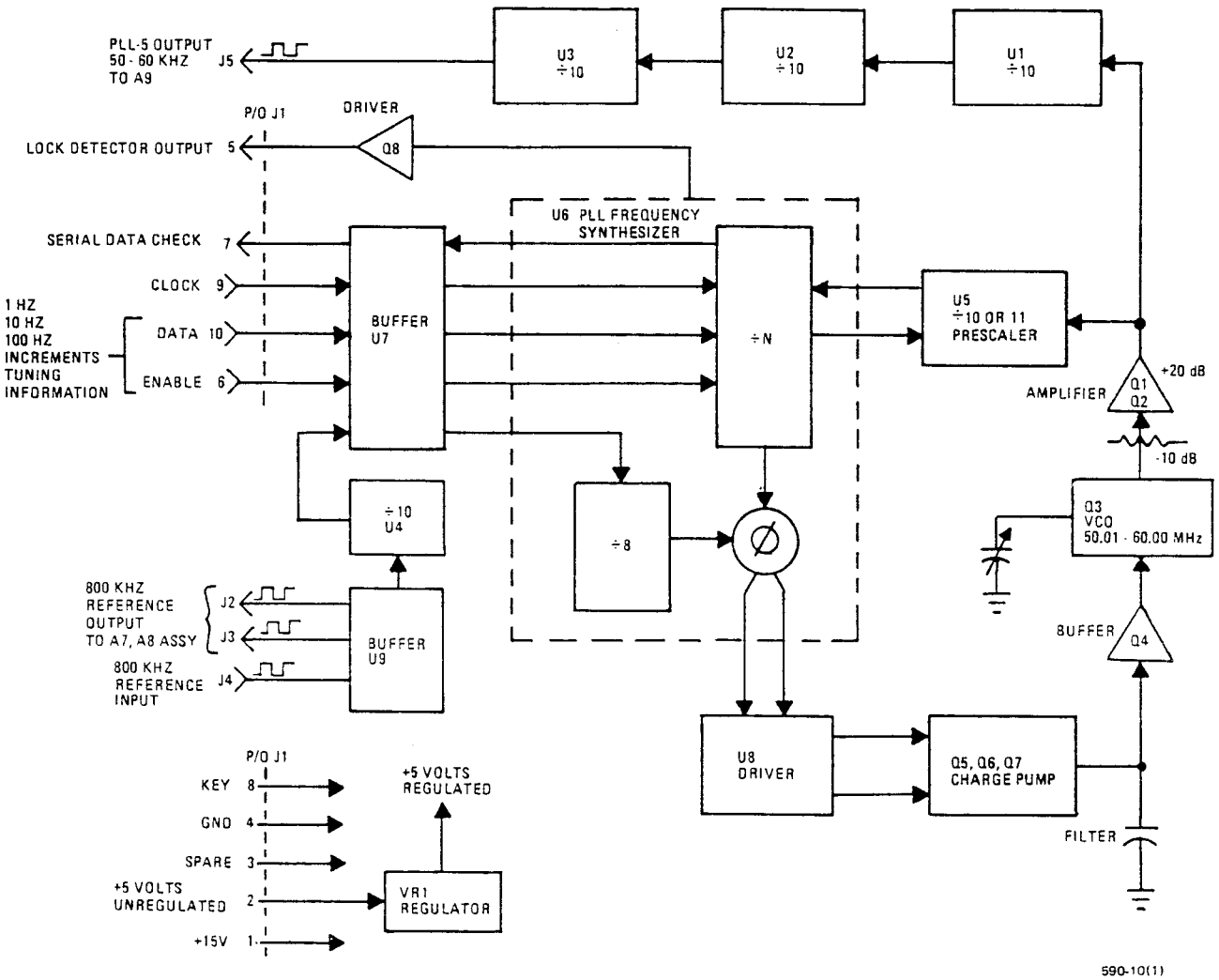
A10
PLL 5 ASSEMBLY



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PLL 5 ASSEMBLY A10

1. GENERAL DESCRIPTION

PLL 5 Assembly A10 is a single phase locked loop (PLL) synthesizer that ultimately provides the 1 Hz, 10 Hz, and 100 Hz tuning increments of the LO 1 frequency. Tuning increments are determined by the digits in the corresponding positions of the transmit frequency.

Frequency select input data is applied to the assembly in serial data form under Control Board Assembly A14 microprocessor control. A10 assembly output to PLL 4 Assembly A9 is a variable 50 to 60 kHz signal in 10 Hz controllable steps. Since 1000 frequency steps are possible, the net results of A10 operation (after further translation to 1 Hz increments in the synthesizer chain) are 1 Hz, 10 Hz, and 100 Hz tuning increments in the LO 1 output.

