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Project Engineer:	Y.S.Cho

Maxon America, Inc.
10828 NW Airworld Drive
Kansas City, Missouri 64153

Table of Revisions

Date	Revision	Changes
Mar. 8th, 1999	0.0	1) First draft release

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1. General Description of Product.

The Maxon J-STD-008 Line Access Unit (LAU) is an J-STD-008 compatible transceiver unit which provides an interface between a standard EIA-470 compliant telephone-type device and a J-STD-008 CDMA PCS base station.

1.1. Basic Features and Design Requirements of Product.

The following general requirements will be provided by the Maxon J-STD-008 LAU.

Electrical

Main Power Source:	Country-specific ac/dc wall transformer, with input voltages between 90 - 280 Vac, 50-60 Hz, and an output dc voltage of 16 - 30 Vdc (nominal ~ 19 Vdc).
Reserve Power Source:	Sealed-cell lead acid battery, ~ 12 V, rechargeable, with sufficient capacity to provide up to 1.5 hours TALK time and up to 22 hours STANDBY time, when measured from a condition of full charge, at an ambient temperature of 25° C.
Battery Recharge Time:	The recharge system will provide sufficient capability to fully recharge the reserve battery from maximum allowable discharge to maximum charge level in less than 36 hours.
Surge Protection:	Product will meet the requirements of paragraph 4.2.7.4.5. of EIA/TIA-571, for Type 2 surges.
RF Transmitter Power (maximum):	200 mW, measured at antenna connector.
Antenna Interface:	50 ohms
Power Fuse:	Internal, not accessible by the customer..

Mechanical

Shock:	The unit shall be designed to withstand the drop requirements of EIA/TIA-571, paragraph 4.1.1.1.3.-3.a., which specifies single face drops from 6" and single corner drops from 3" onto a tiled surface, with battery installed.
Vibration:	Required to survive typical transportation and shipping induced vibrations, as defined by paragraph 4.1.1.2. of EIA/TIA-571, with battery removed. The battery is not covered by this specification.

Dimensions:	Approximately 9" x 5" x 2".
Weight:	~ 3.75 pounds, with battery installed. Transformer weight is ~ 2.25 pounds.
Connectors:	One (1) dc power input connector. Two (2) RJ-11 parallel female telephone connectors. One (1) mini-DIN programming interface connector. One (1) BNC-type female RF antenna connector. Internally mounted plated-contact battery connector. One (1) country-specific telephone cable to convert between RJ11 and country specific telephone interface.
Antenna (fixed):	Monopole, λ/2 wavelength, adjustable in z-plane, removable, with shrouded BNC RF connector.
Antenna (remote):	To be defined after further field evaluation.
Indicators:	One (1) LED - **In Service**. Shows: • No PILOT Channel (LED off) • Marginal PILOT Channel (LED blink) • Good PILOT Channel (LED on) The Frame Error Rate will be used as the Pilot Quality indicator. The FER which defines "marginal" Pilot status will be software-programmable. One (1) LED - **Power Status / Battery Status**. Shows: • No Power (LED off) • AC Power (LED on) • Battery Power (LED blink) One (1) LED - **Disruption Indication.** Indicates failure of internal fuse when ON.

General Performance Requirements

RFI Immunity:	Product will demonstrate immunity to external RF fields when applied as specified in TIA/EIA-631. Level of immunity will be determined by through three primary mechanisms: • Audio-band noise measured at the LAU's RJ-11 output. Electrical noise level shall not exceed 39

dBrnC, when the LAU analog loop interface is terminated into a 600Ω load.
- Receiver desensitization, determined by tests specified in Sections 3.4.2 and 3.4.3 of J-STD-018.
- Glitches in product operation, determined by operating the product while subjected to the required interference.

Reliability: ***TBD***(Refer to conditions of Nortel / Maxon Purchase Agreement, WSSM 97108KG.)

Safety Requirements

Telecom Network Voltage (TNV) Isolation: Product will provide mechanical isolation from dangerous internal voltage levels, per requirements of UL1950, CSA950, and EN6950 (optional). The exception to this requirement shall be the housing-mounted antenna connector.

Network Fault Tolerance: The product design will be such that damage will not occur if the RJ-11 connector is accidentally connected to a live analog telephone network. Therefore, the product should operate after the following sources are connected to the tip and ring pins of the RJ-11 output for up to 5 minutes, regardless of polarity:

DC: 56 V_{dc} through 400 Ω.
AC: 56 V_{dc}, with 90 V_{rms} superimposed, through 400 Ω.

It is absolutely essential that no fire be caused within the product under the above conditions. In addition, if product failure should occur, then the required mode is FAIL SAFE. In other words, the RJ11 outputs should fail open with no internally generated voltages present on the output after the failure occurs.

Certification and Regulatory Requirements

Compliance with all or part of the following regulatory standards is required.

- Federal Communications Commission, Part 15, Class B.
- Federal Communications Commission, CFAR-47, Subsection 22.
- Underwriter's Laboratory UL1950.
- Canadian Standards Association CSA1950
- J-STD-008 Mobile Station - Personal Station Base Station Compatibility Requirements for 1.8 to 2.0 GHz Code Division Multiple Access(CDMA) Personal Communication Systems.
- J-STD-018 Recommended Minimum Performance Requirements for 1.8 to 2.0GHz Code Division Multiple Access(CDMA) Personal Stations.

Compliance with all or part of the following regulatory standards is optional, but may become mandatory, dependent upon market requirements..

- CISSPR22, European Union Standard for Emissions, as a Class B device
- Russia-specific requirements.
- India-specific requirements.
- Canada specific requirements.

Environmental

Operating Temperature (ac power, w/ battery installed):	-15° C to 50° C.
Operating Temperature (battery power):	-15° C to 50° C.
Operating Humidity Range:	0 - 95%, non-condensing.
Storage Temperature (excluding battery):	-40° C to 70° C.
Storage Temperature (battery):	-40° C to 60° C (t_{store} < ½ mo.)
	-15° C to 40° C (t_{store} < 12 mo.)
	5° C to 25° C (t_{store} > 12 mo.)

Features and Functions

RF Interface Definition:	Per J-STD-008, Mobile Station - Base Station Compatibility Standard for 1.8 to 2.0GHz Code Division Multiple Access Personal Communications System
Vocoder Requirements:	8 kbps CELP and 13 kbps QCELP, EVRC as optional.
Vertical Network Feature Support:	*CALL WAITING* *CANCEL CALL WAITING* *CALL FORWARD* *CANCEL CALL FORWARD* *CONFERENCE CALLING* *CALL TRANSFER* *CALLER ID NUMBER DELIVERY (US BELLCORE COMPLIANT)* *CALLER ID NAME DELIVERY (US BELLCORE COMPLIANT)* *LINE REVERSAL.*
Data Services:	IS-99, IS-707 Plug-in Analog Fax Module(MDL-1, optional) (9600BPS G3 Fax only)
Programming Interface:	Programming supported via a special isolated interface adapter, which will be supplied only to installation personnel. A PC-based software package and an RS-232 interface converter will facilitate product configuration and test capabilities.
Telephone Network Emulation:	Product provides emulation of “short loop” loop-start analog telephone interface, including signaling, talk,

and idle. Refer to later sections of this specification for detailed information about this interface.

Network Interface:

Interface to external analog telephone devices will be through the product's RJ-11 interface adapters. A special interface cable / converter may be required to connect the analog device to the product.
The electrical characteristics of this interface will assure compatibility with any telephone device which complies with EIA/TIA-RS-470-A. In addition, the interface will be able to source a minimum 25 mA dc current into a worst case British Telecom load of 400 Ω, resistive.

