

KAWAI SX-210

8 VOICE POLYPHONIC PROGRAMMABLE SYNTHESIZER

Service Manual

MANUAL MANOR

www.markglinsky.com/ManualManor.html
glinskym@sbcglobal.net

KAWAI

Kawai Musical Instrument
Manufacturing Co., Ltd.

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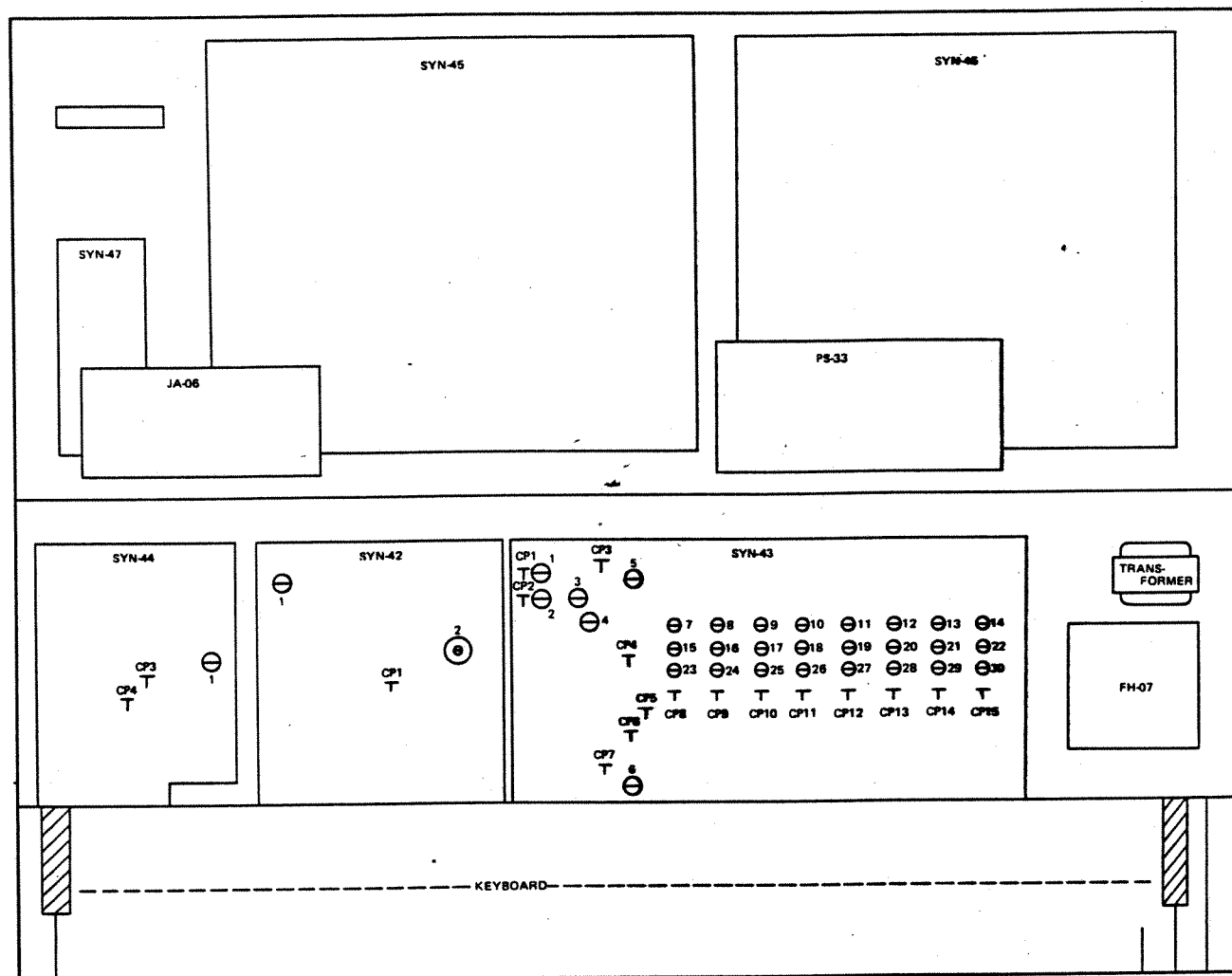
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PRINTED CIRCUIT BOARDS GUIDE

P.C.B. Name	Description	Page
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■ P.C.B. LAYOUT

⊖ ADJUSTER
T CHECK PIN



ADJUSTMENT GUIDE

● SYN-44 (P.C.B)

No.	Description
1	ENSEMBLE DEPTH Adj.

● SYN-42 (P.C.B)


No.	Description
1	PITCH BEND Adj.
2	MASTER FINE TUNE

● SYN-43 (P.C.B)

No.	Description
1	ANTILOG OFFSET Adj.
2	TEMPERATURE COEFFICIENT Adj.
3	KCV LEVEL Adj.
4	KCV OFFSET Adj.
5	VCA OFFSET Adj.
6	NOISE LEVEL Adj.
7	VCF OFFSET (CH1) Adj.
8	VCF OFFSET (CH2)
9	VCF OFFSET (CH3)
10	VCF OFFSET (CH4)
11	VCF OFFSET (CH5)
12	VCF OFFSET (CH6)
13	VCF OFFSET (CH7)
14	VCF OFFSET (CH8)
15	VCF CUTOFF (CH1) Adj.
16	VCF CUTOFF (CH2)
17	VCF CUTOFF (CH3)
18	VCF CUTOFF (CH4)
19	VCF CUTOFF (CH5)
20	VCF CUTOFF (CH6)

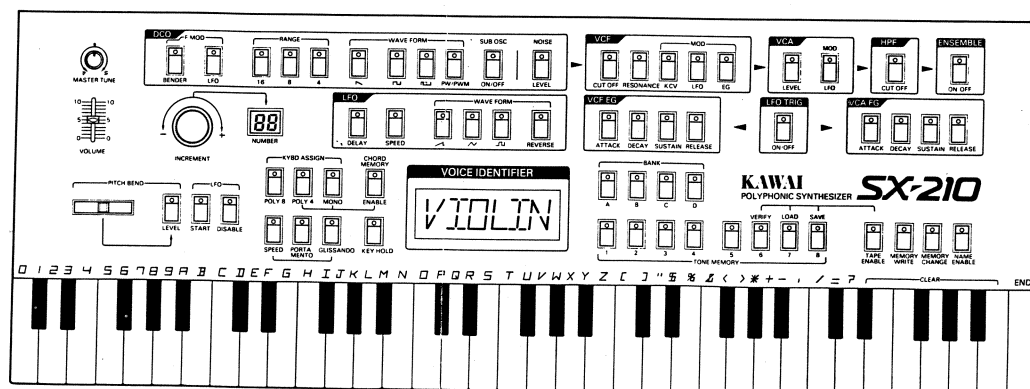
No.	Description
21	VCF CUTOFF (CH7)
22	VCF CUTOFF (CH8)
23	VCF RESONANCE LEVEL (CH1)
24	VCF RESONANCE LEVEL (CH2)
25	VCF RESONANCE LEVEL (CH3)
26	VCF RESONANCE LEVEL (CH4)
27	VCF RESONANCE LEVEL (CH5)
28	VCF RESONANCE LEVEL (CH6)
29	VCF RESONANCE LEVEL (CH8)
30	VCF RESONANCE LEVEL (CH8)

SPECIFICATIONS

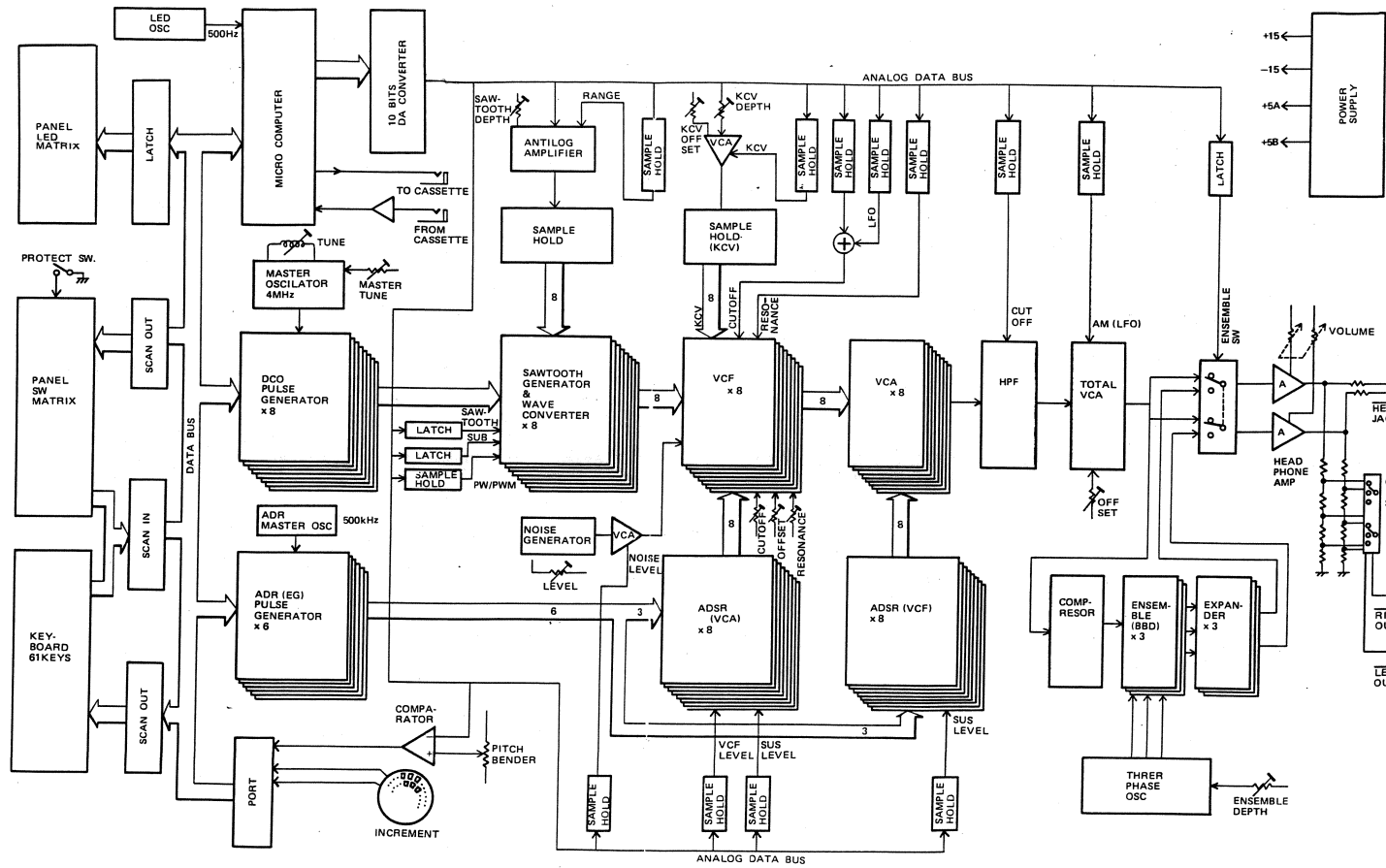
VCF-EG		Attack Time
VCA-EG		Decay Time
		Sustain Level
		Release Time
HPF		Cut-Off Frequency
LFO	Wave Form	
		Reverse
		Speed
		Delay Time
EFFECT		Ensemble
		Portamento
		Glissando
		Speed
		Hold
CONTROLLER	VCF-EG/VCA-EG	LFO Trigger
	Pitch Bender	Hand Controller
		Bend Depth
	LFO Modulation	Disable
		Start
		Total Volume
		Master Tune

MEMORY		Memory Write Memory Change Name Enable
VOICE IDENTIFIER		16 Segment LED x
INCREMENT		7 Segment LED x 2
NUMBER DISPLAY		Tape Enable
TAPE INTERFACE		Save Load Verify
REAR PANEL	Signal Out	Left Right Level Select Switch Headphone
	Tape Save & Load	To Tape From Tape
		Memory Protect Sw
POWER CONSUMPTION	40W	
DIMENSIONS	880(W) x 400(D) x 128(H) mm	
WEIGHT	12.2 kg	

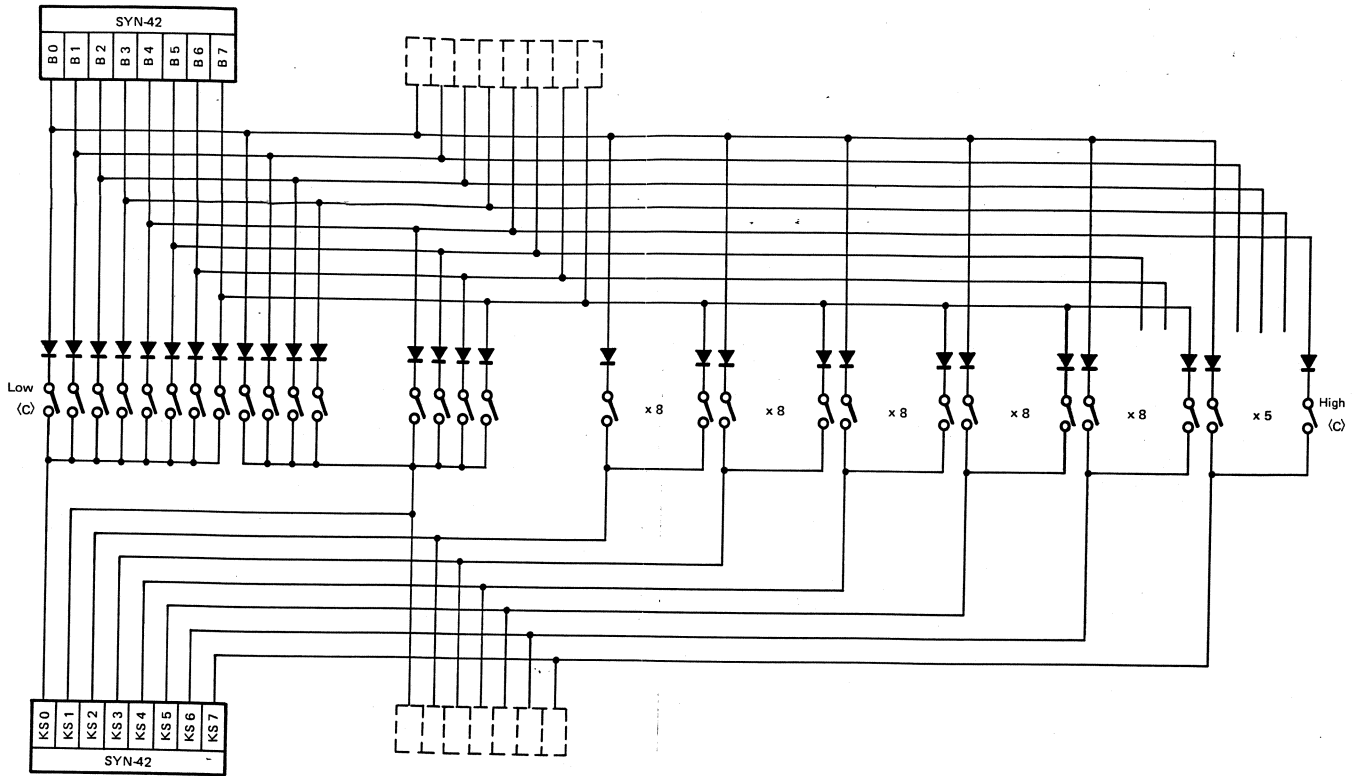
The block diagram illustrates the internal components of the 68000 microprocessor. On the left, a vertical stack of components includes a **RELEASE** pin, a **PROTECT MEMORY PROTECT** pin, and a **FROM TAPE** pin. In the center, the **TO TAPE** pin is shown. To the right of the center are the **HEADPHONE**, **RIGHT**, and **LEFT** pins. A bracket labeled **SIGNAL OUT** spans the **RIGHT** and **LEFT** pins. Above the **RIGHT** and **LEFT** pins is a **PMP 1 x 12** block. On the far right, three signal level indicators are shown: **+4 dBm**, **-12 dBm**, and **-20 dBm**.



