



PRO SOLOIST MODEL 2701 PRO/DGX MODEL 2720

SERVICE MANUAL

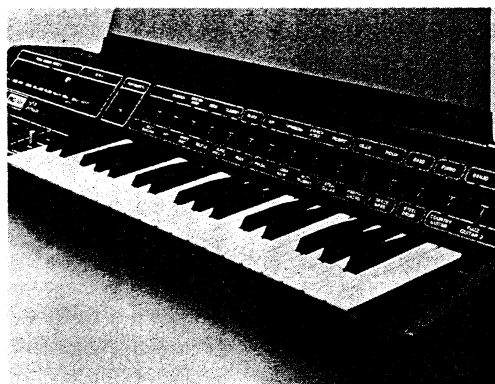


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1. Introduction

Included in this service manual are troubleshooting references which if used properly can greatly reduce the repair time of the Pro Soloist.

Section 2 covers the signal flow through the Pro Soloist. Section 3 describes design techniques unique to the product. Section 4 describes 'where to start' when a problem occurs. The circuit descriptions in section 5 should be consulted once a faulty circuit has been identified by the use of the R.O.M. truth tables and Voice Flow charts in sections 7 and 8.

VOICES AND EFFECTS

Bassoon	Buzz Bassoon
English Horn	Sax
Oboe	Space Reed
Clarinet	Telstar
Flute	Song Whistle
Tuba	Noze
Trombone	Pulsar
French Horn	Comic Wow
Trumpet	Mute Trumpet
Cello	Steel Guitar
Violin	Harpsichord
Bass	Space Bass
Piano	Steel Drum
Banjo	Country Guitar
Fuzz Guitar I	Fuzz Guitar II

CONTROLS:

Portamento— Enables the pitch to slide from note to note.

Portamento Speed—Regulates the time required to slide from note to note.

Touch Sensitivity—Controls the over-all amount of keyboard touch sensor effects.

Brilliance—Permits the addition or subtraction of brilliance.

Volume—Regulates the over-all volume of the instrument.

Repeat—Creates the rapid pick strokes of string instruments.

Vibrato/Repeat Speed—Controls the vibrato speed and repeat rate.

Octave Transpose Switch—Transposes the instrument up and down one octave.

2. Theory of Operation

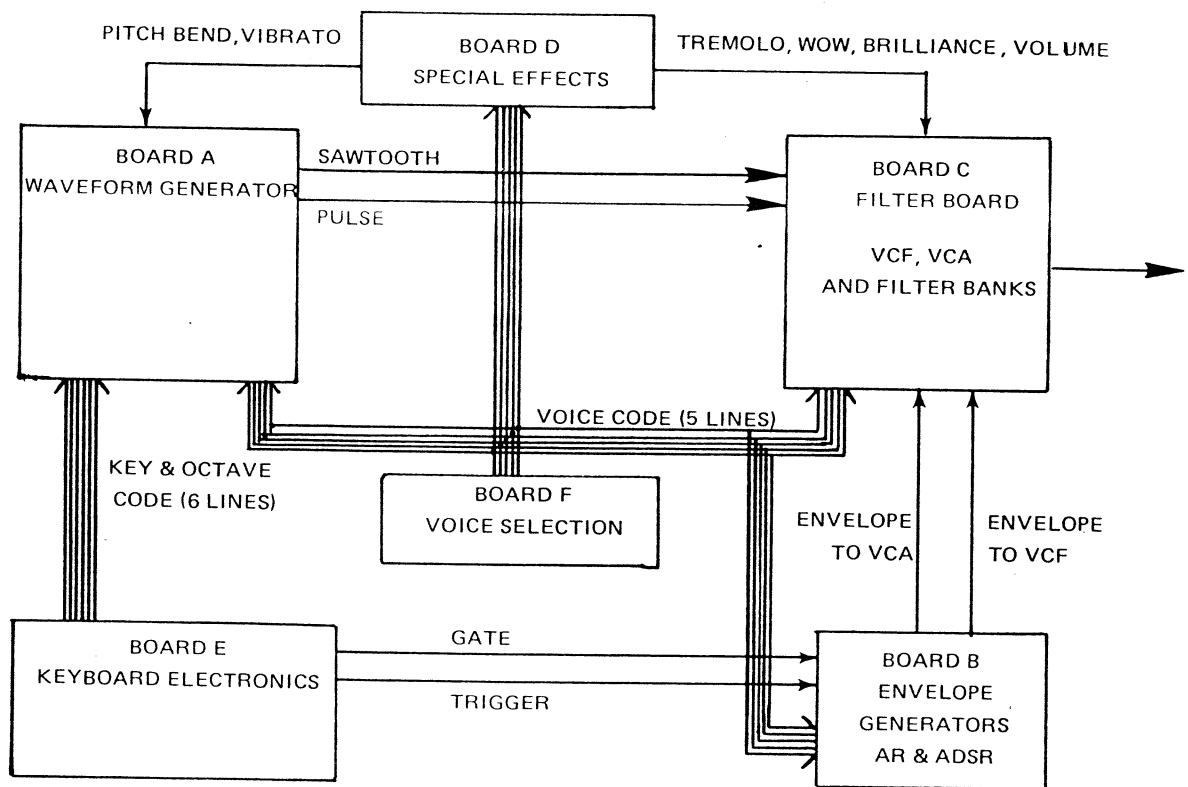
The Pro Soloist is a hybrid of digital and analog circuits. The internal flow of the audio signals is, in most respects, quite similar to any of our other synthesizers. That is, a raw signal (pulse or sawtooth wave) is processed through a voltage controlled filter and a voltage controlled amplifier to the output of the instrument. Two envelope generators (ADSR and AR) are available to control the VCF and VCA to determine the attack and decay characteristics of the instrument. In addition to the voltage controlled filter, there are fixed band pass filters which shape the raw waveforms for particular voices.

