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SPECIFICATIONS

(Measurements are made per EIA Standard RS-382 and are nominal unless otherwise stated.)

GENERAL

Channels	23
Frequency Range	26.965 to 27.255 MHz
Frequency Control	±0.005% crystal, -30°C to +60°C transmit and receive
Overall Dimensions	6.1 cm H x 19 cm W x 27.2 cm D (2.4 in H x 7.5 in W x 10.7 in D)
Weight -	
Unit	2.75 kg (6 lbs)
Shipping	3.20 kg (7 lbs)
Microphone	Ceramic microphone with neoprene cord
Antenna Impedance	50 ohms
Circuitry	32 transistors, 54 diodes, 2 integrated circuits
Intermediate Frequency	7.8 MHz
Metering	Received signal strength/relative power output
Power Requirements	13.8 VDC positive or negative ground 0.4A squelched receive 1.8A fully modulated transmit
Circuit Protection	4 ampere fuse
Compliance	FCC Type Accepted Rule 95 (D)

RECEIVER

Sensitivity	
AM	10 dB (S+N)/N at 0.5 (1.0)*μV input
SSB	10 dB (S+N)/N at 0.35 (0.5)*μV input
Selectivity	4.5 kHz minimum bandwidth at -6 dB and 30 kHz maximum bandwidth at -60 dB
Spurious Rejection	50 dB
Audio Output Power	2 watts with less than 10% distortion at 1000μV, 1000 Hz
Tight Squelch	
AM	50 (30)*μV minimum and 2000μV maximum (NB on)
SSB	25 (15)*μV minimum and 1000μV maximum (NB on)
Squelch Sensitivity	3 dB or less signal change for 40 dB quieting at 1μV
AGC Characteristics	
AM	Flat within ±6 dB from 250,000 to 5μV with 15 dB ±4 rolloff from 5 to 0.5μV
SSB	Flat within +2/-8 dB from 250,000 to 5μV with 15 dB ±4 rolloff from 5 to 0.5μV
Speaker Impedance	8 ohms
Receiver Incremental Tune	±1350 maximum ±600 Hz minimum

TRANSMITTER

Emission	
AM	6A3
SSB	3A3J
RF Power Output	
AM	3 watts minimum/4 watts maximum at 13.8 VDC
SSB	8 watts PEP minimum/12 watts PEP maximum at 13.8 VDC
RF Spurious and Harmonic Attenuation	50 dB
Audio Frequency Response	
AM	+2/-16 dB from 300 to 3000 Hz
SSB	+2/-20 dB from 300 to 3000 Hz
Modulation	80 (70%)* minimum positive and negative
Carrier Suppression	
SSB	40 dB
Unwanted Sideband Suppression	
SSB	50 dB

* MINIMUM PERFORMANCE SPECIFICATIONS are shown in parenthesis if other than NOMINAL value

INSTALLATION INSTRUCTIONS

The transceiver may be mounted under the dash or on the floor of a vehicle and will operate from either positive or negative ground battery voltage. A suggested installation procedure is as follows, for a more detailed installation procedure refer to E. F. Johnson booklet "Installing Your Citizens Radio" Part No. 004-2000-001.

a. Select a mounting location that will allow clearance for heater and air conductioning ducts. Install the antenna and route the transmission line to the intended mounting location.

b. Temporarily assemble the transceiver and the mounting bracket and hold it in the intended mounting location and check for clearance. Remove the bracket from the transceiver and hold the bracket in the mounting location and mark the mounting hole locations.

c. Center punch and drill the mounting holes where marked and install the mounting bracket.

d. Connect the antenna transmission line to the antenna connector, connect the red B+ lead to the positive (+) battery terminal, connect the black B+ lead to the negative (-) battery terminal and connect the external speaker, if used.

e. Install the transceiver in the mounting bracket using the enclosed hardware.

CIRCUIT DESCRIPTION

GENERAL

The Johnson Viking 352 is a 23 channel fully solid state citizens radio transceiver that operates on upper sideband, lower sideband and regular AM channels. All transmit and receive frequencies are generated by a ten crystal frequency synthesizer. The Carrier Insertion Oscillator is a separate oscillator which generates a 7.8025 MHz carrier for sideband detection and transmission.

The receiver is a single conversion receiver with four IF stages and a crystal filter for good selectivity and image rejection. Also included in the receiver is a noise blanker to remove any impulse type noise, an automatic gain control circuit (AGC) to maintain a constant receive signal level and an automatic noise limiter circuit (ANL) to remove any audio noise from the receive signal.

The transmitter consists of a mixer stage and a Class B RF power output stage to provide 4 watts RF output in AM and 12 watts PEP output in SSB.

The transceiver also includes an S/RFO meter which indicates receive signal strength in receive and relative RF output power in transmit in both AM and SSB modes of operation. The transceiver also includes a public address (PA) function so that the audio amplifiers can be used without activating the RF stages of the transmitter.

CARRIER FREQUENCY OSCILLATOR

The Carrier Oscillator consists of Y501, Q19 and associated components. The crystal controlled oscillator uses a crystal operating at series resonance to produce its fundamental frequency of 7.8025 MHz. Oscillator frequency adjustment is provided for by capacitor C510 and temperature compensation is provided by C501 and C502. Since the oscillator is not used in the AM mode, the supply voltage is switched off by the mode switch, S2-2, in the AM position and on in the LSB and USB positions.

In the LSB transmit mode, the 7.8025 MHz is coupled from the emitter of Q19 through C512 to the base of the Buffer stage and then to the Balanced Modulator to be used in audio modulation. In the USB transmit mode, the 7.8025 MHz is used in the Balanced Modulator and it is also coupled by C505 through CR501 to tuned transformers T501 and T502. Transformers T501 and T502 are tuned to pass only 15.6050 MHz (second harmonic of 7.8025 MHz) which is then coupled to the second gate of the USB Mixer transistor through C514 to be used in the Frequency Synthesizer.