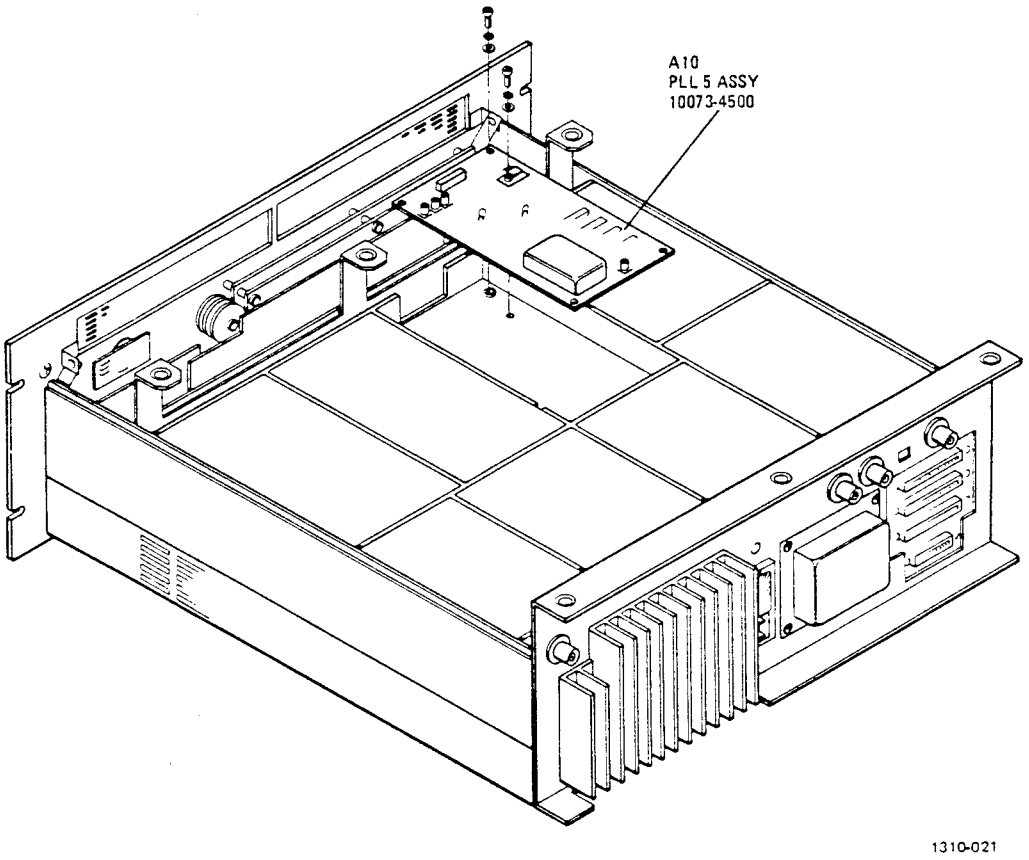


Figure 1. PLL 5 Assembly A10 Location

2. INTERFACE CONNECTIONS

Table 1 details the various input/output connections and other relevant data.

Table 1. PLL 5 Assembly Interface Connections

Connector	Function	Characteristics
J1-1	+ 15 Volts	Approximately 25 mA
J1-2	+ 5 Volts Unregulated	Approximately 240 mA
J1-3	Spare	
J1-4	Ground	
J1-5	Lock Detector Output	+ 5 Vdc = unlocked, 0 Vdc = locked, P/O BITE test
J1-6	Enable	+ going pulse = enabled
J1-7	Serial Data Check	P/O BITE test, + 5 Vdc = ok
J1-8	Key	
J1-9	Clock	TTL, 750 kHz
J1-10	Data	Serial TTL
J2	800 kHz Reference Output	TTL
J3	800 kHz Reference Output	TTL
J4	800 kHz Reference Input	TTL
J5	PLL 5 Output	TTL, 50 to 60 kHz

3. CIRCUIT DESCRIPTION

NOTE

A10 assembly operation is similar (in operation) to the general divide-by-N PLL and charge pump circuits described in section 4. A review of section 4 at this point would aid in the understanding of A10 assembly operation.

3.1 Reference Generation

The 800 kHz from Reference Generator Assembly A12 enters PLL 5 Assembly A10 at J4. This signal is buffered via TTL NAND gates in U9 and directed through J2 and J3 to the A7 and A8 assemblies. It is also routed to divide-by-10 counter U4 where it is divided down to 80 kHz. This 80 kHz signal is applied via buffer U7 to a divide-by-eight counter internal to U6 to produce a 10 kHz reference signal. Since this has been derived from

the RF-1310 crystal frequency standard via the A12 assembly, stable and accurate A10 assembly operation is assured.

3.2 Divide-by-N Counter

Since the A10 assembly requires a variable 50 to 60 kHz output frequency, a programmable counter has been designed into the VCO feedback path to the phase comparator. This counter consists of dual modulus divide-by-10/divide-by-11 prescaler U5 and a programmable divide-by-N counter internal to U6. Together, U5 and the programmable portion of U6 create a total division range of N = 5001 to N = 6000, where N is a function of the digits entered in the 1, 10, and 100 positions of the frequency display.

The output of the divide-by-N counter will always attempt to equal the 10.000 kHz reference frequency at the phase comparator inputs, despite changes in the divide-by-N factor due to changing the 1, 10, or 100 Hz exciter frequency display digits. The VCO frequency will change to accomplish this (in response to command signals generated by the phase comparator). The VCO frequency will always equal (N) (reference frequency), or (N) (10.000 kHz) = 50.01 MHz to 60.00 MHz. Division of this range by 1000 will result in the required A10 assembly output range of 50.01 kHz to 60.00 kHz.

