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Nokia Care Academy

Nokia Customer Care

Service Manual

RM-994/ RM-995/ RM-996
(Nokia Lumia 1320; L3&4)

Mobile Terminal

Part No: (Issue 1)

NOKIA INTERNAL USE ONLY

NOKIA

Care

Amendment Record Sheet

Amendment No	Date	Inserted By	Comments
Issue 1	12/2013	MT	
Issue 2			

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IMPORTANT

This document is intended for use by qualified service personnel only.

Warnings and cautions

Warnings

- IF THE DEVICE CAN BE INSTALLED IN A VEHICLE, CARE MUST BE TAKEN ON INSTALLATION IN VEHICLES FITTEDWITH ELECTRONIC ENGINE MANAGEMENT SYSTEMS AND ANTI-SKID BRAKING SYSTEMS. UNDER CERTAIN FAULT CONDITIONS, EMITTED RF ENERGY CAN AFFECT THEIR OPERATION. IF NECESSARY, CONSULT THE VEHICLE DEALER/ MANUFACTURER TO DETERMINE THE IMMUNITY OF VEHICLE ELECTRONIC SYSTEMS TO RF ENERGY.
- THE PRODUCT MUST NOT BE OPERATED IN AREAS LIKELY TO CONTAIN POTENTIALLY EXPLOSIVE ATMOSPHERES, FOR EXAMPLE, PETROL STATIONS (SERVICE STATIONS), BLASTING AREAS ETC.
- OPERATION OF ANY RADIO TRANSMITTING EQUIPMENT, INCLUDING CELLULAR TELEPHONES, MAY INTERFERE WITH THE FUNCTIONALITY OF INADEQUATELY PROTECTED MEDICAL DEVICES. CONSULT A PHYSICIAN OR THE MANUFACTURER OF THE MEDICAL DEVICE IF YOU HAVE ANY QUESTIONS. OTHER ELECTRONIC EQUIPMENT MAY ALSO BE SUBJECT TO INTERFERENCE.
- BEFORE MAKING ANY TEST CONNECTIONS, MAKE SURE YOU HAVE SWITCHED OFF ALL EQUIPMENT.

Cautions

- Servicing and alignment must be undertaken by qualified personnel only.
- Ensure all work is carried out at an anti-static workstation and that an anti-static wrist strap is worn. Ensure solder, wire, or foreign matter does not enter the telephone as damage may result.
- Use only approved components as specified in the parts list.
- Ensure all components, modules, screws and insulators are correctly re-fitted after servicing and alignment.
  Ensure all cables and wires are repositioned correctly.
- Never test a mobile phone WCDMA transmitter with full TX power, if there is no possibility to perform the measurements in a good performance RF-shielded room. Even low power WCDMA transmitters may disturb nearby WCDMA networks and cause problems to 3G cellular phone communication in a wide area.
- During testing never activate the GSM or WCDMA transmitter without a proper antenna load, otherwise GSM or WCDMA PA may be damaged.

For your safety

QUALIFIED SERVICE

Only qualified personnel may install or repair phone equipment.

ACCESSORIES AND BATTERIES

Use only approved accessories and batteries. Do not connect incompatible products.

CONNECTING TO OTHER DEVICES

When connecting to any other device, read its user's guide for detailed safety instructions. Do not connect incompatible products.

ESD protection

Nokia requires that service points have sufficient ESD protection (against static electricity) when servicing the phone.

Any product of which the covers are removed must be handled with ESD protection. The SIM card can be replaced without ESD protection if the product is otherwise ready for use.

To replace the covers ESD protection must be applied.

All electronic parts of the product are susceptible to ESD. Resistors, too, can be damaged by static electricity discharge.

All ESD sensitive parts must be packed in metallized protective bags during shipping and handling outside any ESD Protected Area (EPA).

Every repair action involving opening the product or handling the product components must be done under ESD protection.

ESD protected spare part packages MUST NOT be opened/closed out of an ESD Protected Area.

For more information and local requirements about ESD protection and ESD Protected Area, contact your local Nokia after Market Services representative.

Care and maintenance

This product is of superior design and craftsmanship and should be treated with care. The suggestions below will help you to fulfill any warranty obligations and to enjoy this product for many years.

- Keep the phone and all its parts and accessories out of the reach of small children.
- Keep the phone dry. Precipitation, humidity and all types of liquids or moisture can contain minerals that will corrode electronic circuits.
- Do not use or store the phone in dusty, dirty areas. Its moving parts can be damaged.
- Do not store the phone in hot areas. High temperatures can shorten the life of electronic devices, damage batteries, and warp or melt certain plastics.
- Do not store the phone in cold areas. When it warms up (to its normal temperature), moisture can form inside, which may damage electronic circuit boards.
- Do not drop, knock or shake the phone. Rough handling can break internal circuit boards.
- Do not use harsh chemicals, cleaning solvents, or strong detergents to clean the phone.
- Do not paint the phone. Paint can clog the moving parts and prevent proper operation.
- Use only the supplied or an approved replacement antenna. Unauthorized antennas, modifications or attachments could damage the phone and may violate regulations governing radio devices.

All of the above suggestions apply equally to the product, battery, charger or any accessory.

Company policy

Our policy is of continuous development; details of all technical modifications will be included with service bulletins.

While every endeavor has been made to ensure the accuracy of this document, some errors may exist. If any errors are found by the reader, NOKIA MOBILE PHONES Business Group should be notified in writing/e-mail.

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2. Latest Amendment Number (if applicable).
3. Page(s) and/or Figure(s) in error.

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Battery information

Note: A new battery's full performance is achieved only after two or three complete charge and discharge cycles!

The battery can be charged and discharged hundreds of times but it will eventually wear out. When the operating time (talk-time and standby time) is noticeably shorter than normal, it is time to buy a new battery.

Use only batteries approved by the phone manufacturer and recharge the battery only with the chargers approved by the manufacturer. Unplug the charger when not in use. Do not leave the battery connected to a charger for longer than a week, since overcharging may shorten its lifetime. If left unused a fully charged battery will discharge itself over time.

Temperature extremes can affect the ability of your battery to charge.

For good operation times with Lithium-Ion Polymer Rechargeable batteries, discharge the battery from time to time by leaving the product switched on until it turns itself off (or by using the battery discharge facility of any approved accessory available for the product). Do not attempt to discharge the battery by any other means.

Use the battery only for its intended purpose.

Never use any charger or battery which is damaged.

Do not short-circuit the battery. Accidental short-circuiting can occur when a metallic object (coin, clip or pen) causes direct connection of the + and - terminals of the battery (metal strips on the battery) for example when you carry a spare battery in your pocket or purse. Short-circuiting the terminals may damage the battery or the connecting object.

Leaving the battery in hot or cold places, such as in a closed car in summer or winter conditions, will reduce the capacity and lifetime of the battery, Always try to keep the battery between 15°C and 25°C (59°F and 77° F). A phone with a hot or cold battery may temporarily not work, even when the battery is fully charged. Batteries' performance is particularly limited in temperatures well below freezing.

Do not dispose of batteries in a fire!

Dispose of batteries according to local regulations (e.g. recycling). Do not dispose as household waste.

Nokia Lumia 1320; L3&4 Service Manual Structures

1 General Information

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Product selection

RM-994/RM-995/RM-996 are multimedia computer with capacitive touch UI and integrated GPS (A-GPS OMA SUPL)/Glonass, WLAN, Bluetooth 4.0 + EDR standard. Among them, GSM/WCDMA/LTE are supported in RM-994/RM-995 where RM-994 supports GSM850/900/1800/1900, WCDMA I/V/VIII, LTE III/VII/XX, RM-995 supports GSM850/900/1800/1900, WCDMA I/II/IV/V, LTE II/IV/V/XVII, and RM-996 supports GSM850/900/1800/1900, WCDMA I/VIII.

For WCDMA the maximum bit rate is up to 384 kbit/s for downlink and 384 kbit/s for uplink with simultaneous CS speech or CS video (max. 64 kbit/s). RM-94X series supports HSDPA + category 24 with downlink peak data rate up to 42 Mbit/s (in limited use cases), HSUPA belongs to category 6 with uplink peak data rate up to 5.76 Mbit/s (in limited use cases).

In PS/CS mode, the device supports DTM with multi slot class 11 (max. 4 RX + 3 TX, sum 5). With EGPRS this means a maximum download speed of up to 236.8 kbit/s simultaneously with speech. With GPRS this means a maximum download speed of up to 64.2 kbit/s simultaneously with speech.

In PS only mode, the device supports MSC 12, a maximum of 5 RX + 4 TX, sum 6 timeslots resulting in a maximum download speed of up to 296 kbit/s with EGPRS, and up to 107 kbit/s with GPRS.

The device has a large 5.98” (1280 x 720 pixels) X TFT HD touch display with 2D curved glass, 16 million colors and support for pinch zoom. It also has a 5 megapixel autofocus camera, 4 x digital zoom and an integrated LED flash. The device supports two-way video calls with two integrated cameras, one on the front and one on the back.

The MMS implementation follows the OMA MMS standard release 1.3. The browser is a highly advanced Internet browser also capable of viewing operator domain XHTML Mobile Profile (MP) content.

The device uses Windows Phone 8 operating system (release 8, Apollo) and supports the full Web Browser for Internet Explorer 10 with desktop rendering which brings desktop-like Web browsing experience to mobile devices.

Figure 1 View of Lumia 1320

■ Product features and sales package

Imaging

Main camera:

- Sensor: 5 megapixel
- F number/Aperture: F2.4
- Digital zoom: 4x
- Auto focus: Two-stage capture key
- Focus range: 10 cm ~ infinity
- Flash: Integrated LED flash

Front facing camera:

- Sensor: VGA (640 x 480 pixels)
- F number/Aperture: F2.8
- Fixed focus

Video:

- Video resolution: nHD 30 fps (1080p)
- Audio recording: High amplitude audio capture
- Video stabilization
- Video clip length: Max. 90 min
- Video file format: .mp4 H.264
- White balance: Automatic, sunny, cloudy, incandescent, fluorescent
- Zoom (digital): 4x
  Continuous auto focus
- Touch focus
- Video recording indicator

Photo:

- Still image resolutions: 5M (4:3), 3.8M (16:9)
- Still image file format: JPEG/EXIF
- View finder: Full screen view finder
- Continuous autofocus
- Touch focus
- Auto exposure: Center weighted AE
- Image orientation: Automatic
- Exposure compensation: +2 ~ -2EV at 0.5 step
- White balance: Automatic, sunny, cloudy, incandescent, fluorescent
- Zoom (digital): Up to 4x

Edit

- On device Photo editor (manual & automatic)

View

- 5.98” TFT HD (1280 x 720 pixels) color display, up to 16M colors
- Capacitive touch
- Corning® Gorilla® Glass (7N)
- 2D curved glass
- Alphamon sensor - a combination of ALS and proximity, ALS to optimize display brightness and power consumption, Proximity for turning off the display when in a call for power consumption.
- Slideshow from Pictures

Share

- Share effortlessly from Pictures or after capture
- Video sharing support (WCDMAD/LTE services)
- Online Album: Image/Video uploading from Pictures

Store

- 8 GB internal memory
- 1 GB RAM
- Micro SD support up to 64 GB
- Easy to transfer and organize photos and video between your device and a compatible PC

Music

- Digital music player: Supports MPEG-4 AAC/ AAC+/ eAAC+/ MPEG-1 audio Layer3 (MP3)/ WMA Pro 9 and 10
- Synchronies music with PC application
  High Dynamic Range (HDR) microphones
- Bluetooth speakers
- Integrated hands free speaker

Media

- Full-screen video playback to view downloaded, streamed or recorded video clips
- Supported video formats: MPEG-4, H.264/AVC, H.263/3GPP, WMV, AVI, MOV.

Productivity

Context management:

- Internet Explorer 10 with desktop rendering
- OMA DRM version 2.0
- OTA provisioning

Messaging:

- E-mail (SMTP, IMAP4, POP3), MMS, SMS, unified editor

Office applications:

- Viewing of email attachments – doc, .xls, .ppt, .pdf, .zip
- Mail for Exchange
- Rich HTML
- Office 15, SharePoint 15, Office 365

PIM:
- Contacts, calendar, calculator, clock, To-do, Notes

Synchronization:
- Local/Remote (using SkyDrive)
- Data: Calendar, Contacts, E-mail, To-do list.
- PC Applications: Microsoft Outlook (98, 2000, 2002, 2003), Outlook Express

Call management:
- Call logs, speed dial, voice dialing (with SIND) and voice commands

Connectivity

- Integrated GPS (A-GPS OMA SUPL) and Glonass
- WLAN - IEEE802.11 b/g/n with 2.4GHz
- Micro USB interface with USB 2.0 high speed
- Bluetooth wireless technology 4.0 + EDR
- Nokia 3.5 mm AV connector

Additional technical specifications

- Vibrating alert
- 3GPP Rel 8/6 compliant
- Speech codecs supported: FR, EFR, HR, AMR-NB, AMR-WB
- 1.7 GHz dual core processor
- WCDMA DL 384 kbit/s, UL 384 kbit/s
- GPRS/EGPRS Class B, multi slot class 12
- Dual Transfer Mode (DTM) class A, multi slot class 11
- HSDPA up to 21.1 Mbit/s, HSUPA 5.76 Mbit/s
- LTE support CAT3 DL 100 Mbit/s, UL 50 Mbit/s

Sales package

- Transceiver RM-994/ RM-995/ RM-996
- USB charger
  - ✓ RM-994 (AC-60 E/U/X/N/AR/K/A)
  - ✓ RM-995 (AC-60 uUSB black charger)
  - ✓ RM-996 (AC-50C for china)
- Music headset (WH-108)
- Connectivity cable (CA-189CD/ CA-190CD)
- Product information booklet
- Quick Start Guide

Product and module list

Module name	Type code	Notes
System/RF module PWB	3VW	
Sub PWB module	3VX	
Flash flex module	3VZ	Part of CWS carrier assembly

Accessories

Table 1 Audio

Accessory	Type
JBL PowerUp Wireless Charging Speaker for Nokia	MD-100W
JBL PlayUp Portable Wireless Speaker for Nokia	MD-51W
Nokia Purity HD Stereo Headset	Signature headset
Nokia Purity Pro Stereo Headset	BT Stereo headset
Nokia Reaction	BT headset
Wired speaker	MD-11
Wired headsets	WH-510
	WH-520
	WH-530
	WH-930
	WH-920
	WH-108
	WH-208
Bluetooth stereo headsets	BH-111
	BH-118
	BH-221
	BH-121
	BH-940
Bluetooth headsets	BH-310
	BH-118
	BH-220
	BH-907
	WS-2 precious
Inductive loopset	LPS-5

Table 2 Car

Accessory	Type
Car holder	CR-123
Bluetooth car kit	CK-600

Table 3 Data

Accessory	Type
Connectivity cable	CA-189CD
	CA-190CD
	CA-191C
Memory card	MU-37(2GB)
	MU-41(4GB)
	MU-43(8GB)
	MU-44(16GB)
	MU-45(32GB)

Table 4 Power

Accessory	Type
Charger	AC-20
	AC-21C
	AC-21W
	DC-16
	DC-18
	DC-19
	DC-20
	DT-900
	DT-910
	CR-200
Fast USB charger	AC-60 / AC-50C
Battery	BV-4BWA

■ Technical specifications

Transceiver general specifications

Unit	Dimensions (L x W x T) (mm)	Weight (g)	Volume (cm3)
Transceiver with BV-4BWA 3400mAh Li-ion battery pack	164.25 x 85.9 x 9.79mm	220	125

RM-994 Main RF characteristics for GSM850/900/1800/1900, WCDMA I/V/VIII, LTE III/VII/XX with Diversity phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), WCDMA V (850), and WCDMA I (2100),LTE III(1800),LTE VII(2600),and LTE XX(800)
Main antenna	GSM850:869 - 894 MHz;
Rx frequency band	EGSM900:925 - 960 MHz GSM1800:1805 - 1880 MHz GSM1900:1930 - 1990 MHz WCDMA VIII (900): 925 - 960 MHz WCDMA V (850): 869 – 894 MHz WCDMA I (2100): 2110 - 2170 MHz LTE III (1800): 1805 - 1880 MHz LTE VII(2600): 2620 - 2690 MHz LTE XX(800): 791 - 821MHz
Diversity antenna	LTE III (1800): 1805 - 1880 MHz
Rx frequency band	LTE VII(2600): 2620 - 2690 MHz LTE XX(800): 791 - 821MHz
Main antenna	GSM850: 824 – 849 MHz
Tx frequency band	EGSM900:880 - 915 MHz GSM1800:1710 - 1785 MHz GSM1900:1850 - 1910 MHz WCDMA VIII (900): 880 - 915 MHz WCDMA V (850): 824 – 849 MHz WCDMA I (2100): 1920 - 1980 MHz LTE III (1800): 1710 - 1785 MHz LTE VII(2600): 2500 - 2570 MHz LTE XX(800): 832 - 862MHz
Output power	GSM850: +5 ...+33 dBm/3.2 mW ... 2 W GSM900: +5 ...+33 dBm/3.2 mW ... 2 W GSM1800: +0 … +30 dBm/1 mW … 1 W GSM1900: +0 … +30 dBm/1 mW … 1 W WCDMA VIII (900): -50 ... +23 dBm/0.01 µW ... 251 mW WCDMA V (850): -50 … +23 dBm /0.01uW … 251 mW WCDMA I (2100): -50 … +23 dBm /0.01uW … 251 mW LTE III (1800): -40…+23 dBm/0.01uW…251mW LTE VII(2600): -40…+23 dBm/0.01uW…251mW LTE XX(800): -40…+23 dBm/0.01uW…251mW
EDGE output power	EDGE850: +5 … +27 dBm/3.2 mW … 501 mW EDGE900: +5 … +27 dBm/3.2 mW … 501 mW EDGE1800: +0 … +26 dBm/1.0 mW … 398 mW EDGE1900: +0 … +26 dBm/1.0 mW … 398 mW

Number of RF channels	GSM850: 124 GSM900: 174 GSM1800: 374 GSM1900: 299 WCDMA VIII (900): 152 WCDMA V (850): 108 WCDMA I (2100):277 LTE III (1800): 352 LTE VII(2600): 327 LTE XX(800): 127
Channel spacing	200 kHz WCDMA /GSM 15 kHz LTE
Number of Tx power levels	GSM850: 15 GSM900: 15 GSM1800: 16 GSM1900: 16 WCDMA VIII (900): 75 WCDMA V (850): 75 WCDMA I (2100):75 LTE III (1800): 65 LTE VII(2600): 65 LTE XX(800): 65

RM-995 Main RF characteristics for GSM850/900/1800/1900, WCDMA I/II/IV/V phones, LTE II/IV/V/XVII with Diversity phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA V (850), WCDMA IV (1700),WCDMA II (1900),WCDMA I (2100),LTE II(1900),LTE IV(1700),LTE V (850) and LTE XVII (700)
Main antenna	GSM850: 869 – 894 MHz
Rx frequency band	EGSM900: 925 - 960 MHz GSM1800: 1805 - 1880 MHz GSM1900: 1930 - 1990 MHz WCDMA V (850): 869 – 894 MHz WCDMA IV (1900): 2110 – 2155 MHz WCDMA II (1900): 1930 – 1990 MHz WCDMA I (2100): 2110 - 2170 MHz LTE II (1900): 1930 - 1990 MHz LTE IV(1700): 2110 - 2155 MHz LTE V(850): 869 - 894MHz LTE XVII(700): 734 - 746MHz

Diversity antenna Rx frequency band	WCDMA V (850): 869 – 894 MHz WCDMA II (1900): 1930 – 1990 MHz LTE II (1900): 1930 - 1990 MHz LTE IV(1700): 2110 - 2155 MHz LTE V(850): 869 - 894MHz LTE XVII(700): 734 - 746MHz
Main antenna Tx frequency band	GSM850: 824 – 849 MHz EGSM900:880 - 915 MHz GSM1800: 1710 - 1785 MHz GSM1900: 1850 - 1910 MHz WCDMA V (850): 824 – 849 MHz WCDMA IV (1700): 1710 – 1755 MHz WCDMA II (1900): 1850 – 1910 MHz WCDMA I (2100): 1920 - 1980 MHz LTE II (1900): 1850 - 1910 MHz LTE IV(1700): 1710 - 1755 MHz LTE V(850): 824 - 849MHz LTE XVII(700): 704 - 716MHz
Output power	GSM850: +5 ...+33 dBm/3.2 mW ... 2 W GSM900: +5 ...+33 dBm/3.2 mW ... 2 W GSM1800: +0 … +30 dBm/1 mW … 1 W GSM1900: +0 … +30 dBm/1 mW … 1 W WCDMA V (850): -50 … +23 dBm /0.01uW … 251 mW WCDMA IV (1700): -50 … +23 dBm /0.01uW … 251 mW WCDMA II (1900): -50 … +23 dBm /0.01uW … 251 mW WCDMA I (2100): -50 … +23 dBm /0.01uW … 251 mW LTE II (1900): -40…+23 dBm/0.01uW…251mW LTE IV(1700): -40…+23 dBm/0.01uW…251mW LTE V(850): -40…+23 dBm/0.01uW…251mW LTE XVII(700): -40…+23 dBm/0.01uW…251mW
EDGE output power	EDGE850: +5 … +27 dBm/3.2 mW … 501 mW EDGE900: +5 … +27 dBm/3.2 mW … 501 mW EDGE1800: +0 … +26 dBm/1.0 mW … 398 mW EDGE1900: +0 … +26 dBm/1.0 mW … 398 mW

Number of RF channels	GSM850: 124 GSM900: 174 GSM1800: 374 GSM1900: 299 WCDMA V (850): 108 WCDMA IV (1700): 202 WCDMA II (1900): 277 WCDMA I (2100):277 LTE II (1900): 277 LTE IV(1700): 202 LTE V(850): 102 LTE XVII(700): 37
Channel spacing	200 kHz WCDMA /GSM 15 kHz LTE
Number of Tx power levels	GSM850: 15 GSM900: 15 GSM1800: 16 GSM1900: 16 WCDMA V (850): 75 WCDMA IV (1700): 75 WCDMA II (1900): 75 WCDMA I (2100):75 LTE II (1900): 65 LTE IV(1700): 65 LTE V(850): 65 LTE XVII(700): 65

RM-996 Main RF characteristics for GSM850/900/1800/1900, WCDMA I/VIII phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), and WCDMA I (2100)
Main antenna Rx frequency band	GSM850: 869 – 894 MHz EGSM900:925 - 960 MHz GSM1800:1805 - 1880 MHz GSM1900:1930 - 1990 MHz WCDMA VIII (900): 925 - 960 MHz WCDMA I (2100): 2110 - 2170 MHz
Main antenna Tx frequency band	GSM850: 824 – 849 MHz EGSM900:880 - 915 MHz GSM1800:1710 - 1785 MHz GSM1900:1850 - 1910 MHz WCDMA VIII (900): 880 - 915 MHz WCDMA I (2100): 1920 - 1980 MHz

Output power	GSM850: +5 ...+33 dBm/3.2 mW ... 2 W GSM900: +5 ...+33 dBm/3.2 mW ... 2 W GSM1800: +0 … +30 dBm/1 mW … 1 W GSM1900: +0 … +30 dBm/1 mW … 1 W WCDMA VIII (900): -50 ... +23 dBm/0.01 µW ... 251 mW WCDMA I (2100): -50 … +23 dBm /0.01uW … 251 mW
EDGE output power	EDGE850: +5 … +27 dBm/3.2 mW … 501 mW EDGE900: +5 … +27 dBm/3.2 mW … 501 mW EDGE1800: +0 … +26 dBm/1.0 mW … 398 mW EDGE1900: +0 … +26 dBm/1.0 mW … 398 mW
Number of RF channels	GSM850: 124 GSM900: 174 GSM1800: 374 GSM1900: 299 WCDMA VIII (900): 152 WCDMA I (2100):277
Channel spacing	200 kHz WCDMA /GSM
Number of Tx power levels	GSM850: 15 GSM900: 15 GSM1800: 16 GSM1900: 16 WCDMA VIII (900): 75 WCDMA I (2100):75

■ Battery endurance

Battery	Capacity(mAh)	Talk time	Stand-by	Music playback	HD video playback
BV-4BWA	3400	Up to 11.2 h (GSM) Up to 12.5 h (WCDMA)	Up to 640hrs	Up to 72hrs	Up to 7.4hrs

■ Environmental conditions

Temperature conditions

Environmental condition	Ambient temperature	Notes
Normal operation	0°C...+45°C	Specifications fulfilled
Reduced performance	-10°C...0°C	Operational for shorts periods only
	+45°C...+55°C	
Intermittent operation	-40°C...-10°C	Operation not guaranteed but an attempt to operate does not damage the phone.
	+55°C...+70°C	
No operation or storage	<-40°C...>+73°C	No storage or operation: an attempt may damage the phone.
Charging range	-3°C...+60°C	an attempt to charge in -40°C… 0°C and +45°C…76°C does not damage the phone but charging may be disabled.
Long term storage	0°C...+45°C	

Humidity

Relative humidity range is 5...95%.

The HW module is not protected against water. Condensed or splashed water might cause malfunction. Any submersion of the phone will cause permanent damage. Long-term high humidity, with condensation, will cause permanent damage because of corrosion.

Vibration

The module should withstand the following vibrations:

- 1200rpm
- 50dB(A)max

ESD strength

Conducted discharge is 4 kV (>10 discharges) and air contact 8 kV (>10 discharges).
The standard for electrostatic discharge is IEC 61000-4-2, and this device fulfills level 4 requirements.

RoHS

This device uses RoHS compliant components and lead-free soldering process.

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2 Service Tools and Service Concepts

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Service tools

Nokia product specific tools

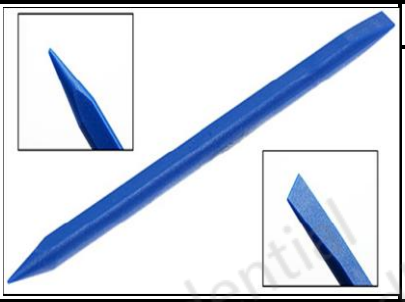
The table below gives a short overview of service devices that can be used for testing error analysis, and repair of product RM-994/RM-995/RM-996. For the correct use of the service devices and the best effort of workbench setup please refer to various concepts.

	SS-305	Camera removal tool	0781564
	The camera removal tool SS-210 is used to remove/attach the camera module from/to the socket.		
	SS-298	RF Coaxial Cable Tool	0781548
	The RF Coaxial Cable tool is used to disconnect the coaxial cable in the device.		

General tools

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

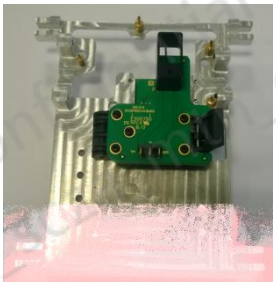
	CA-101	Micro USB cable	0730634
	The CA-101 is a USB-to-micro USB data cable that allows connections between the PC and the phone.		
	RJ-245	Soldering jig	0781484
	RJ-245 is a soldering jig used for soldering and as a rework jig for the engine module.		

	SRT-6	Opening tool	0770431
	SRT-6 is used to open phone covers. **Note:** The SRT-6 is included in the Nokia Standard Toolkit.		
	SS-93	Opening tool	0780727
	SS-93 is used for opening JAE connectors. **Note:** The SS-93 is included in Nokia Standard Toolkit.		
	SX-4T	Smart card	0780392
	SX-4T is a BB5 security device used to protect critical features in tuning and testing.		

Optional tools

The table below gives a short overview of service devices that can be used for testing, error analysis and repair of product. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

	XRS-6	RF cable	0730231
	The RF cable is used to connect, for example, a module repair jig to the RF measurement equipment.		

	MJ-300	Module Jig	0781441
	Module jig MJ-300 can be used for flashing via USB and RF, battery and system testing. The main functions are: ● Powering with external power ● WLAN/BT/GPS RF-interface with probes ● GSM/WCDMA RF-interfaces with probes ● BSI mode selector(Tabby and Lynx interface, selected with battery cable) ● VBATT interface (Tabby and Lynx interface, selected with battery cable) ● SS-314 RF guide plate is required with this jig ● CA-158RS cable is used together with this jig for RF testing		
	SS-334	RF guide plate	0781609
	SS-334 is an RF guide plate used with MJ-300 module jig		
	PCS-1	Power cable	0730012
	The PCS-1 power cable (DC) is used with a docking station, a module jig or a control unit to supply a controlled voltage		

■ Service concepts (Nokia)

POS (Point of Sale) flash concept

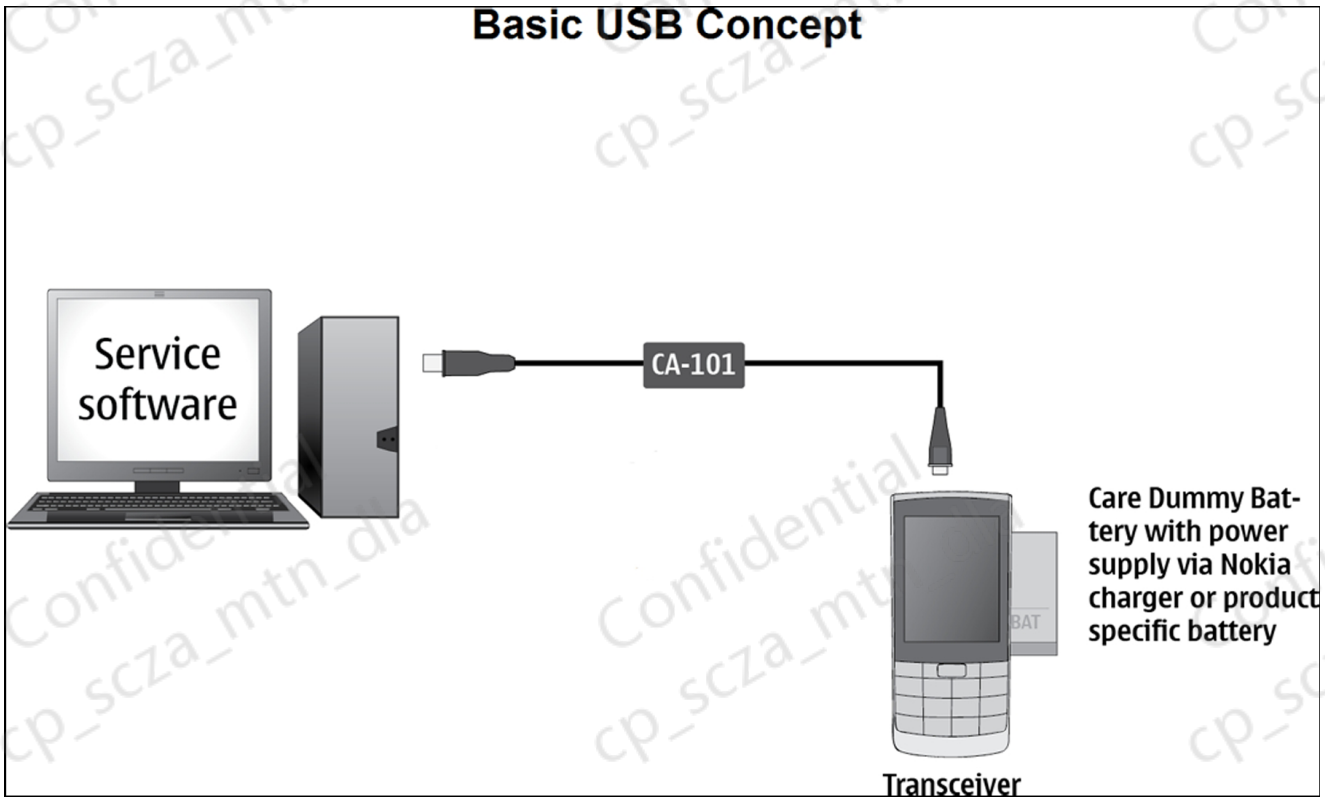


Figure 2 POS flash concept

Type	Description
Product Specific Devices	
BV-4BWA	Battery
Cables	
CA-101	Micro USB cable

Concept for flashing and product code change

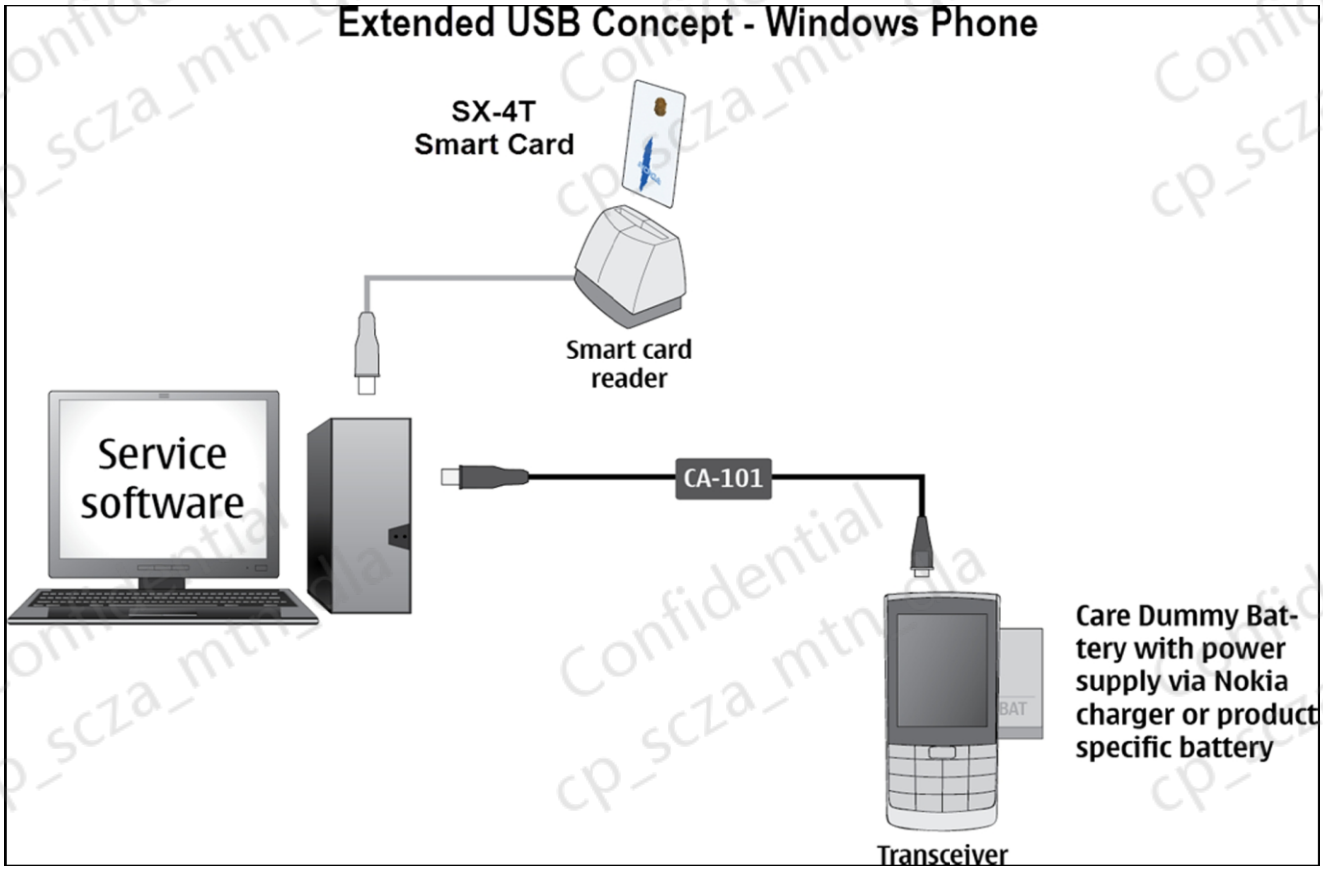


Figure 3 BE concept for flashing and product code change

Type	Description
Product Specific Devices	
BV-4BWA	Battery
Other Devices	
SX-4	Smart Card
Cables	
CA-101	Micro USB cable

Optional Module jig service concept 1 (Troubleshooting)

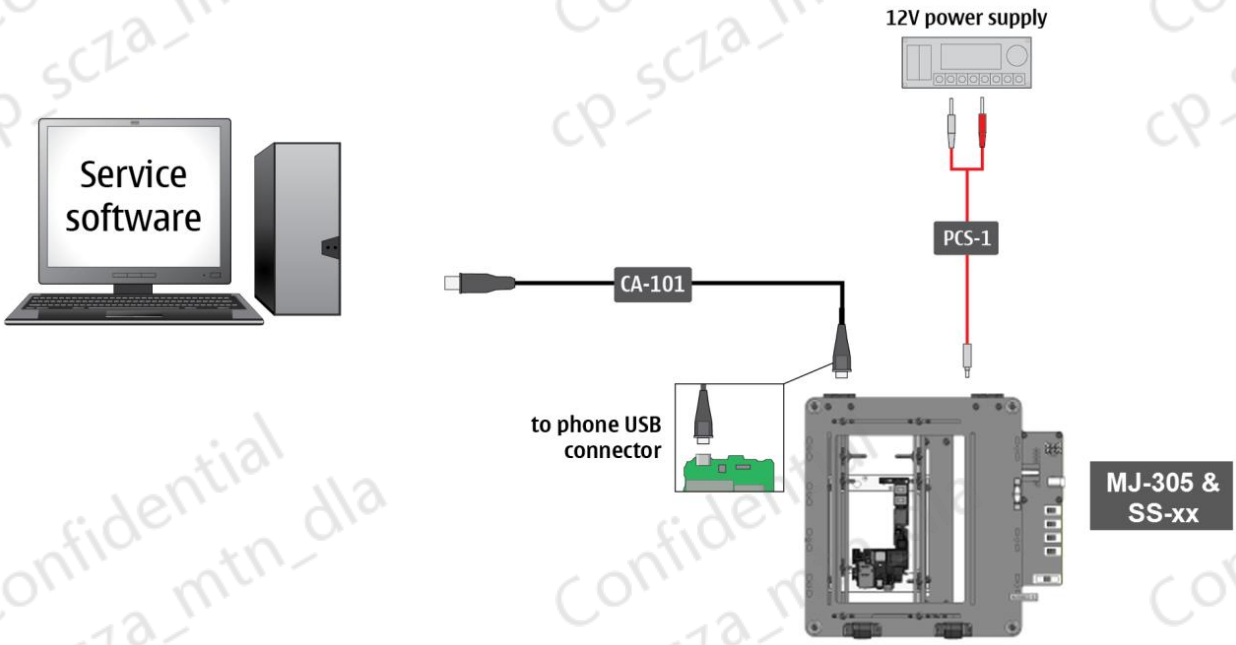


Figure 4 BE Module jig service concept 1

Type	Description
Product Specific Devices	
MJ-300	Module Jig
SS-334	RF guide plate
Cables	
CA-101	Micro USB cable
PCS-1	DC Power cable

