CLASS B INSTRUCTION MANUAL
FOR
TYPES FS-101-2 AND FS-102-2
FREQUENCY SYNTHESIZERS

INTRODUCTION

In addition to the system configuration described in this manual, the FS-101-2 and FS-102-2 Frequency Synthesizers are used as components of the RS-160 Receiving System. Various configurations are employed, typically including a 205-(X) Receiver or 215-(X) Receiver, VH-Series and UH-Series Tuning Heads, and a CSU-160 Tuner Switching Unit. A control interface unit is also required to supply frequency data to the synthesizer. In such a system, cabling to the receiver or tuner switching unit may replace tuner code plugs described in this manual. UH-Series Tuning Heads require use of the FS-102-2 unit.

WATKINS-JOHNSON COMPANY
700 QUINCE ORCHARD ROAD
GAITHERSBURG, MARYLAND 20760

WARNING

This equipment employs voltages which are dangerous and may be fatal if contacted. Extreme caution should be exercised in working with the equipment with any of the protective covers removed.

Table 1-1. Types FS-101-2 and FS-102-2

Frequency Synthesizers, Specifications

Tuned Frequency Range(1)	
FS-101-2	2 MHz to 300 MHz
FS-102-2	2 MHz to 1000 MHz
Resolution	
2 MHz to 300 MHz Tuned Frequency, FS-101-2 and FS-102-2	1 kHz
250 MHz to 1000 MHz Tuned Frequency, FS-102-2 only	10 kHz
Frequency Agility	
Acquisition Time, 10 kHz Step	10 milliseconds, maximum
Acquisition Time, Large Band Step(2)	100 milliseconds, maximum
Control Data Input	
Format	Self clocking, three level serial
Clock Rate	200 kHz, nominal
Data Content	4 bit binary address, 3 spare bits, 24 bit BCD frequency word
BCD Data Weight	10^0 digit = 1's of kHz or 10's of kHz, same conditions as resolution
Local Oscillator Inputs	
Frequency Range, FS-101-2	30-321.4 MHz
Frequency Range, FS-102-2	30-1160 MHz
Level	50 mVrms, minimum 500 mVrms, maximum
Impedance	50 ohms, nominal
Tuning Voltage Output	-10.00V to +10.00V when in lock
Internal Standard Frequency Stability	±1 PPM, 0°C to 50°C
Standard Frequency In/Out	
Input Required	1 MHz @ 100 mVrms, minimum, into 50 ohm load
Output Provided	1 MHz @ 75 mVrms, minimum, sine wave from 50 ohm source
Loss of Lock Indications	
Visual	Red LED on front panel illuminates
Data	TTL output line, 1 = loss

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Frequency Agility	
Acquisition Time, 10 kHz Step	10 milliseconds, maximum
Acquisition Time, Large Band Step[2]	100 milliseconds, maximum
Control Data Input	
Format	Self clocking, three level serial
Clock Rate	200 kHz, nominal
Data Content	4 bit binary address, 3 spare bits, 24 bit BCD frequency word
BCD Data Weight	10^0 digit = 1's of kHz or 10's of kHz, same conditions as resolution
Local Oscillator Inputs	
Frequency Range, FS-101-2	30-321.4 MHz
Frequency Range, FS-102-2	30-1160 MHz
Level	50 mVrms, minimum 500 mVrms, maximum
Impedance	50 ohms, nominal
Tuning Voltage Output	-10.00V to +10.00V when in lock
Internal Standard Frequency Stability	±1 PPM, 0°C to 50°C
Standard Frequency In/Out	
Input Required	1 MHz @ 100 mVrms, minimum, into 50 ohm load
Output Provided	1 MHz @ 75 mVrms, minimum, sine wave from 50 ohm source
Loss of Lock Indications	
Visual	Red LED on front panel illuminates
Data	TTL output line, 1 = loss

Table 1-1. Types FS-101-2 and FS-102-2

Frequency Synthesizers, Specifications (Continued)

Input Power	115/220 or 230 Vac, 50-400 Hz.
Dimensions	3.5 inches high, 19 inches wide, 16 inches deep[3]
Weight	11.5 lbs., approximately

NOTES: (1) For associated receiver with 21.4 MHz (or 67.8 MHz) IF frequency on VHF ranges and 160 MHz IF frequency on UHF ranges.

(2) Magnitude of step to new frequency is 95% of tuning range of associated receiver.

(3) Measured from back of front panel to rear panel.

Figure 1-1. Type FS-102-2 Frequency Synthesizer, Front View

SECTION I

GENERAL DESCRIPTION

1.1 ELECTRICAL CHARACTERISTICS

1.1.1 The Types FS-101-2 and FS-102-2 Frequency Synthesizers provide highly accurate control of the tuned frequencies of compatible receivers with voltage tuned local oscillators. By counting the frequency of the local oscillator (LO) of the receiver and comparing it to the frequency of an internal standard, the synthesizer produces a tuning voltage to hold the receiver at the desired frequency. Together the receiver local oscillator and the FS-101-2 or FS-102-2 form a phase locked loop employing indirect frequency synthesis techniques. Digital data from an external source determines the tuned frequency which the synthesizer loop acquires. Due to high spectral purity, the local oscillator signal produced causes no degradation of performance as compared to manually tuned receivers. Rapid response to tuning commands assures a high degree of frequency agility for the receiver/synthesizer combination.

1.1.2 The FS-101-2 operates over the range of 60-300 MHz when used with the 208-2-1 through 208-4-1 Receivers. Tuned frequency of the receivers may be incremented in 1 kHz steps, with a stability of ± 1 PPM. For use on the UHF ranges, the FS-102-2 extends frequency of operation to 1000 MHz. The 208-5-1 and 208-6-1 Receivers are used for UHF operation, and are tuned with a resolution of 10 kHz. Although different IF frequencies are employed by these receivers in the VHF and UHF ranges, no compensation is required in the frequency programming data. BCD serial data to tune the FS-101/102-2 units need only indicate the tuned frequency, as the synthesizer provides an IF offset to compensate for the difference between tuned frequency and local oscillator frequency. A three level format is used for the serial input so that a single line can carry both clock and data information. The 200 kHz clock rate used is high enough to prevent the data reception period from adding appreciably to the time needed to acquire a new frequency. In addition to the BCD frequency word, the data stream contains a unit address code which is individually programmed into each synthesizer. Inputs of several FS-101/102-2 units may therefore be bussed together, with only the unit which recognizes its own address responding to a given data transmission.

1.1.3 The FS-101/102-2 supplies a digital output indicating loss of lock when failure of the synthesizer/receiver loop occurs. A front panel alarm indication is also provided by illumination of a red light emitting diode. By actuation of a rear panel switch, the unit may be adapted for use with an external standard frequency input of 1 MHz.

1.2 MECHANICAL CHARACTERISTICS

1.2.1 The FS-101-2 and FS-102-2 Frequency Synthesizers are constructed for mounting in 19-inch racks. The chassis consists of a shallow pan of formed aluminum with a removable top dust cover. A heavy machined plate is used for the front panel, and it requires only 1.75" of vertical space for mounting in the rack. A black anodized bezel with etched markings is overlaid on the front panel. All internal subassemblies are constructed on printed circuit boards. They are horizontally mounted and are separated by shielding partitions to prevent leakage of signals which would be RFI sources. Input and output wiring connects through low pass filters, and a conductive RFI gasket seals the dust cover to the chassis.

1.2.1 Front panel controls and indicators include only the POWER PUSH ON/OFF switch, which is internally illuminated, and the UNLOCK INDICATOR. The rear panel mounts the power line fuses and several connectors. Included are coaxial jacks to carry LO inputs and the tuning voltage output. In addition to the receptacle for the serial data input, two other multipin connectors perform system functions.

1.3 EQUIPMENT SUPPLIED

This equipment consists only of the Type FS-101-2 Frequency Synthesizer or Type FS-102-2 Frequency Synthesizer.

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

The FS-101-2 or FS-102-2 functions as a system component and is not capable of independent operation. Necessary associated equipments are as follows:

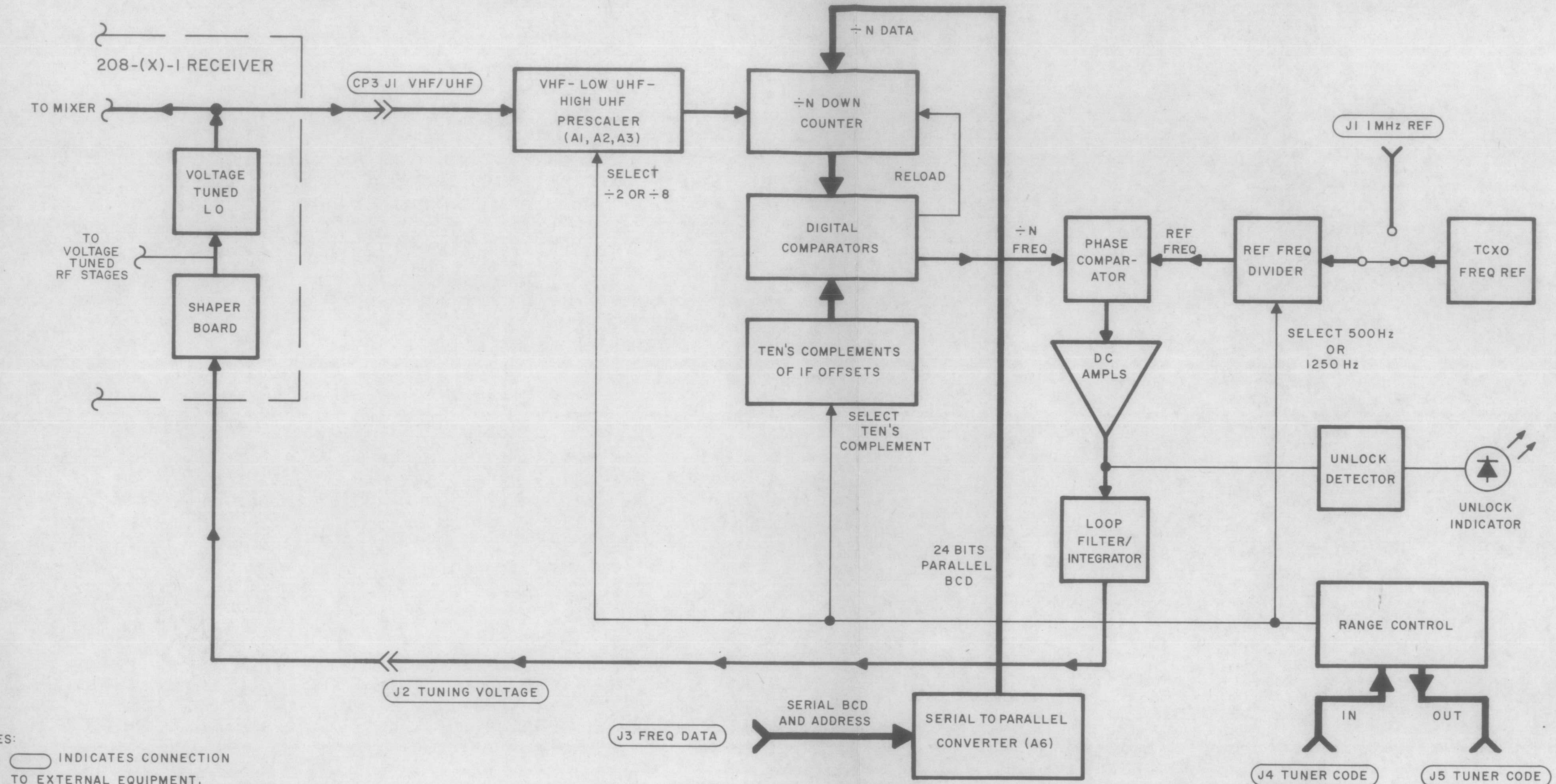
(1) A 208-(X)-1 Receiver is mated to each synthesizer on a one-to-one basis. The FS-101-2 may be used with receivers tuning up to 300 MHz. Tuned frequencies up to 1000 MHz are obtainable with the FS-102-2. Complete receiver type numbers are listed below:

COMPATIBLE RECEIVERS

FS-101-2	FS-102-2
208-2-1 Receiver	208-2-1 Receiver
208-3-1	208-3-1
208-4-1	208-4-1
	208-5-1
	208-6-1

(2) A source of serial control data such as the WJ-9565 Computer Interface Unit is required. The WJ-9565 can address and provide frequency data for up to sixteen FS-101/102-2 units. Input requirements for the interface unit are described in its own instruction manual.

(3) As an optional requirement, an external 1 MHz frequency standard may be provided. This option is indicated only where extreme frequency stability of the synthesized LO signal is required.



NOTES:

1. ( ) INDICATES CONNECTION TO EXTERNAL EQUIPMENT.
2. HEAVY LINES WITH MULTIPLE ARROWS INDICATE MAIN SIGNAL PATH OF PLL.
3. EXCEPT AS NOTED, ALL FUNCTIONAL BLOCKS ARE PART OF MODULE A5.
4. PRESCALER MODULES A1 AND A2 ARE USED ONLY ON THE FS-102-2. THE FS-101-2 OPERATES ONLY ON VHF RANGES.
5. TABLE 2-1 CORRELATES RECEIVER AND FS-101/102-2 FUNCTIONS.

TABLE 2-1

TUNING RANGE	208-(X)-1 RECEIVER	IF FREQUENCY	TUNER CODE 2^0 2^1 2^2	PRESCALER RATIO	CHANNEL SPACING	REFERENCE FREQUENCY	IF TEN'S COMPLEMENT
60-120MHz	208-2-1	21.4MHz	1 0 1	÷2	1kHz	500Hz	978.600
100-180MHz	208-3-1	21.4MHz	0 1 1				
180-300MHz	208-4-1	21.4MHz					
250-500MHz	208-5-1	160MHz	0 0 0	÷8	10kHz	1250Hz	9840.00
500-1000MHz	208-6-1	160MHz	1 0 0				

Figure 2-1. Types FS-101/102-2 Frequency Synthesizers, Overall Block Diagram

SECTION II

CIRCUIT DESCRIPTION

2.1 INTRODUCTION

Operation of the circuitry in the FS-101/102-2 Frequency Synthesizers is described in the following paragraphs. Paragraphs 2-2 and 2-3 give overall theory of operation. Following paragraphs describe individual circuits and modules in greater detail. Figure 2-1 is an overall block diagram of the unit, and it is followed by additional detailed block diagrams. Schematic diagrams for the main chassis and all modules are provided in Section VI. Note that the unit numbering method is used for electrical components. Parts on subassemblies and modules carry a prefix before the component designator. For example, A4R2 refers to a resistor in subassembly A4 and A2Q1 refers to a transistor in subassembly A2. Subassembly prefixes may be omitted in the text and on illustrations except where confusion might result from their omission.

2.2 BASIC ÷N PHASE LOCKED LOOP

The basic circuit concept of the FS-101/102-2 Frequency Synthesizers is that of the phase-locked loop with the addition of a programmable counter, which divides by a selected integer N. The function of the phase-locked loop (PLL) is to lock the frequency of a generated signal to the frequency of a reference signal. Circuit elements which are required to do so are a voltage controlled oscillator, a phase detector, and a low pass filter. The phase detector produces an output signal indicating frequency or phase difference between the two signals. This output is a pulse train whose average duty cycle indicates the magnitude of the frequency error. When converted to a slowly changing voltage by the low pass filter, the error signal drives the voltage controlled oscillator to the reference frequency. Figure 2-2 shows the PLL with the addition of a programmable ÷N counter. This counter divides the frequency of the voltage controlled oscillator (VCO) by a factor determined by the programming data. If the factor N equals one, the VCO frequency equals the reference frequency. If N=2, the VCO must be driven to twice the reference frequency for the comparator to sense phase lock. Within the design range,

$$f_{VCO} = N(f_{Ref})$$

That is, the VCO frequency equals the reference frequency times the integer N. As successive values of N are employed, the output frequency changes in discrete steps equal to the reference frequency. A large number of frequencies may thus be programmed with a resolution or "channel spacing" equal to the reference frequency. This type of phase locked loop forms the basis of frequency synthesis in the FS-101/102-2 units. Synthesizers such as these, employing VCO's, are classified as indirect synthesizers. Use of a two pole loop filter further classifies the configuration as a second order loop.

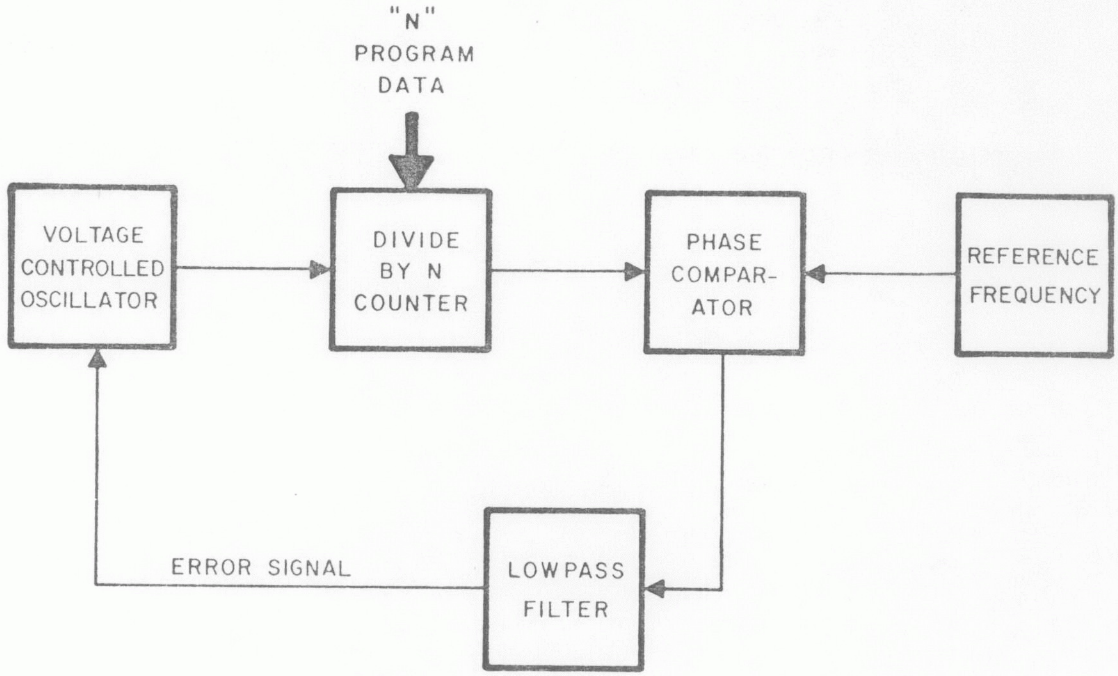


Figure 2-2. Basic Synthesizer Loop

2.3 ÷N PLL AS THE RECEIVER LOCAL OSCILLATOR

The FS-101/102-2 Frequency Synthesizers include several features adapting them to use as sources of control for receiver local oscillators. The receiver LO is the VCO portion of the synthesizing phase-locked loop. All other functions of ÷N PLL are contained in the FS-101/102-2. Figure 2-1 is a block diagram of the synthesizer and receiver, interconnected in a closed loop.

2.3.1 Prescaler Ratios and Reference Frequencies. - The VHF and UHF frequencies used by the receiver LO are too high to be readily accomodated by a ÷N counter. Prescaling is therefore employed to reduce the frequency by a ratio of two (VHF range) or eight (UHF ranges). Placing a fixed division ratio, or modulus ahead of the ÷N counter necessitates a reduction in reference frequency. Otherwise the prescaler would have the effect of multiplying the ÷N value, which would increase channel spacing. To maintain the channel spacing, the reference frequency must be divided by the prescaling ratio before it is applied to the phase detector. A reference frequency of 500 Hz is used by the FS-101/102-2 units on the VHF ranges. The effective reference frequency equals the actual reference frequency times the prescaling factor.

For the VHF range:

$$\underbrace{2}_{\text{Prescaler Ratio}}\ \underbrace{(500\text{ Hz})}_{\text{Ref. Freq.}} = \underbrace{1\text{ kHz}}_{\text{Channel Spacing}}$$

Thus the desired VHF channel spacing of 1 kHz is maintained. A different channel spacing, 10 kHz, is used on the UHF ranges. The reference frequency employed is 1250 Hz.

Therefore, the UHF channel spacing is:

$$8\ (1250\ \text{Hz}) = 10\ \text{kHz}$$

The reference frequency normally originates in a temperature compensated crystal oscillator module (TCXO). An external 1 MHz standard frequency input may also be employed if greater stability is required. A variable modulus divider is used to convert the TCXO output or external 1 MHz signal to the reference frequency. The modulus of this frequency divider is determined by a range control circuit. It accepts a three bit binary tuner code and provides outputs to control prescaler subassemblies, the reference frequency divider, and the IF offset modules.

2.3.2 IF Offset. - IF offsetting is required because the ÷N counter is programmed with the desired tuned frequency, but receives an input signal that is the local oscillator frequency. The LO signal is always higher in frequency because the associated 208-(X)-1 Receivers use only high beat conversion. On the VHF ranges, the receivers use a 21.4 MHz IF frequency. When the ÷N counter is programmed for a tuned frequency of 100 MHz, the synthesizer must lock on an input frequency of 121.4 MHz. To compensate for the 21.4 MHz difference, the ÷N counter does not stop its count when it has counted down from the initial value of 100 000 to a value of 000 000. It continues to count down through the values 999 999, 999 998, etc., until it has reached a value which adds 21,400 input pulses to the initial value. This value is the ten's complement of the 21.4 MHz IF frequency. Counting down to the tens complement may be considered additive since down counting is a subtractive process. To add 21 400 to the count, the tens complement is obtained by subtracting each digit individually from 9 and adding 1 to the result. This procedure may be illustrated as:

	9 9 9 9 9 9	
-	0 2 1 4 0 0	Intermediate Frequency
	9 7 8 5 9 9	
+	1	
	9 7 8 6 0 0	Ten's Complement of Intermediate Frequency

The FS-101/102-2 units contain groups of modules which provide tens complements for IF frequencies of 21.4 MHz and 160 MHz, as shown in the table in Figure 2-1. A third complement is also provided but is unused in these units. To detect that the down count value has reached the tens complement, digital comparators monitor the parallel outputs of the ÷N counter and the active tens complement modules. When equality occurs, the comparators and associated logic provide a pulse which is the ÷N count output to the phase comparator. At this time, the ÷N counters are reloaded with the receiver tuned frequency and a new count cycle begins.

2.3.3 Phase Comparator and Loop Filter. - The phase comparator, receiving the ÷N count and the reference frequency, indicates their relative frequency and phase. The phase comparator has two output lines, one or the other of which has pulses present to indicate that the receiver local oscillator frequency should be driven higher or lower.

The pulses are applied to dc current amplifiers which provide inputs to the loop filter. Its functions are low pass filtering and integration to provide the necessary value of the error signal to establish and maintain lock. The loop filter/integrator output is designated as the tuning voltage, and varies over the range of -10V to +10V. When the voltage is returned to the 208-(X)-1 Receiver, it is applied to the voltage tuned local oscillator through a shaping amplifier. This circuit modifies the tuning voltage before applying it to the varactor tuned oscillator to give a more linear characteristic of voltage versus frequency. In generation of the tuning voltage within the FS-101/102-2, the dc amplifiers have separately adjustable gain for up and down outputs from the comparator. The overall loop gain can therefore be adjusted for best frequency agility - the ability to quickly seek and lock to a new frequency. However, gain is kept below the value that would cause excessive overshoot and instability which could result in oscillation of the overall loop. The low pass filter has a nominal cut-off frequency which is high enough to provide satisfactory frequency agility. However, the cut-off frequency is low enough to minimize spurious content of the receiver LO signal by making the frequency corrective action of the loop unresponsive to perturbations not near the LO frequency. The low pass filter is also adjustable, as its cutoff frequency affects both speed of new frequency acquisition and loop stability.

2.4 PROGRAM COUNTER, PART OF A5

The program counter of the FS-101/102-2 Frequency Synthesizers consists of the ÷N counter circuits, IF offset components, and control logic. A detailed block diagram is shown in Figure 2-3. The ÷N counter is a down counter which operates in BCD format. Six TTL packages are used as the down counters. For the four most significant digits, 10^2 through 10^5, the IC's are used in a straight forward ripple counter arrangement which counts down to the tens complement of the IF frequency. Each of three tens complement numbers (4 digits each) is provided by a group of modules containing diode matrices. Offsetting is not required for the 10^1 or 10^0 digits. For the 10^0 digit, the TTL down counter IC does not have sufficient speed to count all input frequencies. It is therefore used as a control counter for a dual modulus ECL frequency divider IC. Together the two packages form a circuit configuration designated as a "pulse swallowing counter".

2.4.1 Pulse Swallowing Counter. - The least significant digit stage of the program counter receives signals directly from prescaler board A3. This stage is therefore required to accept signals up to 160 MHz in frequency. Such counting frequencies are not within the range of TTL devices. A BCD counter performing the ÷N function could be implemented with ECL devices, but would have the disadvantages of high package count and cost, and excessive heat dissipation. In the pulse swallowing counter, only a single ECL package with a specialized function is used. The function is a dual modulus, ÷10 or ÷11 prescaler. As shown in Figure 2-3, the ÷10/11 prescaler is U1 of the program counter. A modulus control line selects the prescaling ratio. State of the control line is determined by the output of U2, the "swallow control counter". It is TTL device identical to that used in other counter stages, and its function is to receive the BCD frequency data for the least significant digit of the ÷N count and condition the modulus control line.

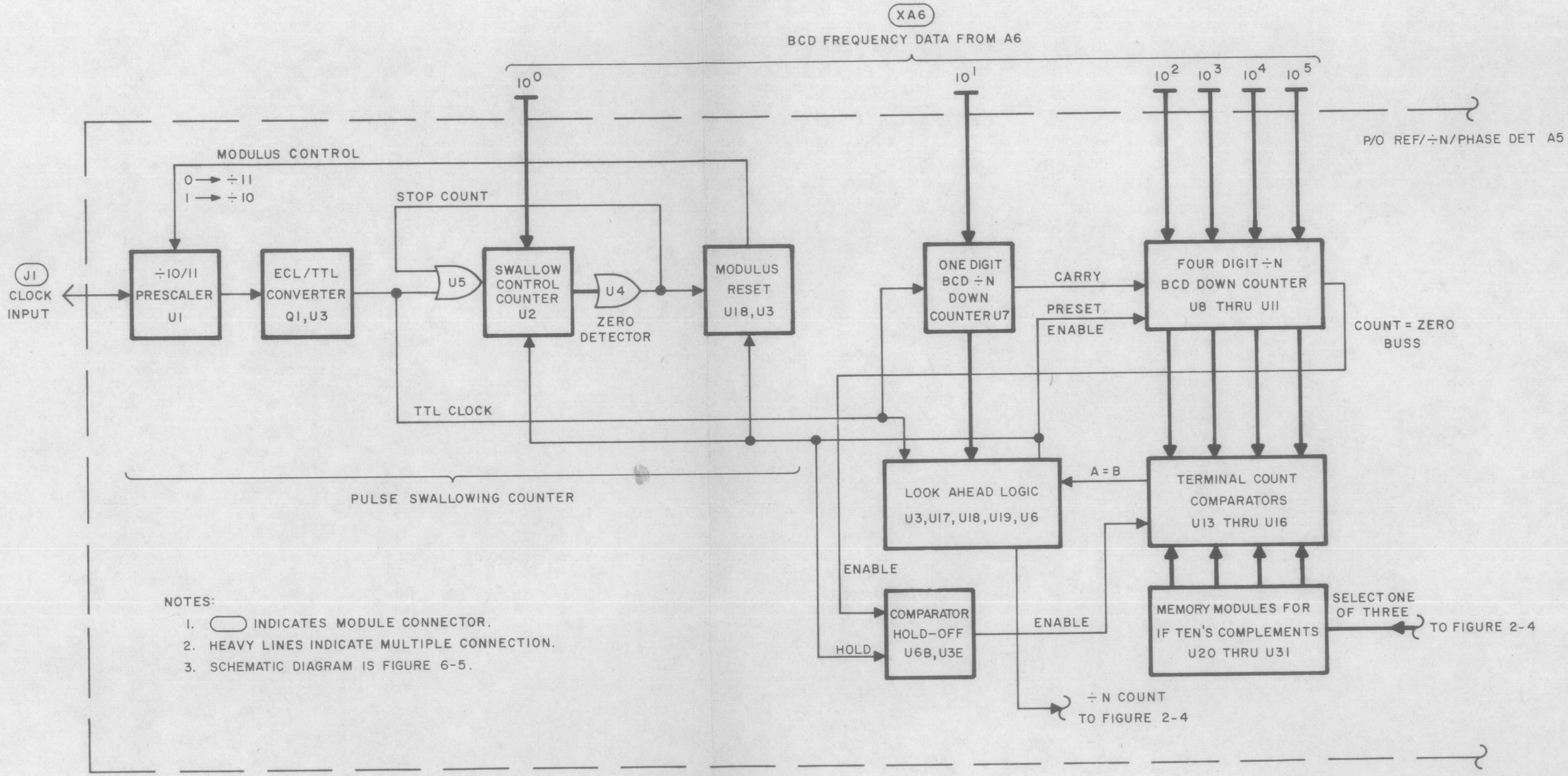


Figure 2-3. Program Counter, Detailed Block Diagram

2.4.1.1 Before examining operation of the pulse swallowing counter in detail, the operation of one of the single package BCD ÷N counters should be considered. Counter U7, for example, may be preset to 4 by the BCD frequency data from connector XA6. As clock pulses are received after presetting, the count at the Q_0 through Q_3 outputs steps through the values 3, 2, 1, 0. When the zero value is reached - all Q outputs low - a carry to the next, more significant count stage is provided by Q_3. The IC will now continue to count 9, 8......0 for many cycles, as consistent with BCD format. A carry will be produced for each count value of zero. Thus it is seen that:

--- The first carry pulse is produced after a number of clock pulses equal to the preset number.

