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CIRCUIT & DEVICE DESCRIPTIONS

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PARA. 2.983 (d)(10-12)

(10) FREQUENCY STABILIZATION

A temperature compensated crystal oscillator (N1302) provides a reference frequency signal for the transmitter and receiver frequency synthesizers. It has an temperature of  $\pm 2.5$  ppm over the temperature range of  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . After the unit acquires a base station signal it locks itself to the high accuracy time base of the base station.

(11a) ATTENUATION OF SPURIOUS EMISSIONS

The 800 MHz band transmitter frequency is obtained from mixing a phase locked VCO operating from 979.53 MHz to 1004.49 MHz with a 155.52 MHz signal. The 155.52 MHz signal is obtained by phase locking an oscillator to the VCTCXO output.

The 800 MHz band receiver frequency is obtained by dual conversion. The first conversion is obtained by mixing the incoming signal with the 979.53 MHz to 1004.49 MHz VCO to a first IF frequency of 110.52 MHz. The second conversion mixes the IF frequency with a phase locked VCO at 109.92 MHz to obtain the second IF frequency of 600 kHz. All VCO's are phase locked to the reference VCTCXO U1.

For 1900 MHz band transmit:

1002.765 to 1032.735 MHz synthesizer mixed with a 155.52 MHz signal. Result is then mixed back with the 1002.765 to 1032.735 MHz VCO signal to produce 1850.01 to 1909.95 transmit signal.

1900 MHz band Receive:

Output of 1020.285 to 1050.255 MHz synthesizer is doubled to 2040.57 to 2100.51 MHz. This is used to mix down to a first IF of 110.52 MHz.

As a result of the above circuitry, the spurious signals are transmitter harmonics, reference oscillator 19.44 MHz harmonics, the local oscillators and the microprocessor clock.

The use of multi-layer printed circuit boards, with signal tracks between ground planes, for the radio as well as for the logic areas reduces the radiation to a minimum. Ceramic resonator bandpass filters for the duplexer attenuate conducted transmitter harmonics, reference oscillator and local oscillator signals. A bandpass filter in the receiver front end attenuates the local oscillator signal further. Additional suppression of radiation is achieved by shielding and key isolation between circuits.

(11b) LIMITING MODULATION

The modulation for the transmitter is produced inside a Digital Signal Processing integrated circuit. The modulation limiting is therefore controlled by an algorithm inside this chip. The limit is preset at the factory and cannot be changed thereafter.

ATTENUATING HIGHER AUDIO FREQUENCIES

The DSP chip provides an audio filter with a 120 log (f/3000) response,  $f=3\text{K}$  to  $20\text{KHz}$ . Manchester encoded data signals are filtered prior to transmission by a four-pole lowpass filter providing an attenuation of 24 dB/Octave above 20 kHz.

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The signal produced by the DSP chip is a differentially shifted PI/4 QPSK signal for the digital system and a FM signal for the analog cellular system. These signals are fed through a three-pole lowpass filter with a 3 dB down cut-off frequency of 25 kHz to limit the adjacent channel energy in the digital mode.

(11c) OUTPUT POWER CONTROL

A loop circuit under supervision of the logic sets the output to any of the eleven power levels.

A digital word is transmitted to the gain control amplifier for output power adjustment.

A detector at the output of the power amplifier module senses the RF energy present and sends a corresponding DC voltage to the digital logic circuitry.

Upon receiving a command to set power level from the handset or from a base station the microprocessor sends a predetermined word to the ALC amplifier. The output detector voltage is then read by the microprocessor and compared to a preset value. If the detector voltage is outside the allowed tolerance an adjustment is made to the gain-controlled amplifier to bring the detector voltage into the proper range.

(12) DIGITAL MODULATION TECHNIQUES

800 MHz: The NRZ data stream is transformed to 10kbps Manchester encoded data in such a way that each NRZ binary one is transformed to a zero-to-one transition, and each NRZ binary zero is transformed to a one-to-zero transition.

The Manchester encoded data stream is filtered before being applied to the modulator. Direct binary frequency shift keying is used. A binary one into the modulator corresponds to a normal peak frequency deviation of 8kHz above the carrier frequency and a zero corresponds to a nominal peak frequency deviation 8 kHz below the carrier frequency.

(12a) DESCRIPTION OF PI/4 DQPSK

The modulation method used for the digital mode is known as PI/4 shifted differentially encoded Quadrature Phase Shift Keying. Eight distinct phase states are possible. The signal information is differentially encoded; symbols are transmitted as changes in phase rather than absolute phases. Transition of phase which would result in zero amplitude momentarily are not allowed.

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## CIRCUIT & DEVICE DESCRIPTIONS

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### PARA.