Optional Module jig service concept 2 (Troubleshooting + RF Measurement)

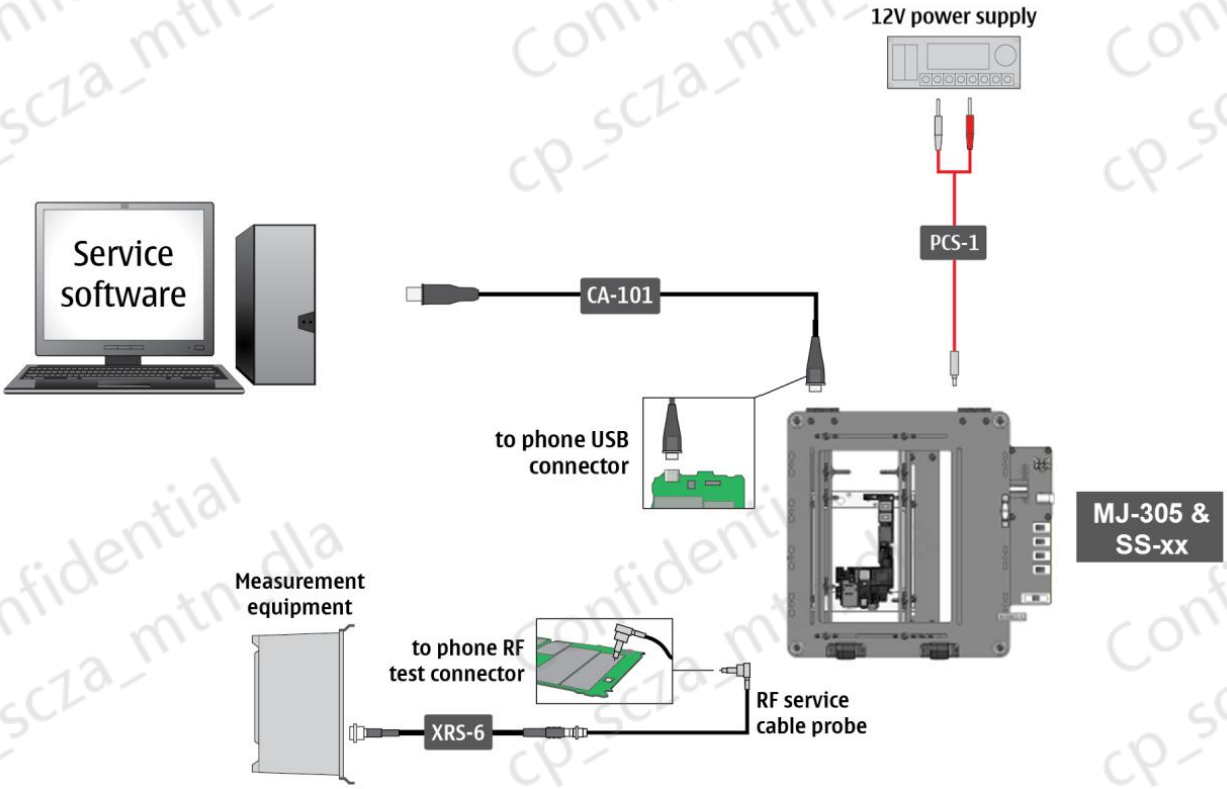


Figure 5 BE Module jig service concept 2

Type	Description
Product Specific Devices	
MJ-305	Module Jig
SS-334	RF guide plate
Cables	
CA-101	Micro USB cable
PCS-1	DC Power cable
XRS-6	RF cable

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3 BB Troubleshooting Guide

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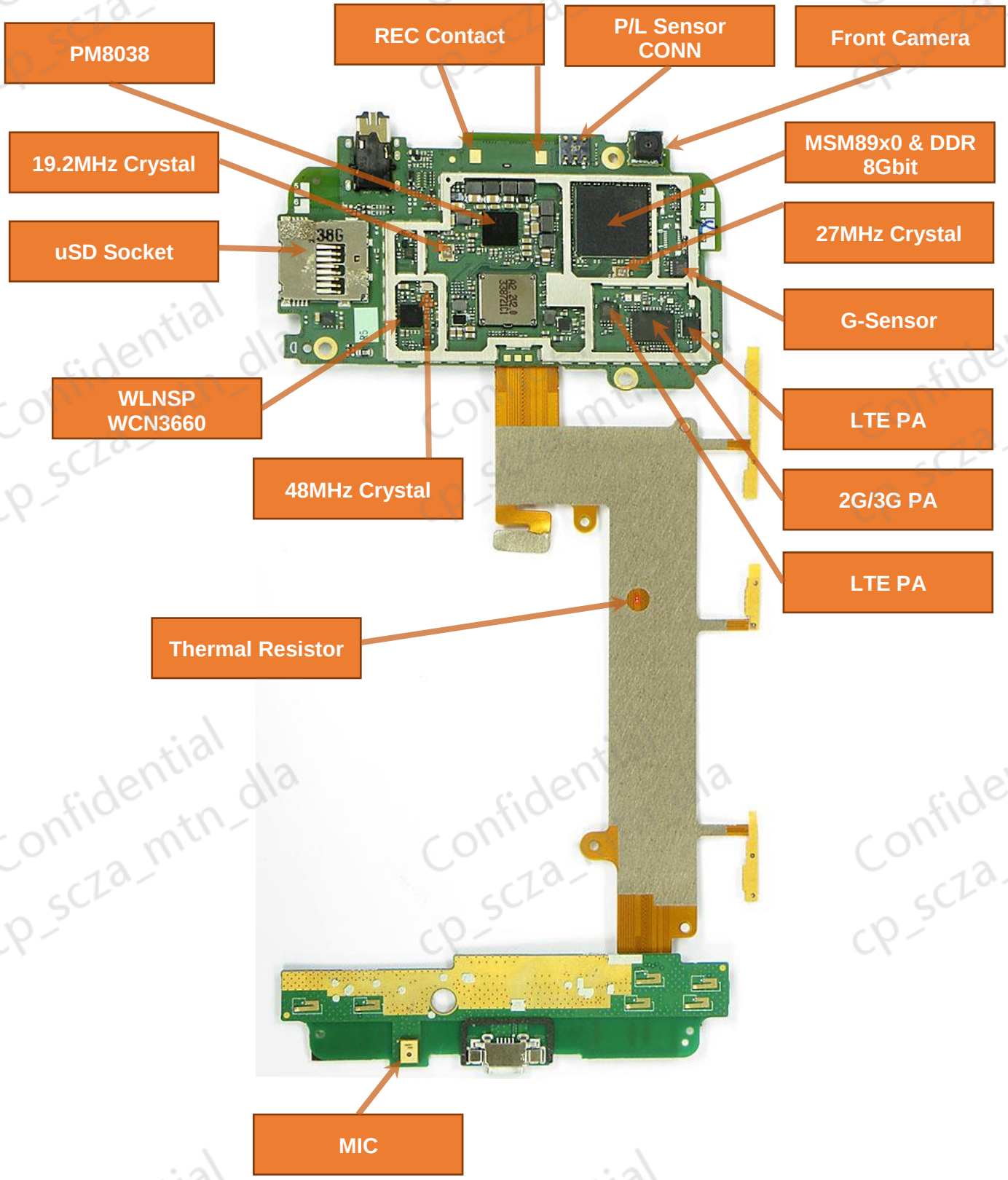
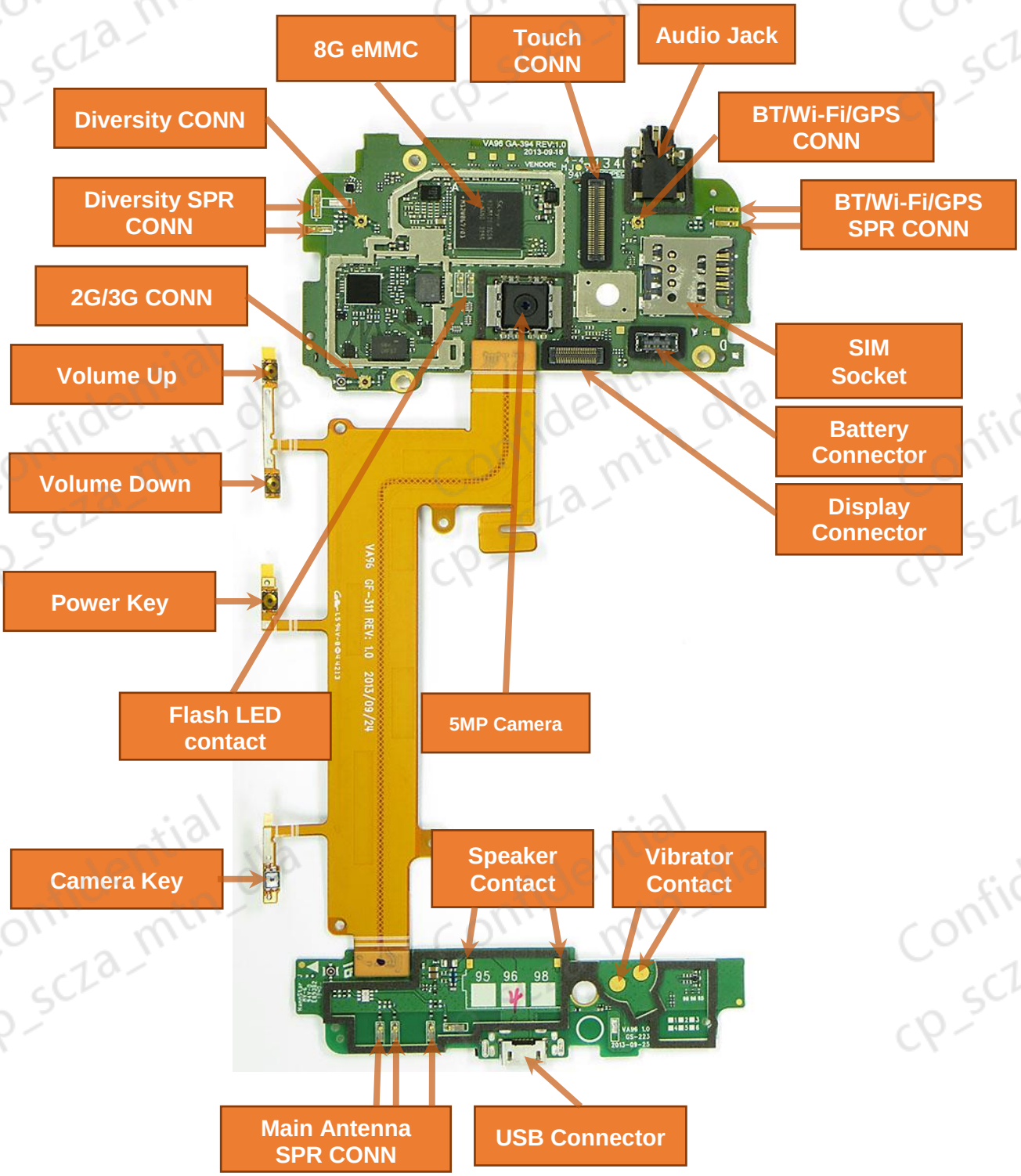
Placement

Placement – Main Board (Top side)

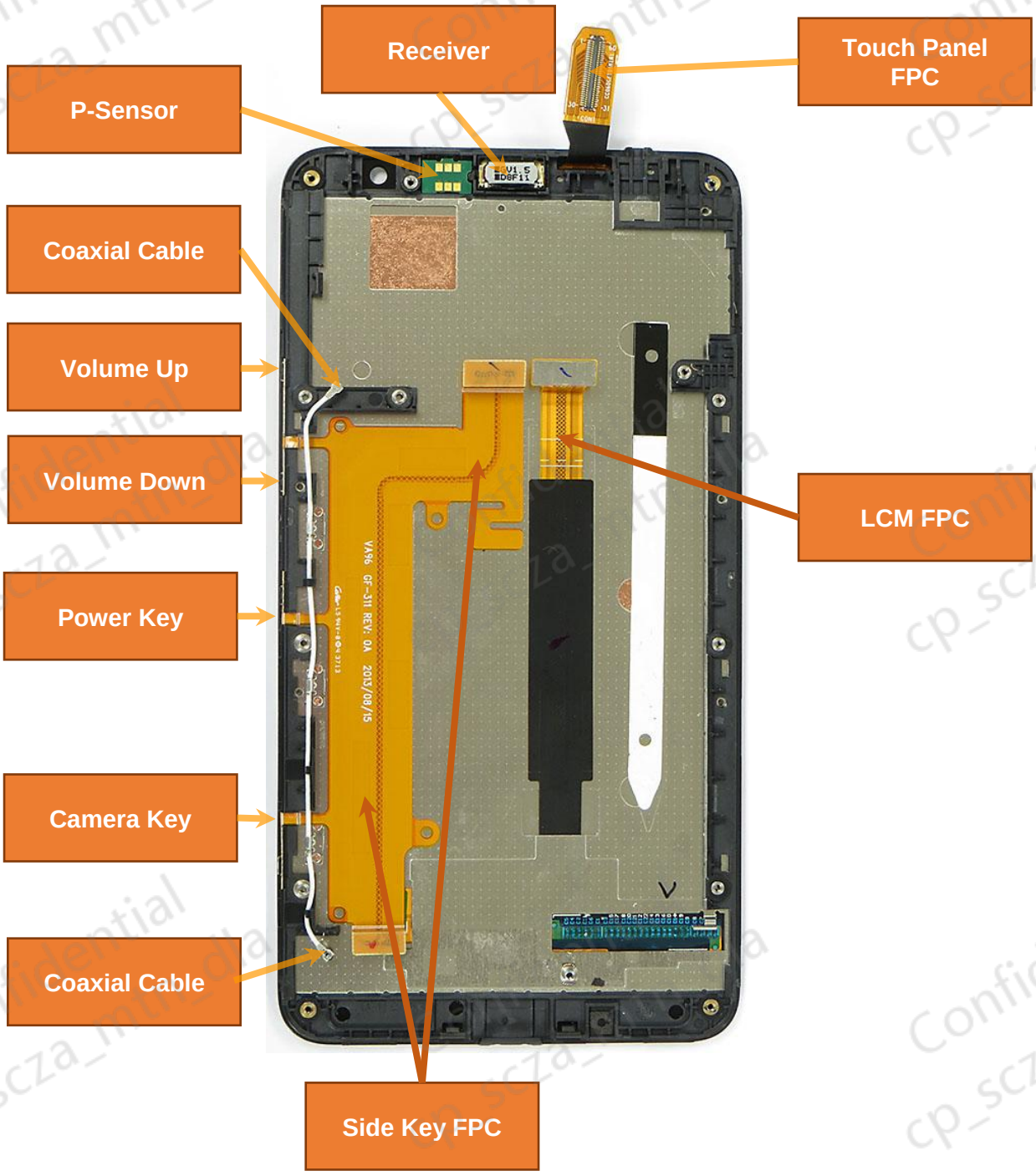


Placement - Main Board (Bottom side)



D-Cover

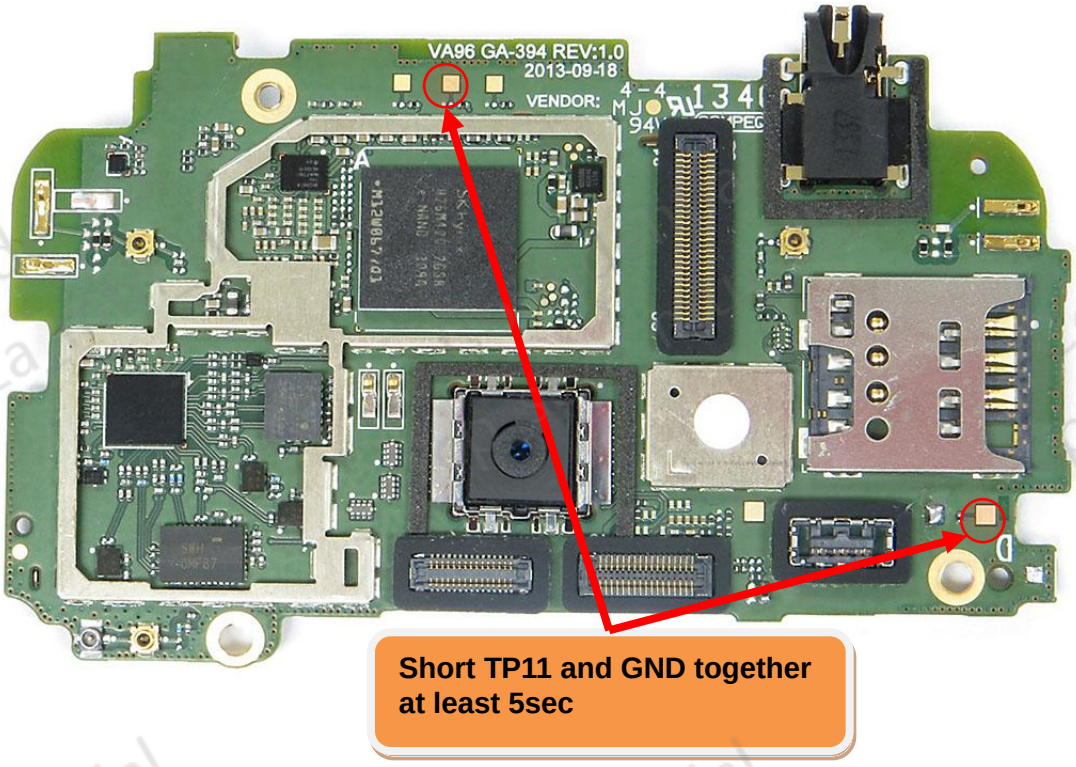
A_COVER (Include Touch Panel, LCM)



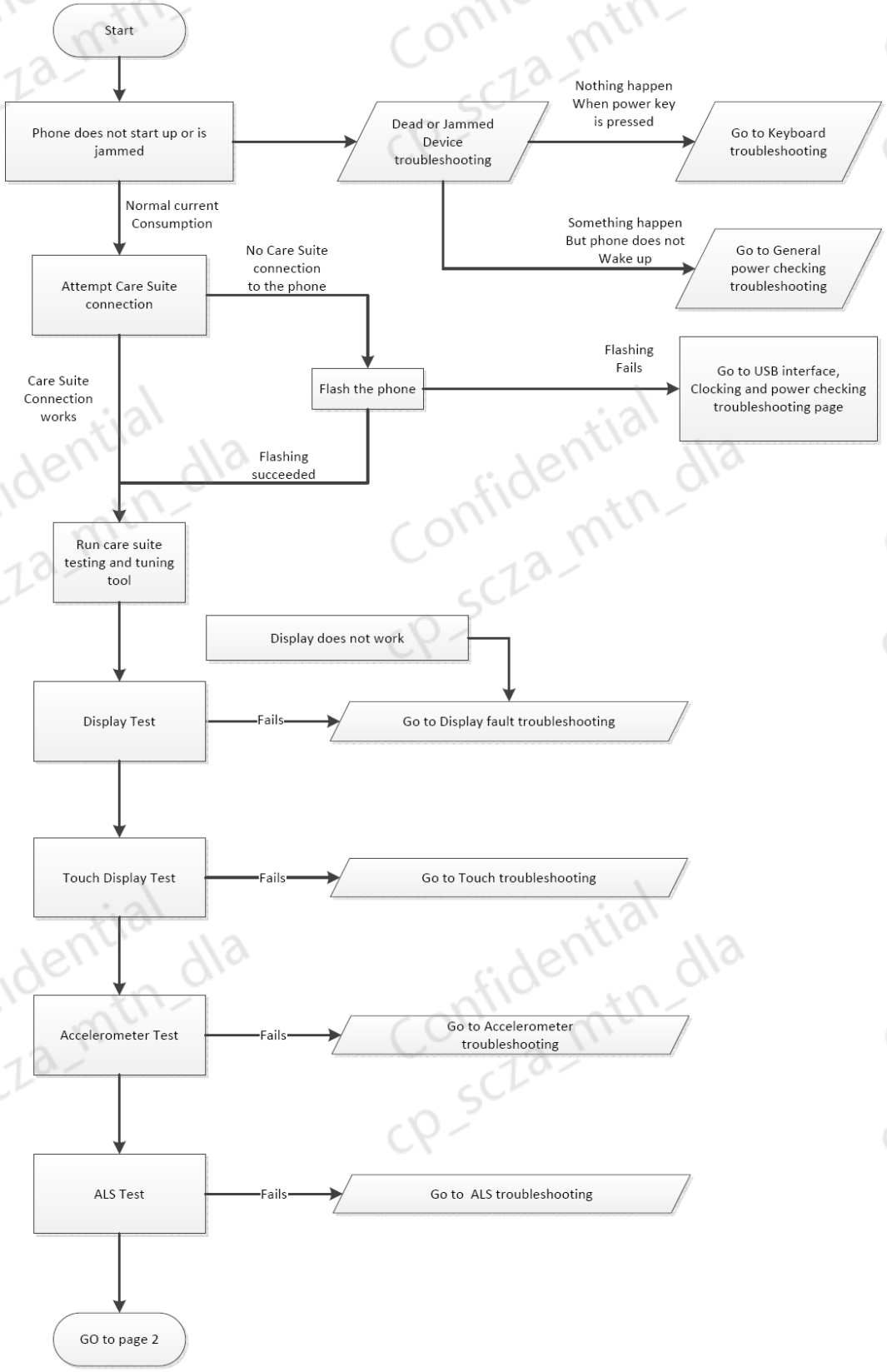
How to power on Handset

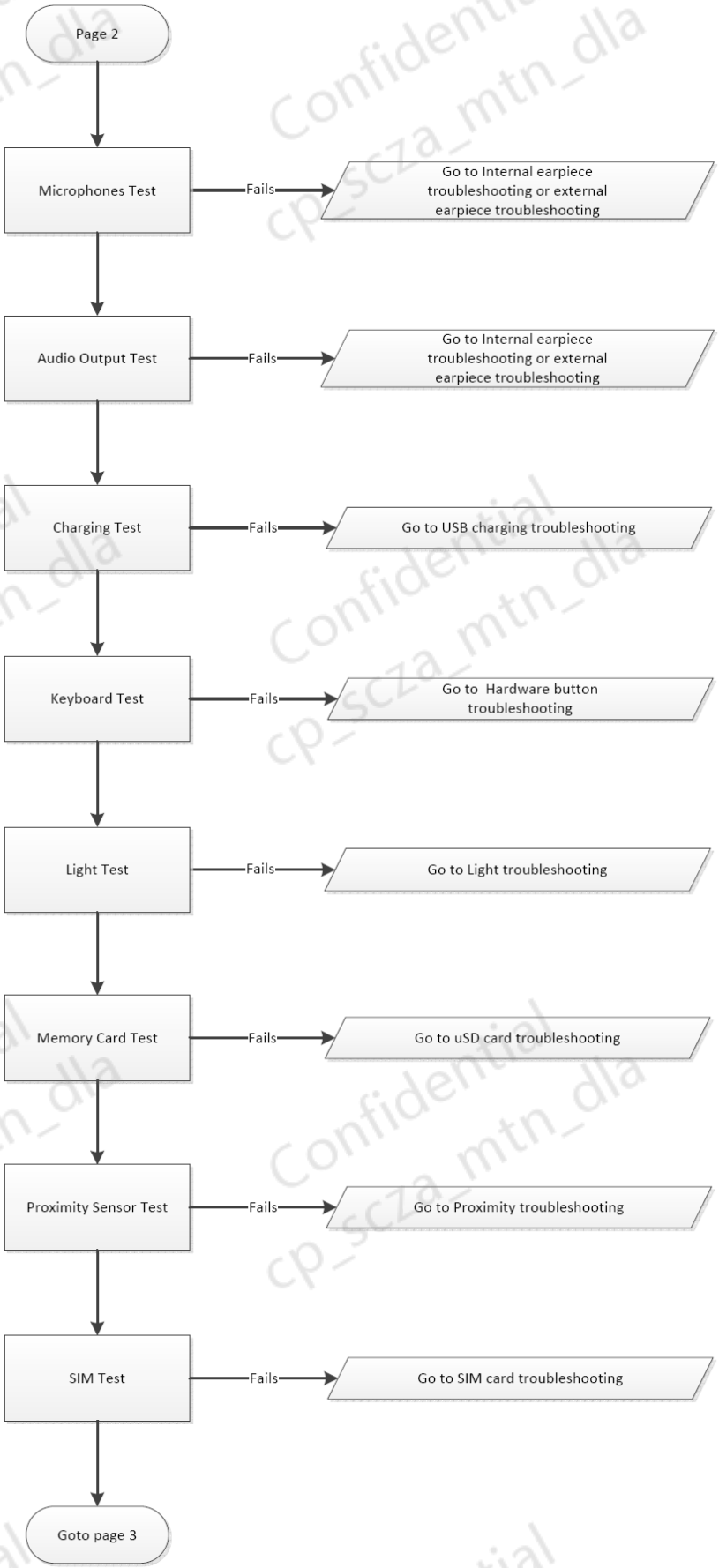
1. Push power key

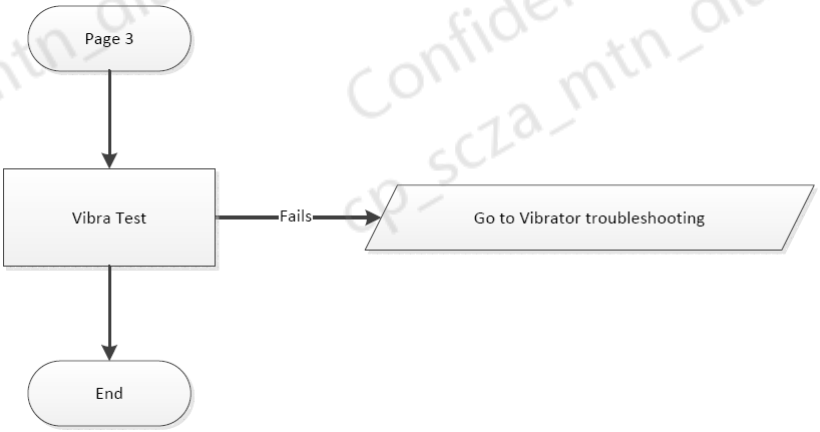
2. Short TP11 and GND.