--- Each succeeding carry is produced after 10 additional clock pulses.

2.4.1.2 The ÷N operation of the pulse swallowing counter can be described as a sequence of specific count events.

(1) The ÷10/11 prescaler is set to modulo 11 at the beginning of the count cycle. At the same time, the preset number for the 10^0 digit of the frequency data is loaded into the swallow control counter.

(2) Beginning from the preset number, the swallow control counter counts the output pulses from the ÷10/11 prescaler, as the prescaler divides the ECL clock input frequency by 11.

(3) When the swallow control counter reaches a count value of zero-all Q outputs low- the output of Shottky NOR U4 goes high. The ECL preset enable circuit then switches prescaler U1 to modulo 10. The modulus control circuitry enables the new prescaler ratio so quickly that no clock pulses to U1 are lost. OR gate U5 interrupts the TTL clock input to U2 to hold the prescaler IC at modulo 10.

(4) For all remaining clock pulses of the count cycle prescaler U1 divides by 10. A great many carry outputs will be produced during modulo 10 operation. Prescaler U1 will be reset to modulo 11 when a ÷N output pulse is produced by the entire program counter and the count cycle restarts at step 1 above.

2.4.1.3 Operations equivalent to the two conditions defined in paragraph 2.4.1.1 for a BCD ÷N counter have now been performed by the pulse swallowing counter. During the first portion of the count, prescaler U1 was dividing by 11, and control counter U2 was counting down to zero from the U1 output. If U2 were preset to 4, it would require 4 outputs from the prescaler IC before changing the prescaler modulus. There were thus four outputs of U1 for which one additional ECL clock input pulse was required or "swallowed"; that is, while U1 was in the ÷11 mode. The number of input pulses required was 4(11)=44 input pulses. This is the same number of clock pulses and carry output pulses as present for a conventional BCD ÷N counter, which would produce the first carry after 4 pulses and an additional carry for every 10 pulses.

The clock pulses required for the conventional counter would be:

BCD Count Values:

3, 2, 1, 0 → 1 carry
9, 8, ... 0 → 1 carry
9, 8, ... 0 → 1 carry
9, 8, ... 0 → 1 carry
9, 8, ... 0 → 1 carry

44 clock pulses → 4 carries

For the pulse swallowing counter:

Prescaler Modulo = 11:

Initial Value*. . .(11 pulses). . .Terminal Value* → 1 carry
Initial Value . . .(11 pulses). . .Terminal Value → 1 carry
Initial Value . . .(11 pulses). . .Terminal Value → 1 carry
Initial Value . . .(11 pulses). . .Terminal Value → 1 carry

44 clock pulses → 4 carries

* The prescaler does not use standard code values.

After these 4 carries, the prescaler produces one carry for 10 clock pulses, like the conventional BCD ÷N counter. The pulse swallowing counter must have at least enough clock inputs to produce all required carry pulses for the ÷11 mode, but this characteristic is not a restriction for frequencies used in operation of the FS-101/102-2 units.

2.4.2 Program Counter Operations. - To provide the ÷N function, the program counter accepts parallel data, counts down to zero, continues counting down to the IF tens complement, provides the ÷N output, and reloads parallel data. The pulse swallowing counter and BCD ÷N counters U7 through U11 accept the 10^0 through 10^5 digits of parallel data from connector XA6, indicating the desired tuned frequency. Down counting proceeds for the clock pulses from J1. Comparators U13 through U16 which will eventually terminate the count, are initially disabled. Comparator hold-off flip-flop U6B keeps the enable input to the 10^2 digit comparator in the inactive state until the down count reaches zero. Holding off the comparators is necessary to prevent a false terminal count condition for high UHF tuned frequencies. On the UHF ranges, the 10^0 digit of frequency data represents tens of kilohertz. The UHF preset is 9840, or 9840.00 with a decimal point positioned equivalent to the frequency data. If a tuned frequency of

9940.00 were indicated by the frequency data, a down count of only 100 MHz would occur before the comparators sensed equality and stopped the count. However, with the comparators inhibited by the hold-off circuitry, the count continues until counters U8 through U11 all hold zero values. A wired OR buss indicates this condition, and the hold-off circuit enables the comparators. The down count proceeds through the values 999 999, 999 998, ...etc, until the comparators sense that the count value equals the tens complement value. The A=B output from the comparators then goes high to indicate that the terminal count has been reached for four digits and a ÷N cycle is nearly complete. It will be complete when the 10^1 and 10^0 digit values have reached zero. (This occurs after the final values for the more significant digits in a down counter.) A look ahead logic circuit senses the end of count cycle to reload new parallel data. This logic is needed because the internal count equal zero outputs from the down counters are too slow for the maximum operating frequencies used. The look ahead logic detects when U7 has counted down to three. If the comparators have indicated equality, a counter composed of high speed and Shottky gates also begins counting down to zero, triggering on the TTL clock. The TTL clock is the least significant digit carry, indicating LSD=0. When zero count is reached, the last Shottky flip-flop provides the ÷N count out. Its complement is also provided and is used as the preset enable. When in its active low state, the preset enable reloads frequency data into all TTL counters. Gates U18A and U3B now provide an output to reset the modulus of prescaler U1 to 11. The preset enable pulse also sets the comparator hold-off circuit to the inhibit condition. As the preset enable line rises all stages are ready for down counting. Prescaler U1 goes to the initial internal value when set to modulo 11. It provides the first TTL clock pulse after 11 input pulses and there is no LSD indeterminancy for the count.

2.5 REFERENCE GENERATOR AND PHASE DETECTOR, PART OF A5

Figure 2-4 is a detailed block diagram of additional components on A5. Included are three major portions of the PLL: the reference frequency, the phase comparator, and the loop filter. Three auxiliary circuits - a ±15 power supply, a loss of lock detector, and the range control logic-are also shown.

2.5.1 Reference Frequency. - The loop reference frequency may be derived from a internal or external frequency standard. Temperature compensated crystal oscillator module U32 is the internal standard. Its output is divided down to 1 MHz by U33A and applied to a group of gates which allow selection of internal or external reference frequency. The internal 1 MHz standard is buffered by operational amplifier U34 and is available as a low level output at J8. The op amp low pass characteristic produces a sine wave output. Where extreme stability of the standard frequency is required, an external 1 MHz signal may be applied to J7. It will be converted to TTL levels by the comparator and NAND contained in U35. When control pin J9 is held at logical zero, the external 1 MHz signal will be passed on to divider U33B. Its output is applied to another divider which may be set to one of two ratios. A control line from the range control logic, if high, sets the divider to 200. The 500 Hz output obtained from the divider is applied to the phase detector on the VHF range. For UHF operation, division by 80 produces a 1250 Hz output.

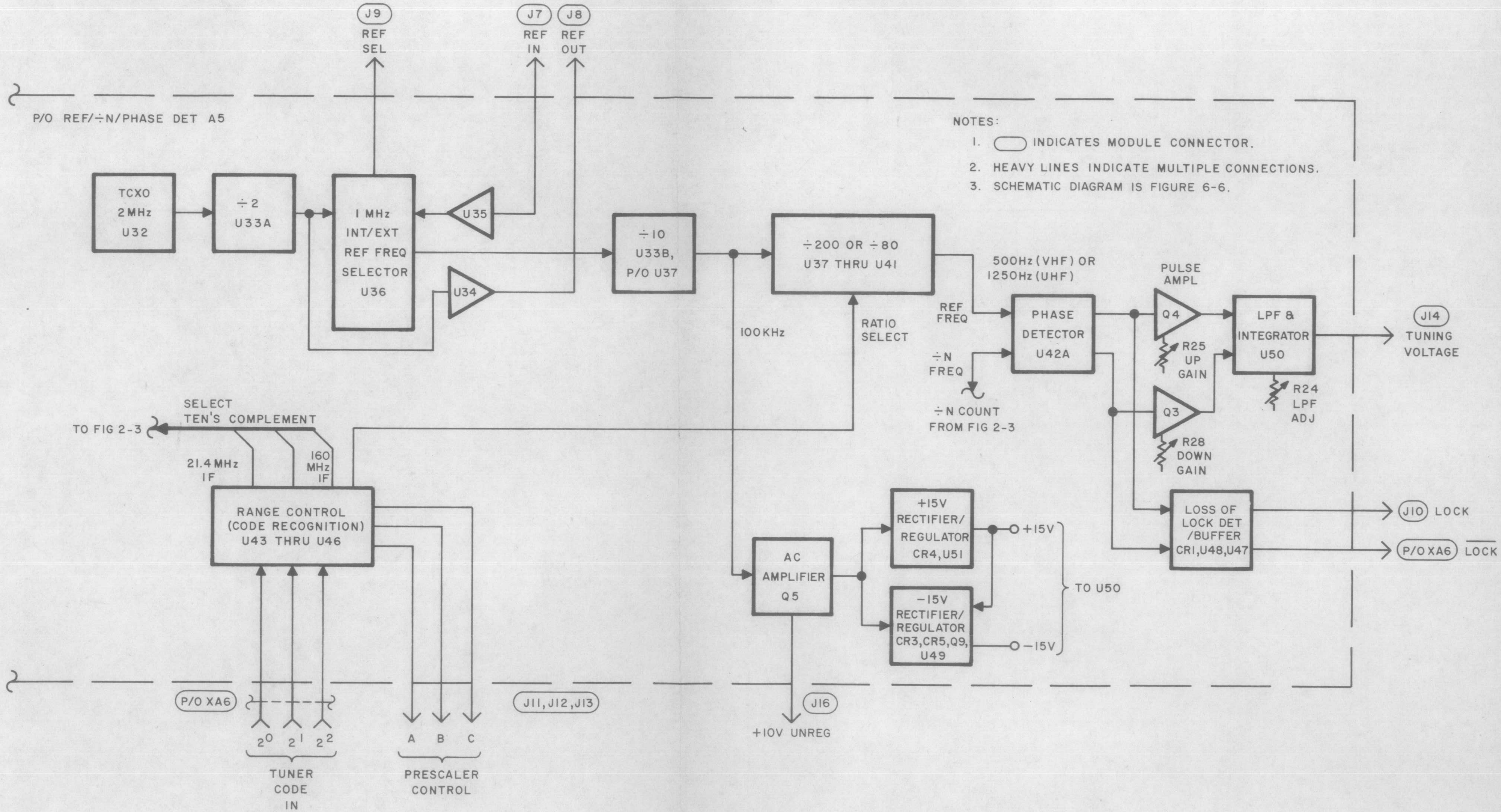


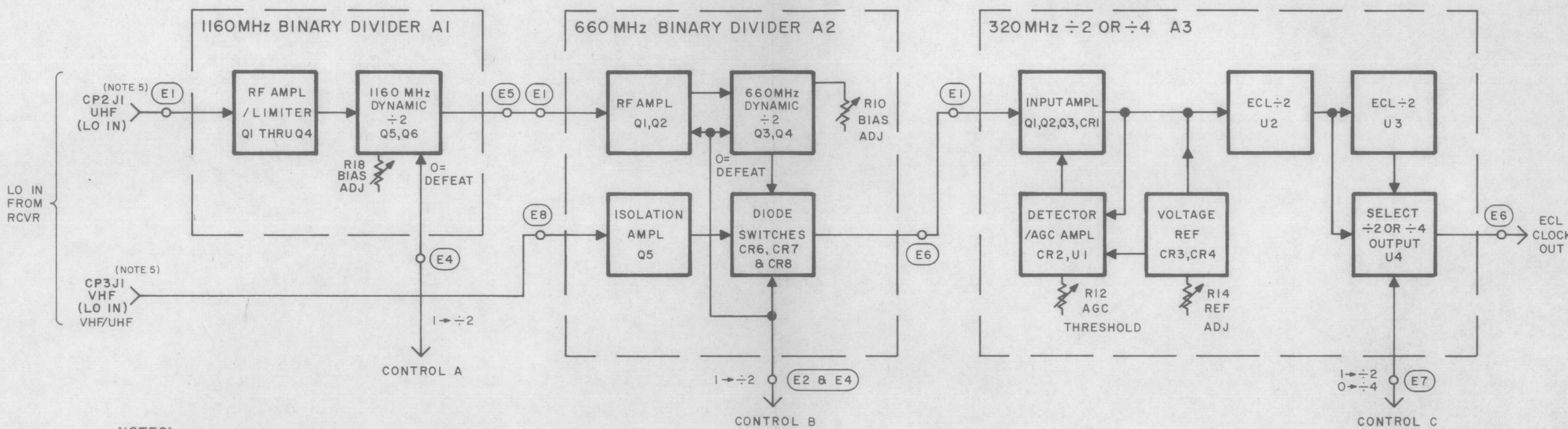
Figure 2-4. Reference Generator and Phase Detector, Detailed Block Diagram

2.5.2 Phase Detector and Loop Filter. - The phase detector consists of a single IC package, U42A. It receives the ÷N count from the program counter and the reference frequency of 500 or 1250 Hz. In comparing the frequency and phase of the two signals, U42A responds only to negative transitions and can accomodate the highly asymmetrical ÷N pulse train. When the loop is in a locked condition, both comparator outputs stand high, indicating that no correction of VCO frequency is required. When the loop is seeking lock, low-going pulses are present at one or the other comparator output, indicating that up or down frequency correction is required. Output pulses for up correction are amplified by Q4, whose gain is controlled by R25. Down pulses are received by Q3 and R28. Current pulses from both amplifiers are applied to FET input operational amplifier U50. Its feedback loop includes components to produce both low pass and integrating characteristics. Potentiometer R24 adjusts the low pass cutoff frequency. The operational amplifier output, which is the receiver tuning voltage, is available at module connector J14. It is routed to the receiver through a floating ground, double shielded cable, to a common mode rejection amplifier.

2.5.3 Auxiliary Circuitry. - Range control circuitry consists of a group of 13 gates which recognize tuner codes from the associated receivers. The code is three bit binary, and connects to the board at XA6. Figure 2-1, at the beginning of this section, includes a table of tuner codes vs. FS-101/102-2 functions. Three control lines determine prescaler functions, and a truth table for their states is included in Figure 2-5. As shown in the detailed block diagram for this paragraph, the range control logic also supplies two on-board output functions: a single control line to select the ratio of the reference frequency divider and three lines (active low) to select IF tens complement for the program counter. Another auxiliary circuit of this module is the loss of lock detector. It monitors both outputs of the phase detector. If constant pulse activity exists on either line, the dc output of detector diode CR1 changes output states of open-loop operational amplifier U47B. Two high power NAND gates provide the lock and unlock outputs. Front panel LED CR1, connected between J10 of this module and unregulated +10 Vdc, is illuminated when phase detector outputs indicate an unlocked condition. An on board power supply produces the +15 Vdc and -15 Vdc voltages required by U50. The 100 kHz signal from the reference frequency divider is used to produce about 20V peak of ac signal voltage across the inductive load of Q5. This voltage is rectified by CR4 and converted to a +15 Vdc output by monolithic regulator U51. The Q5 output is ac coupled to negative rectifier CR5, with positive portions of the signal clamped to ground by CR3. Operational amplifier U49 and emitter follower regulate the -15 Vdc output, which is referenced to the positive supply.

2.6 PRESCALER MODULES A1, A2, AND A3

Prescaling is accomplished by three separate modules. Their operation is presented in Figure 2-5 and the table it contains. Control lines from A5 determine which modules will be active, and what prescaling ratio will be employed. On the VHF range, LO input signals from rear panel connector CP3J1 are buffered in A2 and applied to frequency divider A3. It operates in its divide-by-two mode. In the FS-101-2, input signals are applied directly to A3 and it is the only prescaler module. UHF signals may be applied to CP2J1. (Internal cabling options also allow CP3J1 to be used for both VHF



NOTES:

1. ⬭ INDICATES MODULE CONNECTOR.
2. SCHEMATIC DIAGRAMS ARE FIGURES 6-1 (A1) THRU 6-3 (A3).
3. TABLE 2-3 CORRELATES PRESCALER MODULE FUNCTIONS TO TUNER CODES & CONTROL OUTPUTS FROM A5.
4. MODULES A1 & A2 ARE USED ONLY ON FS-102-2.
5. CP2J1 & CP3J1 ARE REAR PANEL INPUT CONNECTORS.

TABLE 2-3

TUNER CODE			CONTROL LINE STATES			DIVISION FACTORS REF DESIG		
2^0	2^1	2^2	A	B	C	A1	A2	A3
1	0	1	0	0	1	—	—	2
0	1	1						
0	0	0	0	1	0	1	2	4
1	0	0	1	1	1	2	2	2

Figure 2-5. Prescaler Modules, Detailed Block Diagram

and UHF inputs.) For low UHF, the frequency division capability of A1 is not used. Module A2 divides by two and A3 changes to the divide-by-four mode. The UHF prescaling ratio of 8 is thus obtained. For high UHF, both A1 and A2 divide by two, and A3 reverts to the divide-by-two mode. An overall prescaling ratio of 8 is thus maintained. Table 2-3 of the detailed block diagram indicates the logic states of the control lines for the different tuner codes.

2.6.1 1160 MHz Binary Divider. - This module provides a divide-by-two function for high UHF input signals to the FS-101/102-2. It can also pass lower frequency signals with no frequency division. This module includes two amplifiers with constant current source biasing and a dynamic frequency divider. The common emitter RF amplifier stages, Q2 and Q4, are biased by current sources Q1 and Q3. The bias transistor for each RF amplifier stage sets up a constant current through a resistor which provides collector supply current to the amplifier transistor. The resistor also supplies base current to the RF transistor in a configuration that establishes an equilibrium condition to regulate amplifier collector current. Diode limiters maintain constant level of the output signal. This prescaler module achieves direct counting over its rated frequency span by use of a frequency divider capable of operating into the UHF range. The circuit structure used is similar to a conventional steered flip-flop, but there are major differences in switching operations. Determination of which transistor will be triggered by the input signal is determined not by initial conduction states of the input diodes, but by charges stored in R-C networks in the emitters of the transistors. Output waveforms from the transistor collectors are not always complementary; instead, they are negative going pulses alternating between the collectors, interspersed with period when both collectors stand high. The extremely high frequency of operation achieved by the dynamic frequency divider is obtained by use of microwave transistors, fast switching Shottky barrier diodes, and a stripline printed circuit board. Potentiometer R18 allows adjustment of the base bias on the two transistors to obtain widest operating frequency range. A defeat line is provided, which when set to a logical zero state, clamps the base of Q6 below the cutoff bias point. Signals then pass through A1 with no frequency division.

2.6.2 660 MHz Binary Divider. - Module A2 contains RF amplifier and dynamic divide-by-two circuits similar to those in A1. A grounded base isolation amplifier is also provided for VHF input signals. Either the isolation amplifier or the dynamic divide-by-two may provide the module output. One signal is selected by a group of diode switches. When the control line at module pins E2 and E4 is in the 1 state, the output of the dynamic frequency divider is selected as the module output. This is the condition on both UHF ranges. For VHF operation, the control line is in the 0 state and the isolation amplifier provides the output to A3.

2.6.3 320 MHz Divide-By-Two-Or-Four. - This module includes a discrete component input amplifier with AGC and two ECL flip-flops. The main signal path through the amplifier is through PIN diode CR1, high gain cascode amplifier Q1 and Q2, and driver Q3 to a clock input of U2. A reference voltage is supplied by CR3 and CR4 and adjusted by R14. This voltage is applied directly to a clock input of U3 to bias it into the center of the range of logic swing. The reference voltage is connected to the AGC circuitry at two points. A fixed voltage is supplied to the inverting input of the AGC amplifier by threshold set potentiometer R12. Detector CR2, which samples the output of driver Q3, is also connected to the reference voltage, and drives the non-inverting input of the AGC amplifier. If the output level of Q3 rises, the positive voltage detected by CR2 causes the output voltage of the AGC amplifier to go more positive. This voltage decreases the current through the PIN diode so that its RF resistance increases. In a forward AGC configuration, the U1 output also increases the current through Q1 so that its gain is reduced. The overall effect of the AGC circuit is to provide a constant input level to frequency divider U2. It is a type D flip-flop capable of toggling at frequencies above 300 MHz. This flip-flop drives a similar IC, U3. Three ECL NOR gates are used to select the output from one flip-flop. The control line from E7 selects the U2 output for divide-by-two operation or the U3 output for divide-by-four operation.

2.7 SERIAL INPUT CONVERTER A6

Module A6 receives data from the associated computer interface unit to determine tuned frequency of the FS-101/102-2. The serial data is converted to parallel format for use by the program counter. Figure 2-7 is a detailed block diagram of the module.

2.7.1 <u>Serial BCD Configuration.</u> - Input data is normally received in a three level code. The three level format allows both data and clock to be transmitted on the same line. Figure 2-6 shows the structure and sequence of the serial bits. When the clock is high, a positive or negative voltage level is used to indicate data value. When the clock goes low, a level of zero volts is received. The bit sequence begins with a logical 1 start pulse. (The first bit of the data stream is shown at the left in Figure 2-6, as it would appear on an oscilloscope display). A unit address is then transmitted to enable the hold register of the module. Use of the unit address allows a single data buss to connect to the inputs of several FS-101/102-2 units. Only the synthesizer enabled by the address prefix will accept the frequency data.

2.7.2 <u>Input Data Processing.</u> - The input signal is applied to a clock and data separator. Two differential line receivers, U1A and U1B, detect the positive and negative levels of the code. Potentiometers R3 and R6 supply reference voltages to set the thresholds for voltage levels accepted. The comparators and the NOR gates in U2 supply binary data and binary clock outputs. Before being applied to the serial to parallel converters, the two binary streams pass through a selector which may accept separate, external binary data and binary clock inputs in place of the three level code.

2.7.3 <u>S/P Conversion and Timing.</u> - Each of the serial to parallel converters, U4 through U7, has eight parallel outputs. The most significant output of each converter, Q_H, drives the input of the next converter. After 32 clock pulses are received, all data has been shifted in and the clock stops. Data present at the Q outputs of the converters now contains the unit address and frequency data. The first data bit has been shifted to the Q_H output of U7. This bit sets flip-flop U15A-U15B. One-shot U38B is then enabled by the flip-flop to generate a parallel load command. This pulse will be applied to the hold register <u>if</u> address recognition has occurred. The unit address is programmed into the FS-101/102-2 by four jumper wires, JW1 through JW4. They

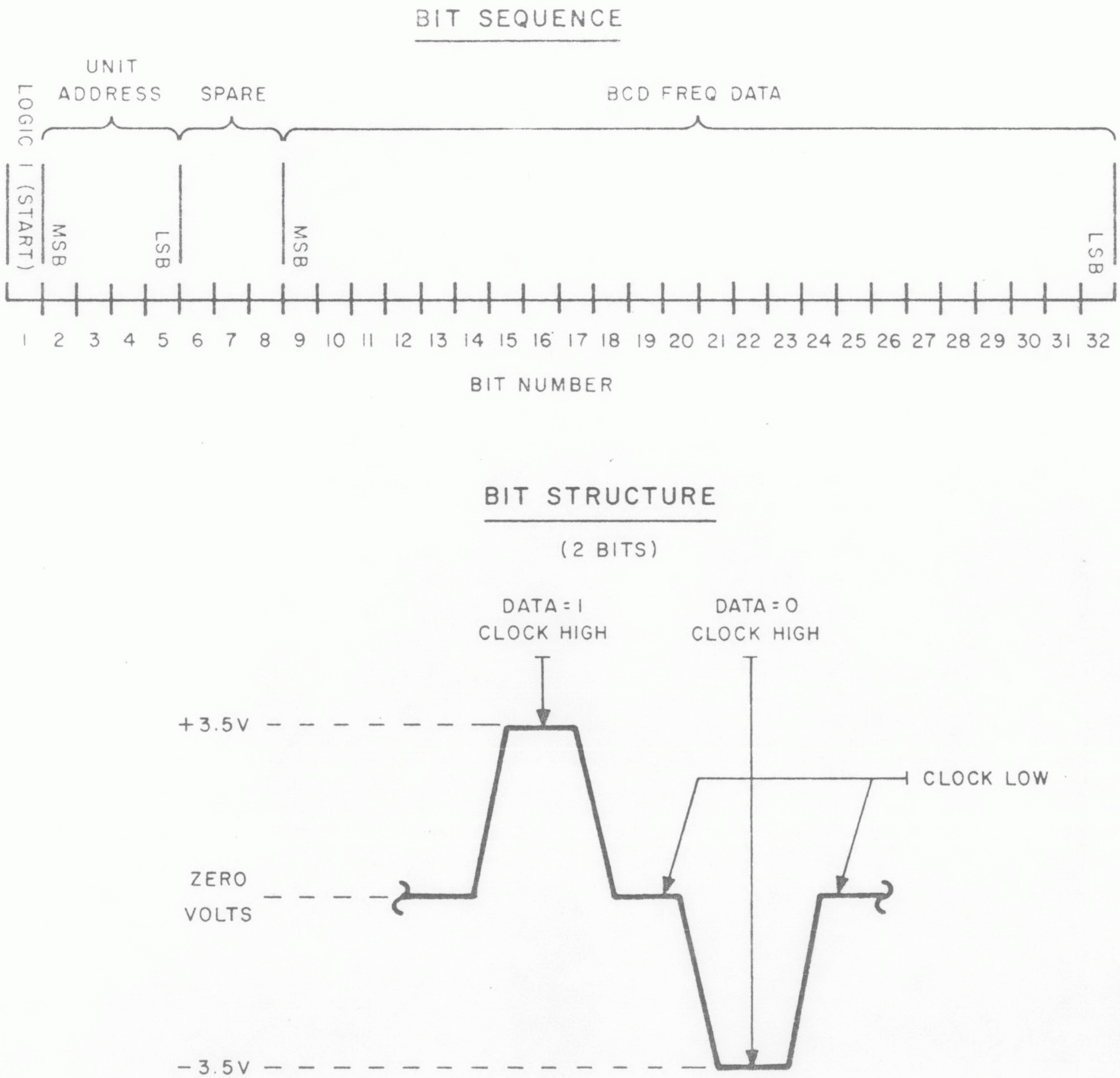


Figure 2-6. Serial Data Configuration

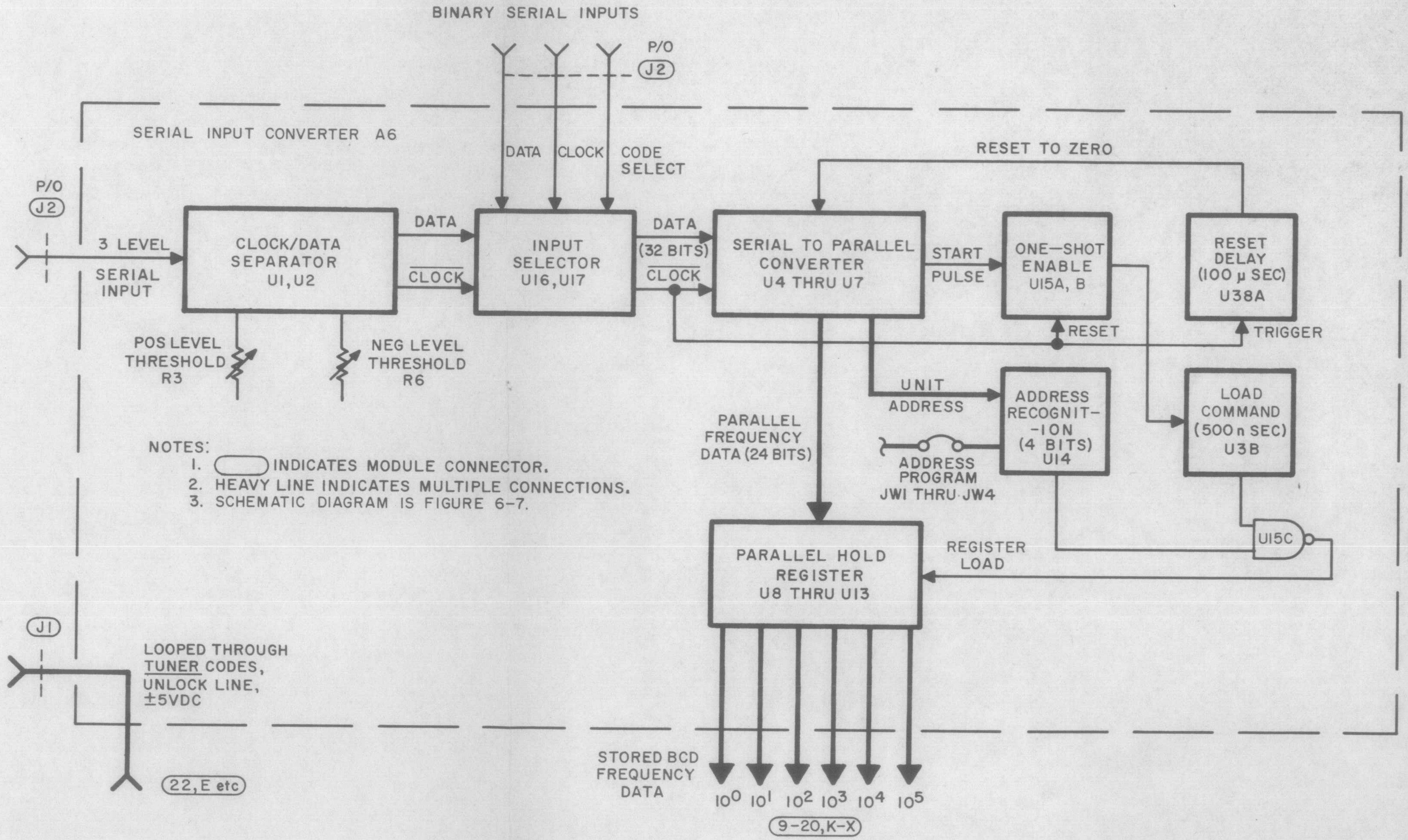


Figure 2-7. Serial Input Converter, Detailed Block Diagram

represent a four bit binary value which is compared to the address held in serial to parallel converter U7. Open collector exclusive NOR gates make the comparison. If the address is valid, the wired OR output from the comparison gates goes high. NAND U15C then passes a low going load enable to the parallel hold register. It consists of six packages, U8 through U3. They are presettable counters whose clock inputs are unused. Data from the serial to parallel converters enters the register during the 500 nanosecond duration of the load pulse. When the load pulse returns to the inactive state, the hold register outputs are stored frequency data, but the register inputs are insensitive to any subsequent data changes. Converters U4 through U7 may now be reset to all zero outputs in preparation for the next serial data burst. One-shot U38A resets the converters. The one-shot is a retriggerable type, and its active low trigger input is used. In its idle condition, it is not triggered, and the $\overline{Q}$ output stands at zero. Reset inputs of the serial converters are therefore in the active state. However, when a serial data burst begins, U38A is triggered by the first clock transition and releases the converters from the reset condition. The clock is high when idle. When the leading edge of the first clock pulse goes low, the one shot is triggered and begins timing out for its 30 μsec period. When the trailing edge of the first clock pulse goes high, the converters shift in the first data bit. Following clock pulses continue to retrigger U38A so that its $\overline{Q}$ output stays high. About 30 μsec after the leading edge of the last clock pulse, the one-shot times out and $\overline{Q}$ falls to the active low state. The converter outputs all go to zero, but this event occurs well after the time that the parallel hold register has been loaded and has become insensitive to input data.

