W
BRE128	63-10565	1 OHM RESISTOR ±5% FAILSAFE	1/2W
R127	63-0797	1 K ohm RESISTOR 2%	1/2W
R201	63-7763	330 OHM RESISTOR ±5% CARBON COMP.	1/2W
R202	63-7714	18 OHM RESISTOR ±5% CARBON COMP.	1/2W
R203	63-7780	2.2KOHM RESISTOR ±10% CARBON COMP.	1/2W
R204	63-7827	10K OHM RESISTOR ±10% CARBON COMP.	1/2W
R205	63-7855	47K OHM RESISTOR ±10% CARBON COMP.	1/2W
R206	63-7771	470 OHM RESISTOR ±10% CARBON COMP.	1/2W
R301	63-0822-27	200 K OHM RESISTOR ±5% FILM	1/4W
R302	63-0821-82	6.8 K OHM RESISTOR ±5% FILM	1/4W
R303	63-0822-84	22K OHM RESISTOR ±5% FILM	1/4W
R304	63-0821-95	8.1 K OHM RESISTOR ±5% FILM	1/4W
R305	63-0822-10	39K OHM RESISTOR ± 5% FILM	1/4W
R306	63-0821-40	47 OHM RESISTOR ±5% FILM	1/4W
WRX307	63-10559-36	33 OHM RESISTOR ± 5% FAILSAFE	1/4W
R308	63-0822-42	820K OHM RESISTOR ± 5% FILM	1/4W
R309	63-10651-13	CONTROL 250K OHM VERT. SIZE	
R310	63-0824-48	1.5 MEG OHM RESISTOR ±10% FILM	1/4W
R311	63-0822-22	120K OHM RESISTOR ±5% FILM	1/4W
R312	63-0822-06	27K OHM RESISTOR ± 5% FILM	1/4W
R313	63-0822-10	39K OHM RESISTOR ± 5% FILM	1/4W
R314	63-0821-78	1.8K OHM RESISTOR ± 5% FILM	1/4W
R315	63-0824	15K OHM RESISTOR ± 5% FILM	1/4W

ITEM NUMBER	PART NUMBER	DESCRIPTION	
R316	63-0821-72	1000 OHM RESISTOR ±5% FILM	1/4W
R317	63-7818	5.6K OHM RESISTOR ± 5% CARBON COMP.	1/2W
R318			
RX319	63-10545-66	220 OHM RESISTOR ± 5% FAILSAFE	1/2W
R320	63-0822-84	22K OHM RESISTOR ± 5% FILM	1/4W
R321	63-0821-45	75 OHM RESISTOR ± 5% FILM	1/4W
R322	63-0821-84	3.3K OHM RESISTOR ± 5% FILM	1/4W
R323	63-0821-73	1100 OHM RESISTOR ±5% FILM	1/4W
R324	63-0821-66	560OHM RESISTOR 5% FILM	1/4W
R325	63-0821-18	2.7 OHM RESISTOR ± 5% FILM	1/4W
R401			
R402	63-0821-72	1K OHM RESISTOR ± 5% FILM	1/4W
R403	63-0821-72	1K OHM RESISTOR ± 5% FILM	1/4W
R404	63-0821-40	47 OHM RESISTOR ± 5% FILM	1/4W
R405	63- 0821	12K OHM RESISTOR ± 5% FILM	1/4W
R406	63-0821-37	22 OHM RESISTOR ± 5% FILM	1/4W
R407	63-10371-70	820 OHM RESISTOR ± 5% FILM	2W
R408	63-0821-40	47 OHM RESISTOR 5% FILM	1/4W
R409			
R410			
R411	63-0822	15K OHM RESISTOR ±5% FILM	1/4W
R412	63-10651-12	CONTROL 100 K OHM BRIGHTNESS	
R413	63-0822	15K OHM RESISTOR ±5% FILM	1/4W
R414			
R415	63-10812-01	CONTROL 2 MEG OHM FOCUS	
R416	63-0822-18	68K OHM RESISTOR ±5% FILM	1/4W
R417	63-0822-48	680K OHM RESISTOR ±5% FILM	1/4W
R418	63-0822	15K OHM RESISTOR ±5% FILM	1/4W
R419			
CR101	183-142-01	DIODE	
CR102	183-142-01	DIODE	
CR103	183-142-01	DIODE	
CR104	183- 295-03A	DIODE	
CR105	183-294	DIODE	
CR106	212-78-02	DIODE	
CR107	183-288-06A	DIODE	
CR108	212-78-02	DIODE	
CR109	183-142-01	DIODE	
CR201X	183- 316-04	DIODE	
CR301			
CR302			
CR303			
CR304	183-142-01	DIODE	
CR305	212-78-02	DIODE	
CR401	212-78-02	DIODE	
L101	28-3006-02	COIL, RCF LINEARITY	
L102	28-3005	COIL, RCF TUNABLE WIDTH	
L201	28-3024	COIL, HORIZ. FILTER CHOKE	
L401	28-3007-10C	COIL, RCF 6.8 MH	

ITEM NUMBER	PART NUMBER	DESCRIPTION	
TX101	85-3138-03	TRANSFORMER HORIZ. DRIVER	
TX201	85-3305-01	H.V. SWEEP TRANSFORMER	
TX202	85-3307-02	DEFLECTION YOKE	
Q101	121-875	TRANSISTOR HORIZ OSC. I	
Q102	121-875	TRANSISTOR HORIZ. OSC II	
Q103	121-875	TRANSISTOR HORIZ OSC. III	
Q104	121-875	TRANSISTOR HORIZ. OSC. IV	
Q105	121-872	TRANSISTOR HORIZ. DRIVER	
Q106	121-1030	TRANSISTOR HORIZ. OUTPUT	
Q301	121-875	TRANSISTOR VERT. OSC. I	
Q302	121-880	TRANSISTOR VERT. OSC. II	
Q303	121-880	TRANSISTOR VERT. AMP. I	
Q304	121-875	TRANSISTOR VERT. AMP II	
Q305	121-872	TRANSISTOR VERT. DRIVER	
Q306	121-1095	TRANSISTOR VERT. OUTPUT I	
Q307	121-1096	TRANSISTOR VERT. OUTPUT II	
Q308	121-844	TRANSISTOR VERT. RETRACE CONTROL	
Q401	121-1050	TRANSISTOR VIDEO OUTPUT 121-1034 ALT.	
Q402	121-895	TRANSISTOR VIDEO DRIVER	
E201	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)	
E202	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)	
E203	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)	
E204	52-2240-01	SPARK GAP (PART OF CRT SOCKET ASSY)	
V8201	100-684	12" CRT	

BOTTOM VIEWS OF TRANSISTORS

Q NUMBER	PART NUMBER	SKETCHES A	B	C	D	E	F	G	H	J	K	L	M
Q101	121-875			X					X				
Q102	121-875			X					X				
Q103	121-875			X					X				
Q104	121-875			X					X				
Q105	121-872 / 1050	X		X			X		X				
Q106	121-1030												
Q301	121-875			X					X				
Q302	121-880			X					X				
Q303	121-880			X					X				
Q304	121-875			X					X				
Q305	121-872 /		X	X					X				
Q306	121-1095												
Q307	121-1034					X							
Q308	121-1036					X							
Q308	121-844 1050	X		X					X				
Q401	121-1050		X										
Q402	121-895			X	X								

TRANSISTOR TYPES

PNP — BASE, COLLECTOR, EMITTER

NPN — BASE, COLLECTOR, EMITTER

SKETCH "A" — COLLECTOR, EMITTER, BASE

SKETCH "B" — COLLECTOR, EMITTER, BASE

SKETCH "C" — COLLECTOR, EMITTER, BASE

SKETCH "D" — BASE, COLLECTOR, EMITTER

SKETCH "E" — EMITTER, BASE, COLLECTOR

SKETCH "EA" — BASE, EMITTER, COLLECTOR

SKETCH "G" — BASE, EMITTER, COLLECTOR

SKETCH "H" — COLLECTOR, EMITTER, BASE

SKETCH "J" — COLLECTOR, EMITTER, BASE

SKETCH "K" — EMITTER, COLLECTOR, BASE

SKETCH "L" — BASE, COLLECTOR, EMITTER

SKETCH "M" — COLLECTOR, EMITTER, BASE

DI2-NF-11		100-684
MODEL USED ON	DIFFERENCE	CRT #

MAR 2 6 '80 ONLY

123-5416-1

SHEET 25

TOLERANCES			
LINEAR	INCH	mm	ANGULAR
X.X	±	±	±
X.XX	±	±	±
X.XXX	±		

UNLESS OTHERWISE SPECIFIED

CHANGES			

DRAWN			
CHECKED			
APPROVED			

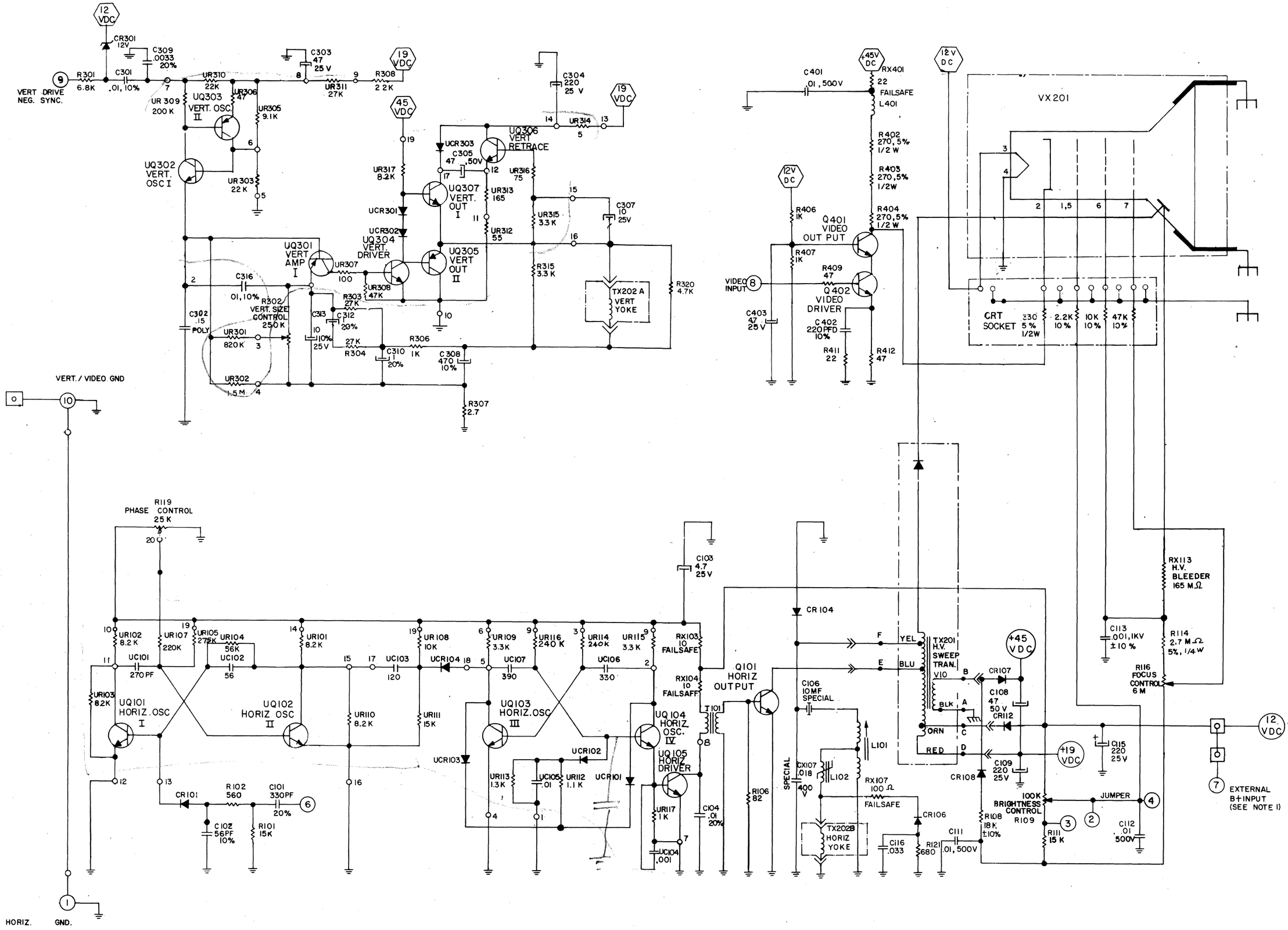
DI2-NF-11

LEGEND FOR DI2 VIDEO DISPLAY 18.61KHz HORIZ. SCAN. FREQ.

ZENITH RADIO CORP CHICAGO, ILL.

123-5416

123-5416	
MUST PASS THE FOLLOWING SPECIFICATIONS	
OTHER	ZENITH


12 VDC
CR301 12V
C309 .0033 20%
R301 6.8K
C301 .01, 10%
VERT. DRIVE NEG. SYNC.
9
UR310 22K
UR306 47
UR309 200 K
UQ303 VERT. OSC. II
UR305 9.1K
UR303 22 K
UQ302 VERT. OSC I
C303 47 25 V
UR311 27K
19 VDC
R308 2.2K
45 VDC
C304 220 25 V
UR314
UQ306 VERT RETRACE
UCR303
C305 47 ,50V
UR316 75
UR313 165
UQ307 VERT. OUT I
UR317 8.2K
UCR301
UCR302
UR312 55
UR315 3.3 K
C307 10 25V
UQ304 VERT. DRIVER
UQ305 VERT OUT II
UQ301 VERT AMP I
UR307 100
UR308 47K
C316 .01, 10%
R303 27K
R302 VERT. SIZE CONTROL 250 K
C313
C312 20%
C302 .15 POLY
UR301 820K
27K R304
R306 1K
C310 1 20%
C308 470 10%
UR302 1.5 M
R307 2.7
TX202 A VERT YOKE
R320 4.7K
VERT. / VIDEO GND
R119 PHASE CONTROL 25 K
UR102 8.2 K
UR107 220K
UR105 275K
UR104 56K
UC102 56
UC101 270 PF
UR103 8.2K
UQ101 HORIZ. OSC I
UR101 8.2 K
UQ102 HORIZ OSC II
UR110 8.2 K
UR111 15K
UR108 10K
UR109 3.3K
UR116 240 K
UR114 240K
UR115 3.3 K
UC107 390
UC106 330
UC103 120
UCR104
UQ103 HORIZ. OSC III
UQ104 HORIZ. OSC. IV
UQ105 HORIZ DRIVER
UCR103
UCR102
UCR101
UR113 1.3K
UC105 .01
UR112 1.1 K
UR117 1K
UC104 .001
R102 560
C101 330PF 20%
CR101
C102 56PF 10%
R101 15K
C103 4.7 25V
RX103 10 FAILSAFE
RX104 10 FAILSAFF
Q101 HORIZ OUTPUT
T101
C104 .01 20%
R106 82
CR104
C106 10MF SPECIAL
SPECIAL
CX107 .018 400 V
L102
L101
RX107 100 Ω FAILSAFE
TX202B HORIZ YOKE
C116 .033
CR106
R121 680
C111 .01, 500V
C401 .01, 500V
+45V DC
RX401 22 FAILSAFE L401
R402 270, 5% 1/2 W
R403 270, 5% 1/2W
R404 270, 5% 1/2 W
12V DC
R406 1K
Q401 VIDEO OUT PUT
R407 1K
R409 47
VIDEO INPUT 8
Q402 VIDEO DRIVER
C403 47 25 V
C402 220 PFD 10%
R411 22
R412 47
12 V DC
VX 201
CRT SOCKET
330 5% 1/2W
2.2K 10%
10K 10%
47K 10%
RX113 H.V. BLEEDER 165 M.Ω
C113 .001, 1KV ±10 %
R114 2.7 M-Ω 5%, 1/4 W
R116 FOCUS CONTROL 6 M
TX201 H.V. SWEEP TRAN.
F YEL
E BLU
VIO
BLK
ORN
RED
A
B
C
D
CR107
C108 47 50 V
CR112
C109 220 25V
CR108
+45 VDC
+19 VDC
C115 220 25V
12 VDC
EXTERNAL B+ INPUT (SEE NOTE 1)
100K BRIGHTNESS CONTROL R109
JUMPER
R108 18K ±10%
R111 15 K
C112 .01 500V
HORIZ. GND.

ITEM NUMBER	PART NUMBER	DESCRIPTION	
C101	22-7614-06A	330 PFD CAPACITOR ±20% DISC.	50V
C102	22-7622-28A	56 PFD CAPACITOR ±10% DISC.	50V
C103	22-7152-03	4.7 MFD CAPACITOR +100-10% ELEC.	25V
C104	22-7614-24A	.01 PFD CAPACITOR ±20% DISC.	50V
C105			
C106	22-7313	10 MFD CAPACITOR SPECIAL NPZD	
CX107	22-7530-08	.018 MFD CAPACITOR SPECIAL 5%	400 V
C108	22-7153-07	47 MFD CAPACITOR +100-10% ELEC.	50V
C109	22-7152-09	220 MFD CAPACITOR +100-10% ELEC.	25V
C110			
C111	22-4905-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C112	22-4905-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C113	22-3748	.001 MFD CAPACITOR 10% DISC.	1KV
C115	22-7152-09	220 MFD CAPACITOR 100 -10% ELEC	25V
C116	22-7615-09	.033 MFD CAPACITOR +80-20% DISC	50V
C301	22-7613-24A	.01 MFD CAPACITOR ±10% DISC.	50V
C302	22-7548	.15 MFD CAPACITOR ±10% POLY	50V
C303	22-7152-07	47 MFD CAPACITOR +100-10% ELEC.	25V
C304	22-7152-09	220 MFD CAPACITOR +100-10% ELEC.	25V
C305	22-7153-07	47 MFD CAPACITOR +100-10% ELEC.	50V
C306			
C307	22-7152-04	10 MFD CAPACITOR +100-10% ELEC.	25V
C308	22-7579-07	470 MFD CAPACITOR ±10% ELEC.	16V
C309	22-7614-18A	3300 PFD CAPACITOR ±20% DISC.	50V
C310	22-7389-02	1 MFD CAPACITOR ±20% ELEC.	25V
C311			
C312	22-7389-02	1 MFD CAPACITOR ±20% ELEC.	25V
C313	22-7389-10	10 MFD CAPACITOR ±10% ELEC.	25V
C316	22-7613-24	.01 MFD CAPACITOR ±10% DISC.	50V
C401	22-4905-01	.01 MFD CAPACITOR +80-20% DISC.	500V
C402	22-7613-04A	220 PFD CAPACITOR ±10% DISC.	50V
C403	22-7152-03	4.7 MFD CAPACITOR +100-10% ELEC.	25V
R101	63-9922	15K OHM RESISTOR 5% FILM	1/4W
R102	63-9921-66	560 OHM RESISTOR 5% FILM	1/4W
RX103	63-10559-24	10 OHM RESISTOR 5% FAILSAFE	1/4W
RX104	63-10559-24	10 OHM RESISTOR 5% FAILSAFE	1/4W
R105			
R106	63-9921-46	82 OHM RESISTOR 5% FILM	1/4W
RX107	63-10559-48	100 OHM RESISTOR 5% FAILSAFE	1/4W
R108	63-7838	18K OHM RESISTOR 10% CARBON COMP.	1/2W
R109	63-10811-04	CONTROL 100K BRIGHTNESS	
R110			
R111	63-9922	15K OHM RESISTOR 5% FILM	1/4W
R112			
R113	63-10824	RESISTOR H.V. BLEEDER 160 MEG.	
R114	63-10182-54	2.7 MEG OHM RESISTOR 5% CARBON	1/4W
R115			
R116	63-10670-04	CONTROL 6 MEG. FOCUS	
R117			
R118			
R119	63-10811-03	CONTROL 25K PHASE (ALT. 63-10651-11)	
R120			
R121	63-9921-68	680 OHM RESISTOR 5% CARBON COMP.	1/4W
R301	63-9921-92	6.8K OHM RESISTOR 5% FILM	1/4W
R302	63-10811-05	CONTROL 250K VERT SIZE. (ALT. 63-10651-13)	
R303	63-9922-06	27K OHM RESISTOR 5% FILM	1/4W
R304	63-9922-06	27K OHM RESISTOR 5% FILM	1/4W
R305			1/4W
R306	63-9921-72	1K OHM RESISTOR 5% FILM	1/4W
R307	63-9921-10	2.7 OHM RESISTOR 5% FILM	
R308	63-8803	22K OHM RESISTOR 5% FILM	1/4W
R309			
R310			
R311			
R312			
R313			
R314			1/4W
R315	63-9921-84	3.3K OHM RESISTOR 5% FILM	1/4W
R320	63-09921-88	4.7K OHM RESISTOR 5% FILM	

ITEM NUMBER	PART NUMBER	DESCRIPTION	
RX401	63-10559-32	22 OHM RESISTOR 5% FAILSAFE	1/4W
R402	63-7760	270 OHM RESISTOR 5% CARBON COMP.	1/2W
R403	63-7760	270 OHM RESISTOR 5% CARBON COMP.	1/2W
R404	63-7760	270 OHM RESISTOR 5% CARBON COMP.	1/2W
R405			
R406	63-9921-72	1K OHM RESISTOR 5% FILM	1/4W
R407	63-9921-72	1K OHM RESISTOR 5% FILM	1/4W
R408			
R409	63-9921-40	47 OHM RESISTOR 5% FILM	1/4W
R410			
R411	63-9921-32	22 OHM RESISTOR 5% FILM	1/4W
R412	63-9921-40	47 OHM RESISTOR 5% FILM	1/4W
CR101	103-142-01	DIODE	
CR102			
CR103			
CR104	103-298-03A	DIODE	
CR105			
CR106	103-254-01	DIODE	
CR107	103-323-03A	DIODE	
CR108	103-323-03A	DIODE	
CR112	103-316-02A	DIODE	
CR301	103-336-21A	DIODE ZENER 12V	
L101	20-3943-02	COIL RCF TUNABLE WIDTH	
L102	20-3906	COIL RCF LINEARITY	
L401	20-3887-10C	COIL RCF 6.8 μh	
TX101	95-3136	TRANSFORMER HORIZ. DRIVER	
TX201	95-3479	TRANSFORMER H.V. SWEEP	
TX202	95-3397-02	TRANSFORMER DEFLECTION YOKE	
Q101	121-1070	TRANSISTOR HORIZ. OUTPUT	
Q401	121-1058	TRANSISTOR VIDEO OUTPUT	
Q402	121-895	TRANSISTOR VIDEO DRIVER	
S101	223-15-04	INT. CKT. THICK FILM SUBSTRATE HORIZ.	
S301	223-14	INT. CKT. THICK FILM SUBSTRATE VERT.	
VX201	100-708	12" CRT	

Section 4

POWER SUPPLY MODULE

This module may be one of two types: (1) a series pass supply, or (2) a switching supply.

A. Theory of Operation - Series Pass Type

The power supply is designed for full-wave, center-tapped operation with series pass regulation. One center-tapped winding is used to develop the +5 V supply. A 5 V, 3-terminal regulator is used to develop a 3 A regulated output capability. The regulator is virtually blowout proof and has internal current limiting, power limiting and thermal shutdown. A second center-tapped winding is used to develop the ± 12 V supplies. The -5 V supply is derived from the -12 V supply. These supplies are also implemented using three terminal regulators. These regulators have a 1 A output capability with internal current limiting, power limiting and thermal shutdown.

The power supply is designed for convection cooling. The three terminal regulators are attached to the aluminum rear panel for thermal conduction; the rear panel is black-anodized to maximize radiation. Thermally conductive pads are installed between the regulators and the rear panel. If a regulator is replaced, the pads must also be replaced or a thermally conductive grease applied.

