

6(a) - Baseband Troubleshooting and Manual Tuning Guide

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Table of Contents

	Page No
Introduction to NHL-10 troubleshooting	4
Dead or jammed phone	5
BB Selftest tools	5
Flash programming fault	7
General Power checking	8
Baseband serial interface troubleshooting	9
CBUS	9
FBUS	10
MBUS	10
Energy management calibration	14
Troubleshooting tips	14
ADC-offset over limits	14
BSI Gain over limits	14
Vbatt offset and Gain	14
Vchar over limits	14
Ichar over limits	14
ADC-reading	14
Backup battery	15
IrDA Interface Fault	17
SIM Card Fault	18
"Insert SIM Card" in device display although card is inserted	21
Keypad Interface Fault	22
Display Fault	23
Illumination Fault (Display/Keyboard backlight)	24
MMC Interface Fault	25
Audio troubleshooting	26
Microphone	26
Earpiece	28
IHF	30
Accessory detection troubleshooting	32
Camera Module Troubleshooting	33
Terms	33
Image taking condition effect on image quality	33
Image quality analysis	38
Possible faults in image quality	38
Testing for dust	38
Testing for sharpness	39
Bit errors	40
Hardware failure message	41
No recognizable viewfinder image	42
Bad image quality	43
Baseband Tuning operation	44
Energy management calibration	44
Connections	44
Phoenix Setup	44

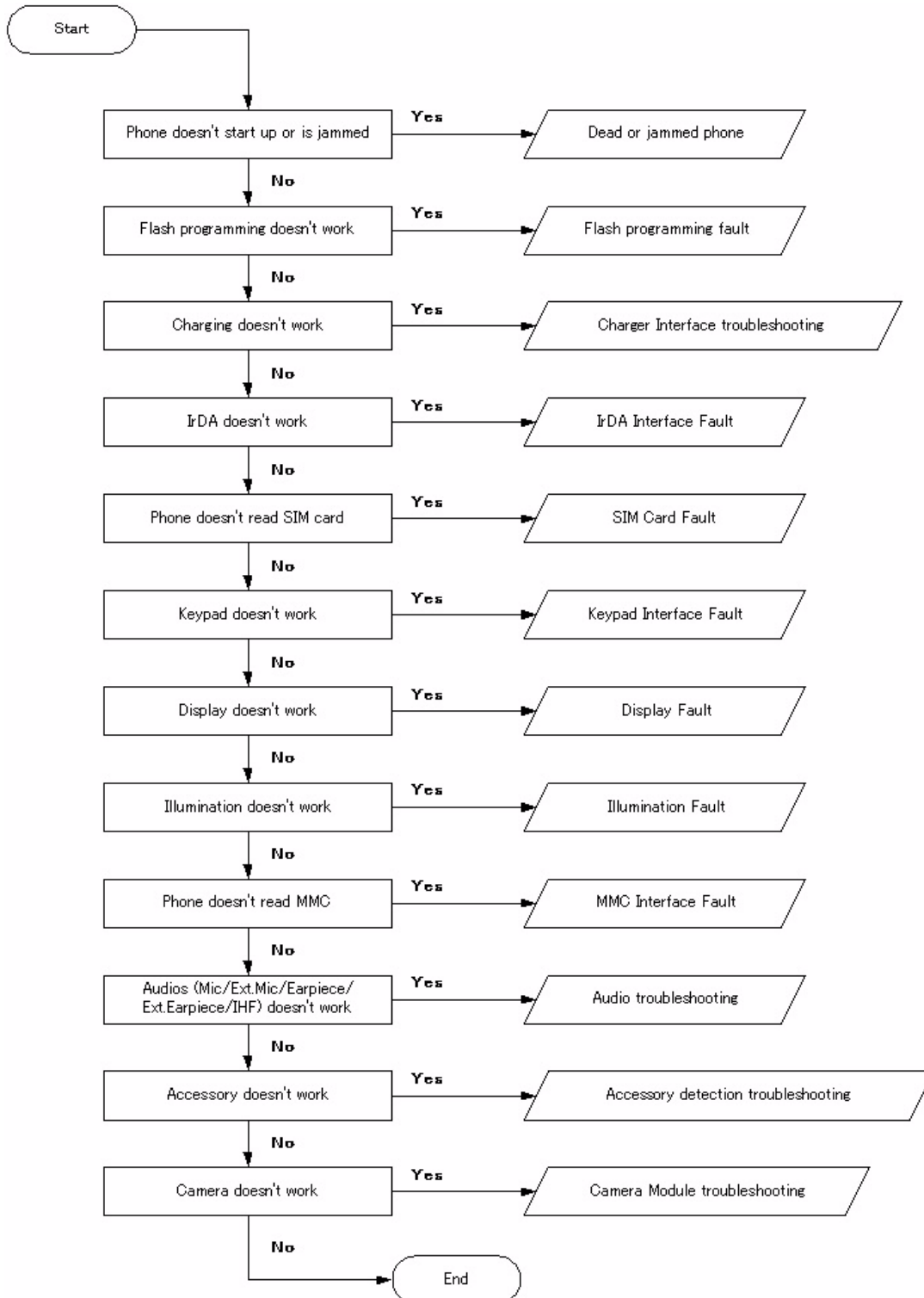
Calibration procedure with JBV-1 45
Zocus (IBAT) calibration with MJ-2 module jig 46
 Connections 46
 Phoenix Setup 46
Zocus (IBAT) calibration procedure with MJ-2 module jig 47

