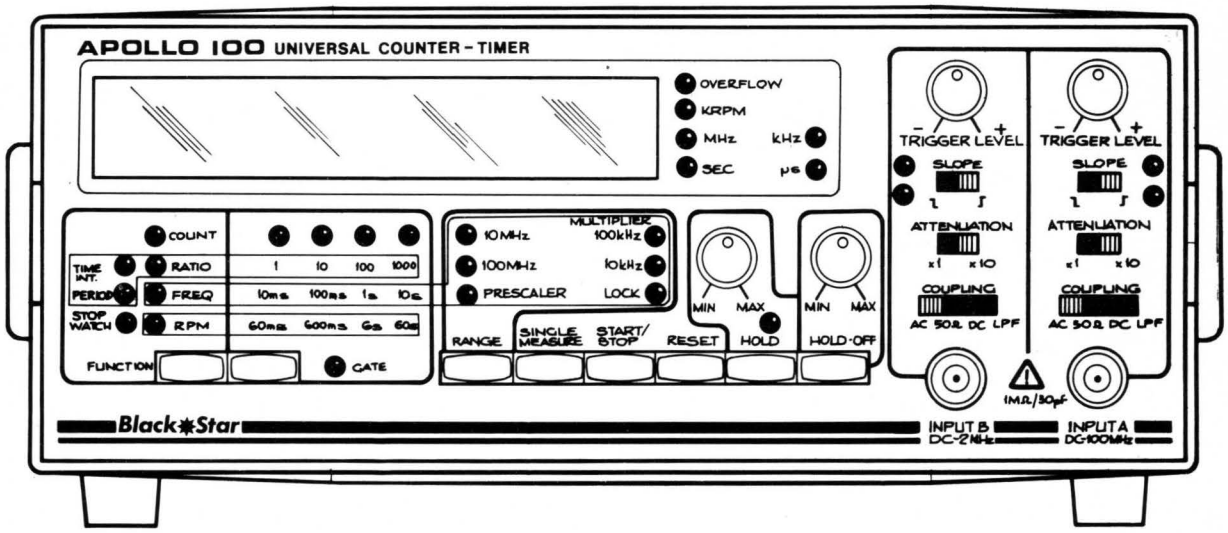
Black★Star

APOLLO

SERIES OF UNIVERSAL COUNTER TIMERS

APOLLO 10
APOLLO 100
APOLLO 10X
APOLLO 100X



Service Manual

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SPECIFICATIONS

	APOLLO 10	APOLLO 10X	APOLLO 100	APOLLO 100X
TIMEBASE Crystal Oscillator Frequency	10MHz			
Time between measurements	200ms nom.		Adjustable 200ms to 10 sec. nom. (Hold Control)	
Aging	<±5ppm/year	<±1ppm/year	<±5ppm/year	<±1ppm/year
Setability	<±0.5ppm	<±0.2ppm	<±0.5ppm	<±0.2ppm
Temperature Stability	±10ppm −10°C to +70°C	< ±1ppm 0°C to 50°C	±10ppm −10°C to +70°C	< ±1ppm 0°C to 50°C
INPUT A Bandwidth/Sensitivity	10MHz range < 5mV DC − 10MHz 100MHz range <10mV 1MHz − 50MHz <30mV 50MHz − 100MHz			
Coupling and Input Impedance	DC @ 1MΩ//30pF; AC @ 1MΩ//30pF; 50Ω			
Low Pass Filter	Coupling DC; cut-off frequency 50kHz nom.; switch selectable			
Maximum Input Voltage	AC Coupling: 50V DC or 250V rms @ 50Hz decreasing to 5V rms @ >70kHz; DC Coupling: 300V DC			
Triggering	Level adjustable, +ve or −ve edge; L.E.D.'s Indicate when triggered			
Attenuator	x1, x10 switchable			
INPUT B Bandwidth/Sensitivity	<5mV DC − 2 MHz			
Coupling and Input Impedance	DC @ 1MΩ//30pF; AC @ 1MΩ//30pF; 50Ω			
Low Pass Filter	Coupling DC; cut-off frequency 50kHz.; switch selectable			
Maximum Input Voltage	AC Coupling: 50V DC or 250V rms @ 50Hz decreasing to 5V rms @ >70kHz; DC Coupling: 300V DC			
Triggering	Level adjustable, +ve or −ve edge; L.E.D.'s indicate when triggered			
Attenuator	x1, x10 switchable			
FREQUENCY A Gate Times	0.01 sec.; 0.1 sec.; 1 sec.; 10 sec.			
Ranges/Resolution			Multiplier 6Hz − 10kHz (0.01 ÷ Gate Time) Hz ‡ Multiplier 14Hz − 100kHz (0.1 ÷ Gate Time) Hz ‡	
	DC − 10MHz (1 ÷ Gate Time) Hz 1MHz − 100MHz (10 ÷ Gate Time) Hz			
			PSC (100 ÷ Gate Time) Hz	
	PSC ÷ 100 (100 ÷ Gate Time) Hz			
Accuracy	±(1 count + timebase accuracy)			
FREQUENCY RATIO A TO B Frequency Maximum	Input A: 10MHz; Input B:2 MHz			
Ratio Averaged Over	1, 10, 100, 1000 cycles of Input B			
Resolution	1 ÷ no. of cycles of Input B			
Accuracy	±1 count			
PERIOD A Measurement Type	Single Cycle and Multiple Period Average			
Period Range	500ns − 10 sec.			
Display	μs			
Period Averaged Over	1, 10, 100, 1000 cycles			
Resolution	100ns ÷ no. of cycles averaged			
Accuracy	±(timebase accuracy + resolution + (trigger error* ÷ no. of cycles averaged))			
TIME INTERVAL A TO B Range	250ns − 10 sec.			
Display	μs			
Minimum Pulse Width	250ns			
Maximum Frequency	2 MHz			
Time Interval Averaged Over	1, 10, 100, 1000 Intervals			
Resolution	100ns ÷ no. of intervals averaged			
Accuracy	±(timebase accuracy + resolution + (trigger error* ÷ no. of intervals averaged))			

	APOLLO 10	APOLLO 10X	APOLLO 100	APOLLO 100X
COUNT A Count Maximum	10^8-1			
Input Frequency	10MHz max.			
Resolution	1 count			
Reset	External reset Input		Manual (reset button) or External reset Input	
Gating	Input B		Manual (stop/start button) or Input B	
STOPWATCH Display			Seconds	
Times to			10^8 sec. (>11 days)	
Resolution			10ms	
Accuracy			±(timebase accuracy + 10ms)	
Reset			Manual (reset button) or External reset Input	
Gating			Manual (stop/start button) or Input B	
RPM A Display			1000's RPM	
Range			1 to 10^{11} RPM	
Gate Time			0.06 sec.; 0.6 sec.; 6 sec.; 60 sec.	
Resolution			(60 ÷ Gate Time) RPM	
Accuracy			±(timebase accuracy + 1 count)	
EXTERNAL TIMEBASE OSCILLATOR	External oscillator in/Internal oscillator out; switch selectable; TTL compatible			
Calibration Frequency	10MHz			
Input Frequency Range	100kHz nom. min. to 10MHz			
Input Voltage Range	0V to +5V max.			
Input Load	1 HCMOS Input			
Output Frequency	10MHz			
Output Drive	Sink 5mA, source 5mA			
EXTERNAL RESET INPUT	Active low; TTL compatible; Input Voltage range ±20V max.			
POWER REQUIREMENTS	Mains operation only. 220−240V AC 50−60Hz; 24VA			
DISPLAYS	8 Digit 7-segment 0.5" bright L.E.D.'s; automatic decimal point; leading zero suppression Unit Indicators for MHz, kHz, sec., μsec., KRPM; overflow indicator; gate indicators			
ANCILLARY CONTROLS (Front Panel)			Display Hold: adjustable 200ms to 10 sec. nom. Trigger Hold-off: adjustable 5 to 500ms nom. Single Measurement. Start/Stop & Reset	
General Environmental Operating Range	0°C to +40°C (10% − 80% RH non-condensing)			
Case	Custom-moulded, sturdy, lightweight ABS, with tilt stand			
Size	219mm x 240mm x 98mm (product only) 310mm x 330mm x 135mm (packed)			
Weight	2.2Kg (product only) 2.9 Kg (packed)			
Supplied Accessories	Mains Lead, Instruction Manual, Spare Fuse			
Optional Accessories	Passive Probes, BNC Cable Assemblies, Service Manual			
Rear Panel facilities	Power on/off; spare fuse; External reset Input; External timebase; Int. Timebase out			

*Typical Trigger Error = $\frac{1.6}{\text{Slope}/(\text{V}/\mu\text{s})}$ ns

‡ Typically 5 sec. settling time.

INTRODUCTION

1. HANDLING

While the APOLLO counter timers have been designed to be rugged, severe shocks can be destructive and should be avoided. Do not expose to radiant heat, including direct sunlight for long periods, or excessively high humidity. When servicing suitable precautions should be taken against static discharge as the unit contains CMOS components.

2. TEST EQUIPMENT

(a) Signal generators 2Hz to 100MHz with calibrated output.

(b) Frequency standard with an accuracy of 0.05ppm or better.

(c) Oscilloscope with 100MHz bandwidth and 5mV/div sensitivity.

(d) x10, 10MΩ oscilloscope probe.

(e) 3½ digit multimeter.

3. DISMANTLING

(a) Remove TRIGGER LEVEL, HOLD and HOLD OFF knobs by gently but firmly pulling from shaft.

(b) Remove tilt stand by pushing firmly inwards on one side.

(c) Unscrew the four recessed pozidrive screws set into the feet on the under side of the case.

(d) Gently separate the two case halves ensuring the rear panel remains in the lower case half.

NOTE: If the counter only requires calibration no further disassembly is necessary. If component replacement is required then proceed as follows.

(e) Remove the four self-tapping screws securing the main p.c.b. to the lower case half.

(f) Carefully lift the entire assembly including rear panel from the lower case half.

(g) Desolder the GROUND connection between the front and rear panels.

(h) Separate the rear panel from the main p.c.b. by disconnecting PL401, PL100 and PL101.

(i) Separate the front panel assembly by pulling it away from the main circuit board. Take care not to bend the connector pins.

(j) The pre-amplifier p.c.b. can now be removed by gently pulling upwards. Take care not to bend the connector pins.

(k) Desolder the two B.N.C. connectors and the GROUND connection from the rear of the front panel p.c.b.

(l) Remove the front panel from the front panel p.c.b.

Disassembly is now complete. Reassembly is the reverse of disassembly.

FUNCTIONAL DESCRIPTION

1. INPUT A

The signal at input A passes through the signal conditioning circuit. This is the x1 /x10 attenuator, A.C. 50 Ω and D.C. coupling circuits. The signal then passes to the pre-amplifier where the signal is amplified, filtered by the low pass filter if required, and the trigger level is adjusted.

The signal can then follow one of two paths, (1) through a Schmitt trigger squaring circuit or (2) through an E.C.L. amplifier to provide a suitable signal for the 100MHz pre-scaler.

The 10MHz output can be routed via the frequency multiplier to achieve greater resolution when making low frequency measurements.

The three outputs from the input A amplifier are then passed to the input A selector.

2. INPUT B

The signal at input B passes through identical signal conditioning and pre-amplifier circuitry as input A, with the exception of the E.C.L. amplifier, 100MHz pre-scaler and frequency multiplier circuits.

3. INPUT SELECTOR

This selects which signal is fed to the main counter i.e. 10MHz, 100MHz, frequency multiplier or stopwatch pre-scaler output.

4. INPUT CONTROL CIRCUITS

This section contains the start/stop control logic, the hold off monostable, single measure priming circuit, slope selection and input A gating circuit.

5. MAIN COUNTER INTEGRATED CIRCUIT

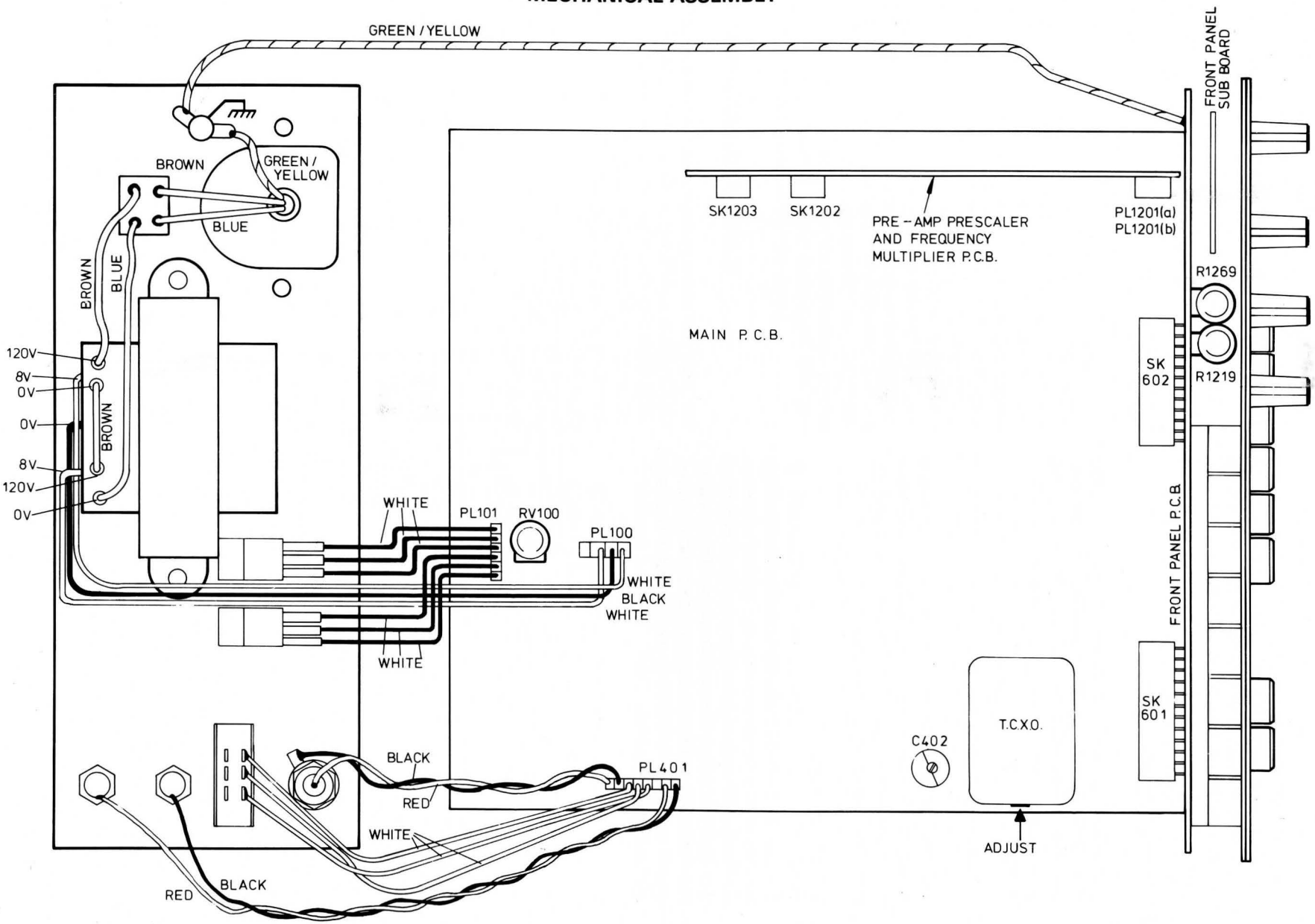
This is a fully integrated Universal counter and display driver. It contains all the circuitry necessary to function as a frequency counter, a period counter, a unit counter, a frequency ratio counter and a time interval counter.

