hy-gain electronics corporation

PRELIMINARY SERVICE BULLETIN

ORDER NO. 681, 682, & 683

Hy-Gain I, II, & III CB transceivers

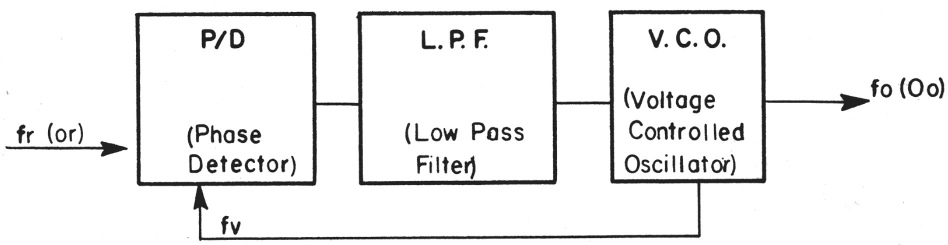
(Complete service manual to be published at a later date)

THEORY OF OPERATION

Phase Locked Loop Circuitry

PLL is an abbreviation for "Phase Locked Loop" which is a signal processed to track the frequency and phase of a reference signal. Therefore, PLL is an automatic frequency control loop or an automatic phase control.

PLL circuitry consists of three main units as shown in the figure below. As the theory of operation is read, refer to the block diagram, as needed for clarification.



In the above block diagram, when the reference frequency, fr, and the VCO output frequency, fv, are applied to the Phase Detector P/D, fv is compared with fr in terms of phase lag and lead.

The resulting output (the phase difference) is converted into a DC outlet voltage corresponding to the phase difference. Since the phase comparison is made at every cycle, the DC output may include unnecessary harmonics and noises. The DC output is, therefore, led to the low pass filter (LPF) and integrated or smoothed to continuous DC voltage in proportion to the phase difference. The frequency of the Voltage Controlled Oscillator (VCO) is controlled by the LPF output voltage. Thus the VCO produces two outputs.

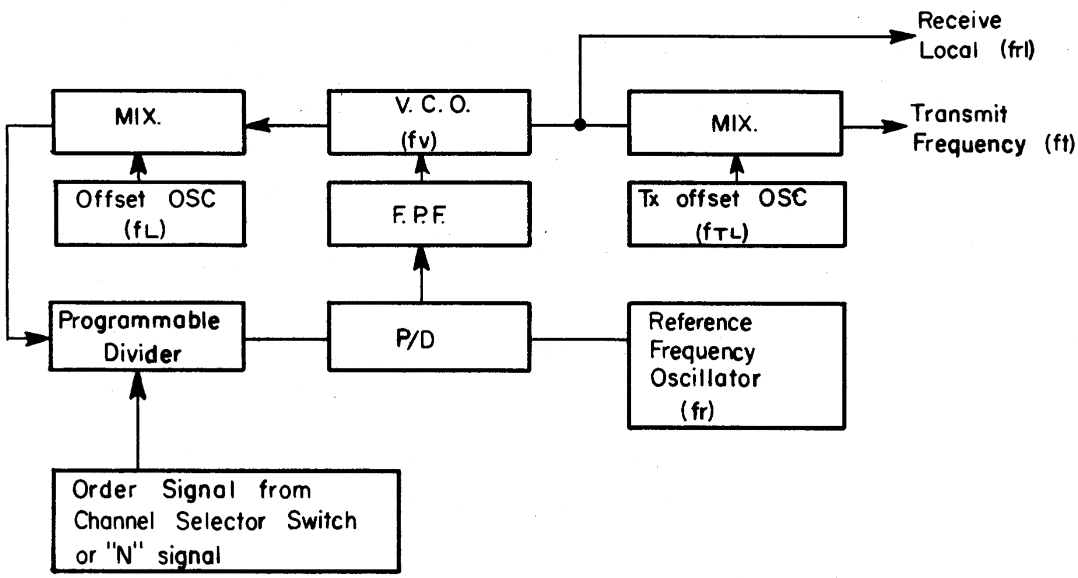
One frequency is used as the operating frequency of the unit and the other is returned to the P/D, making a closed loop. The closed loop will continue to operate until the following condition is met:

$$Or\ (t) - Oo\ (t)$$

This condition is called locked.