Introduction to NHL-10 troubleshooting

This document is intended to be a guide for localizing and repairing electrical faults in the NHL-10 device. The fault repairing is divided into troubleshooting paths.

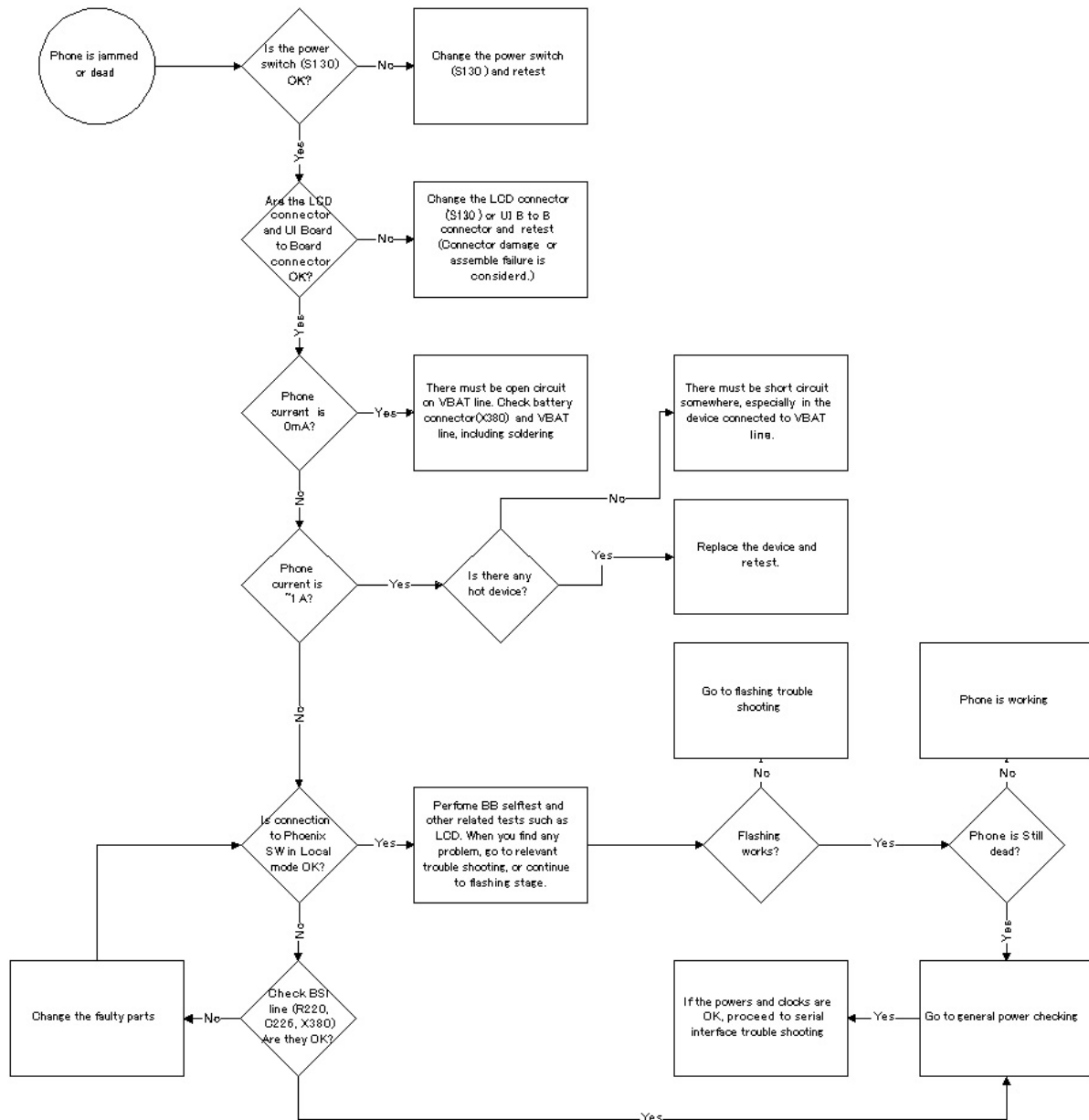
The following diagrams describe baseband troubleshooting.