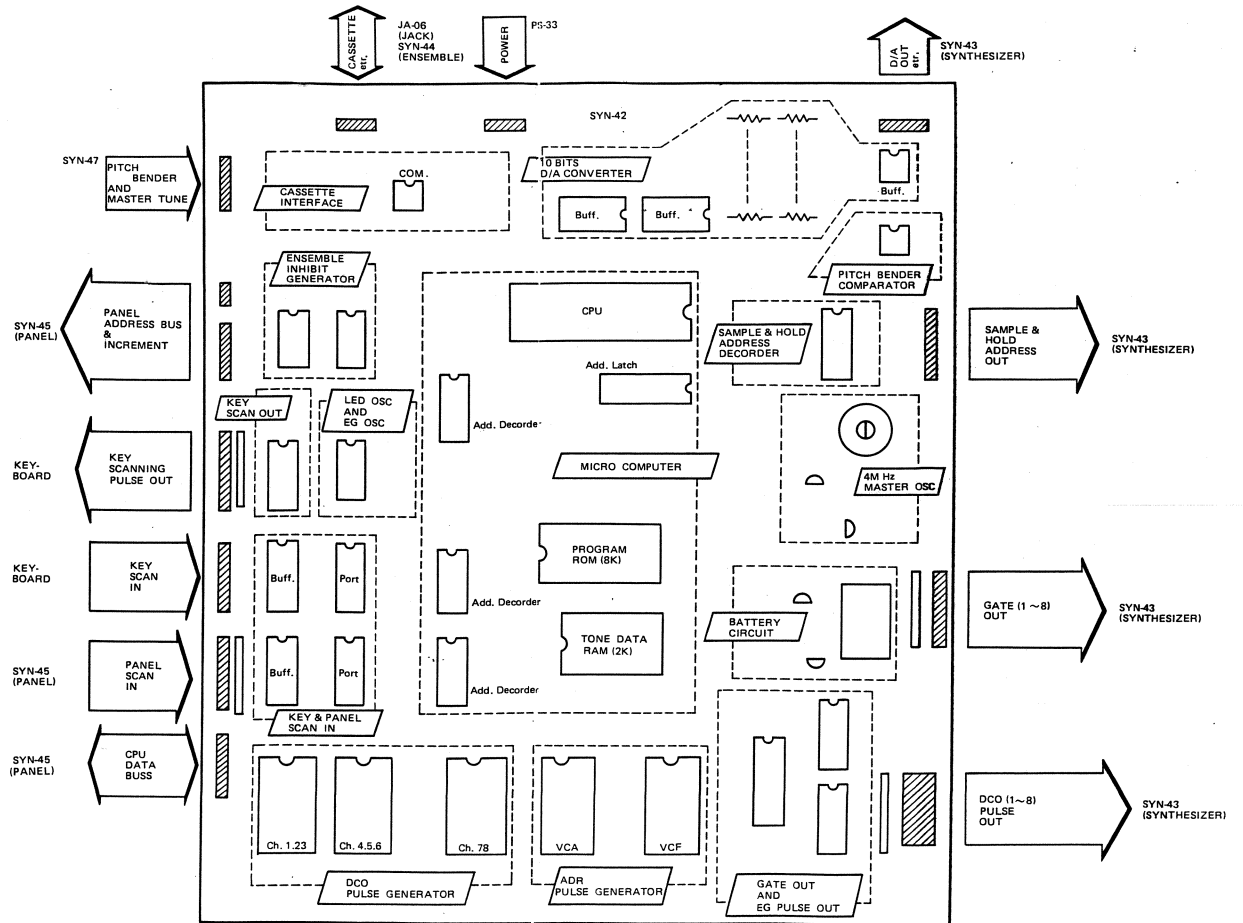
■ BLOCK DIAGRAM



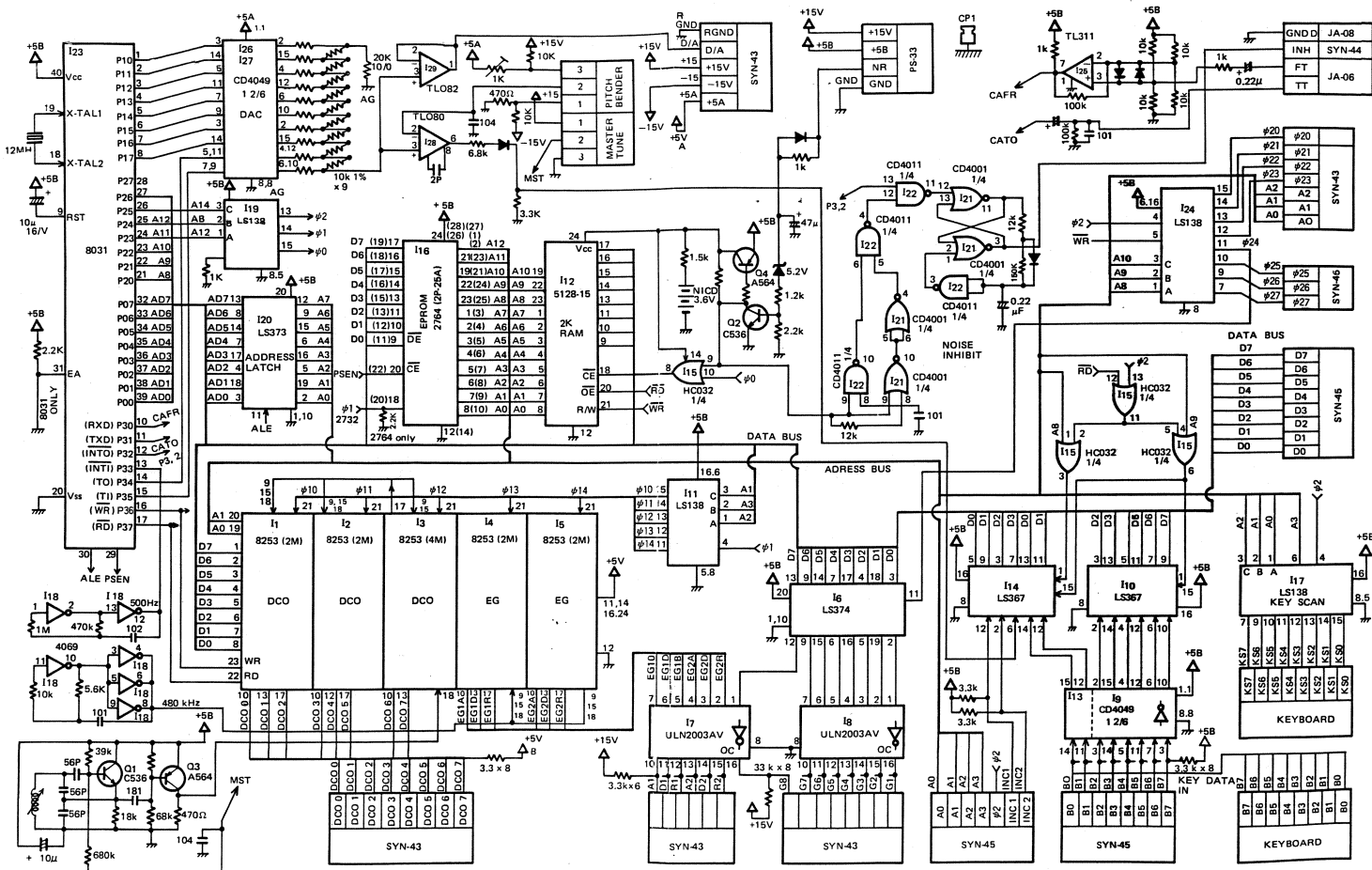
■ KEYBOARD CIRCUIT DIAGRAM



■ SYN-42 CIRCUIT BLOCK LAYOUT

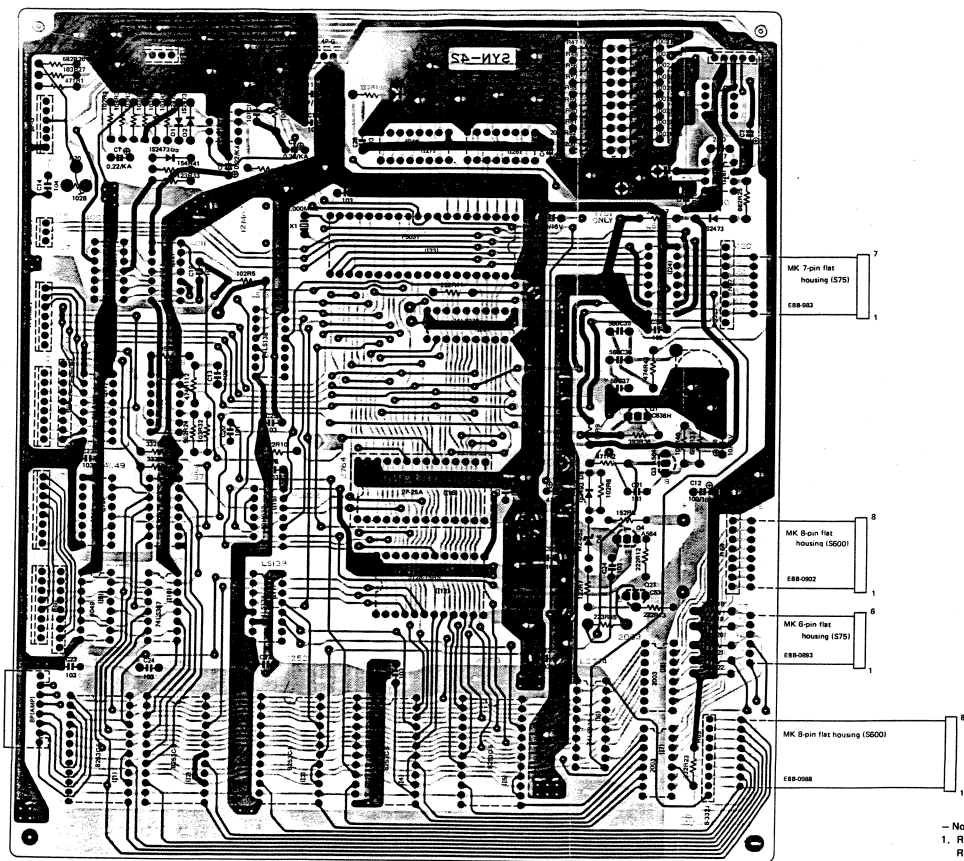


■ SYN-42 CIRCUIT DIAGRAM MICRO COMPUTER



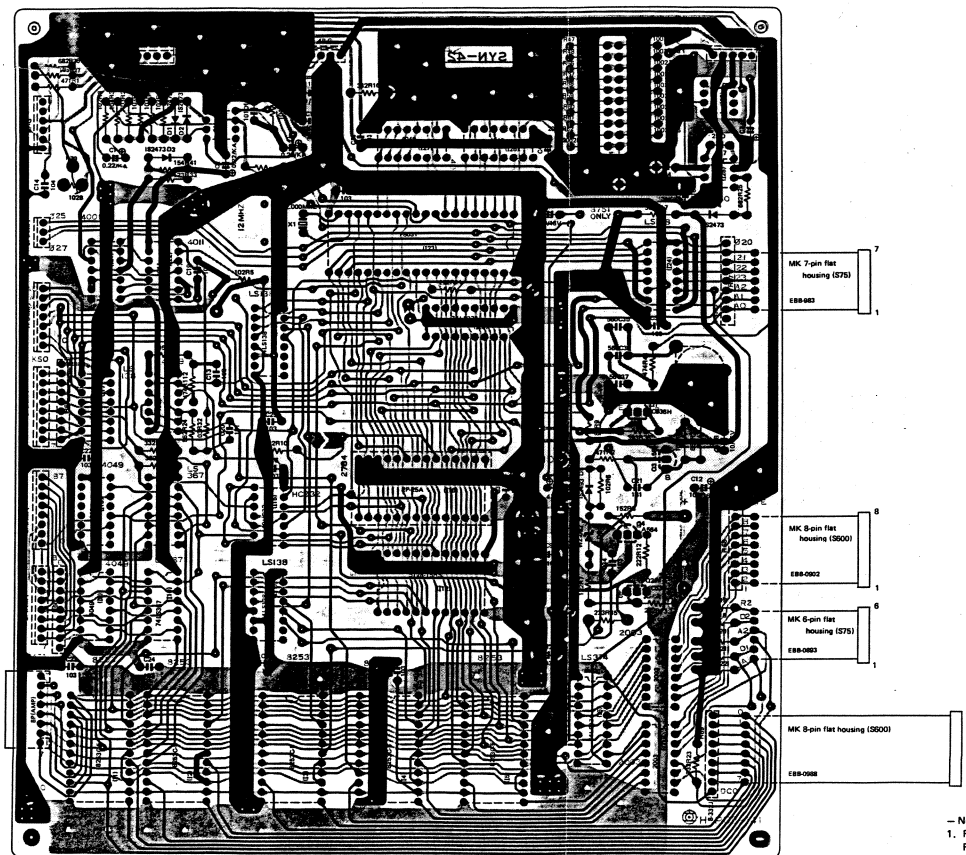
- 12 -

- 13 -



— Notes —

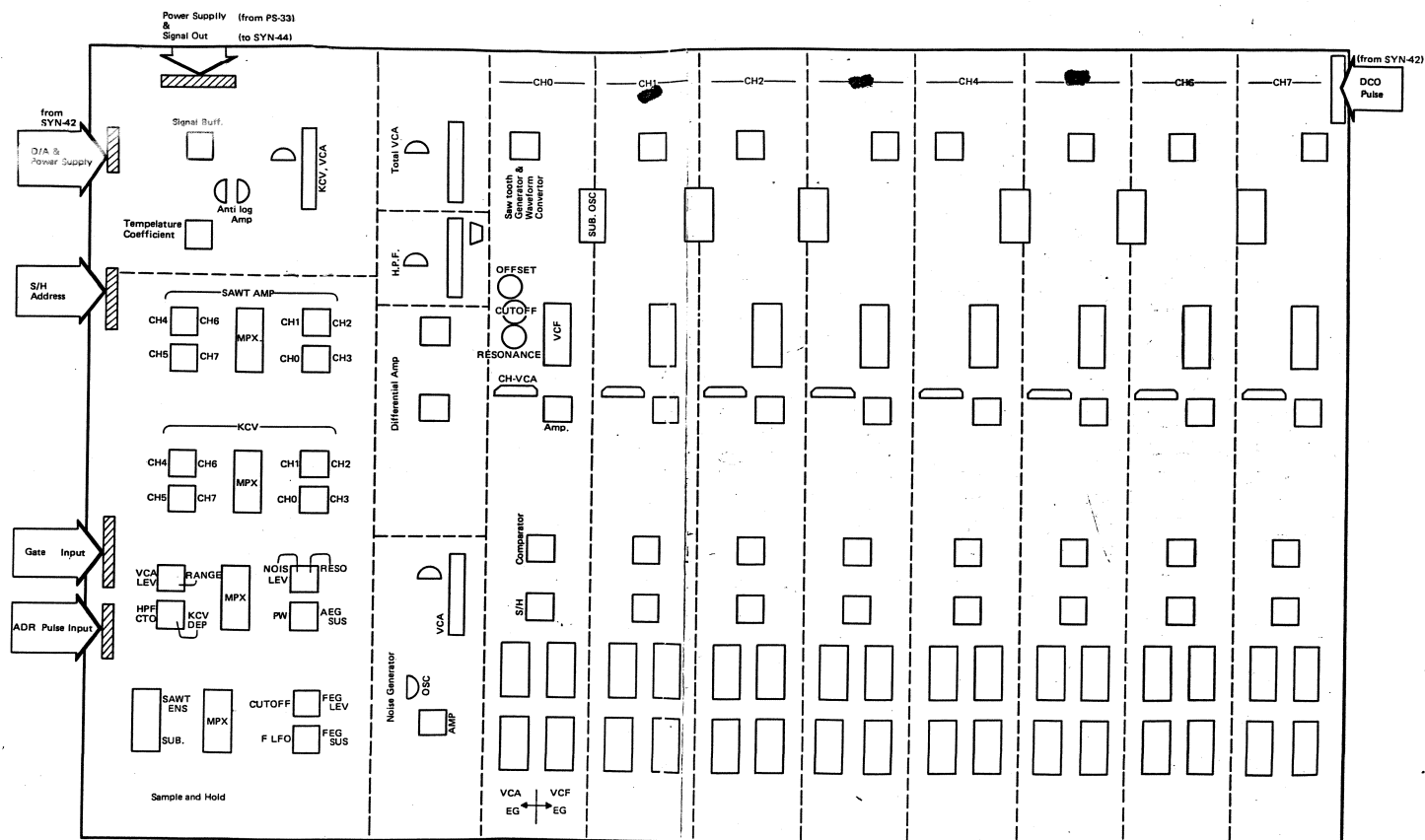
1. Resistors R45-48 (green 5th band) should be accurate to within 0.5%.
Resistors R49-64 (brown 5th band) should be accurate to within 1%.
2. Ceramic condensers C35-37 are all Part No. 800153.



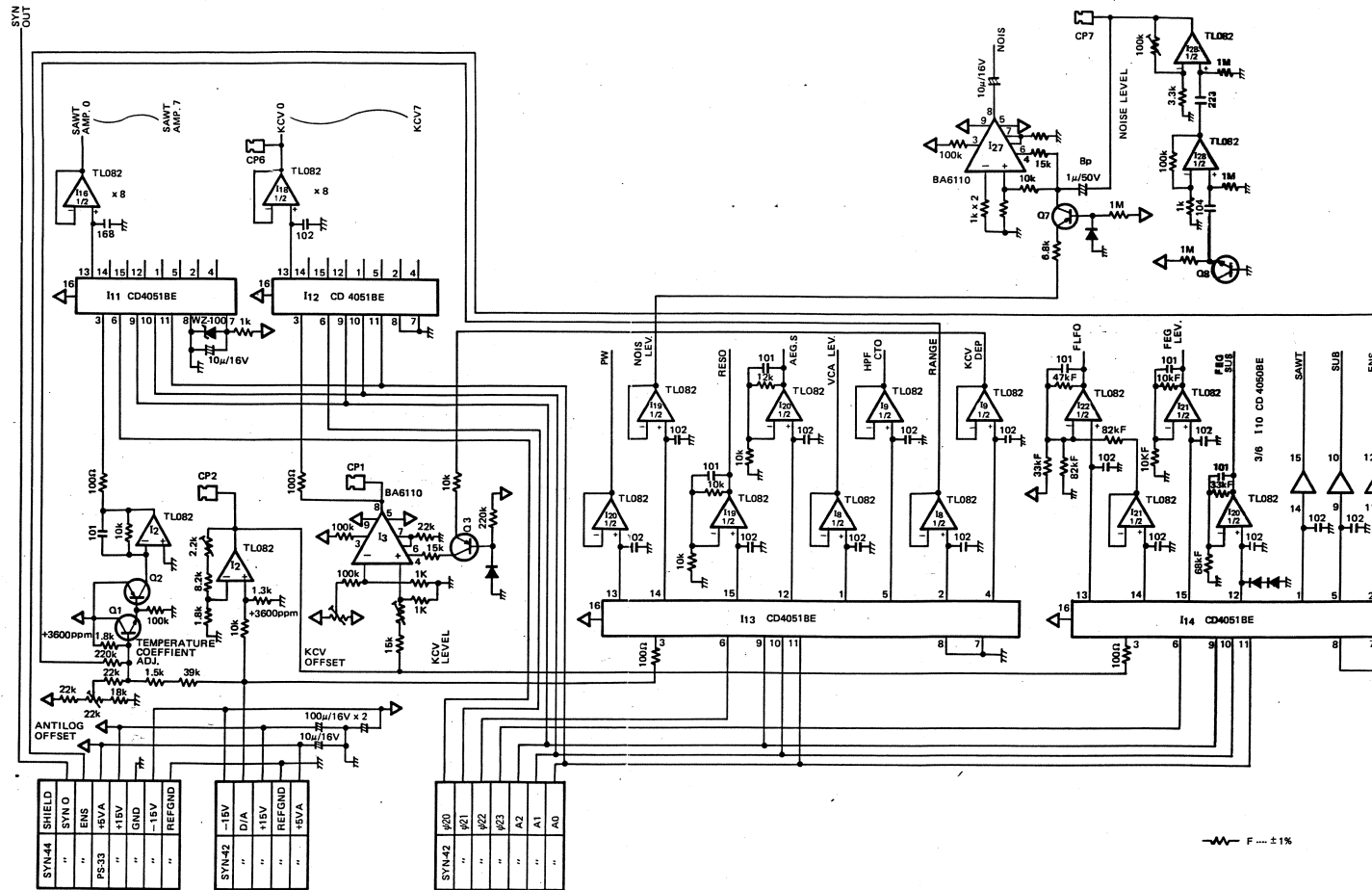
— Notes —

1. Resistors R45-48 (green 5th band) should be accurate to within 0.5%.
Resistors R49-64 (brown 5th band) should be accurate to within 1%.
