USER'S MANUAL

SAMPO®

MODEL CN3165
HIGH RESOLUTION COUNTER

SAMPO CORPORATION

INDEX

SAMPO
INSTRUMENT

1. Description

The SAMPO model CN3165 is a high resolution counter which is microprocessor based design, measuring signals over a wide range from 0.1Hz to 100MHz in CH.A band. The instrument measures frequency and period that are displayed in engineering notation with up to eight digits of resolution.

The CH.A input has an attenuator (X1, X20), trigger level control (AUTO or manual), AC-DC coupling and a switchable low-pass filter. The input sensitivity in full band is below 25mV. The gate time is continuously variable control from 60 mS to 10S.

In CH.B, allows frequency measurements in the range of 50MHz to 1GHz. The input sensitivity is 15mV for frequency between 50MHz and 650MHz, and 35mV for frequency between 650MHz and 1GHz. **The CH.B is a 50-ohm impedance with a dynamic input range of 1Vrms.** The input signal is prescaled by 256 to achieve the microprocessor counting range.

2. Specifications

Input Characteristics

CH. A (0.1Hz ~ 100MHz)

Frequency Range: DC couple 0.1Hz to 80 MHz
AC couple 30Hz to 80MHz
Sensitivity : 15mVrms 0.1Hz to 50 MHz
25mVrms 0.1Hz to 80 MHz
25mVrms 50MHz to 80 MHz
Dynamic Range : Sensitivity to 2Vrms
Coupling : AC/DC
Filter : Low Pass (≈ 100KHz, -3dB), CH.A only
Input Impedance: 1MΩ // 40PF
Attenuator : X1, X20
Trig Mode : AUTO or Manual
Trig Level : AUTO: Preset
Manual: -2.5V to +2.5V Variable
Max. Input : 250V (DC +AC peak)
Period Range : 10nS to ≥ 10S

CH. B (50MHz~1GHz)

Frequency Range : 50MHz to 1 GHz
Sensitivity : 20 mV, to 650 MHz
70 mV, to 1GHz
Coupling : AC only
Input Impedance : 50Ω
Max. Input : 3Vrms

Resolution: At least five digits display at Minimum gate time. Resolution depend on setting gate time control.

Timebase:

Frequency : 10MHz
Aging Rate : ≤ 1PPM/Month
Coefficient : ≤10PPM, 0°C ~ 40°C
Accuracy : ≤ 50PPM
Line Variation : ≤0.1PPM for line voltage ±10%

Gate Time: Continuously Variable, from 60mS to 10S, or 1 period of input signal, whichever is longer

Display:

Frequency : 8 digit, 0.3" LED
Exponent : 1 digit, 0.3" LED
Unit : Hz, S
Sign : "–"
Operating Indication: OVFL (overflow), Gate time, Trig level.

Operation Environment:

Normal Range : 15°C ~ 35°C, ≤80% R.H.
Usable Range : 0°C ~ 50°C; ≤85% R.H.

Power : 110V ± 10%,60Hz or 220V ± 10%, 50Hz (ordered)

Weight : About 2.5Kg

Dimension : 277(ℓ) x 236(W) x 85(h) mm

Accessories : Manual, Power Cord, Test Probe

3. Function Description

3.1 Front Panel Indication:

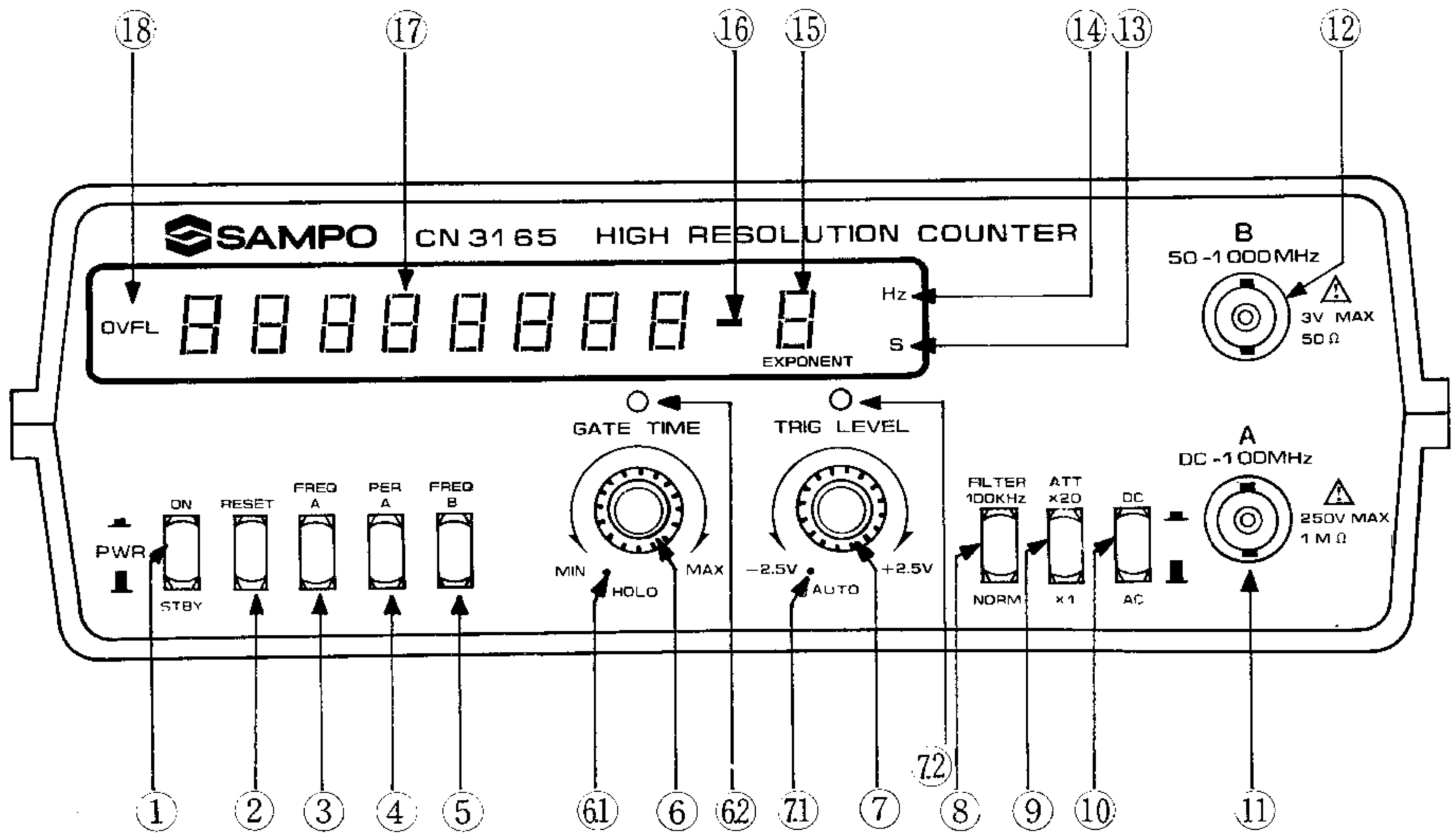

FIG. 3.1 FRONT PANEL

3.2 Function Description

Item	Indication	Description
1	ON/STBY	Power switch
2	RESET	Reset switch
3	FREQ A	CH. A Frequency function (0.1Hz~100MHz)
4	PER A	CH. A Period function
5	FREQ B	CH. B Frequency function (50MHz~1GHz)
6	GATE TIME	Variable gate time control, 60ms to 10s
6.1	HOLD	Hold gating function, measured data keep on LED
6.2	GATE LED	Gate LED in ON state indicates that gating interval is proceeding.
7	TRIG LEVEL	Variable manual trig level control, range from -2.5V to +2.5V (CH. A only)
7.1	AUTO	Auto trig mode
7.2	TRIG LED	Trig LED flickering indicates trig function actuated. LED is always in ON or OFF that indicates trig function in idle state
8	FILTER	Low pass filter, 100KHz (-3dB)
9	ATT	Attenuator, XI, X20 (Signal Level>2Vrms, use X20)
10	DC/AC	Coupling switch, Normal: AC, Push in: DC (Freq.<30Hz, use DC)
11	A	CH. A input BNC, 0.1Hz~100 MHz
12	B	CH. B input BNC, 50MHz~1GHz
13	S	Second, period domain
14	Hz	Hertz, Frequency domain
15	EXPONENT	Displays the value of exponent of measurement in engineering notation, with exponent of blank (0), ±3, ±6, ±9 .
16	EXPONENT SIGN	Minus ("–") sign, indicates the polarity of the displayed exponent.
17	DATA LED	Eight digit red LED display
18	OVFL	Overflow, LED ON indicates that one of the more of the most significant digits are not displayed.

4. OPERATING INSTRUCTION:

4.1 Power ON self-check: (Refer to fig. 3.1 front panel)

1. Before switching ON the instrument, ensure that the power voltage is matched to the voltage setting of the instrument, the setting voltage is indicated in the label on the back side of the instrument.
2. Set all push button switches in OUT position.
3. Set GATE TIME in "MIN" position.
4. Set TRIG LEVEL control in "AUTO" position.
5. Set power switch to the ON position and observe LED display.
6. Verify all segments of the LED, decimal point, OVFL, SIGN, Hz, S, and EX-PONENT cycling display from 00000000 0 to 999999999 continuously.

4.2 Frequency Measurement:

A. General Measurement (30Hz~20 MHz)

1. Set POWER switch to ON position.
2. Push in FREQ A.
3. Set GATE TIME control to "MIN" (≈ 60mS)
4. Set TRIG LEVEL control to "AUTO".
5. Connect a signal about 10 MHz, 1 Vpp, square wave to CH. A input BNC.
6. Verify TRIG LED and GATE LED frequently flicker.
7. Observe DATA LED, which displayed input frequency.
8. Rotate GATE TIME control to center position (gate time ≈ 1S). Verify GATE LED flicker slowly about one cycle per second.
9. Observe DATA LED, which the resolution of the displayed frequency increases at least one digit or more.
10. Rotate GATE TIME control to "MIN".
11. Slightly rotate TRIG LEVEL control off AUTO position (near -2.5V). Verify TRIG LED in OFF state, and GATE LED in idle state too. If TRIG LEVEL control set to inadequate position, the progress of the measuring function will be prohibited.
12. Rotate TRIG LEVEL control clockwise until TRIG LED flicker frequently. Verify GATE LED flicker too, and the measuring function is progressing.

