MAINTENANCE MANUAL
FOR
VHF TRANSMITTER SYNTHESIZER MODULE
19D902780G1

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DESCRIPTION

The principle function of the Transmitter Synthesizer Module is to provide the RF excitation for input to the MASTR III station power amplifier. The output of the synthesizer is a frequency modulated signal at the desired frequency. The module contains the following functional blocks:

- A voltage controlled oscillator.
- A chain of integrated circuit RF Amplifiers.
- A reference buffer amplifier.
- Dual modulus prescaler and synthesizer integrated circuits.
- Loop amplifiers and passive loop filter.
- An audio amplifier and a pre-modulation integrator.
- IC voltage regulators for +5 and -5 Vdc. A discrete component regulator for +8 Vdc, and an Operational Amplifier regulator for +4 Vdc.
- Logic circuitry: address decoder, input signal gates, and a lock indicator circuit.

ERICSSON

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Private Radio Systems
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1-800-528-7711 (Outside USA, 804-528-7711)

Printed in U.S.A.

Table 1 - General Specifications

ITEM	SPECIFICATION
FREQUENCY RANGE	136 to 174 MHz
in 4 bands	136 to 144 MHz
	142 to 152 MHz
	150 to 162 MHz
	160 to I74MHz
RF POWER OUT(50 Ohm load)	10 to 13 dBm
	(10 to 20 mW)
RF HARMONICS	<-30 dBc
NON-HARMONIC SPURS	
I to 200 MHz	<-90 dBc
200 MHz to 1 GHz	<-60 dBc
CARRIER ATTACK TIME	<50 ms
REFERENCE INPUT	
input level	0 dBm ±1.5dB
input impedance	50 Ohm
frequency	5 to 17.925 MHz (must be integer divisible by channel spacing)
MODULATION SENSITIVITY	5 kHz peak dev/1 Vrms
AF INPUT IMPEDANCE	600 Ohm
AF RESPONSE	
10 Hz	±1.5 dB
1000 Hz	0 dB reference
3 kHz	±1.5 dB
10 Hz SQUARE WAVE MODULATION	<10%
Sq wave droop	
HUM & NOISE	-55 dB
POWER REQUIREMENTS	13.8 Vdc @ 275 mA
	-12.0 Vdc@ 10 mA

CIRCUIT ANALYSIS

VOLTAGE CONTROLLED OSCILLATOR

Transistor Q1 and associated circuitry comprise a low noise Voltage Controlled Oscillator (VCO). Inductor L1 and associated capacitors form the oscillator resonant circuit (tank). The noise characteristic of this oscillator is dependent on the Q of this resonant circuit. The components used in the tank are specified to have especially high Q. Diode D1 aids in setting the bias point for low noise operation. (Any field replacement of oscillator parts should use identical parts).

Switches SWIA, SWIB, SWIC and SWID set the fixed capacitance in the tank and therefore set the frequency range over which the oscillator can be voltage tuned. Table 2 shows the switch settings for the various frequency ranges.

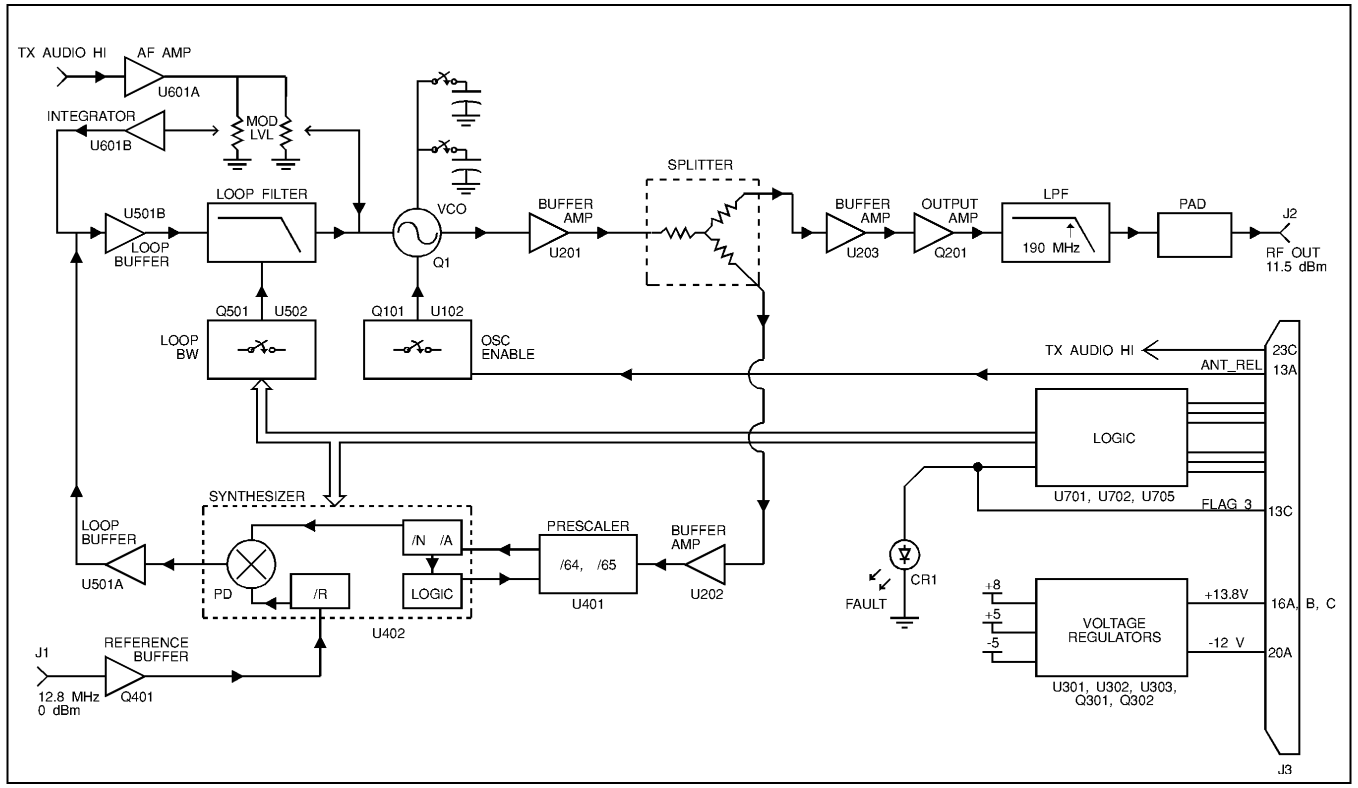


Figure 1 - Block Diagram

Table 2 - Frequency Range Switch Settings

FREQUENCY RANGE (MHz)	SW1A (SW#1)	SW1B (SW#2)	SW1C (SW#3)	SW1D (SW#4)
160-174	OPEN	OPEN	OPEN	OPEN
150-162	CLOSED	OPEN	CLOSED	OPEN
142-152	OPEN	CLOSED	OPEN	CLOSED
136-143	CLOSED	CLOSED	CLOSED	CLOSED

Switches SW1E (SW#5) and SW1F (SW#6) also set the fixed capacitance in the tank and perform the frequency trimming function. These two switches are factory set and should not need resetting unless any oscillator components are changed. (See alignment procedure section of this manual for instructions on resetting SW1E and SW1F).

The oscillator frequency is voltage tuned by the signal applied through R5 and L5 to the two varicap diodes D2 and D3. Additionally, audio modulation is applied as an AF voltage to the two varicap diodes. This AF voltage varies the oscillator frequency at an audio rate (i.e., it frequency modulates the oscillator). Low frequency audio is applied along with the varicap control voltage through R5 and L5 while high frequency audio (MOD) is applied via C16.

Resistors R6 through R9 provide a two volt negative bias on the varicap diodes.

Transistors Q101 and Q102 and associated circuitry form the oscillator enable switch. This switch allows the station control circuitry to turn the VCO ON or OFF via the ANT_REL line. Setting the ANT_REL line to a logic low causes Q102 to conduct. The five (5) volt output at Q102 collector (OSCON) enables the fault indicator gates, U705C and U705D, and turns on Q101. Q101 starts to conduct, providing a ground path for Q1. This turns ON the VCO.

RF AMPLIFIERS

Integrated circuits U201 and U202 and U203 and transistor Q201 form a chain of RF amplifiers. These amplifiers serve two purposes; amplifying the RF signal for input to the power amplifier and providing a signal to the Phase-locked Loop (PLL) .

Integrated circuits U201, U203 and transistor Q201 provide amplification for the RF signal which will be fed to the station power amplifier. U201 operates with a gain of about 5 dB. Its output is fed to a resistive signal splitter composed of R203 through R210.

One of the resistive signal splitter outputs drives U203. U203 operates with a gain of about 10 dB. Q201 and associated circuitry comprise the output amplifier which has a gain of about 6 dB. This amplifier is followed by a 190 MHz cutoff low -pass filter (C216, C217, L203 and L204) and a 6 dB resistive attenuator (R219 through R221). The final output at the front panel BNC connector (J2) is nominally 11.5 dBm into a 50 ohm load.

The other output of the resistive splitter drives U202. U202 is a buffer amplifier with a gain of about 10 dB. U202 drives the synthesizer prescaler (i.e. it provides a signal to the PLL).