In the LSB receive mode, the 7.8025 MHz is coupled through C457 to the emitters of Q16 and Q17, the SSB Detector, to detect the audio signals. To receive USB, the 15.6050 MHz from T502 is coupled to the gate of the USB Mixer and the 7.8025 MHz is also used by the SSB Detector.

FREQUENCY SYNTHESIZER

General

The frequency synthesizer circuitry consists of six high frequency crystals and four low frequency crystals, a high frequency (HF) oscillator, a low frequency (LF) oscillator, a synthesizer mixer, a 19 MHz amplifier, an upper sideband mixer, a 35 MHz amplifier and a diode switching network.

The synthesizer output is <u>7.8025 MHz below</u> the channel frequency for AM transmit and Lower Sideband (LSB) transmit and receive, <u>7.800 MHz below</u> the channel frequency for AM receive and <u>7.8025 MHz above</u> the channel frequency for Upper Sideband (USB) transmit and receive.

Low Frequency (LF) Oscillator

The LF oscillator consists of crystals Y607 through Y610, Q21 and its associated circuitry. The Channel Selector Switch, S1-3, selects one of these crystals and applies the signal to the base of the oscillator transistor, Q21. The oscillator is a modified Colpitts oscillator connected in a common collector configuration to provide high input impedance. In the transmit and receive SSB mode and the transmit AM mode, the crystals operate on their fundamental frequencies along with capacitors C601 and C602 to provide the low frequencies. In the AM receive mode, the LF crystal frequency is increased 2.5 kHz by CR603 so that the output of the synthesizer mixer will be 7.800 MHz below the channel frequency and the signal will pass at the center frequency of the crystal filter, F401.

The low frequency signal is coupled from the emitter of Q21 through C604 to the gate of the Synthesizer Mixer, Q25, where it is mixed with the signal from the high frequency oscillator.

High Frequency (HF) Oscillator

The HF oscillator consists of Q22, its associated circuitry, and crystals Y601 through Y606. The oscillator is a modified Colpitts oscillator connected in a common collector configuration to provide high input impedance. The crystals operate at series resonance to produce their fundamental frequencies and are adjustable ±800 Hz with the Fine Tune Control. Since the carrier is not transmitted in the SSB mode, the receiver reinserts the carrier and the Fine Tune Control allows the receive crystals to be compensated for any difference between the transmitter carrier frequency and the receiver carrier frequency. The Fine Tune Control, R625, varies the voltage across CR606, this voltage change is felt as a change in capacitance across the high frequency crystals which results in a corresponding change in oscillation and improved audio reproduction.

The desired HF crystal is selected by S1-1 at the same time as S1-3 selects the LF crystal. The crystal frequency is connected to the base of the HF oscillator transistor, Q22, through C638. The HF signal is amplified by the transistor and then coupled from the emitter of Q22 through C608 to the gate of the Synthesizer Mixer, Q25. To eliminate any crystal frequency other than the desired frequency, S1-2 shorts out the unused crystals. To prevent the transceiver from operating on the blank space between channels 22 and 23, S1-4 effectively shorts the synthesizer B+ through R608 to ground.

SYNTHESIZER OUTPUT

Lower Sideband (LSB) and AM

The signal from the LF oscillator is mixed with the signal from the HF oscillator at the synthesizer mixer, Q25. The synthesizer output circuitry T601 and T602 is tuned to pass the sum of the two frequencies, which is in the 19 MHz range and is coupled to the base of the 19 MHz amplifier, Q26, through C617. The output of Q25 is coupled to the switching diode CR602 through T603. The output frequency of Q26 for AM receive is 2.5 kHz higher than the AM transmit and the LSB transmit and receive frequencies. For example channel 1 on AM transmit and LSB would be; 11.700 MHz + 7.4625 MHz = 19.1625 MHz and channel 1 on AM receive would be; 11.700 MHz + 7.465 MHz = 19.165 MHz.

Upper Sideband (USB)

The 19 MHz signal from C616/T602 junction is coupled to the first gate of Q23, the USB Mixer, where it is mixed with 15.6050 MHz from the carrier oscillator. The output of the carrier oscillator is doubled by T501 and T502 to produce 15.6050 MHz which is then coupled through C514 to the second gate of Q23 to be mixed with the 19 MHz. The output circuitry of T604, C611, T605 and C612 is tuned to pass the sum frequency which is in the 35 MHz range. The 35 MHz signals are then coupled through C612 to the base of the 35 MHz Amplifier, Q24. The amplified 35 MHz signals are then coupled to the diode switch, CR601, through T606. The bias and supply voltage for the USB Mixer and 35 MHz Amplifier and CR601 are switched from the 19 MHz Amplifier by the Mode Switch S2-6.

The output of the USB Mixer for channel 1 USB transmit and receive frequencies would be 19.1625 MHz (from the Synthesizer Mixer) + 15.6050 MHz (2 x 7.8025 MHz from the Carrier Oscillator) = 34.7675 MHz.

VIKING 352D DIGITAL SYNTHESIZER

GENERAL

The frequency synthesizer consists of a voltage controlled oscillator, a reference oscillator, a mixer, a custom integrated circuit (IC), the channel selector switch and the out of lock circuit. The digital synthesizer circuit generates all the mixing frequencies for the transmitter and receiver. Refer to Figure 1, the block diagram of the digital synthesizer circuitry.