B. Low Frequency Measurement (≤ 0.1Hz ~ 30Hz)

13. Set TRIG LEVEL control to "AUTO".
14. Change input signal to 1~2Hz, 1Vp-p square wave and connect to CH. A BNC.
15. Push in DC/AC switch to DC coupling. (Frequency below 30Hz, use DC couple)
16. Observe TRIG LED that flickers following to the input signal.
17. Observe GATE LED that flickering frequency is one half of the TRIG LED. The gate time automatically extendes to one cycle of the input frequency.
18. Observe DATA LED.
19. Change input signal to 0.5Hz, 1Vp-p square wave and connect to CH. A BNC.
20. Observe TRIG LED and GATE LED slowly flicker.
21. Observe DATA LED, SIGN (16), EX-PONENT (15). Verify SIGN annuciator is lit, that indication is negative exponent value.

C. High Frequency Measurement (20MHz~100 MHz)

22. Set GATE TIME to MIN.
23. Set TRIG LEVEL to AUTO.
24. Change input signal to 40MHz ~ 50MHz, 100mVrms and connect to CH. A BNC
25. Verify TRIG LED flickeres frequently and periodically. If TRIG LED flickeres aperiodically (unstably), adjust TRIG

LEVEL control until TRIG LED and GATE LED flicker periodically or regularly.

26. Observe DATA LED, If displayed frequency is stable, that the TRIG LEVEL is properly actuated. If displayed frequency is variable or unstable that the TRIG LEVEL is necessary to slightly adjust until stable display is obtained.

[CAUTION]: Frequency range between 40MHz and 100MHz, setting manual trig level can get better and easier measurement.

4.3. Period Measurement (10nS~10S)

1. Set power switch to ON position.
2. Push in PER A switch (4) .
3. Set GATE TIME to MIN.
4. Set TRIG LEVEL to AUTO.
5. Connect a signal about 1MHz, 1Vp-p to CH. A BNC.
6. Verify TRIG LED and GATE LED is actuated.
7. Observe DATA LED display the period of input signal.

4.4 Very High Frequency Measurement (50MHz~1GHz)

1. Set Power ON.
2. Push in FREQ B (5) switch.
3. Connect a signal about 350MHz, 35mVrms to CH. B BNC (12).
4. Set GATE TIME to MIN
   Verify GATE LED flicker.
5. Observe DATA LED display input frequency.

5. PRINCIPLE OF OPERATION

5.1 Block Diagram

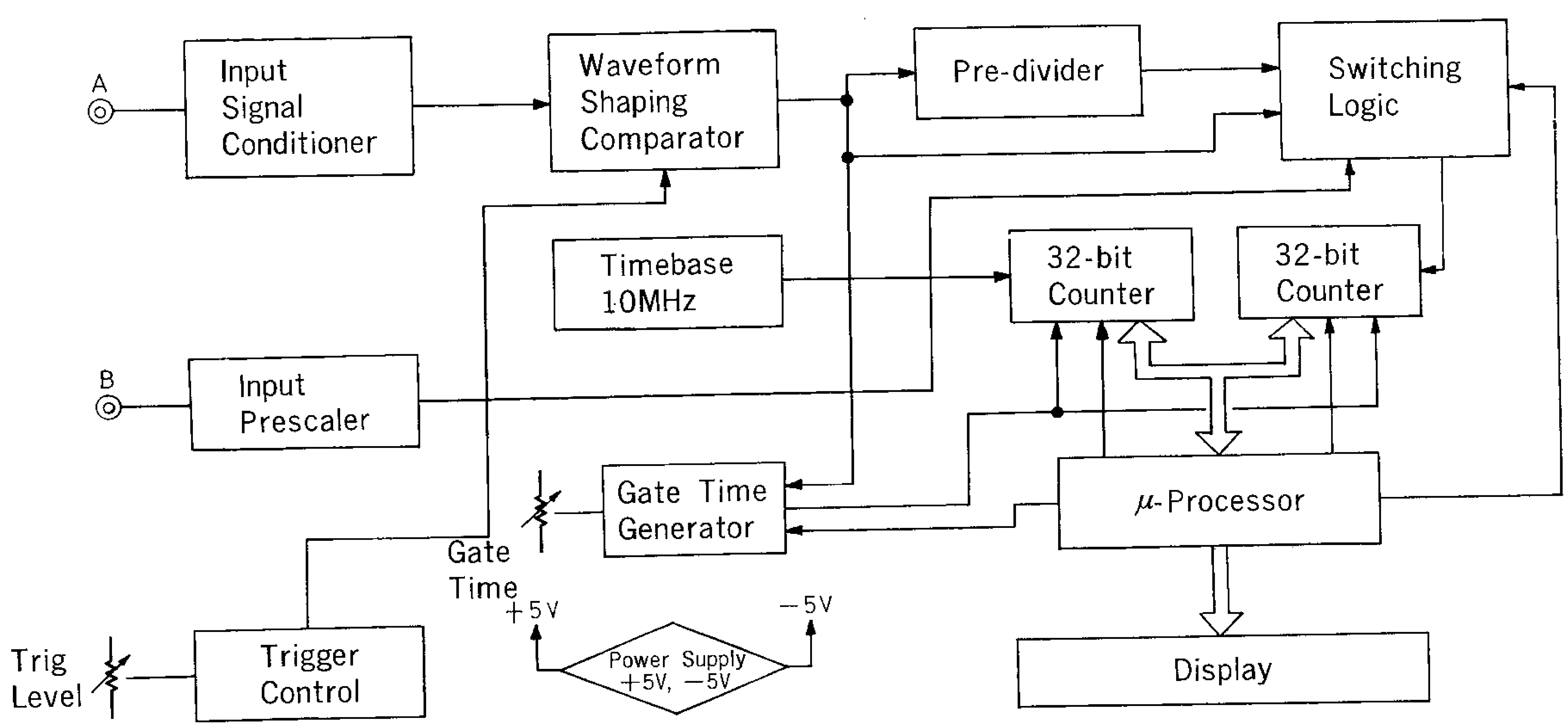

FIG. 5.1 BLOCK DIAGRAM

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5.2 AC Power Source:

The transformer of the instrument has design with 110V/220V combination. The power source of the instrument can be selected by a jumper wire on the internal PWB board, Fig. 5.2 is a portion of component layout.

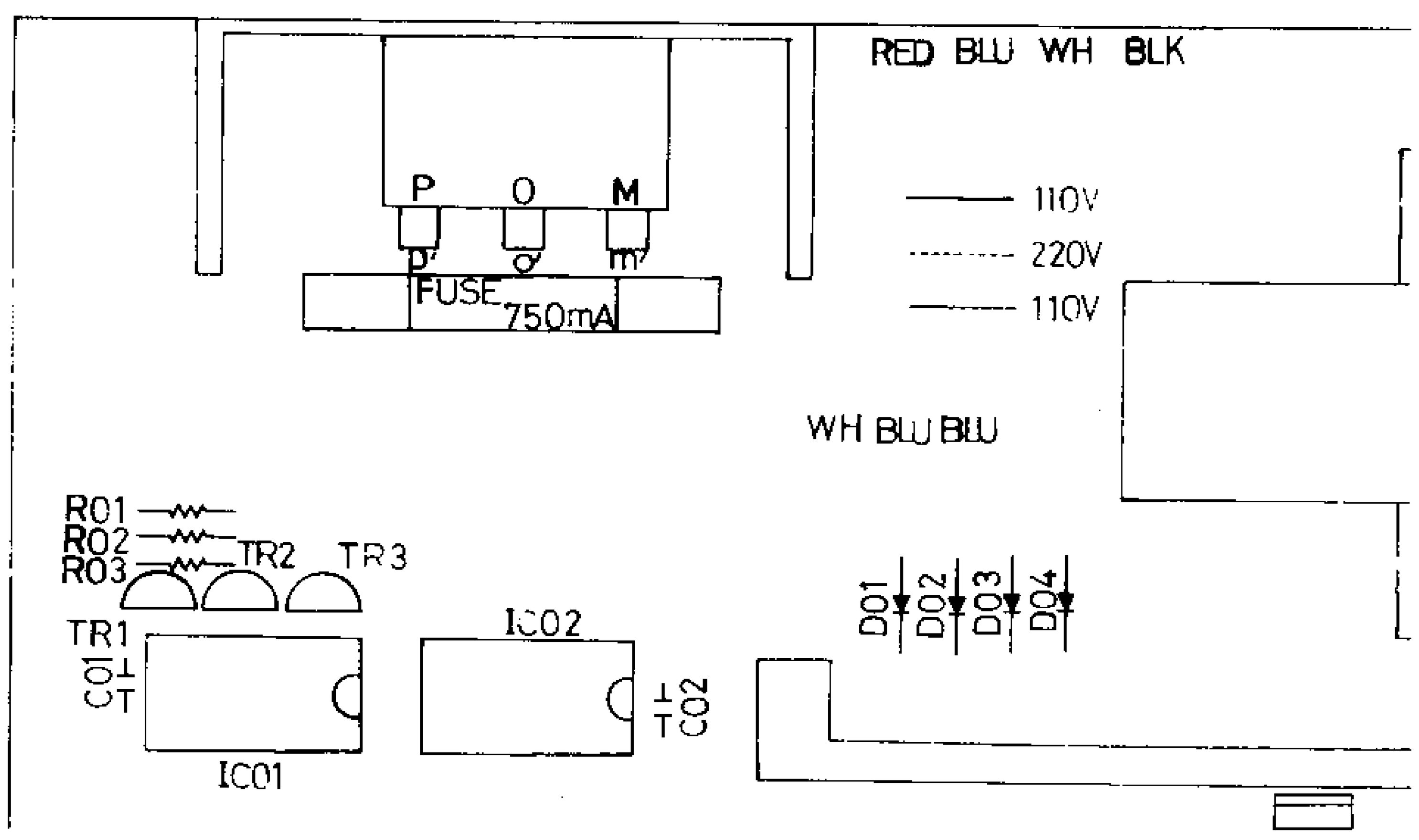


FIG. 5.2 POWER SOURCE SELECTION

On the layout showing (Fig. 5.2), two solid wire indicates that two jumper wire is conneted on the board, 110V power source is selected. One dotted wire indicates that 220V is selected.