The exact value of N is determined by the value of the digits in the 1, 10, and 100 places of the displayed frequency. These front panel selections cause the A14 assembly to generate a serial data code containing information pertaining to the values of the digits chosen. This code is applied synchronously with the 750 kHz system clock to U6 whenever the U6 enable line is gated open by the A14 assembly. In general, N = (6000-XXX), where XXX is the value of the three least significant bits of the transmit frequency. The least significant digit is not selectable and is always zero.

For example, tuning the RF-1310 to 10.401470 MHz would make N = (6000-470) = 5530. The VCO frequency will be (N) (reference) = (5530) (10.000 kHz) = 55.30 MHz. The VCO output is then divided by 1000 to produce the A10 assembly output at 55.30 kHz.

The actual frequency of the A10 assembly output may therefore be calculated from the following formula: f = 10 (6000-XXX) Hz, where XXX is the value of the exciter 100 Hz, 10 Hz, and 1 Hz digits of the transmit frequency.

3.3 Phase Comparator and Charge Pump Operation

Phase comparison of the 10 kHz reference and the 10 kHz VCO derived signal at the divide-by-N counter output is accomplished by a phase comparator internal to U6. When these two signals are equal in frequency and phase, the phase comparator outputs at TP2 and TP3 are essentially 5 Vdc. U8 functions as a buffer for the phase comparator to the input of the charge pump circuit, consisting of Q5, Q6, and Q7. This 5-volt level holds Q6 and Q7 off. Consequently, Q5 is also off and the voltage across C24 is at some constant level. This biases Q4 to some specific source current, and the voltage across R16 at TP1 is constant. This VCO control voltage holds the VCO frequency constant, somewhere between 50 and 60 MHz.

Assume that the VCO derived feedback signal at the divide-by-N counter output is suddenly less than the reference frequency. This is what will happen at the instant the divide-by-N factor is increased. Since the two phase comparator inputs are no longer equal, the phase comparator will output a series of negative pulses at TP3. Q7 will turn on, forcing Q5 on. Q5 will start to pump charge into C24, causing Q4 to conduct more current as the voltage across C24 increases. This produces a higher dc level at TP1. The VCO frequency will increase in response to it until the signals at the phase comparator inputs are again equal. As the VCO derived signal is approaching the reference frequency, the output pulse width at TP3 will get smaller until the signal is essentially + 5 Vdc again. Q7 and Q5 will turn off. The voltage at C24 will rest at this new higher dc value causing the VCO frequency to also rest at its new higher value.

Assume that the VCO feedback signal at the divide-by-N counter output is suddenly greater than the reference signal (meaning that the divide-by-N factor has just decreased). The two phase comparator inputs are again unequal, but now the phase comparator will output the negative pulses at TP2. Q6 will turn on, drawing charge out of C24, and causing the VCO control voltage to drop. Consequently, the VCO will shift lower in frequency, and the VCO derived signal at the phase comparator input will again approach the reference frequency. The output pulses will become very narrow and the signal will almost become a steady 5 Vdc level. This will turn Q6 off and the VCO will stabilize at the lower frequency.

3.4 VCO Operation and Control

A charge pump circuit consisting of Q5, Q6, Q7, and associated components in conjunction with filters C24 and C25 convert the two phase comparator pulse outputs into an analog dc control voltage. Buffer amplifier Q4 applies this control voltage to the varactor diode string in the VCO. The VCO itself is a JFET (Q3) Hartley oscillator stage whose frequency shifts as the capacitance of the varactor diodes changes with changes in control voltage. A net control voltage change of 5 Vdc to 10 Vdc produces a net VCO frequency shift of 50 MHz to 60 MHz. Note also that the 10 volt limit corresponds to N = 6000, while the 5 volt limit corresponds to N = 5001.

The VCO output is fed through 10 dB attenuator network, R10 and R11, to a + 20 dB gain amplifier stage consisting of Q1, Q2, and associated components. This output is split and sent to divide-by-N circuit U5 and U6 and to a divide-by-1000 divider chain consisting of U1, U2, and U3. This divider output is therefore at a frequency range of 50.01 to 60 kHz (in 10 Hz increments) and is the PLL 5 output. This output is fed through J5 to PLL 4 Assembly A9 where further signal processing occurs.

3.5 BITE Circuits

The A10 assembly contains two circuits for self-test evaluation:

- Lock detector Q8, whose output is 0 Vdc whenever the PLL is tracking properly. This line is constantly monitored by the A14 assembly. It will cause a front panel fault light to appear if the loop ever unlocks.

- Serial data check that verifies the tuning data from the A14 assembly has been received and properly translated into the correct divide-by-N factor. A serial data word is sent on the data line (J1 pin 10) and the U6 serial data check line is read back to the A14 assembly (J1 pin 7). If the word has been received and properly decoded, this line will pulse to + 5 Vdc. The serial data check occurs automatically, but only when the exciter BITE self test is actuated.

4. MAINTENANCE

The following adjustments should not be performed as a routine maintenance procedure, but only when a failure indicates a definite need. All tests should be performed with all connections in normal contact, unless otherwise specified.

4.1 VCO Frequency Adjustment

a. Connect equipment as shown in figure 2.

b. Set RF-1310 frequency to 02.00050 MHz.

c. Adjust C20 for 7.5 Vdc at TP1. PLL 5 output vs. exciter tune frequency should agree with table 2. The output waveform should always be a TTL signal.

