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ELLIS ELECTRONICS LIMITED

Information in this manual has been compiled from our engineering data files which were used in the design and manufacture of this instrument. In practice it is possible for variations to occur due to availability of parts, resulting in substitution, mainly of resistors and capacitors of different values. Most of these parts are concerned with time constants, and resistances may be changed along with a corresponding change in capacitance, maintaining the same time factor. No variation in performance is caused in such cases. Values may also have been changed in the course of custom tailoring of voicing, attack or decay characteristics.

A section of empty pages has been included at the back of this manual for the purpose of recording any changes or modifications which may be made in the future, as well as any variations from the information herein which may be noted. Reference should be made in the appropriate pages to the page number where notes have been made.

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TROUBLE DETECTION

Wherever possible, use the console to pinpoint source of dead notes or ciphers. By observing effects of different keys and controls a problem can usually be narrowed down a few possible causes.

Dead note: Try several stops. If note is not dead on all stops, trouble is likely in the generator. If note is dead on all stops, try the transposer. If the note works on other transposer positions, trouble is likely in the particular row of IC's for the affected setting. If the same key remains dead on different settings, trouble is in the keyswitch, cable, or buffer section of transposer board. If the dead note changes to different keys as transposer is moved, trouble is likely in coupler board or between board and generators. Try playing the note through couplers using Sub and Super, as well as from other keyboard if possible. If note plays from other sources then trouble is in IC strip for the unison position on coupler board. If note is dead from other sources as well, then trouble must be in cable or termination between couplers and generators.

If two lines are shorted together between buffer IC's and Switching IC's the effect will be two separate notes being dead unless they are played together. If two adjacent semitones behave this way, the trouble will be on the transposer board. If two notes an octave apart behave this way, the trouble will be on the coupler board.

Ciphers can be traced down in the same manner as above. Ciphers are usually caused by shorts to negative in input circuits, or to positive in internal key lines on coupler or transposer boards. One of these lines disconnected from buffer output will cause all gates on the line to cipher.

Dead notes on generators: If six adjacent semitones are dead, check for a shorted or open collector buss common to one filter. If two sets of six are dead an octave apart, suspect the OP amp chip.

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 been 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

TRANSPOSER SYSTEM

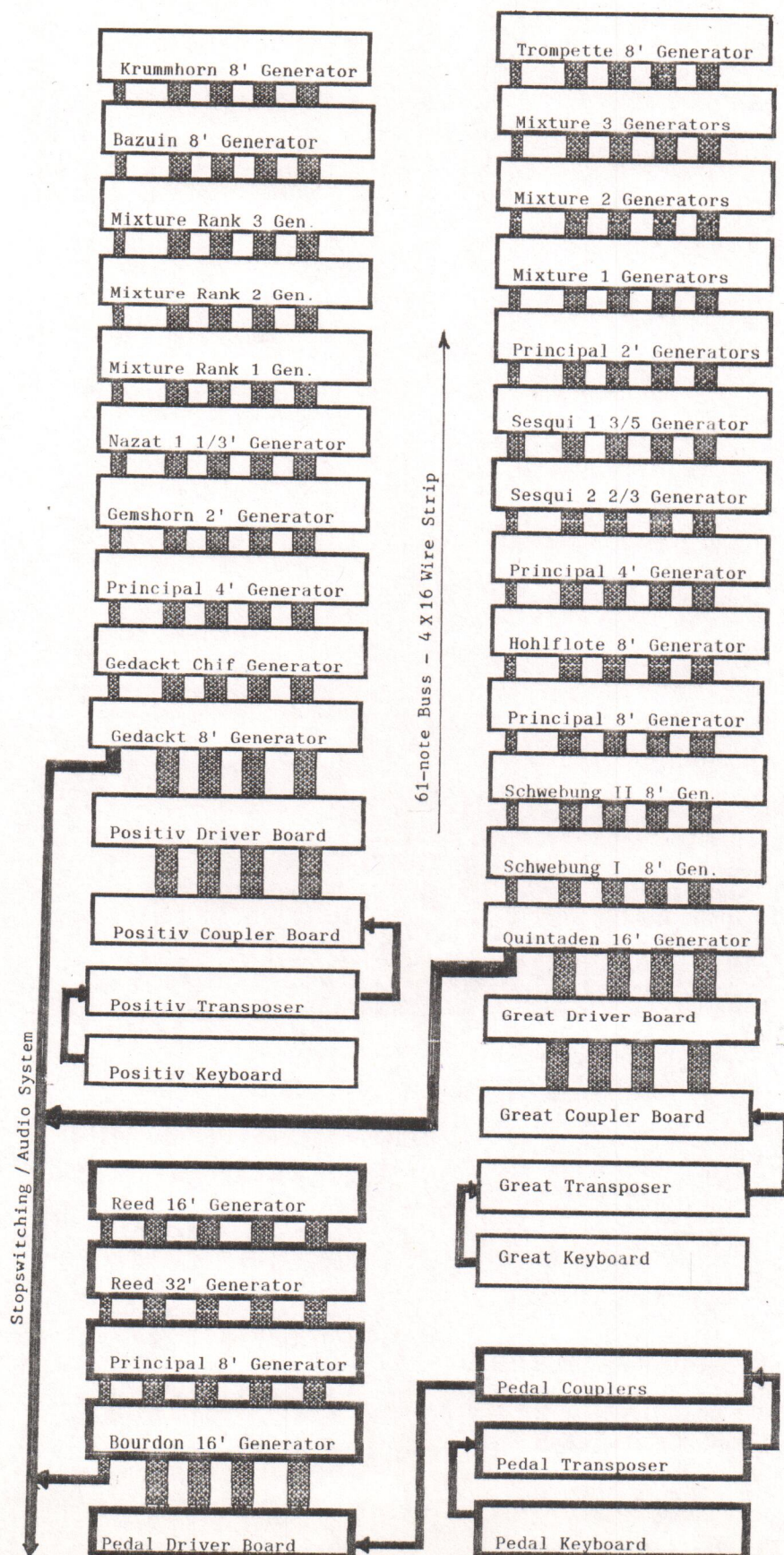
The transposer used in this organ uses a TTL switching system similar to the TTL Unit Switch previously used, but more compact, using Hex Inverters instead of Quad Nand Gates, switching six notes per chip rather than the previous four. Without the second input in each gate, row switching is accomplished by applying the +5 volt supply only to the pitch required. Cross wiring is simple, each row is offset by one chromatic step, allowing change of one semitone per strip. Console control is wired so that only one pitch can be selected at a time, of course. As in the earlier unit switch system, a row of buffer hex inverters at the inputs changes the data from negative on to positive on in order to supply the required negative on condition at the outputs, which are of the open collector configuration, with all outputs of a common pitch tied together with a common pullup resistor. Only an active output will change the condition of the common line, ignoring all other outputs connected.

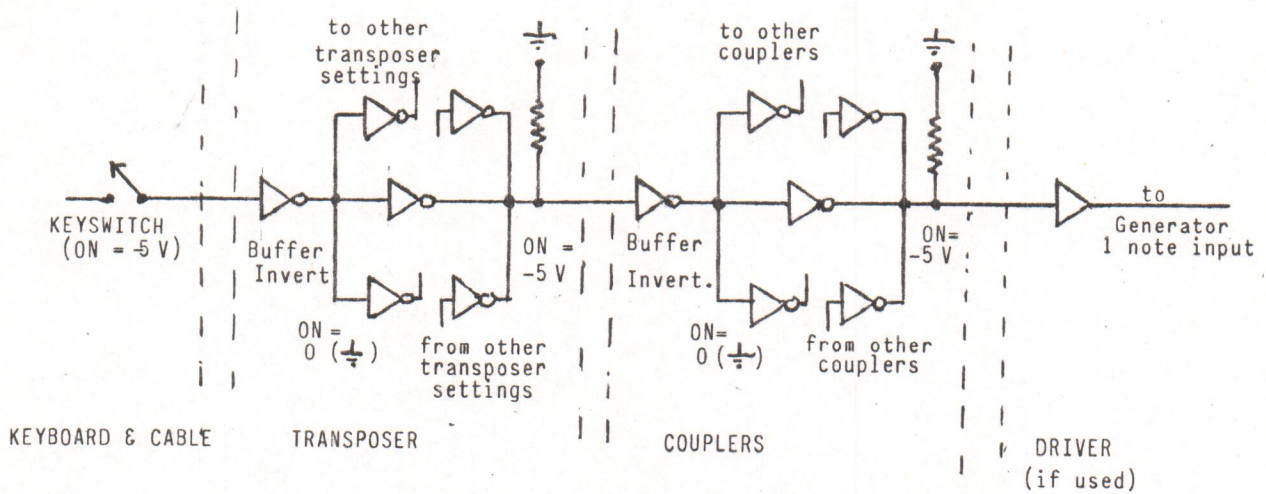
One circuit board is fitted for each keyboard, each board having one buffer row of 7404 inverters, plus a row of 7405 inverters for each pitch, including unison. All VCC terminals from all four boards for each pitch are tied, and serve as control input, with + being pitch ON.

COUPLERS

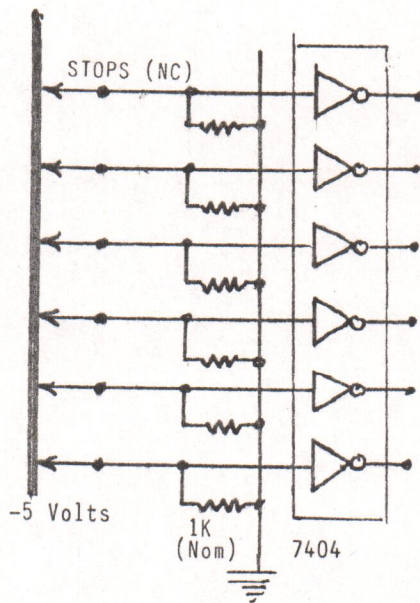
Coupler boards used in this organ are identical to transposers, differing only in the order in which they are connected. Transposer inputs are connected directly to key contacts, and inputs are arranged chromatically, whereas coupler inputs are arranged in ascending octave order, to match tone generators, and to simplify interconnection of outputs from row to row, as adjacent rows usually select adjacent octaves. Re sorting of input order takes place in interconnecting cables between transposers and couplers. Outputs of couplers drive tone generator inputs.

