TECHNICAL MANUAL

METRON VECTORSURGE 4

INTERFERENTIAL THERAPY UNIT

MODEL VS-400/450

Prepared by
Metron Medical Australia P/L
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1. SPECIFICATIONS

MAINS POWER SUPPLY REQUIREMENTS:

Voltage	110 - 120 Volts AC or 220 - 240 Volts AC
Frequency	50/60 Hz
Power	45 VA Nominal

FUSES:

Primary External 110V Series	2 of 1 A 5x20 mm Delay
Primary External 220V Series	2 of 500 mA 5x20 mm Delay
Secondary	1 of 4 A 5x20 mm Delay

MAINS TRANSFORMER:

Chassis mounted toroidal transformer manufactured to comply with international safety standards and test specifications for transformers in electromedical equipment.

Secondary Voltages	30 Volts AC (C/T) @ 2 A

OUTPUT SPECIFICATION:

Maximum current in each patient circuit	60 mA average
Maximum voltage in each patient circuit	120 V peak-to-peak
Current Surge Programmes	Disabled or Enabled
Enabled	Rise 0 - 20 seconds On 0 - 20 seconds Fall 0 - 20 seconds Off 0 - 80 seconds
Waveform Beat Frequencies	
Preset Ranges	0 - 15 Hz 0 - 150 Hz 80 - 120 Hz
Adjustable Range	0 - 300 Hz
Current Waveform Type	Rectangular
Waveform Pulse Frequencies	2, 4 or 10 kHz

Waveform Pulse Widths	50, 125 or 250 μs
Current Delivery Modes	2 or 4 Pole

ELECTRICAL SAFETY:

Manufactured to Australian standards:

AS 3100 - 1985	Definitions and general requirements for electrical materials and equipment.
AS 3200.1 - 1990	Approval and test specification - Electromedical equipment - General requirements (direct equivalent of IEC 601-1, 1988, Second edition).

Applied parts	Patient Connections (Interferential)
Patient circuit classification	BF
Chassis classification	1

DIMENSIONS:

Width	370 mm
Height	130 mm
Depth	410 mm

WEIGHT:

Packed	7.0 kg
Unpacked	6.0 kg

2. INTRODUCTION

This Manual presents all the relevant technical information for the Metron Vectorsurge 4 Interferential Therapy Unit, Model VS 400. This information is provided as a service to medical, paramedical, engineering and technical personnel. This information is intended for the fair purposes of maintenance and repair of the Vectorsurge. It is provided as commercial-in-confidence material to the distributor or equipment purchaser and shall not be made available to any other organisation or person without the specific written permission of Metron Medical Australia Pty Ltd. Refer to the Vectorsurge 4 Operator Manual for operator information.

This Manual describes the detailed operation of the electronic circuits, presents the necessary preventative maintenance calibration adjustments and provides all schematics and printed circuit board component legends.

While every attempt has been made to ensure that this manual is accurate and complete, no responsibility is taken for any errors or omissions. Product specifications and component types are subject to change without notice.

If you, as a user of this manual, have any relevant comment or questions on this manual, your communication with us would be welcomed. You may contact us by mail or fax as detailed below:

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Fax: (03) 775-1990 from within Australia or
+61 3 775 1990 International.

WARNING

* **The output current available at each patient circuit is of a magnitude sufficient to be potentially dangerous.**

* **The Vectorsurge 4 is a therapy device and may only be operated by qualified personnel.**

* **The Vectorsurge 4 must not be used in a trans-thoracic application (The patient circuit electrodes must not be positioned such that current flow is possible through the chest area).**

* **The Vectorsurge 4 must not be used on a person with an implanted cardiac pacemaker.**

3. SCHEMATIC DIAGRAM DESCRIPTION

This section describes the Vectorsurge 4 schematic diagrams. Reference should be made to the Printed Circuit Board (PCB) Component Legends contained in Section 5 and the Schematic Diagrams contained in Section 6.

The following should assist with the interpretation of the Schematic Diagrams. The Schematic Diagrams are organised in a heirachical manner; that is, each PCB has a master schematic with blocks containing descending schematic layers. Electrical connectivity is shown by continuous wires and net labels on partial wires within a schematic sheet or labelled modules between schematic sheets or blocks.

3.1 Main Printed Circuit Board

The Main PCB contains the following functions:

A. Microcontroller and Memory

B. Output Waveform Generators

C. +5 Volt DC and +15 Volt DC Power Supplies

3.1.1 Main PCB Master - Sheet 1 of 6

This schematic shows the overall design of the Main PCB. It contains the schematic blocks discussed below and the four connectors to the Power Transformer (JP3), Patient Circuit (JP4), Display PCB (JP1) and General Purpose Input/Output (JP2) which is unused but reserved for future expansion such as in combined instruments such as an Interferential Therapy/Ultrasonic Therapy Unit (Vectorsonic).

3.1.2 Main PCB Microprocessor & ROM - Sheet 2 of 6

This schematic shows the microcontroller (U7), EPROM (U5), EEPROM (U3), address decoder (U4) and low order address latch (U6).

The microcontroller contains a number of features and functions of which the following are utilised in the design:

A. CPU
B. RAM
C. Counter/Timers
D. Analog-to-Digital Converter with multiplexed analog inputs
E. Watchdog Timer
F. Digital Input/Output Ports

This section performs the following functions:

i. Generates all the signals for the control of the Display PCB displays and speaker

ii. Monitors the rotary and push-button switch inputs from the Display PCB

iii. Generates all the signals for the control of the Output Waveform Generators

iv. Monitors the voltage representing the output current in each patient circuit

3.1.3 Output Power Amplifiers - Sheet 3 of 6

This schematic shows the two schematic blocks for the two Output Waveform Generators. The two Output Waveform Generators are identical but are controlled and operate independently.

3.1.4 Blue Channel Output Waveform Generator - Sheet 4 of 6

This schematic shows one of the two identical Output Waveform Generators. The schematic comprises two major sections:

A. Power MOSFET switches, voltage transformer and current transducer

B. Programmable power supply

The Power MOSFET switches (Q13 & Q14) are switched on and off at the selected carrier frequency by the complementary drive signals DRIVE_BLUE & DRIVE_BLUE\) generated by the microcontroller. The Power MOSFET's alternately switch the output transformer (T11) limbs to ground. The programmable power supply voltage (V_BLUE) is applied to the output transformer centre tap.

The current waveform generated in the patient circuit is transduced to a voltage waveform by a current transformer (T12) and resistor (R107). The voltage waveform produced is half-wave rectified by a diode (D102) and filtered by a capacitor (C107) to generate a DC voltage (mA_BLUE). This voltage is proportional to the output current amplitude and is input to one of the microcontroller analog inputs. The microcontroller performs an analog-to-digital conversion of this voltage and the Blue Channel output current is displayed using a LED bar graph.

