TECHNICAL REPORT FOR TYPE ACCEPTANCE

OF RELM COMMUNICATIONS,INC.

FCC ID ARUSRE35AB

TABLE OF CONTENTS

1.0 Equipment Identification ARUSRE35AB

Equipment will be operated in the Frequency Range: 805MHz–870MHz under FCC Rule Parts: 22, 74, 90

1.1 Specifications

S Series Overall Physical Size	3.5-in (89mm) high, 13-in (360mm) deep, 19-in (483mm) wide
Weight	19.8-lbs (9kg)
Supply Voltage:	13.8V +/- 20%
Power Consumption:	<600 mA receive, typical 440 mA <10A for 35W TX RF
Operating Temperature:	-30 to +60 C option
Synthesis Method:	Non mixing PL Fractional N synthesizer
Modulation:	Direct FM, +/-5 kHz +/-2.5 kHz narrow band
Channel Spacing:	30 kHz, 25 kHz, or 12.5 kHz
Synthesizer Step Size:	30, 25, 12.5, 7.5, or 6.25KHz
Channels:	256 Software or switch selectable

Transmitter Module Specifications

Frequency Range:	850 MHz–~~870 MHz~~
RF Power Output:	~~10W~~ to 35W, (850-870 MHz)
Frequency Stability:	1.0PPM
Audio Response:	Flat within +/- 0.5dB across BW (No Pre-Emphasis)
Audio Bandwidth:	(-0.5dB) 300Hz to 3000Hz for EIA-603 (Pre-Emphasis Characteristic)
Audio Distortion:	Less than 5 %. 1000 Hz @ 60% RSD
Deviation Limiting	± 5 kHz or ± 2.5 kHz Maximum
Fm Hum & Noise:	Better than 50dB, wide band. Better than 44dB, narrow band.
Spurious:	Better than -90dBc.
Duty Cycle:	100% for 35W RF output with Thermal controlled fan.
Carrier Attack Time:	4mS typical with continuous VCO selected 20 ms typical with VCO off

Receiver Module Specifications

Frequency Range:	805 MHz–825 MHz
Sensitivity (12dB SINAD):	Better than –117dBm (0.35uV)
Adjacent Channel Rejection:	More than 70 dB for 25 kHz adj. channel more than 65 dB for 12.5 kHz
Spurious Resp:	Better than 90dB
Intermodulation:	Better than 80dB
Distortion:	Less than 2%
Fm Hum & Noise:	Better than 42dB, wide band. Better than 36dB, narrow band
Audio Bandwidth:	DC to 3000Hz (–3.0 dB)
Squelch Opening Time:	20mS
Squelch Closing Time:	100mS
Conducted Spurious:	Less than -57dBm, typ –90dBm

1.2 Technical Description

Theory of operation General Description

The base Station/Repeater circuitry is distributed on four PC boards as follows:

a. Main control board containing the Microprocessor and TX/RX audio processing section
b. Exciter Module containing the TX VCO and transmitter exciter
c. Receiver Module containing the RX VCO and RF/IF discriminator section
d. Power Amplifier Module containing the power amp and 13 element elliptical low-pass filter

Main control board

The Main control board uses 13.6 VDC supplied to **IC35** for regulation to 8VDC, and **IC21& IC27** for regulation to 5VDC. This regulated power is only used with in the module.

The Main control board contains the microprocessor **IC1,** that provides data to the exciter and receiver module synthesizers, data to the CTCSS tone generator **IC25**, and data to **IC11, IC10** Digital pots. **IC10** is used to control the VCO modulation and uses **IC24A** to control the ref modulation. **IC10** is used along wit **IC23A** to set the power level.

The Detected audio from the receiver module is routed to a selectable high pass filter made up of **IC37** and IC38B. Then it is routed to a selectable low pass filter made up of **IC38A** and **IC39. IC40** is the audio amplifier, which is used to drive an external audio source.

Transmit audio applied to pin 15 of the Db15 connector on the back of the unit routed to Selectable VF compressor made up of **IC34** and **IC33**. Next to audio is routed to a selectable LPF& PRE-Emp correction made up of **IC26**. A selectable TXHPF is next made up of **IC30** and **IC29**. The audio is next routed to a LPF made up of **IC29B** and **IC28A&B**. Finally it is routed thru **IC11** digital pot before being sent to the exciter module.

Exciter Module Description

The exciter module uses 13.6 VDC supplied to **IC3 & IC8** for regulation to 8VDC, and **IC7& IC5** for regulation to 5VDC. This regulated power is only used with in the module.

The unit has provisions for different type of audio modulation. These signal are routed thru the control board before being applied to the VCO (voltage control oscillator) formed around **TR1.** The VCO is buffered by **IC2** and **IC1** The buffer output is routed to a broad band pre-amplified **TR3** then to a broad band Driver amplifier **TR4.** This output is 400mWwhich is routed out of the exciter to the Power amplifier module.