BLOCK DIAGRAM MAIN ORGAN





TYPICAL CONTROL PATH THROUGH ORGAN SYSTEM for ONE KEY to ONE GENERATOR INPUT



TYPICAL STOP CONTROL CIRCUIT Showing
Six stops and one type 7404 Hex Inverter
STOP CONTACTS ARE ALL NORMALLY CLOSED (-5 V)
INVERTERS PROVIDE ALTERNATIVE ON = (-)
OUTPUTS USED BY MOST OF THE SYSTEM.
A +ON output is available directly from
stop contacts, when needed such as TREMULANTS
and UNISON OFF Couplers

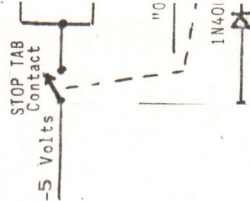
TONE GENERATION AND KEYING

Tone generators are arranged in ranks of 61 notes each, usually of a common voice. Highest octaves are produced by twelve CMOS three-gate oscillators on each board. Type 4069 hex inverters provide two oscillators per chip, the outputs connected to the clock inputs of six 4024 7-stage dividers which provide all of the lower octaves.

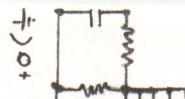
Keying is accomplished through biased diodes. One diode per note is used in most voices except where a second diode is connected to the next octave higher for the purpose of introducing even numbered harmonics into the waveform. Input voltage of about 5 volts from switching logic outputs is processed through resistor-capacitor network in each note input circuit to provide the proper attack and decay characteristics of the note. Outputs are mixed through resistors in half octave groups (6 notes) and connected to filter inputs. Outputs of the filters are mixed through trimmer resistors to mixer/output stage.

Two variations will be found on principal and reed generators. Extra circuitry to provide the more complex attacks and waveforms of these voices is included on special generator boards which are somewhat larger than standard boards.

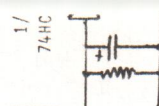
Separate tremulants are provided for most ranks, using the half 1455 chip corresponding to the output amplifier at the opposite end of the board. The tremulant is a phase shift oscillator set at about 6 Hz. Output is connected to the supply voltage line of the master generators, causing a slight fluctuation in pitch at the tremulant frequency. Stop control simply biases the shunt transistor connected across the negative feedback resistor, preventing oscillation.



Only



511



Ellis Electronics Ltd.
Generator & Socket Connections

[illegible]

Edge of Board

View from Component Side

- Edge of Board -

Section A (C-F)

Section B (F#-B)

C1 120 pf

C1 120 pf

R1,R2 Selected for tuning

R1,R2 Selected for tuning

R3	100K	R4	50K
----	------	----	-----

R3	100K	R4	50K
----	------	----	-----

	R3	50K	R5	100K	R4	50K
All master generator integrated circuits				4069 CMOS hex inverter		

All divider integrated circuits 4069 CMOS hex inver

KEYERS/GATES

Section A (C-F)

Section B (F#-B)

R8	10K
----	-----

R8	10K
----	-----

R9 10K

R9 10K

R10 6.8K

R10 6.8K

R11 -

R11 -

R12 -

R12

R12 -

[illegible]

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

ORS	Section A (C-F)	Section B (F#-B)
	C1 120 pf	C1 120 pf
	R1,R2 Selected for tuning	R1,R2 Selected for tuning
	R3 100K R4 10K	R3 100K R4 10K
	All master generator integrated circuits	4069 CMOS hex inverter
	All divider integrated circuits	4024 CMOS seven stage divider

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	1.5K	1.5K	1.5K	1.5K	1.5K	1K	1K	1K	1K	1K
C5	4.7uf	2.2uf	1uf	.47uf	-	4.7uf	2.2uf	1uf	.47uf	-
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	10uf	10uf	4.7uf	2.2uf	1uf	10uf	10uf	47uf	22uf	1uf
	All Diodes type 1N916				All Transistors type 2N3906					

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

POSITIV PRINCIPAL 4'

GENERATORS

ORS	Section A (C-F)	Section B (F#-B)
	C1 120 pf	C1 120 pf
	R1,R2 Selected for tuning	R1,R2 Selected for tuning
	R3 100K R4 50K	R3 100K R4 50K
	All master generator integrated circuits	4069 CMOS hex inverter
	All divider integrated circuits	4024 CMOS seven stage divider

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	1M	R12	1K	R11	1M	R12	1K

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	1K	1K	1K	1K	1K	1K	.68K	.68K	.68K	.68K
C5	2.2uf	1uf	.47uf	.22uf	.1uf	2.2uf	1uf	.47uf	.22uf	.1uf
C6	-	-	-	-	-	-	-	-	-	-
C7	.022uf	.01uf	.0047uf	.0022uf	.0015uf	.01uf	.0068uf	.0033uf	.0022uf	820pf
C8	2.2uf	1uf	.47uf	.22uf	.1uf	2.2uf	1uf	.47uf	.22uf	.1uf

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

POSITIV GEMSHORN 2'

GENERATORS

ORS	Section A (C-F)	Section B (F#-B)
	C1 120 pf	C1 120 pf
	R1,R2 Selected for tuning	R1,R2 Selected for tuning
	R3 47K R4 10K	R3 47K R4 10K
	All master generator integrated circuits	4069 CMOS hex inverter
	All divider integrated circuits	4024 CMOS seven stage divider

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

[illegible]

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

POSITIV MIXTURES - THREE SIMILAR RANKS - Variations in values may occur

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	120 pf			C1	120 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	47K	R4	10K	R3	47K	R4	10K

All master generator integrated circuits 4069 CMOS hex inverter
All divider integrated circuits 4024 CMOS seven stage divider

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	1K	1K	1K	1K	1K	.68K	.68K	.68K	.68K	.68K
C5	1uf	.47uf	.22uf	.1uf	-	1uf	.47uf	.22uf	.1uf	-
C6	-	-	-	-	-	-	-	-	-	-
C7	.01uf	.0047uf	.0022uf	.0015uf	.01uf	.0068uf	.0033uf	.0022uf	820pf	.0068
C8	1uf	.47uf	.22uf	.1uf	-	1uf	.47uf	.22uf	.1uf	-

All Diodes type 1N916 All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS All Integrated Circuits type 1458 Dual Operational Amplifiers

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
	.1uf	.047uf	.022uf	.0068uf	.0033uf	.1uf	.047uf	.022uf	.0068uf	.0033uf
C3	.1uf	.047uf	.022uf	.0068uf	.0033uf	.1uf	.047uf	.022uf	.0068uf	.0033uf
C4	.1uf	.047uf	.022uf	.022uf	.0068uf	.1uf	.047uf	.022uf	.01uf	.0068uf
R5	5k	5K	5K	5K	5K	5K	5K	5K	5K	5K
R6	100K	100K	100K	100K	100K	100K	100K	100K	100K	100K

Ranks tuned at 2' or 1 1/3' pitches, but octaves rewired up or down as required at switching diod

Ranks tuned at 2' or 1 1/3' pitches, but octaves rewired up or down as required at switching diod

Section A (C-F)

	R1 50K	R2 50K	R3 100K	R4 50K
All master generator integrated circuits	4069	CMOS	hex inverter	
All divider integrated circuits	4024	CMOS	seven stage divider	

Section B (F#-B)

```
C1 240 pf
R1,R2 Selected for tuning
R3 100K      R4 50K
```

Section A (C-F)

R8	10K		
R9	10K	R10	6.8K
R11	-	R12	-

Section B (F#-B)

R8	10K		
R9	10K	R10	6.8K
R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	3.3K	1.5K	1.5K	1.5K	1.5K	2.2K	1K	1K	1K	1K
C5	33uf	33uf	22uf	10uf	4.7uf	33uf	33uf	22uf	10uf	4.7uf
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	.047uf	.033uf	.022uf	.015uf	.01uf	.047uf	.033uf	.022uf	.15uf	.01uf
	All Diodes type 1N916				All Transistors type 2N3906					

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

Section A (C-F)

	R1 50K	R2 100K	R3 50K
All master generator integrated circuits	4069 CMOS hex inverter		
All divider integrated circuits	4024 CMOS seven stage divider		

Section A (C-F)

Section B (F#-B)

All Diodes type 1N916 All Transistors type 2N3906

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

Section B (F#-B)

All master generator integrated circuits 4069 CMOS hex inverter
All divider integrated circuits 4024 CMOS seven stage divider

Section B (F#-B)

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	3.3K	1.5K	1.5K	1.5K	1.5K	2.2K	1K	1K	1K	1K
C5	33uf	33uf	22uf	10uf	4.7uf	33uf	33uf	22uf	10uf	4.7uf
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	-	-	-	-	-	-	-	-	-	-
	All Diodes type 1N916			All Transistors type 2N3906						

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

Section A (C-F)

Section B (F#-B)

Section A (A#-A)		Section B (B#-B)	
C1	120 pf	C1	120 pf
R1,R2 Selected for tuning		R1,R2 Selected for tuning	
R3	100K	R3	100K
R4	50K	R4	50K
All master generator integrated circuits		4069 CMOS hex inverter	
All divider integrated circuits		4024 CMOS seven stage divider	

Section A (C-F)

Section B (F#-B)

Section A (F# A)				Section B (F# B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

[illegible]