2. Ceramic condensers C35-37 are all Part No. 800153.

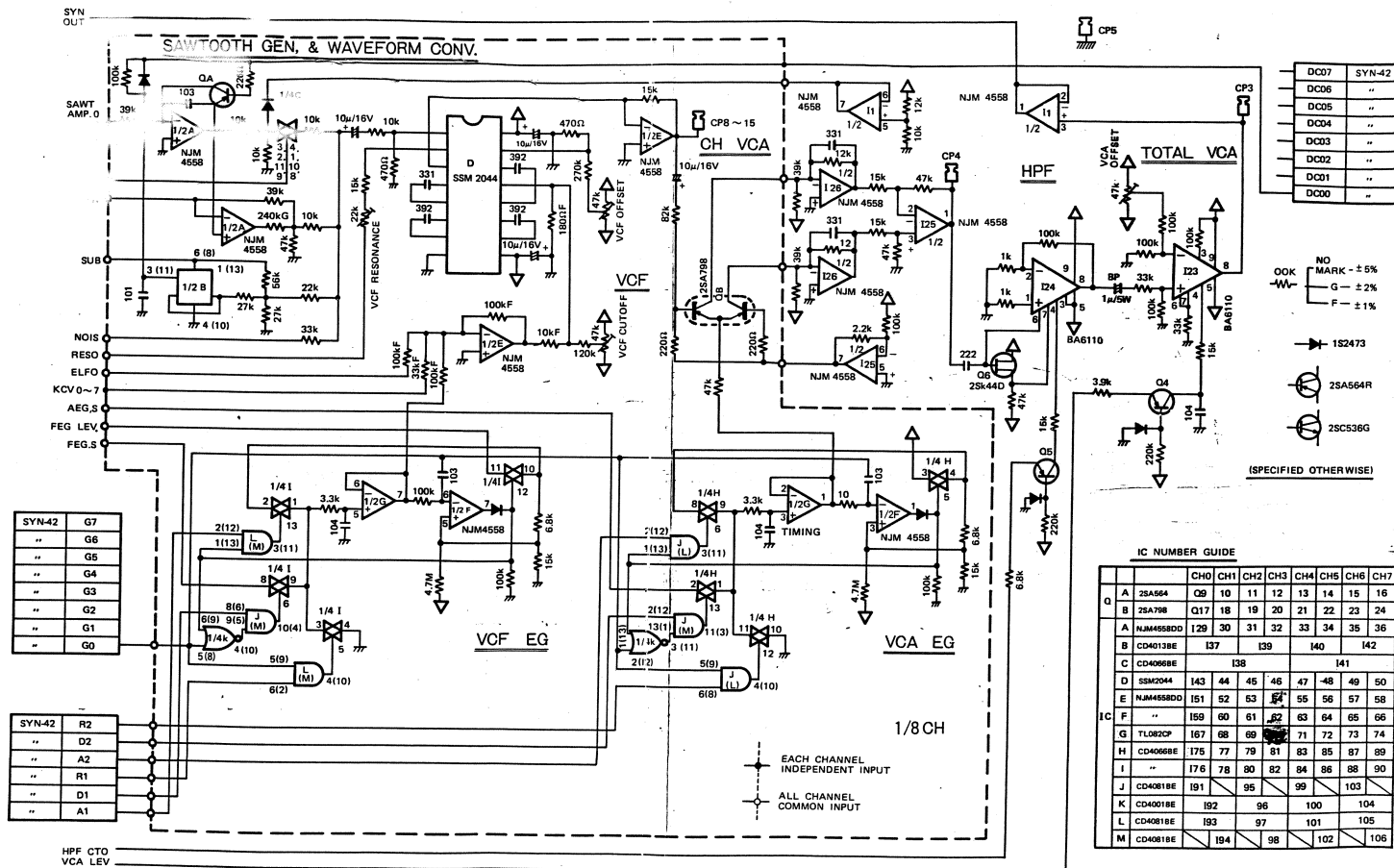
■ SYN-43 CIRCUIT BLOCK LAYOUT

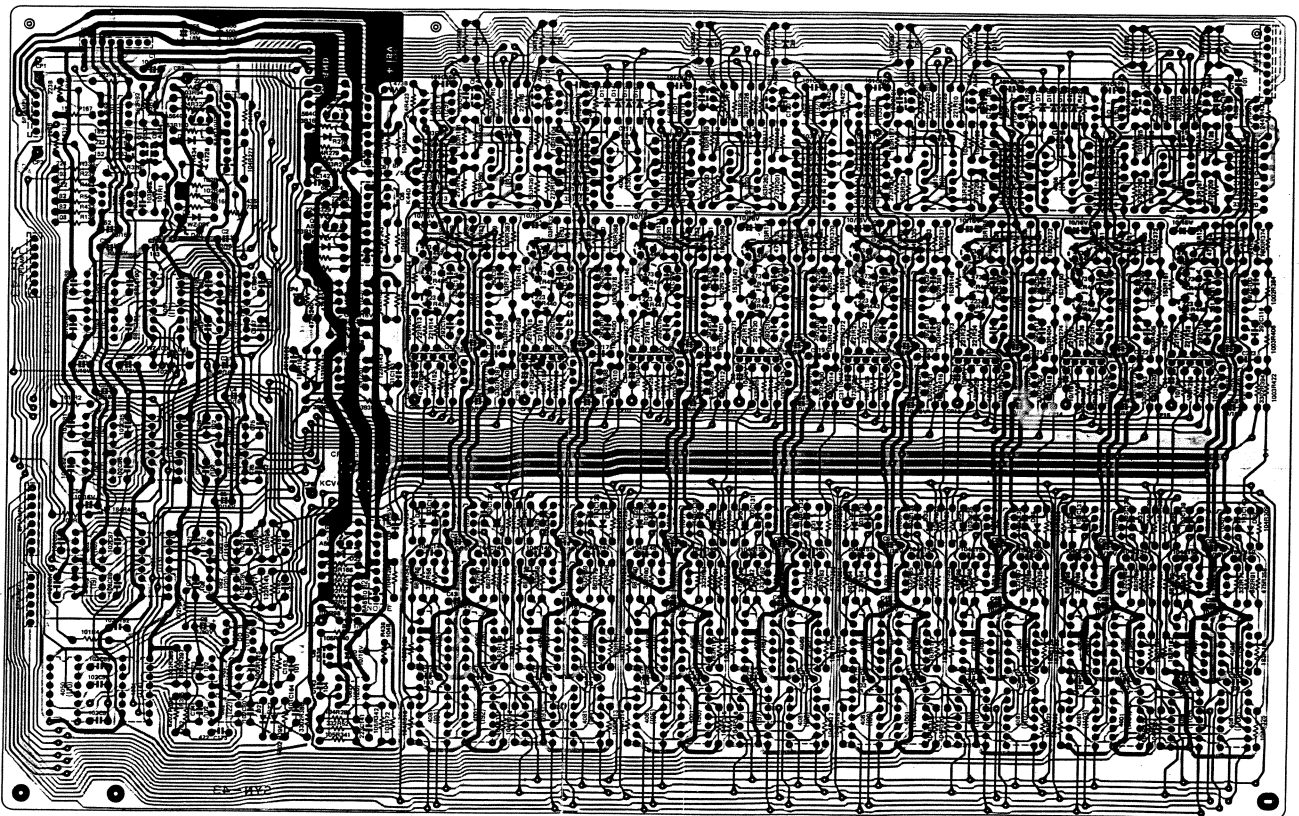


■ SYN-43 (1/2) CIRCUIT DIAGRAM SAMPLE AND HOLD, NOISE GENERATOR



■ SYN-43 (2/2) CIRCUIT DIAGRAM SAWTOOTH GEN. WAVE FORM CONV. VCF. VCFEG. VCAEG. HPF. VCA





— Notes —

1. Unless otherwise specified, all transistors (Q17-24) are Part No. 2SA798.
2. Unless otherwise specified, all diodes are Part No. 152473.
3. Resistors R367-422 are metal-clad. (Tolerance: 1%)
Resistors R423-430 are carbon resistors. (Tolerance: 2%)
Resistors R431-432 are high-stability resistors.
4. Resistors R439-462 are semi-variable resistors, VR (Part No. H06 1A).
5. Mylar condensers C216-223 are all Part No. 333.