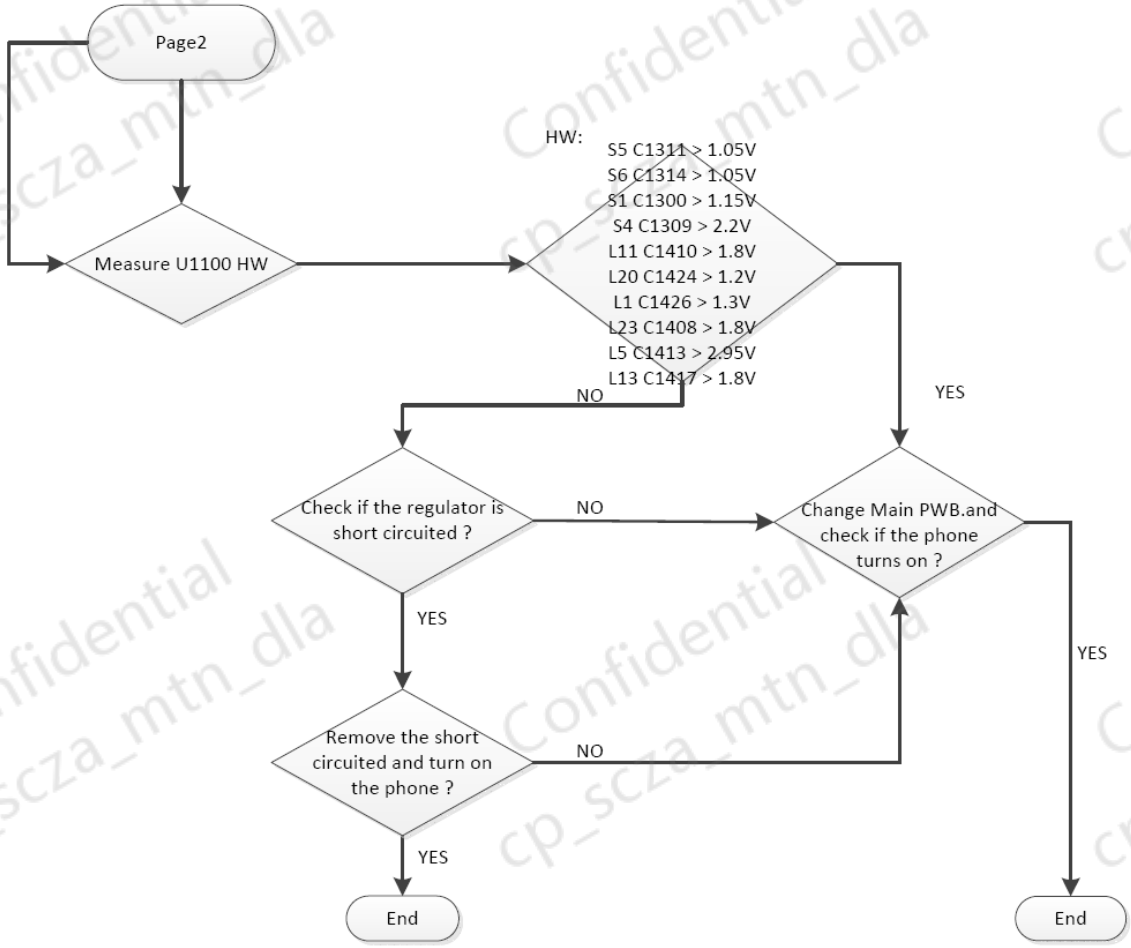
Overall Troubleshooting flow



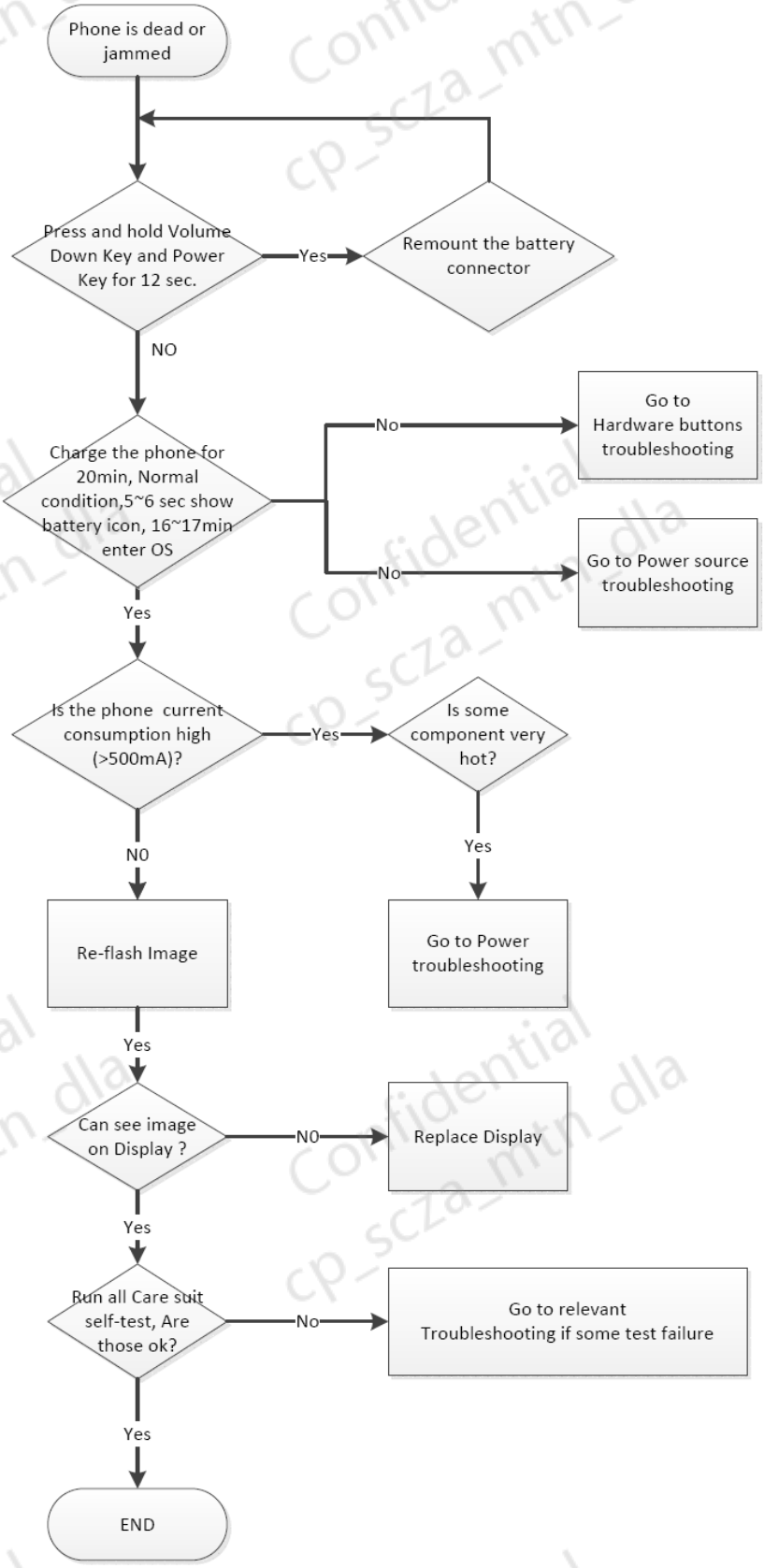




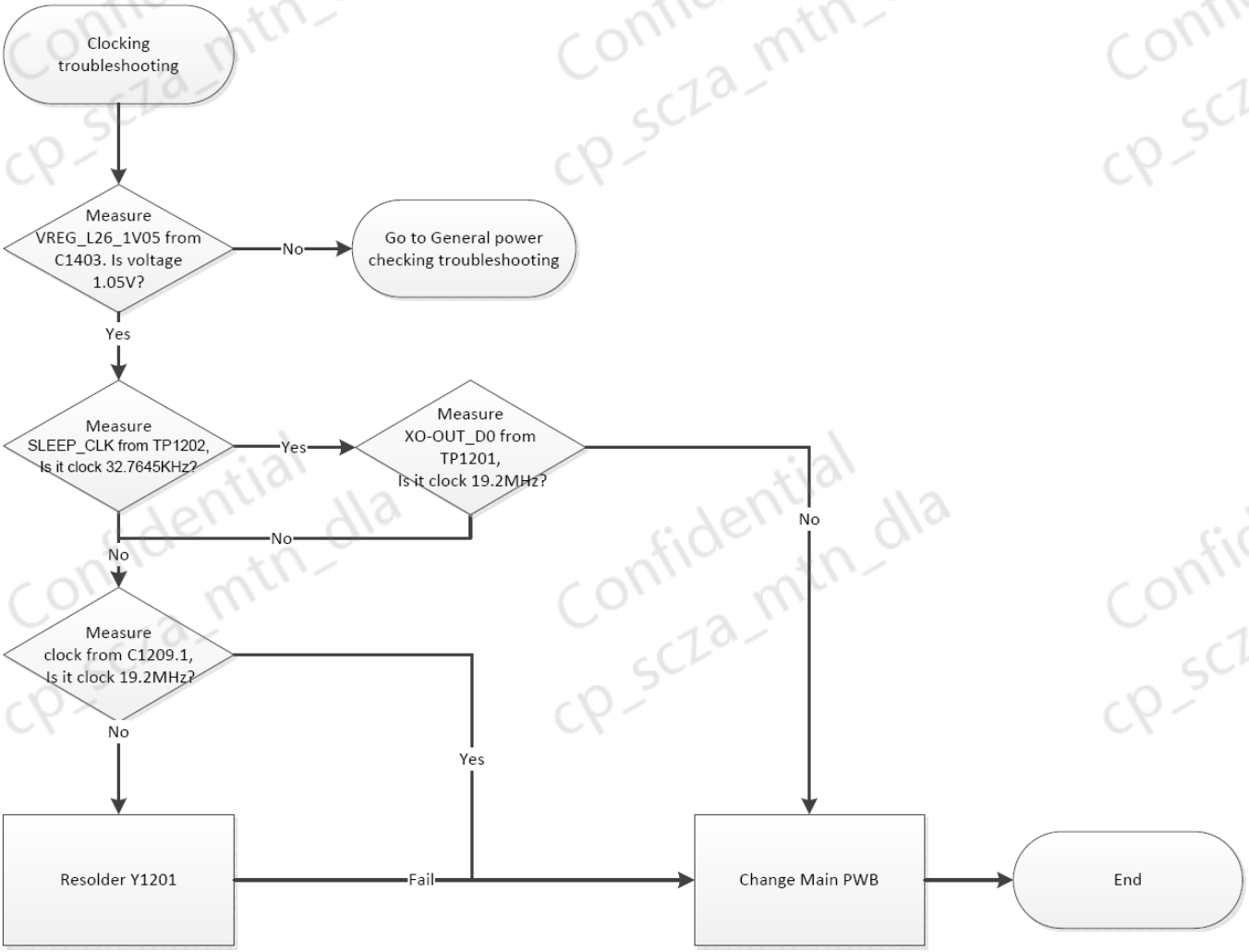
General power checking troubleshooting



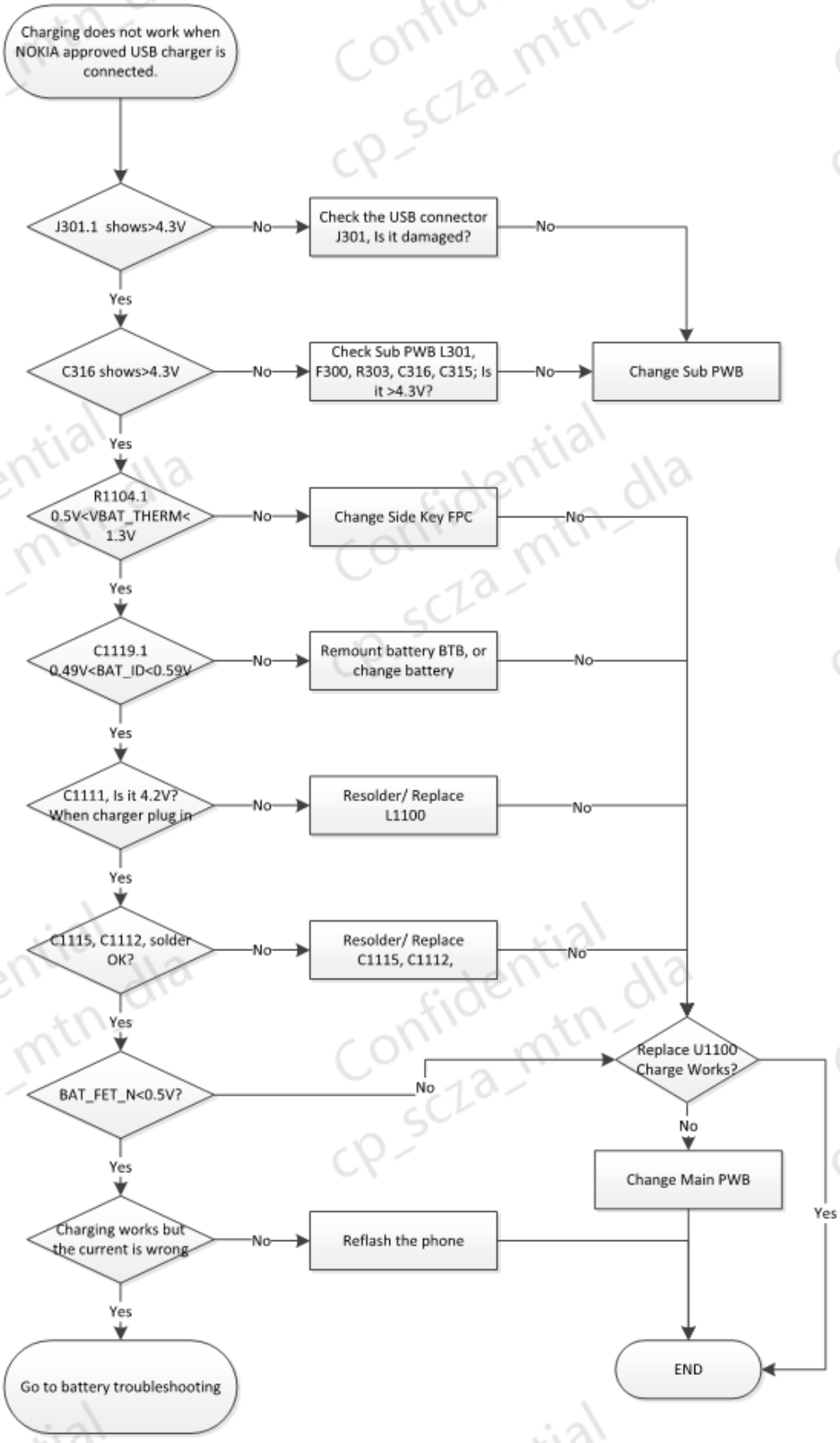
Dead or jammed device troubleshooting



Clocking troubleshooting

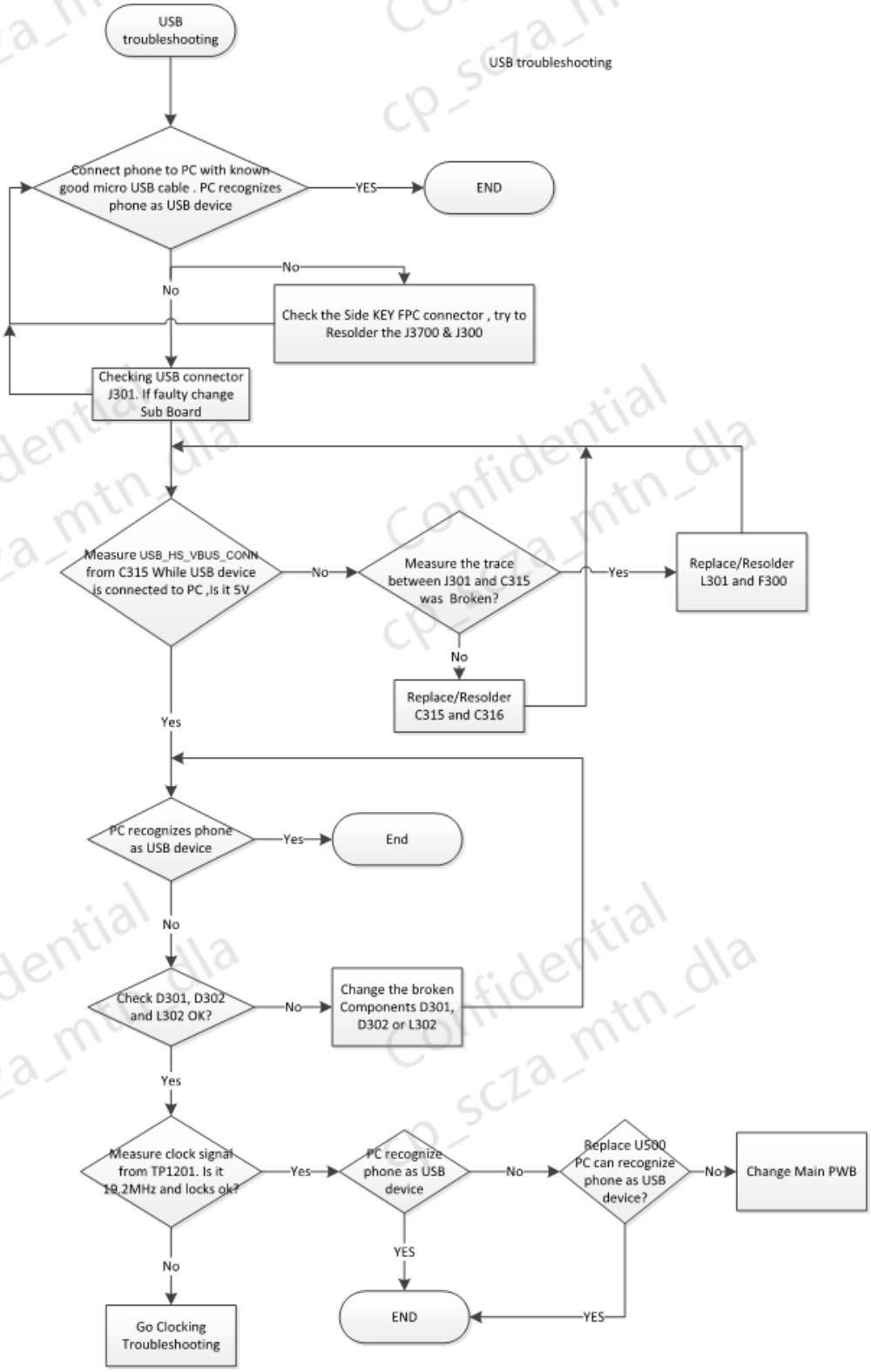


USB charging troubleshooting

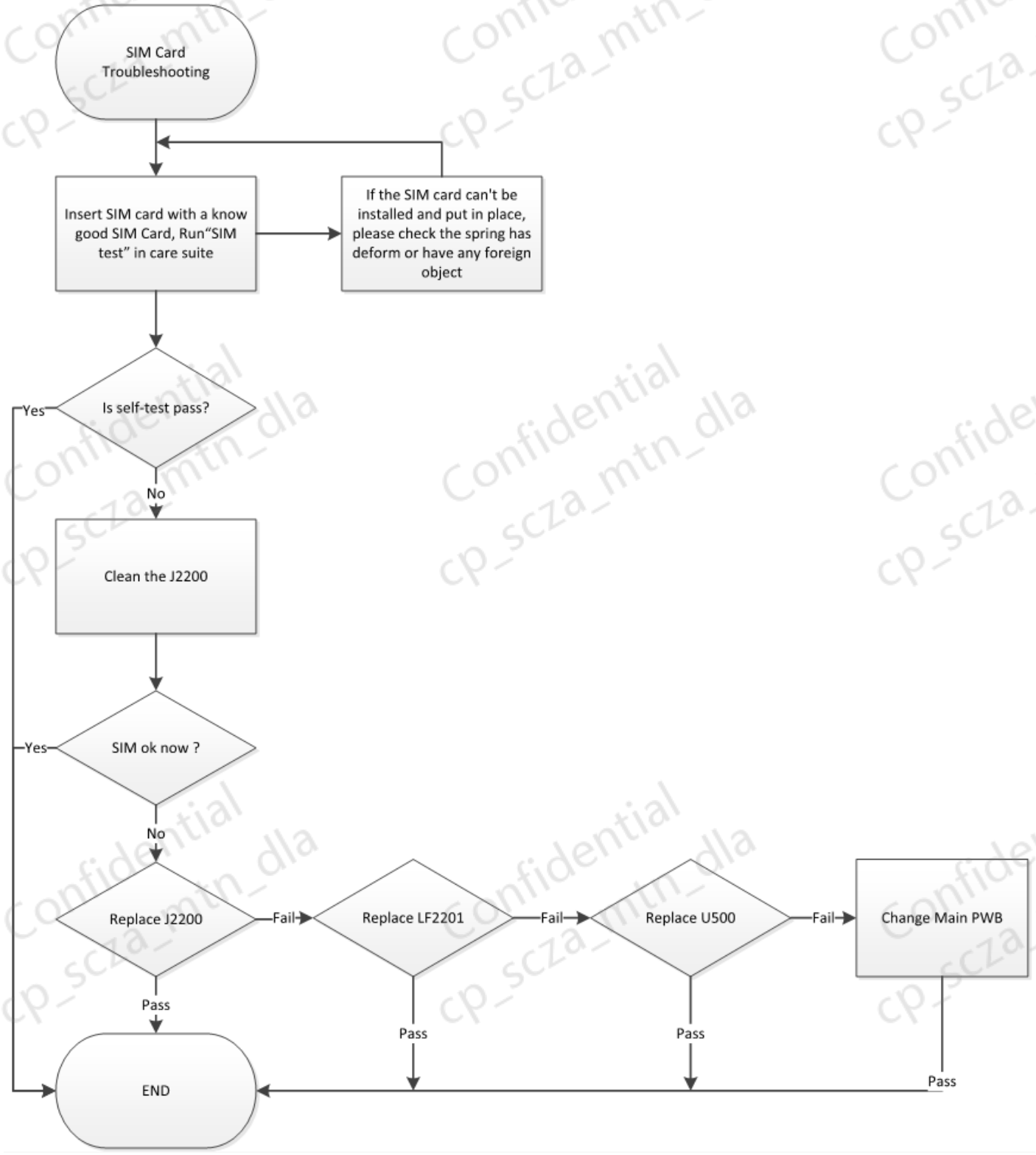


■ Interface troubleshooting

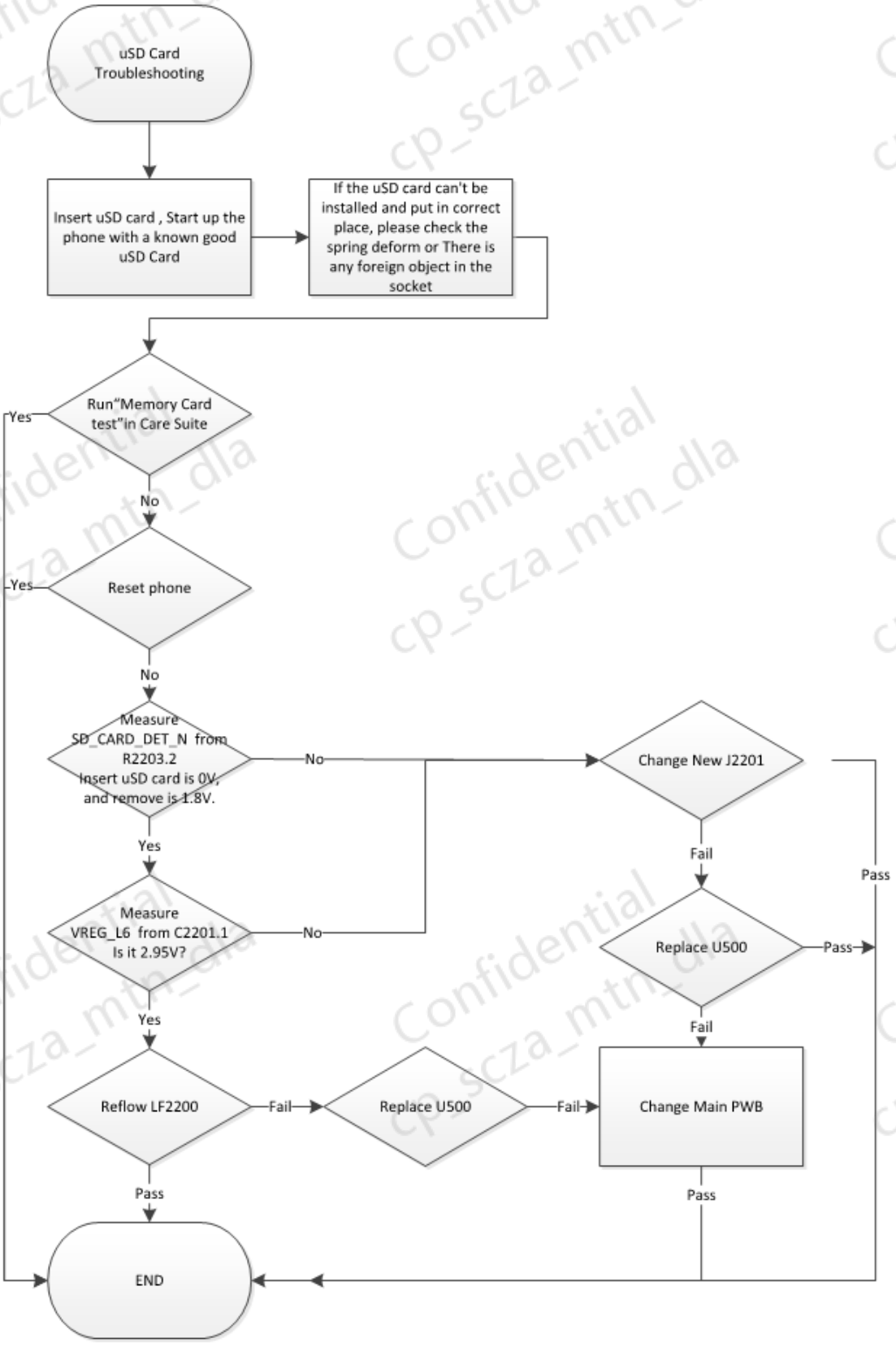
USB data interface troubleshooting



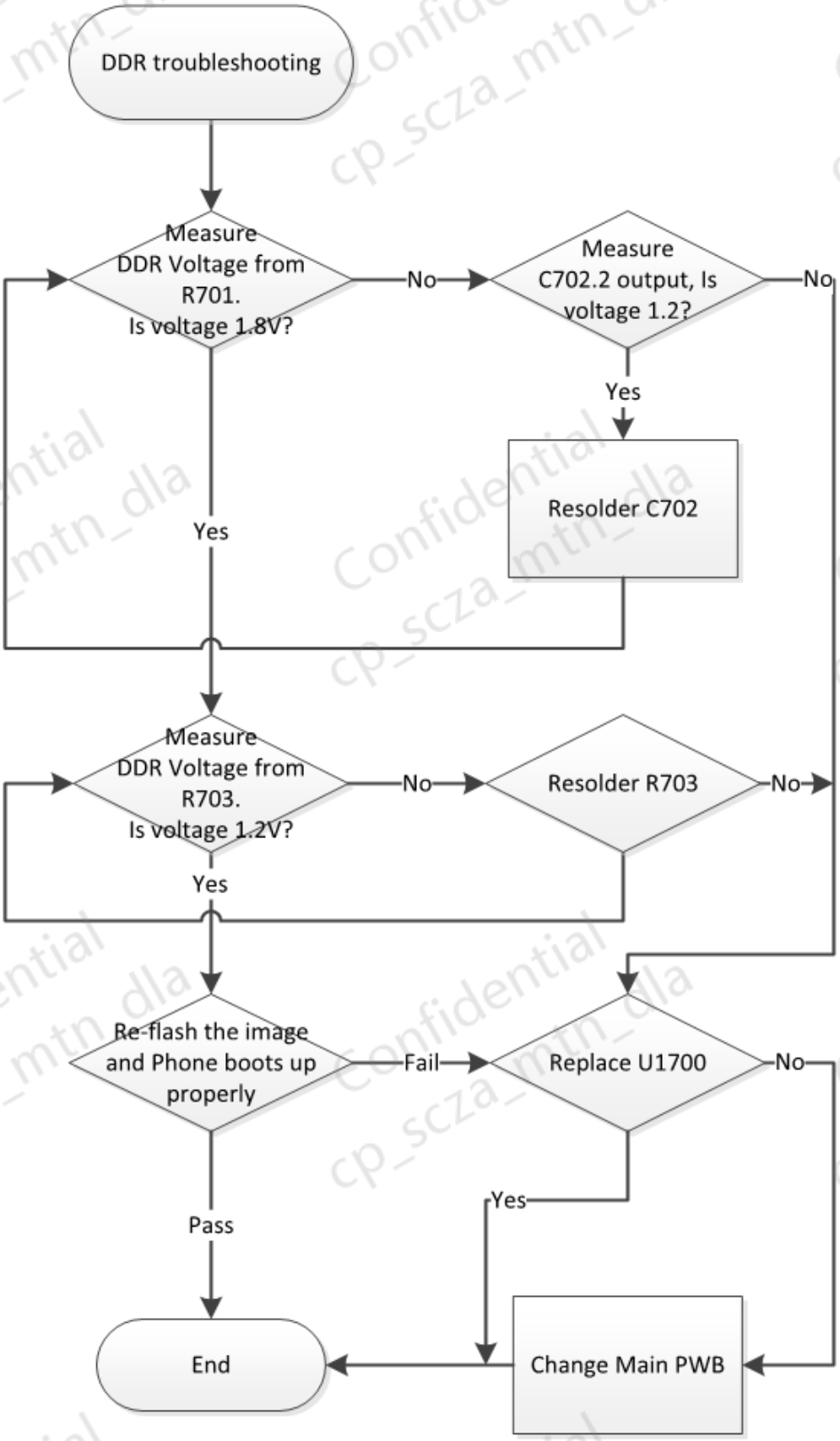
SIM card troubleshooting



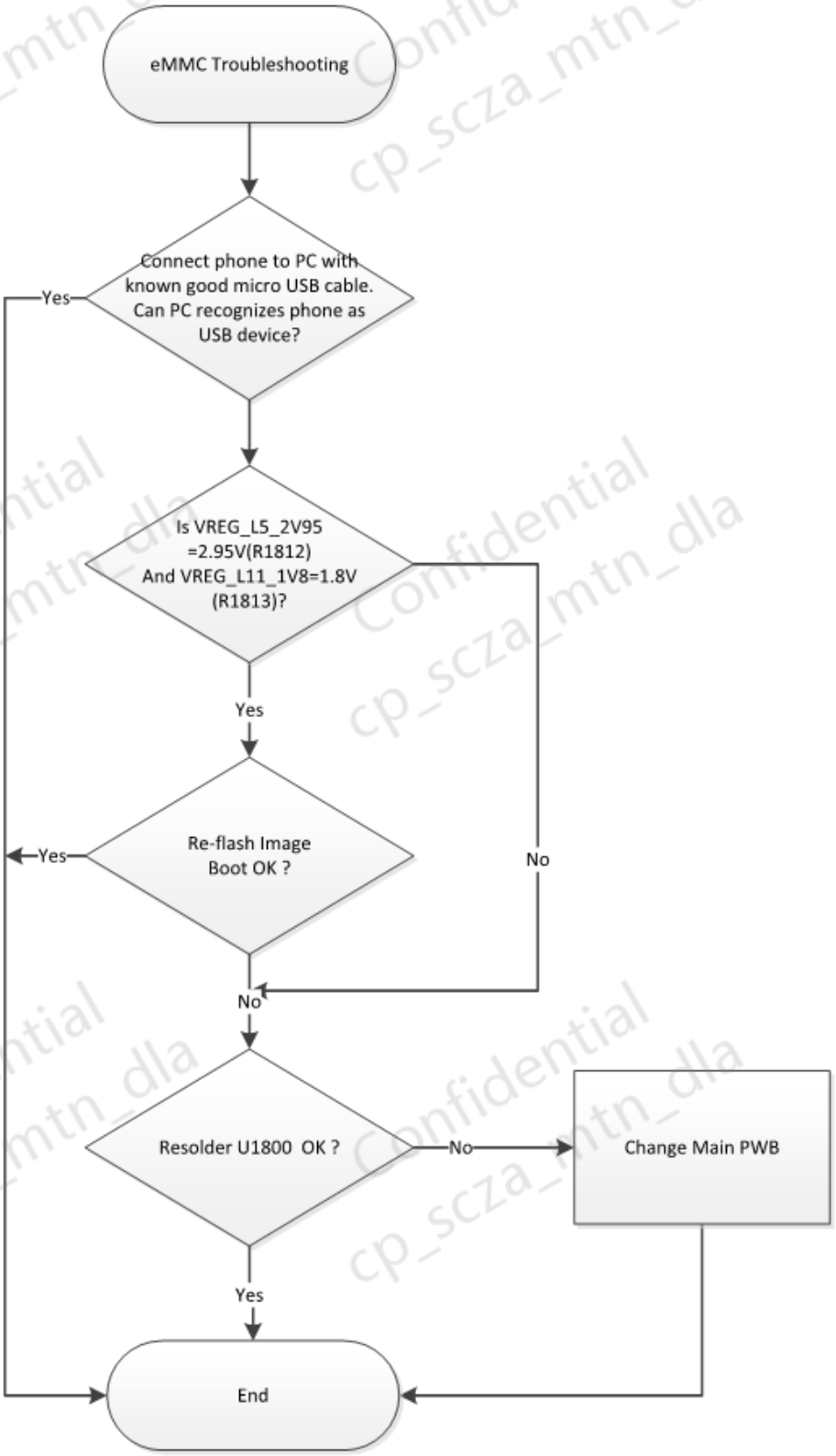
MicroSD interface troubleshooting



DRAM troubleshooting



eMMC troubleshooting



■ Display module troubleshooting

General instructions for display troubleshooting

The first step is to verify with a working display that the fault is not on the display module itself. The display module cannot be repaired.

Note: Always use the display with the phone's window while checking the display's visual functionality.

The second step is to check that the engine is working normally. This can be done by connecting the phone to a docking station and starting service software. With the help of service software read the phone information to check that also the application engine is functioning normally (you should be able to read the APE ID).

After these checks proceed to the display troubleshooting flowcharts, Use the Care Suite to find the detailed fault mode.

Pixel defects

Table 5 Display module troubleshooting cases

Display blank	there is no image on the display. The display looks the same when the phone is on as it does when the phone is off.
Image on the display not correct	Image on the display can be corrupted or a part of the image can be missing. If a part of the image is missing, change the display module. If the image is otherwise corrupted, follow the appropriate troubleshooting diagram.
Visual defects (pixel)	Pixel defects can be checked by controlling the display with service software. Use both colors, black and white, on a full screen. R, G, B are also helpful. The display may have some random pixel defects that are acceptable for this type of display. The criteria when pixel defects are regarded as a display failure, resulting in a replacement of the display, are presented in the following table.

Table 6 Pixel defects

Bright sub-pixels	(sometimes called on-pixels or stuck-on) are characterized by the appearance of bright/colored pixels in, for example, black full screen picture.
Dark sub-pixels	(sometimes called off-pixels, stuck-off, or black pixels) are characterized by the appearance of dark pixels in white, red, green, or blue full-screen picture.
Combined sub-pixel	defects are characterized by at least two sub-pixels defects (bright or dim) being closer than 5 mm to each other.

Temporal sub-pixels	(sometimes called blinking defects) exhibit temporal variations not related to any steady-state video input. Temporal sub-pixel defects may be intermittent, exhibit a sudden change of state, or be flickering.

Table 7 Defects table

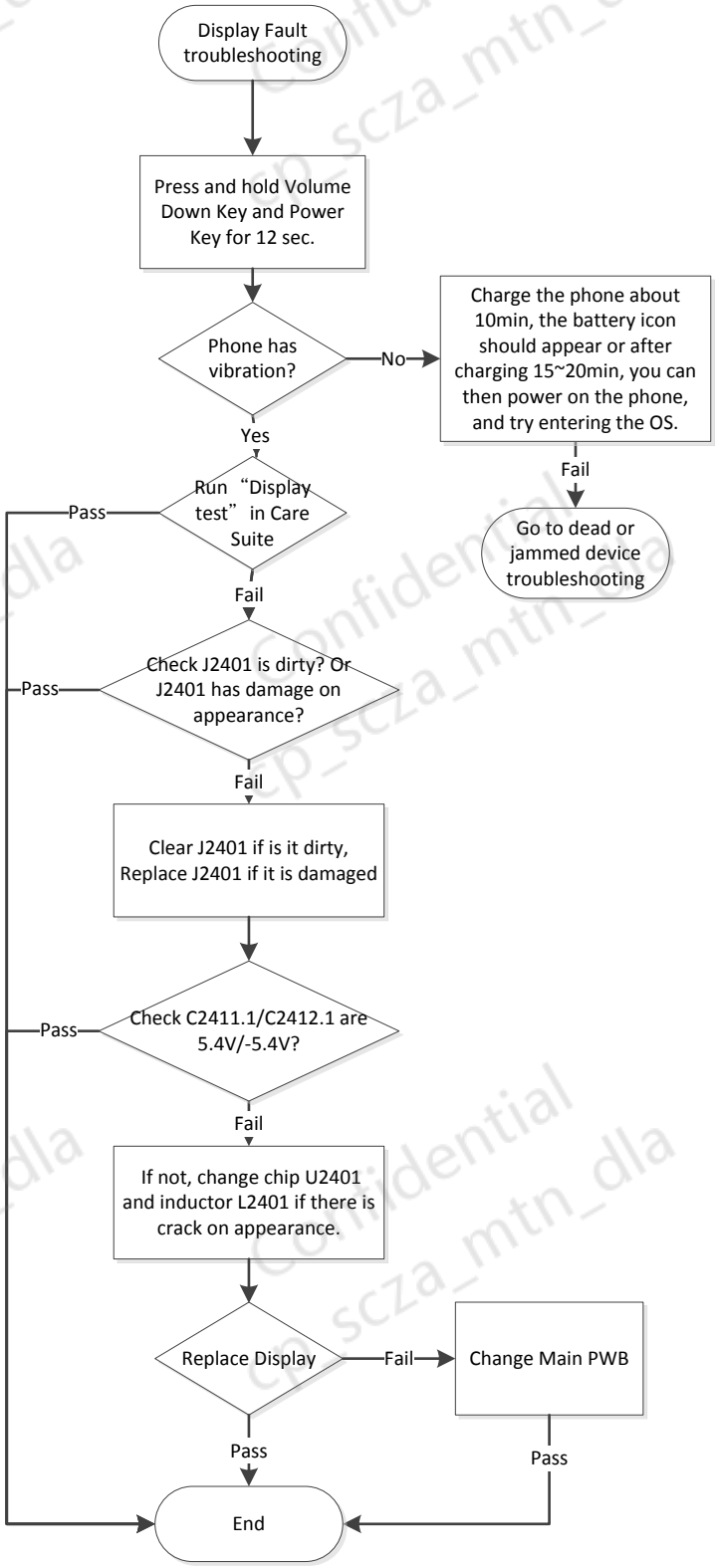
ITEM	VISUAL BRIGHT DOT DEFECT			VISUAL DIM DOT DEFECT		
Dot	Red	Green	Blue	Red	Green	Blue
Max number of dot defects	0	0	0	0	0	0
Not acceptable dot (dot defect)	R050	G030	B070	R0	G0	B0
	Not Acceptable			Not Acceptable		
	R255	G255	B255	R120	G230	B020
Acceptable dot	R0	G0	B0	R121	G231	B021
	Acceptable			Acceptable		
	R049	G029	B069	R255	G255	B255

Note: Blinking pixels are not allowed in normal operating temperatures and light conditions.

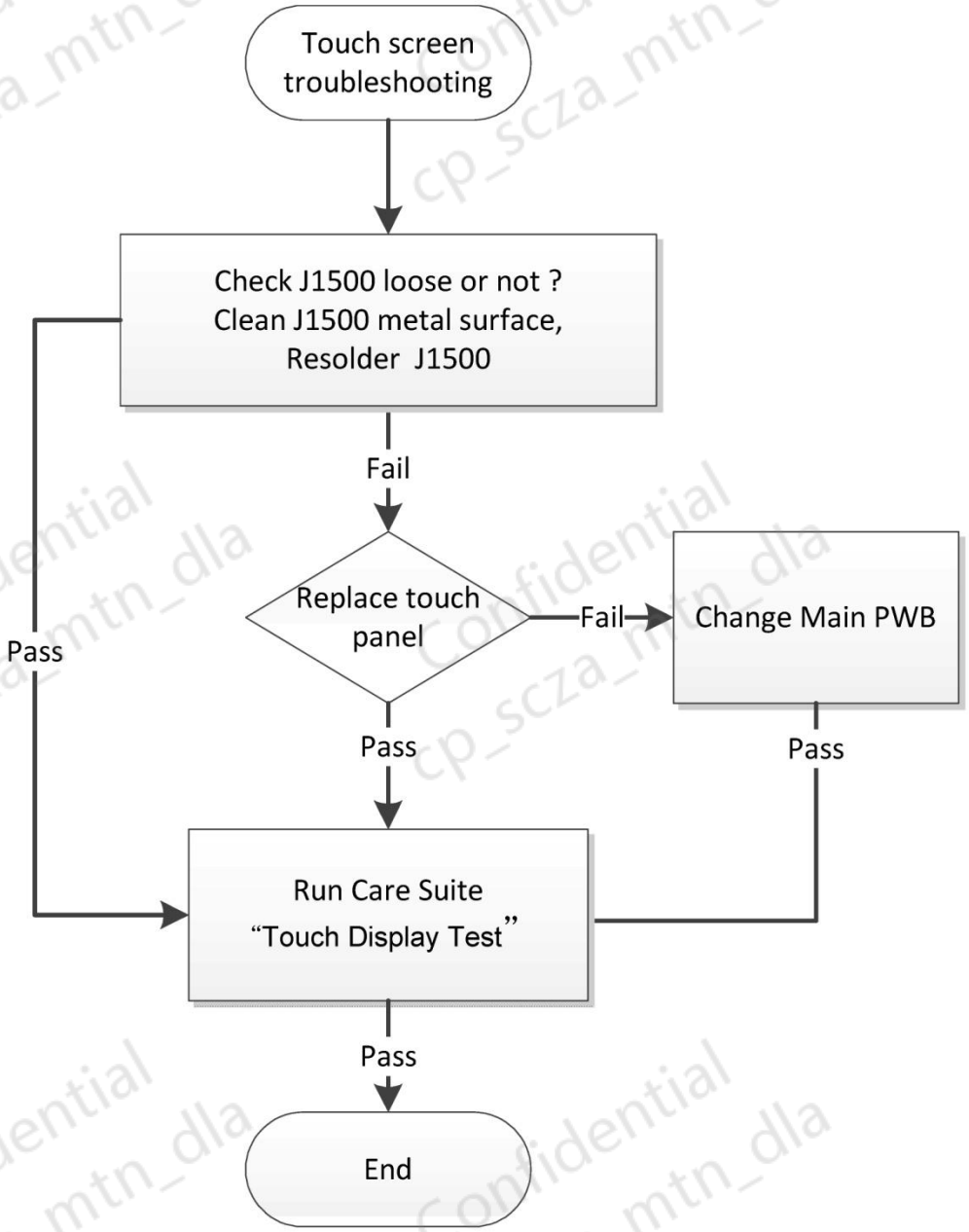
Introduction to display troubleshooting

The display module used is based on IPS technology and supports display format of 720 columns x 1280 rows. The dimension of the display module only is 77.68 mm x 140.64 mm x 1.57 mm. The display is connected to MSM8930/ 8230 with a 4-lane MIPI DSI.

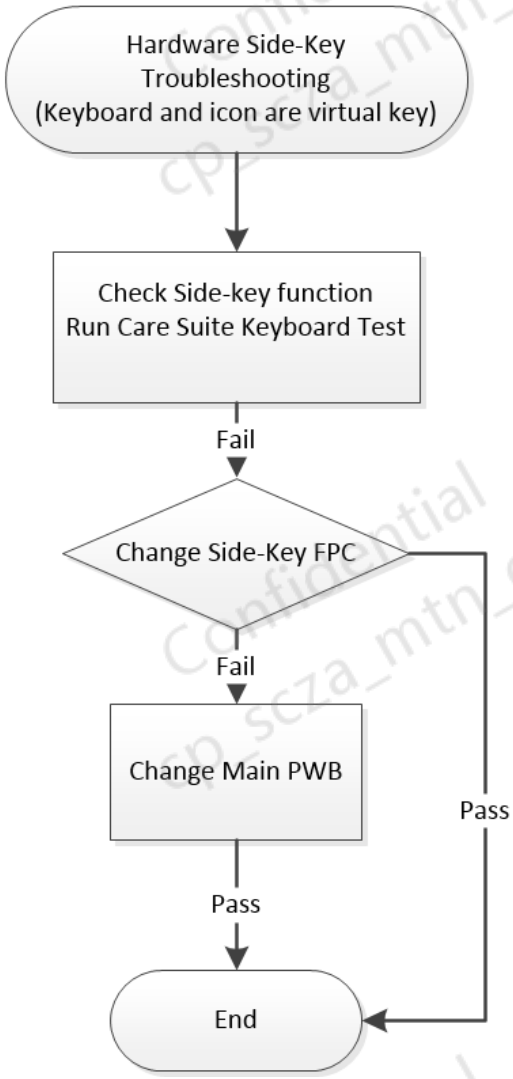
Display fault troubleshooting



Touch panel troubleshooting

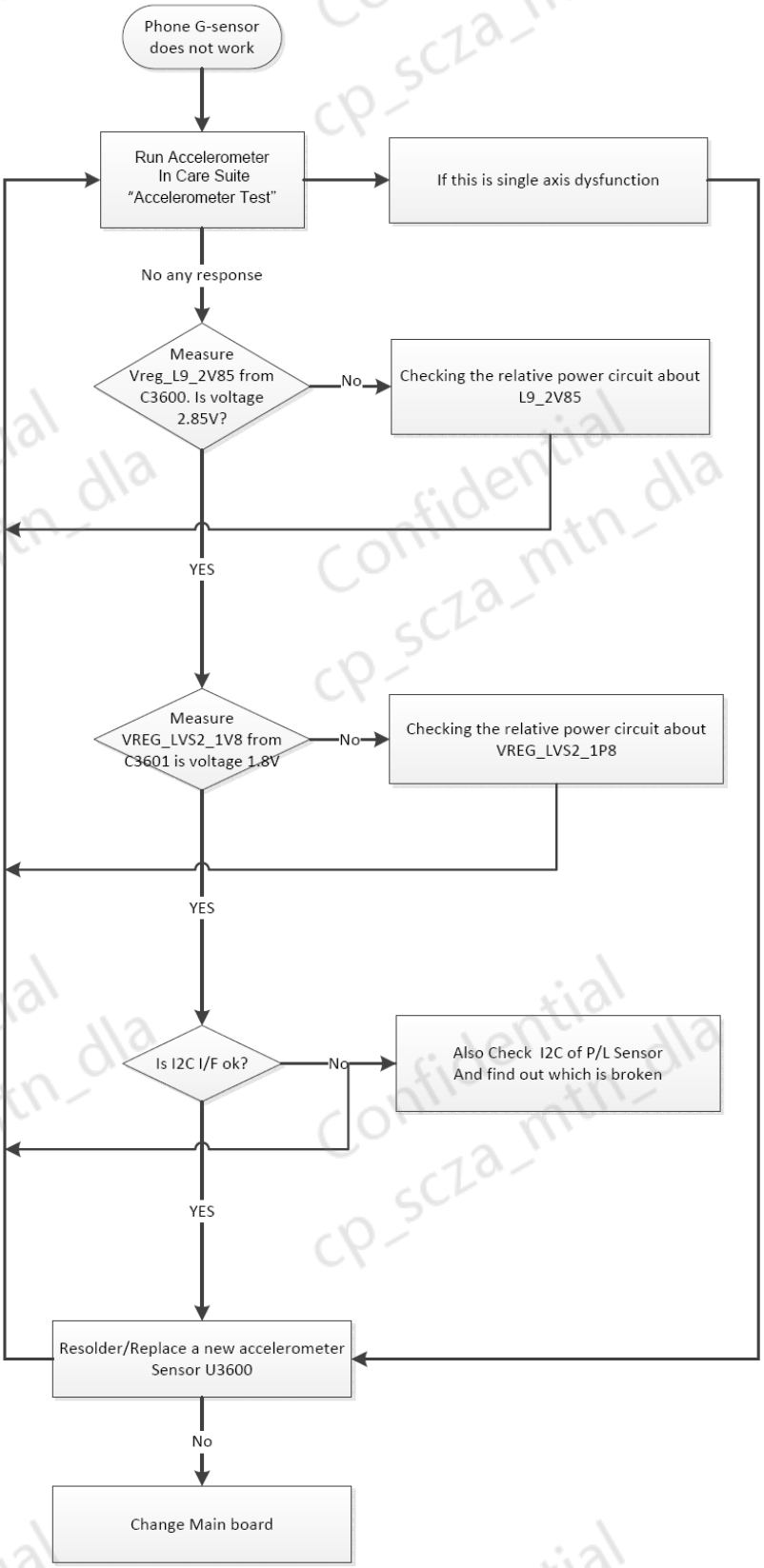


Keyboard troubleshooting

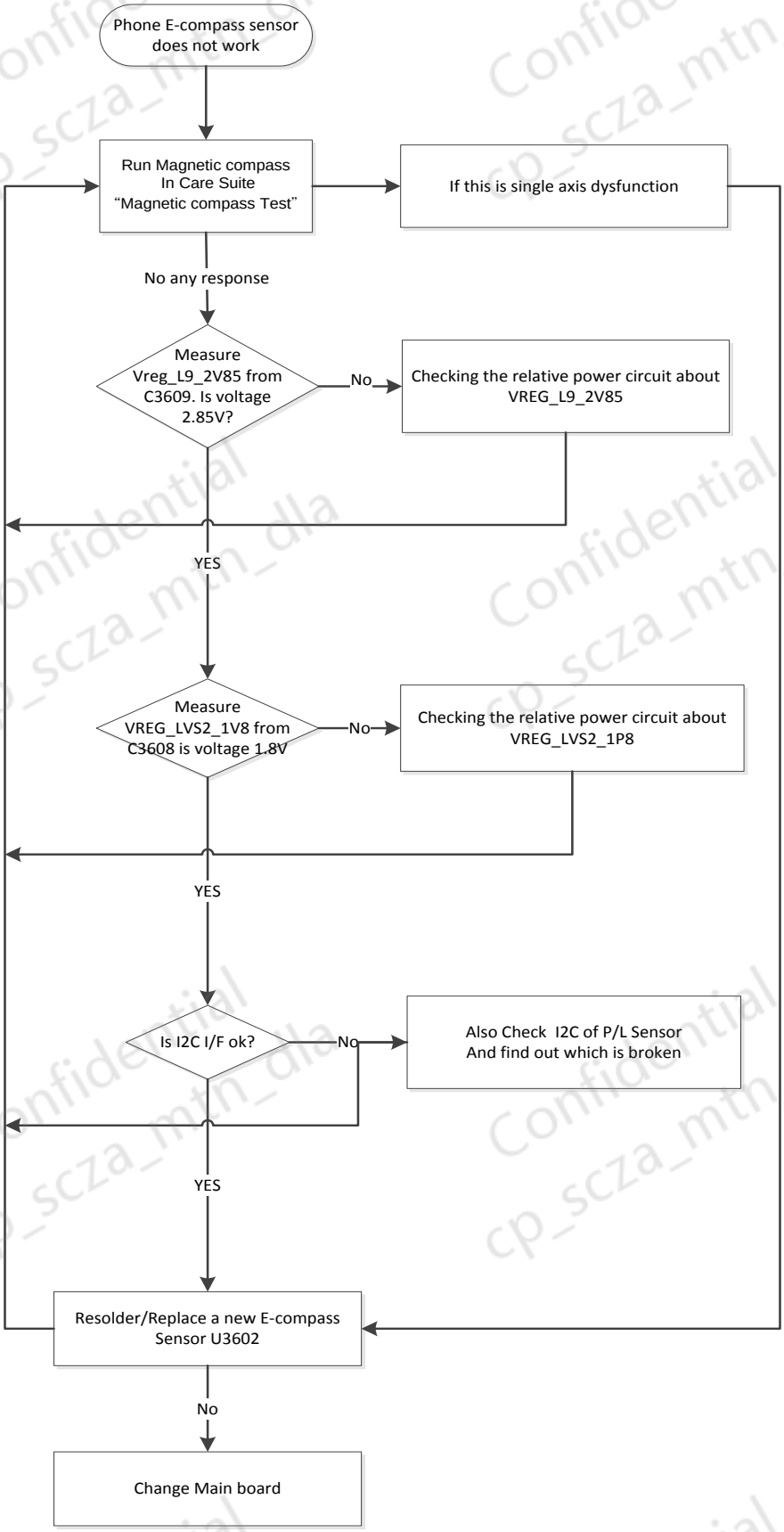


■ Sensors troubleshooting

Accelerometer troubleshooting



Magnetic compass troubleshooting



Proximity sensor and ambient light sensor (ALS)