The programmable power supply voltage is controlled by a pulse-width modulated signal (PWM_BLUE) generated by the microcontroller. This voltage waveform is integrated by a resistor (R103) and capacitor (C101) network to generate a DC control voltage. This voltage is proportional to the duty cycle of the pulse-width modulated signal (PWM_BLUE).

The voltage regulator (U11) is a monolithic power switching regulator capable of delivering 2.5 A at a voltage variable from 5 V to 40 V in a step-down (Buck) configuration. This voltage regulator has output current limiting, soft start and thermal protection features. The capacitor (C104) connected to the SS input determines the soft-start time constant and the average maximum output current. The parallel resistor (R101) and capacitor (C102) network connected to the OSC input determines the switching frequency of

approximately 100 kHz. The parallel series resistor (R102) and capacitor (C105 & C103) network connected to the COMP input determines the regulation loop gain characteristics. The feedback voltage to FB input is compared to the internal reference voltage of 5.1 V to control the switching duty cycle and the regulated voltage.

To enable the voltage regulator to regulate down to 0 VDC, a constant voltage independent of the regulated voltage and equal to the voltage regulator's internal reference voltage is applied to the FB input. The Zero Adjust trim pot (RV101) provides adjustment of this voltage which is added to the inverted control voltage by the voltage adder circuit formed by the operational amplifier (U8D) and associated components.

The regulated voltage (V_BLUE) is divided by the resistor (R104) and trim pot (RV102) network. The Span Adjust Trim pot (RV102) provides adjustment of the fraction of the regulated voltage (V_BLUE) sampled and consequent regulated voltage span. This sampled voltage is added to the voltage output by the operational amplifier (U8D) by the voltage adder circuit formed by the operational amplifier (U8C) and associated components to generate the feedback voltage to the voltage regulator. The voltage regulator regulates the voltage (V_BLUE) such that voltage at the voltage regulator FB input is maintained at the voltage regulator's internal reference voltage of 5.1 V.

3.1.5 Black Channel Output Waveform Generator - Sheet 5 of 6

Refer to the Blue Channel Output Power Amplifier schematic block description - this schematic is identical.

3.1.6 Power Supplies - Sheet 6 of 6

This schematic shows the +5 VDC and +15 VDC power supplies. The +5 VDC (VCC) power supply is generated by a monolithic switching regulator (U1). The +15V DC (VDD) power supply is generated by a linear regulator (U2).

3.2 Display Printed Circuit Board

The Display PCB contains the following functions:

A. Rotary encoder and push-button switches
B. Piezo loud speaker
C. Digital LED displays
D. Discrete LED displays
E. Bar LED displays
F. Display drivers

3.2.1 Display PCB Master - Sheet 1 of 4

This schematic shows the overall design of the Display PCB. It contains the schematic blocks discussed below and the connectors to the Main PCB,

rotary encoder and push-button switches, rotary encoder debounce circuit formed by the Schmitt trigger NAND gates (U13) and associated components and the piezo loud speaker.

3.2.2 Digital Displays - Sheet 2 of 4

This schematic shows the Treatment Timer and Sweep Frequency digital seven segment LED displays and their display driver U1. The display driver's unused capacity is used to drive the discrete LED displays (see below).

3.2.3 Discrete LED Displays - Sheet 3 of 4

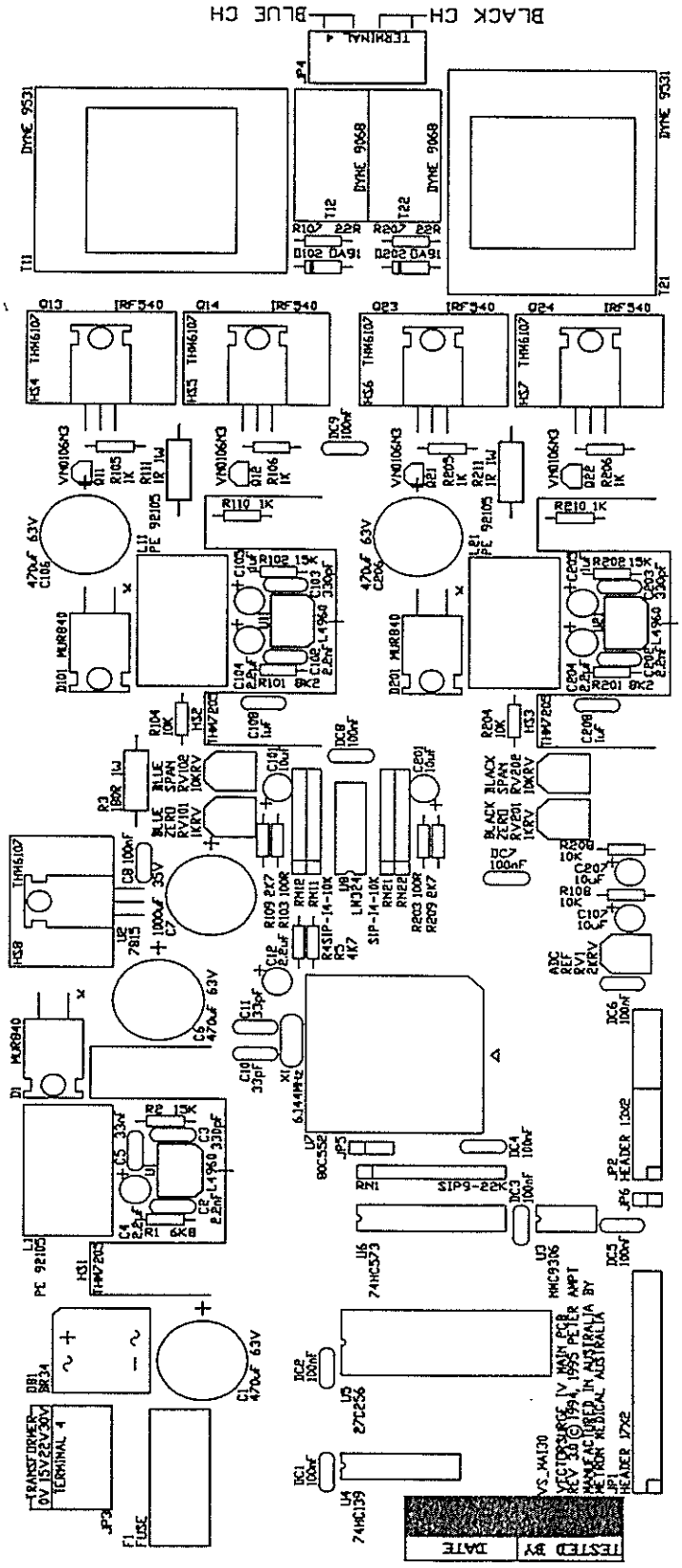
This schematic shows the discrete LED displays.