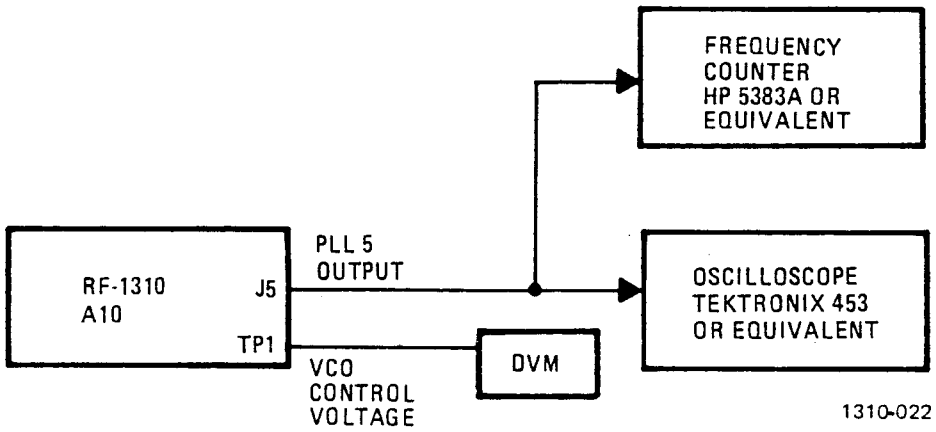


Figure 2. PLL 5 VCO Adjustment

Table 2. VCO Frequency Range

Exciter Tune Frequency, MHz	PLL 5 Output Frequency, kHz	Approximate TP1 Voltage, Vdc
02.00050	55.00	7.5
02.00000	60.00	10.0
02.00099	50.01	5.0

d. Fully reconnect the A10 assembly to RF-1310. Initiate BITE self-test. Exciter must pass all tests associated with assembly A10. Test is complete.

5. PARTS LIST, COMPONENT LOCATIONS, AND SCHEMATIC DIAGRAMS

All replaceable components of PLL 5 Assembly A10 are listed in table 3. Component locations are shown in figure 3. The PLL 5 assembly A10 schematic is shown in figure 4.

Table 3. PLL 5 Assembly A10 Parts List

Ref. Desig.	Part Number	Description
A10	10073-4500	PLL 5 ASSEMBLY
	MP-0121	CLIP, MTG, SPRING STEEL
	10073-7116	CAN RECT DEEP DRAWN
C1	M39014/02-1310	CAP .1UF 10% 100V CER-R
C2	C26-0025-470	CAP 47UF 20% 25V TANT
C3	M39014/02-1310	CAP .1UF 10% 100V CER-R
C4	CK05BX103M	CAP .01UF 20% 100V CER
C5	CK05BX102M	CAP 1000PF 20% 200V CER
C6	M39014/02-1310	CAP .1UF 10% 100V CER-R
C7	M39014/02-1310	CAP .1UF 10% 100V CER-R
C8	M39014/02-1310	CAP .1UF 10% 100V CER-R
C9	CK05BX103M	CAP .01UF 20% 100V CER
C10	CK05BX103M	CAP .01UF 20% 100V CER
C11	CK05BX103M	CAP .01UF 20% 100V CER
C12	CK05BX103M	CAP .01UF 20% 100V CER
C13	CK05BX102M	CAP 1000PF 20% 200V CER
C14	M39014/02-1310	CAP .1UF 10% 100V CER-R
C15	M39014/02-1310	CAP .1UF 10% 100V CER-R
C16	M39014/02-1310	CAP .1UF 10% 100V CER-R
C17	C26-0025-680	CAP 68UF 20% 25V TANT
C18	M39014/02-1310	CAP .1UF 10% 100V CER-R
C19	CK05BX103M	CAP .01UF 20% 100V CER
C20	C84-0003-008	CAP, VAR 3-15PF
C21	CK05BX102M	CAP 1000PF 20% 200V CER
C22	CK05BX102M	CAP 1000PF 20% 200V CER
C23	C26-0025-100	CAP 10UF 20% 25V TANT
C24	C25-0003-004	CAP 0.33UF 10% 50V TANT
C25	CK05BX393M	CAP FXD CER 039UF
C26	C26-0025-470	CAP 47UF 20% 25V TANT
C27	M39014/02-1310	CAP .1UF 10% 100V CER-R
C28	C25-0001-301	CAP 1.0UF 20% 20V TANT
C29	C26-0016-151	CAP 150UF 20% 16V TANT
C30	M39014/02-1310	CAP .1UF 10% 100V CER-R
C31	C26-0025-100	CAP 10UF 20% 25V TANT
C32	M39014/02-1310	CAP .1UF 10% 100V CER-R
C33	M39014/02-1310	CAP .1UF 10% 100V CER-R
C34	M39014/02-1310	CAP .1UF 10% 100V CER-R
C35	C25-0001-301	CAP 1.0UF 20% 20V TANT
C36	M39014/02-1310	CAP .1UF 10% 100V CER-R
C37	M39014/02-1310	CAP .1UF 10% 100V CER-R
C38	M39014/02-1310	CAP .1UF 10% 100V CER-R
C39	M39014/02-1310	CAP .1UF 10% 100V CER-R
C40	M39014/02-1310	CAP .1UF 10% 100V CER-R

Table 3. PLL 5 Assembly A10 Parts List (Cont.)