The exciter fractional –n synthesizer **IC10** receives its frequency information from the microprocessor on the controller board **IC1.** The synthesizer uses a 14.4 MHz TCXO (1PPM temperature compensated crystal oscillator) **X1.** The error voltage from the synthesizer IC is filter by an active loop filter **IC8** before being applied to the VCO (voltage control oscillator) formed around **TR1.**

Receiver Module Description

The receiver module uses 13.6 VDC supplied to **IC2 & IC9** for regulation to 8 VDC, **IC3** for regulation to 9VDC, and **IC7& IC8** for regulation to 5VDC. This regulated power is only used with in the module.

The RF signal enters the receiver section via pre-set band pass filter and is amplified by a RF amplifier, **IC12**. Then the signal is pass thru a second pre-set band pass filter before being fed to high level diode ring mixer.

The receiver fractional –n synthesizer **IC10** receives its frequency information from the microprocessor on the controller board **IC1** The synthesizer uses a 14.4 MHz TCXO (1PPM temperature compensated crystal oscillator) **X2.** The error voltage from the synthesizer IC is filter by an active loop filter **IC11** before being applied to the VCO (voltage control oscillator) formed around **TR1.** The VCO operates at the local oscillator injection frequency 90 MHz below the receive frequency. The VCO is buffered by **IC2** and amplified by **IC4** before being coupled to the mixer **M1**.

The output of the mixer **M1** is at 90 MHz and is amplified by **TR2** before being coupled to a 4 pole crystal filter **FL3**. The output of **FL3** is again amplified by **TR3** before being coupled to a 2 pole crystal filter **FL4**. Its output is applied to **IC1**. Inside **IC1,** the 90 MHz signal becomes the input to the second mixer with a LO frequency of 89.545MHz as determined by crystal **X1**. The second mixer output at 455kHz is filtered by a ceramic filter **FL5** and **FL6** before being amplified and applied to the FM detector. The detected audio is buffered by **IC5A** before being routed to the control board.

Power Amplifier Module Description

The output of the exciter is injected into the power amplifier and routed to a RF power hybrid **IC1**. The power to the first stage of **IC1** is controlled by a **TR2**, which receives a signal (PTT) from the control board. The output of **IC1** (10 to 15 Watts) is connected to broadband power amplifier **TR1**. Th output of **TR1** (35watts) is routed thru a dual directional coupler then to a 13 element elliptical low pass filter before leave the unit thru the RF connector on the back of the unit.

1.3 Alignment Procedures

All of the minor unit adjustments are performed through software commands using a computer. See the calibration section of the user manual. Major alignments are covered below.

Receiver Module

Frequency Alignment: With the unit set to the correct receiver frequency, remove the receiver section shield. Using a frequency counter connected to C62. Adjust the TCXO (X1) to 90 MHz ± 1 PPM below the unit receive frequency.

Sensitivity Alignment: With the unit set to the correct receiver frequency, connect a RF Signal Generator to the Rec. RF connector on the back of the unit. Inject 1KHz tone at 3KHz deviation at the receive frequency. With a SINAD meter connected to pins 15 and of the DB15 rear connector, adjust T1, T2, L14, and CT1 in that order for a 12dB SINAD. Reinstall receiver shield.

Exciter Module

Frequency Alignment: With the unit set to the correct Transmit frequency, remove the Transmit section shield. Using a 30 dB pad connect a modulation analyzer to the Transmit RF connector on the back of the unit. Key the transmitter Adjust the TCXO (X1) ± 1 PPM of the unit transmits frequency. Reinstall transmitter shield.

PA module

Power out alignment: Remove the shield from the P.A. deck Using a 30 dB pad connect a power meter to the Transmit RF connector on the back of the unit. Key the transmitter and adjust CT1 and CT2 in that

1.4 Block Diagrams and Schematic Diagrams

The Block Diagrams and Schematic Diagrams are located at end for the User manual

1.5 Model Label Detail

The FCC label will be located on the back of the unit below the power input connector see photos

ARUSRE35AB	TX 805 to 825 MHz Rx 850 to 870 MHz	SRE35AB

FCCID: ARUSRE35AB

800 MHz Band Transceiver
Model: SRE35AB
Canada:
RELM Communications, Inc
W. Melbourne, FL 32904
Made in Australia

1.6 Personnel

Tests were performed by one of the undersigned.

Signature - Fred R Anderson
Position - Engineering Assistant - RELM communication, Inc

Signature - Walter Simciak
Position - Engineering Manager - RELM communication, Inc.

Signature - Tom Roche
Position - Engineering Manager of Control Design & Testing
Field Strength of Spurious Radiation test was completed at the Control Design & Testing facility Spotsylvania VA.