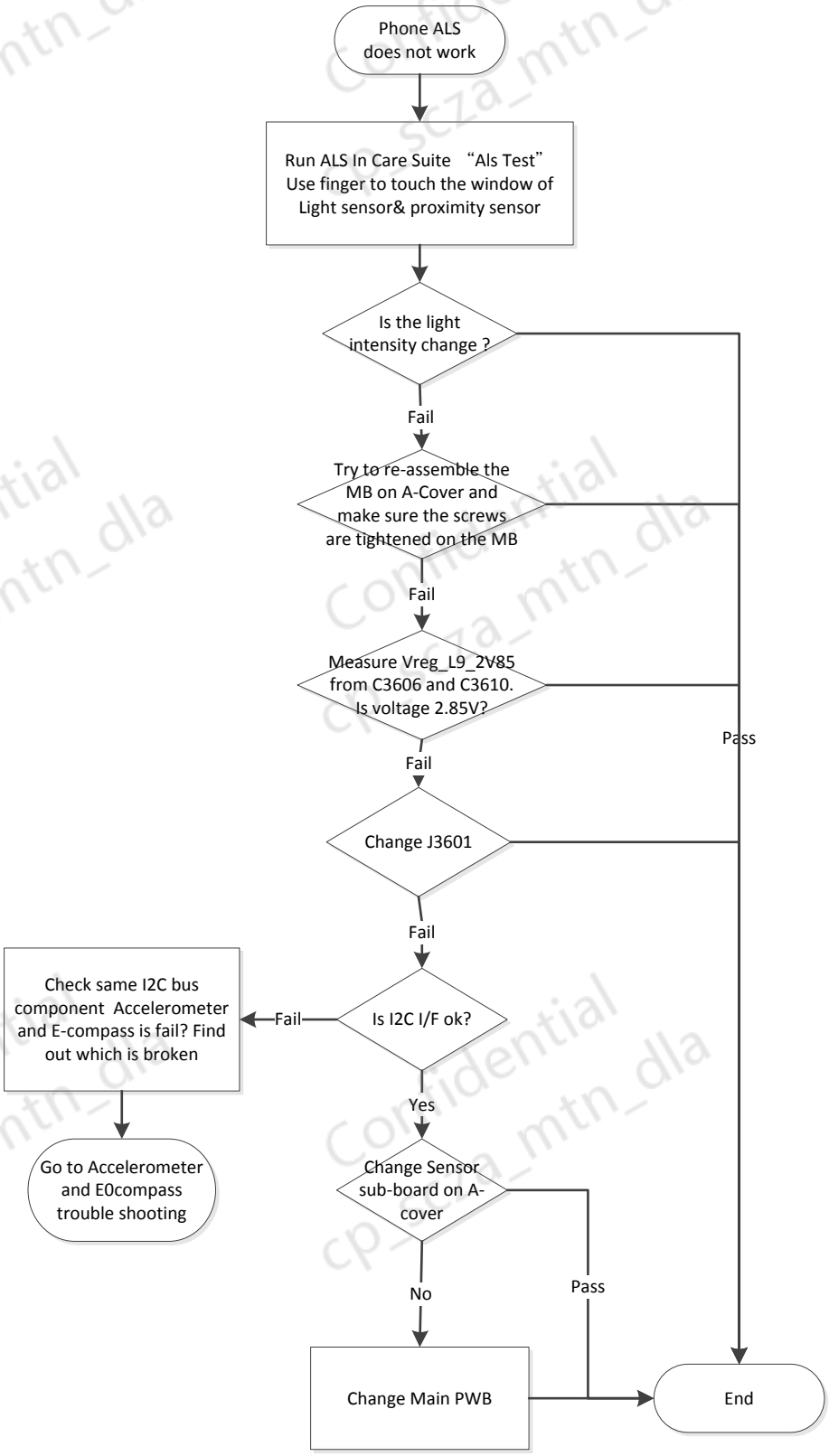
This phone uses a combined proximity and ambient light sensor called Alphamon. The proximity sensor is integrated to the module and uses an internal LED supplied by VPH_PWR. The current this LED consumes is controlled by Alphamon and set using software. The interrupt output of Alphamon changes state when the infra-red light from the LED is reflected back by a suitable reflective surface. The ambient light sensor detects the level of ambient light and adjusts the display brightness accordingly whenever the display is active.

Covering this sensor results in dimmed display lights.

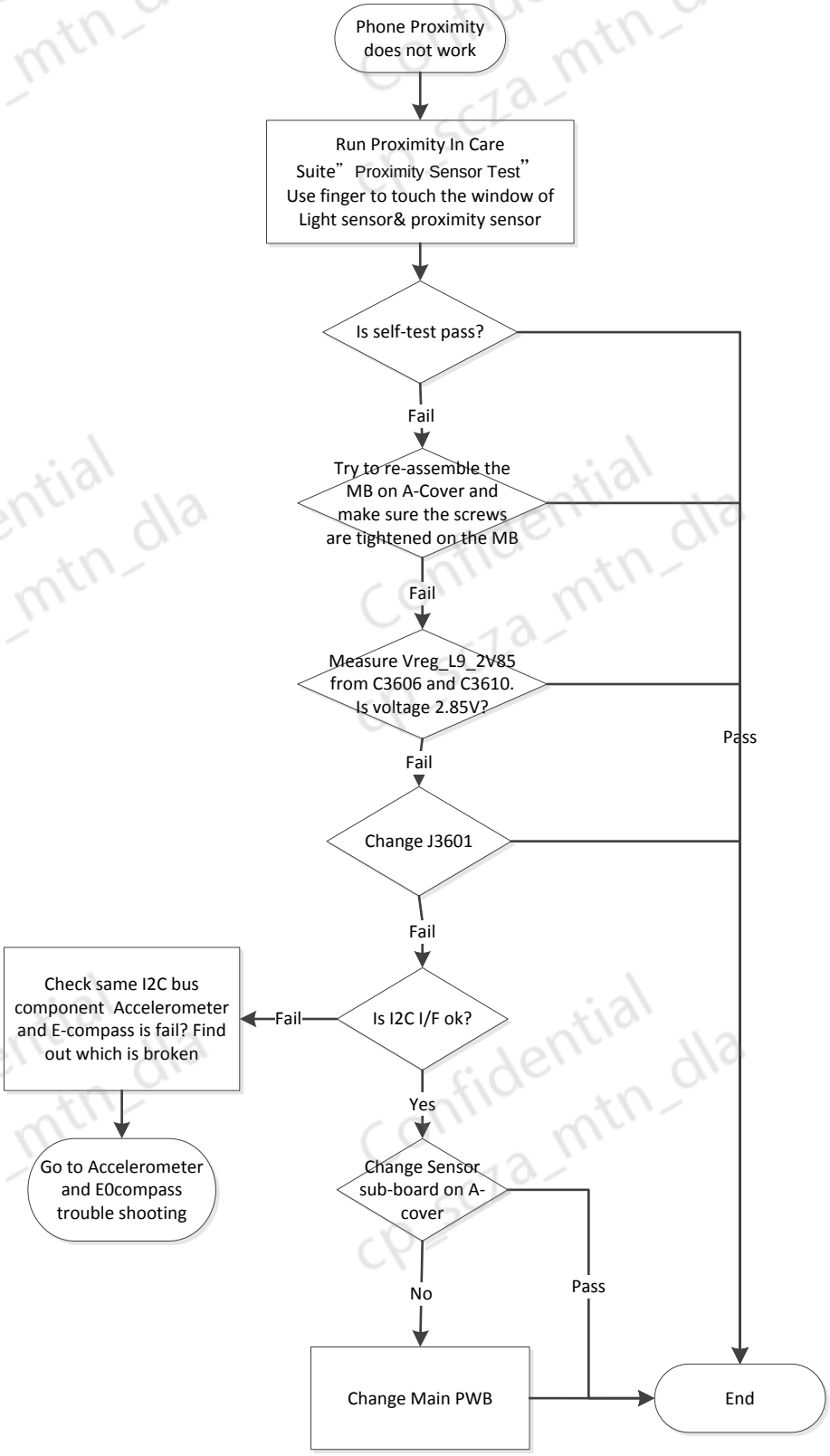
Use service software to verify that ALS works. Use a finger to hide the Alphamon sensor window, the light intensity in mLux changes.

Note: The light intensity could vary depending on how the finger hides the Alphamon window.

ALS troubleshooting



Proximity troubleshooting



Audio troubleshooting

Audio troubleshooting test instructions

Single-ended external earpiece and differential internal earpiece outputs can be measured either with a single-ended or a differential probe.

When measuring with a single-ended probe, each output is measured against the ground. When measuring against the ground, two separate single-end probes are needed.

Internal handsfree output is measured using a current probe, if a special low-pass filter designed for measuring a digital amplifier is not available. Note also that when using a current probe, the input signal frequency must be set to 2 kHz.

The input signal for each loop test can be either single-ended or differential. Exception to this is a digital microphone which needs input signal from an external sound source (laptop speaker) to playback, e.g. 1 kHz sine wave from 5 cm distance.

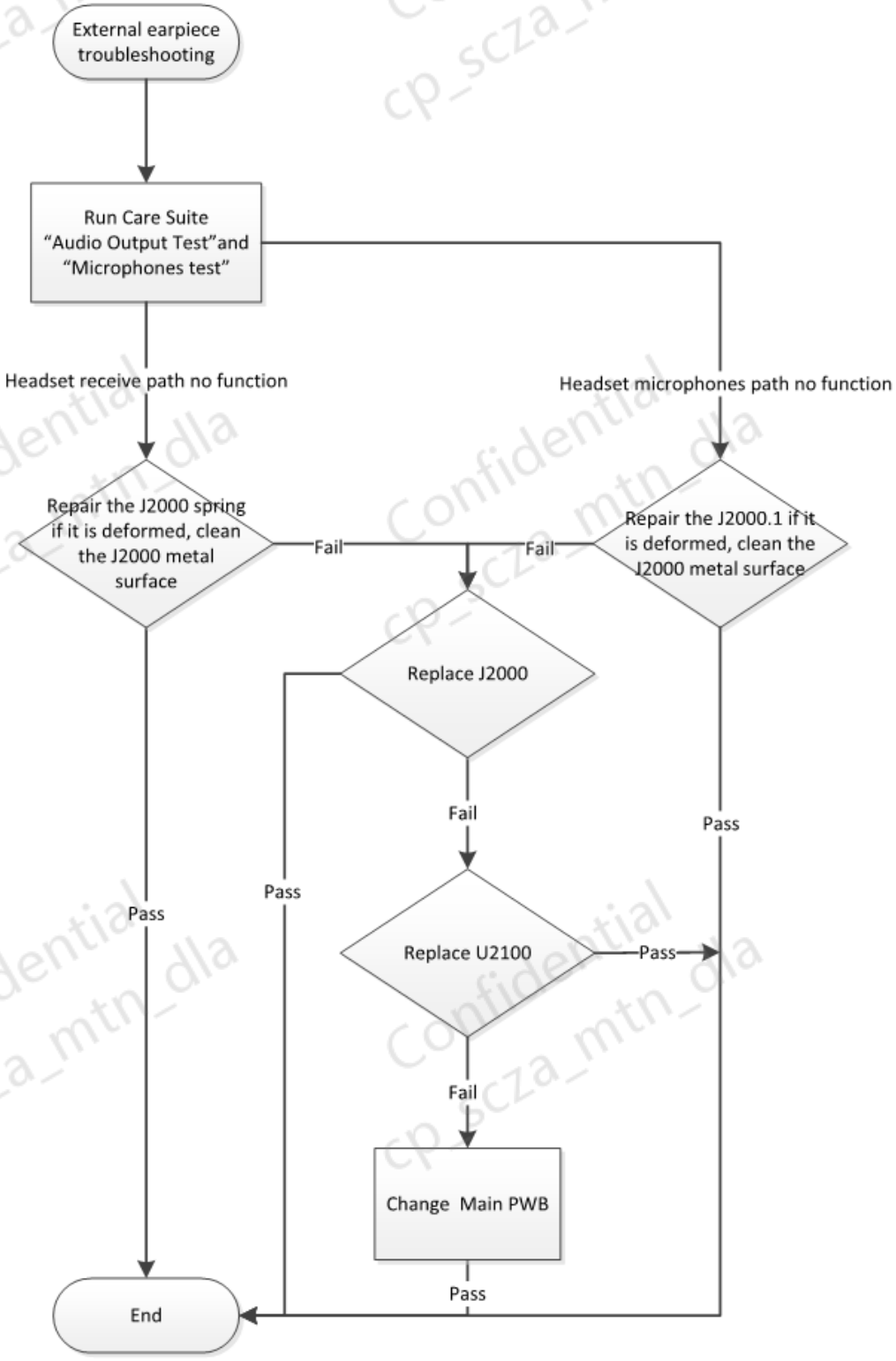
Required equipment

The following equipment is needed for the tests:

- Oscilloscope
- Function generator (sine waveform)
- Current probe (Internal handsfree DPMA output measurement)
- Service software
- Battery voltage 3.7V
- Sound source (laptop speaker or B&K type 4231 calibrator)

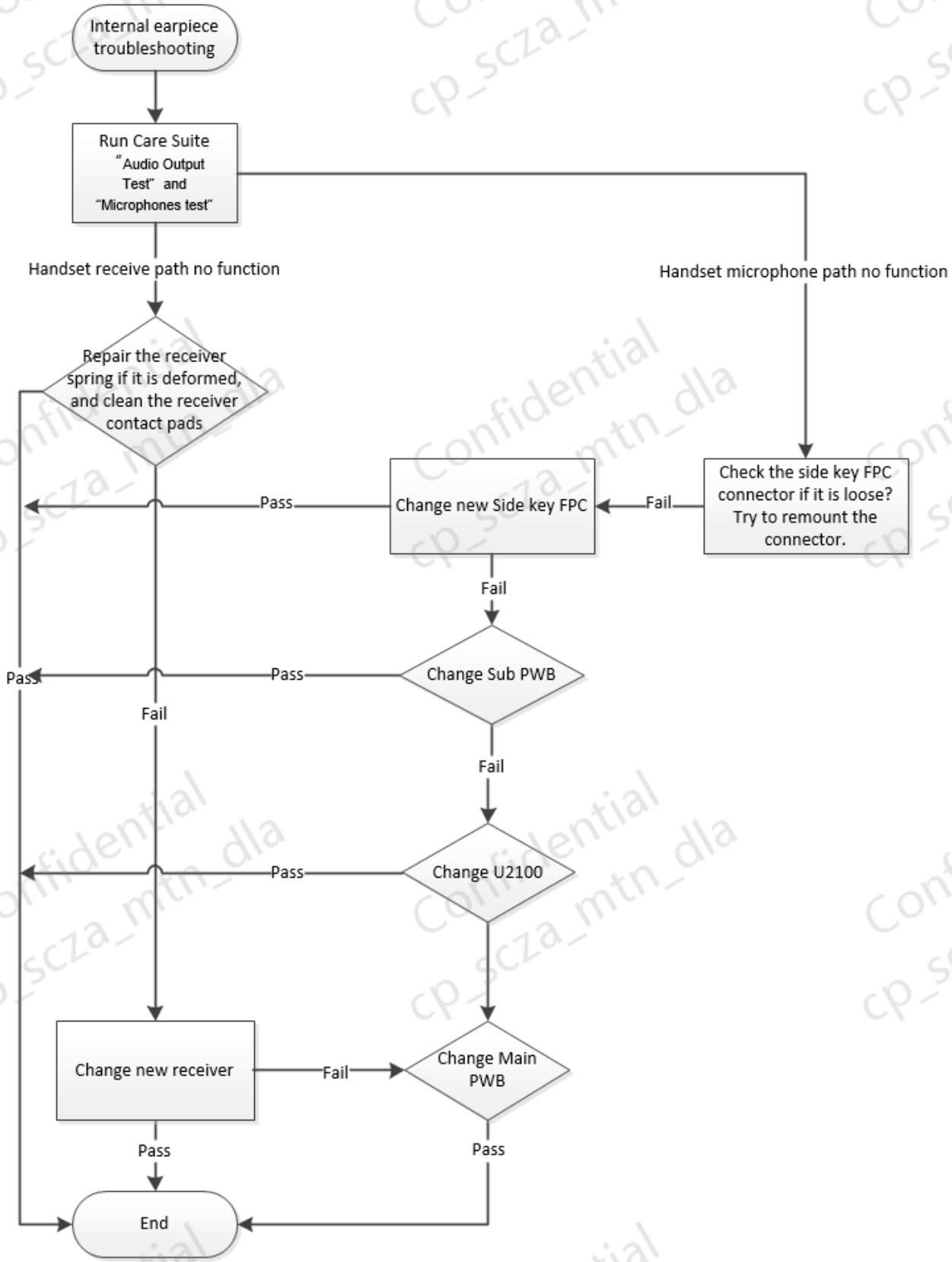
External earpiece troubleshooting

Troubleshooting flow



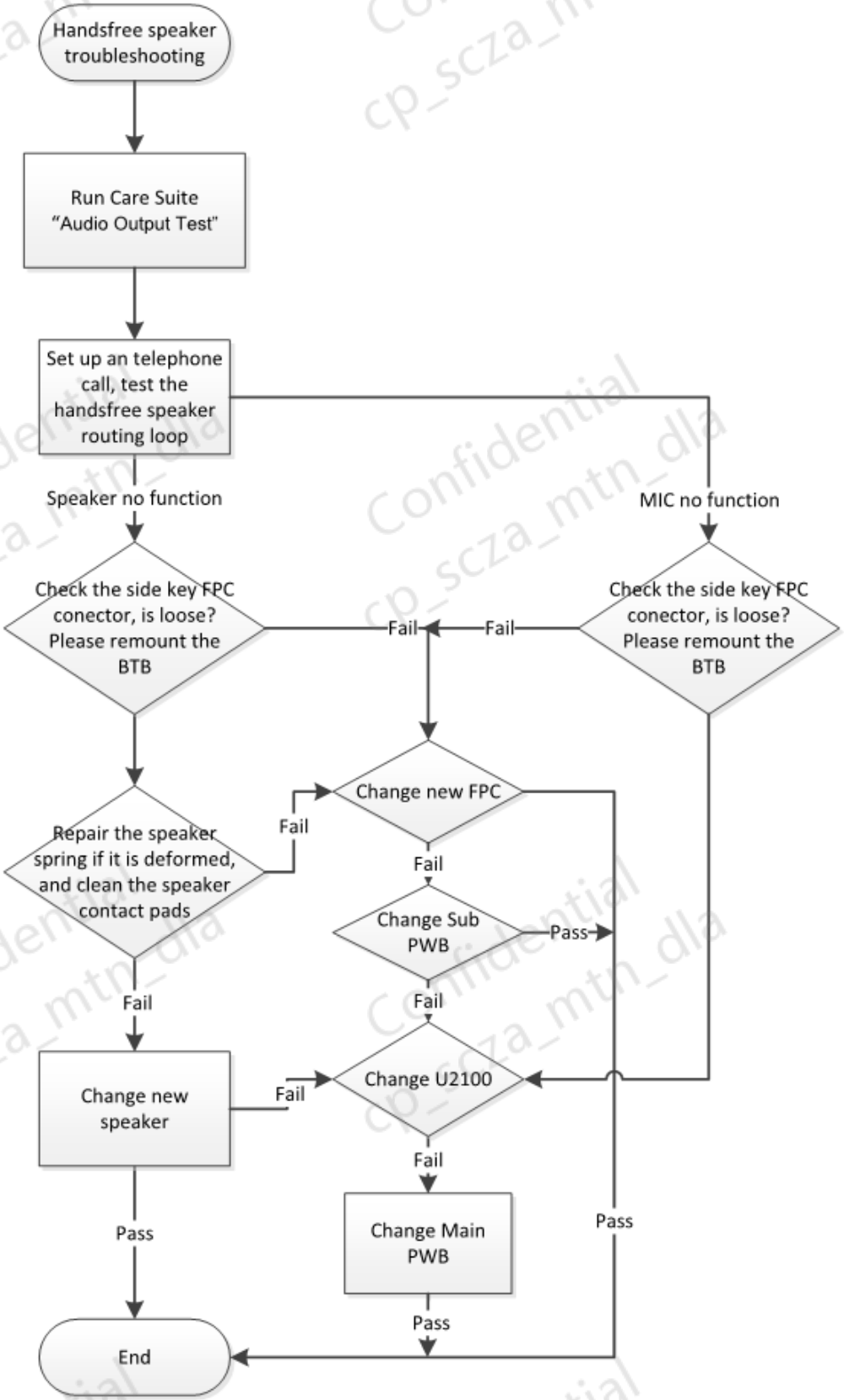
Internal earpiece troubleshooting

Troubleshooting flow



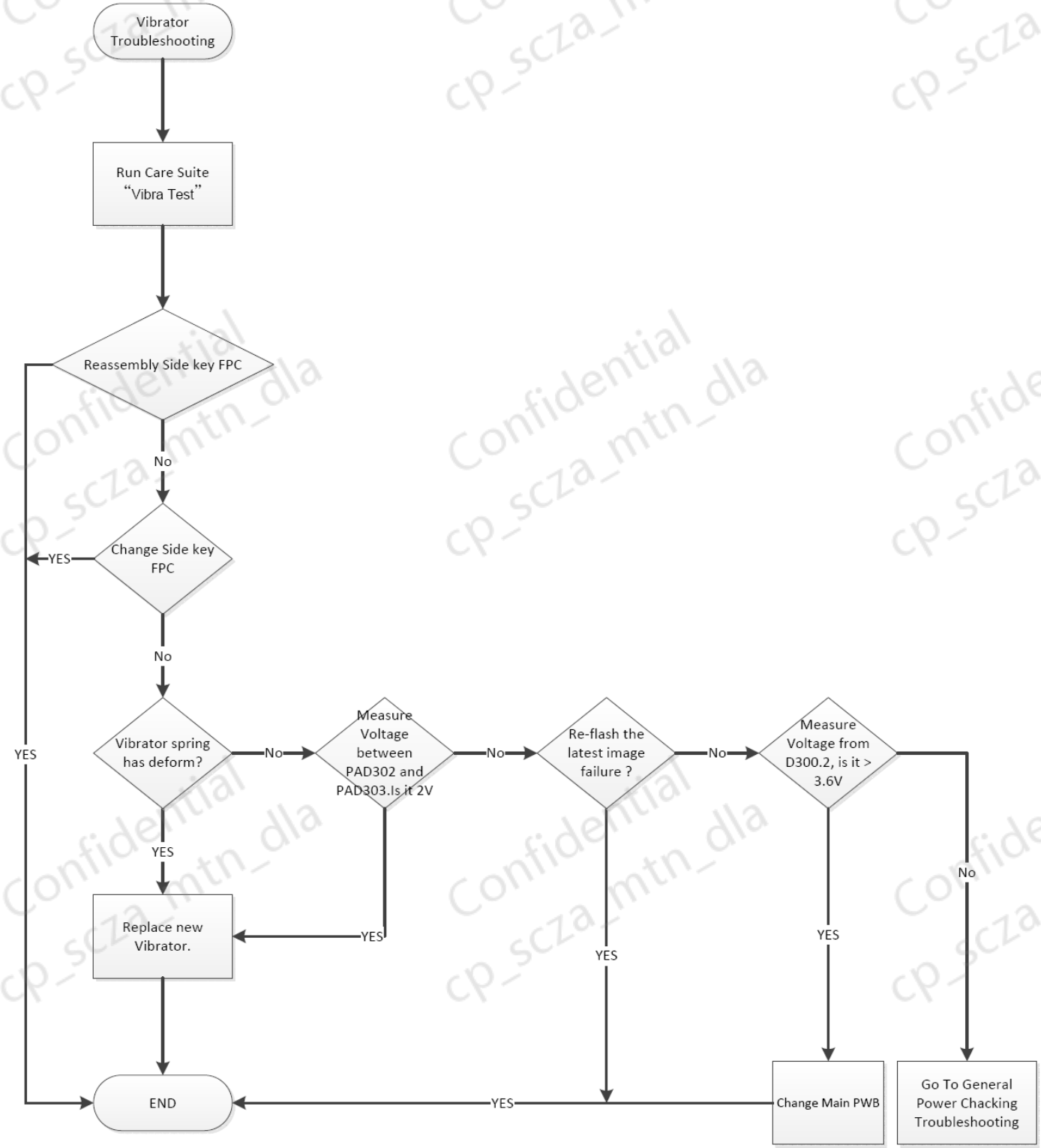
Internal Handsfree (IHF) speaker troubleshooting

Troubleshooting flow



Vibra troubleshooting

Troubleshooting flow



Connectivity module troubleshooting

Introduction to connectivity module troubleshooting

The WCN3660 module supports WLAN and BT.

REFCLK_I single ended 48 MHz analog clock from an external crystal (Y3300) is provided to WCN3660. The clock request for the reference clock in the WCN3660 module is shared between WLAN and BT blocks. When either system requires a clock, this signal will be active. The CLK_REQ is connected to LDO of 48 MHz crystal. The SLEEPCLK input of 32.768 KHz clock from EM ASIC (PMIC 8038) is used for power management. The internal SMPS supplies the whole WCN3660 solution from the phone battery supply, VBAT, apart from VIO which is needed for interface signal reference levels.

Baseband part of the connectivity functions is integrated into MSM8930/8230.

The following figure shows a top level block diagram of the WCN3660 module.

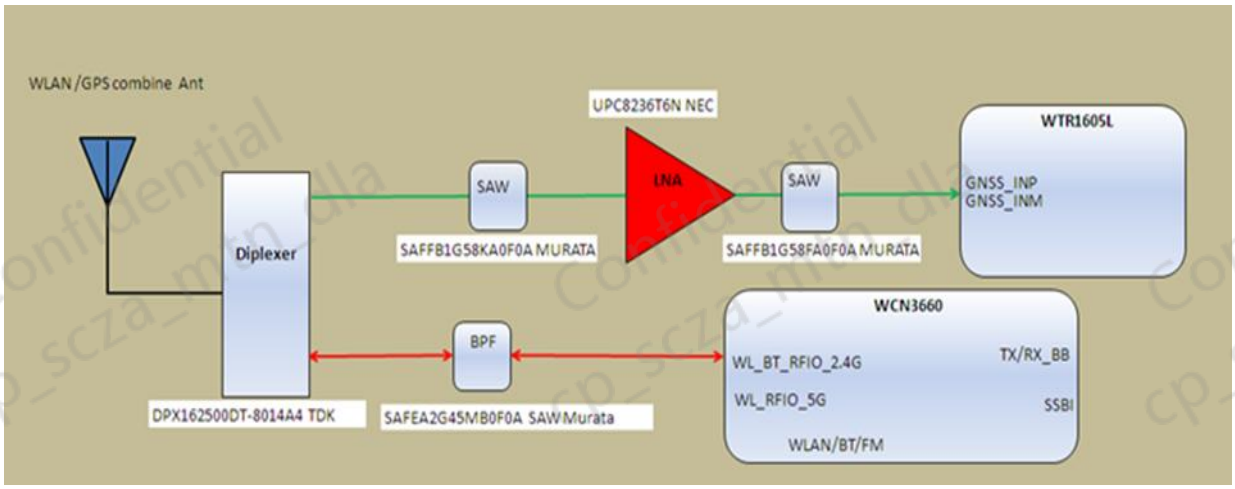


Figure 6 CWR block diagram

WLAN/BT antenna

The WLAN/BT antenna is laser deposited on a plastic carrier which is part of the CWS carrier assembly on the top back side of the phone. The antenna radiator is painted black and is visible only around contact areas. The WLAN/BT signal is routed from the connectivity module through the RF diplexer.

The antenna positions are presented in the following figure.

Figure 7 LDS antenna positions

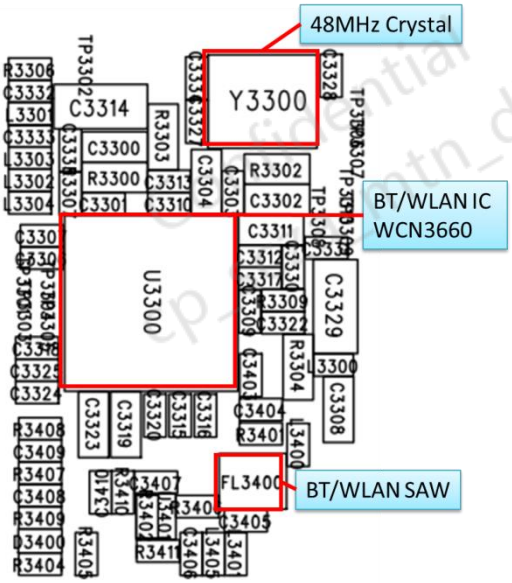
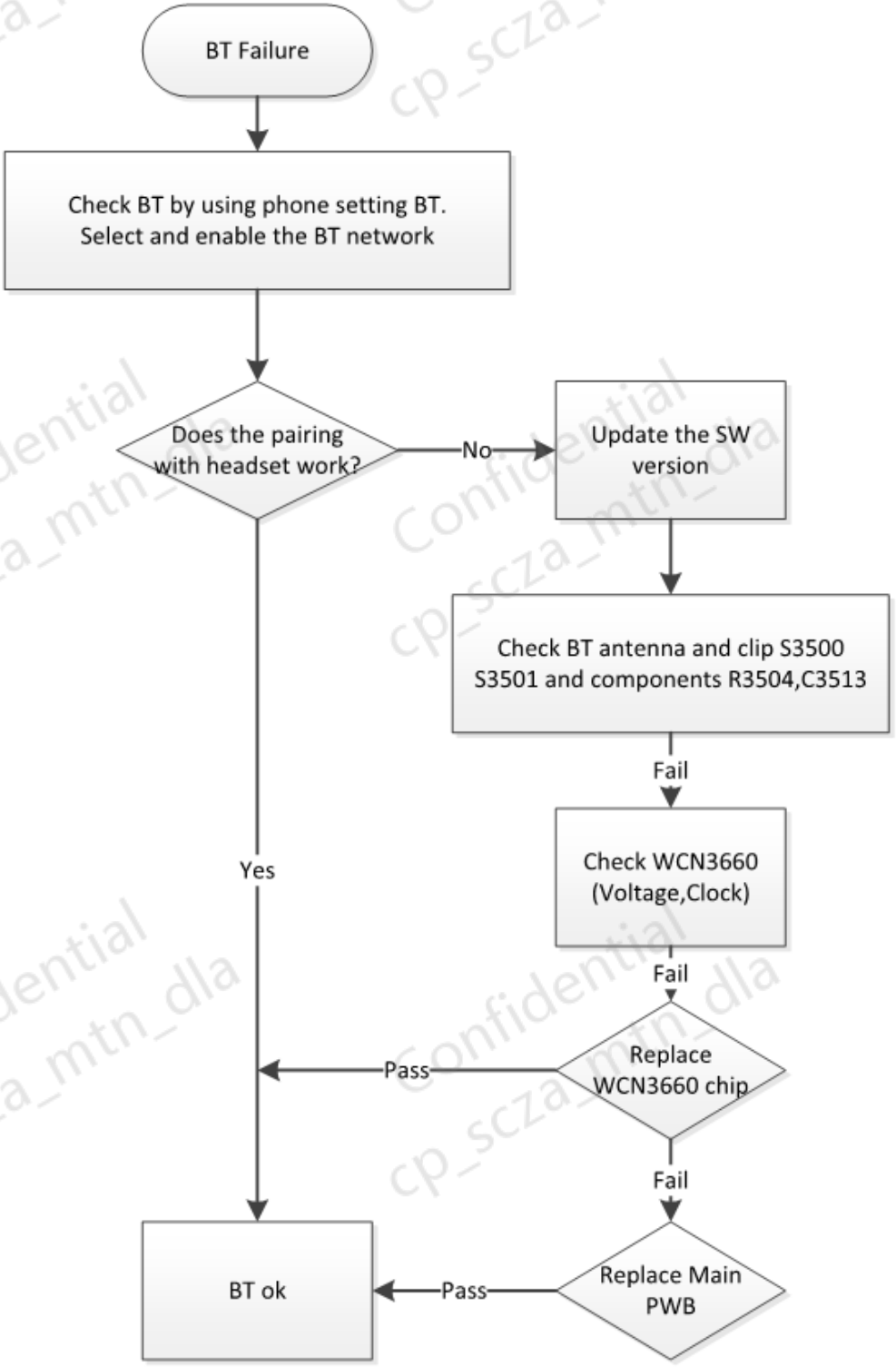


Figure 8 WLAN/BT component layout

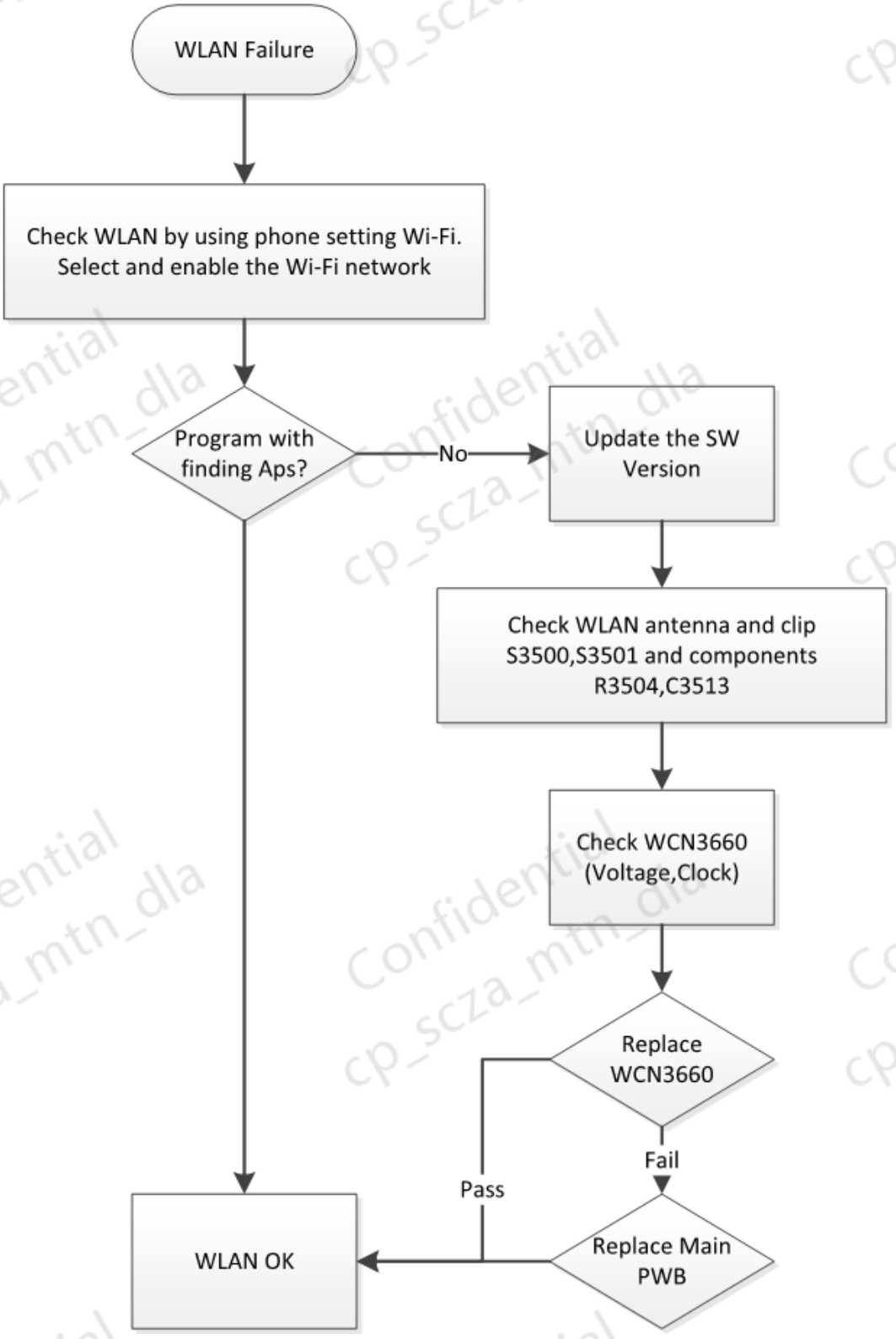
Bluetooth troubleshooting

Troubleshooting flow



WLAN troubleshooting

Troubleshooting flow



GPS troubleshooting

Introduction to GPS troubleshooting

Use the phone **Menu —> HERE Maps** to check GPS.

