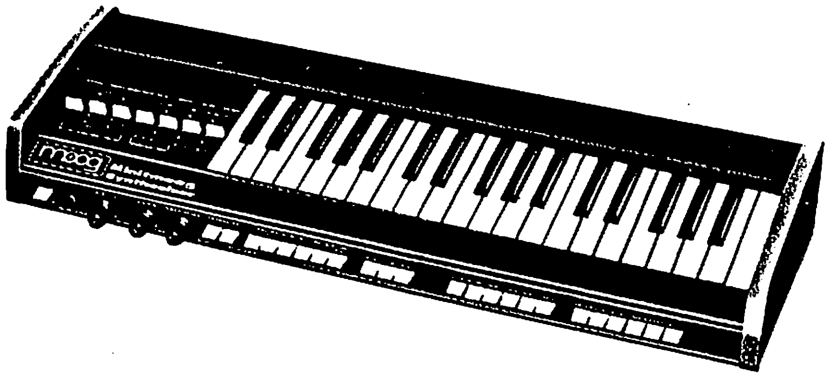
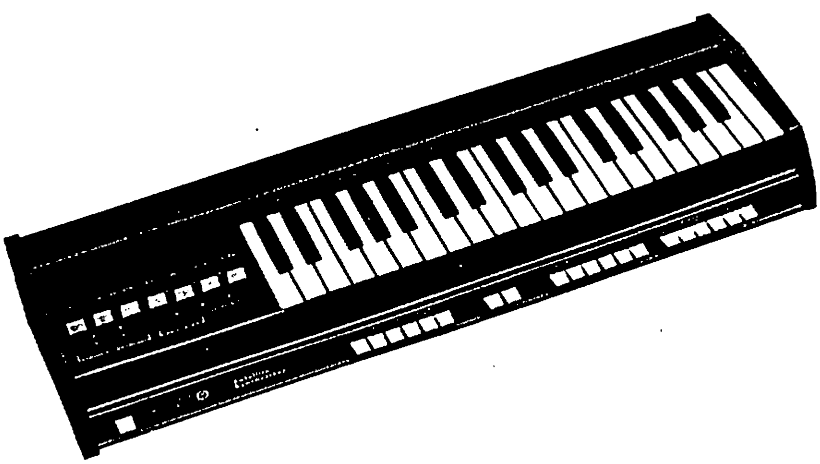
MANUAL NO. 993-041990-002

OWNERS and SERVICE MANUAL for

MINITMOOG/ SATELLITE

Minitmoog
Model 300A





Satellite
Model 5330

Introduction

The owners portion of this manual, pages 1 through 11, provides introductory material to familiarize the owner with the features, specifications and initial set-up of the Minitmoog Synthesizer, Model 300A, and the Satellite Synthesizer, Model 5330.

The technical portion of this manual, pages 12 through 57, provides servicing, replacement parts list and illustrations to enable a qualified technician to service and maintain the Minitmoog and Satellite Synthesizers.

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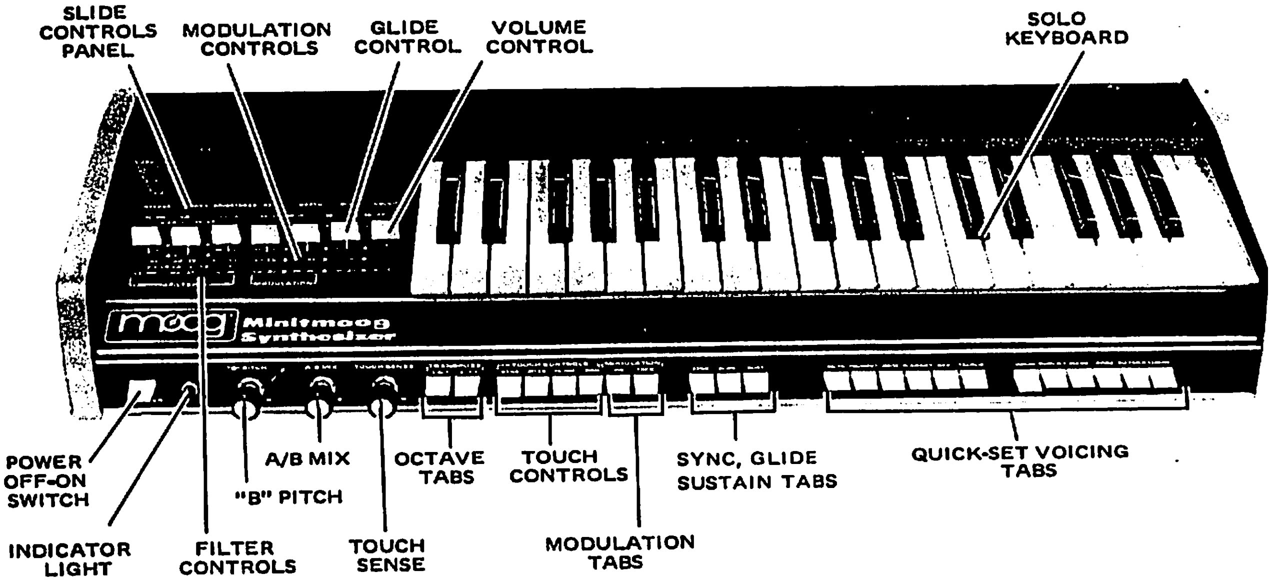
MINITMOOG SYNTHESIZER

SATELLITE SYNTHESIZER

Minitmoog Controls



Before proceeding with Operation and Adjustment of your unit, please refer to page 10 for Connection Instructions.

LEVEL ADJUST

This rotary control (located on the back of the unit) sets the overall output level, or volume, of the unit. Smaller changes in volume may be made with the VOLUME control on the Slide Control Panel.

TUNE

This rotary control (located on the back of the unit) provides a range of tuning which extends more than one-half octave. This flexibility can be used to tune your MOOG MINITMOOG to other instruments, transpose to different keys, or even provide a glissando effect.

POWER AND INDICATOR LIGHT

An ON-OFF power switch is conveniently located on the front panel, with a red light which indicates when the power is ON.

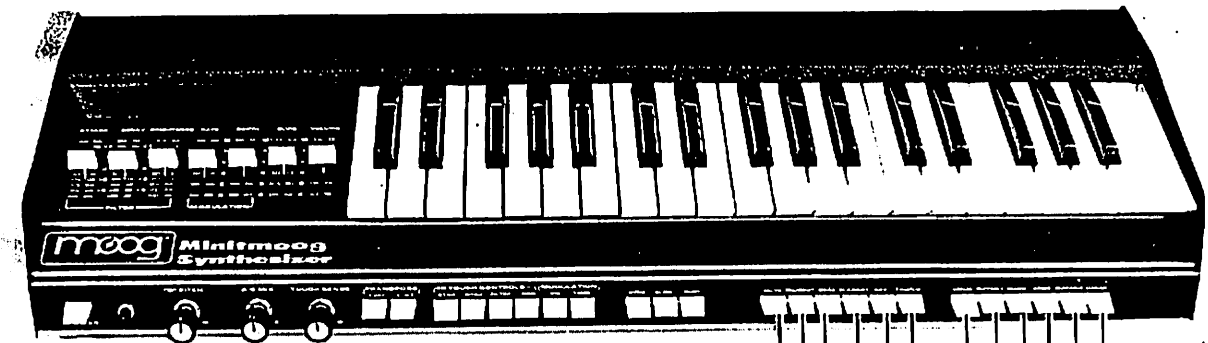
OCTAVES

With neither tab depressed, your MOOG MINITMOOG will play in its highest pitch level. Depress tab "1", and whatever you play on the keyboard will be one octave lower. Raise tab "1" and depress tab "2", and the keyboard pitch level is lowered another octave. Depress both tabs and the pitch level is lowered still a third octave. Because of the electronic tailoring of the sounds to the requirements of each pitch level, you will find that the effectiveness of every sound seems to change magically as you change from octave to octave. Try all sound effects in all four pitch levels.

SUSTAIN

This "Quick-Set" tab allows the sound of a note to "linger" after the key is released. It provides interesting variations to the special voice settings described in this Manual.

Minitmoog Quick-Set Voice Tabs



With the unit connected and power ON, a sound can be heard when a note on the keyboard is struck, even though no voices are selected and all slide controls are set at "0" (except for the VOLUME control). The controls described herein will add and subtract from that sound in a multitude of combinations available for your exploration - shape it, change its attack and release, raise it, or lower it. We suggest that you play a phrase or two with each of the twelve "QUICK-SET" VOICE TABS conveniently located on the front of the unit. Try each with all the slide controls set at "0" (except for VOLUME).

Exact setting of slide controls for any particular effect will depend, not only on your musical taste, but also on your complete electronic reproduction system including amplifiers, speakers and other components.

NOTE: If more than one "QUICK-SET" Voice Tab is depressed at the same time the sound will be that controlled by the Voice Tab farthest to the left.

MUTE

This voice is a new version of the wah-wah effect. The sound approximates a double-acting wah-wah, or "ooo-wah-ooo." It starts with an emphasis on the "lows", moves to the "highs" and returns. Each time a key is depressed the "ooo-wah-ooo" sound is produced. Try it in each octave.

TRUMPET

The sounds of a trumpet, trombone, or tuba can be approximated by selecting this tab, and varying it with other controls. Characteristic of this voice (and some of the other "Quick-Set" voices) is a built-in timbre change which is faster in the upper octaves and is automatically slower in the lower octaves - much as the attack of a tuba differs from that of a trumpet. This attention to the authentic details of the attack in different octaves is a unique feature of the Minitmoog. Try it in each octave setting.

OBOE

This voice provides a sound similar to that of a double reed. In the top octave the sound is oboe-like. In the lower octaves, the sound of a bassoon is approximated. You will note a slight timbre change in the onset of the tone and a slow attack.

CLARINET

The hollow reed sound and the soft attack of the traditional clarinet and bass clarinet are characteristic of this voice - an excellent voice in all octave registers.

SAX

This full bodied reed sound is unique to the Minitmoog. It combines some of the qualities of a double reed wind instrument with those of a pipe organ with a little saxophone added. In the lowest registers, it is an excellent reproduction of the sound of the sarrusophone, a wind instrument popular in bands of the early 1900's.

TAURUS

This voice approximates that of a saxophone. With adjustment of other controls you will be able to vary the sound through the characteristics of alto and tenor, baritone, and bass sounds of the Taurus Synthesizer.

VIOLIN

This gentle voice with its slow attack can be made to simulate violin, viola, cello, and even some of the sounds of the bass violin.

GUITAR – 1

This sound is quite percussive with a lingering decay. It is most useful for creating guitar-like or harpsichord-type effects, including that of a folk guitar.

PIANO

In the upper registers this voice is that of an electronic piano. In the lower registers it provides an interesting sound similar to that of an electric bass guitar.

AIRES

Banjo type sounds are provided with the hollow sound characteristic of this voice. In the lower registers it can simulate the plucked sound of the string bass, or bass violin.

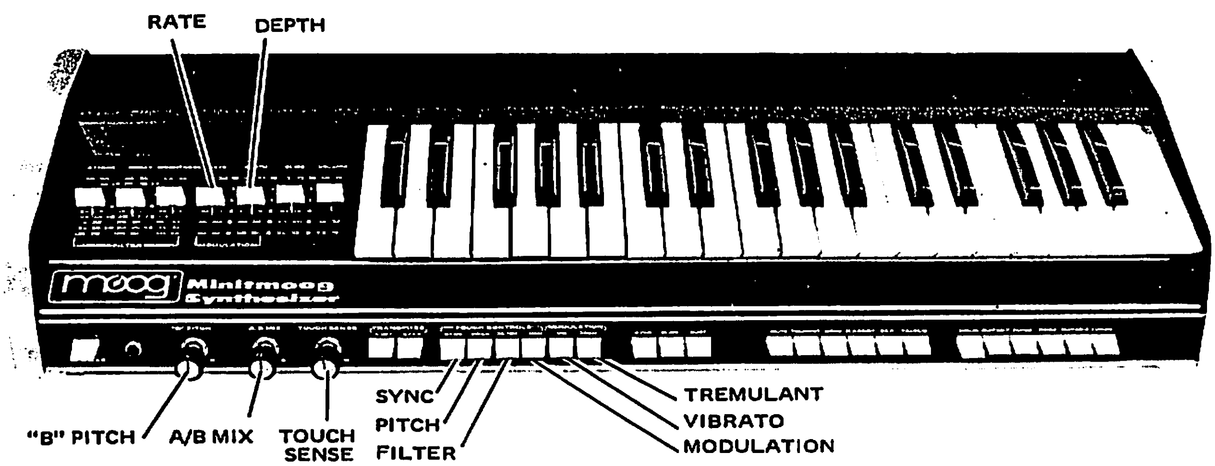
GUITAR – 2

In the upper octaves a fine bell sound is provided by this voice. In the lower octaves, the huge sound of a large carillon can be reproduced.

LUNAR

This versatile voice perhaps is most characteristic of the Moog sounds. It provides, in its various adjustments, a wide variety of timbre changes with which you can produce many popular electronic "Moog" sound effects. It is most effective when used with SUSTAIN.

Minitmoog Modulation, Oscillation and Touch Controls



The two function tabs labeled MODULATION on the front of the unit provide a selection of modulation types. The two MODULATION slide controls on the slide control panel adjust the RATE and DEPTH of modulation.

VIB (VIBRATO)

This tab provides a frequency-modulation vibrato similar to the type used in electronic organs. However, the wide range of effects offered by the two slide controls extends the capability of this effect far beyond vibrato and into the realm of the synthesizer.

When the VIB tab is depressed, the basic frequency of a note is varied (or "wiggled") to a degree determined by the DEPTH control and at a rate determined by the RATE control.

RATE

The rate of modulation may be varied from approximately one second at "0" to a rate so fast that at "10" the sound becomes a buzz. However, even at extreme settings, the basic character of the "QUICK-SET" voices is still apparent. For instance, MUTE, with VIB plus RATE at 10 becomes a BUZZ-WAH type of effect. With slower settings it is easy to obtain the effect of trills between notes, regardless of the voice selected.

DEPTH

This control adjusts the degree or intensity of modulation. For vibrato (VIB), increasing DEPTH corresponds to greater frequency variation. This frequency variation may be adjusted from less than one-half step (on the scale) to more than one octave. For tremulant (TREM), increasing DEPTH corresponds to greater timbre variation.

This flexibility, combined with the RATE control, makes possible synthesis of such effects as "out of tune" strings, huge bells whose clanging sounds interfere with each other, quarter tone scales, trumpet "shake" effects, and a myriad of others.

TREM (TREMULANT)

This tab provides modulation of the harmonic content of the tone. The harmonic content, or timbre, is varied at a rate determined by the RATE control and with an intensity determined by the DEPTH control.

NOTE: VIB and TREM can be used together.

SYNC

This tab is only active when other SYNC tab switch is also down. Raises pitch of B tone oscillator as a key is depressed harder producing a phasing effect.

PITCH

This tab bends pitch of both A and B tone oscillators up to an interval of at least seven semitones when a key is depressed harder.

FILTER

This tab adds familiar Moog "wah" to most voices when pressure on the keys is increased. This effect adds directly to the effect produced by the FILTER BRIGHTNESS slide control.

MOD

This tab allows either vibrato or tremolo to be added to the tone as the pressure on the keys is increased. The DEPTH slide control in this mode acts as a touch sensitivity control and the MODULATION RATE slide control sets the speed of the effect. This tab switch has an effect only if the MODULATION VIB or MODULATION TREM tab switch is also depressed.

TOUCH SENSE

This control regulates the range of expressive effects when additional pressure is exerted on the keys for SYNC, PITCH and FILTER (brightness) modes.

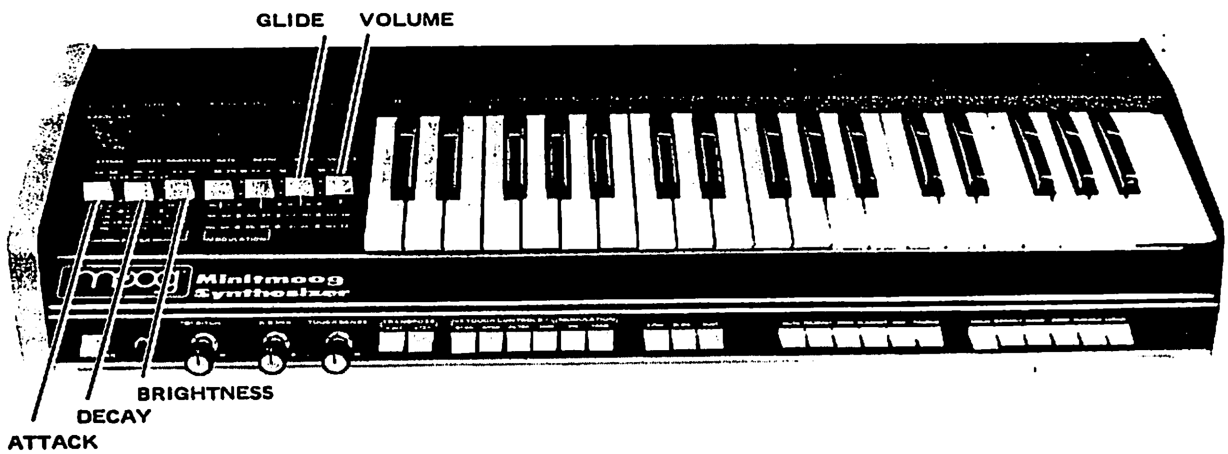
"B" PITCH

This control varies pitch of B tone producing oscillator over a two octave range.

A/B MIX

Controls mixing of A and B tone source oscillator outputs. A only or B only occur at the CCW and CW extremes of rotation, respectively.

Minitmoog Slide Control Panel



FILTER CONTROLS

Once a "Quick-Set" tab voice selection is made, further refinement and adjustment of that voice may be made by using the three slide controls labeled FILTER.

ATTACK

This controls the speed of the timbre change associated with the onset of the voice, and/or the timbre change associated with the release of that voice. The wide range of this control can provide both slow settings (useful for simulation of bass violin or tuba effects) and fast timbre change settings (which can provide wild chirping effects).

DECAY

This acts as a brightness control, but it has such a wide range that it can have major effect on the basic sound itself. Your choice may lie anywhere between adding in all of the high harmonics you wish, or eliminating them.

BRIGHTNESS

This control adds a resonance frequency area to the spectrum of the tone. At "0", spectrum of the "Quick-Set" sound is unchanged. As the control is pushed forward, the intensity of the sound within a pre-selected resonance area is increased. At maximum, there is a well defined narrow sharp peak in the spectrum of the tone.

FILTER CONTROLS SUMMARY

Remember, the "Quick-Set" tabs establish an overall range of sound and the three Filter slide controls give you a wide selection and control within the limitations of that range.

Try this:

1. Depress TRUMPET tab, and set the slide controls at "0".
2. Play a few notes on the keyboard.
3. Play again with various settings of the DECAY slide pot. The range of sound will be from that of a very dull trumpet to a very brassy one.
4. Now do the same with the BRIGHTNESS control. The sound will range through cornet, trumpet, and flugelhorn characteristics.
5. Repeat with various settings of the ATTACK control. It will show the wide range of contoured timbers in the onset of the tones.

ADDITIONAL CONTROLS

MODULATION CONTROLS

See discussion under MODULATION on page 3.

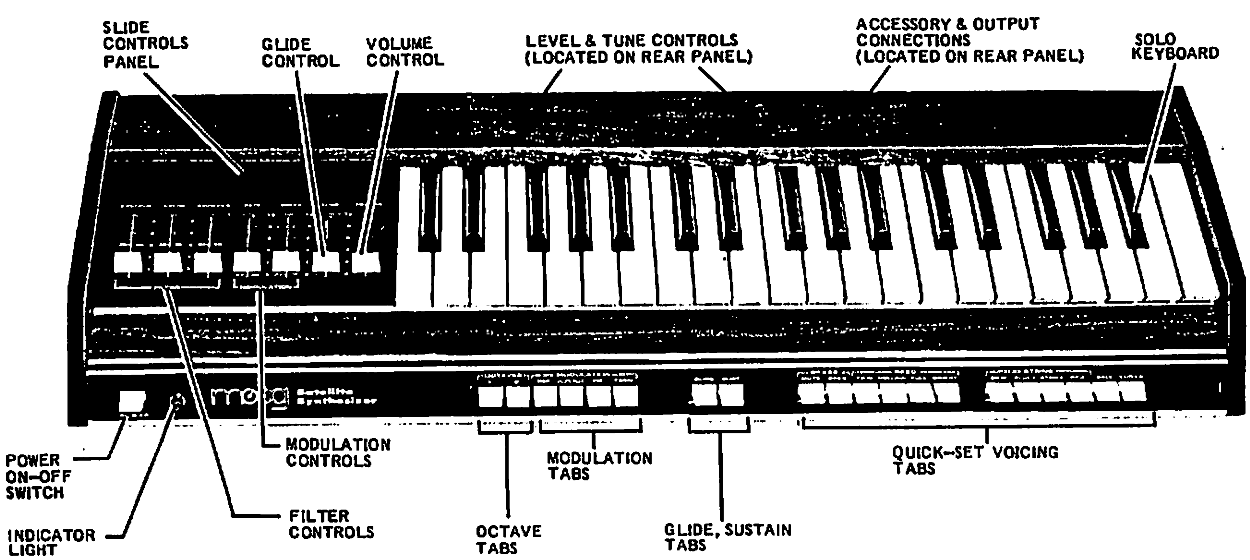
GLIDE

This is one of the most interesting of the Moog effects. Depress the GLIDE tab and set the GLIDE slide control at 6. Play any note on the keyboard. Release this note and quickly play a second note some distance away. The sound automatically glissandos from the first note to the second. The setting of the slide control determines the speed of the glissando, (10 is slow – 1 is fast). Try a melody of detached notes and notice the succession of glide attacks.

VOLUME

The VOLUME slide control provides finger-tip adjustment of fine gradations of the Minitmoog output. Major changes in sound level are obtained by means of the rotary knob on the back of the unit.

Satellite Controls



Before proceeding with Operation and Adjustment of your unit,refer to page 10 for Connection Instructions.

LEVEL ADJUST

This rotary control (located on the back of the unit)sets the overall output level, or volume, of the unit. Smaller changes in volume may be made with the VOLUME control on the Slide Control Panel.

TUNE

This rotary control (located on the back of the unit) provides a range of tuning which extends more than one-half octave. This flexibility can be used to tune your MOOG SATELLITE to other instruments, transpose to different keys, or even provide a glissando effect.

POWER AND INDICATOR LIGHT

An ON-OFF power switch is conveniently located on the front panel, with a red light which indicates when the power is ON.

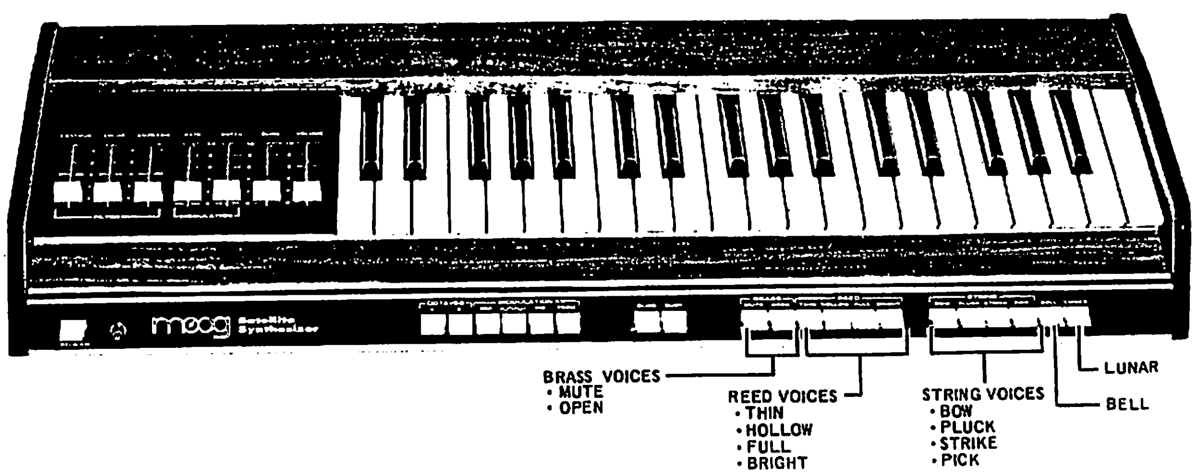
OCTAVES

With neither tab depressed, your MOOG SATELLITE will play in its highest pitch level. Depress tab "1", and whatever you play on the keyboard will be one octave lower. Raise tab "1" and depress tab "2", and the keyboard pitch level is lowered another octave. Depress both tabs and the pitch level is lowered still a third octave. Because of the electronic tailoring of the sounds to the requirements of each pitch level, you will find that the effectiveness of every sound seems to change magically as you change from octave to octave. Try all sound effects in all four pitch levels.

SUSTAIN

This "Quick-Set" tab allows the sound of a note to "linger" after the key is released. It provides interesting variations to the special voice settings described in this Manual.

Satellite Quick-Set Voice Tabs



With the unit connected and power ON, a sound can be heard when a note on the keyboard is struck, even though no voices are selected and all slide controls are set at "O" (except for the VOLUME control). The controls described herein will add and subtract from that sound in a multitude of combinations available for your exploration – shape it, change its attack and release, raise it, or lower it. We suggest that you play a phrase or two with each of the twelve "QUICK-SET" VOICE TABS conveniently located on the front of the unit. Try each with all the slide controls set at "O" (except for VOLUME).

Exact setting of slide controls for any particular effect will depend, not only on your musical taste, but also on your complete electronic reproduction system including amplifiers, speakers and other components.

NOTE: If more than one "QUICK-SET" Voice Tab is depressed at the same time the sound will be that controlled by the Voice Tab farthest to the left.

MUTE BRASS

This voice is a new version of the wah-wah effect. The sound approximates a double-acting wah-wah, or "ooo-wah-ooo." It starts with an emphasis on the "lows", moves to the "highs" and returns. Each time a key is depressed the "ooo-wah-ooo" sound is produced. Try it in each octave.

OPEN BRASS

The sounds of a trumpet, trombone, or tuba can be approximated by selecting this tab, and varying it with other controls. Characteristic of this voice (and some of the other "Quick-Set" voices) is a built-in timbre change which is faster in the upper octaves and is automatically slower in the lower octaves – much as the attack of a tuba differs from that of a trumpet. This attention to the authentic details of the attack in different octaves is a unique feature of the Satellite. Try it in each octave setting.

THIN REED

This voice provides a sound similar to that of a double reed. In the top octave the sound is oboe-like. In the lower octaves, the sound of a bassoon is approximated. You will note a slight timbre change in the onset of the tone and a slow attack.

HOLLOW REED

The hollow reed sound and the soft attack of the traditional clarinet and bass clarinet are characteristic of this voice – an excellent voice in all octave registers.

FULL REED

This full bodied reed sound is unique to the Satellite. It combines some of the qualities of a double reed wind instrument with those of a pipe organ with a little saxophone added. In the lowest registers, it is an excellent reproduction of the sound of the sarrusophone, a wind instrument popular in bands of the early 1900's.

BRIGHT REED

This voice approximates that of a saxophone. With adjustment of other controls you will be able to vary the sound through the characteristics of alto and tenor, baritone, and even bass saxophone.

BOW STRING

This gentle voice with its slow attack can be made to simulate violin, viola, cello, and even some of the sounds of the bass violin.

PLUCK STRING

This sound is quite percussive with a lingering decay. It is most useful for creating guitar-like or harpsichord-type effects, including that of a folk guitar.

STRIKE STRING

In the upper registers this voice is that of an electronic piano. In the lower registers it provides an interesting sound similar to that of an electric bass guitar.

PICK STRING

Banjo type sounds are provided with the hollow sound characteristic of this voice. In the lower registers it can simulate the plucked sound of the string bass, or bass violin.

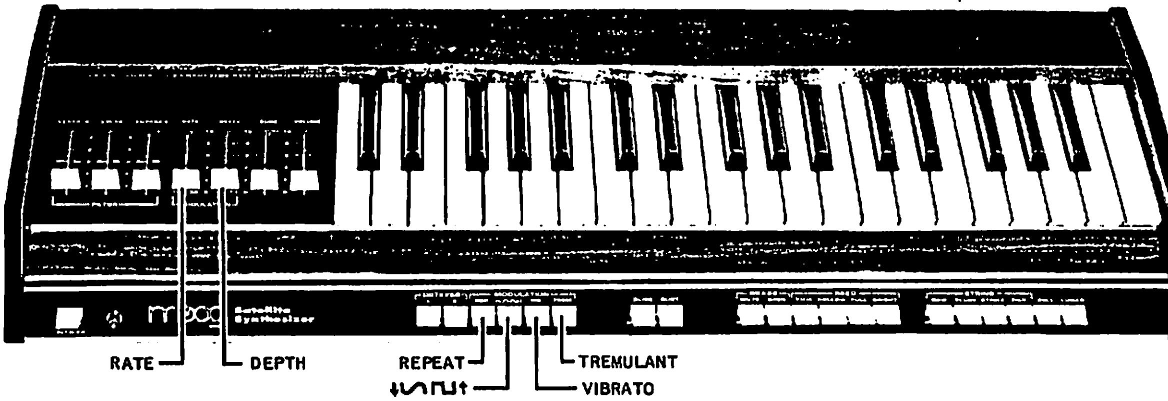
BELL

In the upper octaves a fine bell sound is provided by this voice. In the lower octaves, the huge sound of a large carillon can be reproduced.

LUNAR

This versatile voice perhaps is most characteristic of the Moog sounds. It provides, in its various adjustments, a wide variety of timbre changes with which you can produce many popular electronic "Moog" sound effects. It is most effective when used with SUSTAIN.

Satellite Modulation



The four function tabs labeled MODULATION on the front of the unit provide a selection of modulation types. The two MODULATION slide controls on the slide control panel adjust the RATE and DEPTH of modulation.

VIB (VIBRATO)

This tab provides a frequency-modulation vibrato similar to the type used in electronic organs. However, the wide range of effects offered by the two slide controls extends the capability of this effect far beyond vibrato and into the realm of the synthesizer.

When the VIB tab is depressed, the basic frequency of a note is varied (or "wiggled") to a degree determined by the DEPTH control and at a rate determined by the RATE control.

RATE

The rate of modulation may be varied from approximately one second at "O" to a rate so fast that at "10" the sound becomes a buzz. However, even at extreme settings, the basic character of the "QUICK-SET" voices is still apparent. For instance, MUTE BRASS, with VIB plus RATE at 10 becomes a BUZZ-WAH type of effect. With slower settings it is easy to obtain the effect of trills between notes, regardless of the voice selected.

DEPTH

This control adjusts the degree or intensity of modulation. For vibrato (VIB), increasing DEPTH corresponds to greater frequency variation. This frequency variation may be adjusted from less than one-half step (on the scale) to more than one octave. For tremulant (TREM), increasing DEPTH corresponds to greater timbre variation.

This flexibility, combined with the RATE control, makes possible synthesis of such effects as "out of tune" strings, huge bells whose clanging sounds interfere with each other, quarter tone scales, trumpet "shake" effects, and a myriad of others.

TREM (TREMULANT)

This tab provides modulation of the harmonic content of the tone. The harmonic content, or timbre, is varied at a rate determined by the RATE control and with an intensity determined by the DEPTH control.

NOTE: VIB and TREM can be used together.

REP (REPEAT)

The repeat tab affects only those "QUICK - SET" voices which have built-in timbre changes. The timbre change associated with a specific voice will be repeated over and over again at a speed controlled by the RATE slide control. This is easily demonstrated by depressing MUTE BRASS, REP, OCTAVE 1 and 2, and setting RATE at 0. Play a sustained tone, then slowly move the slide control to 10 and return, while sustaining the tone.

NOTE: The DEPTH slide control has no effect on the REP function.

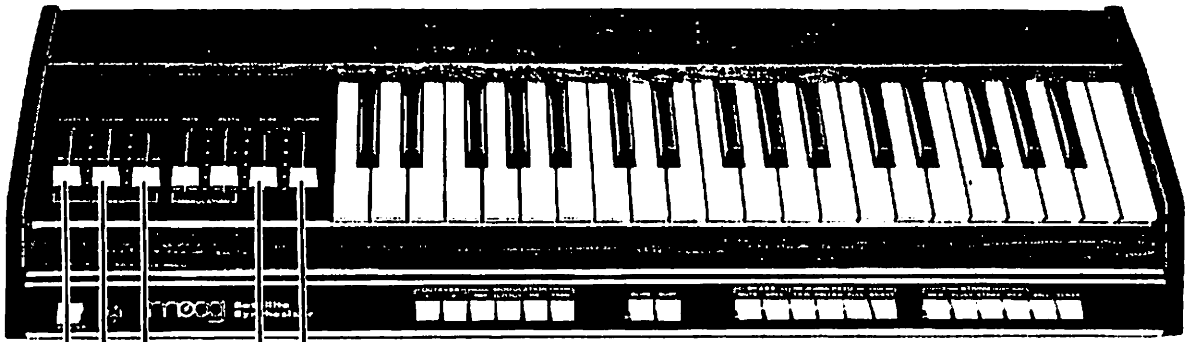
↓∿⊓⊔↑

This control provides a most versatile tool in achieving the distinctive sounds associated with the MOOG synthesizer. It affects the type of modulation obtained by two of the other MODULATION functions, VIBRATO and TREMULANT.

When this tab is in the up position, ↓∿⊓⊔↑ VIB and TREM are with a square-wave pattern. The variation of frequency (VIB), or variation of timbres (TREM), will be very abrupt and choppy, with discontinuities. With VIB, for instance, a definitive variation in frequency can be obtained, like a trill

When ↓∿⊓⊔↑ is depressed, a sine wave type of modulation is obtained which provides a smooth variation of timbre or frequency – almost a glissando. The difference between the two effects is easily discernible in the following characteristically MOOG-type settings. Depress ↓∿⊓⊔↑ , MUTE BRASS, OCTAVE 2, VIB, set RATE at 3, and DEPTH at 6. Depress any key on the keyboard and listen to the smooth variation in frequency as you keep your finger on the key. Then raise the tab marked ↓∿⊓⊔↑ and observe the abrupt variation in frequency. Repeat the above steps with TREM instead of VIB, and then combine the two.

Satellite Slide Control Panel



FILTER CONTROLS

Once a "Quick-Set" tab voice selection is made, further refinement and adjustment of that voice may be made by using the three slide controls labeled FILTER.

CONTOUR

This controls the speed of the timbre change associated with the onset of the voice, and/or the timbre change associated with the release of that voice. The wide range of this control can provide both slow settings (useful for simulation of bass violin or tuba effects) and fast timbre change settings (which can provide wild chirping effects).

COLOR

This acts as a brightness control, but it has such a wide range that it can have major effect on the basic sound itself. Your choice may lie anywhere between adding in all of the high harmonics you wish, or eliminating them.

EMPHASIS

This control adds a resonance frequency area to the spectrum of the tone. At "O", spectrum of the "Quick-Set" sound is unchanged. As the control is pushed forward, the intensity of the sound within a pre-selected resonance area is increased. At maximum, there is a well defined narrow sharp peak in the spectrum of the tone.

FILTER CONTROLS SUMMARY

Remember, the "Quick-Set" tabs establish an overall range of sound and the three Filter slide controls give you a wide selection and control within the limitations of that range.

Try this:

1. Depress OPEN BRASS tab, and set the slide controls at "O".
2. Play a few notes on the keyboard.
3. Play again with various settings of the COLOR slide pot. The range of sound will be from that of a very dull trumpet to a very brassy one.
4. Now do the same with the EMPHASIS control. The sound will range through cornet, trumpet, and flugelhorn characteristics.
5. Repeat with various settings of the CONTOUR control. It will show the wide range of contoured timbres in the onset of the tones.

ADDITIONAL CONTROLS

MODULATION CONTROLS

See discussion under MODULATION on page 8.

GLIDE

This is one of the most interesting of the Moog effects. Depress the GLIDE tab and set the GLIDE slide control at 6. Play any note on the keyboard. Release this note and quickly play a second note some distance away. The sound automatically glissandos from the first note to the second. The setting of the slide control determines the speed of the glissando, (10 is slow – 1 is fast). Try a melody of detached notes and notice the succession of glide attacks.

VOLUME

The VOLUME slide control provides finger-tip adjustment of fine gradations of the Satellite output. Major changes in sound level are obtained by means of the rotary knob on the back of the unit.

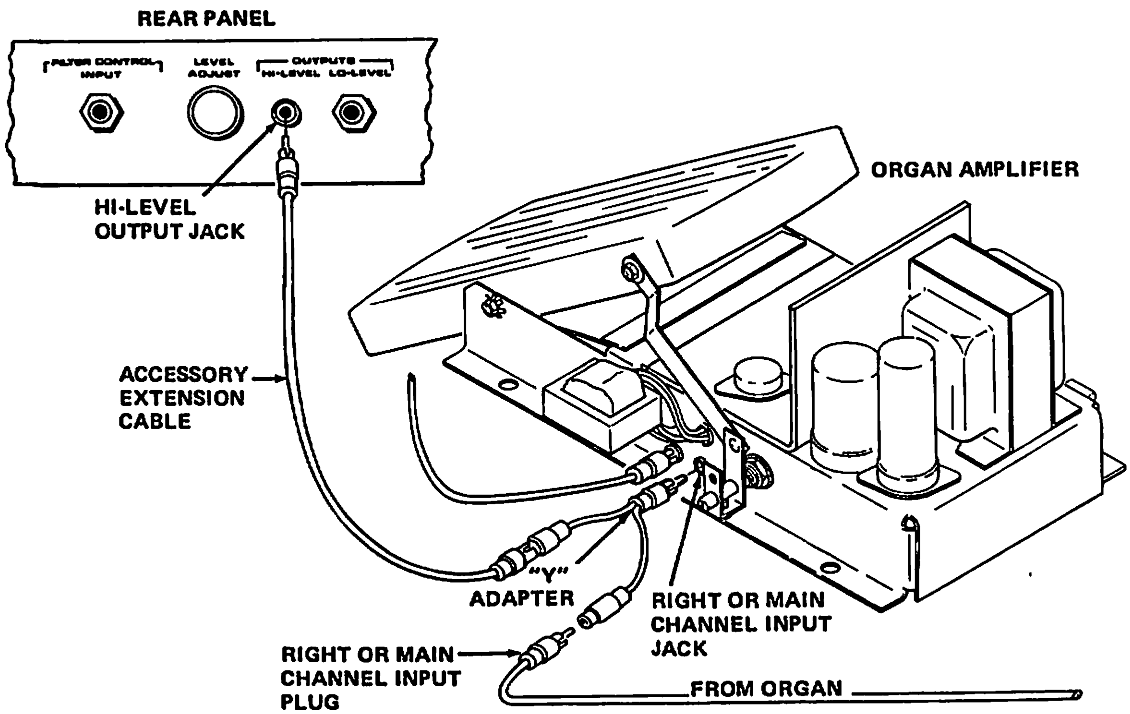
Accessory and Connections

For operation, the Synthesizer unit should be placed on a horizontal surface in a location which will not interfere with its operation.

NOTE: Avoid placement in close proximity to electronic circuitry, as on the top of some electronic organs, because excessive hum may result.

LO-LEVEL OUTPUT (30 millivolts RMS), Phone Jack designed for use with Guitar Amplifier, P.A. Systems, etc.

HI-LEVEL OUTPUT (1 volt RMS), RCA Phono Jack designed for use with Electronic Organs. ("Y" Adapter and Accessory extension cable are included with your unit).