B. Theory of Operation - Switching Type

The OL25 is a 25 watt supply providing ± 12 V and ± 5 V. It is a fly-back switcher whose feedback loop is closed with respect to a primary reference winding on the power transformer. Multiple output voltages are provided through the use of multiple secondary windings, producing outputs that are related by winding count and are, therefore, not independently adjustable. However, all outputs are simultaneously adjusted when the +5 V potentiometer is adjusted. Short circuit and overvoltage protection are provided on all outputs.

C. PARTS LIST

Title: ASSY-POWER SUPPLY, 1061 #D53615 Rev: D

ITEM	DESCRIPTION	PART NO.	INVENTORY	1	2	3	4
1	Assy-Power Supply, 1061		3B2159	X			
2	Trimpot - 500 Ohm	91X	6B0311	X			
3	IC-LIN, Voltage Regulator 5V	LM323K-5	33B0363	X			
4	IC-LIN, Voltage Regulator 12V	7812CK	33B0364	X			
5	IC-LIN, Voltage Regulator -12V	7912UC	33B0365	X			
6	IC-LIN, Voltage Regulator -5V	79M05UC	33B0256	X			
7	Diode	IN5624	32B0271				X
8	Diode	IN4003	32C0133		X		
9	Capacitor-10,000 MFD/15V, Ele.	TVA1175.8	15B0306	X			
10	Capacitor-2500 MFD/25V, Ele.	TVA1213.5	15B0307		X		
11	Capacitor-10 MFD/63V, Ele.	VTT10D63	15B0196				X
12	Capacitor-.1 MFD/50V, Disc.	DG015E104Z	15B0304			X	
13	Fuse - 1 Amp, 125V, Slo-Blo	313001	17B0183	X			
14	Transformer	023-2851	7B0240	X			

ORDERING INFORMATION

1) For ordering information and latest prices, contact your local representative or the RESEARCH Incorporated factory in Minneapolis, Minnesota.

2) When ordering spare parts, please include reference both to this parts list number and revision level, and the model number and serial number of the instrument for which these parts are being ordered.

D. Boschert OL25

Maintenance Manual
Schematics

SINGLE STAGE

(FLYBACK-DISCONTINUOUS)

POWER SUPPLY

MAINTENANCE MANUAL

SINGLE STAGE (FLYBACK-DISCONTINUOUS) POWER SUPPLY

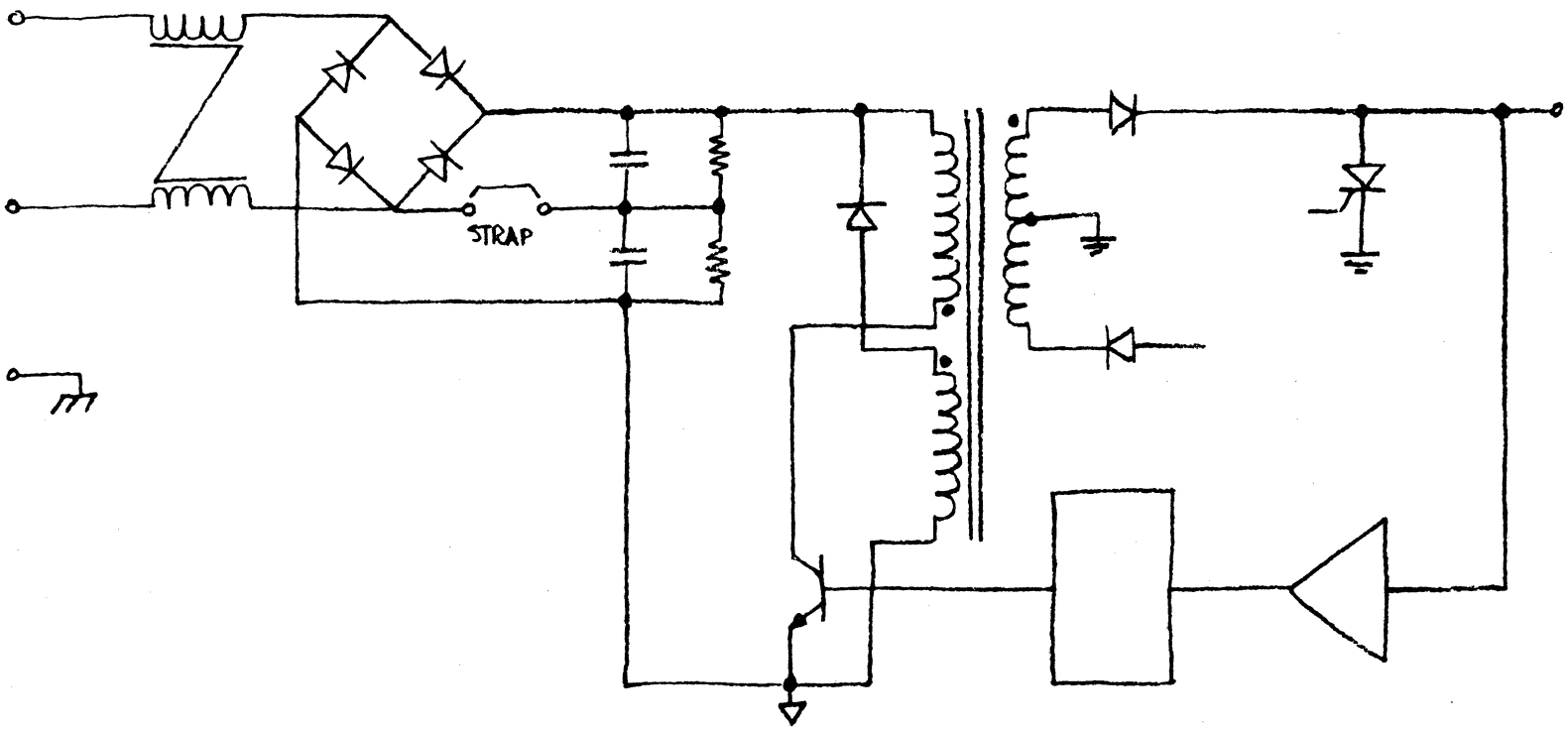
TABLE OF CONTENTS

NOTE: The descriptions and component designations in this manual refer to the OL25-1001. However, all flyback-discontinuous supplies have analogous circuits which operate in a manner similar to the OL25-1001.

FIGURE 1

SINGLE STAGE (FLYBACK - DISCONTINUOUS) POWER SUPPLY

SIMPLIFIED SCHEMATIC



SINGLE STAGE (FLYBACK-DISCONTINUOUS) POWER SUPPLY

GENERAL THEORY OF OPERATION

The flyback converter-discontinuous mode derives its name from the fact that during each cycle a point is reached where current ceases to flow in either the primary or secondary windings. Thus, the flux in the transformer virtually "ceases" at some point in the cycle.

The converter design is extremely simple. This class of converter operates as a blocking oscillator under the following control law: The output is linearly proportional to the current flowing in the power switch when it turns off, i.e., the output voltage is proportional to the amount of energy loaded into the core in the form of a magnetic field. The greater the field, the higher the output voltage.

The feedback loop regulates output voltages by adjusting the turn-off point of the power switch. Switching frequency is around 25 kHz at full power, and operating frequency is inversely proportional to the output power. The duty cycle remains relatively constant for a constant line voltage.

SINGLE STAGE (FLYBACK-DISCONTINUOUS) POWER SUPPLY

DETAILED THEORY OF OPERATION

Input Circuit

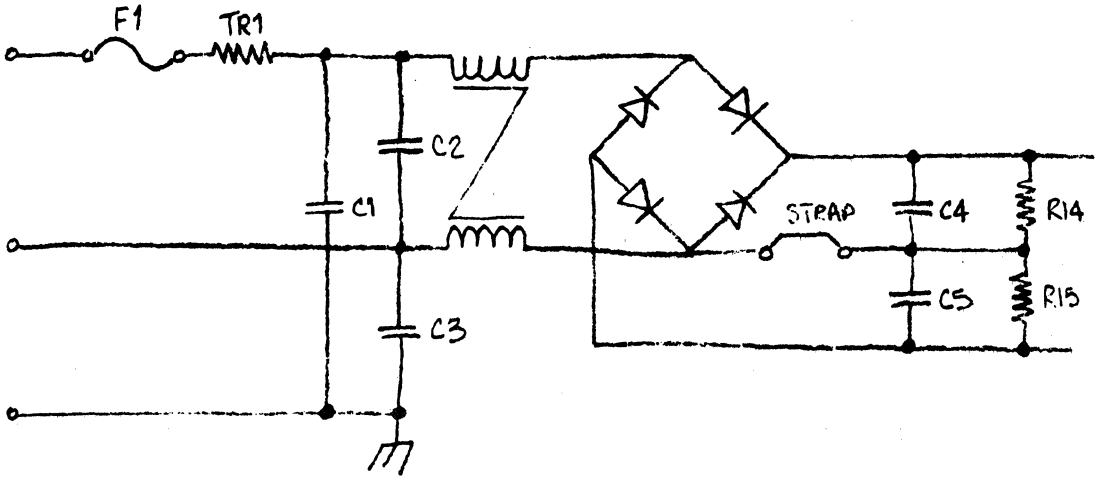


Figure 2
INPUT CIRCUIT

a. RFI Filter. Consists of L1, C1, C2 and C3. The purpose of this circuit is to filter out 20 kHz and above switching noise, preventing it from being transmitted back out the input line.

b. Fuse. F1 is included to protect the PC board traces and to reduce fire and personal hazard in the event of catastrophic supply failure. Boschert strongly recommends the use of an additional external line fuse for further protection. A Littlefuse 3AG series or equivalent rated at 1-1/2 A is sufficient.

c. Voltage Doubler Circuit is a method of allowing the supply to operate from either a 115 VAC or 220 VAC source. In the 115 VAC mode (strap in) capacitors C4 and C5 charge on alternate line half cycles. The voltage which appears across each capacitor is approximately the peak input voltage (about 150 V). The total voltage to the switching regulator is about 300 V.

In the 220 VAC mode (strap out) the input rectifiers act as a full wave bridge rectifier, charging C4 and C5 to approximately the peak input voltage (about 300 V). Resistors R14 and R15 force C4 and C5 to charge equally, and discharge the capacitors when the power is turned off.

d. Inrush Limiting is accomplished with thermistor R1. When cool, its resistance is high. When the supply is initially turned on, it prevents a huge surge current from flowing into C4 and C5, which are initially discharged. In operation, the normal input current quickly heats R1 decreasing its resistance by a factor of about 10. Since C4 and C5 are fully charged by this time, there is no further need for surge limiting. When the supply is turned off, R1 cools and C4 and C5 discharge. The circuit is designed so that the discharge time constant and cooling time constant are roughly equal. Thus, if the supply is turned back on before R1 has fully cooled, the inrush current is limited by a combination of the charge remaining on C4 and C5, and the resistance of R1.

e. Energy Storage in capacitors C4 and C5 insure that the supply will continue to operate within regulation limits for a minimum of 16 mS after the input line has fallen below limits or failed. This allows time for information in a volatile memory to be stored permanently before system failure following line interruption or line brownout.

Power Switch Circuit

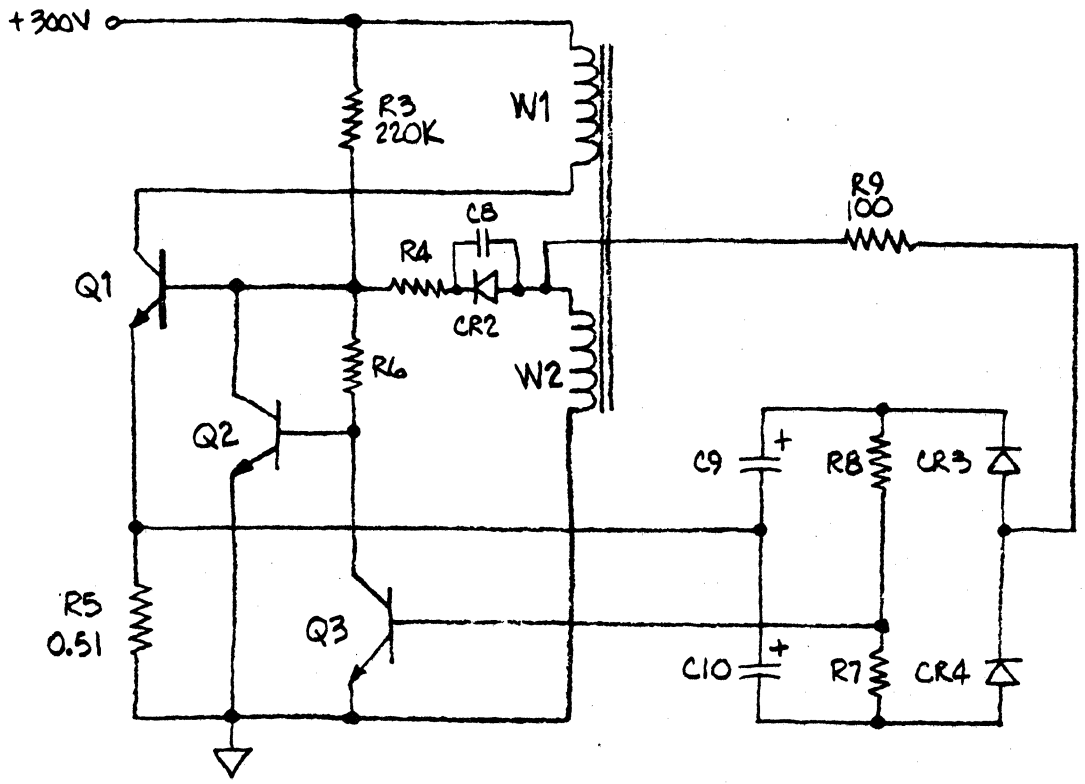


Figure 3
POWER SWITCH CIRCUIT

In the first half of the power cycle, switch Q1 will turn on and load energy into the transformer in the form of a magnetic field. Switch Q1 will then turn off.

The second half of the power cycle is described in the Output Circuit description.

When power (+300) is applied, a small trickle current through R3 begins to bias Q1 on. As the full supply voltage +Vcc begins to appear across winding one (W1), transformer action induces about 6 V across winding two (W2). CR2 is forward biased, and regenerative feedback current from W2 quickly forces Q1 into saturation.

Now the current in W1 begins to ramp up linearly. A voltage ramp also appears across R5 due to the current ramp.

Meanwhile, W2 is also charging C9 to about +6 V via R9 and CR3. When this voltage rises high enough, Q3 is biased on. This also turns on current buffer Q2. Q1 begins to turn off because Q2 and Q3 are conducting base drive away from Q1. The current ramp in W1 stops rising because Q1 is beta limited and is coming out of saturation. The rate of current change (di/dt) has become negative, therefore the voltage polarity on the windings must change. W2 has now reversed voltage (the dotted end is now positive) and it helps turn off Q1 by completely backbiasing the base emitter junction via R5, R4 and C8. When Q1 is off, and the voltage across all transformer windings has reversed, C10 is charged via CR4 and R9.

(The second half of the cycle is continued in the Output Circuit Section.)

Output Circuit

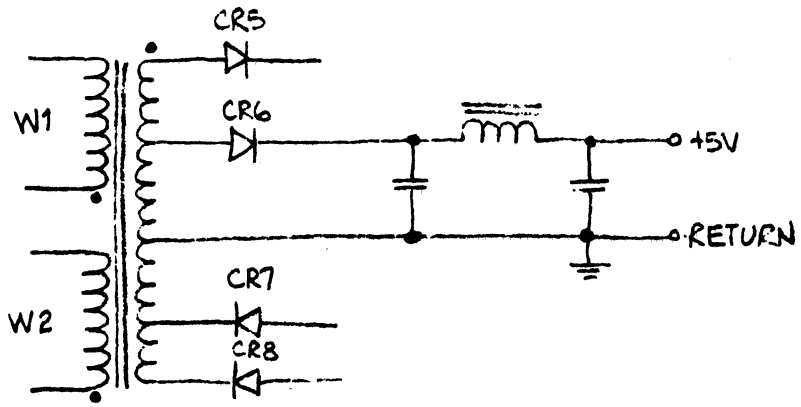


Figure 4
OUTPUT CIRCUIT

This section describes the second half of the power cycle. The first half was described in the Power Switch Circuit description.

In the first half of the power cycle, switch Q1 turned on and loaded energy into the transformer in the form of a magnetic field. Q1 then turned off, and the collapsing magnetic field is now driving positive the dotted ends of all transformer windings, looking for a discharge path.

As the voltage rises on the dotted ends of all the windings, it will eventually forward bias diodes CR5 through CR8. The magnetic field in the transformer rapidly collapses by discharging energy into the outputs. The C-L-C PI filters in the output store and filter this energy.

When the magnetic field has sufficiently collapsed, diodes CR5 through CR8 stop conducting. There is enough energy left in the core to allow it to "ring back." That is, the current in the secondary suddenly reduces its rate of discharge when the diodes stop conducting. di/dt changes, and the dotted end of all windings becomes negative. Q1 begins to conduct again. This is the start of the next cycle.

Modulator Circuit

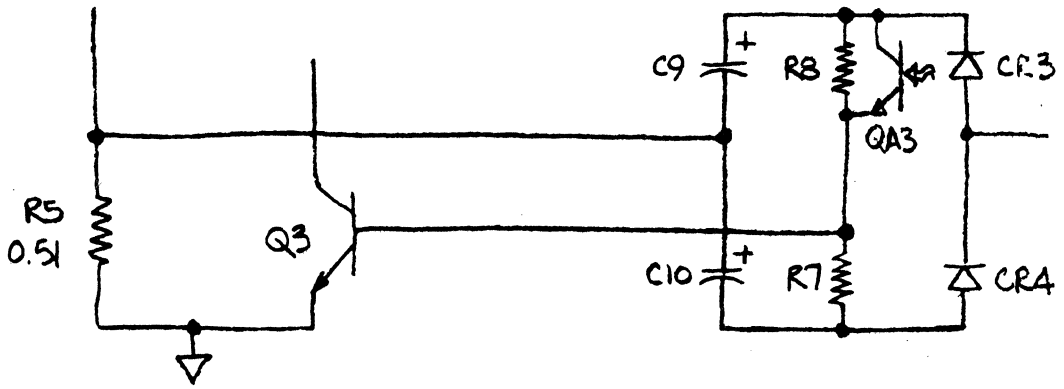


Figure 5
MODULATOR CIRCUIT

The modulator varies the point at which Q1 turns off thereby regulating the output voltages.

In the absence of any feedback loop, Q1 would continue loading energy into the core until a fixed point was reached. This fixed amount of energy would be subsequently discharged into the load. If the load changed, the output voltage would change because Q1 was still loading a fixed amount of energy into the transformer. To compensate for load changes, the feedback loop varies the point at which Q1 turns off, thereby varying the amount of energy loaded in the core. The greater the load, the more energy is loaded into the core. This accomplishes regulation.

During normal operation, C9 and C10 are each charged to about 6 V, or about 12 V total. Since the junction of C9 and C10 is referenced essentially to ground via R5, the base-emitter junction of Q3 must be back

biased due to the base voltage determined by dividers R8 and R9. When Q1 turns on, the voltage across R5 ramps up. This makes the entire modulator circuit voltage rise relative to ground. Eventually a point is reached where Q3 is biased on, which turns off Q1, terminating the first half of the cycle.

The point at which Q3 turns on can be varied by changing the ratio of R8 to R9. The opto-isolator transistor, Q A3, acts as a variable resistor to change this ratio. If the +5 V output tended to fall due to an increase in load, for example, the opto-isolator transistor would turn off, making the base voltage on Q3 more negative. It would take longer for the voltage ramp on R5 to reach a point where Q3 was biased on. More energy would be loaded into the transformer, which would be discharged into the load, raising the output voltage.

Main Feedback Loop

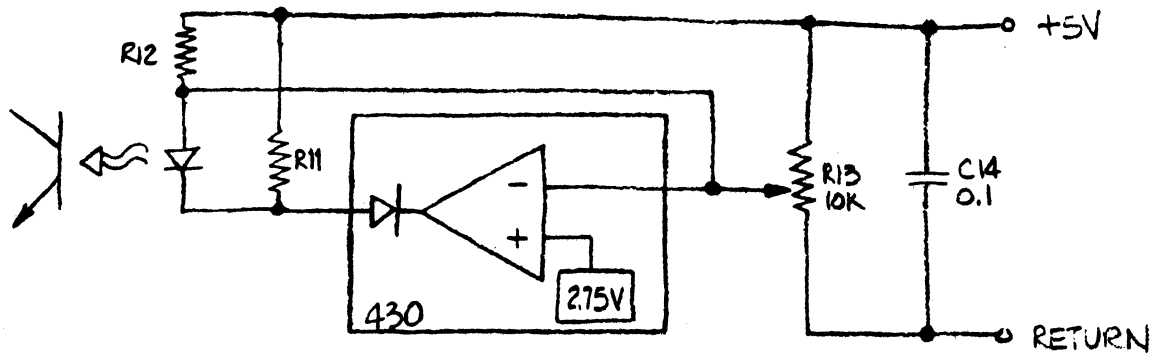


Figure 6
MAIN FEEDBACK LOOP

This circuit maintains the +5 V output at a constant voltage. The loop compares a voltage divided down from the +5 V output via R13 to a 2.75 V reference within the 430 integrated circuit. A proportional current is sunk by the 430, driving the opto-isolator diode via R12. R11 provides bias current for the 430. C13 frequency compensates the loop.

The auxiliary (other than +5V) outputs are "semi-regulated." That is, because of the tight magnetic coupling of all the outputs, an increased load on an auxiliary output lowers the volts per turn of the transformer, which is reflected in the +5V output (which begins to go down). The feedback loop works to restore the +5V output, and in so doing partially compensates for the load change on the auxiliary output. Boschert calls this "semi-regulation."

Overvoltage Protection

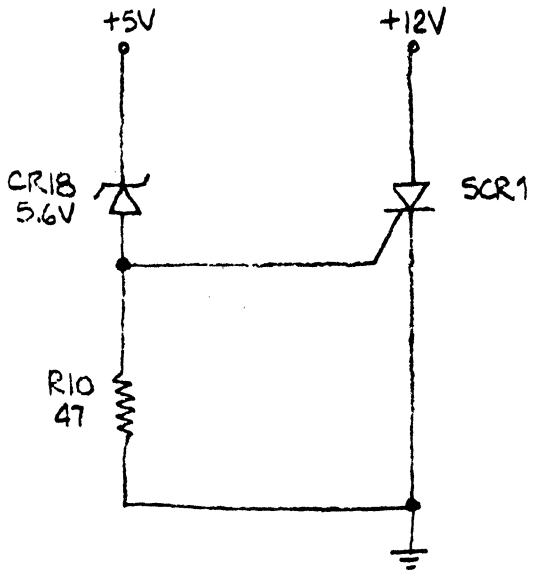


Figure 7
OVP CIRCUIT

The purpose of overvoltage protection is to protect the user's load from an overvoltage condition caused by supply failure. All standard Boschert supplies incorporate this feature. Also, Boschert supplies require OVP on only one output. If all outputs have simple passive filtering, and if one output should rise due to supply failure, they all would rise. Thus, protection is needed on only one output.

If the +5 V output exceeds 6.25 V ±0.75 V, the SCR pulls the +12 V supply down (to about 1.5 V) and activates the short circuit protection. The +12 V supply is used to insure clean foldback. Pulling the +5 V down to 1.5 V might not exceed the foldback point, and might simply deliver a lot of power to the SCR, destroying it.

This circuit can be cleared by cycling line power.