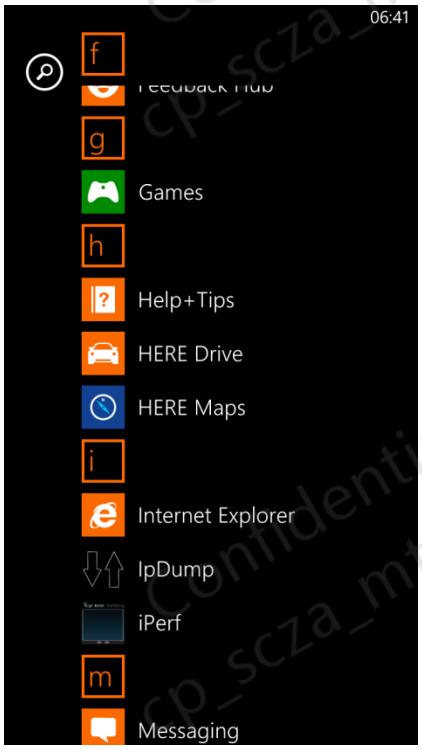
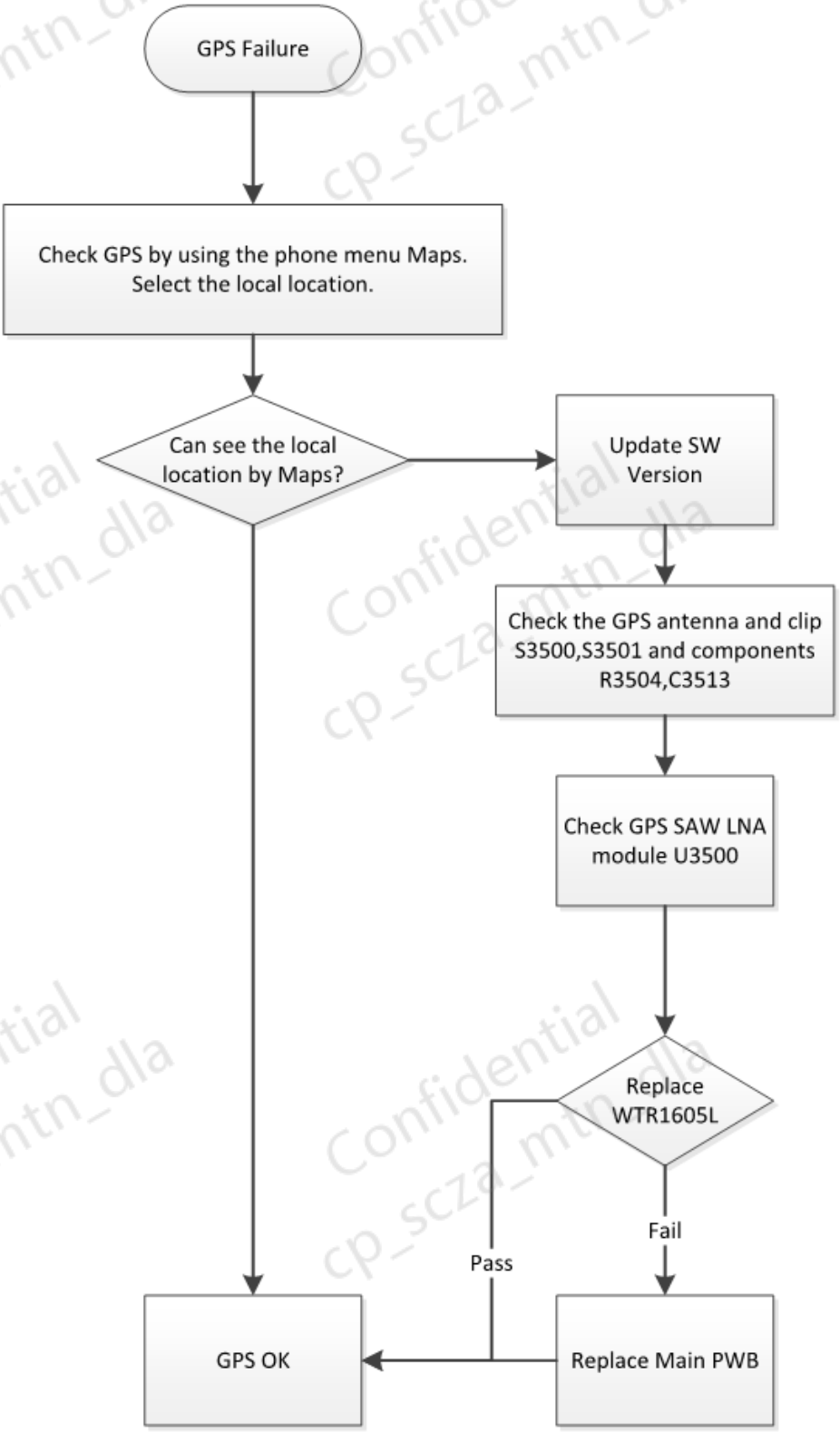


Figure 9 Phone Menus->HERE Maps

Figure 10 GPS Maps

Troubleshooting flow



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4 RF Troubleshooting Guide

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List of Figures

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■ General instructions for cellular RF troubleshooting

Most RF semiconductors are static sensitive

ESD protection must be applied during repair (ground straps and ESD soldering irons).

Measuring equipment

All measurements should be done using Rohde & Schwarz CMW-500 (CMU-200 support under development) radio communication tester.

Note: A mobile phone WCDMA transmitter should never be tested with full TX power (permitted only if measurements and tests are performed in an RF-shielded environment). Even low power WCDMA transmitters may disturb nearby WCDMA networks and cause problems to 3G cellular communication in a wide area.

Note: All measurements with an RF coupler should be performed in an RF-shielded environment because nearby base stations can disturb sensitive receiver measurements. If there is no possibility to use an RF-shielded environment, testing at frequencies of nearby base stations should be avoided.

Note: All communication test set screen dumps are from CMU-200. Other testers are different.

RF shield cans

All RF shield cans are solid and should not be opened in service centers.

Level of repair

The scope of this guideline is to verify functionality of the cellular RF block as well as possible without removing RF shields.

■ RF key components

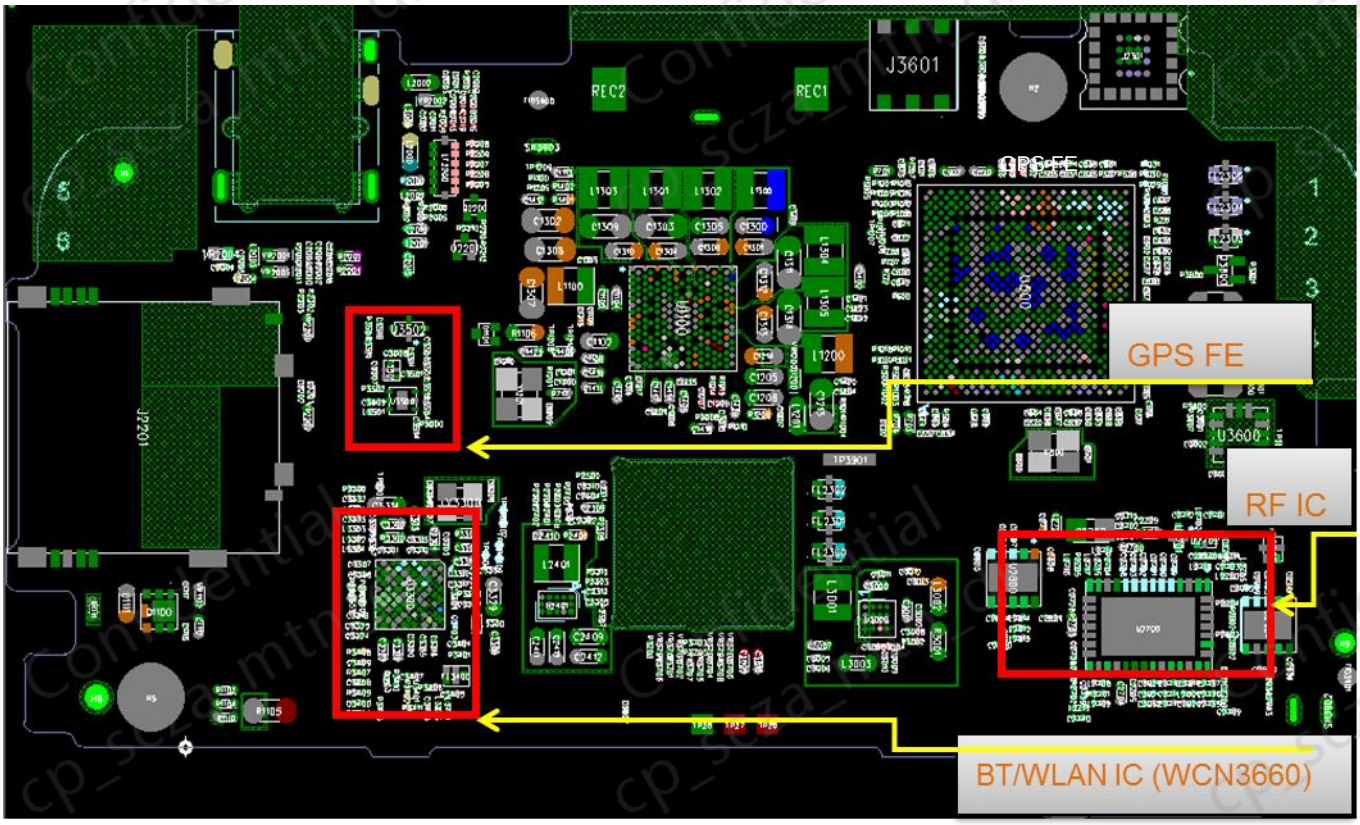


Figure 11 RF key components and antenna contacts, Top side

Figure 12 RF key components and antenna contacts, Bottom side

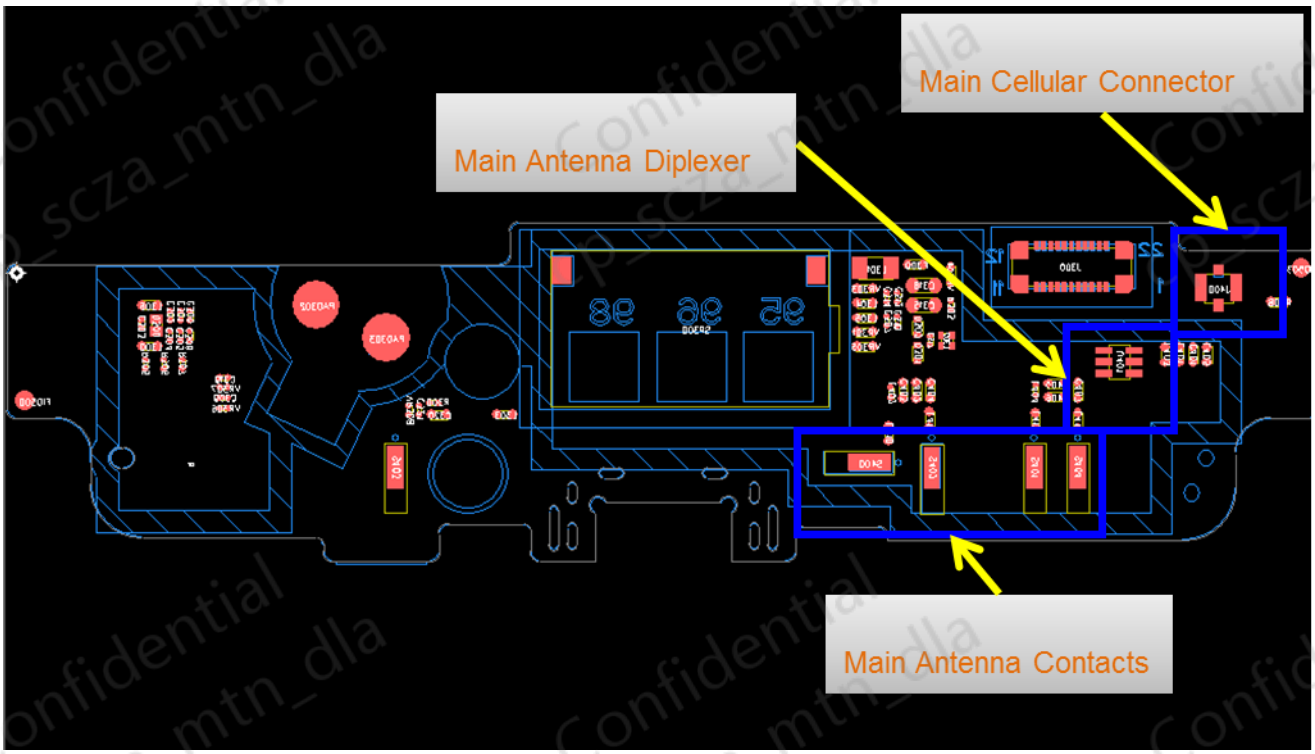
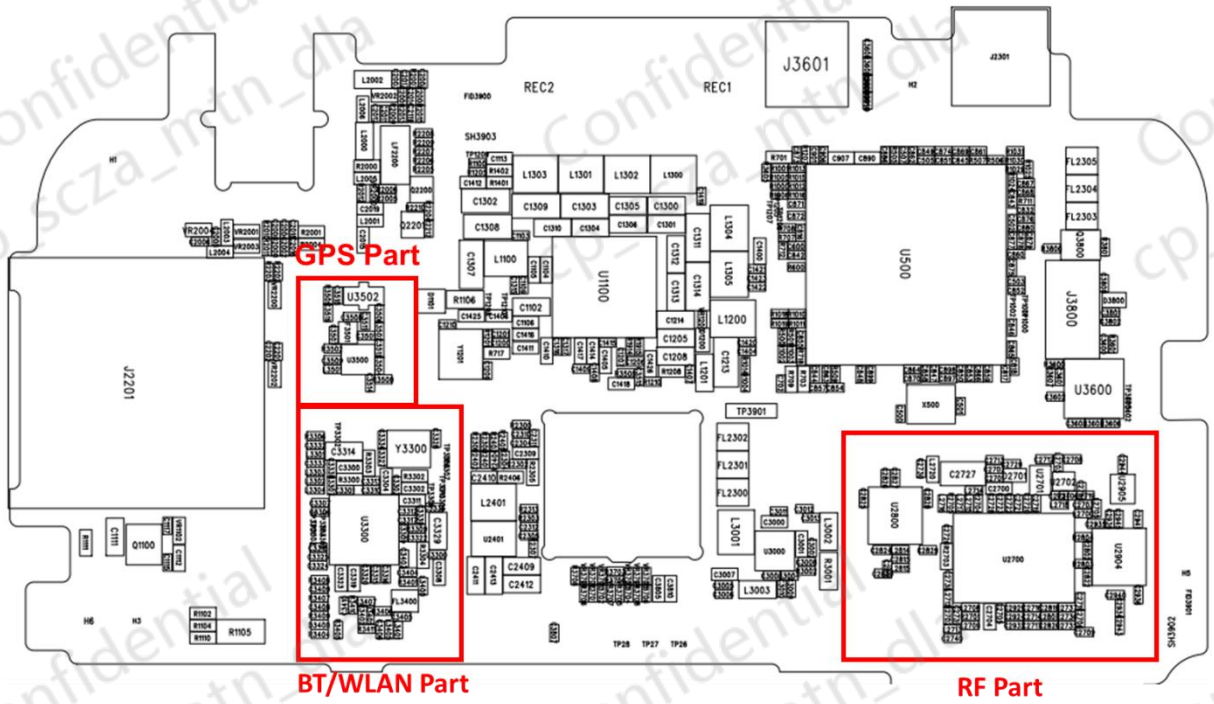
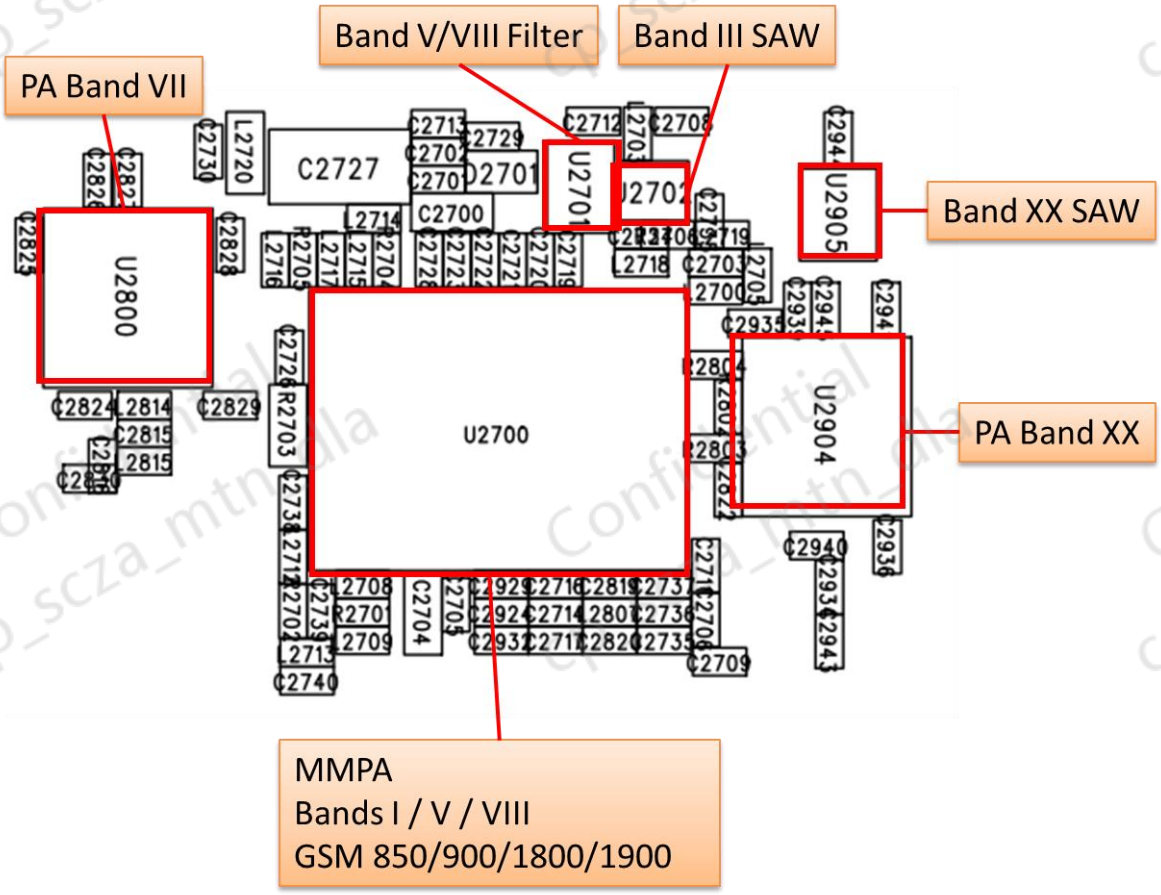
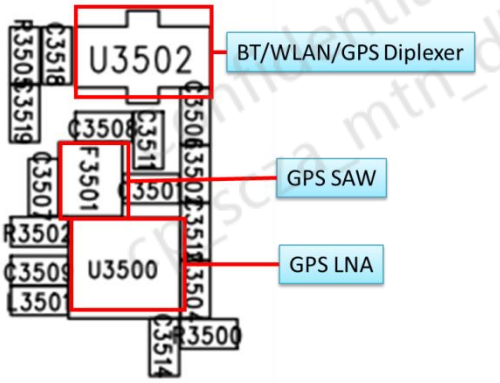


Figure 13 RF key components and antenna contacts, Bottom side

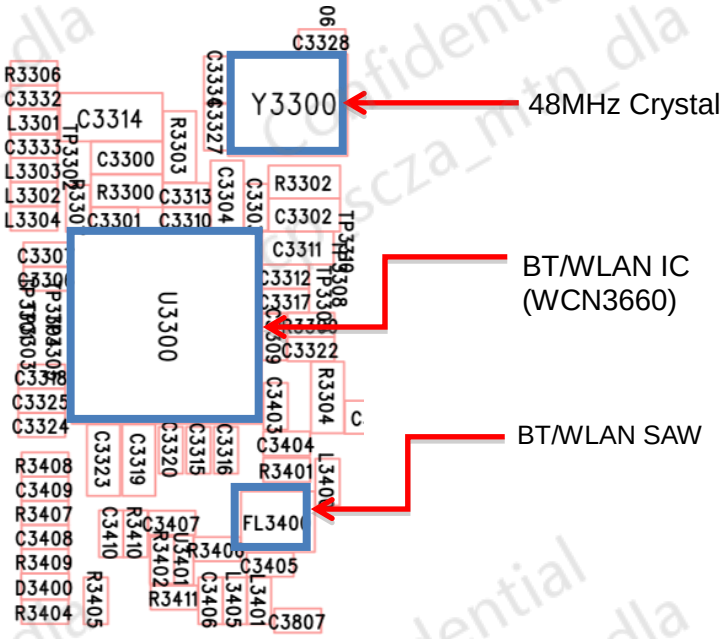




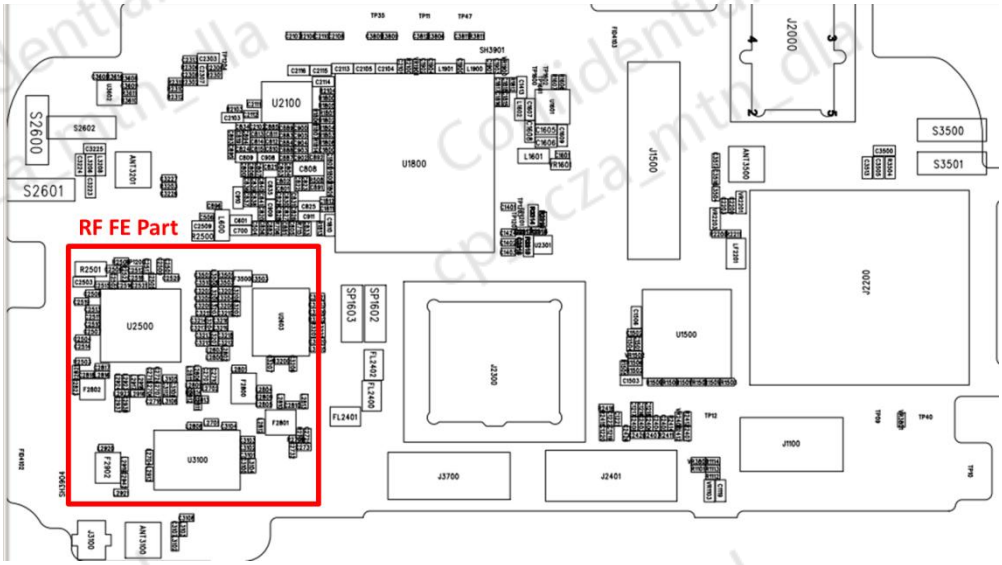
RF Part

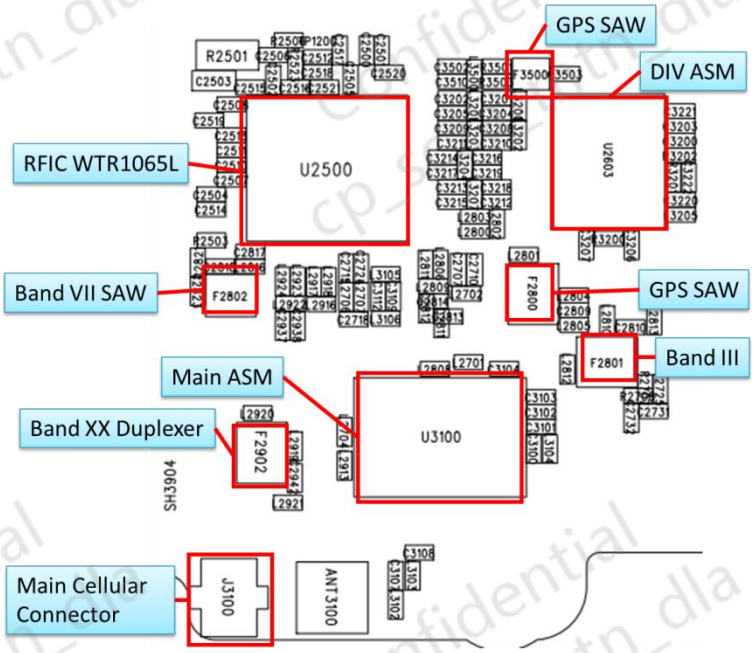


GPS Part



BT/WLAN Part





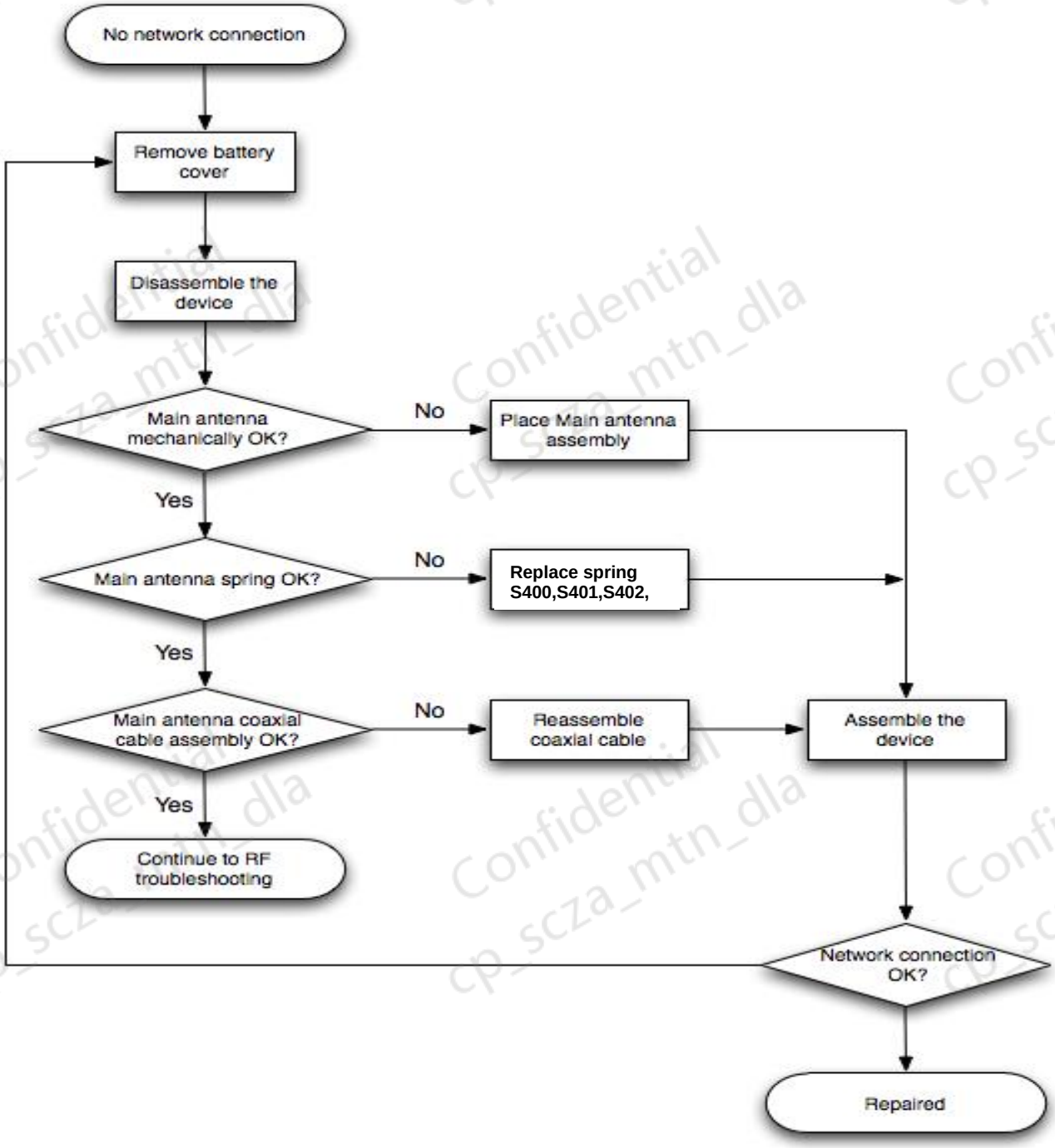
RF FE Part

■ Cellular RF main troubleshooting

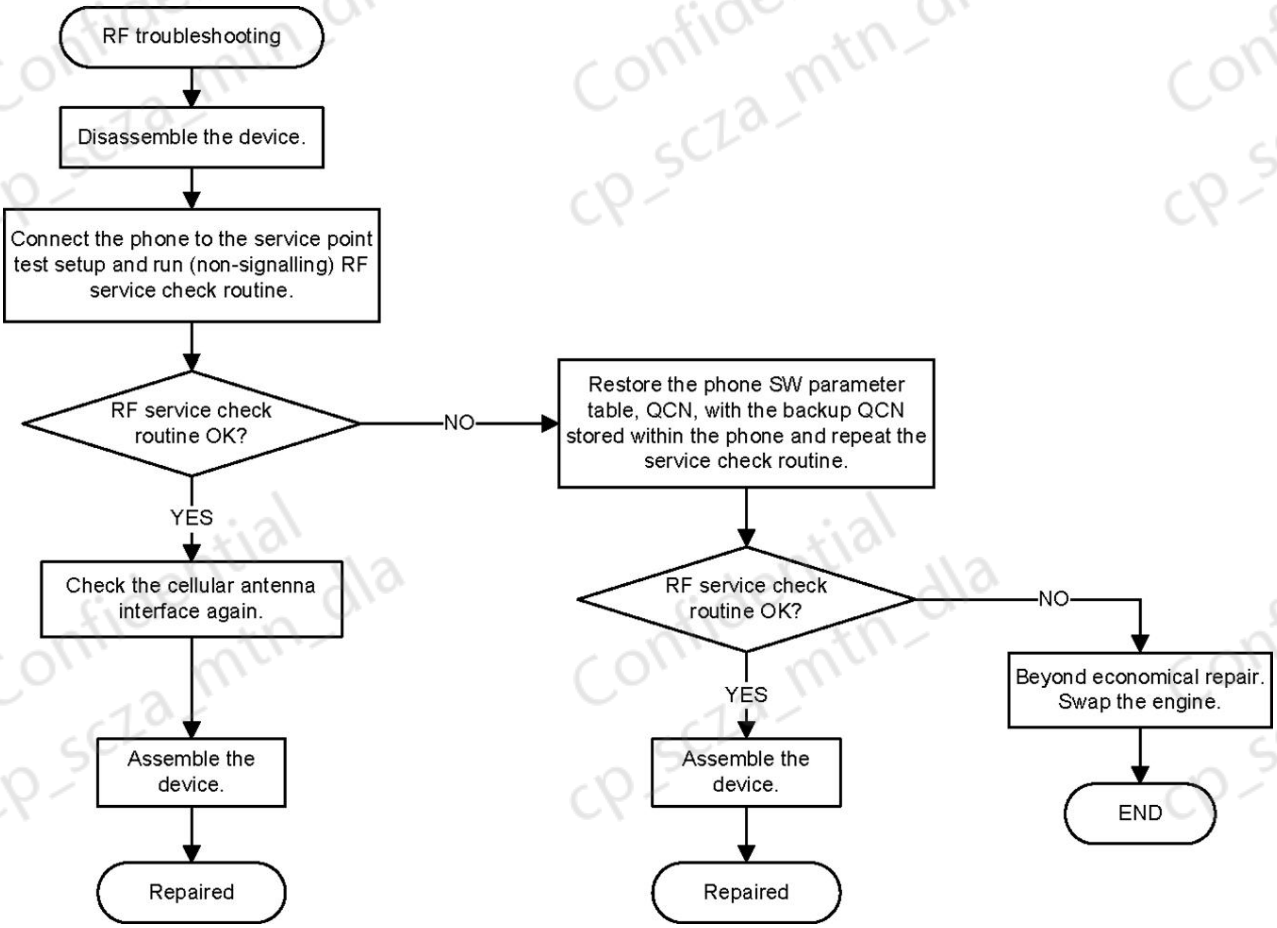
Context

Always start the cellular RF related troubleshooting procedure by following the diagram below.

Troubleshooting flow — Page 1 of 2



Troubleshooting flow — Page 2 of 2



■ RF tuning and testing

RF tuning and testing section will be updated when the WP8 Testing Tool for Care is available.

■ Antenna

Antenna overview

The phone has five different antennas:

- The main antenna is placed at the bottom of the phone
- A MIMO/diversity antenna is placed on the top left side of the phone
- A GPS/WLAN/BT antenna is placed on the top right side of the phone

The main antenna covers 4 GSM bands (GSM850, GSM900, GSM1800, and GSM1900), WCDMA bands (WCDMA B1, WCDMA B2, WCDMA B4, and WCDMA B5,WCDMA B8) and LTE bands(LTE B2,LTE B3, LTE B4, LTE B5,LTE B7 ,LTE B17 and LTE B20), and has 2 connection. The antenna radiator is deposited on a plastic carrier with LDS technology and connected to the board through C-clips. A diplexer is used for dividing HB and LB due to antenna structure.

The diversity antenna covers WCDMA bands (WCDMA B2 and WCDMA B5) and LTE bands (LTE B2, LTE B3, LTE B4, LTE B5, LTE B7, LTE B17, and LTE B20). The antenna has one feed contact and one ground contact. The antenna radiator is deposited on a plastic carrier with LDS technology and connected to the board through standard C-clips.

The GPS/WLAN/BT antenna covers GPS/WLAN/BT bands. The antenna radiator is deposited on a plastic carrier with LDS technology and connected to the board through a standard C-clip.

Figure 14 CWS antenna positions

Figure 15 Main antenna position

Antenna troubleshooting

All antennas are painted and therefore the radiators are visible only around contact areas. Check the areas where the springs touch the radiator for mechanical damage. If the antenna, LDS radiator of the feed pad on antenna looks obviously damaged, replace the entire antenna assembly. If replacing the antenna assembly does not correct the problem, check for further mechanical damage and repair.

The antennas and PWB are connected by spring. Inspect the PWB for damage to any of the antenna and spring, if the spring are missing or are obviously damaged (i.e. deformed), the clips must be replaced with new ones.

If corrosion is present on the PWB or the antenna contact areas are corroded, most likely the PWB and/or the phone need to be replaced. If the antenna contact areas are obstructed or covered, the contact areas should be cleaned or the entire antenna assembly replaced.

Figure 16 LDS antenna contact clip

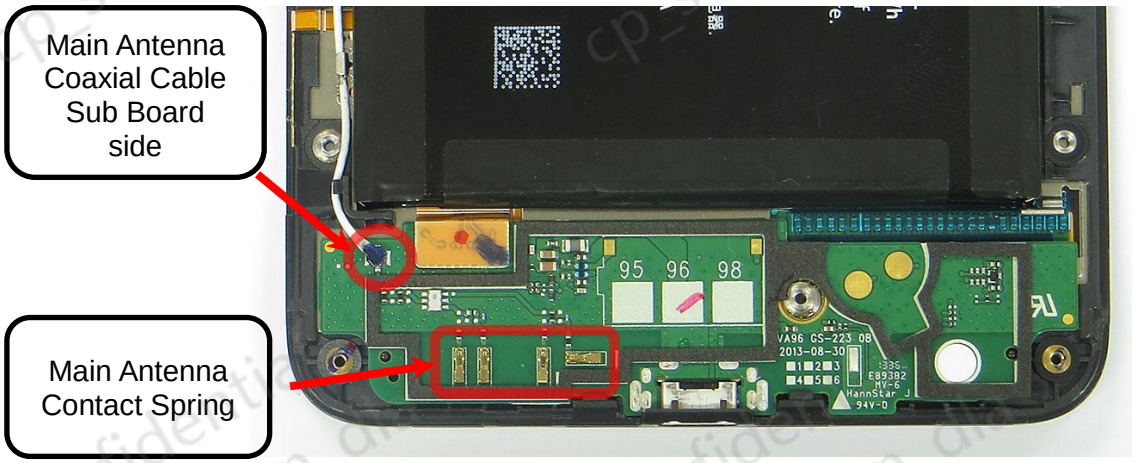
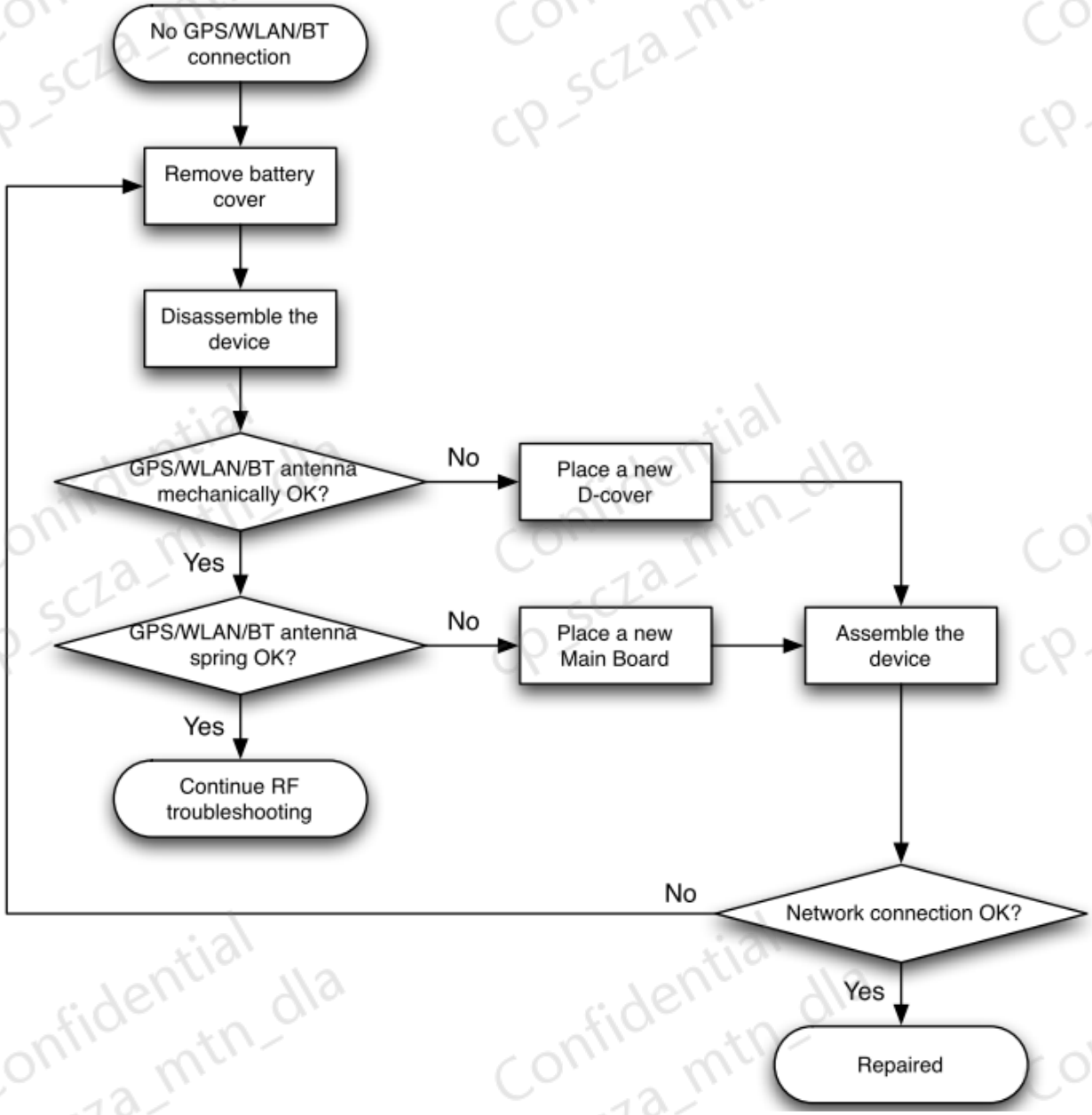


Figure 17 Main antenna contact cli

GPS/WLAN/BT antenna troubleshooting

Troubleshooting flow



5 Camera Module Troubleshooting

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■ Introduction to camera module troubleshooting

Background, tools and terminology

Faults or complaints in camera operation can be roughly categorized into three subgroups:

1 Camera is not functional at all; no image can be taken.

2 Images can be taken but there is nothing recognizable in them.

3 Images can be taken and they are recognizable but for some reason the quality of images is seriously degraded, or customer complains about image quality.