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

ORS	Section A (C-F)	Section B (F#-B)
	C1 120 pf	C1 120 pf
	R1,R2 Selected for tuning	R1,R2 Selected for tuning
	R3 100K R4 50K	R3 100K R4 50K
	All master generator integrated circuits	4069 CMOS hex inverter
	All divider integrated circuits	4024 CMOS seven stage divider

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	1M	R12	1K	R11	1M	R12	1K

[illegible]

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

ORS	Section A (C-F)	Section B (F#-B)
	C1 120 pf	C1 120 pf
	R1,R2 Selected for tuning	R1,R2 Selected for tuning
	R3 100K R4 50K	R3 100K R4 50K
	All master generator integrated circuits	4069 CMOS hex inverter
	All divider integrated circuits	4024 CMOS seven stage divider

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	8.2K	R9	10K	R10	8.2K
R11	-	R12	-	R11	-	R12	-

[illegible]

All Diodes type 1N916

All Transistors type 2N3906

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

Section A (C-F)

Section B (F#-B)

	100K	100K	50K
All master generator integrated circuits	4069 CMOS hex inverter		
All divider integrated circuits	4024 CMOS seven stage divider		

Section A (C-F)

Section B (F#-B)

All Diodes type 1N916

All Transistors type 2N3906

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

GREAT PRINCIPAL 2'

GENERATORS

Section A (C-F)		Section B (F#-B)	
C1	120 pf	C1	120 pf
R1,R2 Selected for tuning		R1,R2 Selected for tuning	
R3	47K	R3	47K
R4	10K	R4	10K

	NO	10K	NO	10K	NO	10K	NO	10K
All master generator integrated circuits	4069	CMOS	hex	inverter				

All divider integrated circuits 4024 CMOS seven stage divider

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	1M	R12	1K	R11	1M	R12	1K

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	1K	1K	1K	1K	1K	.68K	.68K	.68K	.68K	.68K
C5	1uf	.47uf	.22uf	.1uf	-	1uf	.47uf	.22uf	.1uf	-
C6	-	-	-	-	-	-	-	-	-	-
C7	.01uf	.0047uf	.0022uf	.0015uf	.01uf	.0068uf	.0033uf	.0022uf	820pf	.0068
C8	1uf	.47uf	.22uf	.1uf	-	1uf	.47uf	.22uf	.1uf	-

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

[illegible]

GREAT MIXTURES - FIVE SIMILAR RANKS - Variations in values may occur

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	120 pf			C1	120 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	47K	R4	10K	R3	47K	R4	10K
All master generator integrated circuits				4069 CMOS hex inverter			
All divider integrated circuits				4024 CMOS seven stage divider			

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	1K	1K	1K	1K	1K	.68K	.68K	.68K	.68K	.68K
C5	1uf	.47uf	.22uf	.1uf	-	1uf	.47uf	.22uf	.1uf	-
C6	-	-	-	-	-	-	-	-	-	-
C7	.01uf	.0047uf	.0022uf	.0015uf	.01uf	.0068uf	.0033uf	.0022uf	820pf	.0068
C8	-	-	-	-	-	-	-	-	-	-

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
C1	.1uf	.047uf	.022uf	.0068uf	.0033uf	.1uf	.047uf	.022uf	.0068uf	.0033uf
C2	.1uf	.047uf	.022uf	.0068uf	.0033uf	.1uf	.047uf	.022uf	.0068uf	.0033uf
C4	.1uf	.047uf	.022uf	.022uf	.0068uf	.1uf	.047uf	.022uf	.01uf	.0068uf
R5	5k	5K	5K	5K	5K	5K	5K	5K	5K	5K
R6	100K	100K	100K	100K	100K	100K	100K	100K	100K	100K

SESQUIATLERA - Two similar non-breaking ranks at 2 2/3' and 1 3/5'

MIXTURE and CYMBAL - Taken from three ranks, Octaves adjusted up or down as required at switching diodes

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	240 pf			C1	240 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	100K	R4	50K	R3	100K	R4	50K
All master generator integrated circuits				4069 CMOS hex inverter			
All divider integrated circuits				4024 CMOS seven stage divider			

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	8.2K	R9	10K	R10	8.2K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div
R7	3.3K	1.5K	1.5K	-	-	2.2K	1K	1K	-	-
C5	33uf	33uf	22uf	-	-	33uf	33uf	22uf	-	-
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	-	-	-	-	-	-	-	-	-	-

All Diodes type 1N916

All Transistors type 2N3906

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div
C2	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
C3	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
C4	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
R5	5k	5K	5K	-	-	5K	5K	5K	-	-
R6	100K	100K	100K	-	-	100K	100K	100K	-	-

PEDAL PRINCIPAL 8'

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	120 pf			C1	120 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	220K	R4	50K	R3	220K	R4	50K
All master generator integrated circuits				4069 CMOS hex inverter			
All divider integrated circuits				4024 CMOS seven stage divider			

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.2K	R9	10K	R10	6.2K
R11	1M	R12	1K	R11	1M	R12	1K

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	2.2K	2.2K	2.2K	-	-	1.5K	1.5K	1.5K	-	-
C5	22uf	10uf	4.7uf	-	-	22uf	10uf	4.7uf	-	-
C6	-	-	-	-	-	-	-	-	-	-
C7	.047uf	.022uf	.01uf	-	-	.022uf	.01uf	.0047uf	-	-
C8	1uf	.47uf	.47uf	-	-	1uf	.47uf	-	-	-
All Diodes type 1N916					All Transistors type 2N3906					

FILTERS / BUSS AMPLIFIERS

All Integrated Circuits type 1458 Dual Operational Amplifiers

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
C1	.47uf	.22uf	.0068uf	-	-	.47uf	.22uf	.0047uf	-	-
C3	.47uf	.22uf	.0068uf	-	-	.47uf	.22uf	.0047uf	-	-
C4	.47uf	.22uf	.1uf	-	-	1uf	.47uf	.22uf	-	-
R5	5K	5K	5K	-	-	5K	5K	5K	-	-
R6	100K	100K	100K	-	-	100K	100K	100K	-	-

PEDAL POSAUNE 32'

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	240 pf			C1	240 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	220K	R4	100K	R3	220K	R4	100K
All master generator integrated circuits				4069 CMOS hex inverter			
All divider integrated circuits				4024 CMOS seven stage divider			

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	5.6K	3.3K	1.5K	-	-	5.1K	2.2K	1K	-	-
C5	33uf	33uf	22uf	-	-	33uf	33uf	22uf	-	-
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	.1uf	.047uf	.033uf	-	-	.47uf	.047uf	.033uf	-	-
All Diodes type 1N916				All Transistors type 2N3906						

FILTERS / BUSS AMPLIFIERS All Integrated Circuits type 1458 Dual Operational Amplifiers

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
C2	1uf	1uf	.47uf	-	-	1uf	1uf	.47uf	-	-
C3	1uf	1uf	.47uf	-	-	2.2uf	1uf	.47uf	-	-
C4	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
F	5K	5K	5K	-	-	5K	5K	5K	-	-
R6	100K	100K	100K	-	-	100K	100K	100K	-	-

PEDAL TROMPET 16'

GENERATORS

Section A (C-F)				Section B (F#-B)			
C1	240 pf			C1	240 pf		
R1,R2	Selected for tuning			R1,R2	Selected for tuning		
R3	220K	R4	50K	R3	220K	R4	50K
All master generator integrated circuits				4069 CMOS hex inverter			
All divider integrated circuits				4024 CMOS seven stage divider			

KEYERS/GATES

Section A (C-F)				Section B (F#-B)			
R8	10K			R8	10K		
R9	10K	R10	6.8K	R9	10K	R10	6.8K
R11	-	R12	-	R11	-	R12	-

	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
R7	3.3K	1.5K	1.5K	-	-	2.2K	1K	-	-	-
C5	33uf	22uf	10uf	-	-	33uf	22uf	-	-	-
C6	-	-	-	-	-	-	-	-	-	-
C7	-	-	-	-	-	-	-	-	-	-
C8	.047uf	.033uf	.022uf	-	-	.047uf	.033uf	-	-	-
	All Diodes type 1N916			All Transistors type 2N3906						

FILTERS / BUSS AMPLIFIERS			All Integrated Circuits type 1458 Dual Operational Amplifiers							
	Div C1	Div C2	Div C3	Div C4	Div C5	Div F#1	Div F#2	Div F#3	Div F#4	Div F#5
C2	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
C3	1uf	.47uf	.22uf	-	-	1uf	.47uf	.22uf	-	-
C4	.47uf	.22uf	.1uf	-	-	.47uf	.22uf	.1uf	-	-
R	5K	5K	5K	-	-	5K	5K	5K	-	-
R6	100K	100K	100K	-	-	100K	100K	100K	-	-

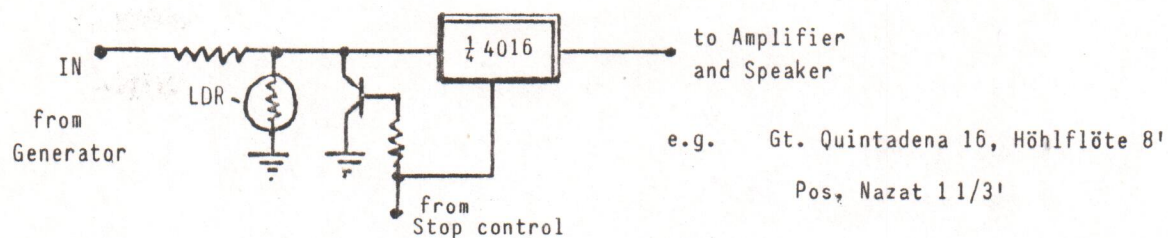
AUDIO SECTION

The overall principle used in this organ is to avoid unification, using instead the multiple rank approach, using where possible a separate rank of generators, separate amplifier and separate speaker for EACH STOP. The basic design used here has used this principle, but has been modified to provide extra usefulness from many of the stops by way of providing a second stop, similar, but ususally softer. This does not compromise the individual rank approach, as the second voice provided would normally be used as an alternative to the original voice, rather than both voices be used together as some form of ensemble. Twenty-four channels of discrete audio amplification are provided by three units each containing eight independent power amplifiers, each with two mixing inputs for flexibility. Twenty-four speaker units are distributed in two chambers, above the right and left sides of the stage area.

