

Circuit Description

Reception and transmission are switched by “RX” and “TX” lines from the microprocessor unit (MPU). The receiver uses double-conversion superheterodyne circuitry, with a 43.95MHz 1st IF and 450 kHz 2nd IF. The 1st LO, produced by a PLL synthesizer, yields the 43.95MHz 1st IF.

The 2nd LO uses a 43.5 MHz (43.95 MHz-450 kHz) signal generated by a crystal oscillator. The 2nd mixer and other circuits use a custom IC to convert and amplify the 2nd IF, and detect FM to obtain demodulated signals. During transmit, the PLL synthesizer oscillates at the desired frequency directly, for amplification to obtain RF power output. During transmit, voice modulation and CTCSS (or DCS) modulation are applied to this synthesizer. Transceiver functions, such as TX/RX control, PLL synthesizer settings, and channel programming, are controlled using the MPU.

VHF

Receiver

Incoming RF signals from the antenna connector are delivered to the MAIN Unit, and pass through a low-pass filter (LPF) antenna switching network consisting of coils L1001, L1002, L1003 and L1006, capacitors C1001, C1006, C1009, C1013, and C1023, and antenna switching diodes D1006, D1007 and D1008 for delivery to the receiver front end.

Signals within the frequency range of the transceiver are then passed through a varactor-tuned bandpass filter consisting of L1008, L1009 / L1024, L1025 before RF amplification by Q1012 (3SK228).

The amplified RF is then band-pass filtered again by varactor-tuned resonators L1018, L1019 / L1038, L1039 to ensure pure in-band input to 1st mixer Q1025(2SK228).

Buffered output from the VCO Unit is amplified by Q1021 (2SC5107) and low-pass filtered by L1042 / L1046 and C1132 / C1139 / C1142, to provide a pure 1st local signal between 112.3 and 152.3 MHz to the 1st mixer.

The 43.95MHz 1st mixer product then passes through dual monolithic crystal filters XF1001 and XF1002 (7.5 kHz BW), and is amplified by Q1029 (2SC4215Y) and delivered to the input of the FM IF subsystem IC Q1026 (TA31136FN).

This IC contains the 2nd mixer, 2nd local oscillator, limiter amplifier, FM detector, noise amplifier, and squelch gates.

The 2nd LO in the IF-IC is produced from crystal X1001 (14.500MHz), and the 1st IF is converted to 450kHz by the 2nd mixer and stripped of unwanted components by ceramic filter CF1001 or CF1002. After passing through a limiter amplifier, the signal is demodulated by the FM detector.

Demodulated receive audio from the IF-IC is amplified by Q1031 (2SA1602A) / Q2014 (CXA1846N). After volume adjustment by the AF power amplifier Q2029 (TDA7240AV), the audio signal is passed to the optional

headphone jack or 4-ohm loudspeaker.

PLL synthesizer

The 1st LO maintains stability from the PLL synthesizer by using a 14.500 MHz reference signal from crystal X1001. PLL synthesizer IC Q1024 (SA7025DK) consists of a prescaler, reference counter, swallow counter, programmable counter, a serial data input port to set these counters based on the external data, a phase comparator, and charge pump. The PLL-IC divides the 14.500 MHz reference signal by 725 using the reference counter (20.0 kHz comparison frequency). The phase detector comparison frequency to be eight times the channel spacing (2.5kHz). The VCO output is divided by the prescaler, swallow counter and programmable counter. These two signals are compared by the phase comparator and input to the charge pump. A voltage proportional to their phase difference is delivered to the low-pass filter circuit, then fed back to the VCO as a voltage with phase error, controlling and stabilizing the oscillating frequency. This synthesizer also operates as a modulator during transmit.

