

Errata

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OPERATING AND SERVICE MANUAL

NOISE GENERATOR

3722A



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OPERATING AND SERVICE MANUAL

MODEL 3722A NOISE GENERATOR

SERIALS PREFIXED: U801

For instruments with prefixes other than U801, refer to Appendix A and/or the Manual Change sheet.

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MANUAL CONTENT

This manual is supplied to help you make best use of your instrument. The manual includes 8 sections of information as follows:

Section I is an introduction to the instrument. Electrical and mechanical specifications are given.

Section II covers inspection, power and signal connexions, packing and shipping.

Section III outlines operating procedures.

Section IV discusses technical details of circuit operation.

Section V provides performance check, trouble-shooting, and adjustment procedures.

Section VI lists replaceable parts.

Section VII gives information on conversion to Option 01.

Section VIII contains circuit diagrams, component locations and individual parts lists extracted from Section VI.

Appendix A gives backdating and updating information.

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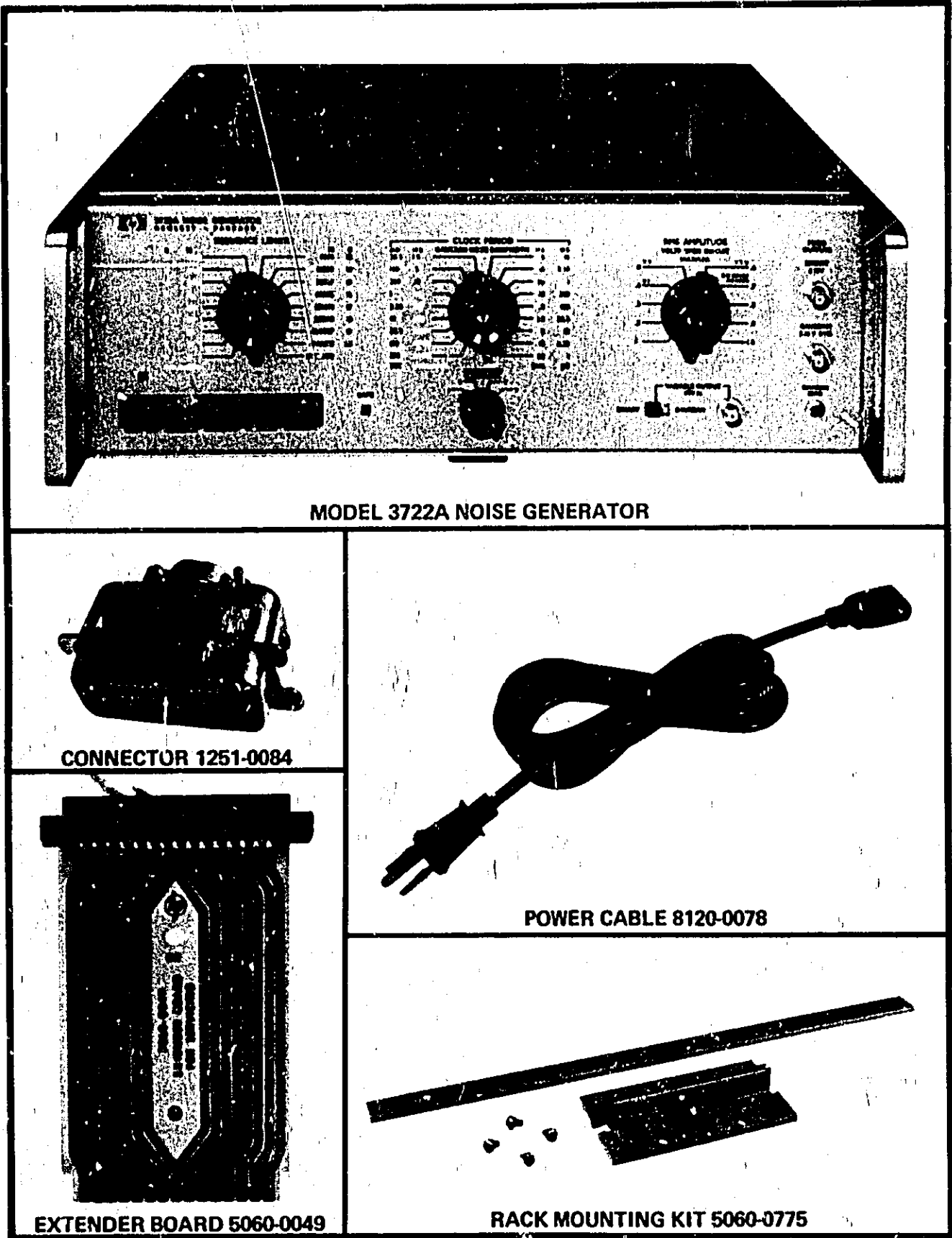


Figure 1-1 Model 3722A Noise Generator

SECTION I INTRODUCTION

1-1 DESCRIPTION

1-2 The Hewlett-Packard *Model 3722A* is a low-frequency broadband noise generator designed primarily for use in control systems evaluation and applications requiring the simulation of random disturbances. Parameters of the *hp 3722A* noise outputs are stable, well-defined and variable over a wide range.

1-3 The *hp 3722A* provides two types of random noise output - a two-level (binary) signal and a continuous analog waveform of approximately Gaussian amplitude distribution. In addition, the *hp 3722A* generates pseudo-random versions of the binary and Gaussian signals: in this mode, the signals are repeated noise patterns, or 'sequences' of known content and duration.

1-4 The spectrum of the binary output is of $(\sin x/x)^2$ form, and that of the Gaussian output is approximately rectangular. Frequency of the first null in the binary spectrum is selectable from 0.003 Hz to 1 MHz (CLOCK PERIOD from 333 seconds to $1\mu\text{S}$), and the bandwidth (at -3 dB point) of the Gaussian noise is selectable from 0.00015 Hz to 50 kHz.

1-5 In the random mode the outputs have continuous spectra extending down to dc. In the pseudo-random mode the outputs have line spectra, the harmonic spacing being established by the combination of CLOCK PERIOD (ΔT) and SEQUENCE LENGTH (N) settings. The product of ΔT and N gives the duration of the pseudo-random noise pattern, and its reciprocal is the lowest frequency in the spectrum. Outputs from the *hp 3722A* are

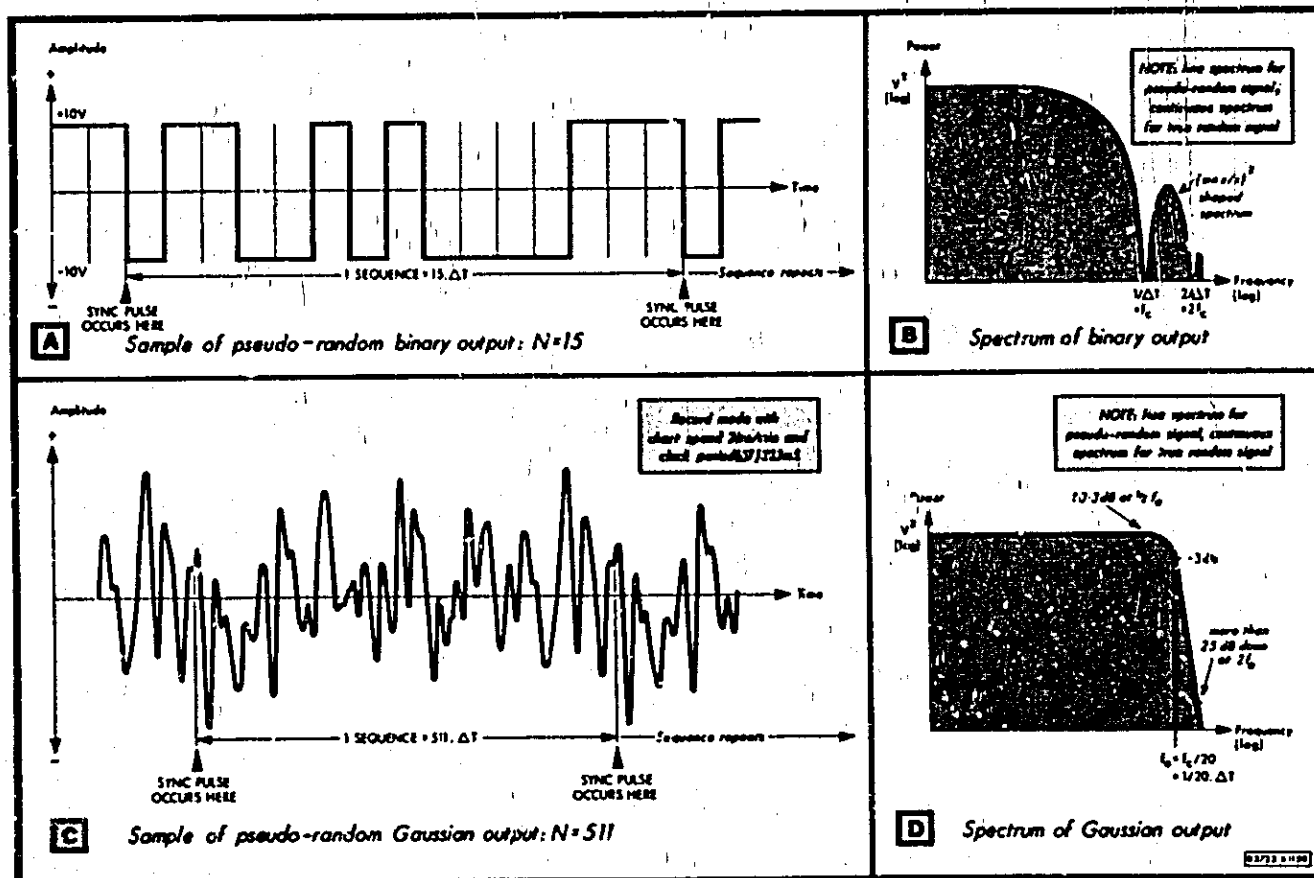


Figure 1-2 Examples of binary & Gaussian outputs

SPECIFICATIONS

BINARY OUTPUT (FIXED AMPLITUDE)

AMPLITUDE

$\pm 10V \pm 1\%$ when clock period $> 333\mu S$,
 $\pm 3\%$ when $333\mu S > \text{clock period} > 1\mu S$,
 $\pm 5\%$ when clock period = $1\mu S$.

OUTPUT IMPEDANCE

$< 5\Omega$ if clock period $> 333\mu S$, $< 10\Omega$ if
clock period $< 100\mu S$

LOAD IMPEDANCE

$1k\Omega$ minimum

RISE TIME

$< 100ns$

POWER DENSITY

(clock period $\times 200$) volt^2/Hz , at low fre-
quency end of spectrum

POWER SPECTRUM

($\sin x/x$)² form: first null occurs at clock fre-
quency and -3dB point occurs at $0.45 \times$ clock
frequency

GAUSSIAN OUTPUT (FIXED AMPLITUDE)

AMPLITUDE

$3.16V \text{ rms} \pm 2\%$ when bandwidth $> 0.15\text{Hz}$,
 $+6\% -2\%$ if bandwidth $< 0.05\text{Hz}$: this speci-
fication is valid only when sequence length
 $> 1,023$

OUTPUT IMPEDANCE

$< 1\Omega$

LOAD IMPEDANCE

600Ω minimum

ZERO DRIFT

$< 5mV$ change in zero level in any 10°C range
from 0° to $+55^\circ\text{C}$

POWER DENSITY

Approximately equal to (clock period $\times 200$)
 volt^2/Hz , at low frequency end of spectrum

POWER SPECTRUM

Rectangular, low pass: nominal upper fre-
quency f_0 (-3dB point) equal to $1/20\text{th}$ of
clock frequency. Spectrum is fiat within
 $\pm 0.3\text{dB}$ up to $1/2 f_0$, and more than 25dB
down at $2 f_0$

CREST FACTOR

Ratio of peak to rms amplitude: up to 3.75
dependent on sequence length

PROBABILITY DENSITY FUNCTION

See error curves, Figure 3-9

VARIABLE OUTPUT (BINARY OR GAUSSIAN)

AMPLITUDE (OPEN CIRCUIT)

BINARY

4 ranges: $\pm 1V$, $\pm 3V$, $\pm 3.16V$ and $\pm 10V$,
with ten steps in each range, from $\times 0.1$ to
 $\times 1.0$

GAUSSIAN

3 ranges: $1V \text{ rms}$, $3V \text{ rms}$ and $3.16V \text{ rms}$, with
ten steps in each range, from $\times 0.1$ to $\times 1.0$

CALIBRATION ACCURACY

Better than $\pm 2.5\%$, plus tolerance on binary
or Gaussian output, as selected

OUTPUT IMPEDANCE

$600\Omega \pm 1\%$, plus impedance of binary or
Gaussian output, as selected

SPECIFICATIONS

MAIN CONTROLS

SEQUENCE LENGTH SWITCH

First 17 positions select different pseudo-random sequence lengths: final position selects random mode of operation (INFINITE sequence length). Sequence length (N) is number of clock periods in sequence: possible values of N are 15, 31, 63, 127, 255, 511, 1023, 2047, 4095, 8191, 16383, 32767, 65535, 131071, 262143, 524287, 1048575. $N = 2^n - 1$; where n is in the range 4 to 20 inclusive.

CLOCK PERIOD SWITCH

Selects 18 frequencies from internal clock:

Clock period	Clock frequency	Gaussian noise bandwidth
333 sec	0.003Hz	0.00015Hz
100 sec	0.01Hz	0.0005Hz
33.3 sec	0.03Hz	0.0015Hz
10 sec	0.1Hz	0.005Hz
↓	↓	↓
333μs	300kHz	15kHz
1μs	1MHz	50kHz

INTERNAL CLOCK

CRYSTAL FREQUENCY

3MHz nominal

FREQUENCY STABILITY

Better than ± 25 ppm over ambient temperature range 0° to +55°C

OUTPUT

+1V to +12.5V rectangular wave, period as selected by CLOCK PERIOD switch. Maximum current at 1V level, 10mA

EXTERNAL CLOCK

INPUT FREQUENCY

1MHz maximum, for stated specifications. Usable BINARY output (pseudo-random only) with external clock frequencies up to 1.5MHz

INPUT LEVEL

Negative-going signal from +5V to +3V initiates clock pulse. Maximum input ± 20 V

INPUT IMPEDANCE

1k Ω nominal

SECONDARY OUTPUTS

SYNC

Negative-going pulse (+12V to +1.5V) occurring once per pseudo-random sequence; duration of pulse equal to selected clock period. Maximum current at 1.5V level, 10mA

GATE

Gate signal indicates start and completion of selected number of pseudo-random sequences (1, 2, 4 or 8, selected by front panel control). Two outputs are provided:-

- (1) Logic signal: output normally +12.5V, falls to +1V at start of gate interval and returns to +12.5V at end of interval. Maximum current at 1V level, 10mA

SPECIFICATIONS

- (2) Relay changeover contacts: gate relay switching is synchronous with logic signal

Maximum current controlled by relay: 500mA (cont.)

Maximum voltage across relay contacts: 100V

Maximum load controlled by relay: 3W (cont.)

BINARY RELAY

Relay changeover contacts operate in sync with binary output signal (available only when clock period $\geq 100\text{ms}$). Relay specification as for gate relay, above

REMOTE CONTROL

CONTROL INPUTS

Remote control inputs for RUN, HOLD, RESET and GATE RESET functions are connected to 36-way receptacle on rear panel

Command signal (each input): dc voltage between +1.5V and zero volts

No-command condition: open-circuit input, or dc voltage between +5.5V and +12.5V.

Input impedance: $5\text{k}\Omega$ nominal (RUN, HOLD, RESET)

$1.5\text{k}\Omega$ nominal (GATE RESET)

SEQUENCE LENGTH INDICATION

18 pins plus one common pin on the 36-way receptacle are used for remote signalling of selected sequence length (contact closure between common pin and any one of the 18 pins)

GENERAL

CONSTRUCTION

Standard 19 in. rack-width module, with tilt stand

AMBIENT TEMPERATURE RANGE

0° to $+55^{\circ}\text{C}$

POWER REQUIREMENT

115 or 230V $\pm 10\%$, 50 to 1000Hz, 70W

WEIGHT

Net 10.5kg (23 lb), shipping 13.5kg (30 lb)

ACCESSORIES FURNISHED

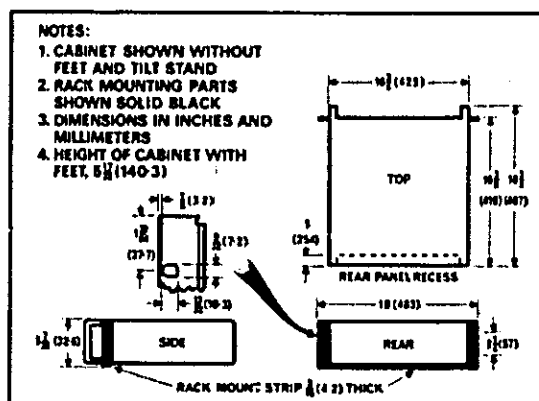
Detachable power cord, rack mounting kit, circuit extender board, 36-way male cable plug, operating and service manual.

OPTION 01

ZERO MOMENT OPTION

Shifts relative position of sync pulse and pseudo-random binary sequence such that first time moment of sequence, taken with respect to sync pulse, is zero (sequence shift mechanism is operative only when selected sequence length is ≤ 1023): option 01 also provides facility for inverting binary output signal

DIMENSIONS



available at fixed amplitudes of $\pm 10V$ (binary) and 3.16V rms (Gaussian), and a precision RMS AMPLITUDE control provides a variable output ranging from 0.1V up to the level of the fixed outputs. When operating in the pseudo-random mode, the *hp 3722A* provides timing signals (sync and gate pulses) for the control of external measurements.

1-6 OPTION 01

1-7 Time averages taken over one period of a pseudo-random sequence are normally independent of the point in time at which the averaging starts. However, when the test signal is contaminated by background disturbances, such as steady drifts, the result of the averaging measurement can be in error. In such cases, the magnitude and sign of the error depend critically on the starting point of the averaging process. In Option 01 models, the starting point (identified by the sync pulse) is optimised for each of the seven shortest sequences (15, 31, 63, 127, 255, 511 and 1023).

1-8 A standard instrument may be converted into an Option 01 version simply by the removal of a wire link and the insertion of a circuit board (the sequence advance assembly) into a pre-wired socket on the main chassis. The conversion procedure is described in Section VII.

1-9 INSTRUMENT IDENTIFICATION

1-10 An identification plate on the rear panel of the instrument carries a two-section, eight-digit serial number. The first three digits form the serial prefix number and the last five digits refer to a specific instrument. If the serial prefix on your instrument is not as given on the title page of this manual, there are differences between the manual and your instrument: these differences are described, together with manual errata, in the yellow change sheet included with the manual. For the latest information on the instrument, contact your nearest Hewlett-Packard field office. In any communication with the Company, specify model number and complete serial number.

SECTION II

INSTALLATION

2-1 INTRODUCTION

2-2 This section contains information on unpacking, inspection, storage, shipment and installation.

2-3 UNPACKING AND INSPECTION

2-4 If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for damage (scratches, dent, broken knobs, etc). If the instrument is damaged or fails to meet specifications (Performance check, Section V), notify the carrier and the nearest Hewlett-Packard field office immediately (field offices are listed at the back of this manual). Retain the shipping carton and the padding material for the carrier's inspection. The field office will arrange for the repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5 STORAGE AND SHIPMENT

2-6 **PACKAGING.** Use the original shipping carton and packing material, if available. Your Hewlett-Packard field office will provide information and recommendations on materials to be used if the original packing material has been discarded, or is not re-usable.

Materials used should include:

- (1) A double-walled carton (350 lb/sq. in. bursting test).
- (2) Heavy paper, polythene or sheets of cardboard to protect all instrument surfaces. Use extra material around projecting parts.
- (3) At least 4 in. thickness of tightly-packed shock-absorbing material surrounding the instrument.

Close the carton securely with durable shipping tape. If the instrument is to be shipped to a Hewlett-Packard field office, attach a tag showing owner and address, model number, serial number, trouble symptoms and/or repairs required.

2-7 **ENVIRONMENT.** Conditions during storage and shipment should be limited as follows:

- (1) Maximum altitude 20,000 feet
- (2) Minimum temperature -40°F (-40°C)
- (3) Maximum temperature +167°F (+75°C)

2-8 POWER CONNEXION

2-9 **LINE VOLTAGE.** The 3722A will operate from either 115V or 230V ($\pm 10\%$) power lines. A slide switch on the rear panel permits rapid selection of the appropriate line transformer tapings. Insert a screwdriver into the switch slot and slide the switch to expose the appropriate number (115 or 230). For fuse ratings, see Table 2-1.

CAUTION

Before connecting the instrument to the power supply, check that the slide switch is in the correct position.

Table 2-1 115/230V conversion

Line voltage	115V	230V
Slide switch	115	230
Fuse	2 ampere slow-blow hp 2110-0006	1 ampere slow-blow hp 2110-0007

2-10 **POWER CABLE.** The 3722A is equipped with a detachable 3-wire power cable. Proceed as follows for installation:

- (1) Plug the flat connector on the power cable into the 3-pin jack on the rear panel of the instrument.
- (2) Connect the power cable plug (2-blade with round grounding pin) to a 3-wire power outlet. Exposed metal parts of the instrument are grounded through the round pin on the plug. If the plug does not fit your power outlet, either use a 3-blade to 2-blade adapter (hp 1251-0048) or cut off the plug and fit one to suit your requirements. If the instrument is powered, via an adapter, from a 2-contact outlet, the green pigtail on the adapter should be grounded.

2-11 Power cable connexions are as follows:

Black wire	LIVE (hot)
White wire	NEUTRAL
Green wire	GROUND (safety)

Paragraphs 2-12 to 2-18

2-12 SIGNAL CONNEXIONS.

2-13 All signal inputs and outputs, excepting those concerned with remote control, are via BNC female connectors. Connexions to the 36-way remote control receptacle are shown in Section III.

2-14 BENCH USE

2-15 As shipped from the factory, the 3722A is ready for bench use. The cabinet is fitted with a foldaway tilt stand which allows the instrument to be inclined for more convenient viewing of the control panel. Plastic feet on the cabinet provide positive location for the 3722A when stacked with other *hp* full-width modular instruments.

2-16 A control panel cover with carrying handle, *hp* 5060-0827, is available for the 3722A. The cover, which provides protection in transit, fits between the handles at the front of the instrument, and is held in place by two push-button latches.

2-17 RACK INSTALLATION

2-18 A rack mounting kit, *hp* 5060-0775, is supplied with the instrument. For location of the rack mounting parts, refer to Figure 2-1. The assembly procedure is as follows:

- (1) Spring the tilt stand free from the feet at the front of the instrument.
- (2) Remove the feet (press the release button, slide foot towards the centre of the instrument, and lift clear).
- (3) Remove the adhesive-backed corrugated trim strips from the side frames.
- (4) Attach the two rack-mount flanges to the side frames (larger corner-notch in the flanges towards the bottom of the instrument).
- (5) Attach the wedge shaped grey plastic filler strip to the bottom edge of the front panel (thicker edge of the strip towards the front of the instrument).

CAUTION

Ambient temperature in the rack should not exceed +55°C. Ensure that the position of the instrument in the rack permits air circulation to the intakes on the sides of the instrument, and that nearby instruments do not discharge hot air near the intakes.

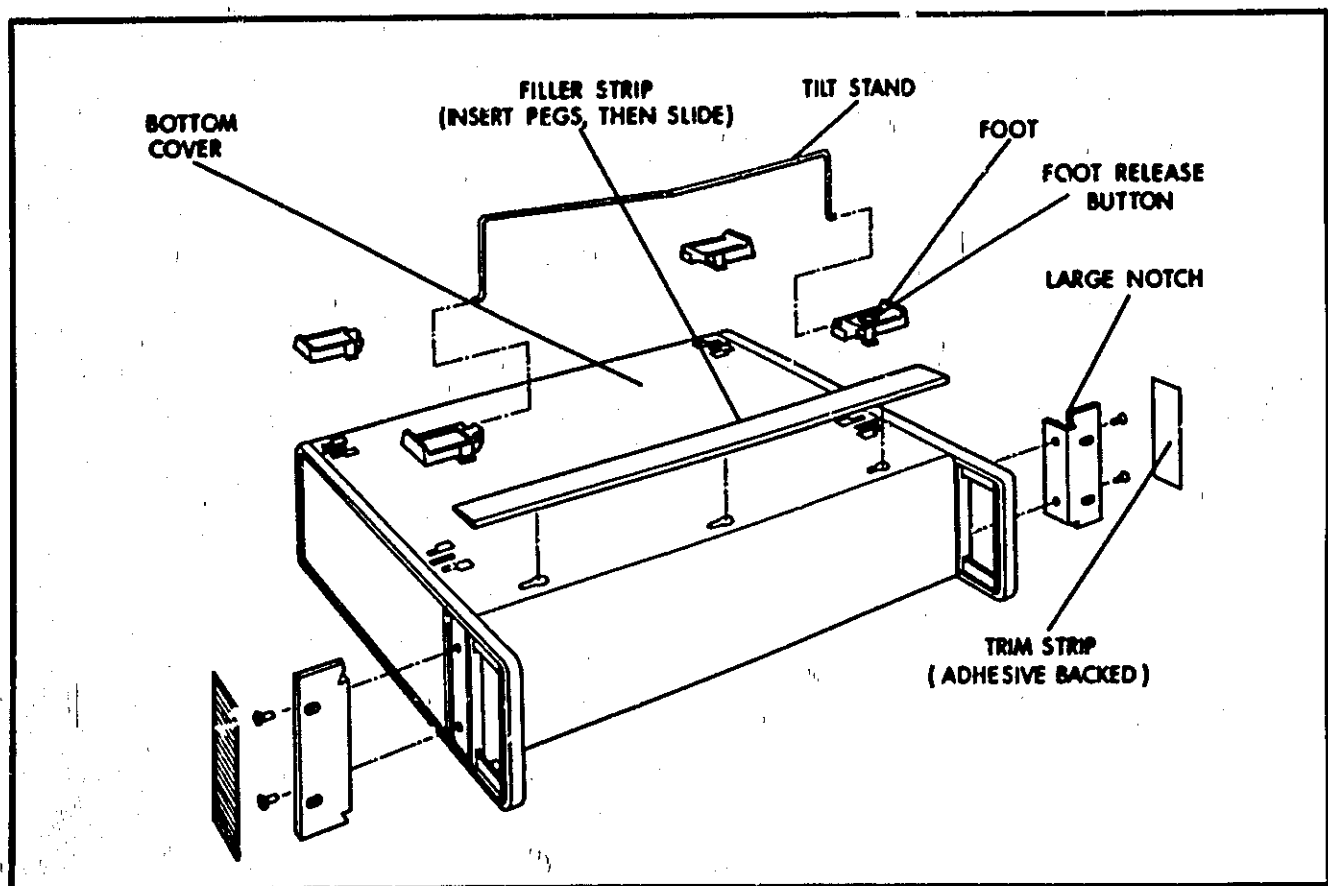


Figure 2-1 Assembly of rack mounting parts

SECTION III OPERATION

3-1 INTRODUCTION

3-2 Switch-on instructions, together with a summary of the push-button control functions, are given in paragraphs 3-3 to 3-7. Paragraphs 3-8 to 3-37 describe in detail the BINARY and GAUSSIAN outputs from the *hp 3722A*, and the effect upon them of the CLOCK PERIOD and SEQUENCE LENGTH controls. Some description of the noise generation mechanism is included, as this is essential user information. Details of timing outputs from the *hp 3722A* are given in paragraphs 3-38 to 3-41, and a summary of all controls and outputs is given in the text related to Figure 3-18.

3-3 SWITCH-ON PROCEDURE

3-4 Essential steps are as follows:-

- (1) Check line voltage selector on rear panel: set as appropriate (115 or 230). Connect supply.
- (2) Set CLOCK switch on rear panel to INT (or EXT if an external clock is to be used to time 3722A: for specifications of external clock, refer to Figure 3-13).
- (3) Set CONTROL selector on rear panel to LOCAL.
- (4) Complete, if required the rapid functional check detailed in Table 3-1.

3-5 PUSH-BUTTON CONTROLS

3-6 HOLD and RESET. Either of these push-buttons, when operated, stops the supply of shift pulses to the shift register (paragraph 3-9), and thus inhibits both noise outputs (binary and Gaussian) from the 3722A. The HOLD button allows the generator to be stopped at any point in a pseudo-random sequence; when the instrument is re-started, by operation of the RUN button, noise generation is resumed from the point in the sequence at which it ceased. The RESET button performs two functions — it stops the supply of shift pulses *and* drives the shift register to a pre-determined state. Both HOLD and RESET operations are illustrated in Figure 3-1.

3-7 GATE RESET. When operated, the GATE RESET control primes a store circuit which, on the following sync pulse, initiates a gate signal. The gate interval depends on (1) the selected duration of pseudo-random sequence, and (2) the setting of the

'SEQUENCES PER GATE INTERVAL' control on the front panel: the latter control can be set for 1, 2, 4 or 8 sequences. Thus with a sequence length of 15 and clock period of 1 second (sequence duration = 15 seconds), the gate signal lasts for 15, 30, 60 or 120 seconds, depending upon the setting of the control. The gate signal falls from +12.5V to zero at the start of the gate interval, and returns to +12.5V at the end. A relay contact version of the gate signal is also provided.

3-8 BINARY OUTPUT

3-9 GENERAL. The binary output is generated by a shift register which is triggered at regular intervals by shift pulses derived from a crystal-controlled clock. A change in the output level (from binary '1' to binary '0', or vice-versa) can occur only when the shift register receives a shift pulse: in the interval between shift pulses, the output remains at a constant level.

3-10 The binary signal is available, at fixed amplitude, from the BINARY connector on front and rear panels. Amplitude of the 'fixed' output is nominally $\pm 10V$. Note that a binary signal of $\pm 10V$ has an rms amplitude of 10V. Logic definitions used in this section are:

Binary '1'	-10V
Binary '0'	+10V

Important characteristics of the binary output are as follows:

Output impedance	$< 10\Omega$
Load impedance	1k Ω minimum
Rise time	$< 100nS$

3-11 The binary signal is available, from a 600 Ω impedance source, at the VARIABLE OUTPUT connectors on front and rear panels. The red RMS AMPLITUDE control selects one of four multiplier ranges, and the black control selects one of ten intermediate steps from $\times 0.1$ to $\times 1.0$. Multiplier ranges are:

$\pm 10V$, $\pm 3.16V$ ($= \pm \sqrt{10V}$), $\pm 3V$ and $\pm 1V$.

NOTE These are *open-circuit* amplitudes (i.e. if the VARIABLE OUTPUT is connected to a 600 Ω load, the voltage across the load is half that indicated by the RMS AMPLITUDE controls).

Paragraphs 3-12 to 3-14

3-12 A relay-contact version of the binary signal is available (rear panel BINARY RELAY binding posts) when the selected clock period is 100mS or greater.

3-13 PSEUDO-RANDOM MODE. In the pseudo-random mode, the shift register generates repeated sequences (or patterns) of binary ones and zeros, the form and length of the sequence being established by feedback connexion to the first stage of the register. Feedback selection is made by the SEQUENCE LENGTH switch.

3-14 Pseudo-random, 'maximum length' type, binary sequences (p.r.b.s.) generated by the *hp 3722A* are described in terms of the number of clock periods (or bits) they contain, this being a function of the number of shift register stages involved in generation of the sequence (a maximum of 20 stages is connected into the feedback loop which establishes the length of sequence). The length of a sequence = N bits = $2^n - 1$, where n is the number of stages in the feedback system. Thus with

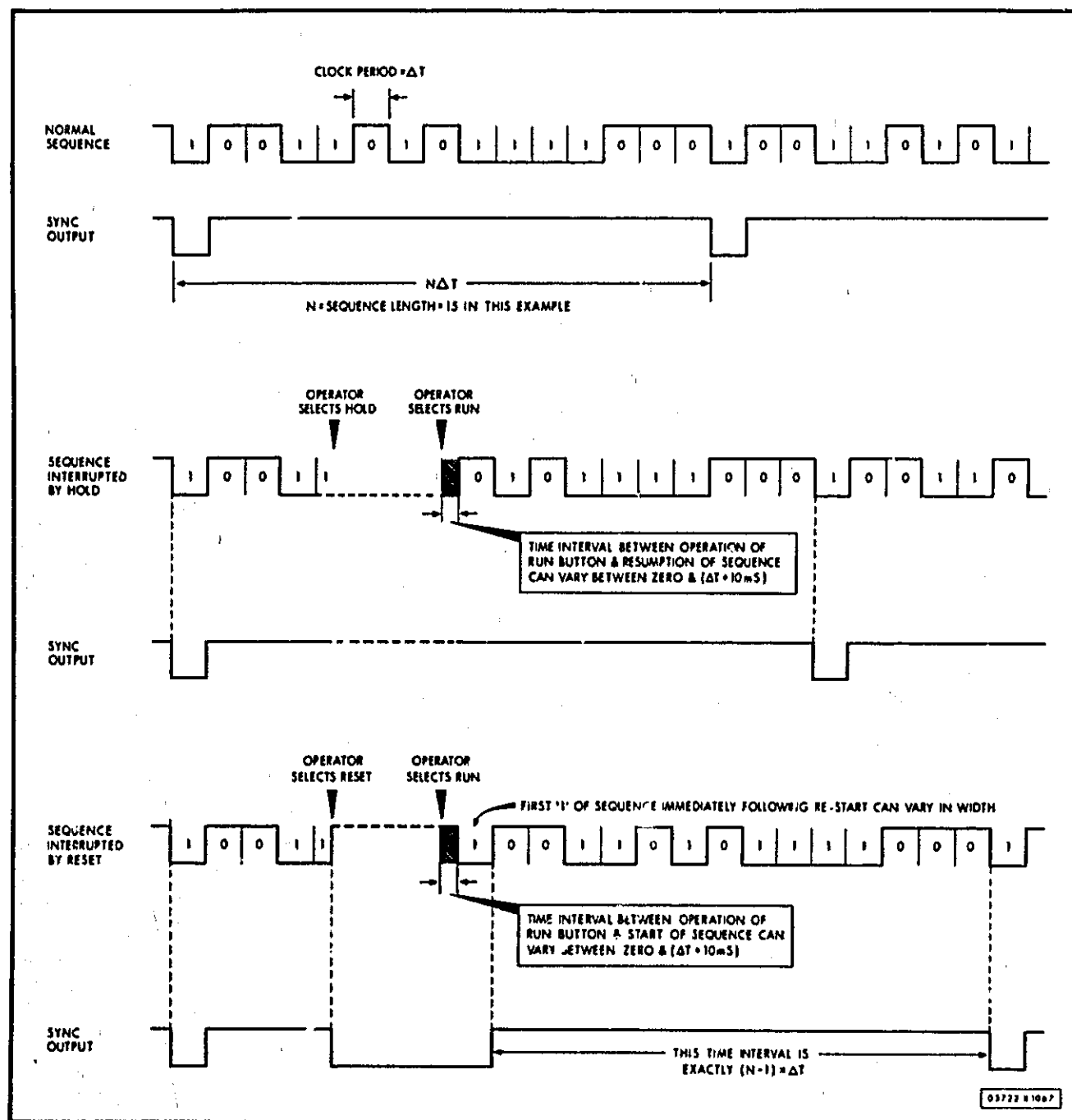


Figure 3-1 Interruption of sequence by HOLD and RESET

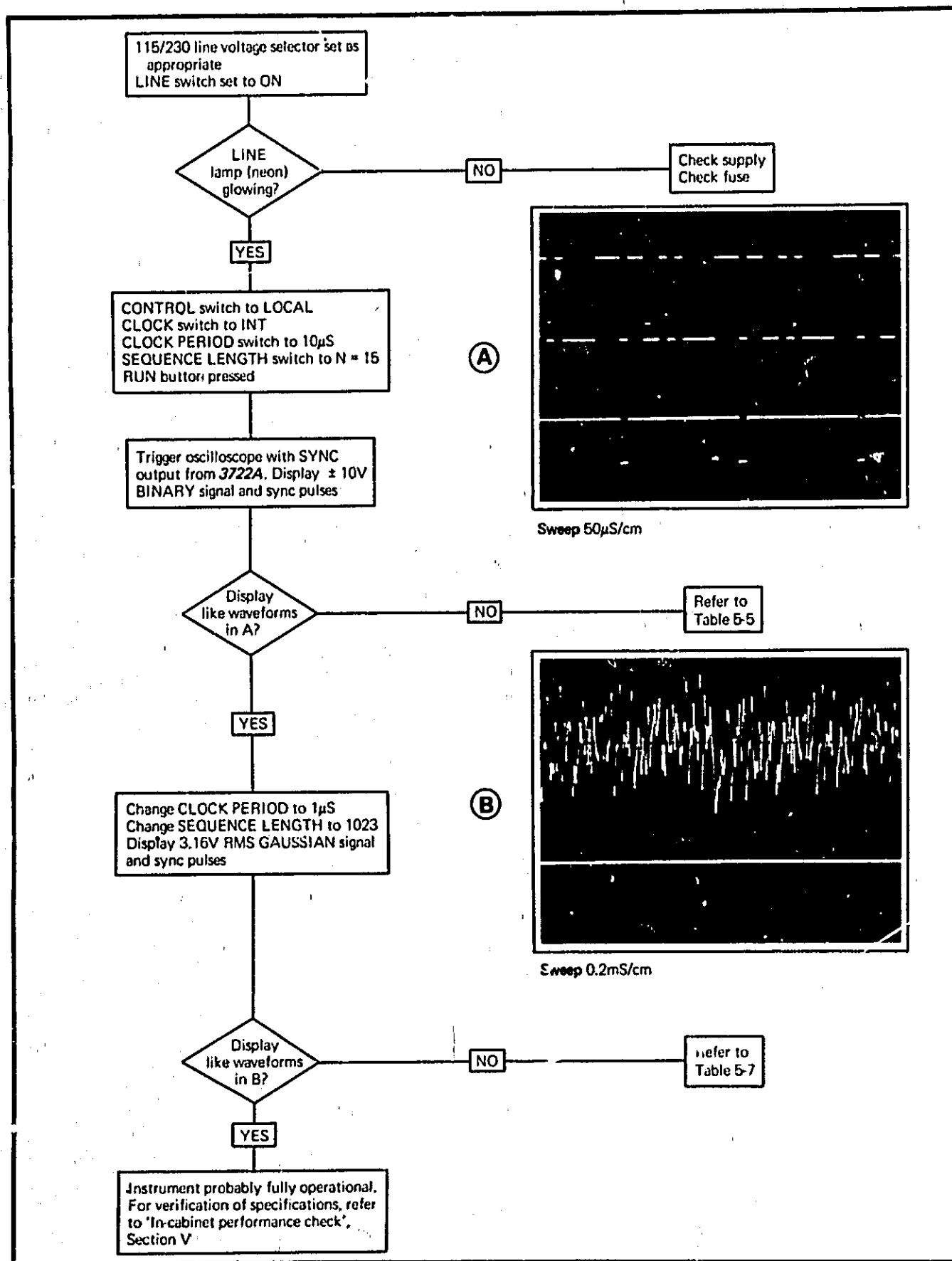


Table 3-1 Rapid functional check

Paragraphs 3-15 to 3-21

4 'active' stages, the sequence length is $2^4 - 1 = 15$ bits. The SEQUENCE LENGTH switch selects values of n from 4 to 20 inclusive: these, together with the corresponding values of N , are marked on the front panel.

3-15 For a particular number of active stages (i.e. for a particular value of n) there are many possible sequences, all of the same maximum length, $N = 2^n - 1$, but of different form. In applications where binary noise is used as the test signal, the actual form of the sequence (i.e. the pattern of ones and zeros) is generally of little concern. For each length of sequence generated by the *hp* 3722A, however, a particular form has been chosen to give a good distribution of amplitude in the Gaussian Signal — which is derived from the shift register outputs by a digital to analog conversion process. This optimisation of sequence form applies only to sequences of length 255 periods ($n = 8$) and greater (with the shorter sequences, it is not possible to obtain a Gaussian-type distribution of amplitude).

3-16 The period (T) of a pseudo-random sequence is equal to the product of N and ΔT , where ΔT is the clock period. ΔT is set by the CLOCK PERIOD switch and is selectable, in 18 steps, from $1\mu\text{s}$ to 333 seconds.

3-17 An example of a pseudo-random binary sequence is given in Figure 3-2. This shows the actual waveform at the BINARY connector of the *hp* 3722A, with the SEQUENCE LENGTH switch set to $N = 15$.

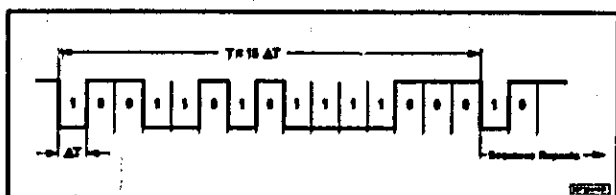


Figure 3 - 2 15-bit p.r.b.s. generated by 3722A

3-18 A pseudo-random binary sequence has a line power spectrum (Figure 3-3), the envelope of which is of the mathematically defined $(\sin x/x)^2$ form. The fundamental frequency (i.e. the lowest frequency component in the spectrum) is $1/T = 1/N\Delta T = f_c/N$. All other components in the spectrum are harmonics of $1/T$ (i.e. integral multiples of $1/T$, giving frequencies of $2/T$, $3/T$, $4/T$, etc).

3-19 If, with constant ΔT , N is increased, the frequency of the fundamental (and the spacing of the harmonics) is reduced, causing the number of harmonic components per spectrum lobe to increase. Since the total power of the binary output remains

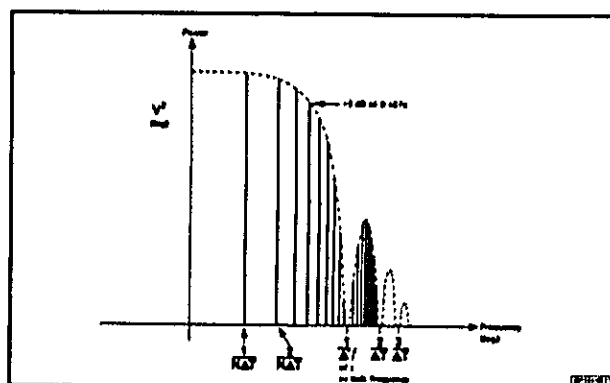


Figure 3 - 3 Power spectrum of p.r.b.s.

the same (the waveform still switches between the same amplitude levels), the magnitude of the harmonics is proportionately reduced. If, say, N is doubled, there will be twice the number of components in the spectrum, and the power contributed by each component will be halved. Variations in N therefore do not affect power density, i.e. power per unit bandwidth.

3-20 The envelope of the p.r.b.s. line spectrum is given by the expression:

$$G(f_k) = 2a^2 \left(\frac{N+1}{N^2} \right) \left(\frac{\sin \frac{\pi k}{N}}{\frac{\pi k}{N}} \right)^2$$

Where: $G(f_k)$ is the power, in (volts)², contributed by the k th harmonic
 'a' is the rms amplitude (half peak-to-peak voltage) of the binary signal
 'N' is the sequence length

3-21 POWER DENSITY. Calculation of the power contributed by each harmonic is illustrated by the following example, when $N = 1023$ and $\Delta T = 1\mu\text{s}$. For the power contributed by the fundamental, let $k = 1$ in the above expression.

$$G(f_1) = 2a^2 \left(\frac{N+1}{N^2} \right) \left(\frac{\sin \frac{\pi}{N}}{\frac{\pi}{N}} \right)^2$$

Since N is large, $(N+1)/N^2$ is approximately $1/N$, and the squared term is approximately unity. The amplitude, 'a', of the binary signal is 10V.

$$\text{Therefore, } G(f_1) \approx \frac{200}{N} = \frac{200}{1023} = 0.195V^2$$

Since there are no power contributions at frequencies between the discrete lines of the spectrum, the power in each line (at the low frequency end of the spectrum) must also be equal to $0.195V^2$.

The line spacing is equal to $1/N\Delta T$ Hz.

$$\begin{aligned} \text{Therefore, power density} &= \text{power per unit bandwidth} \\ &= \frac{200}{N} N\Delta T \\ &= 200 \Delta T \\ &= 200 \times 10^{-6} \\ &= 0.0002 V^2/\text{Hz} \end{aligned}$$

3-22 From the above, it can be seen that power density is directly proportional to clock period, as illustrated by Figure 3-5. The number of lines in

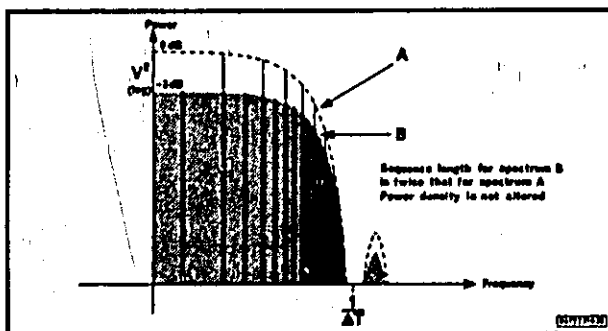


Figure 3 - 4 Effect of varying sequence length

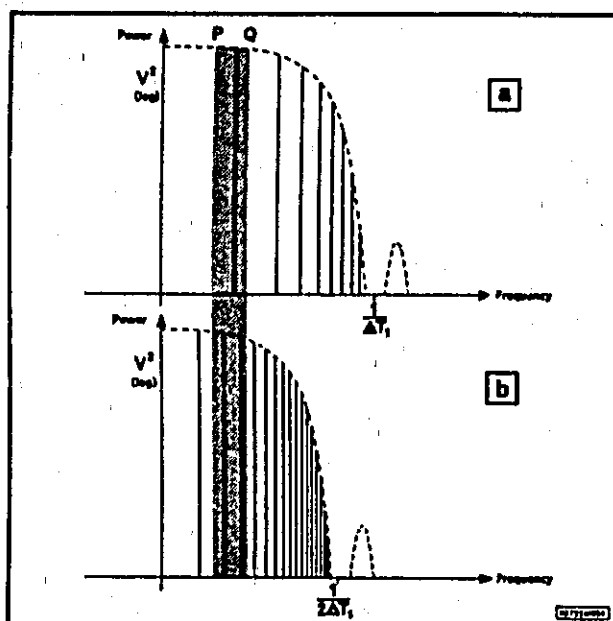


Figure 3 - 5 Effect of varying clock frequency

the first lobe depends only on N . Reducing the clock frequency $f_c (= 1/\Delta T)$ squeezes these lines into a narrower bandwidth. Hence, the power per unit bandwidth increases.

NOTE The amplitude of individual lines is independent of clock frequency.

3-23 By adjusting the clock period, the power density of the BINARY output can be varied from a minimum of $0.0002 V^2/\text{Hz}$ (clock period $1\mu\text{S}$) to a maximum of $67,000 V^2/\text{Hz}$ (clock period 333 sec).

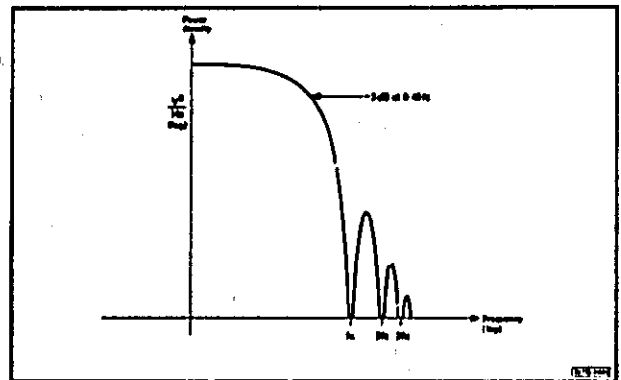


Figure 3 - 6 Continuous spectrum of random binary output

3-24 RANDOM MODE. When the SEQUENCE LENGTH switch is set to INFINITE, the shift register feedback loop is disconnected, and the first stage of the register is controlled by a noise source giving a truly random output. Triggering of the shift register remains under the control of the clock. Just before each shift pulse, the random signal is sampled by a level detector which decides, on arrival of the shift pulse, whether a '1' or '0' is to be placed in the first stage of the register. Since the random signal is non-periodic, there is no repeated pattern in the resulting series of ones and zeros from the register (i.e. N is infinite). In this 'random' mode, the spectrum (Figure 3-6) of the binary output is continuous (it contains no discrete harmonics) and is the same shape as the envelope of the p.r.b.s. line spectrum. Power density of the random output, at the low frequency end of the spectrum, is the same as for the p.r.b.s., i.e. $(200 \Delta T)V^2/\text{Hz}$.

3-25 GAUSSIAN OUTPUT

3-26 GENERAL. The two-level binary signal from the shift register is converted, by low-pass filtering, into a continuous analog waveform having an approximately Gaussian probability density function (p.d.f.). Low-pass filtering and spectrum shaping is performed by a digital filter working in con-

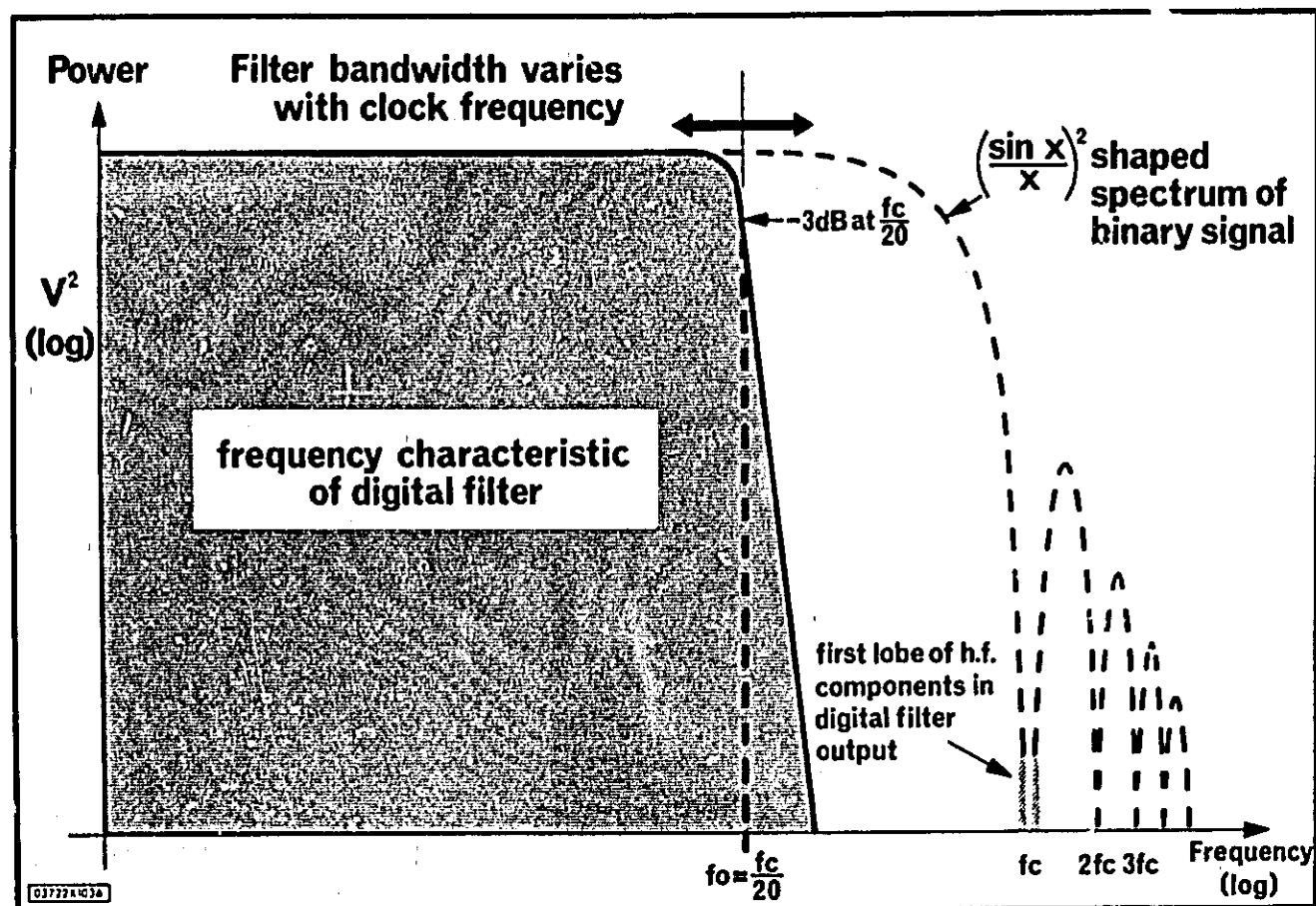


Figure 3 - 7 Conversion of binary noise to Gaussian noise by low-pass filtering

junction with the shift register. High frequency components arising from the digital filtering process are removed by a second order analog smoothing filter.

3-27 SPECTRUM. The frequency response of the digital filter (which alone determines the shape of the Gaussian noise spectrum) approaches the 'ideal' rectangular shape, as shown in Figure 3-7.

Important features of the Gaussian noise spectrum are:

- (1) The cut-off frequency is directly proportional to clock frequency (f_c), and is therefore selectable (18 settings with internal clock, infinitely variable with external clock). Nominal bandwidth (to half-power frequency, f_0) of the Gaussian output is $f_c/20$: e.g. with clock frequency 1MHz (CLOCK PERIOD 1 μ S), the GAUSSIAN NOISE BANDWIDTH is 50kHz.
- (2) The rectangular shape of the spectrum does not deteriorate as the clock frequency is reduced (the spectrum is flat within ± 0.3 dB at $1/2f_0$). Precise shaping of spectrum is achieved even with the lowest cut-off frequencies (lowest

f_0 with internal clock is 0.00015Hz).

3-28 In the pseudo-random mode, the output from the GAUSSIAN connector is a series of identical patterns of Gaussian type noise. The pseudo-random Gaussian output has a line power spectrum, the envelope of which is shown — by the thick continuous line — in Figure 3-7. Harmonic frequencies are the same as those for pseudo-random binary sequences, given in Table 3-1. In the random mode, the spectrum of the Gaussian output is continuous, and is the same shape as the envelope of the pseudo-random line spectrum.

3-29 Total power of the Gaussian output remains constant regardless of SEQUENCE LENGTH and CLOCK PERIOD (i.e. Gaussian noise bandwidth) settings. Variations in sequence length and clock period have the same effect on the Gaussian noise spectrum as that described above for the p.r.b.s. spectrum. Summarising:

- (1) If sequence length N is doubled, the number of harmonic components in the spectrum is doubled, and the power contributed by each component is halved. Variations in N do not affect power density.

- (2) If clock period ΔT is doubled, the spacing of the harmonic components is halved, doubling the number of lines in a given bandwidth and thus doubling the power density. Variations in ΔT do not affect the power contributed by the harmonic components.

3-30 POWER DENSITY MEASUREMENT. The power density of the Gaussian signal (measured at the output connector) is approximately $(200\Delta T)V^2/\text{Hz}$, at the low frequency end of the spectrum. The exact figure, under any operating conditions, can be checked as follows:-

- (1) Press the RESET button on the 3722A: this resets the shift register to the 'all zeros' state, and gives a stable dc voltage at the GAUSSIAN output connector.
- (2) Measure the voltage at the GAUSSIAN output connector or, if required, at some other point in the system to which the 3722A is connected.
- (3) Power per unit bandwidth = power density, in V^2/Hz
 $= 2\Delta T \times (\text{measured voltage})^2$.

3-31 In some applications it is permissible to assume that the GAUSSIAN output has a truly rectangular spectrum.

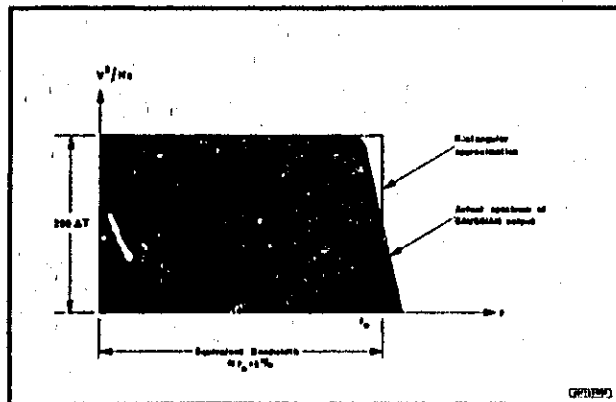


Figure 3 - 8 Equivalent rectangular spectrum

If the spectrum is assumed to be rectangular, the following relationship must be satisfied:

$$\text{Total power} = \text{equivalent bandwidth} \times \text{power density.}$$

Equivalent bandwidth normally exceeds stated GAUSSIAN NOISE BANDWIDTH (f_0) by approximately 5%.

3-32 OUTPUT CHARACTERISTICS. The Gaussian noise signal is available, at constant rms amplitude,

from the GAUSSIAN connectors on front and rear panels. Amplitude of the 'fixed' output is nominally 3.16V rms. Important features of the Gaussian output are as follows:

Output impedance	$< 1\Omega$
Load impedance	600 Ω minimum
Crest factor (= ratio of peak to rms amplitude)	Up to 3.75, depending on sequence length.

3-33 The Gaussian signal is available, from a 600 Ω impedance source, at the VARIABLE OUTPUT connectors on front and rear panels. The red RMS AMPLITUDE control selects one of three multiplier ranges, and the black control selects one of ten intermediate steps from $\times 0.1$ to $\times 1.0$. Multiplier ranges are:

3.16V rms ($= \sqrt{10V}$), 3V rms and 1V rms.

3.16V rms is obtained at both the third and fourth (fully cw) positions of the red control.

NOTE These are *open-circuit* amplitudes (i.e. if the VARIABLE OUTPUT is connected to a 600 Ω load, the voltage across the load is half that indicated by the RMS AMPLITUDE controls).

3-34 PROBABILITY DENSITY FUNCTION. Figure 3-9 shows that the probability density function (p.d.f.) of the Gaussian output, when derived from the longer sequences, is a close approximation to the normal curve. Also shown in Figure 3-9 are error plots for the p.d.f.'s of first and second derivatives of the Gaussian signal obtained with $N = 32767$: these p.d.f.'s also show unusually small departures from the normal curve. Freedom from discontinuities in the signal, even after two differentiations, is achieved by second order analog filtering of the Gaussian output: this feature applies to all Gaussian noise bandwidths above 0.05Hz.

3-35 In the pseudo-random mode, measurements of p.d.f. are taken over one complete period ($T = N\Delta T$), or an integral number of periods, of the noise. An important feature of pseudo-random noise is the complete absence of statistical fluctuations. All sequences generated with the same settings of SEQUENCE LENGTH and CLOCK PERIOD switches are identical, and all must therefore have the same p.d.f.

3-36 For sequence lengths below $N = 8191$; the p.d.f. shows significant departures from the normal curve. Two typical examples of this are shown in Figure 3-10.

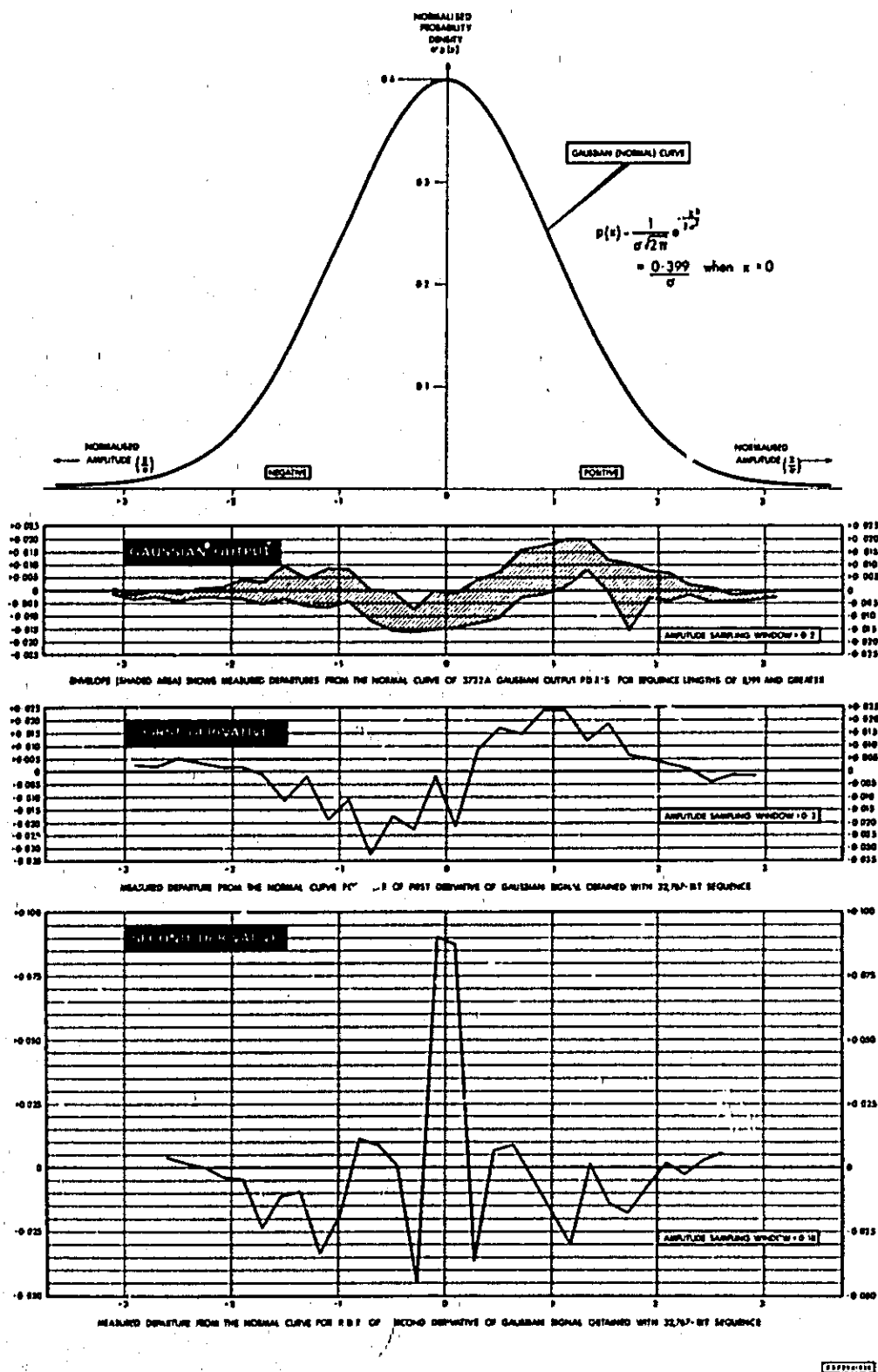


Figure 3 - 9 Probability density functions of Gaussian signal and its derivatives

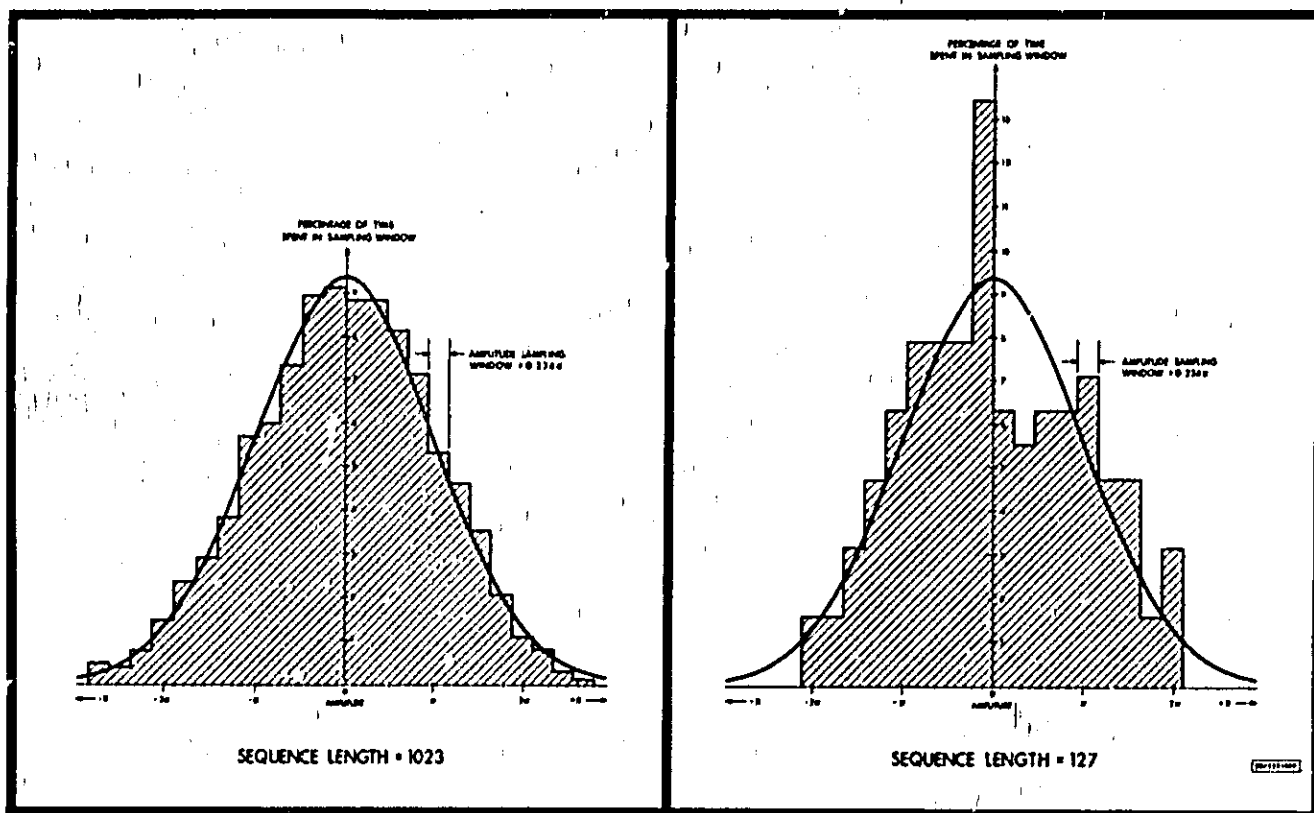


Figure 3 - 10 Amplitude histograms of short sequence Gaussian signals

3-37 FILTER CHARACTERISTICS. Frequency characteristics of the digital filter and analog filter are shown in Figures 3-11 and 3-12 respectively. These will be found particularly useful for the prediction of spectrum shape when the *hp 3722A* is driven by an external clock. The two filters are in cascade and the effect of both must be considered in any calculations of spectrum shape. In this connexion, two important points are:

- (1) The half-power frequency of the digital filter varies directly with the clock frequency, even when the clock signal is derived from an external source.
- (2) The corner frequency of the analog filter is selected by the CLOCK PERIOD switch (i.e. it is independent of clock frequency if an external clock is used).

3-38 TIMING SIGNALS

3-39 CLOCK. When the instrument is controlled by internal clock (clock switch on rear panel set to INT), a timing signal at the internal clock frequency (18 settings, 0.003Hz to 1MHz) is available at the CLOCK connector.

3-40 SYNC. At a particular point in each pseudo-random sequence, the instrument generates a sync

pulse which can be used to synchronise external processing or display equipment. In Option 01 versions of the instrument, the point in the sequence at which the sync pulse occurs is optimised (for the seven shortest sequences, $N = 15$ to $N = 1023$) such that the first time moment of the p.r.b.s., with respect to the sync pulse, is zero. Details of this Option are given in Section VII.

3-41 GATE. The gate facility is used for the synchronous control of external measuring processes — in particular, when the process is required to last for a selected number of sequences (1, 2, 4 or 8). Duration of the gate is set by the 4-position SEQUENCES PER GATE INTERVAL switch on the front panel. Operation of the GATE RESET push-button initiates the gate signal, which starts on the following sync pulse and ends on the sync pulse marking completion of the selected number of sequences.

The gate signal is available at the GATE connector and GATE RELAY binding posts on the rear panel.

NOTE The gate mechanism is a one-shot device: only one gate signal is generated per operation of the GATE RESET button.

Table 3-2

Shows the frequency of the fundamental (first harmonic) given by combinations of $1\mu\text{S}$ and $3.33\mu\text{S}$ clock periods with all possible sequence lengths from 15 to 1048575. For fundamental frequencies given by clock periods other than $1\mu\text{S}$ and $3.33\mu\text{S}$, multiply the listed frequency by the appropriate power of 10.

Example A

Find the fundamental frequency given by clock period 1mS and sequence length 1023.

Listed frequency for clock period $1\mu\text{S}$ and sequence length 1023 = 977.517Hz.

$1\text{mS} = 1\mu\text{S} \times 10^3$, so the fundamental frequency with 1mS clock period is one thousandth of that listed = $977.517 \times 10^{-3} = 0.977517\text{Hz}$

Example B

Find the fundamental frequency given by clock period $333\mu\text{S}$ and sequence length 8191.

Listed frequency for clock period $3.33\mu\text{S}$ and sequence length 8191 = 36.6256Hz.

$333\mu\text{S} = 3.33\mu\text{S} \times 10^2$, so the fundamental frequency with $333\mu\text{S}$ clock period is one hundredth of that listed = $36.6256 \times 10^{-2} = 0.366256\text{Hz}$.

SEQUENCE LENGTH (N)	CLOCK PERIOD	
	$1\mu\text{S}$	$3.33\mu\text{S}$
15	66.6667kHz	20.0000kHz
31	32.2581kHz	9.67742kHz
63	15.8730kHz	4.76190kHz
127	7.87402kHz	2.36220kHz
255	3.92157kHz	1.17647kHz
511	1.95695kHz	587.084Hz
1023	977.517Hz	293.255Hz
2047	488.520Hz	146.556Hz
4095	244.200Hz	73.2601Hz
8191	122.085Hz	36.6256Hz
16383	61.0389Hz	18.3117Hz
32767	30.5185Hz	9.15555Hz
65535	15.2590Hz	4.57771Hz
131071	7.62945Hz	2.28884Hz
262143	3.81471Hz	1.14441Hz
524287	1.90735Hz	0.572206Hz
1048575	0.953675Hz	0.286103Hz

Table 3 - 2 List of fundamental frequencies

Table 3 - 3 Parameters of binary noise spectrum

Clock period ΔT	Clock frequency $f_c = 1/\Delta T$	1/2 power frequency* (Nom. spectrum width) = -3dB point
1 μ S	1MHz	450kHz
3.33 μ S	300kHz	135kHz
10 μ S	100kHz	45kHz
33.3 μ S	30kHz	13.5kHz
100 μ S	10kHz	4.5kHz
333 μ S	3kHz	1.35kHz
1mS	1kHz	0.45kHz
3.33mS	300Hz	0.135kHz
10mS	100Hz	45Hz
33.3mS	30Hz	13.5Hz
100mS	10Hz	4.5Hz
333mS	3Hz	1.35Hz
1 sec	1Hz	0.45Hz
3.33 sec	0.3Hz	0.135Hz
10 sec	0.1Hz	0.045Hz
33.3 sec	0.03Hz	0.0135Hz
100 sec	0.01Hz	0.0045Hz
333 sec	0.003Hz	0.00135Hz

* Other spectrum widths obtainable
with external clock.

Table 3 - 4

Shows number of harmonic components between dc and -3dB frequency in the spectrum of pseudo-random binary noise.

Sequence length	Number of harmonics
15	6
31	13
63	28
127	57
255	114
511	229
1023	460
2047	921
4095	1,842
8191	3,685
16383	7,372
32767	14,745
65535	29,490
131071	58,981
262143	117,964
524287	235,929
1048575	471,858

Table 3 - 5

Approximate crest factor of GAUSSIAN output obtained with sequence lengths of 8191 and greater.

Sequence length	Crest factor
8191	3.20
16383	3.35
32767	3.70
65535	3.75
131071	3.80
262143	3.85
524287	3.85
1048575	3.85

Table 3 - 6 Parameters of Gaussian noise spectrum

Clock period ΔT	Clock frequency $f_c = 1/\Delta T$	1/2 power frequency* (Nom. spectrum width) = -3dB point	$\pm 0.3\text{dB}$ frequency in Gaussian spectrum
1 μS	1MHz	50kHz	25kHz
3.33 μS	300kHz	15kHz	7.5kHz
10 μS	100kHz	5kHz	2.5kHz
33.3 μS	30kHz	1.5kHz	0.75kHz
100 μS	10kHz	0.5kHz	0.25kHz
333 μS	3kHz	0.15kHz	75Hz
1mS	1kHz	50Hz	25Hz
3.33mS	300Hz	15Hz	7.5Hz
10mS	100Hz	5Hz	2.5Hz
33.3mS	30Hz	1.5Hz	0.75Hz
100mS	10Hz	0.5Hz	0.25Hz
333mS	3Hz	0.15Hz	0.075Hz
1 sec	1Hz	0.05Hz	0.025Hz
3.33 sec	0.3Hz	0.015Hz	0.0075Hz
10 sec	0.1Hz	0.005Hz	0.0025Hz
33.3 sec	0.03Hz	0.0015Hz	0.00075Hz
100 sec	0.01Hz	0.0005Hz	0.00025Hz
333 sec	0.003Hz	0.00015Hz	0.000075Hz

*Other spectrum widths obtainable with external clock

Table 3 - 7

Shows number of harmonic components between dc and -3dB frequency in the spectrum of pseudo-random Gaussian noise.

Sequence length	Number of harmonics	Sequence length	Number of harmonics
		4095	204
15	—	8191	409
31	1	16383	819
63	3	32767	1,638
127	6	65535	3,276
255	12	131071	6,553
511	25	262143	13,107
1023	51	524287	26,214
2047	102	1048575	52,428

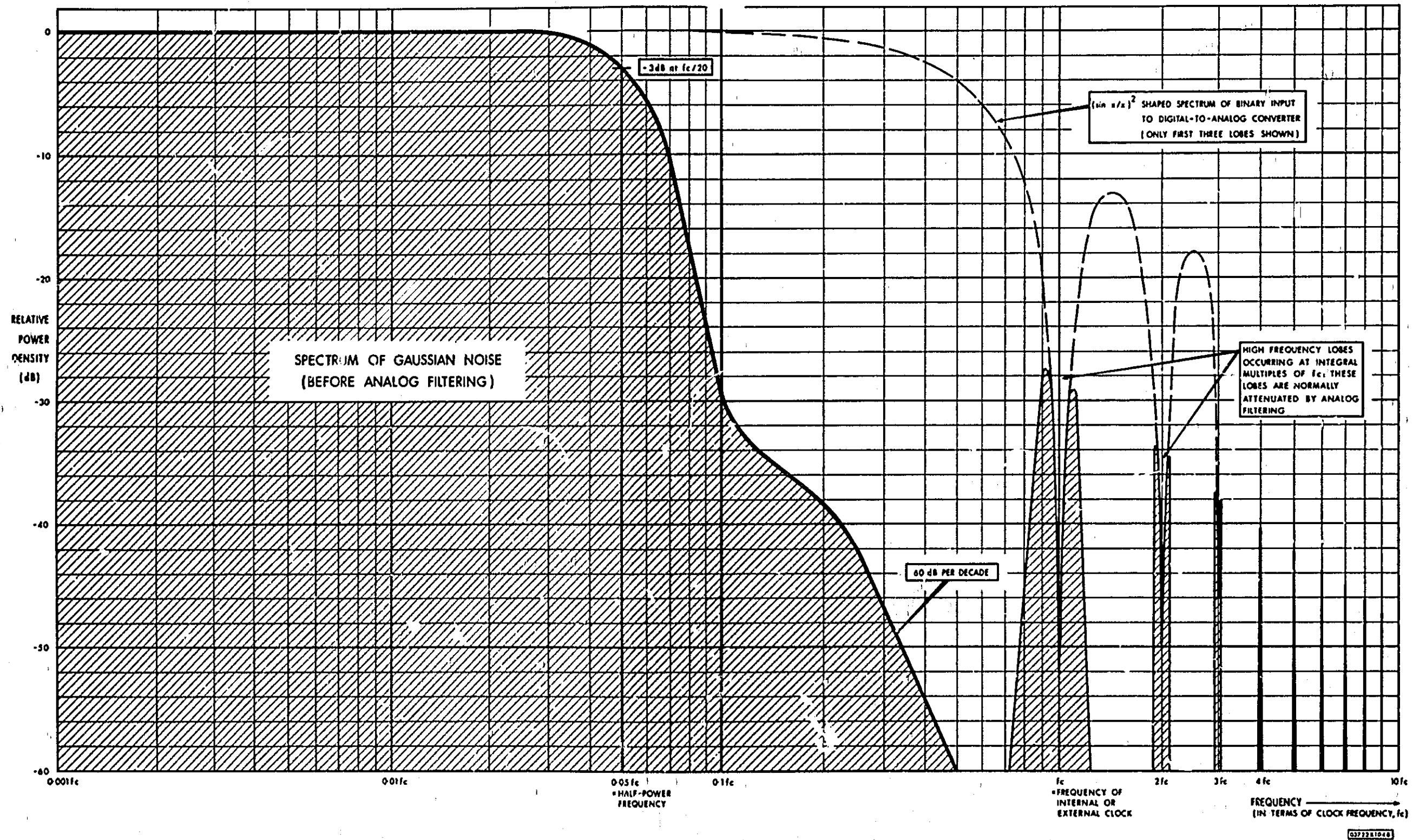


Figure 3 - 11 Frequency characteristic of digital filter

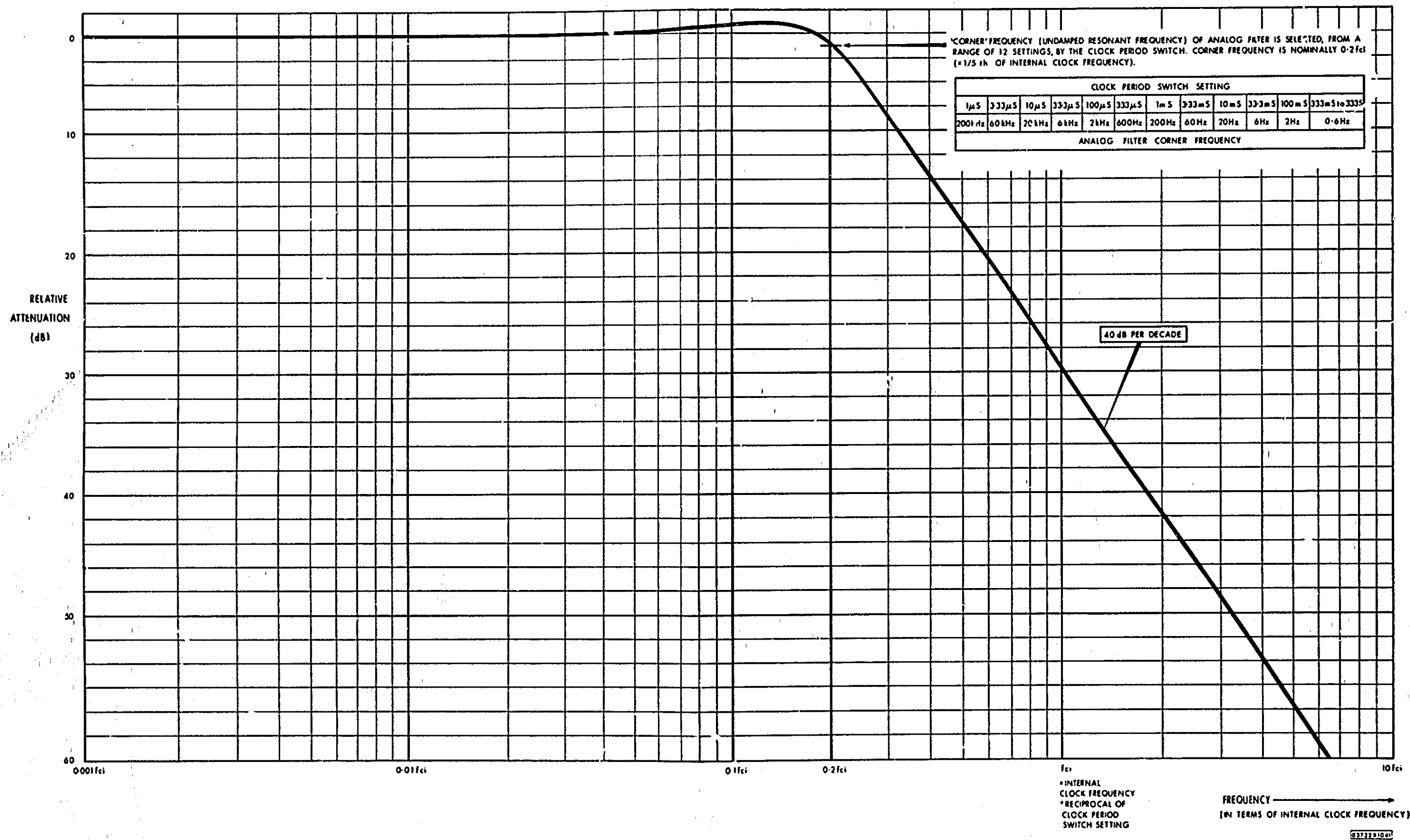


Figure 3 - 12 Frequency characteristic of analog filter

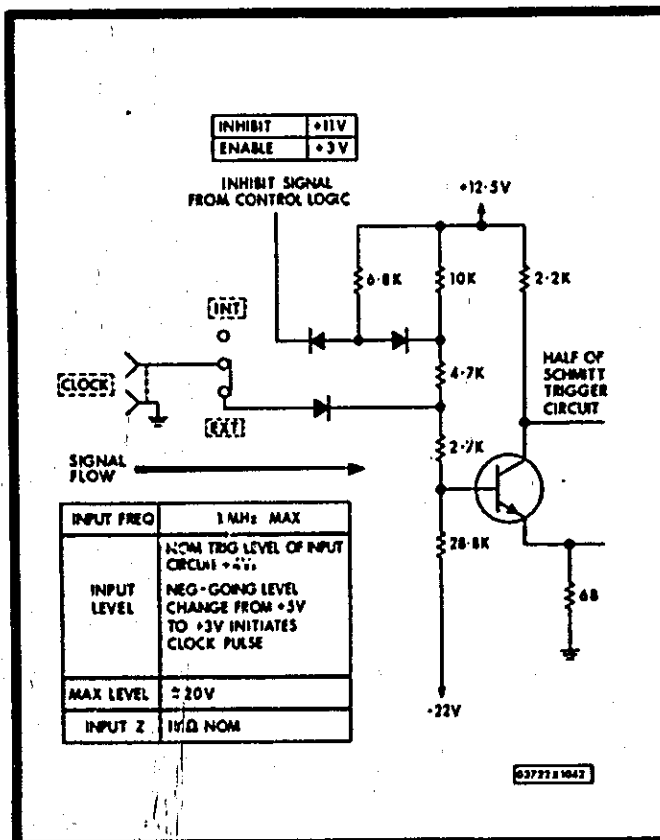


Figure 3 - 13 CLOCK input circuit

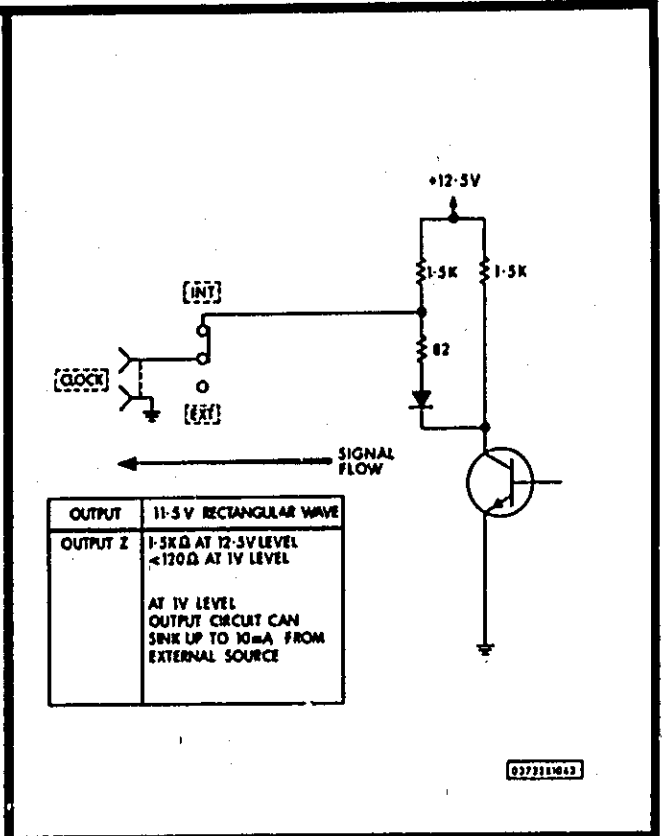


Figure 3 - 14 CLOCK output circuit

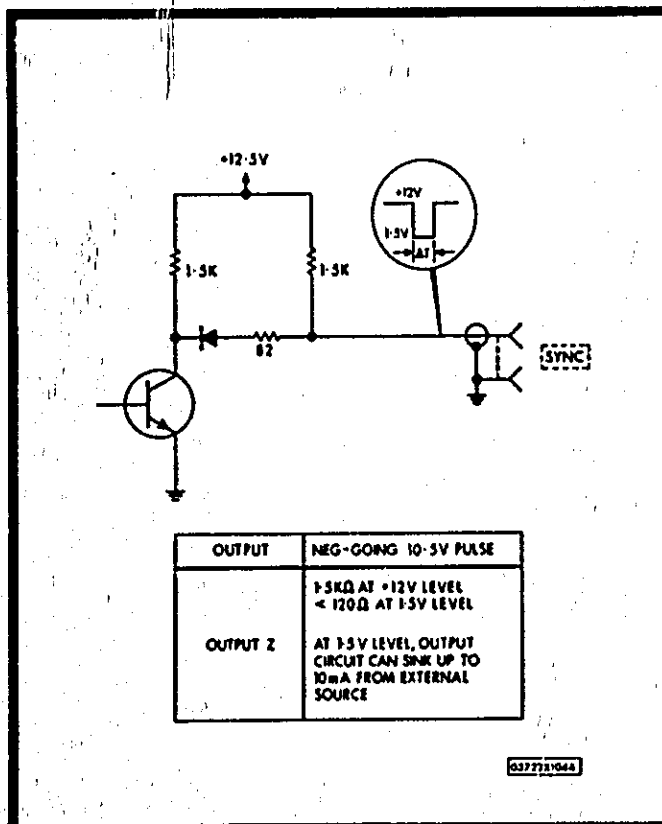


Figure 3 - 15 SYNC output circuit

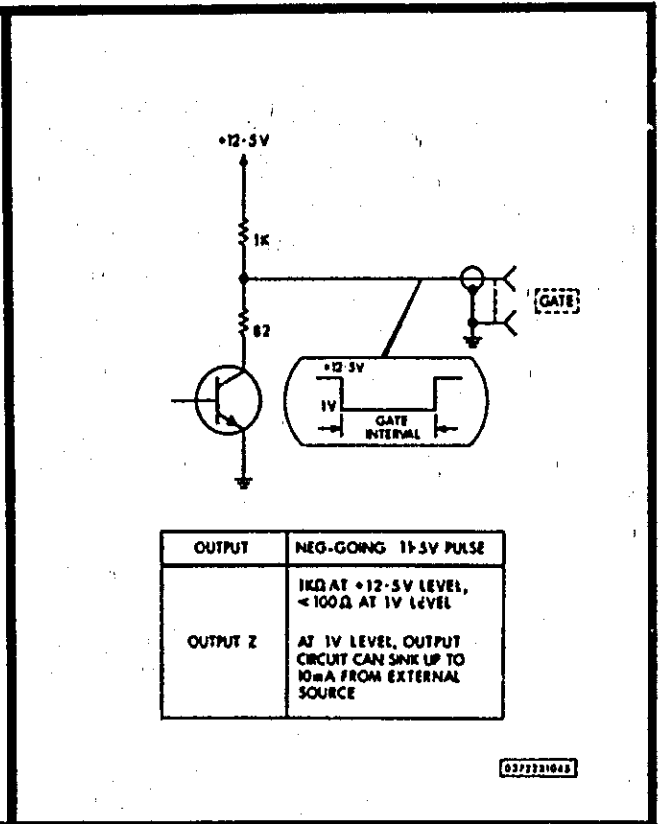


Figure 3 - 16 GATE output circuit

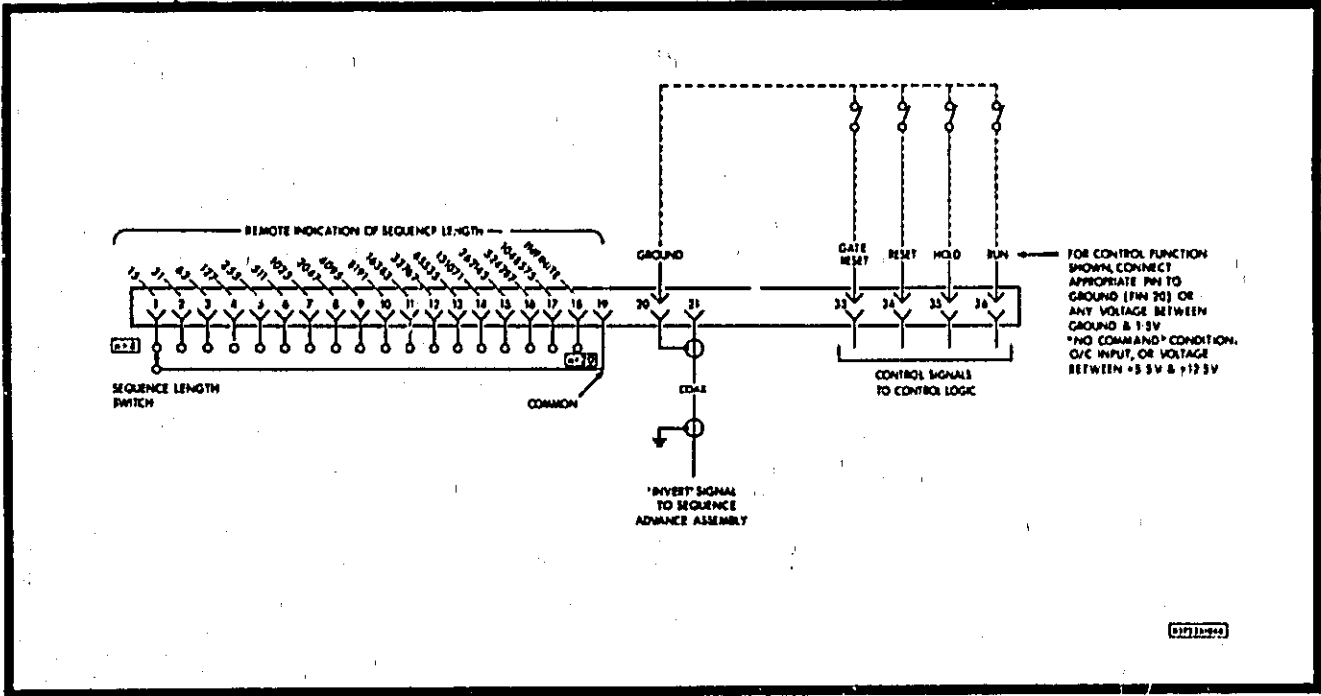


Figure 3 - 17 36-way receptacle on rear panel

Key to Figure 3-18

FRONT PANEL CONTROLS

- (1) LINE ON-OFF control. Latching push-button. When operated, the indicator lamp glows.
- (2) RUN control. Push-button, push-pull coupled to the HOLD and RESET buttons. For the *hp 3722A* to generate outputs, the RUN button must be 'in' (this allows the shift register to operate).
- (3) HOLD control. Push-button which, when operated, stops the shift register and thus holds the outputs at a steady dc level.
- (4) BINARY (fixed output) connector. Two-level signal taken from one stage of the shift register. Signal amplitude is $\pm 10V$, impedance less than 10Ω (because signal amplitude is constant, total output power is constant, regardless of CLOCK PERIOD and SEQUENCE LENGTH settings).
- (5) GAUSSIAN (fixed output) connector. Smoothed multi-level signal derived from shift register outputs. Signal amplitude is 3.16V rms (regardless of GAUSSIAN NOISE BANDWIDTH setting), and impedance is less than 1Ω .
- (6) GAUSSIAN ZERO control. Preset potentiometer for adjusting the mean dc level of the Gaussian signal. Range of adjustment is approximately $\pm 50mV$.
- (7) VARIABLE OUTPUT connector. Variable amplitude output of either binary or Gaussian signals (selection by slide switch (8)). Output impedance 600Ω ; amplitude controlled by concentric switches (9).
- (8) VARIABLE OUTPUT selector. Slide switch connects either the $\pm 10V$ binary or the 3.16V rms Gaussian signal via the amplitude controls to the VARIABLE OUTPUT connector.
- (9) RMS AMPLITUDE controls. The red control selects one of four 'full scale' multiplier ranges, and the black control selects one of ten intermediate steps from $\times 0.1$, to $\times 1.0$. The red control selects the same full scale rms values for both Gaussian and binary outputs on the three lower ranges (1V, 3V and 3.16V), but only the binary signal is available at the 10V level: the $\times 10$ position of the red control selects $\pm 10V$ binary and 3.16V rms Gaussian.

NOTE A 10V rms binary signal swings between levels of $\pm 10V$. The RMS AMPLITUDE control is calibrated in volts, open circuit.

- (10) CLOCK PERIOD control. 18-way selector determines the timebase frequency, and thus controls the stepping rate of the shift register. The CLOCK PERIOD is selectable from $1\mu S$ to 333 SEC (outer engravings). Note that the period is directly related to GAUSSIAN NOISE BANDWIDTH, which is selectable from 50kHz to .00015Hz (inner engravings).

- (11) SEQUENCE LENGTH control. 18-way selector which, by altering the shift register feedback arrangements, determines the number of bits (clock periods) in the pseudo-random sequences. Outer engravings (n) indicate the number of register stages involved in sequence generation, and the inner engravings ($N = 2^n - 1$) state the actual number of bits in the sequence. N is selectable from 15 to 1048575, corresponding to values of n from 4 to 20.

- (12) SEQUENCES PER GATE INTERVAL control. 4-way selector determines the duration of the gate signal in terms of a number of sequences (1, 2, 4 or 8).

- (13) GATE lamp. Normally out, but lights during a gate interval.

- (14) GATE RESET control. Push-button which initiates a gate signal.

- (15) RESET control. Push-button which, when operated, stops the shift register (as does the HOLD control) and resets it (together with some other circuits) to a pre-determined state.

REAR PANEL CONTROLS

- (16) BINARY (fixed output) connector. Connected in parallel with (4).

- (17) GAUSSIAN (fixed output) connector. Connected in parallel with (5).

- (18) VARIABLE OUTPUT connector. Connected in parallel with (7).

- (19) BINARY RELAY terminals. Changeover relay mimics the binary signal (at connectors (4) and (16)) when the clock period is 100 mS and greater.

- (20) RELAY DISABLE control. Slide switch: inhibits the binary relay, when set to OFF, so prolonging the life of the relay contacts.

- (21) CLOCK INT/EXT control. Slide switch: selects the source of timing pulses for the shift register. When the switch is set to INT, the *hp 3722A* is controlled by its internal clock (period from $1\mu S$ to 333 sec), the output from which is available at the CLOCK connector (22). When the switch is set to EXT the internal clock is disconnected and the *hp 3722A* is timed by an external device (frequency up to 1MHz) coupled to the CLOCK connector. Figures 3-13 and 3-14 show clock input and output circuits.

- (22) CLOCK connector. Dual-purpose: output for internal clock or input from external clock. Internal clock output is a rectangular wave between zero and +12.5V.

- (23) SYNC connector. Negative-going pulse (+12.5V to zero) occurring once per pseudo-random sequence (Figure 3-15). This output is used to synchronise external processing or display equipment (oscilloscope, for example).

- (24) GATE connector. Gate signal output: falls from +12.5V to zero at start of gate interval, and returns to +12.5V at end (Figure 3-16).

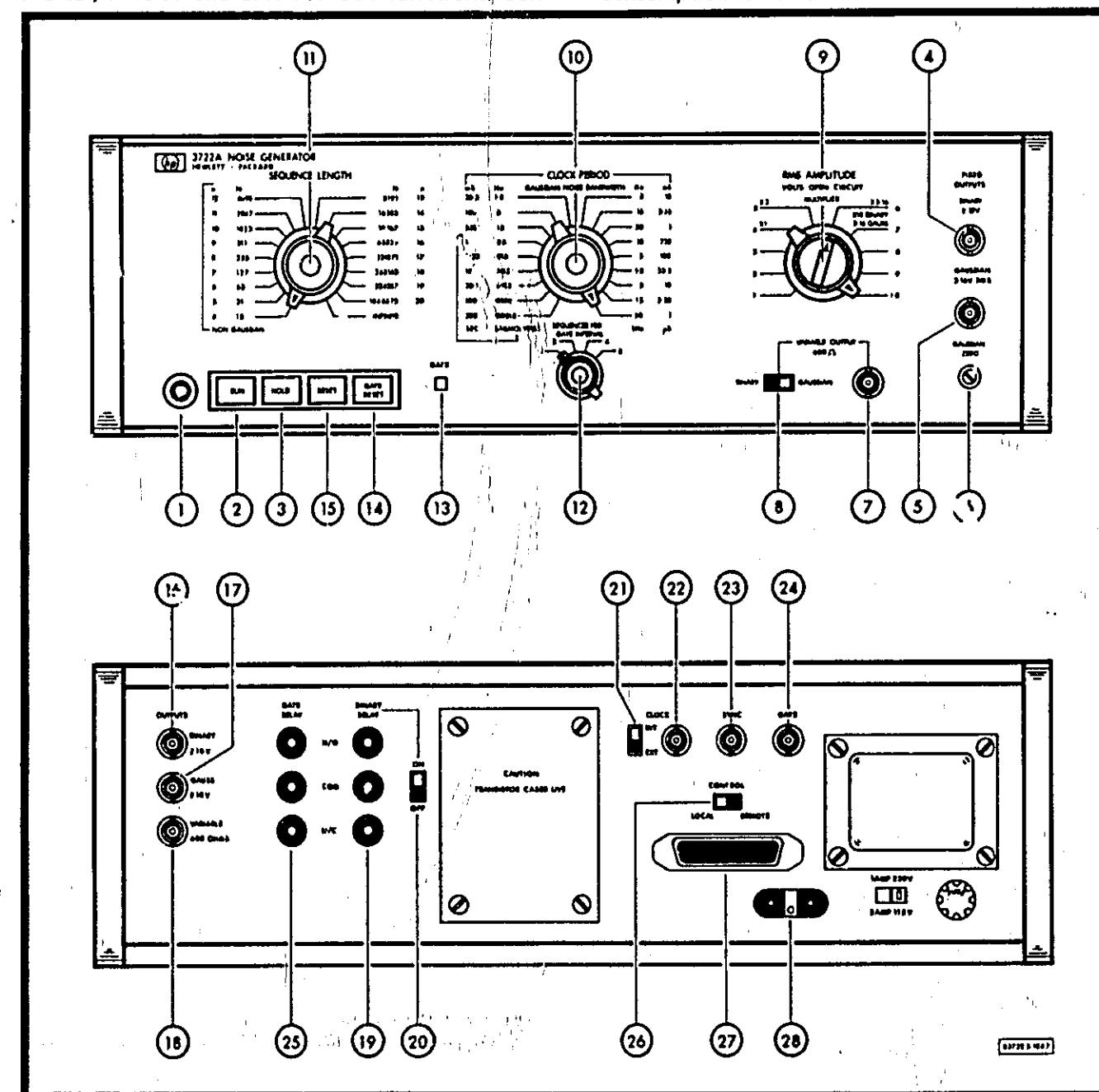
- (25) GATE RELAY terminals. Changeover relay mimics signal at GATE connector.

- (26) CONTROL selector. Slide switch: when set to REMOTE disables the RUN, HOLD, RESET and GATE RESET controls on the front panel. These functions can then be remotely controlled via the 36-way CONTROL receptacle (27).

- (27) CONTROL receptacle. 4 pins of this 36-way receptacle are used for remote control of the RUN, HOLD, RESET and GATE RESET functions. Con-

trol is achieved by grounding the appropriate pin (Figure 3-17). 18 pins, plus one common pin, are used for remote signalling of the sequence length selected on the *hp 3722A* front panel. Each pin (Figure 3-17) is related to a particular position of the SEQUENCE LENGTH switch and, when the switch is set to that position, is connected to the common pin (the remaining 17 pins in the group are open-circuit). One pin of the 36-way receptacle is used for the 'invert' input to the sequence shift mechanism (Option 01 models only).

- (28) POWER receptacle. The *hp 3722A* is powered by 115 or 230V, 50 to 1000Hz ac supply. Power consumption is 70W.

Figure 3 - 18 Front and rear panels of *hp 3722A*

SECTION IV

PRINCIPLES OF OPERATION

4-1 INTRODUCTION

4-2 This section contains a brief description of the 3722A system, to block diagram level, and describes in detail the circuits of individual assemblies. A summary of Hewlett-Packard logic terminology is given at the end of the section. Block diagram and schematics of the printed circuit assemblies are contained in Section VIII.

4-3 SYSTEM DESCRIPTION

4-4 Illustrations relevant to this description are:

Block diagram	Figure 8-5
Location of assemblies	Figure 8-2
Location of chassis mounted components	Figure 8-3
Location of components on front and rear panels	Figure 8-4

Acquaintance with the '1' and '0' notation of signal levels is assumed (see Paragraph 4-91).

