Anthony John Ellis

Quality Church Organs

Abbotsford, B.C., Canada Phone 604)859-8265

Yarrow Mennonite Brethren Church

Pipe Organ

SERVICE AND TECHNICAL INFORMATION

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ELLIS ELECTRONICS LIMITED

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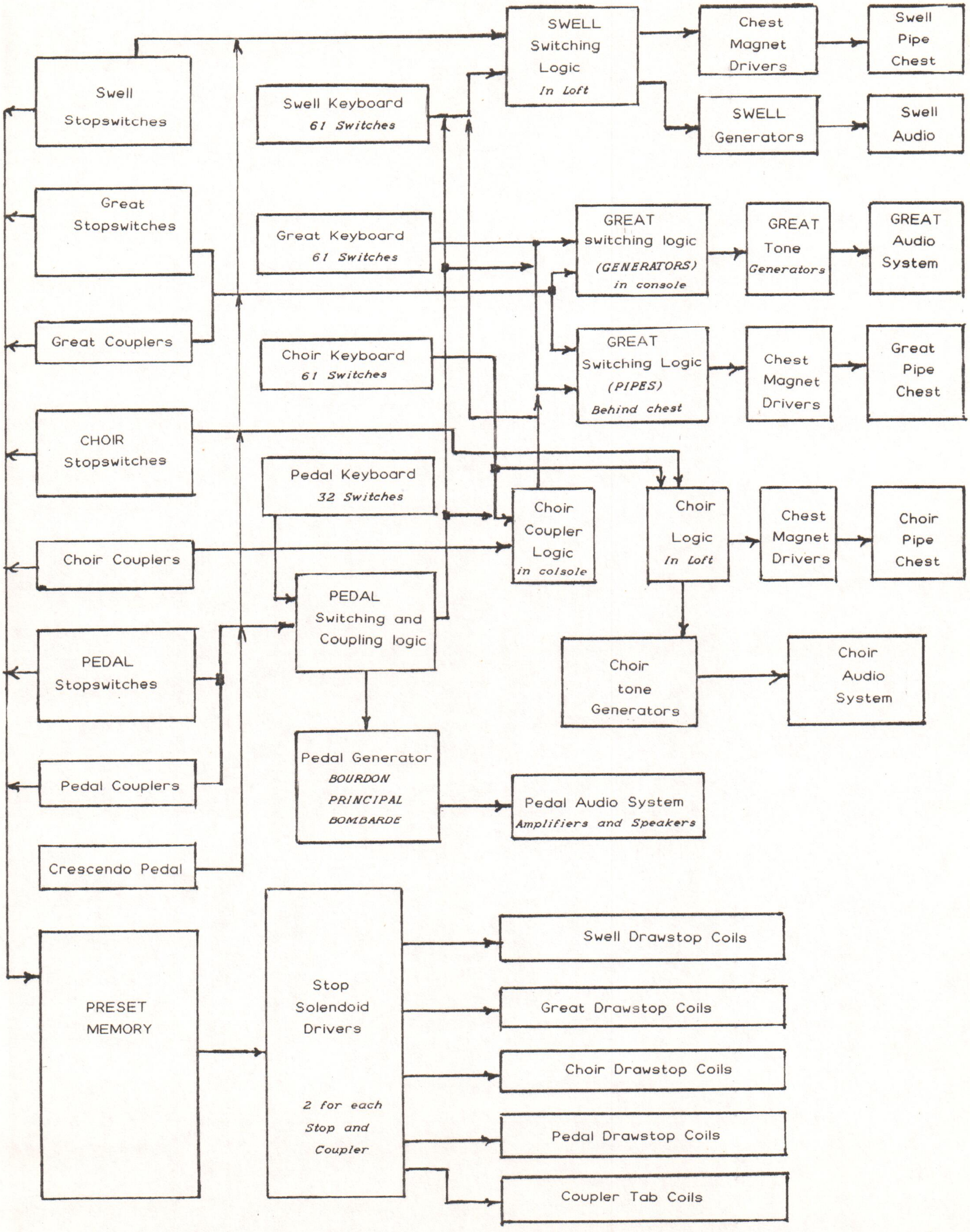
BLOCK DIAGRAM - Yarrow M.B. Church Organ



THEORY OF OPERATION - TTL Switching

The centre of any ELLIS organ system is the data switching network made up of a number of circuit boards containing the data routing equipment using TTL technology.

Switching operation is based on the Two-Input inverted AND (NAND) gate. The condition required to produce a logic 0 at the output is that both inputs be held to logic 1. The board is wired so that one gate receives data from a key and the other receives data from a stop. When both conditions are met, i.e. a key pressed with a stop ON, the appropriate gate output will switch to logic 0. The system is wired common positive, so the output will read -5 volts when ON. Tone generators and pipe drivers are designed to respond to an input of -5 volts.

All gate outputs which are to drive the same generator or pipe are diagonally tied on the face of the circuit board. The switching gates are of the Open Collector type, and only drive in the (-) direction. A resistor on each set of outputs common to a note pulls the line to (+) when no gate is ON (-).

Keyboard outputs are normally (+) when off, switching to (-5) when keys are pressed. Each switching board, therefore has a row of gates at the keyboard inputs for the purpose of inverting the keyboard data so that a key ON will produce the required (+) at the input of the NAND gates. Each key inverter is tied to all gate inputs in vertical line with it. STOP inputs are tied together in horizontal lines on the board. Usually, a transistor inverter / shunt circuit keeps all stop inputs in a common horizontal row in the logic 0 condition when its stop is turned off.

A variation has bee used in several models where the stop inputs of the gates are either left open or tied to the key input gates next to them. Stop control is effected by wiring all VCC (+5 volt) pins of the IC's together and applying the 5 volts via the stop control. No output is possible anywhere in the row unless voltage is provided by turning ON the stop. Switching action is the same in either method.

IT SHOULD BE NOTED that both types of output devices driven by these switching systems contain other voltages considerably higher than the 5 volts used by the TTL components. *APPLYING VOLTAGES HIGHER THAN THE SUPPLY VOLTAGE TO EITHER THE INPUTS OR THE OUTPUTS AS WELL AS THE COMMON POWER SUPPLY WILL BURN OUT TTL DEVICES*. As many as 10 or 12 common gate outputs may be connected to any given output line, so *ACCIDENTAL SHORTING to OTHER SUPPLY VOLTAGES could cause EXTENSIVE DAMAGE*.

BE CAREFUL

UNIT SWITCHING

Unit switching is used in pipe organs in order to make greater use of the available pipes, based on the fact that many stops on the organ are identical except for the pitch of the pipes, usually one being an octave above or below the other. It is possible through some type of switching arrangement to use one set of pipes for as many as three or four such stops. This organ uses the TTL switching system described in this manual to make the necessary switching arrangements. The same method is used with the electronic ranks, as it is possible at some time in the future to replace any electronic rank with a set of pipes. A specification sheet is included in this manual to show which ranks the various stops are derived from.

One additional variation is used in the case of some electronic voices when controled by TTL switching. By pulsing the stop input of any given pitch, a resulting LOWER input voltage appears at the generator. This makes possible two different stops of the SAME pitch. This is used in the Pedal system, with the FAGOTTO 16, which is a softer BOMBARDE, and the GEDECKT 16, a softer BOURDON. The pul   are taken from a higher pitched tone generator at random. Generator square waves result in about half the normal input voltage when used to strobe the stop inupt.

Note that all PIPE stops use electronic notes for the lowest octave in 8' pitches, and in 4' pitch in Great Principal. Swell and Choir flutes also use high octave electronic extensions. These may be located on unused sections of other generator boards. In cases where Celeste board is used, Keying diodes are cabled to other generator boards for correct tuning.

