Exhibit Type: Operational Description
Date: January 4, 1999

This exhibit includes, but is not limited to, the following items required under FCC part 2.983 (d):

(1) Type of emission.
(2) Frequency range.
(3) Range of operating power, and means to provide variation in operating power.
(5) DC voltage chart.
(6) Complete circuit diagrams.
(10) A description of all frequency determining and stabilization circuits.
(11) A description of the circuits used to limit spurious radiation, bandwidth and power.

The Ritron model RQT-450, FCC ID: AIERIT10-450, is a 450-470 MHz, 120 milli-Watt, UHF-FM Stored Voice Notification Radio Transmitter for operation with both 25 and 12.5 KHz channel separation. It will be manufactured and marketed on a continuing basis in the United States of America by the applicant, RITRON, INC. of Carmel, Indiana.

A detailed description of this device's intended use is contained in the Owner's Manual which is a separate exhibit.

Technical Specifications

Models:	RQT-150 VHF-FM RQT-450 UHF-FM
FCC ID & Rule Parts:	AIERIT09-150 Parts 22, 74, 90 * AIERIT10-450 Parts 22, 74, 90, 95 *
Emission Designator:	11K0F3E / 16K0F3E +/- 2.5 / 5.0 KHz peak deviation Internal Jumper Selectable
Operating Frequency Range:	150 – 160 MHz 450 – 470 MHz
Transmitter Power:	120 mW
Frequency Selection:	Synthesized Programmable
Coded Signaling Encoder:	CTCSS, Quiet Call, 51 Tones DCS, Digital Quiet Call, all codes
Typical Range:	One half mile to a handheld radio transceiver using the standard flexible antenna. Greater range is possible if a better antenna or a radio repeater is used.
Battery Life:	1 year when using AA Alkaline batteries and the unit transmits a 5 second message once each hour, 24 hours per day, 5 days per week or approximately 7,000 transmissions.
Internal Battery Requirement:	6 AA Alkaline or NiCd batteries.
External Power Requirement:	9 – 15 Volts DC Jumper Enables Charging of Internal Batteries
Antenna Connector:	BNC, 50 Ohms
Standard Antenna:	Flexible Whip, 14 inches long with elbow connector.
Enclosure:	GE-Noryl, Grey, Ultraviolet Stable NEMA-4-4X Water-Resistant with 4 mounting ears
Dimensions:	5.25” x 5.25 x 2.5”
Weight:	1 pound, less batteries and antenna
Number of Switch Inputs:	2 Momentary, Latching, Analog Voltage or Resistance
Switch Connectors:	4 screw terminals

External Power Input:	2 screw terminals
Maximum Voice Message Length:	8 seconds per switch condition when 1 switch input is used. 3.25 seconds per switch condition when 2 switch inputs are used. Plus a 3.25 second location message.
Auxiliary Messages:	Low Battery (1.5 seconds) External Power Failure (1.5 seconds)
Message Scheduling:	Programmable Intervals and Repeat Times
Programming Method:	Programmable with a standard pulse dial telephone.
Programmable Features:	Transmit Frequency Sub-Audible Squelch Signaling Tones and Codes Voice Messages Message Schedules Switch Types
Standard Factory Presets:	Single Switch Mode Switch Closed Message Switch Open Message Low Battery Message External Power Fail Message (disabled) Messages Transmitted on switch changes Internal Battery Charging Disabled +/- 5 Khz Voice Deviation Batteries not included Frequency as marked on box