REFERENCE BUFFER AMPLIFIER

Transistor Q401 and associated components comprise a buffer amplifier for the reference oscillator signal. (The reference oscillator signal is produced by the receiver synthesizer module of a MASTR III station.) The 0 dBm reference oscillator signal is fed through the front panel BNC connector J1. Resistor R405 provides a 50 ohm load to the reference oscillator. The output of the Reference Buffer Amplifier is fed directly to the synthesizer integrated circuit. The output level at TP9 is approximately 3 volts peak to peak.

PRESCALER AND SYNTHESIZER

Integrated circuit U402 is the heart of the synthesizer. It contains the necessary frequency dividers and control circuitry to synthesize output frequencies by the technique of dual modulus prescaling. U402 also contains an analog sample and hold phase detector and a lock detector circuit.

Within the synthesizer (U402) are three programmable dividers which are loaded serially using the CLOCK, DATA, and ENABLE inputs (pins 11, 12, and 13 respectively). A serial data stream (DATA) on pin 12 is shifted into internal shift registers by low to high transitions on the clock input (CLOCK) at pin 11. A logic high (ENABLE) on pin 13 then transfers the program information from the shift registers to the divider latches.

The reference signal is applied to U402 pin 2 and divided by the "R" divider. This divides the reference signal down to a divided reference frequency (Fr). The typical reference frequency is 12.8 MHz and the typical divided reference frequency is 5 kHz providing for synthesizer steps of 5 kHz for use with both 25 kHz and 30 kHz channel spacing. Other channel spacings are possible by providing proper programming.

The "A" and "N" dividers process the loop feedback signal provided by the VCO (by way of the dual modulus prescaler U401). The output of the "N" divider is a divided version of the VCO output frequency (Fv).

Synthesizer U402 also contains logic circuitry to control the dual modulus prescaler U401. If the locked synthesizer output frequency is 150 MHz. The prescaler output nominally will be equal to 2.34375 MHz (150 MHz/64). This frequency is further divided down to Fv by the "N" divider in U402. Fv is then compared with Fr in the phase detector section.

The phase detector output voltage is proportional to the phase difference between Fv and Fr. This phase detector output serves as the loop error signal. This error signal voltage tunes the VCO to whatever frequency is required to keep Fv and Fr locked (in phase).

LOOP BUFFER AMPLIFIERS AND LOOP FILTER

The error signal provided by the phase detector output is buffered by operational amplifiers (op-amp) U501A and U501B. The audio modulation signal from U601B is also applied to the input of U501B. The output of U501B is the sum of the audio modulation and the buffered error signal.

The output of the second buffer (U501B) is applied to a loop filter consisting of R506, R507, R508, C505 and C506. This filter controls the bandwidth and stability of the synthesizer loop. The VHF transmitter synthesizer has a loop bandwidth of only several Hertz. This is very narrow, resulting in an excessively long loop acquisition time. To speed acquisition, switches U502A and U502C bypass the filter circuit whenever an ENABLE pulse is received by the Input Gates.

AUDIO FREQUENCY AMPLIFIER

The transmitter synthesizer audio input line is fed to U601A. U601A is configured as a unity gain op-amp. Resistor R601 sets the 600 ohm input impedance of this amplifier. (NOTE: Data for digital modulation is fed to the synthesizer through the audio input line).

The amplifier output is split into two components and fed to two variable resistors VR601 and VR602. VR601 sets the level in the low frequency audio path and VR602 sets the level in the high frequency audio path. (There is no clear break between the low and high frequency ranges. All voice frequencies are within the high frequency range. The low frequency range contains low frequency data components).

The wiper of VR601 (low frequency path) connects to the input of U601B, the pre-modulation integrator. U601B performs the function of a low-pass filter and integrator. The integrator output is summed with the PLL control voltage at the input of loop buffer amplifier U501B. This integrated audio signal phase modulates the VCO. The combination of pre- integration and phase modulation is equivalent to frequency modulation.

The wiper of VR602 (high frequency path) is connected to the modulation input of the VCO through C16.

VOLTAGE REGULATORS

U301 and U303 are monolithic voltage regulators (+5 Vdc and -5 Vdc respectively). These two voltages are used by synthesizer circuitry. The +5 V regulator output is also used as a voltage reference for the +8 Vdc discrete regulator circuit.

U302A, Q302 and associated circuitry comprise the +8 volt regulator. Most module circuitry is powered from the +8 volt line. The regulator is optimized for especially low noise performance. This is critical because the low noise VCO is powered by the +8 volt line.

The +8 Vdc line also feeds the +4 Vdc regulator, U302B and associated resistors. The +4 Vdc regulator provides a bias voltage for several op-amps in the module.

LOGIC CIRCUITS

Logic circuitry (other than that inside the synthesizer IC - U402) consists of the following:

- An address decoder
- Input gates and level shifters
- Lock Indicator circuitry

The address decoder, U702, enables the Input Gates when the A0, A1, and A2 input lines receive the proper logic code (110 for the transmitter synthesizer). After receiving the proper code, Y3 (U702-12) sends a logic low signal to U701C. U701C acts as an inverter and uses the logic high output to turn on Input Gates U701A, U701B, and U701D. The Input Gates allow the clock, data and enable information to pass on to the synthesizer via the level shifters. The Level Shifter Transistors Q701, Q702 and Q703 convert the 5 volt gate logic level to the 8 volt logic level required by the synthesizer U402.

The Fault Indicator circuitry indicates when the synthesizer is in an out-of-lock condition. The fault detector latches, U705A and U705B are reset by the enable pulse during initial loading of data into the synthesizer. If at any time afterwards the lock detector signal (LD) goes low, the high output of U705B will cause the output of gates U705C and U705D to go low. The low output from U705C causes Q704 to turn off, thus turning on the front panel LED (CR701). The output of U705D (FLAG) i s connected to J3-13C for external monitoring of the Synthesizer Module. A logic low on the FLAG line indicates an out-of-lock condition.

MAINTENANCE

RECOMMENDED TEST EQUIPMENT

The following test equipment is required to test the synthesizer Module:

1. RF signal source for 12.8 MHz, 0 dBm reference (included with item 10)
2. AF Generator or Function Generator
3. Modulation Analyzer; HP 8901A, or equivalent, or a VHF receiver
4. Oscilloscope; 20 MHz
5. DC Meter; 10 meg ohm (for troubleshooting)
6. Power Supply;13.8 Vdc @ 350 mA 12.0 Vdc @ 25 mA
7. Spectrum Analyzer; 0-1 GHz
8. Frequency Counter; 10 MHz - 250 MHz
9. Personal Computer (IBM PC compatible) to load frequency data
10. Service Parts Kit, (TQ0650), (includes software for loading frequency data)

TEST PROCEDURE

(Steps 5, 6, and 7 can be done using a modulation analyzer or VHF receiver with 750us de-emphasis switchable in or out.

1. Lock synthesizer at 167.5 MHz using software provided in the service parts kit.
   Verify lock (flag = high)
   Verify front panel LED is off.
2. Measure output frequency.
   Verify frequency = 167.5000 MHz ±100 Hz.
3. Measure harmonic content (335 MHz, 502.5MHz).
   Verify 2nd harmonic is 30 dBc.
4. Measure RF power output into 50 ohm load.
   Verify 10 to 13 dBm (10 to 20 mW).
5. Measure AF distortion with standard modulating signal input.
   Verify <5%.
6. Measure Hum and Noise relative to 0.44 kHz average deviation, (de-emphasis on).
   Verify <-55dB
7. Measure AF response at 300 Hz, 1 kHz (ref) and 3 kHz, (de-emphasis off).
   Verify within ±1.5 dB with respect to 1 kHz reference.
8. Verify lock at different frequencies.
   a. Close switches SW1A and SW1C.
   b. Lock synthesizer at 156 MHz.
      Verify LED is off.

c. Open switches SW1A and SW1C and close switches SW1B and SW1D.

d. Lock synthesizer at 147 MHz.
Verify LED is off.

e. Close switches SW1A, SW1B, SW1C and SW1D.

f. Lock synthesizer at 139.5 MHz.
Verify LED is off.

g. Open switches SW1A, SW1B, SW1C and SW1D.

ALIGNMENT PROCEDURE

1. Set all sections of SW1 to the open position.
2. Apply +13.8 Vdc and -12 Vdc. Verify the current drain on the 13.8 volt supply is <300 mA and the current drain on the -12 volt supply is <20 mA.

NOTE

Perform step 3 only if switch SW1 has been replaced. Otherwise go to step 4.

3. Lock the synthesizer at 175 MHz. Set SW1E and SW1F (4 possible Combinations = both closed, both open, E open and F closed, or E closed and F open) to set V_{test} (pin 23A of 96 pin connector) as close to 6.0 volts as possible, but always between 5.5 and 6.5 volts.
4. Lock synthesizer at 167.5 MHz for the following three adjustments

- Set VR602 for 4.5 kHz peak deviation with a standard modulating signal applied to the audio input.
- Set VR601 for 4.4 kHz peak deviation with 1.0 Vrms, 10 Hz sine wave audio applied to module AF input.
- Apply a 10 Hz 1.4 Vpk square wave (same peak value as 1.0 Vrms (sine wave) to module AF input. Adjust VR601 slightly for the flattest demodulated square wave using a modulation analyzer or receiver (no de-emphasis) and an oscilloscope . The maximum net variation in voltage over 1/2 cycle is 10%.