[CAUTION]: If it is necessary to change power source, it must be performed by a qualified personnel only. 110V source, 750mA Fuse, 220V source, 350mA Fuse.

5.3 DC Regulation:

The DC power supply of the instrument is designed with adjustable and high stable regulation, it has +5V and -5V, the adjustable range is about ±10%. Fig. 5.3 is the DC power supply circuits. If DC power supply is varied or adjusted that may affect timebase accuracy, therefore timebase must be recalibrated if DC power is trimmed (Refer to ALIGNMENT section)

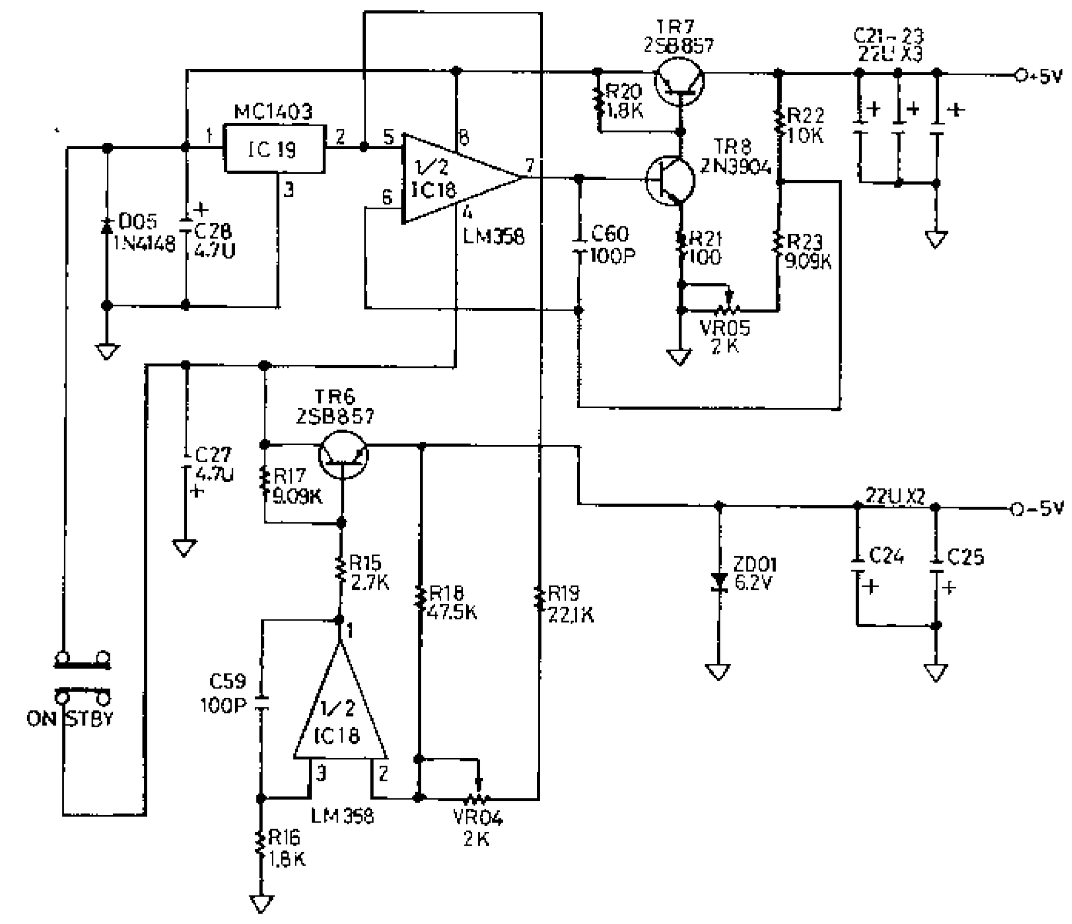


FIG. 5.3 DC POWER SUPPLY

5.4 Timebase Oscillator:

The timebase is generated from a high stable quartz oscillator, shown in Fig. 5.4. Capacitor trimmer 22P align accuracy, the standard frequency is trimmed to 10,000,000 Hz, ±5PPM. Variable Resistor 10KΩ is a loading impedance, which adjusting to an adequate value can obtain proper DC level and better waveform.

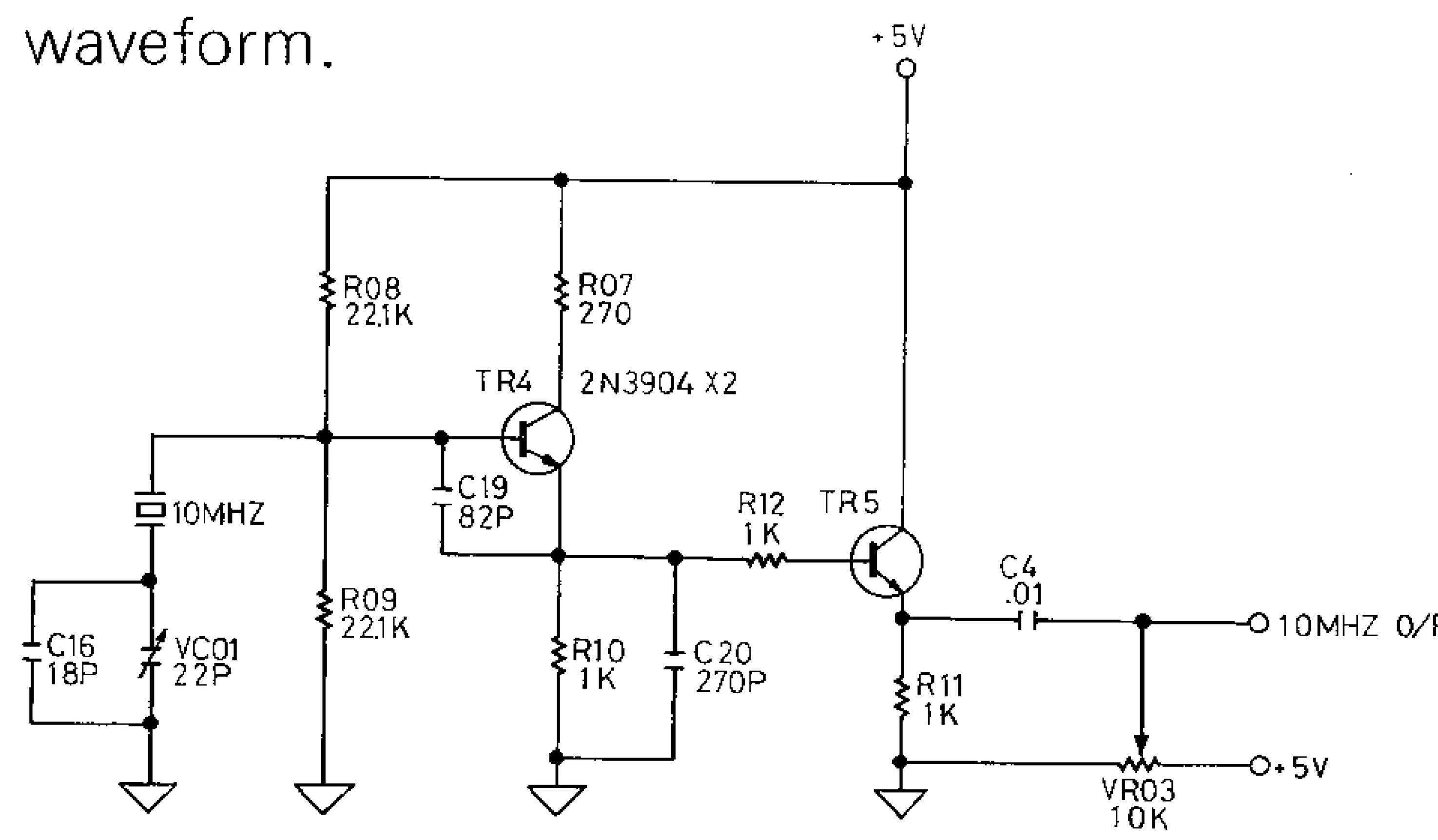


FIG. 5.4 TIMEBASE OSCILLATOR

5.5 Signal Conditioner

5.5.1 CH. A (FREQ A, PER A, 0.1Hz~100 MHz)

FREQ A is frequency function, PER A is period function. Both FREQ A and PER A have the same input signal conditioning, except display unit is different, FREQ A is Hz, the other is second. Both input signal are connected to CH. A BNC, a coupling switch AC/DC, an attenuator (X1, X20) and clipping diodes are design before signal passing into the buffer FET stage. A low-pass filter (100KHz, -3dB) switch selects signal passing to the full band buffer

(FT 01) or to the high band buffer (TR 14). Then the buffered signal is transfered to a high speed comparator.