In variable synthesizers, such as the ARP Odyssey or the ARP 2600, the signal paths, oscillator waveforms and filter characteristics are adjusted manually. In the Pro Soloist, each of these settings are programmed by a digital memory. (Read Only Memory, or R.O.M.).

Referring to the block diagram, Board A is the

Waveform Generator board. A sawtooth wave and a pulse wave are supplied (at the correct pitch) to Board C, the Filter board. Board C contains the voltage controlled filter (VCF), the voltage controlled amplifier (VCA), and 14 fixed filters. The signal paths through board C are determined by the R.O.M. outputs which select one of several paths through the different filters.

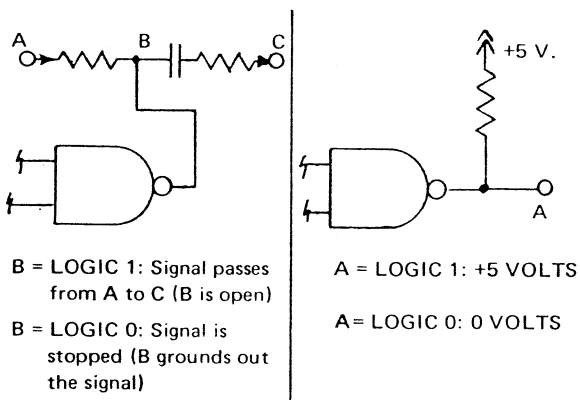
Board B provides the ADSR or AR output to the VCF and/or the VCA (again determined by the R.O.M.s). Board E (keyboard electronics) sends a 6 bit (6 line) code to board A to control the pitch of the oscillator. Board E also supplies the envelope generators on board B with a gate and trigger. Board F, the Voice Selection board, generates a 5 bit code which addresses all of the R.O.M.s (eight total) which in turn program the signal paths and filter settings. The Special Effects board (D) generates the touch sensor effects: vibrato, growl, wow, volume, brilliance and pitch bend.



PRO SOLOIST BLOCK DIAGRAM

3. General Information

The digital circuits in the Pro Soloist employ 'open collector' TTL devices. This means that a logic 1 is an open circuit, and a logic 0 is ground. The voltage level on the output of this type of gate does not necessarily relate to the logic level. Illustrated below are two uses for the open collector type gates which will be found in the Pro Soloist.



It is necessary in some circuits to add (externally) a "pull up" resistor (22K typical) from the +5 volt power supply to the output of an open collector type gate so that the logic level can be identified with a DVM or oscilloscope. Always verify the logic state of these chips in this manner before assuming the device is defective.