4-5 TIMEBASE (CLOCK) GROUP. The internal timebase of the 3722A comprises a 3MHz crystal-controlled oscillator, a divide-by-three circuit and a chain of nine standard decade dividers (of the type used in Hewlett-Packard electronic counters). Operation of the divide-by-three circuit is basically similar to that of the decade dividers — it is a standard 'count of four' circuit modified, by feedback, such that the number of pulses counted per complete cycle is reduced to three. The timebase is so arranged that, as the CLOCK PERIOD switch S1 is rotated, 3MHz and 1MHz signals (from the oscillator and divide-by-three respectively) are applied alternately to the divider chain. A second wiper of the switch selects tapings in the chain to give a range of output frequencies from 1MHz to 0.003Hz (period, ΔT , from 1 μ S to 333 seconds). The selected clock output is applied, via the INT/EXT switch S13, to the shift pulse generator, which supplies a train of trigger pulses (one per cycle of the clock) to the shift register. With S13 set to EXT, the shift pulse generator is driven by an external timing signal applied to the CLOCK connector.

4-6 CONTROL LOGIC. Principal functions of the control logic are the enabling and disabling of the shift pulse generator. When the HOLD button is operated, the control logic produces an inhibiting signal which stops the shift pulse generator, and

hence the shift register. No further shift pulses are generated until the inhibit is removed, by operation of the RUN button. When the RESET button is operated, the control logic generates a similar inhibit signal and, in addition, applies a reset pulse to the shift register. Again, the instrument re-starts only when the RUN button is operated. The third function (GATE RESET) of the control logic is described in Paragraph 4-42.

4-7 Each of the four 'push-button' functions can be remotely controlled by a signal (contact closure to ground, or suitable voltage applied) on the appropriate pin of the 36-way CONTROL receptacle on the rear panel (details in Figure 3-17).

4-8 SHIFT REGISTER. The shift register is a chain of 32 flip-flops (stages) four of which are contained in each shift register assembly. These flip-flops, which are of a type commonly encountered in digital computers and data processing systems, must not be confused with the more familiar divide-by-two flip-flop used in the decade divider assemblies (A4, etc): the shift register flip-flop is not a divider, it is an information store. Each stage of the shift register can store one 'bit' of information ('1' or '0'), i.e. it can be in one or other of two stable states (Paragraph 4-60). The flip-flop is said to contain '1' if in the set state, and '0' if reset. The length of time that a bit of information remains in a stage is equal to the time interval between two successive clock, or shift, pulses: for this reason, each shift register stage can be thought of as a delay line in which the time delay between input and output is equal to the clock period.

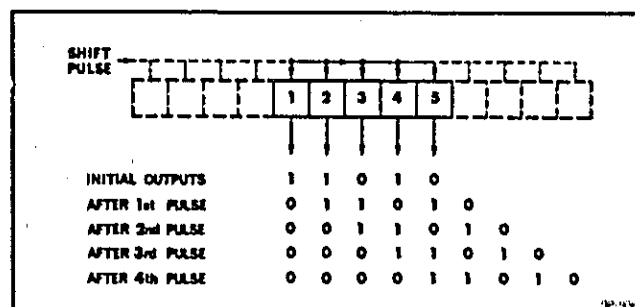
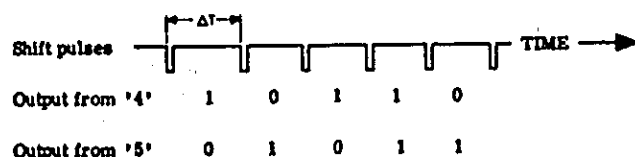


Figure 4-1 Typical sequence of shift register outputs

Paragraphs 4-9 to 4-13

4-9 The shift register stages are connected in cascade so that, on receipt of shift pulses, the information they contain is stepped progressively along the chain (in this case, 'information' means the pattern of ones and zeros in the register). This is illustrated by Figure 4-1, in which five stages of the shift register are shown initially to give — quite arbitrarily — the output pattern 11010. All preceding stages are assumed to be in the reset state (giving '0' outputs).

4-10 The state into which a given stage is switched by a shift pulse depends on the state of the preceding stage, before the shift pulse arrives. Information ('0' or '1') contained in one stage is thus transferred, by the shift pulse, to the next stage. This has the effect of stepping the entire pattern of ones and zeros progressively along the chain — as though on a conveyor belt. Note that the sequence of ones and zeros observed at the output from one stage is a delayed replica of that from the preceding stage. The delay between the two adjacent sequences is equal to one period (ΔT) of the clock:



4-11 **SEQUENCE GENERATION.** In the 3722A, the shift register operates in a closed loop condition, and the input to the first stage is supplied via a feedback path from later stages of the shift register. Under these conditions, the closed loop system generates a repeated series of identical sequences — known as 'maximum-length' or 'pseudo-random' binary sequences (p.r.b.s.). Figure 4-2 shows a simple form of p.r.b.s. generator. In this example, only the first four of the 32 register stages are actually involved in generation of the sequence.

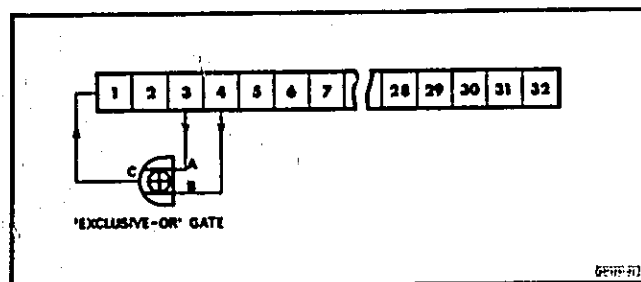


Figure 4 - 2 15-bit p.r.b.s. generator

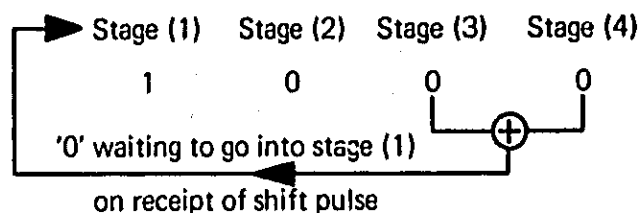
4-12 Here, feedback to the first stage is taken from stages 3 and 4, the outputs from which are processed in an exclusive OR gate (otherwise known as: modulo-two adder, half-adder, non-equivalence or anti-coincidence gate). This gate, which gives a '1' output only when its two inputs are dissimilar, is described by Table 4-1.

Table 4 - 1 Truth table for modulo-two adder

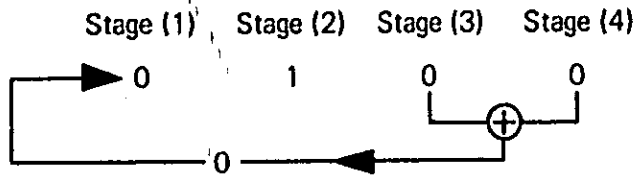
INPUTS		OUTPUT
A	B	C
0	0	0
1	0	1
0	1	1
1	1	0

4-13 The sequence generated by the four-stage arrangement of Figure 4-2 can easily be derived. For the purpose of illustration, the initial contents of the first four stages are taken, arbitrarily, to be as follows:

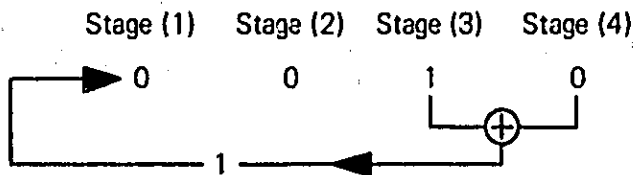
Before 1st shift pulse



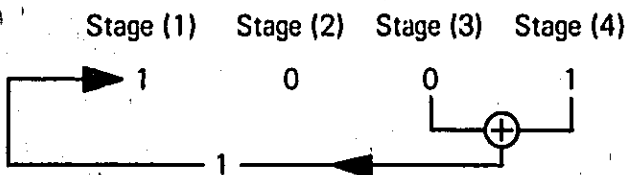
The modulo-two sum of the outputs from the last two stages is '0' (this can be written $0 \oplus 0 = 0$). At the first shift pulse, the '1' in the first stage is transferred to the second, and is replaced by the '0' in the feedback line. This gives the pattern:

After 1st pulse

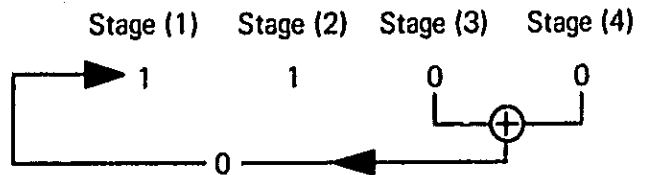
Again, the modulo-two summation yields '0'. The next pattern is therefore:

After 2nd pulse

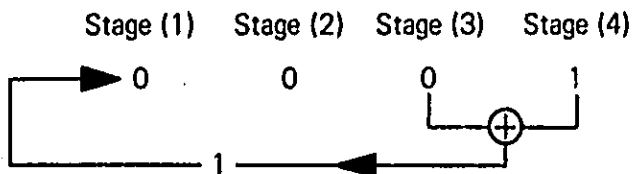
With this pattern, the outputs from the third and fourth stages are dissimilar — so the modulo-two sum is '1'. The '1' thus placed in the feedback line enters the first stage on arrival of the next shift pulse:

After 3rd pulse

This pattern again places a '1' in the feedback line. So the result after the next shift pulse is:

After 4th pulse

The remainder of the sequence can be worked out in a similar manner. After the 14th pulse, the register pattern is:

After 14th pulse

4-14 The fifteenth pulse restores the register to the initial state (1000), and thereafter the sequence repeats. The complete 15-bit sequence is summarised in Table 4-2.

Table 4 - 2 15-bit pseudo-random sequence

TIME →																
Shift pulses	Initial	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Stage (1)	1	0	0	1	1	0	1	0	1	1	1	1	0	0	0	1
Stage (2)	0	1	0	0	1	1	0	1	0	1	1	1	1	0	0	0
Stage (3)	0	0	1	0	0	1	1	0	1	0	1	1	1	1	0	0
Stage (4)	0	0	0	1	0	0	1	1	0	1	0	1	1	1	1	0

Paragraphs 4-15 to 4-18

Note that, with the exception of 0000, the register generates the maximum number of '1' and '0' combinations possible with four stages. The all-zero condition cannot arise (if it were to occur, all stages of the shift register would remain in the '0' state, and the output would thereafter be an infinite sequence of zeros).

4-15 The above table shows that the pattern appearing at the output from the first stage is exactly the same as that from the second, the third and the fourth (and so on throughout the 32 stages of the register). Note that there is a delay of one clock period between the pattern from one stage and the pattern from the next. The digit sequence from any of the 32 stages is:



Figure 4-3 shows this sequence translated into a two-level, or 'binary' waveform ('1' is represented by the relatively negative level).

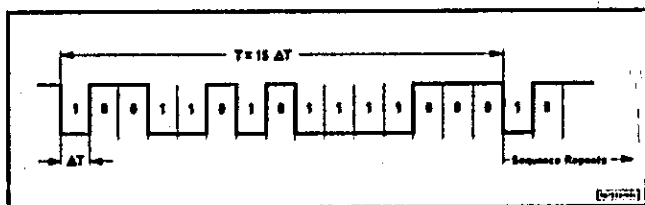


Figure 4 - 3 15-bit binary waveform

This in fact is the waveform obtained at the BINARY connector with the SEQUENCE LENGTH switch S2 set to 15 (compare with the oscilloscope photograph 'A', Table 3-1).

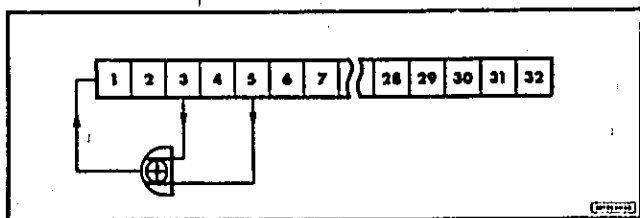


Figure 4 - 4 31-bit p.r.b.s. generator

4-16 The next setting (31) of the SEQUENCE LENGTH switch selects, for modulo-two addition, the outputs from stages 3 and 5, as shown in Figure 4-4.

With five stages the maximum number of '1' and '0' combinations is 32 but, as before, the all-zero condition cannot occur. The resulting p.r.b.s. is therefore 31 bits long.

4-17 The 'active' length of the shift register (i.e. that part involved in sequence generation) is selectable, from 4 to 20, by the SEQUENCE LENGTH switch. Feedback is always taken from the last of the active stages, and from one or more of the preceding stages. For the 127-bit sequence in the 3722A, for example, feedback is taken from stage 7 (7 is the 'n' number engraved on the front panel) and also from stages 3, 4, 5. Where more than two outputs are modulo-two added, extra exclusive OR gates are used, as in Figure 4-5.

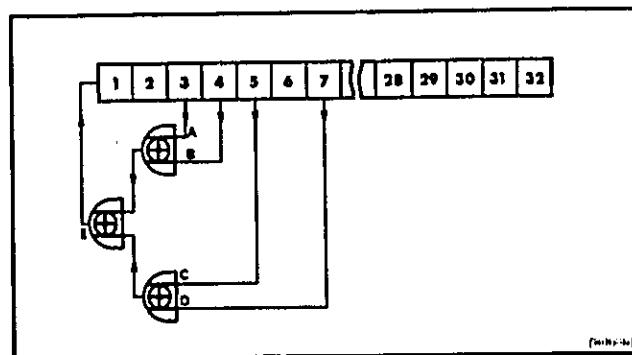


Figure 4 - 5 127-bit p.r.b.s. generator

The group of gates shown in Figure 4-5 gives a '1' output only when there is an odd number of '1' inputs. The overall truth table for the group is given in Table 4-3.

4-18 Note that the number of bits, N , in pseudo-random sequences generated by the 3722A is always one less than the maximum number of '1' and '0' combinations possible with the selected length of register. Thus if n is the number of active stages, $N = 2^n - 1$. For a particular active length of shift register, there are many possible feedback combinations giving sequences of the same length but of different form. The 3722A provides only one feedback arrangement for each active length of register. If required, the feedback arrangements – and hence the form of the sequences – can be modified by re-wiring the SEQUENCE LENGTH switch. This should be undertaken with care, as the GAUSSIAN output amplitude distribution can be seriously affected by changes in the form of binary sequence from the shift register.

Table 4 - 3 Truth table for three modulo-two adders

INPUTS				OUTPUT
A	B	C	D	E
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

4-19 SYNC PULSE. At a particular point in each pseudo-random sequence, the 3722A generates a sync pulse, which is used to time external processing and display equipment (for example, an oscilloscope triggered by the sync pulse gives a stationary display of the 3722A output waveforms). The sync pulse is generated by a gate which seeks the all-zero condition in the active stages of the shift register, excluding the first stage. Thus for the 15-bit sequence, the sync pulse occurs when the first four stages contain the pattern:

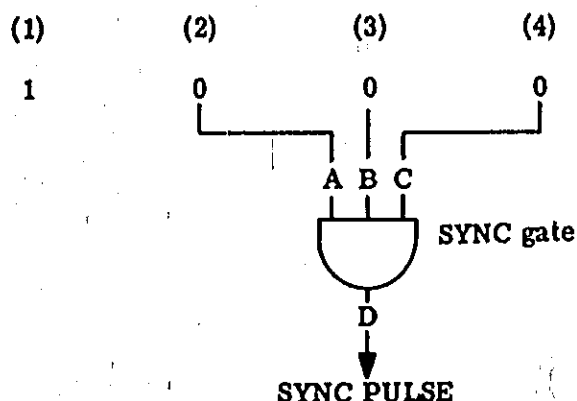


Table 4 - 4 Truth table for sync gate

INPUTS			OUTPUT
A	B	C	D
1	0	0	1
0	1	0	1
0	0	1	1
1	1	0	1
0	1	1	1
1	0	1	1
1	1	1	1
0	0	0	0

← SYNC pulse condition

4-20 Note that this is an AND gate for '0' levels: this may seem unusual, but it should be remembered that the assignment of signal level to logic notation is quite arbitrary, and varies from point to point through the system.

4-21 Clearly, the duration of the sync pulse is equal to the interval between shift pulses, and hence equal to the selected clock period (at the next shift pulse, the shift register output pattern changes — no longer satisfying the AND function). The number of inputs to the sync gate is controlled by the SEQUENCE LENGTH switch, and is always one less than the number (n) of active shift register stages.

4-22 RESET and AUTO-START. When the RESET button is operated, all stages of the register are driven into the '0' state by a signal from the control logic: the register remains in the all-zero state until the RUN button is operated (restoring the supply of shift pulses). Since the all-zero condition never arises in the normal course of events, action must be taken to get the shift register under way following reset — and possibly after switch-on (with the shorter sequences in particular, there is the possibility that all active stages could go into the '0' state when power is applied). This difficulty is overcome by the gating arrangement shown in Figure 4-6. If all stages in the feedback system are in the '0' condition, then the output from the sync gate will be '0' (the 'sync' condition): this, coupled with the '0' from the first stage, gives '0' output from the auto-start gate. The logic inverter, which supplies one input of the exclusive OR gate, turns this '0' into a '1' level. The other input of the gate is supplied by the feedback line which, if all stages are in the '0' condition, must be at the '0' level. Since its two inputs are dissimilar, the exclusive OR gate gives a '1' output — which ensures that the first stage of the register will go into the '1' state when the first shift pulse is received.

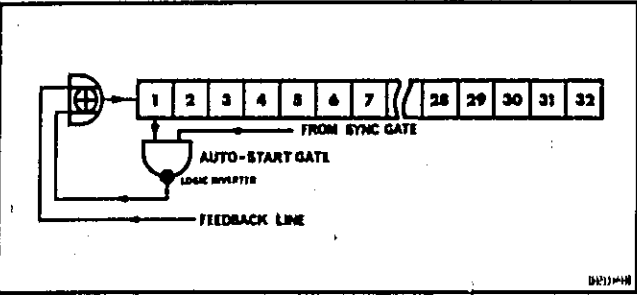


Figure 4-6 Auto-start logic

4-23 BINARY OUTPUT. In the standard version of the 3722A (without Option 01), the output from the first stage of the shift register is taken directly to the output switch circuit. This produces an accurately defined $\pm 10V$ version of the signal from the first stage. The signal from the output switch is taken to the BINARY (fixed output) connector, the amplitude control (600 Ω VARIABLE OUTPUT) and a relay driver circuit, the output from which controls the BINARY RELAY.

4-24 ZERO MOMENT OPTION (OPTION 01). In some applications of binary noise signals it is desirable that the sync pulse should occur at a pre-determined point in the pseudo-random sequence other than the all-zero (with '1' in first stage) condition of the register.

4-25 When Option 01 is included, the position of the sync pulse is shifted with respect to the sequence for each of the seven shortest sequences ($n=15$ to 1023). The necessary shift in relative position is achieved by generating the sync pulse at the same point as before, and by delaying the actual BINARY output sequence, with respect to the pulse, by a pre-set amount (which is specially selected for each sequence).

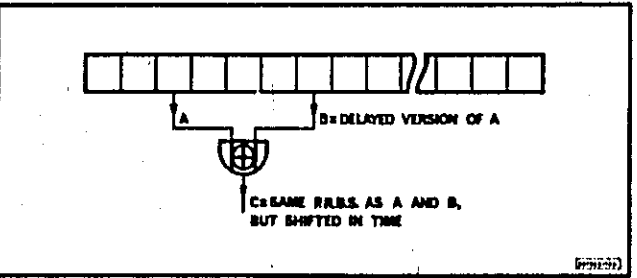


Figure 4-7 Sequence shift by combining outputs

4-26 As shown in Paragraph 4-10, the sequence of ones and zeros produced by one stage of the register appears, delayed by one clock period, at the output from the next. The shift register itself thus generates 32 differently delayed versions of the same sequence.

As a result, relative timing of sync pulse and BINARY output sequence could be adjusted by up to 32 clock periods, simply by taking the output (i.e. the output switch drive) from the appropriate stage. The optimum shift for the longer sequences, however, is greater than 32 bits. To achieve greater delays, use is made of the 'shift and add' property of pseudo-random sequences: this means that a sequence added (modulo-two) to a delayed version of itself produces yet another delayed version of the original sequence, as in Figure 4-7.

4-27 The pairs of shift register outputs from which the binary signal is derived are selected by the SEQUENCE LENGTH switch.

4-28 RANDOM OPERATION OF SHIFT REGISTER. With the SEQUENCE LENGTH switch set to infinite, the feedback system is disconnected, and the first stage of the register is controlled by a semiconductor noise source giving a truly random output signal. Just before each shift pulse, the random signal is sampled by a level detector which decides, on arrival of the shift pulse, whether a '1' or a '0' is to be placed in the first stage of the register. Since the random signal is non-periodic, there is no repeated pattern in the resulting series of ones and zeros from the register.

4-29 GAUSSIAN NOISE. In the 3722A, the Gaussian multi-level noise signal is generated by low-pass filtering the binary output from the shift register. Examples of this are shown in Figure 4-8, where a pseudo-random binary signal is applied in turn to three low-pass RC filters, of diminishing cut-off frequency. The first filter, having a time constant equal to approximately one third of the clock frequency (period 3.3 μS , frequency 300kHz), distorts the edges of the waveform but leaves a still recognisable pattern. The third filter, however, has a much longer time constant and gives a multi-level output very similar in appearance to the Gaussian-type waveform from the 3722A (oscilloscope photograph 'B' Table 3-1): not only does this filter convert from two-level to multi-level, it also modifies the frequency spectrum of the signal, as shown in Figure 4-9.

4-30 The filter in the 3722A is a digital device which is not subject to the same limitations as the conventional low-pass filter (in particular, the 3722A filter is required to yield a rectangular spectrum of selectable cut-off frequency down to 0.00015Hz – not practicable with conventional devices).

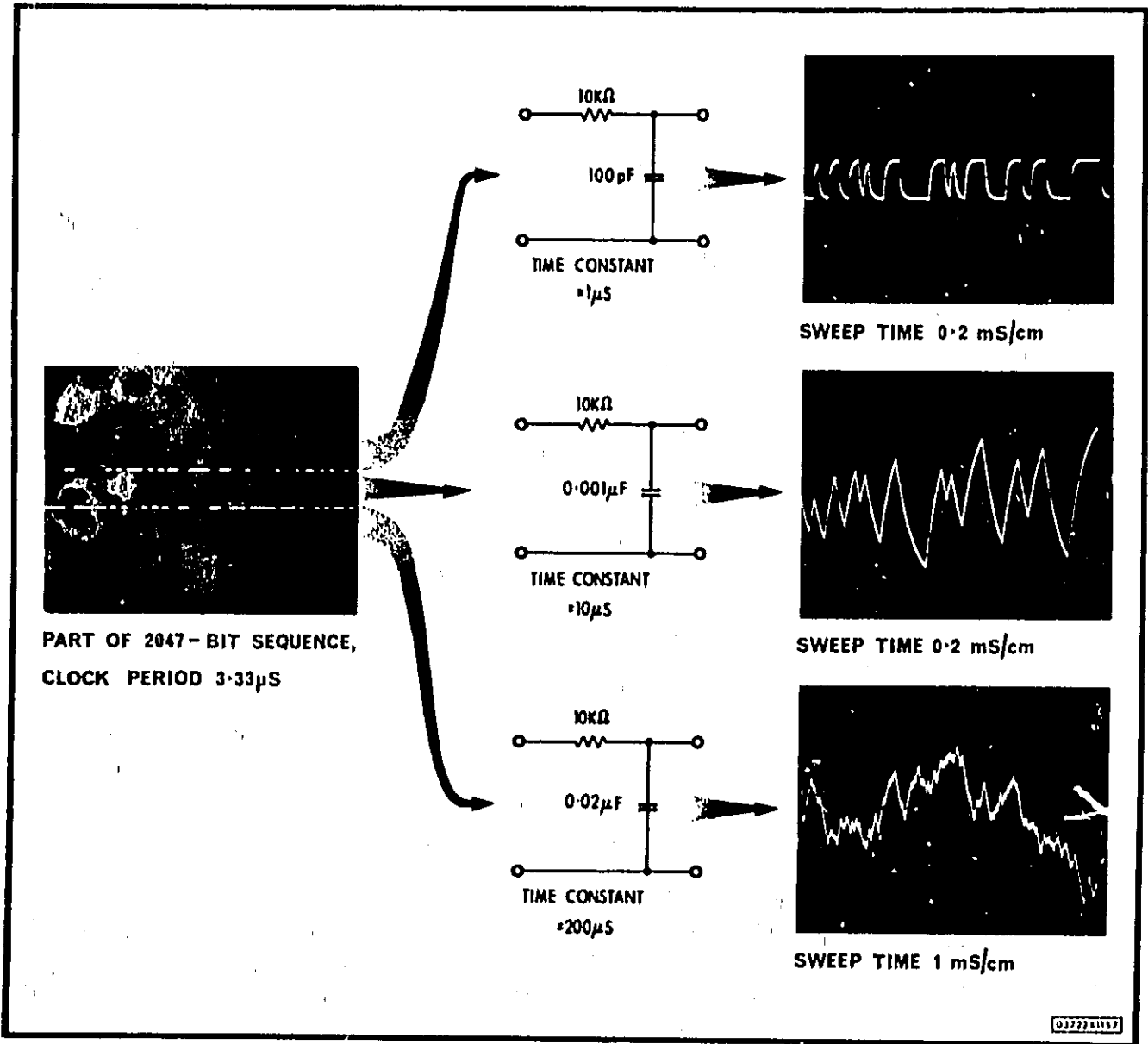


Figure 4-8 Low-pass filtering of p.r.b.s.

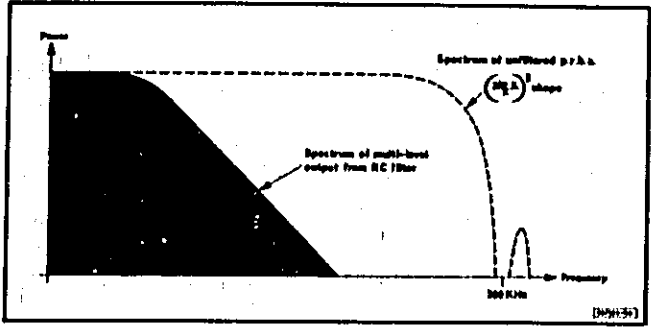


Figure 4-9 Spectrum shaping by simple low-pass filtering

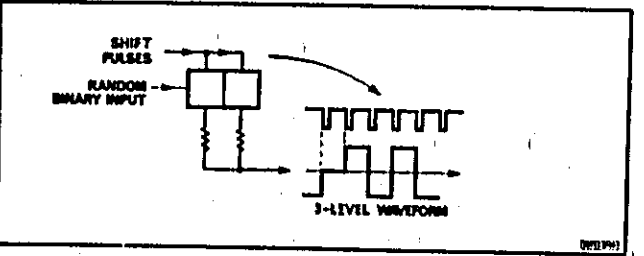


Figure 4-10 Two-stage 'digital to analog' converter

4-31 Consider first a simple method of digitally converting a binary signal into a multi-level waveform. In Figure 4-10, two stages of a shift register are coupled to resistors of similar value, and the circuit is so arranged that the current flowing through each resistor depends upon the state ('0' or '1') of its associated stage. If, say, a stage in the '1' state causes its load resistor to pass one unit of current, then the possible combinations with two stages are:-

- (1) No current (both stages in '0' state).
- (2) One unit of current (either stage in '1' state).
- (3) Two units of current (both stages in '1' state).

Hence the signal at the summing point can at any given time have one of three values, depending on the combination of digits in the two stages. Figure 4-10 shows the sort of three-level signal which could be produced by a two-stage device, assuming arbitrary changes in digital pattern. Note that, in normal shift register fashion, the pattern changes only when a shift pulse is received. Clearly, with a larger number of 'bits' contributing to the output, the number of possible signal levels is increased. The device therefore acts as a filter in that it derives a multi-level waveform from a two-level signal, as does the low-pass filter described above.

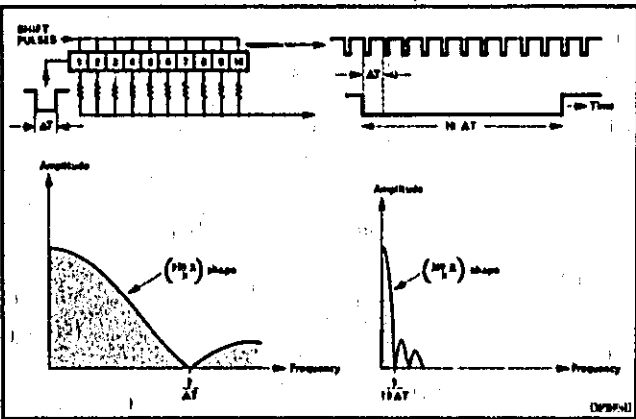


Figure 4 - 11 10-stage shift register acts as low-pass filter

4-32 Now consider the other aspect — frequency response. Figure 4-11 shows a single pulse (i.e. a '1' input), of width ΔT , applied to a 10-stage shift register driving 10 identical loads. Since the resistors are of the same value, there is no change in level at the summing point as the '1' passes from one stage to the next: the output is therefore a stretched rectangular pulse. If the shift pulses are at intervals of ΔT , then the width of the output pulse will be $10\Delta T$: the shift register thus behaves exactly like

a low-pass filter: — narrow pulse in, wide pulse out. A train of pulses of width ΔT has a $(\sin x/x)$ shaped spectrum with the first null occurring at the frequency $1/\Delta T$. Clearly, for a train of stretched pulses as in Figure 4-11, the frequency of the first null is $1/10\Delta T$: in other words, the bandwidth of the signal has been reduced by the factor 10.

4-33 It follows that the shift register with equal load resistors acts as a low-pass filter having a $(\sin x/x)$ shaped characteristic. In the 3722A, however, the requirement is for a Gaussian signal having a *rectangular* spectrum: in other words, the shift register device must be modified in such a way that it behaves as an ideal filter.

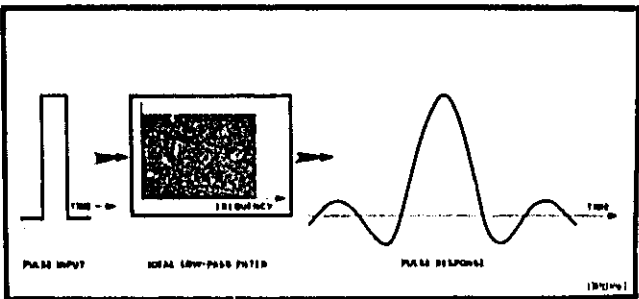


Figure 4 - 12 Pulse response of ideal low-pass filter

4-34 An ideal filter, when excited by a pulse input, gives an output (in the TIME domain) of $(\sin x/x)$ form (Figure 4-12). If, therefore, the shift register can be arranged to give a $(\sin x/x)$ shaped time waveform for each '1' pulse applied to the input, then it must be acting as an ideal filter, with rectangular frequency response. This is achieved by choosing resistor values such that the current contribution to the summing point is graded, from one end of the shift register to the other, to follow the $(\sin x/x)$ curve as closely as possible (Figure 4-13).

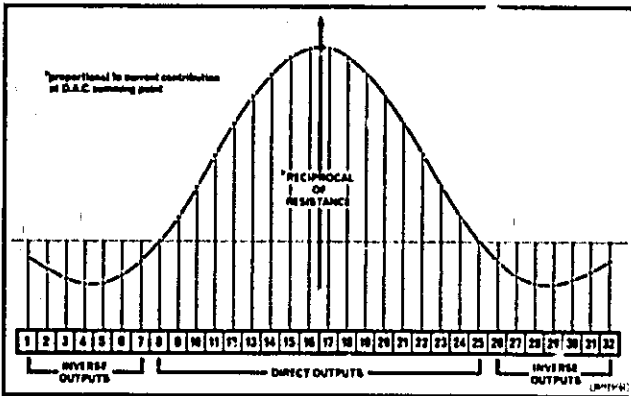


Figure 4 - 13 Weighting resistors chosen to give $\sin x/x$ waveform

4-35 As shown in Figure 4-13, the $(\sin x/x)$ curve is incomplete, and stops short at a point in the second lobe on either side of the centre line: this is because of practical limitations on the size of shift register. Note that the contribution to the signal made by the first and last groups of seven resistors is required to be of the opposite polarity to that made by resistors in the central group. This is arranged by supplying all resistors in the central group with 'reset' outputs from the shift register, and supplying those in the outer groups with 'set' outputs (Paragraph 4-60). It follows that a '1' starting at one end of the register and being conveyed to the other, by a series of shift pulses, will generate the waveform shown in Figure 4-14: this is similar to the waveform produced by the digital filter when in the test condition. With the SEQUENCE LENGTH switch S2 set to INFINITE and the chassis-mounted switch S15 set to TEST, a single pulse recirculates in the shift register, and a waveform like that shown in Figure 4-14 can be observed at the digital filter summing point (refer to Section VIII, Digital Filter Service Note).

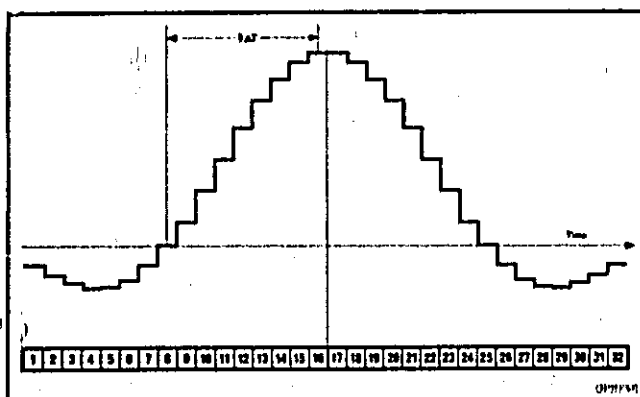


Figure 4-14 Time waveform generated by recirculating '1'

4-36 The digital filter in the 3722A has the almost rectangular frequency characteristic shown in Figure 4-15. Owing to the limited size of shift register, which results in truncation of the $(\sin x/x)$ curve, the corner of the frequency characteristic is not perfectly square. The high frequency components in the Gaussian output spectrum are caused by *abrupt* changes in output level as pulses pass down the register, and are removed by analog filtering (Paragraph 4-40).

4-37 The unique feature of this digital filter is that the cut-off frequency *automatically keeps in step with clock frequency*: even at the lowest clock frequencies, the filter always has a flat response

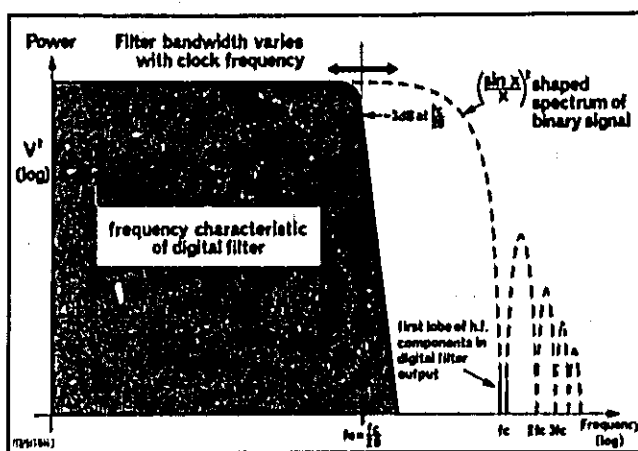


Figure 4-15 Spectrum of Gaussian noise output

and sharp cut-off. The direct relationship between clock frequency and cut-off frequency follows from the relationship between the $(\sin x/x)$ time function and the corresponding frequency function. This relationship is shown in Figure 4-16: if the clock frequency is *increased* then τ decreases, and the cut-off frequency π/τ *increases*.

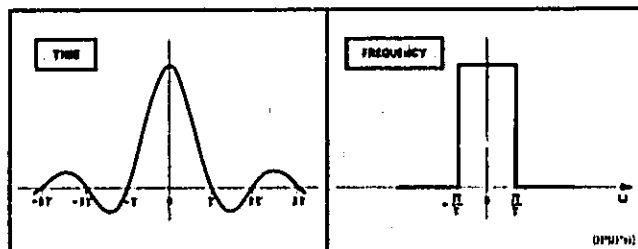


Figure 4-16 Sin x/x shaped waveform & corresponding frequency function

4-38 The digital filter in the 3722A is designed such that the half-power frequency of the Gaussian noise spectrum occurs at 1/20th of the clock frequency. With a clock period of $1\mu\text{S}$, for example, the relative power at 50kHz is -3dB.

4-39 The output from the digital filter is a multi-level signal having an approximately Gaussian distribution of amplitude (Figure 4-17): it is distinguished from a conventionally low-pass filtered signal only by abrupt steps between levels (these give rise to the high frequency components mentioned above). The amplitude p.d.f. of the multi-level signal is not significantly affected by the values of weighting resistor assigned to the various stages. The Gaussian nature of the p.d.f. arises mainly from the apparent randomness of the changing pattern of ones and zeros in the shift register — the p.d.f. becomes more

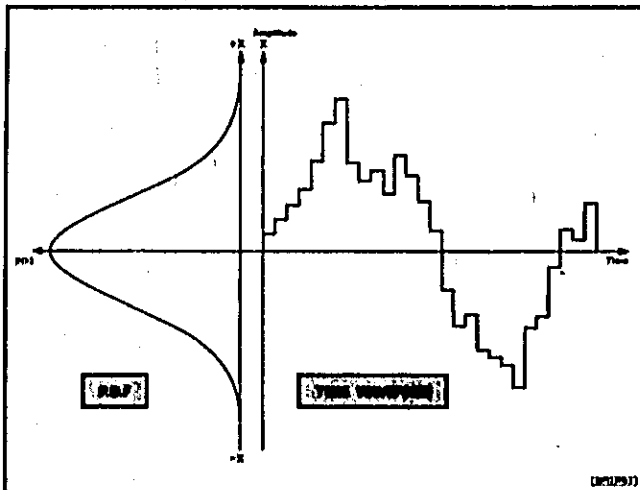


Figure 4-17 Gaussian multi-level output from digital filter

nearly Gaussian as the sequence length, and hence the 'randomness', is increased (Section III, Figures 3-9 and 3-10).

4-40 ANALOG FILTERING. In analog computing applications, time derivatives (i.e. differentiated versions) of signals occur frequently and, whenever a signal has sharp edges, there is the danger that derivatives could cause overload. In the case of a stepped waveform, with its very fast transit times, even the first time derivative would be a series of very large amplitude spikes. For this reason, a second order analog filter is included in the 3722A to remove sharp edges from the digital filter output waveform. As a result, neither the first nor the second time derivatives of the waveform yield sharp spikes. The p.d.f. for both derivatives is reasonably Gaussian (Section III, Figure 3-9).

4-41 The analog filter cut-off frequency is selected by the **CLOCK PERIOD SWITCH S1**, and is nominally $1/5$ th of the clock frequency (that is, four times the half-power frequency of the digital filter output). This feature is included for all clock

period selections of interest to analog computer users, that is, noise bandwidths from 50kHz to 0.15Hz. At frequencies of 0.05Hz and below, the analog filter cut-off remains at the same frequency as for the 0.15Hz setting.

4-42 GATE SYSTEM. The gate system comprises a four-stage binary counter and a selector switch, S4, which sets the number of sequences (1, 2, 4 or 8) in the gate interval. When the **GATE RESET** button is operated, (i.e. pressed and released), the counter is primed to accept sync pulses. The first of these sets a store in the gate output circuit and thus marks the start of the gate interval. The sync pulses cause the counter to change state as follows:-

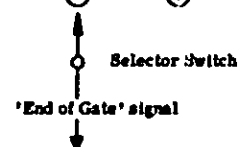
	Stage (1)	Stage (2)	Stage (3)	Stage (4)
Initial contents	0	0	0	0
After 1st pulse	1	0	0	0
After 2nd pulse	0	1	0	0
After 3rd pulse	1	1	0	0
After 4th pulse	0	0	1	0
After 5th pulse	1	0	1	0
After 6th pulse	0	1	1	0
After 7th pulse	1	1	1	0
After 8th pulse	0	0	0	1

'Sequences per gate interval' ①

②

④

⑧



Here the selector switch is shown set to '4 SEQUENCES PER GATE INTERVAL'. The '0' signal appearing on the wiper at the end of the fourth sequence resets the store in the output circuit and so marks the end of the gate interval. At the same time, the '0' signal on the wiper inhibits the counter and thus prevents the acceptance of further sync pulses. The inhibit is removed only when the **GATE RESET** button is again operated (hence there is only one gate signal per operation of the button).

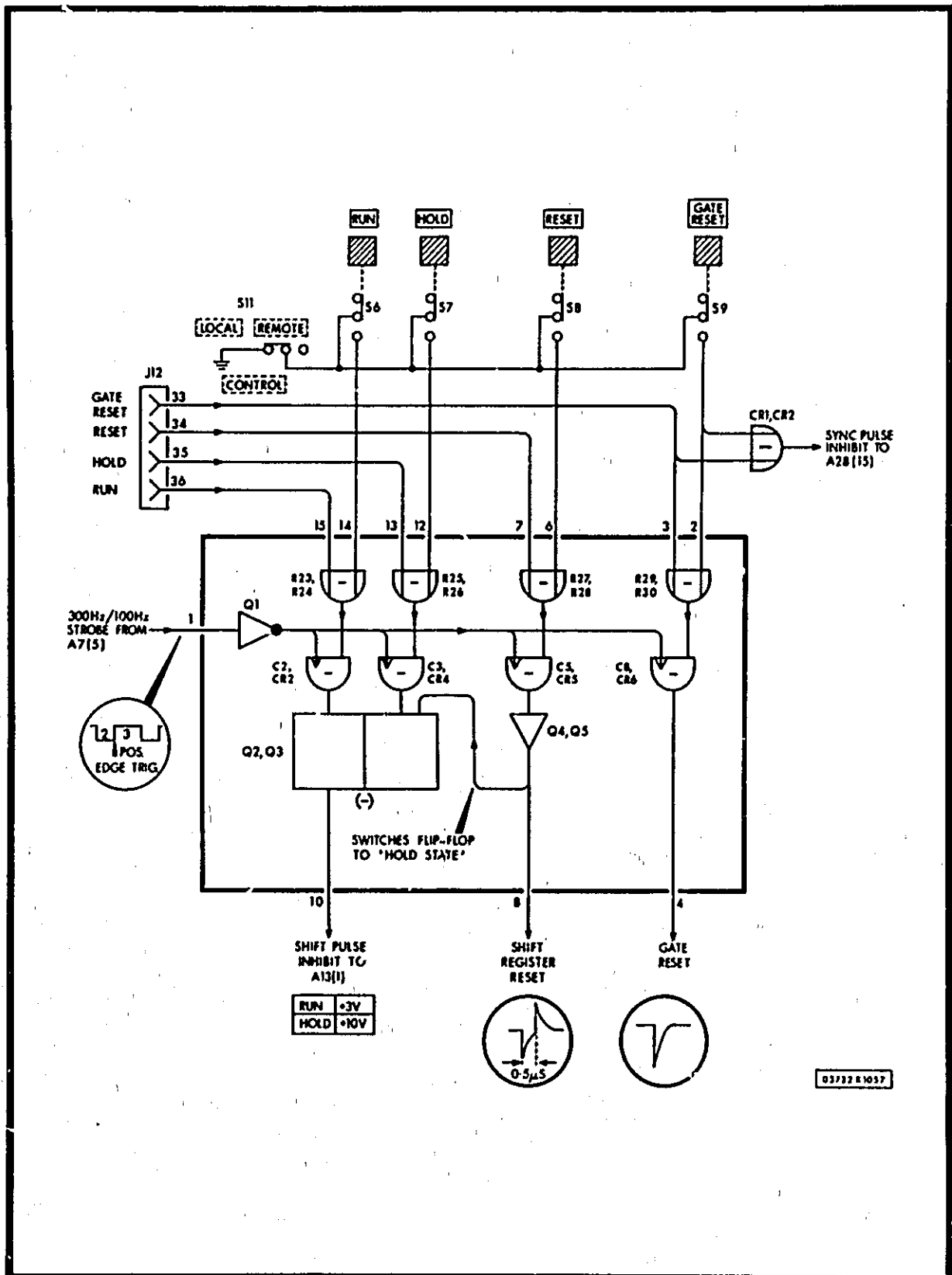


Figure 4-18 Control logic assembly A1: logic diagram

Paragraphs 4-43 to 4-49

4-43 CIRCUIT DESCRIPTION

4-44 CONTROL LOGIC ASSEMBLY A1. The control logic assembly A1 (Figures 4-18 and 8-7) receives inputs from either the push-buttons on the front panel or the 36-way CONTROL receptacle on the rear panel. Only one of these sources of control signals may be used at any one time, and the CONTROL selector S11 (rear panel) must be set as appropriate — LOCAL for push-button control or REMOTE for control signals via the 36-way receptacle (typically, the instrument is remote controlled by grounding the appropriate pin of the CONTROL receptacle). The four function circuits in A1 are basically similar, each comprising an OR-gate (A1R23+A1R24) and an ac coupled AND-gate (A1C2+A1CR2) similar to those in the shift register assembly (Paragraph 4-61). The OR-gate, when one of its inputs is grounded (via push-button or CONTROL receptacle), primes the AND-gate to pass the next negative-going signal from inverter A1Q1 (which receives a synchronising signal from the decade divider chain). The reset outputs (pins 4 and 8) are negative-going pulses of short duration: the gate reset is taken directly from AND-gate A1C8+A1CR6, but the shift register reset, which is more heavily loaded, is amplified by A1Q4+A1Q5.

4-45 The run/hold mechanism includes a memory element, flip-flop A1Q2+A1Q3. On receipt of a RUN signal, OR-gate A1R23+A1R24 primes the dc input of AND-gate A1C2+A1CR2. On the next falling edge of the synchronising signal from A1Q1, the gate passes a negative-going pulse which switches the flip-flop into the 'run' state (output at pin 10 falls from +10V to +3V). The flip-flop remains in this state until reset by *either* HOLD or RESET signals.

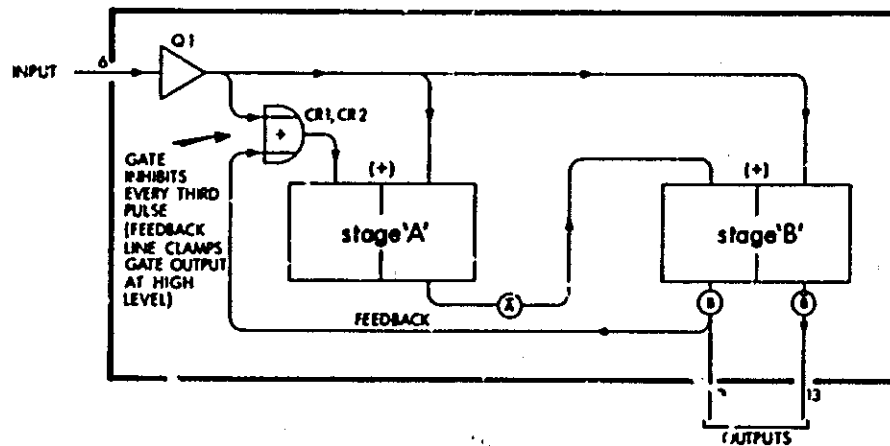
4-46 3MHz CRYSTAL OSCILLATOR ASSEMBLY A2. The oscillator assembly (Figure 8-8) is a two-section circuit comprising a 3MHz crystal-controlled oscillator A2Q1 and a Schmitt trigger A2Q2+A2Q3, which produces a squared version of the 3MHz signal suitable for application to either the divide-by-three assembly, A3, or decade divider A4. Capacitor A2C3 allows frequency adjustment of approximately 0.03%, this being sufficient to accommodate the known tolerance on 'as cut' crystal frequency, and thus allow two or more 3722A noise generators to be operated at the same frequency.

4-47 DIVIDE-BY-THREE ASSEMBLY A3. The divide-by-three assembly (Figures 4-19 and 8-10) derives a 1MHz signal from the 3MHz oscillator output. The assembly comprises a conventional flip-flop (stage B) and a binary stage (stage A) similar to the typical decade divider stage shown

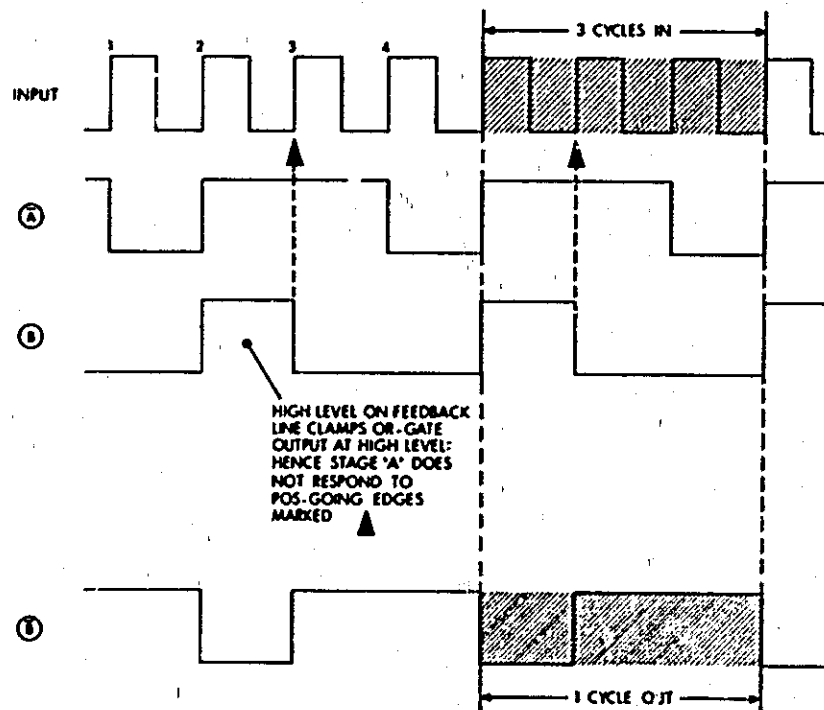
in Figure 4-20. A binary stage is a special flip-flop with commoned inputs arranged so that, on receipt of a train of input pulses, it switches alternately from one state to the other. The circuit of Figure 4-20 is a 'positive true' device, that is, only positive-going input signals have any effect. A positive-going pulse passed by the input capacitor turns off the conducting transistor which, via the cross-coupling components, turns off the other transistor. The following pulse at the input restores the device to its original state, thus completing the cycle of operation. Since one complete cycle requires two input pulses, the binary stage can be said to divide by two.

4-48 The binary stage, A, in the divide-by-three assembly is a modification of the standard arrangement — the left-hand input is supplied via a 'control valve' (OR-gate A3CR1+A3CR2), which is turned on only when the feedback signal from stage B is at the low level (-22V). In the waveforms of Figure 4-19, stages A and B are assumed initially to be in the same state — outputs A and B at the high level (zero volts). The first rising edge of the input signal from A3Q1 is applied to both sides of stage A — direct to the right-hand side, and via A3CR1+A3CR2 to the left. Since the right-hand output, A, was already at the high level, the right-hand input has no effect: the left-hand input, however, causes the device to flip to its other stable state — output A low. The second rising edge of the input signal restores the binary to its original state, where A is at the high level (note that this time the signal is effective at the right-hand input). The rising edge at A flips stage B, causing the feedback line to switch to the high (zero volt) level: the zero-volt feedback level clamps the output from OR-gate A3CR1+A3CR2, preventing the transmission of pulses via C1, and thus inhibiting the left-hand input of the binary. Since output A is already at the high level, the right-hand input of the binary is also ineffective. The third rising edge of the input signal therefore does not affect the binary, but instead flips stage B: when B flips, the feedback level falls to -22V, removing the inhibit and thus allowing the cycle of operations to repeat.

4-49 DECADE DIVIDER ASSEMBLIES A4 THROUGH A12. Each decade divider assembly divides by 10 the frequency of its input signal. In the 3722A, nine decade divider assemblies are connected in cascade, and their outputs are tapped by the CLOCK PERIOD switch to provide a selection of frequencies to drive the shift pulse generator.



NOTE: THESE FLIP-FLOPS RESPOND ONLY TO POSITIVE-GOING INPUT SIGNALS



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Figure 4 - 19 Divide-by-three assembly A3: logic diagram

Paragraphs 4-50 to 4-54

4-50 Each decade divider assembly (Figures 4-21, 8-12 and 8-14) comprises three binary stages A, B, D (Figure 4-20) and a conventional flip-flop, C.

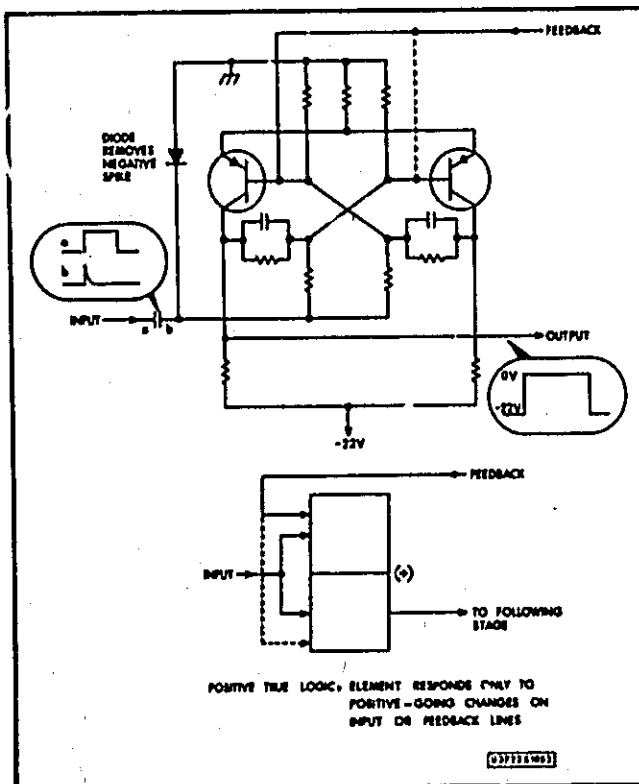


Figure 4-20 Schematic of binary stage

4-51 A normal cascade arrangement of four two-state circuits acts, overall, as a divide by 16 device — each stage operating at half the frequency of the preceding stage. By selective feedback, however, the four stages can be modified to divide by ten, that is, ten cycles in for one cycle out. The arrangement used in the decade dividers is shown in Figure 4-21. Note the provision of clipping diodes between stages, and also on the feedback line: these diodes allow the transmission of positive pulses only.

4-52 OPERATION OF DIVIDER. One complete cycle of decade divider operation is illustrated by the waveforms in Figure 4-21. All stages are assumed initially to be in the same state — outputs A, B, D and C all at the low level (-22V). On receipt of the first positive pulse derived from the input signal, stage A flips, causing output A to switch to the high level (zero volts). Differentiation of A gives a positive pulse (A') which flips stage B; output B in turn flips stage D, and so on. This 'chain reaction' is virtually instantaneous, ending with all stages in the alternate state — outputs A, B, D and C all at high level.

4-53 Events in the remainder of decade divider cycle are summarised below. Pulse numbers refer to positive-going edges of the input signal, Figure 4-21.

2nd pulse

A switches low: negative-going transition, therefore stage B is not affected.

3rd pulse

A switches high. Positive pulse at A' switches B low. No other effect.

4th pulse

A switches low. No other effect.

5th pulse

A switches high. Positive pulse at A' switches B high. Positive pulse at B' switches D low and $\bar{C}$ high (as $\bar{C}$ rises to high level, C falls to low level). Positive pulse ($\bar{C}'$) on feedback line restores B to low level and D to high level.

6th pulse

A switches low. No other effect.

7th pulse

A switches high. Positive pulse at A' switches B high. Positive pulse at B' switches D low.

8th pulse

A switches low. No other effect.

9th pulse

A switches high. Positive pulse at A' switches B low. No other effect.

10th pulse

A switches low. No other effect.

11th pulse

A switches high. Positive pulse at A' switches B high. Positive pulse at B' switches D high, and positive pulse at D' switches C high.

The sequence then repeats: the decade divider output, C, is at one tenth the frequency of the input.

4-54 Both high-speed (A4, A5) and low-speed (A6 through A12) decade dividers use similar logic configurations, but differ in circuit detail. The high-speed assemblies include several refinements designed to increase the switching rate of the binaries: very fast switching is achieved by the use of

- (1) High frequency transistors.
- (2) Low time constants in the interstage coupling networks.
- (3) Steering diodes, which determine the path taken by pulses applied to the binaries.

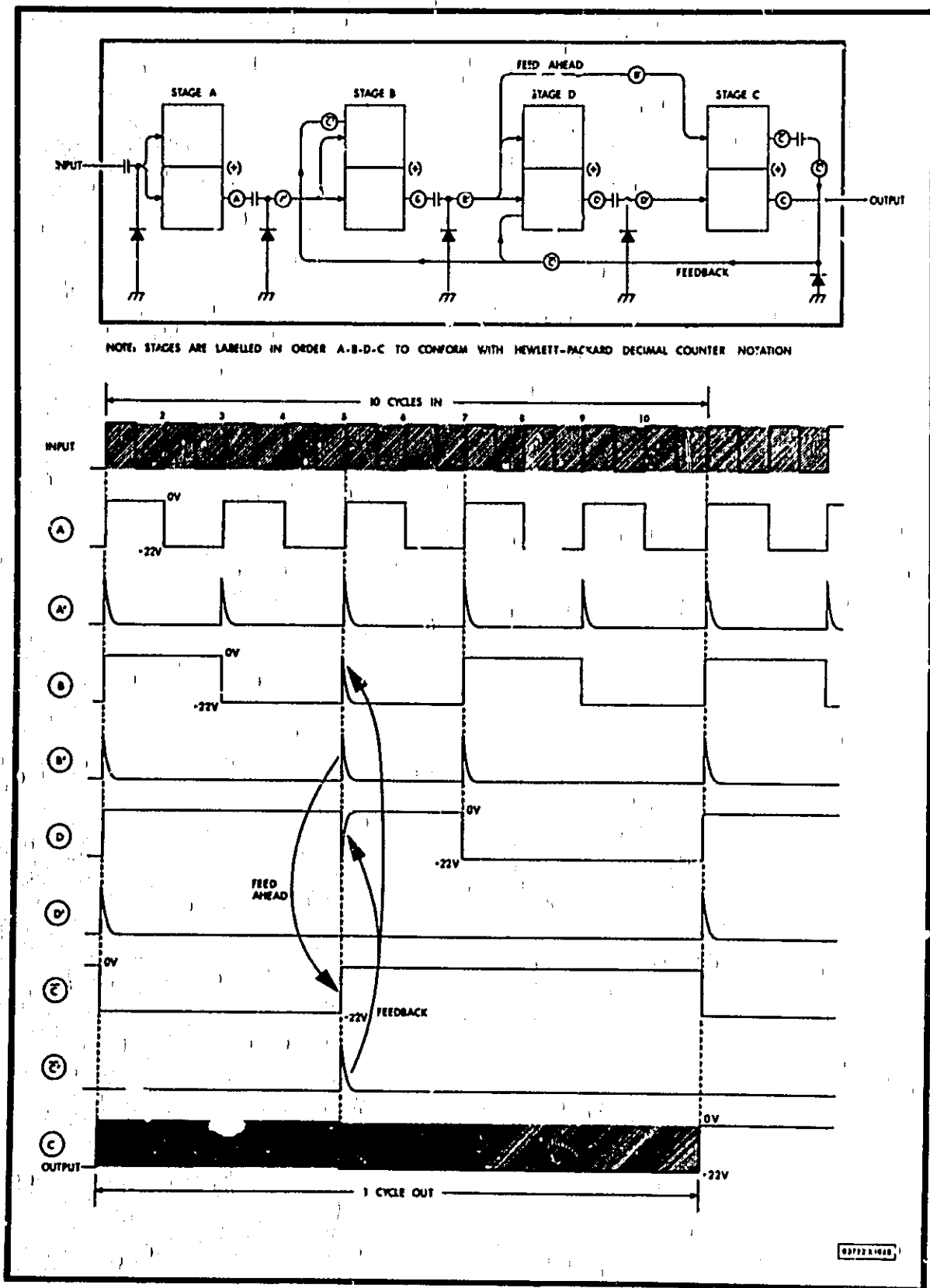


Figure 4 - 21 Decade divider assemblies A4-A12

Paragraphs 4-55 to 4-57

4-55 SHIFT PULSE GENERATOR ASSEMBLY
A13. Principal functions of the shift pulse generator (Figure 8-16) are:

- (1) Generation of shift pulses from either internal or external clock signals.
- (2) Shaping and amplifying the internal clock signal (from the decade divide. chain) for re-transmission as a timing signal for use with external equipment.

Assembly A13 comprises a Schmitt trigger A13Q1+A13Q2, three stages of amplification A13Q3+A13Q4+A13Q5, and a pulse generator circuit A13Q6+A13T1.

4-56 Quiescent conditions in the Schmitt circuit are: A13Q1 cut off and A13Q2 conducting. A positive-going edge applied to A13Q1 base very rapidly switches the Schmitt into its other state,

where A13Q1 conducts and A13Q2 is cut off. Quiescent conditions are restored — again almost instantaneously — by the next negative-going edge. The circuit thus acts as a shaper capable of converting almost any type of input signal (e.g. sinusoidal or triangular from an external generator) into a rectangular waveform. After amplification in A13Q3 and A13Q4, the Schmitt output is taken, as a timing signal, to the random noise sampler A30, and also to the CLOCK connector (when S13 is set to INT). A13R19+A13R20+A13CR5 protect A13Q4 against damage arising from signals applied accidentally to the CLOCK connector. There is no inversion between the input (A13 pin 3 or pin 4) and the main output at A13(7) — positive-going input gives positive-going output.

4-57 In quiescent conditions, A13Q5, the drive amplifier, is turned off. A13Q6 conducts, and a

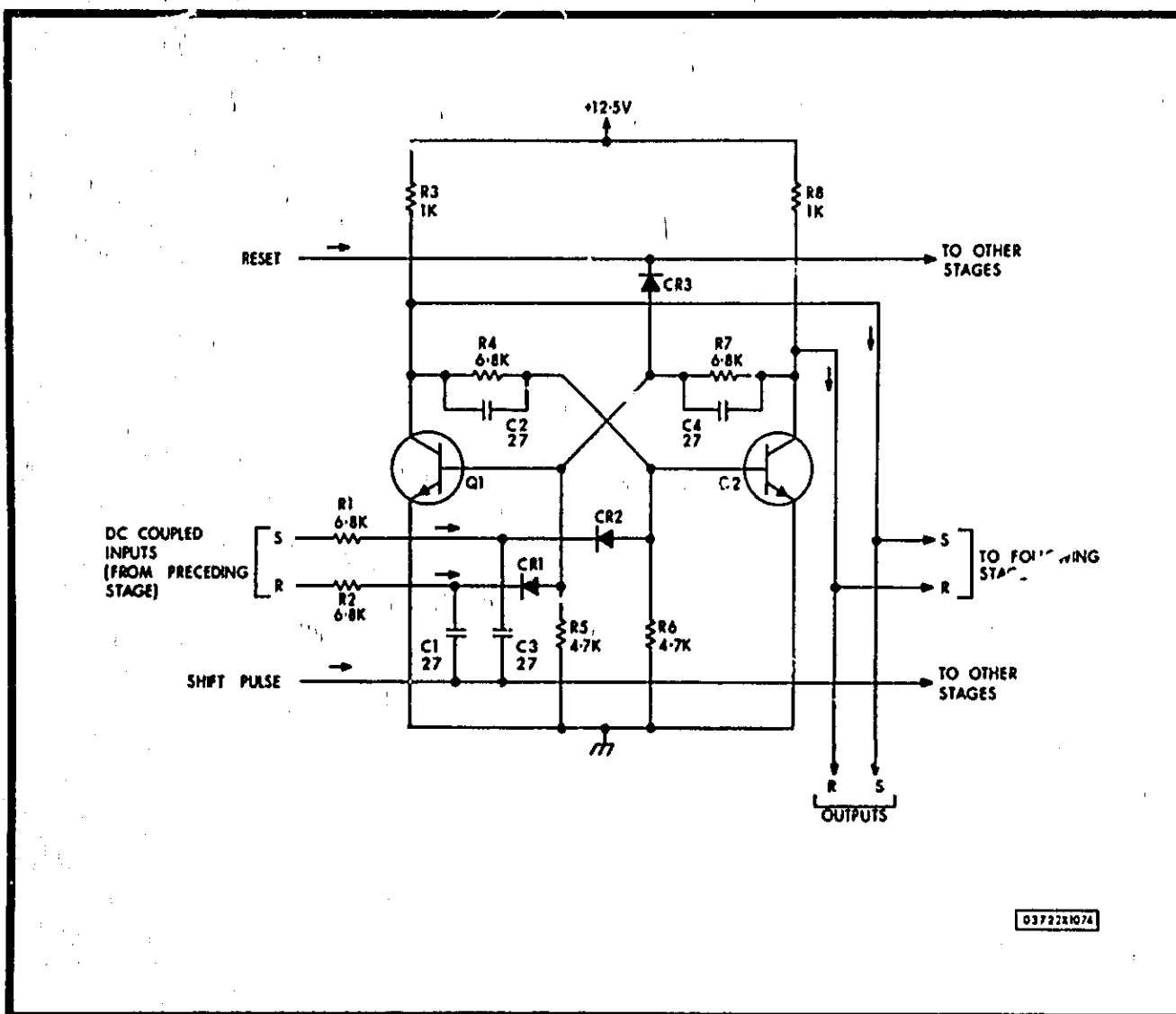


Figure 4 - 22 Schematic of shift register stage

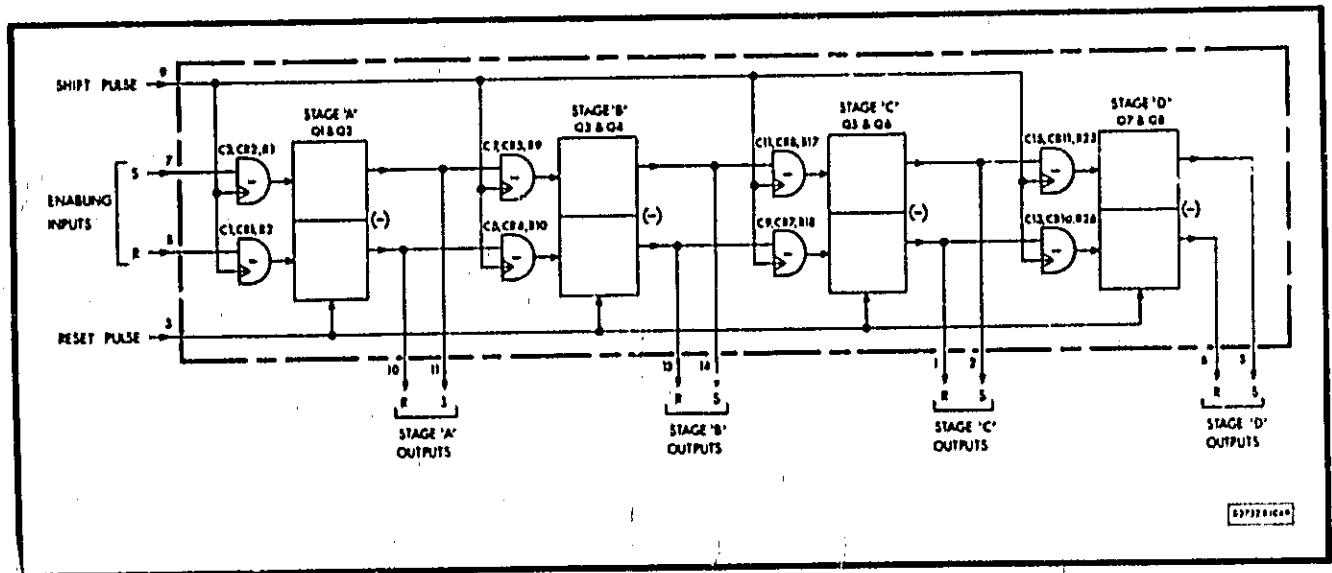


Figure 4 - 23 Shift register assembly A14 etc

standing current defined by the supply voltage and A13R25 flows through the primary winding of A13T1. When A13Q5 is switched on (coincident with a negative-going edge on A13Q1 base), the rapid rise in collector voltage transmits a positive-going pulse via A13C5 to the base of A13Q5: this pulse momentarily turns on A13Q5, which in turn cuts off A13Q6. Cutting off A13Q6 is in effect breaking the series circuit A13T1+A13R25 between +12.5V and ground: this results in a high initial rate of current decay in A13T1 primary, and hence a large induced voltage tending to maintain the current. This action yields a positive-going pulse of approximately 50V amplitude across the primary of A13T1, and a negative-going 10V pulse is induced in the secondary. Duration of the shift pulse at A13(9) is approximately 100nS. The shift pulse, which is applied simultaneously to all stages of the shift register, is used also to generate inhibit signals (A13 pins 13 and 14) which disable the auto-start logic during the instant of change in the register.

4-58 The shift pulse generator is under the control of the RUN/HOLD mechanism in the control logic assembly (Paragraph 4-45). When the control logic is in the HOLD condition, the dc level at A13(1) is approximately +10V and A13CR1 is biased off. A13CR2 conducts, and the resulting voltage on A13Q1 base is held positive with respect to the emitter voltage. The transistor is thus held in the conducting condition and cannot respond to the input signal. When the control logic is switched into the RUN condition, the level at A13(1) falls to

approximately +3V, this time biasing off A13CR2: the base of A13Q1 then assumes the relatively negative voltage set by the potential divider between the +12.5V and -22V supply rails. In the absence of an input signal, therefore, A13Q1 is cut off.

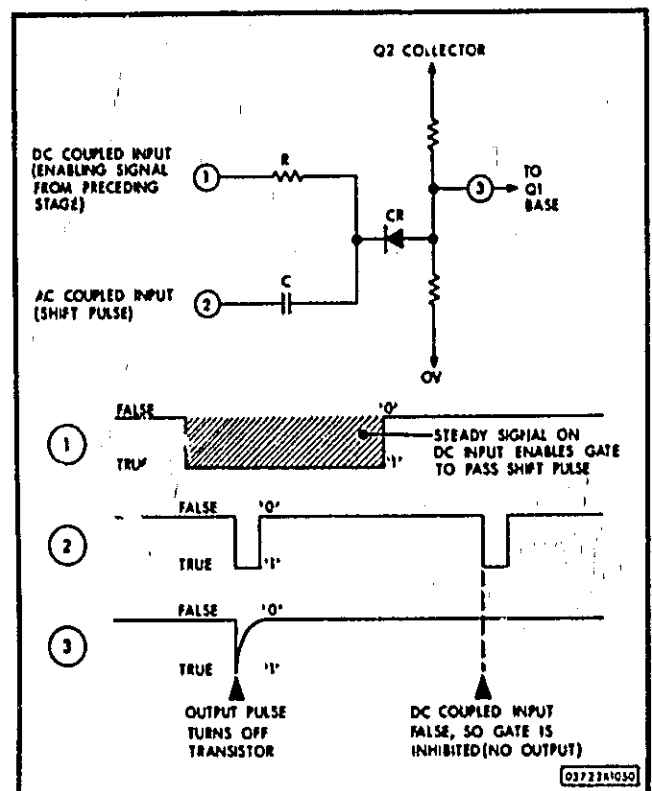


Figure 4 - 24 Shift register AND gate

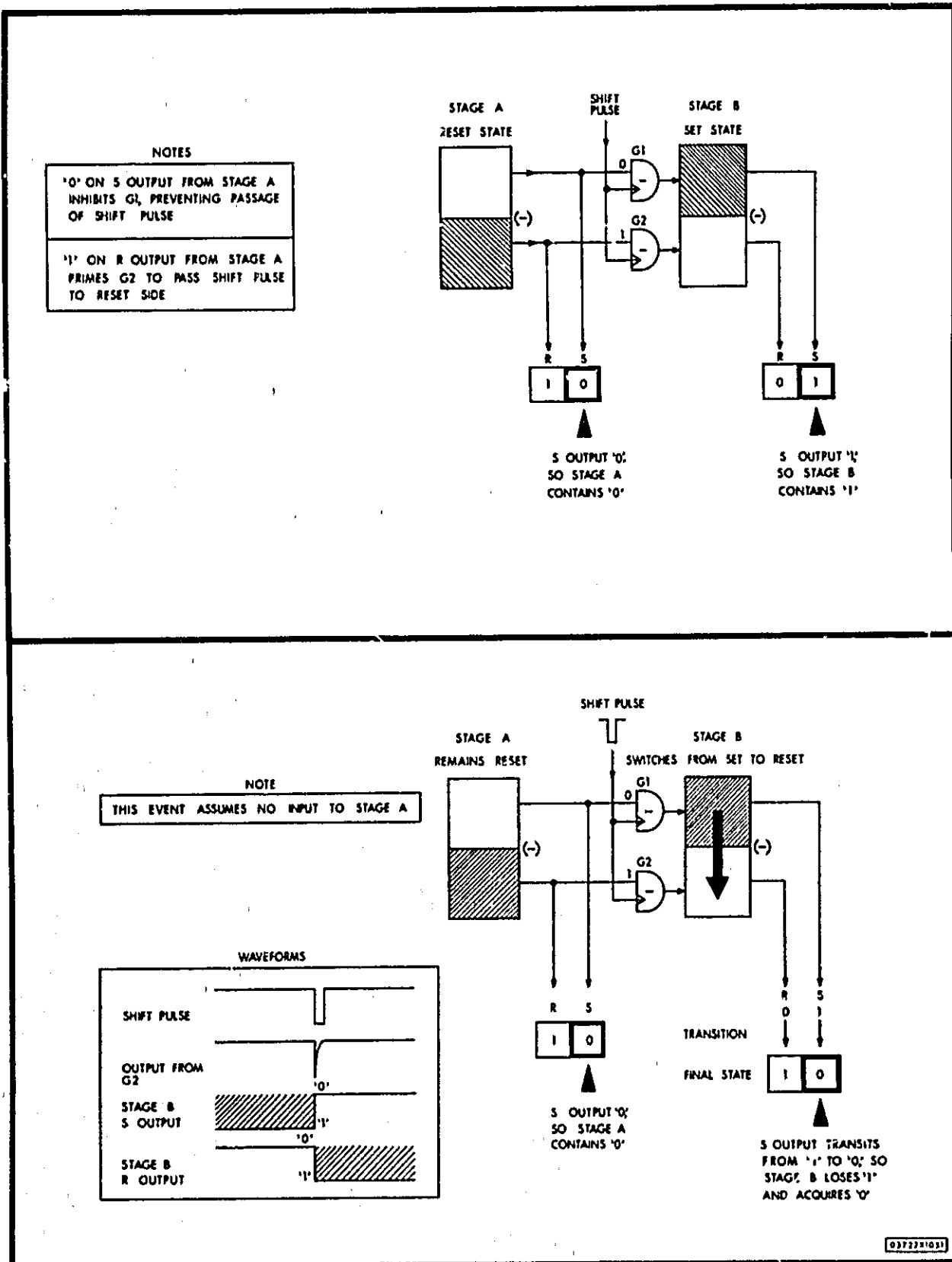


Figure 4 - 25 Operation of shift register

4-59 SHIFT REGISTER ASSEMBLY A14 ETC. Each shift register assembly (Figure 8-18) comprises four flip-flops of the type shown in Figure 4-22. The logic of a complete assembly is given in Figure 4-23.

4-60 Logic signal levels in the shift register are nominally +12V and zero volts. The shift register logic is *negative true*; the 'true' condition is represented by zero volts. Each flip-flop gives two outputs, known as 'S' and 'R': when the flip-flop is in the set state (i.e. when it contains '1'), output S is true and output R is false. Output conditions are reversed when the flip-flop is in the reset state:-

State of flip-flop	Output	
	S	R
SET	True ('1')	False ('0')
RESET	False ('0')	True ('1')

4-61 The two outputs from each stage are connected, via AND gates, to the corresponding inputs of the next. Information is transferred from one stage to another only on receipt of a shift pulse, a negative-going signal applied simultaneously to the ac coupled inputs of all AND gates in the shift register. Each AND gate comprises a resistor, diode and capacitor arrangement as shown in Figure 4-24. Note that the AND gate allows the shift pulse to pass through only when it is enabled by zero volts (true) on the dc coupled input. In this condition, the junction of R and CR is held at approximately zero volts, and the shift pulse passes via CR as a negative-going spike superimposed on the junction voltage. If, on the other hand, the dc coupled input is at the false (+12V) level when the shift pulse arrives, the junction voltage is high and the pulse does not cause CR to conduct — hence no output from the gate. Operation of the complete shift register mechanism is illustrated by Figure 4-25, in which the '0' held by one stage is shown to be transferred, by the shift pulse, to the next.

4-62 DIGITAL FILTER ASSEMBLY A15 ETC. The complete digital filter comprises four similar assemblies, A15, A18, A21 and A24 (Figure 8-20 to 8-26). Overall function of the filter group is described in Paragraphs 4-31 to 4-39.

4-63 Basis of the filter assemblies is the clamp circuit shown in Figure 4-26. The clamp circuits are identical in every respect other than the value of the weighting resistor, R5 — from one end of the filter to the other, the 'weights' follow the approximate $(\sin x/x)$ curve of Figure 4-13. One end of the weighting resistor is taken to the collector junction

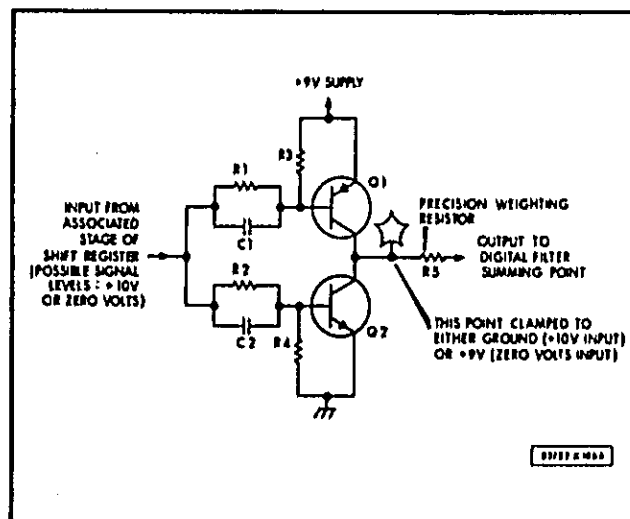


Figure 4 - 26 Digital filter clamp circuit

in the clamp circuit, and the other to the filter busbar, or summing point, which feeds the GAUSSIAN output amplifier system. With the exception of stages 8 and 25, each stage of the shift register is associated with one particular clamp circuit. Stages 8 and 25 do not drive clamp circuits, and therefore make no contribution to the filter output (this is equivalent to assigning zero weighting to the two stages, which correspond to the zero crossing points on the curve of Figure 4-13).

4-64 Depending upon the state of the associated shift register stage, the collector junction in the clamp circuit is held at either ground or +9V. At a given time, therefore, the current contribution made by a particular stage to the digital filter output depends on:-

- (1) The state ('set' or 'reset') of the stage.
- (2) The weight assigned to the stage.
- (3) The voltage at the filter summing point (this in turn is dependent upon the contributions made by all other stages).

4-65 FEEDBACK LOGIC ASSEMBLY A27. The feedback logic assembly (Figures 4-27 and 8-28) contains three identical modulo-two adders of the type described in Paragraph 4-99. The overall truth table for the assembly is given in Table 4-3.

4-66 AUTO-START ASSEMBLY A28. Principal functions of the auto-start assembly (Figures 4-28 and 8-30) are:-

- (1) Prevention of shift register failure arising from the 'all zero' condition (after switch-on or RESET).

Paragraphs 4-67 to 4-68

- (2) Provision of push-pull inputs for the first stage of the shift register: A28Q2 provides an inverted version of the direct output at A28(7).
- (3) Amplification of the sync signal: amplifying stages are A28Q1 and A28Q3.

4-67 If all stages of the shift register are in the '0' state, both the 'all-zeros' signal from the sync gate and the output from the first stage of the register must be at the '0' level. Since there is no inversion (overall) in A28Q1 and A28Q3, it follows that the two active inputs to OR-gate A28CR3+A28CR4 will also be '0'. Inversion by A28Q4 gives a '1' input to the modulo-two adder A28Q5+A28Q6+A28Q7, the other input of which is supplied by the feedback logic. With all stages of the register in the '0' state, this feedback signal must also be '0'. The modulo-two adder thus receives dissimilar inputs and, in consequence, supplies a '1' signal to the first stage of the shift register.

4-68 OR-gate A28CR3+A28CR4 is inhibited, for the duration of each shift pulse, by the signal at A28(5): this signal clamps the output from A28Q4

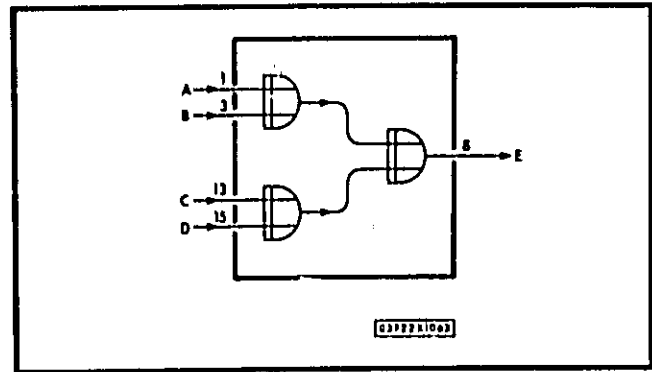


Figure 4 - 27 Feedback logic assembly A27

at the '0' level, and thus prevents a spurious logic decision at the instant of change in the register. The sync signal path is similarly inhibited for the duration of the shift pulse. In addition, the sync signal is inhibited for the length of time that the GATE RESET button is held in, or a remote control gate reset input is applied: this inhibit is achieved by grounding A28(15) via either CR1 or CR2.

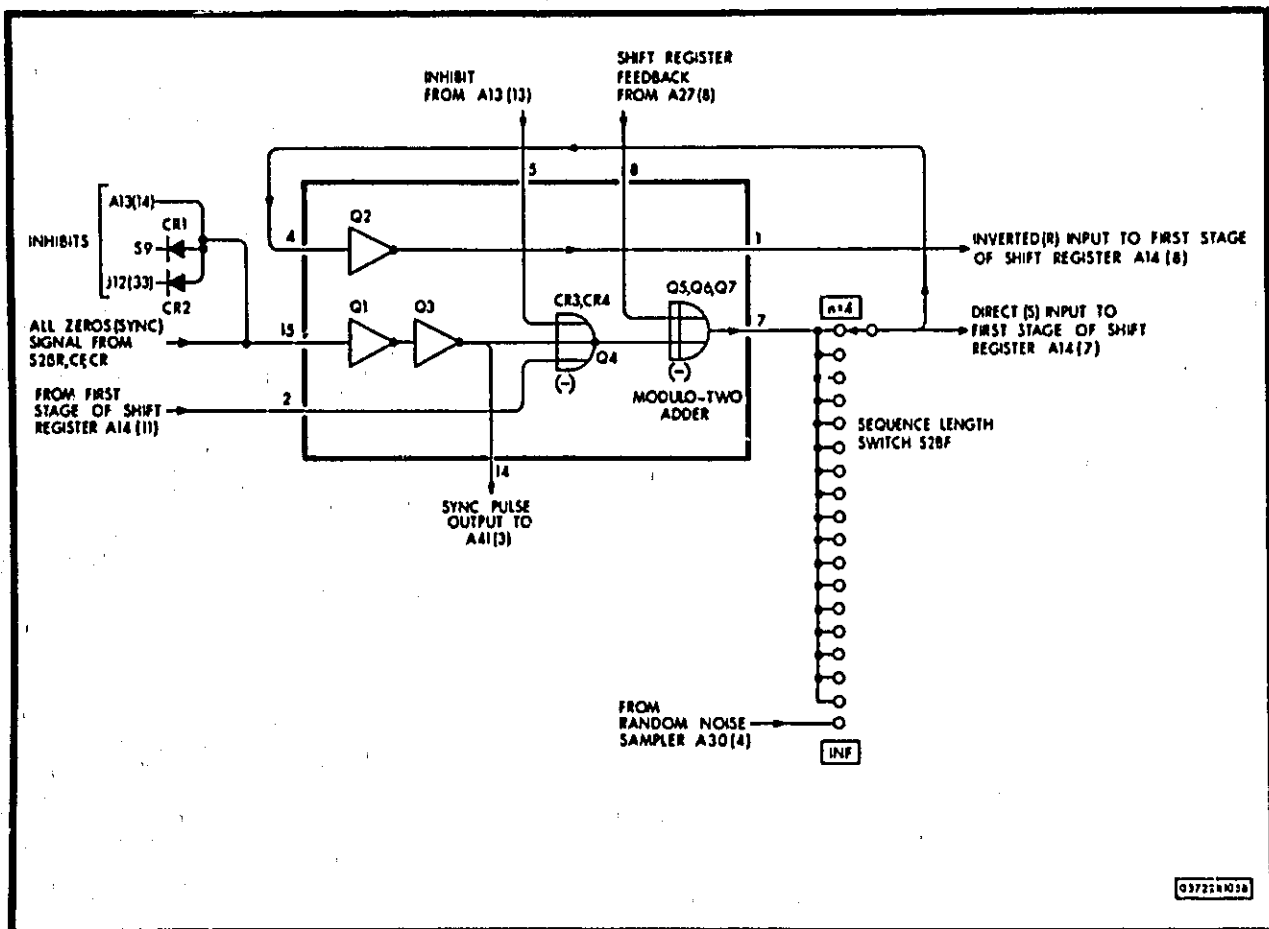


Figure 4 - 28 Auto-start logic assembly A28

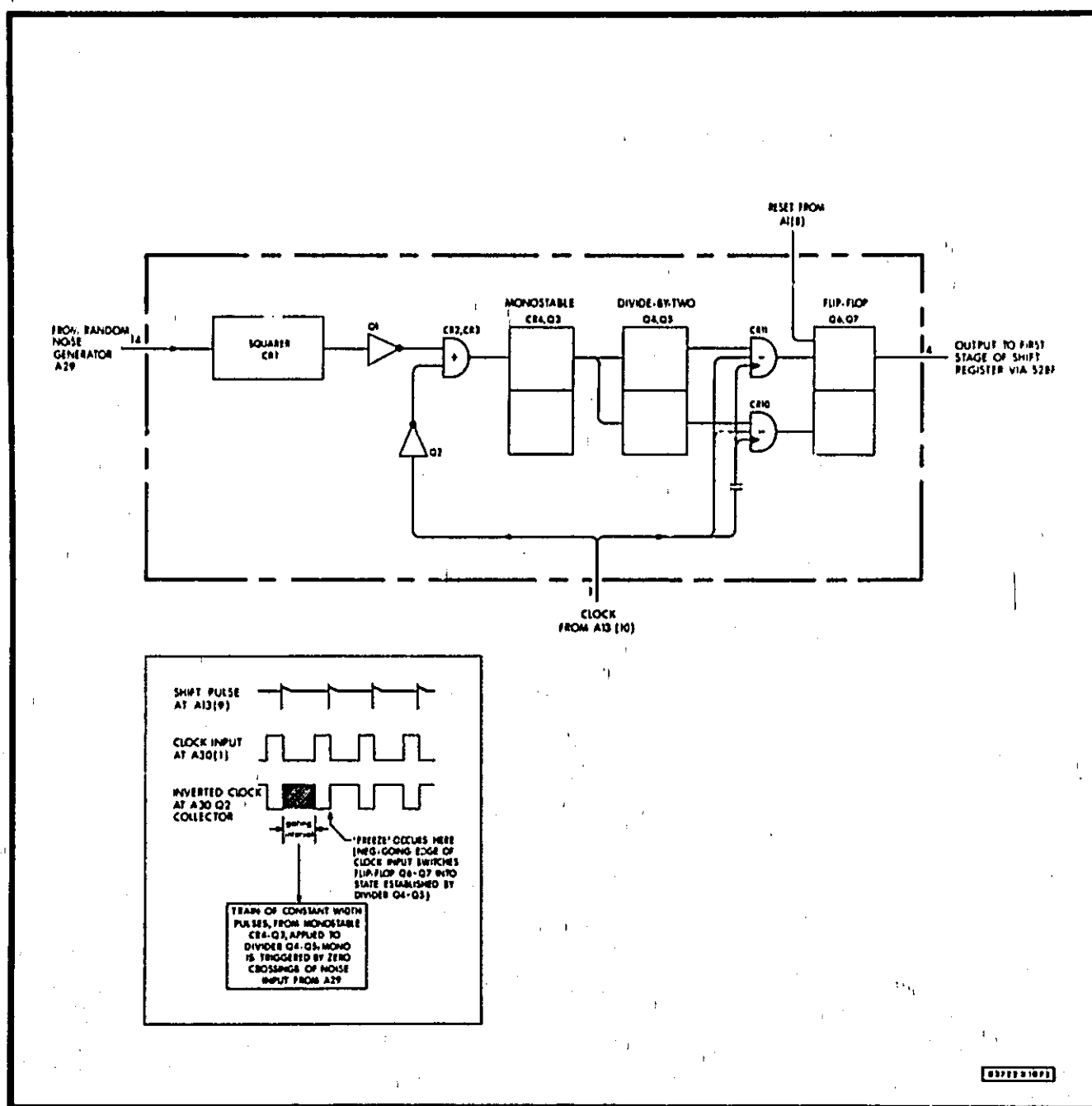


Figure 4 - 29 Random noise sampler assembly A30

4-69 RANDOM NOISE GENERATOR ASSEMBLY A29. The random noise generator assembly (Figure 8-32) uses as a noise source a transistor (A29Q1) biased in the base-emitter breakdown condition. The output from Q1 is amplified by A29Q2+A29Q6. The output from the assembly is white noise of approximately 10MHz bandwidth and 5V peak-to-peak amplitude.

4-70 RANDOM NOISE SAMPLER ASSEMBLY A30. When the SEQUENCE LENGTH switch is set to INFINITE, the feedback logic (A27) is dis-

connected and the input to the first stage of the shift register is provided by the random noise sampler assembly (Figures 4-29 and 8-34). The principal function of this assembly is to decide, before arrival of each shift pulse, whether a '0' or a '1' is to be supplied to the register.

4-71 The requirement is for one sampling per clock period and, with clock frequencies as high as 1MHz, this allows only a very short time in which the sampling decision can be made. In the worst case (1/16th clock), the time available for sampling is

Paragraphs 4-72 to 4-73

approximately 600nS (that being the longer of the two events in the clock cycle). To avoid any significant correlation between the results of successive samplings, a reasonable number of zero crossings of the noise input (from A29) must occur during the 600nS: the average number of zero crossings per second is related to bandwidth which, to guarantee non-correlation, must in this case be around 10MHz. 4-72 Noise from A29 is squared by tunnel diode A30CR1, and the result is gated with the inverted clock waveform from A30Q2. The gating interval starts immediately after the shift pulse, and ends at the next positive-going transition of the clock signal at A30(1). The gate output drives monostable A30CR4+A30Q3, which generates constant-width pulses (approximately 100nS): the number of pulses generated in a particular gating interval depends on the number of zero crossings, in that interval, of the noise input.

4-73 Pulses from the monostable alternately set and reset the divide-by-two flip-flop A30Q4+A30Q5. Since the clock interval (for a given setting of the CLOCK PERIOD switch) remains constant, the state in which the flip-flop remains at the end of the gating interval depends entirely on the number — odd or even — of pulses received from the monostable (with a 10MHz bandwidth noise input, the probability of either state is almost exactly 1/2). If the divide-by-two flip-flop were connected directly to the shift register, there would be the possibility of asymmetrical loading on the flip-flop owing to stray capacitance, etc: this could give rise to a predominance of 'ones' or 'zeros' in the BINARY output, that is, there would no longer be a probability of 1/2. To prevent such one-way bias the divide-by-two circuit is buffered locally by an extra shift register stage A30Q6+A30Q7, the mechanism of which is similar to that of a normal shift register

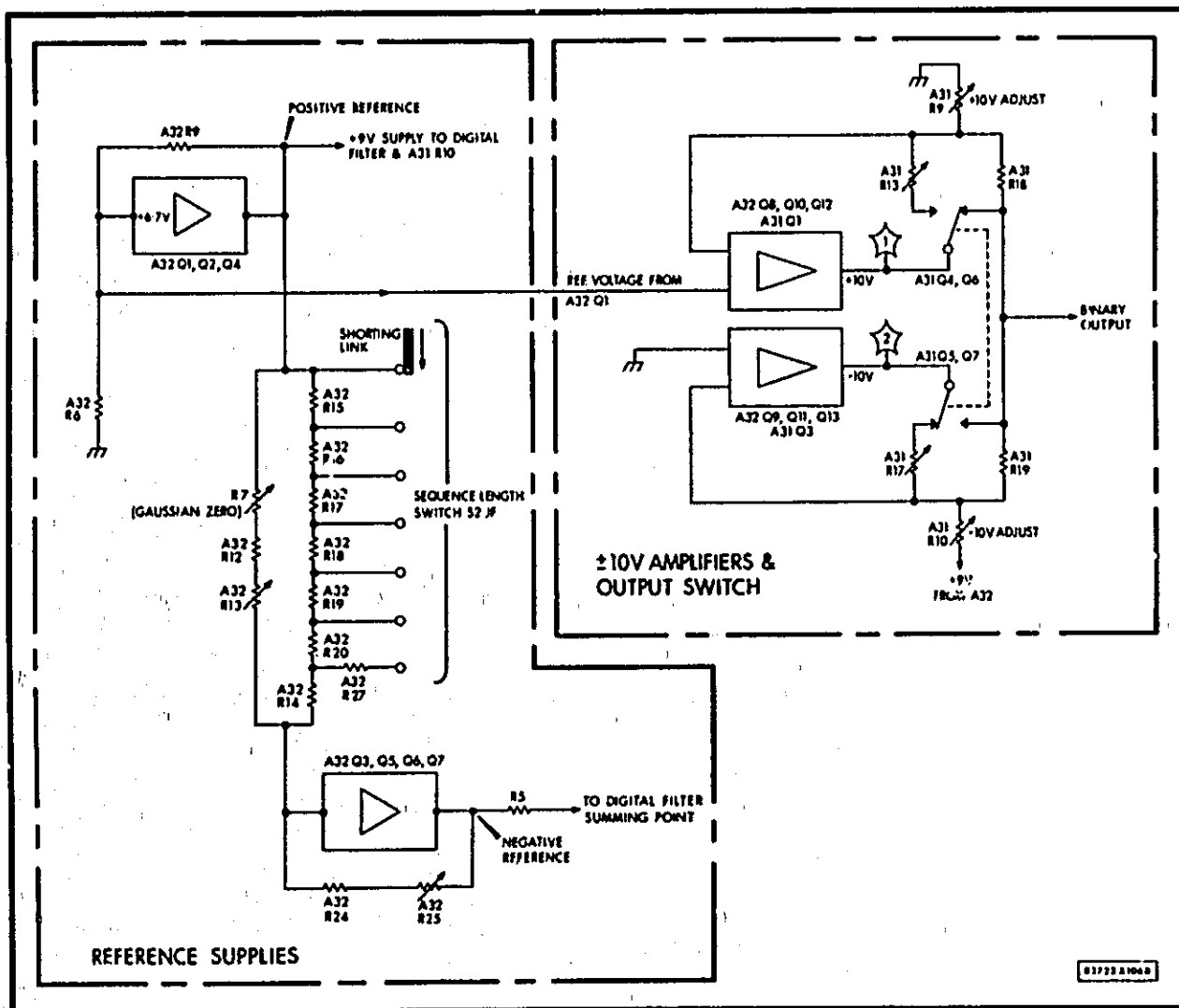
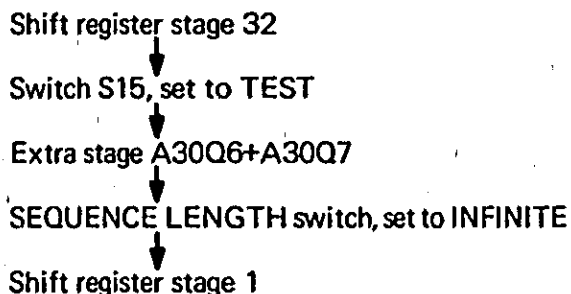


Figure 4 - 30 Output switch and reference power supply assemblies A31, A32

stage (Paragraph 4-61). The state into which the extra stage is 'frozen' depends on the state assumed by the divide-by-two circuit at the end of the gate interval. Note that the extra stage is strobed by the negative-going edge of the clock signal, that is, at the same time as the shift pulse is applied to the shift register.

4-74 When the chassis-mounted switch S15 is set to NORMAL, there is the possibility that noise picked up by the switch and interconnecting wires could be fed back into the sampler assembly. To prevent the possible biasing effects of this noise, the divide-by-two stage is effectively disconnected from all external circuits during the gating interval. The voltage at the junction of resistors A30R24+A30R25 is determined by the clock input at A30(1) which, during the gating interval, is at zero volts: in consequence, diodes A30CR6+A30CR9 are biased off, and the circuit cannot be affected by noise on pins A30(8) and A30(9). When S15 is set to TEST, the 'extra' stage A30Q6+A30Q7 converts the shift register from the normal open-ended arrangement into a closed loop, which generates the recirculating '1' used for checking the digital filter. The loop is completed as follows:



The '1' is placed in the closed loop simply by arranging for the extra stage to be reset to the '1' state, not '0' — as are all stages of the register.

4-75 OUTPUT SWITCH & REFERENCE POWER SUPPLY ASSEMBLIES A31, A32. The reference power supply assembly A32 (Figures 4-30 and 8-37) provides a stabilised +9V supply for the digital filter, and a negative reference to which the digital filter summing point is connected via R5. A32 also contains part of the +10V and -10V operational amplifiers associated with the output switch. A32Q1 is a stable voltage source supplying amplifier A32Q2+A32Q4, the output from which (nominally +9V) is determined by A32R9/A32R6. The negative reference voltage is provided by amplifier A32Q3+A32Q5+A32Q6+A32Q7, and is determined by the ratio of A32R24+A32R25 to the parallel network R7+A32R12+A32R13+A32R14...A32R20. The resistance of the parallel network (and hence the negative reference voltage) is variable, and depends on

the setting of the SEQUENCE LENGTH switch — as the switch is turned clockwise (from n=4), the resistance is progressively reduced by a shorting link (S2JF). The resulting shift in reference voltage compensates for dc bias in the GAUSSIAN output, arising from a predominance of 'ones' in the shorter binary sequences (the difference between the numbers of 'ones' and 'zeros' is not significant in sequences longer than N=1023: hence no further correction).

4-76 The +10V level is provided by operational amplifier A32Q8+A32Q10+A32Q12+A31Q1, the output from which is determined by A31R18/A31R8+A31R9. A31R9 allows adjustment of the +10V level. Principal components of the switching mechanism are the inverter A31Q2 (not shown in Figure 4-30) and switching transistors A31Q4, A31Q5, A31Q6, A31Q7. When the input at A31(7) switches to the low level (zero volts), A31Q2 conducts and switches on A31Q6, thus connecting the BINARY output A31(6) to the +10V rail. When A31Q6 switches off (at the next transition of the input signal), A31Q7 switches on, connecting the output to the -10V rail (established by A31R19/A31R10+A31R11 in conjunction with amplifier A32Q9+A32Q11+A32Q13+A31Q3). When A31Q6 switches off, the feedback loop via A31R18 is broken, and the +10V amplifier would saturate if no alternative feedback path were provided (if saturation were to occur, the amplifier recovery time would be unacceptably long, and high frequency operation of the output switch would be unsatisfactory). The alternative feedback path is via A31R13, which is switched into circuit by A31Q5 at the instant A31Q6 ceases to conduct. A31R13 is adjusted so that the voltage at test point 1 remains constant when the transition occurs. This mechanism, which ensures that conditions in the amplifier remain undisturbed, makes possible very rapid switching between output levels, with very little distortion of waveform (transition time less than 100ns). The -10V amplifier is similarly protected by A31R17, which is switched in by A31Q5.

4-77 ANALOG FILTER & OUTPUT AMPLIFIER ASSEMBLIES A33 THROUGH A37. The GAUSSIAN output is amplified by assemblies A35, A36 and A37 (Figure 8-44), the frequency response of which is tailored by negative feedback via components in A33 and A34 (Figure 8-40). Figure 4-31 shows a simplified version of the complete system, comprising an operational amplifier A, and a feedback network R1, R2, R3, C1 and C2. The dc and low frequency gain of the system is determined by the ratio R1/R2, and the frequency response — which is determined by the values of all feedback

Paragraphs 4-78 to 4-81

components — has the form shown in Figure 4-32. The response is flat to a frequency $1/2f_0$, and rises by 10% at $4f_0$ (f_0 is selected by the CLOCK PERIOD switch, and is the frequency indicated on the front panel of the instrument).