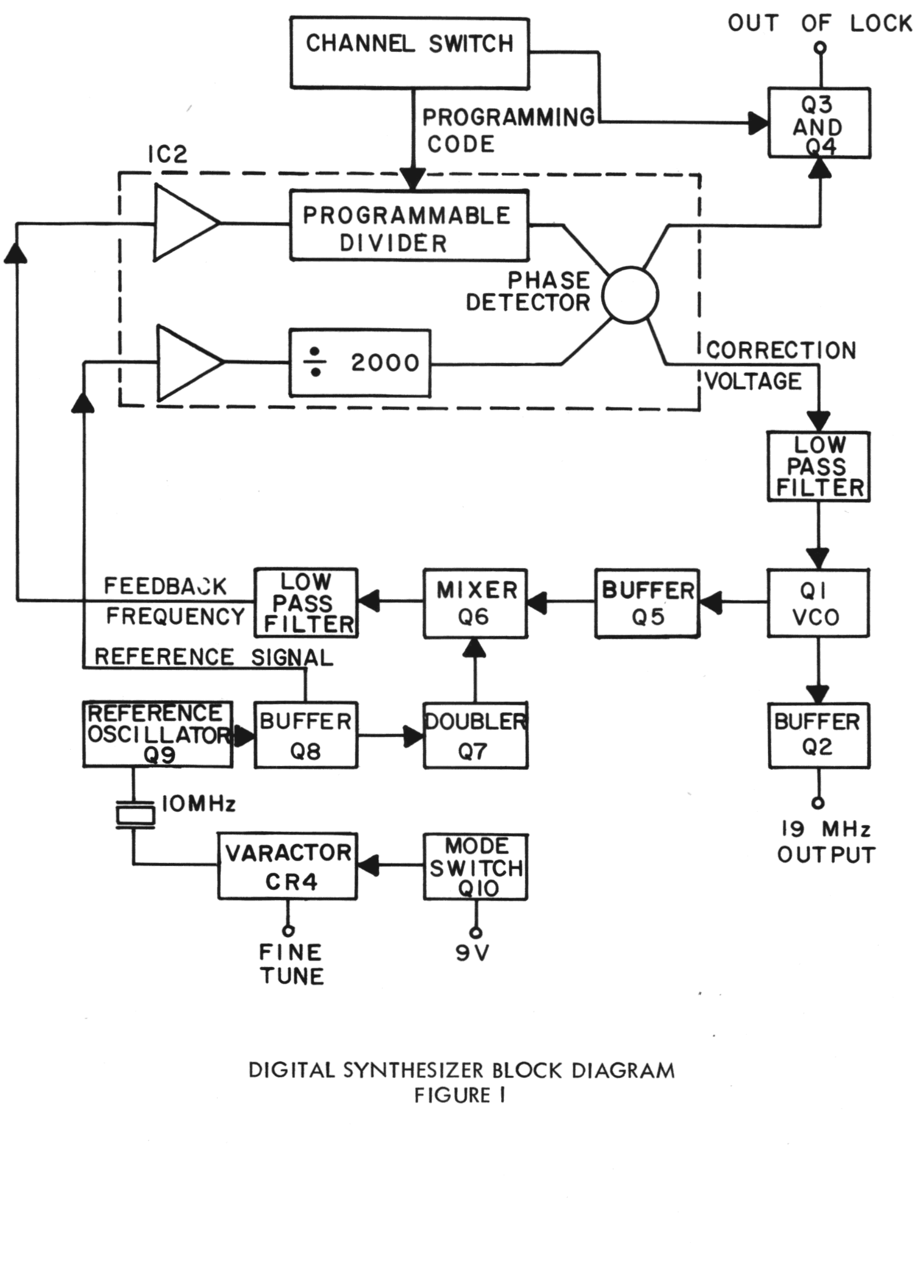
The voltage controlled oscillator (VCO) is tuned to operate in the 19 MHz range. Its output is used as a mixing frequency to generate the transmit and receive channel frequencies. The VCO output is controlled by the phase locked loop (PLL) circuit consisting of the reference oscillator (Q9), the doubler (Q7), the mixer (Q6) and the synthesizer IC (IC2).

To bring the VCO on to the correct frequency as required by the channel selector switch setting, the VCO frequency is compared in phase and frequency to a crystal controlled reference frequency by IC2. The VCO frequency is applied to gate 1 of the dual gate MOS FET mixer (Q6) through a buffer stage (Q5). On gate 2 of Q6 is 20 MHz from the reference oscillator (Q9) through a buffer stage (Q8) and a frequency doubler stage (Q7). The difference frequency from the mixer is coupled through a low pass filter to the synthesizer IC pin 2 as a feedback frequency. This feedback frequency is then divided by a programmable divider within the IC which has been programmed by the channel selector switch, to divide by 167 (channel 1 example). The output of the programmable divider is applied to the phase comparator section of IC2. The 10 MHz from the reference oscillator is coupled through a buffer stage (Q8) and applied to the IC on pin 3. This reference frequency is divided by 2000 to provide a reference of 5 kHz to the phase detector as a basis of comparison.

If the VCO frequency is not exactly correct, the feedback frequency, when divided by the programmable divider section of IC2, will not be exactly 5 kHz to the phase detector. The phase detector will then detect a difference between the reference and the feedback. This difference, which is called the "error signal", is applied to the VCO from IC2 pin 6 to adjust its frequency until the phase detector no longer detects any difference.

Refer to Table 1 which shows the synthesizer output for each channel and each mode. Table 1 also shows the binary programming code required to program the divider for each channel. The "divide by" number on Table 1 is the decimal equivalent of the binary programming code. The USB "divide by" number is one less than the AM and LSB to provide the required frequency offset for USB operation.