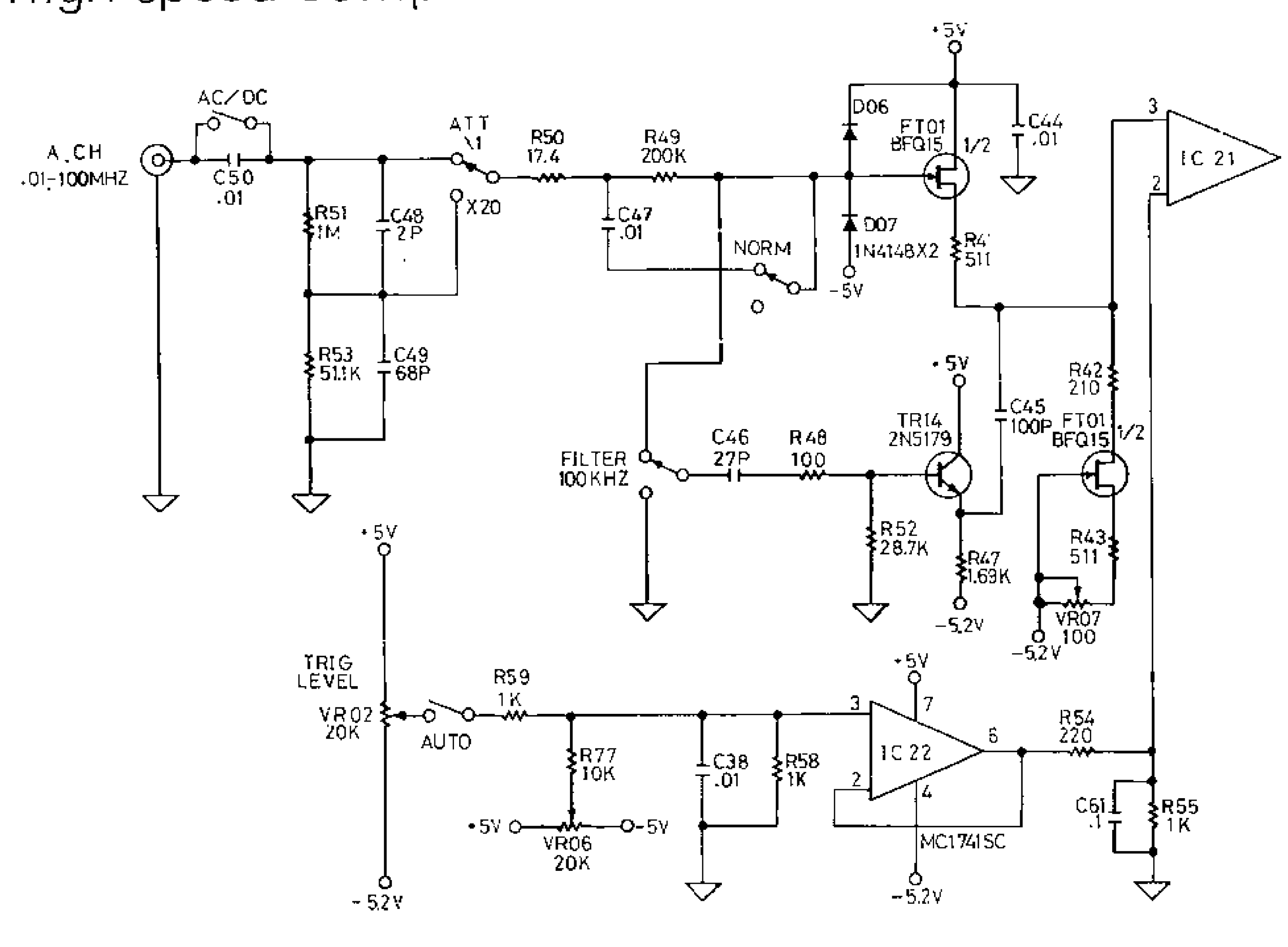


FIG. 5.5.1 CH. A SIGNAL CONDITIONER

5.5.2 CH. B (FREQ B, 50MHz~1GHz)

FREQ B is specially designed for very high frequency measurement from 50MHz to 1GHz. The input signal connects to CH. B BNC, input coupling is AC only, input impedance is 50Ω, two high speed and low capacitance diodes protect over voltage. The maximum input is about 3Vrms. A high sensitivity prescaler divides input frequency by a factor of 256.

[CAUTION]: In order to protect CH. B input, connecting a 50Ω terminator to CH. B BNC before measurement is necessary.

5.6 Triggering

The buffered signal is applied to noninverting input of high speed comparator, and a adjustable trig level applied to inverting input as shown in Fig. 5.6 a. If the trig level is within input signal's peak to peak range, then the comparator is actuated and transfers square wave to counting circuitry. The trig function of the comparator will be idle if trig level is out of signal's peak range. The trig operation has AUTO and Manual modes. In AUTO mode, the triggering is preset in very sensitive, frequency from 0.1Hz to 50MHz can be easily actuated. In Manual mode, frequency from 10Hz to 100MHz can be properly triggered if trig level is appropriately adjusted. For easier operating of trig function when signal is below 10Hz, AUTO trig mode must be selected.

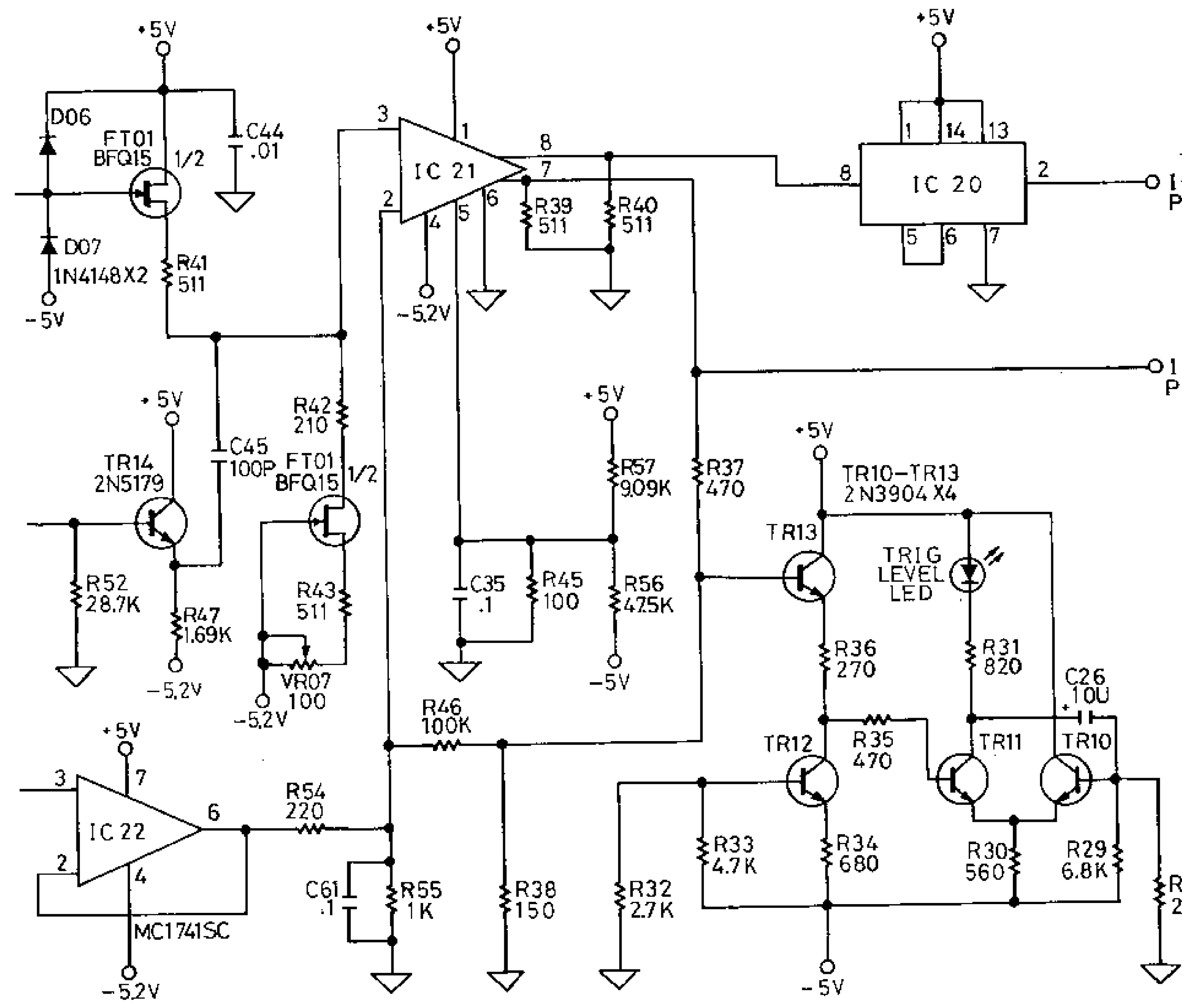


FIG. 5.6.a

If input signal is complex waveform as shown in Fig 5.6.b. User can adjust trig level to select proper trig point and get desired peaks, if trig level is set to Lo (as Figure shown), the comparator is actuated by double peak and generates double square wave to the counting circuits therefore displayed frequency is 2kHz. If trig level is set to L_1, single peak is triggered and the counting result is 1kHz.