#### 1.0 LOGIC BOARD OPERATION

The logic board is the central controller system for the radio. It is made up of a microprocessor, DSP, codec, memory, and control logic.

##### 1.1 ASIC CONTROL CHIP – D1001

The ASIC control chip is made up of an ARM microprocessor and application specific logic circuits. The chip is the main control center for the radio and provides interfaces to the DSP, codec, memories, keypad, display, alarms, and system interfaces.

##### 1.2 MEMORY CHIP'S

D901 is the 1M x 8 flash memory used to store the radio's operating algorithm. This part may be field programmed to allow new revisions of the operating algorithm to be installed without opening the radio case.

D903 is the 128k x 8 static RAM used for stack, and microprocessor operation.

D905 is the 32k x 8 electrically erasable programmable read only memory. The part stores all of the users phone numbers, any system parameters that change, and the power down status of the radio.

##### 1.3 USER INTERFACES

Keypad is a 3x5 arrangement with a yes and no key and two side volume keys that provides a standard touch tone telephone key pad plus 6 radio functions.

LCD display is a full graphics display that provides complete radio user interface with the operator. The display is connected to the radio with a bi-directional serial data line and one clock line. There is also temperature compensation when the microprocessor reads a thermistor and then furnishes control information to the display.

When the telephone receives an incoming call the 2048 Hz transducer will sound a variety of alarm sequences to alert the operator of the pending call. There is also an internal vibrator that can be used to alert the user.

There are two indicator LED's that provide the operator with information about low battery and when the radio has established service with a cell site. The green LED indicates service and the red LED indicates low battery.

##### 1.4 AUDIO INTERFACE

D1000 codec will provide the necessary audio conversions from analog to digital and digital to analog for all user interfaces. The codec will provide all necessary filters, A to D and D to A control functions for the radio.

##### 1.5 DIGITAL SIGNAL PROCESSING

D904 is the DSP and provides all signal conversion and error correction for the incoming audio receive path and all signal conversions for the transmitted digital signal.

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## ALIGNMENT PROCEDURE

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### PARA. 2.983(d)(9) Alignment Procedures

Due to the high accuracy of the I/O, the modulation, transmit voice, DTMF, SAT and data deviations are all preset in the DSP software and are not normally set in production and /or field. These procedures give the test method to verify the phone has proper deviations.

#### 1.0 RADIO TUNE/TEST INSTRUCTIONS

##### 1.1 800 MHz and 1900 MHz FILTERING

SAW and fixed ceramic elements, therefore no tuning is required at 800 MHz or 1900 MHz.

#### REFERENCE FREQUENCY ADJUSTMENT

##### TEST SETUP

Testing of the VCTCXO circuit is temperature dependent and should be carried out at an ambient room temperature of +23°C to +27°C. Any frequency adjustments should be made **1.0 hour** after re-flow soldering to allow for relaxation of thermal stress. Additionally, the adjustment accuracy depends on having the transceiver completely closed up in the case. If this is not possible at board level with some kind of fixture or the fixture is suspect, this test must be re-done (checked) at final test.

Terminate ANT (X301) into a frequency counter with a 50Ω input impedance.

Enter the following test commands:

\*\*\*\* *The same channel should be used for all parts of this test* \*\*\*\*

@2705            (read thermistor A/D from Patti)  
check result 1  
@80              (initialize the transceiver- carrier off and audio muted)  
@6502            (AFC off)  
@E11401FF       (center DAC3)  
@3Czzxxxx       (select a MID-CHANNEL PCS BAND)  
@840A            (set the transmitter power level 10)  
@81              (turn the transmitter on)  
check result 2

##### TEST RESULTS

1. Verify that the returned value is in the range 41 to 54 hex. (A higher temperature corresponds to a lower reading).
2. Wait until output is stable (<±42Hz variation in frequency). Log output frequency and calculate error in Hz.

Verify that the transmitter frequency is <±100Hz of the channel frequency.

If necessary, adjust DAC3 with the commands @E1140xxx where xxx is 000 to 3FF (each step is approx. 48Hz) to achieve a transmitter frequency that is <±100Hz of the channel frequency plus 0.35ppm. DAC3 calibration limits are 110h and 300h.

##### END OF TEST

@80    (carrier off and audio muted)

#### 1.3 SET TRANSMIT RF POWER

##### TEST SETUP

Before testing, provide the antenna (TP1) with a 50 ohm load capable of dissipating 1 W (average power).