The FUNCTION, RANGE, CONTROL and EXTERNAL DECIMAL POINT inputs are time multiplexed to select the desired input function. This is done by connecting the appropriate digit strobe to the control inputs F, R and DP. The control of these inputs is done by the FUNCTION, RANGE and EXTERNAL DP multiplexers, which are in turn controlled by the various CONTROL LOGIC circuits and front panel switches.

6. STOPWATCH PSC

In order to provide the counter with a stopwatch function the counter is set to the count mode. The internal 10MHz reference oscillator is divided down by the stopwatch pre-scaler to produce a frequency

MECHANICAL ASSEMBLY



of 100Hz. This is then sent to the main counter via the input selector.

7. R.P.M. PSC

A r.p.m. measurement is performed in essentially the same way as a frequency measurement but with the GATE time increased by a factor of six. This is done by dividing the system clock with the R.P.M. pre-scaler before applying it to the main counter.

8. RESET CIRCUITS

These provide the necessary electronics to reset the main counter IC by the front panel pushbutton and the rear panel reset inputs. Internal resets are generated when a function, gate or range change is made.

9. HOLD/SINGLE MEASURE

This circuit arrangement provides the necessary signals to the main IC in order to enable the counter to (1) store the result of a measurement and (2) provide the display hold function.

10. T.C.X.O. and OSC

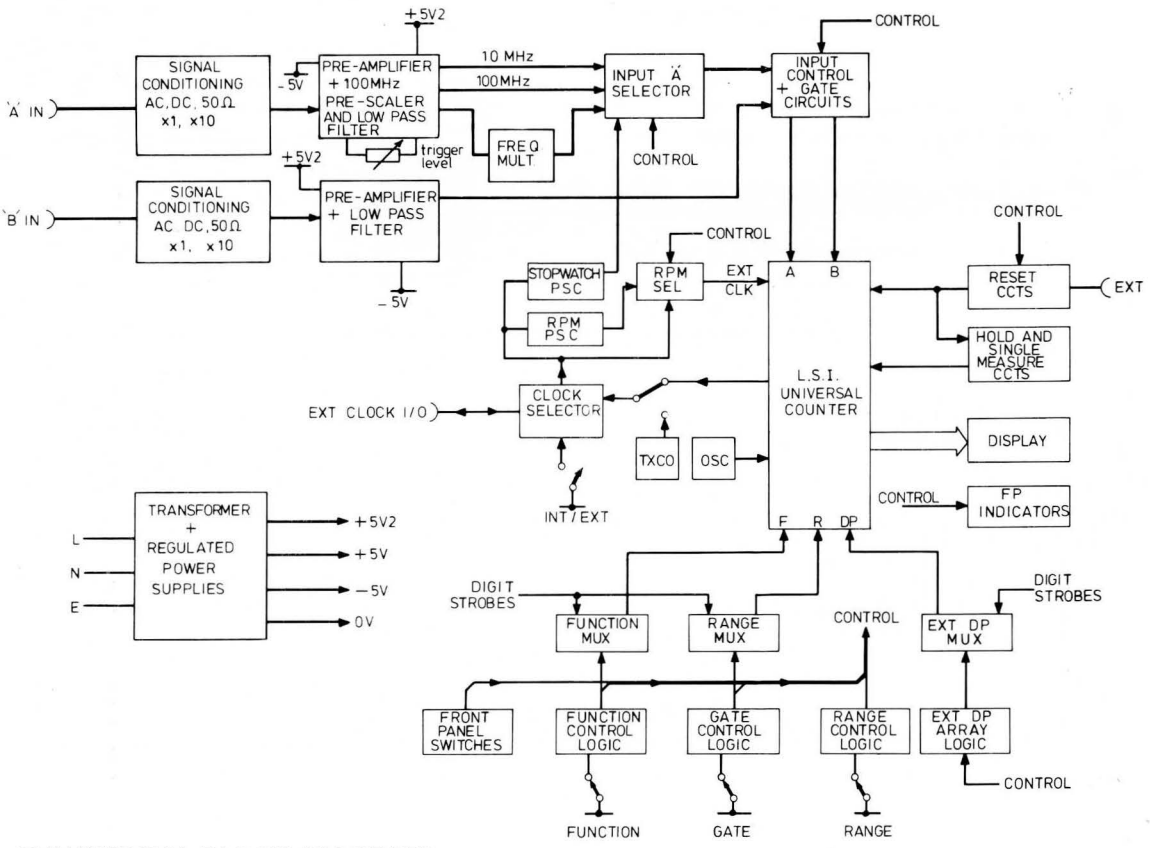
The standard APOLLO counters are fitted with a high stability crystal which provides the 10MHz reference oscillator. The main IC provides a buffered output of this signal which is the system clock. The circuitry has the facility to include a temperature compensated crystal oscillator (T.C.X.O.) to provide higher accuracy and stability if required.

11. CLOCK SELECTOR

The clock selector circuit selects, using a rear panel switch, either the internal system clock or an external clock signal (e.g. an off-air frequency standard).

12. FUNCTION, RANGE and GATE control logic

This section decodes the function, range and gate pushbuttons to provide the various control lines.



FUNCTIONAL BLOCK DIAGRAM

CIRCUIT DESCRIPTION

The following description applies to the APOLLO 100 counter timer. Certain sections are not applicable to the APOLLO 10. Refer to circuit diagrams for the differences. NOTE control signals marked with a '*' are active low e.g. (* FREQ).

1. POWER SUPPLY (CCT. DIAG. 1)

Three separate voltages are generated by the power supply circuit. These voltages are provided by monolithic integrated circuit regulators IC100, 101, 102 and their associated components. The +5V2, and the −5V supplies are used by the pre-amplifier, pre-scaler and frequency multiplier circuits. The +5V2 supply is adjusted by RV100 to 5.2V ± 0.05V so that the ECL circuits operate at their optimum voltage. The +5V supply is used by the main logic circuits. Test points TP100, TP101, TP102 and TP103 are provided for convenient monitoring of the power supplies. All three voltage supplies have built in short circuit protection. The mains transformer T100 provides the necessary voltage conversion and isolation of the mains supply voltage. Transformer taps are provided to enable conversion to 110/120V operation. Fuse F100 provides protection against fault currents. SW100 is the instrument ON/OFF switch and is mounted on the rear panel.

2. PRE-AMPLIFIERS (CCT. DIAG. 2)

S1200 selects the input coupling mode AC, 50Ω, DC or LPF. With the switch in the 50Ω position C1201 and R1200 terminate the input with nominally 50Ω, (the input is DC coupled in this position). With DC selected the input signal is directly coupled to the pre-amplifier. R1201 sets the input impedance to 1MΩ. With S1201 in the x10 position the input signal passes through the x10 attenuator, R1202 and R1203 perform the voltage division and C1202 and C1203 provide frequency compensation.

The pre-amplifier is protected from excessive input voltage by R1204, R1239, C1204, D1200, and D1201.

The input coupling components are situated on the front panel sub-board, which is mounted between the front panel and the front panel p.c.b.

Q1200, Q1201 and Q1202 form a high input impedance, wide bandwidth voltage follower. The high input impedance is necessary to avoid loading the input coupling and attenuator circuits.

The next stage of the pre-amplifier consists of two differential amplifiers Q1208, Q1209 and Q1206, Q1207. Amplifier Q1206, Q1207 is operative when the LPF (low pass filter) is selected. Amplifier Q1208, Q1209 is operative when AC, 50Ω or DC is selected. Normally Q1205 is biased on so that the current source Q1203 is connected to the emitters of Q1208, Q1209, so that this amplifier is operative. Alternatively if the LPF is selected Q1204 is biased on and Q1205 is biased off so that the current source is connected to the emitters of Q1206 and Q1207. This amplifier is then operative and the input signal passes through the low pass network R1213 and C1205 before amplification. The filter components values are calculated to give a cut of frequency of nominally 50kHz.

The variable resistor R1218 is the front panel TRIGGER LEVEL control and sets the working point of the differential amplifiers. Resistor R1219 is adjusted during calibration to take account of component tolerances. The emitter follower Q1210 applies the working point voltage to the base of Q1206, Q1207, Q1208, Q1209. Diodes D1204 and D1205 provide temperature compensation for the trigger level control.

The antiphase outputs from the differential amplifier provide the input to IC1200(b). IC1200(b) forms the main gain stage of the pre-amplifier, this IC is an ECl differential line driver biased to operate in the linear mode to provide higher gain. The output from IC1200(b) feeds two circuits (1) a Schmitt trigger ECL to TTL converter, Q1211, Q1212 and Q1213. Q1213 is a high speed switching transistor to ensure the fastest possible rise time. Overall feedback around this amplifier is provided by R1229. (2) IC1200(c) buffers the output of IC1200(b) to provide a signal for the 100MHz pre-scaler (see CCT. DIAG. 3).

3. FREQUENCY MULTIPLIER AND PRE-SCALER CIRCUITS (CCT. DIAG. 3)

IC1105 is a ÷10 or ÷11 pre-scaler. D1103 pulls pins 2 and 3 high to set the pre-scaler to the ÷10 mode. The 10MHz output from the pre-scaler is inverted by the Schmitt trigger IC1106(b) and sent to the input selector (see CCT. DIAG. 4).

Channel A output from Q1213 (see CCT. DIAG. 3) is inverted by IC1106(f) and sent to the input selector. The channel B signal from the pre-amplifier is passed through IC1106(a,c) and sent to the Gating and Input B circuits (see CCT. DIAGS. 4 and 5).

IC1101 performs level shifting for the input signals to the frequency multiplier circuit. This is necessary as the frequency multiplier circuit operates from dual supplies. The frequency multiplier function is performed by IC1102, IC1103, IC1104 and associated components, which form a frequency multiplying PHASE LOCKED LOOP. IC1102 is a phase locked loop integrated circuit, containing two phase comparators, a voltage controlled oscillator (VCO) and a source follower. IC1103 is a two stage counter which divides the VCO output by either 10 or 100 and sends the signal to the phase comparator input pin 3. The two multiplier ranges are selected by the control lines (* 100kHz) and (* 10kHz). When the 10kHz range is selected the gate IC1104(a) is enabled and the divide by 100 output of IC1103 is sent to the phase comparator input of IC1102 to provide a multiplication factor of 100. When the 100kHz range is selected the gate IC1104(b) is enabled and the divide by 10 output from IC1103 is sent to phase comparator input of IC1102 to provide a multiplication factor of 10.

The phase comparator output (PC OUT) is smoothed by the filtering components R1107, R1108, R1116, C1102 and C1103 to provide the control voltage for

the voltage controlled oscillator (VCO IN). NOTE C1102, C1103 and R1116 are only in circuit when the 10kHz range is selected, these components are required to reduce the amount of ripple on the VCO control voltage when making low frequency measurements to ensure a stable display.

The (FM 1NH) signal (see also CCT. DIAG. 8) is used as the enable for the multiplier function. When either the 10kHz or 100kHz range is selected the (* FM INH) signal goes high and turns off TR1101 causing the voltage at pin 5 of IC1102 to go low and enable the frequency multiplier. TR1102 ensures that the filter capacitors C1102 and C1103 are fully discharged and that the VCO is operating at its lowest frequency when the multiplier function is selected.

4. INPUT SELECTOR (CCT. DIAG. 4)

The INPUT SELECTOR selects which of the input signals, 10MHz, 100MHz, FM or STOPWATCH is sent to the main counter for measurement. IC304 is a 1 of 8 data selector, the three control signals A, B, C determine which of the inputs are transmitted to the output (A IN).

The table below shows how the various functions are selected.

C	B	A	W	FUNCTION
H	H	H	D7	100MHz
L	H	L	D2	10MHz
L	L	H	D1	FM (multiplier)
L	H	H	D3	STOPWATCH

5. STOPWATCH PSC (CCT. DIAG. 4)

IC307, IC308 and IC309 form the stopwatch prescaler circuit. The purpose of this circuit is to provide an accurate 100Hz signal from the 10MHz system clock (SYS CLK) that can then be counted by the main counter IC. IC307, IC308 and IC309 are dual $\div 2$ and $\div 5$ counters. IC307 and IC308 are arranged to each divide 100 and IC309 to divide by 10 to give a total division by 100,000.

The counters are provided with a clear signal, which is derived from the (RESET) line. The (CLEAR) signal ensures that counting always begins on the same signal edge so that counting errors are avoided.

6. START/STOP and GATING (CCT. DIAG. 4)

The START/STOP button controls the stopwatch and count functions. The start/stop circuit generates two signals when the start/stop button is pressed, (1) the Q output of IC306 (pin 5) and (2) the (START) signal from IC708d. IC305 and IC306 give a toggle action to the start/stop button (S1007). When the (START) signal is high and (*STOPW + COUNT) is low then (GATE) is low, which opens the input A gate and allows counting or timing to begin (see Fig. 5). IC306 is provided with a (RESET) signal to close the input A gate and reset the count or stopwatch when a reset occurs. The (START) signal is also used to prime the counter when using the single measure facility.