The synthesizer output is 7.8 MHz below the channel frequency in AM receive, 7.8025 MHz below in LSB receive and 7.7975 MHz below in USB receive. In transmit, the synthesizer output is 7.8025 MHz below the channel frequency in AM and LSB and 7.7975 MHz below in USB. The synthesizer output is mixed with the carrier oscillator frequency to produce the channel frequencies in each mode. To provide the USB synthesizer frequencies, the mode switch causes the varactor in the reference oscillator circuit to shift the reference frequency applied to the phase detector. The "divide by" number is also shifted by the mode switch placing a "0" on pin 15 of IC2 as shown in Table 1.



DIGITAL SYNTHESIZER BLOCK DIAGRAM
FIGURE I

TABLE 1
DIGITAL SYNTHESIZER PROGRAMMING

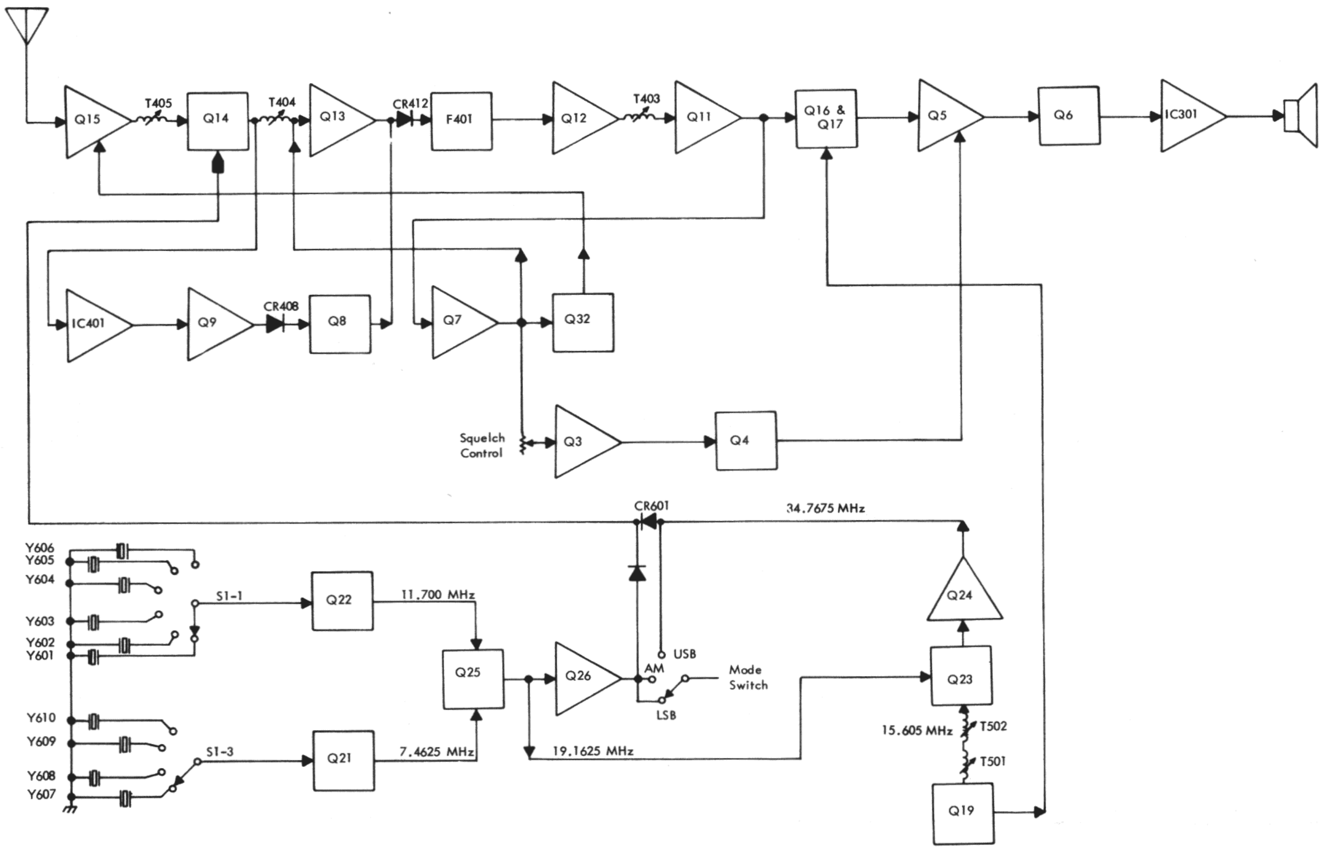
Channel Number	Programming Code IC2 Pin No. 8 9 10 11 12 13 14 15	Divide By AM/LSB	Number USB	AM Receive Synthesizer Frequency	AM Transmit and LSB Synthesizer Frequency	USB Synthesizer Frequency
1	1 0 1 0 0 1 1 *	167	166	19.165	19.1625	19.1675
2	1 0 1 0 0 1 0 *	165	164	19.175	19.1725	19.1775
3	1 0 1 0 0 0 1 *	163	162	19.185	19.1825	19.1875
4	1 0 0 1 1 1 1 *	159	158	19.205	19.2025	19.2075
5	1 0 0 1 1 1 0 *	157	156	19.215	19.2125	19.2175
6	1 0 0 1 1 0 1 *	155	154	19.225	19.2225	19.2275
7	1 0 0 1 1 0 0 *	153	152	19.235	19.2325	19.2375
8	1 0 0 1 0 1 0 *	149	148	19.255	19.2525	19.2575
9	1 0 0 1 0 0 1 *	147	146	19.265	19.2625	19.2675
10	1 0 0 1 0 0 0 *	145	144	19.275	19.2725	19.2775
11	1 0 0 0 1 1 1 *	143	142	19.285	19.2825	19.2875
12	1 0 0 0 1 0 1 *	139	138	19.305	19.3025	19.3075
13	1 0 0 0 1 0 0 *	137	136	19.315	19.3125	19.3175
14	1 0 0 0 0 1 1 *	135	134	19.325	19.3225	19.3275
15	1 0 0 0 0 1 0 *	133	132	19.335	19.3325	19.3375
16	1 0 0 0 0 0 0 *	129	128	19.355	19.3525	19.3575
17	0 1 1 1 1 1 1 *	127	126	19.365	19.3625	19.3675
18	0 1 1 1 1 1 0 *	125	124	19.375	19.3725	19.3775
19	0 1 1 1 1 0 1 *	123	122	19.385	19.3825	19.3875
20	0 1 1 1 0 1 1 *	119	118	19.405	19.4025	19.4075
21	0 1 1 1 0 1 0 *	117	116	19.415	19.4125	19.4175
22	0 1 1 1 0 0 1 *	115	114	19.425	19.4225	19.4275
23	0 1 1 0 1 1 0 *	109	108	19.455	19.4525	19.4575

