Nokia Customer Care

Service Manual

RM-824; RM-825; RM-826 (Nokia Lumia 820; L3&4)

Mobile Terminal

Part No: (Issue 2)

NOKIA INTERNAL USE ONLY

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Care

Amendment Record Sheet

Amendment No	Date	Inserted By	Comments
Issue 1	10/2012	MT	
Issue 2	11/2012	MT	Section *Proximity sensor and ambient light sensor (ALS)* has been updated in the *BB Troubleshooting Guide* chapter. Chapter 8, titled *Service information differences between RM-826 and RM-824*, has been added to the manual. The new chapter describes the key hardware differences between the RM-826 and RM-824 variants of the Nokia Lumia 820.

Copyright

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 FITTED WITH 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 fulfil 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. Unauthorised 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 endeavour 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.

Please state:

- Title of the Document + Issue Number/Date of publication
- Latest Amendment Number (if applicable)
- 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 Li-Pol 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.

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Nokia Lumia 820; L3&4 Service Manual Structure

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3 BB Troubleshooting Guide
4 Cellular RF troubleshooting
5 Camera Module Troubleshooting
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1 — General Information

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Product selection

RM-825 is a GSM/WCDMA dual-mode handportable monoblock multimedia computer with a capacitive touch UI, integrated GPS (A-GPS OMA SUPL) and Glonass, WLAN and an internal FM radio. The device also supports Bluetooth 2.1 + EDR standard and Near Field Communication (NFC). RM-825 supports GSM 850/900/1800/1900, WCDMA I/II/V/VIII and LTE B1/B3/B7/B8/B20 bands, GPRS/EGPRS and WCDMA/HSDPA/HSUPA data bearers.

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-825 supports HSDPA + dual carrier category 24 with downlink peak data rate up to 42.1 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). RM-825 supports LTE category 3 with a maximum bit rate of up to 100 Mbit/s for downlink and up to 50 Mbit/s for uplink. The device also supports RX diversity.

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, RM-825 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 AMOLED 4.3" (800 x 480 pixels) ClearBlack WVGA touch display with 2D flat glass, 16 million colors and support for pinch zoom. It also has an 8 megapixel autofocus camera with Carl Zeiss optics, 3 x digital zoom and an integrated dual 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 RM-825

Product features and sales package

Imaging

Main camera:

- Sensor: 8 megapixel
- Carl Zeiss Optics: Tessar™ lens
- F number/Aperture: F2.2
- Digital zoom: 3x
- Auto focus: Two-stage capture key
- Focal length: 28 mm (35 mm equivalent)
- Focus range: 10 cm ~ infinity
- Flash: Integrated dual LED flash
- Macro focus distance: 10-50 cm

Secondary camera:

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

Video:

- Video resolution: Full HD 1080p video capture 30fps
- Audio recording: AAC (AMR for MMS)
- Video stabilization
- Video clip length: Max. 90 min
- Video file format: .mp4 H.264 (for lower fps)
- White balance: automatic, sunny, cloudy, incandescent, fluorescent
- Scene: automatic, night
- Zoom (digital): 3x
- Video recording indicator

Photo:

- Aspect ratio: 16:9 (7.1 Mpix), 4:3 (8 Mpix), 3:2 (7 Mpix)
- View finder: Full screen view finder
- Still image resolutions: up to 8 megapixel: 3248 x 2448
- Still image file format: JPEG/EXIF
- Auto focus
- Auto exposure: center weighted AE
- Image orientation: automatic
- Automatic red eye removal
- Exposure compensation: +2 ~ -2EV at 0.5 step
- White balance: automatic, sunny, cloudy, incandescent, fluorescent
- Scene: automatic, sports, portrait, close-up, landscape, night
- Zoom (digital): up to 3x

Edit

- On device Photo editor (manual & automatic)

View

- 4.3” ClearBlack AMOLED WVGA (800 x 480 pixels) color display, up to 16M colors, 16:9 aspect ratio
- Capacitive touch
- 2D flat 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 (WCDMA services)
- Online Album: Image/Video uploading from Pictures

Store

- 8 GB internal memory
- 1 GB SDRAM
- MicroSD card slot, support up to 32 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
- Synchronise music with Zune PC application
- Stereo FM radio (87.5-108 MHz /76-90 MHz)
- Bluetooth speakers
- Integrated handsfree speaker
- Nokia Music Headset (WH-208), inbox

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 Zune PC SW)
  - 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 dialling (with SIND) and voice commands

Connectivity

- Integrated GPS (A-GPS OMA SUPL) and Glonass
- WLAN - IEEE802.11 a/b/g/n with 2.4GHz and 5.0GHz
- Micro USB interface with USB 2.0 high speed
- Wireless charging with accessory battery cover
- Bluetooth wireless technology 2.1 + EDR
- Near Field Communication (NFC)
- 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
- 1.5 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 42.1 Mbit/s, HSUPA 5.76 Mbit/s
- LTE DL up to 100 Mbit/s, UL up to 50Mbit/s

Sales package

- Transceiver RM-825
- Battery (BP-5T)
- USB charger (AC-50)
- Music headset (WH-209)
- Connectivity cable (CA-190CD)
- Micro SIM card
- SIM door key
- Booklet (including quick guide and legal information)

Product and module list

Module name	Type code	Notes
System/RF module PWB	3VJ	
Sidekey flex	3WD	
AV flex	3WE	
LED flex	3WC	

Mobile enhancements

Table 1 Audio

Enhancement	Type
Music headsets	WH-209 (inbox)
Wireless music receiver	MD-20W
Mini speakers	MD-50W
Hearing aids	LPS-5
Wired headsets	WH-102
	WH-103
	WH-108
	WH-205
	WH-206
	WH-207
	WH-208
	WH-209
	WH-701
	WH-702
	WH-902
	WH-920
	WH-930

Enhancement	Type
Bluetooth headsets	BH-108
	BH-109
	BH-110
	BH-111
	BH-112
	BH-218
	BH-219
	BH-220
	BH-221
	BH-310
	BH-505
	BH-609
	BH-610
	BH-905i
	BH-907
	Nokia J (BH-806)

Table 2 Car

Enhancement	Type
Nokia Universal Mobile Holder	CR-114
	CR-115
	CR-123
Wireless plug-in car handsfree	HF-210
Car kit	CK-100
	CK-200
Display car kit	CK-600
Mobile charger	DC-11K
	DC-11K-B
	DC-16
	DC-20

Table 3 Data

Enhancement	Type
Connectivity cable	CA-146
	CA-157
	CA-159
	CA-167
	CA-179
	CA-185CD
	CA-189CD
	CA-190CD (inbox)
	CA-191C

Table 4 Power

Enhancement	Type
Battery 1650 mAh Li-Polymer	BP-5T
Travel charger	AC-16
	AC-20
	AC-50 (inbox)
	AC-50C
	AC-50U

Technical specifications

Transceiver general specifications

Unit	Dimensions (L x W x T) (mm)	Weight (g)	Volume (cm^3)
Transceiver with BP-5T 1650 mAh Li-Pol battery pack	124 x 68.5 x 10.7	158	82

Main RF characteristics for GSM850/900/1800/1900, WCDMA VIII/V/II/I and LTE B1/B3/B7/B8/B20 phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), WCDMA V (850), WCDMA II (1900), WCDMA I (2100), LTE B1 (2100), LTE B3 (1800), LTE B7 (2600), LTE B8 (900) and LTE B20 (800)

Parameter	Unit
Main antenna Rx frequency band	GSM850: 869 - 894MHz
	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 II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B1 (2100): 2110 - 2170 MHz
	LTE B3 (1800): 1805 - 1880 MHz
	LTE B7 (2600): 2620 - 2690 MHz
	LTE B8 (900): 925 - 960 MHz
	LTE B20 (800): 791 - 821 MHz
Diversity antenna Rx frequency band	WCDMA VIII (900): 925 - 960 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B1 (2100): 2110 - 2170 MHz
	LTE B3 (1800): 1805 - 1880 MHz
	LTE B7 (2600): 2620 - 2690 MHz
	LTE B8 (900): 925 - 960 MHz
	LTE B20 (800): 791 - 821 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 V (850): 824 - 849 MHz
	WCDMA II (1900): 1850 - 1910 MHz
	WCDMA I (2100): 1920 - 1980 MHz
	LTE B1 (2100): 1920 - 1980 MHz
	LTE B3 (1800): 1710 - 1785 MHz
	LTE B7 (2600): 2500 - 2570 MHz
	LTE B8 (900): 880 - 915 MHz
	LTE B20 (800): 832 - 862 MHz

Parameter	Unit
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 II (1900): -50 ... +23 dBm/0.01 µW ... 251 mW
	WCDMA I (2100): -50 ... +23 dBm/0.01 µW ... 251 mW
	LTE B1 (2100): -40 ...+23 dBm/0.1 uW ... 251 mW
	LTE B3 (1800): -40 ...+23 dBm/0.1 uW ... 251 mW
	LTE B7 (2600): -40 ...+23 dBm/0.1 uW ... 251 mW
	LTE B8 (900): -40 ...+23 dBm/0.1 uW ... 251 mW
	LTE B20 (800): -40 ...+23 dBm/0.1 uW ... 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 V (850): 108
	WCDMA II (1900): 289
	WCDMA I (2100): 277
	LTE B1 (2100): 600
	LTE B3 (1800): 750
	LTE B7 (2600): 700
	LTE B8 (900): 350
	LTE B20 (800): 300
Channel spacing	200 kHz (WCDMA II and V 100/200 kHz, and LTE 100 kHz)

Parameter	Unit
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA VIII (900): 75
	WCDMA V (850): 75
	WCDMA II (1900): 75
	WCDMA I (2100): 75
	LTE B1 (2100): 64
	LTE B3 (1800): 64
	LTE B7 (2600): 64
	LTE B8 (900): 64
	LTE B20 (800): 64

Battery endurance

Battery	Capacity (mAh)	Talk time	Stand-by	Music playback	Video playback H.264 720p 30fps
BP-5T	1650	up to 7.9 h (GSM) up to 8.5 h (WCDMA)	up to 464 h (WCDMA)	up to 78 h	up to 6.5 h

Environmental conditions

Temperature conditions

Environmental condition	Ambient temperature	Notes
Normal operation	-10°C...+55°C	Specifications fulfilled
Reduced performance	-25°C...-15°C +55°C...+70°C	Operational for shorts periods only
Intermittent operation	-40°C...-15°C +70°C...+85 °C	Operation not guaranteed but an attempt to operate does not damage the phone.
No operation or storage	<-40°C...>+85°C	No storage or operation: an attempt may damage the phone.
Charging allowed	-10°C...+60°C	BTemp measurement range for charging.
Long term storage conditions	0°C...+85°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:

- 5 - 10 Hz; +10dB / octave
- 10 - 50 Hz; 5.58 m^2 / s^3 (0.0558 g^2/ Hz)
- 50 - 300 Hz; - 10 dB / octave

ESD strength

Conducted discharge is 8 kV (>10 discharges) and air contact 15 kV (>10 discharges).

The standard for electrostatic discharge is IEC 61000-4-2, and this device fulfils 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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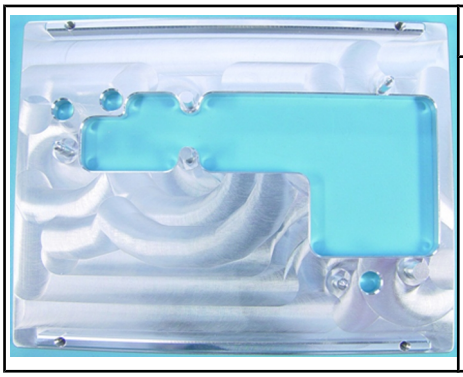
Service tools

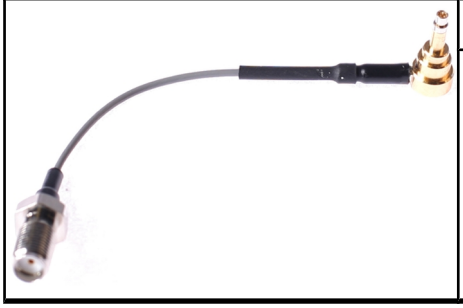
Product specific tools

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-824; RM-825; RM-826. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

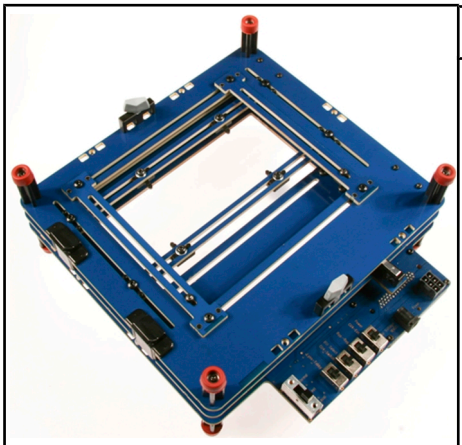
	SS-293	RF guiding plate	0781542
	SS-293 is an RF guiding plate used with MJ-305 module jig.		

General tools

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-824; RM-825; RM-826. 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-microUSB data cable that allows connections between the PC and the phone.		
	CA-158RS	RF tuning cable	0730390
	Product-specific adapter cable for RF testing.		

CA-205PS	Power cable	0730487
The CA-205PS power cable is used with MJ-305 module jig to supply a controlled voltage.		



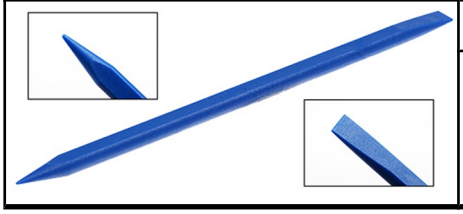
MJ-305	Module jig	0781487

Module jig MJ-305 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-interfaces 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-293 RF guiding plate is required with this jig
- CA-205PS power cable is used with this jig
- CA-158RS cable is used together with this jig for RF testing
-

Attenuation values for CA-158RS cable				
Band	**Default f/ MHz RX**	**Att. RX**	**Default f/ MHz TX**	**Att. TX**
GSM 850	881.6	-0.2	836.6	-0.2
GSM 900	942.4	-0.2	897.4	-0.2
GSM 1800	1842.8	-0.3	1747.8	-0.3
GSM 1900	1960.0	-0.3	1880.0	-0.3
WCDMA I / LTE B1	2140.0	-0.4	1950.0	-0.3
WCDMA II	1960.0	-0.3	1880.0	-0.3
LTE B3	1842.5	-0.3	1747.5	-0.3
WCDMA V	880.0	-0.2	835.0	-0.2
LTE B7	2655.0	-0.4	2535.0	-0.4
WCDMA VIII / LTE B8	942.6	-0.2	897.6	-0.2
LTE B20	806.0	-0.2	847.0	-0.2
WLAN	n/a	n/a	2442.0	-0.4

	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.		
	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 STR-6 is included in the Nokia Standard Toolkit.		
	SS-210	Camera removal tool	0781189
	The camera removal tool SS-210 is used to remove/attach the camera module from/to the socket.		
	SS-93	Opening tool	0780727
	SS-93 is used for opening JAE connectors. **Note:** The SS-93 is included in the Nokia Standard Toolkit.		

	SX-4T	Smart card	
	SX-4T is a security device used to protect critical features in tuning and testing as well as SIM lock opening.		
	XRS-6	RF cable	0730231
	The RF cable is used to connect, for example, a module repair jig to the RF measurement equipment. SMA to N-Connector approximately 610 mm. Attenuation for: • GSM850/900: 0.3+-0.1 dB • GSM1800/1900: 0.5+-0.1 dB • WCDMA V/VIII: 0.3+-0.1dB • WCDMA I/II: 0.5+-0.1dB • LTE B1/B3: 0.5+-0.1dB • LTE B7: 0.6+-0.1dB • LTE B8/20: 0.3+-0.1dB • BT/WLAN: 0.5+-0.1dB		

Service concepts

POS (Point of Sale) flash concept

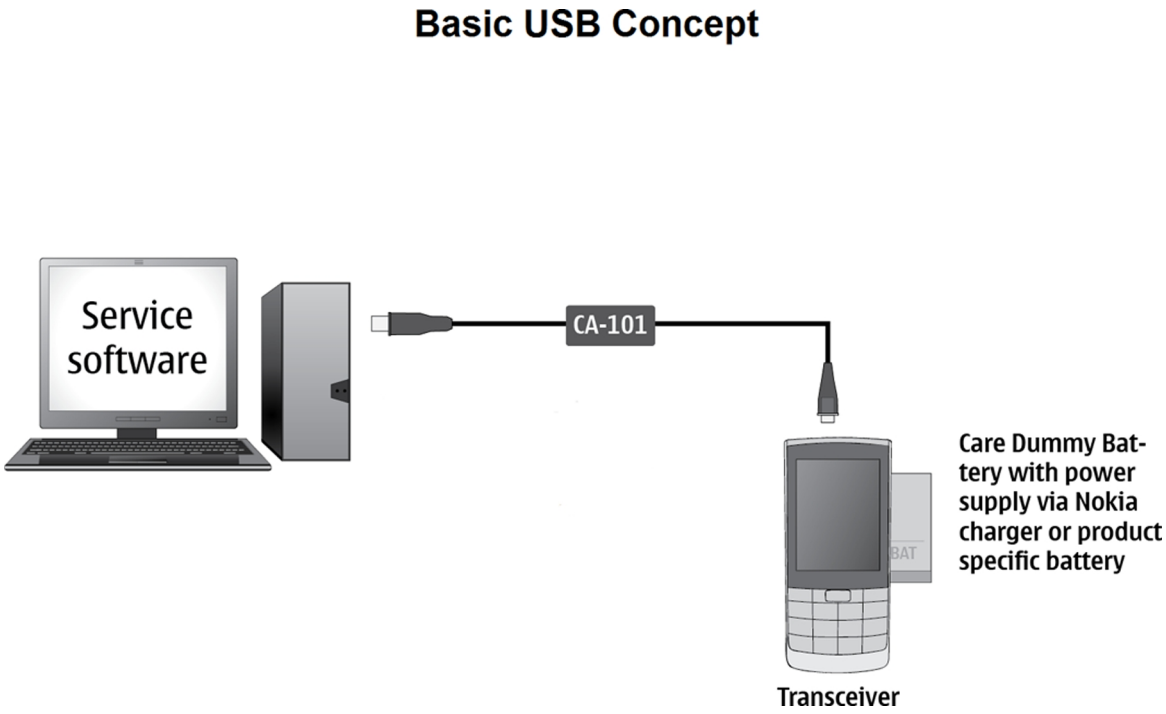


Figure 2 POS flash concept

Type	Description
Product specific tools	
BP-5T	Battery
Other tools	
	PC with service software
Cables	
CA-101	Micro USB cable

Concept for flashing and product code change

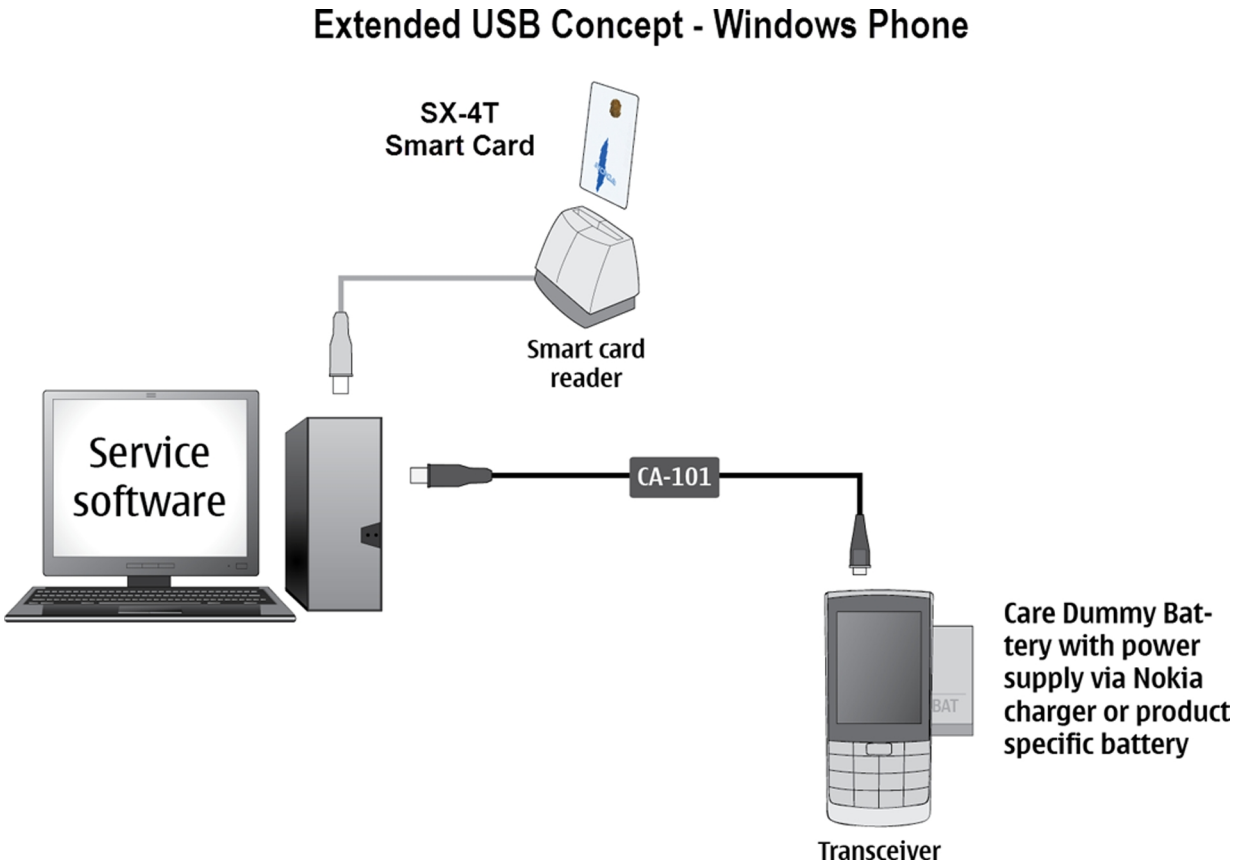


Figure 3 BE concept for flashing, certificate restore and product code change

Type	Description
Product specific devices	
BP-5T	Battery
Other devices	
SX-4T	Smart card
	PC with service software
	Smart card reader
Cables	

Type	Description
CA-101	Micro USB cable

USB flash concept with MJ-305

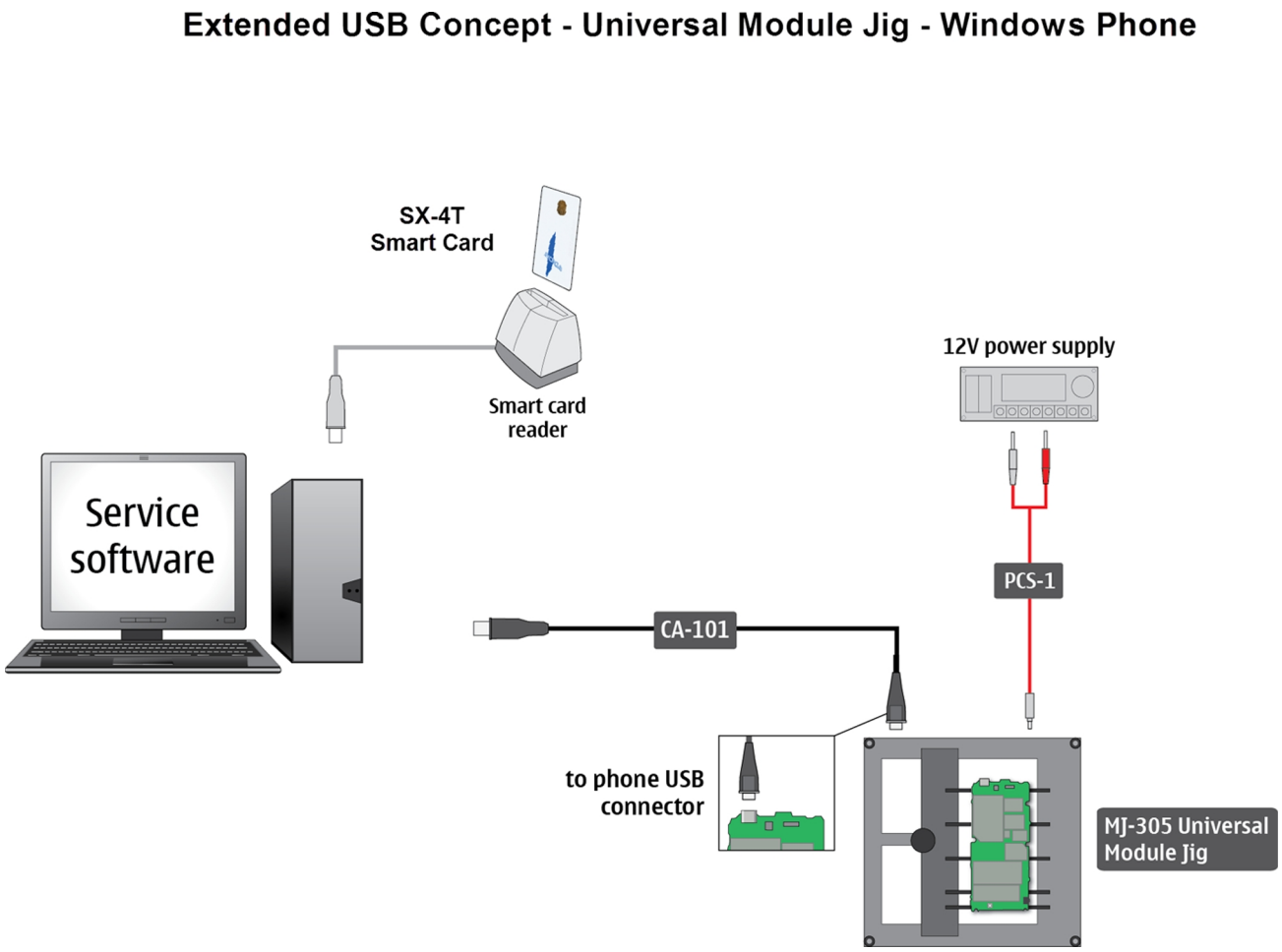
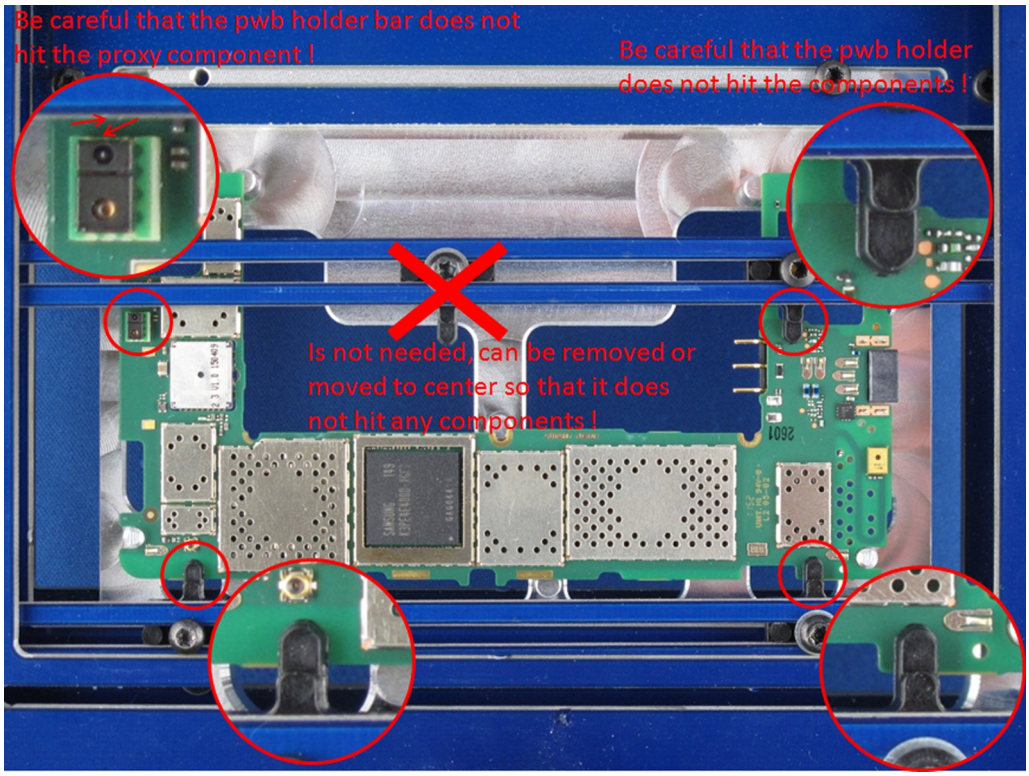


Figure 4 USB flash concept with MJ-305

Type	Description
Product specific tools	
MJ-305	Module jig
SS-293	RF guiding plate
Other tools	
SX-4T	Smart card
	PC with service software
	Smart card reader
Cables	
CA-101	Micro USB cable
PCS-1	Power cable

Type	Description
CA-205PS	Power cable

MJ-305 and SS-293 RF guiding plate assembly instructions



3 — BB Troubleshooting Guide

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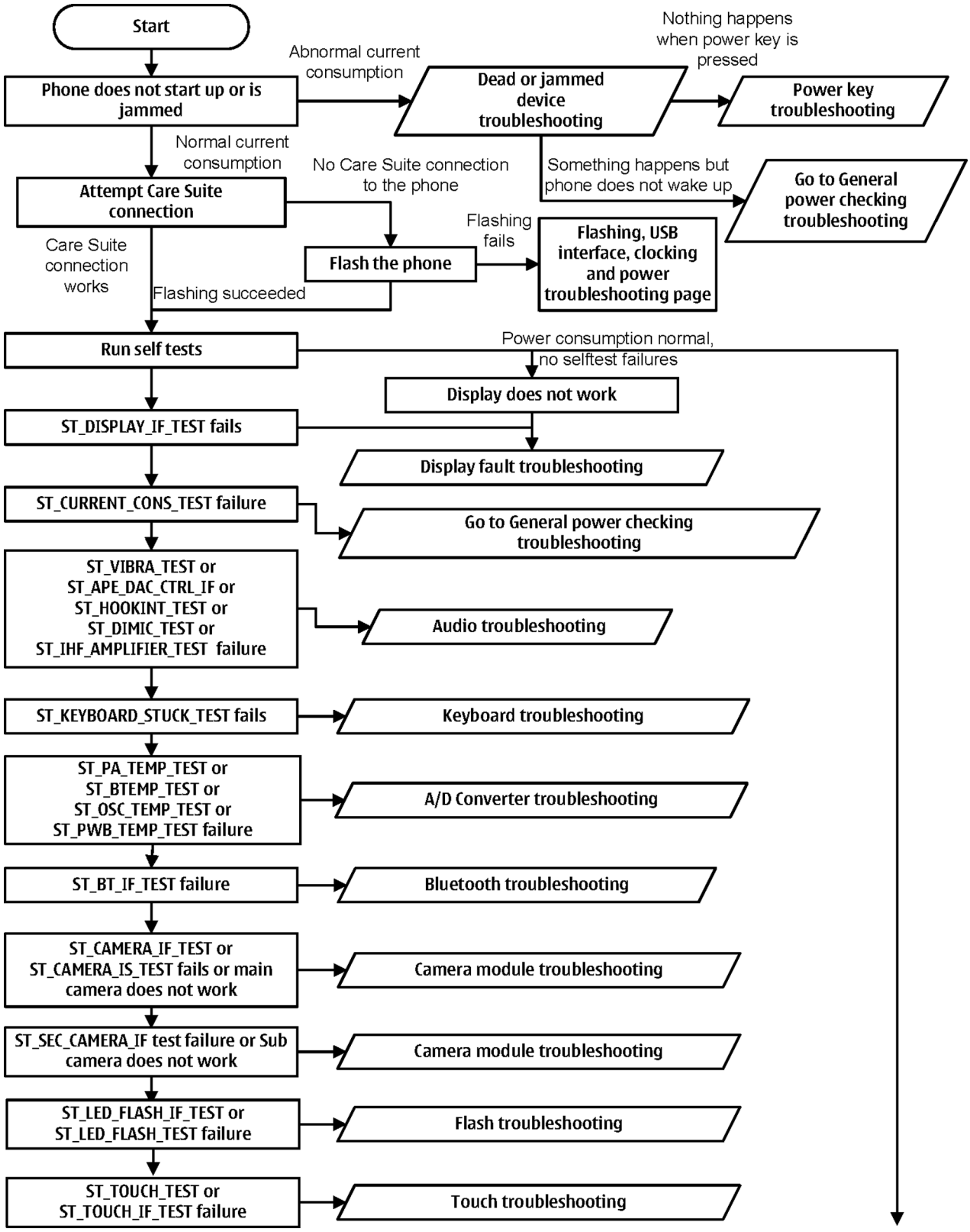
Baseband main troubleshooting

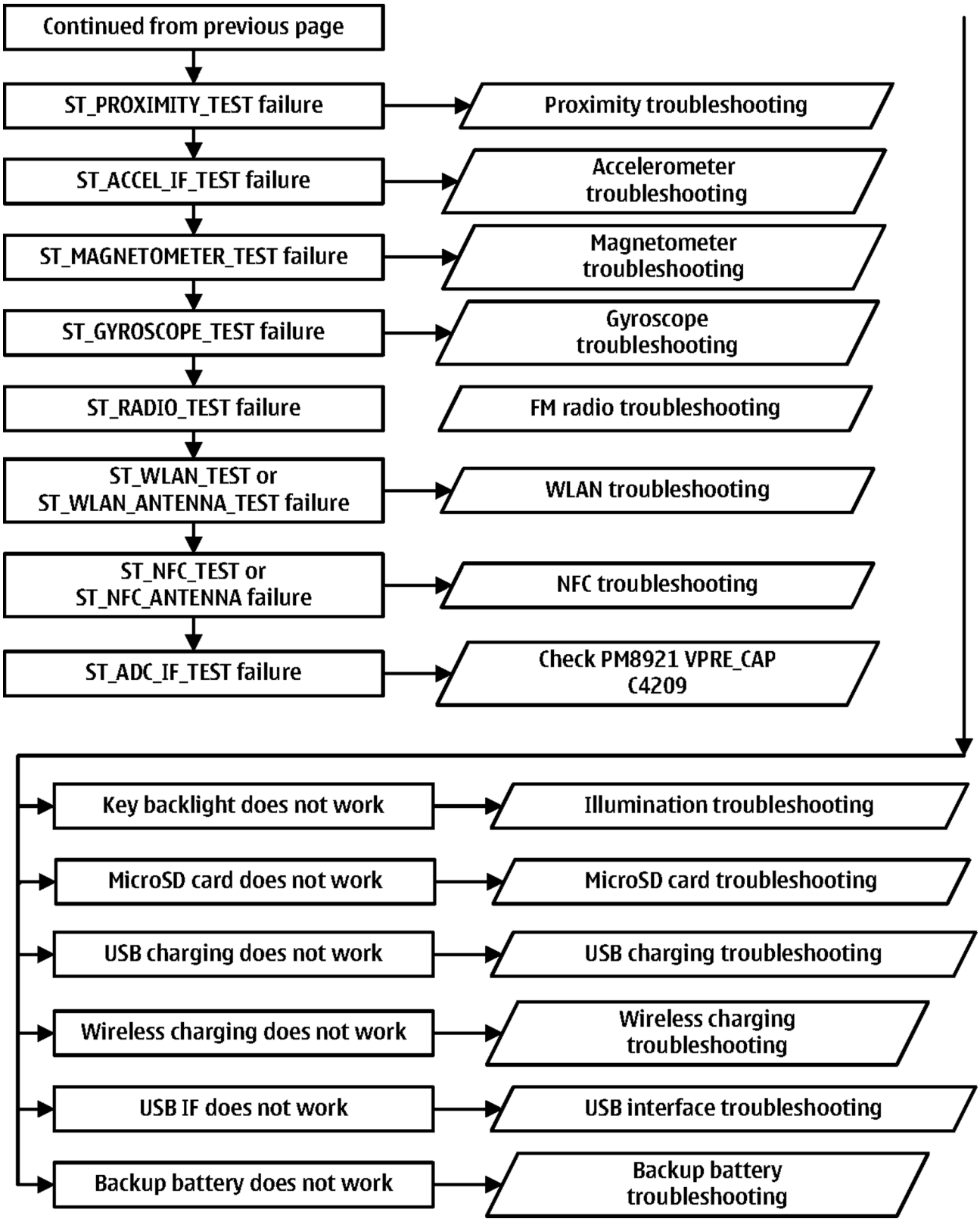
Context

Always start the troubleshooting procedure by running the Nokia Care Suite self tests. If a test fails, please follow the diagrams below. If the phone is dead and you cannot perform the self tests, go to *Dead or jammed device troubleshooting*.