SPECIFICATION

#	SWELL RANKS	TYPE
1	Open Flute	Pipes, Wood
2	Salicional	Pipes, Metal
3	Celeste	Electronic
4	Trompette	Electronic
5	Oboe	Electronic

#	GREAT RANKS	TYPE
6	Principal	Pipes, Metal
7	Gedeckt	Pipes, Wood
8	Mixture	Electronic

#	CHOIR RANKS	TYPE
9	Gedeckt	Pipes, Wood
10	Salicional	Pipes, Metal
11	Flute Celeste	Pipes, Wood
12	Celeste	Electronic
13	Krummhorn	Electronic

#	PEDAL RANKS	TYPE
14	Bourdon	Electronic
15	Principal	Electronic
16	Bombarde	Electronic

SWELL STOPS		Rank
WALDFLOTE	8	1
CELESTE	8	3
HOLTZFLOTE	4	1
NAZARD	2 2/3	1
BLOKFLOTE	2	1
SALICIONAL	8	2
SALICET	4	2
CYMBAL	II	2,1
OBOE	16	5
TRUMPET	8	4
OBOE	8	5
CLARION	4	4

GREAT STOPS		Rank
PRINCIPAL	8	6
OCTAVE	4	6
TWELFTH	2 2/3	6
FIFTEENTH	2	6
GEDECKT	8	7
FLUTE	4	7
MIXTURE	III	8

CHOIR STOPS		Rank
ERZAHLER	8	10
CELESTE	8	12
CELESTE	4	12
ERZAHLER	4	10
DULCET	2	10
"TRUMPET"	8	13
"TRUMPET"	4	13
FLUTE	8	9
FLUTE CELESTE	8	11
GEDECKT	4	9
FLUTE CELESTE	4	11
PICCOLO	2	9

PEDAL STOPS		Rank
CONTRA FAGOTTO	32	16
BOMBARDE	16	16
FAGOTTO	16	16
TRUMPTET	8	16
FLUTE	4	14
PRINCIPAL	32	15
PRINCIPAL	16	15
BOURDON	32	14
BOURDON	16	14
GEDECKT	16	14
OCTAVE	8	15
CHORAL BASS	4	15
MIXTURE		15

TONE GENERATION and KEYING

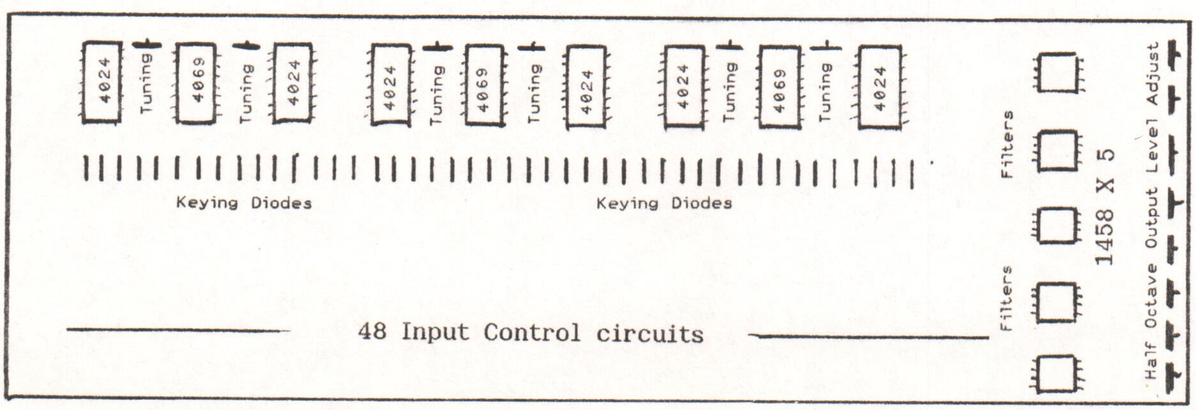
Tone generators are arranged in sets of two circuit boards, one containing notes C to F, the other notes F# to B, up to eight octaves of each. Highest octaves are produced by six CMOS three-gate oscillators on each board. Type 4069 hex inverters provide two oscillators per chip. Common emitter transistor buffers are used if the oscillator outputs are to be played, otherwise the outputs are connected to the clock inputs of six 4024 7-stage dividers which provide all of the lower octaves.

Keying is accomplished through biased diodes. One diode per note is used in some voices and in others a second diode is connected to the next octave higher. Input voltage of about 5 volts from switching logic outputs is processed through resistor-capacitor network in each note input circuit. Outputs are mixed through the 22k resistors half octave groups (6 notes) and connected to filter inputs. Outputs of the filters are mixed through trimmer resistors to mixer/output stage on only ONE of the two boards. Mixer output goes directly to power amplifier.

Two variations will be found on some DIAPASON and REED generators. Extra circuitry to provide the characteristic attack and vaveforms are added to the main circuit boards using a small circuit board for each note. These circuits usuall replace the 22K mixing resistors and connect to their solder points, and also connect acrross the Electrolytic Capacitor of each input.

Separate tremulants are provided for each set of generators, using the other half of the 1455 OP amp used for the mixing amplifier. The tremulant is a phase shift oscillator set at about 6 Hz.. Output is connected either to the supply voltage of the master oscillator chips, or to the bias line which runs along the top of each circuit board, connecting to each oscillator through 1 to 2 meg. resistors. Tremulant stop control simply biases the shunt transistor connected across the negative feedback resistor, stopping oscillation.

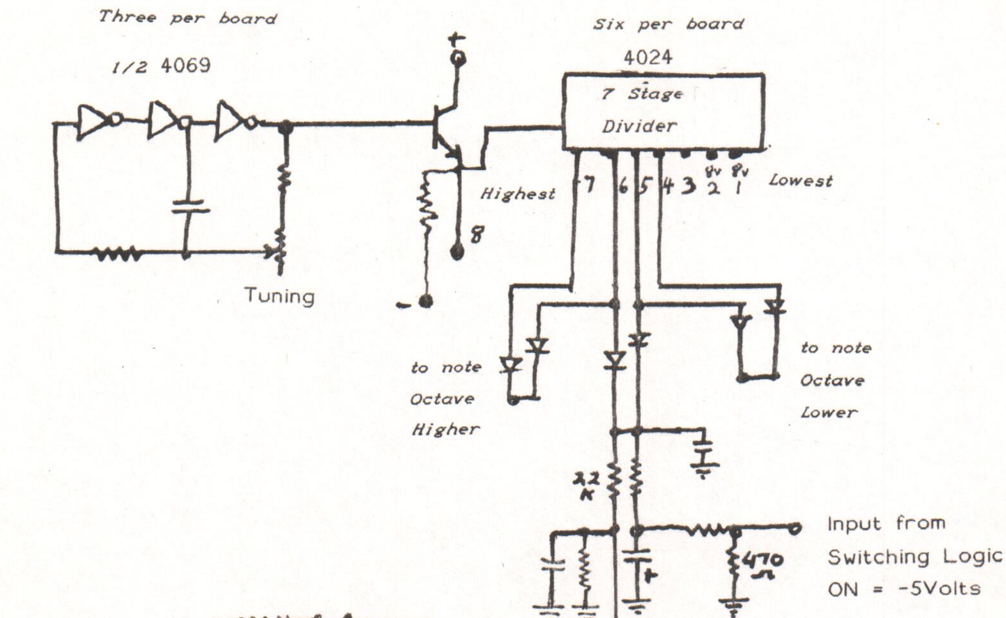
Generator / Keyer Board *ONE of TWO BOARDS PER SET*

