6 - Baseband Description and Troubleshooting

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Abbreviations

ACI	Accessory Interface
APE	Application Processor Engine
ASIC	Application Specific Integrated Circuit
ASIP	Application Specific Integrated Passive
BB	Baseband
BT	Bluetooth (Low range radio link standard)
CCS	Customer Care Solution
CMT	Cellular Mobile Telephone
COG	Chip on Glass
CSR	Cambridge Silicon Radio
DAC	Digital to Analog Converter
DC/DC	Switched mode power supply
DCT4.x	Digital Core Technology, fourth.x generation
DSP	Digital Signal Processing
EEPROM	Electrically Erasable Programmable Read Only Memory
EM	Energy Management
EMC	Electro Magnetic Compatibility
EMIFF	External Memory Interface Fast
EMIFS	External Memory Interface Slow
ESD	Electro Static Discharge
FBUS	Serial bus
FPWB	Flex Printed Wiring Board
FM	Frequency Modulation
GSM	Global System for Mobile communications
HSCSD	High Speed Circuit Switched Data
HW	Hardware
IC	Integrated Circuit
IMEI	International Mobile Equipment Identity
IO	Input / Output

LDO	Low Drop Out
LoSSI	Low Speed Screen Interface
MBUS	Serial bus
MCU	MicroController Unit
MMC	Multi-Media Card
MCBSP1	Multi-channel Buffer Serial Port
NAND	Flash memory cell type
OMAP	Open Multimedia Architecture Platform
OSP	Organic Solderable Preservative
PA	Power Amplifier
PWB	Printed Wiring Board (same than PCB)
RF	Radio Frequency
RTC	Real Time Clock
SDRAM	Synchronous Dynamic Random Access Memory
SPI	Serial Perpheral Interface
SPR	Standard Product Requirements
SW	SoftWare
UART	Universal Asynchronous Receiver Transmitter
UEMEK	Universal Energy Management ASIC (DCT4 EM asic)
UI	User Interface
UPP	Universal Phone Processor ASIC (DCT4 processor asic)
USB	Universal Serial Bus
ViSSI	Video Streaming Screen Interface

Baseband Top-Level Description

RAE-6/RA-4 HW architecture consists of:

- Two colour displays
- QWERTY keyboard
- Cover keyboard
- Engine PWB

There are three PWBs: main engine board, QWERTY flex and UI flex. Both displays and the cover keyboard are connected to the engine via the UI flex. The QWERTY keyboard is connected to the engine through a QWERTY controller.

RAE-6/RA-4 engine PWB architecture consists of four main building blocks:

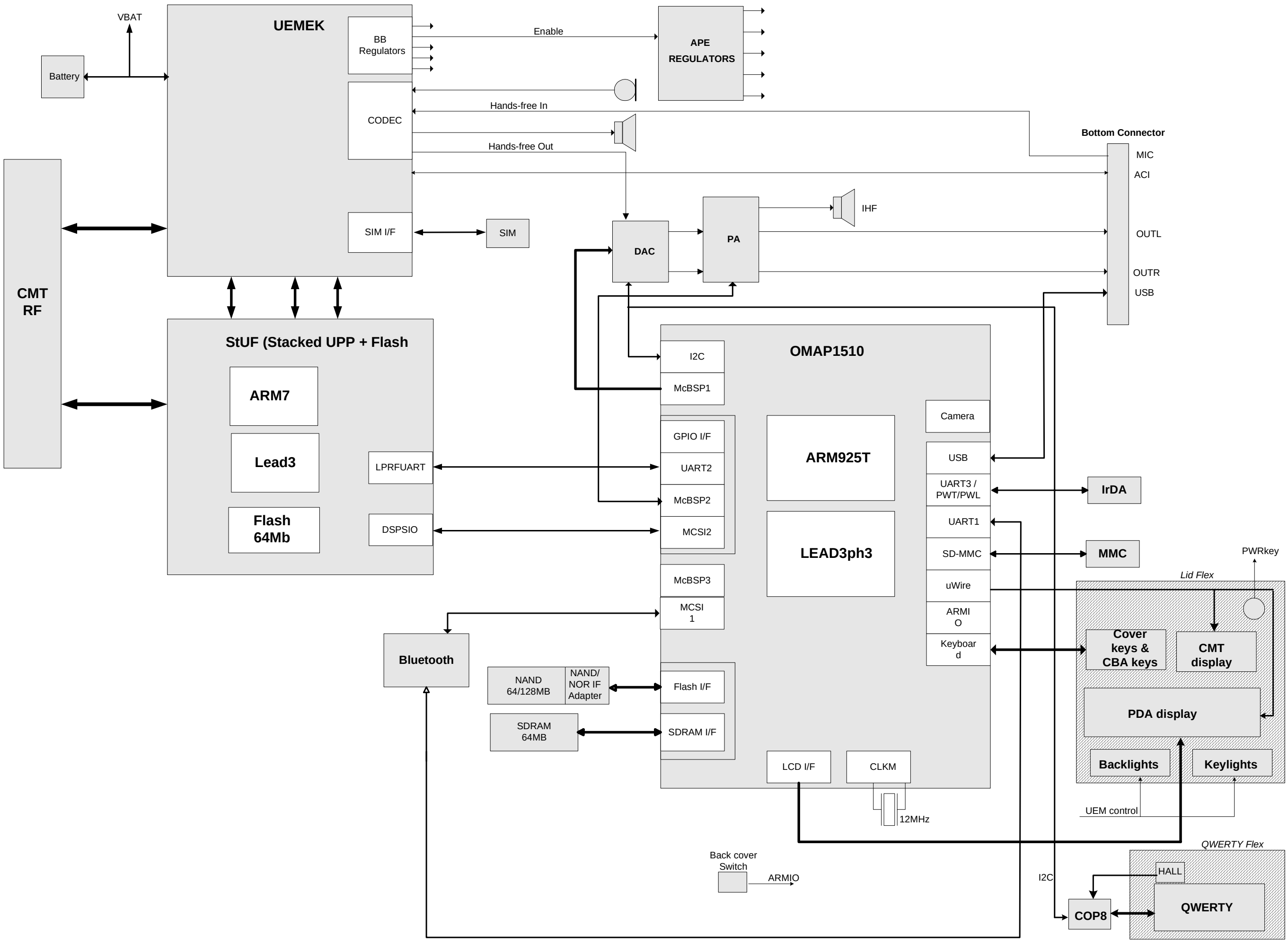
- Application Processor Engine (APE)
- Cellular Mobile Telephone (CMT)
- CMT RF

The APE part is constructed using OMAP1510 processor with external SDRAM and NAND based flash memory as the core. Other major parts for APE are power supplies, UI interfaces, audio support and Bluetooth.

APE and CMT parts are connected together by serial communication buses and by a few control lines. The APE part reset and power control comes from the CMT side. Audio control is mostly on the APE side. APE and CMT operate with no clear master-slave nomination.

The diagram below shows a high level block diagram of RAE-6/RA-4.

Figure 1:Simplified RAE-6/RA-4 block diagram



Operating conditions

Absolute maximum ratings

Table 1: Absolute maximum ratings

Signal	Note
Battery Voltage (Idle)	-0.3V - 5.5V
Battery Voltage (Call)	Max 4.8V
Charger Input Voltage	-0.3V - 16V

Battery voltage maximum values are specified during active charging.

DC characteristics

Table 2: Battery voltage range

Signal	Min	Nom	Max	Note
VBAT	3.1V	3.6V	4.2V (charging high limit voltage)	3.4V SW RF cut off

Battery maximum voltage is specified when charging switch is disconnected after/between charging pulses.

Temperature conditions

Full functionality is achieved in the ambient temperature range -15 ^{o}C to +55 ^{o}C. Reduced functionality between -25 ^{o}C to -10 ^{o}C and +55 ^{o}C to +70 ^{o}C.

The required storage temperature is -40 ^{o}C to +85 ^{o}C.

ESD immunity

SPR limits are 8kV for galvanic contact and 15kV for air discharge with normal and reversed polarity.

Functional Description of CMT

The CMT architecture of RAE-6/RA-4 is based on DCT4 Common Baseband. The main functionality of the CMT baseband is implemented into two ASICs: UPP (Universal Phone Processor) and UEMEK (Universal Energy Management).

32Mbit NOR flash is used to store the program code. For a simplified block diagram of the RAE-6/RA-4 CMT baseband, see Figure 2, “Simplified CMT baseband block diagram” on page 13.

System clock for the CMT is derived from the RF circuits. For GSM it is 26 MHz. The low frequency sleep clock is generated in the UEMEK using an external 32.768 kHz crystal. The I/O voltage of the CMT baseband is 1.8V and the analog parts are powered from 2.8V power rails. The core voltage of UPP can be altered with SW depending on the prevailing processing power requirements.

UEMEK is a dual voltage circuit. The digital parts are running from the baseband supply (1.8V) and the analog parts are running from the analog supply (2.8V). Some blocks of UEMEK are also connected directly to the battery voltage (VBAT). UEMEK includes 6 linear LDO (low drop-out) regulator for the baseband and 7 regulators for the RF. It also includes 4 current sources for biasing purposes and internal usage.

Some parts of the SIM interface have been integrated into UEMEK. The SIM interface supports only 1.8V and 3V SIM cards. Data transmission between the UEMEK and UPP is handled via two serial buses: DBUS for DSP and CBUS for MCU. There are also separate signals for PDM coded audio. Digital speech processing is handled by the DSP inside UPP and the audio codec is in UEMEK.

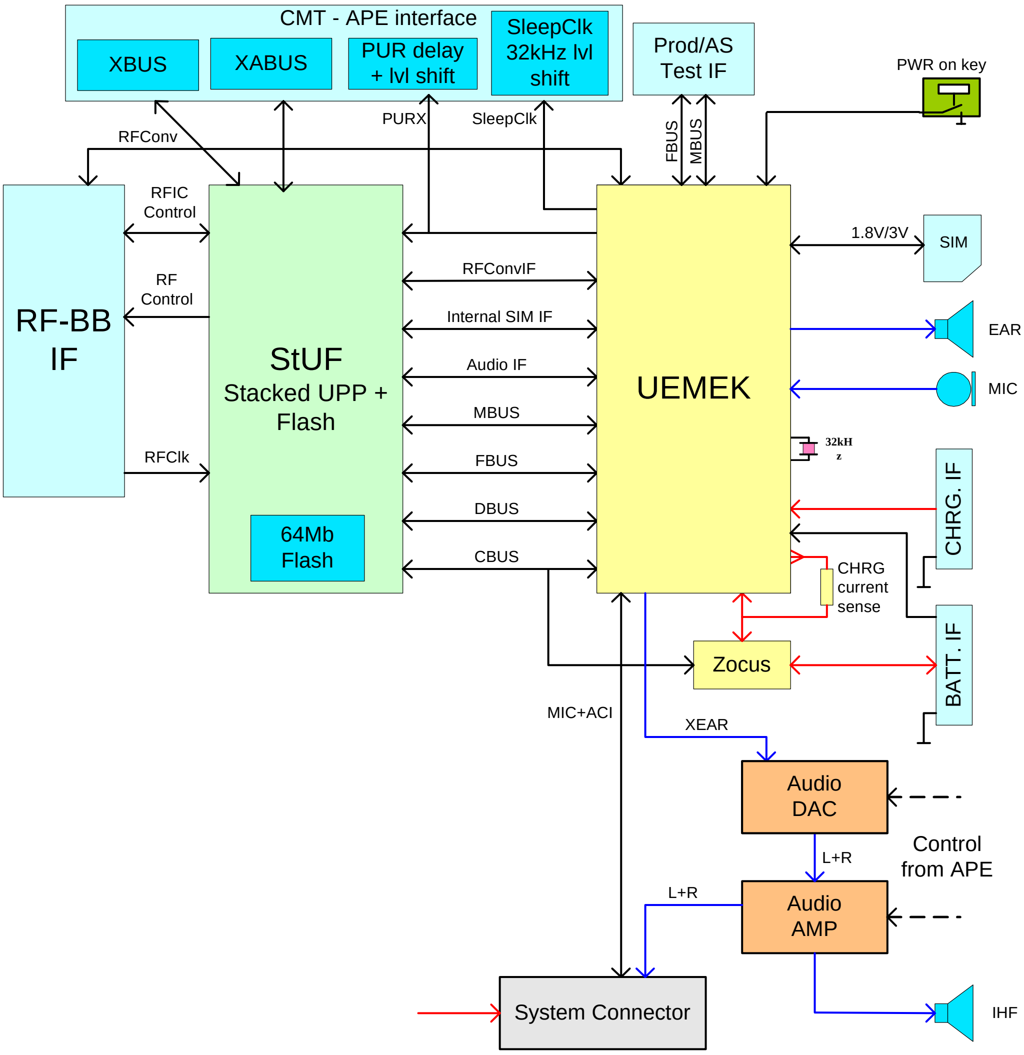
The analog interface between the baseband and the RF sections has been implemented into UEMEK. UEMEK provides A/D and D/A conversion of the in-phase and quadrature receive and transmit signal paths and supplies the analog TXC and AFC signals to RF section under the UPP DSP control. The digital RF-BB interface, consisting of a dedicated RFIC control bus and a group of GenIO pins, is located in the UPP.

The baseband side supports both internal and external microphone inputs and speaker outputs. Input and output signal source selection and gain control is performed in the UEMEK according to control messages from the UPP. Keypad tones, DTMF, and other audio tones are generated and encoded by the UPP and transmitted to UEMEK for decoding.

RAE-6/RA-4 has two galvanic serial control interfaces for CMT: FBUS and MBUS.

Communication between the APE and CMT parts is handled through 2 serial buses: XBUS and XABUS. XBUS is the main communication channel for general use, and XABUS is intended mainly for audio data transfer. Also the system reset (PURX) and SleepClk for APE are taken from the CMT side. The PURX is delayed approximately 130ms to fulfil OMAP1510 reset timing requirements. External level shifter, D4801, is used for 32 kHz SleepClk level shifting to APE.

Figure 2:Simplified CMT baseband block diagram



Interfaces between CMT and APE

XBUS

XBUS is the main communication interface between the CMT and APE parts of RAE-6/RA-4. This 6-pin interface is implemented using UART2 of OMAP1510 (APE), LPRFUART of UPP (CMT) and 2 general purpose I/O pins from both ASICs.

XABUS

XABUS is a synchronous serial interface which is used for uncompressed PCM audio data transfer between the DSPs of UPP (CMT) and OMAP1510 (APE). This interface utilises the DSPSIO of UPP and the MCSI_2 of OMAP1510. In addition to these one UPP GenIO and two dedicated pins of OMAP1510 are needed for XABUS clock generation and control.

Functional Description of APE

APE term includes not only the processor itself but also the peripherals around it, clocking, resetting and power management for these parts.

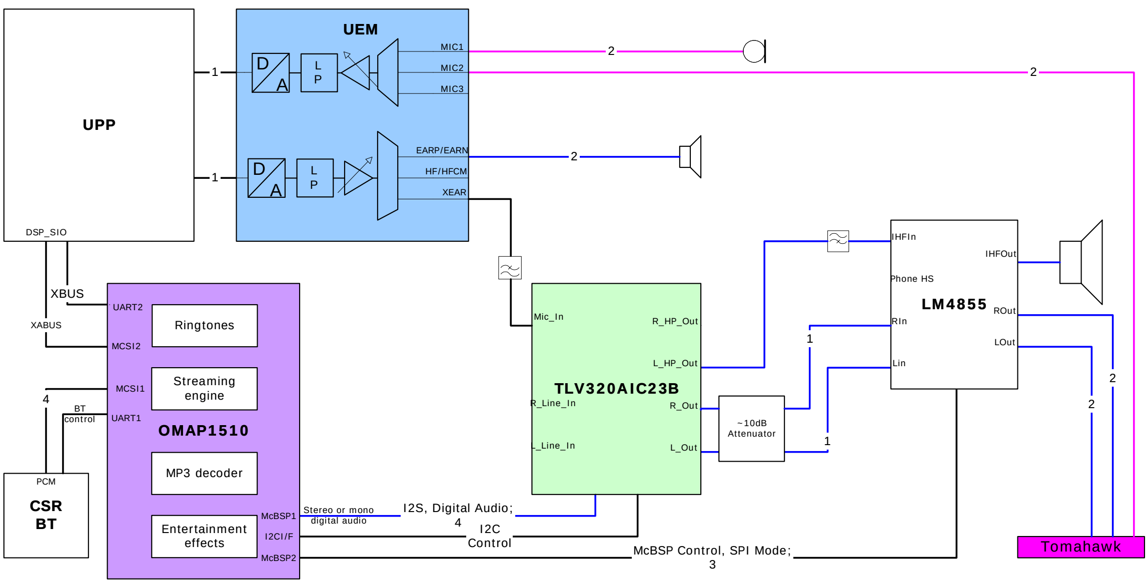
APE is based around OMAP1510 (Open Multimedia Application Platform) processor. Peripherals attached to OMAP1510 include:

- Audio DAC
- Bluetooth
- Cover display
- PDA display
- Memory card
- IrDA
- Cover keypad & command buttons
- QWERTY controller
- External SDRAM
- Flash memories

APE acts as a system slave compared to the CMT side. CMT holds the master reset and power management logic. APE and CMT are connected through a serial link called XBUS.

Audio

Figure 3:RAE-6/RA-4 Audio architecture



As RAE-6/RA-4 is based on a dual-processor architecture, audios are also divided into APE and CMT parts. Audio control is mostly on the APE side. Phone audio is routed from the CMT side to APE in analog form. On the CMT side, audio HW is integrated into the UEMEK ASIC. On the APE side, the most important parts are OMAP1510, audio DAC and audio power amplifier.

The stereo output of this amplifier is designed for use with the extended Pop-port^{TM} connector. It also has a differential mono output for driving the handsfree speaker.

The battery voltage (VBAT) is used directly as a supply voltage for the audio amplifier.

The type of DAC used is TLV320AIC23B and the supply voltage for this is coming from V28.

Audio control signals

Audio DAC is controlled via I^2C bus by OMAP1510. Digital audio data from OMAP1510 to DAC is coming via MCBSP1.

The audio amplifier is controlled through a 3-wire SPI bus (MCBSP2 of OMAP1510). Audio mode of the amplifier and gain values are controlled via SPI bus.

The HEADINT signal is needed for recognising the external device (e.g. headset) connected to system. The recognition is based on the ACI-pin of the system connector, which is shorted to ground inside the external device.

The button of the external device generates HOOKINT interrupt and is used to answer or end a phone call.

Audio modes

HP call

The basic audio mode is the hand portable mode. This is entered when no audio accessories are connected and handsfree mode is not selected by opening the cover.

The call is created by CMT. The internal earpiece is driven by the CMT engine for voice calls. The internal microphone is driven by the CMT for voice calls and voice recording. The internal microphone is enabled and uses the MICB1 bias voltage from UEMEK.

IHF call

This mode can be entered by user selection (opening the cover).

The call is created by CMT. The internal microphone is driven by the CMT for voice calls and voice recording. The internal microphone is enabled and uses the MICB1 bias voltage from UEMEK as in HP mode.

XEAR output of UEMEK is used to drive mono output signal is connected to the APE Audio DAC. Signal is then routed to the Phone_In_IHF input of the LM4855 audio power amplifier. This drives the internal speaker via the SPKRout driver.

Accessory call

This mode is used when accessory is connected to the system connector.