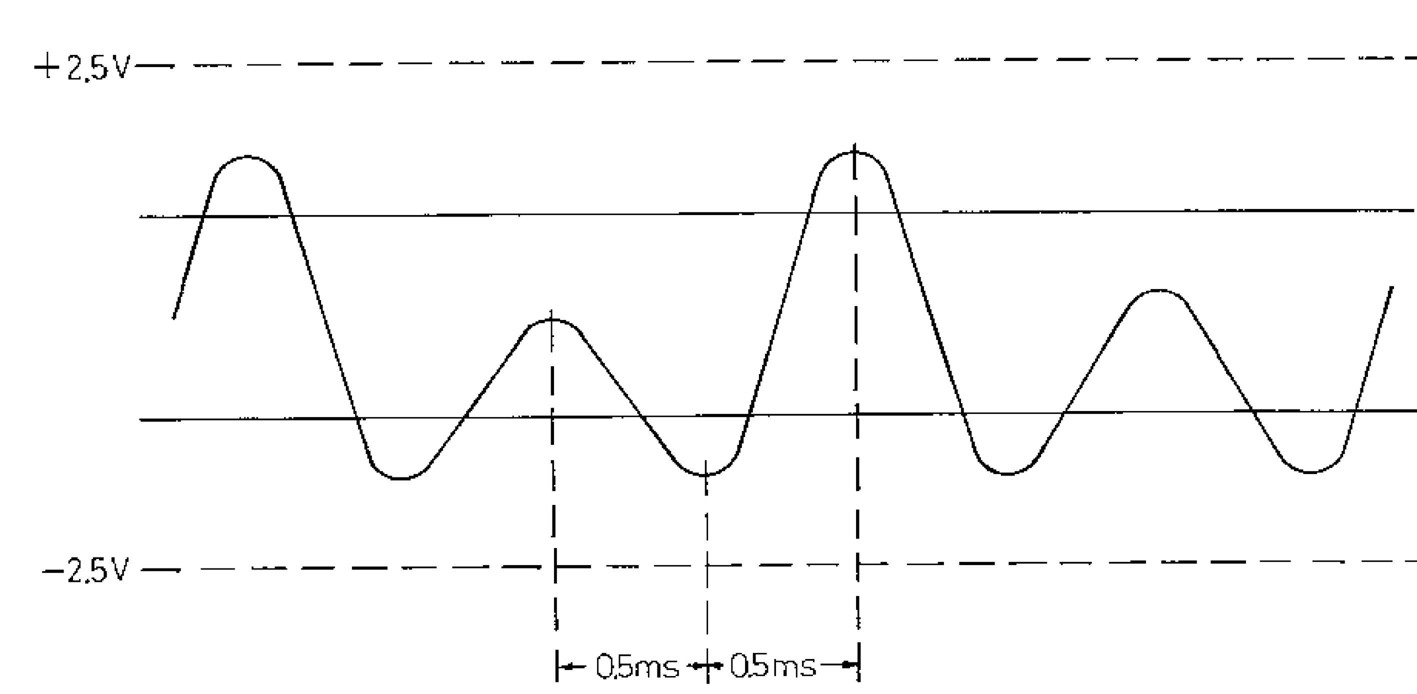


FIG. 5.6.b TRIGGERING COMPLEX WAVEFORM

5.7 Counting Circuitry:

The counting circuitry is a microprocessor based design, therefore it has high gating response, high resolution and very suitable for low frequency measurement. Its gate time can be countinuously adjustable from 60ms to 10S. The microprocessor dominates the counting process, the counting sequence are self counting check, enable trig and gate, enable counter, sensing gate time, disable counter, disable gate, get data from two 32-bit counters, calculating data and display. The detail process is shown in flowchart (section 5.8). The counting is commenced by gate-on pulse which is lag manual setting gate pulse about one cycle of input signal owing to gate-on pulse is generated after trigger operation is actuating. The measuring process will be idle, if input signal suddenly interrupt or triggering stop, because of the trigger action is monitored by microprocessor momentarily. There are two 32-bit register counter, one is for counting input unknown frequency, the other is timebase 10MHz counter. Assume the contents of the unknown register counter is C_X, Timebase register counter is C_S and the interval of the gate time is T_0, input unknown frequency: Fx, Timebase frequency: F_S. In a complete measurement, the counting result in the register counters are:

Unknown register counter $C_X = F_X \cdot T_0$

Timebase register counter $C_S = F_S \cdot T_0$

Therefore

$$\frac{C_X}{F_X} = \frac{C_S}{F_S}$$

The input unknown frequency F_X is

$$F_X = F_S \cdot \frac{C_X}{C_S}$$

If in period function the calculating result P_X is

$$P_X = \frac{1}{F_X}$$

5.8 Processing Flow-chart

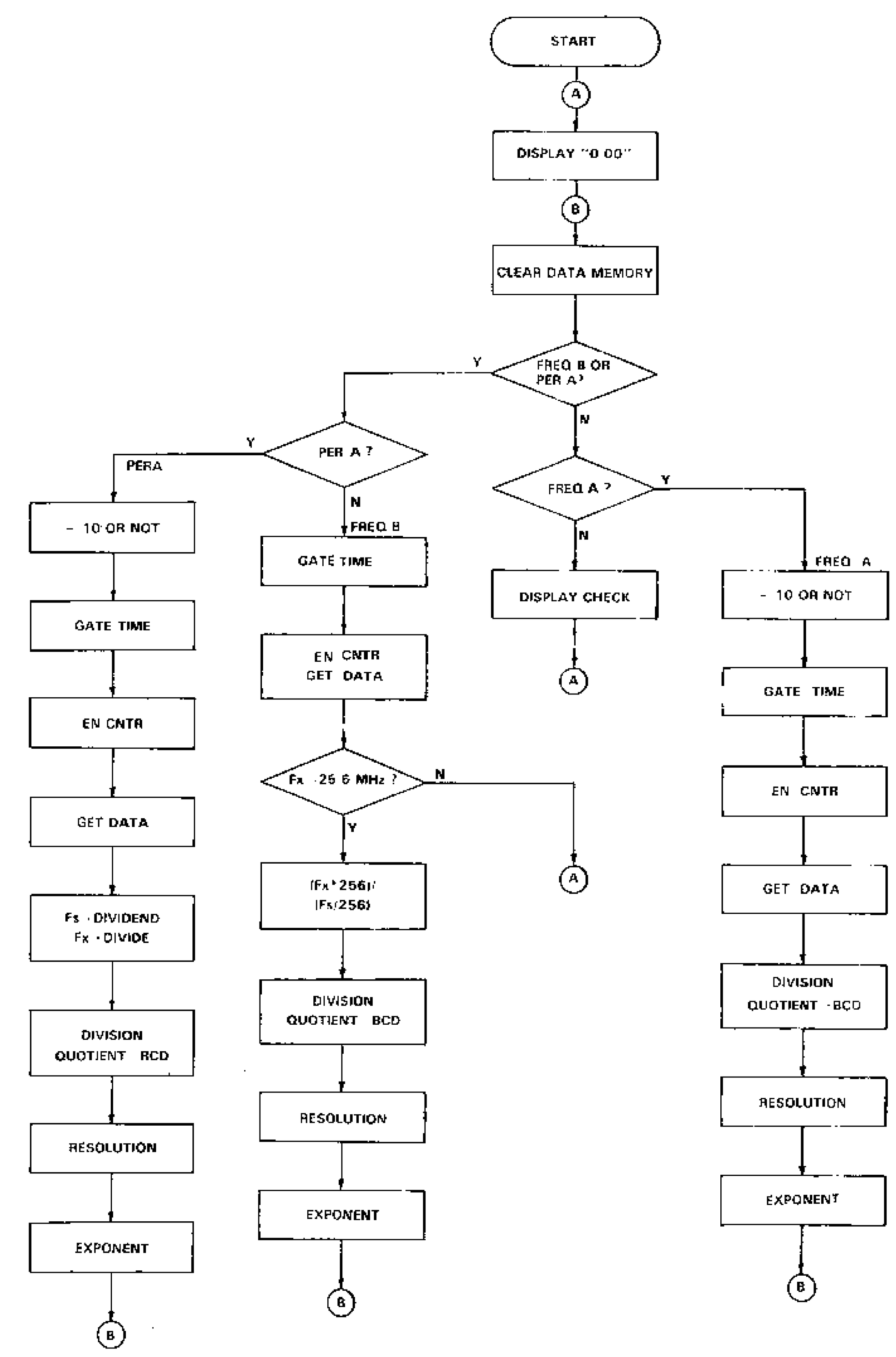


FIG. 5.8 FLOW CHART

6. ALIGNMENT: (Refer to component layout)

[CAUTION]: Before alignment and Calibration; the instrument must be warm up at least 30 minuts, and the environment conditions are 23°C ± 2°C, 60%~80% R. H..

6.1 DC Power Supply (+5V/-5V):

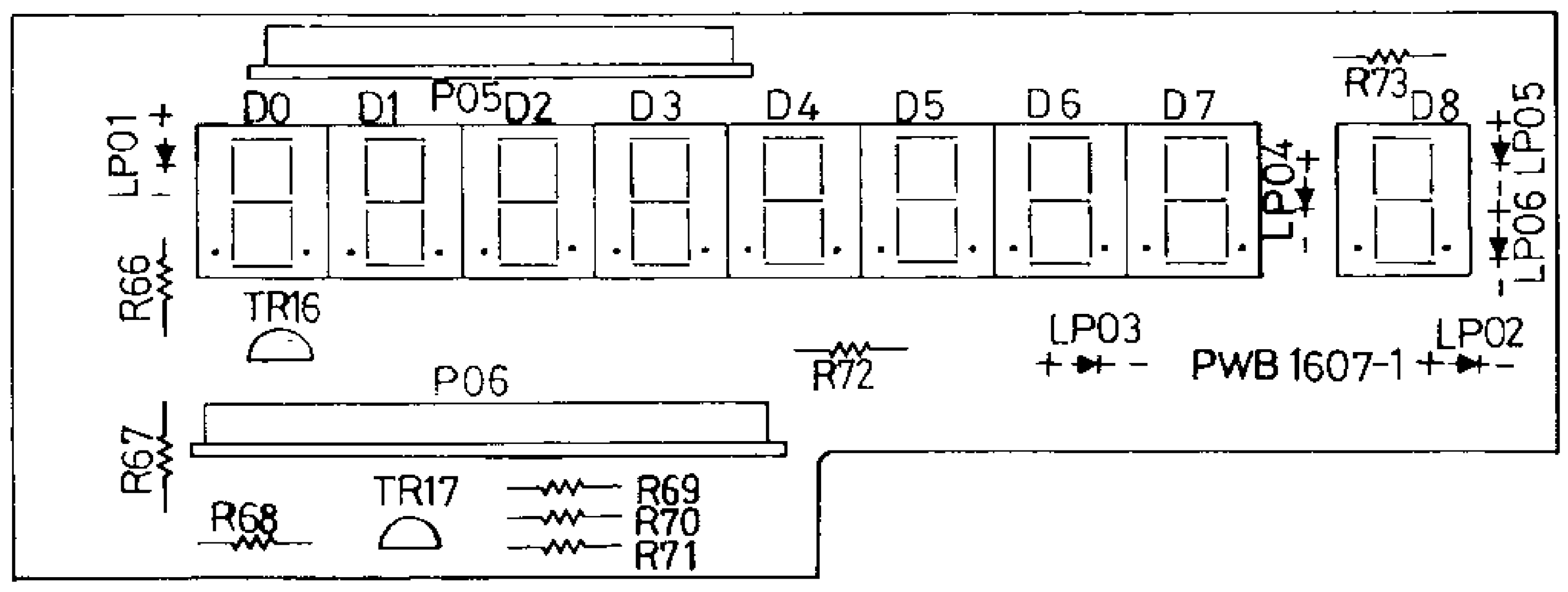
+5V adjustment: VR05, 5V±0.3V
−5V adjustment: VR04, -5V±0.3V