Employing the PLL system in a CB transceiver requires some modification so that the VCO generates a specific frequency corresponding to each channel frequency as channels 1 through 23 are selected.

Below is a block diagram with this modification. As is shown, a Programmable Divider, Mixer and Offset Oscillator are added.



In the block diagram of the synthesizer, the first local oscillator frequency, fRL, for reception, is given below:

fRL = fL + (N x fr).............

The transmit frequency fT, where N is an order signal from the channel selector switch, is:

fT = RL + fTL.................
= fL + (N x fr) + fTL.........

When using the system in a transceiver, fr should have the same frequency as the channel spacing, namely, fr - 10 KHz. When receving channel No. 1, 26.965 MHz, the VCO frequency, fRL, should be,

fRL = 26.965 - 5.965 = 21.020 MHz

N codes will be determined from the equation:

$$N = \frac{fRL - fL}{fr}$$

When substituting the frequency yields:

$$N = \frac{21.020 - (9.51 \times 2)}{0.01} = 200$$

This means that the selection of channel 1 is to select one of the N Codes (ie, 200) instead of selecting the proper crystal, as in a conventional CB transceiver. Thus by varying N numbers and by selecting one of them, any channel can be selected. This is the major difference between a conventional crystal type and a PLL Frequency Synthesizer type transceiver.

Receiver

In the receive mode of operation, transistors Q109, Q110, and Q111 are not operating, but transistors, Q114, Q115, Q118, and Q119 are powered and operate.

Q114 is a 27 MHz RF Amplifier and amplifies the signal supplied from the antenna through C154 and T104. The amplified signal is then applied to the base of the Mixer, Q115, where the VCO output frequency is also being applied, thus resulting in a first IF frequency.

When CH 1 is selected:

1st IF = 26.965 - 21.020 = 5.945 MHz.

The 1st IF signal is then applied to the 2nd Mixer, Q116, at which a 6.400 MHz injection signal is also being applied from Q117. The 455 KHz second IF signal is produced as follows:

2nd IF = 6.400 - 5.945 = 0.455 MHz

The 455 KHz signal is applied to IF amplifiers, Q118 and Q119, and detected into the audio signal at the Detector Diode, D110. The audio signal is applied to the Audio Amplifier at pin 6 of IC 102. The Audio Amplifier output is supplied to the built-in speaker through the Audio Output Transformer, T110.

Because the base bias of Q120 is supplied during receiver operation, the squelch circuit will be operative.

Transmitter

IC101 (PLL LSI), Q101 (VCO), Q102 (Mixer 1), Q103 (Buffer 2), Q104 (Buffer 2), Q108 (Buffer 3), Q117 (Reference OSC) and Q105 (0.51 MHz Oscillator) are operating regardless of the transceiver mode selected. When the transceiver is set to the transmit mode, Q109, Q110, Q107, Q111, Q112 and Q113 are powered and will operate.

The channel selector switch decides the N code corresponding to the channel selected. These N code signals are applied to the proper IC (PIN 11-16) to preset the Programmable Divider in IC 101 for dividing the input frequency from Buffer 2, Q103.

Oscillator, Q105, oscillates at a frequency of 9.51 MHz, but the second harmonic of the frequency is used and applied to the Mixer, Q102, and mixed with the VCO output frequency. The mixed and converted output, difference frequency (2 - 2.290 MHz), is then applied to Buffer Amplifier, Q103, which in turn feeds its output to the buffer circuit in IC101. The buffer output is then applied to the Programmable Divider and divided into a low frequency predetermined by the N code. Finally, the low frequency is led to the Phase Detector and compared with the reference frequency sent through the Reference Frequency Oscillator, Q117 - Buffer Q104 - Divider 1/640 in IC101.

The Phase Detector generates a DC output voltage corresponding to the phase difference between the two signals applied. The DC output is applied to the VCO circuit through the Low Pass Filter and changes the VCO frequency so that the VCO frequency (in terms of count-down frequency) exactly coincides with the reference frequency. When both frequencies coincide, the phase loop circuitry will be locked and the VCO circuit provides on stable frequency over the band of 21.020-21.310 MHz (depending upon N code or channel selected). The stable frequency is then applied to the buffer amplifier Q108. The buffered output of Q108 is split into two: one will be used as a Local Oscillator signal for receiver operation, and the other is led to the Mixer, Q110, to produce a transmitting frequency.