2.8 ±5V SWITCHING REGULATOR A4

This power supply has two regulated outputs. The high current +5 Vdc supply uses switching mode techniques for maximum efficiency. The non-dissipative regulator utilizes a pass transistor that switches between cut-off and saturated states. In either state very little power is dissipated, and the need for elaborate heat sinking is avoided. The square wave output from the switching pass transistor is converted to dc by a low pass filter. A high switching frequency, approximately 20 kHz, is employed. Filter capacitors and chokes are therefore of low value and small size. Figure 2-8 shows a simplified schematic diagram of the switching regulator circuitry. A rectangular wave is present at the emitter of switching pass transistor Q2. During the t_{on} period Q2 is conducting. It supplies current from the unregulated input to the load through L2. Diode CR1 is reversed biased. When Q2 cuts off, the energy stored in the reactive components supplies the output current. Inductor L2 tends to sustain current through itself as its magnetic field collapses, and it becomes a current source. The end of L2 connected to filter capacitor C5 is maintained at +5V. The end of the inductor connected to CR1 is more negative than ground. Therefore the diode is forward biased, clamping the negative end of the inductor to just below ground potential. The negative voltage at this point is consistent with the fact that electron flow--I_e in Figure 2-8--is from plus to minus terminal through a source. The filter components supply a dc output voltage which is the time average of the square wave voltage. Therefore, the output voltage can be increased by increasing the time that Q2 is conducting. The higher the ratio of t_{on} to t_{off}, the higher the output voltage. Additional components shown in the figure give the regulator circuitry the ability to generate its own drive waveform for Q2, and to regulate the output voltage by varying the duty cycle of the square wave. Both functions are accomplished by a positive feedback loop containing a differential amplifier and a voltage reference with a known internal impedance. The differential amplifier compares the reference voltage plus a sample of the Q2 collector signal to the filtered +5V output. Due to the positive feedback, the amplifier develops a drive signal for Q2 which holds the regulated output at +5 Vdc plus and minus a small ripple voltage. Input and output voltages for the switching regulator are extensively filtered for RFI. A second output from the module, -5 Vdc, is provided by simple series regulator using a Zener diode and an emitter follower.

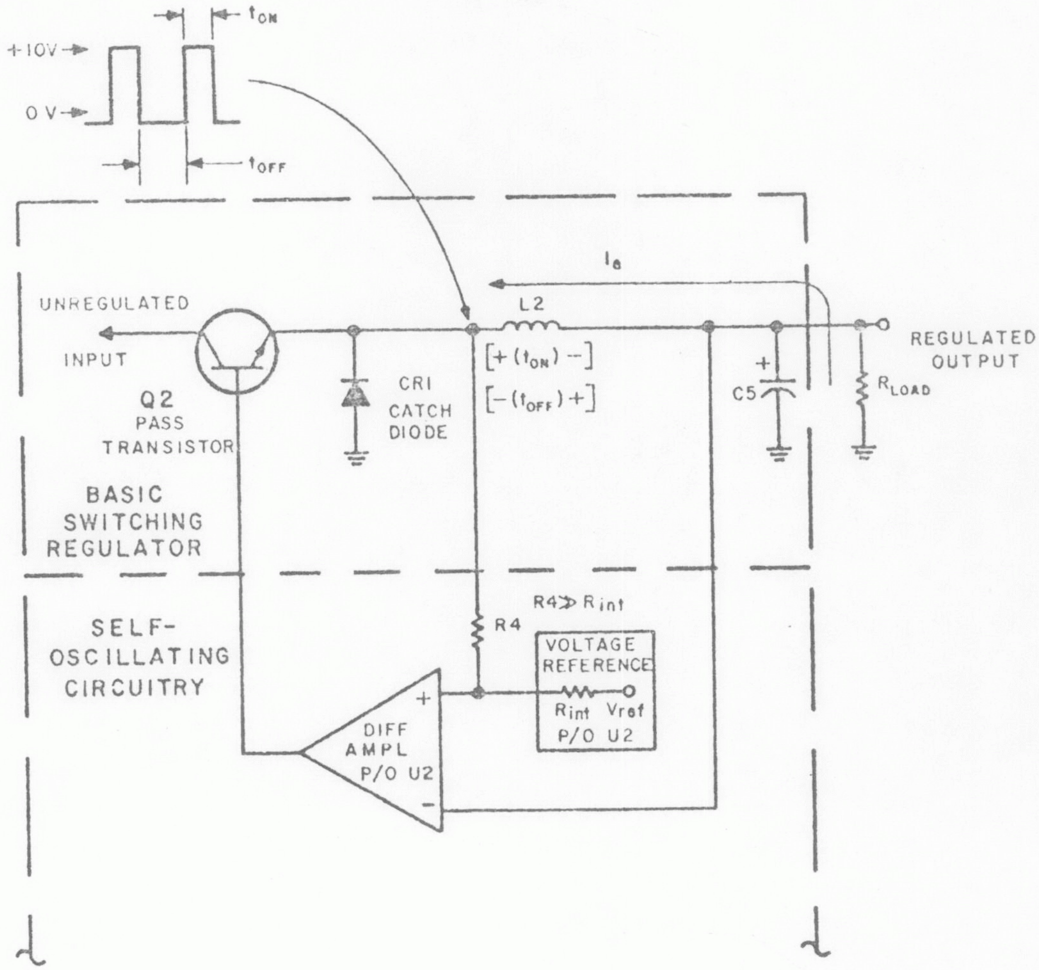


Figure 2-8. Switching Regulator, Simplified Schematic Diagram

SECTION III

INSTALLATION AND OPERATION

3.1 UNPACKING AND INSPECTION

3.1.1 Examine the shipping carton for damage before the equipment is unpacked. If the carton has been damaged, try to have the carrier's agent present when the equipment is unpacked. If not, retain the shipping cartons and padding material for the carrier's inspection if damage to the equipment is evident after it has been unpacked.

3.1.2 See that the equipment is complete as listed on the packing slip. Contact Watkins-Johnson Company, Rockville, or your Watkins-Johnson representative with details of any shortage.

3.1.3 The unit was thoroughly inspected and factory adjusted for optimum performance prior to shipment. It is, therefore, ready for use upon receipt. After uncrating and checking contents, against the packing slip, visually inspect all exterior surfaces for dents and scratches. If external damage is apparent, make an internal inspection. Check the internal cables for loose connections and the printed wiring boards which may have been loosened from their receptacles.

3.2 INSTALLATION

3.2.1 Rack/Mounting Support. - Rack mount equipment, manufactured by WJ-Rockville, is designed for assembly in standard 19-inch racks in accordance with MIL-STD-189, or E.I.A. Standard No. RS-310. It is recommended that chassis slides be added for ease of assembly, access to the unit, and to provide additional support for the installation. Mobile installations of the equipment should be evaluated on an individual basis. Additional information, such as recommended mounting methods, may be found in WJ-Rockville Application Note 1302.50. The critical dimensions drawing Figure 3-2, gives characteristics of significance in mounting. Weight of the unit is 11.5 lbs.

3.2.2 Thermal Considerations. - WJ-Rockville equipment is designed for operational temperatures from 0°C to +50°C (32°F to 122°F). The operational temperature range is further qualified for free, unrestricted ambient air at sea level pressure. Equipment installation should provide for free flow of air around and through ventilated units. Multiple stacking, particularly close adjacent stacking of electronic equipment in a standard console, can produce an appreciable increase in the ambient air temperature for the units compared to the ambient air in the vicinity of the console. Forced-air ventilation may be necessary to maintain the proper ambient air temperature in a console which accommodates equipment that contributes to a high thermal density. Additional information may be obtained from WJ-Rockville in Application Note 1303.50.

3.2.3 Power Connection. - Before energizing the equipment, it is necessary to set the unit to match the input power voltage to be used. The equipment can operate from either a 115 or 220 Vac, 50-400 Hz source. A rear-panel switch must be set accordingly. Additionally, the unit has a tapped-primary main power transformer which can be set for 230 Vac operation where high line voltage is common. Consult the main chassis schematic diagram. After setting the unit for the proper input voltage, make sure that the PUSH ON/OFF POWER switch is off (more projecting position) before making the power connection. The power plug may now be connected to the ac outlet. The third pin on the unit power plug supplies a safety ground connection. If the two pin to three pin adapter supplied with the unit must be used, be certain that the ground wire of the adapter is securely connected to a low impedance ground.

3.2.4 System Connections. - The FS-101/102-2 requires interconnection with its associated type 208-(X)-1 Receiver and Type WJ-9565 Computer Interface Unit.

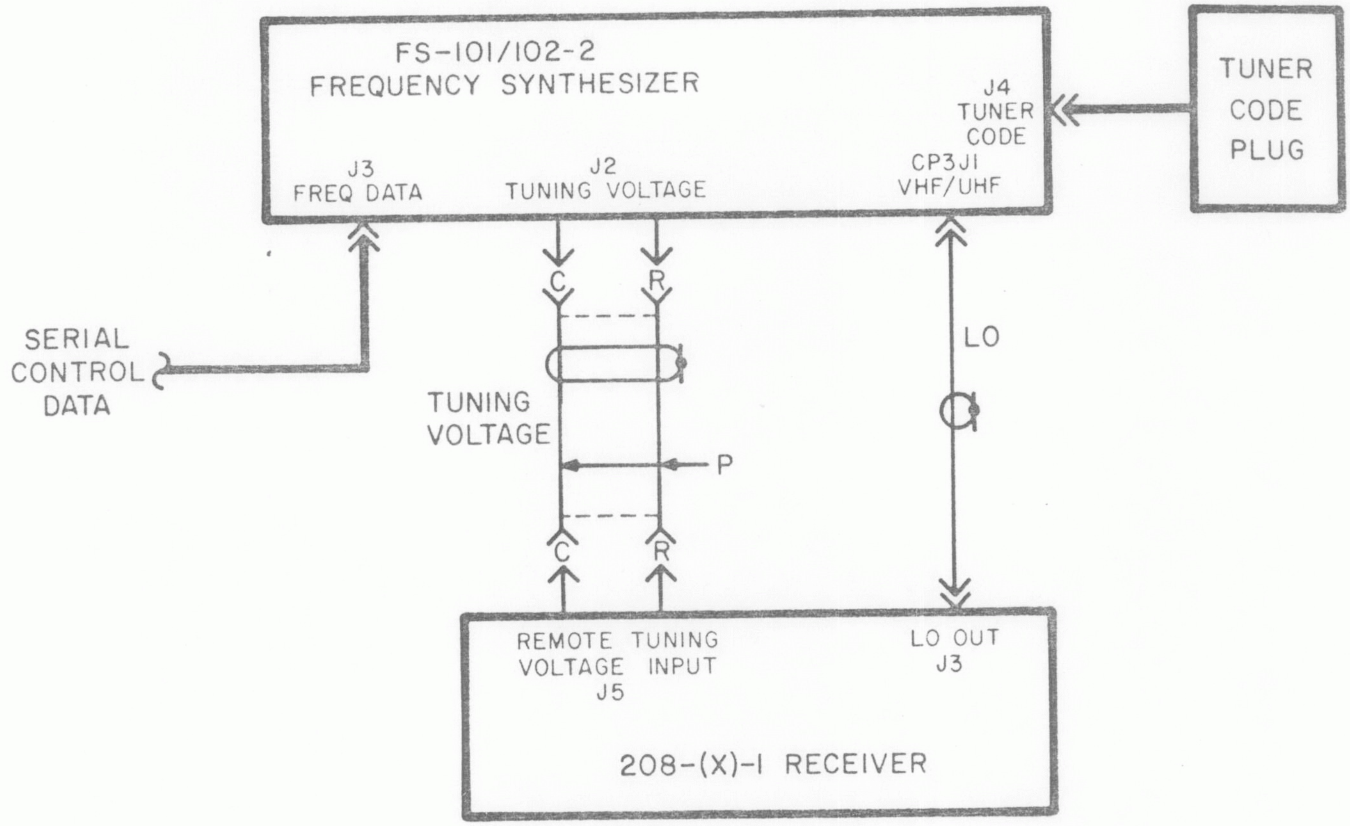
3.2.4.1 Receiver Compatibility. - While the FS-101-2 can be used only with VHF models of the 208-(X)-1 Receiver, the FS-102-2 can be used with VHF or UHF receivers from this series. Refer to the table below to verify that synthesizer, receiver, and tuner code plug installed together are compatible. The FS-101/102-2 unit requires

Table 3-1. Synthesizer/Receiver Compatibility

Frequency Synthesizer	FS-101-2	FS-102-2	Tuner Code
Compatible Receivers	208-2-1	208-2-1	1
	208-3-1	208-3-1	2
	208-4-1	208-4-1	3
		208-5-1	4
		208-6-1	5

that a tuner code plug be attached to a rear panel connector to indicate which 208-(X)-1 Receiver is mated to the synthesizer. Internal jumper wires in the plug provide the 3 bit binary tuner code. The plug is marked "TUNER CODE 1", etc. Install the plug by mating it with rear panel connector J4 of the FS-101/102-2. For Types 208-2-1 through 208-6-1 Receivers, tuner code plugs have the WJ-Rockville part numbers 23491-1 through 23491-5. Thus the part number suffix digit is the same as the tuner code number. Plugs are normally supplied with the WJ-9565 Computer Interface Unit per system requirements.

3.2.4.2 System Cabling. - Figure 3-1 shows how the FS-101/102-2 Frequency Synthesizer is cabled to the associated 208-(X)-1 Receiver. Internal connections to the serial CONTROL DATA cable are specified in Instruction Manual for the WJ-9565 Computer Interface Unit.



NOTES:

(1) The TUNING VOLTAGE cable is constructed using Trompeter Electronics Triaxial Series Plugs, Part PL-76, Mfr. Code 14949; see paragraph 5.3. Interconnecting cable must have double center conductor with shield; Type RG-108A/U is recommended.

(2) The LO cable is constructed using BNC connectors, Type UG-88/U, and double shielded cable, Type RG-55/U.

(3) The connector for the SERIAL CONTROL DATA cable is Deutsch Company Plug, Part DS07-12P-059, Mfr. Code 11139; see paragraph 5.3

(4) FS-102-2 units should be configured to use CP3J1 as common VHF/UHF connector per Note 6 of main chassis schematic diagram, Figure 6-9.

Figure 3-1. System Cabling for Types FS-101/102-2 Frequency Synthesizers

CAUTION

Shielding of the TUNING VOLTAGE cable is critical, as any induced noise may degrade spectral purity of the receiver LO signal. Although the dual center conductor cable and associated circuitry have high common mode rejection, care should be exercised to avoid locating cable run through areas with high EMI potential.

3.2.4.3 Standard Frequency Input/Output. - If rear panel switch S3 of the unit is set to INT, a 1 MHz standard frequency output may be obtained at BNC connector J1. The sine wave signal has a frequency stability of ±1 PPM over the temperature range of 0°C to 50°C. Output level is at least 75 mVrms into a 50 ohm load. If an external 1 MHz standard frequency with extremely high stability is available, it may be used as the FS-101/102-2 reference frequency. Set S3 to EXT and connect the external reference signal as an input to J1. The level of the external signal must be at least 100 mVrms into a 50 ohm load.

3.3 OPERATION

3.3.1 Operator Controls. - The only front panel operator control is the PUSH ON/OFF POWER switch. It is illuminated when power is on.

3.3.2 Loss of Lock Alarm. - Failure of the receiver/synthesizer loop causes an alarm indication by a red LED on the front panel. If this UNLOCK INDICATOR is illuminated, phase lock has been lost and the tuned frequency of the receiver is uncontrolled. Continuous illumination of the UNLOCK indicator indicates reception of invalid control data, or equipment failure. Refer to troubleshooting information in paragraph 4.5.

NOTE

Under normal operating conditions, the UNLOCK INDICATOR will momentarily flash during a change of frequency step.

3.4 PREPARATION FOR RESHIPMENT AND STORAGE

3.4.1 If the unit must be prepared for reshipment, the packaging methods should follow the pattern established in the original shipment. If retained, the original materials can be reused to a large extent or will at a minimum provide guidance for the repackaging effort.

3.4.2 Conditions during storage and shipment should normally be limited as follows:

(1) Maximum humidity: 95% (no condensation)
(2) Temperature range: -30°C to +85°C

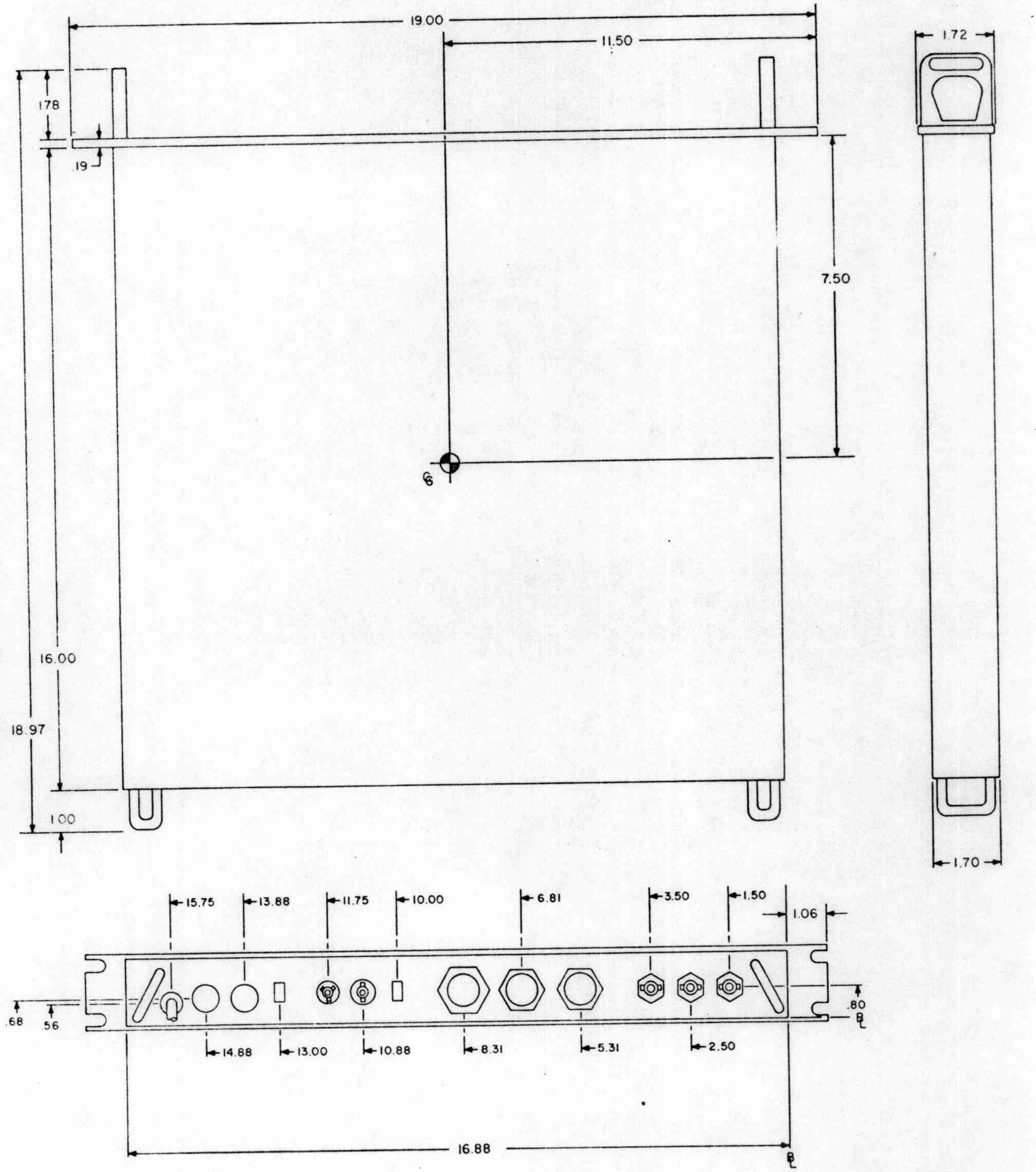


Figure 3-2. Type FS-101/102-2 Frequency Synthesizers, Critical Dimensions

SECTION IV

MAINTENANCE

4.1 GENERAL

The Types FS-101/102-2 Frequency Synthesizers have been conservatively designed to operate for extended periods of time with little or no routine maintenance. An occasional cleaning and inspection are the only preventive maintenance operations recommended. The intervals for these operations should be based on the operating environment. Should trouble occur, repair time will be minimized if the maintenance technician is familiar with the circuit descriptions found in Section II. Reference should also be made to the functional block diagrams, and to the schematic diagrams found in Section VI. A complete parts list and illustrations showing part locations can be found in Section V.

4.2 CLEANING AND ROUTINE REPLACEMENTS

4.2.1 Cleaning. - The unit should be kept free of dust, moisture, grease, and foreign matter to ensure troublefree operation. If available, use low velocity compressed air to blow accumulated dust from the exterior and interior of the unit. A clean, dry cloth, a soft bristled brush, or a cloth saturated with cleaning compound may also be used. The FS-101/102-2 do not require lubrication.

4.2.2 Lamp Replacement. - The only component of the FS-101/102-2 which may normally require replacement is the long life lamp internal to the self illuminated pushbutton switch on the front panel. To change the lamp in the PUSH ON/OFF POWER switch, first set the unit to off (the pushbutton extends further outward from the front panel when in the off position). Then grasp the red pushbutton of the switch and pull firmly. The pushbutton will release, and the lamp contained in the button can be removed by gripping the flange of the lamp base with fingers or pliers. Insert a replacement bulb into the button and press it into the opening in the switch body. The bulb will illuminate, and the button will remain latched into the switch.

4.3 INSPECTION FOR DAMAGE OR WEAR

Many potential or existing troubles can be detected by a visual inspection of the unit. For this reason, a complete visual inspection should be made for indication of mechanical and electrical defects on a periodic basis, or whenever the unit is inoperative. Electronic components that show signs of deterioration, such as overheating, should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Modules should be firmly mounted, and connectors on cables should make secure contact. Damage to parts due to heat is often the result of other less apparent troubles in the circuit. It is essential that the cause of the overheating be determined and corrected before replacing the damaged parts. Mechanical parts, including front panel controls and switches, should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

4.4 ALIGNMENT AND ADJUSTMENT PROCEDURES

4.4.1 General. - The alignment procedures given here are suitable when making adjustments after replacing transistors or other components. Alignment should be performed only with suitable equipment by technicians familiar with the unit. Malfunctions indicated by the performance tests in subsection 4.4, or diagnosed by troubleshooting procedures, section 4.5, may be corrected by execution of the alignment procedures.

WARNING

Avoid contact with the two heat sinks on card A4. They reach sufficiently elevated temperatures to become an operator hazard after sustained operation.

4.4.2 Test Equipment Required. - The following instruments or their equivalents are required to perform adjustments on the FS-101/102-2 Frequency Synthesizers:

(1) Receiver(s) Watkins-Johnson Type 208-(X)-1. (Receivers of all ranges to be used with FS-101/102-2 under alignment are required).

(2) Computer Interface Unit, WJ-9565, and appropriate controlling computer, and Tuner Code plugs.

(3) Digital Multimeter, Fluke 8100A.

(4) Oscilloscope, Hewlett-Packard Model 180A, with 1801A Dual Channel Vertical Amplifier and 1821A Time Base and Delay Generator.

(5) Signal Generator, Hewlett Packard Model 608E.

(6) Signal Generator, Hewlett Packard Model 612A.

(7) Frequency Counter, Hewlett Packard Model 5245L with Models 5253B and 5254C Heterodyne Converter Plug-Ins.

4.4.3 Adjustment of ±5V Switching Regulator A4. -

(1) Connect the digital multimeter probe to forked terminal E4 of prescaler module A3.

(2) Adjust the only potentiometer on power supply module A4 for a reading of +5.0 Vdc on the digital multimeter. Insert the adjustment tool for the potentiometer through the access hole in the chassis side wall.

4.4.4 Adjustment of Serial Input Converter A6. -

(1) Interconnect the FS-101/102-2 and the computer control equipment as shown in Figure 4-1. Set the control equipment to send serial data bursts at maximum repetition rate.

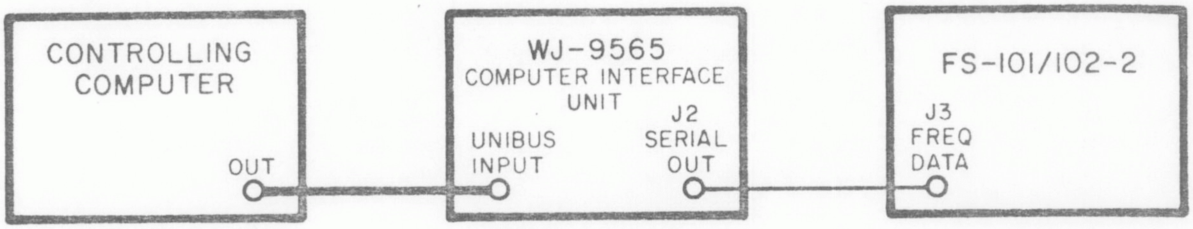


Figure 4-1. Equipment Setup for Alignment of Serial Input Converter

(2) Set control equipment for the appropriate address code for the FS-101/102-2 under test. Use a frequency value of 155.555 or 0555.55 MHz.

(3) Connect the oscilloscope to U2 pin 2 of module A6.

(4) Set potentiometers A6R4 and A6R6 fully clockwise.

(5) While observing the oscilloscope, rotate the actuator of A6R4 counterclockwise. When low-going pulses appear on the scope, use the DVM to measure the voltage at U1 pin 2. Record the voltage.

(6) Continue to adjust the potentiometer in the same direction until noise spikes appear on the pulse train. Again measure and record the voltage at U1 pin 2.

(7) Compute the mean of the voltages recorded in steps 5 and 6. Reset the potentiometer so that the DVM indicates the computed value at U1 pin 2.

(8) Move the oscilloscope connection to A6U2 pin 3.

(9) Repeat steps 5 through 7, but adjust potentiometer A6R6. Take voltage readings at U1 pin 12. (All readings will be negative).

(10) Move the oscilloscope connection to A6U2 pin 1.

(11) Verify that a continuous train of 32 clock pulses is present during each data burst. No gross asymmetry should be observed.

4.4.5 <u>Alignment of Prescaler Modules A1, A2, A3.</u> -

4.4.5.1 VHF Alignment. -

Initial Equipment Setup. -

(1) Connect a tuner code plug to J4 of the FS-101/102-2. The tuner code plug should be for tuner code 1, 2, or 3.

(2) Interconnect equipment as shown in Figure 4-2.

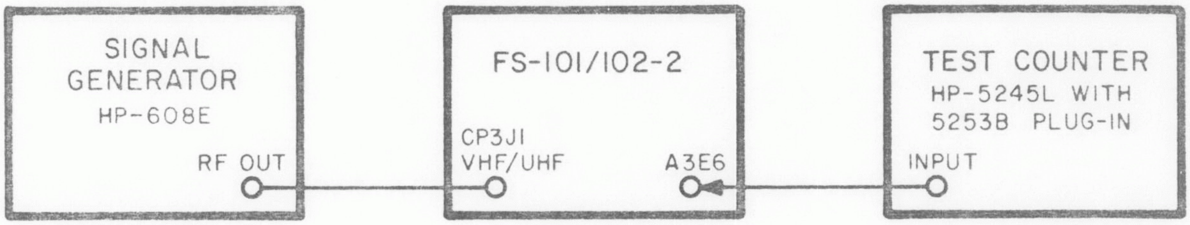


Figure 4-2. Equipment Setup for Alignment of VHF Prescaler Module A3.