7. SLOPE CONTROLS and HOLD-OFF (CCT. DIAG. 5)

The input signals (AIN) and (BIN) pass through the exclusive OR gates IC200. Switches ATRIG and BTRIG, the SLOPE controls, invert the signals to set the trigger edge to +VE or −VE slope. When the control signal (GATE) is low IC202b passes the signal through to be measured by the main counter IC.
signal through to be measured by the main counter IC.

When making time interval measurements it is sometimes necessary to delay the triggering of input B to avoid triggering problems. This trigger hold off facility is accomplished by IC201, IC209 and their associated components. IC201 is a precision CMOS timer configured as a monostable. The monostable period is set by the front panel hold off control RV1001 and C200. The timing range of the hold off control is from nominally 5ms to 500ms. The monostable is triggered on by the negative going edge of the (AIN) signal via C213.

8. SINGLE MEASURE PRIMING (CCT. DIAG. 5)

Before making a single time interval measurement the main counter IC205 must be "primed". This is done by generating a negative signal edge at AIN (pin 40) followed by a negative signal edge at BIN (pin 2). The priming signals are generated by the shift register IC203. The (START) signal is clocked through the shift register by the system clock and outputs are taken from pins 3 and 11 to provide the priming signals. The (SINGLE CYCLE) signal clears the shift register prior to priming.

9. TRIGGER LED CONTROL (CCT. DIAG. 5)

The front panel trigger level LED's are driven by signals derived from the signal inputs to the main counter IC205. The B signal is first inverted by IC204b and then sent to the display p.c.b. The gate arrangement IC208, 204 selects the (10M INP) signal when the frequency multiplier function is active, this ensures that the input A trigger LED flashes at the same rate as the signal being measured and not at the multiplied rate of the frequency multiplier output.

10. RESET (CCT. DIAG. 5)

The RESET circuitry enables the user to set the display to zero and prepare the counter for the next measurement. Two user resets are provided, (1) the front panel pushbutton and, (2) the rear panel input sockets. The front panel reset is performed by S1003. When this button is pressed, pin 19 of IC205 is pulled low, this resets the main counter. Note the reset signal is also sent to other parts of the counter circuit to perform various necessary resets.

When the rear panel reset input is pulled low TR206 is turned off allowing TR205 to turn on which pulls the reset line low to perform a reset. When the reset signal is removed TR206 is turned on via R207 and R213 which allows the reset line to return high.

Protection up to ± 20V is provided by D201, D203 an D204, with the input current limited by R207.

An internal reset is generated by the front panel switch logic, this resets the counter whenever a range of function change is made.

11. DISPLAY HOLD (CCT. DIAG. 5)

The display hold "freezes" the last measurement made on the display. Two separate functions are available (1) a variable display hold and (2) an indefinite display hold. The variable hold is performed by the monostable IC201. After the main IC has performed and displayed the result of a measurement, the STORE output of IC205 goes low and triggers the monostable. The Q output of IC201 passes via the NOR gate IC206 and sets the following RS latch IC206(a,b) output high, this causes IC205 to "freeze" the display. At the end of the monostable timing period the RS latch is reset and the counter makes the next measurement. RV1000 and C206 adjust the HOLD time between nominaly 200ms and 10s.

When the front panel HOLD button is pressed the RS latch output is set high and the display is held indefinitely. When the single measure button is depressed the monostable output sets the RS output high and causes IC205 to "freeze" the display until the counter is reset.

12. MAIN COUNTER IC (CCT. DIAG. 5)

IC205 is a fully integrated universal counter and display driver. It contains all the circuitry necessary to function as a frequency counter, a unit counter, a frequency ratio counter and a time interval counter.

The FUNCTION, RANGE, CONTROL and EXTERNAL DECIMAL POINT inputs are time multiplexed to select the desired input function. This is done by connecting the appropriate digit strobe (D1 to D8) to the control inputs. The control of these inputs is achieved by the function, range and external decimal point multiplexers (see CCT. DIAG. 8), which are in turn controlled by the various control and logic circuitry and front panel switches.

A display test facility is provided, which is activated by connecting together pins 1 and 2 of PL202. PL202 is situated on the main p.c.b. The display test illuminates all the display segments and all decimal points except decimal point 8.

13. FRONT PANEL SWITCH LOGIC (CCT. DIAG. 7)

Resistors R701 to R703 and capacitors C701 to 703 in conjunction with IC708(a,b,c) ensure that the set up times of the following J-K flip flops are met. IC701 and IC702 are clocked by the (SLO CLK) and produce a single pulse of 1ms duration each time FUNCTION, FREQ or GATE buttons are pressed. Diodes D701, D702, D703 and TR700 form a three input NOR gate which generates a reset whenever the FUNCTION, RANGE or GATE button is pressed. The next stage of the circuit is the Programmable Array Logic (PAL). IC703. This IC is a fusible link AND-OR gate array, and is used to perform the complex logic functions necessary to decode the FUNCTION, RANGE and GATE switches. The advantage of using this device is that it replaces many discreet IC's and therefore allows a more compact design.

The function of IC703 can be divided into three sections (1) the FUNCTION logic, (2) the RANGE logic and (3) the GATE logic.

The FUNCTION outputs Q14, Q13, Q12 of IC703 is a 3 bit binary code which increments by one each time the FUNCTION button is pressed. IC704 is a 3 to 8 line decoder which decodes the PAL outputs to provide the seven function control lines: (*FREQ), (*RATIO), (*TIME INT), (*COUNT), (*RPM), (*STOPWATCH) and (*PERIOD).

The RANGE outputs Q19, Q18, Q17 are decoded by IC705 to give the five frequency range control lines: (*10M), (*100M), (*10kHz), (PSC) and (*100kHz).

The GATE outputs Q15 and Q16 are decoded by IC706 to provide the four GATE control lines: (*1SEC), (*10SEC), (*100ms) and (*10ms).

Note that when either the stopwatch or count functions are selected the control lines from IC706 are inhibited by the (*STOPW + COUNT) control line.

The PAL has its own "power up reset" circuit R705, C700 and D700. This ensures that when the counter is first switched on the RANGE is set to 10MHz, the GATE is set to 1sec and the FUNCTION set to FREQUENCY.

IC707 provides the correct decimal point positioning for all possible combinations of selected function range and gate time. IC707 is a fusible link ROM (read only memory) with its address lines connected to the PAL outputs. The ROM data lines are the decimal point control signals (DPC), (DPD), (DPC).

14. RANDOM LOGIC and DISPLAY MULTIPLEXERS (CCT. DIAG. 8)

The random logic circuitry generates various control signals from the 1 of 8 decoders IC704, IC705, IC706. One example is the (*FM INH) signal which is used to enable the frequency multiplier circuit when either the 10kHz or 100kHz frequency range is selected.

As described in section 12 the FUNCTION and RANGE selection is accomplished by connecting the appropriate digit drive to the control inputs of the main counter IC. IC804 and IC805 perform this function.

IC804 and IC805 are 8 channel analog multiplexers which form digitally controlled single pole 8-way switches which are controlled by the switch function logic control signals.

See over for table showing the functions selected by each digit for the control input.

	FUNCTION	DIGIT
Function Pin 4	Frequency	D1
	Period	D8
	Frequency Ratio	D2
	Time Interval	D5
	Unit Counter	D4
	Oscillator Frequency	D3
Range Input Pin 21	0.01 Sec/1 Cycle	D1
	0.1 Sec/10 Cycles	D2
	1 Sec/100 Cycles	D3
	10 Sec/1k Cycles	D4
Pin 31	Enable External Range Input	D5
Control Input Pin 1	Display Off	D4 and Hold
	Display Test	D8
	1MHz Select	D2
	External Oscillator Enable	D1
	External Decimal Point Enable	D3
External Decimal Point Input, Pin 20	Decimal point output is for same digit that is connected to this input	

15. SYSTEM CLOCK and R.P.M. PRE-SCALER (CCT. DIAG. 6)

In the standard model the 10MHz system clock is provided by the crystal oscillator circuit XTAL 400, C400, C401, C402 and R407. Frequency adjustment is provided by trimmer capacitor C401.

The clock signal for IC205 is not provided directly by the on chip oscillator but via the EXT OSC IN, this allows for the provision of a T.C.X.O. (Temperature Compensated Crystal Oscillator) or an externally connected oscillator via the rear panel B.N.C. connector.

The gate arrangement IC401(a,b,c) selects either the BUFF OSC OUT signal via IC401(d) OR the externally applied oscillator signal EXT OSC IN. The output from pin 6 of IC401 is pre-scaled by the divide by six counter IC402 to give a frequency of 1.6667MHz necessary for the RPM function. IC403 selects either the 10MHz signal from pin 6 of IC401 or the pre-scaled output of IC402 which provides the clock input for IC205.

The 10MHz output from IC401 pin 3 is buffered by IC400 which then drives the switching transistor TR401. The 4 gates in IC400 are connected in parallel to ensure that there is adequate drive for TR401. To set the rear panel B.N.C. socket to an output the rear panel INT/EXT switch is set to the INT position, this turns on the current mirror formed by TR402 and TR400 which provides collector current for TR401. To set the B.N.C. socket to an input the switch is set to the EXT position, this turns off TR401 by pulling the collector of TR402 high via R403 and R410. Gate IC401(a) is closed and Gate IC401(c) is opened allowing an externally applied signal to be routed to the main counter IC.

MIP output; this output from the main counter IC205 is used to drive the front panel GATE LED and indicates that a measurement is in progress.

When using the STOPWATCH or COUNT mode or if the input signal is gated by input B then the (GATE) signal controls the GATE LED which then illuminates when counting or timing is in progress. IC207(b,c) and associated components form a pulse stretching circuit that ensures that the GATE LED is visible even when the measurement cycle is short.

16. FRONT PANEL DISPLAY SECTION (CCT. DIAG. 9)

IC's 600, 601, 602 and 603 provide buffering for the various control signals to drive the front panel LED's. TR600 and TR601 drive the overflow LED.

17. CONVERTING FROM 220/240V to 110/120V OPERATION

IMPORTANT — Disconnect Mains Lead

Referring to DISMANTLING Section 3, page 2, disassemble up to Section 3(d).

Referring to MECHANICAL ASSEMBLY DIAGRAM, page 3:

1. On transformer primary terminals, remove 0V to 120V link.
2. Using 16/0.1 insulated wire, connect the two 0V terminals together, and connect the two 120V terminals together.
3. Replace 250mA anti-surge fuse with 315mA anti-surge fuse (and replace spare).
4. Fit label to back panel indicating voltage and fuse type.

CALIBRATION

1. In order to calibrate the APOLLO series of counter timers it is first necessary to dismantle the case (see Introduction p. 2).

2. POWER SUPPLY

The first step in calibrating the instrument is to ensure that the +5V2 supply is set to within its design limits of ±0.05V. If adjustment is required, use a digital voltmeter and adjust RV100 until the supply is within the required limits.

3. TRIGGER LEVEL calibration (see diagram p. 3)

(a) Centre both TRIGGER LEVEL controls as accurately as possible.
(b) Set both ATTENUATION switches to x1.
(c) Set both COUPLING switches to A.C.
(d) Carefully adjust R1219 until both input A trigger LED's are illuminated.
(e) Carefully adjust R1269 until both input B trigger level LED's are illuminated.

4. CRYSTAL CLOCK calibration (standard model)

Calibration of the crystal oscillator becomes necessary is crystal drift exceeds requirements.

(a) Switch on the instrument and allow at least a 30 minute warm up period before proceeding.
(b) Set INPUT A COUPLING to AC.
(c) Set INPUT A ATTENUATION to x1.
(c) Set FUNCTION to FREQ.
(e) Set GATE time to 1s.
(f) Set RANGE to 10MHz.
(g) Connect a frequency standard of known accuracy (0.1ppm or better) to INPUT A. Typically a 10MHz off-air standard would be used.
(h) Adjust TRIGGER LEVEL control until a stable reading is displayed.
(i) Adjust C401 for a reading of 10,000000 ±5 digits.

5. T.C.X.O. calibration

(a) Proceed as section 3 steps (a) to (f).
(b) Connect a frequency standard of known accuracy (0.05ppm or better) to INPUT A. Typically a 10MHz off-air standard would be used.
(c) Adjust a TRIGGER LEVEL control until a stable reading is displayed.
(d) Adjust T.X.C.O. for a reading of 10.000000 ±2 digits.

TROUBLE SHOOTING AND FAULT FINDING

GENERAL

Check all control settings before assuming the instrument is faulty. In particular the position of the SINGLE MEASURE, HOLD, HOLD OFF, LPF, TRIGGER LEVEL, and rear panel INT OUT/EXT IN controls.

Check that the correct fuse is fitted: 20mm 250mA anti-surge. NO OTHER TYPE SHOULD BE USED.

When replacing components always use a part of the specified type and tolerance. This is not just a matter of accuracy, but often a specified component will have improved stability and thermal performance compared to superficially similar items. It is particularly important that transistors are replaced with the specified item otherwise performance may be degraded.

It is always advisable to re-calibrate the instrument after servicing to ensure that the performance is within specification.

POWER SUPPLIES

A faulty power supply can cause a variety of faults. Use test points TP100, TP101 and TP102 to check the supply voltages. It is particularly important that the 5V2 supply is set to 5V $\pm$ 0.05V.

PRE-AMPLIFIERS

The pre-amplifiers do not normally cause problems. If however any components associated with the differential amplifiers are changed then re-calibration of the trigger level controls is essential.

OSCILLATOR

If the crystal oscillator fails this is immediately apparent as only one digit lights up with very high intensity. The oscillator should be monitored with an oscilloscope at pin 38 of the main counter IC205. If no 10MHz signal is present then suspect the crystal XTAL400, (or T.C.X.O. if fitted).

DISPLAY

The display digit strobes are used for control of the counter's functions and leakage between the very fine tracks can cause a variety of function and display problems, including "ghosting of display segments".

EXTERNAL REF OSC INPUT

This input is TTL compatible, ensure that signal source used has a compatible output level. Check that frequency of reference signal is within the range 100kHz to 10MHz. The calibration frequency is 10MHz, if other frequences are used then the measurement cycle time will increase accordingly and the display multiplexing rate will decrease.