The call is created by CMT. The uplink signal is generated by external microphone and transferred to UEMEK MIC2 input (via XMIC signals from Pop-port^{TM} connector). Hence the MIC2B bias voltage and MIC2P/N inputs are enabled on UEMEK.

As in IHF call down link audio signal is routed through the single ended XEAR output driver in UEMEK. The mono XEAR output is connected to the DAC and then signal is routed to the L_{IN} and R_{IN} inputs of the LM4855. Accessories are driven via Pop-port^{TM} connector using the L_{OUT} driver of LM4855 audio power amplifier.

APE audio

This mode is entered when user starts the multimedia application (e.g. MP3, AAC etc.), which is played via IHF speaker or Pop-port^{TM} accessories.

Audio data from MMC is sent by OMAP1510 to the external audio DAC through the I^2S connection. The DAC performs the digital to analog audio conversion.

For playback via the internal speaker signal from DAC is routed to Phone_in_IHF input on LM4855 audio power amplifier.

For playback via the stereo/ mono headset or other Pop-port^{TM} accessories signal from DAC is routed to the L_{IN} /R_{IN} inputs of the LM4855 audio power amplifier. In case of mono accessory OMAP1510 will produce monophonic signal to DAC.

Internal interfaces

In practice, all APE internal interfaces consist of interfaces connected from OMAP1510 to peripheral devices. All UI related interfaces, memory interfaces, USB and MMC are covered in separate sections of this document.

McBSP interfaces

OMAP1510 can support maximum of three independent Multi-channel Buffer Serial Ports (McBSPs) interfaces. However, these ports are slightly different and particularly suitable for different purposes. McBSP1 supports I2S protocol and is connected to external audio codec. McBSP#2 and #3 can be used as general purpose SPI interface supporting bit rates up to 5Mbits/s. McBSP2 is used to control the audio PA. McBSP3 clock output is used as audio codec master clock. Other McBSP3 signals cannot be used because they are multiplexed with µWire signals.

MCSI interfaces

The MCSI is a serial interface with multi-channels transmission capability. MCSI1 is used to interface with Bluetooth and MCSI2 is used as XABUS (DSP-DSP bus between CMT and APE)

UART interfaces

OMAP1510 has three UART interfaces capable of 1.5Mbit/s data rates. UART1 is used as Bluetooth control interface, UART2 is used as XBUS (MCU-MCU bus between CMT and APE), UART3 includes 115.2 kbit/s IrDA modulation support, and is used to communicate with external IrDA device.

µWire interface

The µWire interface is a standard serial synchronous bus protocol with two chip select lines. Interface is used as PDA LCD control bus (CS3) and as a unidirectional data bus for the Cover display (CS0).

I^2C

The I^2C is a half-duplex serial port using two lines, data and clock, for data communications with software addressable external devices. I^2C is used as audio codec. External keyboard controller COP8 is also connected to APE via I^2C.

ARMIO

ARMIO provides 5 ARM processor controllable GPIOs by default, and 5 more are available with different multiplexing scheme. ARMIOs also include a keyboard interface. The GPIOs consists programmable debouncing circuit but can be accessed directly only by the ARM processor. Both ARMIOs and keyboard interface signals can wake-up OMAP1510 from deep sleep and big sleep states.

GPIO

14 General Purpose Input/ Output External pins are multiplexed between ARM/DSP. Multiplex logic is programmed and controlled by ARM and supports pin-by-pin configuration.

External interfaces

Back cover switch

A switch is used for back cover removal detection. A rib is attached to the back cover. A sensor gives a warning to prevent data loss or corruption when writing to the MMC card.

Lid hall switch

A hall switch is used to detect the lid position. The switch is located on QWERTY flex and is connected to COP8 controller. The magnet is in the lid.

MMC

The MMC Interface in OMAP1510 is fully compliant with the MultiMediaCard system specification version 3.1. RAE-6/RA-4 MMC interface voltage is 3 V.

USB

The OMAP1510 USB Controller is a Full Speed Device (12 Mb/s) fully compliant with the Universal Serial Bus specification Revision 2.0. The USB Client (a mobile terminal) is connected to the USB Host (a PC) through the system connector.

UI interfaces

Displays

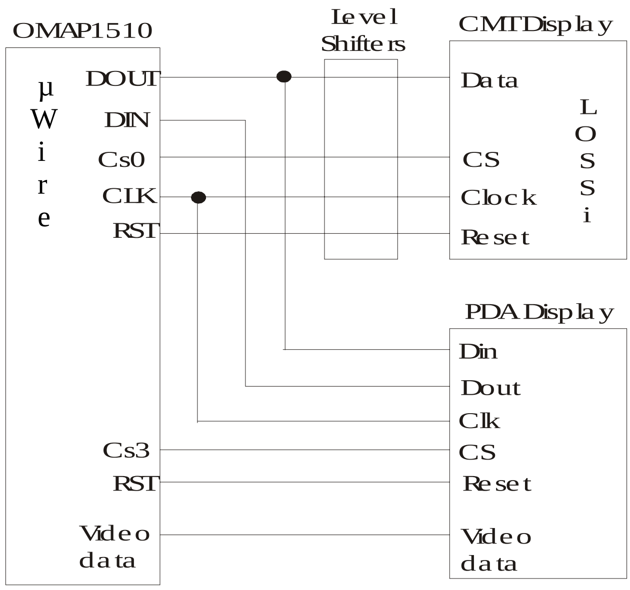
S80 display interface

S80 display utilizes the 16-bit synchronous LCD interface of OMAP1510, and µWire for control data.

Cover display interface

RAE-6/RA-4 has a separate small 64k colours display connected to OMAP1510 via µWire interface. There is an unidirectional level shifter between OMAP and the display, so no data can be read from the display.

Figure 4:Display interfaces



Keyboards

Cover keyboard and command buttons

The cover keyboard and the four command buttons are directly connected to the OMAP1510 keyboard matrix.

QWERTY

An external keyboard controller is used for the QWERTY keyboard. COP8 is connected via I^2C bus to OMAP1510 with an additional interrupt line to OMAP1510.

Power button

The power button is connected directly to UEMEK in the DCT4 engine. See Chapter Power up and system states for further details on the power button operation.

Bluetooth

A single chip Bluetooth solution, BC02, is used in RAE-6/RA-4. The chip contains radio and baseband parts as well as MCU and on-chip ROM memory. Together with some external components (filter, balun etc.) and the antenna, it forms the Bluetooth system, which is attached to the host (OMAP1510). Bluetooth components are mounted directly to the PWB.

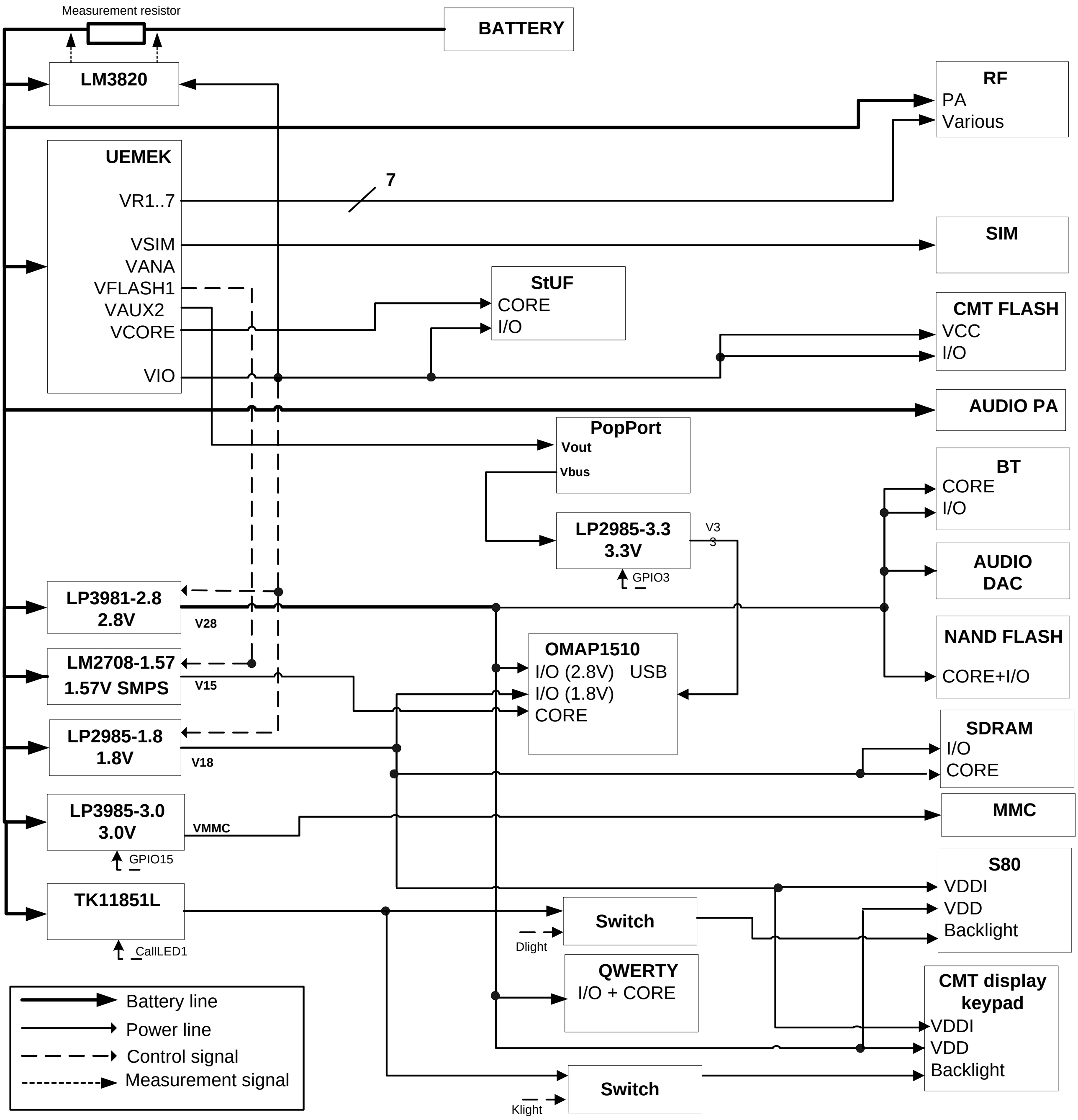
IrDA

RAE-6/RA-4 design includes a small (height 2.2 mm) metal shielded module. The modules use speeds up to 115.2kbps.

Energy Management

Energy Management covers both CMT and APE sides. Battery and charging functions are integrated into CMT Universal Energy Management (UEMEK) ASIC. UEMEK includes also all needed regulators for CMT BB and RF. APE side has its own discrete power supplies.

Figure 5:Power distribution diagram

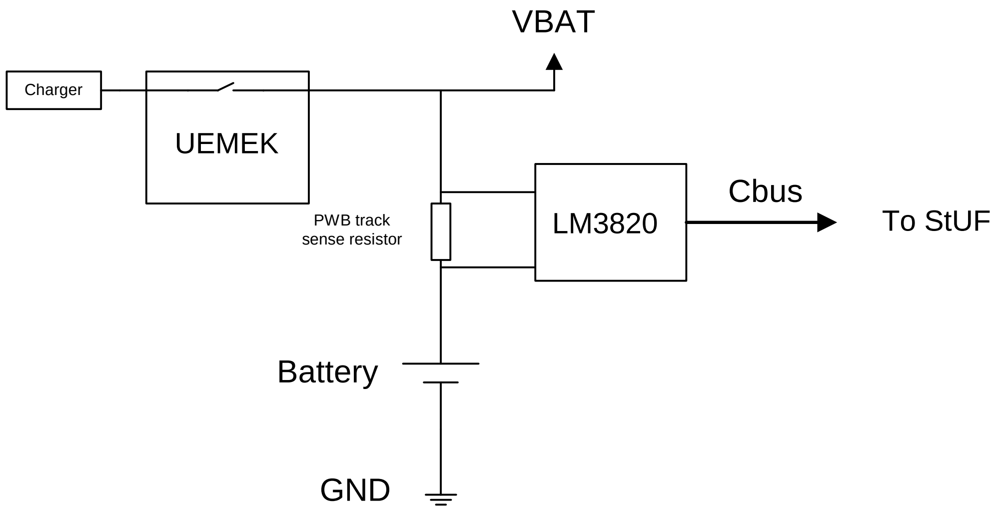


CMT EM

UEMEK includes following blocks:

- Baseband regulators (8 different LDOs)
- RF regulators (6 different 2.78V LDOs, 4.75V LDO and two current regulators)
- Power up/down logic (state machine).
- Charger switch and control

LM3820 (=Zocus-C) is the current measurement chip used for phone and charging current measurement. It can be used to estimate the battery charge level presented as battery bars on the display. Results are read with CBUS interface to the StUF.



APE EM

APE side EM HW consists of several discrete regulators (listed shortly below):

- One DC/DC converters for generating 1.57V to OMAP1510.
- One linear regulator for 2.8V APE side logic, NAND, etc.
- One 3.0V linear regulator for powering of MMC card.
- One 3.3V linear regulator for powering the USB block of OMAP1510.
- One 1.8V linear regulator for powering the SDRAM.

Battery

970 mAh Li-Po battery pack BP-6M is used in RAE-6/RA-4.

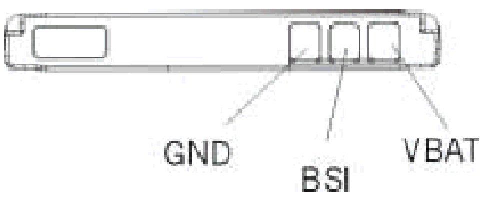
Table 3: BP-6M characteristics

Description	Value
Nominal discharge cut-off voltage	3.1V
Nominal battery voltage	3.6V
Nominal charging voltage	4.2V

Table 4: Pin numbering of battery pack

Signal name	Pin number	Function
VBAT	1	Positive battery terminal
BSI	2	Battery capacity measurement (fixed resistor inside the battery pack)
GND	3	Negative/common battery terminal

Figure 6:Battery pack contacts



Temperature and capacity information is needed for charge control.

The BSI fixed resistor value indicates type and default capacity of a battery.

NTC-resistor that measures the battery temperature is located inside the phone on the engine PWB. This resistor is connected to the UEMEK BTEMP –line.

BSI resistor is connected to the battery connector pin. Phone has 100 kOhm pull-up resistor for the line so that it can be read by A/D input in the phone.

Table 5: BSI Resistor Values

Parameter	Min	Typ	Max	Unit	Notes
Battery size indicator resistor BSI		82		kOhm	Battery size indicator for 970 mAh battery (BP-6M), Tolerance +/- 1%
NTC thermistor BTEMP (inside phone)		47		kOhm	Battery temperature indicator (NTC pulldown) 47kOhm +/- 5% @ 25C
		4000		Ohm	Beta value (B). Tolerance ”5%, 25C / 85C

Charging

RAE-6/RA-4 supports all DCT4 chargers. 3-wire chargers are supported, but 3-wire charging is not. In practice, this means that the 3-wire chargers are internally connected (charger control wire connected to GND) as 2-wire chargers. 1Hz PWM signal is used to control UEMEK's charge switch.

Backup battery and RTC

Rechargeable backup battery is used for keeping real time clock running in case the main battery is either removed or the power level is below the cutoff limit.

Real Time Clock (RTC), crystal oscillator and backup battery circuitry are inside UEMEK. Two regulators are used to provide needed voltages for external backup supply and backup battery charging: VRTC for internal clock circuitry and VBU for backup battery charging. The backup battery has voltage range VBACK = $2.0V_{min} – 3.2V_{typ} – 3.3V_{max}$ (charged to 3.2V and discharged down to 2.0V).

Display and keypad illumination

One DC-DC converter generates the voltage for displays and keypad illumination. The converter is able to supply cover display and keypad OR PDA display, but both cannot be active at the same time. UEMEK controls the DC-DC converter and selection of cover/PDA display under APE control. The brightness of both cover and PDA display can be adjusted with UEMEK PWM output. For further details, see RAE-6/RA-4 flex section.

Power up and system states

System starts automatically after the battery is inserted. The power button is connected to UEMEK PWRONX pin on the CMT side. This power button is only used for selecting operating mode and switching the RF part of the device ON and OFF when needed. APE is started when UEMEK releases a PURX-signal, which controls OMAP1510 processor reset input.

Power off happens in the lowest SW cutoff limit when UEMEK watchdog is not updated anymore by SW and after that PURX goes to reset and system power supplies are switched OFF. However also in this power OFF mode (BACK_UP mode in UEMEK) part of UEMEK is powered ON but for user the device is dead. Only way to wake up from this mode is to plug in the charger or replace empty battery with the charged one.

Operating modes

- NO_SUPPLY mode means that the main battery is not present or its voltage is too low (below UEMEK master reset threshold limit) and back-up battery voltage is too low.
- In BACK_UP mode the main battery is disconnected or empty but back-up battery has sufficient charge in it
- IN POWER_OFF mode the main battery is present and its voltage is over UEMEK master threshold limit. All regulators are disabled. Device can enter in Power Off – mode e.g. due to thermal shutdown or watchdog elapsing or VBAT falling below VCOFF-.
- RESET mode is a synonym for start-up sequence and contains in fact several modes. In this mode certain regulators and system oscillators are enabled and after they have stabilized, the system reset (PURX) is released and PWR ON mode entered.
- In POWER_ON mode SW is running and controlling the system
- SLEEP mode is entered only from PWR ON mode when system activity is low. CMT and APE sides can be in sleep mode independently from each other.

Power up sequence

RESET mode can be entered in three ways: by inserting the battery or charger, or by RTC alarm.

System Connector

RAE-6/RA-4 supports usage of Pop-Port^{TM} bottom connector. This means support for Pop-Port^{TM} stereo and mono headsets with and without ACI, USB cable.

Pop-Port consists of a charging plug socket and system connector. The Pop-Port is a feature-based interface. The accessory contains information about its features (ACI ASIC) and it is detected with a fully digital detection procedure.

FBUS accessories are not supported.

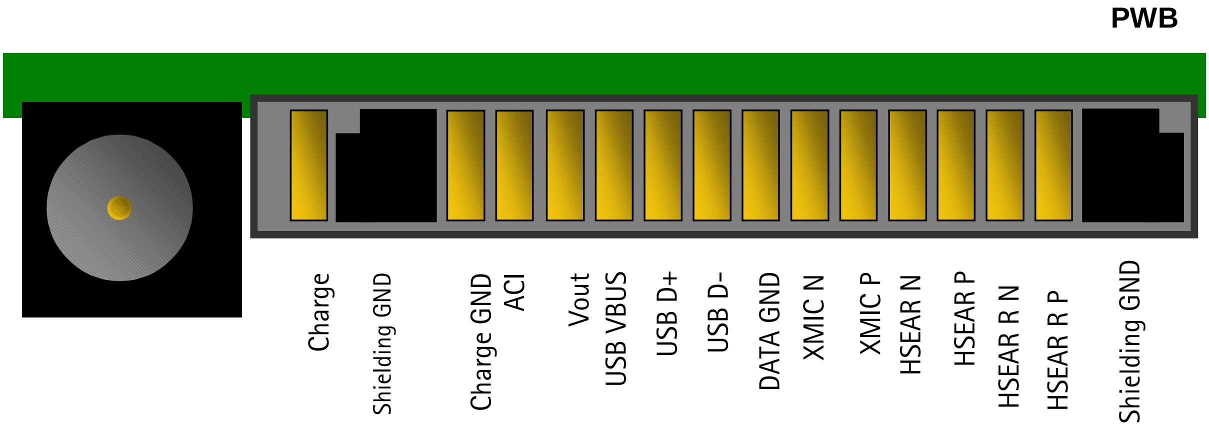
Pop-Port^{TM} connector includes VOUT pin, which is 2.78V/70mA output to accessories. VOUT voltages are: 2.43V(min.) and 2.86V(max.). In RAE-6/RA-4 2.8V VAUX2 regulator from UEMEK is used to supply accessories. Regulator output current capability is 70mA.