Adjustment Operations, Bias and AGC Threshold. -

(1) Adjust the signal generator controls for a CW output signal with a level of 100 mVrms.

(2) Tune the signal generator to 325 MHz, or to the highest frequency that will give a stable readout on the test counter.

NOTE

The reading on the test counter will be 1/2 the frequency of the signal generator output.

(3) Increase the frequency of the signal generator output until the count just fails.

(4) Refer to Figure 5-9 to identify potentiometers A3R12 and A3R14.

(5) Adjust bias set potentiometer A3R14 to restore a stable count. Determine the range of rotation of the control that provides proper function and set the control to the center of this range.

(6) Repeat step (5), but adjust AGC threshold set potentiometer A3R12.

(7) Repeat steps (3), (5), and (6), until no further increase in maximum count frequency can be obtained. Note that an adjustment of A3R14 must always be followed by an adjustment of A3R12.

Adjustment Operations, Emitter Trimmer Capacitors. -

(1) Tune the signal generator to 180 MHz.

(2) Reduce the output level of the signal generator until the count displayed by the test counter just fails.

(3) Refer to Figure 5-9 to locate trimmer capacitors A3C4 and A3C5.

(4) Adjust A3C5 to restore a stable count.

(5) Repeat steps (2) and (4) until no lower input level can be counted.

(6) Tune the signal generator to 325 MHz and repeat steps (2), (4), and (5), adjusting A3C4.

(7) Vary the signal level from 35 mVrms to 500 mVrms and verify that stable prescaling can be obtained.

Prescaler Alignment of the FS-101-2 is now complete.

NOTE

Following paragraphs apply only to the FS-102-2.

4.4.5.2 Low UHF Alignment. -

(1) Replace the tuner plug at J4 with a plug for tuner code 4.

(2) Refer to Figure 5-8 to locate potentiometer A2R10 and A2C10.

(3) Connect the multimeter probe to the junction of these two components.

(4) Adjust the potentiometer for a reading of +1.65 Vdc. Disconnect the multimeter.

(5) Interconnect equipment as shown in Figure 4-1, but connect the HP-612A Signal Generator to input connector CP3J1 of the FS-102-2 unit.

NOTE

For subsequent steps, input cables of the FS-102-2 should be configured for separate VHF and UHF inputs. See Note 6 of Figure 6-9.

4.4.6 Adjustment of Loop Filter, Part of A5. -

NOTE

Adjustment of the loop filter should be performed with all 208-(X)-1 Receivers to be used with the FS-101/102-2 unit under alignment. The test should be performed with each -(X)- version of the receiver so that control settings which give satisfactory operation with each receiver can be obtained.

4.4.6.1 Initial Equipment Setup. -

(1) Interconnect equipment as shown by solid lines in Figure 4-3. Use the tuner code plug corresponding to the receiver under test.

(2) Set the 1 MHz reference switch, S3 of the FS-101/102-2, to INT.

(3) Set the oscilloscope for external positive dc triggering and dc vertical coupling.

4.4.6.2 Adjustment Operations. -

(1) Using the computer and computer interface unit, tune the synthesizer to the low step test frequency shown in Table 4-1.

(2) While observing the tuning voltage on the oscilloscope, command a tuning step to the high test frequency.

(3) Measure the time required for the tuning voltage to settle at the value required for the high step test frequency. The time shall be no more than 100 milliseconds. Refer to Figure 4-4 for an illustration of tuning voltage characteristics during a frequency step.

(4) If the acquisition time is satisfactory, proceed to step (5). If satisfactory results are not obtained, repeat steps (1) and (2) while adjusting the controls specified in Table 4-2. Adjust the controls in small increments as many times as required, each time repeating steps (1) and (2) above.

NOTE

Attempts to adjust controls for excessively small acquisition times may result in over-correction and loop oscillation. It will then be impossible to obtain stable tuning voltages.

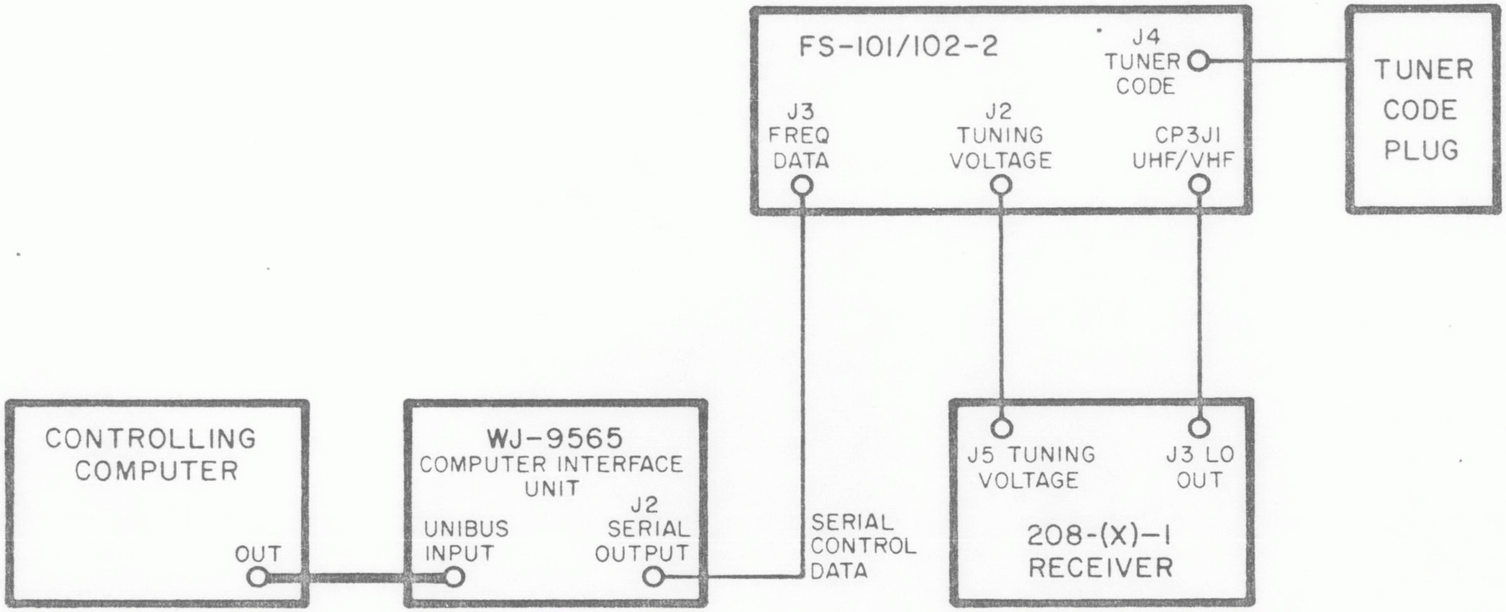


Figure 4-3. Equipment Interconnection for Acquisition Time Test

Table 4-1. Test Frequencies, Adjustment of Acquisition Time

208-(X)-1 Receiver

	-2-	-3-	-4-	-5-	-6-
Low Step Test	070.000	113.000	200.000	0292.00	0583.00
High Step Test	110.000	167.000	280.000	0458.00	0917.00
Lower Band Edge	060.000	100.000	180.000	0250.00	0500.00
Upper Band Edge	120.000	180.000	300.000	0500.00	1000.00
LO Test Freq.	141.400	201.400	321.400	0660.00	1160.00
LO Error	± 1 kHz	± 1 kHz	± 1 kHz	± 10 kHz	± 10 kHz

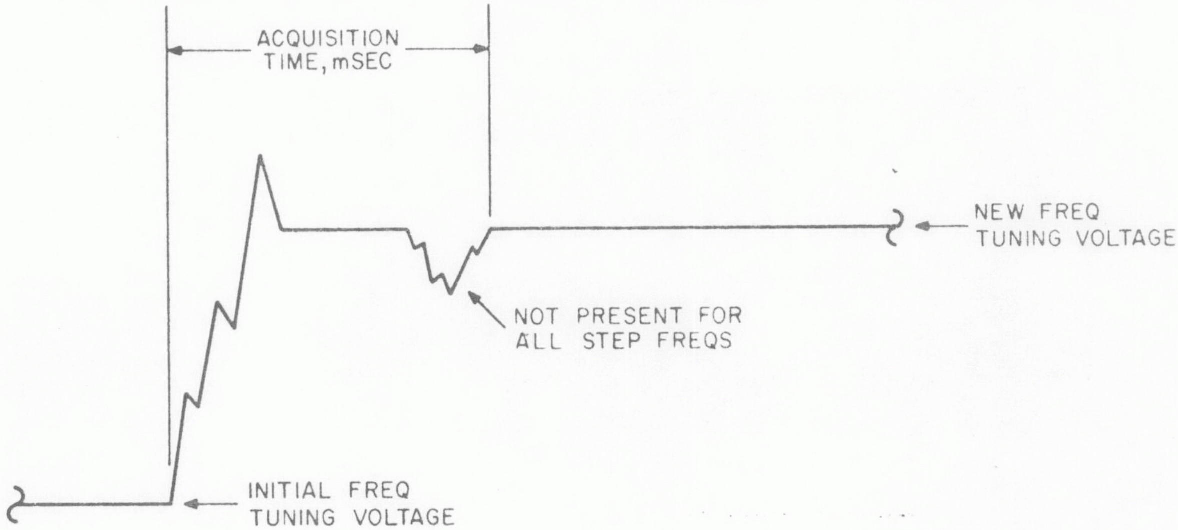


Figure 4-4. Tuning Voltage Step Characteristic

(5) Repeat all steps above, but use the high step test frequency as the initial setting and command a tuning step to the low step step test frequency. The tuning voltage characteristic will be inverted from that shown in Figure 4-4.

(6) Tune the FS-101/102-2 to the lower band edge frequency as given in Table 4-1. Command a step to a frequency 10 kHz higher and measure the acquisition time. Step down 10 kHz and measure the acquisition time. Both shall be less than 10 milliseconds. If not, make readjustments per Table 4-2.

(7) Tune the synthesizer to the upper band edge frequency per Table 4-1.

Table 4-2. Loop Filter Adjustments

Effects	Component	Rotation
Decrease Acquisition Time, Upward Freq Step	A5R28	CW
Decrease Acquisition Time, Downward Freq Step	A5R25	CW
Decrease Acquisition Time, Both Up and Down Freq Step	A5R24	CCW

(8) Connect a 50 ohm T-pad and test counter to the receiver LO output, maintaining the connection to the synthesizer. Use the HP-5245L Frequency Counter and the 5253B or 5254C plug-in, depending on frequency specified in the following step.

(9) Measure the receiver LO frequency. It shall equal the LO test frequency given in Table 4-1, plus or minus the specified LO error.

4.5 TROUBLESHOOTING

4.5.1 Introduction. - Troubleshooting and corrective maintenance are indicated when the FS-101/102-2 gives a loss of lock alarm, fails to respond to input data, or produces an unstable receiver LO signal. Since in normal operation the synthesizer is part of a complex closed loop, it may be impossible to simulate actual operation during troubleshooting. Therefore it is advisable when locating faults to attempt to isolate individual portions of the overall loop.

4.5.2 Test Equipment Required. - The following instruments, or their equivalents, are required to troubleshoot the FS-101/102-2 Frequency Synthesizers.

(1) Computer Interface Unit, WJ-9565, and appropriate controlling computer, and Tuner Code Plugs.

(2) Digital Multimeter, Fluke 8100A.

(3) Power Supply, Hewlett Packard Model 6206B.

(4) Oscilloscope, Hewlett Packard Model 180A, with 1801A Dual Channel Vertical Amplifier and 1821A Delayed Time Base.

(5) Signal Generator, Hewlett Packard Model 608E.

(6) Signal Generator, Hewlett Packard Model 612A.

(7) Frequency Counter, Hewlett Packard Model 5245L with Model 5253B Heterodyne Converter Plug-In.

(8) Spectrum Analyzer, composed of Hewlett Packard Model 8554L Tuning Section, Model 8552B IF Section, and Model 140T Display Section.

4.5.3 System Equipment. - Apparent failure of the FS-101/102-2 may actually be caused by a fault in associated equipment. The problem may be invalid input data from the computer interface unit or improper response of the receiver to the tuning voltage from the synthesizer.

4.5.3.1 Input serial data should be checked for three characteristics:

(1) Correct data levels of zero volts, +3.5 volts for logical one, and -3.5 volts for logical zero.

(2) Correct start pulse and binary address code.

(3) Valid BCD frequency word.

Monitor the serial data by connecting the oscilloscope to main chassis feedthrough capacitor C29 of the FS-101/102-2. Use a time base of 20 μsec/cm and a vertical sensitivity of 2 volts/cm. A display similar to Figure 4-5 should be observed. Check for the start pulse and read the code value for the binary address. It must agree with address programmed into the FS-101/102-2 by jumper wires on A5. The address code is stamped on the rear panel of the unit. Read the BCD frequency data code. It must be compatible with the associated 208-(X)-1 receiver and tuner code plug. Also, the value must be less than 300 MHz for the FS-101-2 and less than 1000 MHz for the FS-102-2. Additional information can be obtained from the instruction manual for the WJ-9565 Computer Interface Unit.

4.5.3.2 The associated receiver should be checked for correct response to tuning voltage and LO output level. Connect a variable power supply and a DVM to J2, REMOTE TUNING VOLTAGE INPUT, of the 208-(X)-1 Receiver. Connect to the two inner conductors of the jack, using the center contact (pin C) for the applied voltage, and the ring contact (pin R) for ground. Connect the frequency counter with plug-in to J3, LO OUT, of the receiver. Adjust the power supply voltage for +10.00V, as indicated by the DVM. Verify that the counter indicates a high band edge LO frequency as indicated in Table 4-3.

Table 4-3. Receiver LO Frequency Checks

Receiver Type	High Band Edge LO Freq	Low Band Edge LO Freq	Mid-Band LO Freq
208-2-1	141.4	81.4	111.4
208-3-1	201.4	121.4	161.4
208-4-1	321.4	201.4	261.4
208-5-1	660	410	535
208-6-1	1160	660	910

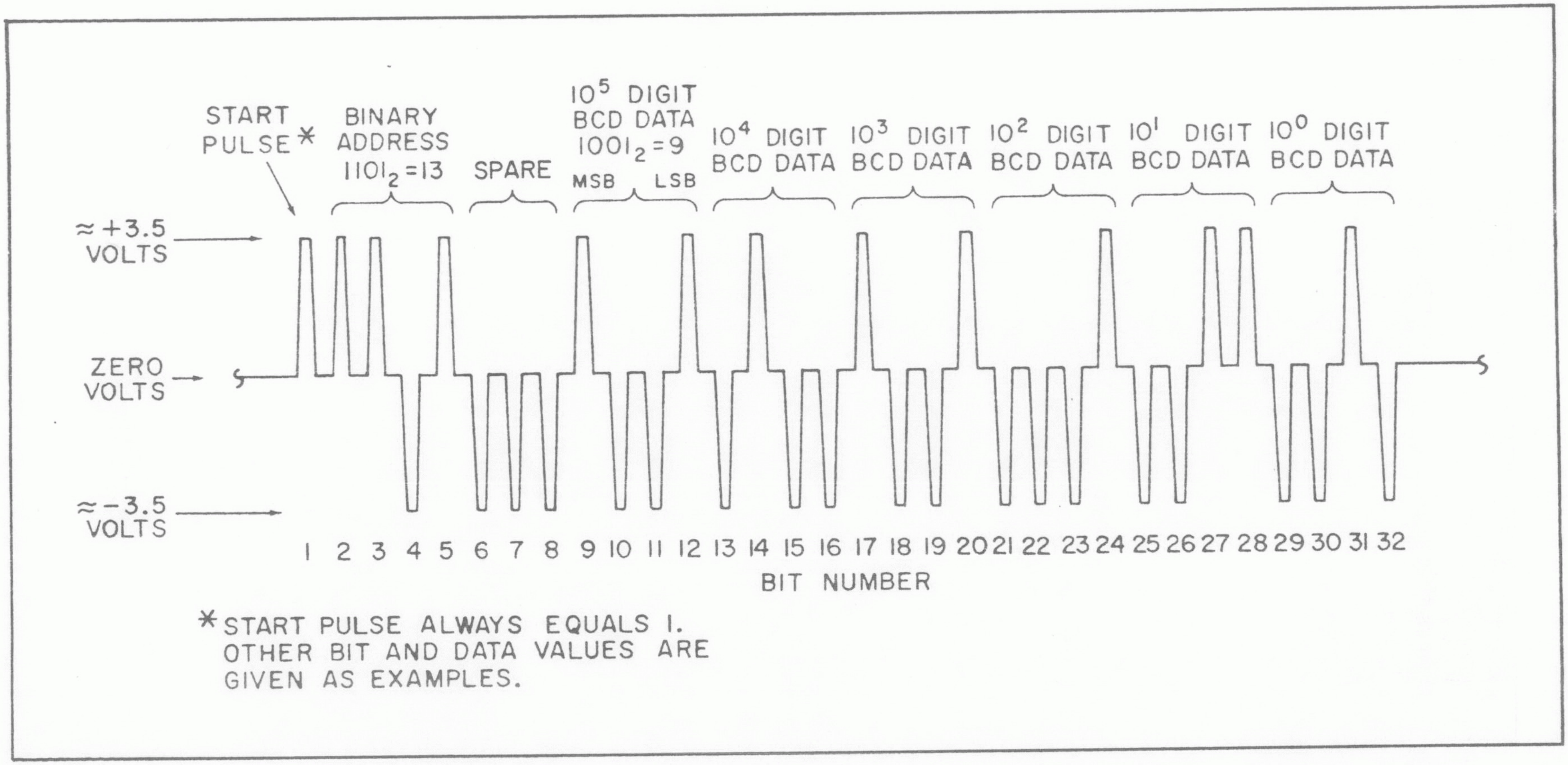


Figure 4-5. Serial Input Data Value Checks

Tolerance is ±1%. Adjust the power supply to provide an output of -10.00V. Verify that the low band edge LO frequency per the table is obtained. Disconnect the power supply and DVM. Short together the center and ring contacts of the receiver tuning voltage jack. The LO mid-band frequency should be obtained, equal to the value shown in the table ±2%. Disconnect the counter and connect the RF voltmeter to J3, the LO OUT jack of the receiver. A level of at least 50 mVrms should be indicated. See the instruction manual for Type 208-(X)-1 Receivers if further troubleshooting information is required.

4.5.4 Visual Inspection. - If system equipment is not at fault proceed with a thorough visual inspection of the FS-101/102-2. This method is valuable in avoiding additional damage which might result from continued operation of the equipment. Look for burned or crushed components, broken wires, loosened retaining brackets on plug-in modules, improper mating of connectors, etc.

4.5.5 Static Voltage and Frequency Checks. - Fixed voltage and frequencies within the FS-101/102-2 may be checked with the loop in an unlocked condition. Using the DVM, check the outputs of power supply A4 at nearby feedthrough filters. At FL8 and FL9, +5V should be present. Check for -5V at FL7. On board A5, verify +15V at TP7 and -15V at TP8. Also on this board, connect the oscilloscope to TP5 and check for a 1 MHz square wave at TTL levels. If the rear panel time base switch is set to EXT, an external standard frequency must be applied to rear panel jack J1. Connect the scope at TP10 and observe the reference frequency. It should be a 500 Hz square wave when a plug for tuner code 1 through 3 is installed at J4; for tuner codes 4 and 5 the frequency should be 1250 Hz.

4.5.6 Input Data Conversion Checks. - Once normal power supply voltage and reference frequencies are verified, input data conversion should be checked. Test points listed below are all on board A6. All checks are made with the oscilloscope while applying serial data bursts with the proper address code prefix to the FS-101/102-2. Pulse trains and logic states should conform to nominal TTL levels. At U15, pin 1, the 32 bits of the clock signal should be observed. The wave should have a period of about 5 μ sec, and should be high when idle. Input data can be observed at U4 pin 1. A 500 nanosecond load command for the parallel register must occur at U15C pin 11after each properly addressed data burst. This pulse is low-going. If it is used to trigger the oscilloscope, a negative transition will occur at U3 pin 4 about 30 microseconds later. This transition resets the serial to parallel converter IC's. Finally, states of the parallel data output lines can be read and compared to the known value of the input frequency data. Parallel data is accessable at the pins of IC's U8 through U13. The schematic diagram for A6, Figure 6-7, gives data weights of the lines.

4.5.7 Prescaler Checks. - Before applying input signals to the prescaler modules, the logic states of the control lines should be checked. Install a tuner code plug for a tuner code 1 through 3 at J4 of the FS-101/102-2; then make VHF checks. Control line states should read as follows, where 0 = +0.4V or less, and 1 = +2.6V or greater:

FL1 = 0	FL2 = 0	FL6 = 1
(Control A)	(Control B)	(Control C)

Break the signal connection from A3 to A5 by disconnecting clip J17. Connect the test counter to A3E6 (signal out) and A3E8 (ground). Apply a 320 MHz CW signal with a level of 100 mVrms to CP3J1. The test counter should indicate an output frequency of 160 MHz.

NOTE

Following checks apply only to the FS-102-2. Leave the test equipment connected, as specified above.

Proceed to UHF checks by replacing the tuner code plug with one for tuner code 4. Control line states should read as follows:

FL1 = 0 (Control A)	FL2 = 1 (Control B)	FL6 = 0 (Control C)

Leave the test counter connected, and also connect the spectrum analyzer at A2E6 (signal) and A2E7 (ground). Apply a CW input signal at 660 MHz to CP3J1. Use a level of 100 mVrms. At the A2 output, the spectrum analyzer should indicate an output signal at 330 MHz with a level of about -13 dBm. The second harmonic content will be within 10 dB of that level. At the output of A3, the test counter should indicate about 82 MHz (one-eighth of the input frequency). Replace the tuner code plug with one for tuner code 5. Control line states should read as follows:

FL1 = 1 (Control A)	FL2 = 1 (Control B)	FL6 = 1 (Control C)

Connect the spectrum analyzer to A1E5. Change the input frequency to 1160 MHz. The spectrum analyzer should display an output at 580 MHz with high second harmonic content. Levels will approximate those of A2. The test counter should indicate an output from A3 at a frequency of 145 MHz (again, one-eighth of the input frequency). After prescaler troubleshooting checks are complete, restore the connection from P12 to board A5.

4.5.8 Program Counter Checks. - The portion of A5 designated as the program counter is checked primarily by observation of waveforms. Figure 6-5 shows the portion of the circuit to be checked by the following procedures. Waveforms obtained are illustrated in idealized form in Figure 4-6. To provide the A5 input signal, apply a 10 MHz, 100 mVrms signal to CP3J1. A tuner code plug for tuner code 1 through 3 should be installed. Next check for a stable TTL clock waveform at U3A, pin 2. If it is absent, vary the input level or increase the input frequency to the unit. When the clock is obtained, trigger the scope externally on the negative edge of the pulse train at U17 pin 8. The remaining signals can now be checked. Perturbations will be present as is usual for the rapid rise and fall times employed. The swallow clock is shown with two pulses per $\div$N cycle, indicating that the frequency input data for the 10^0 digit is 2. The number of swallow clock pulses must always equal the 10^0 data value. Signals shown in Figure 4-6 are not affected by data values for the 10^1 through 10^5 bits. However, in checking the corresponding counter IC's, the data values determine the number of carry pulses at the Q_3

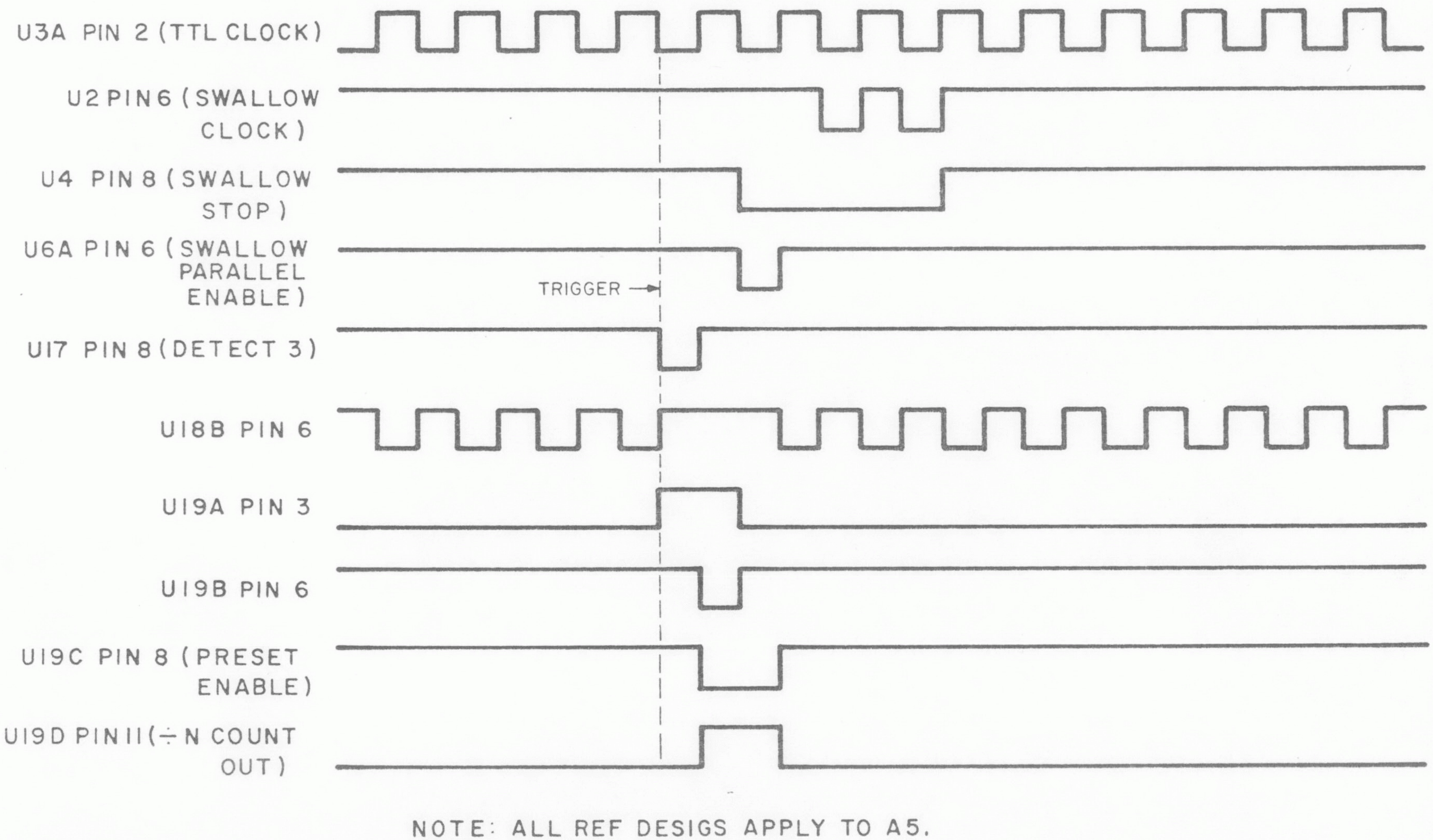


Figure 4-6. Program Counter Waveforms

outputs. To check these outputs, connect the scope successively to pin 1 of U7 through U11. Maintaining the same trigger point, and employing the time base delay feature of the scope, any point during the ÷N cycle may be viewed. By this method, the carry pulses for each of the remaining counter IC's can be observed. The number of carries which should be present can then be determined by examining the input data.

4.6 SUBASSEMBLY REMOVAL, REPAIR AND REPLACEMENT

All modules of the FS-101/102-2 are constructed on printed circuit cards. Power supply A1 may be removed by releasing its retaining bracket and unplugging the module from its socket.

WARNING

Turn off ac power and allow a cooling off period before removing the power supply module. Heat sinks on the module reach elevated temperatures.

When dismounting the serial input converter, A6, exercise care when disengaging connectors on the two ribbon cables. Remove the mounting screws, and unplug the card from XA6, part of module A5. This large printed circuit card, A5, has a number of miniature single conductor clip-on plugs which must be removed before removing mounting screws and lifting the board. For boards A1, A2, and A3, dismounting requires unsoldering of leads to forked terminals as well as removal of mounting screws. No special problems should be encountered in repair if good rework practices are followed. Observe precautions to avoid application of excessive heat to components leads and etched circuit patterns. A minimum amount of solder should be employed.

CAUTION

Any rework on areas of board A5 involving the components listed below must be followed by careful cleaning and drying of the board, and replacement of the conformal coating per MIL-STD-275. This requirement applies to top and bottom sides. Components affected are:

Q3, Q4, U50, R16, R17, R18, R19, R21, R22, R23, R24, R25, R28, R29, C24, C37, C38, and VR1.

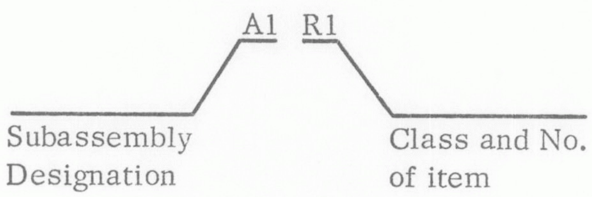
When reinstalling modules, take care to insure that the edge connector of card A6 is mechanically aligned to engage socket XA6. Mounting screws for all boards should be firmly tightened to assure good ground contact.