The 27 MHz transmitting signal is applied to the 27 MHz amplifiers, Q111, Q112, and Q113, where it is amplified to the high power level required for transmission.

When transmitting, the microphone signal is applied to the Audio Amplifier (No. 6 pin of IC102). The resultant amplified output is then fed to the collectors of Q112 and Q113 through the secondary coil of Output Transformer, T110, and Switching Diode, D105. This modulates the carrier frequency.

Noise Blanking Circuit (683 only)

This circuit silences undesirable impulse noises by disabling the receiver circuit for a short time during which the impulse is applied to the antenna circuit.

When the ANL-NB Switch is in the NB position, a fraction of the noise impulse will be applied to D115 and D116 from the mixer stage through C186 and rectified into a DC voltage. The DC voltage is than applied to the base of Q120, making Q120 activate.

Q125 will also operate making T107 short-circuit to ground, inactivating the receive circuit for a short time. In this way, the receiver will be silenced during reception of noise impulses. C233 determines the cut-off time.

RF Power & SWR Meter Circuits (683 only)	A fraction of the RF power output is applied to the Diode, D501, through the inductive/capacitive coupling circuit provided on the pc board, PTSR002BOX, and rectified into a DC voltage. The DC voltage is then applied to the meter terminals through the Meter Adjustment Trimmer, RV501, if the Meter Mode Switch, S3, is placed in the CB position as in the schematic diagram. In this way the RF output will be indicated on the meter. However, when S3 is placed in the CAL position, the DC voltage is switched to the SWR meter calibrating circuit, consisting of R504 on PTSR002BOX and VR-4, the cal. variable resistor on the front panel. Placing the meter pointer in the SET position on the meter scale by adjusting VR-4, is to predetermine the standard reference level in terms of forward traveling RF power. When S3 is placed in the SWR position, another DC voltage is produced by rectifing the antenna reflection energy applied to Diode D502. The inductive/capacitive coupling circuit is switched to the SWR indication circuit, consisting of RV502, VR-4 and the meter, thus giving the SWR of the antenna system.
TX Lamp Circuit (683 only)	When the switching transistor Q107 supplied DC voltage to the transmit circuit, the voltage is also applied to terminal 3 on EPO-0649. This makes Q802 (on EPO-0649) activate. The TX lamp, PL3, will be lit. Since the power line of PL 3 is connected to the modulation circuit, the brightness of the lamp will vary slightly during transmission.
RX Lamp Circuit (683 only)	When the switching diode D106 starts to supply DC voltage to the receive circuit, voltage will be applied to terminal 1 on EPO-0649. This makes the emitter-collector of Q801 conductive and lights the receive lamp, PL2.

ALIGNMENT PROCEDURES FOR MODELS 681, 682, & 683 TRANSCEIVER

Test Equipment

1. Audio signal generator, 10 Hz - 20 KHz
2. VTVM, 1 mV measurable
3. DC Ampere Meter, 2A
4. Regulated power supply, DC 0 - 20V, 2A or higher
5. Frequency Counter, 0 - 40 MHz, high input impedance type
6. RF VTVM, Probe Type
7. Oscilloscope, 30 MHz, high input impedance
8. RF watt meter, thermo-couple type, 50 ohm, 5W
9. Standard signal generator, 100 KHz - 50 MHz, -10 - 100 dB, 50 ohm unbalanced
10. Speaker dummy resistor, 8 ohm, 5W
11. Circuit tester, DC V/20K ohm or higher