2. General Description of the Line Access Unit.

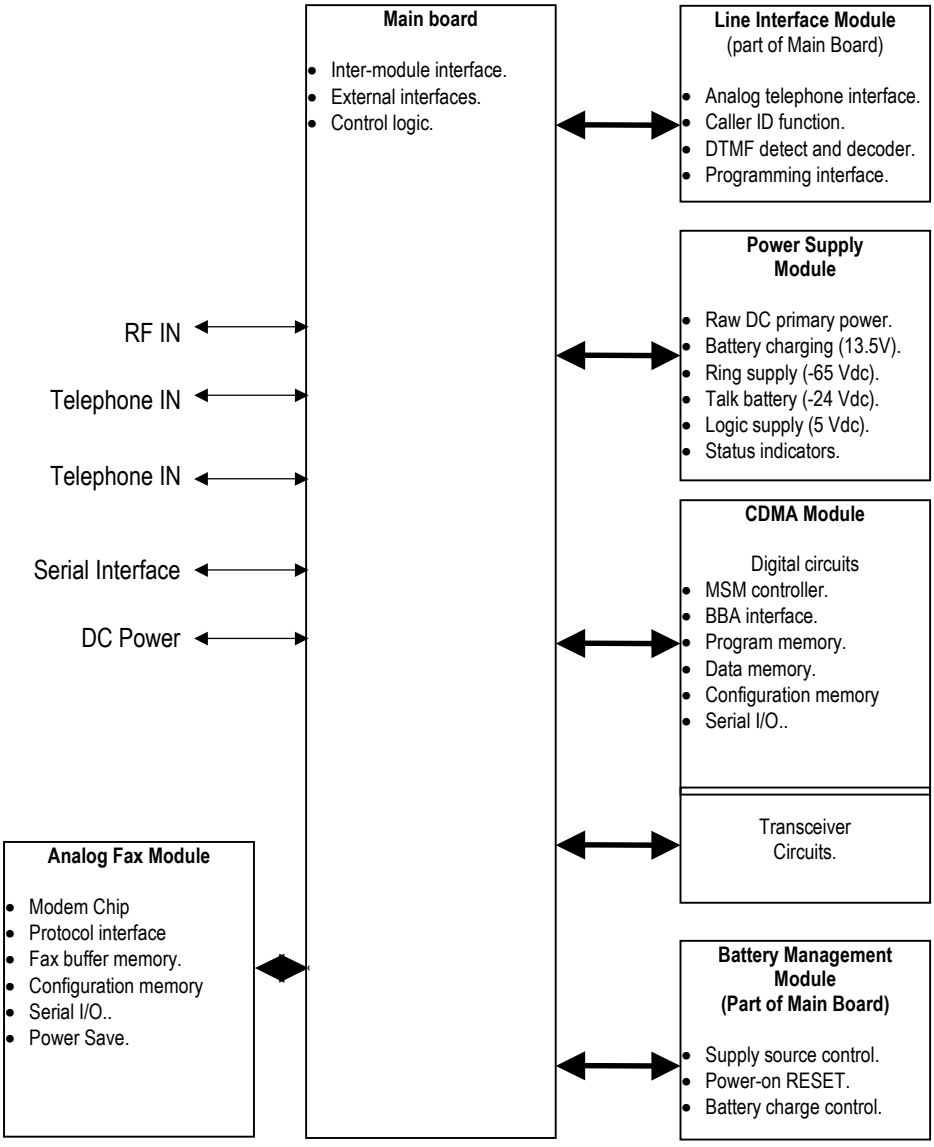

Figure 2.1.-1: Product Basic Block Diagram.

2.2. Main board.

The LAU's Main board provides the interface between the indicated modules. It also serves as the mechanical mounting point and electrical interface for the LAU's external connectors.

2.2.1. Functional Description.

The Main Board acts primarily as an interface between the CDMA Printed Circuit Assemblies (PCAs), the Power Supply Module, and the external connectors. It contains these major hardware functions:

1. External Interfaces.
2. Line Interface Module.
3. Battery Management Module.
4. Interface between the above functions and the CDMA Modules.
5. Power distribution.

These functions will be discussed in detail in subsequent sections of this document.

2.2.2. I/O Definitions.

The primary Main Board I/O points are listed below. Note that this list is not totally inclusive. It contains only the I/O which is critical in defining the operation of the product.

Connector	Pin Count	Function
RJ11-A	2 or 4	Analog telephone device interface. Two wires (TIP and RING).
RJ11-B	2 or 4	Analog telephone device interface. Two wires (TIP and RING). Paralleled with RJ11-A.
DC Power Input	2	Rectified DC power input, from ac / dc converter transformer.
Service	3	Two wire serial I/O interface, with ground reference pin. Serial data is output as a unipolar TTL level signal, referenced to the LAU's internal ground. Maximum data rates are 115.2 kbaud.
RF Antenna	1	RF I/O point. Mating point for external antenna.

Table 2.2.2.-1: Main Board I/O Primary Definitions.

2.2.3. Critical Electrical Characteristics.

The Main Board provides the primary protection circuitry to meet the product's RF Immunity and ESD specifications. These requirements are defined earlier in this specification.

2.3. Line Interface Unit (LIU).

The LIU provides the interface between the digital baseband module and the external analog telephone unit(s). It's primary functions and provisions are as follows:

- Loop start interface compatibility.
- AC loop impedance matching for all states (on hook, off hook, signaling, ringing, and talk)
- DC loop voltage supervision to external analog telephone device for all states (on hook, off hook).
- Caller ID compatible FSK signaling.
- Loop interfaces to monitor loop status.
- Analog band-limited talk/receive interface between LAU and analog telephone unit.
- DTMF Detection and Decoder capability.

2.3.1. Functional Characteristics.

The LIU is the hardware interface between the external analog telephone device and the Qualcomm MSM controller, which is located in the CDMA Module. The primary requirement of the LIU is to supply the necessary electrical interface for telephone devices which comply with EIA/TIA-RS-470-A.

There are several important software-driven functions which are critical to the proper operation of the LIU interface. Most of these functions are associated with the LIU only in that the LIU provides the necessary signals used by the software to establish hardware timing and control. As consequence, the following table of Functional Characteristics will include both hardware and software controlled parameters.

Characteristic	Performance Criteria
Hookswitch Transition (On to Off Hook)	Must Acknowledge (Idle): t < 150 ms Must Acknowledge (Ring Trip): t < 200 ms. Must Ignore: t <= 25 ms. Steady State DC level: t < 300 ms
Hookswitch Transition (Off to On Hook)	Must Acknowledge: t >= 1550 ms Must Ignore: t < 100 ms Steady State DC Level: t < 300 ms
Hookflash Signal	300 ms <= t <= 1 sec
Dial Tone Delay after Valid Off Hook detected (assuming Network Accessed).	$T_{network\_Accessed}$ + (20 ms <= t <= 300 ms) ***NOTE: The value*** $T_{network\_Accessed}$ ***is system dependent. The product continuously verifies network access conditions when powered. If a valid PILOT signal is present, then*** $T_{network\_Accessed}$ ***will be very short (< 300 mS). However, if a valid PILOT signal is not present when OFF HOOK occurs, then*** $T_{network\_Accessed}$ ***is undefined. Fast Busy will be presented to the analog loop interface.***
Detection of Improper Off Hook conditions.	Must be able to detect condition in which loop is improperly active. Conditions are: • a disconnect has been issued by the far end, but the near end has not gone on hook after a 1 minute time-out. ***NOTE: The suggested handling is to first detect the J-STD-008 Far End Disconnect signal, then to generate an 800 mS disconnect, and then to re-issue dial tone.*** • the near end has come off hook, not for the purpose of receiving a call, and, after a 1 minute time-out, has not initiated a dialing sequence: generate ROH tone. • the near end has come off hook, initiated, but failed to complete a dialing sequence after a 1 minute time-out: generate ROH tone. ***NOTE: The LAU should support an optionally programmable control called AUTO-SEND. If AUTO-SEND is set TRUE, then the LAU will transmit any collected digits to the switch after a programmed time-out interval.***
Improper Loop Termination detection.	No requirement.

Caller ID Transmission.	Must be able to transmit valid Caller ID information to the analog telephone set, as defined in relevant Bellcore North American voice-band data transmission specifications.
Standard Call Progress Tones	These tones provide audio feedback to the user, through the audio voice path. All Standard Call Progress Tones, as defined by EIA/TIA-464B, Table 29, will be supported. The Tone Plan data table and software should be designed to allow programmable selection of different tone tables, which may be required to support different network specifications. To this end, the product shall support the ability to alter the frequencies, timing, and power levels of each specified tone. • **Dial Tone:** Applied to external telephone when user is off hook and the LAU is operating in the *Mobile Station Idle State* (meaning that a valid CDMA Pilot and Sync Channel are obtained). • **Reorder Tone:** Also called "Fast Busy Tone". Applied to an off hook analog telephone when the LAU is unable to acquire a valid CDMA Pilot and Sync channel. Also applied during certain situations to warn the user of improper operating conditions on the LAU / Telephone interface (dialing time-outs, etc.). • **Busy Tone:** This tone should be supported. However, there is currently no recognized mode of operation in which the LAU would be required to generate this tone locally. • **ROH Tone:** Also called "Receiver Off Hook Tone". Not specified in EIA-464, but the default tone is specified here as follows: 1400 Hz + 2260 Hz, +3 to -6 dBm per frequency into 600 ohms.
Other Call Progress Tones	These tones provide the user with special audible call progress feedback for events not covered by Standard Call Progress tones. Specific frequencies and levels are as defined by EIA/TIA-464B, Table 30. Software should support use of multiple tone tables, to facilitate setting the product operation for different market requirements. To this end, the product shall support the ability to alter the frequencies, timing, and power levels of each specified tone. • **Recall Tone:** This tone is applied over the air interface by the system base station. The LAU need not generate this tone. • **Call Waiting Tone:** This tone is generated over the air interface by the base station. The LAU need not generate this tone. • **Stutter Dial Tone:** A special tone which indicates

	Message Waiting status. This tone will be applied initially to an off hook analog telephone if the LAU has received a network-provided *Message Waiting* command. Feature can be enabled and disabled. Tone characteristics defined per Bellcore document SR-INS-002461. • **Loss of RF Tone:** Standard Reorder Tone. • **Battery Low Tone:** 2, 3, or 4 beep tone. Individual tone duration is 250 mS, with a 50% duty cycle. Tone occurs once every 10 minutes when battery level drops within 30 minutes of full discharge, and once every minute when battery charge level drops within 5 minutes of full discharge. Feature can be disabled.
Extension Support (Ringing)	Product must provide fully functional support for up to 4 REN equivalents. Typical electronic telephones have RENs between 0.5 - 1.0. Electro-mechanical phones are typically between 1.0 - 2.0. Four (4) REN = 1.75 KΩ.
PBX/Key System Support	There is no current requirement for the LAU to interface with PBX or key system trunk cards. It is *desirable* , but not required for the product to interface with 1A2 and 1A3 trunks.
DTMF Tone Detection	The DTMF detection circuitry must detect any valid DTMF tone which complies with the requirements of EIA-470-A within 50 mSec of receipt over a 100Ω loop length.
Caller ID Number Delivery	Per industry specifications as follows: • Bellcore GR-30 • Bellcore TR-NWT-000031 • Cellular(PCS) Feature Specification
Caller Name Delivery	Per industry specifications as • Bellcore GR-30 • Bellcore TR-NWT-001188 • Cellular(PCS) Feature Specification Note: This feature is not currently supported by the J-STD-008 specification, although the basic hardware capability will be available in the product. A general message stating that “Name is Unavailable” will appear on compatible Caller ID units.
Serial Interface	Logic level outputs. Special RS-232 converter is required to interface to a computer.