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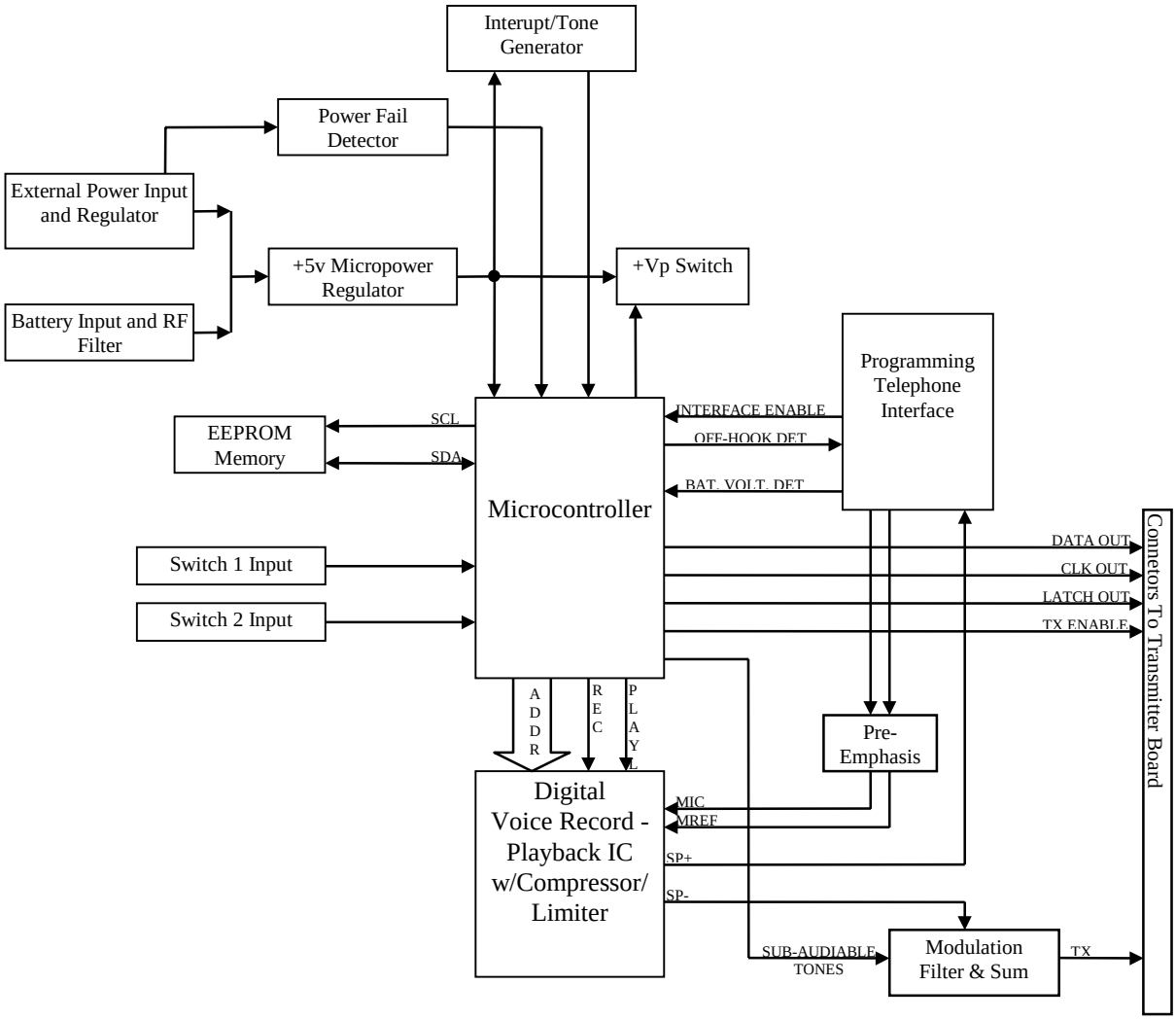
* not yet Type Accepted

RQT Theory of Operation

Introduction

Ritron RQT Quick Talk units are comprised of two (2) printed circuit board sub-assemblies. These are the Control and Transmitter Boards. The Control Board is common to both the RQT-150 and RQT-450 models. Below is a block diagram of the Control Board. A detailed description of the circuit blocks follows.



1. DC Voltage Distribution

Operating power for the radio is derived from two sources:

1.1.A. Internal Battery Pack

The internal battery pack (**B101**) consists of six AA size alkaline or NiCd rechargeable batteries. These supply approximately 6-9 Volts to the RF interference filter (**L101, L102, C109, C110**) located on the control board. This power is routed through a Schottky diode to a power supply summing node at the fuse (**F101**).

1.1.B. External Power Supply Connections

An external power supply in the range of 9-15 VDC can be connected to the screw terminals marked DC+ and DC-. These two terminals run through a RF filter (**L103-L106, C101-C103**) this filtered supply is then fed through a diode to a regulator transistor (**Q107**) and power fail circuitry (**Q101**).

Q107 is configured as a series-pass emitter follower regulator. Zener diode **CR106** and **R109** supply a bias voltage (10 VDC) to the base of **Q107**. The emitter is filtered by **C104** and fed through **PJ103** and **R102** to charge the battery pack when rechargeable batteries are used. **PJ103** should be removed when using an external primary power source and the alkaline batteries as a backup power source. The output of **Q107** is also fed to the power supply summing point at fuse (**F101**). This series pass regulator is needed to protect the voltage regulator **IC101** from voltages above 10 VDC.