Troubleshooting flow - Page 1 of 2



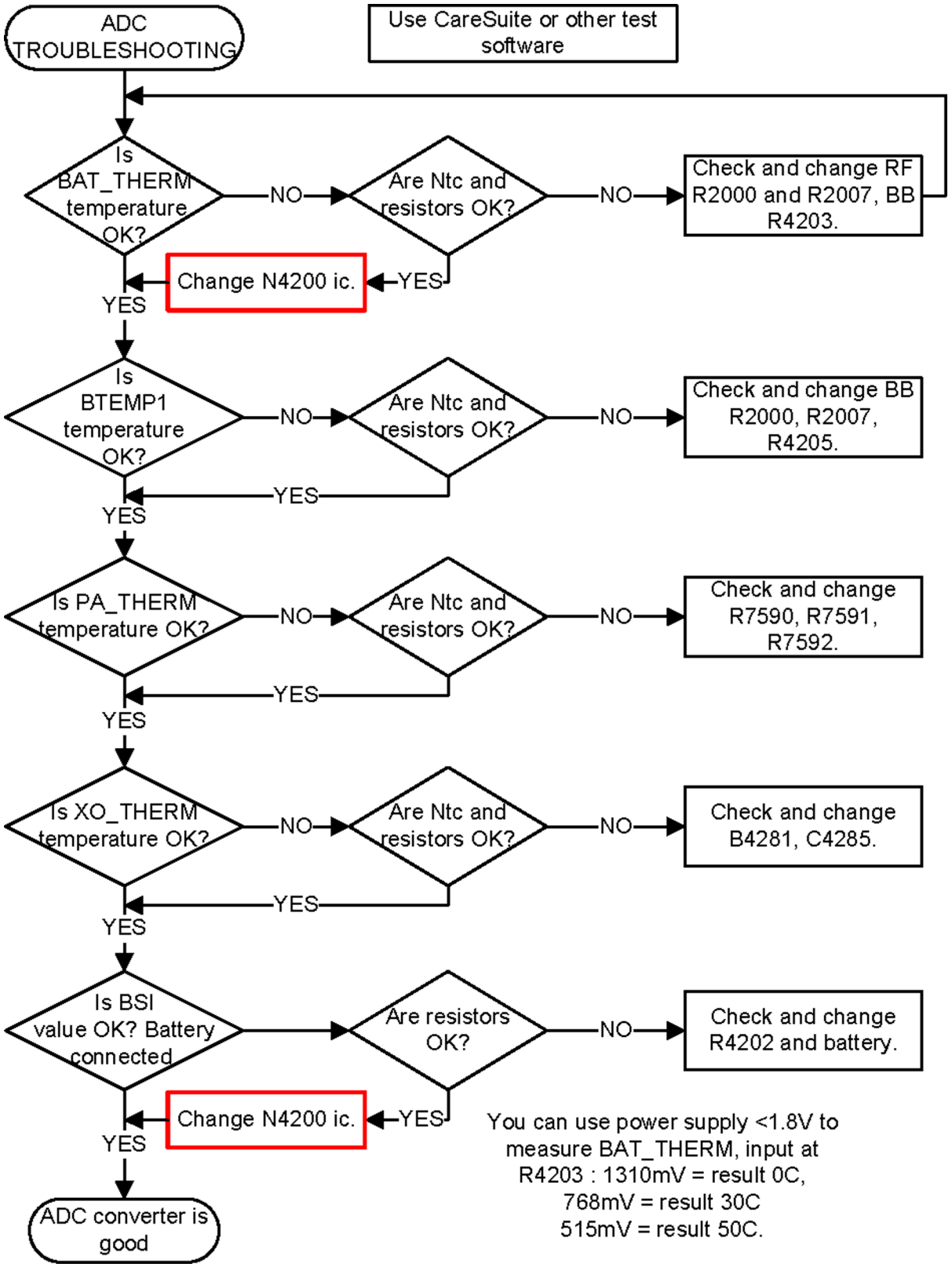
Troubleshooting flow - Page 2 of 2



Power and charging troubleshooting

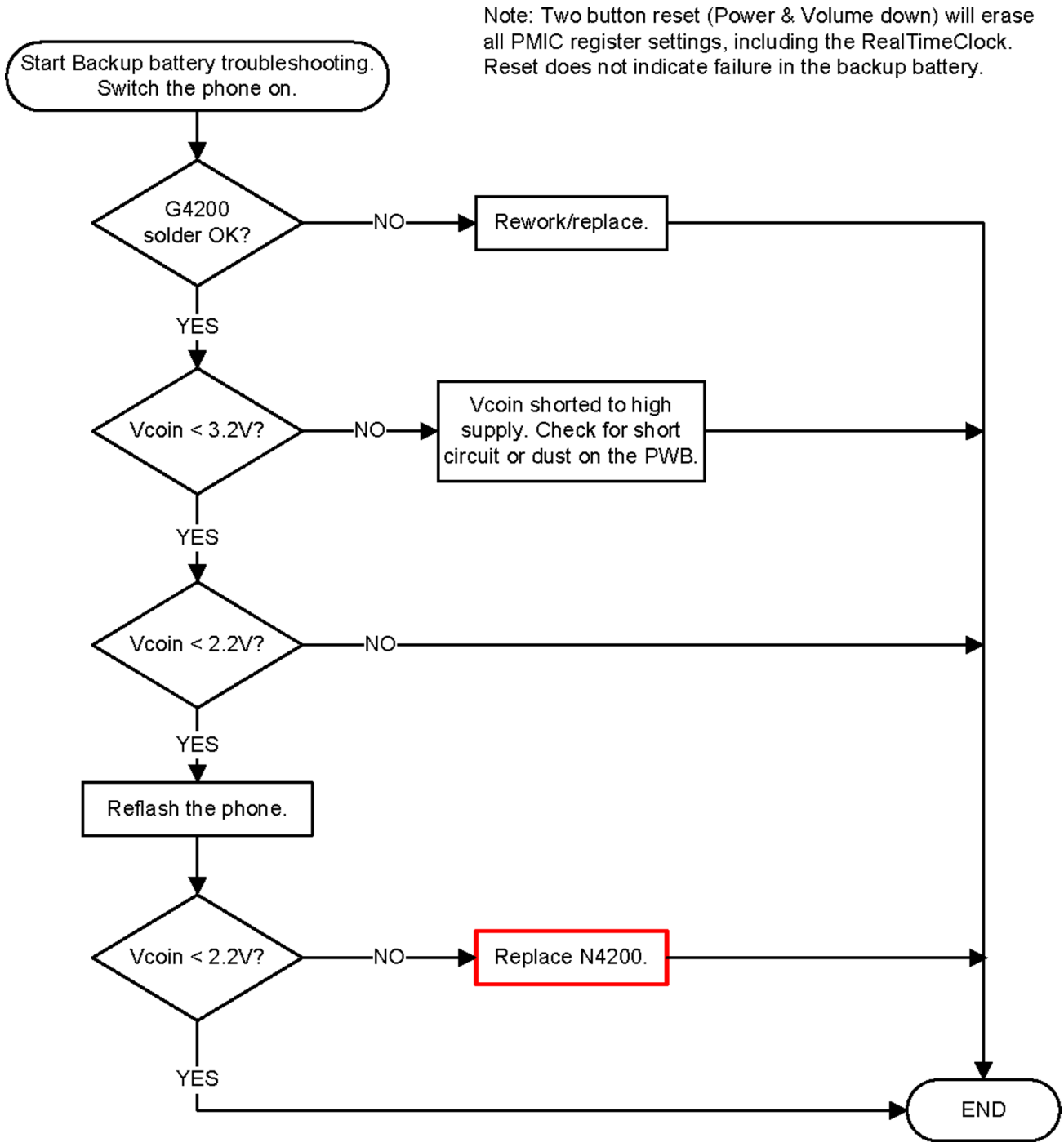
A/D converter troubleshooting

Troubleshooting flow



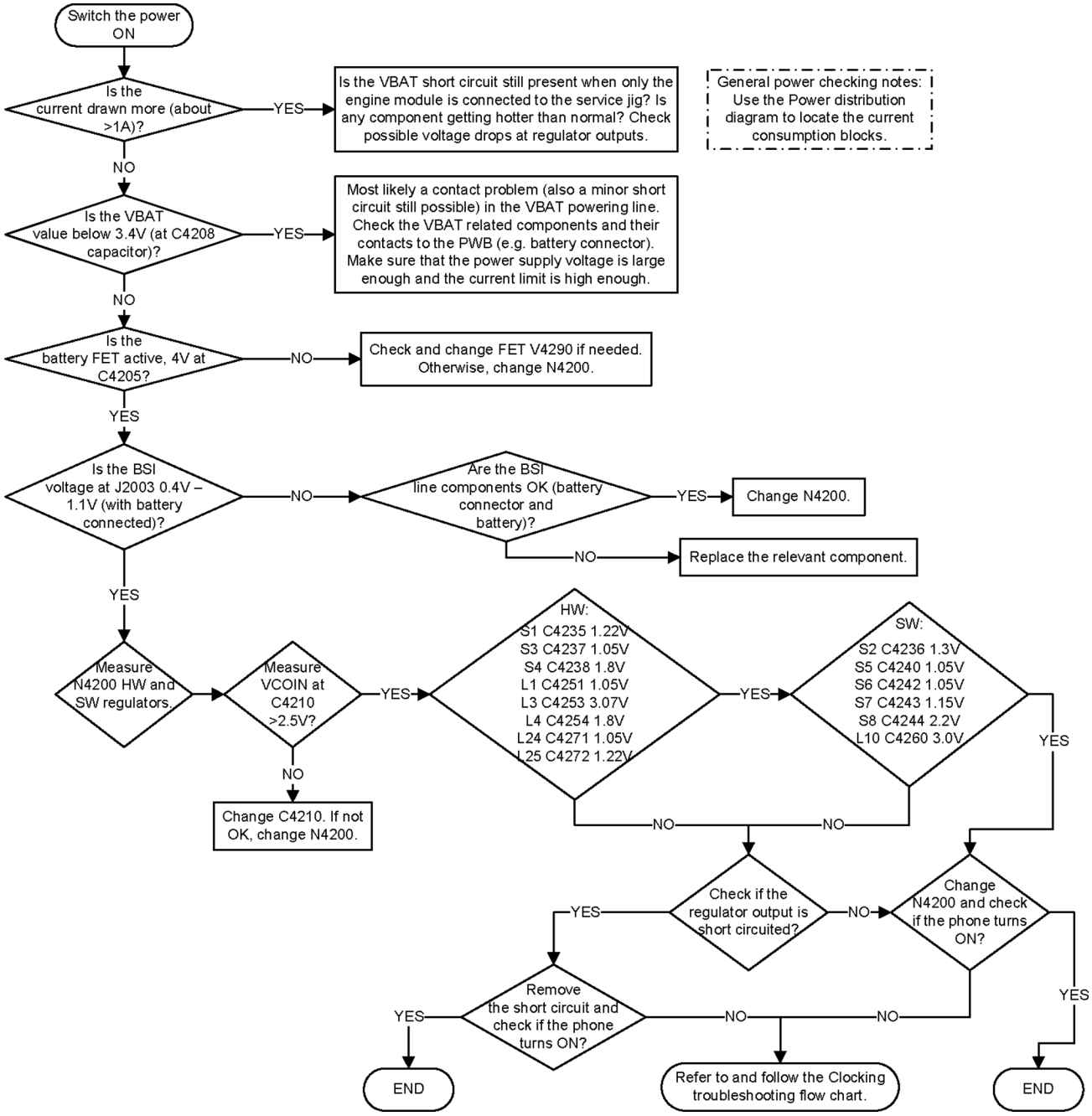
Backup battery troubleshooting

Troubleshooting flow



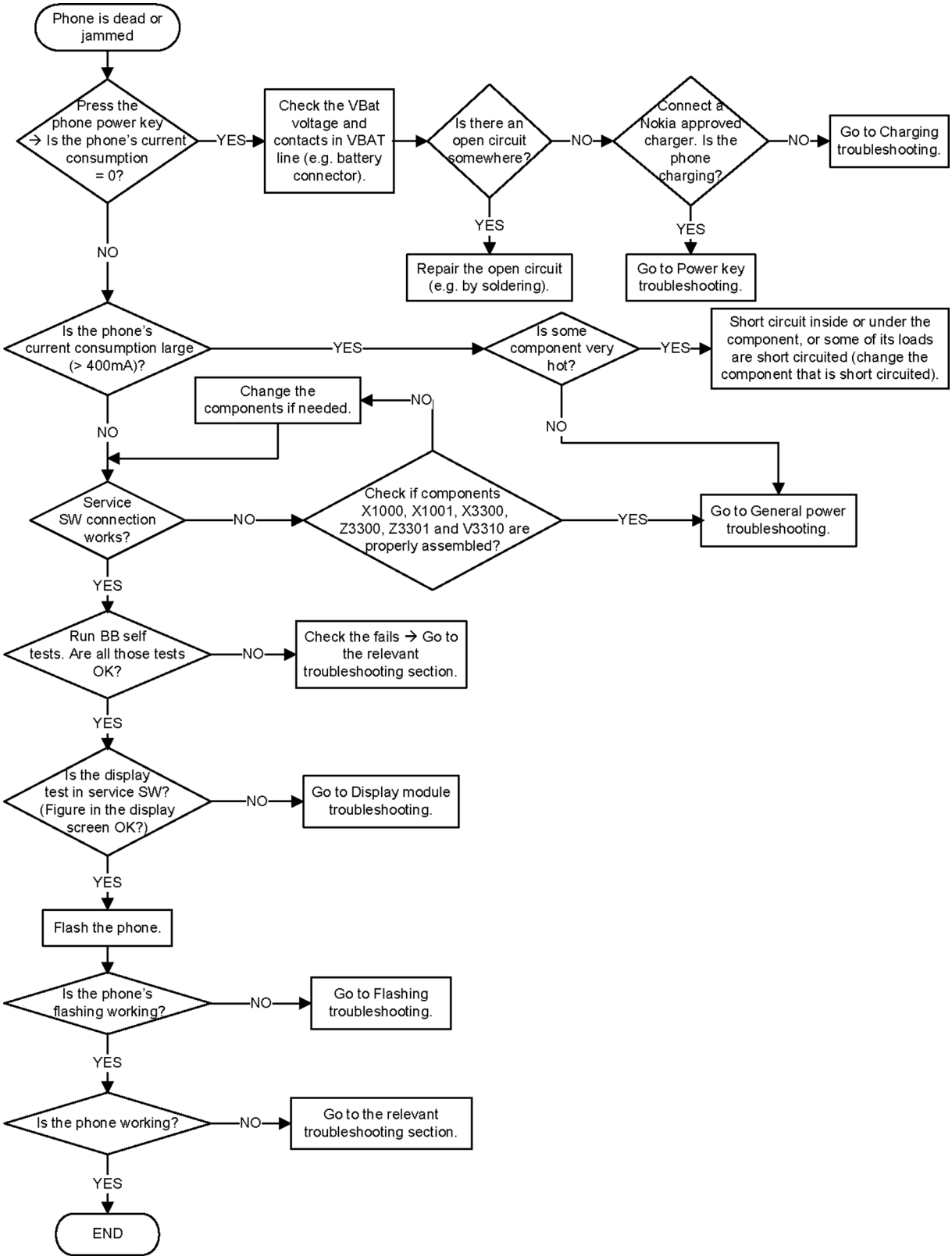
General power checking troubleshooting

Troubleshooting flow



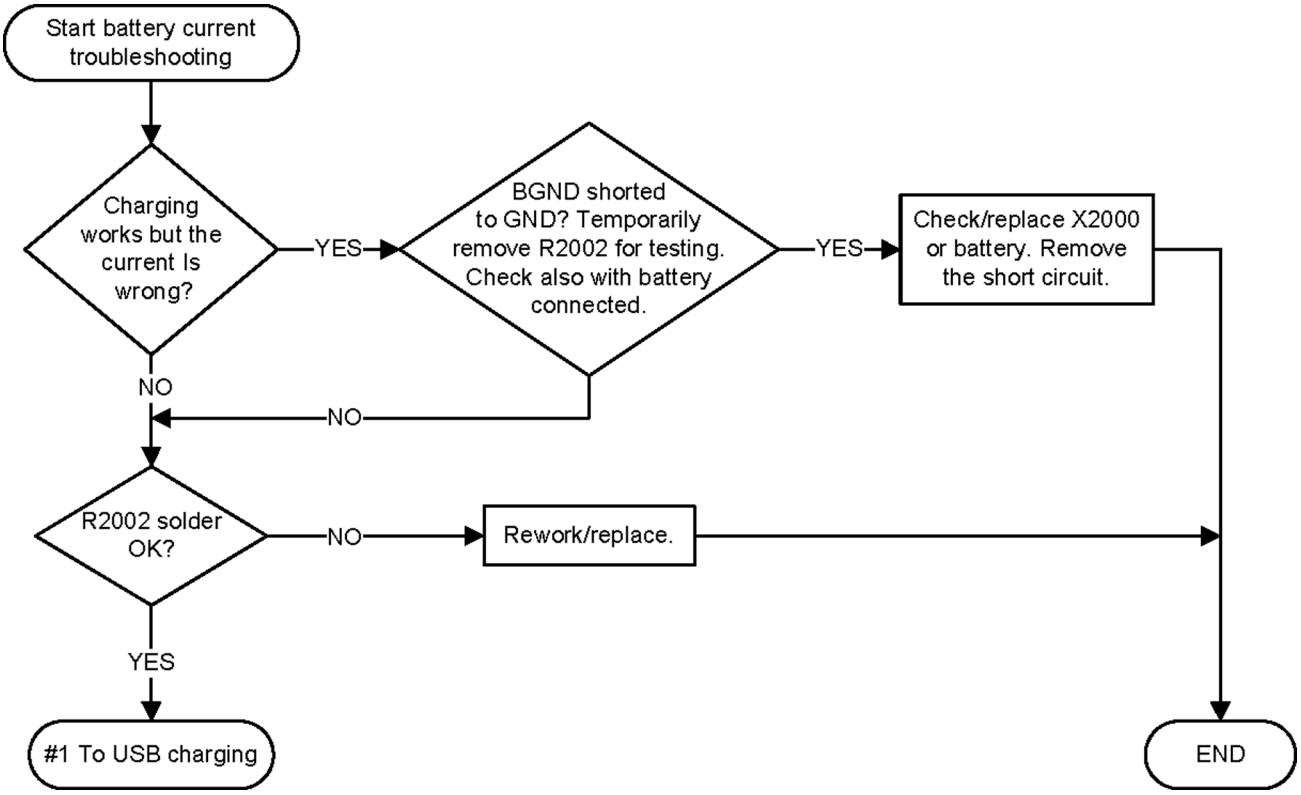
Dead or jammed device troubleshooting

Troubleshooting flow



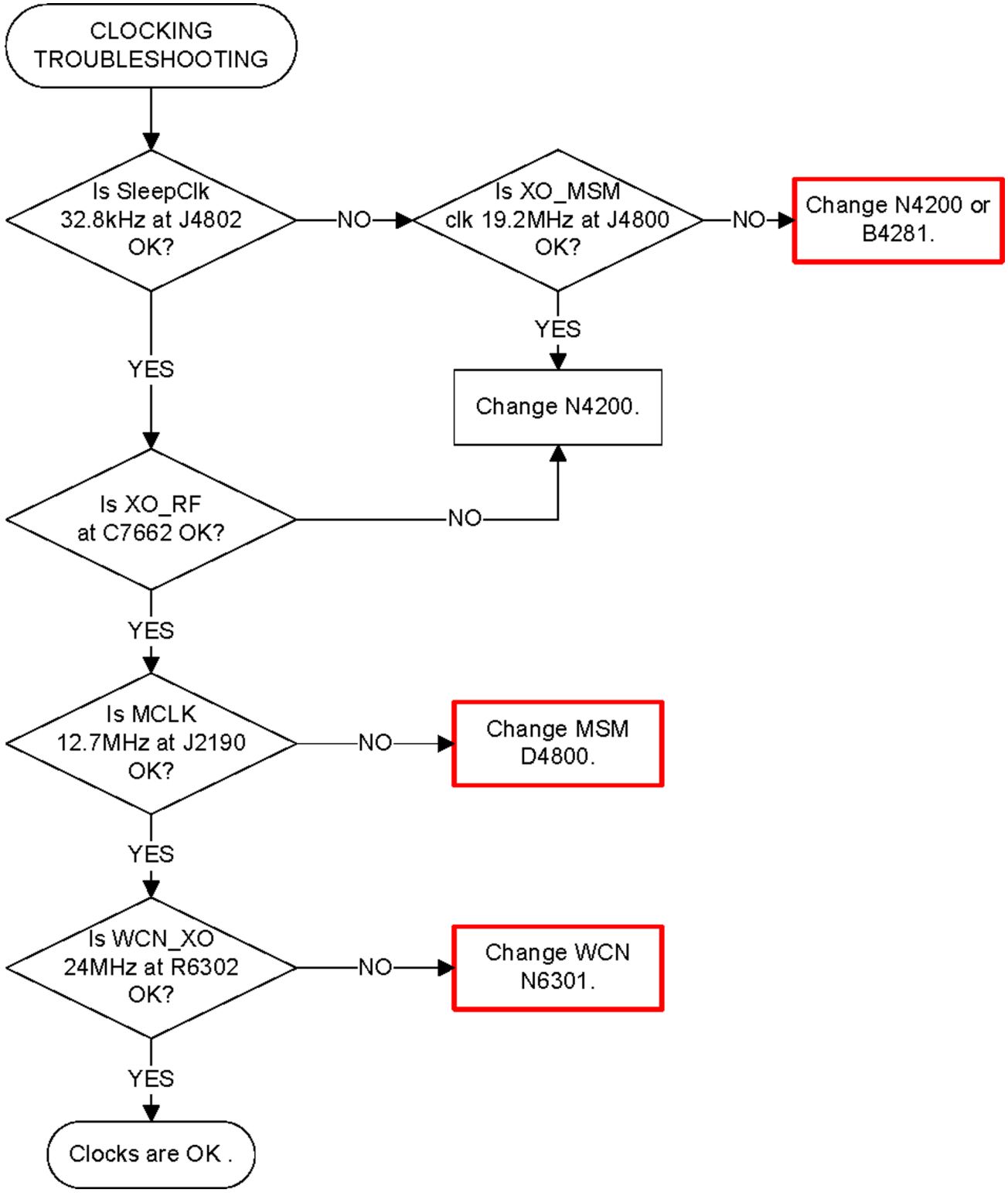
Battery current troubleshooting

Troubleshooting flow



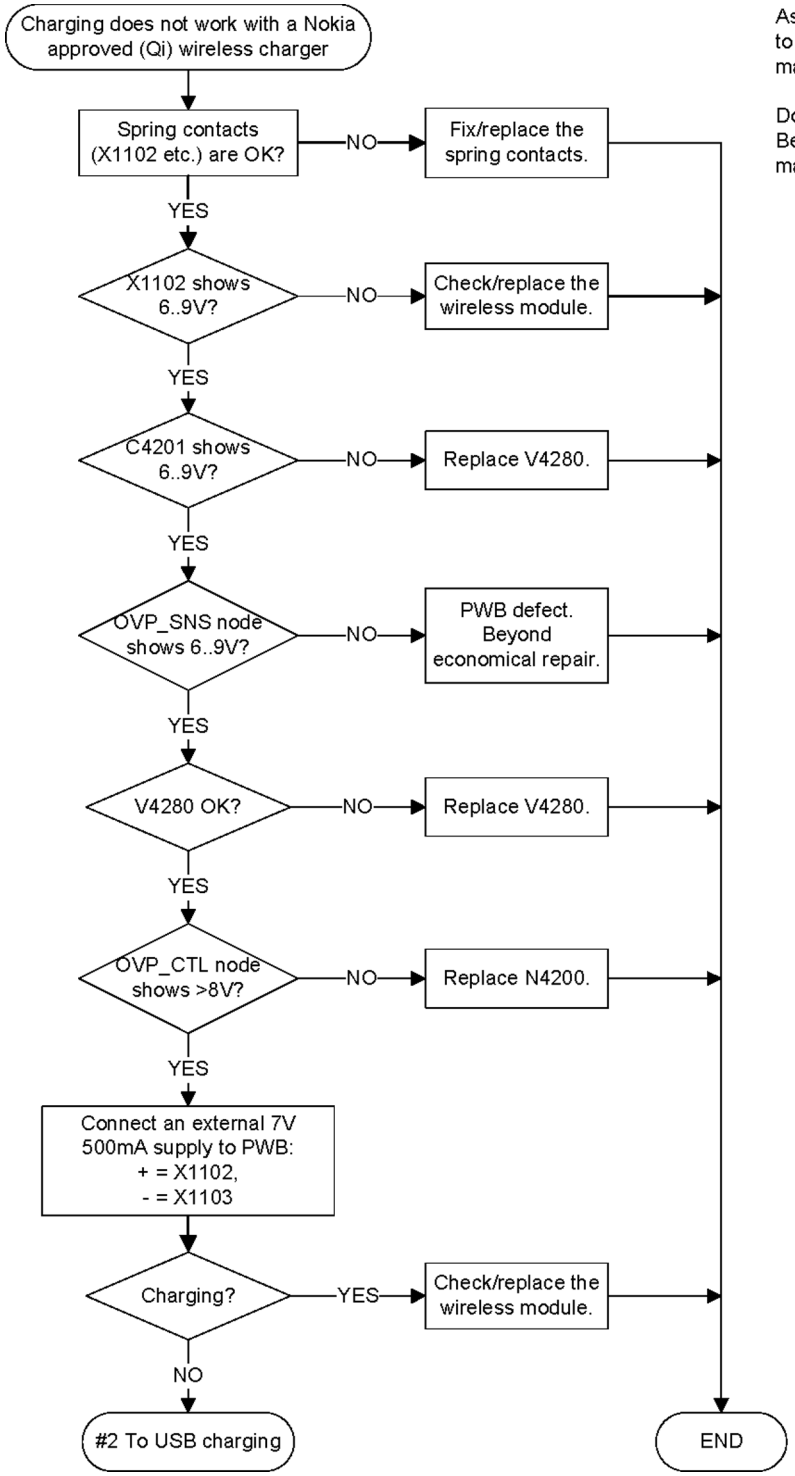
Clocking troubleshooting

Troubleshooting flow



Wireless charging troubleshooting

Troubleshooting flow

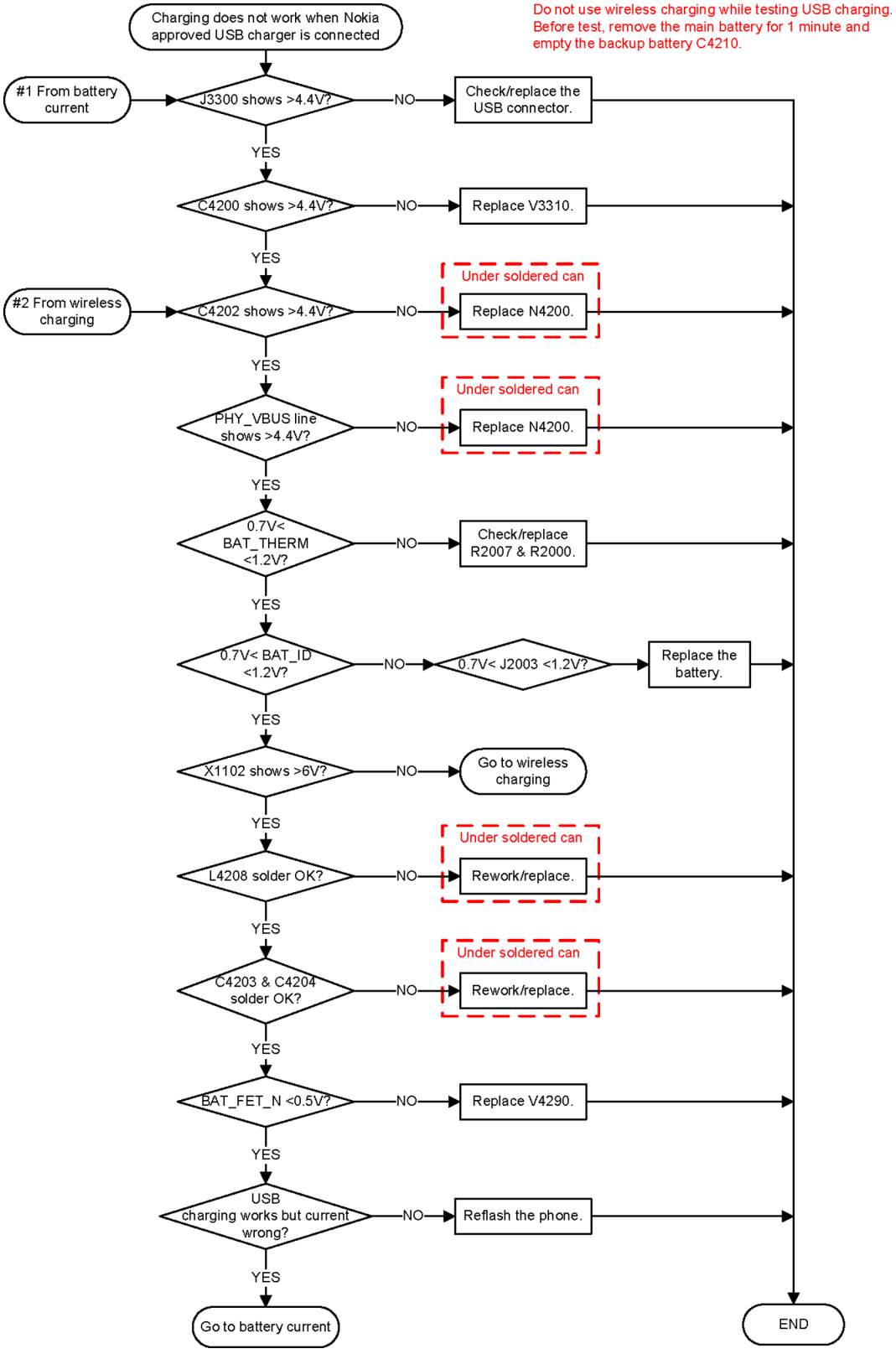


As the wireless charging module is connected via springs to the main PWB, some external wiring or testing harness may need to be used for testing.

Do not connect the USB while testing wireless charging. Before test, empty the backup battery and remove the main battery for 1 minute.

USB charging troubleshooting

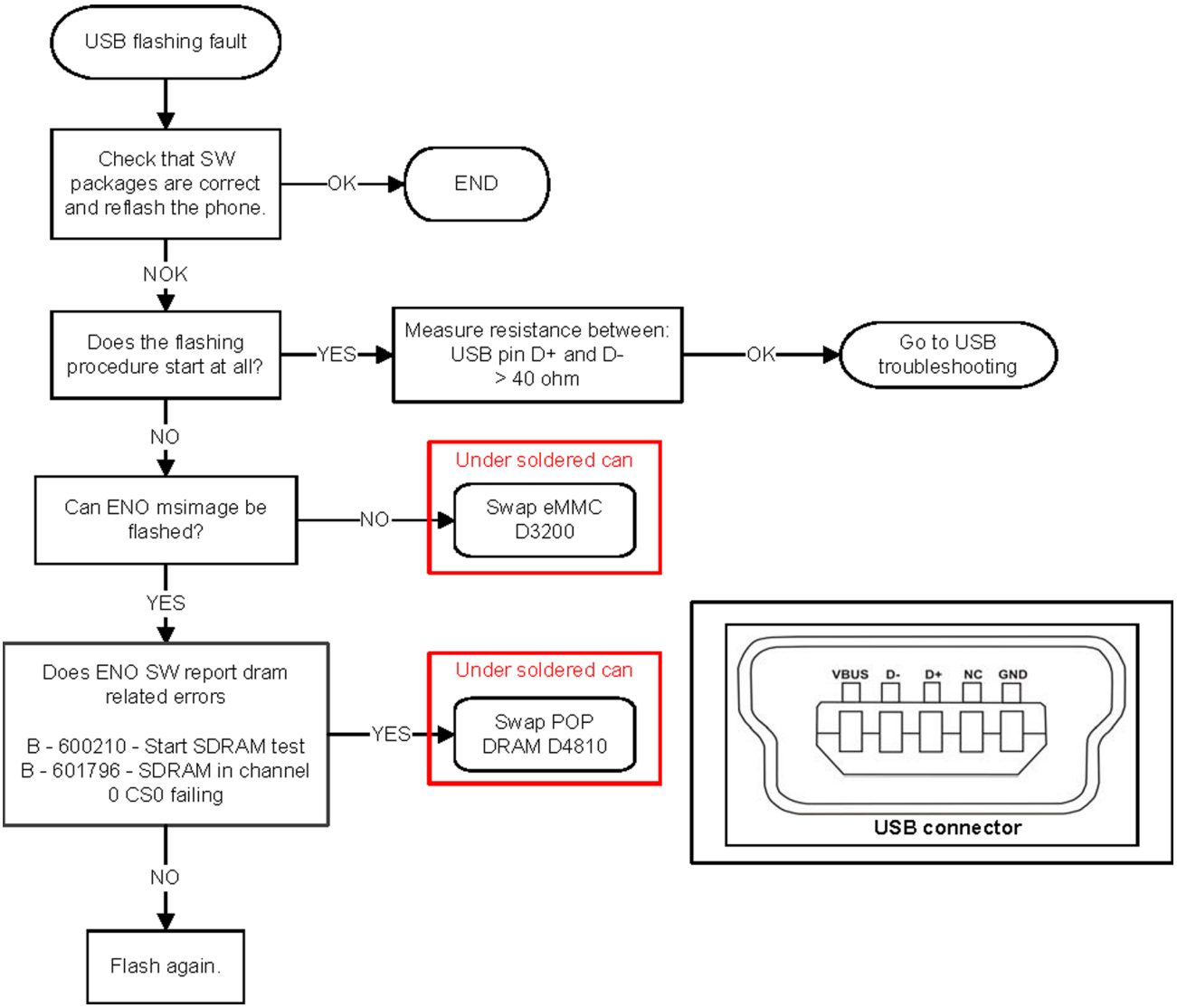
Troubleshooting flow



Interface troubleshooting

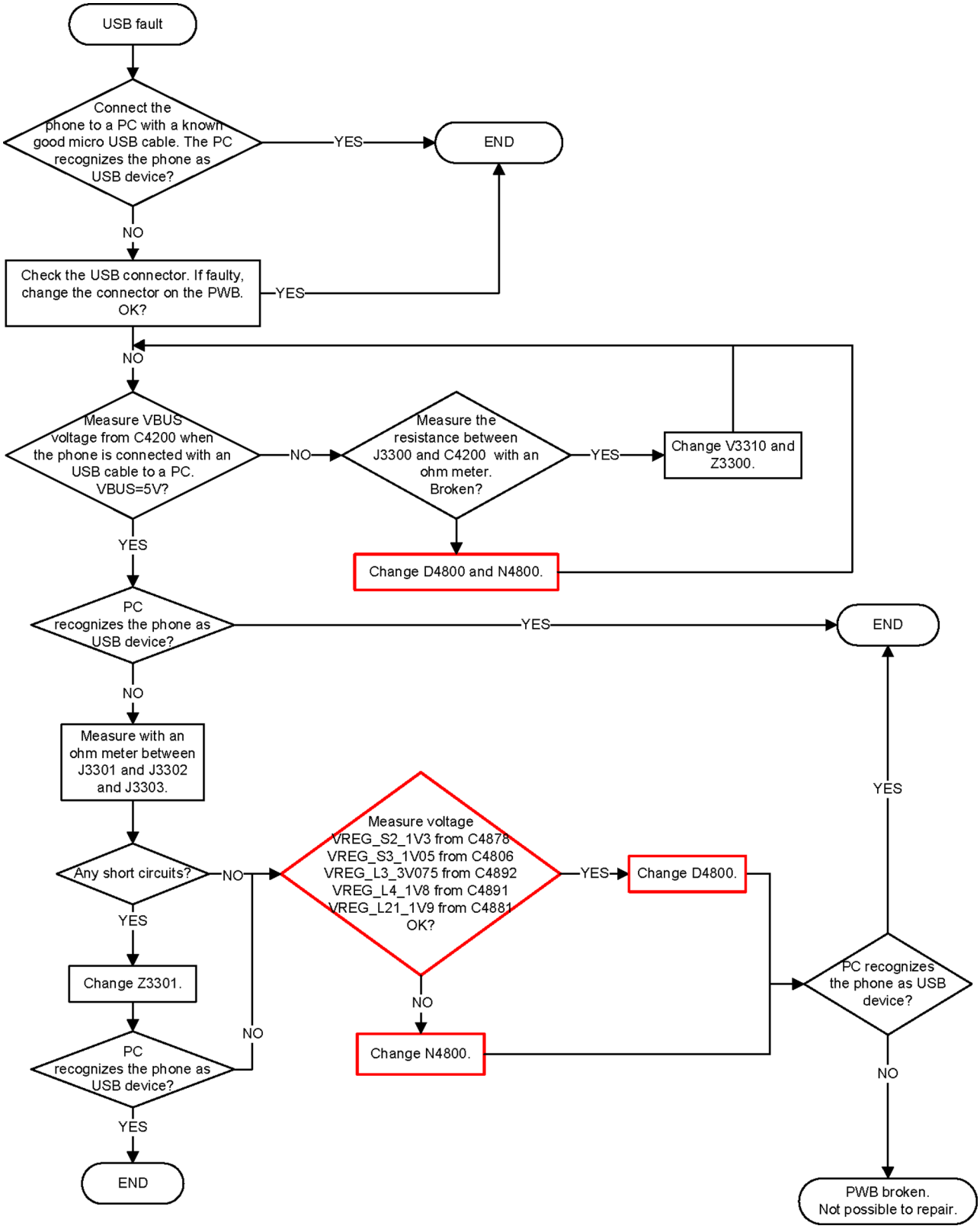
USB flashing fault troubleshooting

Troubleshooting flow



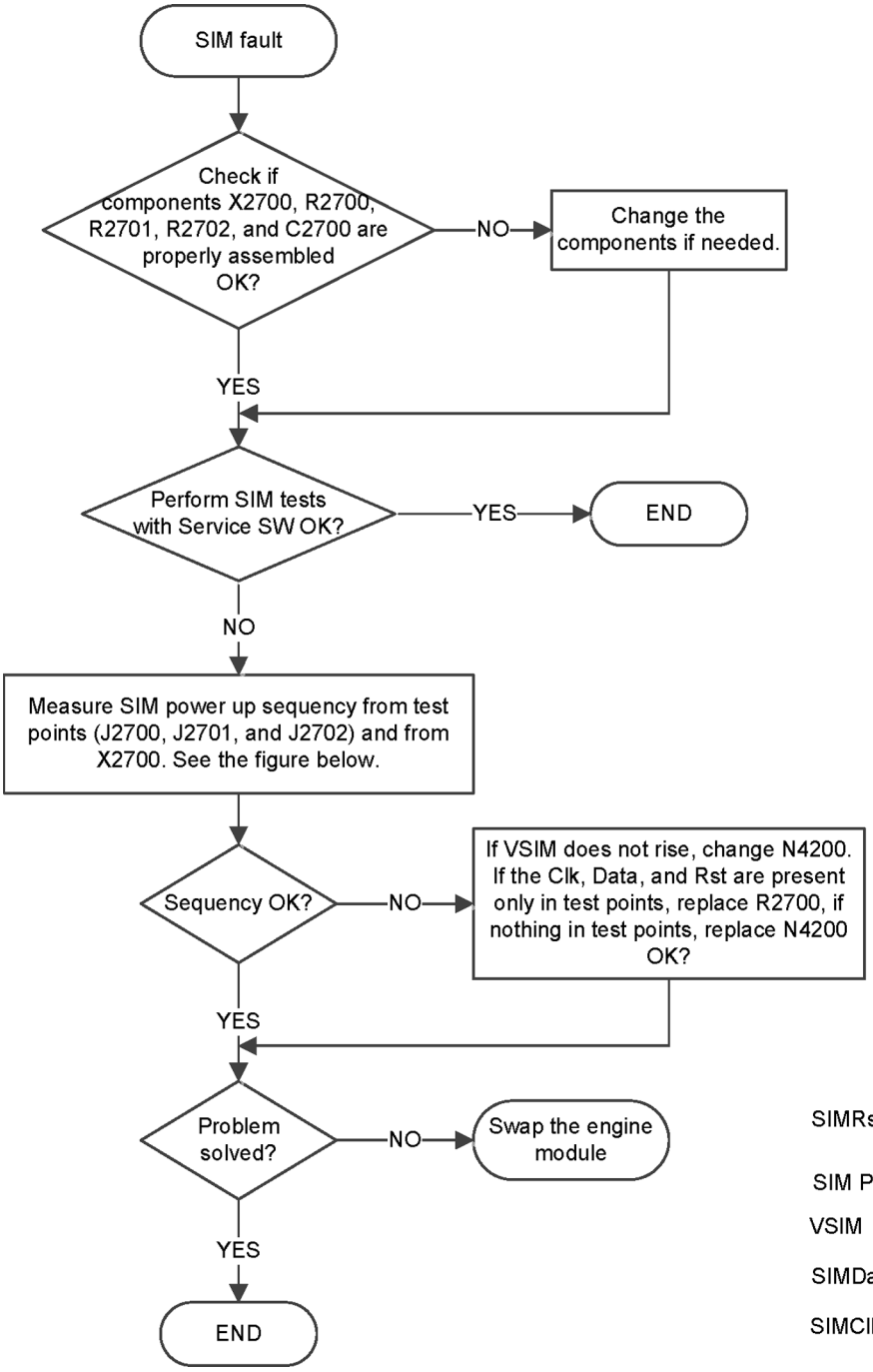
USB data interface troubleshooting

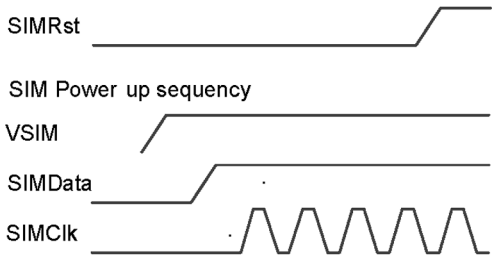
Troubleshooting flow



SIM interface troubleshooting

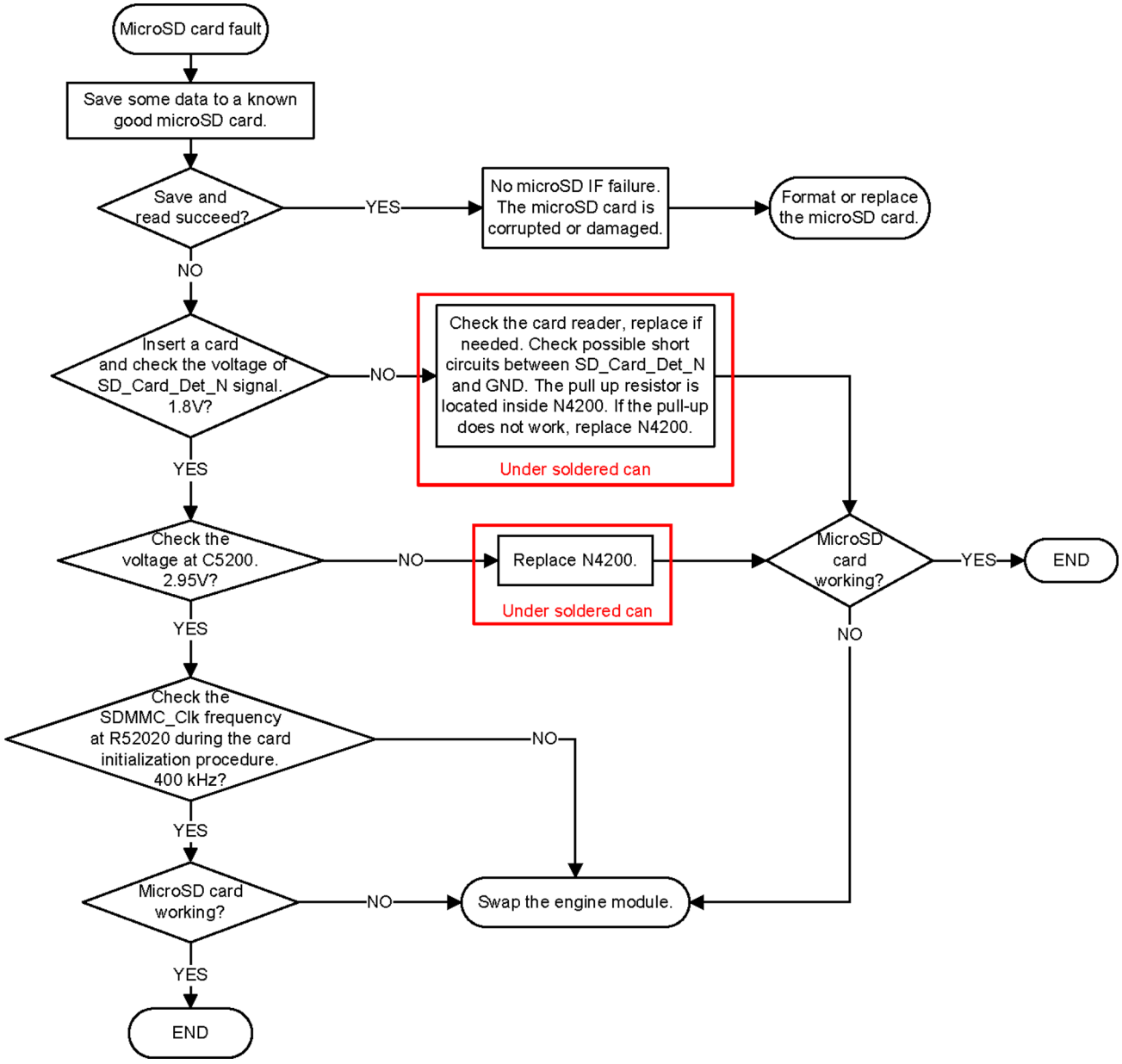
Troubleshooting flow





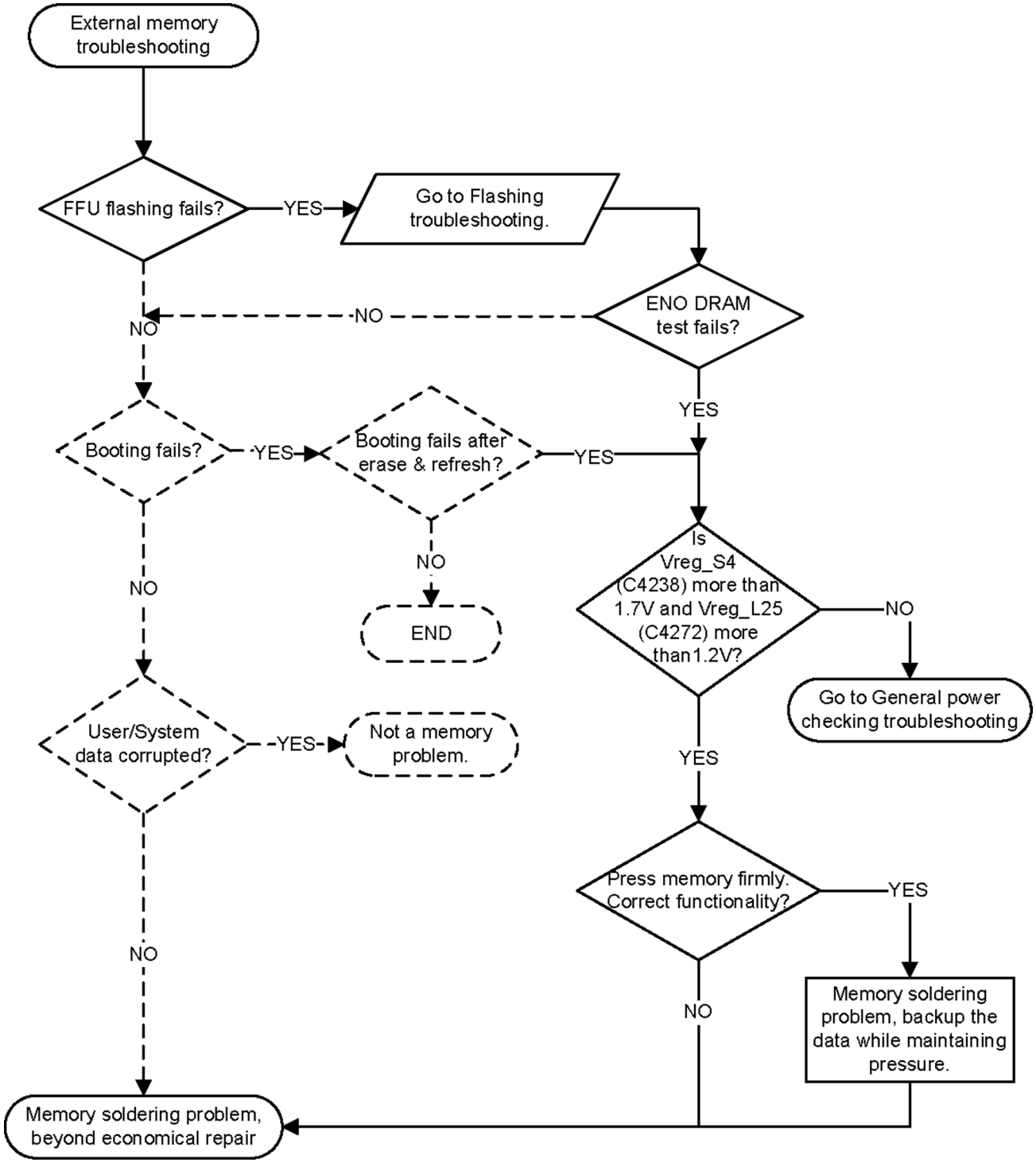
MicroSD interface troubleshooting

Troubleshooting flow



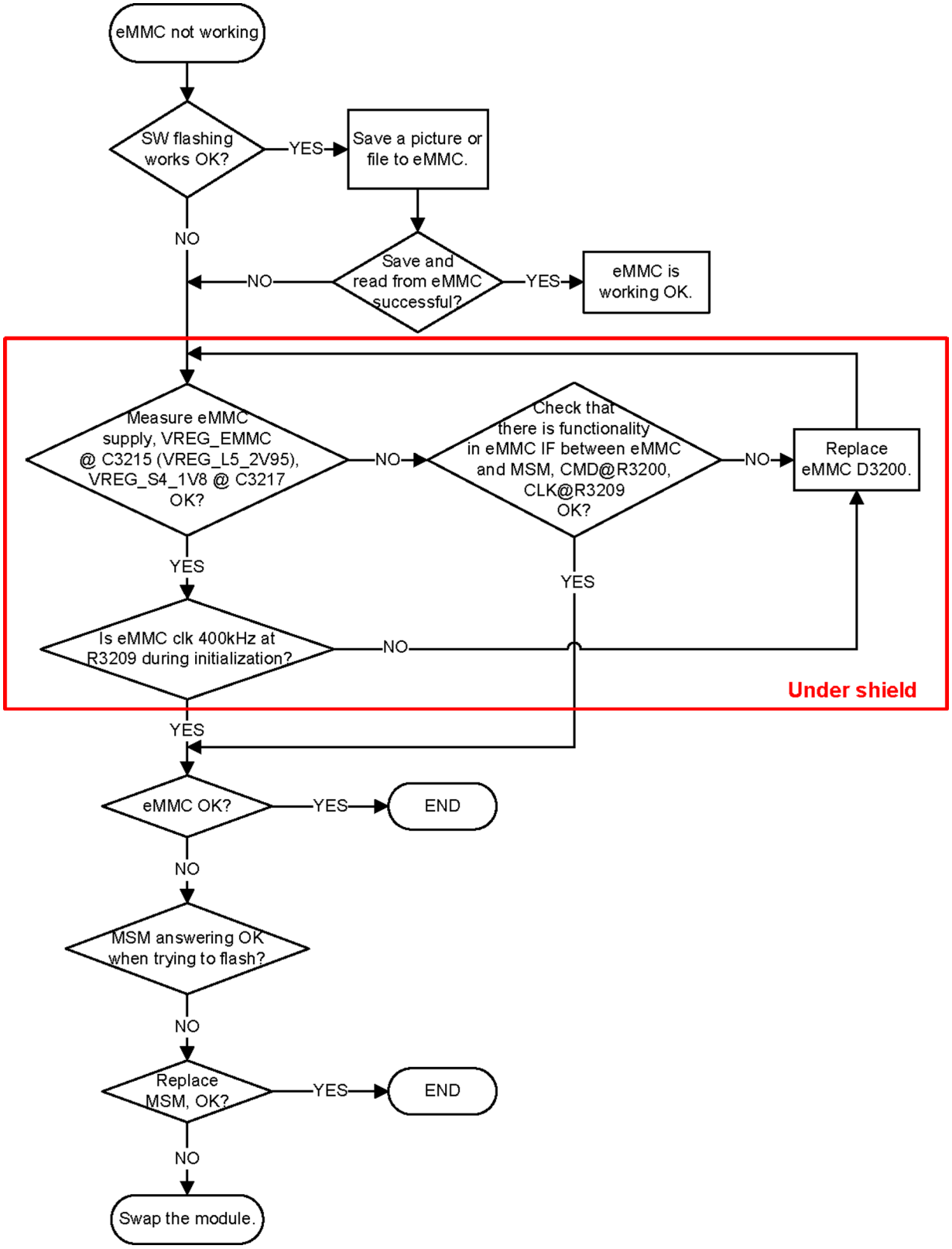
DRAM troubleshooting

Troubleshooting flow



eMMC troubleshooting

Troubleshooting flow



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.

After this, proceed to the display troubleshooting flowcharts.

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)	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.

Table 7 Defects table

<table>
<tr><th>Item</th><th colspan="3">Bright dot defect (R & G & B are 0)</th><th colspan="3">Dim dot defect (G is 0)</th></tr>
<tr><td rowspan="6">Defect counts</td><td>Red</td><td>Green</td><td>Blue</td><td>Red</td><td>Green</td><td>Blue</td></tr>
<tr><td>R0</td><td>G0</td><td>B0</td><td rowspan="2">2 dim dots acceptable</td><td>G0</td><td rowspan="2">2 dim dots acceptable</td></tr>
<tr><td colspan="3">Acceptable</td><td>Not acceptable</td></tr>
<tr><td>R40</td><td>G30</td><td>B70</td><td>NA</td><td>G230</td><td>NA</td></tr>
<tr><td>R41</td><td>G31</td><td>B71</td><td>R201</td><td>G231</td><td>B101</td></tr>
<tr><td colspan="3">Not acceptable</td><td colspan="3">Acceptable</td></tr>
<tr><td></td><td>R255</td><td>G255</td><td>B255</td><td>R255</td><td>G255</td><td>B255</td></tr>
</table>

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

Introduction to display troubleshooting

The display module used is based on AMOLED technology and supports the display format of 800 columns x 480 rows. The dimension of the display module is 61 mm x 103.7 mm x 1.11 mm. The display is connected to MSM8960 with a 4-lane MIPI DSI.

The following references on the PWB help in the effective debugging and troubleshooting of the display.

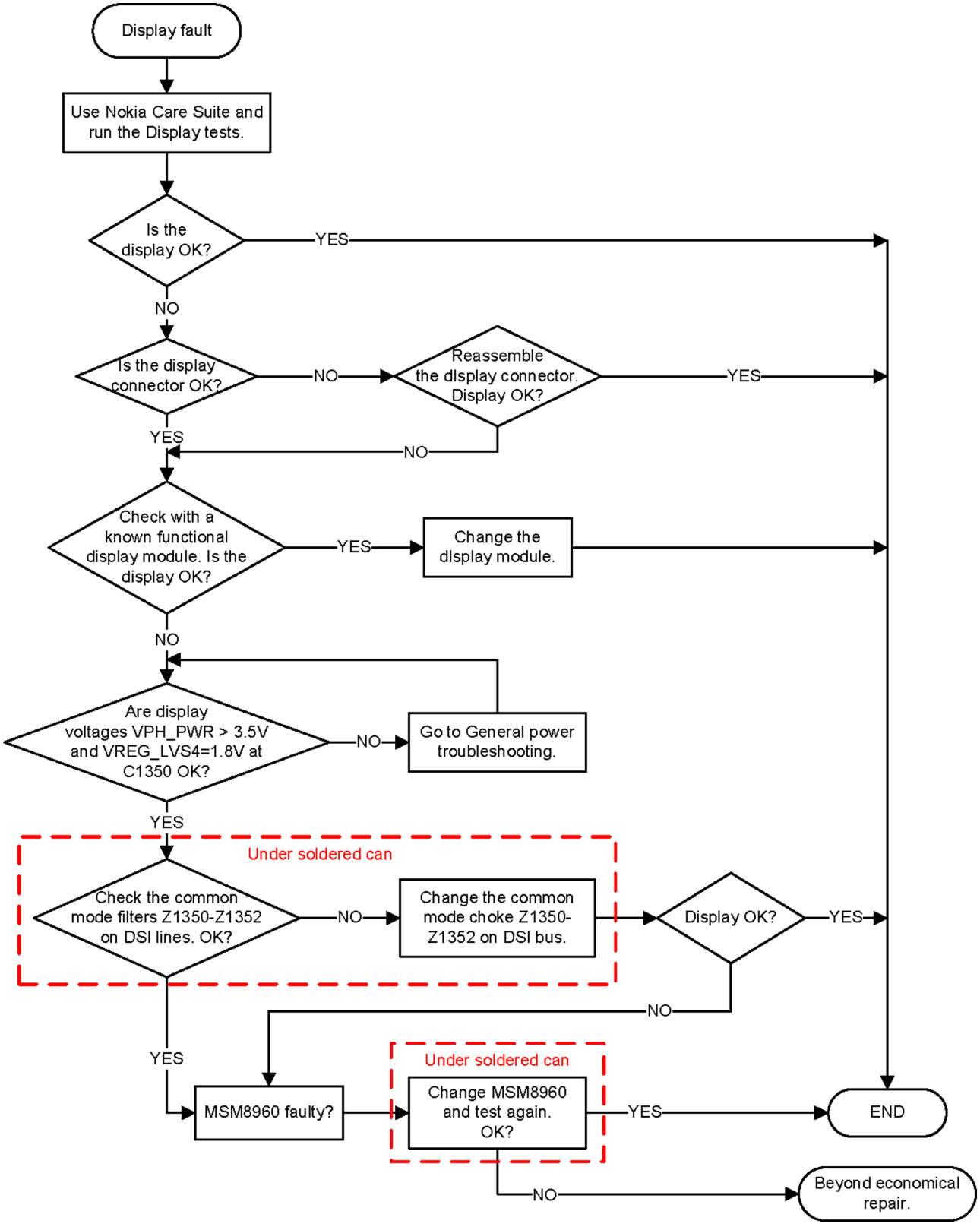
Sr No	Reference	Description
1	X1350	Display connector

The following test points on the PWB help in the effective debugging and troubleshooting.