SERVICE NOTES

The following service information applies when aligning, testing, or troubleshooting the TX Synthesizer:

- Standard Modulating Signal = 1 kHz sinussoidal voltage, 1.0 Vrms at the module input terminals (600 ohm Rin).
- Logic Levels:

  Logic 1 = high = 4.5 to 5.5 Vdc
  Logic 0 = Low = 0 to 0.5 Vdc

- Transmitter Synthesizer Address = A0 A1 A2 = 110
- Synthesizer data input stream is as follows:

  14-bit "R" divider most significant bit (MSB) = R13 through "R" divider least significant bit (LSB) = R0

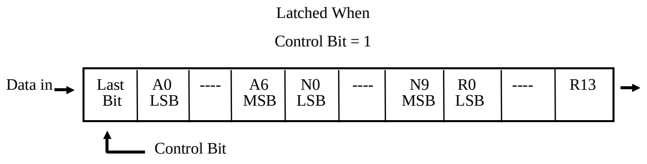
  10-bit "N" divider MSB = N9 through "N" divider LSB = N0

  7-bit "A" divider MSB = A6 through "A" divider LSB = A0

  Single high Control bit (last bit)

  Latched When Control Bit = 1

DATA ENTRY FORMAT



For the transmitter synthesizer, 5 kHz channel spacing
R=2560
N = integer part of (frequency in kHz) / (320)
A = (frequency in kHz)/(5) - 64*N
All numbers must be converted to binary.

- ANT_REL line must be logic low (0V) in order to lock synthesizer.
- Synthesizer lock is indicated by the extinguishing of the front panel LED indicator and a logic high on the fault flag line (J3 pin 1 3C).
- Always verify synthesizer lock after each new data loading.

TROUBLESHOOTING GUIDE

SYMPTOM	CHECK (CORRECT READINGS SHOWN)	INCORRECT READING INDICATES DEFECTIVE COMPONENT
SYNTHESIZER FAILS TO LOCK	Check DC voltages +5 V @ U301 Pin 1 +8 V @ Q301 collector - 5 V @ U303 Pin 1	 U301 or associated components U302, Q301, Q302 or associated components U303 or associated components
	Check 12.8 MHz reference signal 3V P-P, 12.8 MHz @ TP9 or U402 Pin 2	No reference signal to front panel BNC or Q401
	Check oscillator signal 11.5 1.5 dBm 125 to 180 MHz at front panel BNC	Proceed to "Low/No RF output" below
	Check prescaler output 1V P-P, 2.5 MHz @ U401 Pin 4	U202, U401
	Check CLOCK, DATA, ENABLE While loading frequency data into synthesizer Check 8V logic signals @ Pins 11, 12, 13 of U402	Wrong address or U701, U702, Q701, Q702, Q703
	Check Phase detector output 5 kHz random signal @ U501 Pin 7	U402, U501
Low/No RF Output	Check oscillator LESS than 0.5 Vdc @ TP3 or collector of Q101	Synthesizer not keyed (low on ANT relay line) or Q101, Q102
	50 mV, 125 to 180 MHz @ TP4	Q1
	Check RF chain 0 dBm, 125 to 180 MHz @ TP6 +5 dBm, 125 to 180 MHz @ TP7 11.5 ±1.5 dBm to 180 MHz at front panel BNC	 U201 U203 Q201
No Modulation	Check AF amplifier	
	Apply IV, 1 kHz signal to TX/Audio/ Hi	U601
	Check 1V signal @ TP12 or U601 Pin 1	

TROUBLESHOOTING

A troubleshooting guide is provided showing typical measurements at the various test points. The location of the test points and adjustments are shown in Figure 2.

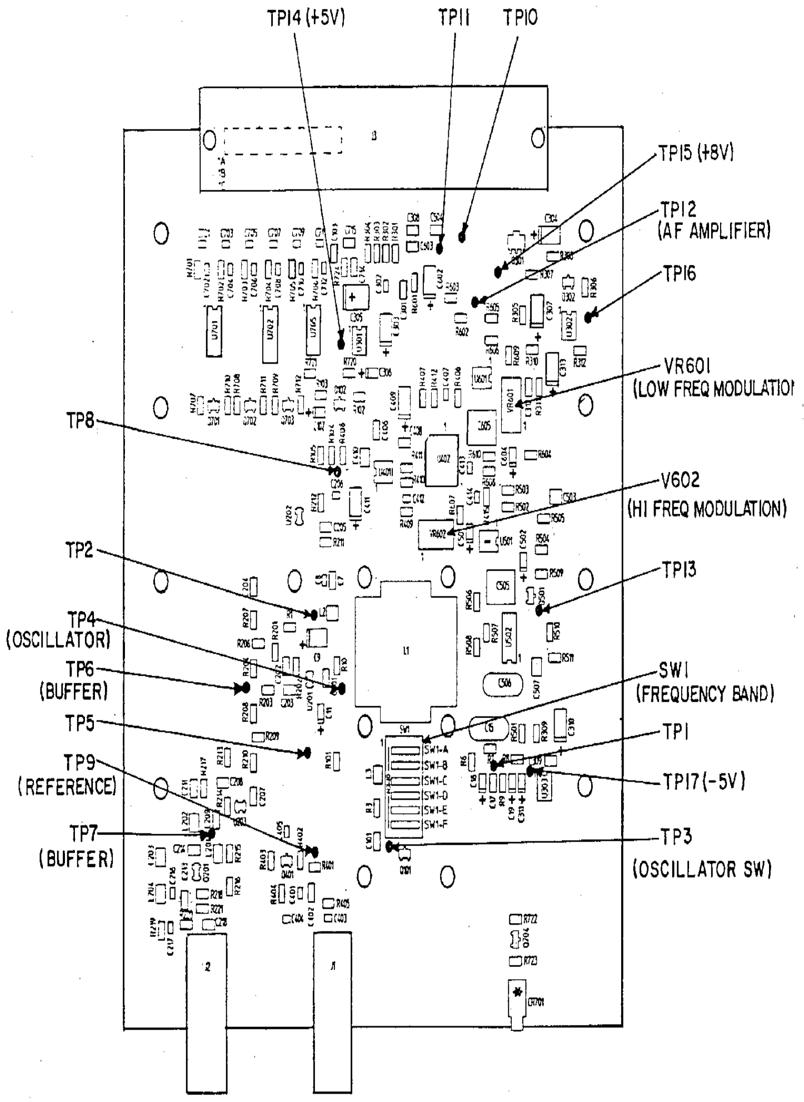
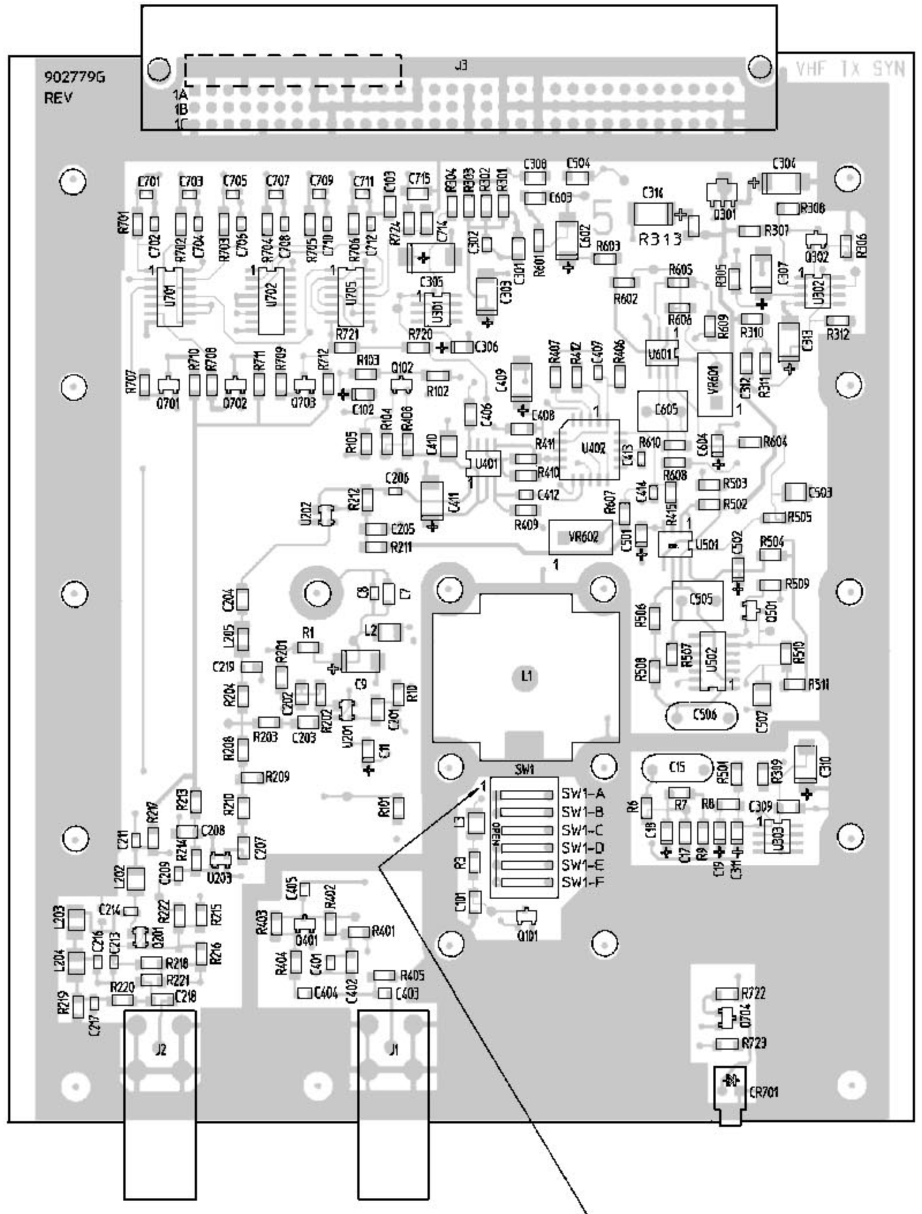