3.2.4 Bar LED Displays - Sheet 4 of 4

This schematic shows the two Output Current and Surge Status bar LED displays and their display driver (U2).

5. SCHEMATIC DIAGRAMS

5.1 Main Printed Circuit Board



4. PREVENTATIVE MAINTENANCE

4.1 Calibration Procedure

Equipment Required:

A. Two 1 kohm 10 Watt resistors

B. Dual Trace Oscilloscope with 1 MHz Bandwidth

C. Vectorsurge 4 Operator's Manual

Procedure:

i. Set all trim pots (RV101, 102, 201 & 202) to mid position and RV1 fully anti-clockwise.

ii. Connect the 1 kohm resistors across the patient output channels and connect the oscilloscope probes across the resistors.

iii. Set the oscilloscope vertical sensitivity to 0.5 V/div.

iv. Turn the unit on and press start. Do not adjust the Intensity Control. Disable the Surge mode.

v. Adjust the two Zero Adjust trim pots (RV101 & 201) until the voltage measured across both patient output channels is as near to zero as possible.

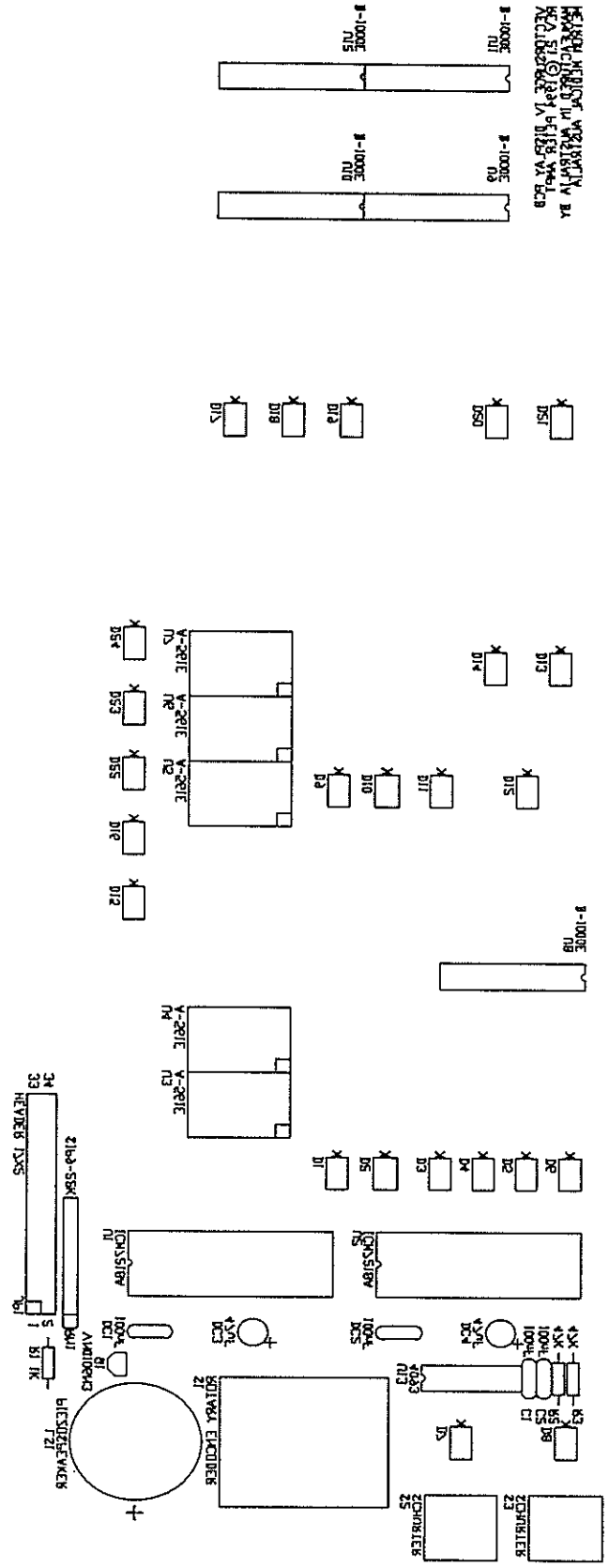
vi. Set the oscilloscope vertical sensitivity to 20 V/div.

vii. Adjust the Vectorsurge Intensity Control until the voltage measured across the Blue patient output channels is 80V peak-to-peak.