Sr. No	Signal name	Measuring point	Description
1	VDDI		VREG_L23_1V8
2	VPNL		VPH_PWR
3	ELVSS		Negative supply to display -4.0V
4	ELVDD		Positive supply to display 4.6V

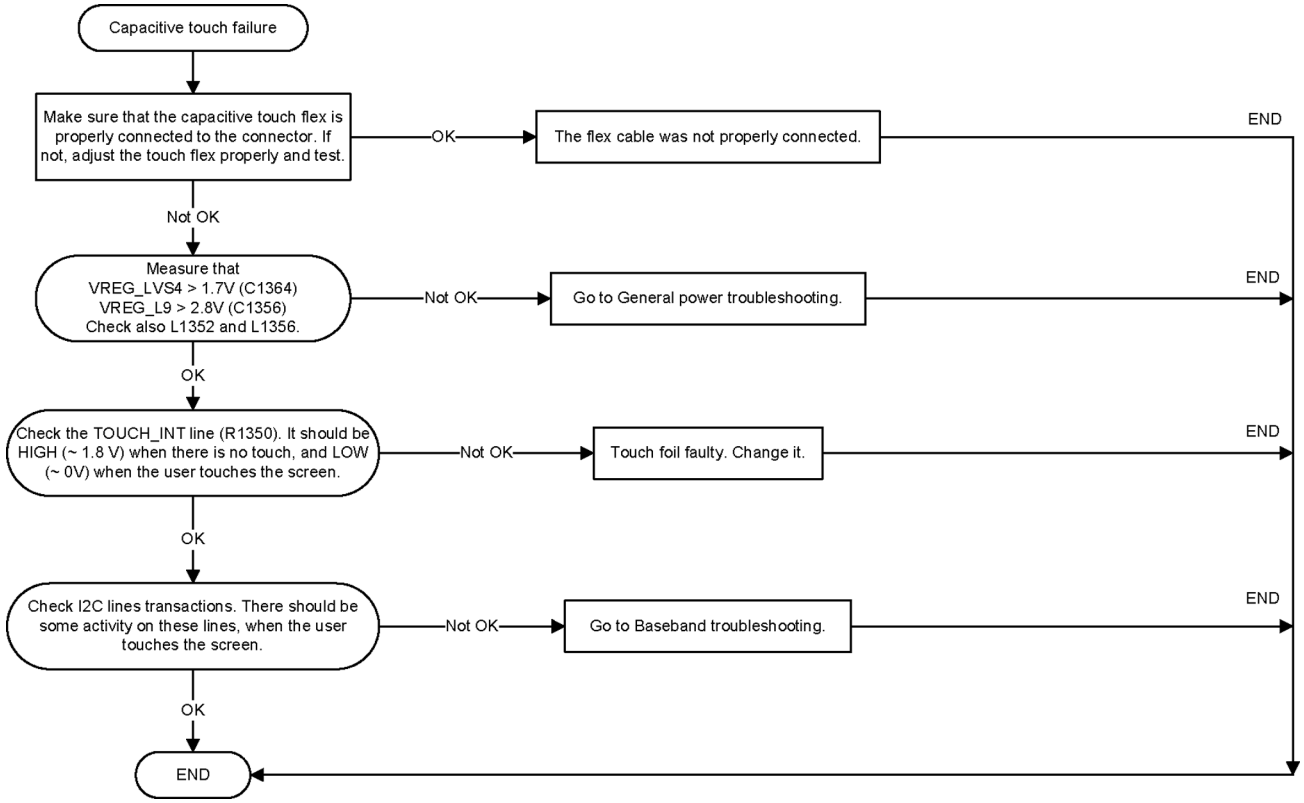
Display troubleshooting

Troubleshooting flow



Touch panel troubleshooting

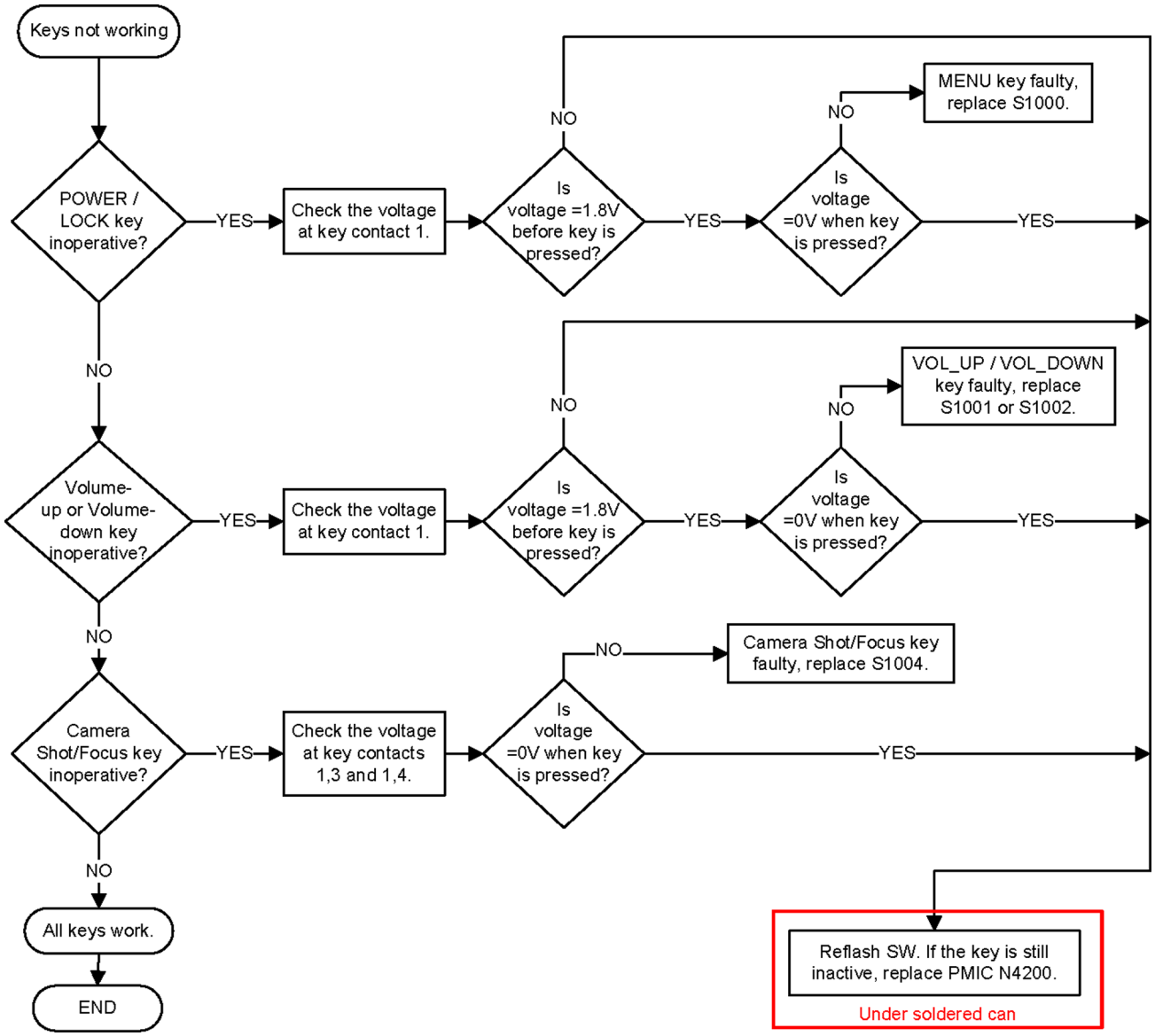
Troubleshooting flow



Keys troubleshooting

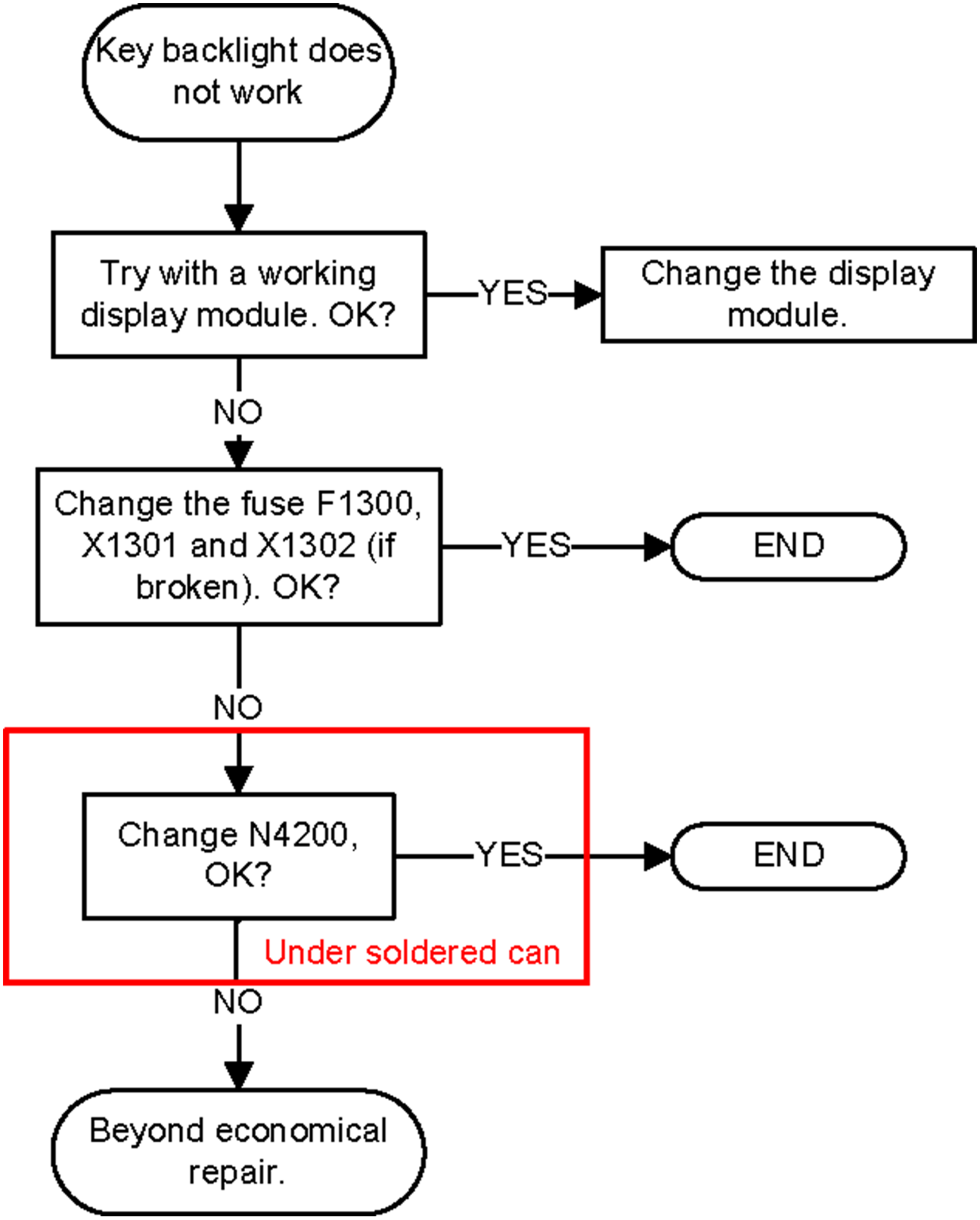
Keyboard troubleshooting

Troubleshooting flow



Keyboard backlight troubleshooting

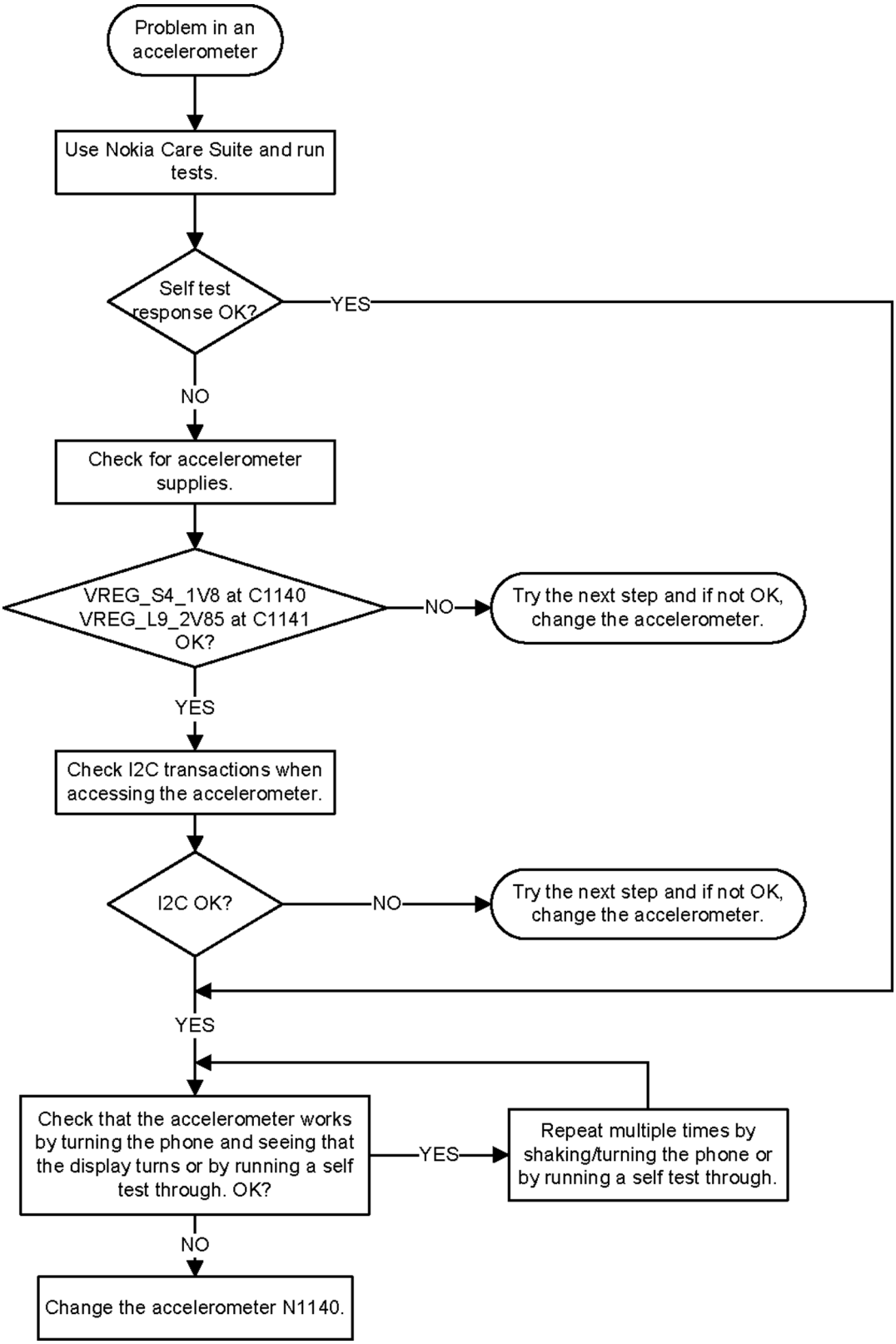
Troubleshooting flow



Sensors troubleshooting

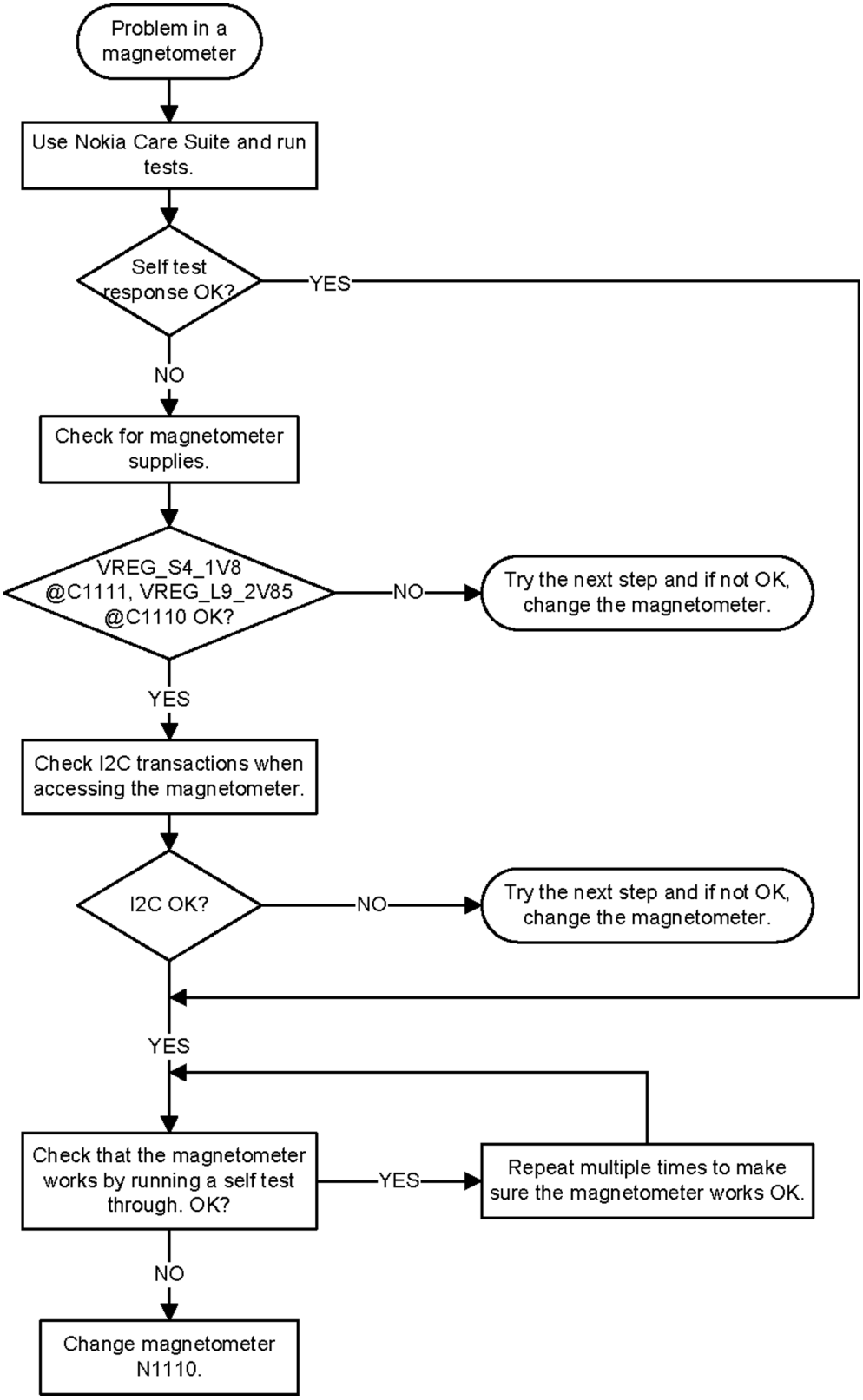
Accelerometer troubleshooting

Troubleshooting flow



Magnetometer troubleshooting

Troubleshooting flow



Alphamon technical description and 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 VBAT. 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 it works. Use a finger to hide the Alphamon sensor window, the light intensity in mLux changes from 0 to approx. 130 000.

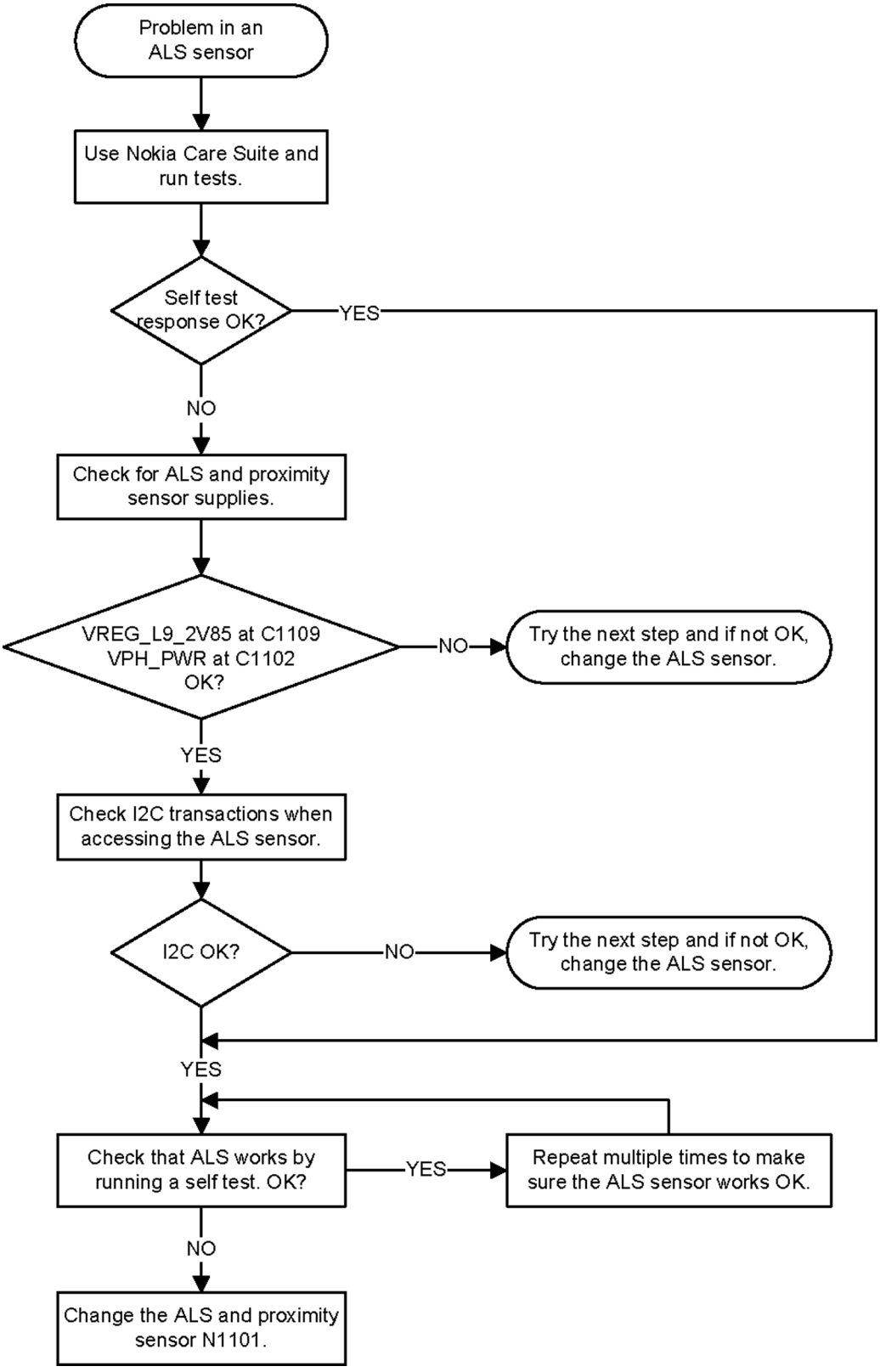
Note: The light intensity could vary depending on how the finger hides the Alphamon window.

Proximity and ALS sensor calibration

Use Service SW to calibrate the proximity and ALS sensors after A-cover assembly change.

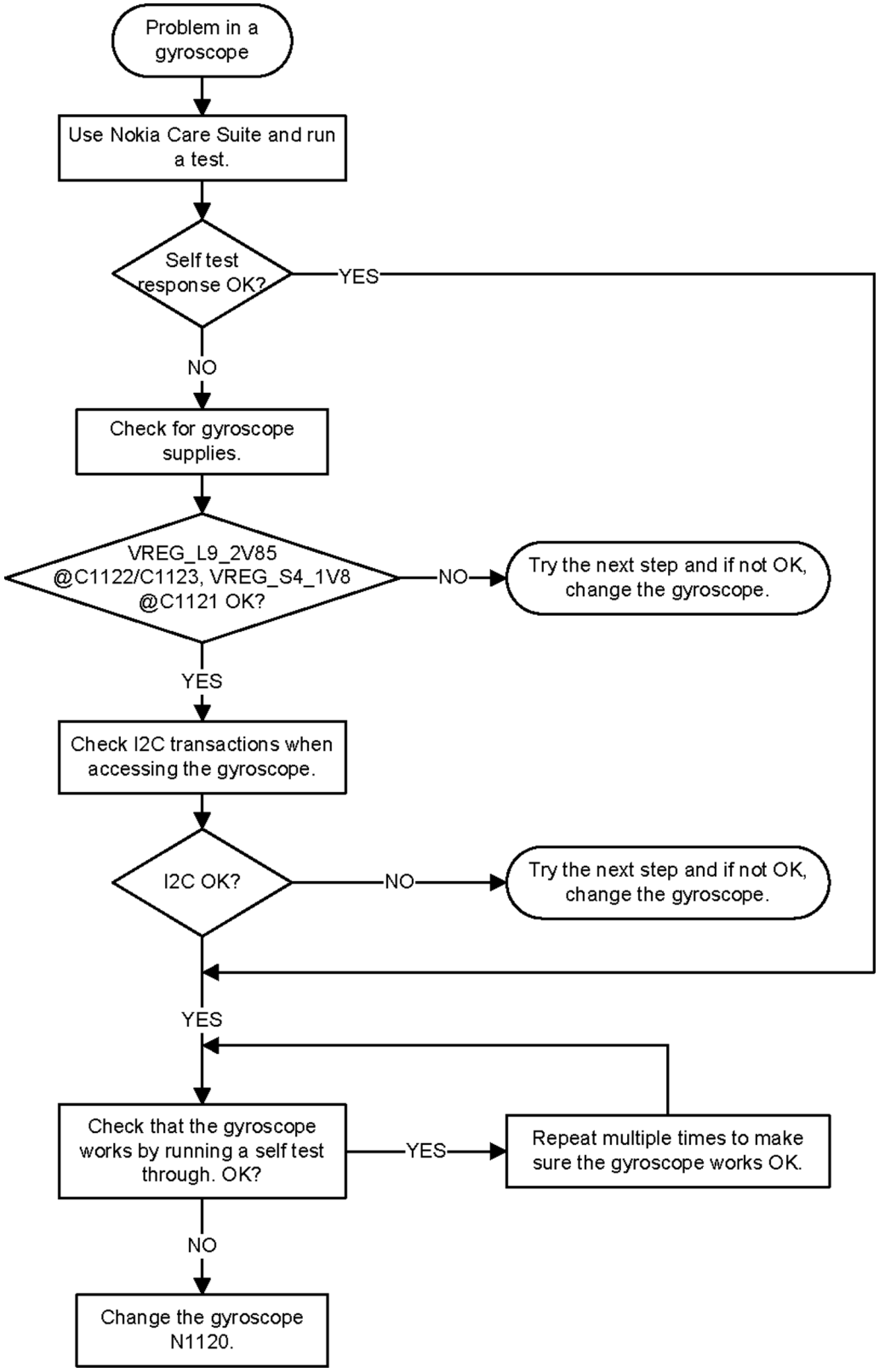
Proximity and ALS troubleshooting

Troubleshooting flow



Gyroscope troubleshooting

Troubleshooting flow



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.

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, eg. 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)

Test procedure

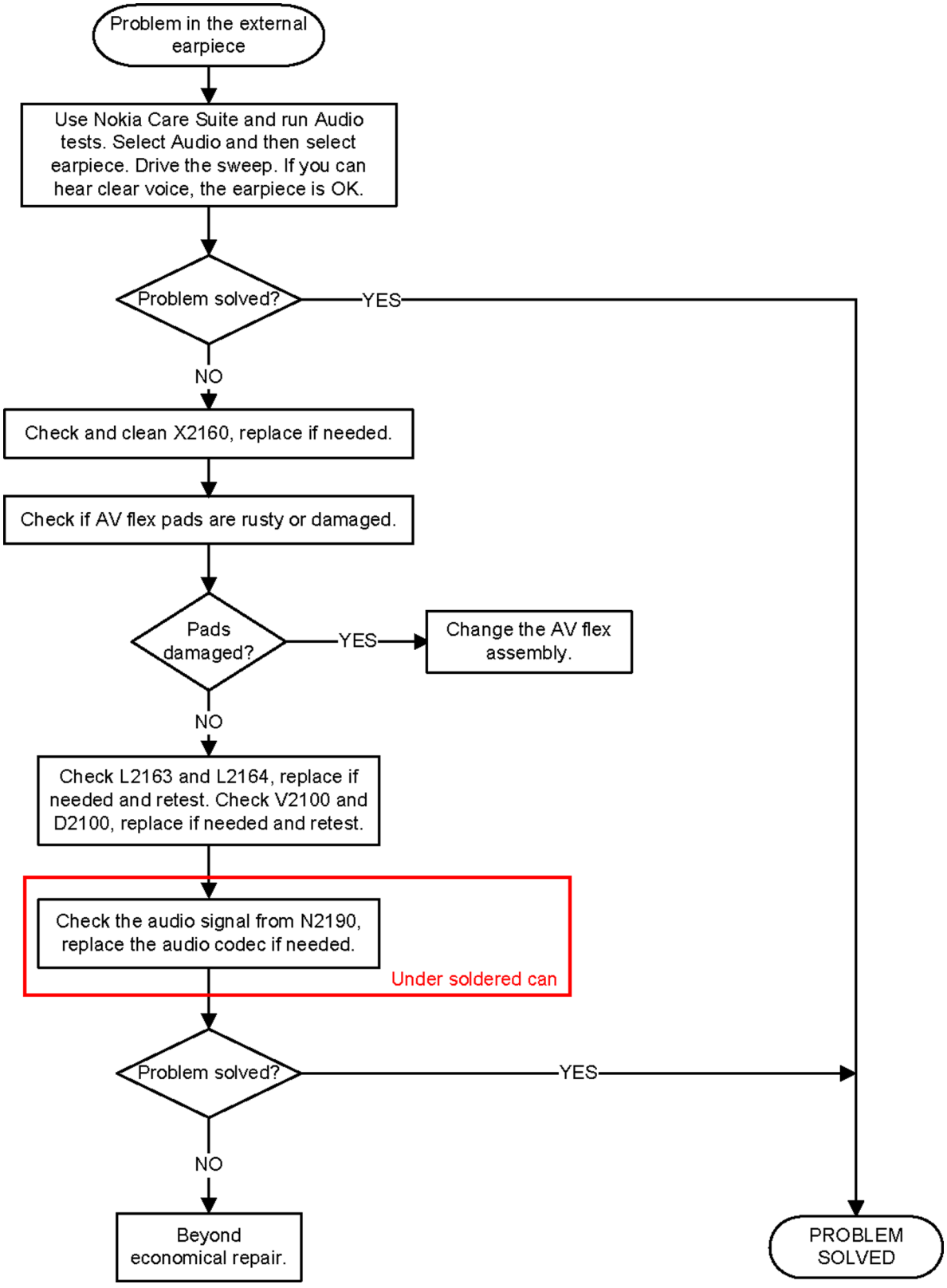
Audio can be tested using the application in NWP. Three different audio loop paths can be activated:

- XMIC to XEAR (L) and (R)
- MIC1 to EAR
- MIC1 to IHF

Each audio loop sets routing from the specified input to the specified output enabling a quick in-out test. Loop path gains are fixed and they cannot be changed using the application.

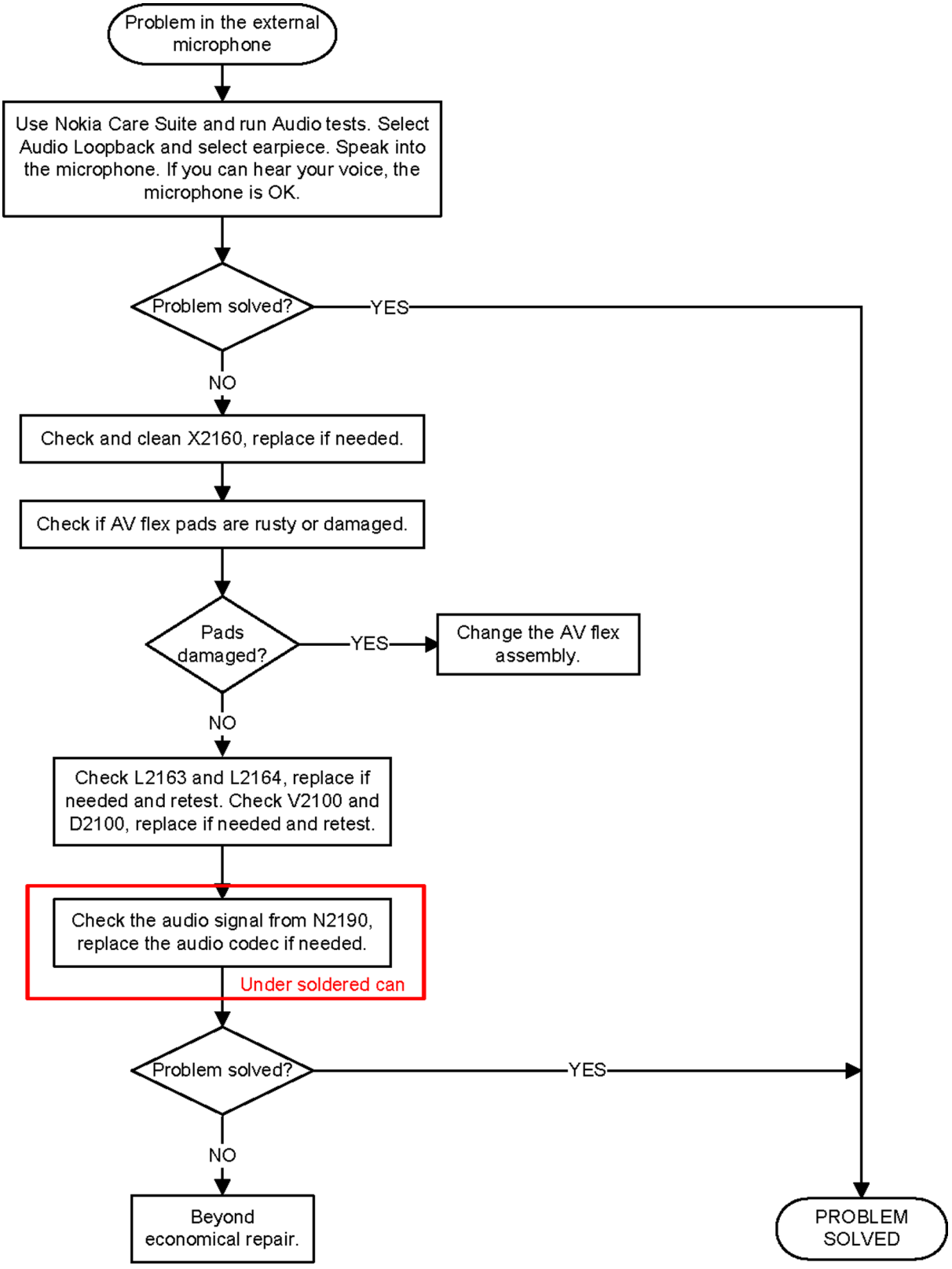
External earpiece troubleshooting

Troubleshooting flow



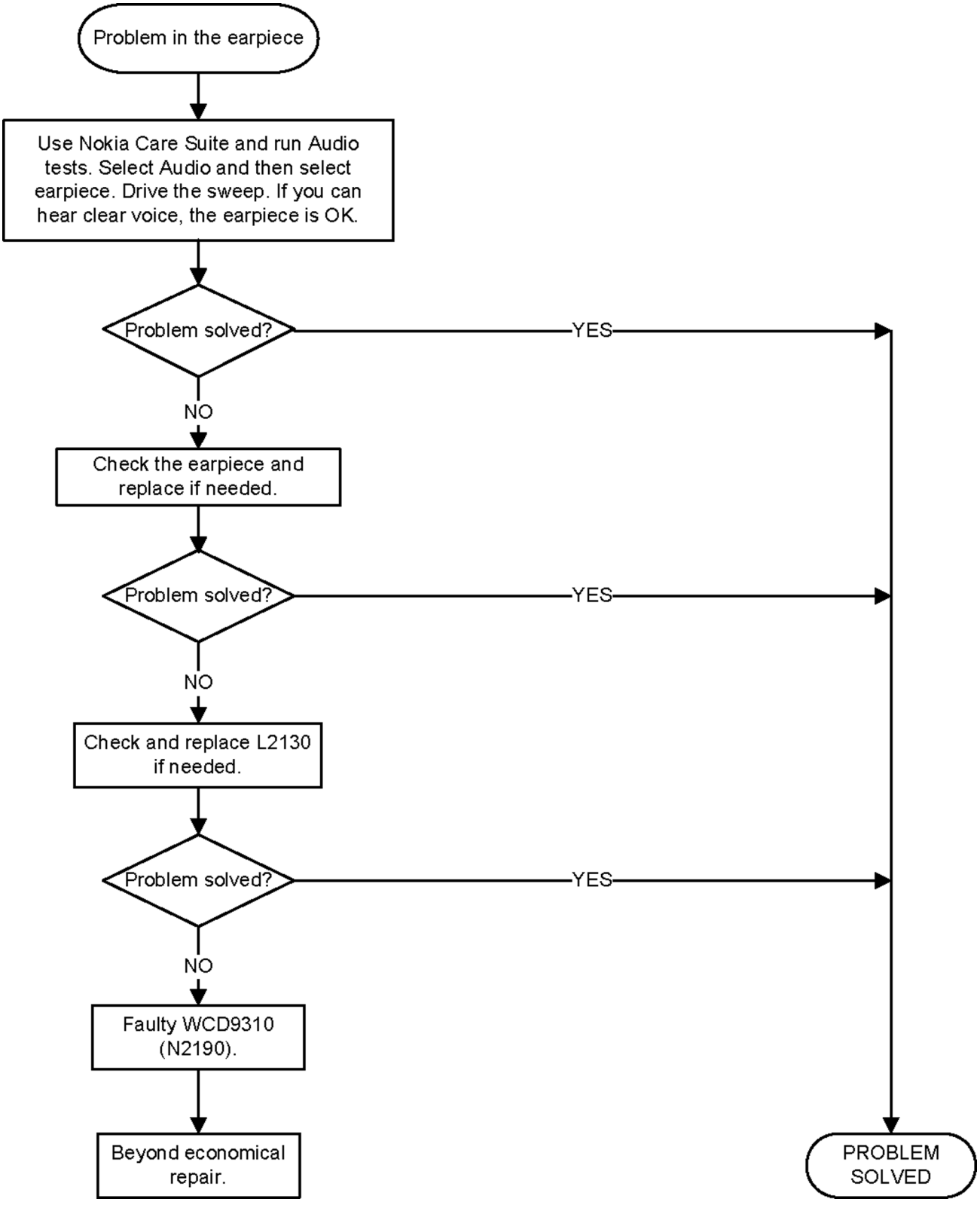
External microphone troubleshooting

Troubleshooting flow



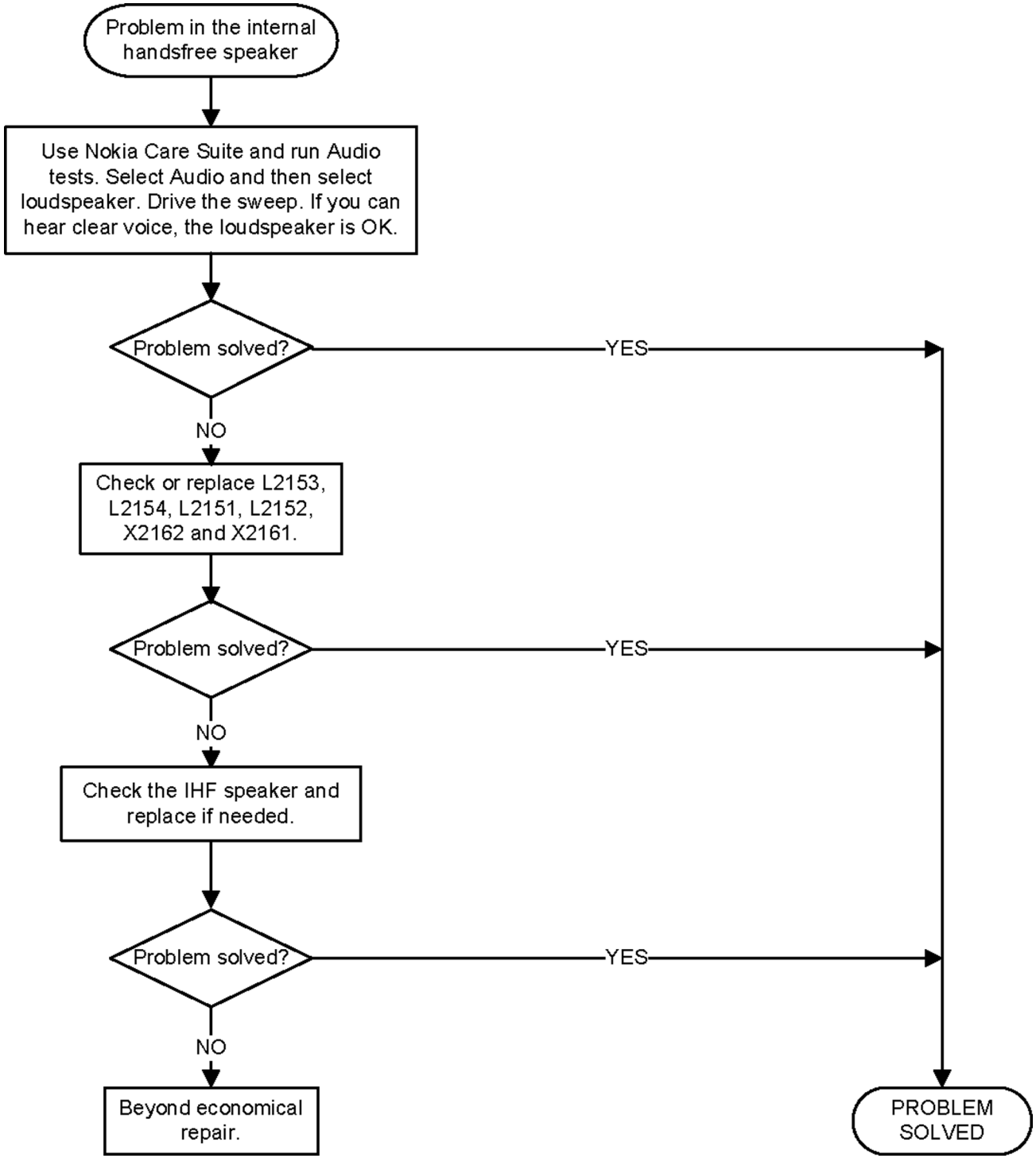
Internal earpiece troubleshooting

Troubleshooting flow



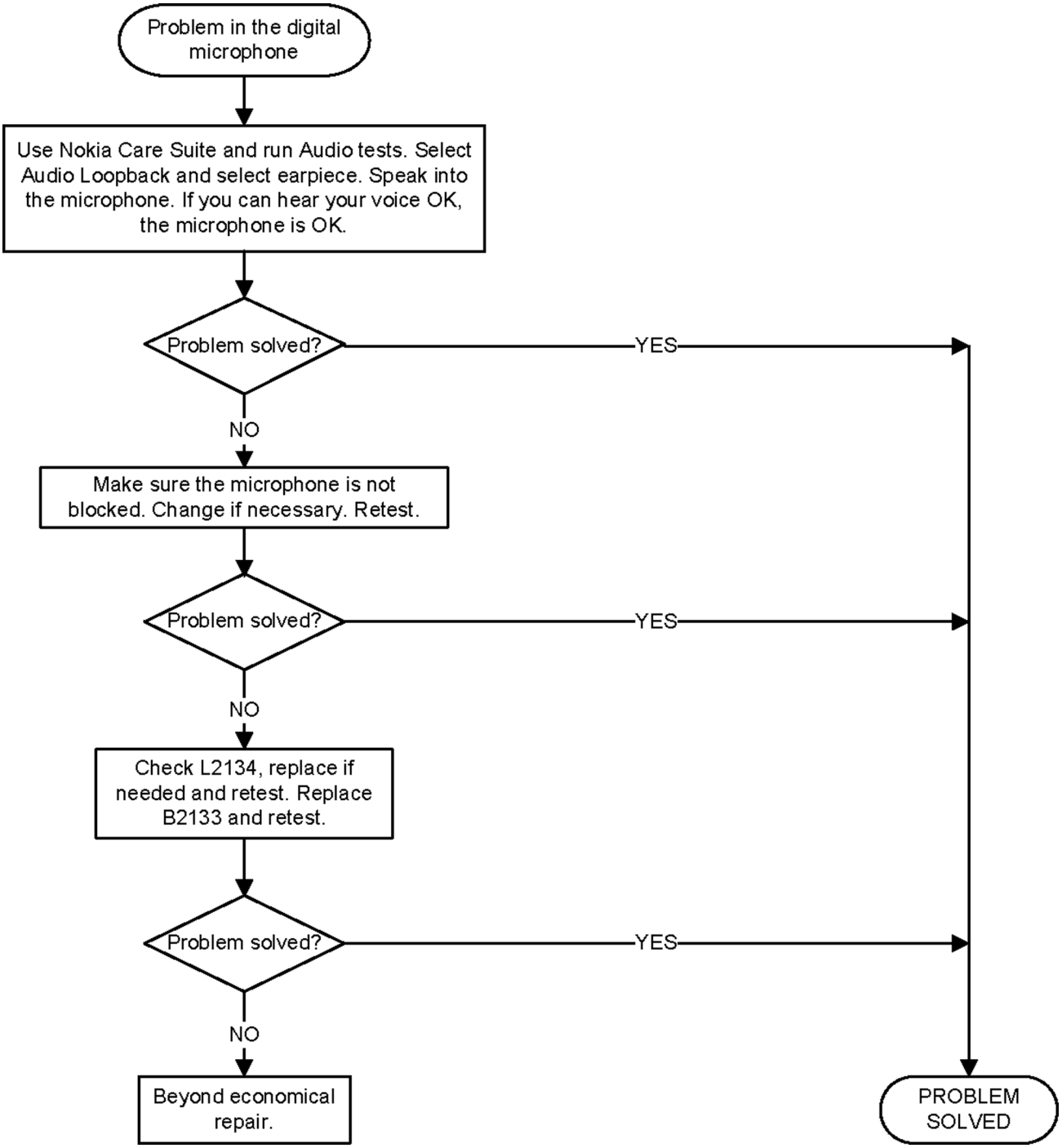
Internal handsfree (IHF) troubleshooting

Troubleshooting flow



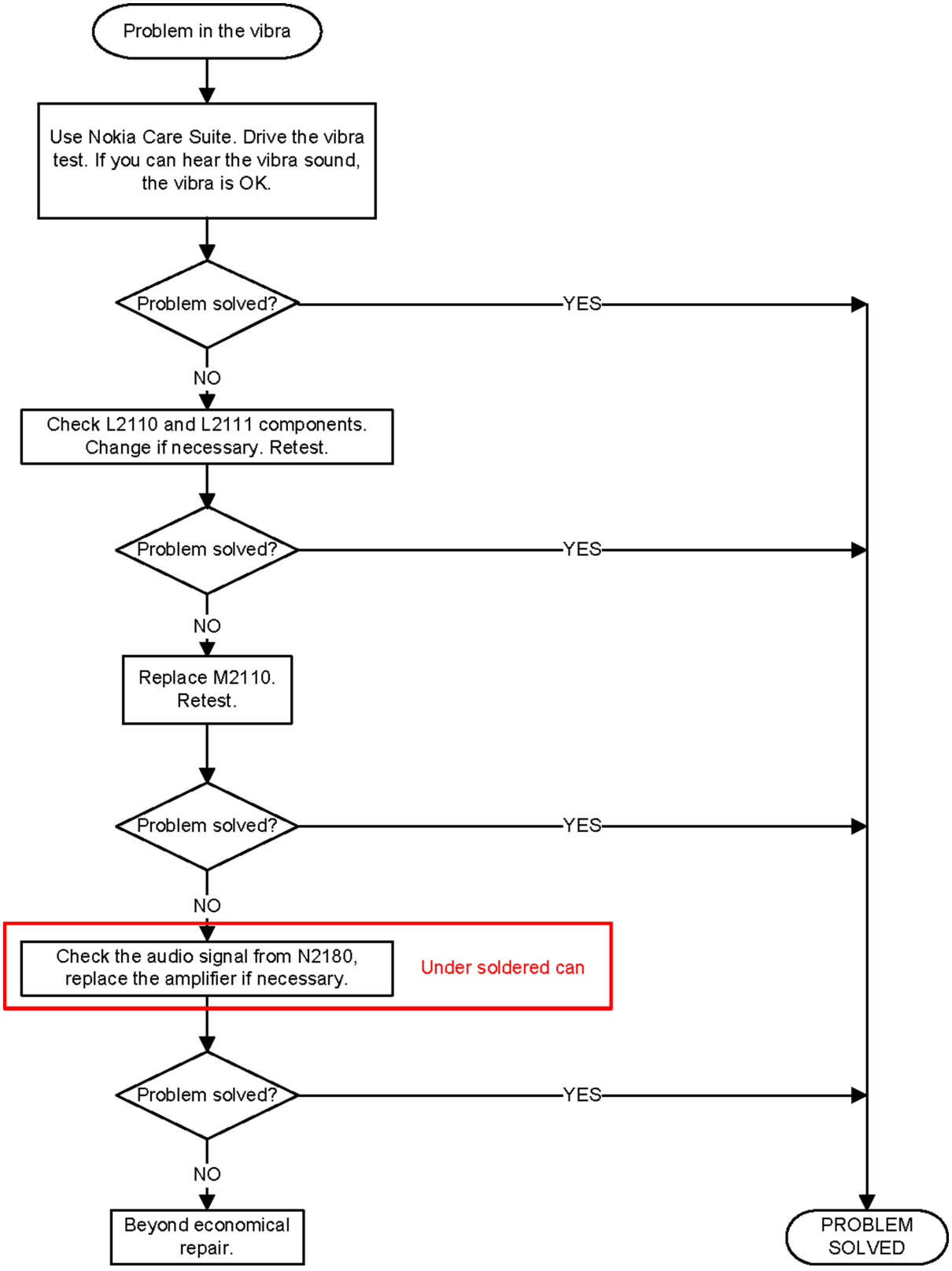
Internal microphone troubleshooting

Troubleshooting flow



Vibra troubleshooting

Troubleshooting flow



Connectivity troubleshooting

Introduction to connectivity module troubleshooting

The WCN3660 analog device supports WLAN 2 and 5 GHz, BT and FMRX. The FM RX & TX are not supported in the product. The baseband part of the connectivity functions is integrated into MSM8960. The Bluetooth and WLAN 2 GHz share the common front-end parts and FM Rx only uses headset wiring as an antenna. The Bluetooth and WLAN 2 GHz path is connected to WLAN 5 GHz path with a diplexer, only one antenna feed is needed for 2G and 5G signals. Transmitting output power level is changed according to data rate. The highest power levels are provided in 802.11b data rates.