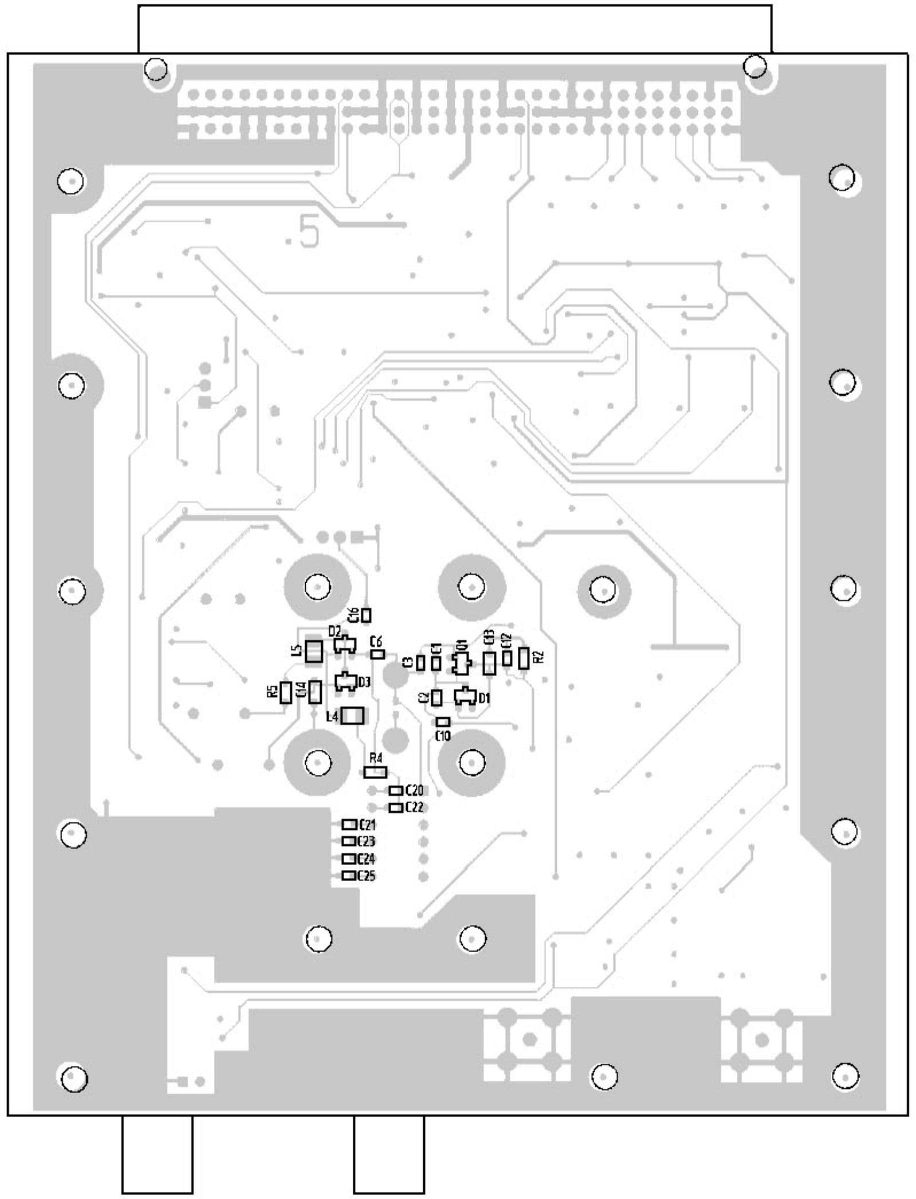
Figure 2 - Test Point Locations

COMPONENT SIDE



PHYSICAL LOCATION OF TERMINAL NUMBER 1 (AS SHOWN ON SCHEMATIC DIAGRAM)

SOLDER SIDE



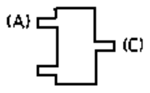
CAUTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICES

THE FOLLOWING ARE ELECTROSTATIC SENSITIVE DEVICES REQUIRING SPECIAL CARE PER 19A701294: U401, U402, U502, U701, U702, U705

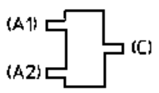
VHF TRANSMITTER SYNTHESIZER BOARD 19D902779G1

(19D902779, Sh. 1, Rev. 7)
(19D902644, Layer 4, Rev. 5)

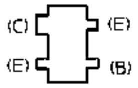
LEAD IDENTIFICATION FOR
D1
(SOT) DIODES
(TOP VIEW)



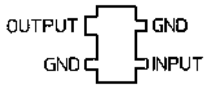
LEAD IDENTIFICATION FOR
D2, AND D3
(SOT) DIODES
(TOP VIEW)



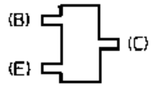
LEAD IDENTIFICATION FOR
Q201
(SOT) TRANSISTORS
(TOP VIEW)



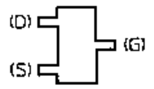
LEAD IDENTIFICATION FOR
U201, U202, AND U203
(SOT) INT CKT
(TOP VIEW)



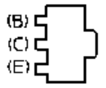
LEAD IDENTIFICATION FOR
Q101, Q102, Q302, Q401, Q501,
Q701 - Q704
(SOT) TRANSISTORS
(TOP VIEW)

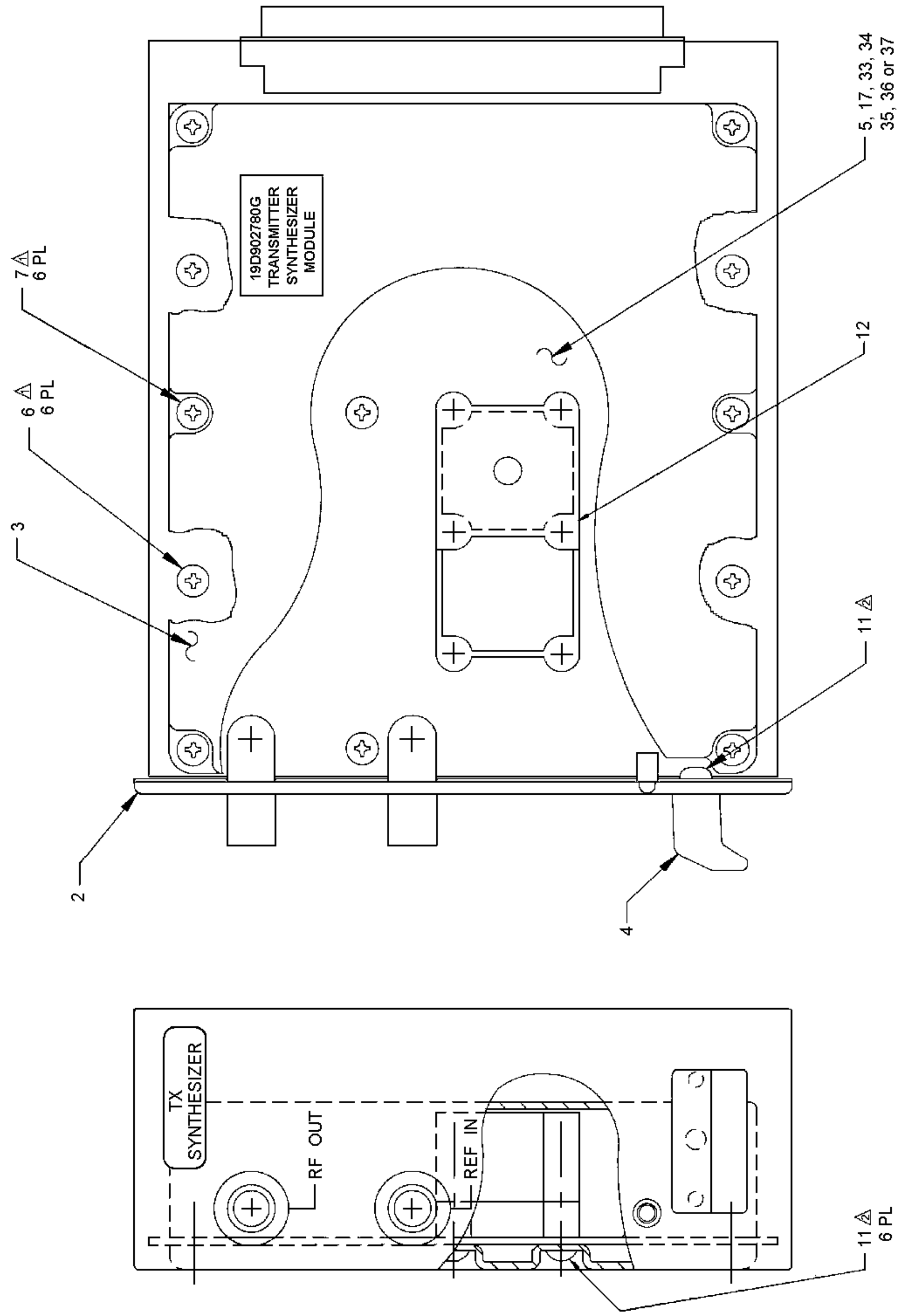


LEAD IDENTIFICATION FOR
Q1
(SOT) TRANSISTORS
(TOP VIEW)