SECTION V

REPLACEMENT PARTS LIST

5.1 UNIT NUMBERING METHOD

The unit numbering method of assigning reference designations (electrical symbol numbers) has been used to identify assemblies, subassemblies (and modules), and parts. An example of the unit method follows:



Identify from right to left as: First (1) resistor (R) of first (1) subassembly (A)

As shown on the main chassis schematic, components which are an integral part of the main chassis have no subassembly designation.

5.2 REFERENCE DESIGNATION PREFIX

Partial reference designations have been used on the equipment and on the illustrations in this manual. The partial reference designations consist of the class letter(s) and identifying item number. The complete reference designations may be obtained by placing the proper prefix before the partial reference designations. Reference Designation Prefixes are provided on drawings and illustrations in parenthesis within the figure titles.

5.3 LIST OF MANUFACTURERS

Mfr. Code	Name and Address
00779	AMP, Incorporated P. O. Box 3608 Harrisburg, Pennsylvania 17105
01037	Pyroferric-New York, Inc. 621 E. 206th Street Bronx, New York 10467
01121	Allen-Bradley Company 1201 South 2nd Street Milwaukee, Wisconsin 53212
01295	Texas Instruments, Inc. Semiconductor-Components Division 13500 North Central Expressway Dallas, Texas 75231

Mfr. Code	Name and Address
02114	Ferroxcube Corporation P. O. Box 359 Mt. Marion Road Saugerties, New York 12477
04013	Taurus Corporation 1 Academy Hill Lambertville, New Jersey 08530
04713	Motorola Semiconductor Products, Inc. 5005 East McDowell Road Phoenix, Arizona 85008
07263	Fairchild Camera and Instrument Corporation Semiconductor Division 464 Ellis Street Mountain View, California 94040
11139	Deutsch Company Electronic Component Division Municipal Airport Banning, California 92220
12969	Unitrode Corporation 580 Pleasant Street Watertown, Massachusetts 02172
13103	Thermalloy Company 8717 Diplomacy Row Dallas, Texas 75247
14632	Watkins-Johnson Company 700 Quince Orchard Road Gaithersburg, Maryland 20760

Mfr. Code	Name and Address
14655	Cornell-Dubilier Electronics Division of Federal Pacific Electric Company 150 Avenue L Newark, New Jersey 07101
14949	Trompeter Electronics, Inc. 8936 Comanche Avenue Chatsworth, California 91311
16733	Phelps Dodge Communications Co. Division of Phelps Dodge Copper Products, Corporation 60 Dodge Avenue North Haven, Connecticut 06473
18324	Signetics Corporation 811 East Argues Avenue Sunnyvale, California 94086
19505	Applied Engineering Products Co. Division of Samarius, Inc. 26 E. Main Street Ansonia, Connecticut 06401
27014	National Semi-Conductor Corporation 2950 San Ysidro Way Santa Clara, California 95051
28480	Hewlett-Packard Company 1501 Page Mill Road Palo Alto, California 94304
49956	Raytheon Company 141 Spring Street Lexington, Massachusetts 02173

Mfr. Code	Name and Address
56289	Sprague Electric Company Marshall Street North Adams, Massachusetts 01247
71279	Cambridge Thermionic Corporation 445 Concord Avenue Cambridge, Massachusetts 02138
71400	Bussman Manufacturing Division of McGraw-Edison Co. 2536 W. University Street St. Louis, Missouri 63107
71700	General Cable Corporation Cornish Wire Company Division 101 Water Street Williamstown, Massachusetts 01267
71785	Cinch Manufacturing Company Howard B. Jones Division 1026 South Homan Avenue Chicago, Illinois 60624
72136	Electro Motive Manufacturing Company, Inc. South Park & John Streets Willimantic, Connecticut 06226
72982	Erie Technological Products, Inc. 644 West 12th Street Erie, Pennsylvania 16512
73138	Beckman Instruments, Inc. Helipot Division 2500 Harbor Boulevard Fullerton, California 92634

Mfr. Code	Name and Address
73899	JFD Electronics Company Division of Stratford Retreat House 15th at 62nd Street Brooklyn, New York 11219
74868	Bunker Ramo Corporation The Amphenol RF Division 33 East Franklin Street Danbury, Connecticut 06810
75037	Minnesota Mining and Mfg. Co. Electro Products Division 3M Center St. Paul, Minnesota 55101
75915	Littelfuse, Incorporated 800 E. Northwest Highway Des Plaines, Illinois 60016
77820	Bendix Corporation The Electrical Components Division Sherman Avenue Sidney, New York 13838
80058	Joint Electronic Type Designation System
80131	Electronic Industries Association 2001 Eye Street, N. W. Washington, D. C. 20006
81349	Military Specifications

Mfr. Code	Name and Address
81640	Controls Company of America Control Switch Division 1420 Delmar Drive Folcroft, Pennsylvania 19032
82389	Switchcraft, Inc. 5555 North Elston Avenue Chicago, Illinois 60630
87034	Marco-Oak Industries, Division of Oak Electro/Netics Corporation 207 South Helena Street Anaheim, California 92803
88245	Litton Industries USECO Division 13536 Saticoy Street Van Nuys, California 91402
91418	Radio Materials Company 4242 West Bryn Mawr Avenue Chicago, Illinois 60646
91984	Maida Development Company 214 Academy Street Hampton, Virginia 23369
95121	Quality Components, Inc. P. O. Box 113 St. Mary's, Pennsylvania 15857
97137	TRW Electronic Components Division Chicago, Illinois 60600
99800	American Precision Industries Delevan Electronics Division 270 Quaker Road East Aurora, New York 14052
99848	Wilco Corporation 4030 West 10th Street P. O. Box 22248 Indianapolis, Indiana 46222

5.4 PARTS LIST

The parts list which follows contains all electrical parts used in the equipment and certain mechanical parts which are subject to unusual wear or damage. When ordering replacement parts from the Watkins-Johnson Company, specify the type and serial number of the equipment and the reference designation and description of each part ordered. The list of manufacturers provided in paragraph 5.3 and the manufacturer's part numbers for components are included as a guide to the user of the equipment in the field. These parts may not necessarily agree with the parts installed in the equipment, however the parts specified in this list will provide satisfactory operation of the equipment. Replacement parts may be obtained from any manufacturer as long as the physical and electrical parameters of the part selected agree with the original indicated part. In the case of components defined by a military or industrial specification, a vendor which can provide the necessary component is suggested as a convenience to the user.

NOTE

As improved semiconductors become available it is the policy of CEI Division to incorporate them in proprietary products. For this reason some transistors, diodes, and integrated circuits installed in the equipment may not agree with those specified in the parts lists and schematic diagrams of this manual. However, the semiconductors designated in the manual may be substituted in every case with satisfactory results.

5.4.1 Type FS-101-2 Frequency Synthesizer, Main Chassis

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	NOT USED				
A2	NOT USED				
A3	320 MHz DIVIDE BY 2 OR 4	1	17009	14632	
A4	±5V SWITCHING REGULATOR	1	76192	14632	
A5	REFERENCE/DIVIDE BY N/PHASE DETECTOR	1	791077	14632	
A6	SERIAL INPUT CONVERTER	1	791075	14632	
CP1	CONNECTOR, RECEPTACLE	2	701067	16733	
CP2	NOT USED				
CP3	Same as CP1				
CR1	DIODE	1	5082-4403	28480	
CR2	DIODE	1	1N4446	80131	93332
C1	CAPACITOR, FIXED, PAPER: 0.01 μF, 20%, 600V	4	102P515	56289	
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	CAPACITOR, ELECTROLYTIC, ALUMINUM: 1000 μF, -10+75%, 15V	1	34D108G015GL4	56289	
C6	CAPACITOR, ELECTROLYTIC, ALUMINUM: 8000 μF, -10+75%, 15V	1	39D808G015JT4	56289	
C7	CAPACITOR, ELECTROLYTIC, TANTALUM: 220 μF, 20%, 10V	2	196D227X0010MA3	56289	
C8	Same as C7				
C9	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pF, GMV, 500V	4	2404-00X5U0-102P	72982	

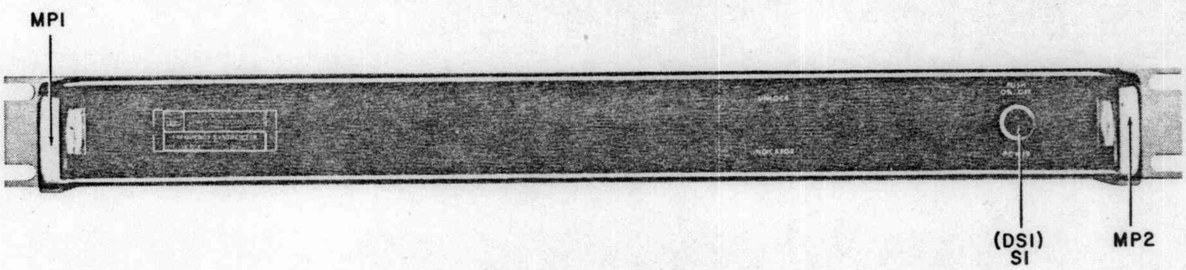


Figure 5-1. Type FS-101-2 Frequency Synthesizer, Front View, Locations of Components

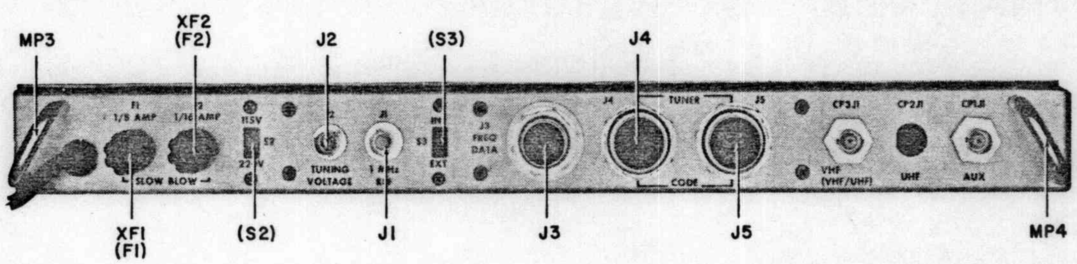


Figure 5-2. Type FS-101-2 Frequency Synthesizer, Rear View, Locations of Components

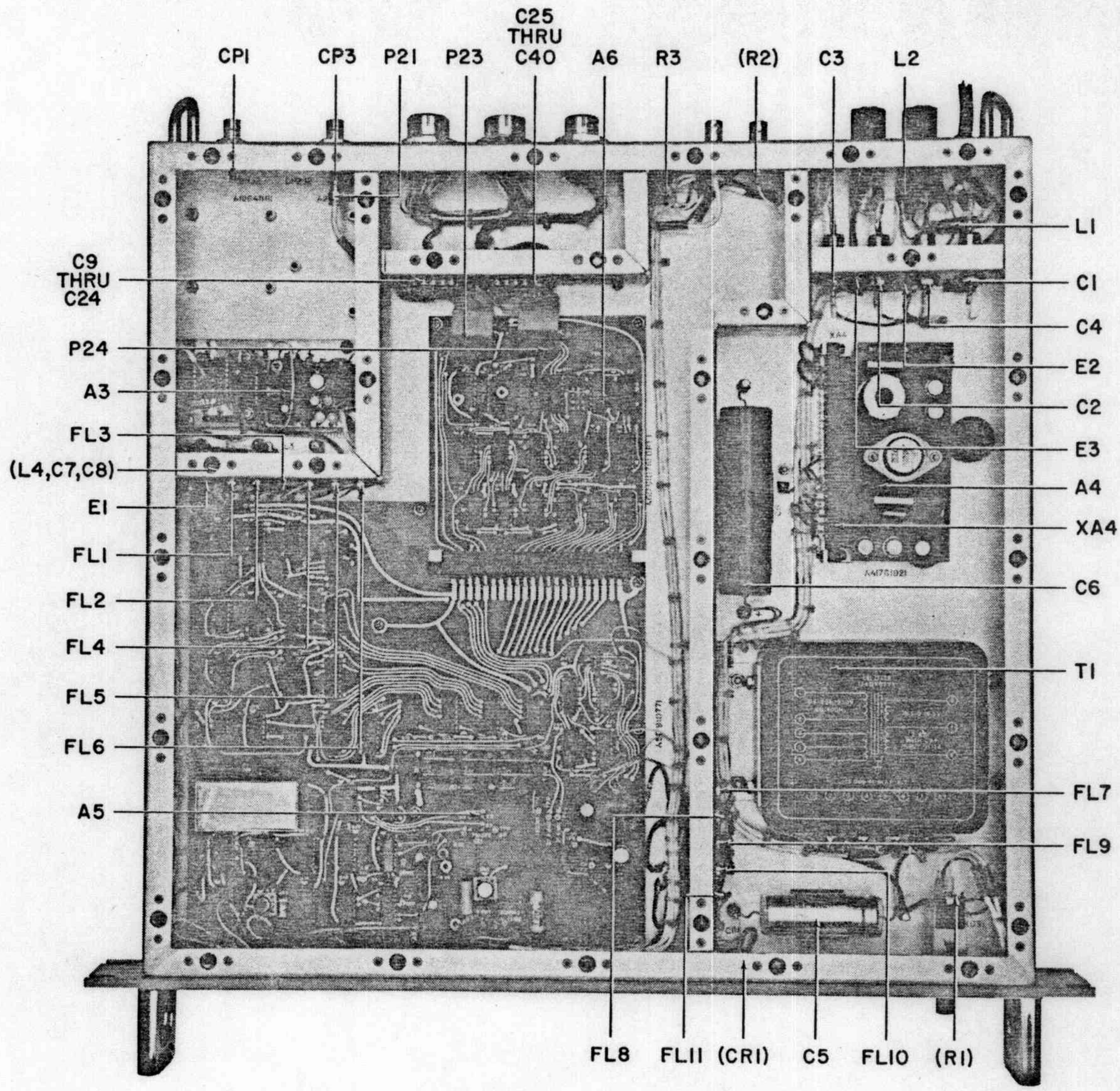


Figure 5-3. Type FS-101-2 Frequency Synthesizer, Top View, Locations of Components

EF SIG	DESCRIPTION		QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C10 hru C36	CAPACITOR, CERAMIC, FEEDTHRU: 0.05 μF, GMV, 300V		28	MS001DA503P	01121	
C37	Same as C9					
C38	Same as C9					
C39	Same as C10					
C40	Same as C9					
DS1	LAMP, NEON	Part of S1	1	A1H	87034	
E1	TERMINAL, FEEDTHRU, INSULATED		3	SFU16	04013	
E2	Same as E1					
E3	Same as E1					
L1 hru L11	FILTER, LOW PASS		11	FS001HA552P	01121	
1	FUSE, CARTRIDGE: 1/8 AMP, 3 AG		1	MDL1/8	71400	
2	FUSE, CARTRIDGE: 1/16 AMP, 3 AG		1	MDL1/16	71400	
1	CONNECTOR, RECEPTACLE		1	17825-1002	74868	
2	CONNECTOR, RECEPTACLE		1	BJ77	14949	
3	CONNECTOR, RECEPTACLE		1	DS04-12S	11139	
4	CONNECTOR, RECEPTACLE		1	DS04-19S	11139	
1	COIL, FIXED		2	21210-84	14632	

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
L2	Same as L1				
L3	NOT USED				
L4	COIL, FIXED	1	21210-112	14632	
MP1	HANDLE	2	32306-3	14632	
MP2	Same as MP1				
MP3	HANDLE	2	1070-12	88245	
MP4	Same as MP3				
MP5	COVER	1	41983-1	14632	
P1 thru P19	CONNECTOR, PLUG	19	60598-5	00779	
P20	CORD, POWER	1	3598-181-007	71700	
P21	CONNECTOR, PLUG	2	UG-1465/U	80058	74868
P22	NOT USED				
P23	CONNECTOR, PLUG	2	3416	75037	
P24	Same as P23				
R1	RESISTOR, FIXED, COMPOSITION: 27 kΩ, 5%, 1/2W	1	RCR20G273JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 51 Ω, 5%, 1/4W	1	RCR07G510JS	81349	01121
S1	SWITCH, PUSH	1	671-6A1H	87034	
S2	SWITCH, SLIDE	2	11A1211	82389	
S3	Same as S2				

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
1	POWER TRANSFORMER	1	17133	14632	
R1	DIODE, ZENER	1	MZ70-10C	04713	
A4	CONNECTOR, PRINTED CIRCUIT CARD	1	250-22-30-170	71785	
F1	FUSEHOLDER	2	342004	75915	
F2	Same as XF1				

.4.2 Type FS-102-2 Frequency Synthesizer, Main Chassis

REF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	1160 MHz BINARY DIVIDER	1	16488-2	14632	
A2	660 MHz BINARY DIVIDER	1	16461-2	14632	
A3	320 MHz DIVIDE BY 2 OR 4	1	17009	14632	
A4	±5V SWITCHING REGULATOR	1	76192	14632	
A5	REFERENCE/DIVIDE BY N/PHASE DETECTOR	1	791077	14632	
A6	SERIAL INPUT CONVERTER	1	791075	14632	
CP1	CONNECTOR, RECEPTACLE	3	701067	16733	
CP2	Same as CP1				
CP3	Same as CP1				
CR1	DIODE	1	5082-4403	28480	
CR2	DIODE	1	1N4446	80131	93332
C1	CAPACITOR, FIXED, PAPER: 0.01 μF, 20%, 600V	4	102P515	56289	
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	CAPACITOR, ELECTROLYTIC, ALUMINUM: 1000 μF, -10+75%, 15V	1	34D108G015GL4	56289	
C6	CAPACITOR, ELECTROLYTIC, ALUMINUM: 8000 μF, -10+75%, 15V	1	39D808G015JT4	56289	
C7	CAPACITOR, ELECTROLYTIC, TANTALUM: 220 μF, 20%, 10V	2	196D227X0010MA3	56289	
C8	Same as C7				
C9	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pF, GMV, 500V	4	2404-000X5U0-102P	72982	

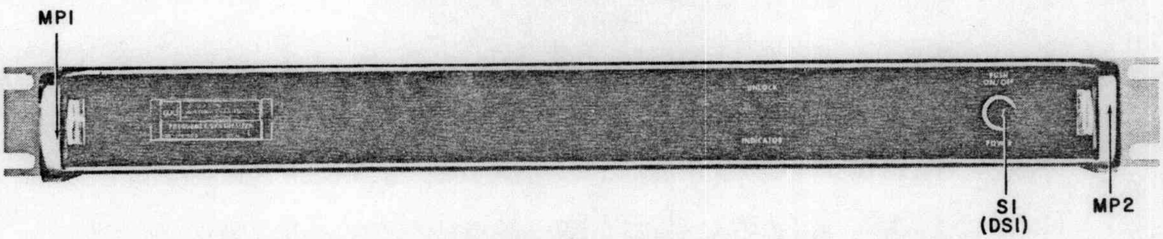


Figure 5-4. Type FS-102-2 Frequency Synthesizer,
Front View, Locations of Components

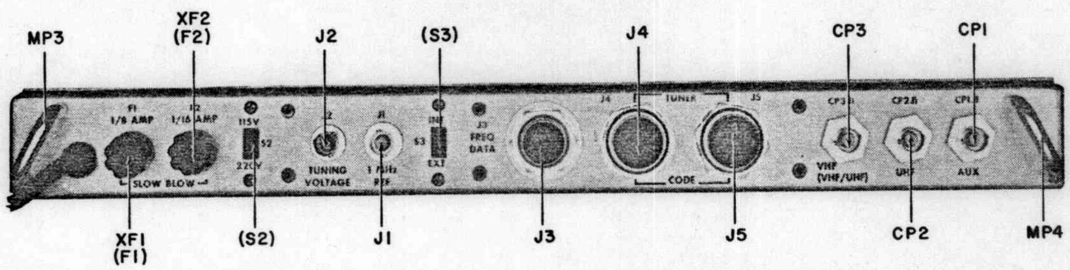


Figure 5-5. Type FS-102-2 Frequency Synthesizer,
Rear View, Locations of Components

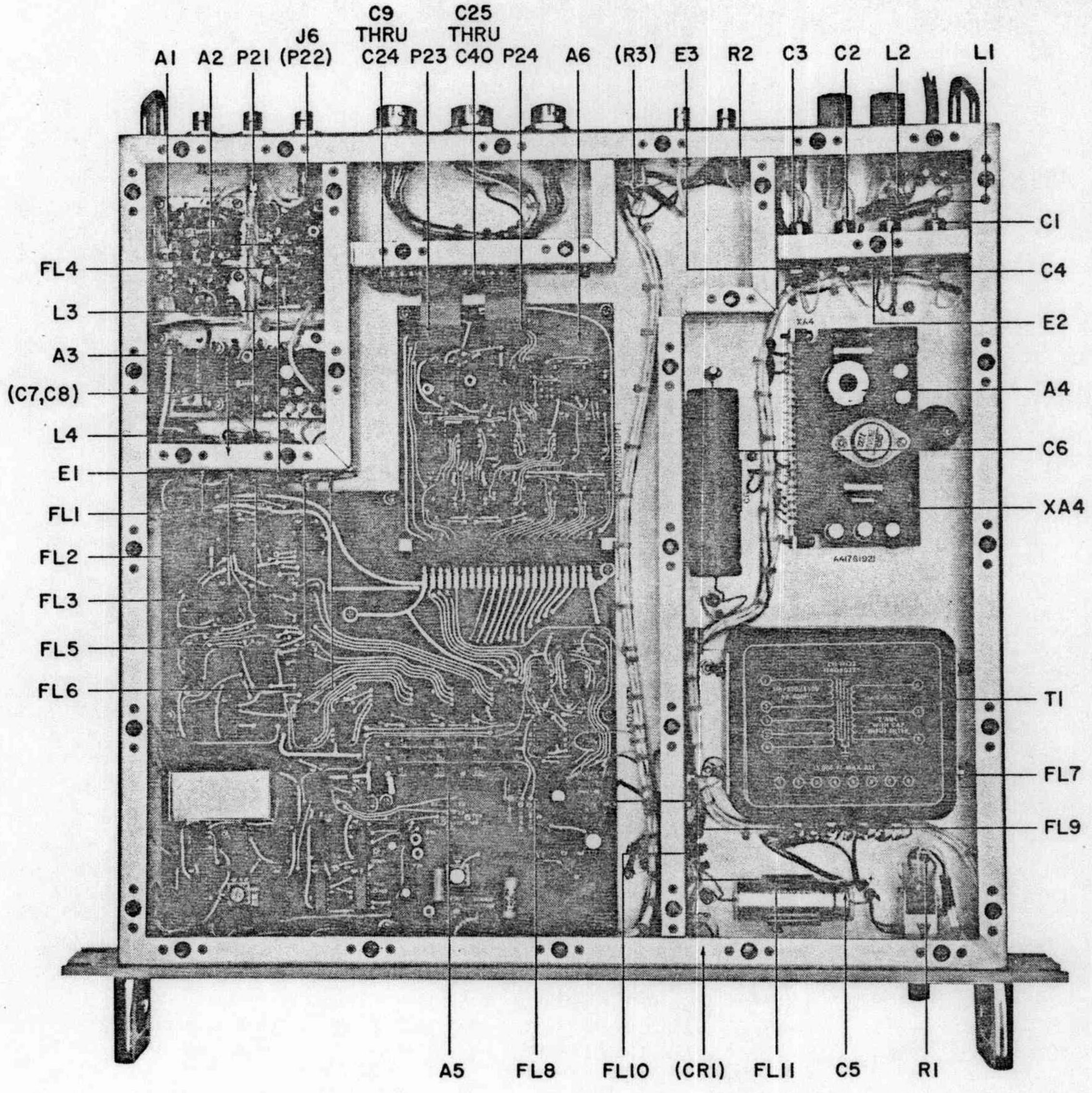


Figure 5-6. Type FS-102-2 Frequency Synthesizer, Top View, Locations of Components

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
10 hru 36	CAPACITOR, CERAMIC, FEEDTHRU: 0.05 μF, GMV, 300V	28	MS001DA503P	01121	
37	Same as C9				
38	Same as C9				
39	Same as C10				
40	Same as C9				
S1	LAMP, NEON	1	A1H	87034	
1	TERMINAL, FEEDTHRU, INSULATED	3	SFU16	04013	
2	Same as E1				
3	Same as E1				
B1	FERRITE BEAD	1	P5-1288	01037	
L1 hru L11	FILTER, LOW PASS	11	SF001HA552P	01121	
1	FUSE, CARTRIDGE: 1/8 AMP, 3AG	1	MDL1/8	71400	
2	FUSE, CARTRIDGE: 1/16 AMP, 3AG	1	MDL1/16	71400	
	CONNECTOR, RECEPTACLE	1	17825-1002	74868	
	CONNECTOR, RECEPTACLE	1	BJ77	14949	
	CONNECTOR, RECEPTACLE	1	DS04-12S	11139	
	CONNECTOR, RECEPTACLE	1	DS04-19P	11139	
	CONNECTOR, RECEPTACLE	1	DS04-19S	11139	

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
6	CONNECTOR, RECEPTACLE	1	132	19505	
L1	COIL, FIXED	2	21210-84	14632	
L2	Same as L1				
L3	COIL, FIXED: 80 μH	1	3080-15	99848	
L4	COIL, FIXED	1	21210-112	14632	
MP1	HANDLE	2	32306-3	14632	
MP2	Same as MP1				
MP3	HANDLE	2	1070-12	88245	
MP4	Same as MP3				
MP5	COVER	1	41983-1	14632	
P1 thru P19	CONNECTOR, PLUG	19	60598-5	00779	
P20	CORD, POWER	1	3598-181-007	71700	
P21	CONNECTOR, PLUG	2	UG-1465/U	80058	74868
P22	Same as P21				
P23	CONNECTOR, PLUG	2	3416	75037	
P24	Same as P23				
R1	RESISTOR, FIXED, COMPOSITION: 27 kΩ, 5%, 1/2W	1	RCR20G273JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 51 Ω, 5%, 1/4W	1	RCR07G510JS	81349	01121
S1	SWITCH, PUSH	1	671-6A1H	87034	

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
2	SWITCH, SLIDE	2	11A1211	82389	
3	Same as S2				
1	POWER TRANSFORMER	1	16931	14632	
R1	DIODE, ZENER	1	MZ70-10C	04713	
A4	CONNECTOR, PRINTED CIRCUIT CARD	1	250-22-30-170	71785	
F1	FUSEHOLDER	2	342004	75915	
F2	Same as XF1				

5.4.3 Part 16488-2 1160 MHz Binary Divider — REF DESIG PREFIX A1 FS-102-2, only

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	1	1N4446	80131	93332
CR2 thru CR9	DIODE	8	5082-2900	28480	
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 μF, 20%, 10V	3	196D226X0010JA1	56289	
C2	CAPACITOR, COMPOSITION, TUBULAR: 0.22 pF, 10%, 500V	1	QC0.22PFK	95121	
C3	CAPACITOR, CERAMIC, DISC: 1000 pF, 10%, 300V	6	UY02101K	73899	
C4	CAPACITOR, ELECTROLYTIC, TANTALUM: 2.2 μF, 20%, 35V	1	196D225X0035JA1	56289	
C5	CAPACITOR, CERAMIC, DISC: 470 pF, 5%, 300V	2	UY03471J	73899	
C6	Same as C1				
C7	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	4	8131M100-651-104M	72982	
C8	Same as C7				
C9	Same as C3				
C10	Same as C7				
C11	Same as C5				
C12	Same as C3				
C13	Same as C3				
C14	CAPACITOR, COMPOSITION, TUBULAR: 1.0 pF, 10%, 500V	2	QC1.0PFK	95121	
C15	Same as C3				
C16	CAPACITOR, CERAMIC, DISC: 11 pF, 5%, 300V	2	UY01110J	73899	
C17	Same as C14				
C18	Same as C7				

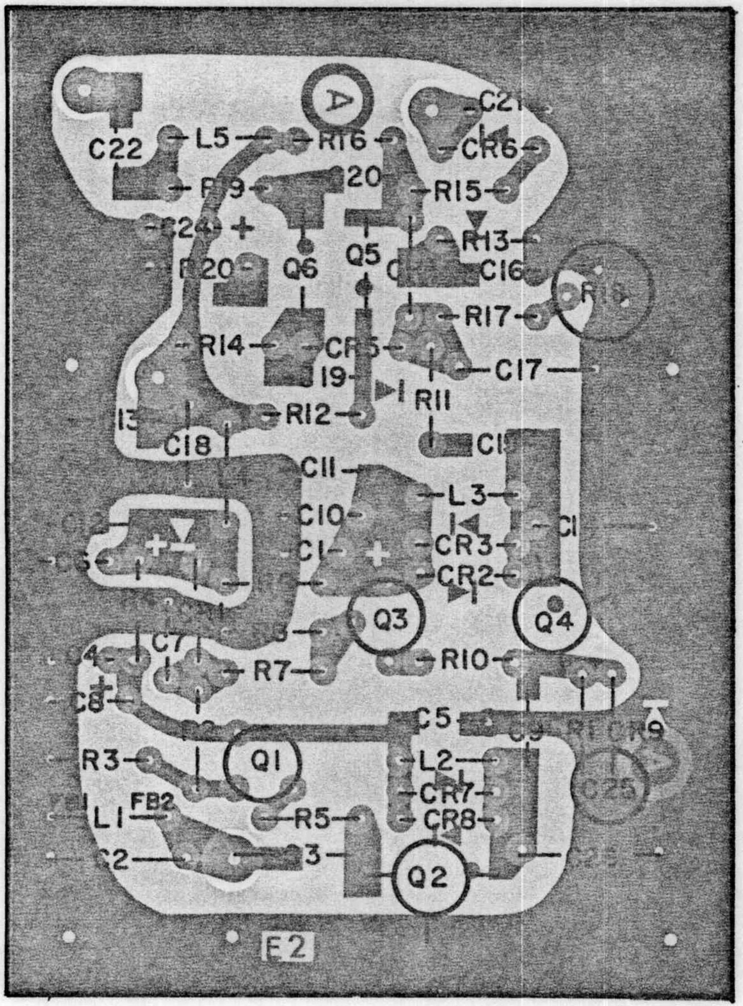


Figure 5-7. Part 16488-2 1160 MHz Binary Divider (A1), Locations of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C19	CAPACITOR, CERAMIC, DISC: 4.7 pF, ± 1.25 pF, 300V	2	UY014R7C	73899	
C20	Same as C19				
C21	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	1	8131A200Z5U0-103M	72982	
C22	Same as C3				
C23	Same as C16				
C24	Same as C1				
C25	CAPACITOR, CERAMIC, DISC: 200 pF, 500V	1	32-257578-40	91984	
C26	CAPACITOR, COMPOSITION, TUBULAR: 0.5 pF, 10%, 500V	1	QC0.5PFK	95121	
E1 thru E5	TERMINAL, FORKED	5	140-1941-02-01	71279	
FB1	FERRITE BEAD	2	56-590-65-4A	02114	
FB2	Same as FB1				
L1	COIL, FIXED	2	21209-11	14632	
L2	Same as L1				
L3	COIL	1	16209-1	14632	
L4	COIL	1	16209-3	14632	
L5	COIL	1	16209-2	14632	
Q1	TRANSISTOR	2	2N3251	80131	04713
Q2	TRANSISTOR	2	22840-2	14632	
Q3	Same as Q1				
Q4	Same as Q2				