SWITCH CONTROL LOGIC

A lack of response to the function, range and gate switches is indicative of a fault in the switch control logic, this is most commonly caused by IC703 (PAL), or a failure of the (SLO CLK) signal. Check that the 'Q' outputs of IC703 respond to the function, range and gate switches and for the presence of the clock signal at pin 1 of IC703.

PARTS LIST

CIRCUIT POSITION	DESCRIPTION	PART No.
Semiconductors		
IC100	LM 340T - 5 (7805CT)	24-036
IC101	LM 317T	24-038
IC102	LM 320LZ - 5 (79L05 ACP)	24-037
IC200	74HC 86N	24-030
IC201	7556 IPD	24-040
IC202	74HC 27N	24-019
IC203	74HC 175N	24-024
IC204	74HC 04N	24-016
IC205	ICM 7226 BIPL	24-012
IC206	74HC 10N	24-018
IC207	74HC 02N	24-028
IC208 - IC209	74HCT00N	24-029
IC304	74HC 151N	24-031
IC305	74HC 02N	24-028
IC306	74HC 107N	24-022
IC307 - IC309	74HC 390N	24-027
IC400	74LS 37N	24-020
IC401	74HCT 00N	24-029
IC402	74LS 92N	24-021
IC403	74HCT 00N	24-029
IC600 - IC603	74LS 365N	24-025
IC604	74LS 366N	24-026
IC700 - IC702	74HC 107N	24-022
IC703	PAL 16R8	24-041
IC704 - IC706	74HC 138N	24-023
IC707	N82S129 (AM27S21PC)	24-042
IC708	74HC 14N	24-015
IC800 - IC801	74HC 08N	124-017
IC802	74HC 04N	24-016
IC803 - IC805	4051B	24-035
IC1101	LM339	24-039
IC1102	4046B	24-033
IC1103	4518B	24-034
IC1104	4011B	24-032
IC1105	SP8647B DG	24-014
IC1106	74HC 14N	24-015
IC1200	MC10116P	24-013
TR205-TR206	BC 184	22-005
TR400	2N3906	22-006
TR401	MPS2369 (PN2369, 2N2369)	22-008
TR402	2N3906	22-006
TR600	BC212A	22-001
TR601	BC184	22-005
TR700	BC184	22-005
TR1101	BC212A	22-001
TR1102	BC184	22-005
Q1200	BF256A	22-019
Q1201-Q1202	BF240	22-004
Q1203-Q1205	BC184	22-005
Q1206-Q1209	BF199	22-003
Q1210	BC184	22-005
Q1211-Q1212	2N3906	22-006
Q1213	MPS2369	22-008
Q1250	BF256A	22-019
Q1251-Q1255	BF240	22-004
Q1256-Q1259	BF199	22-003
Q1260-Q1262	BC184	22-005
Q1263	MPS2369 (PN2369, 2N2369)	22-008
D100	S005	23-008
D201	BZY88 C4V7	23-007
D202 - D204	IN4148	23-005
D206 - D208	IN4148	23-005
D402	IN4148	23-005
D600 - D628	Lamp L.E.D. T.1	26-001
D700 - D703	IN4148	23-005
D1101-D1103	IN4148	23-005
D1200-D1201	IN906	23-004
D1202-D1205	IN4148	23-005
D1250-D1251	IN916	23-004
D1252-D1255	IN4148	23-005
DSY1-DSY8	Display L.E.D. 0.5"	26-002
Crystal		
XTAL 400	Crystal 10MHz	25-001
Inductors		
L1200-L1201	Inductor 1uH	17-001
Capacitors		
C102	Electrolytic 470uF 25V	20-044
C103	Ceramic 100nF 63V	20-013
C104	Electrolytic 100uF 25V	20-005
C105	Ceramic 100nF 63V	20-013
C106	Electrolytic 10uF 16V	20-018
C107	Ceramic 100nF 50V	20-013
C108	Electrolytic 100uF 25V	20-005
C109 - C125	Ceramic 100nF 50V	20-013
C200	Tantalum 0.47uF 35V	20-039
C201	Ceramic 39pF 100V	20-009
C202	Ceramic 100nF 50V	20-013
C203	Electrolytic 10uF 16V	20-018
C204	Ceramic 100nF 50V	20-013
C205	Electrolytic 100uF 6V3	20-011
C206	Tantalum 10uF 16V	20-041
C207	Ceramic 100nF 50V	20-013
C210 - C212	Ceramic 100nF 50V	20-013
C213	Ceramic 1nF 100V	20-048
C305	Ceramic 100nF 50V	20-013
C400	Ceramic 39pF 100V	20-009
C401	Ceramic 56pF 63V	20-067
C402	Trimmer 2-22pF	21-003

CIRCUIT POSITION	DESCRIPTION			PART No.
Capacitors				
C403 - C405	Ceramic	100nF	50V	20-013
C406	Tantalum	1uF	35V	20-038
C407	Ceramic	68pF	100V	20-037
C408	Polyester	22nF	63V	20-043
C600 - C605	Ceramic	100nF	50V	20-013
C606	Electrolytic	100uF	6V3	20-011
C700	Tantalum	1uF	35V	20-038
C701 - C703	Ceramic	100nF	50V	20-013
C704	Polyester	22nF	63V	20-043
C1101	Ceramic	27pF	100V	20-049
C1102	Tantalum	2u2	16V	20-040
C1103	Tantalum	10uF	16V	20-041
C1104-C1109	Ceramic	100nF	50V	20-013
C1200	Ceramic	220nF	100V	20-042
C1201	Ceramic	6n8	500V	20-035
C1202	Ceramic	18pF	500V	20-047
C1203	Ceramic	150pF	100V	20-046
C1204	Ceramic	47pF	500V	20-006
C1205	Ceramic	4n7	63V	20-036
C1206	Ceramic	100nF	50V	20-013
C1207-C1208	Ceramic	10nF	63V	20-008
C1210	Ceramic	100nF	50V	20-013
C1211	Electrolytic	100uF	6V3	20-011
C1212	Ceramic	100nF	50V	20-013
C1213	Electrolytic	100uF	6V3	20-011
C1214	Ceramic	100nF	50V	20-013
C1216-C1217	Ceramic	100nF	50V	20-013
C1218	Electrolytic	100uF	6V3	20-011
C1250	Ceramic	220nF	100V	20-042
C1251	Ceramic	6n8	500V	20-035
C1252	Ceramic	18pF	500V	20-047
C1253	Ceramic	150pF	100V	20-046
C1254	Ceramic	47pF	500V	20-006
C1255	Ceramic	4n7	63V	20-036
C1256	Ceramic	100nF	63V	20-013
C1257-C1258	Ceramic	10nF	63V	20-008
C1260	Ceramic	100nF	50V	20-013
C1261	Electrolytic	100uF	6V3	20-011
C1262	Ceramic	100nF	50V	20-013

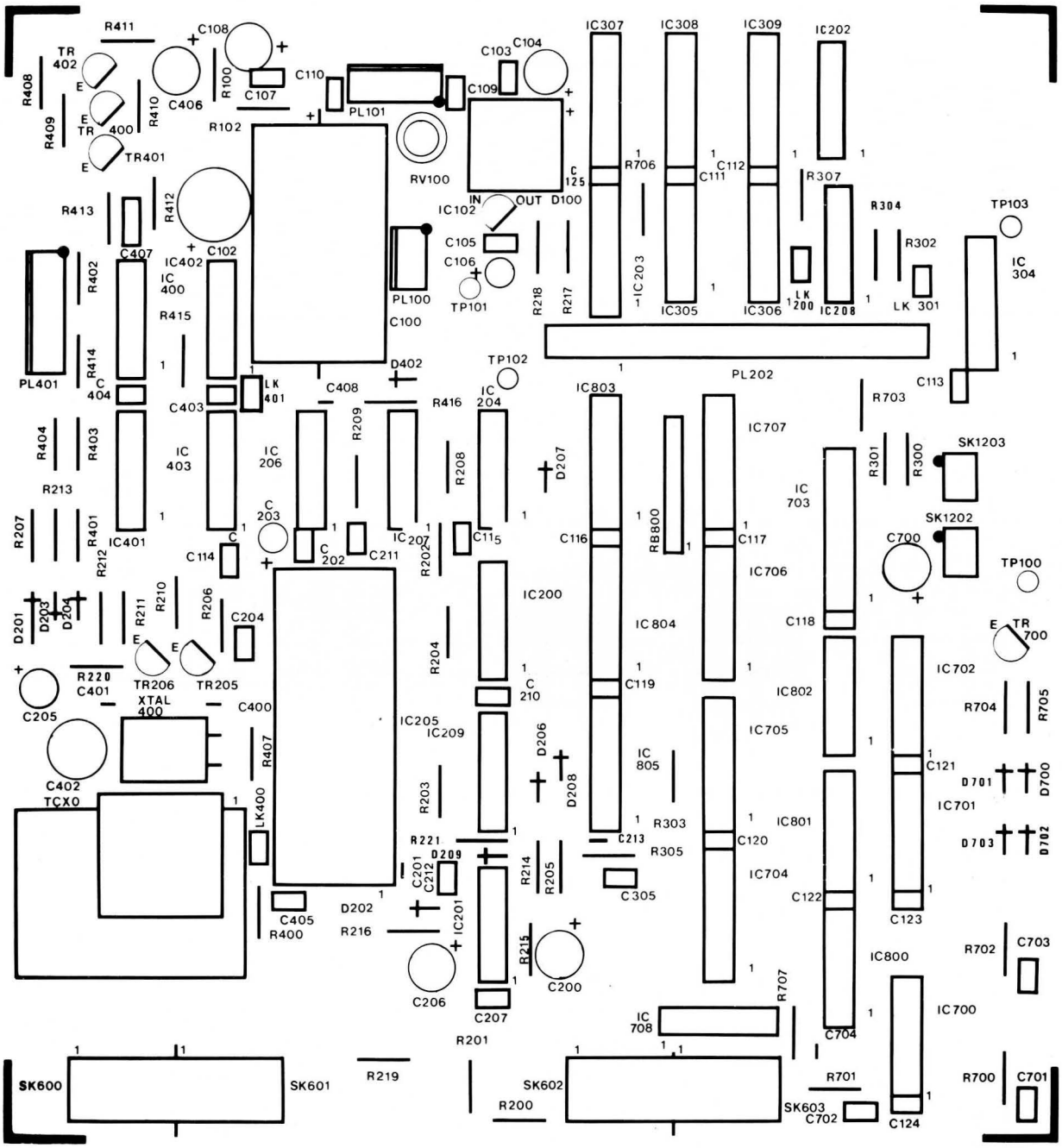
CIRCUIT POSITION	DESCRIPTION				PART No.
Resistors, Fixed					
R100	CF	W33	270R		18-014
R102	CF	W33	1K		18-020
R200-R201	CF	W33	4K7		18-027
R202-R206	CF	W33	10K		18-029
R207	CF	W33	470R		18-016
R208-R212	CF	W33	10K		18-029
R213	CF	W33	1K		18-020
R214	CF	W33	4K7		18-027
R215	CF	W33	10K		18-029
R216	CF	W33	100K		18-037
R217-R220	CF	W33	10K		18-029
R300-R304	CF	W33	10K		18-029
R305	CF	W33	4K7		18-027
R307	CF	W33	10K		18-029
R400	CF	W33	100K		18-037
R401	CF	W33	4K7		18-027
R402	CF	W33	1K		18-020
R403-R404	CF	W33	4K7		18-027
R407	CC	W25	22M		18-001
R408	CF	W33	22R		18-074
R409	CF	W33	27R		18-075
R410	CF	W33	270R		18-014
R411	CF	W33	22R		18-074
R412	CF	W33	680R		18-018
R413	CF	W33	1K2		18-021
R414-R415	CF	W33	10K		18-029
R416	CF	W33	1M2		18-077
R600-R606	CF	W33	270R		18-014
R607	CF	W33	10R		18-008
R608-R609	CF	W33	270R		18-014
R610	CF	W33	4K7		18-027
R611	CF	W33	1K		18-020
R612	CF	W33	4K7		18-027
R613-R614	CF	W33	270R		18-014
R700-R703	CF	W33	4K7		18-027
R704-R705	CF	W33	10K		18-029
R706	CF	W33	4K7		18-027
R707	CF	W33	47K		18-031
R1000-R1001	CF	W33	10K		18-029
R1101	CF	W33	3K3		18-063
R1102	CF	W33	1K8		18-023
R1103	CF	W33	10K		18-029
R1104-R1105	CF	W33	22K		18-030
R1106	CF	W33	4K7		18-027
R1107	CF	W33	1M2		18-077
R1108	CF	W33	22K		18-030
R1109	CF	W33	10K		18-029
R1110	CF	W33	5k6		18-078
R1111	CF	W33	470R		18-016
R1112	CF	W33	6K8		18-076
R1113	CF	W33	22K		18-030
R1114	CF	W33	10K		18-029
R1115	CF	W33	10K		18-029
R1116	CC	W25	22M		18-001
R1200	MF	1W	51R		18-083
R1201	CF	W25	1M	250V	18-081
R1202	CF	W25	910K	250V	18-080
R1203	CF	W33	100K		18-037
R1204	CC	1W	100K	250V	18-002
R1205	CF	W33	680R		18-018