All frequencies in MHz
"1" = +5 VDC
"0" = open
* = "1" for AM and LSB modes
* = "0" for USB modes

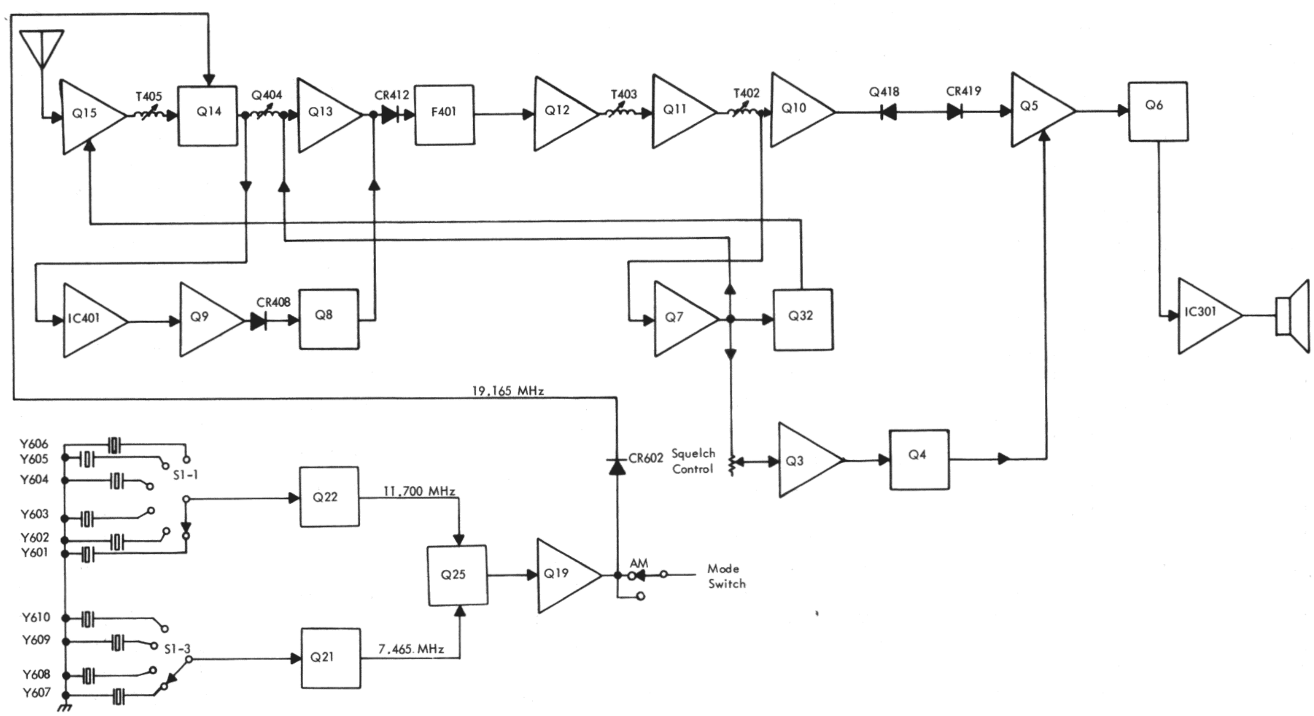
TABLE 2
FREQUENCY SYNTHESIZER TABLE

CHANNEL NUMBER	HIGH FREQUENCY CRYSTAL +	LOW FREQUENCY CRYSTAL =	LSB SYNTHESIZER OUTPUT +	2 (x) CARRIER FREQUENCY =	USB SYNTHESIZER OUTPUT
1	Y601-11.700 MHz	Y607-7.4625 MHz	19.1625 MHz	15.605 MHz	34.7675 MHz
2	Y601-11.700 MHz	Y608-7.4725 MHz	19.1725 MHz	15.605 MHz	34.7775 MHz
3	Y601-11.700 MHz	Y609-7.4825 MHz	19.1825 MHz	15.605 MHz	34.7875 MHz
4	Y601-11.700 MHz	Y610-7.5025 MHz	19.2025 MHz	15.605 MHz	34.8075 MHz
5	Y602-11.750 MHz	Y607-7.4625 MHz	19.2125 MHz	15.605 MHz	34.8175 MHz
6	Y602-11.750 MHz	Y608-7.4725 MHz	19.2225 MHz	15.605 MHz	34.8275 MHz
7	Y602-11.750 MHz	Y609-7.4825 MHz	19.2325 MHz	15.605 MHz	34.8375 MHz
8	Y602-11.750 MHz	Y610-7.5025 MHz	19.2525 MHz	15.605 MHz	34.8575 MHz
9	Y603-11.800 MHz	Y607-7.4625 MHz	19.2625 MHz	15.605 MHz	34.8675 MHz
10	Y603-11.800 MHz	Y608-7.4725 MHz	19.2725 MHz	15.605 MHz	34.8775 MHz
11	Y603-11.800 MHz	Y609-7.4825 MHz	19.2825 MHz	15.605 MHz	34.8875 MHz
12	Y603-11.800 MHz	Y610-7.5025 MHz	19.3025 MHz	15.605 MHz	34.9075 MHz
13	Y604-11.850 MHz	Y607-7.4625 MHz	19.3125 MHz	15.605 MHz	34.9175 MHz
14	Y604-11.850 MHz	Y608-7.4725 MHz	19.3225 MHz	15.605 MHz	34.9275 MHz
15	Y604-11.850 MHz	Y609-7.4825 MHz	19.3325 MHz	15.605 MHz	34.9375 MHz
16	Y604-11.850 MHz	Y610-7.5025 MHz	19.3525 MHz	15.605 MHz	34.9575 MHz
17	Y605-11.900 MHz	Y607-7.4625 MHz	19.3625 MHz	15.605 MHz	34.9675 MHz
18	Y605-11.900 MHz	Y608-7.4725 MHz	19.3725 MHz	15.605 MHz	34.9775 MHz
19	Y605-11.900 MHz	Y609-7.4825 MHz	19.3825 MHz	15.605 MHz	34.9875 MHz
20	Y605-11.900 MHz	Y610-7.5025 MHz	19.4025 MHz	15.605 MHz	35.0075 MHz
21	Y606-11.950 MHz	Y607-7.4625 MHz	19.4125 MHz	15.605 MHz	35.0175 MHz
22	Y606-11.950 MHz	Y608-7.4725 MHz	19.4225 MHz	15.605 MHz	35.0275 MHz
23	Y606-11.950 MHz	Y610-7.5025 MHz	19.4525 MHz	15.605 MHz	35.0575 MHz

NOTE: The synthesizer output for AM transmit is the same as the LSB, the AM receive output is 2.5 kHz higher than the LSB output.



SSB RECEIVE
BLOCK DIAGRAM



AM RECEIVE
BLOCK DIAGRAM

RECEIVER

RF Amplifier

The received signal is coupled through the antenna switching diodes through C444 to the primary of tuned transformer T406. T406 passes the desired 27 MHz signals which are then applied to the gate of the RF Amplifier, Q15. The negative gate bias voltage for Q15 is supplied through CR415. CR425 provides stability of the RF amplifier by rectifying the AGC voltage and applying the resultant negative voltage as degenerative feedback to the gate of Q15. The gate voltage establishes the rate of conduction and the stage gain of Q15. As the received signal is applied to the gate of Q15, it is also applied to the receiver image trap, L404 and C461, which removes the first image frequency. The amplified RF Amplifier output is coupled to the Receive Mixer by T405 and C439.

Receive Mixer