Connection Instructions

SINGLE CHANNEL ORGANS (MONAURAL)

Disconnect the RCA Phono plug from Amplifier Input Jack and insert the "Y" Adapter plug into the Amplifier Input Jack. Connect Accessory extension cable plug into "Y" Adapter socket and insert the plug on the other end of the extension cable into the HI-LEVEL OUTPUT jack on your Synthesizer unit. Connect the organ plug (previously removed) into the other "Y" Adapter socket.

DUAL CHANNEL ORGANS (STEREO)

Disconnect the RCA Phono plug from the Right of Main Channel Amplifier Input Jack and insert "Y" Adapter plug into Right or Main Channel Input Jack. Connect the Accessory extension cable plug into the "Y" Adapter socket and insert the plug on the other end of the extension cable into HI-LEVEL OUTPUT jack on your Synthesizer unit. Connect the Right or Main Channel plug (previously removed) into the other "Y" Adapter socket.

NOTE: Do not connect the Synthesizer into Leslie or Left Channel Input.

FILTER CONTROL INPUT

This jack is provided for the control of the Timbre with a Moog Pedal controller.

ACCESSORY SOCKET

Permits the attachment of a Foot Pedal to control several Synthesizer features. (Consult your dealer for availability of Moog Accessories).

Care of Your Synthesizers

Your MOOG Synthesizer is carefully designed to give you maximum pleasure and satisfaction with a minimum of care. Following these tips on the care of your Synthesizer will help keep it "showroom new."

- **LOCATION**

  As with any electronic instrument, avoid placement in direct or prolonged sunlight. Normal variation of temperature will not affect the tuning or electronic circuitry of the synthesizer. Storage location should be chosen to avoid placement in front of hot air registers, or beside an outside doorway in winter, as these elements may affect the finish of the cabinet.

- **CABINET**

  Quality hardwoods are used in your MOOG Synthesizer. Therefore, a minimum amount of care will insure you of having a piece of furniture that will retain its beauty. An occasional dusting with a soft, dry cloth should remove both fingerprints and dulling film. To clean the keys a soft cloth dampened in a mild soap solution should remove even the most persistent stains. Under no circumstances should solvents or cleaning fluids be used to clean keys or cabinet.

- **POWER REQUIREMENTS**

  This instrument must be operated from a standard 120 VAC 60Hz power outlet. Normal line voltage variation will not affect its operation. Power requirements of this unit are very low. All solid state circuits are operated at a very low voltage and component life is therefore extended.

- **SAFETY**

  Your MOOG Synthesizer has been designed for maximum safety in its operation and trouble free performance. However, repair or service of electronic products should be done by qualified personnel familiar with the hazards relating to electricity and electronic circuitry. The risk of repair or service must not be assumed by the customer. Your dealer will provide a competent, experienced service technician for that purpose. Please contact your dealer, if your unit needs repair or service.

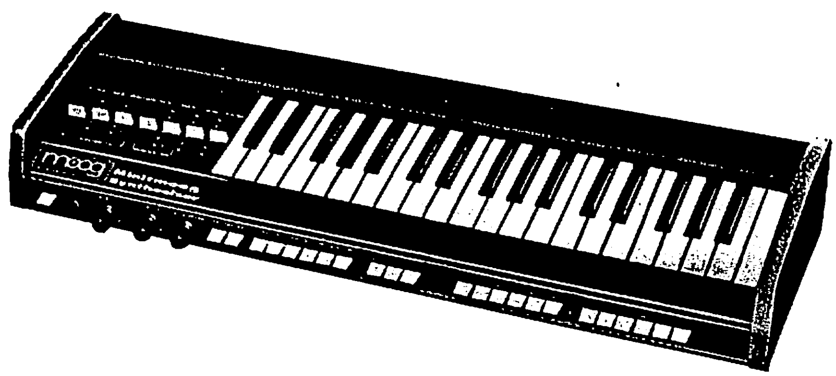
- **CONCLUSION**

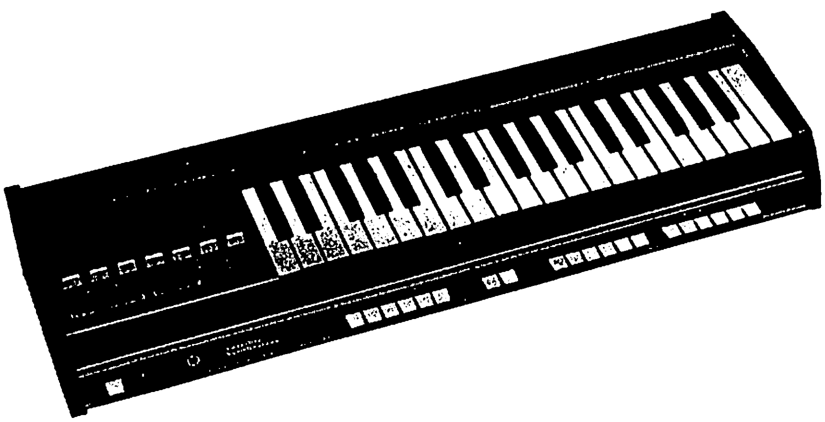
  And now as you play . . . . Let us offer you our best wishes for a happy and rewarding experience with your MOOG Synthesizer. We know it will bring you great pleasure and creative satisfaction.

TECHNICAL SERVICE SECTION for

MINITMOOG/ SATELLITE

Minitmoog
Model 300A





Satellite
Model 5330

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SECTION 1
INTRODUCTION

This manual provides servicing and parts information for Minitmoog Synthesizer Model 300A and Satellite Synthesizer Model 5330, manufactured by Moog Music Inc., 2500 Walden Avenue, Buffalo, New York 14225. This manual was written basically for the Minitmoog Synthesizer which includes the touch sensor board 4 and oscillator B board 5 not found in the Satellite Synthesizer. Differences in operating control panel markings are indicated in Section 5. Any major differences will be noted. The Minitmoog and Satellite Synthesizers are monophonic live performance synthesizers intended primarily as auxiliary instruments for keyboardists and features a dozen "QUICK-SET" tabs that allow for instantaneous changes among various voices preset within the instrument.

The sound producing chain of the Synthesizers consists of an "A" oscillator that produces both sawtooth and rectangular waveforms, a "B" scillator (Minitmoog only) that produces only sawtooth waveforms, a band pass filter, a low pass filter and a variable gain amplifier. All five of these circuits in the sound producing chain are voltage controlled and the remaining circuitry is devoted to producing appropriate control voltages. The keyboard circuit produces one pitch control voltage, the magnitude of which depends on which key is depressed. In addition, the keyboard produces a trigger voltage whenever one or more of the keys are depressed. The modulating oscillator produces triangular waveforms for modulating the oscillators and filters. Two contour generators produce voltages that rise and fall each time a key is depressed. One contour generator sweeps one of the filters while the other sweeps the amplifier. A resistor matrix determines the nominal values of the voltage-controlled parameters. The power supply delivers ± 18 volts unregulated and ± 9 volts regulated. Refer to page 52.

The resistor matrix has fifteen input rows and twelve output columns. A row is on when +9 volts is applied to it and off when it is open circuited. The two upper rows are connected to the 2 OCT and 1 OCT tab switches, respectively, and shorten the contour times and raise filter frequencies when on. The remaining rows are for the quick set voices and only one can be on at a time. The column outputs are applied to low impedance points in the circuitry. Of the twelve matrix output columns, eight supply control currents for continuously variable parameters, while the remaining four supply switching current to determine circuit states.

SECTION 2
CIRCUIT DESCRIPTION

2.1 GENERAL

The main circuit board mounts underneath the keyboard and contains a large portion of the Synthesizer circuitry. All connections to this board are made through Molex connectors. Looking at the board from the component side with the connectors along the top edge, the left connector is designated "A" and the right connector is designated "B" with the pins numbered from 1 to 24 starting with the left pin on each connector. Block diagrams, schematic diagrams and printed circuit board diagrams are illustrated in Section 10 for quick reference.

2.2 POWER SUPPLY

The unregulated portion of the power supply is located on power supply board No. 2 and is completely conventional. The nominal total load supplied from each of the unregulated voltages is 45 milliamperes. The positive and negative voltage regulator circuits for the power supply are located on main board No. 1 .

The positive power supply voltage regulator consists of IC1 and associated components and its circuitry is completely conventional. The supply delivers 55 or 60 milliamperes before voltage developed across current sense resistor R2 limits the current.

The negative power supply voltage regulator consists of IC2, Q1 and associated components and adjusts its output to have the same magnitude as the regulated +9 volt output. No current limiting, other than that supplied by R8, is provided.

2.3 KEYBOARD CIRCUIT

The keyboard circuit consists of IC3 thru IC7, IC9, IC10 and related circuitry. The keyboard contains a string of thirty-six 100-ohm resistors connected between pins A5 and A6. The current through the resistor string is regulated by IC7 so that the drop across R79 and R80 is exactly 4.5 volts. R79 is set so that the voltage at pin A6 is exactly -4.5 volts.This sets a scale factor of 3 volts per octave (250 mv per semitone).

2.3.1 TRIGGERING (SINGLE)

The voltage at the keyboard buss is applied to voltage follower IC4. The keyboard buss voltage rises to approximately 7 volts (detail A, Figure 2-1) when no key is depressed because of R53. The output of voltage follower IC4 is applied to comparator IC5 whose output swings from -16 to +7 volts whenever the input goes below +4.8 volts (detail B). Q5 and Q6 comprise a monostable multivibrator producing a pulse of approximately 20 milliseconds duration (detail C). When the output of IC5 swings positive, a positive spike is applied through C7 and D7 to the base of Q6, initiating a 20 millisecond pulse. R63, R73 and R72 are proportioned so that Q7 conducts only when the output of IC5 is positive and the output of the monostable multivibrator (the collector of Q5) is negative. That is, Q7 begins to conduct approximately 20 milliseconds after a key is depressed and stops conducting as soon as all keys are released. When Q7 conducts, Q8 is turned on and the voltage at its collector rises from 0 to +9 volts. When this happens, C13 discharges through R61 producing a ramp voltage at the base of Q4 that decreases from +9 volts to -0.6 volt in approximately 20 milliseconds (detail E). Emitter follower Q4 supplies a current through R62 and Q3 to turn on IC10. IC10 and Q51 with associated circuitry comprise a sample and hold circuit. When the current ramp is applied to pin 5 of IC10, the voltage at the source of Q51 rapidly approaches that at the output of IC4. As soon as the base of Q4 drops below 0.8 volt, the bias current being applied to IC10 through Q3 drops to zero and the voltage at the source of Q51 remains constant. As long as the output of IC5 remains positive (that is, as long as any key is depressed), a very small bias current of approximately 50 nanoamperes flows through R59 allowing IC10 to supply a small current to C5 keeping its voltage constant. As soon as all keys are released, the output of IC5 goes negative and IC10 is virtually completely shut off. Thus, when only one key at a time is depressed, the voltage at the source of Q51 begins to approach the new key voltage approximately 20 milliseconds after the key is depressed and this voltage is equal to the new key voltage well before the ramp current turning IC10 on goes to zero. As long as a key is depressed, the correct voltage at the source of Q51 is maintained by the small trickle current going through R59. When the key is released, the trigger output at the collector of Q8 drops to zero, and the sample and hold circuit no longer samples the keyboard voltage. The 20 millisecond delay supplied by Q5 and Q6 is necessary to bypass the effect of contact bounce during key depression.

2.3.2 TRIGGERING (MULTIPLE)

IC6 becomes important when two keys are depressed. Any abrupt change in voltage at the output of IC4 is applied through R66 and C10 to the input of IC6. C11 filters out spikes less than 1 millisecond that are associated with contact bounce or spurious interference. The resulting rounded pulse is amplified by IC6 (detail G, Figure 2-1). Whenever the keyboard buss voltage increases, the output of IC6 goes positive, D9 conducts and fires Q6 producing a 20 millisecond positive going pulse at the collector of Q5. While this 20 millisecond pulse is on, the trigger voltage at the collector of Q8 drops to zero. Also, the collector of Q50 drops to zero. This causes C13 to recharge to +8.8 volts at the leading edge of the 20 millisecond pulse and resets the contour generators which are described later. Thus, when a key is held down and a higher key is depressed, the keyboard sample and hold circuit again samples and the trigger is reset momentarily. The same happens when a higher key is released while a lower key is being held

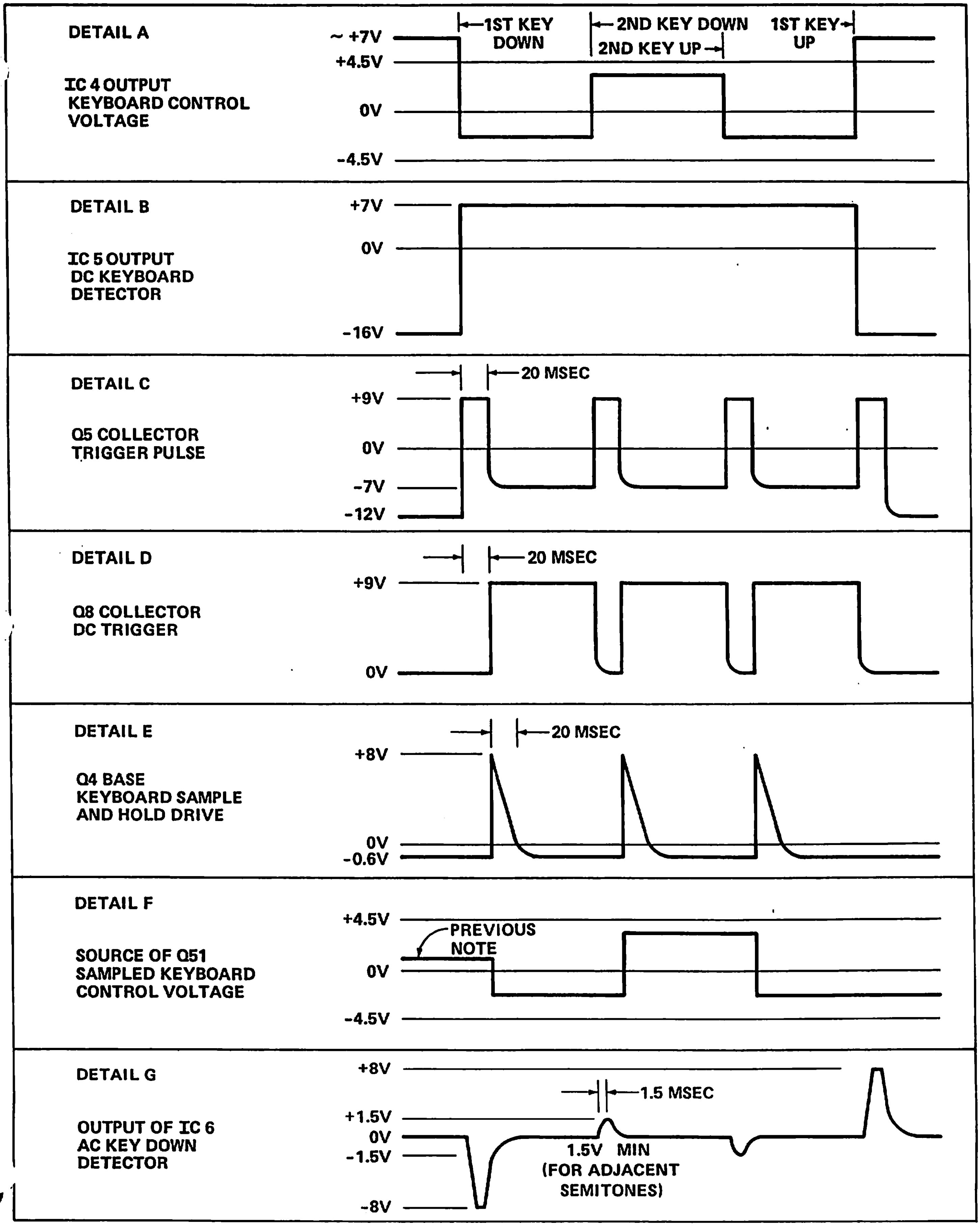


FIGURE 2-1 KEYBOARD TRIGGER VOLTAGE WAVEFORMS

down since Q6 is fired by the negative going output pulse of IC5 coupled via C9, R192, R78 and D10. However, if the higher key is held and the lower key is depressed or released, nothing will happen since the keyboard buss voltage remains constant. When all keys are released, D9 conducts and a 20 millisecond pulse appears at the collector of Q5. However, the output of IC5 goes negative, so that when the collector of Q5 again goes negative, Q8 is not reset.

2.3.3 KEYBOARD CONTROL VOLTAGE

IC3 is a voltage follower whose output is the voltage of the last key depressed. Variable resistor R12 controls the glide rate and is connected between pins A7 and A24. The time constant of this resistor and C4 determines the glide rate. IC9 and Q2 comprise another voltage follower. The difference between this voltage follower and IC3 is the amount of input current required. IC9 is biased at a low current level so that input current does not result in a pitch error when the glide rate potentiometer is at its maximum resistance. The voltage at the emitter of Q2 determines the pitch of the audio oscillators and is also applied to the filters and contour generators so that as the keyboard voltage goes up, the filter frequency also goes up and the contour time constants decrease.

2.4 OSCILLATOR

IC8 is a dc summer adding pitch, one-octave transpose voltage, a tuning voltage from the fine tuning potentiometer on the rear panel, a modulating voltage and the voltage from the touch sensor. R14 is a temperature compensating feedback resistor. The summation constant increases with a temperature coefficient of approximately 3400 parts per million. The relationship between R14 and the input resistors is such that the output of IC8 decreases approximately 20 millivolts for each octave increase in frequency.

2.4.1 OSCILLATOR A

The oscillator A audio sawtooth waveform is generated by linearly discharging C38 through one of the transistors in IC11, then rapidly recharging it through Q45. The current discharging C38 is determined by the voltage difference between pins 2 and 4 of IC11. The ratio of currents through these two transistors in IC11 is an exponential function of the voltage difference between their bases. The current fed into pin 1 of IC11 is kept constant by IC21 which maintains the voltage at pin 1 at the reference voltage appearing at the junction of R28 and R29. It accomplishes this via current feedback to pin 3 of IC11. The overall effect is that C38 discharge current doubles (increases 1 octave) for each 20 mv increase across pins 2 and 4 of IC11. When 2 OCT switch is up, R30 conducts and Q49 is saturated, effectively placing the series combination of R20 and R21 in parallel with R19. The current at pin 1 of IC11 is then determined by the current flowing through parallel resistors R19 and R20/R21. When 2 OCT switch is down, R30 does not conduct, Q49 is open, and R20/R21 are out of the circuit. Thus the current flowing into pin 1 of IC11 is 25 percent as much when Q49 is open as it is when it is saturated and, for the same voltage difference between the bases, the current flowing into pin 5 is also 25 percent as much.

The lower end of C38 is applied to low-input-bias-current voltage follower IC12/Q46. The voltage at the emitter of Q46 is applied to Schmitt trigger Q43 and Q44. The Schmitt trigger has a high hysteresis factor and when the voltage descends to the point where the Schmitt trigger fires, Q45 is turned on and C38 is rapidly recharged. The Schmitt trigger begins to shut off when the recharge is approximately 66 percent complete. Because of the storage time of Q44 and Q45, C38 is fully recharged before Q45 is completely off.

2.4.2 OSCILLATOR A WAVESHAPING

The sawtooth wave developed at the emitter of Q46 (Figure 2-2) is applied through R41 to the base of Q47 and through R43 to the collector of Q48. The width of the rectangular wave that appears at the collector of high gain amplifier Q47 depends on the bias current supplied through R45 from the output

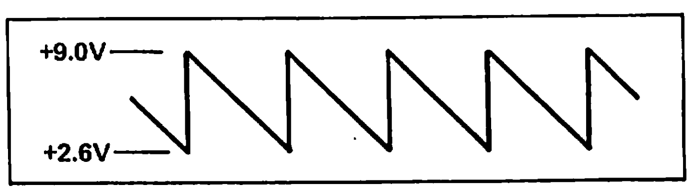


FIGURE 2-2 EMITTER OF Q46

of IC13. The control current applied to the input of IC13 from the resistor matrix determines the output voltage of IC13. When the control current is zero, Q47 remains saturated throughout the entire sawtooth cycle. Q48 is also biased by IC13 (via R118) and remains shut off and as a result, the output voltage is the undistorted sawtooth. As the control current increases, the voltage at the output of IC13 goes negative. When it is approximately -1 volt, the current through R118 is sufficient to completely saturate Q48 and effectively short out the sawtooth waves. When it is approximately -3 volts, Q47 begins to conduct on part of the sawtooth cycle and a narrow rectangular waveform appears at its collector. When the voltage at the output of IC13 is approximately -9 volts, the clipping of Q47 is symmetrical and a square wave appears at its collector. Thus, the waveform at the junction of R119 and R44 is first a sawtooth when the control current into IC13 is zero, then changes to a narrow rectangular, then to a broad rectangular, and finally to a square wave as the control current is increased. This waveform is applied to the band pass filter via an attenuator network associated with oscillator board No. 5 (oscillator B).

2.4.3 OSCILLATOR B (Minitmoog Only)

The circuitry for the second oscillator is located on oscillator board No. 5 and consists of a current source network, sawtooth oscillator and a mixing network for combining the A and B oscillator tones. The sawtooth waveform is produced by charging C503 through line P and discharging it by turning on Q501. The current through line P is supplied from one of the transistors in IC11 on the main board. This particular transistor is located on the same chip with the current source transistor for oscillator A and its characteristics are very close to those of the oscillator A current source. As a result, the ratio of oscillator A to oscillator B currents will be fairly constant as the instrument's pitch is varied. Resistors R501 thru R510 supply a relatively small voltage change at pin M to vary the ratio between oscillator currents by a factor of 4. Oscillator B range trimpot R504 sets the center value of oscillator B pitch. When pin T is grounded by the SYNC tab switch, the "B" PITCH control moves oscillator B pitch up and down an octave relative to oscillator A. When pin V is grounded by the SYNC tab switch, the "B" PITCH control sweeps the natural frequency of oscillator B over a range of more than four octaves. In this case, R505 shifts the pitch of oscillator B such that oscillators A and B are approximately in unison when the "B" PITCH control is fully counterclockwise. Note that the "B" PITCH control is centertapped with a center deadband to allow the musician to quickly and precisely set oscillator B pitch in unison with oscillator A. Octave trimpot R510 is set so that the pitch of oscillator B is either an octave above or below that of oscillator A when the "B" PITCH control is at either end of its rotation.

The oscillator circuitry consists of IC501, IC502 and Q501 with related circuitry. Q502 and Q503 are active only when oscillator B is synchronized to oscillator A. A positive going pulse is produced at the output of Schmitt trigger IC502 when the output voltage of integrator IC501 surpasses the threshold voltage at the junction of R514 and R531. Q501 is turned on for approximately 10 microseconds. Trimpot R511 increases the frequency at high charging currents and is used as a high end tuning adjustment. The sawtooth waveform appears at the output of IC501.

Sync pulses from oscillator A are applied at pin R to the base of Q502. When +9 volts are connected to pin Q by the SYNC tab switch, Q502 is always saturated. When pin Q is grounded by the SYNC tab switch, the sync pulses turn Q502 off and Q503 on once for every cycle of oscillator A. When Q503 conducts, the threshold of IC502 drops to 0 and the oscillator B waveform starts over (Figure 2-3).

Resistors R522 thru R525 form the mixing network. The A/B MIX control on the front panel

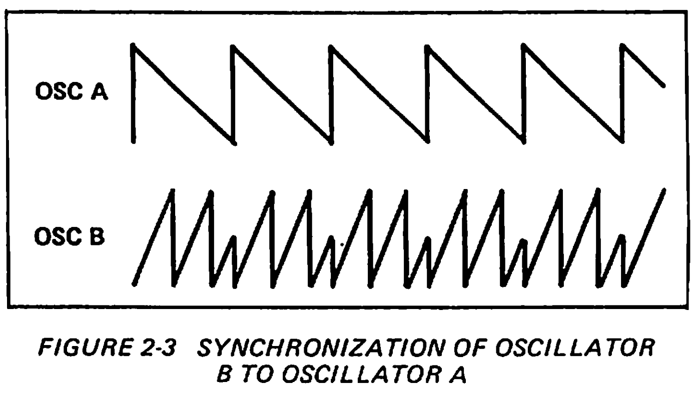


FIGURE 2-3 SYNCHRONIZATION OF OSCILLATOR B TO OSCILLATOR A

shunts varying proportions of oscillators A and B to ground. The values of resistors R522 thru R525 relative to the value of the A/B MIX control are set so that the signal power sum at pins Z and ZZ tends to remain constant as the A/B MIX control is rotated. The output at pin Z is the oscillator A signal applied to the normal input portion of the band pass filter via R122 and R124. The output at pin ZZ is the oscillator B signal applied further down the chain of the band pass filter to produce a different sound character.

2.5 BAND PASS FILTER

The band pass filter consists of IC15, IC16 and IC17 with associated components. IC16 and IC17 are identical integrators effectively connected in series and their gains determine the center frequency of the band pass filter while the gain of IC15 determines the bandwidth (Q). These gains are set by bias currents applied from transistor pairs Q39/Q40 and Q37/Q38, respectively. These transistor pairs may be compared directly to the transistor pair in IC11 which determines the frequency of oscillation. The main difference is that relatively constant currents are fed to these transistor pairs through R133 and R129. A precise, wide range relationship between output current and base-to-base voltage is not required of these transistor pairs. Only reasonable repeatability and the rough approximation of exponential characteristics are required.

2.5.1 BAND PASS FILTER CONTROL INPUTS

The bandwidth is determined by the voltage difference between the bases of Q37 and Q38. The voltage at the base of Q37 is the result of the bandwidth control current flowing through R128. An increase of 18.5 mv doubles the bandwidth. The one source of bandwidth control current is column 8 of the resistor matrix. The center frequency is determined by the voltage difference between the bases of Q39 and Q40. The voltage at the base of Q40 is the result of the center frequency control currents flowing through R134. An increase of 18.5 mv doubles the center frequency. The currents come from column 7 of the resistor matrix, the BRIGHTNESS potentiometer voltage applied to R193, the FILTER CONTROL INPUT jack voltage applied to R184, the modulation voltage applied to R181, the filter contour voltage applied to R116 and the keyboard pitch voltage applied through R179 and R180. The current from column 4 of the resistor matrix determines whether or not Q25 conducts. When Q25 conducts, it becomes saturated and shorts out the keyboard voltage controlling the center frequency.

R130 and R132 are offset adjustments for setting correct values of bandwidth and center frequency, respectively and compensate for transistor offset voltages, resistor variations and gain variations of IC15, IC16 and IC17.

2.6 LOW PASS FILTER

The output of the band pass filter is taken from the source of Q41 and applied across the bases of the bottom transistor pair of IC19. This transistor pair and the two immediately following it constitute a low pass filter whose cutoff frequency is proportional to the standing current. This current is determined by the voltage difference between pin 13 (ground) of IC19 and the base of Q33. The voltage at the base of Q33 is the result of cutoff frequency currents flowing through R151. These currents come from column 9 of the resistor matrix, the BRIGHTNESS potentiometer voltage applied to R186, FILTER CONTROL INPUT jack voltage applied to R185, modulation voltage applied to R187 and filter contour voltage applied through R117. The setting of R139 determines the calibration current through R140. An increase of approximately 18.5 mv at the base of Q33 results in a one octave increase in the cutoff frequency of the low pass filter.

2.7 VOLTAGE CONTROLLED AMPLIFIER

The transistor pair with common emitters on pin 3 of IC20 controls the amplitude of the audio waveform by variable transconductance. The current which determines this transconductance is determined by the voltage at pin 12 of IC20 and the resistance between pin 13 and ground. The voltage applied to pin 12 is the amplitude contour voltage and the resistance from pin B19 to ground is the 100K VOLUME control potentiometer. IC22 is a differential amplifier, the output of which is the final audio waveform.

2.8 AMPLITUDE CONTOUR GENERATOR

Of the two contour generators, the amplitude contour generator is the simplest, so it will be described first. This contour generator consists of Q34, Q35, Q36, IC18, transistor pairs Q26/Q27 and Q28/Q29, Q30, Q31, Q32 and associated circuitry. When the leading edge of the trigger occurs, Q35 partially charges C25 so that the emitter of Q35 rises to approximately 3.5 volts. If Q36 is saturated, Q34 does not conduct at all. Column 3 of the resistor matrix determines whether or not Q36 is turned on. If Q34 is not turned on, C25 is free to immediately begin linearly discharging through Q26. The discharging current from Q26 is determined by the voltage control developed across R189. If Q36 is off, Q34 holds the voltage at +3.5 volts until the end of the dc trigger occurs (detail D, Figure 2-1). Thus, the voltage at the emitter of Q35 is as shown in Figure 2-4. The rise time of the voltage at the emitter of Q35 is determined only by the ability of Q35 to discharge C25. Typically, this rise time is less than 1 millisecond. The decay time of the amplitude contour is determined by the voltage difference between the bases of Q26 and Q27. The voltage across R189 results from the amplitude contour decay time control currents coming from column 2 of the resistor matrix, the keyboard voltage applied to R199 and the shaping current from R169 and R171. R190 corrects for transistor offsets and other normal component variations. A voltage increase of 18.5 mv at the base of Q26 cuts the decay time in half.

IC18, C35 and Q32 comprise a voltage follower whose slew rate is proportional to the bias current of IC18. This bias current applied from the collector of Q28 is determined by the voltage difference between the bases of Q28 and Q29. Thus, since the decay time of an envelope is generally longer than the attack time, the voltage appearing at the source of Q32 has an attack time inversely proportional to the collector current of Q26. The contributions to attack time control are similar to those of decay time control. The quick-set current comes from column 1 of the resistor matrix.

Since Q26 is a nearly ideal current source, the decay slope at the source of Q32 would be a straight line if not for the action of Q30. At the beginning of the decay slope, the voltage at the base of Q30 is more positive than the emitter, and Q30 does not conduct. When the base of Q30 approaches -0.6 volt (i.e., when source of Q32 is equal to +1.8 volts), Q30 acts as an emitter follower and the current through R169 flows to R189 and slows down the decay slope. The more negative the base of Q30 goes, the higher its control current and the more the decay slope decreases. This gives the decay slope an extended tail and therefore sounds like a more natural exponential decay. (See Figure 2-5.)

When the voltage at pin B21 is +9 volts, Q31 is saturated and very little current flows through R171. When the voltage at pin B21 is zero, Q31 is open and current flows through R170 and R171 to greatly speed up the decay slope. The SUST tab switch connects pin B21 to +9 volts when it is down and to the trigger line when it is up. As a result, the tone is rapidly squelched when the SUST tab switch is up and the keys are released.

As noted previously, the keyboard pitch voltage controls both attack and decay times through R199 and R198, respectively. These times change by a factor of approximately 2.5 over the complete keyboard range.

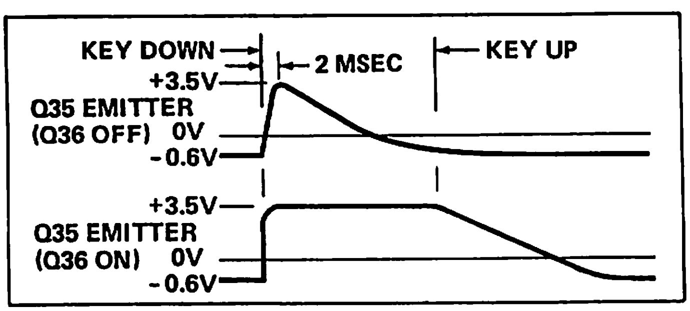


FIGURE 2-4 EMITTER VOLTAGE OF Q35

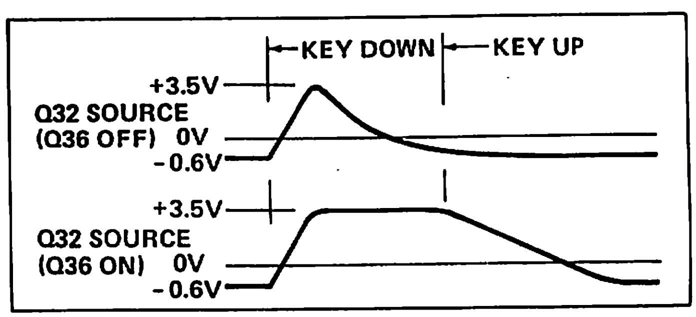


FIGURE 2-5 SOURCE VOLTAGE OF Q32

2.9 FILTER CONTOUR GENERATOR

The filter contour generator contains most of the features of the amplitude contour generator. Q15 of the filter contour generator corresponds to Q35 of the amplitude contour generator, Q13 to Q34 and Q12 to Q36. The filter decay mode control voltage from matrix column 11 through R88 and R91 determines whether the filter contour will rise and then immediately fall or fall only upon release of all keys. Q9 and Q10 of the filter contour generator corresponds to Q26 and Q27 of the amplitude contour generator. The current from Q10 determines the decay time of the contour. Similarly, IC14 corresponds to IC18, Q18/Q19 corresponds to Q28/Q29 and Q16 corresponds to Q30. R95 and R101 couple the keyboard voltage to the attack and decay control circuits. The voltage applied to pin B18 from the ATTACK potentiometer varies the attack time of the filter contour. The voltage applied to pin B13 from the DECAY potentiometer varies the decay time of the filter contour. Q22 and Q23 are routing switches and only one is on at a time. The filter contour routing control voltage from matrix column 5 determines whether Q17 is open or saturated. If Q17 is open, then Q21 is also open and Q24 is saturated. Thus, Q22 is biased on and Q23 is biased off and the contour is routed to the low pass filter. On the other hand if Q17 is saturated, Q23 is biased on and the contour is routed to the center frequency control input of the band pass filter.

2.10 MODULATION OSCILLATOR

The modulation oscillator is mounted on power supply board No. 2 along with seven slide potentiometers and consists of Schmitt trigger IC1 and integrator IC2 with their associated components. The output of IC2 is a triangular waveform and the output of IC1 is a square wave. The current supplying integrator IC2, and therefore the oscillator frequency, is varied over the frequency range of 1 to 50 Hz by RATE control R10.

2.11 TOUCH SENSOR

2.11.1 MECHANISM

The touch sensor mechanism, mounted underneath the keys, has a 20 inch long anodized aluminum rod on which a key bears when it is fully down (bottomed). Excess key pressure forces the rod to compress its foam rubber support pad causing the rod to come into more intimate contact with the grounded conductive nylon strip glued to the foam rubber pad. The assembly functions as a variable capacitor and the more force with which one holds a key down, the greater the capacitance. The touch sensor circuit on board No. 4 senses this capacitance increase and produces a dc control voltage ranging from 0 (no excess pressure) to +6 volts (maximum pressure).

2.11.2 VARIABLE FILTER AND AVERAGE VALUE DETECTOR

Multivibrator IC401, located on touch sensor board No. 4, produces a square wave at a nominal frequency of 100 KHz. The touch sensor element is a variable capacitance (C410) connected across pin E and ground. C410 and R402 form a variable low pass filter wherein the peak-to-peak voltage at pin E decreases as the value of variable capacitor C410 increases. C402 couples the waveform to clamp CR401. The dc component of the signal appearing at CR401 becomes less negative as the touch sensor's capacitance is increased. R403 and C403 filter out the ac components leaving only the dc component of the signal to be applied to emitter follower Q401. R404 at the emitter of Q401 and C404 provide additional filtering of the output signal.

2.11.3 DC RESTORER

The keyboard circuitry generates a trigger voltage which is applied to pin A of board No. 4 whenever a key is depressed. With no key depressed, this voltage is zero, Q403 conducts and IC402 turns on. The voltage at the junction of R404 and R406 (pin 2 of IC402) is kept very close to zero when the input trigger is zero through a feedback loop consisting of Q402 and R406.

Whenever any key is depressed, the trigger voltage at pin A rises to +9 volts and Q403 shuts off, shutting off IC402. C405 holds the voltage that existed before the trigger appeared and the junction of R406 and R404 remains close to zero until the touch sensor element capacitance increases. When the element's capacitance begins to increase (as a result of pressing down harder upon a key), the voltage at the junction of R404 and R406 begins to rise. Thus IC402, Q402, Q403 and related circuitry form a dc restorer that keeps the voltage at the junction of R404 and R406 at zero until a key is depressed and returns it to zero when a key is released.

2.11.4 AMPLIFIER

The voltage at the junction of R404 and R406 is applied to open loop amplifier IC403. The value of R408 is set so that the input of IC403 begins to saturate when the touch control output rises to approximately 50 percent of its maximum value and saturates more and more as the touch sensor element is depressed further. This allows the touch sensor to be more sensitive at the beginning of its travel and to become increasingly less sensitive as a key is depressed with more force.

The touch control output at pin G rises from 0 to approximately +6 volts and sweeps the filters, both oscillators or just the second oscillator depending on how the front panel touch sensor switches are set.

2.11.5 MODULATION AMOUNT

The touch control output from pin 6 of IC403 is also applied through R411 and Q404 to control the gain of IC404. The triangular modulation wave is applied at pin H from the output of IC2. The modulating signal of varying amplitude at pin J is available for modulation when the TOUCH CONTROLS MOD tab switch is depressed. It should be noted that the ratio between R412 and R413 is set so that C409 rounds off the triangular wave to yield a desirable sinusodial wave effect.

SECTION 3

DISASSEMBLY, VISUAL INSPECTION AND REASSEMBLY

3.1 DISASSEMBLY

Disassembly and inspection are essentially the same for both Synthesizers except where the Touch Sensor Board 4 and the Oscillator Board 5 are mentioned. These boards are used only on the Minitmoog.

a) Disconnect power cord connector and all other rear panel connections.

b) Stand instrument on one end and remove three screws securing large bottom cover (Figure 3-1) to instrument using a medium sized Phillips head screwdriver and remove cover.

> **NOTE**
> All internal alignment and adjustment controls are now accessible.

c) If necessary, the narrow bottom cover may be removed by taking out an additional 10 screws.

> **WARNING**
> Removing narrow bottom cover exposes live terminals of the ac POWER tab switch. Use extreme care when power cord is connected to primary power.

3.2 VISUAL INSPECTION

a) Inspect instrument for broken wires, loose printed circuit boards or electrical connectors, cable harness wires pushed into keyswitches and rotary pots with terminals shorted to chassis.

b) Check for frayed conductive nylon on touch sensor assembly shorting to keyboard switch assembly.

3.3 PRINTED CIRCUIT BOARD REMOVAL

a) Main Board No. 1 – Disconnect 5 electrical connectors, depress levers on 6 fastening devices and remove board from bottom cover. (See Figure 3-1.)

b) Power Supply Board No. 2 – Remove 7 slide knobs, narrow bottom cover, 2 electrical connectors, 2 screws and 1 foot and carefully lift power supply from instrument.

> **WARNING**
> Removing narrow bottom cover exposes live terminals of the ac POWER tab switch. Use extreme care when power cord is connected to primary power.

