

Circuit Description

Reception and transmission are switched by “RX-CNTL” and “TX-CNTL” lines from the CNTL Unit. The receiver uses double-conversion superheterodyne circuitry, with a 21.4 MHz 1st IF and 450 kHz 2nd IF. The 1st local is produced by a PLL synthesizer, yielding the 21.4 MHz 1st IF. The 2nd local uses a 21.850 MHz crystal oscillator, yielding the 450 kHz 2nd IF. 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 is applied to this synthesizer. Transceiver functions, such as TX/RX control, PLL synthesizer settings, and channel programming, are controlled using the MPU.

Receiver

Incoming RF signals from the antenna connector are delivered to the MAIN Unit, and pass through a low-pass filter (LPF) consisting of coils and capacitors, and antenna switching diodes **D1003** and **D1004** (both **XB15A308**) for delivery to the receiver front end.

Signals within the frequency range of the transceiver are then passed through a bandpass filter consisting of T1001 and T1002 before RF amplification by **Q1016** (**2SC5006**).

The amplified RF is then bandpass filtered again by T1003, T1004, and T1005, to ensure pure in-band input to 1st mixer **Q1024** (**3SK320**).

Buffered output from the VCO Unit is amplified by **Q1022** (**2SC5006**) and bandpass filtered by L1013, L1015, C1125, C1131, and C1134, to provide a pure 1st local signal between 133.75 and 140.975 MHz for delivery to the 1st mixer.

The 22.3 MHz 1st mixer product then passes through dual monolithic crystal filter **XF1001** and **XF1002** (± 6.5 kHz BW), and is amplified by **Q1031** (**2SC4400-3**) and delivered to the input of the FM IF subsystem IC **Q1036** (**TA31136FN**). This IC contains the 2nd mixer, 2nd local oscillator, limiter amplifier, FM detector, noise amplifier, and squelch gates.

The 2nd local is produced by crystal **X1001** (21.850 MHz) then passes through the amplifier **Q1017** (**2SC4154**), and delivered to the 2nd mixer in the IF-IC. The 1st IF is converted to 450 kHz by the 2nd mixer and stripped of unwanted components by ceramic filter **CF1001**.

Filtered signal from the ceramic filter **CFa001** is applied to the limiter amplifier in the FM IF subsystem IC **Q1036** (**TA31136FN**), and then demodulate by the FM detector in the FM IF subsystem IC **Q1036** (**TA31136FN**). Demodulated receive audio from the FM IF subsystem IC **Q1036** (**TA31136FN**) is amplified by **Q1038** (**2SC4154E**), then the

signal is through the AF switch **Q1040** (**BU4053BCFV**), the AF amplifier **Q1045** (**NJM12902V**) and the AF Mute switch **Q1035** (**BU4066BCFV**).

After volume adjustment by the D/A converter **Q1033** (**M62364FP**) and the AF power amplifier **Q1043** (**LA4425A**), the audio signal is passed to the external Speaker terminal in the accessory cable and 16-Ohm internal loudspeaker.

PLL Synthesizer

The 1st LO maintains stability from the PLL synthesizer by using a 21.850 MHz reference signal from crystal **X1001**. PLL synthesizer IC **Q1021** (**MB15A02PFV**) 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 a charge pump.

The PLL-IC divides the 21.850 MHz reference signal by 874 using the reference counter (25 kHz comparison frequency). The VCO output is divided by the prescaler, swallow counter and programmable counter. These two signals are compared by the phase comparator and applied 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 **Q1027** (**2SK520-K43**) and **D1009**, **D1010**, **D1014**, **D1015** (all **HVC3068**); it oscillates at 22.3 MHz below the receiving frequency. The TX VCO is comprised of **Q1029** (**2SC5006**) and **D1012** (both **HVC3068**); it oscillates at the fundamental frequency, with direct frequency-modulation using varactor diode **D1016** (**HVC3068**). The VCO output passes through buffer amplifier **Q1022** (**2SC5006**) to obtain stable output. The VCO DC supply is regulated by **Q1018** (**2SC4154E**). Synthesizer output is fed to the 1st mixer **Q1024** (**3SK320**) by diode switch **D1006** (**DAN235U**) during receive, and to drive amplifier **Q1014** (**2SC3357**), and the RF power amplifier **Q1007** (**RA35H1516M**) for transmit.