ALIGNMENT PROCEDURE

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**TEST SETUP**

Before testing, provide the antenna (X301) with a 50Ω load capable of dissipating 1W (average power). Use 4.8 V at battery terminals

Enter the following test commands:

@6502 (set DCTCXO control voltage)  
@3C000383 (tune to MID-CHANNEL CELLULAR BAND, CHAN 383)  
@81 (turn on carrier output)

For each power level, 0 through 10, repeat the following setup and adjust the power level to comply with the Calibration Goal Mid-Channel column of the table in test results below:

@840x (x is power level to be set, 0=pl 2, 3=pl3,..., A=pl 10)  
@3900yyy (yyy is hex setting corresponding to power level as follows:)

Each hex setting is approx. 0.15dB.

Record the VGA hex setting for power levels 0 - 10.

@222D (store power level value)

**NOTE: you MUST store a value here, EVEN if it's the same as the initial guess. Levels 0, 1 & 2 are set when level 0 is set.**

For Power Levels 0 - 10 with Low and High Channel, verify that output power meets Low and High Channel Power Limits column of the table in test results below.

**NOTE: Before changing channels the carrier is to be turned off using the @82 command. After tuning to the desired channel using the @3C00xxxx command, turn on the carrier output using @81.**

**TEST RESULTS**

Verify that the power levels for each of the setup settings is within the tolerance shown below. Use Calibration Goal Mid-Channel for calibration of levels 0 through 10.

| POWER LEVEL | POWER OUTPUT | Calibration Goal<br>Mid-Channel | Low and High<br>Channel<br>Power Limits |
|-------------|--------------|---------------------------------|-----------------------------------------|
| 0,1,2       | +26.0dBm     | +0.25/-0.25dB                   | +1.0dB/-1.5dB                           |
| 3           | +22.5dBm     | ±0.5dB                          | +2.0dB/-2.0dB                           |
| 4           | +19.0dBm     | ±0.5dB                          | +2.0dB/-2.5dB                           |
| 5           | +15.5dBm     | ±0.5dB                          | +2.0dB/-3.0dB                           |
| 6           | +12.0dBm     | ±0.5dB                          | +1.5dB/-3.5dB                           |
| 7           | + 8.0dBm     | ±0.5dB                          | +1.5dB/-3.5dB                           |
| 8           | + 4.0dBm     | ±0.25dB                         | ±2.5dB                                  |
| 9           | +0.0dBm      | ±0.25dB                         | ±5.5dB                                  |
| 10          | - 4.0dBm     | ±0.25dB                         | ±8.5dB                                  |

**END OF TEST**

@82 (turn carrier off)

Repeat for MID-CHANNEL PCS BAND, 1100

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ALIGNMENT PROCEDURE

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PARA. 2.983

TRANSMIT DEVIATION

**TEST SETUP**

Set the modulation test equipment to have 50 Hz high-pass and 15kHz low-pass filtering, and use Average detector.

Inject a 1004 Hz signal into the system connector input (X1200-2 ATMS and X1200-4 AGND). Adjust the level of the input signal to 45mV RMS.

Enter the following test commands:

|          |                                                   |
|----------|---------------------------------------------------|
| @6502    | (AFC off)                                         |
| @3Czzxxx | (tune to MID-CHANNEL CELLULAR BAND)               |
| @8400    | (set attenuation to power level 0)                |
| @81      | (turn the carrier on)                             |
| @88      | (un-mute the transmit path)                       |
| @AC      | (turn on the compander)                           |
| @2C0001  | (disable auto-writes to PATTI addr. 40, 48, & 88) |
| @2C482C  | (Tx PGA = -2.5dB, Rx PGA = +2.5dB)                |
| @2C4005  | (audio to system connector)                       |

Record the average deviation level. Multiply by 1.414 to get peak deviation.

**TEST RESULTS**

The transmit peak deviation should be 2.9kHz±500Hz

*NOTE: Use of an Average detector (not peak) and multiplying the number measured by 1.414 to get peak removes the incidental FM from the measurement.*

**END OF TEST**

@80 (reset transceiver)

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ALIGNMENT PROCEDURE

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PARA. 2.983

DTMF DEVIATION AND HIGH FREQUENCY

**TEST SETUP**

Set modulation analyzer for 50Hz HP and 15kHz LP, and use Average detector.

Enter the following test commands:

@3Czzxxx     *(tune to MID-CHANNEL CELLULAR BAND)*  
@88           *(open transmit audio)*  
@8400         *(set attenuation to power level 0)*  
@81           *(turn the carrier on)*  
@AA0D         *(turn on DTMF high tone)*

Turn off injected audio signal to TU.

**TEST RESULTS**

Verify that the mobile transmitted tone is 1143Hz  $\pm 1.5\%$  and the Average deviation 3.64kHz  $\pm 10\%$ . This corresponds to a peak radian deviation of  $(3.64\text{kHz} \pm 10\% \times 1.414) / 1.143\text{kHz} = 4.5 \pm 10\%$ .