4. Trouble Shooting Procedure

INSTRUMENT DEAD: When the Pro Soloist is totally dead, the following should be checked:

1. Power supply: Check the +15 volt, -15 volt and +5 volt outputs. If the power supply (board G) is malfunctioning, remove the power connector from board C and connect the supply to a dummy load while trouble shooting (see the power supply section for dummy load values).
2. VCA: All signals in the Pro Soloist are routed through the VCA; therefore, the output of the VCA should be checked while a key is depressed. If there is no signal, check the output of the VCF. If there is still no signal, check the sawtooth and pulse outputs of board A.

VOICES MISSING, INCORRECT OR DEAD: When some of the voices are correct and some incorrect, the defective circuit common to the incorrect voices must be identified. Proceed as follows:

1. Check the voice code output of board F: This code addresses ALL of the Read Only Memory chips in the Pro Soloist. See the board F circuit description section for the voice code truth table.

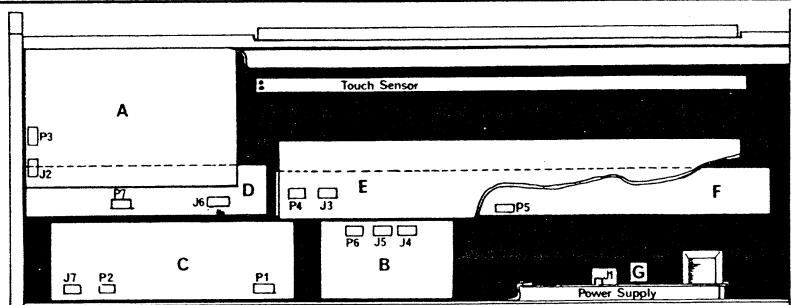
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2. Make a list of *all* the defective voices.
3. Consult the Voice Flow charts in this manual to determine the circuit which is common only to the voices listed above.
4. Consult the schematics, Voice Flow chart test points and the R.O.M. truth tables to determine the code outputs of the R.O.M. which

is in the suspected circuit. *Caution: The R.O.M. is often falsely accused of being defective; the failure rate of the R.O.M.s is actually very low. Example: Oboe, Electric Bass and Electric Piano are dead, Violin and Cello are not correct. Conclusion: defective resonator bank 3, board C; change Z2B.*

5. Tuning and Calibrations

REF.	TRIMMER	TRIM PROCEDURE	BOARD A
R37	VCF TRACK	<ol style="list-style-type: none"> 1. Pin low C on the keyboard. 2. Monitor TP-1 (J2-4) with a digital voltmeter. 3. Adjust trimmer R37 for exactly zero volts. 	
R29	SET 'B'	<ol style="list-style-type: none"> 1. Pin low C on the keyboard. 2. Turn ON the VIOLIN voice switch. 3. Put the vibrato switch DOWN. 4. Adjust trimmer R24 (TUNE) so that the Pro Soloist is tuned to low C on an organ or strobe tuner. 5. Pin the B1 key on the keyboard. 6. Adjust trimmer R29 so that the output of the Pro Solist is tuned to 'B' on the organ or strobe tuner. 	
R49	TOUCH SENSITIVITY	<ol style="list-style-type: none"> 1. Turn ON the TRUMPET and PITCH BEND switches. 2. Put the TOUCH SENSITIVITY slider on the front panel in the MIDPOSITION. 3. Adjust trimmer R49 for the amount of pitch bend desired by the customer on a firm key depression (usually maximum). 	
R24	TUNE	<ol style="list-style-type: none"> 1. This control is used to tune the Pro Soloist to the same frequency as other instruments it is being used with. It is adjustable from the front for the customer. 	
		BOARD C TRIM PROCEDURE	
R20	VCF OFFSET (CALIBRATE)	<ol style="list-style-type: none"> 1. Turn ON the FLUTE voice switch. 2. Put the BRILLIANCE slider on the front panel MIDPOSITION. 3. Adjust R20 for the best flute sound possible. 	
R45	VCF CONTROL REJECT	<ol style="list-style-type: none"> 1. Turn ON the HARPSICHORD voice switch. 2. Adjust trimmer R45 for minimum 'thump' on key depression (turn amplifier up) 	
R54	VCA CONTROL	<ol style="list-style-type: none"> 1. Adjust trimmer R45 (see above) 2. Turn ON the HARPSICHORD voice switch. 3. Adjust trimmer R54 for minimum 'thump' on key depression (turn amplifier up) 	