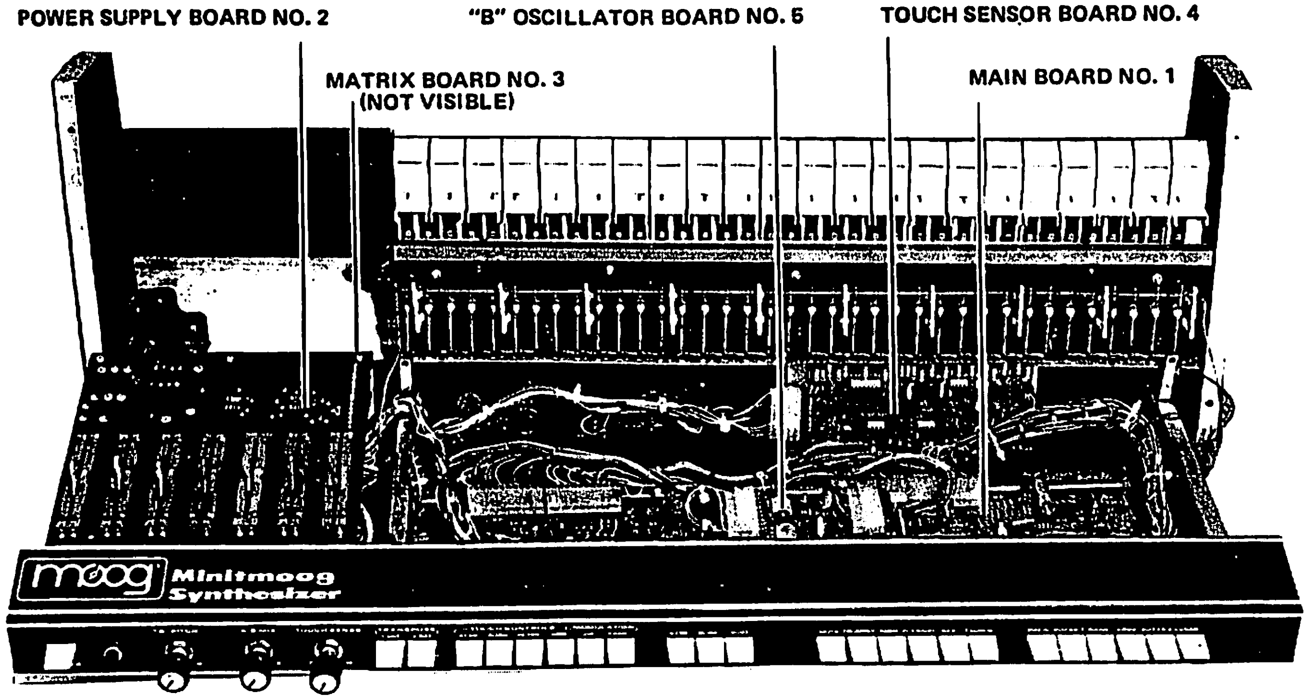


FIGURE 3-1 MINITMOOG PRINTED CIRCUIT BOARD LOCATIONS (INSIDE VIEW)

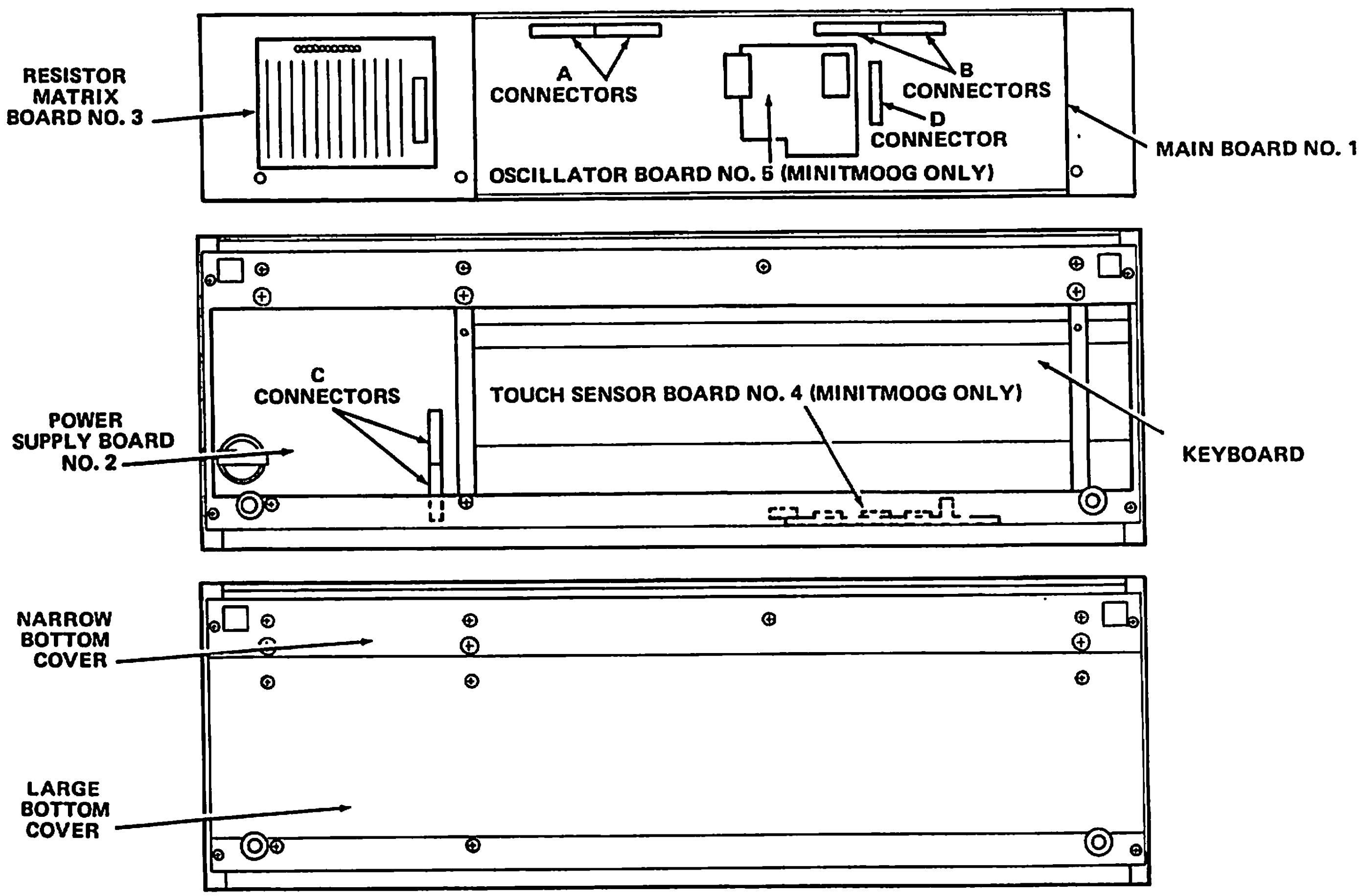


FIGURE 3-2 MINITMOOG COVER AND PRINTED CIRCUIT BOARD LOCATIONS (BOTTOM VIEWS)

c) Resistor Matrix Board No. 3 — Disconnect electrical connector, depress levers on 4 fastening devices and remove board with cable assembly attached. Disconnect "D" connector on main board No. 1.

d) Touch Sensor Board No. 4 — Disconnect electrical connector, remove 2 nuts and carefully lift board from instrument.

e) Oscillator Board No. 5 — Disconnect 2 electrical connectors, remove 2 nuts and carefully lift board from main board No. 1.

f) Keyboard — Remove cabinet by taking out 4 small screws on the end pieces. Remove narrow bottom cover. Disconnect 1 snap fastener and unsolder 3 wires (1 at top and 2 at bottom). Remove 2 large screws and washers, 2 hex head screws securing L-bracket to rear of keyboard frame and carefully lift keyboard from chassis.

3.4 REASSEMBLY

a) Keyboard - Reassemble keyboard in the reverse order of disassembly making certain that the 2 large washers between the chassis and keyboard frame are not forgotten and that the 2 screws do not touch the sensor assembly.

b) Oscillator Board No. 5 - Make certain insulating spacers are reinstalled so that nuts do not short out top or bottom side of board.

c) Large Bottom Cover - Ascertain harness wires are not forced into keyswitches. Assure cover does not pinch matrix harness wires passing through cutout in chassis.

SECTION 4
TUNING AND CALIBRATION PROCEDURES

4.1 GENERAL

Tuning and calibration procedures are essentially the same for both Synthesizers. Unless otherwise indicated the following instructions apply to both units.

The oscillator tuning procedure, paragraph 4.2, provides a method of tuning the instrument for proper oscillator range, scale, octave shift and tracking. A voice calibration procedure, paragraph 4.3, provides a method of calibrating the sound modifying circuits to voice the presets.

4.2 OSCILLATOR TUNING

4.2.1 TEST SETUP

A stable oscillator (or another synthesizer) is required to provide a reference tone (hereafter referred to as REF) tunable a few semitones above and below B♭4 (466 Hz).

REFERENCE = 

B♭4 = 466 Hz

In addition, an oscilloscope, digital voltmeter (DVM) and an amplifier/speaker system is required for tuning and calibration and oscillator board No. 5 must be carefully raised (not disconnected) from main board No. 1 to gain access to trimpots R16 and R190. The minimal test setup shown in Figure 4-1 will suffice. However the setup shown in Figure 4-2 will prove to be much more convenient and

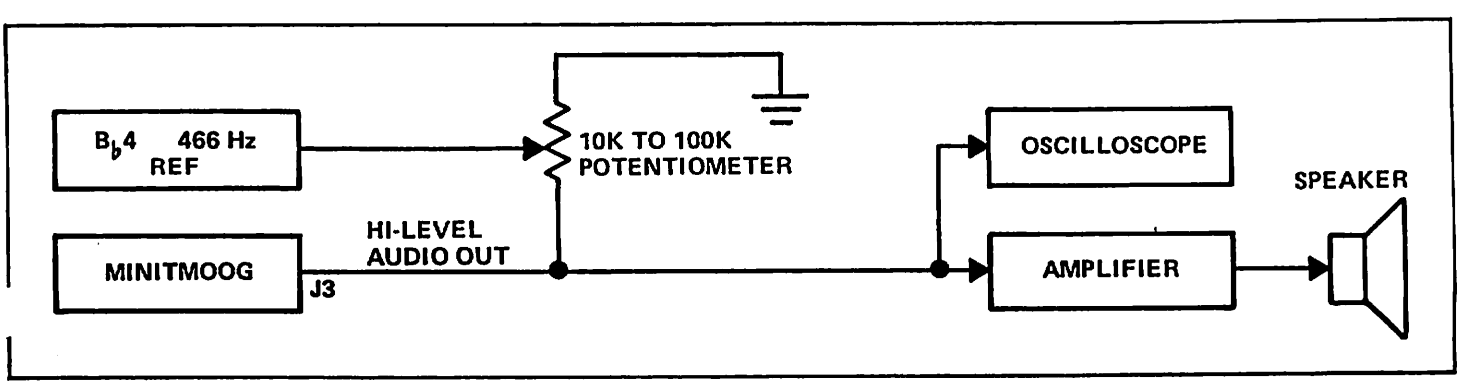


FIGURE 4-1 MINIMAL TEST SETUP FOR TUNING

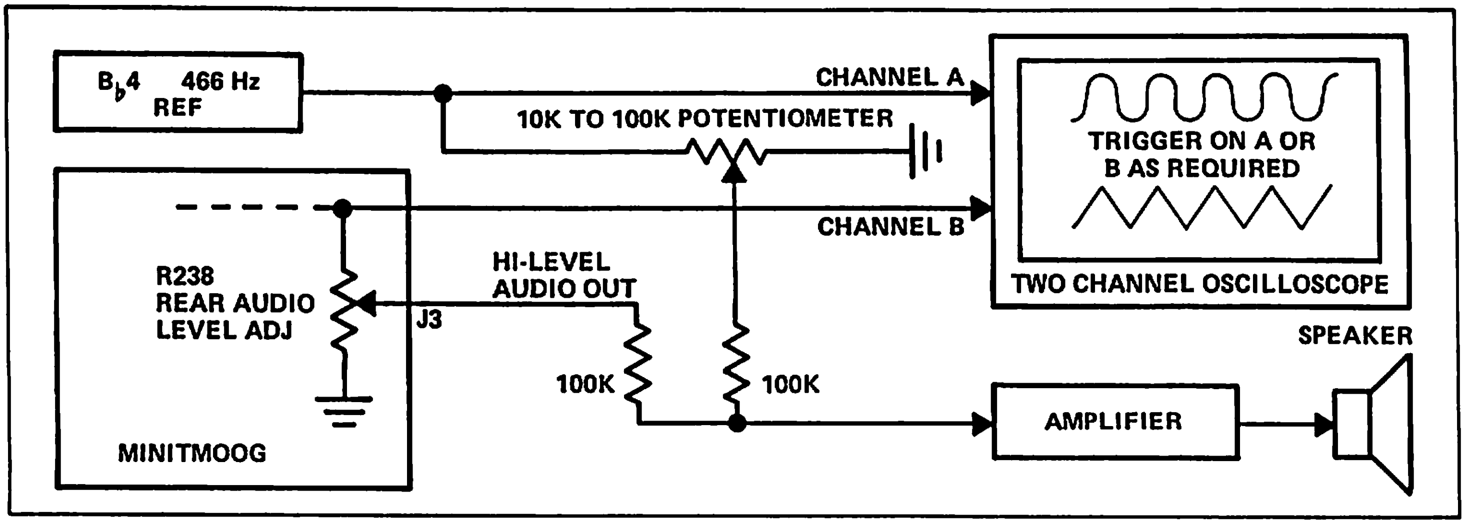


FIGURE 4-2 TWO CHANNEL OSCILLOSCOPE TEST SETUP FOR TUNING

should be used if a two channel oscilloscope is available. In the test setup of Figure 4-2, display height and audio level are independent and it is not necessary to trigger the oscilloscope off of a composite waveform. Trigger the oscilloscope off the lower of the two frequencies.

4.2.2 POWER SUPPLY ADJUSTMENT (Minitmoog Only)

a) Connect DVM across pins J (+) and K (-) of oscillator board No. 5 and turn +9 volt adjust trimpot R4 on main board No. 1 (Figure 4-3) until the +9 volt line is exactly +9.000 V ±10 mv.

b) Connect DVM across pins L (-) and K (+) of oscillator board No. 5 and verify that the -9 volt line is -9.000 V ±200 mv.

4.2.3 KEYBOARD CURRENT ADJUSTMENT

a) Connect DVM across pins A5 (+) and A6 (-)

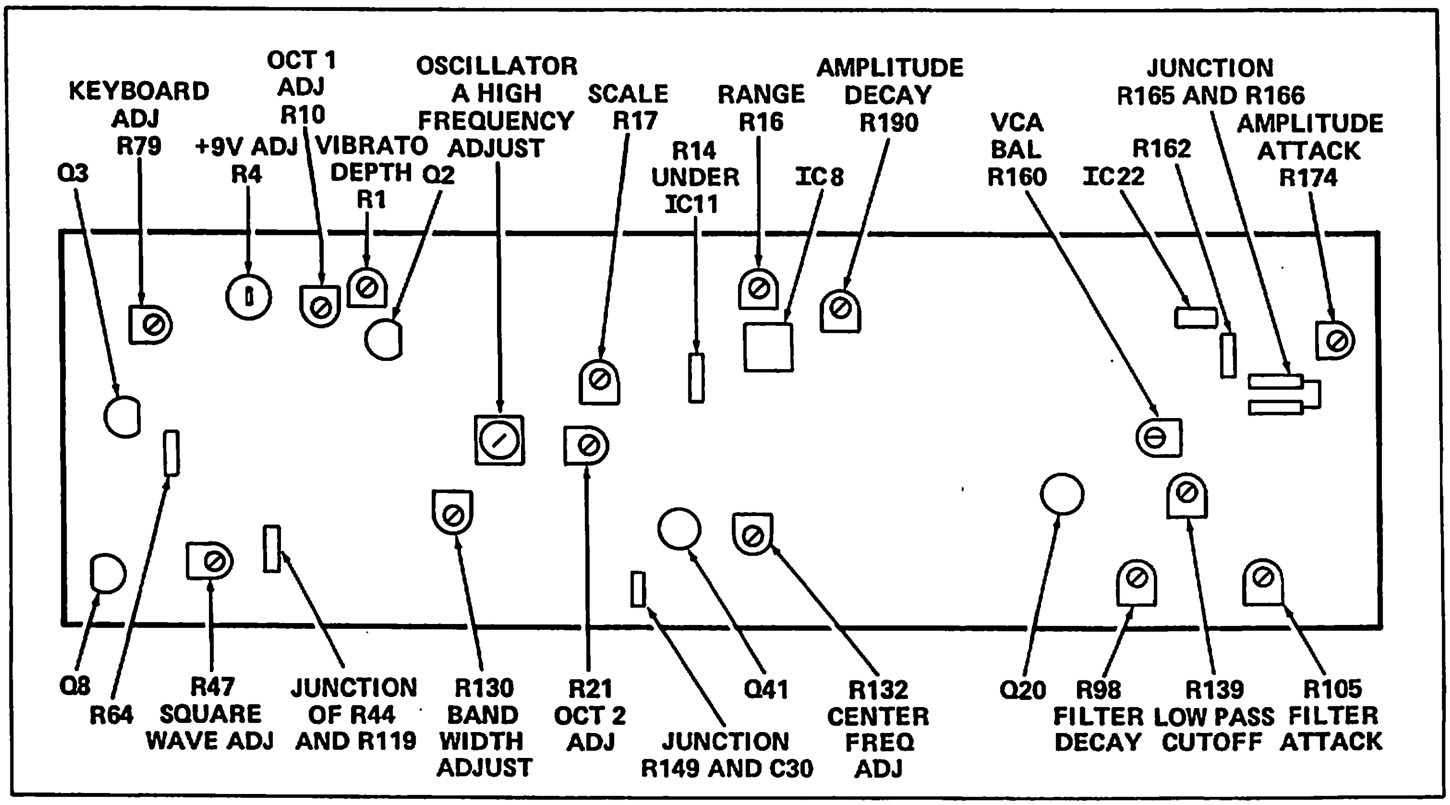


FIGURE 4-3 MAIN BOARD NO. 1 ADJUSTMENT CONTROLS AND OSCILLOSCOPE TEST POINT LOCATIONS

of main board No. 1 and observe voltage drop across keyboard.

b) Adjust keyboard trimpot R79 (Figure 4-3) for a voltage indication of +9.000 V ± 10 mv.

4.2.4 TRIGGERING

a) Connect oscilloscope to the collector of Q8 (Figure 4-3) and verify that the trigger voltage waveform present is as shown in Figure 4-4 with a single key depressed.

b) Hold one key down, depress next higher key and verify that a retrigger occurs.

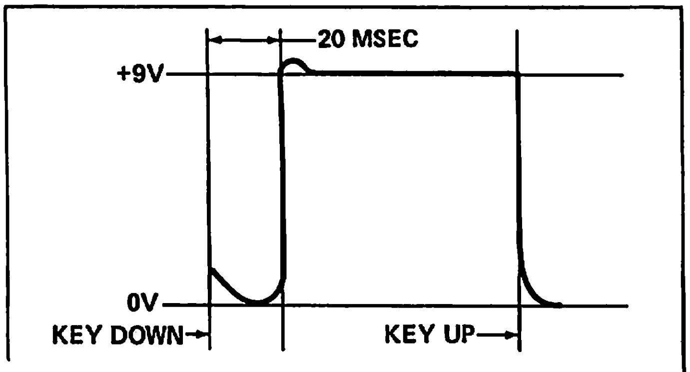


FIGURE 4-4 TRIGGER AT COLLECTOR OF Q8

4.2.5 KEYBOARD DRIFT

a) Connect DVM to emitter of Q2 (Figure 4-3) and verify the keyboard pitch voltage ranges from -4.50 V ±100 mv at the lowest key to +4.50 V ±100 mv at the highest key.

b) Verify that the pitch voltage holds steady while a key is being depressed and after the key is released. In neither case should the drift exceed 25 mv per minute.

4.2.6 PREPARATION FOR OSCILLATOR A TUNING (MAIN BOARD NO. 1)

a) Place all tab switches and slide controls up, turn all potentiometers counterclockwise and place VIOLIN tab switch down.

b) Connect a jumper between the collector and base of Q3 (Figure 4-3) in order to keep IC10 on and thereby eliminate keyboard control voltage drift.

c) Hold down the middle B♭ key (14 semitones below topmost key) for oscillator A tuning.

d) Center the rear panel TUNE control, connect wiper to ground, place 1 OCT tab switch down and connect DVM test leads between pin 6 of IC8 (bottom of R14, Figure 4-3) and ground. Adjust range trimpot R16 for an indication of 0.0000 ±0.0001 V.

> **NOTE**
> Steps c and d place the current source at a point where scale adjustments do not affect range adjustments.

4.2.7 OSCILLATOR SCALE

> 1 OCT tab switch down
> 2 OCT tab switch down

a) Adjust REF frequency for zero beat with oscillator A. Normally the REF frequency will be between 430 and 500 Hz and the Synthesizer frequency will be two octaves lower (nominally 117 Hz).

b) Hold down high B♭ key (highest black key) and zero beat oscillator A with REF frequency using scale trimpot R17 (Figure 4-3, Synthesizer ≃ 233 Hz, 1 octave below REF frequency).

4.2.8 OSCILLATOR A HIGH FREQUENCY COMPENSATION

> 1 OCT tab switch up
> 2 OCT tab switch up

a) Adjust REF frequency to zero beat with oscillator A (Synthesizer ≃ 932 Hz, 1 octave above REF frequency).

b) Hold down the high B♭ key and zero beat oscillator A with the REF frequency using the oscillator A high frequency trimpot (Figure 4-3, tacked on to the left of R21). Repeat steps a and b several times.

> **NOTE**
> Repeat paragraphs 4.2.7 and 4.2.8 several times as the adjustments interact, i.e., each time the scale is reset, the high frequency will go off frequency and vice versa. The process converges quickly so that both adjustments can be accurately set.

4.2.9 OSCILLATOR A OCTAVE TRANSPOSITION

> 1 OCT tab switch down
> 2 OCT tab switch down

a) Adjust REF frequency for zero beat with oscillator A (Synthesizer ≃ 117 Hz, 2 octaves below REF frequency).

b) Place 1 OCT tab switch up and zero beat oscillator A with REF frequency using octave 1 adjust trimpot R10 (Figure 4-3, Synthesizer ≃ 233 Hz, 1 octave below REF frequency).

c) Place 2 OCT tab switch up and 1 OCT tab switch down and zero beat oscillator A with the REF frequency using octave 2 adjust trimpot R21 (Figure 4-3, Synthesizer ≃ 466 Hz, unison with REF frequency).

4.2.10 OSCILLATOR A RANGE

> 1 OCT tab switch down
> 2 OCT tab switch up
> REF frequency exactly 466 Hz

a) Set range trimpot R16 (Figure 4-3) so that oscillator A zero beats with REF frequency (Synthesizer = 466 Hz, unison with REF frequency).

4.2.11 PREPARATION FOR TRACKING OSCILLATOR B TO OSCILLATOR A (Minitmoog Only)

a) Perform paragraphs 4.2.6 through 4.2.10 to tune oscillator A before tuning oscillator B (located on oscillator board No. 5).

b) Disconnect jumper between collector and base of Q3.

c) Hold down lowest $B_\flat$ key using a wedge.

d) Turn off REF source since oscillator B will be tuned by making it track oscillator A.

e) Set A/B MIX control to vertical so that the pitch of oscillators A and B may be compared.

4.2.12 OSCILLATOR B SCALE (Minitmoog Only)

> 1 OCT tab switch up
> 2 OCT tab switch down
> "B" PITCH control full CCW

a) Zero beat oscillator B with oscillator A using range trimpot R504, Figure 4-5 (oscillator B will be 1 octave lower than oscillator A).

b) Hold down highest $B_\flat$ key and zero beat oscillator B with oscillator A using scale trimpot R529, Figure 4-5 (oscillator B one octave below oscillator A).

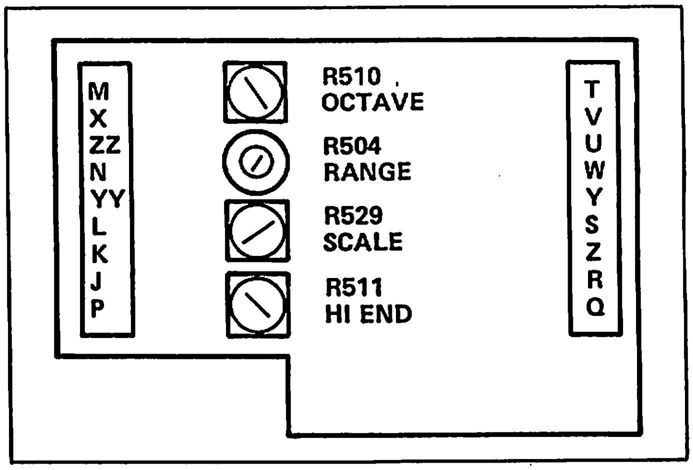


FIGURE 4-5 OSCILLATOR B TRIMPOT LOCATIONS (BOARD NO. 5)

4.2.13 OSCILLATOR B HIGH FREQUENCY COMPENSATION (Minitmoog Only)

> 1 OCT tab switch up
> 2 OCT tab switch up
> "B" PITCH control vertical (in deadband)

a) Zero beat oscillator B with oscillator A using range trimpot R504, Figure 4-5 (oscillators A and B in unison).

b) Hold down highest $B_\flat$ key and zero beat oscillator B with oscillator A using high end trimpot R511, Figure 4-5 (oscillators A and B in unison). Repeat steps a and b several times.

c) Repeat paragraphs 4.2.12 and 4.2.13 several times as scale and high end adjustments interact.

4.2.14 OSCILLATOR B OCTAVE TRANSPOSITION (Minitmoog Only)

1 OCT tab switch down
2 OCT tab switch up
"B" PITCH control vertical (in deadband)

a) Zero beat oscillator B with oscillator A using range trimpot R504, Figure 4-5 (oscillators A and B in unison).

b) Set "B" PITCH control fully clockwise to 10 and zero beat oscillator B with oscillator A using octave trimpot R510, Figure 4-5 (oscillator B one octave above oscillator A).

NOTE

Allow a small adjustment latitude by tuning oscillator B slightly sharp in step b (approximately 2 Hz beat rate). Thus oscillator B will be in tune with oscillator A slightly before the control reaches full rotation.

4.3 VOICE CALIBRATION

4.3.1 PREPARATION

Set the following controls to their initial position as follows: Satellite panel marking differences are in parentheses.

ATTACK (CONTOUR)		0
DECAY (COLOR)		0
BRIGHTNESS (EMPHASIS)		0
RATE		0
DEPTH		10
GLIDE		0
VOLUME		10
Tab Switches		All up
"B" PITCH	(Minitmoog Only)	Vertical
A/B MIX	(Minitmoog Only)	A (Full CCW)
LEVEL ADJUST (Rear Panel)		Full CW

4.3.2 SQUARE WAVE DUTY CYCLE

a) Observe waveform at junction of R44 and R119 (Figure 4-3).

b) Depress CLARINET (REED HOLLOW, Satellite) tab switch and adjust square wave adjust trimpot R47 for a symmetrical square wave as shown in Figure 4-6.

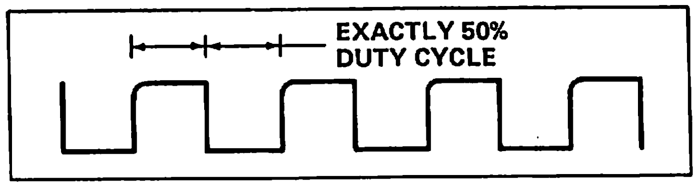


FIGURE 4-6 SQUARE WAVE AT JUNCTION OF R44 AND R119

4.3.3 BAND PASS FILTER RESONANCE (Q) AND CENTER FREQUENCY (F_c)

a) Observe waveform at source of Q41 (Figure 4-3) with CLARINET (REED HOLLOW, Satellite) tab switch still depressed.

b) Depress 1 OCT tab switch and C key one octave up from bottom of keyboard and adjust band width and center frequency trimpots R130 and R132 to obtain waveform shown in Figure 4-7.

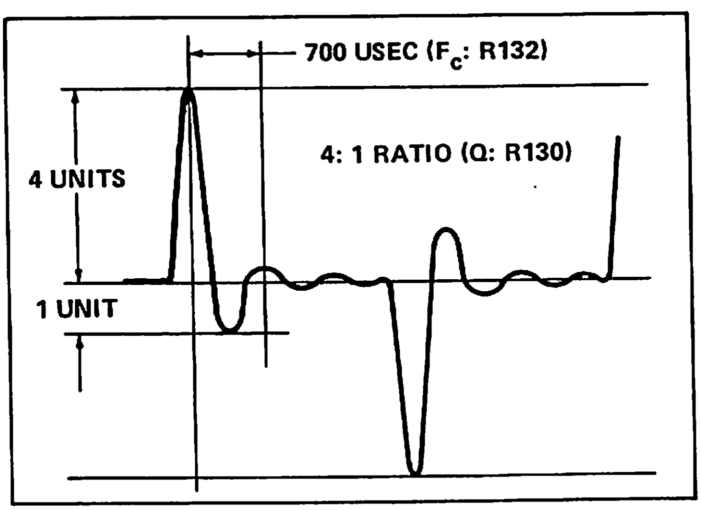


FIGURE 4-7 BAND PASS FILTER Q AND F_C AT Q41 SOURCE

4.3.4 LOW PASS FILTER CUTOFF FREQUENCY (F_L)

a) Raise all tab switches and depress highest key on keyboard.

b) Set VOLUME slide control all the way up and adjust low pass cutoff trimpot R139 (Figure 4-3) until the waveform at output pin 6 of IC22 (top of R162) is two volts peak-to-peak.

4.3.5 FILTER CONTOUR ATTACK AND DECAY TIMES

a) Depress 1 OCT tab switch.

b) Depress MUTE (BRASS MUTE, Satellite) tab switch and observe filter contour at the source of Q20 (Figure 4-3) while repeatedly striking C key one octave from bottom of keyboard.

c) Adjust filter decay and attack trimpots R98 and R105 until the filter contour matches the pattern shown in Figure 4-8.

> **NOTE**
> It may prove convenient to externally trigger the oscilloscope from the bottom of R64 for paragraphs 4.3.5 through 4.3.7.

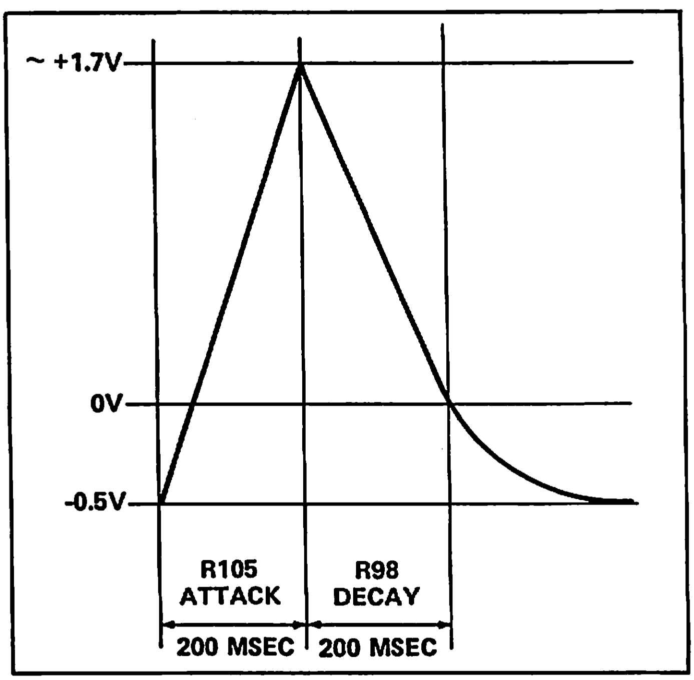


FIGURE 4-8 FILTER CONTOUR AT Q20 SOURCE

4.3.6 LOUDNESS CONTOUR ATTACK TIME

a) Observe waveform at junction of R165 and R166 (Figure 4-3) with MUTE (BRASS MUTE, Satellite) and 1 OCT tab switches still down.

b) Depress C key one octave up from bottom of keyboard and adjust amplitude attack trimpot R174 to match the attack contour shown in Figure 4-9.

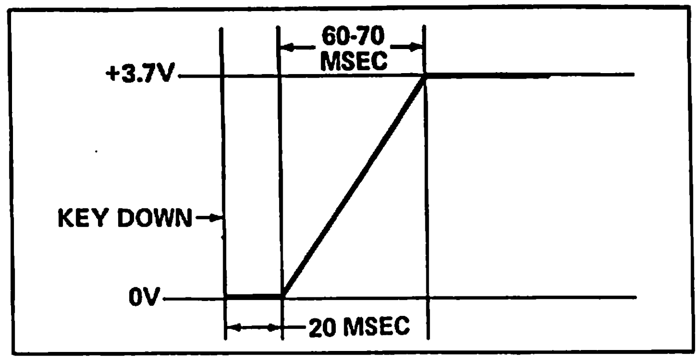


FIGURE 4-9 LOUDNESS ATTACK AT JUNCTION OF R165 AND R166

4.3.7 LOUDNESS CONTOUR DECAY TIME

a) Lift MUTE (BRASS MUTE, Satellite) tab switch and depress PIANO (STRING STRIKE, Satellite) tab switch.

b) Assure 1 OCT tab switch is still down and depress C key one octave up from bottom of keyboard.

c) Observe waveform at junction of R165 and R166 (Figure 4-3) and adjust amplitude decay trimpot R190 for the decay contour shown in Figure 4-10.

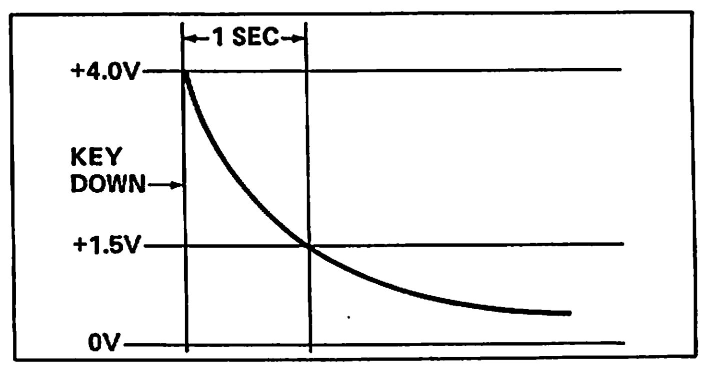


FIGURE 4-10 LOUDNESS DECAY AT JUNCTION OF R165 AND R166

4.3.8 VOLTAGE CONTROLLED AMPLIFIER BALANCE

a) Lift PIANO (STRING STRIKE, Satellite) tab switch and short junction of R149 and C30 (Figure 4-3) to ground.

b) Set VOLUME slide control at maximum and connect oscilloscope probe to top of R162.

c) Hit and release a key and adjust VCA balance trimpot R160 until a minimum click or thump is heard and step waveform at top of R162 does not exceed 10mv.

4.3.9 VIBRATO DEPTH

a) Set vibrato depth trimpot R1 fully CCW.

SECTION 5
OPERATING CONTROLS, INDICATORS AND CONNECTORS

Satellite Synthesizer panel marking differences are shown in parentheses.

PANEL MARKING	REF DESIG	FUNCTION
FILTER ATTACK (FILTER CONTOUR) Slide Control	R7	Controls amount of time it takes for the brightness to reach a peak; 0 is the normal setting, -4 indicates the longest attack and +4 the shortest attack times.
FILTER DECAY (FILTER COLOR) Slide Control	R8	Controls amount of time it takes for the brightness to die away on most voices; 0 is the normal setting, -4 indicates the longest decay and +4 the shortest decay times.
FILTER BRIGHTNESS (FILTER EMPHASIS) Slide Control	R9	Determines voice clarity from dull to bright sounds.
MODULATION RATE Slide Control	R10	Varies rate of modulation from approximately one per second at 0 to a buzz rate at 10.
MODULATION DEPTH Slide Control	R11	Adjusts degree or intensity of modulation. With MODULATION VIB tab switch depressed, increasing MODULATION DEPTH corresponds to periodic frequency deviation that increases from zero to more than one octave. With MODULATION TREM tab switch depressed, increasing MODULATION DEPTH corresponds to greater periodic timbre variation.
GLIDE Slide Control	R12	Adjusts keyboard glide time from note to note from 0 to 4 seconds when GLIDE tab switch is depressed.
VOLUME Slide Control	R13	Adjusts Synthesizer output level over a range of 30dB.
POWER Tab Switch and Indicator Light	SW21	Controls primary power supplied to instrument. Red indicator light indicates when POWER tab switch is depressed and primary power is supplied to the instrument.
"B" PITCH Variable Resistor (Minitmoog Only)		Varies pitch of B tone producing oscillator over a two octave range.
A/B MIX Variable Resistor (Minitmoog Only)		Controls mixing of A and B tone source oscillator outputs. A only or B only occur at the CCW and CW extremes of rotation, respectively.

OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont.)

PANEL MARKING	REF DESIG	FUNCTION
TOUCH SENSE Variable Resistor (Minitmoog only)		Regulates range of expressive effects when additional pressure is exerted on the keys for SYNC, PITCH and FILTER (brightness) modes.
TRANSPOSE 1 OCT (OCTAVE 1) Tab Switch	SW20	When depressed, moves pitch down one octave.
TRANSPOSE 2 OCT (OCTAVE 2) Tab Switch	SW19	When depressed, moves pitch down two octaves.
TOUCH CONTROLS SYNC Tab Switch (Minitmoog only)		Active only when other SYNC tab switch is also down. When depressed, raises pitch of B tone oscillator as a key is depressed harder producing a phasing effect.
TOUCH CONTROLS PITCH Tab Switch (Minitmoog only)		When depressed, bends pitch of both A and B tone oscillators up to an interval of at least seven semitones when a key is depressed harder.
TOUCH CONTROLS FILTER (MODULATION REP) Tab Switch		When depressed, adds familiar Moog "wah" to most voices when pressure on the keys is increased. This effect adds directly to the effect produced by the FILTER BRIGHTNESS slide control.
TOUCH CONTROLS MOD ↓∿ ⊓⊔↑ Tab Switch	SW17	When depressed, allows either vibrato or tremolo to be added to the tone as the pressure on the keys is increased. The DEPTH slide control in this mode acts as a touch sensitivity control and the MODULATION RATE slide control sets the speed of the effect. This tab switch has an effect only if the MODULATION VIB or MODULATION TREM tab switch is also depressed.
MODULATION VIB Tab Switch	SW16	When depressed, adds vibrato to the pitch. Vibrato depth is set by the MODULATION DEPTH slide control if touch control is not being employed.
MODULATION TREM Tab Switch	SW15	When depressed, adds tremolo to the tone. Tremolo depth is set by the MODULATION DEPTH slide control if touch control is not being employed.
SYNC Tab Switch (Minitmoog only)		When depressed, synchronizes B oscillator pitch to A oscillator pitch so that "B" PITCH control acts as an overtone control.
GLIDE Tab Switch	SW14	Activates GLIDE slide control when depressed.