Ref. Desig.	Part Number	Description
C41	M39014/02-1310	CAP .1UF 10% 100V CER-R
C43	C26-0025-470	CAP 47UF 20% 25V TANT
CR1	10073-7118	VARACTOR 26.0 - 32.0pF
CR2	10073-7118	VARACTOR 26.0 - 32.0pF
CR3	10073-7118	VARACTOR 26.0 - 32.0pF
CR4	10073-7118	VARACTOR 26.0 - 32.0pF
CR5	10073-7118	VARACTOR 26.0 - 32.0pF
CR6	10073-7118	VARACTOR 26.0 - 32.0pF
CR7	10073-7118	VARACTOR 26.0 - 32.0pF
CR8	10073-7118	VARACTOR 26.0 - 32.0pF
CR9	1N6263	DIODE, HOT CARRIER
CR10	1N3064	DIODE 75mA 75V SW
CR11	10073-7118	VARACTOR 26.0 - 32.0pF
CR12	10073-7118	VARACTOR 26.0 - 32.0pF
J1	J46-0032-010	HEADER, 10 PIN DISCRETE
J2	J-0031	CONN SMB VERT PCB
J3	J-0031	CONN SMB VERT PCB
J4	J-0031	CONN SMB VERT PCB
J5	J-0031	CONN SMB VERT PCB
L1	MS14046-9	COIL 27UH 10% FXD RF
L2	MS75084-3	COIL 1.8UH 10% FXD RF
L3	MS75084-10	COIL 6.8UH 10% FXD RF
L4	L08-0001-001	CHOKE W B 50 MHZ
Q1	Q35-0003-000	XSTR U310 JFET HIGH GM
Q2	2N2369	XSTR SS/RF NPN
Q3	Q35-0003-000	XSTR U310 JFET HIGH GM
Q4	Q05-0001-000	XSTR JFET N-CH
Q5	2N2907	XSTR SS/GP PNP TO-18
Q6	2N2222	XSTR SS/GP NPN TO-18
Q7	2N2222	XSTR SS/GP NPN TO-18
Q8	2N2907	XSTR SS/GP PNP TO-18
R1	R65-0003-201	RES,200 5% 1/4W CAR FILM
R2	R65-0003-102	RES,1.0K 5% 1/4W CAR FILM
R3	R65-0003-513	RES,51K 5% 1/4W CAR FILM
R4	R65-0003-270	RES,27 5% 1/4W CAR FILM
R5	R65-0003-201	RES,200 5% 1/4W CAR FILM
R6	R65-0003-472	RES,4.7K 5% 1/4W CAR FILM
R7	R65-0003-152	RES,1.5K 5% 1/4W CAR FILM
R8	R65-0003-100	RES,10 5% 1/4W CAR FILM
R9	R65-0003-151	RES,150 5% 1/4W CAR FILM
R10	R65-0003-101	RES,100 5% 1/4W CAR FILM
R11	R65-0003-201	RES,200 5% 1/4W CAR FILM
R12	R65-0003-101	RES,100 5% 1/4W CAR FILM

Table 3. PLL 5 Assembly A10 Parts List (Cont.)

Ref. Desig.	Part Number	Description
R13	R65-0003-470	RES,47 5% 1/4W CAR FILM
R14	R65-0003-513	RES,51K 5% 1/4W CAR FILM
R15	R65-0003-102	RES,1.0K 5% 1/4W CAR FILM
R16	R65-0003-272	RES,2.7K 5% 1/4W CAR FILM
R17	RN55D3651F	RES,3650 1% 1/8W MET FLM
R18	R65-0003-470	RES,47 5% 1/4W CAR FILM
R19	R65-0003-470	RES,47 5% 1/4W CAR FILM
R20	RN55D6810F	RES,681.0 1% 1/8W MET FLM
R21	RN55D6810F	RES,681.0 1% 1/8W MET FLM
R22	RN55D9091F	RES,9090 1% 1/8W MET FLM
R23	RN55D3321F	RES,3320 1% 1/8W MET FLM
R24	RN55D6810F	RES,681.0 1% 1/8W MET FLM
R25	RN55D6810F	RES,681.0 1% 1/8W MET FLM
R26	R65-0003-472	RES,4.7K 5% 1/4W CAR FILM
R27	R65-0003-472	RES,4.7K 5% 1/4W CAR FILM
R28	R65-0003-103	RES,10K 5% 1/4W CAR FILM
R29	R65-0003-472	RES,4.7K 5% 1/4W CAR FILM
R30	R65-0003-102	RES,1.0K 5% 1/4W CAR FILM
R31	R65-0003-103	RES,10K 5% 1/4W CAR FILM
T1	10073-7002	TRANSFORMER, RF, FIXED
TP1	J-0071	TP PWB BRN TOP ACCS .080"
TP2	J-0066	TP PWB RED TOP ACCS .080"
TP3	J-0069	TP PWB ORN TOP ACCS .080"
TP4	J-0070	TP PWB YEL TOP ACCS .080"
TP5	J-0068	TP PWB GRN TOP ACCS .080"
U1	I65-0004-001	IC 12013 PLASTIC ECL
U2	I05-0000-090	IC 74LS90 PLASTIC TTL
U3	I05-0000-090	IC 74LS90 PLASTIC TTL
U4	I05-0000-090	IC 74LS90 PLASTIC TTL
U5	I65-0004-001	IC 12013 PLASTIC ECL
U6	I70-0002-001	IC MC145156 PLASTIC CMOS
U7	I01-0000-019	IC 4050B PLASTIC CMOS
U8	I05-0000-000	IC 74LS00 PLASTIC TTL
U9	I05-0000-000	IC 74LS00 PLASTIC TTL
VR1	I11-0001-001	IC VR 7805 + 5V 1.5A 4%