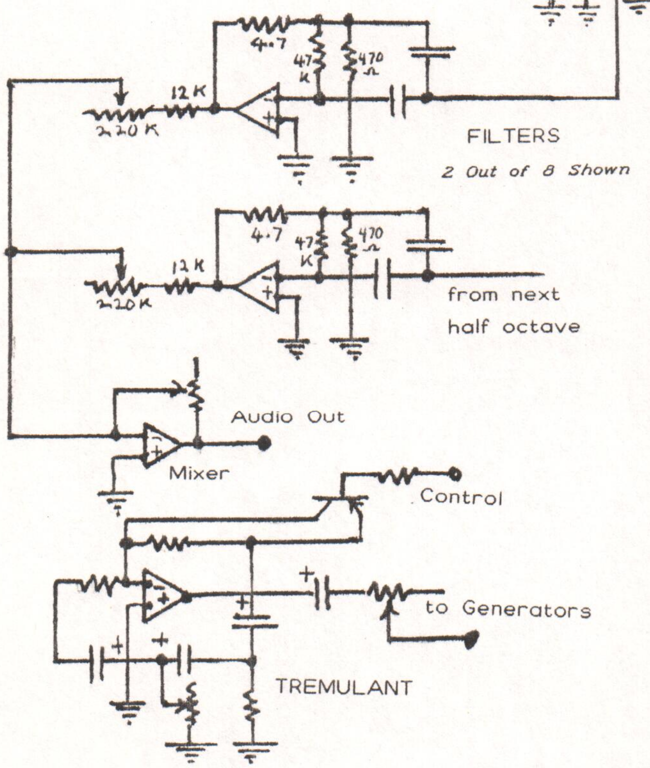


KEYER INPUTS from LOGIC CONTROL - up to 48 per board

POWER SUPPLY and AUDIO CONNECTIONS

TONE GENERATORS and KEYERS - Diapason and String



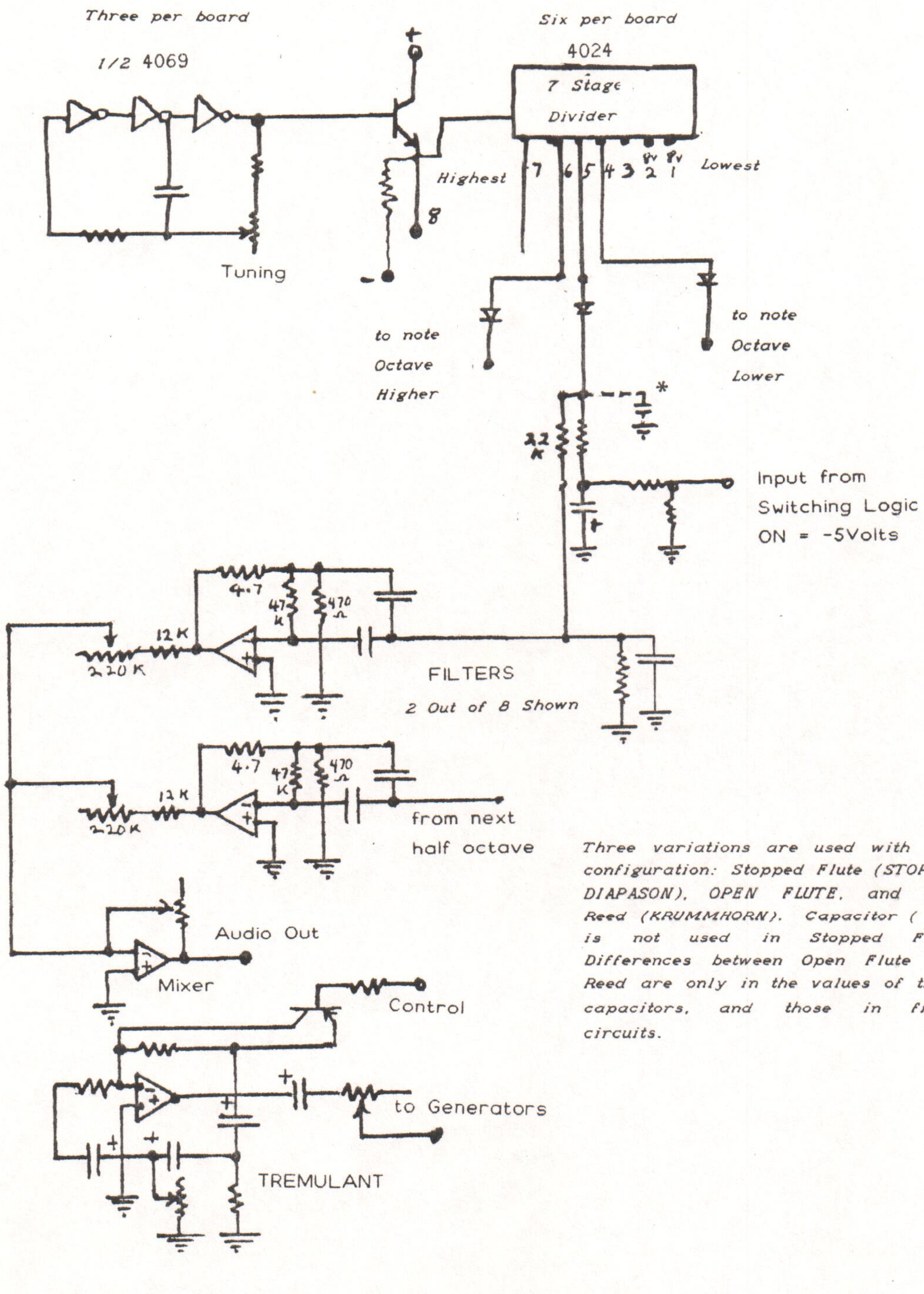


NOISE GATES

Many of the Tone Generator systems in this instrument have been fitted with noise gates on the outputs of the mixing amplifiers. These gates simply consist of a transistor connected across the negative feedback resistor of the output stage at the top right-hand corner of one of the two boards. The transistor is nomally biased to cancel the gain of the amplifier. Keydown voltage is derived from a bank of diodes on one of the concerned logic boards, and wired so that the bias is removed when a key is pressed. Some units may also require the stop be drawn before output is enabled.

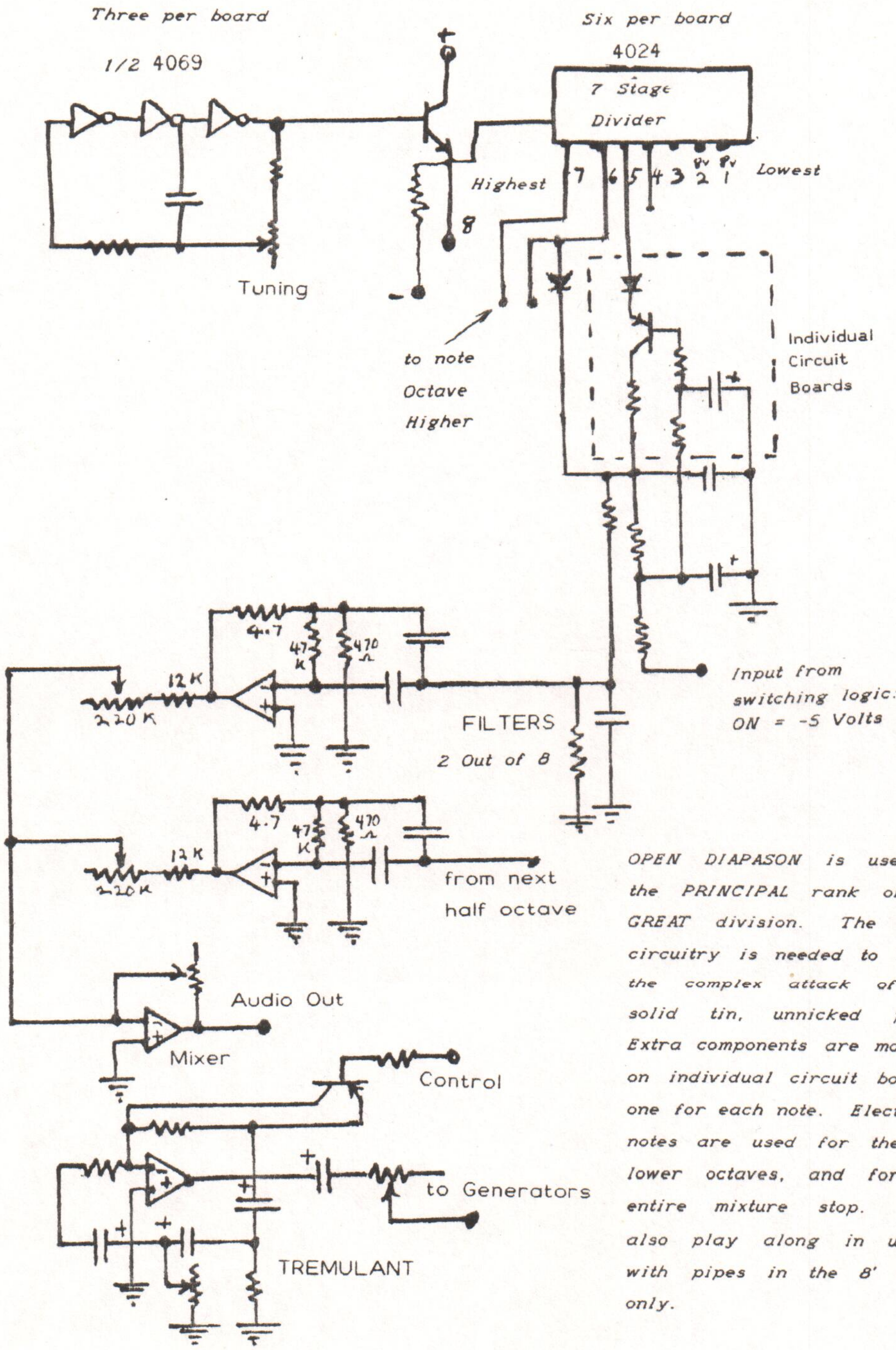
When testing, therefore, remember that the audio system on a generator board will appear dead unless a key is pressed. The transistor may be simply removed during testing, if desired.