Spike Catcher Circuit

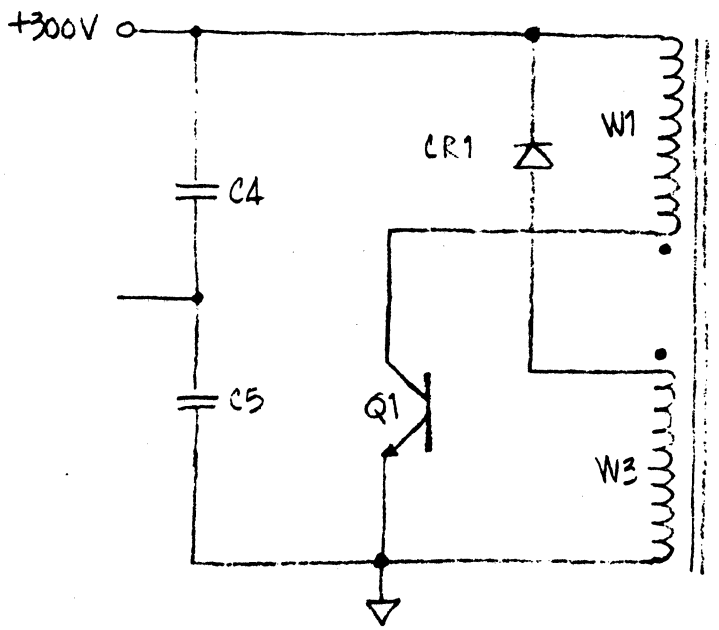


Figure 8
SPIKE CATCHER CIRCUIT

The purpose of the spike catcher circuit is to prevent high voltage turn off transients on the collector of Q1 from destroying it.

C4 and C5 are the input capacitors, charged to about 300 V. When Q1 has finished loading energy into the transformer core and turns off, W1 begins to look like a current source. Its dotted end becomes positive and the voltage rises. Although the discharge path is ultimately through the output, there is enough leakage inductance in W1 to allow the voltage to rise to a destructive value. However, as the dotted end of W1 reaches 300 V, so does the dotted end of W3. (They both have the same number of turns.) As the voltage tries to rise further, CR1 conducts and clamps the collector voltage to 600 V. This prevents the destruction of Q1.

SINGLE STAGE (FLYBACK-DISCONTINUOUS) POWER SUPPLY

TROUBLESHOOTING INSTRUCTIONS

EQUIPMENT NEEDED:

1 50 MHz oscilloscope with isolated ground

1 DVM or VTVM with isolated ground

1 Isolation transformer

1 1A Variac (0-130Vac)

2 Adjustable lab supplies, 0-20VDC @ 500mA, with adjustable current limit. A good supply of resistors and clip leads.

1 AC voltmeter (0-130Vac)

CAUTION: Lethal voltages are present in this supply. Only authorized service technicians should perform these tests. Use AC isolated equipment in all tests.

NOTE: It is desirable to use an AC isolation transformer in performing all tests to minimize shock hazard. The kVA rating of this transformer should be three times the maximum supply power to avoid AC line waveform distortion.

NOTE: Steps 1 thru 9 are intended as passive tests to be performed with the supply completely disconnected from line power. To prevent any oscillations, connect jumper wire from the anode of CR5 to the cathode of CR8.

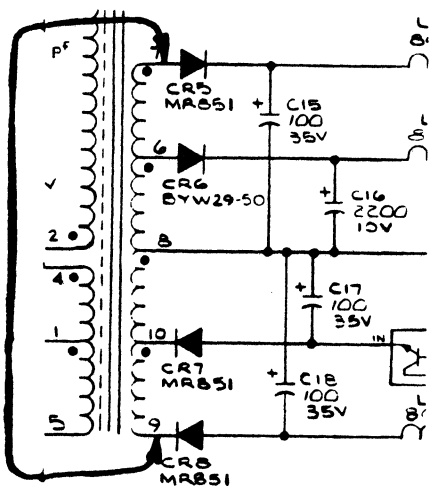


Figure 9

1. Use DVM to check the continuity of the input fuse (F1), thermistor (TR1) bridge rectifier (BR-1), diodes CR1 thru CR8 for proper continuity. Replace as necessary.

2. Connect a lab supply (15V with current limit at 500mA) across the AC input terminals. After an initial surge, no current should flow. Reverse the leads and repeat. If any current flows, check the input section for shorts.

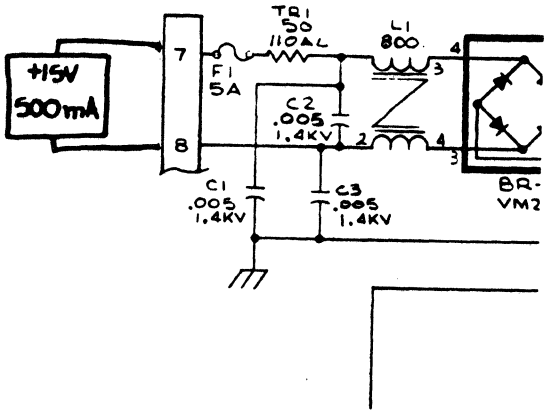


Figure 10

3. Check the operation of Q1. Set the lab supply for 15V with the current limit set for 500mA. Connect a 220 ohm resistor in series with the positive output and connect this to the 115V input terminals as shown. With the DVM across the collector-emitter terminals of Q1, momentarily parallel R3 (220K) with a 100 ohm 1/4W resistor. Is voltage drop across Q1 as follows?

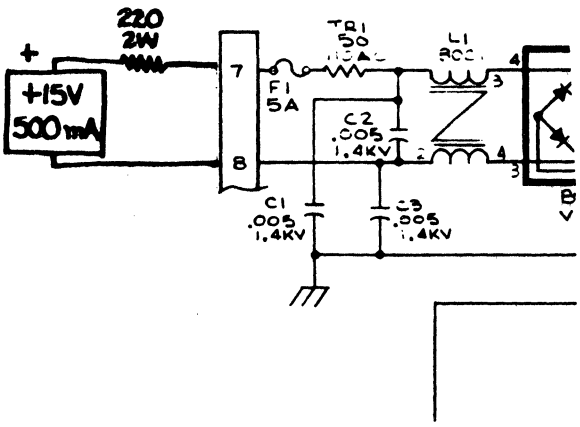


Figure 11

	Vce (Q1)
R3 not paralleled	13.5V ±1V
R3 paralleled	1.5V ±1V

Yes - Go to Step 4

No - Replace Q1 and repeat Step 3

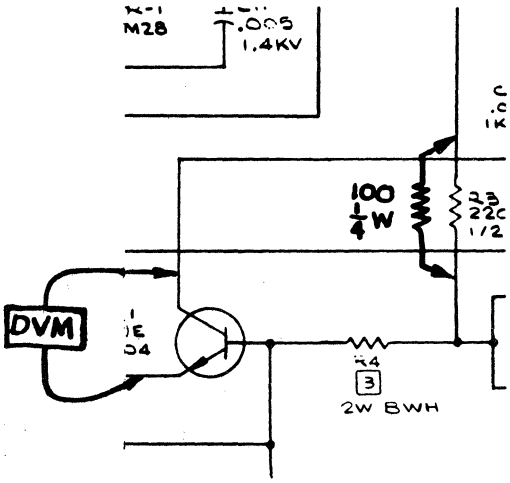


Figure 12

4. Check the operation of Q2 and Q3. Use a DVM or a lab supply with the output set at +5V, current limit at 10mA. Check the continuity of Q2 and Q3 for opens or shorts. Replace as necessary. Then go to Step 5.

5. Check overvoltage protection operation. Set both supplies to +5.0V with the current limit set to 100mA. Connect the first supply across the +5V output and return. Connect the second supply across the +12V output and return. (The +12V output should be the one which the anode of the SCR is connected to. If not, the supply should be connected to the output which is connected to the SCR anode. Now slowly ramp up the voltage on the first supply. At 6.25V ±0.75V on the first supply, does the second supply suddenly go into current limit?

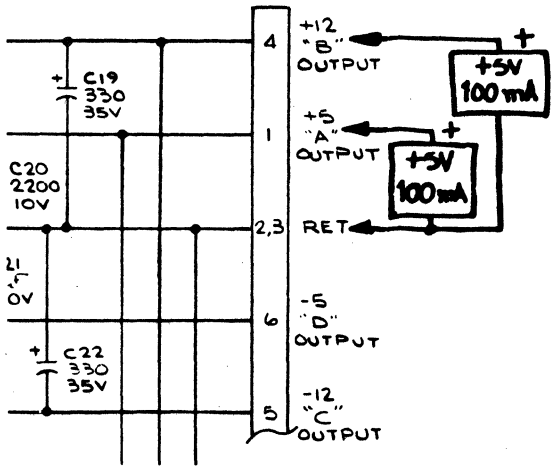


Figure 13

Yes - Go to Step 7
No - Go to Step 6

6. Check CR9. Set lab supply current limit to 100mA and the voltage to 0. Connect the positive terminal to the +5V output and the negative terminal to the return. Put a DVM across CR9. Turn the voltage slowly up to 10V, or to the point where the supply limits. Does the DVM voltage ramp up to 5.6V ± 0.25V and stop?

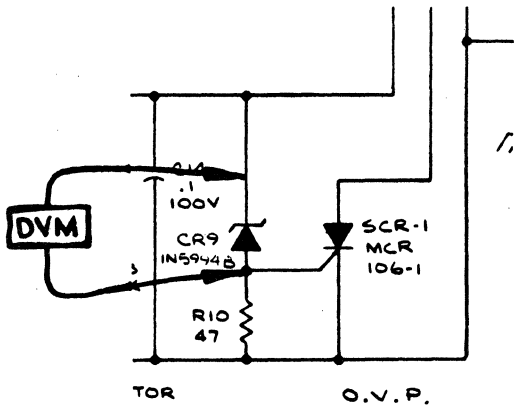


Figure 14

Yes - Replace CR4, and Repeat Step 5
No - Replace SCR-1 and Repeat Step 5

7. Check A2. Set lab supply to +5.0V (Ilim = 300 mA) across +5V output. Read voltage across R11 with DVM while adjusting pot R13. Are the voltages as follows?

   R13 fully clockwise 3.0V ± 0.5V
   R13 fully counterclockwise 0.2V ± 0.2V

   Yes - Go to Step 8
   No - Replace A2 and repeat Step 7

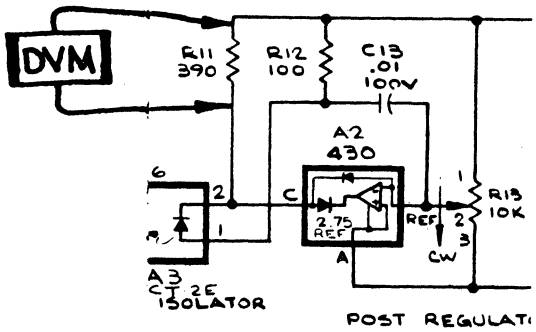


Figure 15

8. Check A3 and modulator. Hook up first supply (+5V, Ilim = 300mA) across the +5V output. Hook up second supply (+5V, Ilim = 300mA) across the modulator. Watch the voltage across R8 with the DVM while adjusting R13. Are the voltages as follows?

   R13 fully clockwise 3.0V ± 0.5V
   R13 fully counterclockwise 0.3V ± 0.2V

   Yes - Go to Step 9
   No - Replace A3, repeat Step 8

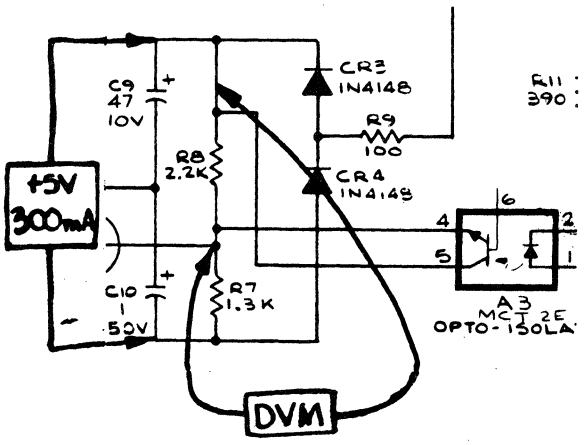


Figure 16

NOTE: This concludes all the passive tests. Disconnect all supplies, DVM, and jumper from CR5 to CR8 before proceeding.

9. Disconnect all connections made for the passive tests. Plug the supply into the Variac and turn the voltage up to 115Vac. Is the voltage across the input capacitor(s) within the following limits?

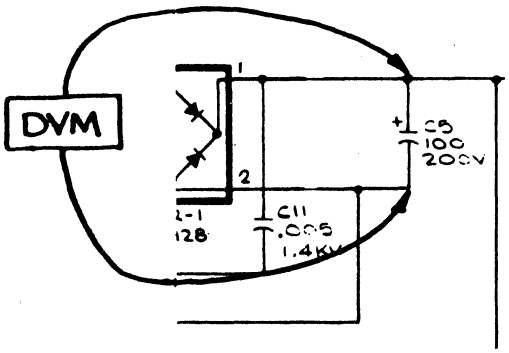


Figure 17

Supply designed for 115Vac only
150V ±10V

Supply designed for 220Vac only
300V ±20V

Supply 115/220 strappable
300V ±20V

Yes - Go to Step 10

No - Look for faulty component in input circuit. Repeat Step 9.

10. Use an oscilloscope to check the voltage waveform on the collector of Q1 with respect to emitter.

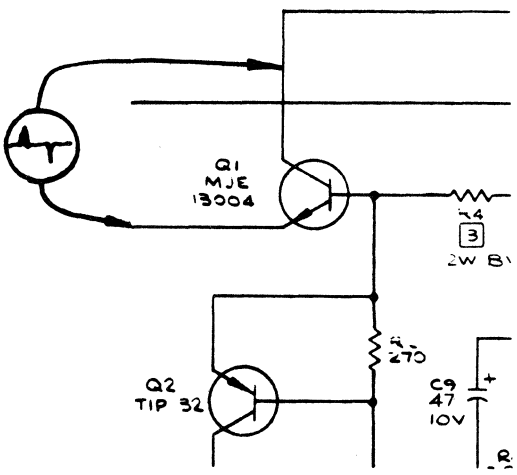


Figure 18

With proper waveform, notice that duty cycle is roughly 50%.

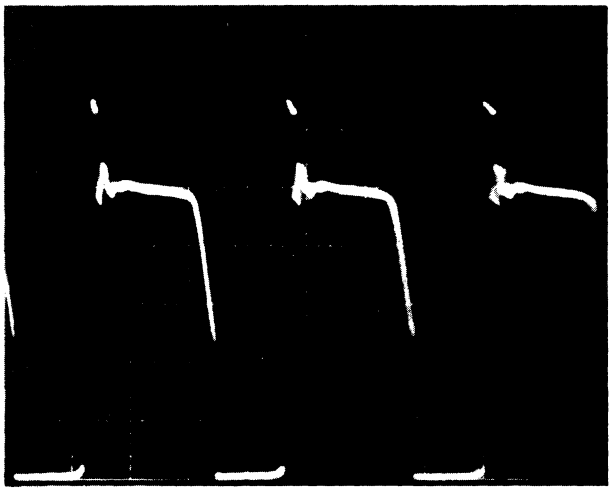


Figure 19
Proper Waveform
Horizontal - 5 μs/Div.
Vertical - 50V/Div.

With no output load, the supply "burps" every 120 ms or so. This is known as the burp mode. (The supply waits about 120ms, tries to turn on, the SCR fires because there is no +5V load to keep it from overshooting, and it folds back and waits 120ms again.)

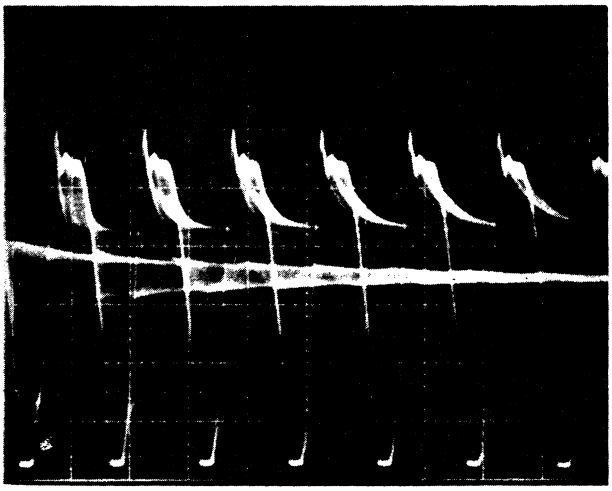


Figure 20
No load waveform
Horzontal - 5μs/Div.
Vertical - 50V/Div.

In an overload condition, all output voltages and currents are very low. Notice the very short duty cyle (about 12%) which typifies the overload condition. Under a heavy overload, the supply "burps" every 500ms or so.

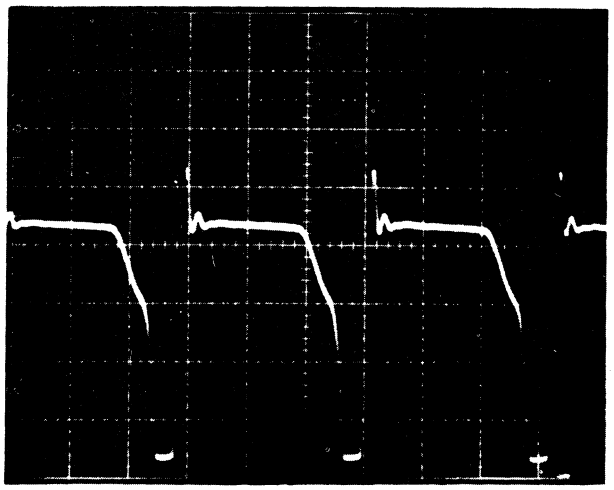


Figure 21
Overload Waveform
Horizontal 5μs/Div.
Vertical 50V/Div.

With an output short, the supply goes into its "burp" mode again. The period is about 160ms between "burps."

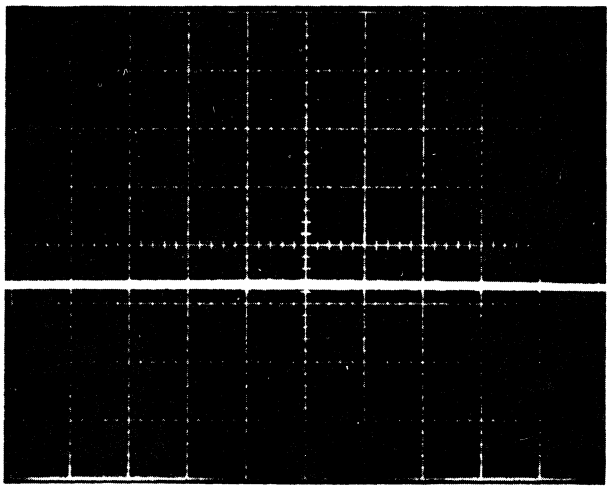


Figure 22
Output Short Waveform
Horizontal 5μs/Div.
Vertical 50V/Div.

11. Use the oscilloscope on each or any output to determine if any faults are occurring.

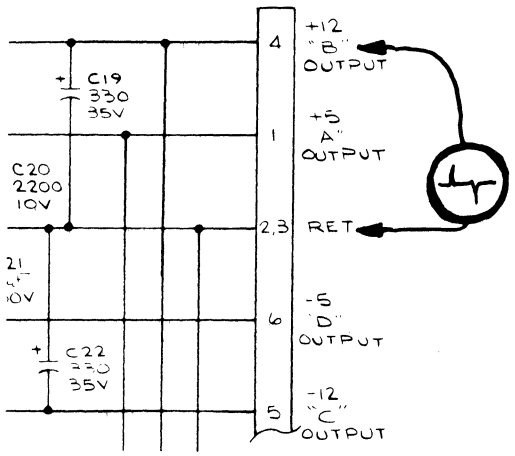


Figure 23

+12V Output Proper Waveform

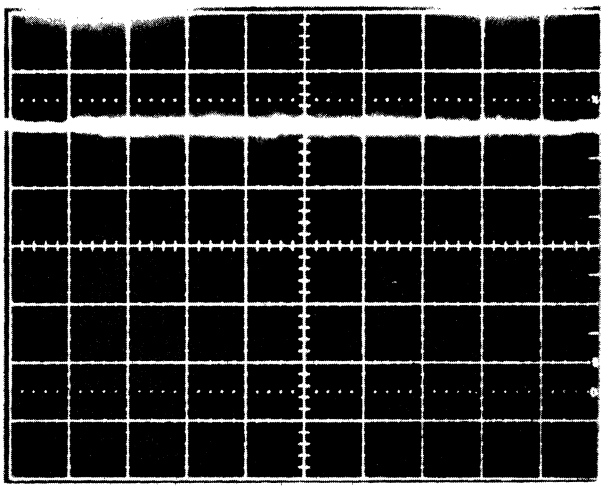


Figure 24
Proper Output Waveform
Horizontal - 50ms/Div.
Vertical - 2V/Div.

The sharp rise and fall time of an output is due to unloaded outputs. Generally only an SCR firing can cause such a rapid fall time on an output.

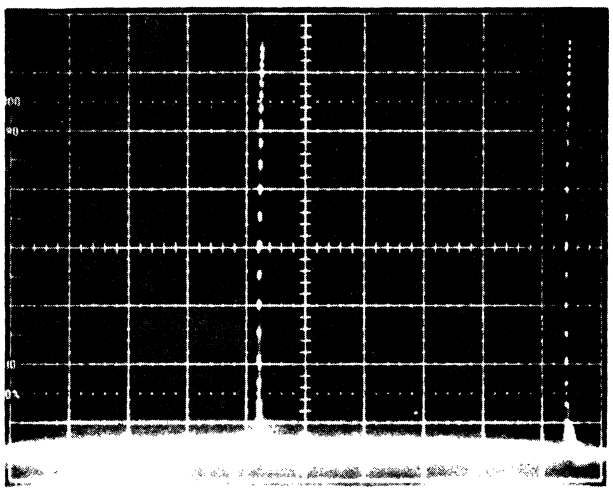


Figure 25
No Load on Outputs
Horizontal - 50ms/Div.
Vertical - 2V/Div.

The much longer fall time of an output indicates a short on some other output than the one measured.

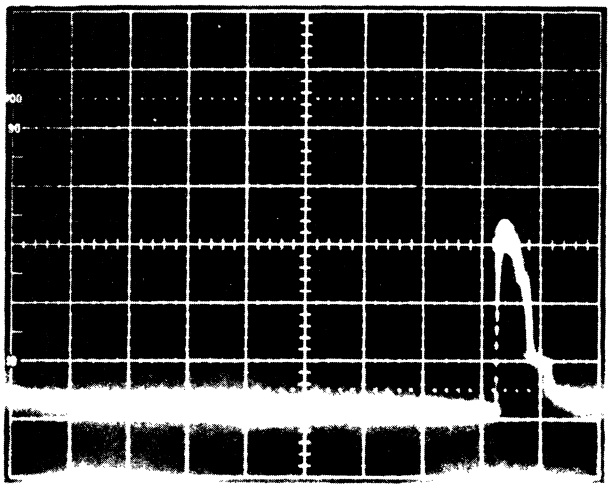


Figure 26
Short on some other output
Horizontal - 50ms/Div.
Vertical - 2V/Div.

No rise or fall indicates the short is on this output.

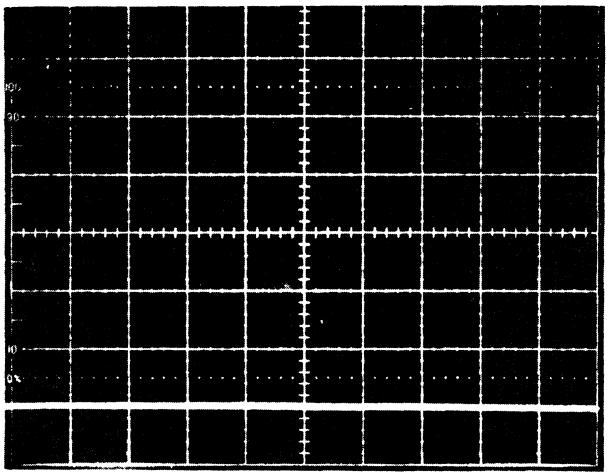


Figure 27
Short on this output
Horizontal - 50ms/Div.
Vertical - 2V/Div.