The voltage at **F101** (**+VB**) is filtered by **C106** and **C107** to reduce noise. The voltage at this point ranges between 6 and 9.5 VDC. This voltage is supplied to the Transmitter Board and the telephone interface on the Control Board.

1.2. 5 Volt Regulator and Switched 5 Volts

A source of 5 VDC regulated power (**+5V**) is provided by **IC101** and filtered by **C108**. This is then applied to **Q103**, which acts as a switch to provide controlled 5 Volts to most of the Control Board circuitry. Q103 is controlled by the microcontroller (**IC100**) at pin 20, through R114.

1.3. External Power Fail Sensing

When an external source of DC power is applied to the RQT, transistor **Q101** is normally biased on via a voltage divider consisting of **R103** and **R104**. When the input voltage at the collector of **Q107** reaches approximately 8 VDC, transistor **Q101** switches off, indicating an external power fail condition which is noted by the microcontroller.

2. Interrupt / Tone Generator (IC102)

IC102 is an oscillator divider IC used to generate a 4 Hz interrupt signal (pin 2) which is applied to **IC100** to periodically 'wake' it from a power saving sleep mode, and to generate a 1024 Hz signal (pin 5) used for audible tones. IC102 has an internal amplifier and with a 32.768 KHz crystal (**Y102**) and associated parts (**C111, C112, R106-R108**) form the oscillator which drives the internal divider. **CR103** and **CR104** lower the supply voltage and therefore the current required to operate **IC102**.

2.1. Audio Gate (IC107)

IC107 is a NOR gate which enables audible tones. The audio signal enters pin 1, is gated by the digital signal on pin 2 then appears on pin 4 and is passed to the rest of the audio circuitry. The gating signal on pin 2 is from **IC100** and is normally +5 VDC (audio off).

3. External Input Circuits

External inputs are applied to screw terminals (**J601-J604**). (The two switch inputs are identical and therefore only switch input 1 will be described here). Input filtering and transient protection is provided by **C601-C603**, and over voltage protected by **CR601**, **R601**, and **R603**. **R602** provides a pull-up to 5 VDC to provide a 'normal' switch state.

4. Telephone Interface

The telephone interface requires an operating voltage of greater than 5 VDC. This voltage is switched on by **U100** via **Q102** and **Q104** and applied to the telephone jack via **R124**, **R127** and **R129**, **R130**. When current is being drawn through the **R124**, **R127** pair of resistors, they provide a bias voltage to **Q105** and turn it on, indicating an off-hook condition. When **Q105** conducts, it turns on **Q106**. **Q106** pulls **IC100** pin #17 to ground and indicates an off hook condition to the microcontroller. This same path is used to detect the pulses dialed on the rotary telephone.

Low battery voltage sense is determined by a voltage divider consisting of **R119** and **R120**. The voltage from this divider is sent to **U100** pin 18 and read by an on-chip A/D converter.

5. ISD Sound Record / Playback IC (IC106)

IC106 is an analog voice record and playback IC. It accepts speech from the programming telephone, processes the speech with an internal compressor-limiter, samples and records it in non-volatile memory. On command from the microcontroller (**IC100**), it plays back the previously recorded messages through an internal anti-aliasing low pass filter.

5.1. Analog Inputs

The analog voice signal is applied differentially to pins 17 & 18. This signal is taken directly from the telephone input jack (**J101**) through a filter network consisting of **C206**, **C122**, **C219**, **C220**, and **C224**. Resistor **R235** provides attenuation for the audio signals.

5.2. Analog outputs

The analog voice output of IC106 at pin 14 is routed to the telephone for playback of a recorded message. The audio goes through a DC blocking capacitor (**C203**) and an attenuation resistor (**R205**) before connecting to the telephone jack (**J101**). The analog voice output from pin 15 is routed through an amplifier and filter to the radio transmitter board.

5.3. Digital Control

Address lines A0-A7 tell **IC106** where in memory to record the messages, and also tell **U106** where in memory to begin message playback. These address lines are multiplexed with several other **U100** peripherals.

Pin 27, $\overline{\text{REC}}$, is pulled low to start a record cycle of **U106**. When the $\overline{\text{REC}}$ line is pulled high, the record cycle stops.