\$ 320.10

• Noncombustibility Reg. (4711/ZWJ)

22 }
101 } Ceramic
221 } Capacitor
471 }
681 }
103 }

I1 : CD4053BE
I2, I3 : NE571N
I4 : NJM4558D
I5 : CD4049BE
I6 : NJM4558D
I7 : NJM4556D
I8 : NJM4556D
I9 : MN3009
Q1, Q2 : 2SA564R
D4 : WZ-052
D5 : WZ-052
D1 : WZ-120
D6 ~ D13 : IS2473

ENS SYN-43
INH SYN-42
SYNO SYN-43
GND "

SYN-47 GND
" VIR
" VOR
" VOL
" VIL
" GND

JA-06 GND
" OUTR
" OUTL
" GNDL

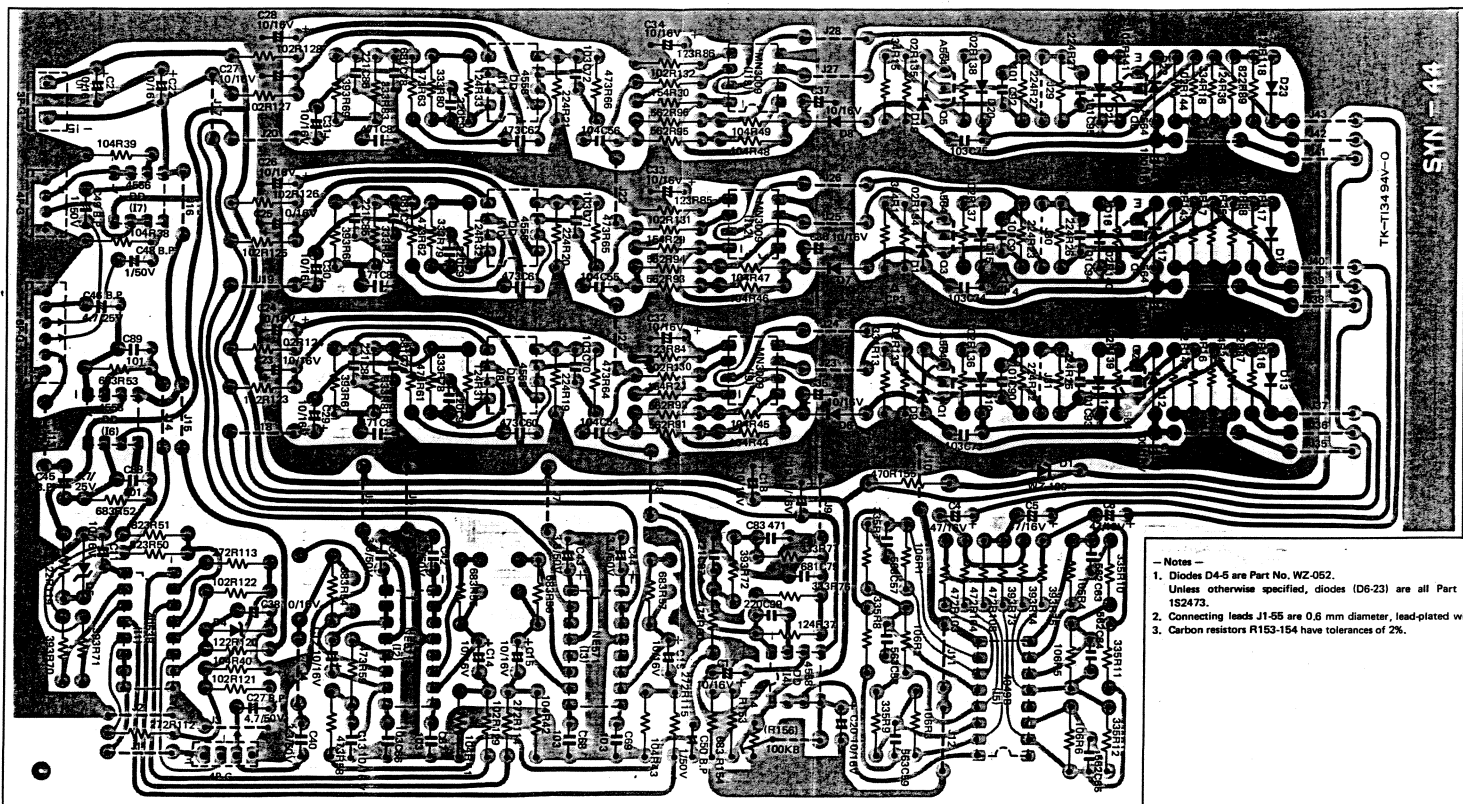
PS-33 -15
" GND
" +15

SYN-44

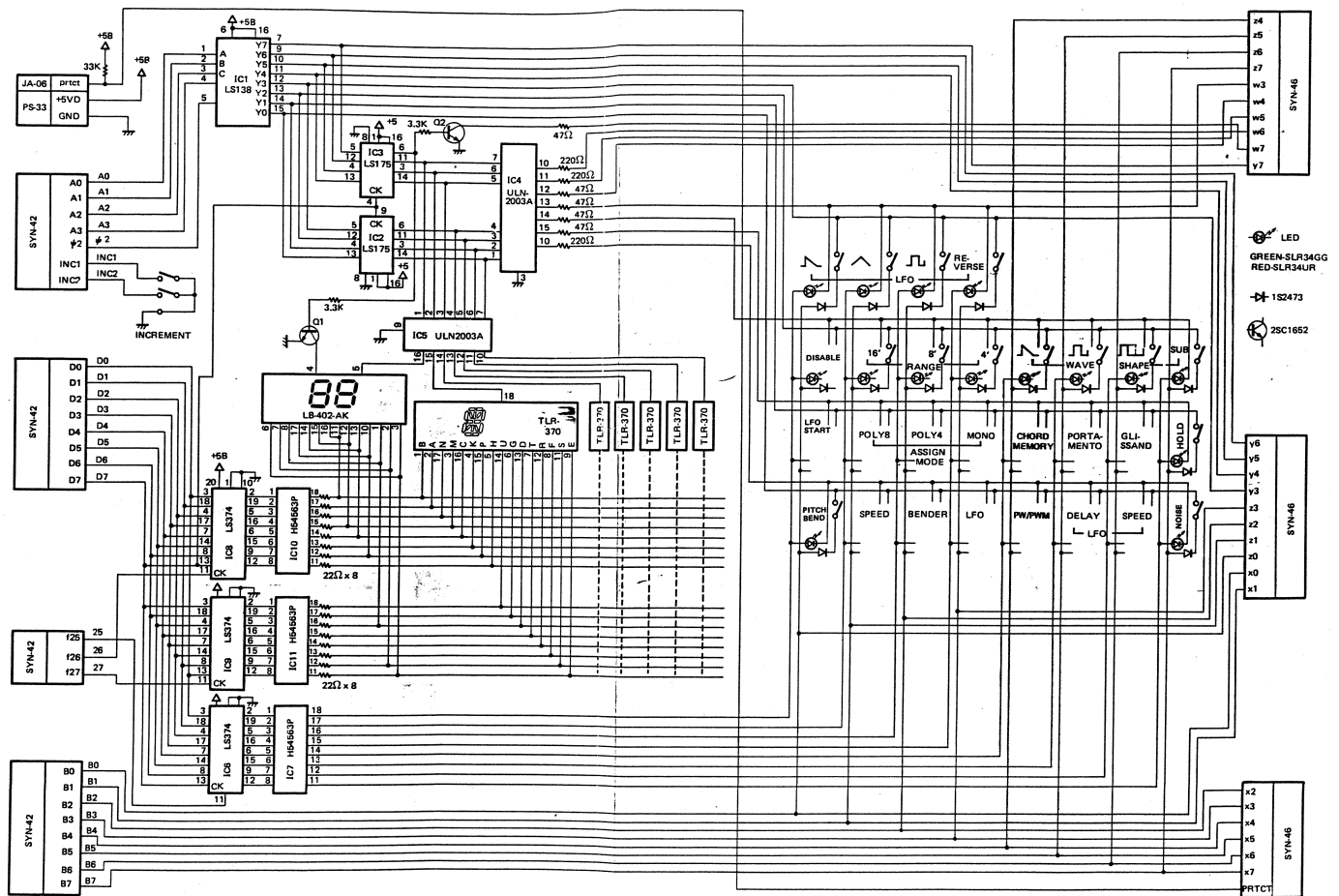
ch-a
ch-b (Same as ch-a)
ch-c (Same as ch-a)