APPLICATION	
NEXT ASSY	USED ON
10006	

REVISION				
REV	ECO	DESCRIPTION	DATE	APPROVED
1	1986	PRE RELEASED FOR PROD		
A	2259	RELEASED FOR PROD.	9-13-78	
B	2385	CORRECTED CURRENT CALL-OUTS ADDED PARA. 3 ON PG. 3	12-18-78	
C	3335	CORRECTED NOTE 3C. SHT 3 OF 3.	11-2-79	RKS
D	4072	INCORPORATED	4-23-80	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
± — .XX ± — ± °
.XXX ± —

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN FRANK KRALOVETZ	7-13-78
CHECKED	7-17-78
W S Lee	9-19-78
	9-19-78
A Jackson	9-20-78

BOSCHERT

TEST SPECIFICATION

MODEL: 25-1001

SIZE	CODE IDENT NO.	DRAWING NO.	REV
A		91-20269	D

SCALE N/A | SHEET 1 OF 3

20269 REV

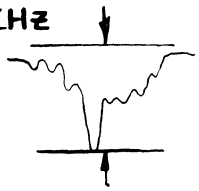
25-1001

	TEST MINIMUM	SPECIFICATION MAXIMUM
VISUAL INSPECTION		
TURN ON AND TURN OFF		
SWITCH WAVEFORM		
CURRENT MAX. LIMIT RANGE	SEE PAGE 3 FOR LIMITS	
CURRENT MIN. LIMIT RANGE		
INVERTER WAVE FORMS SAME		
INVERTER PERIOD RANGE		
INVERTER PEAK-PEAK VOLTAGE		

OUTPUT VOLTAGE-CURRENT TEST POINTS:

OUTPUT	VOLTAGE		CURRENT		MINIMUM		MAXIMUM		
1	+5	V	1.5	A	+4.98	V	+5.02	V	[SET VOLTAGE HERE]
2	+12	V	0.25	A	+11.45	V	+12.55	V	
3	-12	V	0.25	A	-11.45	V	-12.55	V	
4	-5	V	0.25	A	-4.75	V	-5.25	V	
5		V		A		V		V	
6		V		A		V		V	
1	+5	V	3	A	+4.96	V	+5.04	V	
2	+12	V	0.1	A	+10.40	V	+13.60	V	
3	-12	V	0.1	A	-10.40	V	-13.60	V	
4	-5	V	0.1	A	-4.75	V	-5.25	V	
5		V		A		V		V	
6		V		A		V		V	
1	+5	V	0.6	A	+4.96	V	+5.04	V	
2	+12	V	.5	A	+10.40	V	+13.60	V	
3	-12	V	.5	A	-10.40	V	-13.60	V	
4	-5	V	.5	A	-4.75	V	-5.25	V	
5		V		A		V		V	
6		V		A		V		V	
1	+5	V	3	A	+4.96	V	+5.04	V	
2	+12	V	.4	A	+10.40	V	+13.60	V	
3	-12	V	.4	A	-10.40	V	-13.60	V	
4	-5	V	.1	A	-4.75	V	-5.25	V	

120 Hz & 20 KHz



MAX. RIPPLE & NOISE:

95	MV P-P		MV
228	MV P-P		MV
228	MV P-P		MV
95	MV P-P		MV

	MINIMUM	MAXIMUM
OVP 5994B (IN752)	5.7	6.8
5993B (IN751)		

SNAP-ON

AUDIBLE NOISE

FACTORY SELECT PROCEDURE FOR R4, SEE PAGE 3.

BURN IN NO. 001

TEST CABLE NO. 050

- [X] 110 VAC
- [ ] 220 VAC
- [ ] STRAPABLE

SIZE	CODE IDENT NO.	DRAWING NO	RE
A		91-20269	D
SCALE N/A		SHEET 2 OF 3	

J Ham 9-19-78

FACTORY SELECT PROCEDURE FOR R4

1. a. SET LOAD AT: 3A, +5V
   .5A, +12V
   .5A, -12V
   .5A, -5V
   b. SET LINE VOLTAGE AT 90VAC
   c. SELECT R4 FOR +5V OUTPUT TO BE 4.95V ≤ +5V OUTPUT ≤ 5.05V

2. a. SET LINE VOLTAGE TO 110VAC
   b. SET ALL LOADS TO 0 AMP
   c. LOAD 5V SLOWLY. 5V OUTPUT VOLTAGE MUST REGULATE TO 5V ± 0.050V AT +5V OUTPUT CURRENT OF ≤ 0.8 AMP.

CURRENT MAX LIMIT TEST

a. SET LINE VOLTAGE TO 110 V AC

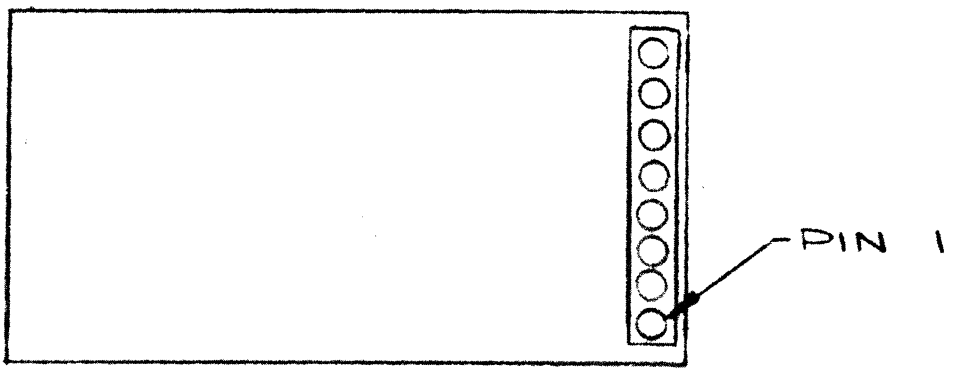
b. SET LOAD TO: +5V 3A
   ±12V 0.5A
   -5V 0.5A

c. INCREASE OUTPUT CURRENT OF +5V AND NOTE MAXIMUM CURRENT.
   MAXIMUM CURRENT, I_{MAX}, MUST BE: $6.5A \leq I_{MAX} \leq 8.0A$. IF CURRENT LIMIT IS NOT IN SPEC, CHANGE R14 TO ANOTHER VALUE BETWEEN 470 AND 10K (NOMINAL VALUE INSTALLED IS 1.2K). LOWER THE RESISTOR VALUE TO BRING THE CURRENT LIMIT DOWN OR RAISE THE VALUE TO INCREASE THE CURRENT LIMIT.

SIZE	CODE IDENT NO.	DRAWING NO.	REV
A		91-20269	D
SCALE N/A		SHEET 3 OF 3	

APPLICATION		REVISION				
NEXT ASSY	USED ON	LTR		DESCRIPTION	DATE	APPROVED
		1	1986	PRE-RELEASED FOR PROD		
		A	2259	RELEASED FOR PROD.	9-13-78	

PIN #	FUNCTION
1	+5V
2	RETURN
3	RETURN
4	+12V
5	-12V
6	-5
7	AC IN
8	AC IN



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± — DECIMALS .XX ± — .XXX ± — ANGLES ± —

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN FRANK KRALOVETZ	7-13-78
CHECKED Miyasaki	7-17-78
WSL	
[illegible] GB	9/19/78
A Jackson	9/29/78

BOSCHERT

PINOUT CHART
25-1001

SIZE	CODE IDENT NO.	DRAWING NO.	REV
A		20267	A

SCALE N/A SHEET 1 OF 1

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-7825

20267 RKS

REVISIONS

ECO	LTR	DESCRIPTION	DATE	APPROVED
1986	4	PRE-RELEASED FOR PRODUCTION	5-2-78	
2259	A	RELEASED FOR PRODUCTION	9-13-78	
2369	B	ITEM 28 WAS P/N 2061 (NO DESCRIPTION CHG.); ITEM 45 WAS P/N 1140 (NO DESCRIPTION CHG); ADDED P/N 3810 TO ITEM 86 22Ω 2W BWH SAT R4.	12-13-78	
2413	C	ASSY CHG ONLY	12-13-78	
2623	D	ITEM 76 WAS 1.3K (NOT F.S) ADDED R7 REF TO NOTE 8. ADDITIONAL CHGS NOT PER ECO AS FOLLOWS: DELETED NOTE [8] REF AT ITEM 86 & NOTE [4] REF AT ITEMS 107 & 108	3-27-79	
2799	E	ITEM 76 WAS 1.3K; DELETED ITEM 8 P/N 7641, 45 P/N 10-10056-01, 59 P/N 1081; 61 P/N 1142; ADDED ITEMS 4,5,6.	9-25-79	
3335	F	CHG'D NOTE [8], ITEM 76 WAS P/N 3075, ITEM 81 WAS P/N 3080; ADDED ITEM 77 TVA Pending	5-1-79 11-2-79	2546 RKS
3915	H	INCORPORATED	3-5-80	
4440	J	CHANGED PER ECO	7-1-[illegible]	

SEE SEPARATE ASSY, DWG NO. 40006 "C" SIZE

FINAL	25-1001
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
± — .XX ± — ± —
.XXX ± —

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN FRANK KRALOVETZ	4-5 78
CHECKED	5-2-78
W S Lee	9-19-78
[illegible]	9/14/78
G. Jackson	9/20/78

boschert

ASSEMBLY, POWER SUPPLY 25WATT 115V

SIZE	CODE IDENT NO.	DRAWING NO.	REV
A		45-40006	J

SCALE N/A | SHEET 1 OF 6

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

NOTES:

8. FACTORY SELECT R4 & R14.
7. FOR QA SPEC SEE DWG NO. 20270
6. FOR PINOUT CHART SEE DWG NO 20267
5. FOR OUTLINE INSTALLATION SEE DWG NO. 20168
4.
3. FOR TEST SPEC SEE DWG NO. 20269
2.
1. FOR SCHEMATIC SEE 20139

NEXT ASSY	USED ON	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .XX ± ± .XXX ±	CONTRACT NO.		
			APPROVALS	DATE	
			DRAWN		
		MATERIAL	CHECKED		
		FINISH			
APPLICATION		DO NOT SCALE DRAWING			

Beckett

ASSEMBLY, POWER SUPPLY
25W, 115V

SIZE	CODE IDENT NO.	DRAWING NO.	REV
A		45-40006	J

SCALE N/A | SHEET 2 OF 6

ITEM	PART NO.	QTY	DESCRIPTION	REF DES
1	51-9148	1	BOARD, P.C.	
2				
3				
4	43-10568	1	SUB ASSY, HEATSINK, RECTIFIER, BYW 29-50	CR6 REF
5	43-10570	1	SUB ASSY, HEATSINK, TRANSISTOR, MJE-13004	Q1 REF
6	43-10575	1	SUB ASSY, HEATSINK, VOLT REG. I.C., MC7905CT	A4 REF
7				
8				
9				
10				
11	80-8001	1	INDUCTOR,	L1
12	80-8135	1	INDUCTOR,	L2
13	80-8077	2	INDUCTOR,	L3,5
14				
15				
16	80-8190	1	TRANSFORMER, 25W	T1
17				
18				
19	22-2060	1	CAP, CERM, 470 pF, ±20%, 1000V	C7
20	22-2002	4	" " .005μf, ±20%, 1.4KV	C1,2,3,11
21	22-2005	2	" " .01 μf, ±20%, 1000V	C6,12
22	22-2008	2	" " .1 μf, ±20%, 100V	C8,14
23				
24				
25				
26				
27	22-2059	1	CAP, CERM, .01μf, ±20%, 100V	C13

TITLE: POWER SUPPLY 115V 25WATT	beschert	DRAWING NO. 45-40006	REV J
		SIZE A / SCALE N/A	SHEET 3 OF 6

ITEM	PART NO.	QTY	DESCRIPTION	REF DES
28	20-2089	1	CAP, ELECT, 100μf, +75%-10%, 200V	C5
29	20-2083	2	" " 330μf, +75%-10%, 35V	C19,22
30	20-2106	1	" " 47μf, +75%-10%, 10V	C9
31				
32	20-2119	3	" " 100 uf +50% -10%, 35V	C15,17,18
33	20-2047	2	" ELECT, 2200μf, +50%-10%, 10V	C16,20
34				
35				
36	21-2076	2	CAP, TANT, 1μf, ±10%, 50V	C10,21
37				
38				
39	10-1038	2	DIODE, GEN PUR, IN4004	CR1,2
40				
41				
42	10-1013	2	" GEN PUR, IN4148	CR 3,4
43				
44				
45				
46				
47				
48	10-1088	3	" FAST RECV, MR851	CR5,7,8
49				
50				
51	11-1014	1	DIODE, ZENER, IN5994B	CR9
52				
53	1141	1	BRIDGE, VM28	BR1
54				

TITLE		DRAWING NO.	REV
POWER SUPPLY 115V, 25 WATT	beschert	45-40006	J
		SIZE A / SCALE N/A / SHEET 4 OF 6	

ITEM	PART NO.	QTY	DESCRIPTION	DES
55	16-1132	1	SCR, MCR106-1	SCR-1
56				
57	15-1001	1	I.C, OPTO-ISOLATOR, MCT-2E	A3
58	14-1071	1	I.C, VOLTAGE REG, 430	A2
59				
60				
61				
62	13-1055	1	TRANS, NPN, AMPL, MPS-2222	Q3
63	12-1146	1	TRANS, PNP, TIP32	Q2
64				
65				
66	83-7011	1	FUSE, SUB-MINI, 5A	F1
67				
68				
69	30-3024	1	RES, C.F., 10, ±5% 1/4W	R1
70	3040	1	47	R10
71	3048	2	100	R9, 12
72				
73	3058	1	270	R6
74	3062	1	RES, C.F., 390, ±5%, 1/4 W	R11
75				
76	3074	1	RES, C.F. 1.2K, ± 5%, 1/4 W,	R7
77	3074	1	RES. C.F. SAT. (1.2K NOM) ±5% 1/4W	R14 [8]
78				
79				
80				
81	30-3082	1	RES, C.F., 2.7K, ±5%, 1/4W	R8

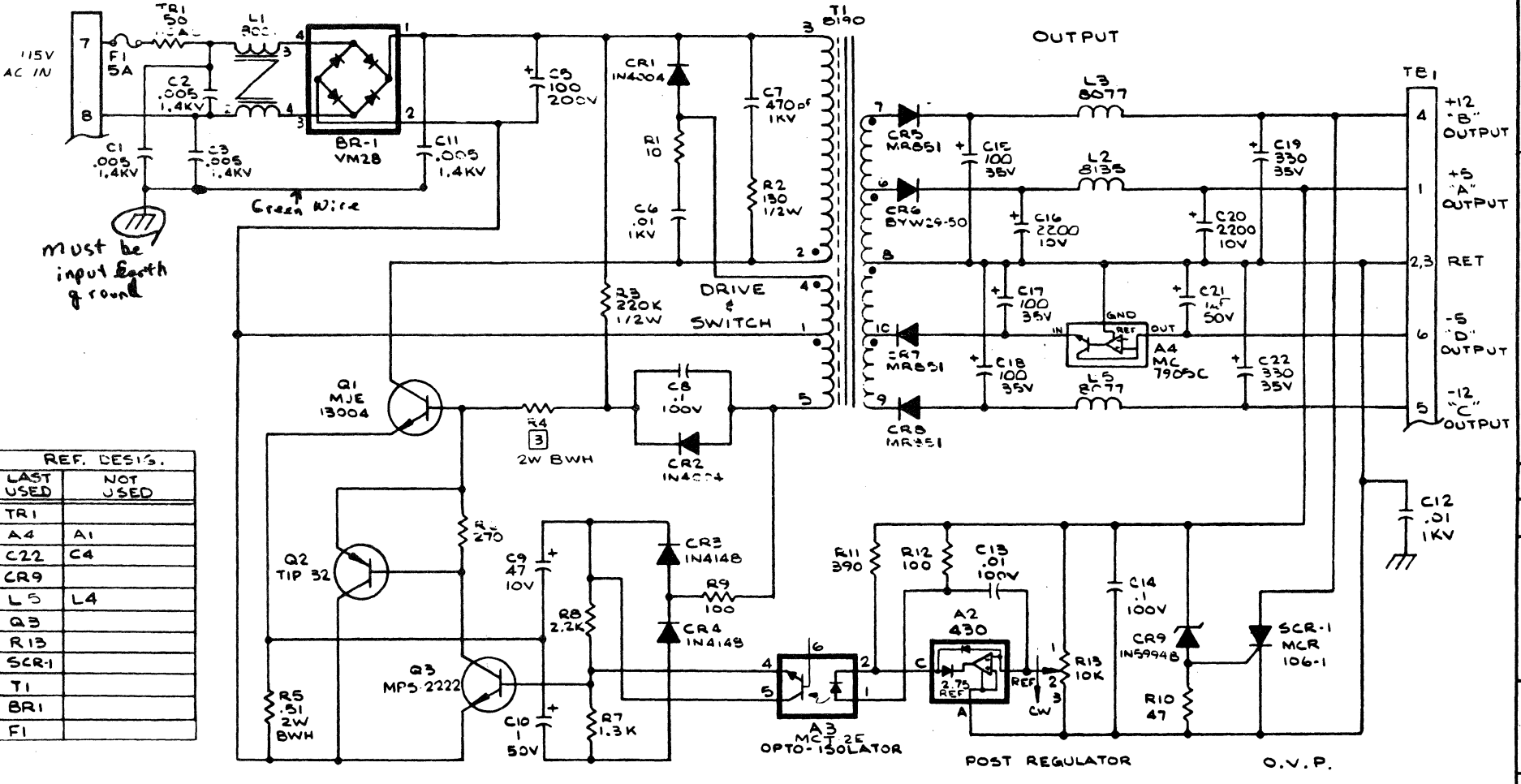
TITLE: POWER SUPPLY 115V, 25 WATT	beckett	DRAWING NO. 45-40006	REV J
		SIZE A / SCALE N/A	SHEET 5 OF 6

ITEM	PART NO.	QTY	DESCRIPTION	REF DES
82	30-3251	1	RES, C.F., 130 , ±5%, 1/2 W	R2
83				
84	30-3328	1	, C.F., 220K , ±5%, 1/2 W	R3
85				
86	31-3810	1	, C.C., SAT (22 Ω NOM.) 10%, 2W BWH	R4 [8]
87				
88	35-3802	1	, W.W., .51Ω , ±10%, 2W BWH	R5
89				
90				
91				
92	36-3944	1	, POT, 10K	R13
93				
94	39-3900	1	RES, 50Ω, THERMISTOR	TR1
95				
96	73-6058	1	TERMINAL STRIP	
97				
98				
99				
100	53-7742	1	LABEL, 115 VOLTS	
101	53-7740	1	LABEL, DANGER HIGH VOLTAGE	
102	53-7881	1	LABEL, MODEL & SERIAL NUMBER	
103				
104	-7884	A/R	GLYPTAL, RED	
105	87-7959	1	WIRE BARE 22 AWG, .50LG	
106	87-7960	1	WIRE, BARE, 22 AWG, .60LG	
107	87-7464	1	WIRE, GRN, 22 AWG, 3.00 × 1/4 × 1/4	
108				

TITLE		DRAWING NO.	REV
POWER SUPPLY 115V, 25 WATT	beechert	45-40006	T
		SIZE A / SCALE N/A	SHEET 6 OF 6

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
1986	4	PRE-REL. FOR PROD.	5-2-78	
2259	A	RELEASED FOR PRODUCTION	9-13-78	

INPUT FILTER & BRIDGE



REF. DESIG.	
LAST USED	NOT USED
TR1	
A4	A1
C22	C4
CR9	
L5	L4
Q3	
R13	
SCR-1	
T1	
BR1	
F1	

[3] FACTORY SELECTED. SAT (22 NOM)
2. CAPACITORS ARE IN μf.
1. RESISTORS ARE IN OHMS, 1/4 W.

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

	25-1001
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± — DECIMALS .XX ± — .XXX ± — ANGLES ± —

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN FRANK KRAJEWITZ	4-4-78
CHECKED	5-2-78
W S Lee	9-19-78

BOSCHERT

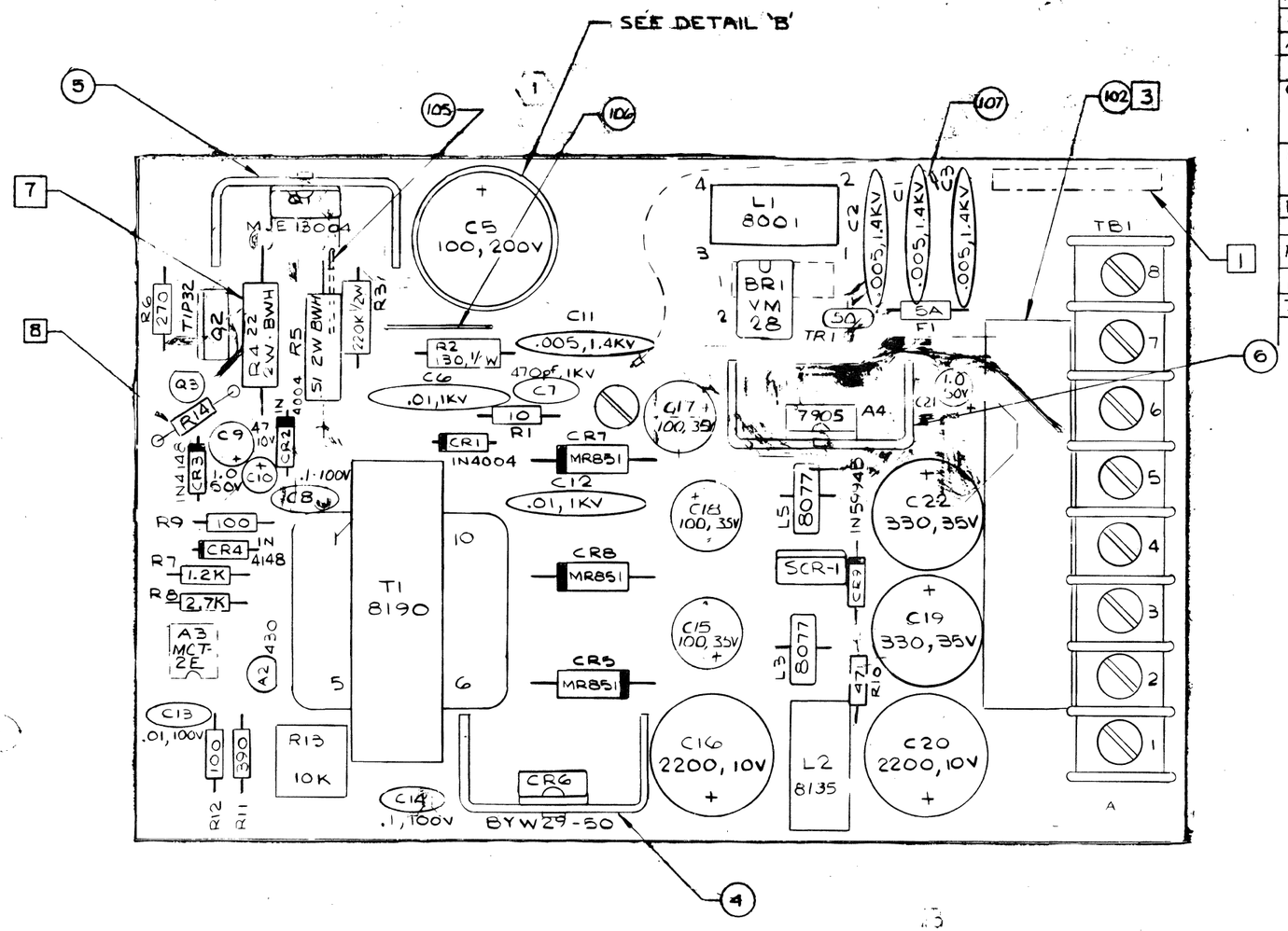
SCHEMATIC, 115V 25 WATT

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
C		20139	A

SCALE N/A SHEET 1 OF 1

20139 REV. A

REV	DESCRIPTION	ECO	DATE	APPROVED
4	PRE-RELEASED FOR PROD.	1782	5-2-78	
A	RELEASED FOR PRODUCTION	2259	7-13-78	
B	L/M CHG ONLY	2369	12-13-78	
C	ADDED DETAIL B; DELETED [3] & (100) FROM T1 AND [3] & (100) FROM C-5	2413	12-13-78	
D	ADDED NOTE [6] & CALL OUT. CHG NOT PER ECO: ADDED VALUE TO R4.	2623	3-27-79	
E	REVISED PER ECO CHG'S	2799		
	TVA PENDING 2596 5-1-79			
F	ADDED R14, R7 WAS F.S. R8 WAS 2.2K.	3335	11-2-79	
H	INCORPORATED	3915		
J	CHANGED PER ECO	4446	7-1-80	



DWG NO 40006

[8] FACTORY SELECTED SAT (1.2K NOM).