Image quality is very hard to measure quantitatively, and even comparative measurements are difficult (comparing two images) to do, if the difference is small. Especially if the user is not satisfied with his/her device's image quality, and tells, for example, that the images are not sharp, it is fairly difficult to accurately test the device and get an exact figure which would tell whether the device is functioning properly.

Often subjective evaluation has to be used for finding out if a certain property of the camera is acceptable or not. Some training or experience of a correctly operating reference device may be needed in order to detect what actually is wrong, or is there anything wrong at all.

It is easy for the user to take bad images in bad conditions. Therefore the camera operation has to be checked always in constant conditions (lighting, temperature) or by using a second, known-to-be good device as reference. Experience helps significantly in analyzing image quality.

Terms

Autofocus	Camera module contains lens movement mechanics for focus adjustment. Autofocus enables camera to take sharp images of objects positioned between 10cm to infinity. During AF the viewfinder image will be momentarily blurred as the camera searches for the right focus setting.
Digital zoom	Digital zoom is done by first cropping the image by the zoom ratio and then up scaling it to the output resolution. This will decrease the image quality especially with high zoom ratios.
Dynamic range	Camera's ability to capture details in dark and bright areas of the scene simultaneously.
Exposure time	Camera modules use silicon sensor to collect light and for forming an image. The imaging process roughly corresponds to traditional film photography, in which exposure time means the time during which the film is exposed to light coming through optics. Increasing the time will allow for more light hitting the film and thus results in brighter image. The operation principle is exactly the same with silicon sensor, but the shutter functionality is handled electronically.
Flicker	Phenomenon, which is caused by pulsating in scene lighting, typically appearing as wide horizontal stripes in an image.
ND-filter	Neutral density filter is a filter which is used in very bright conditions to reduce the amount of light hitting the sensor. The filter is built into the camera module and applied automatically when needed.
Noise	Variation of response between pixels with same level of input illumination.
Resolution	Usually the amount of pixels in the camera sensor. In some occasions the term resolution is used for describing the sharpness of the images.
Sensitivity	Camera module's sensitivity to light, in equivalent illumination conditions, a less sensitive camera needs a longer exposure time to gather enough light in forming a good image, Analogous to ISO speed in photographic film.

Sharpness	Good quality images are 'sharp' or 'crisp', meaning that image details are well visible in the picture. However, certain issues, such as non-idealities in optics, cause image blurring, making objects in picture to appear 'soft'. Each camera type typically has its own level of performance.
Shutter	The electronic shutter is used when short exposure times are needed and in video. When the mechanical shutter is used a black sheet will cover the lens after the exposure.

■ The effect of image taking conditions on image quality

There are some factors, which may cause poor image quality, if not taken into account by the end user when shooting images, and thus may result in complaints. The items listed are normal to camera operation and are not a reason for changing the camera module.

Autofocus

When the camera is focusing a lens is moved inside the module to give the sharpest possible image. This camera module is specified to operate satisfactorily from 10 cm to infinite distance of scene objects. Trying to photograph objects closer than 10 cm is likely to result in a blurred out of focus image. The lack of sharpness is first visible in full resolution images. Images taken very close to the subject, a limited depth of focus will be visible, that is the upper or lower parts of the image may be out of focus. This is normal; do not change the camera module.

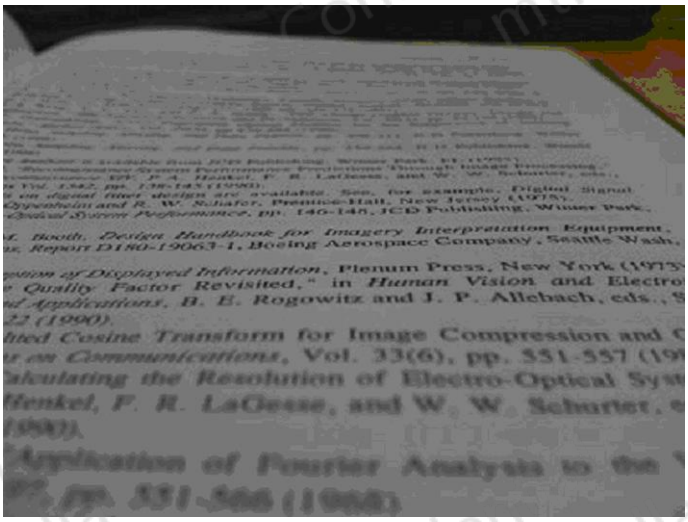


Figure 18 Only center part of image is in focus due to limited depth of focus

The amount of light available

In dim conditions camera runs out of sensitivity. The exposure time is long (especially in the night mode) and the risk of getting shaken (= blurred) images increases. In addition, image noise level grows. The maximum exposure time in the night mode is ¼ seconds. Therefore, images need to be taken with extreme care and by supporting the phone when the amount of light reflected from the target is low. Because of the longer exposure time and larger gain value, noise level increases in low light conditions. Sometimes blurring may even occur in daytime, if the image is taken very carelessly. See the figure below for an example. This is normal; do not change the camera module.

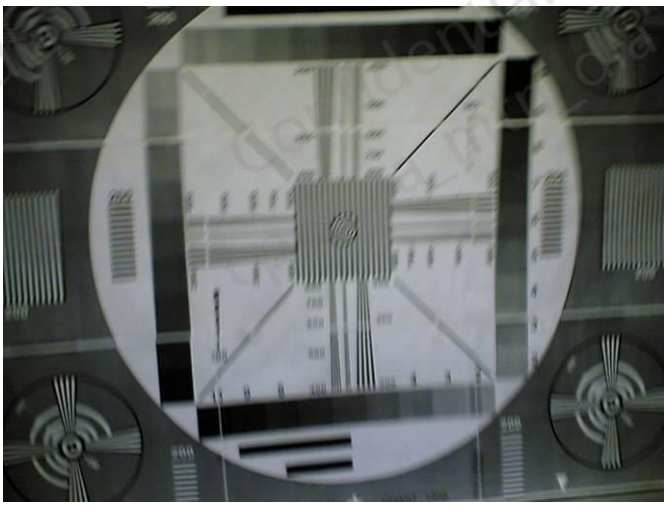


Figure 19 Blurring caused by shaking hands

Movement in bright light

If an image is taken of moving objects or if the device is used in a moving vehicle, object 'skewing' or 'tilting' may occur. This phenomenon is fundamental to most CMOS camera types, and may happen when using the electronic shutter. The movement of camera or object sometimes cause blurring indoors or in dim lighting conditions because of long exposure time. This is normal; do not change the camera module.

Figure 20 near objects get skewed when taking images from a moving vehicle

Temperature

High temperatures inside the mobile phone cause more noise to appear in images. For example, in +70 degrees (Celsius), the noise level may be very high, and it further grows if the conditions are dim. If the phone processor has been heavily loaded for a long time before taking an image, the phone might have considerably higher temperature inside than in the surrounding environment. This is also normal to camera operation; do not change the camera module.

Figure 21 Noisy image taken in +70 degrees Celsius

Phone display

If the display contrast is set too dark, the image quality degrades: the images may be very dark depending on the setting. If the display contrast is set too bright, image contrast appears bad and "faint". This problem is solved by setting the display contrast correctly. This is normal behavior; do not change the camera module.

Basic rules of photography (especially shooting against light)

Because of dynamic range limitations, taking images against bright light might cause either saturated image or the actual target appears too dark. In practice, this means that when taking an image indoors and having, for example, a window behind the object, the result is usually poor. This is normal behavior; do not change the camera module.

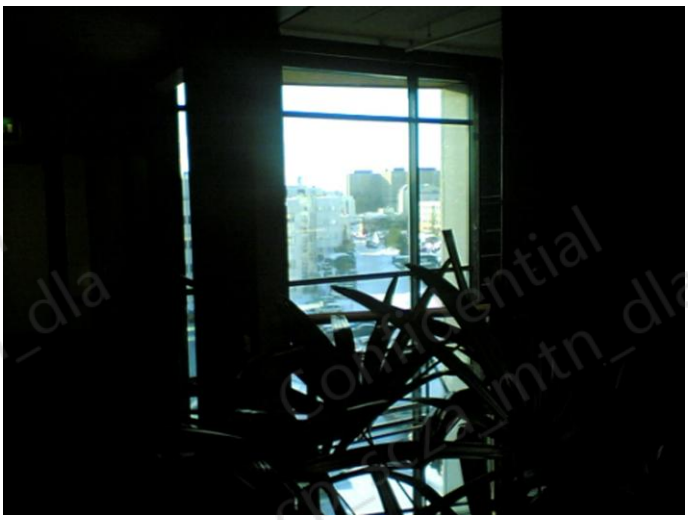


Figure 22 Image taken against light

Flicker

In some occasions a bright fluorescent light may cause flicker in the viewfinder and captured image. This phenomenon may also be a result, if images are taken indoors under the mismatch of 50/60 Hz electricity network frequency. The electricity frequency used is automatically detected by the camera module. In some very few countries, both 50 and 60 Hz networks are present and thus probability for the phenomenon increases. Flickering occurs also under high artificial illumination level. Flickering only occurs when the rolling shutter is used. This is normal behavior; do not change the camera module.

Figure 23 Flicker in an image; object illuminated by strong fluorescent light

Bright light outside of image view

Especially the sun can cause clearly visible lens glare phenomenon and poor contrast in images. This happens because of undesired reflections inside the camera optics. Generally these kinds of reflections are common in all optical systems. This is normal behavior; do not change the camera module.

Figure 24 A lens reflection effect caused by sunshine

Examples of good quality images

Figure 25 Good image taken indoors

Figure 26 Good image taken outdoors

■ Image quality analysis

Possible faults in image quality

When checking for possible errors in camera functionality, knowing what error is suspected significantly helps the testing by narrowing down the amount of test cases. The following types of image quality problems may be expected to appear:

- Dust (black spots)
- Lack of sharpness
- Bit errors

In addition, there are many other kinds of possibilities for bad image quality, but those are ruled out from the scope of this document since the probability of their appearance is small.

Testing for dust in camera module

Symptoms and diagnosis

For detecting these kinds of problems, take an image of a uniform white surface and analyze it in full resolution. A good quality PC monitor is preferred for analysis. Search carefully, since finding these defects is not always easy. Figure "Effects of dust on optical path" is an example image containing easily detectable dust problems.

When taking a white image, use uniformly lightened white paper or white wall. One possibility is to use uniform light but in this case make sure that the camera image is not flickering when taking the test image. In case flickering happens, try to reduce illumination level. Use JPEG image format for analyzing, and set the image quality parameter to 'High Quality'.

Black spots in an image are caused by dirt particles trapped inside the optical system. Clearly visible and sharp edged black dots in an image are typically dust particles on the image sensor. These spots are searched for in the manufacturing phase, but it is possible that the camera body cavity contains a particle, which may move onto the image sensor active surface, for example, when the phone is dropped. Thus it is also possible that the problem will disappear before the phone is brought to service. The camera should be replaced if the problem is present when the service technician analyses the phone.

If a dust particle is lying on the infrared filter surface on either side, they are hard to locate because they are out of focus, and appear in the image as large, grayish and fading-edge 'blobs'. Sometimes they are invisible to the eye, and thus the user probably does not notice them at all. However, it is possible that a larger particle disturbs the user, causing need for service.

Figure 27 Effects of dust on optical path

If large dust particles get trapped on top of the lens surface in the cavity between camera window and lens, they will cause image blurring and poor contrast. The dust gasket between the window and lens should prevent any particles from getting into the cavity after the manufacturing phase.

If dust particles are found on the sensor, this is classified as a manufacturing error of the module and the camera should be replaced. Any particles inside the cavity between the protection window and lens have most probably been trapped there in the assembly phase at a Nokia factory. Unauthorized disassembling of the product can also be the root of the problem. However, in most cases it should be possible to remove the particle(s) by using clean compressed air. Never wipe the lens surface before trying compressed air; the possibility of damaging the lens is substantial. Always check the image sharpness after removing dust.

Testing camera image sharpness

Symptoms and diagnosis

If pictures taken with a device are claimed to be blurry, there are five possible sources for the problem:

1 The protection window is fingerprinted, soiled, dirty, visibly scratched or broken.
2 The camera module has failed to focus correctly, producing a blurred image.
3 User has tried to take pictures in too dark conditions and images are blurred due to handshake or movement. This is not a cause to replace camera module.
4 There is dirt between the protection window and the camera lens.
5 The protection window is defective. This can be either a manufacturing failure or caused by the user. The window should be changed.

A quantitative analysis of sharpness is very difficult to conduct in any other environment than optics laboratory. Therefore, subjective analysis should be used.

If no visible defects (items 1-4) are found, a couple of test images should be taken. Generally, a well-illuminated typical indoor scene, such as the one in Figure "Good image taken indoors", can be used as a target. The main considerations are:

- The camera module has to be given time to focus correctly. Correct focusing is normally indicated with a flashing icon or green bracket in the viewfinder. During focusing, the image in the viewfinder moves slightly back and forth, this is normal and shows that the lens unit is moving. During the movement a faint sound can be heard from the camera head.
- The protection window has to be clean.
- The amount of light (300 – 600 lux (bright office lighting)) is sufficient.
- The scene should contain, for example, small objects for checking sharpness. Their distance should be 1–2 meters.
- If possible, compare the image to another image of the same scene, taken with a different device. Note that the reference device has to be a similar Nokia phone.

There are several conditions in which AF operation is challenging for the camera module, i.e. failing from time to time. These include:

- Low light scenes and night mode
- Scenes with low contrast
- Fast-moving objects

AF operation is disabled on purpose in "night", “landscape", and "sports” modes.

When using these modes the lens is set to a predetermined focal position and is not moved during use. The AF lens is fixed in hyper focal in video mode.

Under low light and night mode the AF function is slower than under good light, it may even fail to find correct focus position. Low contrast scenes or fast moving objects may also slow down or cause AF to fail. This is normal operation, and is not a cause to replace camera.

The operation of AF can be tested by taking images of objects at different distances. Good distances are 20 cm, 60 cm and infinity (>3 m). Any LED or xenon flashes should not be used while taking the images.

The taken images should be analyzed on PC screen at 100% scaling simultaneously with a reference image. Pay attention to the computer display settings; at least 65000 colors (16 bit) have to be used. 256 (8-bit) color setting is not sufficient; true color (24 bit, 16 million colors) or 32 bit (full color) setting is recommended.

If the differences are noticeable at a glance and also if the one under investigation is significantly inferior, the module might have a faulty lens, In this case, the module should be changed. Always re-check the resolution after changing the camera module. If a different module produces a clearly noticeable quality gap,

The fault is probably in the camera window. Check the window by looking carefully through it when replacing the module. As references Figure "Good image taken indoors" and Figure "Good image taken outdoors" can be used, another possibility is to use a service point comparison phone, if available.

Effects of dirty or defective camera lens protection window

The following series of images demonstrates the effects of fingerprints on the camera protection window.

Note: The effects of any dirt in images can vary very much; it may be difficult to judge if the window has been dirty when some image has been taken or if something else has been wrong. That is why the cleanness of the protection window should always be checked and the window should be wiped clean with a suitable cloth.

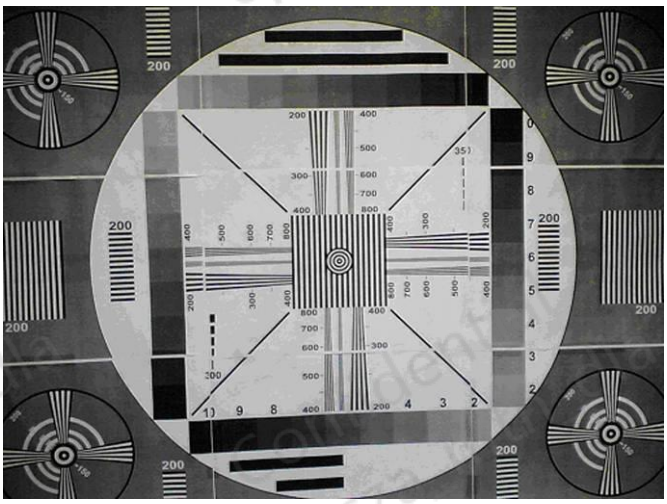


Figure 28 Image taken with clear protection window

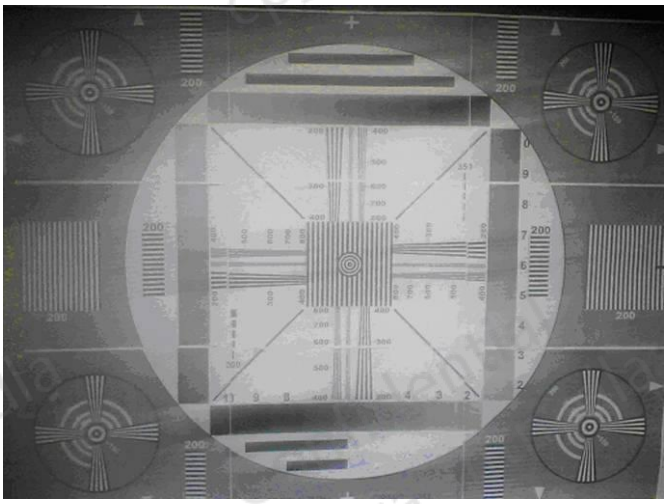


Figure 29 Image taken with greasy protection window

Bright point light sources might cause images that have flares around the light source if the protection window is dirty. A smeared fingerprint may be hard to see on the protective window but if will affect the image quality. These flares can be avoided by cleaning the window with a suitable cloth.

Figure 30 Image of point light sources taken with a clean protective window

Figure 31 Image of point light sources taken with a dirty (finger print) protective window

Faulty pixels in images

Faulty pixels are pixels that do not respond to light in the same way as the pixels around them. There are three main types of faulty pixels, dead, stuck and hot pixels.

Dead pixels are always black or significantly darker than their surroundings. Dead pixels appear as black spots in all lightning conditions. Camera modules producing images with dead pixels that are clearly noticeable should be replaced.

If the pixel remains always saturated to its maximum value it is stuck. Stuck pixels may appear as red, green, blue or white spots in all lightning conditions. Camera modules producing images with one or more stuck pixels should be replaced.

Hot pixels are pixels that easily saturate in dim light conditions. It is normal to get a lot of noise and hot pixels in night conditions or otherwise dark conditions. The hot pixels should disappear when the ambient light is increased, but may still appear in darker areas of an otherwise well illuminated scene. This is normal behavior, do not change the camera.

When examining an image for defect pixels, test images should be viewed as 100% enlargements on a PC Monitor.

■ Main camera, camera flash and front camera troubleshooting

Main camera troubleshooting

Context

First verify the problem by testing the camera with a camera application.

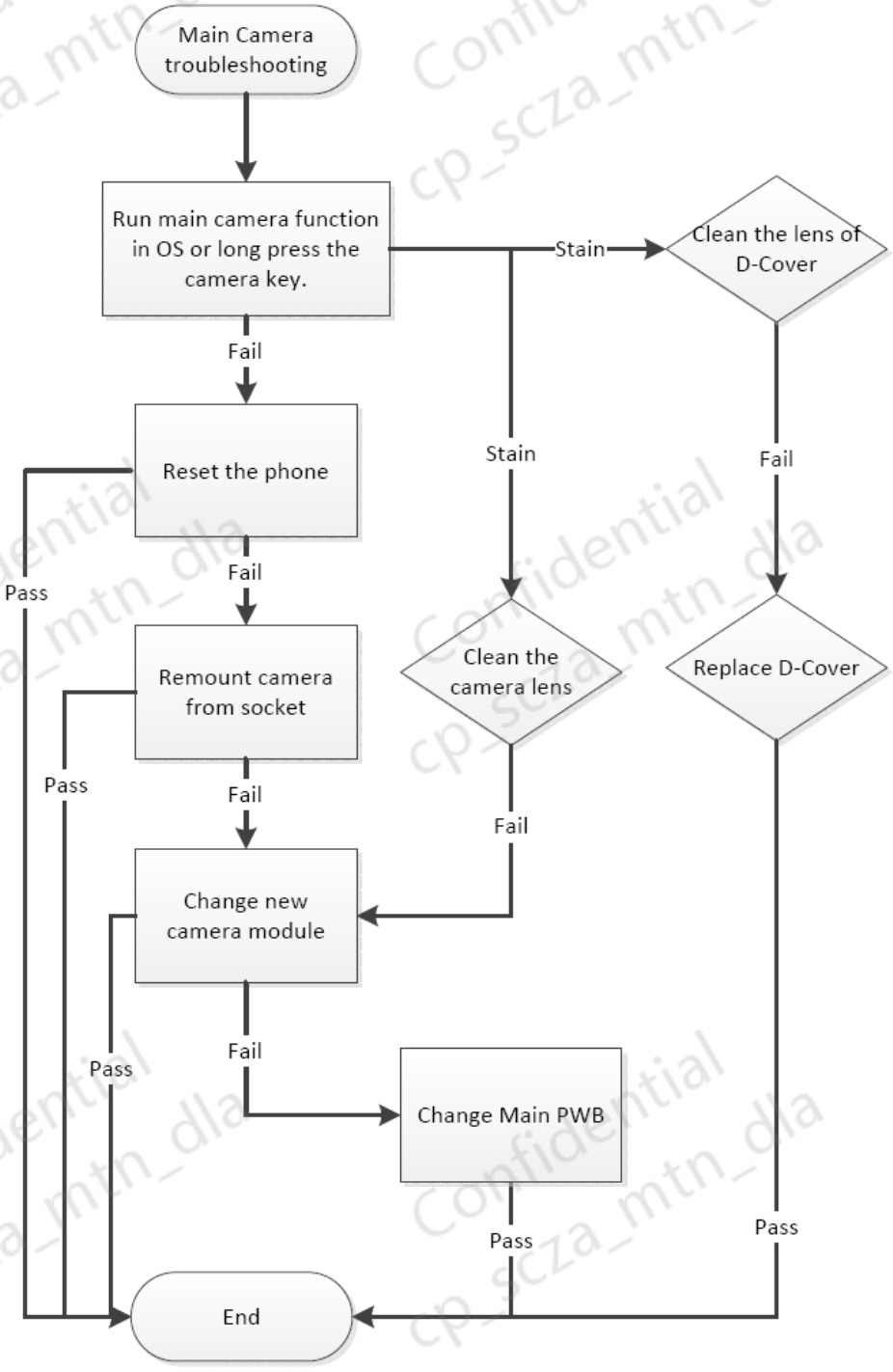
In case of image quality (IQ) related problems:

- Check the problem with a reference phone to see that it actually is a problem and not some Misunderstanding of the camera capabilities.
- Check that nothing is blocking the camera's field of view, such as a broken camera window, dirt, or a Window protective foil still attached.
- If the IQ problem is real and there is nothing visibly wrong, the camera module should be changed.

If the camera does not start, locate the problem using camera tests in the Care suite. Other checks without going under the cans:

- Visually inspect component/PWB damages
- Change the main camera and test again

Troubleshooting flow



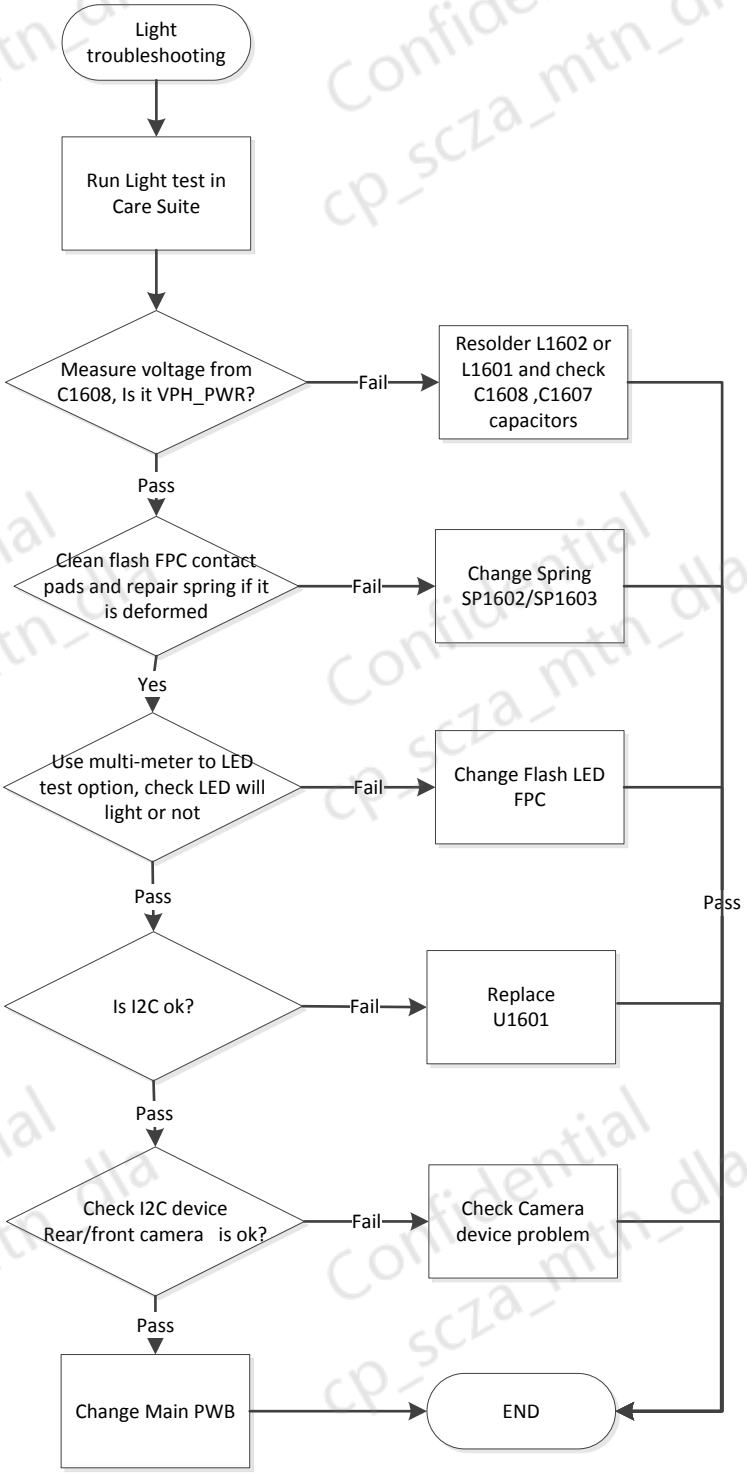
Camera flash troubleshooting

Context

When the LED flash is not working:

- Visually inspect components, PWB and flash flex for damages
- Check the flash LED contact springs
- Check the flash LED with a multi meter if the LED is broken change the camera window/antenna cover (the Flash LED is part of it).

Troubleshooting flow



Front (secondary) camera troubleshooting

Context

First verify the problem by testing the camera with a camera application. In case of image quality (IQ) related problems:

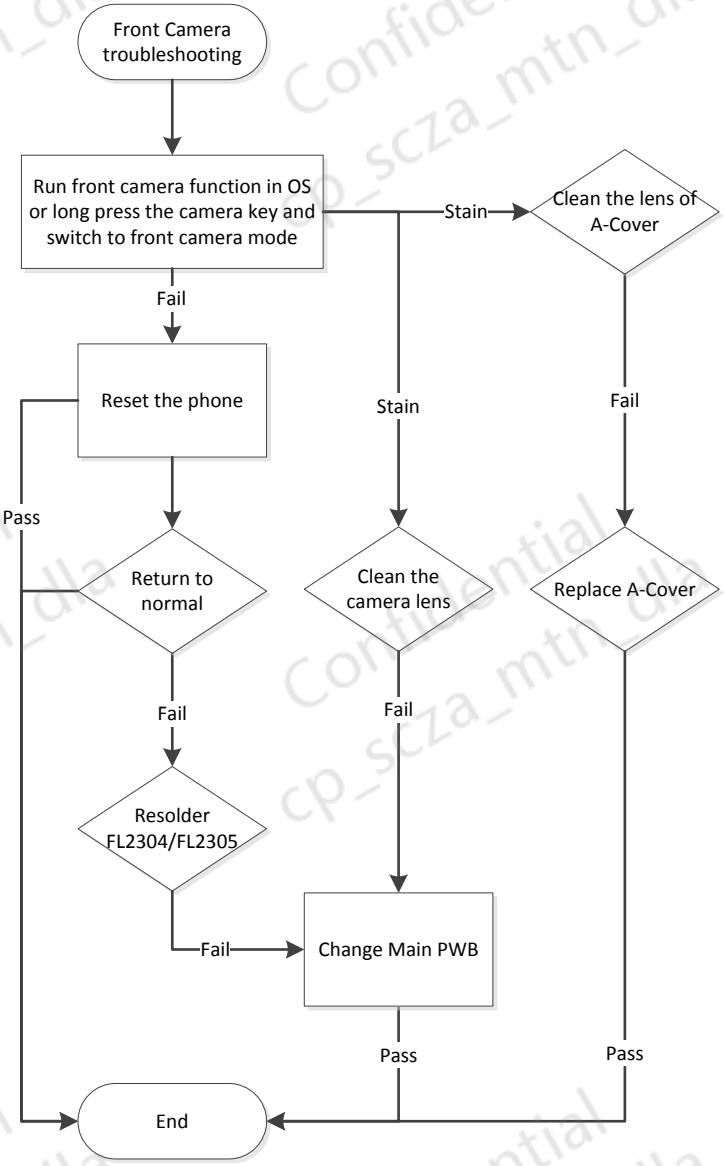
- Check the problem with a reference phone to see that it actually is a problem and not some misunderstanding of the camera capabilities.
- Check that nothing is blocking the camera's field of view, such as a broken camera window, dirt, or a window protective foil still attached.

If the camera does not start, locate the problem using camera tests in the Care suite. Other checks without going under the cans:

- Visually inspect component/PWB damages
- Check the camera lines that can be measured with a multi meter:
  - SDA (I2C3) line from the R2311 on the main PWB
  - SCL (I2C3) line from the R2310 on the main PWB

  If the camera failure is located to the camera module, change the main PWB.

Troubleshooting flow



6 System Module

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Introduction

Phone description

MSM8930/8227 is the main digital baseband ASIC in the phone. It contains functionality for both WCDMA and GSM EDGE. The hardware accelerator is used for imaging and video.

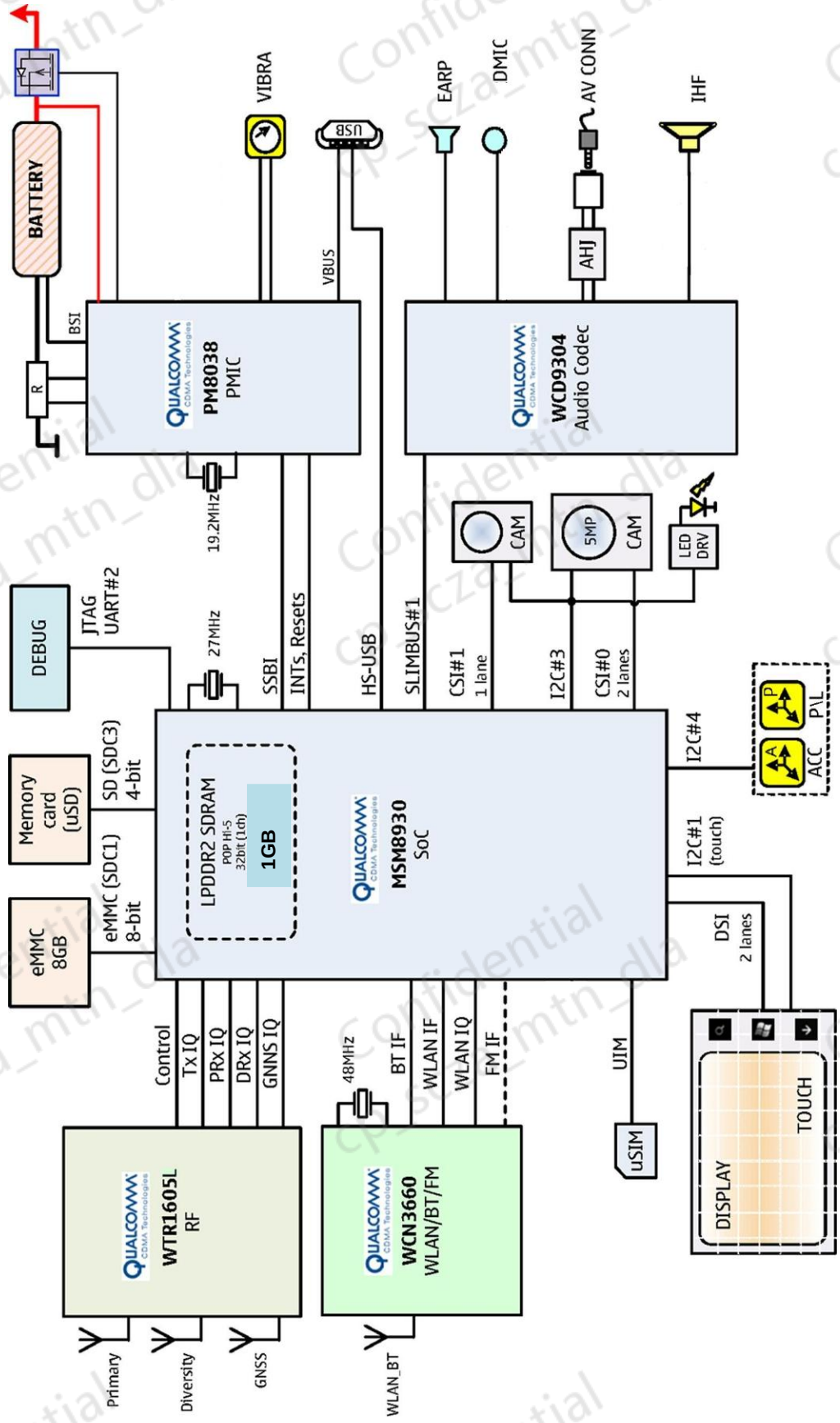
PM8038 (U1100) is the main energy and power management controller for the phone. WCD9304 (U2100) is the main audio controller for the phone.

Key components

Function	Description	Item ref
Main PWB	GA-394 (RM-994&995) GA-396 (RM-996)	PWB
Sub PWB	GS-223 (RM-996 & 994) GS-231 (RM-995)	PWB
Side key Flex	Side key flex	Flex
LED Flex	Flash LED	Flex
Display module	Barbie LCM module	Assembly
Touch module	A-cover touch assembly	Assembly
Power management IC	PM8038	U1100
RF ASIC	WTR1605L	U2500
Processor	MSM8930 / 8230	U500
GSM/WCDMA/LTE	MMPA	U2700
LTE B7 PA	B7(RM-941)	U2800
LTE B17, B20 PA	B17(RM-942),B20(RM-941)	U2904
PA DC/DC converter	LM3243TMX	U3000
Antenna switch module	LMSW6SGM-F87	U3100
Div antenna switch	HFQSWEJUA-136	U2603
Oscillators	Crystal 19.2 MHZ	Y1201
	Crystal 27 MHZ	X500
	Crystal 48 MHZ	Y3300
CMT memory	POP 1GB LPDDR2 (stacked with MSM8930 / 8230)	U1700
WLAN/Bluetooth/FM radio	WCN3660	U3300
GPS	GPS/Glonass integrated into WTR1605	U2500
GPS LNA (external)	UPC8236T6N-E2-A	U3500
Main RF connector		ANT3100
Diversity connector		ANT2601
WLAN/BT/GPS RF connector		ANT3500
Battery	BV-4BWA	Assembly
Battery connector	Tabby blade interface	J1100
Display connector	Board-to-board connector	J2401
Touch connector	Board-to-board connector	J1500
Side key connector	Board-to-board connector	J3700

Function	Description	Item ref
eMMC	8 GB internal mass memory	U1800
USB connector	Micro USB-B	J301
Micro SIM connector	Micro SIM reader	J2200
Micro SD connector	Micro SD reader	J2201
Audio codec	WCD9304	U2100
AV connector	Standard 3.5 mm, AHJ	J2000
Earpiece	HWH108	Assembly
Microphone	MD07OT263-01	MIC300
Vibra	MVMF-A303F2	PAD302, PAD303
Accelerometer	3-axis accelerometer Ahti2	U3600
Combined Proximity Sensor and Ambient Light Sensor	Digi ALS/Proxy	U3601
E-compass	3-AXIS MAGNETIC SENSOR IC	U3602

System module block diagram



■ Energy management

Battery and charging

BV-4BWA

The phone is powered by a 3-pole BV-4BWA 3400 mAh battery. The three poles are named VBAT(+), BSI and GND(-) where the BSI line is used to recognize the battery capacity. This is done by means of an internal battery pull down resistor.