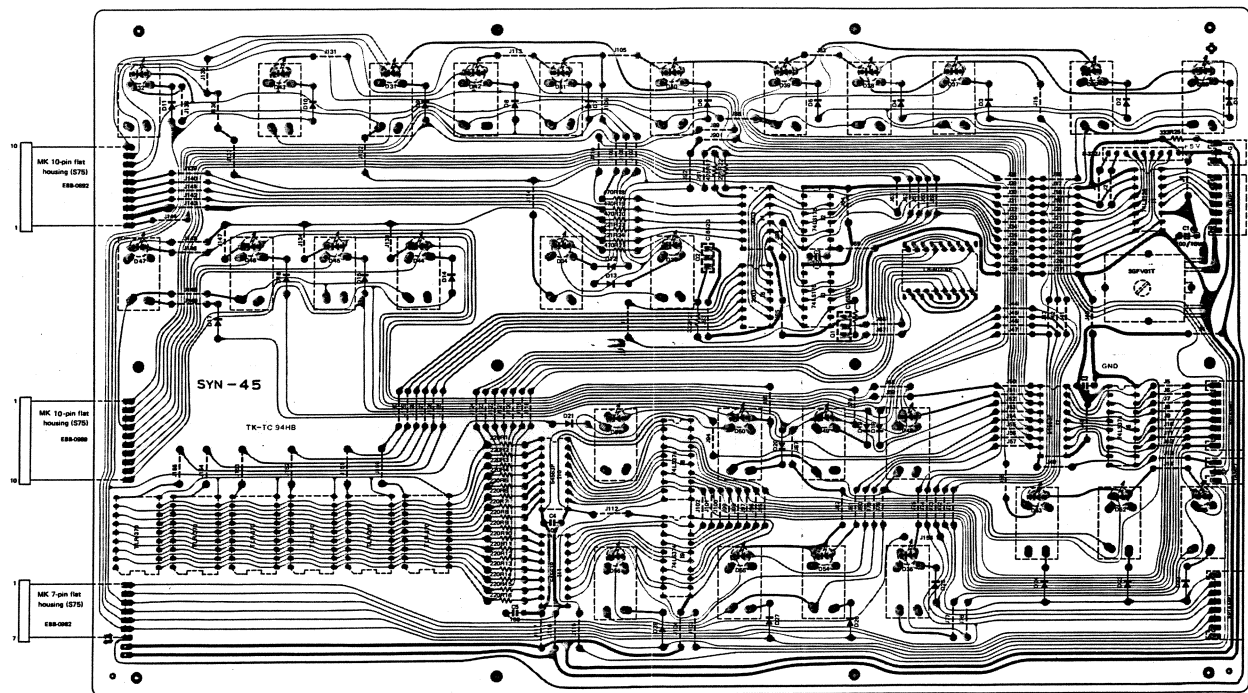
CP3
CP4



4711/ZWJ

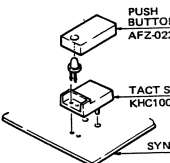


■ SYN-45 CIRCUIT DIAGRAM LEFT HALF PANEL

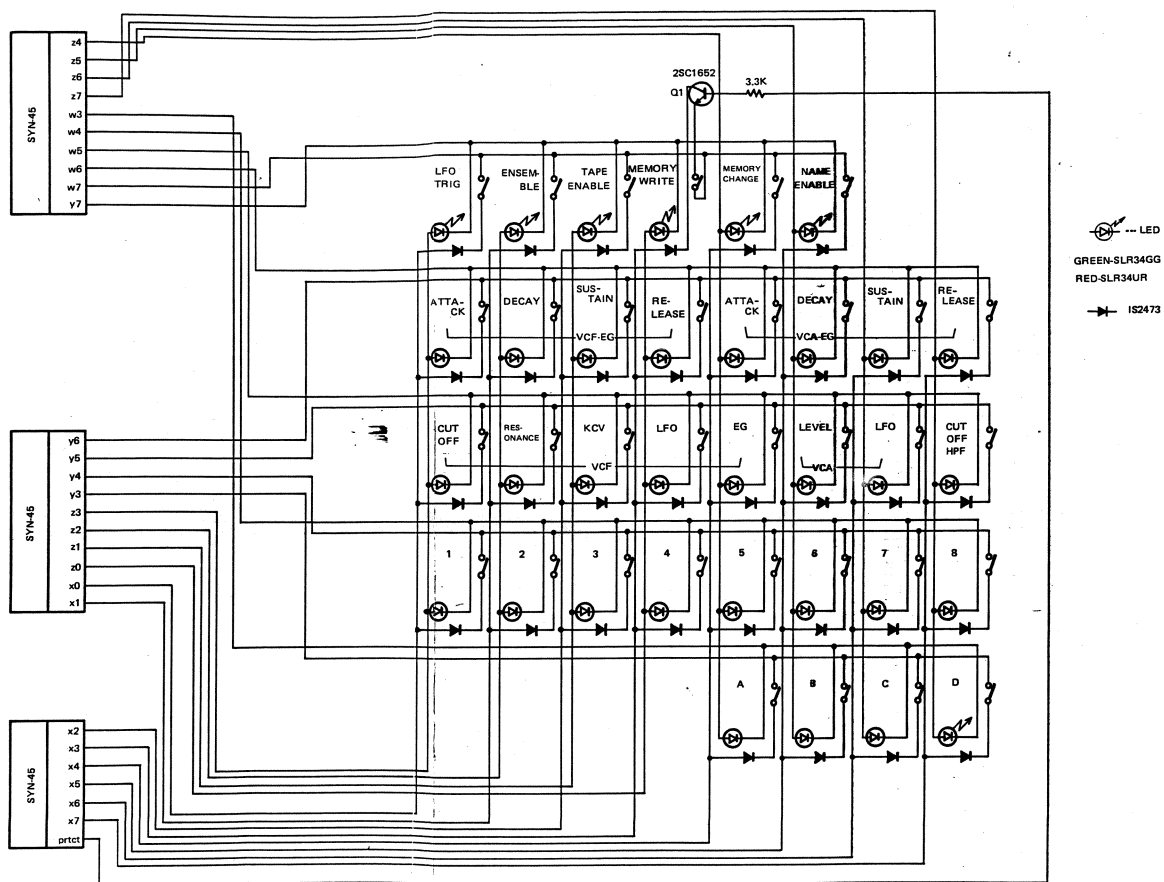


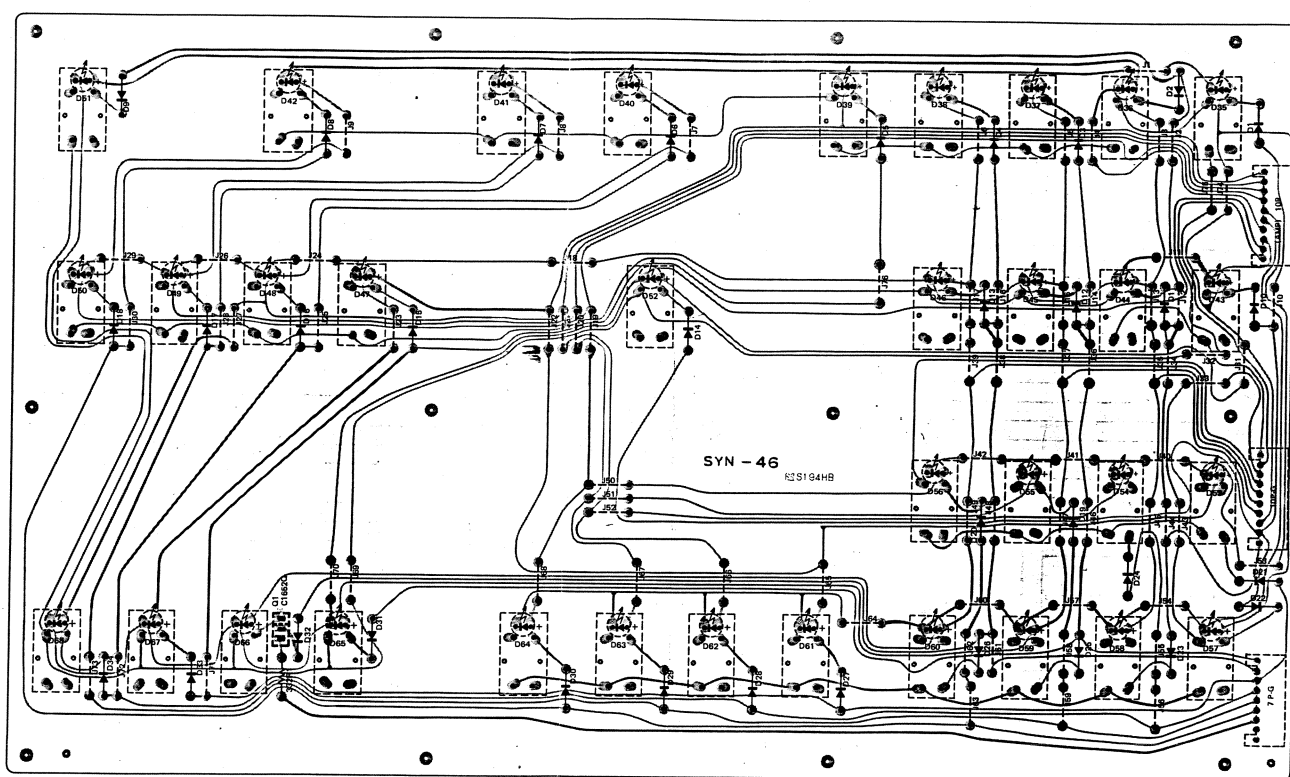


- Notes —
1. Unless otherwise specified, all diodes (D1-28) are Part No. 152473.
 2. LEDs D29-36 are Part No. SLR-34UR.
LEDs D37-56 are Part No. SLR-34GG.
 3. Connecting leads J1-156 are 0.5 mm diameter, lead-plated wires.
 4. SLR-34UR → 
SLR-34GG → 



■ SYN-46 CIRCUIT DIAGRAM RIGHT HALF PANEL





- Notes —
1. Unless otherwise specified, all diodes (D1-34) are Part No. 1S2473.
 2. LEDs D35-50 are Part No. SLR-34UR.
LEDs D51-68 are Part No. SLR-34GG.
 3. Connecting leads J1-76 are 0.6 mm diameter, lead-plated wires.

The schematic diagram illustrates the power supply and control circuitry for a medical device. The power supply section (top) features a transformer (TSE-218D) with a 220V/110V primary and a secondary with 0V, 18V, 0V, 18V, 7V, and 0V taps. The secondary is connected to a full-bridge rectifier (RB-152) and a 4700/10 electrolytic filter capacitor. The output is regulated by a 7805 (Q1) and 7815 (Q2) ICs. The control circuit section (bottom) includes a 220V/110V transformer, a 1A fuse, and a 1A switch. The control circuit also includes a 1A switch, a 1A fuse, and a 1A switch. The schematic also includes a table of component values and a list of component types.

Component	Value
I ₁ , I ₂	NJM4558DD
Q ₁ , Q ₂	TL431C
Q ₃ , Q ₄	2S8941Q
Q ₅ , Q ₆ , Q ₇	2SD1266Q
Q ₈ , Q ₉ , Q ₁₀	2SC536F
Q ₁₁ , Q ₁₂	2SA564R

Component	Value
GND	SYN-43
"	"
"	SYN-42
"	SYN-44
"	SYN-45
"	SYN-42
"	SYN-43

Component	Value
-15V	SYN-43
+15V	SYN-44
"	SYN-44
"	SYN-42
"	SYN-43

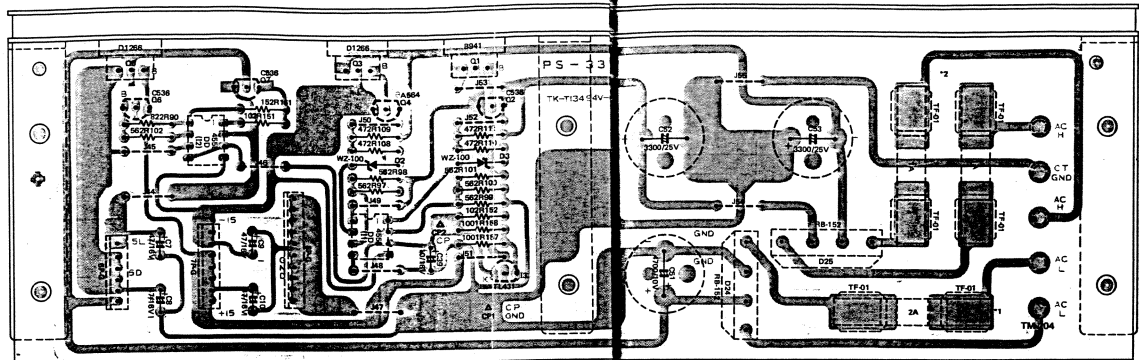
Component	Value
+5A	SYN-43
+5B	SYN-44
"	SYN-45
"	SYN-42
NR	SYN-42

The schematic also includes a table of component values and a list of component types.

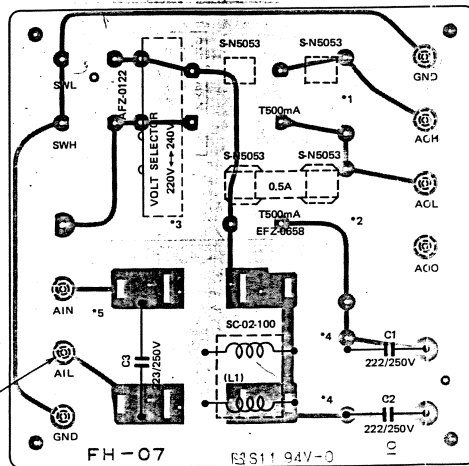
Component	Value
GND	SYN-43
"	"
"	SYN-42
"	SYN-44
"	SYN-45
"	SYN-42
"	SYN-43

Component	Value
-15V	SYN-43
+15V	SYN-44
"	SYN-44
"	SYN-42
"	SYN-43

Component	Value
+5A	SYN-43
+5B	SYN-44
"	SYN-45
"	SYN-42
NR	SYN-42



— Note —
Resistors R157-158 are metal-clad.



PS-33

Item	*1	*2
Market	Fuse	Fuse
CEE SAA	2A (5mm x 20mm)	1A (5mm x 20mm)
USA CSA	2A (6mm x 31mm)	1.5A (6mm x 31mm)
OTHERS	2A (6mm x 31mm)	1A (6mm x 31mm)

FH-07

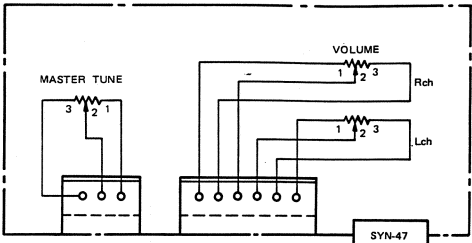
Item	*1	*2	*3	*4	*5
Market	Fuse	Fuse	Seal	Condenser	Condenser
SAA	Not Use	0.5A (5mm x 20mm)	VOLT SELECTOR 220V → 240V	222/250V (MP Condenser)	223/250V (MP Condenser)
NE-SE-CEE			Not Use		
USA	Seal	1.5A (6mm x 31mm)		222/125V	223/125V
CSA	Not Use				
JAPAN		1.25A (6mm x 31mm)		222/1000V	223/1000V
OTHERS	1A	Not Use	VOLT SELECTOR 220V → 240V		

Yellow wires
current
draw
from
micro-proc
- 240ma
to front
panel

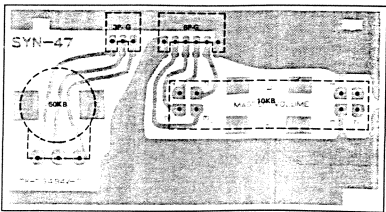
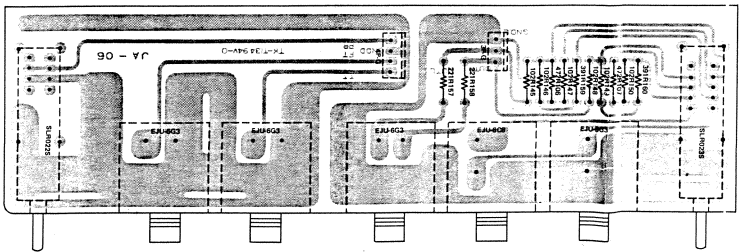
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[illegible]

OUT R	SYN-44
OUT L	SYN-44
GND L	SYN-44



GND	VIR	VOR	VOL	VIL	GND
SYN147	SYN147	SYN147	SYN147	SYN147	SYN147



8031 SINGLE-COMPONENT 8-BIT MICROCOMPUTER

■ 8031-Control Oriented CPU With RAM and I/O

- 4K x 8 ROM/EPROM
- 128 x 8 RAM
- Four 8-Bit Ports, 32 I/O Lines
- Two 16-Bit Timer/Event Counters
- High-Performance Full-Duplex
- Serial Channel
- External Memory Expandable to 128K
- Compatible with MCS-80 /MCS-85 Peripherals
- Boolean Processor
- MCS-48 Architecture Enhanced with:
 - Non-Paged Jumps
 - Direct Addressing
 - Four 8-Register Banks
 - Stack Depth Up to 128-Bytes
 - Multiply, Divide, Subtract, Compare
- Most Instructions Execute in 1 μ s
- 4 μ s Multiply and Divide

The Intel 8031/8051/8751 is a stand-alone, high-performance single-chip computer fabricated with Intel's highly-reliable +5 Volt, depletion-load, N-Channel, silicon-gate HMOS technology and packaged in a 40-pin DIP. It provides the hardware features, architectural enhancements and new instructions that are necessary to make it a powerful and cost effective controller for applications requiring up to 64K bytes of program memory and/or up to 64K bytes of data storage.

The 8051/8751 contains a non-volatile 4K x 8 read-only program memory; a volatile 128 x 8 read/write data memory; 32 I/O lines; two 16-bit timer/counters; a five-source, two-priority-level, nested interrupt structure; a serial I/O port for either multi-processor communications, I/O expansion, or full duplex UART; and on-chip oscillator and clock circuits. The 8031 is identical, except that it lacks the program memory. For systems that require extra capability, the 8051 can be expanded using standard TTL compatible memories and the byte oriented MCS-80 and MCS-85 peripherals. The 8051 microcomputer, like its 8048 predecessor, is efficient both as a controller and as an arithmetic processor. The 8051 has extensive facilities for binary and BCD arithmetic and excels in bit-handling capabilities. Efficient use of program memory results from an instruction set consisting of 44% one-byte, 41% two-byte, and 15% three-byte instructions. With a 12 MHz crystal, 58% of the instructions execute in 1 μ s, 40% in 2 μ s and multiply and divide require only 4 μ s. Among the many instructions added to the standard 8048 instruction set are multiply, divide, subtract and compare.

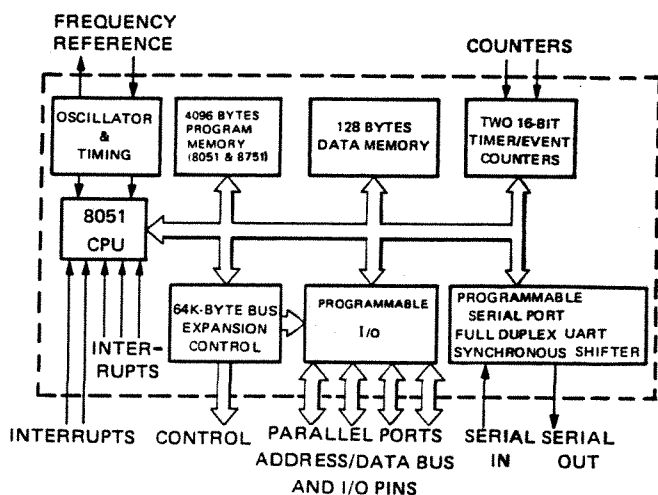


Figure 1.
Block Diagram

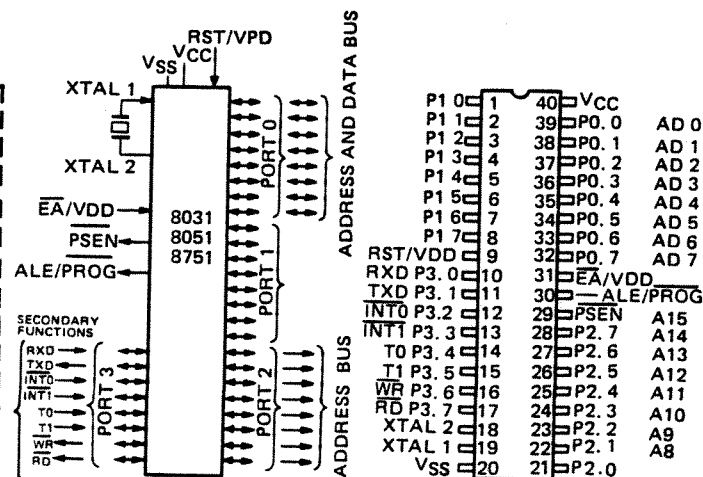


Figure 2.
Logic Symbol

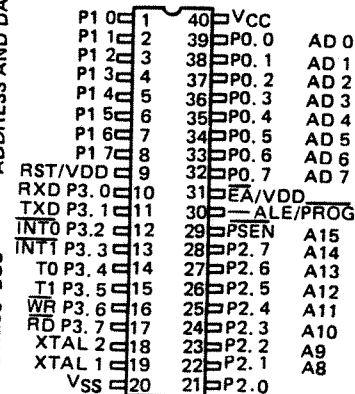


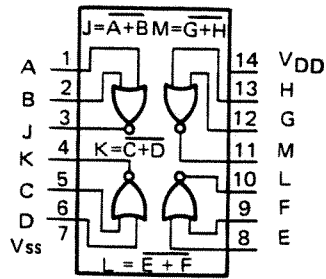
Figure 3.
Pin Configuration

Vpp	1	28	VCC
A ₁₂	2	27	PGM
A ₇	3	26	NC (1)
A ₆	4	25	A ₅
A ₅	5	24	A ₄
A ₄	6	23	A ₁₁
A ₃	7	22	OE
A ₂	8	21	A ₁₀
A ₁	9	20	CE
A ₀	10	19	O ₇
O ₆	11	18	O ₆
O ₅	12	17	O ₅
O ₄	13	16	O ₄
GND	14	15	O ₃

