FCC INFORMATION

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES.
OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:
(1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND
(2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED,
INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

(NOTE) : The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

AIRTECH INFORMATION &
COMMUNICATION CO., LTD.
FCC ID: ONKFR-464
EXHIBIT #: 9

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1. INTRODUCTION

FR-464 is a micro size FM transceiver operating on the 14 FCC approved channels for Family Radio Service (FRS) on frequencies between 462.5625 to 467.7125 MHz. With the output power of 500mW, the radio is capable of communicating up to 2 miles.

In addition to its small size, FR-464 offers many advanced features that could only be found in the most expensive FRS radios.

Like other Airtech I & C Co., Ltd. quality products, the FR-464 carries a 12 months limited warranty. Please call our technical or customer service representatives at +82-2-3662-6511(#602) when you needed help, or visit us on the Web at E-mail \\.airtech.users.unitel.co.kr

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2. TECHNICAL SPECIFICATIONS

Model Number : Airtech™ FR-464

A. GENERAL

1) Frequency Range	: 462.5625 to 467.7125 MHz
2) Modulation Type	: F3E (FM)
3) Channel capacity	: 14 FCC approved FRS channels
4) Channel spacing	: 12.5 KHz
5) Power Supply	: 3 pcs AAA size Alkaline Batteries or NiMh Rechargeable Batteries
6) Battery Voltage	: 4.5V (Alkaline), 3.6V (NiMh Rechargeable Batteries)
7) Battery Life	: 14hrs (Alkaline), 9hrs (NiMh Rechargeable Batteries) (At 5%-5%-90% transmit-receive-standby cycles)
8) Operating Temperature	: -20°C to +60°C (-20 F to +160 F)
9) Dimensions	: 85(H) x 45(W) x 25(D)mm
10) Weight(W/Batteries)	: 120 g

B. TRANSMITTER

1) Power Output	: 500mW Max (ERP)
2) Frequency Stability	: Better than +/- 2.5ppm within operating temperature
3) Hum & Harmonic	: -40dB (with 300Hz to 3KHz audio filter)
4) Spurious & Harmonics	: -55dBc
5) Audio Distortion	: Less than 5% (1KHz tone 60% modulation)
6) Audio Response @6dB/oct	: -10.5 / 0 / +9.5dB (pre-emphasized)
7) Current Drain on TX	: 350mA @ 4.5V, 400mA @ 3.6V

C. RECEIVER

1) Sensitivity	: 0.25uV (12dB SINAD)
2) Selectivity	: -50dB
3) Inter-modulation	: -50dB
4) Spurious and image rejection	: -50dB
5) Maximum Audio Output	: More than 180mW (10% distortion)
6) Audio Distortion	: less than 5% nominal
7) Current Drain on RX	: 25mA standby, 270mA @ 4.5V, 160mA @ 3.6V (maximum audio output)

3. THERORY OF OPERATION

INTRODUCTION

The FR-464 is a micro size 14 channel FRS portable FM transceiver constructed with a microprocessor controlled, temperature compensated Phase Locked Loop (PLL) frequency synthesizer. The radio features double conversion receiver and a direct FM transmitter modulator. A special integrated circuit provides support to sub-audible signaling (CTCSS) and most of the receiving parts are switched off periodically in th power saver mode to reduce battery current drain during standby.

The Block Diagram RF and Control Circuit Diagrams for FR-464 shall be used in associate with the followi circuit description.

FREQUENCY GENERATION

a. Phase Locked Loop (PLL) Circuit

The Temperature Compensated Crystal Oscillator (TCXO)(X301), PLL IC (U301) and the varicap diode Voltage Controlled Oscillator (VCO) (Q303/D301/C318/L302) are the main components generating the correct FRS channels for the FR-464.

The reference frequency of the PLL is provided by the 12.8MHz TCXO, the division ratio is supplied by CPU (U401) through the SYNC_DT line. The phase detector output (DO) is filtered and drives the Varicap Diode D303/C318/L302 to generate the FRS channel frequency being selected by the CPU. The VCO output is buffered by Q305 and sent to TX or RX circuits via diode switch D203,D103.

Normal FM Modulation is achieved by feeding voice signals to the Varicap Diode D302 VCO circuit. Q505,Q504 sets the maximum deviation level.

Sub audible signaling (CTCSS) are generated by the U403 and is fed to the TCXO for low deviation modulation. R522 sets the signaling deviation level.

In the case of PLL out of lock, the SYN_LD line will become active to inform the CPU to shut off the transmitter. This ensures the radio only operates on the correct frequencies.

b) Transmitter

The transmitter operates on the 14 FCC approved FRS channels generated directly from the PLL VCO. See table 1 for details.

c) Receiver

The PLL VCO output feeds the first mixer in the dual conversion receiver. The VCO frequency is 21.4MHz lower than the transmitter frequency. A diode switch D2 is used to switch in C318 to correct the tuning range of the VCO.