LEAD IDENTIFICATION FOR
Q301
(SOT) TRANSISTORS
(TOP VIEW)

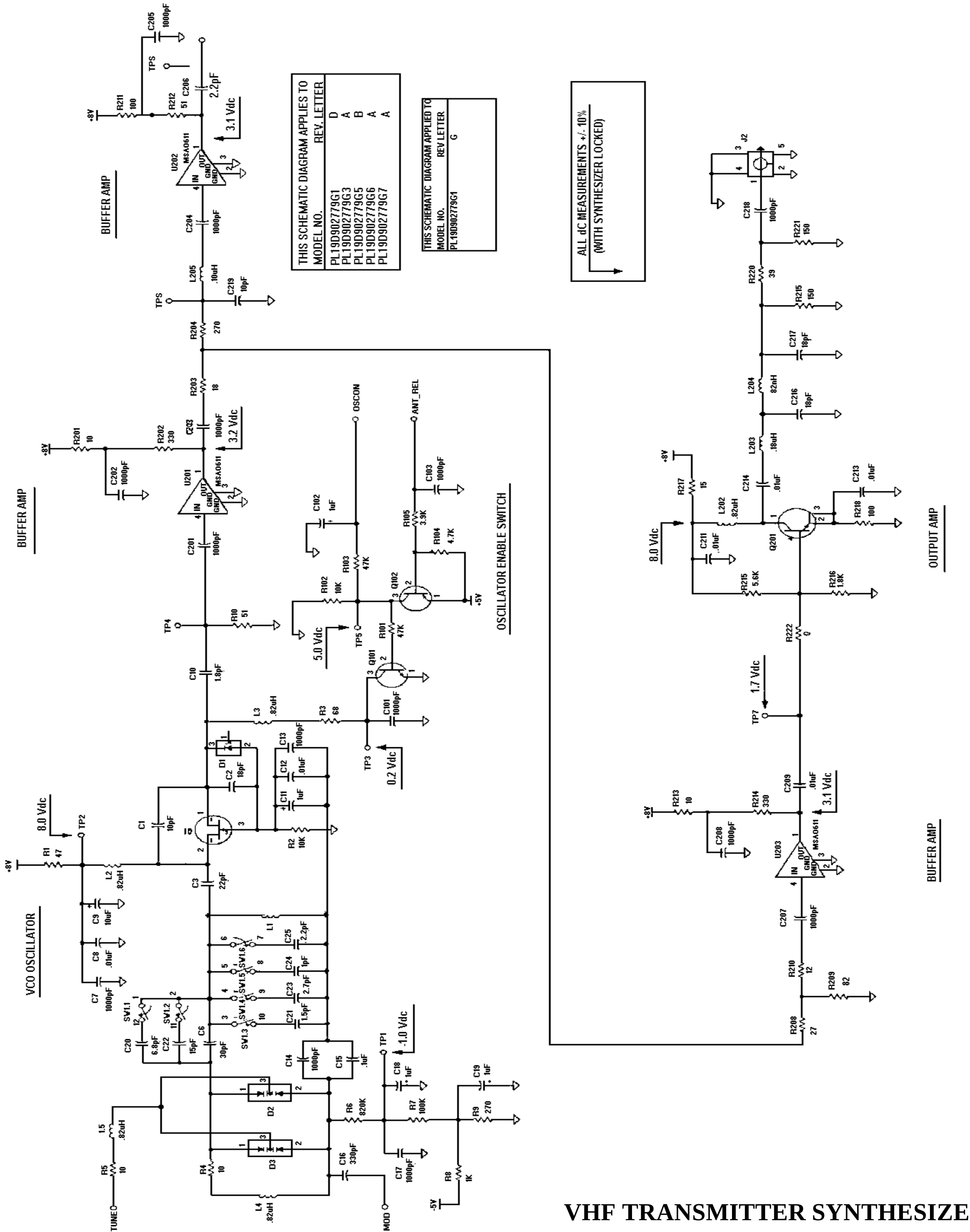




NOTES:
△1 TORQUE SCREWS, ITEMS 6 AND 7, TO 10.0 ± 1.3 INCH POUNDS.
△2 TORQUE SCREWS, ITEM 11 TO 20 ± 1.3 INCH POUNDS

VHF TRANSMITTER SYNTHESIZER MODULE
19D902780G1

(19D902780, Sh. 1, Rev. 5)



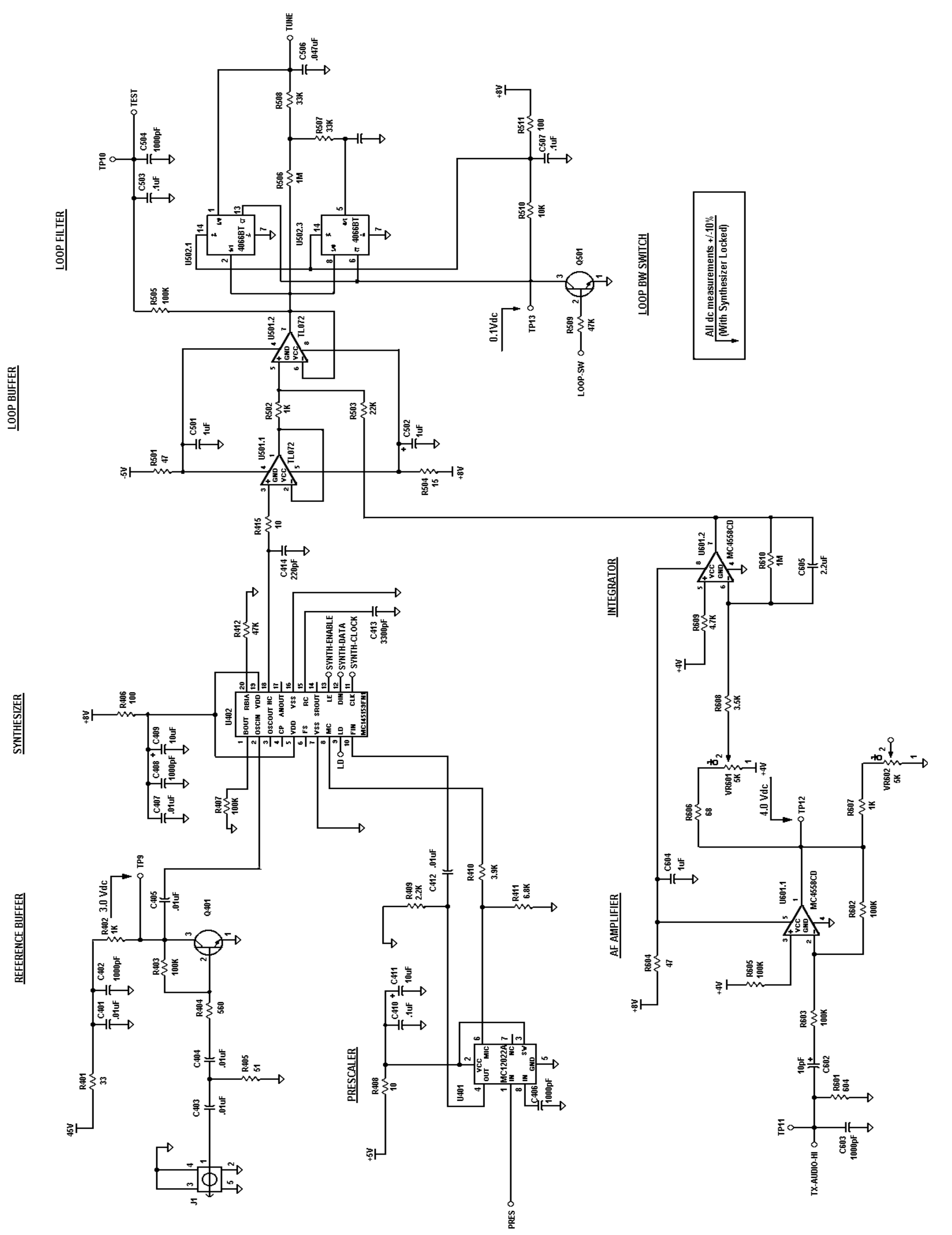
THIS SCHEMATIC DIAGRAM APPLIES TO MODEL NO.	REV. LETTER
PL19D902779G1	D
PL19D902779G3	A
PL19D902779G5	B
PL19D902779G6	A
PL19D902779G7	A

THIS SCHEMATIC DIAGRAM APPLIED TO MODEL NO.	REV LETTER
PL19D902779G1	G

ALL dC MEASUREMENTS +/- 10%
(WITH SYNTHESIZER LOCKED)