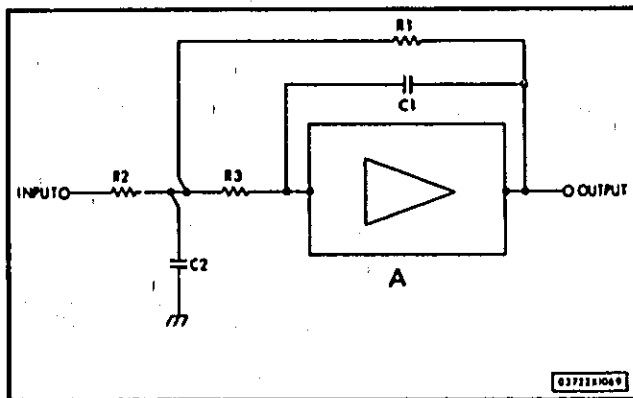


Figure 4-31 Block diagram of complete amplifier system

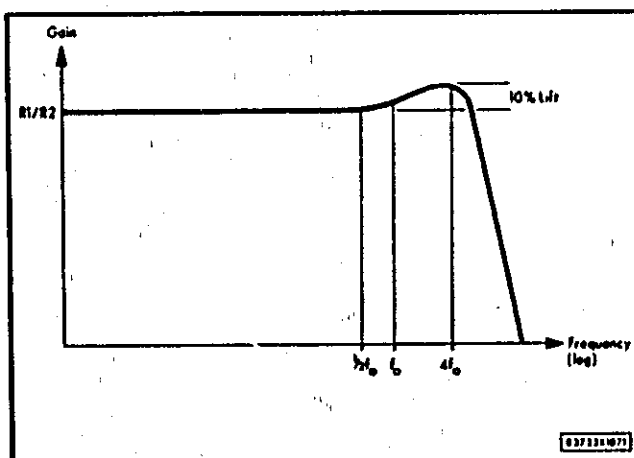


Figure 4-32 Frequency response of amplifier system

4-78 The output amplifier is required to have wide-band capability and very low dc drift. This is achieved by a combination of chopper amplifier (for good dc and low frequency performance) and differential amplifier (designed for wideband performance). The amplifier block 'A' of Figure 4-31 can therefore be considered as two separate amplifiers X and Y, as shown in Figure 4-33. The input signal is applied to the differential amplifier Y via two paths — the chopper amplifier X, and the high-quality capacitor C. This capacitor prevents the base current of the differential amplifier input transistor (A35Q7) flowing in the feedback resistors, and thus causing current drift. The voltage drift of Y is reduced by the gain of X, when referred to input of A.

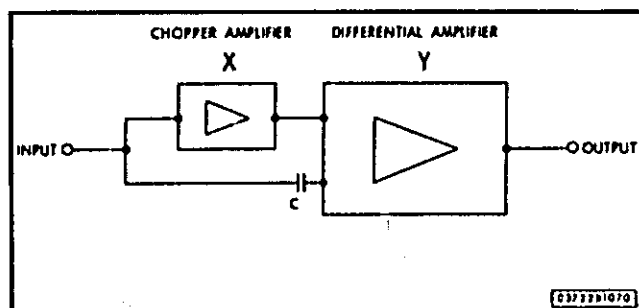


Figure 4-33 Arrangement of chopper and differential amplifiers

4-79 The chopper amplifier comprises the multi-vibrator A35Q2+A35Q5, modulator (FET) A35Q1, ac amplifier A35Q3+A35Q4 and demodulator A35Q6. The capacitor-coupled input to differential amplifier A35Q8+A35Q9 is buffered by emitter follower A35Q7. The signal on A35Q8 collector drives A36Q1 which, in conjunction with A37Q1, gives a gain of 10. A37Q1 is coupled via emitter follower A37Q2 to the output driver A37Q6. Q4 and Q5, the output transistors, are connected as complementary emitter followers, in which the quiescent current conditions are defined by A37CR1, A37CR2 and A37R11, A37R12. Resistance-capacitance networks (e.g. A36R1+A36C1) shape the frequency response characteristics of the amplifier to match the feedback network characteristics, these being dependent on CLOCK PERIOD switch setting.

4-80 ATTENUATOR ASSEMBLY A38. The attenuator assembly (Figure 8-46) provides a selectable-amplitude output of either BINARY or GAUSSIAN signals, as selected by slide switch S10 on the front panel. The assembly comprises two rotary switches, mounted in line and controlled by the dual concentric RMS AMPLITUDE knobs on the front panel. The red (inner) knob controls the rear section of the switch assembly, and selects one of four multiplier ranges; x1, x3, x3.16 and x10 (for the GAUSSIAN output, only *three* multipliers are available, namely x1, x3 and x3.16: at both the x3.16 and x10 settings of the red control, the output amplitude is 3.16V rms). Intermediate steps in output amplitude, from x0.1 to x1.0, are provided by the front section of the switch assembly, which is controlled by the black (outer) knob.

4-81 SEQUENCE COUNTER ASSEMBLY A39. The sequence counter assembly (Figures 4-34 and 8-48), which is part of the gate system, is a four-stage binary counter with an input inhibiting mechanism controlled by the GATE INTERVAL switch, S4. The binary stages in A39, while similar

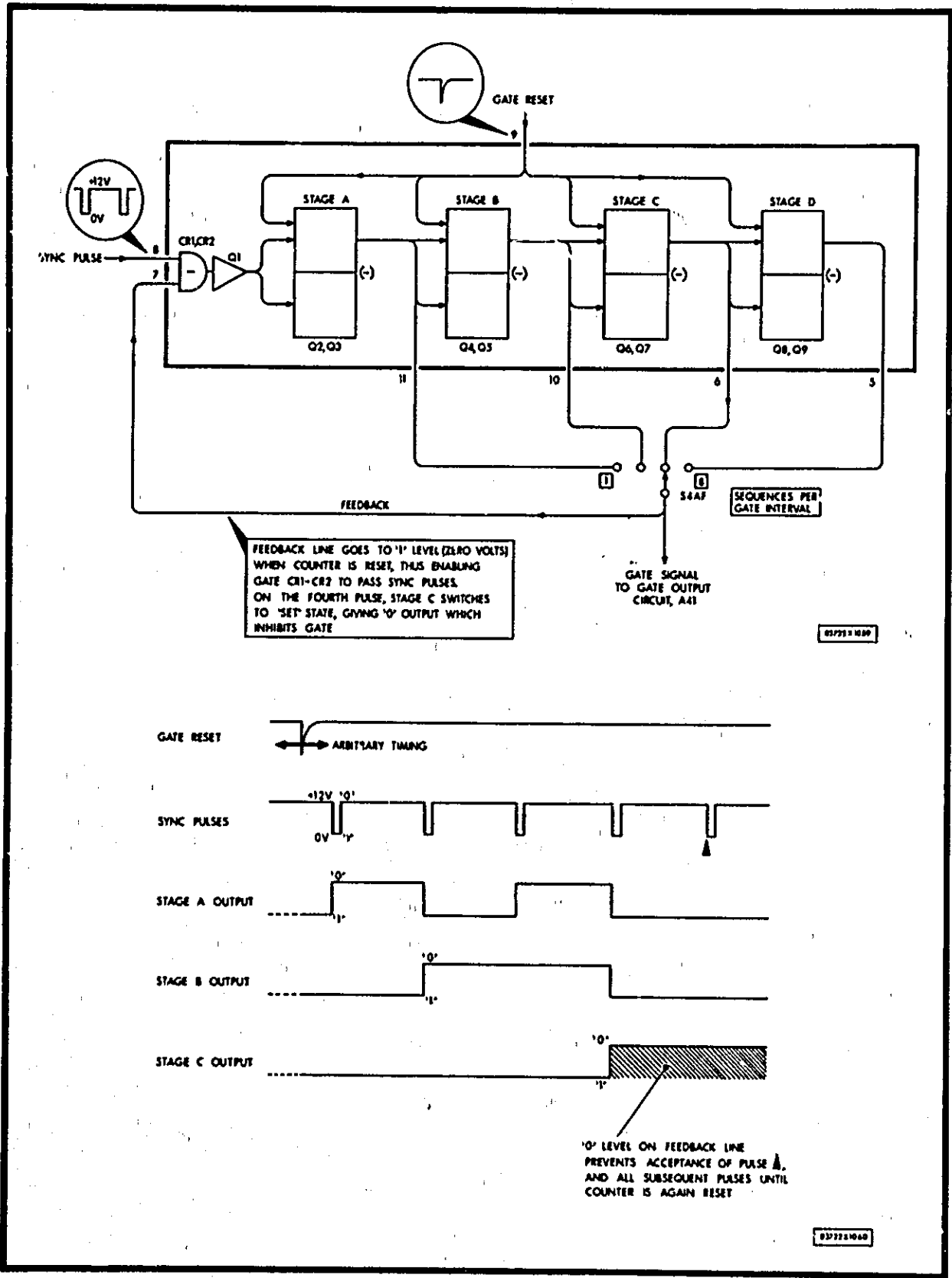


Figure 4 - 34 Sequence counter assembly A39

in principle to those in the decade dividers, are negative-edge triggered. When the GATE RESET button is operated, the negative-going signal at A39(9) resets the four binaries to give zero-volt ('1') outputs at A39(11), A39(10), etc. The resulting '1' level on the wiper of S4AF primes AND-gate A39CR1+A39CR2 to accept the next sync pulse from A41. This pulse sets stage A only:

	A	B	C	D
Initial contents (reset)	1	1	1	1
After 1st sync pulse	0	1	1	1

The second sync pulse resets stage A, and the resulting negative-going edge at the output from A sets stage B:

	A	B	C	D
After 2nd sync pulse	1	0	1	1

The third sync pulse sets stage A, but has no further effect:

	A	B	C	D
After 3rd sync pulse	0	0	1	1

This process continues, with stage A being alternately set and reset by input pulses, and each of the other stages operating at half the frequency of its preceding stage. Paragraph 4-42 shows the complete count-of-eight sequence.

4-82 At some point in the count sequence, the feedback signal (on the wiper of S4AF) will be switched to the '0' level (+12V): this inhibits AND-gate A39CR1+A39CR2, thus preventing the acceptance of further sync pulses until the counter is again reset. The point at which the inhibit is applied depends on the setting of the switch, that is, 1, 2, 4 or 8 SEQUENCES PER GATE INTERVAL. With the switch set as shown in Figure 4-33, the feedback signal goes to the '0' level after the fourth sync pulse:

	A	B	C	D
After 4th sync pulse	1	1	0	1

4-83 GATE & SYNC OUTPUT ASSEMBLY A41. The gate and sync output assembly (Figures 4-35 and 8-51) performs the following main functions:

- (1) Amplification of the sync signal.
- (2) Amplification of the binary relay drive signal.
- (3) Generation of the gate signal.

The sync signal is amplified and inverted by A41Q1, which feeds both the sequence counter A39 and the SYNC output connector J10. A41Q1 also supplies a strobe signal to the ac coupled gates associated with the gate latch circuit A41Q3+A41Q4. A41Q7, the binary relay driver, is supplied with a binary signal taken from the first stage of the shift register (or from assembly A40 in the Option 01 version) via a buffer diode A31CR1 in the output switch assembly (A31CR1 prevents loading of the shift register stage).

4-84 Operation of the gate latch circuit is illustrated by the waveforms of Figure 4-35. The flip-flop is assumed to be initially in the reset ('gate off') state. When the GATE RESET button is operated, the sequence counter is reset (Paragraph 4-81), and the resulting zero volt signal on the wiper of S4AF primes AND-gate A41C3+A41CR6 to pass the next sync pulse (a negative-going signal) from A41Q1: this pulse sets the flip-flop to give a high output (+12V, waveform 4) and hence a low output (zero volts) at the GATE connector J11. This transition marks the start of the gate interval.

4-85 After counting the demanded number of sync pulses (Figure 4-35 shows the case where the gate switch S4 is set to '4'), the sequence counter is inhibited and the resulting high level (+12V) signal on the wiper of S4AF switches inverter A41Q2 to give a zero volt output: this primes AND-gate A41C2+A41CR4 to pass the next sync pulse from A41Q1. On receipt of this pulse, the flip-flop is reset and the GATE signal at J11 switches to the high level, thus marking the end of the gate interval. Amplifier/inverter A41Q6 drives both the GATE lamp (front panel) and gate relay in A42. Note the provision of a gate reset input to flip-flop A41Q3+A41Q4. Under normal circumstances this is not required, as the flip-flop is automatically reset at the end of the gate cycle: it is significant only if the gate is cancelled — by operation of the GATE RESET button — during the actual gate interval.

4-86 RELAY ASSEMBLY A42. The relay assembly (Figure 8-51) contains two similar changeover-type reed relays. The changeover contacts are brought out to two sets of terminal posts on the rear panel. A42K1, the binary relay, is de-energised when the main BINARY output is at +10V, and energised when the BINARY output is at -10V. A42K2, the gate relay, is normally de-energised, and is energised only during a gate interval.

4-87 RECTIFIER ASSEMBLY A43. For circuit details, refer to Figure 8-56. The ac supply, of line voltage 115V or 230V, is connected through fuse

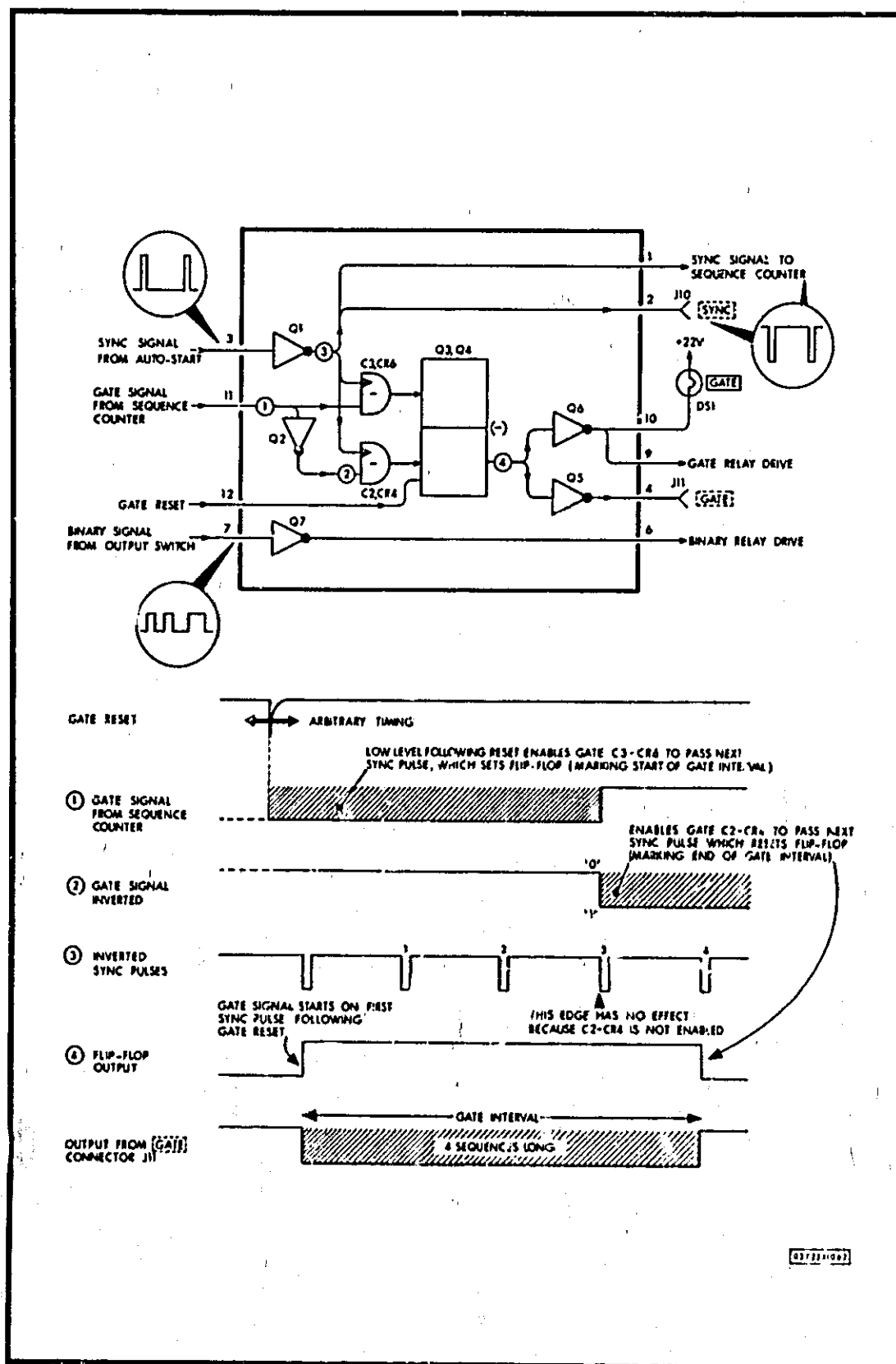


Figure 4 - 35 Gate and sync output assembly A41

Paragraphs 4-88 to 4-89

F1 and LINE switch S5 to the primary of transformer T1, which supplies the three rectifier bridges in assembly A43. For 115V operation, the primary windings of T1 are connected in parallel, and for 230V operation, the windings are in series: the appropriate primary connections are selected by the 115/230 slide switch, S16, on the rear panel. Assembly A43 provides three unstabilised dc supplies — one of approximately 20V and two of approximately 30V.

4-88 POWER SUPPLY STABILISER ASSEMBLY A44. This assembly (Figure 8-56), in conjunction with chassis mounted components Q1, Q2, Q3, etc, stabilises the three dc outputs from A43. The three circuits are similar, and only the +12.5V group is described here.

4-89 The output from bridge rectifier A43CR5-A43CR8 is smoothed by L3+C3, and is stabilised by the circuit comprising control amplifier A44Q4, emitter follower A44Q3, and emitter follower Q2. Q2 is the regulator which controls the current drawn by those circuits supplied from the +12.5V line. Voltage variations on this line are sensed by A44Q4, the output from which is buffered by A44Q3 and supplied as a control signal to Q2. If, for example, the output voltage tends towards +13V, A44Q4 base becomes more positive: the resulting negative-going voltage shift at A44Q4 collector is passed by A44Q3 to the base of Q2, which passes less current and thus restores the load voltage to +12.5V. The output voltage is adjustable by potentiometer A44R9, which sets the bias voltage on A44Q4 base.

4-90 SUMMARY OF LOGIC TERMINOLOGY

4-91 LOGIC SIGNAL LEVELS. In a digital system, information is conveyed by signals which can have only two possible levels. In logic notation, these levels are designated '1' and '0'. The '1' level is generally taken to mean yes, enable, true; hence, '0' means no, disable, false. When relating logic to hardware, the '1' and '0' levels must be carefully defined — in a particular part of a system, the '1' could be represented by the more positive of the two signal levels but equally, in another part of the system, it could be represented by the more negative. With the *hp* notation, the symbol for each logic element is assigned (+) or (-) to indicate which of the two signal levels the element recognises as 'true'.

4-92 TRUTH TABLE. Using the '1' and '0' notation, a truth table completely describes the function of a logic element. For example, AND gate having inputs A, B and an output C, is described in the following way:

INPUTS		OUTPUT
A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

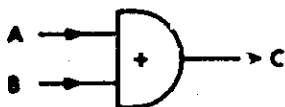
Gate gives a 'true' output only when both A and B are true.

4-93 SYMBOLS

4-94 AND GATE. The symbol for a two-input AND gate is:



The truth table for this gate is given in Paragraph 4-3 above. If the gate is 'positive true', the symbol contains (+):



The (+) implies that when (and only when) both A and B are at the relatively *positive* level, the output

C will also be at the relatively positive level. If, for example, the two possible signal levels are +12V and zero volts, the truth table could be re-written:

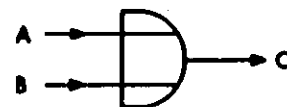
zero volts $\equiv$ '0' false

+12V $\equiv$ '1' true

INPUTS		OUTPUT
A	B	C
0V	0V	0V
+12V	0V	0V
0V	+12V	0V
+12V	+12V	+12V

An AND gate may have more than two inputs: for a multiple-input AND gate to give a true output, *all* inputs must be true.

4-95 OR GATE. The symbol for a two-input OR gate is:

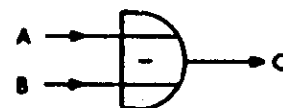


The truth table for this gate is:

INPUTS		OUTPUT
A	B	C
0	0	0
1	0	1
0	1	1
1	1	1

True output when A *or* B (or both) are true.

Again, the signal level chosen to represent the true state is indicated by (+) or (-) within the logic symbol. The following example shows a negative true OR gate, together with truth table in terms of +12V and zero volt signal levels:



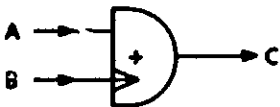
+12V $\equiv$ '0' (false)
zero volts $\equiv$ '1' (true)
(i.e. relatively negative voltage represents '1')

INPUTS		OUTPUT
A	B	C
+12V	+12V	+12V
0V	+12V	0V
+12V	0V	0V
0V	0V	0V

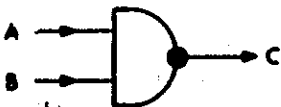
An OR gate may have more than two inputs: a multiple-input OR gate gives a true output if *one*, or more, of the inputs is true.
4-96 AC COUPLING. AC coupling is indicated by an arrow:



AC coupling is commonly used in logic elements to which a timing, or strobe, signal is applied. Only *abrupt* level changes at the ac coupled input affect the element. The *direction* of level change is also important: a positive true gate, for example, responds only to abrupt positive-going signals at the ac coupled input (changes in the opposite direction have no significant effect).



4-97 INVERSION. The symbol for logic inversion is a large dot at the output of the element in which inversion takes place:



This is simply a conventional AND gate (Paragraph 4-94) followed by an inverter which changes true to false ('1' to '0') and vice versa. The truth table for AND gate plus inverter is:

INPUTS		OUTPUT
A	B	C
0	0	1
1	0	1
0	1	1
1	1	0

False output only when both inputs true (NAND function).

4-98 AMPLIFIERS. The symbol for an amplifier is:



A	B
1	1
0	0

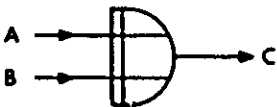
This symbol could be used to represent, say, an emitter follower. An equally common type of buffer stage is the inverting amplifier, represented by:



A	B
1	0
0	1

Logic inversion between A and B.

4-99 MODULO-TWO ADDER. A modulo-two adder gives a true output only when its two inputs are *dissimilar*:



INPUTS		OUTPUT
A	B	C
0	0	0
1	0	1
0	1	1
1	1	0

Modulo-two adders in the *hp 3722A* are composed of a number of conventional logic elements (OR gates and inverters) arranged to have the overall logic function described by the above truth table. Other terms for the modulo-two adder are:

Exclusive OR-gate
Half adder
Non-equivalence element
Anti-coincidence element

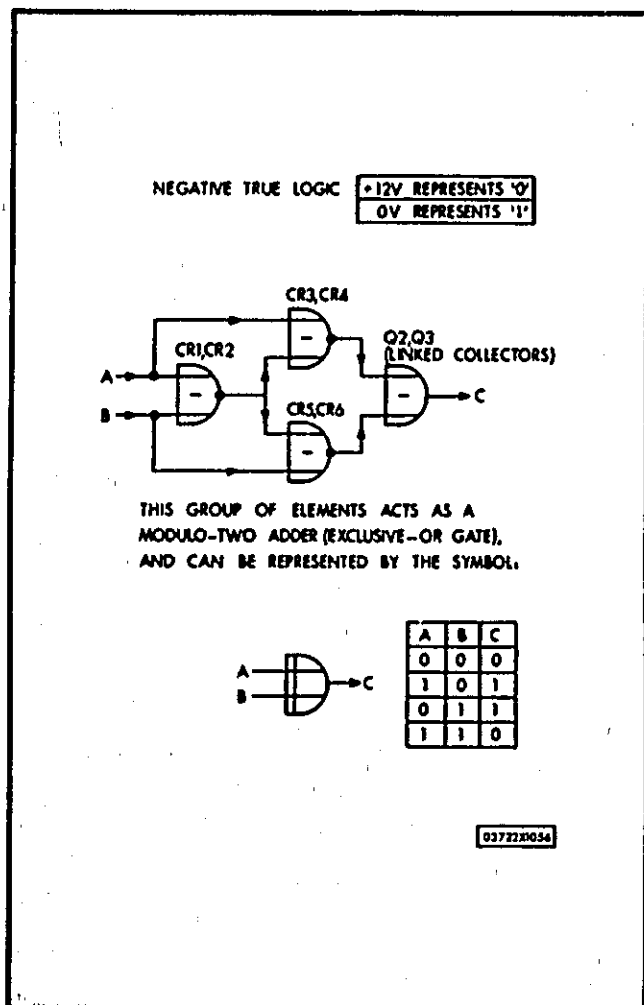


Figure 4 - 36 Logic of modulo-two adder

02182-1

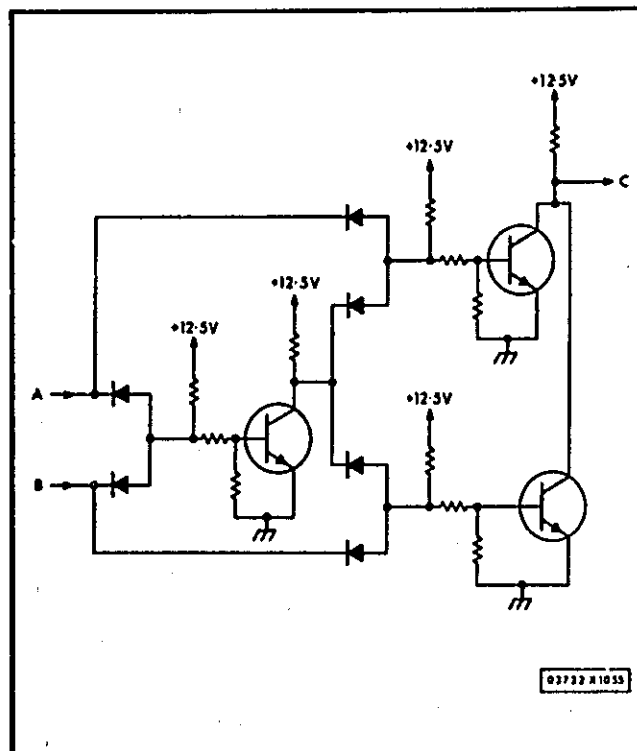
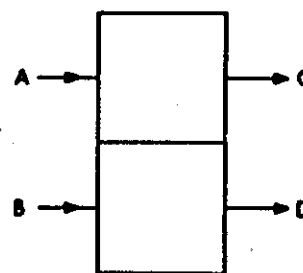


Figure 4 - 37 Typical circuit of modulo-two adder

4-100 FLIP-FLOP. The flip-flop is represented by the symbol:



This device has two stable states:

'SET' C true, D false

'RESET' D true, C false

The flip-flop can change state only on receipt of a true signal applied to the appropriate input: for example, a flip-flop in the reset state is switched to the set state by a true signal on input A. The signal level defined as true for a particular flip-flop is defined by (+) or (-) near the flip-flop symbol:

Figures 4-38 and 4-39

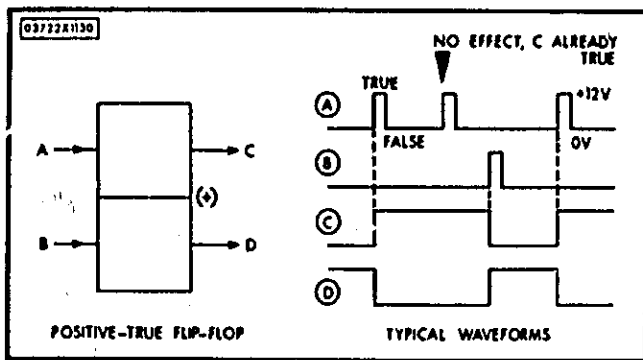


Figure 4 - 38 Logic of flip-flop

Note that the signal level definition applies to both inputs and outputs. In logic symbol terms, a true output is given by the 'side' *last to receive a true input signal*. The relationship between logic symbol

and schematic of a typical flip-flop is illustrated in Figure 4-39.

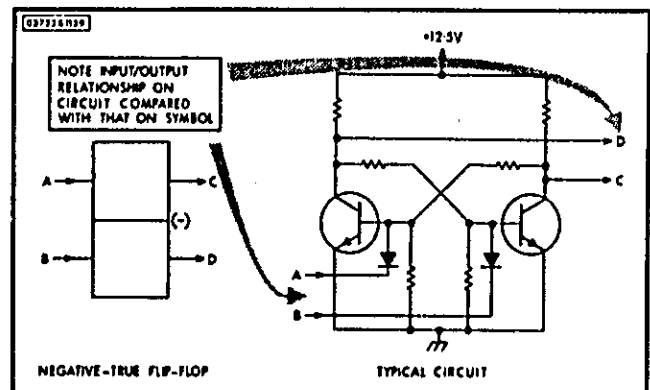


Figure 4 - 39 Relationship of flip-flop logic and practical circuit

SECTION V MAINTENANCE

5-1 TEST EQUIPMENT

5-2 Recommended test equipment for troubleshooting and performance checking is listed in Table 5-1. Test instruments other than those listed may be used if their specifications equal or exceed the stated characteristics.

5-3 ASSEMBLY CONNEXION IDENTIFICATION

5-4 Throughout the manual, connexions to printed circuit assemblies are referred to in abbreviated form. For example, the connexion to pin 15 of assembly A6 is written A6(15).

5-5 INSTRUMENT COVER REMOVAL

5-6 TOP & BOTTOM COVERS. Unscrew and remove the four crosshead screws at front and rear of cover. Slide cover towards rear of instrument. There is no need to remove the feet from the bottom cover.

5-7 SIDE COVERS. Unscrew and remove the two crosshead screws securing each cover.

CAUTION

115/230 Vac supply wires are exposed when any of the instrument covers is removed

5-8 PRINTED CIRCUIT COMPONENT REPLACEMENT

5-9 Component lead holes in the *Model 3722A* circuit boards have plated walls to ensure good electrical contact between conductors on opposite sides of the board. To prevent damage to this plating and to the replacement component, apply heat sparingly and work carefully. The following replacement procedure is recommended:

- (a) Remove the defective component by first cutting it free from its connecting leads, and then melting solder to remove the bits of wire from the holes.
- (b) Melt solder in the component lead holes. Use a clean, dry soldering iron to remove excess solder. Clean holes with a toothpick or wooden splinter; do NOT use a metal tool for cleaning, as this may damage the through-hole plating.
- (c) After bending the leads of the replacement component to the correct shape, insert them into the appropriate lead holes in the board. Using heat and solder sparingly, solder the leads in place. Heat may be applied to either side of the board. A heat sink (longnose pliers, commercial heat-sink tweezers, etc.) should be used when replacing transistors and diodes, in order to prevent conduction of excessive heat from the soldering iron to the component.
- (d) Through-hole plating breaks are indicated by lifting of the round conductor pads on either side of the board. To repair breaks, press the conductor pads against the board and solder the replacement component lead to the conductor pad on both sides of the board.

NOTE Special care must be taken when servicing the following assemblies:-

A29 Random noise generator

A35 Output amplifier (1)

A36 Output amplifier (2)

Component lead holes on these assemblies, although through-plated, have pads on only one side of the board. These pads are more susceptible to lifting off than the normal double-sided type.

Table 5 - 1 Recommended maintenance test equipment

Instrument	Brief specifications	Recommendation
Oscilloscope	20MHz bandwidth, dual trace, external trigger facility, preferably with 10cm vertical deflexion.	<i>hp 140A + hp 1420A + hp 1402A</i>
Wave Analyzer	DC to 50kHz range, preferably with 'restored frequency' output for accurate frequency indication using electronic counter.	<i>hp 302A</i>
DC Null Voltmeter	$\pm 10\text{mV}$ full scale.	<i>hp 419A</i>
Digital Recorder	Must be interfaced for operation with DVM.	<i>hp 562A</i>
Signal Generator	Sine wave output, continuously variable from 1MHz to 1.5MHz, variable amplitude (at least 10V peak-to-peak).	<i>hp 606A</i>
Voltage-to-Frequency Converter	Pulse train output, 10^5 pulses per second for 1Vdc input.	<i>hp 2212A</i>
Function Generator	500Hz square wave, output impedance 600Ω .	<i>hp 3300A</i>
RMS Voltmeter	True rms responding, accuracy within $\pm 1\%$ of full scale over frequency range 50Hz to 1MHz.	<i>hp 3400A</i>
Digital Voltmeter	DC and AC measurement capability, accuracy $\pm 0.001\text{V}$: preferably with auto-ranging facility and digital recorder outlet.	<i>hp 3440A + hp 3445A</i>
Electronic Counter	At least 2MHz capability, with 7 digit (minimum) display: must have period averaging facility.	<i>hp 5245L</i> (no plug-in required)

Table 5 - 2 List of assemblies in *hp 3722A*

Assembly No.	Title	hp Part No.
A1	Control logic assembly	03722-713
A2	Crystal oscillator assembly	03722-715
A3	Divide by three assembly	03722-705
A4,A5	High speed decade divider assembly	03722-725
A6 - A12	Low speed decade divider assembly	5212A-65C
A13	Shift pulse generator assembly	03722-703
A14	Shift register assembly	03722-704
A15	Digital filter assembly (1)	03722-706
A16	Shift register assembly	03722-704
A17	Shift register assembly	03722-704
A18	Digital filter assembly (2)	03722-721
A19	Shift register assembly	03722-704
A20	Shift register assembly	03722-704
A21	Digital filter assembly (3)	03722-723
A22	Shift register assembly	03722-704
A23	Shift register assembly	03722-704
A24	Digital filter assembly (4)	03722-724
A25	Shift register assembly	03722-704
A26	Not assigned	
A27	Feedback logic assembly	03722-701
A28	Auto-start logic assembly	03722-702
A29	Random noise generator assembly	03722-716
A30	Random noise sampler assembly	03722-709
A31	Output switch assembly	03722-720
A32	Reference power supply assembly	03722-719
A33	Analog filter assembly (1)	03722-712
A34	Analog filter assembly (2)	03722-718
A35	Output amplifier assembly (1)	03722-708
A36	Output amplifier assembly (2)	03722-730
A37	Output amplifier assembly (3)	03722-707
A38	Attenuator assembly	03722-728
A39	Sequence counter assembly	03722-710
A40	Sequence advance assembly (Option 01)	03722-739
A41	Gate and sync output assembly	03722-714
A42	Relay assembly	03722-722
A43	Rectifier assembly	03722-717
A44	Power supply stabiliser assembly	03722-711
S1	Clock period switch assembly	03722-738
S2	Sequence length switch assembly	03722-734

BINARY OUTPUT (fixed amplitude)

AMPLITUDE

Specification states $\pm 10\text{V}$ ($\pm 1\%$ when clock period $\geq 333\mu\text{S}$,
 $\pm 3\%$ when $333\mu\text{S} > \text{clock period} > 1\mu\text{S}$,
 $\pm 5\%$ when clock period $= 1\mu\text{S}$).

Comment

Amplitude of the binary output is not easily measurable at frequencies greater than can be accommodated by a digital voltmeter (DVM). Typically, digital voltmeters can reliably sample discrete voltage levels when the rate of switching between levels does not exceed, say, 2 or 3 per second. In this performance check, the digital voltmeter is used to verify the binary output amplitude at all clock frequencies less than and including 1Hz (clock periods of 1 sec and greater). The amplitude at frequencies greater than 1Hz is checked by the visual comparison technique described below.

Procedure for low frequency measurement

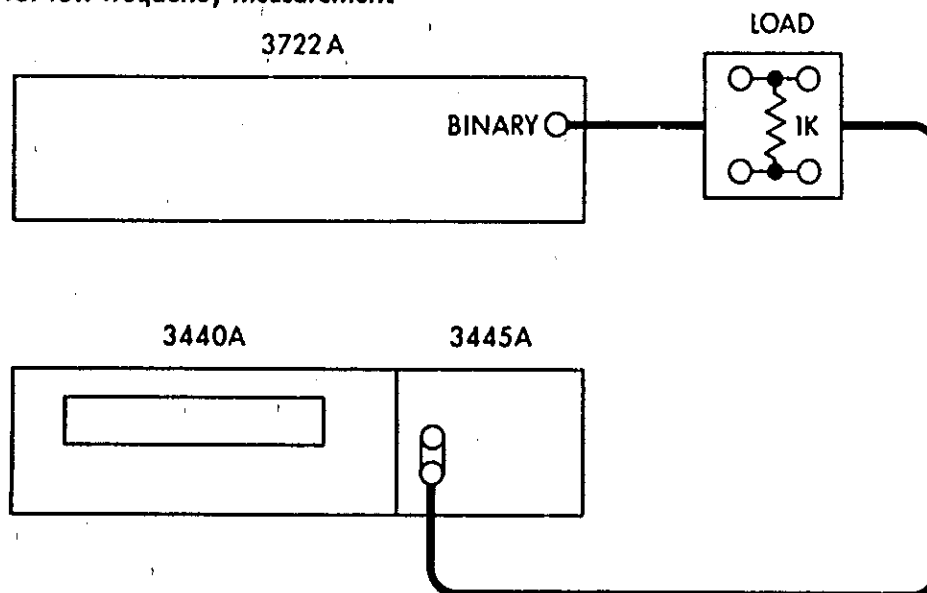


Figure 5-1

03722H133

- 1) As shown in Figure 5-1, connect the 3722A BINARY output to a 3440A DVM via a 1kΩ load (1kΩ is the minimum load impedance for this output).
- 2) Set the 3445A range unit to AUTO DC.
- 3) Set the 3722A controls as follows:
 - CONTROL selector to LOCAL
 - CLOCK selector to INT
 - SEQUENCE LENGTH switch to N = 15
 - CLOCK PERIOD switch to 1 SEC

Table 5-3 In-cabinet performance check

BINARY OUTPUT (fixed amplitude)

- 4) Press the RESET button. This should drive the binary output to the positive level, giving a DVM reading of $+10V \pm 0.1V$.
- 5) Press the RUN button. The DVM reading should alternate (though not at regular intervals) between $+10V$ and $-10V$, thus indicating that a binary sequence is in progress. Press the HOLD button at the appropriate time to stop the sequence when the binary output is at the negative level. The DVM reading should be $-10V \pm 0.1V$.

Procedure for measurement at frequencies greater than 1Hz

NOTE The visual comparison technique is valid only if the binary waveform is reasonably rectangular. Check this using the set-up of Figure 5-2. On the oscilloscope, select EXT-VE trigger, sweep time $1\mu S/cm$ and vertical sensitivity $5V/cm$. Set the 3722A CLOCK PERIOD switch to $1\mu S$, press RUN button and, with the oscilloscope triggered by sync pulses from the 3722A, display the 15-bit sequence (SEQUENCE LENGTH switch set to $N = 15$). The waveform should be essentially rectangular, and the dwell at upper and lower levels should be reasonably flat.

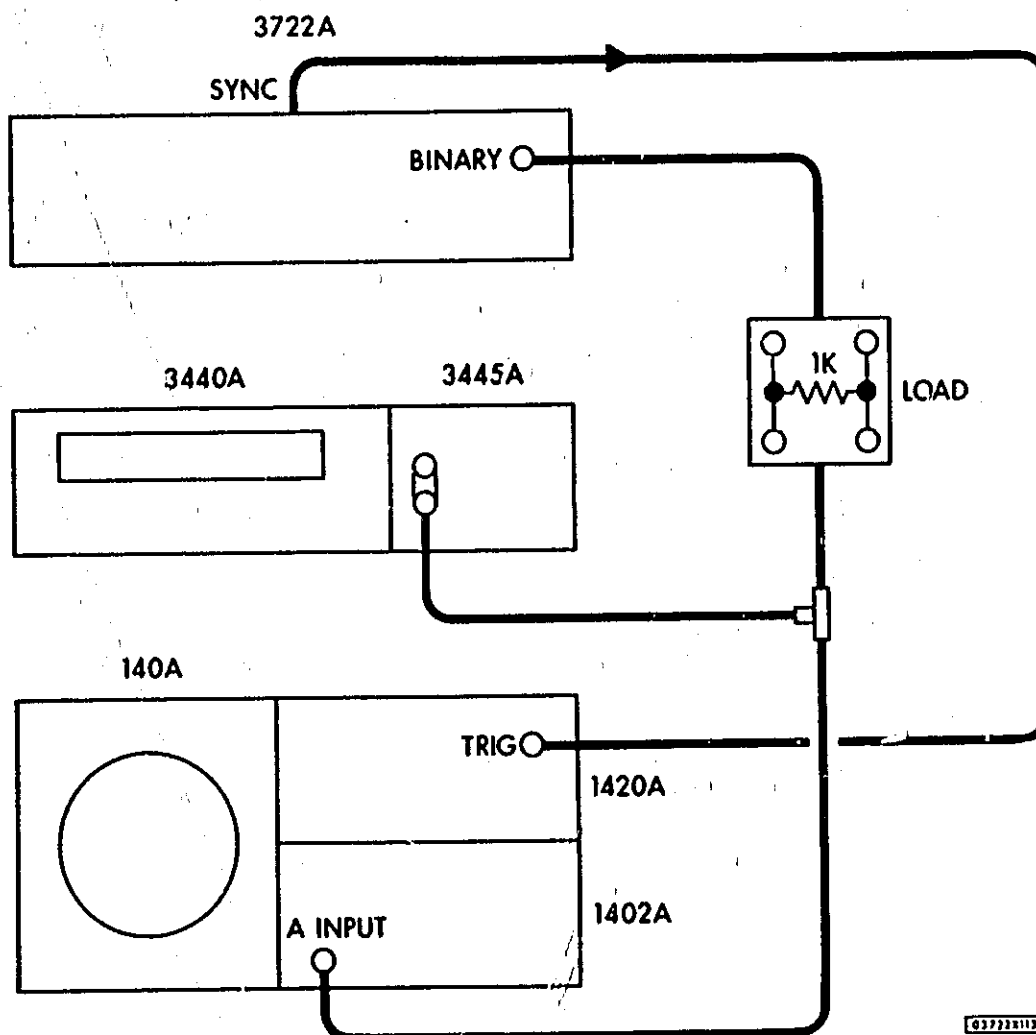


Figure 5-2

Table 5-3 In-cabinet performance check (continued)

BINARY OUTPUT (fixed amplitude)

- 1) Set the oscilloscope vertical sensitivity to 2V/cm, dc coupled (note that this sensitivity is suitable only if the oscilloscope has a vertical display of at least 10cm, as on the 140A).
- 2) Set the sweep time to 5 μ S/cm and select FREE RUN triggering.
- 3) Set the 3722A CLOCK PERIOD switch to 1 SEC.
- 4) Press the RUN button. The display should switch between ± 10 V levels. Adjust the oscilloscope sensitivity to place the two horizontal traces exactly 10cm apart (or the maximum separation possible with the particular oscilloscope in use).
- 5) Set the CLOCK PERIOD switch to 333mS and check that the two horizontal traces remain at the same separation.
- 6) Repeat the observation for all other CLOCK PERIOD switch settings. There should be no detectable change in trace separation for clock periods down to, and including, 333 μ S. Some reduction in separation may be observed as the clock period is reduced beyond 333 μ S. This reduction should not exceed 4% overall (2% shift each trace) for periods between 100 μ S and 3.33 μ S inclusive, and 8% overall at the 1 μ S setting.

This 3722A/DVM/oscilloscope set-up is used in the next test.

OUTPUT IMPEDANCE

Specification states $< 5\Omega$ if clock period $\geq 333\mu$ S,
 $< 10\Omega$ if clock period $\leq 100\mu$ S.

Procedure

- 1) With the set-up described above, free-run the scope and observe the horizontal traces produced by the binary output with clock period 1 μ S. Detach the 1k Ω load from the BINARY connector. Adjust the oscilloscope sensitivity to place the traces exactly 10cm apart.
- 2) Couple the load to the BINARY connector and check that the separation does not decrease by more than 1%, implying an output impedance of less than 10 Ω (this is the 'worst case' test for the range of clock periods 100 μ S to 1 μ S).
- 3) The output impedance for the range of clock periods 333 μ S upwards is verified by a dc level check. Press the RESET button and measure the +10V level with and without the 1k Ω load. The level change should not exceed 0.05V = 0.5%, implying an output impedance of less than 5 Ω . The 3722A remains connected to the oscilloscope for the next test.

RISE TIME

Specification states < 100 nS

Procedure

Trigger the oscilloscope from the 3722A SYNC signal (select EXT-VE trigger), with sweep time 50nS/cm (0.5 μ S/cm with x10 multiplier) and clock period 1 μ S, measure the rise time between 10% and 90% amplitude levels of the binary waveform. Rise time should not exceed 100nS.

Table 5-3 In-cabinet performance check (continued)

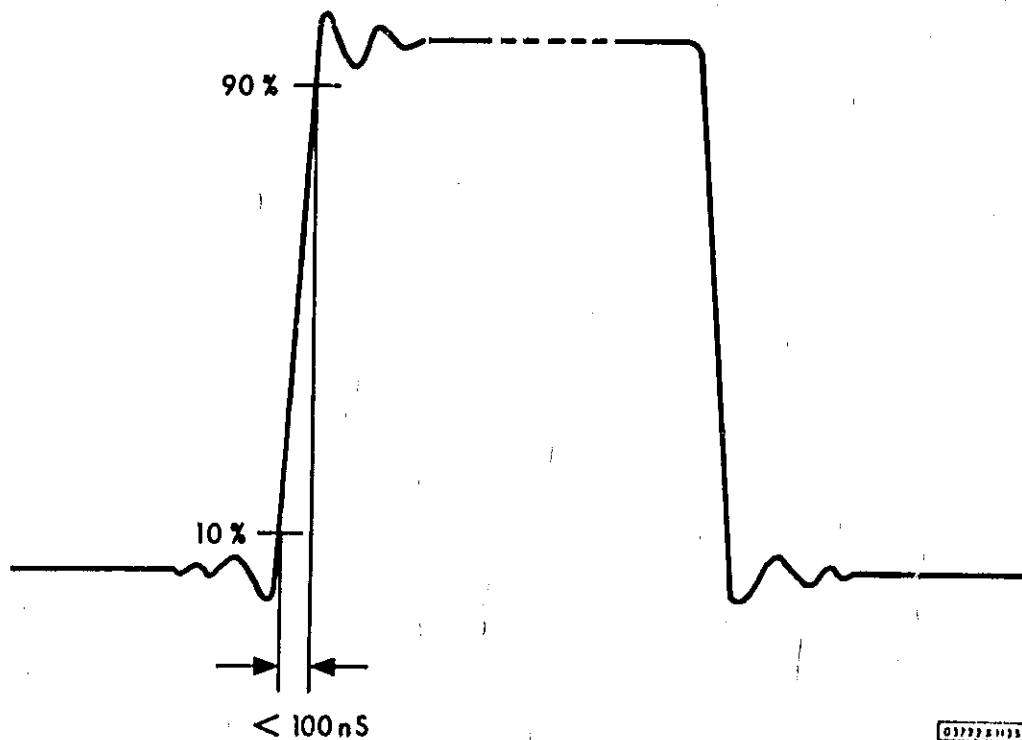
BINARY OUTPUT (fixed amplitude)

Figure 5-3

POWER DENSITY

Specification states (clock period $\times 200$) volts²/Hz, at low frequency end of spectrum.

Comment

This is true if the rms amplitude of the binary signal is as specified above. Power density is approximately $2 \times (\text{rms amplitude of binary signal})^2$; hence $2 \times 10^2 = 200$ volts²/Hz. Note that the rms amplitude of a binary signal is equal to half the peak-to-peak amplitude.

POWER SPECTRUM

Specification states $(\sin x/x)^2$ form: first null occurs at clock frequency and -3dB point occurs at $0.45 \times$ clock frequency.

Comment

One of the fundamental properties of a binary signal is its $(\sin x/x)^2$ shaped spectrum. This does not need to be verified as part of the performance check. If required, the spectrum shape can be demonstrated using the test set-up described below for the Gaussian power spectrum check.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

AMPLITUDE

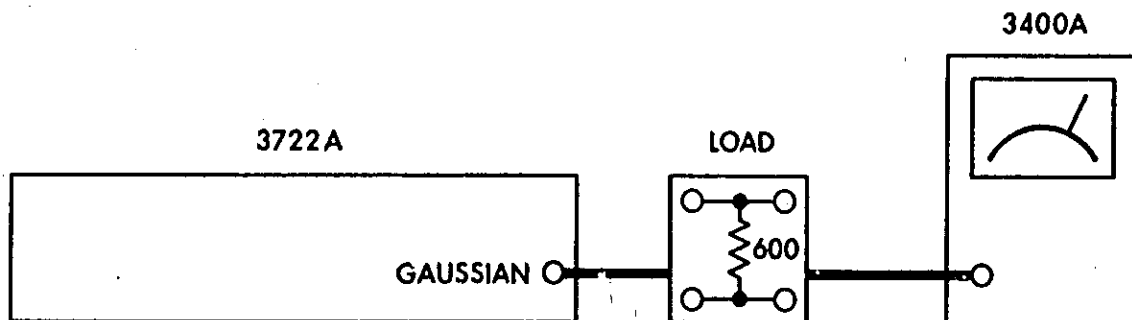
Specification states 3.16V rms $\pm$ 2% when bandwidth $\geq$ 0.15Hz,
+6% -2% if bandwidth $\leq$ 0.05Hz
(this specification is valid only when the sequence length $\geq$ 1023).

Comment

In the basic performance check, two techniques are used to verify rms amplitude of the Gaussian output: these are (1) direct *measurement* using an rms voltmeter, this being possible only at the higher clock frequencies, and (2) sampling (with a DVM) the various voltage levels generated in a complete sequence, followed by *calculation* of rms amplitude. This second method is limited by the sampling rate of the DVM and, typically, is not suitable for clock frequencies greater than 1Hz. There is no straightforward technique of measuring the rms amplitude in the middle frequency range ($333\text{mS} \geq \text{clock period} \geq 333\mu\text{S}$), but for most purposes it can be assumed that, if the amplitude is within specifications at the upper and lower frequencies, then the middle frequency performance is satisfactory. On occasion, however, it is essential to measure the amplitude of the mid-band frequencies, and for this purpose, a method using a voltage-to-frequency converter and an electronic counter is described below.

Procedure for high frequency measurement

- 1) As shown in Figure 5-4, connect the 3722A GAUSSIAN output to a 3400A rms voltmeter via a 600Ω load (600Ω is the minimum load impedance for this output): the load is not significant in the amplitude check, but is used later to determine output impedance.



03722A113A

Figure 5-4

- 2) Set the 3722A controls as follows:-
SEQUENCE LENGTH switch to 1023
CLOCK PERIOD switch to $100\mu\text{S}$ (bandwidth 0.5kHz).
- 3) Measure the rms amplitude: this should be 3.16V rms $\pm$ 2%.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 4) Repeat the measurement at each of the higher clock frequencies, (i.e. shorter clock periods, $33.3\mu\text{S}$, $10\mu\text{S}$, $3.33\mu\text{S}$, $1\mu\text{S}$): at each setting, the rms amplitude should be $3.16\text{V rms} \pm 2\%$.

This 3722A/3400A set-up, plus a DVM is used for form factor and output impedance measurement.

Procedure for low frequency measurement

In this test, the Gaussian output is sampled at regular intervals by a DVM controlled by the 3722A clock. The DVM samples the Gaussian output each time a positive-going transition occurs in the clock output, i.e. once in each clock period (Figure 5-5).

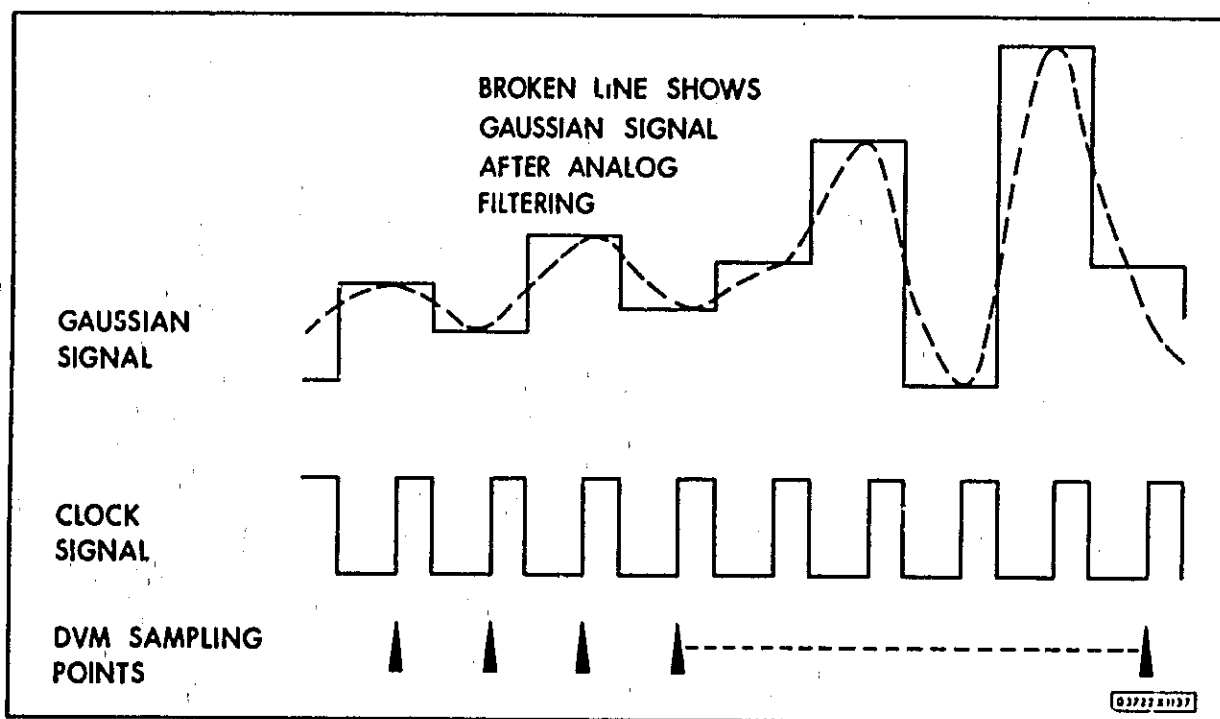


Figure 5-5

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

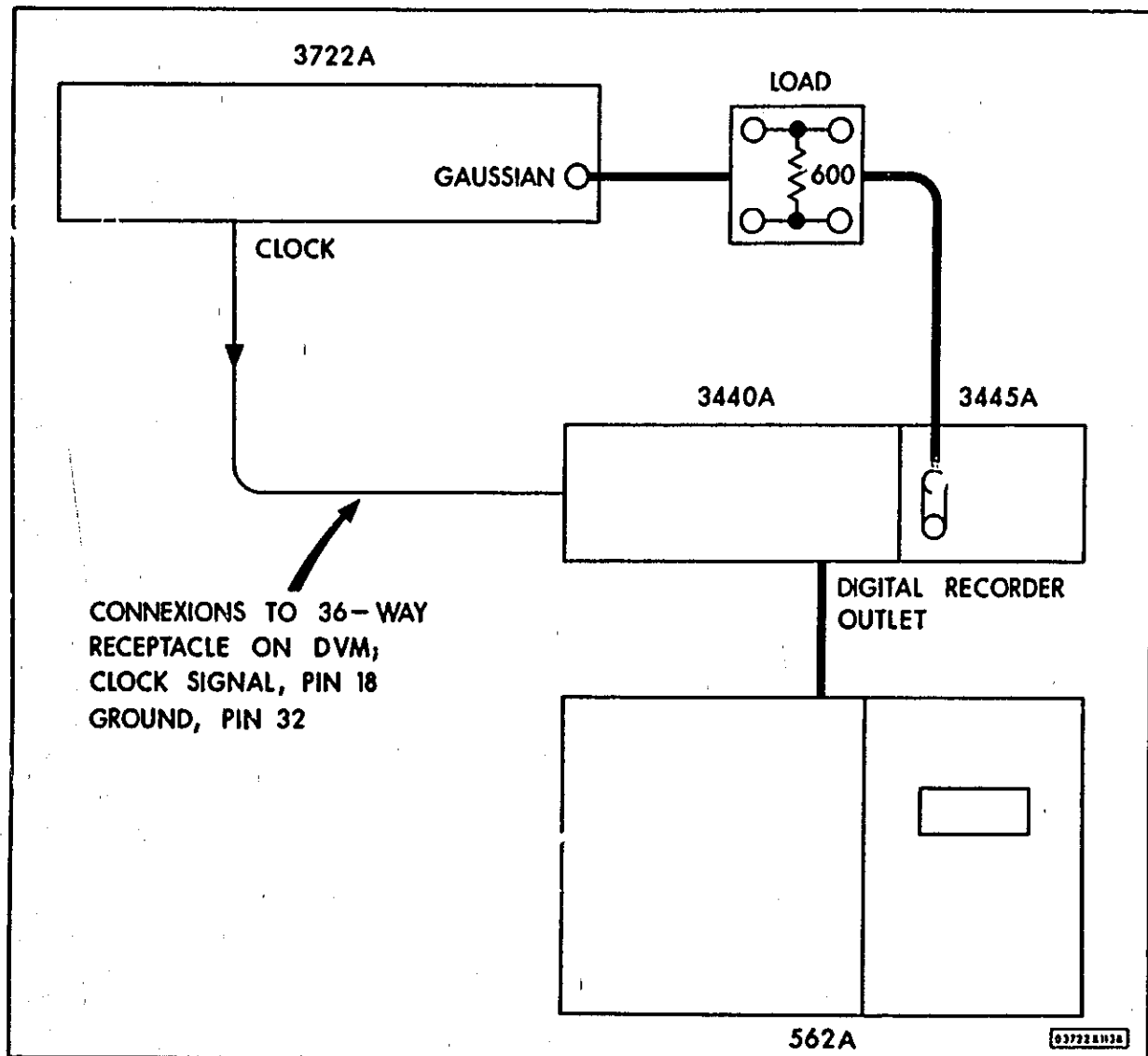


Figure 5-6

NOTE In factory tests of the 3722A, the digital recorder shown in Figure 5-6 is replaced by a Hewlett-Packard 2116A digital computer fitted with an interface which allows direct acquisition and storage of data from the 3440A. On completion of data acquisition, the calculation of rms amplitude is performed by the computer.

Since mathematical operations on the 1023 samples required for this test are very time-consuming, some form of automatic processor is strongly recommended.

- 1) Switch on the 562A, but do not switch on the RECORD toggle.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 2) Set the 3722A controls as follows:-

SEQUENCE LENGTH switch to 1023

CLOCK PERIOD switch to 1 SEC.

- 3) On the 3440A set the SAMPLE RATE control fully cw to HOLD. Set the range unit to AUTO DC.

Check that the displayed number changes at regular 1 second intervals.

- 4) On the 562A, switch on the RECORD toggle. Make a note of the first five or so samples. Allow the recorder to print out 1023 samples (as verified, firstly, by timing with a watch, and secondly, by comparing the print-out at the appropriate time with the record of the first five samples - there should be a ± 1 digit similarity between the first five and those starting the next complete sequence).

- 5) Calculate the square of each sample, add together all the squares, divide by 1023 and take the square root of the result. Thus if (a_j) is the amplitude of the j th sample, then:-

$$\text{rms amplitude} = \sqrt{\frac{(a_1)^2 + (a_2)^2 + (a_3)^2 + \dots + (a_{1023})^2}{1023}}$$

The calculated amplitude should be 3.16V rms $\pm 6\%$ $\pm 2\%$.

NOTE The above procedure can be used for all clock periods in the range 1 second to 333 seconds.

Procedure for mid-band frequency measurement

This procedure is in two parts:-

- (a) Measurement of form factor of the 1023-bit Gaussian signal. This measurement is made at a clock frequency which allows simultaneous readings of both rms amplitude (with 3400A) and mean rectified amplitude (with 3440A).
- (b) Measurement of the mean rectified amplitude of the 1023-bit Gaussian signal. Mean rectified amplitude of the signal is given by integration over a known period (at least 1023 x clock period in use) of the output from a voltage-to-frequency converter driven by the Gaussian signal. Division of the result by the integration time gives the mean rectified amplitude, which is multiplied by the form factor to give rms amplitude.

(a) Form Factor

- 1) As shown in Figure 5-7, connect the 3722A GAUSSIAN output via a tee-piece to the 3400A rms voltmeter and a 3440A digital voltmeter.

- 2) Set the 3722A controls as follows:-

SEQUENCE LENGTH switch to 1023

CLOCK PERIOD switch to 100 μ S.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

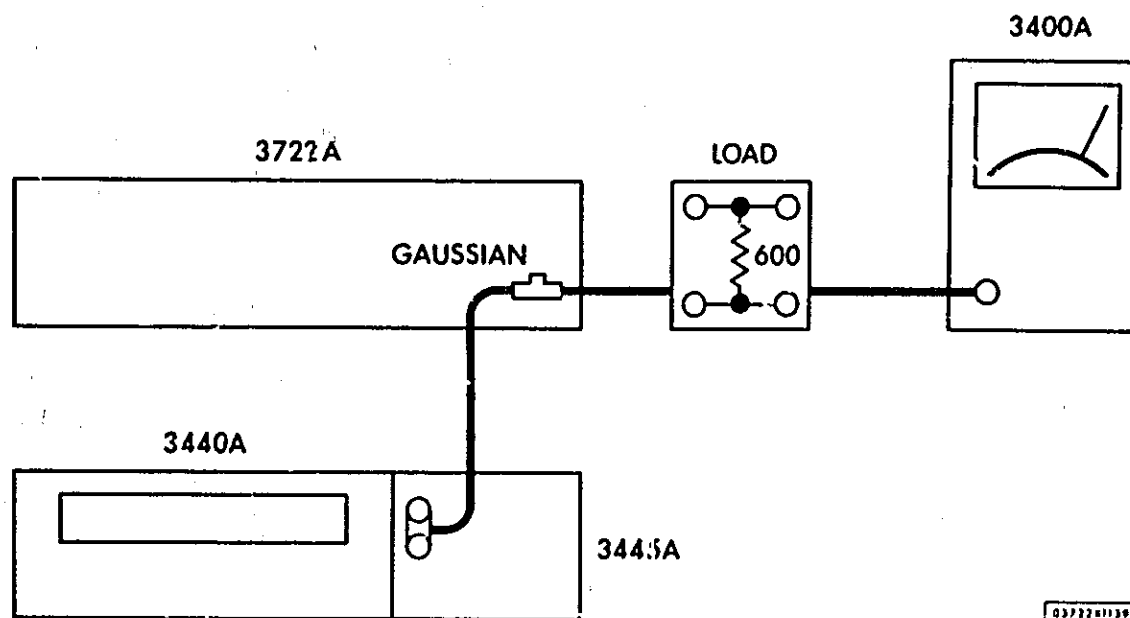
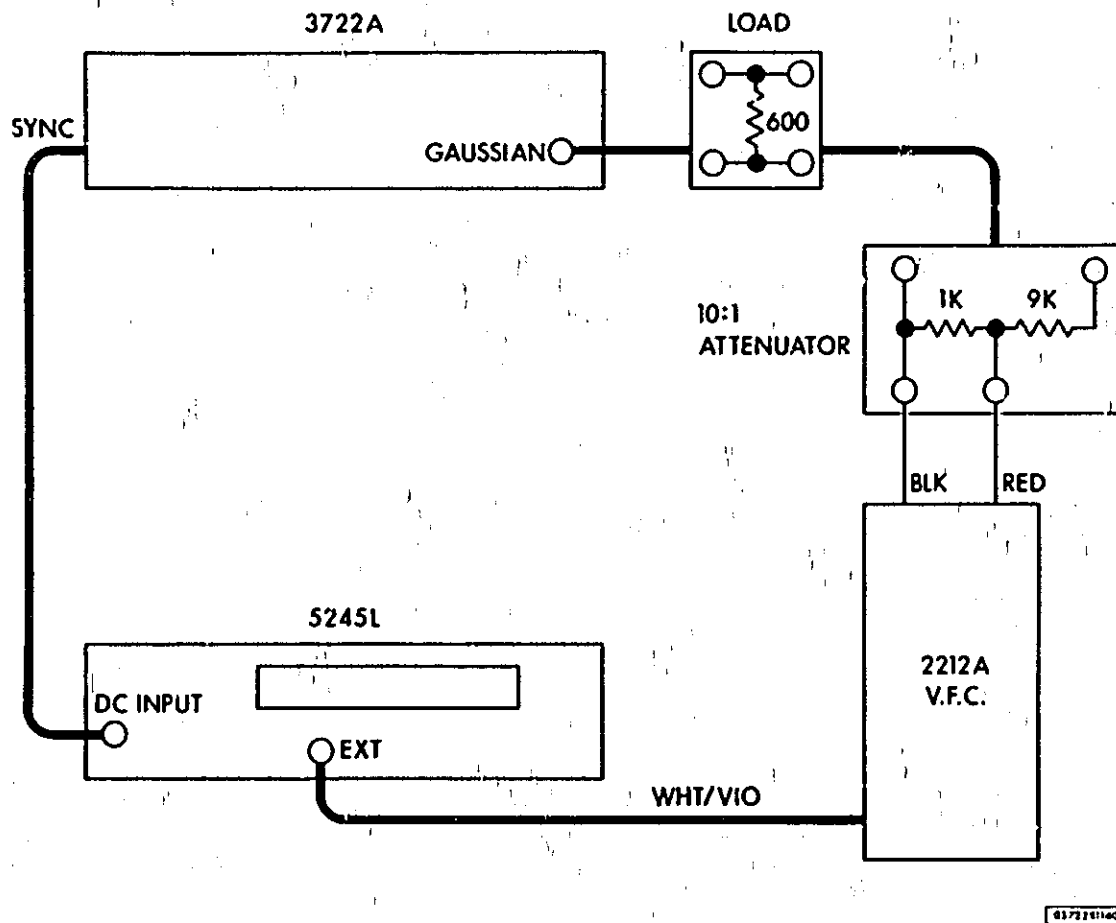


Figure 5-7

- 3) With the 3445A range unit set to AUTO AC, note the reading on the 3440A DVM. This reading, which should be in the region of 2.8V, is divided by 1.11 for conversion to mean rectified amplitude. (Since the 3440A reads rms amplitude of a *sine wave* input, the indicated amplitude is converted to mean rectified amplitude when divided by the form factor of a sine wave). Mean rectified amplitude = $2.8/1.11$.
 - 4) Form factor is the ratio of rms amplitude to mean rectified amplitude, and for this Gaussian signal is approximately equal to $3.16 \times 1.11/2.8 \approx 1.24$.
- (b) Mean rectified amplitude measurement
- 1) As shown in Figure 5-8, connect the GAUSSIAN output from the 3722A via a 600Ω load and a *precision* 10: 1 attenuator to a 2212A voltage-to-frequency converter (VFC). The accuracy of absolute measurements made by this process depends on attenuator precision and the setting-up of the 2212A VFC.
 - 2) Couple the SYNC output from the 3722A to the DC input of a 5245L counter. Couple the output from the 2212A to the EXT connector of the 5245L.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)**Figure 5-8**

- 3) Set the **5245L** controls as follows:-

SENSITIVITY switch to 1 VOLT RMS
 TIMEBASE switch to EXT
 FUNCTION switch to '1' PERIOD AVERAGE.

In this condition, the **5245L** counts the number of pulses generated by the **2212A** in the interval between sync pulses.

- 4) Set the **3722A** SEQUENCE LENGTH control to 1023 and the CLOCK PERIOD switch to the required position in the range 333 μ S to 333mS inclusive.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 5) Press the 5245L RESET button. On the next sync pulse from the 3722A, the 5245L GATE lamp should light, indicating that the count is in progress. The GATE lamp should be extinguished on the following sync pulse, which stops the count. Repeat the measurement and take the average of several pulse counts.

Calculation With a steady input of 1Vdc, the 2212A generates 10^5 pulses/sec. The reading obtained with the 5245L is the total of pulses from the 2212A during the interval (clock period $\times$ 1023). The average input to the 2212A is therefore equal to:-

$$\frac{\text{pulse count}}{10^5 \times 1023 \times \text{clock period}}$$

Since the 2212A is fed via a 10: 1 attenuator, the mean rectified amplitude of the 3722A output is equal to:-

$$\frac{10 \times \text{pulse count}}{10^5 \times 1023 \times \text{clock period}}$$

Typically, with a clock period of 10mS the pulse count could be 260865. This gives a mean rectified amplitude of 2.55V and an rms amplitude (based on 1.24 form factor) of 3.16V.

OUTPUT IMPEDANCE

Specification states $< 1\Omega$

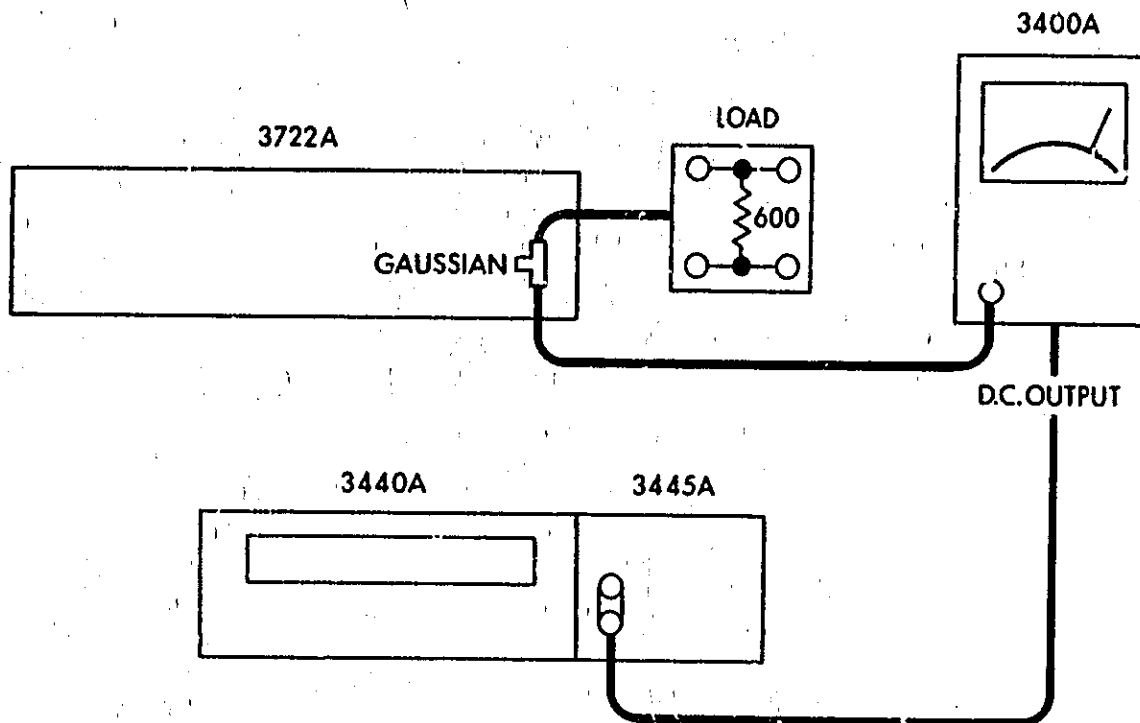


Figure 5-9

Table 5-3 In-cabinet performance check (continued)

Table 5-3

GAUSSIAN OUTPUT (fixed amplitude)

Procedure

- 1) As shown in Figure 5-9, connect the 3722A GAUSSIAN output directly to 3400A rms voltmeter. In order that a load may be applied, fit a BNC tee-piece to the GAUSSIAN output connector. The DC OUTPUT from the 3400A is connected to a 3440A DVM.
- 2) Set the 3722A controls as follows:-
 SEQUENCE LENGTH switch to 1023
 CLOCK PERIOD switch to 1μS.
- 3) With the DVM set to AUTO DC, measure the output from the rms voltmeter with *no load* connected to the GAUSSIAN output.
- 4) Connect the 600Ω load and note the change in DVM reading.

Calculation Output impedance = $\frac{\text{change in voltage}}{\text{change in current}}$

The full-scale reading on the DVM will be approximately 1V, this being equivalent to the rms voltmeter full scale reading of approximately 3.2V. Typically, the change in DVM reading, when the 600Ω load is applied, will be 1mV - which is equivalent to 3.2×10^{-3} V. The change in current when the load is applied is approximately 3.16/600A.

Therefore, output impedance =

$$\frac{3.2 \times 10^{-3} \times 600}{3.16} \approx 0.6\Omega$$

ZERO DRIFT

Specification states <5mV change in zero level in any 10°C range from 0°C to +55°C.

Procedure

Figure 5-10 shows the arrangement for this check.

- 1) With the input of the 419A null voltmeter open-circuit, set the meter zero on the most sensitive range: then set the RANGE switch to 10 VOLTS.
- 2) Set the 3722A controls as follows:
 SEQUENCE LENGTH to 2047
 CLOCK PERIOD to 10μS.
 Allow the 3722A to operate for at least one hour in a controlled environment, at a selected ambient temperature (say 20°C) in the range 0°C to +55°C.
- 3) Connect the 419A to the GAUSSIAN output of the 3722A. Adjust the GAUSSIAN zero potentiometer to give null reading on the 419A.
- 4) Progressively increase the 419A sensitivity, adjusting the zero level at each setting of the RANGE switch. Make final adjustments on the 10 MILLIVOLT range. Note the reading.

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 5) Increase the ambient temperature by at least 10°C and allow at least one hour for the 3722A zero level to stabilise. Note the new reading on the 419A and calculate zero drift.

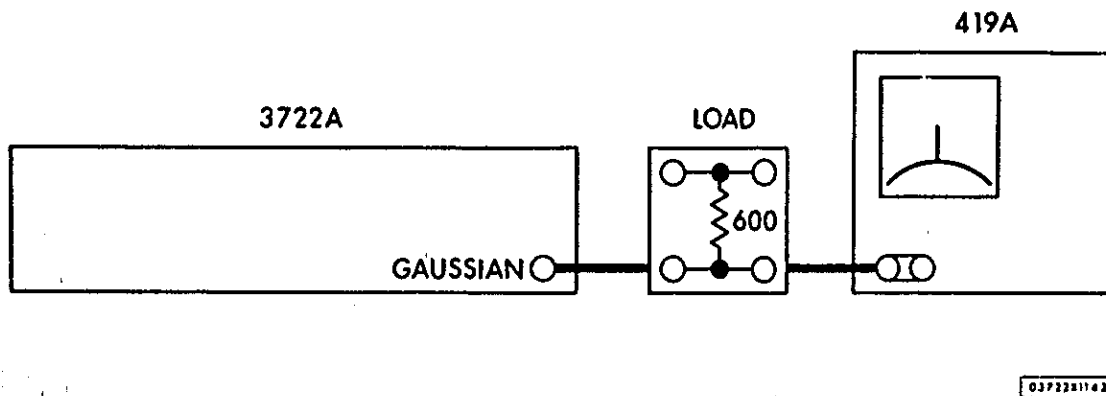


Figure 5-10

POWER DENSITY

Specification states Approximately equal to (clock period x 200) volts²/Hz, at low frequency end of spectrum.

Procedure

- 1) Connect the 3722A GAUSSIAN output to a DVM, as shown in Figure 5-7.
- 2) Press the RESET button on the 3722A and note the DVM reading: this should be approximately 10Vdc.
Power density = 2 x clock period x (measured voltage)².

POWER SPECTRUM

Specification states Rectangular, low pass: nominal upper frequency f_0 (-3dB point) equal to 1/20th of clock frequency. Spectrum is flat within ± 0.3 dB up to $1/2f_0$, and more than 25dB down at $2f_0$.

Comment

Using conventional techniques, the spectrum can easily be verified for all clock frequencies greater than, and including, 3kHz (i.e. Gaussian noise bandwidth > 150 Hz). There is no straightforward technique of checking the spectrum in the mid-band frequency range $50\text{Hz} > f_0 > 0.15\text{Hz}$. The technique used in the factory for checking the ultra low frequency spectra, where $f_0 < 0.05\text{Hz}$, involves:-

- 1) Measurement, with a DVM sampling under control of the 3722A clock, of the various voltage levels generated in a complete sequence (this applies to the pseudo-random mode only). In practice, this data acquisition is performed by the computer used subsequently to calculate the spectrum (compare with rms amplitude measurement described above).

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 2) Computation from the above of the auto-correlation function of the Gaussian output. The Fourier transform of this function yields the amplitude of the harmonics in the spectrum (note that a pseudo-random signal has a line power spectrum).

Procedure for high frequency check

- 1) As shown in Figure 5-11, connect the GAUSSIAN output from the 3722A to a 302A wave analyser. The 302A output is monitored in both frequency (by 5245L) and amplitude by (3440A). A recorder, model 562A, may be used to print-out DVM readings if required.
- 2) Set the 302A controls as follows:
 - REFERENCE ADJUST fully cw
 - SCALE VALUE to RELATIVE
 - MAX INPUT VOLTAGE to 10V
 - RANGE window to 300mV
 - MODE SELECTOR to NORMAL
- 3) Set the 5245L controls as follows:
 - SENSITIVITY to 1 VOLT RMS
 - TIMEBASE to 0.1S
 - FUNCTION to FREQUENCY
- 4) Set the 3445A range unit in the DVM to AUTO AC.
- 5) Set the 3722A controls as follows:
 - SEQUENCE LENGTH to 511
 - CLOCK PERIOD to 1μS

These settings give a nominal bandwidth (f_0) of 50kHz and harmonics at intervals of 1.957kHz.

- 6) Starting from zero, wind the 302A FREQUENCY dial to around 1.9kHz and, with the FINE control, slowly adjust the dial until the meter shows a reading. Set the MODE SELECTOR to AFC. Allow the wave analyser to lock in and set the REFERENCE ADJUST control to give a meter reading of exactly 0dB. This is the reference against which all other harmonics will be compared: the meter indication provides a useful double-check in conjunction with DVM reading.
- 7) Print-out the DVM reading.
- 8) Tune the 302A to the next harmonic (2.914kHz) and again print the DVM reading.
- 9) Repeat the tune/print operation for each of the harmonics up to 50kHz.

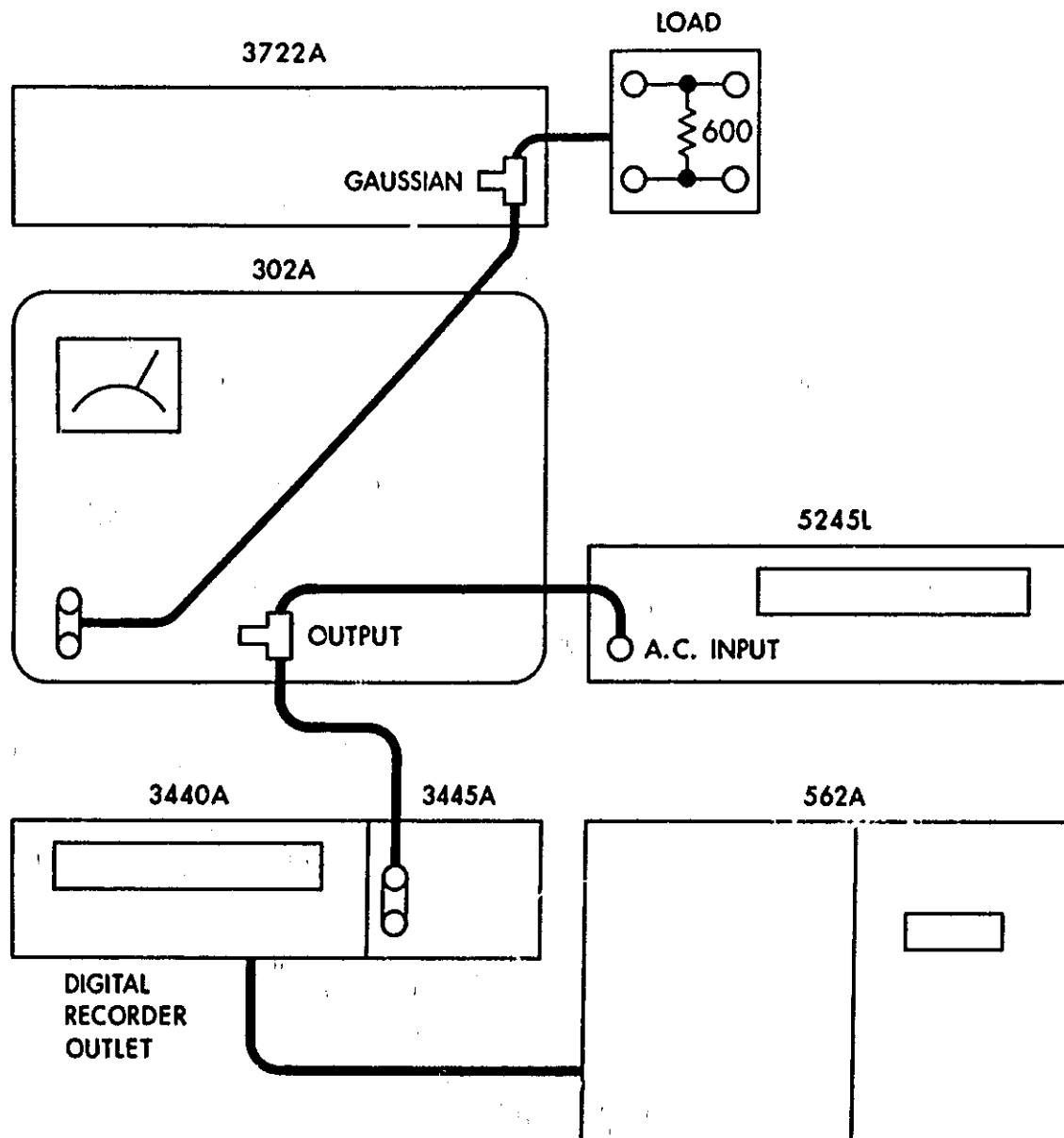
Calculation The DVM reads the rms amplitude of the restored frequency output from the wave analyser. If the voltage reading for the fundamental is x volts rms, and that for a particular harmonic is y volts rms, then the power (in dB) of the harmonic, relative to the fundamental, is:

$$20 \log_{10} \frac{x}{y}$$

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

Use this to calculate the relative power of the harmonic nearest to $1/2f_0$ ($\approx 25\text{kHz}$) and harmonic nearest to f_0 ($\approx 50\text{kHz}$). The relative powers should be $\pm 0.3\text{dB}$ at $1/2f_0$ and -3dB at f_0 .



03722 R1143

Figure 5-11

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

- 10) Set the 3722A controls as follows:

SEQUENCE LENGTH to 511

CLOCK PERIOD to 3.33 μ S.

These settings give a nominal bandwidth (f_0) of 15kHz and harmonics at intervals of 587.1Hz.

- 11) Print-out the voltage readings obtained at each harmonic frequency. Calculate the relative power at $1/2f_0$ and f_0 (i.e. 7.5kHz and 15kHz).
- 12) Check the relative power at $2f_0$ (i.e. 30kHz). This should be more than 25dB down, relative to the fundamental.
- 13) Check the GAUSSIAN output spectrum at the other clock period settings listed below:

Clock period	Sequence length	f_0	Fundamental
10 μ S	511	5kHz	195.7 Hz
33.3 μ S	511	1.5kHz	58.71Hz
100 μ S	511	500Hz	19.57Hz
333 μ S	255	150Hz	11.8 Hz

CREST FACTOR

Specification states Up to 3.75, dependent on sequence length.

Procedure

- 1) With an oscilloscope having accurately calibrated Y sensitivity, display the Gaussian output from the 3722A.
- 2) Set the 3722A controls as follows:
SEQUENCE LENGTH to 1048575
CLOCK PERIOD to 1 μ S.
- 3) Without timebase, observe the vertical deflexion caused by Gaussian signal. Note particularly the peaks attained by the signal. Crest factor is the ratio of peak to rms amplitude, i.e. observed peak excursion (approximately 12V) divided by 3.16. The peak amplitude (and hence crest factor) will be observed to diminish as the sequence length is reduced.

PROBABILITY DENSITY FUNCTION

Measured deviations (from the Gaussian curve) of the 3722A output probability density functions are shown in Section III, Figure 3-9.

Comment

It is not necessary, as part of the in-cabinet performance check, to verify the probability density function (p.d.f.) of the Gaussian output. The p.d.f. varies with sequence length but, if the shift register, feedback mechanism and output amplifier are functioning correctly, then deviations in

Table 5-3 In-cabinet performance check (continued)

GAUSSIAN OUTPUT (fixed amplitude)

p.d.f. should not exceed those shown in Figure 3-9: both shift register and feedback are completely checked in the 'SEQUENCE LENGTH' test below. If verification of p.d.f. is required, the Gaussian output can be sampled by DVM and a histogram plotted of the voltage levels generated in a complete sequence (sampling method as for rms amplitude measurement described above).

VARIABLE OUTPUT (binary or Gaussian)

A rapid functional check of the RMS AMPLITUDE control can be made with the 3722A in-operative, i.e. with RESET or HOLD buttons depressed.

Procedure

- 1) Connect the 3722A BINARY fixed output to a DVM as shown in Figure 5-1, but without the 1k Ω load.
- 2) Press the RESET button and note the DVM reading, which should be approximately +10V.
- 3) Transfer the DVM input cable to the 3722A VARIABLE OUTPUT connector.
- 4) Set the red (inner) amplitude control to $\times 10$, and the black (outer) control to 1.0. The DVM reading should be as before, within $\pm 2.5\%$.
- 5) Check each setting of the red and black controls in turn. The calibration accuracy at each setting should be $\pm 2.5\%$ with respect to the voltage at the fixed output.

MAIN CONTROLS

SEQUENCE LENGTH

Procedure

- 1) Connect the 3722A to a 5245L counter as shown in Figure 5-12.
- 2) Set the 5245L controls as follows:

INPUT SENSITIVITY to 1 VOLT RMS

TIME BASE to EXT

FUNCTION to '1' PERIOD AVERAGE

In this condition, the 5245L counts the number of clock periods between sync pulses from the 3722A.

Table 5-3 In-cabinet performance check (continued)

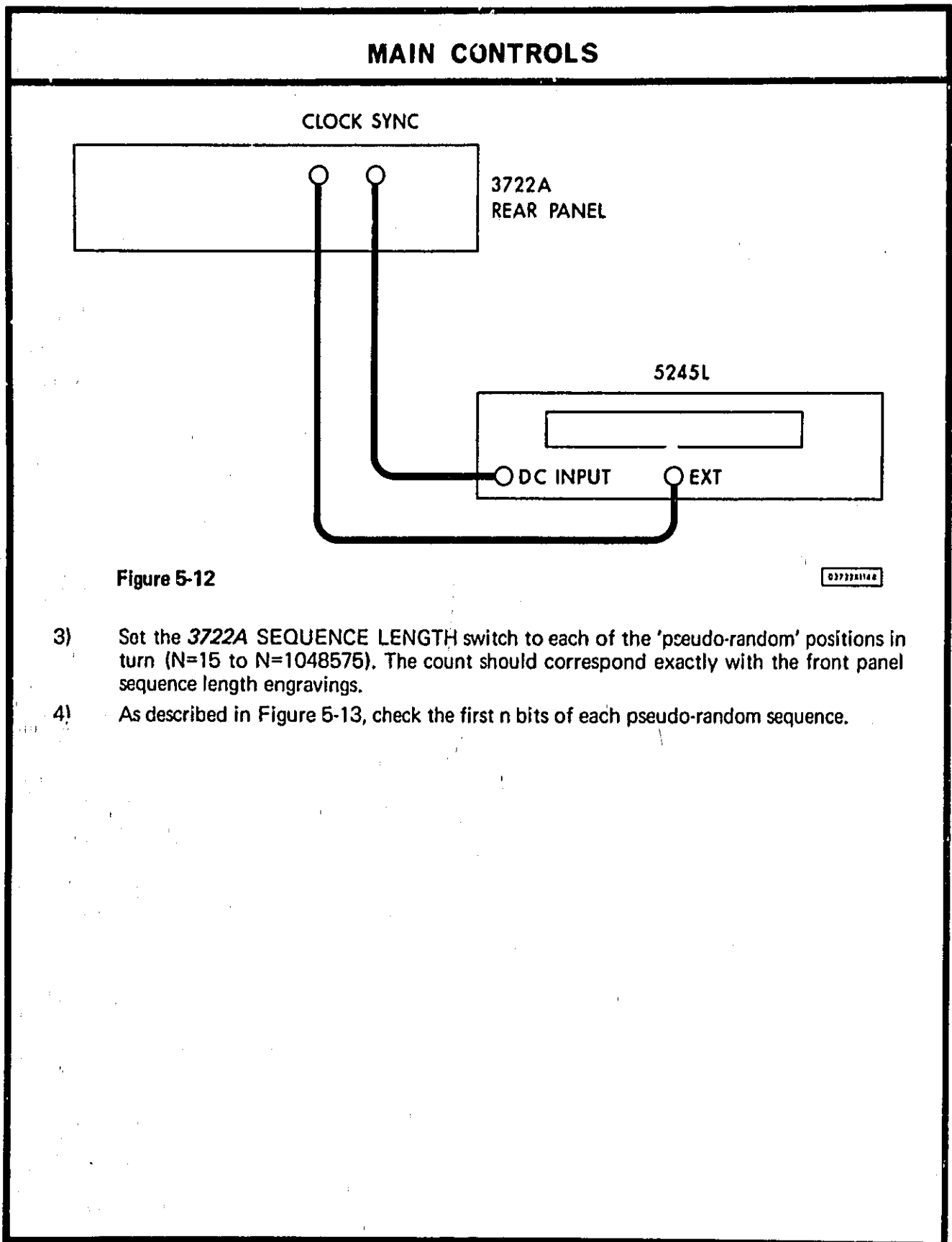


Table 5-3 In-cabinet performance check (continued)

MAIN CONTROLS

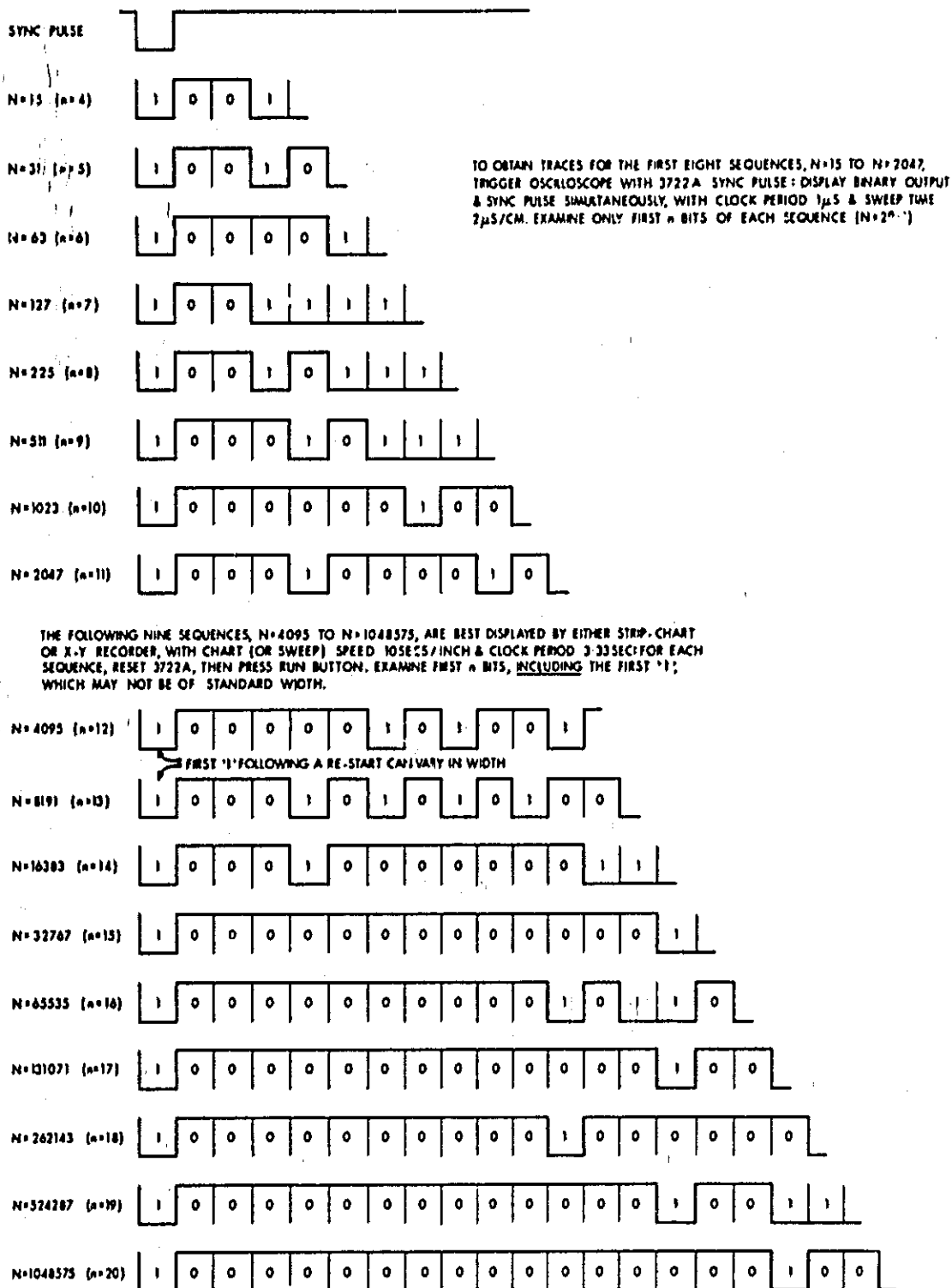
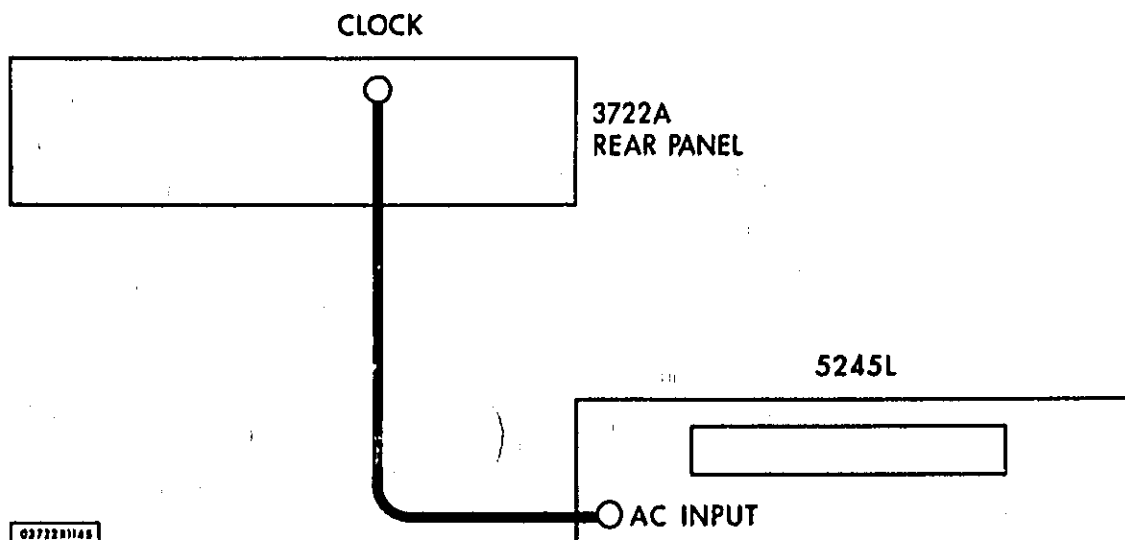


Figure 5-13

03722 X 1069

Table 5-3 In-cabinet performance check (continued)

MAIN CONTROLS

02722011A5

Figure 5-14**CLOCK PERIOD****Procedure**

- 1) Connect the 3722A to a 5245L counter as shown in Figure 5-14.
- 2) Set the 5245L INPUT SENSITIVITY to 1 VOLT RMS.
- 3) Check the 3722A clock period using the settings of 5245L TIMEBASE and FUNCTION switches listed on the next page.

Table 5-3 In-cabinet performance check (continued)

MAIN CONTROLS

3722A CLOCK PERIOD	5245L TIMEBASE	5245L FUNCTION	5245L READOUT
1 μ S	10mS	FREQUENCY	1000kHz
3.33 μ S	0.1 μ S	100 Per'd Av'ge	3.333 μ S
10 μ S	0.1 μ S	10	10.00 μ S
33.3 μ S	0.1 μ S	10	33.33 μ S
100 μ S	0.1 μ S	1	100.0 μ S
333 μ S	0.1 μ S	1	333.3 μ S
1mS	1 μ S	1	1000 μ S
3.33mS	1 μ S	1	3333 μ S
10mS	10 μ S	1	10.00mS
33.3mS	10 μ S	1	33.33mS
100mS	0.1mS	1	100.0mS
333mS	0.1mS	1	333.3mS
1 sec	1mS	1	1000mS
3.33 sec	1mS	1	3333mS
10 sec	10mS	1	10.00 sec
33.3 sec	10mS	1	33.33 sec
100 sec	0.1 sec	1	100.0 sec
333 sec	0.1 sec	1	333.3 sec

- 4) With CLOCK PERIOD switch set to 100 μ S, display on an oscilloscope (sweep time 20 μ S/cm) the clock output from the 3722A. The waveform should be rectangular, and should switch between +1V and +12.5V

EXTERNAL CLOCK

Procedure

Check CAUTION note, Figure 5-15

- 1) With the arrangement shown in Figure 5-15, display the output from the 606A set to approximately 1MHz. Adjust the 606A output attenuator to give a 10V peak-to-peak signal.
- 2) Set the SEQUENCE LENGTH switch to 15 and observe the pseudo-random BINARY output from the 3722A. From left to right on the display, the binary waveform should read: 100110101111000, where '1' is the more negative level.

Table 5-3 In-cabinet performance check (continued)

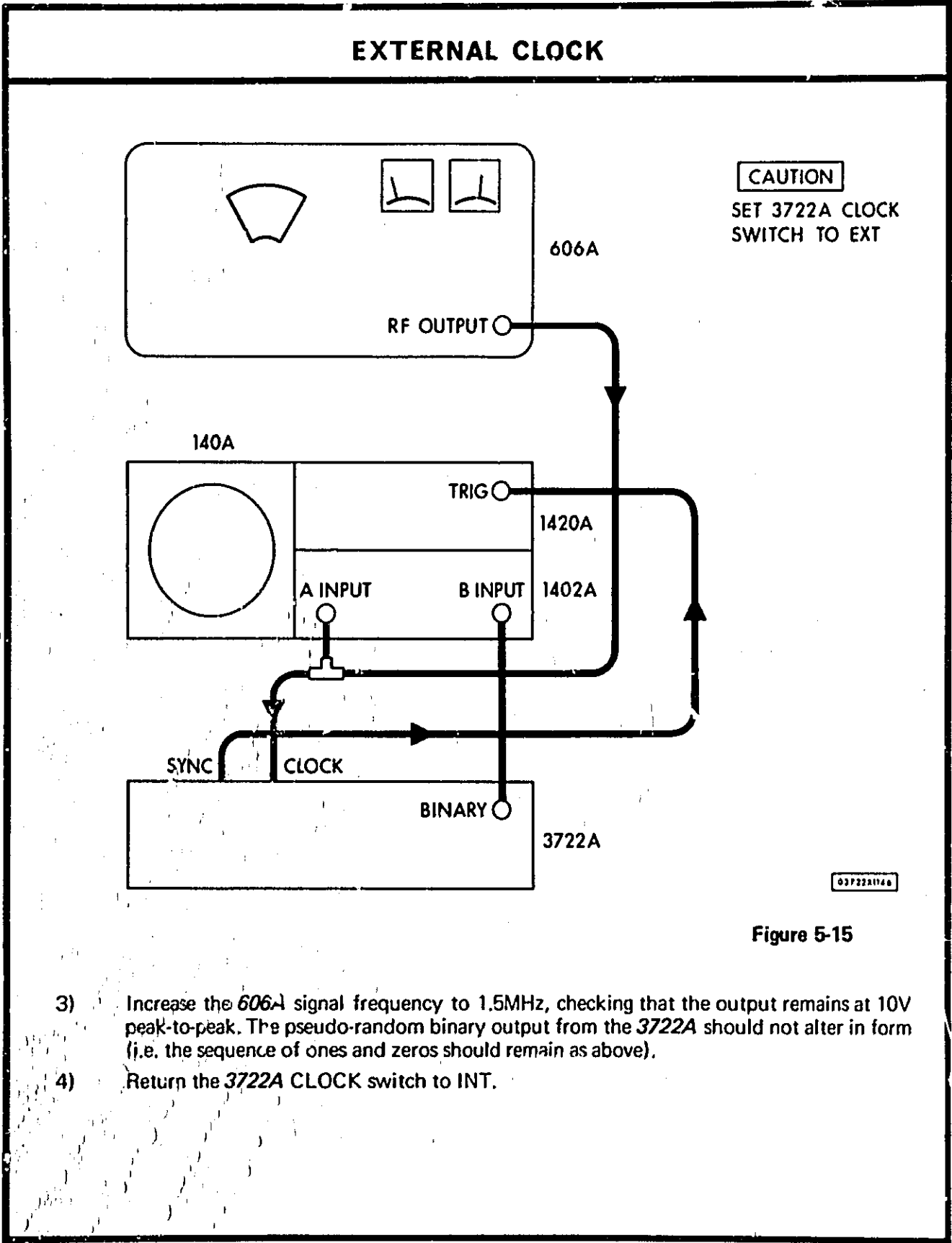


Table 5-3 In-cabinet performance check (continued)

Table 5-3

SECONDARY OUTPUTS**SYNC****Procedure**

- 1) Set the 3722A controls as follows:
SEQUENCE LENGTH to 15
CLOCK PERIOD to 100 μ S.
- 2) With oscilloscope sweep time 20 μ S/cm, display the SYNC output from the 3722A. The sync pulse should be negative-going, of 100 μ S duration, and extend from approximately +1.5V to +12V.