Pin 23, $\overline{\text{PLAYL}}$, is pulled low to start a playback cycle of **U106**. When the $\overline{\text{PLAYL}}$ line is pulled high, the playback cycle stops.

Components **C204** and **R207** set the sensitivity of the automatic gain control (AGC) circuitry.

6. Audio filters (U103)

6.1. Vag

Vag is a voltage equal to 1/2 Vcc used in the audio filter section. The Vag voltage is developed using a voltage divider consisting of **R214** and **R215**. This voltage is then filtered by **C213** to remove AC components.

6.2. Sub-Audible Tones

Digitally synthesized Quiet Call ™ and Digital Quiet Call ™ CTCSS signals are generated by the microcontroller and are output on pin 22. These signals are then bandwidth limited by an infinite gain, multiple feedback low-pass filter with a corner frequency of approximately 250 Hz at pin 1 of **IC103A**. Potentiometer **R212** is used to adjust the amplitude of these signals for their application to the Transmitter Board.

6.3. Voice and Audio Tone Path

The amplitude and bandwidth limited recorded voice output of **IC105** is summed with the audio 'beep' tone from **IC107** through **C209**, **C218**, **R220**, and **R221** and applied to the voice deviation potentiometer (**R219**). The outputs of the voice and sub-audible potentiometers are summed together at pin 6 of **IC103B**. **IC103B** is configured as a summing node amplifier with an additional low pass cutoff pole at approximately 3 KHz.

6.4. Transmit Deviation Selector

A voltage divider consisting of **R230** and **R231** divide the amplitude of the output audio signal in half when jumper **PJ102** is open. This is to allow the RQT to be easily set for a transmit deviation of +/- 5KHz or +/- 2.5KHz. For +/-5KHz deviation, **PJ102** should be installed in the shorted position.

R238 is not presently used but is available for possible future models where an external modulation balance potentiometer may be required.

7. Microcontroller (IC100)

IC100 controls the operation of the unit including these functions:

-Contact Closure Input Responses
-Telephone programming interface
-Audible 'beep' tone gating
-Power management
-Radio transmitter frequency synthesizer programming
-Quiet Call ™ and Digital Quiet Call ™ generation
-Voice message record and playback chip control
-Message Timing and Control

7.1. EEPROM

IC105 is a 128 byte serial non-volatile EEPROM. All user programmable options are stored in **IC105**. **R125** provides an external +5 VDC pull-up on the EEPROM data line.

RQT-450 Transmitter Board Theory of Operation

Introduction

The transmitter sub-assembly includes a reference oscillator, frequency synthesizer, Voltage Controlled Oscillator (VCO), power amplifier, and antenna low-pass filter circuitry. All are located on one printed circuit board, called the Transmitter Board. Two header/plug connectors (P301, P501) are used for connection to the Control Board.

Power Supply and Voltage Distribution

Voltage regulator IC302 applies +5 Volts (via Q315) to the prescaler/synthesizer controller (IC301), VCO, reference oscillator, and frequency temperature compensation circuit. C355 and C354 provide filtering for IC302.

Voltage switch Q313 applies the regulated voltage to the final transmitter power amplifier device.

Phase-locked Loop

The transmitter is built around a common phase-locked loop (PLL) that consists of a voltage controlled oscillator (VCO) and a frequency synthesizer. The PLL generates transmitter carrier signals.

Voltage Controlled Oscillator / Buffer Amplifier

Q307, L303, varactor CR307 and associated components form the VCO (Voltage Controlled Oscillator), a resonant circuit that oscillates between 450 and 470 MHz. Varying the voltage at the cathode of CR307 changes the varactor's capacitance, which in turn alters the VCO output frequency; for example, when the voltage at CR307 is increased (normally, the charge in C322-324 provides this voltage), CR307's capacitance decreases, which increases the VCO output frequency. +5 VDC is tied to the collector of Q307. C332 and C333 serve as a feedback network. C338 couples the oscillator signal to buffer amplifier Q308. C335 and C341 function as RF bypass capacitors. The amplified signal at Q308's collector is coupled by C340 and applied both to synthesizer controller IC301 pin 8 (via R342 and C342) and to buffer amplifier Q309. The output of Q309 feeds Q311 (through C345 and C346), the transmitter final amplifier.

Prescaler Divider/Synthesizer Controller

IC301 contains both a prescaler and synthesizer controller. The prescaler squares and divides the VCO output tied to pin 8 by either 64 or 65, determined by a synthesizer controller logic signal. A logic high instructs the prescaler to divide the VCO frequency by 64, a low by 65. The exact number of times the prescaler is instructed to change divisors is determined by the channel frequency. +5 VDC is supplied to IC301 at pin 4.