Along with the receive RF signal on gate 1 of the mixer, the mixing frequency from the synthesizer diode switching network is coupled through C701 to gate 2 of the mixer. The output circuitry of the mixer, T404, is tuned to pass the difference between the received RF and the synthesizer mixing frequency. In the AM and LSB mode, the synthesizer frequency is low side injection and in the USB mode the synthesizer uses high side injection. The mix frequency for AM is 7.8 MHz below the receive RF, for LSB reception the mix frequency is 7.8025 MHz below the receive RF and for USB reception the mix frequency is 7.8025 MHz above the receive RF signal. The IF frequencies from T404 are applied directly to the base of the IF Amplifier, Q13.

IF Amplifier and Crystal Filter

The IF Amplifier amplifies the IF frequency enough to be applied to the crystal filter. The output of Q13 is coupled through C433 and through the noise gate diode CR412 and through C432 to the input of the crystal filter. C432, R426 and R425 provide a proper impedance match between the IF Amplifier and the crystal filter to get maximum signal coupling. The crystal filter has a center frequency of 7.8 MHz and a narrow bandwidth to provide good selectivity and image rejection of the received signal.

The output of the filter is coupled through C431 to the base of Q12, the second IF Amplifier. The IF frequency is amplified and coupled through three tuned transformer stages, at the collector of Q10 the IF signal is coupled through C459 to the AM Detector diodes CR417 and CR418.

AM Detector and Noise Limiter

In the AM mode, the amplified IF signal is coupled to the detector diodes through coupling capacitor, C459. When the signal is applied to the detector, current will flow only during the negative portion of the IF signal. This current causes C445 to charge to the peak value of the rectified voltage on each negative half cycle. Capacitor C446 acts as a filter to remove the IF frequency component of the detector output so that the remaining DC component varies only according to the modulation of the original signal.

The Noise Limiter, CR419, works in conjunction with the Noise Blanker circuit. With the Noise Blanker Switch, S4, in the "ON" position, nine volts bias is applied to CR419 anode through R443 to forward bias the diode. With the Noise Blanker Switch in the "OFF" position, the nine volts is applied to the anode and cathode of CR419 which biases the diode off.

With the Noise Blanker "ON", the amplitude of the audio signal is limited by the conduction of CR419. CR419 is biased so that it will conduct only when aided by a specified level of audio which removes the AM noise from the audio waveform. Capacitor C447 couples the audio to the detector switch diode CR420 which is forward biased in the AM mode by the Mode Switch, S2-2. In the AM mode, the audio is passed through CR420 to the Volume Control.

SSB Detector

The SSB Detector, detects audio from the IF frequency by mixing the received signal with the 7.8025 MHz carrier. Since the carrier is removed from the transmitted signal by the balanced modulator, the receiver must reinsert the carrier as a reference to detect the audio.