GATE**Procedure**

- 1) Set the 3722A controls as follows:
SEQUENCE LENGTH to 15
CLOCK PERIOD to 1 SEC
SEQUENCES PER GATE INTERVAL to '1'
- 2) Connect a multimeter, set for resistance measurement, to the N/O and COM terminals of the 3722A GATE RELAY.
- 3) With sweep time 2 sec/cm, display the signal from the 3722A GATE connector (BNC).
- 4) Press the GATE RESET button. On the next sync pulse, the display should switch from +12.5V to +1V, and the GATE lamp should light. At the same time, the meter reading should change from open-circuit to short-circuit. After 15 seconds, initial conditions should be restored.
- 5) Repeat the test with the SEQUENCES PER GATE INTERVAL switch set to 2, 4 and 8, in turn.

BINARY RELAY**Procedure**

- 1) Set the 3722A controls as follows:
SEQUENCE LENGTH to 15
CLOCK PERIOD to 1 SEC.
- 2) Connect a multimeter, set for resistance measurement, to the N/O and COM terminals of the 3722A BINARY RELAY.
- 3) Switch ON the BINARY RELAY.
- 4) With sweep time 2 sec/cm, display the 3722A BINARY output on an oscilloscope. The meter reading should alternate between open-circuit and short-circuit in synchronism with the level switching on the display.

Table 5-3 In-cabinet performance check (continued)

REMOTE CONTROL

Procedure

- 1) Set the 3722A controls as follows:
 SEQUENCE LENGTH to 15.
 CLOCK PERIOD to 100mS.
- 2) Press the RUN button, then set the LOCAL/REMOTE switch to REMOTE.
- 3) With oscilloscope sweep time 5 μ S/cm, display the BINARY output from the 3722A.
- 4) Connect pin 34 (RESET) of the CONTROL receptacle (on the 3722A rear panel) briefly to ground. The display should immediately switch to, and remain at, the positive level (+10V).
- 5) Connect pin 36 (RUN) of the receptacle briefly to ground. The display should again alternate between $\pm$ 10V levels.
- 6) Connect pin 35 (HOLD) of the receptacle briefly to ground. The display should immediately hold at one or other of the two levels.
- 7) Repeat step (5). Connect pin 33 (GATE RESET) of the receptacle briefly to ground. On the next sync pulse, the GATE lamp should light. On completion of the gate interval (1.5 seconds), the lamp should be extinguished.

SEQUENCE LENGTH INDICATION

Procedure

- 1) Set the SEQUENCE LENGTH switch to 15.
- 2) Connect a multimeter, set for resistance measurement, between pins 19 (common) and 1 of the CONTROL receptacle. The meter should indicate zero resistance.
- 3) Set the SEQUENCE LENGTH switch to 31.
- 4) Connect the multimeter between pins 19 and 2 of the receptacle. The meter should again indicate zero resistance.
- 5) Repeat the check at the remaining settings of the SEQUENCE LENGTH switch, at each setting connecting the multimeter between pin 19 and the appropriate pin of the CONTROL receptacle.

See following table for list of settings.

Table 5-3 In-cabinet performance check (continued)

SEQUENCE LENGTH INDICATION

SEQUENCE LENGTH	PIN NUMBER
15	1
31	2
63	3
127	4
255	5
511	6
1023	7
2047	8
4095	9
8191	10
16383	11
32767	12
65535	13
131071	14
262143	15
524287	16
1048575	17
INFINITE	18

Table 5-3 In-cabinet performance check (continued)

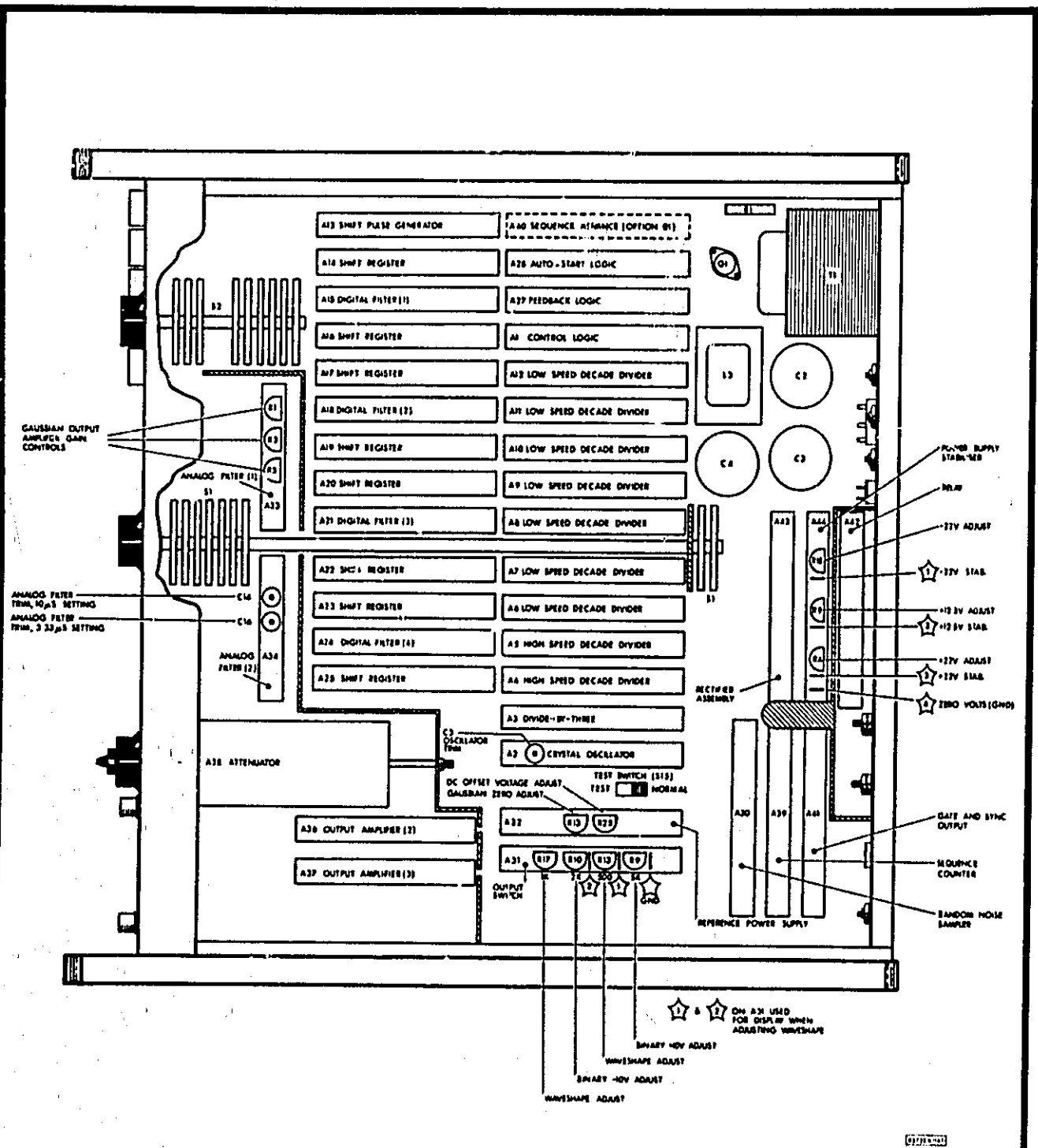


Figure 5-16 Location of assemblies and main test points

Table 5-3 In-cabinet performance check (continued)

Figure 5-16 shows the location of all test points and trimmers.

Stabilised power supplies

+22V supply

Monitor the voltage at test point 3 on A44. This should be $+22V \pm 100mV$. If necessary, adjust A44R4.

+12.5V supply

Monitor the voltage at test point 2 on A44. This should be $+12.5V \pm 100mV$. If necessary, adjust A44R9.

-22V supply

Monitor the voltage at test point 1 on A44. This should be $-22V \pm 100mV$. If necessary, adjust A44R15.

Crystal oscillator

- (1) Set the 3722A controls as follows:

CLOCK PERIOD to $1\mu S$

CLOCK switch (rear panel) to INT

CONTROL switch (rear panel) to LOCAL.

- (2) Operate the RUN button.
- (3) Using an electronic counter, measure the frequency of the CLOCK output (BNC connector, rear panel). Adjust the clock frequency to 1MHz using A2C3.

Binary output amplitude

- (1) Set the 3722A controls as follows:

SEQUENCE LENGTH to 15

CLOCK PERIOD to 3.33 sec

- (2) Connect the DVM to the BINARY output (fixed).
- (3) Operate the 3722A RESET button. The DVM should read $+10V \pm 20mV$. If necessary, adjust A31R9.
- (4) Operate the 3722A RUN button and, as soon as the DVM shows a negative voltage, operate the HOLD button. The DVM should read $-10V \pm 20mV$. If necessary, adjust A31R10.

NOTE Adjustments to A31R9 and A31R10 must be followed by waveshape adjustment (below).

Binary waveshape

- (1) Set the 3722A controls as follows:
SEQUENCE LENGTH to 15
CLOCK PERIOD to 1mS
- (2) Operate the RUN button.
- (3) Set the oscilloscope controls as follows:
INPUT AC coupled
SENSITIVITY 0.05V/CM
TRIGGER EXT from 3722A SYNC
SWEEP TIME 1mS/CM
- (4) Using a 10:1 divider probe, display the waveform at test point 1 on A31. Adjust A31R13 for minimum signal.
- (5) Using the same probe, display the waveform at test point 2 on A31. Adjust A31R17 for minimum signal.



Figure 5 - 17 Typical near-correct adjustment of A31R13

Analog filter trim

This procedure requires the use of a generator providing a 500Hz square wave at 600 Ω output impedance: *hp* function generator, model 3300A, is recommended.

- (1) Remove assemblies A15, A18, A21, A24 and A32.
- (2) Set the CLOCK PERIOD switch to 3.33 μS and operate the HOLD button.
- (3) Connect the CHANNEL A output from the 3300A between socket XA15 pin 4 and ground.

Table 5-4 Adjustment procedures

- (4) Set the 3300A controls as follows:

FREQUENCY 5
RANGE x 100
CHANNEL A SQUARE
CHANNEL B SQUARE

- (5) Connect an oscilloscope to the GAUSS-
IAN (fixed) output.

- (6) Set the oscilloscope controls as follows:

SENSITIVITY 0.2V/CM
TRIGGER EXT (from channel B
of 3300A)
SWEEP TIME 2mS/CM

- (7) Adjust the 3300A channel A amplitude
for 5cm display (excluding overshoot),
then set sweep time to 2 μ S/CM and ob-
serve leading edge of waveform. Ampli-
tude of the overshoot should be between
0.45 and 0.55cm (9 to 11% overshoot); if
necessary, adjust A34C16 to achieve this.

- (8) Repeat with CLOCK PERIOD switch set
to 10 μ S. Again, the overshoot on the 5cm
waveform should be 0.45 to 0.55cm; if
necessary, adjust A34C14 to achieve this.

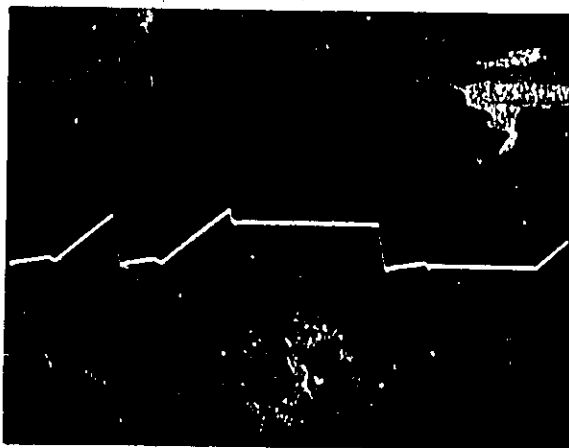


Figure 5-18 Extreme maladjustment
of A31R17

Gaussian offset & zero adjustments

- (1) Connect a dc null voltmeter, model 419A,
to the GAUSSIAN (fixed) output. Set
the voltmeter RANGE switch to 300mV.
Depress the VM button.

- (2) Set the 3722A controls as follows:

SEQUENCE LENGTH to 2047
CLOCK PERIOD to 10 μ S

- (3) Set the GAUSSIAN ZERO control (front
panel) to the mid-position (note the meter
reading at the fully cw and ccw settings,
then set the control to give a meter read-
ing midway between the two). Set both
A32R13 and A32R25 to their mid-
positions.

- (4) Adjust A32R13 (10k Ω) to give null read-
ing on the meter.

- (5) Set the SEQUENCE LENGTH switch to
15 and note the change in meter reading.
If the meter reading changes by more
than 3mV, the dc offset voltage must be
adjusted using A32R25 (1k Ω). The pro-
cedure for this is as follows:

- Make a *very small* adjustment to
A32R25, remembering the direction
of rotation.
- Change the sequence length to 2047
and zero the meter using A32R13.
- Return to sequence length 15 and
note the change in meter reading. If
this is greater than the change ob-
served before, A32R25 was rotated
in the wrong direction. Rectify this
and repeat step (b). Once the correct
direction of A32R25 rotation has
been established, the procedure is
repeated until the change in meter
reading on switching from sequence
length 2047 to 15 is less than 3mV.

- (6) Make final adjustments to the GAUSSIAN
ZERO control.

Table 5-4 Adjustment procedures (continued)

Gaussian output amplifier gain

- (1) Set the 3722A controls as follows:

SEQUENCE LENGTH to 2047

CLOCK PERIOD to 33.3 μ S

- (2) Connect the rms voltmeter, model 3400A, to the GAUSSIAN (fixed) output. The meter reading should be 3.16V rms (full scale on the 3V range); if necessary, adjust A33R1.

- (3) Remove the rms voltmeter and connect in its place a DVM.

- (4) Set the CLOCK PERIOD switch to 333 μ S and operate the RESET button. The DVM reading should be 9.96V $\pm$ 20mV.

- (5) Set the CLOCK PERIOD switch to 1mS. The DVM reading should remain the same; if necessary, adjust A33R3 to achieve this.

- (6) Set the CLOCK PERIOD switch to 3.33mS. Again, the DVM reading should be as before; if necessary, adjust A33R5 to achieve this.

Table 5-4 Adjustment procedures (continued)

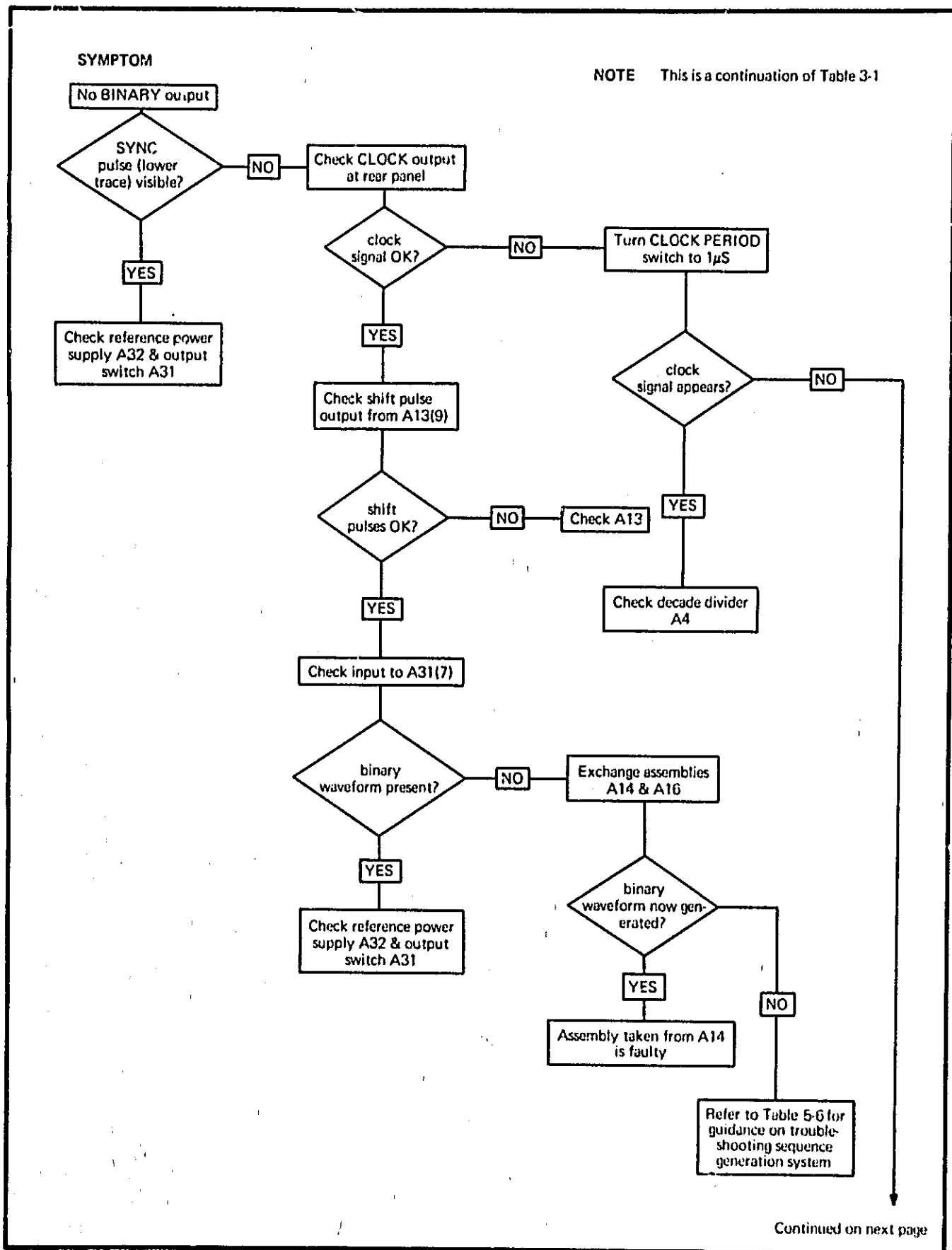


Table 5 - 5 Troubleshooting BINARY system

Table 5-5

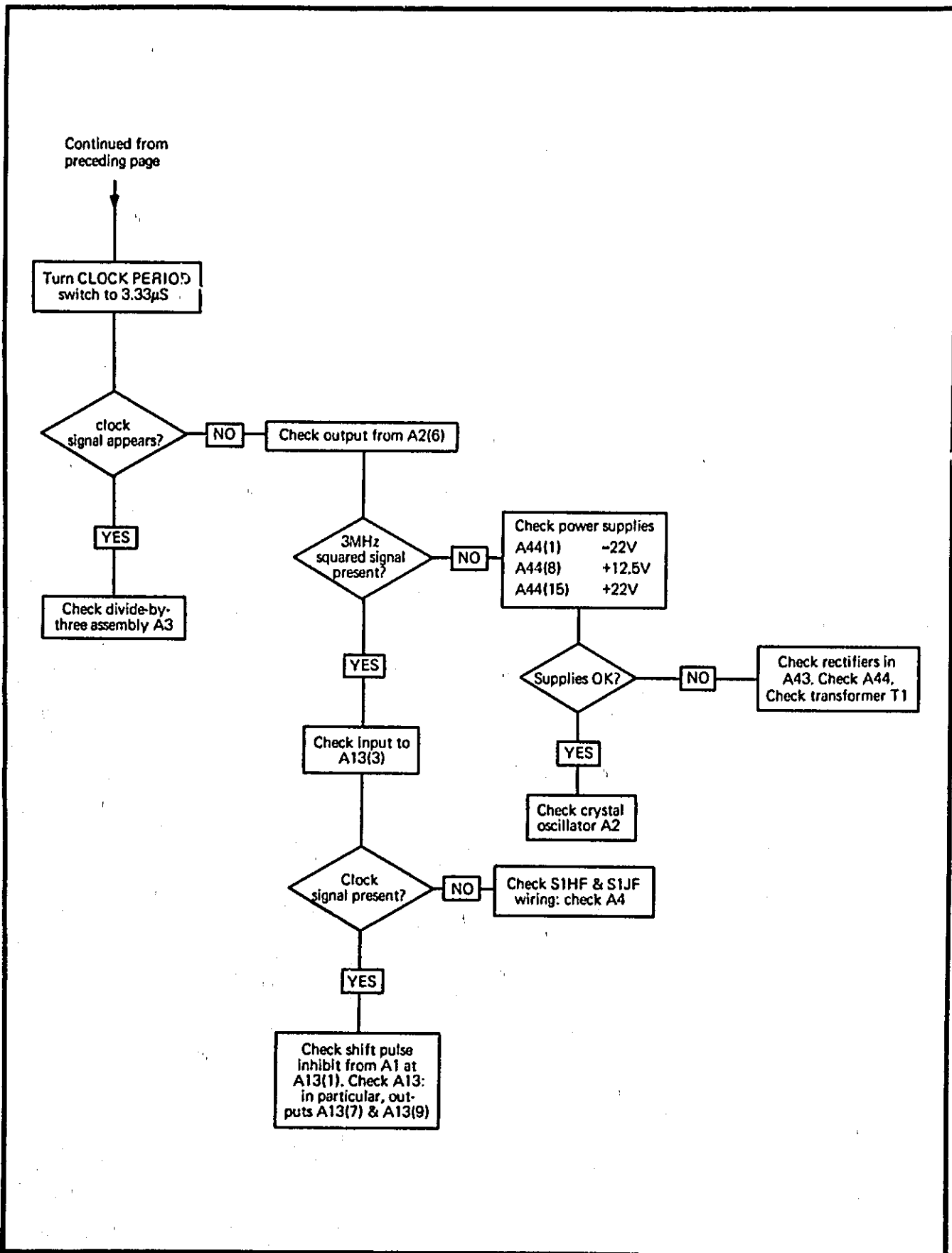


Table 5 - 5 (continued)

SYMPTOM

No sequence generated (that is, no binary waveform present at A31(7)).

LOCATION OF FAULT

If the system fails to generate a sequence even at the lowest (N=15) setting of the SEQUENCE LENGTH switch, the fault must lie in the loop:-

A14 ---> SEQUENCE LENGTH switch S2, wafers DF & EF ---> A27 ---> A28 ---> S2BF
 Check shift register assembly A14 by replacement with any of the other shift register assemblies (see Table 5-5).

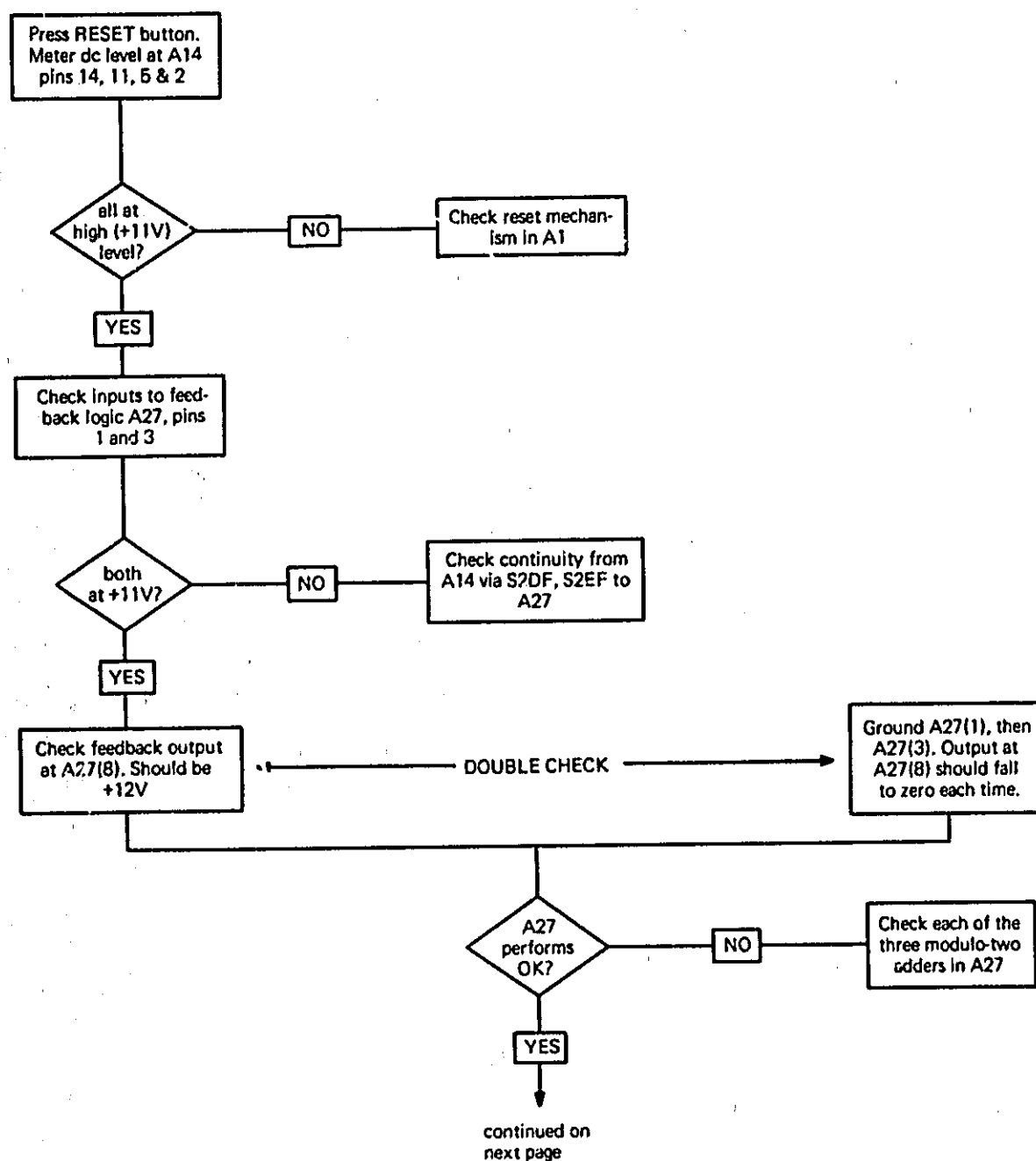


Table 5 - 6 Troubleshooting sequence generation system

Table 5-6

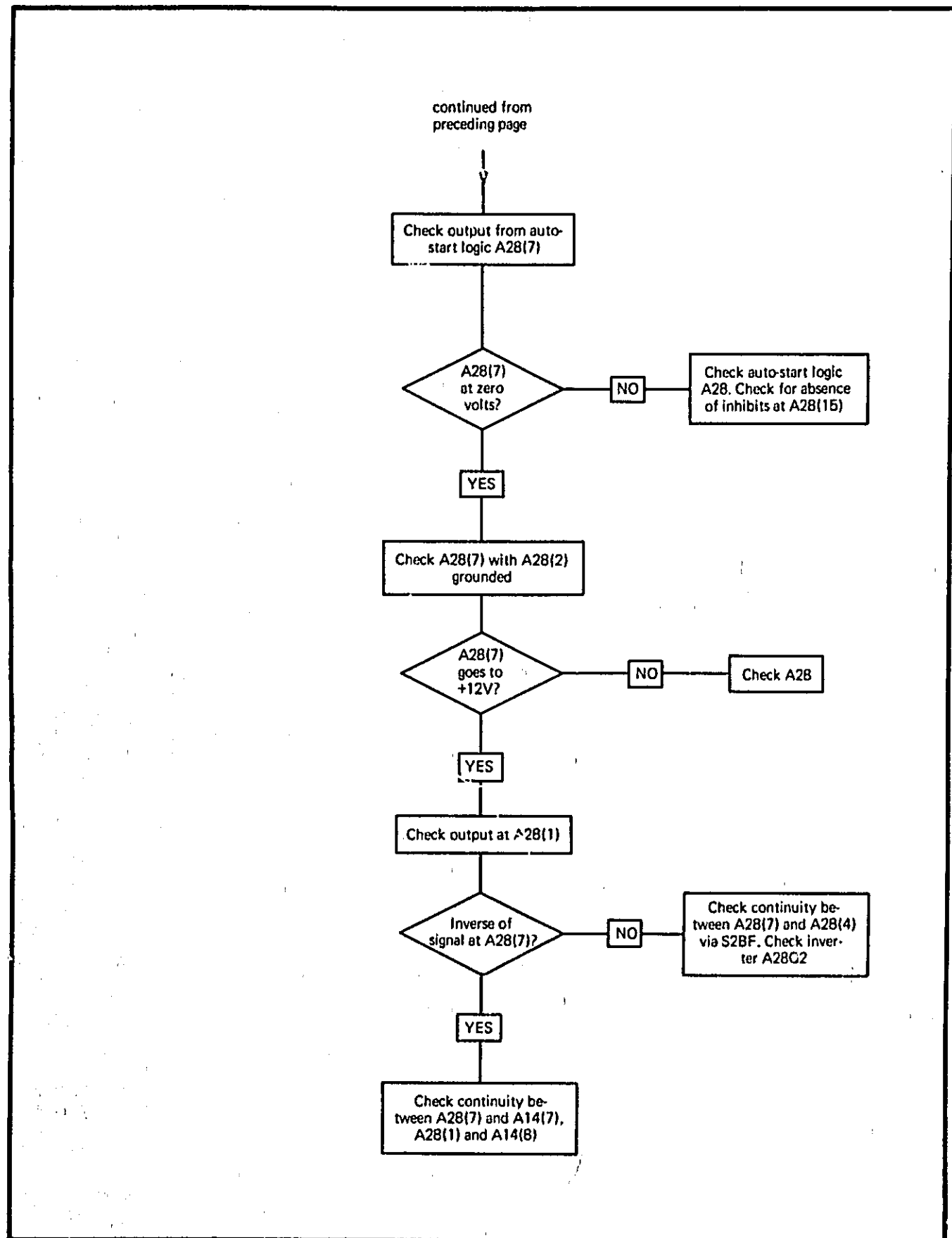


Table 5 - 6 (continued)

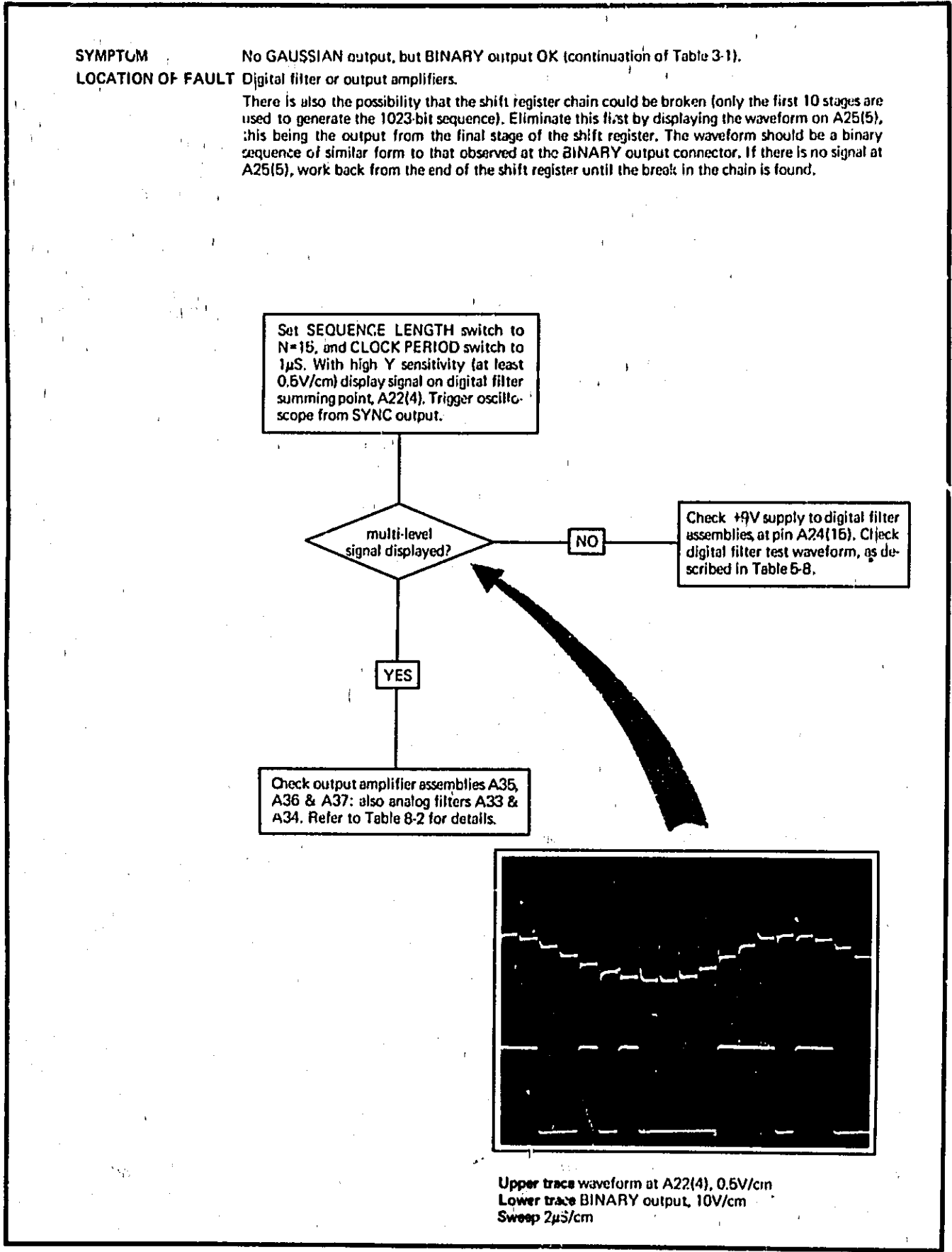


Table 5 - 7 Troubleshooting GAUSSIAN system

Table 5-8

COMMENT

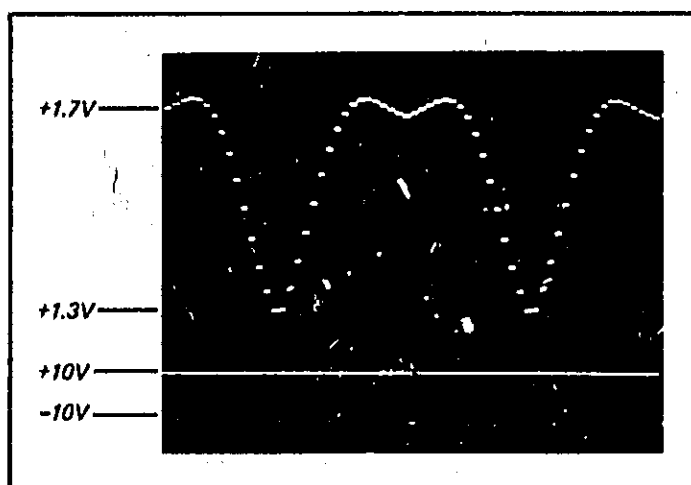
The signal to the GAUSSIAN output spectrum depends almost entirely on the frequency characteristic of the filter. The filter characteristic is very easily checked by the recirculating '1' test, which causes the filter to generate a repeated sequence of $(\sin x/x)$ type waveforms – a train of waveforms. In effect, the impulse response of the filter. The impulse response *completely defines* the frequency characteristic of the filter.

Observation of the output from the filter, when in the recirculating '1' condition, thus reveals any trouble spots likely to affect the output spectrum. The voltage levels (i.e. the steps) in the filter output are defined by precision resistors, and are unlikely to vary by other than small amounts. A really significant failure – for example, a non-functioning resistor clamp circuit – is shown up by an obvious departure from the correct voltage level. Some difference in voltage levels between the 'up slope' and 'down slope' of the $(\sin x/x)$ type waveform may be observed. This difference, which is not normally significant, is owing to the load imposed on the digital filter by the output amplifiers and analog filters: these contain reactive components, the effect of which is particularly apparent in the range of CLOCK PERIOD settings $1\mu\text{S}$ to $333\mu\text{S}$. In other words, it is not possible (at high frequencies) to obtain an undistorted display of the test waveform without disconnecting the amplifiers and analog filters.

TO DISPLAY THE TEST WAVEFORM WITHOUT DISTORTION, detach the white/black wire from A22(4). The voltage levels on the up and down slope should then be identical, even at the shorter CLOCK PERIOD settings.

Procedure to obtain display

- (1) Set the chassis-mounted test switch to TEST.
- (2) Set the SEQUENCE LENGTH switch to INFINITE.
- (3) Display the BINARY output from the 3722A on the B channel of an oscilloscope, with Y sensitivity 20V/cm.
- (4) Display the signal at the digital filter summing point A22(4) on the A channel of the oscilloscope, with Y sensitivity 0.1V/cm, ac coupled.
- (5) Set the CLOCK PERIOD switch to $10\mu\text{S}$.
- (6) Set the oscilloscope sweep rate to $50\mu\text{S}/\text{cm}$.
- (7) Press the RESET button, then the RUN button.
- (8) Trigger the oscilloscope from the B channel input.



Upper trace pattern generated by recirculating '1'
Lower trace BINARY output

Table 5 - 8 Digital filter functional check

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-1 (Reference Designation Index) lists parts in alpha-numerical order of their reference designators and gives the following information for each part:

- Hewlett-Packard stock number.
- Description (abbreviations given in list below).
- Any applicable notes.

6-3 Table 6-2 (Replaceable Parts) lists parts in numerical order of their Hewlett-Packard stock numbers and provides the following information:

- Description of each part (abbreviations given in list below).
- Total quantities of each part used in the instrument (refer to TQ column).

6-4 Table 6-3 (Commercial Equivalents) lists in Hewlett-Packard stock number order all transistors

and diodes used in 3722A and gives for each the following information:

- Jedec equivalent (if any).
- Manufacturer and manufacturer's part number.

6-5 ORDERING INFORMATION

6-6 To order a replacement part, address the order or enquiry to your local Hewlett-Packard field office (see lists at rear of manual for addresses).

6-7 Specify the following information for each part:

- Model and full serial number of instrument.
- Hewlett-Packard stock number.
- Circuit reference designator.
- Description.

6-8 To order a part not listed in the tables, give a complete description of the part including its function and location in the instrument.

REFERENCE DESIGNATORS

A = assembly
C = capacitor
CR = diode
DS = device signalling (lamp)
F = fuse
J = jack

K = relay
L = inductor
MP = miscellaneous part (mechanical)
Q = transistor
R = resistor
S = switch

T = transformer
W = cable
X = socket
XA = printed-circuit assembly connector
XF = fuse holder
Y = crystal

ABBREVIATIONS

A = amperes
AL = aluminium
ASSY = assembly

CCW = counter clockwise
CER = ceramic
COAX = coaxial
COMP = composition
CW = clockwise

LIN = linear taper
LOG = log arithmetic taper

m = milli (10^{-3})
MEG = mega (10^6)
MHz = mega cycles/second
*METALAC = metallized lacquer
MET FLM = metal film
MET OX = metallic oxide
MY = mylar

TA = tantalum
U (μ) = micro (10^{-6})
V = volts
VAR = variable
VDCW = dc working volts

W = watts
W/ = with
WW = wirewound

ELECT = electrolytic
EXT = external

n = nano (10^{-9})
N/C = normally closed
NE = neon
N/O = normally open
NSR = not separately replaceable

COLOUR ABBREVIATIONS

F = farads
FET = field effect transistor
FXD = fixed

PC = printed circuit
P = pico (10^{-12})
PIV = peak inverse voltage
POLY = polystyrene
PPM = parts per million

BLK = black
BRN = brown
RED = red
ORG = orange
YEL = yellow
GRN = green
BLU = blue
VIO = violet
GRY = grey
WHT = white

GE = germanium
GND = ground

RMS = root-mean-square

H = henries

SI = silicon

INT = internal

K = kilo (10^3)
kHz = kilo cycles/second

*U.K. Trade Name

Table 6-1

Table 6-1. Reference Designation Index

Reference Designation	Part No.	Description *	Note
A1	03722-713 03722-313	ASSY: CONTROL LOGIC BOARD: BLANK PC (NSR)	
A1C1	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A1C2	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A1C3	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A1C4	0160-0134	C: FXD MICA 220PF 5% 300VDCW	
A1C5	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A1C6	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A1C7	0160-0300	C: FXD MY 2700PF 10% 200VDCW	
A1C8	0160-0134	C: FXD MICA 220PF 5% 300VDCW	
A1CR1	1901-0040	DIODE: SI	
A1CR2	1901-0040	DIODE: SI	
A1CR3	1901-0040	DIODE: SI	
A1CR4	1901-0040	DIODE: SI	
A1CR5	1901-0040	DIODE: SI	
A1CR6	1901-0040	DIODE: SI	
A1Q1	1854-0605	TRANSISTOR: SI NPN	
A1Q2	1854-0605	TRANSISTOR: SI NPN	
A1Q3	1854-0605	TRANSISTOR: SI NPN	
A1Q4	1854-0605	TRANSISTOR: SI NPN	
A1Q5	1854-0605	TRANSISTOR: SI NPN	
A1R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A1R2	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A1R3	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A1R4	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A1R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A1R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A1R7	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A1R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A1R11	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A1R12	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A1R13	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A1R14	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A1R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A1R16	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A1R17	0758-0015	R: FXD MET OX 220 OHM 5% 1/2W	
A1R18	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W	
A1R19	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A1R20	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A1R21	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A1R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A1R23	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R24	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R25	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A1R26	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R27	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A1R29	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A1R30	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A2	03722-715 03722-315	ASSY: CRYSTAL OSCILLATOR BOARD: BLANK PC (NSR)	
A2C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	
A2C2	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	
A2C3	0121-0105	C: VAR CER 9-35PF	
A2C4	0160-2197	C: FXD MICA 10PF 5% 300VDCW	
A2C5	0150-0086	C: FXD CER 4700PF 20% 500VDCW	
A2C6	0160-2208	C: FXD MICA 330PF 5% 300VDCW	
A2C7	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	
A2C8	0160-0179	C: FXD MICA 33PF 5% 300VDCW	
A2C9	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A2C10	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A2CR1	1901-0040	DIODE: SI	
A2L1	9100-1633	L: FXD COIL 68UH 5%	
A2MP1	0380-0509	BEAD: GLASS	
A2MP2	0380-0509	BEAD: GLASS	
A2Q1	1854-0605	TRANSISTOR: SI NPN	
A2Q2	1853-0034	TRANSISTOR: SI PNP	
A2Q3	1853-0034	TRANSISTOR: SI PNP	
A2R1	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A2R2	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A2R3	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A2R4	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	
A2R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A2R6	0758-0017	R: FXD MET OX 1.5K OHM 5% 1/2W	
A2R7	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A2T1	9100-0619	TRANSFORMER: CRYSTAL OSCILLATOR	
A2Y1	0410-0601	CRYSTAL: QUARTZ 3MHz	
A3	03722-705 03722-305	ASSY: DIVIDE-BY-THREE BOARD: BLANK PC (NSR)	
A3C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A3C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A3CR1	1901-0040	DIODE: SI	
A3CR2	1901-0040	DIODE: SI	
A3CR3	1901-0040	DIODE: SI	
A3CR4	1901-0040	DIODE: SI	
A3CR5	1901-0040	DIODE: SI	
A3CR6	1901-0040	DIODE: SI	
A3CR7	1901-0040	DIODE: SI	
A3CR8	1901-0040	DIODE: SI	
A3CR9	1901-0040	DIODE: SI	
A3CR10	1901-0040	DIODE: SI	
A3Q1	1854-0605	TRANSISTOR: SI NPN	
A3Q2	1853-0034	TRANSISTOR: SI PNP	
A3Q3	1853-0034	TRANSISTOR: SI PNP	
A3Q4	1853-0034	TRANSISTOR: SI PNP	
A3Q5	1853-0034	TRANSISTOR: SI PNP	
A3R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A3R2	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A3R3	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A3R4	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A3R5	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A3R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A3R7	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A3R8	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A3R9	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A3R10	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A3R11	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A3R12	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A3R13	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A3R14	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A3R15	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W	
A4	03722-725 03722-325	ASSY: HIGH-SPEED DECADE DIVIDER BOARD: BLANK PC (NSR)	
A4C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	
A4C2	0140-0193	C: FXD MICA 82PF 5% 300VDCW	
A4C3	0140-0191	C: FXD MICA 56PF 5% 300VDCW	
A4C4	0140-0191	C: FXD MICA 56PF 5% 300VDCW	
A4C5	0150-0122	C: FXD CER 2000PF 20% 500VDCW	
A4C6	0140-0191	C: FXD MICA 56PF 5% 300VDCW	
A4C7	0160-0181	C: FXD MICA 30PF 5% 300VDCW	
A4C8	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A4C9	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A4C10	0140-0193	C: FXD MICA 82PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A4C11	0140-0195	C: FXD MICA 130PF 5% 300VDCW	
A4C12	0140-0193	C: FXD MICA 82PF 5% 300VDCW	
A4C13	0140-0193	C: FXD MICA 82PF 5% 300VDCW	
A4C14	0140-0195	C: FXD MICA 130PF 5% 300VDCW	
A4C15	0140-0176	C: FXD MICA 100PF 2% 300VDCW	
A4C16	0140-0193	C: FXD MICA 82PF 5% 300VDCW	
A4CR1	1901-0040	DIODE: SI	
A4CR2	1901-0040	DIODE: SI	
A4CR3	1901-0040	DIODE: SI	
A4CR4	1901-0040	DIODE: SI	
A4CR5	1901-0040	DIODE: SI	
A4CR6	1901-0040	DIODE: SI	
A4CR7	1901-0040	DIODE: SI	
A4CR8	1901-0040	DIODE: SI	
A4CR9	1901-0040	DIODE: SI	
A4CR10	1901-0040	DIODE: SI	
A4CR11	1901-0040	DIODE: SI	
A4Q1	1853-0034	TRANSISTOR: SI PNP	
A4Q2	1853-0034	TRANSISTOR: SI PNP	
A4Q3	1853-0034	TRANSISTOR: SI PNP	
A4Q4	1853-0034	TRANSISTOR: SI PNP	
A4Q5	1853-0034	TRANSISTOR: SI PNP	
A4Q6	1853-0034	TRANSISTOR: SI PNP	
A4Q7	1853-0034	TRANSISTOR: SI PNP	
A4Q8	1853-0034	TRANSISTOR: SI PNP	
A4R1	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A4R2	0758-0024	R: FXD MET FLM 100 OHM 5% 1/2W	
A4R3	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W	
A4R4	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A4R5	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A4R7	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W	
A4R8	0698-4232	R: FXD MET OX 110 OHM 5% 1/4W	
A4R9	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A4R11	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W	
A4R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R13	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A4R14	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W	
A4R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A4R16	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W	
A4R17	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A4R18	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A4R20	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A4R21	0698-4232	R: FXD MET OX 110 OHM 5% 1/4W	
A4R22	0698-4288	R: FXD MET OX 27K OHM 5% 1/4W	
A4R23	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A4R24	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W	
A4R25	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R26	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A4R27	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W	
A4R28	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A4R29	0758-0004	R: FXD MET FLM 2.7K OHM 5% 1/2W	
A4R30	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A4R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R32	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A4R33	0698-5707	R: FXD MET OX 47 OHM 5% 1/4W	
A4R34	0698-4232	R: FXD MET OX 110 OHM 5% 1/4W	
A4R35	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R36	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A4R37	0698-3799	R: FXD MET OX 22 OHM 5% 1/4W	
A4R38	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R39	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A4R40	0758-0004	R: FXD MET FLM 2.7K OHM 5% 1/2W	
A4R41	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A4R42	0758-0004	R: FXD MET FLM 2.7K OHM 5% 1/2W	
A4R43	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A4R44	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R45	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A4R46	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R47	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	
A4R48	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A4R49	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A4R50	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A4R51	0758-0004	R: FXD MET FLM 2.7K OHM 5% 1/2W	
A4R52	0698-4265	R: FXD MET OX 3.0K OHM 5% 1/4W	
A4R53	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W	
A5		SAME AS A4: USE PREFIX A5	
A6	5212A-65C 5212A-65C-1	ASSY: LOW-SPEED DECADE DIVIDER BOARD: BLANK PC (NSR)	
A6C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	
A6C2	0140-0194	C: FXD MICA 110PF 5% 300VDCW	
A6C3	0140-0195	C: FXD MICA 130PF 5% 300VDCW	
A6C4	0140-0195	C: FXD MICA 130PF 5% 300VDCW	
A6C5	0140-0196	C: FXD MICA 150PF 5% 300VDCW	
A6C6	0140-0196	C: FXD MICA 150PF 5% 300VDCW	
A6C7	0140-0196	C: FXD MICA 150PF 5% 300VDCW	
A6C8	0140-0199	C: FXD MICA 240PF 5% 300VDCW	
A6C9	0140-0195	C: FXD MICA 130PF 5% 300VDCW	
A6C10	0140-0195	C: FXD MICA 130PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A6C11	0140-0194	C: FXD MICA 110PF 5% 300VDCW	
A6C12	0140-0198	C: FXD MICA 200PF 5% 300VDCW	
A6C13	0140-0198	C: FXD MICA 200PF 5% 300VDCW	
A6C14	0140-0200	C: FXD MICA 390PF 5% 300VDCW	
A6CR1	1910-0016	DIODE: GE	
A6CR2	1910-0016	DIODE: GE	
A6CR3	1910-0016	DIODE: GE	
A6CR4	1910-0016	DIODE: GE	
A6CR5	1910-0016	DIODE: GE	
A6Q1	1850-0062	TRANSISTOR: GE PNP	
A6Q2	1850-0062	TRANSISTOR: GE PNP	
A6Q3	1850-0062	TRANSISTOR: GE PNP	
A6Q4	1850-0062	TRANSISTOR: GE PNP	
A6Q5	1850-0062	TRANSISTOR: GE PNP	
A6Q6	1850-0062	TRANSISTOR: GE PNP	
A6Q7	1850-0062	TRANSISTOR: GE PNP	
A6Q8	1850-0062	TRANSISTOR: GE PNP	
A6R1	0683-3915	R: FXD COMP 390 OHM 5% 1/4W	
A6R2	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R3	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R4	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R5	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R6	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R7	0683-2015	R: FXD COMP 200 OHM 5% 1/4W	
A6R8	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R9	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R10	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R11	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R12	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R13	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R14	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R15	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R16	0683-8225	R: FXD COMP 8.2K OHM 5% 1/4W	
A6R17	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R18	0683-2015	R: FXD COMP 200 OHM 5% 1/4W	
A6R19	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R20	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R21	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R22	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R23	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R24	0383-6835	R: FXD COMP 68K OHM 5% 1/4W	
A6R25	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R26	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R27	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R28	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R29	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R30	0683-2015	R: FXD COMP 200 OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation. Inde: (Cont'd)

Reference Designation	Part No.	Description *	Note
A6P31	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R32	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R33	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R34	0683-8225	R: FXD COMP 8.2K OHM 5% 1/4W	
A6R35	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R36	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R37	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R38	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R39	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R40	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R41	0683-2015	R: FXD COMP 200 OHM 5% 1/4W	
A6R42	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	
A6R43	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	
A6R44	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A6R45	0683-1035	R: FXD COMP 10K OHM 5% 1/4W	
A6R46	0683-4735	R: FXD COMP 47K OHM 5% 1/4W	
A7		SAME AS A6: USE PREFIX A7	
A8		SAME AS A6: USE PREFIX A8	
A9		SAME AS A3: USE PREFIX A9	
A10		SAME AS A6: USE PREFIX A10	
A11		SAME AS A6: USE PREFIX A11	
A12		SAME AS A6: USE PREFIX A12	
A13	03722-703 03722-303	ASSY: SHIFT PULSE GENERATOR BOARD: BLANK PC (NSR)	
A13C1	0160-0137	C: FXD CER 0.33UF 20% 25VDCW	
A13C2	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A13C3	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A13C4	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A13C5	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A13C6	0160-2009	C: FXD MICA 820PF 5% 300VDCW	
A13C7	0160-2208	C: FXD MICA 330PF 5% 300VDCW	
A13CR1	1901-0040	DIODE: SI	
A13CR2	1901-0040	DIODE: SI	
A13CR3	1901-0040	DIODE: SI	
A13CR4	1901-0040	DIODE: SI	
A13CR5	1910-0034	DIODE: GE	
A13CR6	1910-0034	DIODE: GE	
A13CR7	1901-0040	DIODE: SI	
A13CR8	1901-0040	DIODE: SI	
A13CR9	1901-0040	DIODE: SI	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A13Q1	1854-0605	TRANSISTOR: SI NPN	
A13Q2	1854-0605	TRANSISTOR: SI NPN	
A13Q3	1853-0034	TRANSISTOR: SI PNP	
A13Q4	1854-0605	TRANSISTOR: SI NPN	
A13Q5	1854-0605	TRANSISTOR: SI NPN	
A13Q6	1854-0215	TRANSISTOR: SI NPN	
A13R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A13R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A13R3	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A13R4	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A13R5	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A13R6	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A13R7	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A13R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A13R9	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	
A13R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A13R11	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A13R12	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A13R13	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A13R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A13R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A13R16	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A13R17	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A13R18	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A13R19	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A13R20	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W	
A13R21	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A13R22	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W	
A13R23	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A13R24		NOT ASSIGNED	
A13R25	0761-0026	R: FXD MET OX 220 OHM 5% 1W	
A13R26	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A13R27	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A13T1	9100-0620	TRANSFORMER: SHIFT PULSE GENERATOR	
A14	03722-704 03722-304	ASSY: SHIFT REGISTER BOARD: BLANK PC (NSR)	
A14C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A14C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A14CR1	1901-0040	DIODE: SI	
A14CR2	1901-0040	DIODE: SI	
A14CR3	1901-0040	DIODE: SI	
A14CR4	1901-0040	DIODE: SI	
A14CR5	1901-0040	DIODE: SI	
A14CR6	1901-0040	DIODE: SI	
A14CR7	1901-0040	DIODE: SI	
A14CR8	1901-0040	DIODE: SI	
A14CR9	1901-0040	DIODE: SI	
A14CR10	1901-0040	DIODE: SI	
A14CR11	1901-0040	DIODE: SI	
A14CR12	1901-0040	DIODE: SI	
A14Q1	1854-0605	TRANSISTOR: SI NPN	
A14Q2	1854-0605	TRANSISTOR: SI NPN	
A14Q3	1854-0605	TRANSISTOR: SI NPN	
A14Q4	1854-0605	TRANSISTOR: SI NPN	
A14Q5	1854-0605	TRANSISTOR: SI NPN	
A14Q6	1854-0605	TRANSISTOR: SI NPN	
A14Q7	1854-0605	TRANSISTOR: SI NPN	
A14Q8	1854-0605	TRANSISTOR: SI NPN	
A14R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R3	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R5	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R6	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R8	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R10	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R11	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R13	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R14	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R16	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R19	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R20	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A14R21	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R22	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R24	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R26	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A14R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R29	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A14R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A14R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A15	03722-706 03722-306	ASSY: DIGITAL-TO-ANALOG CONVERTER (1) BOARD: BLANK PC (NSR)	
A15C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A15Q1	1853-0015	TRANSISTOR: SI PNP	
A15Q2	1854-0605	TRANSISTOR: SI NPN	
A15Q3	1853-0015	TRANSISTOR: SI PNP	
A15Q4	1854-0605	TRANSISTOR: SI NPN	
A15Q5	1853-0015	TRANSISTOR: SI PNP	
A15Q6	1854-0605	TRANSISTOR: SI NPN	
A15Q7	1853-0015	TRANSISTOR: SI PNP	
A15Q8	1854-0605	TRANSISTOR: SI NPN	
A15Q9	1853-0015	TRANSISTOR: SI PNP	
A15Q10	1854-0605	TRANSISTOR: SI NPN	
A15Q11	1853-0015	TRANSISTOR: SI PNP	
A15Q12	1854-0605	TRANSISTOR: SI NPN	
A15Q13	1853-0015	TRANSISTOR: SI PNP	
A15Q14	1854-0605	TRANSISTOR: SI NPN	
A15R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R5	0757-0484	R: FXD MET FLM 619K OHM 1% 1/8W 100 PPM	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A15R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R10	0698-5797	R: FXD MET FLM 296K OHM 1% 1/8W 150 PPM	
A15R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R15	0698-5796	R: FXD MET FLM 186K OHM 1% 1/8W 150 PPM	
A15R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R20	0698-5795	R: FXD MET FLM 138K OHM 1% 1/8W 100 PPM	
A15R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R25	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM	
A15R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R30	0757-0468	R: FXD MET FLM 130K OHM 1% 1/8W 100 PPM	
A15R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A15R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A15R35	0757-0472	R: FXD MET FLM 200K OHM 1% 1/8W 100 PPM	
A15TP1	0360-0124	TERMINAL PIN	
A15TP2	0360-0124	TERMINAL PIN	
A15TP3	0360-0124	TERMINAL PIN	
A15TP4	0360-0124	TERMINAL PIN	
A15TP5	0360-0124	TERMINAL PIN	
A15TP6	0360-0124	TERMINAL PIN	
A15TP7	0360-0124	TERMINAL PIN	
A16		SAME AS A14: USE PREFIX A16	
A17		SAME AS A14: USE PREFIX A17	
A18	03722-721 03722-321	ASSY: DIGITAL-TO-ANALOG CONVERTER (2) BOARD: BLANK PC (NSR)	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A18C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A18Q1	1853-0015	TRANSISTOR: SI PNP	
A18Q2	1854-0605	TRANSISTOR: SI NPN	
A18Q3	1853-0015	TRANSISTOR: SI PNP	
A18Q4	1854-0605	TRANSISTOR: SI NPN	
A18Q5	1853-0015	TRANSISTOR: SI PNP	
A18Q6	1854-0605	TRANSISTOR: SI NPN	
A18Q7	1853-0015	TRANSISTOR: SI PNP	
A18Q8	1854-0605	TRANSISTOR: SI NPN	
A18Q9	1853-0015	TRANSISTOR: SI PNP	
A18Q10	1854-0605	TRANSISTOR: SI NPN	
A18Q11	1853-0015	TRANSISTOR: SI PNP	
A18Q12	1854-0605	TRANSISTOR: SI NPN	
A18Q13	1853-0015	TRANSISTOR: SI PNP	
A18Q14	1854-0605	TRANSISTOR: SI NPN	
A18Q15	1853-0015	TRANSISTOR: SI PNP	
A18Q16	1854-0605	TRANSISTOR: SI NPN	
A18R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R5	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM	
A18R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R10	0698-5794	R: FXD MET FLM 52.6K OHM 1/2% 1/8W 50 PPM	
A18R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R15	0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A18R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R20	0698-5792	R: FXD MET FLM 21.3K OHM 1/2% 1/8W 50 PPM	
A18R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R25	0698-5791	R: FXD MET FLM 16K OHM 1/2% 1/8W 50 PPM	
A18R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R30	0698-5790	R: FXD MET FLM 12.95K OHM 1/2% 1/8W 50 PPM	
A18R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R35	0698-5789	R: FXD MET FLM 11.1K OHM 1/2% 1/8W 50 PPM	
A18R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A18R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A18R40	0698-5788	R: FXD MET FLM 10K OHM 1/2% 1/8W 50 PPM	
A18TP1	0360-0124	TERMINAL PIN	
A18TP2	0360-0124	TERMINAL PIN	
A18TP3	0360-0124	TERMINAL PIN	
A18TP4	0360-0124	TERMINAL PIN	
A18TP5	0360-0124	TERMINAL PIN	
A18TP6	0360-0124	TERMINAL PIN	
A18TP7	0360-0124	TERMINAL PIN	
A18TP8	0360-0124	TERMINAL PIN	
A19		SAME AS A14: USE PREFIX A19	
A20		SAME AS A14: USE PREFIX A20	
A21	03722-723 03722-323	ASSY: DIGITAL-TO-ANALOG CONVERTER (3) BOARD: BLANK PC (NSR)	
A21C1	0160-2306	C: FXD MICA 27PF 5% 300VDCV	
A21C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A21C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A21Q1	1853-0015	TRANSISTOR: SI PNP	
A21Q2	1854-0605	TRANSISTOR: SI NPN	
A21Q3	1853-0015	TRANSISTOR: SI PNP	
A21Q4	1854-0605	TRANSISTOR: SI NPN	
A21Q5	1853-0015	TRANSISTOR: SI PNP	
A21Q6	1854-0605	TRANSISTOR: SI NPN	
A21Q7	1853-0015	TRANSISTOR: SI PNP	
A21Q8	1854-0605	TRANSISTOR: SI NPN	
A21Q9	1853-0015	TRANSISTOR: SI PNP	
A21Q10	1854-0605	TRANSISTOR: SI NPN	
A21Q11	1853-0015	TRANSISTOR: SI PNP	
A21Q12	1854-0605	TRANSISTOR: SI NPN	
A21Q13	1853-0015	TRANSISTOR: SI PNP	
A21Q14	1854-0605	TRANSISTOR: SI NPN	
A21Q15	1853-0015	TRANSISTOR: SI PNP	
A21Q16	1854-0605	TRANSISTOR: SI NPN	
A21R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R5	0698-5788	R: FXD MET FLM 10K OHM 1/2% 1/8W 50 PPM	
A21R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R10	0698-5789	R: FXD MET FLM 11.1K OHM 1/2% 1/8W 50 PPM	
A21R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R15	0698-5790	R: FXD MET FLM 12.95K OHM 1/2% 1/8W 50 PPM	
A21R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R20	0698-5791	R: FXD MET FLM 16K OHM 1/2% 1/8W 50 PPM	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A21R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R25	0698-5792	R: FXD MET FLM 21.3K OHM 1/2% 1/8W 50 PPM	
A21R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R30	0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM	
A21R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R35	0698-5794	R: FXD MET FLM 52.6K OHM 1/2% 1/8W 50 PPM	
A21R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A21R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A21R40	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM	
A21TP1	0360-0124	TERMINAL PIN	
A21TP2	0360-0124	TERMINAL PIN	
A21TP3	0360-0124	TERMINAL PIN	
A21TP4	0360-0124	TERMINAL PIN	
A21TP5	0360-0124	TERMINAL PIN	
A21TP6	0360-0124	TERMINAL PIN	
A21TP7	0360-0124	TERMINAL PIN	
A21TP8	0360-0124	TERMINAL PIN	
A22		SAME AS A14: USE PREFIX A22	
A23		SAME AS A14: USE PREFIX A23	
A24	03722-724 03722-324	ASSY: DIGITAL-TO-ANALOG CONVERTER (4) BOARD: BLANK PC (NSR)	
A24C1		NOT ASSIGNED	
A24C2		NOT ASSIGNED	
A24C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A24C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A24Q1		NOT ASSIGNED	
A24Q2		NOT ASSIGNED	
A24Q3	1853-0015	TRANSISTOR: SI PNP	
A24Q4	1854-0605	TRANSISTOR: SI NPN	
A24Q5	1853-0015	TRANSISTOR: SI PNP	
A24Q6	1854-0605	TRANSISTOR: SI NPN	
A24Q7	1853-0015	TRANSISTOR: SI PNP	
A24Q8	1854-0605	TRANSISTOR: SI NPN	
A24Q9	1853-0015	TRANSISTOR: SI PNP	
A24Q10	1854-0605	TRANSISTOR: SI NPN	
A24Q11	1853-0015	TRANSISTOR: SI PNP	
A24Q12	1854-0605	TRANSISTOR: SI NPN	
A24Q13	1853-0015	TRANSISTOR: SI PNP	
A24Q14	1854-0605	TRANSISTOR: SI NPN	
A24Q15	1853-0015	TRANSISTOR: SI PNP	
A24Q16	1854-0605	TRANSISTOR: SI NPN	
A24R1		NOT ASSIGNED	
A24R2		NOT ASSIGNED	
A24R3		NOT ASSIGNED	
A24R4		NOT ASSIGNED	
A24R5		NOT ASSIGNED	
A24R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R10	0757-0472	R: FXD MET FLM 200K OHM 1% 1/8W 100 PPM	
A24R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R15	0757-0468	R: FXD MET FLM 130K OHM 1% 1/8W 100 PPM	
A24R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R20	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM	
A24R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R25	0698-5795	R: FXD MET FLM 138K OHM 1% 1/8W 100 PPM	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A24R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R30	0698-5796	R: FXD MET FLM 186K OHM 1% 1/8W 150 PPM	
A24R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R35	0698-5797	R: FXD MET FLM 296K OHM 1% 1/8W 150 PPM	
A24R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A24R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A24R40	0757-0484	R: FXD MET FLM 619K OHM 1% 1/8W 100 PPM	
A24TP1		NOT ASSIGNED	
A24TP2	0360-0124	TERMINAL PIN	
A24TP3	0360-0124	TERMINAL PIN	
A24TP4	0360-0124	TERMINAL PIN	
A24TP5	0360-0124	TERMINAL PIN	
A24TP6	0360-0124	TERMINAL PIN	
A24TP7	0360-0124	TERMINAL PIN	
A24TP8	0360-0124	TERMINAL PIN	
A25		SAME AS A14: USE PREFIX A25	
A26		NOT ASSIGNED	
A27	03722-701 03722-301	ASSY: FEEDBACK LOGIC BOARD: BLANK PC (NSR)	
A27C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A27CR1	1901-0040	DIODE: SI	
A27CR2	1901-0040	DIODE: SI	
A27CR3	1901-0040	DIODE: SI	
A27CR4	1901-0040	DIODE: SI	
A27CR5	1901-0040	DIODE: SI	
A27CR6	1901-0040	DIODE: SI	
A27CR7	1901-0040	DIODE: SI	
A27CR8	1901-0040	DIODE: SI	
A27CR9	1901-0040	DIODE: SI	
A27CR10	1901-0040	DIODE: SI	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A27CR11	1901-0040	DIODE: SI	
A27CR12	1901-0040	DIODE: SI	
A27CR13	1901-0040	DIODE: SI	
A27CR14	1901-0040	DIODE: SI	
A27CR15	1901-0040	DIODE: SI	
A27CR16	1901-0040	DIODE: SI	
A27CR17	1901-0040	DIODE: SI	
A27CR18	1901-0040	DIODE: SI	
A27Q1	1854-0605	TRANSISTOR: SI NPN	
A27Q2	1854-0605	TRANSISTOR: SI NPN	
A27Q3	1854-0605	TRANSISTOR: SI NPN	
A27Q4	1854-0605	TRANSISTOR: SI NPN	
A27Q5	1854-0605	TRANSISTOR: SI NPN	
A27Q6	1854-0605	TRANSISTOR: SI NPN	
A27Q7	1854-0605	TRANSISTOR: SI NPN	
A27Q8	1854-0605	TRANSISTOR: SI NPN	
A27Q9	1854-0605	TRANSISTOR: SI NPN	
A27R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R5	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R7	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A27R8	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A27R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R10	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R11	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R17	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R18	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A27R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A27R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R26	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A27R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A27R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A27R31	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R32	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A27R33	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A28	03722-702 03722-302	ASSY: AUTO-START LOGIC BOARD: BLANK PC (NSR)	
A28C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A28CR1	1901-0040	DIODE: SI	
A28CR2	1901-0040	DIODE: SI	
A28CR3	1901-0040	DIODE: SI	
A28CR4	1901-0040	DIODE: SI	
A28CR5	1901-0040	DIODE: SI	
A28CR6	1901-0040	DIODE: SI	
A28CR7	1901-0040	DIODE: SI	
A28CR8	1901-0040	DIODE: SI	
A28CR9	1901-0040	DIODE: SI	
A28CR10	1901-0040	DIODE: SI	
A28Q1	1854-0605	TRANSISTOR: SI NPN	
A28Q2	1854-0605	TRANSISTOR: SI NPN	
A28Q3	1854-0605	TRANSISTOR: SI NPN	
A28Q4	1854-0605	TRANSISTOR: SI NPN	
A28Q5	1854-0605	TRANSISTOR: SI NPN	
A28Q6	1854-0605	TRANSISTOR: SI NPN	
A28Q7	1854-0605	TRANSISTOR: SI NPN	
A28R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R4	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R6	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A28R7	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R10	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A28R11	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R12	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A28R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R15	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A28R16	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A28R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R20	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A28R21	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R22	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A28R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R26	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A28R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A29	03722-716 03722-316	ASSY: RANDOM NOISE GENERATOR BOARD: BLANK PC (NSR)	
A29C1	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A29C2	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A29C3	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A29C4	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A29C5	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A29MP1	0340-0038	PIN	
A29MP2	0340-0038	PIN	
A29MP3	0340-0038	PIN	
A29MP4	0340-0038	PIN	
A29MP5	0340-0039	INSULATOR	
A29MP6	0340-0039	INSULATOR	
A29MP7	0340-0039	INSULATOR	
A29MP8	0340-0039	INSULATOR	
A29MP9	03722-122	SCREEN	
A29Q1	1853-0015	TRANSISTOR: SI PNP	
A29Q2	1854-0605	TRANSISTOR: SI NPN	
A29Q3	1854-0071	TRANSISTOR: SI NPN	
A29Q4	1853-0015	TRANSISTOR: SI PNP	
A29Q5	1853-0036	TRANSISTOR: SI PNP	
A29Q6	1854-0071	TRANSISTOR: SI NPN	
A29R1	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A29R2	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A29R3	0698-4243	R: FXD MET OX 330 OHM 5% 1/4W	
A29R4	0698-4267	R: FXD MET OX 3.6K OHM 5% 1/4W	
A29R5	0698-5701	R: FXD MET OX 27 OHM 5% 1/4W	
A29R6	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A29R7	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A29R8	0698-5707	R: FXD MET OX 47 OHM 5% 1/4W	
A29R9	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A29R10	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A29R11	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A29R12	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A30	03722-709 03722-309	ASSY: RANDOM NOISE SAMPLER BOARD: BLANK PC (NSR)	
A30C1	0140-0196	C: FXD MICA 150PF 5% 300VDCW	
A30C2	0180-0291	C: FXD TA 1.0UF 10% 35VDCW	
A30C3	0150-0093	C: FXD CER 0.01UF 100VDCW	
A30C4	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A30C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C7	0160-2208	C: FXD MICA 330PF 5% 300VDCW	
A30C8	0150-0093	C: FXD CER 0.01UF 100VDCW	
A30C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A30CR1	1912-0002	DIODE: TUNNEL	
A30CR2	1901-0040	DIODE: SI	
A30CR3	1901-0040	DIODE: SI	
A30CR4	1912-0002	DIODE: TUNNEL	
A30CR5	1901-0040	DIODE: SI	
A30CR6	1901-0040	DIODE: SI	
A30CR7	1910-0034	DIODE: GE	
A30CR8	1910-0034	DIODE: GE	
A30CR9	1901-0040	DIODE: SI	
A30CR10	1901-0040	DIODE: SI	
A30CR11	1901-0040	DIODE: SI	
A30CR12	1901-0040	DIODE: SI	
A30CR13	1901-0040	DIODE: SI	
A30L1	9140-0114	COIL: FXD 10UH	
A30L2	9140-0112	COIL: FXD 4.7UH	
A30Q1	1854-0605	TRANSISTOR: SI NPN	
A30Q2	1854-0605	TRANSISTOR: SI NPN	
A30Q3	1854-0605	TRANSISTOR: SI NPN	
A30Q4	1854-0605	TRANSISTOR: SI NPN	
A30Q5	1854-0605	TRANSISTOR: SI NPN	
A30Q6	1854-0605	TRANSISTOR: SI NPN	
A30Q7	1854-0605	TRANSISTOR: SI NPN	
A30R1	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R2	0758-0086	R: FXD MET OX 100 OHM 5% 1/4W	
A30R3	0758-0086	R: FXD MET OX 100 OHM 5% 1/4W	
A30R4	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A30R5	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A30R6	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R7	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A30R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A30R9	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R11	0698-4246	R: FXD MET OX 470 OHM 5% 1/4W	
A30R12	0698-4234	R: FXD MET OX 130 OHM 5% 1/4W	
A30R13	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A30R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R17	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	
A30R18	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	
A30R19	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A30R20	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A30R21	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R23	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A30R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R26	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A30R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A30R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R29	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A30R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A30R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A30R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A31	03722-720 03722-320	ASSY: OUTPUT SWITCH BOARD: BLANK PC (NSR)	
A31C1	0180-0376	C: FXD TA 0.47UF 10% 35VDCW	
A31C2	0180-0059	C: FXD AL 10UF -10%+100% 25VDCW	
A31C3	0180-0376	C: FXD TA 0.47UF 10% 35VDCW	
A31C4	0140-0192	C: FXD MICA 88PF 5% 300VDCW	
A31C5	0180-0376	C: FXD TA 0.47UF 10% 35VDCW	
A31C6	0180-0059	C: FXD AL 10UF -10%+100% 25VDCW	
A31CR1	1801-0040	DIODE: SI	
A31CR2	1801-0040	DIODE: SI	
A31Q1	1853-0036	TRANSISTOR: SI PNP	
A31Q2	1853-0036	TRANSISTOR: SI PNP	
A31Q3	1854-0071	TRANSISTOR: SI NPN	
A31Q4	1853-0015	TRANSISTOR: SI PNP	
A31Q5	1854-0605	TRANSISTOR: SI NPN	
A31Q6	1854-0215	TRANSISTOR: SI NPN	
A31Q7	1853-0036	TRANSISTOR: SI PNP	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A31R1	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A31R2	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A31R3	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A31R4	0704-0016	R: FXD MET FLM 1.0K OHM 5% 2W	
A31R5	0760-0022	R: FXD MET FLM 330 OHM 2% 1W	
A31R6	0760-0022	R: FXD MET FLM 330 OHM 2% 1W	
A31R7	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A31R8	0698-6033	R: FXD MET FLM 7.5K OHM 1% 1/4W 50 PPM	
A31R9	2100-1760	R: VAR WW LIN 5.0K OHM 10% 1/2W	
A31R10	2100-1759	R: VAR WW LIN 2.0K OHM 10% 1/2W	
A31R11	0698-6033	R: FXD MET FLM 7.5K OHM 1% 1/4W 50 PPM	
A31R12	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A31R13	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A31R14	0757-0914	R: FXD MET FLM 390 OHM 2% 1/8W	
A31R15	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A31R16	0757-0436	R: FXD MET FLM 4.32K OHM 1% 1/8W 100 PPM	
A31R17	2100-1758	R: VAR WW LIN 1.0K OHM 10% 1/2W	
A31R18	0698-3763	R: FXD MET FLM 3.92K OHM 1% 1/4W 50 PPM	
A31R19	0698-6034	R: FXD MET FLM 9K OHM 1% 1/4W 50 PPM	
A31R20	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A31TP1	0360-0124	TERMINAL PIN	
A31TP2	0360-0124	TERMINAL PIN	
A31TP3	0360-0124	TERMINAL PIN	
A32	03722-719 C3722-319	ASSY: REFERENCE POWER SUPPLY BOARD: BLANK PC (NSR)	
A32C1	0180-0374	C: FXD TA 10UF 10% 20VDCW	
A32C2	0160-0161	C: FXD MY 0.01UF	
A32C3	0180-0374	C: FXD TA 10UF 10% 20VDCW	
A32C4	0160-0297	C: FXD MY 1200PF 10% 200VDCW	
A32C5	0160-0297	C: FXD MY 1200PF 10% 200VDCW	
A32CR1	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32CR2	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32CR3	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32CR4	1901-0040	DIODE: SI	
A32CR5	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32CR6	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32CR7	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	
A32MP1	0380-0509	BEAD: GLASS	
A32MP2	0380-0509	BEAD: GLASS	
A32MP3	0380-0509	BEAD: GLASS	
A32MP4	0380-0509	BEAD: GLASS	
A32Q1	1820-0001	TRANSISTOR: SI NPN (AMPLIFIER REFERENCE)	
A32Q2	1854-0071	TRANSISTOR: SI NPN	
A32Q3	1853-0607	TRANSISTOR: SI PNP (MATCHED WITH Q5)	
A32Q4	1853-0036	TRANSISTOR: SI PNP	
A32Q5	1853-0607	TRANSISTOR: SI PNP (MATCHED WITH Q3)	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A32Q6	1853-0036	TRANSISTOR: SI PNP	
A32Q7	1853-0036	TRANSISTOR: SI PNP	
A32Q8	1854-0071	TRANSISTOR: SI NPN	
A32Q9	1853-0015	TRANSISTOR: SI PNP	
A32Q10	1854-0071	TRANSISTOR: SI NPN	
A32Q11	1853-0015	TRANSISTOR: SI PNP	
A32Q12	1854-0071	TRANSISTOR: SI NPN	
A32Q13	1853-0015	TRANSISTOR: SI PNP	
A32R1	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W	
A32R2	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W	
A32R3	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W	
A32R4	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	
A32R5	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W	
A32R6	0698-3768	R: FXD MET FLM 12K OHM 1% 1/4W	
A32R7	0698-4300	R: FXD MET OX 82K OHM 5% 1/4W	
A32R8	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W	
A32R9	0698-3763	R: FXD MET FLM 3920 OHM 1% 1/4W	
A32R10	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W	
A32R11	0698-4300	R: FXD MET OX 82K OHM 5% 1/4W	
A32R12	0698-5793	R: FXD MET FLM 31.1K OHM 1% 1/8W 50 PPM	
A32R13	2100-0989	R: VAR WW LIN 10K OHM 5% 1W	
A32R14	0811-0601	R: FXD WW 8K OHM 1% 1/2W 5 PPM	
A32R15	0698-3779	R: FXD MET OX 305 OHM 1% 1/4W	
A32R16	0698-3778	R: FXD MET OX 138 OHM 1% 1/4W	
A32R17	0698-3777	R: FXD MET OX 65 OHM 1% 1/4W	
A32R18	0698-3776	R: FXD MET OX 32 OHM 2% 1/4W	
A32R19	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W	
A32R20	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W	
A32R21	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A32R22	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A32R23	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A32R24	0811-0602	R: FXD WW 9K OHM 1% 1/2W 5 PPM	
A32R25	2100-0941	R: VAR WW LIN 1.0K OHM 5% 1W	
A32R26	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	
A32R27	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W	
A32R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A32R29	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W	
A32R30	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W	
A32R31	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W	
A32R32	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W	
A33	03722-712 03722-312	ASSY: ANALOG FILTER (1) BOARD: BLANK PC (NSR)	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A33C1	0160-0615	C: FXD METALAC 10UF 10% 63VDCW	
A33C2	0160-0615	C: FXD METALAC 10UF 10% 63VDCW	
A33C3		C: FXD METALAC SELECTED ON TEST	
A33C4	0160-0646	C: FXD POLY 0.022UF 1% 63VDCW	
A33C5	0160-0647	C: FXD POLY 6200PF 1% 500VDCW	
A33R1	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A33R2	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM	
A33R3	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A33R4	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM	
A33R5	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A33R6	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM	
A33R7	0698-3770	R: FXD MET FLM 23.1K OHM 1% 1/4W 50PPM	
A33R8	0698-3765	R: FXD MET FLM 6.53K OHM 1% 1/4W 50PPM	
A33R9	0698-3759	R: FXD MET FLM 1.81K OHM 1% 1/4W 50PPM	
A33R10	0698-3773	R: FXD MET FLM 141.6K OHM 1% 1/4W 50PPM	
A33R11	0698-3772	R: FXD MET FLM 42.48K OHM 1% 1/4W 50PPM	
A33R12	0698-3769	R: FXD MET FLM 14.16K OHM 1% 1/4W 50PPM	
A33R13	0698-3771	R: FXD MET FLM 23.6K OHM 1% 1/4W 50PPM	
A33R14	0698-3766	R: FXD MET FLM 7.08K OHM 1% 1/4W 50PPM	
A33R15	0698-3761	R: FXD MET FLM 2.36K OHM 1% 1/4W 50PPM	
A34	03722-718 03722-318	ASSY: ANALOG FILTER (2) BOARD: BLANK PC (NSR)	
A34C1		C: FXD MY SELECTED ON TEST	
A34C2	0160-0620	C: FXD METALAC 2UF 10% 63VDCW	
A34C3	0160-0648	C: FXD POLY 0.16UF 1% 63VDCW	
A34C4	0160-0649	C: FXD POLY 0.051UF 1% 63VDCW	
A34C5	0160-0650	C: FXD POLY 0.062UF 1% 63VDCW	
A34C6	0160-0651	C: FXD POLY 2200PF 1% 500VDCW	
A34C7	0160-2598	C: FXD MICA 620PF 2% 300VDCW	
A34C8	0160-0655	C: FXD METALAC 1UF 5% 63VDCW	
A34C9	0170-0019	C: FXD MY 0.1UF 5% 200VDCW	
A34C10	0160-0633	C: FXD POLY 0.01UF 1% 63VDCW	
A34C11	0160-0652	C: FXD POLY 3000PF 1% 500VDCW	
A34C12	0160-0653	C: FXD POLY 1000PF 1% 500VDCW	
A34C13	0140-0206	C: FXD MICA 270PF 5% 500VDCW	
A34C14	0121-0105	C: VAR CER 9-35PF	
A34C15	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A34C16	0121-0105	C: VAR CER 9-35PF	
A35	03722-708 03722-303	ASSY: OUTPUT AMPLIFIER (1) BOARD: BLANK PC (NSR)	
A35C1	0160-0163	C: FXD MY 0.033UF 10%	
A35C2	0160-0619	C: FXD METALAC 1UF 10% 63VDCW	
A35C3	0140-0204	C: FXD MICA 47PF 5% 500VDCW	
A35C4	0160-0157	C: FXD MY 0.0047UF 10% 200VDCW	
A35C5	0160-0128	C: FXD CER 2.2UF 20% 25VDCW	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A35C6		NOT ASSIGNED	
A35C7	0180-1714	C: FXD TA 330UF 10% 6VDCW	
A35C8	0180-0059	C: FXD AL 30UF -10%+100% 25VDCW	
A35C9	0160-0157	C: FXD MY 0.0047UF 10% 200VDCW	
A35C10	0160-0619	C: FXD METALAC 1UF 10% 63VDCW	
A35C11	0160-0615	C: FXD METALAC 10UF 10% 63VDCW	
A35C12	0180-1714	C: FXD TA 330UF 10% 6VDCW	
A35C13	0160-2198	C: FXD MICA 20PF 5% 300VDCW	
A35C14	0150-0096	C: FXD CER 0.05UF 100VDCW	
A35C15	0160-0137	C: FXD CER 0.33UF 20% 25VDCW	
A35C16	0160-0128	C: FXD CER 2.2UF 20% 25VDCW	
A35C17	0160-0128	C: FXD CER 2.2UF 20% 25VDCW	
A35CR1	1901-0040	DIODE: SI	
A35CR2	1901-0040	DIODE: SI	
A35CR3	1901-0040	DIODE: SI	
A35CR4	1901-0040	DIODE: SI	
A35CR5	1901-0040	DIODE: SI	
A35CR6	1901-0040	DIODE: SI	
A35MP1	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP2	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP3	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP4	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP5	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP6	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP7	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP8	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP9	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP10	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP11	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP12	0340-0060	TERMINAL: CLOVER LEAF PTFE	
A35MP13	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35MP14	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35MP15	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35MP16	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35MP17	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35MP18	0360-0065	TERMINAL: SUBMINIATURE BRASS	
A35Q1	1855-0603	TRANSISTOR: SI FET	
A35Q2	1854-0071	TRANSISTOR: SI NPN	
A35Q3	1854-0071	TRANSISTOR: SI NPN	
A35Q4	1854-0071	TRANSISTOR: SI NPN	
A35Q5	1854-0071	TRANSISTOR: SI NPN	
A35Q6	1854-0071	TRANSISTOR: SI NPN	
A35Q7	1854-0071	TRANSISTOR: SI NPN	
A35Q8	1854-0071	TRANSISTOR: SI NPN	
A35Q9	1854-0071	TRANSISTOR: SI NPN	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A35R1	0698-4290	R: FXD MET OX 33K OHM 5% 1/4W	
A35R2	0698-4290	R: FXD MET OX 33K OHM 5% 1/4W	
A35R3	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R4	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R5	0683-2255	R: FXD COMP 2.2 MEG OHM 5% 1/4W	
A35R6	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A35R7	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	
A35R8	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	
A35R9	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R10	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	
A35R11	0683-1055	R: FXD COMP 1 MEG OHM 5% 1/4W	
A35R12	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A35R13	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	
A35R14	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R15	0683-1055	R: FXD COMP 1 MEG OHM 5% 1/4W	
A35R16	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	
A35R17	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	
A35R18	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R19		R: FXD MET OX SELECTED ON TEST	
A35R20	0683-3345	R: FXD COMP 330K OHM 5% 1/4W	
A35R21	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A35R22	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R23	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R24	0683-4755	R: FXD COMP 4.7 MEG OHM 5% 1/4W	
A35R25	0757-0473	R: FXD MET FLM 221K OHM 1% 1/8W	
A35R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A35R27	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A35R28	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	
A35R29	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A35R30	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A35W1	03722-772	CABLE: COAX (CODED RED/GRY)	
A36	03722-730 03722-330	ASSY: OUTPUT AMPLIFIER (2) BOARD: BLANK PC (NSR)	
A36C1	0160-0163	C: FXD MY 0.033UF 10%	
A36C2	0160-0157	C: FXD MY 4700PF 10%	
A36C3	0160-2225	C: FXD MICA 2000PF 5% 300VDCW	
A36C4	0160-0297	C: FXD MY 1200PF 10% 200VDCW	
A36C5	0160-0153	C: FXD MY 1000PF 10%	
A36C6	0160-0134	C: FXD MICA 220PF 5% 300VDCW	
A36C7	0180-1846	C: FXD TA 2.2UF 10% 35VDCW	
A36Q1	1853-0012	TRANSISTOR: SI PNP	
A36R1	0683-0685	R: FXD COMP 6.8 OHM 5% 1/4W	
A36R2	0698-4252	R: FXD MET OX 820 OHM 5% 1/4W	
A36R3	0698-4252	R: FXD MET OX 820 OHM 5% 1/4W	
A36R4	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	
A36R5	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A36R6	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W	
A36R7	0698-5701	R: FXD MET OX 27 OHM 5% 1/4W	
A36R8	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W	
A37	03722-707 03722-307	ASSY: OUTPUT AMPLIFIER (3) BOARD: BLANK PC (NSR)	
A37C1	0170-0066	C: FXD MY 0.027UF 10% 200VDCW	
A37C2	0160-0161	C: FXD MY 0.01UF 10%	
A37C3	0160-0301	C: FXD MY 0.012UF 10% 200VDCW	
A37C4	0160-0157	C: FXD MY 0.0047UF 10% 200VDCW	
A37C5	0140-0179	C: FXD MICA 1000PF 5% 300VDCW	
A37C6	0180-0291	C: FXD TA 1UF 10% 35VDCW	
A37C7	0180-0291	C: FXD TA 1UF 10% 35VDCW	
A37C8	0180-0291	C: FXD TA 1UF 10% 35VDCW	
A37C9	0160-2204	C: FXD MICA 100PF 5% 300VDCW	
A37C10	0180-0291	C: FXD TA 1UF 10% 35VDCW	
A37CR1	1901-0040	DIODE: SI	
A37CR2	1901-0040	DIODE: SI	
A37CR3	1902-0126	DIODE: BREAKDOWN 2.31V 400mW	
A37L1	9100-1653	L: FXD COIL 910UH 5%	
A37L2	9100-1653	L: FXD COIL 910UH 5%	
A37Q1	1853-0012	TRANSISTOR: SI PNP	
A37Q2	1854-0039	TRANSISTOR: SI NPN	
A37R1	0683-1205	R: FXD COMP 12 OHM 5% 1/4W	
A37R2	0683-1205	R: FXD COMP 12 OHM 5% 1/4W	
A37R3	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	
A37R4	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	
A37R5	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	
A37R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A37R7	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A37R8	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A37R9	0764-0016	R: FYD MET OX 1.0K OHM 5% 2W	
A37R10	0760-0024	R: FXD MET OX 100 OHM 5% 1W	
A37R11	0758-0606	R: FXD MET OX 22 OHM 5% 1/2W	
A37R12	0758-0606	R: FXD MET OX 22 OHM 5% 1/2W	
A37R13	0760-0024	R: FXD MET OX 100 OHM 5% 1W	
A37R14	0760-0024	R: FXD MET OX 100 OHM 5% 1W	
A37R15	0698-3624	R: FXD MET OX 150 OHM 5% 2W	
A37R16	0698-3774	R: FXD MET FLM 600 OHM 0.25% 1/4W	
A37R17	0698-3624	R: FXD MET OX 150 OHM 5% 2W	
A38	03722-728 03722-109	ASSY: ATTENUATOR (COMPLETE WITH OUTER SCREEN & ALL COMPONENTS PREFIXED A38 BELOW) ATTENUATOR: OUTER SCREEN (SEE CHASSIS MOUNTED COMPONENTS MP41)	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A38R1	0698-3760	R: FXD MET FLM 1900 OHM 1/4% 1/4W 50 PPM	
A38R2	0698-3754	R: FXD MET FLM 877 OHM 1/4% 1/4W 50 PPM	
A38R3	0698-3780	R: FXD MET OX 32.2 OHM 1% 1/2W 250 PPM	
A38R4	0698-3758	R: FXD MET FLM 1300 OHM 1/4% 1/4W 50 PPM	
A38R5	0698-4204	R: FXD MET FLM 11.75K OHM 1% 1/4W 100 PPM	
A38R6	0698-3754	R: FXD MET FLM 877 OHM 1/4% 1/4W 50 PPM	
A38R7	0757-1021	R: FXD MET FLM 66.5 OHM 1% 1/4W 100 PPM	
A38R8	0698-5798	R: FXD MET FLM 257 OHM 1/2% 1/4W 100 PPM	
A38R9	0698-3774	R: FXD MET FLM 600 OHM 1/4% 1/4W 50 PPM	
A38R10	0698-3369	R: FXD MET FLM 1.4K OHM 1/4% 1/4W 100 PPM	
A38R11	0698-3764	R: FXD MET FLM 5400 OHM 1/4% 1/4W 50 PPM	
A38R12	0757-0715	R: FXD MET FLM 150 OHM 1% 1/4W 100 PPM	
A38R13	0757-1035	R: FXD MET FLM 400 OHM 1/2% 1/4W 100 PPM	
A38R14	0698-3755	R: FXD MET FLM 900 OHM 1/2% 1/4W 100 PPM	
A38R15	0698-3762	R: FXD MET FLM 2400 OHM 1/2% 1/4W 50 PPM	
A38R16	0757-1023	R: FXD MET FLM 6.04K OHM 1% 1/4W 100 PPM	
A38R17	0757-0339	R: FXD MET FLM 3.01K OHM 1% 1/4W 100 PPM	
A38R18	0757-0739	R: FXD MET FLM 2.0K OHM 1% 1/4W 100 PPM	
A38R19	0698-5584	R: FXD MET FLM 1.5K OHM 1/2% 1/4W 100 PPM	
A38R20	0698-3757	R: FXD MET FLM 1200 OHM 1% 1/4W 100 PPM	
A38R21	0698-3145	R: FXD MET FLM 1.0K OHM 1/4% 1/4W 9 PPM	
A38R22	0698-3753	R: FXD MET FLM 857 OHM 1/4% 1/4W 50 PPM	
A38R23	0698-3752	R: FXD MET FLM 750 OHM 1/4% 1/4W 50 PPM	
A38R24	0698-5800	R: FXD MET FLM 667 OHM 1/4% 1/4W 50 PPM	
A38S1	3100-0621	SWITCH (NSR: USE COMPLETE ASSEMBLY)	
A38W1	03722-760	CABLE: COAX (CODED BRN/WHT)	
A38W2	03722-761	CABLE: COAX (CODED RED/BLK)	
A38W3	03722-762	CABLE: COAX (CODED RED/BRN)	
A38W4	03722-763	CABLE: COAX (CODED RED/RED)	
A39	03722-710 03722-310	ASSY: SEQUENCE COUNTER BOARD: BLANK PC (NSR)	
A39C1	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A39C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A39C4	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C5	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C6	0140-0192	C: FXD MICA 60PF 5% 300VDCW	
A39C7	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C8	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C9	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39C10	0140-0192	C: FXD MICA 68PF 5% 300VDCW	
A39CR1	1901-0040	DIODE: SI	
A39CR2	1901-0040	DIODE: SI	
A39CR3	1901-0040	DIODE: SI	
A39CR4	1901-0040	DIODE: SI	
A39CR5	1901-0040	DIODE: SI	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A39CR6	1901-0040	DIODE: SI	
A39CR7	1901-0040	DIODE: SI	
A39CR8	1901-0040	DIODE: SI	
A39CR9	1901-0040	DIODE: SI	
A39CR10	1901-0040	DIODE: SI	
A39CR11	1901-0040	DIODE: SI	
A39CR12	1901-0040	DIODE: SI	
A39CR13	1901-0040	DIODE: SI	
A39CR14	1901-0040	DIODE: SI	
A39Q1	1853-0015	TRANSISTOR: SI PNP	
A39Q2	1854-0605	TRANSISTOR: SI NPN	
A39Q3	1854-0605	TRANSISTOR: SI NPN	
A39Q4	1854-0605	TRANSISTOR: SI NPN	
A39Q5	1854-0605	TRANSISTOR: SI NPN	
A39Q6	1854-0605	TRANSISTOR: SI NPN	
A39Q7	1854-0605	TRANSISTOR: SI NPN	
A39Q8	1854-0605	TRANSISTOR: SI NPN	
A39Q9	1854-0605	TRANSISTOR: SI NPN	
A39R1	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	
A39R2	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	
A39R3	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R7	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R11	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R13	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R15	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R16	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R18	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R20	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R22	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R23	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R24	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R29	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A39R31	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R32	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A39R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A39R34	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A39R35	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40	03722-739	ASSY: SEQUENCE ADVANCE (fitted in Option 01 Models only - see Section VII)	
	03722-339	BOARD: BLANK PC (NSR)	
A40C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A40CR1	1901-0040	DIODE: SI	
A40CR2	1901-0040	DIODE: SI	
A40CR3	1901-0040	DIODE: SI	
A40CR4	1901-0040	DIODE: SI	
A40CR5	1901-0040	DIODE: SI	
A40CR6	1901-0040	DIODE: SI	
A40CR7	1901-0040	DIODE: SI	
A40CR8	1901-0040	DIODE: SI	
A40CR9	1901-0040	DIODE: SI	
A40CR10	1901-0040	DIODE: SI	
A40CR11	1901-0040	DIODE: SI	
A40CR12	1901-0040	DIODE: SI	
A40CR13	1901-0040	DIODE: SI	
A40CR14	1901-0040	DIODE: SI	
A40CR15	1901-0040	DIODE: SI	
A40CR16	1901-0040	DIODE: SI	
A40Q1	1854-0605	TRANSISTOR: SI NPN	
A40Q2	1854-0605	TRANSISTOR: SI NPN	
A40Q3	1854-0605	TRANSISTOR: SI NPN	
A40Q4	1854-0605	TRANSISTOR: SI NPN	
A40Q5	1854-0605	TRANSISTOR: SI NPN	
A40Q6	1854-0605	TRANSISTOR: SI NPN	
A40Q7	1854-0605	TRANSISTOR: SI NPN	
A40Q8	1854-0605	TRANSISTOR: SI NPN	
A40Q9	1854-0605	TRANSISTOR: SI NPN	

**OPTION 01
MODELS
ONLY**

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A40R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R3	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R4	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R9	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R11	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R14	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R21	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A40R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A40R29	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A40R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A40R33	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A40R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41	03722-714 03722-314	ASSY: GATE AND SYNC OUTPUT BOARD: BLANK PC (NSR)	
A41C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A41C2	0160-2150	C: FXD MICA 33PF 5% 300VDCW	
A41C3	0160-2150	C: FXD MICA 33PF 5% 300VDCW	
A41C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	
A41CR1	1901-0040	DIODE: SI	
A41CR2	1910-0034	DIODE: GE	
A41CR3	1901-0040	DIODE: SI	
A41CR4	1901-0040	DIODE: SI	
A41CR5	1901-0040	DIODE: SI	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A41CR6	1901-0040	DIODE: SI	
A41CR7	1901-0040	DIODE: SI	
A41CR8	1901-0025	DIODE: SI	
A41CR9	1901-0025	DIODE: SI	
A41Q1	1854-0605	TRANSISTOR: SI NPN	
A41Q2	1854-0605	TRANSISTOR: SI NPN	
A41Q3	1854-0605	TRANSISTOR: SI NPN	
A41Q4	1854-0605	TRANSISTOR: SI NPN	
A41Q5	1854-0605	TRANSISTOR: SI NPN	
A41Q6	1854-0071	TRANSISTOR: SI NPN	
A41Q7	1854-0071	TRANSISTOR: SI NPN	
A41R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R3	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A41R4	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A41R5	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W	
A41R6	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A41R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R9	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A41R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A41R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A41R12	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A41R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R14	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A41R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R16	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A41R17	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A41R18	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A41R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	
A41R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	
A41R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A41R22	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W	
A41R23	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	
A41R24	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	
A41R25	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A41R26	0698-4286	R: FXD MET OX 3.3K OHM 5% 1/4W	
A41R27	0758-0029	R: FXD MET FLM 470 OHM 5% 1/2W	
A41R28	0758-0029	R: FXD MET FLM 470 OHM 5% 1/2W	
A41R29	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	
A41R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	
A41R31	0698-4286	R: FXD MET OX 3.3K OHM 5% 1/4W	
A41R32	0758-0029	R: FXD MET FLM 470 OHM 5% 1/4W	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A42	03722-722 03722-322	ASSY: RELAY BOARD: BLANK PC (NSR)	
A42K1	9161-0013	RELAY: COIL	
A42K2	9161-0013	RELAY: COIL	
A42K1A	0490-0604	RELAY: REED	
A42K2A	0490-0604	RELAY: REED	
A42MP1	0340-0039	FEEDTHROUGH: TEFLON	
A42MP2	0340-0039	FEEDTHROUGH: TEFLON	
A42MP3	0340-0039	FEEDTHROUGH: TEFLON	
A42MP4	0340-0039	FEEDTHROUGH: TEFLON	
A42MP5	0340-0039	FEEDTHROUGH: TEFLON	
A42MP6	0340-0039	FEEDTHROUGH: TEFLON	
A42MP7	0340-0059	TERMINAL POST: BRASS	
A42MP8	0340-0059	TERMINAL POST: BRASS	
A42MP9	0340-0059	TERMINAL POST: BRASS	
A42MP10	0340-0059	TERMINAL POST: BRASS	
A42MP11	0340-0059	TERMINAL POST: BRASS	
A42MP12	0340-0059	TERMINAL POST: BRASS	
A43	03722-717 03722-317	ASSY: RECTIFIER BOARD: BLANK PC (NSR)	
A43C1	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A43C2	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A43C3	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A43CR1	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR2	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR3	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR4	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR5	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR6	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR7	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR8	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR9	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR10	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR11	1901-0045	DIODE: SI 100PIV 0.75A	
A43CR12	1901-0045	DIODE: SI 100PIV 0.75A	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
A44	03722-711 03722-311	ASSY: POWER SUPPLY STABILISER BOARD: BLANK PC (NSR)	
A44C1	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A44C2	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW	
A44C3	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A44C4	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW	
A44C5	0170-0040	C: FXD MY 0.047UF 10% 200VDCW	
A44C6	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW	
A44CR1	1902-0017	DIODE: BREAKDOWN 6.81V 400mW	
A44CR2	1902-0017	DIODE: BREAKDOWN 6.81V 400mW	
A44CP3	1902-3234	DIODE: BREAKDOWN 19.6V 400mW	
A44CR4	1902-0017	DIODE: BREAKDOWN 6.81V 400mW	
A44Q1	1853-0001	TRANSISTOR: SI PNP	
A44Q2	1853-0001	TRANSISTOR: SI PNP	
A44Q3	1854-0003	TRANSISTOR: SI NPN	
A44Q4	1854-0003	TRANSISTOR: SI NPN	
A44Q5	1854-0003	TRANSISTOR: SI NPN	
A44Q6	1854-0003	TRANSISTOR: SI NPN	
A44R1	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A44R2	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A44R3	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W	
A44R4	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A44R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A44R6	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A44R7	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A44R8	0698-4241	R: FXD MET OX 270 OHM 5% 1/4W	
A44R9	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A44R10	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A44R11	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	
A44R12	0698-4246	R: FXD MET OX 470 OHM 5% 1/4W	
A44R13	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	
A44R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	
A44R15	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	
A44R16	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W	
A44R17	0698-4233	R: FXD MET OX 120 OHM 5% 1/4W	
A44R18	0698-3799	R: FXD MET OX 22 OHM 5% 1/4W	
A44R19	0698-5707	R: FXD MET OX 47 OHM 5% 1/4W	
A44TP1	0360-0124	TERMINAL PIN	
A44TP2	0360-0124	TERMINAL PIN	
A44TP3	0360-0124	TERMINAL PIN	
A44TP4	0360-0124	TERMINAL PIN	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
CHASSIS MOUNTED COMPONENTS			
C1	0160-0664	C: FXD CER 2x0.001UF -0% +100% 1000VDCW	
C2	0180-0129	C: FXD ELECT 975UF 40VDCW	
	1520-0001	MOUNTING BASE (C2)	
C3	0180-0129	C: FXD ELECT 975UF 40VDCW	
C4	0180-0129	C: FXD ELECT 975UF 40VDCW	
	1520-0001	MOUNTING BASE (C4)	
CR1	1901-0040	DIODE: SI	
CR2	1910-0034	DIODE: GE	
DS1	2140-0602	LAMP: FILAMENT (GATE)	
	5040-0234	LAMP HOLDER (DS1)	
	5040-0235	RETAINER (DS1)	
DS2	1450-0106	LAMP: NEON, COMPLETE WITH LENS (PART OF LINE SWITCH S5)	
F1	2110-0006	FUSE: CARTRIDGE SLOW-BLOW 2A 125V (FOR 115V OPERATION)	
	2110-0007	FUSE: CARTRIDGE SLOW-BLOW 1A 250V (FOR 230V OPERATION)	
J1	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (BINARY OUTPUT: FRONT PANEL)	
J2	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (GAUSSIAN OUTPUT: FRONT PANEL)	
J3	1250-0118	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (VARIABLE OUTPUT: FRONT PANEL)	
J4	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (BINARY OUTPUT: REAR PANEL)	
J5	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (GAUSSIAN OUTPUT: REAR PANEL)	
J6	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (VARIABLE OUTPUT: REAR PANEL)	
J7		GROUP OF 3 BINDING POSTS (GATE RELAY): EACH POST COMPRISES 3 ITEMS AS LISTED BELOW:-	
	5060-0635	BINDING POST ASSY (BLK)	
	0340-0099	INSULATOR	
	0340-0100	INSULATOR: BINDING POST	
J8		GROUP OF 3 BINDING POSTS (BINARY RELAY): COMPONENTS AS LISTED FOR J7	
J9	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (CLOCK: REAR PANEL)	
J10	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (SYNC: REAR PANEL)	
J11	1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING (GATE: REAR PANEL)	
J12	1251-0085	CONNECTOR: 36-CONTACT FEMALE RECEPTACLE (CONTROL: REAR PANEL)	
		PART OF SEQUENCE LENGTH SWITCH HARNESS 63722-736	
	1251-0084	CONNECTOR: 36-CONTACT MALE CABLE PLUG (MATES WITH J12) *	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
L1	9140-0136	INDUCTOR: 22UH	
L2	9140-0136	INDUCTOR: 22UH	
L3	9110-0051	INDUCTOR: 40MH	
	7100-0333	COVER (L3)	
MP1	5060-0732	FRAME ASSEMBLY	
MP2	03722-101	FRONT PANEL	
MP3	03722-123	DUMMY FRONT PANEL	
MP4	5000-0738	SIDE COVER (REAR)	
MP5	5000-0739	SIDE COVER (FRONT)	
MP6	03722-118	TOP COVER	
MP7	03722-119	BOTTOM COVER	
MP8	5060-0222	SIDE HANDLE ASSEMBLY	
MP9	5060-0766	HANDLE ASSEMBLY RETAINER	
MP10	5060-0767	FOOT ASSEMBLY	
MP11	1490-0030	TILT STAND	
MP12	5000-0051	TRIM STRIP (SIDE)	
MP13	03722-104	REAR PANEL	
MP14	00140-24701	PANEL TRIM (TOP)	
MP15	00140-24702	PANEL TRIM (BOTTOM)	
MP16	03722-105	CLIP	
MP17	7120-1254	LOGO	
MP18	5060-0775	RACK MOUNTING KIT	
MP19	0340-0039	INSULATOR (ACCEPTS MP20 OR MP21)	
MP20	0340-0038	FEEDTHROUGH PIN (Q4, Q5, Q6)	
MP21	0340-0058	MOUNTING POST (R1, R2, R3)	
MP22	0360-0117	TERMINAL BOARD (MOUNTS L1 & L2)	
MP23	0370-0035	KNOB: 1 DIA 1/4 SHAFT W/ARROW BLK (S1)	
MP24	0370-0035	KNOB: 1 DIA 1/4 SHAFT W/ARROW BLK (S2)	
MP25	0370-0037	KNOB: 1 DIA 17/64 SHAFT W/ARROW BLK (RMS AMPLITUDE)	
MP26	0370-0027	KNOB: 3/4 DIA 1/8 SHAFT W/ARROW RED (RMS AMPLITUDE)	
MP27	0370-0104	KNOB: 5/8 DIA 1/4 SHAFT W/ARROW BLK (S4)	
MP28	0370-0118	KNOB: PUSH-BUTTON (FITS S6, S7, S8 & S9)	
MP29	5000-0316	LABEL: RUN (S6)	
MP30	5000-3363	LABEL: RESET (S8)	
MP31	5000-3365	LABEL: HOLD (S7)	
MP32	5000-3366	LABEL: GATE RESET (S9)	
MP33		NOT ASSIGNED	
MP34	5060-0049	ASSY: EXTENDER BOARD 15-CONTACT 4.6 LONG	
MP35	03722-735	HARNESS: MAIN	
MP36	03722-740	HARNESS: LINE, REAR PANEL & PUSH-BUTTON	
MP37	03722-741	HARNESS: CLOCK PERIOD SWITCH (REAR)	
MP38	03722-106	RELAY SCREEN	
MP39	03722-107	CLOCK PERIOD SWITCH SCREEN	
MP40	03722-108	ATTENUATOR SUPPORT BRACKET	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
MP41	03722-109	ATTENUATOR SCREEN	
MP42	03722-110	SWITCH MOUNT (CLOCK PERIOD SWITCH: REAR SECTION)	
MP43	03722-111	TRANSISTOR COVER (REAR PANEL)	
MP44	03722-112	RETAINER (A39, A41, A43 & A44)	
MP45	03722-113	HEAT SINK PLATE (Q4, Q5, Q6)	
MP46	03722-120	RETAINER (U-CHANNEL: FULL WIDTH)	
MP47	03722-121	BRACKET (MOUNTED ON MP40: SUPPORTS MP46)	
MP48	03722-361	CARD SUPPORT: 2 SLOTS 1.43 LONG	
MP49	03722-362	CARD SUPPORT: 3 SLOTS 1.96 LONG	
MP50	03722-363	CARD SUPPORT: 10 SLOTS 4.15 LONG	
MP51	03722-364	CARD SUPPORT: 18 SLOTS 6.34 LONG	
MP52	03722-366	CARD SUPPORT: 1 SLOT 0.8 LONG	
MP53	03722-368	CARD SUPPORT: 2 SLOTS 1.43 LONG	
MP54	03722-367	PILLAR (SUPPORT MP44)	
Q1	1853-0052	TRANSISTOR: SI PNP	
	0340-0162	INSULATING WASHER (Q1)	
	1200-0168	MOUNTING BASE (Q1)	
Q2	1854-0063	TRANSISTOR: SI NPN	
	1200-0043	INSULATING WASHER (Q2)	
	1200-0041	MOUNTING BASE (Q2)	
Q3	1854-0072	TRANSISTOR: SI NPN	
	0340-0162	INSULATING WASHER (Q3)	
	1200-0168	MOUNTING BASE (Q3)	
Q4	1854-0039	TRANSISTOR: SI NPN	
	1205-0050	HEAT SINK (Q4)	
Q5	1853-0012	TRANSISTOR: SI PNP	
	1205-0050	HEAT SINK (Q5)	
Q6	1854-0039	TRANSISTOR: SI NPN	
	1205-0050	HEAT SINK (Q6)	
R1	0812-0033	R: FXD WW 7 OHM 3% 5W	
R2	0812-0046	R: FXD WW 2 OHM 5% 5W	
R3	0812-0033	R: FXD WW 7 OHM 3% 5W	
R4	0683-3335	R: FXD CARBON 33K OHM 5% 1/4W	
R5	0698-6402	R: FXD MET FLM 3.01K OHM 1% 1/4W 50PPM	
R6		NOT ASSIGNED	
R7	2100-0626	R: VAR WW LIN 1.0K OHM 10% 1/2W (GAUSSIAN ZERO)	
	1410-0112	HEX STANDOFF BUSH (R7)	
	5020-0446	HEX NUT (R7)	
R8	0758-0086	R: FXD MET OX 100 OHM 5% 1/4W	
S1	03722-738	ASSY: CLOCK PERIOD SWITCH (INCLUDES JUMPER LEADS & FRONT CABLE HARNESS)	
	3100-2412	SWITCH (MECHANISM ONLY)	
	03722-732	CLOCK PERIOD CABLE HARNESS (FRONT)	