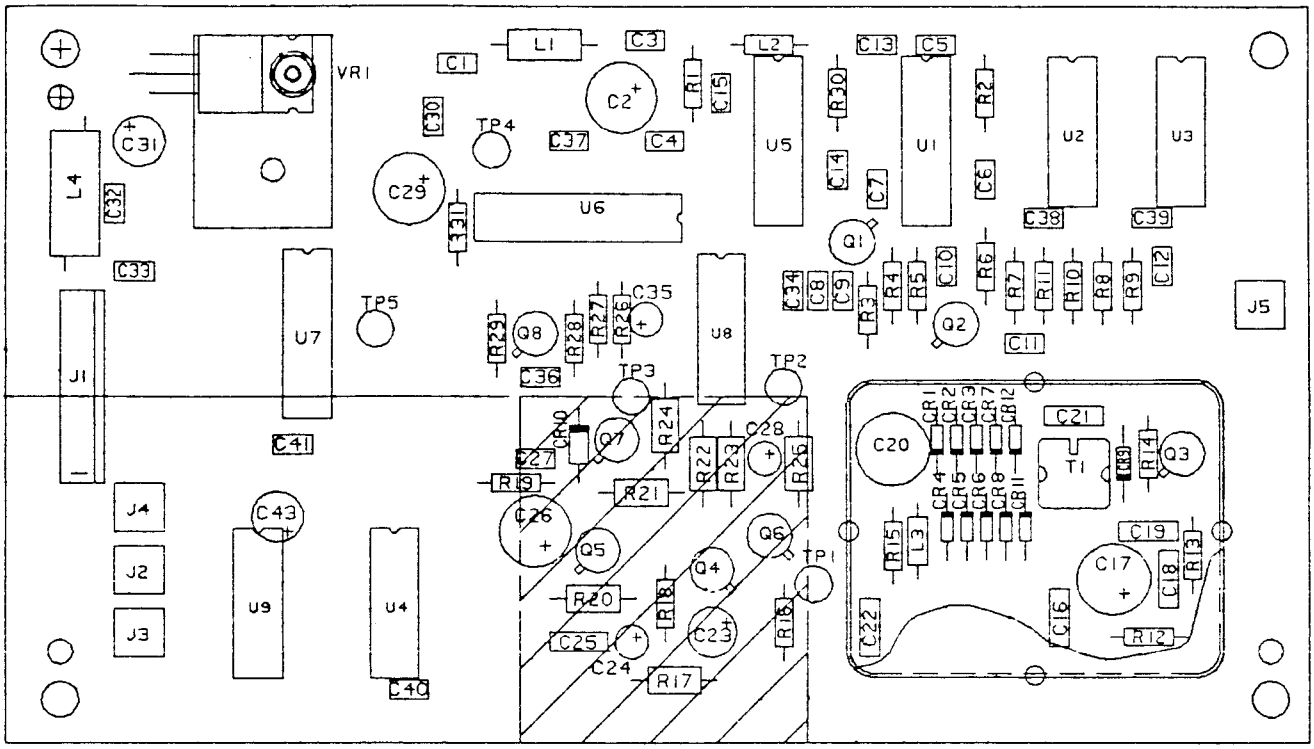
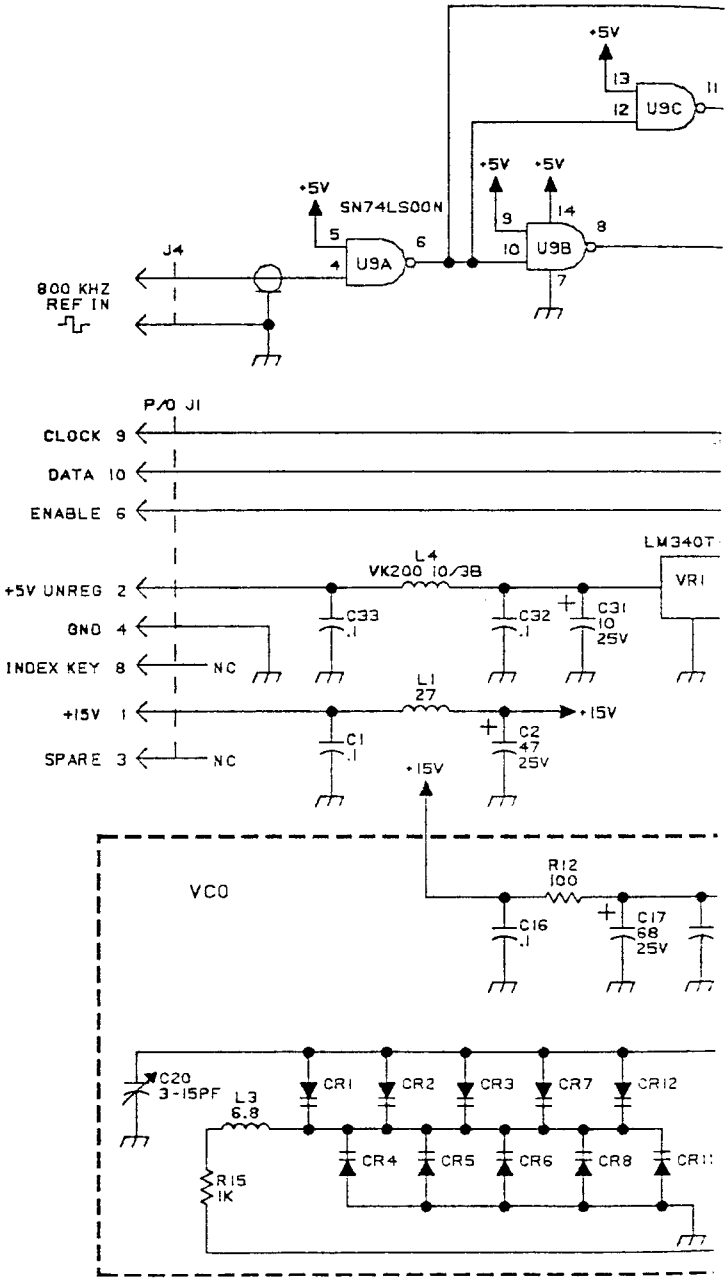