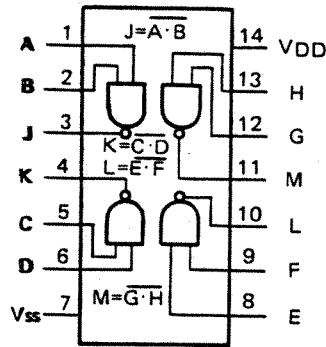
2764
(8K x 8) UV ERASABLE PROM

A ₇	1	24	VDD
A ₆	2	23	A ₈
A ₅	3	22	A ₉
A ₄	4	21	R/W
A ₃	5	20	$\overline{\text{OE}}$
A ₂	6	19	A ₁₀
A ₁	7	18	$\overline{\text{CE}}$
A ₀	8	17	I/O ₈
I/O ₇	9	16	I/O ₇
I/O ₆	10	15	I/O ₆
I/O ₅	11	14	I/O ₅
GND	12	13	I/O ₄

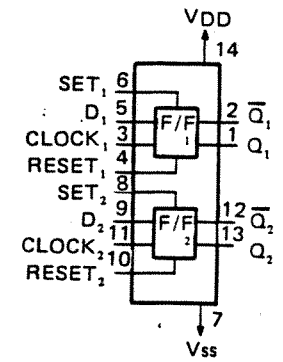
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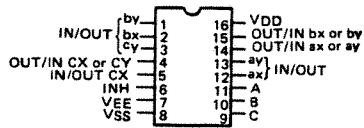
CD4001B
QUAD 2-INPUT NOR GATES



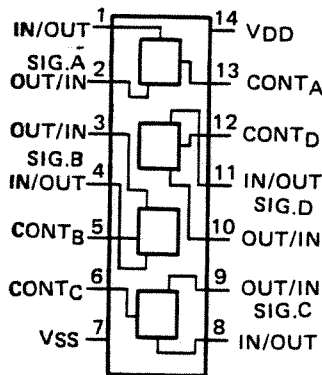
CD4011B
QUAD 2-INPUT NAND GATE



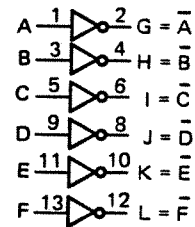
CD4013B
DUAL D-TYPE FLIP-FLOP



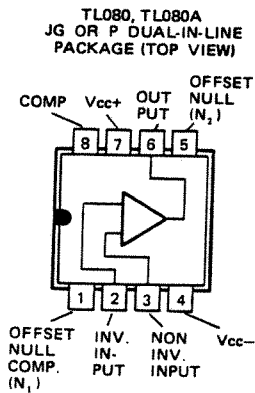
CD4053B
TRIPLE 2-CHANNEL
MULTIPLEXERS



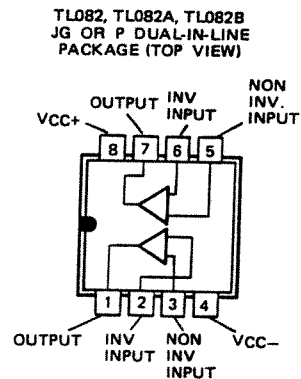
CD4066B
QUAD BILATERAL SWITCH



CD4069UB
HEX INVERTER

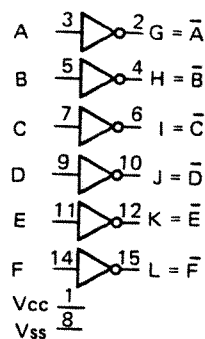


TL080

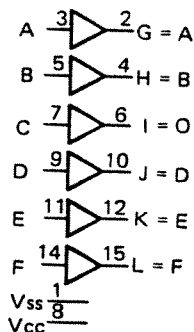


TL082

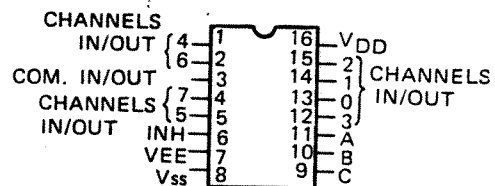
JFET-INPUT OPERATIONAL AMPLIFIERS



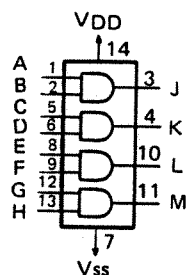
CD4049UB
HEX INVERTING BUFFERS



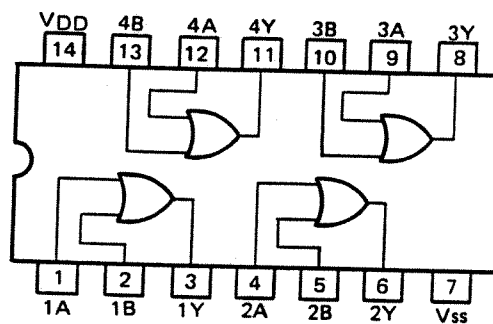
CD4050B
HEX NON-INVERTING
BUFFERS



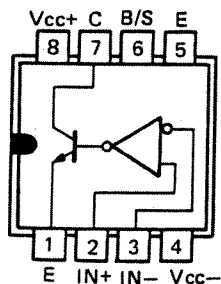
CD4051B
SINGLE 8-CHANNEL
MULTIPLEXERS



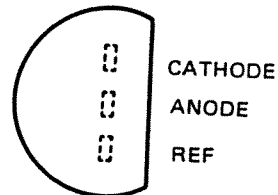
CD4081B
QUAD 2-INPUTS AND GATE



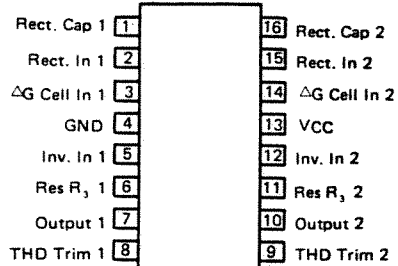
TC40H032
QUAD 2-INPUT OR GATE



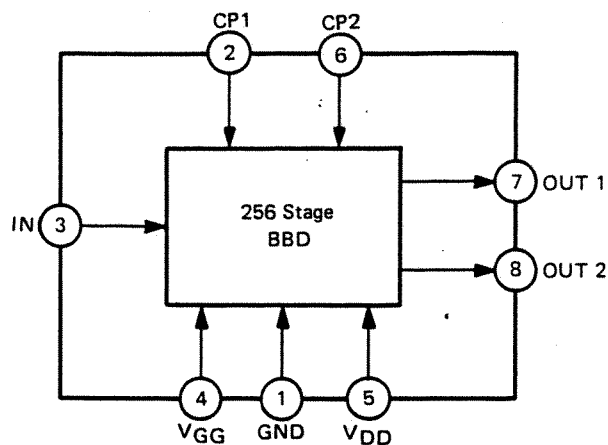
TL311
JFET-INPUT DIFFERENTIAL
COMPARATOR WITH STORBE



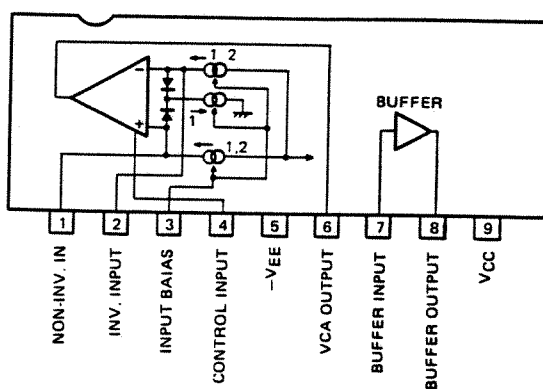
TL431
ADJUSTABLE PRECISION
SHUNT REGULATOR



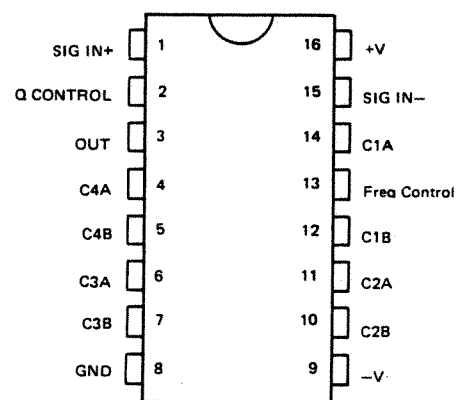
NE571N
COMPANDOR



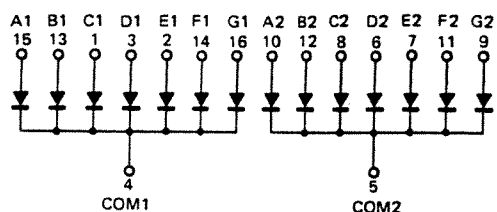
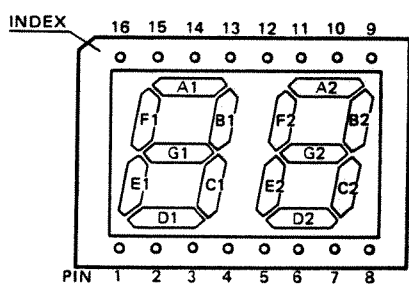
MN3009
256-STAGE BBD



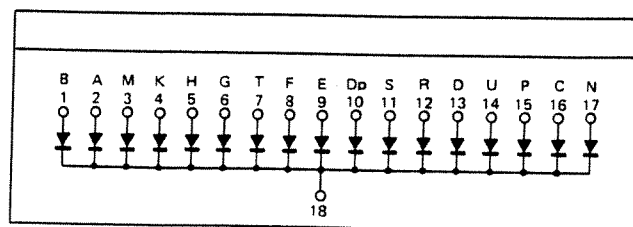
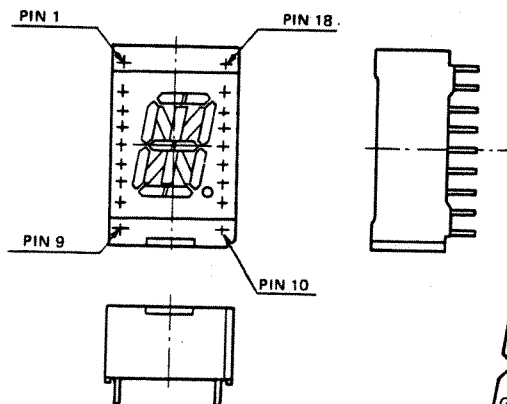
BA6110 V.C.A.



SSM 2044
4 POLE VOLTAGE CONTROLLED FILTER



LB-402



TLR-370

1. SAMPLE & HOLD (SYN-43 CIRCUIT DIAGRAM (1/2))

Components I11-I14 (Part No. CD4051BE) are multiplexers which distribute the SYN-42 digital-analog converter time sharing data.

The transistors Q_1 and Q_2 form an antilog circuit which converts a linear input into a logarithmic output. The component 1/2 I2 (Part No. TL082) then converts the output current value into a voltage, which is negative.

A zener diode supplies a -10V power supply at pin 7 of I11.

Also attached to pin 3 on the I11 component is a WZ-081 component which serves to protect the integrated circuit.

The 1/2 I2 (Part No. TL082) circuit below the antilog circuit is an adjustable temperature compensation amplifier. Its primary function is to compensate for the differences in resistance produced by temperature changes.

Further down is the KCV amplifier built around the component I3 (Part No. BA6110). Even when the KCV LEVEL is zero, pin 1 outputs the time sharing information from this component to the channels. The component is current-regulated through pin 4 so it has a transistor (Q_3) which converts voltage into a current. The base voltage has sufficient bias to ensure that the input-output characteristics are linear even when the emitter voltage (the input) is in the vicinity of zero.

The input to I13 (Part No. CD4051BE) comes directly from the digital-analog converter so is not temperature-dependent.

The SAMPLE & HOLD output from pin 13 passes through a low pass filter made up of a 1-kOHM resistance, a 1 uF capacitance, and a 1/2 I107 (Part No. NJM4558). This filter smooths out pulse width modulation (PWM) waveforms with high low frequency oscillator (LFO) frequencies to eliminate noise.

The VCF CUTOFF and low frequency oscillator (LFO) outputs from the I14 multiplexer (pins 13 and 14, respectively) are mixed to yield a single output FLFO.

The two diodes attached to pin 12 on the I14 multiplexer are to prevent the envelope generator from oscillating when the sustain level becomes negative.

The output from the component I10 (Part No. CD4050 BE) is not linear, but digital, alternating between 0 and 5V. Since the CMOS IC has a high input impedance, this output acts as a latch.

2. NOISE GENERATOR (SYN-43 CIRCUIT DIAGRAM (1/2))

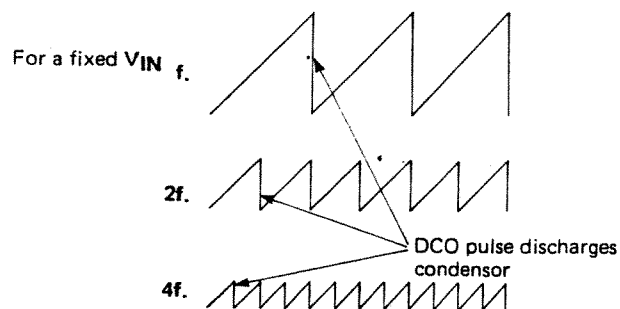
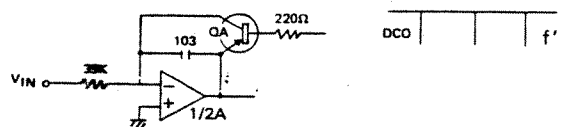
This circuit uses two 1/2 I28 (Part No. TL082) components to amplify, in two stages, the noise generated by applying a reverse bias between the base and emitter of the transistor Q_8 .

3. SAWTOOTH GENERATOR (SYN-43 CIRCUIT DIAGRAM (2/2))

As mentioned earlier, the input voltage (V_{in} in the accompanying Figure) applied to the 39 kOHM resistor is negative. This means that the operational amplifier (OP AMP) output rises at a rate proportional to this voltage value.