Four new functions are introduced with the system connector interface:

- Accessory control interface (ACI)
- Power out
- Stereo audio output
- Universal serial bus (USB)

Function	Note
Charging	Pads for 2-wire charging in cradles
Audio	4-wire fully differential stereo audio output
Power supply for accessories	2.78V/70mA output to accessories
ACI (Accessory Control Interface)	Accessory detection/removal & controlling
FBUS	Standard FBUS, Fast FBUS *Note! RAE-6/RA-4 does not support accessories using FBUS serial interface.*
USB (default)	USB v.2.0 device mode (full speed 12M)

Figure 7:Pop-Port™ connections



Pin #	Signal	Note
1	VCHAR	
2	GND	Charge ground
3	ACI	Insertion & removal detection /Serial data bi-directional 1 kbit/s
4	Vout	200mW
5	USB VBUS	
6	USB D+/FBUS RX	
7	USB D-/FBUS TX	
8	USB data GND	Data ground
9	XMIC N	Negative audio in signal
10	XMIC P	Positive audio in signal
11	HSEAR N	Negative audio out signal. Max bandwidth from the phone
12	HSEAR P	Positive audio out signal. Max bandwidth from the phone
13	HSEAR R N	Not connected or grounded in mono.
14	HSEAR R P	Not connected or grounded in mono.

Universal Serial Bus (USB)

The USB interface of OMAP1510 supports the implementation of a full speed device, fully compliant to USB2.0 standard. RAE-6/RA-4 uses an integrated USB transceiver.

Accessory Control Interface (ACI)

ACI (Accessory Control Interface) is a point-to-point, bi-directional serial bus. ACI has two main features: 1) detecting the insertion and/or removal of an accessory device 2) acting as a data bus. A third function provided by ACI is to identify and authenticate a specific accessory which is connected to the system connector interface.

All accessories cause *headint* interrupt when connected to or disconnected from the system connector. The insertion of an accessory generates a Headint interrupt by pulling the ACI line down. When no accessory is present, the UEMEK’s internal Headint pull-up resistor keeps the line high.

All accessories have common detection start sequence, when phone gets headint interrupt from high to low transition in ACI pin.

VOUT (Accessory Voltage Regulator)

UEMEK internal regulator is needed for accessory power supply purposes. All ACI-accessories require this power supply.

HookInt

The hook signal is generated by creating a short circuit between the headset microphone signals. In this case, an LP-filter is needed on the HookInt input to filter the audio signal. When no accessory is present, the HookInt signal is pulled up by the UEM resistor. When the accessory is inserted and the microphone path is biased the HookInt signal decreases to 1.8V due to the microphone bias current flowing through the resistor. When the button is pressed the microphone signals are connected together, and the HookInt input gets half of micbias DC value 1.1 V. This change in DC level will cause the HookInt comparator output to change state, in this case from 0 to 1. The button can be used for answering incoming calls but not to initiate outgoing calls.

DC-plug

RAE-6/RA-4 uses a 3.5mm DC-plug. 3-wire chargers are supported, but 3-wire charging is not. In practice this means that the 3-wire chargers are internally connected (charger control wire connected to GND) as 2-wire chargers. 1Hz PWM signal is used to control UEMEK's charge switch.

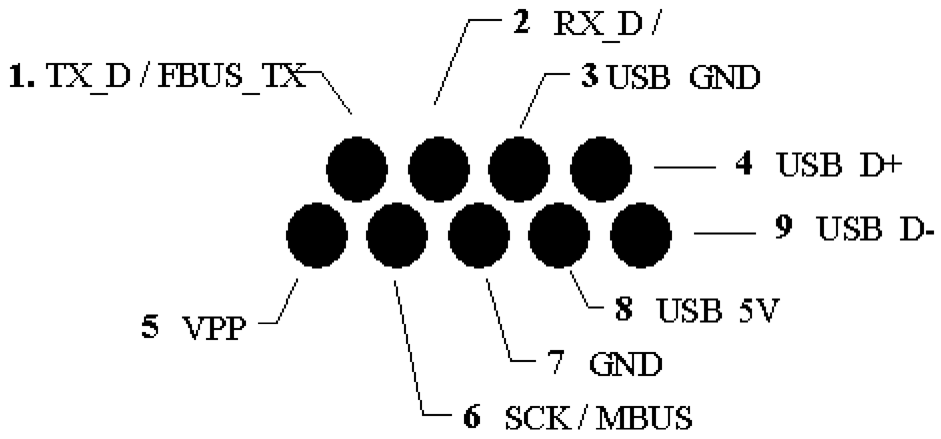
VCHAR pins of system connector

The VCHAR and ChargeGND pin are directly connected to the normal charger lines of the DC-plug.

After Sales Interface

Test pads are placed on engine PWB on battery side for service flashing and testing purposes.

Figure 8: Pin assignment in test pattern



COMPANY CONFIDENTIAL

User Interface

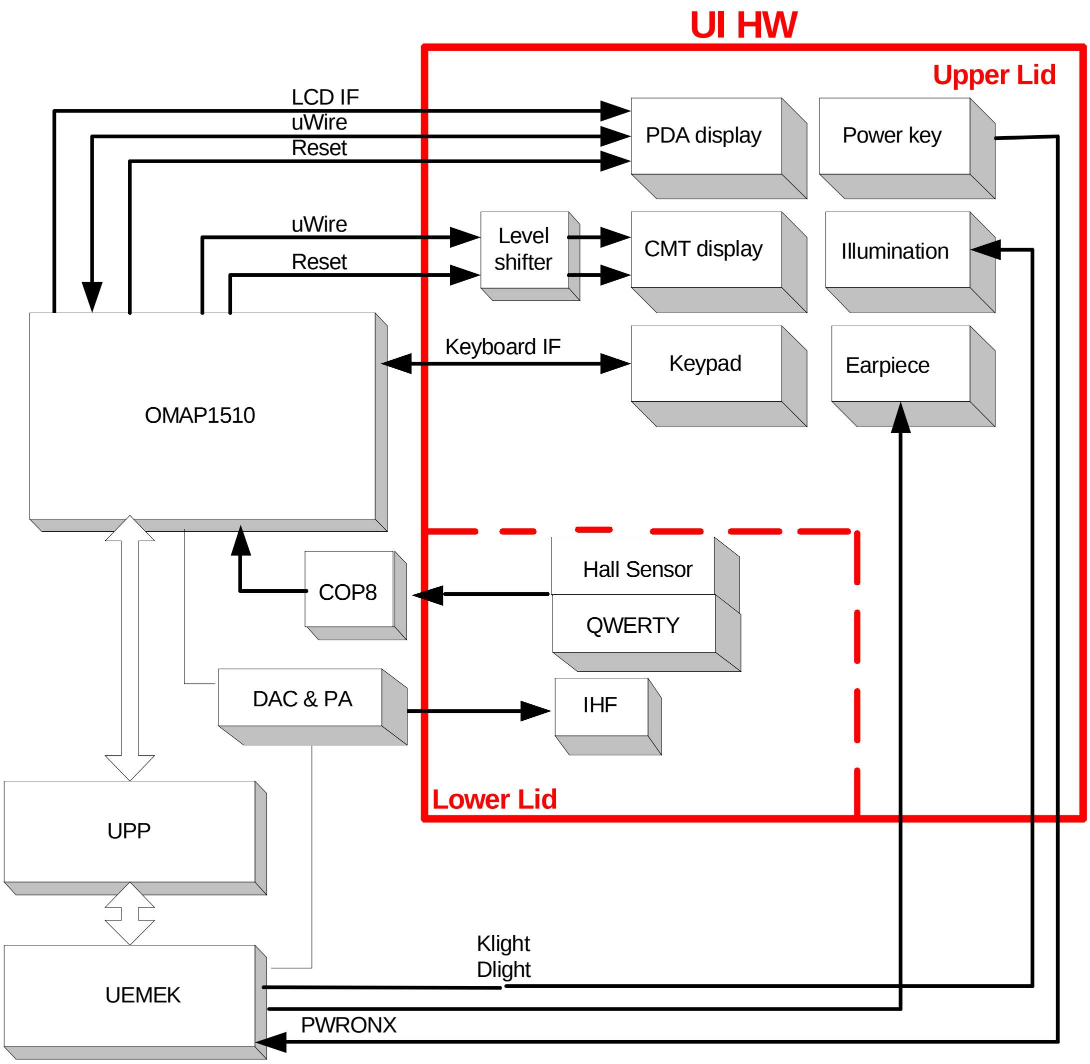
1BD is the UI flex module of RAE-6 & RA-4 (US variant) communicators locating on the upper lid and connecting the following functional blocks to phone engine:

- PDA display
- CMT display
- CMT keypad
- Power key
- Illumination
- Earpiece

In addition to the actual components to provide the needed functionality, there are some components to filter out possible EMI/ESD disturbance. Figure 9, "Block Diagram of UI HW" shows a block diagram of the UI HW of RAE-6/RA-4.

The HW UI is based on APE chip (OMAP1510).

Figure 9:Block Diagram of UI HW



Component placement and FPWB outline of 1BD

1BD FPWB board size is 150x70mm. It has a double-layer structure. Hinge part is single layer. All the components are placed on one side of the 1BD FPWB. Figure 10, “Main components of 1BD” shows the main components and all the test points of the 1BD module.

Figure 10:Main components of 1BD

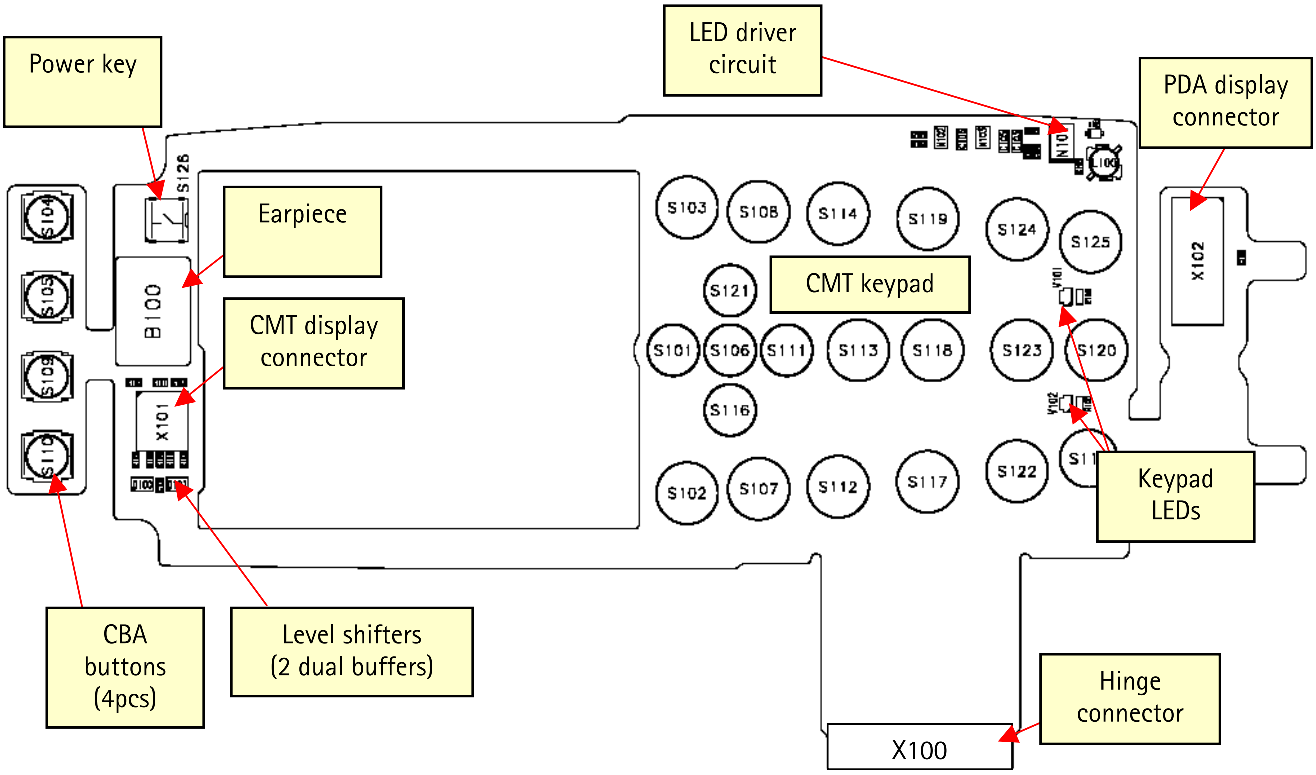
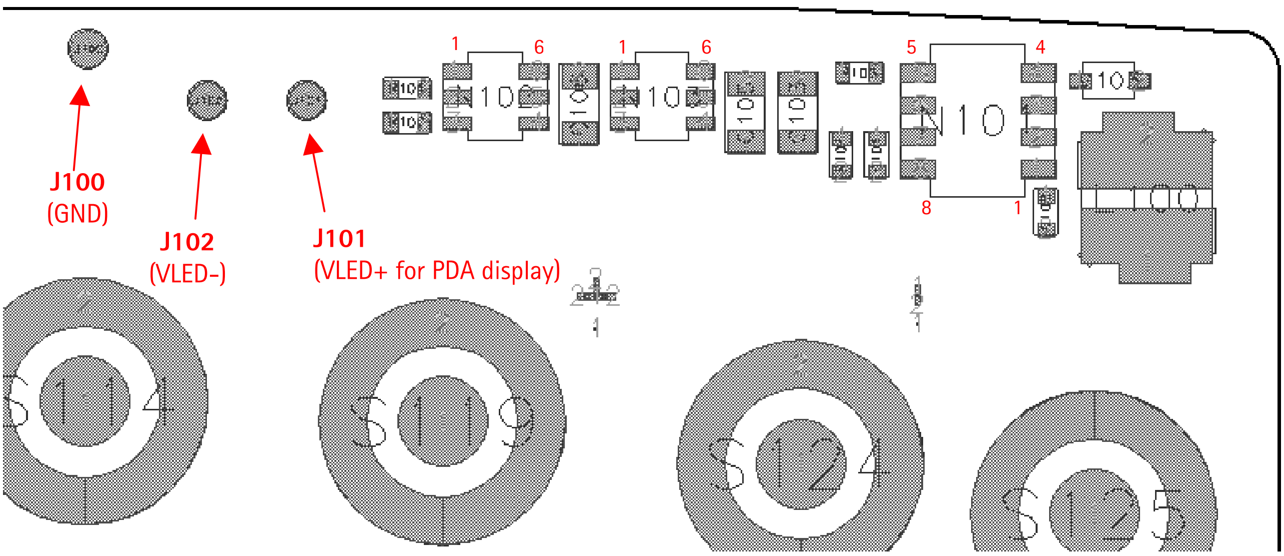


Figure 11:Test points of 1BD module



Hinge connector

Hinge connector is a 61-pin board-to-board type connector with 0,5mm pitch, which connects flex module to the engine module. Table 8 shows all the signals through hinge area of the flex.

Table 6: Signal description of the hinge flex connector X100

Pin	Signal	Pin	Signal
1	**GND** (Ground)	32	**VBAT** (supply voltage)
2	**GND** (Ground)	33	**APE_GPIO(13)** RESET for PDA display
3	**V18** (Supply voltage 1.8V)	34	**V28** (Supply voltage 2.8V)
4	**V28** (Supply voltage 2.8V)	35	**LCD(10)** (Green5)
5	**APE_GPIO(12)** (RESX for CMT display)	36	**LCD(0)** (Blue0 RGB data for PDA display)
6	**EARN** (Audio signal for earpiece)	37	**LCD(1)** (Blue1 RGB data for PDA display)
7	**EARP** (Audio signal for earpiece)	38	**LCD(2)** (Blue2 RGB data for PDA display)
8	**PWRONX** (Power-on-signal)	39	**LCD(3)** (Blue3 RGB data for PDA display)
9	**ROW0** (Row-line of keyboard matrix)	40	**LCD(19)** (DE for PDA display)
10	**UWIRE(4)** (CS for PDA display)	41	**GND** (Ground)
11	**UWIRE(3)** (CSX for CMT display)	42	**GND** (Ground)
12	**ROW2**	43	**GND** (Ground)
13	**ROW1**	44	**GND** (Ground)
14	**UWIRE(2)** (SCL for CMT and PDA display)	45	**LCD(18)** (VSYNCH for PDA display)
15	**UWIRE(1)** (SDA for CMT and SDIN for PDA display)	46	**LCD(17)** (HSYNCH for PDA display)
16	**UWIRE(0)** (DOUT for PDA display)	47	**LCD(4)** (Blue4 RGB data for PDA display)
17	**ROW3**	48	**LCD(9)** (Green4 RGB data for PDA display)
18	**ROW4**	49	**LCD(8)** (Green3 RGB data for PDA display)
19	**GND** (Ground)	50	**LCD(11)** (Red0 RGB data for PDA display)
20	**GND** (Ground)	51	**LCD(16)** (PCLK for PDA display)
21	**GND** (Ground)	52	**LCD(7)** (Green2 RGB data for PDA display)
22	**GND** (Ground)	53	**LCD(6)** (Green1 RGB data for PDA display)
23	**COL5** (Column-line of keyboard matrix)	54	**LCD(12)** (Red1 RGB data for PDA display)

24	**COL4**	55	**LCD(13)** (Red2 RGB data for PDA display)
25	**COL3**	56	**LCD(14)** Red3 RGB data for PDA display)
26	**COL2**	57	**LCD(15)** (Red4 RGB data for PDA display)
27	**COL1**	58	**LCD(5)** (Green0 RGB data for PDA display)
28	**KLIGHT** (control signal for CMT LEDs)	59	**GND** (Ground)
29	**DRVEN** (LED driver enable)	60	**GND** (Ground)
30	**DLIGHT** (control signal for PDA display LEDs)	61	**GND** (Ground)
31	**VBAT** (supply voltage)		

PDA display

PDA display is an S80L display module, 640(H) x RGB(H) x 200(V) transflective active matrix colour LCD. It is capable of showing 65536 colours (5xR, 6xG, 5xB). It incorporates a backlight system with 2x3 white LEDs connected in series.

The display has the following on-chip features: contrast control, DC/DC converter, temperature compensation and N-line inversion for low cross talk CMOS compatible inputs/outputs.

The complete display module includes LCD glass, flex cable (FPWB), driver IC and illumination system.

Interface

The PDA display has two interfaces: 16 data lines parallel video RGB interface ViSSI and optional 3-wire 9-bit serial interface LoSSI. Video interface is used for image data transfer (video and still) and serial interface is used for sending commands. GPIO13 is reset signal for PDA display.

The display is connected to the LCD interface of the OMAP1510 chip.

The interconnection between the LCD module and engine is implemented with a 40-pin board-to-board connector.

All the signals go through the hinge flex and are filtered by EMI filters.

Table 7: Interface signals of PDA display.