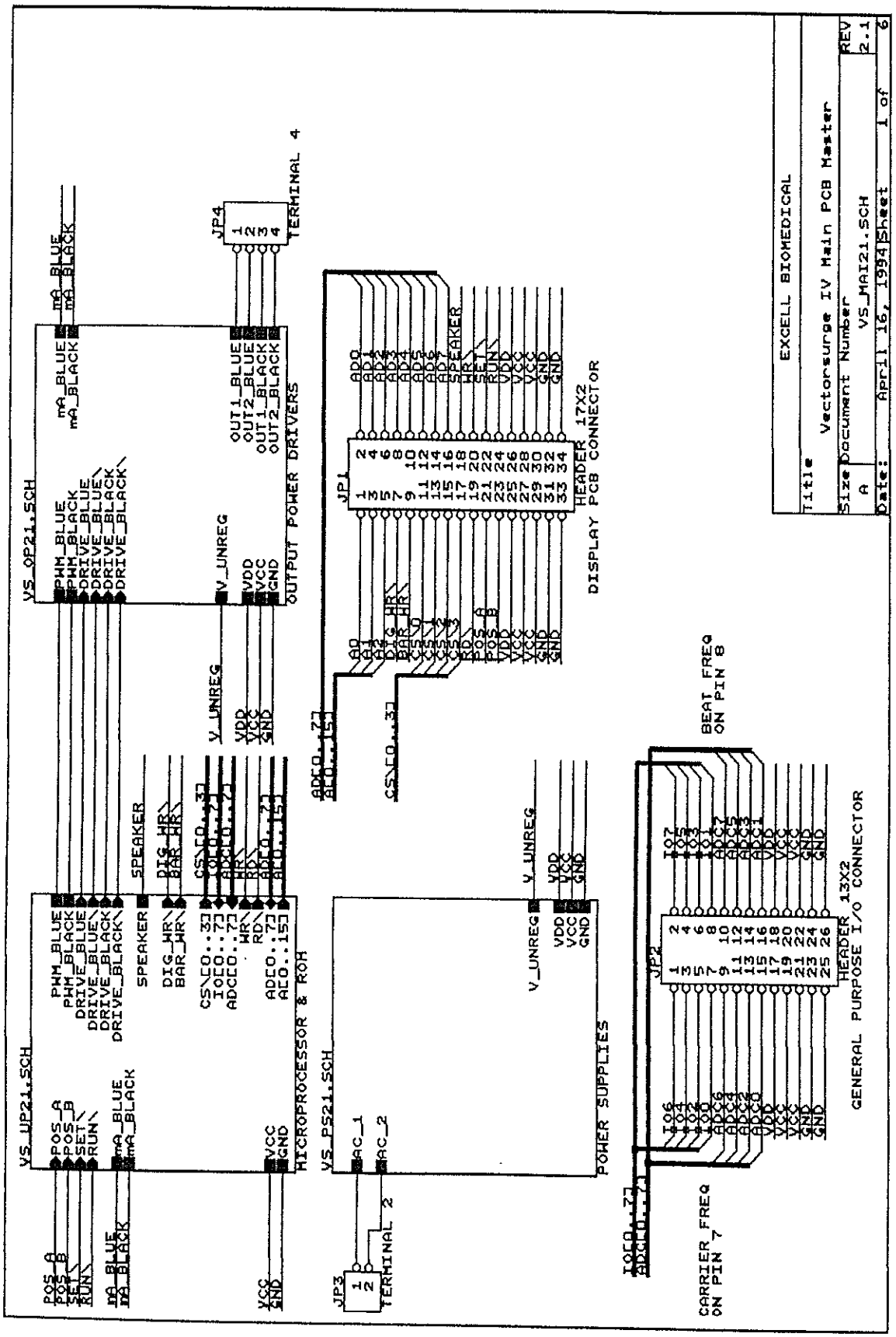
viii. Adjust the Black Channel Span Adjust trim pot (RV202) until the voltage measured across the Black patient output channels is equal to the voltage measured across the Blue patient output channel (80V peak-to-peak).

ix. Adjust the ADC Reference trim pot (RV1) until the illuminated segments of the Output Current bar LED displays just attain 40 mA.