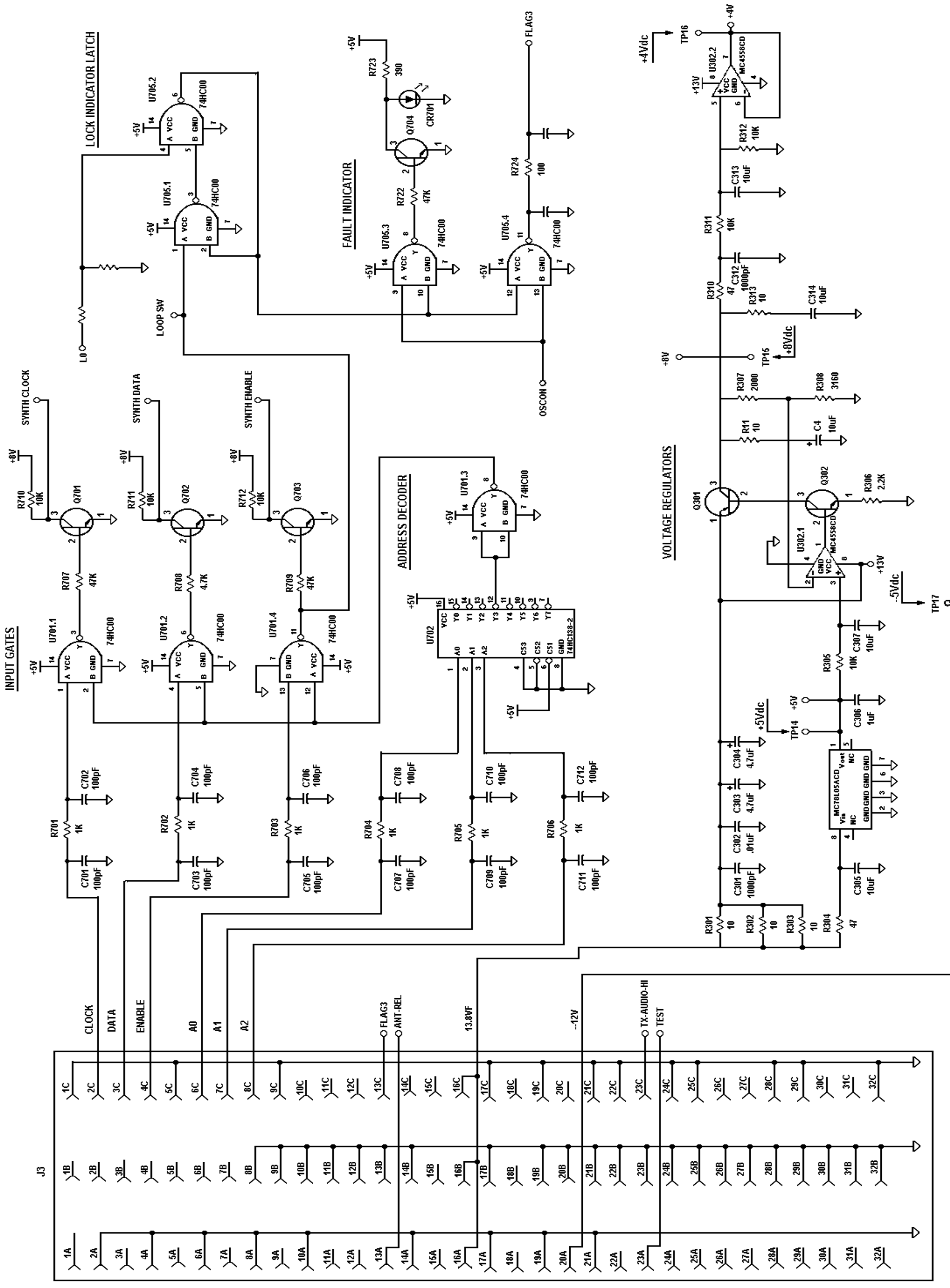
VHF TRANSMITTER SYNTHESIZER
19D902780G1

(19D902622 Sh. 1, Rev. 7)



VHF TRANSMITTER SYNTHESIZER
19D902780G1

(19D902622, Sh. 2,Rev. 6)



VHF TRANSMITTER SYNTHESIZER
19D902780G1

(19D902622, Sh. 3, Rev. 7)