Table 2.3.1.-1: Line Interface Functional Requirements.

2.3.2. Electrical Characteristics.

The LIU must conform to the electrical characteristics for analog loop start interfaces defined by EIA-464-B, except where modified below.

Characteristic	Performance Criteria
Tip-Ring AC Impedance (Off Hook)	270 Ω + (750 Ω || 0.15 μF)
Ring Signal	19 Hz <= f_{ring} <= 21 Hz V_{rms} >= 45 V_{rms} into 1.75 KΩ impedance on a 1000 ft. loop. Ringing Waveform: Trapezoidal signal is acceptable. 1.2 <= Peak / RMS <= 1.6.
Tip to Signal Ground Impedance	No requirement.
Ring to Signal Ground Impedance	No requirement.
LIU Loop Supply Voltage / Current	Idle State: Per EIA-464. Talk State: Per EIA-464, plus 25 mA < I_{sc} < 40 mA for R_L < 100 Ω. Also required to drive at least 25 mA into a standard British Telecom 400Ω load. Ring State: Per EIA-464, plus 100 mA > I_{sc}> 70 mA for R_L < 100 Ω.
Maximum Supported Loop Length	100 Ω.
Audio Path Frequency Response	300 - 3300 Hz, +/- 3 dB.
Audio Path Distortion Limits	TX: System must accurately decode all DTMF digits when signals are applied to input at maximum allowed levels. RX: Assuming a network signal input level of 3 dBm, and an internal RX loss plan of 3 dB, output signal levels must not show clipping over the range from 300 -3300 Hz.
Loss Plan	TX: Total gain in is -4.1 dB, and is comprised of a hardware gain from Tip/Ring to the CODEC PCM output after A/D conversion of -4.1 dB and 0 dB gain in the baseband DSP function, measured at 1 kHz. The PCM bit stream is processed or generated by a 900 Ω CODEC. RX: Total gain is programmable from -5 dB to -14 dB and is comprised of a programmable range of +3 dB to -6 dB in the baseband DSP function (including vocoder) and a hardware gain from the CODEC PCM inputs (before D/A conversion) to Tip/Ring terminated 600 Ω load of -8 dB, measured at 1 kHz. The PCM bit stream is processed or generated by a 900 Ω CODEC.
Serial interface	Logic “1”: Logic “0”:

Table 2.3.2.-1: Primary LIU Electrical Characteristics, Where Different from EIA-464.

2.3.3. Applicable Specifications.

These specifications provide necessary information concerning the operation and interface requirements for the LIU module. This list is intended as a source of reference, and is not meant as a strict list of compliance requirements.

- **EIA/TIA RS-470-A (North American Analog Telephone Interface Requirements)** - *defines interface requirements for telephone devices. Document is a reference showing performance ranges of most high-quality analog telephone devices.*
- **EIA/TIA RS-464-B (PBX Interface and Operation Requirements)** - *defines the interface and operational requirements for Private Branch Exchange switches. The analog interface between these systems and analog telephone devices is a subset of this specification.*
- **FCC Part 68 (North American Analog Telephone Network Compliance Requirements)** - *defines the requirements which the U.S. Federal Communications Commission imposes upon all subscriber devices which are permitted to connect to the U.S. public telephone network. This document is a reference. It's requirements are not imposed upon this product, because the product is not to be connected to a functioning telephone network.*
- **Bell System Switched Network Capability and Performance Specification, Technical Reference PUB 61100, Description of the Analog Voiceband Interface Between the Bell System Local Exchange Lines and Terminal Equipment** - *reference document. Defines operation of North American Public Telephone Network analog interface.*
- **EIA/TIA - 571 -1996, Environmental Considerations for Telephone Terminals.**
- **TIA/EIA - 631 -1996, Telecom Telephone Terminal Equipment - Radio Frequency Immunity Requirements for Equipment Having an Acoustic Output.**
- **Bellcore GR-30, Voice Band Data Transmission Interface** - *defines the analog signaling interface used to provide Incoming Caller Identification data over the analog public telephone network.*
- **TR-NWT-000031, Issue 4, CLASS Feature: Calling Number Delivery** - *defines specific transmission specification for ICLID Calling Number delivery.*
- **TR-NWT-001188, Issue 1, CLASS Calling Name Delivery Generic Requirements -** *defines specific transmission specification for ICLID Calling Name delivery*
- **TA-NWT-000575, Issue 1, CLASS Feature: Calling Identity Delivery on Call Waiting** - *defines specific transmission specification for ICLID Calling Name and Number delivery with Call Waiting services. This specification is provided as a reference. The product is not intended to comply with this requirement at this time.*

2.4. Power Supply Module (PSM).

The Power Supply module receives unregulated power from the Battery Management module, and then provides the necessary regulated dc outputs required to operate the other circuitry within the LAU. The PSM also contains the unit's three Status Indicators. The specific requirements of this module are defined in detail below.

2.4.1. Functional Characteristics.

There are no special functional requirements for the Power Supply Module.

2.4.2. Electrical Characteristics.

The PSM must conform to the following electrical characteristics, under all operating conditions, unless specifically indicated.

Characteristic	Performance Criteria	Conditions
5V Supply Output	Max Current: 1.45 A. DC Output: 4.85 to 5.25V. Max Ripple: < 100 mV_{rms}. Efficiency: > 90%	All operating temperatures, transmitter at full power, external loop active with full range of loads.
-24V Supply Output	Max Current: 50 mA. DC Output: -22.0 to -26.0 V. Max Ripple: < 500 mV_{rms}, Efficiency: > 90%	All operating temperatures, transmitter at full load, external loop active with full range of loads.
-65V Supply Output	Max Current: 100 mA. DC Output: -61.0 to -69.0 V. Max Ripple: < 500 mV_{rms} Efficiency: > 80%	All operating temperatures, transmitter at full load, external loop active with full range of loads.
Power efficiency (ac operation)	Talk Mode: > 80% at max output. Standby Mode: > 80% at max output.	All operating conditions, transmitter at full power operation.
Power efficiency (battery operation)	Talk Mode: > 80% at max output. Standby Mode: > 80% at max output.	All operating conditions, transmitter at full power operation.

Table 2.4.2.-1: Primary PSU Electrical Characteristics.

2.5. Battery Management Module (BMM).

The Battery Management Module (BMM) manages the distribution and source for the LAUs primary power sources, battery and ac power. As such, it provides the following basic functions:

- Monitors the status of the input ac power signal, and controls the switch-over between ac power and battery reserve power when ac power failure occurs.
- Measures the charge level of the reserve battery, and controls the charging input to the battery according to the discharge level, battery temperature, and ambient temperature conditions.
- Generates necessary power-on reset signals to other modules within the LAU, assuring proper initialization when power is applied.
- Provides output indications of certain power-related fault conditions.

2.5.1. Functional Characteristics.

These are the functional requirements for the Battery Management Module.

Characteristic	Performance Criteria
Battery / AC Power Source Selection	The BMM controls the source of electrical power for the LAU by monitoring the ac power input and the dc battery level. The following criteria determine which source provides the operating power for the LAU circuitry: • If AC power is present on the 19 VOLTS IN line, then battery supply power is turned of. • If Battery power is present and AC power is not,

	then battery power is set as the primary power source, as long as the battery voltage is greater than ~ 10.2 V_{dc}. • If battery voltage falls below ~ 10.2 V_{dc}, then battery operation will not be permitted even if ac power is lost.
Battery Charge Control	The BMM controls the charger operation for the lead acid battery based upon the following criteria: • If battery voltage is below ~ 12 V_{dc}, then charging shall occur. • If the internal temperature of the product is greater than **50(+/-5)°C** or less than **-15(+/-5)°C** then charging shall not occur, regardless of battery voltage level. • Total charge time from ~ 10 V_{dc} to ***100% charge** shall be less than 36 hours. Charge time to 80% full charge shall be less than 24 hours.

* 100% charge means provide enough power to meets standby and talk time.

Table 2.5.1.-1: BMM Functional Characteristics.

2.5.2. Electrical Characteristics.

Charge Lead Acid Battery with current limited constant voltage.
(13.8Volts +/-0.3Volts nominal at +25C)
Provide temperature compensation with -0.026V/C of slope.

2.6. CDMA Module (CDM).

The CDM provides the CDMA RF interface between the outside world and the CDMA modulated IF data signals originating or terminating on the Base Band circuit-a part of CDMA Module- and process the digital signal to audible signals through Mobile Station Modem(MSM) and codec.
This CDMA Module is treated as a "black box", with certain inputs and outputs. These inputs and outputs are generally defined in the following sections.

- Embedded control of all LAU-specific functions, e.g., SLIC operation, Caller ID generation, LED control, Analog Fax Module control, etc.
- A/D conversion of analog signals from the telephone interface to suitable digital data for the CDMA air interface.
- D/A conversion of received digital CDMA air interface data to analog signals suited to the telephone interface.
- J-STD-008 air interface control.
- Serial interface between the J-STD-008 air interface standard and the LAU serial data port.
- Provide LCD function. Even though the LCD is not used on SAU-1900E.

The CDMA Module (CDM) contains the components which make up the product's microcontroller unit. The backbone of this circuit is the MSM, with it's necessary peripheral devices (including RAM, flash, NV_RAM).

2.6.1. I/O Definitions.

The CDMA I/O points are as follows.