The SSB Detector functions as a product detector and consists of T409, Q16, Q17 and associated components. In the SSB mode, supply voltage for the detector transistors and carrier oscillator is provided through the Mode Switch, S2-2. The 7.8025 MHz carrier is taken from the emitter of Q19 and coupled to the emitters of Q16 and Q17 by C457 causing a balanced condition and no output. When a signal is received, a sample of the IF frequency is taken from T402 by coupling capacitor C448 and applied to T409. The IF frequency is then applied to the base of Q16 and Q17 causing Q16 and Q17 to conduct. With 7.8025 MHz on the emitters of Q16 and Q17, the modulation on the IF causes the transistors to conduct. Therefore the audio signal is reproduced on the collectors of Q16 and Q17. The audio from Q17 is then applied to the Volume Control through C325. The signal from Q16 is coupled through C451 to the SSB Meter Amplifier, Q18.

Audio

The audio at the volume control, either from the AM Detector or the SSB Detector, is coupled to the base of the Audio Preamplifier, Q5, through C304. The audio is amplified and filtered by Q6, R311, R312, R313, C309 and C310. The amplified and filtered audio is coupled through R315 and C312 from the emitter of Q6 to the input of the Audio Power Amp, IC301, on pin 5. The Audio Power Amp amplifies the audio to 3 watts which is taken from pin 10 of the integrated circuit to the receive contact of the relay, K1, through C322 through the external speaker jack to the speaker.

Automatic Gain Control (AGC)

The Automatic Gain Control (AGC) circuit causes the receiver audio output to remain constant at the level set by the volume control regardless of the received RF signal level. In the SSB mode the received signal disappears when there is no modulation, therefore the AGC must reduce the receiver gain quickly upon receiving a large signal and increase gain slowly when the signal decreases or disappears. This fast attack and slow release action compensates for short pauses in conversation. The AGC response time can be adjusted by the Q7 source resistor R467. Since the slow release AGC action is not required in the AM mode, CR401 and CR402 are switched out of the circuit in the AM mode by S2-7.

A sample of the received signal is coupled from the collector of Q10 through C416 to the junction of CR404 and the AGC attack rectifier CR405. When the received signal level increases, the signal is rectified by CR405 which applies a negative DC bias voltage on the gate of the AGC Amplifier, Q7. The rate of conduction of Q7 is slowed by a negative voltage on the gate which causes the voltage drop across the source resistor R467 to decrease. This negative going voltage is applied to the base of Q13 through T404 and to the base of Q12 through R424. This negative voltage acts as reverse bias and reduces conduction of both transistors and reduces the IF gain. The negative voltage from Q7 source is also applied to the AGC control, Q32, which causes Q32 conduction to decrease. Since Q32 is in series with the source of the RF Amplifier, the gain of the RF Amplifier decreases. The overall effect is to decrease the RF and IF gain to prevent receiver overloading.

Another IF sample is coupled from T402 through C415 to the AGC release rectifier, CR401. CR401 and CR402 rectify this IF signal which charges C402 which, along with R401, establishes an RC time constant for the AGC release time. When the received signal decreases, the attack rectifier voltage decreases. However the action of Q7, to increase receiver gain, is slowed down by the voltage on C402 discharging through R401 which is felt at the gate of Q7. This negative voltage causes the conduction of Q7 to increase gradually to allow for a conversational pause.

Noise Blanker

The Noise Blanker circuit removes any impulse noise from the received signal. In the "ON" position, the Noise Blanker ON/OFF switch applies B+ to IC401, the Noise Blanker Amplifier, Q9, the Noise Amplifier and, Q8, the Blanker Gate. A sample of the IF frequency is taken from T404 and coupled through L403, C460 and C414 to the 7.8 MHz trap, T407, which effectively removes all 7.8 MHz signal and passes any noise pulses through C412 to the input of IC401 on pin 3. The amplified noise is coupled to the Noise Amplifier, Q9, through T408 and C408. The output from the Drain of Q9 is rectified by CR408 and CR409 and the resultant positive going DC voltage is applied to the gate of Q8, the Blanker Gate. Any negative pulses that may appear at the gate of Q8 are removed by CR424. The positive voltage at the gate of Q8 drives the transistor into saturation which removes the forward bias from the anode of CR412 and blocks the IF frequency from Q13. Since the conduction of the Blanker Gate is coincident with the noise pulses only the noise pulses are removed and all audio is allowed to pass.

Squelch

The squelch circuitry will quiet the receiver until a signal is received to effectively eliminate any noise on the channel. The amount of signal necessary to open the squelch and enable the receiver is determined by the setting of the squelch control, R319. The farther clockwise the control is rotated, the larger the signal level required to open the squelch.

When a signal is received, a sample is coupled from Q10 collector through C416 causing an AGC action. The AGC voltage from the source of Q7 is felt on the base of the Squelch Amplifier, Q3. This voltage causes Q3 to conduct. With Q3 conducting, the collector voltage decreases and this negative going voltage forward biases the Squelch Gate, Q4. With Q4 conducting, the collector voltage decreases, causing Q5, the Audio Preamplifier, to conduct which enables the receiver audio.

When no signal is received, the Audio Preamplifier is reverse biased which disables the receiver audio. With no received signal, Q3 is cut off causing the collector voltage to increase. This positive voltage is felt at Q4 base causing Q4 to cut off. With Q4 cut off, its collector voltage goes high acting to reverse bias the Audio Preamplifier and disable the receiver audio.

TRANSMITTER

General

When the microphone push to talk button is depressed, the relay K1 is energized to switch the B+ voltage from receive to transmit circuitry. With K1 energized, the forward bias is removed from the switching diode CR201 which turns on the mike amp, Q2, (to isolate the microphone input from the receive circuit).