* See list of abbreviations in introduction to this section

Table 6-1

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
S2	03722-734	ASSY: SEQUENCE LENGTH SWITCH (INCLUDES DIODES, JUMPER LEADS, LINKS, SPREADER, HARNESS & CONTROL RECEPTACLE J12)	
	03722-746	ASSY: SEQUENCE LENGTH SWITCH (AS ABOVE BUT WITHOUT HARNESS & CONTROL RECEPTACLE)	
	3100-0619	SWITCH (MECHANISM ONLY)	
	03722-365	SPREADER (JUMPER LEADS)	
	03722-736	HARNESS (INCLUDES CONTROL RECEPTACLE J12)	
S2CR1	1901-0040	DIODE: SI	
S2CR2	1901-0040	DIODE: SI	
S2CR3	1901-0040	DIODE: SI	
S2CR4	1901-0040	DIODE: SI	
S2CR5	1901-0040	DIODE: SI	
S2CR6	1901-0040	DIODE: SI	
S2CR7	1901-0040	DIODE: SI	
S2CR8	1901-0040	DIODE: SI	
S2CR9	1901-0040	DIODE: SI	
S2CR10	1901-0040	DIODE: SI	
S2CR11	1901-0040	DIODE: SI	
S2CR12	1901-0040	DIODE: SI	
S2CR13	1901-0040	DIODE: SI	
S2CR14	1901-0040	DIODE: SI	
S2CR15	1901-0040	DIODE: SI	
S2CR16	1901-0040	DIODE: SI	
S2CR17	1901-0040	DIODE: SI	
S2CR18	1901-0040	DIODE: SI	
S2CR19	1901-0040	DIODE: SI	
S3		NOT ASSIGNED	
S4	3100-0618	SWITCH (SEQUENCES PER GATE INTERVAL)	
S6 to S9	03722-370	ASSY: 4 PUSH-BUTTON SWITCHES (RUN, HOLD, RESET & GATE RESET)	
S10	3101-0032	SWITCH: SLIDE (BINARY/GAUSSIAN)	
S11	3101-0069	SWITCH: SLIDE (CONTROL LOCAL/REMOTE)	
S12	3101-0069	SWITCH: SLIDE (RELAY DISABLE)	
S13	3101-0011	SWITCH: SLIDE (CLOCK)	
S14		NOT ASSIGNED	
S15	3101-0011	SWITCH: SLIDE (DIGITAL FILTER TEST)	
S16	3101-0033	SWITCH: SLIDE (LINE VOLTAGE SELECTOR)	
T1	9100-0624	TRANSFORMER	
W1	8120-0078	CABLE: POWER	
XA1	1251-0135	CONNECTOR: PC 15-CONTACT	
XA2	1251-0135	CONNECTOR: PC 15-CONTACT	
XA3	1251-0135	CONNECTOR: PC 15-CONTACT	
XA4	1251-0135	CONNECTOR: PC 15-CONTACT	
XA5	1251-0135	CONNECTOR: PC 15-CONTACT	
S5	3101-0100	SWITCH: PUSH-BUTTON (LINE) COMPLETE WITH LAMP & LENS ASSY DS2	

* See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description *	Note
XA6	1251-0135	CONNECTOR: PC 15-CONTACT	
XA7	1251-0135	CONNECTOR: PC 15-CONTACT	
XA8	1251-0135	CONNECTOR: PC 15-CONTACT	
XA9	1251-0135	CONNECTOR: PC 15-CONTACT	
XA10	1251-0135	CONNECTOR: PC 15-CONTACT	
XA11	1251-0135	CONNECTOR: PC 15-CONTACT	
XA12	1251-0135	CONNECTOR: PC 15-CONTACT	
XA13	1251-0135	CONNECTOR: PC 15-CONTACT	
XA14	1251-0135	CONNECTOR: PC 15-CONTACT	
XA15	1251-0135	CONNECTOR: PC 15-CONTACT	
XA16	1251-0135	CONNECTOR: PC 15-CONTACT	
XA17	1251-0135	CONNECTOR: PC 15-CONTACT	
XA18	1251-0135	CONNECTOR: PC 15-CONTACT	
XA19	1251-0135	CONNECTOR: PC 15-CONTACT	
XA20	1251-0135	CONNECTOR: PC 15-CONTACT	
XA21	1251-0135	CONNECTOR: PC 15-CONTACT	
XA22	1251-0135	CONNECTOR: PC 15-CONTACT	
XA23	1251-0135	CONNECTOR: PC 15-CONTACT	
XA24	1251-0135	CONNECTOR: PC 15-CONTACT	
XA25	1251-0135	CONNECTOR: PC 15-CONTACT	
XA26		NOT ASSIGNED	
XA27	1251-0135	CONNECTOR: PC 15-CONTACT	
XA28	1251-0135	CONNECTOR: PC 15-CONTACT	
XA29		NOT ASSIGNED	
XA30	1251-0135	CONNECTOR: PC 15-CONTACT	
XA31	1251-0135	CONNECTOR: PC 15-CONTACT	
XA32	1251-0159	CONNECTOR: PC 30-CONTACT	
XA33	1251-0135	CONNECTOR: PC 15-CONTACT	
XA34	1251-0135	CONNECTOR: PC 15-CONTACT	
XA35		NOT ASSIGNED	
XA36			
XA37	1251-0213	CONNECTOR: PC 15-CONTACT	
XA38	1251-0159	CONNECTOR: PC 30-CONTACT	
XA39		NOT ASSIGNED	
XA40	1251-0135	CONNECTOR: PC 15-CONTACT	
XA41	1251-0135	CONNECTOR: PC 15-CONTACT	
XA42	1251-0135	CONNECTOR: PC 15-CONTACT	
XA43	1251-0135	CONNECTOR: PC 15-CONTACT	
XA44	1251-0135	CONNECTOR: PC 15-CONTACT	
XF1	1400-0084	FUSE HOLDER (EXTRACTOR TYPE)	
<u>PACKAGING MATERIAL</u>			
	9211-0249	CARTON	
	9223-0040	CORNER POST (4 REQUIRED)	

* See list of abbreviations in introduction to this section

Table 6-2

Table 6-2 Replaceable Parts

Stock No.	Description *	TQ
0121-0105	C: VAR CER 9-35PF	3
0140-0176	C: FXD MICA 100PF 2% 300VDCW	2
0140-0179	C: FXD MICA 1000PF 5% 300VDCW	1
0140-0191	C: FXD MICA 56PF 5% 300VDCW	6
0140-0192	C: FXD MICA 68PF 5% 300VDCW	15
0140-0193	C: FXD MICA 82PF 5% 300VDCW	10
0140-0194	C: FXD MICA 110PF 5% 300VDCW	14
0140-0195	C: FXD MICA 130PF 5% 300VDCW	32
0140-0196	C: FXD MICA 150PF 5% 300VDCW	22
0140-0198	C: FXD MICA 200PF 5% 300VDCW	14
0140-0199	C: FXD MICA 240PF 5% 300VDCW	7
0140-0200	C: FXD MICA 390PF 5% 300VDCW	7
0140-0204	C: FXD MICA 47PF 5% 500VDCW	7
0140-0206	C: FXD MICA 270PF 5% 500VDCW	1
0150-0086	C: FXD CER 4700PF 20% 500VDCW	1
0150-0093	C: FXD CER 0.01UF -20%+80% 100VDCW	2
0150-0096	C: FXD CER 0.05UF 100VDCW	1
0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW	12
0150-0122	C: FXD CER 2000PF 20% 500VDCW	2
0160-0128	C: FXD CER 2.2UF 20% 25VDCW	3
0160-0134	C: FXD MICA 220PF 5% 300VDCW	3
0160-0137	C: FXD CER 0.33UF 20% 25VDCW	2
0160-0153	C: FXD MY 1000PF 10% 200VDCW	1
0160-0157	C: FXD MY 4700PF 10% 200VDCW	4
0160-0161	C: FXD MY 0.01UF 10% 200VDCW	2
0160-0163	C: FXD MY 0.033UF 10% 200VDCW	2
0160-0179	C: FXD MICA 33PF 5% 300VDCW	1
0160-0181	C: FXD MICA 30PF 5% 300VDCW	2
0160-0297	C: FXD MY 1200PF 10% 200VDCW	3
0160-0300	C: FXD MY 2700PF 10% 200VDCW	1
0160-0301	C: FXD MY 0.012UF 10% 200VDCW	1
0160-0615	C: FXD METALAC 10UF 10% 63VDCW	3
0160-0619	C: FXD METALAC 1UF 10% 63VDCW	2
0160-0620	C: FXD METALAC 2UF 10% 63VDCW	1
0160-0633	C: FXD POLY 0.01UF 1% 63VDCW	1
0160-0646	C: FXD POLY 0.022UF 1% 63VDCW	1
0160-0647	C: FXD POLY 6200PF 1% 500VDCW	1
0160-0648	C: FXD POLY 0.16UF 1% 63VDCW	1
0160-0649	C: FXD POLY 0.051UF 1% 63VDCW	1
0160-0650	C: FXD POLY 0.062UF 1% 63VDCW	1
0160-0651	C: FXD POLY 2200PF 1% 500VDCW	1
0160-0652	C: FXD POLY 3000PF 1% 500VDCW	1
0160-0653	C: FXD POLY 1000PF 1% 500VDCW	1
0160-0655	C: FXD METALAC 1UF 5% 63VDCW	1
0160-0664	C: FXD CER 2x0.001UF -0% +100%	1

* See list of abbreviations in introduction to this section

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
0160-2009	C: FXD MICA 820PF 5% 300VDCW	1
0160-2150	C: FXD MICA 33PF 5% 300VDCW	2
0160-2197	C: FXD MICA 10PF 5% 300VDCW	1
0160-2198	C: FXD MICA 20PF 5% 300VDCW	1
0160-2204	C: FXD MICA 100PF 5% 300VDCW	6
0160-2208	C: FXD MICA 330PF 5% 300VDCW	3
0160-2225	C: FXD MICA 2000PF 5% 300VDCW	1
0160-2306	C: FXD MICA 27PF 5% 300VDCW	226
0160-2598	C: FXD MICA 620PF 2% 300VDCW	1
0170-0019	C: FXD MY 0.1UF 5% 200VDCW	1
0170-0040	C: FXD MY 0.047UF 10% 200VDCW	6
0170-0066	C: FXD MY 0.027UF 10% 200VDCW	1
0180-0059	C: FXD AL 10UF -10%+100% 25VDCW	3
0180-0129	C: FXD AL 975UF -10%+50% 40VDCW	3
0180-0141	C: FXD AL 50UF -10%+75% 50VDCW	3
0180-0291	C: FXD TA 1.0UF 35VDCW	10
0180-0374	C: FXD TA 10UF 10% 20VDCW	2
0180-0376	C: FXD TA 0.47UF 10% 35VDCW	3
0180-1714	C: FXD TA 330UF 10% 6VDCW	2
0180-1846	C: FXD TA 2.2UF 10% 35VDCW	1
0340-0038	PIN	13
0340-0039	INSULATOR	25
0340-0058	MOUNTING POST	6
0340-0059	TERMINAL POST: BRASS	6
0340-0060	TERMINAL: CLOVER LEAF PTFE	12
0340-0099	INSULATOR: BINDING POST	6
0340-0100	INSULATOR: BINDING POST	6
0340-0162	INSULATING WASHER	2
0360-0065	TERMINAL: SUBMINIATURE BRASS	6
0360-0117	TERMINAL BOARD	2
0360-0124	TERMINAL PIN	38
0370-0027	KNOB: 3/4 DIA	1
0370-0035	KNOB: 1 DIA	2
0370-0037	KNOB: 1 DIA	1
0370-0104	KNOB: 5/8 DIA	1
0370-0118	KNOB: PUSH BUTTON	4
0380-0509	FEAD: GLASS	6
0410-0001	CPYSTAL: QUARTZ 3MHz	1
0490-0604	RELAY: REED	2
0683-0685	R: FXD COMP 6.8 OHM 5% 1/4W	1
0683-1035	R: FXD COMP 10K OHM 5% 1/4W	42
0683-1055	R: FXD COMP 1 MEG OHM 5% 1/4W	2
0683-1205	R: FXD COMP 12 OHM 5% 1/4W	2
0683-2015	R: FXD COMP 200 OHM 5% 1/4W	28
0683-2255	R: FXD COMP 2.2 MEG OHM 5% 1/4W	1

* See list of abbreviations in introduction to this section

Table 6-2

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
0683-3335	R: FXD CARBON 33K OHM 5% 1/4W	1
0683-3345	R: FXD COMP 330K OHM 5% 1/4W	1
0683-3915	R: FXD COMP 390 OHM 5% 1/4W	7
0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W	56
0683-4735	R: FXD COMP 47K OHM 5% 1/4W	112
0683-4755	R: FXD COMP 4.7 MEG OHM 5% 1/4W	1
0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W	56
0683-6835	R: FXD COMP 68K OHM 5% 1/4W	7
0683-8225	R: FXD COMP 8.2K OHM 5% 1/4W	14
0683-3145	R: FXD MET FLM 1.0K OHM 1/4% 1/4W	1
0683-3369	R: FXD MET FLM 1.4K OHM 1/4% 1/4W 100 PPM	1
0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50 PPM	3
0698-3624	R: FXD MET OX 150 OHM 5% 2W	2
0698-3752	R: FXD MET FLM 750 OHM 1/4% 1/4W 50 PPM	1
0698-3753	R: FXD MET FLM 857 OHM 1/4% 1/4W 50 PPM	1
0698-3754	R: FXD MET FLM 877 OHM 1/4% 1/4W 50 PPM	2
0698-3755	R: FXD MET FLM 900 OHM 1/2% 1/4W 100 PPM	1
0698-3757	R: FXD MET FLM 1.2K OHM 1% 1/4W 100 PPM	1
0698-3758	R: FXD MET FLM 1.3K OHM 1/4% 1/4W 50 PPM	1
0698-3759	R: FXD MET FLM 1.81K OHM 1% 1/4W 50 PPM	1
0698-3760	R: FXD MET FLM 1.9K OHM 1/4% 1/4W 50 PPM	1
0698-3761	R: FXD MET FLM 2.36K OHM 1% 1/4W 50 PPM	1
0698-3762	R: FXD MET FLM 2.4K OHM 1/2% 1/4W 50 PPM	1
0698-3763	R: FXD MET FLM 3.92K OHM 1% 1/4W 50 PPM	2
0698-3764	R: FXD MET FLM 5.4K OHM 1/4% 1/4W 50 PPM	1
0698-3765	R: FXD MET FLM 6.53K OHM 1% 1/4W 50 PPM	1
0698-3766	R: FXD MET FLM 7.08K OHM 1% 1/4W 50 PPM	1
0698-3768	R: FXD MET FLM 12K OHM 1% 1/4W 50 PPM	1
0698-3769	R: FXD MET FLM 14.16K OHM 1% 1/4W 50 PPM	1
0698-3770	R: FXD MET FLM 23.1K OHM 1% 1/4W 50 PPM	1
0698-3771	R: FXD MET FLM 23.6K OHM 1% 1/4W 50 PPM	1
0698-3772	R: FXD MET FLM 42.48K OHM 1% 1/4W 50 PPM	1
0698-3773	R: FXD MET FLM 141.6K OHM 1% 1/4W 50 PPM	1
0698-3774	R: FXD MET FLM 600 OHM 1/4% 1/4W 50 PPM	2
0698-3775	R: FXD MET OX 16 OHM 2% 1/4W	3
0698-3776	R: FXD MET OX 32 OHM 2% 1/4W	1
0698-3777	R: FXD MET OX 65 OHM 1% 1/4W	1
0698-3778	R: FXD MET OX 138 OHM 1% 1/4W	1
0698-3779	R: FXD MET OX 305 OHM 1% 1/4W	1
0698-3780	R: FXD MET OX 32.2 OHM 1% 1/2W	1
0698-3799	R: FXD MET OX 22 OHM 5% 1/4W	3
0698-4204	R: FXD MET FLM 11.75K OHM 1% 1/4W 100 PPM	
0698-4226	R: FXD MET OX 62 OHM 5% 1/4W	8
0698-4227	R: FXD MET OX 68 OHM 5% 1/4W	6
0698-4230	R: FXD MET OX 82 OHM 5% 1/4W	5
0698-4232	R: FXD MET OX 110 OHM 5% 1/4W	6

* See list of abbreviations in introduction to this section

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
0698-4233	R: FXD MET OX 120 OHM 5% 1/4W	1
0698-4234	R: FXD MET OX 130 OHM 5% 1/4W	1
0698-4239	R: FXD MET OX 220 OHM 5% 1/4W	10
0698-4241	R: FXD MET OX 270 OHM 5% 1/4W	1
0698-4243	R: FXD MET OX 330 OHM 5% 1/4W	1
0698-4245	R: FXD MET OX 390 OHM 5% 1/4W	3
0698-4246	R: FXD MET OX 470 OHM 5% 1/4W	2
0698-4250	R: FXD MET OX 680 OHM 5% 1/4W	4
0698-4252	R: FXD MET OX 820 OHM 5% 1/4W	2
0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	106
0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W	3
0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W	8
0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	19
0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W	11
0698-4265	R: FXD MET OX 3.0K OHM 5% 1/4W	2
0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W	42
0698-4267	R: FXD MET OX 3.6K OHM 5% 1/4W	1
0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	6
0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	96
0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W	258
0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	25
0698-4280	R: FXD MET OX 12K OHM 5% 1/4W	9
0698-4282	R: FXD MET OX 15K OHM 5% 1/4W	7
0698-4286	R: FXD MET OX 22K OHM 5% 1/4W	88
0698-4288	R: FXD MET OX 27K OHM 5% 1/4W	2
0698-4290	R: FXD MET OX 33K OHM 5% 1/4W	2
0698-4292	R: FXD MET OX 39K OHM 5% 1/4W	3
0698-4294	R: FXD MET OX 47K OHM 5% 1/4W	5
0698-4296	R: FXD MET OX 56K OHM 5% 1/4W	5
0698-4298	R: FXD MET OX 68K OHM 5% 1/4W	8
0698-4300	R: FXD MET OX 82K OHM 5% 1/4W	2
0698-4302	R: FXD MET OX 100K OHM 5% 1/4W	8
0698-5584	R: FXD MET FLM 1.5K OHM 1/2% 1/4W 100 PPM	1
0698-5701	R: FXD MET OX 27 OHM 5% 1/4W	2
0698-5707	R: FXD MET OX 47 OHM 5% 1/4W	4
0698-5788	R: FXD MET FLM 10K OHM 1/2% 1/8W 50 PPM	2
0698-5789	R: FXD MET FLM 11.1K OHM 1/2% 1/8W 50 PPM	2
0698-5790	R: FXD MET FLM 12.95K OHM 1/2% 1/8W 50 PPM	2
0698-5791	R: FXD MET FLM 16K OHM 1/2% 1/8W 50 PPM	2
0698-5792	R: FXD MET FLM 21.3K OHM 1/2% 1/8W 50 PPM	2

* See list of abbreviations in introduction to this section

Table 6-2

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM	3
0698-5794	R: FXD MET FLM 52.6K OHM 1/2% 1/8W 50 PPM	2
0698-5795	R: FXD MET FLM 138K OHM 1% 1/8W 100 PPM	2
0698-5796	R: FXD MET FLM 186K OHM 1% 1/8W 150 PPM	2
0698-5797	R: FXD MET FLM 296K OHM 1% 1/8W 150 PPM	2
0698-5798	R: FXD MET FLM 257 OHM 1/2% 1/4W 100 PPM	1
0698-5800	R: FXD MET FLM 667 OHM 1/4% 1/4W 50 PPM	1
0698-6033	R: FXD MET FLM 7.5K OHM 1% 1/4W 50 PPM	2
0698-6034	R: FXD MET FLM 9K OHM 1% 1/4W 50 PPM	1
0698-6402	R: FXD MET FLM 3.01K OHM 1% 1/4W 50 PPM	1
0757-0339	R: FXD MET FLM 3.01K OHM 1% 1/4W 100 PPM	1
0757-0436	R: FXD MET FLM 4.32K OHM 1% 1/8W 100 PPM	1
0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM	4
0757-0468	R: FXD MET FLM 130K OHM 1% 1/8W 100 PPM	2
0757-0472	R: FXD MET FLM 200K OHM 1% 1/8W 100 PPM	2
0757-0473	R: FXD MET FLM 221K OHM 1% 1/8W 100 PPM	1
0757-0484	R: FXD MET FLM 619K OHM 1% 1/8W 100 PPM	2
0757-0715	R: FXD MET FLM 150 OHM 1% 1/4W 100 PPM	1
0757-0739	R: FXD MET FLM 2.0K OHM 1% 1/4W 100 PPM	1
0757-0914	R: FXD MET FLM 390 OHM 2% 1/8W 100 PPM	1
0757-1021	R: FXD MET FLM 66.5 OHM 1% 1/4W 100 PPM	1
0757-1023	R: FXD MET FLM 6.04K OHM 1% 1/4W 100 PPM	1
0757-1035	R: FXD MET FLM 400 OHM 1/2% 1/4W 100 PPM	1
0758-0004	R: FXD MET FLM 2.7K OHM 5% 1/2W	8
0758-0015	R: FXD MET OX 220 OHM 5% 1/2W	1
0758-0017	R: FXD MET FLM 1.5K OHM 5% 1/2W	1
0758-0024	R: FXD MET FLM 100 OHM 5% 1/2W	2
0758-0026	R: FXD MET OX 82 OHM 5% 1/2W	3
0758-0029	R: FXD MET OX 470 OHM 5% 1/2W	3
0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W	8
0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/3W	6
0758-0086	R: FXD MET OX 100 OHM 5% 1/4W	3
0758-0606	R: FXD MET OX 22 OHM 5% 1/2W	2
0760-0022	R: FXD MET FLM 330 OHM 2% 1W	2
0760-0024	R: FXD MET OX 100 OHM 5% 1W	3
0761-0026	R: FXD MET OX 220 OHM 5% 1W	1
0764-0016	R: FXD MET OX 1.0K OHM 5% 2W	2
0811-0601	R: FXD WW 8K OHM 1% 1/2W 5 PPM	1
0811-0602	R: FXD WW 9K OHM 1% 1/2W 5 PPM	1
0812-0033	R: FXD WW 7 OHM 3% 5W	2
0812-0046	R: FXD WW 2 OHM 5% 5W	1
1200-0041	TRANSISTOR MOUNTING TO3	1
1200-0043	TRANSISTOR INSULATING WASHER TO3	1
1200-0168	TRANSISTOR MOUNTING TO66	2
1205-0050	TRANSISTOR HOLDERS	3

* See list of abbreviations in introduction to this section

Table 6-2 Replaceable Parts (Cont'd)

Ⓢ Stock No.	Description *	TQ
1250-0083	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING	8
1250-0118	CONNECTOR: BNC FEMALE BULKHEAD MOUNTING	1
1251-0084	CONNECTOR: 36-CONTACT MALE CABLE PLUG	1
1251-0085	CONNECTOR: 36-CONTACT FEMALE RECEPTACLE	1
1251-0135	CONNECTOR: PC 15 CONTACTS	37
1251-0159	CONNECTOR: PC 30 CONTACTS	2
1251-0213	CONNECTOR: PC 15 CONTACTS	1
1400-0084	FUSE HOLDER EXTRACTOR POST TYPE	1
1490-0030	STAND-TILT	1
1510-0009	BINDING POST	6
1520-0001	MOUNTING BASE	2
1820-0001	AMPLIFIER: REF NPN SI	1
1850-0062	TRANSISTOR: GE	56
1853-0001	TRANSISTOR: SI PNP	2
1853-0012	TRANSISTOR: SI PNP	3
1853-0034	TRANSISTOR: SI PNP	23
1853-0036	TRANSISTOR: SI PNP	7
1853-0052	TRANSISTOR: SI PNP	1
1853-0607	TRANSISTOR: SI PNP MATCHED PAIR	1
1854-0003	TRANSISTOR: SI NPN	4
1854-0039	TRANSISTOR: SI NPN	3
1854-0063	TRANSISTOR: SI NPN	1
1854-0071	TRANSISTOR: SI NPN	17
1854-0072	TRANSISTOR: SI NPN	1
1854-0215	TRANSISTOR: SI NPN	2
1854-0605	TRANSISTOR: SI NPN	143
1855-0603	TRANSISTOR: SI FET	1
1901-0025	DIODE: SI	2
1901-0040	DIODE: SI	235
1901-0045	DIODE: SI	12
1902-0017	DIODE: BREAKDOWN 6.81V 400MW	3
1902-0041	DIODE: BREAKDOWN 5.11V 400MW	6
1902-0126	DIODE: BREAKDOWN 2.61V 400MW	1
1902-3234	DIODE: BREAKDOWN 19.6V 5% 400MW	1
1910-0016	DIODE: GE	35
1910-0034	DIODE: GE	6
1912-0002	DIODE: TUNNEL	2
2100-0626	R: VAR WW LIN 1K OHM 10% 1/2W	1
2100-1757	R: VAR WW LIN 500 OHM 10% 1/4W	7
2100-1758	R: VAR WW LIN 1.0K OHM 10% 1/2W	1
2100-1759	R: VAR WW LIN 2.0K OHM 10% 1/2W	1
2100-1760	R: VAR WW LIN 5.0K OHM 10% 1/2W	1
2100-0941	R: VAR WW LIN 1.0K OHM 5% 1W	1
2100-0989	R: VAR WW LIN 10K OHM 5% 1W	1
2110-0006	FUSE: CARTRIDGE SLOW-BLOW 2A 125V	1
1853-0015	TRANSISTOR: SI PNP	37
1450-0106	LAMP & RED LENS ASSY	1

* See list of abbreviations in introduction to this section

Table 6-2

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
2110-0007	FUSE: CARTRIDGE SLOW-BLOW 1A 2.0V	1
2140-0022	LAMP: NEON	1
2140-0602	LAMP: FILAMENT	1
3100-0618	SWITCH (SEQUENCES PER GATE INTERVAL)	1
3101-0011	SWITCH: SLIDE	2
3101-0032	SWITCH: SLIDE	1
3101-0033	SWITCH: SLIDE	1
3101-0069	SWITCH: SLIDE	2
3101-0100	SWITCH: PUSH-BUTTON (INCLUDES LAMP & LENS ASSY 1450-0106)	1
5000-0051	PLATE: FLUTED AL	2
5000-0316	LABEL: RUN	1
5000-0738	SIDE COVER (REAR)	2
5000-0739	SIDE COVER (FRONT)	2
5000-3363	LABEL: RESET	1
5000-3365	LABEL: HOLD	1
5000-3366	LABEL: GATE RESET	1
5020-0446	HEX NUT	1
5040-0234	LAMP HOLDER	1
5040-0235	RETAINER	1
5060-0049	EXTENDER BOARD	1
5060-0222	SIDE HANDLE ASSY	2
5060-0732	FRAME ASSY	1
5060-0766	HANDLE ASSY RETAINER	2
5060-0767	FOOT ASSY	5
5060-0775	RACK MOUNTING KIT	1
7100-0333	COVER	1
7120-0607	PLATE SERIAL	1
7120-1254	LOGO	1
8120-0078	CABLE: POWER	1
9100-0619	TRANSFORMER: CRYSTAL OSCILLATOR	1
9100-0620	TRANSFORMER: SHIFT PULSE GENERATOR	1
9100-0624	TRANSFORMER	1
9100-1633	L: FXD COIL 68UH 5%	1
9100-1653	L: FXD COIL 910UH 5%	2
9100-0051	INDUCTOR 40MH	1
9140-0112	COIL: FXD 4.7UH 10%	1
9140-0114	COIL: FXD 10UH 10%	1
9140-0136	INDUCTOR: 22UH	2
9161-0013	RELAY: COIL	2
9211-0249	CARTON	1
9223-0040	POST	4
00140-24701	SUPPORT: PANEL TOP	1
00140-24702	SUPPORT: PANEL BOTTOM	1
03722-101	FRONT PANEL	1
03722-103	DECK MAIN	1

* See list of abbreviations in Introduction to this section

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
03722-104	REAR PANEL	1
03722-105	CLIP	2
03722-106	SCREEN: RELAY	1
03722-107	SCREEN: SWITCH	1
03722-108	BRACKET: SUPPORT	1
03722-109	SCREEN: ATTENUATOR	1
03722-110	SWITCH: MOUNT	1
03722-111	SHIELD	1
03722-112	CARD RETAINER	1
03722-113	HEAT SINK	1
03722-114	STIFFENER	1
03722-118	COVER TOP	1
03722-119	COVER BOTTOM	1
03722-120	CARD RETAINER	2
03722-121	BRACKET	1
03722-122	SHIELD	1
03722-361	CARD SUPPORT	1
03722-362	CARD SUPPORT	1
03722-363	CARD SUPPORT	1
03722-364	CARD SUPPORT	1
03722-366	CARD SUPPORT	1
03722-367	PILLAR	1
03722-368	CARD SUPPORT	1
03722-701	ASSY: FEEDBACK LOGIC	1
03722-702	ASSY: AUTO-START LOGIC	1
03722-703	ASSY: SHIFT PULSE GENERATOR	1
03722-704	ASSY: SHIFT REGISTER	8
03722-705	ASSY: DIVIDE-BY-THREE	1
03722-706	ASSY: DIGITAL-TO-ANALOG CONVERTER (1)	1
03722-707	ASSY: OUTPUT AMPLIFIER (3)	1
03722-708	ASSY: OUTPUT AMPLIFIER (1)	1
03722-709	ASSY: RANDOM NOISE SAMPLER	1
03722-710	ASSY: SEQUENCE COUNTER	1
03722-711	ASSY: POWER SUPPLY STABILISER	1
03722-712	ASSY: ANALOG FILTER (1)	1
03722-713	ASSY: CONTROL LOGIC	1
03722-714	ASSY: GATE AND SYNC OUTPUT	1
03722-715	ASSY: CRYSTAL OSCILLATOR	1
03722-716	ASSY: RANDOM NOISE GENERATOR	1
03722-717	ASSY: RECTIFIER	1
03722-718	ASSY: ANALOG FILTER (2)	1
03722-719	ASSY: REFERENCE POWER SUPPLY	1
03722-720	ASSY: OUTPUT SWITCH	1
03722-721	ASSY: DIGITAL-TO-ANALOG CONVERTER (2)	1
03722-722	ASSY: RELAY	1
03722-370	ASSY: PUSH-BUTTON SWITCH	1
03722-123	DUMMY FRONT PANEL	1

* See list of abbreviations in introduction to this section

Table 6-2 Replaceable Parts (Cont'd)

Stock No.	Description *	TQ
03722-723	ASSY: DIGITAL-TO-ANALOG CONVERTER (3)	1
03722-724	ASSY: DIGITAL-TO-ANALOG CONVERTER (4)	1
03722-725	ASSY: HIGH SPEED DECADE DIVIDER	2
03722-728	ASSY: ATTENUATOR SWITCH	1
03722-730	ASSY: OUTPUT AMPLIFIER (2)	1
03722-732	CLOCK PERIOD CABLE HARNESS (FRONT)	1
03722-734	ASSY: SEQUENCE LENGTH SWITCH	1
03722-735	CABLE HARNESS MAIN	1
03722-738	CLOCK PERIOD SWITCH ASSEMBLY	1
03722-740	REAR PANEL AND PUSH BUTTON HARNESS	1
03722-741	CLOCK PERIOD CABLE HARNESS (REAR)	1
03722-746	ASSY: SEQUENCE LENGTH SWITCH	1
03722-760	COAXIAL CABLE (BRN/WHT)	1
03702-761	COAXIAL CABLE (RED/BLK)	1
03722-762	COAXIAL CABLE (RED/BRN)	1
03722-763	COAXIAL CABLE (RED/RED)	1
03722-772	COAXIAL CABLE (RED/GRY)	1
03722-901	MANUAL	1
5212A-65C	ASSY: LOW SPEED DECADE DIVIDER	7

* See list of abbreviations in introduction to this section

Table 6-3 Commercial Equivalents - Transistors and Diodes

Part No.	JEDEC Equivalent	Manufacturer
1820-0001	-----	General Electric 4JX19A519 Motorola SCA-11
1850-0062	-----	RCA 34146 Texas GA287
1853-0001	Similar to 2N1132	Fairchild S3251 Texas SM10168 Transitron ST8047
1853-0012	2N2904A	Motorola 2N2904A Texas 2N2904A
1853-0015	2N3640	Motorola MPS3640-5
1853-0034	-----	Fairchild S18864 Motorola SM3197 Texas SM9477
1853-0036	2N3906	Motorola 2N3906-5
1853-0052	2N3740	Motorola 2N3740
1853-0607	-----	-----
1854-0003	Similar to 2N1714	Fairchild S7088 Motorola SS2199 PSI PT1844 Raytheon RT5299
1854-0030	2N3053	Motorola 2N3053 RCA 2N3053 Transitron 2N3053
1854-0063	2N3055	Motorola 2N3055 RCA 2N3055
1854-0071	-----	Texas SK1124
1854-0072	2N3054	RCA 2N3054
1854-0215	2N3904	Motorola 2N3904-5
1854-0605	-----	Motorola MPS2714
1855-0603	2N3819	Texas 2N3819
1901-0025	-----	Continental CD12298 Fairchild FD2387 General Electric SS410 Raytheon RD9028 Sylvania D3072 Transitron SG817

Table 6-3

Table 6-3 Commercial Equivalents - Transistors and Diodes (Cont'd)

Part No.	JEDEC Equivalent	Manufacturer
1901-0040	-----	Continental CD6319 Fairchild FDG1088 I. T. T. S541 Transitron SG5050 Texas PG512
1901-0045	-----	Motorola SR1358-7
1902-0017	-----	Continental CD35657 Motorola SZ10939-133
1902-0041	-----	Continental CD35622 Motorola SZ10939-98
1902-0126	-----	Continental CD35538 Motorola SZ10939-14
1902-3234	-----	Continental CD35790 Motorola SZ10939-266
1910-0016	-----	General Instruments GD150 I. T. T. G718 Sylvania D2361 Transitron S3185G
1910-0034	-----	Hughes HD1840 I. T. T. G724 Sylvania D6670
1912-0002	-----	General Electric 1N3716 special

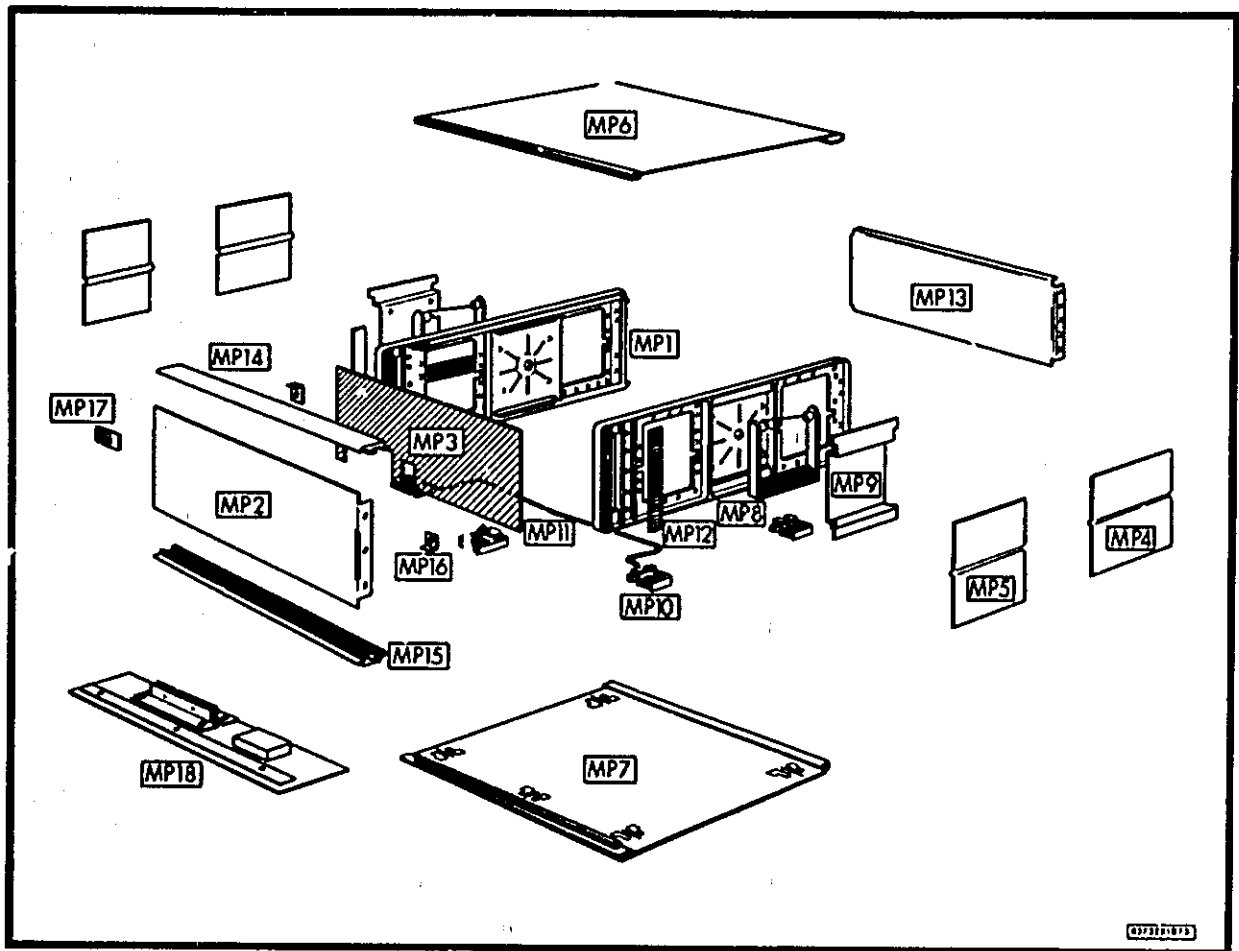


Figure 6 - 1 Location of cabinet components

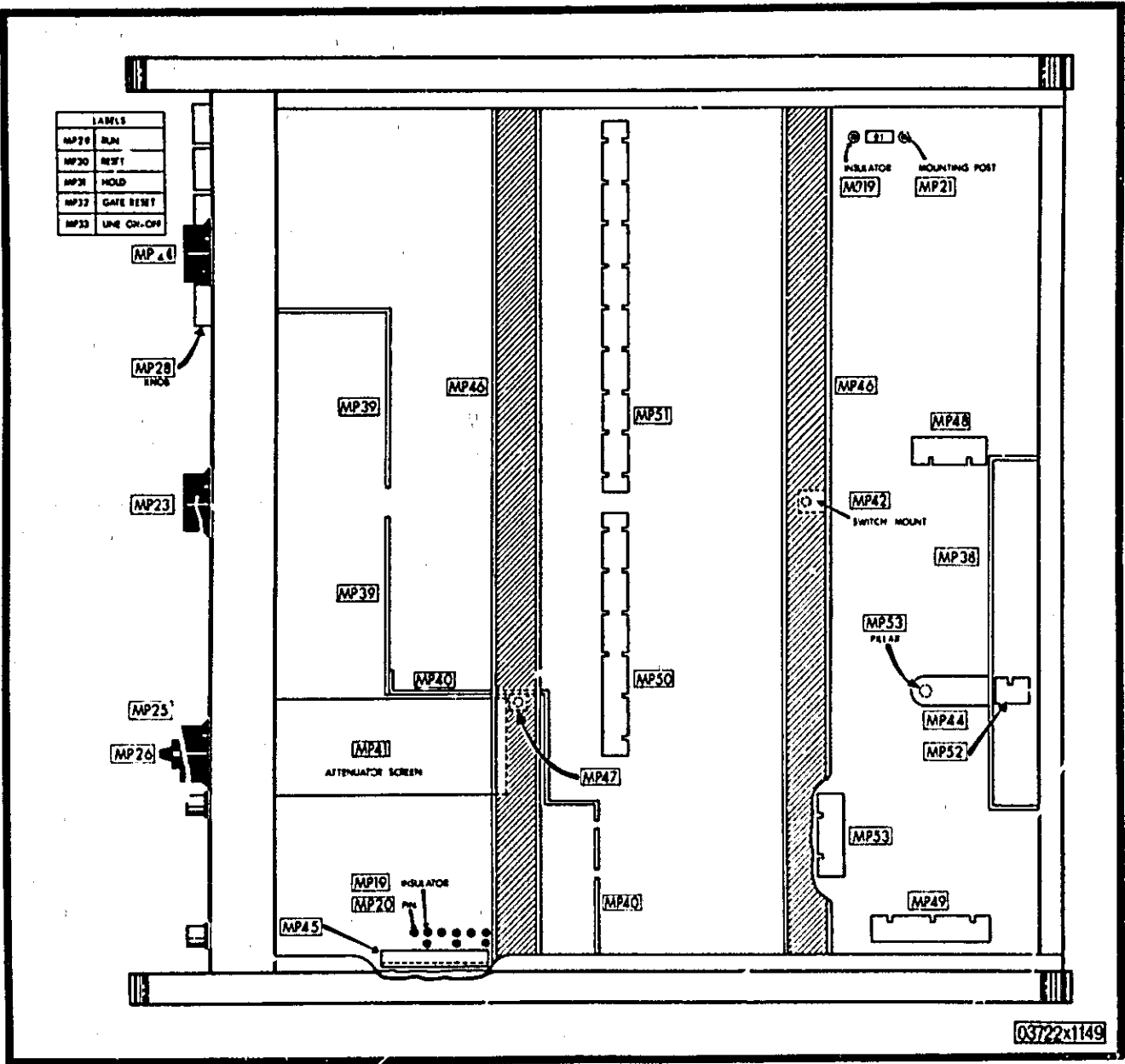


Figure 6 - 2 Location of mechanical parts

SECTION VII

OPTION 01

Sequence shift for zero time moment

7-1 INTRODUCTION

7-2 Time averages taken over one period of a pseudo-random sequence are normally independent of the point in time at which the averaging starts. However, when the test signal is contaminated by background disturbances such as steady drift — as occurs in many practical systems — the result of the averaging measurement can be in error. In such cases, the magnitude and sign of the error depend critically on the starting point of the averaging process. In **Option 01** versions of the *hp 3722A*, an optimum starting point (identified by the sync pulse) has been chosen for each of the seven shortest sequences ($N = 15$ to $N = 1023$). This optimisation is such that the first time moment of the pseudo-random binary sequence, with respect to the sync pulse, is zero.

7-3 SEQUENCE ADVANCE ASSEMBLY A40

7-4 Logic diagram and typical waveforms are given in Figure 7-1. For circuit details, refer to Figure 7-4. General information on the technique of sequence shifting used in the *hp 3722A* is given in Paragraphs 4-24 to 4-27.

7-5 The two main inputs to the assembly, at A40(14) and A40(15), are a selected pair of binary signals from the shift register: selection is performed by wafers S2HF and S2JR of the SEQUENCE LENGTH switch. A40Q1+Q2+Q3 generate the modulo-two sum of the input pair, and supply the result to a second modulo-two adder, A40Q4+Q5+Q6. The other input of the second adder is taken from the CONTROL receptacle on the rear panel: when pin 21 of this receptacle is open-circuit (the normal condition), the binary waveform from the

first modulo-two adder passes without modification through the second. If pin 21 is grounded, however, the second adder receives in effect a permanent '1' input which *inverts the binary waveform*. A40Q8+Q9 is a conventional flip-flop of the type used in the shift register (Paragraphs 4-59 to 4-61). The output from the flip-flop is a delayed, inverted version of that from the second modulo-two adder.

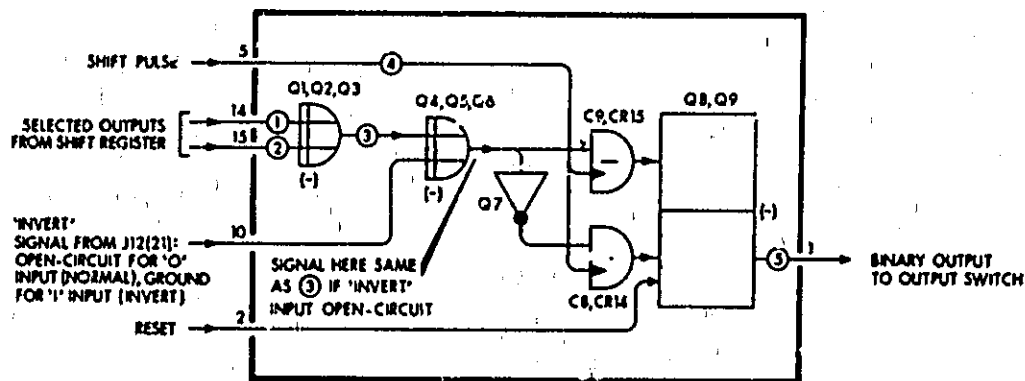
7-6 Pairs of shift register outputs selected by the SEQUENCE LENGTH switch are as follows (refer to block diagram, Figure 8-5):-

SEQUENCE LENGTH switch setting	Shift register outputs
N= 15	2 and 8
N= 31	5 and 11
N= 63	5 and 2
N= 127	26 and 2
N= 255	30 and 11
N= 511	10 and 26
N=1023	3 and 8

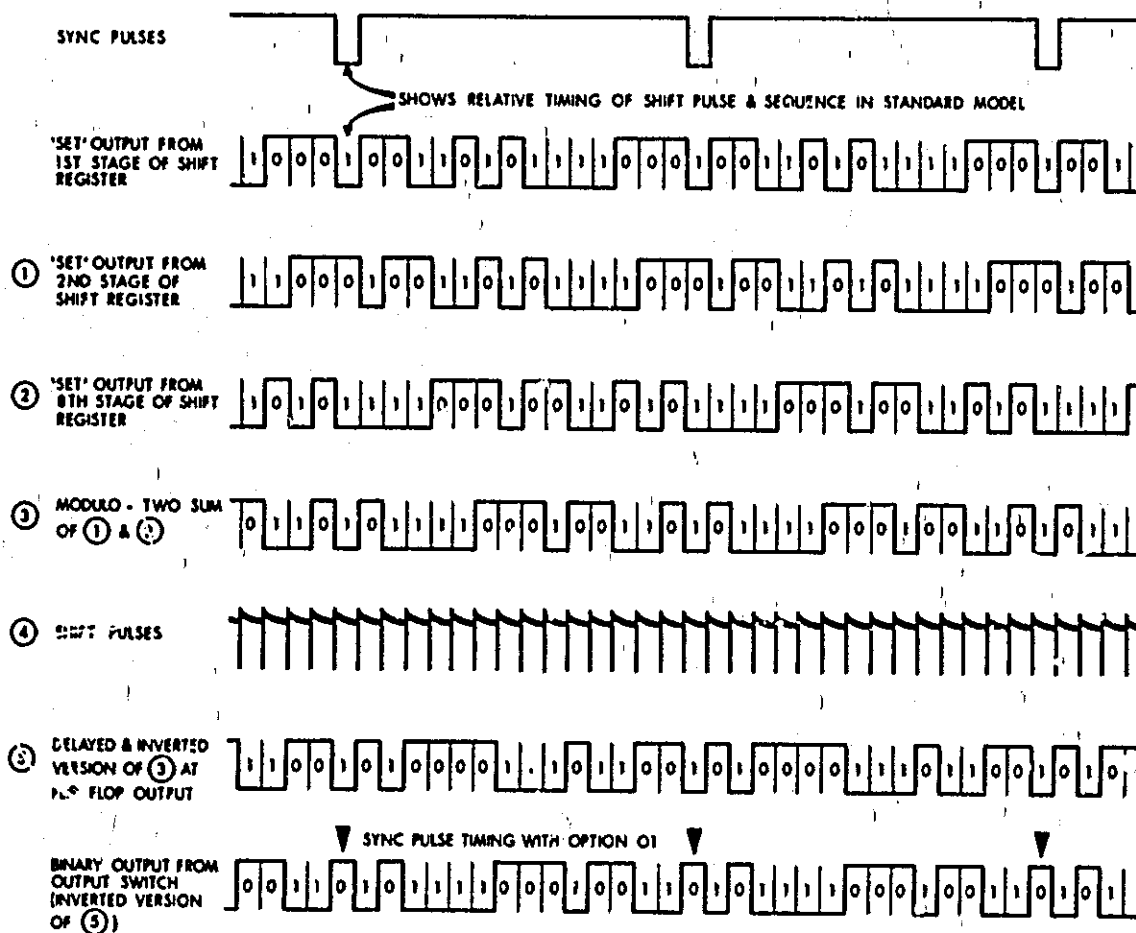
7-7 CONVERSION TO OPTION 01

7-8 To convert a standard *hp 3722A* instrument into an Option 01 version, proceed as follows:-

- (1) Remove the wire link between pins 1 and 4 of socket XA40.
- (2) Insert into socket XA40 a Sequence Advance Assembly, *hp* part number 03722-739.
- (3) Check operation of the converted instrument as detailed in Figure 7-2.

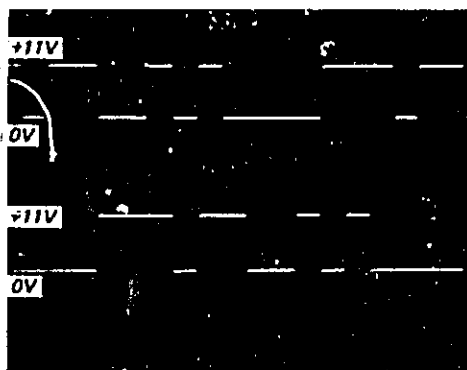


WAVEFORMS BELOW ILLUSTRATE MODULO-TWO ADDITION OF OUTPUTS FROM STAGES 2 & 8 OF SHIFT REGISTER (AS USED IN 3722A TO SHIFT 15-BIT SEQUENCE). OUTPUT SELECTIONS FOR OTHER SEQUENCE LENGTHS ARE LISTED IN TEXT.

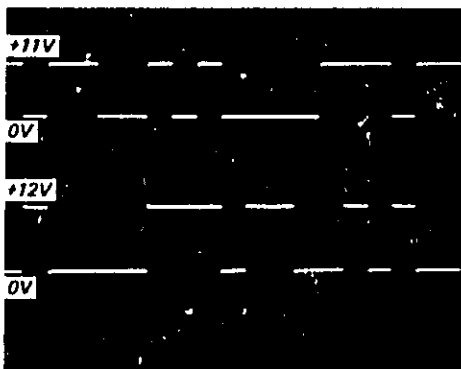


05723 A1061

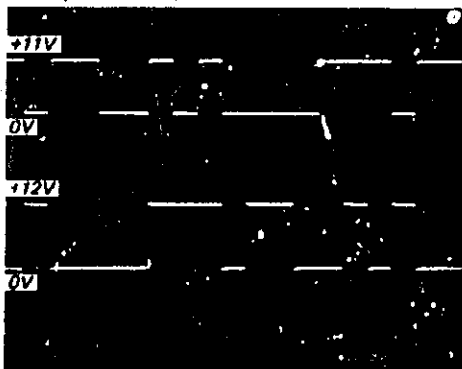
Figure 7 - 1 Generation of shifted sequence



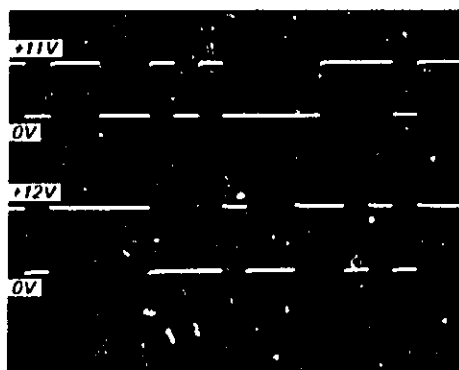
Upper trace input to A40(14), 10V/cm
Lower trace input to A40(15), 10V/cm
Clock period $10\mu\text{S}$ $N = 15$
Sweep $20\mu\text{S/cm}$
Trigger from 3722A SYNC



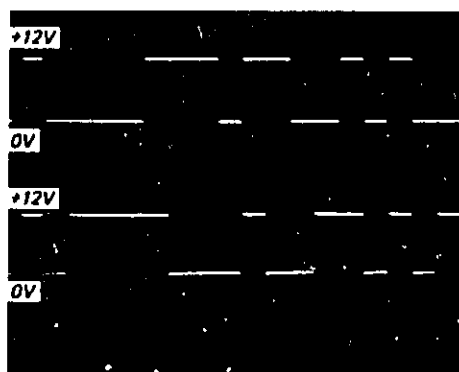
Upper trace input to A40(14), 10V/cm
Lower trace A40Q2 & A40Q3 collectors, 10V/cm
Clock period $10\mu\text{S}$ $N = 15$
Sweep $20\mu\text{S/cm}$
Trigger from 3722A SYNC



Upper trace input to A40(14), 10V/cm
Lower trace A40Q5 & A40Q6 collectors, 10V/cm, with input A40(10) open-circuit. In this condition there is no inversion — so the waveforms are exactly as before.
Clock period $10\mu\text{S}$ $N = 15$
Sweep $20\mu\text{S/cm}$
Trigger from 3722A SYNC



Upper trace input to A40(14), 10V/cm
Lower trace A40Q5 & A40Q6 collectors, 10V/cm, with A40(10) grounded. (A40(10) is brought out to J12(21) on the rear panel). Note inversion of lower trace compared with preceding waveforms.
Clock period $10\mu\text{S}$ $N = 15$
Sweep $20\mu\text{S/cm}$
Trigger from 3722A SYNC



Upper trace A40Q5 & A40Q6 collectors, 10V/cm, with A40(10) open-circuit
Lower trace A40Q9C (output from sequence advance assembly), 10V/cm
Clock period $10\mu\text{S}$ $N = 15$
Sweep $20\mu\text{S/cm}$
Trigger from 3722A SYNC

TO OBTAIN TRACES FOR THE FIRST EIGHT SEQUENCES, $N=15$ TO $N=2047$, TRIGGER OSCILLOSCOPE WITH 3722A SYNC PULSE: DISPLAY BINARY OUTPUT & SYNC PULSE SIMULTANEOUSLY, WITH CLOCK PERIOD $1\mu S$ & SWEEP TIME $2\mu S/CM$. EXAMINE ONLY FIRST n BITS OF EACH SEQUENCE ($N=2^n-1$)

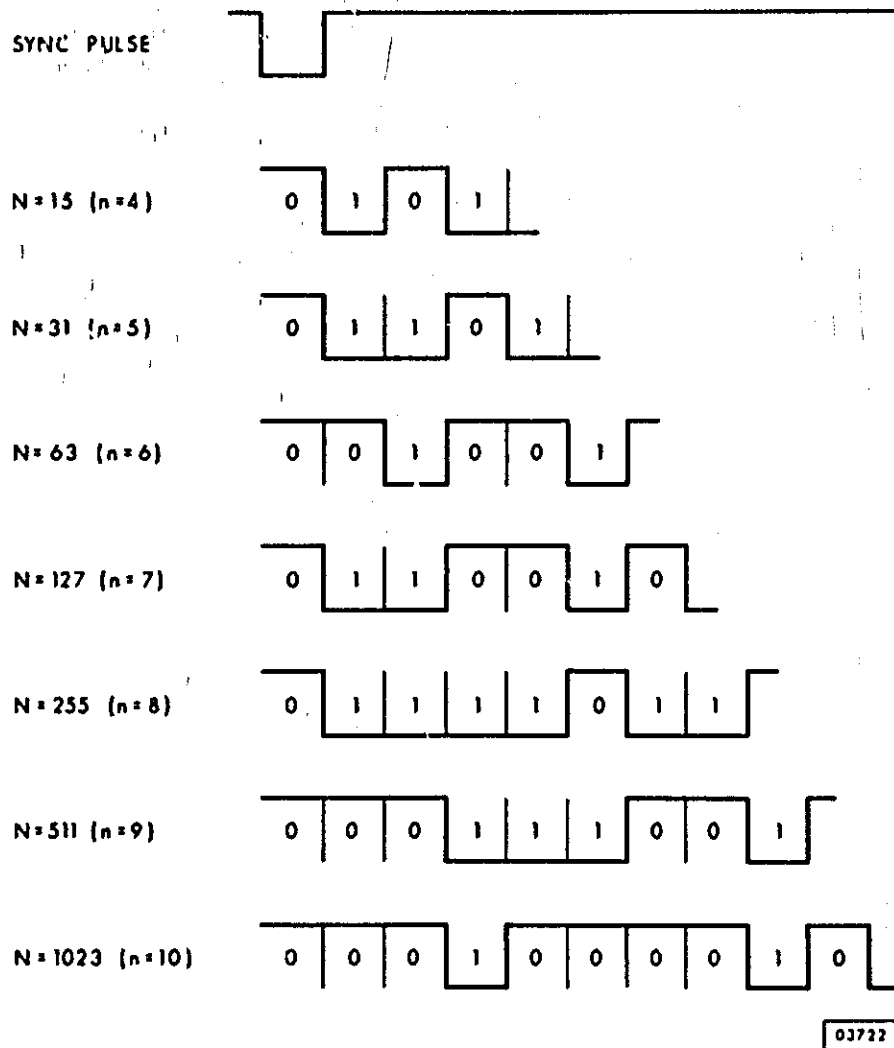


Figure 7 - 2 Sequence shift check

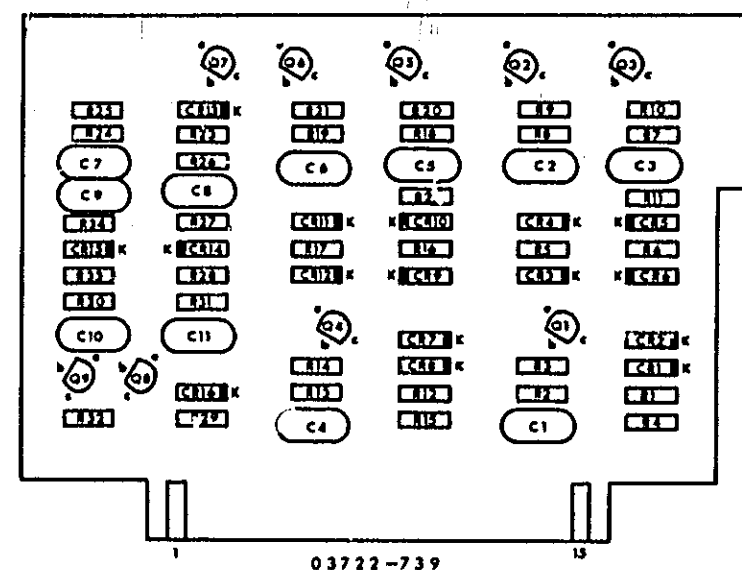


Figure 7-3 Sequence advance assembly A40, component location

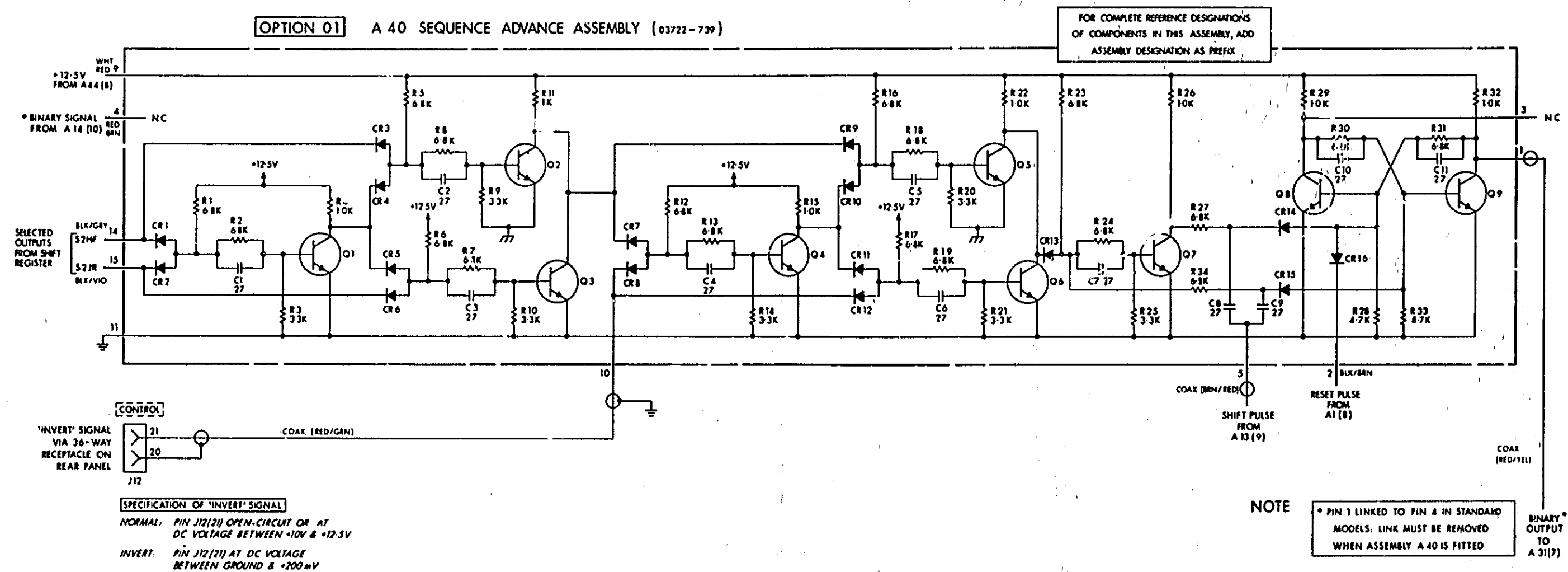


Figure 7-4 Sequence advance assembly A40, schematic

A40	03722-739 03722-339	ASSY: SEQUENCE ADVANCE BOARD: BLANK PC (NSR)	A40R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
			A40R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
			A40R3	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
			A40R4	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
			A40R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R9	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R11	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R14	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A40R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR1	1901-0040	DIODE: SI	A40R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR2	1901-0040	DIODE: SI	A40R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR3	1901-0040	DIODE: SI	A40R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR4	1901-0040	DIODE: SI	A40R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40CR5	1901-0040	DIODE: SI	A40R21	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40CR6	1901-0040	DIODE: SI	A40R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40CR7	1901-0040	DIODE: SI	A40R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR8	1901-0040	DIODE: SI	A40R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR9	1901-0040	DIODE: SI	A40R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A40CR10	1901-0040	DIODE: SI	A40R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40CR11	1901-0040	DIODE: SI	A40R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR12	1901-0040	DIODE: SI	A40R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A40CR13	1901-0040	DIODE: SI	A40R29	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40CR14	1901-0040	DIODE: SI	A40R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR15	1901-0040	DIODE: SI	A40R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40CR16	1901-0040	DIODE: SI	A40R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A40Q1	1854-0605	TRANSISTOR: SI NPN	A40R33	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A40Q2	1854-0605	TRANSISTOR: SI NPN	A40R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A40Q3	1854-0605	TRANSISTOR: SI NPN			
A40Q4	1854-0605	TRANSISTOR: SI NPN			
A40Q5	1854-0605	TRANSISTOR: SI NPN			
A40Q6	1854-0605	TRANSISTOR: SI NPN			
A40Q7	1854-0605	TRANSISTOR: SI NPN			
A40Q8	1854-0605	TRANSISTOR: SI NPN			
A40Q9	1854-0605	TRANSISTOR: SI NPN			

SECTION VIII

SCHEMATICS, COMPONENT LOCATION DIAGRAMS, WAVEFORMS & SERVICE NOTES

8-1 INTRODUCTION

8-2 This section contains all circuit diagrams and component location diagrams, in assembly number order. Where necessary, oscilloscope waveforms and explanatory notes are included. Detailed troubleshooting information is given for the following assemblies:

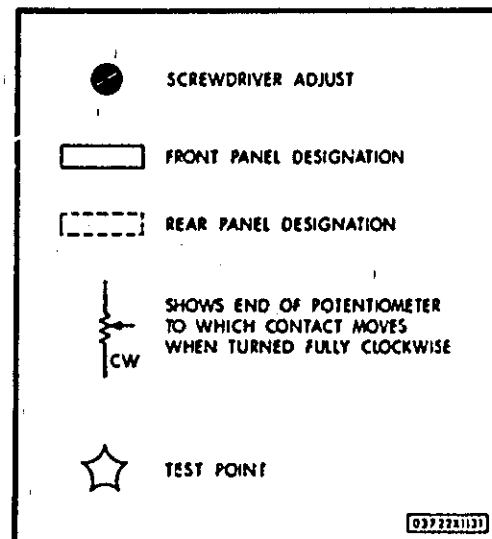
Digital filters A15, A18, A21 and A24

Random noise system A29 and A30

Analog filters A33 and A34

Output amplifiers A35, A36 and A37

On the reverse of each circuit diagram is component list extracted from Table 6-1.



COMPONENTS WHICH ARE NOT MOUNTED ON P.C. BOARDS NEED NO PREFIX e.g. Q5 IS A COMPLETE REFERENCE

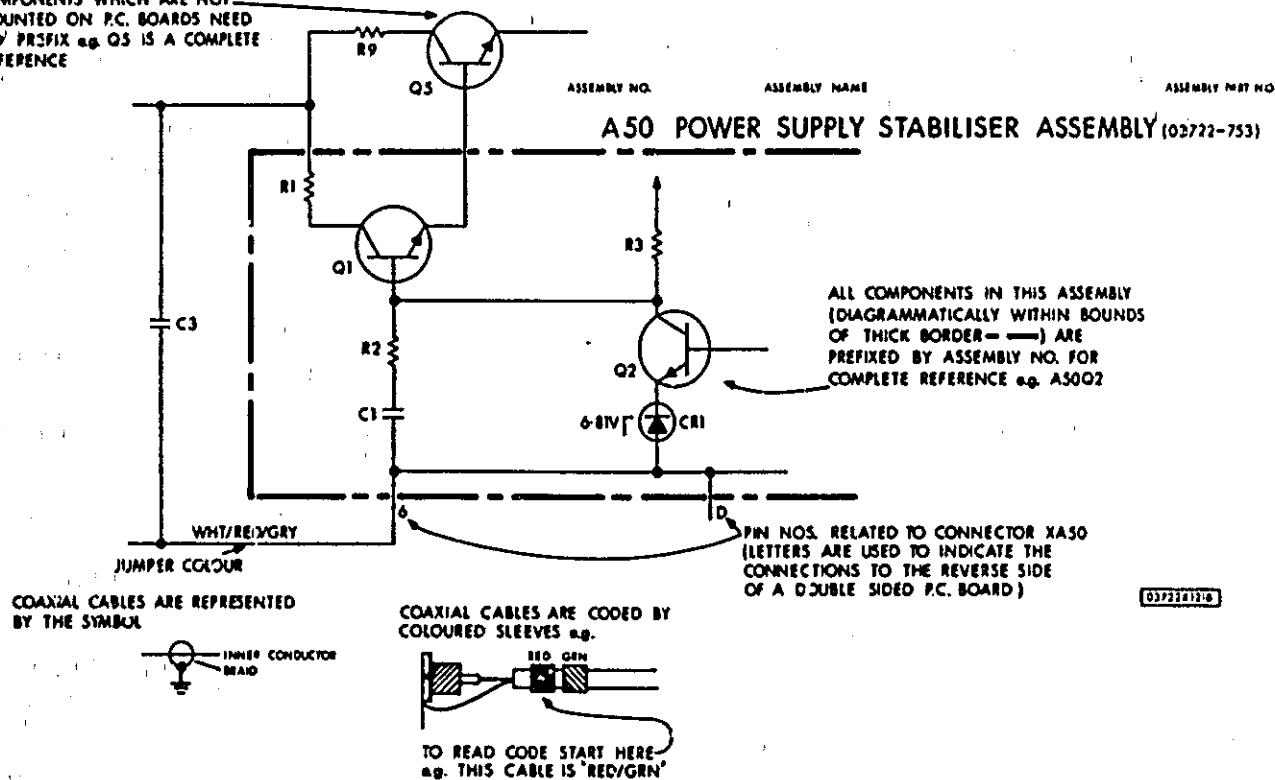


Figure 8-1 Guide to schematics

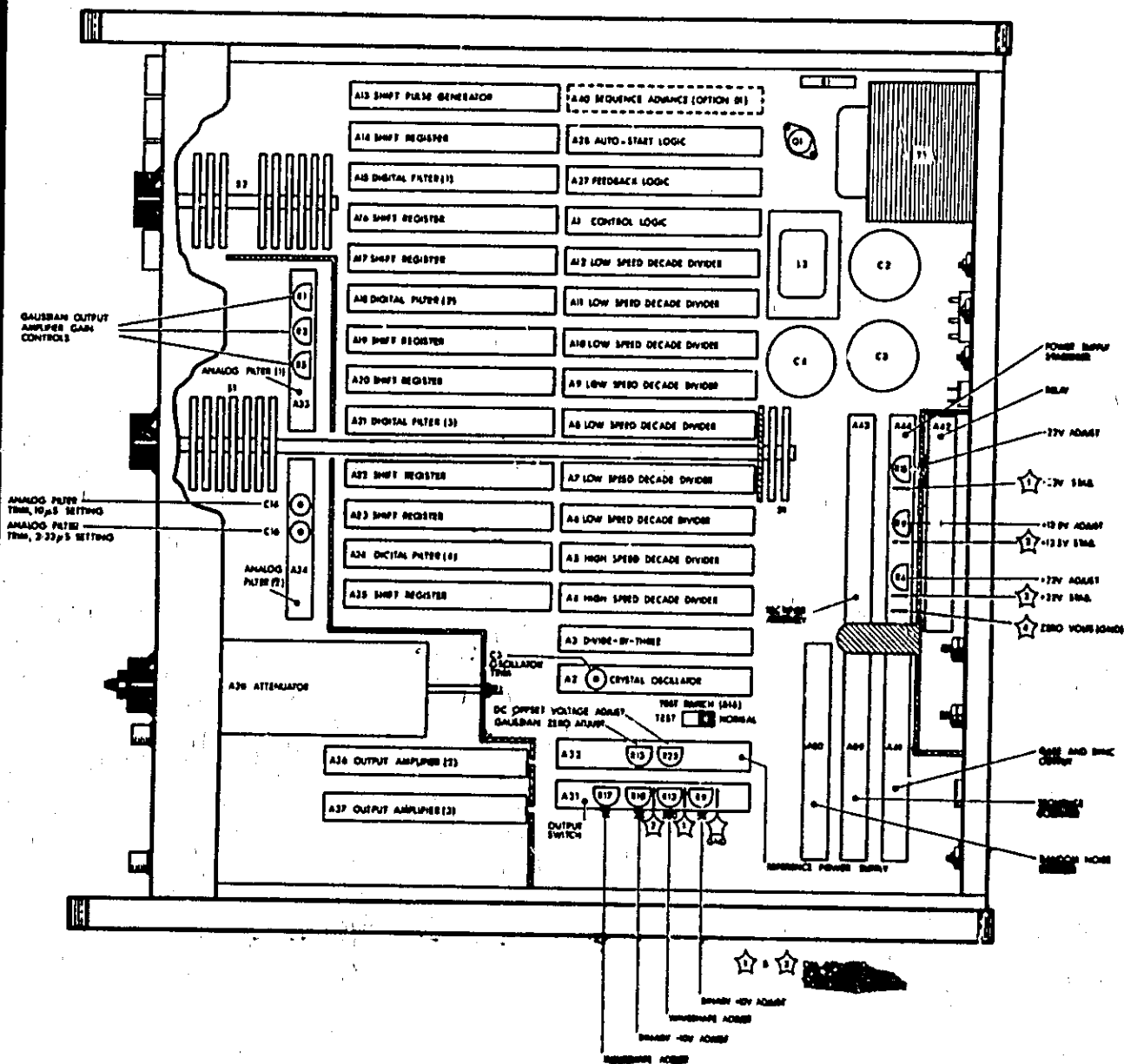


Figure 8 - 2 Location of assemblies

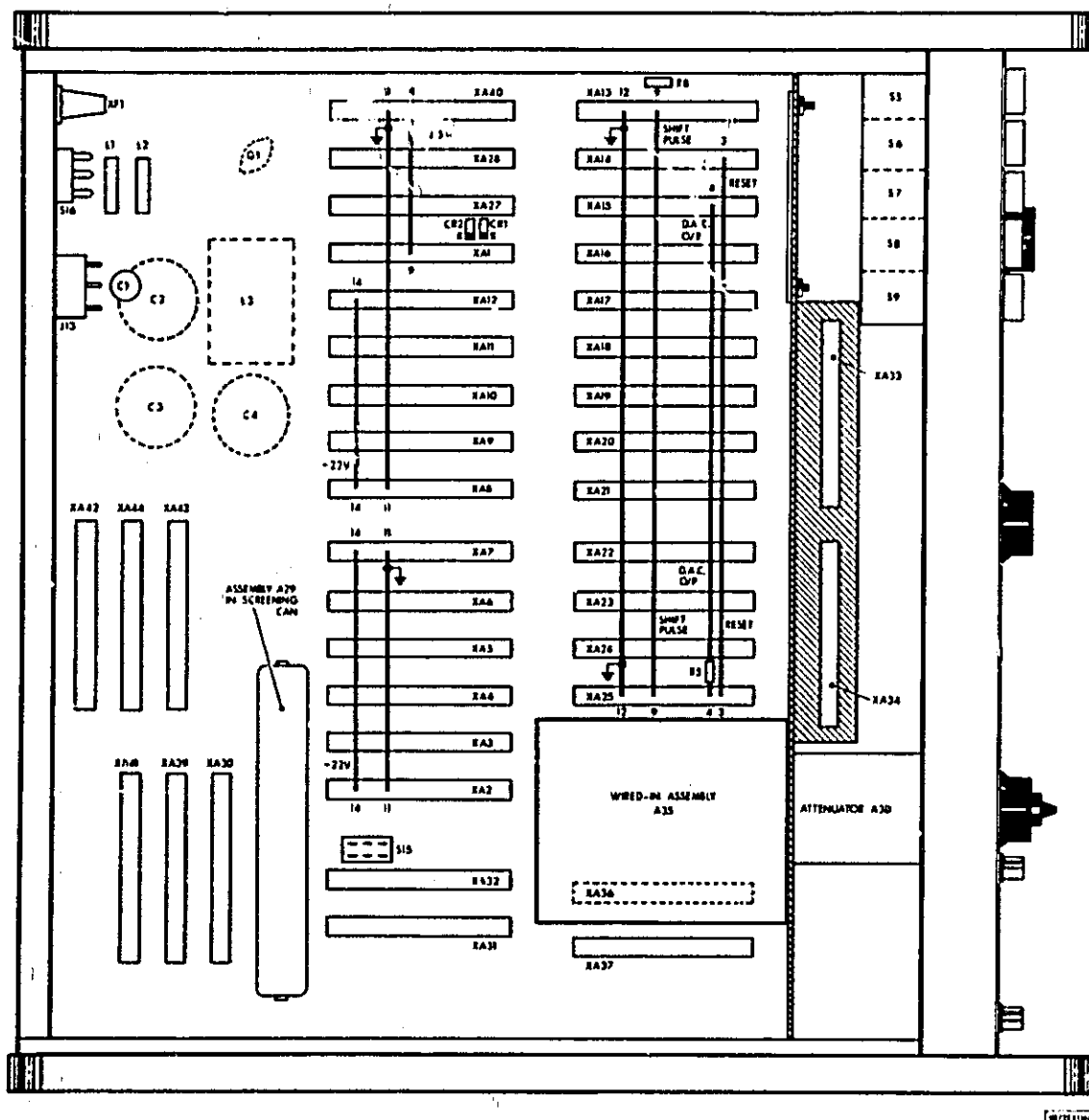


Figure 8 - 3 Location of chassis mounted components

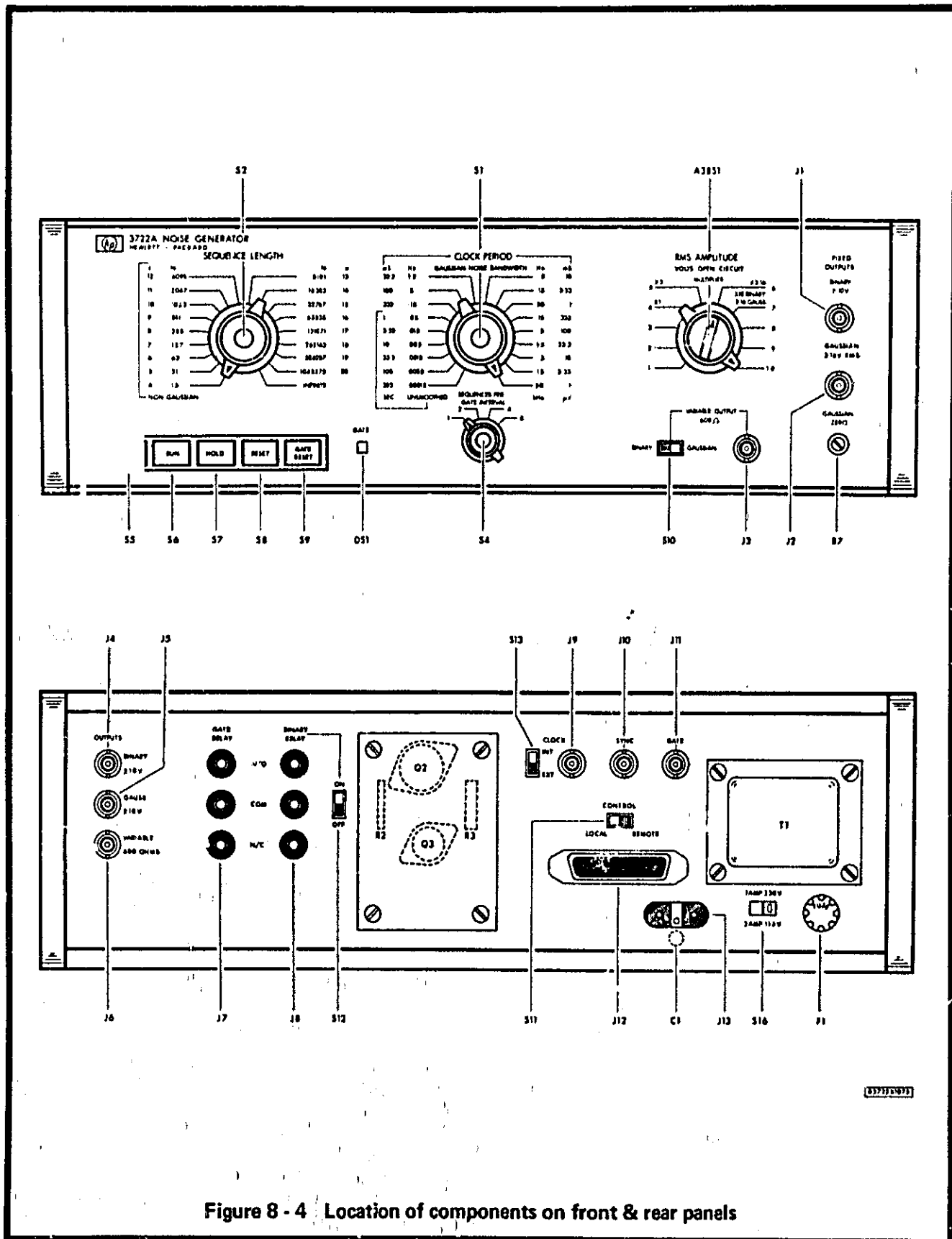
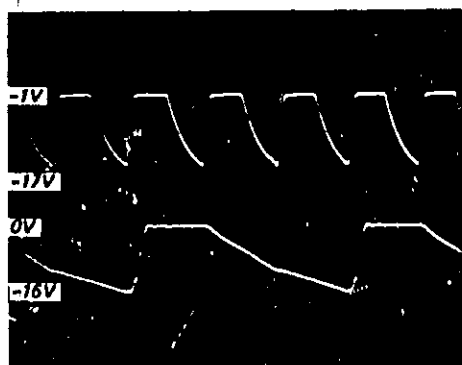
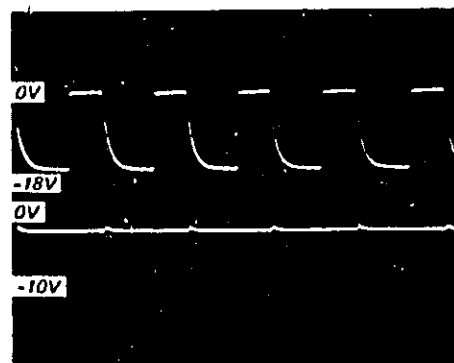


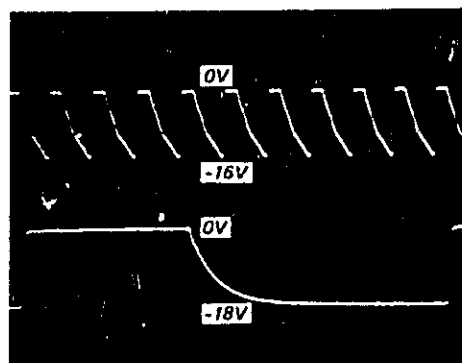
Figure 8 - 4 Location of components on front & rear panels



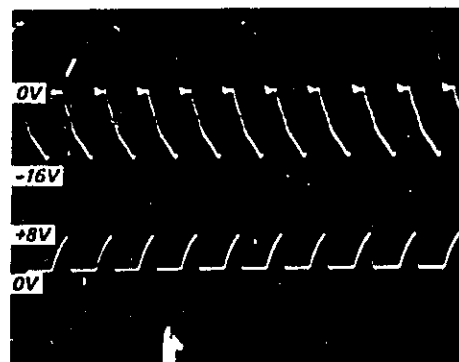
Upper trace crystal oscillator output
A2(6), 10V/cm
Lower trace $\div 3$ output A3(9), 10V/cm
Clock period 1 μ S Sweep 0.2 μ S/cm
Trigger internal



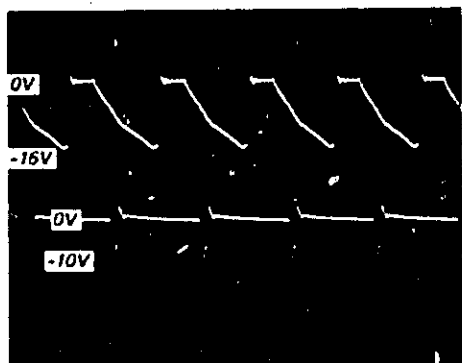
Upper trace clock input to shift pulse
generator A13(3), 10V/cm
Lower trace shift pulse A13(9), 10V/cm
Clock period 10 μ S Sweep 5 μ S/cm
Trigger internal



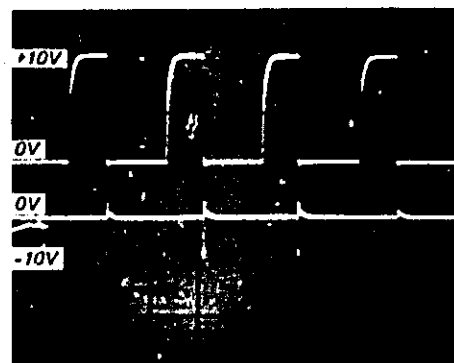
Upper trace $\div 3$ output A3(9), 10V/cm
Lower trace $\div 10$ output A4(13), 10V/cm
Clock period 1 μ S Sweep 1 μ S/cm
Trigger internal



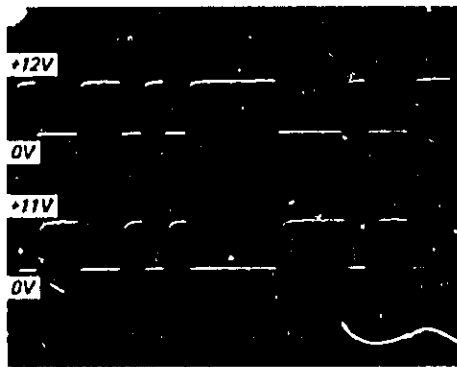
Upper trace clock input to A13(3), 10V/cm
Lower trace clock output at A13(7),
10V/cm
Clock period 1 μ S Sweep 1 μ S/cm
Trigger internal



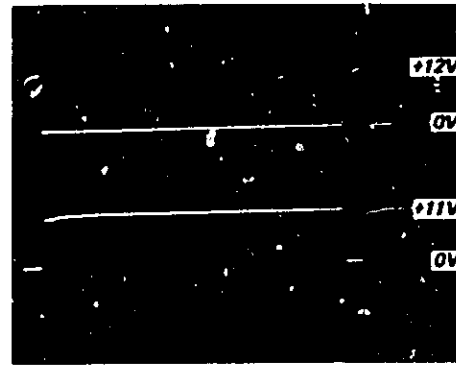
Upper trace clock input to shift pulse
generator A13(3), 10V/cm
Lower trace shift pulse A13(9), 10V/cm
Clock period 1 μ S Sweep 0.5 μ S/cm
Trigger internal



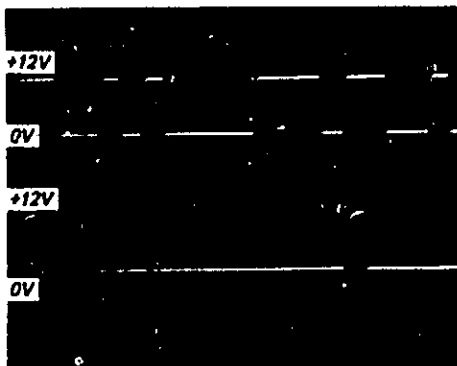
Upper trace clock input to random noise
sampler A30(1), 5V/cm
Lower trace shift pulse at A13(9), 10V/cm
Clock period 10 μ S Sweep 5 μ S/cm
Trigger from 3722A CLOCK



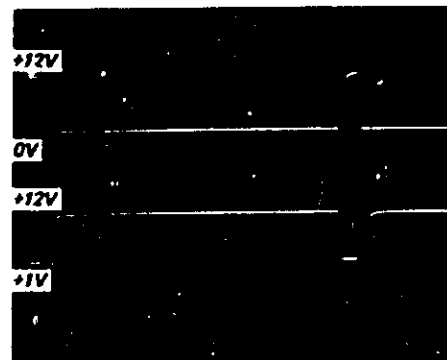
Upper trace shift register output A14(10), 10V/cm
Lower trace shift register output A14(11), 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC



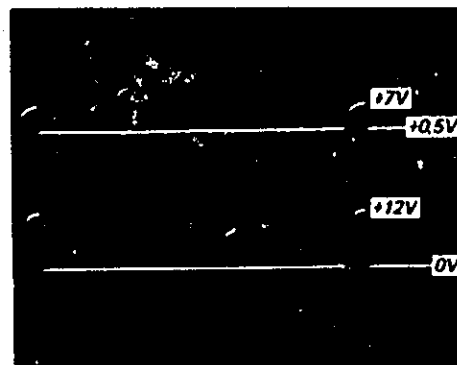
Upper trace sync pulse from A28(14) to A41(3), 10V/cm
Lower trace sync pulse from A41(1) to sequence counter, 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC



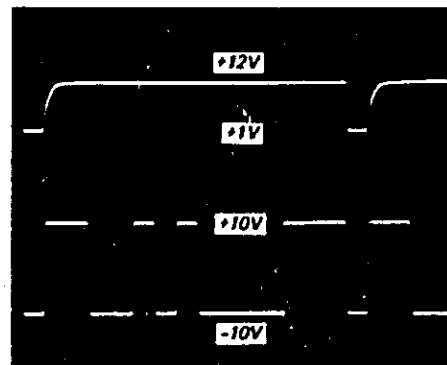
Upper trace feedback signal from A27(8), 10V/cm
Lower trace sync pulse from A28(14), 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC



Upper trace sync pulse at A41(3), 10V/cm
Lower trace SYNC output from A41(2), 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC



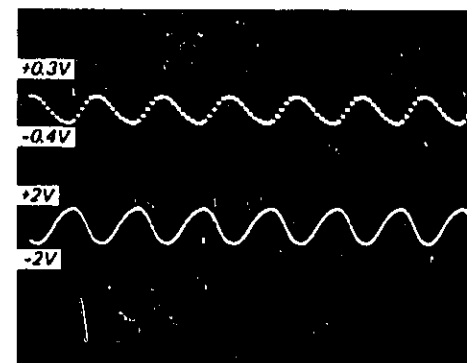
Upper trace 'all zeros' signal to A28(15), 10V/cm
Lower trace sync pulse from A28(14), 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC



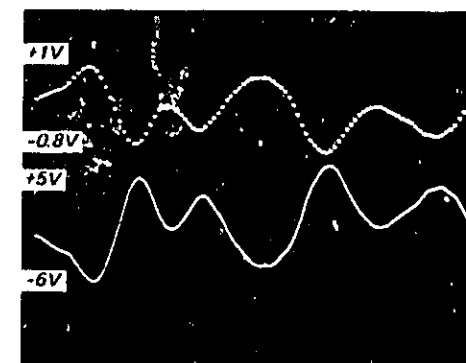
Upper trace SYNC pulse at A41(2), 10V/cm
Lower trace BINARY output at A31(6), 10V/cm
Clock period $1\mu\text{S}$ N = 15 Sweep $2\mu\text{S}/\text{cm}$
Trigger from 3722A SYNC

All photographs

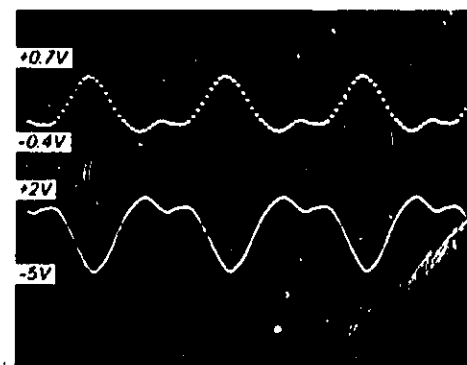
Upper trace digital filter output at A22(4)
1V/cm
Lower trace GAUSSIAN output at J2,
5V/cm
Clock period 1 μ S Sweep 10 μ S/cm
Trigger from 3722A SYNC