Pin #	Signal name (LCD)	Signal name (Engine)	Voltage level	I/O/Z	Description
1	GND	GND	0V	-	Ground
2	VLED+	Vovp (LED Driver)	Variable ~12V	-	Voltage for LEDs
3	VLED1-	Vfb1 (LED Driver)	12 / 1V	-	Return line for LEDs 1
4	VLED2-	Vfb2 (LED Driver)	12 / 1V	-	Return line for LEDs 2
5	GND	GND	0V	-	Ground
6	VDDI	V28	2.8V	I, PSU	Logic power supply voltage
7	GND	GND	0V	-	Ground
8	GND	GND	0V	-	Ground
9	VDD	V28	2.8V	I, PSU	Analog power supply voltage
10	!RES	GPIO13	0 – 2.8V	I	Reset signal
11	!CS	WIRE_nSCS3	0 – 2.8V	I	Chip select signal
12	GND	GND	0V	-	Ground
13	SCLK	WIRE_SCLK	0 – 2.8V	I	Serial clock
14	DIN	WIRE_SDO	0 – 2.8V	I	Serial data input
15	DOUT	WIRE_SDIN	0 – 2.8V	O	Serial data output
16	GND	GND	0V	-	Ground
17	Vsync	LCD_VSYNC	0 – 2.8V	I	Vertical synchronization signal
18	Hsync	LCD_HSYNC	0 – 2.8V	I	Horizontal synchronization signal
19	DE	LCD_AC	0 – 2.8V	I	Data enable
20	GND	GND	0V	-	Ground
21	PCLK	LCD_PCLK	0 – 2.8V	I	Pixel clock signal
22	GND	GND	0V	-	Ground
23	R0	LCD_PXL11	0 – 2.8V	I	Image data input red, LSB
24	R1	LCD_PXL 12	0 – 2.8V	I	Image data input red
25	R2	LCD_PXL 13	0 – 2.8V	I	Image data input red

Pin #	Signal name (LCD)	Signal name (Engine)	Voltage level	I/O/Z	Description
26	R3	LCD_PXL 14	0 – 2.8V	I	Image data input red
27	R4	LCD_PXL 15	0 – 2.8V	I	Image data input red, MSB
28	GND	GND	0V	-	Ground
29	G0	LCD_PXL 5	0 – 2.8V	I	Image data input green, LSB
30	G1	LCD_PXL 6	0 – 2.8V	I	Image data input green
31	G2	LCD_PXL 7	0 – 2.8V	I	Image data input green
32	G3	LCD_PXL 8	0 – 2.8V	I	Image data input green
33	G4	LCD_PXL 9	0 – 2.8V	I	Image data input green
34	G5	LCD_PXL 10	0 – 2.8V	I	Image data input green, MSB
35	GND	GND	0V	-	Ground
36	B0	LCD_PXL 0	0 – 2.8V	I	Image data input blue, LSB
37	B1	LCD_PXL 1	0 – 2.8V	I	Image data input blue
38	B2	LCD_PXL 2	0 – 2.8V	I	Image data input blue
39	B3	LCD_PXL 3	0 – 2.8V	I	Image data input blue
40	B4	LCD_PXL 4	0 – 2.8V	I	Image data input blue, MSB

CMT display

This section outlines the 128 x 128 transflective active matrix LCD with 65536 colours.

The display module includes:

- FPWB foil including connector and required passive components
- Display panel (glass) with COG drivers including display controller and 132 x132 x16 bit RAM
- Illumination system: light guide, optical sheets and LEDs

Interface

The display module is equipped with a DCT4 compatible LCD controller (Driver) with bi-directional 9-bit serial interface. The CMT LCD is connected to the µWire interface of the OMAP1510 chip. The maximum clock frequency of the OMAP1510 µWire is 3.0 MHz. GPIO12 is the reset signal for the CMT display.

Because of different logic levels of OMAP (2,8 V) and display (1,8 V), level shifters are used in the following signal lines: SDA, CSX, RESX and SCL.

The interconnection between the LCD module and engine is implemented with a 12-pin board-to-board connector.

All the signals go through the hinge flex and are filtered by EMI filters.

Table 8: interface signals of CMT display.

Pin #	Signal name (LCD)	Signal name (Engine)	Voltage level	I/O/Z	Description
1	VLED-	Vfb (LED Driver)	12 / 0.4V	-	LED power supply (cathode)
2	VDDI	V18	1.8V	I, PSU	Supply voltage for digital circuits
3	GND	GND	0V	-	Ground
4	SDA	WIRE_SDO	0 – 1.8V (LCD)	I/O	Bi-directional serial interface data but only used as unidirectional.1)
			0 – 2.8V (OMAP1510)		
5	CSX	WIRE_nSCS0	0 – 1.8V (LCD)	I	Chip select (active low) 1)
			0 – 2.8V (OMAP1510)		
6	GND	GND	0V	-	Ground
7	TE	-	0 – 1.8V	O	Tearing Effect signal
8	RESX	GPIO12	0 – 1.8V (LCD)	I	Reset signal (active low) 1)
			0 – 2.8V (OMAP1510)		
9	SCL	WIRE_SCLK	0 – 1.8V (LCD)	I	Serial interface clock 1)
			0 – 2.8V (OMAP1510)		
10	GND	GND	0V	-	Ground
11	VDD	V28	2.8V	I, PSU	Power supply for analogue circuits
12	VLED+	Vovp (LED Driver)	Variable ~12V	-	LED power supply (anode)

Note! Level shifter used.

CMT keypad

The amount of keys in RAE-6/RA-4 on the lid side is 27. The keys are connected to the OMAP1510 keyboard interface, except the power key, which is connected to PWRONX pin of UEMEK. Keyboard interface in OMAP1510 has a 6x5 matrix. The total amount of the keypad signals through hinge flex is 12. Keyboard matrix can be seen in Table 9, "Keypad placement matrix." Keys are divided into CMT keys and CBA Soft Command keys that are also called PDA keys. CMT keys are on the topside of the lid and PDA keys are on the bottom side, next to the PDA display. All the signals go through EMI filters.

Table 9: Keypad placement matrix.

	Col 0	Col 1	Col 2	Col 3	Col 4	Col 5
Row 0	Special key	UP	CMT 1	CMT 2	CBA 1	CBA 2
Row 1		PUSH	SEND	END	CBA 3	CBA 4
Row 2		DOWN	1	2	3	*
Row 3		LEFT	4	5	6	0
Row 4		RIGHT	7	8	9	#

Table 10: OMAP1510 keypad interface

From	Signal Pin(s)	To	Signal Pin(s)	Levels	Description
OMAP1510	APE_KEYB(10:0)	Keyboard Matrix	Column(5:0)	0-2.8V	Keyboard control: Column
Keyboard Matrix	Row (4:0)	OMAP1510	APE_KEYB(10:0)	0-2.8V	Keyboard control: Row with external pull-up

Description of operation

A keyboard Interface in OMAP1510 consists of specific I/O pins, dedicated for the 6 columns X 5 rows keyboard connection.

The keyboard interface is composed of six column lines (output), KBC (5:0); and five row lines (input), KBR (4:0) with the capability to detect multiple key pressing.

When no key is pressed, KBD_INT remains high because of external pull up, once key(s) is (are) pressed, the corresponding row(s) and column(s) are shorted together, since KBC is set to low initially, therefore, KBD_INT is changed to low state and interrupt is generated that CPU will perform a scanning process to tell which key(s) are pressed.

In case of a determined key press SW must ensure is the key pressed or not by multi-read operation.

Illumination and drivers

The illumination includes:

- PDA display
- CMT display
- CMT keypad illumination

PDA keypad

The keyboard matrix is a full QWERTY-keyboard, and consists of 66 keys + 9-way joystick. Space bar is built of 2 domes, so there are altogether 67 key domes in the matrix. Keyboard matrix is organized to 8 columns and 12 rows. Joystick is a 9-way joystick and consists eight directions (cardinal points & half-cardinal points) and push center direction to select.

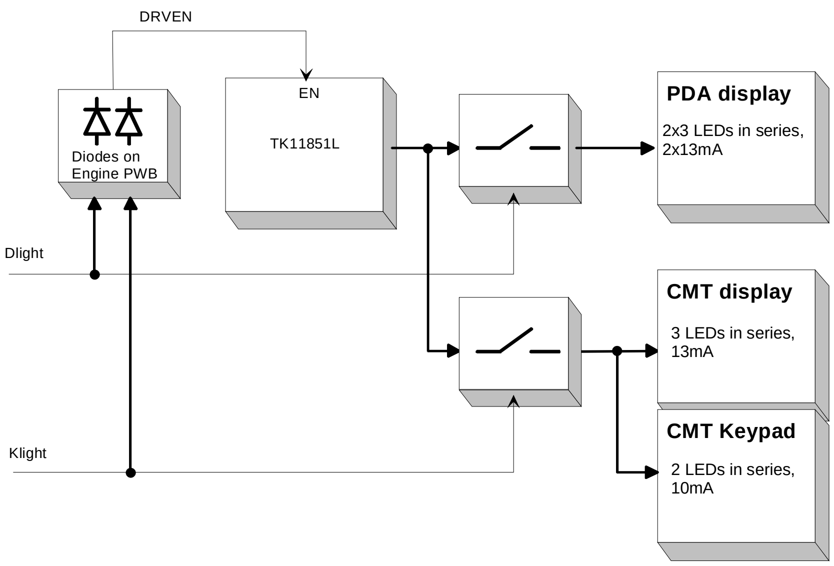
The matrix is connected to a keyboard controller COP8, which wakes up whenever there is a key pressed in the keyboard. The COP8 controller is located in the engine board 1BC. Controller starts to scan the matrix to detect, which keys are pressed, and the scanning is continued until each key is released. If there are no more key events happening inside a certain time period, the controller will return to sleep. During the scanning, the controller will send an interrupt to the main processor to notify that a key is pressed. When the main processor receives the notification, it will read the pressed keys from the controller via I2C-bus. Controller will just send the codes of the pressed keys as Hex-code; the meaning of each key code is determined in the main processor, depending on the language version and the used application.

Hall-sensor

Hall-sensor is used to detect the PDA-lid position: there is a magnet in the coverlid just above the Hall-sensor when the lid is closed; when the lid is opened, the Hall is released, thus waking up the keyboard controller. The Hall-sensor has one dedicated input in the controller, and as soon as the wake-up is detected, controller sends the lid-opened -message to the main processor.

Block diagram

Figure 12: Block diagram of illumination.



- S80L backlight
- Keypad backlight
- TK11851L: white LED driver for backlight
- UEMEK PWM signals Dlight and Klight are to turn on/off white LED circuits

Description of operation

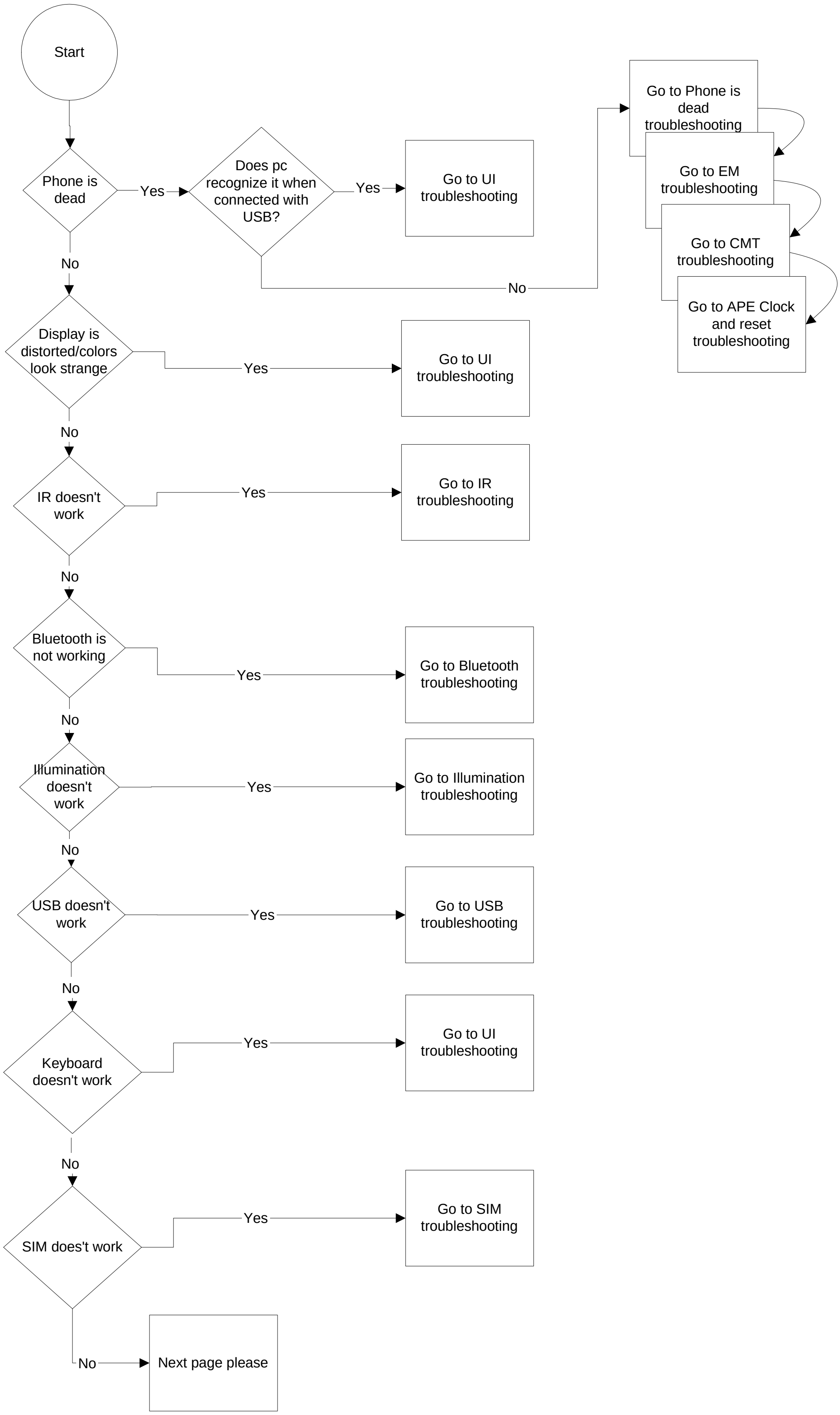
There are 6 white LEDs for illumination built in S80L module. There are two LED chains connected in parallel. Each of these chains consists of three LEDs in series. Common TK11851L driver is used for S80L display and for CMT display + keypad.

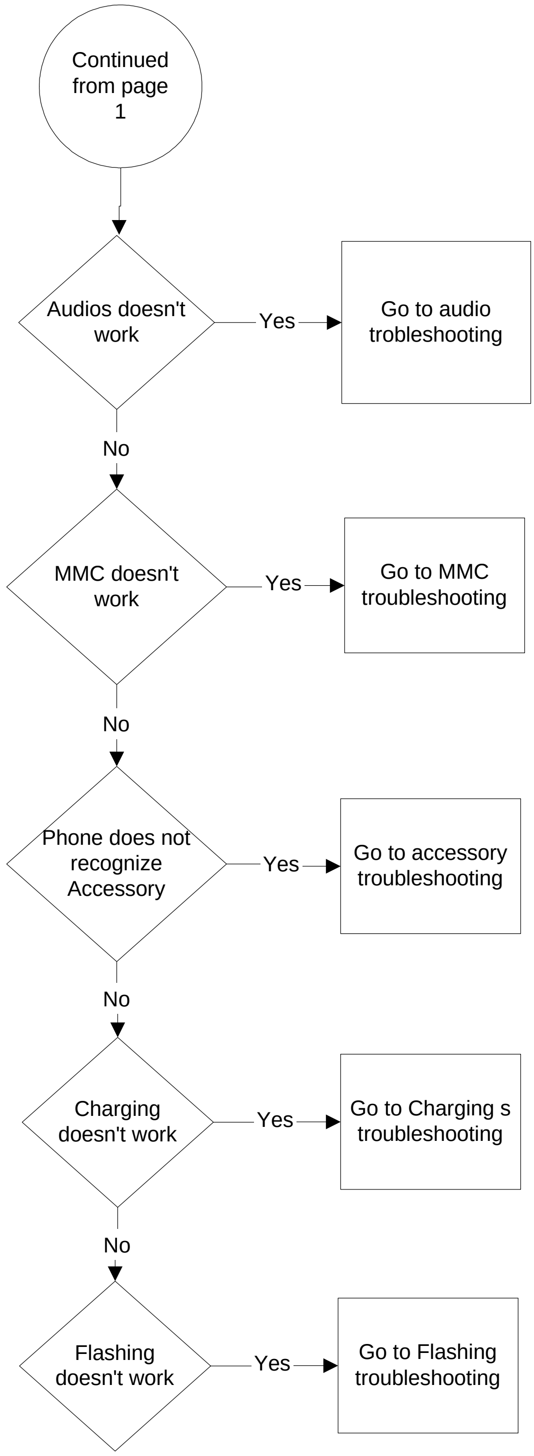
Baseband Troubleshooting

This section is intended to be a guide for localizing and repairing electrical faults in RAE-6/RA-4 baseband.

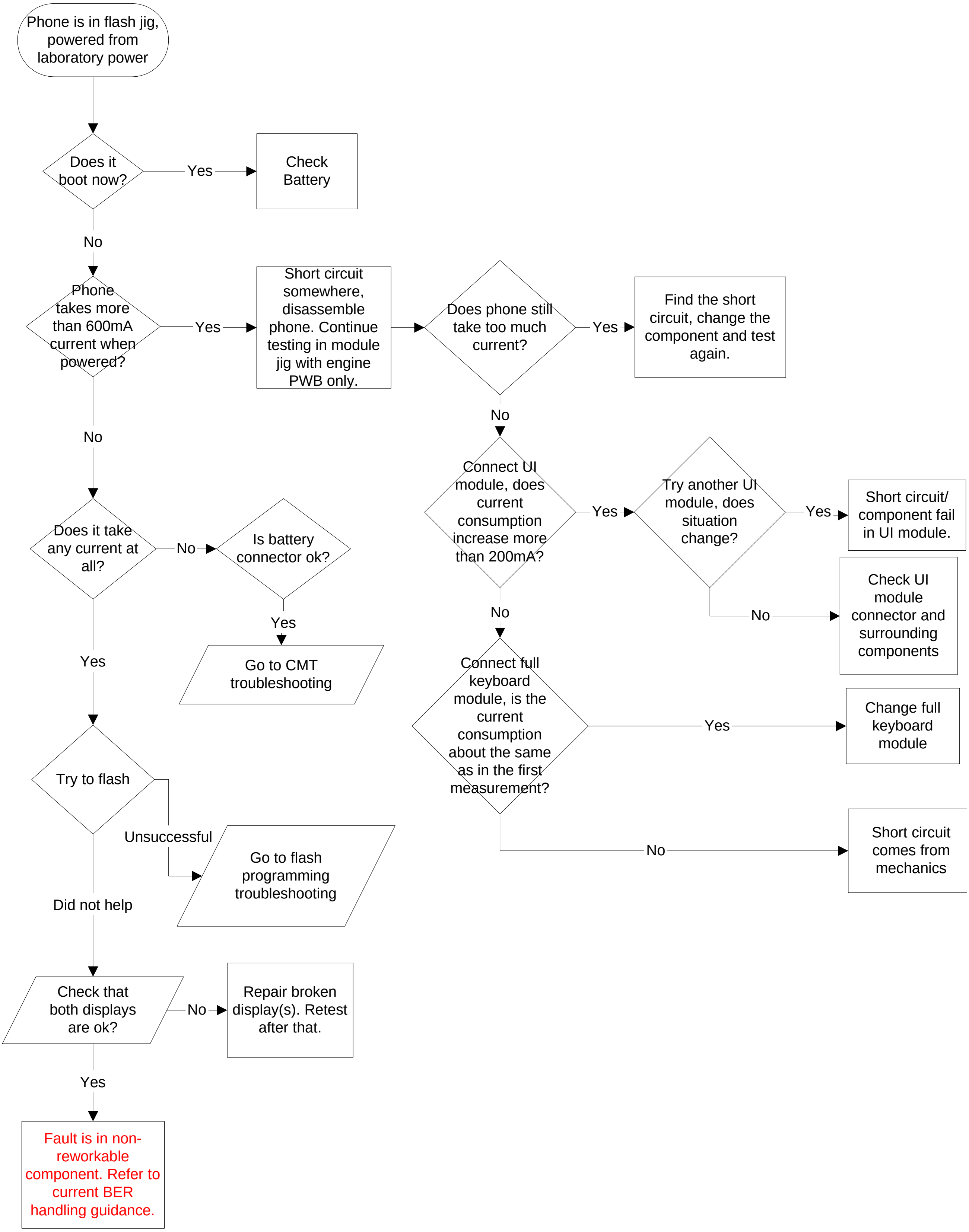
Before any service operation you must be familiar with the RAE-6/RA-4 product and module level architecture. You have to be also familiar with the RAE-6/RA-4 specific service tools such as the Phoenix service software, flashing tools and software.