Each time a pulse from the 16-bit DCO PULSE GENERATOR (Part No. 8253) on circuit board SYN-42 reaches the base of transistor Q_A , it short-circuits the collector and emitter so that the condenser discharges and the operational amplifier (OP AMP) outputs starts rising from 0V once more, (see Figure 1)

Two 10 kOHM resistors divide this output in half for output to the ANALOG SWITCH (1/4C: Part No. CD4066). This terminal is also clamped through a diode to the voltage output from the 1/2 I1 (Part No. NJM4558). This clamping not only protects the ANALOG SWITCH but also blocks large amplitude waveforms formed when the frequency suddenly changes, producing a phase difference between the outputs of the timer and the SAMPLE & HOLD circuit.



For a fixed V_{IN} , the slope remains constant. As a result, the amplitude decreases in inverse proportion to the relative frequency. Therefore, V_{IN} is made proportional to the frequency.

<Figure 1>

4. PULSE WIDTH AND SUB OSC (SYN-43 CIRCUIT DIAGRAM (2/2))

The other 1/2 A (Part No. NJM4558) is a comparator. The sawtooth waveform from its noninverting (NON INV) terminal and the SAMPLE & HOLD output from its INV terminal are combined to produce the pulse width modulation (PWM) output. This output in the range $\pm 15V$ is reduced with 240 kOHM resistor. The S/H (PW) output is divided with a 39 kOHM and 47 kOHM resistor. This output provides a bias so that the PMW output has the same mean value for all values of PULSE WIDTH.

The component 1/2 B (Part No. 4013BE) is a frequency divider which outputs a square wave with a frequency half that of the digitally controlled oscillator (DCO). The integrating circuit between the oscillator and this component (made up of a 100 kOHM resistor, a diode, and condenser #101) uses the base capacity of the transistor Q_A to assure correct operation.

5. VOLTAGE CONTROLLED FILTER (VCF) (SYN-43 CIRCUIT DIAGRAM (2/2))

Central to the VCF circuit is the ID component (Part No. SSM2044).

Pins 1 and 15 are for the noninverting (NON INV) and INV inputs, respectively. Both inputs are grounded through 470-ohm resistors to provide bias.

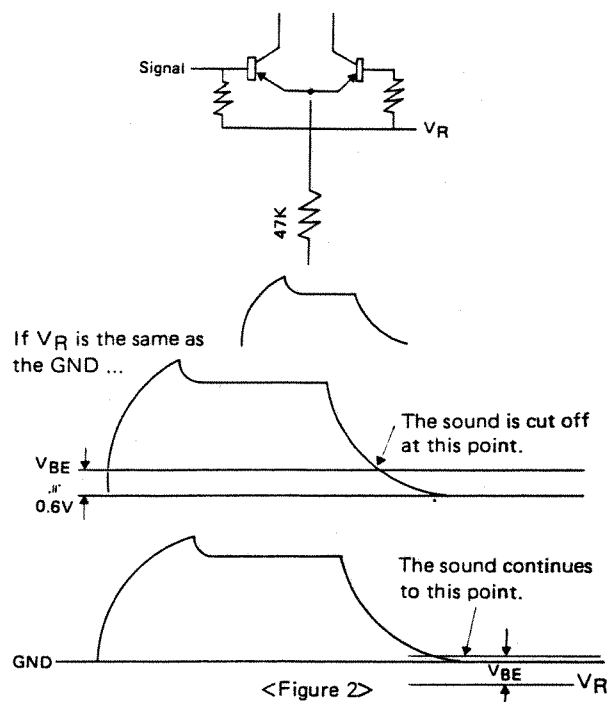
Pins 2 and 13 control the RESONANCE and CUTOFF frequencies, respectively. These inputs can be linear because the ID component incorporates linear-antilog converters. The cutoff frequency changes approximately 10 octaves for every 1V change in the output of the 1/2 E (Part No. NJM4558), a component which simultaneously mixes the outputs of the SAMPLE & HOLD CUTOFF, SAMPLE & HOLD KEY CONTROLLED VOLTAGE (KCV), and VCF envelope generator and reverses the polarity of the output waveform.

The output from ID component (pin 3) is a current. A second 1/2 E (Part No. NJM4558) converts this into a voltage supplied to the check pin of each channel.

6. CHANNEL VCA (SYN-43 CIRCUIT DIAGRAM (2/2))

The CH voltage controlled amplifier (VCA) circuit uses a transistor QB (Part No.2SA798) with a common emitter to form a differential amplifier. The emitter's regulating current is the output from the VCA envelope generator. The 1/2 I25 component and the two 1/2 I26 components mix the outputs from the channels, convert the current differential output into a voltage input for the variable input amplifier.

The remaining 1/2 I25 component provides, through a 220 OHM resistor, a bias to the base of the QB transistor QB. This bias serves the same function as that applied with a diode to the transistor controlling the component I3 (Part No.BA6110) discussed in SECTION 1. SAMPLE & HOLD; it keeps the sound from disappearing as the QB emitter voltage approaches 0V. (see Figure 2) The net result is clear aftereffects for tones such as PIANO.



7. HIGH PASS FILTER (HPF) AND TOTAL VCA CIRCUITS (SYN-43 CIRCUIT DIAGRAM (2/2))

These two circuits represent variations on the KCV portion of the I3 (Part No.BA6110) circuit discussed in SECTION 1. SAMPLE & HOLD. The only differences are that, in the HPF circuit, the I24 (Part No.BA6110) component's condenser input is connected to what is normally the current output and the buffered output is fed back into the noninverting (NON INV) input.

8. ENVELOPE GENERATORS (SYN-43 CIRCUIT DIAGRAM (2/2))

Note: The two generators are identical so we shall limit our description to the VCF one.

The normal voltage after no key has been played for some time is 0V at the points P_1 & P_2 in Figure 3 (at the outputs of the component 1/2 G and after the diode attached to the output of the component 1/2 F (Part No. NJM4558)). The circuit's negative logic relies on a normal voltage of 15V for the KEYING SIGNAL from SYN-42.

8.1 ATTACK

When a key is pressed, the leading edge of the voltage drop in the KEYING SIGNAL passes through the condenser (Part No.103) to feed a negative pulse to the INV terminal of the component 1/2 F. On the NON INV ter-

minal, there is only a slight negative balance so the output inverts to +15V. The voltage at point P_2 also becomes 15V short circuiting the component GE1 and putting point P_1 at the EG LEVEL.

On the other side of the circuit, the AND GATE (a) passes the ATTACK CLOCK signal to trigger the component GE2 and hence start the condenser 104 charging toward the EG LEVEL.

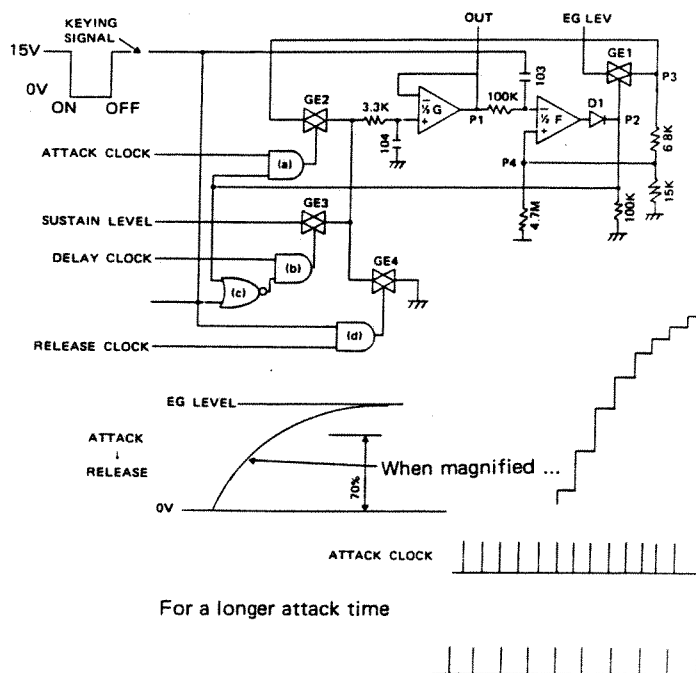
8.2 DECAY OR SUSTAIN

The voltage at P_4 is approximately 70% [= 15/(6.8 - 15)] that at P_3 , the EG LEVEL. When the 1/2 G output (at point P_1) reaches this voltage level, the component 1/2 F inverts once again to produce a level of 0V at point P_2 . The component GE1 opens to return the point P_4 to its previous state.

This voltage drop changes the output of the AND GATE (a) to LOW, but results in a HIGH output from the combination of the AND and NOR gates (b) & (c). In conjunction with the DECAY CLOCK, this output closes the component GE3 to bleed the charge from the condenser (Part No.104) to the SUSTAIN LEVEL.

8.3 RELEASE

When the key is released, the KEYING SIGNAL returns to 15V, the level which produces a LOW output from the NOR gate (c). The NAD gate (d) combines the KEYING SIGNAL with the RELEASE CLOCK to close the component GE4 and divert the condenser's remaining charge from the SUSTAIN LEVEL to the circuit GND.



9. MICROCOMPUTER (SYN-42)

The core of the microcomputer is the component I23, the central processing unit (CPU), a 8051-series 8-bit micro-processor. The pins 00–07 (AD0–AD7) output the multiplexed data and lower half of the address to the DATA and ADDRESS BUSES, while the next eight pins (20–27) output the upper half of the address (A8–A14). The component I20 separates out the lower half of the address (A0–A7) from the multiplexed data (AD0–AD7).

9.1 PROGRAM

The SX-210 program is stored in the component I16 (Part No.2764), an 8-kilobyte erasable programmable read-only memory (EPROM). The CPU follows the instruction steps contained in this program.

9.2 STORAGE

The computer's 2 kilobytes of main storage is located in the component I12 (Part No.5517). This battery-protected ROM [?] acts primarily as the TONE MEMORY, but also serves as a work area for the CPU.

9.3 DIGITAL-ANALOG CONVERTER

Components I26, I27 (combined in Part No.CD4049), and I29 (Part No.TL082), together with the ladder network built up of 10 kOHM and 20 kOHM resistors, form a 10-bit digital-analog converter which outputs, on a time-shared basis, the voltage outputs from the CPU's output port (pins 10–17). This output is used primarily as the voltage output of the SAMPLE & HOLD function. It is also fed into the component I28 (Part No.TL080) to form an 8-bit analog-digital converter for the PITCH BENDER circuits.

9.4 500 Hz OSCILLATOR

The two inverter gates (I18) form a 500 Hz oscillator, the output of which is connected to one of the CPU's interrupt terminals (pin 33) to flash all the LEDs on the SX-210 panel.

9.5 480 kHz OSCILLATOR

The other oscillator in the component I18 provides the components I4 and I5 (both Part No.8253(2M)) with the master clock signal for the envelope generators.

9.6 MASTER OSCILLATOR

The circuit containing the transistors Q1 and Q3 generates the master frequency (approximately 4 MHz) for building sounds.

9.7 DCO PULSE GENERATOR

Together, the components I1, I2 and I3 (Part Nos.8253 (2M)/(4M)) generate the DCO PULSE from data supplied by the CPU. The pulse outputs (DC0–DC7) are then fed into the SAWTOOTH GENERATOR on circuit board SYN-43.

9.8 SHIFT CIRCUITS

The components I7 and I8 (both Part No.U1N2003AV) shift the input voltages—EG PULSE and KEYING SIGNAL, respectively—from 0 vs. +5V to 0 vs. +15V.

9.9 PULSE INPUT PORTS

The components I10 and I14 (both Part No.LS367) are input ports for the pulses returning from the KEYBOARD, PANEL, and INCREMENTER.

9.10 KEY SCAN

The component I17 (Part No.LS138) generates the SCANNING PULSES sent to the keyboard. Pulses returning from the keyboard signal the program to generate a sound.

9.11 DELAY CIRCUIT

The eight elements of the components I21 and I22 (Part Nos. CD4001 and CD4011, respectively) form a monostable vibrator which momentarily blocks the output and thus eliminates shock noise when changing tones.

9.12 CASSETTE INTERFACE

The component I25 (Part No.TL211) is an amplifier which converts data from the cassette player into the digital form.

9.13 CASSETTE INTERFACE

The transistors Q2 and Q4 (Part Nos. A564 and C536) cut in the battery to protect the contents of the TONE MEMORY when the power supply is turned off.

10. PROGRAM

10.1 SOUND GENERATION

The first stage of the program is a KEY SCAN. The component I17 (Part No.LS138) sends out eight consecutive pulses to each group of eight keys in order from the lower end of the keyboard through the circuits marked KS0–KS7.

Note: KS7 is attached to only five keys so the component sends only five pulses.

If none of the keys are depressed, none of these pulses return to the components I10 and I14 (both Part No. LS367). The microprocessor repeats the scan until receives such a pulse.

When, however, a key is pressed, the returning pulse signals the processor to compute, from the pulse timing, which key has been pressed. The relevant frequency data for that key then goes to an open channel selected from the 8 provided by the components I1, I2 and I3 (Part No.8253). It is the channel which outputs the actual frequency. At the same time, the computer directs the component I8 (Part No.U1N2003AV) to start issuing the KEYING SIGNAL for the channel so that the circuit board SYN-43 can generate the sound.

10.2 REGENERATING THE SAMPLE & HOLD DATA

The SAMPLE & HOLD circuit forms the interface between the digital circuits of the microcomputer and the analog circuits generating the sound output. The program sets the 31 condensers in the SAVE & HOLD circuit by inputting the data stored in digital form in the EPROM I26 (Part No.2764) and outputting it sequentially, on a time-shared basis, through the digital-analog converter made up of the components I26 and I27 (combined into Part No. CD4049). However, with the passage of time, the charge on the condensers fades. Therefore, the computer must repeat this process at regular intervals to regenerate the data.

Note that this data differs for each tone. When the tone is changed, the computer completely replaces all data in the SAMPLE & HOLD condensers.

10.3 INCREMENT

The INCREMENT knob on the panel, as is readily evident from the SYN-45 circuit diagram, is connected to only two switches. The position of this knob determines the relative timing with which these two switches turn on. The component I14 then outputs this parameter to the computer.

If the increment knob is off the mid-position, this parameter is non-zero so the computer adjusts the output to the synthesizer. The change in parameter then produces a change in tone.

10.4 PITCH BENDER

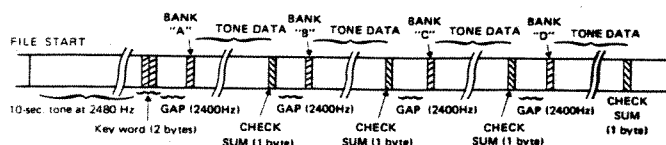
The PITCH BENDER is connected to a self-restoring rotating rheostat. The analog-digital converter—made up of the component I28 (Part No.TL080), the ladder network of 10- and 20-kOHM resistors, and components I26 and I27 (combined into Part No.CD049)—changes the electrical analogue of the rheostat position to a digital input for the computer. This converter is programmed for sequential comparisons. The computer, once it has this information, calculates the proper frequency to be added to the waveforms of each channel.

10.5 PANEL SCAN

The PANEL SCAN is essentially the same as the KEYBOARD SCAN and immediately follows it. The only difference is that only one switch can be pressed at a time. When one of the panel switches is pressed, the computer immediately alters the corresponding section of the program flow. Otherwise, it simply proceeds with the current flow.