Pin No.	Signal Name(Function)	Signal Description
1	GND(Ground)	Ground to +5V.
2	GND(Ground)	Ground to +5V.
3	+5V(+5Volts)	+5Volts main power supply for CDMA board.
4	+5V(+5Volts)	+5Volts main power supply for CDMA board.
5	+5V(+5Volts)	+5Volts main power supply for CDMA board.
6	+5V(+5Volts)	+5Volts main power supply for CDMA board.
7	AUX_PCM_DOUT	MSM terminal 138 AUX_PCM_DOUT, Not used with SAU-1900E
8	AUX_PCM_CLK	MSM terminal 142 AUX_PCM_CLK, Not used with SAU-1900E
9	AUX_PCM_DIN)	MSM terminal 139 AUX_PCM_DIN, Not used with SAU-1900E
10	AUX_PCM_SYNC.	MSM terminal 140, Not used with SAU-1900E
11	+3.3V(+3.3V_D)	+3.3Volts output from CDMA Module. Can drive up to 15mA for digital circuits.
12	GPIO9(GPIO9)	General GPIO9, tied to Analog Fax Module. Function is not defined yet.
13	KEYSENSE0(OFF_HOOK_IN T(3.3V))	Keysense0 line, used to detect OFF_HOOK status. 1= On Hook, 0=Off Hook.
14	KEYSENSE1(DTMF_DV)	Keysense1 line, used to detect Valid DTMF signal. 1= Invalid, 0=Valid.
15	U20_X2(MAIN_TEMP)	A/D input for Main board(battery) temperature sensor.
16	KEYSENSE2(DTMF_D1)	Keysense2 line, used to detect DTMF digit in conjunction of KEYSENSE3(D2), GPIO1(D4), GPIO5(D8).
17	KEYSENSE3(DTMF_D2)	Keysense3 line, used to detect DTMF digit in conjunction of KEYSENSE2(D1), GPIO1(D4), GPIO5(D8).
18	U20_X0(AC_MONI)	A/D input for AC power status monitor
19	U20_X3(V_BATT)	A/D input for Battery voltage level.
20	GPIO1(DTMF_D4)	General GPIO1, used to detect DTMF digit in conjunction of KEYSENSE2(D1), KEYSENSE3(D2), GPIO5(D8).
21	GPIOI2(EXP_STR)	General GPIO2, used to drive MC14094 port expander STR line in conjunction of GPIO3(EXP_CLK) and GPIO4(EXP_DATA).
22	GPIO3(EXP_CLK)	General GPIO3, used to drive MC14094 port expander CLK line in conjunction of GPIO2(EXP_STR) and GPIO4(EXP_DATA).
23	GPIO4(EXP_DATA)	General GPIO4, used to drive MC14094 port expander DATA line in conjunction of GPIO2(EXP_STR) and GPIO3(EXP_CLK).
24	GPIO0(RING_BURST)	General GPIO0, used to generate ring signal(20Hz Square wave).
25	TMS(JTAG_TMS)	One of the JTAG line.
26	GPIO5(DTMF_D8)	General GPIO5, used to detect DTMF digit in conjunction of KEYSENSE2(D1), KEYSENSE3(D2),

		GPIO1(D4).
27	KEYSENSE4(KEY_PAD2)	One of the KEYSENSE line. Low this line will cause interrupt service. Not used with SAU-1900E but can be used to receive serial keypad information from external key pad detector module in conjunction of GPIO26(KEY_PAD1)
28	TCK(JTAG_TCK)	One of the JTAG line.
29	TDO(JTAG_TDO)	One of the JTAG line.
30	TDI(JTAG_TDI)	One of the JTAG line.
31	\TRST(JTAG_\TRST)	One of the JTAG line.
32	RESIN(JTAG_RESIN)	One of the JTAG line, MSM Reset line.
33	SLIC_RX+(RX CODEC OUT)	Demodulated received audio signal coming out from codec.
34	GND(Ground)	Ground to SLIC_RX+
35	SLIC_TX+(TX CODEC IN)	Transmit audio signal fed in to codec.
36	GND(Ground)	Ground to SLIC_TX+
37	SIGNAL_LED	0 = Turn On LED 1 = Turn Off LED
38	GPIO\19(EXP_\OE)	Inverted General GPIO19, used to drive MC14094 port expander Output Enable(OE) line.
39	\CTS(\CTS)	Clear To Send line.
40	DP_RX_DATA(MSM_RXD)	Serial port received data string. Data levels are 3.3 volt, ground referenced, unipolar digital signals. Maximum data rates are 115.2 kbaud.
41	\RFR(\RFR)	Ready to Send Line
42	DP_TX_DATA(MSM_TXD)	Serial port transmitted data string. Data levels are 3.3 volt, ground referenced, unipolar digital signals. Maximum data rates are 115.2 kbaud.
43	GPIO26	MSM GPIO26 port, not used with SAU-1900E.
44	BOOT_MODE(BOOT_MODE)	BOOT_MODE. 0 = Normal Operation. 1 = BOOT Mode.
45	GPIO27	VOCODER PCM IN port, not used with SAU-1900E.
46	LCD_SER_CS(LCD_CS)	LCD Drive line, not used with SAU-1900E.
47	LCD_SER_CLK(LCD_CLK)	LCD Drive line, not used with SAU-1900E.
48	LCD_SER_DATA(LCD_DATA)	LCD Drive line, not used with SAU-1900E.
49	RINGER	MSM terminal 49, Ringer output. not used with SAU-1900E
50	GND(Ground)	Ground to +5Volts.
ANT	Antenna(RF I/O)	The RF input / output point for the RFM. This point connects directly to the LAU's external RF connector.

Table 2.6.1.-1: RF Module I/O Definitions.

2.6.2. Electrical Characteristics.

The electrical characteristics of the CDM are defined by TIA/EIA J-STD-008 and J-STD-018, Recommended Minimum Performance Standards for 1.8 to 2.0 GHz Code Division Multiple Access(CDMA) Personal Stations.

The operation of the Digital part of CDM which relates to the J-STD-008 CDMA air interface is governed by TIA / EIA / J-STD-008, Mobile Station - Personal Station Base Station Compatibility Requirements for 1.8 to 2.0 GHz Code Division Multiple Access(CDMA) Personal Communication Systems. Special operational considerations which apply to the specific LAU application are defined elsewhere in this specification.

2.7. Analog Fax Module Interface(AFMI).

The Anlog Fax Module Interface(AFMI) necessary interfaces between LAU and Analog Fax Module:

- Serial communication with Analog Fax Module(MDL-1).
- Provide power for MDL-1
- Provide Hook status to MDL-1
- Power Save Information to MDL-1 when MDL-1 is not in use.
- Tx/Rx Audio level fax data interface.

2.7.2. Functional Characteristics.

The operation of the AFMI supposed to communicate with Analog Fax Module(MDL-1) and transmit and receive G3 9600BPS FAX via LAU's RJ-11 telephone interface.
Received Analog fax information by LAU are fed to MDL-1 and converted to Digital fax information by MDL-1 than returned to LAU to translate/transmit proper fax signal over the air using IS-99 and IS-707 service option 5 and 13.

3. Software Description.

The LAU software package consists of the following major subsystems.

- **J-STD-008 Air Interface Module:** This module is a real time multi-tasking software package provided by Qualcomm, and designed to run specifically with the Qualcomm Mobile Station Modem (MSM) and Base Band ASIC (BBA) system ICs. This module is responsible for all internal aspects of the J-STD-008 protocol.
- **Telephone Interface Module:** This module provides the interface between the specific hardware application and the Qualcomm J-STD-008 Air Interface module. It's primary function is to interface with any application-specific external hardware that is built around Qualcomm chipset. In the LAU, this hardware includes all external memory, RF circuitry, line interface hardware, battery management and power supply hardware. The module also contains code segments which are designed to permit the LAU to emulate a Central Office Analog Telephone interface.
- **Test and Configuration Module:** The function of this code segment is to permit one to test the unit, or to configure it for a certain set of operating conditions. The user interfaces to this portion of the code via the serial interface port. A stand-alone PC-based application and a special hardware interface unit facilitate the interface.
- **IS-99 and 707 interface Module:** This module provide Data service by interfacing serial communication line on service port and J-STD-008 Air Interface module.

3.1. Telephone Interface.

The Telephone Interface consists of two distinct functional segments. These segments are not unique, easily identifiable code blocks. Instead, they consist of numerous small code portions which are

interspersed at various locations throughout the controller software package, which is resident in flash memory on the Digital Module. This memory also contains the operating software used by the Qualcomm MSM ASIC.

The two major functional parts of the telephone interface consist of the application-specific hardware interface, and the Central Office emulation software. Each will be described in the following sections.

3.1.1. Telephone Interface State Diagram.

The state diagram for the Telephone Interface software is shown below.