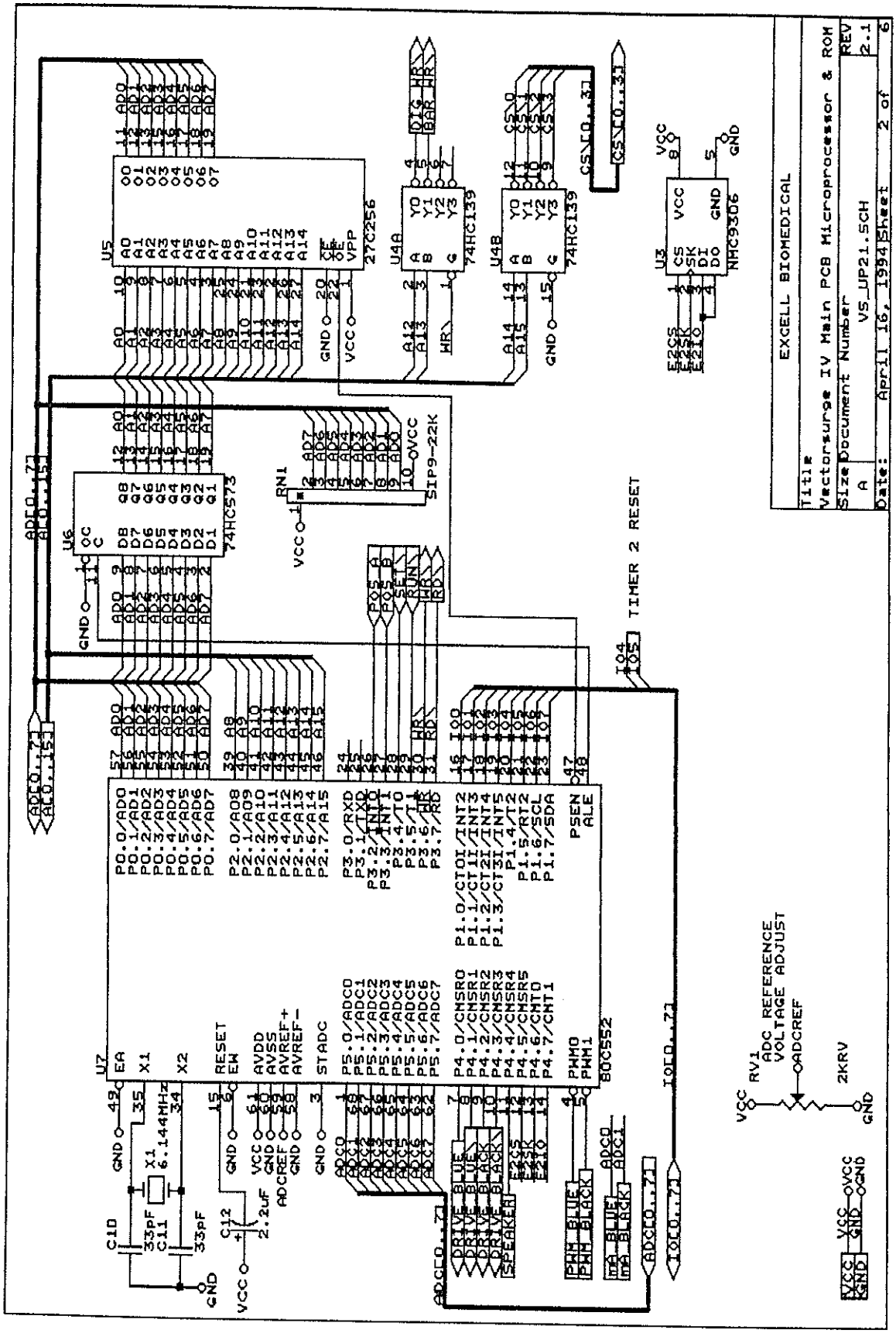
5.2 Display Printed Circuit Board



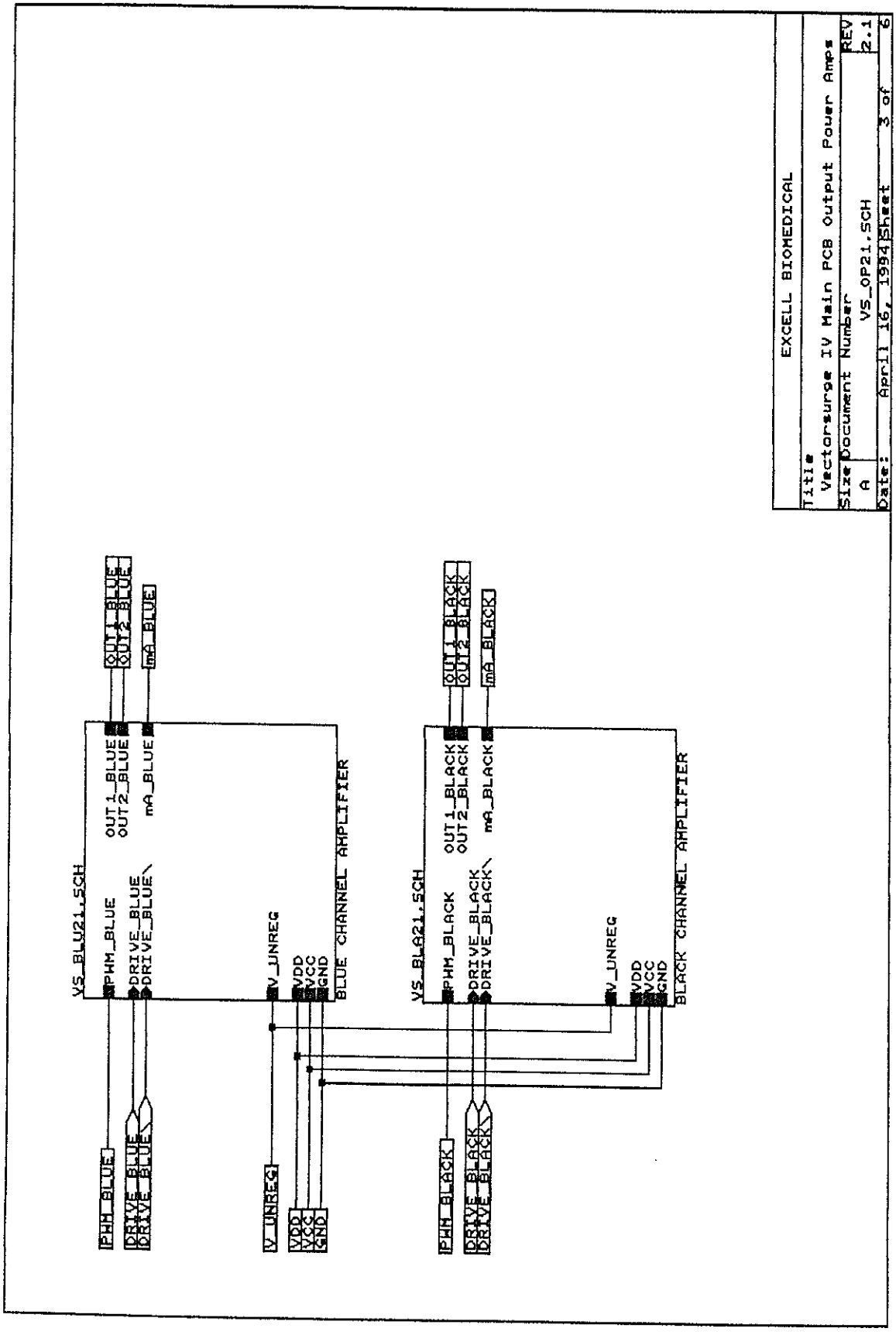
5.3 Main PCB Master



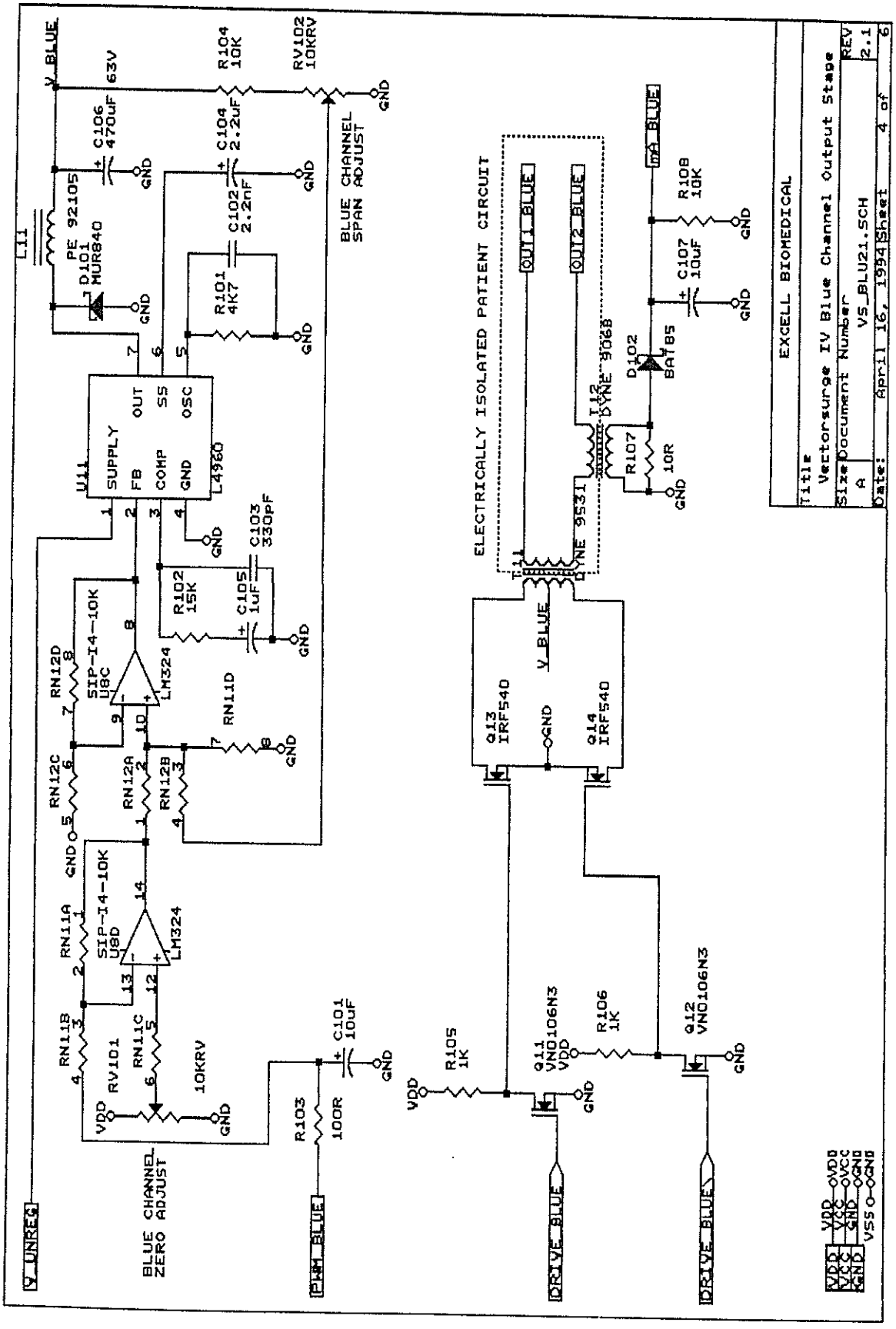