TONE GENERATORS and KEYERS - FLUTE / SOLO REED



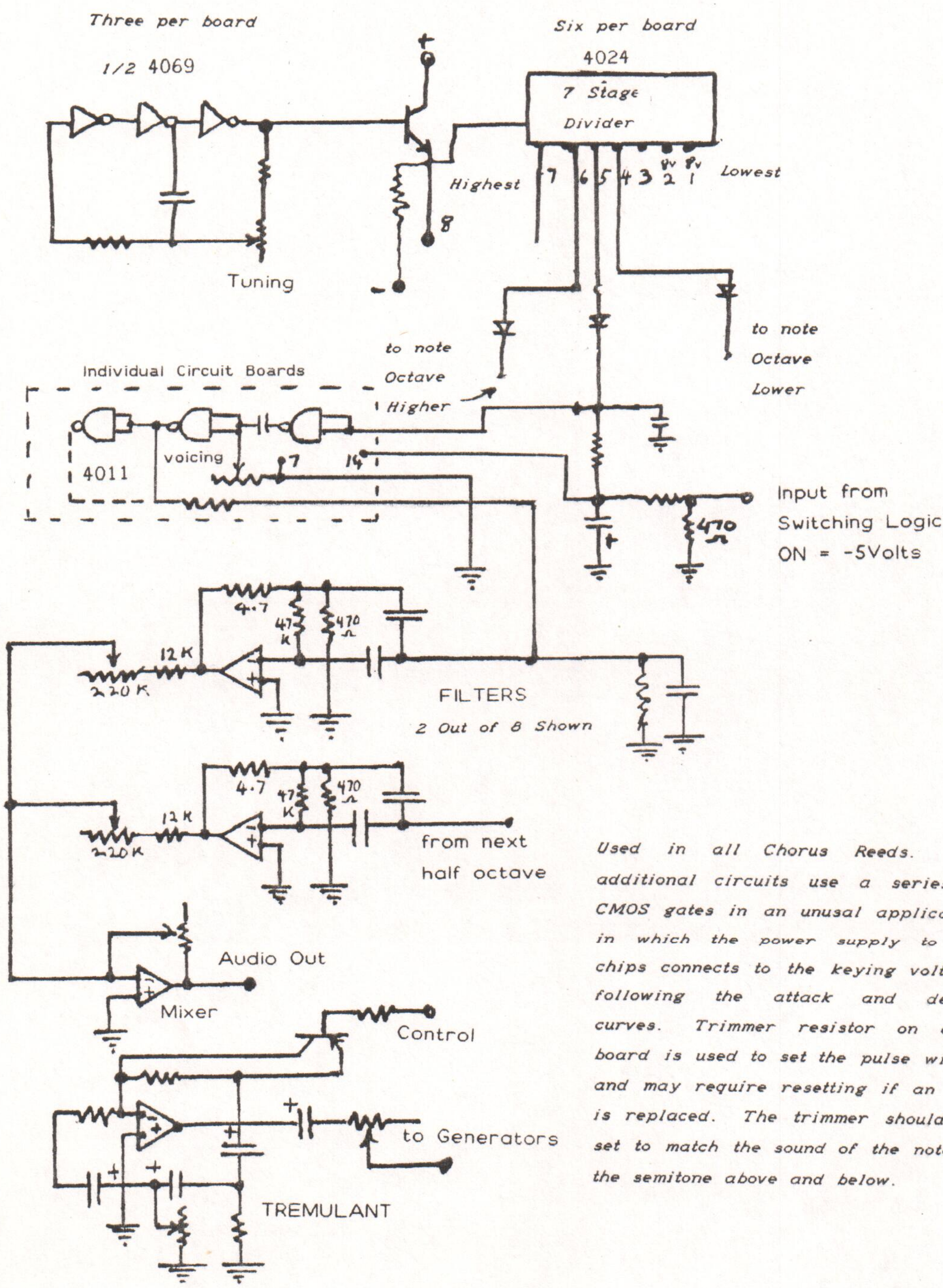
*Three variations are used with this configuration: Stopped Flute (STOPPED DIAPASON), OPEN FLUTE, and Solo Reed (KRUMMHORN). Capacitor (*) is not used in Stopped Flute. Differences between Open Flute and Reed are only in the values of these capacitors, and those in filter circuits.*

TONE GENERATORS and KEYERS - OPEN DIAPASON



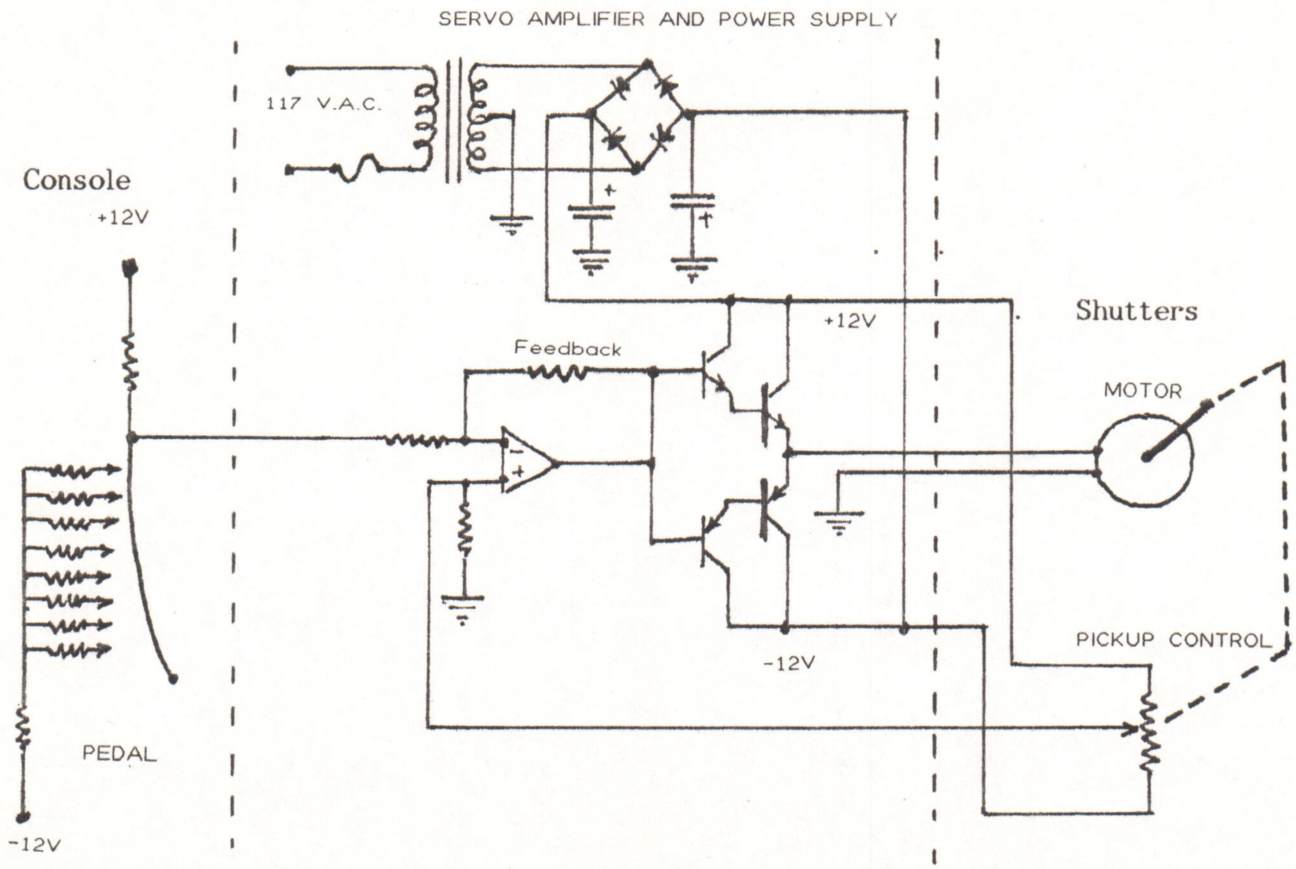
OPEN DIAPASON is used in the PRINCIPAL rank of the GREAT division. The extra circuitry is needed to match the complex attack of the solid tin, unnicked pipes. Extra components are mounted on individual circuit boards, one for each note. Electronic notes are used for the two lower octaves, and for the entire mixture stop. They also play along in unison with pipes in the 8' pitch only.

TONE GENERATORS and KEYERS - CHORUS REED



Used in all Chorus Reeds. The additional circuits use a series of CMOS gates in an unusal application in which the power supply to the chips connects to the keying voltage, following the attack and decay curves. Trimmer resistor on each board is used to set the pulse width, and may require resetting if an I.C. is replaced. The trimmer should be set to match the sound of the note to the semitone above and below.

SWELL and CHOIR SHUTTER CONTROL SYSTEMS



The control systems for the Swell and Choir shutters each consist of three parts: The pedal in the console, the power supply and servo amplifier in the chamber, the servo motor and the position sensing pickup, both coupled to the shutter assembly.