PANEL MARKING	REF DESIG	FUNCTION
SUST Tab Switch	SW13	When depressed, allows note to die away more gradually after key is released.
MUTE (BRASS MUTE) Tab Switch	SW12	When depressed, approximates a "wah-wah" muted brass voice starting with an emphasis on the lows, moving to the highs and returning each time a key is depressed.
TRUMPET (BRASS OPEN) Tab Switch	SW11	When depressed, keyboard produces the sounds of a trumpet, trombone or tuba by depending on various other controls.
OBOE (REED THIN) Tab Switch	SW10	When depressed, keyboard produces the sounds similar to that of a double reed. In the top octave, the sound is of an oboe. In the lower octaves, the sound of a bassoon is approximated.
CLARINET (REED HOLLOW) Tab Switch	SW9	When depressed, keyboard produces the hollow reed sound and soft attack of the traditional clarinet.
SAX (REED FULL) Tab Switch	SW8	When depressed, keyboard produces the bright reed sounds of a saxophone.
TAURUS (REED BRIGHT) Tab Switch	SW7	When depressed, keyboard simulates the bass sound characteristic of the Taurus Synthesizer.
VIOLIN (STRING BOW) Tab Switch	SW6	When depressed, keyboard produces a gentle voice with a slow attack simulating the sounds of a violin.
GUITAR - 1 (STRING PLUCK) Tab Switch	SW5	When depressed, keyboard produces a plucked string voice with a lingering decay for creating guitar or harpsichord effects.
PIANO (STRING STRIKE) Tab Switch	SW4	When depressed, keyboard produces a percussive struck string voice similar to a piano.
AIRES (STRING PICK) Tab Switch	SW3	When depressed, produces a typical synthesizer sound.
GUITAR - 2 (BELL) Tab Switch	SW2	When depressed, produces an interesting sound similar to that of an electric bass guitar.
LUNAR Tab Switch	SW1	This versatile voice provides a wide variety of timbre changes which produce many popular electronic Moog sound effects when depressed.
TUNE Variable Resistor	R237	Adjusts pitch of Synthesizer to match the pitch of another instrument.

OPERATING CONTROLS, INDICATORS AND CONNECTORS (Cont.)

PANEL MARKING	REF DESIG	FUNCTION
FILTER CONTROL INPUT Phone Jack	J2	Provides for an external Moog Foot Pedal Controller to be connected to the instrument for additional timbre control of the filter. When employed, touch sensor filter sweep is defeated.
LEVEL ADJUST Variable Resistor	R238	Sets maximum output level of instrument with performance changes in output level adjusted by the VOLUME slide control.
HI-LEVEL OUTPUT Phono Jack	J3	Provides instrument high level output (1 volt RMS) for connection to external amplifier AUX or TAPE input connector.
LO-LEVEL OUTPUT Phone Jack	J4	Provides instrument low level output (30 mv RMS) for connection to external Maestro sound modifiers, preamplifiers, guitar amplifiers or public address amplifiers.

SECTION 6
KEYBOARD MAINTENANCE AND ADJUSTMENT

6.1 CONTACTS

6.1.1 DIRTY CONTACTS

The J-wire switch contact to the buss bar may become dirty or corroded. If so, use ordinary rubbing alcohol (isopropanol) on a cotton swab to clean the contact area. Do not spray contact cleaner onto the key contacts or use abrasives (emery paper or burnishing tools) as they will remove the gold plating. Be careful not to bend the J-wires (fine whiskers). Stubborn cases may require cleaning with a nonabrasive rubber eraser. If the contact area has been damaged, rotate the buss bar or J-wire or gently bend the J-wire laterally to contact a new portion of the buss bar.

CAUTION

Do not touch J-wires or buss bar with bare fingers as salty, oily fingerprints will eventually cause corrosion and dust collection resulting in intermittent operation.

6.1.2 CONTACT HEIGHT

Dirty contacts are revealed by improper triggering of notes. Triggering problems may also occur if the contact height (the distance tip of key travels downward before the note sounds) is set too high (i.e., makes contact too soon). Black keys should make contact between 1/8 and 3/16 inch of downward travel and white keys between 3/16 and 1/4 inch. If necessary, rebend by gently massaging the portion of the wire between the actuator and the attachment point. The contact must make before the key bottoms on the touch sensor assembly.

6.2 KEYS

6.2.1 CLANKING

Keys will clank or thump if the tails hit the case on the down stroke. This problem can be repaired by gluing a thin spacer such as a 1/16 inch thick piece of wood to the case immediately above the plastic strip over the key pivots. The case will be forced away from the keys upon reassembly and clanking should cease.

6.2.2 STICKING OR SLUGGISH FEEL

Check the pivot for being too tight. Rotate the pivot tab about the vertical axis by bending a few degrees with a pair of pliers. Make certain the key tails are not rubbing on the back of the case necessitating the removal of some of the wood with coarse sandpaper. Keys near either end of the keyboard may stick because the hex head screw that fastens the rear mounting brackets to the keyboard frame does not have its flats aligned vertically. In this case, the screw head will rub against the key return springs and cause the trouble.

6.2.3 LEVELING

If a key does not return to the same height as its neighbors, the key leveling tab located inside the front end of the metal body of the key must be bent up or down as required. Remove the key screw so the ivory comes off and reposition the tab using the keyboard adjusting tool, part number 962-043031-001.

6.3 TOUCH SENSOR

6.3.1 SENSOR MOUNTING

The touch sensor assembly is mounted to the keyboard frame by 5 studs attached to the sensor assembly. The height of the assembly must be set so that the keys will bottom on the sensor assembly and not on the key leveling tabs. The 5 studs are locked into position by 10 nuts on either side of the keyboard frame. The sensor is intentionally warped by the extreme end studs when mounted so that its ends are approximately 1/16 inch further away from the keyboard frame than its center. This must be accomplished before the keyboard is installed in the chassis. The warping must be accomplished so that touch sensitivity for keys at the ends of the keyboard is the same as that for the keys in the center. If this is not accomplished, the center keys will be overly sensitive while the end keys will not have enough response.

6.3.2 ADJUSTING SCREWS

Two slotted screws set the pressure with which the rod bears against the foam pad. Adjust these screws as follows:

> 1 OCT and 2 OCT tab switches up
> VIOLIN and PITCH tab switches down
> TOUCH SENSE variable resistor
> full clockwise

Play over the entire keyboard with a normal light playing touch. If unwanted pitch bending occurs, tighten slotted screws by turning counterclockwise until bending occurs only when extra pressure is applied to the keys.

If the screws are over tightened, the sensor will not be responsive enough. The pitch should bend upward at least a fifth (7 semitones) for any key pressed down heavily. Especially check the keys near each end of the keyboard as they normally will be less responsive. If necessary, loosen screws slightly by turning clockwise and recheck for over sensitivity.

6.3.3 TOUCH SENSOR INTERMITTENT OPERATION WHEN DEPRESSED OR TOUCH SENSOR DEAD

This trouble may be due to open contacts between the shielded cable and either the conductive nylon (snap fastener) or the touch bar (No. 6 screw in end) or there may be a short between the touch bar and the nylon. Shorts may occur around the two holes in the rod through which the adjusting screws pass or at the end of the rod if the No. 6 screw touches the nylon. Repair these shorts by sticking a small piece of Scotch No. 156 2 mil mylar tape over the area of the short. Burn a hole in the tape with a soldering iron for the adjusting screw. If the nylon is frayed, look for a strand touching either end of the buss bar causing a short circuit. Repair this by burning off the strand with a soldering iron.

6.3.4 OTHER DIFFICULTIES

If one, several or all of the keys are inoperative, make certain the wiring harness is not pushed into the key contacts. In addition, check for a strand of frayed conductive nylon contacting the key switches causing nonfunctioning or crazy operation. If when bending pitch, the pitch drifts down at an objectionable rate while the key is pressed down fully, replace IC402. (IC402 is a factory selected part requiring a CA3080 with low output leakage. Try several CA3080s until one with the proper characteristics is located.)

Sometimes the audio output may die out completely when a key is pressed down hard. This trouble may be caused by one of the 5 mounting studs contacting the top of a socketed CA3080 metal can on the main board. If this occurs, shorten the CA3080 leads, studs or both as required.

SECTION 7
TROUBLESHOOTING GUIDE

The procedures that follow generally apply to both Synthesizers except where the Oscillator Board 5 and Touch Sensor Board 4 are mentioned. These components are used only on the Minitmoog. An aid in control selection is presented in Section 5 indicating the different panel markings for identical controls.

SYMPTOM	PROBABLE CAUSE
	7.1 POWER SUPPLY
A. No +18 or -18V supply voltages present.	1. Transformer T1 defective. 2. Capacitor C1 or C2 shorted. 3. Diode D1, D2, D3 or D4 open.
B. +18V supply voltage present but no -18V supply voltage or vice versa.	1. Individual 18V supply line shorted.
C. No +9 or -9V supply voltage present but +18 and -18V supply voltages are present.	1. IC1 defective. 2. Shorted +9V supply line.
D. No -9V supply voltage but +9V supply voltage is present.	1. IC2 or Q1 defective. 2. Shorted -9V supply line.
E. Ripple voltage appearing on +9 or -9V supply line	1. Capacitor C1, C2 or C3 defective. 2. Diode D1, D2, D3 or D4 defective. 3. Transformer T1 has an open secondary winding.
F. Voltage drift, noise or oscillation on power supply lines.	1. IC1 defective. 2. If only on -9V supply line, IC2.

SYMPTOM	PROBABLE CAUSE
7.2 SOUND CHAIN	
Set the following controls as follows for all sound chain troubleshooting procedures. All tab switches up except VIOLIN tab switch down. All slide controls at zero position except VOLUME slide control at 10. All front panel rotary controls full counterclockwise position.	
A. No sound and POWER indicator light off.	1. 115 VAC wiring faulty. 2. POWER switch SW21 defective.
B. No sound, POWER indicator light on and 9 volt power supplies operating properly.	1. Connect oscilloscope probe to emitter of Q46 and verify oscillator A is operating properly. 2. Connect oscilloscope probe to pin 6 of IC501 and verify oscillator B is operating properly. 3. If both oscillators are operating properly, set A/B MIX control vertical and check waveforms on pins Z (oscillator A) and ZZ (oscillator B) of board No. 5 (Figure 4-5). Levels should cross fade as A/B MIX control is rotated. Trouble would most likely be caused by faulty wiring from pins S, X, Y, Z or ZZ. If only oscillator A is not operating, trouble may be in waveform selector circuit. If proper waveforms are observed on pins Z and ZZ, proceed to step 4. 4. Check band pass filter output waveform at source of Q41. Signal level should be approximately 300 mv peak-to-peak. No output indicates trouble is in band pass filter section. If proper output is observed, proceed to step 5. 5. Check low pass filter output waveform at pin 1 of IC20 with a key depressed. Signal level should be approximately 400 mv peak-to-peak. If not, trouble is in the voltage controlled filter or amplifier (IC19 or IC20). If proper waveform is observed, proceed to step 6. 6. Check waveform at pin 6 of IC22 while holding a key down. Signal level should be approximately 3 volts peak-to-peak. If normal, trouble is in output wiring, R236, J3, J4 or associated circuitry. Otherwise IC22 or associated circuitry is faulty.
C. Intermittent sound or sound dies when key is depressed firmly.	1. Keyboard shorting to top of a CA3080 integrated circuit can. Shorten leads or touch sensor mounting studs. 2. Harness wiring or rotary control lug shorting to front panel extrusion.
D. Neither oscillator A or B operating.	1. Faulty exponential current source IC11 or IC21. 2. IC8 or associated dc summer circuitry faulty (possible shorted summing resistor). 3. Resistor R14 broken. 4. Improper input to dc summer input resistors.

TROUBLESHOOTING GUIDE (Cont.)

SYMPTOM	PROBABLE CAUSE
7.2 SOUND CHAIN (Cont.)	
E. No oscillator B output, oscillator A operating properly.	1. IC501, IC502, Q501, Q502 or Q503 defective. 2. Input wire to board No. 5 broken. 3. Resistor R501 broken. 4. Connector pin M, R or P shorted. 5. IC11 defective.
F. No oscillator A output, oscillator B operating properly.	1. IC12, Q43, Q44, Q45 or Q46 defective. 2. Open OSC A HI END trimpot. 3. Capacitor C38 shorted.
G. No waveshaper output.	1. IC13, Q47 or Q48 defective. 2. Resistor R47 open. 3. Faulty wiring to pin D6 of resistor matrix.
H. Band pass filter will not pass signal.	1. Ground collectors of Q38 and Q39. If signal still does not pass, trouble is in IC15, IC16, IC17, Q41 or Q42 or associated circuitry. If signal passes the filter, check filter control current sources.
I. Band pass filter current sources at fault.	1. Remove one short and then the other to determine which transistor pair, Q37 and Q38 or Q39 and Q40, is faulty. 2. Ground both transistor bases of the faulty pair and observe if signal passes (collectors not shorted). If signal passes, the fault lies in the summing network, matrix or matrix interconnecting wiring. Otherwise the transistor pair or trimpot is at fault.
J. Low pass VCF and VCA do not pass signal (no signal on pin 1 of IC20).	1. Short pin 14 of IC19 to ground. If signal passes, the fault is in either the filter contour circuitry or the transistor the collector of which is tied to pin 14. If signal still does not pass, proceed with step 2. 2. With pin 14 of IC19 still shorted to ground, measure waveform at pins 7 and 10 of IC20. Signal at each pin should be approximately 10 mv peak-to-peak (about half the 20 mv peak-to-peak observed at pin 2 of IC19). If signal is present, VCF is operating properly and the problem lies within the VCA. If signal is not present, trouble is in IC19.
K. Low pass VCF operating properly (proper signals at pins 7 and 10 of IC20) but VCA has no output (pin 1 of IC20).	1. Hold down a key and check that voltage at pin 12 of IC20 holds at approximately +3.5 VDC. If voltage holds, trouble is in IC20, R164, VOLUME control R13 or wiring from R164 to R13. If voltage at IC20 does not rise, the amplitude envelope generator is not functioning.
L. VCA operating properly but has no output.	1. Trouble is in IC22, C32, LEVEL ADJUST control R238 or output wiring.

SYMPTOM	PROBABLE CAUSE
7.3 CONTROL CIRCUITS	
A. Neither envelope (contour) generator will operate properly.	1. No trigger from keyboard. Refer to the waveforms in Figure 2-1 and signal trace envelope (contour) generator.
B. VCF sweep defective but amplitude envelope generator is operating normally.	1. Defective filter contour envelope generator component IC14, Q9 thru Q14, Q16, or Q18 thru Q20.
C. Band pass filter sweep operating properly but low pass filter sweep defective or vice versa.	1. Defective electronic switch component Q17 or Q20 thru Q23. Defective matrix or wiring from matrix.
D. Defective loudness sweep but VCF sweep operating properly.	1. Defective amplitude envelope generator component Q26 thru Q32, Q34 thru Q36 or IC18.
E. No vibrato but tremolo operating normally or vice versa.	1. Broken wire or TREM or VIB switch SW15 or SW16 defective.
F. No vibrato or tremolo.	1. Defective modulation oscillator component. Check waveforms at pin 6 of IC1 and IC2 and replace defective component. 2. Broken wire or defective DEPTH control R11 or MOD switch SW17.
G. Normal vibrato and tremolo but touch control not operating. PITCH, SYNC and FILTER touch controls operating normally.	1. Wiring to pin H or J of touch sensor board No. 4 open. 2. Q404 or IC404 defective.
H. Touch control of vibrato and tremolo operating properly but PITCH, FILTER and SYNC touch controls not operating.	1. Defective wiring or R3 open.
I. All touch controls do not operate.	1. Touch sensor element C410 defective. 2. IC401 thru IC403, Q401 or Q402 defective. 3. No trigger pulse to pin A of touch sensor board No. 4. 4. No + or -9 volt power at pins B and D of touch sensor board No. 4.
J. Faulty voicing.	1. Out of calibration. Perform tuning and calibration procedures outlined in Section 4. 2. Individual matrix circuit boards shorted together. 3. Defective wiring to matrix.
K. Keyboard totally inoperative, no trigger or pitch change.	1. IC7 or IC4 defective. 2. Open wiring to pins A4 thru A6.

SYMPTOM	PROBABLE CAUSE
7.3 CONTROL CIRCUITS (Cont.)	
K. Keyboard totally inoperative, no trigger or pitch change. (Continued)	3. Shorted resistor string or buss wire possibly caused by frayed nylon from touch sensor.
L. Pitch normal but no trigger.	1. Trigger circuit component IC5, Q5 thru Q8 or Q50 defective.
M. No retrigger occurs when second key is depressed.	1. IC6, Q5 or Q6 defective.
N. Trigger present but no pitch change. Fine TUNE control R237 and other inputs operating properly.	1. Q2 thru Q4, Q51, IC3, IC9 or IC10 defective. 2. GLIDE control R12 defective or associated wiring open.
O. Pitch drifts after all keys are released.	1. Capacitor C4 or C5 leaky. 2. IC9, IC10 or Q51 leaky.
7.4 OSCILLATOR TUNING	
A. Oscillator A will not tune or stay in tune. Oscillator B tracks oscillator A.	1. IC11 defective. 2. IC4, IC7, IC8 or IC21 defective. 3. SCALE trimpot R17 defective. 4. Check power supply output voltages for drifting out of tolerance.
B. Oscillator B cannot be tuned to track oscillator A or will not stay tracked to oscillator A.	1. IC11 defective. 2. IC501 or IC502 defective. 3. IC12 or Q43 thru Q46 defective.

NOTE

Some range drift of oscillator B relative to oscillator A is normal. However scale tracking should not drift once "B" PITCH control is retuned.

SYMPTOM	PROBABLE CAUSE
C. Oscillator A goes out of tune but oscillator B still operates normally.	1. IC11 defective. 2. IC12 or Q43 thru Q46 defective.

SECTION 8
MODIFICATIONS

8.1 SERVICE BULLETIN 802

This Service Bulletin was issued and is included in this manual to avoid future maintenance because of defective or intermittent touch sensor bar. This condition occurs because of a chemical reaction between the foam and conductive nylon material.

8.2 TOUCH SENSOR BAR
(Minitmoog Serial Numbers below 2144)

Rebuilt touch sensor bars are available under part number 997-043976-001. It is estimated to require 1 hour to perform the following procedures:

1. Remove the touch sensor from the unit by removing the bottom cover and unscrewing four screws (Figure 8-1) to disassemble the unit to the extent shown in Figure 8-2.

2. Remove the five nuts from the captive screws (Figure 8-2) securing the top support to the unit and remove the support.

3. Unscrew the two screws that attach the sensor to the top support (Figure 8-3).

4. Remove and discard the conductive nylon material and the double sided tape (Figure 8-4) being careful to avoid damaging the foam pad.

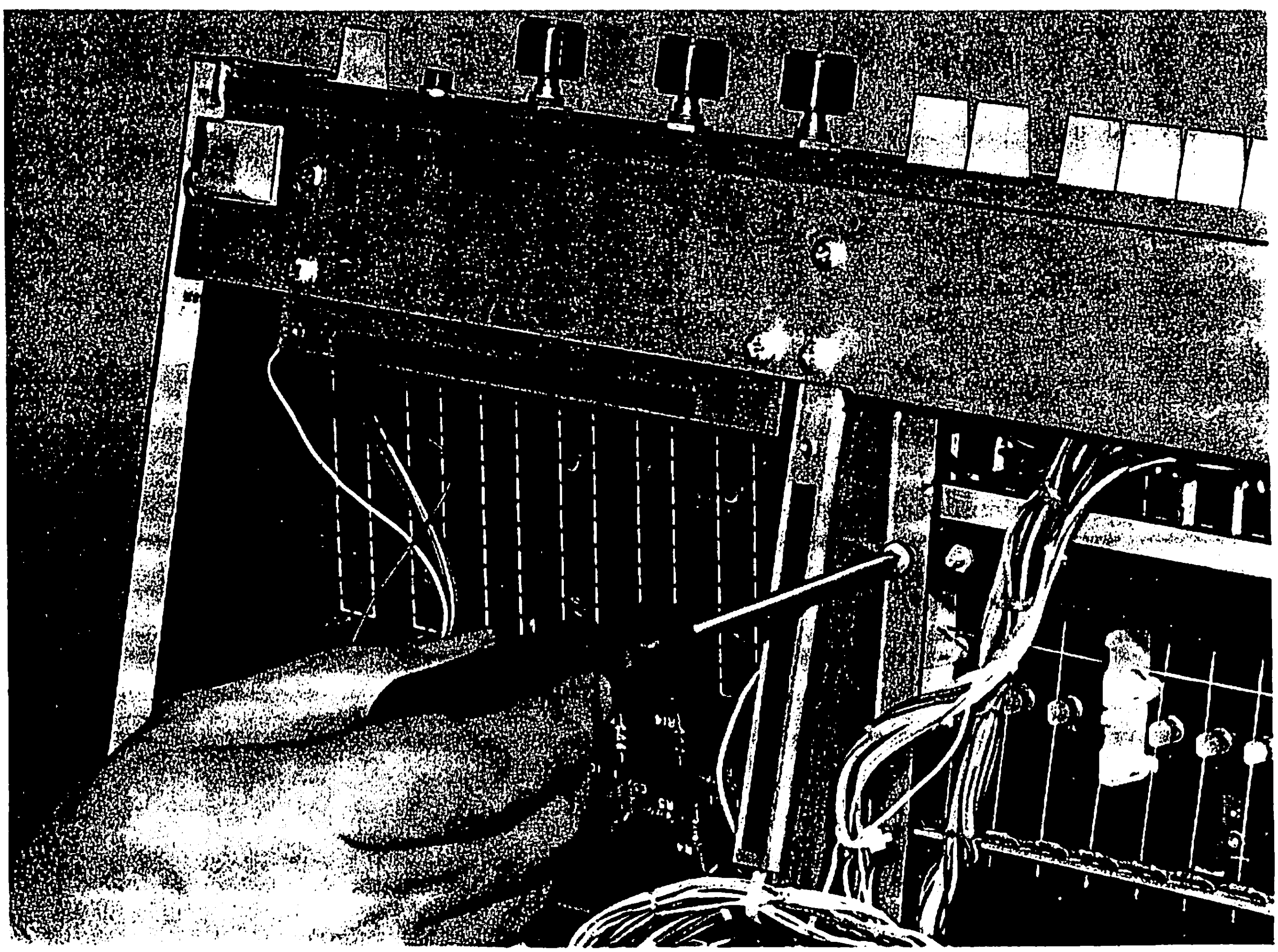


FIGURE 8-1 DISASSEMBLY OF MINITMOOG

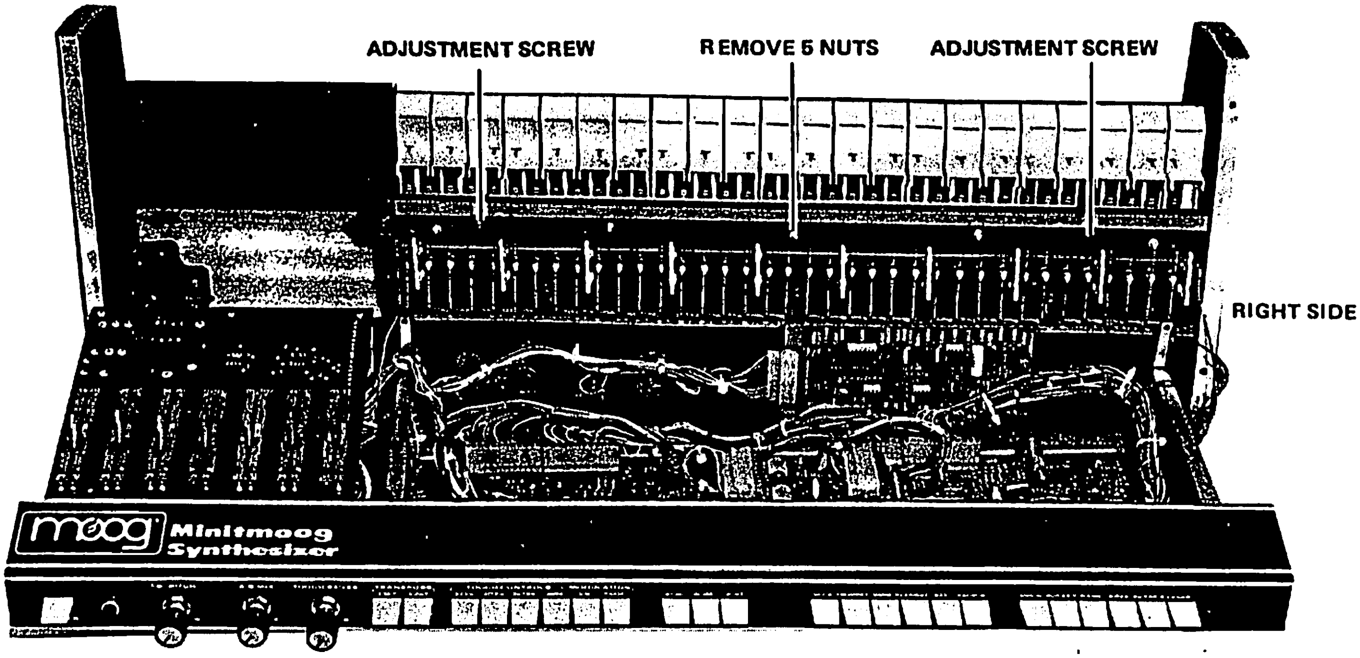


FIGURE 8-2 MINITMOOG DISASSEMBLED

5. Apply two strips of double sided tape to completely recover the foam pad (Figure 8-5).

6. Install a drain wire, No. 30 AWG gauge (No. 30 buss wire), generally centered along the length of the touch sensor bar. However, carefully route the wire around the two mounting holes and allow sufficient excess wire to extend beyond the right side of the bar to permit soldering the wire to the cable braid after the touch sensor bar is installed. The wire should be slightly less than flush on the left side of the sensor bar.

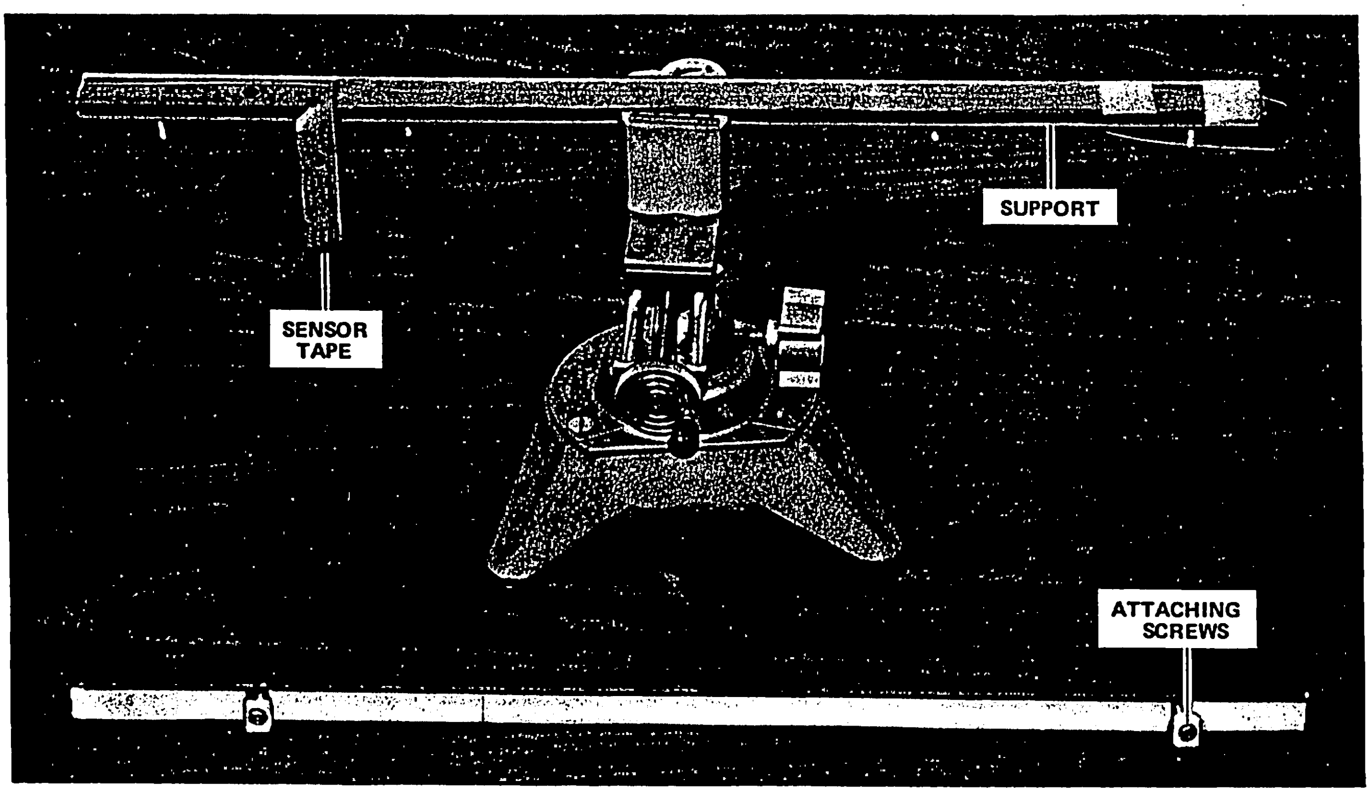


FIGURE 8-3 SENSOR REMOVAL

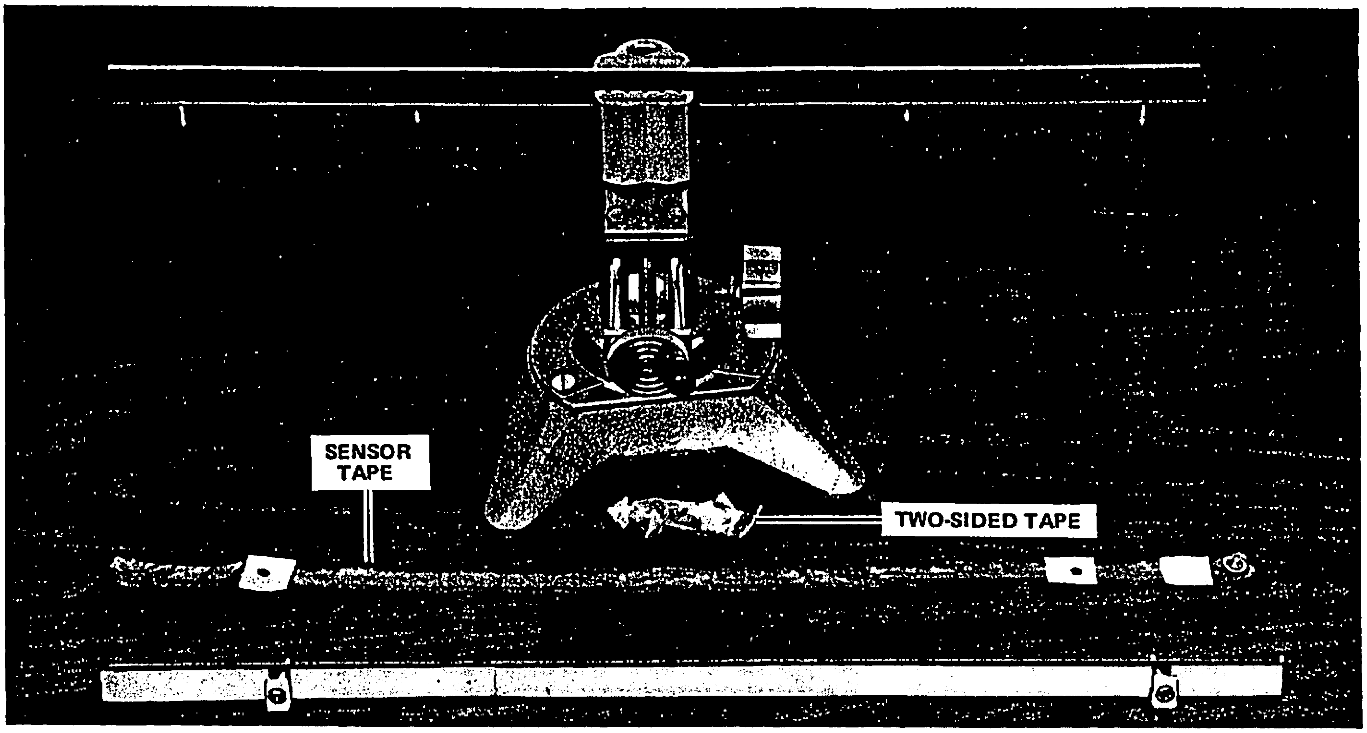


FIGURE 8-4 SENSOR REMOVED FROM TOP SUPPORT

7. Install new conductive nylon.

8. Add mylar tape insulating pads over the nylon material at the two mounting holes (Figure 8-6).

9. Also wrap the end of the touch sensor bar with mylar tape at the point where the drain wire extends beyond the end of the bar (Figure 8-6) to prevent shorts after connection in the circuit.

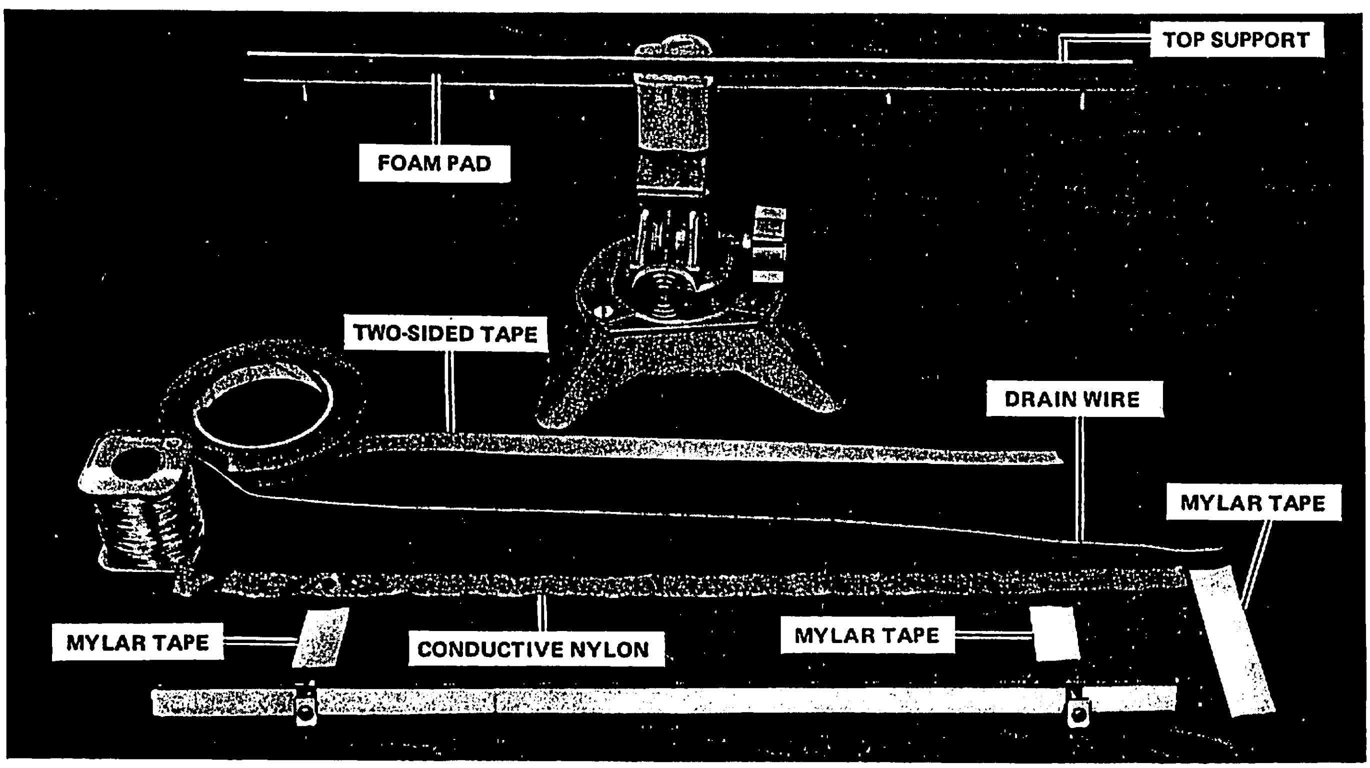


FIGURE 8-5 MODIFICATION MATERIAL

10. Remove the snap fastener from the shield braid in the Minitmoog.

11. Install the touch sensor bar in the unit and solder the drain wire to the shield braid of the interconnecting cable.

12. Mechanically reassemble the touch sensor bar in the reverse order of disassembly.

> **NOTE**
> The drain wire should be positioned to the left side when reassembling the unit.

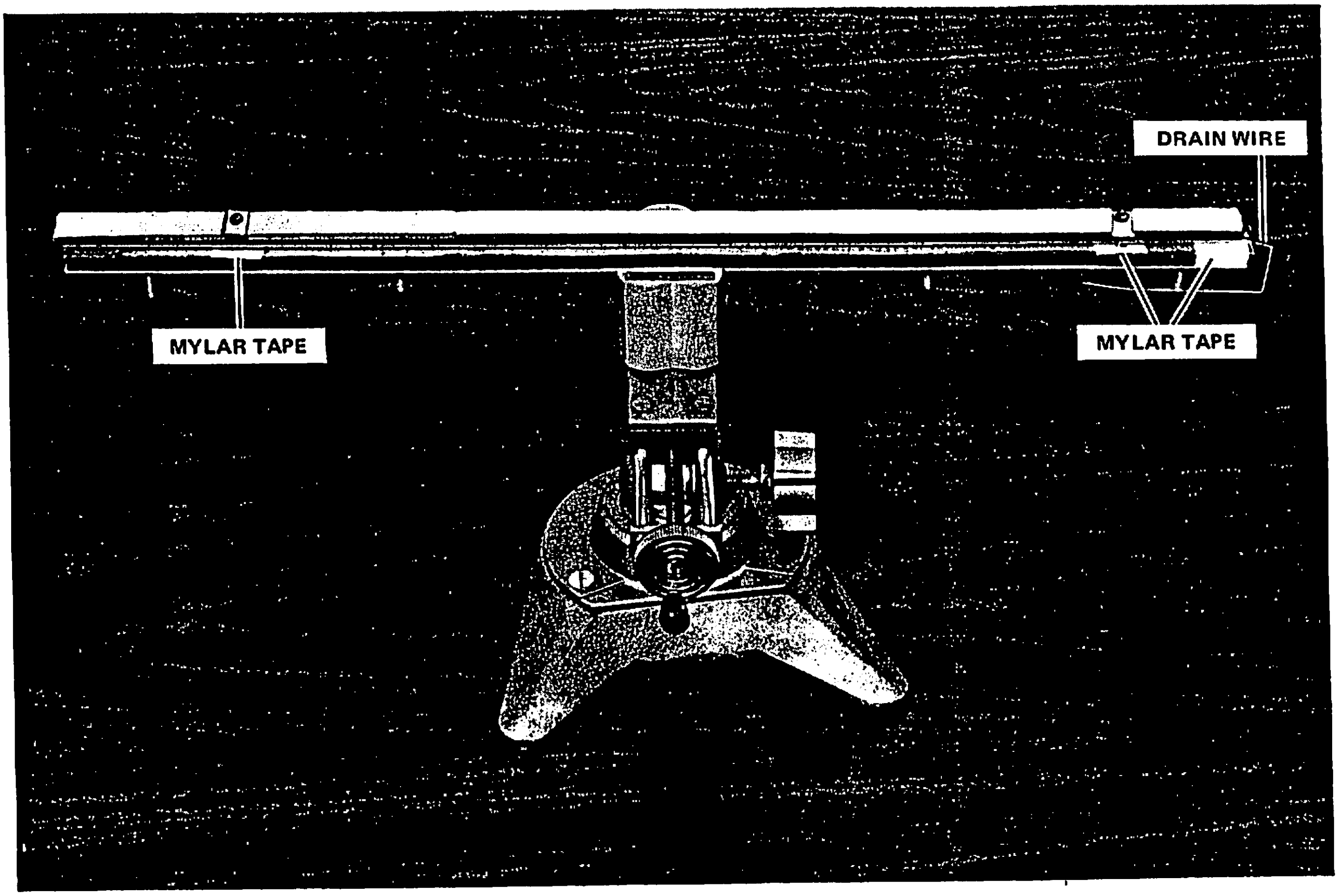


FIGURE 8-6 TOUCH SENSOR BAR REASSEMBLED

8.3 INSTALLATION OF NEW OR REBUILT TOUCH SENSOR BAR

1. Remove case.

2. Set unit on rear panel using support blocks.

3. Remove bottom access cover.

4. Compress touch sensor bar by tightening all adjusting screws.

5. Remove five mounting nuts.

6. Disconnect wiring to touch sensor bar and dislodge bar from keyboard "L" channel, ensuring all mounting screws are clear of mounting holes.