The reference oscillator feeds the PLL synthesizer.

Transmitter

Voice audio from the microphone is delivered via the MIC connector to the MAIN Unit. After passing through amplifier **Q1028** (**NJM12902V**), a pre-emphasis network, the D/A converter **Q1033** (**M62364FP**) for MIC switch, the MIC mute switch **Q1035** (**BU4066BCFV**), limiter (IDC: instantaneous deviation control), and LPF **Q1028** (**NJM12902V**), the audio is adjusted for optimum devia-

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tion level and delivered to the next stage.

Voice or DSC (Digital Selective Calling) encode signal inputs from the LPF **Q1028 (NJM12902V)** are FM-modulated in the VCO of the synthesizer. Synthesizer output, after passing through diode switch **D1006 (DAN235U)**, is amplified by driver **Q1014 (2SC3357)**, and the RF power amplifier **Q1007 (RA35H1516M)** to obtain full RF output.

The RF energy then passes through antenna switch **D1003 (XB15A308)** and a low-pass filter circuit and finally to the antenna connector.

RF output power from the final amplifier is sampled by C1013 and C1019 and is rectified by **D1002 (1SS321)**. The resulting DC is fed through Automatic Power Controllers **Q1034 (NJM2904V)** to transmitter RF power amplifier **Q1007 (RA35H1516M)**, thus providing positive control of 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 coils and capacitors, resulting in more than 80 dB of harmonic suppression prior to delivery of the RF energy to the antenna.

1050 Hz Weather Alert Decoder

1050Hz Weather Alert signals are demodulated on the CNTL Unit, and are applied to low-pass filter **Q1037 (2SC4154E)**, and delivered to the 16-bit MPU IC **Q2004 (M30624FGAGP)**.

ATIS Decoder

The receiving ATIS signal is demodulated by the FM IF subsystem IC **Q1036 (TA31136FN)**, then fed through the low-pass filter **Q1037 (2SC4154E)** to the ATIS Decoder IC **Q1041 (NJM2211M)** which the receiving ATIS code is decoded. The decoded ATIS signal delivered to the 16-bit MPU IC **Q2004 (M30624FGAGP)**.

DSC Encoder/Decoder

Encoder

The DCS (Digital Selective Calling) encode signal which D/A converted in the 16-bit MPU IC **Q2004 (M30624FGAGP)** is fed through the low-pass filter **Q1028 (NJM12902V)** on the MAIN Unit to the VCO.

Decoder

Incoming the receiving DSC code on the CH70 from the antenna connector are delivered to the SUB-RX Unit, and are passed through an RF amplifire **Q4001 (3SK294)** to the bandpass filter consisting of T4002 and T4003. The filtered signal deliver to 1st mixer **Q4010 (3SK320)**.

Buffered output from the SUB VCO Unit is amplified by **Q4007 (2SC5006)** and bandpass filtered by L4004, L4005, C4045, C4046, and C4047, to provide a pure 1st local signal (137.225 MHz) for delivery to the 1st mixer.

The 19.3 MHz 1st mixer product then passes through monolithic crystal filter **XF4001** and **XF4002** (± 6.5 kHz BW), and is amplified by **Q4014 (2SC4400-3)** and delivered to the input of the FM IF subsystem IC **Q4015 (TA31136FN)**. This IC contains the 2nd mixer, 2nd local oscillator, limiter amplifier, FM detector, noise amplifier, and squelch gates.

The 2nd local is produced by crystal **X4001** (18.850 MHz) then passes through the amplifier **Q4006 (2SC4154)**, and delivered to the 2nd mixer in the FM IF subsystem IC **Q4015 (TA31136FN)**. The 1st IF is converted to 450 kHz by the 2nd mixer and stripped of unwanted components by ceramic filter **CF4001**.

Filtered signal from the ceramic filter **CF4001** is applied to the limiter amplifier in the FM IF subsystem IC **Q4015 (TA31136FN)**, and then demodulate by the FM detector in the FM IF subsystem IC **Q4015 (TA31136FN)**. Demodulated signal from the FM IF subsystem IC **Q4015 (TA31136FN)** is passes through the low-pass filter **Q4016 (2SC4154E)** to the DSC Decoder IC **Q4018 (NJM2211M)** which the receiving DCS code is decoded. The decoded DCS signal delivered to the 16-bit MPU IC **Q2004 (M30624FGAGP)**.