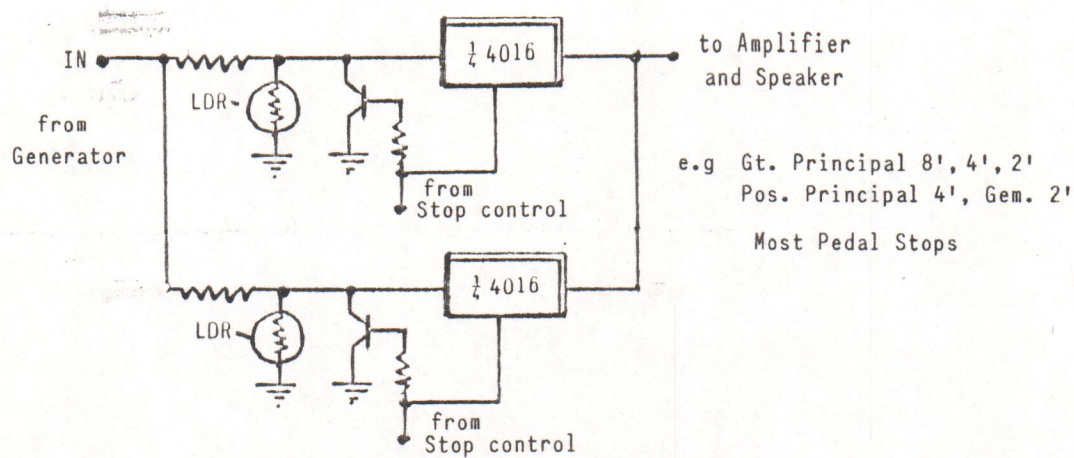
Usually, one rank plays through one speaker, with such exceptions as mixtures. Outputs from the tone generators are routed through the expressing control system, which consists of a photoresistor for each stop, (except "unenclosed" pedal voices), housed in one of two clusters around lamps driven be the swell pedal. Photoresistor action is that of a shunt, therefore the lamps decrease in brightness to increase volume. Stop control circuitry occurs in the same part of the circuit, consisting of a shunting transistor, and a series connected CMOS analog switch, from which audio proceeds directly to power amplifier.

Several configurations are used for the various recipies for providing secondary stops, which are detailed in the following pages. A listing of orginal and secondary stops also follows.

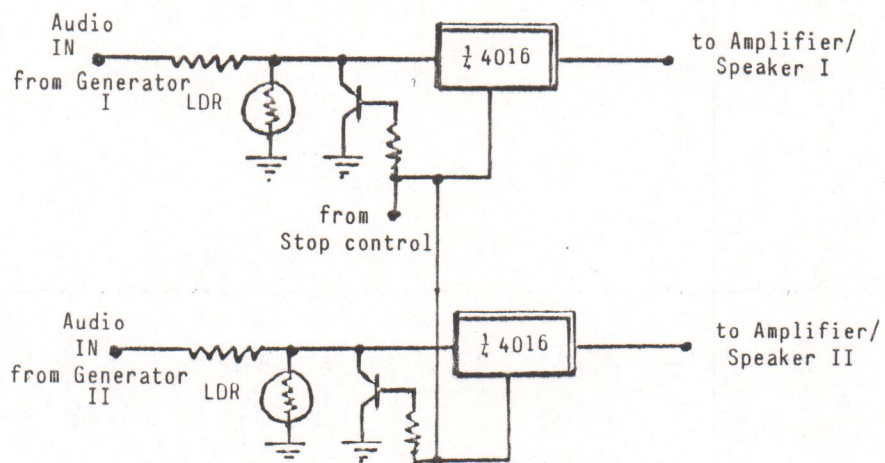
PRIMARY STOP	DERIVED STOP	DETAILS
POSITIV		
GEDACKT 8'	WALDFLOTE 8'	Softer flute with no Chiff
PRINZIPAL 4'	NACHTHORN 4'	Softer, less brilliant
GEMSHORN 2'	BLOCKFLOTE 2'	Less Brilliant
BAZUIN 16'	KNOPFREGAL 16'	Separate amplifier driving horn speaker - Sharper sound
SCHARFF III	ZIMBEL II	Mixture with one less partial, Softer but brighter sound
DULZIAN 8'	KRUMMHORN 8'	Amplified through same system as Knopfregan above
GREAT:		
PRINZIPAL 8'	KLEIN PRINZIPAL	Softer volume, blends w. SCHEBUNG
PRINZIPAL 4'	KOPPELFLOTE 4'	Softer and less brilliant
PRINZIPAL 2'	FLACHFLOTE 2'	As above
TROMPETTA 8'	TROMPETTE 8'	Separate amplifier with Horn
MIXTURE	CYMBAL	As ZIMBAL above
PEDALS;		
SUBBASS 16'	GEDACKT 16'	Pedal secondary stops are all similar to their primary counterparts, but are controlled by the expression pedal
PRINZIPAL 8'	SALIZIONAL 8'	
POSAUNE 32'	BAZUIN 32'	
POMMER 16'	TROMPETE 16'	



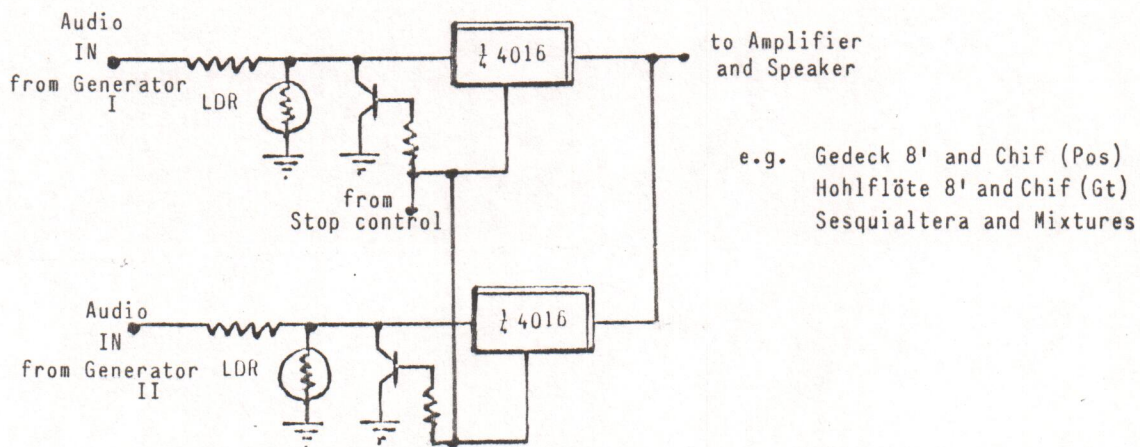
BASIC CONFIGURATION - ONE RANK, ONE STOP, ONE AMPLIFIER



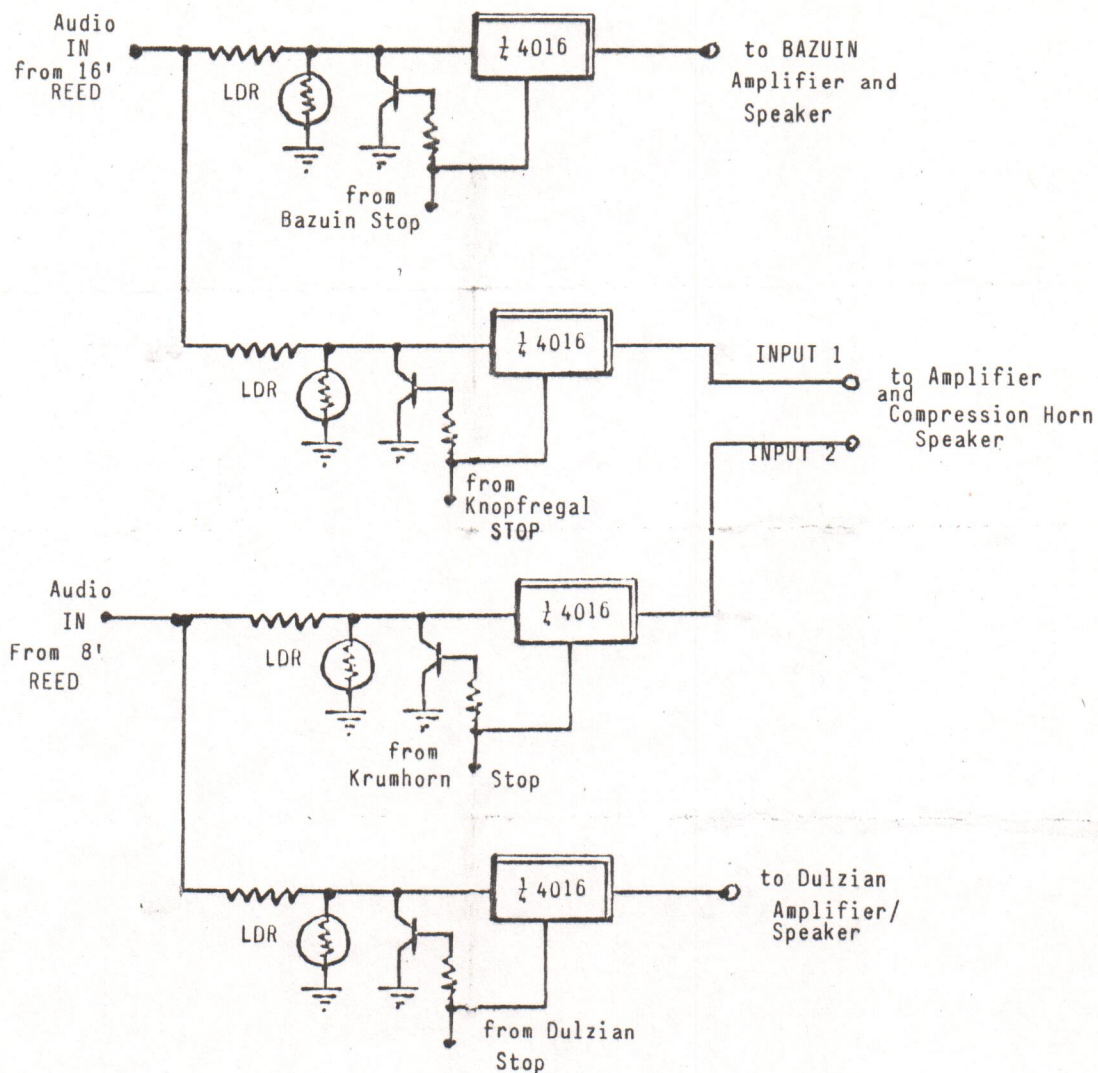
VARIATION 1, ONE RANK, ONE AMPLIFIER Producing Two Stops