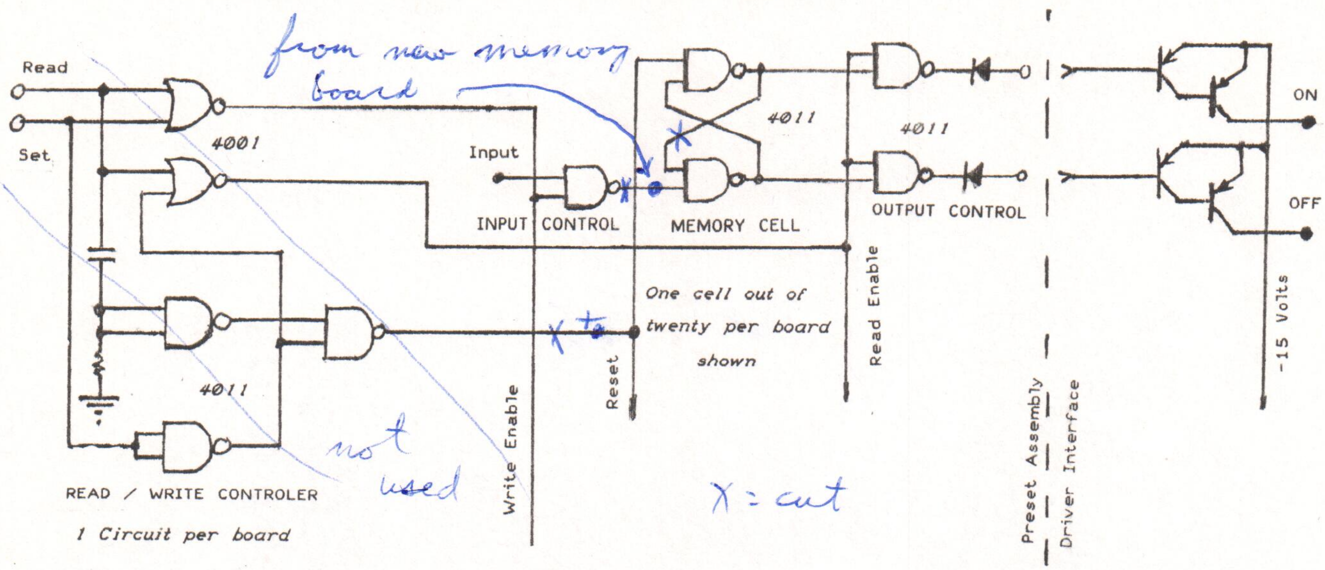
The action works on the principle of a differential amplifier which constantly compares the position of the shutters and the control pedal. When a difference occurs, the amplifier reacts by shifting its output either positive or negative, turning the motor in the appropriate direction until the difference is eliminated, at which point the amplifier output returns to zero and the motor stops. Amplifier gain can be adjusted at the feedback loop. Excess gain will cause overshooting, with resulting oscillation of the shutters, while insufficient gain will not provide enough power to drive the shutters to an equalized position, resulting in the motor stalled with a low voltage applied. This condition could damage motor brushes or over heat driver transistors.

The motor used is simply a common automotive windshield wiper motor, which is designed for much heavier duty than is likely to occur here, and should require little or no attention. Position sensing is accomplished using a slider type potentiometer, which may need cleaning with a good quality control cleaner from time to time. This condition would cause sudden or changes in shutter position, not relative to pedal position. The pedal is a 32-contact progressively liked switch with self cleaning sliding contacts, and should require little attention.

Both Choir and Swell systems are the same, but may vary from the digram in polarity of inputs and motor connections. Either polarity works the same, as long as the overall direction is maintained. Reversing polarity of one device only would result in shutters driven to one extreme and stalling under full power. If any rewiring is done, polarity should be tested for this condition.

One set of old boards retained for solenoid driver interface

PRESET MEMORY SYSTEM



The preset system consists of about 500 individual memory cells made up of cross-connedted 2 input NAND gates with associated input and output controls, also in the form of NAND gates. System is organized into boards containing twenty such cells each, plus one Read/Write control circuit per board. All cells common to a board connect to common write enable, reset, and output enable lines from the read/write control. One board is usually controled by one preset button, and serves up to twenty stops, having one input and two outputs per stop. General presets (those which control all stops on the organ) usually have one button controling several boards. In such cases, the read/write circuit is left out of the extra boards, with the control lines interconnectd.

To write into the memory, also called *Setting* the memory, the user first presses the *SET* or *WRITE* button, then while holding this button, presses the desired Preset button. The SET button is connected to the WRITE input of ALL boards with read/write controlers. This simply disables the read-enable lines and makes the write-enable lines available. When the selected Pre-set button is pressed, no action occurs in the stops because the Read-enable line is held off. With the Set button held, the input enable line is raised, and all of the cells under the control of the button are first reset by a momentary reset pulse on the reset line, then allowed to assume the information from the inputs, which are simply connected to the stop switches. The reset pulse, generated by the capacitor in the read/write circuit is ingnored during READ operations, because the Write-enable line is off.

Reading from the memory is simply a matter of raising the output enable line, which sends data from both legs of the memory cells to the external driver circuits. Two outputs are required per stop because the switches have both ON and OFF solenoids.

Power for the memory circuitry is supplied from an independent source which is not controlled by the main power switch. If power is removed, all data is lost. Data may be retained for a considerable time during power failures with a simple 9 volt alkeline battery, connected through a 4 or 5 volt zener diode so that while normal power is available, no drain is made on the battery. When the supply voltage drops below about 4 volts, the battery then takes over. the CMOS memory cells will retain their data down to about 2.5 volts, at which virtually no current is drawn.

Modification

CAPTURE MEMORY SYSTEM

Parallel input/output system using type 6116 CMOS static RAM chips, each chip having 8 input/output pins reading and writing eight stops, with sufficient number of chips to supply all stops on the organ at the same time, eliminating the need for multiplexing. During read or write operations, all stops are read or driven from memory board whether from full organ presets or individual department presets. All stops are memorized, but in the case of departmentals, only the desired set of stops have power sent to solonoids or coils.

~~The main board has two sets of power driver circuits made up of two or three stage transistor circuits. The first set of drivers supplies power to the individual current amplifiers for each coil. This provides control enabling only the desired group of coils be energized e.g. GREAT, SWELL etc. The second supplies power to the medium "holding voltage" which is delivered to each coil through a diode, supplying enough pull to hold the tab "ON" when pressed manually, but not enough to pull it on from its OFF position. When a preset is called, the holding voltage is removed, allowing all tabs to fall to the OFF position except those which are addressed ON. Also any tabs which were OFF and are called ON will be pulled ON by the much higher voltage deliverd individually through the switching transistors, supplied by the first set of drivers. Stops in other departments will remain unchanged, as their holding voltage will go uninterupted, and no higher ON voltage will be delivered to their drivers. On calling a preset, therefore, the first drivers turn on the higher voltage while the second ones turn off the hold voltage.~~

Not used as this organ has separate on + off coils. See P 12

Data is selected from some two thousand locations by pressing one of forty preset buttons which activate the appropriate address lines. There are eleven lines in all, eight are controled by the preset buttons. Each set of eight buttons is connected, through schmidt trigger buffers, to its own eight to three line encoder chip. The three outputs connect to three 7407 non inverting open collector buffers (six per chip) which are used to wire-and all outputs to the same three lines, as only one division is used at a time. A chip output from each of the five 8 to 3 encoder chips drives its own individual address line, so that each button can call its own set of data. These five address lines also are connected to the hold and driver voltage switchers to limit the output action to the appropriate stop coils through the 7400 gates near the driver circuits. The five lines continue to the 5 diodes next to the 7407 chip which then connect to the 4011 pulse generator, providing a properly timed pulse on the write enable line when enabled by the SET relay, in order to write new data to the memory.

Normally, the first four sets of encoder chips (74148 type) are used for individual department presets and the fifth is used for General presets in which all stops on the organ are affected at once. This is accomplished using the second set of inputs in the two 7400 gates, which are all connected to the address line from the chip output of the General encoder chip. This line also connects to a third 7400 chip which controls a fifth set of set and hold driver circuits which are available for any stops which are not required to be included in any of the Departmentals such as inter manual couplers. Stops driven by these will only be activated when General buttons are pressed, along with all the other stops from the departments.

The WRITE or SET operation works as follows. When the SET button is pressed, energizing the set relay, the Output Enable line from the memory chips is disabled (high) placing the memory outputs go into high impedance state so that tab settings will not be changed when a button is pressed. This line (from the common of the relay contacts) also connects to the second input of the last cmos gate in the 4011 pulse generator, enabling the pulse to be output to the write enable inputs of the memory chips. When an individual button is pressed while the set relay is enrgised, first the appropriate address is set up by the encoder chip involved, after which a short pulse is output from the 4011 chip momentarily enabling the memory write inputs. The memory input/output terminals, now high impedance, contain data from the stop tab contacts, through the isolating resistors near the in/out terminals, and the appropriate levels are retained in the selected memory location. The data from the stop switches is otherwise shunted by the normally active outputs of the memory chips. Note that during the SET cycle, the Holding voltage is still cancelled when the selected button is pressed, but stops whech are on will not drop out due to the self holding effect caused by the switch data appearing at the memory input/output terminals driving the ON coils as they normally would during normal read cycle.

Power supply to memory chips is isolated from the rest of the circuit so that power can be supplied to the memory only while the organ is turned off. With the "CHIP ENABLE" inputs disabled, the memory only draws microamps, and can retain data with as low as 2 volts, so the electrlytic capacitors can support memory retention for hours in the event of a power failure, with a set of small batteries connected through diode as a further backup, able to hold memory for weeks or months.

MEMORY EXPANSION

The main board holds up to eight 6116 chips, each having eight input/outputs which provide for a maximum of 64 stops. If the organ has more than this, an expansion socket is provided for addition of a second board which is connected using a 16 pin DIP jumper cable. All data and power supply lines are included, so the expansion board requires only the memory chip section with input and output sockets.