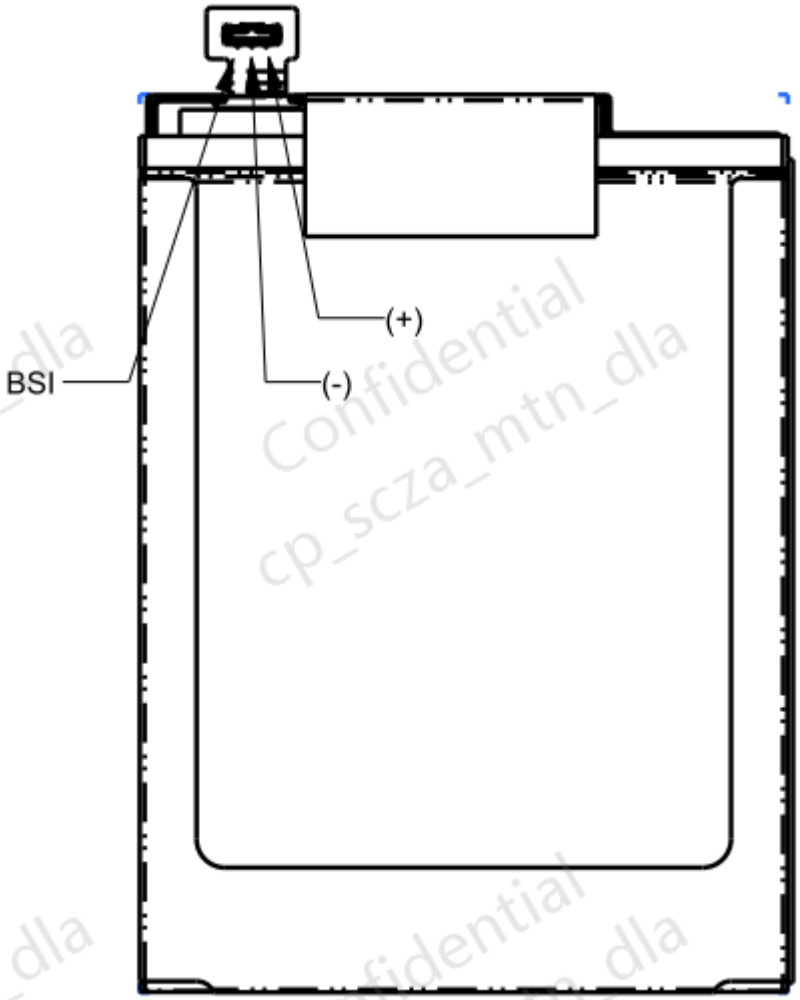


Figure 32 Battery pin order

The battery temperature is estimated by measuring separate battery temperature NTC via the BTEMP line. This is located on the Side key FPC, at the place where the phone temperature is closest to the battery temperature.

Battery connector

The battery connector is a FPC connector. It has three poles;

- BSI (Battery size indicator)
- GND (-) (Ground)
- VBAT (+) (Battery voltage)

The BSI line is used to recognize the battery capacity by a battery internal pull down resistor.

Charging

The phone can be charged through the micro USB interface.

Charging is controlled by energy management, and external components are needed to protect the baseband module against EMC, reverse polarity and transient frequency deviation.

Charging a dead battery

When charging a dead battery it may take up to several minutes before the phone is able to boot to Operating System. Meanwhile, the charging is indicated by a charging symbol on the screen. The symbol is shown for a few seconds each time the power key is pressed.

Normal and extreme voltages

Energy management is mainly carried out in the EM ASIC (U1100). That contains a number of regulators. In the table below normal and extreme voltages are shown when a BV-4BWA battery is used.

Table 8 Nominal voltages

Voltage	Voltage [V]	Condition
	General Conditions	
Nominal voltage	3.700	

Parameter	Voltage	others
Higher extreme voltage	4.2V	
(Fast charging)	SW Shutdown	
SW shutdown	3.49V	

The PM8038 PMIC determines the system boot up (or shutdown) by comparing the battery voltage with the UVLO thresholds.

Table 9 UVLO performance specifications

Parameter	Comments	Min	Typ	Max	Units
Threshold voltage, falling	Programmable value	1.500	2.700	3.050	V
Threshold voltage accuracy		-5	-	+5	%
Hysteresis		100	175	250	mV
UVLO detection interval		-	1.0	-	µs

The hysteresis acts the following way:

- For rising threshold (during power up), the threshold would be 2700 + 175 mV
- For falling threshold (to determine shutdown), the threshold would be 2700 mV

Power key and system power up

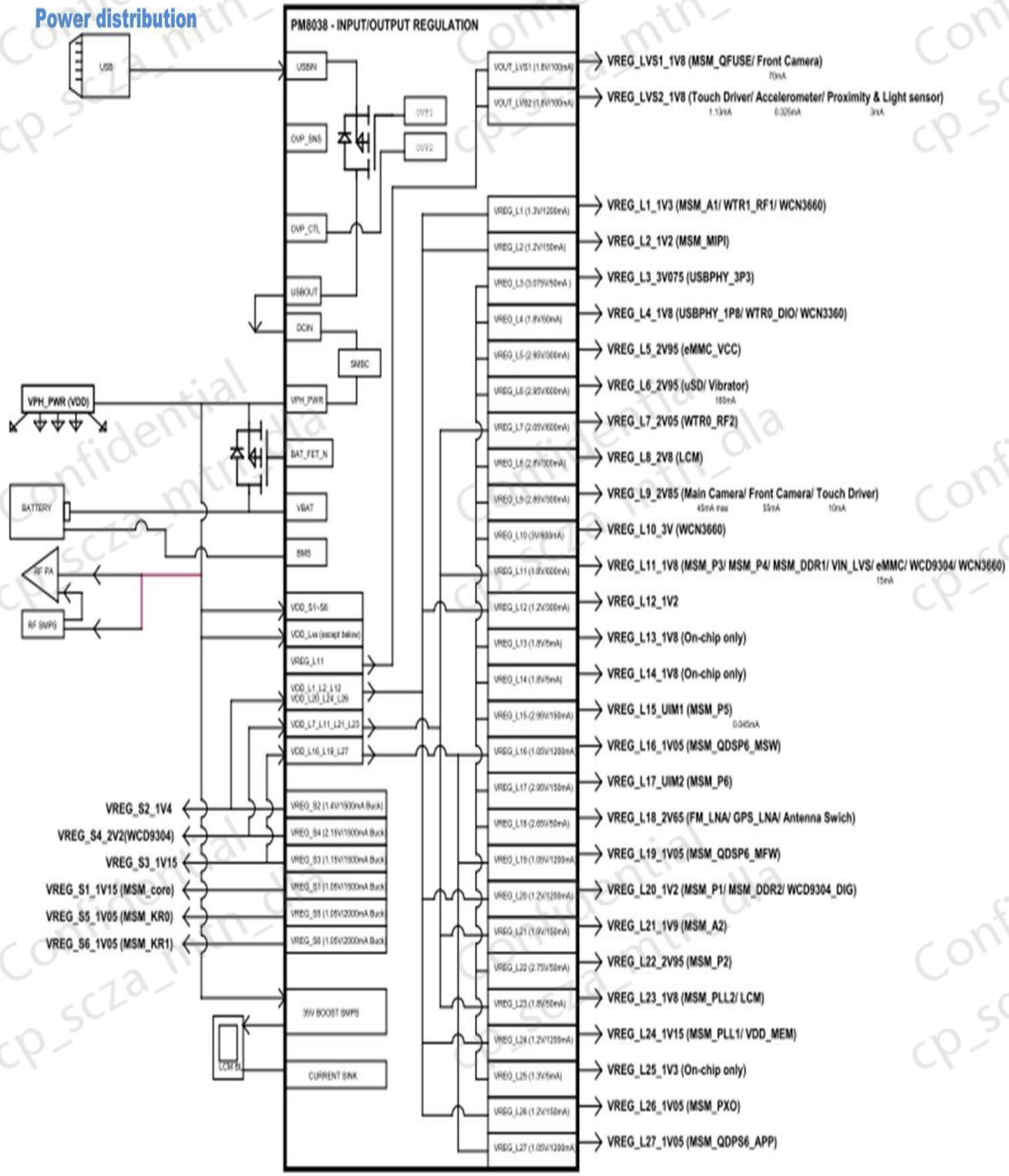
When the battery is placed in the phone, the power key circuits are energized. When the power key is pressed, the system boots up (if an adequate battery voltage is present).

Power down can be initiated by pressing the power key again and the system is powered down with the aid of SW. The power key is connected to EM ASIC (U1100) via the PON_RESET_N signal.

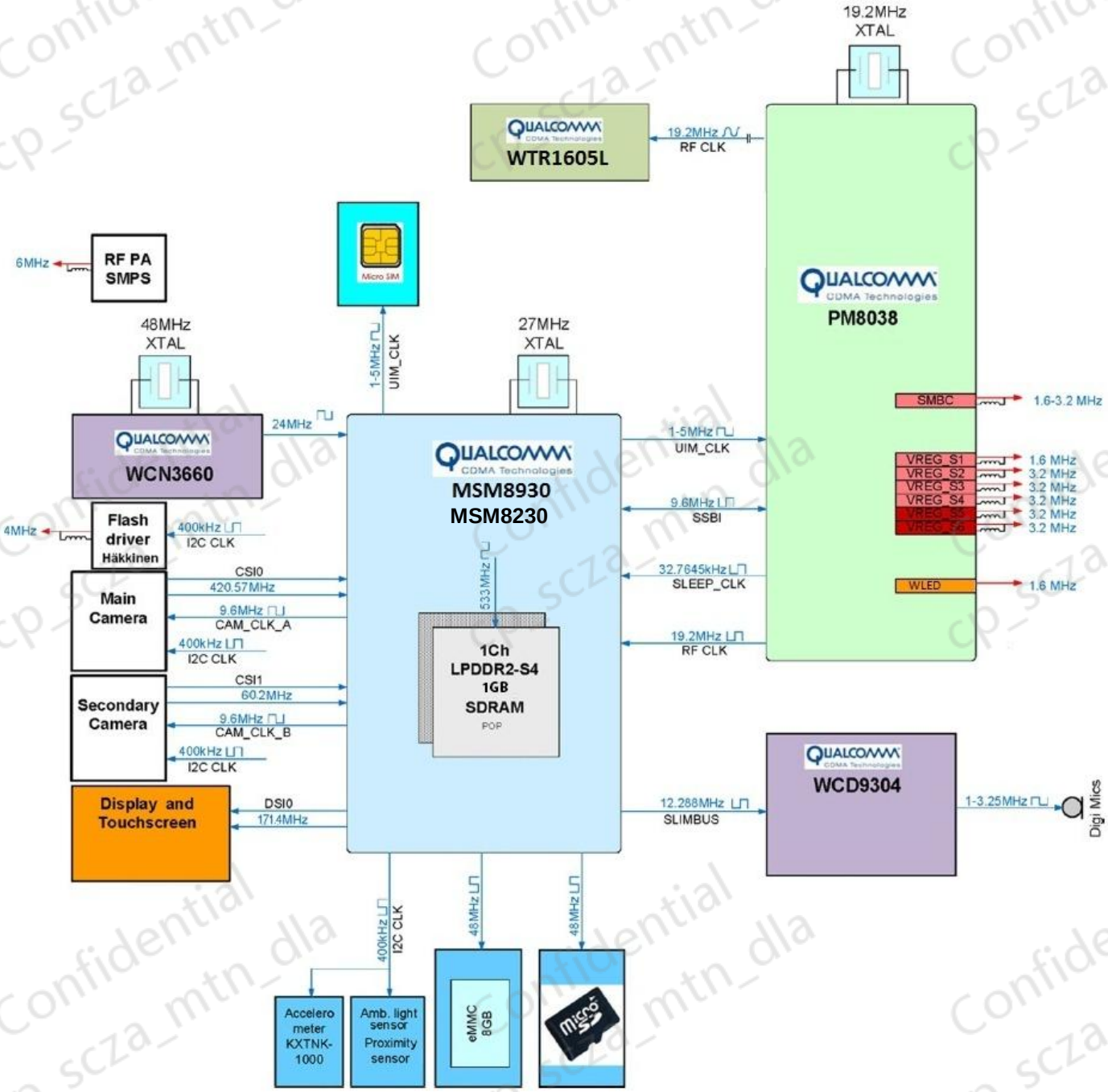
Modes of operation

Mode	Description
NO_SUPPLY	(Dead) mode means that the main battery is not present or its voltage is too low (below U1100 master reset threshold) and that the back-up battery voltage is too low.
BACK_UP	The main battery is not present or its voltage is too low but back-up battery is adequate and the 32 kHz oscillator is running.
PWR_OFF	In this mode (warm), the main battery is present and its voltage is over U1100 master reset threshold. All regulators are disabled, PON_RESET_N is on low state, the RTC is on and the oscillator is on. PWR_OFF (cold) mode is almost the same as PWR_OFF (warm), but the RTC and the oscillator are off.
RESET	RESET mode is a synonym for start-up sequence. RESET mode uses 32 kHz clock to count the RESET mode delay (typically 16ms).
SLEEP	SLEEP mode is entered only from PWR_ON mode with the aid of SW when the system's activity is low.
FLASHING	FLASHING mode is for SW downloading.

Power distribution



Clock scheme



■ Micro SIM interface

The phone has a micro SIM (Micro Subscriber Identification Module) interface including a micro SIM connector. The micro SIM interface consists of an interface between MSM (U500) and micro SIM contacts, while PMIC 8038 (U1100) feeds the SIM power supply (VREG_L15).

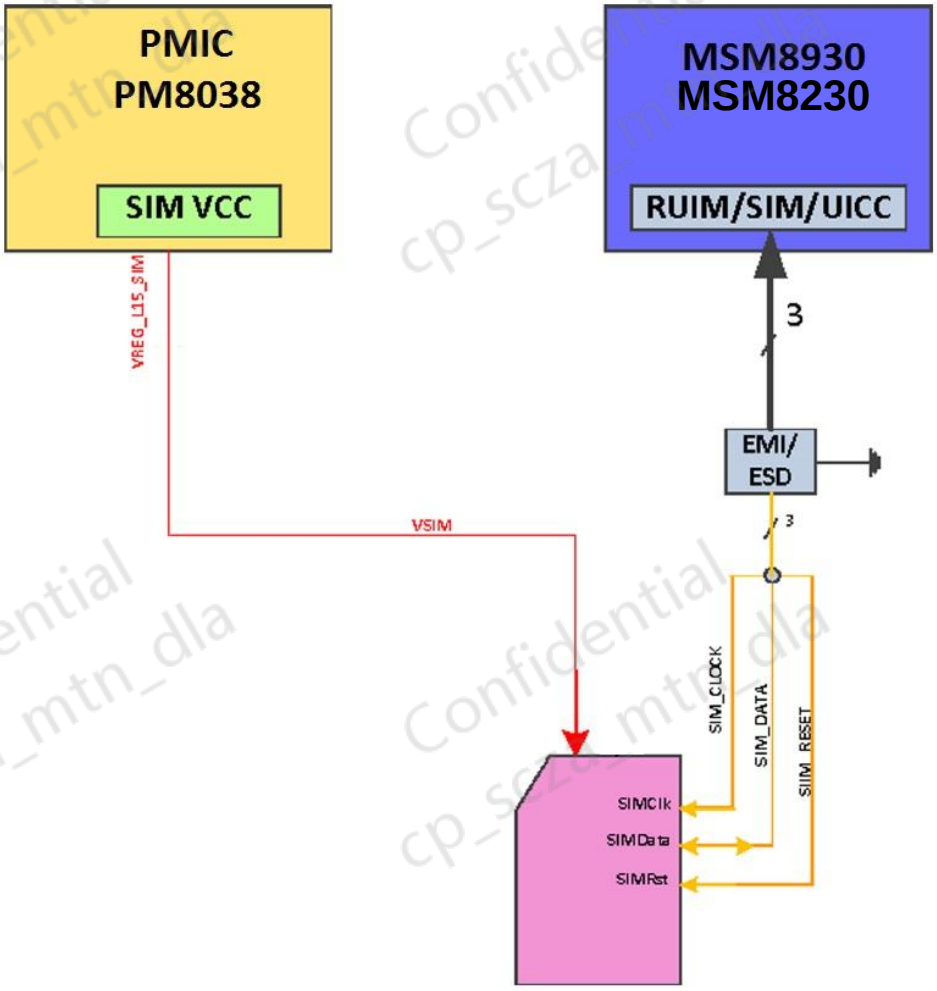


Figure 33 Micro SIM interface

Device memory

The memory components of the device are internal POP 1GB LPDDR2, a card reader for MicroSD, and 8 GB eMMC memory which is non-removable and internal to the phone.

The MicroSD is used as a user's data storage memory. The µSD card is connected to MSM which has an internal level shifter with an ESD protection filter. The µSD card insertion state is detected by a detect switch connected to MSM8930/ 8230 GPIO94. When the card is moved to remove it, the µSD card is powered off. Hot swap is supported, which means that the card may be plugged in/out at any time, without removing the battery.

The device uses 8 GB eMMC (U1800) external memory. The eMMC interface is an 11-wire serial/parallel data bus which includes a clock (CLK), 8 data signals (DAT), a reset, and command (CMD) wires. The eMMC interface is made up of the SDC1 bus from the MSM. The eMMC consists of an internal NAND controller and an MMC controller for I/O interface. It is a dual supply device which requires VCC of 2.95V for the NAND core and VCCQ of 1.8V for the MMC I/O interface.

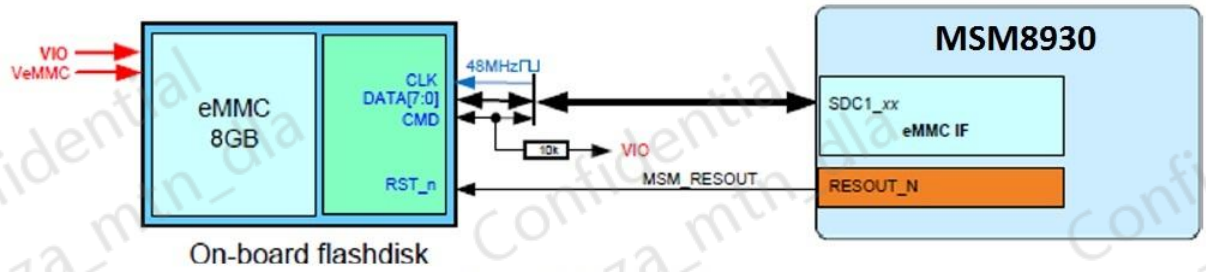


Figure 34 eMMC interface

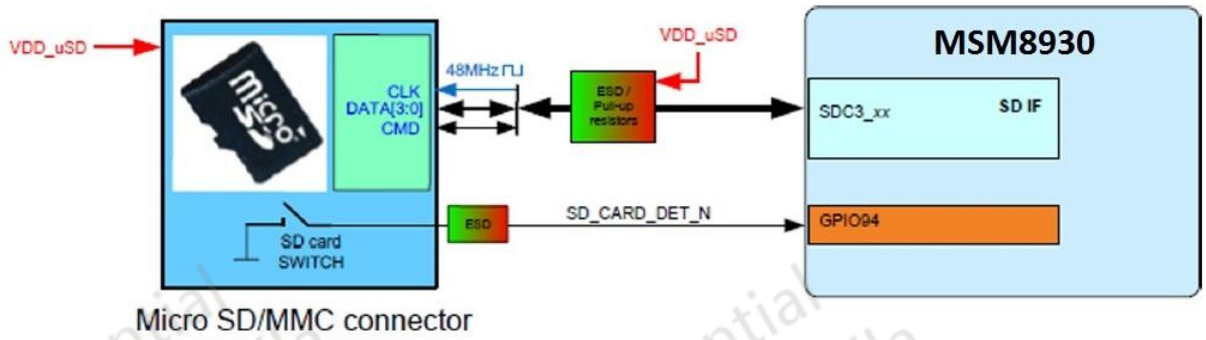


Figure 35 MicroSD connector

WCN3660 module

The Qualcomm WCN3660 single chip device provides WLAN, BT and FM radio functionality.

WLAN functionality provides full 802.11b, g and n.

The WLAN 2.4GHz transceiver is integrated into the WCN3660 chipset. The WLAN antenna route goes through the FEM, discrete WLAN/BT RF band pass filter and discrete RF diplexer component. Bluetooth and WLAN use the same antenna. Transmitting output power level is changed according to data rate. The highest power level is provided in 802.11b data rates.

The 4-line analog baseband interface for TRX multi-plexing and 5-line digital interface for command and control are designed between the Nokia BB and the WLAN chipset. WLAN chipset uses a dedicated 48 MHz reference clock, which is generated by external crystal.

Figure 3-4 WCN3660 RF connections for dual-band (2.4 GHz and 5.0 GHz) using default internal coupler

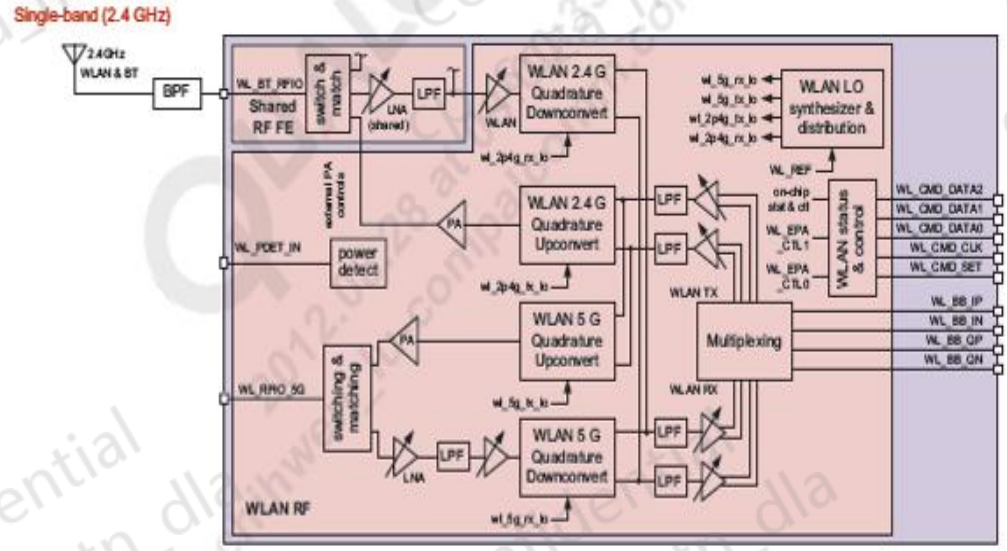


Figure 36 CWR block diagram

■ GPS interface

GPS support is built into WTR1605(L) and interfaces with the MSM8930/ 8230 GNSS Processor. The 19.2MHz reference clock of WTR1605(L) is also used for GPS.

The front end includes a unbalun SAW filter before LNA ,and balun filter before WTR1605(L). A diplexer is used to combine GPS+GLONASS and BT/WLAN to the same antenna.

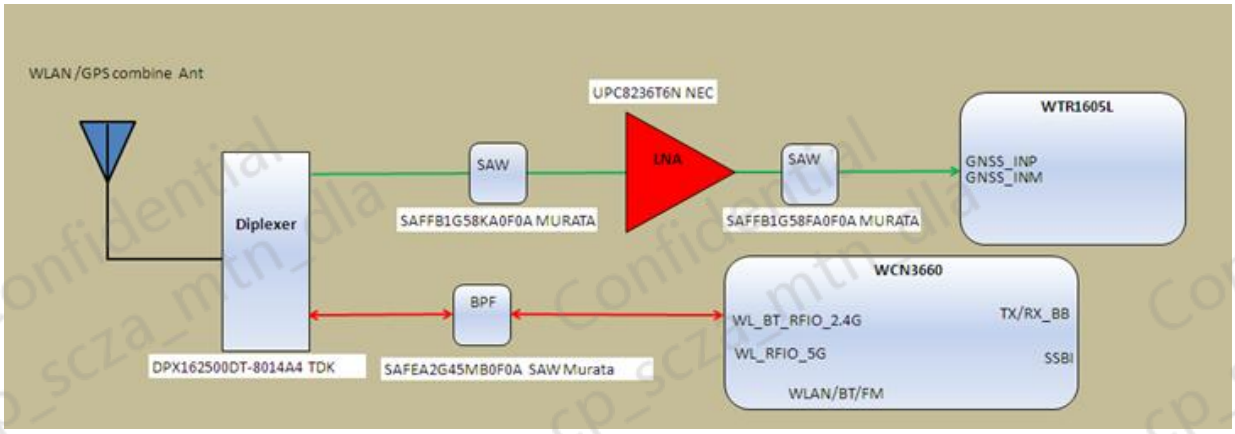


Figure 37 GPS interface

MicroUSB

MicroUSB interface and charging

The phone has an interface for USB (Universal Serial Bus). USB is a differential serial bus that provides a wired connectivity between a PC and peripheral devices, as in this case a mobile phone.

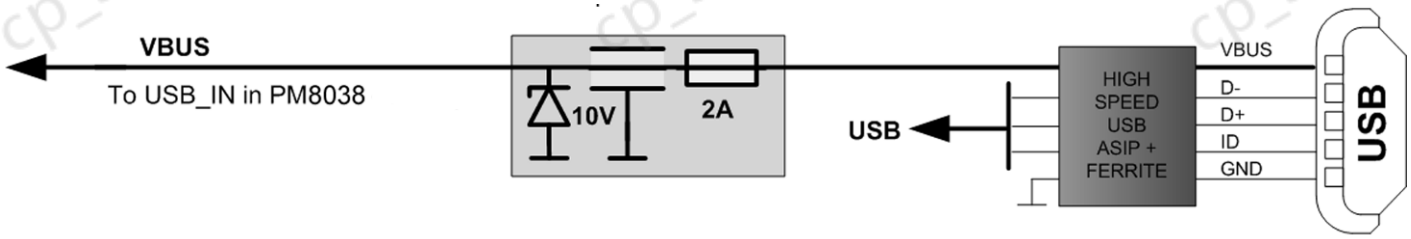


Figure 38 USB interface

The phone supports USB 2.0 with High-Speed (480 Mbps).
Hot swap is supported, which means that USB devices may be plugged in and out at any time.

MicroUSB connector

This phone is provided with a specific connector for microUSB.

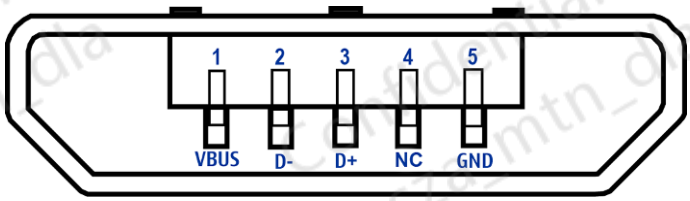


Figure 39 MicroUSB connector

■ User interface

Touch module

This phone uses Synaptics capacitive touch solution.

The Synaptics touch module interfaces with MSM via I2C and GPIO 52 for Reset and GPIO 11 for Touch INT.

The Synaptics touch module uses PM8038 VREG_L9_2V85 for its analogue supply and VREG_LVS2_1V8 for its digital supply.

Whenever the user touches the touch screen, the controller raises an interrupt to MSM which initiates I2C transactions to identify the locations the user touches on the display.

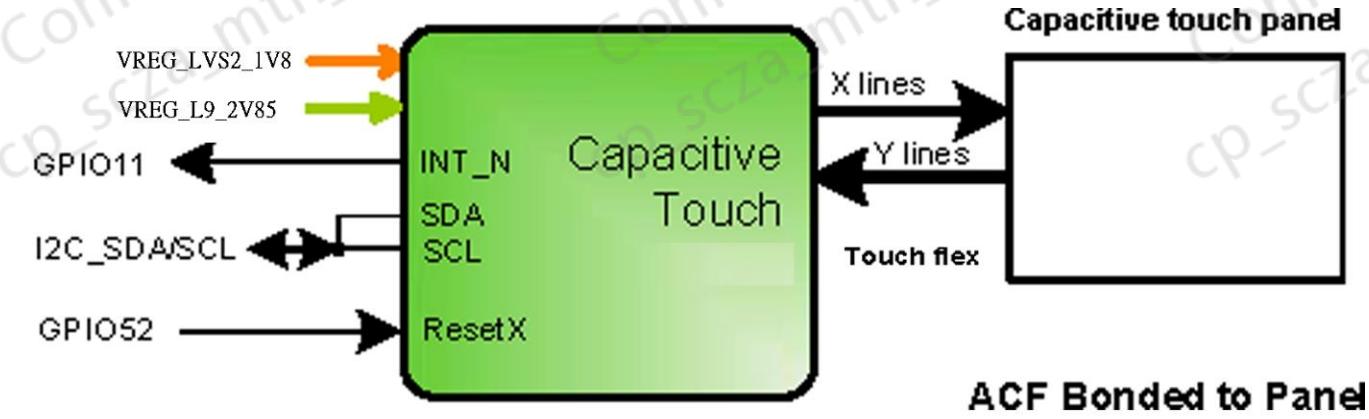


Figure 40 Touch module interface

Proximity sensor and ambient light sensor

This phone uses a combined proximity and ambient light sensor called Alphamon.

Alphamon includes a digital proximity sensor, ambient light sensor and IR LED in the same package. Alphamon is mainly targeted for adjusting the display illuminance and turning the touch display off during a phone call if the earpiece of the phone is used.

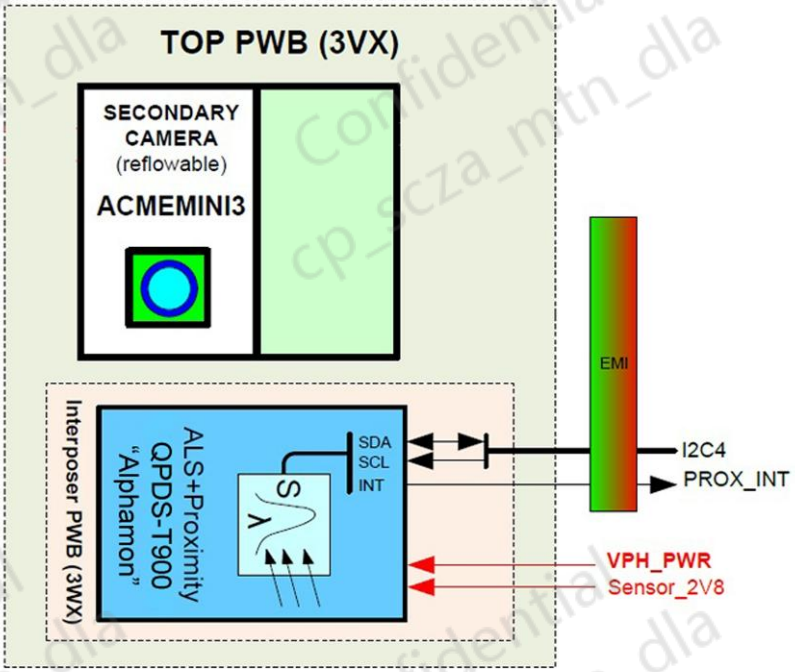


Figure 41 Proximity sensor and ALS

Imaging and video

Display module

This phone uses a 5.98" HD display with 16 million colors. The display module supports the display format of 720 columns x 1280 rows. The dimension of the display module only is 77.68 mm x 140.64 mm x 1.57 mm. The module interfaces to the phone via FPC with a 34 pins board-to-board connector. The display is connected to MSM8930 with a 4-lane MIPI DSI.

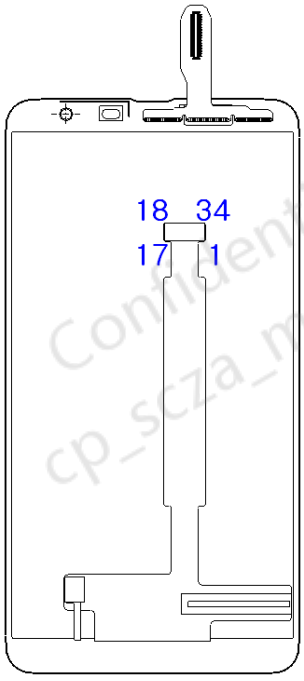


Figure 42 Display flex orientation

1	MTP	GND	34
2	GND	GND	33
3	D3+	AVEE	32
4	D3-	AVDD	31
5	GND	GND	30
6	D2+	GND	29
7	D2-	RESET	28
8	GND	TE	27
9	CLK+	BC	26
10	CLK-	GND	25
11	GND	VDDI	24
12	D1+	VDDA	23
13	D1-	GND	22
14	GND	LED1-	21
15	D0+	LED2-	20
16	D0-	LED+	19
17	GND	GND	18

Figure 43 Display flex pin order

Cameras

This phone has two cameras, a 5 MPix resolution main (rear) camera and a VGA resolution secondary camera. A LED flash is used for the main camera.

Primary camera

The primary camera is a 5 Megapixel AF (autofocus) camera module. The module size is 7.5 mm x 7.5 mm x 4.6 mm and it fits into the 16-pin camera socket on the phone. The camera module is SMIA 75++ compliant and is configured by the MSM using I2C control bus. Image data is transferred to the MSM8930 for further processing over CSI-2 (MIPI_CSI0).

Secondary camera

The secondary camera is a 0.3 MPix fixed focus camera module. It is SMIA compliant, directly connected to MSM8930 and controlled by the I2C bus. Image data is transferred to the MSM8930 for further processing over a CSI-2 based bus (MIPI_CSI1).

Flash (LED module)

A LED module, high power, white flash LED is for use as a camera flash and torch. The torch has significantly reduced power compared to the image capture flash.

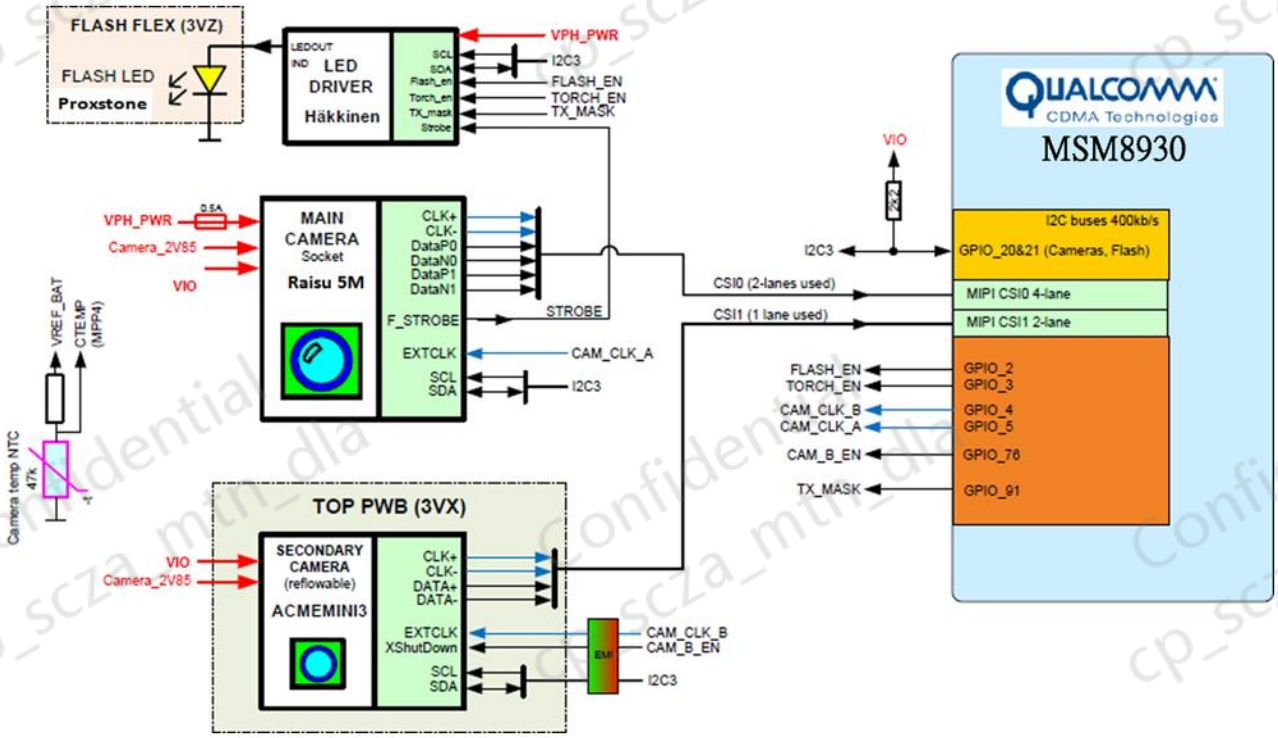


Figure 44 Camera system interface

Illumination

Backlight illumination is supported and is handled by eight white LEDs that are located on the LCM module. These LEDs are powered by VPH_PWR and controlled by PM8038 via V_LED_N1 and V_LED_N2

System Mudues

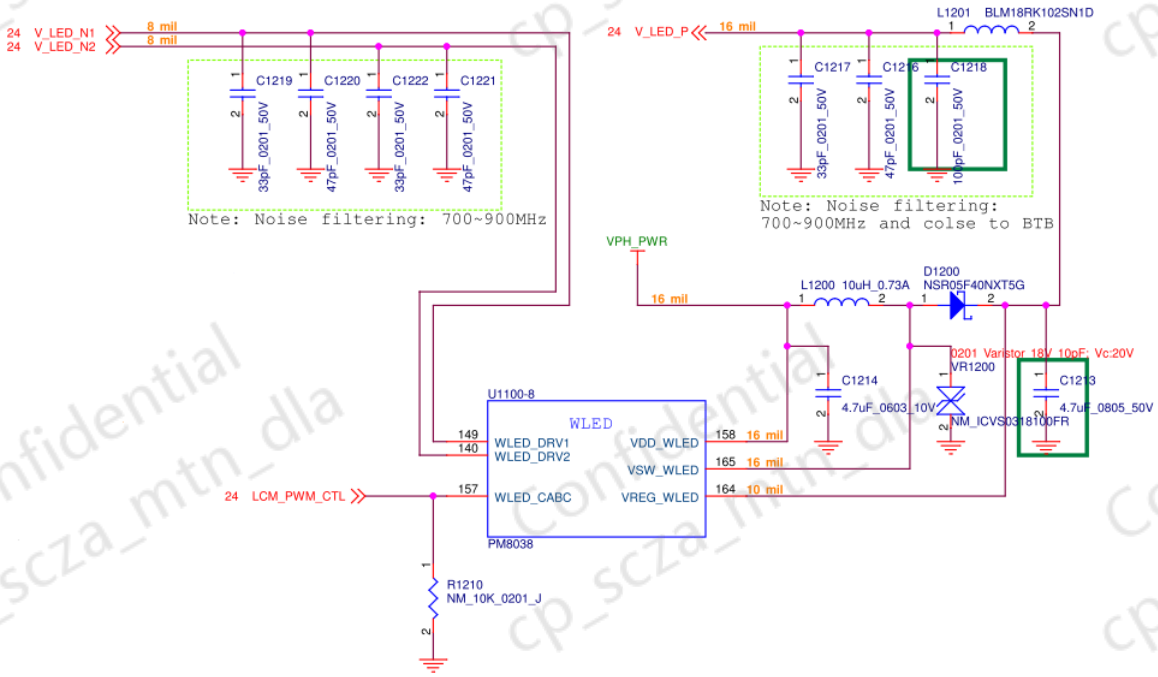


Figure 45 Illumination diagram

Keypad interface

The phone HW supports standard 3 x Windows Phone 8 keypad, side keys (Volume up/down keys, Power/ Lock key and bi-functional Camera key for half and full key press detection), and Back, Home and Search touch keys on the front.