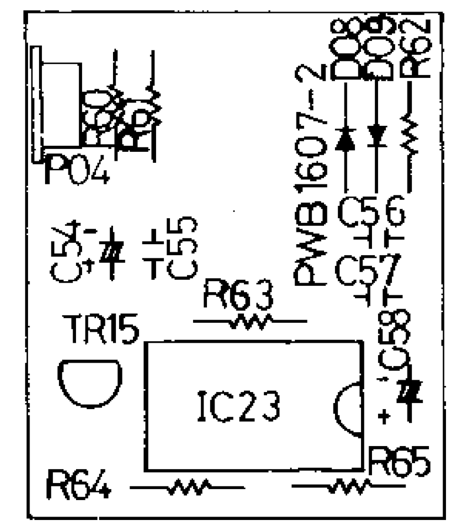
6.2 Timebase Adjustment:

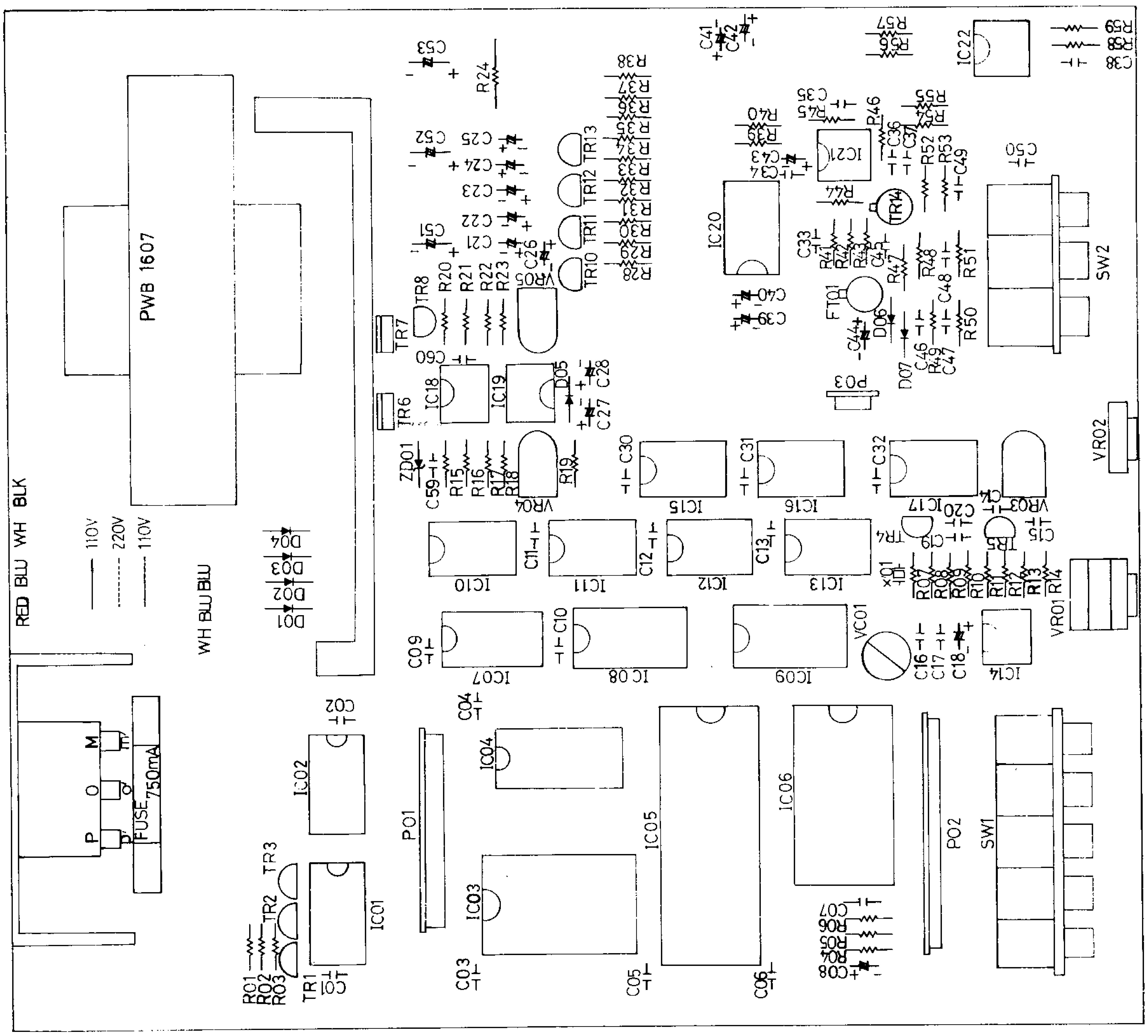
Accuracy: 10,000,000Hz±5Hz, VC01
Amplitude: 4.5Vp-p (MAX.); VR03