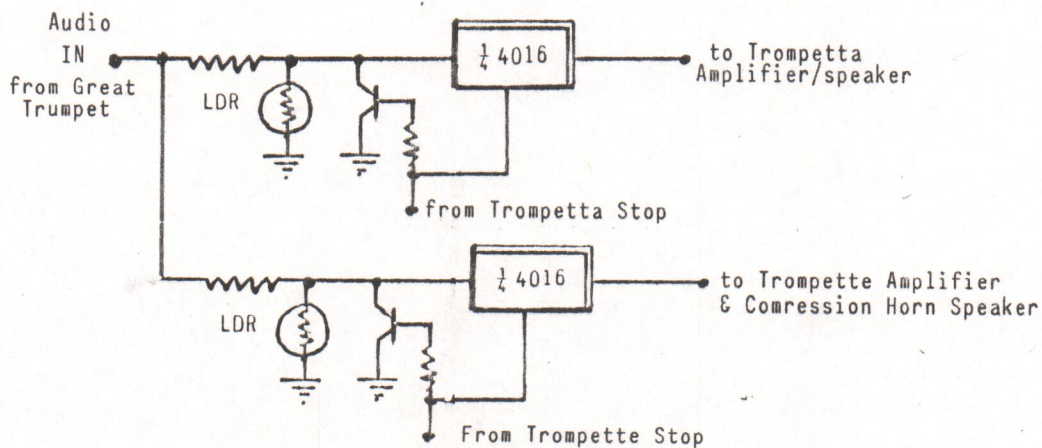
VARIATION 2 - TWO RANKS, TWO AMPLIFIERS, ONE STOP (SCHWEBUNG)



VARIATION 3 - TWO RANKS, ONE STOP, ONE AMPLIFIER/SPEAKER

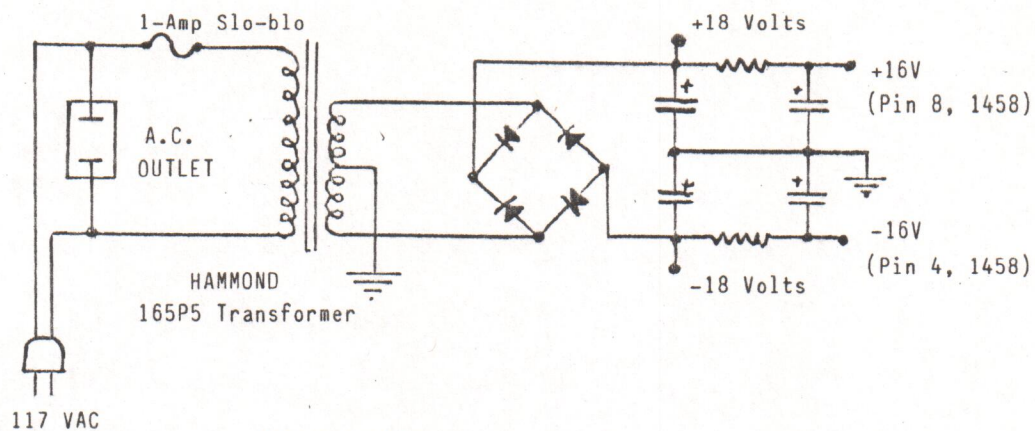


VARIATION 4 - TWO RANKS, FOUR STOPS, THREE SPEAKERS

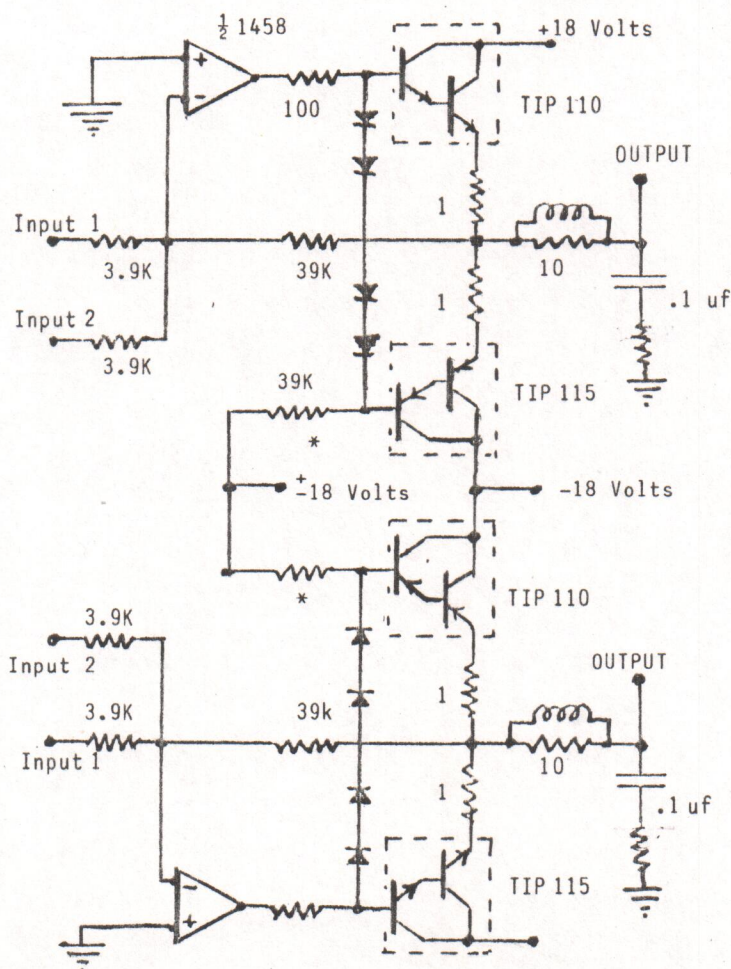


VARIATION 5 - ONE RANK, TWO STOPS, TWO DIFFERENT SPEAKERS

EIGHT CHANNEL POWER AMPLIFIERS



POWER SUPPLY =

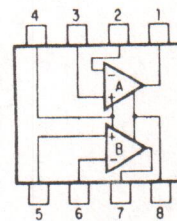
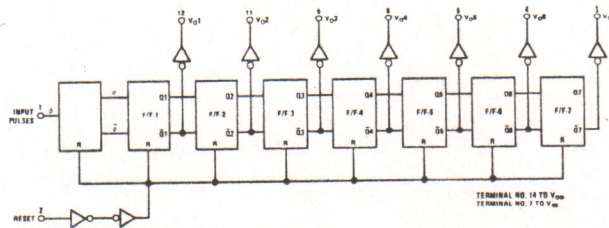


POWER AMPLIFIERS - 1 OF 4 CIRCUITS per CHASSIS

PINOUTS FOR INTEGRATED CIRCUITS

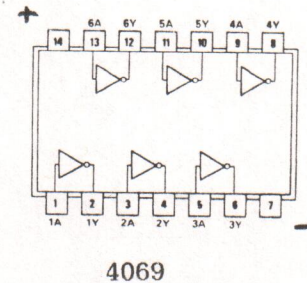
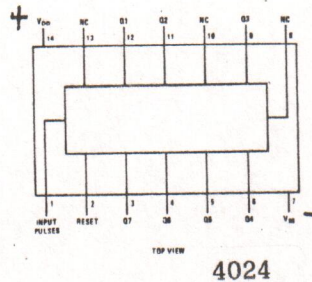
I.C.s Used in TONE GENERATORS

logic diagram

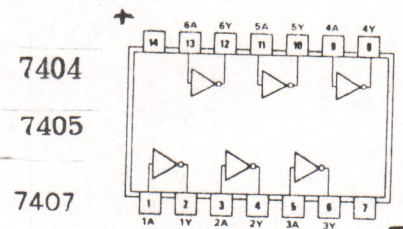
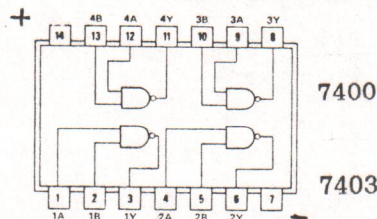


1. Output A
 2. Inverting Input A
 3. Noninverting Input A
 4. V^-
 5. Noninverting Input B
 6. Inverting Input B
 7. Output B
 8. V^+
- 1458 CS

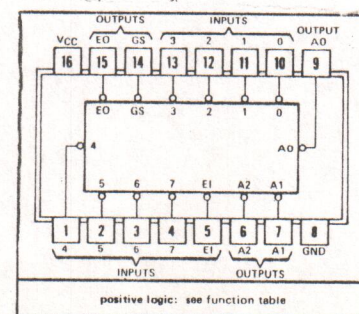
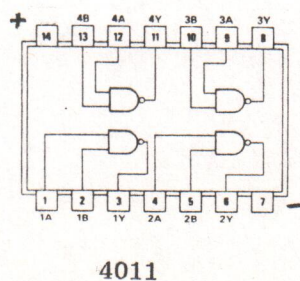
connection diagram



I.C.s Used in TTL SWITCHING



I.C.s used in MEMORY BOARDS



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 solenoids 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 delivered 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 uninterrupted, 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.