[7] FACTORY SELECTED SAT (22 NOM).

6. ALL RESISTORS 2 WATT AND ABOVE MUST BE MOUNTED .15 INCHES ABOVE BOARD.

5

4

[3] APPLY LABELS IN APPROX LOCATION SHOWN.

2. FOR REFERENCE DWG. SEE SHEET TWO OF L/M.

[1] APPLY ASSY. NO. AND CURRENT REVISION LEVEL IN APPROX LOCATION SHOWN.

NOTES:

11 of 19

SEE SEPARATE P/L DWG NO. 40006 "A" SIZE

ITEM	QTY	PART NUMBER	DESCRIPTION	REF DESIGNATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES:
TOLERANCES:
DECIMALS (.XX) ± — FRACTIONS ± —
DECIMALS (.XXX) ± — ANGLES ± —

NEXT ASSY	MOD NO.
FINAL	25-1001

DO NOT SCALE DRAWING

APPROVALS:		DATE
DRAWN	FRANK FRANCOVITZ	4-6-78
CHECKED		5-2-78
ENG		11-1-78
ENG MGR		
MFG MGR		
QA MGR		
RELEASED		

boschert BOSCHERT ASSOCIATES SUNNYVALE, CALIFORNIA

POWER SUPPLY 115V, 25W

SIZE C | DWG NO 45-40006 | REV J

SCALE 2:1 | SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
1984	4	PRE-REL. FOR PROD.	5-2-78	
2259	A	RELEASED FOR PRODUCTION	9-13-78	
2623	B	ADDED NOTE [4]; AT R7 DELETED VALUE AND ADDED NOTE [4] REF	3-27-79	
3335	C	ADDED R14, R7 WAS F.S., R8 WAS 2.2K	11-2-79	RKS

INPUT FILTER & BRIDGE

115V AC IN

TR1 50 110AC

F1 5A

L1 8001

C2 .005 1.4KV

C1 .005 1.4KV

C3 .005 1.4KV

BR-1 VM28

C11 .005 1.4KV

C5 100 200V

CR1 IN4004

R1 10

C6 .01 1KV

C7 470pf 1KV

R2 130 1/2W

T1 8190

R3 220K 1/2W

DRIVE & SWITCH

Q1 MJE 13004

R4 [3] 2W 8 WH

C8 .1 100V

CR2 IN4004

OUTPUT

L3 8077

CR5 MR851

C15 100 35V

L2 8135

C19 330 35V

CR6 BYW29-50

C16 2200 10V

C20 2200 10V

C17 100 35V

C21 50V

CR7 MR851

A4 MC 7905C

C18 100 35V

L5 8077

C22 330 35V

CR8 MR851

TB1

+12 "B" OUTPUT

+5 "A" OUTPUT

RET

-5 "D" OUTPUT

-12 "C" OUTPUT

C12 .01 1KV

Q2 TIP 32

R6 270

C9 47

R14 10V F.S. [4]

R8 2.7K

CR3 IN4148

R9 100

CR4 IN4148

Q3 MPS 2222

R5 .51 2W BWH

C10 1 50V

R7 1.2K

A3 MCT 2E OPTO-ISOLATOR

R11 390

R12 100

C13 .01 100V

A2 430

REF

R13 10K CW

C14 .1 100V

CR9 IN5248B

R10 47

SCR-1 MCR 106-1

MODULATOR

POST REGULATOR

O.V.P.

REF. DESIG.	
LAST USED	NOT USED
TR1	
A4	A1
C22	C4
CR9	
L5	L4
Q3	
R14	
SCR-1	
T1	
BR1	
F1	

[4] FACTORY SELECTED SAT (1.2K NOM)

[3] FACTORY SELECTED. SAT (22 NOM)

2. CAPACITORS ARE IN mf.

1. RESISTORS ARE IN OHMS, 1/4W.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT ASSY	USED ON
	25-1001

APPLICATION

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± — DECIMALS .XX ± — .XXX ± — ANGLES ± —

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN FRANK KRALOWETZ	4-1-78
CHECKED	4-3-78

BOSCHERT

SCHEMATIC, 115V 25 WATT

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
C		90-20139	C

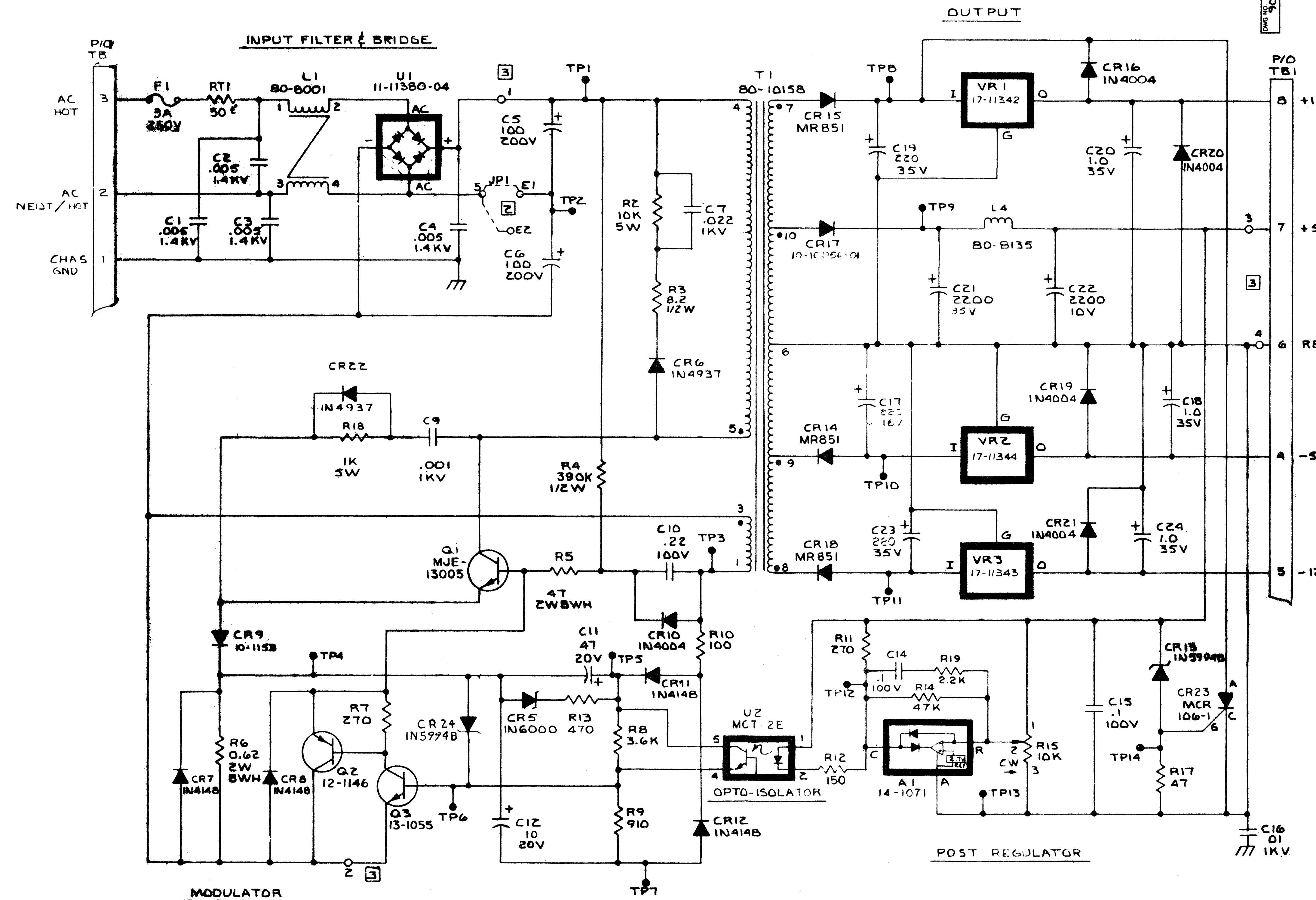
SCALE N/A SHEET 1 OF 1

20139 RKS

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-7827

DWG NO 90-10150 REV 1

REV	DESCRIPTION	ECO	DATE	APPROVED
2	REVISED & REDRAWN		3-30-79	
3	ENG PROTOTYPE			
4	ENG PROTOTYPE			
5	PRE REL TO PROD		16 Oct 79	
A	REL FOR PROD.			
B	INCORPORATED	4213	3-31-80	



TP14	
VR3	
T1	
U2	
RT1	
R19	R1,16
Q3	
L4	L3,2
JP1	
TB1	
F1	
E2	
CR24	CR1,2,3,4,
C24	C8, C13
A1	
LAST USED	NOT USED
REFERENCE DESIGNATOR	

3 STRAP POINTS 1 THRU 4 ARE FOR FLYING LEADS.
2 FOR 220V OPERATION STRAP FROM JP1 TO E2
FOR 110V OPERATION STRAP FROM JP1 TO E1
1. UNLESS OTHERWISE SPECIFIED:
CAPACITORS ARE IN [illegible] GRADE
RESISTORS ARE IN [illegible]

NOTES:

ITEM	QTY	PART NUMBER	DESCRIPTION	REF DESIGNATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES:
TOLERANCES:
DECIMALS (.XX) ± ~ FRACTIONS ± ~
DECIMALS (.XXX) ± ~ ANGLES ± ~

VOLTAGE	NEXT ASSY	MOD NO.
110 V	45-10152-01	XL25-3001
220 V	45-10152-02	XL25-4001

DO NOT SCALE DRAWING

APPROVALS — DATE
DRAWN
CHK
ENG
MGR
MGR
MGR
RELEASED

BOSCHERT ASSOCIATES
SUNNYVALE, CALIFORNIA

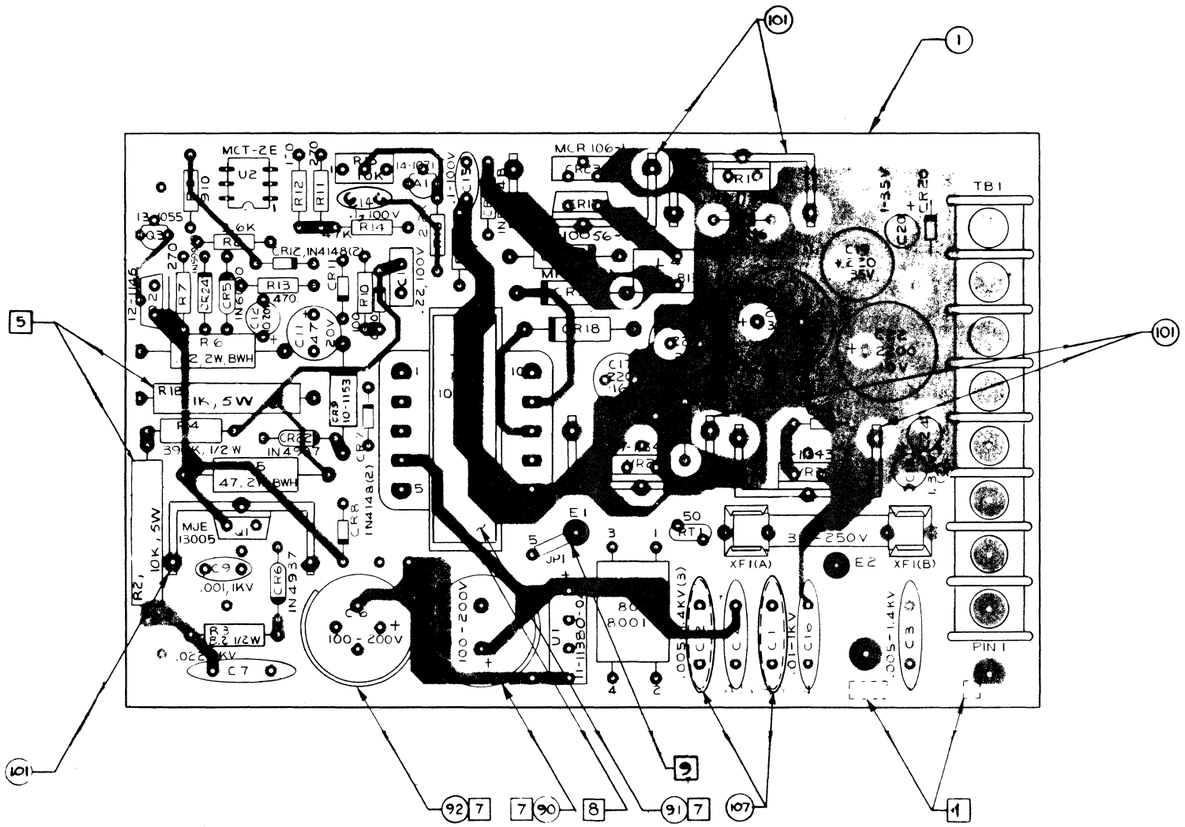
SCHEMATIC
XL25-3001/4001
110/220V

SIZE D DWG NO. 90-10150 REV B

SCALE NONE SHEET 1 OF

REV	DESCRIPTION	ECO	DATE	APPROVED
1	PRE REL FOR PROD		10-22-79	WJ
A	REL FOR PROD.		2-6-80	
B	INCORPORATED	4070 4213	3-20-80	

DWG NO 45-10152-01/02 REV



OPTION TABLE [1]

ASSY P/N	MOD NO.	VOLT. RATING
45-10152-01	XL25-3001	110
45-10152-02	XL25-4001	220

11. UNLESS OTHERWISE SPECIFIED : RESISTORS ARE 1/4 W : DIODES ARE IN4004 : CAPACITANCE IS IN μf.
10.
[9] FOR -01 (110 V) STRAP JP1 TO E1 AS SHOWN ; FOR -02 (220V) STRAP JP1 TO E2
[8] CORE MUST BE .15 ABOVE BOARD.
[7] APPLY LABELS IN APPROX POSITION SHOWN NOT COVERING THE COMPONENT IDENTIFICATION.
[6]
[5] R2 & R18 MUST BE MOUNTED .30 IN. OFF THE BOARD.
4. ALL HEATSINKS MUST BE MOUNTED .10 IN OFF THE BOARD.
3. ALL RESISTORS TWO (2) WATTS AND ABOVE MUST BE MOUNTED .15 IN OFF THE BOARD UNLESS OTHERWISE SPECIFIED.
2. FOR REFERENCE DWG SEE LIST OF MATERIAL.
[1] MARK ASSY IDENT NO & CURRENT REV LEVEL IN APPROX LOCATION SHOWN PER OPTION TABLE.

NOTES:

ITEM	QTY	PART NUMBER	DESCRIPTION	REF DESIGNATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES:
TOLERANCES:
DECIMALS (.XX) ± FRACTIONS ±
DECIMALS (.XXX) ± ANGLES ±

NEXT ASSY	MOD NO.
FINAL	XL25-3001
FINAL	XL25-4001

DO NOT SCALE DRAWING

APPROVALS: DATE
DRAWN 8-17-79
CHECKED 10-19-79
ENG 10-22-79
ENG MGR
MFG MGR
QA MGR
RELEASED 3-20-80

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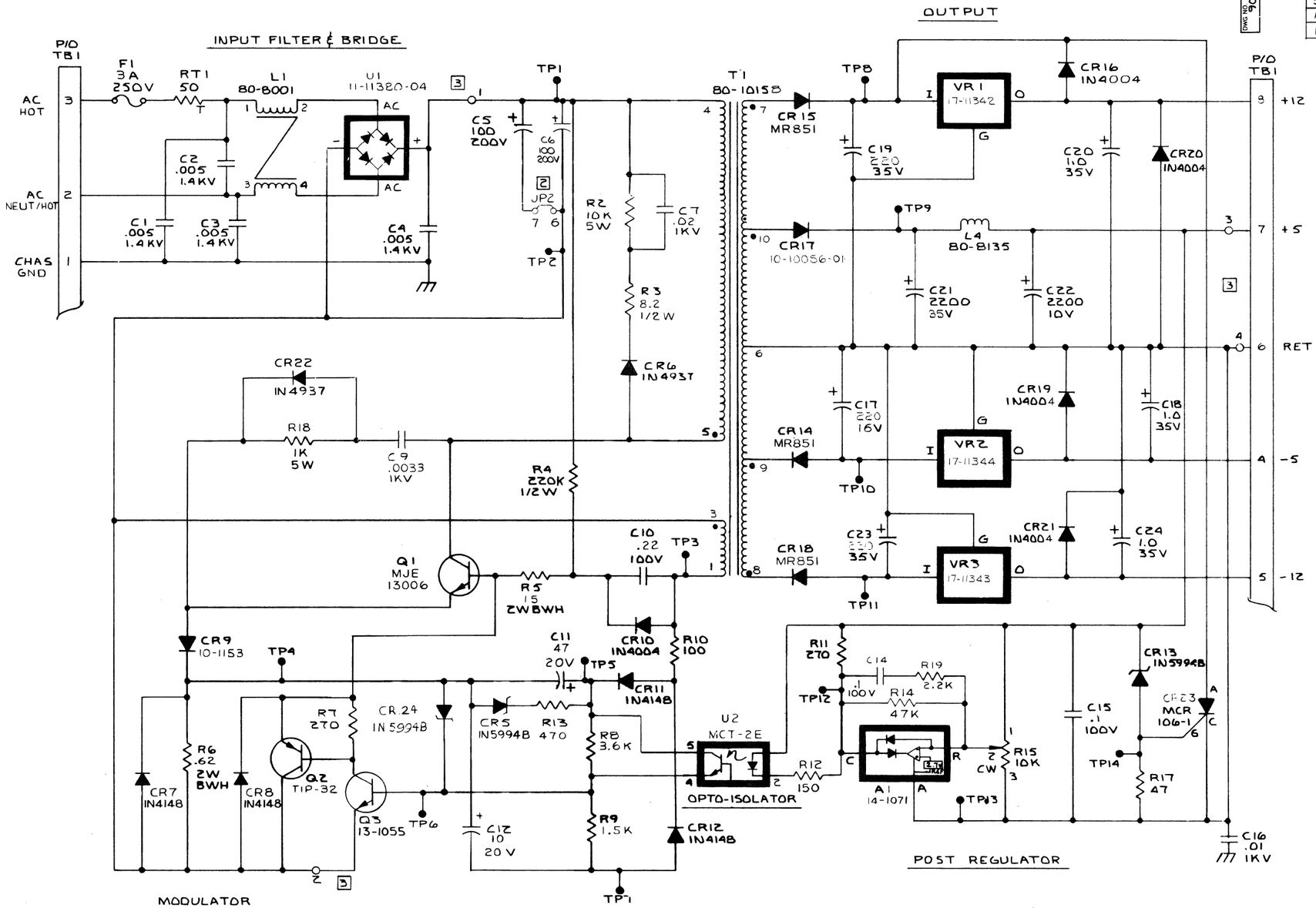
ASSEMBLY
XL25-3001/4001
110/220 V

SIZE D | DWG NO. 45-10152-01/-02 | REV B
SCALE 2:1 | SHEET 1 OF 1

REV	DESCRIPTION	ECO	DATE	APPROVED
2	REVISED & REDRAWN			
3	ENG PROTOTYPE			
4	ENG PROTOTYPE			
5	PRE REL FOR PROD		10-27-79	
A	REL FOR PROD		1-4-80	
B	INCORPORATED	4291	3-27-80	

DWG NO. 90-10155 REV



TP14	
VR3	
T1	
U2	
RT1	
R19	R1,13
Q3	
L4	L3,2
TB1	
F1	
JP2	JP1
CR24	CR1,2,3,4,
C24	C8,13
A1	
LAST USED	NOT USED
REFERENCE	DESIGNATOR

[3] STRAP POINTS 1 THRU 4 ARE FOR FLYING LEADS.

[2] BARE WIRE STRAP ACROSS STRAP POINTS, 6-7.