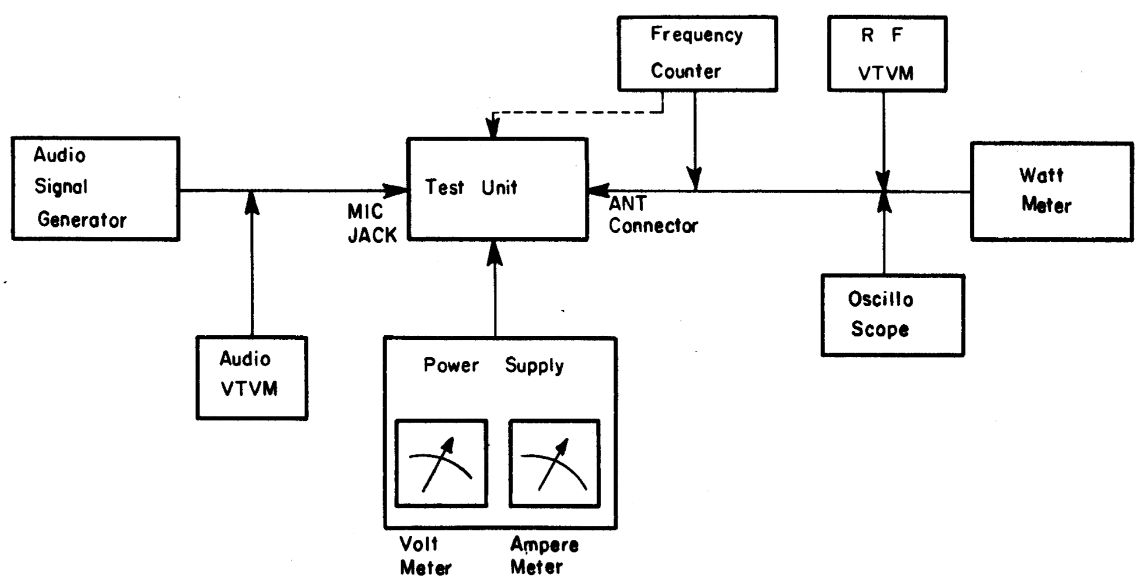
All test equipment should calibrated properly.

NOTE: Test voltage is DC 13.8 V ± 5%, unless otherwise specified.

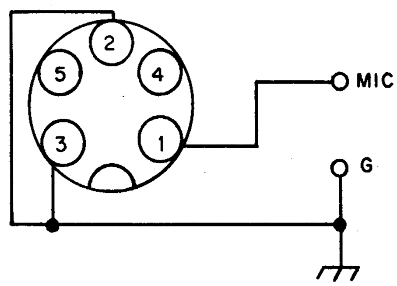
Transmitter Alignment

Equipment Set-up

Connect all test equipment as shown below.



To set the transceiver to the transmit mode without the microphone, insert a 5-pin plug wired as shown below into the MIC jack on the transceiver. When applying an audio modulation signal to the microphone input circuit, use the same plug.



PLL Alignment

Before alignment, check the operating frequencies at the following points, using the frequency counter through a 1000 PF coupling capacitor connected in series with the counter input probe.

1. 6.4 MHz Buffer 1, Q104. Collector frequency should be 6400.500 $\pm$ 0.13 KHz.

2. VCO, Q108, base frequency should be 21.0195 $\pm$ 0.38 KHz at the CH 1 position.

3. 5.945 MHz OSC 2, Q109, emitter frequency should be 5945.300 $\pm$ 0.12 KHz.

4. Place the channel selector in the channel 1 position.

5. Connect the circuit tester (DC 3V range) between ground and R114 (TP-8 side).

6. Adjust the T101 core clockwise to obtain 1.5V $\pm$ 0.1V on the tester. (The tester should be calibrated and have an input impedance of V/20K ohm or higher).

7. Place the channel selector in open channel position. A voltage reading of 5.1 - 5.4V will be obtained.

8. Place the channel selector in the channel 23 position and read the value on the tester. It should be 2.7 - 0.6V.

Alignment of Stages Before the RF Power Amplifier

1. Place the channel selector in the channel 13 position.

2. Adjust the power supply voltage to 8.0V.

3. Connect the oscilloscope to the base side of T102 (C141) and ground.

4. Adjust L103, L104, and T102 for maximum amplitude on the oscilloscope display (27.115 MHz).

5. Connect the oscilloscope to the base of Q112 and adjust T102 and T103 for maximum amplitude.

RF Power Amplifier Alignment

1. Switch the channel selector to channel 13 and the power supply voltage to 13.8V.

2. Adjust L106 for maximum reading on the RF watt meter.

3. Adjust L109 for maximum RF power output.

4. Adjust L110 for maximum RF power output.

5. Adjust L109 for maximum RF power output.

6. Turn L106 core clockwise so that the RF watt meter indicates 4.4W.

7. Turn the L110 core counter clockwise until a power reading of 3.8W is obtained.

After completion of the above alignment, read the total DC current flowing into the power cord, using an ampere meter built into the power supply unit or an ampere meter connected series in the power cord. The reading should be 900 mA or less.