5.4 Main PCB Microprocessor & ROM



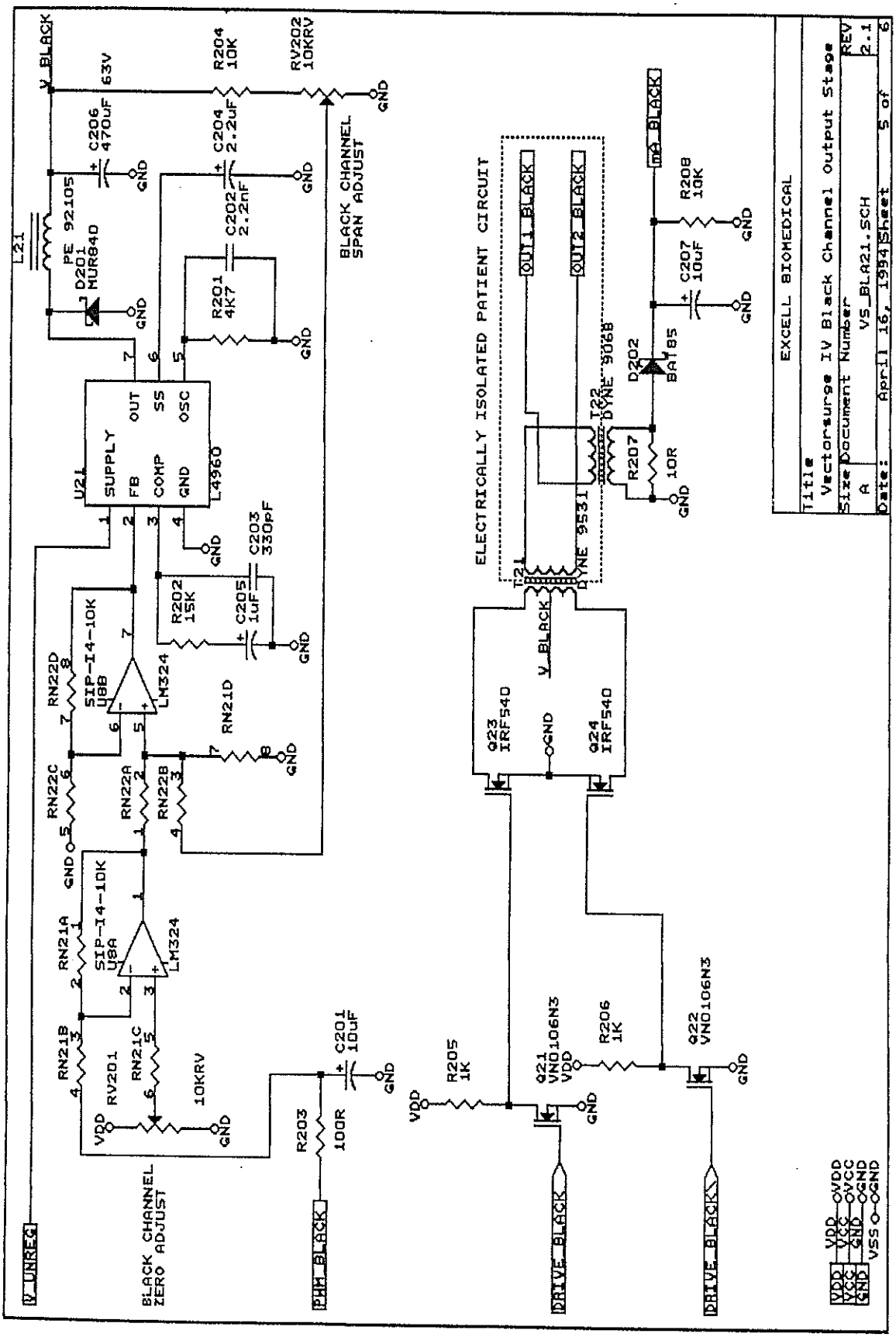
5.5 Output Power Amplifiers



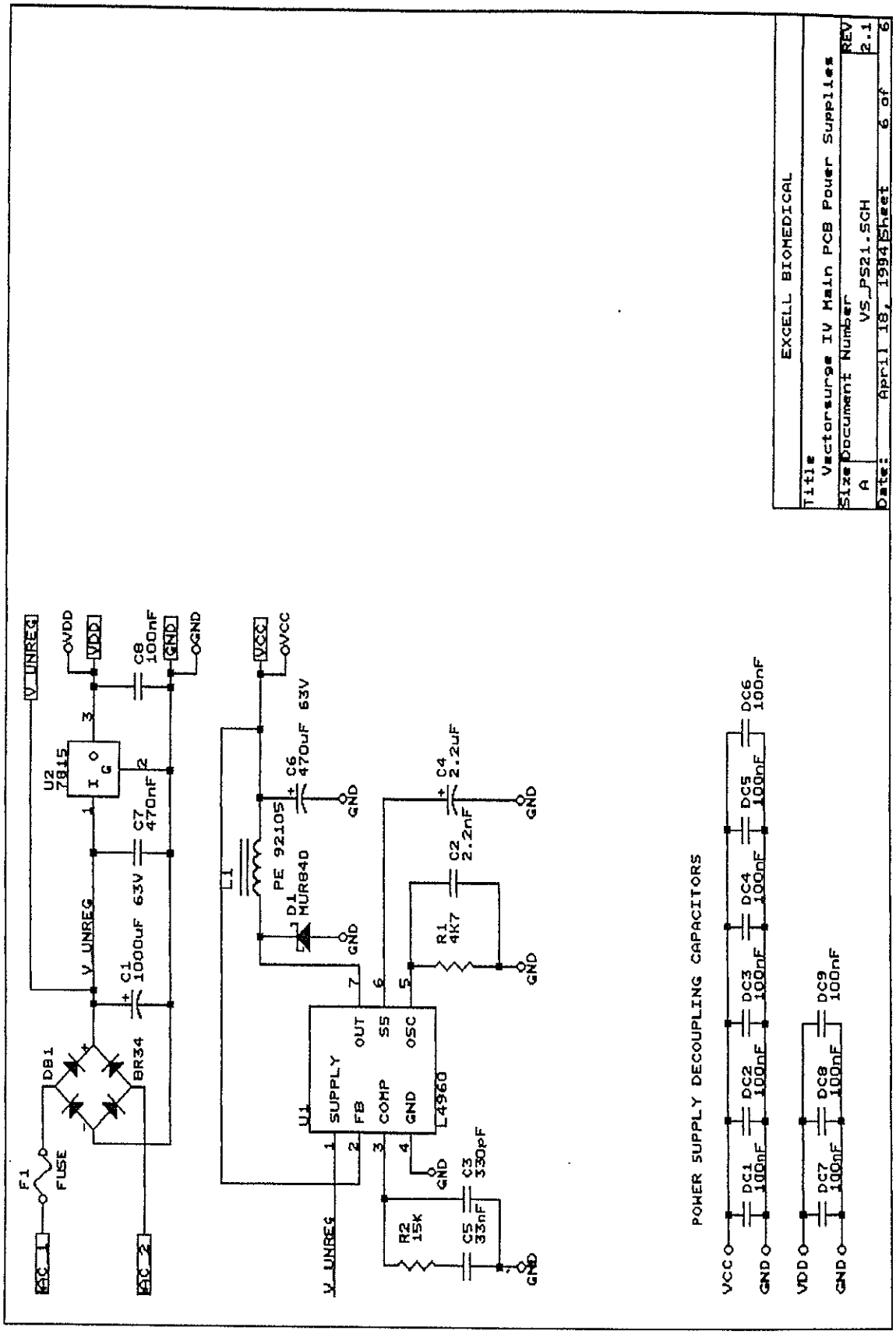
5.6 Blue Channel Output Waveform Generator



