METAWARE CO., LTD.

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THEORY OF OPERATION

(MODEL : AT2000)

1. FREQUENCY GENERATION CIRCUITRY

The frequency generation circuit is composed of the synthesizer U13 and the VCO. The block diagram illustrates the interconnection and support circuitry used in the design. Refer to the schematic for reference designator.

The supply for the synthesizer is regulated 4.0 volts. In addition to the VCO, the synthesizer must interface with the logic and AF filter circuitry. Programming for the synthesizer is accomplished through the clock, data and strobe signals (pin 6, 7 and 8) from the microprocessor U301.

A serial data is sent whenever the synthesizer is programmed. A 4.0 volts DC signal from pin 5 indicates to the microprocessor that the synthesizer is locked. While unlock is indicated by a low voltage on this pin. The audio signal from the AF filter is modulated by D18 of the VCO.

PLL FREQUENCY SYNTHESIZER

The U13 PLL IC includes all functions such as the phase comparator, the programmable divider, the lock detector, and reference oscillator.

The synthesizer uses a 21.25 MHz crystal (X13) to provide the reference frequency for the system. The other components of reference oscillator are VC11, C50, C51 and C52. The TCXO (21.25MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of -20℃.

The loop filter, composed of R44, C62, C63, R45, C64 provides the necessary DC steering voltage for the VCO as well as filtering of spurious signals from the phase detector. The pre-scaler for the loop is internal of U13 with the value determined by the frequency band of operation.

The phase comparator sends out the output power to the loop filter through 3rd pin of the U13. When phase comparator detects phase difference, LD terminal (pin 5) outputs "LOW". When phase comparator locks, LD terminal outputs "HIGH".

Metware Co., Ltd.
FCC ID: PF7AT2000
Job #: 614U0
Exhibit #: 8A

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V C O

The VCO, in conjunction with the synthesizer (U13), oscillates 462.5625 MHz to 467.7125 MHz in the transmit mode and 440.8625 MHz to 446.0125 MHz in the receive mode. The VCO consists of the Colpitts oscillator of the Q19. A sample of the RF signal from the enabled oscillator is routed from Q20, R57, C80, through to the pre-scaler input (U13 pin 1). After frequency comparison in the synthesizer, a resultant control voltage is received at the VCO. This dc voltage presents between 2.0 and 3.4 volts when the PLL is locked on frequency.

In the receive mode, the RF signal through Q20 is the local oscillator RF injection and it is applied to the first mixer at Q14.

In the transmit mode, the RF signal at Q20 is run to the input of the pre-drive amplifier (Q21 base). This RF signal is the Tx RF injection. Also in transmit mode, the audio signal to be frequency modulated onto the carrier is received by VCO modulation circuitry at audio in.

During receiving, a 21.7MHz lower frequency should be oscillated compared to transmission frequency. Therefore, the D17 is adversely biased by the Q18, and as a result, the C67 is added in serial to the resonance circuit of the VCO. And desired frequency is oscillated.

11. RECEIVER

The receiver of the UHF consists of 4 major blocks each: Front-end, Mixer, First IF and the second IF/Demodulator IC.

FRONT - END

The UHF Front-end contains two separate circuits. They are RF Amplifier and SAW Filter. RF Amplifier, consist of two transistor Q11 and Q12 is the cascade in all-bipolar form which is also referred to as common emitter-common base (CE-CB) connection. This amplifier get approximately 20dB gain owing to high output impedance, a noise figure of approximately 3dB and is supplied by the receive 4.0V line.

The SAW Filter is BPF of high stability and reliability with good performance and no adjustment and is fixed-tuned design to eliminate the need for tuning and to provide narrow-band operation. The 3dB bandwidth is approximately 6MHz, centered on 465MHz with an insertion loss of approximately 4dB.

The net-gain from the Front-end selection is approximately 20dB in the center of the band, falling to approximately 4dB at band edges, with a center band noise figure of approximately 5.5dB.

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MIXER

The Mixer operates with an adequate local oscillator drive level (minimum -4dBm). The mixer provides excellent isolation between the ports and operates over a large bandwidth. The received signal is mixed down to 21.7MHz, the frequency of the first IF.

FIRST IF

The first IF consists of a 21.7MHz crystal filter and amplifier. The crystal filter provides selectivity, second image protection and intermodulation protection with an approximately 3dB band with of 3.75kHz for 12.5kHz models. The IF Amplifier, Q104, provides approximately 20dB of gain at 21.7MHz.