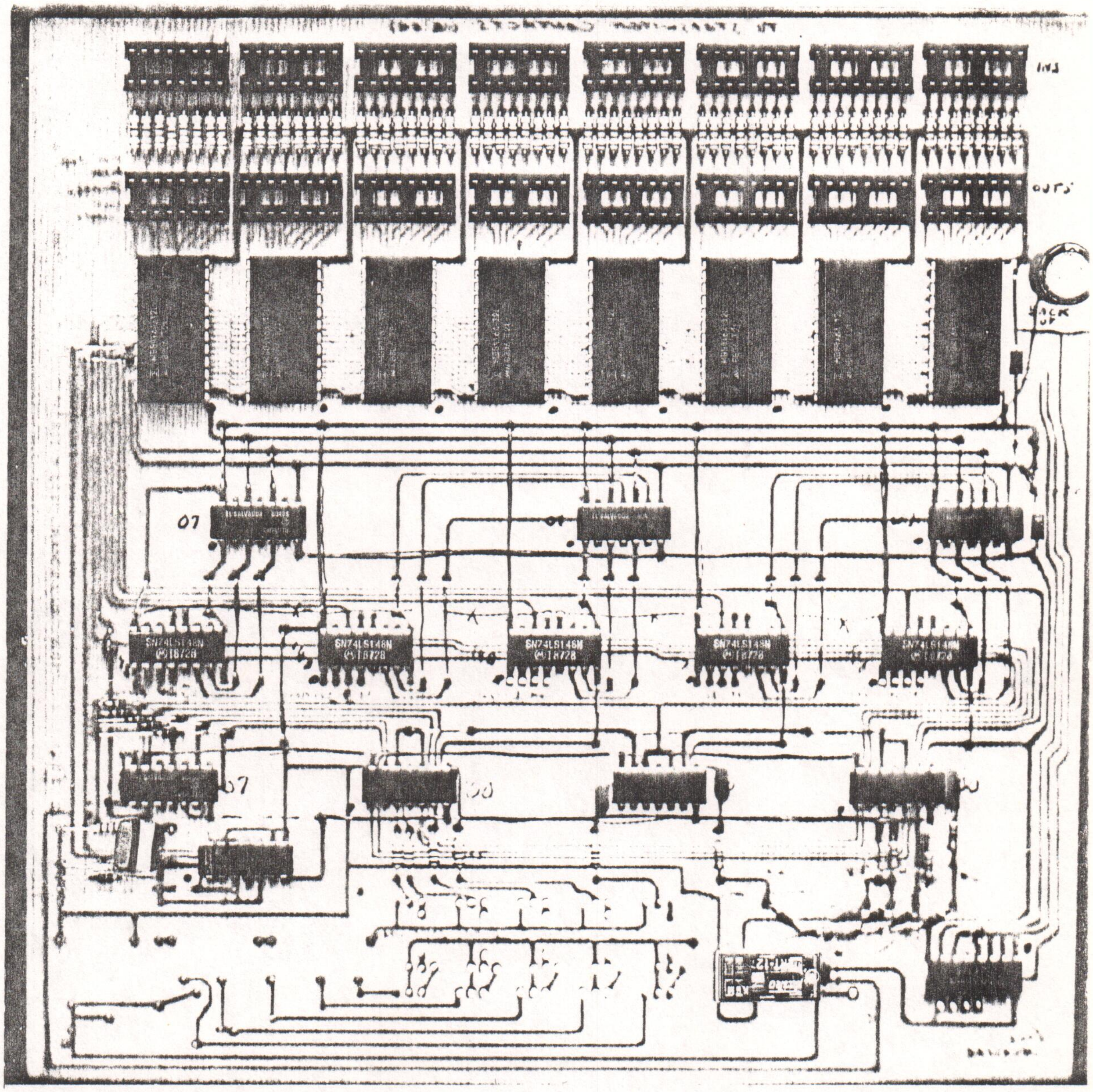
The preset button input and encoding system can handle up to 40 buttons. While this number cannot be increased it is possible to use any unused department inputs to provide more general presets. In such a case, the extra inputs are connecte through diodes to a common line used to energize a small 5 volt relay with SPDT contacts wired in such a way as to interupt the generals data line between the 74148 section and the driver circuit section, leaving the 74148 section of the line open and connecting the driver section of the line to -5 volts. Energizing the relay from any source will then cause all stops to be driven. All stop settings are memorized during write operations whether Generals or Departmental. NA

The system described so far has used eight of the eleven data lines into the memory chips: three button address lines and five division address lines. The three remaining lines are connected to a sixth 74148 encoder providing another eight inputs. These are used to add seven more complete sets of memory if a selector switch is connected, bringing one input at a time to -5 volts.

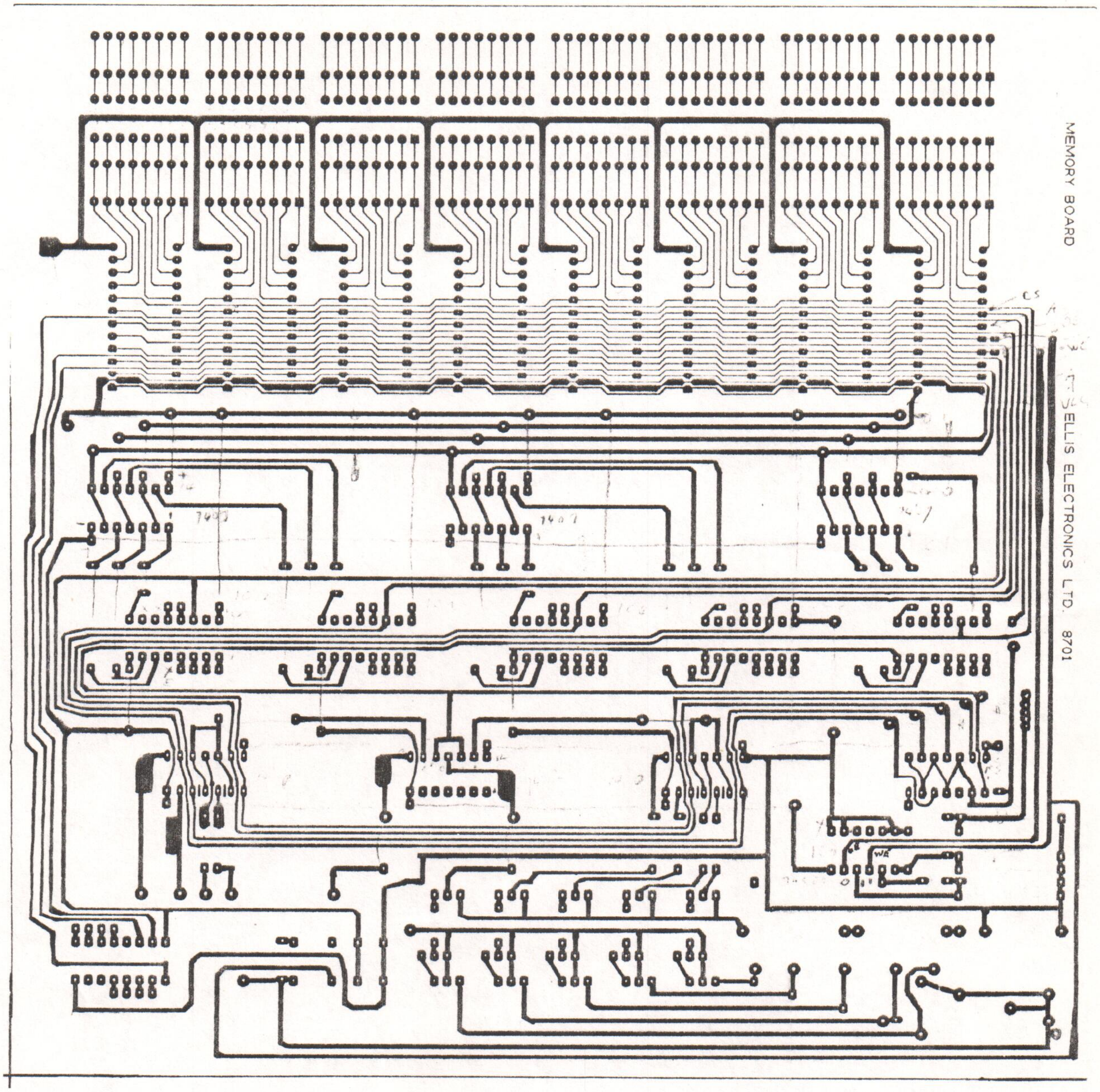
PRESET INPUT PROCESSING

A set of input buffers has been provided to prevent unintentional writing of data to other memory locations caused by intermittent loss of button contact during the Write Pulse, and also to provide a slight hold on the preset action to allow mechanical stabilization of stop movement before power is removed. A capacitor from the switch contact to ground charges when the button is pressed and discharges through the resistor in parallel. This voltage is input to a HCMOS Schmitt Trigger inverter and then through a standard TTL inverter to return correct polarity and provide sufficient current sink for the 74148 inputs. One such ciruit is provided for each button, and is located on a separate board inserted between the keyboard rail and the main Preset board. N.A.