7. Slide touch sensor bar out of right side of unit.

8. Reassemble in reverse order using a new or rebuilt touch sensor bar.

SECTION 9
SELECTED REPLACEMENT PARTS LIST

MINITMOOG AND SATELLITE MISCELLANEOUS
SELECTED REPLACEMENT PARTS LIST

REF DESIG	PART NUMBER	CROSS REF NO.	DESCRIPTION
J1	910-041707-006	45-5022-1	Socket, 6 Pin Cinch Jones
J2	910-041306-001	45-5023-1	Jack, Phone, 2 Conductor
J3	910-043872-001	45-5076-3	Jack, RCA Phone
J4	910-041306-002	45-5024-1	Jack, Phone, 2 Conductor Shorting
R237,R238	925-040265-001	24-5354-0	
		24-5353-0	Potentiometer, Rotary, 100K Ohm Linear
SW1 thru SW21	960-043048-001	69-5367-0	Switch, Slide, DPDT, Tab Handle
	918-043238-001		Buss Bar, Keyboard, Gold Plated
	997-043393-002		Cabinet, Minitmoog
	997-043393-001		Cabinet, Satellite
	917-043245-001		Contact, Keyboard, Straight Gold Plated Wire
	916-040885-001	49-5330-0	Foot, Front, Rubber
	935-043952-001	49-5331-0	Foot, Rear, Adjustable
	997-043397-001		Keyboard, 37 Note Without Touch Sensor
	964-042611-001	62-8283-1	Key, Black, Sharp and Flat
	964-041418-003	62-8268-1	Key, Ivory, Natural A
	964-041418-004	62-8269-1	Key, Ivory, Natural B
	964-041418-005	62-8270-1	Key, Ivory, Natural C
	964-041418-006	62-8271-1	Key, Ivory, Natural D
	964-041418-007	62-8272-1	Key, Ivory, Natural E
	964-041418-008	62-8273-1	Key, Ivory, Natural F
	964-041418-009	62-8274-1	Key, Ivory, Natural G
	964-041418-010	62-8275-1	Key, Ivory, Natural High C
	915-040921-001	52-5220-0	Knob, Rotary Knurl
	915-043394-001	52-5221-0	Knob, Slide Pot, White
	935-041919-001	89-5083-0	Lamp, Pilot
	996-043392-002		PC Board Assembly, Main Board, Minitmoog
	996-043392-001		PC Board Assembly, Main Board, Satellite
	996-043391-001		PC Board Assembly, Oscillator, Minitmoog
	996-043390-001		PC Board Assembly, Power Supply and Control Panel
	996-043388-001		PC Board Assembly, Resistor Matrix
	996-043389-001		PC Board Assembly, Touch Sensor, Minitmoog
	925-043251-001		Potentiometer, Rotary, 100K Ohm Linear CT
	964-043932-002	77-5130-0	Standoff, PC Board Mounting
	997-043976-001		Touch Sensor Assembly, Minitmoog

MAIN PRINTED CIRCUIT BOARD
SELECTED REPLACEMENT PARTS LIST

REF DESIG	PART NUMBER	CROSS REF NO.	DESCRIPTION
		CAPACITORS	
C2,C3	945-040209-012	18-5217-3	
		18-5104-3	Electrolytic, 220uf, 25V
C4	946-040231-001	18-5214-3	Tantalum, 1.5uf, 20V
C15,C25	945-040209-014	18-5215-3	
		18-5218-3	Electrolytic, 2.2uf, 25V
C31	945-040209-003	18-5216-3	
		18-5103-3	Electrolytic, 220uf, 6V
		DIODES	
D1 thru D12	919-041075-001	86-5037-3	
		86-5044-3	Signal, 1N4148
		INTEGRATED CIRCUITS	
IC1	991-041484-001	13-5020-6	723 Regulator, DIP
IC2 thru IC8, IC13,IC21,IC22	991-041101-001	13-5018-6	741 Operational Amplifier
IC9,IC10, IC12, IC14 thru IC18	991-041089-001	13-5019-6	3080 Transconductance Amplifier, TO-5
IC11,IC19, IC20	991-041104-001	13-5015-6	3046 (3821), Transistor Array
		POTENTIOMETERS	
R1,R47,R98, R105,R139, R174,R190	925-040281-006	24-5340-3	Trim, 100K Ohm Linear
R4	925-040281-004	24-5335-3	Trim, 500 Ohm Linear
R10	925-040281-009	24-5338-3	Trim, 20K Ohm Linear
R10	925-040275-003	24-5344-3	Trim, 50K Ohm Linear
R16,R21	925-040281-005	24-5337-3	Trim, 10K Ohm Linear
R17,R79	925-040281-003	24-5342-3	Trim, 100 Ohm Linear
R25	925-043977-001	24-5341-3	Trim, 2 Megohm Linear
R130,R132	925-040281-002	24-5339-3	Trim, 2K Ohm Linear
R160	925-040281-001	24-5336-3	Trim, 1K Ohm Linear
		RESISTORS	
R3	853-427500-031	61-750001-2	Metal Film, 750 Ohm, 1/4 W, 1%
R5	853-423321-031	61-332101-2	Metal Film, 3.32K Ohm, 1/4W, 1%
R6,R7	853-421002-031	61-100201-2	Metal Film, 10K Ohm, 1/4W, 1%
R9	853-424423-031	61-402301-2	Metal Film, 442K Ohm, 1/4W, 1%
R13,R19,R48	853-421503-031	61-150301-2	Metal Film, 150K Ohm, 1/4W, 1%
R14	924-040183-001	61-5000-1	Temperature Compensating, 1K Ohm, 3%
R18	853-424750-031	61-475001-2	Metal Film, 475 Ohm, 1/4W, 1%
R18,R24,R182	853-426810-031	61-681001-2	Metal Film, 681 Ohm, 1/4W, 1%
R20	853-424752-031	61-475201-2	Metal Film, 47.5K Ohm, 1/4W, 1%
R80	853-421741-031	61-174101-2	Metal Film, 1.74K Ohm, 1/4W, 1%
R81,R82	853-425112-031	61-511201-2	Metal Film, 51.1K Ohm, 1/4W, 1%

MAIN PRINTED CIRCUIT BOARD
SELECTED REPLACEMENT PARTS LIST (Continued)

REF DESIG	PART NUMBER	CROSS REF NO.	DESCRIPTION
			TRANSISTORS
Q1	991-041062-001	86-5150-2	PNP, TIS93
Q2,Q4,Q6,Q7,			
Q9 thru Q15,			
Q17,Q25,Q26,			
Q27,Q31,Q34,			
Q35,Q36,Q43,			
Q44,Q46,Q47,			
Q48,Q50	991-041052-001	86-5115-2	
		86-5149-2	PNP, 2N3906
Q3,Q5,Q8,			
Q16,Q19,Q21,			
Q24,Q28,Q29,			
Q30,Q33,Q37			
thru Q40,Q49	991-041051-001	86-5148-2	
		86-5124-2	NPN, 2N3904
Q20,Q32,Q41,			
Q42,Q51	991-041064-001	86-5096-2	
		86-5147-2	FET, 2N4303
Q22,Q23	991-041055-001	86-5146-2	
		86-5096-2	FET, E112
Q45	991-041063-001	86-5151-2	PNP, 2N4402

MINITMOOG TOUCH SENSOR BOARD NO. 4
SELECTED REPLACEMENT PARTS LIST

REF DESIG	PART NUMBER	DESCRIPTION
C405	946-040226-105	Capacitor, Polyester, 1uf, 50V
CR401	919-041075-001	Diode, Signal, 1N4148
IC401	991-041088-001	Integrated Circuit, CMOS, Quad 2 Input Nand Gate
IC402,IC404	991-041089-003	Integrated Circuit, 3080, Transconductance Amplifier, DIP
IC403	991-041210-001	Integrated Circuit, 3094, Transconductance Amplifier, DIP
Q401,Q403, Q404	991-041052-001	Transistor, PNP, 2N3906
Q402	991-041064-001	Transistor, FET, 2N4303

MINITMOOG OSCILLATOR BOARD NO. 5
SELECTED REPLACEMENT PARTS LIST

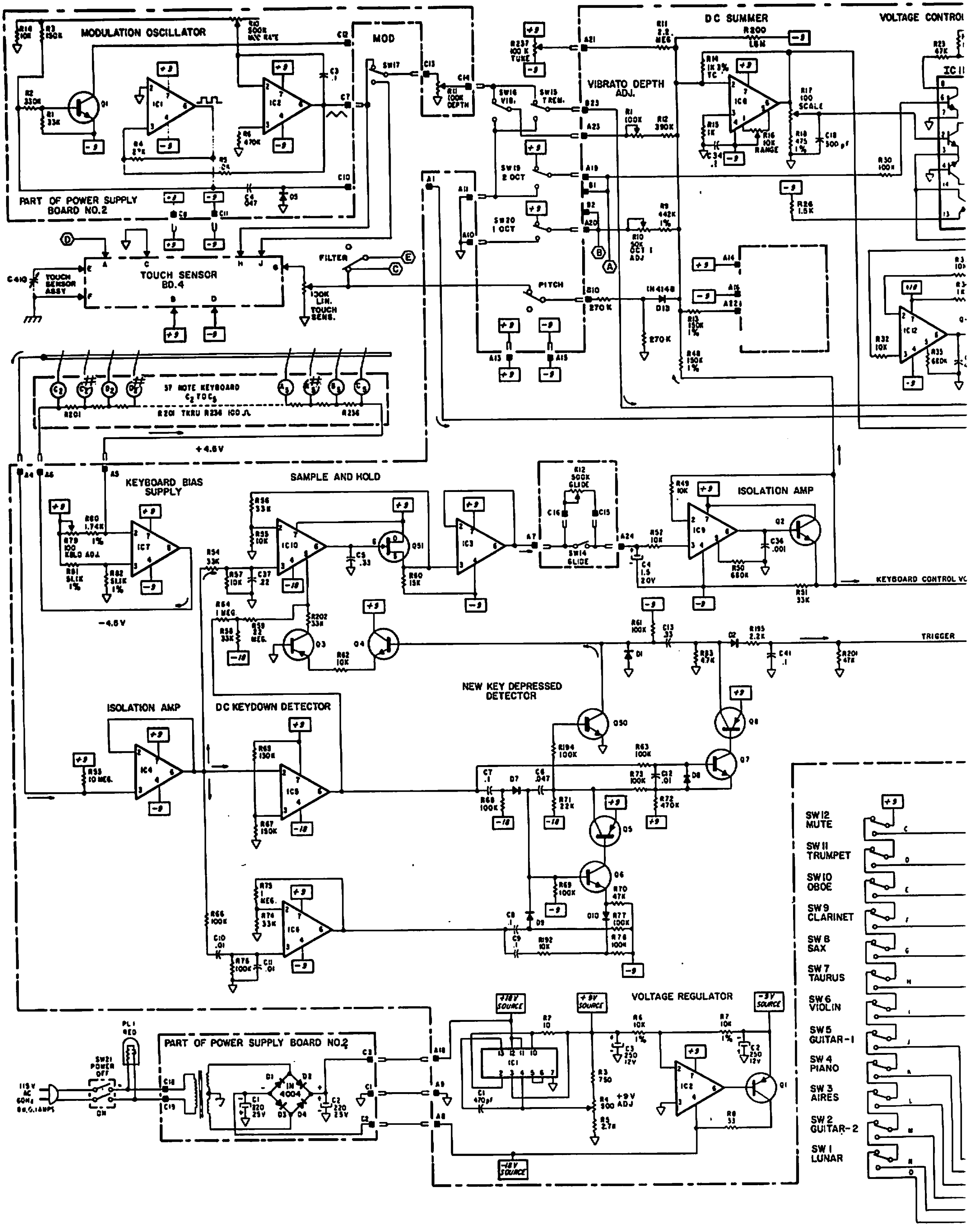
REF DESIG	PART NUMBER	DESCRIPTION
C503	946-042021-103	Capacitor, Polystyrene, .01uf, 35V
IC501	991-041083-001	Integrated Circuit, 3130, CMOS, FET, Operational Amplifier
IC502	991-041089-003	Integrated Circuit, 3080, Transconductance Amplifier, DIP
Q501	991-041055-001	Transistor, FET, E112
Q502,Q503	991-041051-001	Transistor, NPN, 2N3904
R501	924-040183-001	Resistor, Temperature Compensating, 1K Ohm, 3%
R502,R503	853-222213-021	Resistor, Metal Film, 221K Ohm, 1/8W, 1%
R504	925-043975-001	Potentiometer, Trim, 200K Ohm Linear, 4 Turn
R510	925-040266-002	Potentiometer, Trim, 100K Ohm Linear, Horizontal Mount
R511,R529	925-040266-001	Potentiometer, Trim, 10K Ohm Linear, Horizontal Mount

CONTROL BOARD (POWER SUPPLY)
SELECTED REPLACEMENT PARTS LIST

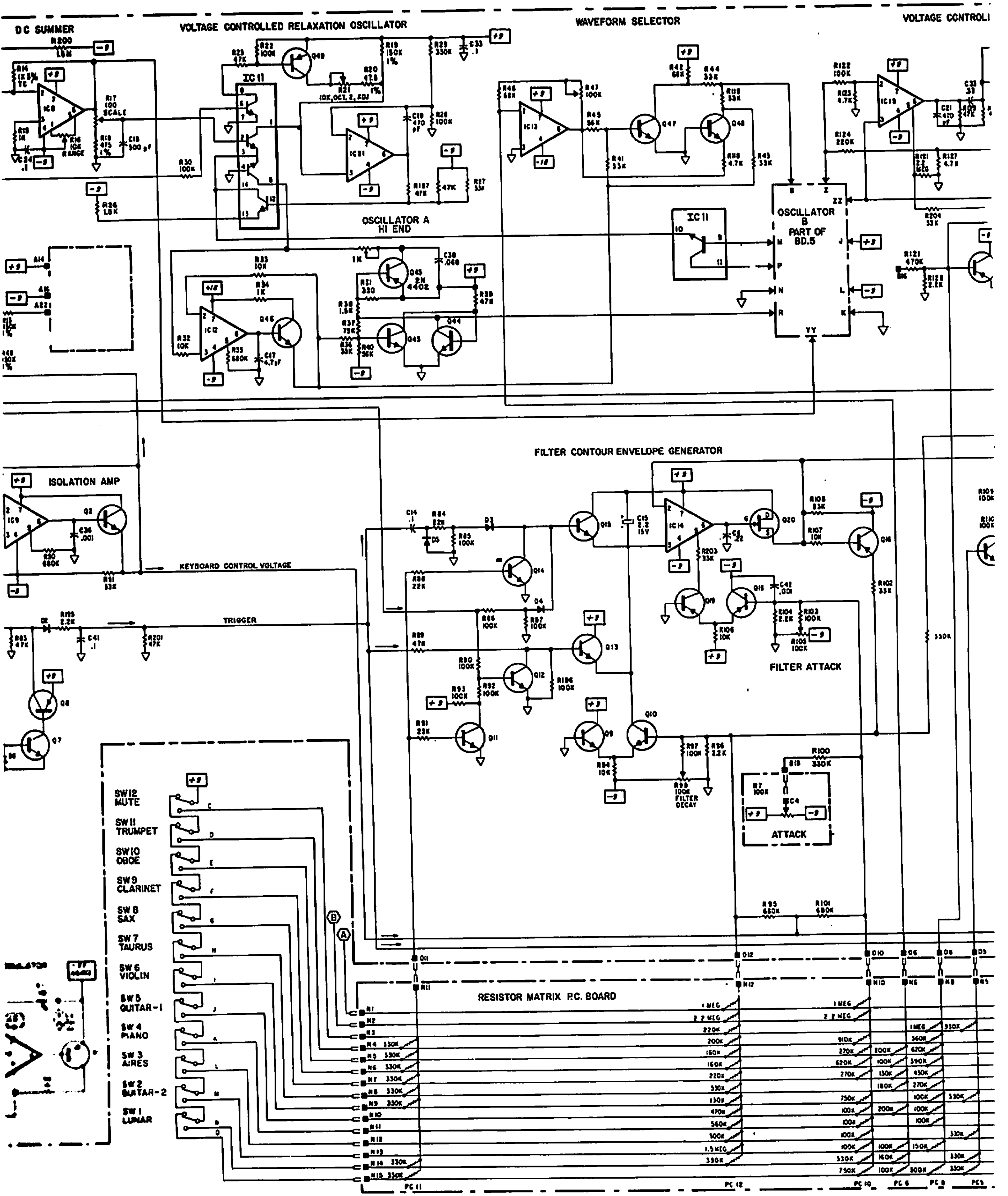
REF DESIG	PART NUMBER	CROSS REF NO.	DESCRIPTION
C1,C2	945-040209-012	18-5217-3	Capacitor, Electrolytic, 220uf, 25V
D1 thru D4	919-042019-001	86-5045-3	Diode, Rectifier, 1 Amp, 400PIV, 1N4004
D5	919-041075-001	86-5044-3	
		86-5037-0	Diode, Signal, 1N4148
IC1,IC2	991-041101-001	13-5018-6	Integrated Circuit, 741, Operational Amplifier
Q1	991-041051-001	86-5115-2	
		86-5148-2	Transistor, NPN, 2N3904
R7,R8,R9	925-040271-001	24-5350-0	Potentiometer, Slide, 100K Ohm Linear
R10,R12	925-043107-001	24-5352-0	Potentiometer, Slide, 500K Ohm Audio
R11,R13	925-043106-001	24-5351-0	Potentiometer, Slide, 100K Ohm Audio
T1	954-042097-001	80-5008-0	
		80-5011-0	Transformer, Power, 23V, 40mA

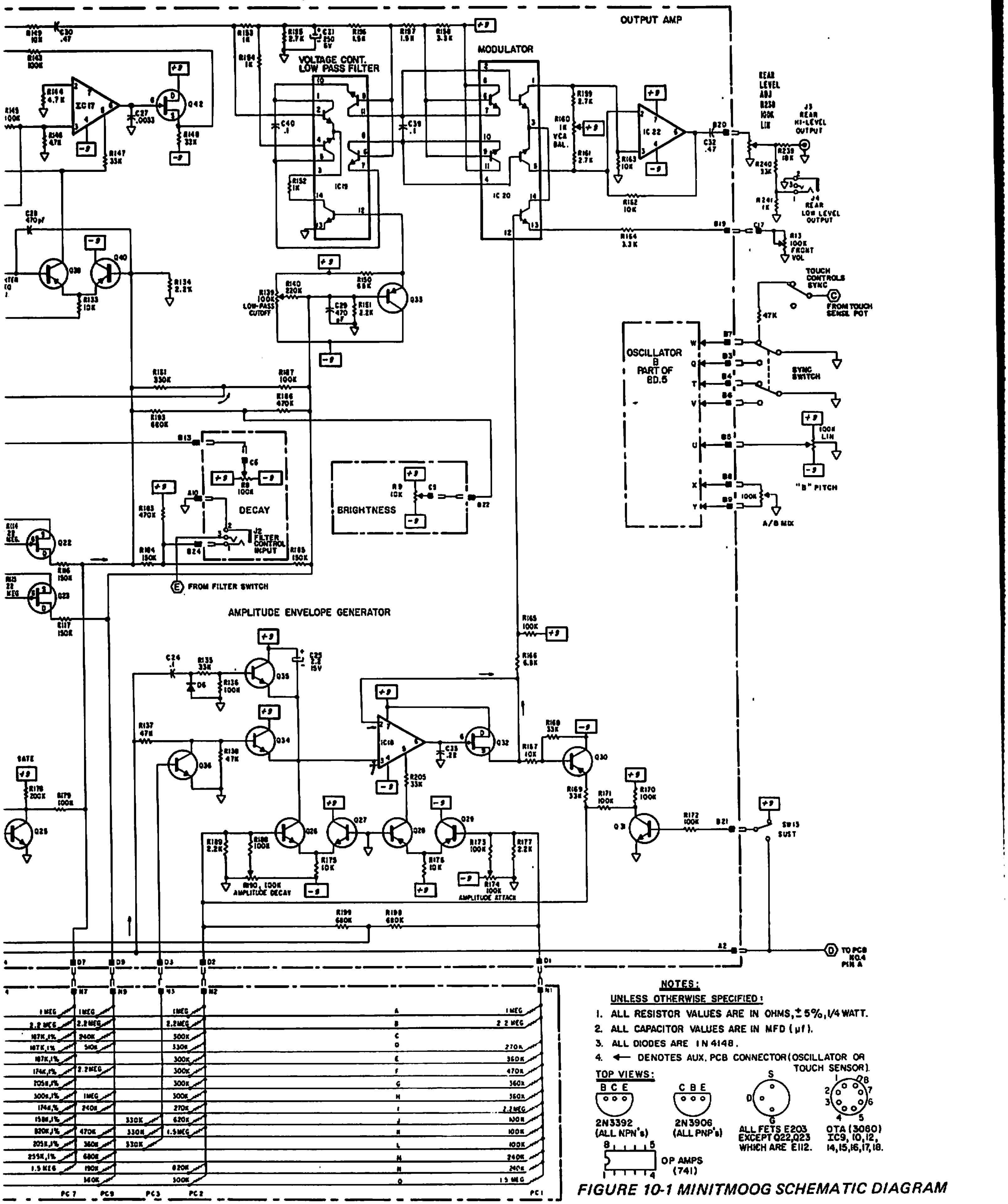
SECTION 10
BLOCK AND SCHEMATIC DIAGRAMS

FIGURE	TITLE	PAGE



MODULATION OSCILLATOR
MOD
PART OF POWER SUPPLY BOARD NO.2
TOUCH SENSOR BD.4
TOUCH SENSOR ASSY
FILTER
PITCH
DC SUMMER
VIBRATO DEPTH ADJ.
VOLTAGE CONTROL
37 NOTE KEYBOARD
+4.6V
KEYBOARD BIAS SUPPLY
SAMPLE AND HOLD
ISOLATION AMP
KEYBOARD CONTROL V
TRIGGER
-4.6V
NEW KEY DEPRESSED DETECTOR
ISOLATION AMP
DC KEYDOWN DETECTOR
VOLTAGE REGULATOR
PART OF POWER SUPPLY BOARD NO.2
SW12 MUTE
SW11 TRUMPET
SW10 OBOE
SW9 CLARINET
SW8 SAX
SW7 TAURUS
SW6 VIOLIN
SW5 GUITAR-1
SW4 PIANO
SW3 AIRES
SW2 GUITAR-2
SW1 LUNAR


DC SUMMER
VOLTAGE CONTROLLED RELAXATION OSCILLATOR
WAVEFORM SELECTOR
VOLTAGE CONTROLL
OSCILLATOR A
HI END
OSCILLATOR
B
PART OF
BD.5
FILTER CONTOUR ENVELOPE GENERATOR
ISOLATION AMP
KEYBOARD CONTROL VOLTAGE
TRIGGER
FILTER ATTACK
FILTER DECAY
ATTACK
SW12 MUTE
SW11 TRUMPET
SW10 OBOE
SW9 CLARINET
SW8 SAX
SW7 TAURUS
SW6 VIOLIN
SW5 GUITAR-1
SW4 PIANO
SW3 AIRES
SW2 GUITAR-2
SW1 LUNAR
RESISTOR MATRIX P.C. BOARD



NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4 WATT.
2. ALL CAPACITOR VALUES ARE IN MFD (μf).
3. ALL DIODES ARE 1N4148.
4. ← DENOTES AUX. PCB CONNECTOR (OSCILLATOR OR TOUCH SENSOR).

TOP VIEWS:

- 2N3392 (ALL NPN's) — B C E
- 2N3906 (ALL PNP's) — C B E
- ALL FETS E203 EXCEPT Q22, Q23 WHICH ARE E112. — S, D, G
- OTA (3080) IC9, 10, 12, 14, 15, 16, 17, 18.
- OP AMPS (741)

FIGURE 10-1 MINITMOOG SCHEMATIC DIAGRAM

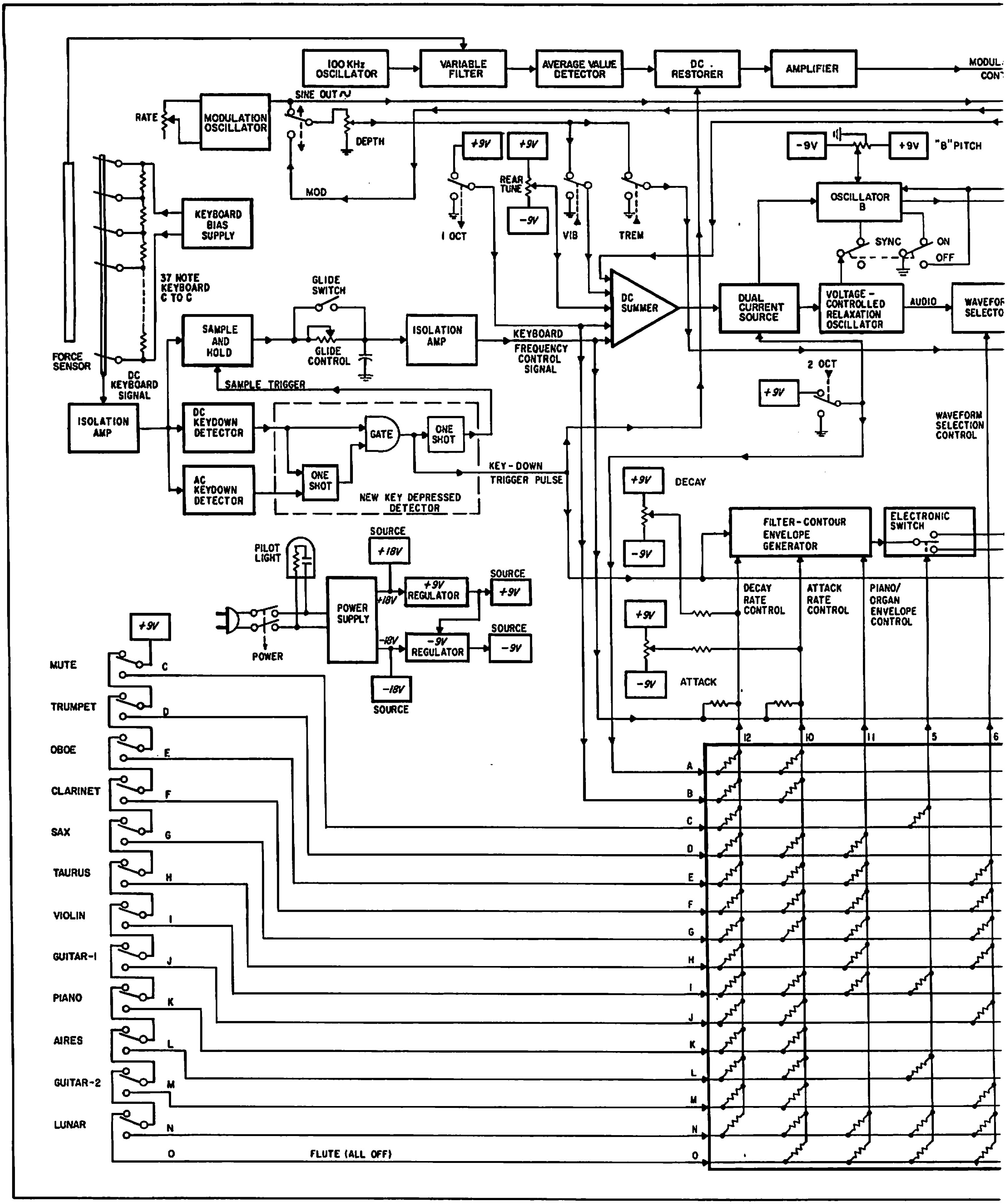
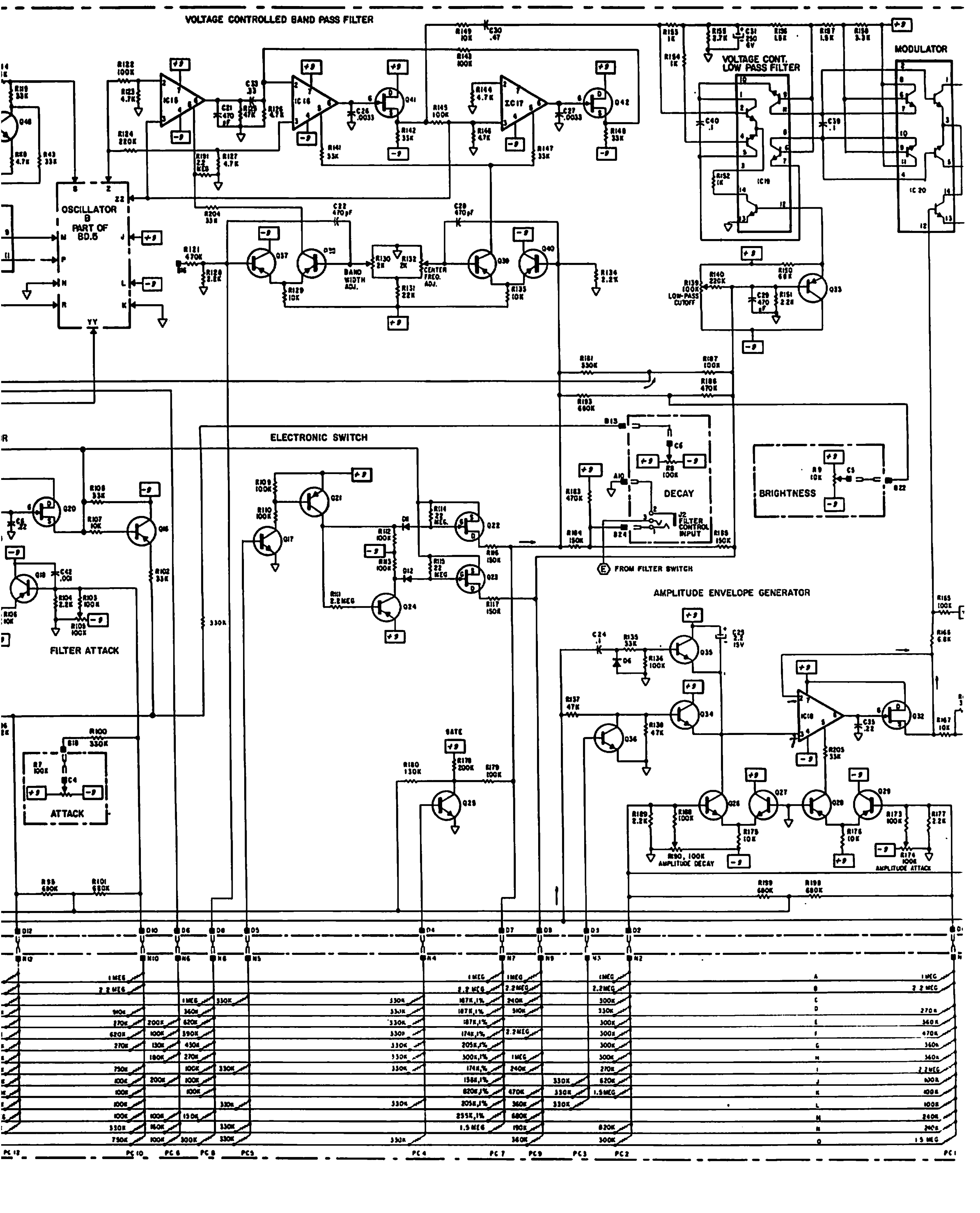
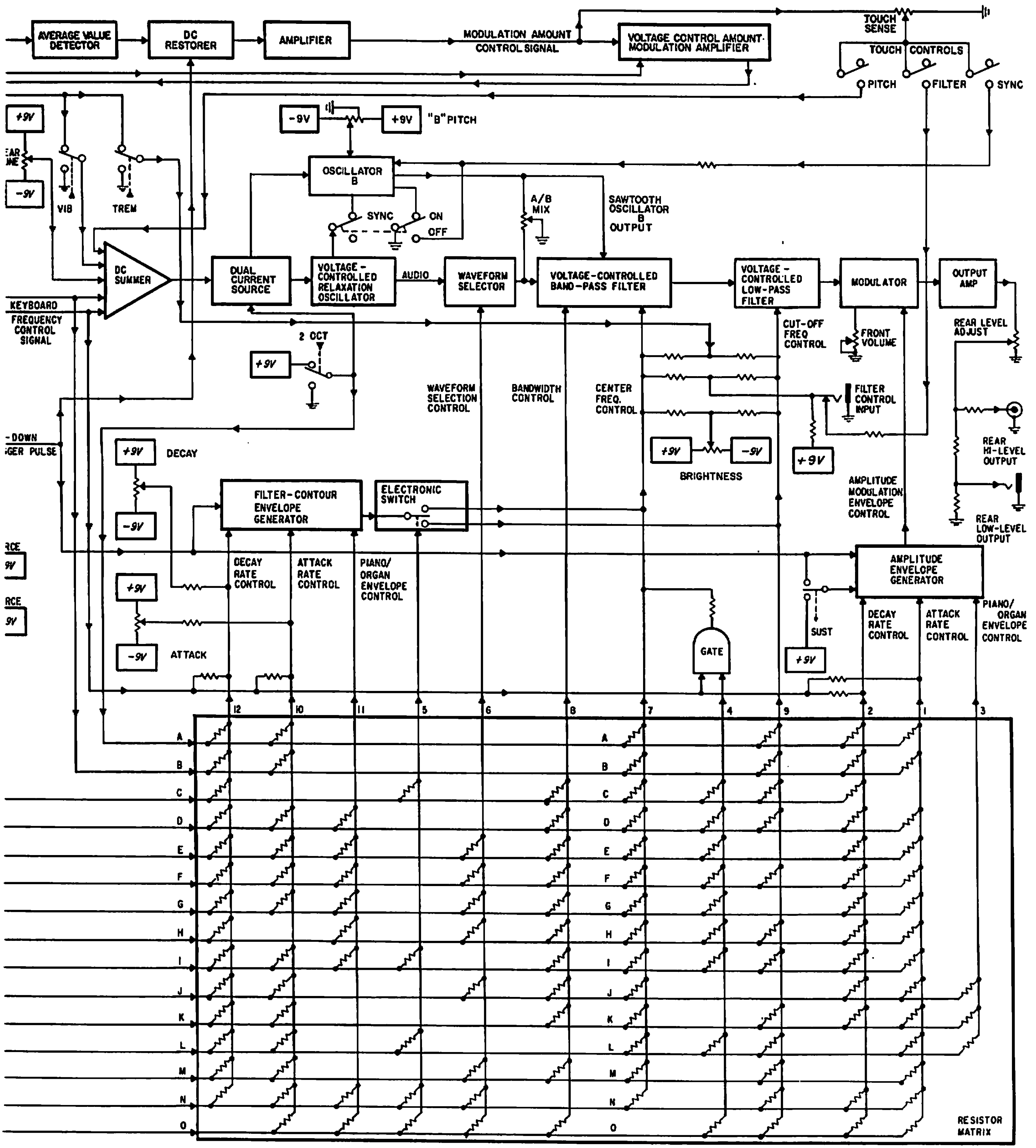


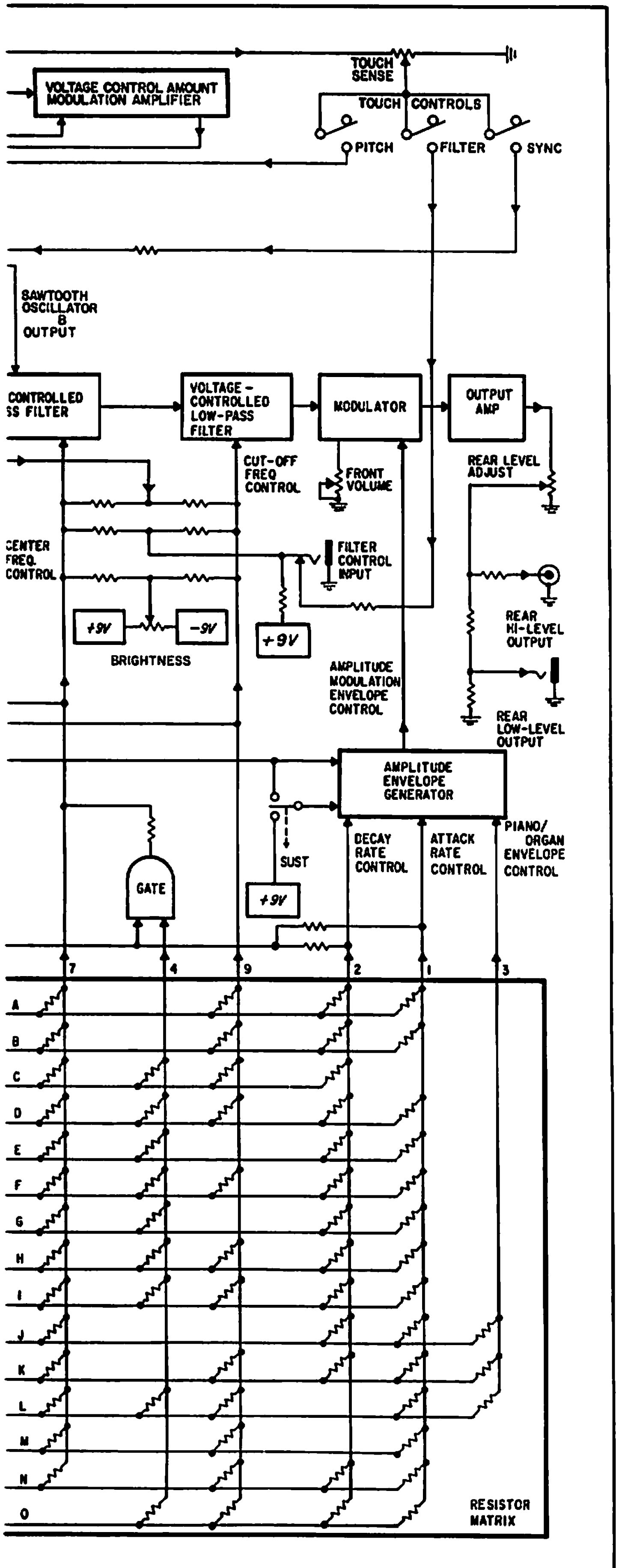
FIGURE 10-2 MINITMOOG BLOCK DIAGRAM

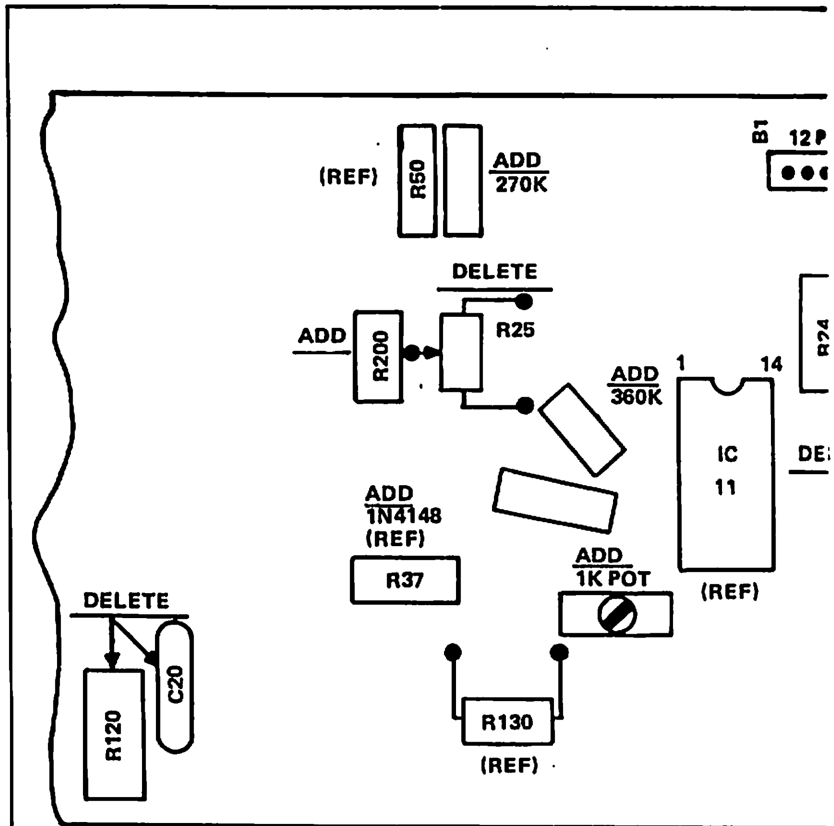


VOLTAGE CONTROLLED BAND PASS FILTER
VOLTAGE CONT. LOW PASS FILTER
MODULATOR
OSCILLATOR B PART OF BD.5
BAND WIDTH ADJ.
CENTER FREQ. ADJ.
LOW-PASS CUTOFF
ELECTRONIC SWITCH
DECAY
BRIGHTNESS
J2 FILTER CONTROL INPUT
FROM FILTER SWITCH
FILTER ATTACK
ATTACK
AMPLITUDE ENVELOPE GENERATOR
GATE
AMPLITUDE DECAY
AMPLITUDE ATTACK