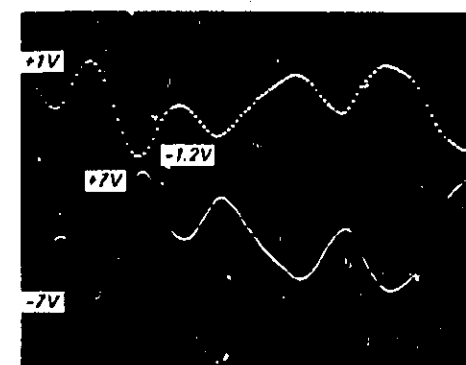
N = 15



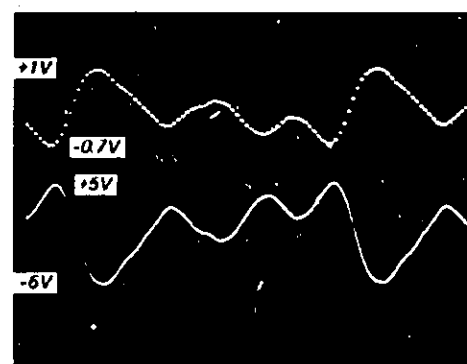
N = 127



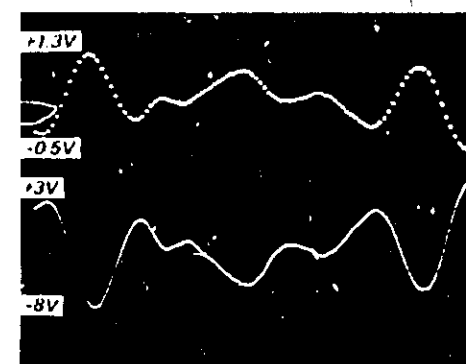
N = 31



N = 255



N = 63



N = 511

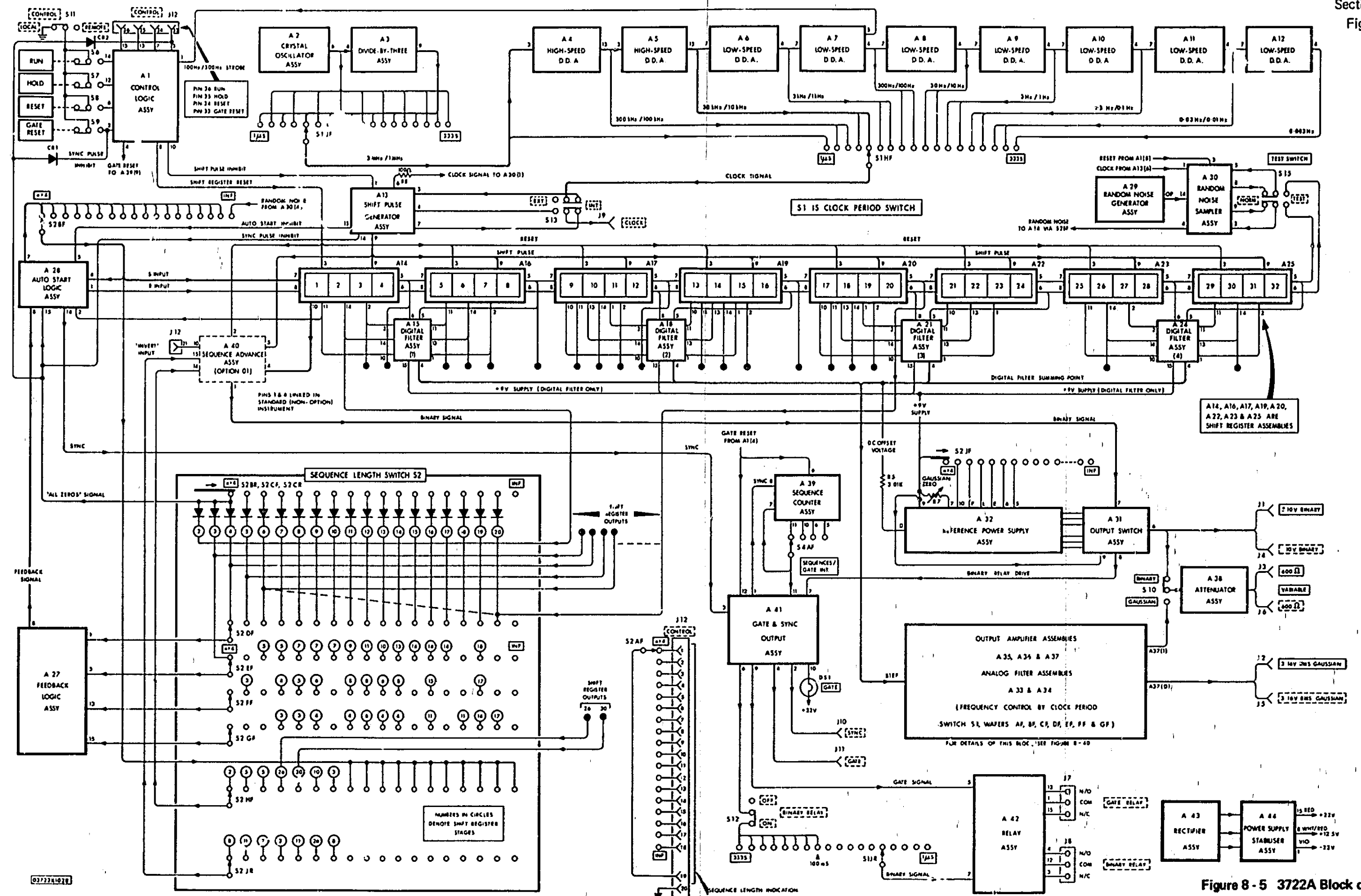


Figure 8-5 3722A Block diagram

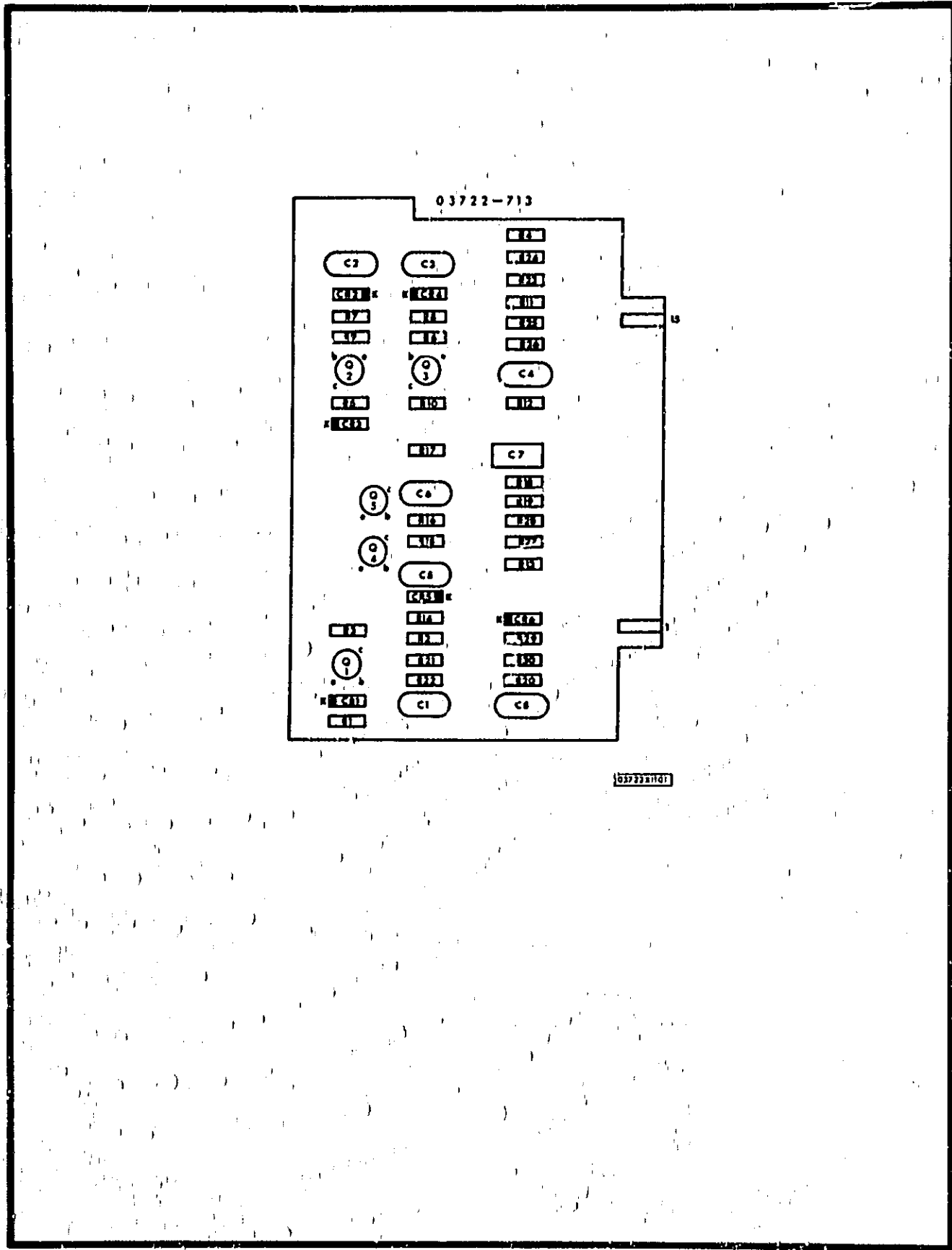


Figure 8 - 6 Control logic assembly A1, component location

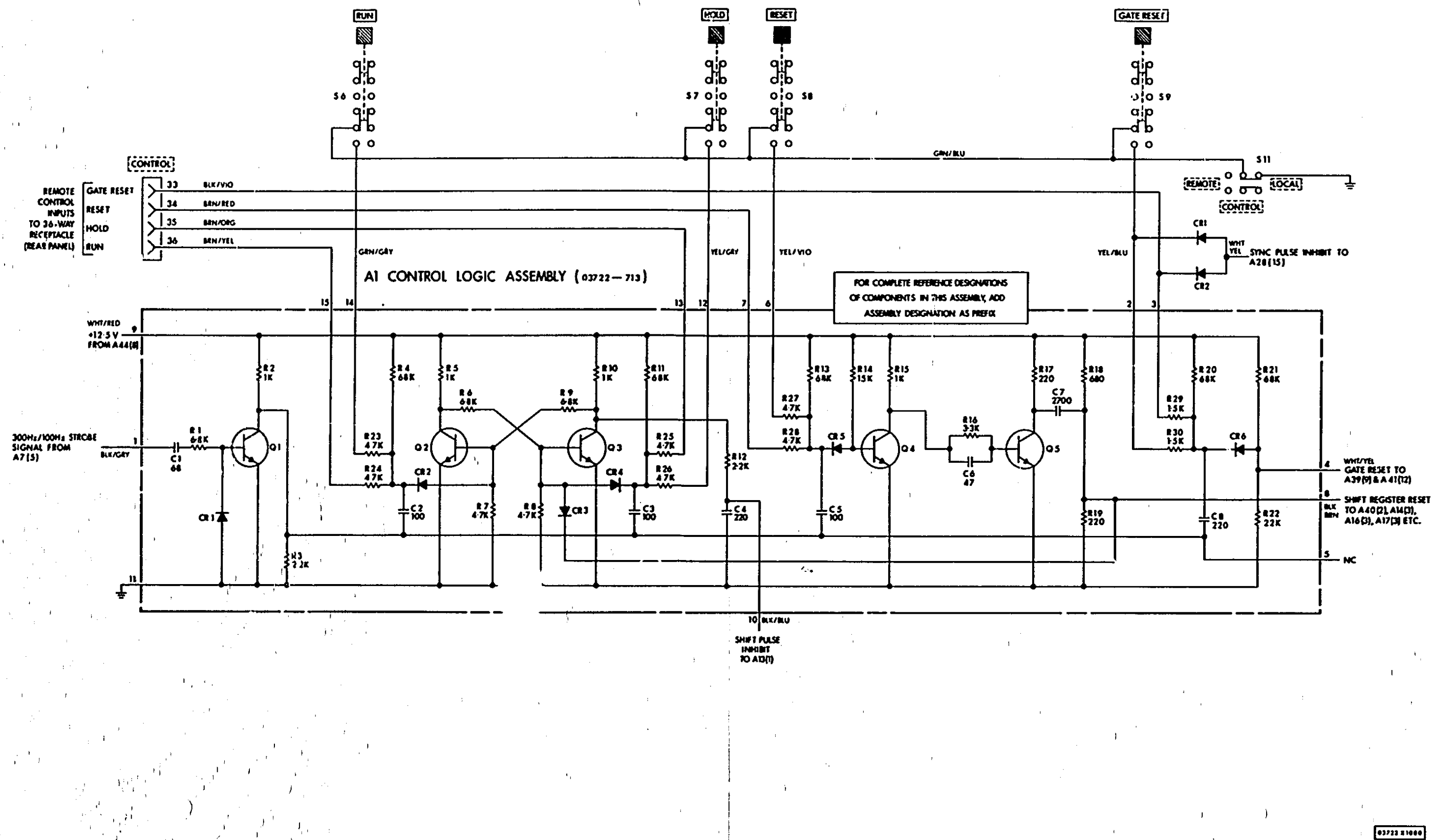
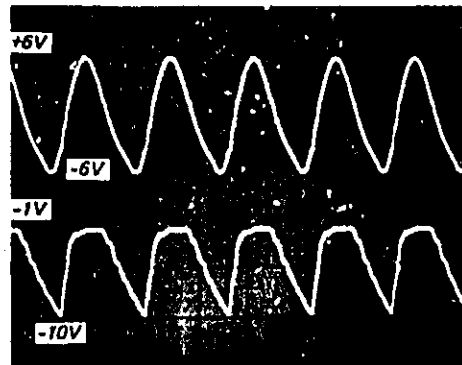


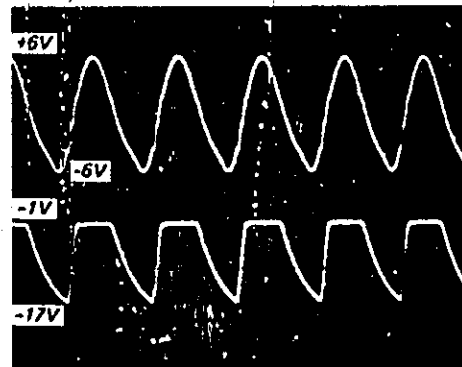
Figure 8 - 7 Control logic assembly A1, schematic

A1	03722-713 03722-313	ASSY: CONTROL LOGIC BOARD: BLANK PC (NSR)
A1C1	0140-0192	C: FXD MICA 68PF 5% 300VDCW
A1C2	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C3	0160-2204	C: FXD MICA 190PF 5% 300VDCW
A1C4	0160-0134	C: FXD MICA 220PF 5% 300VDCW
A1C5	9160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C6	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A1C7	0160-0300	C: FXD MY 2700PF 10% 200VDCW
A1C8	0160-0134	C: FXD MICA 220PF 5% 300VDCW
A1CR1	1901-0040	DIODE: SI
A1CR2	1901-0040	DIODE: SI
A1CR3	1901-0040	DIODE: SI
A1CR4	1901-0040	DIODE: SI
A1CR5	1901-0040	DIODE: SI
A1CR6	1901-0040	DIODE: SI
A1Q1	1854-0605	TRANSISTOR: SI NPN
A1Q2	1854-0605	TRANSISTOR: SI NPN
A1Q3	1854-0605	TRANSISTOR: SI NPN
A1Q4	1854-0605	TRANSISTOR: SI NPN
A1Q5	1854-0605	TRANSISTOR: SI NPN
A1R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A1R2	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A1R3	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A1R4	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A1R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A1R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A1R7	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A1R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A1R11	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A1R12	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A1R13	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A1R14	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A1R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A1R16	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A1R17	0758-0015	R: FXD MET OX 220 OHM 5% 1/2W
A1R18	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W
A1R19	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A1R20	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A1R21	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A1R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A1R23	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R24	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R25	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R26	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R27	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A1R29	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A1R30	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W

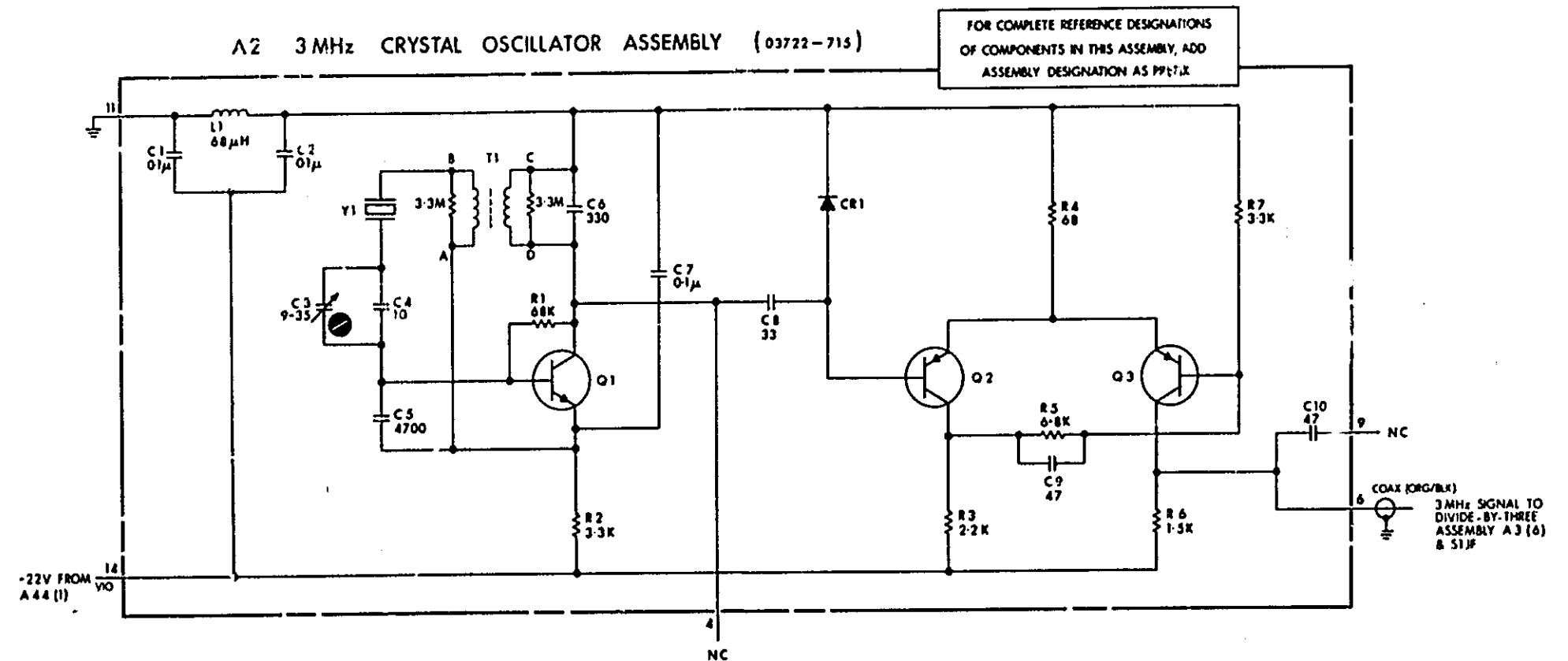
A2 Test waveforms



Upper trace A2Q1C, 5V/cm
Lower trace A2Q3C, 5V/cm
Clock period 3.33 μ S, 33.3 μ S, etc
Sweep 0.2 μ S/cm
Trigger internal



Upper trace A2Q1C, 5V/cm
Lower trace A2Q3C, 10V/cm
Clock period 1 μ S, 10 μ S, etc
Sweep 0.2 μ S/cm
Trigger internal



03722-1001

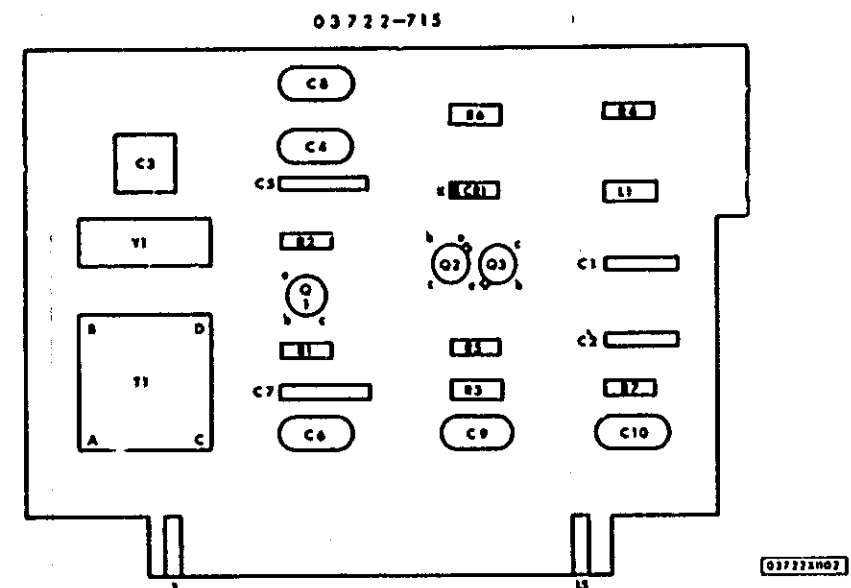


Figure 8 - 8 Crystal oscillator assembly A2, schematic & component location

A2	03722-715 03722-315	ASSY: CRYSTAL OSCILLATOR BOARD: BLANK PC (NSR)
A2C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A2C2	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A2C3	0121-0105	C: VAR CER 9-35PF
A2C4	0160-2197	C: FXD MICA 10PF 5% 300VDCW
A2C5	0150-0086	C: FXD CER 4700PF 20% 500VDCW
A2C6	0160-2208	C: FXD MICA 330PF 5% 300VDCW
A2C7	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A2C8	0160-0179	C: FXD MICA 33PF 5% 300VDCW
A2C9	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A2C10	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A2CR1	1901-0040	DIODE: SI
A2L1	9100-1633	L: FXD COIL 68UH 5%
A2MP1	0380-0509	BEAD: GLASS
A2MP2	0380-0509	BEAD: GLASS
A2Q1	1854-0605	TRANSISTOR: SI NPN
A2Q2	1853-0034	TRANSISTOR: SI PNP
A2Q3	1853-0034	TRANSISTOR: SI PNP
A2R1	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A2R2	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A2R3	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W
A2R4	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W
A2R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A2R6	0758-0017	R: FXD MET OX 1.5K OHM 5% 1/2W
A2R7	0638-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A2T1	9100-0619	TRANSFORMER: CRYSTAL OSCILLATOR
A2Y1	0410-0301	CRYSTAL: QUARTZ 3MHz

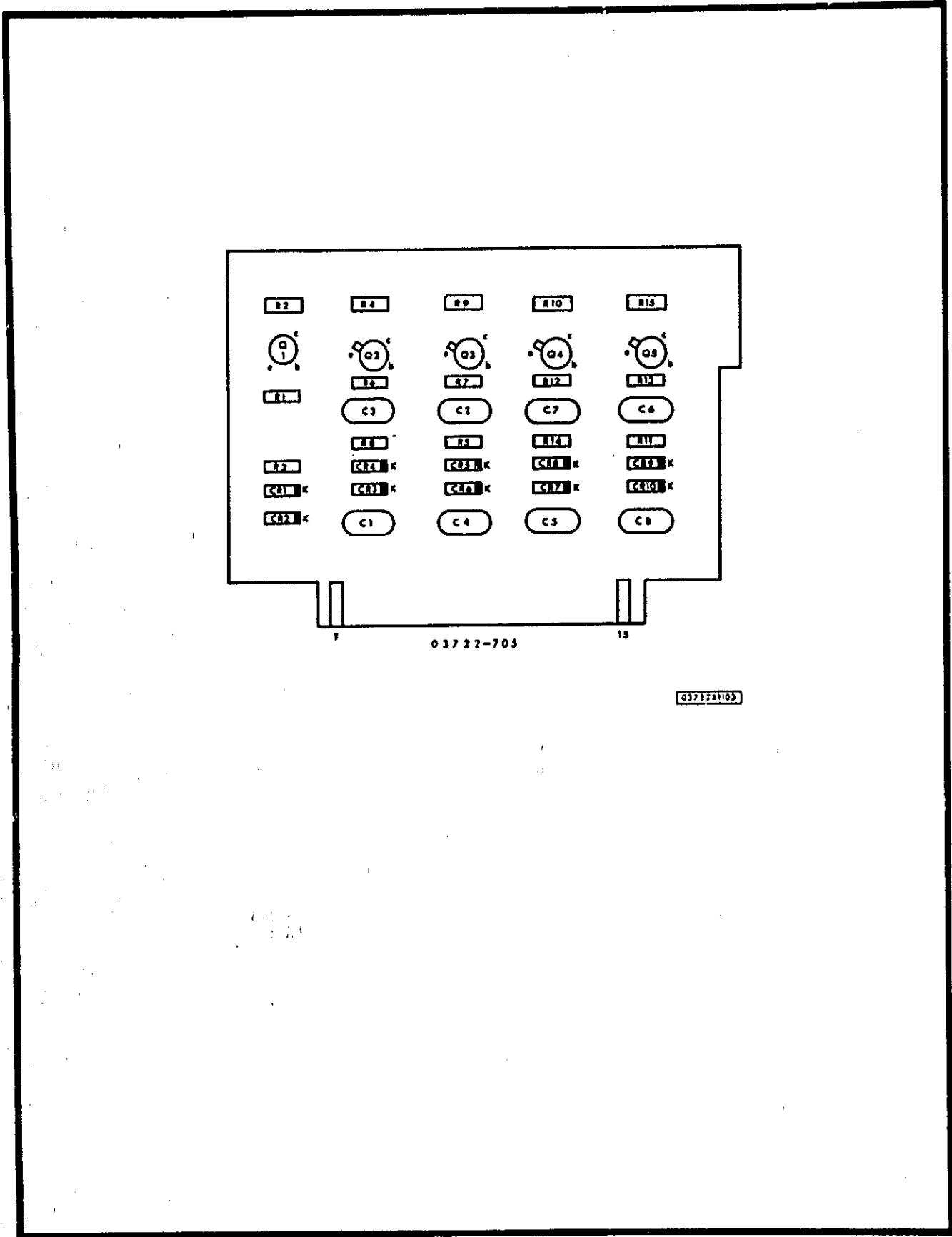


Figure 8 - 9 Divide-by-three assembly A3, component location

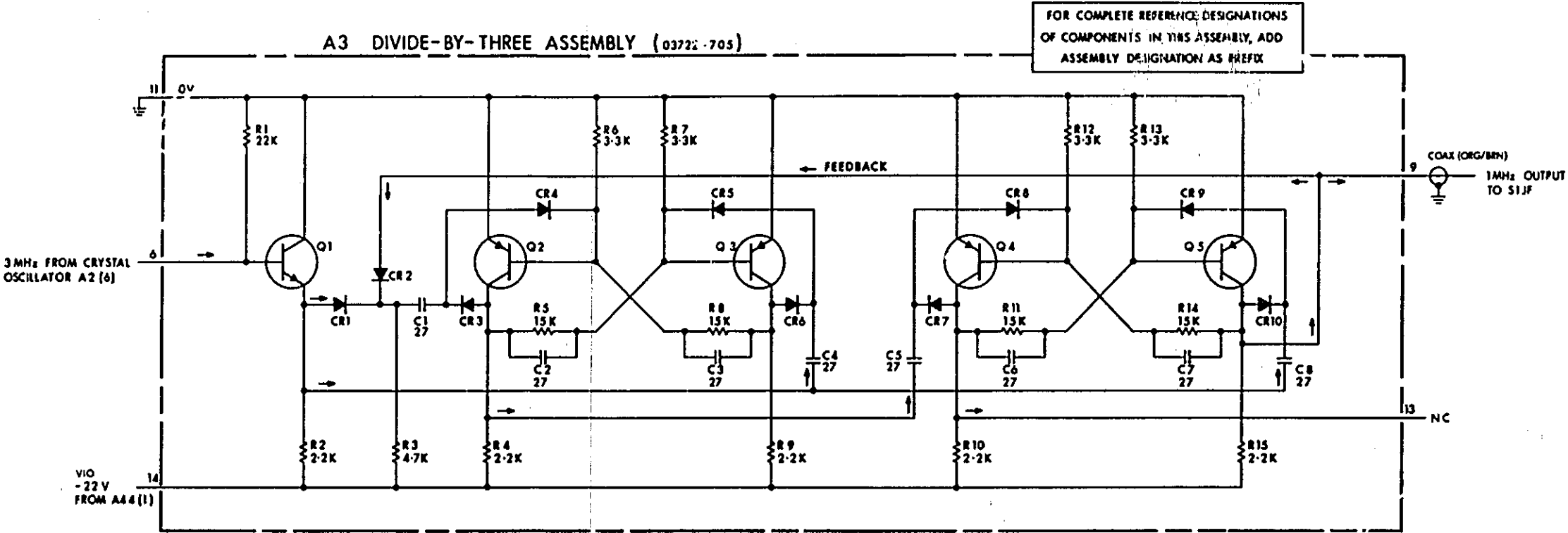


Figure 8 - 10 Divide-by-three assembly A3, schematic

A3	03722-705 03722-305	ASSY: DIVIDE-BY-THREE BOARD: BLANK PC (NSR)
A3C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A3CR1	1901-0040	DIODE: SI
A3CR2	1901-0040	DIODE: SI
A3CR3	1901-0040	DIODE: SI
A3CR4	1901-0040	DIODE: SI
A3CR5	1901-0040	DIODE: SI
A3CR6	1901-0040	DIODE: SI
A3CR7	1901-0040	DIODE: SI
A3CR8	1901-0040	DIODE: SI
A3CR9	1901-0040	DIODE: SI
A3CR10	1901-0040	DIODE: SI
A3Q1	1854-0605	TRANSISTOR: SI NPN
A3Q2	1853-0034	TRANSISTOR: SI PNP
A3Q3	1853-0034	TRANSISTOR: SI PNP
A3Q4	1853-0034	TRANSISTOR: SI PNP
A3Q5	1853-0034	TRANSISTOR: SI PNP
A3R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A3R2	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W
A3R3	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A3R4	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W
A3R5	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A3R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A3R7	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A3R8	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A3R9	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W
A3R10	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W
A3R11	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A3R12	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A3R13	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A3R14	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A3R15	0758-0044	R: FXD MET FLM 2.2K OHM 5% 1/2W

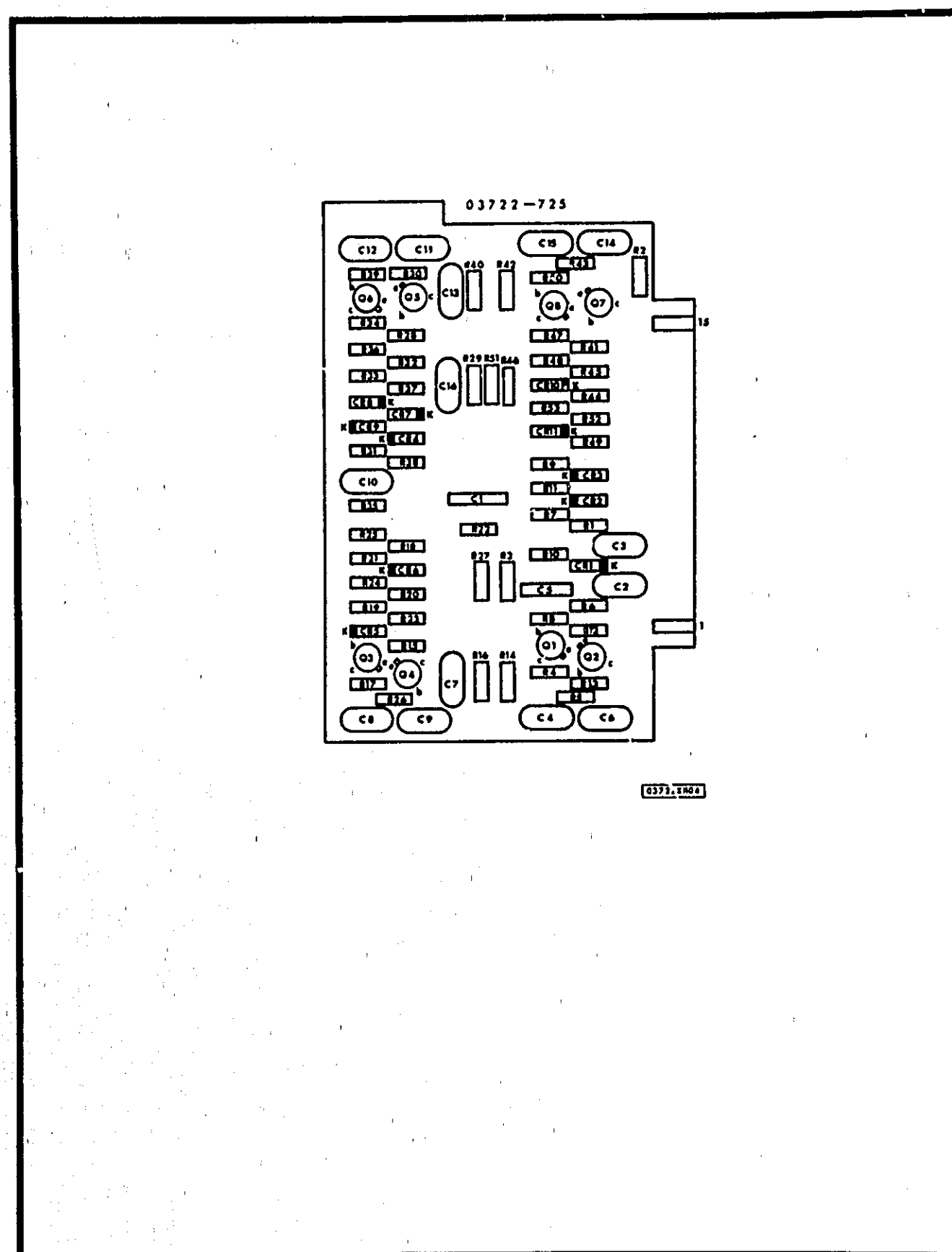


Figure 8-11 High speed decade divider assembly A4, A5; component location

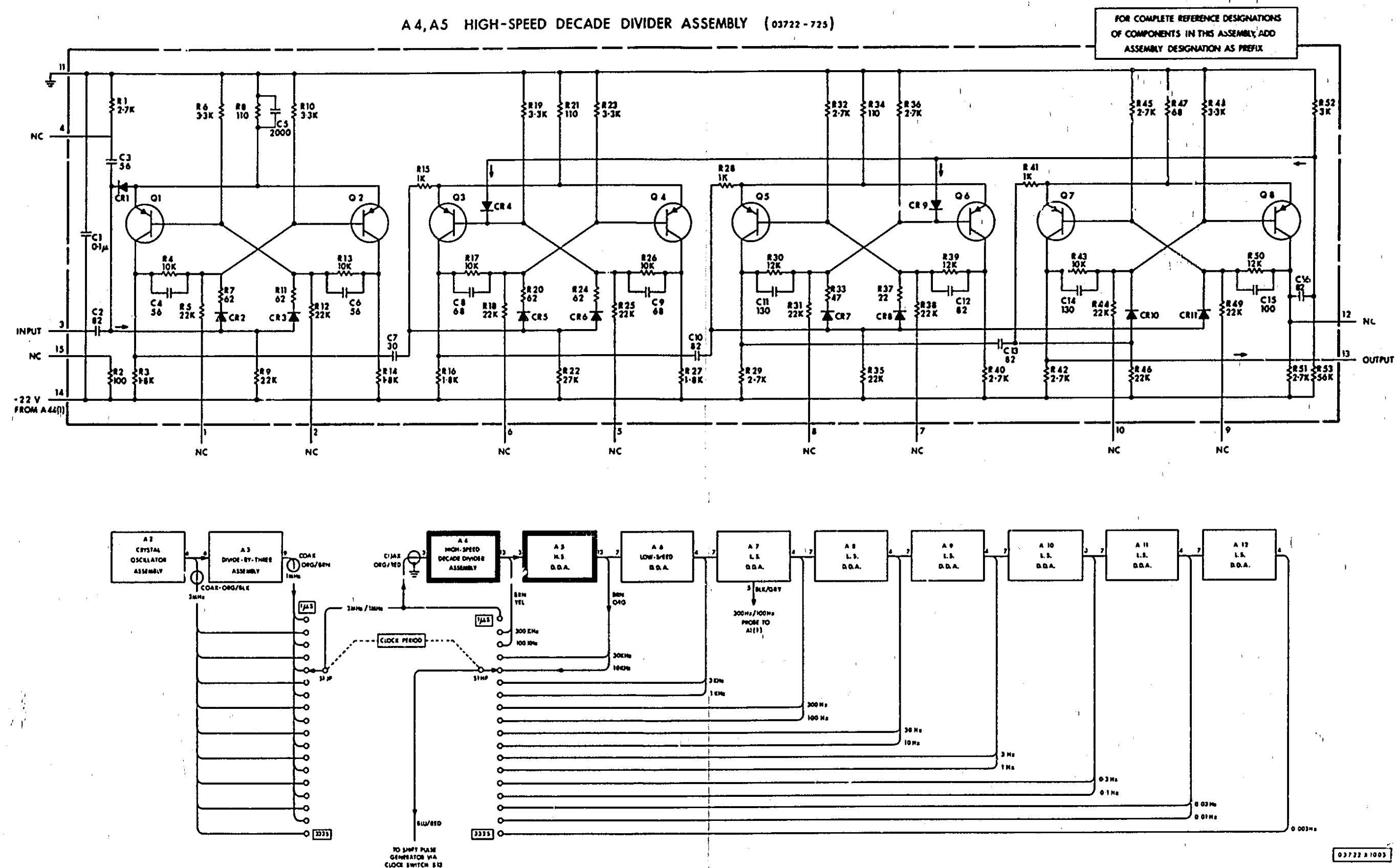


Figure 8-12 High speed decade divider assembly A4, A5; schematic

A4	03722-725 03722-325	ASSY: HIGH-SPEED DECADE DIVIDER BOARD: BLANK PC (NSR)
A4C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A4C2	0140-0193	C: FXD MICA 82PF 5% 300VDCW
A4C3	0140-0191	C: FXD MICA 56PF 5% 300VDCW
A4C4	0140-0191	C: FXD MICA 56PF 5% 300VDCW
A4C5	0150-0122	C: FXD CER 2000PF 20% 500VDCW
A4C6	0140-0191	C: FXD MICA 56PF 5% 300VDCW
A4C7	0160-0181	C: FXD MICA 30PF 5% 300VDCW
A4C8	0140-0192	C: FXD MICA 68PF 5% 300VDCW
A4C9	0140-0192	C: FXD MICA 68PF 5% 300VDCW
A4C10	0140-0193	C: FXD MICA 82PF 5% 300VDCW
A4C11	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A4C12	0140-0193	C: FXD MICA 82PF 5% 300VDCW
A4C13	0140-0193	C: FXD MICA 82PF 5% 300VDCW
A4C14	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A4C15	0140-0176	C: FXD MICA 100PF 2% 300VDCW
A4C16	0140-0193	C: FXD MICA 82PF 5% 300VDCW
A4CR1	1901-0040	DIODE: SI
A4CR2	1901-0040	DIODE: SI
A4CR3	1901-0040	DIODE: SI
A4CR4	1901-0040	DIODE: SI
A4CR5	1901-0040	DIODE: SI
A4CR6	1901-0040	DIODE: SI
A4CR7	1901-0040	DIODE: SI
A4CR8	1901-0040	DIODE: SI
A4CR9	1901-0040	DIODE: SI
A4CR10	1901-0040	DIODE: SI
A4CR11	1901-0040	DIODE: SI
A4Q1	1853-0034	TRANSISTOR: SI PNP
A4Q2	1853-0034	TRANSISTOR: SI PNP
A4Q3	1853-0034	TRANSISTOR: SI PNP
A4Q4	1853-0034	TRANSISTOR: SI PNP
A4Q5	1853-0034	TRANSISTOR: SI PNP
A4Q6	1853-0034	TRANSISTOR: SI PNP
A4Q7	1853-0034	TRANSISTOR: SI PNP
A4Q8	1853-0034	TRANSISTOR: SI PNP
A4R1	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W
A4R2	0758-0024	R: FXD MET FLM 100 OHM 5% 1/2W
A4R3	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W
A4R4	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A4R5	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A4R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A4R7	0698-4228	R: FXD MET OX 62 OHM 5% 1/4W
A4R8	0698-4232	R: FXD MET OX 110 OHM 5% 1/4W
A4R9	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A4R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A4R11	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W
A4R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A4R13	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A4R14	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W
A4R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A4R16	0758-0043	R: FXD MET FLM 1.8K OHM 5% 1/2W
A4R17	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A4R18	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A4R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A4R20	0698-4226	R: FXD MET OX 62 OHM 5% 1/4W

A4R21	0698-4232
A4R22	0698-4288
A4R23	0698-4266
A4R24	0698-4226
A4R25	0698-4286
A4R26	0698-4278
A4R27	0758-0043
A4R28	0698-4254
A4R29	0758-0004
A4R30	0698-4280
A4R31	0698-4286
A4R32	0698-4264
A4R33	0698-5707
A4R34	0698-4232
A4R35	0698-4286
A4R36	0698-4264
A4R37	0698-3799
A4R38	0698-4286
A4R39	0698-4280
A4R40	0758-0004
A4R41	0698-4254
A4R42	0758-0004
A4R43	0698-4278
A4R44	0698-4286
A4R45	0698-4264
A4R46	0698-4286
A4R47	0698-4227
A4R48	0698-4266
A4R49	0698-4286
A4R50	0698-4280
A4R51	0758-0004
A4R52	0698-4265
A4R53	0698-4286
A5	

R: FXD MET OX 110 OHM 5% 1/4W
R: FXD MET OX 27K OHM 5% 1/4W
R: FXD MET OX 3.3K OHM 5% 1/4W
R: FXD MET OX 62 OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 10K OHM 5% 1/4W
R: FXD MET FLM 1.8K OHM 5% 1/2W
R: FXD MET OX 1.0K OHM 5% 1/4W
R: FXD MET FLM 2.7K OHM 5% 1/2W
R: FXD MET OX 12K OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 2.7K OHM 5% 1/4W
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R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 2.7K OHM 5% 1/4W
R: FXD MET OX 22 OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 12K OHM 5% 1/4W
R: FXD MET FLM 2.7K OHM 5% 1/2W
R: FXD MET OX 1.0K OHM 5% 1/4W
R: FXD MET FLM 2.7K OHM 5% 1/2W
R: FXD MET OX 10K OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 2.7K OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 68 OHM 5% 1/4W
R: FXD MET OX 3.3K OHM 5% 1/4W
R: FXD MET OX 22K OHM 5% 1/4W
R: FXD MET OX 12K OHM 5% 1/4W
R: FXD MET FLM 2.7K OHM 5% 1/2W
R: FXD MET OX 3.0K OHM 5% 1/4W
R: FXD MET OX 56K OHM 5% 1/4W
SAME AS A4: USE PREFIX A5

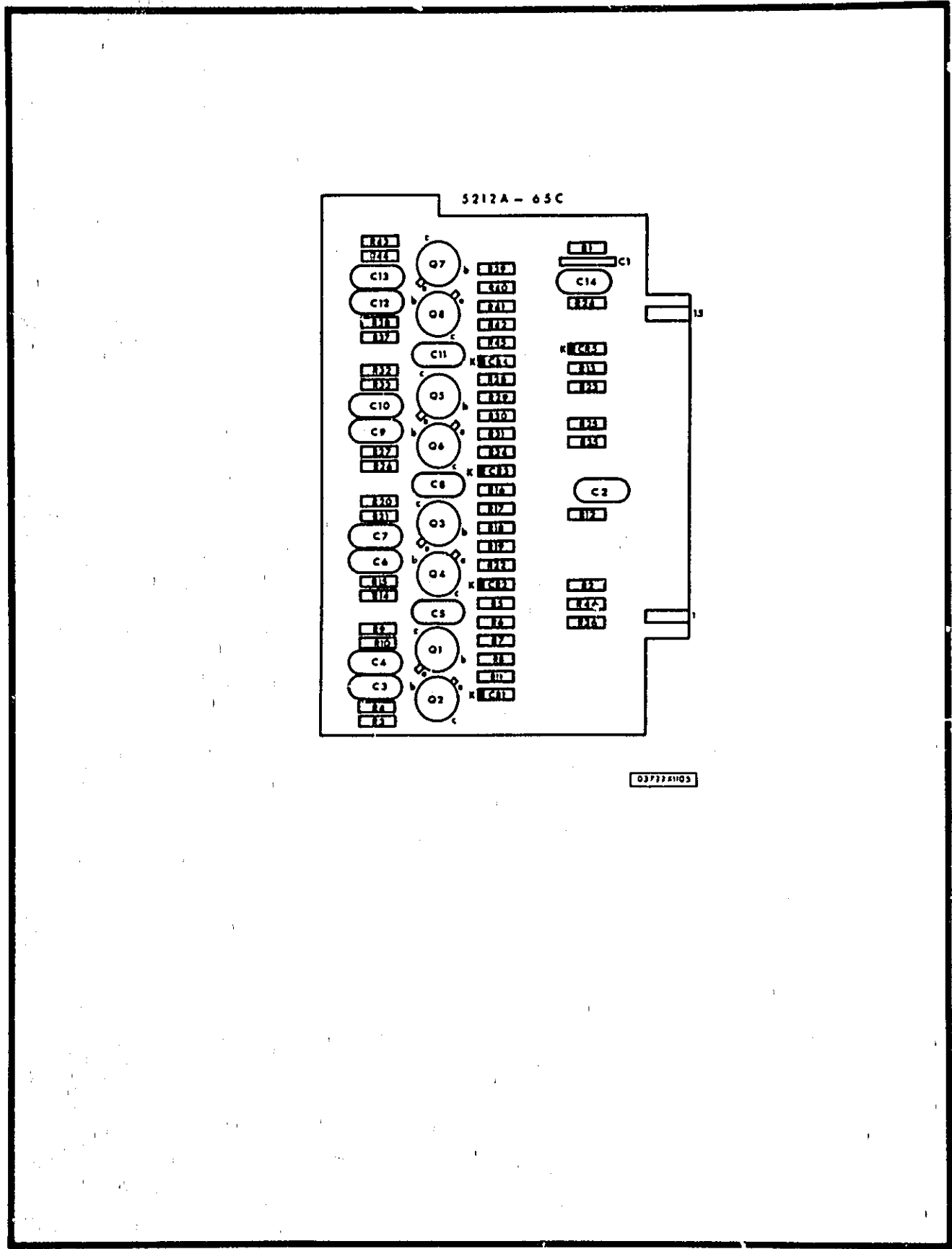
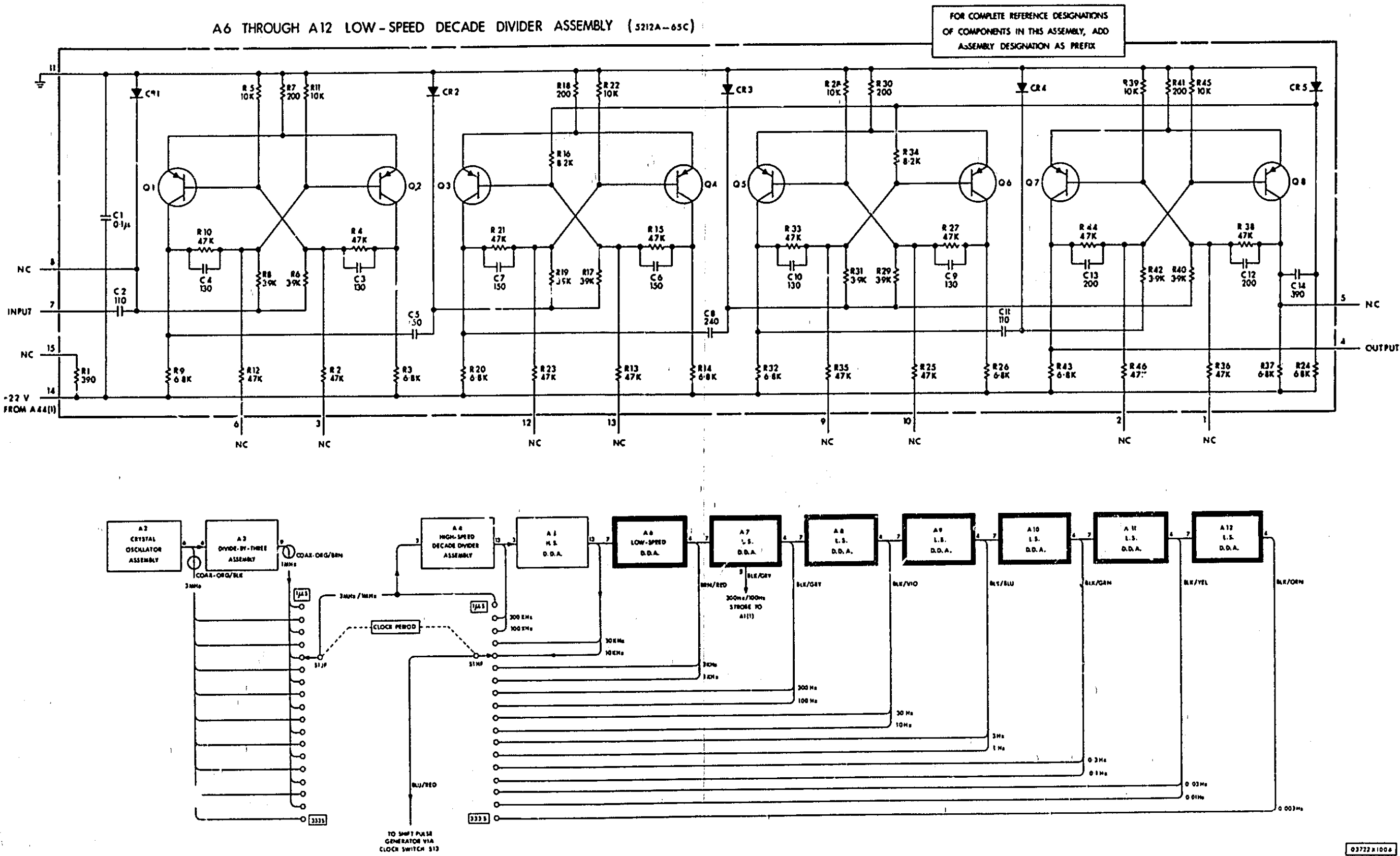
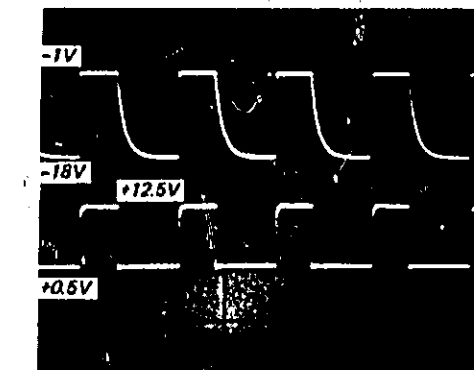


Figure 8-13 Low speed decade divider assembly A6 (etc), component location

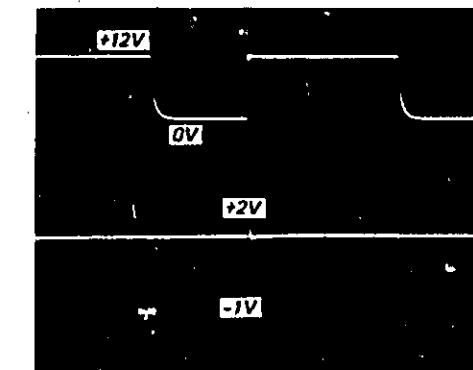


A6	5212A-65C 5212A-65C-1	ASSY: LOW-SPEED DECADE DIVIDER BOARD: BLANK PC (NSR)
A6C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A6C2	0140-0194	C: FXD MICA 110PF 5% 300VDCW
A6C3	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A6C4	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A6C5	0140-0196	C: FXD MICA 150PF 5% 300VDCW
A6C6	0140-0196	C: FXD MICA 150PF 5% 300VDCW
A6C7	0140-0196	C: FXD MICA 150PF 5% 300VDCW
A6C8	0140-0199	C: FXD MICA 240PF 5% 300VDCW
A6C9	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A6C10	0140-0195	C: FXD MICA 130PF 5% 300VDCW
A6C11	0140-0194	C: FXD MICA 110PF 5% 300VDCW
A6C12	0140-0198	C: FXD MICA 200PF 5% 300VDCW
A6C13	0140-0198	C: FXD MICA 200PF 5% 300VDCW
A6C14	0140-0200	C: FXD MICA 390PF 5% 300VDCW
A6CR1	1910-0016	DIODE: GE
A6CR2	1910-0016	DIODE: GE
A6CR3	1910-0016	DIODE: GE
A6CR4	1910-0016	DIODE: GE
A6CR5	1910-0016	DIODE: GE
A6Q1	1850-0062	TRANSISTOR: GE PNP
A6Q2	1850-0062	TRANSISTOR: GE PNP
A6Q3	1850-0062	TRANSISTOR: GE PNP
A6Q4	1850-0062	TRANSISTOR: GE PNP
A6Q5	1850-0062	TRANSISTOR: GE PNP
A6Q6	1850-0062	TRANSISTOR: GE PNP
A6Q7	1850-0062	TRANSISTOR: GE PNP
A6Q8	1850-0062	TRANSISTOR: GE PNP
A6R1	0683-3915	R: FXD COMP 390 OHM 5% 1/4W
A6R2	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R3	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R4	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R5	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R6	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R7	0683-2015	R: FXD COMP 200 OHM 5% 1/4W
A6R8	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R9	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R10	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R11	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R12	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R13	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R14	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R15	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R16	0683-8225	R: FXD COMP 8.2K OHM 5% 1/4W
A6R17	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R18	0683-2015	R: FXD COMP 200 OHM 5% 1/4W
A6R19	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R20	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W

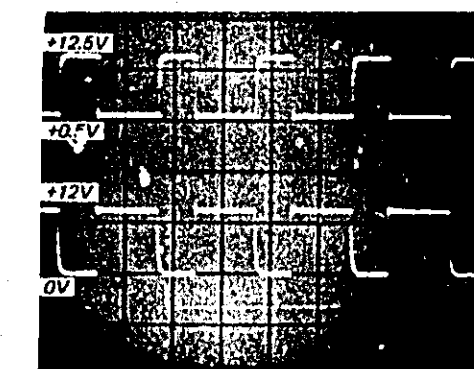
A6R21	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R22	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R23	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R24	0683-6835	R: FXD COMP 68K OHM 5% 1/4W
A6R25	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R26	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R27	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R28	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R29	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R30	0683-2015	R: FXD COMP 200 OHM 5% 1/4W
A6R31	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R32	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R33	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R34	0683-8225	R: FXD COMP 8.2K OHM 5% 1/4W
A6R35	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R36	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R37	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R38	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R39	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R40	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R41	0683-2015	R: FXD COMP 200 OHM 5% 1/4W
A6R42	0683-3925	R: FXD COMP 3.9K OHM 5% 1/4W
A6R43	0683-6825	R: FXD COMP 6.8K OHM 5% 1/4W
A6R44	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A6R45	0683-1035	R: FXD COMP 10K OHM 5% 1/4W
A6R46	0683-4735	R: FXD COMP 47K OHM 5% 1/4W
A7		SAME AS A6: USE PREFIX A7
A8		SAME AS A6: USE PREFIX A8
A9		SAME AS A6: USE PREFIX A9
A10		SAME AS A6: USE PREFIX A10
A11		SAME AS A6: USE PREFIX A11
A12		SAME AS A6: USE PREFIX A12



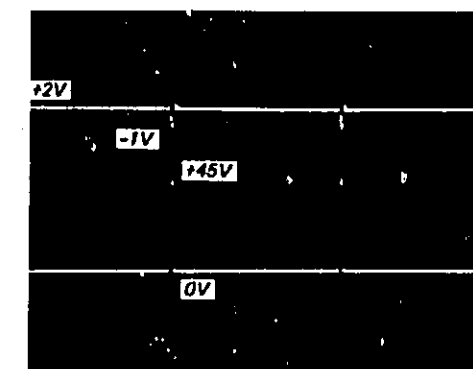
Upper trace clock input A13(3), 10V/cm
Lower trace Schmitt output A13Q2C,
10V/cm
Clock period 10µs Sweep 5µs/cm
Trigger internal



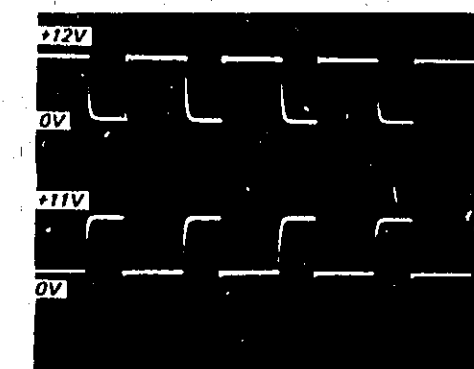
Upper trace A13Q3C, 10V/cm
Lower trace A13Q5C, 2V/cm
Clock period 10µs Sweep 2µs/cm
Trigger internal



Upper trace A13Q2C, 10V/cm
Lower trace A13Q3C, 10V/cm
Clock period 10µs Sweep 5µs/cm
Trigger internal



Upper trace A13Q5C, 5V/cm
Lower trace A13Q6C, 20V/cm
Clock period 3.33µs Sweep 1µs/cm
Trigger internal



Upper trace A13Q3C, 10V/cm
Lower trace A13Q4C, 10V/cm
Clock period 10µs Sweep 5µs/cm
Trigger internal

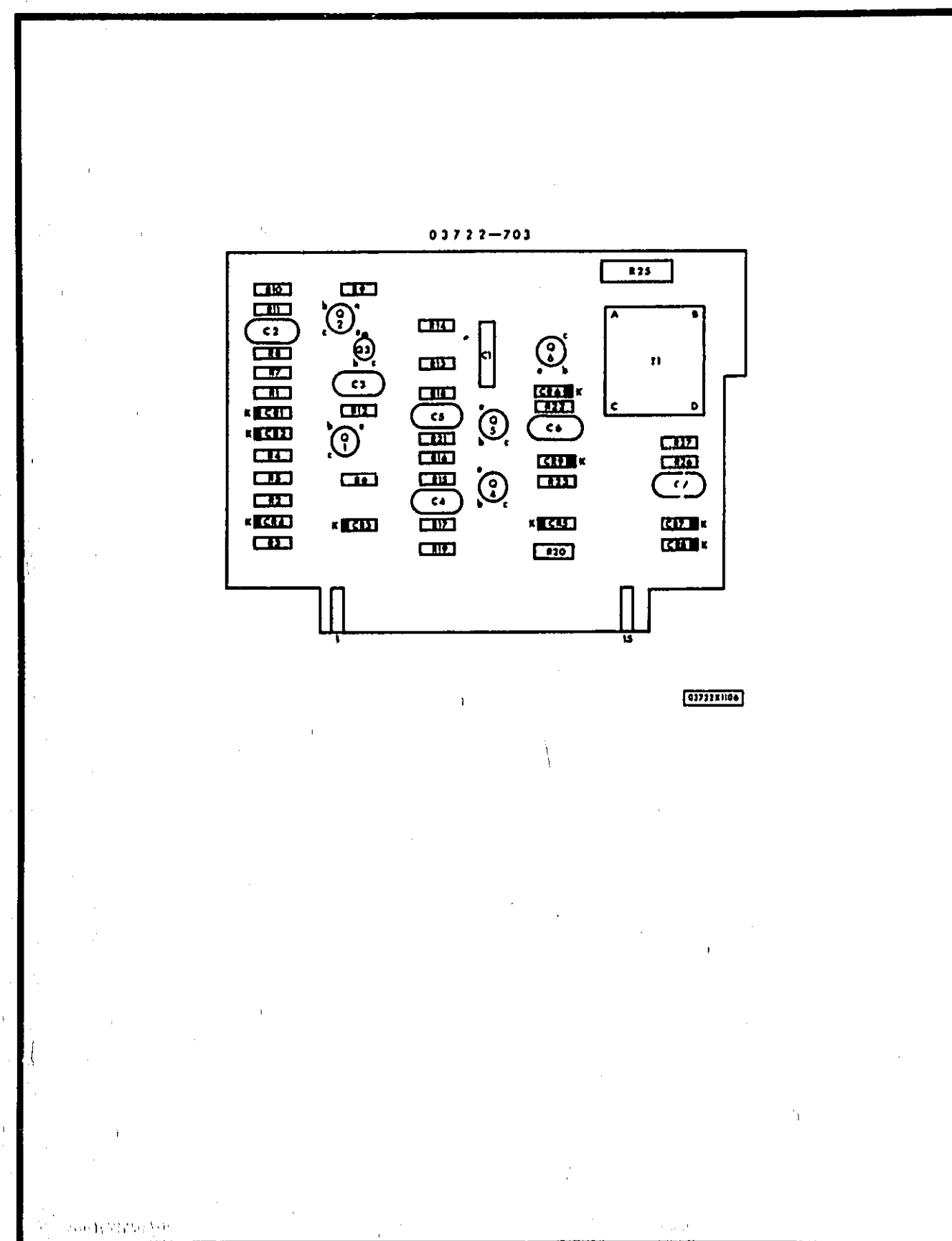


Figure 8-15 Shift pulse generator assembly A13, component location

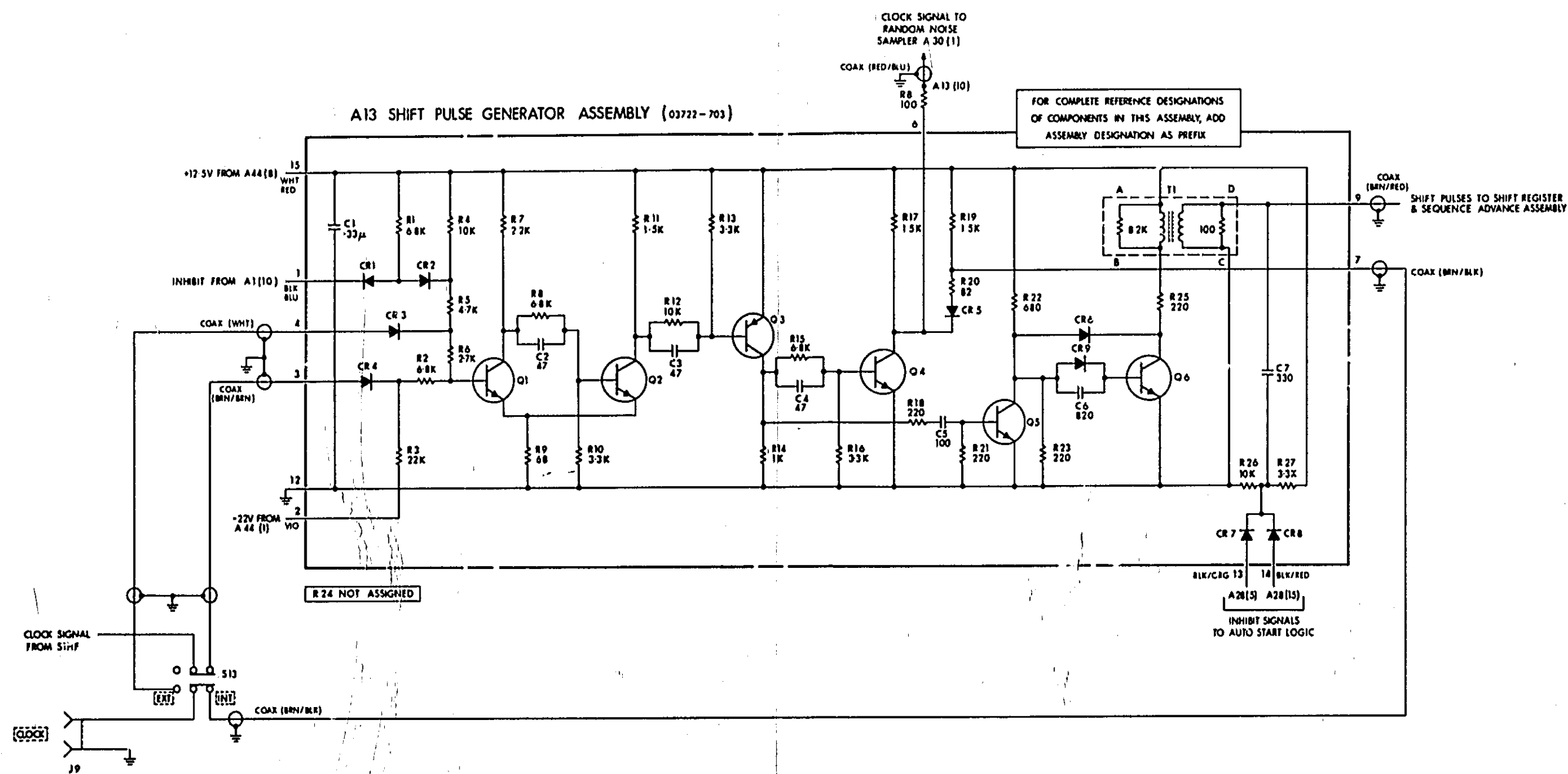
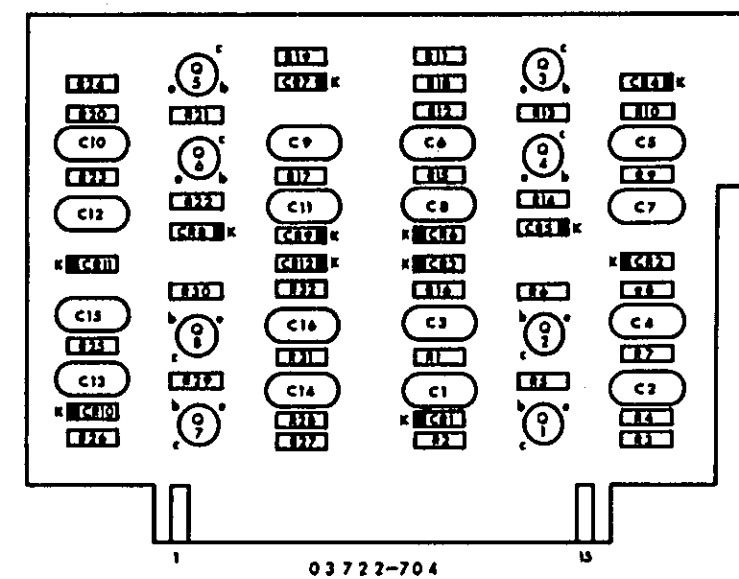


Figure 8-16 Shift pulse generator A13, schematic

A13	03722-703 03722-303	ASSY: SHIFT PULSE GENERATOR BOARD: BLANK PC (NSR)
A13C1	0160-0137	C: FXD CER 0.33UF 20% 25VDCW
A13C2	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A13C3	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A13C4	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A13C5	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A13C6	0160-2009	C: FXD MICA 820PF 5% 360VDCW
A13C7	0160-2208	C: FXD MICA 330PF 5% 300VDCW
A13CR1	1901-0040	DIODE: SI
A13CR2	1901-0040	DIODE: SI
A13CR3	1901-0040	DIODE: SI
A13CR4	1901-0040	DIODE: SI
A13CR5	1910-0034	DIODE: GE
A13CR6	1910-0034	DIODE: GE
A13CR7	1901-0040	DIODE: SI
A13CR8	1901-0040	DIODE: SI
A13CR9	1901-0040	DIODE: SI
A13Q1	1854-0605	TRANSISTOR: SI NPN
A13Q2	1854-0605	TRANSISTOR: SI NPN
A13Q3	1853-0034	TRANSISTOR: SI PNP
A13Q4	1854-0605	TRANSISTOR: SI NPN
A13Q5	1854-0605	TRANSISTOR: SI NPN
A13Q6	1854-0215	TRANSISTOR: SI NPN
A13R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A13R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A13R3	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A13R4	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A13R5	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A13R6	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W
A13R7	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A13R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A13R9	0698-4227	R: FXD MET OX 68 OHM 5% 1/4W
A13R10	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A13R11	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A13R12	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A13R13	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A13R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A13R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A13R16	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A13R17	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A13R18	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A13R19	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A13R20	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W
A13R21	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A13R22	0698-4250	R: FXD MET OX 680 OHM 5% 1/4W
A13R23	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A13R24		NOT ASSIGNED
A13R25	0761-0026	R: FXD MET OX 220 OHM 5% 1W
A13R26	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A13R27	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A13T1	9100-0620	TRANSFORMER: SHIFT PULSE GENERATOR



03722-1107

Figure 8-17 Shift register assembly A14 (etc), component location

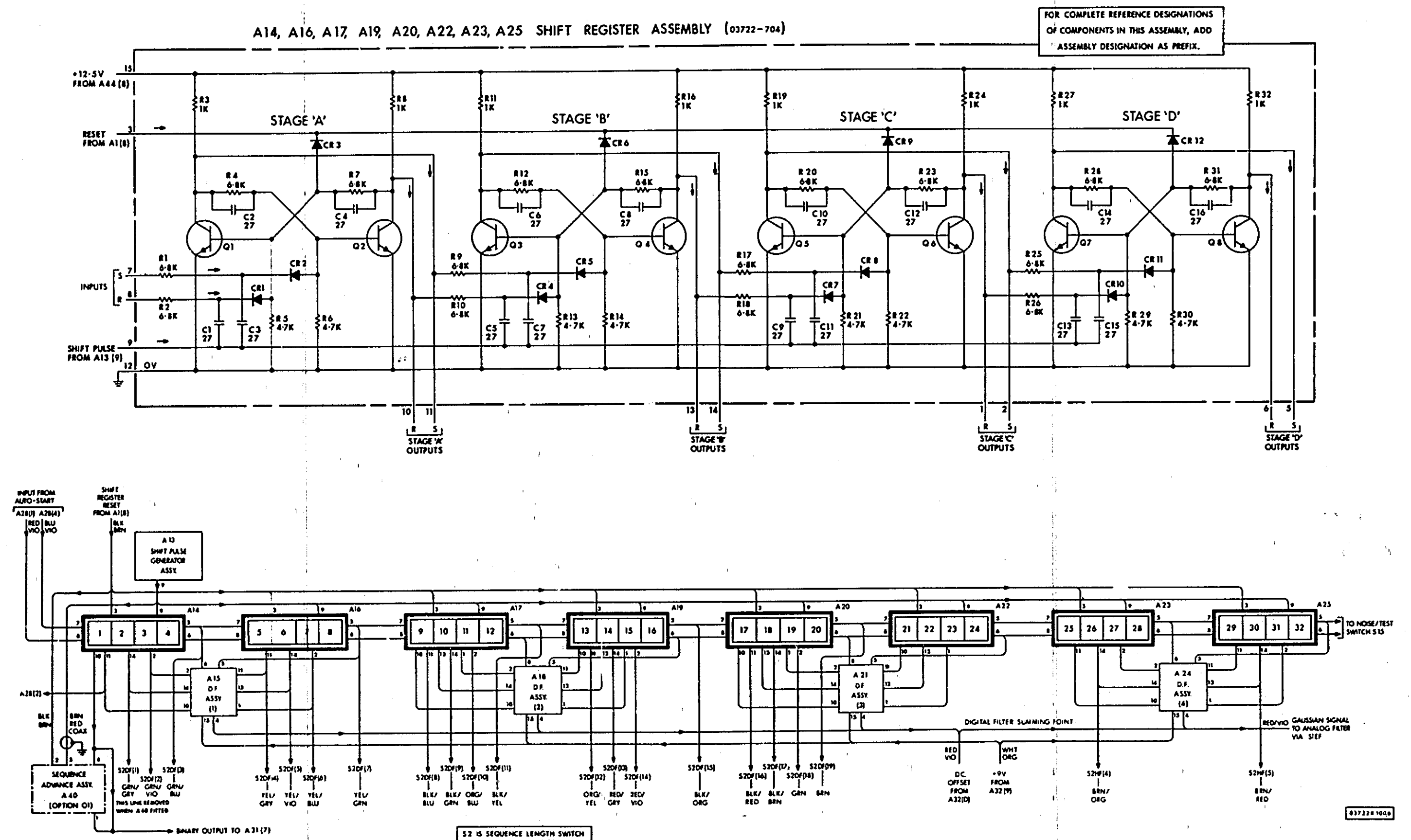


Figure 8-18 Shift register assembly A14 (etc), schematic

A14	03722-704 03722-304	ASSY: SHIFT REGISTER BOARD: BLANK PC (NSR)
A14C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A14CR1	1901-0040	DIODE: SI
A14CR2	1901-0040	DIODE: SI
A14CR3	1901-0040	DIODE: SI
A14CR4	1901-0040	DIODE: SI
A14CR5	1901-0040	DIODE: SI
A14CR6	1901-0040	DIODE: SI
A14CR7	1901-0040	DIODE: SI
A14CR8	1901-0040	DIODE: SI
A14CR9	1901-0040	DIODE: SI
A14CR10	1901-0040	DIODE: SI
A14CR11	1901-0040	DIODE: SI
A14CR12	1901-0040	DIODE: SI
A14Q1	1854-0605	TRANSISTOR: SI NPN
A14Q2	1854-0605	TRANSISTOR: SI NPN
A14Q3	1854-0605	TRANSISTOR: SI NPN
A14Q4	1854-0605	TRANSISTOR: SI NPN
A14Q5	1854-0605	TRANSISTOR: SI NPN
A14Q6	1854-0605	TRANSISTOR: SI NPN
A14Q7	1854-0605	TRANSISTOR: SI NPN
A14Q8	1854-0605	TRANSISTOR: SI NPN
A14R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R3	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R5	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R6	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R8	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R10	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W

A14R11	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R13	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R14	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R16	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R19	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R20	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R21	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R22	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R24	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R26	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A14R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R29	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A14R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A14R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A16		SAME AS A14: USE PREFIX A16
A17		SAME AS A14: USE PREFIX A17
A22		SAME AS A14: USE PREFIX A22
A23		SAME AS A14: USE PREFIX A23
A19		SAME AS A14: USE PREFIX A19
A20		SAME AS A14: USE PREFIX A20
A25		SAME AS A14: USE PREFIX A25
A26		NOT ASSIGNED

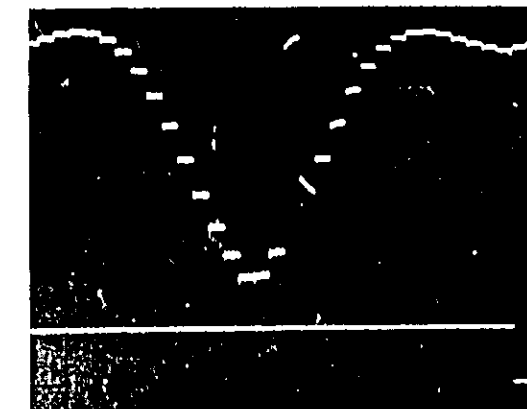
SERVICE NOTE

Digital filter check

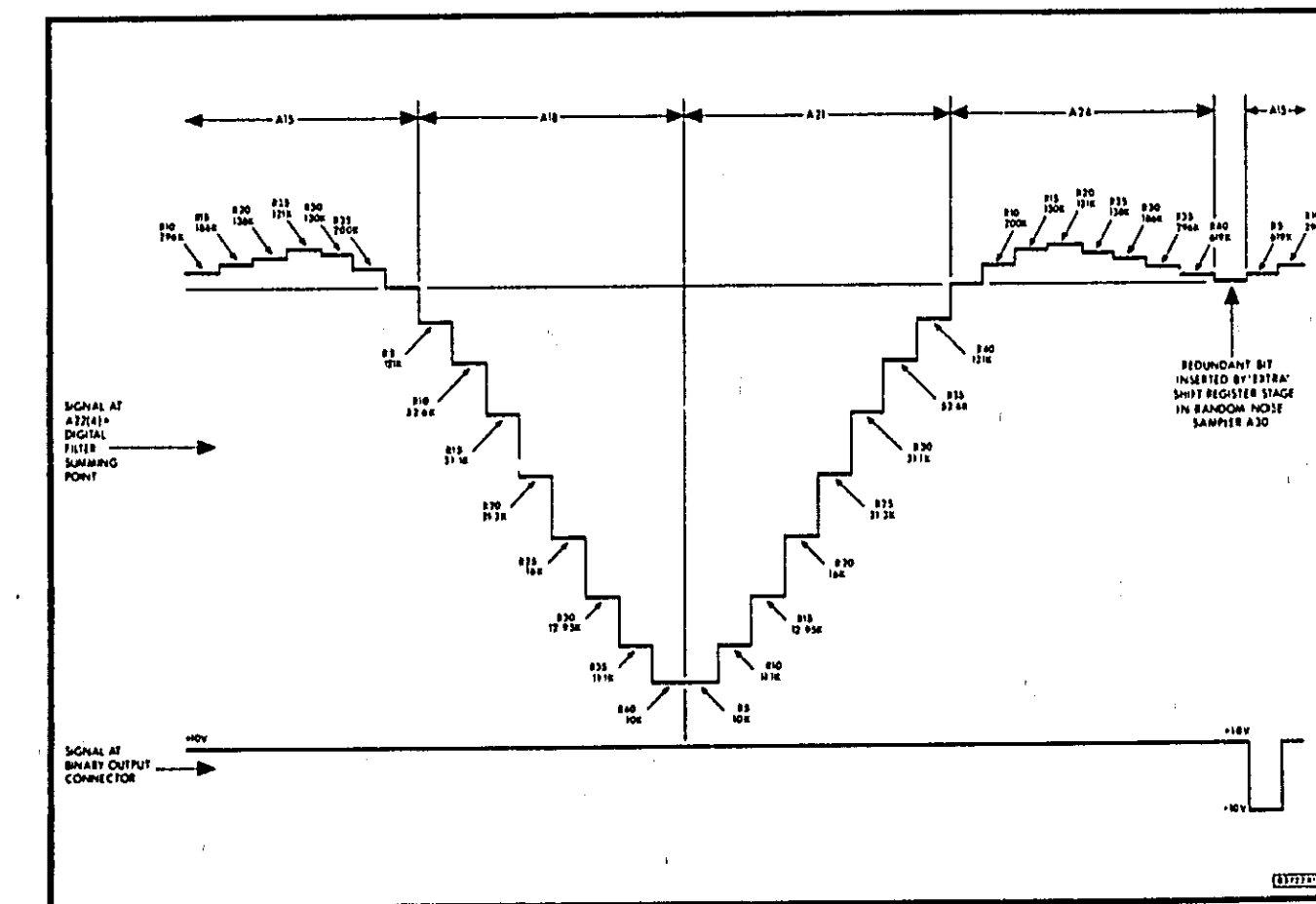
(Applies to A15, A18, A21 & A24)

Procedure

Perform the digital filter functional check detailed in Table 5-8. Extreme faults in the filter will be immediately obvious — for example, the photograph right shows the waveform obtained with resistor R15 in A21 open-circuit. Isolate the fault by reference to the annotated waveform on this page. Note that failure of a clamp circuit can cause the same distortion of the test waveform as a resistor fault. Each clamp circuit comprises two transistors situated, physically, near opposite ends of the associated precision resistor — for example, resistor A15R15 located between the transistors of its clamp circuit, A15Q5 + A15Q6.



Faulty test waveform



Digital filter troubleshooting guide

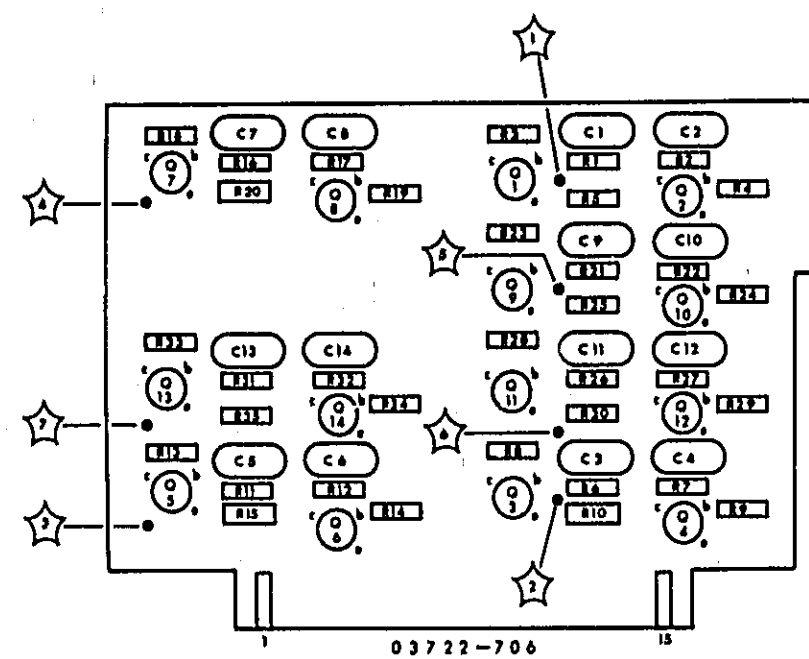


Figure 8-19 Digital filter assembly (1) A15, component location

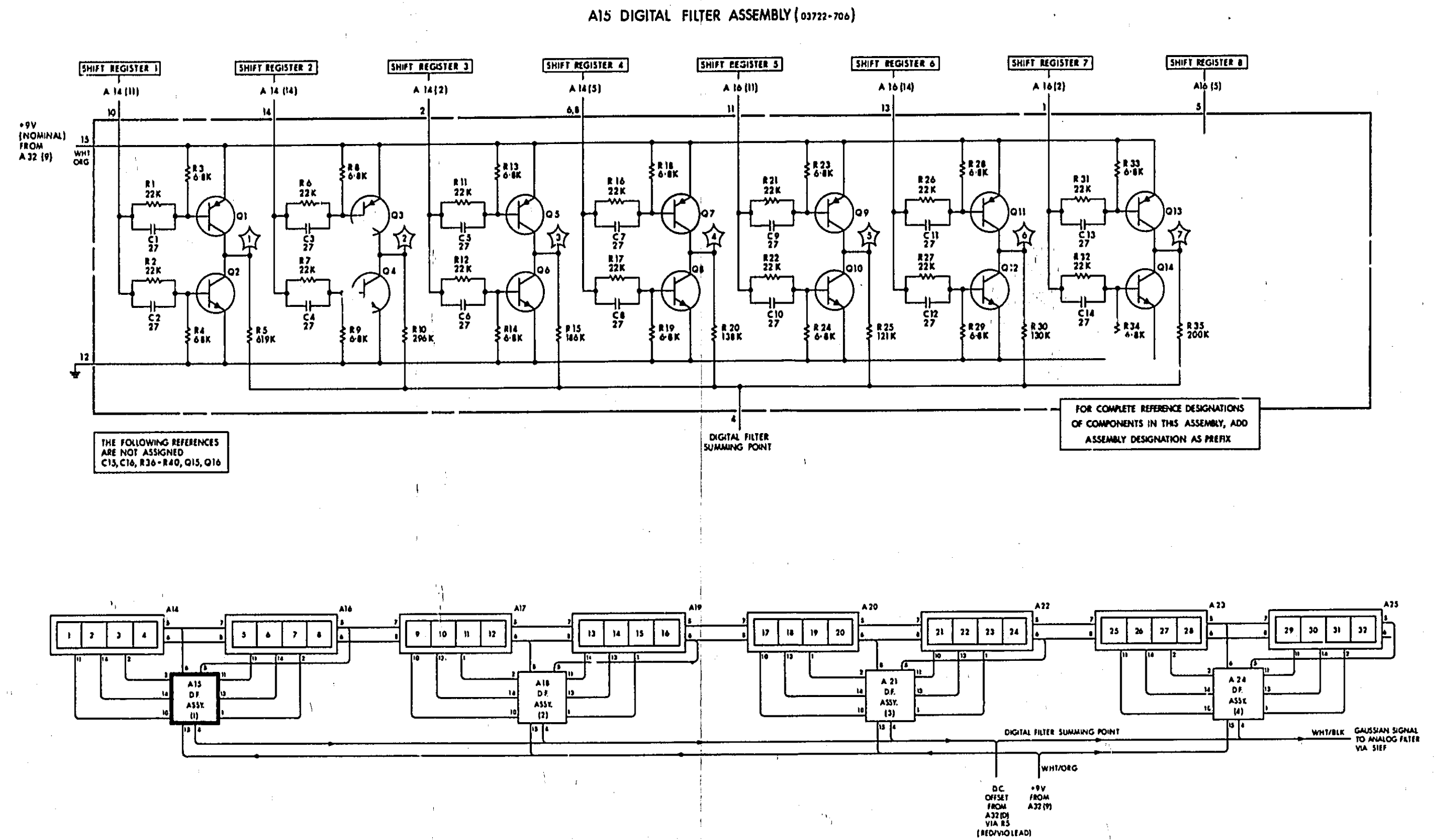


Figure 8-20 Digital filter assembly (1) A15, schematic

A15	03722-706 03722-306	ASSY: DIGITAL-TO-ANALOG CONVERTER (1) BOARD: BLANK PC (NSR)
A15C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A15Q1	1853-0015	TRANSISTOR: SI PNP
A15Q2	1854-0605	TRANSISTOR: SI NPN
A15Q3	1853-0015	TRANSISTOR: SI PNP
A15Q4	1854-0605	TRANSISTOR: SI NPN
A15Q5	1853-0015	TRANSISTOR: SI PNP
A15Q6	1854-0605	TRANSISTOR: SI NPN
A15Q7	1853-0015	TRANSISTOR: SI PNP
A15Q8	1854-0605	TRANSISTOR: SI NPN
A15Q9	1853-0015	TRANSISTOR: SI PNP
A15Q10	1854-0605	TRANSISTOR: SI NPN
A15Q11	1853-0015	TRANSISTOR: SI PNP
A15Q12	1854-0605	TRANSISTOR: SI NPN
A15Q13	1853-0015	TRANSISTOR: SI PNP
A15Q14	1854-0605	TRANSISTOR: SI NPN
A15R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R5	0757-0484	R: FXD MET FLM 619K OHM 1% 1/8W 100 PPM

A15R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R10	0698-5797	R: FXD MET FLM 296K OHM 1% 1/8W 150 PPM
A15R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R15	0698-5796	R: FXD MET FLM 182K OHM 1% 1/8W 150 PPM
A15R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R20	0698-5795	R: FXD MET FLM 138K OHM 1% 1/8W 100 PPM
A15R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R25	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM
A15R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R30	0757-0468	R: FXD MET FLM 130K OHM 1% 1/8W 100 PPM
A15R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A15R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A15R35	0757-0472	R: FXD MET FLM 200K OHM 1% 1/8W 100 PPM
A15TP1	0360-0124	TERMINAL PIN
A15TP2	0360-0124	TERMINAL PIN
A15TP3	0360-0124	TERMINAL PIN
A15TP4	0360-0124	TERMINAL PIN
A15TP5	0360-0124	TERMINAL PIN
A15TP6	0360-0124	TERMINAL PIN
A15TP7	0360-0124	TERMINAL PIN

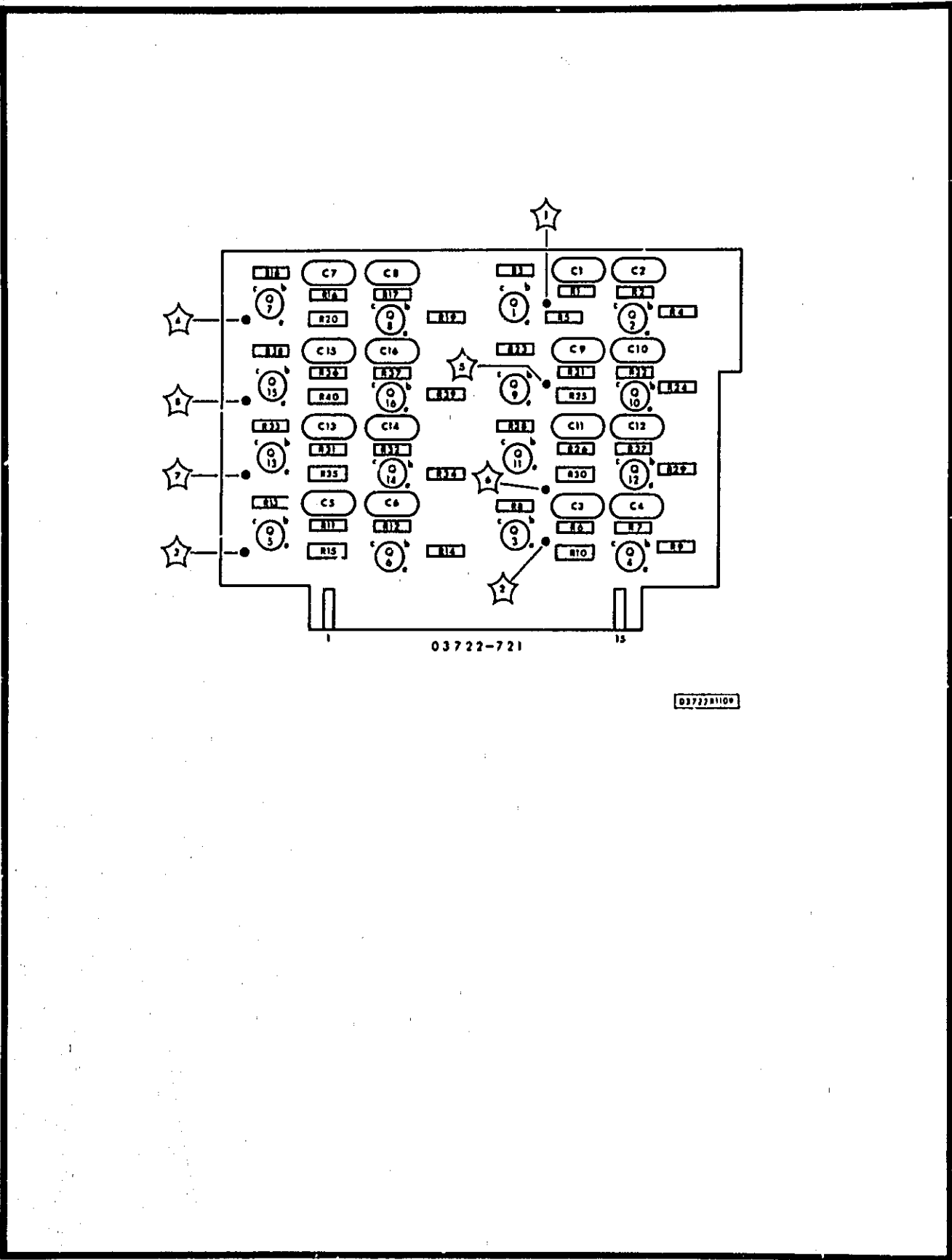


Figure 8 - 21 Digital filter assembly (2) A18, component location

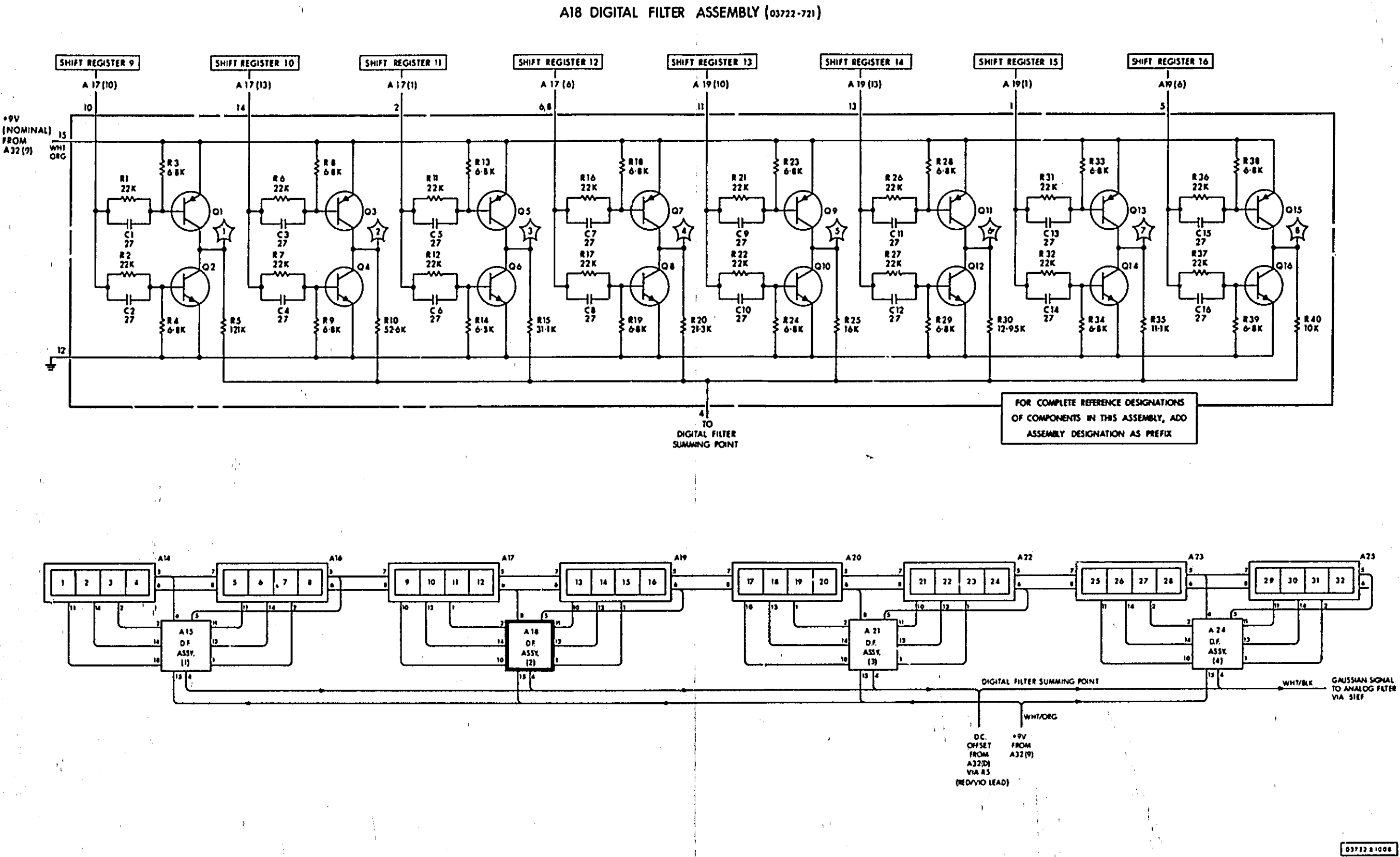


Figure 8 - 22 Digital filter assembly (2) A18, schematic

A18	03722-721 03722-321	ASSY: DIGITAL-TO-ANALOG CONVERTER (2) BOARD: BLANK PC (NSR)	A18R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R20	0698-5792	R: FXD MET FLM 21.3K OHM 1/2% 1/8W 50 PPM
A18C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R25	0698-5791	R: FXD MET FLM 16K OHM 1/2% 1/8W 50 PPM
A18C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R30	0698-5790	R: FXD MET FLM 12.95K OHM 1/2% 1/8W 50 PPM
A18C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A18R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18Q1	1853-0015	TRANSISTOR: SI PNP	A18R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18Q2	1854-0605	TRANSISTOR: SI NPN	A18R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18Q3	1853-0015	TRANSISTOR: SI PNP	A18R35	0698-5789	R: FXD MET FLM 11.1K OHM 1/2% 1/8W 50 PPM
A18Q4	1854-0605	TRANSISTOR: SI NPN	A18R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18Q5	1853-0015	TRANSISTOR: SI PNP	A18R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A18Q6	1854-0605	TRANSISTOR: SI NPN	A18R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18Q7	1853-0015	TRANSISTOR: SI PNP	A18R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A18Q8	1854-0605	TRANSISTOR: SI NPN	A18R40	0698-5788	R: FXD MET FLM 10K OHM 1/2% 1/8W 50 PPM
A18Q9	1853-0015	TRANSISTOR: SI PNP	A18TP1	0360-0124	TERMINAL PIN
A18Q10	1854-0605	TRANSISTOR: SI NPN	A18TP2	0360-0124	TERMINAL PIN
A18Q11	1853-0015	TRANSISTOR: SI PNP	A18TP3	0360-0124	TERMINAL PIN
A18Q12	1854-0605	TRANSISTOR: SI NPN	A18TP4	0360-0124	TERMINAL PIN
A18Q13	1853-0015	TRANSISTOR: SI PNP	A18TP5	0360-0124	TERMINAL PIN
A18Q14	1854-0605	TRANSISTOR: SI NPN	A18TP6	0360-0124	TERMINAL PIN
A18Q15	1853-0015	TRANSISTOR: SI PNP	A18TP7	0360-0124	TERMINAL PIN
A18Q16	1854-0605	TRANSISTOR: SI NPN	A18TP8	0360-0124	TERMINAL PIN
A18R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R5	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM			
A18R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R10	0698-5794	R: FXD MET FLM 52.6K OHM 1/2% 1/8W 50 PPM			
A18R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W			
A18R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A18R15	0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM			

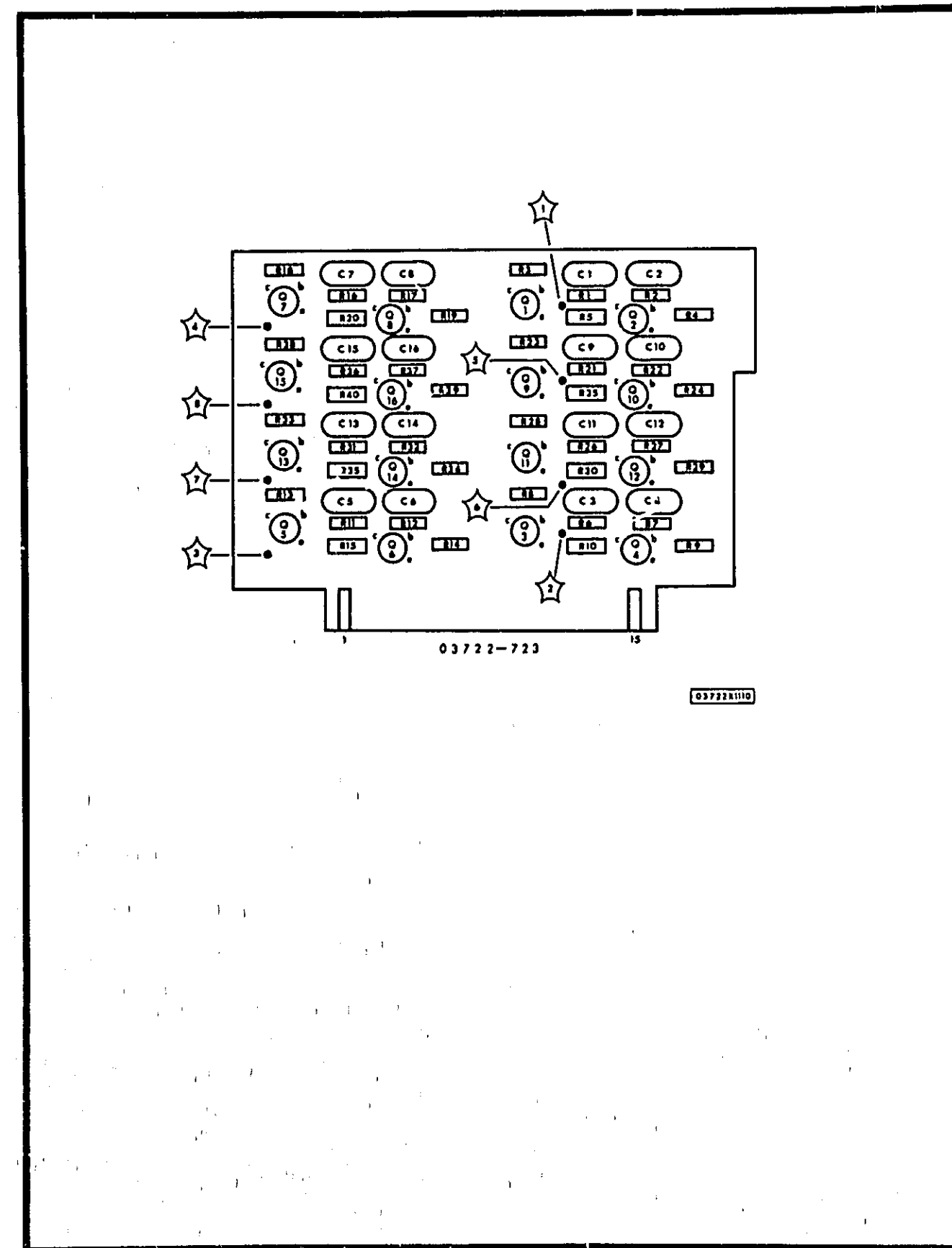


Figure 8-23 Digital filter assembly (3) A21, component location

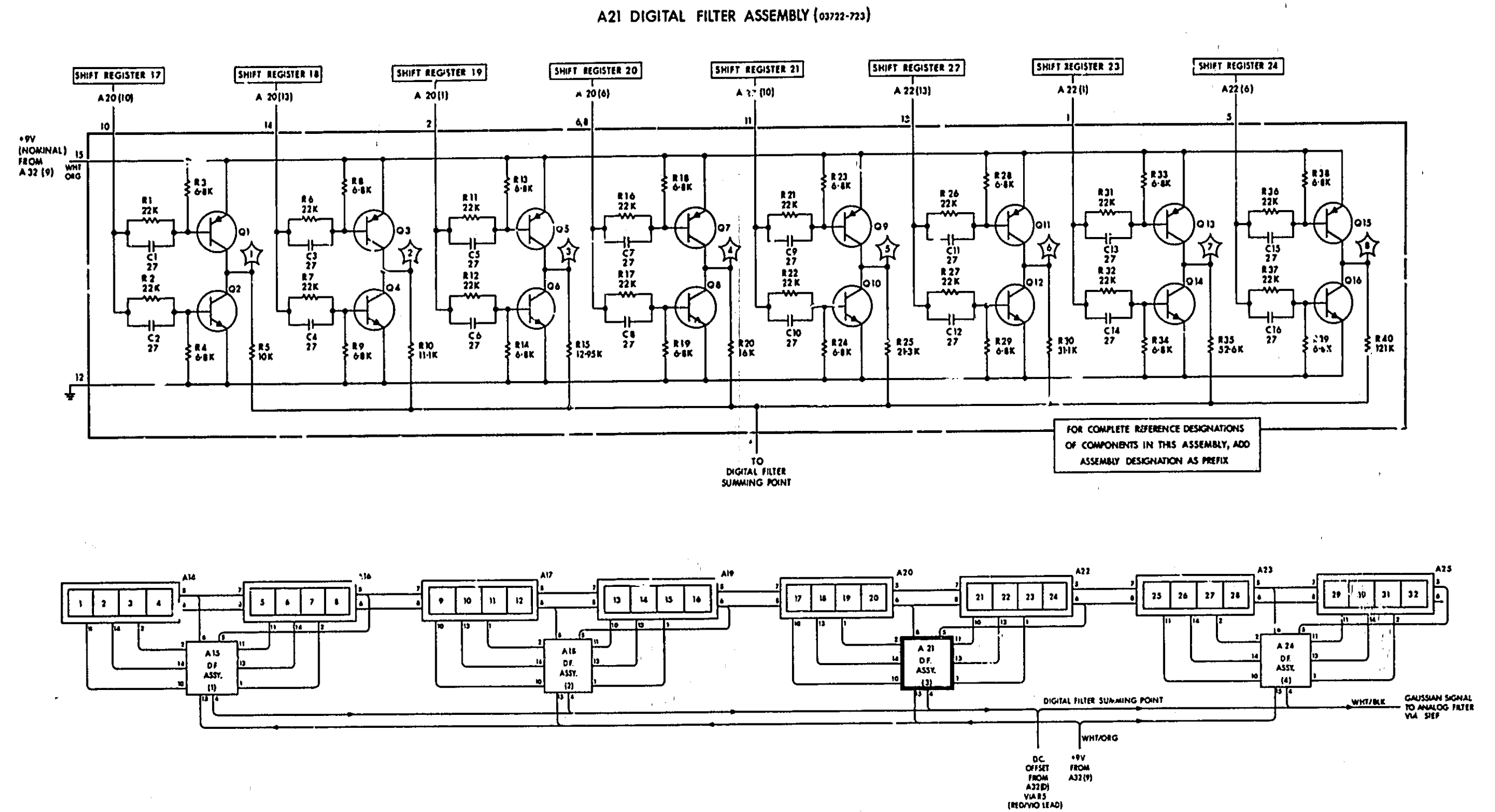


Figure 8-24 Digital filter assembly (3) A21, schematic

A21	03722-723 03722-323	ASSY: DIGITAL-TO-ANALOG CONVERTER (3) BOARD: BLANK PC (NSR)
A21C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A21Q1	1853-0015	TRANSISTOR: SI PNP
A21Q2	1854-0605	TRANSISTOR: SI NPN
A21Q3	1853-0015	TRANSISTOR: SI PNP
A21Q4	1854-0605	TRANSISTOR: SI NPN
A21Q5	1853-0015	TRANSISTOR: SI PNP
A21Q6	1854-0605	TRANSISTOR: SI NPN
A21Q7	1853-0015	TRANSISTOR: SI PNP
A21Q8	1854-0605	TRANSISTOR: SI NPN
A21Q9	1853-0015	TRANSISTOR: SI PNP
A21Q10	1854-0605	TRANSISTOR: SI NPN
A21Q11	1853-0015	TRANSISTOR: SI PNP
A21Q12	1854-0605	TRANSISTOR: SI NPN
A21Q13	1853-0015	TRANSISTOR: SI PNP
A21Q14	1854-0605	TRANSISTOR: SI NPN
A21Q15	1853-0015	TRANSISTOR: SI PNP
A21Q16	1854-0605	TRANSISTOR: SI NPN
A21R1	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R2	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R5	0698-5788	R: FXD MET FLM 10K OHM 1/2% 1/8W 50 PPM
A21R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R10	0698-5789	R: FXD MET FLM 11.1K OHM 1/2% 1/8W 50 PPM
A21R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R15	0698-5790	R: FXD MET FLM 12.95K OHM 1/2% 1/8W 50 PPM