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 controlled 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 wech 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 electrytic 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

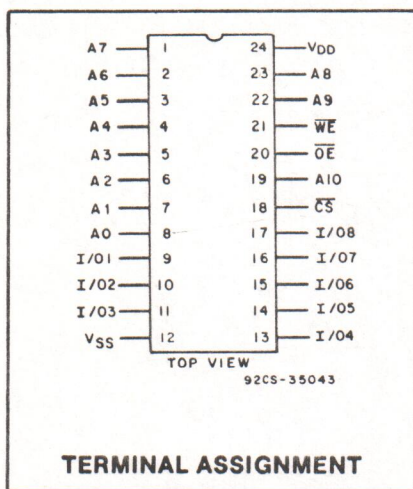
The main board holds up to eight 6116 chips, each having eight input/outputs which provide for a maximum of 64 stops. If the organ has more than this, an expansion socket is provided for addition of a second board which is connected using a 16 pin DIP jumper cable. All data and power supply lines are 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 connected through diodes to a common line used to energize a small 5 volt relay with SPDT contacts wired in such a way as to interrupt 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.

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 circuit is provided for each button, and is located on a separate board inserted between the keyboard rail and the main Preset board.



CMOS 2048-Word by 8-Bit LSI Static RAM

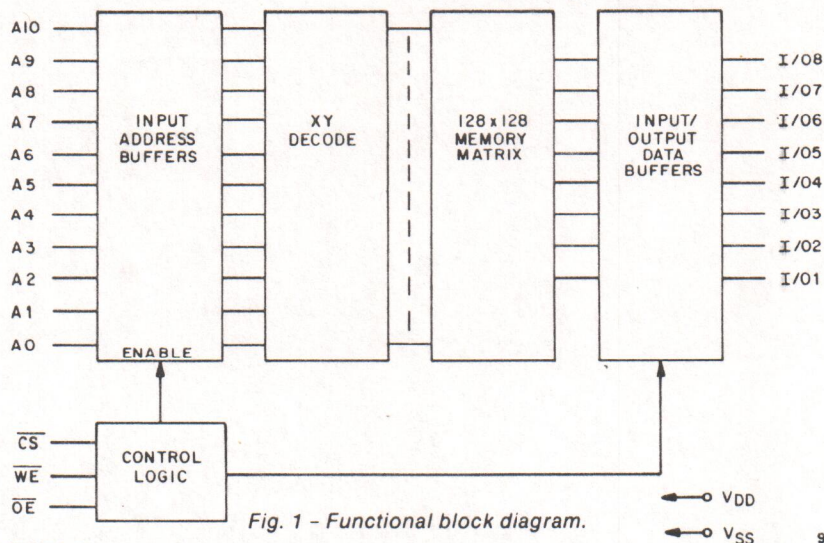
Features:

- Fully static operation
- Single power supply - 4.5 V to 5.5 V
- All inputs and outputs directly TTL compatible
- 3-state outputs
- Industry standard 24 pin configuration
- Input address buffers gated off with chip deselect
- Fast access time
- Low standby and operating power - $I_{DDS1} = 1 \mu A$ typical, $I_{OPER} = 35 mA$ maximum
- Data retention voltage - 2 V min.
- Operating temperature range (Max. Rating) - 0° to $70^\circ C$

The RCA-CDM6116 is a 2048-word by 8-bit static random-access memory. It is designed for use in memory systems where high-speed, low power and simplicity in use are desirable. This type has common data input and data output and utilizes a single power supply of 4.5 V to 5.5 V.

The input address buffers are gated off with chip deselect for minimum standby power with inputs toggling.

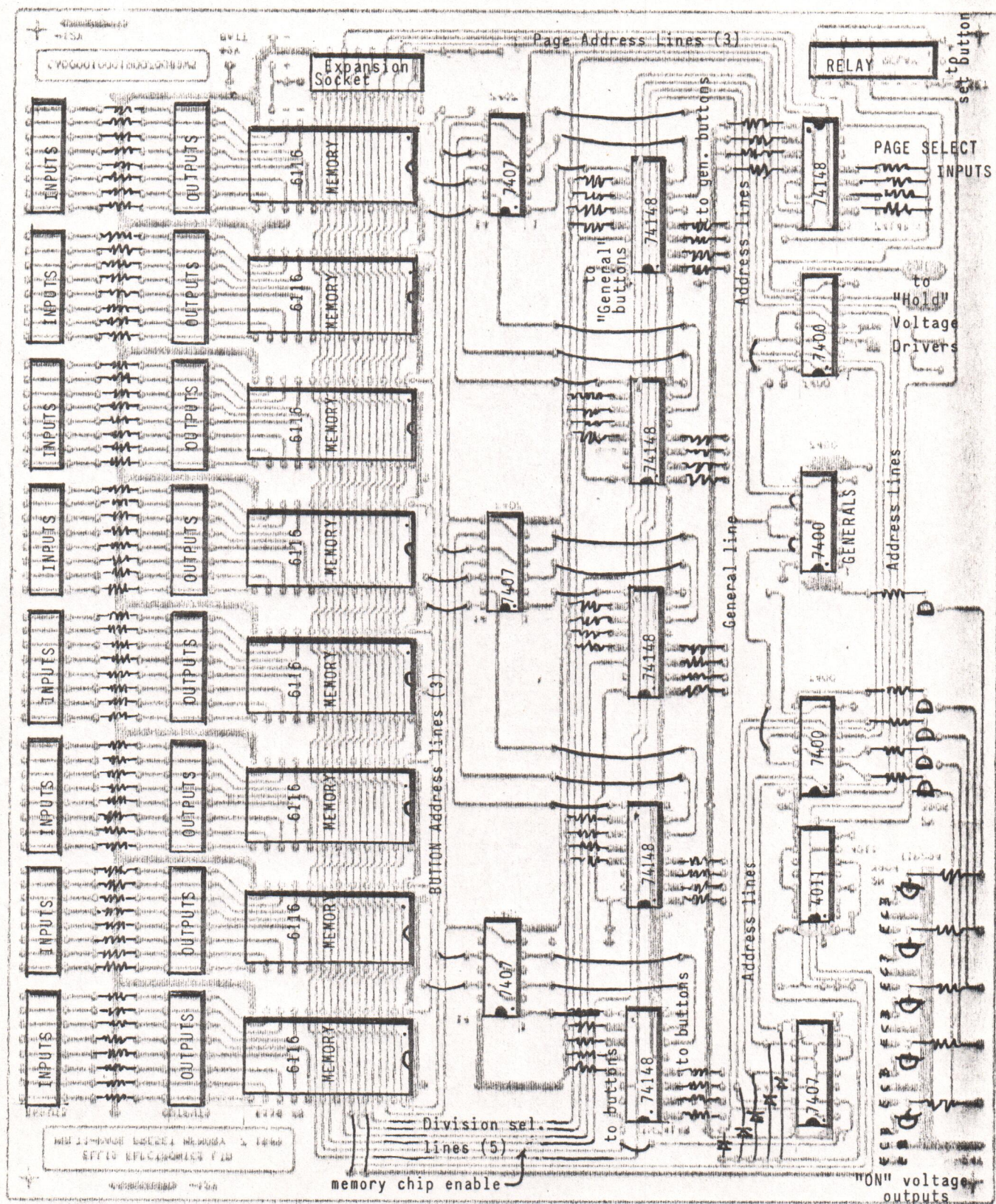
The CDM6116 is supplied in 24-lead, hermetic, dual-in-line side-brazed ceramic (D suffix) and in 24-lead dual-in-line plastic packages (E suffix).



TRUTH TABLE

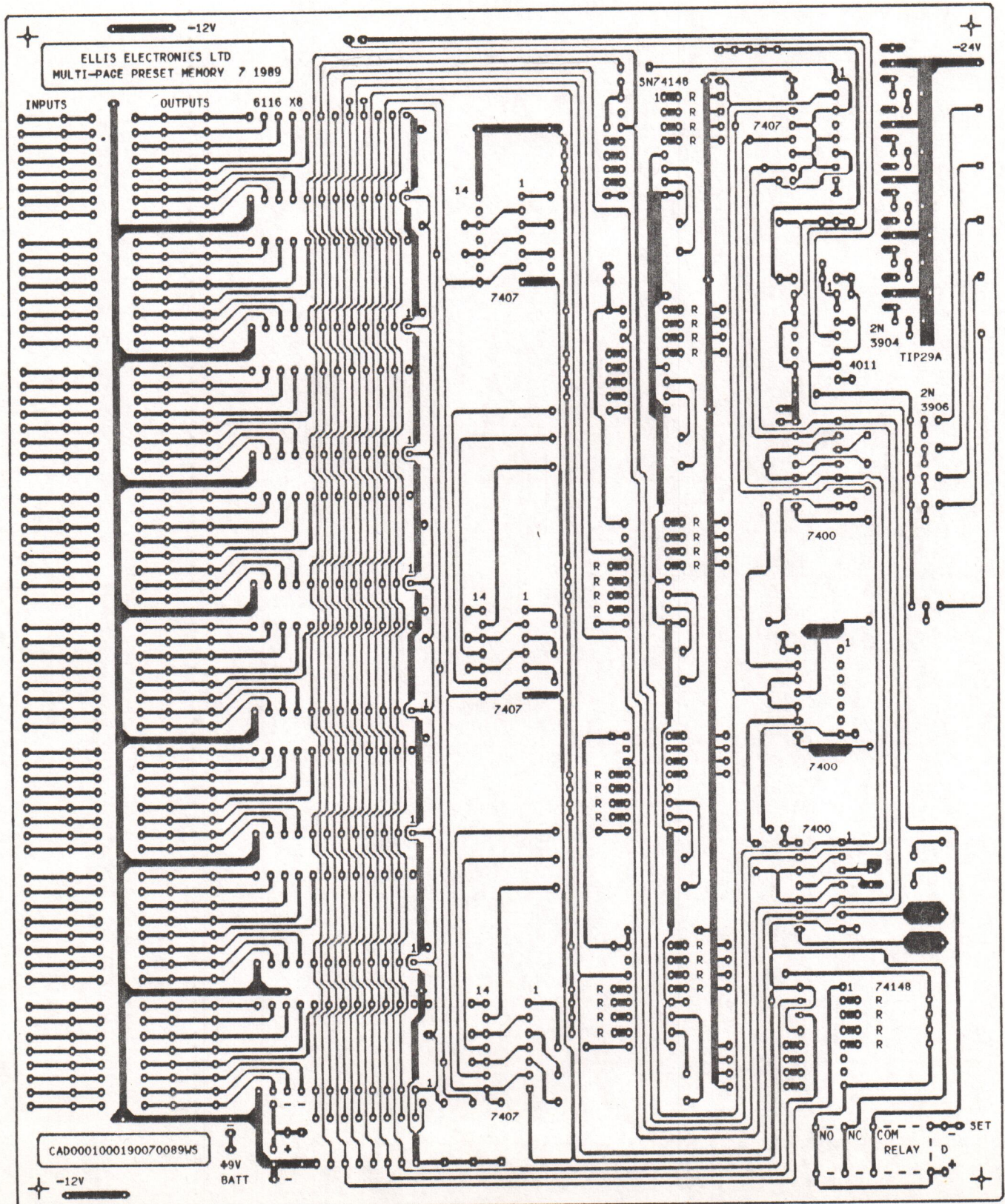
$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	A0 TO A10	MODE	DATA I/O
H	X	X	X	STANDBY	HIGH Z
L	L	H	STABLE	READ	DATA OUT
L	H	L	STABLE	WRITE	DATA IN
L	L	L	STABLE	WRITE	DATA IN