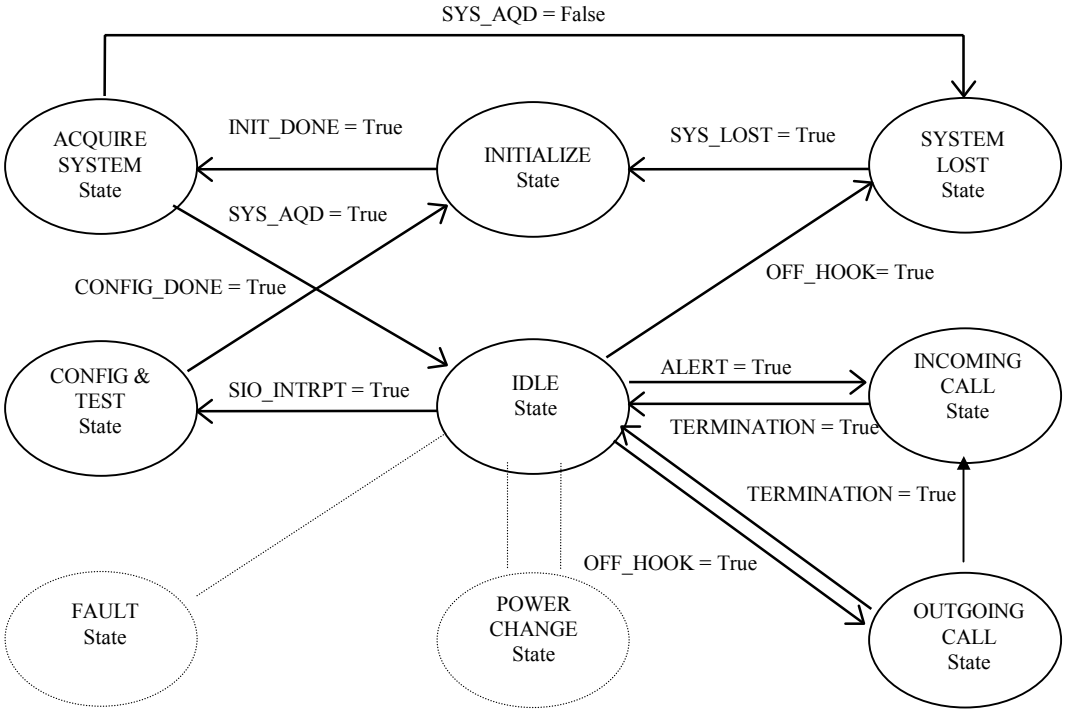

Figure 3.1.1.a. - Telephone Interface State Diagram.

The function of the software sub-states are generalized as follows:

INITIALIZE State: The LAU's MSM controller unit reads in E²PROM configuration data, and then performs various operations necessary to set up the LAU's hardware interfaces.

ACQUIRE SYSTEM State: This state is actually a major state within the Qualcomm MSM operating code. Upon power-up of the unit, the LAU's MSM hardware and software perform a number of functions to initialize the system. Once initialized, the unit begins searching for an appropriate CDMA base station. Once the b/s is located, the LAU registers with the station, and moves to the IDLE state. IDLE state is reached once

	the LAU receives and locks onto a valid CDMA Pilot and Sync channel.
SYSTEM LOST State:	This is actually a major sub-state of the Qualcomm MSM code. The LAU relates to this sub-state by virtue of how it presents to the end user the fact that no system is presently registered.
CONFIGURATION / TEST State:	This state is entered when a serial communications device is connected to the LAU's external serial port. While operating in this sub-state, the LAU does not attempt to access a base station, and will not provide support for incoming calls. It will accept configuration information and will also perform certain operational tests, as instructed from the remote configuration terminal.
IDLE State:	The LAU is linked to a base station, and is waiting for input from either the INCOMING or the OUTGOING call states, the CONFIGURATION / TEST state, or the SYSTEM LOST state.
OUTGOING CALL State:	The LAU enters this state when a hook switch transition is detected on the analog telephone interface. The LAU then initiates the necessary control sequence to receive dialed digits, seize an RF channel, and place the call. If an incoming call occurs prior to the time that the dial string is sent to the B/S, then the LAU will terminate the OUTGOING call state.
INCOMING CALL State:	The LAU enters this state when an ALERT message is received from the base station, indicating an incoming call. The LAU then applies the appropriate ring treatment to the telephone interface, sends caller id data (if configured to do so), and awaits the receipt of the switch hook transition interrupt from the analog telephone circuit. Once received, it then connects the voice paths.
CONVERSATION State (Not Shown):	The LAU enters this state from either the OUTGOING CALL state or the INCOMING CALL state. The LAU is primarily involved with providing and maintaining a suitable voice path. It also continuously monitors the analog loop interface and J-STD-008 air interface for any one of several events which would signal a change or termination of the CONVERSATION state.

3.1.2. INCOMING CALL State.

The state diagram for this operating state is shown below.

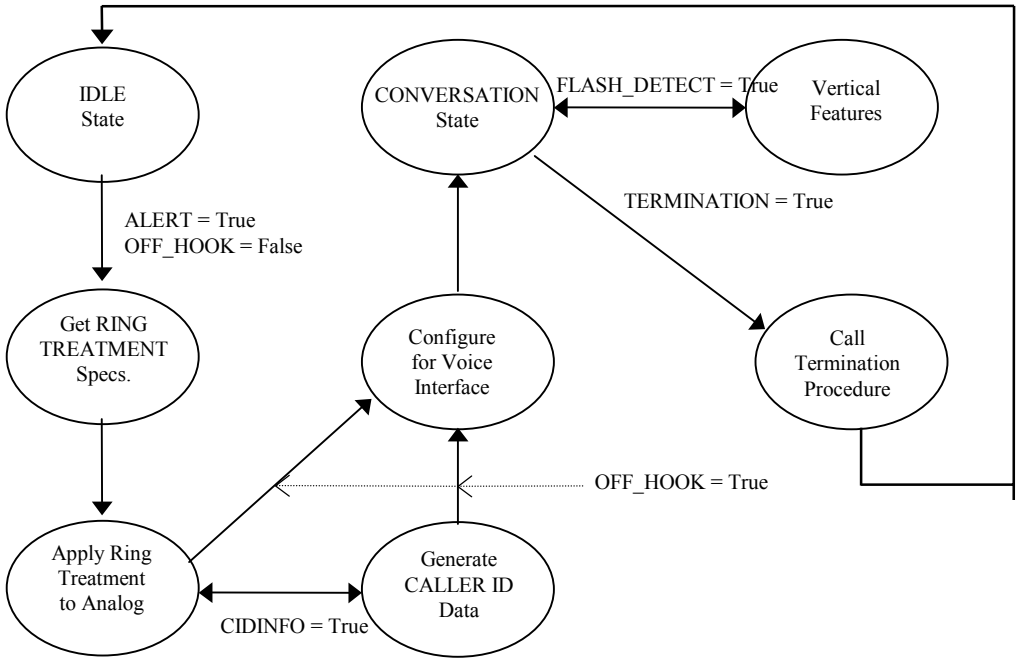

Figure 3.1.2.a. - High Level State Diagram, INCOMING CALL State.

3.1.2.1. IDLE State.

To enter the INCOMING CALL state, the LAU must first be operating in the IDLE state. In the IDLE state, the LAU performs the following repetitive activities:

- Verifies presence of a valid PILOT and SYNC channel.
- Monitors for incoming ALERT signal, which would then initiate the INCOMING CALL state.
- Monitors for input on the Configuration and Maintenance Interface, which would signal transition to the CONFIGURATION state.
- Monitors for a transition of the LIU Hookswitch Transition input. Such a transition causes initiation of the CALL PLACEMENT state.

3.1.2.2. Ring Treatment and Caller ID Data Transmission.

The LAU enters this substate when an ALERT indication has been detected. The LAU now determines which type of ring treatment is to be applied over the analog interface, and then transmits the first ring burst to the interface. Between the first and second ring burst, Caller ID data is transmitted, if present.

This state is maintained until one of several possible events occur:

- A Hookswitch Transition is detected. In this case, the LAU moves to initiate the Conversation mode.

- The Far End party disconnects from the call. In this case, ringing is terminated, and the LAU returns to the IDLE state.
- The system is lost. In this case, ringing terminates, and the LAU attempts to re-acquire a new base station. Fast busy is applied if the user seizes the loop by lifting the analog telephone handset.

3.1.2.2.1. Caller Identification Data Transmission.

Many widely available analog CPE devices are available to detect, decode, and display FSK data transmissions on the analog telephone loop. This FSK data transmission is employed by telephone service providers within a feature set known as Calling Line Identification, or CLID. The typical CLID data transmission occurs between the first and second ring bursts of an incoming call. An FSK serial data stream is encoded with time, date, calling party number, and often, Calling Party Name information. This data stream is received, decoded, and displayed on the receiving device's LCD.

In the J-STD-008 environment, CLID information is transmitted with the initial Alert message, in a format known as Alert_With_Information. This message serves a dual purpose. It tells the LAU that a call is incoming. This data causes the LAU to generate a ring burst to the analog interface. The message also contains the calling party number information.

The LAU is then able to build an appropriate CLID message, by drawing the calling number information from the Alert message, and the date / time information from the J-STD-008 system date / time parameters which are continuously updated over the Pilot channel. This message is then transmitted to the analog interface, following the first ring burst.

At present, the J-STD-008 interface does not support Calling Name delivery.

The LAU fills the name and number fields of the CID data string according to the following rules:

- The NAME field is always filled with "Absence of Name", and the reason is "Unavailable or Out of Area". The LAU has the capability to transmit name information, but this feature is not currently supported by the CDMA system.
- Only numeric digits are expected and tested for in the Alert_With_Information message. Alpha characters are not expected, and are not tested for.
- The "PRIVATE" indication will be sent if the Presentation Indicator bits specify "Presentation Restricted".
- The CALLING NUMBER will be transmitted if the Presentation Indicator bits specify "Presentation Allowed".
- The "OUT OF AREA" indication will be transmitted if the Presentation Indicator bits specify "Number Not Available" or "Presentation Reserved".
- Date and Time information is loaded with the CDMA System Date and System Time information.

3.1.3. Call Placement State.

The following state diagram outlines the general requirements for the software flow during the call placement stage.