VHF TRANSMITTER SYNTHESIZER MODULE
19D902780G1
ISSUE 2

SYMBOL	PART NUMBER	DESCRIPTION
2	19D902508P4	Chassis.
3	19D902509P2	Cover.
4	19D902555P1	Handle.
5	19D902779G1	Transmitter Synthesizer Board (See separate parts list).
6	19A702391P506	Screw, thread forming: TORX, No. M3.5 - 0.6 x 6.
7	19A702381P513	Screw, thread forming: TORX, No. M3.5 - 0.6 x 13.
8	19B235310P1	Nameplate.
11	19A702381P508	Screw, thread forming: TORX, No. M3.5 - 0.6 x 8.
12	19D902824P1	Casting, RF.
		TRANSMITTER SYNTHESIZER BOARD 19D902779G1
		——————CAPACITORS ————
C1	19A702236P25	Ceramic: 10pF ± 0.5pF, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C2	19A702236P32	Ceramic: 18 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM.
C3	19A702236P34	Ceramic: 22 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM.
C6	19A702236P37	Ceramic: 30 pF ±5%, 50 VDCW.
C7	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C8	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C9	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C10	19A702238P9	Ceramic: 1.8 pF ± 2.5 pF, 50 VDCW, temp coef 0 ± 30 PPM.
C11	19A705205P2	Tantalum: 1µF, 16 VDCW; sim to Sprague 293D.
C12	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C13 and C14	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C15	19A700004P2	Metallized polyester, 0.1µF ± 10%, 63 VDCW.
C16	19A702061P73	Ceramic: 330 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C17	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C18 and C19	19A705205P2	Tantalum: 1µF, 16 VDCW; sim to Sprague 293D.
C20	19A702236P21	Ceramic: 6.8pF ± 0.5pF, 50 VDCW, temp coef 0 ± 60 PPM.
C21	19A702236P8	Ceramic: 1.5pF ± 0.25pF, 50 VDCW, temp coef 0 ± 30 PPM.
C22	19A702236P30	Ceramic: 15 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C23	19A702236P11	Ceramic: 2.7pF ± 0.5pF, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C24	19A702236P6	Ceramic: 1.0pF ± 0.25pF, 50 VDCW, temp coef 0 ± 30 PPM.
C25	19A702236P10	Ceramic: 2.2 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM.
C26	19A702236P9	Ceramic: 1.6pF ± 2.5 pF, 50 VDCW, temp coef 0 ± 30 PPM. (Deleted by Rev. A)
C101	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C102	19A705205P2	Tantalum: 1µF, 16 VDCW; sim to Sprague 293D.
C103	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C201 thru C205	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C206	19A702236P10	Ceramic: 2.2pF ± 2.5 pF, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C207 thru C209	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C211	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C212	19A702236P10	Ceramic: 2.2 pF ± 2.5 pF, 50 VDCW, temp coef 0 ± 30 PPM/°C. (Deleted by Rev. A)
C213 and C214	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C216	19A702236P32	Ceramic: 18 pF ± 0.5pF, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C217	19A702236P32	18 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM.
C218	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C219	19A702236P25	Ceramic: 10 pF ± 0.5pF, 50 VDCW, temp coef 0 ± 60 PPM.
C301	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C302	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C303 and C304	19A705205P17	Tantalum: 4.7 µF ± 20%, 20 VDCW.
C305	19A705205P6	Tantalum: 10 µF ± 20%, 16 VDCW; sim to Sprague 293D.
C306	19A705205P2	Tantalum: 1 µF ± 20%, 16 VDCW; sim to Sprague 293D.
C307	19A705205P7	Tantalum: 10 µF ± 20%, 25 VDCW; sim to Sprague 293D.
C308 and C309	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C310	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C311	19A705205P2	Tantalum: 1 µF, 16 VDCW; sim to Sprague 293D.
C312	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C313 and C314	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C401	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C402	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C403 thru C405	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C406	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C407	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C408	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C409	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C410	19A702052P26	Ceramic: 0.01µF ± 10%, 50 VDCW.
C411	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C412	19A702052P14	Ceramic: 0.01µF ± 10%, 50 VDCW.
C413	19A702052P108	Ceramic: 0.01µF ± 10%, 50 VDCW.
C414	19A702061P69	Ceramic: 220 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C501 and C502	19A705205P2	Tantalum: 1 µF, 16 VDCW; sim to Sprague 293D.
C503	19A702052P26	Ceramic: 0.01µF ± 10%, 50 VDCW.
C504	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C505	19A703684P3	Metallized polyester, 2.2 µF ± 10%, 50 VDCW.
C506	19A703902P3	Metal: 0.047 µF ± 10%, 50 VDCW.
C507	19A702052P26	Ceramic: 0.1µF ± 10%, 50 VDCW.
C602	19A705205P6	Tantalum: 10 µF, 16 VDCW; sim to Sprague 293D.
C603	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
C604	19A705205P2	Tantalum: 1 µF, 16 VDCW; sim to Sprague 293D.
C605	19A703684P3	Metallized polyester, 2.2 µF ± 10%, 50 VDCW.
C701 thru C712	19A702061P61	Ceramic: 100 pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM.
C714 and C715	19A702061P99	Ceramic: 1000pF ±5%, 50 VDCW, temp coef 0 ± 30 PPM/°C.
		——————— DIODES ———————
CR701	19A703595P10	Diode, Optoelectronic. Red LED in right anglehousing: sim to Hewlett Packard HLMP-1301-010.
D1	19A705377P1	Silicon, Hot Carrier: sim to MMB0201.
D2 and D3	19A149674P3	High Tuning Ratio Dual Diode: sim to Toyo KV1430.
		——————— JACKS ———————
J1 and J2	19A115938P24	Connector, receptacle.
J3	19B801587P7	Connector, 2 part DIN.
		———————INDUCTORS ———————
L1	19C851001P2	Coil, RF: sim to Paul Smith SK-901-1.
L2 thru L5	19A705470P24	Coil, fixed: .082 µH: sim to Toko 380NB-R82M. Coil: 82nH ±20%; sim to Toko 380NB-82nM.
L201	19A705470P5	Coil, fixed: 22 nH: sim to Toko 380NB-22nM.
L202	19A705470P24	Coil, fixed: .082 µH: sim to Toko 380NB-R82M.
L203	19A705470P16	Coil, fixed: 0.18 µH: sim to Toko 380NB-R18M.
L204	19A705470P12	Coil: 82nH ±20%; sim to Toko 380NB-82nM.
L205	19A705470P13	Coil: 100nH ±20%; sim to Toko 380NB-R10M.
		———————TRANSISTORS———————
Q1	19A702624P2	N-Type, field effect; sim to MMBFU310.
Q101	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q102	19A700059P2	Silicon, PNP: sim to MMBT3906, low profile.
Q201	344A3061P1	Silicon, NPN, Low noise: sim to Avantek AT- 41411.
Q301	19A134577P2	Silicon, PNP: sim to Phillips BCX51-16.
Q302	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q401	19A704708P2	Silicon, NPN: sim to NEC 2SC3356.
Q501	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q701 thru Q704	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
		——————— RESISTORS———————
R1	19B800607P470	Metal film: 47 ohms ± 5%, 1/8 w.
R2	19B800607P183	Metal film: 18K ohms ± 5%, 1/8 w.
R3	19B800607P680	Metal film: 68 ohms ± 5%, 1/8 w.
R4 and R5	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R6	19B800607P824	Metal film: 820K ohms ± 5%, 1/8 w.
R7	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R8	19B800607P102	Metal film: 1K ohms ± 5%, 1/8 w.
R9	19B800607P271	Metal film: 270 ohms ± 5%, 1/8 w.
R10	19B800607P510	Metal film: 51 ohms ± 5%, 1/8 w.
R101	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R102	19B800607P103	Metal film: 10K ohms ± 5%, 1/8 w.
R103	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R104	19B800607P472	Metal film: 4.7K ohms ± 5%, 1/8 w.
R105	19B800607P392	Metal film: 3.9K ohms ± 5%, 1/8 w.
R201	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R202	19B800607P331	Metal film: 330 ohms ± 5%, 1/8 w.
R203	19B800607P180	Metal film: 18 ohms ± 5%, 1/8 w.
R204	19B800607P271	Metal film: 270 ohms ± 5%, 1/8 w.
R206	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w. (Deleted by Rev. B.).
R207	19B800607P120	Metal film: 12 ohms ± 5%, 1/8 w. (Deleted by Rev. B.).
R208	19B800607P270	Metal film: 27 ohms ± 5%, 1/8 w.
*R209	19B800607P820	Metal film: 82 ohms ± 5%, 1/8 w.
R210	19B800607P120	Metal film: 12 ohms ± 5%, 1/8 w.
R211	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w.
R212	19B800607P510	Metal film: 51 ohms ± 5%, 1/8 w.
R213	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R214	19B800607P331	Metal film: 330 ohms ± 5%, 1/8 w.
R215	19B800607P582	Metal film: 5.6K ohms ± 5%, 1/8 w.
R216	19B800607P182	Metal film: 1.8K ohms ± 5%, 1/8 w.
R217	19B800607P150	Metal film: 15 ohms ± 5%, 1/8 w.
R218	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w.
R219	19B800607P151	Metal film: 150 ohms ± 5%, 1/8 w.
R220	19B800607P390	Metal film: 39 ohms ± 5%, 1/8 w.
R221	19B800607P151	Metal film: 150 ohms ± 5%, 1/8 w.
R301 thru R303	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R304	19B800607P470	Metal film: 47 ohms ± 5%, 1/8 w.
R305	19B800607P103	Metal film: 10K ohms ± 5%, 1/8 w.
R306	19B800607P222	Metal film: 2.2K ohms ± 5%, 1/8 w.
R307	19B800607P230	Metal film: 2000 ohms ± 1%, 200 VDCW, 1/8 w.
R308	19B800607P249	Metal film: 3160 ohms ± 1%, 200 VDCW, 1/8 w.
R309	19B800607P471	Metal film: 470 ohms ± 5%, 1/8 w.
R310	19B800607P470	Metal film: 47 ohms ± 5%, 1/8 w.
R311 and R312	19B800607P103	Metal film: 10K ohms ± 5%, 1/8 w.
R313	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R401	19B800607P330	Metal film: 33 ohms ± 5%, 1/8 w.
R402	19B800607P102	Metal film: 1K ohms ± 5%, 1/8 w.
R403	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R404	19B800607P561	Metal film: 560 ohms ± 5%, 1/8 w.
R405	19B800607P510	Metal film: 51 ohms ± 5%, 1/8 w.
R406	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w.
R407	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R408	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R409	19B800607P222	Metal film: 2.2K ohms ± 5%, 1/8 w.
R410	19B800607P392	Metal film: 3.9K ohms ± 5%, 1/8 w.
*R411	19B800607P682	Metal film: 6.8K ohms ± 5%, 1/8 w.
R412	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R415	19B800607P100	Metal film: 10 ohms ± 5%, 1/8 w.
R501	19B800607P470	Metal film: 47 ohms ± 5%, 1/8 w.
R502	19B800607P102	Metal film: 1K ohms ± 5%, 1/8 w.
R503	19B800607P223	Metal film: 22K ohms ± 5%, 1/8 w.
R504	19B800607P150	Metal film: 15 ohms ± 5%, 1/8 w.
R505	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R506	19B800607P105	Metal film: 1M ohms ± 5%, 1/8 w.
R507 and R508	19B800607P333	Metal film: 33K ohms ± 5%, 1/8 w.
R509	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R510	19B800607P103	Metal film: 10K ohms ± 5%, 1/8 w.
R511	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w.
R601	19B800607P176	Metal film: 604 ohms ± 1%, 200 VDCW, 1/8 w.
R602 and R603	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R604	19B800607P470	Metal film: 47 ohms ± 5%, 1/8 w.
R605	19B800607P104	Metal film: 100K ohms ± 5%, 1/8 w.
R606	19B800607P680	Metal film: 68 ohms ± 5%, 1/8 w.
R607	19B800607P102	Metal film: 1K ohms ± 5%, 1/8 w.
R608	19B800607P392	Metal film: 3.9K ohms ± 5%, 1/8 w.
R609	19B800607P472	Metal film: 4.7K ohms ± 5%, 1/8 w.
R610	19B800607P105	Metal film: 1M ohms ± 5%, 1/8 w.
R701 and R706	19B800607P102	Metal film: 1K ohms ± 5%, 1/8 w.
*R707	19B800607P472	Metal film: 4.7K ohms ± 5%, 1/8 w.
R708 and R709	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R710 thru R712	19B800607P103	Metal film: 10K ohms ± 5%, 1/8 w.
R720	19B800607P392	Metal film: 3.9K ohms ± 5%, 1/8 w.
R721	19B800607P562	Metal film: 5.6K ohms ± 5%, 1/8 w.
R722	19B800607P473	Metal film: 47K ohms ± 5%, 1/8 w.
R723	19B800607P391	Metal film: 390 ohms ± 5%, 1/8 w.
R724	19B800607P101	Metal film: 100 ohms ± 5%, 1/8 w.
		—————— SWITCHES ——————
SW1	19A149955P2	Rocker, DIP: 8 position SPST: sim to Grayhill 76PSB08S.

* COMPONENTS, ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SYMBOL	PART NUMBER	DESCRIPTION
		——— INTEGRATED CIRCUITS ———
U201 thru U203	19A705927P1	Silicon, bipolar: sim to Avantek MSA-0611.
U301	19A704971P9	Voltage Regulator, Positive: sim to Motorola MC78L05ACD.
U302	19A116297P7	Linear: Dual Op Amp: sim to MC4558CD.
U303	19A704971P7	Voltage Regulator,Negative:sim to Motorola MC79L05ACD.
U401	19A149944P201	Dual Modulus Prescaler: sim to Motorola MC12022A.
U402	19B800902P6	Synthesizer, custom: CMOS, serial input.
U501	344A3070P1	Dual Operational Amplifier: sim to Motorola TL072.
U502	19A702705P4	Digital: Quad Analog Switch/Multiplexer: sim to 4066BM.
U601	19A116297P7	Linear: Dual Op Amp: sim to MC4558CD.
U701	19A703483P302	Digital, CMOS: QUAD 2-INPUT NAND GATE, sim to 74HC00.
U702	19A703471P320	Digital: 3-to-8 Decoder/Demultiplexer; sim to 74HC138.
U705	19A703483P302	Digital, CMOS: QUAD 2-INPUT NAND GATE, sim to 74HC00.
		——— VARIABLE RESISTORS ———
VR601 and VR602	19B235029P7	25-turn Cermet trimmer; 5K ohms, + 10%, .6w: sim to Bourn 3296W-1502-R.

PRODUCTION CHANGES

Changes to the equipment to improve performance or to simplify circuits are identified a Revision Letter which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for the descriptions of parts affected by this revision.