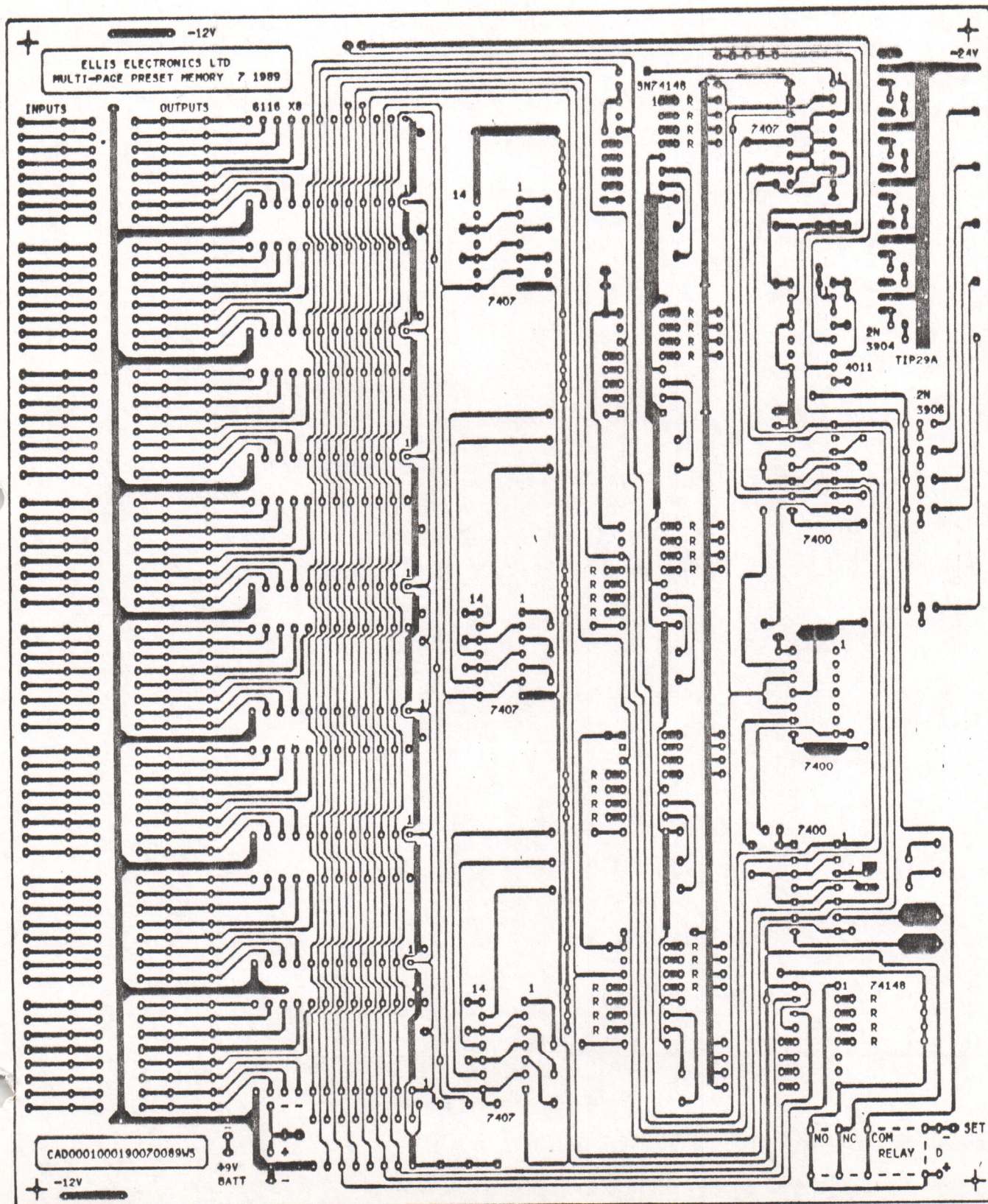
L = LOW H = HIGH X = DON'T CARE

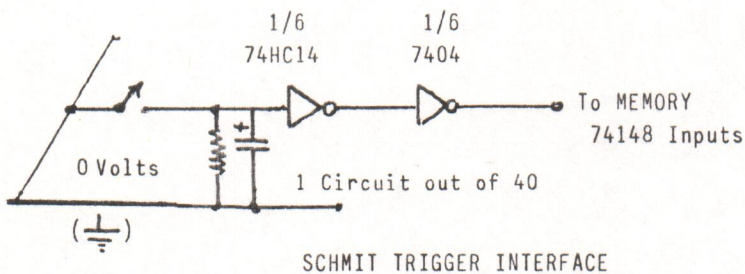
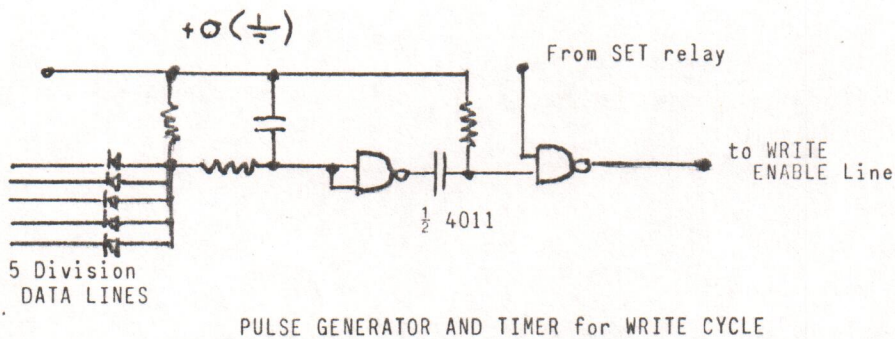
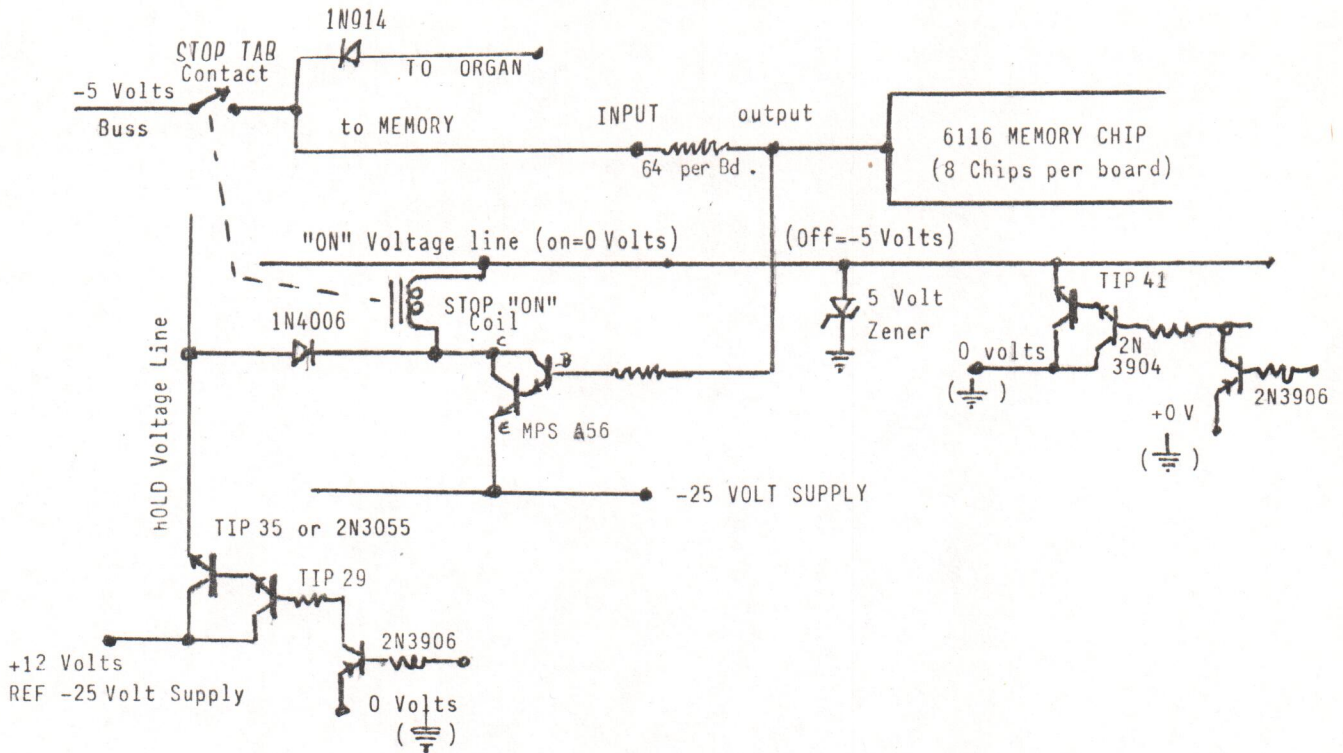


PRESET MEMORY BOARD - COMPONENT SIDE

PRESET MEMORY BOARD - FOIL SIDE







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.