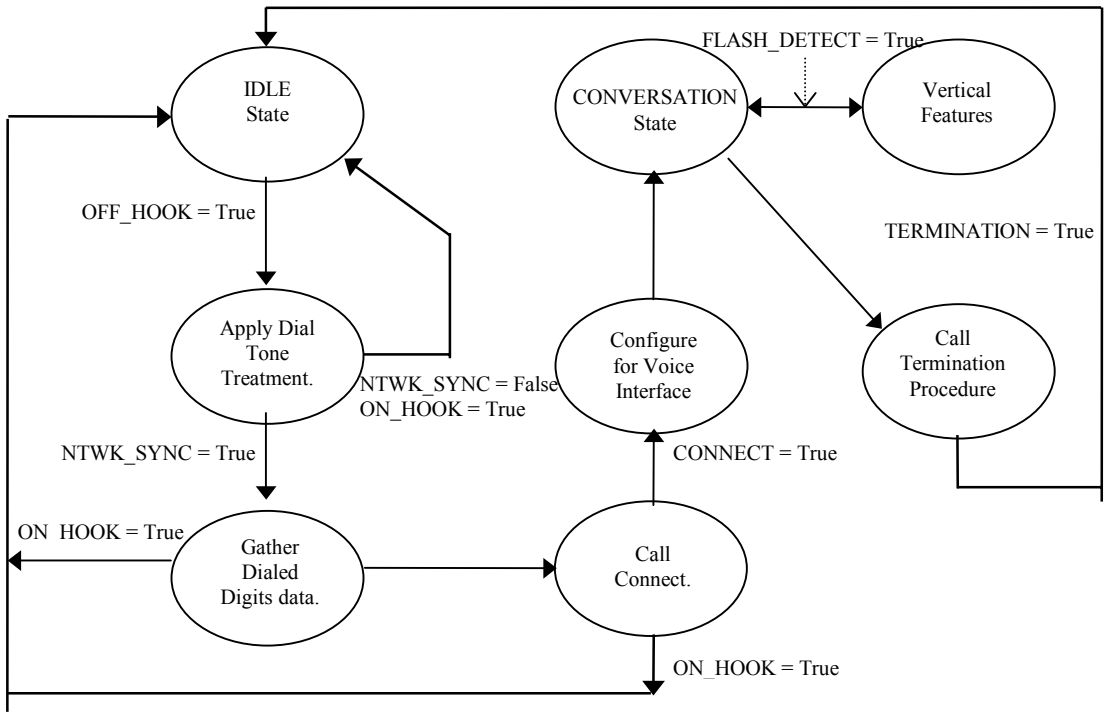

Figure 3.1.3.a. - High Level State Diagram, CALL PLACEMENT State.

3.1.3.1. IDLE State.

Previously defined.

3.1.3.2. Dial Tone and Digit Collection.

The LAU enters this substate when an Off Hook condition has been detected. The LAU now determines which type of dial tone treatment is to be applied over the analog interface. Possible dial tones are:

- Country-specific standard dial tone.
- Stutter dial tone (for Message Waiting configurations).
- Fast dial tone (no service available).

Dial tone is provided until the LAU detects a dialed DTMF digit from the analog interface, or until an On Hook condition is detected, or until the Receiver On Hook timer expires.

3.1.3.3. Gather Dialed Digits Substate.

The LAU begins gathering digits immediately upon detection of the first DTMF input from the analog loop interface. Detection and decoding is taken care of by hardware DTMF detection circuitry which is located in the LIU module. The following general digit gathering scheme is used.

- When Off Hook is detected, and no incoming ALERT message is present, the MSM controller activates the DTMF detection hardware block. Detection is enabled continuously during the OFF HOOK state.
- DTMF tones are detected, then registered as dialed digits. If the first dialed digit is a "#" key, it is registered for subsequent transmission as part of the dialed digit string. "#" will never act as a "SEND" function when it is the first dialed digit of a dialing sequence.
- After each new tone is received, then an optional timer Dial_Time_Out is initiated. If Dial_Time_Out expires, then all newly received digits are transmitted to the B/S. This automatic send capability can be disabled.
- If Dial_Time_Out does not expire, but a "#" key tone is detected at any time after the first digit is entered, then all gathered digit data is transmitted immediately to the B/S.
- A System Lost condition occurs. In this case, the LAU applies the appropriate tone to the analog interface.
- If no digits are entered, or if entered digits are not transmitted to the B/S within a programmable timeout period [while Auto Dial is disabled], then the LAU applies the Receiver Off Hook tone to the analog loop interface.
- There are two special cases governing how the LAU handles the "#" key, when this key is pressed at a certain point during the dialing sequence. These cases are when the "#" key is either the third or the fourth button pressed by the user in the dialing chain. Each case represents a situation in which a special network function is being accessed by the user. Such functions generally consist of two or three digits, followed by the "#" tone. With this software switch set TRUE in the LAU software, the software will accept the "#" button in either the third or fourth digit position, and register it as part of the dial string. A subsequent occurrence of the "#" button will cause SEND to occur, depending on configuration of the "# to SEND" function.
- The "#" send feature can be enabled and disabled using the programming tool.

Received DTMF digits may or may not be considered valid, depending on the current LAU operating conditions.

3.1.4. TALK State.

The LAU enters the TALK state via either the Call Placement routine or the Incoming Call routine. While in this state, the LAU provides the appropriate voice data interface to the J-STD-008 system, and also monitors for one of several possible interrupting events:

- **Call Waiting event:** If this network feature is enabled, the event occurs when a second call is made to the LAU, while the LAU is in the Conversation state. An audible tone is sent over the voice path to the LAU user. This tone informs the LAU user that a second call is available. The LAU user accepts the second call by "flashing" the LAU's analog loop interface.
- **Three Way Call event:** If this network feature is enabled, the user is allowed to access multiple far end parties simultaneously. The event is initiated when the LAU user "flashes" the LAU's analog loop interface.
- **DTMF Detected event:** This event occurs if the user sends a DTMF tone to the LAU's analog loop interface. If the DTMF tone is of sufficient duration, it will cause detection hardware within the LAU's LIU circuitry to send an interrupt to the MSM controller. The controller will decode the incoming digit, and store it into a software digit count buffer. The recorded digit information will be transmitted to the B/S if an appropriate command (loop flash) is received by the LAU. The digit buffer is then cleared.
- **LAU Call Termination event:** An On Hook condition is detected on the analog interface by the LAU. In this case, the LAU performs necessary house-keeping, then returns to the IDLE state.

- **B/S Call Termination event:** A Disconnect message is received from the B/S. In this case, the LAU performs necessary house-keeping, then disconnects from the TALK state. If the user remains off hook, then dial tone is returned. Otherwise, the LAU returns to the IDLE state.
- **System Lost event:** A System Lost condition occurs. In this case, the LAU applies the appropriate tone to the analog interface.

3.1.5. VERTICAL FEATURES Interactions.

The LAU supports several network vertical features. General implementation guidelines are defined below.

Calling Line Identification: This feature is defined in a previous section.

Call Waiting: Call Waiting is a network feature which permits the LAU user to access incoming calls without terminating the current call. The presence of an incoming call is signaled to the LAU by the B/S by application of a special audio tone over the voice path. Upon receipt of this tone, the LAU user has the option of accepting the incoming call, or ignoring it. If ignored, no further action occurs. To accept the incoming call, the user applies a hook flash to the analog loop interface. This flash is detected by the LAU, which then transmits a FLASH_WITH_INFORMATION message to the B/S. The B/S places the current call on hold, then connects the incoming call. The LAU user returns to the held call be generating a second hook flash.

Three Way Calling: Three Way Calling (3WC) is initiated by the LAU user while connected in the Conversation state with another party. The feature is initiated when the LAU user applies a hookflash to the analog loop interface. The LAU transmits a FLASH_WITH_INFORMATION message tot he B/S, which then responds by placing the current call on hold. It then applies dial tone to the voice path. The LAU user responds by dialing the third party's number, terminated by another hook flash. The terminating hook flash causes the LAU to transmit the received digits to the B/S, which then connects the second party. The LAU user connects the first party by applying a third hook flash to the analog loop. The second party is disconnected when the LAU user sends a hook flash after the three parties have been connected.

Call Forwarding: Call Forward is initiated when the LAU user takes the analog loop off hook and dials the appropriate initiating DTMF code, followed by the number to be forwarded to, then terminated by the appropriate termination sequence (either "#" or Autosend). The B/S responds with a confirmation tone.

Cancel Call Forwarding:	Call Forward is canceled when the LAU user sends the appropriate cancellation code to the B/S.
Message Waiting (Stutter Dial Tone):	Implementation of this feature is provided through either the FLASH_WITH_INFORMATION message or FEATURE_NOTIFICATION message**.** Upon receipt of the appropriate information from the B/S, the LAU will apply a suitable stuttered dial tone when an off hook condition is detected on the analog loop interface. In addition, an appropriate CLID format Message Waiting indication will be provided to activate the Message Waiting indicator on any attached CLID device.

3.1.6. Special Notes.

There are certain special conditions which are considered in the software operation, and are defined below.

- **The "Glare" Condition:** The LAU must provide dial tone to an external telephone immediately when an off hook condition is detected, as long as a valid PILOT channel is present. However, this means that a user could be in the process of dialing a call when a call comes in from the network, because the network is not aware of the off hook condition.