The RX-VCO is comprised of Q1015 (2SK520) and D1017, D1018, D1035, D1036 (HVU356x4), and oscillates between 177.950MHz and 217.950MHz according to the programmed receiving frequency. And the TX-VCO is comprised of Q1014 (2SC5107) and D1015, D1016, D1019 (1SV276x3), and oscillates between 134.000MHz and 174.000MHz according to the programmed transmit frequency. The VCO output passes through buffer amplifier Q1018 (2SC5107), and a portion is fed to the buffer amplifier Q1019 (2SC5107) of the PLL IC, and at the same time amplified by Q1021 (2SC5107) to obtain stable output. The VCO DC supply is regulated by Q1008 (2SC4154E). Synthesizer output is fed to the 1st mixer by diode switch D1024 (1SS321) during receive, and to drive amplifier Q1020/Q1022 (2SC5415Ex2) for transmit. The reference oscillator feeds the PLL synthesizer, and is composed of crystal X1001 (14.500 MHz), the temperature compensation circuit which includes D1033 (MC2850) and thermostats TH1003 and TH1002, and transmit (DCS) modulation circuit D1029 (1SV2309).

Transmitter

Voice audio from the microphone is delivered via the Mic (Jack) Unit to the MAIN Unit, after passing through amplifier Q3039/Q2108 (NJM2902V), pre-emphasis, limiter (IDC instantaneous deviation control), and LPF Q2001 (NJM2902V), is adjusted for optimum deviation level and delivered to the next stage.

Voice input from the microphone and CTCSS are FM-modulated to the VCO of the synthesizer, while DCS audio is modulated by the reference frequency oscillator of the synthesizer.

Synthesizer output, after passing through diode switch D1024 (1SS321), is amplified by driver Q1020 / Q1022 (2SC5415Ex2) and power module Q1013 (M67746) to obtain full RF output. The RF energy then passes through antenna switch D1007 / D1008 and a low-pass filter circuit and finally to the antenna connector.

RF output power from the final amplifier is sampled by CM coupler and is rectified by D1011, D1014

(HSM88ASx2). The resulting DC is fed through Automatic Power Controller Q1007 (NJM2904V), Q1001 (2SC4154E), Q1002 (2SB1143S) to transmitter RF amplifier and thus the power output.

Generation of spurious products by the transmitter is minimized by the fundamental carrier frequency being equal to the final transmitting frequency, modulated directly in the transmit VCO. Additional harmonic suppression is provided by a low-pass filter consisting of L1002, L1003, L1007, L1012 and C1006, C1009, C1013, C1023, C1033, C1037 and C1046, resulting in more than 60dB of harmonic suppression prior to delivery to the RF energy to the antenna.

DCS Demodulator

DCS signals are demodulated on the MAIN-UNIT, and are applied to low-pass filter Q2110 (NJM2902V), as well as the limiter comparator Q2110.

CTCSS encoder/decoder

The CTCSS code is generation and encoding by MPU IC Q2019 (MB90F583B).

Demodulation and detection of the CTCSS tones are carried out by IC Q2013 (MX165C).

MPU

Operation is controlled by 16-bit MPU IC Q2019 (MB90F583B). The system clock uses a 16.000 MHz crystal for a time base. IC Q2027 (S-80735SN) resets the MPU when the power is on, and monitors the voltage of the regulated 5V power supply line.

EEPROM

The EEPROM retains TX and RX data for all memory channels and CTCSS data, DCS data, prescaler dividing, and REF oscillator data (internal/external).

UHF

Receiver

Incoming RF signals from the antenna connector are delivered to the MAIN Unit, and pass through a low-pass filter (LPF) antenna switching network consisting of coils L1001, L1002, L1003, L1004 and L1005, capacitors C1004, C1008, C1009, C1011, and C1014, and antenna switching diodes D1006, D1007 and D1008 for delivery to the receiver front end.

Signals within the frequency range of the transceiver are then passed through a varactor-tuned bandpass filter consisting of L1009, L10014 before RF amplification by Q1012 (2SK4227).

The amplified RF is then band-pass filtered again by varactor-tuned resonators L1022, L1026 to ensure pure in-band input to 1st mixer Q1025 (2SK228).

Buffered output from the VCO Unit is amplified by Q1021 (2SC5107) and low-pass filtered by L1030 / L1031 and C1178 / C1180 / C1182, to provide a pure 1st local signal between 112.3 and 152.3 MHz to the 1st mixer.

The 43.95MHz 1st mixer product then passes through dual monolithic crystal filters XF1001 and XF1002 (7.5

kHz BW), and is amplified by Q1029 (2SC4215Y) and delivered to the input of the FM IF subsystem IC Q1026 (TA31136FN).