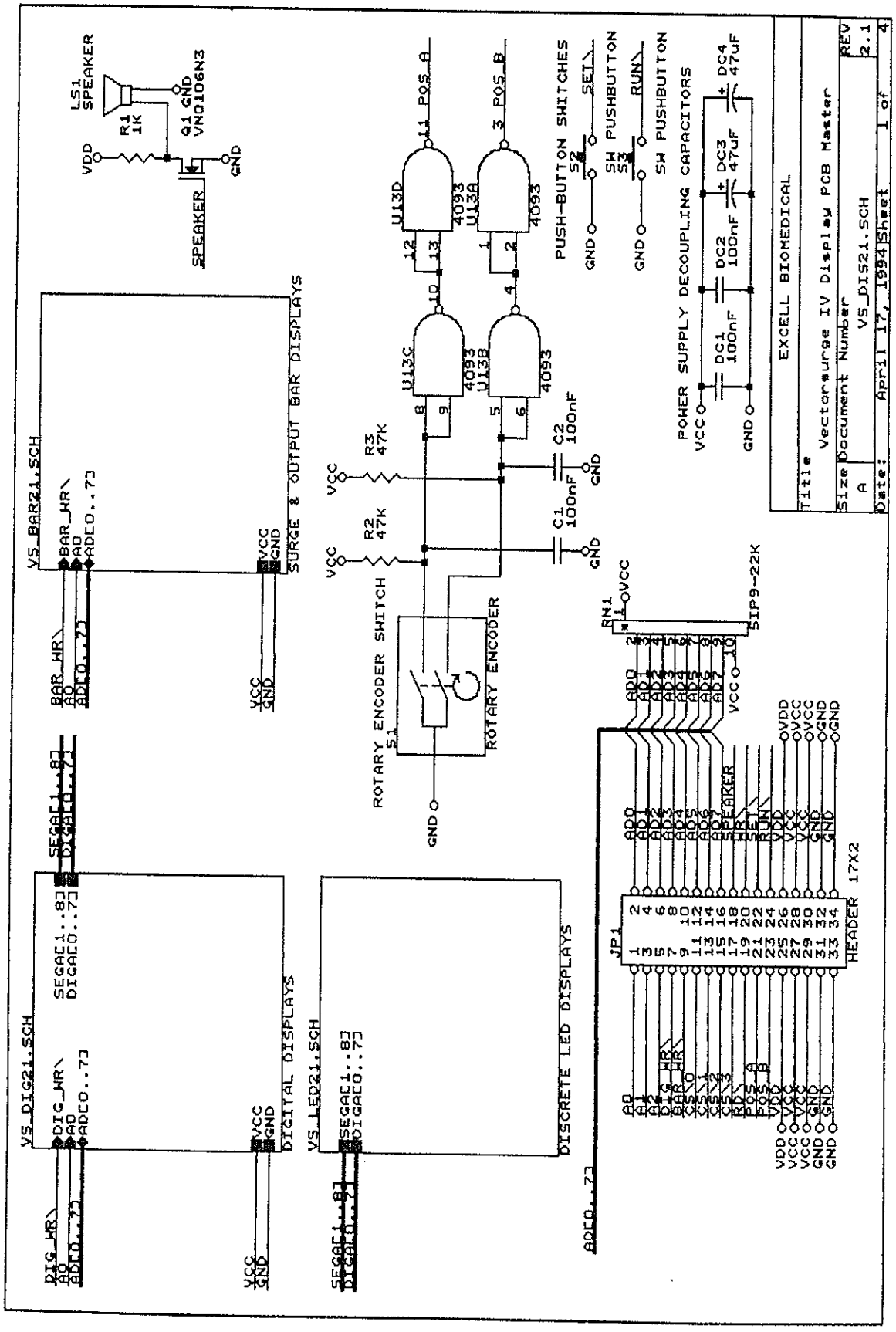
5.7 Black Channel Output Waveform Generator