  The LAU handles the "glare" situation as follows:

  1. The incoming call will cause the LAU to apply a Call Waiting tone to the analog loop interface.
  2. When the Call Waiting tone is received by the user, two options exist. In the first option, the user may connect immediately to the incoming call by flashing the loop interface. When the flash is received, the LAU will establish the voice path to the incoming call. The second option is for the user to hang up the handset. In that case, the LAU will apply ring signal to the analog loop, and the voice path will be established when the handset is lifted.
  3. If the far end disconnects before the voice path is established (via the above process), then dial tone is returned to the loop interface, and digit collection begins again from the first entered digit

  In either case, the LAU will discontinue the process of collecting dialed digits if an incoming call indication is received prior to sending the dialed digits to the B/S.

3.1.7. Emergency Numbers.

The product will accept certain three digit emergency numbers and will send them without waiting for any special termination or SEND operation.
Also System provider can set **Emergency Call Hold** information to prevent terminate the call by subscriber if the call is Emergency call.

3.2. Hardware Interfaces.

The following sections detail the general requirements of the LAU's hardware / software interface.

3.2.1. Line Interface Module.

The Line Interface Module provides the hardware voice and data interface between the external telephone device and the Qualcomm MSM. The LIU control software must support these functional requirements.

1. Configuration and state control signaling for the LIU SLIC device. The parameters which are set include:
   - Loop Start / Ground Start operation.
   - Loop voltage level (on hook or off hook)
   - Ringing state.
   - Forward Disconnect control.
   - Low Power Scan mode.
2. Hook switch status sensing.
3. Conversion of digital Caller Identification information into analog data, which is then transmitted across the analog interface.

3.2.1.1. SLIC Operation.

The SLIC has four inputs for control; B0, B1, B2, BR. These 4 lines control what state the SLIC is in. The possible states for the SLIC are:

B0	B1	B2	BR	State
1	1	0	1	Power Up Forward -24 V
1	0	0	1	Power Up Reverse -24 V
1	1	1	1	Power Up Forward -65 V
1	0	1	1	Power Up Reverse -65 V
0	1	1	1	Ground Start
0	*1*	*1*	*1*	*Low Power Scan*
0	X	0	1	Forward Disconnect
1	X	1	0	Ring State

Values in *italics* are initial conditions at power-up.

The SLIC is initialized to Low Power Scan, at unit power up. When the phone is on hook in the idle state the SLIC will be in Low Power Scan. When the phone goes off hook (either originating or answering incoming call), the SLIC will be in Power Up Forward -24 V (the -24 V and -65 V inputs are outputs of the power supply board which is explained later).

When alerting for an incoming call the SLIC will go to the Ring State. The ringing of the phone is controlled by a 20 Hz square wave output on B1, the normal ring cadence is 2 seconds on, 4 seconds off. Different ring cadences are available, and are selected via switches within the MSM controller software, or by commands received over the J-STD-008 air interface.

The MSM accepts the Off Hook Int output of the SLIC card as and input into the Keysense 0 pin (normally used to sense a keypress on the mobile to set off an interrupt to wake the phone from Sleep mode). This Off Hook Int output is High when the phone is on hook and goes to Low when the phone is off hook (the off hook low transition is <u>not</u> a transient). The interrupt is called so the incoming call alert (phone

ringing) will stop immediately when the phone goes off hook. This line must be debounced due to the fact that it briefly pulses low when ringing is started.

3.2.1.2. Caller ID Circuit Operation.

The Caller ID circuit consists of simple 8 bit microcontroller, followed by a summing network and amplifier, and finally a low pass filter. The microcontroller is serially connected to the MSM controller. Serial caller identification information is transmitted to this D/A at 38.4 kbps, after the MSM enables the CID_CTO_0 (CID ENABLE) control line. The MCU then formats the data into the appropriate CID format, as indicated by the data header information. This serial data is then used to control the 8 bit output into the ladder network / summing amplifier circuitry. The outputs are stepped to create a continuous phase sine wave output, whose frequency is modulated according to the requirements of the CID standard. The sine wave is amplified, low pass filtered, then applied to a summing point on the analog loop interface.

3.2.2. Power Supply Module.

The power supply board has two control inputs, as shown below.

Control Signal	State	Function
DCDC_0	0 - Power Supply is OFF. **1 - Power Supply is ON.*	-65/-24Vdc Power Supply ON/OFF control.
DCDC_1	0 - Off Hook Loop Voltage = -24 Vdc. *1 - On Hook Loop Voltage = -65 Vdc.*	Loop Voltage control.

Values in *italics* are the settings at power-up
* DCDC_0 must stay 0 till SLIC mode is initialized.

The power supply is controlled via the MSM processor, and is turned on immediately after power is applied to the product. The operating voltage level is determined by the hook switch status, as indicated in the above table.

3.2.3. Battery Management Module.

The Battery Management module has two control inputs, as shown below.

Control Signal	State	Function
BATT_OFF	*0 - Battery is ON.* 1 - Battery is OFF.	Battery source power control.
CHG_OFF	*0 - Charger circuit is ON.* 1 - Charger circuit is OFF.	Loop Voltage control.

Values in *italics* are the settings at power-up.

The battery control circuit is used to turn the battery off if the battery voltage falls below a safe operating range while the unit is being powered by the battery.

CHG_OFF is used to turn the charging circuit on and off. The charger circuit is turned off when either of the following events occur:

- the unit goes from AC to battery power.

- the housing's internal temperature falls below -15(+/-5)°C.
- the housing's internal temperature rises above 50(+/-5)°C.

The Battery Management module has three outputs, as shown below.

Output	Signal Type	Function
AC_POWER	Analog	Indicates whether AC power is present. MSM ADC levels as follows: • ADC <= 0x4D: No AC. • ADC > 0x4D: AC present.
BATT_TEMP	Analog	Battery Temperature monitor. Set-points are placed for both the low and high temperature limits.
V_BATT	Analog	Indicates battery voltage level. The following conditions are tested: • V_BATT <= 0x86: Battery is low.

Values in *italics* are the settings at power-up.

The Battery Management circuit has three analog outputs, shown above, which are fed into the MSM ADC through the MSM pin BATT_THERM. The control of which output is connected to the MSM input pin is through an analog MUX.

AC_POWER is monitored to determine if AC_POWER is present or not. If AC power is not present, then the unit is running on battery power. If this is the case then the software will go to the battery voltage monitoring state.

The software monitors the battery voltage through the output V_BATT. If the V_BATT reading from the ADC drops below the minimum set point for more than one second, the battery is shut off.

If AC_POWER is present, the software shall go into the Temperature Monitoring state. In this state the software monitors the battery temperature through the output BATT_TEMP. If a Temperature Out Of Range condition is detected the charger is shut off. Otherwise, the charger remains on.

3.2.4. GPIO Expansion Bus.

The purpose of the GPIO Expansion Bus is to serially expand the available four MSM GPIO control lines into 16 outputs. These four control lines, and their functions, are defined below:

GPIO Pin	Signal Name	Function
GPIO_2	GPIO_EXPAND_CS	Strobes data to outputs of shift registers.
GPIO_3	GPIO_EXPAND_CLK	Clocks data into the registers serially.
GPIO_4	GPIO_EXPAND_DATA	Data to be clocked in.
GPIO_19	GPIO_EXPAND_ENAB	Chip enable. Outputs of shift registers are enabled when this bit is set to "1".

Values in *italics* are the settings at power-up.

The bus is initialized by clocking 16 zeroes with the GPIO_EXPAND_ENAB set low. After the data is clocked in it is strobed to the output of the registers by a low to high transition on the

GPIO_EXPAND_CS line. GPIO_EXPAND_ENAB is then set high and remains in this state until power down.

To set an output on the bus all 16 bits must be shifted in, therefore when calling the bus it is necessary to send a mask of the bits which are to remain unchanged, along with the new values of changed bits.

The state of the expansion bus is kept in a global static variable. Any number of bits can be changed during one call to the gpio_exp_out function. After all 16 bits are clocked in a high to low transition on GPIO_EXPAND_CS strobes the bits to the outputs.

Sets of bits on the bus that are control lines for certain hardware (B0,B2,BR on the SLIC for example) have been defined by one mask so that only one call to the gpio_exp_out function is needed.

3.2.5. Analog Multiplexer (MUX).

An analog multiplexer is utilized to allow more than one input to the BBASIC ADC. The analog mux has three input select lines which are outputs of the GPIO of MSM.
These select lines determine which line is to be input to the BBASIC ADC.

The MUX currently has six (6) inputs from CDMA Module, Battery management Module.(PA_TEMP, PA_DET, AC_POWER, MAIN_TEMP, V_BATT, Vref(2.084Volts).

The MUX is initialized to select X4, which a reference voltage to calibrate A/D converter.

ADC INPUT	MUX INPUT	GPIO SETTING
Vref(2.084Volts)	X4	GPIO13(2^2)=1, GPIO12(2^1)=0, GPIO11(2^0)=0
AC_MONI	X0	GPIO13(2^2)=0, GPIO12(2^1)=0, GPIO11(2^0)=0
MAIN_TEMP (BATT_TEMP)	X2	GPIO13(2^2)=0, GPIO12(2^1)=1, GPIO11(2^0)=0
V_BATT	X3	GPIO13(2^2)=0, GPIO12(2^1)=1, GPIO11(2^0)=1
PA_DET	X5	GPIO13(2^2)=1, GPIO12(2^1)=0, GPIO11(2^0)=1
PA_TEMP	X7	GPIO13(2^2)=1, GPIO12(2^1)=1, GPIO11(2^0)=1

3.2.6. LED Indicators.

The user interface consists of three LEDs , IN_SERVICE, POWER, and DISRUPTION.

The DISRUPTION LED is controlled directly by hardware. It indicates ON when any one of a limited number of internal hardware failures occur.

The IN_SERVICE indicator is controlled by outputs of the gpio_expansion bus. This LED indicates ON if a CDMA pilot channel has been acquired. This LED will be turned on/off within 10 seconds (maximum) of the software detecting in service/out of service.