The BT BB interface can be logically divided into a 2-line digital serial interface that supports Rx/Tx and single-wire serial bus (SSBI) for status and control. The WLAN BB interface can be logically divided into a 4-line analog baseband interface and a 5-line digital command and control interface.

The WCN3660 device uses a 48.0 MHz clock from an external crystal (B6300).

The PMIC Asic supplies the whole WCN3660 solution, 1.8V, 1,3V and 3.0V. The WCN3660 has also an on-chip LDO regulator to provide power supply to the WCN3660 1.2 V digital core. The integrated LDO input voltage is applied from the VDD_XO_1P8 voltage.

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

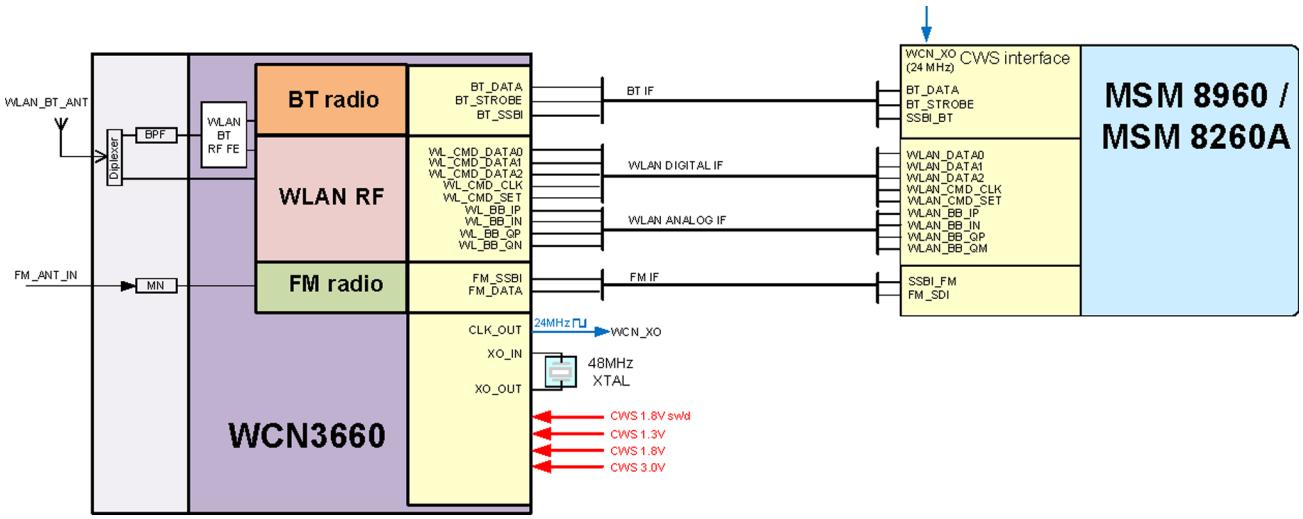


Figure 5 WCN3660 block diagram

GNSS and WLAN/BT antennas

The GNSS and WLAN/BT antennas are laser deposited on a plastic carrier and then glued into the upper-left side (GNSS) and the right upper corner (WLAN/BT) of the backside of the unibody. The WLAN 2 GHz/Bluetooth and WLAN 5 GHz are connected to the same dual band antenna.

The antenna positions are presented in the following figure.

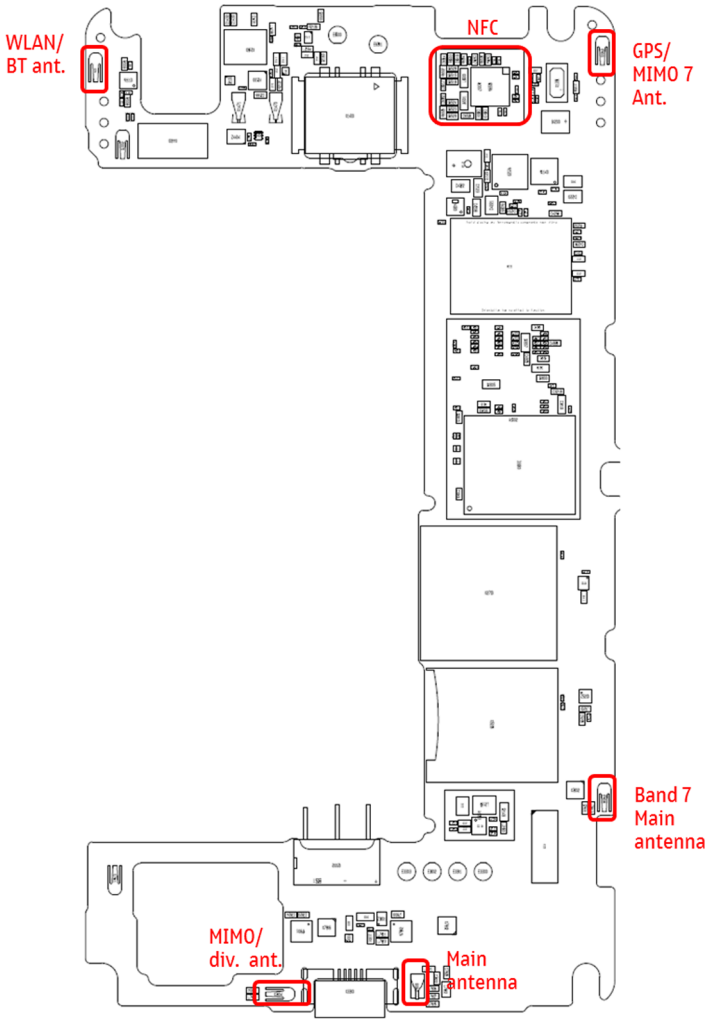


Figure 6 Antennas on component layout, bottom side

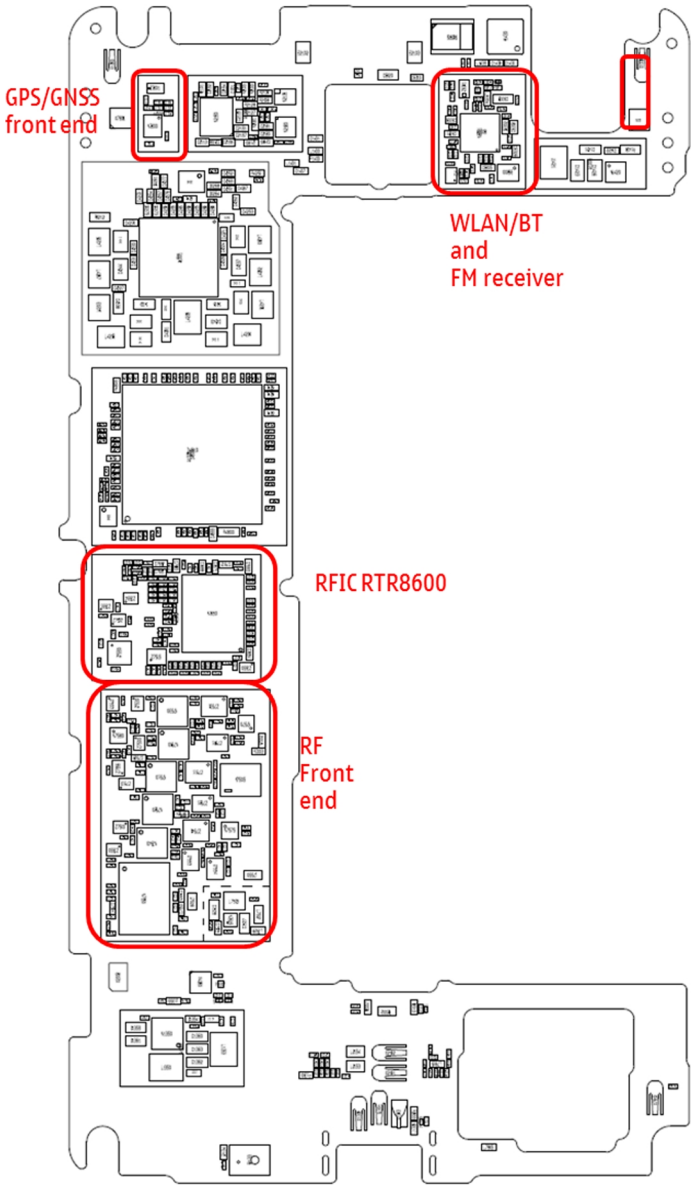


Figure 7 Component layout of the connecitivity module, top side

Bluetooth and WLAN troubleshooting

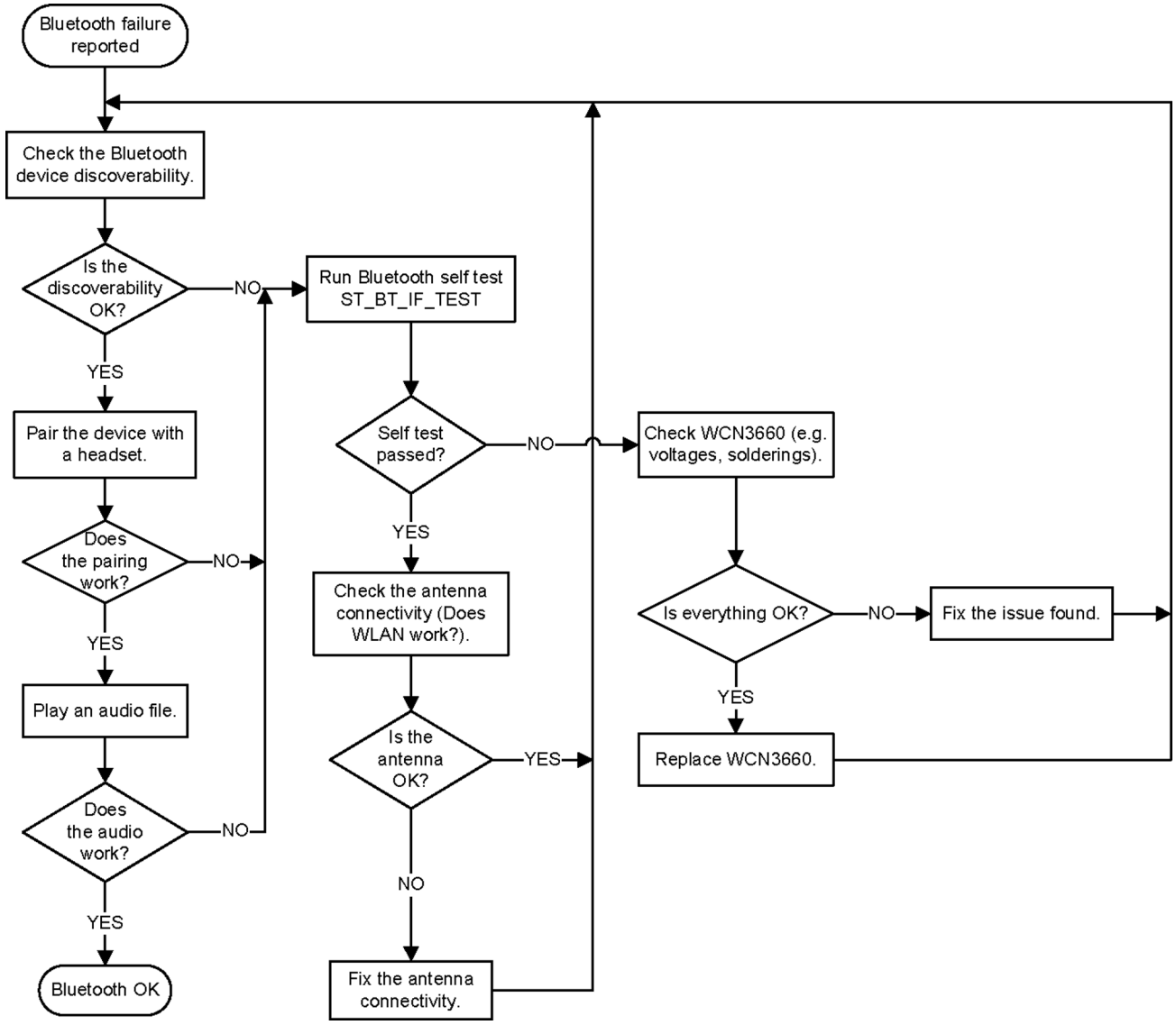
Introduction to Bluetooth and WLAN troubleshooting

The Bluetooth and WLAN functionality can be checked with the care tool. A phone data cable connected to a PC with care service SW is required.

The recommended troubleshooting procedure is described in chapter Baseband main troubleshooting (page 3–5) .

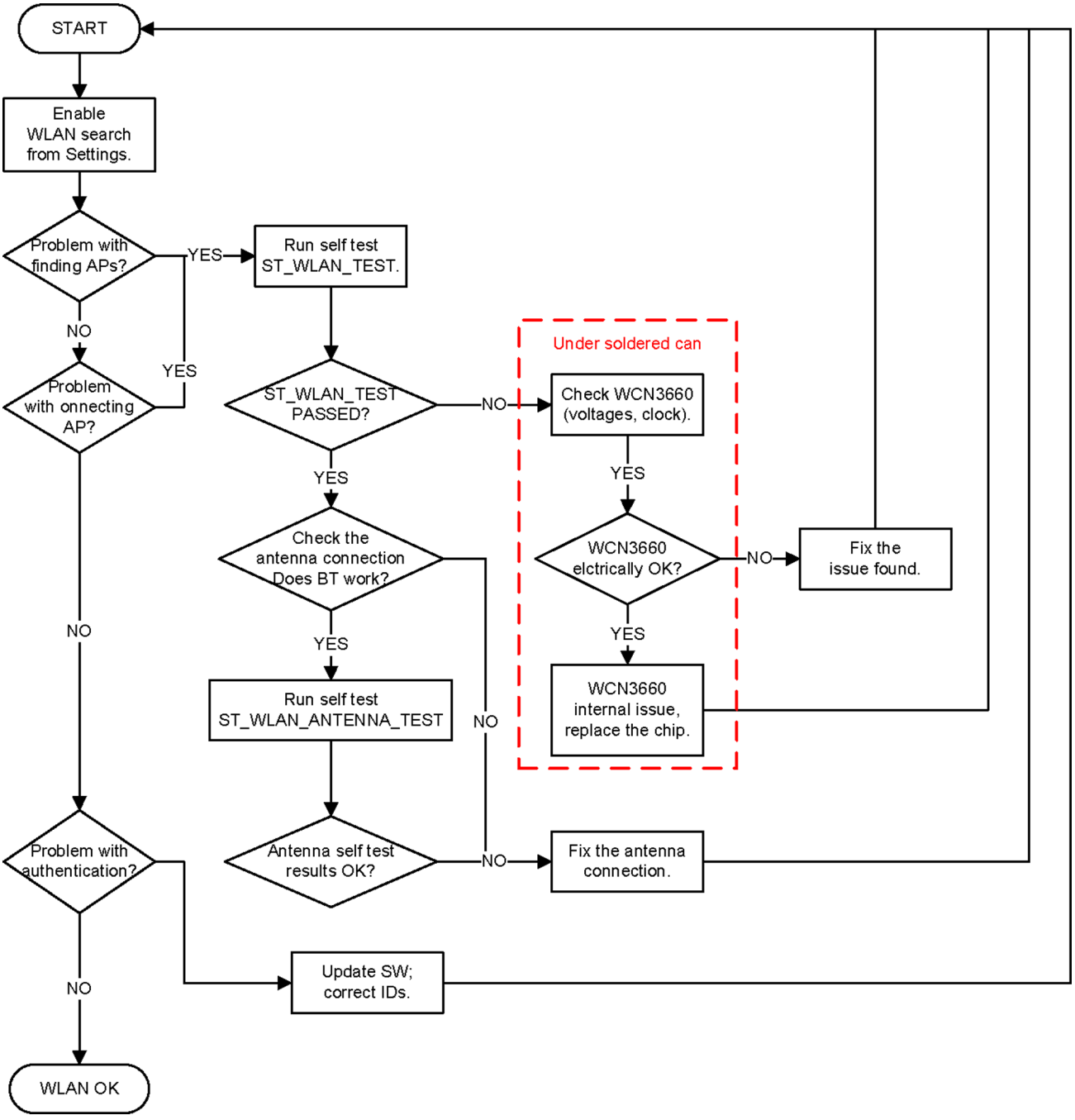
Bluetooth troubleshooting

Troubleshooting flow



WLAN troubleshooting

Troubleshooting flow



GPS troubleshooting

Introduction to GPS troubleshooting

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

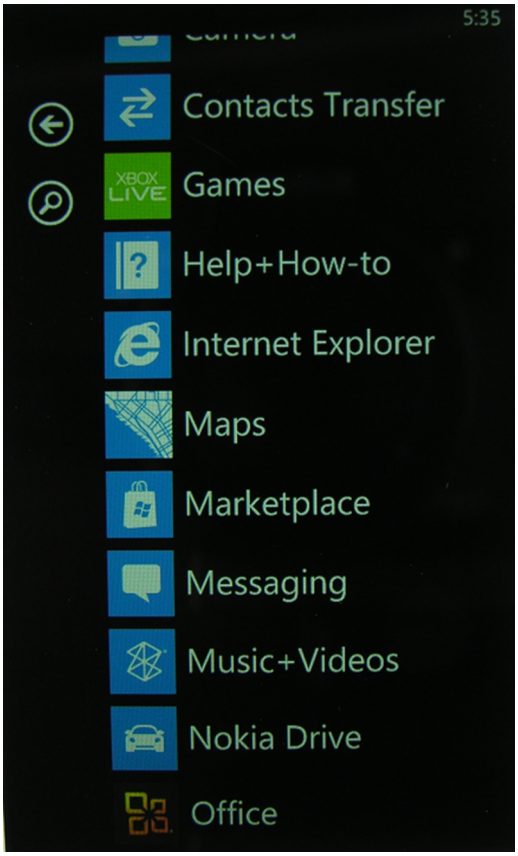


Figure 8 Phone Menu->Maps

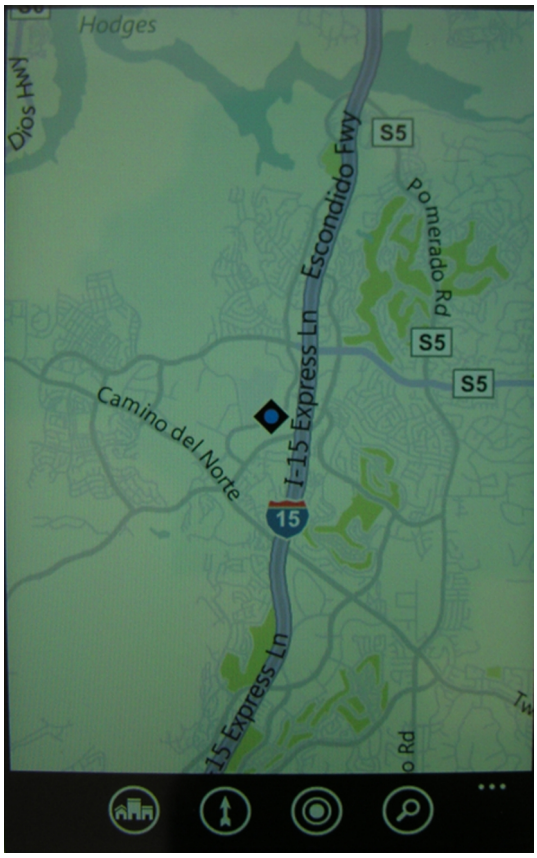
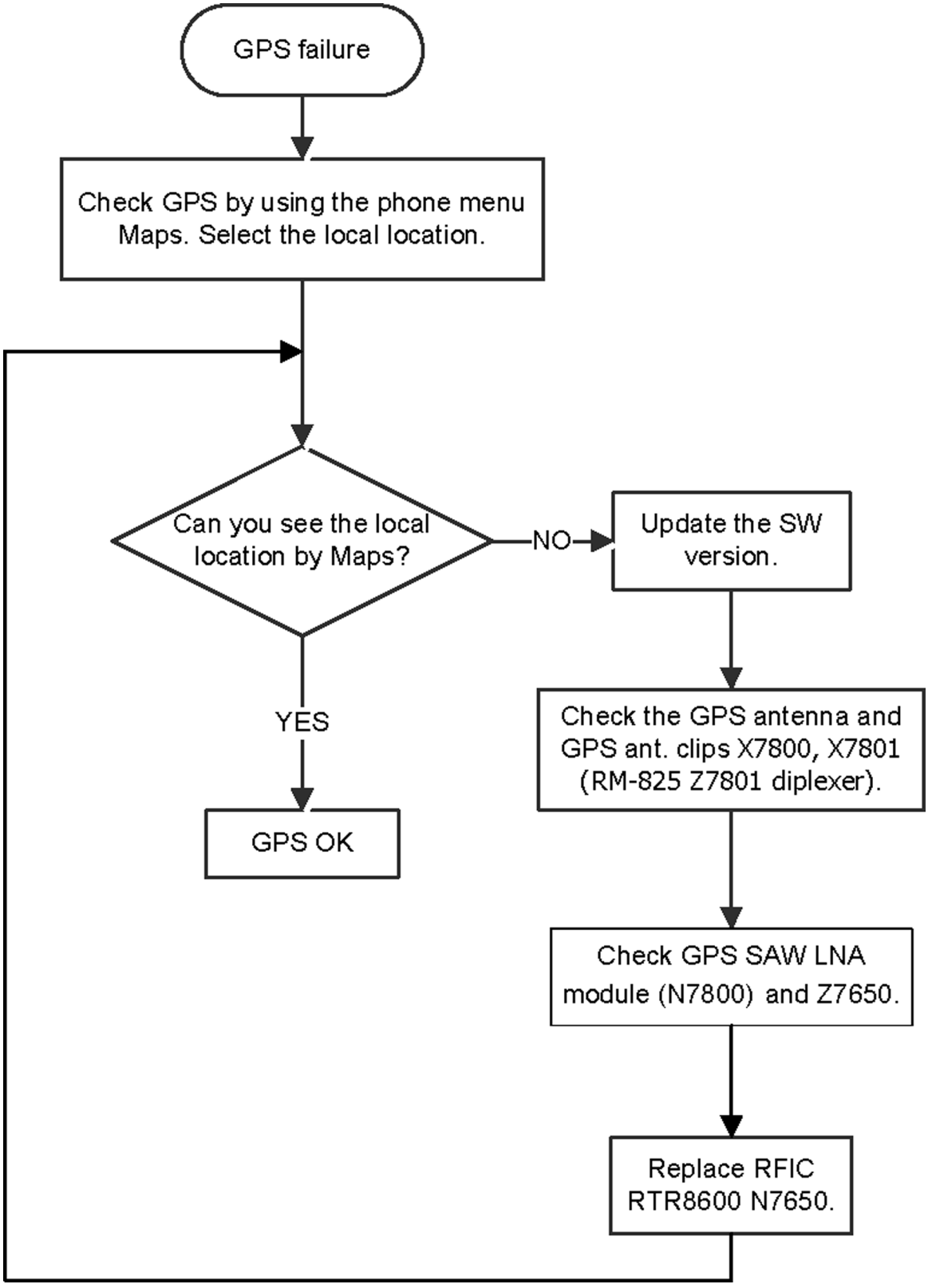


Figure 9 GPS Maps

GPS troubleshooting

Troubleshooting flow



NFC troubleshooting

Introduction to NFC troubleshooting

The NFC engine comprises a single chip mixed signal ASIC (N6500) and external matching components for a magnetic loop antenna as well as decoupling capacitors for the integrated LDO regulators.

NFC general information

NFC ASIC and most NFC block HW components are located under permanent shielding (A6500). This limits NFC HW troubleshooting methods.

The NFC HW block consists of NFC ASIC, antenna matching circuit, antenna and power supply decoupling capacitors.

The testing is performed with care service SW. The menus used are Self Tests and Near Field Communication.

The following problems can occur with the NFC hardware:

Symptom	Problem	Action	Repair solution
Unable to switch on NFC on phone user interface	Open circuit solder joints or component failure of NFC ASIC	Run self tests	Replacement of engine PWB
NFC can be switched on but communication does not work	Problem with antenna connection or matching circuit	Run self tests	Replacement of battery cover, chassis or engine PWB
Phone can read tag but Payment & Ticketing feature does not work	Incorrect SIM card fitted (SIM must contain secure element) or faulty SWP interface	Perform Single Wire test	Replacement of SIM connector or engine PWB
Poor operating distance	Damaged antenna, poor antenna connection or transmitter power supply problem	Run self tests	Replacement of B-cover or chassis

NFC test coverage

The tests listed in the table below should be performed to verify whether NFC is functional. NFC should be re-tested after repair.

Test	Test Coverage	Repair solution
Self Test: ST_NFC_TEST	NFC ASIC host interface including I2C, IRQ and FW_RESET	Replacement of engine PWB
Self Test: ST_NFC_ANTENNA_TEST	Antenna matching circuit and antenna	Replacement of antenna (battery cover) or engine PWB
Near Field Communication Test: Single Wire	SWP interface between NFC ASIC and SIM	Replacement of SIM connector or engine PWB
Near Field Communication Test: Upgrade Firmware	Check and update NFC ASIC's firmware	

The self tests run from care testing software are used for fault diagnosis.

If the care testing software is not available, the functional tests with phone accessories are sufficient to verify the functionality of NFC.

NFC self tests in care tool

Note that the battery cover must be in place when executing the NFC Antenna self tests (the NFC antenna is located in the battery cover). For this reason, the NFC Antenna self test should be done using USB connection directly to the phone mechanics. A phone USB cable connected to a PC with care service SW is required.

Near Field Communication tests in care tool

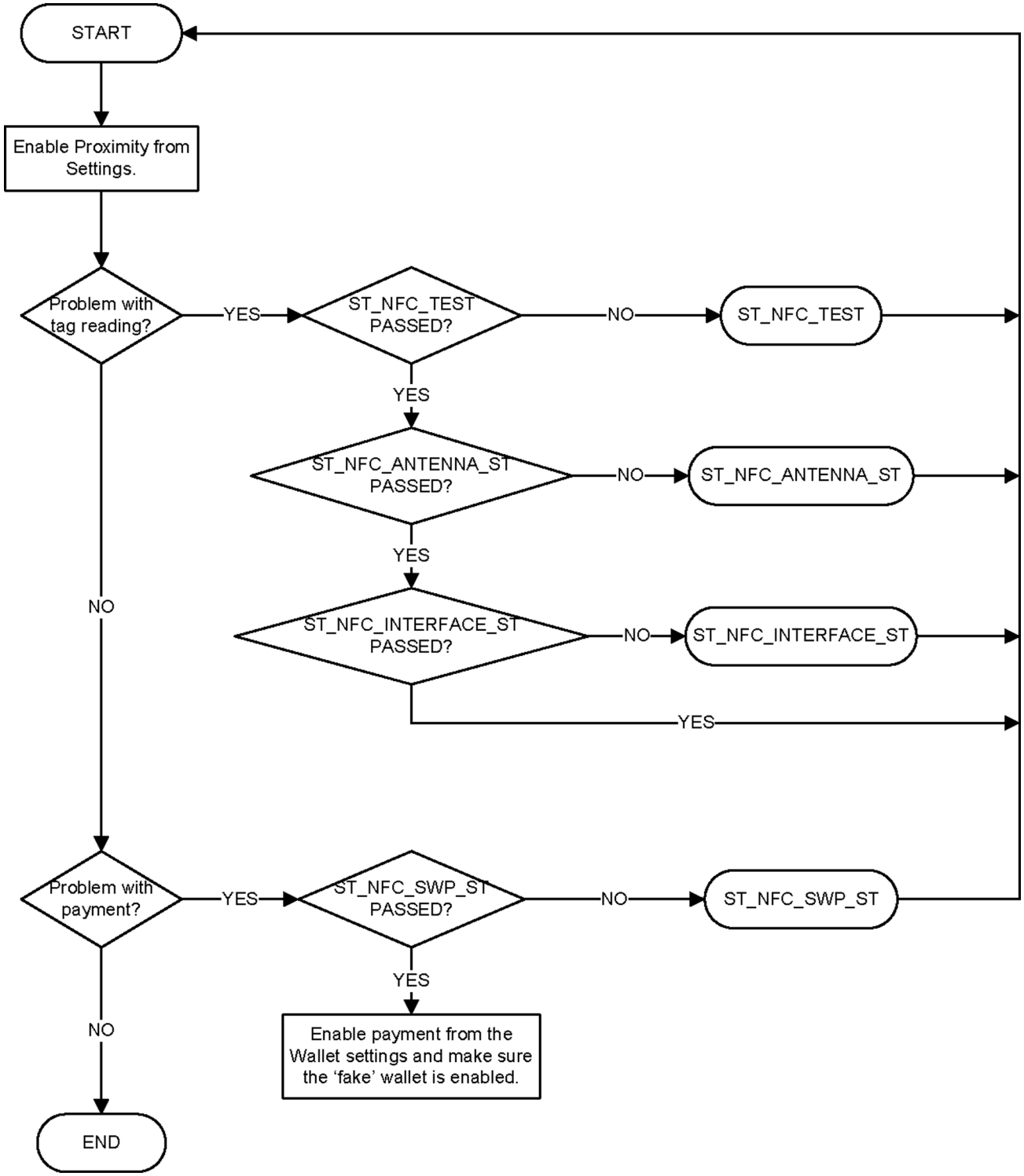
SWP functionality is tested with the Single Wire test. An SWP enabled SIM card is required for this test.

NFC ASIC contains firmware. The firmware can be updated after the phone has been manufactured. If the ASIC's manufacturer releases new firmware, it will be contained in the phone software. The NFC ASIC firmware must be upgraded every time the phone has been serviced, irrespective of the service done. The upgrading is done in the Near Field Communication test window with the Upgrade Firmware test.

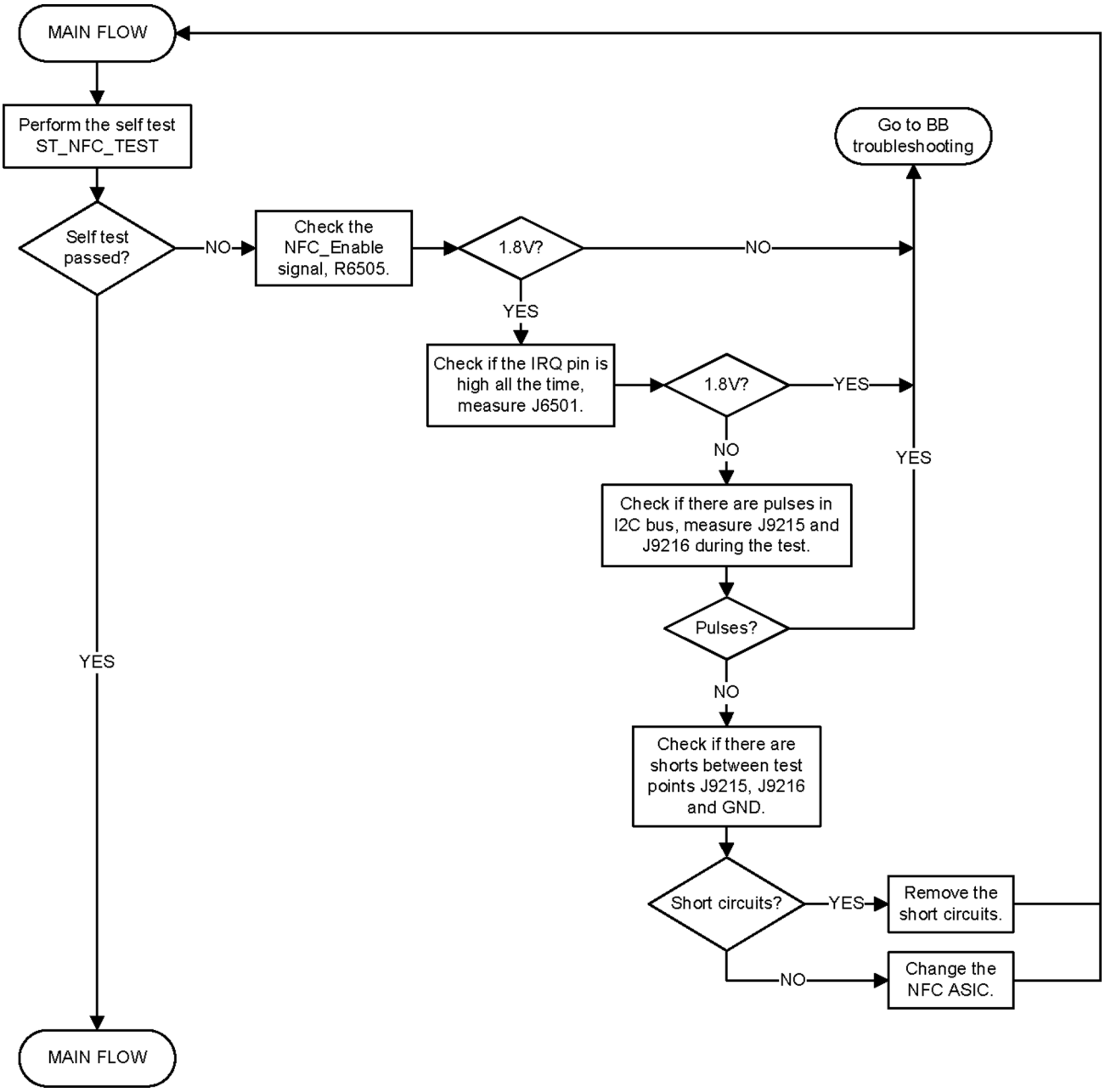
The recommended troubleshooting procedure is described in chapter Baseband main troubleshooting (page 3–5) .

NFC troubleshooting

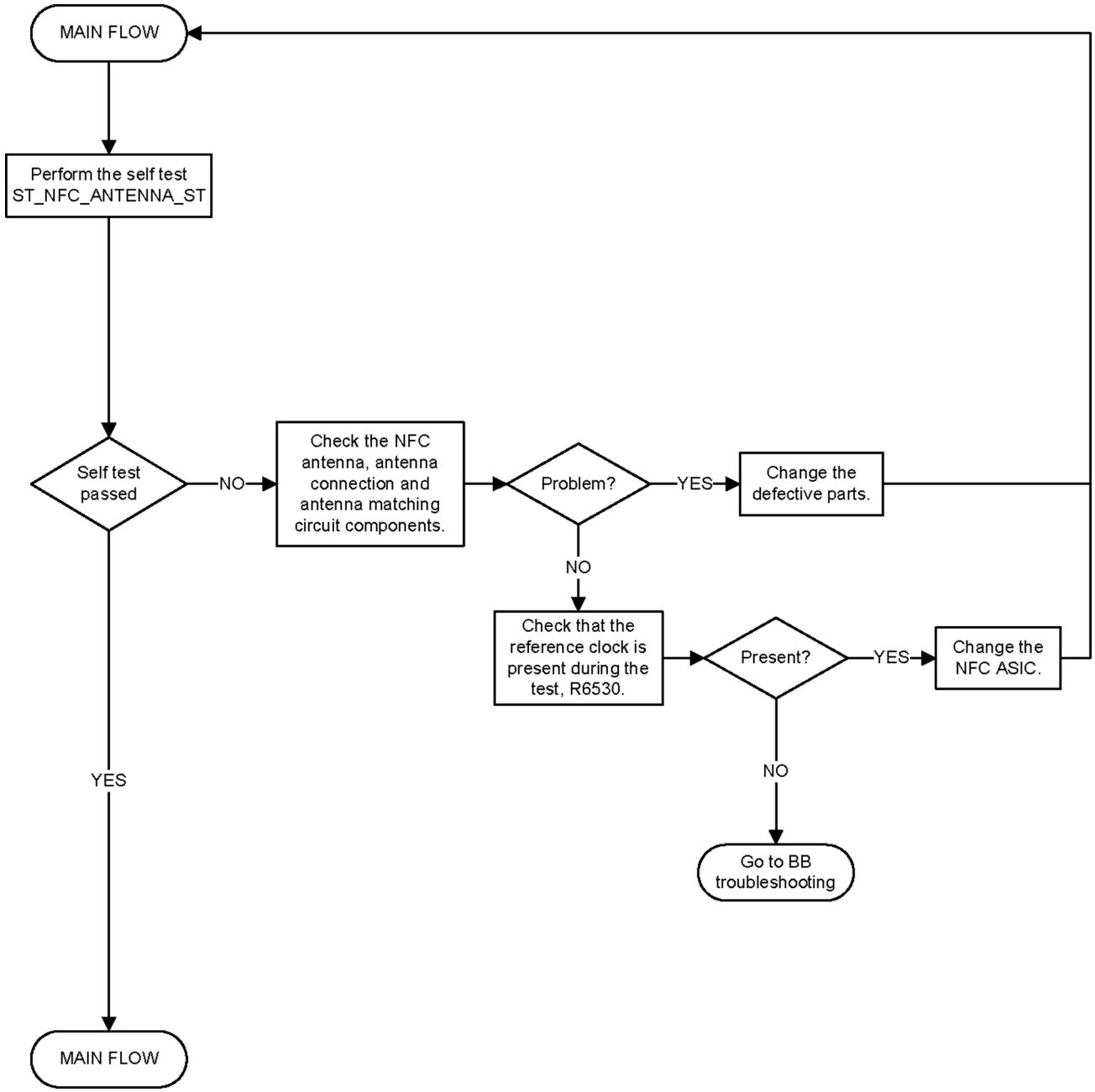
Troubleshooting flow



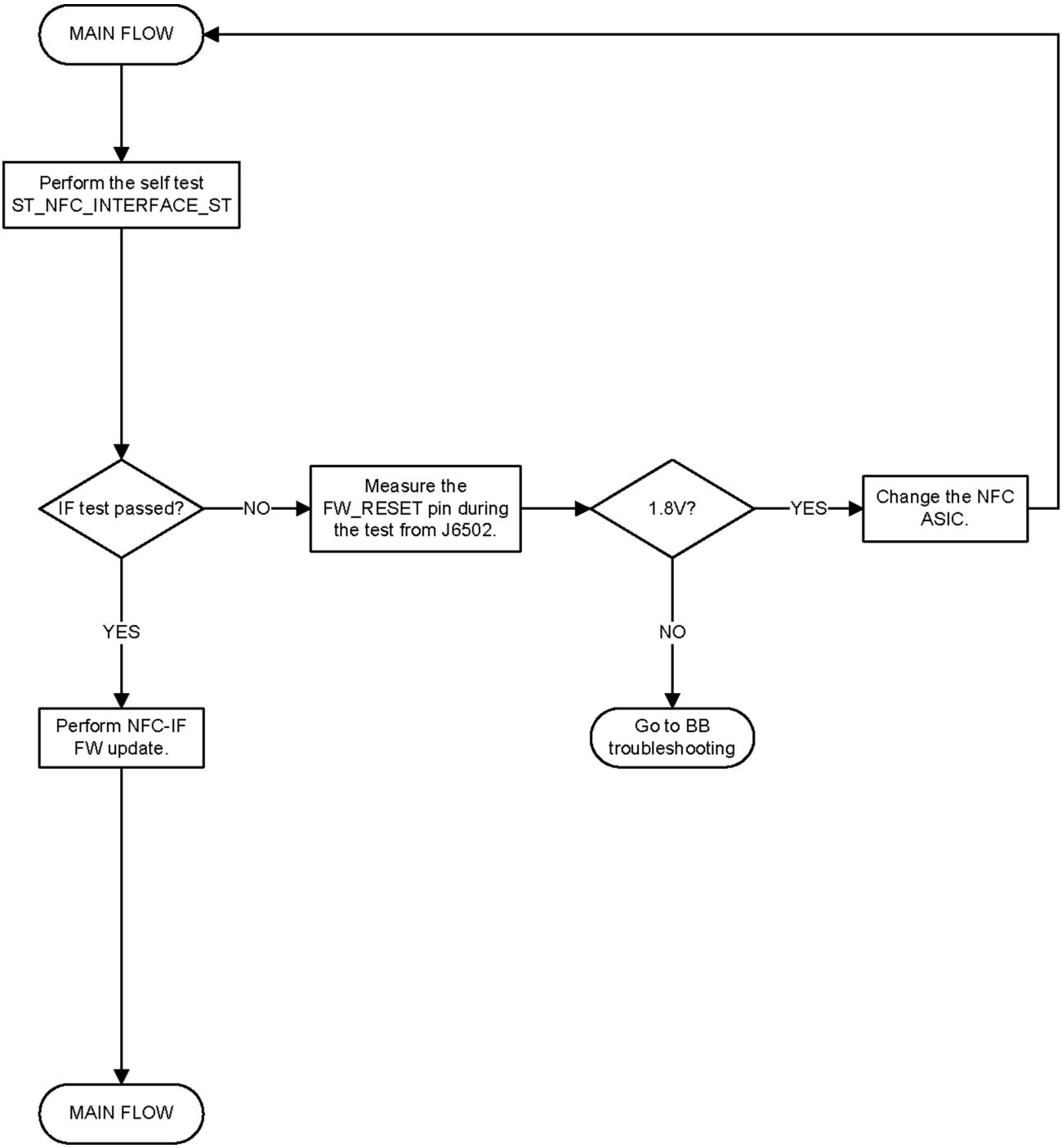
Troubleshooting flow - ST_NFC_TEST



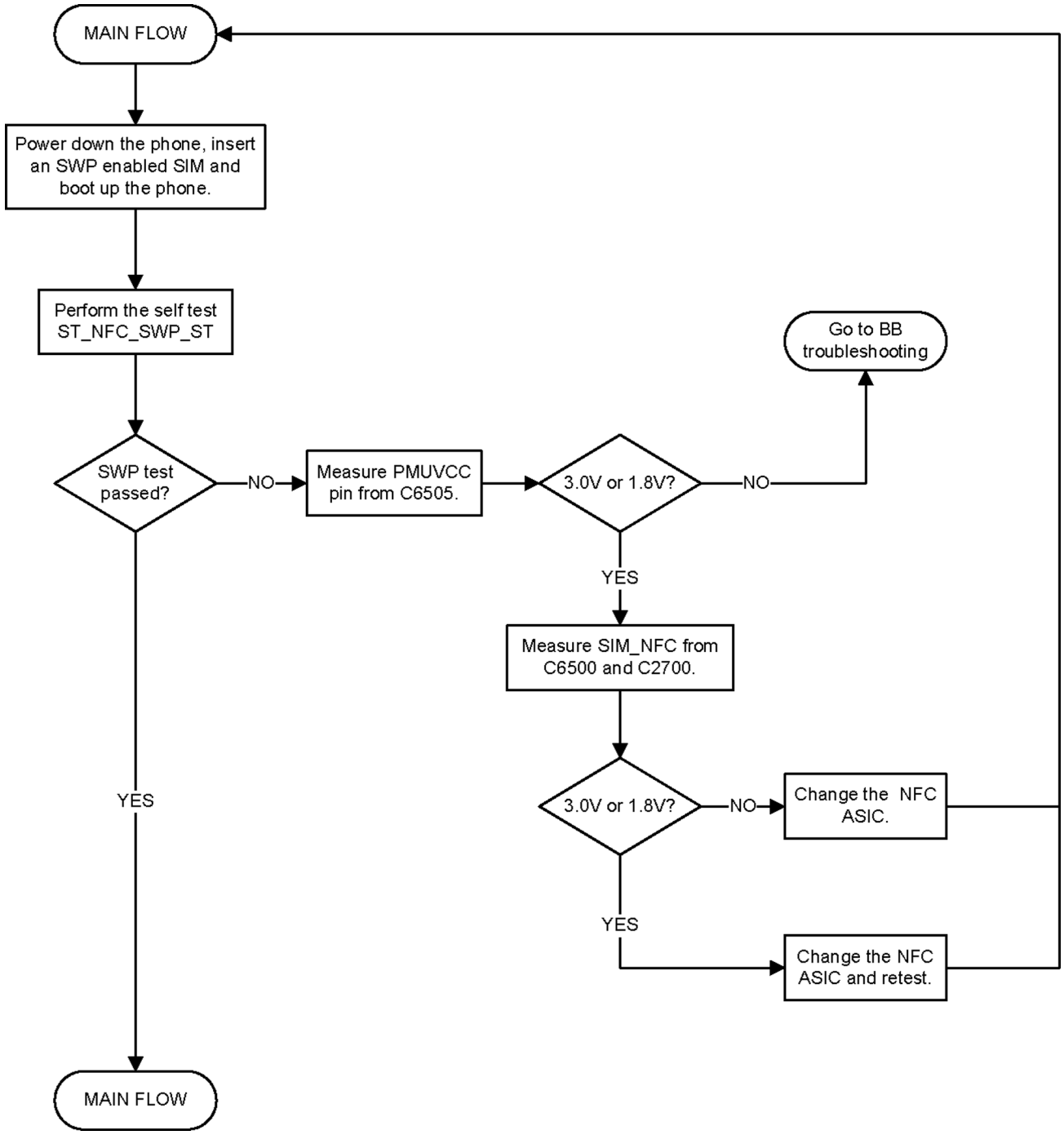
Troubleshooting flow - ST_NFC_ANTENNA_ST



Troubleshooting flow - ST_NFC_INTERFACE_ST



Troubleshooting flow - ST_NFC_SWP_ST



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4 — Cellular RF troubleshooting

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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 Willtek/Aeroflex 440x/3100, Rohde & Schwarz CMU-200 or CMW-500 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 auto tune

RF auto tune is not available for WP8 devices.

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.