10.6 TAPE INTERFACE

The hardware component of the tape interface consists of only the circuitry centered on component I25. The bulk of the formatting is handled by the computer program.



The data transfer itself only takes about 20 seconds.

11. INTERRUPTS

The SX-210 uses three different types of interrupts. In order of decreasing precedence, they are:

11.1 LED INTERRUPT

All LEDs on the panel flash at the frequency of 500 Hz provided by the oscillator in component I18. This interrupt keeps the LED from flickering.

11.2 PORTAMENTO/GLISSANDO INTERRUPT

This interrupt occurs only for PORTAMENTO/GLISSANDO notes. This interrupt uses the CPU's internal timer so it can occur at frequencies of up to 5 kHz.

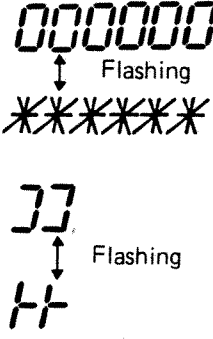
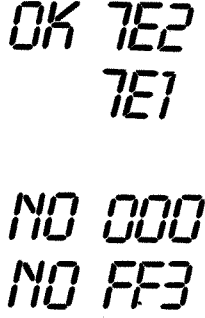


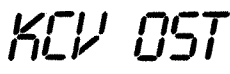
11.3 LOW FREQUENCY OSCILLATOR (LFO) INTERRUPT





The low frequency oscillator function is handled entirely with interrupts. The only physical correlate is the output terminal to the SAMPLE & HOLD circuit.

This interrupt, too, uses the CPU's internal timer, but the frequency is controlled by the LFO SPEED setting. The maximum frequency is 300 Hz.

Processing affected includes DELAY, VIBRATO, PITCH BENDER, VCF MODULATION, VCA MODULATION and EG TRIGGER. There are two LFO outputs: VCF MODULATION and VCA MODULATION (S/H).

ADJUSTMENTS

Adjustment	Voice Identifier	Procedure
1. Panel check		<ol style="list-style-type: none"> 1. Holding down the lowest C-major chord (C6-E5-G5), switch on the power. 2. Hold the chord for 1 or 2 seconds and then release. 3. All LEDs should start flashing. 4. Press each switch on the panel. 5. The corresponding LED should stop flashing. 6. If the MEMORY PROTECT switch on the rear panel is in the PROTECT position, the LED in the MEMORY WRITE switch will keep flashing even when it is pressed. 7. When the LEDs for all the switches are out, the diagnostic routine will automatically proceed to STEP 2: PITCH BEND. 8. To bypass any or all of the panel check, press the C6 key once. - Use the same key to signal the end of steps 2-4.
2. PITCH BEND adjustment		<ol style="list-style-type: none"> 1. Turn the PITCH BEND adjuster (#1) on the SYN-42 circuit board until the last three digits of the VOICE IDENTIFIER display read either 7E1 or 7E2. 2. Rotate the PITCH BEND lever all the way in both directions. The VOICE IDENTIFIER display should read 000 at the counterclockwise extremity and FF3 at the other. 3. Press the C6 key once to proceed to the next step. (The same applies to steps 3 & 4.)
3. MASTER OSC adjustment		<ol style="list-style-type: none"> 1. Set the MASTER TUNE control in mid-position. 2. Turn the MASTER FINE TUNE adjuster (#2) on the SYN-42 circuit board until the VOICE IDENTIFIER display reads in the range 440.81-440.88. Note: This is the only step requiring a turning screwdriver.
4. TEMPERATURE COEFFICIENT adjustment		<ol style="list-style-type: none"> 1. Turn the TEMPERATURE COEFFICIENT adjuster (#2) on the SYN-43 circuit board until the voltage at check pin #2 is 4.50V. Note: Use a digital voltmeter to measure the voltage.
5. KCV OFFSET adjustment		<ol style="list-style-type: none"> 1. Turn the KCV OFFSET adjuster (#4) on the SYN-43 circuit board until the waveform at check pin #1 is centered on the 0V line. Note: Use the oscilloscope's maximum voltage range. 2. Simultaneously press C6 and F#5 once to proceed to the next step. Note: The diagnostic routine will replace the contents of the 32 tone memory locations with ROM test data so SAVE the current data, if required, on tape before proceeding to the next step.

Adjustment	Voice Identifier	Procedure										
6. VCF OFFSET RESONANCE adjustment		<p>Note: Set the parameters to the follow values:</p> <table><tr><td>VCF CUTOFF</td><td>50</td></tr><tr><td>RESONANCE</td><td>98</td></tr><tr><td>MOD (KCV, LFO, EG)</td><td>0</td></tr><tr><td>KEY</td><td>all off and C1 (CH.1) only</td></tr></table> <ol style="list-style-type: none">After setting the tone memory switches to A-1, examine the SYN-43 check pin #8 trace on an oscilloscope set to its maximum range.Turn the VCF OFFSET (CH.1) adjuster (#7) until the waveform (or trace) is centered on the 0V line.After turning the VCF RESONANCE LEVEL (CH.1) adjuster (#23) counterclockwise to start the signal, turn it clockwise to the exact level at which the signal stops.Repeat the above procedure for the A-2 through A-8 tone control settings (connecting the oscilloscope to check pins #9 – #15 and using the corresponding of adjusters) to adjust all eight channels.	VCF CUTOFF	50	RESONANCE	98	MOD (KCV, LFO, EG)	0	KEY	all off and C1 (CH.1) only		
VCF CUTOFF	50											
RESONANCE	98											
MOD (KCV, LFO, EG)	0											
KEY	all off and C1 (CH.1) only											
7. VCF CUTOFF (CH.1) adjustment		<p>Note: Set the parameters to the follow values:</p> <table><tr><td>VCF CUTOFF</td><td>50</td></tr><tr><td>RESONANCE</td><td>99</td></tr><tr><td>MOD (KCV, LFO, EG)</td><td>0</td></tr></table> <ol style="list-style-type: none">After setting the tone memory switches to A-1 and the SUB OSC switch to ON, write into A-1.With the oscilloscope attached to check pin #8 on the SYN-43 circuit board, turn the VCF CUTOFF (CH.1) adjuster (#15) on the SYN-43 circuit board until the amplitude is at its maximum.Set the tone memory switches to B-1 and make sure that the pitch is still approximately the same when heard through the monitor amplifier.	VCF CUTOFF	50	RESONANCE	99	MOD (KCV, LFO, EG)	0				
VCF CUTOFF	50											
RESONANCE	99											
MOD (KCV, LFO, EG)	0											
8. VCF CUTOFF (CH2-CH8)		<ol style="list-style-type: none">Connect the SIGNAL OUT terminal to the monitor amplifier. (Or, alternatively, use a headphone.)Change the tone memory switches to B-2 to compare channels 1 and 2. Turn the VCF CUTOFF (CH.2) adjuster (#16) on the SYN-43 circuit board until the pitches agree.Repeat this process for channels 3 through 8, changing the tone memory number and turning the appropriate VCF CUTOFF adjuster (#17 – #22).										
9. KCV LEVEL adjustment		<p>Note: Set the parameters to the follow values:</p> <table><tr><td>C-1 Signal generators</td><td>all OFF</td></tr><tr><td>VCF CUTOFF</td><td>50</td></tr><tr><td>RESONANCE</td><td>99</td></tr><tr><td>LFO EG</td><td>0</td></tr><tr><td>Oscilloscope range</td><td>200 μsec/div</td></tr></table> <ol style="list-style-type: none">Set the tone memory switches to B-1 and observe the waveform at check pin #4 on the SYN-43 circuit board.Adjust the oscilloscope until one wavelength occupies eight (8) divisions on the horizontal scale.Change the tone memory switches to C-1 and turn the KCV LEVEL adjuster (#3) on the SYN-43 circuit board until one wavelength occupies one (1) division on the horizontal scale. <p>Note: It is also possible to tune by ear until C-1 is three octaves higher than B-1. However, in this case, it is necessary to check the intervals by striking each key in order from the lower end of the keyboard.</p>	C-1 Signal generators	all OFF	VCF CUTOFF	50	RESONANCE	99	LFO EG	0	Oscilloscope range	200 μ sec/div
C-1 Signal generators	all OFF											
VCF CUTOFF	50											
RESONANCE	99											
LFO EG	0											
Oscilloscope range	200 μ sec/div											

set PW control to 50
1st

Adjustment	Voice Identifier	Procedure
10. ANTILOG AMP adjustment	PLSWIS	1. After setting the tone memory switches to C-2 and connecting the SYN-43 check pin #4 output to the oscilloscope, turn the ANTILOG OFFSET adjuster (#1) until the duty is 50%. Note: Use the 200 μ sec/div range of the oscilloscope.
11. VCA OFFSET adjustment	VCA ADJ	1. With the same connections, change memory switches to C-3. 2. Turn the VCA OFFSET adjuster (#5) until the level is at its minimum.
12. NOISE LEVEL adjustment		1. Attach a millivoltmeter to check pin #7 and turn the NOISE LEVEL adjuster (#6) on the SYN-43 circuit board until the level is -10 dBm. Note: Use a millivoltmeter. The RMS reading should be approximately 1.8 volts.
13. ENSEMBLE DEPTH adjustment		1. Connect the oscilloscope to check pin #4 on the SYN-44 circuit board and turn the ENSEMBLE DEPTH adjuster (#1) until the waveform measures approximately 2.5V peak-to-peak.
14. Signal-to-noise ratio check	MAX (C-4) BASIC (C-5)	1. With the panel VOLUME at the maximum (10), set the output level selector switch (located on the rear panel) to the +4 dBm position, and attach the millivoltmeter to the SIGNAL OUT (LEFT) socket. 2. Shift the tone memory switches between C-4 and C-5. The signal-to-noise ratio should be at least 70 dB.

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■ PARTS LIST

235740 SYN-42 (1)
 235741 SYN-43 (1)
 235742 SYN-45 (1)
 235743 SYN-46 (1)
 235744 FH-07 (1) JAPAN
 235745 FH-07 (2) CEE, SAA
 235746 FH-07 (3) OTHERS
 235747 FH-07 (4) USA
 235748 FH-07 (5) CSA
 235753 FH-07 (6) NE
 235749 SYN-44, 47, PS-33, JA-06 (1) JAPAN
 235750 SYN-44, 47, PS-33, JA-06 (2) USA
 235751 SYN-44, 47, PS-33, JA-06 (3) CEE, SAA, NE
 235752 SYN-44, 47, PS-33, JA-06 (4) CSA
 708028 BATTERY GB50-3
 800084 POWER TRANS TSE-218D
 POWER TRANS TSE-218U
 POWER TRANS TSE-218I
 POWER TRANS TSE-218E
 710368 VOLUME GM70E 50KB
 713616 POWER SWITCH WK2A44
 787302 KNOB RVT-4
 787422 KNOB SVT-4 (YELLOW)
 800079 KNOB RVT-10
 787329 SENSOR LEVER
 787376 CODE WINDER
 789322 SHIELDED CODE 2.5M
 800078 SW. GUARD
 800080 VOICE PLATE
 800081 NUMBER COVER
 800073 C-SCALE KEYBOARD ESK-7013
 C KEY
 D KEY
 E KEY
 F KEY
 G KEY
 A KEY
 B KEY
 TOP-C KEY
 # KEY
 800094 DATA CASSETTE TAPE
 900215 SIDE BOARD (RIGHT)
 900220 SIDE BOARD (LEFT)

SYN-42

706025 IC C-MOS 4001 BP
 706029 IC C-MOS 4069
 706039 IC CD 4011
 706069 IC TL 082CP
 706080 IC C-MOS 4049B
 706085 IC TL 080
 706102 TRANSISTOR 2SA564R
 706123 TRANSISTOR 2SC536G
 706544 Z. DIODE WZ-052
 706917 IC SN74LS367N
 706929 IC SN74LS373N
 706939 IC SN74LS138
 706986 IC 8253C-5
 706996 IC MB74LS374
 710412 OSC COIL 25MH
 800044 RESISTOR RM 8-332J
 800046 IC P8031
 800047 IC MSM5128-15RS
 800048 IC TC40H032P
 800049 IC ULN2003A
 800050 IC TL311P
 800053 X-TAL HC18/U12.000MHZ
 900841 IC 2P25A MBM2764-25
 706301 DIODE 1S2473

SYN-43

706025 IC C-MOS 4001 BP
 706032 IC C-MOS 4081B
 706042 IC C-MOS 4013B
 706051 IC C-MOS 4050B
 706069 IC TL082CP
 706077 IC NJM-4558DD
 706102 TRANSISTOR 2SA564R
 706123 TRANSISTOR 2SC536G
 706141 TRANSISTOR 2SA798
 706301 DIODE 1S2473
 706502 Z. DIODE WZ-100
 706511 FET 2SK44D
 706937 IC BA6110
 800051 IC CD4066 BE
 800056 IC SSMT2044
 800057 Z. DIODE WZ-081
 800140 IC CD4051 BE

SYN-45

706529	LED	SLR-34UR
706530	LED	SLR-34GG
706939	IC	SN74LS138
706994	IC	MB74LS175
706996	IC	MB74LS374
800031	IC	M54563P
800032	TRANSISTOR	2SC1652Q
800033	LED DISPLAY	TLR-370
800034	LED DISPLAY	LB-402-AK
800035	TACT SW	KHC10011
800036	PULSE SW	SGFV01T
800044	RESISTER	RM 8-332J
800049	IC	ULN2003A
900090	PUSH BUTTON	BLACK
900095	PUSH BUTTON	RED
900100	PUSH BUTTON	GRAY
900105	PUSH BUTTON	WHITE
706301	DIODE	1S2473

SYN-46

706529	LED	SLR-34UR
706530	LED	SLR-34GG
800032	TRANSISTOR	2SC1652Q
800035	TACT SW	KHC10011
900090	PUSH BUTTON	BLACK
900095	PUSH BUTTON	RED
900100	PUSH BUTTON	GRAY
900105	PUSH BUTTON	WHITE
706301	DIODE	1S2473

FH-07

800058	SC COIL	SC-02-100
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SYN-44, 47 PS-33 JA-06

706071	IC	MN3009
706077	IC	NJM-4558DD
706080	IC	C-MOS 4049
706101	TRANSISTOR	2SC536F
706102	TRANSISTOR	2SA564R
706319	DIODE	RB-152
706502	Z. DIODE	WZ-100
706507	Z. DIODE	WZ-120
706544	Z. DIODE	WZ-052
706906	IC	C-MOS 4053B
707019	IC	NJM-4556D
713327	LEVER SW	SLR02337
713656	LEVER SW	SLR022
784104	PHONE JACK	EJU6G3
784105	SHORT JACK	EJU6C8
800060	INCREMENT VR.	EVH-5XAK15B54
800061	SLIDE VOL	EVH-VBPS10B14
800062	IC	NE571
800063	IC	TL431
800064	TRANSISTOR	2SB941Q
800065	TRANSISTOR	2SD1266Q
706301	DIODE	1S2473