Figure 3. PLL 5 Assembly A10 Component Location Diagram (10073-4500)

NOTE: UNLESS OTHERWISE SPECIFIED:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR A COMPLETE DESIGNATION, PREFIX WITH UNIT NO. AND/OR ASSEMBLY NO. DESIGNATION.
2. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ±5%.
3. ALL CAPACITOR VALUES ARE IN MICROFARADS
4. ALL INDUCTOR VALUES ARE IN MICROHENRIES.
5. VENDOR PART NO. CALLOUTS ARE FOR REFERENCE ONLY. COMPONENTS ARE SUPPLIED PER PART NO. IN PARTS LIST.



OTHERWISE SPECIFIED:

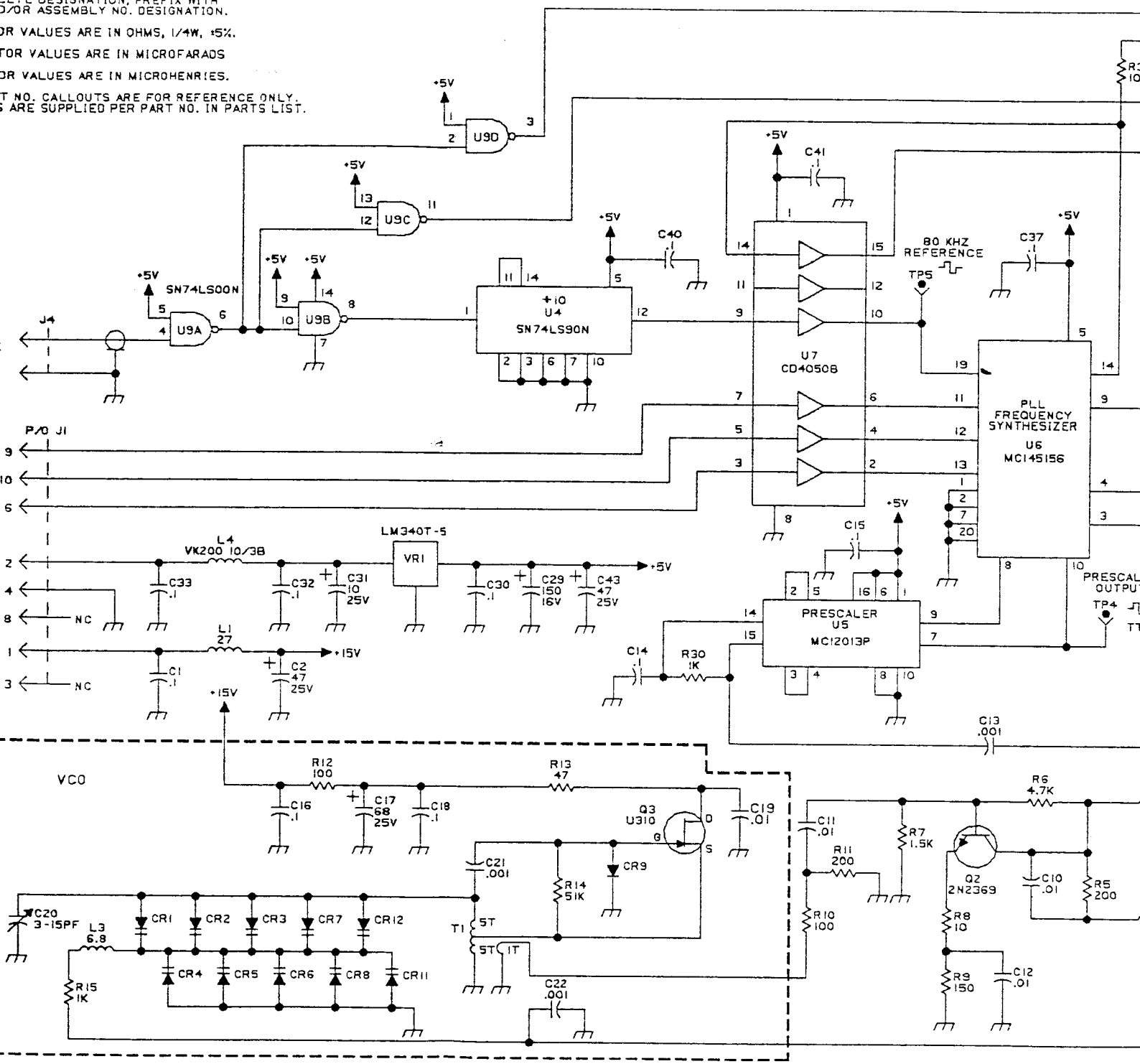
ERENCE DESIGNATIONS ARE SHOWN.
LETE DESIGNATION, PREFIX WITH
D/OR ASSEMBLY NO. DESIGNATION.