7. COMPONENT LAYOUT

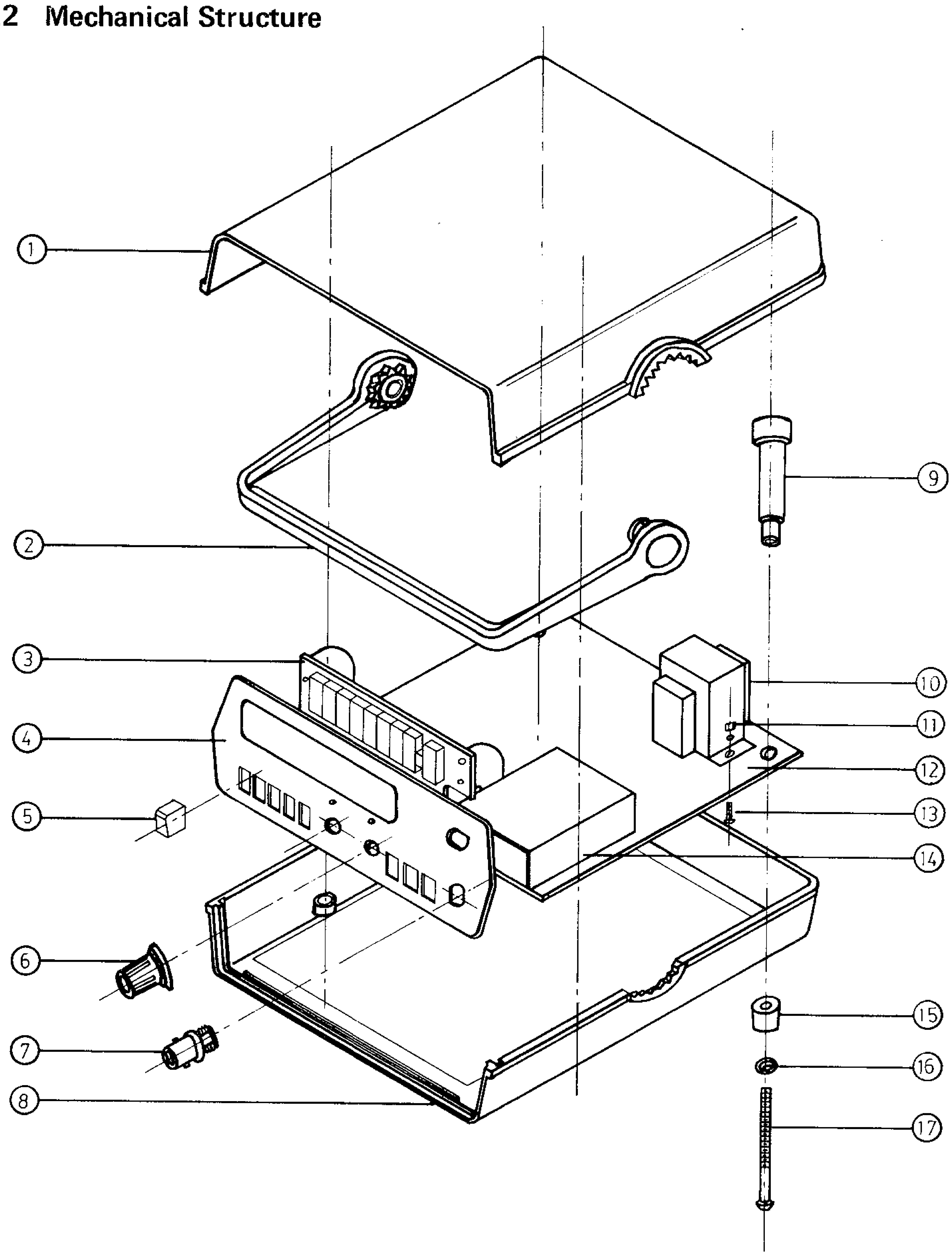
7.1 PWB Component Layout







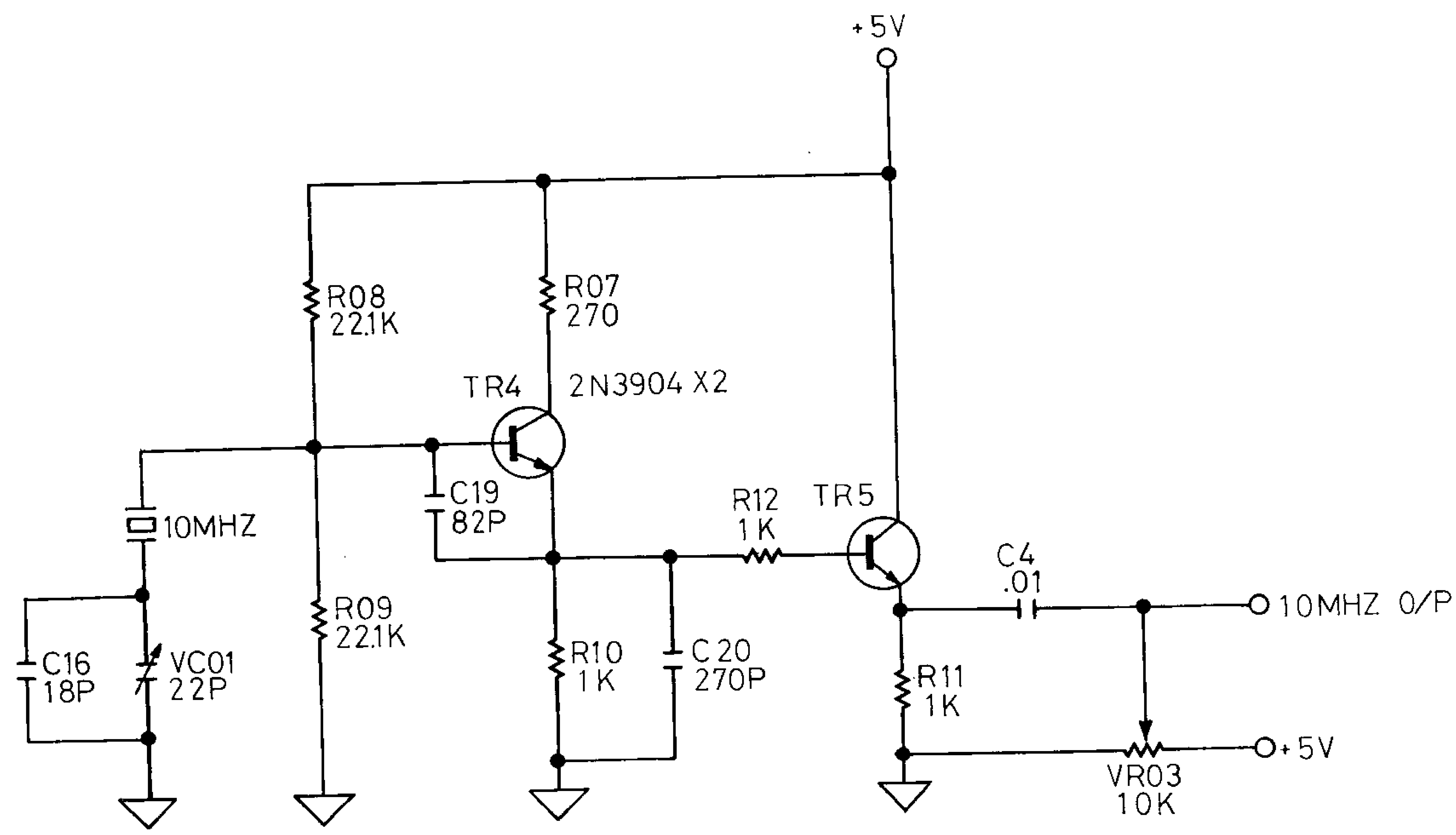
7.2 Mechanical Structure



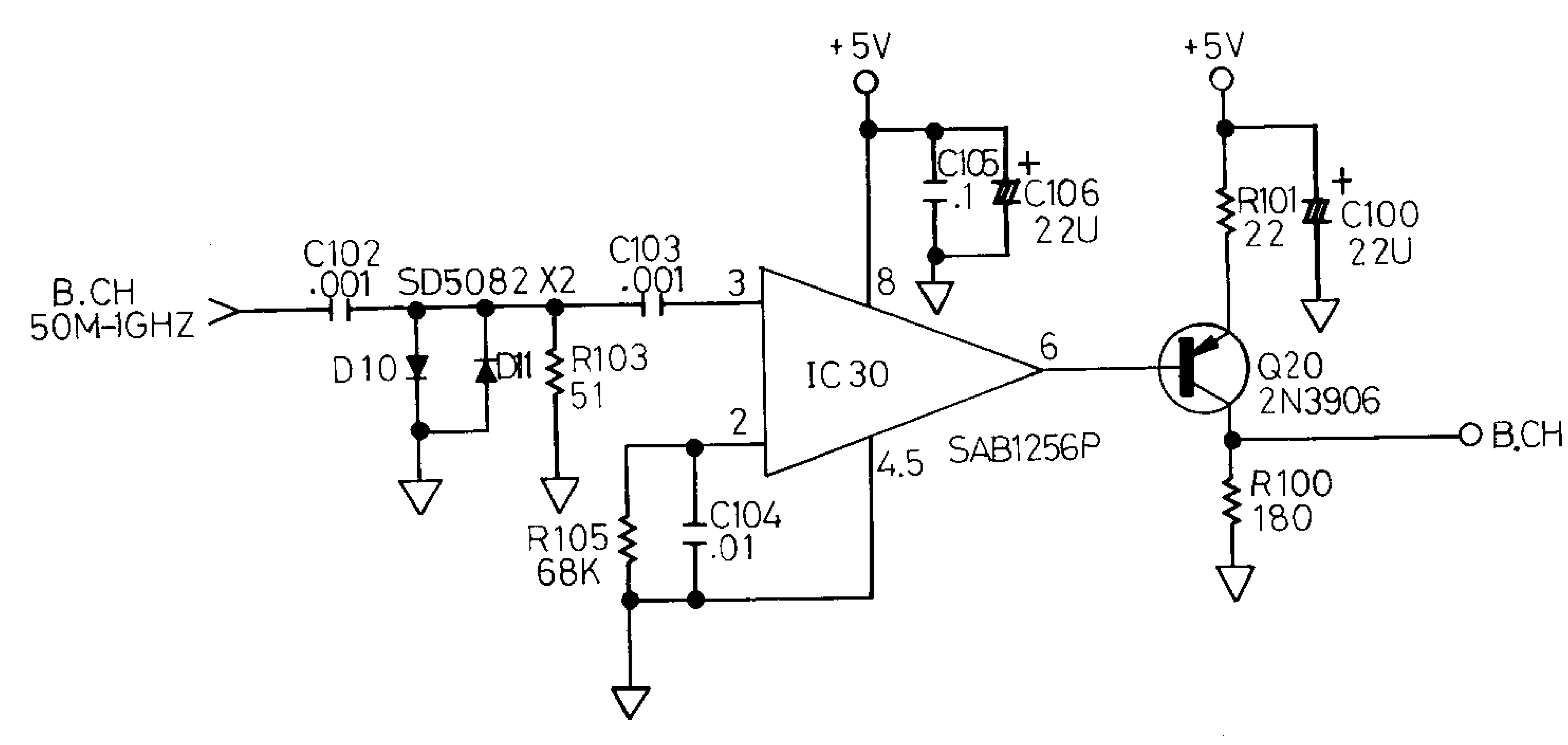
Compoenent List

1. CAB-A-1132
2. HANDEL-1017
3. ANG-PWB-1046
4. PANEL-1137
5. KNOB-1194
6. KNOB-1311
7. CNC-1006
8. CAB-B-1132
9. HOLD-1038
10. TRNS-PWR-1308-S
11. NUT
12. WASHER (3M+8S)
13. SCREW (3.2W8-0.5S)
14. SHIELD
15. LEG-1004
16. WASHER-3.2W7.0-0.5S
17. SRW-SPE-1183