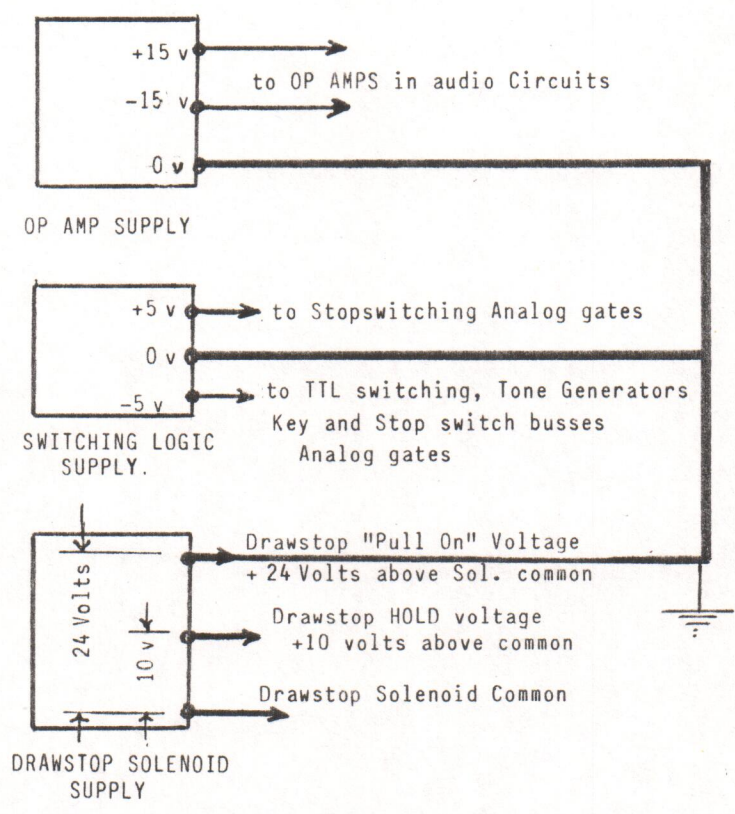
E.I.A. COLOUR CODE

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

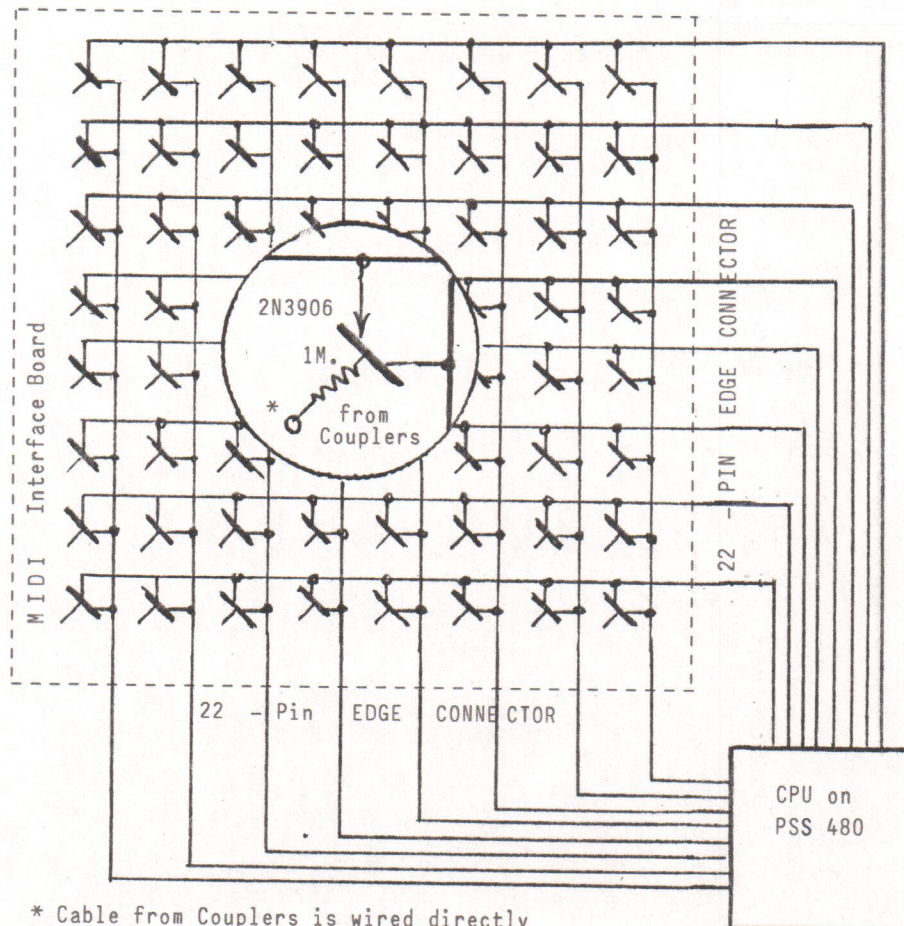
TELEPHONE COLOUR CODE

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

RELATIVE VOLTAGE LEVELS WITHIN THE SYSTEM



MIDI INTERFACE



* Cable from Couplers is wired directly

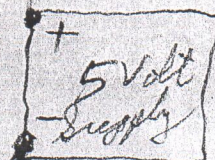
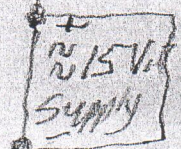
.. 8X8 matrix shown. Actual matrix is 6X6

As in most commercial electronic keyboards, the MIDI driver used here is designed to scan the keyboard using an "X/Y" grid, six by eleven lines, providing up to 66 inputs. Interfacing with the real time data output of the organ keyboard data switches requires a bank of transistors connected to switch between the 61 appropriate crosspoints, providing 61 discrete inputs through 1 Meg. resistors to the transistor bases. Using PNP transistors correctly matches the -5 volt output of the coupler switching I.C.'s. One set of such outputs is provided from all three keyboards, treating the MIDI interface as a fourth keyboard coupled down to any of the others.

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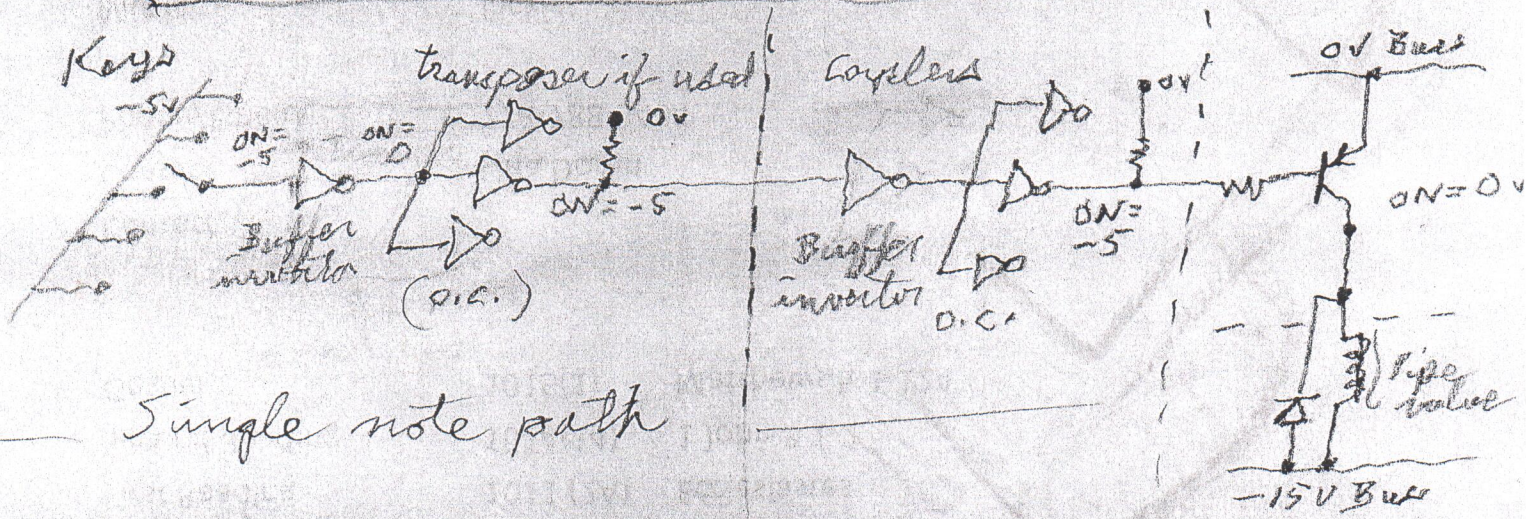
Organ Common Bus (0)



-5V all TTL Switching Boards

all Pipe -15V chest magnets / valves / solenoids

-5 volts is considered "ON"



Single note path

TTL switching may be activated by powering (+5V) to rows of gates or 2nd inputs of 2 input NAND gates. All switching uses open collector gates which are tied to other switches.