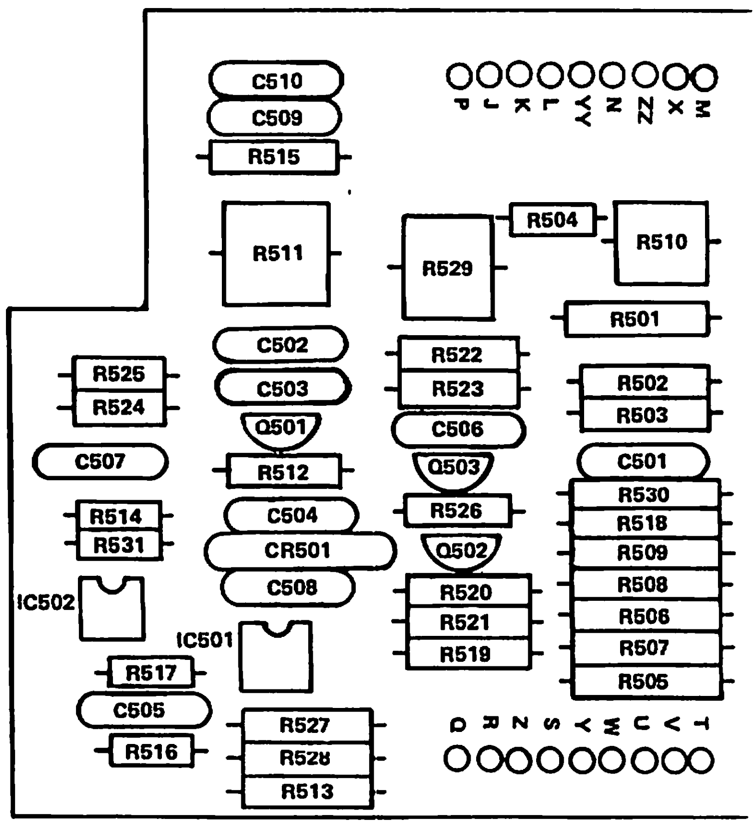


AVERAGE VALUE DETECTOR
DC RESTORER
AMPLIFIER
MODULATION AMOUNT CONTROL SIGNAL
VOLTAGE CONTROL AMOUNT MODULATION AMPLIFIER
TOUCH SENSE
TOUCH CONTROLS
PITCH
FILTER
SYNC
+9V
-9V
"B" PITCH
VIB
TREM
OSCILLATOR B
SYNC
ON
OFF
A/B MIX
SAWTOOTH OSCILLATOR B OUTPUT
DC SUMMER
DUAL CURRENT SOURCE
VOLTAGE-CONTROLLED RELAXATION OSCILLATOR
AUDIO
WAVEFORM SELECTOR
VOLTAGE-CONTROLLED BAND-PASS FILTER
VOLTAGE-CONTROLLED LOW-PASS FILTER
MODULATOR
OUTPUT AMP
KEYBOARD FREQUENCY CONTROL SIGNAL
2 OCT
CUT-OFF FREQ CONTROL
FRONT VOLUME
REAR LEVEL ADJUST
WAVEFORM SELECTION CONTROL
BANDWIDTH CONTROL
CENTER FREQ. CONTROL
FILTER CONTROL INPUT
REAR HI-LEVEL OUTPUT
BRIGHTNESS
AMPLITUDE MODULATION ENVELOPE CONTROL
REAR LOW-LEVEL OUTPUT
DECAY
FILTER-CONTOUR ENVELOPE GENERATOR
ELECTRONIC SWITCH
AMPLITUDE ENVELOPE GENERATOR
DECAY RATE CONTROL
ATTACK RATE CONTROL
PIANO/ORGAN ENVELOPE CONTROL
ATTACK
GATE
SUST
12
10
11
5
6
8
7
4
9
2
1
3
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
RESISTOR MATRIX



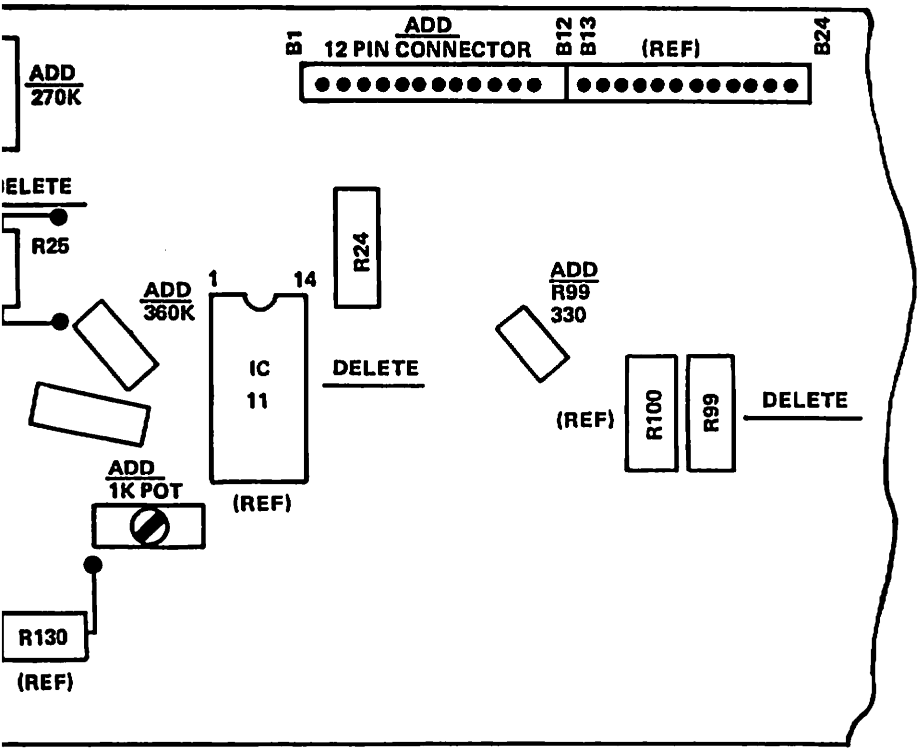


MODIFICATION OF SATELLITE
CIRCUIT BOARD TO CONFORM TO MINITMO

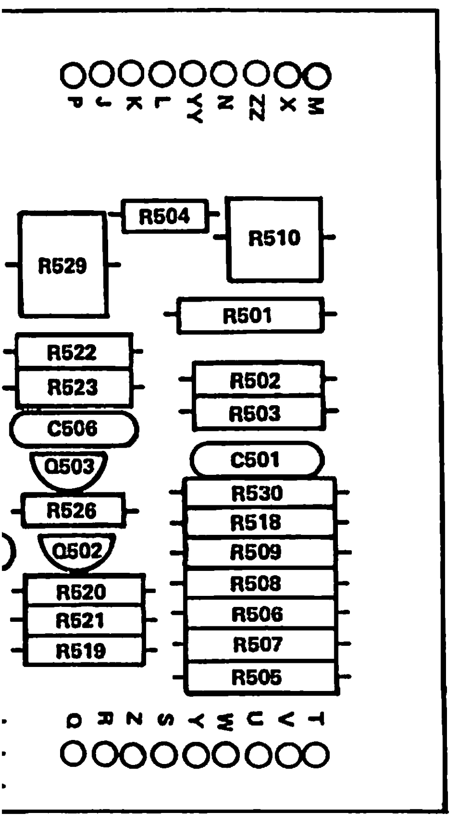


OSCILLATOR BOARD NO. 5
PRINTED CIRCUIT BOARD ASSEMBLY

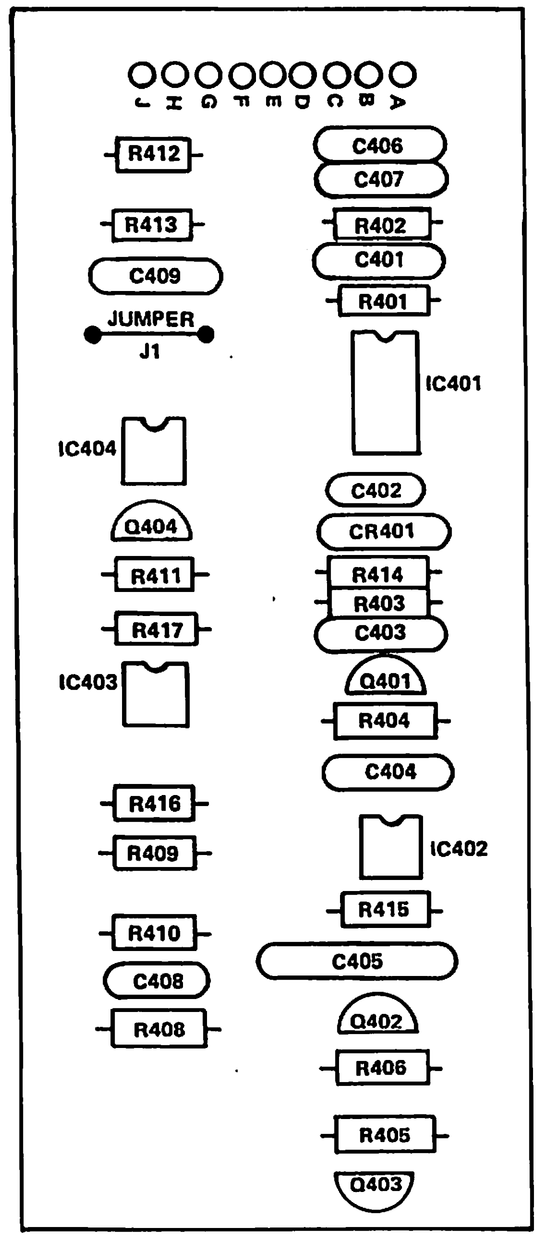
FIGURE 10-3 MINIT



ODIFICATION OF SATELLITE PRINTED
RD TO CONFORM TO MINITMOOG CONFIGURATION



ATOR BOARD NO. 5
UIT BOARD ASSEMBLY



TOUCH SENSOR PRINTED CIRCUIT BOARD
NO. 4 ASSEMBLY

FIGURE 10-3 MINITMOOG PRINTED CIRCUIT BOARD ASSEMBLIES

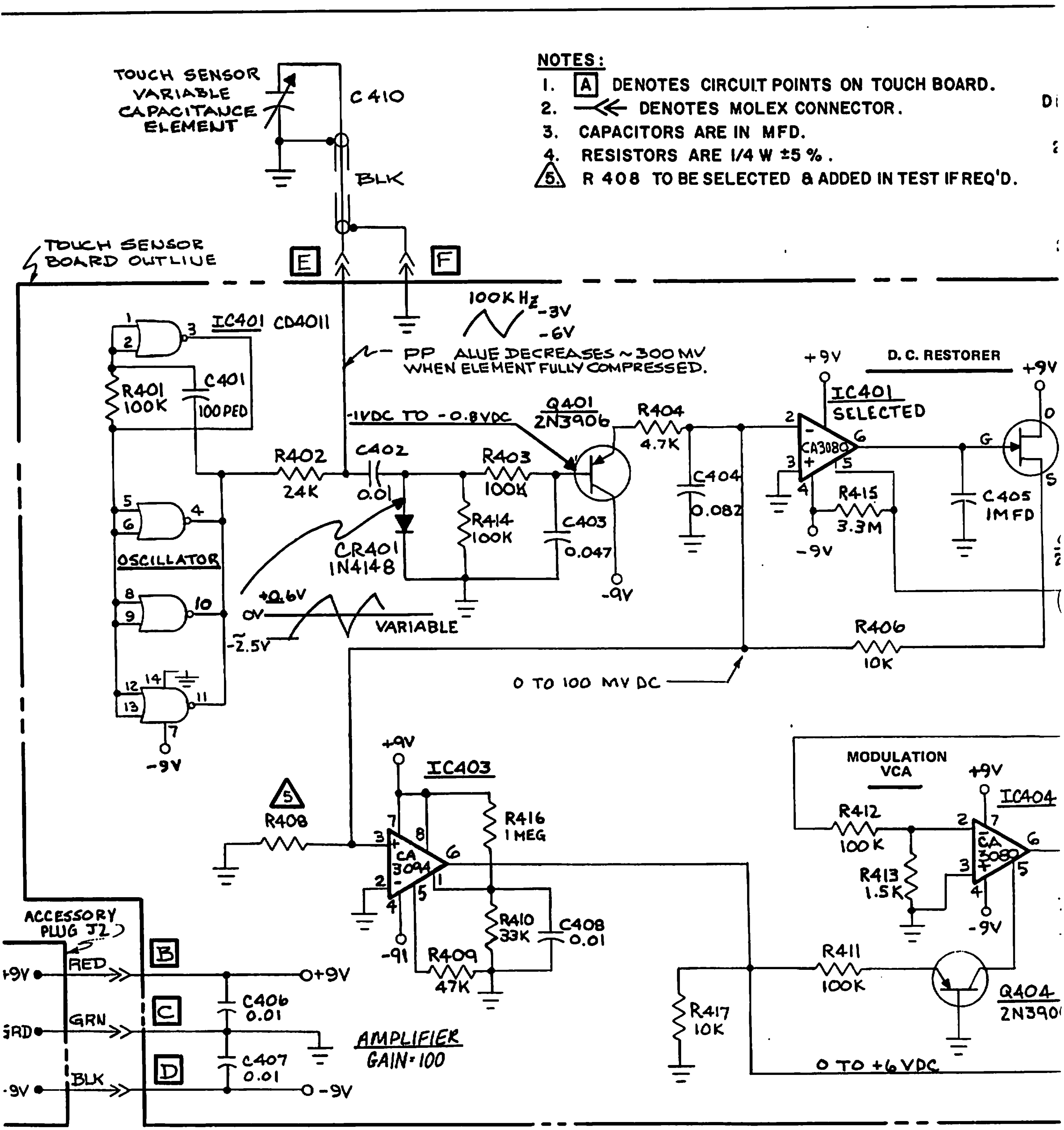
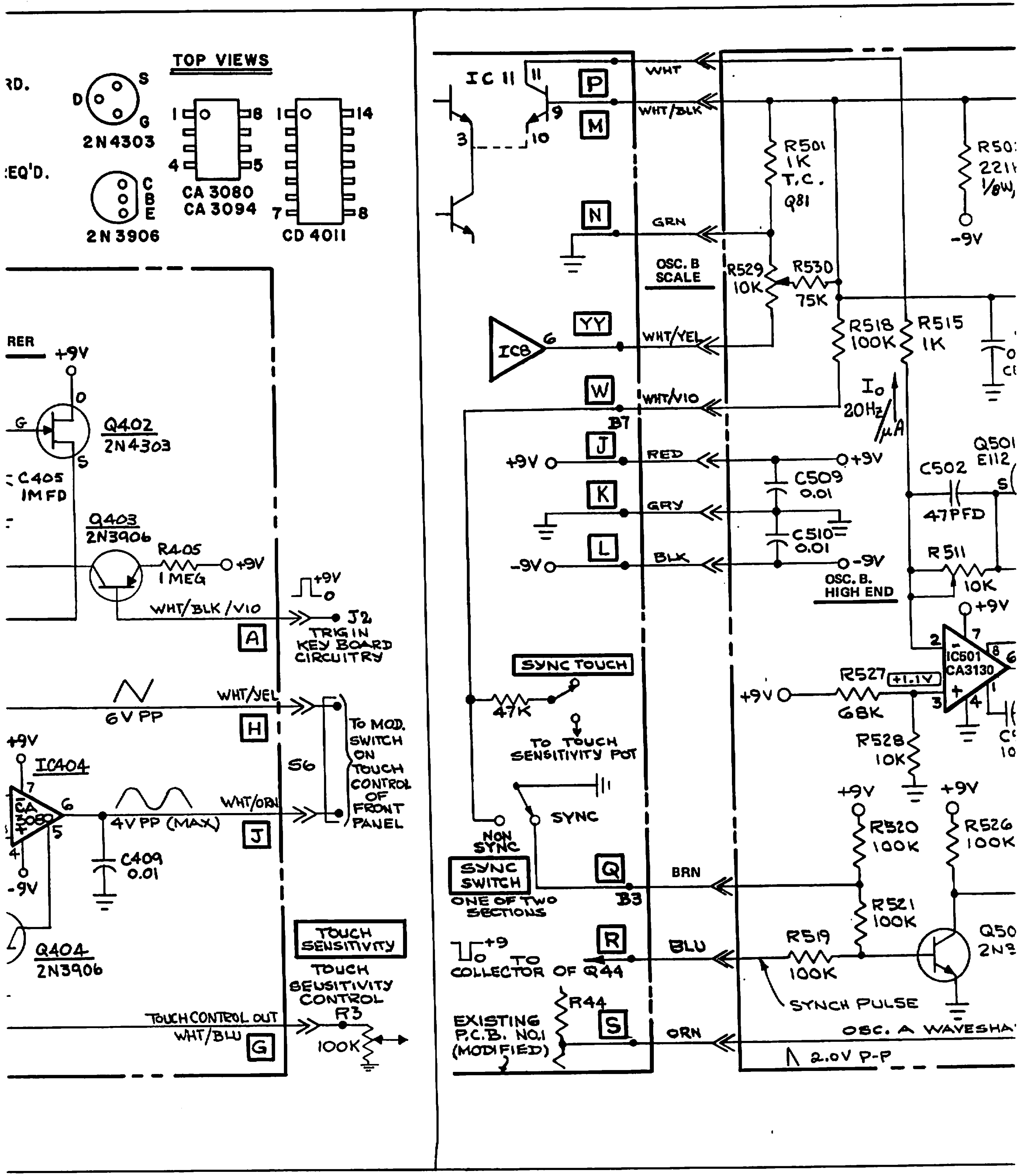
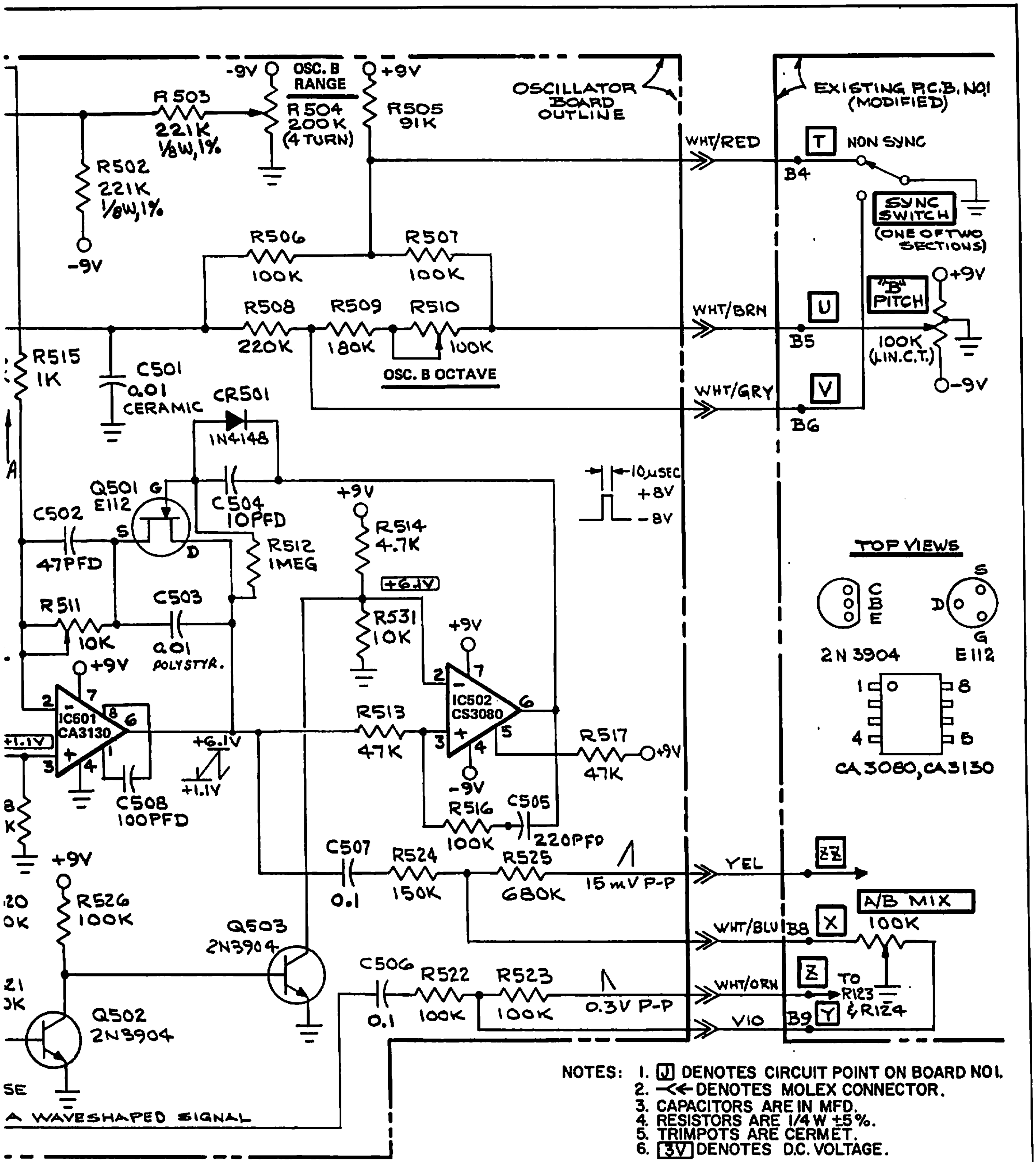


FIGURE 10-4 MINITMOOG TOUCH SENSOR BOARD ASSEMBY NO. 4 SCHEMATIC DIAGRAM


TOP VIEWS
2N4303
2N3906
CA 3080
CA 3094
CD 4011
Q402
2N4303
C405
1MFD
Q403
2N3906
R405
1 MEG
+9V
WHT/BLK/VIO
A
J2
TRIG IN
KEY BOARD
CIRCUITRY
6V PP
WHT/YEL
H
IC404
CA 3080
4V PP (MAX)
WHT/ORN
J
C409
0.01
-9V
S6
To MOD. SWITCH ON TOUCH CONTROL OF FRONT PANEL
Q404
2N3906
TOUCH SENSITIVITY
TOUCH SENSITIVITY CONTROL
R3
100K
TOUCH CONTROL OUT
WHT/BLU
G
IC 11
P
M
N
WHT
WHT/BLK
GRN
OSC. B SCALE
R501
1K
T.C.
Q81
R502
221K
1/8W
R529
10K
R530
75K
R518
100K
R515
1K
YY
IC8
WHT/YEL
W
WHT/VIO
B7
I0
20Hz
μA
J
RED
K
GRY
L
BLK
C509
0.01
C510
0.01
C502
47PFD
Q501
E112
R511
10K
OSC. B. HIGH END
IC501
CA3130
R527
+1.1V
68K
R528
10K
SYNC TOUCH
47K
TO TOUCH SENSITIVITY POT
SYNC
NON SYNC
SYNC SWITCH
ONE OF TWO SECTIONS
Q
BRN
B3
R520
100K
R526
100K
R521
100K
R
BLU
R519
100K
TO COLLECTOR OF Q44
SYNCH PULSE
EXISTING P.C.B. NO.1 (MODIFIED)
R44
S
ORN
OSC. A WAVESHA
2.0V P-P

IAGRAM



NOTES:
1. [J] DENOTES CIRCUIT POINT ON BOARD NO1.
2. —<<— DENOTES MOLEX CONNECTOR.
3. CAPACITORS ARE IN MFD.
4. RESISTORS ARE 1/4 W ±5%.
5. TRIMPOTS ARE CERMET.
6. [3V] DENOTES D.C. VOLTAGE.

FIGURE 10-5 MINITMOOG OSCILLATOR BOARD ASSEMBLY NO. 5 SCHEMATIC DIAGRAM

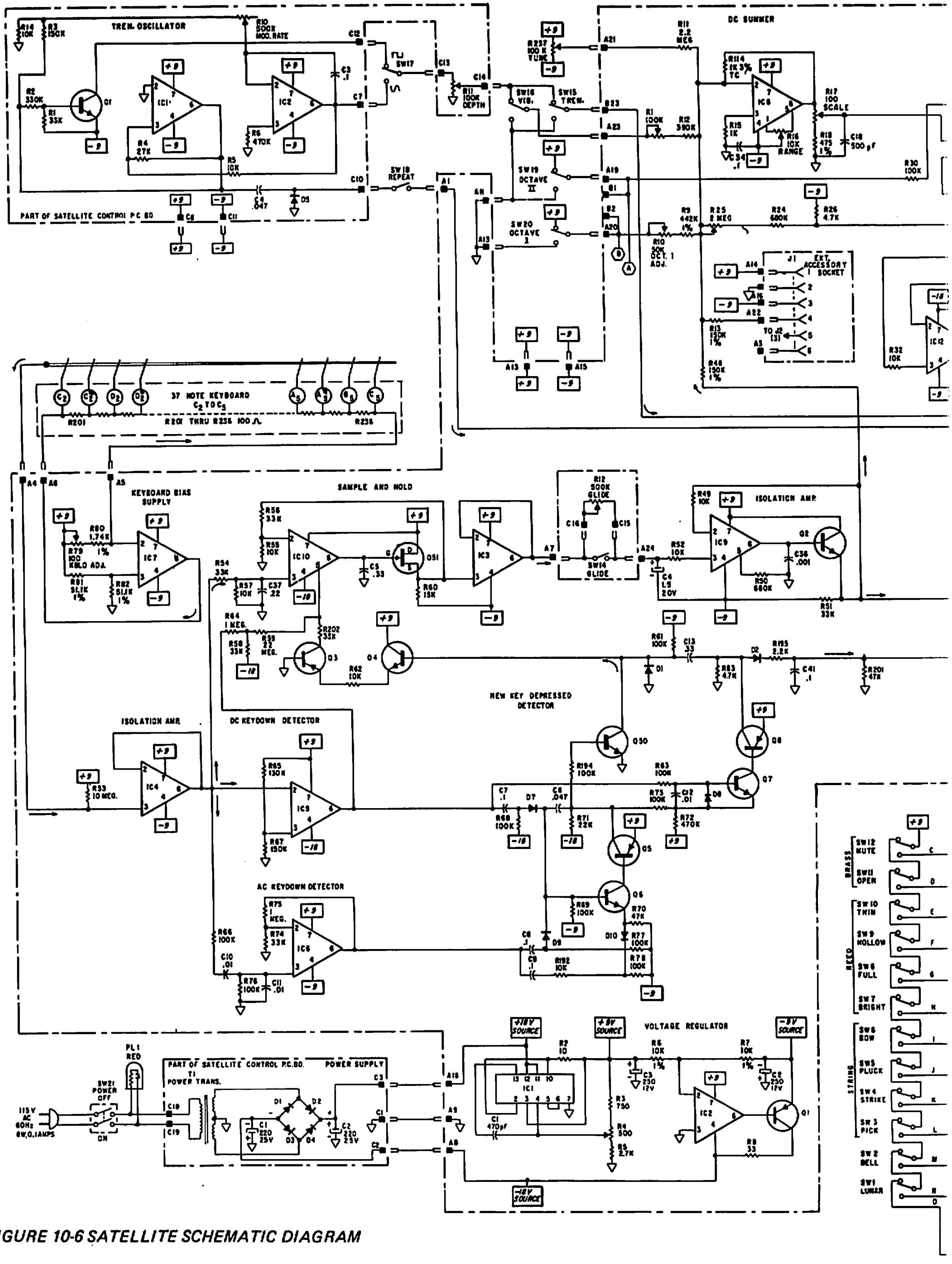
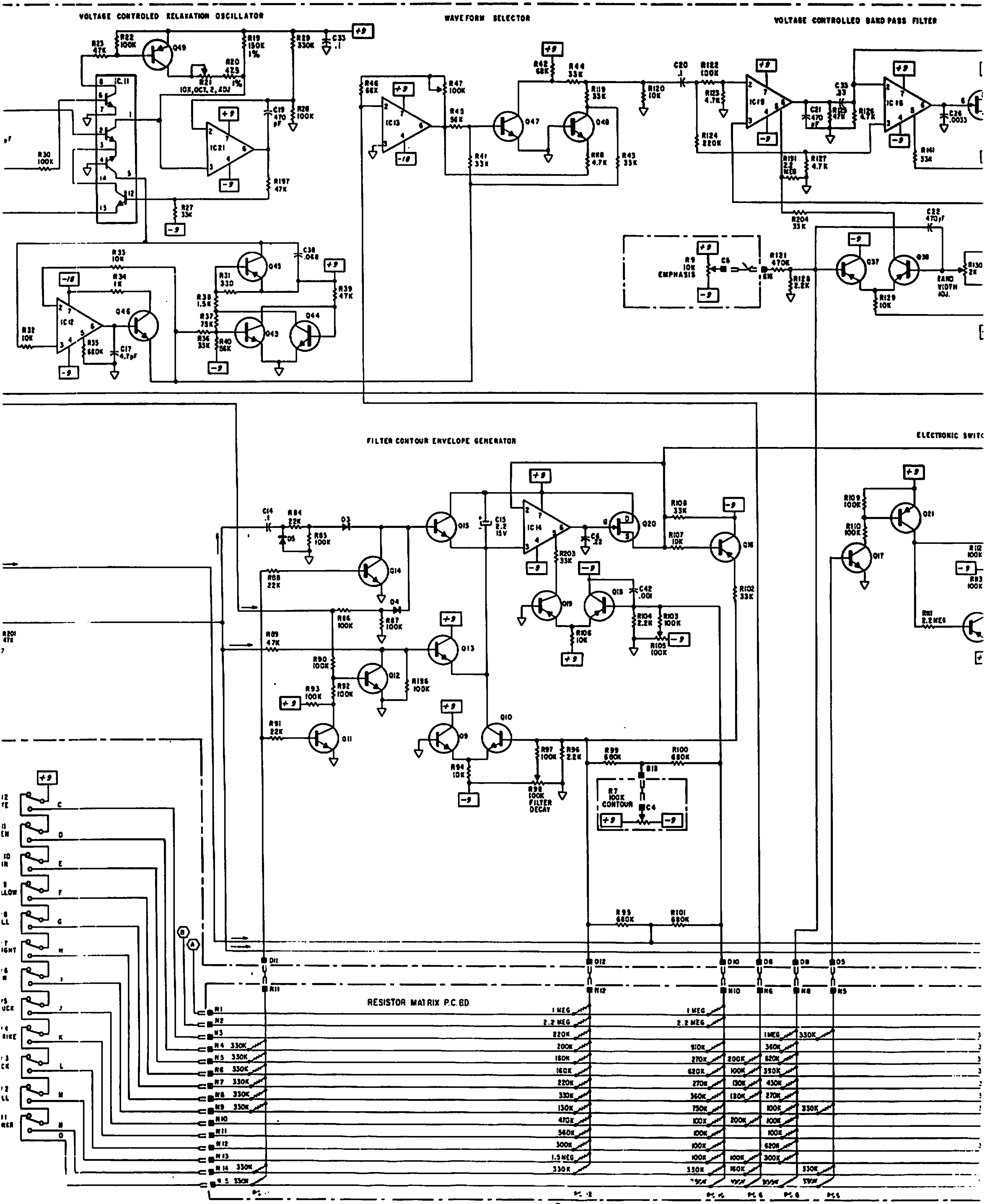
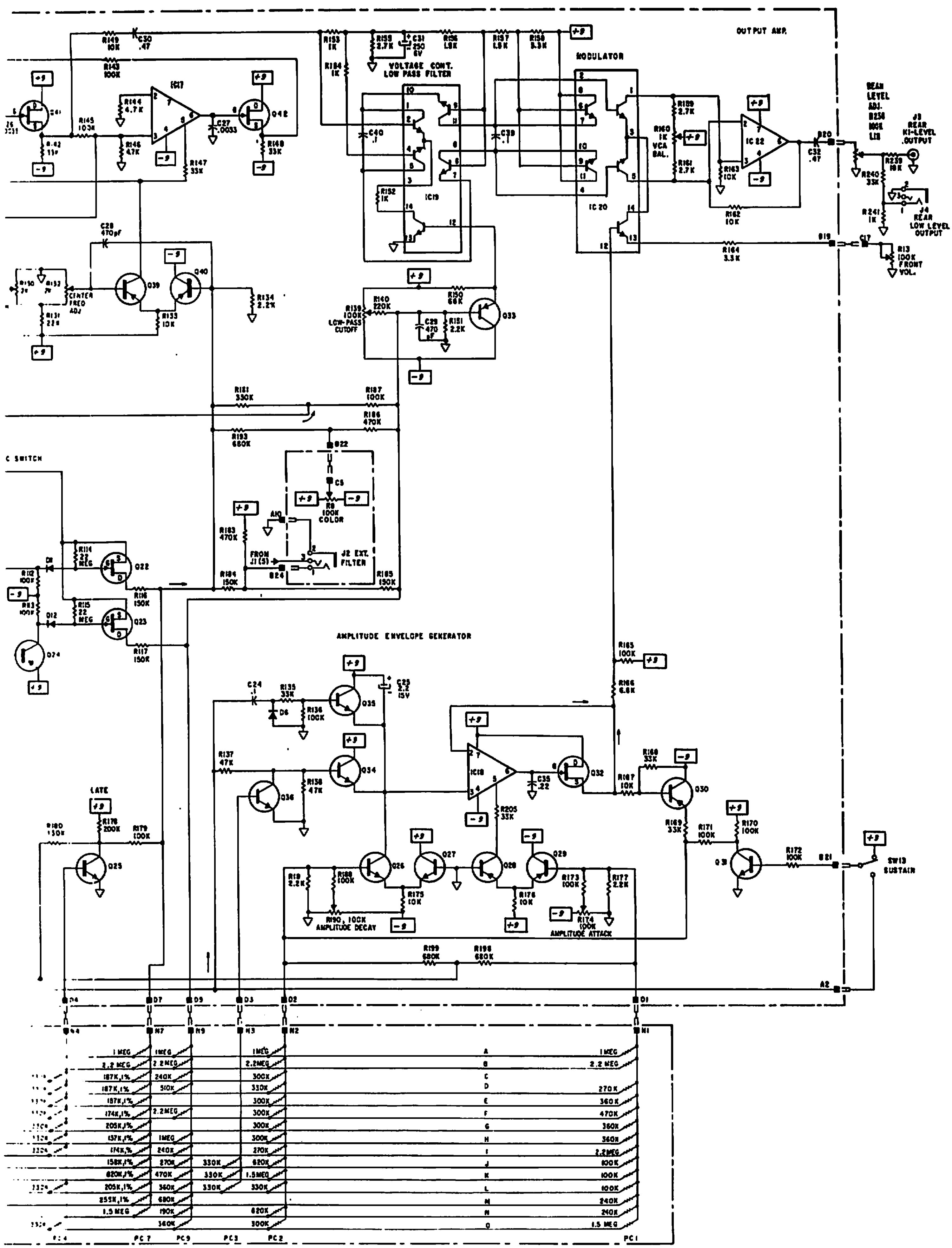
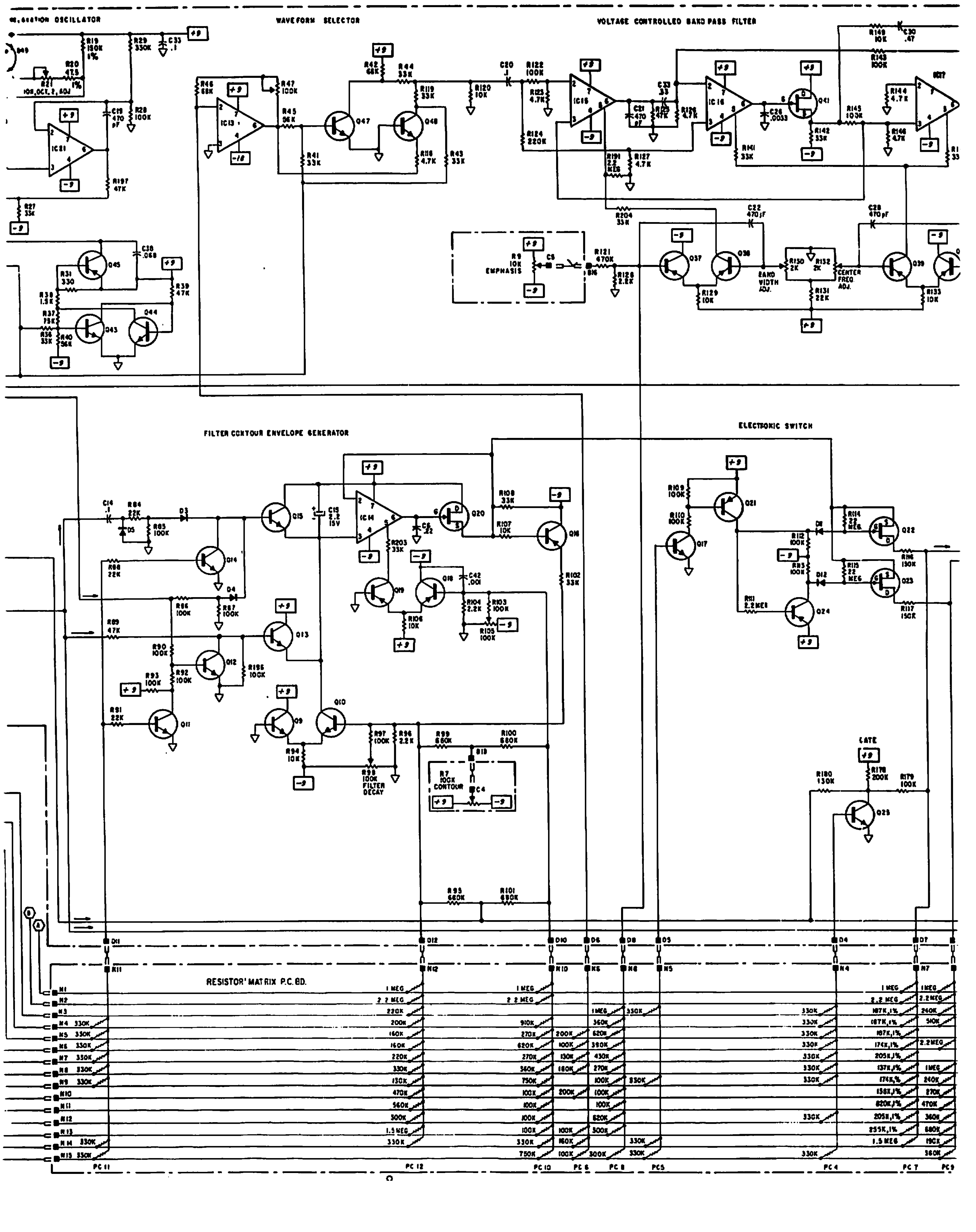


FIGURE 10-6 SATELLITE SCHEMATIC DIAGRAM

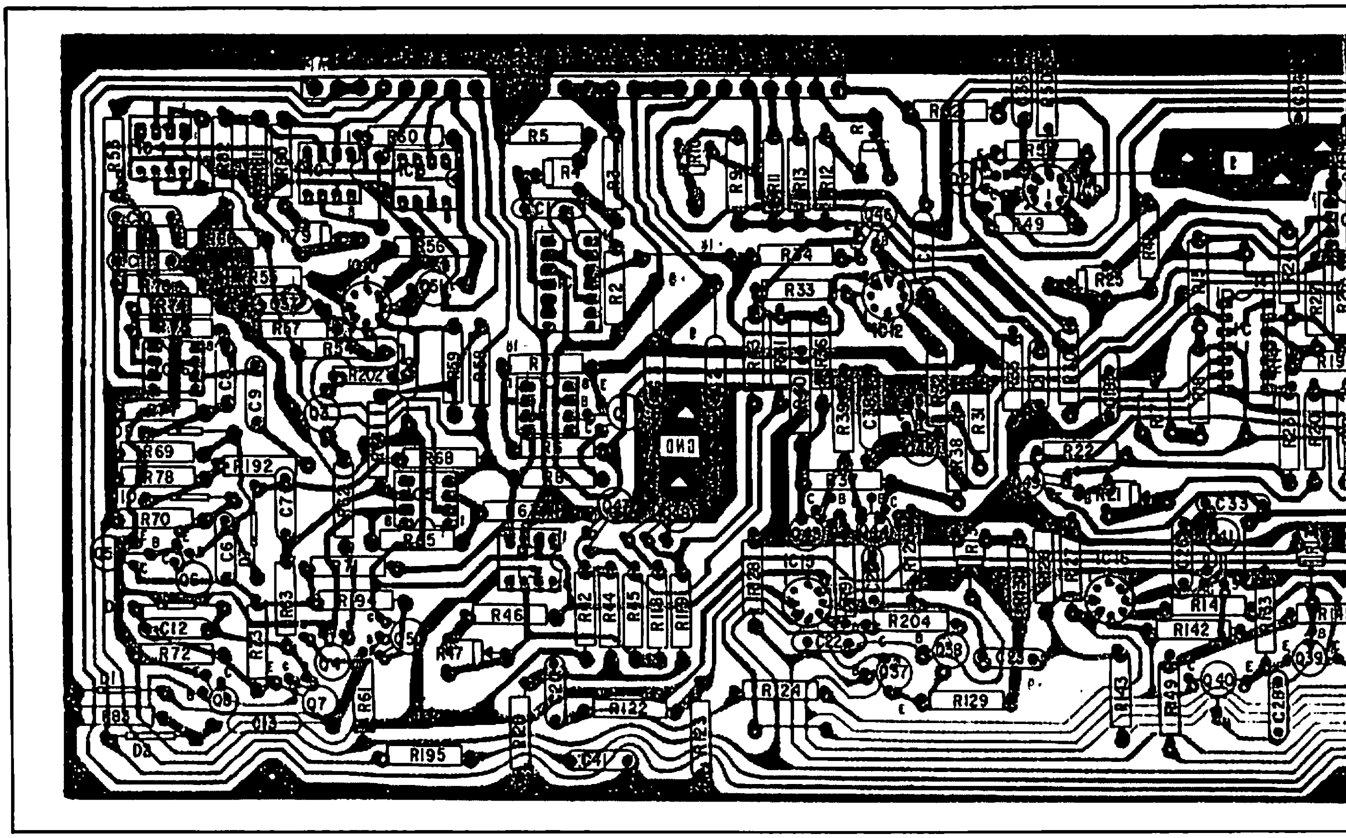


VOLTAGE CONTROLED RELAXATION OSCILLATOR
WAVEFORM SELECTOR
VOLTAGE CONTROLLED BAND PASS FILTER
FILTER CONTOUR ENVELOPE GENERATOR
ELECTRONIC SWITC
EMPHASIS
BAND WIDTH ADJ.
FILTER DECAY
CONTOUR
RESISTOR MATRIX P.C. BD.