REF DESIG PREFIX A1 FS-102-2, only

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
Q5	TRANSISTOR	2	22840-1	14632	
Q6	Same as Q5				
R1	RESISTOR, FIXED, COMPOSITION: 270 Ω, 5%, 1/8W	1	RCR05G271JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 680 Ω, 5%, 1/8W	1	RCR05G681JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/8W	2	RCR05G103JS	81349	01121
R4	RESISTOR, FIXED, COMPOSITION: 33 Ω, 5%, 1/8W	2	RCR05G330JS	81349	01121
R5	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/8W	4	RCR07G471JS	81349	01121
R6	NOT USED				
R7	RESISTOR, FIXED, COMPOSITION: 820 Ω, 5%, 1/8W	3	RCR05G821JS	81349	01121
R8	Same as R3				
R9	Same as R4				
R10	Same as R5				
R11	RESISTOR, FIXED, COMPOSITION: 10 Ω, 5%, 1/8W	1	RCR05G100JS	81349	01121
R12	RESISTOR, FIXED, COMPOSITION: 200 Ω, 5%, 1/8W	1	RCR05G201JS	81349	01121
R13	Same as R5				
R14	Same as R7				
R15	RESISTOR, FIXED, COMPOSITION: 100 Ω, 5%, 1/8W	3	RCR05G101JS	81349	01121
R16	Same as R7				
R17	Same as R15				
R18	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 1/2W	1	62PR1K	73138	

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R19	Same as R15				
R20	Same as R5				

5.4.4 Part 16461-2 660 MHz Binary Divider

REF DESIG PREFIX A2 FS-102-2, only

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	3	1N4446	80131	93332
CR2	DIODE	3	5082-2900	28480	
CR3	Same as CR2				
CR4	DIODE	3	5082-3080	28480	
CR5	Same as CR1				
CR6	Same as CR4				
CR7	Same as CR1				
CR8	Same as CR4				
CR9	Same as CR2				
C1	CAPACITOR, CERAMIC, DISC: 1000 pF, GMV, 500V	5	SM1000PFP	91418	
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 2.2 μF, 20%, 35V	1	196D225X0035JA1	56289	
C3	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 1000V	2	B470PFM	91418	
C4	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	2	8131M100-651-104M	72982	
C5	CAPACITOR, CERAMIC, DISC: 100 pF, 10%, 300V	1	UY02101K	73899	
C6	NOT USED				
C7	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	4	8131A200Z5UD-103M	72982	
C8	CAPACITOR, CERAMIC, DISC: 4.7 pF ± 1.25 pF, 300V	2	UY014R7C	73899	
C9	CAPACITOR, CERAMIC, DISC: 15 pF, 5%, 300V	2	UY01150J	73899	
C10	Same as C3				
C11	Same as C8				
C12	Same as C9				

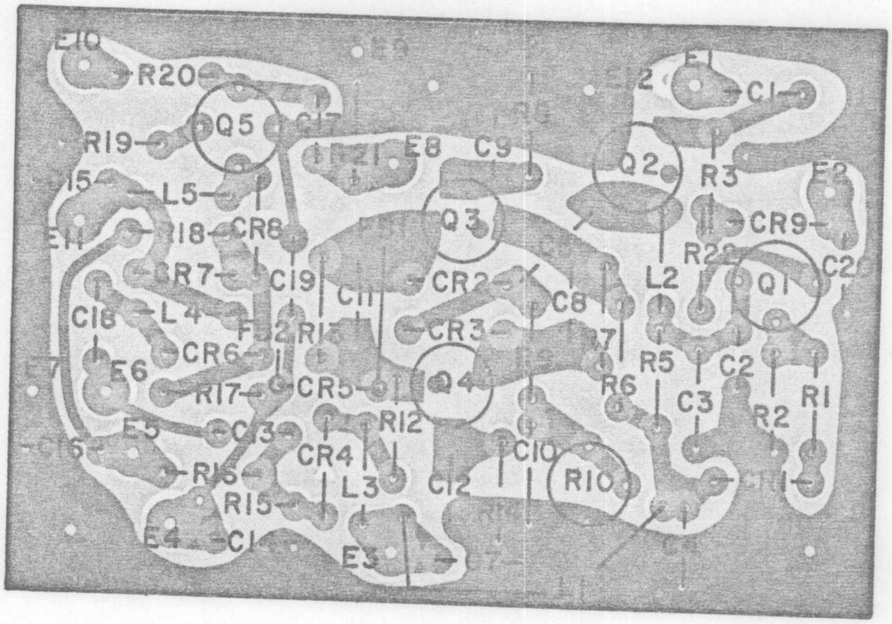


Figure 5-8. Part 16461-2 660 MHz Binary Divider (A2), Locations of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C13	Same as C1				
C14	Same as C7				
C15	Same as C7				
C16	Same as C7				
C17	Same as C1				
C18	Same as C1				
C19	Same as C1				
C20	Same as C4				
E1 thru E12	TERMINAL, FORKED	12	140-1941-02-01	71279	
FB1	FERRITE BEAD	2	P5-1288	01037	
FB2	Same as FB1				
L1	COIL, FIXED	4	16209-3	14632	
L2	COIL, FIXED	1	22292-40	14632	
L3	Same as L1				
L4	Same as L1				
L5	Same as L1				
Q1	TRANSISTOR	1	2N3251	80131	04713
Q2	TRANSISTOR	3	22840-2	14632	
Q3	Same as Q2				

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
Q4	Same as Q2				
Q5	TRANSISTOR	1	2N3572	80131	01295
R1	RESISTOR, FIXED, COMPOSITION: 330 Ω, 5%, 1/8W	1	RCR05G331JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 4.7 kΩ, 5%, 1/8W	1	RCR05G472JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 47 Ω, 5%, 1/8W	1	RCR05G470JS	81349	01121
R4	NOT USED				
R5	RESISTOR, FIXED, COMPOSITION: 18 Ω, 5%, 1/8W	1	RCR05G180JS	81349	01121
R6	RESISTOR, FIXED, COMPOSITION: 200 Ω, 5%, 1/8W	1	RCR05G201JS	81349	01121
R7	RESISTOR, FIXED, COMPOSITION: 1.2 kΩ, 5%, 1/8W	2	RCR05G122JS	81349	01121
R8	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/8W	4	RCR05G471JS	81349	01121
R9	RESISTOR, FIXED, COMPOSITION: 220 Ω, 5%, 1/8W	1	RCR05G221JS	81349	01121
R10	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 1/2W	1	62PR1K	73138	
R11	NOT USED				
R12	RESISTOR, FIXED, COMPOSITION: 150 Ω, 5%, 1/8W	1	RCR05G151JS	81349	01121
R13	Same as R7				
R14	Same as R8				
R15	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/8W	2	RCR05G102JS	81349	01121
R16	RESISTOR, FIXED, COMPOSITION: 2.2 kΩ, 5%, 1/8W	2	RCR05G222JS	81349	01121
R17	Same as R8				
R18	Same as R16				
R19	RESISTOR, FIXED, COMPOSITION: 10 Ω, 5%, 1/8W	1	RCR05G100JS	81349	01121

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R20	Same as R15				
R21	RESISTOR, FIXED, COMPOSITION: 270 Ω, 5%, 1/8W	1	RCR05G271JS	81349	01121
R22	Same as R8				

5.4.5 Part 17009 320 MHz Divide by 2 or 4

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	1	5082-3080	28480	
CR2	DIODE	3	5082-2900	28480	
CR3	DIODE	1	1N4446	80131	93332
CR4	Same as CR2				
CR5	Same as CR2				
C1	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 1000V	10	B470PFM	91418	
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 100 μF, 20%, 10V	1	196D107X0010LA3	56289	
C3	CAPACITOR, CERAMIC, DISC: 1000 pF, GMV, 500V	3	SM1000PFP	91418	
C4	CAPACITOR, VARIABLE, CERAMIC: 6-22 pF, 25V	2	511-000-G6-22	72982	
C5	Same as C4				
C6	Same as C3				
C7	CAPACITOR, MICA, DIPPED: 100 pF, 5%, 500V	1	CM05FD101J03	81349	72136
C8	Same as C1				
C9	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	5	8131A200Z5UD-103M	72982	
C10	Same as C3				
C11	Same as C9				
C12	CAPACITOR, CERAMIC, TUBULAR: 12 pF, 5%, 500V	1	301-000C0G0-120J	72982	
C13	Same as C1				
C14	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	1	8131M100-651-104M	72982	
C15	Same as C1				
C16	Same as C1				

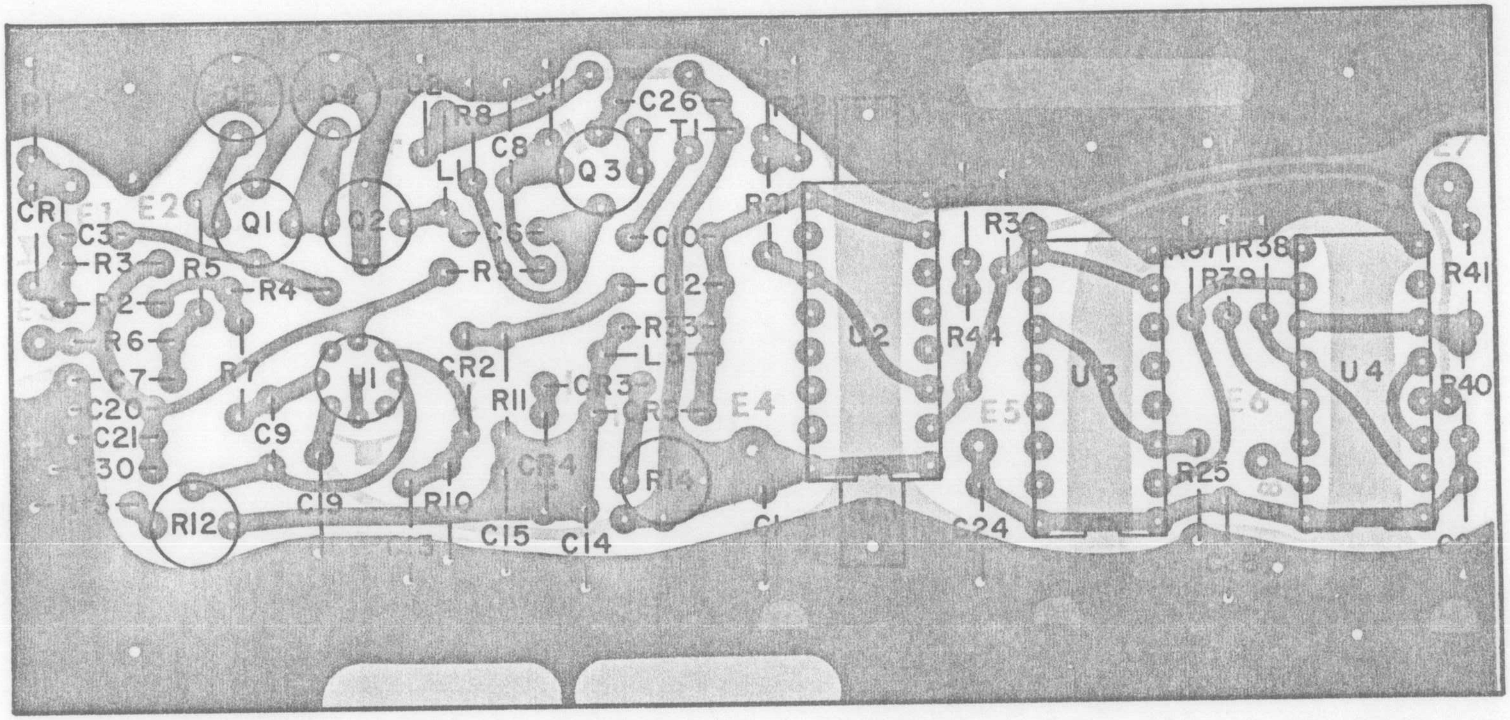


Figure 5-9. Part 17009 320 MHz ÷ 2 or ÷ 4 (A3), Locations of Components

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C17	NOT USED				
C18	NOT USED				
C19	Same as C1				
C20	Same as C9				
C21	Same as C9				
C22	NOT USED				
C23	NOT USED				
C24	Same as C9				
C25	Same as C1				
C26	Same as C1				
C27	Same as C1				
C28	Same as C1				
C29	NOT USED				
C30	CAPACITOR, ELECTROLYTIC, TANTALUM: 220 μF, 20%, 10V	1	196D227X0010MA3	56289	
L1	COIL, FIXED	2	16209-3	14632	
L2	NOT USED				
L3	Same as L1				
Q1	TRANSISTOR	2	2N3572	80131	01295
Q2	Same as Q1				
Q3	TRANSISTOR	1	2N5179	80131	04713
RA1	RADIATOR, INTEGRATED CIRCUIT	1	16492-1	14632	

REF DESIG PREFIX A3

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
RA2	RADIATOR, INTEGRATED CIRCUIT	1	16594-1	14632	
R1	RESISTOR, FIXED, COMPOSITION: 100 Ω, 5%, 1/8W	2	RCR05G101JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/8W	3	RCR05G102JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/8W	1	RCR05G103JS	81349	01121
R4	RESISTOR, FIXED, COMPOSITION: 1.8 kΩ, 5%, 1/8W	1	RCR05G182JS	81349	01121
R5	RESISTOR, FIXED, COMPOSITION: 47 Ω, 5%, 1/8W	4	RCR05G470JS	81349	01121
R6	NOT USED				
R7	Same as R1				
R8	Same as R2				
R9	RESISTOR, FIXED, COMPOSITION: 270 Ω, 5%, 1/8W	2	RCR05G271JS	81349	01121
R10	RESISTOR, FIXED, COMPOSITION: 18 kΩ, 5%, 1/8W	1	RCR05G183JS	81349	01121
R11	Same as R2				
R12	RESISTOR, VARIABLE, FILM: 500 Ω, 10%, 1/2W	2	62PR500	73138	
R13	RESISTOR, FIXED, COMPOSITION: 2.4 kΩ, 5%, 1/8W	1	RCR05G242JS	81349	01121
R14	Same as R12				
R15	NOT USED				
R16	RESISTOR, FIXED, COMPOSITION: 150 Ω, 5%, 1/8W	1	RCR05G151JS	81349	01121
R17 thru R20	NOT USED				
R21	Same as R5				
R22	RESISTOR, FIXED, COMPOSITION: 390 Ω, 5%, 1/8W	1	RCR05G391JS	81349	01121

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
23	NOT USED				
24	NOT USED				
25	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/8W	4	RCR05G471JS	81349	01121
26 hru 32	NOT USED				
33	Same as R5				
34	NOT USED				
35	NOT USED				
36	RESISTOR, FIXED, COMPOSITION: 330 Ω, 5%, 1/8W	1	RCR05G331JS	81349	01121
37	Same as R25				
38	Same as R25				
39	Same as R25				
40	RESISTOR, FIXED, COMPOSITION: 240 Ω, 5%, 1/8W	1	RCR05G241JS	81349	01121
41	Same as R9				
42	NOT USED				
43	NOT USED				
44	Same as R5				
1	TRANSFORMER	1	16597-1	14632	
J1	INTEGRATED CIRCUIT	1	U5B7741393	07263	
J2	INTEGRATED CIRCUIT	1	SC8359L	04713	
J3	INTEGRATED CIRCUIT	1	MC1671L	04713	

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U4	INTEGRATED CIRCUIT	1	MC1663L	04713	

.4.6 Type 76192 ±5V Switching Regulator

REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	2	1N4998	80131	04713
CR2	Same as CR1				
CR3	DIODE	1	UTR3305	12969	
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 47 μF, 10%, 35V	1	CS13BF476K	81349	56289
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 10%, 35V	1	CS13BF475K	81349	56289
C3	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	1	8131A200Z5UD-103M	72982	
C4	CAPACITOR, CERAMIC, DISC: 0.05 μF, 20%, 100V	1	29C212A7	56289	
C5	CAPACITOR, ELECTROLYTIC, TANTALUM: 150 μF, 10%, 15V	1	CS13BD157K	81349	56289
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 27 μF, 10%, 35V	1	196D276X9035MA3	56289	
C7	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	1	8131M100-651-104M	72982	
C8	CAPACITOR, MICA, DIPPED: 1000 pF, 5%, 100V	1	DM15-102J	72136	
L1	COIL, FIXED	2	21210-84	14632	
L2	COIL, FIXED	1	30316-3	14632	
L3	Same as L1				
Q1	TRANSISTOR	1	2N4037	80131	02735
Q2	TRANSISTOR	1	2N5039	80131	02735
Q3	TRANSISTOR	1	2N2905A	80131	04713
XA1	HEATSINK	1	2225B	13103	
XA2	HEATSINK	1	6103B	13103	
R1	RESISTOR, FIXED, COMPOSITION: 270 Ω, 5%, 1/4W	2	RCR07G271JS	81349	01121
R2	Same as R1				

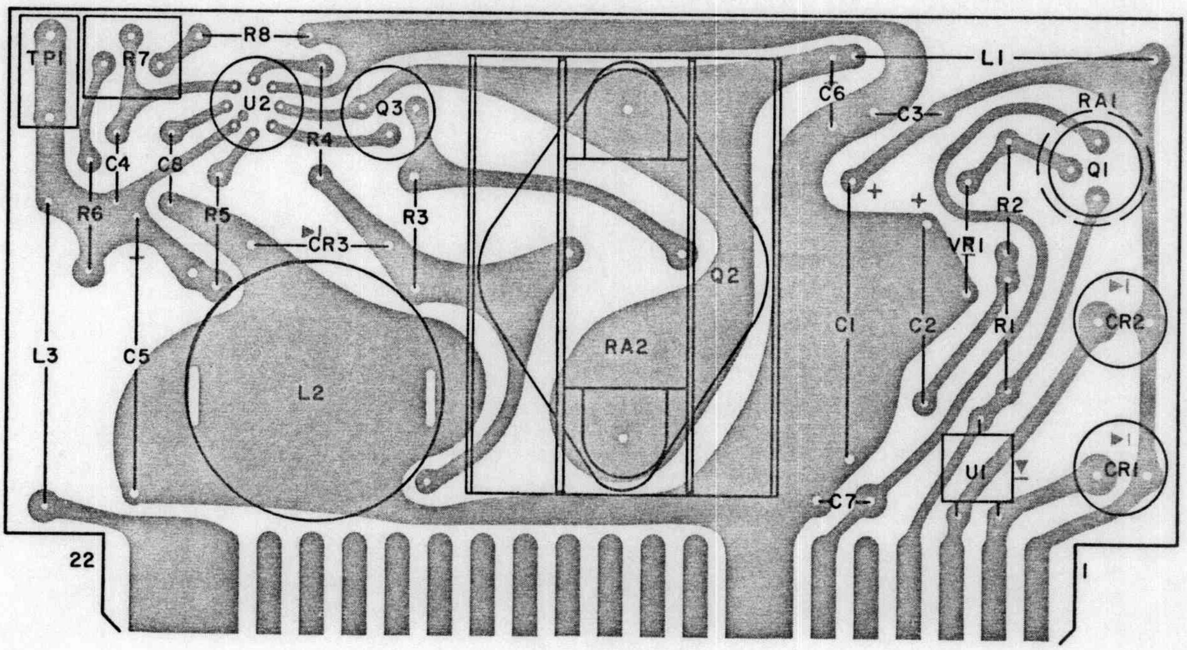


Figure 5-10. Type 76192 ±5V Switching Regulator (A4), Locations of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R3	RESISTOR, FIXED, COMPOSITION: 68 Ω, 5%, 1/4W	1	RCR07G680JS	81349	01121
R4	RESISTOR, FIXED, COMPOSITION: 510 kΩ, 5%, 1/4W	1	RCR07G514JS	81349	01121
R5	RESISTOR, FIXED, COMPOSITION: 22 Ω, 5%, 1/4W	1	RCR07G220JS	81349	01121
R6	RESISTOR, FIXED, COMPOSITION: 4.3 kΩ, 5%, 1/4W	1	RCR07G432JS	81349	01121
R7	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 1/2W	1	62PAR1K	73138	
R8	RESISTOR, FIXED, COMPOSITION: 2.4 kΩ, 5%, 1/4W	1	RCR07G242JS	81349	01121
TP1	JACK, TIP	1	TJ203R	49956	
U1	RECTIFIER ASSEMBLY	1	MDA950A3	04713	
U2	INTEGRATED CIRCUIT	1	LM305	27014	
VR1	DIODE	1	LVA56A	97137	

5.4.7 Type 791077 Reference/Divide By N/ Phase Detector   REF DESIG PREFIX A5

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	1	1N4446	80131	93332
CR2	DIODE	4	1N4449	80131	93332
CR3	Same as CR2				
CR4	Same as CR2				
CR5	Same as CR2				
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 10%, 35V	2	CS13BF475K	81349	56289
C2 thru C16	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	23	8131M100-651-104M	72982	
C17	CAPACITOR, ELECTROLYTIC, TANTALUM: 220 μF, 20%, 10V	2	196D227X0010MA3	56289	
C18	Same as C17				
C19	Same as C2				
C20	Same as C1				
C21	Same as C2				
C22	Same as C2				
C23	NOT USED				
C24	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 1000V	1	B470PFM	91418	
C25	CAPACITOR, CERAMIC, TUBULAR: 3.0 pF, ±0.25 pF, 500V	1	301-000C0J0-309C	72982	
C26	CAPACITOR, MICA, DIPPED: 100 pF, 5%, 500V	1	CM05FD101J03	81349	72136
C27	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	2	8131A200Z5U0-103M	72982	
C28	Same as C27				

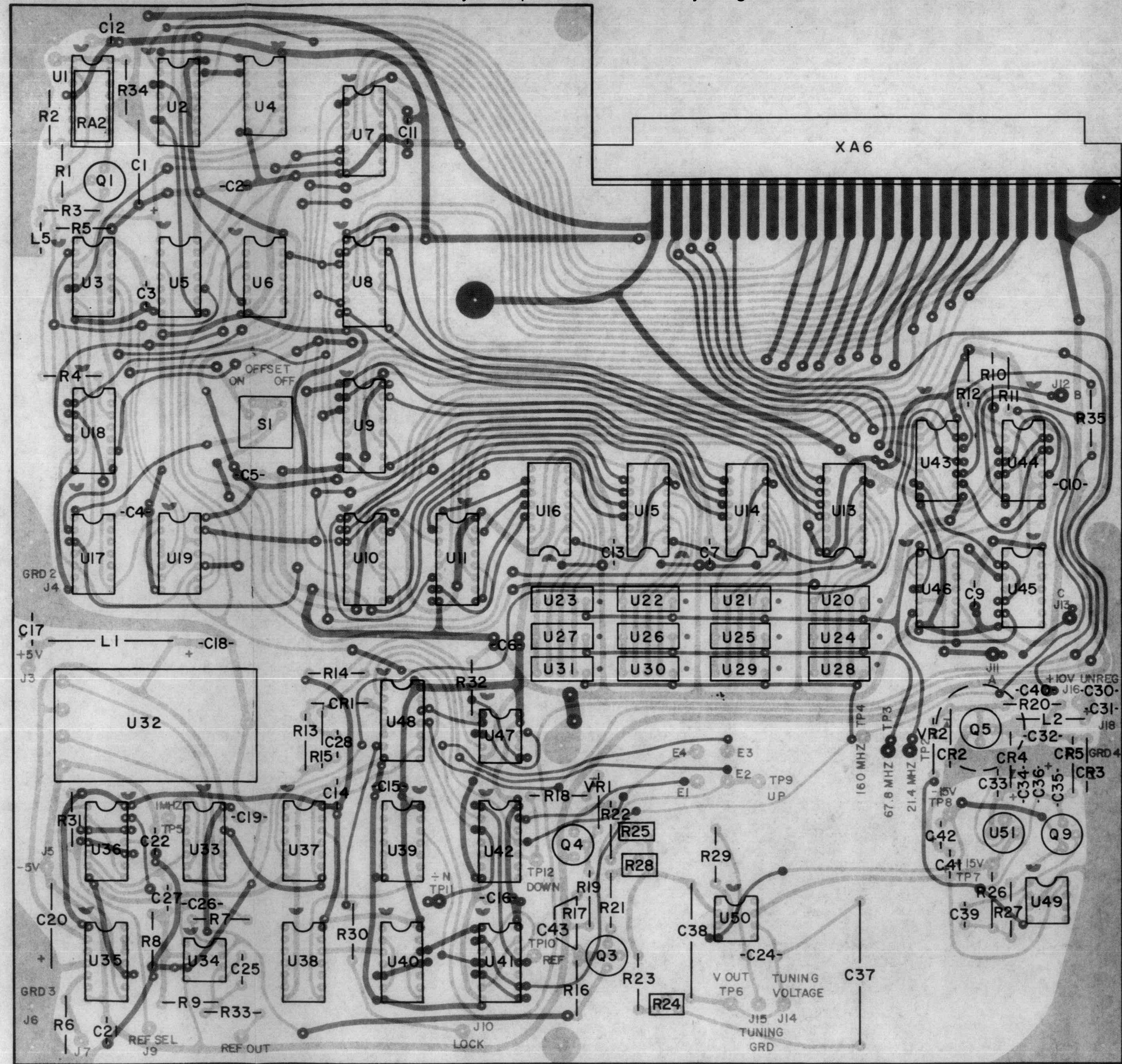


Figure 5-11. Type 791077 Reference/÷ N/Phase Detector (A5), Locations of Components

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C29	NOT USED				
C30	Same as C2				
C31	CAPACITOR, ELECTROLYTIC, TANTALUM: 2.2 μF, 20%, 35V	5	196D225X0035JA1	56289	
C32	Same as C2				
C33	Same as C2				
C34	Same as C31				
C35	Same as C2				
C36	Same as C31				
C37	CAPACITOR, FIXED, PLASTIC: 0.1 μF, 10%, 100V	1	WMF1P1	14655	
C38	CAPACITOR, PLASTIC, TUBULAR: 0.022 μF, 10%, 100V	1	CTM223VBK	14655	
C39	Same as C31				
C40	Same as C2				
C41	Same as C31				
C42	CAPACITOR, ELECTROLYTIC, TANTALUM: 27 μF, 10%, 35V	1	196D276X9035MA3	56289	
C43	CAPACITOR, CERAMIC, TUBULAR: 12 pF, 5%, 500V	1	301-000C0G0-120J	72982	
thru J18	CONNECTOR, RECEPTACLE	18	60599-3	00779	
L1	COIL, FIXED	1	21210-112	14632	
L2	COIL, FIXED: 1000 μH, 5%	1	2500-28	99800	
L3	NOT USED				
L4	NOT USED				
L5	COIL, FIXED	1	16209-3	14632	

REF DESIG PREFIX A5

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
Q1	TRANSISTOR	1	2N3906	80131	04713
Q2	NOT USED				
Q3	TRANSISTOR	1	2N3251	80131	04713
Q4	TRANSISTOR	1	2N929	80131	04713
Q5	TRANSISTOR	1	2N2270	80131	02735
Q6	NOT USED				
Q7	NOT USED				
Q8	NOT USED				
Q9	TRANSISTOR	1	2N4037	80131	02735
RA1	HEATSINK	1	2225B	13103	
RA2	HEATSINK	1	6012B	13103	
R1	RESISTOR, FIXED, COMPOSITION: 120 Ω, 5%, 1/4W	3	RCR07G121JS	81349	01121
R2	Same as R1				
R3	Same as R1				
R4	RESISTOR, FIXED, COMPOSITION: 270 Ω, 5%, 1/4W	3	RCR07G271JS	81349	01121
R5	RESISTOR, FIXED, COMPOSITION: 240 Ω, 5%, 1/4W	1	RCR07G241JS	81349	01121
R6	RESISTOR, FIXED, COMPOSITION: 51 Ω, 5%, 1/4W	3	RCR07G510JS	81349	01121
R7	RESISTOR, FIXED, COMPOSITION: 1.5 kΩ, 5%, 1/4W	1	RCR07G152JS	81349	01121
R8	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	4	RCR07G102JS	81349	01121
R9	Same as R8				
R10	RESISTOR, FIXED, COMPOSITION: 3.6 kΩ, 5%, 1/4W	5	RCR07G362JS	81349	01121