Top level flowchart

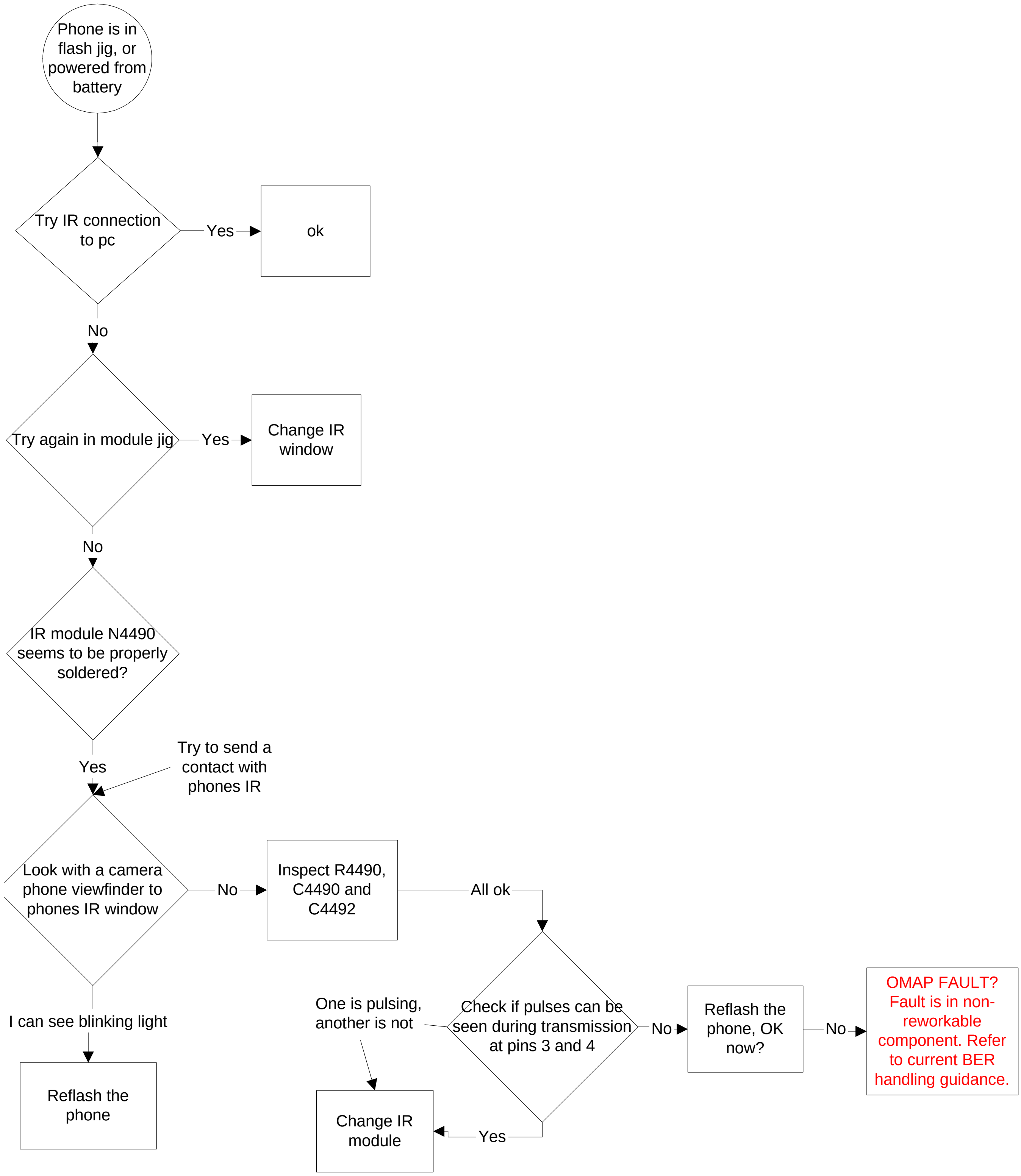



Continued from page 1
Audios doesn't work
Yes
Go to audio trobleshooting
No
MMC doesn't work
Yes
Go to MMC troubleshooting
No
Phone does not recognize Accessory
Yes
Go to accessory troubleshooting
No
Charging doesn't work
Yes
Go to Charging s troubleshooting
No
Flashing doesn't work
Yes
Go to Flashing troubleshooting