2701 BOARD LOCATIONS

CIRCUIT DESCRIPTIONS SECTION 6

6.1 Board A circuit Description

The 4 bit key code from board E is converted to an analog control voltage in the D to A converter. Although the 2 bit octave code is also fed to the D to A converter, it serves as a correction voltage; the octave control over the voltage controlled oscillator is in the Frequency to Voltage converter circuit. The output of the D to A converter is +5 volts when any C key is depressed. When any C# key is depressed, the D to A output increases to about +5.3 volts. The highest voltage produced by the D to A converter is +9 volts when any B key is depressed. Trimmer R29 (set 'B' trimmer) sets the interval between each key and is equivalent to the volts per octave trimmers in the standard ARP synthesizers except that it only affects the interval between C and B on the keyboard rather than from low C to high C.

The voltage from the D to A converter is fed through a differential amplifier to the voltage controlled oscillator circuitry. Here the control voltage (now -1 V/OCT) is supplied to a linear voltage to exponential current converter (Q3 and Q4). Q4 determines the charging time on capacitor C7. C7 and Q5 are a uni-junction oscillator operating at about seven or eight octaves higher than the pitch that is heard on the output of the Pro Soloist. Q6 makes the sawtooth from Q5 compatible with TTL circuitry and supplies it to the frequency to voltage converter. Z3 and half of Z1 are divide by two chips which are enabled by the two bit octave code from board E. Depending in which octave a key is being depressed, none, one, two or three of these dividers are enabled to supply Z22 (one shot) with a pulse wave which is either at the same frequency as the oscillator, or one, two or three octaves lower. Since the pulse width on the output of the one shot is constant, the repetition rate (frequency) of the pulses is integrated to provide an offset voltage to the differential amplifier thus providing the octave control over the oscillator (4 octaves). The output of the differential amplifier will have a large AC component which is filtered by C4 and C5 to yield a DC control voltage (-1V/OCT) on J2-4.

The output of the voltage controlled oscillator is also supplied to the Programmable Octave Dividers. Depending on the voice selected, R.O.M. Z15 will instruct half of Z1 and Z8 to either send the signal through the circuit, or divide it either once, twice or three times (down 1, 2 or 3 octaves). The manual octave dividers divide the signal even lower, depending on the position of the Transpose switch. The signal then enters the Six Stage Frequency divider circuit whose output is processed in the Sawtooth Sum circuit. Each of the divisions is weighted and summed to produce a +10 volt sawtooth made of 64 small steps.

The Pulse Generator circuit monitors the outputs of the six stage dividers to develop the following pulse widths: 1/14, 1/9, 1/64 and 2/11. Additionally, the Dynamic Pulse Converter circuit develops a variable (dynamic) width pulse wave. All of the pulse waves are supplied to the Pulse Selection circuit where one is selected by R.O.M. Z15 and routed to the pulse output.

6.2 Board B Circuit Description

Board B is the Envelope Generator Board. Z1, Z2 and Z3 (R.O.M.s) program the attack time, decay time, sustain level, and release time of the ADSR envelope generator and the attack and release times of the AR envelope generator.

ADSR: The output of the attack R-S flip flop (Z4 pin 3) changes from logic 1 to logic 0 when a gate and trigger are supplied from the keyboard electronics (board E) on J4-6 and J4-7. Z5 pin 3 provides a logic 1 which allows R64 to charge the integrating capacitor, C3. Q4 and Q5 follow the voltage and supply it to the switching circuitry to be routed to either the VCF and/or the VCA.

Q6 is a "peak detector" comparator. When the ADSR output reaches the maximum voltage (about +5 volts) Q6 resets the R-S flip flop output (Z4 pin 3) to logic 1. The voltage on C3 then discharges through CR16, CR17 or CR18 to the voltage level on the junction of R30, R31 and R32 (sustain level). When the gate on J4-6 is no longer present (all keys up) the remaining voltage on C3 discharges through CR20 and pins 3, 4 or 5 of Z1 to zero.

AR: The gate voltage is supplied to the AR circuit from Z5 pin 8 to charge capacitor C2 through CR2, CR3 or CR4. When all keys are released, the voltage on C4 discharges through CR5 or CR6 back to pin 8 of Z5.

R.O.M. Z3 selects which envelope (ADSR and/or AR) is to be routed to P6-16, the VCA control input. Z3 also selects which envelope is to be supplied to Z6. R1, R2, R3 and R4 attenuate the envelope before it is processed through Z6. Z6 sums and inverts the ADSR or AR envelope, the growl signal from board D and the touch brilliance voltage from board D. The envelope must be inverted because the VCF accepts negative going control voltages. The output of Z6 is connected to the control input of the filter via the brilliance slider on board A.