CIRCUIT POSITION	DESCRIPTION				PART No.
Resistors, Fixed					
R1206	CF	W33	330R		18-015
R1207	CF	W33	680R		18-018
R1208	CF	W33	1K		18-020
R1209	CF	W33	330R		18-015
R1210	CF	W33	560R		18-017
R1211	CF	W33	680R		18-018
R1212	CF	W33	100R		18-012
R1213-R1214	CF	W33	680R		18-018
R1215-R1216	CF	W33	82R		18-038
R1217	CF	W33	15K		18-036
R1220	CF	W33	12K		18-065
R1221	CF	W33	10K		18-029
R1222	CF	W33	4K7		18-027
R1223	CF	W33	330R		18-015
R1224	CF	W33	470R		18-016
R1225	CF	W33	330R		18-015
R1226	CF	W33	470R		18-016
R1227	CF	W33	1K8		18-023
R1228	CF	W33	820R		18-019
R1229	CF	W33	10K		18-029
R1230	CF	W33	1K		18-020
R1231	CF	W33	10R		18-008
R1232	CF	W33	100R		18-012
R1233	CF	W33	180R		18-062
R1234	CF	W33	1K		18-020
R1235	CF	W33	180R		18-062
R1236	CF	W33	1K		18-020
R1237-R1238	CF	W33	2K2		18-024
R1239	MF	W5	82R		18-087
R1250	MF	1W	51R		18-083
R1251	CF	W25	1M	250V	18-081
R1252	CF	W25	910K	250V	18-080
R1253	CF	W33	100K		18-037
R1254	CC	1W	100K	250V	18-002
R1255	CF	W33	680R		18-018
R1256	CF	W33	330R		18-015
R1257	CF	W33	680R		18-018
R1258	CF	W33	1K		18-020
R1259	CF	W33	330R		18-015
R1260	CF	W33	560R		18-017
R1261	CF	W33	680R		18-018
R1262	CF	W33	100R		18-012
R1263-R1264	CF	W33	680R		18-018
R1265-R1266	CF	W33	82R		18-038
R1267	CF	W33	15K		18-036
R1270	CF	W33	12K		18-085
R1271	CF	W33	10K		18-029
R1272	CF	W33	4K7		18-027
R1273	CF	W33	330R		18-015
R1274	CF	W33	470R		18-016

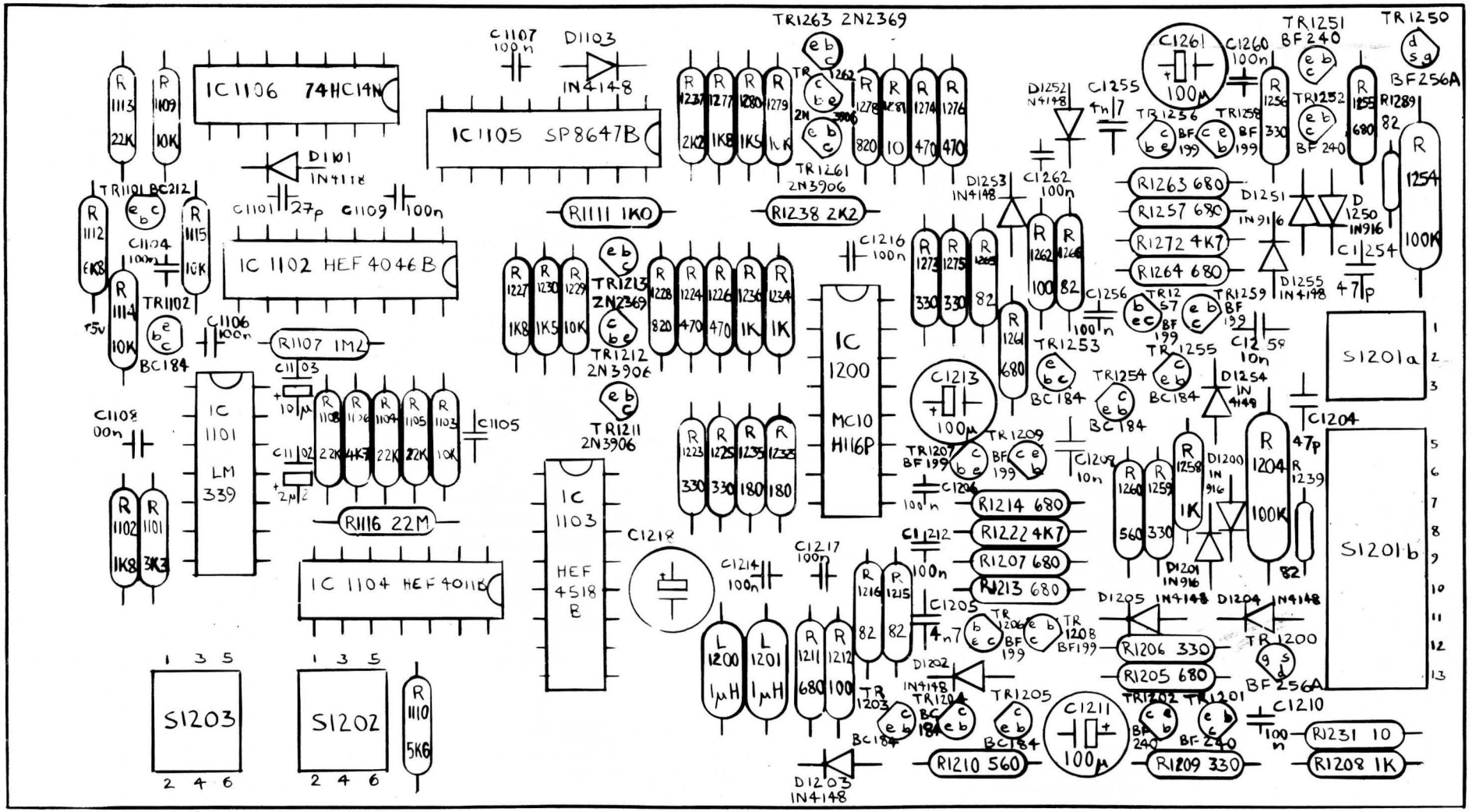
CIRCUIT POSITION	DESCRIPTION			PART No.
R1275	CF	W33	330R	18-015
R1276	CF	W33	470R	18-016
R1277	CF	W33	1K8	18-023
R1278	CF	W33	820R	18-019
R1279	CF	W33	10K	18-029
R1280	CF	W33	1K	18-020
R1281	CF	W33	10R	18-008
R1289	MF	W5	82R	18-087
RB800	Block SIL 8 x 4K7			18-082
Resistors, Variable				
R101	Open preset Hor. W2 100R			19-004
R1218	Variable Pot. linear 2K			19-001
R1219	Open preset Vert W2 4K7			19-011
R1268	Variable Pot. linear 2K			19-001
R1269	Open preset Vert W2 4K7			19-011
RV1000-RV1001	Variable Pot. linear 1M			19-003
Switches				
S400	Slide 2P2W			16-001
S1001-S1002	Slide 2W2W			16-006
S1003-S1010	Push 8 position			16-009
S1008-S1010	Push 3 position			16-010
S1200	Slide 2P4W			16-007
S1201	Slide 2P2W			16-006
S1250	Slide 2P4W			16-007
S1251	Slide 2P2W			16-006
SW100	Mains, on/off rocker			16-011
Sockets/Connectors/Pins				
SK100	Socket housing 4 way			14-029
SK101	Socket housing 6 way			14-031
SK102	Socket mains I.E.C.			14-017
SK401	Socket housing 8 way			14-033
SK200	Socket 4mm red			14-023
SK200	Socket 4mm black			14-022
SK400	Socket BNC 50 Ohm			14-002
SK600-SK603	Socket P.C.B.			14-025
SK1200	Socket BNC 50 Ohm			14-002
SK1201a	Socket P.C.B.			14-026
SK1201b	Socket P.C.B.			14-027
SK1202	Socket P.C.B.			14-014
SK1203	Socket P.C.B.			14-026
SK1250	Socket BNC 50 Ohm			14-002
TP100-TP103	Test pins			14-005
PL100	Plug 4 way			14-028
PL101	Plug 6 way			14-030
PL401	Plug 8 way			14-032

DESCRIPTION	PART No.
Miscellaneous	
Socket I.C. 40 pin D.I.L. (3)	14-013
Socket I.C. 20 pin D.I.L.	14-036
Socket I.C. 16 pin D.I.L.	14-016
Socket I.C. 14 pin D.I.L.	14-037
Spacer P.V.C. (L.E.D.) (29)	13-030
Tag, Solder (B.N.C.) (3)	14-003
Sleever, Rubber H15 (13)	15-004
Shroud, mains	15-005
Pin, P.C.B. (8)	14-024
Pin, P.C.B. (62)	14-015
Fuse, 20mm 250mA anti-surge (2)	33-002
P.C.B. (main)	30-006
P.C.B. (Front panel)	30-007
P.C.B. (Pre-amp)	30-008
P.C.B. (Switch)	30-009
Front panel printed (Apollo 10)	28-007
Front panel printed (Apollo 100)	28-008
Case upper (inserts)	27-001
Case lower (drilled)	27-002
Expansion strip (2)	27-003
Foot A (2)	27-004
Foot B (2)	27-005
Leg	27-008
Screw M3 x 70 (4)	13-003
Pad, foot (4)	27-009
Rear Panel, printed	28-010
Knob, grey (4)	29-011
Knob cap blue (4)	29-013
Knob cap green (2)	29-012
Stand-off washer B.N.C. (2)	13-020
Insulator B.N.C. (2)	15-002
Button, grey (8)	29-007
Washer, Mic (2)	13-028
Screw 6BA x ½" Pozi PN HD (2)	13-021
Nut 6BA (2)	13-009
Washer 6BA (2)	13-007
Washer, shakeproof M3 (5)	13-018
Insulator, top hat T0220 (2)	15-003
Screw M3 x 12 Tamper proof	13-022
Screw M3 x 10 Pozi C/S (2)	13-023
Screw No. 4 x ¼" Pozi (4)	13-010
Nut M3 (3)	13-019
Screw M4 x 12 Pozi PN HD (27	
Screw M4 x 12 Pozi PN HD (2)	13-024
Nut M4 (2)	13-025
Solder tag 5BA (2)	14-035
Screw M2.5 x 0.45 x 5 Pozi PN HD (2)	13-026
M4 Shakeproof washer (2)	13-027
Poly bag 12" x 16"	31-010
Poly bag 7" x 9" (2)	31-011

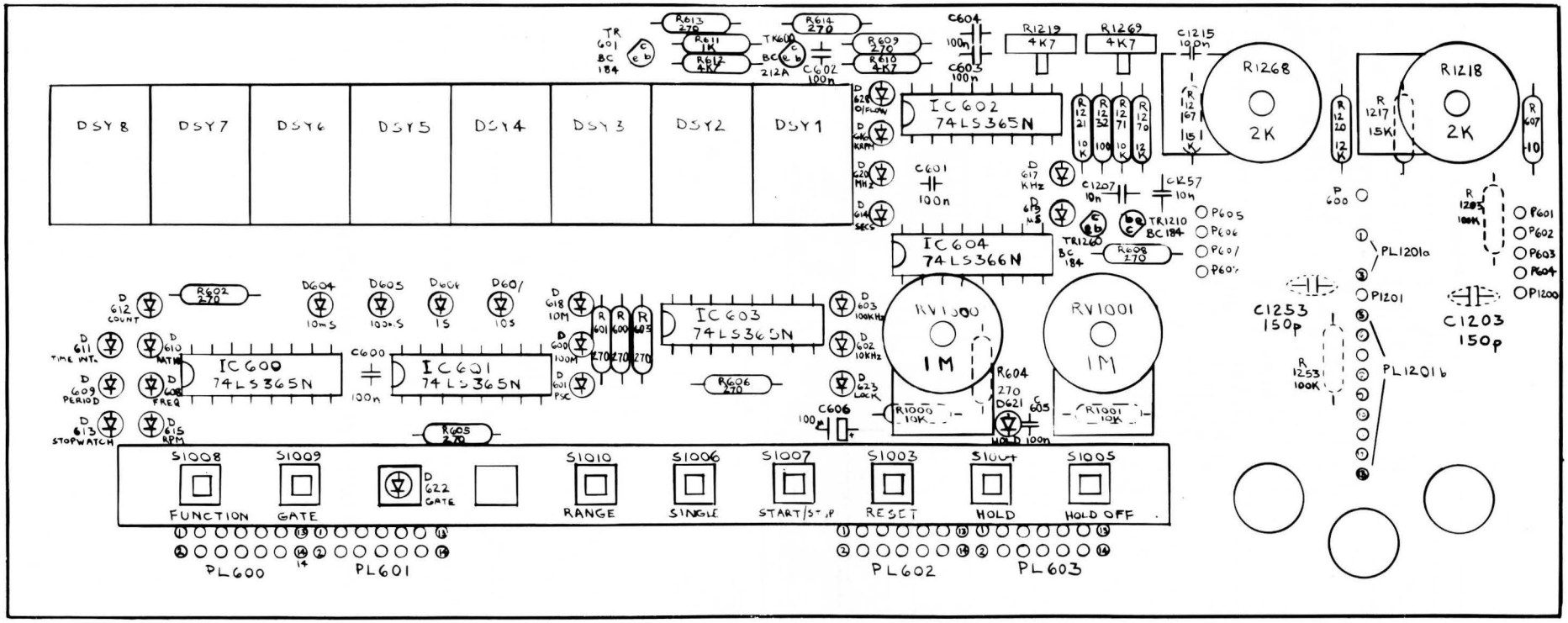
DESCRIPTION	PART No.
Manual, instruction	31-038
Guarantee card (U.K.)	31-009
Mains lead (U.K., Euro or USA)	As appropriate
Polystyrene end cap (2)	31-004
Carton	31-006
Heatsink	38-002
Transformer 24VA	40-002