Transmitter Frequency Check

1. Set the transceiver into transmit mode, no modulation.

2. Connect the frequency counter to the antenna connector and read the frequency at each channel. The frequency should be within -800 Hz from each center channel frequency as tabulated in the frequency table attached.

Modulation Sensitivity Alignment

1. Set the unit in the transmit mode and apply a 20 mV, 1 KHz signal to the microphone input circuit.

2. RV-102 should be adjusted to obtain 90% modulation in this condition.

3. Next, decrease the signal input at 6 mV and observe that the modulation ratio is still keeping a value higher than 80%.

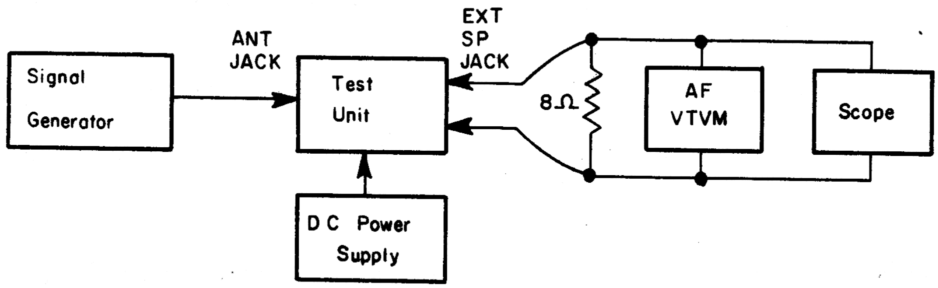
RF Meter Alignment

Adjust RV-104 (RV-501 in the 683) so that the meter pointer indicates the same wattage as the reading obtained on the watt meter; or so that the meter pointer coincides with the center of the red zone on the meter scale.

NOTE: (Refer to step 3 of the RF power alignment procedure to set the reference power level (3.8W on the watt meter).

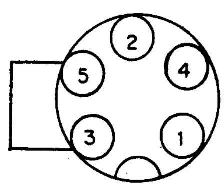
Receiver Alignment

Equipment Set-Up



NOTE: Place the ANL switch in the on position (682 & 683 only).

To put the transceiver in the receive mode, insert a 5-pin plug wired as shown below into the microphone jack on the front panel.



Receiver Sensitivity Alignment

1. Set the Signal Generator to 27.115 MHz, 1 KHz 30% modulation and set the transceiver to the channel 13 position.

NOTE: This alignment should be performed with an extremely small signal input from the signal generator to avoid inaccurate alignment due to agc action.