1. UNLESS OTHERWISE SPECIFIED:
   CAPACITORS ARE IN MICROFARADS
   RESISTORS ARE IN OHMS 1/4W

NOTES:

ITEM	QTY	PART NUMBER	DESCRIPTION	REF DESIGNATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES:
TOLERANCES:
DECIMALS (XX) ± .02 FRACTIONS ± 1/32
DECIMALS (XXX) ± .010 ANGLES ± 1°

NEXT ASSY	MOD NO.
45-10157-01	XL25-1001

DO NOT SCALE DRAWING

APPROVALS:		DATE
DRAWN	R Ge	3-27-79
CHECKED	[illegible]	4-3-79
ENG	[illegible]	1-24-80
ENG MGR	C Fo[illegible]	1-28-80
MFG MGR	[illegible]	2-6-80
QA MGR	[illegible]	2/7/80
RELEASED	[illegible]	2/7/80

boschert BOSCHERT ASSOCIATES SUNNYVALE, CALIFORNIA

SCHEMATIC XL25-1001 115V

SIZE	DWG NO.	REV
D	90-10155	B
SCALE NONE	SHEET 1 OF 1	

REV	DESCRIPTION	ECO	DATE	APPROVED
5	PRE REL FOR PROD		10/17/79	WJ
A	REL FOR PROD		11-4-80	
B	INCORPORATED	4023 4069 4241	3-27-80	
C	ADDED SUFFIX "R" TO MODEL NO.	4636	6-17-80	

DWG NO. 45-10157 REV

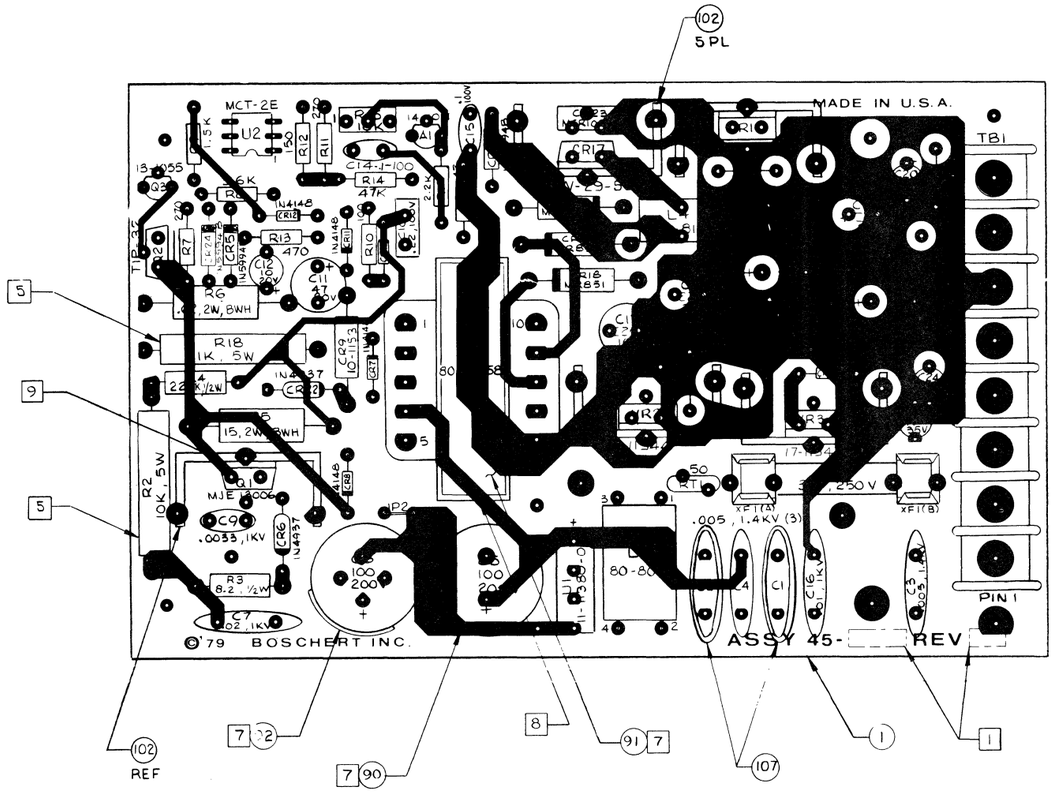


TABLE A

ASSY NO	MODEL NO	VOLT RATING
45-10157-01	XL25-1001R	115 V

10. UNLESS OTHERWISE SPECIFIED: RESISTORS ARE 1/4 W; DIODES ARE IN4004; CAPACITANCE IS IN μf.
9. APPLY A THIN COAT OF HEATSINK COMPOUND (P/N 74-7765) BEFORE ASSY.
8. CORE MUST BE .15 ABOVE BOARD.
7. APPLY LABELS IN APPROX POSITION SHOWN NOT COVERING THE COMPONENT IDENTIFICATION.
6.
5. R2 & R18 MUST BE MOUNTED .30 OFF BOARD.
4. ALL HEATSINKS MUST BE MOUNTED .10 IN. OFF THE BOARD.
3. ALL RESISTORS TWO (2) WATTS AND ABOVE MUST BE MOUNTED .15 IN. OFF THE BOARD UNLESS OTHERWISE SPECIFIED.
2. FOR REFERENCE DWG SEE LIST OF MATERIAL.
1. MARK ASSY IDENT NO & CURRENT REV LEVEL IN APPROX LOCATION SHOWN PER TABLE A

NOTES:

ITEM	QTY	PART NUMBER	DESCRIPTION	REF DESIGNATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES:
TOLERANCES:
DECIMALS (XX) ± FRACTIONS ±
DECIMALS (XXX) ± ANGLES °

NEXT ASSY	MOD NO.
FINAL	XL25-1001R

DO NOT SCALE DRAWING

APPROVALS: DATE
DRAWN LNH VO 10-16-79
CHECKED TOMLINSON 25 OCT 79
ENG
ENG MGR
MFG MGR 2-6-80
QA MGR
RELEASED

boschert BOSCHERT ASSOCIATES SUNNYVALE, CALIFORNIA

ASSEMBLY
XL25 - 1001R
115 V

SIZE D | DWG NO. 45-10157 | REV C
SCALE 2:1 | SHEET 1 OF 1

APPLICATION		REVISION				
NEXT ASSY	USED ON	REV	ECO	DESCRIPTION	DATE	APPROVED
45-10157-01	XL25-1001	1	—	PRE REL FOR PROD	11-6-79	[illegible]
45-10152-01	XL25-3001	A		REL. FOR PROD.		[illegible] 2/6/80
45-10152-02	XL25-4001					

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES - ——— .XX ± ——— ± ——— .XXX ± ———	APPROVALS	DATE
	DRAWN John Sanchez	11-6-79
	CHECKED SCHATZMAN	2 JAN 80
	ENG [illegible]	1-25-80
	MFG MGR [illegible]	2-6-80
	QA MGR [illegible]	2/7/80
	RELEASED [illegible]	1-28-80
	C. Forney	1-28-80

boschert

BOSCHERT INCORPORATED
SUNNYVALE, CALIFORNIA

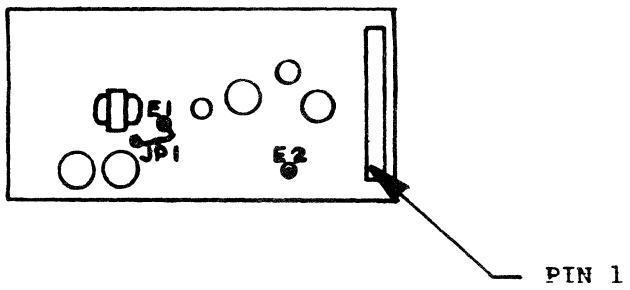
PIN OUT CHART
XL 25

MATERIAL	FINISH	DO NOT SCALE DRAWING

SIZE	DRAWING NO.	REV
A	97-10147	A

SCALE N/A | SHEET 1 OF 2

PIN ORIENTATION



NOTE 1 - For 110V as shown; For 220V strap JP1 to E2 (applicable to the XL25-3001/4001 only).

PIN		VOLTAGE
2	INPUT	A.C. NEUT/HOT
3	INPUT	A.C. HOT
1	CHAS GND	
4	OUTPUT	-5V
5	OUTPUT	-12V
7	OUTPUT	+5V
8	OUTPUT	+12V
	OUTPUT	
	OUTPUT	
	OUTPUT	
	OUTPUT	
6	RETURN	
	NOT USED	

MODEL NO. XL-25

MFG. ASSEMBLY NO. _____

MATING CONNECTOR

AUTOMATIC SHORT CIRCUIT RECOVERY ☐

AUTOMATIC SHORT CIRCUIT SHUT DOWN ☐

DWG. NO. 97-10147 REV A

SHT. 2 OF 2

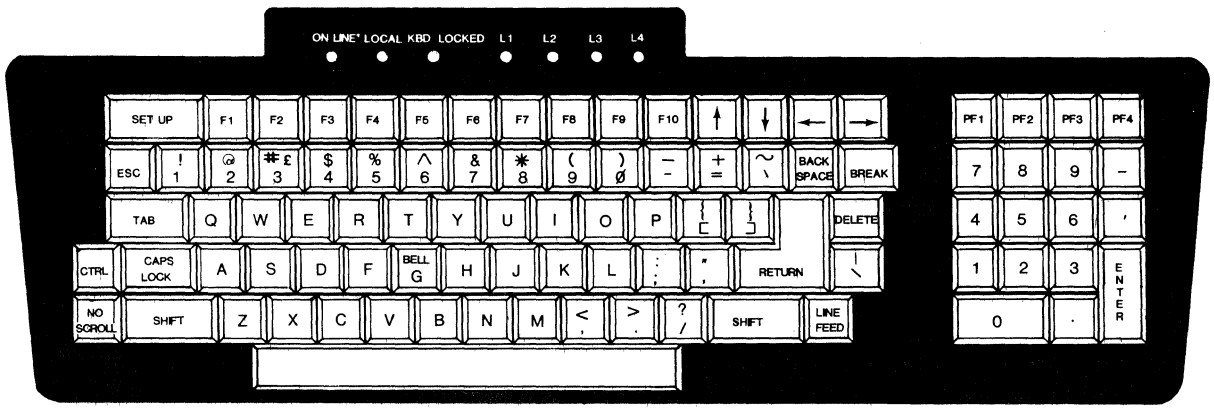
Section 5

KEYBOARD MODULE

A. Theory of Operation

The keyboard is fully detachable from the terminal (except for "T" style) for operator comfort and optional space utilization. The coiled handset cord leading from the keyboard is terminated in a telephone type 4-pin connector; the cord supplied is compatible with those commonly used on Western Electric type telephones. The Teleray 100 keyboard has seven LED indicators: three are used to indicate the (legended) terminal status; the remaining four are used by the host computer to alert the operator of application dependent conditions.

The figure below shows the keyboard.



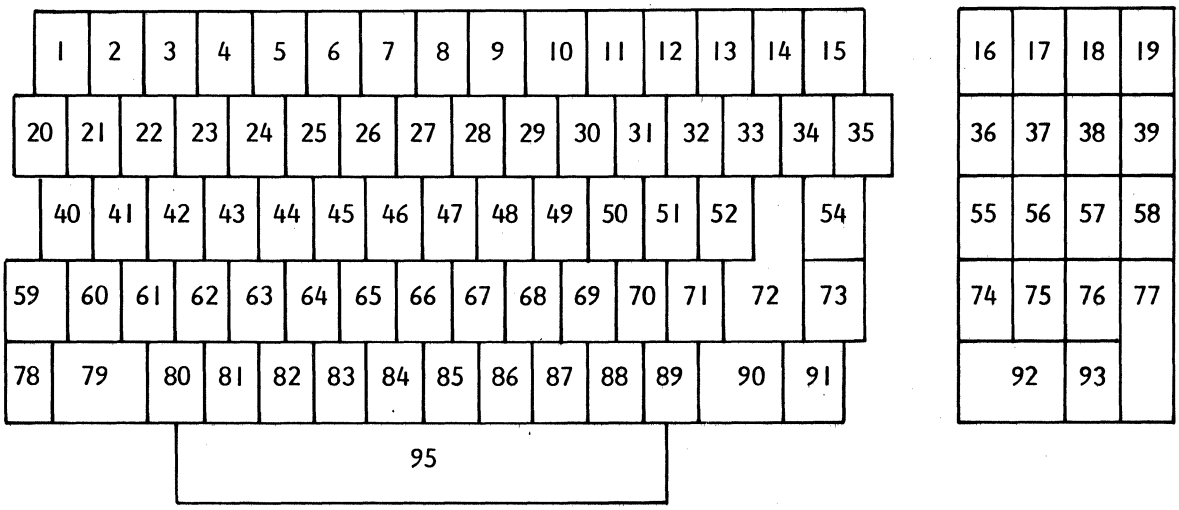
Communications between the keyboard module and the logic module are asynchronous and are controlled by the keyboard. Every 150 milliseconds, the keyboard module sends a request for information, to which the logic module responds with a single-word reply. The keyboard module transmits keyboard depression information whenever keyboard keys are pressed.

The cable between the keyboard module and the logic module has a resistance of about 1.1 ohms per meter. This resistance makes it necessary to send 12 V to the keyboard module and regulate it to 5 V at the keyboard module.

The keyboard module is controlled by a microcomputer. The microcomputer is a single integrated circuit that scans the keyboard switch matrix, transmits and receives, and turns on the seven keyboard LED indicators. Each keyboard key consists of a mechanically sealed switch with a diode in series. The diodes isolate each switch from every other switch, thereby allowing N-key rollover.

B. Key Encoding

Key Numbering Scheme



Key No.	Unshifted	Shifted	Control
1	----------Unencoded----------		
2 thru 11	---Dynamically Programmable--		
20	ESC	ESC	ESC
21	1	!	1
22	2	@	NUL
23	3	# or£	3
24	4	$	4
25	5	%	5
26	6	^	6
27	7	&	7
28	8	*	8
29	9	(	9
30	0	)	0
31	-	_	-
32	=	+	=
33	`	~	RS
34	BS	BS	BS
35	BREAK	BREAK-DISCONNECT	ANSWERBACK
40	HT	HT	HT
41	q	Q	DC1
42	w	W	ETB
43	e	E	ENQ
44	r	R	DC2
45	t	T	DC4
46	y	Y	EM
47	u	U	NAK
48	i	I	HT
49	o	O	SI
50	p	P	DLE
51	[	{	ESC
52	]	}	GS

Key No.	Unshifted	Shifted	Control
54	Delete	DELETE	DELETE
59	----------Unencoded----------		
60	----------Unencoded----------		
61	a	A	SOH
62	s	S	DC3
63	d	D	EOT
64	f	F	ACK
65	g	G	BEL
66	h	H	BS
67	j	J	LF
68	k	K	VT
69	l	L	FF
70	;	:	;
71	'	"	'
72	return	return	return
73	\	|	FS
78	----------Unencoded----------		
79	----------Unencoded----------		
80	z	Z	SUB
81	x	X	CAN
82	c	C	ETX
83	v	V	SYN
84	b	B	STX
85	n	N	SO
86	m	M	CR
87	,	<	,
88	.	>	.
89	/	?	US
90	----------Unencoded----------		
91	LF	LF	LF
95	SP	SP	NUL

C. Coding Information

I.

Key Codes	
Bit 8	0
Bit 7	Data 6
Bit 6	Data 5
Bit 5	Data 4
Bit 4	Data 3
Bit 3	Data 2
Bit 2	Data 1
Bit 1	Data 0

A key code is transmitted when a key is down.

A function code is transmitted when a function changes state.

Data is active high = 1

II.

Function Codes		
Bit 8	1	
State of Data Bit	1	0
Bit 7	Control Key Down	Normal
Bit 6	Shift Key Down	Normal
Bit 5	Caps Lock Key Down	Normal
Bit 4	Auto Repeating	Normal
Bit 3		
Bit 2	① Request Command Word	Normal
Bit 1	Keyboard Power Up	Normal

① Command Request Interval = 150 ms

III.

Serial Format ②	
Stop Bits	1
Start Bits	1
Data Bits	8
Parity	None
Mark State	1 = high
Baud Rate	4800 bps

② Asynchronous - LSB first

IV.

	Command Word ④	Status Word
Bit 8	LED Data Bit 1 = off, 0 = on	
Bit 7	LED Address Bit MSB	
Bit 6	LED Address Bit	
Bit 5	LED Address Bit LSB	
Bit 4	③ Auto Repeat 1 = on, 0 = off	
Bit 3	Auto Repeat Rate 1 = 30 cps, 0 = 15 cps	
Bit 2	Request Status Word	1 = RAM Bad, 0 = Normal
Bit 1	Invoke Keyboard Test	1 = Switch Short, 0 = Normal

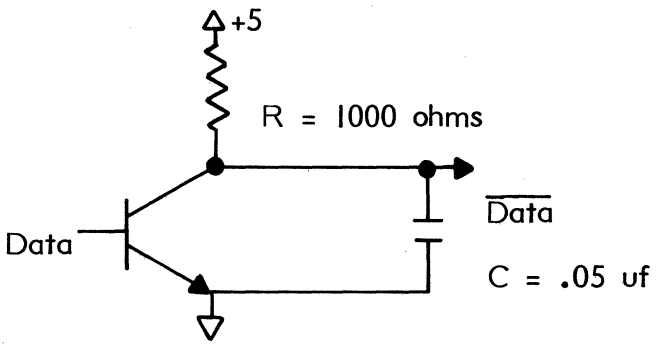
③ Single key auto repeat, which transfers to the next key pressed.

④ Command word receive window = 5 ms

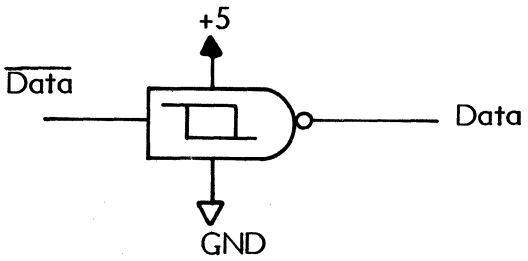
V. Electrical

a) High level = 1 = 2 to 5.5 volts
Low level = 0 = -.3 to .8 volts

b) Open collector serial output such as 7406.



c) Hysteresis serial input such as 7414.



VI. Other

a) N-key rollover.
b) Colors - gray, blue and white

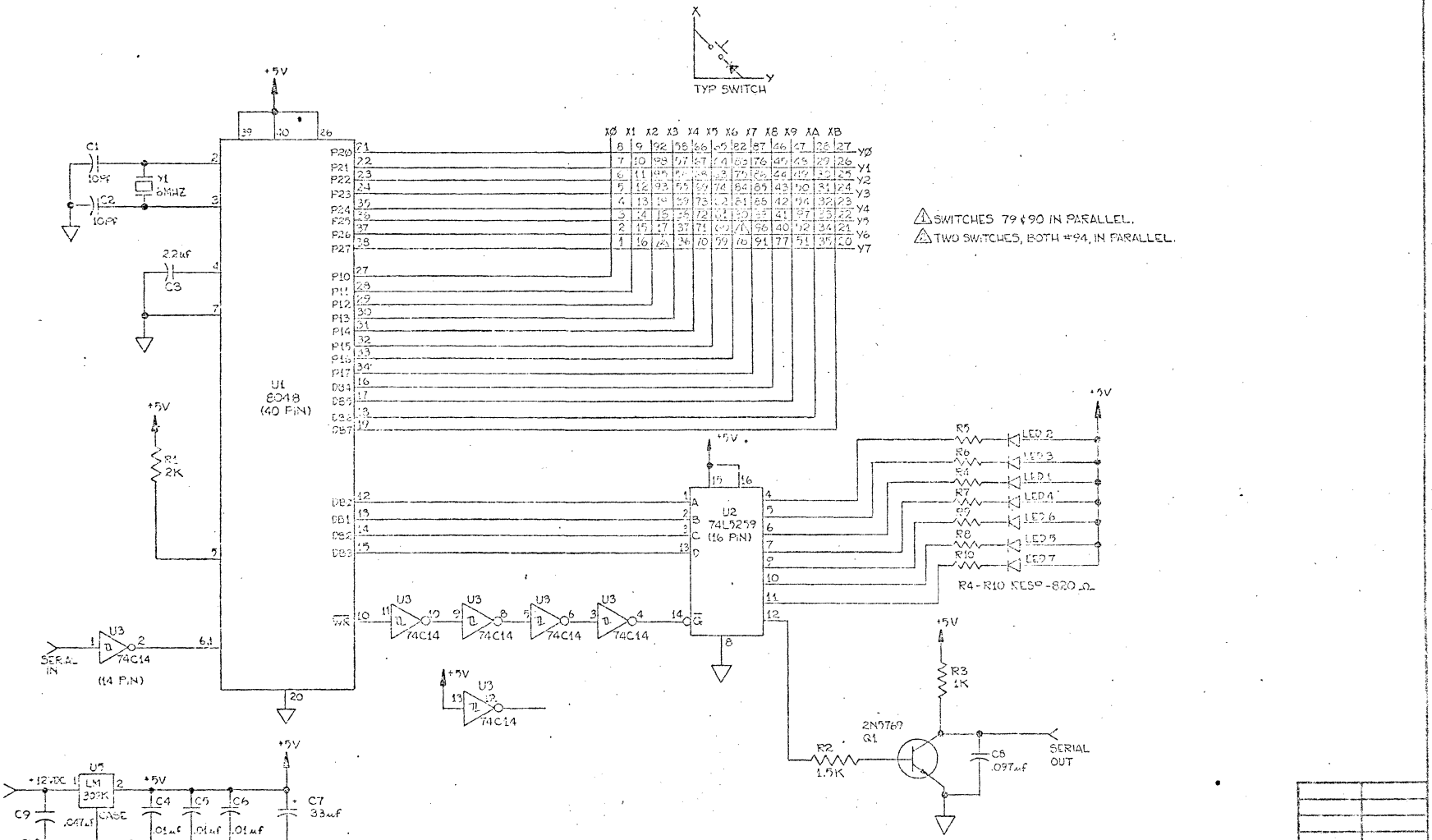
A command word is received on a command word request.

A status word must be transmitted after the command word upon request.

D. Keyboard Schematic

0C059522 Keyboard - Model 100
Page 2 of 2

REVISIONS				
SYM	ECO NO	DESCRIPTION	DRAFT	DATE
		SEE SHEET ONE		



DRAFTSMAN	MATERIAL	TOLERANCES UNLESS OTHERWISE SPECIFIED		
CHECKED	FINISH	2 PLACE DEC	ANGULAR	
APPROVED		3 PLACE DEC		

TITLE: KEYBOARD-MODEL 100

ECO 79-522-001 REV 2

Section 6

LOGIC MODULE

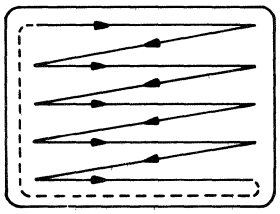
A. Architecture

The Teleray logic module is a microprocessor-oriented bus structured design. Specialized hardware is provided for the display of data from RAM on the CRT (display refresh hardware, character generator). Specialized hardware is also provided for enhancing the data display (Attribute Logic). Bus-oriented interfaces are provided for the keyboard, the serial input/output and non-volatile memory. Program space for ROM and RAM is also provided. The Logic Module Architecture Diagram shows this structure; the Logic Module Block Diagram further details the organization.