OR VALUES ARE IN OHMS, 1/4W, ±5%.

TOR VALUES ARE IN MICROFARADS

OR VALUES ARE IN MICROHENRIES.

T NO. CALLOUTS ARE FOR REFERENCE ONLY.
S ARE SUPPLIED PER PART NO. IN PARTS LIST.



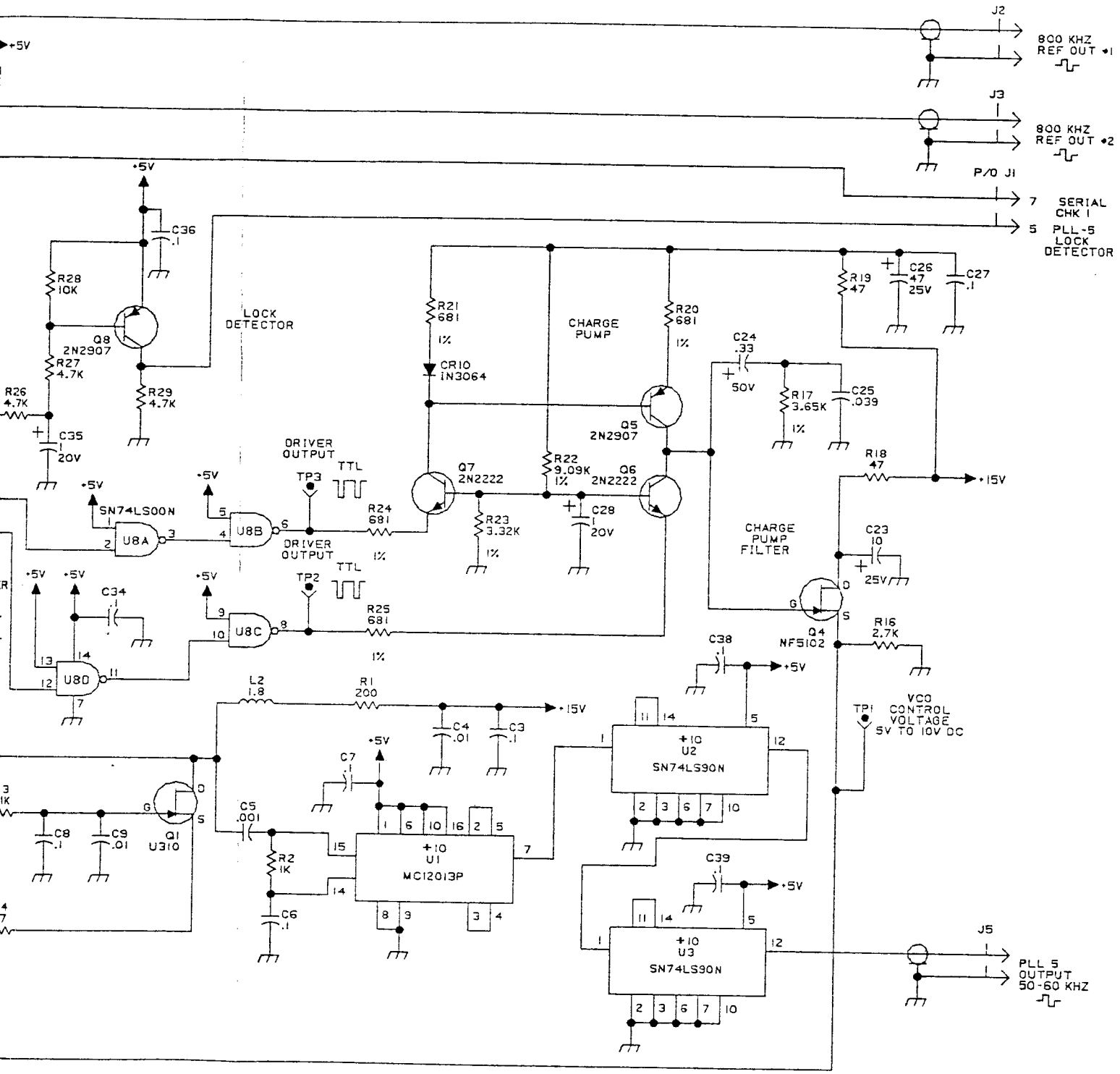


Figure 4. PLL 5 Assembly A10 Schematic Diagram (10073-4501 Rev. E)