MEMORY CIRCUIT BOARD - COMPONENT SIDE

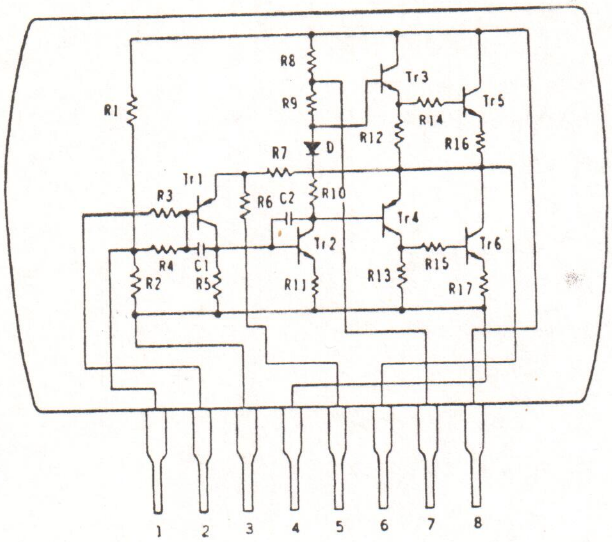


MEMORY CIRCUIT BOARD - FOIL SIDE

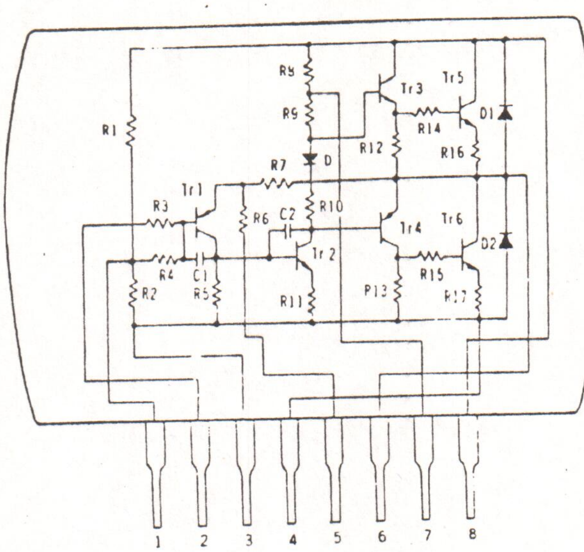


SCHEMATIC

SI-1010G



SI-1020G



TERMINAL ASSIGNMENTS

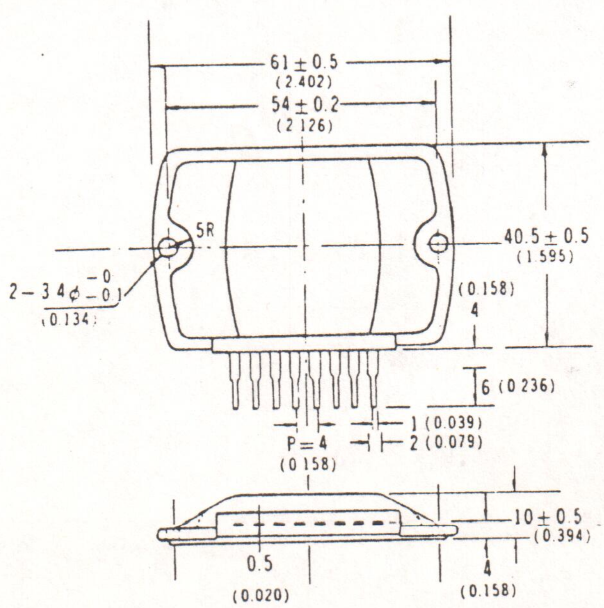
A. With single power supply

1. Ripple filter capacitor (+)
2. Input (+)
3. Input (−)
4. Ground for power supply & ground for output
5. Feedback
6. Output
7. Boot strap capacitor(+)
8. Power supply (+)

B. With split (dual) power supply

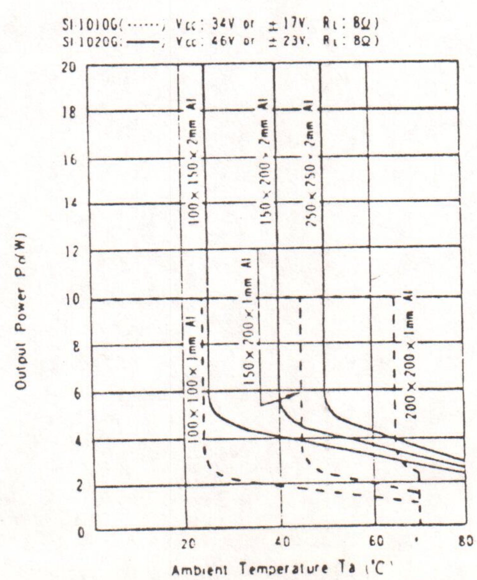
1. Ripple filter capacitor (−)
2. Input (+)
3. Spare
4. Power supply (−)
5. Feedback
6. Output
7. Boot strap capacitor (+)
8. Power supply (+)

OUTLINE DRAWINGS
(SI-1010G & SI-1020G)



in mm (approx. inch)

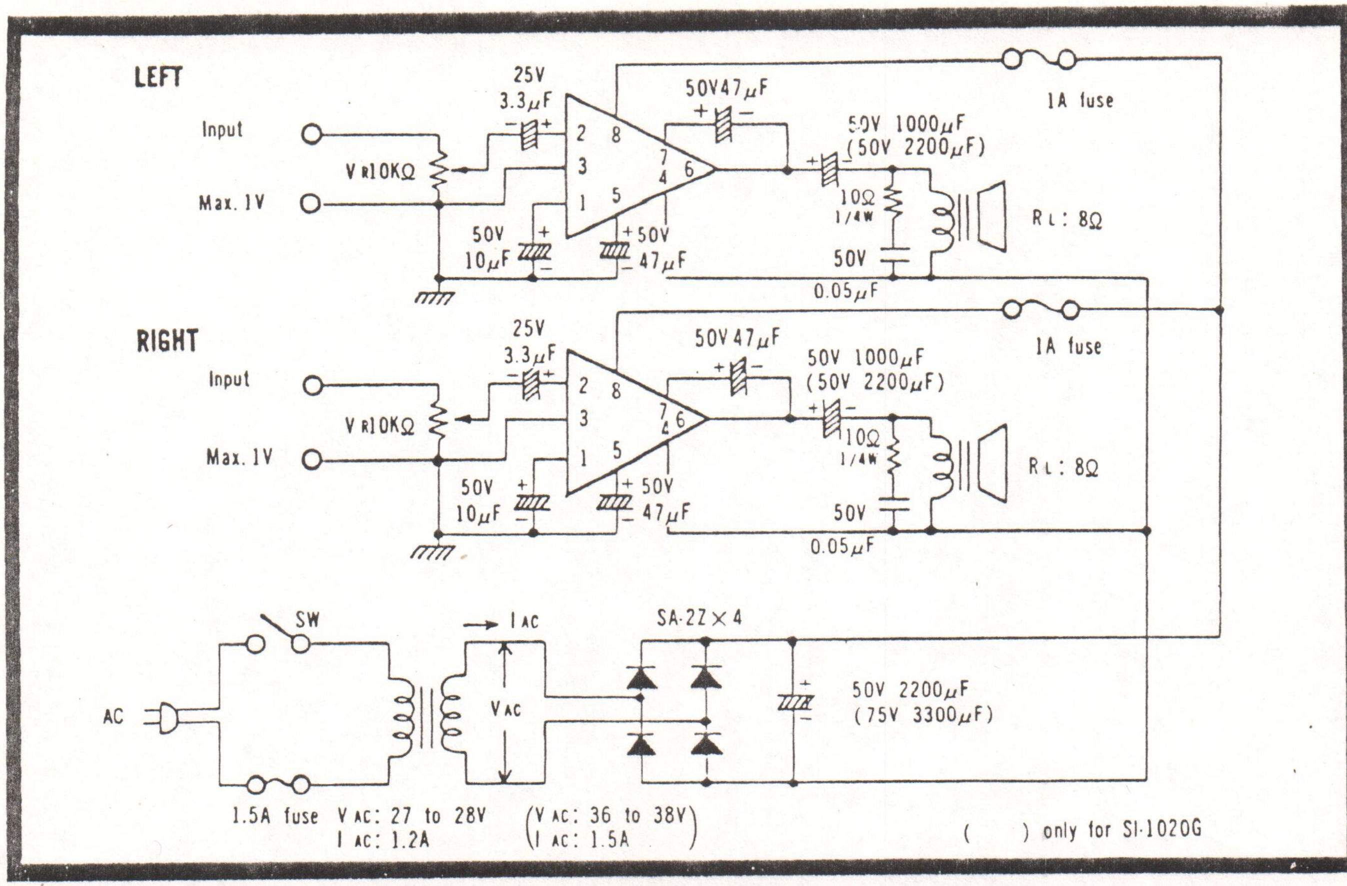
POWER DERATING
(SI-1010G & SI-1020G)