REF DESIG PREFIX A5

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R11	Same as R10				
R12	Same as R10				
R13	RESISTOR, FIXED, COMPOSITION: 510 kΩ, 5%, 1/4W	1	RCR07G514JS	81349	01121
R14	RESISTOR, FIXED, COMPOSITION: 36 kΩ, 5%, 1/4W	3	RCR07G363JS	81349	01121
R15	Same as R14				
R16	RESISTOR, FIXED, COMPOSITION: 1.6 kΩ, 5%, 1/4W	2	RCR07G162JS	81349	01121
R17	RESISTOR, FIXED, COMPOSITION: 4.7 kΩ, 5%, 1/8W	1	RCR05G472JS	81349	01121
R18	RESISTOR, FIXED, COMPOSITION: 4.7 kΩ, 5%, 1/4W	1	RCR07G472JS	81349	01121
R19	RESISTOR, FIXED, COMPOSITION: 2.0 kΩ, 5%, 1/4W	1	RCR07G202JS	81349	01121
R20	Same as R8				
R21	Same as R8				
R22	Same as R10				
R23	Same as R14				
R24	RESISTOR, VARIABLE, FILM: 20 kΩ, 10%, 1/2W	1	62PR20K	73138	
R25	RESISTOR, VARIABLE, FILM: 5 kΩ, 10%, 1/2W	2	62PR5K	73138	
R26	RESISTOR, FIXED, COMPOSITION: 20 kΩ, 5%, 1/4W	2	RCR07G203JS	81349	01121
R27	Same as R26				
R28	Same as R25				
R29	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	1	RCR07G103JS	81349	01121
R30	Same as R6				
R31	Same as R10				

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R32	RESISTOR, FIXED, COMPOSITION: 200 Ω, 5%, 1/4W	1	RCR07G201JS	81349	01121
R33	Same as R4				
R34	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/4W	1	RCR07G471JS	81349	01121
R35	Same as R4				
S1	SWITCH, TOGGLE	1	T8001	81640	
U1	INTEGRATED CIRCUIT	1	U6B95H9059X	07263	
U2	INTEGRATED CIRCUIT	6	MC4016P	04713	
U3	INTEGRATED CIRCUIT	1	SN74S04N	01295	
U4	INTEGRATED CIRCUIT	1	SN74S64N	01295	
U5	INTEGRATED CIRCUIT	1	SN74H52N	01295	
U6	INTEGRATED CIRCUIT	1	SN74S74N	01295	
U7	Same as U2				
U8	Same as U2				
U9	Same as U2				
U10	Same as U2				
U11	Same as U2				
U12	NOT USED				
U13	INTEGRATED CIRCUIT	4	869324	14632	
U14	Same as U13				
U15	Same as U13				
U16	Same as U13				

REF DESIG PREFIX A5

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U17	INTEGRATED CIRCUIT	1	8674H30	14632	
U18	INTEGRATED CIRCUIT	1	SN74S10N	01295	
U19	INTEGRATED CIRCUIT	1	SN74S00N	01295	
U20	PRESET MODULE	1	31689-16	14632	
U21	PRESET MODULE	2	31689-18	14632	
U22	PRESET MODULE	1	31689-17	14632	
U23	PRESET MODULE	3	31689-19	14632	
U24	PRESET MODULE	2	31689-12	14632	
U25	Same as U24				
U26	PRESET MODULE	1	31689-13	14632	
U27	Same as U23				
U28	PRESET MODULE	1	31689-10	14632	
U29	PRESET MODULE	1	31689-14	14632	
U30	Same as U21				
U31	Same as U23				
U32	TEMPERATURE COMPENSATING CRYSTAL OSCILLATOR	1	32913-1	14632	
U33	INTEGRATED CIRCUIT	3	868292	14632	
U34	INTEGRATED CIRCUIT	1	U5B770939X	07263	
U35	INTEGRATED CIRCUIT	1	NE526A	18324	
U36	INTEGRATED CIRCUIT	2	867400	14632	
U37	Same as U33				

REF DESIG PREFIX A5

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U38	Same as U33				
U39	INTEGRATED CIRCUIT	1	N8293A	18324	
U40	INTEGRATED CIRCUIT	1	867474	14632	
U41	Same as U36				
U42	INTEGRATED CIRCUIT	1	MC4044P	04713	
U43	INTEGRATED CIRCUIT	1	867404	14632	
U44	INTEGRATED CIRCUIT	1	8674H11	14632	
U45	INTEGRATED CIRCUIT	1	867408	14632	
U46	INTEGRATED CIRCUIT	1	867402	146 32	
U47	INTEGRATED CIRCUIT	2	N5558V	27014	
U48	INTEGRATED CIRCUIT	1	SN7437N	01295	
U49	Same as U47				
U50	INTEGRATED CIRCUIT	1	U5B7740393	07263	
U51	INTEGRATED CIRCUIT	1	UGH7815393	07263	
VR1	DIODE, ZENER	1	1N752A	80131	04713
VR2	DIODE, ZENER	1	1N967B	80131	04713

5.4.8 Type 791075 Serial Input Converter

REF DESIG PREFIX A6

EF SIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 20%, 35V	2	196D475X0035JA1	56289	
C2	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	5	8131M100-651-104M	72982	
C3	Same as C2				
C4	Same as C2				
C5	Same as C2				
C6	Same as C1				
C7	Same as C2				
C8	CAPACITOR, MICA, DIPPED: 3300 pF, 5%, 500V	1	CM06FD332J03	81349	72136
C9	CAPACITOR, MICA, DIPPED: 100 pF, 5%, 500V	1	CM05FD101J03	81349	72136
E1 thru E8	TERMINAL	8	1019-2	71279	
1	CONNECTOR	2	583529-1	00779	
2	Same as J1				
R1	RESISTOR, FIXED, COMPOSITION: 5.1 kΩ, 5%, 1/4W	2	RCR07G512JS	81349	01121
R2	Same as R1				
R3	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	4	RCR07G103JS	81349	01121
R4	RESISTOR, VARIABLE, FILM: 10 kΩ, 10%, 1/2W	2	62PR10K	73138	
R5	Same as R3				
R6	Same as R4				
R7	Same as R3				
R8	Same as R3				

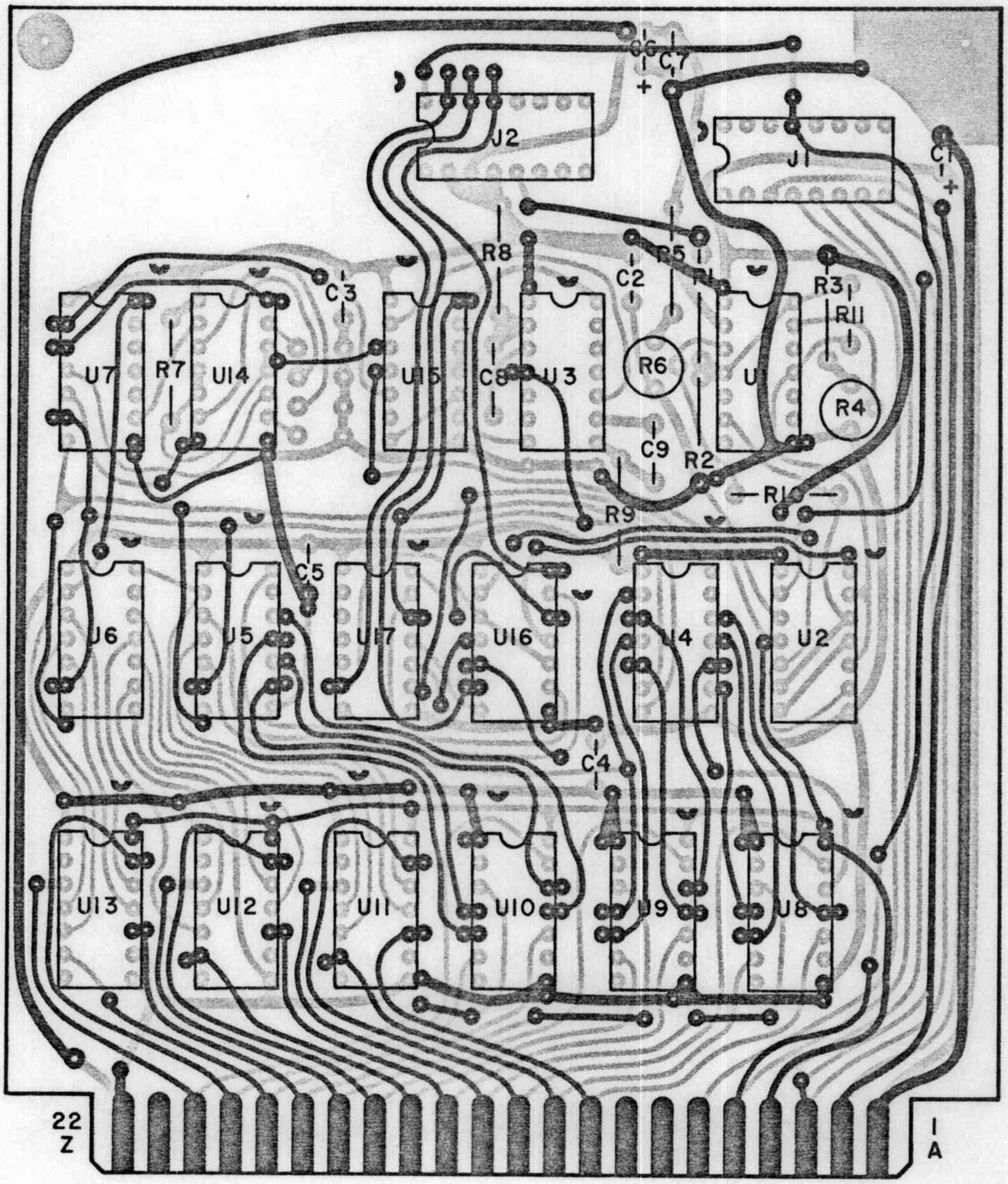
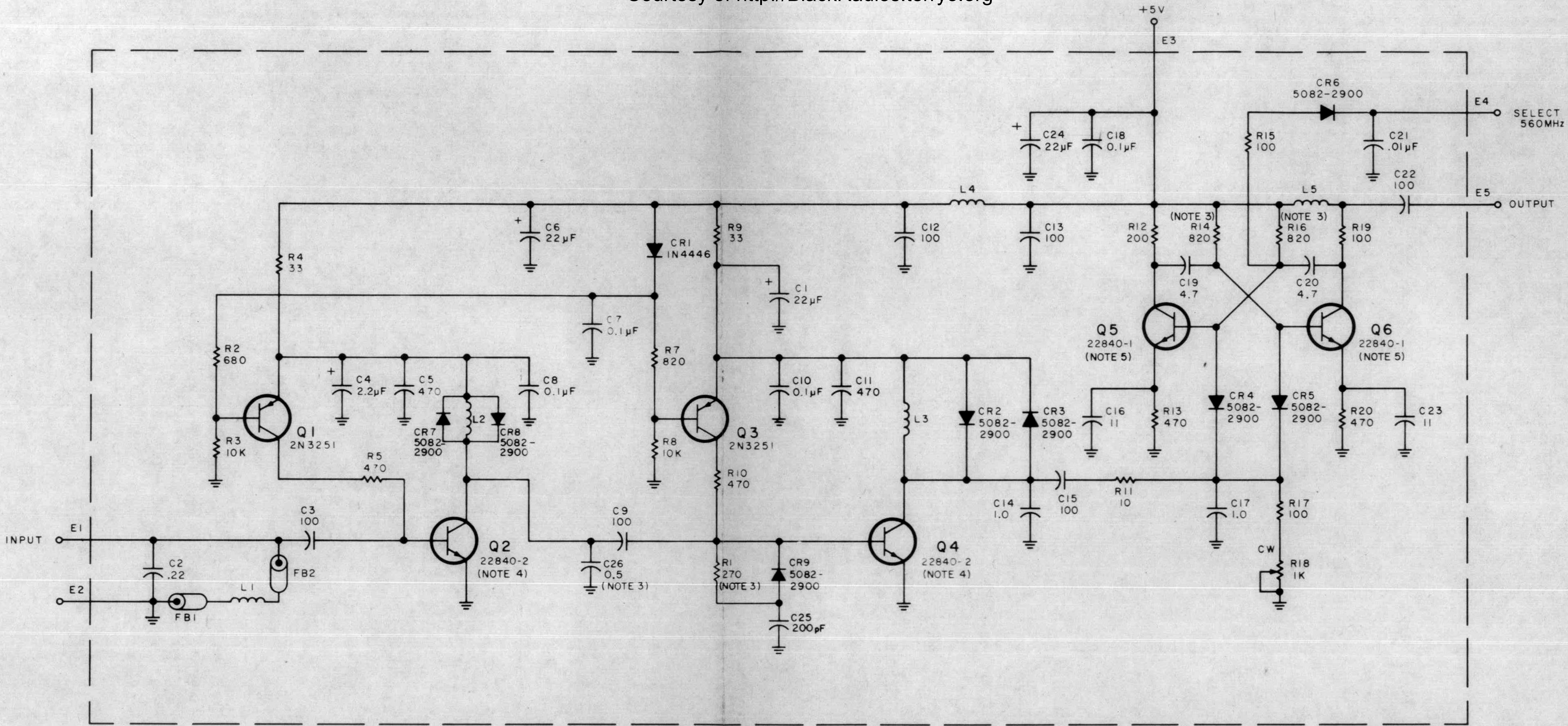


Figure 5-12. Type 791075 Serial Input Converter (A6), Locations of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R9	RESISTOR, FIXED, COMPOSITION: 12 kΩ, 5%, 1/4W	1	RCR07G123JS	81349	01121
R10	RESISTOR, FIXED, COMPOSITION: 24 kΩ, 5%, 1/4W	1	RCR07G243JS	81349	01121
R11	RESISTOR, FIXED, COMPOSITION: 22 kΩ, 5%, 1/8W	1	RCR05G223JS	81349	01121
U1	INTEGRATED CIRCUIT	1	SN75107AN	01295	
U2	INTEGRATED CIRCUIT	1	867402	14632	
U3	INTEGRATED CIRCUIT	1	SN74123N	01295	
U4 thru U7	INTEGRATED CIRCUIT	4	8674164	14632	
U8 thru U13	INTEGRATED CIRCUIT	6	868292	14632	
U14	INTEGRATED CIRCUIT	1	868242	14632	
U15	INTEGRATED CIRCUIT	3	867400	14632	
U16	Same as U15				
U17	Same as U15				

SECTION VI

SCHEMATIC DIAGRAMS



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ± 5%, 1/8W.
   b) CAPACITANCE IS IN pF.
2. CW ON R18 DENOTES CLOCKWISE ROTATION OF ACTUATOR.
3. NOMINAL VALUE. FINAL VALUE FACTORY SELECTED
4. FOR Q2, Q4 LEAD ARRANGEMENT, SEE DETAIL A.
5. FOR Q5, Q6 LEAD ARRANGEMENT, SEE DETAIL B.

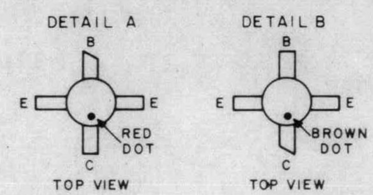
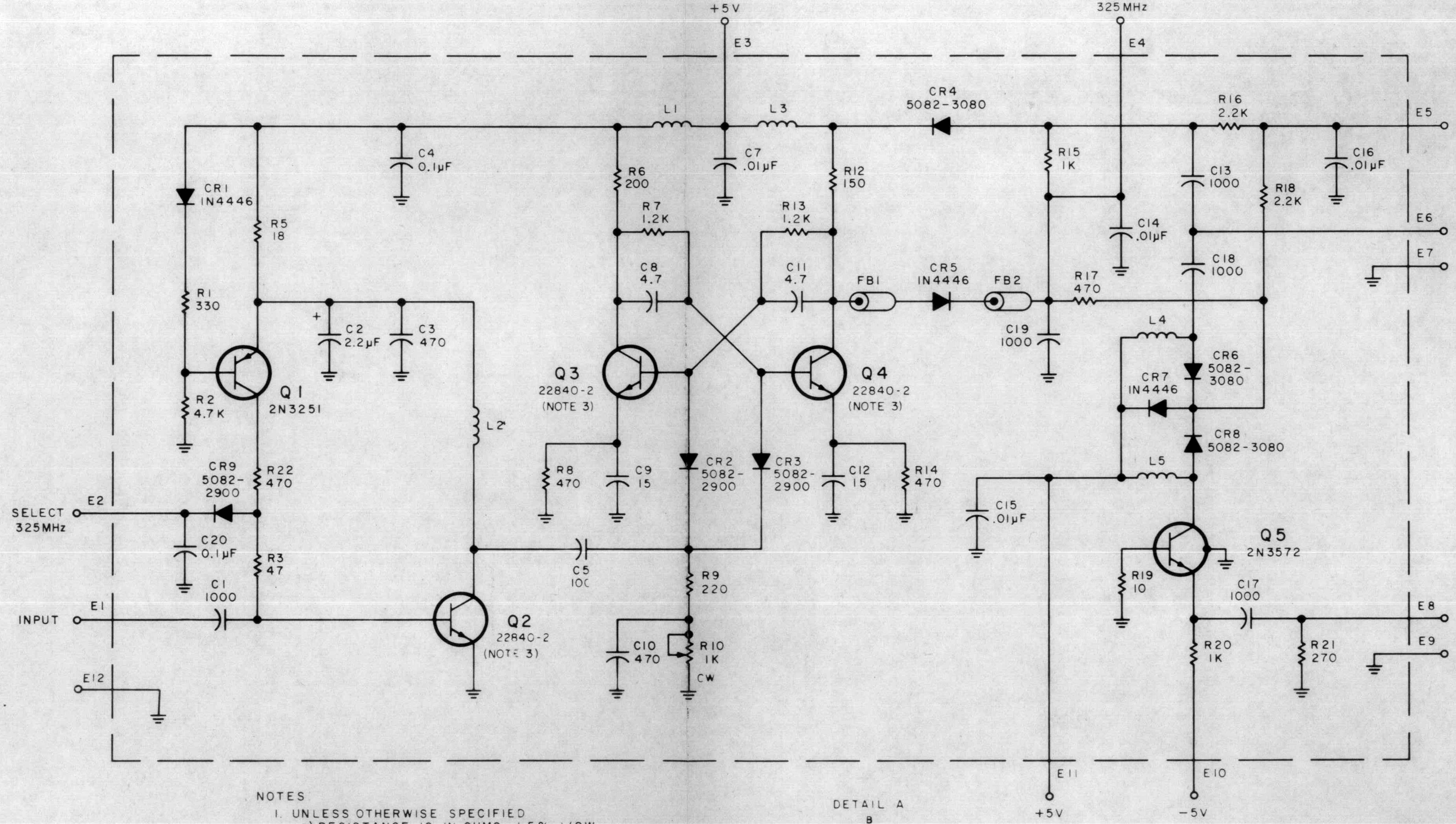


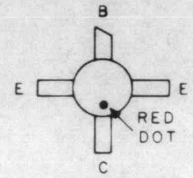
Figure 6-1. Part 16488-2 1160 MHz Binary Divider (A1), Schematic Diagram



NOTES

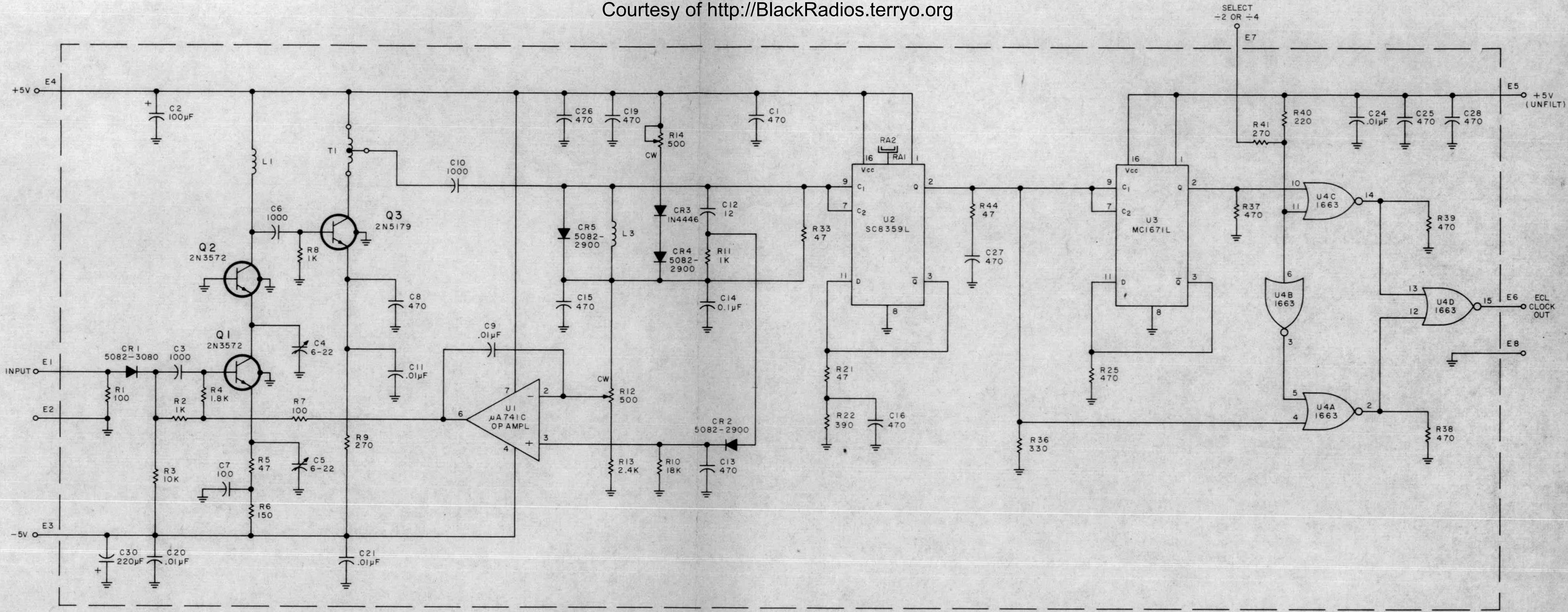
1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ±5%, 1/8W
   b) CAPACITANCE IS IN pF.
2. CW ON R10 DENOTES CLOCKWISE ROTATION OF ACTUATOR
3. FOR Q2, Q3, Q4 LEAD ARRANGEMENT, SEE DETAIL A

DETAIL A



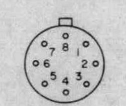
TOP VIEW

Figure 6-2. Part 16461-2 660 MHz Binary Divider (A2), Schematic Diagram



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5%, 1/8W.
   b) CAPACITANCE IS IN pF.
2. CW ON R12, R14 INDICATES CLOCKWISE ROTATION OF ACTUATOR.
3. FOR U1 PIN ARRANGEMENT, SEE DETAIL A.
4. FOR U2, U3, U4 LEAD ARRANGEMENT, SEE DETAIL B.

DETAIL A



BOTTOM VIEW

DETAIL B

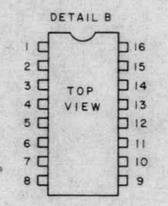
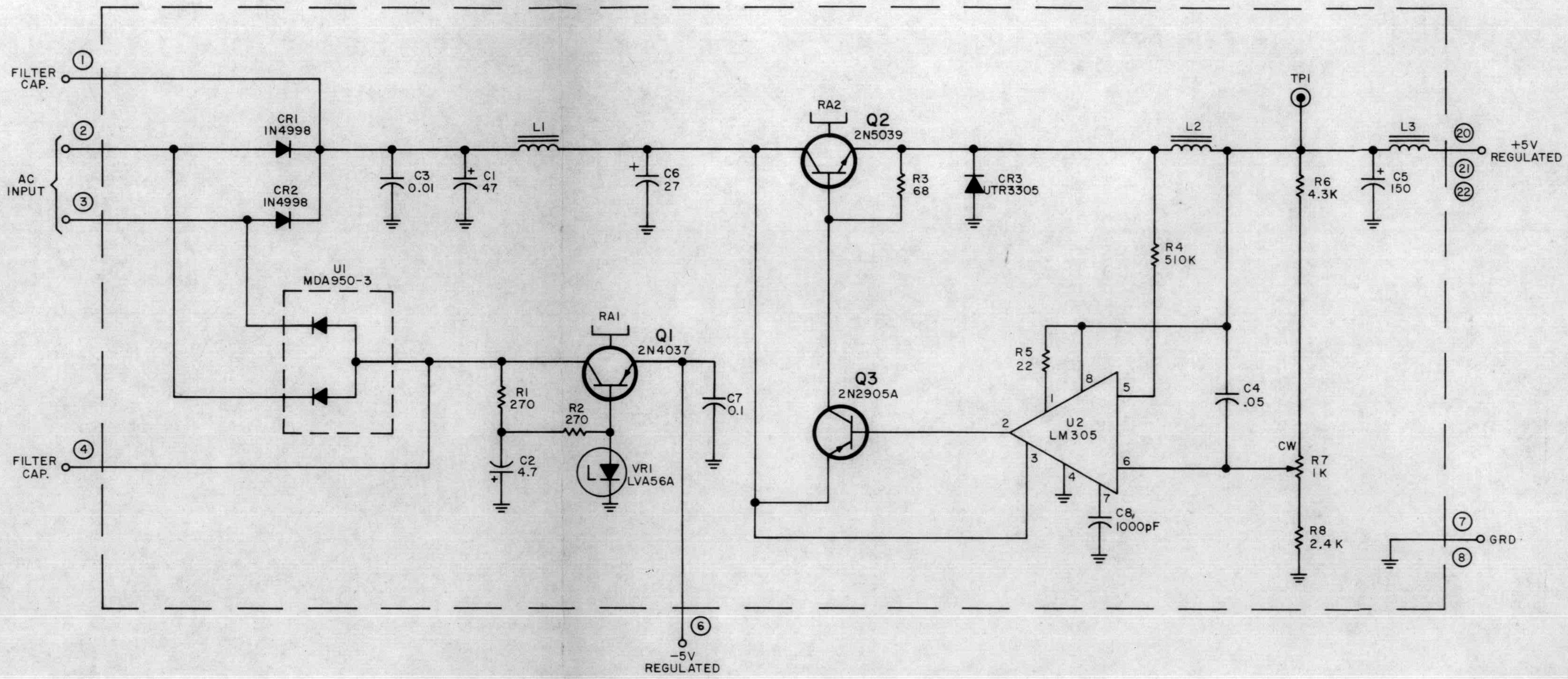


Figure 6-3. Part 17009 320 MHz ÷ 2 or ÷ 4 (A3), Schematic Diagram



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS MEASURED IN OHMS, ±5%, 1/4W.
   b) CAPACITANCE IS MEASURED IN μF.
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.
3. CW ON R7 DENOTES CLOCKWISE ROTATION OF ACTUATOR.
4. FOR U2 PIN ARRANGEMENT, SEE DETAIL A.