This IC contains the 2nd mixer, 2nd local oscillator, limiter amplifier, FM detector, noise amplifier, and squelch gates.

The 2nd LO in the IF-IC is produced from crystal X1001 (14.500MHz), and the 1st IF is converted to 450kHz by the 2nd mixer and stripped of unwanted components by ceramic filter CF1001 or CF1002. After passing through a limiter amplifier, the signal is demodulated by the FM detector.

Demodulated receive audio from the IF-IC is amplified by Q2014 (CXA1846N). After volume adjustment by the AF power amplifier Q2029 (TDA7240AV), the audio signal is passed to the optional headphone jack or 4-ohm loudspeaker.

PLL synthesizer

The 1st LO maintains stability from the PLL synthesizer by using a 14.500 MHz reference signal from crystal X1001. PLL synthesizer IC Q1024 (SA7025DK) consists of a prescaler, reference counter, swallow counter, programmable counter, a serial data input port to set these counters based on the external data, a phase comparator, and charge pump. The PLL-IC divides the 14.500 MHz reference signal by 725 using the reference counter (20.0 kHz comparison frequency). The phase detector comparison frequency to be eight times the channel spacing (2.5kHz). The VCO output is divided by the prescaler, swallow counter and programmable counter. These two signals are compared by the phase comparator and input to the charge pump. A voltage proportional to their phase difference is delivered to the low-pass filter circuit, then fed back to the VCO as a voltage with phase error, controlling and stabilizing the oscillating frequency. This synthesizer also operates as a modulator during transmit.

The RX-VCO is comprised of Q1015 (2SK508) and D1017, D1018 (1SV276x4), and oscillates between 356.050MHz and 468.050MHz according to the programmed receiving frequency. And the TX-VCO is comprised of Q1014 (2SC4226) and D1015, D1016, D1019 (1SV276x2, 1SV230), and oscillates between 400.000MHz and 512.000MHz according to the programmed transmit frequency. The VCO output passes through buffer amplifier Q1018 (2SC5107), and a portion is fed to the buffer amplifier Q1019 (2SC5107) of the PLL IC, and at the same time amplified by Q1021 (2SC5107) to obtain stable output. The VCO DC supply is regulated by Q1008 (2SC4154E). Synthesizer output is fed to the 1st mixer by diode switch D1024(1SS321) during receive, and to drive amplifier Q1020 (2SC5107) / Q1022 (2SC5415E) / Q1031 (2SC2954) for transmit. The reference oscillator feeds the PLL synthesizer, and is composed of crystal X1001 (14.500 MHz), the temperature compensation circuit which includes D1033 (MC2850) and thermostats TH1003 and TH1002, and transmit (DCS) modulation circuit D1029 (1SV230).

Transmitter

Voice audio from the microphone is delivered via the Mic (Jack) Unit to the MAIN Unit, after passing through

amplifier Q3039/Q2108 (NJM2902V), pre-emphasis, limiter (IDC instantaneous deviation control) ,and LPF Q2001 (NJM2902V), is adjusted for optimum deviation level and delivered to the next stage.

Voice input from the microphone and CTCSS are FM-modulated to the VCO of the synthesizer, while DCS audio is modulated by the reference frequency oscillator of the synthesizer.

Synthesizer output, after passing through diode switch D1024 (1SS321), is amplified by driver Q1020 (2SC5107) / Q1022 (2SC5415E) / Q1031 (2SC2954) and power module Q1013 (M68759) to obtain full RF output. The RF energy then passes through antenna switch D1007 / D1008 and a low-pass filter circuit and finally to the antenna connector.

RF output power from the final amplifier is sampled by CM coupler and is rectified by D1011,D1014(HSM88ASx2). The resulting DC is fed through Automatic Power Controller Q1007 (NJM2904V), Q1001 (2SC4154E), Q1002 (2SB1143S) to transmitter RF amplifier and thus the power output.

Generation of spurious products by the transmitter is minimized by the fundamental carrier frequency being equal to the final transmitting frequency, modulated directly in the transmit VCO. Additional harmonic suppression is provided by a low-pass filter consisting of L1001, L1003, L1004 and C1004, C1008, C1009, C1011 and C1014, resulting in more than 60dB of harmonic suppression prior to delivery to the RF energy to the antenna.

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