Cellular RF key components

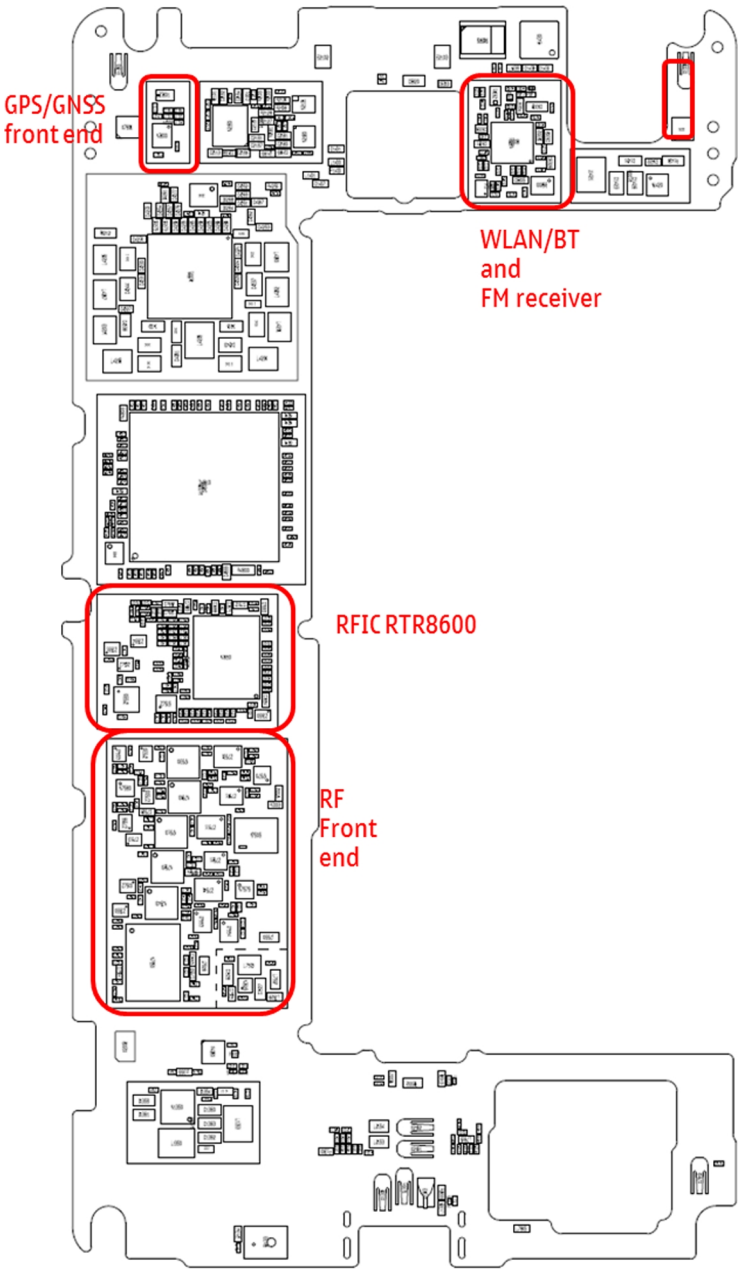


Figure 10 RF key component layout, top side

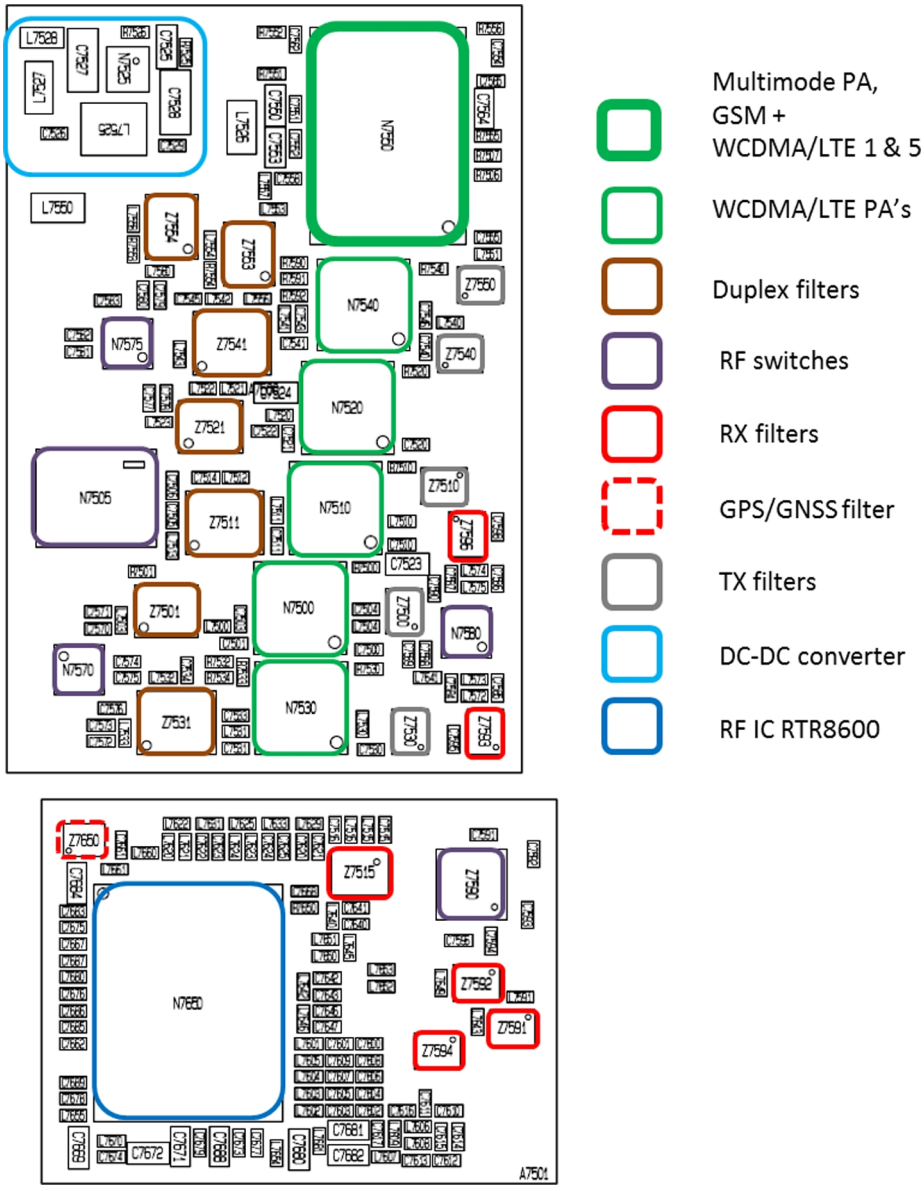


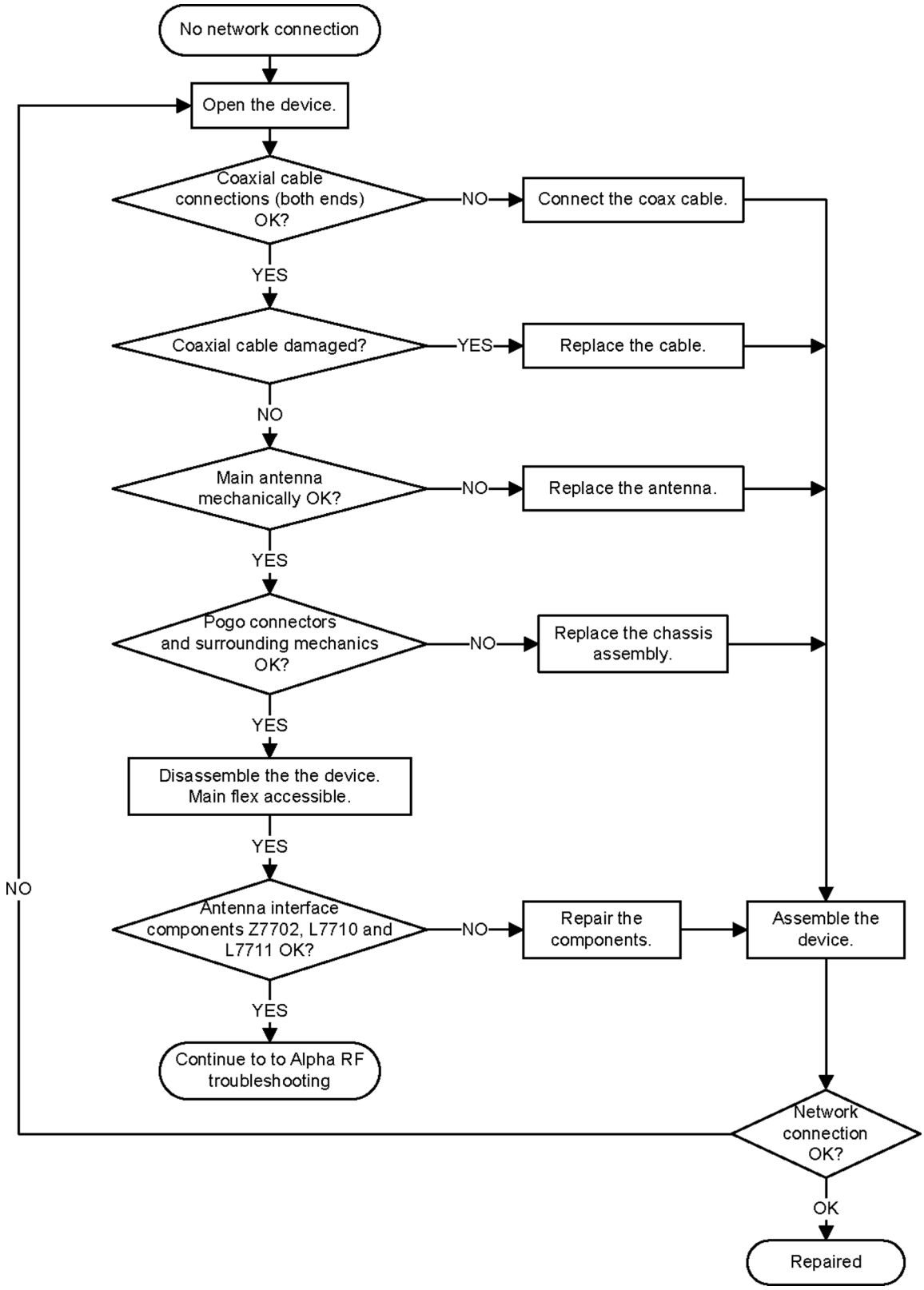
Figure 11 RF key components

Cellular RF main troubleshooting

Context

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

Troubleshooting flow — Page 1 of 2



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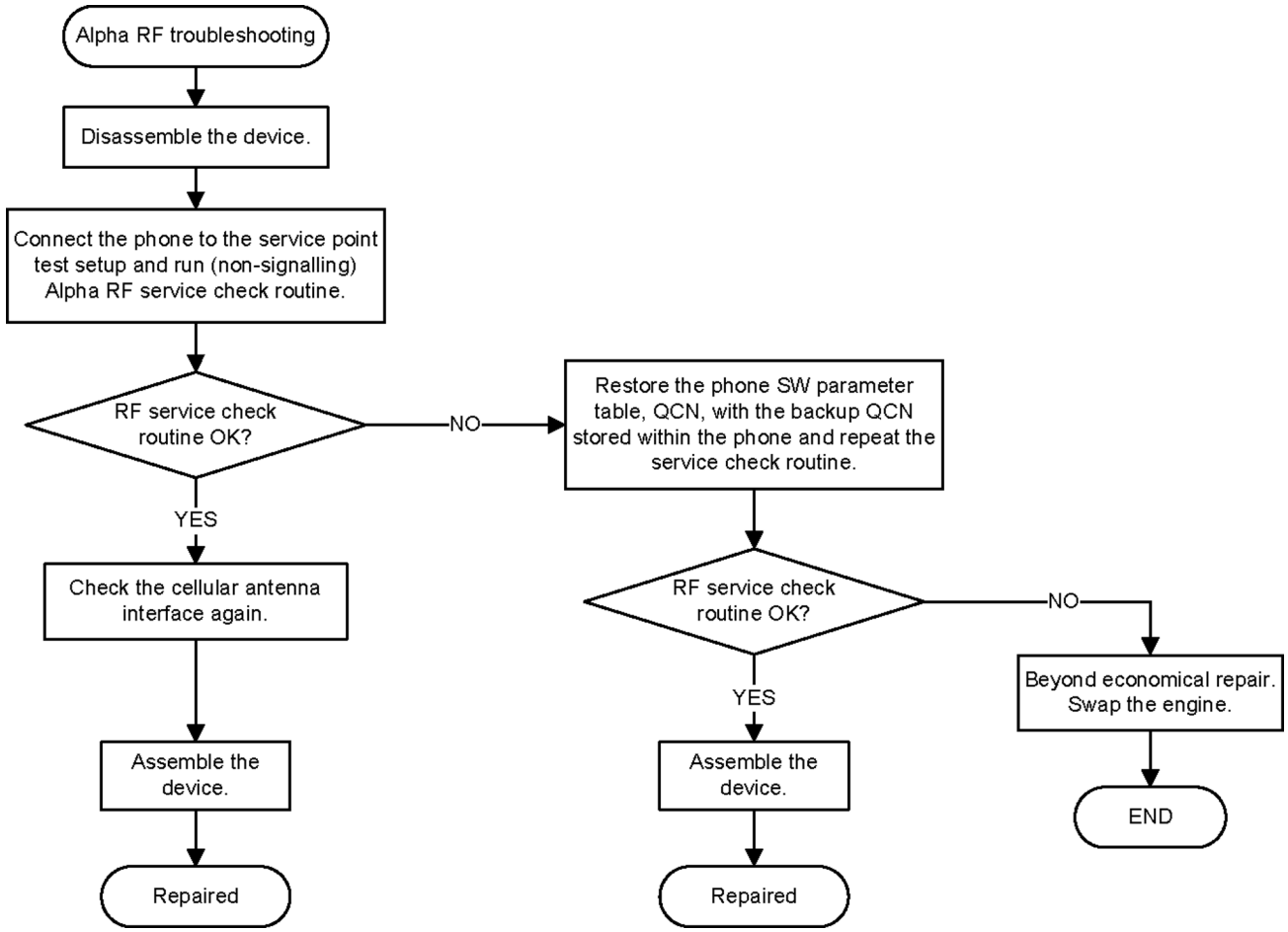


RF testing

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

Antenna

Antenna overview

The phone has five different antenna assemblies:

- The main antenna which is placed at the bottom of the phone
- A MIMO/diversity antenna which is placed on the side of the phone
- A GPS/LTE7 MIMO antenna which is placed at the top of the phone
- WLAN/BT antenna which is placed at the top of the phone
- NFC antenna which is placed on the battery cover

The main antenna covers four GSM bands (GSM850, GSM900, GSM1800, and GSM1900), four WCDMA bands (WCDMA 8, WCDMA 5, WCDMA 2, and WCDMA 1), and four LTE bands (LTE 1, 3, 8 and LTE 20), and has separate antenna feeds for low and high band. The antenna radiators are deposited on a plastic carrier with LDS technology and connected to the board through standard C-clips. The antenna module also functions as an acoustic chamber that has a Donau IHF speaker.

The MIMO/diversity antenna covers four LTE bands (LTE 1, 3, 8 and LTE 20) and four WCDMA bands (WCDMA 8, WCDMA 5, WCDMA 2 and WCDMA 1). The antenna is a dual-feed antenna supporting low bands (LB) and high bands (HB) separately. The antenna radiators are deposited on a plastic carrier with LDS technology and connected to the board through standard C-clips. The signal from the HB antenna is connected to a diplexer through a 60 mm long stripline. The HB branch is then diplexed with the LB branch to the secondary receiver.

The GPS/LTE7 MIMO antenna covers GPS and LTE7 bands (RM-825). The antenna radiator is deposited on a plastic carrier with LDS technology and connected to the board through standard C-clips. A diplexer is used to connect the GPS/LTE7 MIMO antenna to the respective RF engines.

The NFC antenna consists of a flexi and a ferrite-sheet and is attached to the top of the B-cover with adhesive. Connection to the main PWB is implemented by two pogo pins.

Each of the antenna assemblies is glued into the unibody.

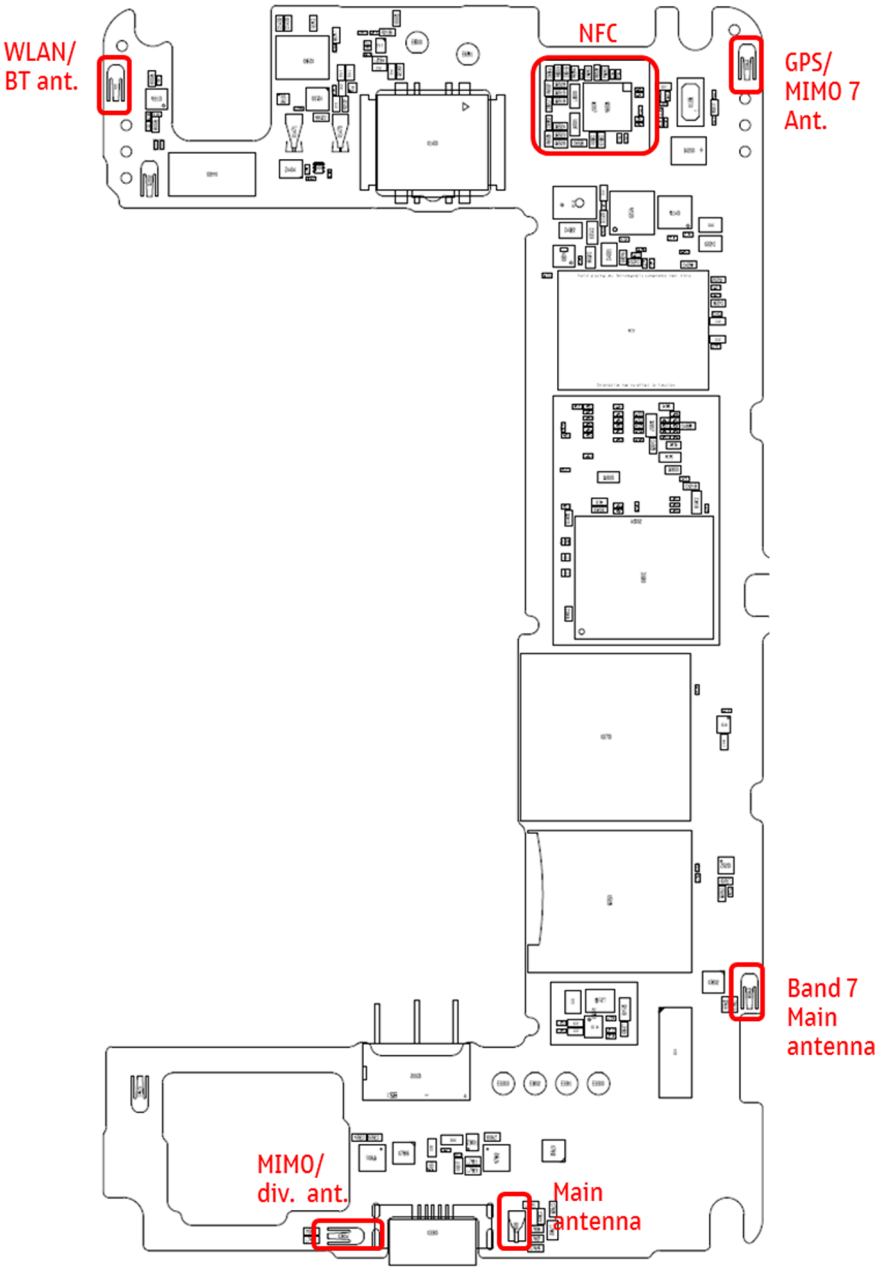


Figure 12 Antennas on the component layout, bottom side

Antenna troubleshooting

All antennas are glued into the unibody and the radiators are visible only around contact areas. Check the areas where the C-clips touch the radiator for mechanical damage. If the antenna, LDS radiator of the feed pad on antenna looks obviously damaged, replace the entire unibody. If replacing the unibody does not correct the problem, check for further mechanical damage and repair. Any damage to the groundings can impact antenna performance and should be repaired. The following diagram describes the antenna related mechanical grounding connections that may need repair.

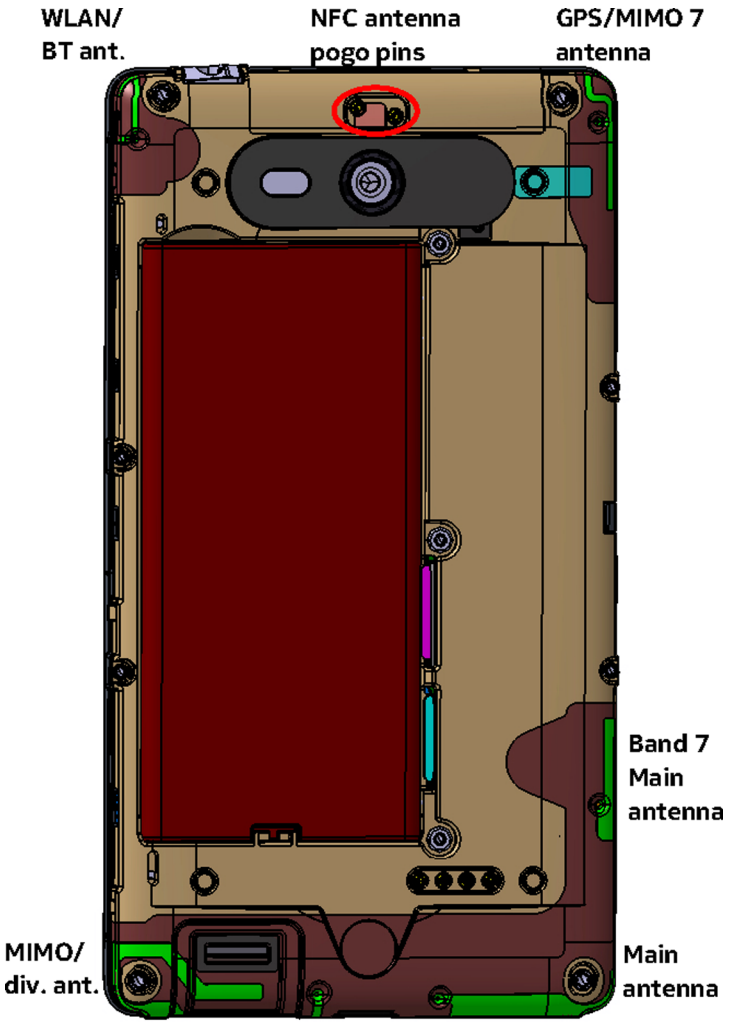


Figure 13 Antennas

Check all ground connections for mechanical damage. Determine if they can be repaired.

The antennas and IHF speaker are connected to the PWB with C-clips. Inspect the PWB for damage to any of the antenna and IHF C-clips. If the C-clips 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 unibody replaced.

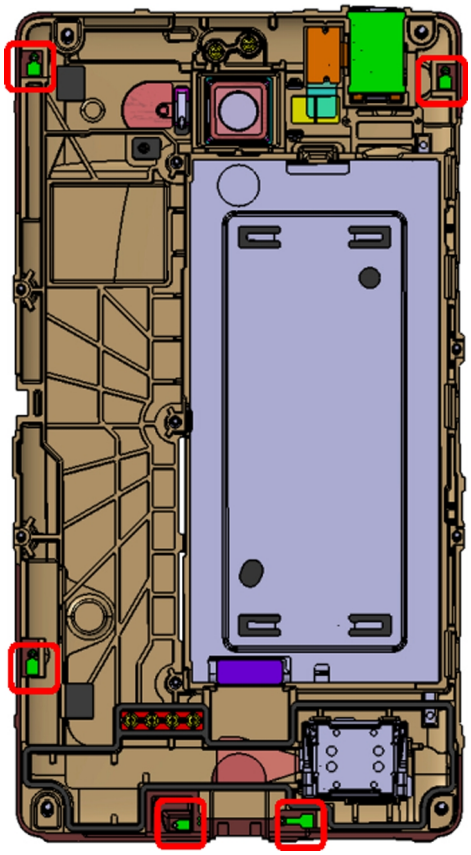


Figure 14 Antenna contact areas

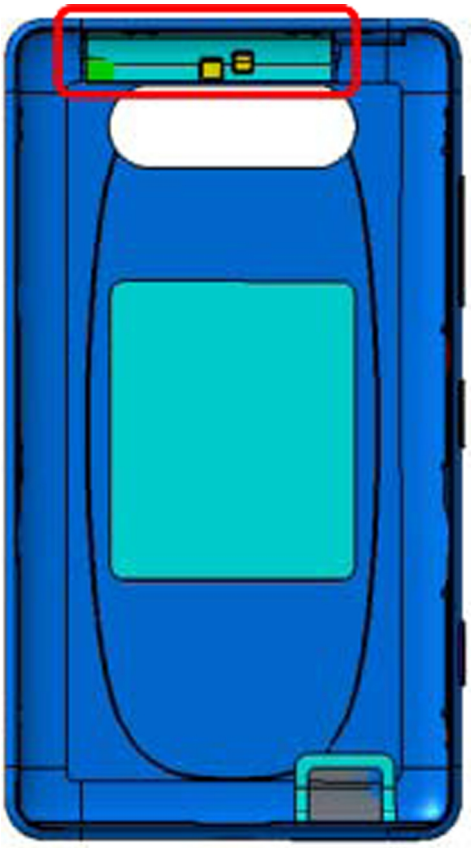
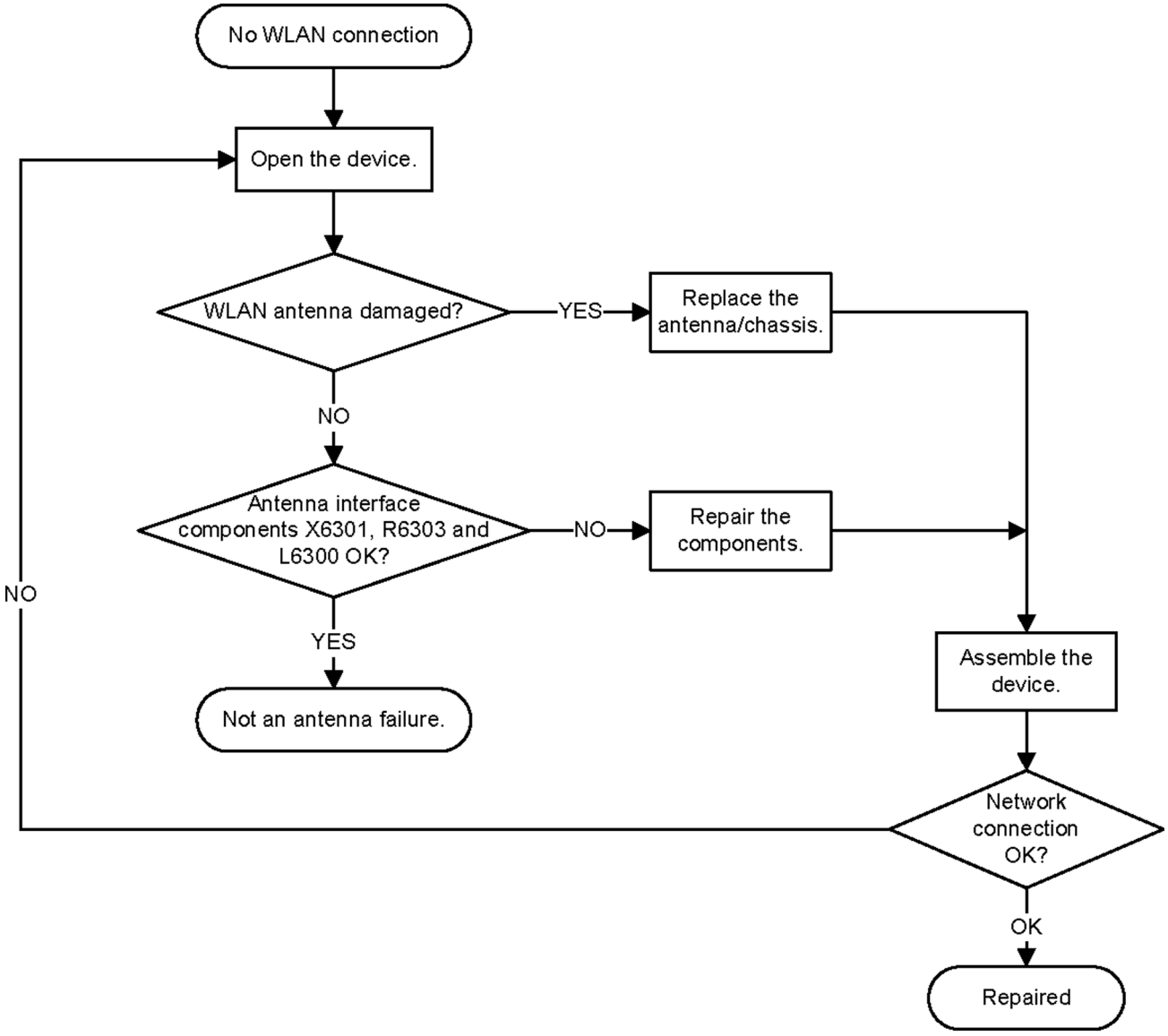


Figure 15 NFC antenna in battery cover

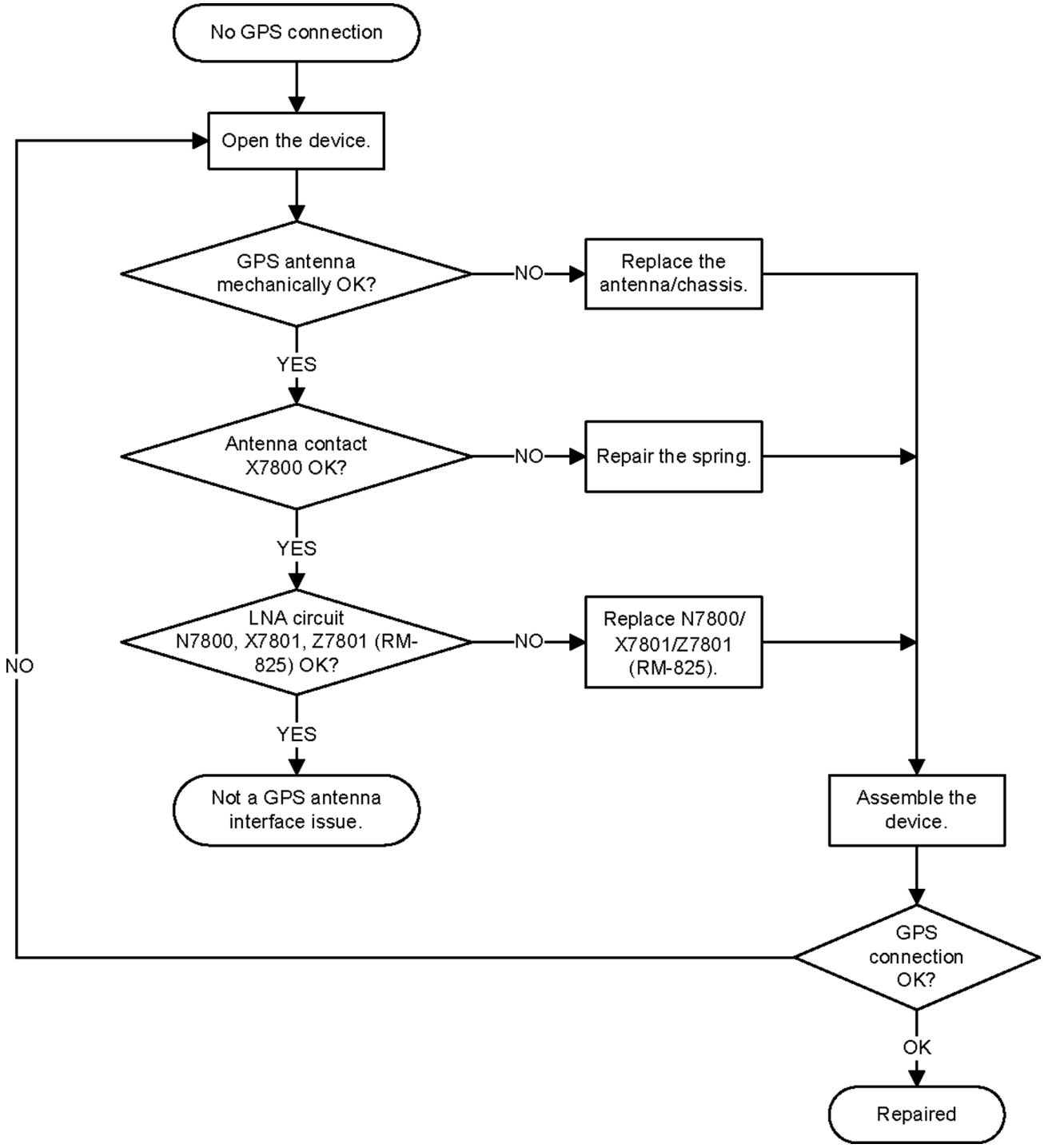
WLAN antenna troubleshooting

Troubleshooting flow



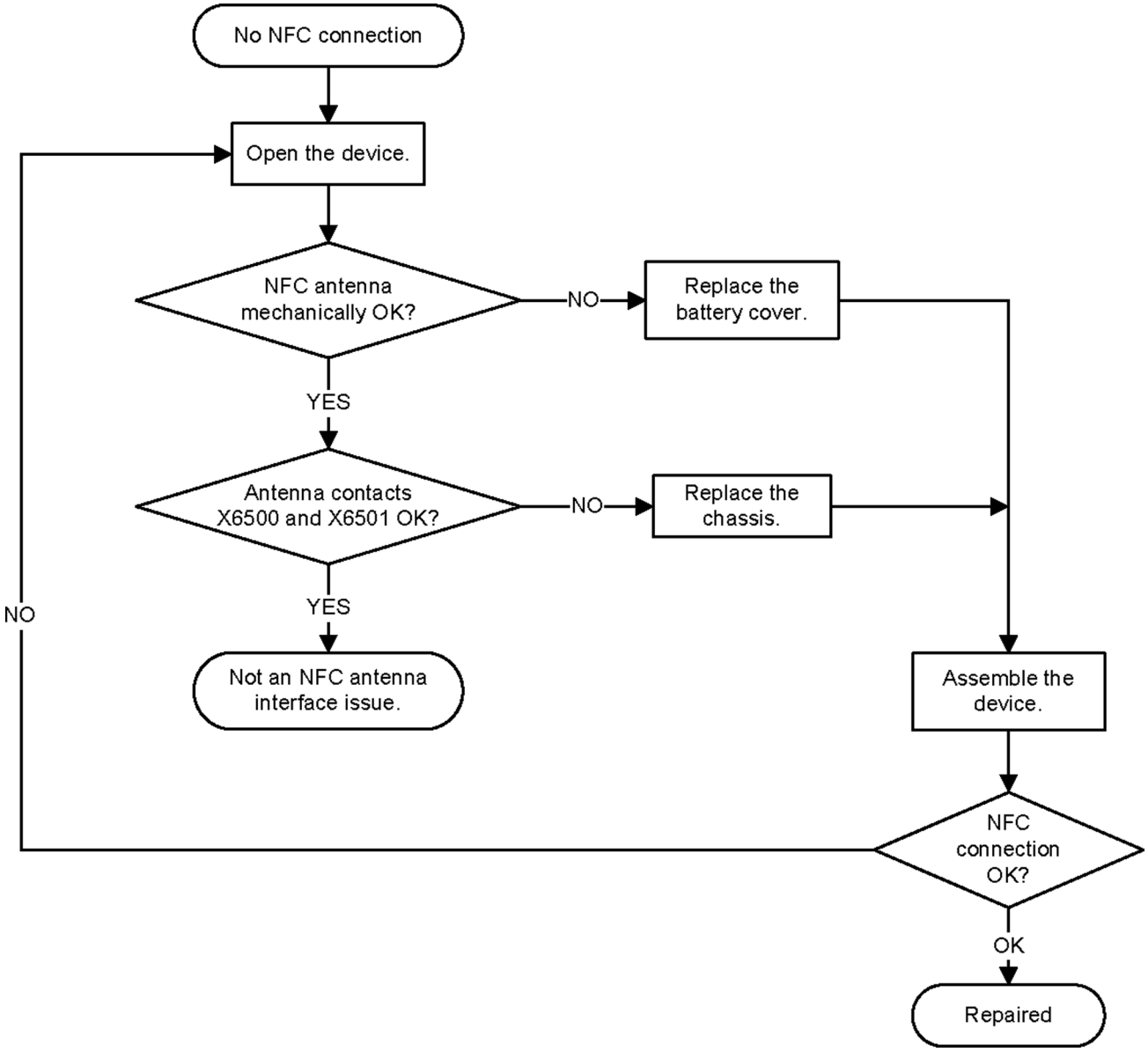
GPS antenna troubleshooting

Troubleshooting flow



NFC antenna troubleshooting

Troubleshooting flow



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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 categorised 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 analysing 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 upscaling 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.

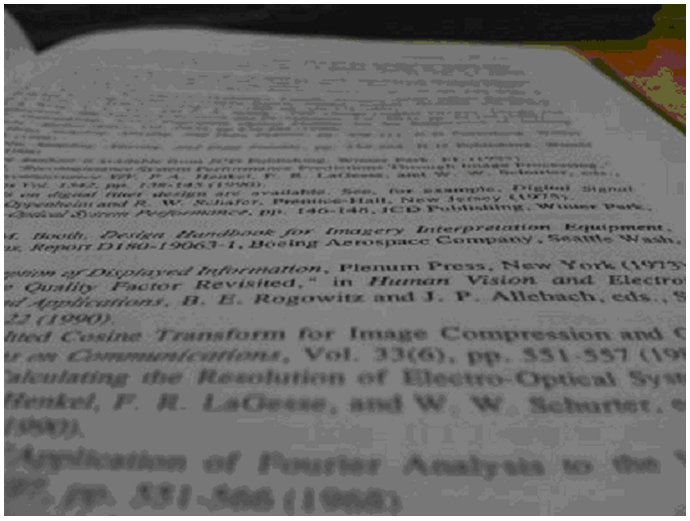


Figure 16 Only center part of image is in focus due to limited depth of focus

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.

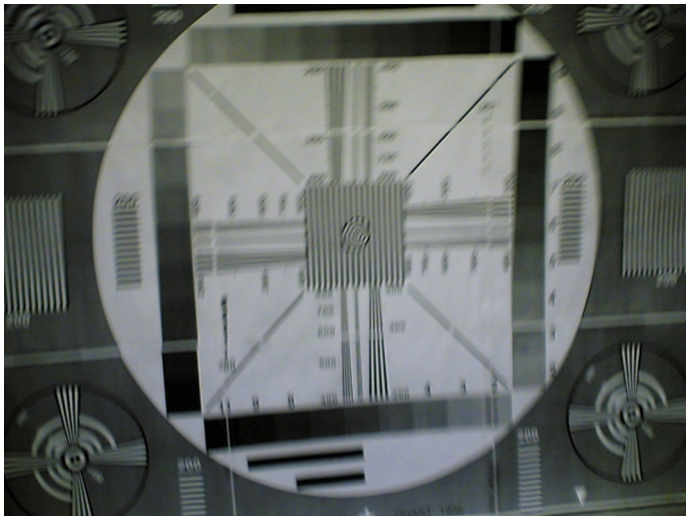


Figure 17 Blurring caused by shaking hands

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 18 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 19 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 behaviour; 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 appear 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 behaviour; do not change the camera module.

Figure 20 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 behaviour; do not change the camera module.

Figure 21 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 this kind of reflections are common in all optical systems. This is normal behaviour; do not change the camera module.

Figure 22 A lens reflection effect caused by sunshine

Examples of good quality images

Figure 23 Good image taken indoors

Figure 24 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 analyse 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 analysing, 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 25 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 analysed 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.

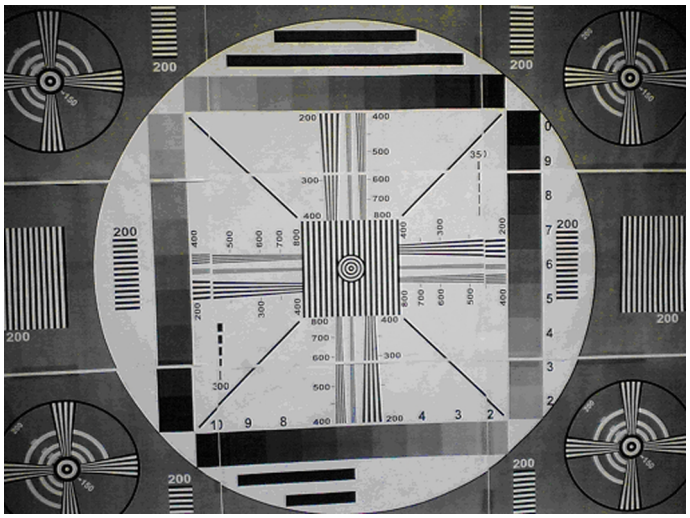


Figure 26 Image taken with clear protection window

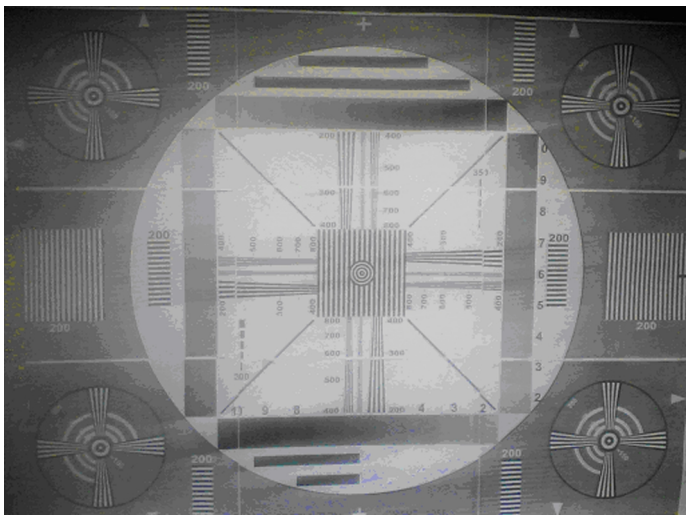


Figure 27 Image taken with greasy protection window

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 28 Image of point light sources taken with a clean protective window

Figure 29 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 surrounding. 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.

Figure 30 Enlargement of a hot pixel

Flash photography problems

Use of flash device may affect the image in many ways.

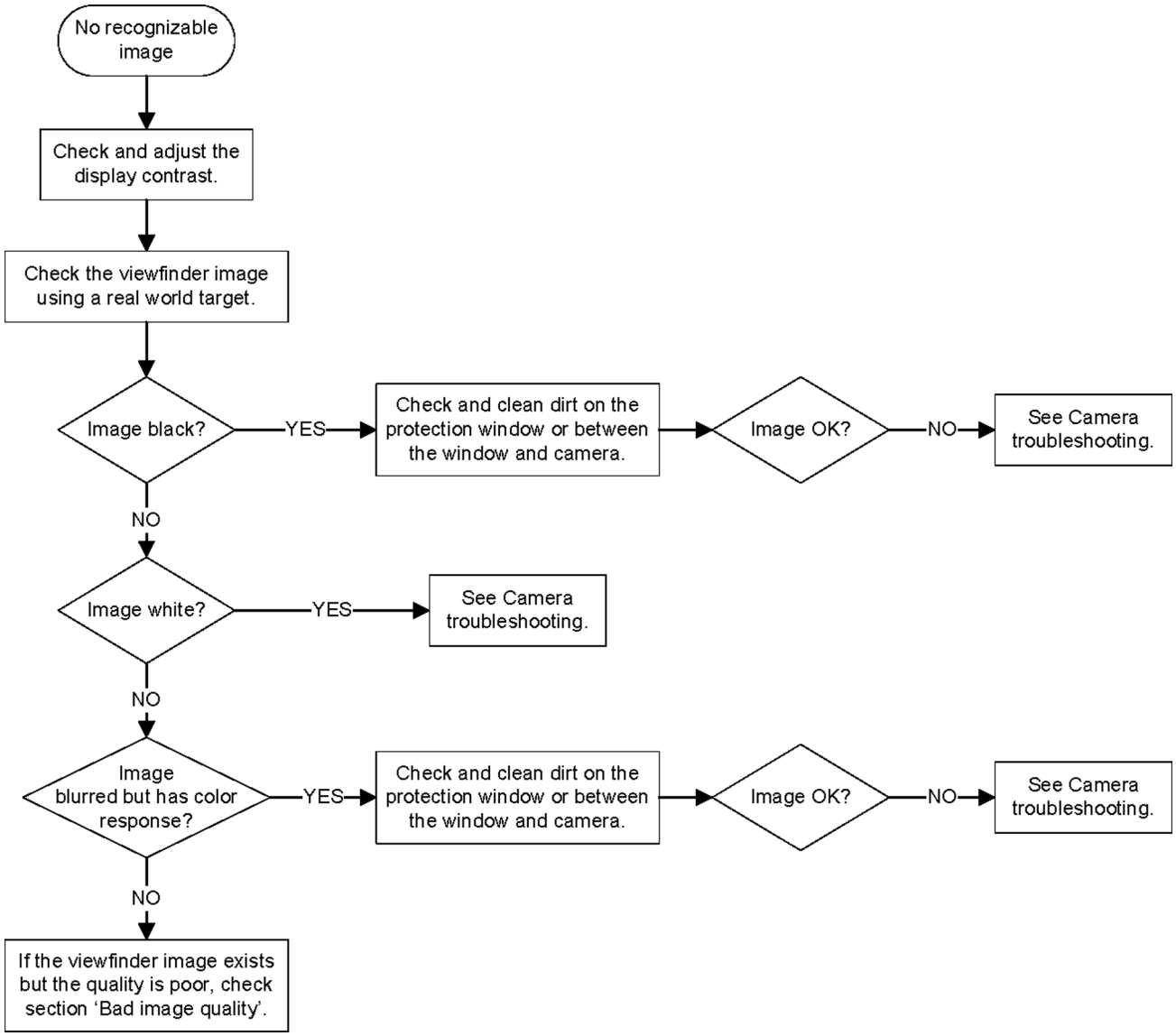
- White balance errors. The image may get a wrong tone due to mixing of flash colour temperature and ambient lightning. This is unwanted but normal feature.
- Dust reflections. Dust or water drops in front of the flash unit may reflect strongly to the camera sensor. See the following figure.