COMPONENT LAYOUT MAIN PCB

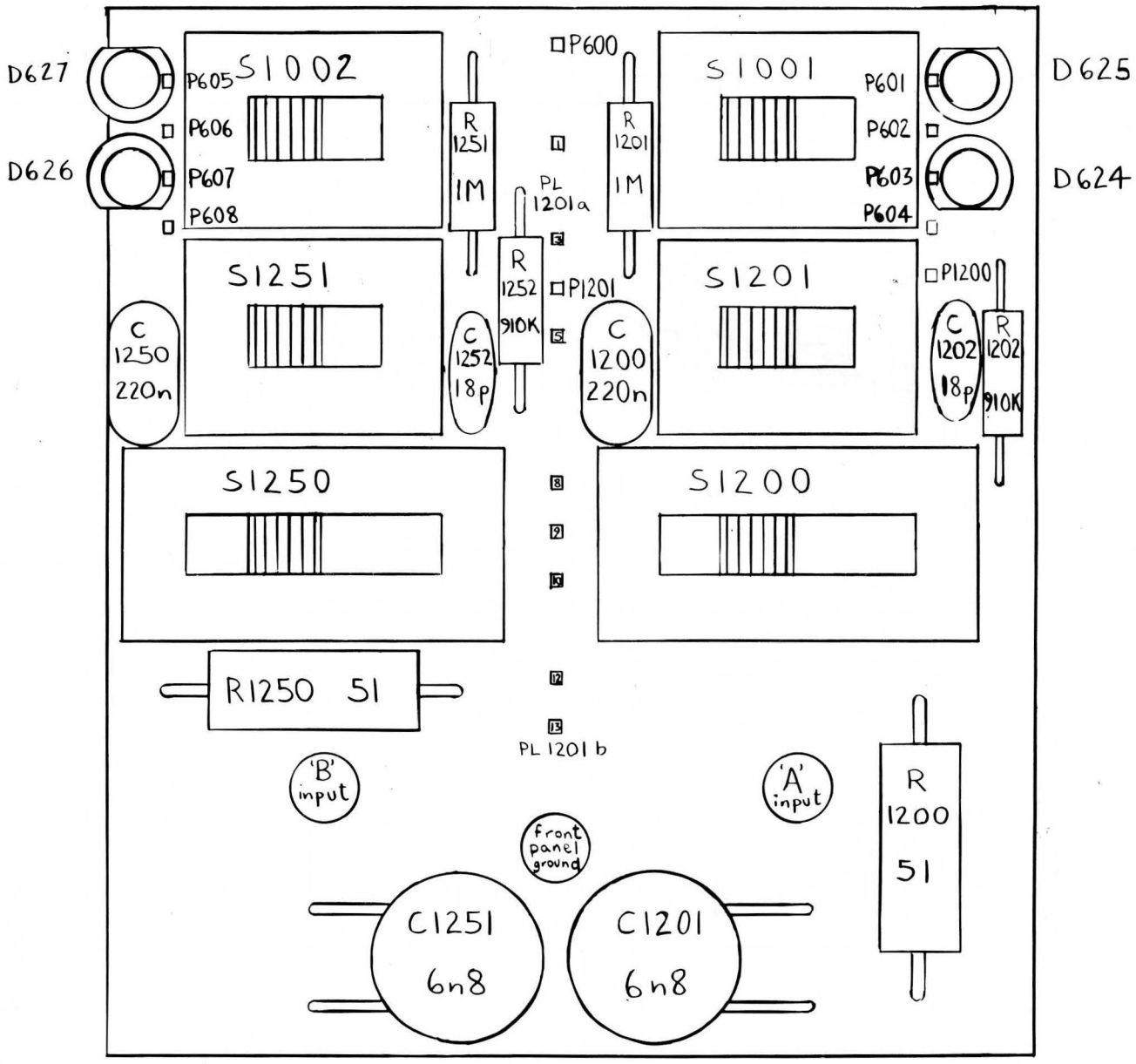


COMPONENT LAYOUT PREAMP PCB

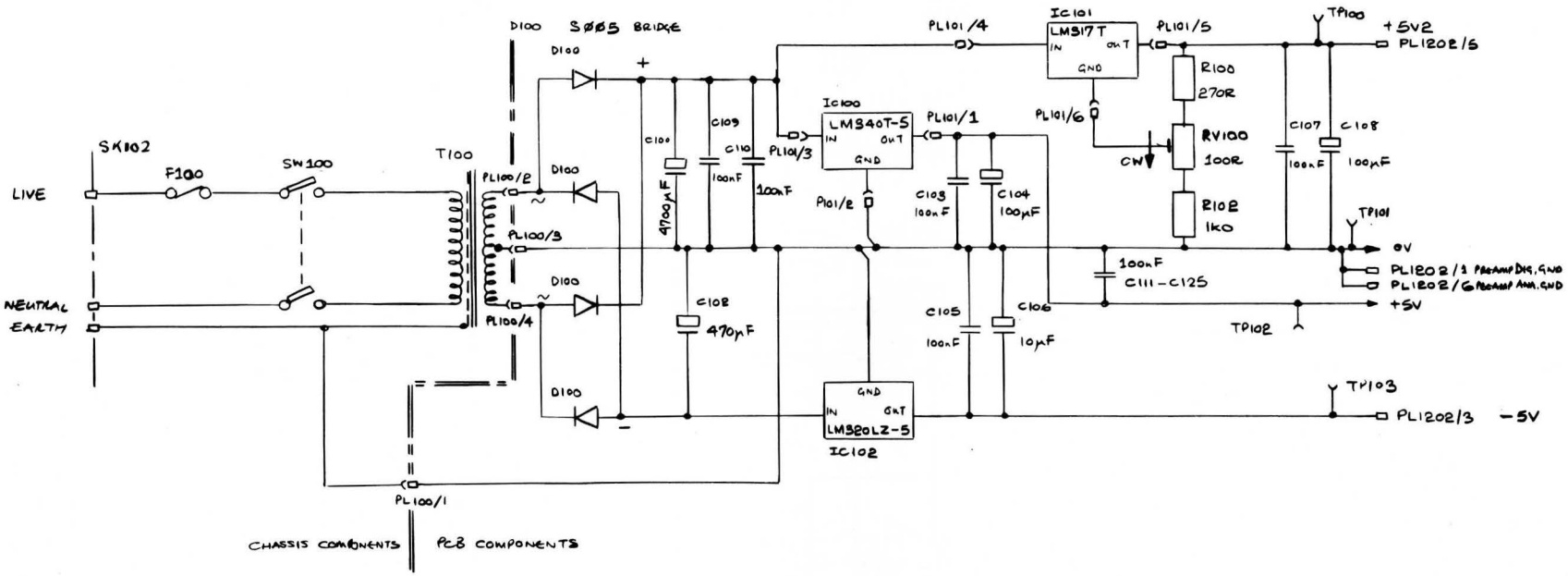


Components shown dotted are obscured by higher components
R1203, 1253 and C1203, C1253 are mounted on the reverse of the board