The 1st LO maintains stability from the PLL synthesizer by using a 18.850 MHz reference signal from crystal **X4001**. PLL synthesizer IC **Q4008 (MB15A02PFV)** consists of a prescaler, reference counter, swallow counter, program-mable counter, a serial data input port to set these counters based on the external data, a phase comparator, and a charge pump.

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The PLL-IC divides the 18.850 MHz reference signal by 754 using the reference counter (25 kHz comparison frequency). The VCO output is divided by the prescaler, swallow counter and programmable counter. These two signals are compared by the phase comparator and applied 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.

The SUB VCO is comprised of **Q4011 (2SK520-K43)** and **D4002** and **D4007** (both **HVC3068**); it oscillates 137.225 MHz. The SUB VCO output passes through buffer amplifier **Q4007 (2SC5006)** to obtain stable output. The SUB VCO DC supply is regulated by **Q4005 (2SC4154E)**. Synthesizer output is fed to the 1st mixer **Q4010 (3SK320)**.

The reference oscillator feeds the PLL synthesizer.

PA (Public Address) Circuit

The voice audio from the microphone is delivered via the MIC connector to the MAIN Unit. The voice audio is amplified by **Q1028 (NJM12902V)**, then passes through the D/A converter **Q1033 (M62364FP)** for MIC switch and MIC switch **Q1040 (BU4053BCFV)** to the buffer amplifier **Q1045 (NJM12902V)**. The audio then passes through the MIC switch **Q1035 (BU4066BCFV)** and buffer amplifier **Q3001 (NJM2904V)** on the PA Unit to the D/A converter **Q1033 (M62364FP)** for volume control. The adjusted audio is delivered to the audio power amplifier **Q3002 (TA8225H)** on the PA Unit which is amplified the voice audio up to 30 watts, and then passes through the relay switch **RL3001** to the external PA speaker.

LB (Listen Back) Circuit

The listen back audio from the PA speaker is delivered to the PA Unit. The audio is passed through the relay switch **RL3001** and buffer amplifier **Q3001 (NJM2904V)** to the D/A converter **Q1033 (M62364FP)** for LB switch, then passes through the LB switch **Q1040 (BU4053BCFV)** to

the buffer amplifier **Q1045 (NJM12902V)**. The audio then passes through the LB switch **Q1035 (BU4066BCFV)** to the D/A converter **Q1033 (M62364FP)** for volume control. The adjusted audio is delivered to the audio power amplifier **Q1043 (LA4425)** which is amplified the voice audio up to 4.5 watts, and then deliver to the internal or external speaker.

A portion of the audio from the **Q1040** is passed through the buffer amplifier **Q1045 (NJM12902V)**, LB switch **Q1040 (BU4053BCFV)** to the RAM microphones, if connected.

Fog Horn Circuit

A 400 Hz square wave for foghorn is generated the microprocessor **Q2004 (M30624FGAGP)** on the CNTL Unit. The signal passes through the FOG switch **Q2005 (DTA144EE)** and **D2001 (MC2846)** to the PA Unit.

The signal from the CNTL Unit passes through the buffer amplifier **Q3001 (NJM2904V)** to the D/A converter **Q1033 (M62364FP)** for volume control. The adjusted audio is delivered to the audio power amplifier **Q3002 (TA8225H)** on the PA Unit which is amplified the voice audio up to 30 watts, and then passes through the relay switch **RL3001** to the external PA speaker.

MPU

Operation is controlled by 16-bit MPU IC **Q2004 (M30620FGAGP)**. The system clock uses a 14.7456 MHz crystal for a time base. IC **Q2003 (PST597CN)** resets the MPU when the power is supplied by the DC power supply, and monitors the voltage of the regulated 5V power supply line.

EEPROM

The EE-PROM **Q2006 (AT24C128N)** retains TX and RX data for all memory channels, prescaler dividing, IF frequency, local oscillator injection side, and reference oscillator data.