Figure 31 Light from the flash has reflected on particles in front of the camera

Camera troubleshooting flowcharts

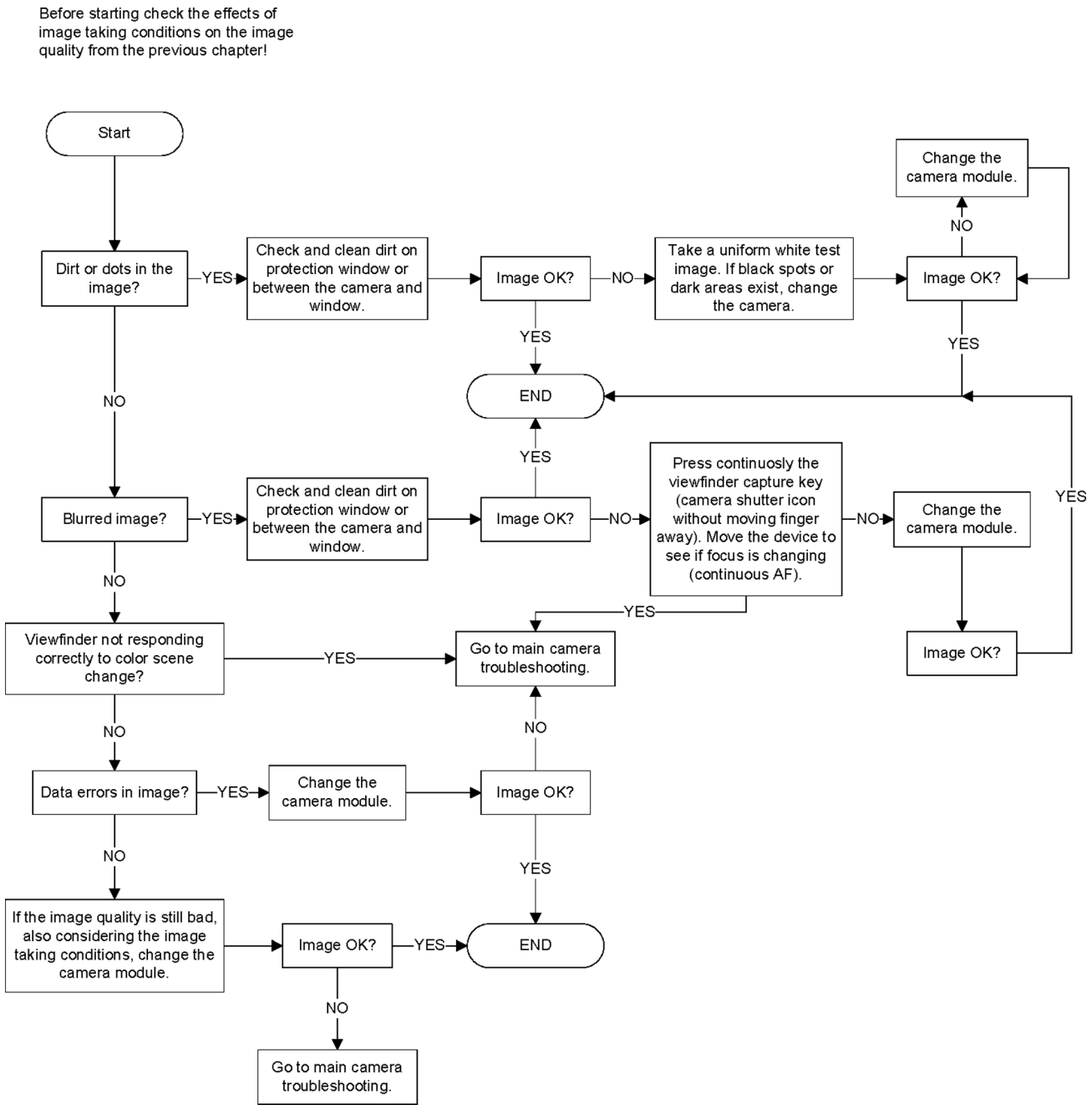
No recognizable viewfinder image

Troubleshooting flow



Bad image quality troubleshooting

Troubleshooting flow



Main camera, camera flash and front camera troubleshooting

Main camera troubleshooting

Context

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

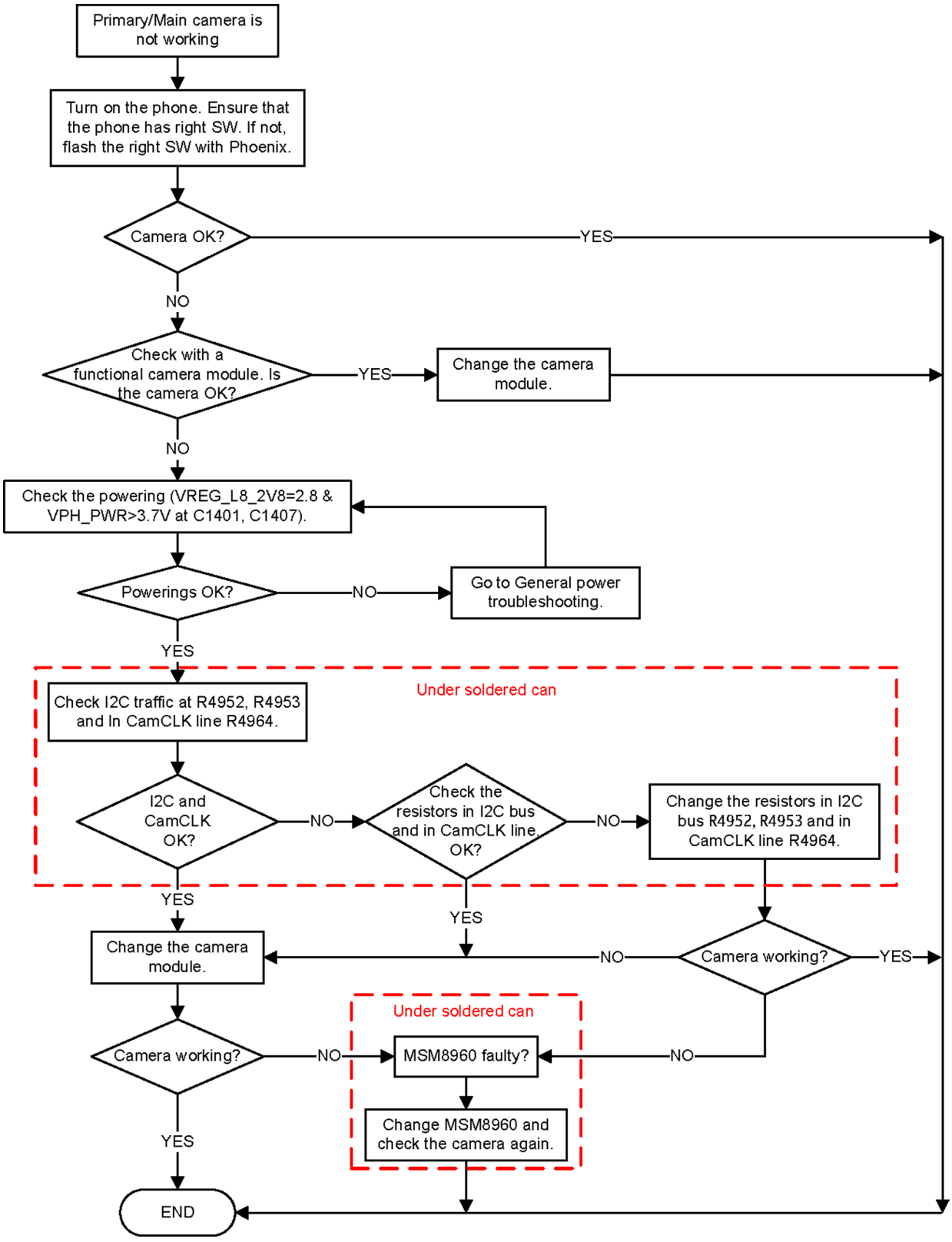
In case of image quality (IQ) related problems:

- 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:

- Measure the camera fuse F1400 and change it if needed. If the fuse is broken change also the camera module.
- Visually inspect component/PWB damages
- Change the main camera and test again

Troubleshooting flow



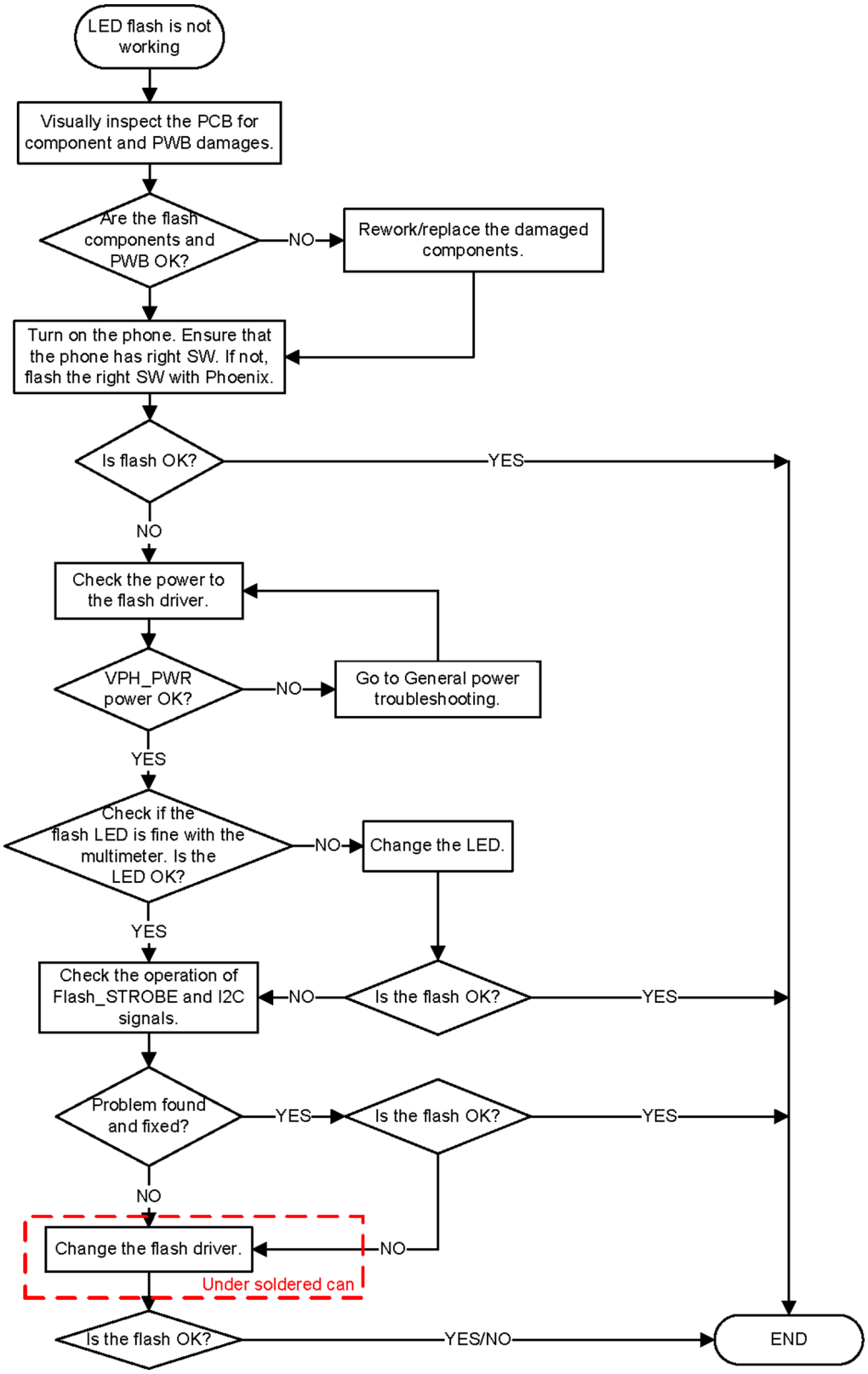
Camera flash troubleshooting

Context

When the LED flash is not working:

- Visually inspect component/PWB damages
- Check the flash LED contact springs
- Check the flash LED with a multimeter. If the LED is broken change the unibody (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.

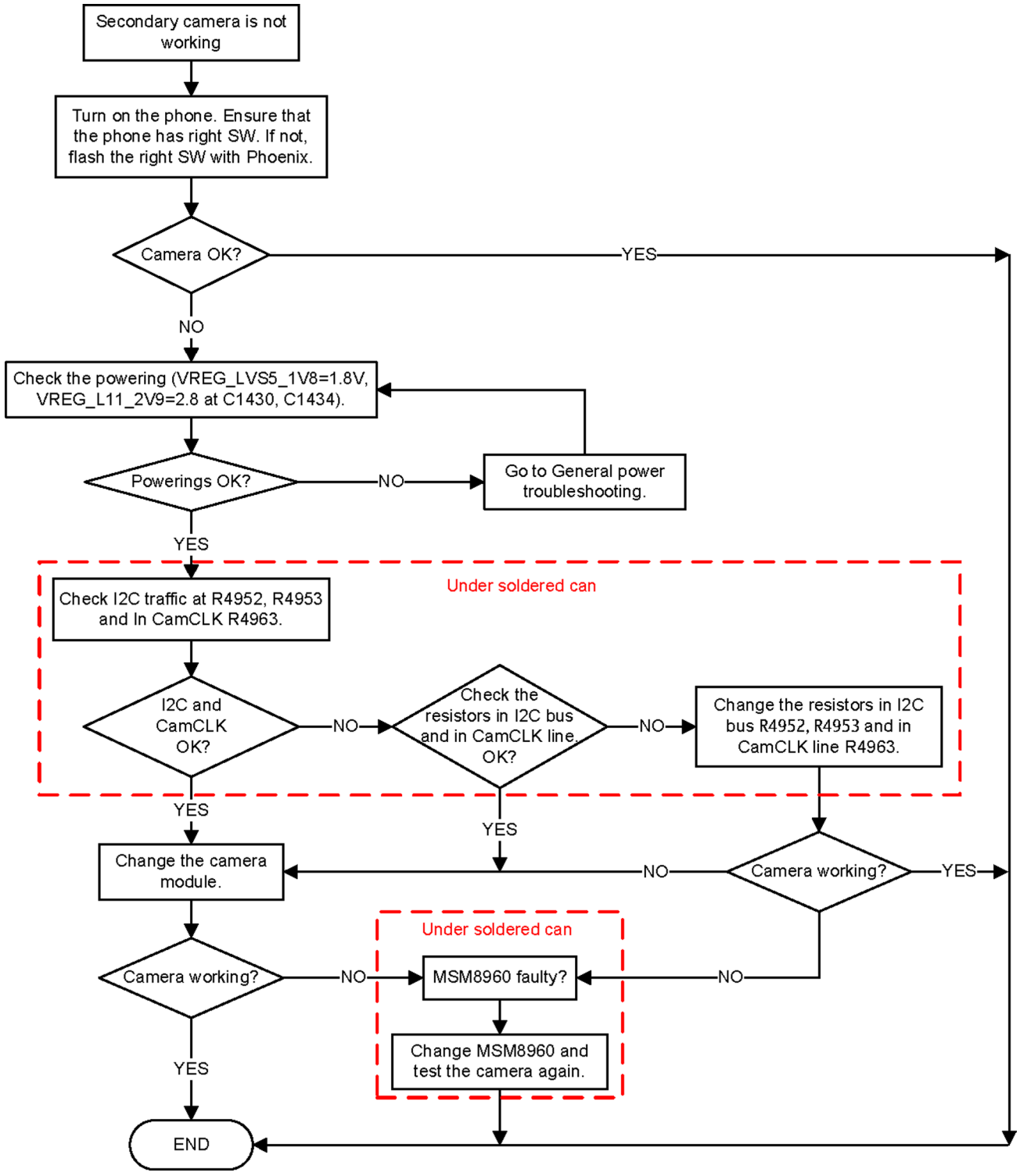
In case of image quality (IQ) related problems:

- 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
- Using a multimeter, measure the camera related external components (resistors and capacitors) that are visible next to the camera

Troubleshooting flow



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6 — System Module

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Introduction

Phone description

MSM8960 is the main digital baseband ASIC in the phone. It contains functionality for LTE, WCDMA/HSPA+ and GSM/GPRS/EDGE. The hardware accelerator is used for imaging and video.

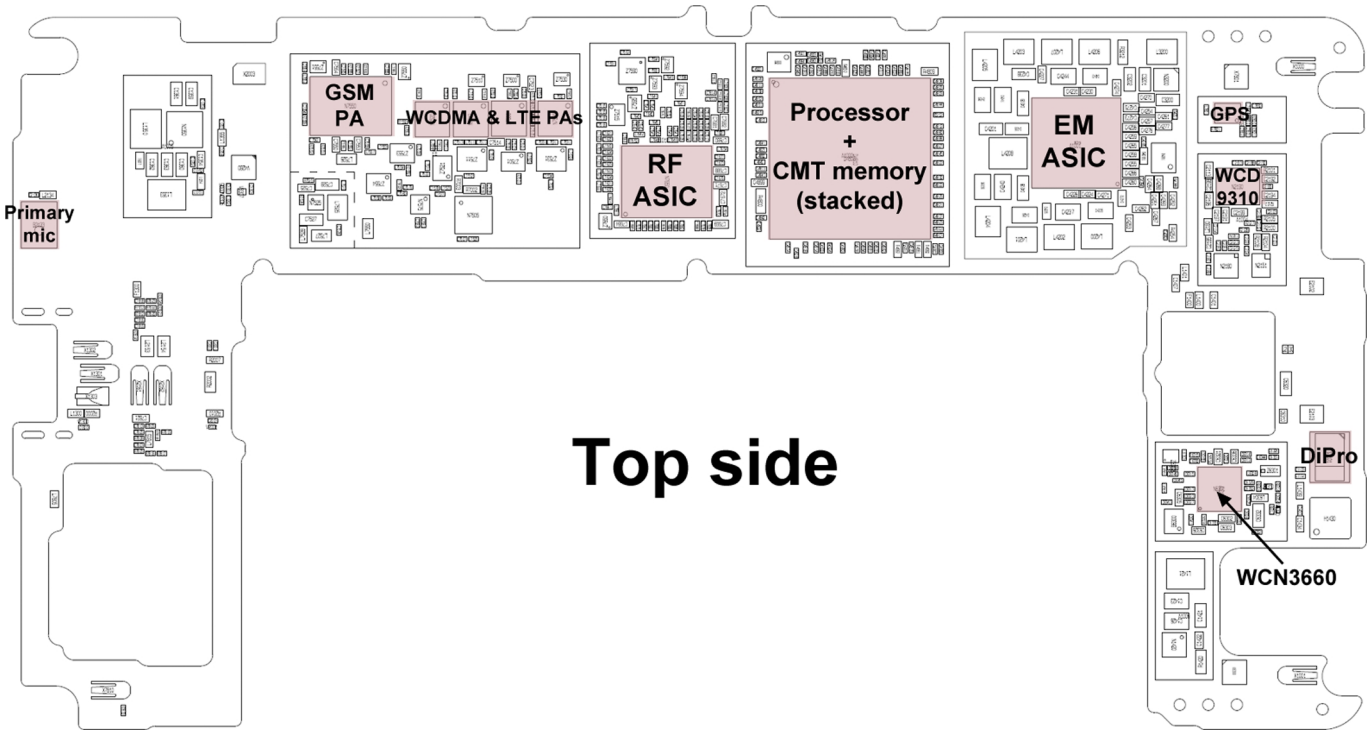
PM8921 (N4200) is the main energy and power management controller for the phone.

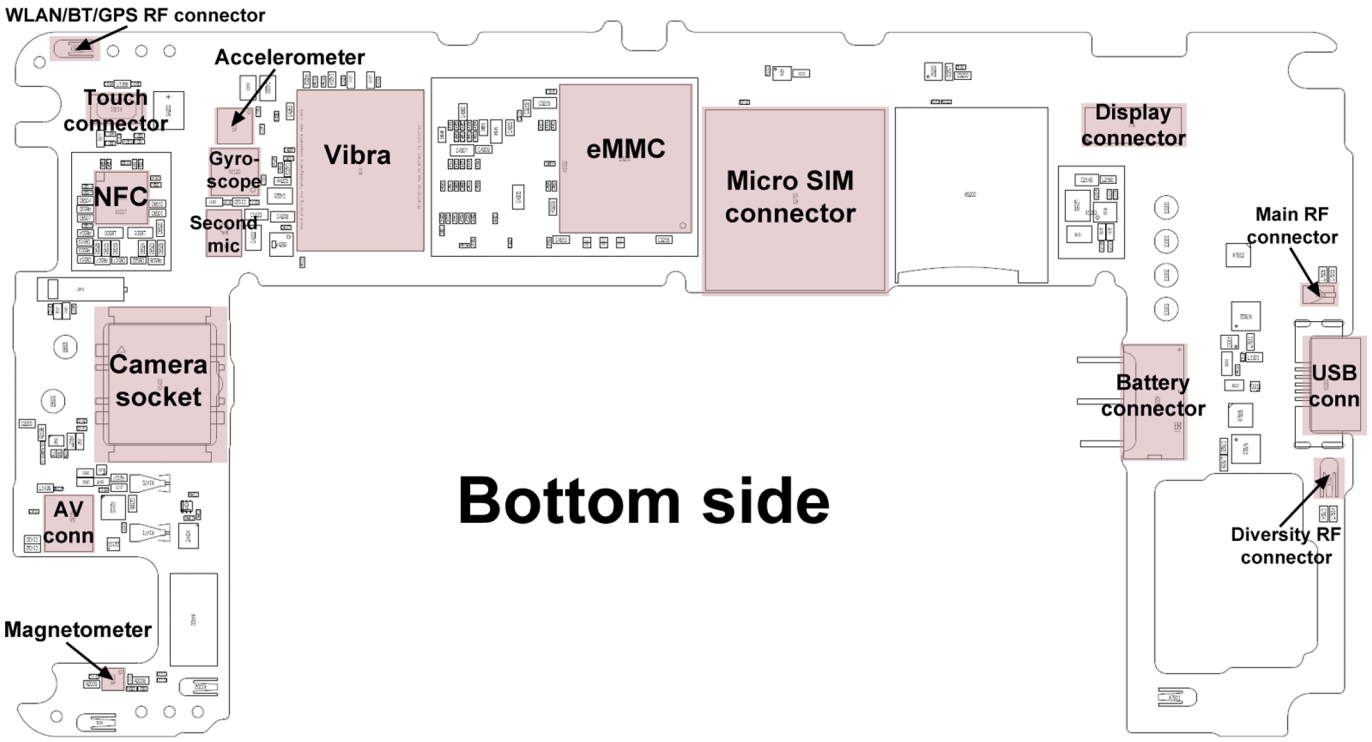
Key components

Function	Description	Item ref
Main PWB	3VJ	
Touch module	A-cover touch assembly	
Power management IC	EM ASIC PM8921	N4200
RF ASIC	RTR8600	N7650
Processor	MSM8960	D4800
GSM/WCDMA B1/WCDMA B5/LTE B1 PA		N7550
WCDMA B2 PA		N7500
LTE B3 PA		N7530
LTE B7 PA		N7540
WCDMA B8/LTE B8 PA		N7520
LTE B20 PA		N7510
PA DC/DC converter	FAN5903	N7525
SP12T antenna switch module	LMSP3WQP-D51	N7505
SP5T div antenna switch	SKY13358-388LF	Z7590
DP4T switch	SKY13421	N7575
Oscillators	Crystal 19.2 MHZ Crystal 27 MHZ Crystal 48 MHZ	B4281 B4800 B6300
CMT memory	POP 1 GB LPDDR2 (stacked with MSM8960)	D4810
WLAN/Bluetooth/FM radio	WCN3660	N6301
GPS	GPS/Glonass integrated into RTR8600	N7650
GPS LNA (external)	BGM1033N7	N7800
NFC	PN544C3	N6500
Main RF connector		X7812
RF connector	For Band 7 antenna (RM-825)	X7802
Diversity RF connector		X7806
WLAN/BT RF connector		X6300

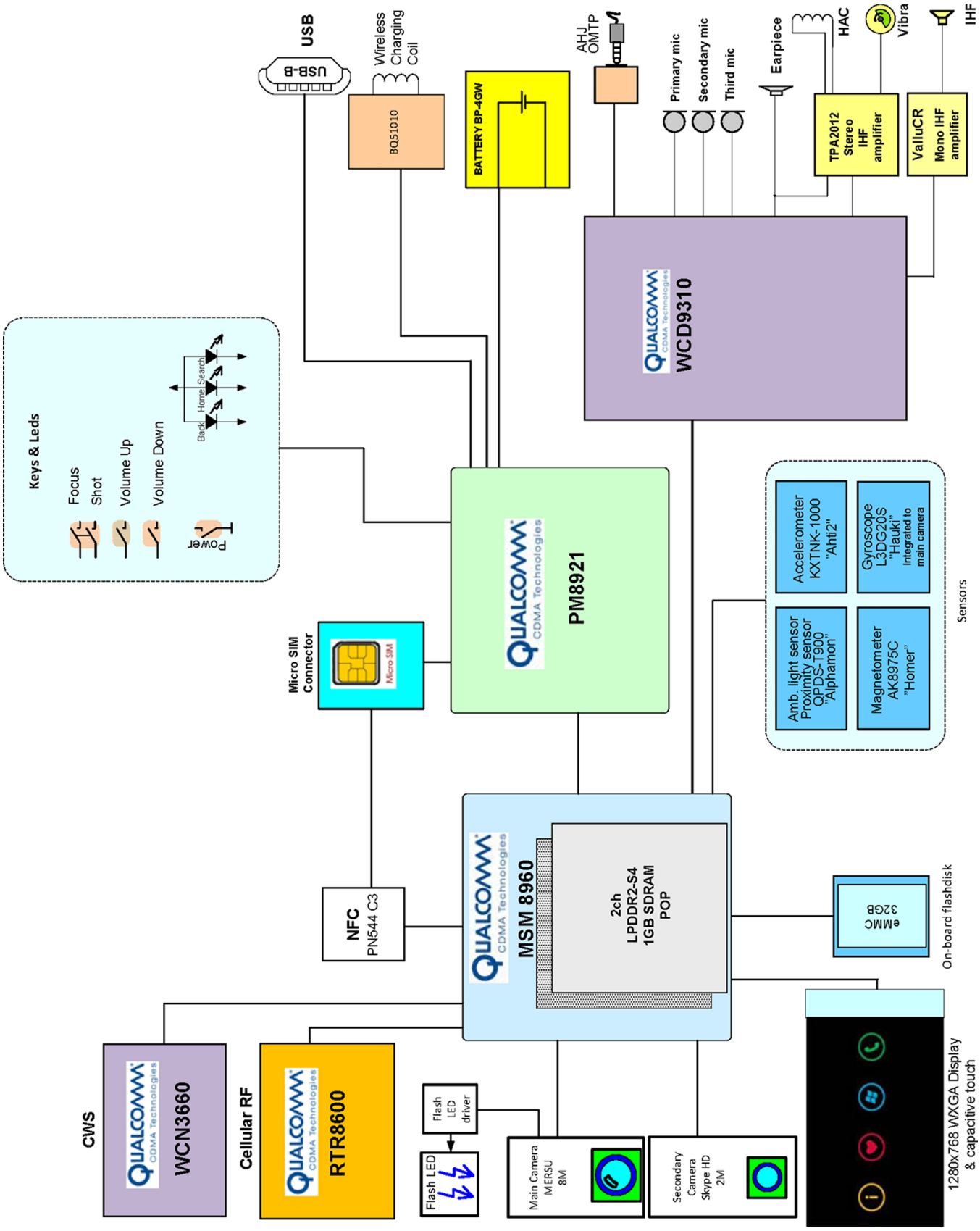
Function	Description	Item ref
GPS RF connector	GPS with combined Band 7 diversity antenna	X7801
Battery	BP-5T	
Battery connector	Tabby blade interface	X2002
Display connector	Board-to-board connector	X1350
Touch connector	Board-to-board-connector	X1351
eMMC	8GB internal mass memory	D3200
USB connector	Micro USB-AB	X3300
Micro SIM connector	Micro SIM connector	X2700
Audio IC	WCD9310	N2190
AV connector	Standard 3.5 mm, dynamic switching for AHJ and NHJ	X2160
Earpiece	Lean	B2130
Microphone	2 x Tufnel	B2132 B2133
IHF	Amazon	B2135
Vibra	SisuX	M2110
Accelerometer	3-axis accelerometer Ahti2	N1140
Magnetometer	3-axis magnetic sensor	N1110
Combined Proximity Sensor and Ambient Light Sensor	Alphamon	N1101
Gyroscope	3-axis sensor	N1120
Camera socket	SMIA85++ AF camera	X1400

Key component placement





System module block diagram



Energy management

Battery and charging

BP-5T battery

The phone is powered by a 3-pole BP-5T 1650 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.

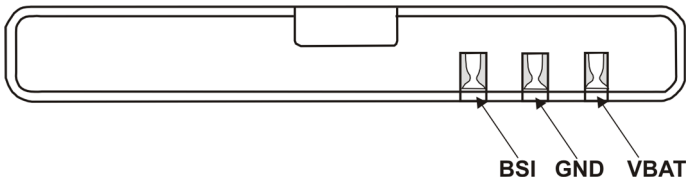


Figure 32 Battery pin order

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

Battery connector

The battery connector is a blade connector. It has three blades;

- 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

It may take up to several minutes before the phone indicates that it is charging if the battery is dead.

Normal and extreme voltages

Energy management is mainly carried out in the EM ASIC (N4200). that contains a number of regulators. In addition there are also some external regulators.

In the table below normal and extreme voltages are shown when a BP-5T battery is used.

Table 8 Nominal voltages

Voltage	Voltage [V]	Condition
General Conditions		
Nominal voltage	3.700	
Lower extreme voltage	3.1	

Voltage	Voltage [V]	Condition
Higher extreme voltage (fast charging)	4.2	
SW Shutdown Voltages		
Sw shutdown	3.3	

The PM8921 PMIC determines the system bootup (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

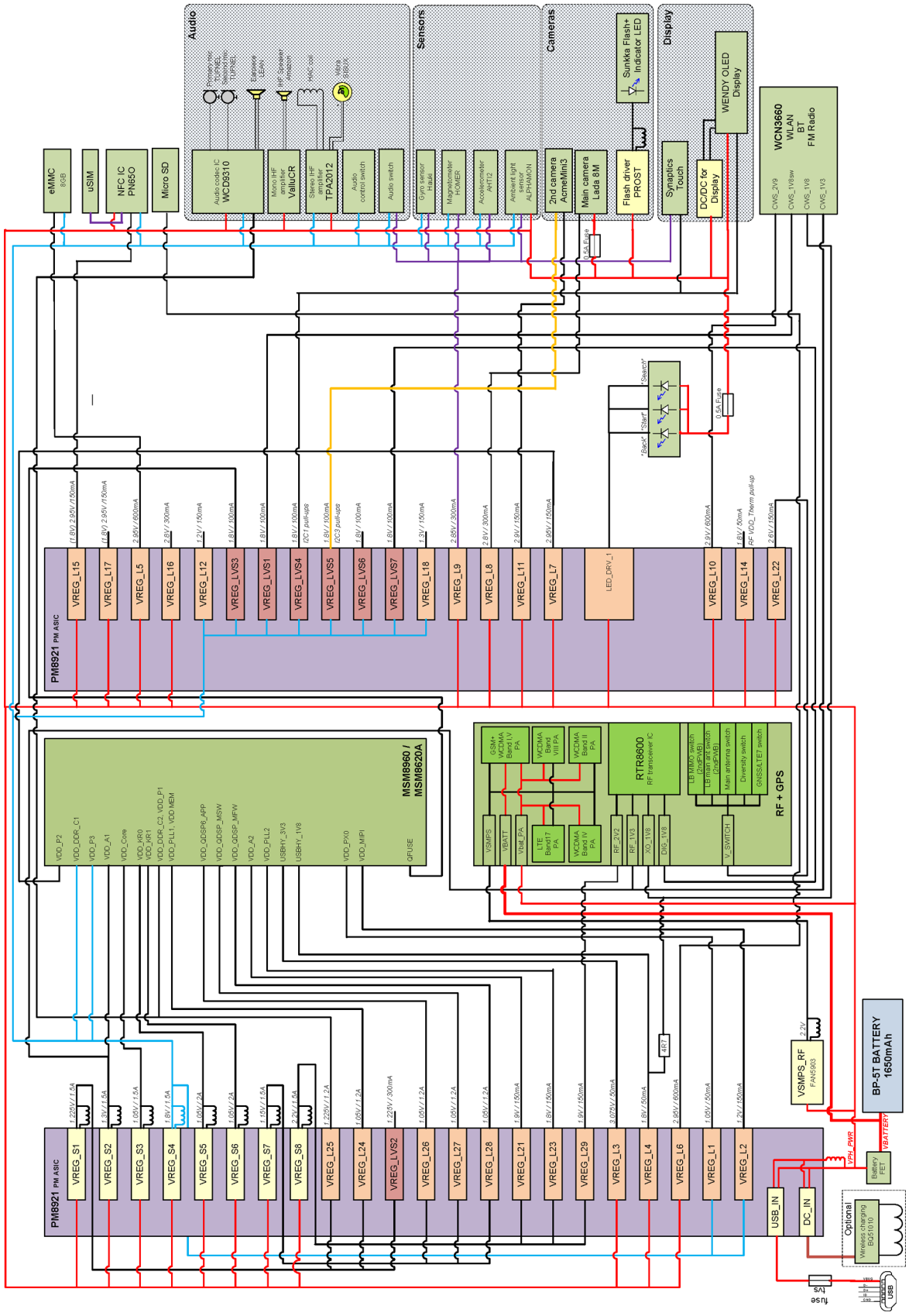
When the battery is placed in the phone, the power key circuits are energized. When the power key is pressed, the system boots up (if an adequate battery voltage is present).

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 (N2200) via the KYPD_PWR_N signal.

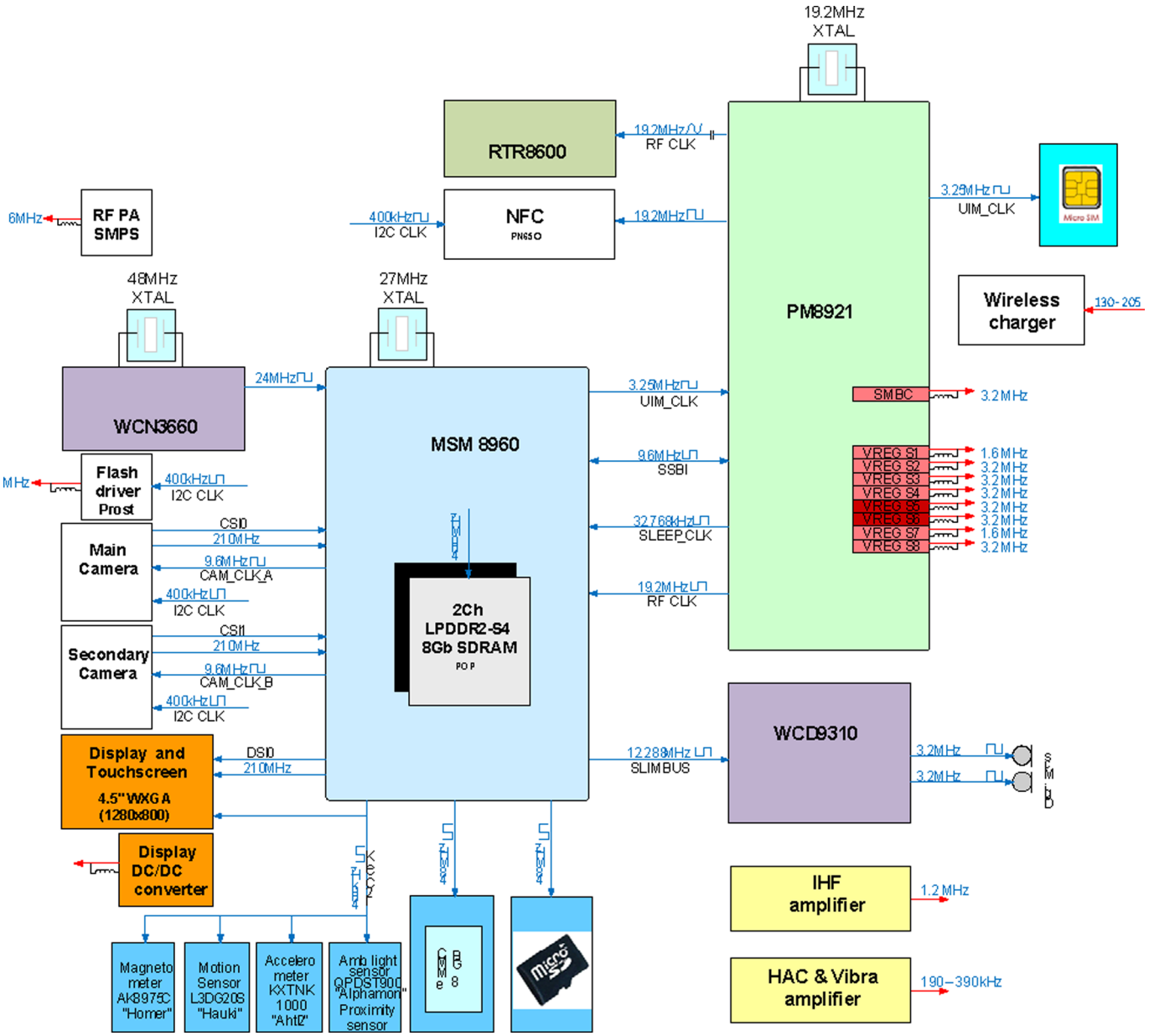
Modes of operation

Mode	Description
NO_SUPPLY	(Dead) mode means that the main battery is not present or its voltage is too low (below N2200 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 N2200 master reset threshold. All regulators are disabled, PURX 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 internal interface between MSM and PMIC8921 (N4200), and an external interface between EM ASIC and micro SIM contacts. SIM power supply VREG_L15 is fed through NFC (N6500) module to enable NFC powered by the field functionality. Single wire Protocol is also connected between the card reader and NFC module to enable UICC based secure element usage.

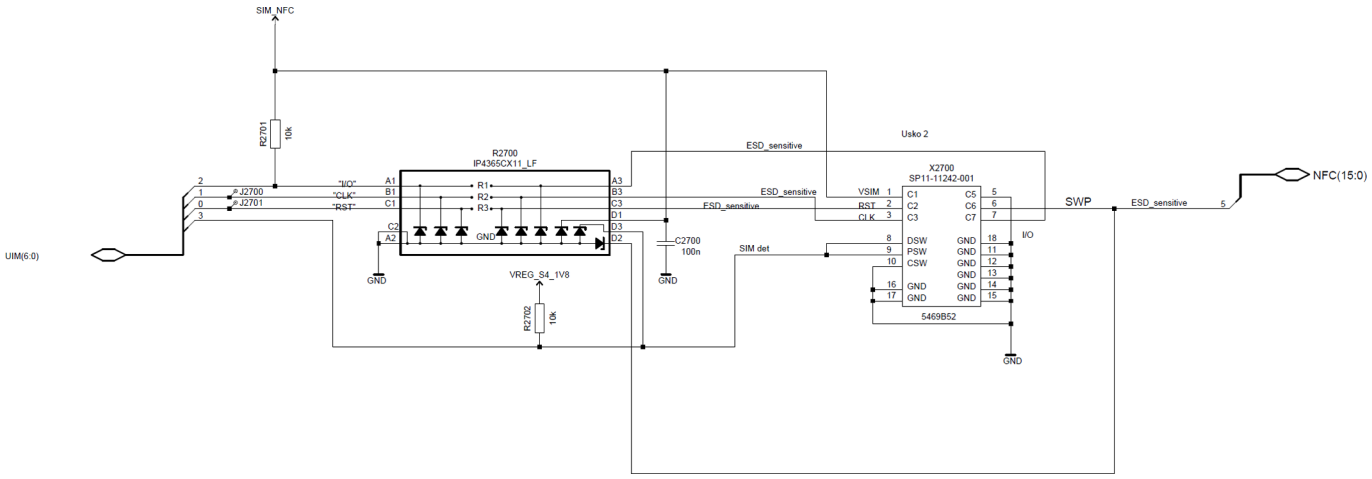


Figure 33 Micro SIM diagram

For detection of SIM card presence, insertion and removal there are two switches in the SIM connector to enable hot swap functionality.

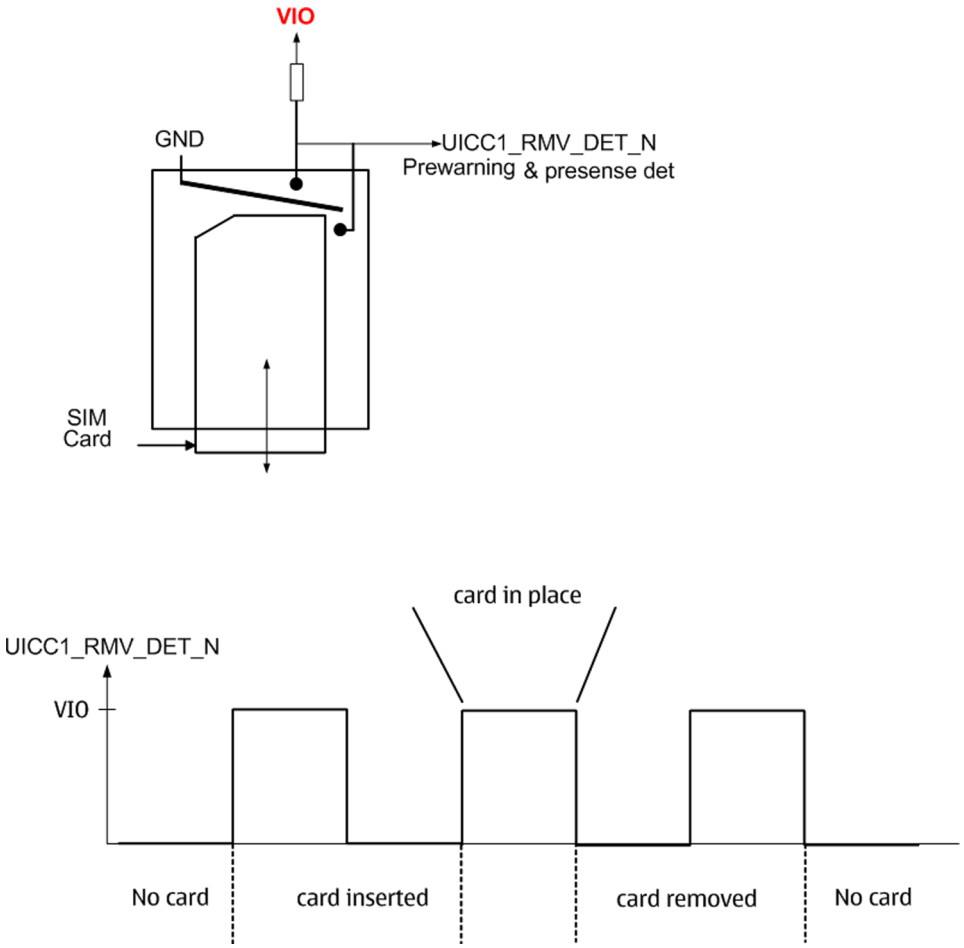


Figure 34 SIM switch behaviour

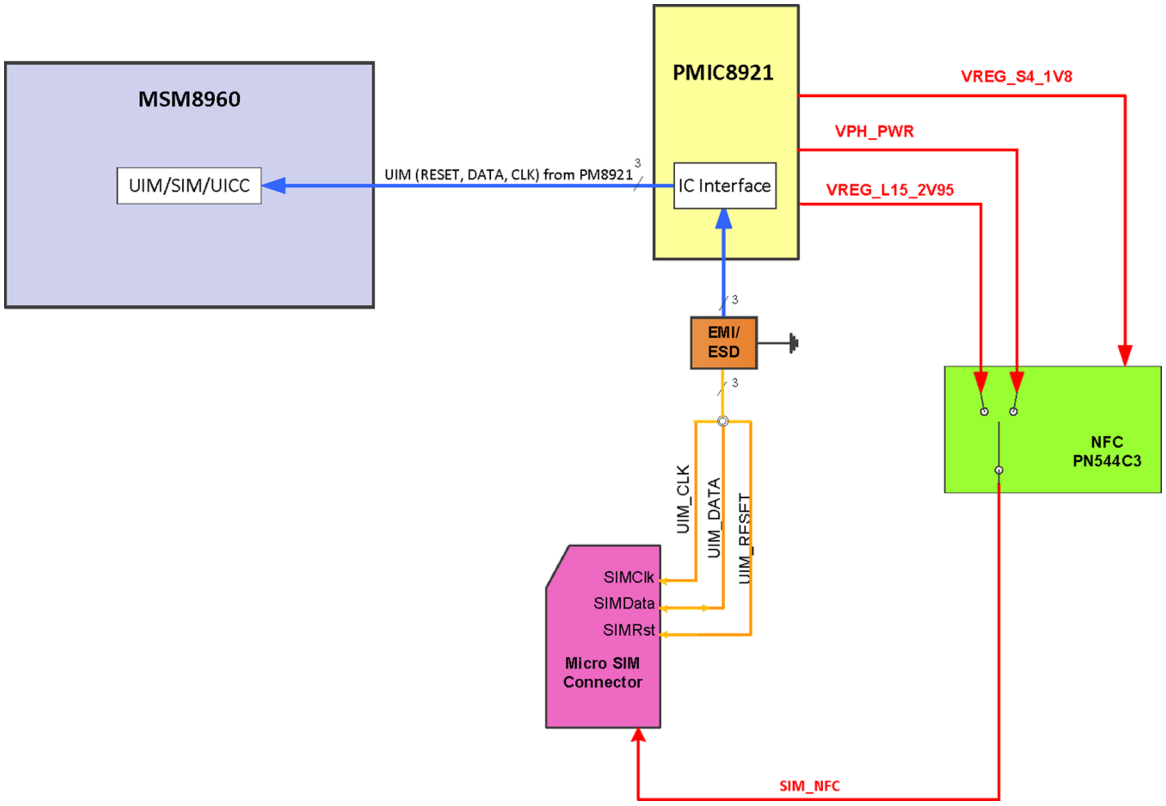


Figure 35 Micro SIM interface

The micro SIM interface supports both 1.8V and 3.0V micro SIM cards. The micro SIM interface voltage is first 1.8 V when the micro SIM card is inserted, and if the card does not response to the ATR (Answer to Request), 3V interface voltage is used.

Device memory

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

The MicroSD is connected to MSM. For detection of card presence, insertion and removal there are two switches in the MicroSD connector to enable hot swap functionality. Even though the hot swap functionality is supported, battery has to be removed before the MicroSD can be removed/inserted.

The device uses 8 GB eMMC (D3200) 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 SDC2 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 2.9V for the NAND core and VCCQ of 1.8V for the MMC I/O interface.

WLAN/BT interface

The WCN3660 (N6301) chip provides full 802.11 a, b, g, n WLAN, BT and FM radio transceiver connectivity. The FM RX & TX are not supported in RM-824/RM-825.

WCN is the name given to a generic technology release that combines WLAN, Bluetooth, and FM RX radio on a single monolithic IC. The solution includes a single chip WCN3660 transceiver, a discrete 2.4 GHz WLAN/BT RF band pass filter, a discrete RF diplexer, a discrete RF coupler, and passive SMDs (Surface Mounted Device). The WCN3660 operates in the 2.4 GHz and 5.0 GHz (ISM), and the 76-108 MHz FM bands. The baseband part of the connectivity functions is integrated into MSM8960.

The BT and WLAN 2G antenna route goes through the discrete WLAN/BT RF bandpass filter and discrete RF diplexer component. Bluetooth and WLAN 2 GHz and WLAN 5 GHz use the same antenna. Transmitting output power level is changed according to data rate. The highest power levels are provided in 802.11b data rates.

The BT BB interface can be logically divided into a 2-line digital serial interface that supports Rx/Tx and single wire serial bus (SSBI) for status and control. The interface between the BB and Bluetooth assumes that all layers above the HCI are implemented in the BB, and all layers below it in the WCN3660 module.

The WLAN BB interface can be logically divided into a 4-line analog baseband interface and a 5-line digital command and control interface. The I/Q baseband analog interface consists of 4-line analog transmission lines shared between the Tx and Rx paths. In Tx mode, the four lines are used to connect DAC output pins to Tx BBF input pins. In Rx mode, the four lines are used to connect Rx BBF output pins to ADC input pins.

For dual-band operation at 2.4 and 5.0 GHz, the WCN3660 device uses a 48.0 MHz clock from an external crystal.

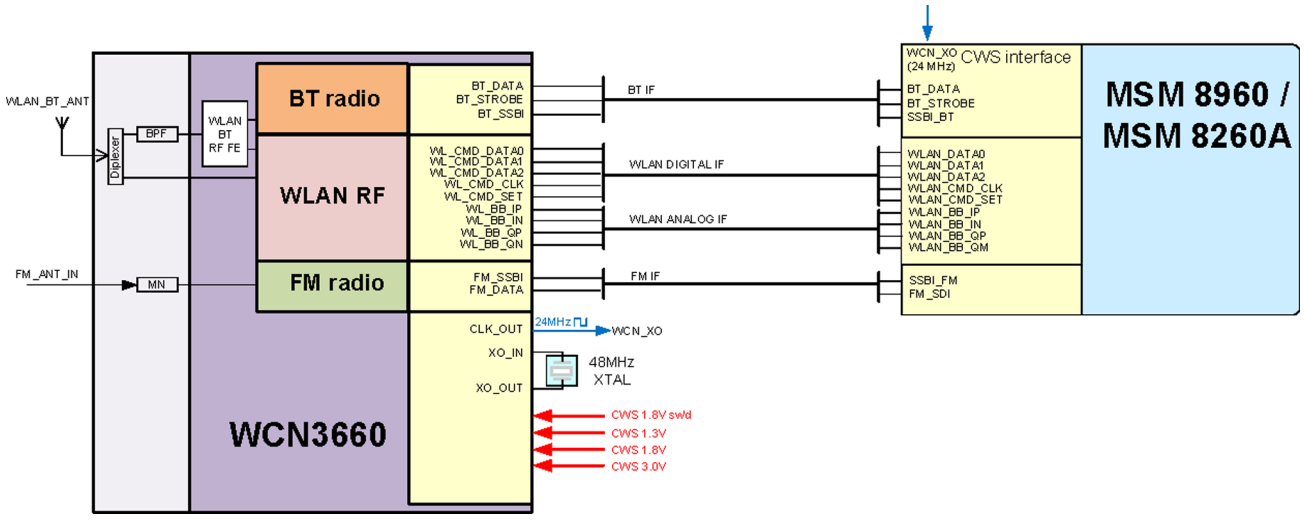


Figure 36 CWS block diagram

GNSS interface

GPS/Glonass support is built into the RTR8600 and interfaces with the MSM8960 GNSS Processor.

The 19.2 MHz reference clock of RTR8600 is also used for GPS.

The front end includes an LNA module with a SAW filter and balun filter before RTR8600. A diplexer is used to combine GPS+GLONASS and LTE RX diversity to the same antenna (RM-825). The diplexer is not needed for RM-824.

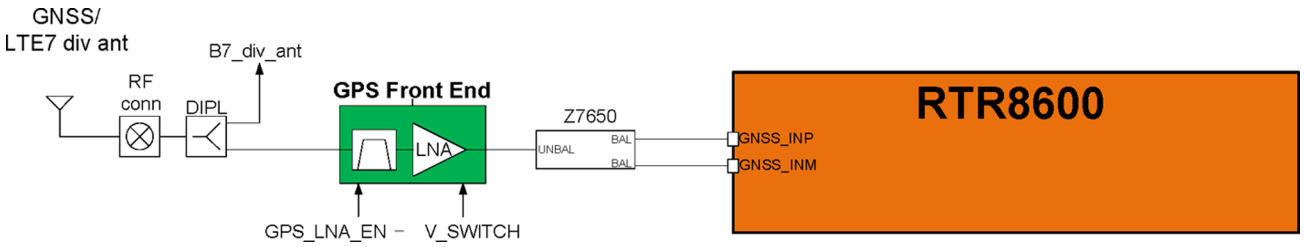


Figure 37 GPS interface

NFC interface

Near Field Communication (NFC) is a short-range wireless connectivity technology standard. NFC is based on inductive-coupling, where loosely coupled inductive circuits share power and data over a distance of a few centimeters. NFC works at 13.56 MHz frequency. It is connected to the host processor via I2C bus. The system has also ENABLE and RESET lines from the host, and IRQ and CLK_REQ lines to the host. NFC requires VBAT and

VIO power supplies and uses 19.2 MHz reference clock from the EM chip. The system has an SWP connection to the SIM card for secure element purposes. The NFC secure element feature also requires a VSIM connection from the host to the NFC engine.

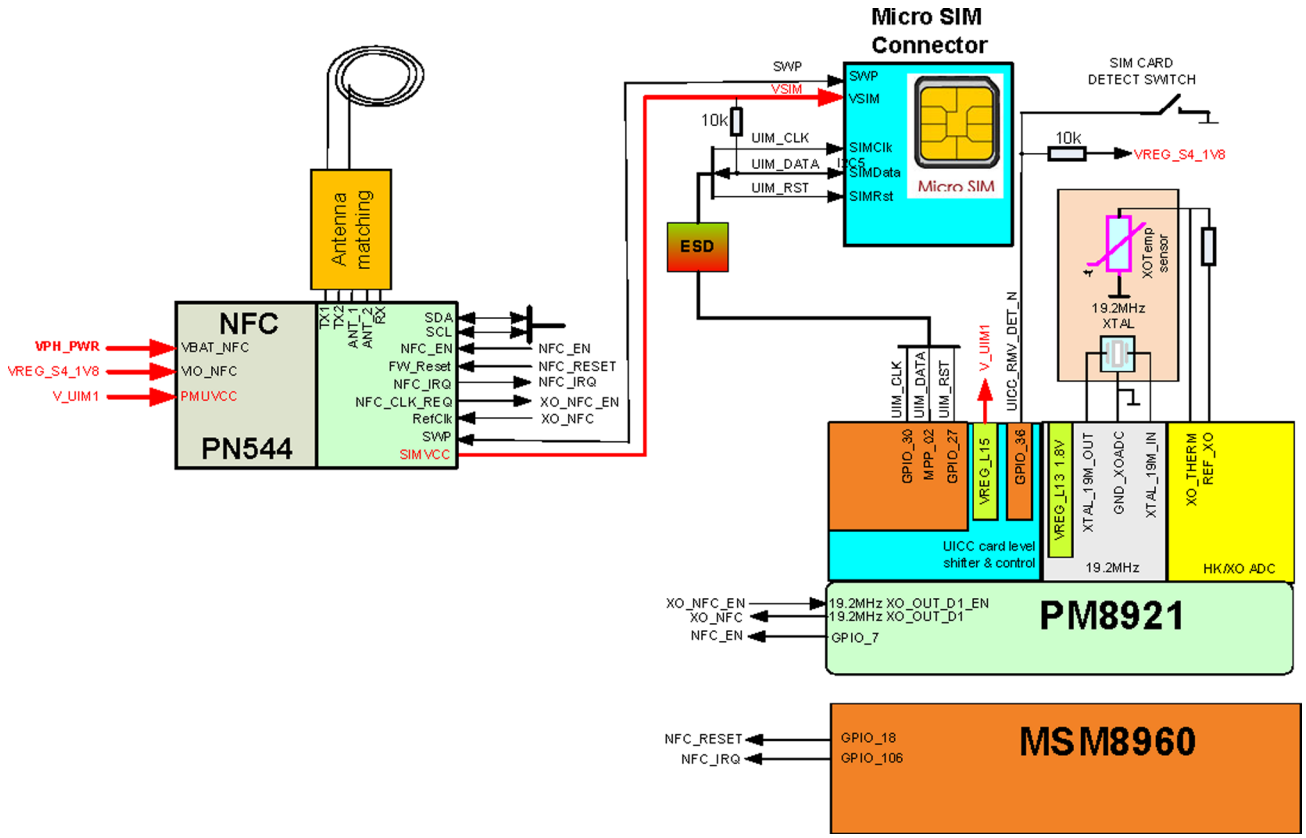


Figure 38 NFC interface

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.