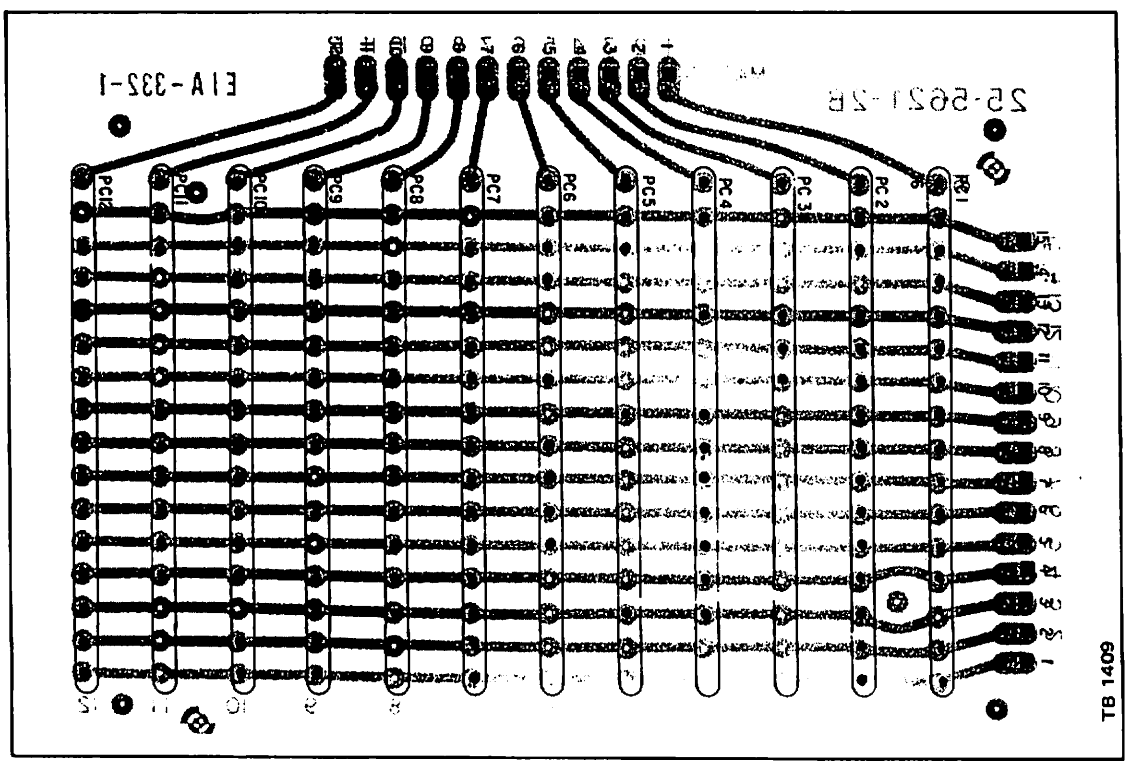

OUTPUT AMP.
MODULATOR
VOLTAGE CONT. LOW PASS FILTER
IC17
IC19
IC20
IC22
IC18
REAR LEVEL ADJ.
J3 REAR HI-LEVEL OUTPUT
J4 REAR LOW LEVEL OUTPUT
R13 100K FRONT VOL.
CENTER FREQ ADJ
LOW-PASS CUTOFF
R8 100K COLOR
J2 EXT. FILTER
FROM J1(5)
VCA BAL.
AMPLITUDE ENVELOPE GENERATOR
R190 100K AMPLITUDE DECAY
R174 100K AMPLITUDE ATTACK
SW13 SUSTAIN
PC 7
PC 9
PC 3
PC 2
PC 1



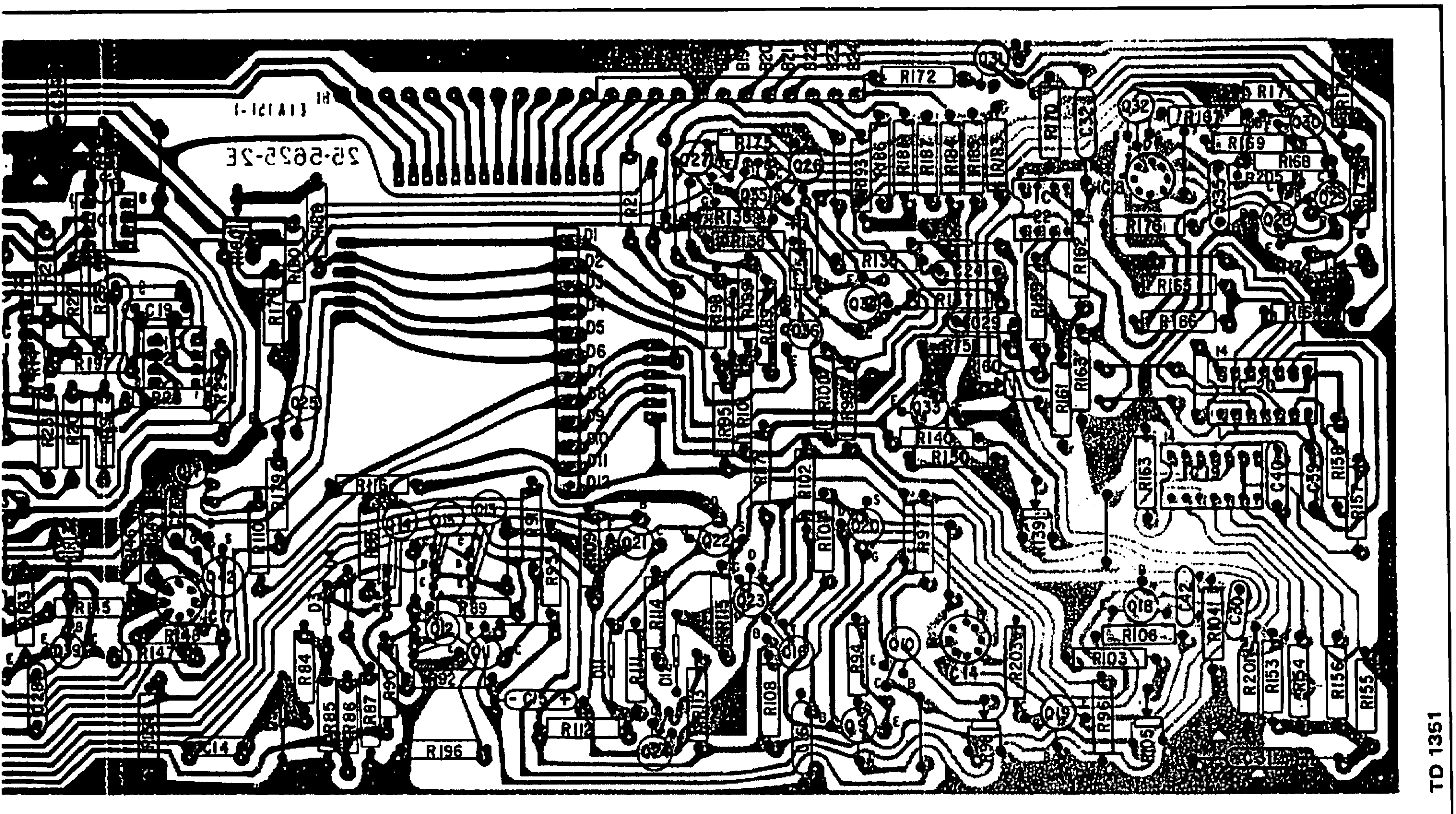
MODULATION OSCILLATOR
WAVEFORM SELECTOR
VOLTAGE CONTROLLED BAND PASS FILTER
FILTER CONTOUR ENVELOPE GENERATOR
ELECTRONIC SWITCH
EMPHASIS
BAND WIDTH ADJ.
CENTER FREQ ADJ.
FILTER DECAY
CONTOUR
GATE
RESISTOR MATRIX P.C. BD.



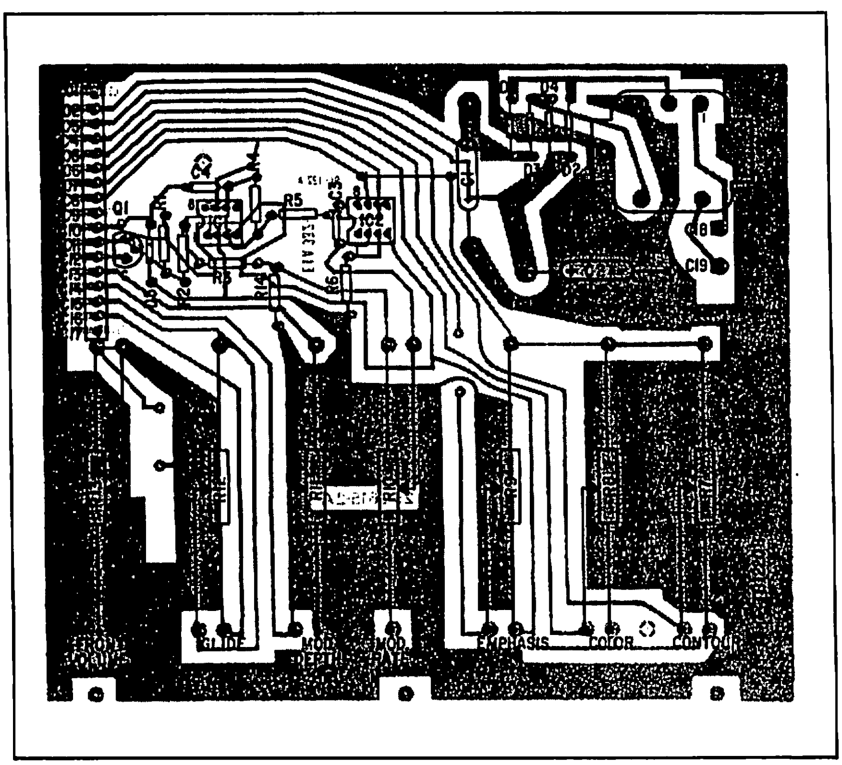
SATELLITE PRINTED CIR



RESISTOR MATRIX PRINTED CIRCUIT
BOARD ASSEMBLY



NTED CIRCUIT BOARD ASSEMBLY



SATELLITE CONTROL PRINTED CIRCUIT BOARD ASSEMBLY

FIGURE 10-7 SATELLITE PRINTED CIRCUIT BOARD ASSE

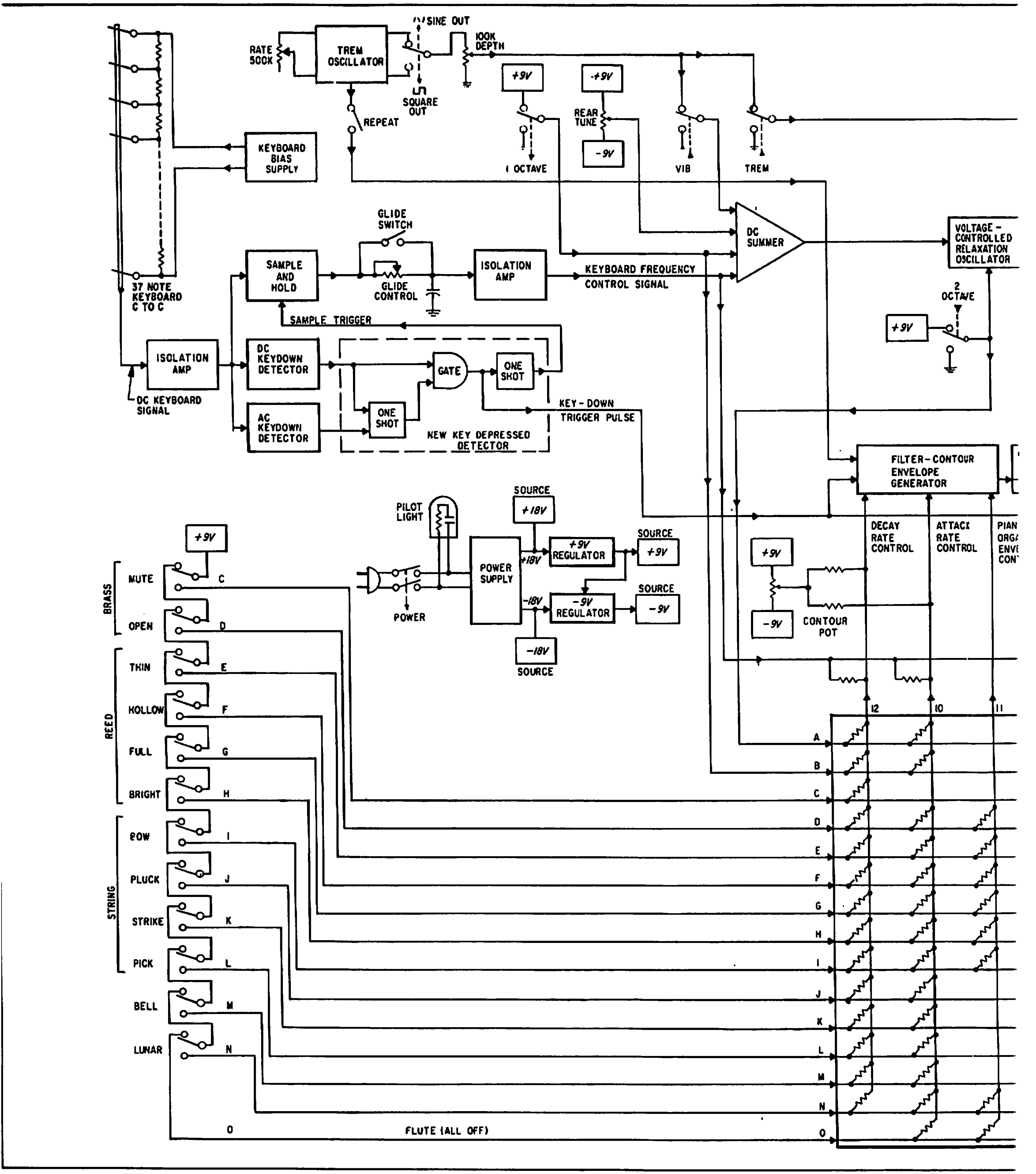
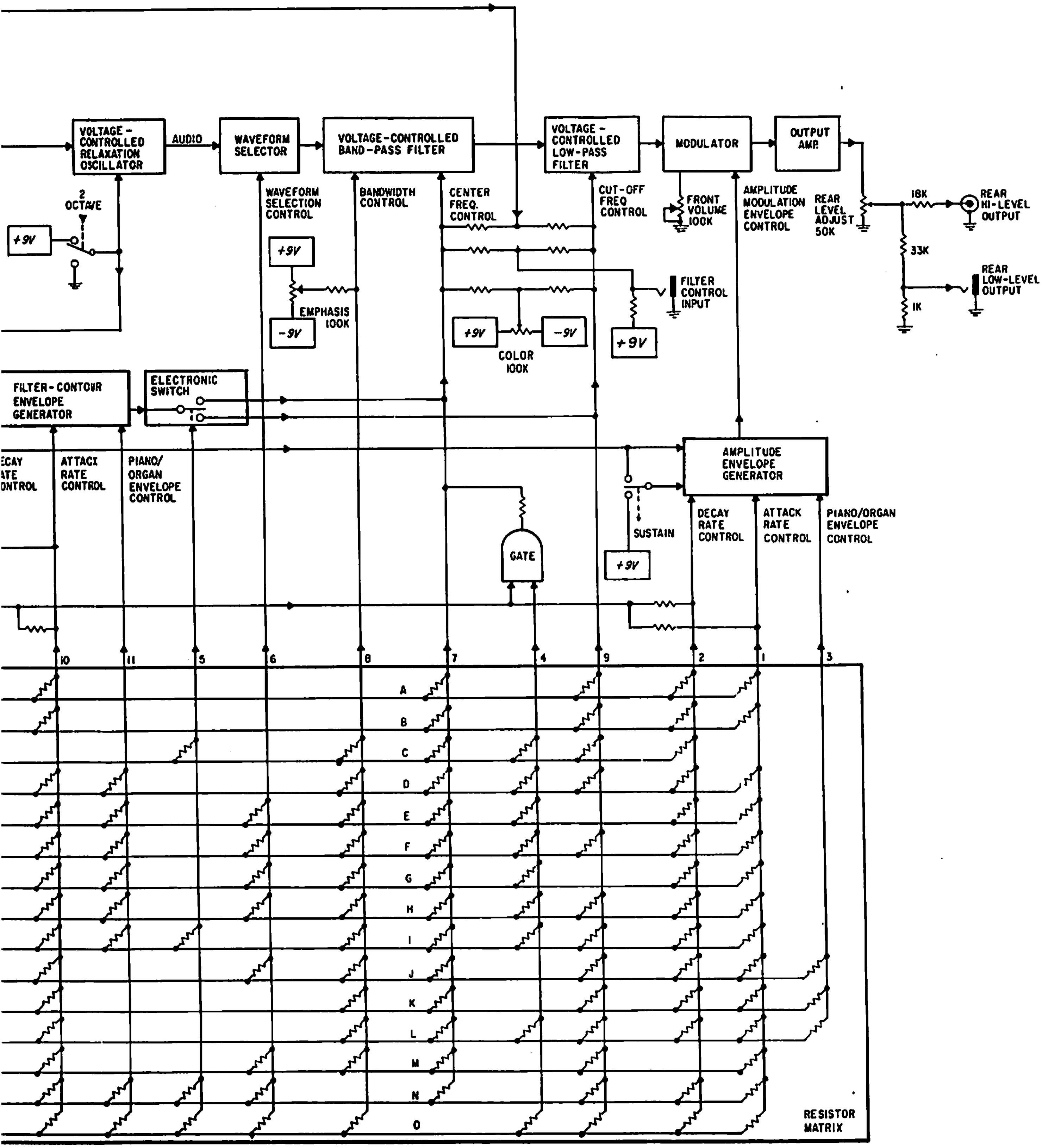
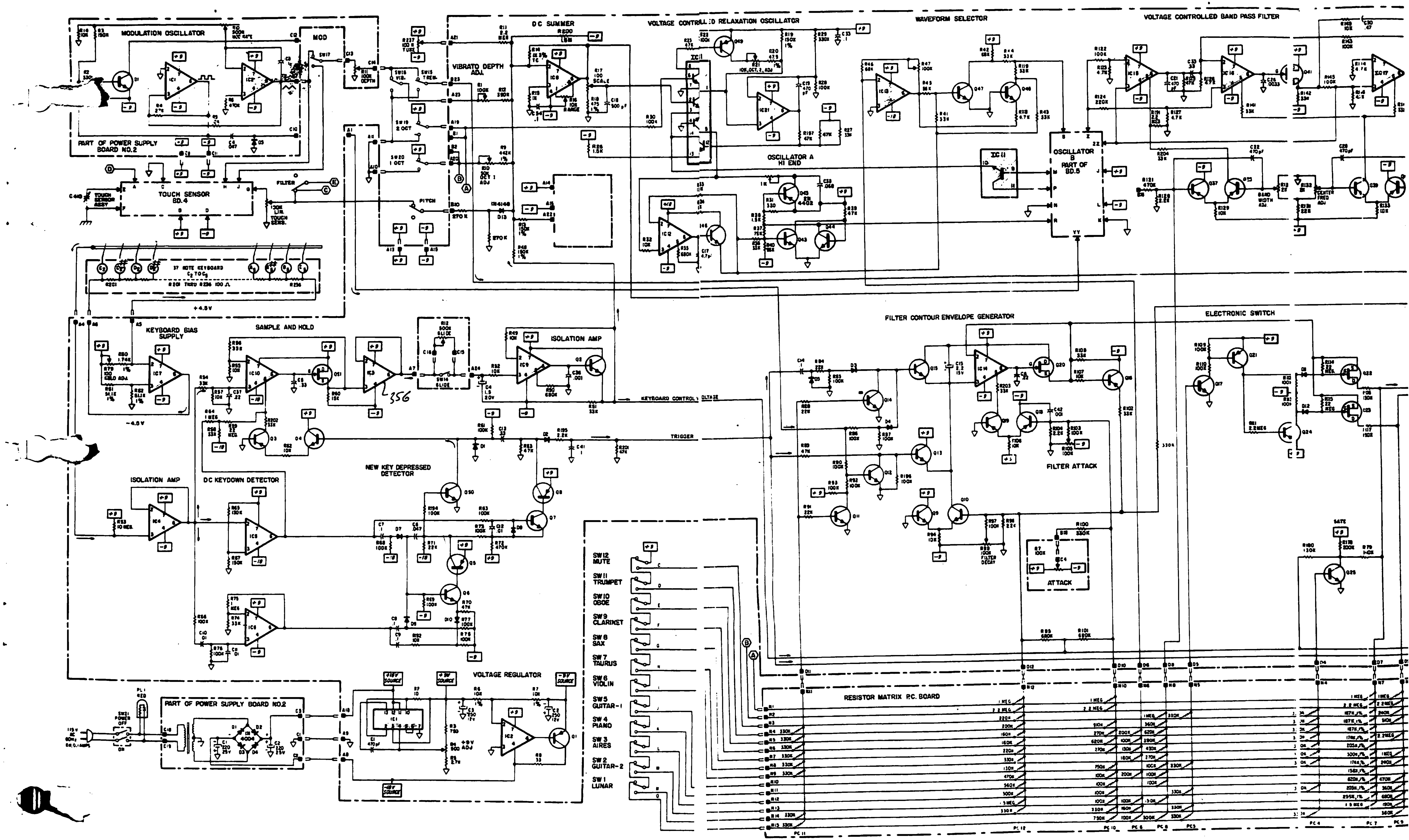


FIGURE 10-8 SATELLITE BLOCK DIAGRAM


VOLTAGE-CONTROLLED RELAXATION OSCILLATOR
AUDIO
WAVEFORM SELECTOR
VOLTAGE-CONTROLLED BAND-PASS FILTER
VOLTAGE-CONTROLLED LOW-PASS FILTER
MODULATOR
OUTPUT AMP.
2 OCTAVE
+9V
WAVEFORM SELECTION CONTROL
BANDWIDTH CONTROL
CENTER FREQ. CONTROL
CUT-OFF FREQ CONTROL
FRONT VOLUME 100K
AMPLITUDE MODULATION ENVELOPE CONTROL
REAR LEVEL ADJUST 50K
18K
REAR HI-LEVEL OUTPUT
33K
REAR LOW-LEVEL OUTPUT
1K
+9V
EMPHASIS 100K
-9V
FILTER CONTROL INPUT
+9V
-9V
COLOR 100K
+9V
FILTER-CONTOUR ENVELOPE GENERATOR
ELECTRONIC SWITCH
AMPLITUDE ENVELOPE GENERATOR
ECAY ATE ONTROL
ATTACK RATE CONTROL
PIANO/ORGAN ENVELOPE CONTROL
SUSTAIN
GATE
+9V
DECAY RATE CONTROL
ATTACK RATE CONTROL
PIANO/ORGAN ENVELOPE CONTROL
10
11
5
6
8
7
4
9
2
1
3
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
RESISTOR MATRIX


MODULATION OSCILLATOR
MOD
PART OF POWER SUPPLY BOARD NO.2
TOUCH SENSOR BD.4
TOUCH SENSOR ASSY
FILTER
PITCH
VIBRATO DEPTH ADJ.
DC SUMMER
VOLTAGE CONTROLLED RELAXATION OSCILLATOR
OSCILLATOR A HI END
WAVEFORM SELECTOR
OSCILLATOR B PART OF BD.5
VOLTAGE CONTROLLED BAND PASS FILTER
BAND WIDTH ADJ.
CENTER FREQ ADJ
37 NOTE KEYBOARD
KEYBOARD BIAS SUPPLY
SAMPLE AND HOLD
SLIDE
ISOLATION AMP
KEYBOARD CONTROL VOLTAGE
TRIGGER
NEW KEY DEPRESSED DETECTOR
ISOLATION AMP
DC KEYDOWN DETECTOR
FILTER CONTOUR ENVELOPE GENERATOR
FILTER ATTACK
FILTER DECAY
ATTACK
ELECTRONIC SWITCH
GATE
SW12 MUTE
SW11 TRUMPET
SW10 OBOE
SW9 CLARINET
SW8 SAX
SW7 TAURUS
SW6 VIOLIN
SW5 GUITAR-1
SW4 PIANO
SW3 AIRES
SW2 GUITAR-2
SW1 LUNAR
RESISTOR MATRIX P.C. BOARD
VOLTAGE REGULATOR
PART OF POWER SUPPLY BOARD NO.2
+18V SOURCE
+9V SOURCE
-9V SOURCE
-18V SOURCE
SW21 POWER
PL1 RED
115V AC 60Hz

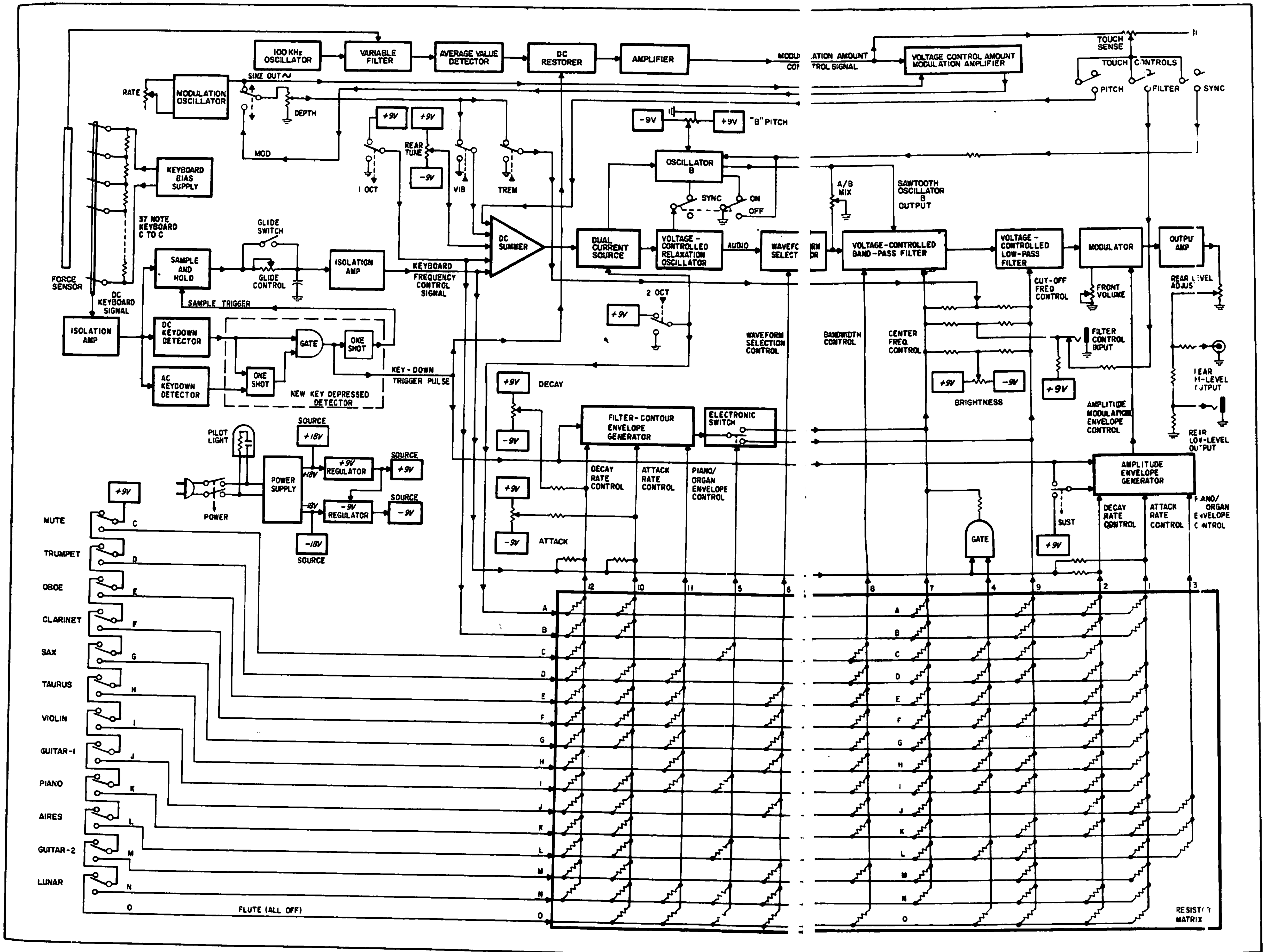
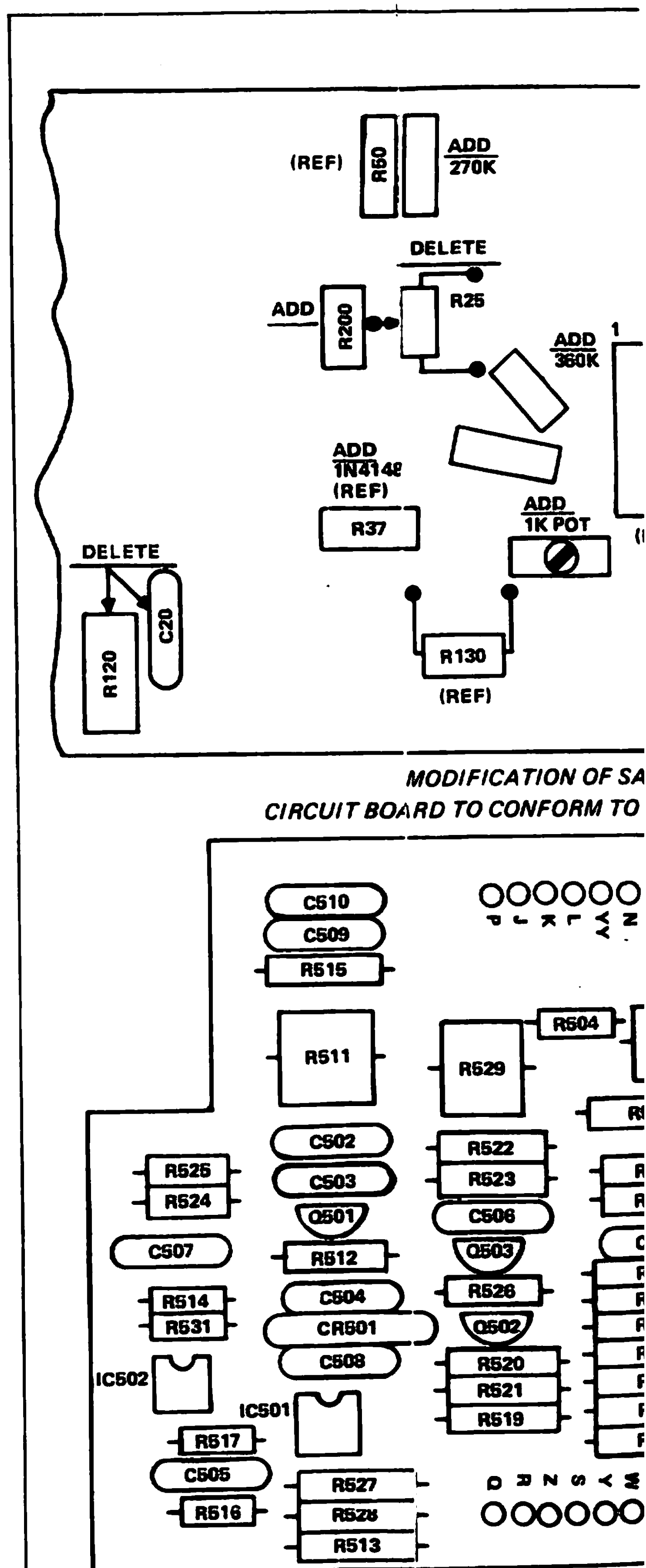