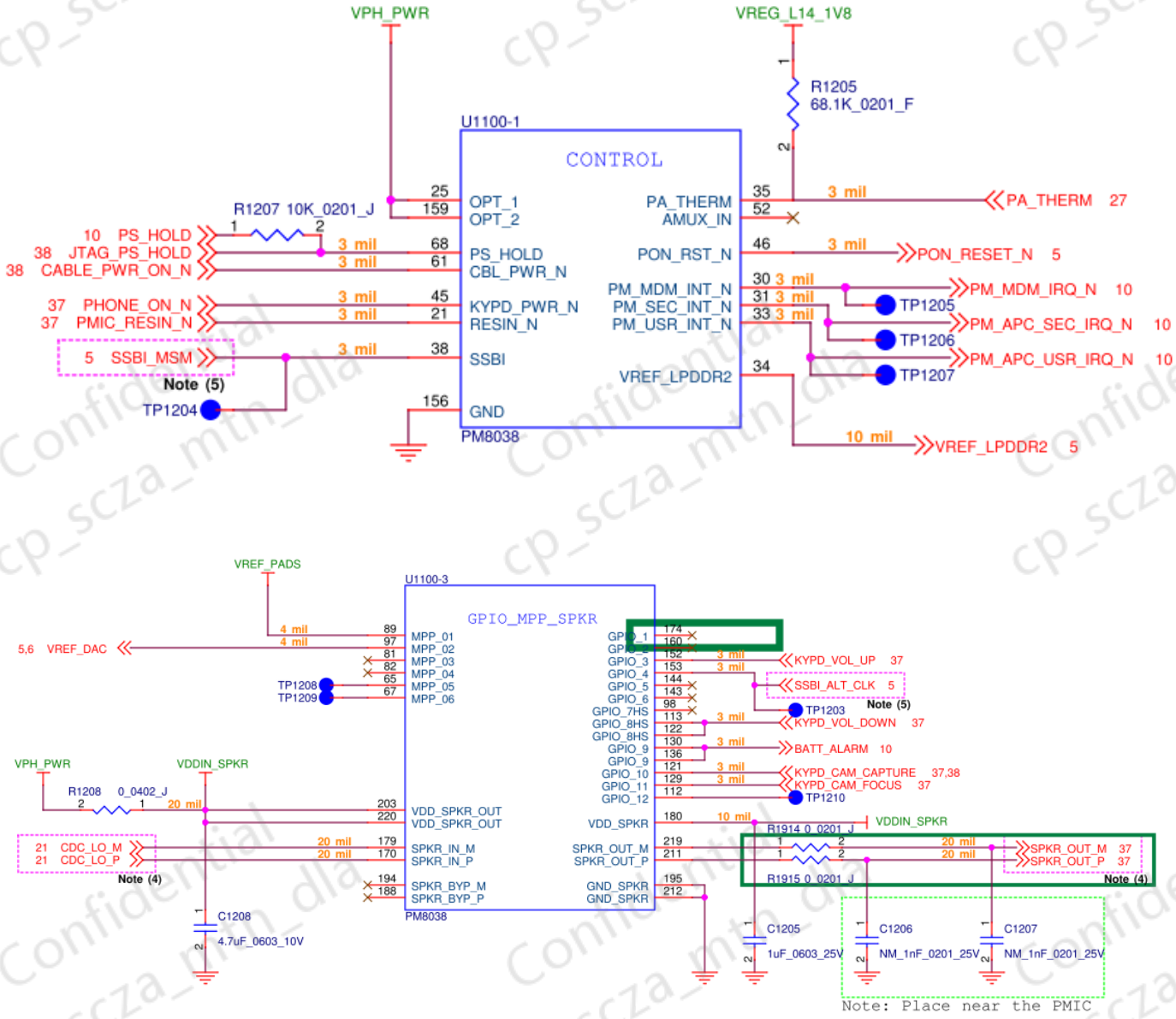


Figure 46 Keypad diagram

Accelerometer

Accelerometer is a geometric type component which is used for example to determine the device orientation. Accelerometer measures acceleration along three axes (x, y, z) and can be configured either to generate an inertial wake-up interrupt signal when a programmable acceleration threshold is exceeded along one of the three axes (x, y, and z), or to detect a free-fall event. Each axis has its own sensor and those can measure positive and negative directions.

The 3D accelerometer (U3600) sensor is connected to MSM via two GPIOS (44 and 45) and the I2C bus. Power is provided from VREG _LVS2 (1.8V) and VREG_L9 (2.85V) from the PMIC.

It has the following features:

- 1.8V compatible IOs
- Low power consumption
- ±2g/±4g/±6g/±8g dynamically selectable scale
- I2C/SPI digital output interface
- Embedded self-test
- 10000g high shock survivability
- Pb free/RoHS compliancy

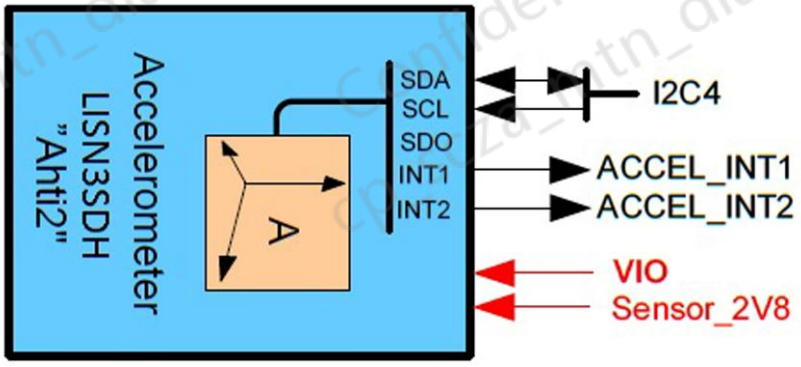


Figure 47 Accelerometer

Magnetometer

Compass is 3-axis electronic compass IC with high sensitive Hall sensor technology. Incorporates magnetic sensors for detecting terrestrial magnetism in the X-axis, Y-axis, and Z-axis, It is suitable for map heading up purpose in GPS-equipped cell phone to realize pedestrian navigation function.

The E-compass (U3602) sensor is connected to MSM via two GPIOS (44 and 45) and the I2C bus. Power is provided from VREG _LVS2 (1.8V) and VREG_L9 (2.85V) from the PMIC.

It has the following features:

- 3-axis magnetometer device suitable for compass application
- Built-in A to D Converter for magnetometer data out
- Sensitivity: 14-bit 0.6 µT/LSB (typ.)
- Measurement range : ±4900 µT
- I2C bus interface compliant with Philips I2C specification Ver.2.1
- Average current consumption at 100 Hz repetition rate: 2.4 mA (typ.)
- Power-down: 3 µA (typ.)

Audio concept

Audio HW architecture

BoostMono (U2100) along with Audio IC WCD9304 provides the analogue audio output interfaces and MSM8930 provides the digital audio output interface support.

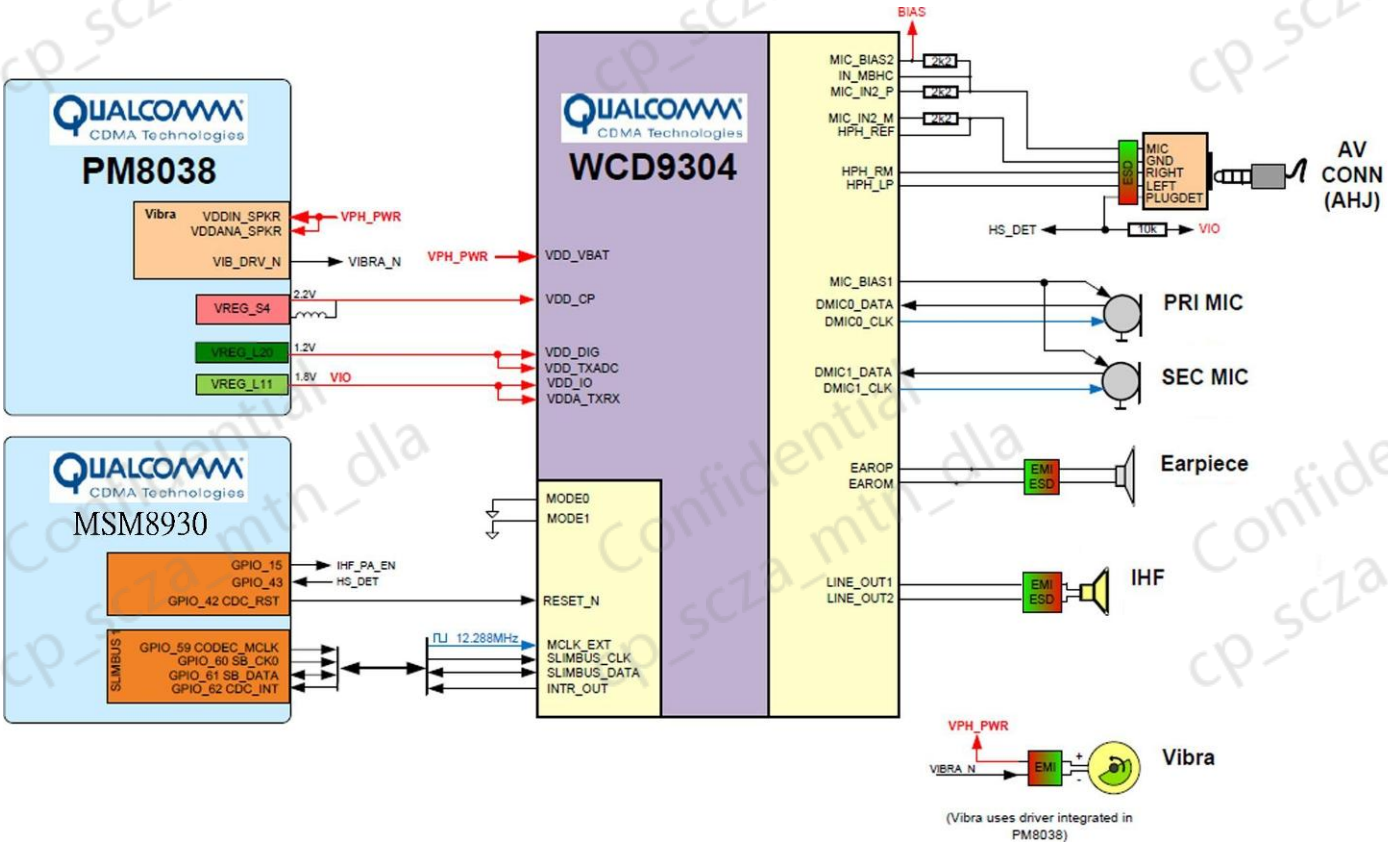


Figure 48 Audio system and AV connector block diagram

Internal earpiece

The internal earpiece used is Goertek and is directly connected to EAR_OP/EAR_OM interface of the WCD9304 Codec.

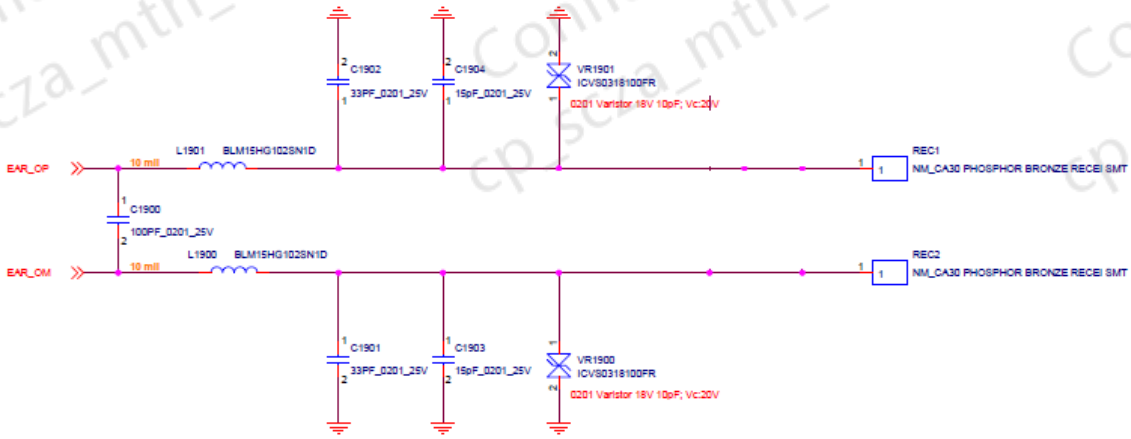


Figure 49 Internal earpiece diagram

Internal handsfree (IHF) speaker

IHF speaker used is AAC and is connected to PMIC spkr_out. PMIC spkr_in differential audio inputs are connected to WCD9304 Line_out1 and Line_out2.

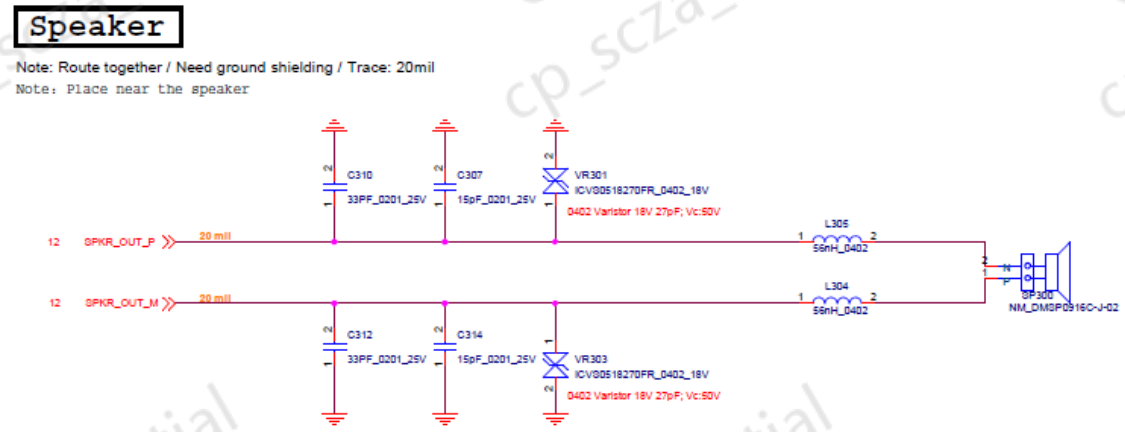


Figure 50 Internal handsfree (IHF) speaker diagram

Internal microphones

Goertek microphones are used as internal microphones. The digital microphones are connected to WCD9304 Codec.

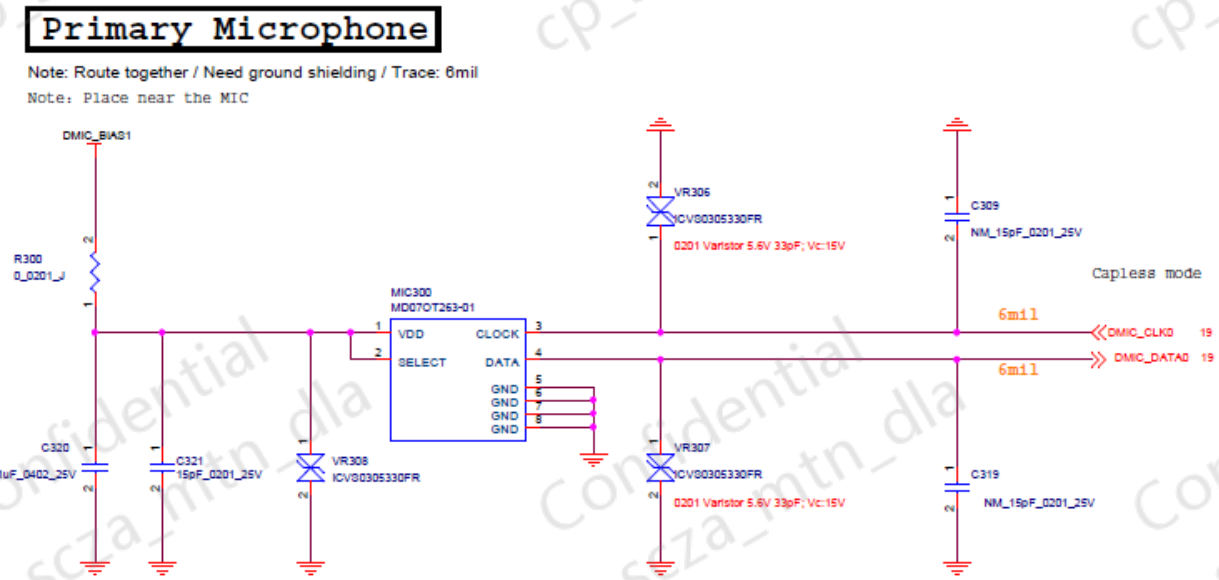


Figure 51 Internal microphones diagram

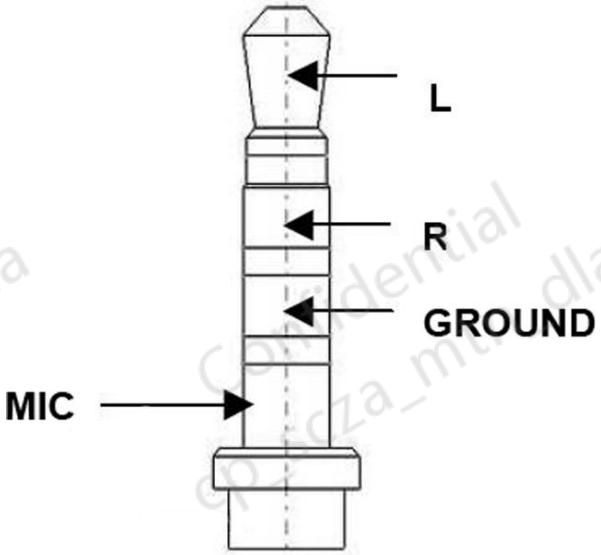
External earpiece and microphone

The AHJ headset earpiece is connected to WCD9304 (U2100) which is used for high quality audio output and to guarantee long playback time for accessory use.

AHJ connector

The AHJ connector handles both audio and video signals output. It has audio left and right signals separately

(Pins 5 and 3) and the microphone signal wired to pin 1.



Pole positions:

Figure 52 AHJ connector pole positions

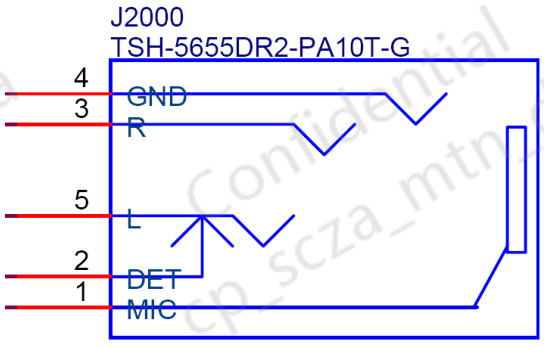


Figure 53 AHJ connector diagram

The plug detection signal handles the AHJ connector plug detection with HSJ_DET signal from MSM8930/ 8230 at GPIO_37.

Vibra

Vibra is connected to VIB_DRV_N pin of the PMIC.

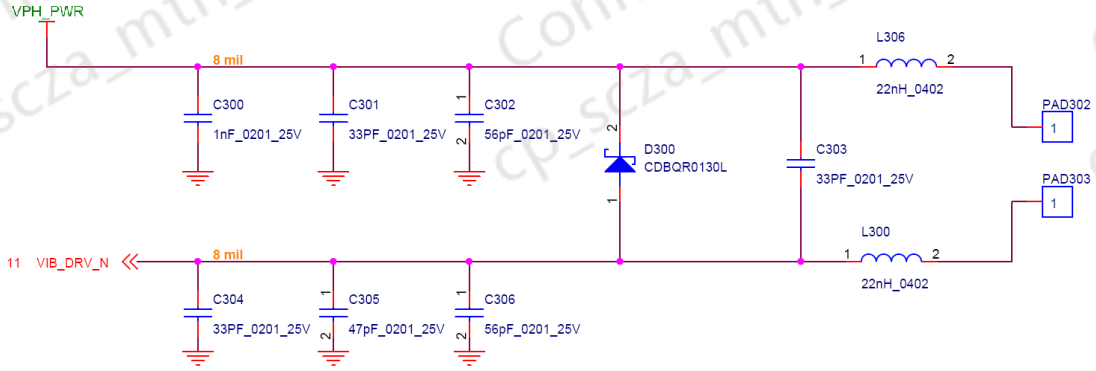


Figure 54 Vibra diagram

■ Cellular RF technical description

The WTR1605L transceiver unit could support GSM/EGPRS/WCDMA/HSPA+/LTE

Receiver (RX)

An analogue signal is received by phone's antenna. The signal is converted to a digital signal and then transferred further to the baseband (e.g. to the earpiece).

The receiver functions are implemented in the WTR1605L RF block. Signals at different frequencies goes different path, and are therefore is processed by different components.

Transmitter (TX)

The digital baseband signal (e.g. from the microphone) is converted to an analogue signal, which is then amplified by amplifier and transmitted from the antenna. The frequency of this signal can be tuned to match the bandwidth of the system in use (e.g. WCDMA Band1 band).

The transmitter functions are implemented in the WTR1605L RF block. Even though WCDMA Band1 signals are sent via different components, the principles of the transmission are the same.

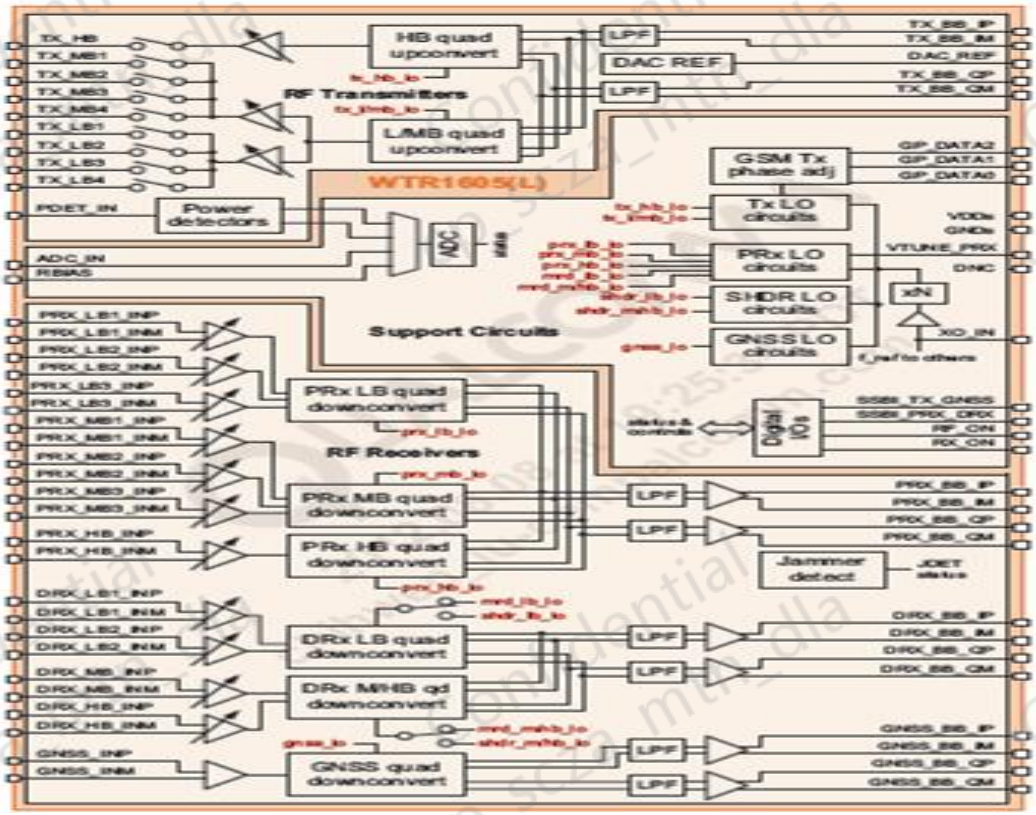


Figure 55 WTR1605(L) System Module

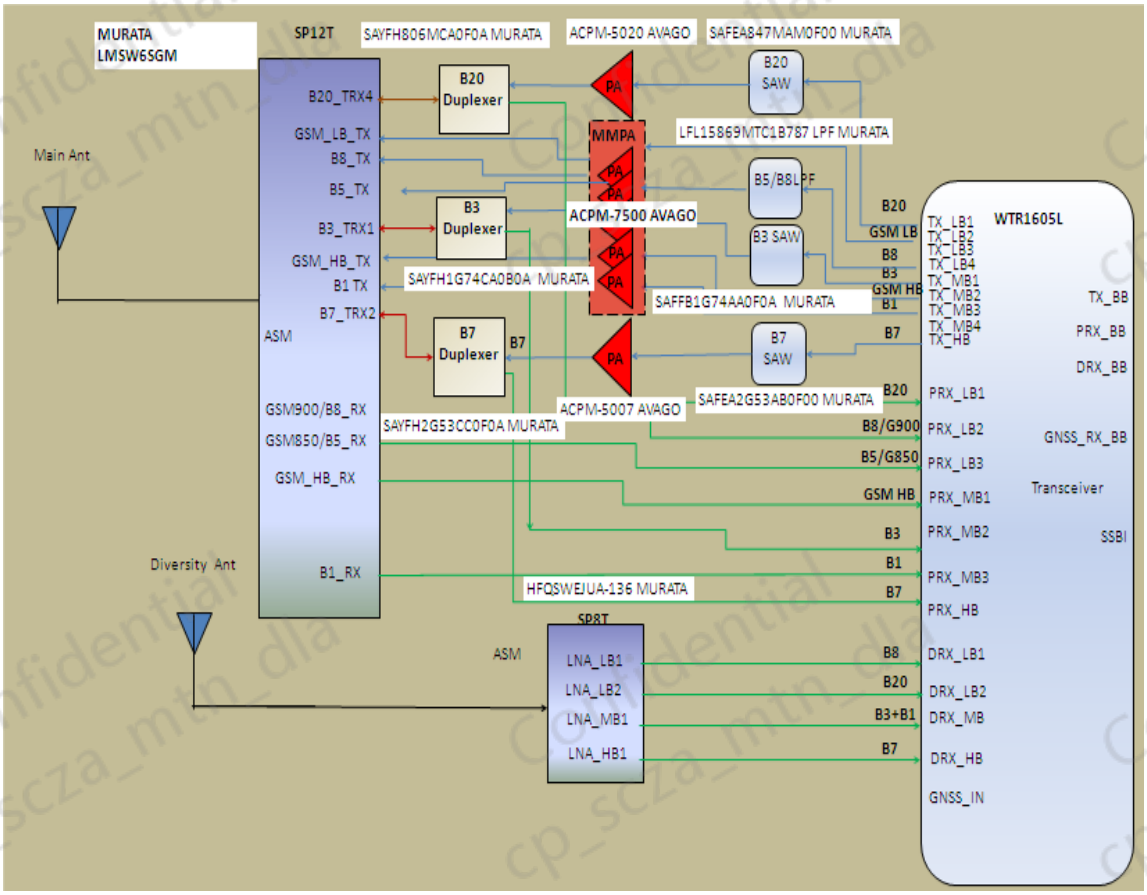


Figure 56 RF block diagram

Frequency mappings

GSM850 frequencies

Channel	TX Freq (MHz)	RX Freq (MHz)	TX VCO Freq (MHz)	RX VCO Freq (MHz)
128	824.2	869.2	3296.8	3476.8
190	836.6	881.6	3346.4	3526.4
251	848.8	893.8	3395.2	3575.2

GSM900 frequencies

Channel	TX Freq (MHz)	RX Freq (MHz)	TX VCO Freq (MHz)	RX VCO Freq (MHz)
975	880.2	925.2	3520.8	3700.8
37	897.4	942.4	3589.6	3769.6
124	914.8	959.8	3659.2	3839.2

GSM1800 frequencies

Channel	TX Freq (MHz)	RX Freq (MHz)	TX VCO Freq (MHz)	RX VCO Freq (MHz)
512	1710.2	1805.2	3420.4	3610.4
700	1747.8	1842.8	3495.6	3685.6
885	1784.8	1879.8	3569.6	3759.6

GSM1900 frequencies

Channel	TX Freq (MHz)	RX Freq (MHz)	TX VCO Freq (MHz)	RX VCO Freq (MHz)
512	1850.2	1930.2	3700.4	3860.4
661	1880.0	1960.0	3760.0	3920.0
810	1909.8	1989.8	3819.6	3979.6

WCDMA I (2100) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
9612	1922.4	3844.8	10562	2112.4	4224.8
9740	1948.0	3896.0	10700	2140.0	4280.0
9888	1977.6	3955.2	10838	2167.6	4335.2

WCDMA II (1900) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
9262	1852.4	7409.6	9662	1932.4	7729.6
9400	1880	7520	9800	1960	7840
9538	1907.6	7630.4	9938	1987.6	7950.4

WCDMA IV (1700) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
1312	1712.4	6849.6	1537	2112.4	8449.6
1413	1732.6	6930.4	1638	2132.6	8530.4
1513	1752.6	7010.4	1738	2152.6	8610.4

WCDMA V (850) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
4132	826.4	3305.6	4357	871.4	3485.6
4183	836.6	3346.6	4408	881.6	3626.4
4233	846.6	3386.4	4458	891.6	3566.4

WCDMA VIII (900) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
2712	882.4	3529.6	2937	927.4	3709.6
2788	897.6	3590.4	3013	942.6	3770.4
2863	912.6	3650.4	3088	957.6	3830.4

LTE II (1900) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
18650	1855	7420	650	1935	7740
18900	1880	7520	900	1960	7840
19150	1905	7620	1150	1985	7940

LTE III (1700) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
19350	1715	6860	1250	1810	7240
19575	1747.5	6990	1575	1842.5	7370
19900	1780	7120	1900	1875	7500

LTE IV (1700) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20000	1715	6860	2000	2115	8460
20175	1732.5	6930	2175	2132.5	8530
20350	1750	7000	2350	2150	8600

LTE V (850) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20450	829	3316	2450	874	3500
20525	836.5	3346	2525	881.5	3526
20600	844	3376	2600	889	3556

LTE VII (2500) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20800	2505	10020	2800	2625	10500
21100	2535	10140	3100	2655	10620
21400	2565	10260	3400	2685	10740

LTE XVII (700) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
23780	709	2836	5780	739	2956
23790	710	2840	5790	740	2960
23800	711	2844	5800	741	2964

LTE XX (800) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
24200	837	3348	6200	796	3184
24300	847	3388	6300	806	3224
24400	857	3428	6400	816	3264

Glossary

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A/D-converter	Analogue-to-digital converter
ACI	Accessory Control Interface
ADC	Analogue-to-digital converter
ADSP	Application DPS (expected to run high level tasks)
AGC	Automatic gain control (maintains volume)
ALS	Ambient light sensor
AMSL	After Market Service Leader
ARM	Advanced RISC Machines
ARPU	Average revenue per user (per month or per year)
ASIC	Application Specific Integrated Circuit
ASIP	Application Specific Interface Protector
B2B	Board to board, connector between PWB and UI board
BA	Board Assembly
BB	Baseband
BC02	Bluetooth module made by CSR
BIQUAD	Bi-quadratic (type of filter function)
BSI	Battery Size Indicator
BT	Bluetooth
CBus	MCU controlled serial bus connected to UPP_WD2, UEME and Zocus
CCP	Compact Camera Port
CDMA	Code division multiple access
CDSP	Cellular DSP (expected to run at low levels)
CLDC	Connected limited device configuration
CMOS	Complimentary metal-oxide semiconductor circuit (low power consumption)
COF	Chip on Foil
COG	Chip on Glass
CPU	Central Processing Unit
CSD	Circuit-switched data

CSR	Cambridge silicon radio
CSTN	Colour Super Twisted Nematic
CTSI	Clock Timing Sleep and interrupt block of Tiku
CW	Continuous wave
D/A-converter	Digital-to-analogue converter
DAC	Digital-to-analogue converter
DBI	Digital Battery Interface
DBus	DSP controlled serial bus connected between UPP_WD2 and Helgo
DCT-4	Digital Core Technology
DMA	Direct memory access
DP	Data Package
DPLL	Digital Phase Locked Loop
DSP	Digital Signal Processor
DTM	Dual Transfer Mode
DtoS	Differential to Single ended
EDGE	Enhanced data rates for global/GSM evolution
EGSM	Extended GSM
EM	Energy management
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
FCI	Functional cover interface
FM	Frequency Modulation
FPS	Flash Programming Tool
FR	Full rate
FSTN	Film compensated super twisted nematic
GMSK	Gaussian Minimum Shift Keying
GND	Ground, conductive mass

GPIB	General-purpose interface bus
GPRS	General Packet Radio Service
GSM	Group Special Mobile/Global System for Mobile communication
HSDPA	High-speed downlink packet access
HF	Hands free
HFCM	Handsfree Common
HS	Handset
HSCSD	High speed circuit switched data (data transmission connection faster than GSM)
HW	Hardware
I/O	Input/Output
IBAT	Battery current
IC	Integrated circuit
ICHAR	Charger current
IF	Interface
IHF	Integrated hands free
IMEI	International Mobile Equipment Identity
IR	Infrared
IrDA	Infrared Data Association
ISA	Intelligent software architecture
JPEG/JPG	Joint Photographic Experts Group
LCD	Liquid Crystal Display
LDO	Low Drop Out
LED	Light-emitting diode
LPRF	Low Power Radio Frequency
MCU	Micro Controller Unit (microprocessor)
MCU	Multiport control unit
MIC, mic	Microphone
MIDP	Mobile Information Device Profile

MIN	Mobile identification number
MIPS	Million instructions per second
MMC	Multimedia card
MMS	Multimedia messaging service
MP3	Compressed audio file format developed by Moving Picture Experts Group
MTP	Multipoint-to-point connection
NFC	Near field communication
NTC	Negative temperature coefficient, temperature sensitive resistor used as a temperature sensor
OMA	Object management architecture
OMAP	Operations, maintenance, and administration part
Opamp	Operational Amplifier
PA	Power amplifier
PCM	Pulse Code Modulation
PDA	Pocket Data Application
PDA	Personal digital assistant
PDRAM	Program/Data RAM (on chip in Tiku)
PIM	Personal Information Management
PLL	Phase locked loop
PM	(Phone) Permanent memory
PUP	General Purpose IO (PIO), USARTS and Pulse Width Modulators
PURX	Power-up reset
PWB	Printed Wiring Board
PWM	Pulse width modulation
RC-filter	Resistance-Capacitance filter
RDS	Radio Data Service
RF	Radio Frequency
RF PopPort ™	Reduced function PopPort ™ interface
RFBUS	Serial control Bus For RF

RSK	Right Soft Key
RS-MMC	Reduced size Multimedia Card
RSS	Web content Syndication Format
RSSI	Receiving signal strength indicator
RST	Reset Switch
RTC	Real Time Clock (provides date and time)
RX	Radio Receiver
SARAM	Single Access RAM
SAW filter	Surface Acoustic Wave filter
SDRAM	Synchronous Dynamic Random Access Memory
SID	Security ID
SIM	Subscriber Identity Module
SMPS	Switched Mode Power Supply
SNR	Signal-to-noise ratio
SPR	Standard Product requirements
SRAM	Static random access memory
STI	Serial Trace Interface
SW	Software
SWIM	Subscriber/Wallet Identification Module
TCP/IP	Transmission control protocol/Internet protocol
TCXO	Temperature controlled Oscillator
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
Tiku	Finnish for Chip, Successor of the UPP
TX	Radio Transmitter
UART	Universal asynchronous receiver/transmitter
UEME	Universal Energy Management chip (Enhanced version)
UEMEK	See UEME
UI	User Interface

UPnP	Universal Plug and Play
UPP	Universal Phone Processor
UPP_WD2	Communicator version of DCT4 system ASIC
USB	Universal Serial Bus
VBAT	Battery voltage
VCHAR	Charger voltage
VCO	Voltage controlled oscillator
VCTCXO	Voltage Controlled Temperature Compensated Crystal Oscillator
VCXO	Voltage Controlled Crystal Oscillator
VF	View Finder
Vp-p	Peak-to-peak voltage
VSIM	SIM voltage
WAP	Wireless application protocol
WCDMA	Wideband code division multiple access
WD	Watchdog
WLAN	Wireless local area network
XHTML	Extensible hypertext markup language
Zocus	Current sensor (used to monitor the current flow to and from the battery)