Q7, Q8 and Z4 pins 9, 10 and 11 are the squelch circuit which provides a momentary pulse to the VCA

control input to turn it off to prevent transients from being heard when a voice switch is turned on.

6.3 Board C Circuit Description

Board C contains a voltage controlled filter (VCF), a voltage controlled amplifier (VCA), four high pass filters (HPF) and ten band pass filters (arranged in one of three banks). R.O.M.s Z6, Z7 and Z8 determine the signal paths through each of these filters and determines the settings for the VCF.

The sawtooth waveform supplied from board A is processed through the Sawtooth/Pulse Mixer and is routed through one or more of the High Pass Filters. The output of the HPF is routed through the VCF and the VCA to the output of the Pro Soloist.

The pulse waveform from the pulse amplifier can take either of two paths: through the Sawtooth/Pulse mixer, or through the resonator banks. Resonator banks 1, 2 and 3 are supplied with the pulse waveform only. R.O.M. Z8 determines which (if any) of the resonators in each bank are enabled. The output of Resonator Bank 1 and 2 may be routed only to the input of the VCA. The output of Resonator Bank 3 may be routed to the input of either the VCF or the VCA (again, determined by R.O.M. Z8).

The VCF Tracking circuit determines whether the VCF will track at one volt per octave, 2 volts per octave, 5 volts per octave, or not at all. The Resonance circuit determines the amount of feedback from the VCF output to the VCF input for 'wow' effects.

6.4 Board D Circuit Description

Board D provides the touch sensor effects: Vibrato, Pitch Bend, Wow, Repeat, Growl, and Brilliance.

Z3 is a low frequency oscillator producing a triangle wave for vibrato and tremolo, and a square wave for repeat triggers.

Z4 and Z5 are a voltage controlled amplifier exclusively for the vibrato signal. Q3, Q4 and Q5 delay the Vibrato VCA from turning on for certain voices (such as violin) producing a delayed vibrato. All 'upper' voices have delayed vibrato (if used at all); lower voices have undelayed vibrato. Z4D and Z4E switch the output of the Vibrato VCA to either P7-11 for vibrato or P7-16 for tremolo. Vibrato and tremolo are never on at the same time. Tremolo affects the VCF on board C; vibrato affects the pitch of the oscillator on board A.

Z2 B and Z2C are an astable flip flop oscillating at

32 Hz. to produce the growl signal. This signal is gated into a band pass circuit (Z2D and Z2E) through CR8. The growl output is applied to the VCF control input through Z6 on board B.

6.5 Board E Circuit Description

The keyboard electronics generate three signals which are routed to other parts of the instrument:

1. Pitch information (4 bit key code and 2 bit octave code).
2. Gate (+5 volts while a key is down),
3. Trigger (short pulse on each new key depression).

The codes for each key are as follows:

C	0000
C#	0001
D	0010
D#	0011
E	0100
F	0101
F#	0110
G	0111
G#	1000
A	1001
A#	1010
B	1011
Not used	1100
" "	1101
" "	1110
" "	1111
Octave 1	00
Octave 2	01
Octave 3	10
Octave 4	11
(High C only)	

In order to generate these coded outputs, the circuitry on board E is designed to scan the keyboard about 100 times per second. When the scanning circuitry comes to a note which is pressed down by the performer, the number corresponding to that note is loaded into the 6 bit memory at the output and a gate and trigger pulse are generated.

An oscillator (Z2C, Z8D Z8B and C3) produces a square wave at about 150 KHz. The output of the oscillator is fed into a six stage frequency divider (Z4 & Z5). The first four stages of the frequency divider (Z4) are wired to a 'data selector' chip (Z11).