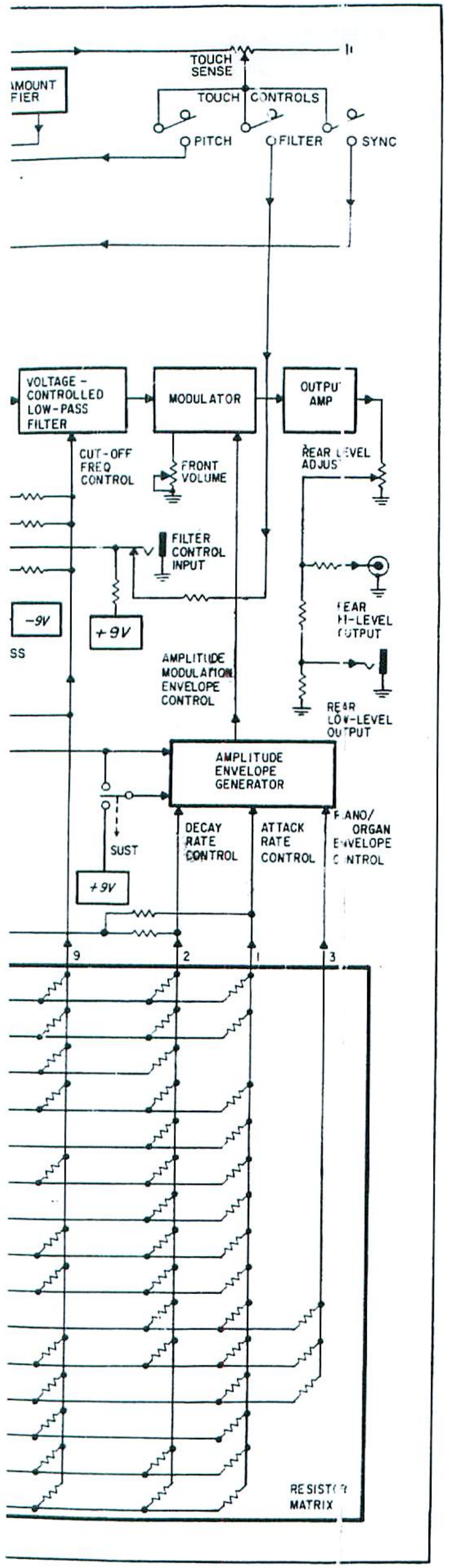
FIGURE 10-2 MINITMOOG BLOCK DIAGRAM

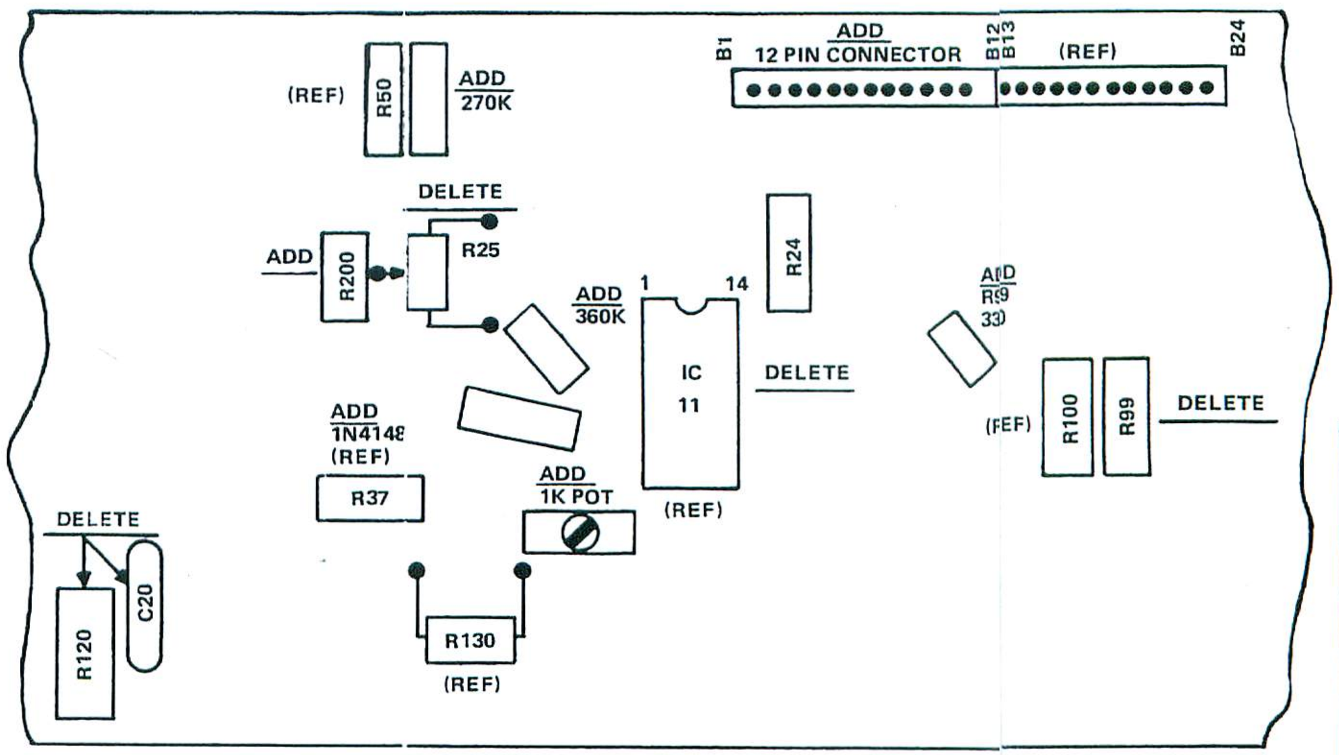


MODIFICATION OF SA CIRCUIT BOARD TO CONFORM TO

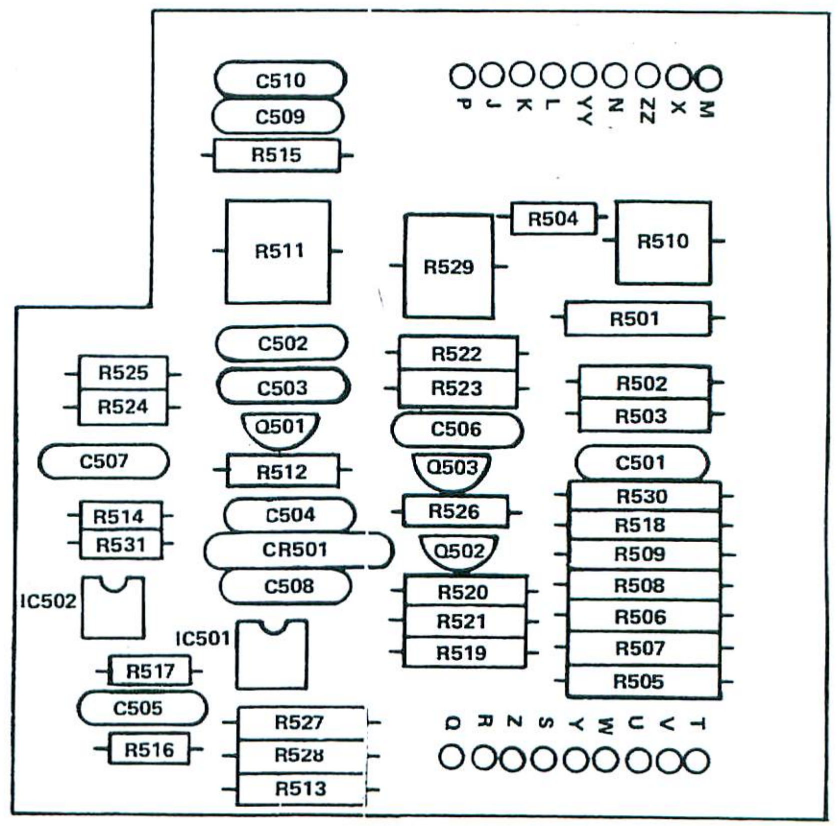
OSCILLATOR BOARD NO. 5 PRINTED CIRCUIT BOARD ASSEMB

FIGURE

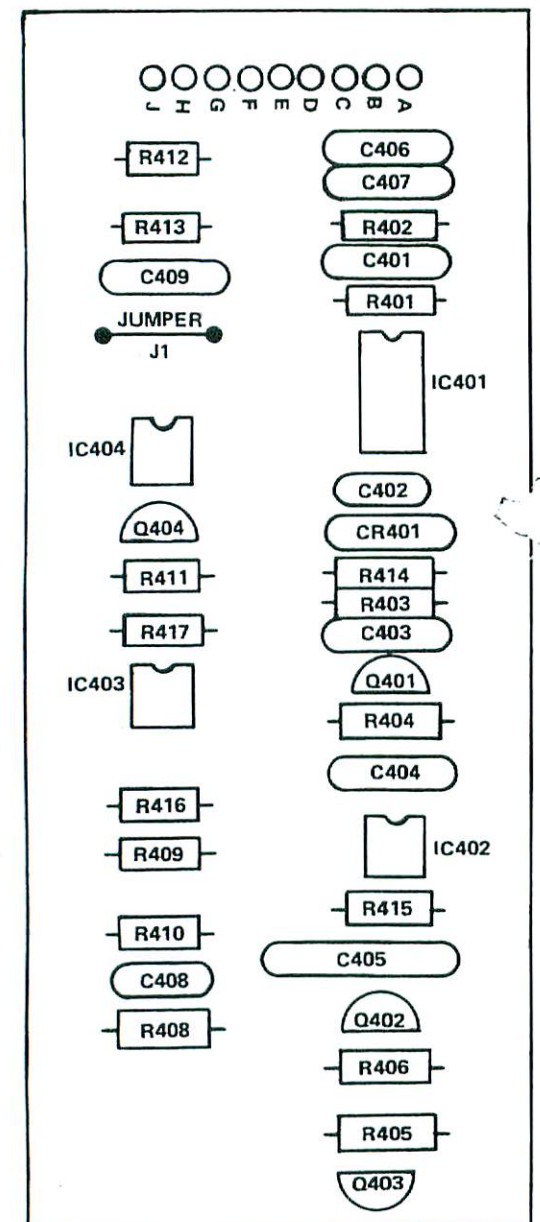




MODIFICATION OF SATELLITE PRINTED CIRCUIT BOARD TO CONFORM TO MINITMOOG CONFIGURATION



OSCILLATOR BOARD NO. 5
PRINTED CIRCUIT BOARD ASSEMBLY



TOUCH SENSOR PRINTED CIRCUIT BOARD NO. 4 ASSEMBLY

FIGURE 10-3 MINITMOOG PRINTED CIRCUIT BOARD ASSEMBLIES

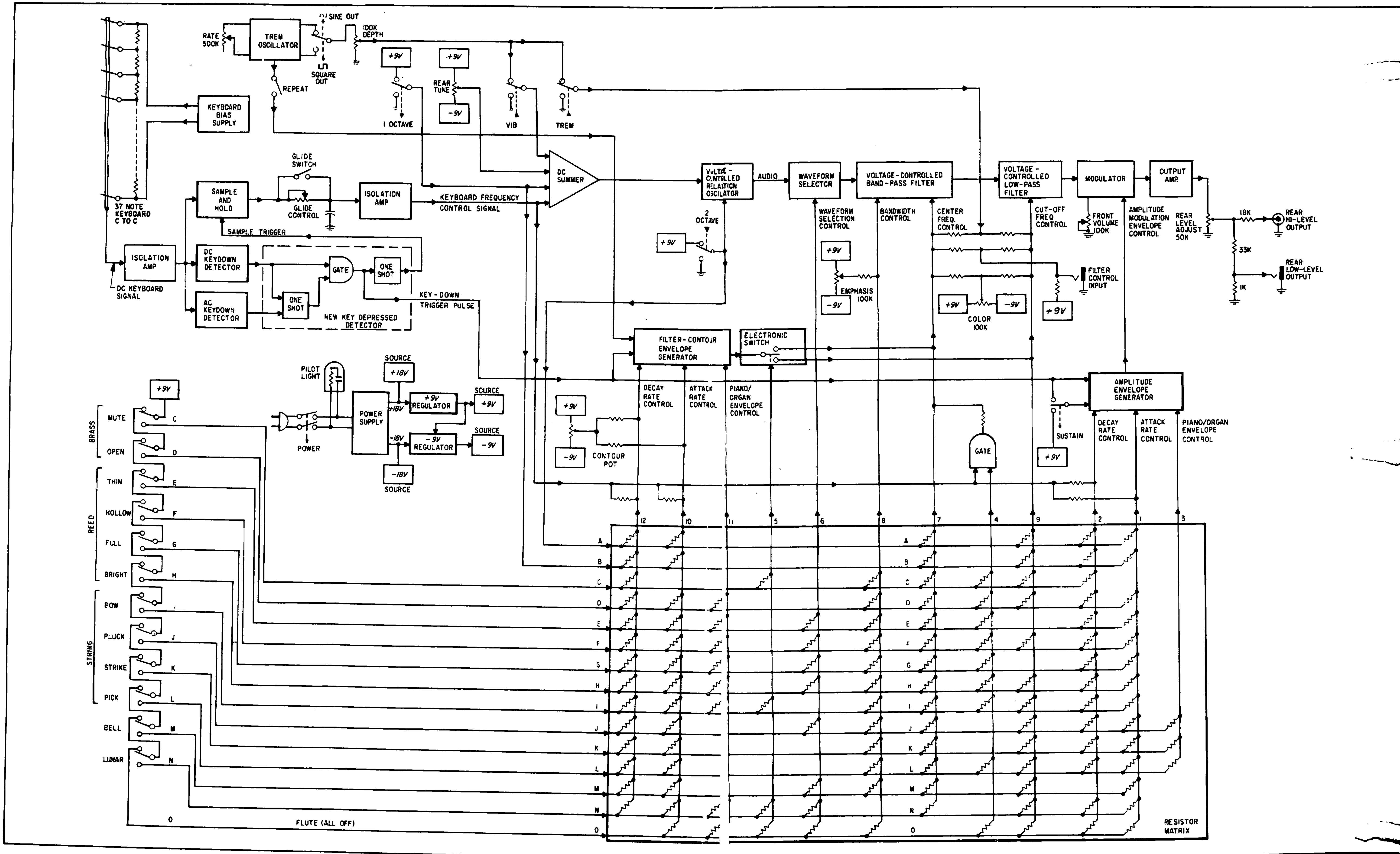


FIGURE 10-8 SATELLITE BLOCK DIAGRAM

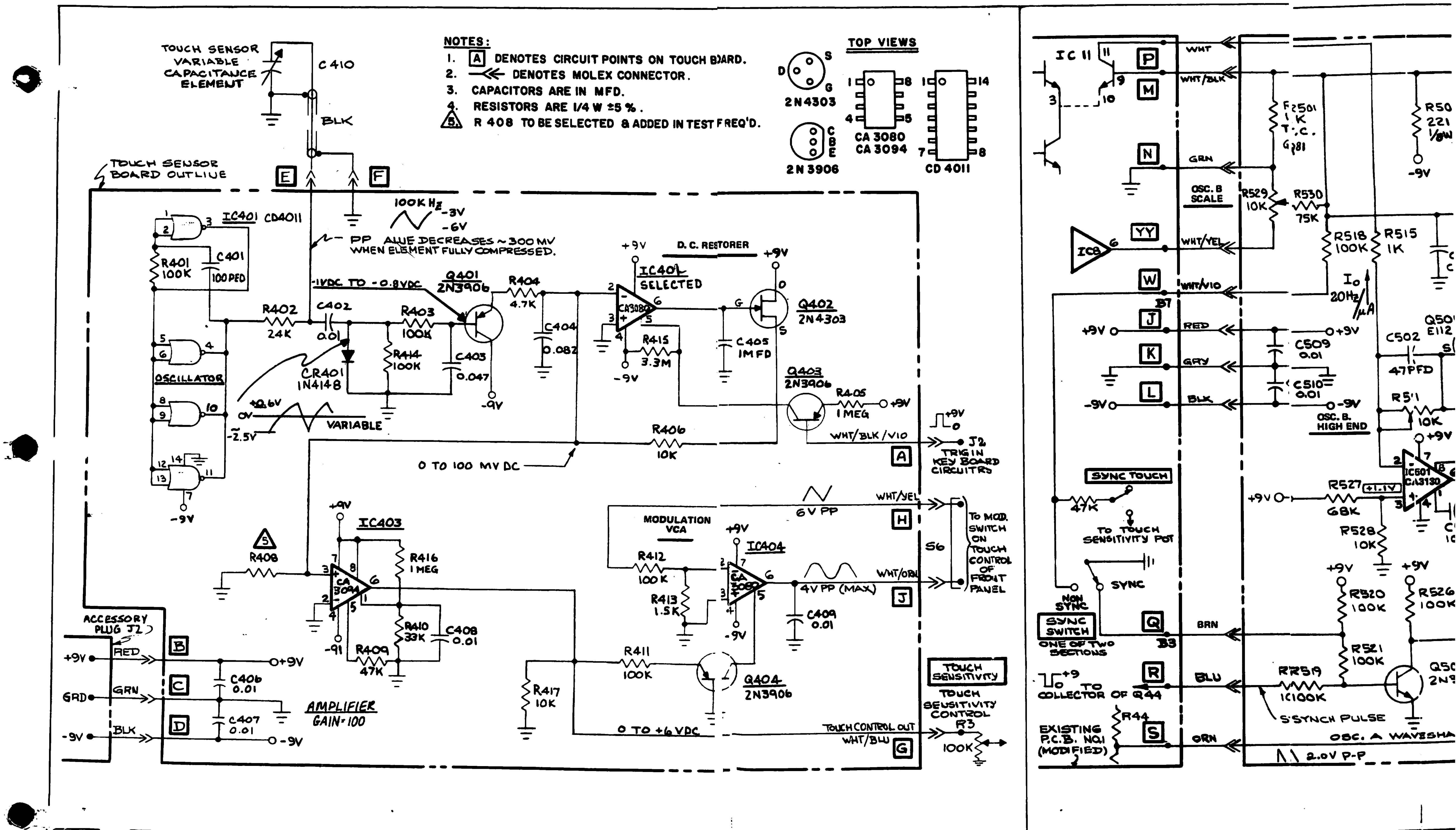
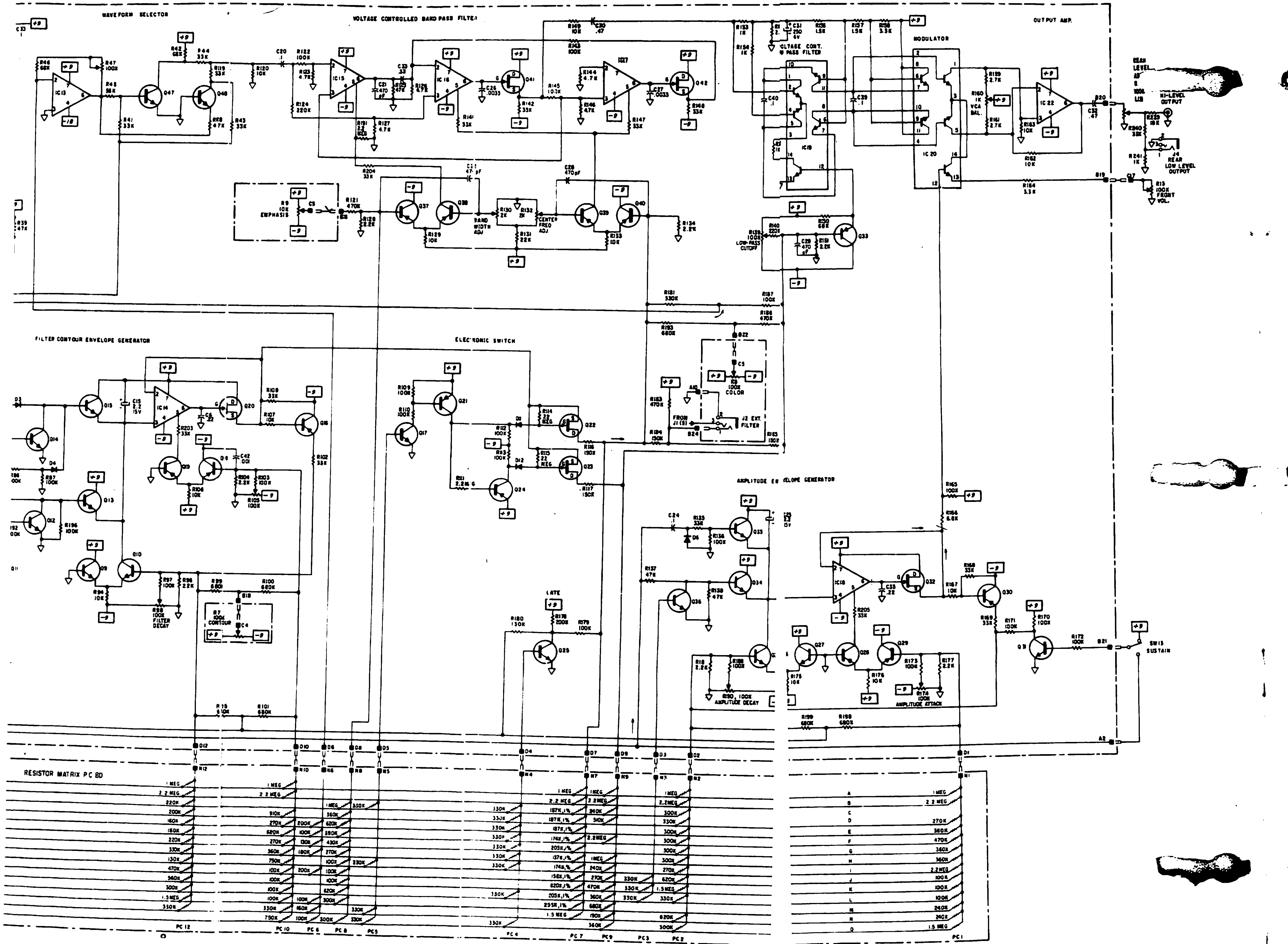


FIGURE 10-4 MINITMOOG TOUCH SENSOR BOARD ASSEMBY NO. 4 SCHEMATIC [illegible]IAGRAM


WAVEFORM SELECTOR
VOLTAGE CONTROLLED BAND PASS FILTER
OUTPUT AMP.
MODULATOR
VOLTAGE CONT. LOW PASS FILTER
EMPHASIS
BAND WIDTH ADJ
CENTER FREQ ADJ.
LOW PASS CUTOFF
REAR LEVEL ADJ
HI-LEVEL OUTPUT
REAR LOW LEVEL OUTPUT
FRONT VOL.
FILTER CONTOUR ENVELOPE GENERATOR
ELECTRONIC SWITCH
COLOR
J2 EXT. FILTER
AMPLITUDE ENVELOPE GENERATOR
FILTER DECAY
CONTOUR
AMPLITUDE DECAY
AMPLITUDE ATTACK
SW15 SUSTAIN
RESISTOR MATRIX PC BD
PC 12
PC 10
PC 6
PC 8
PC 5
PC 4
PC 7
PC 9
PC 3
PC 2
PC 1

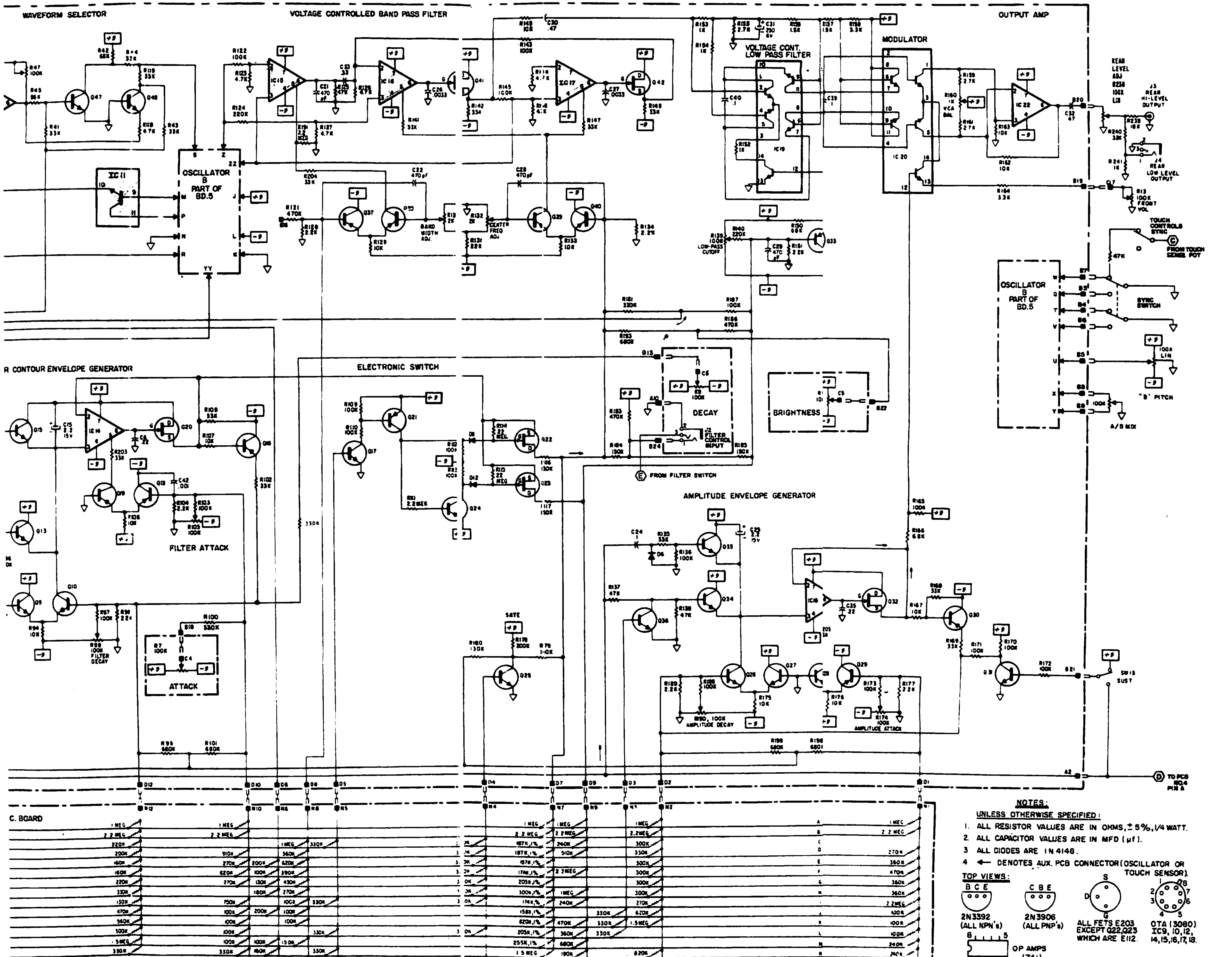


FIGURE 10-1 MINITMOOG SCHEMATIC DIAGRAM

AM
51

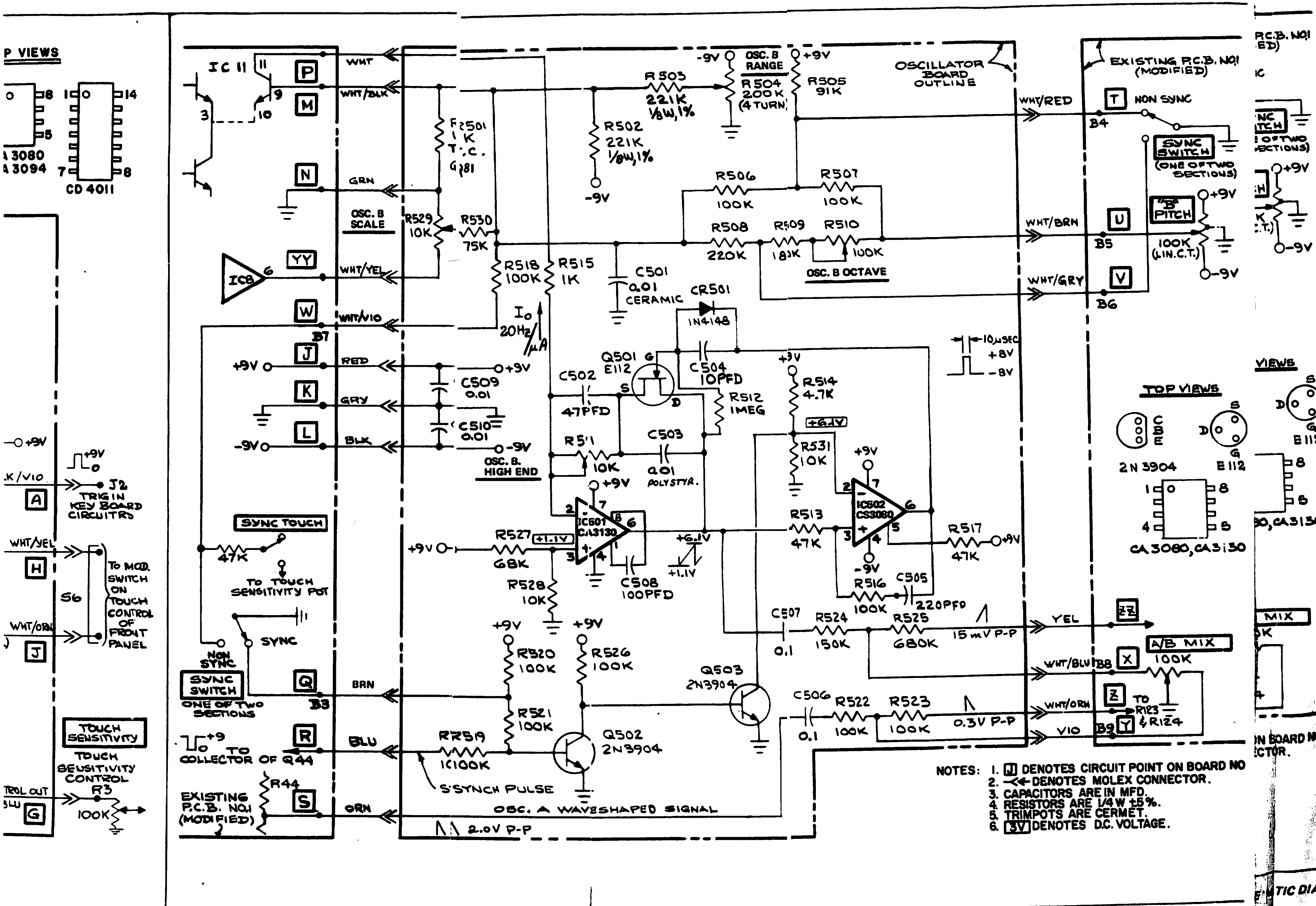


FIGURE 10-5 MINITMOOG OSCILLATOR BOARD ASSEMBLY NO. 5 SCHEMATIC DIA

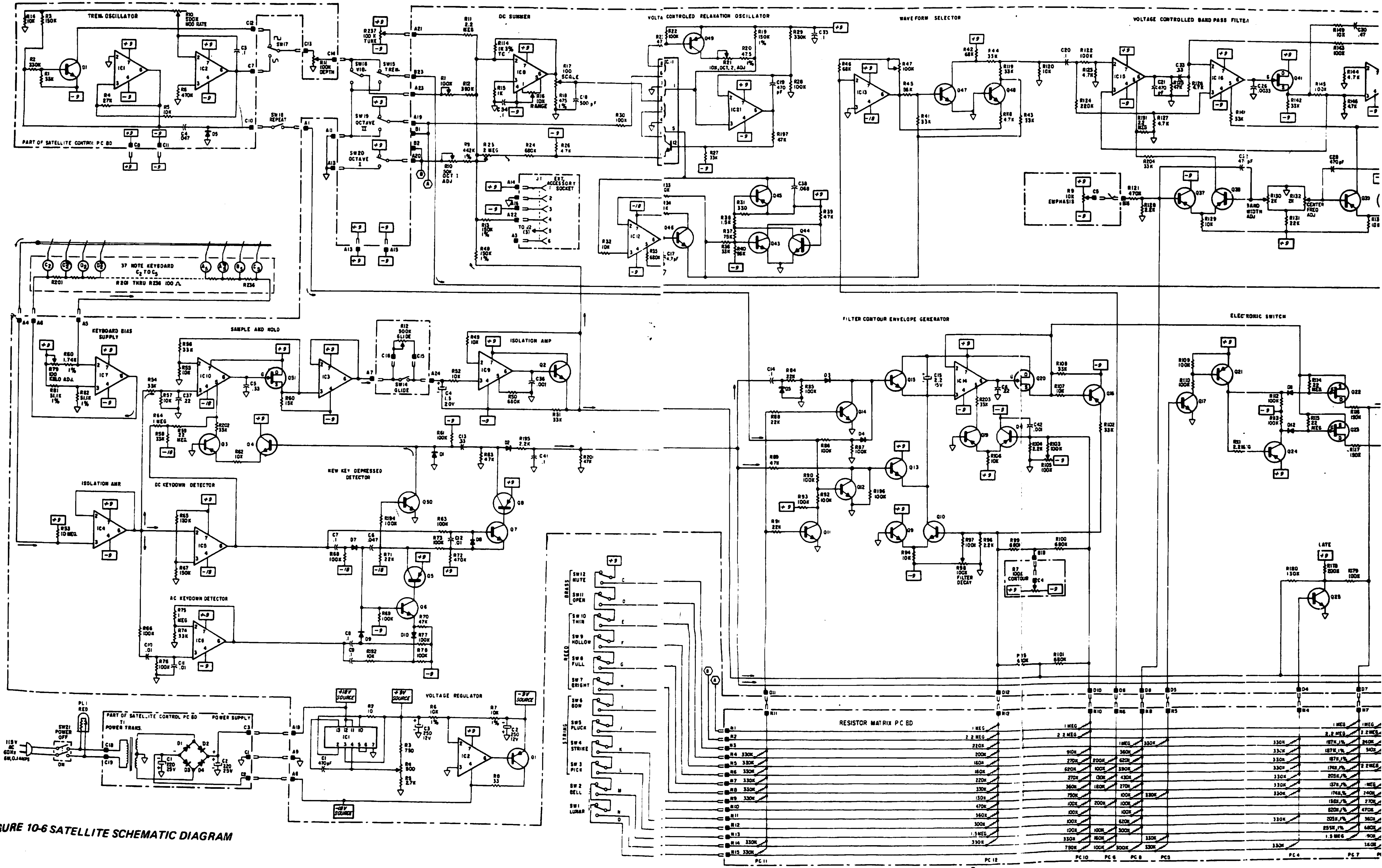
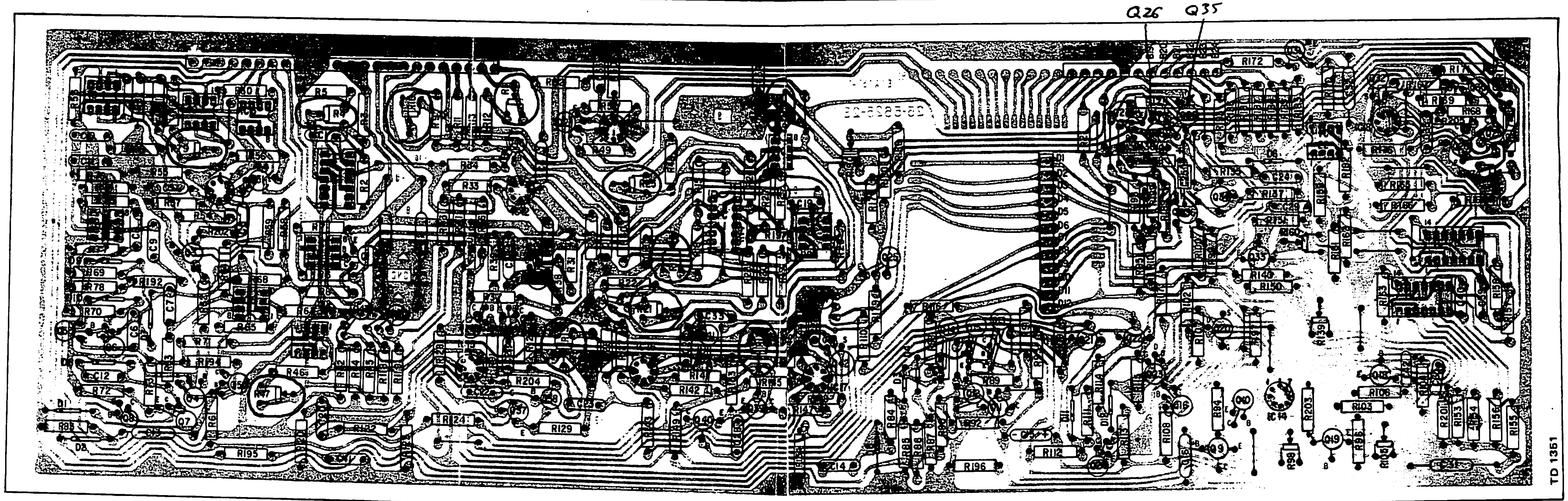
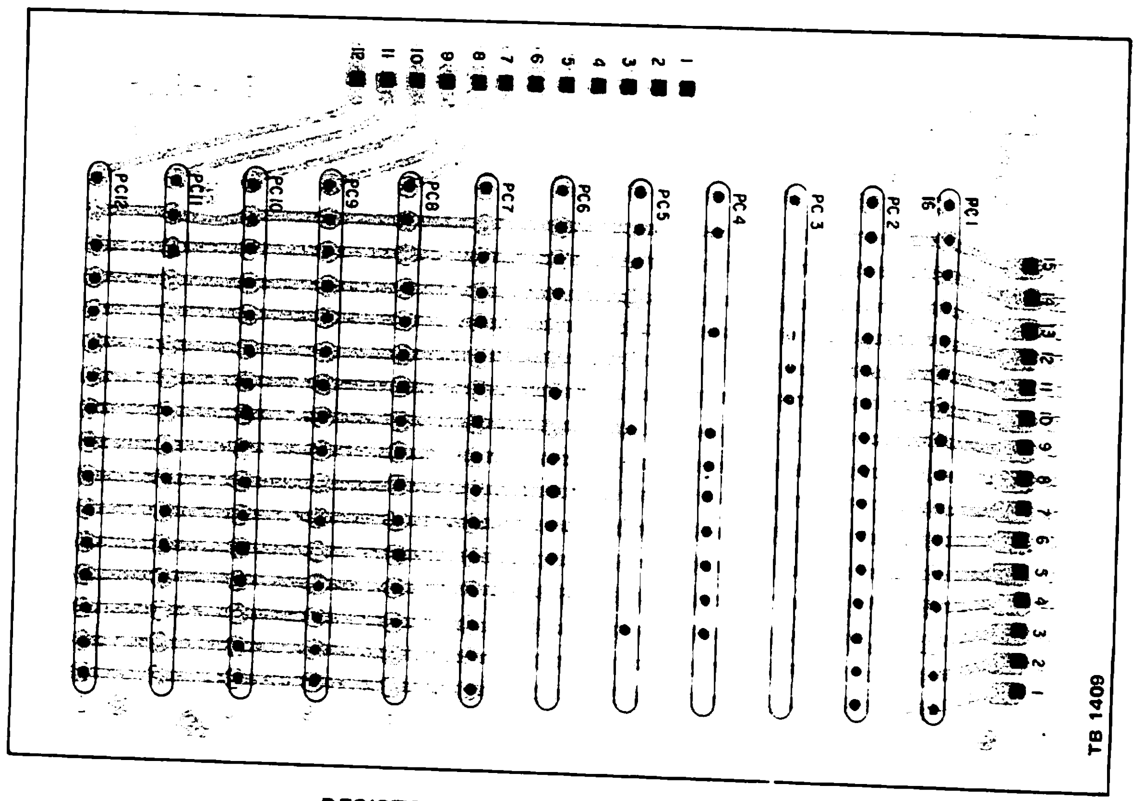


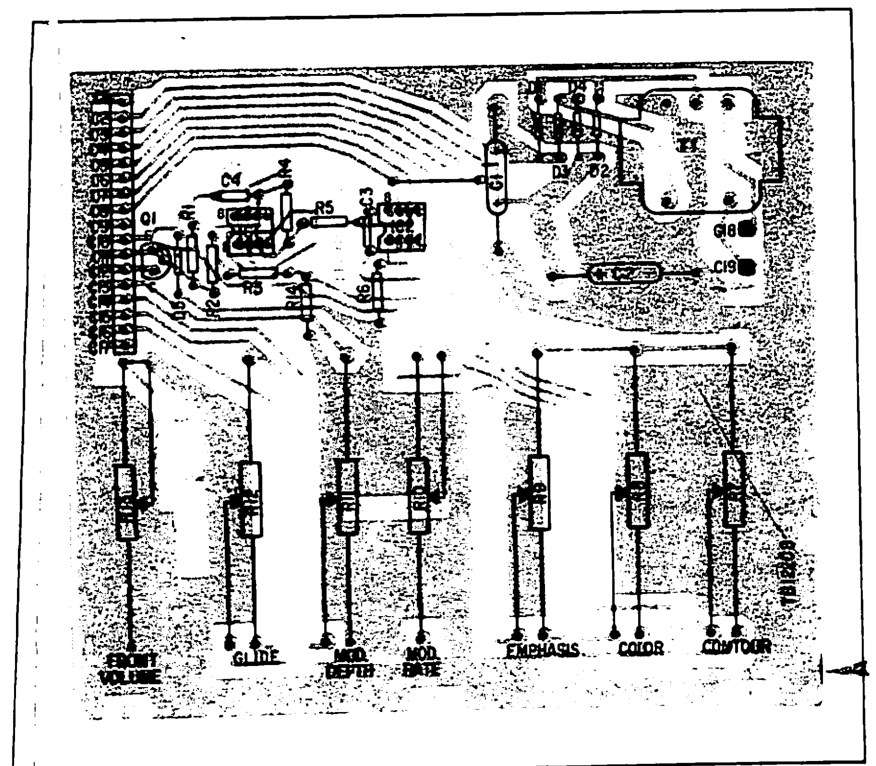
FIGURE 10-6 SATELLITE SCHEMATIC DIAGRAM



SATELLITE PRINTED CIRCUIT BOARD ASSEMBLY



RESISTOR MATRIX PRINTED CIRCUIT BOARD ASSEMBLY



SATELLITE CONTROL PRINTED CIRCUIT BOARD ASSEMBLY

FIGURE 10-7 SATELLITE PRINTED CIRCUIT BOARD ASSEMBLIES

MINITMOOG AND SATELLITE SYNTHESIZERS

MOOG MUSIC INC.
2500 Walden Avenue, Buffalo, New York 14225

NORLIN MUSIC INSTRUMENTS LIMITED
51 Nantucket Blvd., Scarborough, Ontario, Canada MIP 2N6

NORLIN MUSIC SERVICES B.V.
Waalhaven, Zuidzijde 48, 3088 H. J., Rotterdam, The Netherlands

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