2. Tune the generator to the receiver on channel 13.

3. Adjust L115, T104, T105, L112, T106, T107, T108, and T109 for maximum audio output with the 8 ohm dummy resistor.

Squelch Alignment

1. Set the signal generator to provide an RF input signal of 54 dB (1 KHz, 30% mod.)

2. Rotate the squelch control volume fully clockwise.

3. Temporarily adjust RV-101 for maximum audio output, and note the audio output level.

4. Adjust RV-101 so that the audio output level decreases by 6 dB.

S-Meter Adjustment

1. Set the signal generator to provide a 40 dB signal output.

2. Adjust RV-103 so that the S-meter pointer reads 9 on the meter provided on the front panel.

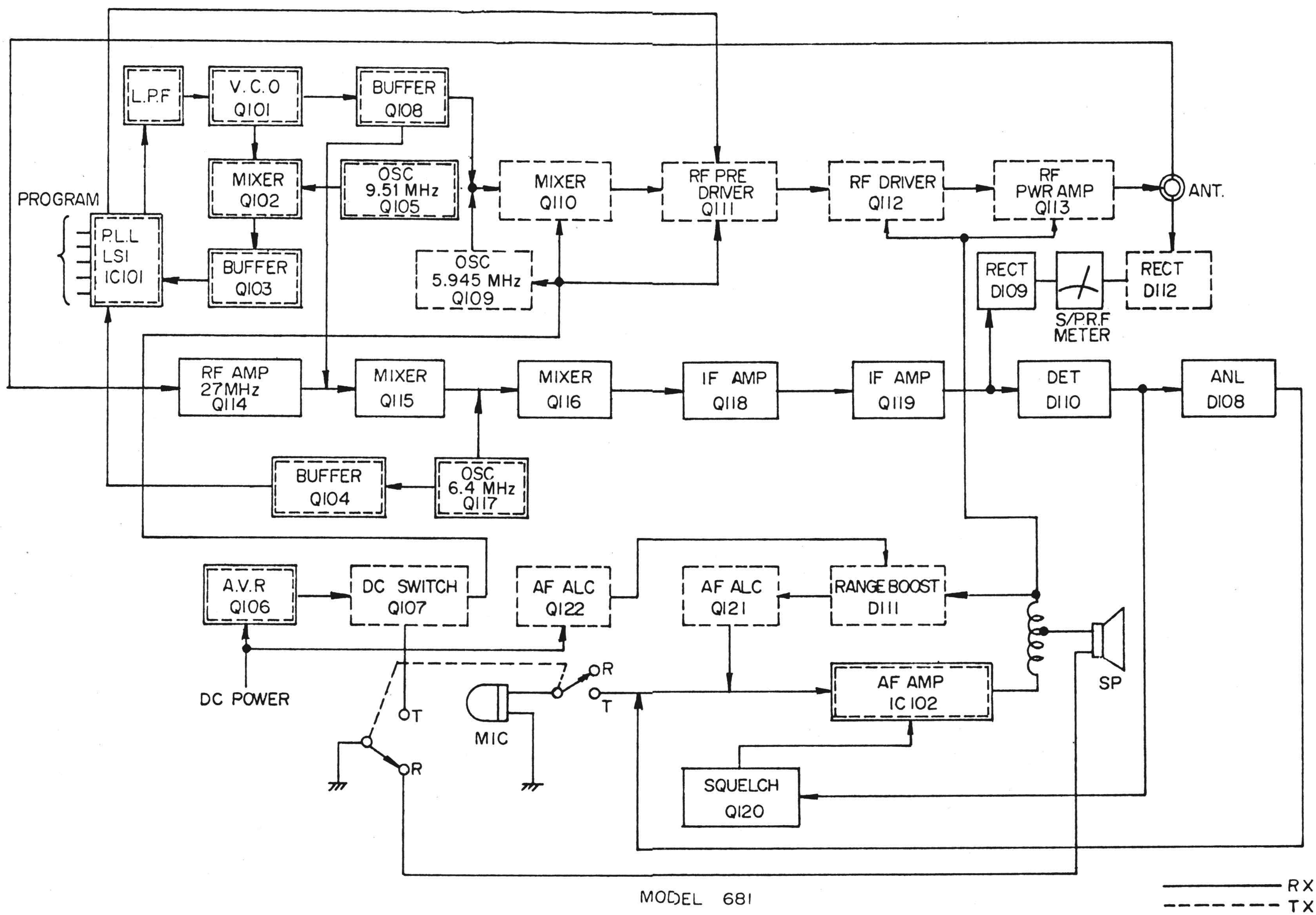
SWR Meter Adjustment (683 only)