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.

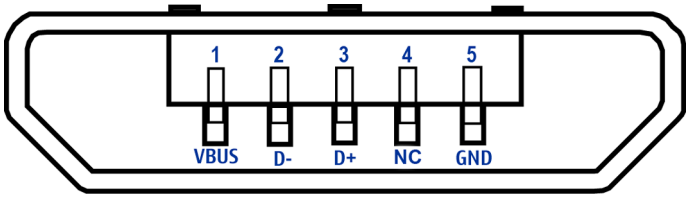


Figure 39 MicroUSB connector

User interface

Touch module

This phone uses Synaptics capacitive touch series S3202 for displays.

The Synaptics touch module interfaces with MSM via I2C and GPIO 50 for Reset and GPIO 11 for Touch INT.

The Synaptics touch module uses VREG_L9 for its analogue supply and VREG_LVS4 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.

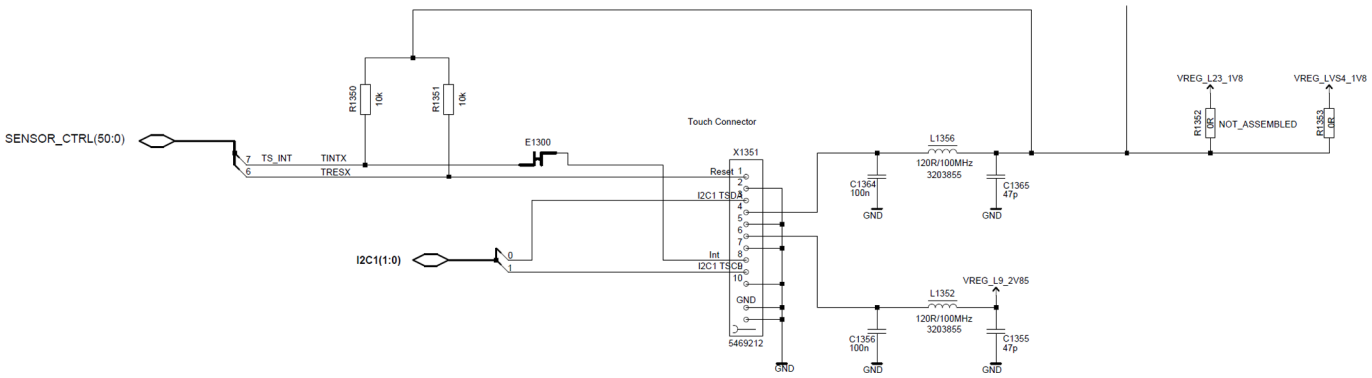


Figure 40 Touch diagram

Proximity sensor and ambient light sensor

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

The proximity part of the device uses an external IR 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 whenever the display is active. Covering this sensor results in dimmed display.

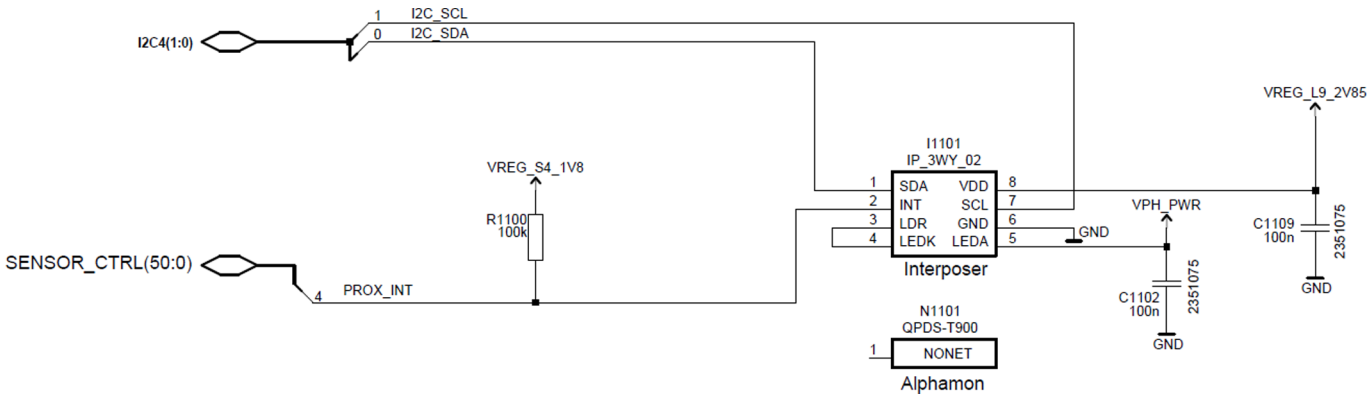


Figure 41 Proximity sensor and ALS diagram

Imaging and video

Display module

This phone uses a 4.3'' AMOLED type WVGA display with 16 million colors. The display module supports the display format of 800 rows x 480 columns. The dimension of the display module is 59.60 mm x 100.80 mm x 1.28 mm. The module interfaces to the phone via FPC with a 50 pins board-to-board connector.

The primary display is controlled by MSM8960 over DSI interface. The DSI Interface is used for data transfer and control. Other display signals, RESET and TE, are interfaced to MSM8960.

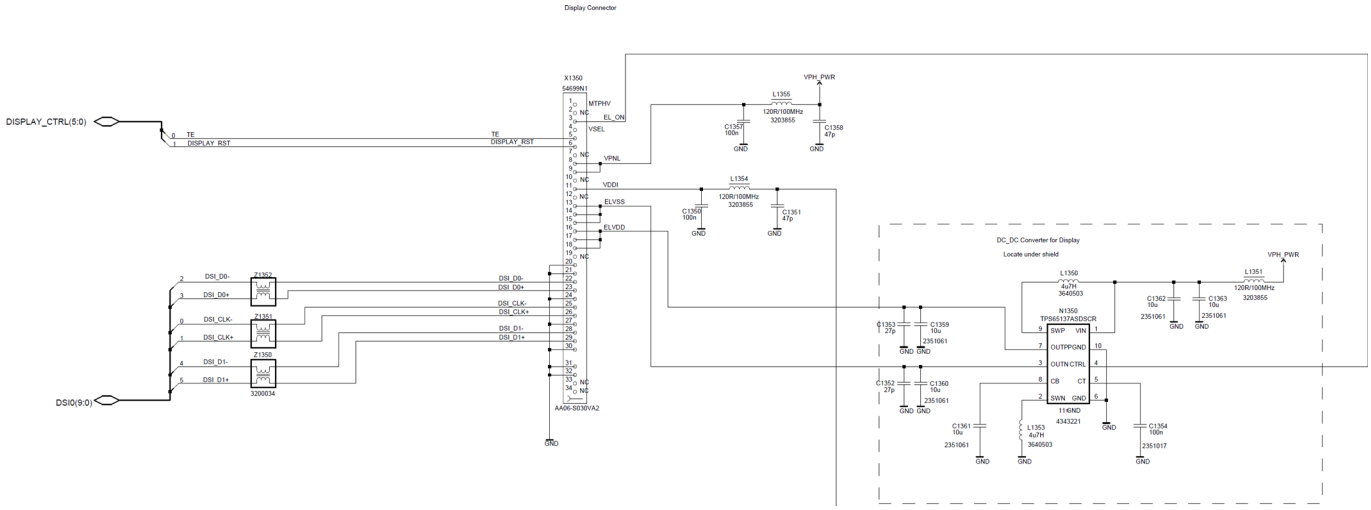


Figure 42 Display diagram

Cameras

This phone has two cameras, an 8 MPix resolution main (rear) camera and a VGA resolution secondary (front) camera. A dual LED flash is used for the main camera.

Primary camera (Lada)

The primary camera is an 8 Megapixel AF (autofocus) camera module. The module size is 8.5 mm x 8.5 mm x 5.9 mm and it fits into the 18-pin camera socket on the phone. The camera module is SMIA profile 2 compliant, directly connected to MSM8960 and controlled by the I2C bus. Image data is transferred to the MSM8960 for furher processing over CSI-2 (PRI_CAM_CSI).

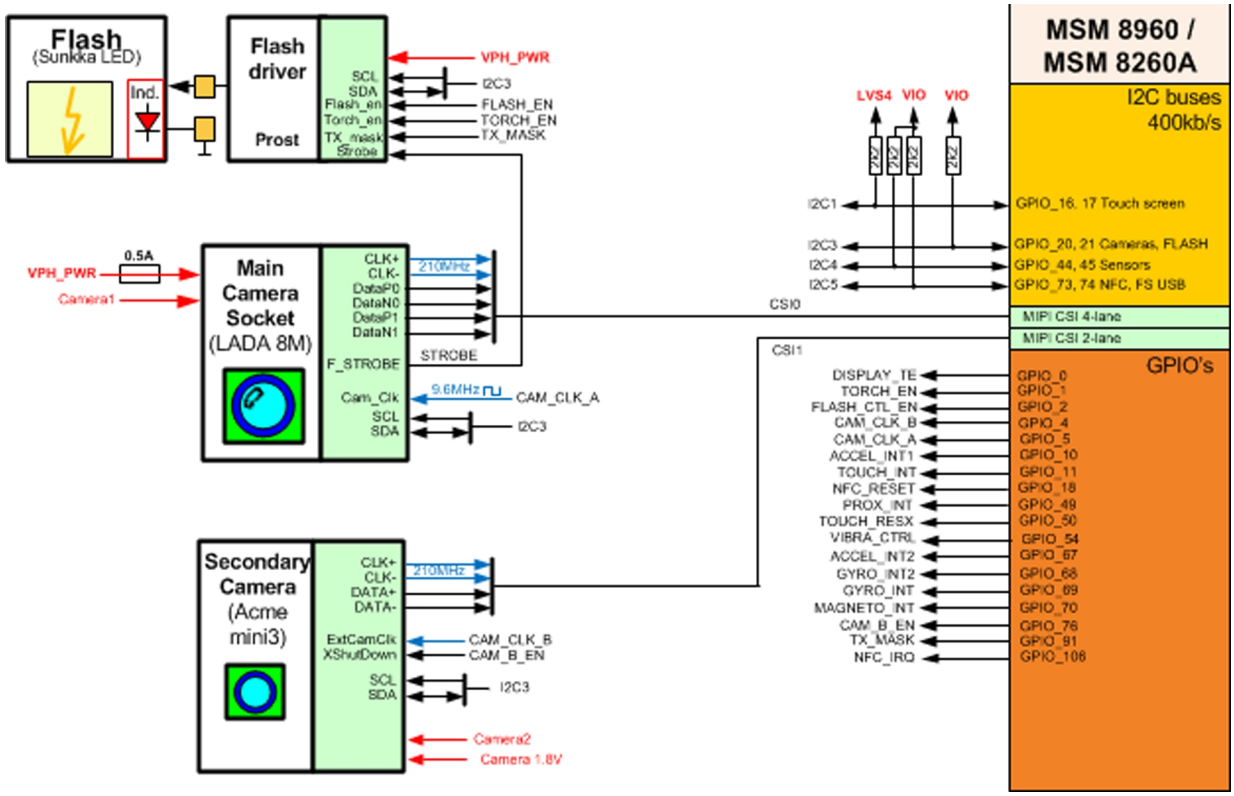


Figure 43 Camera system interface

Secondary camera (VGA Acme mini)

The secondary camera is a 0.3 MPix VGA fixed focus camera module. It is SMIA compliant, directly connected to MSM8960 and controlled by the I2C bus. Image data is transferred to the MSM8960 for further processing over a CCP based bus (SEC_CAM_CCP).

Flash (dual LED module)

A dual LED module, high power, white flash LEDs are for use as a camera flash and torch. The torch has significantly reduced power compared to the image capture flash. There is a red LED inside the flash LED module for video privacy indicator.

Illumination

BACK, HOME and SEARCH keys illumination is supported and is handled by three white LEDs (assembled in LED Flex). These LEDs are controlled by PMIC (internal driver).

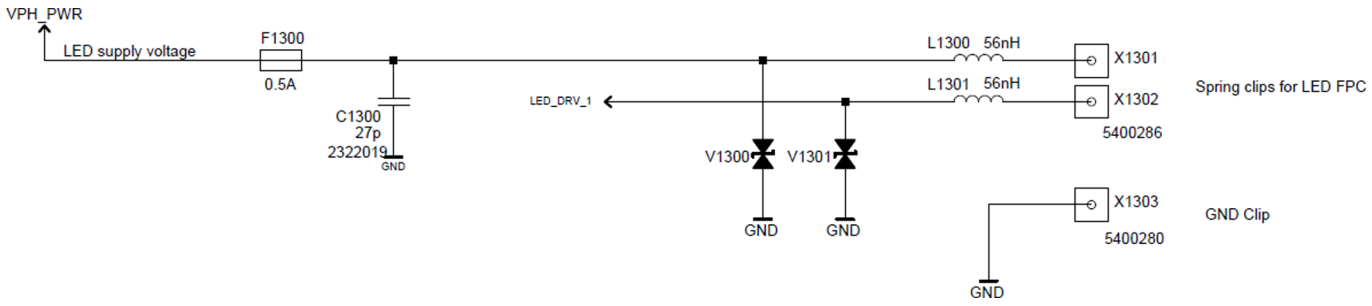


Figure 44 Illumination diagram

Keypad interface

The phone includes a dual action Camera focus/shot key, Volume up/down keys and Power key. The keys are located on the Side key flex. Resetting chipset with HW can be done with a long press of Volume down and Power keys simultaneously. Reset is generated with a dual transistor. These signals are connected to PMIC8921 GPIOs (1, 2, 6, 8 and 10).

The phone has also standard Back, Home and Search keys on the front. These keys are not physical keys, they are handled by touch.

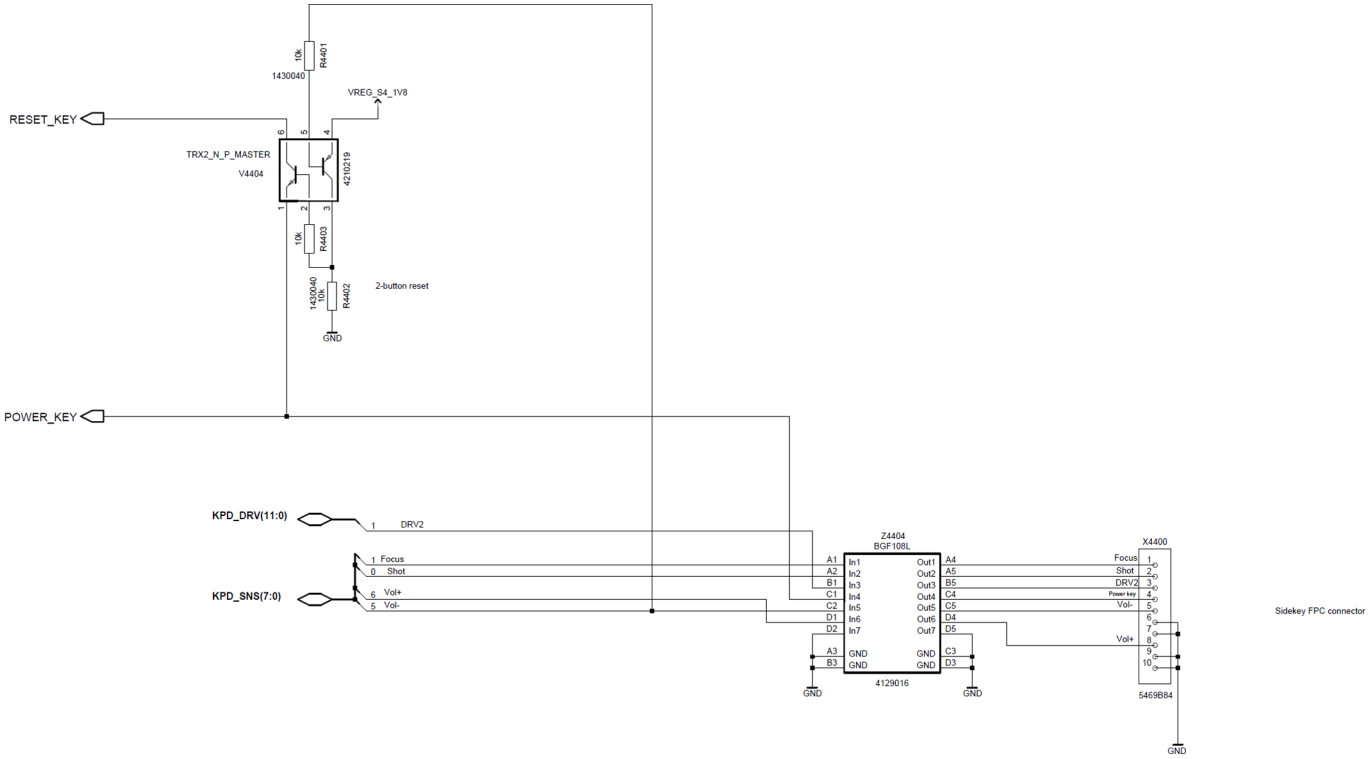


Figure 45 Keypad diagram

Accelerometer

Accelerometer is a geometric type component which 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 (N1140) sensor is connected to MSM via two GPIOS (10 and 67) and the I2C bus. Power is provided from VREG _S4_1V8 and VREG_L9_2V85 from the PMIC.

It has the following features:

- 2.16V to 3.6V supply voltage
- 1.8V compatible IOs
- Low power consumption
- ±2g/±8g dynamically selectable scale
- I^2C/SPI digital output interface
- Embedded self test
- 10000g high shock survivability
- Pb free/RoHS compliancy

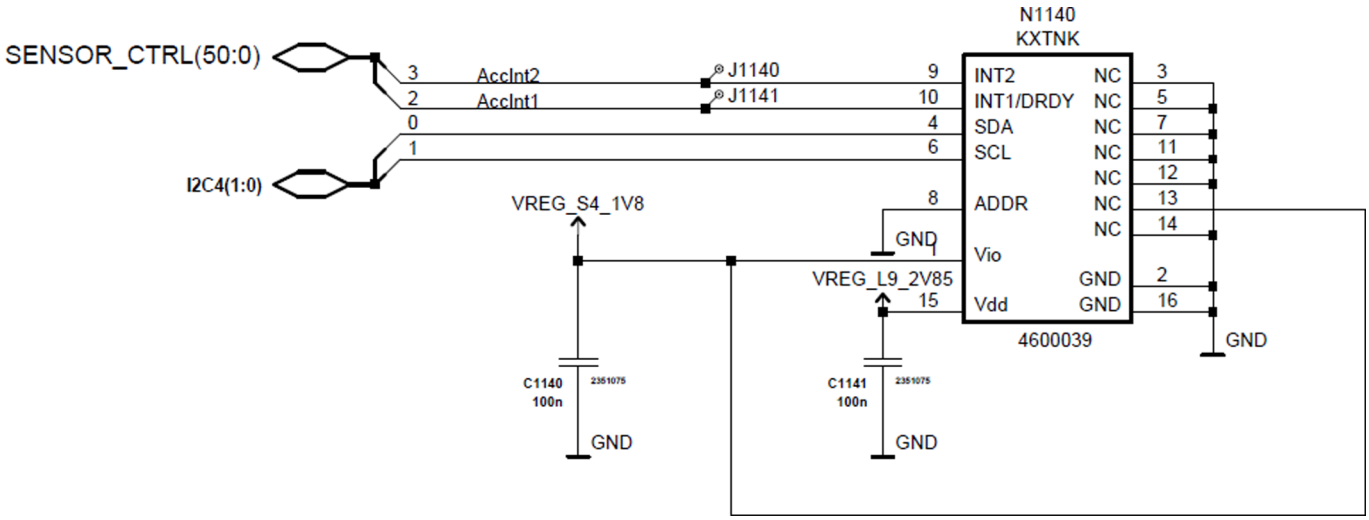


Figure 46 Accelerometer diagram

Magnetometer

The 3D magnetometer (N1110) is connected to MSM8960 via interrupt signal GPIO 70 and I2C2 bus. Supply voltages are VREG_S4 (1.8V) and VREG_L9 (2V8).

The magnetometer is most commonly used for pedestrian navigation when the map north is aligned with the magnetic north. Some gaming, compass and other applications that utilize the magnetometer are also available.

Before using the magnetometer on an application, static magnetic fields caused e.g. by speakers, vibras or magnetized ferromagnetic metals within the phone need to be removed from the 3D data. The calibration is done by rotating the phone for a few seconds around its all axes. In the Maps application, the status of the magnetometer calibration is indicated by the compass color.

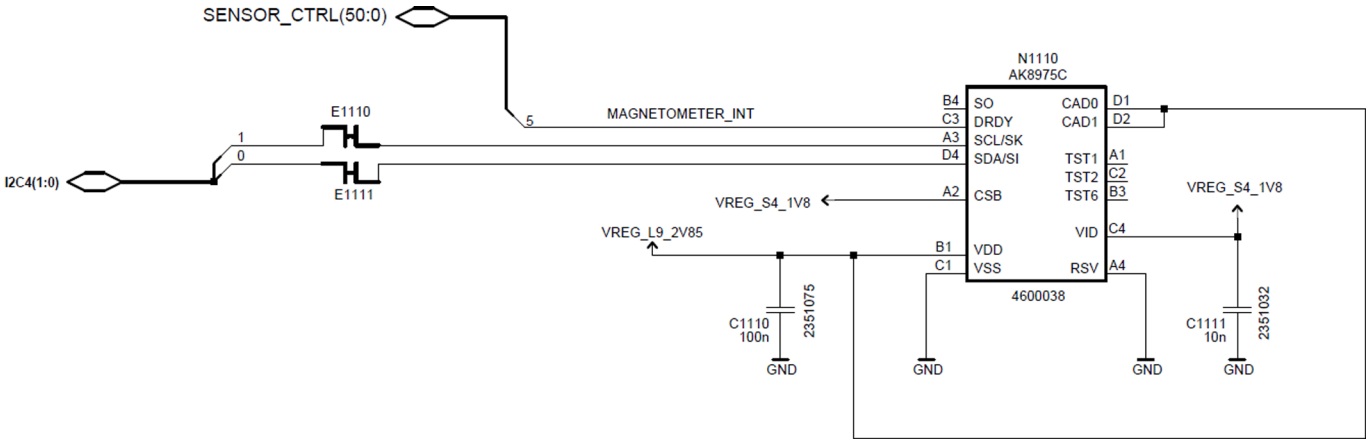


Figure 47 Magnetometer diagram

Gyroscope

A gyroscope is a device for measuring rotation (pitch, roll and yaw) in a three dimensional space.

The 3D gyroscope (N1120) sensor is connected to MSM8960 via two GPIOS (68 and 69) and the I2C bus. Power is provided from VREG _S4_1V8 and VREG_L9_2V85 from the PMIC.

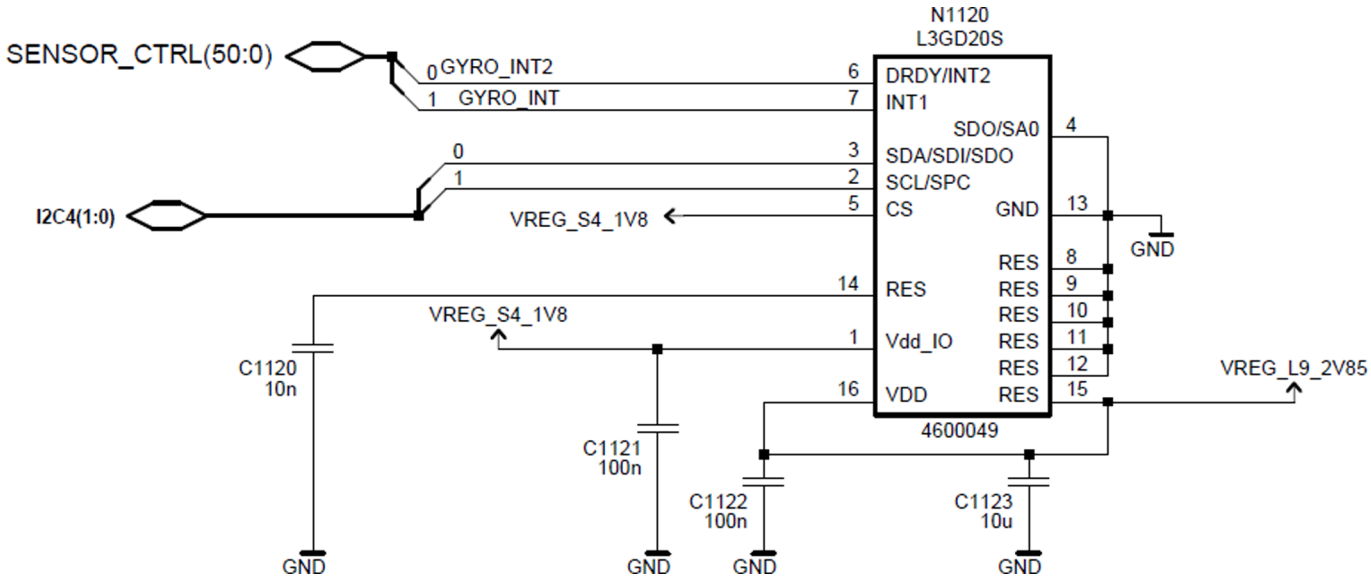


Figure 48 Gyroscope diagram

Audio concept

Audio HW architecture

TPA2012 (N2120), BoostMono (N2150) along with Audio IC WCD9310 provides the analogue audio output interfaces and MSM8960 provides the digital audio output interface support.

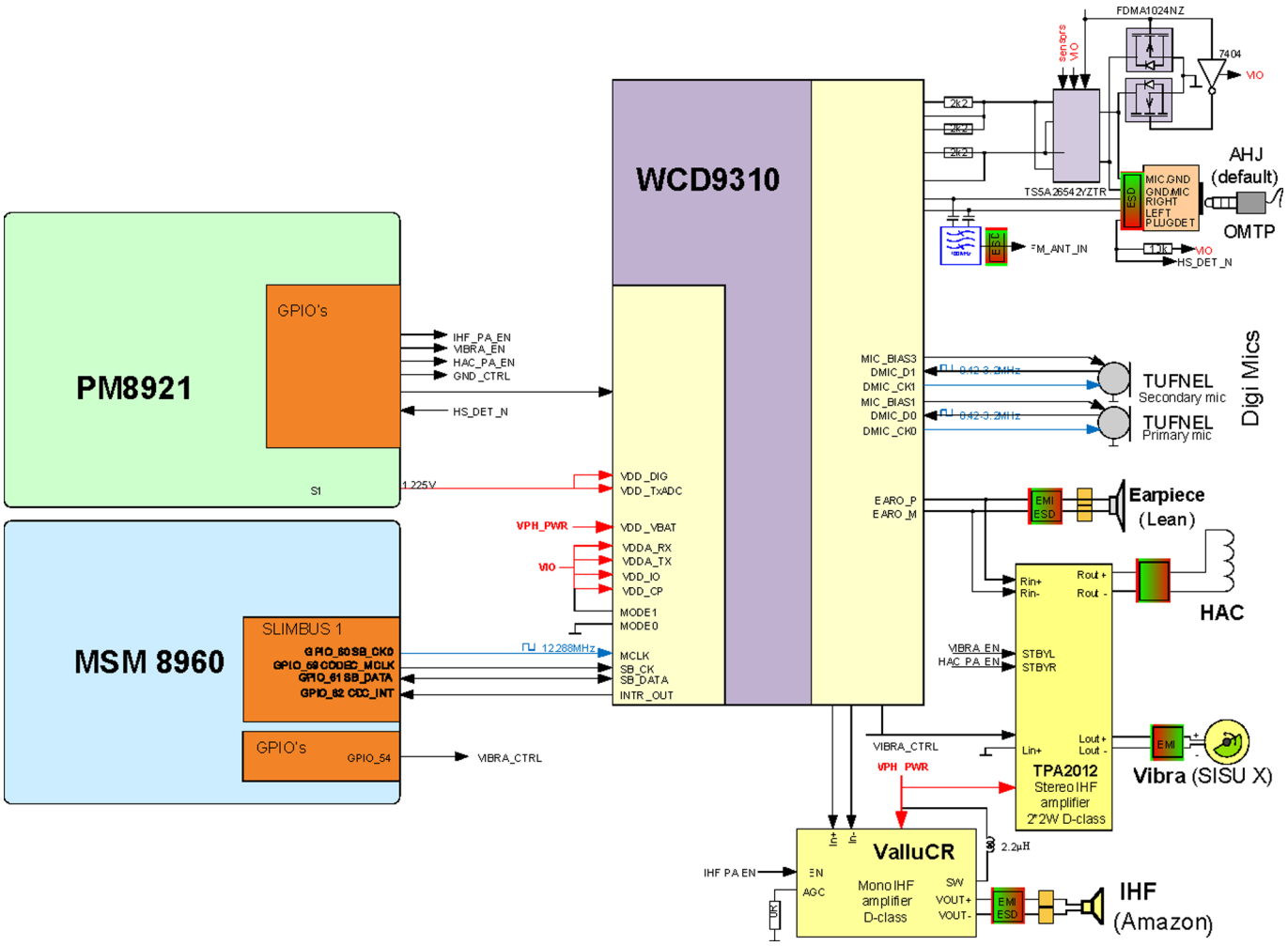


Figure 49 Audio system and AV connector block diagram

Internal earpiece

The internal earpiece used is Lean (6X12) and is connected to WCD9310 Codec EAR_P and EAR_N lines.

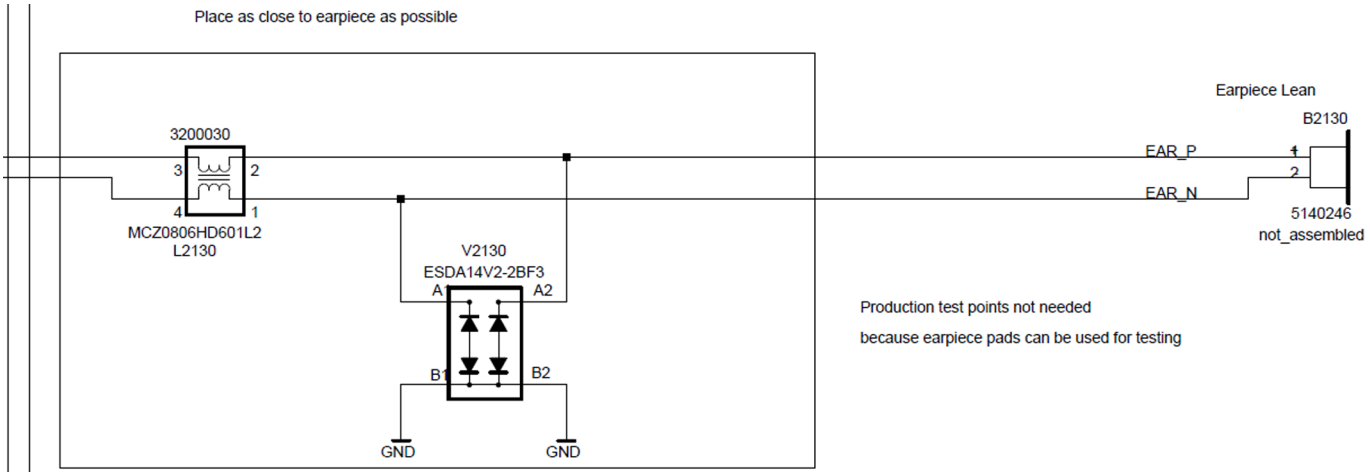


Figure 50 Internal earpiece diagram

Internal handsfree (IHF) speaker

IHF speaker used is Amazon and is connected to BoostMono Vallu N2150. Vallu is a mono D-class speaker amplifier with an integrated inductive boost converter. Vallu's differential audio inputs are connected to WCD9310 Line_out1 and Line_out3 and it can be enabled/disabled by PMIC GPIO19.

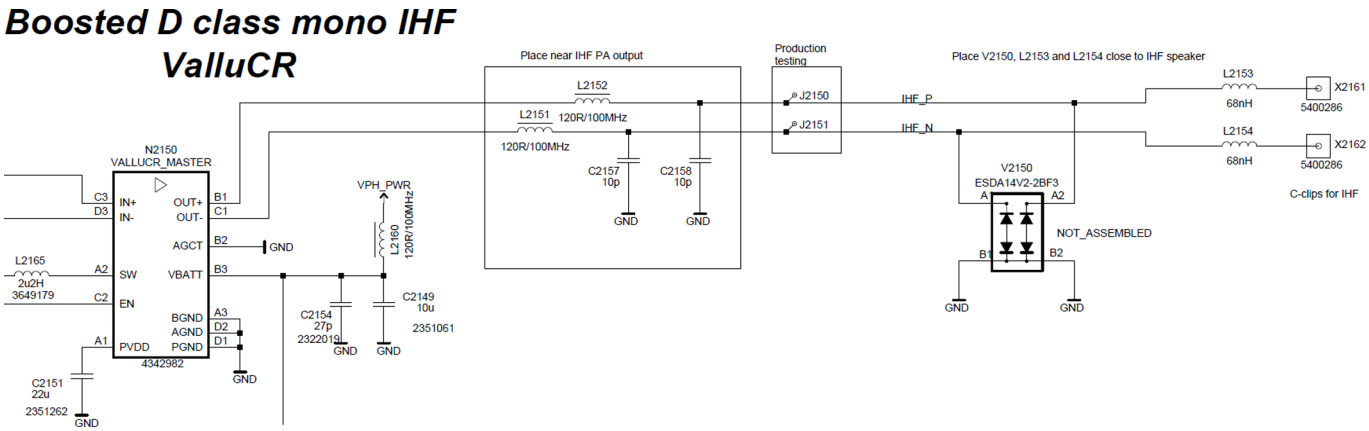


Figure 51 Internal handsfree (IHF) speaker diagram

Internal microphones

Tufnel microphones are used as internal microphones. The digital microphones are connected to WCD9310 Codec.

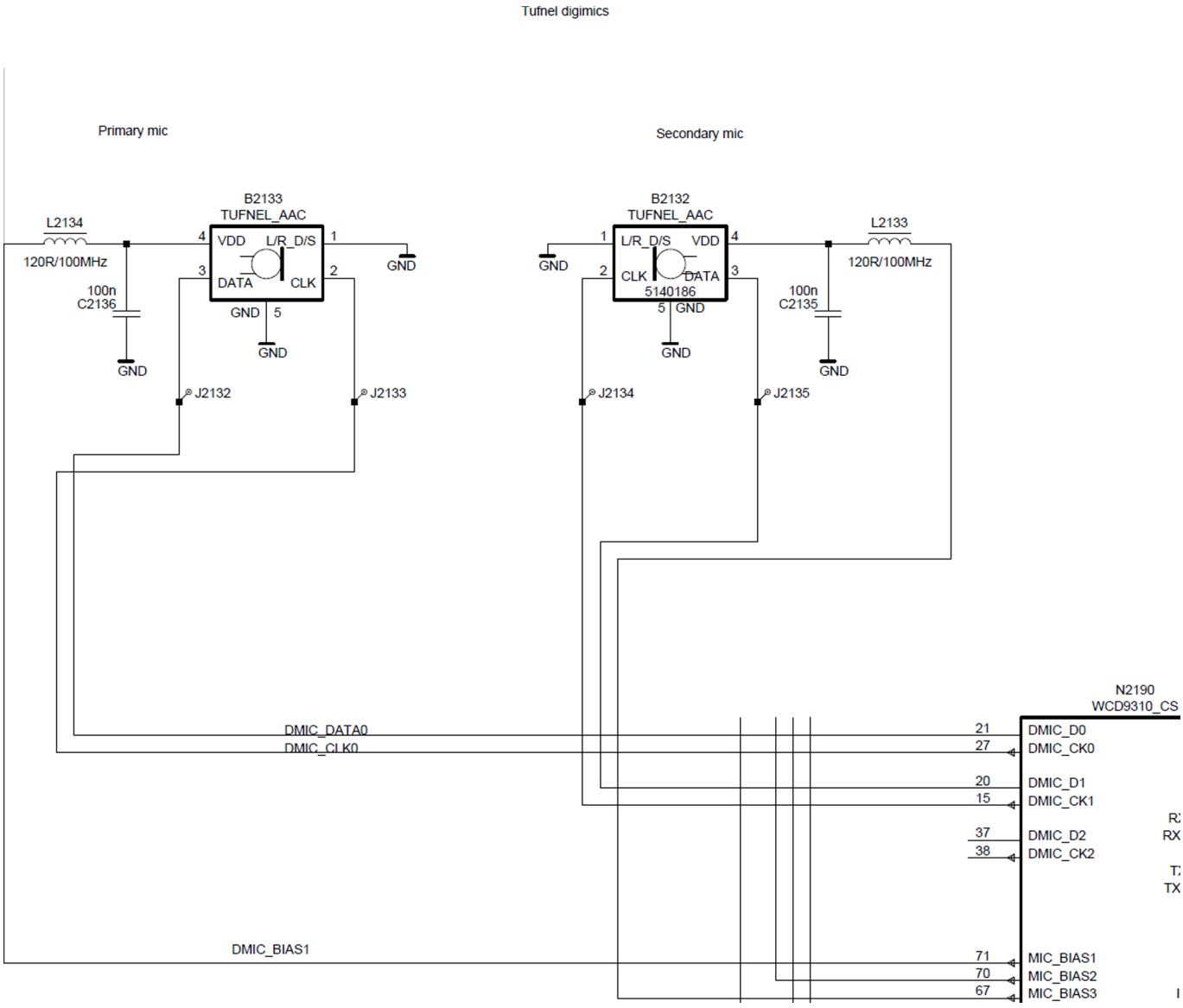


Figure 52 Internal microphones diagram

External earpiece and microphone

The AHJ headset earpiece is connected to WCD9310 (N2190) which is used for high quality audio output and to guarantee long playback time for accessory use.

Vibra

Vibra is connected to VIBRA_N and VIBRA_P lines which are connected to N2180 TPA2012D2.

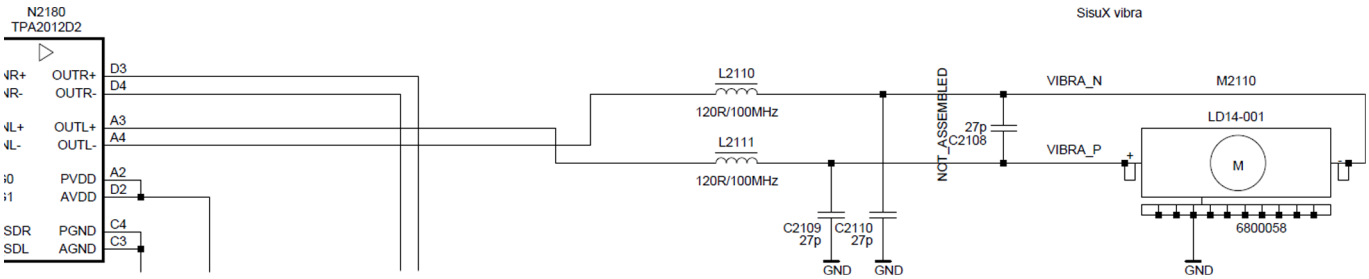


Figure 53 Vibra diagram

AHJ connector

The AHJ connector handles both audio and video signals output. It has audio left and right signals separately (pins 4 and 7) and the microphone signal wired to pin 2.

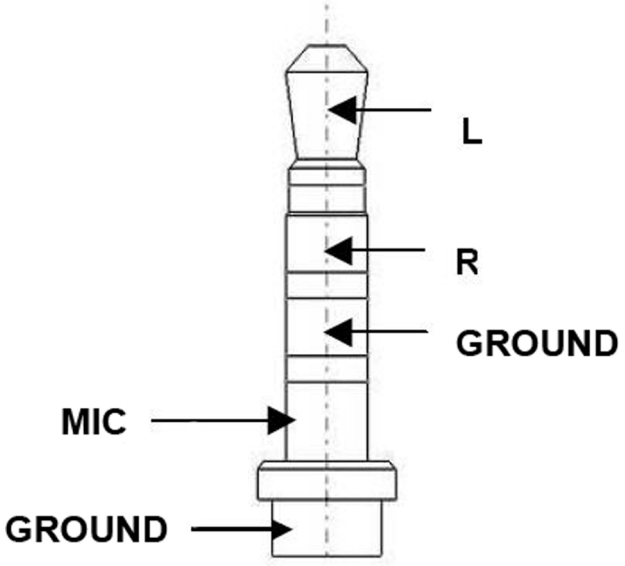


Figure 54 AHJ connector pole positions

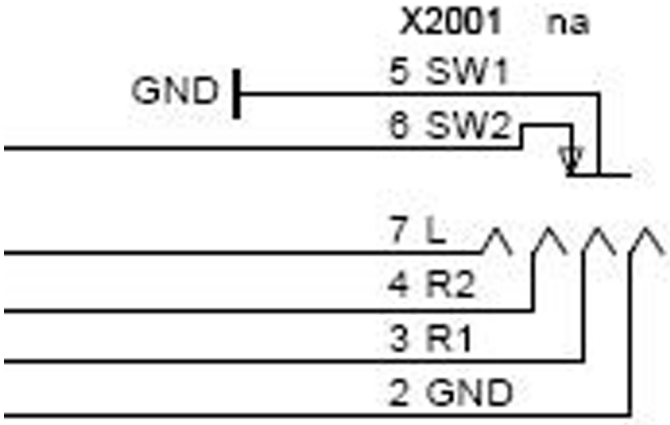


Figure 55 AHJ connector diagram

The plug detection signal handles the AHJ connector plug detection with HS_DET signal from WCD9310.

Cellular RF technical description

The RM-825 transceiver unit supports GSM 850/900/1800/1900, EGPRS (EDGE), WCDMA Band I (2100), II (1900), V (850) and VIII (900), LTE B1/B3/B7/B8/B20, and HSPA. The transceiver is compatible with 3GPP Release 6 specification, and supports Bluetooth 2.1+EDR standard and WLAN a/b/g/n (2.4 GHz and 5.0 GHz). The transceiver consists of a system/RF module which is referred to as the engine, a Bluetooth/WLAN/FM module, and a GPS module for use while the engine is operating in either GSM or WCDMA mode.

The transceiver consists in one PWB. Located on the top side of the PWB it consists of RF, BT, WLAN and GPS engines.

The RF module receives and demodulates the radio frequency signals from the base station and transmits the modulated RF signals to the base station. It consists of the following functional sub-modules: Receiver, Frequency Synthesizer and Transmitter.

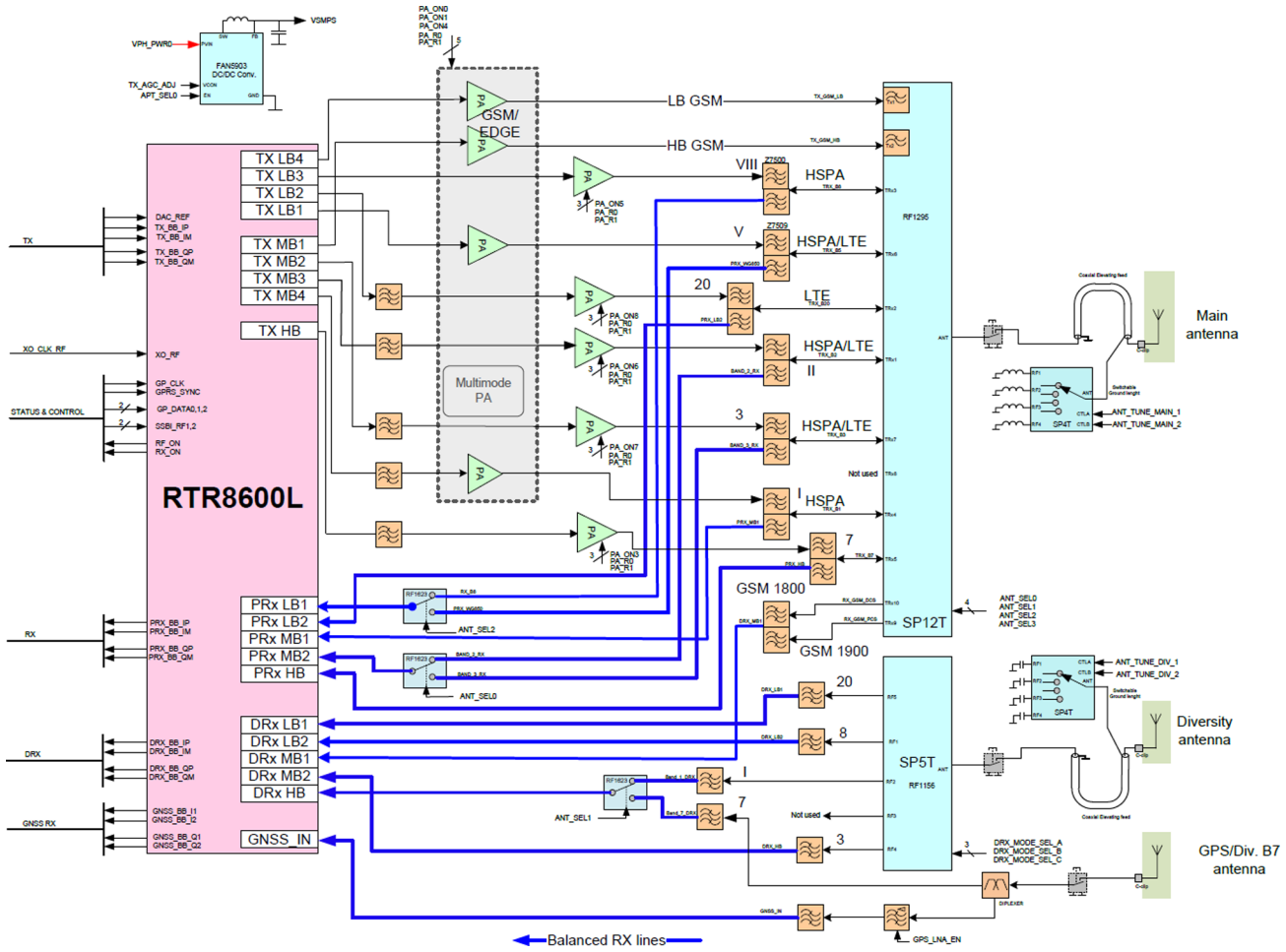


Figure 56 RF block diagram

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

Channel	TX Freq (MHz)	RX Freq (MHz)	TX VCO Freq (MHz)	RX VCO Freq (MHz)
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
9750	1950.0	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	3704.8	9662	1932.4	3864.8
9400	1880.0	3760.0	9800	1960.0	3920.0
9538	1907.6	3815.2	9938	1987.6	3975.2

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	3346.4	4408	881.6	3526.4

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
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 B1 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
18000	1920.0	3840.0	0	2110.0	4220.0
18300	1950.0	3900.0	300	2140.0	4280.0
18599	1979.9	3959.8	599	2169.9	4339.8

LTE B3 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
19200	1710.0	3420.0	1200	1805.0	3610.0
19575	1747.5	3495.0	1575	1842.5	3685.0
19949	1784.9	3569.8	1949	1879.9	3759.8

LTE B7 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20750	2500.0	5000.0	2750	2620.0	5240.0
21100	2535.0	5070.0	3100	2655.0	5310.0
21449	2569.9	5139.8	3449	2689.9	5379.8

LTE B8 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
21450	880.0	3520.0	3450	925.0	3700.0
21625	897.5	3590.0	3625	942.5	3770.0

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
21799	914.9	3659.6	3799	959.9	3839.6

LTE B20 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
24150	832.0	3328.0	6150	791.0	3164.0
24300	847.0	3388.0	6300	806.0	3224.0
24449	861.9	3447.6	6449	820.9	3283.6

7 — Service information differences between RM-824 and RM-825

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General information

RM-824 product data

RM-824 Nokia Lumia 820 is a WCDMA/LTE band variant of the RM-825 Nokia Lumia 820.