The second mixer oscillator operates at 20.945MHz, which convert the 21.4MHz first Intermediate Frequency (IF) into the final IF of 455KHz.

OPERATION

Please refer to the user manual for details

CIRCUIT DESCRIPTION

a) Control Circuits

- CPU

The CPU (U401) is a One Time Programmable (OTP) processor, all the operating software and channel frequencies resides in its Read Only Memory (ROM).

The input to the CPU are:
User controls - front panel buttons, PTT...etc
Sense inputs - Power supply voltage level, PLL out of lock, Power up reset...etc

Factory Test input - For factory automatic test equipment.

The output from the CPU are:
Indicators - LCD screen, LED indicators...etc
Alert tones – gives beeping tones when buttons are depressed
Controls - PLL frequency, Signaling, Audio Muting, Power ON/OFF...etc

EEPROM
All the user selected features (e.g. Volume level, CTCSS settings on each channel, Priority Scan Frequencies...etc) are stored in U402, such that all the information will be retained even when the batteries were removed.

- Power Supply Control
When the PWR button is depressed, Q402 conducts and supplies VCC to the regulators U403 and associated transistor switches to provide stabilized 3V to the control and RF sections.

The CPU is reset through R420 and C416, and then holds #1 of U403 by switching on #20 of U401. #29 of U401 senses any further depression on PWR button, and have the CPU to turn ON Q412. The radio is then in the OFF state.

When the Power Save mode is operating, the receiver circuits will be switched on for 250ms, and off for 250ms continuously during standby.

A A/D converter in U401 operates with the resistor network R405 and R407 to performs Low Battery Detection. When the VCC voltage is under 3.2V, the low battery icon on the LCD panel blinks.

- INDICATORS
Please refer to the user manual for the location of the indicators.

LCD Panel –
Please refer to the user manual for details of all indicators on the Panel

TX/RX LED -

Power On Check up	:	Orange Light
Standby	:	No indication
Receive	:	Green Light
Transmit	:	Red Light

LCD Panel Back light LED –
Green light on the background when Power On and when any of the front panel buttons is operated.

- BUTTONS
Please refer to the user manual for the functions of all the buttons on the radio.

b. Transmitter

PTT Sense and Microphone Switch Circuit
Q402 supplies current to the internal condenser microphone and also serves as the PTT detector. When PTT is depressed, Q402 conducts and inform CPU of the activity via PTT_EN.

When an external microphone is used, it will be connected in parallel with the internal microphone circuit. The use of internal or external PTT will determine which microphone is active.

- MIC Amplifier Circuit
Voice signal from the condenser microphone MIC401 is amplified by U501B. R505 and C503 formed the pre-emphasis circuit for the FM modulator. The low pass filter circuit of U501A/D avoids over modulation on high frequencies transients. The processed audio signal is adjusted by Q504,Q505 for correct deviation level, and fed to VCO for frequency modulation.

- Sub-Audible Signaling
When the user selects sub-audible signaling (CTCSS), The CPU will program U502 to generate the correct signaling at pin 18. The CTCSS output signal is adjusted by R522 for correct deviation level, and then fed to TCXO for low level frequency modulation.

- Oscillator/Modulator Circuit
The transmit frequency is generated by a PLL/VCO oscillator controlled by the CPU. Narrow band frequency modulation can be achieved by applying audio signal directly to the VCO. The FM signal is then switched by D103 for further amplification by the Power Amplifiers.

- Power Amplifiers
The transmit FM signal is amplified by Q101 and Q102, and then to an Bipolar TR Power Amplifier Q103 for final amplification. The RF output is 500mW ERP. The Transmit/Receive (TR) switching diodes D201 and D101 are both conducting, shutting off the receiving circuit and feed the RF power to the antenna filter for transmission.

C. Receiver

- Low Pass Filter and Transmit/Receive Switching Circuit
Received signals from the antenna is fed to the transmit/receive switching circuit through the low pass filter composed of L101~L103 and C101~C105. On receiving D101 becomes off and the transmitter circuit is isolated. The received signal is fed to receiving stage through L104.

- RF Amplifier
The received signal is amplified by Q201, RF selectivity is provided by the band pass fileter composed of L1,L201,L202,L206,L3,L5 and C5,C6,C205,C10,C209,C7,C8,to reject signals outside the FRS band.

- First Mixer Circuit
The amplified receiving signal is fed to G1 of MOSFET mixer (Q203). The 1st local oscillator frequency is fed to G2. The first intermediate frequency of 21.4MHz is output from the drain lead.