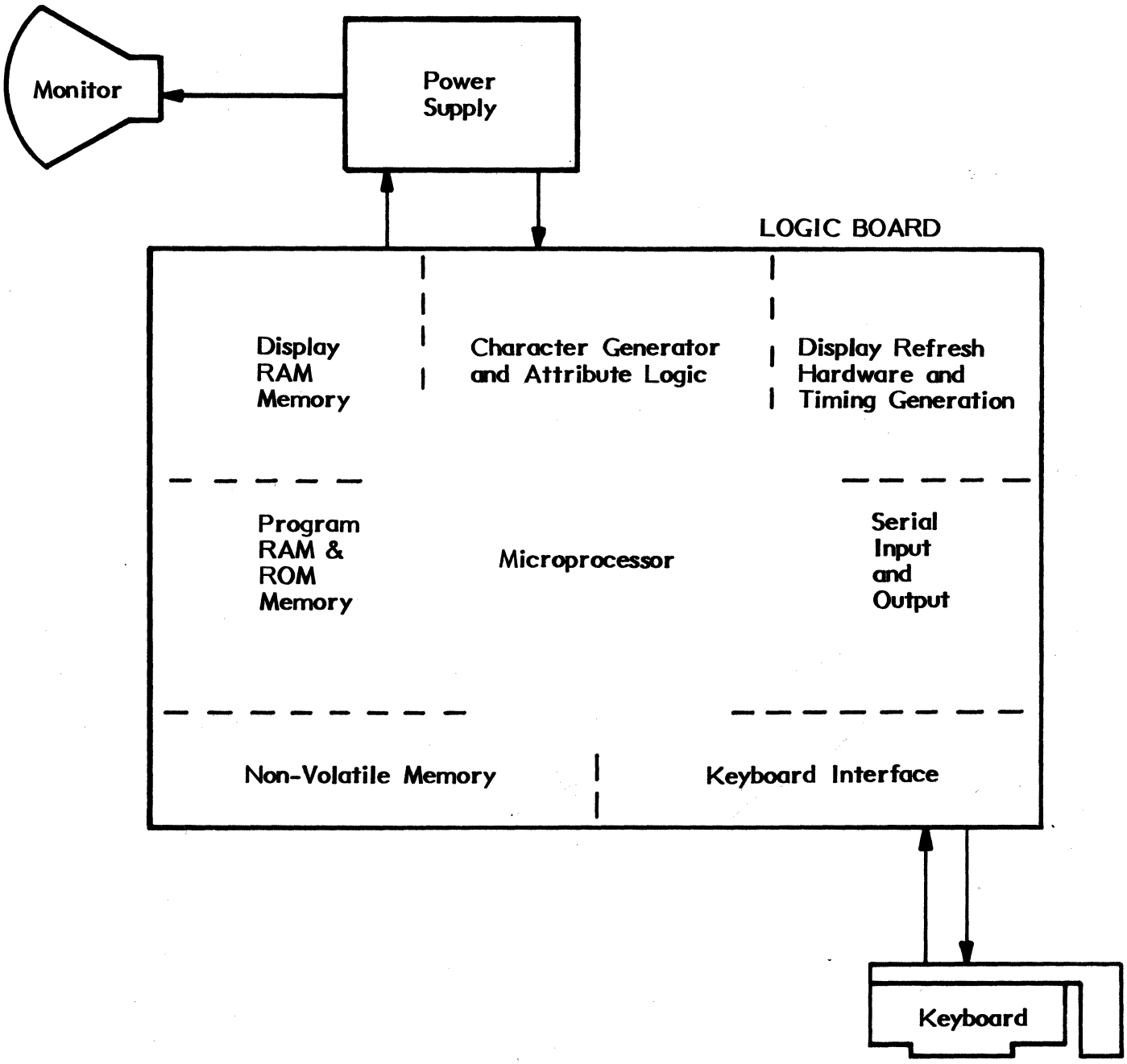
B. Theory of Operation

1. Display Refresh Hardware

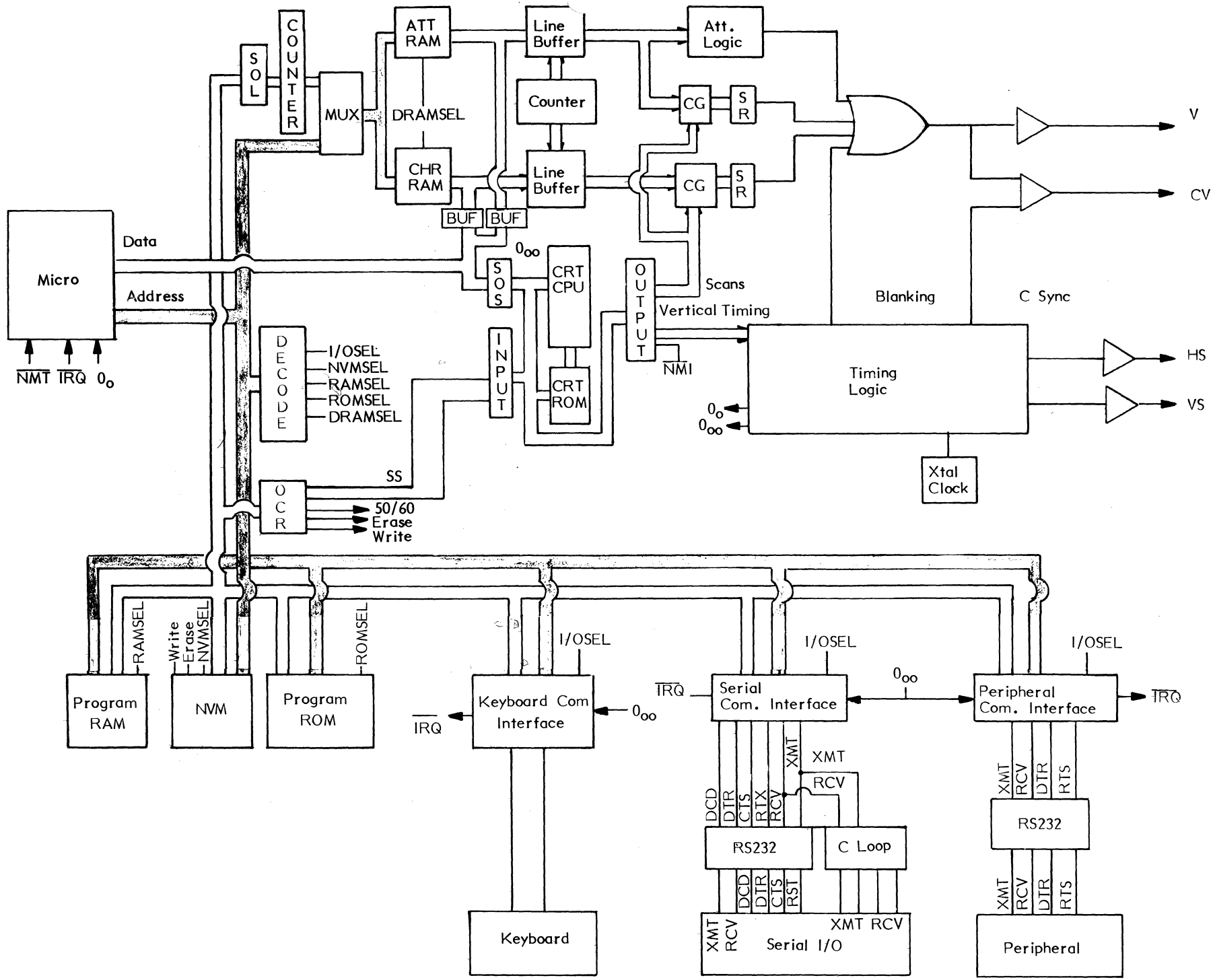
The display logic controls the monitor and provides time and address references for retrieving data from memory. The display of the Teleray monitor is a "raster" scan. The electronic beam scans the face of the CRT 60 times a second following the generalized pattern shown below. The pattern is "non-interlaced"; i.e., the beam starts at the same place every time and horizontal lines remain distinct. The "vertical sync" signal causes the beam to return to the top left corner of the screen; the "horizontal drive" signal causes the beam to start a new line. The characters are formed when the beam is moving from left to right by illuminating a given position as the beam passes. The signal that provides the "illumination" information to the monitor is the video signal. The timing section of the Teleray logic provides the Horizontal Drive and Vertical Sync and controls the video signal.



The characters are formed within a 7 x 9 dot matrix. There are seven dots horizontally and nine dots vertically. In addition, there is one dot (horizontally) of intercharacter separation, and three lines of vertical interline separation. Each character position then occupies 12 horizontal lines of eight dots per line, and the characters themselves are formed on a 7 x 9 dot matrix field within this 8 x 12 position field.



LOGIC MODULE ARCHITECTURE DIAGRAM



LOGIC MODULE BLOCK DIAGRAM

The master oscillator provides the dot clock for a 132-character line. Each character is eight dots horizontally. The master oscillator is divided by 2/3 for the 80-character line dot clock. This divider circuit is synced by the 80-character clock, which is the master oscillator divided by 13. Alternately it requires 13 132-character dots to count an 80-character clock interval.

The following frequencies determine display operation:

Master Clock	23.9568 MHz
Horizontal Refresh	18.6 KHz
Vertical Refresh	50 or 60 Hz
132-Character Clock	2.9946 MHz
80-Character Clock	1.8428 MHz
0_0 CPU Clock	.9214 MHz
0_{00} CRTC CPU Clock	1.8428 MHz

80 or 132 characters are formed on each line and selected on a line-by-line basis. The format for each line is determined during the horizontal retrace before the first scan of that line. The 132-character clock is used as the reference for all line timing. Each line is 161 character times long. Thirty or 29 of these character times are blanked for horizontal retrace, with 80 or 132 character lines, respectively. The horizontal sync pulse starts 24 character times before the start of a line, and is 16 character times in duration. Wide Mode operation can also be selected at the same time that the line length of 80 or 132 characters is selected. In Wide Mode, the character clock and the dot clock frequencies are halved, creating a double width character, but all reference timing remains the same.

There are 310 or 372 horizontal scans for 60 or 50 Hz vertical refresh, respectively. The display consists of 24 displayed lines with 12 horizontal scans for each line. This sets the number of displayed scan lines at 288. Twenty-two or 84 horizontal scan lines are blanked for vertical retrace, with 60 or 50 Hz, respectively. The vertical sync pulse is one horizontal scan line in duration.

Horizontal timing is controlled by various hardware counters and associated logic. Vertical timing and scan line counting are under microprocessor control. The CRT control (CRTC) microprocessor uses the horizontal sync pulse as a reference to produce vertical and scan count timing. The scan count feeds the character generators, causing the proper dots to be displayed for a given character. Double-height characters and smooth scrolling are also implemented using the scan count.

A start of line (SOL) register is loaded with a line address by the main microprocessor during the first scan of a line. The line address is used as the starting count for loading a line buffer with the data contents of that line. The transfer occurs during the first scan. Display line data for the remaining 11 scans is read from the line buffer instead of the display memory. There are two display memory banks and two line buffers allowing simultaneous display of foreground (character) data and background (character attribute) data. The main microprocessor cannot access display memory during the first scan of a line when display data is being down-loaded to the line buffer.

2. Character Generator and Attribute Logic

Character generators are used to convert character data in display memory to character dots that are displayed on a CRT. Attribute logic converts attribute data in display memory to logical enhancements for characters being displayed on a CRT. Character data and attribute data in the Teleray Model 100 are converted simultaneously to allow each character to have its own attribute.

There are two overlayed display pages that will be referred to as foreground and background pages. The foreground page is controlled by one of two character generators. One character generator is a ROM encoded to convert ASCII codes to characters. The other character generator is optional. Seven of the eight bits of data for the foreground page are latched and fed into the seven most significant address lines of the character generators. The eighth data bit is used to control which of the two character generators is operating (see Display Bit Memory Map). The least significant four address lines of the character generators are controlled by the microprocessor programmed scan counter.

The background page is controlled by a character generator or the attribute logic. The character generator is encoded to produce the monitor mode characters. The attribute logic produces six attributes (see Display Memory Map). Seven of the data bits for the foreground page are latched and fed to the attribute logic and the character generator. The eighth data bit controls whether the character generator or the attribute logic is operating.

The data output from each character generator ROM is serialized by an 8-bit serial shift register. The foreground character data, background character data, and attribute data are all logically connected to a single video output.

Display Bit Memory Map Foreground Page

Bit	ASCII Char. Data	Alternate Char. Data
7	0	1
6	X (b7)	X (a7)
5	X (b6)	X (a6)
4	X (b5)	X (a5)
3	X (b4)	X (a4)
2	X (b3)	X (a3)
1	X (b2)	X (a2)
0	X (b1)	X (a1)

Display Bit Memory Map Background Page

Bit	ASCII Char. Data	Alternate Char. Data
7	1	0
6	Spare*	X (a7)
5	Bold*	X (a6)
4	Blink*	X (a5)
3	Inverse*	X (a4)
2	Underline*	X (a3)
1	Overline*	X (a2)
0	Blank*	X (a1)

*A logic "1" turns the attribute on, and a logic "0" turns the attribute off.

Legend

X = Data bits
b = ASCII bit designator
a = Alternate bit designator

3. Program Memory

Program memory is a combination of RAMs (random access memory) and ROMs (read only memory) that is used by the main microprocessor. The memory is used for program execution, saving terminal status and storing displayable characters. The Teleray program is stored in 4K by 8-bit ROMs. There is one 2K by 8-bit RAM for general purpose program use. Two 1K by 4-bit EAROMs are used for non-volatile memory. The display memory is divided into two 4K by 8-bit blocks for foreground and background pages. Each block consists of two 2K by 8-bit RAMs and associated control logic to implement getting display data to the screen. One block of memory is allocated for input and output devices (see Input/Output Memory Map).

MEMORY MAP

Hexidecimal Address	Description
0000-07FF	Program RAM
0800-0FFF	Input and output
1000-13FF	Non-volatile memory (EAROM)
4000-4FFF	Display RAM foreground page
5000-5FFF	Display RAM background page
C000-CFFF	ROM 1
D000-DFFF	ROM 2
E000-EFFF	ROM 3
F000-FFFF	ROM 4

4. CRT Control Microprocessor

The CRT control microprocessor (CRTC) aids the main microprocessor in performing smooth scroll and creating double-height characters. One 2K by 8-bit ROM contains the CRT control program. Two input and one output registers allow interfacing between the main microprocessor, display control logic and the CRTC. The CRTC also controls vertical timing for the display.

5. Input and Output

Four UARTs (universal asynchronous receiver transmitter) control three serial input/output interfaces. They are: serial input/output, peripheral interface and keyboard. Each UART provides a means for the main microprocessor to serially send or receive characters. Any one of these devices may interrupt the main microprocessor, causing data exchange. A 1162.5 Hz clock also interrupts the main microprocessor and is used for timing functions such as cursor blink. A number of input and output registers exist to control and monitor various terminal operations (see Input/Output Memory Map).

INPUT/OUTPUT MEMORY MAP

Hexidecimal Address	Description
0C00-0C03	Transmitter UART
0A00-0A03	Receiver UART
0900-0903	Peripheral UART
0880-0883	Keyboard UART
0840	*NVM erase (1 = on)
0841	*NVM write (1 = on)
0842	*Blink (1 = off)
0843	*Bell (1 = off)
0844	*Inverse (1 = on)
0845	*Spare
0846	*Smooth scroll (1 = on)
0847	*Vertical refresh rate (1 = 50 Hz)
0848	*Reset timer
0850	Spare
0858	Spare
0860	*Start of scan register
0868	*Start of line register low order
0870	*Start of line register high order
0878	*Contrast register
840	**Input register
841	**Input register

*Write only register
**Read only register

6. Self-Testing

The Teleray is automatically tested whenever the terminal is turned on. The self-test can also be induced in the following ways:

1. Typing the 0 key in SET-UP A mode.

2. Entering a Reset function (ESC c).

3. Entering an Invoke Self-Test command. The Invoke Self-Test command can perform additional tests not included in the Reset Self-Test.

NOTE

If the CAPS LOCK key is depressed during self-testing, the keyboard error symbol (4) will be displayed at the end of the test.

There are two categories of errors: fatal and non-fatal.

Fatal errors cause the terminal to immediately stop all operations. The display screen may contain random characters.

Non-fatal errors do not halt the terminal processor. Instead, the terminal is forced to Local mode, and an error code character is displayed in the upper-left corner of the screen.

There are five types of non-fatal errors:

1. (RAM) Program RAM or display RAM error
2. (NVM) Non-volatile memory error
3. (KBD) Keyboard missing or malfunction
4. (SIO) Serial or peripheral data loopback error
5. (EIA) EIA modem control error

Non-Fatal Error Codes

Character Displayed	Fault Detected					Character Displayed	Fault Detected				
	RAM	NVM	KBD	SIO	EIA		RAM	NVM	KBD	SIO	EIA
1	X					@					X
2		X				A	X				X
3	X	X				B		X			X
4			X			C	X	X			X
5	X		X			D			X		X
6		X	X			E	X		X		X
7	X	X	X			F		X	X		X
8				X		G	X	X	X		X
9	X			X		H				X	X
:		X		X		I	X			X	X
;	X	X		X		J		X		X	X
<			X	X		K	X	X		X	X
=	X		X	X		L			X	X	X
>		X	X	X		M	X		X	X	X
?	X	X	X	X		O	X	X	X	X	X

FAULT TYPES

RAM = Random Access Memory
NVM = Non-Volatile Memory
KBD = Keyboard
SIO = Serial Input/Output
(serial and peripheral interfaces)
EIA = SIO Control Signals
(serial and peripheral interfaces)

Possible Bad IC by Grid Location

7H, 1M, 1N, 1P, 1R
7A, 7B, 2C
6A, 3B, 5D

1D, 3D, 4D, 1B, 2B, 3B

Invoked Self-Test - ANSI Mode Only (ESC [2; P_s y)

This command is used to start one or more of the various self-tests on the Teleray. The selective parameter (P_s) indicates which test(s) is to be performed. The parameter value is arrived at by taking the weight of each test and adding them together. A parameter value of 0 causes a reset.

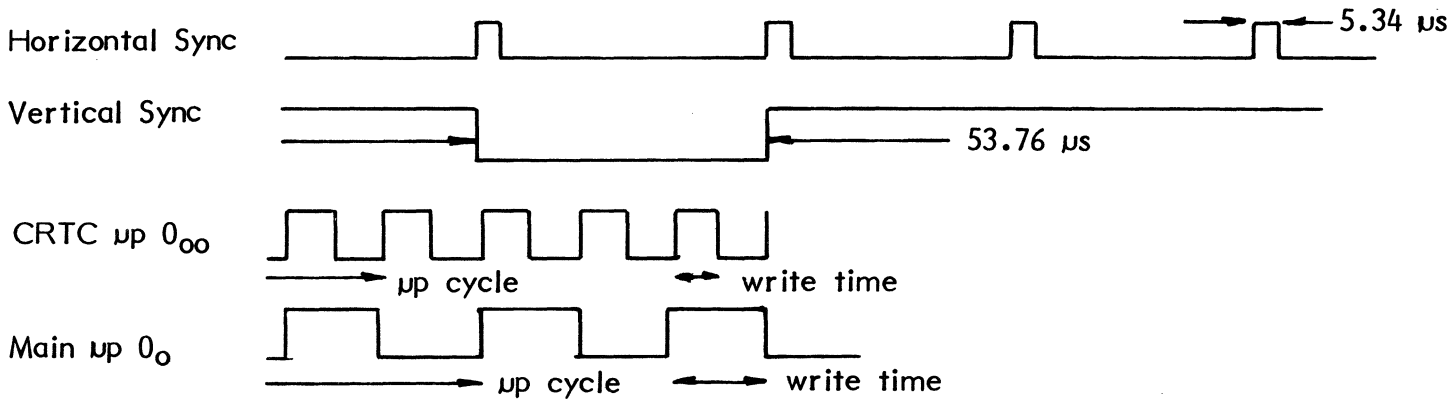
Test	Weight
Power-up checksum	1
Interface Test (Loop Back)	2 (Turn-around plugs needed)*
EIA Test	4 (Turn-around plugs needed)*
Repeat tests until power-off	8

*Tests peripheral interface as well as serial interface; therefore, both plugs are needed. A turn-around plug can be manufactured by using a DB25P connector with the following connections (only).

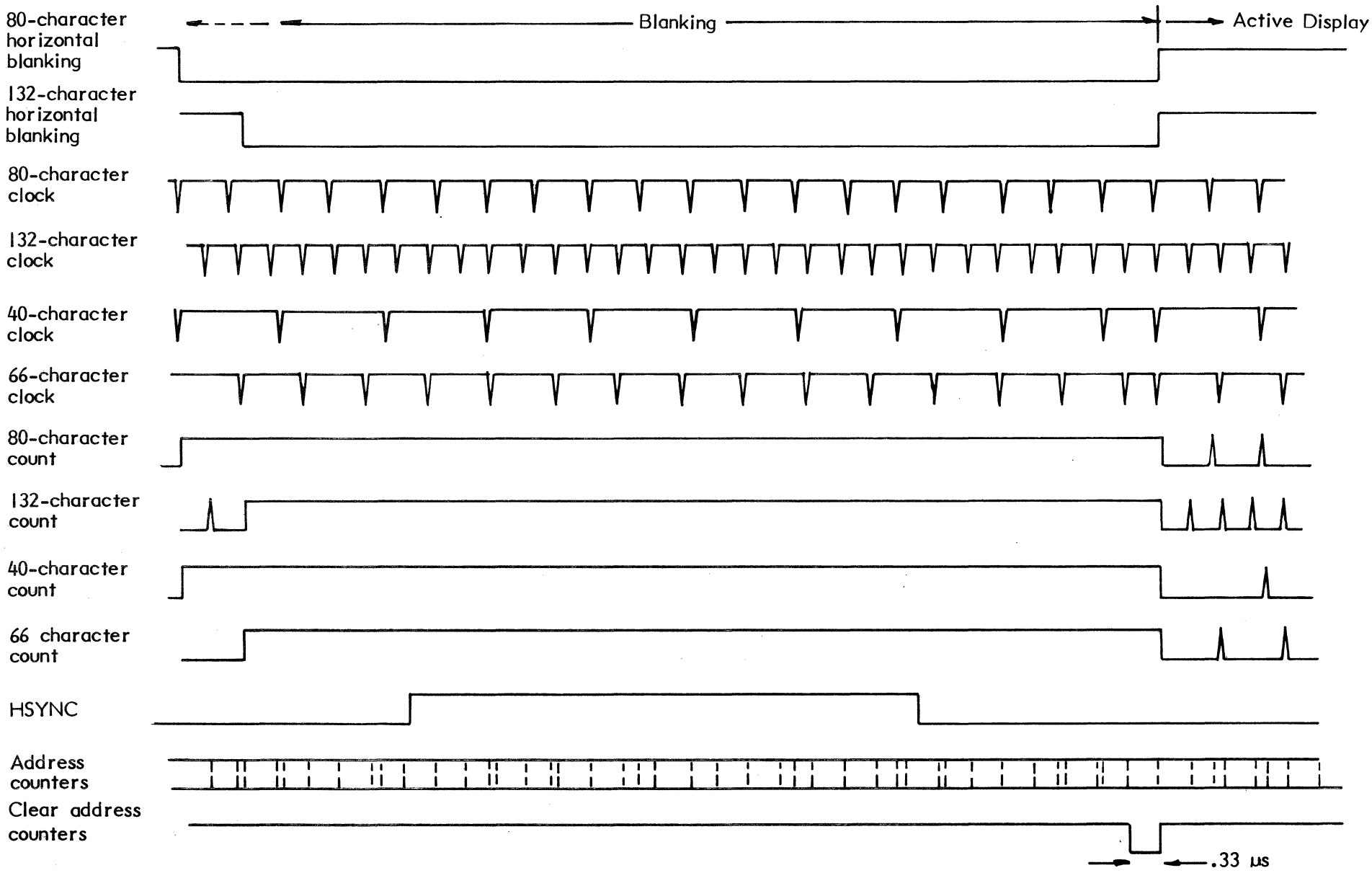
Pin 2 to Pin 3
Pin 4 to Pin 5
Pin 8 to Pin 20

C. Timing Charts

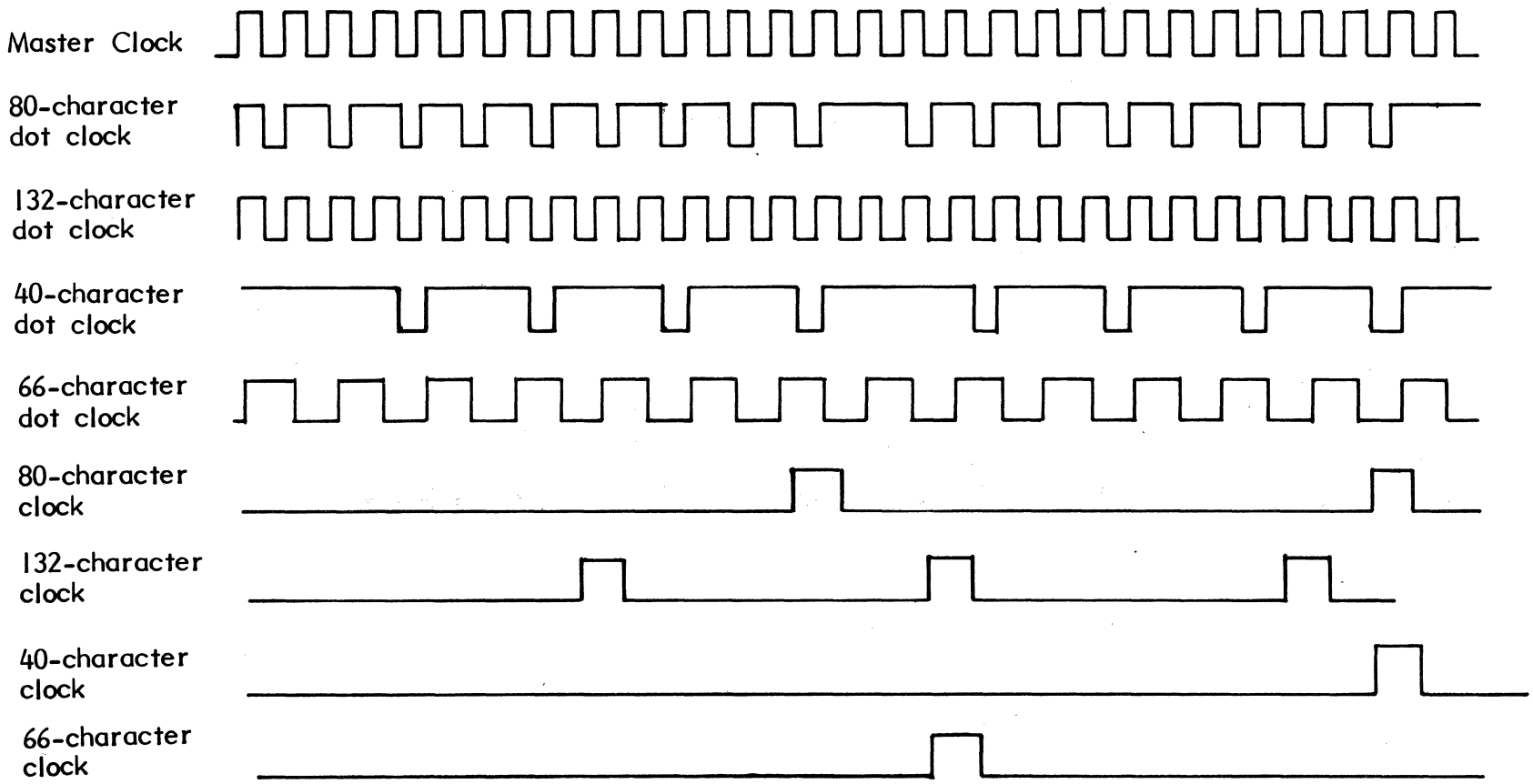
Horizontal Sync, Vertical Sync and Microprocessor Timing



Character Clock and Horizontal Clock Timing Diagrams



Character Shift and Load Timing Diagrams



D. Logic Module Test Points

The following is a list of some important test points and the signal that should be present on each. More test points are listed on the schematic in Section E.