IC301 contains a digital phase detector that works as follows - when an operating channel is changed, which selects a new synthesizer operating frequency, the microcontroller (on the control board) clocks new data into IC301's internal buffer (pin 10) in synchronization with clock pulses applied to IC301 pin 9. Until all data is loaded into the buffer, the synthesizer continues to function at the previous operating frequency.

Once all new data is loaded into the buffer, a single pulse from the microcontroller appears at IC301 pin 11. That pulse instructs the synthesizer controller to latch and execute the new data. IC301 utilizes internal circuitry to determine whether the present VCO output frequency is correct by comparing the phase and frequency of the VCO signal (at pin 8) and the 16.0125 MHz reference oscillator. IC301 produces a pulse output signal proportional to the phase difference between the two input signals. If the VCO output frequency is too high, pin 16 pulses high. If the frequency is too low, pin 15 pulses low.

The charge pump (Q303, Q304 and associated components) and loop filter (C322-325, R323-324 and L302) transform the synthesizer controller output into a DC voltage for application to the VCO. The synthesizer system is "locked" when the phase and frequency of both the reference and the divided VCO signal are the same.

Reference Oscillator

The 16.0125 MHz reference oscillator connected between IC301 pins 1 and 2 is built around crystal Y301, C308, varactor CR301 and tuning capacitor C310. A temperature compensation circuit (R305-307, CR302 and variable thermistor R308) provides the synthesizer controller with a constant 16.0125 MHz reference frequency (+/- 5 PPM).

Transmitter Frequency Modulation

A two-point VCO and Reference Oscillator modulation method is used. The TX modulation input (P301 pin 5) is an input to the reference oscillator via C312, and to the VCO via R310. R310 routes modulation through C317 and R326 to the cathode of varactor CR305. Because CR305 is coupled to the VCO through C328, modulation causes the VCO frequency to vary. C312 applies modulation to the reference crystal to provide for the addition of any Quiet Call or Digital Quiet Call signals. If modulation was not applied to the reference, QC and DQC encode tones would be distorted as the synthesizer attempted to track them.

High Voltage Source

Q301, CR303 and associated components supply approximately +15 Volts to run the charge pump. When the radio is switched on, Q315 provides collector voltage for Q301, a voltage multiplier. The 16.0125 MHz signal at the gate of Q301 is amplified by Q301, then rectified by CR303. The rectified voltage is applied to zener diode CR304 to supply the charge pump.

Charge Pump / Loop filter

The charge pump, Q303, Q304 and surrounding components, processes the phase detector (IC301) pulses to yield a signal that the loop filter can smooth into a DC voltage. R314 applies the pulses to Q303. Q303 turns on, applying a voltage "burst" to the loop filter (C322-325, R323-324 and L302) and charging C322-325 one pulse at time toward +14 Volts. The loop filter provides the DC level at CR307 that governs the VCO frequency.

R320 routes the signal from IC301 pin 16 to Q304. Q304 turns on and discharges C322-325 one pulse at a time, the resulting DC voltage applied to CR307.

Regulated +V TX Supply

A high at pin 1 of P301 (TX ENABLE) activates Q312 and Q313, which form a voltage regulator that supplies power to the final amplifier transistor Q311. The high at pin 1 is routed to Q312, forward biasing the base-emitter junction and causing current to flow from the +V SW line to ground through R353, Q312 and R351. The resulting voltage at Q312's collector switches on Q313, which in turn applies +V TX to Q311. Diode CR310 provides regulation feedback. When the microcontroller releases pin 1 low, Q312 turns off, and so does the transmitter. This regulated voltage eliminates changes in the transmitter power output with respect to changes in the battery voltage.

Power Amplifier

Q311 and associated components amplify the VCO output signal. The resulting 120 milli-Watt signal is matched to 50 Ohms for application to the low-pass filter. There is no provision for the user or field technicians to adjust the RF power output. If necessary due to the variance in component tolerances, the value of the resistor in series the Q311's collector supply will be selected at the time of manufacture to limit the transmitter power output to less than 120 milli-Watts.

Low-pass Filter

A low-pass filter comprised of C420-423 and L411-413 removes harmonics from the transmitter output before applying the RF signal to the antenna connector.

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