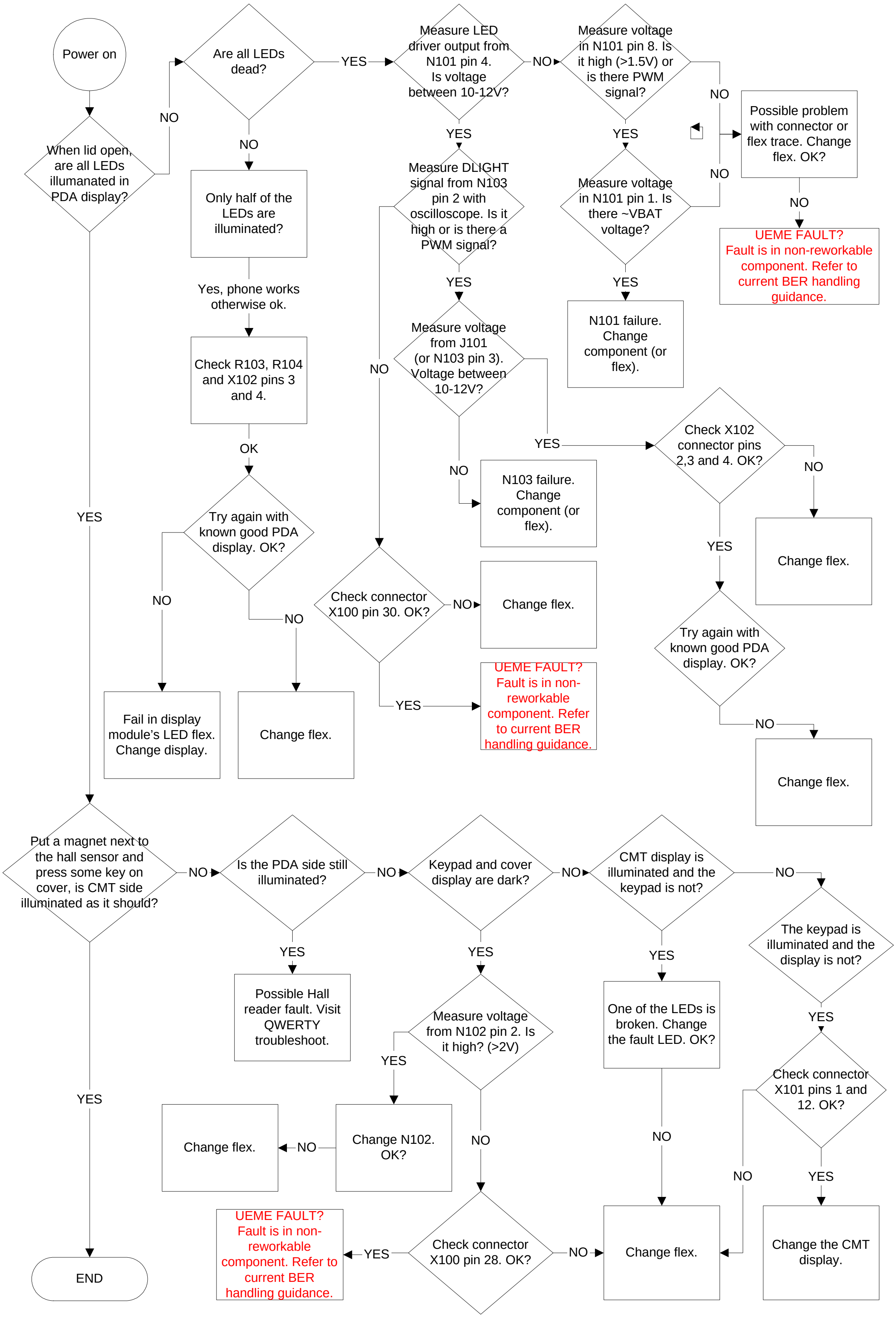
Phone is dead troubleshooting



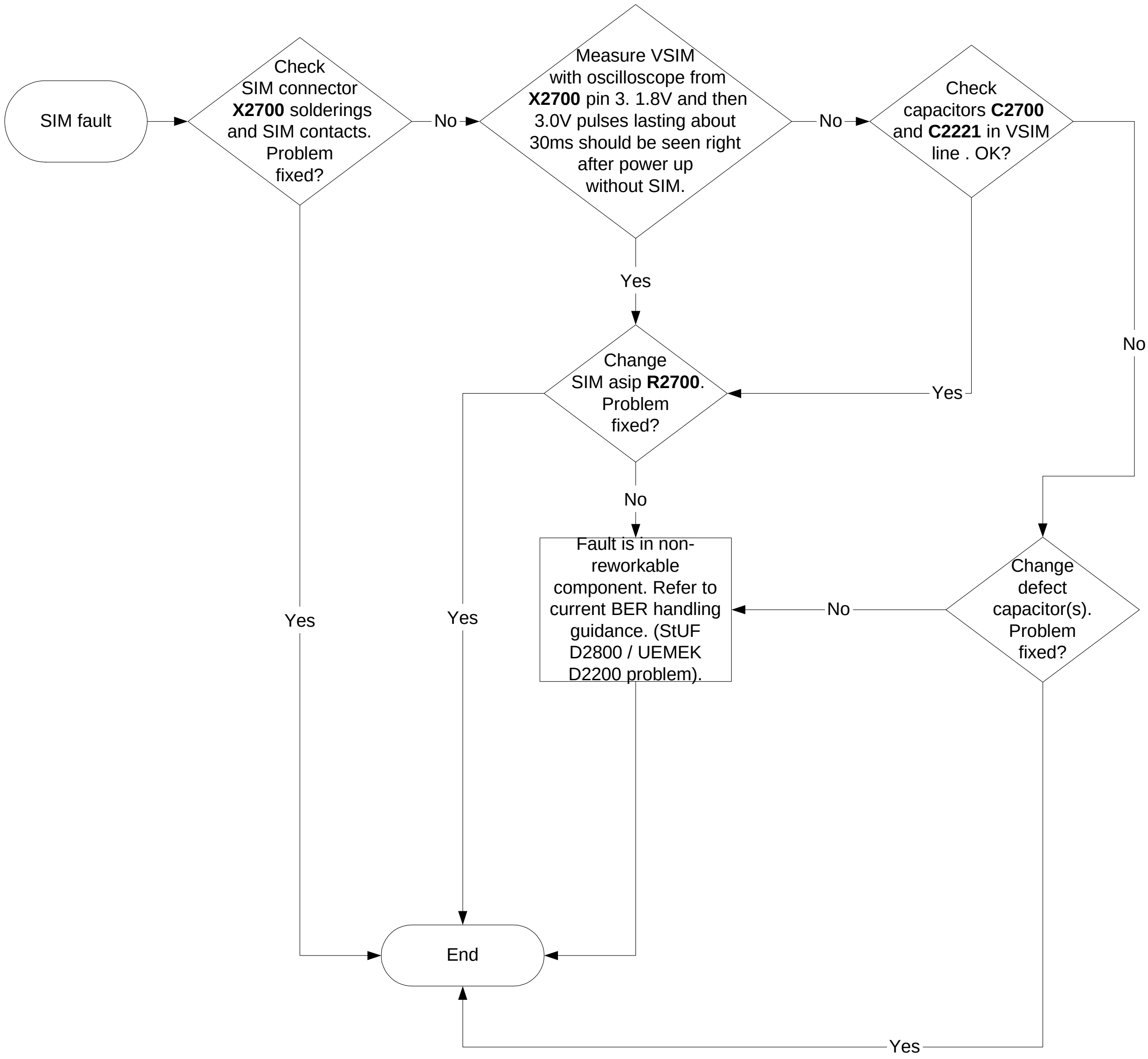
IR troubleshooting



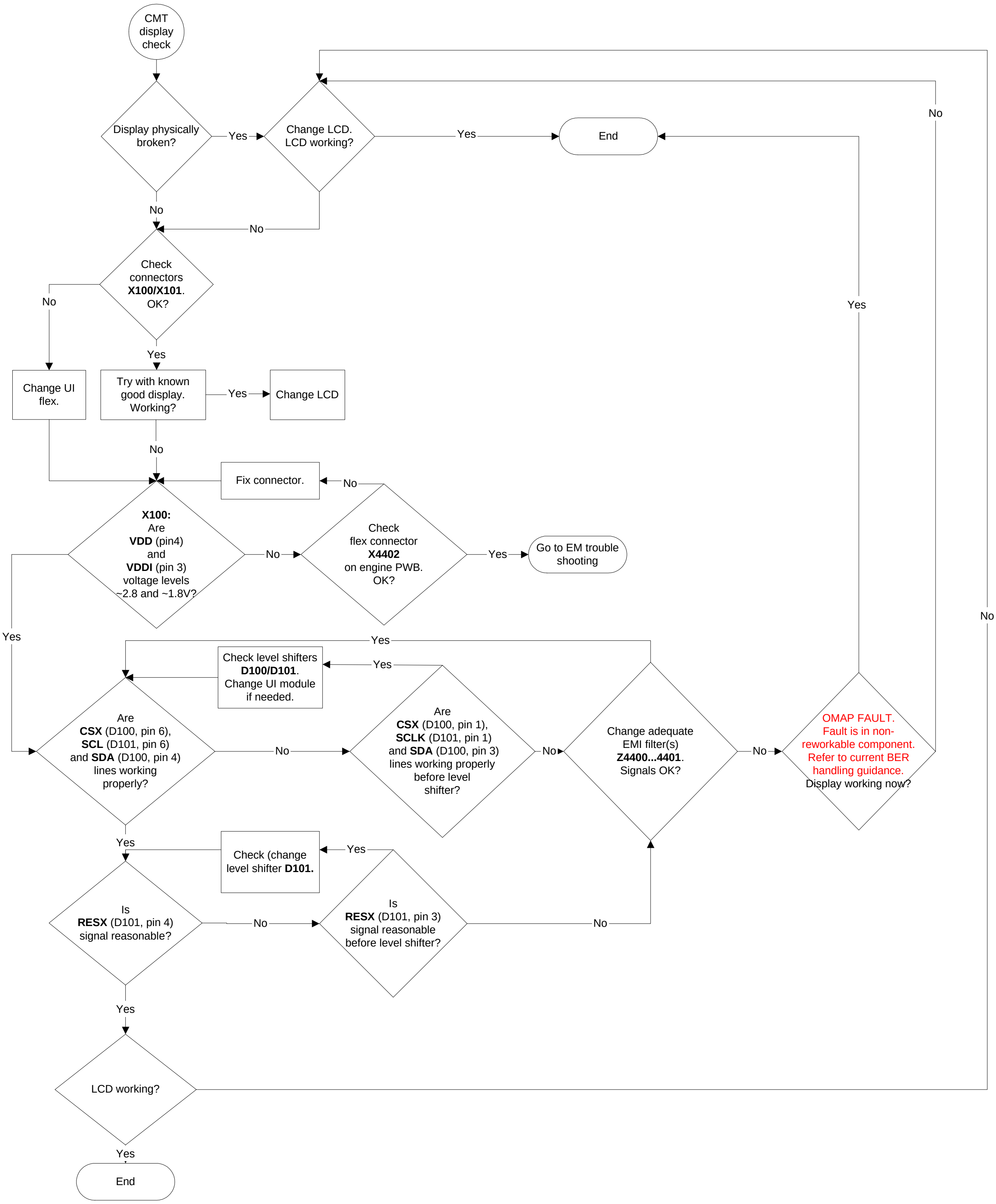
Illumination troubleshooting



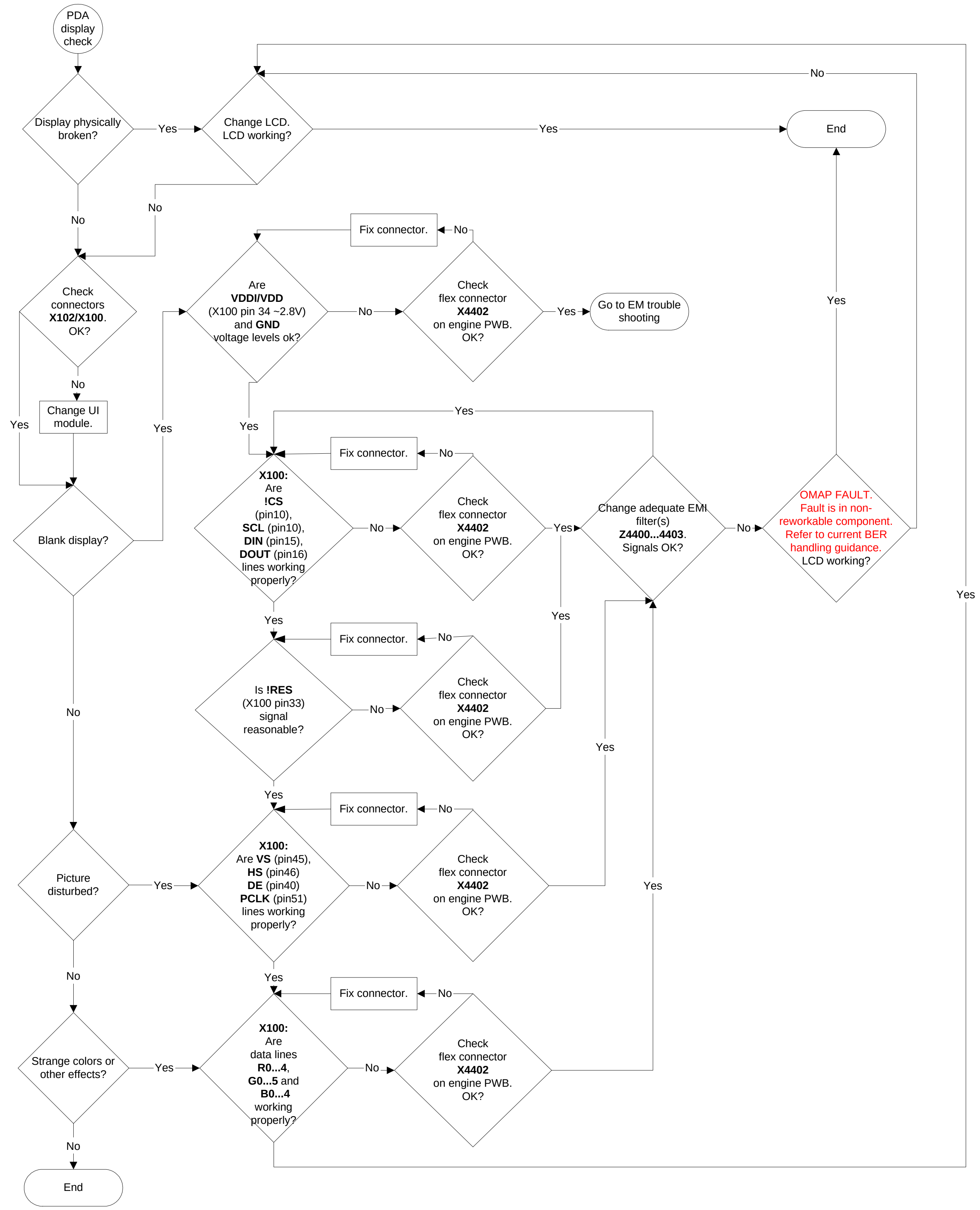
SIM troubleshooting



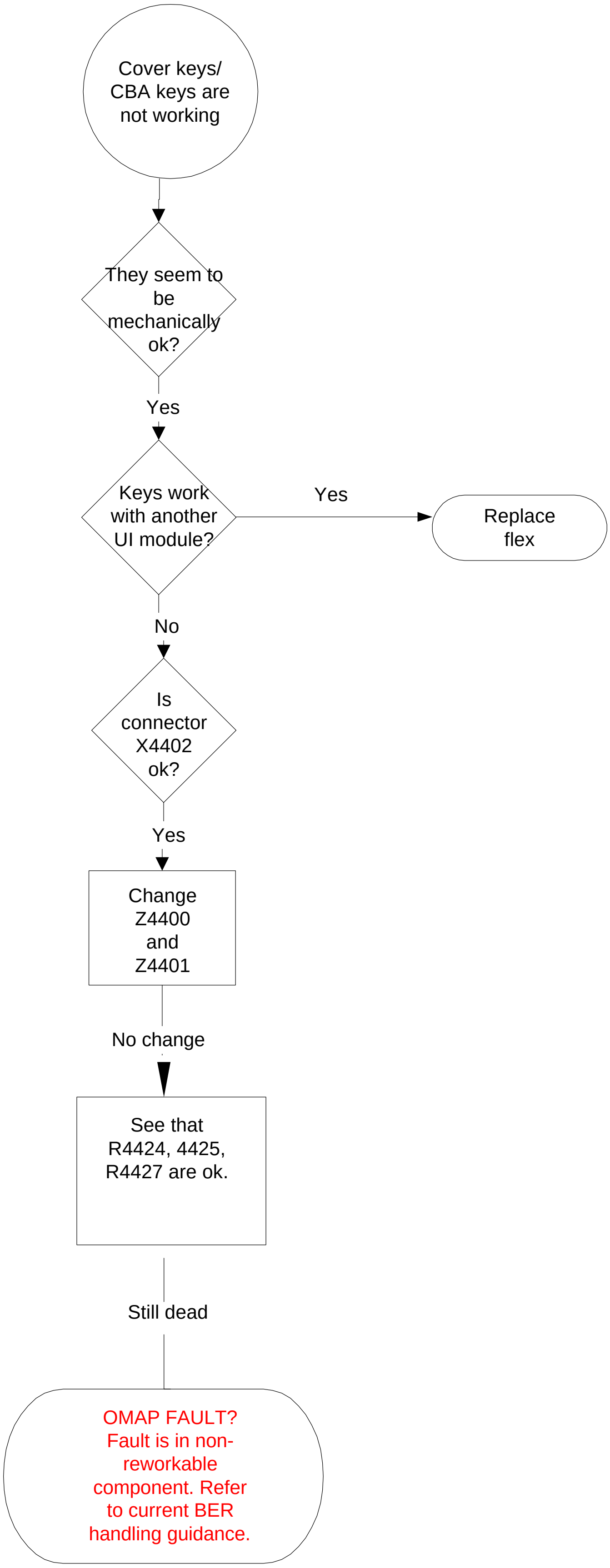
UI troubleshooting



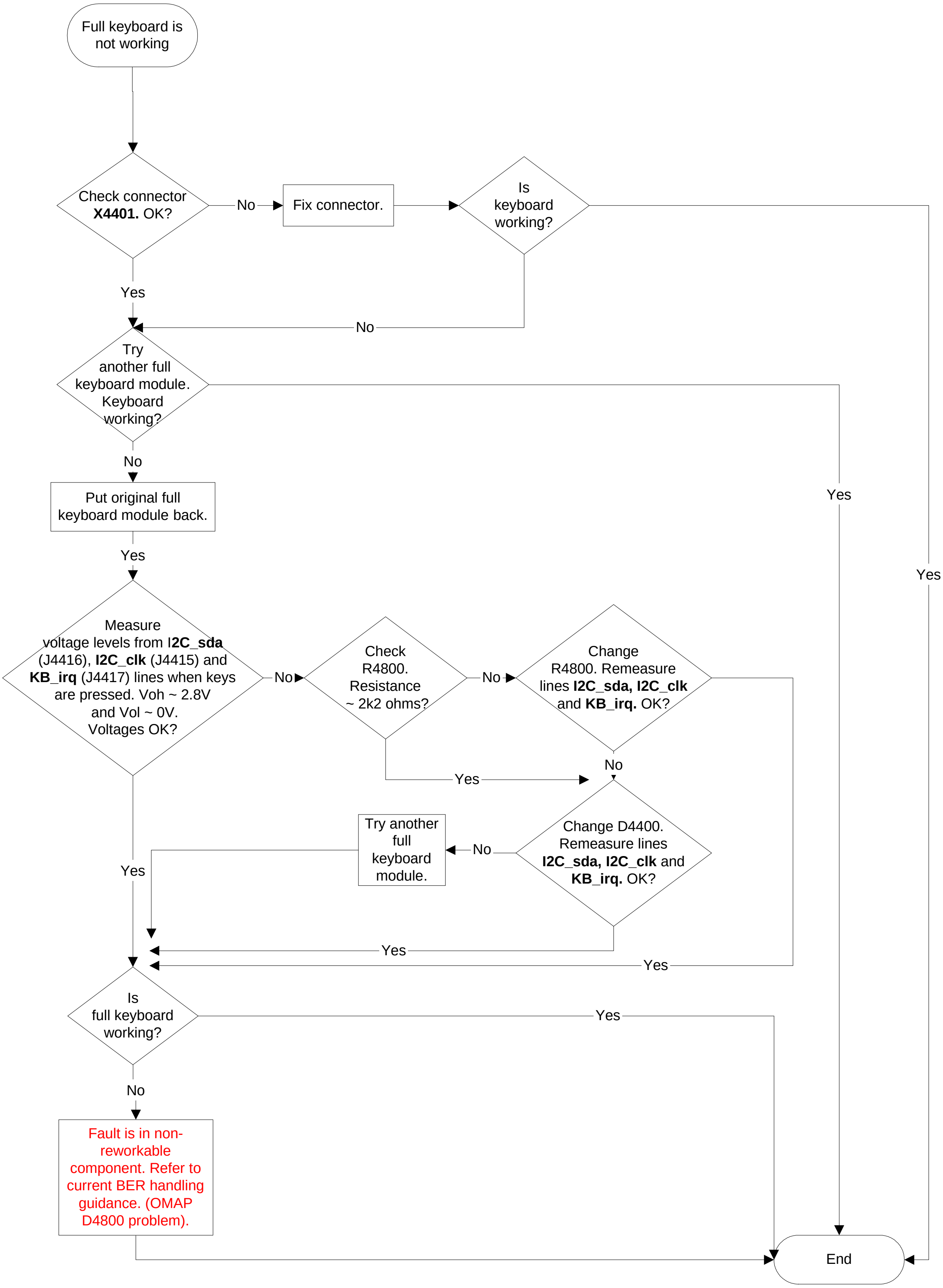
PDA LCD troubleshooting



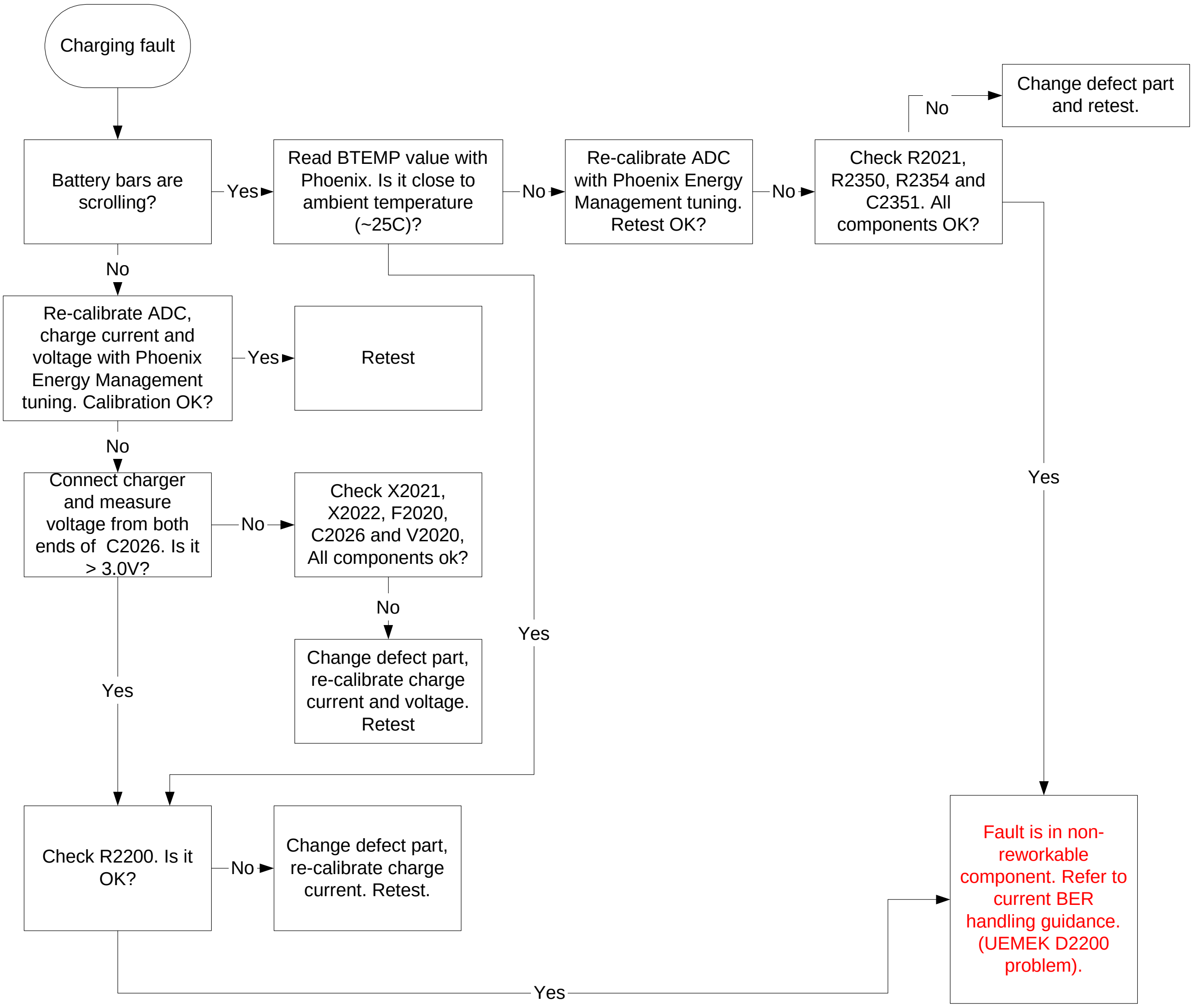
CBA keys troubleshooting



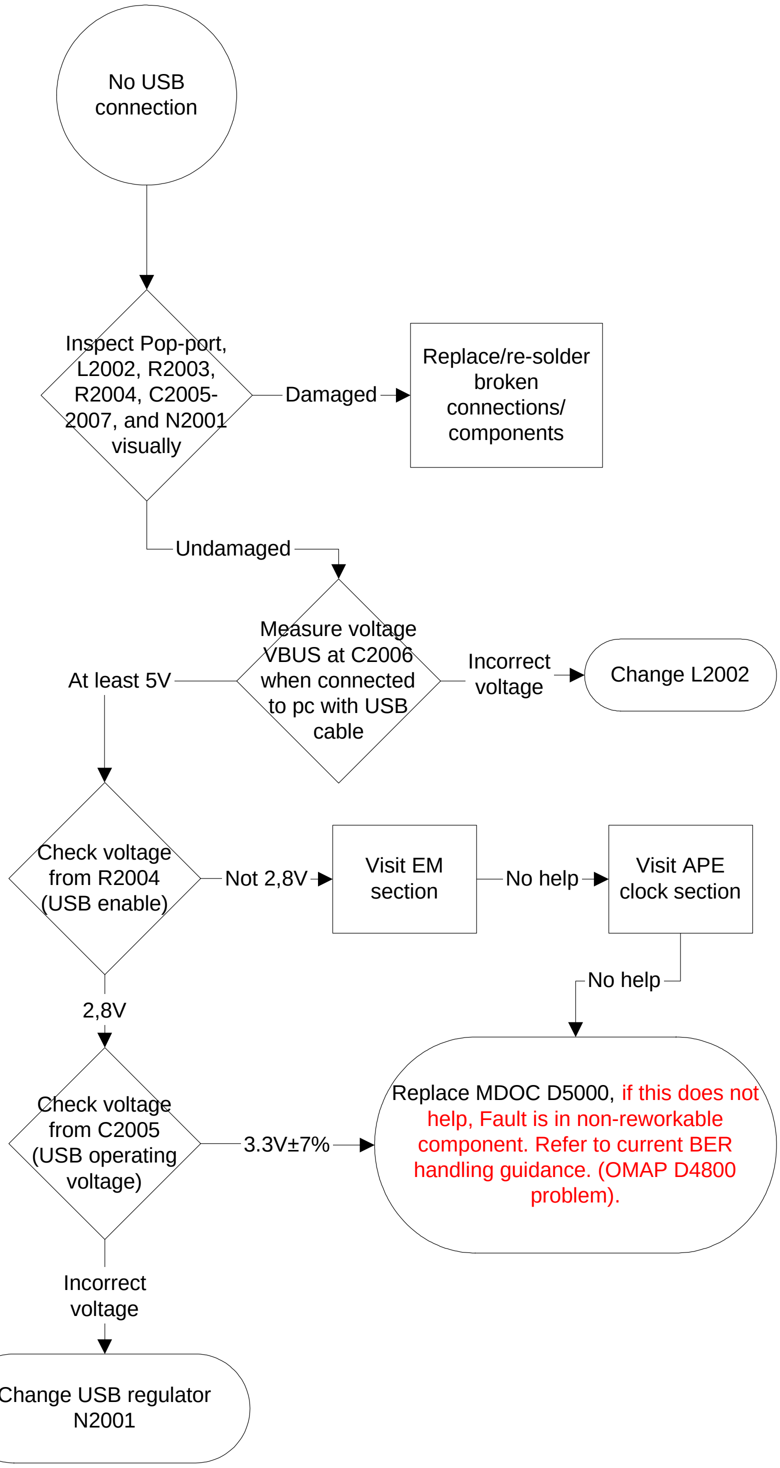
QWERTY troubleshooting



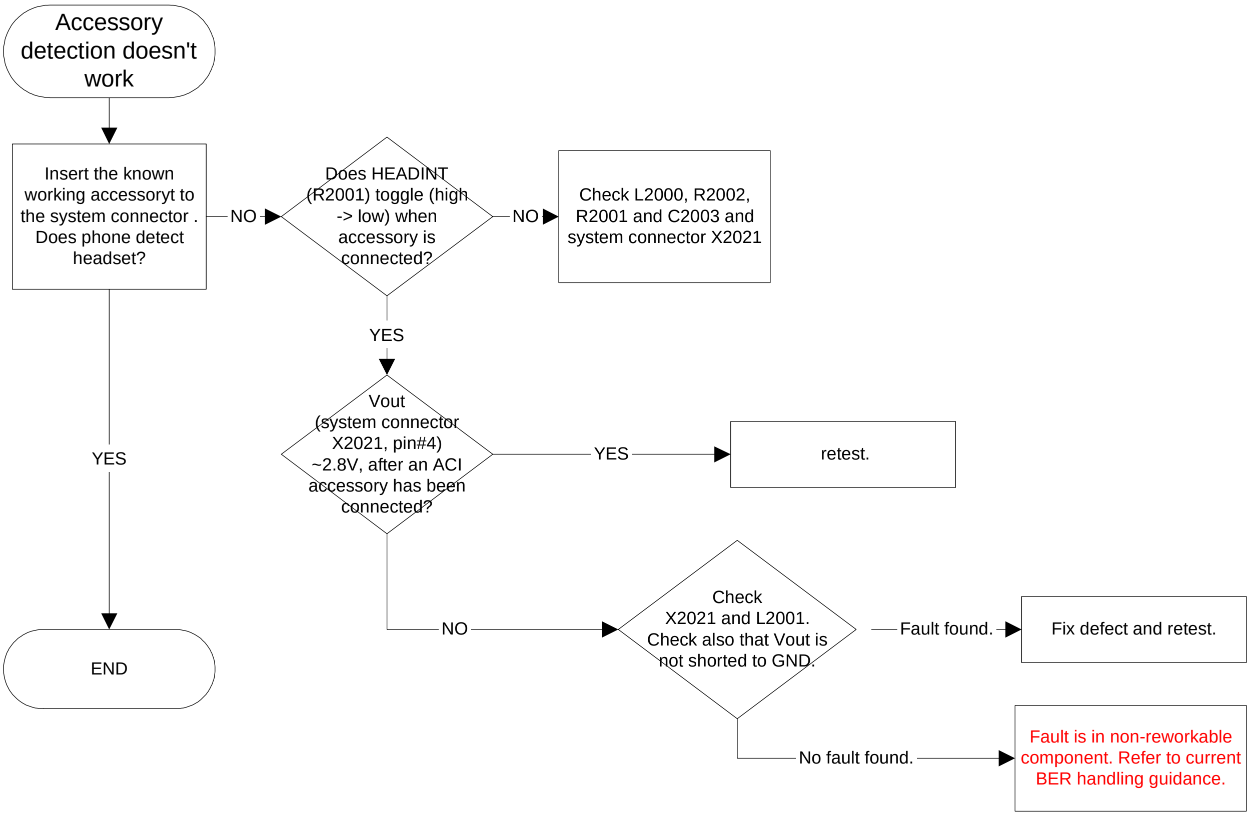
Charging troubleshooting



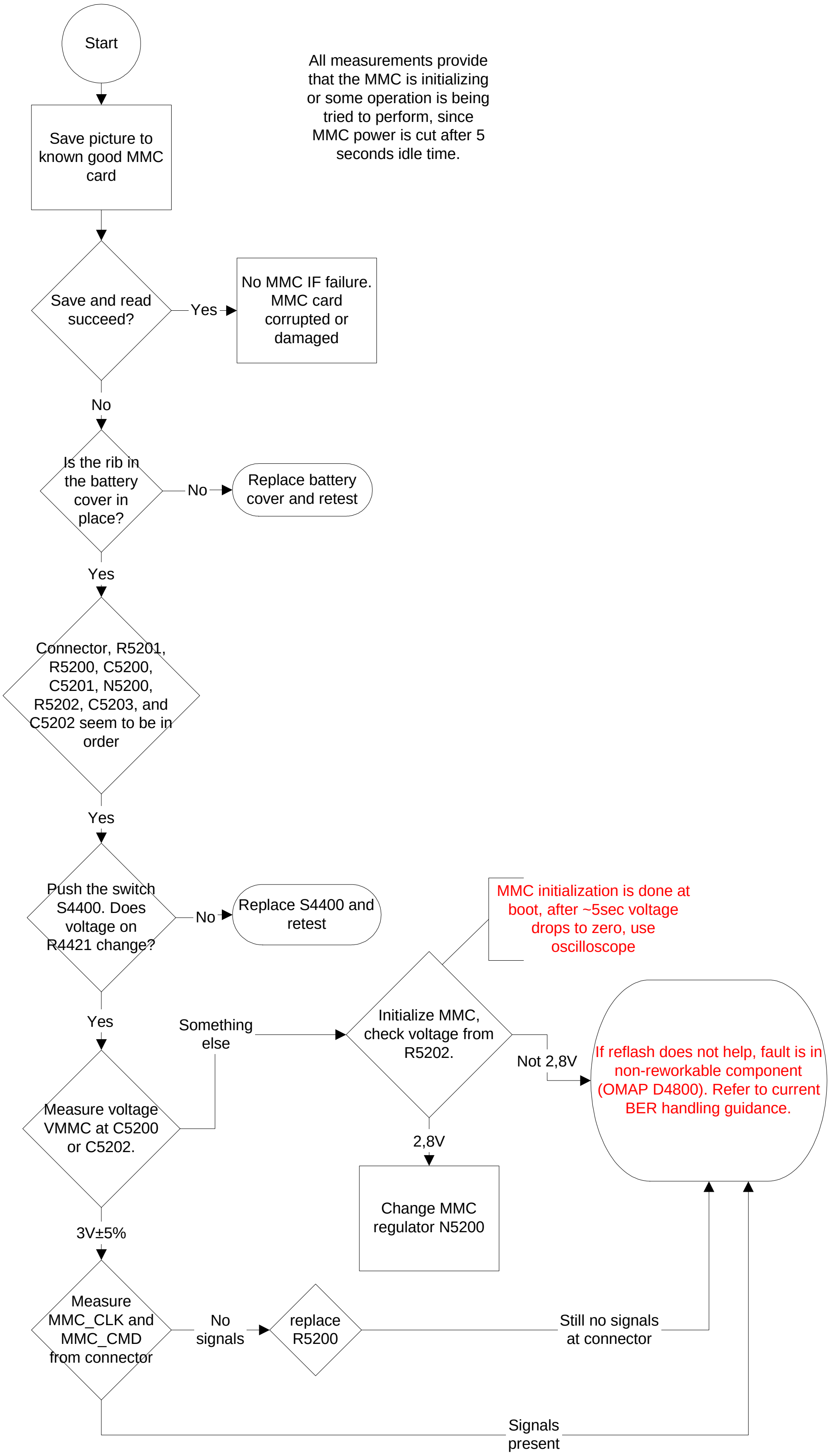
USB troubleshooting



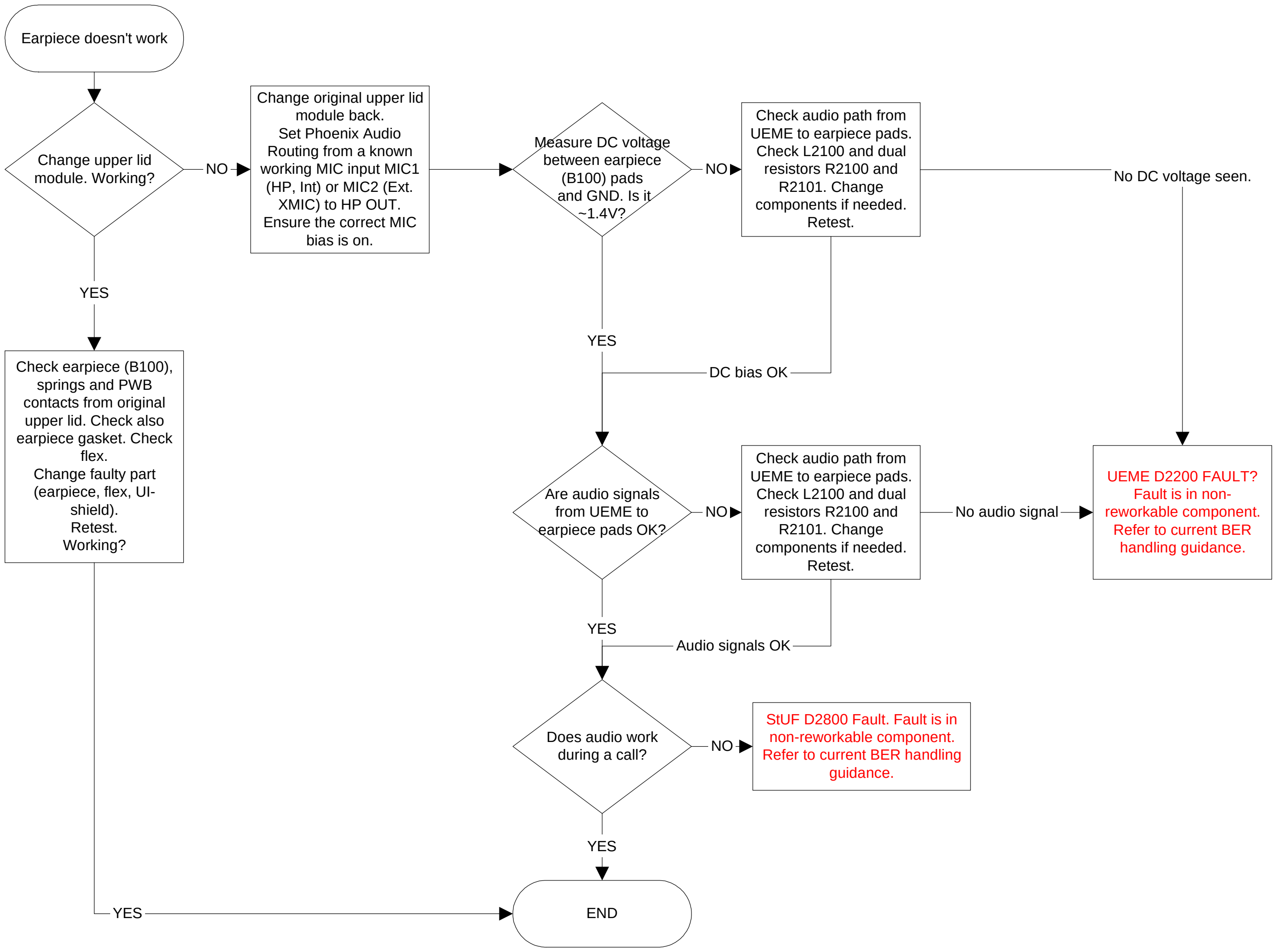
Accessory troubleshooting

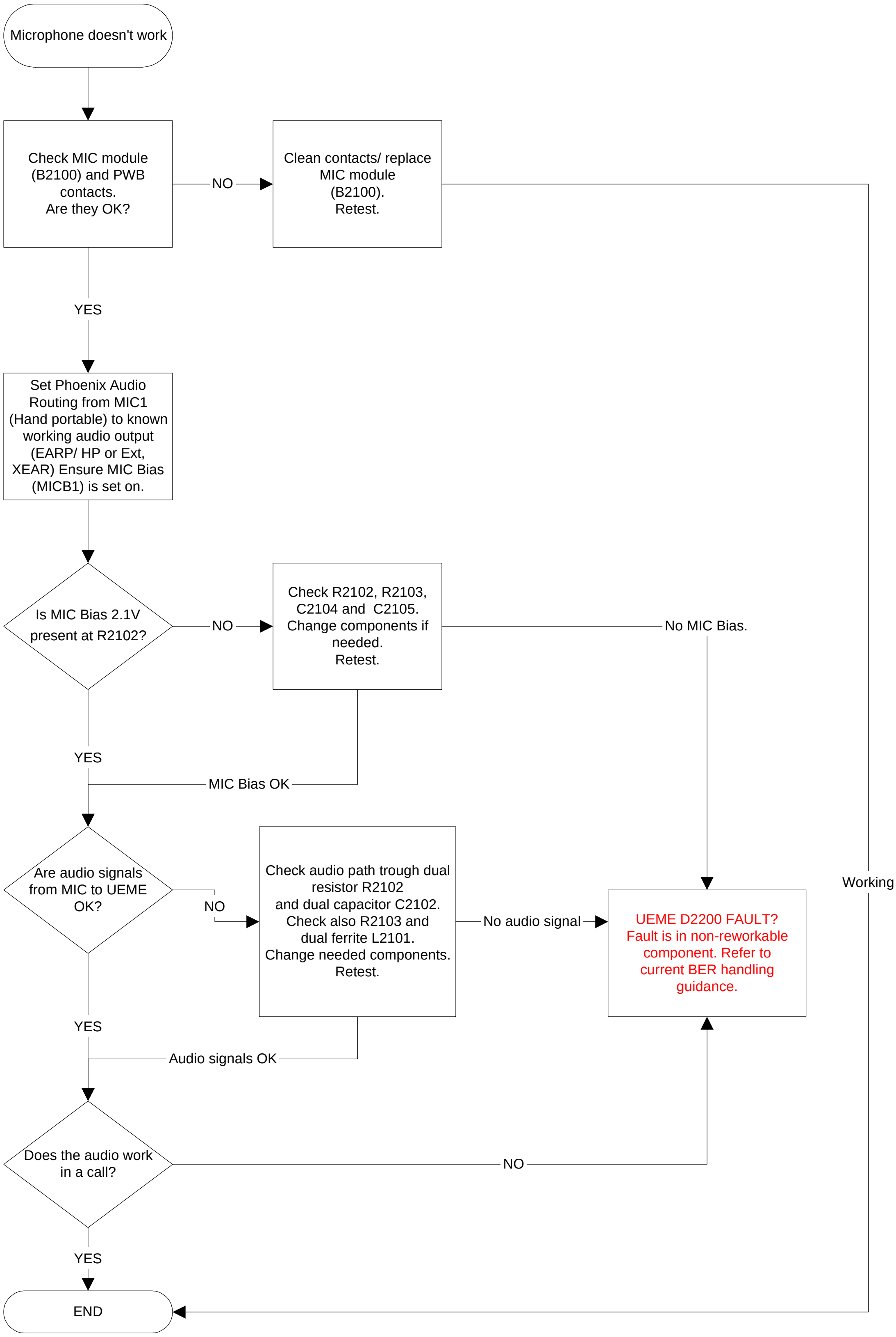


MMC troubleshooting

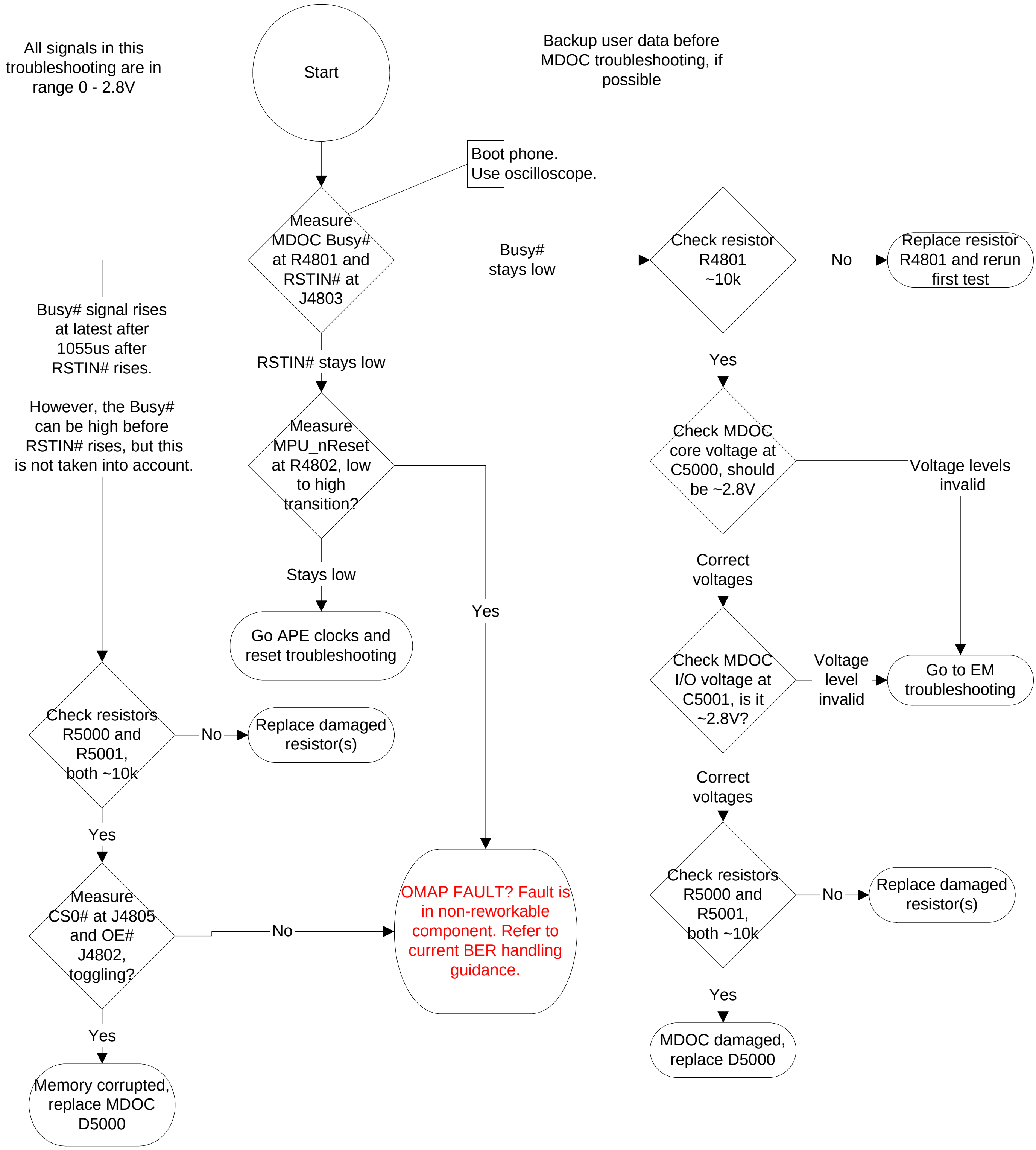


Audio troubleshooting




Microphone doesn't work
Check MIC module (B2100) and PWB contacts. Are they OK?
NO
Clean contacts/ replace MIC module (B2100). Retest.
YES
Set Phoenix Audio Routing from MIC1 (Hand portable) to known working audio output (EARP/ HP or Ext, XEAR) Ensure MIC Bias (MICB1) is set on.
Is MIC Bias 2.1V present at R2102?
NO
Check R2102, R2103, C2104 and C2105. Change components if needed. Retest.
No MIC Bias.
YES
MIC Bias OK
Are audio signals from MIC to UEME OK?
NO
Check audio path trough dual resistor R2102 and dual capacitor C2102. Check also R2103 and dual ferrite L2101. Change needed components. Retest.
No audio signal
UEME D2200 FAULT? Fault is in non-reworkable component. Refer to current BER handling guidance.
Working
YES
Audio signals OK
Does the audio work in a call?
NO
YES
END