Microphone Amplifier and AM Modulator

Audio from the microphone is coupled through C204 through the Limiter, Q1, to the base of the Microphone Amplifier, Q2. In the AM mode, the audio is amplified by Q2 and coupled from the collector through C207 and C208 through S3-4, the CB/PA switch, to the Active Filter, Q6. The Active Filter, which consists of R311, C309, R312, C310, R313 and Q6, provides filtering and audio shaping to limit effective bandwidth of the audio before it is amplified by the Audio Power Amplifier, IC301. The audio is coupled from Q6 emitter through R315 and C312 to pin 5 of IC301. The amplified audio is taken from pin 10 through K1 and switch S3-3 through R217 and diode CR204 to the collectors of Q30 and Q31. This acts as modulated B+ for Q30 and Q31 at a level of approximately 7 volts DC for the required 3 to 4 watt power output.

Automatic Microphone Limiter (Audio Compressor)

In the AM transmit mode, a sample of the audio is coupled from IC301 pin 10 through C212. The compressor diode, CR203 applies negative bias voltage through limiter resistor, R202, to the gate of the Limiter, Q1. The negative voltage at the gate of Q1 decreases the gain of Q1 and limits the audio input from the microphone.

Balanced Modulator

In the SSB transmit mode, the audio from the microphone is coupled through C204 through the Limiter and to the base of the Microphone Amp, Q2, through C205. The audio is amplified by Q2 and is coupled to the Balanced Modulator through C207, CR202, C215 and L501. CR202 is forward biased through S2-3, the Mode switch, by placing 9.0 volts on the anode through R209 in either the LSB or USB position.

The Balanced Modulator consists of CR502, CR503, CR504, CR505, T503, R514 and associated components. With no audio input from the Microphone Amplifier, the Balanced Modulator is balanced with R514. The Carrier Oscillator frequency of 7.8025 MHz is coupled from the emitter of Q19 through C512 to the base of the Buffer, Q20. The Buffer stage is an emitter follower configuration to provide high input impedance and prevent any oscillator loading effects from the Balanced Modulator. The carrier frequency from the Buffer is coupled through C513 to R514 which is adjusted for no output from T503.

With audio applied to the junction of CR502/CR503 and CR504/CR505, the diodes will conduct with respect to the audio sinewave voltage polarity. As the modulator diodes conduct, an unbalanced condition arises and the carrier frequency varies at the audio rate. These variations are felt at T503 primary which induces a corresponding voltage at T503 secondary. The modulated carrier frequency is coupled through the switching diode CR413, which has been forward biased through K1 relay contacts and S3-1, to the 7.8 MHz crystal filter. The filtered, modulated 7.8025 MHz is then coupled to the IF Amplifier, Q12, through C431. After the signals are amplified at Q12 they are coupled through the switching diode CR407, which also is forward biased through the relay contacts, S3-1 and R706, to gate 2 of the Transmit Mixer, Q27.

Mixer

The Mixer, Q27, combines the audio modulated 7.8025 MHz from the Balanced Modulator that appears on gate 2 with the frequency synthesizer output present on gate 1 for Upper and Lower Sideband operation. In the AM mode, the mixer mixes the synthesizer frequency with the unmodulated carrier frequency, 7.8025 MHz. For example on Channel 1 frequencies,
AM; synthesizer output of 19.1625 MHz + carrier frequency of 7.8025 MHz = 26.965 MHz. The 26.965 MHz then is modulated by the Driver and Power Amplifier Stages.

LSB; synthesizer output of 19.1625 MHz + 1 kHz modulated carrier frequency of 7.8015 = 26.9640 MHz.

USB; synthesizer output of 34.7675 - 1 kHz modulated carrier frequency of 7.8015 MHz = 26.9660 MHz.

RF Stages

The output of the mixer is selected by tuned transformers T701 and T702 and coupled to the Transmit Amplifier, Q28. The Transmit Amplifier and the Pre-Driver, Q29, the Driver, Q30, and the Power Amplifier, Q31, amplifiy the SSB signals to an RF, PEP (peak envelope power) of 12 watts. In the AM mode, the unmodulated carrier frequency is amplified by Q28 and Q29 then modulated by Q30 and Q31 and amplified for approximately 4 watts RF output.

The power output of the transmitter is determined by the B+ voltage on the collectors of Q30 and Q31. In the AM mode, the collector voltage is approximately 7 volts and is modulated from audio power amp IC301 which results in a 4 watt RF level. In the SSB mode, the collectors are connected directly to the 13.8 VDC source through S2-4, the mode switch, which results in 12 watts PEP RF output.

Automatic Level Control (ALC)

The ALC is used to limit the modulation in SSB operation. A sample of the transmitted RF is coupled by C723 to the ALC Detector diode CR708, which rectifies the RF and the resulting negative voltage is applied to the gate of Q7 through CR406. The negative bias voltage decreases the gain of Q7 causing the source voltage to decrease. This negative going voltage is applied to the base of the IF Amplifier, Q12, and reduces the gain of Q12, which in turn limits the modulated 7.8025 MHz from the Balanced Modulator.

METER CIRCUITRY

The front panel meter serves the dual purpose of indicating received signal strength in "S" units and relative output power in the transmit condition.

In the AM receive condition, a sample of the IF signal is coupled from the secondary of T401 by C419 and is rectified by CR410 and CR411. This allows current to flow through meter giving an indication of the receive signal strength. Meter adjust potentiometer, R469, is adjusted for an S9 meter reading with a 100 μV signal at the antenna.

In the SSB receive condition, the SSB signal sample is coupled from the collector of Q16 through C451 to the emitter of the SSB Meter Driver, Q18. When Q16 is conducting the collector voltage is a negative going voltage which forward biases Q18. As Q18 conducts, the receive signal from Q18 is rectified by CR422 and CR423. This positive voltage causes current to flow through the meter and R470, the SSB meter adjustment potentiometer.

In the AM and SSB transmit mode, a sample of the output power is coupled through C725 and rectified by CR709. The resultant positive voltage causes current to flow through the meter which is proportional to the modulated RF output.