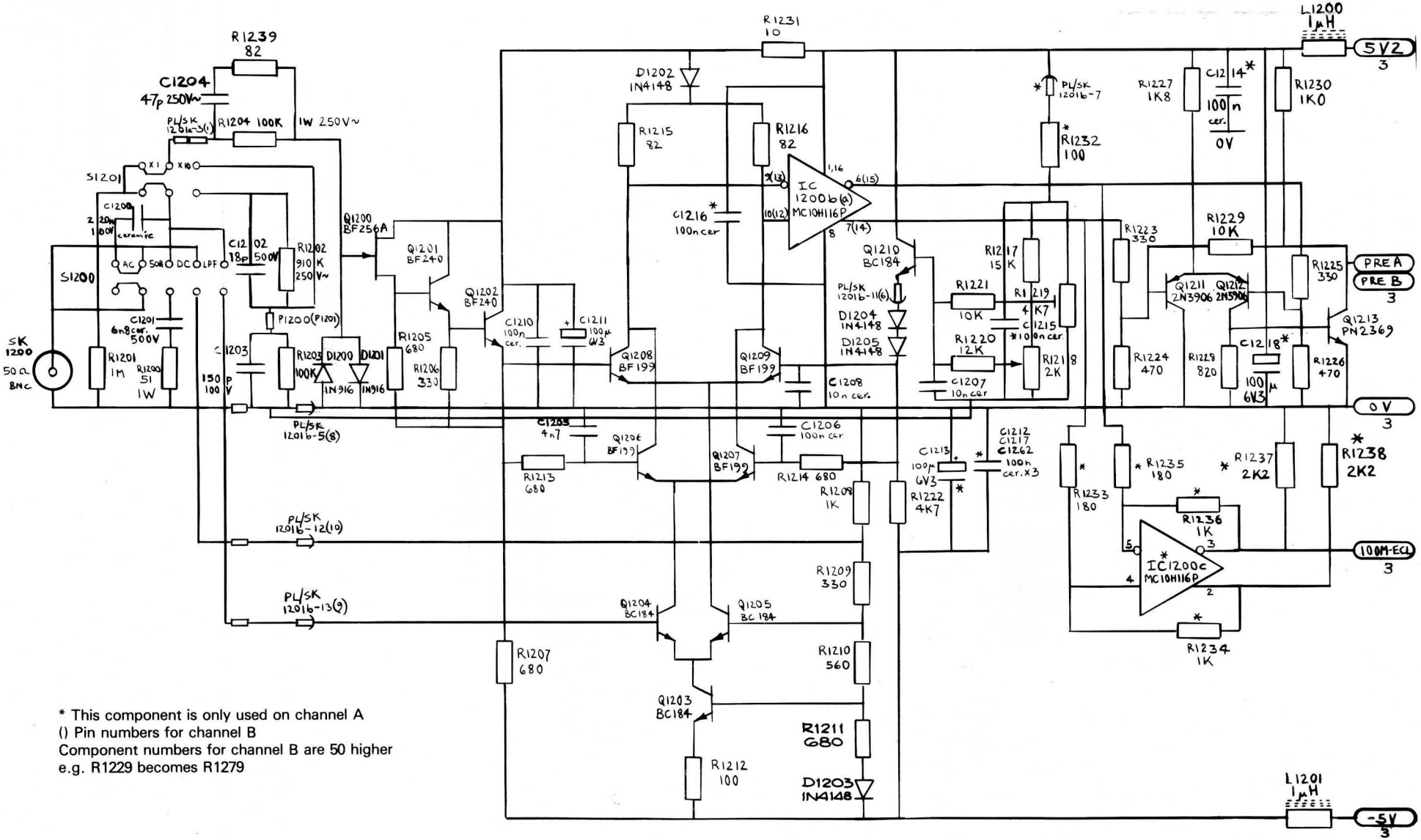
COMPONENT LAYOUT FRONT PANEL PCB



COMPONENT LAYOUT SUB BOARD PCB

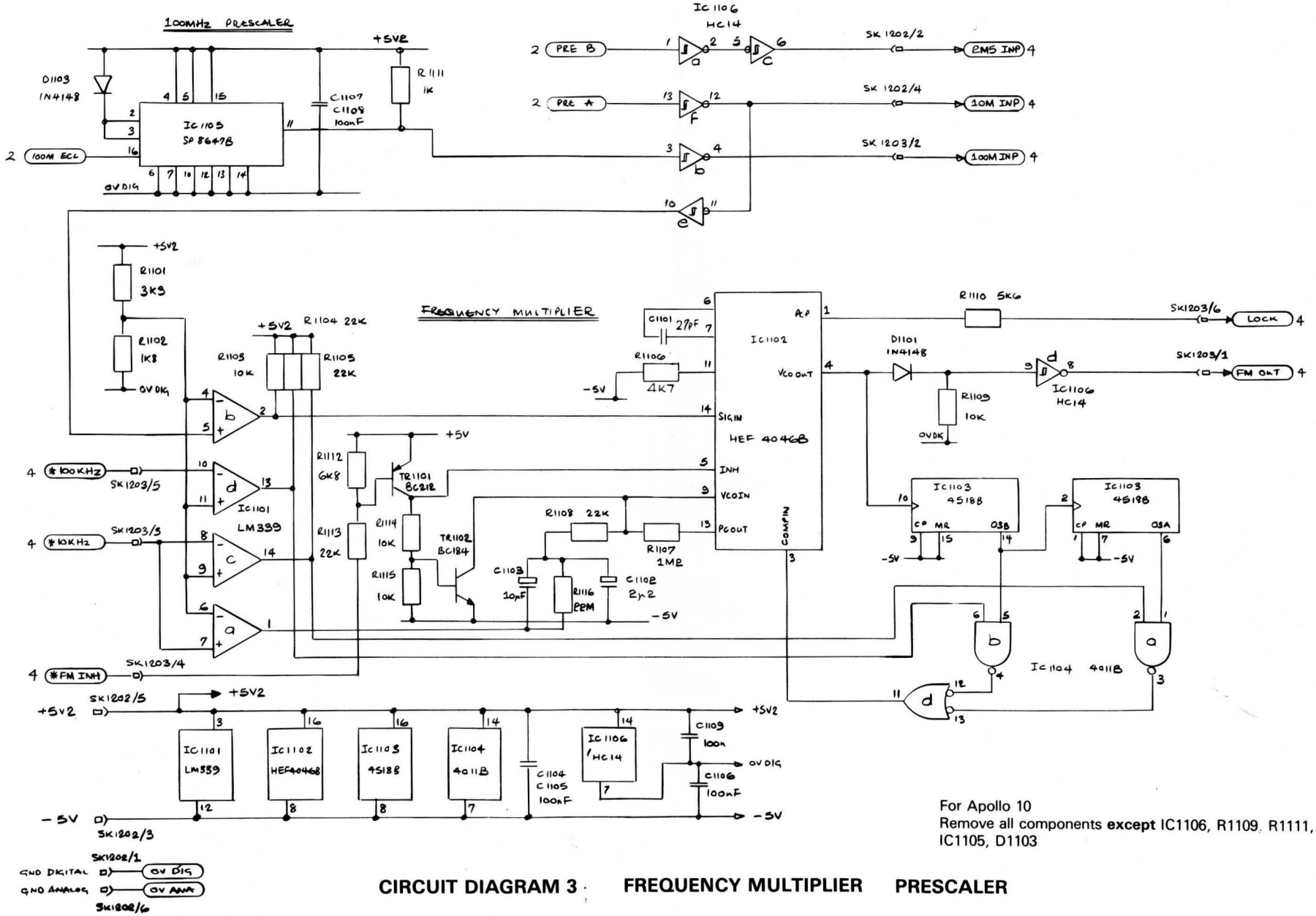


CIRCUIT DIAGRAM 1 POWER SUPPLY



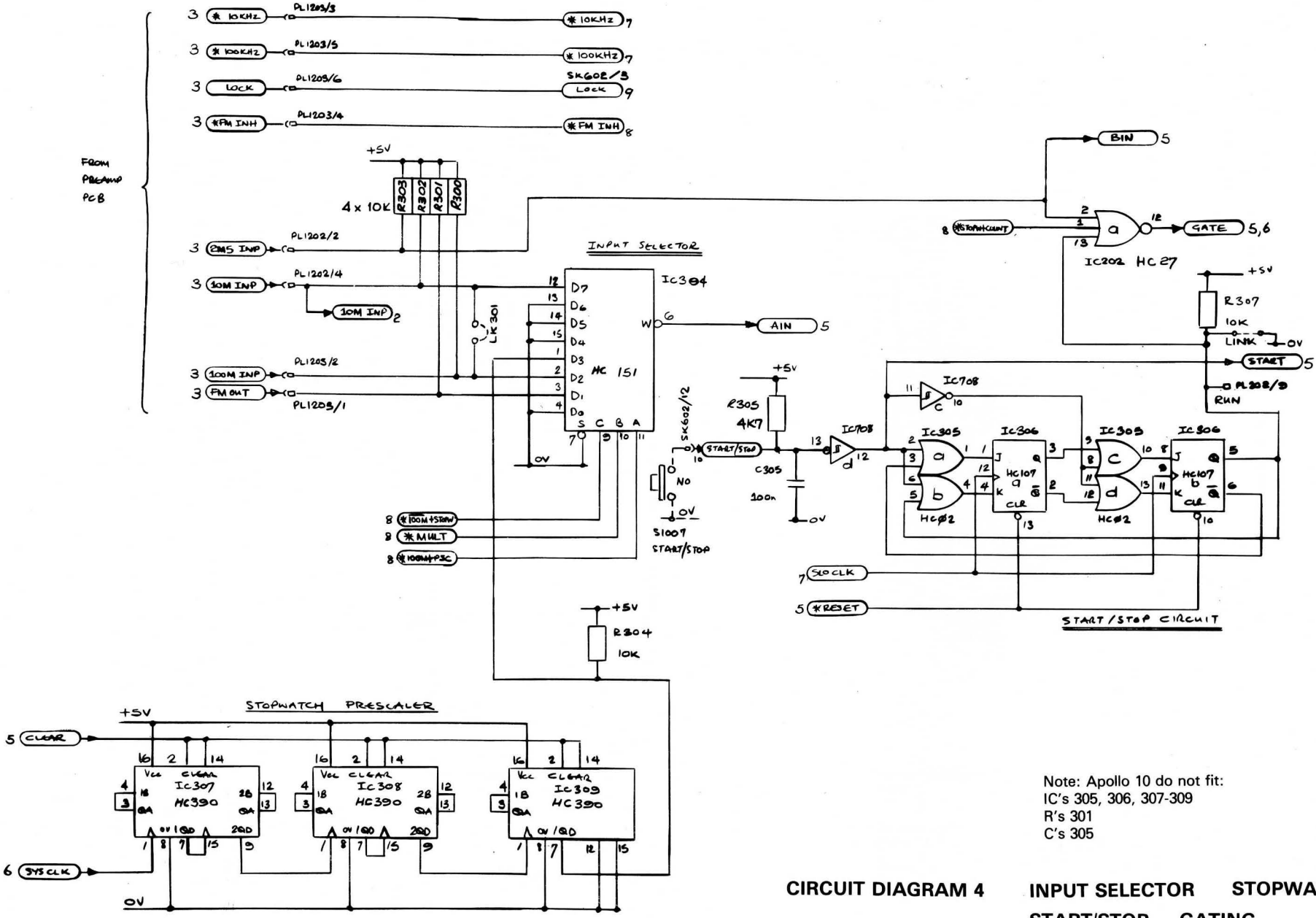
* This component is only used on channel A
() Pin numbers for channel B
Component numbers for channel B are 50 higher
e.g. R1229 becomes R1279

CIRCUIT DIAGRAM 2 PRE-AMPLIFIERS



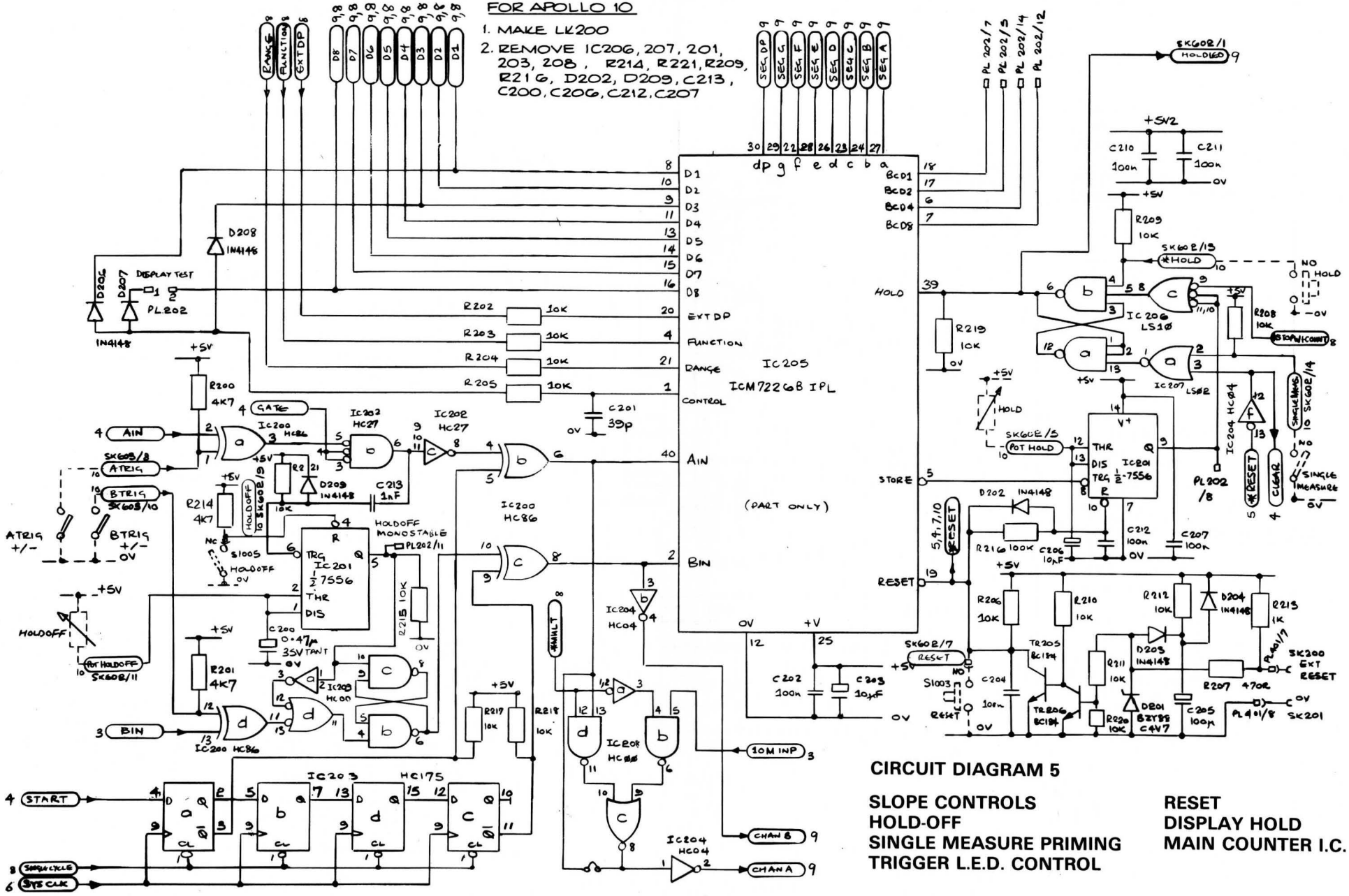
For Apollo 10
Remove all components **except** IC1106, R1109, R1111, C1109, IC1105, D1103

CIRCUIT DIAGRAM 3 · FREQUENCY MULTIPLIER PRESCALER



Note: Apollo 10 do not fit:
IC's 305, 306, 307-309
R's 301
C's 305

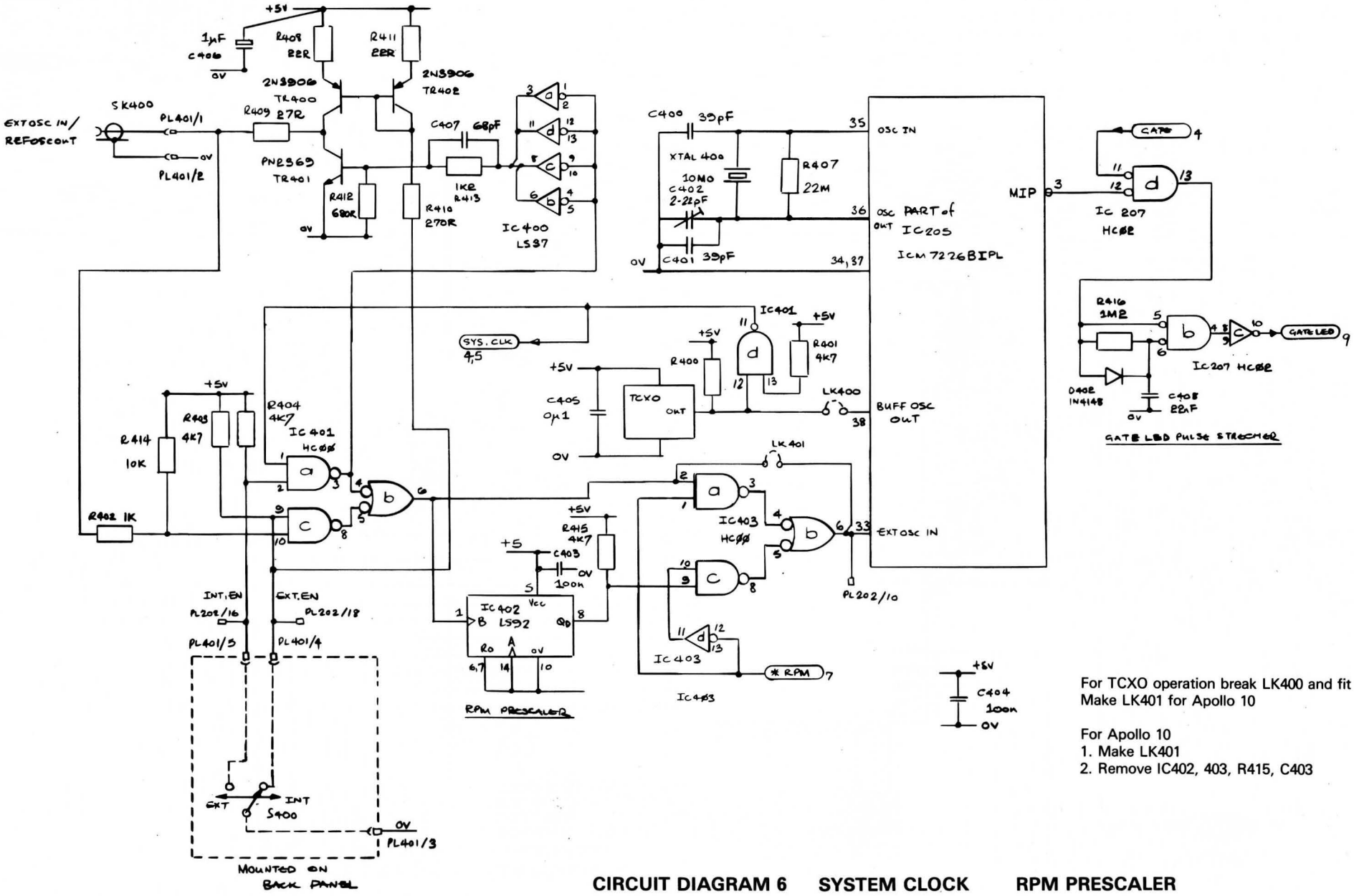
CIRCUIT DIAGRAM 4 INPUT SELECTOR STOPWATCH START/STOP GATING



CIRCUIT DIAGRAM 5

SLOPE CONTROLS
HOLD-OFF
SINGLE MEASURE PRIMING
TRIGGER L.E.D. CONTROL

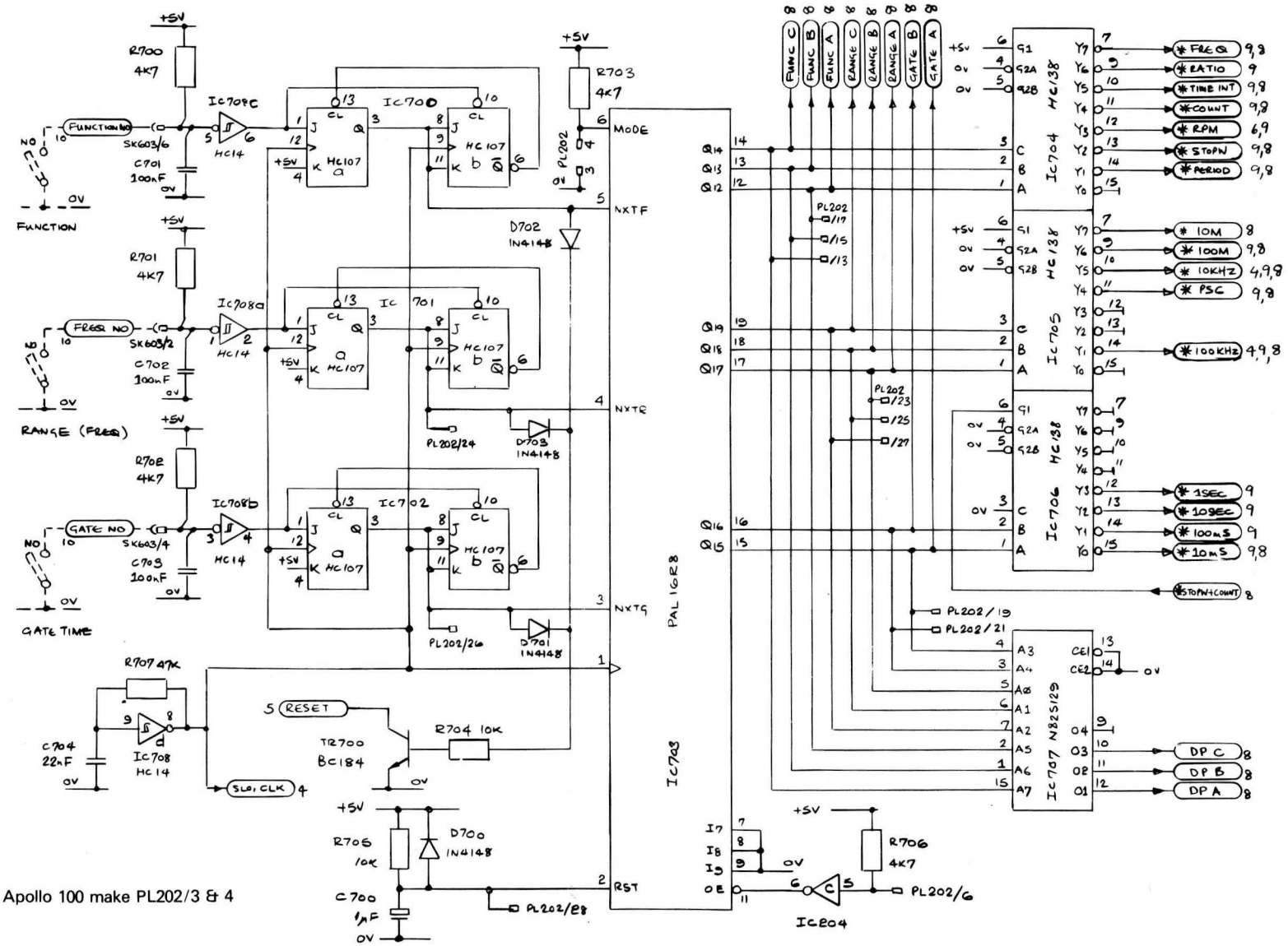
RESET
DISPLAY HOLD
MAIN COUNTER I.C.