SECOND IF/DEMODULATOR IC

The Second IF/Demodulator IC, DBL5018-V, accepts the 21.7MHz IF input and mixes it with a second local oscillator signal derived from an external crystal of 21.25MHz. This produces a second IF (450kHz) which is filtered externally by a ceramic filter and passed back into the IC for amplification.

The signal is passed to a quadrature detector for demodulation and, after being filtered, is pass to the output. The IC, along with some external components, controls the squelch sensitivity, squelch tail, and hysteresis. Internal variable resistor, VR11, controls the noise squelch setting.

III. TRANSMITTER

The AT2000 transceiver contains five basic circuits. They are Pre-Driver, Driver, Final Amplifier, Antenna Switch and a Harmonic Filter. Refer to the block diagram and the schematic for more information.

POWER AMPLIFIER

The Power Amplifier consists of three stages. They are Pre-Diver, Driver and Power Amplifier. It requires a supply voltage of 4.0 volts and 6.0 volts each. And it is capable of supplying maximum 0.5W(ERP).

Metware Co., Ltd.
FCC ID: PF7AT2000
Job #: 614U0
Exhibit #: 8C

POWER CONTROL

R166 control the current of Pre-driver Amp (Q108), can control the bias input level of final TX power amplifier (Q110, 111, 112). And the input level can control the TX power level.

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ANTENNA SWITCH

The antenna switch circuit consists of two pin diodes (D101 and D102). In the transmittion mode, TX-POW LINE is applied to the circuit to bias the diodes "on". The shunt diode (D102) shorts out the receiver port and the PI network, which operates as a quarter wave transmission line and transforms the low impedance. The shunt diode makes high impedance at the input of the harmonic filter.

In the receive mode, The diodes are both off, hence, there exists a low attenuation path between the antenna and receiver ports.

HARMONIC FILTER

The harmonic filter consists of part of C101, L102, C103, L103, C105. The design of the harmonic filter is 5th order chevyshev filter with 0.1dB ripple. This type filter has the advantage that it can give greater attenuation in the stop-band for a given ripple level.

IV. AUDIO PATHS

AT2000 audio paths are composed of U304 and U305. U304 is a compander IC. This chip contains two variable gain circuits configured for compressing and expanding the dynamic range of an audio signal. U305 is a CTCSS encoder/decoder IC. This chip contains CTCSS encoder/decoder with the EIA RS-220A standard, integrated voice signal circuits for emphasis, a limiter, splatter filter, etc. Refer to the AK2342B data sheet.

RX AUDIO PATH

Audio processing for the RX audio is achieved via AMP2, LPF1, De-emphasis, Expander and AMP5 of U305. AMP2 is op amp for adjusting the receiving voice signal and tone signal gain, and preventing SCF aliasing in subsequent stages. LPF1 is SCF circuit which limits the input voice signal higher than 3.0kHz. De-emphasis restores signals which were given high frequency emphasis by the pre-emphasis circuit to their former level. Expander of U304 reduces noise. AMP5 intend to configure a smothing filter. U305 output audio signals are adjusted at R352, 353, 354, 355 and 356 by 32 steps. Adjusted audio signal is fed to the Audio Power Amplifier, U307. This is a Bridged-tied Load amplifier with a fixed gain of 40dB, developing 250mW output at less than 10% harmonic distortion into the 8Ω internal loudspeaker with nominal 6V battery and supply. Maximum audio power output is greater than 1W.

Metware Co., Ltd.
FCC ID: PF7AT2000
Job #: 614U0
Exhibit #: 8D

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RX CTCSS TONES

Audio processing for the RX sub-audio signals is also achieved from U305. TSQBPF of U305 identifies the 38 tone signal frequencies. And DETOUT (pin 22) goes "L" when a tone at the frequency set by serial data is detected.

TX AUDIO path

The TX audio is fed from the microphone to U305. TX audio passes AMP1, Pre-emphasis, LPF1, HPF, Compressor, AMP3, Limiter, Adder, Splatter filter and AMP4 of U305 internal. Pre-emphasis emphasizes the high frequency component of transmitting voice signals to improve the modulation signal's S/N. HPF limits the input voice signal lower than 300Hz. This prevents voice signals below 300Hz from having an adverse effect on the tone signals during transmitting. Compressor of U304 improves S/N by reducing the transmitted dynamic range. Limiter inhibits frequency deviation of the modulation signal. Adder addes TX tone signal to voice signal internally. Splatter filter removes the component above 3kHz included in the limiter output signal. U305 output signal is modulated in VCO.

Metware Co., Ltd.
FCC ID: PF7AT2000
Job #: 614U0
Exhibit #: 8G