Test Point	Description
MC	Master clock should be oscillating at 23.9568 MHz.
0_2	Main processor clock input; .9414 MHz square wave.
RES	Main microprocessor reset input. Should be at high level except during power-up.
CC	Load shift register character clock. See timing diagram.
HS	Horizontal sync output. Should be a 5.34 us high pulse with a 53.76 us period.
VS	Vertical sync output. Should be a 53.76 us low pulse with a 1/50 or 1/60 second period.
IRQ	Main microprocessor input/output interrupt request. If microprocessor is not busy, should be low pulse with about an 860 us period.
NMI	Main microprocessor display interrupt request. Most common interval is a 53.76 us low pulse with a 645 us period.
KR KT	Keyboard serial receive. Keyboard serial transmit. When the keyboard is operating, there will be an asynchronous character received and an asynchronous character response transmitted with about a 150 ms period.

E. Logic Module Schematics

0D059552-001	Schematic - PCB Model 100
KB050940	Schematic - Current Loop/Source Option

REVISIONS					
ENG	ECO	SYM.	DESCRIPTION	DRAFT.	DATE
LAK	1826	2	ADDED INVERTER (6R) AT HL-15; 3F-12 WAS CONNECTED TO 5K-12; 5F-12 WAS CONNECTED TO 6P-6; 3F-5 WAS CONNECTED TO 1E & 1F-15; UPDATE UNUSED IC PORTIONS; 6C-1 WAS AT A13; 6C-3 WAS AT A12; 6C-13 WAS AT A11; 7C,D,E,6-18 WAS AT 6D-3	LK	1-20-81

JUMPERS:

A. SYSTEM PROGRAM ROM - 5 JUMPER SETS

1) STANDARD ARRANGEMENT IS FOR 2716 TYPE EPROM
2) ALTERNATE FOR 2532 (TI) TYPE EPROM
3) ALTERNATE FOR 2732 (INTEL) TYPE EPROM
4) ALTERNATE FOR 8K x 8 BYTE ROM
5) ALTERNATE FOR 2K x 8 BYTE RAM

B. BOLD ATTRIBUTE - 1 JUMPER SET

1) STANDARD BOLD ATTRIBUTE
2) ALTERNATE DIM ATTRIBUTE

C. DOWN LOAD ALTERNATE CHARACTER GENERATOR - 1 JUMPER SET

1) STANDARD ROM ALTERNATE CHARACTER GENERATOR
2) ALTERNATE DOWN-LOADABLE RAM ALTERNATE CHARACTER GENERATOR. (EXTRA HARDWARE AND SOFTWARE IS NEEDED.)

D. HORIZONTAL REFRESH RATE - 2 JUMPER SETS

1) STANDARD 18.6 KHZ HORIZONTAL RATE
2) ALTERNATE 15.6 KHZ HORIZONTAL RATE

(A CHANGE IN HARDWARE AND SOFTWARE IS NEEDED FOR 2)

E. CURRENT LOOP (CLP) - ADD RI ASSEMBLY KB050939-001 INTO 1C AND 2C ON LOGIC BOARD WITH BOARD NUMBER AWAY FROM POWER CONNECTOR.

F. COMPOSITE VIDEO - ASSEMBLE TO LOGIC BOARD NEAR 5A RI 0C060877-001 AND CONNECT LEAD TO COMP. VIDEO TEST POINT.

SIGNAL DESIGNATION

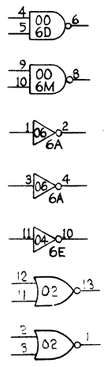
ABBREVIATION	DEFINITION
ø₀₀	6503 CPU AND 6551 UART CLOCK INPUTS
ø₀	6502 CPU CLOCK INPUT
R/W	READ/WRITE
RES	RESET
TIMER	1162.5 HZ TIMER INTERRUPT
NUM	NON-VOLATILE MEMORY
I/O	INPUT/OUTPUT
INVERSE	INVERSE SCREEN
SS	SMOOTH SCROLL
50/60	50/60 HZ SCREEN REFRESH
BLINK	BLINK ATTRIBUTE
SOSE	START OF SCAN ENABLE
WIDE	WIDE CHARACTER
132/80	132/80 COLUMNS
FOREGROUND	CHARACTER DISPLAY MEMORY
BACKGROUND	OVERSTRIKE OR ATTRIBUTE DISPLAY MEMORY
CC	CHARACTER CLOCK
H SYNC	HORIZONTAL SYNC
V SYNC	VERTICAL SYNC
COMP VIDEO	COMPOSITE VIDEO
SCAN ø	FIRST SCAN OF CHARACTER LINE
SCAN 11	LAST SCAN OF CHARACTER LINE
SCANS	SCAN COUNT DATA
H BLANK	HORIZONTAL BLANKING
V BLANK	VERTICAL BLANKING
C LOAD	DOT SHIFT REGISTER CHARACTER LOAD CLOCK
DC	DOT CLOCK

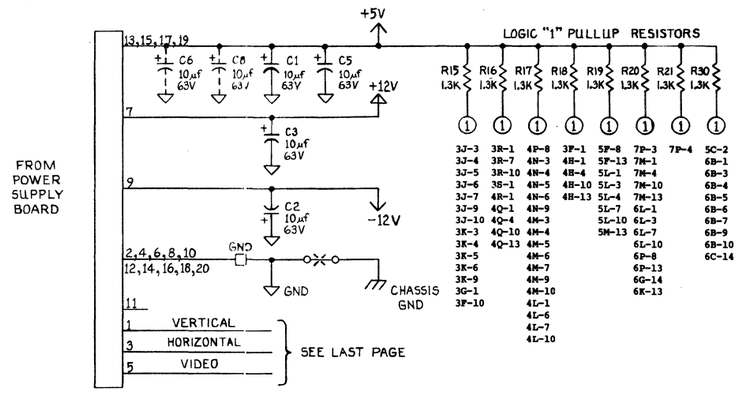
TEST POINTS

CODE	DESCRIPTION
SR	SERIAL I/O RECEIVE
ST	SERIAL I/O TRANSMIT
COMP VIDEO	COMPOSITE VIDEO
HS	HORIZONTAL SYNC (ACTIVE HIGH)
VS	VERTICAL SYNC (ACTIVE LOW)
GND	GROUND
GND	GROUND
GND	GROUND
BELL	BELL SHUTOFF JUMPER
BELL	
KR	KEYBOARD RECEIVE
KT	KEYBOARD TRANSMIT
PT	PERIPHERAL INTERFACE TRANSMIT
RES	RESET
IRQ	CPU INTERRUPT REQUEST
ø2	CPU CLOCK INPUT
NMI	CPU NON-MASKABLE INTERRUPT
CC	CHARACTER CLOCK
HB	HORIZONTAL BLANKING
MC	MASTER CLOCK 23.9568 MHZ

DES	TYPE	+5V	-12V	+12V	GND
00	74LS00	14			7
02	74LS02	14			7
04	74LS04	14			7
06	7406	14			7
08	74LS08	14			7
74	74LS74	14			7
107	74LS107	14			7
155	74LS155	16			8
163	74LS163	16			8
165	74LS165	16			8
257	74LS257	16			8
259	74LS259	16			8
374	74LS374	20			10
8304	8304	20			10
88	1488		1	14	7
89	1489	14			7
6502	6502	8			1,21
S00	74S00	14			7
S04	74S04	14			7
555	555	8			1
451	75451				
S86	74S86	14			7
S157	74S157	14			7
081			4	7	
6503A		5			2
6551		15			1
ROM	2716	24			12
RAM	6116	24			12

UNUSED IC PORTIONS





		D059553
INVENTORY	USED ON	ASSEMBLY

DRAFTSMAN MDS 10-30-80	K = 10^3 M = 10^6	UNLESS OTHERWISE INDICATED: ● RESISTANCE IN OHMS ± 10% ½ WATT ● CAPACITANCE IN MFD ± 20% ● INDUCTANCE IN HENRIES ● USE 60/40 ROSIN CORE SOLDER ● USE NO CORROSIVE FLUX	INVENTORY
CHECKED	CONNECTION NO CONNECTION		
APPROVED 11-5-80			
TITLE SCHEMATIC- PCB MODEL 100		NUMBER 0D059552-001	REV 2
		SHEET 1 OF 3	

R·I CONTROLS — A DIVISION OF RESEARCH, INCORPORATED MINNEAPOLIS, MINNESOTA 55424

FD2500A

MASTER RESET CIRCUIT AND CENTRAL PROCESSING UNIT
CPU CLOCK FREQUENCY = .9214 MHZ

TIMER INTERRUPT CIRCUIT
FREQUENCY = 1162.5 HZ

DISPLAY MEMORY,
FOREGROUND AND BACKGROUND

PAGES, WITH ASSOCIATED CHARACTER ADDRESS CKTS. DISPLAY MEMORY DOWN LOADS INTO THE LINE MEMORY DURING SCAN Ø.

UARTS

SYSTEM RAM

START OF SCAN REGISTER

START OF LINE REGISTER (LOW)

S.O.L. (HIGH)

OUTPUT CONTROL REGISTER

INPUT CONTROL REGISTER

-30V GENERATOR

(NVM) NON-VOLATILE MEMORY

SYSTEM PROGRAM ROM JUMPERS
FOR 16K OR 32K EPROM OR 64K ROM

SERIAL I/O 1A

PERIPHERAL INTERFACE 3A

KEYBOARD 4A

BELL

DATA BUS

ADDRESS BUS

ODO59552-001	REV 2
PAGE 2 OF 3	

MASTER TIMING FOR 132 COLUMN CHARACTER CLOCK AND HORIZONTAL REFRESH RATE. HORIZONTAL RATE = 18.6 KHZ.

CPU AND UART MASTER CLOCK GENERATOR
Ø00 = 1.843 MHZ
Ø0 = .9214 MHZ

CRT CONTROL CPU AND ASSOCIATED CIRCUITRY

CRT CONTROL ROM

CRT CPU CONTROLS VERTICAL TIMING, SCAN COUNTERS AND SCAN Ø OR START OF LINE TIMING.

INPUT REGISTER

OUTPUT REGISTER

80 COLUMN DOT CLOCK GENERATOR

80 COLUMN CHARACTER CLOCK

HORIZONTAL SYNC AND BLANKING GENERATORS

80/130 COLUMN MULTIPLEXER

WIDE MODE MULTIPLEXER

FOREGROUND AND BACKGROUND LINE MEMORIES AND ASSOCIATED CIRCUITRY

OVER STRIKING CHAR GEN

ASCII CHARACTOR GENERATOR

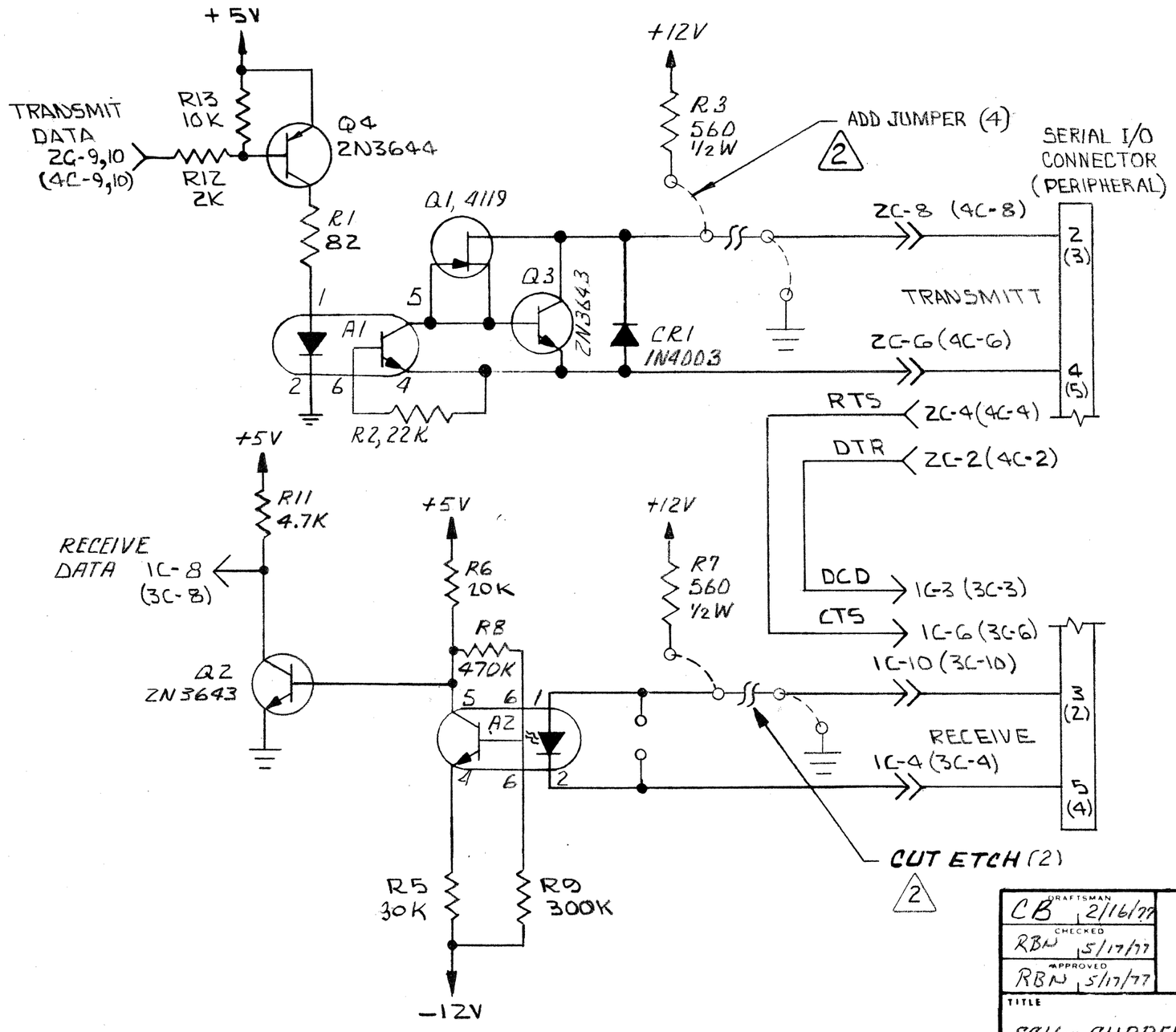
ALTERNATE CHARACTOR GENERATOR

VIDEO ATTRIBUTE LOGIC

CHANGE BOLD TO DIM

CONTRAST CONTROL REGISTER

OD059552-001	REV 2
PAGE 3 OF 3	



REVISIONS

SYM.	DESCRIPTION	DRAFT.	DATE
A		ASW	4-5-77
B	CHG R9 TO 27K, WAS 22K	~~DB~~	5-16-77
C	ADD INV NO	SJ	10/11/77
D	ADDED Q4, R12,13	AKB	11-23-77
E	REMOVED R10, R4, R1 WAS 100, R6 WAS 5.1K R9 WAS 27K, R5 WAS 7.5K	AKB	12-13-77
F	R6 WAS 43K, & R5 WAS 68K	SJ	3/21/78
G	2C-9 TIED TO 2C-10 ARTWORK CHG	MDG	10/6/78
H	DTR, 2C-2 & 4C-2 WERE DTS, 2C-3, 4C-3	AKB	2-19-79
J	DOCUMENTED FOR IMS	SJT	12-18-79

NOTES:

1. FOR MAIN I/O CURRENT LOOP INSTALL IN POSITIONS 1C, 2C AND FOR PERIPHERAL CURRENT LOOP, INSTALL IN POSITION 3C & 4C.
2. CUT ETCH (2) AND ADD JUMPERS (4) FOR CURRENT SOURCE OPTION.

	4041	B50939-2
	4041	B50939-1
INVENTORY	USED ON	ASSEMBLY

DRAFTSMAN CB 2/16/77	K = 10^3 M = 10^6	UNLESS OTHERWISE INDICATED
CHECKED RBN 5/17/77	+ CONNECTION + NO CONNECTION	• RESISTANCE IN OHMS ± 10% ¼ WATT • CAPACITANCE IN MFD ± 20% • INDUCTANCE IN HENRIES • USE 60/40 ROSIN CORE SOLDER • USE NO CORROSIVE FLUX
APPROVED RBN 5/17/77		INVENTORY

TITLE: SCH - CURRENT LOOP/SOURCE OPTION

NUMBER: KB050940-2 REV: K

SHEET 1 OF 1

R·I CONTROLS — A DIVISION OF RESEARCH, INCORPORATED, MINNEAPOLIS, MINNESOTA 55424

TELEDYNE POST (4-75)

F. Parts Lists

PARTS LIST

Title: ASSY, 100 LOGIC BOARD Rev. 4

Item	Description	Inventory No.
1	IC-Control Store 100 Series, 7C, 7D, 7E	00060667-001
2	IC-MOS, Microcomputer, 6502, 5C	00055130-000
3	IC-TTL, 74LS00, 3G, 5G, 5Q, 5R, 6D, 6M	
4	IC-TTL, 74LS02, 5E, 6Q, 7N	00055118-000
5	IC-TTL, 74LS04, 5A, 6E, 6N, 6R	00055124-000
6	IC-TTL, 74LS08, 3M	00055127-000
7	IC-TTL, 74LS74, 4H, 4Q, 7M	00055252-000
8	IC-TTL, 74LS107, 3F, 4P, 5F, 5M, 6K, 6P	00055125-000
9	IC-TTL, 74LS155, 3L, 5S, 6C, 6G, 7L	00055131-000
10	IC-TTL, 74LS163, 3K, 3R, 3S, 4M, 4N, 4R, 6B, 6L	00055113-000
11	IC-TTL, 74LS165, 1E, 1F	00055114-000
12	IC-TTL, 74LS257, 2R, 2S, 4S, 6F, 6J	00055138-000
13	IC-TTL, 74LS259, 7K	00055111-000
14	IC-TTL, 74LS374, 2G, 2K, 3E, 3N, 3P, 5H, 3H, 6H	00055112-000
15	IC-TTL, 74LS00, 4F, 4G, 5N, 5P	00055135-000
16	IC-TTL, 74LS04, 5K	00055136-000
17	IC-TTL, 75451 PRHL DRVR, 1F	00058269-001
18	IC-TTL, 74S86, 4E	00058247-001
19	IC-TTL, 74S157, 4J, 5J	00058249-001
20	IC-TTL, 7406, 2E, 2F, 6A	00055122-000
21	IC-TTL, 8304, 1L, 2M, 2N, 2P	00055116-000
22	IC-TTL, 1488, 1488-5, 1B	00055121-000
23	IC-TTL, 1489, 1489-5, 75189, 2B, 3B	00055120-000
24	IC-LIN, 081, 2C	00058147-001
25	IC-LIN, Timer, 555, 1455P1, 4B	00055188-000
26	IC-MOS, CPU, 6503A, 2MHZ, 7P	00058250-001
27	IC-MOS, 1Kx4 Erasable ROM, 7A, 7B	00058260-001
28	IC-MOS, UART, 6551, 1D, 3D, 4D, 5D	00058277-001
29	IC-MOS, 2Kx8 RAM <=300NS, 2H, 2K, 1M, 1N, 1P, 1R	00058251-001
30	OSC-Crystal, 23.9568 MHZ, 4K	00058261-001
31	Res-Net, SIP, 10K, 10-Pin, RP1, RP2	00058265-001
32	Cap-.001MFD/1000V,DISC	00057737-001
33	Res-Carbon, 1/4W, 5%, 1M, R26, R27	00054984-135
34	Res-Carbon, 1/4W, 5%, 3.3K, R22, R23, R29	00054984-075
35	Res-Carbon, 1/4W, 5%, 1.3K, R15, R16, R17, R18, R19, R20, R21, R23, R30	00054984-066
36	Res-Carbon, 1/4W, 5%, 1K, R24, R5	00054984-063
37	Res-Carbon, 1/4W, 5%, 510, R3	00054984-056
38	Res-Carbon, 1/4W, 5%, 390, R13, R14	00054984-053
39	Res-Carbon, 1/4W, 5%, 270, R6	00054984-049
40	Res-Carbon, 1/4W, 5%, 180, R9	00054984-045
41	Res-Carbon, 1/4W, 5%, 120, R2, R8, R10	00054984-041
42	Res-Carbon, 1/4W, 5%, 100, R11	00054984-039

PARTS LIST, Continued

Item	Description	Inventory No.
43	Res-Carbon, 1/4W, 5%, 56, R4	00054984-033
44	Res-Carbon, 1/4W, 5%, 22, R1	00054984-023
45	Res-Carbon, 1/4W, 5%, 10, R25, R28	00054984-015
46	Res-Carbon, 1/2W, 5%, 68, R12	00054986-035
47	Diode-Switching, IN914, CR1, CR2, CR3	00057565-000
48	Res-Carbon, 1/4W, 5%, 130, R7	00054984-042
49	IC-Char Gen 100 Series, CG1, 1H	00060669-001
50	IC-Char Gen 100 Series, CG2, 1G	00060878-001
51	IC-Control Store 100 Series, 7R	00060668-001
52	Assy-Conn. Rcpt. PCB, 25-Pin, 1A, 1B	00061674-001
53	Conn-Rcpt., Flat, PCB, 20-Pin	00055080-001
54	Connector-Modular, 4-Pin, 4A	00058262-001
55	Cap-10MFD/63V, Elec, C2, C3, C4, C8	00057776-001
56	Cap-270PF/1000V, Disc, C9, C10	00057650-003
57	Cap-.1MFD/50V, Mono	00057661-001
58	Polarizing Key-3M	00055017-008
59	Alarm-Audio Transducer, 4C	00057546-003
60	IC-TTL, 74S163, 3J, 4L, 5L	00061242-001

PARTS LIST

Title: ASSY, CURRENT LOOP (Optional) #B50939 Rev. E

Item	Description	Part No.	Inventory
1	Sch-Current Loop/Source, 1061	B50940	3D2017
2	Transistor C1	1TE4119	34B0155
3	Transistor Q2, Q3	2N3643	34B0114
4	Transistor Pad Q2, Q3	7717-8IN WHT	5A0209
5	Diode CR1	1N4003	32C0133
6	IC-Lin, Phototrans Opto-Isolat A1, A2	IL-1	33B0130
7	Resistor-82, 1/4W, 5%, Carbon R1		14C0652
8	Resistor-20K, 1/4W, 5%, Carbon R6		14C0409
9	Resistor-30K, 1/4W, 5%, Carbon R5		14C0657
10	Resistor-22K, 1/4W, 5%, Carbon R2		14C0280
11	Resistor-560, 1/2W, 5%, Carbon R3, R7		14C0151
12	Wire-#24, Blk, PVC	W76B	10C0223
13	Resistor-4.7K, 1/4W, 5%, Carbon R11		14C0284
14	PCB Connector, 14-Pin	614-AG1	4A0447
15	Resistor-470K, 1/4W, 5%, Carbon R8		14C0279
16	Resistor-27K, 1/4W, 5%, Carbon R9		14C0295
17	Resistor-300K, 1/4W, 5%, Carbon R12		14C0488
18	Resistor-10K, 1/4W, 5%, Carbon R13		14C0267
19	Transistor Q4	2N3644	34B0111

ORDERING INFORMATION

1) For ordering information and latest prices, contact your local representative or the RESEARCH Incorporated factory in Minneapolis, Minnesota.

2) When ordering spare parts, please include references both to this parts list number and revision level, and the model number and serial number of the instrument for which these parts are being ordered.