For TCXO operation break LK400 and fit R400
Make LK401 for Apollo 10

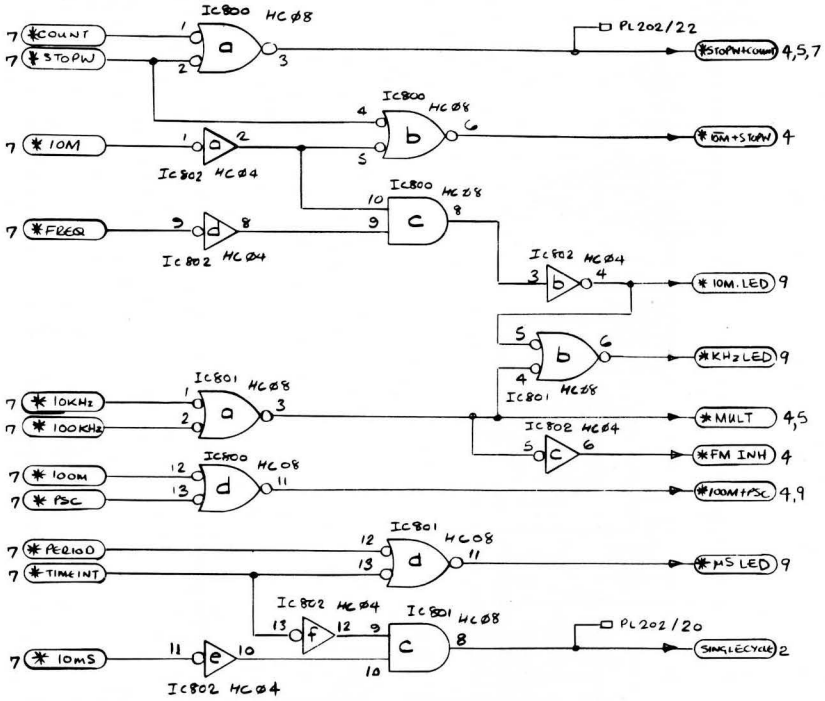
For Apollo 10
1. Make LK401
2. Remove IC402, 403, R415, C403

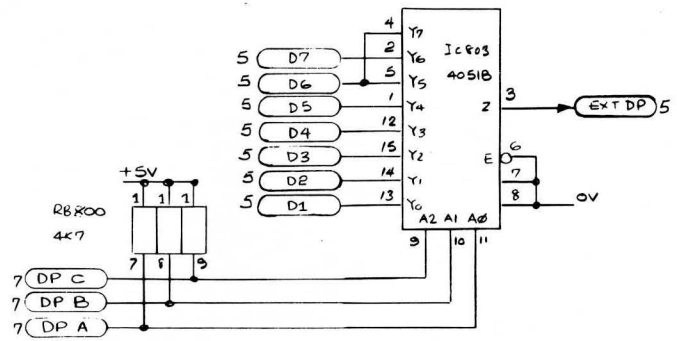
CIRCUIT DIAGRAM 6 SYSTEM CLOCK RPM PRESCALER

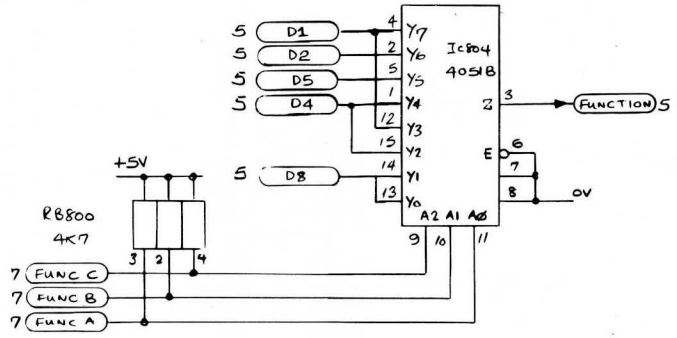


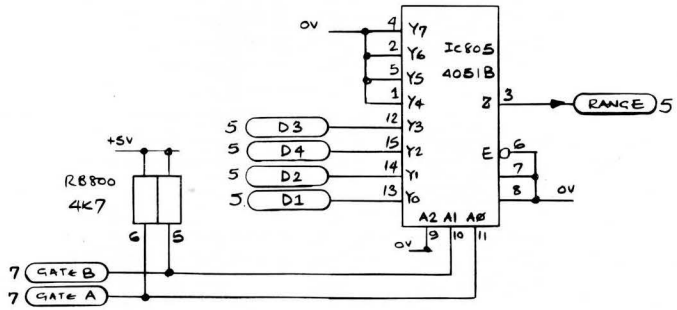
For Apollo 100 make PL202/3 & 4

CIRCUIT DIAGRAM 7 FRONT PANEL SWITCH LOGIC



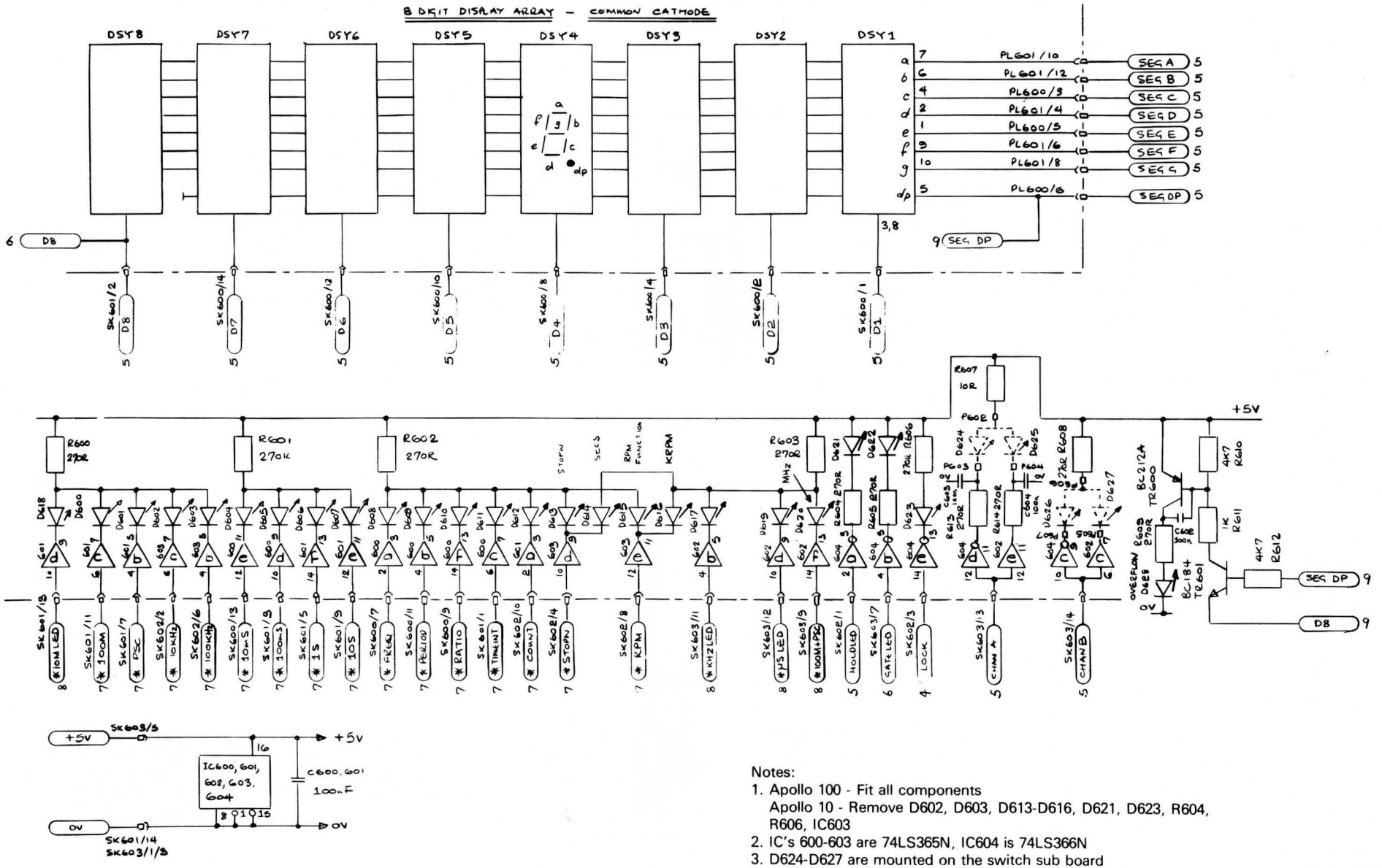






CIRCUIT DIAGRAM 8 **RANDOM LOGIC**

DISPLAY MULTIPLEXERS

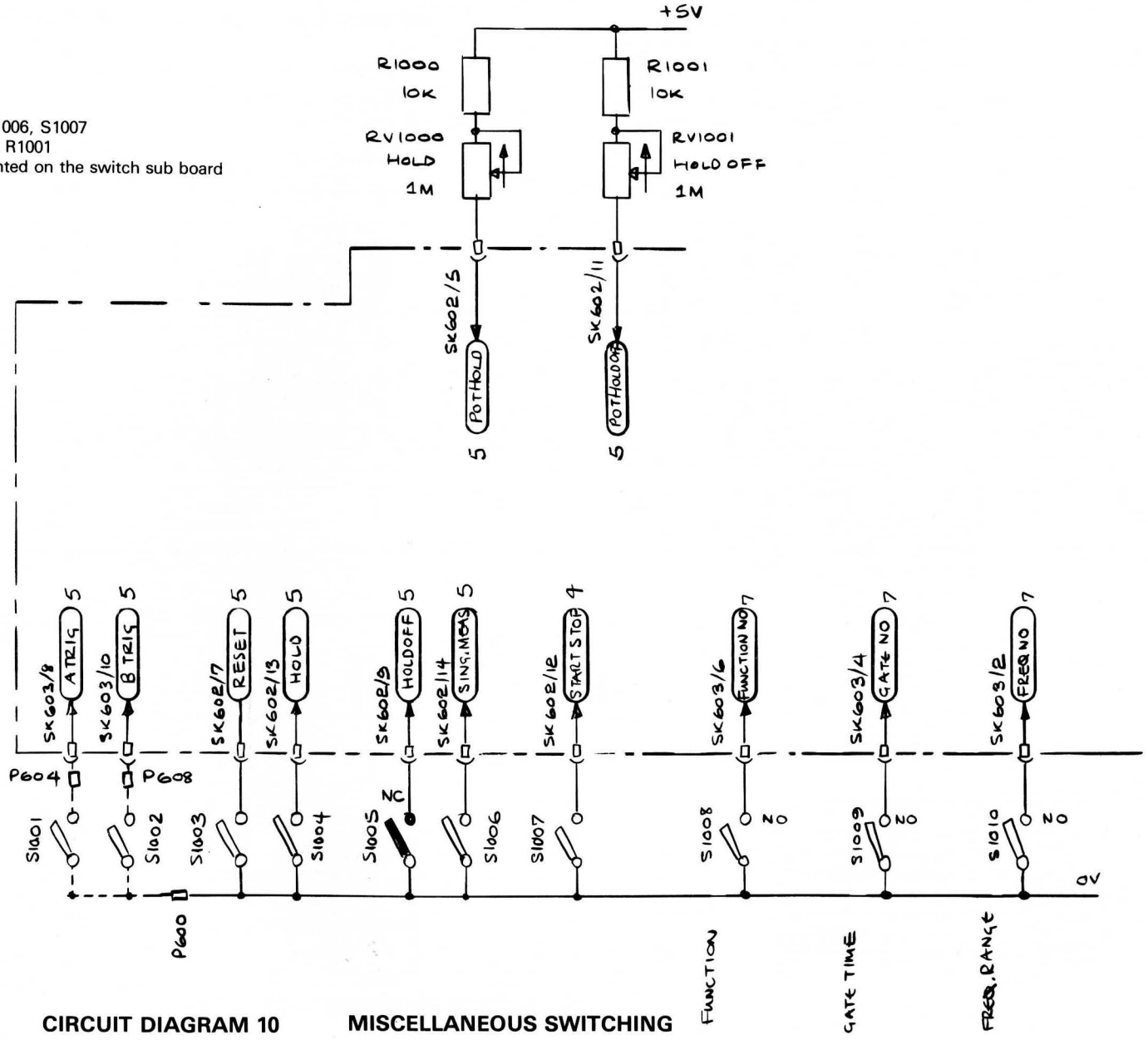


CIRCUIT DIAGRAM 9 FRONT PANEL DISPLAY

Notes:

1. Apollo 100 - Fit all components
   Apollo 10 - Remove D602, D603, D613-D616, D621, D623, R604, R606, IC603
2. IC's 600-603 are 74LS365N, IC604 is 74LS366N
3. D624-D627 are mounted on the switch sub board

Notes:
1. On Apollo 10 do NOT fit
   S1003, S1004, S1005, S1006, S1007
   RV1000, RV1001, R1000, R1001
2. S1001 & S1002 are mounted on the switch sub board



CIRCUIT DIAGRAM 10 **MISCELLANEOUS SWITCHING**

Designed and Manufactured in the U.K. by:

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