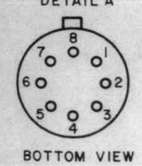
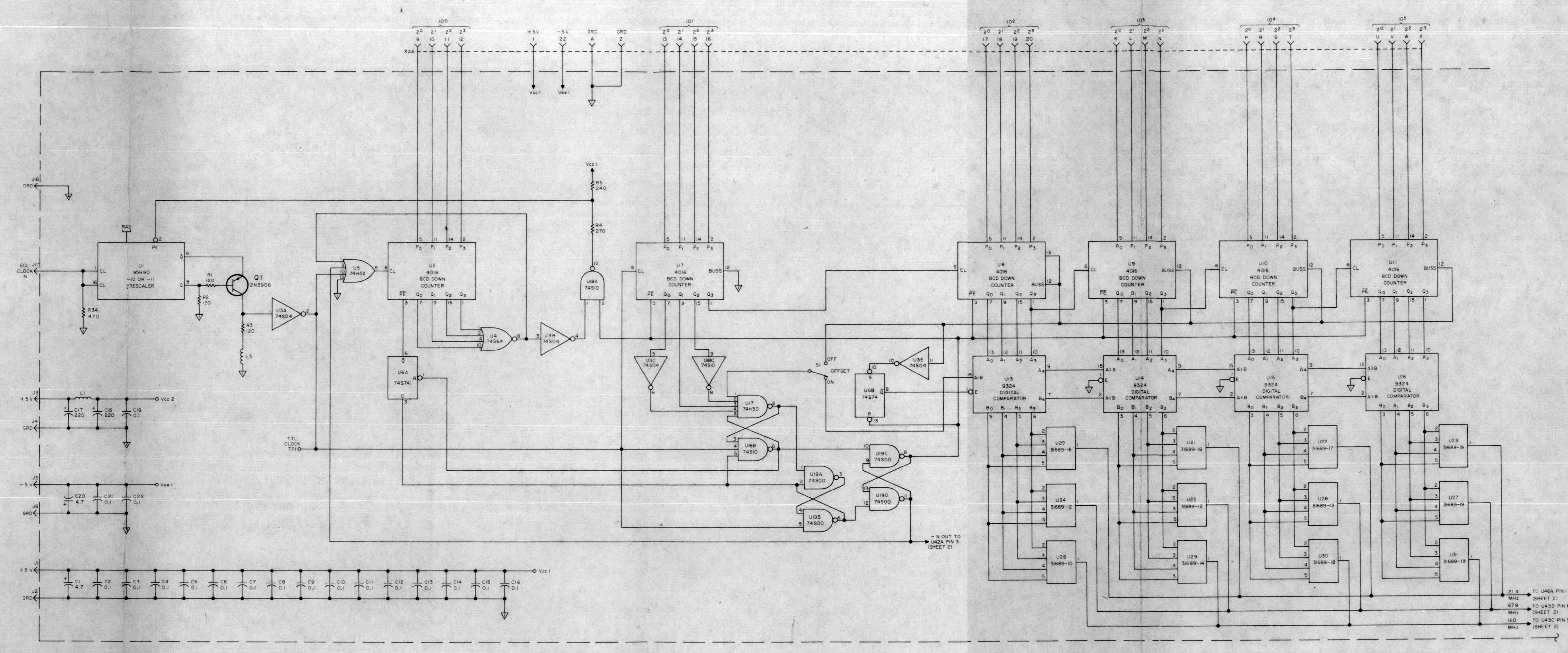
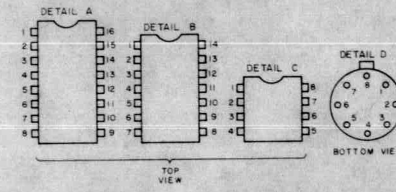


Figure 6-4. Type 76192 ±5V Switching Regulator (A4), Schematic Diagram



NOTES

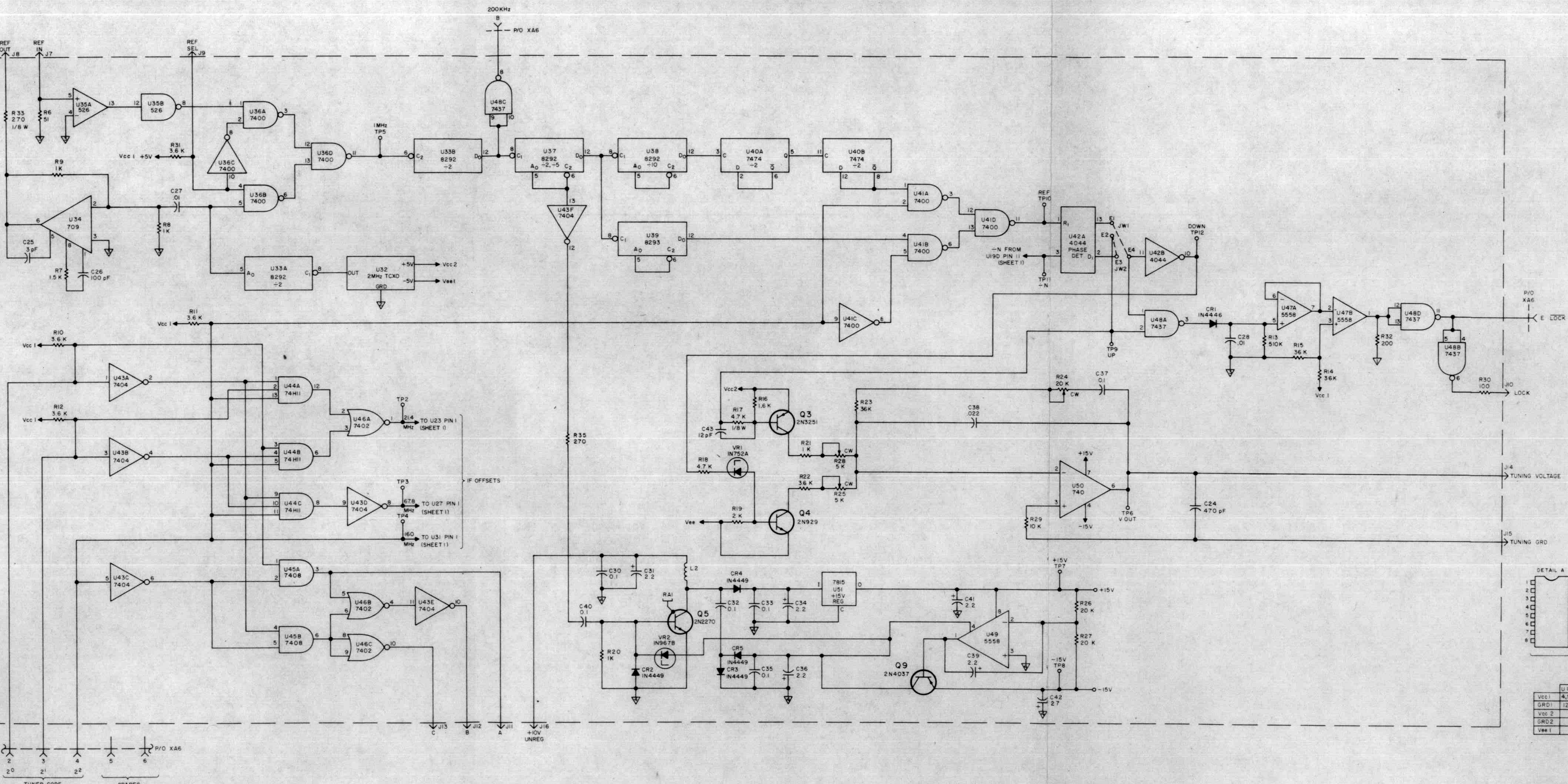
1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W
   b) CAPACITANCE IS IN μF
   c) INDUCTANCE IS IN mH
2. CW ON POTENTIOMETERS INDICATES CLOCKWISE ROTATION OF ACTUATOR
3. FOR PIN ARRANGEMENT OF U1, U2, U7-U11, U13-U16 SEE DETAIL A
4. FOR PIN ARRANGEMENT OF U3-U6, U12, U17-U19, U33, U36-U46, 48 SEE DETAIL B
5. FOR PIN ARRANGEMENT OF U47, U51 SEE DETAIL C
6. FOR PIN ARRANGEMENT OF U34, U49, U50 SEE DETAIL D
7. FOR PIN ARRANGEMENT OF U20-U31 SEE DETAIL E
8. FOR Vcc1, Vcc2, GRD1, GRD2, Vee1 PINS, SEE DETAIL F
9. ▽ INDICATES COMMON CONNECTIONS



DETAIL F

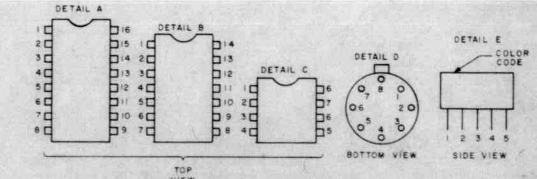
	U1	U2, U7-U11, U13-U16	U3-U6, U17-U19, U36-U46, U48	U33	U35	U47		U34
Vcc1	4, 5	16	14		1	8		
GRD1	12	8	7		10	4		
Vcc2				14	2			7
GRD2				7				
Vee1					7			4

Figure 6-5. Type 791077 Reference/÷ N/Phase Detector (A5), Schematic Diagram, Sheet 1



NOTES:

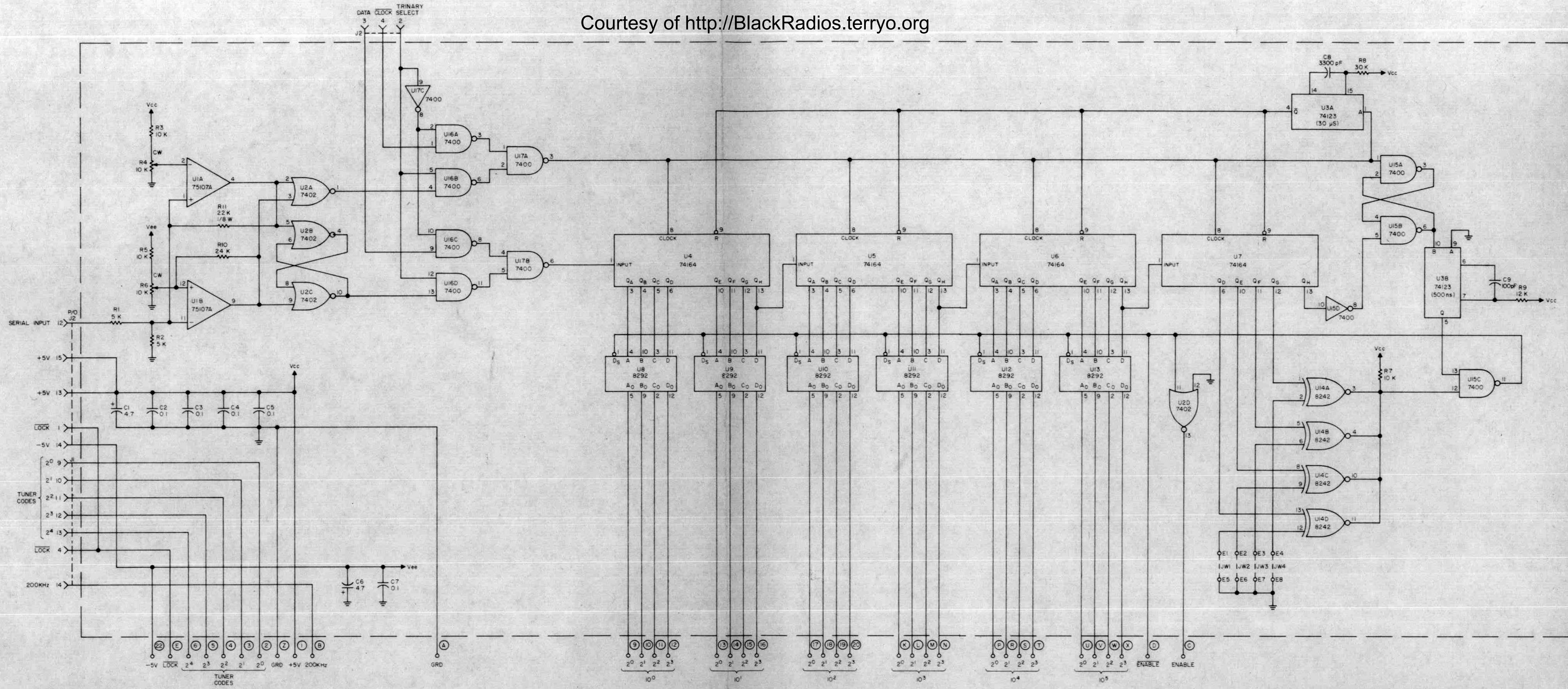
1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ± 5 %, 1/4 W
   b) CAPACITANCE IS IN μF
   c) INDUCTANCE IS IN mH
2. CW ON POTENTIOMETERS INDICATES CLOCKWISE ROTATION OF ACTUATOR
3. FOR PIN ARRANGEMENT OF U1, U2, U7-U11, U13-U16 SEE DETAIL A.
4. FOR PIN ARRANGEMENT OF U3-U6, U12, U17-U19, U33, U36-U46, U48 SEE DETAIL B.
5. FOR PIN ARRANGEMENT OF U47, U51 SEE DETAIL C.
6. FOR PIN ARRANGEMENT OF U34, U49, U50 SEE DETAIL D.
7. FOR PIN ARRANGEMENT OF U20-U31 SEE DETAIL E.
8. FOR Vcc1, Vcc2, GRD 1, GRD 2, Vee1 PINS, SEE DETAIL F.
9. ▽ INDICATES COMMON CONNECTIONS.



DETAIL F

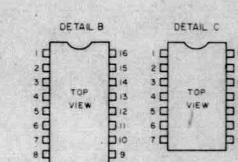
	U1	U2, U7-U11, U13-U16	U3-U6, U17-U19, U36-U46, U48	U33	U35	U47		U34
Vcc1	4,5	16	14		1	8		
GRD1	12	8	7		10	4		
Vcc 2				14	2			7
GRD2				7				
Vee1					7			4

Figure 6-6. Type 791077 Reference/÷ N/Phase Detector (A5), Schematic Diagram, Sheet 2



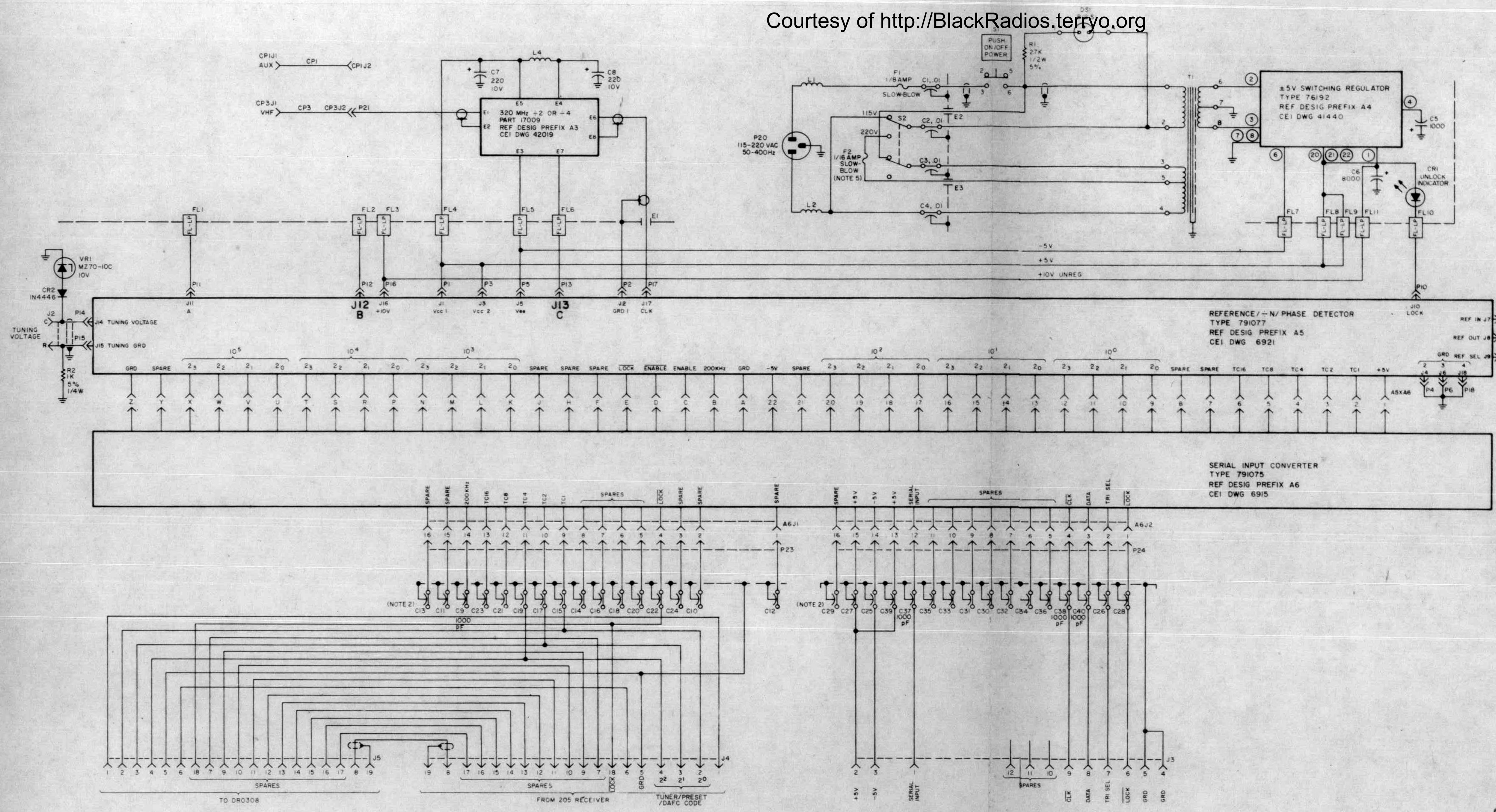
DETAIL A

	U1	U2	U3	U4 - U17
Vcc	14	14	16	14
Vee	13			
GRD	7	7	8	7



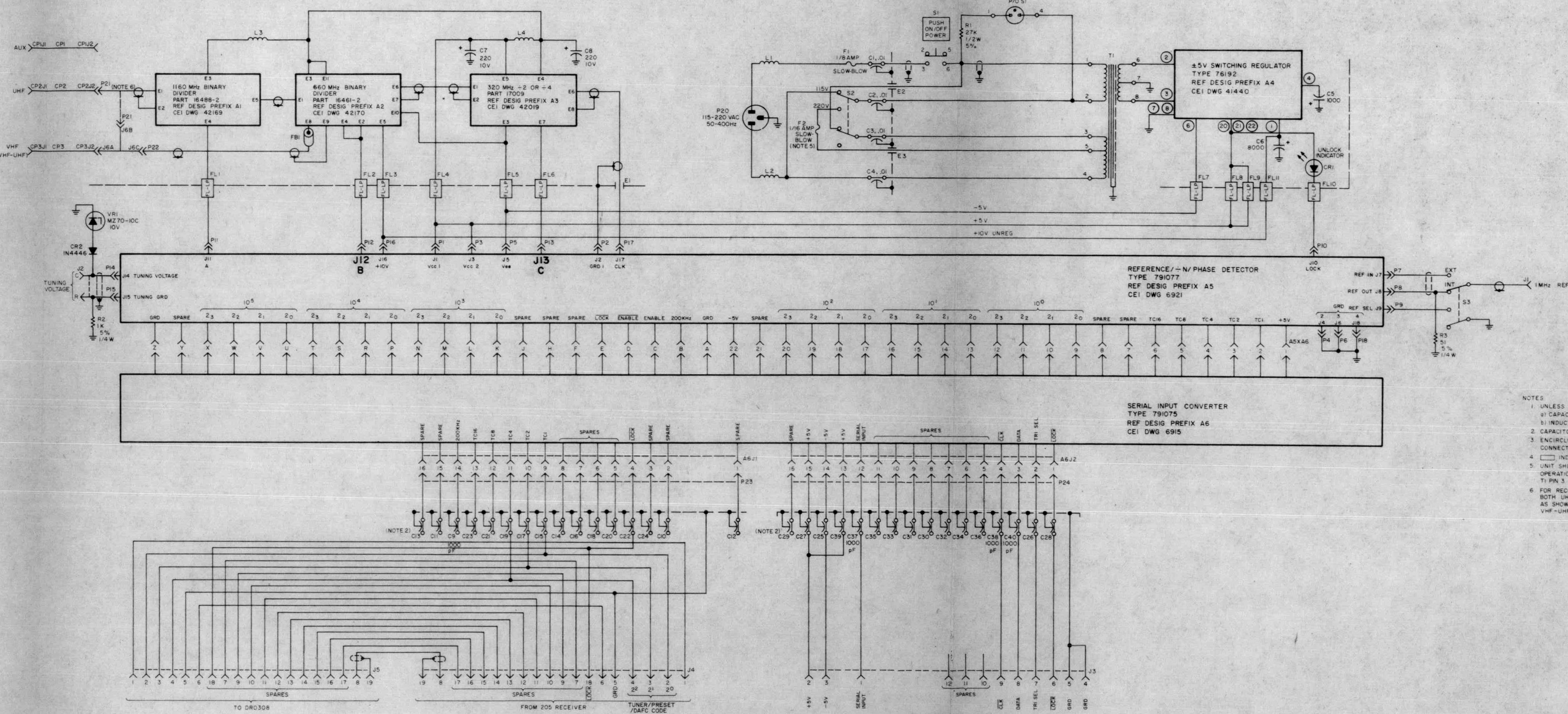
NOTES
1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W
   b) CAPACITANCE IS IN µF
2. ENCIRCLED NUMBERS AND LETTERS ARE MODULE CONNECTOR PINS
3. CW ON R4 AND R6 INDICATES CLOCKWISE ROTATION OF ACTUATOR
4. FOR U1 THRU U17 Vcc, Vee, GRD SEE DETAIL A
5. FOR LEAD ARRANGEMENT OF U3 SEE DETAIL B
6. FOR LEAD ARRANGEMENT OF U1, U2, U4-U17 SEE DETAIL C

Figure 6-7. Type 791075 Serial Input Converter (A6), Schematic Diagram



NOTES:
1. UNLESS OTHERWISE SPECIFIED
   a) CAPACITANCE IS IN µF
   b) INDUCTANCE IS IN µH
2. CAPACITORS C10 THRU C39 ARE .05µF EXCEPT C37, C38
3. ENCIRCLED NUMBERS & LETTERS ARE MODULE CONNECTOR NUMBERS & LETTERS
4. ▭ INDICATES FRONT PANEL CONTROL
5. UNIT SHOWN WIRED FOR 115/220V OPERATION, FOR 115/230V OPERATION DISCONNECT F2 FROM T1 PIN 5 AND CONNECT IT TO T1 PIN 3. CHANGE REFERENCE AT P20 AND S2 TO 115/230V

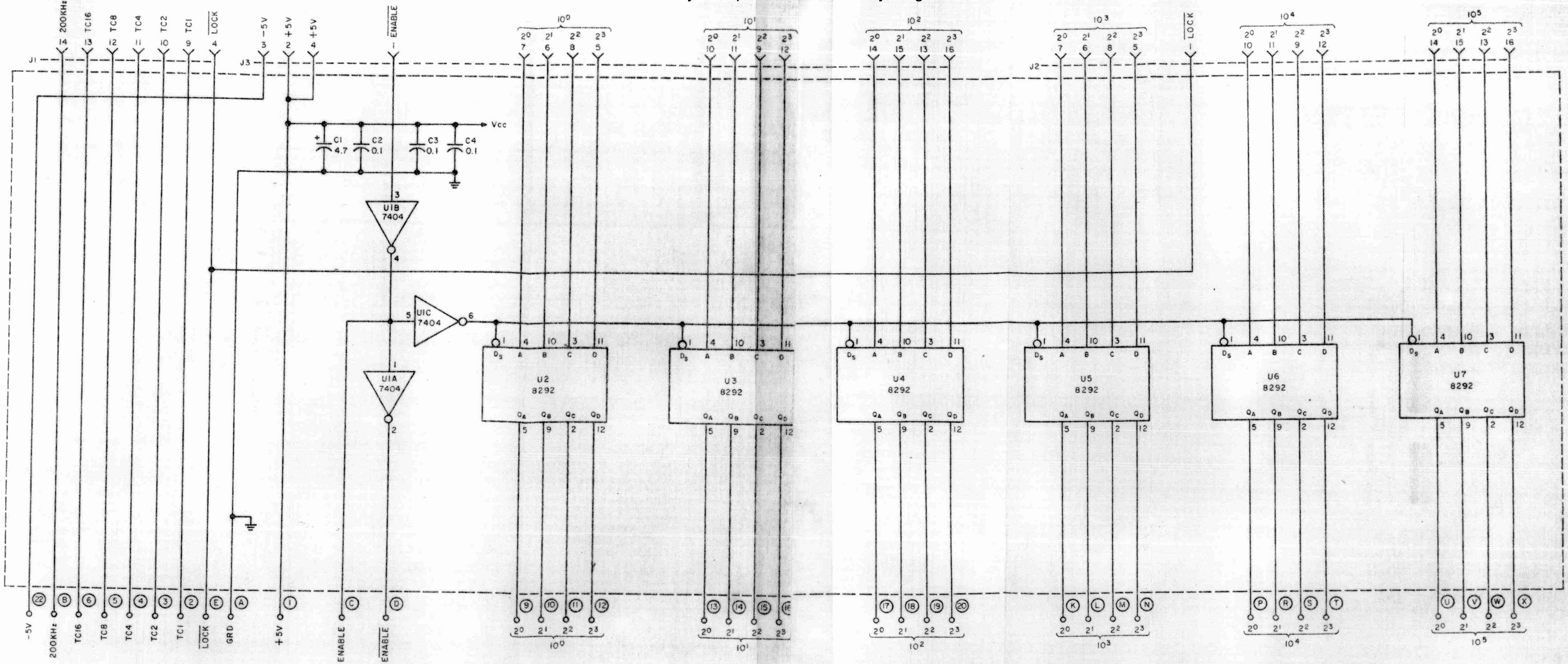
Figure 6-8. Type FS-101-2 Frequency Synthesizer, Main Chassis Schematic Diagram

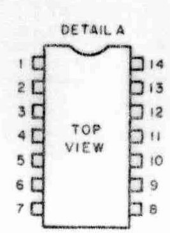


NOTES

1. UNLESS OTHERWISE SPECIFIED
   a) CAPACITANCE IS IN µF
   b) INDUCTANCE IS IN µH
2. CAPACITORS C10 THRU C39 ARE .05µF EXCEPT C37, C38.
3. ENCIRCLED NUMBERS & LETTERS ARE MODULE CONNECTOR NUMBERS & LETTERS.
4. ▭ INDICATES FRONT PANEL CONTROL.
5. UNIT SHOWN WIRED FOR 115/220V OPERATION; FOR 115/230V OPERATION DISCONNECT F2 FROM T1 PIN 5 AND CONNECT IT TO T1 PIN 3. CHANGE REFERENCE AT P20 AND S2 TO 115/230V.
6. FOR RECEIVERS WITH SINGLE LO OUTPUT CONNECTOR FOR BOTH UHF AND VHF TUNERS, CONNECT P21 TO J6B AS SHOWN IN DASHED LINES. CP3J1 THEN BECOMES VHF-UHF LO INPUT.

Figure 6-9. Type FS-102-2 Frequency Synthesizer, Main Chassis Schematic Diagram





NOTES:

1. UNLESS OTHERWISE SPECIFIEI
   a) CAPACITANCE VALUES ARE µF
2. ENCIRCLED NUMBERS & LETT(ARE MODULE CONNECTOR NUMBERS & LETTERS.
3. FOR PIN ARRANGEMENT OF UI RU U7, SEE DETAIL A.
4. FOR Vcc AND GROUND PINS, E DETAIL B.

DETAIL B

	UI THRU U7
Vcc	14
GRD	7

Figure 7-1. Type 791076 Parallel Input Register (A6), Schematic Diagram

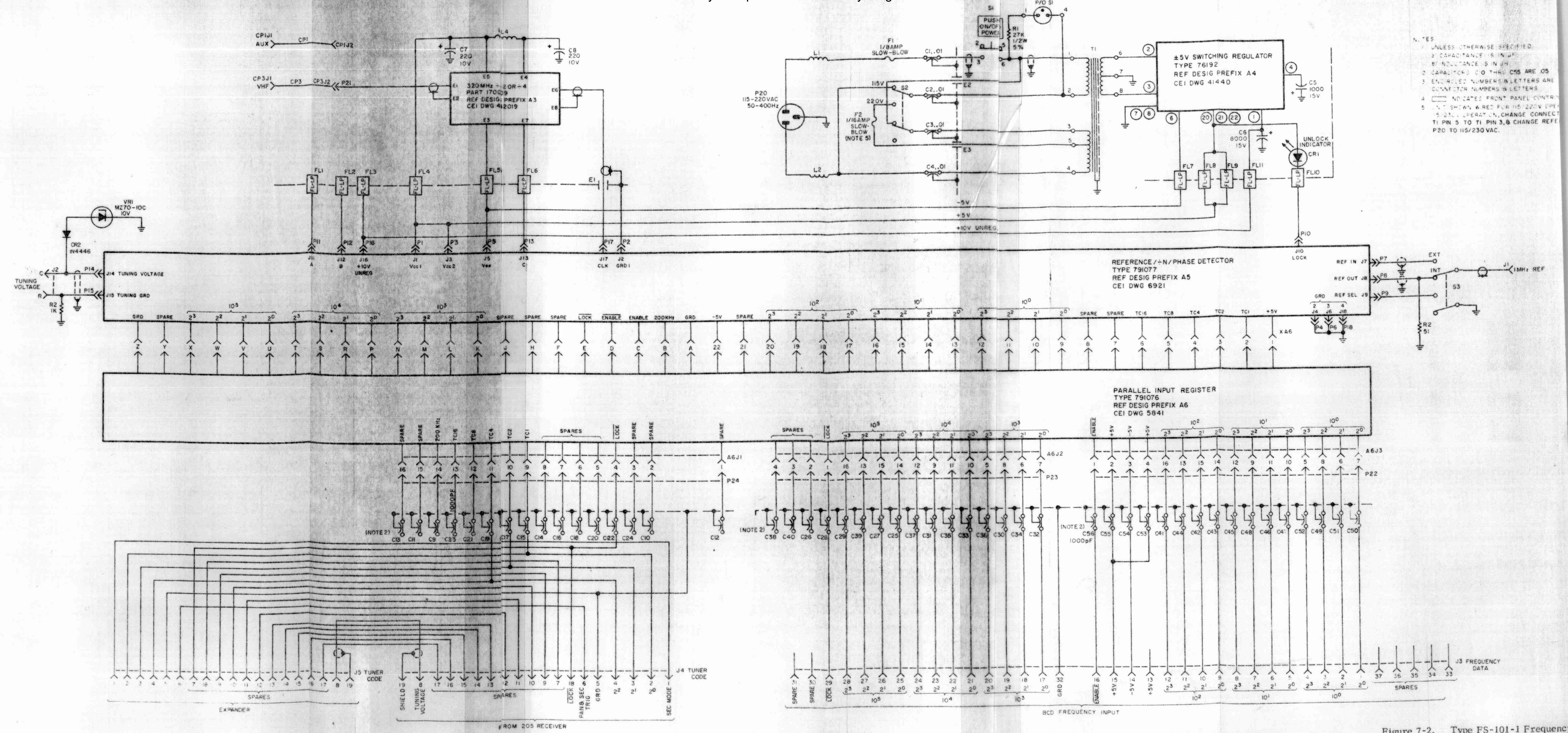


Figure 7-2. Type FS-101-1 Frequenc
Main Chassis Schematic