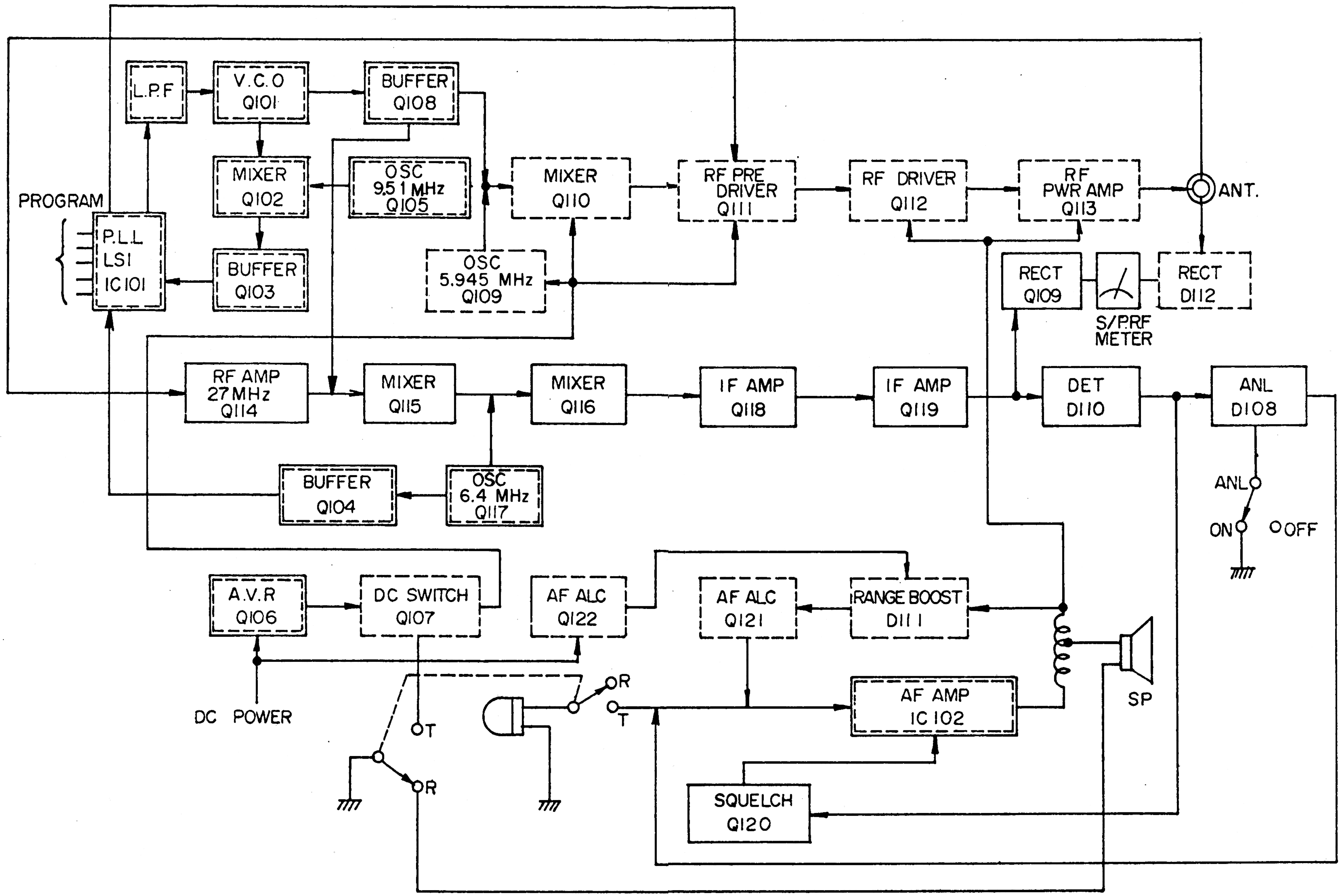
1. Connect a non-inductive resistor of 100Ω to the antenna connector on the rear of the transceiver.

2. Set the transceiver to the transmit mode and place the SWR CAL Switch, S3, in the CAL position.

3. Adjust the CAL control, RV4, to move the meter pointer exactly to the SET mark on the meter scale.

4. Place S3 in the SWR position and adjust RV502 on pc board, PTSR002BOX, so that the meter pointer indicates 2 on the SWR scale.


L.P.F
V.C.O Q101
BUFFER Q108
PROGRAM
P.L.L LSI IC101
MIXER Q102
OSC 9.51 MHz Q105
MIXER Q110
RF PRE DRIVER Q111
RF DRIVER Q112
RF PWR AMP Q113
ANT.
BUFFER Q103
OSC 5.945 MHz Q109
RECT D109
S/P.R.F METER
RECT D112
RF AMP 27MHz Q114
MIXER Q115
MIXER Q116
IF AMP Q118
IF AMP Q119
DET D110
ANL D108
BUFFER Q104
OSC 6.4 MHz Q117
A.V.R Q106
DC SWITCH Q107
AF ALC Q122
AF ALC Q121
RANGE BOOST D111
SP
DC POWER
T
R
MIC
AF AMP IC102
SQUELCH Q120
RX
TX
MODEL 681