Rev. A - Transmitter Synthesizer Board - 19D902779G1

To improve reliability, changed C21, C23, C24, C25, C216, C305, L203, L204, R211, R219, R220 and R221. Deleted C26 and C212 and added C217.

C21 was: 19A702236P11, 2.7 pF.
C23 was: 19A702236P19, 5.6 pF.
C24 was: 19A702236P9, 1.8 pF.
C25 was: 19A702236P13, 3.3 pF.
C216 was: 19A702236P21, 6.8 pF.
C305 was: 19A705205P6, 10 μH.
L203 was: 19A705470P18, 0.27 μH.
L204 was: 19A705470P13, 0.10 μH.
R211 was: 19B800607P100, 10 ohms.
R219 was: 19B800607P221, 220 ohms.
R220 was: 19B800607P270, 27 ohms.
R221 was: 19B800607P221, 220 ohms.

Rev. B - Transmitter Synthesizer Board - 19D902779G1

To improve Lock-on at low end of board and to improve stabilization of +8 volt power supply. Changed C312, R204 and R310; replaced R206 with C219 and R207 with L205.

C312 was: 19A702061P99, 1000 pF.
R204 was: 19B80607P270, 27 ohms.

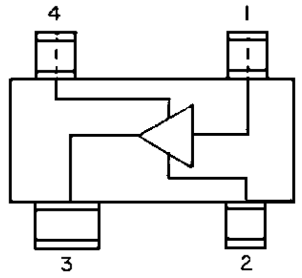
Rev. C - Transmitter Synthesizer Board - 19D902779G1

To improve the margin of stability on the +8 Vdc power supply, changed C312 and R310, and added C314 and R313.

C312 was: 19A705205P2, 1 μF.
R310 was: 19B800607P100, 10 ohms.

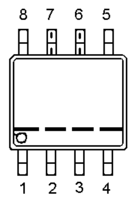
Rev. D - Transmitter Synthesizer Board - 19D902779G1

To correct loading problem.
R209 was: 100 ohms (19B801486P101).
R411 was: 4.7K ohms (19B800607P472).
R707 was: 47K ohms (19B800607P473).



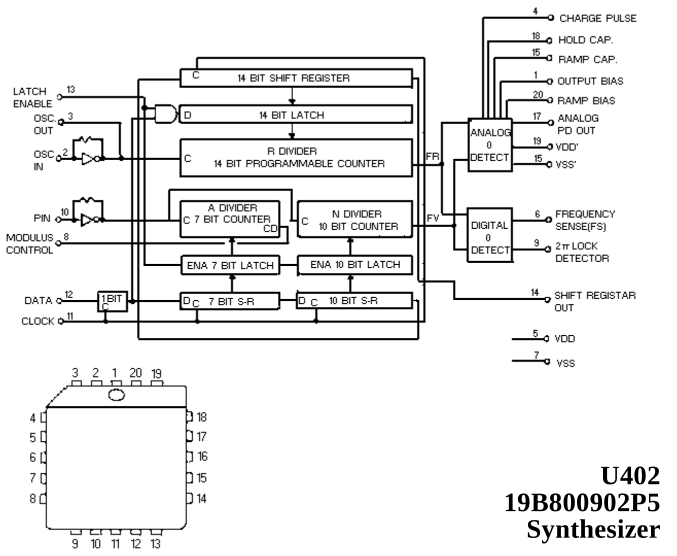
PIN 1. RF INPUT
2. GROUND
3. RF OUTPUT AND BIAS
4. GROUND

U201 & U203
19A705927P11
Silicon Bipolar MMIC

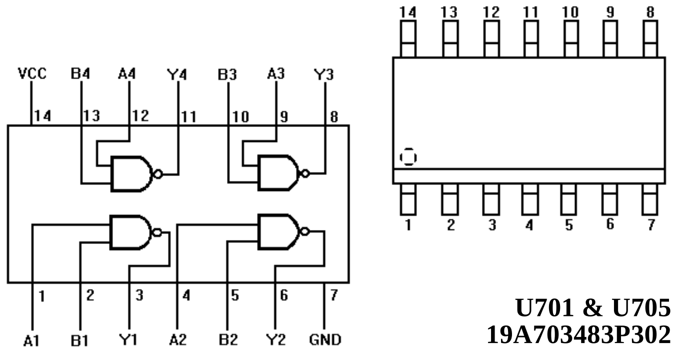


PIN	FUNCTION
1	Vout
2	GROUND
3	GROUND
4	N.C.
5	N.C.
6	GROUND
7	GROUND
8	Vin

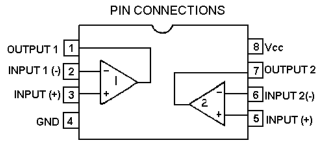
U301
19A704971P9
+5V Regulator



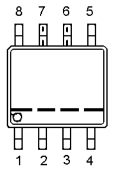
U402
19B800902P5
Synthesizer



U701 & U705
19A703483P302
Quad 2-Input NAND Gate

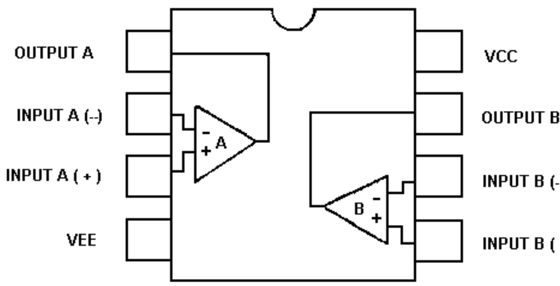


U302 & U601
19A116297P7
Dual Wide Band Op-Amp

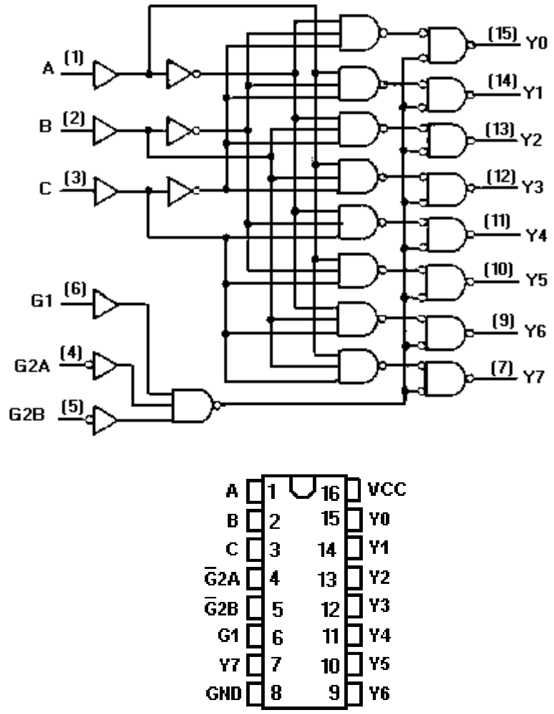


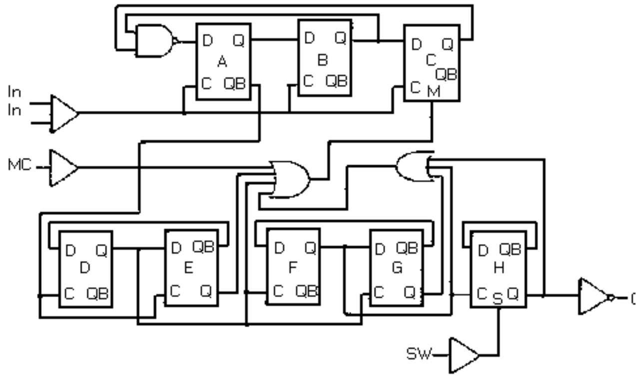
PIN	FUNCTION
1	Vout
2	Vin
3	Vin
4	N.C.
5	GND
6	Vin
7	Vin
8	N.C.

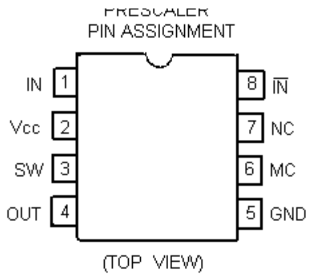
U303
19A704971P7
-5V Regulator



U501
344A3070P1
Operational Amplifier



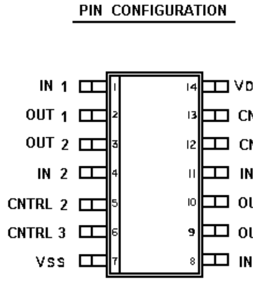


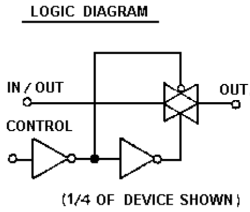


FUNCTION TABLE		
SW	MC	DIVIDE RATIO
H	H	64
H	L	65
L	H	128
L	L	129

SW: H = Vcc L = OPEN
MC: H = 2.0V TO Vcc
L = GND TO 0.8V

U401
19A149944P201
Dual Modulus Prescaler





CONTROL	SWITCH
0	OFF
1	ON

U502
19A702705P4
Quad Analog Switch

FUNCTION TABLE

ENABLE INPUTS			SELECT INPUTS			OUTPUTS							
G1	$\overline{G2A}$	$\overline{G2B}$	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	H	L	H	H	H	H
H	L	L	H	L	L	H	H	H	H	L	H	H	H
H	L	L	H	L	H	H	H	H	H	H	L	H	H
H	L	L	H	H	L	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

U702
19A703471P320
Address Decoder

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