The key product data differences between the RM-824 and RM-825 are described below.

Connectivity

Table 10 Remote connectivity

Operating bands	RM-824 US: EGSM 850/900/1800/1900, WCDMA/HSDPA/HSUPA 900/850/1700-2100/1900/2100 (VIII/V/IV/II/I), LTE 1900/1700-2100/850/700 (B2/B4/B5/B17)
	RM-824 AT&T: EGSM 850/900/1800/1900, WCDMA/HSDPA/HSUPA 900/850/1900/2100 (VIII/V/II/I), LTE 1700-2100/700 (B4/B17)
	RM-824 supports HSDPA category 14 with downlink peak data rate up to 21.1 Mbit/s (in limited use cases). RM-824 supports MSC 10 with GSM GPRS.

Additional features

HAC	RM-824 supports Hearing Aid Compliancy (HAC)

Sales package

- Transceiver RM-824
- Battery (BP-5T)
- USB charger (AC-50)
- Stereo headset (WH-208)
- Connectivity cable (CA-190CD)
- Short user guide

Product and module list

Module name	Type code	Notes
System/RF module PWB	3VT	Main PWB components for RM-824

Main RF characteristics for GSM850/900/1800/1900, WCDMA VIII/V/IV/II/I and LTE B2/B4/B5/B17 phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), WCDMA V (850), WCDMA IV (1700/2100), WCDMA II (1900), WCDMA I (2100), LTE B2 (1900), LTE B4 (1700/2100), LTE B5 (850) and LTE B17 (700)
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 V (850): 869 - 894 MHz
	WCDMA IV (1700/2100): 2110 - 2155 MHz
	WCDMA II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B2 (1900): 1930 - 1990 MHz
	LTE B4 (1700/2100): 2110 - 2155 MHz
	LTE B5 (850): 869 - 894 MHz
	LTE B17 (700): 734 - 746 MHz
Diversity antenna Rx frequency band	WCDMA V (850): 869 - 894 MHz
	WCDMA IV (1700/2100): 2110 - 2155 MHz
	WCDMA II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B2 (1900): 1930 - 1990 MHz
	LTE B4 (1700/2100): 2110 - 2155 MHz
	LTE B5 (850): 869 - 894 MHz
	LTE B17 (700): 734 - 746 MHz

Parameter	Unit
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 V (850): 824 - 849 MHz
	WCDMA IV (1700/2100): 1710 - 1755 MHz
	WCDMA II (1900): 1850 - 1910 MHz
	WCDMA I (2100): 1920 - 1980 MHz
	LTE B2 (1900): 1850 - 1910 MHz
	LTE B4 (1700/2100): 1710 - 1755 MHz
	LTE B5 (850): 824 - 849 MHz
	LTE B17 (700): 704 - 716 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 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA V (850): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA IV (1700/2100): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA II (1900): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA I (2100): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	LTE B2 (1900): -39 ... +23 dBm/0.125 uW ... 200 mW
	LTE B4 (1700/2100): -39 ... +23 dBm /0.125 uW ... 200 mW
	LTE B5 (850): -39 ... +23 dBm/0.125 uW ... 200 mW
	LTE B17 (700): -39 ... +23 dBm /0.125 uW ... 200 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 mW ... 398 mW
	EDGE1900:+0 ... +26 dBm/1 mW ... 398 mW

Parameter	Unit
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA VIII (900): 152
	WCDMA V (850): 108
	WCDMA IV (1700/2100): 211
	WCDMA II (1900): 289
	WCDMA I (2100): 277
	LTE B2 (1900): 599
	LTE B4 (1700/2100): 449
	LTE B5 (850): 249
	LTE B17 (700): 119
Channel spacing	GSM850: 200 kHz
	GSM900: 200 kHz
	GSM1800: 200 kHz
	GSM1900: 200 kHz
	WCDMA VIII (900): 200 kHz
	WCDMA V (850): 100/200 kHz
	WCDMA IV (1700/2100): 100/200 kHz
	WCDMA II (1900): 100/200 kHz
	WCDMA I (2100): 200 kHz
	LTE B2 (1900): 100 kHz
	LTE B4 (1700/2100): 100 kHz
	LTE B5 (850): 100 kHz
	LTE B17 (700): 100 kHz

Parameter	Unit
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA VIII (900): 75
	WCDMA V (850): 75
	WCDMA IV (1700/2100): 75
	WCDMA II (1900): 75
	WCDMA I (2100): 75
	LTE B2 (1900): 62
	LTE B4 (1700/2100): 62
	LTE B5 (850): 62
	LTE B17 (700): 62

Main RF characteristics for GSM850/900/1800/1900, WCDMA VIII/V/II/I and LTE B4/B17 phones

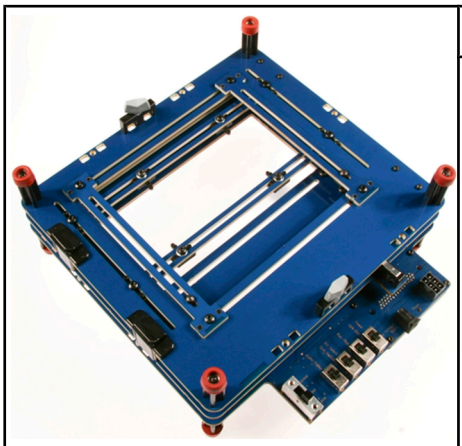
Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), WCDMA V (850), WCDMA II (1900), WCDMA I (2100), LTE B4 (1700/2100) and LTE B17 (700)
Main antenna Rx frequency band	GSM850: 869 - 894 MHz
	EGSM900: 925 - 960 MHz
	GSM1800: 1805 - 1880 MHz
	GSM1900: 1930 - 1990 MHz
	WCDMA VIII (900): 925 - 960 MHz
	WCDMA V (850): 869 - 894 MHz
	WCDMA II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B4 (1700/2100): 2110 - 2155 MHz
	LTE B17 (700): 734 - 746 MHz
Diversity antenna Rx frequency band	WCDMA V (850): 869 - 894 MHz
	WCDMA II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
	LTE B4 (1700/2100): 2110 - 2155 MHz
	LTE B17 (700): 734 - 746 MHz

Parameter	Unit
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 V (850): 824 - 849 MHz
	WCDMA II (1900): 1850 - 1910 MHz
	WCDMA I (2100): 1920 - 1980 MHz
	LTE B4 (1700/2100): 1710 - 1755 MHz
	LTE B17 (700): 704 - 716 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 ... +23.5 dBm/0.01uW ... 224 mW
	WCDMA V (850): -50 ... +23.5 dBm/0.01uW ... 224 mW
	WCDMA II (1900): -50 ... +23.5 dBm/0.01uW ... 224 mW
	WCDMA I (2100): -50 ... +23.5 dBm/0.01uW ... 224 mW
	LTE B4 (1700/2100): -39 ... +23 dBm /0.125 uW ... 200 mW
	LTE B17 (700): -39 ... +23 dBm /0.125 uW ... 200 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 mW ... 398 mW
	EDGE1900:+0 ... +26 dBm/1 mW ... 398 mW
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA VIII (900): 152
	WCDMA V (850): 108
	WCDMA II (1900): 289
	WCDMA I (2100): 277
	LTE B4 (1700/2100): 449
	LTE B17 (700): 119

Parameter	Unit
Channel spacing	GSM850: 200 kHz
	GSM900: 200 kHz
	GSM1800: 200 kHz
	GSM1900: 200 kHz
	WCDMA VIII (900): 200 kHz
	WCDMA V (850): 100/200 kHz
	WCDMA II (1900): 100/200 kHz
	WCDMA I (2100): 200 kHz
	LTE B4 (1700/2100): 100 kHz
	LTE B17 (700): 100 kHz
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA VIII (900): 75
	WCDMA V (850): 75
	WCDMA II (1900): 75
	WCDMA I (2100): 75
	LTE B4 (1700/2100): 62
	LTE B17 (700): 62

Service tools and service concepts

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-824; RM-825; RM-826. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.



MJ-305	Module jig	0781487

Module jig MJ-305 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-interfaces 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-293 RF guiding plate is required with this jig
- CA-205PS power cable is used with this jig
- CA-158RS cable is used together with this jig for RF testing
-

Attenuation values for CA-158RS cable				
Band	**Default f/ MHz RX**	**Att. RX**	**Default f/ MHz TX**	**Att. TX**
GSM 850	881.6	-0.2	836.6	-0.2
GSM 900	942.4	-0.2	897.4	-0.2
GSM 1800	1842.8	-0.3	1747.8	-0.3
GSM 1900	1960.0	-0.3	1880.0	-0.3
WCDMA I	2140.0	-0.4	1950.0	-0.3
WCDMA II / LTE B2	1960.0	-0.3	1880.0	-0.3
WCDMA IV	2140.0	-0.4	1740.0	-0.3
LTE B4	2132.5	-0.4	1732.5	-0.3
WCDMA V	880.0	-0.2	835.0	-0.2
LTE B5	881.5	-0.2	836.5	-0.2
WCDMA VIII	942.6	-0.2	897.6	-0.2
LTE B17	740.0	-0.2	710.0	-0.2
WLAN	n/a	n/a	2442.0	-0.4

	XRS-6	RF cable	0730231
	The RF cable is used to connect, for example, a module repair jig to the RF measurement equipment. SMA to N-Connector approximately 610 mm. Attenuation for: • GSM850/900: 0.3+-0.1 dB • GSM1800/1900: 0.5+-0.1 dB • WCDMA V/VIII: 0.3+-0.1dB • WCDMA I/II/IV: 0.5+-0.1dB • LTE B2/B4: 0.5+-0.1dB • LTE B5/B17: 0.3+-0.1dB • BT/WLAN: 0.5+-0.1dB	

BB troubleshooting

PWB markings in RM-824 and RM-825

Mechanically RM-824 and RM-825 are identical and thus the HW differences are noticeable only by taking a closer look at the PWB. As illustrated in the figure below, the markings on the PWB enable quick differentiation between the two variants.

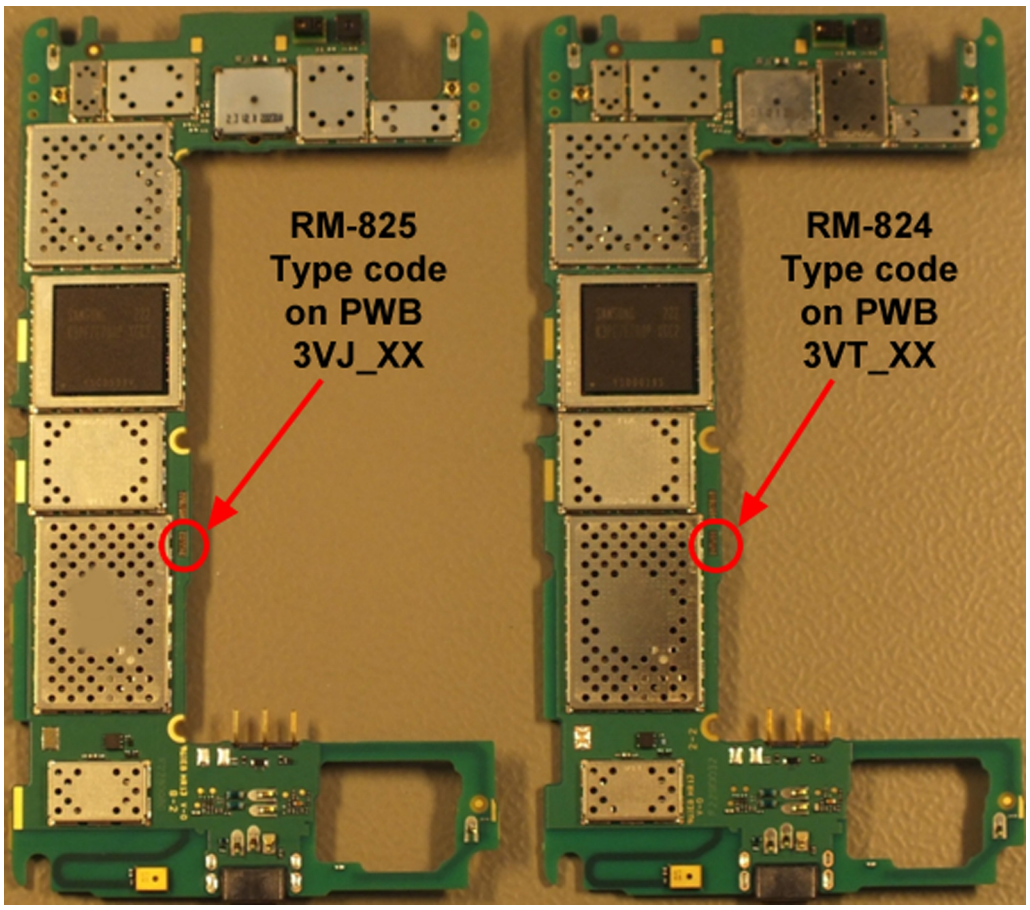


Figure 57 PWB markings in RM-824 and RM-825

RF troubleshooting

Cellular RF key components

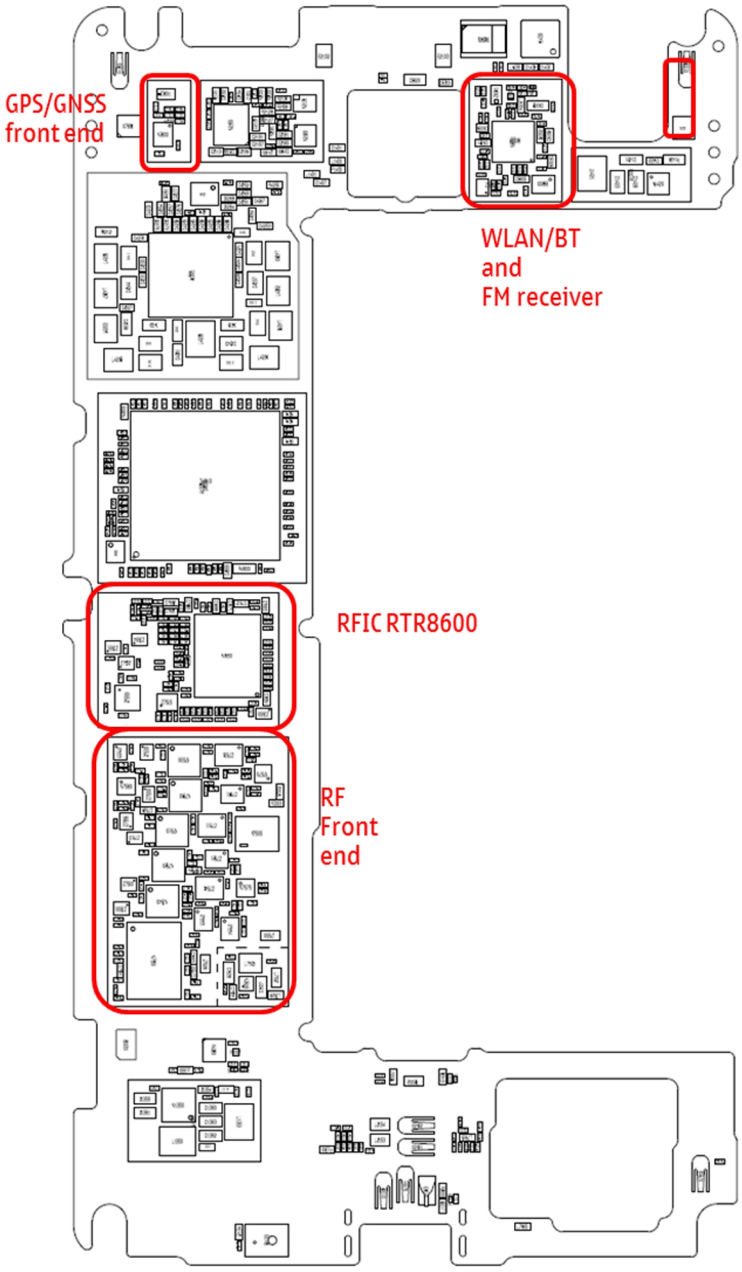


Figure 58 RF key component layout, top side

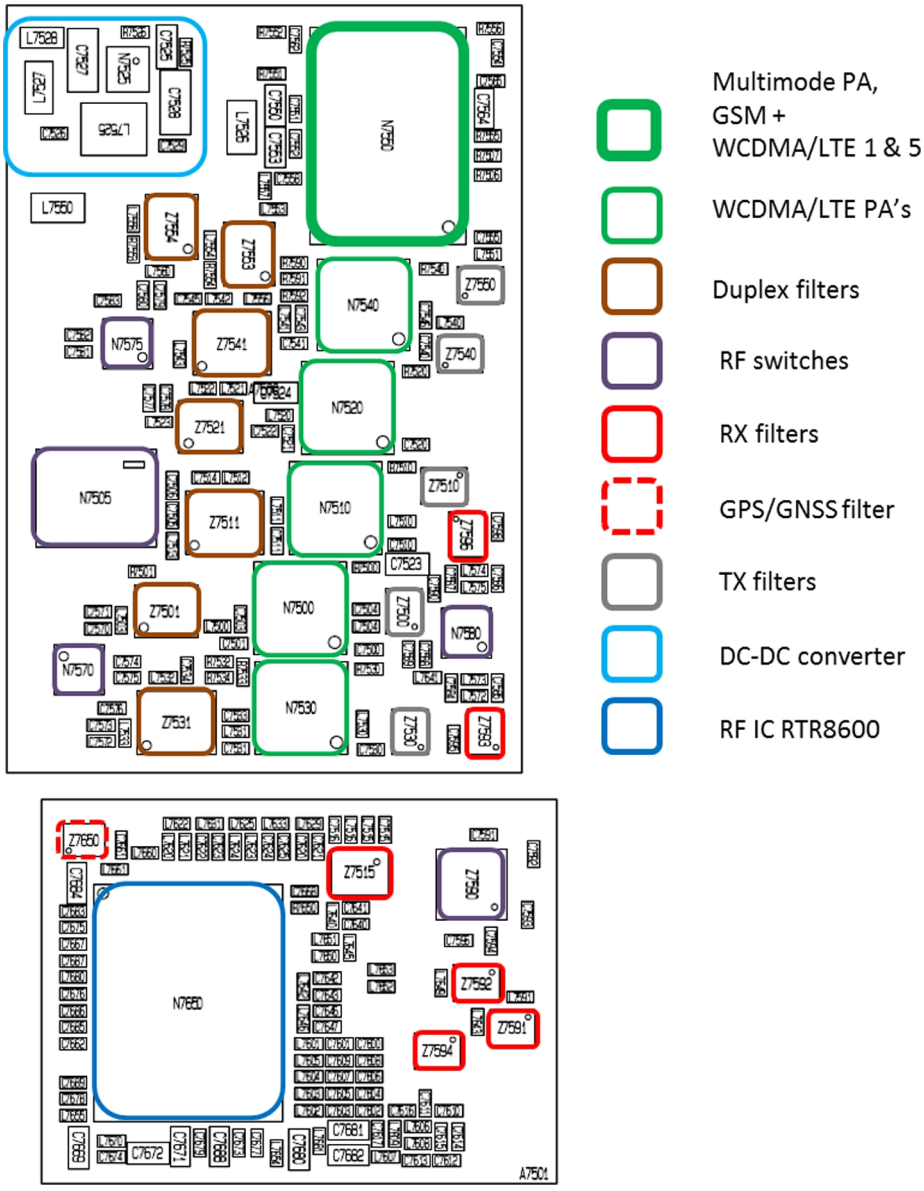


Figure 59 RF key components

RF tuning and testing

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

System module

Phone description

Key components

Function	Description	Item ref
Main PWB	3VT	
GSM/WCDMA B1/WCDMA B5/LTE B5 PA	WCDMA I, V, LTE B5 (RM-824 US) WCDMA I, V (RM-824 AT&T)	N7550

Function	Description	Item ref
WCDMA B2/LTE B2 PA	WCDMA II, LTE B2 (RM-824 US) WCDMA II (RM-824 AT&T)	N7500
WCDMA B4/LTE B4 PA	WCDMA IV, LTE B4 (RM-824 US) LTE B4 (RM-824 AT&T)	N7530
WCDMA B8 PA		N7520
LTE B17 PA		N7510
SP10T antenna switch module		N7505

Cellular RF technical description

The RM-824 transceiver unit supports GSM 850/900/1800/1900, EGPRS (EDGE), WCDMA Band I (2100), II (1900), IV (1700/2100), V (850) and VIII (900), LTE B2/B4/B5/B17, and HSPA. The transceiver is compatible with 3GPP Release 6 specification, and supports Bluetooth 2.1+EDR standard and WLAN a/b/g/n (2.4 GHz and 5.0 GHz). The transceiver consists of a system/RF module which is referred to as the engine, a Bluetooth/WLAN/FM module, and a GPS module for use while the engine is operating in either GSM or WCDMA mode.

The transceiver consists in one PWB. Located on the top side of the PWB it consists of RF, BT, WLAN and GPS engines.

The RF module receives and demodulates the radio frequency signals from the base station and transmits the modulated RF signals to the base station. It consists of the following functional sub-modules: Receiver, Frequency Synthesizer and Transmitter.

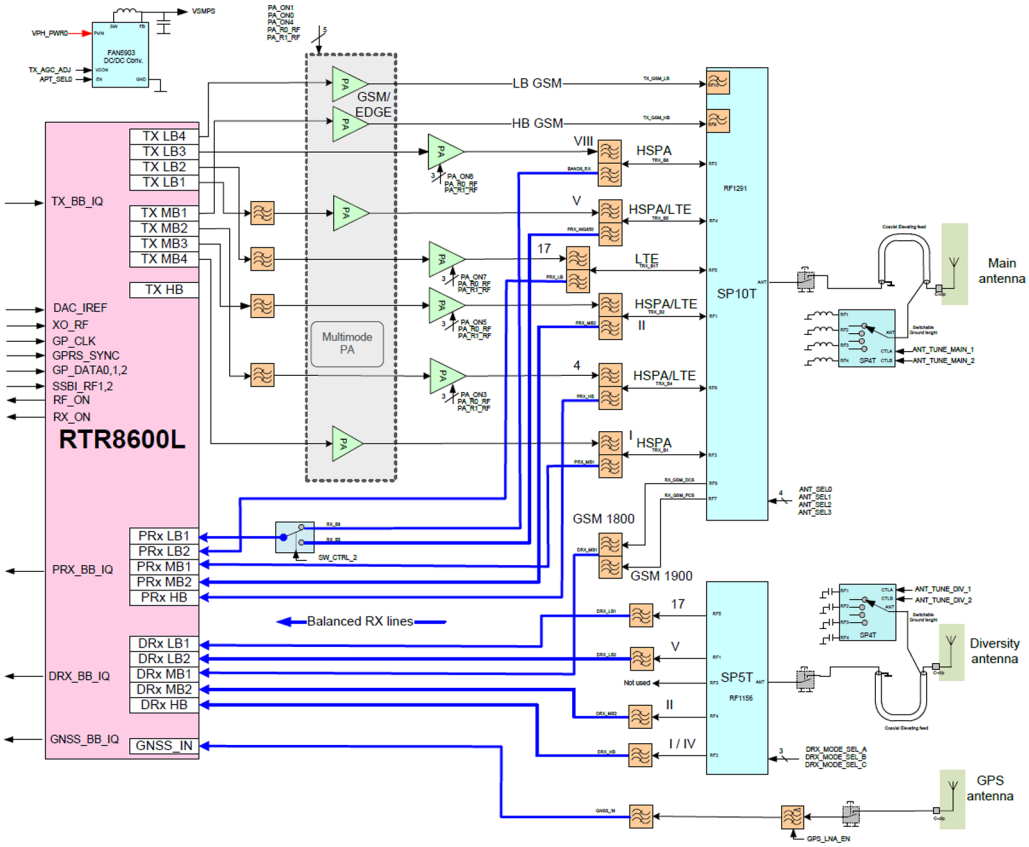


Figure 60 RF block diagram

HAC

HAC coil is connected to N2180 TPA2012D2 which is connected to WCD9310.

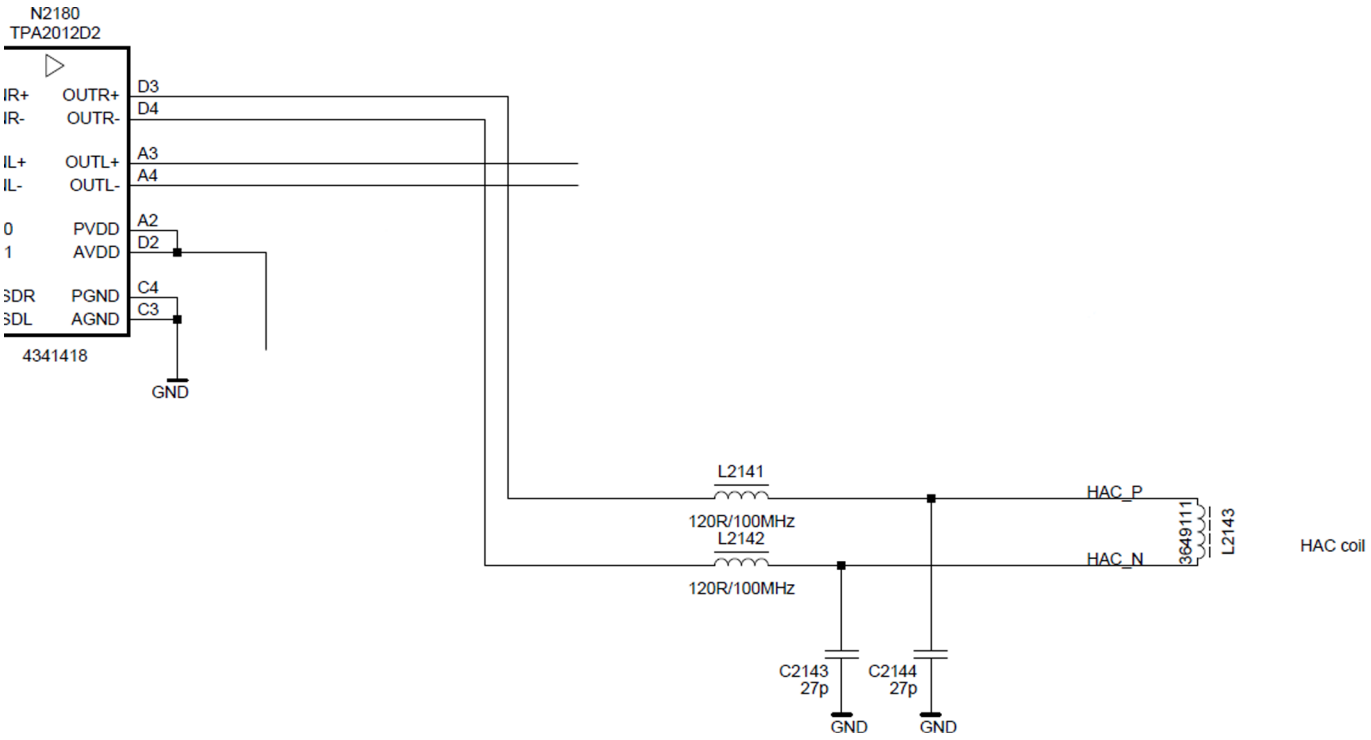


Figure 61 HAC diagram

WCDMA IV (1700/2100) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
1312	1712.4	3424.8	1537	2112.4	4224.8
1412	1732.4	3464.8	1675	2140.0	4280
1513	1752.6	3505.2	1738	2152.6	4305.2

LTE B2 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
18600	1850.0	3700.0	600	1930.0	3860.0
18900	1880.0	3760.0	900	1960.0	3920.0
19199	1909.9	3819.8	1199	1989.9	3979.8

LTE B4 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
19950	1710.0	3420.0	1950	2110.0	4220.0

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20175	1732.5	3465.0	2175	2132.5	4265.0
20399	1754.9	3509.8	2399	2154.9	4309.8

LTE B5 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
20400	824.0	3296.0	2400	869.0	3476.0
20525	836.5	3346.0	2525	881.5	3526.0
20649	848.9	3395.6	2649	893.9	3575.6

LTE B17 frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
23730	704.0	2816.0	5730	734.0	2936.0
23790	710.0	2840.0	5790	740.0	2960.0
23849	715.9	2863.6	5849	745.9	2983.6

8 — Service information differences between RM-826 and RM-824

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General information

RM-826 product data

RM-826 is a non-LTE (HSPA+) variant of the RM-824 US Nokia Lumia 820.

The key product data differences between the RM-826 and RM-824 are described below.

Connectivity

Table 11 Remote connectivity

Operating bands	RM-826: EGSM 850/900/1800/1900, WCDMA/HSDPA/HSUPA 900/850/1700-2100/1900/2100 (VIII/V/IV/II/I)
	RM-826 supports HSDPA category 14 with downlink peak data rate up to 21.1 Mbit/s (in limited use cases). RM-826 supports MSC 10 with GSM GPRS.

Sales package

- Transceiver RM-826
- Battery (BP-5T)
- USB charger (AC-50C)
- Stereo headset (WH-208)
- Connectivity cable (CA-190CD)
- Short user guide

Product and module list

Module name	Type code	Notes
System/RF module PWB	3VU	Main PWB components for RM-826

Main RF characteristics for GSM850/900/1800/1900 and WCDMA VIII/V/IV/II/I phones

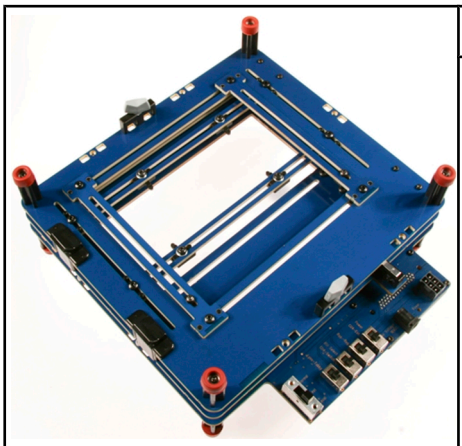
Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900), WCDMA V (850), WCDMA IV (1700/2100), WCDMA II (1900) and WCDMA I (2100)

Parameter	Unit
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 V (850): 869 - 894 MHz
	WCDMA IV (1700/2100): 2110 - 2155 MHz
	WCDMA II (1900): 1930 - 1990 MHz
	WCDMA I (2100): 2110 - 2170 MHz
Diversity antenna Rx frequency band	WCDMA V (850): 869 - 894 MHz
	WCDMA IV (1700/2100): 2110 - 2155 MHz
	WCDMA II (1900): 1930 - 1990 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 V (850): 824 - 849 MHz
	WCDMA IV (1700/2100): 1710 - 1755 MHz
	WCDMA II (1900): 1850 - 1910 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 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA V (850): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA IV (1700/2100): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA II (1900): -50 ... +23.5 dBm/0.01 uW ... 224 mW
	WCDMA I (2100): -50 ... +23.5 dBm/0.01 uW ... 224 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 mW ... 398 mW
	EDGE1900:+0 ... +26 dBm/1 mW ... 398 mW

Parameter	Unit
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA VIII (900): 152
	WCDMA V (850): 108
	WCDMA IV (1700/2100): 211
	WCDMA II (1900): 289
	WCDMA I (2100): 277
Channel spacing	GSM850: 200 kHz
	GSM900: 200 kHz
	GSM1800: 200 kHz
	GSM1900: 200 kHz
	WCDMA VIII (900): 200 kHz
	WCDMA V (850): 100/200 kHz
	WCDMA IV (1700/2100): 100/200 kHz
	WCDMA II (1900): 100/200 kHz
	WCDMA I (2100): 200 kHz
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA VIII (900): 75
	WCDMA V (850): 75
	WCDMA IV (1700/2100): 75
	WCDMA II (1900): 75
	WCDMA I (2100): 75

Service tools and service concepts

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-824; RM-825; RM-826. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.



MJ-305	Module jig	0781487

Module jig MJ-305 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-interfaces 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-293 RF guiding plate is required with this jig
- CA-205PS power cable is used with this jig
- CA-158RS cable is used together with this jig for RF testing
-

Attenuation values for CA-158RS cable				
Band	**Default f/ MHz RX**	**Att. RX**	**Default f/ MHz TX**	**Att. TX**
GSM 850	881.6	-0.2	836.6	-0.2
GSM 900	942.4	-0.2	897.4	-0.2
GSM 1800	1842.8	-0.3	1747.8	-0.3
GSM 1900	1960.0	-0.3	1880.0	-0.3
WCDMA I	2140.0	-0.4	1950.0	-0.3
WCDMA II	1960.0	-0.3	1880.0	-0.3
WCDMA IV	2140.0	-0.4	1740.0	-0.3
WCDMA V	880.0	-0.2	835.0	-0.2
WCDMA VIII	942.6	-0.2	897.6	-0.2
WLAN	n/a	n/a	2442.0	-0.4

XRS-6	RF cable	0730231

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

SMA to N-Connector approximately 610 mm.

Attenuation for:

- GSM850/900: 0.3+-0.1 dB
- GSM1800/1900: 0.5+-0.1 dB
- WCDMA V/VIII: 0.3+-0.1dB
- WCDMA I/II/IV: 0.5+-0.1dB
- BT/WLAN: 0.5+-0.1dB

BB troubleshooting

PWB markings in RM-826 and RM-824

Mechanically RM-826 and RM-824 are identical and thus the HW differences are noticeable only by taking a closer look at the PWB. As illustrated in the figure below, the markings on the PWB enable quick differentiation between the two variants.

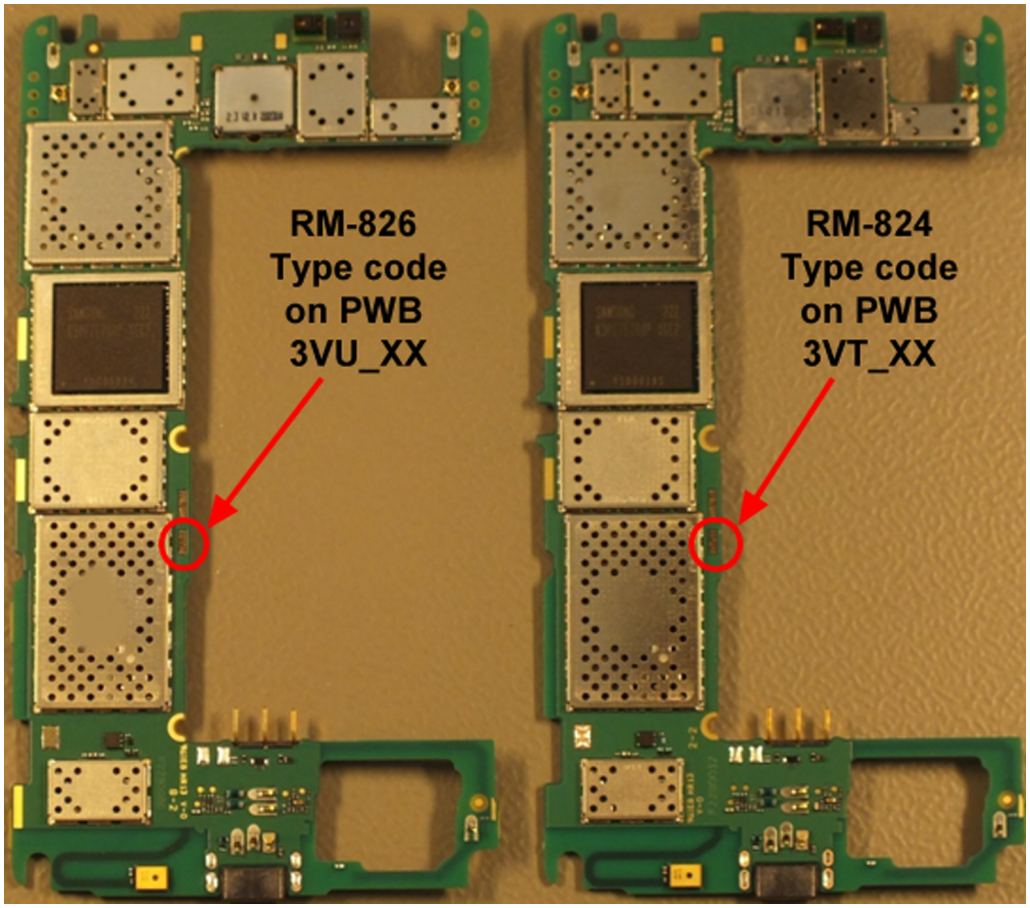


Figure 62 PWB markings in RM-826 and RM-824

RF troubleshooting

Cellular RF key components

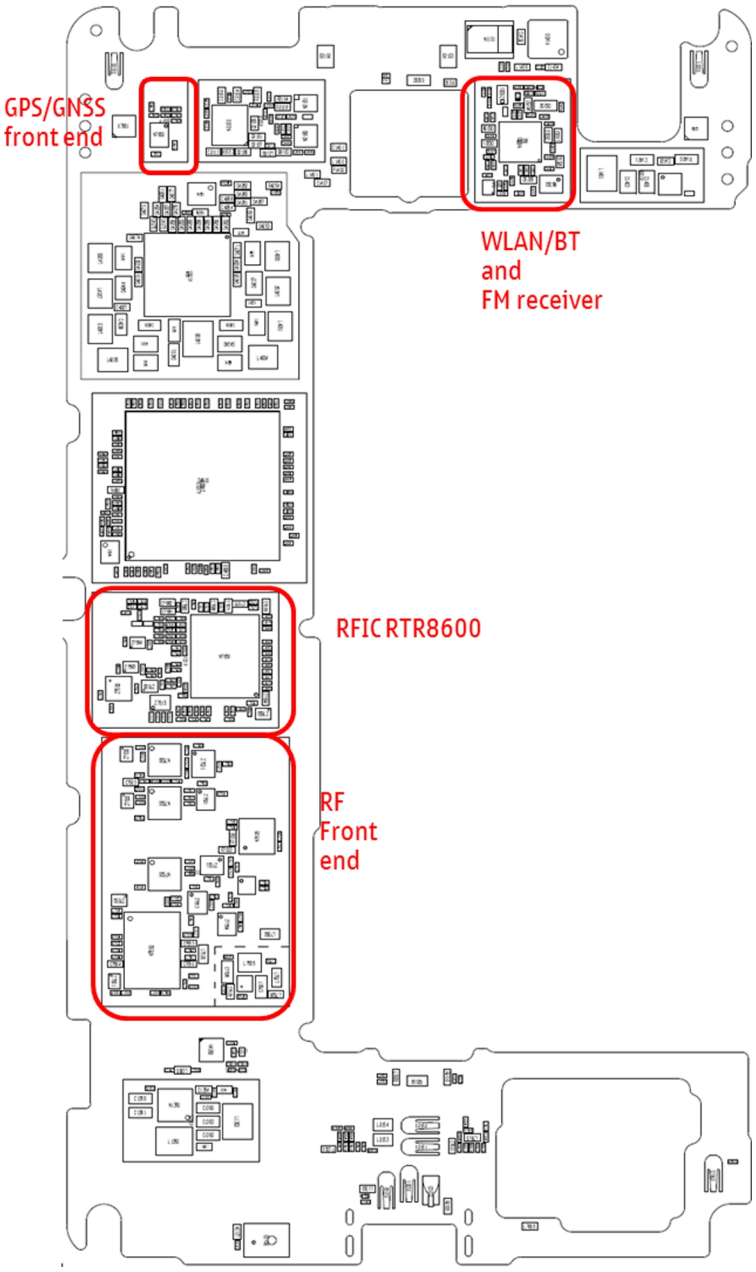


Figure 63 RF key component layout, top side

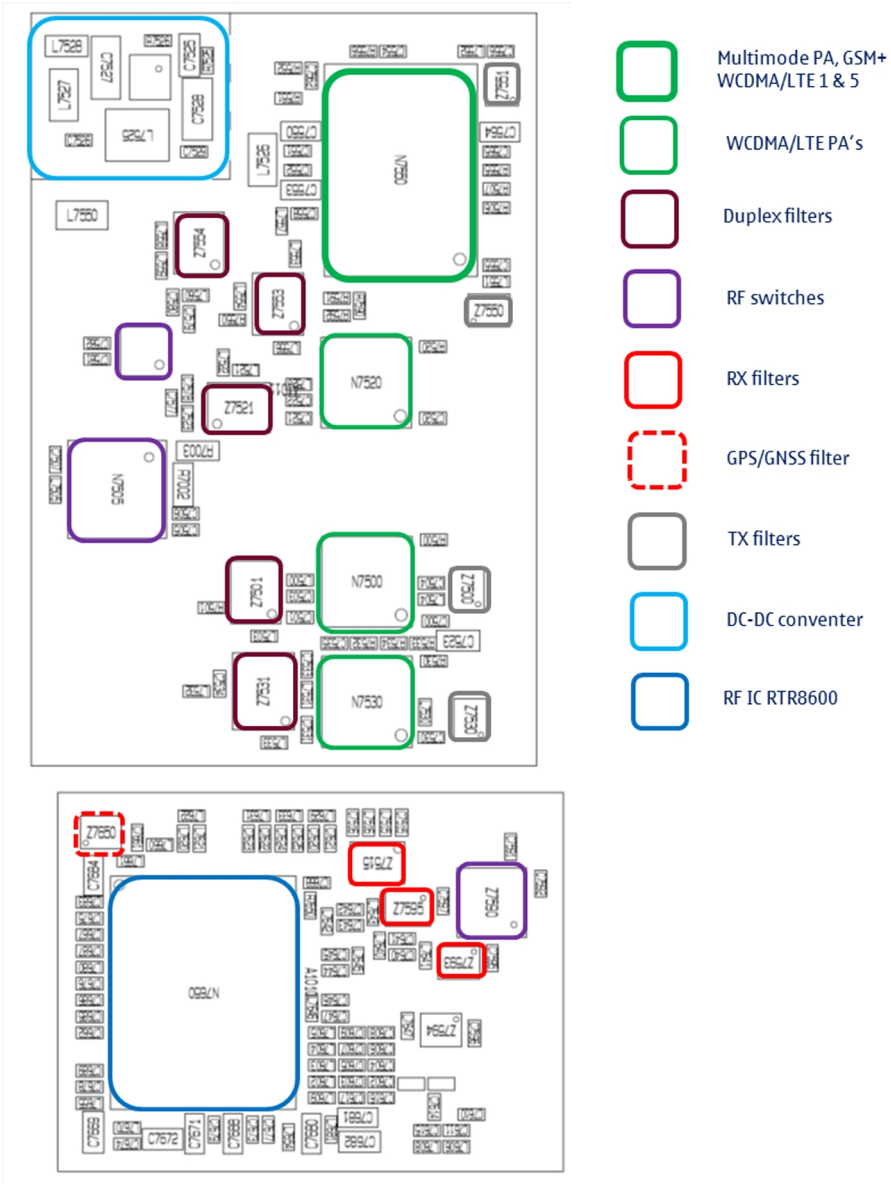


Figure 64 RF key components

RF tuning and testing

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

System module

Phone description

Key components

Function	Description	Item ref
Main PWB	3VU	
GSM/WCDMA B1/WCDMA B5 PA		N7550
WCDMA B2 PA		N7500
WCDMA B4 PA		N7530

Function	Description	Item ref
WCDMA B8 PA		N7520
SP10T antenna switch module		N7505

Cellular RF technical description

The RM-826 transceiver unit supports GSM 850/900/1800/1900, EGPRS (EDGE), WCDMA Band I (2100), II (1900), IV (1700/2100), V (850) and VIII (900), and HSPA. The transceiver is compatible with 3GPP Release 6 specification, and supports Bluetooth 2.1+EDR standard and WLAN a/b/g/n (2.4 GHz and 5.0 GHz). The transceiver consists of a system/RF module which is referred to as the engine, a Bluetooth/WLAN/FM module, and a GPS module for use while the engine is operating in either GSM or WCDMA mode.

The transceiver consists in one PWB. Located on the top side of the PWB it consists of RF, BT, WLAN and GPS engines.

The RF module receives and demodulates the radio frequency signals from the base station and transmits the modulated RF signals to the base station. It consists of the following functional sub-modules: Receiver, Frequency Synthesizer and Transmitter.

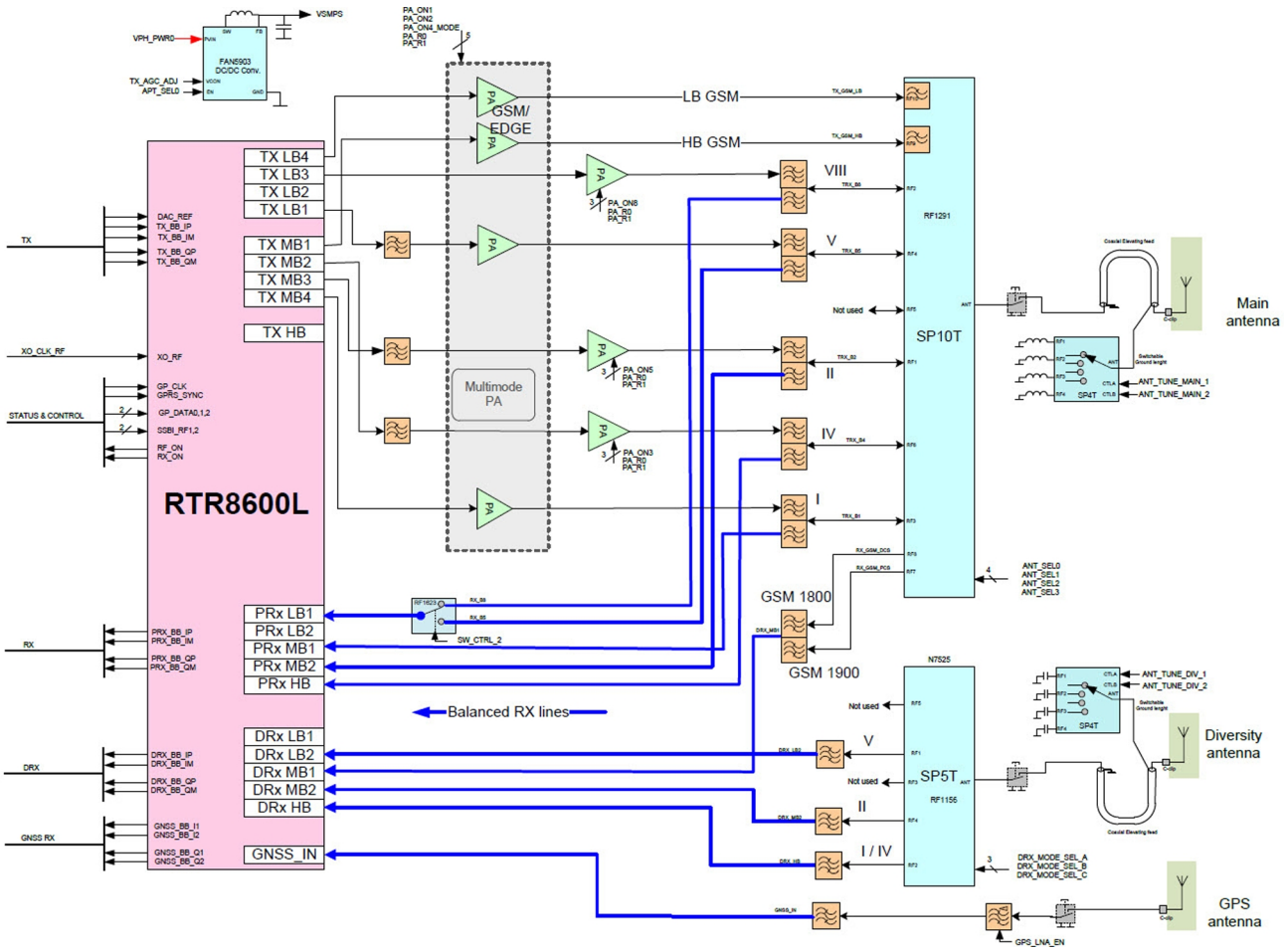


Figure 65 RF block diagram

WCDMA IV (1700/2100) frequencies

Uplink CH (TX)	TX Freq (MHz)	TX VCO Freq (MHz)	Downlink CH (RX)	RX Freq (MHz)	RX VCO Freq (MHz)
1312	1712.4	3424.8	1537	2112.4	4224.8
1412	1732.4	3464.8	1675	2140.0	4280
1513	1752.6	3505.2	1738	2152.6	4305.2

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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)

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