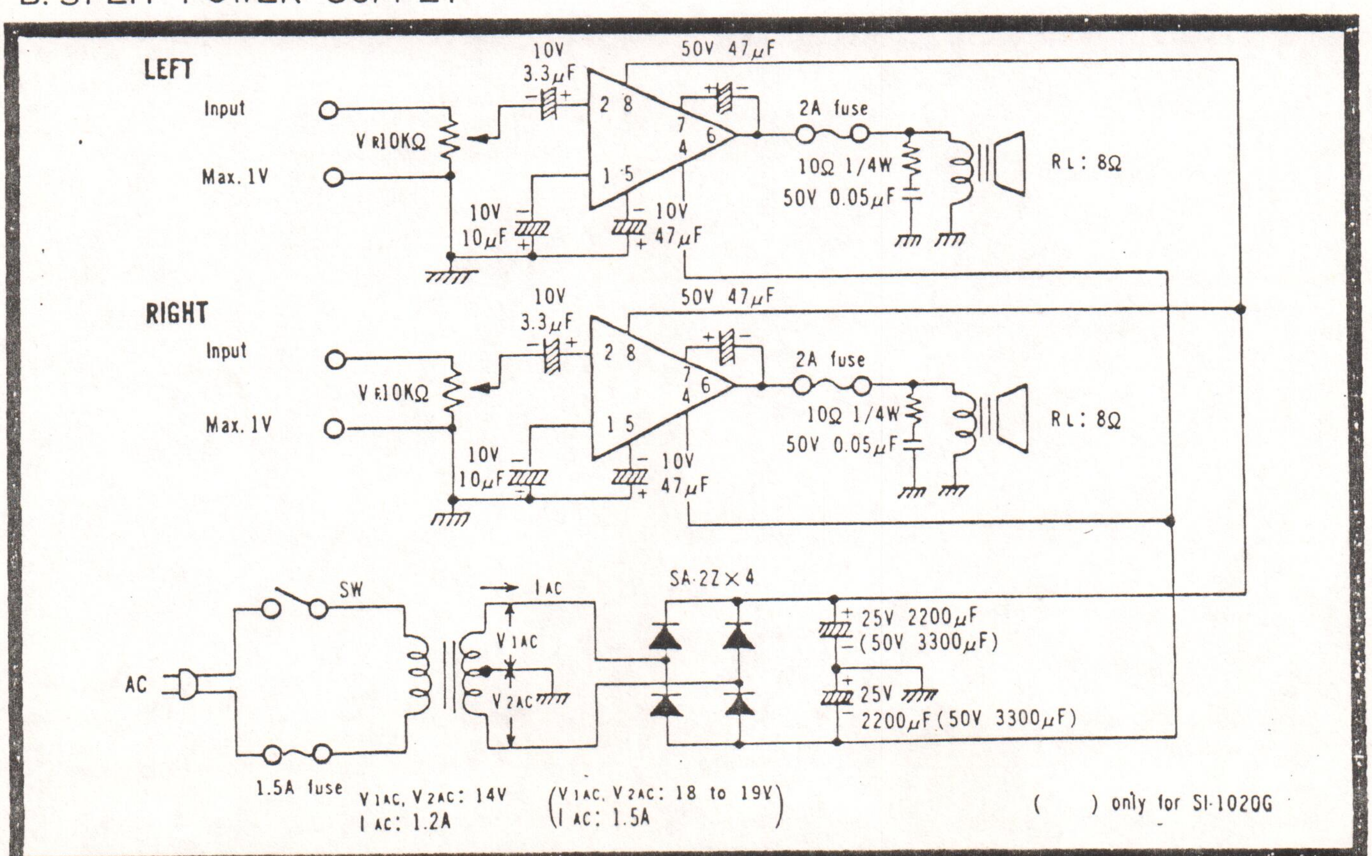
Note: Design heat sink to keep case temperature below 70°C for SI-1010G and below 80°C for SI-1020G

RECOMMENDED CONNECTIONS (SI-1010G & SI-1020G)

A. SINGLE POWER SUPPLY



B. SPLIT POWER SUPPLY

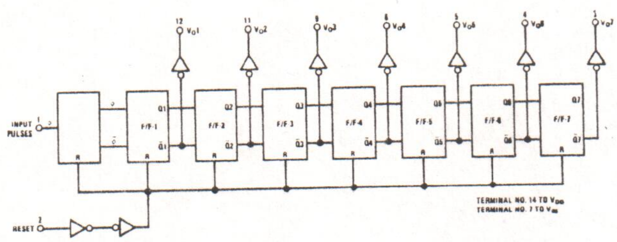


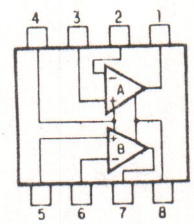
GENERAL INDEX

PINOUTS FOR INTEGRATED CIRCUITS

I.C.s Used in TONE GENERATORS

logic diagram

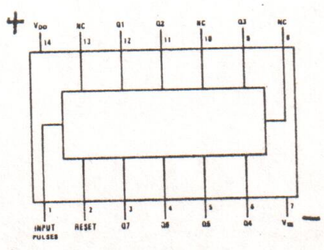




1. Output A
2. Inverting Input A
3. Noninverting Input A
4. V^-
5. Noninverting Input B
6. Inverting Input B
7. Output B
8. V^+

1458 CS

connection diagram



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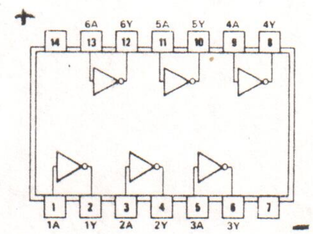
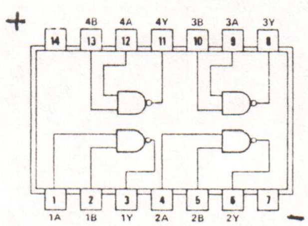


4069

I.C.s Used in TTL SWITCHING



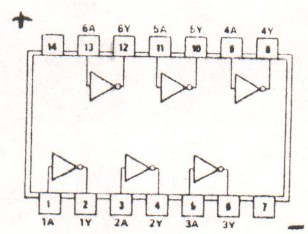
7400

7403

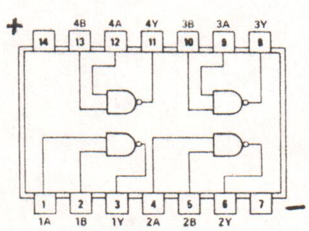
7404

7405

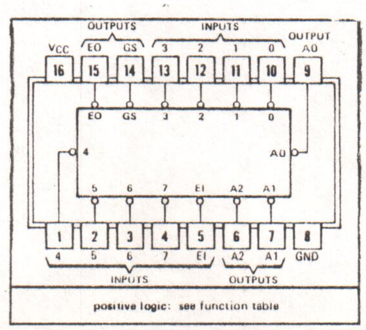
7407



I.C.s used in MEMORY BOARDS



4011



74148

COLOUR CODES

Much of the wiring used in this organ is multi-coloured. It should be understood that the colour codes were used as an aid in assembly only, and therefore do not necessarily represent any particular order or sequence, either musically or electrically. The colours are useful, however, for the purpose of identifying the two ends of individual wires. It may actually be found in many cases that the colours in a cable do follow some sequence, and this can be used as an aid in trouble shooting, as long as it is realized that the sequence may not be consistent.

Two different codes may be found within the system. Wherever possible or practical, the standard EIA code is used, with the number zero being considered the first in a sequence. Where Amphenol telephone type connectors are used in cables the pin numbers will not follow the sequence used at the wired ends of the cable, instead the standard telephone colour code is used, so that the wiring at the connectors will follow the usual sequence for that type of connector. The wires at the equipment ends of the cables will, of course be in sequence with each other.

Both codes are listed below page for reference, but again, use colours only as a guide to tracing.

E.I.A. COLOUR CODE

BLACK	0	BROWN	1	RED	2	ORANGE	3
YELLOW	4	GREEN	5	BLUE	6	VIOLET	7
GREY	8	WHITE	9				

TELEPHONE COLOUR CODE

BE/WE	1	OE/WE	2	GN/WE	3	BN/WE	4	GY/WE	5
BE/RD	6	OE/RD	7	GN/RD	8	BN/RD	9	GY/RD	10
BE/BK	11	OE/BK	12	GN/BK	13	BN/BK	14	GY/BK	15
BE/YW	16	OE/YW	17	GN/YW	18	BN/YW	19	GY/YW	20
BE/VT	21	OE/VT	22	GN/VT	23	BN/VT	24	GY/VT	25
WE/BE	26	WE/OE	27	WE/GN	28	WE/BN	29	WE/GY	30
RD/BE	31	RD/OE	32	RD/GN	33	RD/BN	34	RD/GY	35
BK/BE	36	BK/OE	37	BK/GN	38	BK/BN	39	BK/GY	40
YW/BE	41	YW/OE	42	YW/GN	43	YW/BN	44	YW/GY	45
VT/BE	46	VT/OE	47	VT/GN	48	VT/BN	49	VT/GY	50

MODIFICATIONS AND ADDITIONS

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