The POWER indicator is also controlled by an output from the gpio_expansion bus, and indicates Battery power or AC power. LED solidly on indicates the LAU is running from AC power. A flashing LED indicates that Battery is supplying the power source.

The LEDs are initialized to OFF.

3.3. User Interface Specification.

The key requirement of the SAU-1900E's User Interface involves it's interaction with the external telephone set. Most of these interface requirements have been detailed in previous paragraphs. Those which have not are further defined below.

3.3.1. Product Configuration.

The software configuration requirements for the SAU-1900E are divided into two categories. The first involves J-STD-008 System Configuration parameters, and the second are Product Configuration parameters. The details of each are outlined in subsequent sections.

3.3.1.1. Interface Hardware Description.

The Configuration Interface for the product consists of two items. The hardware component is an RS-232 level converter adapter, which interfaces between the LAU's 7 PIN MINI-DIN service connector and the serial port on an IBM-compatible computer. The software component is a Windows 3.1 / Windows '95 software package which guides the user through the various product configuration options, and provides the necessary LAU programming control.

3.3.1.2. Configuration Requirements for J-STD-008 System Interface.

The following parameters are necessary parts of the LAU's J-STD-008 software protocol. Many of these values are set by the manufacturer, and cannot be changed by non-factory personnel. Others can be configured at any time using the special product hardware and software programming tools described above.

Parameter Name	Function	Memory Type	Programming Requirements
ESN	Product's permanent electronic serial number.	Permanent	• Factory Yes • Field No • End User No
SCM	Product's station class mark assignment.	Permanent	• Factory Yes • Field No • End User No
SLOT_CYCLE_INDEX	Product's required slot cycle index, for slotted mode operation.	Permanent	• Factory Yes • Field No • End User No
MOB_P_REV		Permanent	• Factory Yes • Field No • End User No
MOB_FIRM_REV	Firmware revision number.	Permanent	• Factory Yes • Field No • End User No
MOB_MODEL	Product model number.	Permanent	• Factory Yes • Field No • End User No
WARRANTY DATE CODE	Date of manufacture, for warranty purposes.	Permanent	• Factory Yes • Field No

			• End User No
SECURITY CODE	Code number required for changes to any stored NV parameter.		• Factory Yes • Field No • End User No
FIELD SERVICE CODE			• Factory Yes • Field TBD • End User No
LOCK CODE	A parameter used in mobile handset applications to allow users to lock the handset.	Semi-Permanent	The need for this feature in a WLL application is questionable. Implementation is TBD.
NAM entries (4 total)	***The mobile application supports up to 4 NAMs. It is questionable whether more than 1 NAM is needed per unit for the WLL application.*** Each NAM contains the following parameter: • NAM name. • Directory Number. • Access Overload Class. • CDMA Phone Number. • Mobile Country Code. • Mobile Network Code. • CDMA Primary Channel A. • CDMA Primary Channel B. • CDMA Secondary Channel A. • CDMA Secondary Channel B. • CDMA SID Term Reg. • CDMA Foreign SID Term Reg. • CDMA Foreign NID Term Reg. • SID-NID pairs (4). • Lock SID List. • Preferred Server.	Semi-Permanent	• Factory Yes • Field TBD • End User TBD
Current NAM	***This is a User Preference setting, which may have little application in the WLL environment.***		
Auto NAM	***Same comments as above.***		

3.3.1.3. LAU Application-Specific Hardware Configuration Requirements.

Most of following Application-specific features of the product are required to be programmable but some of them are hardcoded.
* NV_WIN is Windows based LAU programming software

Feature	Comments	Program Values	Programming Requirements

WLL_NV_SIZE	Total count of NV parameters for NV_WIN compatibility.	• TBD	• Hard coded
WLL_FIRM_REV	LAU Firmware revision for NV_WIN compatibility.	• Put firmware revision code.	• Hard coded
WLL_FIRM_FREQ	LAU frequency information for NV_WIN compatibility.	• 1900 for SAU-1900E	• Hard coded
Dialed Digits Autosend time out (AUTOSEND)	Set time out delay for Autosend feature. Also see DDT_TIMEOUT	• Time Delay in mS.	• Factory Yes • Field Yes • *End User No*
Autosend "xx #" Digit Sequence (SND_PND2)	If ENABLED, the processor will accept a "#" button in the third digit position as part of the dial sequence, and will not treat it as a SEND command. The next occurrence of the "#" button will cause a SEND. If DISABLED, then any occurrence of the "#" button after the first digit will cause a SEND function. "#" will always be part of the dial sequence if it occurs in the first digit position. The "#" as SEND option can be enabled or disabled, subject to the rules of that feature.	• Feature ON/OFF.	• Factory Yes • Field Yes • *End User No*
Autosend "xxx #" Digit Sequence (SND_PND3)	If ENABLED, the processor will accept a "#" button in the fourth digit position as part of the dial sequence, and will not treat it as a SEND command. The next occurrence of the "#" button will cause a SEND. If DISABLED, then any occurrence of the "#" button after the first digit will cause a SEND function.	• Feature ON/OFF.	• Factory Yes • Field Yes • *End User No*

	"#" will always be part of the dial sequence if it occurs in the first digit position. The "#" as SEND option can be enabled or disabled, subject to the rules of that feature.		
VOC RX Gain (VOC_INDEX)	CODEC gain in received voice path.	• Gain level.	• Factory Yes • Field Yes • *End User* *No*
Auto Send enable (DDT_BYPASS)	When enabled, causes the LAU to automatically transmit all gathered digits to the B/S at a programmable time after the last detected digit is received. Dialed Digits Manual Send may be enabled concurrent to this feature.	• Feature ON/OFF.	• Factory Yes • Field Yes • *End User* *No*
Dial Tone (DIAL_TONE)	Applied to the analog loop audio path by the LAU when the loop interface enters the OFF HOOK condition, in response to user's intent to place an outgoing call. Terminated upon receipt of first dialed digit.	• Frequency 1 • Frequency 2 • Amplitude	• Factory Yes • Field Yes • *End User* *No*
Reorder Tone (REORDER_TONE)	Applied to the analog loop audio path by the LAU when the CDMA system cannot be accessed.	• Frequency 1 • Frequency 2 • Amplitude	• Factory Yes • Field Yes • *End User* *No*
Receiver Off Hook Tone (ROH_TONE)	Applied to the analog loop audio path by the LAU when the external loop has been in the off hook condition with no call in progress for a period of time.	• Frequency 1 • Frequency 2 • Amplitude • Duration • Delay to Start	• Factory Yes • Field Yes • *End User* *No*
Custom Recall Tone (RECALL_TONE)	Custom recall tone. Currently not used on SAU-1900E	•	•
Marginal Pilot threshold (MARGINAL_PILOT)	Set marginal pilot threshold point so LAU can blink signal led when receive weak signal)	• Threshold	• Factory Yes • Field *Yes* • *End User* *No*

Stutter Dial Tone (STUTTER_DIAL_TONE)	Applied to the analog loop audio path by the LAU when the external loop goes to the off hook condition (except in response to an incoming call) if a Message Waiting signal has been sent to the LAU by the B/S.	• Frequency 1 • Frequency 2 • Feature ON/OFF.	• Factory Yes • Field Yes • *End User No*
Busy Tone (BUSY_TONE)	Applied to the analog loop audio path by the LAU when the CDMA far end party line is busy	• Frequency 1 • Frequency 2 • Amplitude	• Factory Yes • Field Yes • *End User No*
Battery Low Tone (BATTERY_LOW_TONE)	Applied by the LAU to the loop's audio path, at increasing close intervals, when the internal battery voltage falls to within 10 minutes of terminal charge level.	• Frequency 1 • Frequency 2 • Amplitude. • Numbers of beeps.	• Factory Yes • Field Yes • *End User No*
Dialed Digits Manual Send (ENABLE_PND_KEY)	When enabled, forces the user to press the "#" button to send gathered digits to the B/S. If this feature is disabled, then the Dialed Digits Autosend feature must be enabled.	• Feature ON/OFF.	• Factory Yes • Field *Yes* • *End User No*
Massage Waiting (MSG_WAITING)	Indicate massage waiting status	• True/False	• Controlled by Massage waiting information over the Air • Will be cleared when user check up the massage(voice massage)
Enable EVRC (EVRC_ON)	ENABLE EVRC audio vocoding.	• True/False	• Factory Yes • Field *Yes* • *End User No*

3.3.2. Product Test and Maintenance.

The Test and Configuration software package will provide the capability to test each of the following LAU features.

- Visual display of LAU / telephone status (i.e., No Service, Conversation, etc.).
- RF link tests (signal quality measurements and other available link parameters).
- Hook switch status indication.

- Ringer test.
- System parameters monitor (Cell ID, B/S ID, FER, RSSI, others to be defined).

The software package will also provide these additional capabilities:

- Programmed read/write of LAU's NVRAM data.
- Programmed write of new LAU operating software.

4. Replaceable and Optional Components.

The following components will be replaceable items.

- Battery (Sealed lead acid, 12 V, 2 Ahr, Yuasa NP2-12 or equivalent)
- Transformer (Market specific)
- Antenna (fixed - Maxon PN :509-277)
- Remote antenna (definition and PN TBD)
- Test / Configuration software package (Maxon PN TBD).
- Test / Configuration hardware interface unit (Maxon PN TBD).
- Telephone system interface cable (RJ-11, 200mm,Maxon PN:423-753-2A and RJ-11, 1950mm, Maxon PN:423-754-3A).