The outputs of the six stage frequency dividers produce a six bit binary word which 'counts' from 00 0000 to 11 111 (0 to 64). The first four divisions

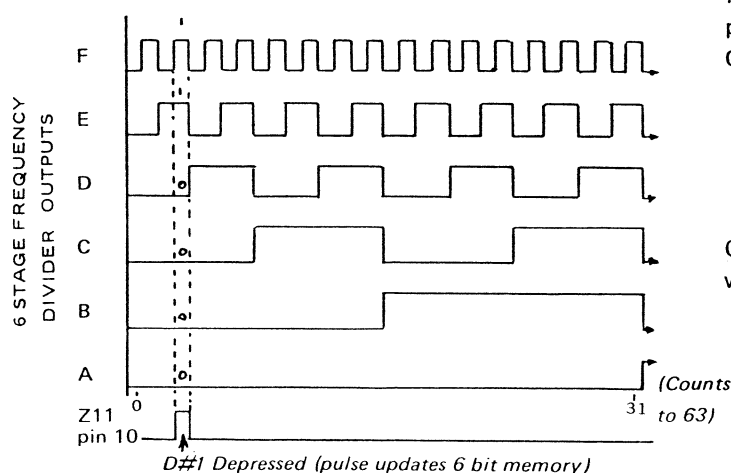
of the frequency divider are connected to the data selector chip which monitors the changing code. The last two divisions (octave information) are decoded so that only one bus rod is enabled at a time (enabled is logic 0).

The inputs of Z11 are wired to the keyboard contacts such that all C's are wired to pin 8, C#s to pin 7 etc. When a key is depressed, one of the outputs of the octave decoder is connected to one of the inputs of the data selector chip. Pin 10 of Z11 will be a logic 1 *only* when the following occurs: 1) A key is depressed (to enable a particular input of Z11), 2) The octave decoder output is enabled (occurs only when the octave code is correct), and 3) The code on pins 11, 13, 14 and 15 matches the enabled input (Example: 'D' input is enabled AND code 0010 is present on the data selector input).

A logic 1 on pin 10 of Z11 indicates that at that instant, the codes on the output of the six stage frequency divider matches the key and octave depressed. The output of Z11 (pin 10) is processed through the strobe gate and the R-S flip flop to update the 6 bit memory by pulsing the clock inputs of the 'D' type flip flops. Thus the outputs of the 6 stage frequency divider are quickly memorized before the number changes.

Since the only time the R-S flip flop changes state is when a key is being depressed, the gate memory circuit monitors the output of the R-S flip flop to provide a gate signal (+5 volts) for as long as a key is depressed. The leading edge of the gate signal (Q bar) is differentiated and processed through the one shot circuit to develop a 15msec. delayed trigger pulse whenever a key is depressed.

When one key is being held, additional triggers are obtained from the 6 bit code change detector. The exclusive OR gates provide pulses to the one shot delay circuit only when the key or octave code change (when a different key is depressed).



6.6 Board F-II & F-III Circuit Description

In order to minimize the number of interconnecting wires between the Voice Select board and the rest of the Pro Soloist, the 15 Voice Select switches are encoded into five bit binary words. In this manner, it is possible to send over five wires all of the information necessary to say which of the 15 switches has been depressed. Separate wires are also brought out for the portamento switch. In addition a Voice select squelch line is also brought out which indicates when none of the switches are on.

VOICE CODE TRUTH TABLE					
A = 0	A = 1	B	C	D	E
OFF	OFF	0	0	0	0
Buzz Bassoon	Bassoon	0	0	0	1
Saxophone	English Horn	0	0	1	0
Space Reed	Oboe	0	0	1	1
Telstar	Clarinet	0	1	0	0
Song Whistle	Flute	0	1	0	1
Noze	Tuba	0	1	1	0
Pulsar	Trombone	0	1	1	1
Comic Wow	French Horn	1	0	0	0
Mute Trumpet	Trumpet	1	0	0	1
Steel Guitar	Cello	1	0	1	0
Harpichord	Violin	1	0	1	1
Space Bass	Electric Bass	1	1	0	0
Steel Drum	Electric Piano	1	1	0	1
Country Guitar	Banjo	1	1	1	0
Fuzz Guitar II	Fuzz Guitar I	1	1	1	1

6.7 Board G (Power Supply)

An apparent malfunction of the power supply may be the result of shorts or other problems on other boards in the Pro Soloist. If there is any doubt about the power supply being defective, remove P1 from board C and clip on a set of dummy loads as follows:

- +15V to ground: 270 ohm, 1 Watt
- 15 V to ground: 330 ohm, 1 Watt
- +5 V to ground: 5 ohm, 10 Watt

Observe the following color coding of power supply wires:

- +15V = Red
- 15V = Violet
- + 5 V = Orange
- Ground = Black