*NOTE: Use of an Average detector (not peak) and multiplying the number measured by 1.414 to get peak removes the incidental FM from the measurement.*

**END OF TEST**

@AB           *(turn DTMF off)*  
@80     *(initialize transceiver)*

ALIGNMENT PROCEDURE

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PARA. 2.983

SAT DEVIATION

**TEST SETUP**

Set modulation analyzer for 50Hz HP and 15kHz LP *NOTE: Use of an Average detector (not peak) and multiplying the number measured by 1.414 to get peak removes the incidental FM from the measurement.* Apply an on-channel RF signal to the antenna connector at -50dBm, 6030.0Hz tone at  $\pm 2$ kHz deviation (*this is required for the phone to transpond the tone*).

Enter the following test commands:

|          |                                     |
|----------|-------------------------------------|
| @3Czzxxx | (tune to MID-CHANNEL CELLULAR BAND) |
| @6502    | (lock the VCTCXO)                   |
| @8400    | (power level 0)                     |
| @81      | (turn on transmitter)               |
| @A002    | (turn SAT on (6030 Hz))             |
| @85      | (mute receive audio)                |
| @87      | (mute transmit audio)               |

**TEST RESULTS**

Verify that the mobile transmitted frequency is 6030Hz  $\pm 1$ Hz and the Average frequency deviation is:  
1.414 KHz  $\pm 10\%$ . This corresponds to a peak deviation of  $(1.414\text{kHz} \pm 10\%) \times 1.414 = 2.0\text{kHz} \pm 10\%$ .

*NOTE: Use of an Average detector (not peak) and multiplying the number measured by 1.414 to get peak removes the incidental FM from the measurement.*

**END OF TEST**

@80 (initialize transceiver)

DATA (SIGNALING TONE) DEVIATION

**TEST SETUP**

Set modulation analyzer for 50Hz HP and 15kHz LP, and use Average detector.

Enter the following test command:

|          |                                     |
|----------|-------------------------------------|
| @3Czzxxx | (tune to MID-CHANNEL CELLULAR BAND) |
| @6502    | (lock the VCTCXO)                   |
| @8400    | (set attenuation to power level 0)  |
| @81      | (turn the carrier on)               |
| @8F      | (turn on 10kHz data tone)           |

**TEST RESULTS**

Verify that the Average transmit deviation level is 5.66kHz  $\pm 10\%$ . This corresponds to a peak deviation of  $(5.66\text{kHz} \pm 10\%) \times 1.414 = 8.0\text{kHz} \pm 10\%$ .

*NOTE: Use of an Average detector (not peak) and multiplying the number measured by 1.414 to get peak removes the incidental FM from the measurement.*

**END OF TEST**

@80 (initialize transceiver)

APPLICANT:  
ERICSSON INC

FCC ID NO:  
AXATR-392-A2

EXHIBIT 12B

ALIGNMENT PROCEDURE

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RECEIVER ALIGNMENT

NO ALIGNMENT REQUIRED

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DESCRIPTION

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- 2.983 (c) This cellular transceiver is being prepared for quantity production.
- (d) This transmitter is only for use in the Domestic Public Cellular Radio telephone Communication service, Subpart H of Part 22 and operating in the 1900 MHz Domestic Public Cellular Radio Telephone Communications Service, as per part 24. When operating in the 1900 MHz range, DAMPS technology will be employed. The frequencies are generated using a phase locked loop frequency synthesizer. The transmit audio contains a 2:1 ratio compander, 6db/Octave per-emphasis,  $\pm 12$  kHz deviation limiting and a post limiter filter per 22.907 (a).
- (1) Type of Emissions: 800Mhz: AMPS 40K0FID, 40K0F8W  
800MHz: DAMPS30K0DXW  
1900 MHz: PCS 30K0DXW
- (2) Frequency Range: 824-849 MHz, 1850-1910 MHz
- (3) Range of Operating Power: This transmitter is designed for cellular mobile telephone operation. The transmitter is adjusted to achieve 0.4 watts measured at the antenna connector. The transmitter output is controlled by a binary data message emitted by the base station. The power level can be controlled in eleven levels, as defined in IS-137-A for a class 4 transmitter. Each power level will be maintained to  $\pm 2$ , -4 dB (with additional tolerances at power levels 8,9, and 10 per IS137-A) over a temperature range of -30 to +60° C and a supply voltage, measured at the radio, between 4.3 and 5.3 VDC.
- (4) Maximum Power Rating: The maximum power rating under environmental and supply voltage variations is equal to 0.4 watts plus the power level tolerance of +2, -4 dB. Therefore the maximum output power is 0.69 watts per IS 137A.
- (5) DC Voltage and Current: The DC voltage and total input current of the entire final power amplifier module is 4.8 VDC and 380 mA in the highest level (0.4 watts) to 100 mA in the lowest power level (0.0004 watts).