1.7 Equipment Used During Testing

HP8656A Signal Generator	Cal 3-9-98
HP8901B Modulation Analyzer	Cal 12-29-97
HP8903A Audio Analyzer	Cal 4-9-98
HP8562B Spectrum analyzer	Cal 1-10-98
HP3580A Audio Spectrum analyzer	Cal 4-14-98
Tech TD420 Oscilloscope	Cal 1-15-98
Ratelco Power Supply	Cal 3-18-98
HP778d Dual Directional Coupler	Cal 3-18-98

2.0 Technical Data

The following test with the exception of the Field Strength of Spurious Radiation test was completed in accordance with TIA/EIA 603 by Fred Anderson at the RELM Communication facility in Melbourne Florida. The Field Strength of Spurious Radiation test was completed by Tom Roche at the control Design & Testing facility Spotsylvania VA.

2.1 RF Power Output

The equipment under test was measured using the test setup shown in Figure 1. Standard Primary Input Voltage was kept constant at 13.6 VDC (measured at the power input connector) throughout the test.

Measured Data

Frequency	RF Power Output	Final Amp DC Input Current	DC Input Voltage	DC Input Power
850.025 MHz	35 watts	8.5 amps	13.62 volts	100 watts
861.001 MHz	35 watts	8.5 amps	13.62 volts	100 watts
869.975 MHz	35 watts	8.5 amps	13.62 volts	100 watts

2.2 Frequency Stability

2.2.1 The frequency stability of the equipment was measured across temperature using the test setup of Figure 1. During this test, the temperature was varied from -30 centigrade to +60 centigrade and primary input voltage of 13.6 maintained throughout entire test. The measured data is shown in Graph 1.

2.2.2 The frequency stability of the equipment was measured across Voltage using the test setup of Figure 1 during this test the primary input voltage was varied by +/- 20%. A standard temperature of 22 degrees centigrade was maintained thought the entire test the measured data is shown in Graph 2.

2.3 Occupied Bandwidth

The occupied bandwidth (calculated using 2x(maximum modulating frequency)+2x(maximum deviation)) was measured using a spectrum analyzer.

The occupied bandwidth of the equipment was measured using the test setup of Figure 2. The measured data is shown in Graph 3 and 4. This data was taken with the Standard Primary Input Voltage at a constant 13.6 volts through out the entire test.

16K0F3E Measurement: The 16K0 bandwidth is calculated using the above formula as shown below:

Maximum Deviation = 5 kHz   Maximum Modulation Frequency = 3 kHz

Occupied Bandwidth = 2 (3000) + 2 (5000) = 16.0 kHz

F3E is FM modulation with analog information used in telephony. The measurement was made with an input to the transmitter audio circuits through the audio line connection that was a 2500 Hz sine wave at a level 16 dB greater than that necessary to produce 50% of the maximum modulation. The modulating frequency was verified using a frequency counter. Data was measured at the unit's middle frequency and is shown in Graphs 4. This is typical of the spectrum across the frequency range.

2.4 Modulation Characteristics

2.4.1 Modulation Deviation

The modulation deviation was measured using the test setup shown in Figure 3. The Primary Input Voltage was set to 13.6 VDC at the primary input connector and maintained throughout the testing. The measured data is shown in Graph 5.

2.4.2 Transmitter Audio Frequency Response

The transmitter audio frequency response was measured using the test setup shown in Figure 4. The Primary Input Voltage was set to 13.6 VDC at the primary input connector and maintained throughout the testing. The measured data is shown in Graph 6.

2.4.3 Low-Pass Filter Response

The transmitter lowpass filter response was measured using the test setup shown in Figure 5. The Primary Input Voltage was set to 13.6 VDC at the primary input connector and maintained throughout the testing. The measured data is shown in Graph 7.

2.5 Spurious Emission at antenna terminal

The transmitter conducted spurious emissions at the transmitter were measured using the test setup shown in Figure 6. The Primary Input Voltage was set to 13.6 VDC at the primary input connector, which was maintained throughout the testing. The measured data is shown in Graph 8.

2.6 Field Strength of Spurious Radiation

The transmitter Radiated spurious emissions at the transmitter were measured at the Control Design and Testing facility. The Primary Input Voltage was set to 13.6 VDC at the primary input connector, which was maintained throughout the testing. The measured data is shown in Tables 1 thru 3

2.7 Transmitter Transient Behavior

The transmitter Transient Behavior at the transmitter was measured using the test setup shown in Figure 7. To showing compliance with part 90.214, we show two sets of plots, one with a generator modulation frequency of 400 Hz and one with a generator modulation frequency of 1 kHz. The storage oscilloscope used produces aliasing distortion on both the 400 Hz as 1 kHz tone, but is worse on the 1 kHz tone. This causes the amplitude of the tone (but not the transient behavior of the unit) to appear incorrect in the plots. The oscilloscope was carefully calibrated, however, with a lower frequency tone to produce +/- 4 divisions at +/- 25 kHz deviation as required by TIA/EIA. The RF output level for the signal generator shown in fig 4 was set 50 dB below the power output of the unit at the combining network. The measured data is shown in Graph 8 and 9