MDOC troubleshooting



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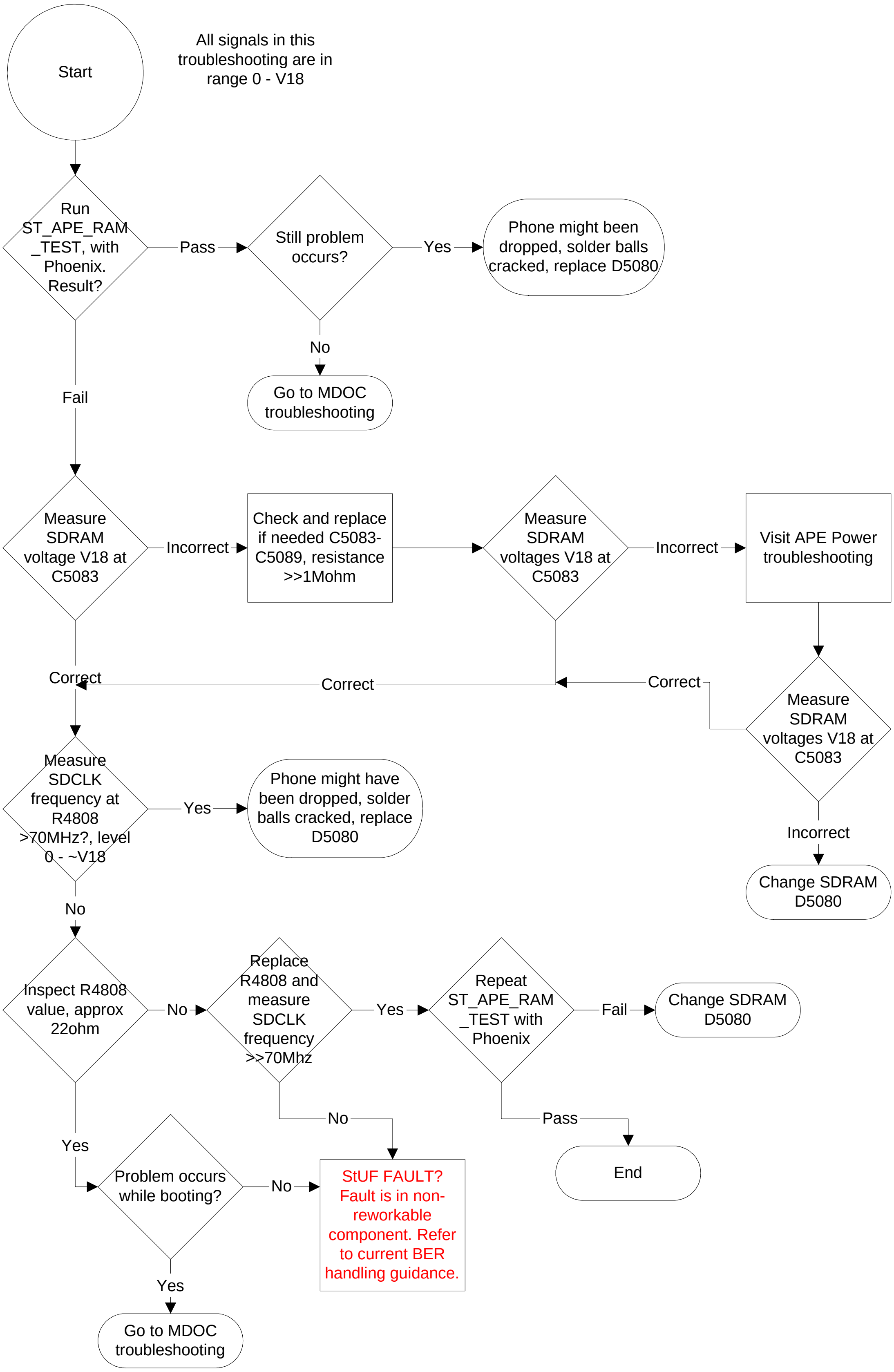
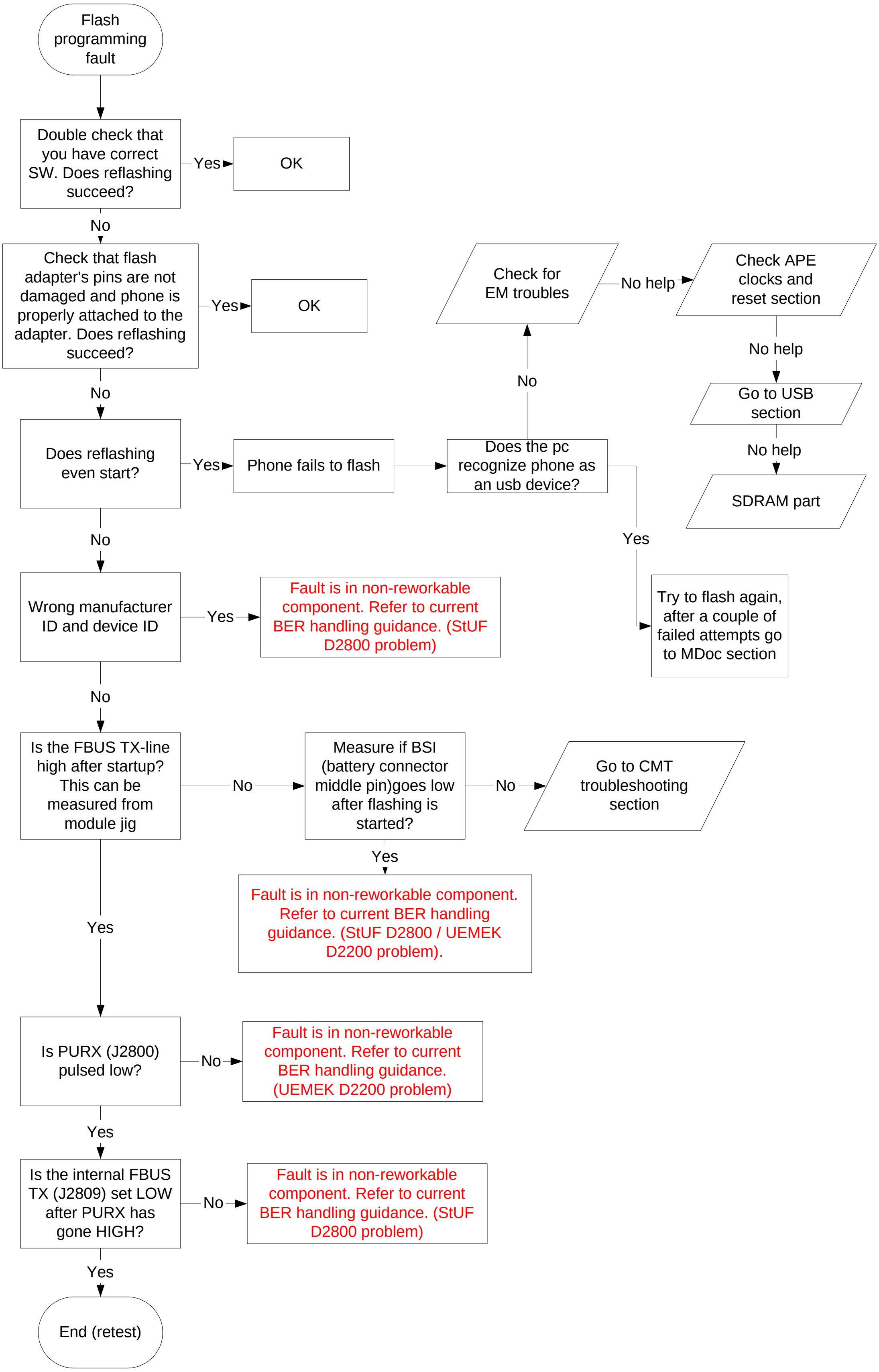
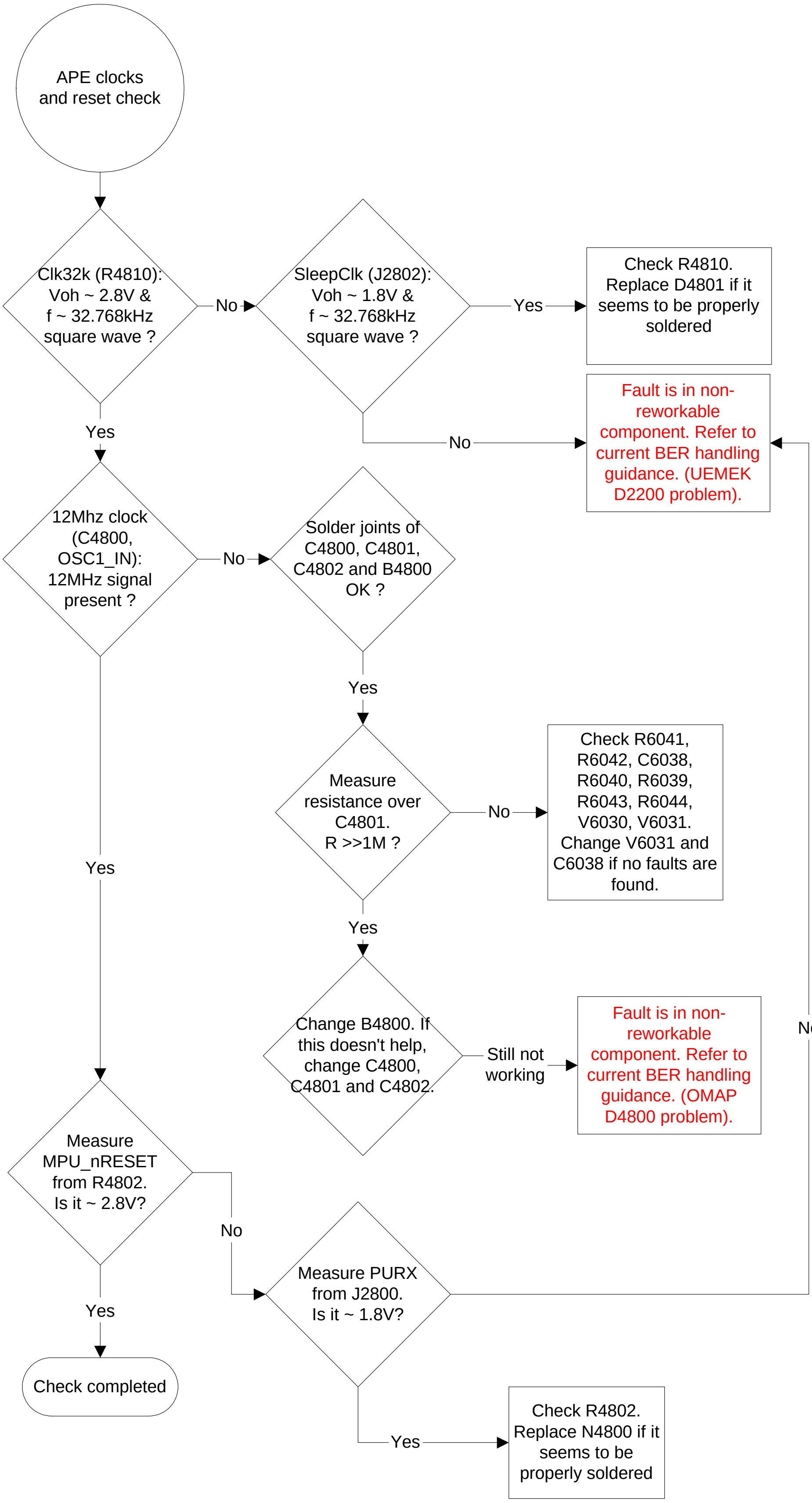
SDRAM troubleshooting



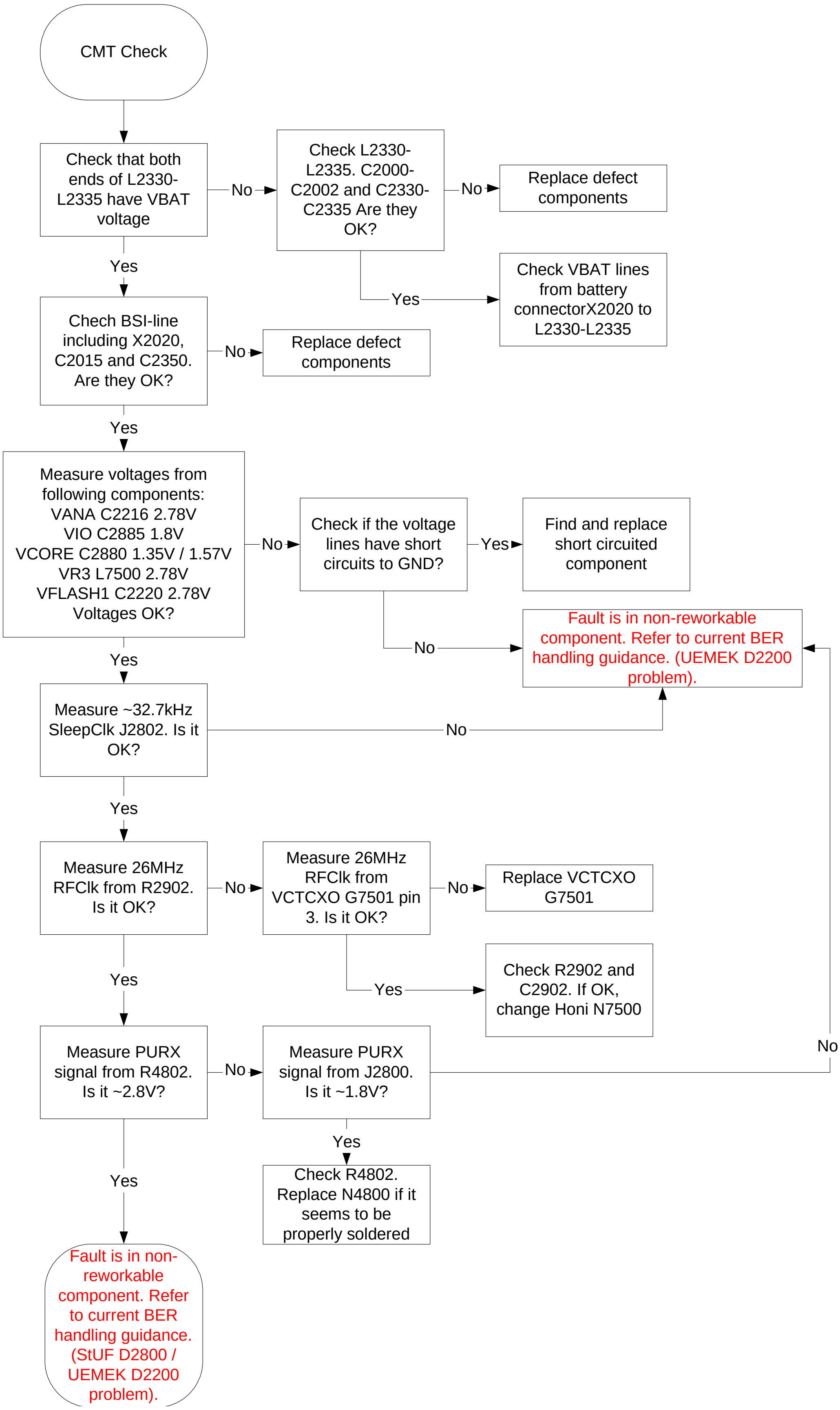
Flash troubleshooting



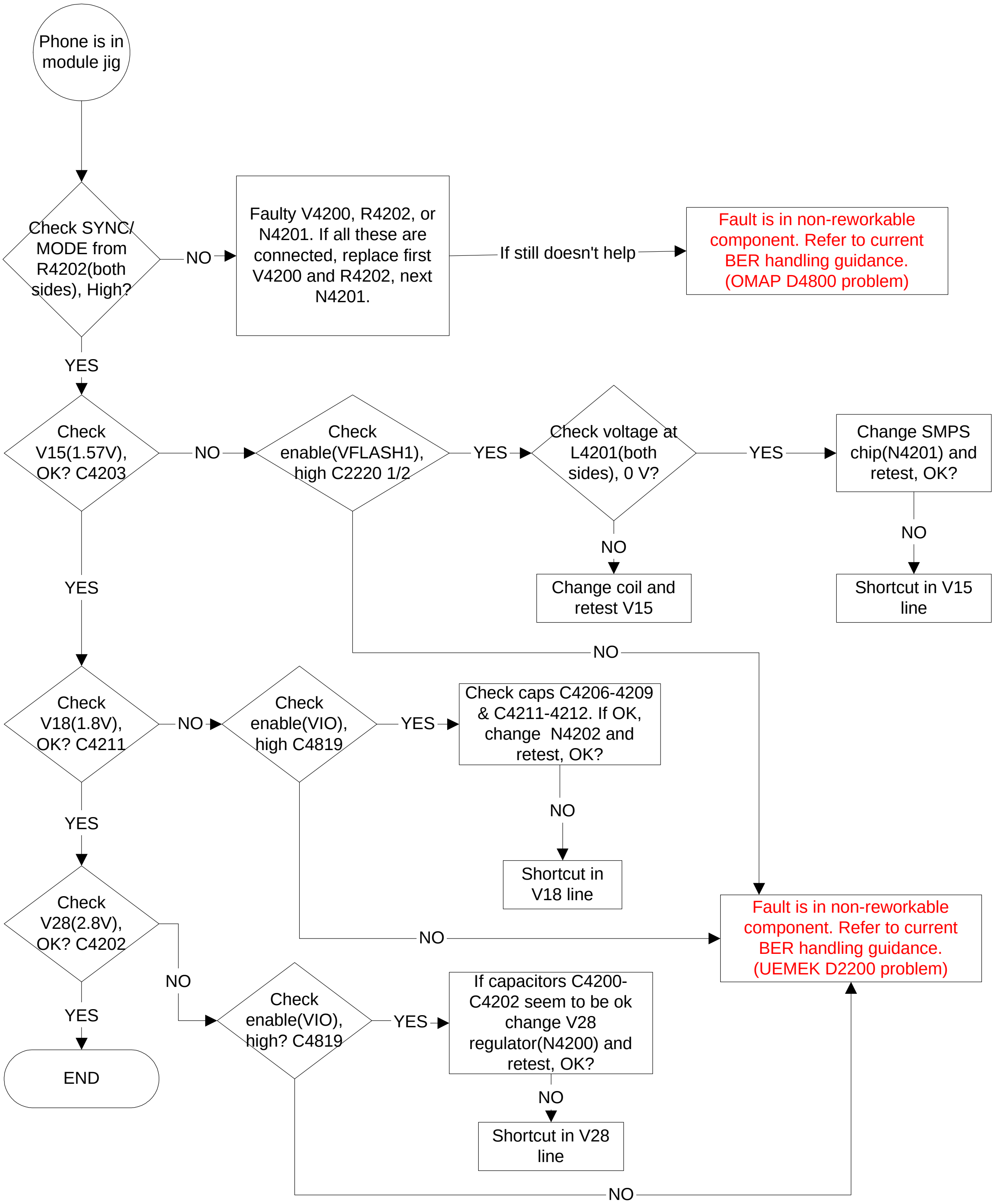
APE clock and reset troubleshooting



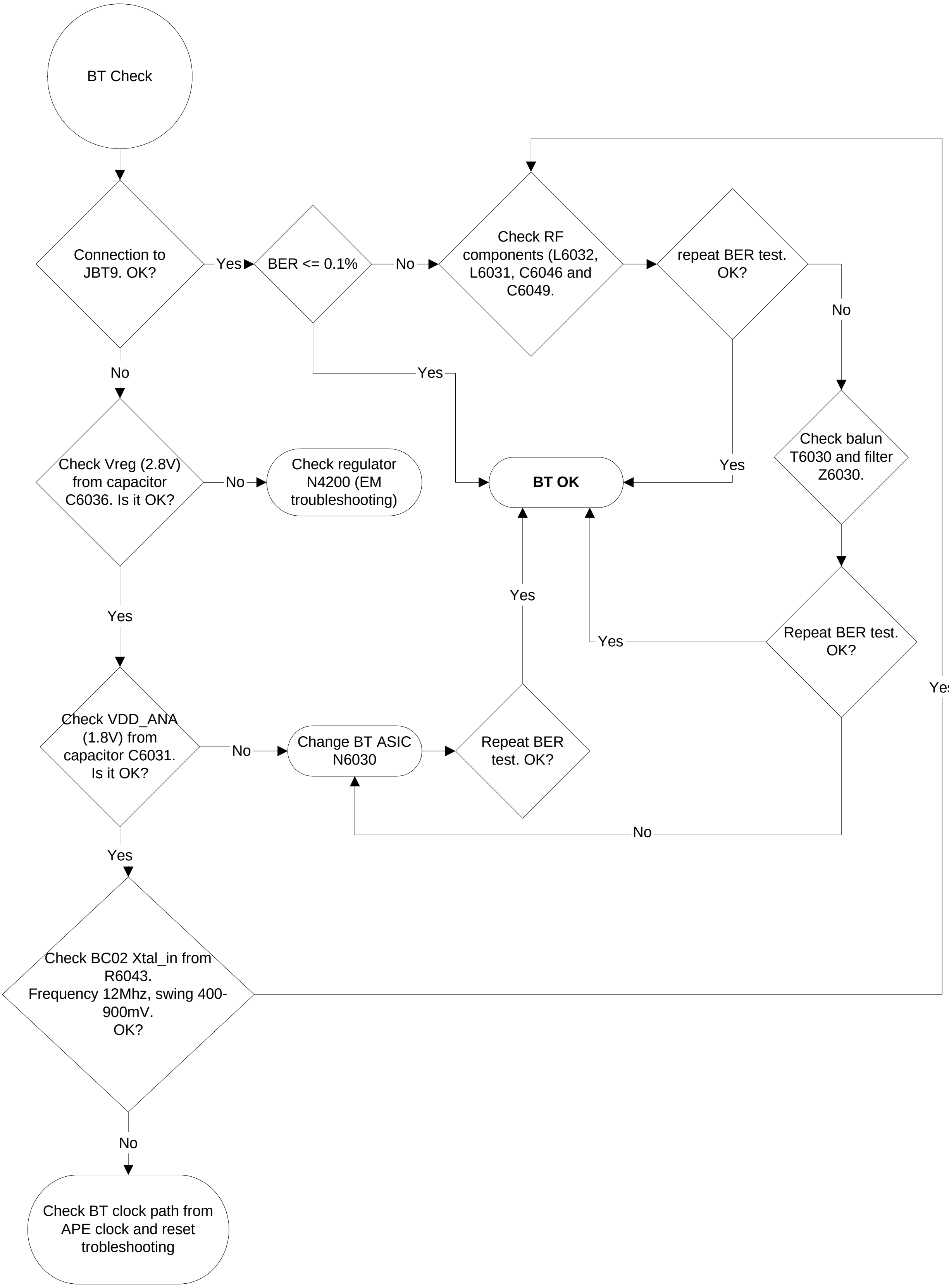
CMT troubleshooting



EM troubleshooting (APE)



Bluetooth troubleshooting



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