A21R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R20	0698-5791	R: FXD MET FLM 16K OHM 1/2% 1/8W 50 PPM
A21R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R25	0698-5792	R: FXD MET FLM 21.3K OHM 1/2% 1/8W 50 PPM
A21R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R30	0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM
A21R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R35	0698-5794	R: FXD MET FLM 52.6K OHM 1/2% 1/8W 50 PPM
A21R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A21R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A21R40	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM
A21TP1	0360-0124	TERMINAL PIN
A21TP2	0360-0124	TERMINAL PIN
A21TP3	0360-0124	TERMINAL PIN
A21TP4	0360-0124	TERMINAL PIN
A21TP5	0360-0124	TERMINAL PIN
A21TP6	0360-0124	TERMINAL PIN
A21TP7	0360-0124	TERMINAL PIN
A21TP8	0360-0124	TERMINAL PIN

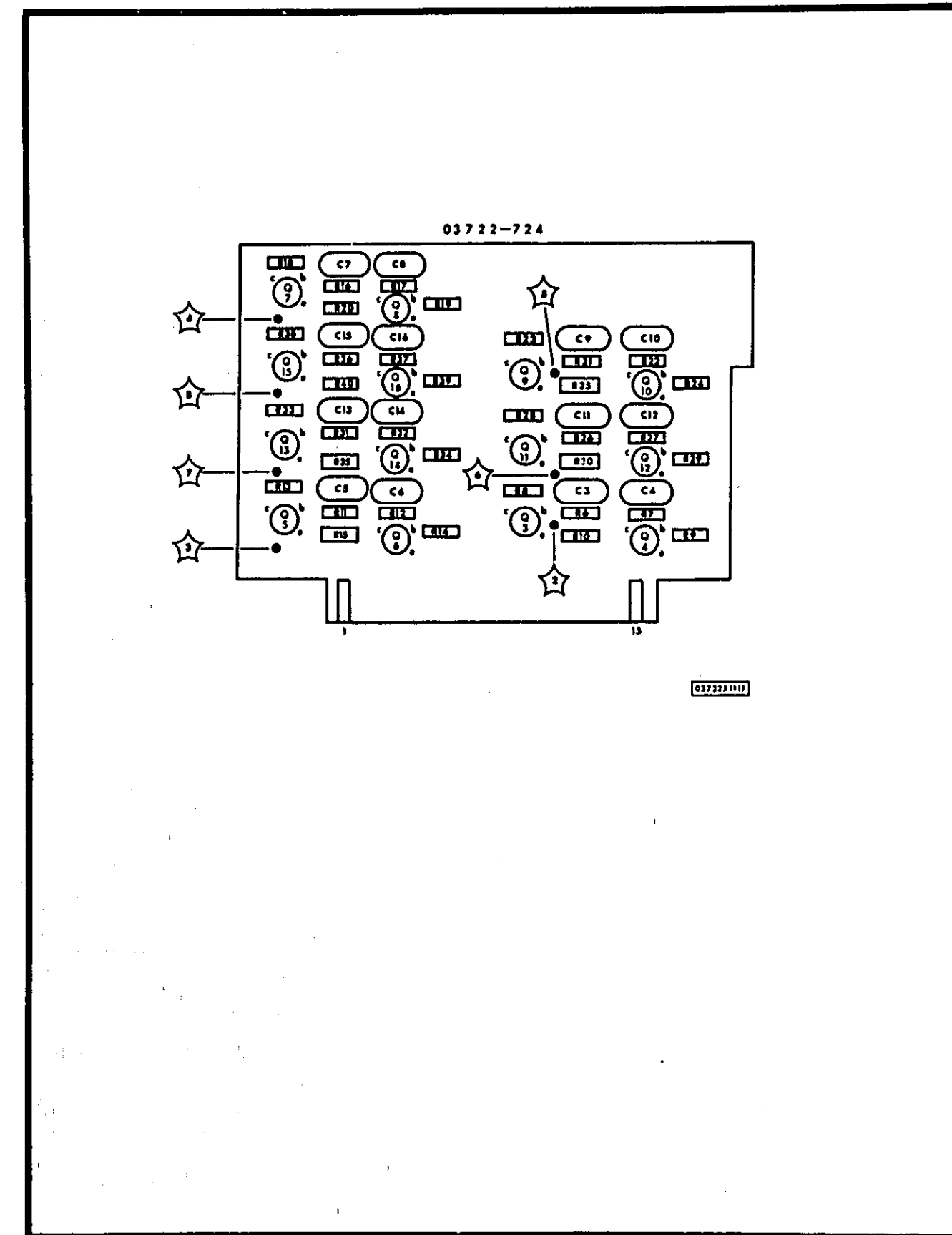


Figure 8 - 25 Digital filter assembly (4) A24, component location

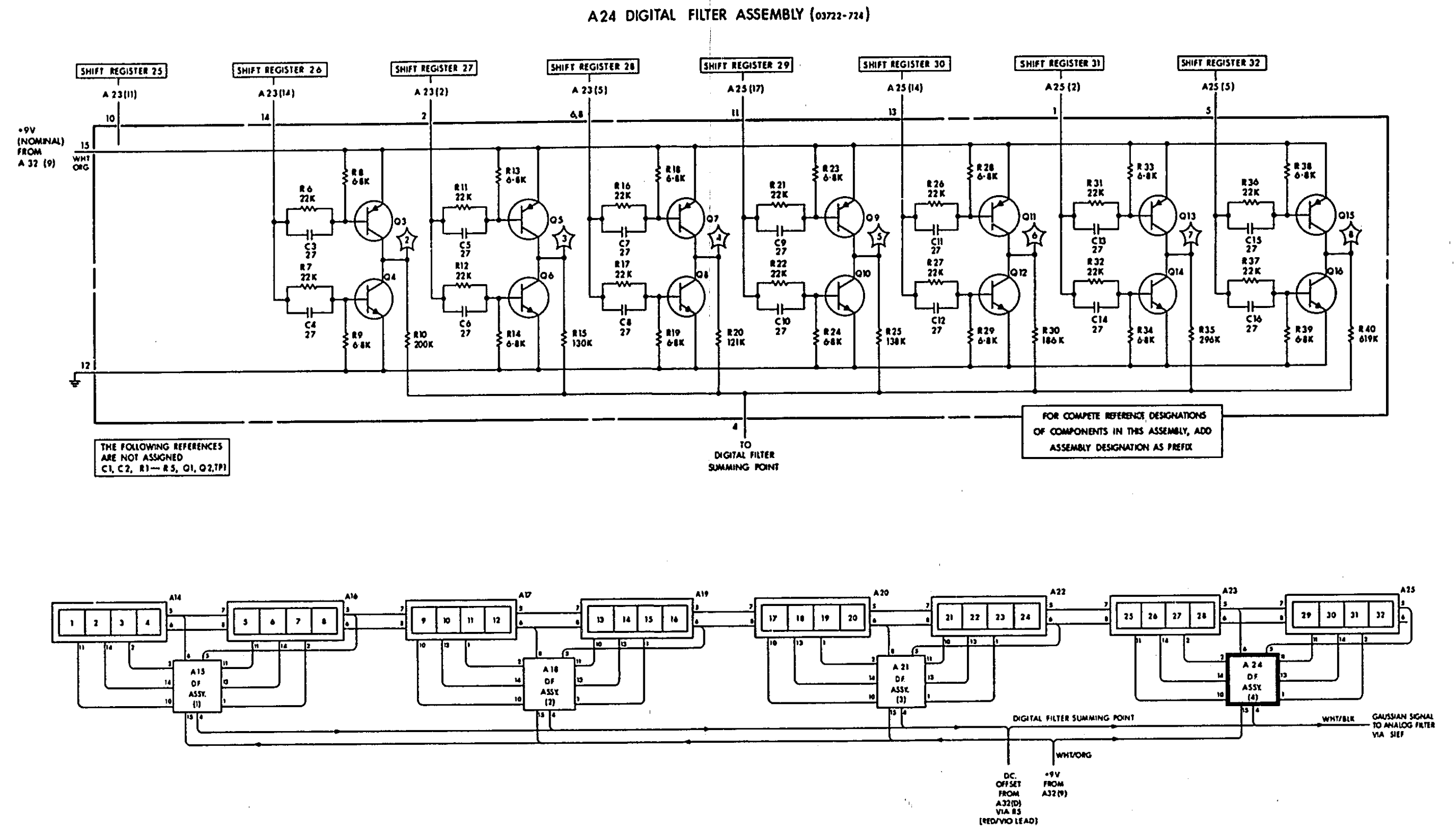


Figure 8 - 26 Digital filter assembly (4) A24, schematic

A24	03722-724 03722-324	ASSY: DIGITAL-TO-ANALOG CONVERTER (4) BOARD: BLANK PC (NSR)
A24C1		NOT ASSIGNED
A24C2		NOT ASSIGNED
A24C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C11	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C12	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C13	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C14	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C15	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24C16	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A24Q1		NOT ASSIGNED
A24Q2		NOT ASSIGNED
A24Q3	1853-0015	TRANSISTOR: SI PNP
A24Q4	1854-0605	TRANSISTOR: SI NPN
A24Q5	1853-0015	TRANSISTOR: SI PNP
A24Q6	1854-0605	TRANSISTOR: SI NPN
A24Q7	1853-0015	TRANSISTOR: SI PNP
A24Q8	1854-0605	TRANSISTOR: SI NPN
A24Q9	1853-0015	TRANSISTOR: SI PNP
A24Q10	1854-0605	TRANSISTOR: SI NPN
A24Q11	1853-0015	TRANSISTOR: SI PNP
A24Q12	1854-0605	TRANSISTOR: SI NPN
A24Q13	1853-0015	TRANSISTOR: SI PNP
A24Q14	1854-0605	TRANSISTOR: SI NPN
A24Q15	1853-0015	TRANSISTOR: SI PNP
A24Q16	1854-0605	TRANSISTOR: SI NPN
A24R1		NOT ASSIGNED
A24R2		NOT ASSIGNED
A24R3		NOT ASSIGNED
A24R4		NOT ASSIGNED
A24R5		NOT ASSIGNED
A24R6	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R7	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R10	0757-0472	R: FXD MET FLM 200K OHM 1% 1/8W 100 PPM
A24R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R12	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R15	0757-0468	R: FXD MET FLM 130K OHM 1% 1/8W 100 PPM

A24R16	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R17	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R20	0757-0467	R: FXD MET FLM 121K OHM 1% 1/8W 100 PPM
A24R21	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R22	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R25	0698-5795	R: FXD MET FLM 138K OHM 1% 1/8W 100 PPM
A24R26	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R27	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R30	0698-5796	R: FXD MET FLM 186K OHM 1% 1/8W 150 PPM
A24R31	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R32	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R34	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R35	0698-5797	R: FXD MET FLM 296K OHM 1% 1/8W 150 PPM
A24R36	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R37	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A24R38	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R39	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A24R40	0757-0484	R: FXD MET FLM 619K OHM 1% 1/8W 100 PPM
A24TP1		NOT ASSIGNED
A24TP2	0360-0124	TERMINAL PIN
A24TP3	0360-0124	TERMINAL PIN
A24TP4	0360-0124	TERMINAL PIN
A24TP5	0360-0124	TERMINAL PIN
A24TP6	0360-0124	TERMINAL PIN
A24TP7	0360-0124	TERMINAL PIN
A24TP8	0360-0124	TERMINAL PIN

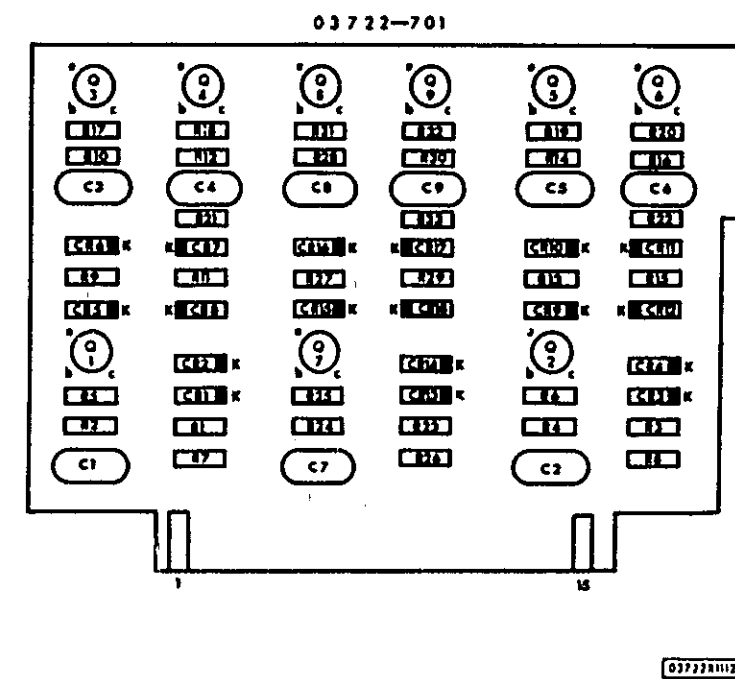


Figure 8 - 27 Feedback logic assembly A27, component location

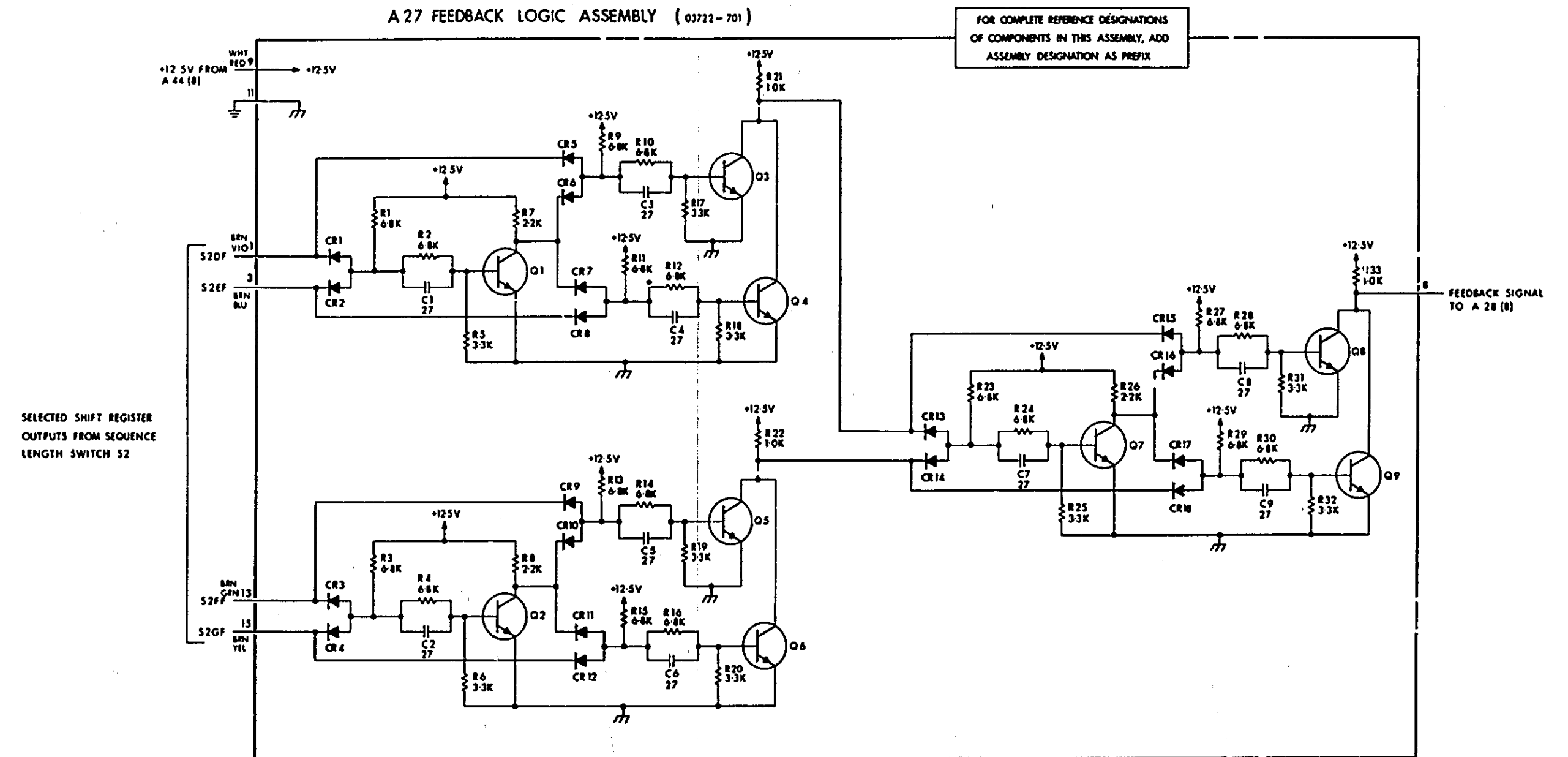


Figure 8 - 28 Feedback logic assembly A27, schematic

A27	03722-701 03722-301	ASSY: FEEDBACK LOGIC BOARD: BLANK PC (NSR)	A27R11	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R17	0698-4266	R: FXD MET OX 5.3K OHM 5% 1/4W
A27C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R18	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27C9	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A27R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27CR1	1901-0040	DIODE: SI	A27R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A27CR2	1901-0040	DIODE: SI	A27R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A27CR3	1901-0040	DIODE: SI	A27R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR4	1901-0040	DIODE: SI	A27R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR5	1901-0040	DIODE: SI	A27R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27CR6	1901-0040	DIODE: SI	A27R26	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A27CR7	1901-0040	DIODE: SI	A27R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR8	1901-0040	DIODE: SI	A27R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR9	1901-0040	DIODE: SI	A27R29	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR10	1901-0040	DIODE: SI	A27R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A27CR11	1901-0040	DIODE: SI	A27R31	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27CR12	1901-0040	DIODE: SI	A27R32	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A27CR13	1901-0040	DIODE: SI	A27R33	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A27CR14	1901-0040	DIODE: SI			
A27CR15	1901-0040	DIODE: SI			
A27CR16	1901-0040	DIODE: SI			
A27CR17	1901-0040	DIODE: SI			
A27CR18	1901-0040	DIODE: SI			
A27Q1	1854-0605	TRANSISTOR: SI NPN			
A27Q2	1854-0605	TRANSISTOR: SI NPN			
A27Q3	1854-0605	TRANSISTOR: SI NPN			
A27Q4	1854-0605	TRANSISTOR: SI NPN			
A27Q5	1854-0605	TRANSISTOR: SI NPN			
A27Q6	1854-0605	TRANSISTOR: SI NPN			
A27Q7	1854-0605	TRANSISTOR: SI NPN			
A27Q8	1854-0605	TRANSISTOR: SI NPN			
A27Q9	1854-0605	TRANSISTOR: SI NPN			
A27R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A27R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A27R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A27R4	0698-4274	R: FXD MET OX 6.6 OHM 5% 1/4W			
A27R5	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W			
A27R6	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W			
A27R7	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W			
A27R8	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W			
A27R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A27R10	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			

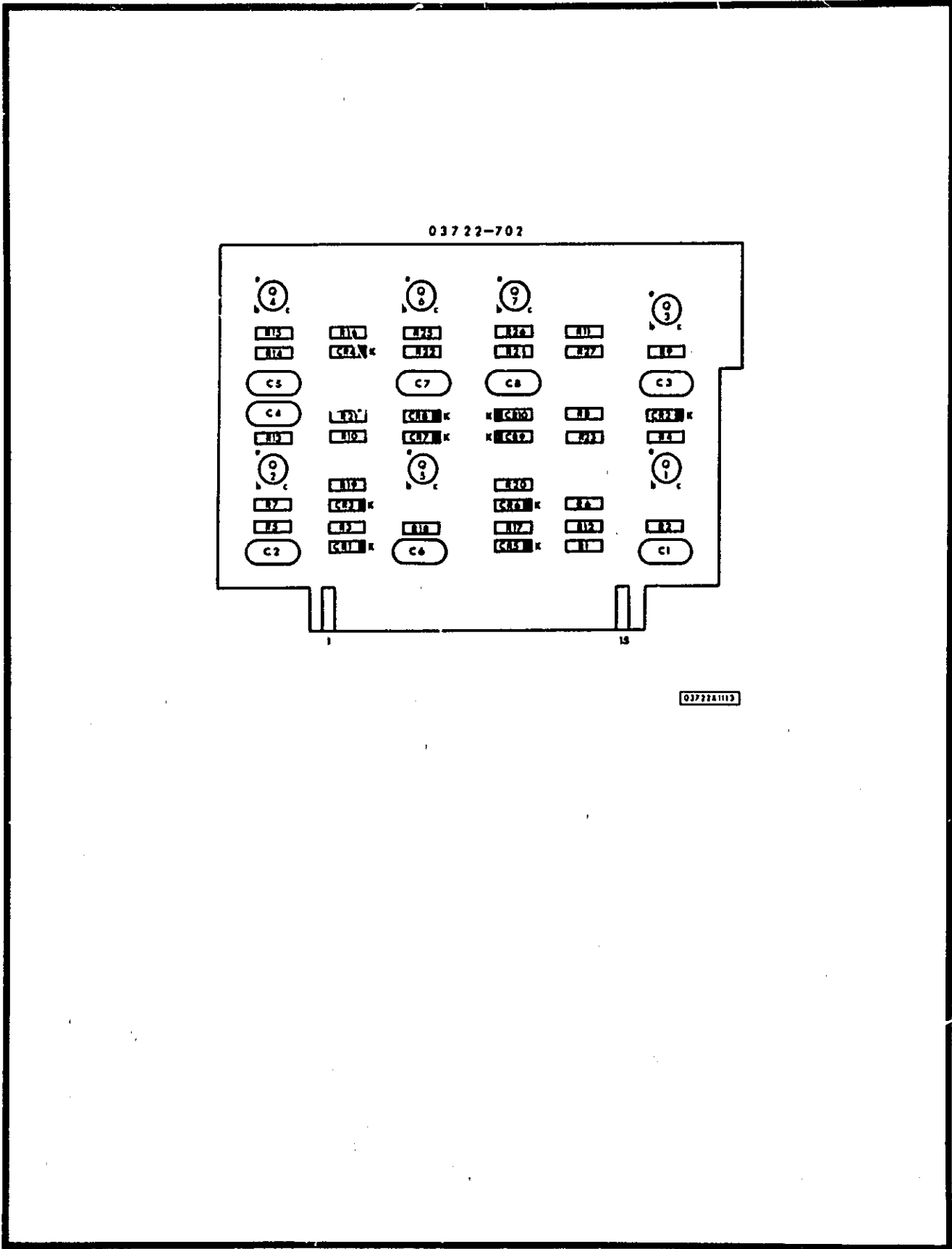


Figure 8 - 29 Auto-start logic assembly A28, component location

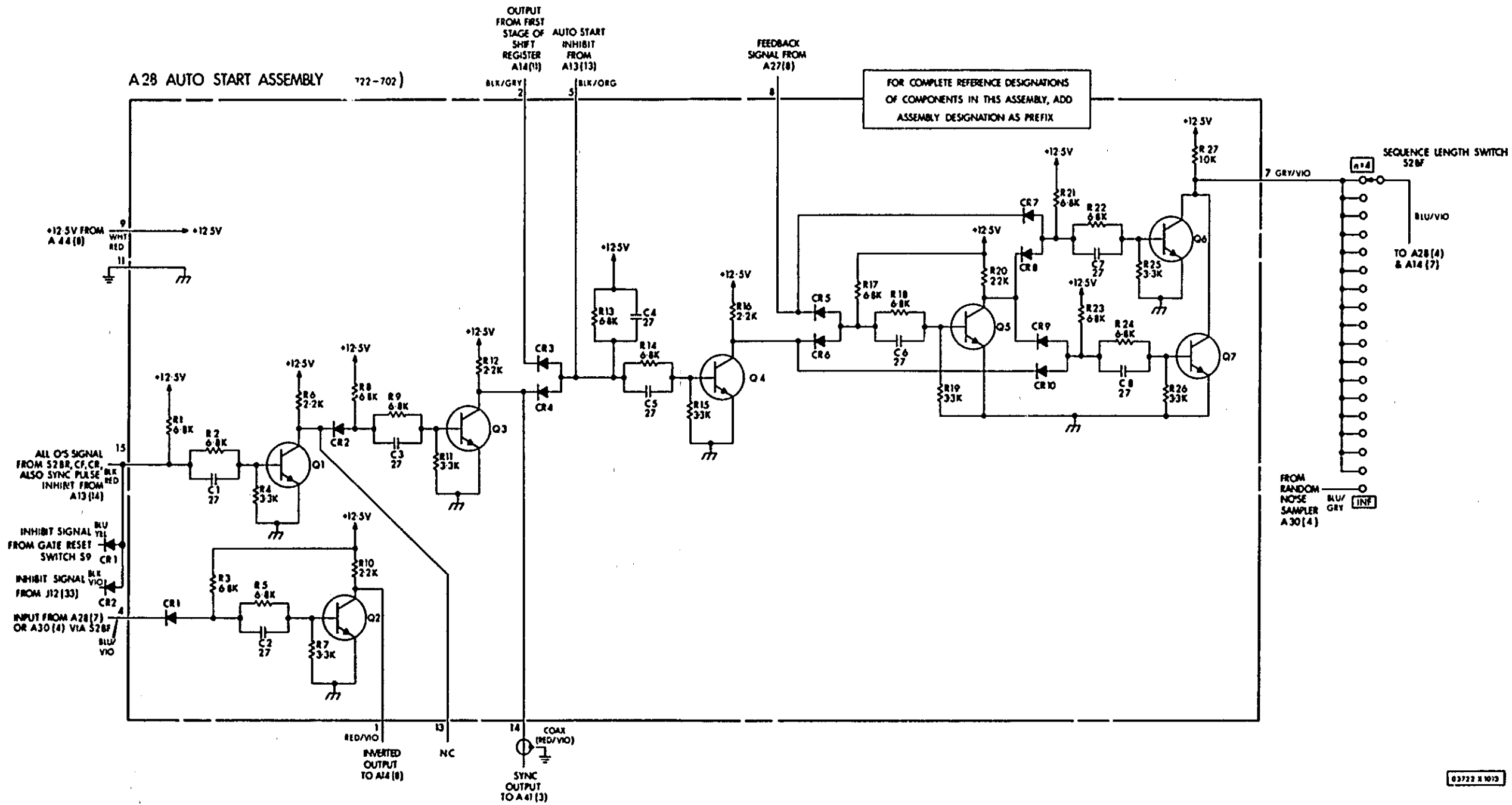


Figure 8 - 30 Auto-start logic assembly A28, schematic

A28	03722-702 03722-302	ASSY: AUTO-START LOGIC BOARD: BLANK PC (NSR)
A28C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C5	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C7	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28C8	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A28CR1	1901-0040	DIODE: SI
A28CR2	1901-0040	DIODE: SI
A28CR3	1901-0040	DIODE: SI
A28CR4	1901-0040	DIODE: SI
A28CR5	1901-0040	DIODE: SI
A28CR6	1901-0040	DIODE: SI
A28CR7	1901-0040	DIODE: SI
A28CR8	1901-0040	DIODE: SI
A28CR9	1901-0040	DIODE: SI
A28CR10	1901-0040	DIODE: SI
A28Q1	1854-0605	TRANSISTOR: SI NPN
A28Q2	1854-0605	TRANSISTOR: SI NPN
A28Q3	1854-0605	TRANSISTOR: SI NPN
A28Q4	1854-0605	TRANSISTOR: SI NPN
A28Q5	1854-0605	TRANSISTOR: SI NPN
A28Q6	1854-0605	TRANSISTOR: SI NPN
A28Q7	1854-0605	TRANSISTOR: SI NPN
A28R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R3	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R4	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R5	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R6	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A28R7	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R10	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A28R11	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R12	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A28R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R15	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R16	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A28R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R18	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R19	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R20	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A28R21	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R22	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R23	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A28R25	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R26	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A28R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W

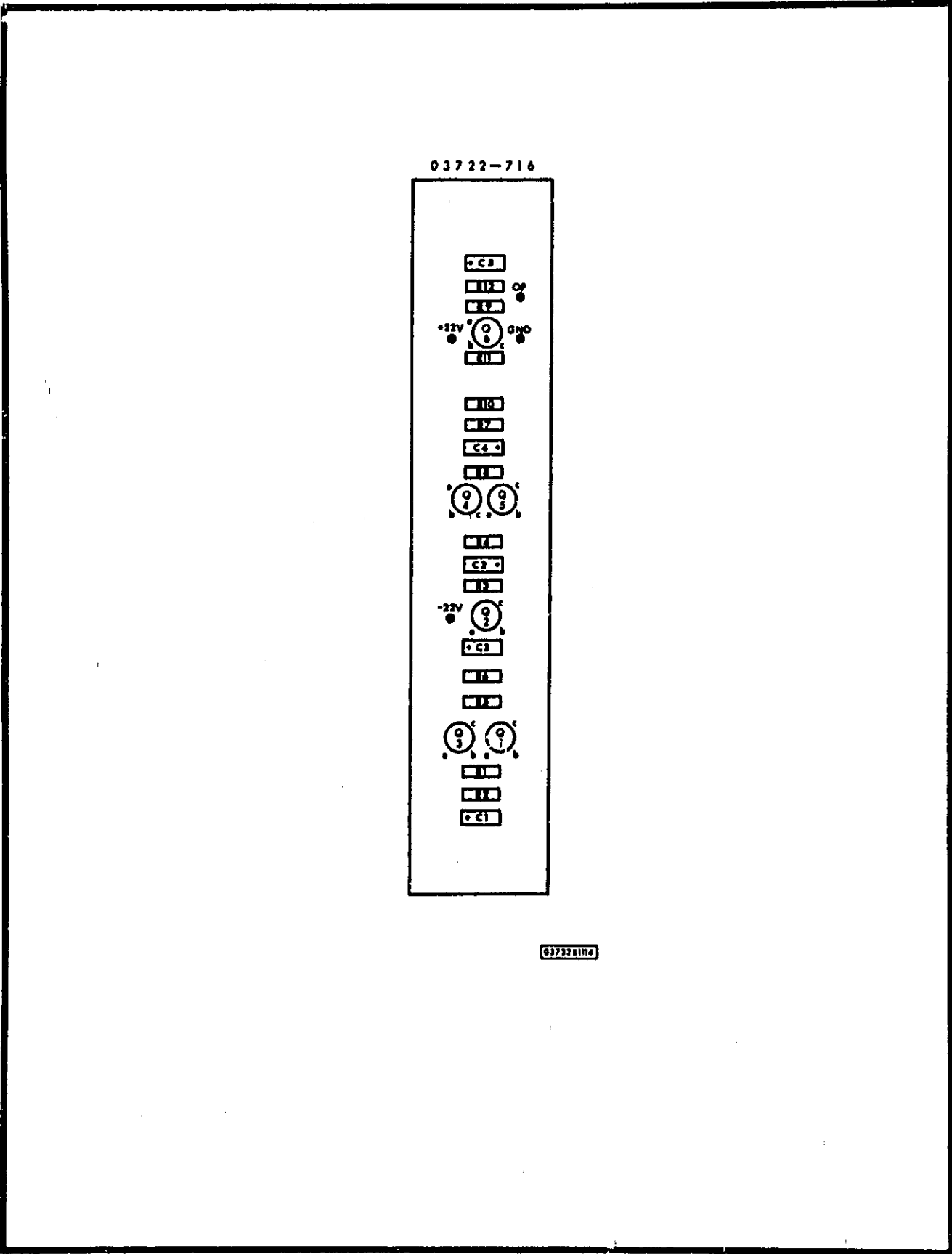


Figure 8-31 Random noise generator assembly A29, component location

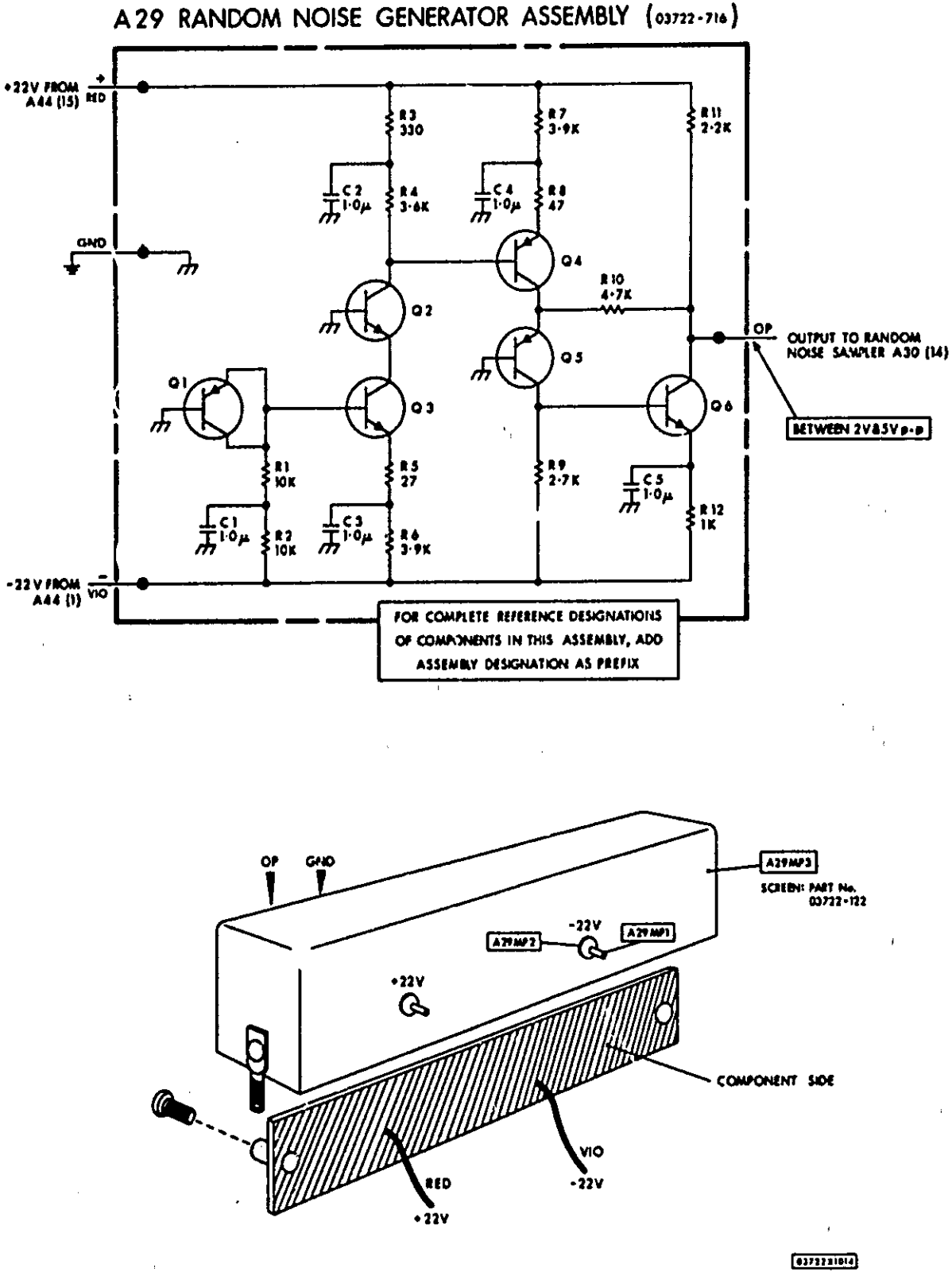


Figure 8-32 Random noise generator assembly A29, schematic

A29	03722-716 03722-316	ASSY: RANDOM NOISE GENERATOR BOARD: BLANK PC (NSR)
A29C1	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A29C2	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A29C3	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A29C4	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A29C5	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A29MP1	0340-0038	PIN
A29MP2	0340-0038	PIN
A29MP3	0340-0038	PIN
A29MP4	0340-0038	PIN
A29MP5	0340-0039	INSULATOR
A29MP6	0340-0039	INSULATOR
A29MP7	0340-0039	INSULATOR
A29MP8	0340-0039	INSULATOR
A29MP9	03722-122	SCREEN
A29Q1	1853-0015	TRANSISTOR: SI PNP
A29Q2	1854-0605	TRANSISTOR: SI NPN
A29Q3	1854-0071	TRANSISTOR: SI NPN
A29Q4	1853-0015	TRANSISTOR: SI PNP
A29Q5	1853-0036	TRANSISTOR: SI PNP
A29Q6	1854-0071	TRANSISTOR: SI NPN
A29R1	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A29R2	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A29R3	0698-4243	R: FXD MET OX 330 OHM 5% 1/4W
A29R4	0698-4267	R: FXD MET OX 3.6K OHM 5% 1/4W
A29R5	0698-5701	R: FXD MET OX 27 OHM 5% 1/4W
A29R6	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W
A29R7	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W
A29R8	0698-5707	R: FXD MET OX 47 OHM 5% 1/4W
A29R9	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W
A29R10	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A29R11	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A29R12	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W

Table 8 - 1 Random noise system — functional check & troubleshooting procedures

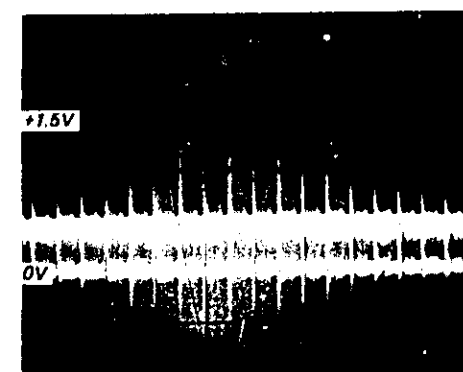
- | | |
|---|---|
| <p>(1) Set the 3722A controls as follows:
SEQUENCE LENGTH switch to INFINITE
CLOCK PERIOD switch to 1μS
CLOCK switch (rear panel) to INT
TEST switch (on chassis) to NORMAL
Press RUN button</p> <p>(2) Connect the 3722A BINARY output to the DC COUPLED input of an electronic counter, e.g. <i>hp 5245L</i>.</p> <p>(3) Set the counter controls as follows:
SENSITIVITY switch to 1V
TIMEBASE switch to 1 SEC</p> | <p>FUNCTION switch to FREQUENCY</p> <p>(4) Check that the counter reads 250kHz ± 5kHz on average of three or four readings. If the count is not correct, check for the presence of noise at the output from A29 (random noise generator). If the noise signal is satisfactory, troubleshoot the random noise sampler, A30, concentrating particularly on the tunnel diode Schmitt and monostable circuits. Disconnect the noise input to A30(14) and substitute a low-amplitude single tone of approximately 10MHz. A suitable signal generator for this purpose is the <i>hp 606A</i>. As the input frequency is swept from around 6MHz to 10MHz, check operation of the Schmitt shaper at A30Q1</p> |
|---|---|

collector, and check also that the width of the monostable output pulses at A30Q3 collector is reasonably constant. If the pulse duration tends to track the period of the input signal, it may be that the monostable is being forced by an over-large input. Re-check after attenuating the signal generator output to the point where the monostable just triggers regularly.

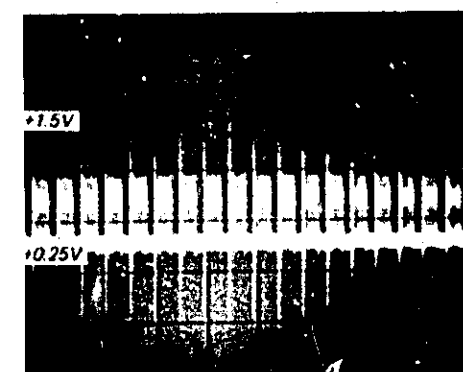
NOTE The monostable operates only when the clock input to the sampler, at A30(1), is at the low (zero volt) level.

Reason for 250kHz frequency count

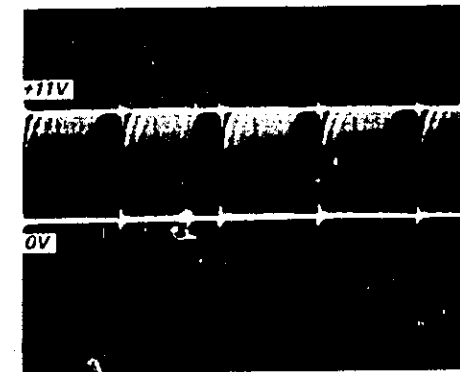
With a true random drive from the noise sampler, there is a 50-50 probability of the output from the first stage of the shift register being at either the high or low levels in any clock period. Hence, the mean crossing rate of the BINARY output — with 1MHz clock — must be 500kHz. Two zero crossings (one positive-going and one negative-going) are equivalent to one cycle of a periodic signal — so the measured frequency of the BINARY output should be approximately 250kHz.



A30CR1 anode, 0.5V/cm
Clock period 1μS Sweep 2μS/cm
Trigger internal

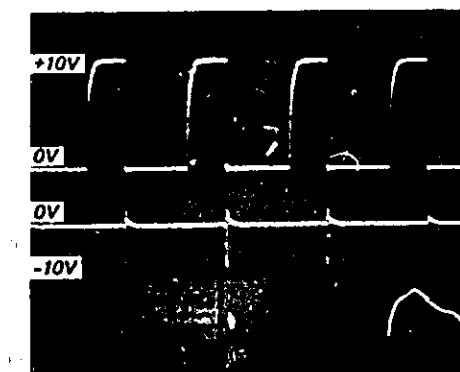


A30CR4 anode, 0.5V/cm
Clock period 1μS Sweep 2μS/cm
Trigger internal



A30Q4C, 5V/cm
Clock period 1μS Sweep 0.5μS/cm

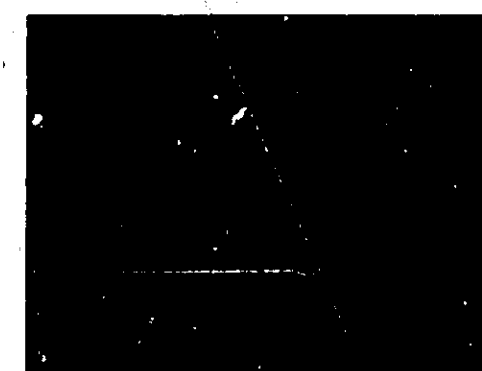
Blurred patches signify free-running divide-by-two stage. At end of gating interval, the divide-by-two stage stops (signified by the clear patches occurring once in each clock period). The divide-by-two stage should show no preference for either high or low levels — hence the even intensity of upper and lower traces.



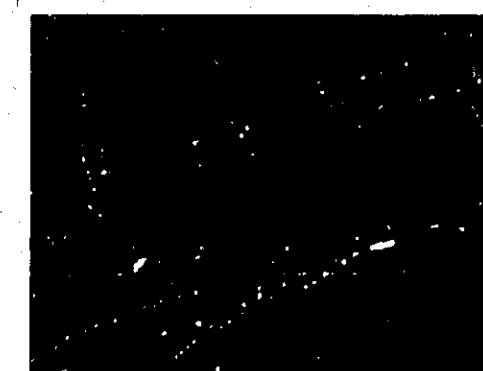
Upper trace clock input to random noise sampler A30(1), 5V/cm
Lower trace shift pulse at A13(9), 10V/cm
Clock period 10μS Sweep 5μS/cm
Trigger from 3722A CLOCK

A30	03722-709 03722-309	ASSY: RANDOM NOISE SAMPLER BOARD: BLANK PC (NSR)
A30C1	0140-0198	C: FXD MICA 150PF 5% 300VDCW
A30C2	0180-0291	C: FXD TA 1.0UF 10% 35VDCW
A30C3	0150-0093	C: FXD CER 0.01UF 100VDCW
A30C4	0180-2204	C: FXD MICA 100PF 5% 300VDCW
A30C5	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C6	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A30C7	0160-2208	C: FXD MICA 330PF 5% 300VDCW
A30C8	0150-0093	C: FXD CER 0.01UF 100VDCW
A30C9	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C10	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A30C11	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C12	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C13	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C14	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30C15	0180-2306	C: FXD MICA 27PF 5% 300VDCW
A30CR1	1912-0002	DIODE: TUNNEL
A30CR2	1901-0040	DIODE: SI
A30CR3	1901-004C	DIODE: SI
A30CR4	1912-0002	DIODE: TUNNEL
A30CR5	1901-0040	DIODE: SI
A30CR6	1901-0040	DIODE: SI
A30CR7	1910-0034	DIODE: GE
A30CR8	1910-0034	DIODE: GE
A30CR9	1901-0040	DIODE: SI
A30CR10	1901-0040	DIODE: SI
A30CR11	1901-0040	DIODE: SI
A30CR12	1901-0040	DIODE: SI
A30CR13	1901-0040	DIODE: SI
A30L1	9140-0114	COIL: FXD 10UH
A30L2	9140-0112	COIL: FXD 4.7UH
A30Q1	1854-0605	TRANSISTOR: SI NPN
A30Q2	1854-0605	TRANSISTOR: SI NPN
A30Q3	1854-0605	TRANSISTOR: SI NPN
A30Q4	1854-0605	TRANSISTOR: SI NPN
A30Q5	1854-0605	TRANSISTOR: SI NPN
A30Q6	1854-0605	TRANSISTOR: SI NPN
A30Q7	1854-0605	TRANSISTOR: SI NPN
A30R1	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R2	0758-0086	R: FXD MET OX 100 OHM 5% 1/4W
A30R3	0758-0086	R: FXD MET OX 100 OHM 5% 1/4W
A30R4	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W
A30R5	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W

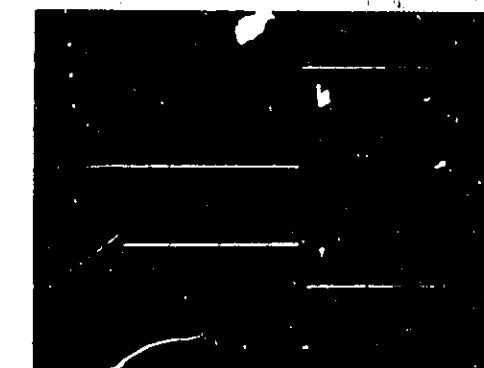
A30R6	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R7	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A30R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A30R9	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R11	0698-4246	R: FXD MET OX 470 OHM 5% 1/4W
A30R12	0698-4234	R: FXD MET OX 130 OHM 5% 1/4W
A30R13	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W
A30R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R15	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R16	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R17	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W
A30R18	0698-4230	R: FXD MET OX 82 OHM 5% 1/4W
A30R19	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A30F20	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A30R21	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R22	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R23	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A30R24	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R26	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A30R27	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A30R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R29	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A30R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A30R31	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A30R32	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W



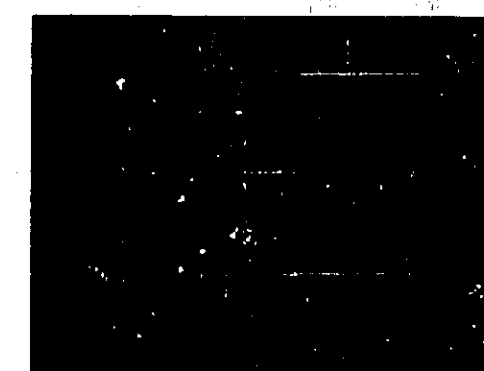
Upper trace BINARY output, 10V/cm
Lower trace A31TP1, R13 maladjusted,
0.5V/cm
Clock period 1mS N = 31
Sweep 1mS/cm
Trigger from 3722A SYNC



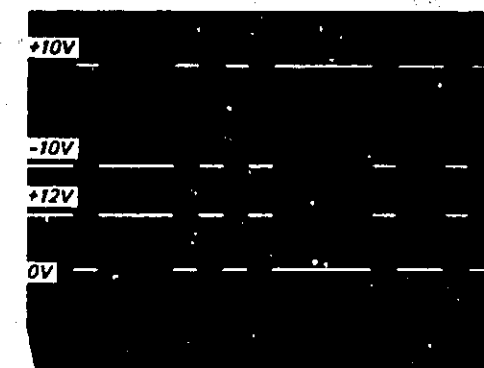
As opposite, but R13 adjusted correctly.



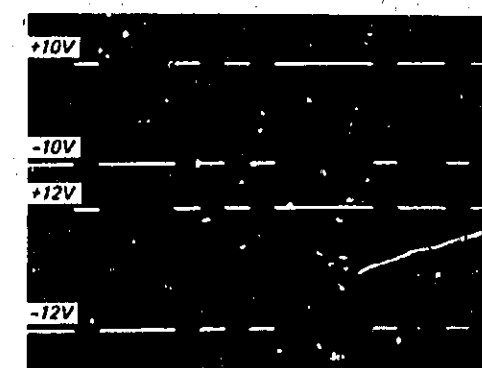
Upper trace BINARY output, 10V/cm
Lower trace A31TP2, R17 maladjusted,
0.5V/cm
Clock period 1mS N = 31
Sweep 1mS/cm
Trigger from 3722A SYNC



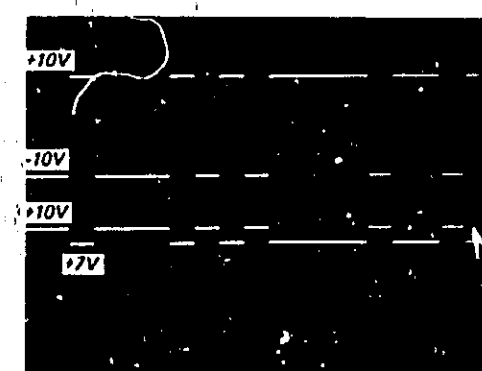
As above, but R17 adjusted correctly.



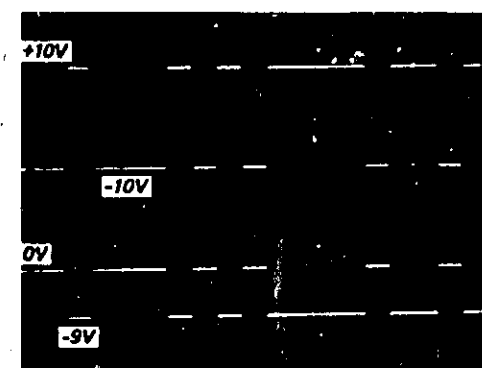
Upper trace BINARY output, 10V/cm
Lower trace input at A31(7), 10V/cm
Clock period 100μS N = 31
Sweep 0.2mS/cm
Trigger from 3722A SYNC



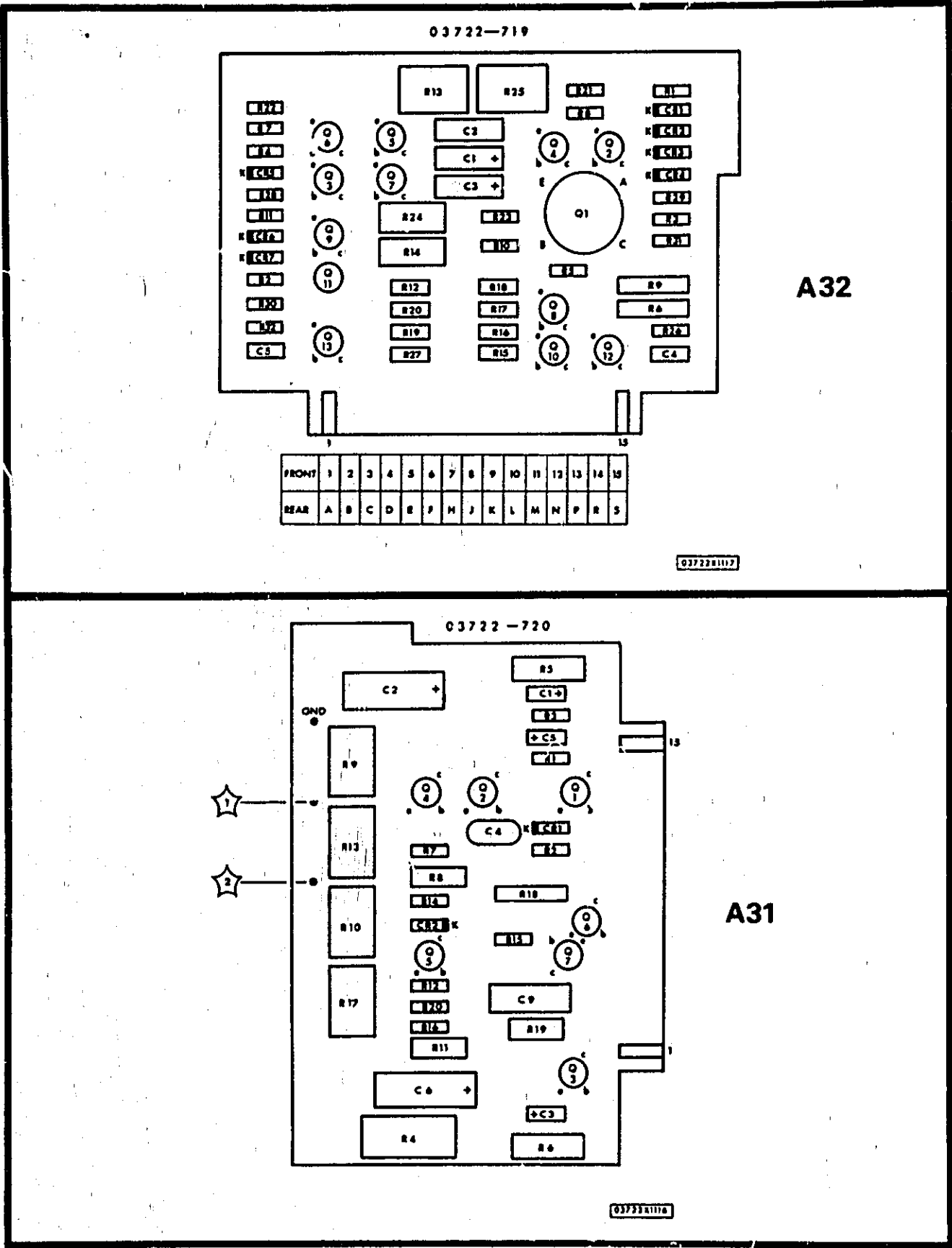
Upper trace BINARY output, 10V/cm
Lower trace A31Q2C, 10V/cm
Clock period 100μS N = 31
Sweep 0.2mS/cm
Trigger from 3722A SYNC



Upper trace BINARY output, 10V/cm
Lower trace A31Q4C, 10V/cm
Clock period 100μS N = 31
Sweep 0.2mS/cm
Trigger from 3722A SYNC



Upper trace BINARY output, 10V/cm
Lower trace A31Q5C, 10V/cm
Clock period 100μS N = 31
Sweep 0.2mS/cm
Trigger from 3722A SYNC



Figures 8 - 35 & 8 - 36 Reference power supply & output switch assemblies A32 & A31, component location

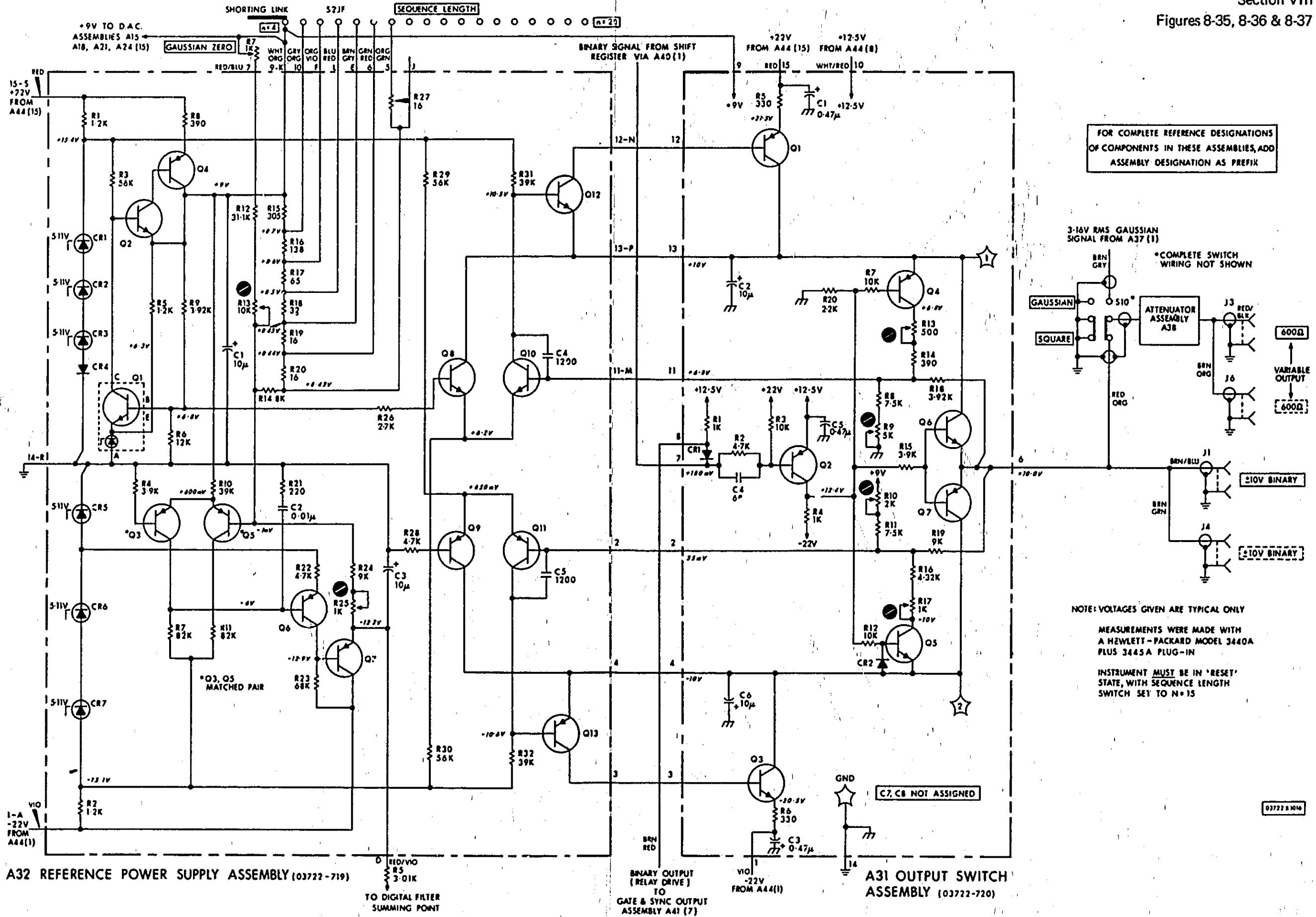
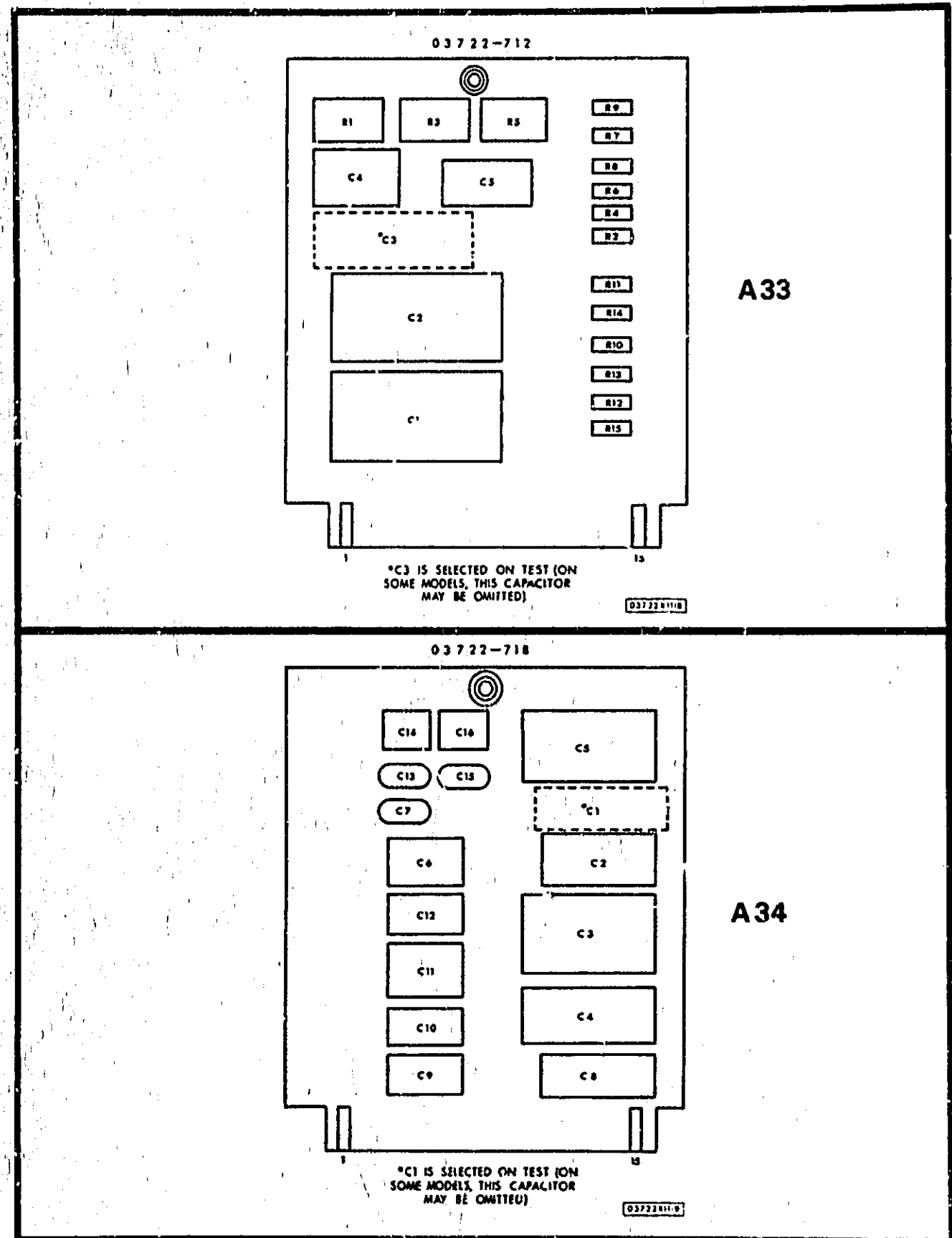


Figure 8 - 37 Reference power supply & output switch assemblies A31 & A32, schematic

A31	03722-720 03722-320	ASSY: OUTPUT SWITCH BOARD: BLANK PC (NSR)	A32CR6 A32CR7	1902-0041 1902-0041	DIODE: BREAKDOWN 5.11V 400mW DIODE: BREAKDOWN 5.11V 400mW
A31C1	0180-0376	C: FXD TA 0.47UF 10% 35VDCW	A32MP1	0380-0509	BEAD: GLASS
A31C2	0180-0059	C: FXD AL 10UF -10%+100% 25VDCW	A32MP2	0380-0509	BEAD: GLASS
A31C3	0180-0376	C: FXD TA 0.47UF 10% 35VDCW	A32MP3	0380-0509	BEAD: GLASS
A31C4	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A32MP4	0380-0509	BEAD: GLASS
A31C5	0180-0376	C: FXD TA 0.47UF 10% 35VDCW			
A31C6	0180-0059	C: FXD AL 10UF -10%+100% 25VDCW	A32Q1	1820-0001	TRANSISTOR: SI NPN (AMPLIFIER REFERENCE)
A31CR1	1901-0040	DIODE: SI	A32Q2	1854-0071	TRANSISTOR: SI NPN
A31CR2	1901-0040	DIODE: SI	A32Q3	1853-0607	TRANSISTOR: SI PNP (MATCHED WITH Q5)
			A32Q4	1853-0036	TRANSISTOR: SI PNP
			A32Q5	1853-0607	TRANSISTOR: SI PNP (MATCHED WITH Q3)
A31Q1	1853-0036	TRANSISTOR: SI PNP			
A31Q2	1853-0036	TRANSISTOR: SI PNP	A32Q6	1853-0036	TRANSISTOR: SI PNP
A31Q3	1854-0071	TRANSISTOR: SI NPN	A32Q7	1853-0036	TRANSISTOR: SI PNP
A31Q4	1853-0015	TRANSISTOR: SI PNP	A32Q8	1854-0071	TRANSISTOR: SI NPN
A31Q5	1854-0605	TRANSISTOR: SI NPN	A32Q9	1853-0015	TRANSISTOR: SI PNP
			A32Q10	1854-0071	TRANSISTOR: SI NPN
A31Q6	1854-0215	TRANSISTOR: SI NPN	A32Q11	1853-0015	TRANSISTOR: SI PNP
A31Q7	1853-0036	TRANSISTOR: SI PNP	A32Q12	1854-0071	TRANSISTOR: SI NPN
			A32Q13	1853-0015	TRANSISTOR: SI PNP
A31R1	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W	A32R1	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W
A31R2	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W	A32R2	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W
A31R3	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	A32R3	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W
A31R4	0764-0016	R: FXD MET FLM 1.0K OHM 5% 2W	A32R4	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W
A31R5	0760-0022	R: FXD MET FLM 330 OHM 2% 1W	A32R5	0698-4256	R: FXD MET OX 1.2K OHM 5% 1/4W
A31R6	0760-0022	R: FXD MET FLM 330 OHM 2% 1W			
A31R7	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	A32R6	0698-3768	R: FXD MET FLM 12K OHM 1% 1/4W
A31R8	0698-6033	R: FXD MET FLM 7.5K OHM 1% 1/4W 50 PPM	A32R7	0698-4300	R: FXD MET OX 82K OHM 5% 1/4W
A31R9	2100-1760	R: VAR WW LIN 5.0K OHM 10% 1/2W	A32R8	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W
A31R10	2100-1759	R: VAR WW LIN 2.0K OHM 10% 1/2W	A32R9	0698-3763	R: FXD MET FLM 3920 OHM 1% 1/4W
			A32R10	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W
A31R11	0698-6033	R: FXD MET FLM 7.5K OHM 1% 1/4W 50 PPM	A32R11	0698-4300	R: FXD MET OX 82K OHM 5% 1/4W
A31R12	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W	A32R12	0698-5793	R: FXD MET FLM 31.1K OHM 1/2% 1/8W 50 PPM
A31R13	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W	A32R13	2100-0989	R: VAR WW LIN 10K OHM 5% 1W
A31R14	0757-0914	R: FXD MET FLM 390 OHM 2% 1/8W	A32R14	0811-0601	R: FXD WW 8K OHM 1% 1/2W 5 PPM
A31R15	0698-4268	R: FXD MET OX 3.9K OHM 5% 1/4W	A32R15	0698-3779	R: FXD MET OX 305 OHM 1% 1/4W
A31R16	0757-0436	R: FXD MET FLM 4.32K OHM 1% 1/8W 100 PPM			
A31R17	2100-1758	R: VAR WW LIN 1.0K OHM 10% 1/2W	A32R16	0698-3778	R: FXD MET OX 138 OHM 1% 1/4W
A31R18	0698-3763	R: FXD MET FLM 3.92K OHM 1% 1/4W 50 PPM	A32R17	0698-3777	R: FXD MET OX 65 OHM 1% 1/4W
A31R19	0698-6034	R: FXD MET FLM 9K OHM 1% 1/4W 50 PPM	A32R18	0698-3776	R: FXD MET OX 32 OHM 2% 1/4W
A31R20	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W	A32R19	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W
			A32R20	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W
A31TP1	0360-0124	TERMINAL PIN			
A31TP2	0360-0124	TERMINAL PIN	A32R21	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A31TP3	0360-0124	TERMINAL PIN	A32R22	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
			A32R23	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
			A32R24	0811-0602	R: FXD WW 9K OHM 1% 1/2W 5 PPM
			A32R25	2100-0941	R: VAR WW LIN 1.0K OHM 5% 1W
A32	03722-719 03722-319	ASSY: REFERENCE POWER SUPPLY BOARD: BLANK PC (NSR)			
A32C1	0180-0374	C: FXD TA 10UF 10% 20VDCW	A32R26	0698-4264	R: FXD MET OX 2.7K OHM 5% 1/4W
A32C2	0180-0161	C: FXD MY 0.01UF	A32R27	0698-3775	R: FXD MET OX 16 OHM 2% 1/4W
A32C3	0180-0374	C: FXD TA 10UF 10% 20VDCW	A32R28	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A32C4	0180-0297	C: FXD MY 1200PF 10% 200VDCW	A32R29	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W
A32C5	0160-0297	C: FXD MY 1200PF 10% 200VDCW	A32R30	0698-4296	R: FXD MET OX 56K OHM 5% 1/4W
A32CR1	1902-0041	DIODE: BREAKDOWN 5.11V 400mW			
A32CR2	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	A32R31	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W
A32CR3	1902-0041	DIODE: BREAKDOWN 5.11V 400mW	A32R32	0698-4292	R: FXD MET OX 39K OHM 5% 1/4W
A32CR4	1901-0040	DIODE: SI			
A32CR5	1902-0041	DIODE: BREAKDOWN 5.11V 400mW			



Figures 8 - 38 & 8 - 39 Analog filter assemblies (1) A33 & (2) A34, component location

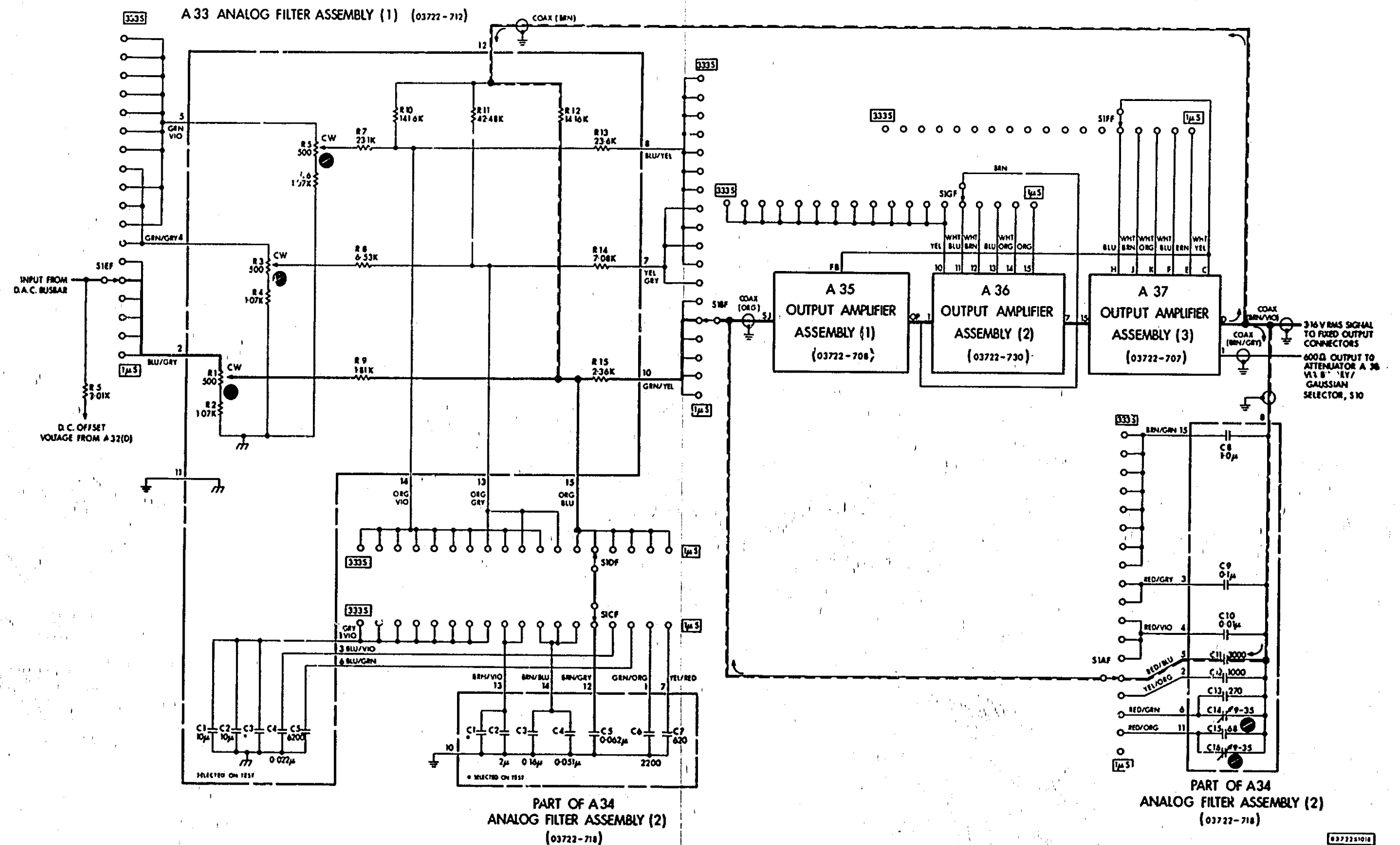


Figure 8 - 40 Analog filter assemblies (1) A33 & (2) A34, schematic

A33	03722-712 03722-312	ASSY: ANALOG FILTER (1) BOARD: BLANK PC (NSR)
A33C1	0160-0615	C: FXD METALAC 10UF 10% 63VDCW
A33C2	0160-0615	C: FXD METALAC 10UF 10% 63VDCW
A33C3		C: FXD METALAC SELECTED ON TEST
A33C4	0160-0646	C: FLD POLY 0.022UF 1% 63VDCW
A33C5	0160-0647	C: FXD POLY 6200PF 1% 500VDCW
A33R1	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A33R2	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM
A33R3	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A33R4	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM
A33R5	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A33R6	0698-3468	R: FXD MET FLM 1.07K OHM 1% 1/4W 50PPM
A33R7	0698-3770	R: FXD MET FLM 23.1K OHM 1% 1/4W 50PPM
A33R8	0698-3765	R: FXD MET FLM 6.53K OHM 1% 1/4W 50PPM
A33R9	0698-3759	R: FXD MET FLM 1.81K OHM 1% 1/4W 50PPM
A33R10	0698-3773	R: FXD MET FLM 141.6K OHM 1% 1/4W 50PPM
A33R11	0698-3772	R: FXD MET FLM 42.48K OHM 1% 1/4W 50PPM
A33R12	0698-3769	R: FXD MET FLM 14.16K OHM 1% 1/4W 50PPM
A33R13	0698-3771	R: FXD MET FLM 23.6K OHM 1% 1/4W 50PPM
A33R14	0698-3766	R: FXD MET FLM 7.08K OHM 1% 1/4W 50PPM
A33R15	0698-3761	R: FXD MET FLM 2.36K OHM 1% 1/4W 50PPM
A34	03722-718 03722-318	ASSY: ANALOG FILTER (2) BOARD: BLANK PC (NSR)
A34C1		C: FXD MY SELECTED ON TEST
A34C2	0160-0620	C: FXD METALAC 2UF 10% 63VDCW
A34C3	0160-0648	C: FXD POLY 0.16UF 1% 63VDCW
A34C4	0160-0649	C: FXD POLY 0.051UF 1% 63VDCW
A34C5	0160-0650	C: FXD POLY 0.062UF 1% 63VDCW
A34C6	0160-0651	C: FXD POLY 2200PF 1% 500VDCW
A34C7	0160-2598	C: FXD MICA 620PF 2% 300VDCW
A34C8	0160-0655	C: FXD METALAC 1UF 5% 63VDCW
A34C9	0170-0019	C: FXD MY 0.1UF 5% 200VDCW
A34C10	0160-0633	C: FXD POLY 0.01UF 1% 63VDCW
A34C11	0160-0652	C: FXD POLY 3000PF 1% 500VDCW
A34C12	0160-0653	C: FXD POLY 1000PF 1% 500VDCW
A34C13	0140-0206	C: FXD MICA 270PF 5% 500VDCW
A34C14	0121-0105	C: VAR CER 9-35PF
A34C15	0140-0192	C: FXD MICA 68PF 5% 300VDCW
A34C16	0121-0105	C: VAR CER 9-35PF

SERVICE NOTE **Output amplifier (1) A35**

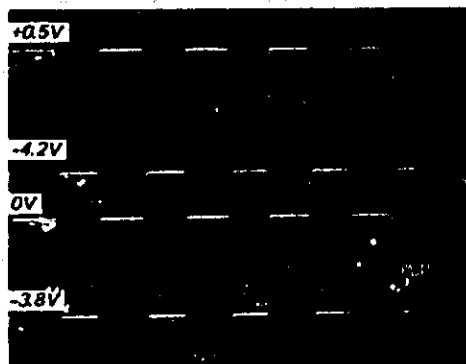
Checking amplifier input offset and replacement of R19

After any servicing of amplifier assembly A35, the input offset should be checked as follows:

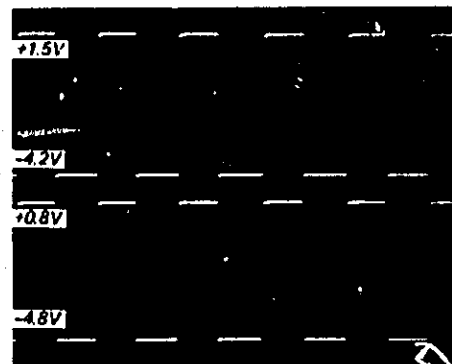
- (1) Connect to the 3722A GAUSSIAN output a DVM fitted with a high-gain auto range plug-in (e.g. *hp 3440A* + *hp 3445A*).
- (2) Set the 3722A CLOCK PERIOD switch to 333 μ S and operate the HOLD button.
- (3) Connect a shorting link between pin 4 of socket XA24 and ground. The DVM reading should be between ± 1 mV.
- (4) Check that for clock periods 1mS and 3.33mS the DVM reading does not exceed ± 2 mV.

If the DVM reading exceeds the stated limits, R19 must be replaced. The value of R19 should be increased if the DVM reading is positive, and vice versa. A range of typical values is given opposite (all resistors are MET OX, 5%, 1/4W).

Value	hp Part No.
1k Ω	0698-4254
1.2k Ω	0698-4256
1.5k Ω	0698-4258
1.8k Ω	0698-4260
2k Ω	0698-4261
2.2k Ω	0698-4262
2.4k Ω	0698-4263
2.7k Ω	0698-4264
3k Ω	0698-4265
3.3k Ω	0698-4266
3.6k Ω	0698-4267
3.9k Ω	0698-4268
4.3k Ω	0698-4269
4.7k Ω	0698-4270
5.1k Ω	0698-4271



Upper trace A35Q2C, 2V/cm
Lower trace A35CR1 anode, 2V/cm
Sweep 1mS/cm Trigger internal



Upper trace A35Q5C, 2V/cm
Lower trace A35CR5 cathode, 2V/cm
Sweep 1mS/cm Trigger internal

COMMENT	One of the problems of fault finding in a feedback system is that a malfunction in one part of the circuit is propagated through the rest of the system. It is therefore necessary to break the loop at some convenient point before attempting to find the source of trouble. However, breaking the feedback loop around a dc amplifier usually gives rise to abnormal circuit conditions, since the feedback also defines quiescent dc conditions. Hence the unorthodox approach necessary when troubleshooting the Gaussian output amplifier system.
EQUIPMENT REQUIRED	(1) Oscilloscope with high impedance probes. (2) High impedance voltmeter ($Z > 10M\Omega$): for example, <i>hp 3440A</i> digital voltmeter. (3) Square wave generator: for example, <i>hp 3300A</i>. (4) Short jumper lead terminated at each end with miniature crocodile clips in insulated sleeves. (5) A $100k\Omega$ resistor, terminated at one end in a BNC plug (to mate with the GAUSSIAN output connector): the other end of the resistor is soldered to an insulated lead terminated with a crocodile clip.
SYMPTOM	Excessive dc offset at output from Gaussian amplifier (i.e. offset observed at GAUSSIAN output connector).