- Intermediate Frequency (IF) Circuit
The first intermediate frequency signal passes through crystal filter (XFL201), buffered by Q204 and fed to the IF Integrated Circuit U601. The IF IC consists of a second local oscillator, the second mixer, limiter and FM demodulator. The second local oscillator operates on 20.945MHz, and converted the IF signal to the second intermediate frequency at 455KHz. The desired IF selectivity is provided by FL601. FL602 is the inductor for FM slope detector, adjust it for maximum demodulated output and minimum distortion.

- Receiver Squelch (SQ) Circuit
Noise from detector output of U601 is fed to an internal filter amplifier (pin 7/8) through an bandpass filter C603,C604,R604. The voltage doubler internal rectifies the filtered noise. Audio Mute output at pin 14 informs the CPU of squelch status.

- Sub-audible signaling recovery
Demodulator output from U601 pin 9 is connected to U502 to recover sub-audible signaling (CTCSS). Any detected codes will be sent to the CPU for further processing. When the received signaling code is correct, the received audio with CTCSS tones being filtered will appear at pin 18 of U502.

- Audio Amplifier
Received audio from U502 is routed through de-emphasis circuit R515 and C513, to the audio amplifier U503 connected in BTL output mode. The two output pins 1 and 3 are isolated from the ground and connected to the External speaker jack. When no external speaker is connected, the amplified signal will be connected to the internal loudspeaker.

The audio amplifier also accept Alert Tones input from the CPU, which will give a telephone type ring tone when the unit is first switched on, and beep tones when the buttons are operated by the user.

4. Alignment Procedure

Measurement Condition

The following sections describes the alignment procedure for the AH-461 FRS transceiver under the following reference environment conditions:

Temperature	:	25°C (77°F)
Relative Humidity	:	65%
Power Supply Voltage	:	4.5VDC +/- 5%

Test Equipment / Tools required

The following list of equipment is recommended for use in setting up the radio properly. Please ensure the test equipment are calibrated according to the manufacturer's instructions:

- Frequency counter 500MHz +/-100Hz tolerance, high input impedance and high sensitivity
- UHF FM Signal generator, 500MHz with adjustable frequency, FM deviation, and RF output attenuators. 50Ω Output impedance.
- Oscilloscope, high input impedance.
- 8Ω 1 Watt resistor as loudspeaker load
- Audio Signal Generator, 10Hz to 20KHz, 600Ω impedance with attentuators.
- RF Watt meter, with 50Ω 1 Watt termination resistor (Or RF Voltmeter with 50Ω termination and external 50Ω attenuators)
- Regulated Power Supply 4.5VDC 1A output
- Digital A-V-O Multi-meter
- SINAD Meter
- External Speaker Mic plug (or special audio test jig)
- Interconnection test cable for RF and Control PCB
- Circuit Diagram for FR-464
- PCB layout diagram for FR-464
- Tuning tools for RF/IF transformer and the VR potentiometers

Disassembling the unit

The Cover

- Open and remove the battery compartment cover.
- Remove batteries in the battery compartment.
- Remove the 6 screws on the side of the battery compartment.
- The case could then be opened for servicing.
- Be careful not to break the rubber button assemblies and the LCD screen.

Transmitter Circuit Adjustment

- TCXO frequency

On receiving mode, check TCXO output (Emitter of Q301) is at 12.8MHz

- VCO control voltage

Set radio to receive on Ch1 (462.5625MHz), adjust L302 for 1.0V on test point VT(Voltage Test).

- Transmitter Frequency

Connect RF Power meter to ANT1, Activate PTT to transmit on Ch1 (462.5625MHz) check transmitting frequency error is within +/- 400Hz.

- Transmitter Output Power

Activate PTT to transmit on CH1, Check 500mW power output at ANT1. Repeat test on Ch14.

- Transmitter Sub-Audible Tone Deviation

Set radio to transmit on CH1, with CTCSS code 01 (67Hz) and no audio modulation. Check for 0.3KHz deviation. Repeat test on Ch14

- Transmitter Deviation Limit

Set radio to transmit on CH1, with CTCSS code 28 (162.2Hz) and no audio modulation. At the external microphone input, inject 1KHz tone at –20dBm. Check for 2.0KHz deviation. Reduce 1KHz tone input to –40dBm, check deviation dropped to 1.2 to 1.5KHz. Repeat test on Ch14.

Receiver Circuit Adjustment

- Receiver Sensitivity

After adjusting the FM demodulator, reduce the output level of RF Signal Generator. Check the receiver sensitivity at 12dB SINAD to be around –120dBm

- Receiver Squelch Adjustment

After checking the receiver sensitivity, further lower the RF Signal Generator output to 8-10dB SINAD and observe the squelch circuit operates..

5. Operational Test

Conduct operational test on all the major features and transmit/receive on all the channels. Observe all LCD/LED displays and alert tones are operative and all the buttons are functional. Refer to user manual for details.

6. Photograghs

7. Full Parts List

8. PCB Layout and circuit diagrams

9. Circuit Description (Transmitter)

10. Semiconductor Data Sheets