TIMEBASE OSCILLATOR



CH. B HIGH FREQUENCY PRESCALER



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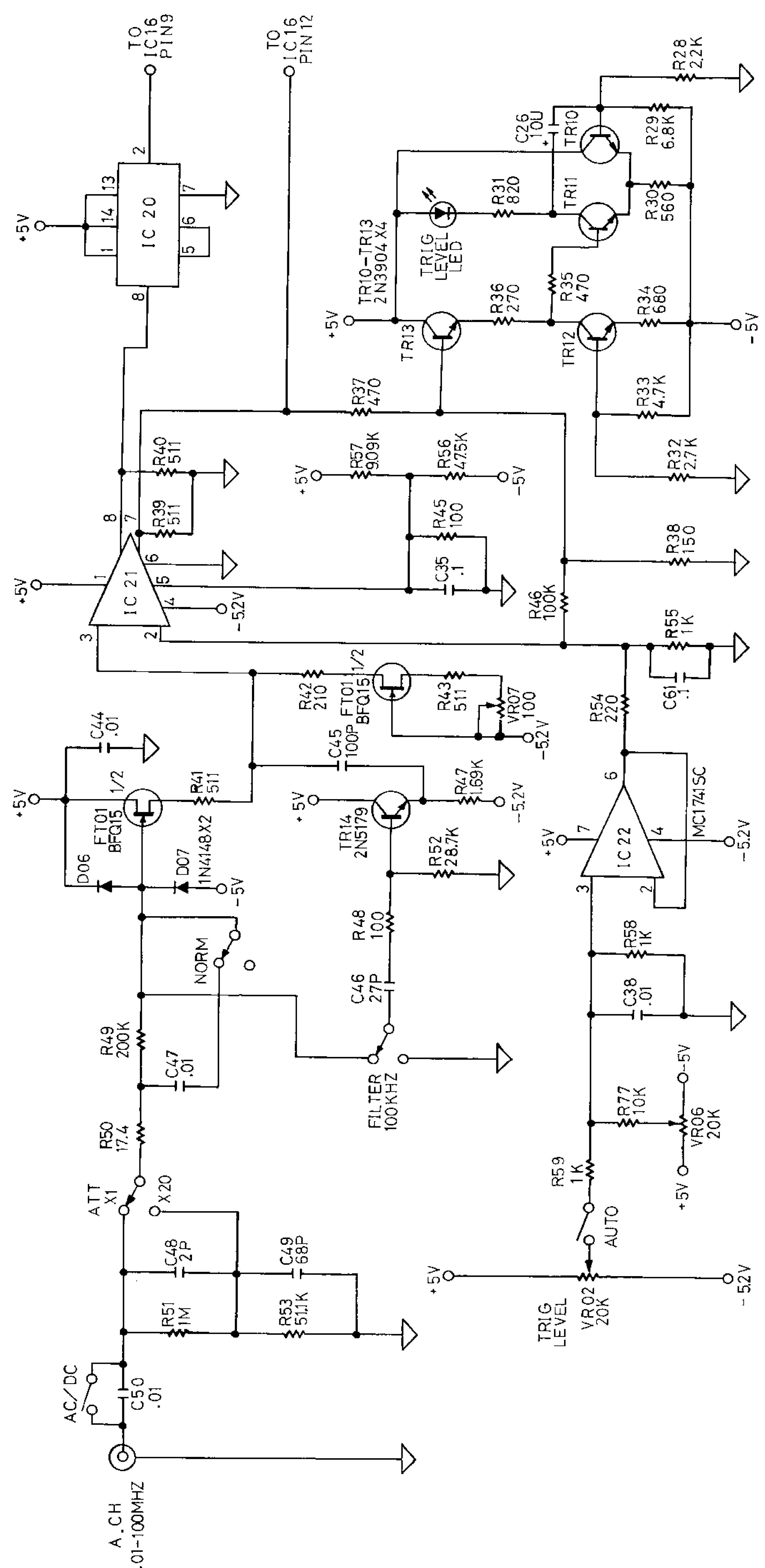
INPUT SIGNAL CONDITIONER & TRIGGERING



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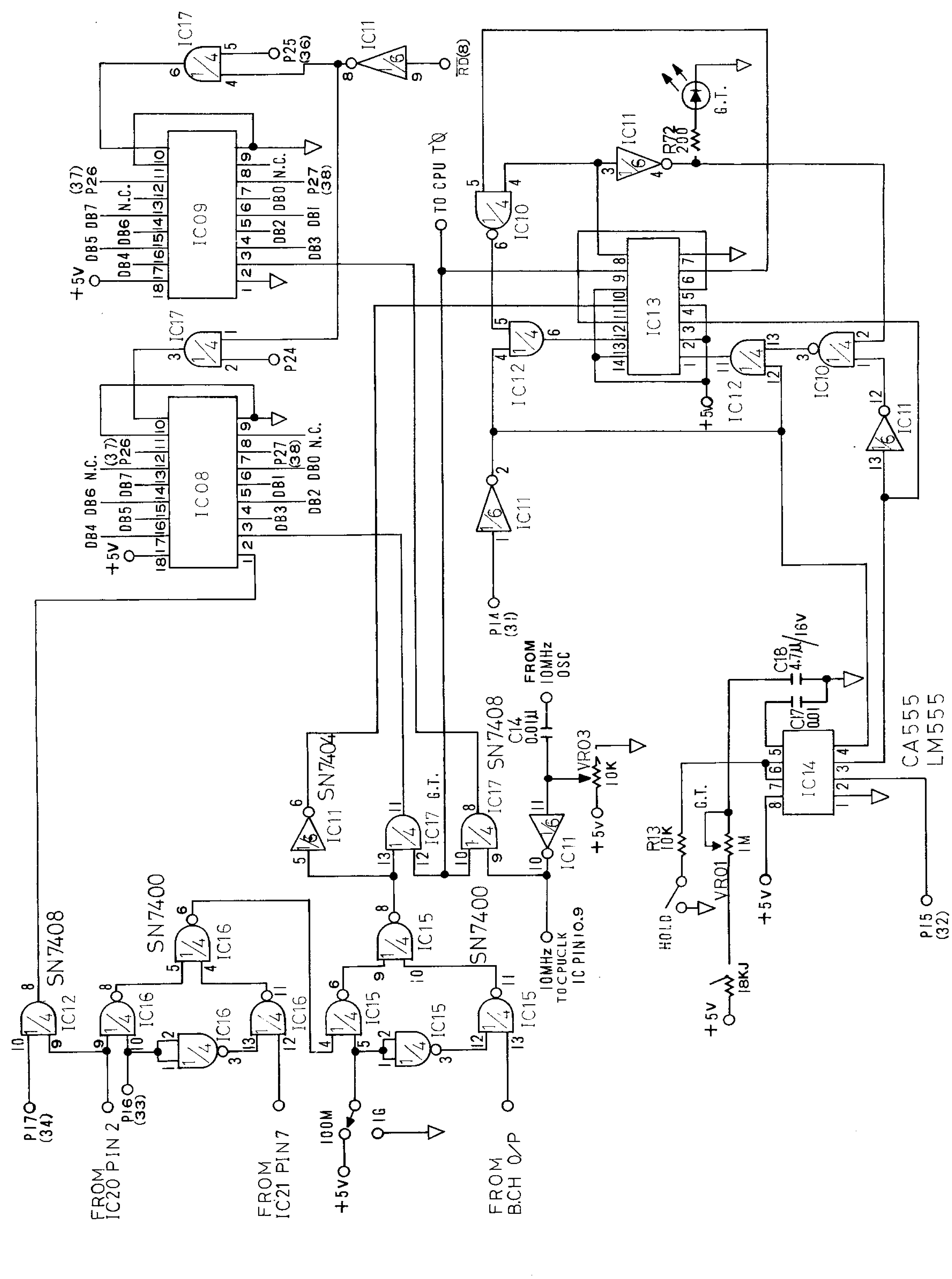
SWITCHING LOGIC, GATE TIME GENERATOR & REGISTER COUNTER



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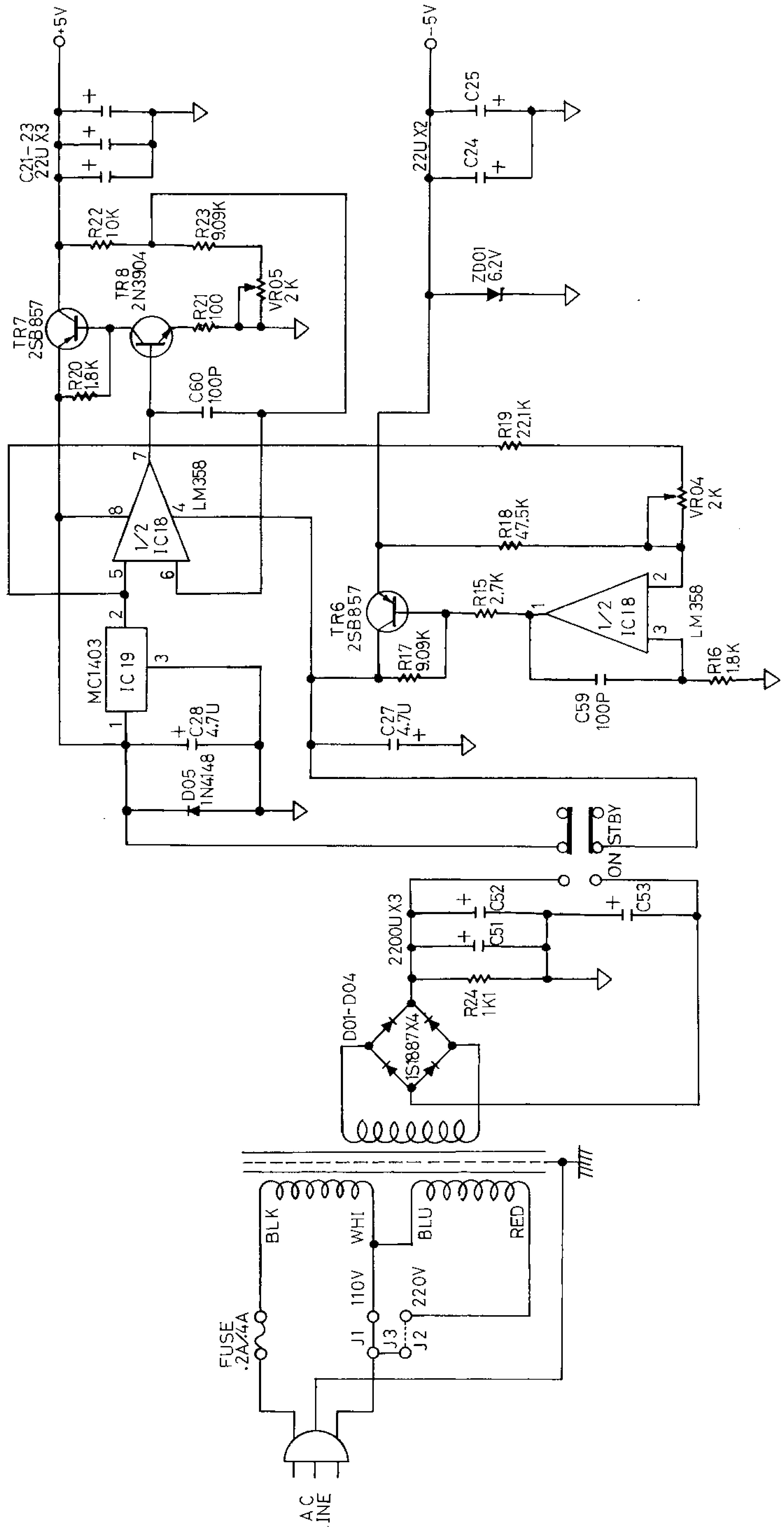
DC POWER SUPPLY



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