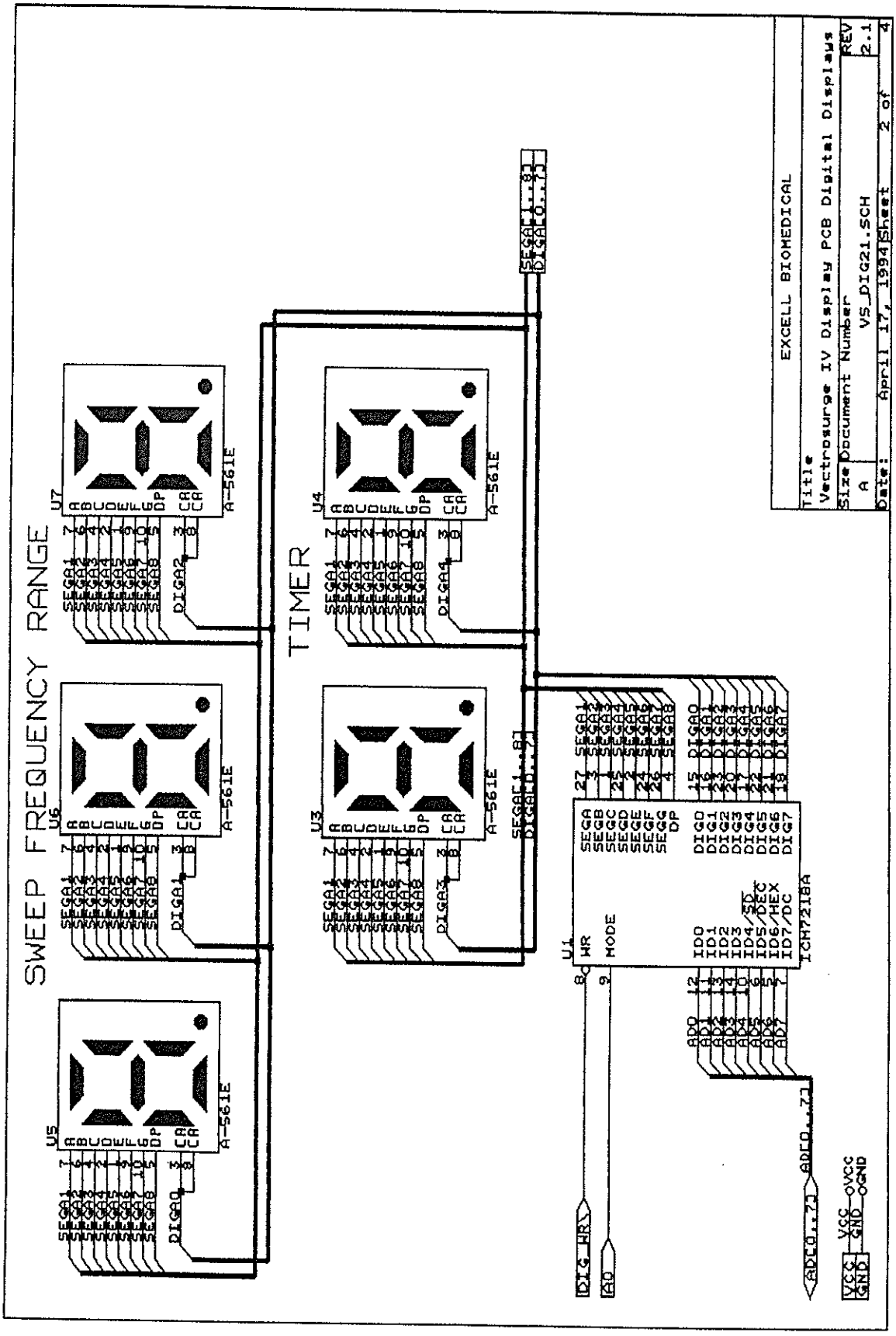
5.8 Power Supplies



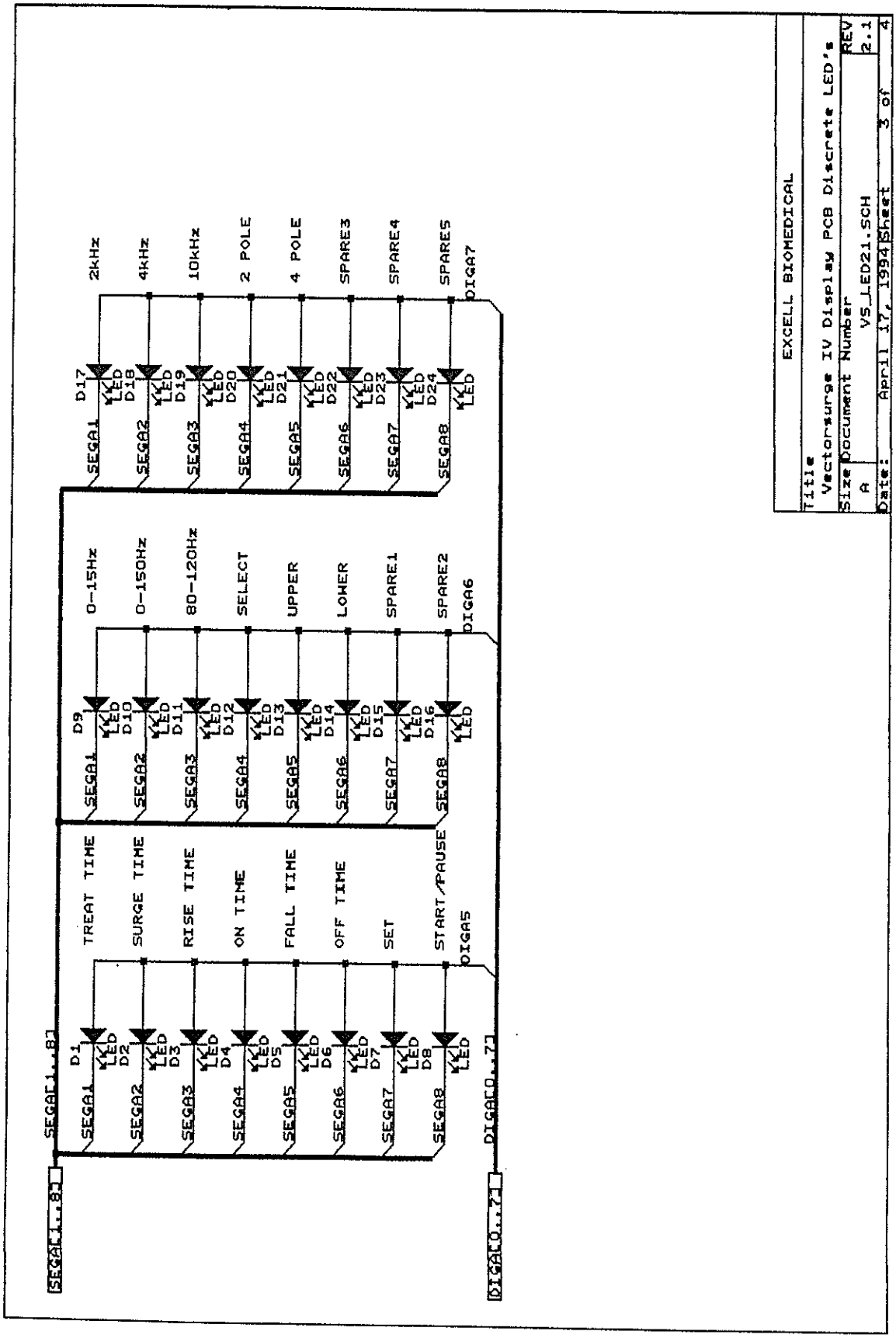
5.9 Display PCB Master



5.10 Digital Displays



5.11 Discrete LED Displays



5.12 Bar LED Displays