L.P.F
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Q112
RF PWR AMP
Q113
ANT.
RECT
Q109
S/PRF METER
RECT
D112
RF AMP
27MHz
Q114
MIXER
Q115
MIXER
Q116
IF AMP
Q118
IF AMP
Q119
DET
D110
ANL
D108
ANL
ON
OFF
BUFFER
Q104
OSC
6.4 MHz
Q117
A.V.R
Q106
DC SWITCH
Q107
AF ALC
Q122
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Q121
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SQUELCH
Q120
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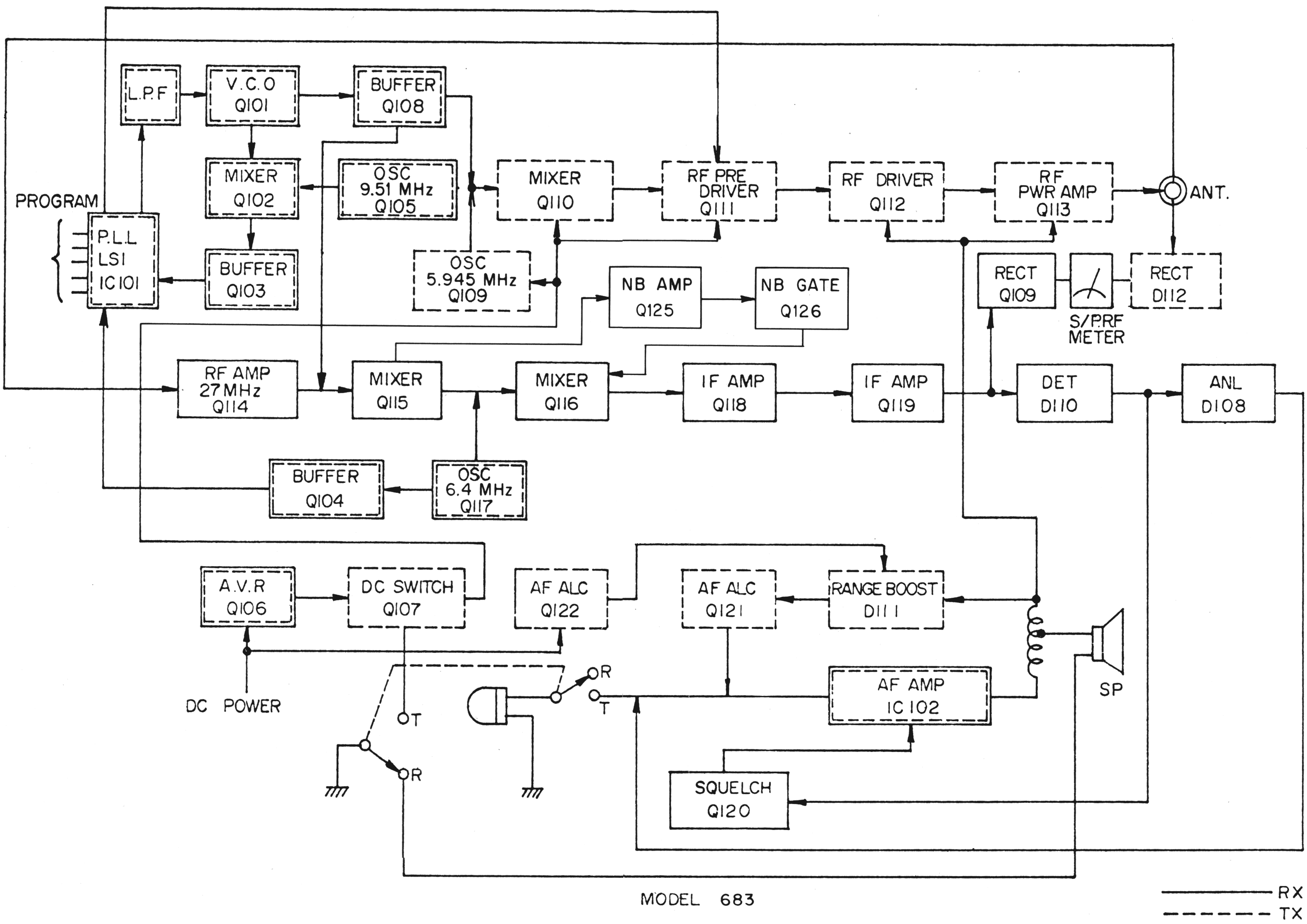
MODEL 682



PROGRAM
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OSC
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Q112
RF
PWR AMP
Q113
ANT.
RECT
Q109
S/P.RF
METER
RECT
D112
NB AMP
Q125
NB GATE
Q126
RF AMP
27MHz
Q114
MIXER
Q115
MIXER
Q116
IF AMP
Q118
IF AMP
Q119
DET
D110
ANL
D108
BUFFER
Q104
OSC
6.4 MHz
Q117
A.V.R
Q106
DC SWITCH
Q107
AF ALC
Q122
AF ALC
Q121
RANGE BOOST
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MODEL 683