Note settings of CLOCK PERIOD switch at which fault is apparent. Inspect under-chassis wiring for breaks or dry joints.

```

graph TD
    Start[Note settings of CLOCK PERIOD switch at which fault is apparent. Inspect under-chassis wiring for breaks or dry joints.] --> D1{offset present at all settings?}
    Start --> D2{offset present at certain settings only?}
    D1 -- YES --> A1[Find faulty card by substitution, if possible.]
    D2 -- YES --> A2[Ground digital filter summing point A22(4). Display GAUSSIAN output on oscilloscope. Check whether or not the system oscillates at defective settings.]
    A2 --> D3{oscillation observed?}
    D3 -- YES --> A3[Refer to Table 8-3 for guidance on curing oscillation.]
    D3 -- NO --> A4[Break the feedback loop by removing filter assembly A33. Connect A35 input terminal SJ to GAUSSIAN connector via 100kΩ resistor. Measure Gaussian output voltage.]
    A4 --> End[continued on next page]
  
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continued on next page

Table 8-2 Troubleshooting analog filters and Gaussian output amplifiers

Table 8-2

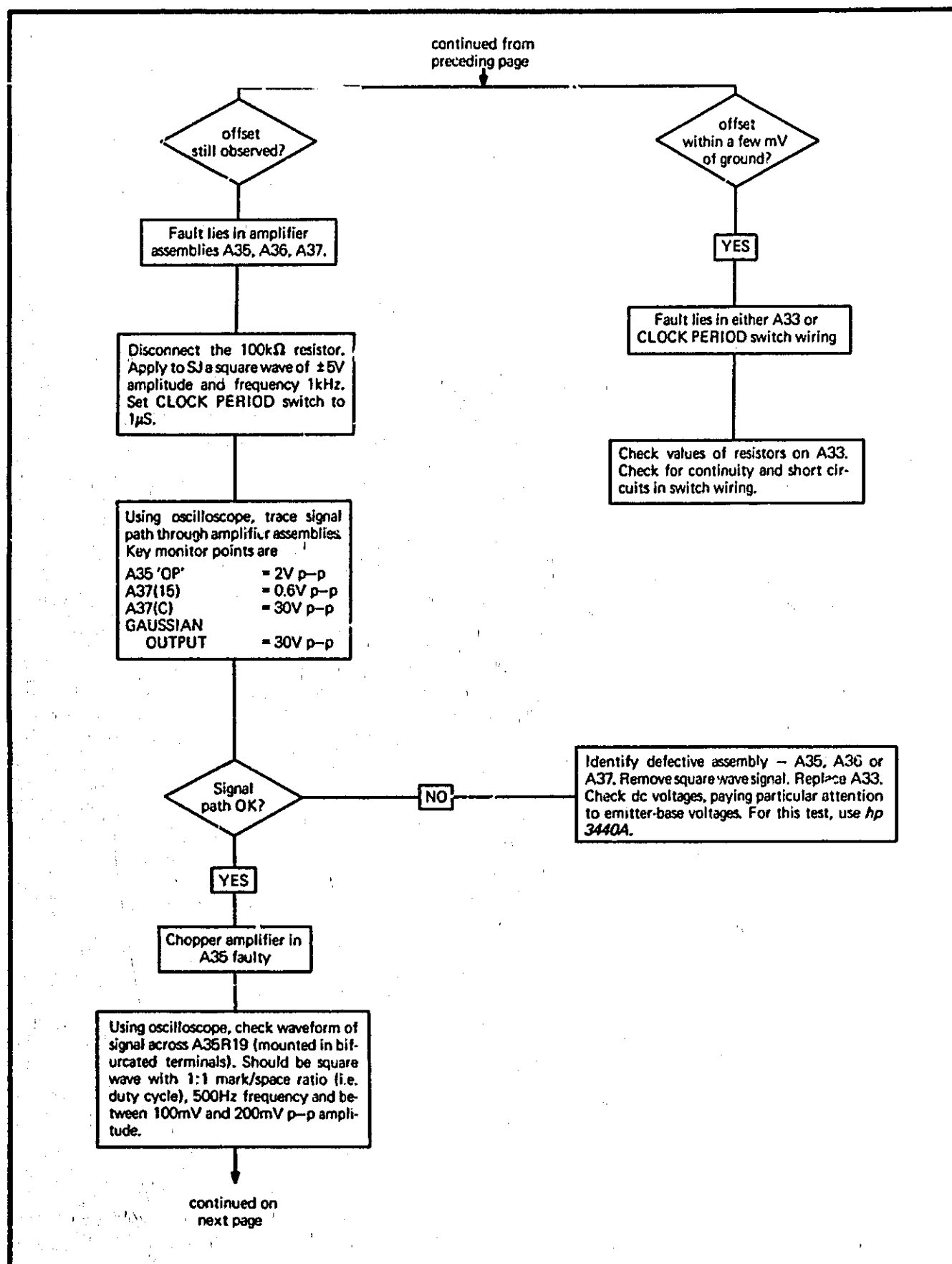


Table 8-2 (continued)

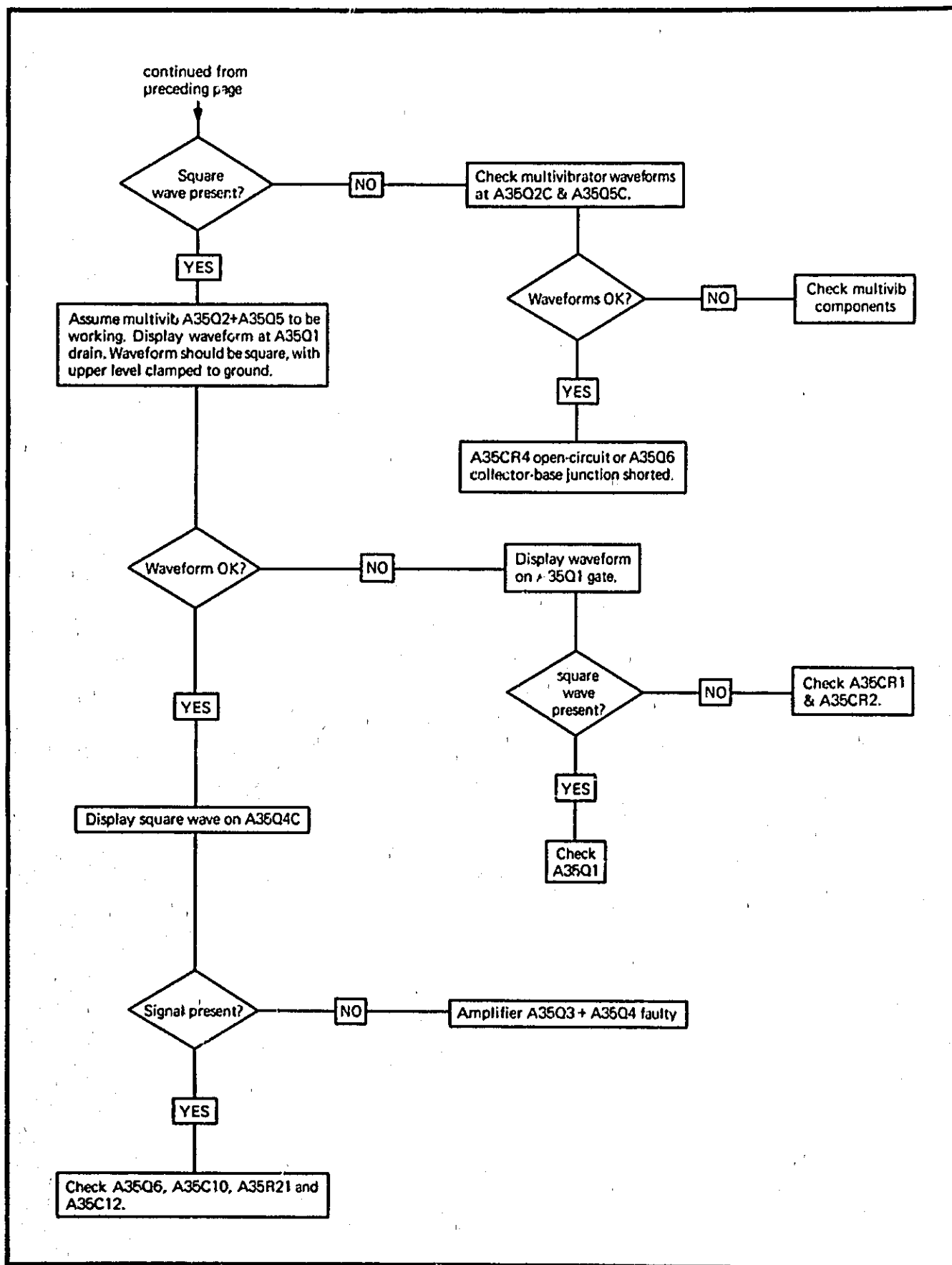


Table 8-2 (continued)

Table 8-3

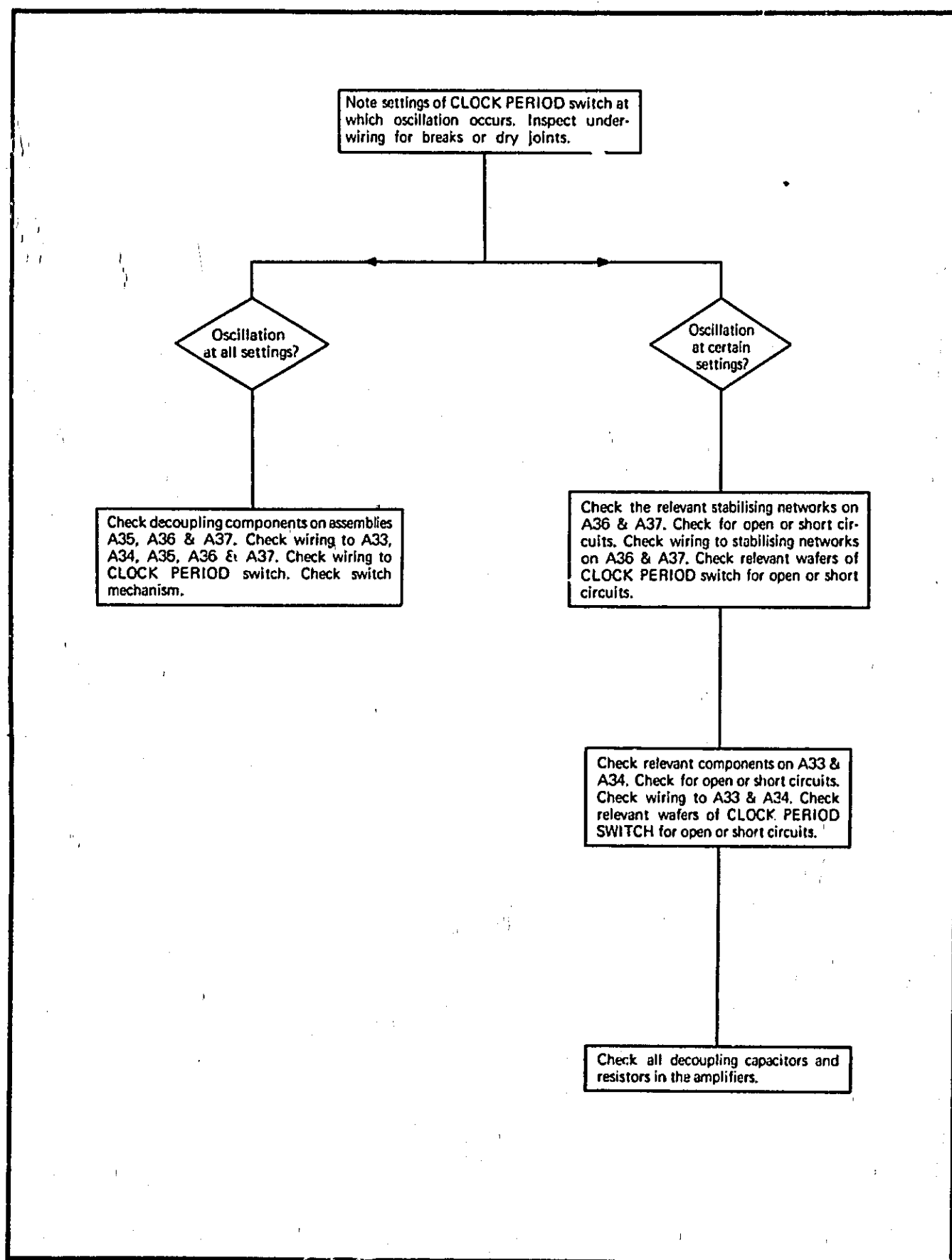
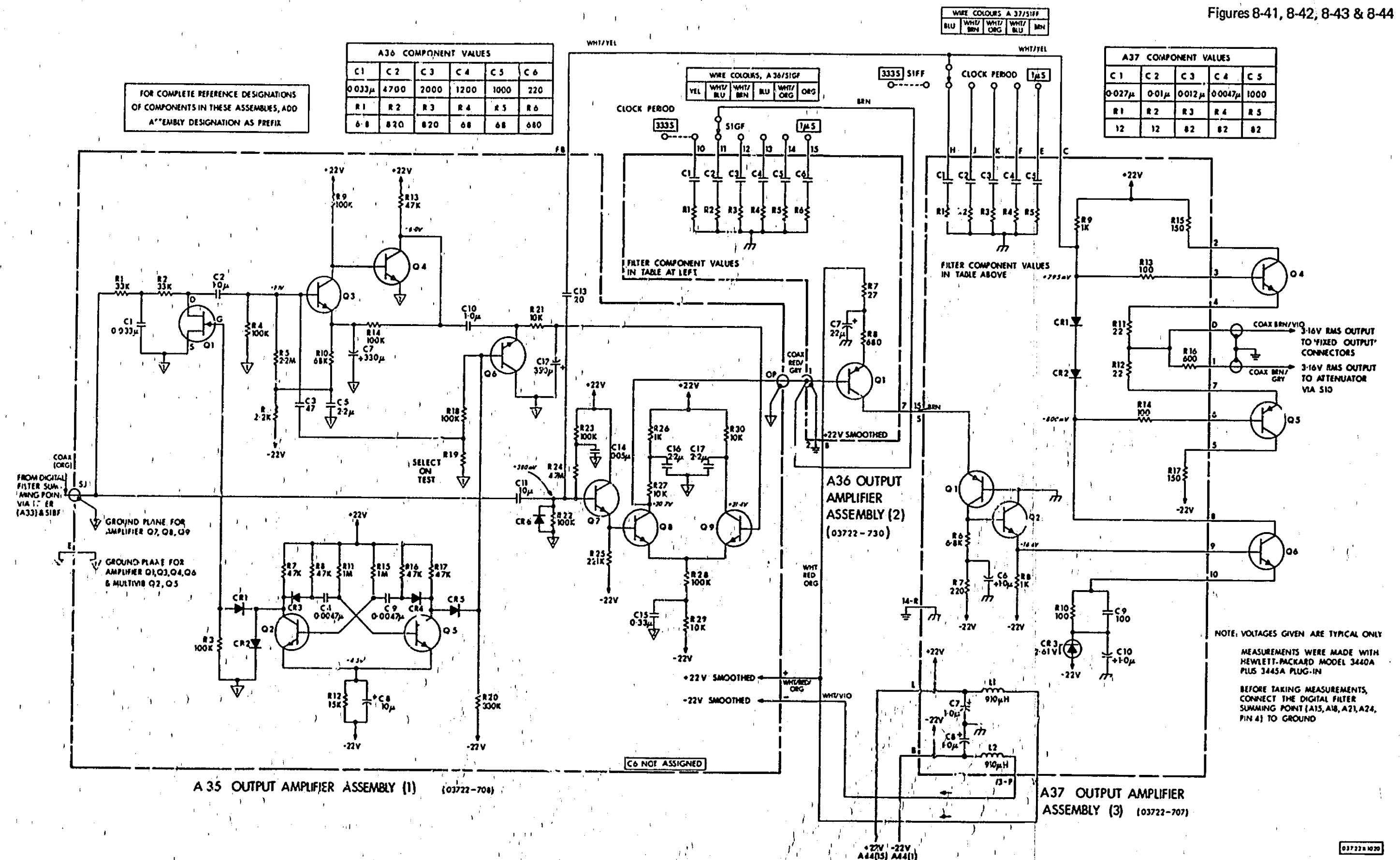


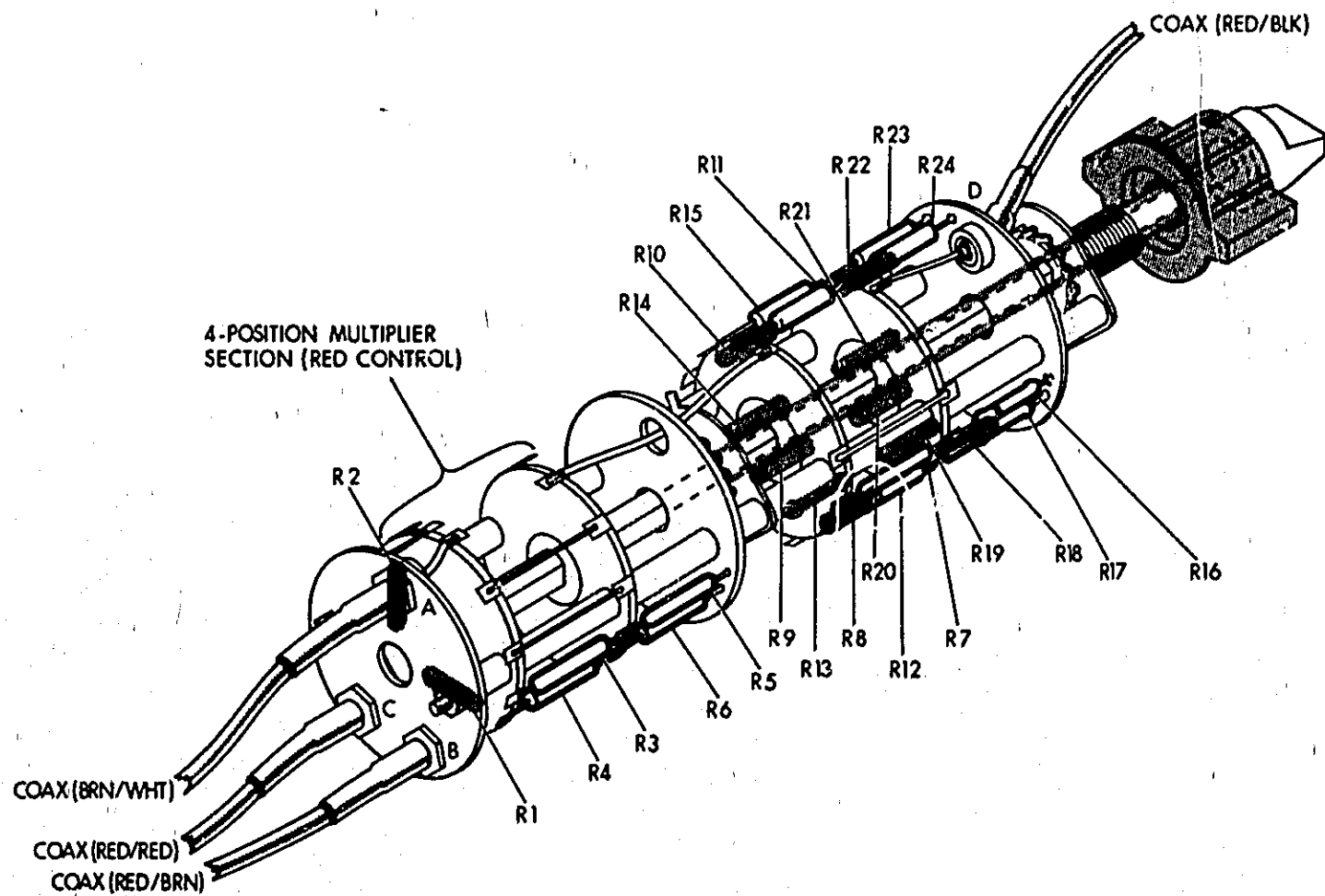
Table 8-3 Troubleshooting oscillation in Gaussian output amplifiers

02182-1



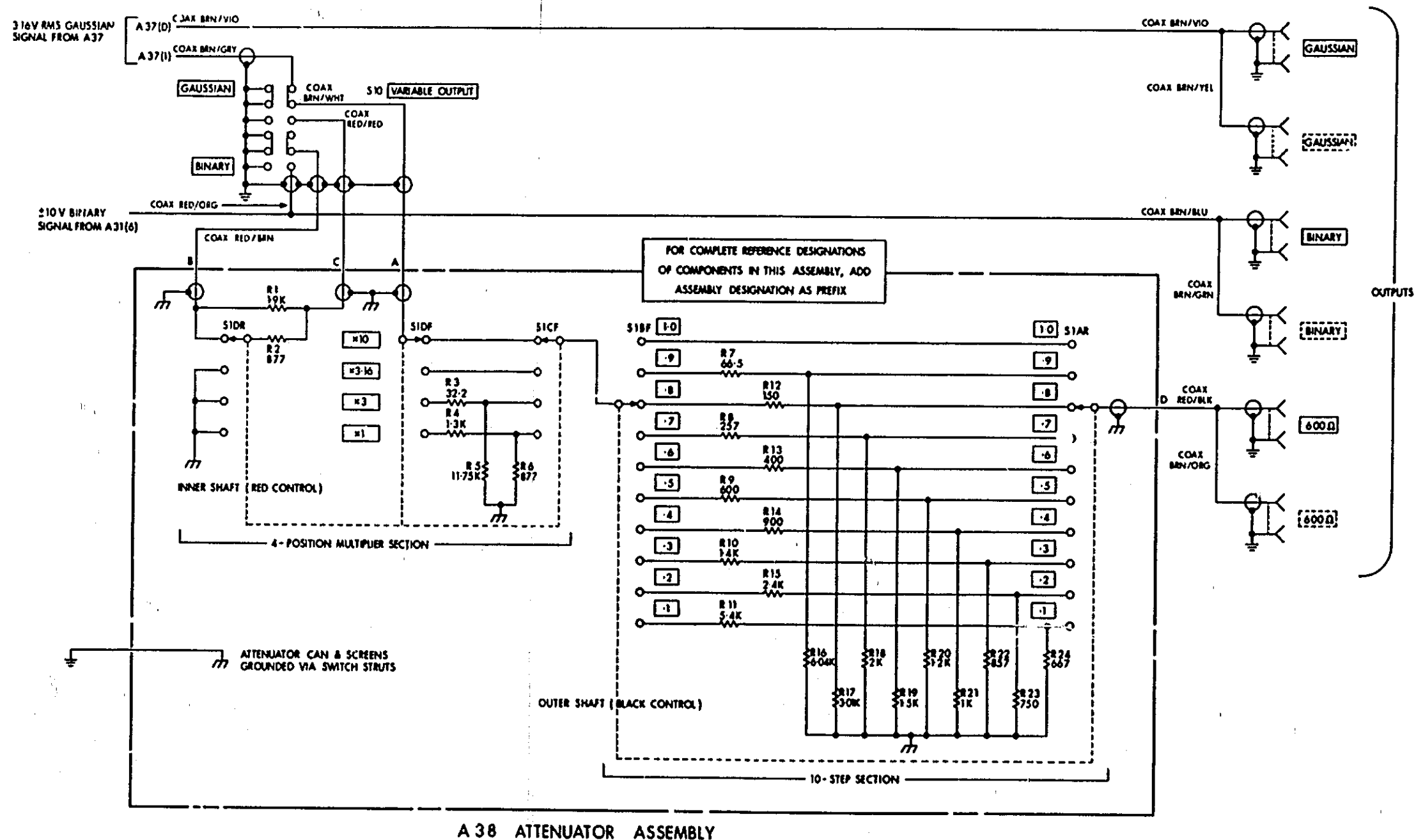
0372321020

A35	03722-708 03722-308	ASSY: OUTPUT AMPLIFIER (1) BOARD: BLANK PC (NSR)
A35C1	0160-0163	C: FXD MY 0.033UF 10%
A35C2	0160-0619	C: FXD METALAC 1UF 10% 63VDCW
A35C3	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A35C4	0160-0157	C: FXD MY 0.0047UF 10% 200VDCW
A35C5	0160-0128	C: FXD CER 2.2UF 20% 25VDCW
A35C6		NOT ASSIGNED
A35C7	0180-1714	C: FXD TA 33UF 10% 6VDCW
A35C8	0180-0059	C: FXD AL 30UF -10%+100% 25VDCW
A35C9	0160-0157	C: FXD MY 0.0047UF 10% 200VDCW
A35C10	0160-0619	C: FXD METALAC 1UF 10% 63VDCW
A35C11	0160-0615	C: FXD METALAC 10UF 10% 63VDCW
A35C12	0180-1714	C: FXD TA 33UF 10% 6VDCW
A35C13	0160-2198	C: FXD MICA 20PF 5% 300VDCW
A35C14	0150-0096	C: FXD CER 0.05UF 100VDCW
A35C15	0160-0137	C: FXD CER 0.33UF 20% 25VDCW
A35C16	0160-0128	C: FXD CER 2.2UF 20% 25VDCW
A35C17	0160-0128	C: FXD CER 2.2UF 20% 25VDCW
A35CR1	1901-0040	DIODE: SI
A35CR2	1901-0040	DIODE: SI
A35CR3	1901-0040	DIODE: SI
A35CR4	1901-0040	DIODE: SI
A35CR5	1901-0040	DIODE: SI
A35CR6	1901-0040	DIODE: SI
A35MP1	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP2	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP3	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP4	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP5	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP6	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP7	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP8	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP9	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP10	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP11	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP12	0340-0060	TERMINAL: CLOVER LEAF PTFE
A35MP13	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35MP14	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35MP15	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35MP16	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35MP17	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35MP18	0360-0065	TERMINAL: SUBMINIATURE BRASS
A35Q1	1855-0603	TRANSISTOR: SI FET
A35Q2	1854-0071	TRANSISTOR: SI NPN
A35Q3	1854-0071	TRANSISTOR: SI NPN
A35Q4	1854-0071	TRANSISTOR: SI NPN
A35Q5	1854-0071	TRANSISTOR: SI NPN
A35Q6	1854-0071	TRANSISTOR: SI NPN
A35Q7	1854-0071	TRANSISTOR: SI NPN
A35Q8	1854-0071	TRANSISTOR: SI NPN
A35Q9	1854-0071	TRANSISTOR: SI NPN
A35R1	0698-4290	R: FXD MET OX 33K OHM 5% 1/4W
A35R2	0698-4290	R: FXD MET OX 33K OHM 5% 1/4W
A35R3	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R4	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R5	0683-2255	R: FXD COMP 2.2 MEG OHM 5% 1/4W
A35R6	0698-4262	R: FXD MET OX 2.2K OHM 5% 1/4W
A35R7	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W
A35R8	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W
A35R9	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R10	0698-4298	R: FXD MET OX 68K OHM 5% 1/4W
A35R11	0683-1053	R: FXD COMP 1 MEG OHM 5% 1/4W
A35R12	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A35R13	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W
A35R14	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R15	0683-1055	R: FXD COMP 1 MEG OHM 5% 1/4W
A35R16	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W
A35R17	0698-4294	R: FXD MET OX 47K OHM 5% 1/4W
A35R18	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R19		R: FXD MET OX SELECTED ON TEST
A35R20	0683-3345	R: FXD COMP 330K OHM 5% 1/4W
A35R21	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A35R22	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R23	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R24	0683-4755	R: FXD COMP 4.7 MEG OHM 5% 1/4W
A35R25	0757-0473	R: FXD MET FLN 221K OHM 1% 1/8W
A35R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A35R27	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A35R28	0698-4302	R: FXD MET OX 100K OHM 5% 1/4W
A35R29	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A35R30	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W
A35W1	03722-772	CABLE: COAX (CODED RED/GRY)
A36	03722-730 03722-330	ASSY: OUTPUT AMPLIFIER (2)<



3722A M48

Figure 8 - 45 Attenuator assembly A38, component location



A 38 ATTENUATOR ASSEMBLY

Figure 8 - 46 Attenuator assembly A38, schematic

83722 11021

A38	03722-728	ASSY: ATTENUATOR (COMPLETE WITH OUTER SCREEN & ALL COMPONENTS PREFIXED A38 BELOW)
	03722-109	ATTENUATOR: OUTER SCREEN (SEE CHASSIS MOUNTED COMPONENTS MP41)
A38R1	0698-3760	R: FXD MET FLM 1900 OHM 1/4% 1/4W 50 PPM
A38R2	0698-3754	R: FXD MET FLM 877 OHM 1/4% 1/4W 50 PPM
A38R3	0698-3780	R: FXD MET OX 32.2 OHM 1% 1/2W 250 PPM
A38R4	0698-3758	R: FXD MET FLM 1300 OHM 1/4% 1/4W 50 PPM
A38R5	0698-4204	R: FXD MET FLM 11.75K OHM 1% 1/4W 100 PPM
A38R6	0698-3754	R: FXD MET FLM 877 OHM 1/4% 1/4W 50 PPM
A38R7	0757-1021	R: FXD MET FLM 66.5 OHM 1% 1/4W 100 PPM
A38R8	0698-5798	R: FXD MET FLM 257 OHM 1/2% 1/4W 100 PPM
A38R9	0698-3774	R: FXD MET FLM 600 OHM 1/4% 1/4W 50 PPM
A38R10	0698-3369	R: FXD MET FLM 1.4K OHM 1/4% 1/4W 100 PPM
A38R11	0698-3764	R: FXD MET FLM 5400 OHM 1/4% 1/4W 50 PPM
A38R12	0757-0715	R: FXD MET FLM 150 OHM 1% 1/4W 100 PPM
A38R13	0757-1035	R: FXD MET FLM 400 OHM 1/2% 1/4W 100 PPM
A38R14	0698-3755	R: FXD MET FLM 900 OHM 1/2% 1/4W 100 PPM
A38R15	0698-3762	R: FXD MET FLM 2400 OHM 1/2% 1/4W 50 PPM
A38R16	0757-1023	R: FXD MET FLM 6.04K OHM 1% 1/4W 100 PPM
A38R17	0757-0339	R: FXD MET FLM 3.01K OHM 1% 1/4W 100 PPM
A38R18	0757-0739	R: FXD MET FLM 2.0K OHM 1% 1/4W 100 PPM
A38R19	0698-5584	R: FXD MET FLM 1.5K OHM 1/2% 1/4W 100 PPM
A38R20	0698-3757	R: FXD MET FLM 1200 OHM 1% 1/4W 100 PPM
A38R21	0698-3145	R: FXD MET FLM 1.0K OHM 1/4% 1/4W 9 PPM
A38R22	0698-3753	R: FXD MET FLM 857 OHM 1/4% 1/4W 50 PPM
A38R23	0698-3752	R: FXD MET FLM 750 OHM 1/4% 1/4W 50 PPM
A38R24	0698-5800	R: FXD MET FLM 667 OHM 1/4% 1/4W 50 PPM
A38S1	3100-0621	SWITCH (NSR: USE COMPLETE ASSEMBLY)
A38W1	03722-760	CABLE: COAX (CODED BRN/WHT)
A38W2	03722-761	CABLE: COAX (CODED RED/BLK)
A38W3	03722-762	CABLE: COAX (CODED RED/BRN)
A38W4	03722-763	CABLE: COAX (CODED RED/RED)

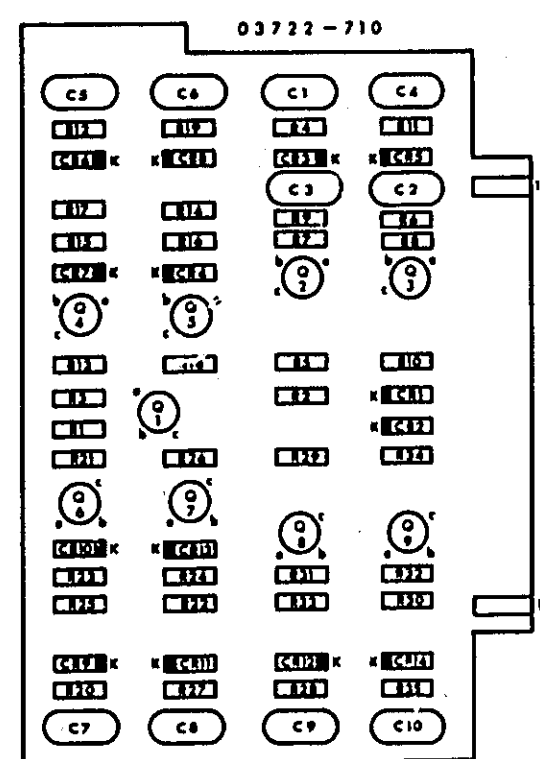


Figure 8-47 Sequence counter assembly A39, component location

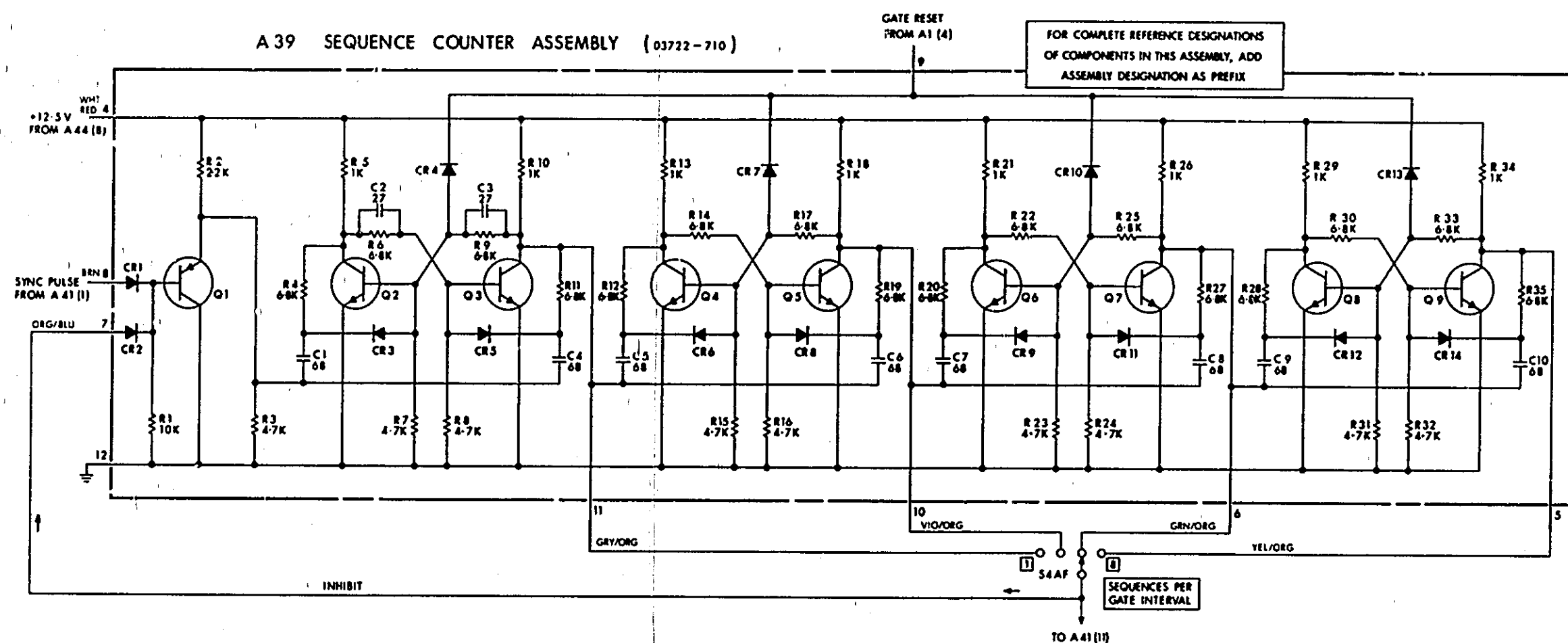
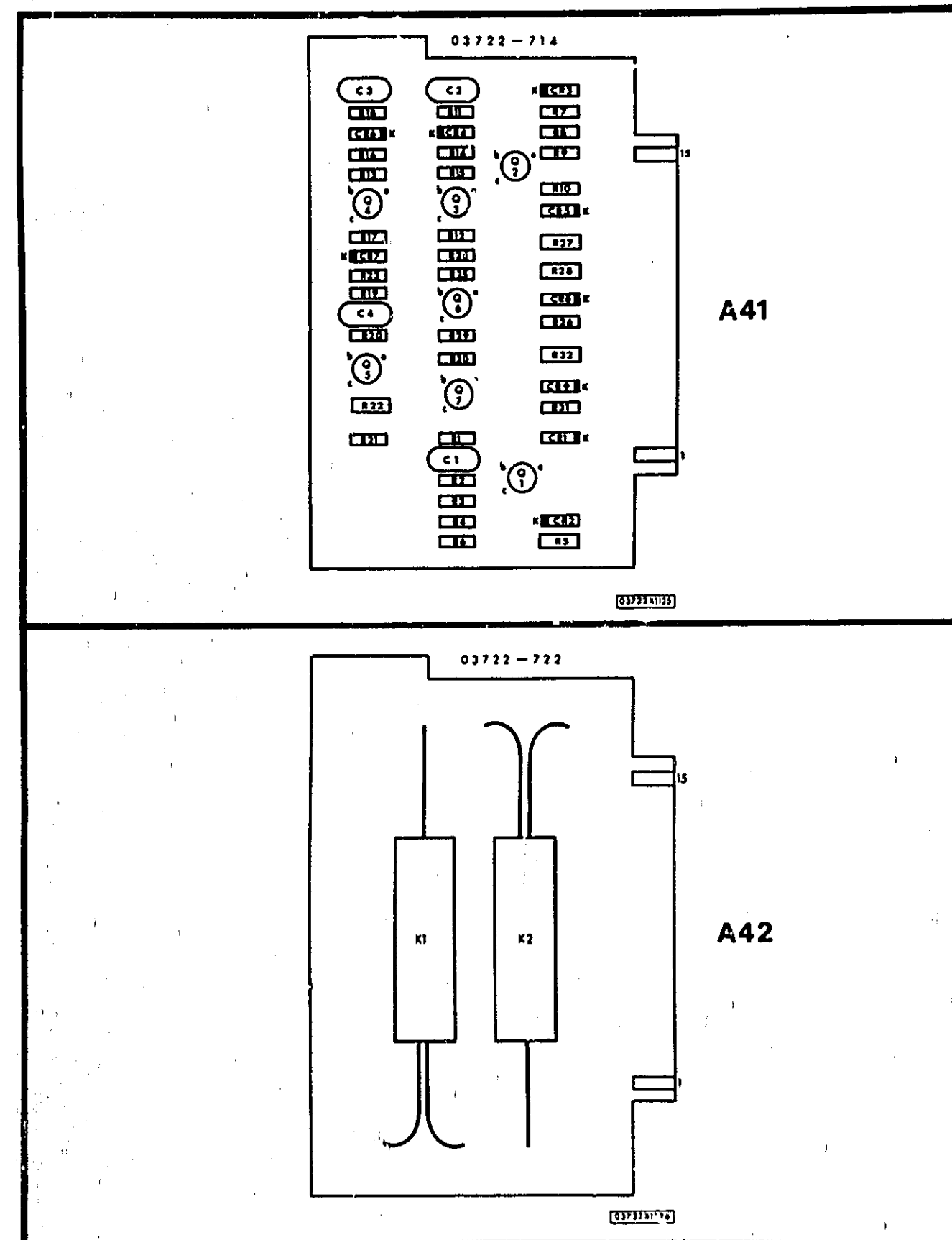


Figure 8-48 Sequence counter assembly A39, schematic

A39	03722-710	ASSY: SEQUENCE COUNTER	A39R16	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
	03722-310	BOARD: BLANK PC (NSR)	A39R17	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39C1	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R18	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A39C2	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A39R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39C3	0160-2306	C: FXD MICA 27PF 5% 300VDCW	A39R20	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39C4	0140-0192	C: FXD MICA 68PF 5% 300VDCW			
A39C5	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A39C6	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R22	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39C7	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R23	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A39C8	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R24	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A39C9	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R25	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39C10	0140-0192	C: FXD MICA 68PF 5% 300VDCW	A39R26	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A39CR1	1901-0040	DIODE: SI	A39R27	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39CR2	1901-0040	DIODE: SI	A39R28	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39CR3	1901-0040	DIODE: SI	A39R29	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A39CR4	1901-0040	DIODE: SI	A39R30	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39CR5	1901-0040	DIODE: SI			
A39CR6	1901-0040	DIODE: SI	A39R31	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A39CR7	1901-0040	DIODE: SI	A39R32	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A39CR8	1901-0040	DIODE: SI	A39R33	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39CR9	1901-0040	DIODE: SI	A39R34	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A39CR10	1901-0040	DIODE: SI	A39R35	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A39CR11	1901-0040	DIODE: SI			
A39CR12	1901-0040	DIODE: SI			
A39CR13	1901-0040	DIODE: SI			
A39CR14	1901-0040	DIODE: SI			
A39Q1	1853-0015	TRANSISTOR: SI PNP			
A39Q2	1854-0605	TRANSISTOR: SI NPN			
A39Q3	1854-0605	TRANSISTOR: SI NPN			
A39Q4	1854-0605	TRANSISTOR: SI NPN			
A39Q5	1854-0605	TRANSISTOR: SI NPN			
A39Q6	1854-0605	TRANSISTOR: SI NPN			
A39Q7	1854-0605	TRANSISTOR: SI NPN			
A39Q8	1854-0605	TRANSISTOR: SI NPN			
A39Q9	1854-0605	TRANSISTOR: SI NPN			
A39R1	0698-4278	R: FXD MET OX 10K OHM 5% 1/4W			
A39R2	0698-4282	R: FXD MET OX 2.2K OHM 5% 1/4W			
A39R3	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W			
A39R4	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W			
A39R6	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R7	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W			
A39R8	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W			
A39R9	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W			
A39R11	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R12	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R13	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W			
A39R14	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W			
A39R15	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W			



Figures 8 - 49 & 8 - 50 Gate & sync output assembly A41 and relay assembly A42, component location

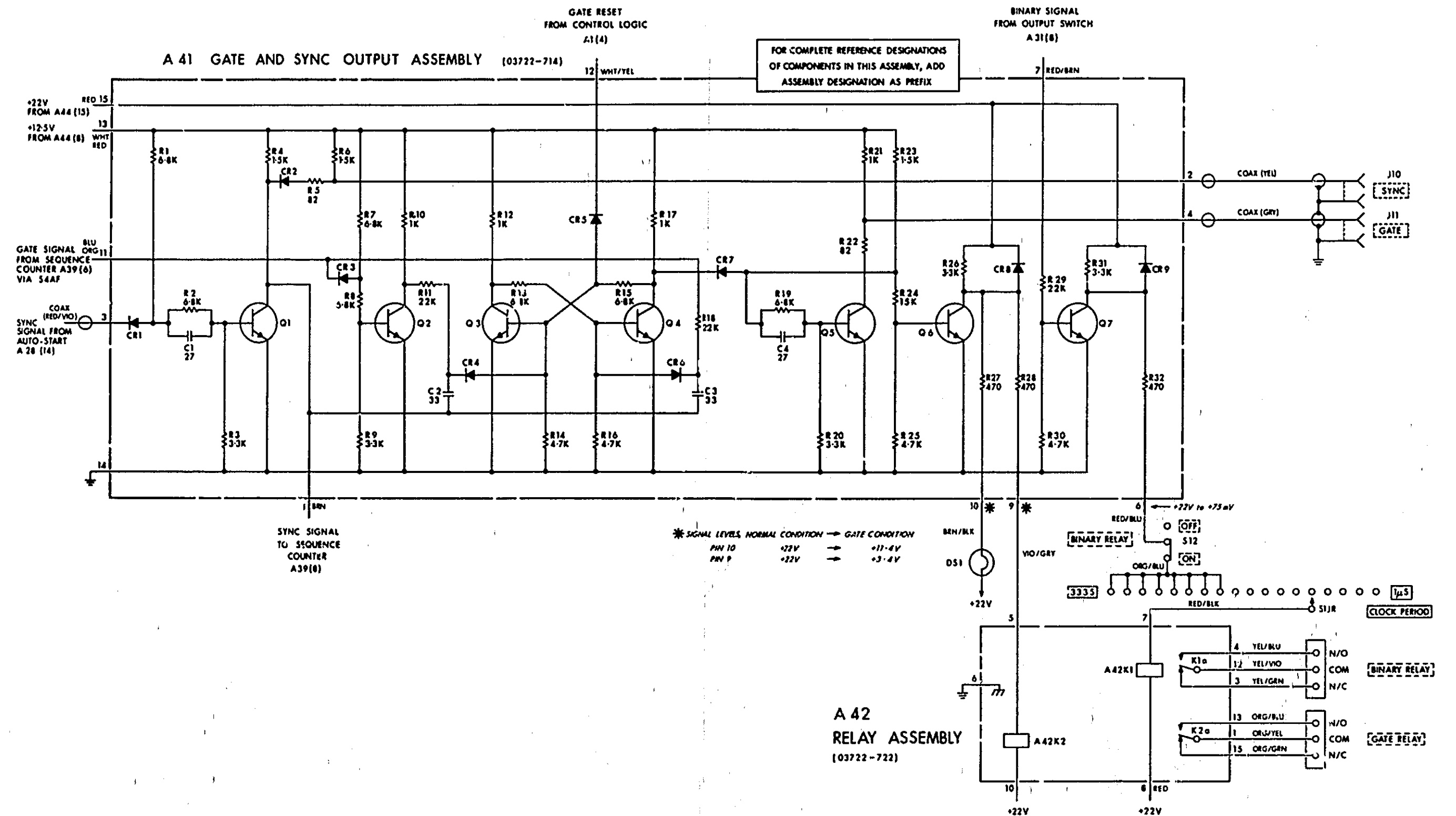
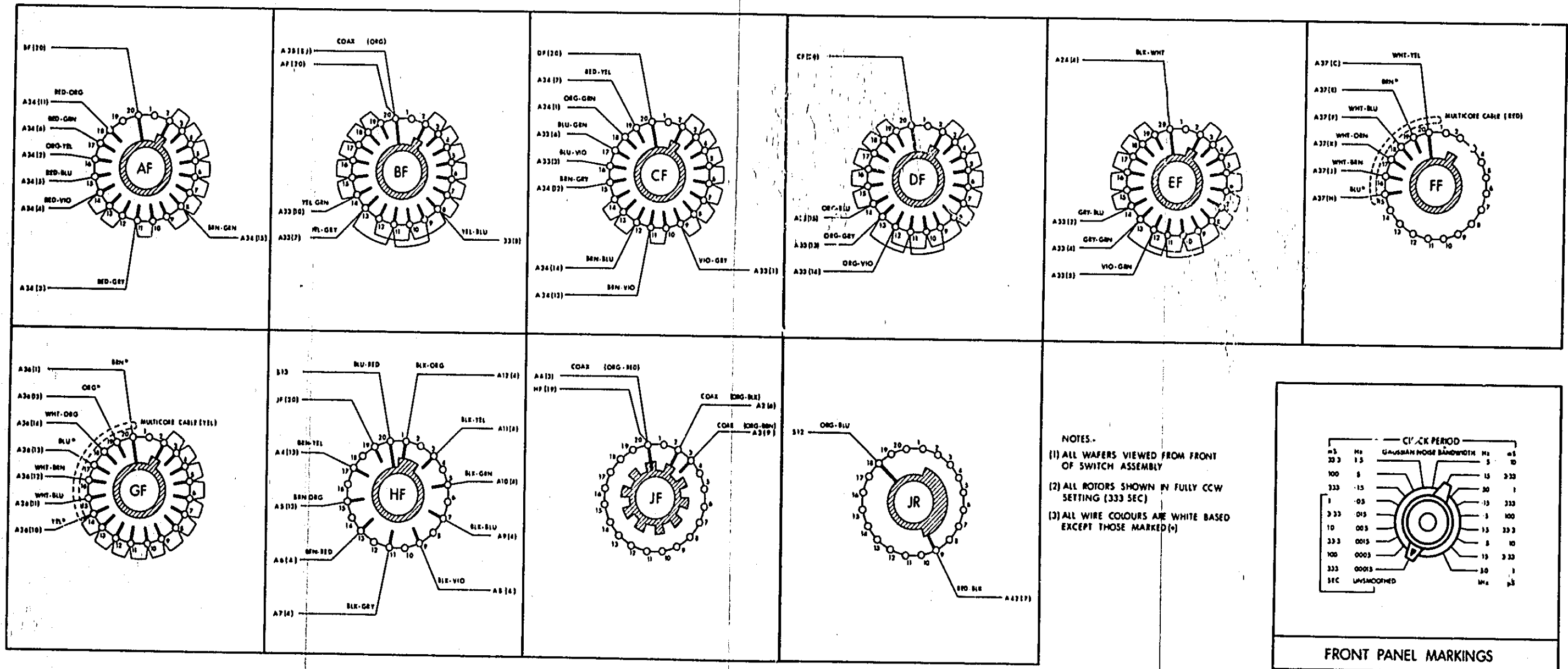
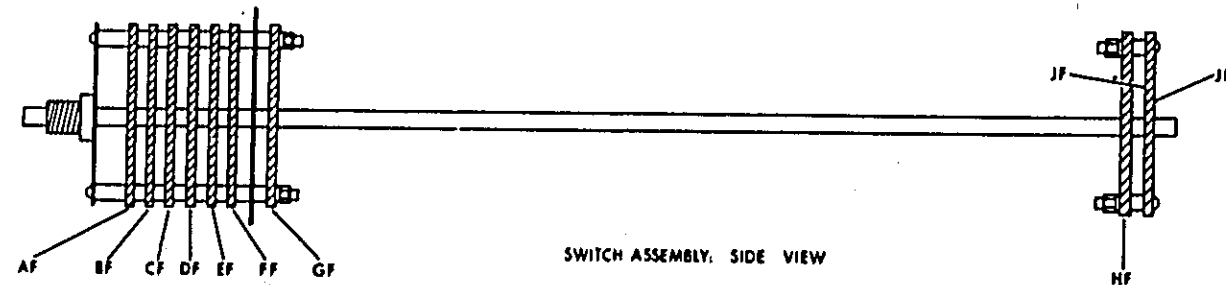
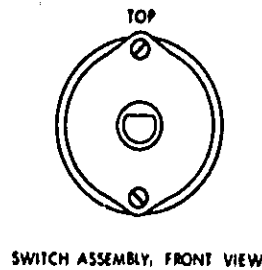


Figure 8 - 51 Gate and sync output assembly A41 & relay assembly A42, schematic

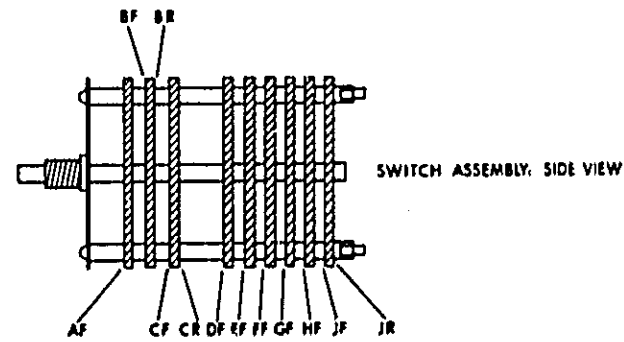
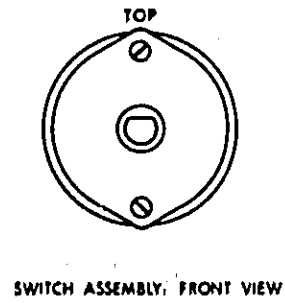
A41	03722-714 03722-314	ASSY: GATE AND SYNC OUTPUT BOARD: BLANK PC (NSR)
A41C1	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A41C2	0160-2150	C: FXD MICA 33PF 5% 300VDCW
A41C3	0160-2150	C: FXD MICA 33PF 5% 300VDCW
A41C4	0160-2306	C: FXD MICA 27PF 5% 300VDCW
A41CR1	1901-0040	DIODE: SI
A41CR2	1910-0034	DIODE: GE
A41CR3	1901-0040	DIODE: SI
A41CR4	1901-0040	DIODE: SI
A41CR5	1901-0040	DIODE: SI
A41CR6	1901-0040	DIODE: SI
A41CR7	1901-0040	DIODE: SI
A41CR8	1901-0025	DIODE: SI
A41CR9	1901-0025	DIODE: SI
A41Q1	1854-0605	TRANSISTOR: SI NPN
A41Q2	1854-0605	TRANSISTOR: SI NPN
A41Q3	1854-0605	TRANSISTOR: SI NPN
A41Q4	1854-0605	TRANSISTOR: SI NPN
A41Q5	1854-0605	TRANSISTOR: SI NPN
A41Q6	1854-0071	TRANSISTOR: SI NPN
A41Q7	1854-0071	TRANSISTOR: SI NPN
A41R1	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R2	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R3	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A41R4	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A41R5	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W
A41R6	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A41R7	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R8	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R9	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A41R10	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A41R11	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A41R12	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A41R13	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R14	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A41R15	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R16	0398-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A41R17	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A41R18	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A41R19	0698-4274	R: FXD MET OX 6.8K OHM 5% 1/4W
A41R20	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A41R21	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A41R22	0758-0026	R: FXD MET FLM 82 OHM 5% 1/2W
A41R23	0698-4258	R: FXD MET OX 1.5K OHM 5% 1/4W
A41R24	0698-4282	R: FXD MET OX 15K OHM 5% 1/4W
A41R25	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A41R26	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A41R27	0758-0029	R: FXD MET FLM 470 OHM 5% 1/2W
A41R28	0758-0029	R: FXD MET FLM 470 OHM 5% 1/2W
A41R29	0698-4286	R: FXD MET OX 22K OHM 5% 1/4W
A41R30	0698-4270	R: FXD MET OX 4.7K OHM 5% 1/4W
A41R31	0698-4266	R: FXD MET OX 3.3K OHM 5% 1/4W
A41R32	0758-0029	R: FXD MET FLM 470 OHM 5% 1/4W

A42	03722-722 03722-322	ASSY: RELAY BOARD: BLANK PC (NSR)
A42K1	9161-0013	RELAY: COIL
A42K2	9161-0013	RELAY: COIL
A42K1A	0490-0604	RELAY: REED
A42K2A	0490-0604	RELAY: REED
A42MP1	0340-0039	FEEDTHROUGH: TEFLON
A42MP2	0340-0039	FEEDTHROUGH: TEFLON
A42MP3	0340-0039	FEEDTHROUGH: TEFLON
A42MP4	0340-0039	FEEDTHROUGH: TEFLON
A42MP5	0340-0039	FEEDTHROUGH: TEFLON
A42MP6	0340-0039	FEEDTHROUGH: TEFLON
A42MP7	0340-0059	TERMINAL POST: BRASS
A42MP8	0340-0059	TERMINAL POST: BRASS
A42MP9	0340-0059	TERMINAL POST: BRASS
A42MP10	0340-0059	TERMINAL POST: BRASS
A42MP11	0340-0059	TERMINAL POST: BRASS
A42MP12	0340-0059	TERMINAL POST: BRASS

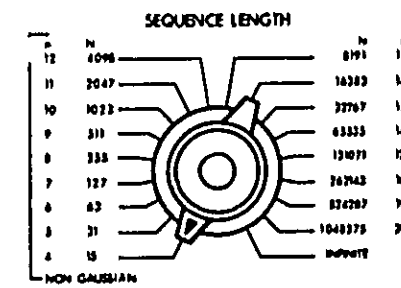


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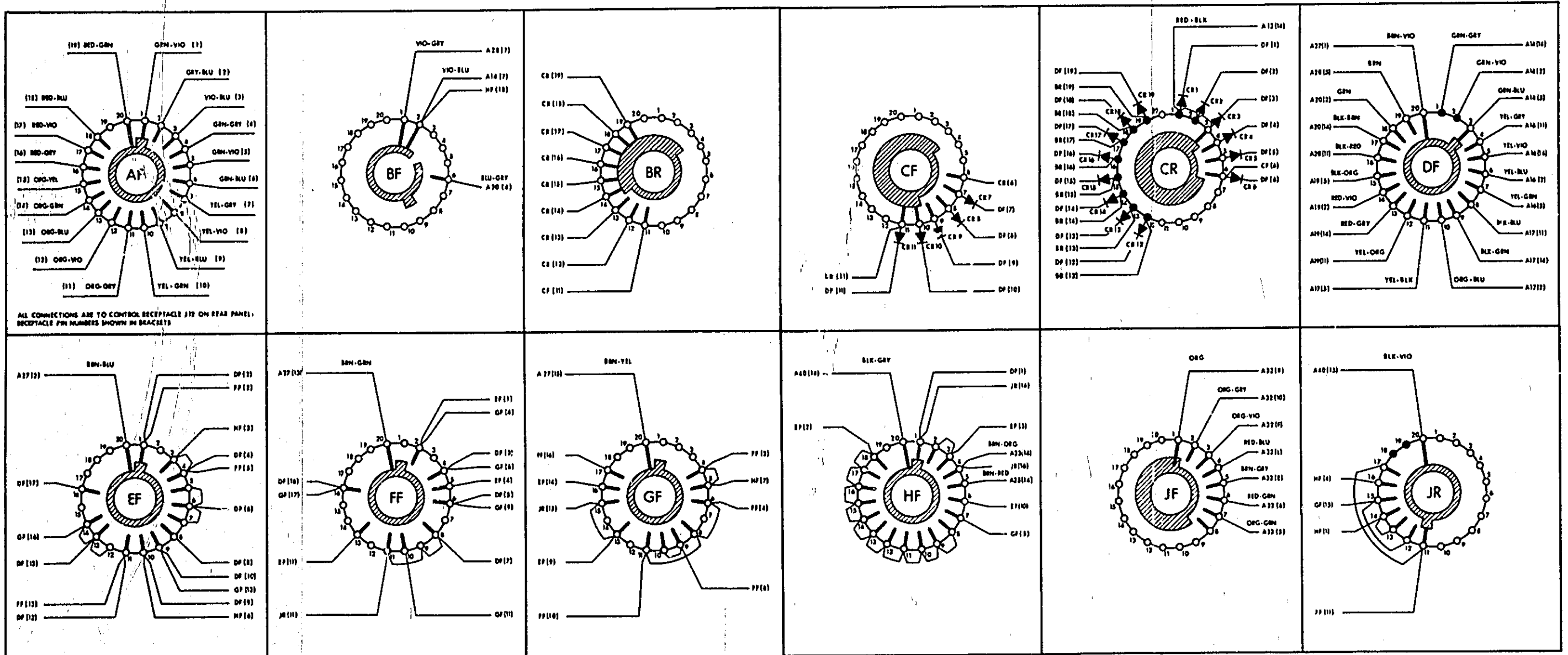
Figure 8 - 52 Clock period switch S1



- NOTES:
- (1) ALL WAFERS VIEWED FROM FRONT OF SWITCH ASSEMBLY
 - (2) ALL ROTORS SHOWN IN FULLY CCW SETTING (N=4, N+15)

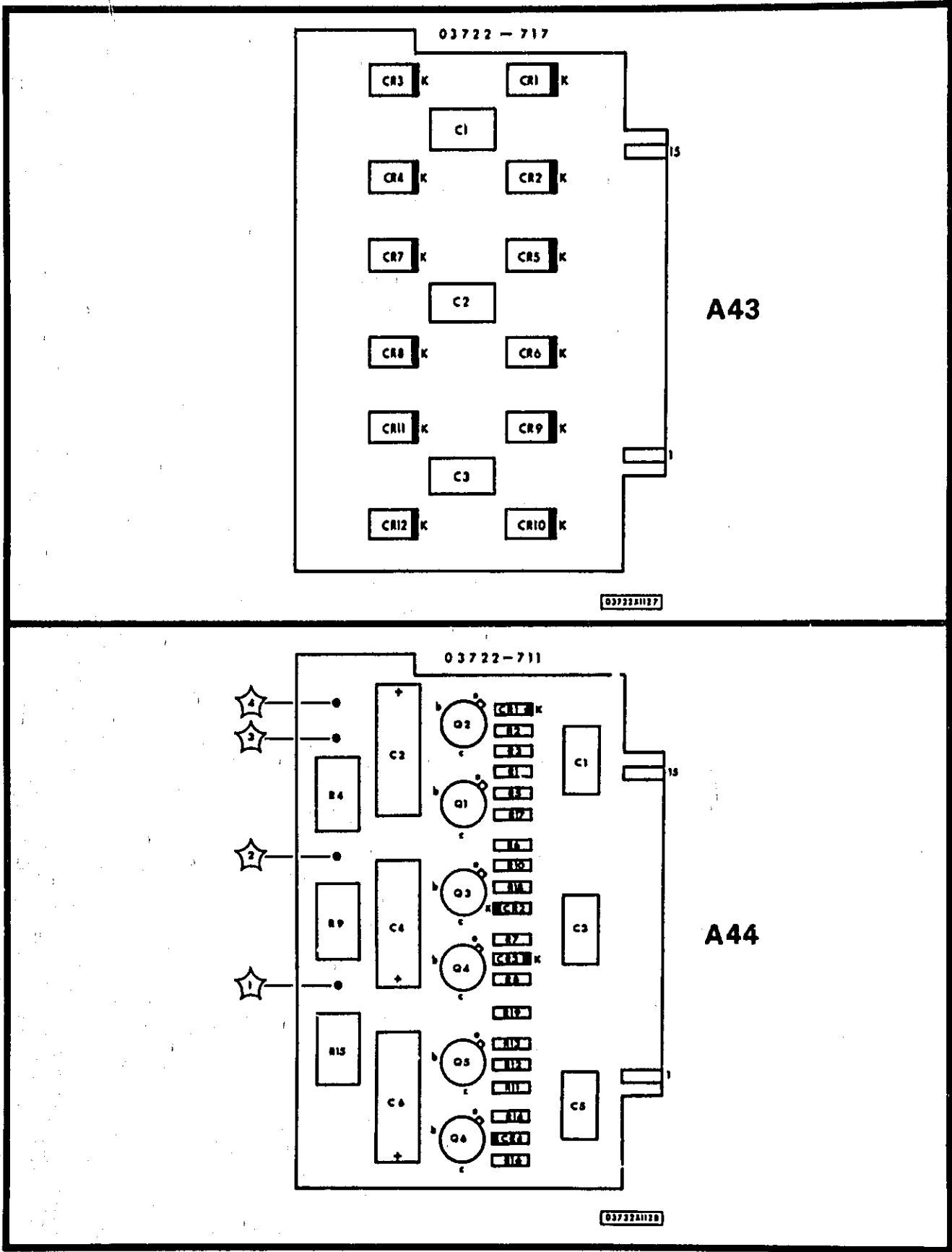


FRONT PANEL MARKINGS

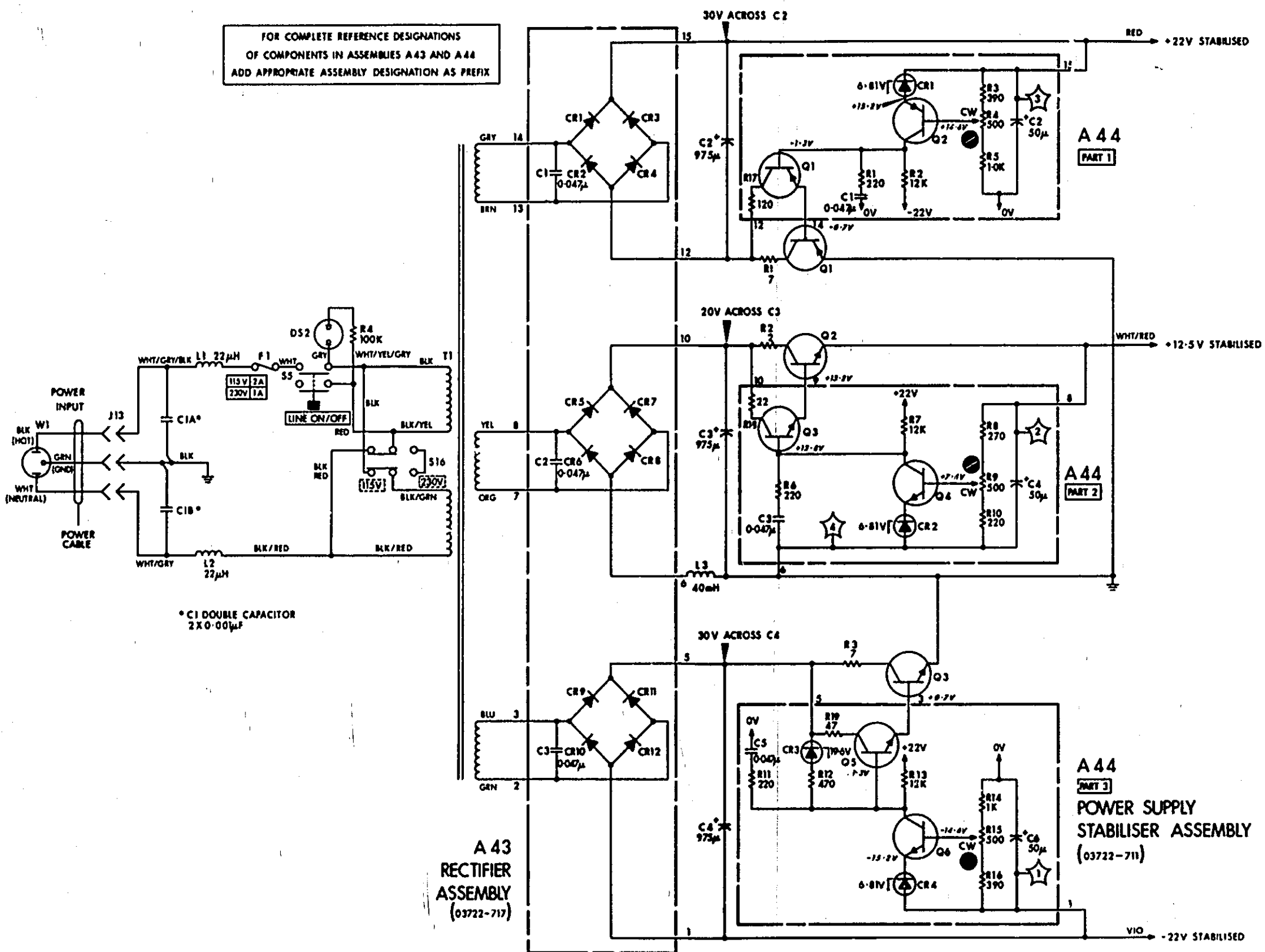


0372231011

Figure 8 - 53 Sequence length switch S2



Figures 8 - 54 & 8 - 55 Rectifier assembly A43 and power supply stabiliser assembly A44, component location



POWER SUPPLY PIN CONNECTIONS ON ASSEMBLIES

ASSY	-22V A44(1)	+12-5V A44(8)	+22V A44(15)
A1	—	9	—
A2	14	—	—
A3	14	—	—
A4,5	14	—	—
A6-12	14	—	—
A13	2	15	—
A14	—	15	—
A15	—	—	—
A16,17	—	15	—
A18	—	—	—
A19,20	—	15	—
A21	—	—	—
A22,23	—	15	—
A24	—	—	—
A25	—	15	—
A27	—	9	—
A28	—	9	—
A29	-22V	—	+22V
A30	—	6	—
A31	1	10	15
A32	1	—	15
A33	—	—	—
A34	—	—	—
A35	STABILISED SUPPLIES FROM A37		
A36	—	—	—
A37	8	—	1
A39	—	4	—
A40	—	9	—
A41	—	13	15
A42	—	—	8&10
VIO WHT RED RED			

Figure 8 - 56 Rectifier assembly A43 & power supply assembly A44, schematic

A43	03722-717 03722-317	ASSY: RECTIFIER BOARD: BLANK PC (NSR)
A43C1	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A43C2	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A43C3	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A43CR1	1901-0045	DIODE: SI 100PIV 0.75A
A43CR2	1901-0045	DIODE: SI 100PIV 0.75A
A43CR3	1901-0045	DIODE: SI 100PIV 0.75A
A43CR4	1901-0045	DIODE: SI 100PIV 0.75A
A43CR5	1901-0045	DIODE: SI 100PIV 0.75A
A43CR6	1901-0045	DIODE: SI 100PIV 0.75A
A43CR7	1901-0045	DIODE: SI 100PIV 0.75A
A43CR8	1901-0045	DIODE: SI 100PIV 0.75A
A43CR9	1901-0045	DIODE: SI 100PIV 0.75A
A43CR10	1901-0045	DIODE: SI 100PIV 0.75A
A43CR11	1901-0045	DIODE: SI 100PIV 0.75A
A43CR12	1901-0045	DIODE: SI 100PIV 0.75A

A44	03722-711 03722-311	ASSY: POWER SUPPLY STABILISER BOARD: BLANK PC (NSR)
A44C1	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A44C2	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW
A44C3	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A44C4	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW
A44C5	0170-0040	C: FXD MY 0.047UF 10% 200VDCW
A44C6	0180-0141	C: FXD AL 50UF -10%+75% 50VDCW
A44CR1	1902-0017	DIODE: BREAKDOWN 6.81V 400mW
A44CR2	1902-0017	DIODE: BREAKDOWN 6.81V 400mW
A44CR3	1902-3234	DIODE: BREAKDOWN 19.6V 400mW
A44CR4	1902-0017	DIODE: BREAKDOWN 6.81V 400mW
A44Q1	1853-0001	TRANSISTOR: SI PNP
A44Q2	1853-0001	TRANSISTOR: SI PNP
A44Q3	1854-0003	TRANSISTOR: SI NPN
A44Q4	1854-0003	TRANSISTOR: SI NPN
A44Q5	1854-0003	TRANSISTOR: SI NPN
A44Q6	1854-0003	TRANSISTOR: SI NPN
A44R1	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A44R2	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W
A44R3	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W
A44R4	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A44R5	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A44R6	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A44R7	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W
A44R8	0698-4241	R: FXD MET OX 270 OHM 5% 1/4W
A44R9	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A44R10	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A44R11	0698-4239	R: FXD MET OX 220 OHM 5% 1/4W
A44R12	0698-4246	R: FXD MET OX 470 OHM 5% 1/4W
A44R13	0698-4280	R: FXD MET OX 12K OHM 5% 1/4W
A44R14	0698-4254	R: FXD MET OX 1.0K OHM 5% 1/4W
A44R15	2100-1757	R: VAR WW LIN 500 OHM 10% 1/2W
A44R16	0698-4245	R: FXD MET OX 390 OHM 5% 1/4W
A44R17	0698-4233	R: FXD MET OX 120 OHM 5% 1/4W
A44R18	0698-3799	R: FXD MET OX 22 OHM 5% 1/4W
A44R19	0698-5707	R: FXD MET OX 47 OHM 5% 1/4W
A44TP1	0360-0124	TERMINAL PIN
A44TP2	0360-0124	TERMINAL PIN
A44TP3	0360-0124	TERMINAL PIN
A44TP4	0360-0124	TERMINAL PIN

APPENDIX A MANUAL CHANGES

This manual applies directly to instruments with Serial Prefix numbers U801. This appendix gives back-dating and updating information which makes the manual applicable to instruments with Serial Prefix numbers below and above U801. Make all alterations in this manual according to the Errata below. Also check the following table for your instrument Serial Prefix and/or Serial Number and make any listed change/s in the manual.

Serial Prefix and/ or Number	Change
U717-00110 and below	1 thru 3
U717-00156 and below	2 thru 3
U801-00160 and below	3
U801-00171 and above	4
U820-00201 and above	4 thru 5
U830-00301 and above	4 thru 6
U850 and above	4 thru 7

Serial Prefix and/ or Number	Change
U850-00452 and above	4 thru 8
U901 and above	4 thru 9
U943/U950 and above	4 thru 10
U968 and above	4 thru 11
U968-00598 and above	4 thru 12
U968-00611 and above	4 thru 13

ERRATA

Page 1-3 Specifications

Change INTERNAL CLOCK OUTPUT to read "approx +1V to approx +12.5V"
SECONDARY OUTPUTS SYNC to read "Negative going pulse (approx +12V to approx +1.5V)"

Page 4-17 Paragraph 4-57

Change . . . "When A13Q5 is switched on (coincident . . ." to read "When A13Q3 is switched on (coincident . . ."

Page 4-23 Paragraph 4-76

Change . . . "The alternative feedback path . . . into circuit by A31Q5" to read . . . "The alternative feedback path . . . into circuit by A31Q4"

Page 5-24 Table 5-3

Change 4) to read ". . . The waveform should be rectangular, and should switch between approx +1V and approx +12.5V"

Page 5-33, 5-34 Table 5-5

Replace these two pages with the updated ones at the end of this appendix.

Section VI Replaceable Parts

Change A33C4 to Part No 0160-0634

A4R37 to Part No 0698-6745

A37R16 and A38R9 to Part No 0698-6261

A44R18 to Part No 0698-6745

Delete Part No 03722-746 ASSY: SEQUENCE LENGTH SWITCH (Part of S2)

CHANGE 1

Section VIII Schematics

Page 8-8 Figure 8-7

Delete From A1(1) BLK/GRY jumper "300Hz/100Hz STROBE SIGNAL FROM A7(5)"

Add To A1(1) Coax RED/WHT "1MHz STROBE SIGNAL FROM A3(13)"

Page 8-10 Figure 8-10

Delete From A3(13) "NC"

Add To A3(13) Coax RED/WHT "1MHz STROBE SIGNAL TO CONTROL LOGIC A1(1)"

Page 8-12 Figure 8-14

Delete From A7(5) BLK/GRY jumper "300Hz/100Hz STROBE TO A1(1)"

- CHANGE 2** Section VI Replaceable Parts
 Change DS2 to Part No 2140-0022 LAMP: NEON (Line ON/OFF)
 5040-0234 LAMP HOLDER (DS2)
 5040-0235 RETAINER (DS2)
 MP3 to Part No 03722-102 DUMMY FRONT PANEL
 S6 to S9 to S5 to S9 Part No 03722-369 ASSY: 5 PUSH BUTTON SWITCHES
 Add MP33 Part No 5000-3394 LABEL: LINE ON/OFF (S5)
- CHANGE 3** Section VIII Schematics
 Page 8-23 Figure 8-37
 Add To A32(J) a WHT/RED/ORG jumper to SEQUENCE LENGTH switch S2JF(8)
 Page 8-34 Figure 8-53
 Add To S2JF(8) a WHT/RED/ORG jumper "TO REFERENCE POWER SUPPLY A32(J)"
- CHANGE 4** Section VI Replaceable Parts
 Change A32Q9, A32Q11, A32Q13 to Part No 1853-0036 TRANSISTOR: SI PNP
- CHANGE 5** Section VI Replaceable Parts
 Change A3C1, C4, C8, } to Part No 0160-0182 C: FXD MICA 47PF 5% 300VDCW
 A4C7 and A5C7 }
- CHANGE 6** Section VI Replaceable Parts
 Change R8 to Part No 0698-3473 R: FXD 5620 OHM 1% 1/4W
- CHANGE 7** Section VI Replaceable Parts
 Change A44CR2 to Part No 1902-0052 DIODE: BREAKDOWN 6.81V 2% 400mW
 A44R8 to Part No 0698-3444 R: FXD FLM 316 OHM 1% 1/8W
 A44R9 to Part No 2100-1754 R: VAR WW LIN 50 OHM 10% 1/2W
 A44R10 to Part No 0757-0415 R: FXD FLM 475 OHM 1% 1/8W
 L3 to Part No 9100-2830 INDUCTOR 40MH
- CHANGE 8** Section VI Replaceable Parts and Section VIII Schematics
 Change the following transistors to Part No 1854-0019 TRANSISTOR: SI NPN
 A1Q1, 2, 3, 4, 5 A27Q1, 2, 3, 4, 5, 6, 7, 8, 9
 A2Q1 A28Q1, 2, 3, 4, 5, 6, 7
 A3Q1 A29Q2
 A13Q1, 2, 4, 5 A30Q1, 2, 3, 4, 5, 6, 7
 A14Q1, 2, 3, 4, 5, 6, 7, 8 A31Q5
 A15Q2, 4, 6, 8, 10, 12, 14 A39Q2, 3, 4, 5, 6, 7, 8, 9
 A18Q2, 4, 6, 8, 10, 12, 14, 16 A40Q1, 2, 3, 4, 5, 6, 7, 8, 9
 A21Q2, 4, 6, 8, 10, 12, 14, 16 A41Q1, 2, 3, 4, 5
 A24Q4, 6, 8, 10, 12, 14, 16
 Change C1 to Part No 0160-2657 C: FXD CER 2x0.001UF 1000VDCW
 A2C6 to Part No 0140-0149 C: FXD 470PF 5%
 A30R3 to Part No 0698-4238 R: FXD FLM 200 OHM 5% 1/4W
- CHANGE 9** Page 6-2, 6-3 Table 6-1 and Page 8-8 Figure 8-7
 Replace these pages with the updated ones at the end of this appendix.
- CHANGE 10** Section VI Replaceable Parts and Section VIII Schematics
 Change A32Q3, 5 to Part No 5080-3505 TRANSISTOR: SI PNP (MATCHED PAIR)
 S5 to Part No 3101-1248 SWITCH: PUSH BUTTON
 S16 to Part No 3101-1234 SWITCH: SLIDE
 W1 to Part No 8120-1351 CABLE: POWER
 Page 8-35 Figure 8-56 Alter the Power Supply input wiring as shown in Figure A-1
 Page 1-4 Specifications
 Change "POWER REQUIREMENT" to read "115 or 230V $\pm 10\%$ 48 to 440Hz, 70W"

CHANGE 11 Section VI Replaceable Parts and Section VIII Schematics

Change the following capacitors to Part No 0140-0202 C: FXD MICA 15PF 5% 500VDCW

A15C1 through C14

A21C1 through C16

A18C1 through C16

A24C3 through C16

Add C5 through C8 Part No 0150-0121 C: FXD 0.1UF between pins 12 and 15 of XA15, XA18, XA21 and XA24

CHANGE 12 Section VI Replaceable Parts and Section VIII Schematics

Change the following capacitors to Part No 0160-2197 C: FXD MICA 10PF 5% 300VDCW

A15C1 through C14

A21C1 through C16

A18C1 through C16

A24C3 through C16

CHANGE 13 Section VI Replaceable Parts

Change A32R13 to Part No 2100-1761 R: VAR W W LIN 10K OHM 5% 1W

A32R25 to Part No 2100-1758 R: VAR W W LIN 1.0K OHM 5% 1W

C1 to Part No 0160-3561 C: FXD 2x0.001UF 1000VDCW

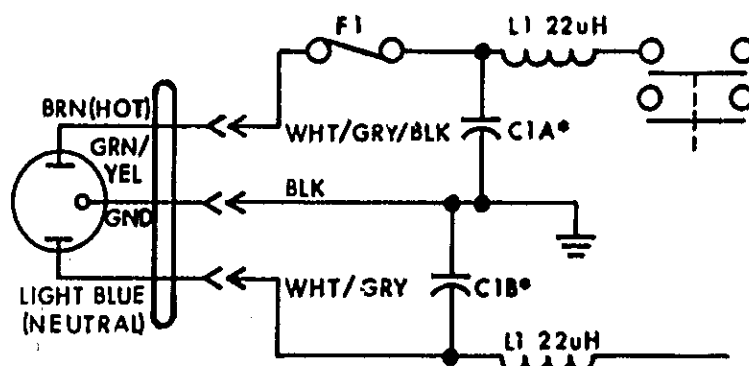


Figure A-1

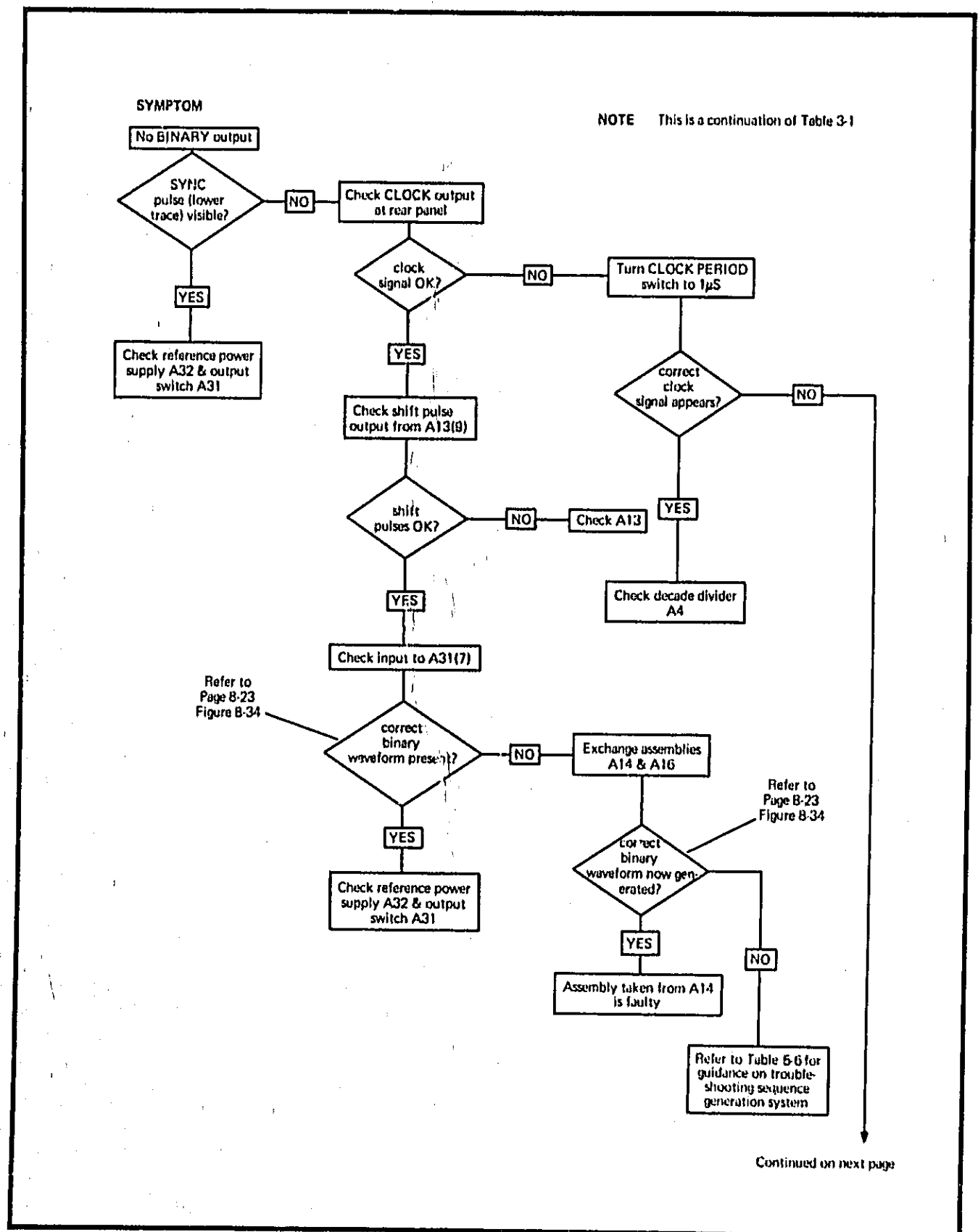


Table 5-5 Troubleshooting BINARY system

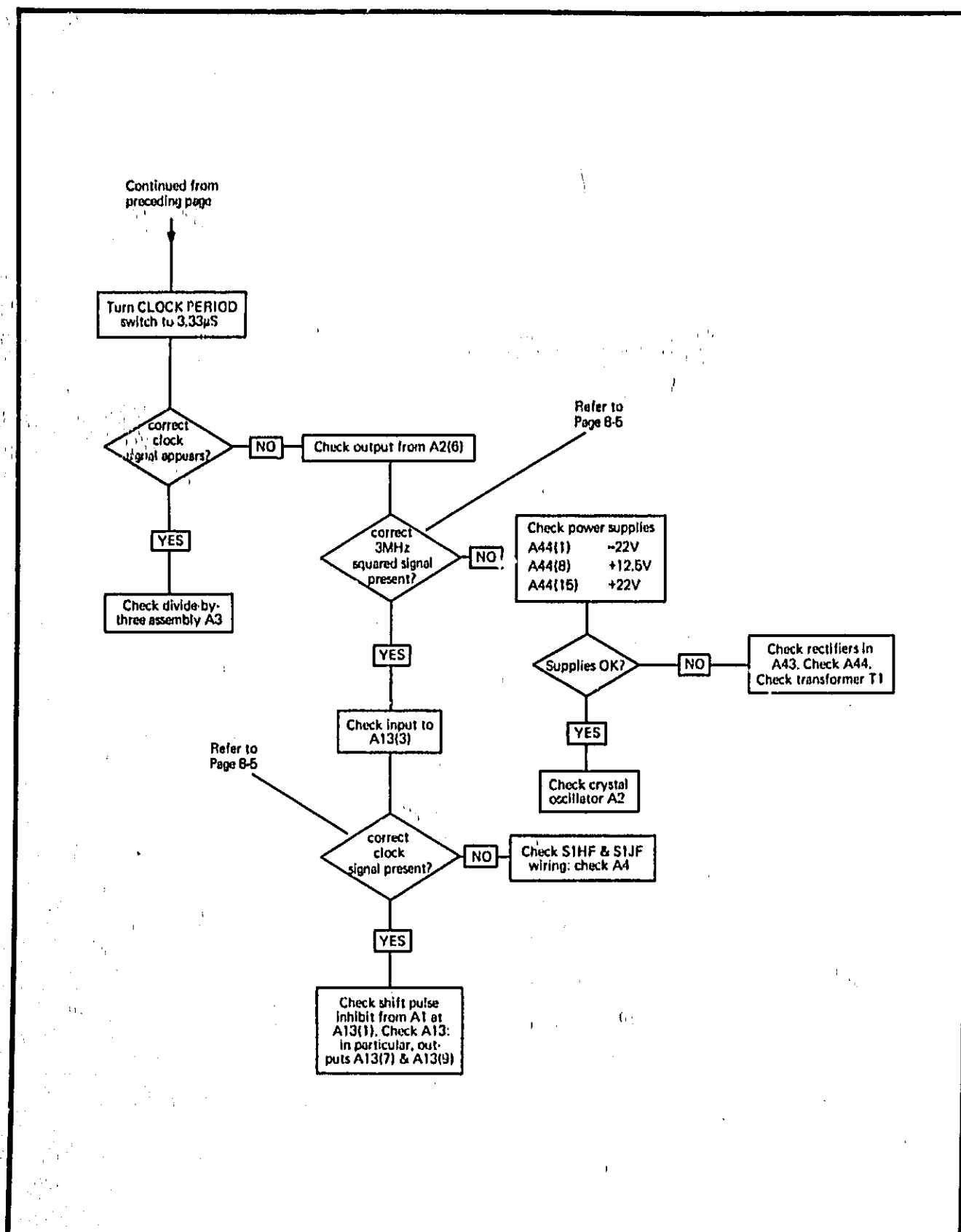


Table 5-5 (continued)

Table 6-1 Reference designation index

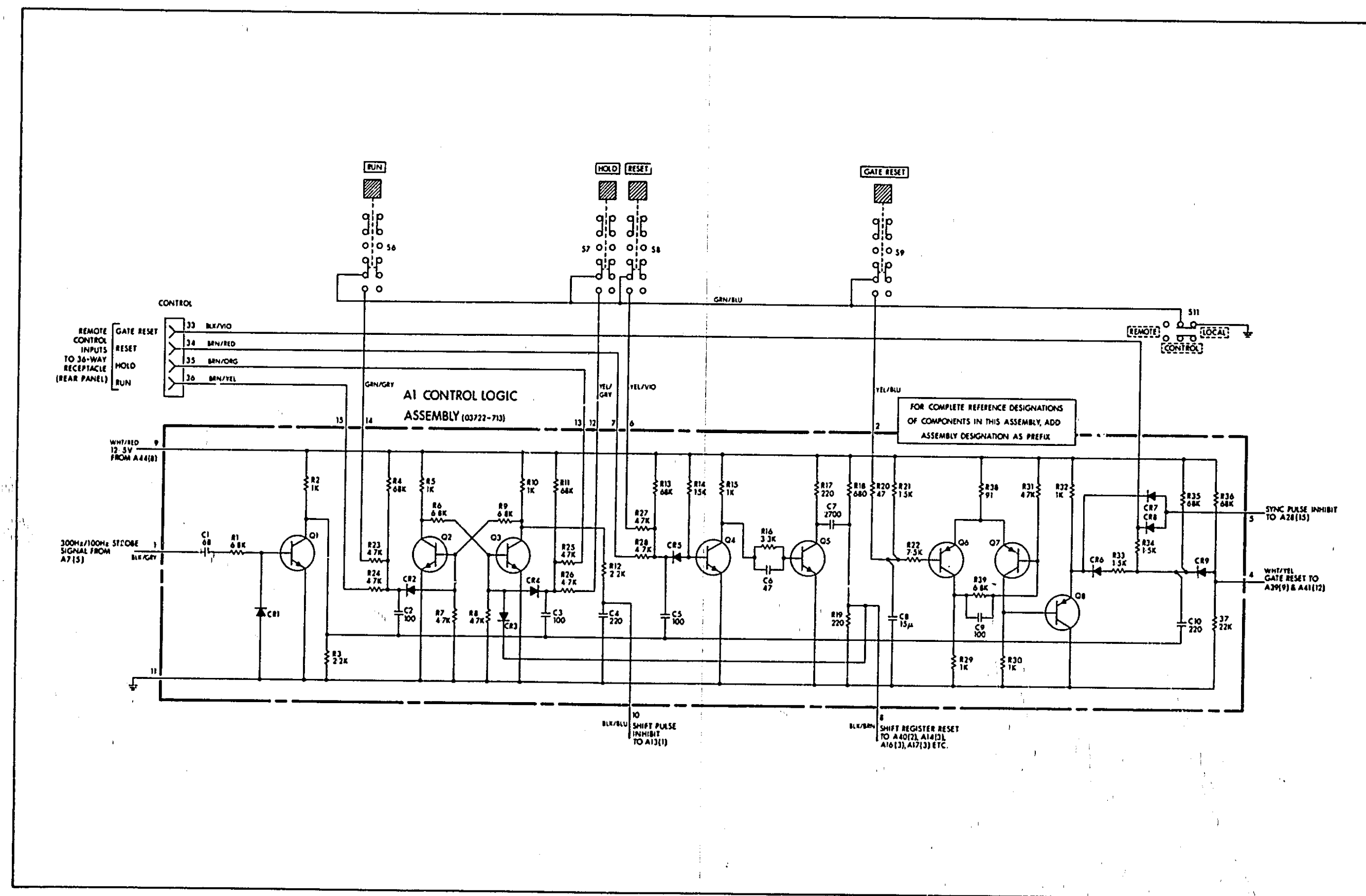
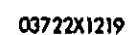
Reference Designation	hp Part No	Description
A1	03722-713 03722-313	ASSY: CONTROL LOGIC BOARD: BLANK PC (NSR)
A1C1	0140-0192	C: FXD MICA 68PF 5% 300VDCW
A1C2	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C3	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C4	0160-0134	C: FXD MICA 220PF 5% 300VDCW
A1C5	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C6	0140-0204	C: FXD MICA 47PF 500VDCW
A1C7	0160-0300	C: FXD MY 2700PF 10% 200VDCW
A1C8	0180-1746	C: FXD TANT 15UF 20VDCW
A1C9	0160-2204	C: FXD MICA 100PF 5% 300VDCW
A1C10	0160-0134	C: FXD MICA 220PF 5% 300VDCW
A1CR1	1901-0040	DIODE: SI
A1CR2	1901-0040	DIODE: SI
A1CR3	1901-0040	DIODE: SI
A1CR4	1901-0040	DIODE: SI
A1CR5	1901-0040	DIODE: SI
A1CR6	1901-0040	DIODE: SI
A1CR7	1910-0034	DIODE: GE
A1CR8	1910-0034	DIODE: GE
A1CR9	1901-0040	DIODE: SI
A1Q1	1854-0019	TRANSISTOR: SI NPN
A1Q2	1854-0019	TRANSISTOR: SI NPN
A1Q3	1854-0019	TRANSISTOR: SI NPN
A1Q4	1854-0019	TRANSISTOR: SI NPN
A1Q5	1854-0019	TRANSISTOR: SI NPN
A1Q6	1853-0036	TRANSISTOR: SI PNP
A1Q7	1853-0036	TRANSISTOR: SI PNP
A1Q8	1853-0036	TRANSISTOR: SI PNP
A1R1	0698-4274	R: FXD MET OX 6.8K OHM 5% $\frac{1}{2}$ W
A1R2	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R3	0698-4262	R: FXD MET OX 2.2K OHM 5% $\frac{1}{2}$ W
A1R4	0698-4298	R: FXD MET OX 68K OHM 5% $\frac{1}{2}$ W
A1R5	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R6	0698-4274	R: FXD MET OX 6.8K OHM 5% $\frac{1}{2}$ W
A1R7	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R8	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R9	0698-4274	R: FXD MET OX 6.8K OHM 5% $\frac{1}{2}$ W
A1R10	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R11	0698-4298	R: FXD MET OX 68K OHM 5% $\frac{1}{2}$ W
A1R12	0698-4262	R: FXD MET OX 2.2K OHM 5% $\frac{1}{2}$ W
A1R13	0698-4298	R: FXD MET OX 68K OHM 5% $\frac{1}{2}$ W
A1R14	0698-4282	R: FXD MET OX 15K OHM 5% $\frac{1}{2}$ W
A1R15	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W

Abbreviations listed in introduction: to this section

Table 6-1 Reference designation index (continued)

Reference Designation	h/ Part No	Description
A1R16	0698-4266	R: FXD MET OX 3.3K OHM 5% $\frac{1}{2}$ W
A1R17	0758-0015	R: FXD MET OX 220 OHM 5% $\frac{1}{2}$ W
A1R17	0758-0015	R: FXD MET OX 220 OHM 5% $\frac{1}{2}$ W
A1R18	0698-4250	R: FXD MET OX 680 OHM 5% $\frac{1}{2}$ W
A1R19	0698-4239	R: FXD MET OX 220 OHM 5% $\frac{1}{2}$ W
A1R20	0698-5707	R: FXD MET OX 47 OHM 5% $\frac{1}{2}$ W
A1R21	0698-4258	R: FXD MET OX 1.5K OHM 5% $\frac{1}{2}$ W
A1R22	0698-4275	R: FXD MET OX 7.5K OHM 5% $\frac{1}{2}$ W
A1R23	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R24	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R25	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R26	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R27	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R28	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R29	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R30	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R31	0698-4270	R: FXD MET OX 4.7K OHM 5% $\frac{1}{2}$ W
A1R32	0698-4254	R: FXD MET OX 1.0K OHM 5% $\frac{1}{2}$ W
A1R33	0698-4258	R: FXD MET OX 1.5K OHM 5% $\frac{1}{2}$ W
A1R34	0698-4258	R: FXD MET OX 1.5K OHM 5% $\frac{1}{2}$ W
A1R35	0698-4298	R: FXD MET OX 68K OHM 5% $\frac{1}{2}$ W
A1R36	0698-4298	R: FXD MET OX 68K OHM 5% $\frac{1}{2}$ W
A1R37	0698-4286	R: FXD MET OX 22K OHM 5% $\frac{1}{2}$ W
A1R38	0698-4231	R: FXD MET OX 91 OHM 5% $\frac{1}{2}$ W
A1R39	0698-4274	R: FXD MET OX 6.8K OHM 5% $\frac{1}{2}$ W
A2	03722-715 03722-315	ASSY: CRYSTAL OSCILLATOR BOARD: BLANK PC (NSR)
A2C1	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A1C2	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A2C3	0121-0105	C: VAR CER 9-35PF
A2C4	0160-2197	C: FXD MICA 10PF 5% 300VDCW
A2C5	0150-0086	C: FXD CER 4700PF 20% 500VDCW
A2C6	0140-0149	C: FXD MICA 470PF 5% 500VDCW
A2C7	0150-0121	C: FXD CER 0.1UF -20%+80% 50VDCW
A2C8	0160-0179	C: FXD MICA 33PF 5% 300VDCW
A2C9	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A2C10	0140-0204	C: FXD MICA 47PF 5% 500VDCW
A2CR1	1901-0040	DIODE: SI
A2L1	9100-1633	L: FXD COIL 68UH 5%
A2MP1	0380-0509	BEAD: GLASS
A2MP2	0380-0509	BEAD: GLASS

Abbreviations listed in introduction to this section



MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: 3722A
Date Printed: March 1971
Part Number: C3722-95002

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
1101U	14	1428U-01196	14-25
1133U	14-15	1451U-01206	14-26
1133U-00806	14-16	1523U	14-27
1133U-00821	14-17	1523U-01286	14-28
1133U-01406	14-18	1640U	14-29
1133U-01096	14-19	1703U	14-30
1133U-01106	14-20	1722U	14-31
1133U-01116	14-21		
1133U-01136	14-22		
1428U	14-23		
1428U-01176	14-24		

* NEW ITEM

ERRATA

Page 1-0, Figure 1-1:
Delete Rack Mounting Kit.

Page 1-3, Under Specifications:
In OUTPUT and GATE, change +12.5V to read +12V.
In SYNC, change +1.5V to read +1V.

Page 1-4, Under Accessories Furnished:
Delete Rack Mounting Kit.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of the supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement or the model number and print date from the title page of the manual.

ERRATA (Cont'd):

Page 2-2, Paragraph 2-18:

Change to read:- "A Rack Mounting Kit is available to install the instrument in a 19-inch rack. Rack Mounting Kits may be obtained through your nearest Hewlett-Packard Office by ordering HP Part Number 5060-8740".

Page 5-12/13/14:

Change to:

(b) MEAN RECTIFIED AMPLITUDE MEASUREMENT.

- 1) As shown in Figure 5-8, connect the GAUSSIAN output from the 3722A via a 600 Ω load to the digital voltmeter input of a 5328A Universal Counter, Option 020 or 021.
- 2) Couple the SYNC output from the 3722A to INPUT A of the 5328A.
- 3) Set the 5328A controls as follows:

FUNCTION to DVM, A>B: this is a "phantom" function, 3 switch positions clockwise from STOP.

DVM to 100V range: DVM Filter OFF (applies to 5328A Option 021 only).

LEVEL A to 0.25V approximately: Check using READ A position on DVM module.

LEVEL B to PRESET.

SLOPE A: +

SLOPE B: -

ATTEN to 1 on both inputs

AC/DC to DC on both inputs

CHECK/Com A/SEP switch to COM A

1M Ω /50 Ω switch to 1M Ω

- 4) Set the 3722A SEQUENCE LENGTH control to 1023 and the CLOCK PERIOD switch to the required position in the range 3.33mS to 333mS inclusive.
- 5) Press the 5328A RESET button. On the next sync pulse from the 3722A, the 5328A G (Gate) lamp should light, indicating that the voltage integration is in progress. The G lamp should be extinguished by the following SYNC pulse, which stops the integration. Allow several repetitions of the integration to occur and take the average result.

ERRATA (Cont'd):

CALCULATION: In the "phantom" position DVM, A→B, the 5328A integrates the voltage at the DVM input over a period determined by the events at Channels A and B. Units of the displayed reading are volt seconds. The sign of the reading has no significance in this test.

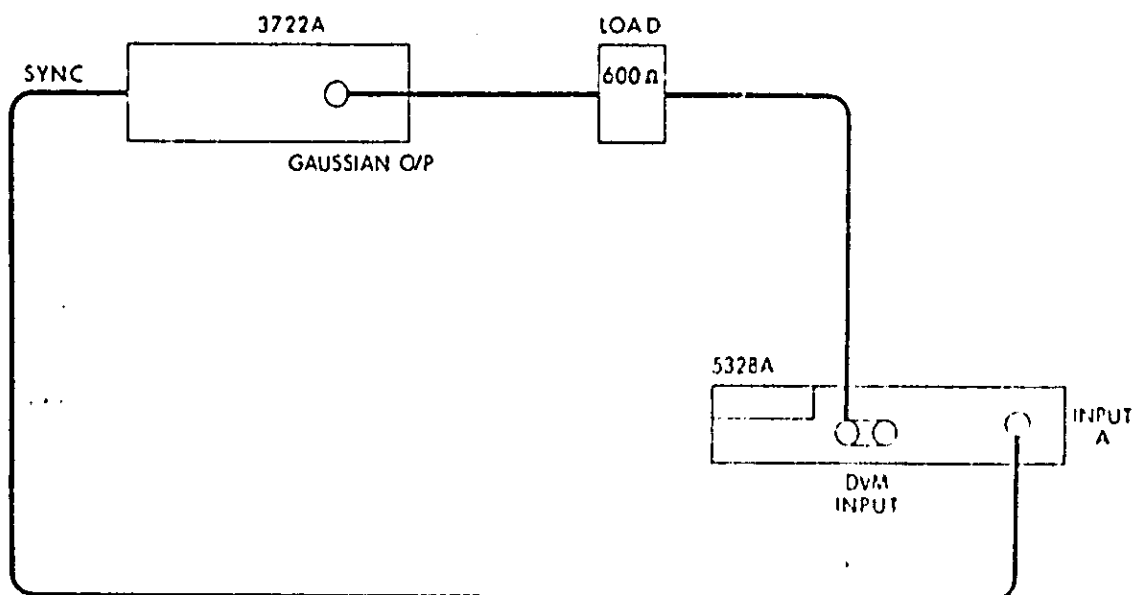
The mean rectified amplitude of the 3722A output is equal to:

$$\frac{\text{Voltage Reading}}{1023 \times \text{Clock Period}}$$

Typically, with a clock period of 10mS the voltage reading could be 26.100. This gives a mean rectified amplitude of 2.55V and an rms amplitude (based on a 1.24 form factor) of 3.16V.

Page 5-13:

Change Figure 5-8 to:



Page 5-24, Under "Main Controls":

Change Paragraph 4 to read "+1V and +12V".

ERRATA (Cont'd):

Page 5-26, Under "Sync":

Change Paragraph 2 to read "+1V to +12V".

Page 5-26, Under "Gate":

Change Paragraph 4 to read "+12v to +1V".

Page 6-36, Table 6-1:

Change A44CR1, 4 to 1902-0048 Diode Zener 6.81V 5%.

Page 6-37, Table 6-1:

Add C9 Part Number 0180-0291 C. FXD 1 μ F.

Page 6-38, Table 6-1:

Delete MP18.

Page 6-41, Table 6-1:

Change XF1 to 2110-0564 Fuse Post.

2110-0565 Fuse Cap.

2110-0569 Fuse Post Nut.

Page 6-47, Table 6-2:

Change 1400-0084 to 2110-0564 Fuse Post.

2110-0565 Fuse Cap.

2110-0569 Fuse Post Cap.

Page 8-8, Figure 8-7:

Add C9 1 μ F (between Pin 6 of A1 board and earth).

ERRATA (Cont'd):

In Tables 6-1 and 6-2 and on each assembly change the Part Number of the following resistors:-

From	to
0698-3775	0757-0382
0698-3776	0757-0180
0698-3777	0698-4389
0698-3778	0698-4410
0698-3779	0757-041C
0698-3780	0698-5019
0698-3799	0698-6745
0698-4226	0757-0276
0698-4227	0757-0397
0698-4230	0757-0399
0698-4232	0757-0402
0698-4233	0757-0403
0698-4234	0698-3437
0698-4239	0698-3441
0698-4241	0698-3132
0698-4243	0698-3444
0698-4245	0698-3446
0698-4246	0698-0082
0698-4250	0757-0419
0698-4252	0757-0421
0698-4254	0757-0280
0698-4256	0757-0274
0698-4258	0757-1094
0698-4262	0698-0084
0698-4264	0698-0085
0698-4265	0698-3151
0698-4266	0757-0279
0698-4267	0698-3152
0698-4268	0698-3153
0698-4270	0698-3155
0698-4274	0757-0439
0698-4278	0757-0442
0698-4280	0757-0444
0698-4282	0698-3156
0698-4286	0757-0199
0698-4288	0698-3159
0698-4290	0698-3160
0698-4292	0698-3161
0698-4294	0698-3162
0698-4296	0757-0459
0698-4298	0757-0461
0698-4300	0757-0463
0698-4302	0757-0465
0698-5701	0698-3432
0698-5707	0698-3436
0758-0015	0698-0088
0758-0026	0757-0711
0758-0086	0757-0401

The following changes are a continuation of those in Appendix A of the Manual.

CHANGE 14

Section VI, Table 6-1:

Change Chassis Mounted Component C1 to Part Number 0160-3561 C. FXD
CER 2 x 0.001uF.

Change A32R13 to Part Number 2100-1761 R. VAR WW Lin 10K ohm 5% 1W.

Change A32R25 to Part Number 2100-1758 R. VAR WW Lin 1.0K 5% 1W.

CHANGE 15

Section VI, Table 6-1:

Change MP2 03722-101 Front Panel to 03722-133.

Change MP4 5000-0738 Side Cover (rear) to 5000-8709.

Change MP5 5000-0739 Side Cover (front) to 5000-8711.

Change MP6 03722-118 Top Cover to 03722-134.

Change MP7 03722-119 Bottom Cover to 03722-135.

Change MP9 5060-0766 Handle Assembly Retainer to 5060-8737.

Change MP14 00140-24701 Panel Trim (top) to 5020-6850.

Change MP18 5060-0775 Rack Mounting Kit to 5060-8740.

Change MP28 0370-0118 Knob: Push-Button (Fits S6, S7, S8 and S9) to 0370-1400.

CHANGE 16

Section VI, Table 6-1:

Change Q4 and Q6 to Part Number 1854-0419 Transistor: SI NPN.

CHANGE 17

Section VI, Table 6-1:

Change MP14 to Part Number 5020-4175 Panel Trim (top)

Change MP15 to Part Number 5020-4176 Panel Trim (bottom).

CHANGE 18

Table 6-1, Page 6-27:

Change A35Q1 to Part Number 1855-0062 Transistor Si Fet.

CHANGE 19

Table 6-1:

Change A2R2 to Part Number 0757-0280 R. FXD 1K ohm 1% 1/2W.

CHANGE 20

Table 6-1:

Change A13R25 to Part Number 0698-3620 R. FXD 100 ohm 5% 2W.

CHANGE 21

Pages 6-26/27, Table 6-1:

Change A35C1, 10 to Part Number 0160-3324 C. FXD 1uF 100V.

CHANGE 22

Table 6-1:

Change S5 to Part Number 3101-1395 S.W. PB.

Change A11 1850-0062 XSTR GE PNP to 1853-0217 XSTR SI PNP.

Change A11 1910-0016 Di GE to 1901-0040 Di SI.

CHANGE 23

Page 6-9, Table 6-1:

Change A13R25 to Part Number 0698-3624 R. FXD 150 Ω 5% 2W.

Pages 6-22/23, Table 6-1:

Delete A30CR13 Part Number 1901-0040 Di SI.

Add A30R33 Part Number 0757-0420 R. FXD 750 Ω 1% $\frac{1}{2}$ W.CHANGE 24

Table 6-1:

Change R41 to Part Number 0683-1015 R. FXD 100 Ω 5% $\frac{1}{4}$ W.Change R38, 44 to Part Number 0683-3935 R. FXD 39K Ω 5% $\frac{1}{4}$ W.CHANGE 25

Page 6-38, Table 6-1:

Add MP60 Part Number 5061-0748 XSTR Socket Assy (for use with Q5).

CHANGE 26

Table 6-1:

Change A6 thru A12: CR1 to CR5 to Part Number 1901-0016 De Ge (Reverses Change 22).

Add A30CR13 Part Number 1901-0040 Di SI (In parallel with A30R33 Ref. Change 23).

CHANGE 27

Page 6-41, Table 6-1:

Change XFI to Part Number 2110-0464 Fuse Holder
 2110-0465 Fuse Cap
 2110-0467 Nut Hex

Page 6-47, Table 2:

Delete 1400-0084 Fuse Holder.
 Add 2110-0464 Fuse Holder.
 2110-0465 Fuse Cap.
 2110-0467 Nut Hex.

CHANGE 28

Delete Change 25.

Page 6-39, Table 6-1:

Change Q5 to Part Number 5080-9061 XSTR ASSY. (This assy is XSTR
 1853-0012 with additional leads welded on).

CHANGE 29

Page 6-3, Table 6-1:

Replace the parts list for the A2 Assembly with the following parts list.

Table 6-1 Replaceable Parts

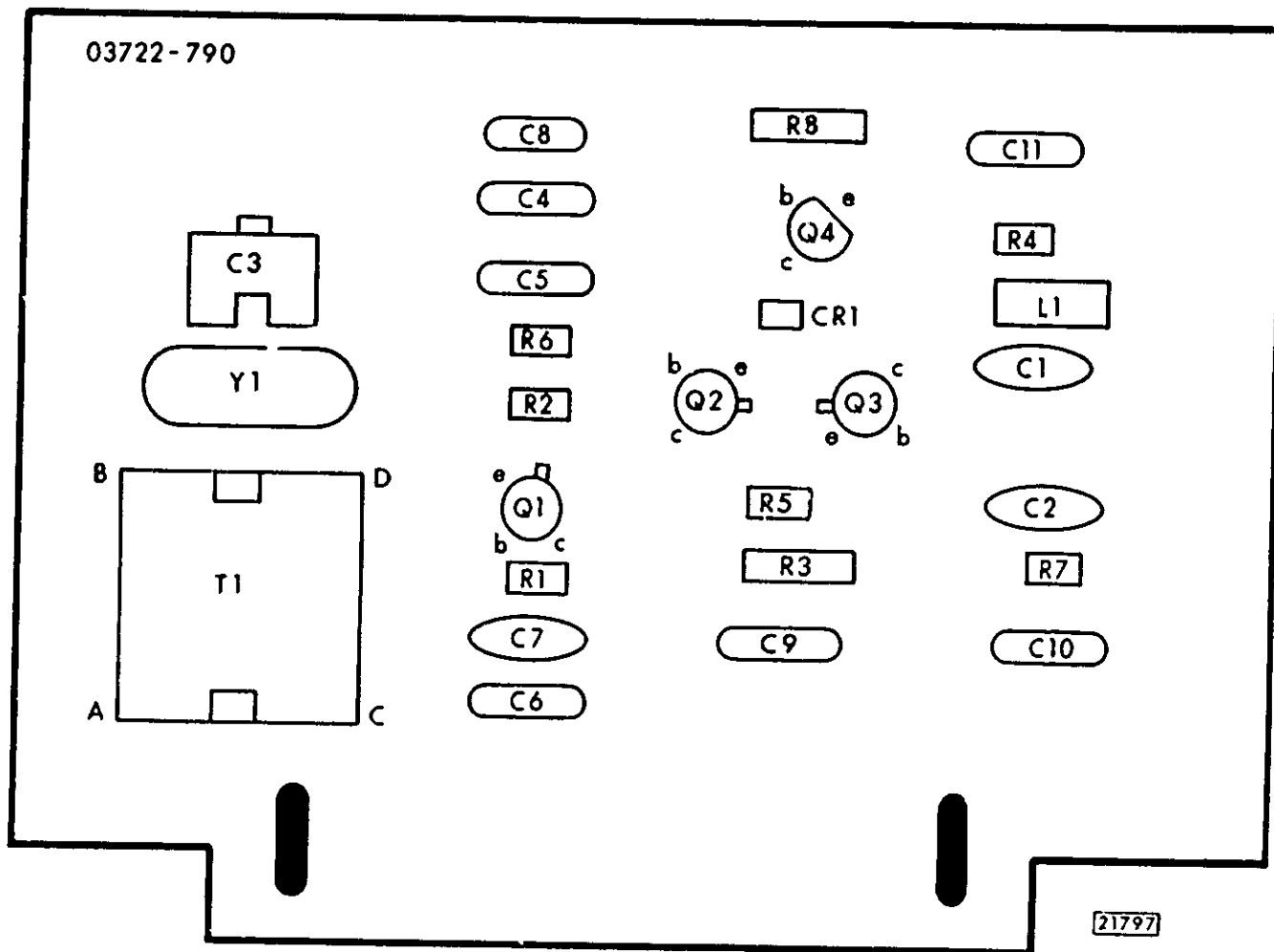
Ref Desig	HP Part No	Description
A2	03722-730 03722-390	ASSY : CRYSTAL OSCILLATOR BOARD : BLANK PC (NSR)
A2C1	0150-0121	CAPACITOR, FXD 0.1LF 50VDC
A2C2	0150-0121	CAPACITOR, FXD 0.1LF 50VDC
A2C3	0121-0105	CAPACITOR, VAR 9-35pF
A2C4	0100-2197	CAPACITOR, FXD 10pF 300V
A2C5	0160-0938	CAPACITOR, FXD 1000pF
A2C6	0160-2208	CAPACITOR, FXD 330pF 300V
A2C7	0150-0121	CAPACITOR, FXD 0.1LF 50VDC
A2C8	0100-0179	CAPACITOR, FXD 33pF 300V
A2C9	0140-0204	CAPACITOR, FXD 47pF 500V
A2C10	0140-0204	CAPACITOR, FXD 47pF 500V
A2C11	0140-0210	CAPACITOR, FXD 270pF 300V
A2CR1	1901-0040	DIODE : SI
A2L1	9100-1633	INDUCTOR, FXD, COIL 68uH 5%
A2J1	1853-0012	TRANSISTOR : SI NPN
A2C2	1853-0034	TRANSISTOR : SI PNP
A2J3	1853-0034	TRANSISTOR : SI PNP
A2J4	1854-0071	TRANSISTOR : SI NPN
A2R1	0698-3150	RESISTOR, FXD 23.7K 1% .25W
A2R2	0757-0280	RESISTOR, FXD 1K 1% .125W
A2R3	0698-3509	RESISTOR, FXD 2.15K 1% .25W
A2R4	0757-0337	RESISTOR, FXD 68.1K 1%
A2R5	0757-0433	RESISTOR, FXD 6.81K 1%
A2R6	0757-0270	RESISTOR, FXD 6.19K 1% .125W
A2R7	0757-0433	RESISTOR, FXD 1.32K 1% .125W
A2R8	0757-0463	RESISTOR, FXD 561K 1% .125W
A2T1	9100-0619	TRANSFORMER, CRYSTAL OSCILLATOR
A2V1	0410-0601	CRYSTAL, QUARTZ 3MHz

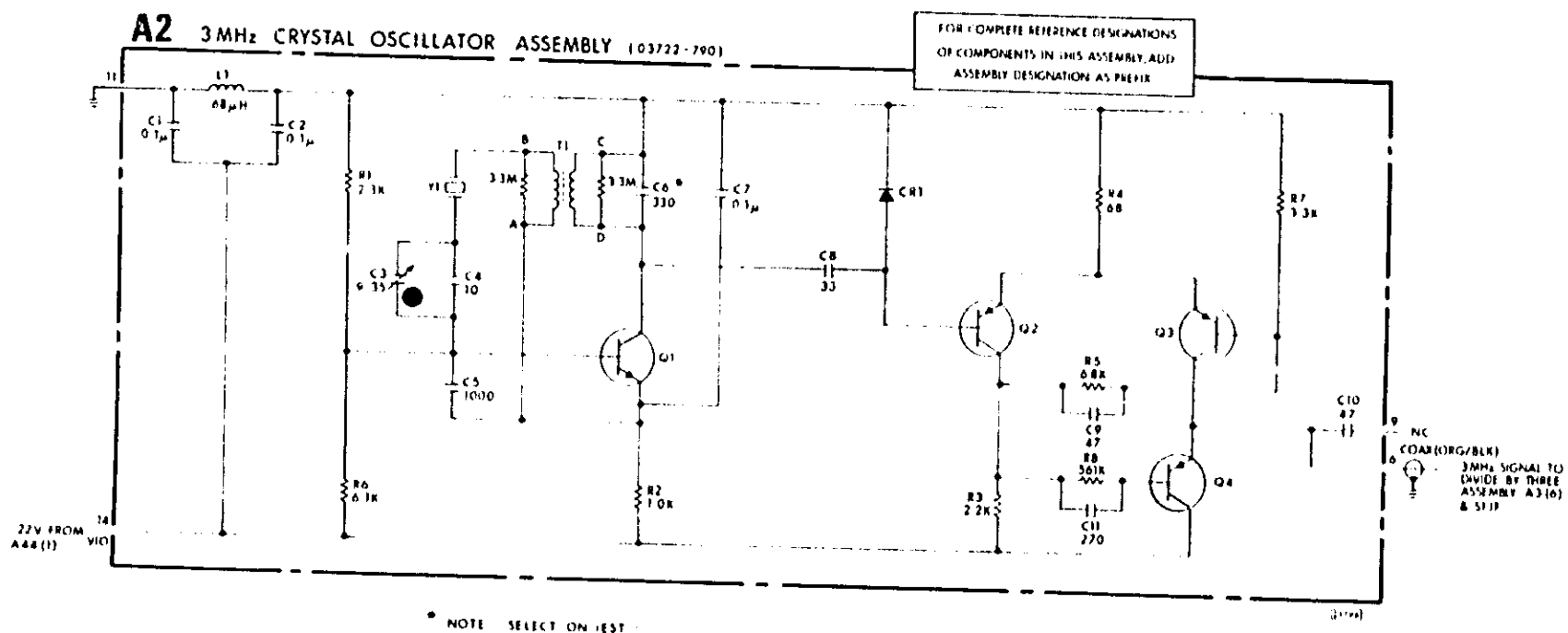
CHANGE 29 (Cont'd):

Page 8-9, Figure 8-8:

Replace Schematic and Layout diagrams with attached diagrams.

Change the parts list on the back of Figure 8-8 to correspond with the replaceable parts list Table 6-1.





CHANGE 30

Page 6-3, Table 6-1:

Replace the parts list for the A2 Assembly with the following parts list.

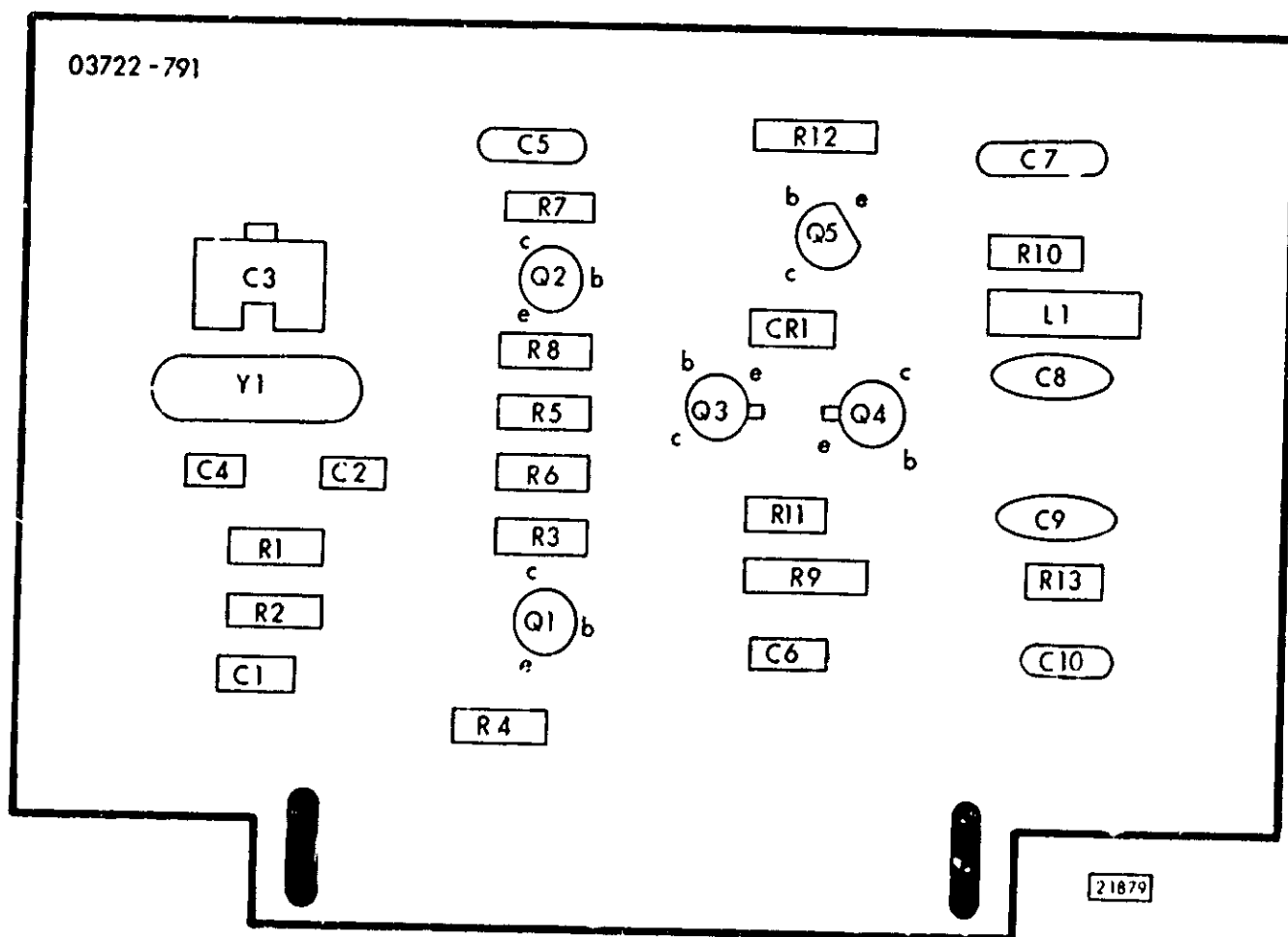
Table 6-1. Replaceable Parts.

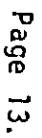
Ref Desig	hp Part No	Description
C1	0160-2055	CF 0.01nf 100V
C2	0160-2055	CF 0.01nf 100V
C3	0121-0105	CV 9/35pF
C4	0160-2197	CF 10pf 300V
C5	0160-0179	CF 33pf 300V
C6	0160-2307	CF 47pf 500V
C7	0140-0210	CF 270pf 200V
C8	0150-0121	CF 0.1nf 50V
C9	0150-0121	CF 0.1nf 50V
C10	0160-2307	CF 47pf 500V
CR1	1901-0040	Dio Swg
L1	9100-1633	Coil Fxd 68nH
Q1	1854 0005	Tstr Si NPN
Q2	1854-0005	Tstr Si NPN
Q3	1853-0034	Tstr Si PNP
Q4	1853-0034	Tstr Si PNP
Q5	1854 0019	Tstr Si NPN
R1	0757 0458	RF 51.5k 1% 1/8W
R2	0757-0442	RF 10k 1% 1/8W
R3	0757-0200	RF 5.62k 1% 1/8W
R4	0757-0280	RF 1k 1% 1/8W
R5	0757-0442	RF 10k 1% 1/8W
R6	0757 0458	RF 51.1k 1% 1/8W
R7	0757-0200	RF 5.62k 1% 1/8W
R8	0757-0280	RF 1k 1% 1/8W
R9	0698-3599	RF 2.15k 1% 1/8W
R10	0757-0397	RF 68.1 1% 1/8W
R11	0757-0439	RF 6.81k 1% 1/8W
R12	0757 0483	RF 562k 1% 1/8W
R13	0698-3152	RF 3.48k 1% 1/8W
T1	0410 0601	Xtal 3MHz

Page 8-9, Figure 8-8:

Replace Schematic and Layout diagrams with attached diagrams.

Change the parts list on the back of Figure 8-8 to correspond with the replaceable parts list, Table 6-1.





CHANGE 31

Pages 6-4/6-6, Table 6-1:

Change A5 to read 03722-792 on A4 assy 03722-725.

Change A4C2 to 0160-2306 C. FXD 27pF (material is same for
A4 and A5 except for C2).

Page 8-11, Figure 8-12:

Add Part Number 03722-792 (A5).

Add Note 1: C2 is 27pF for A4 (03722-725).
82pF for A5 (03722-792).