Figure 1: Main Troubleshooting Diagram



Dead or jammed phone

Figure 2: Phone is jammed or dead



BB Selftest tools

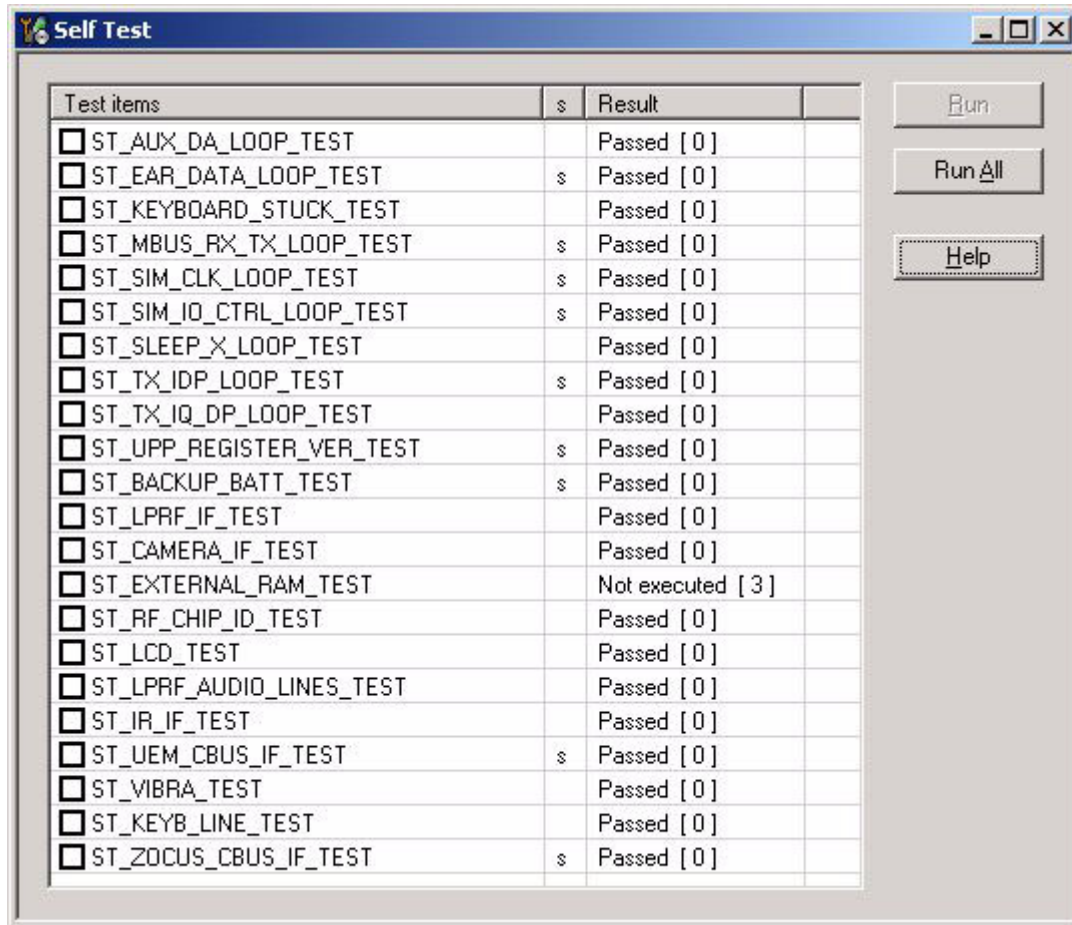
“Selftest failed. Contact service.” on display

This fault means that the software is able to run and thus the watchdog of UEM can be served.

Selftest functions are executed when the phone is powered on, and if one or more selftest functions fail, the message “**Selftest failed. Contact service.**” is shown on the display.

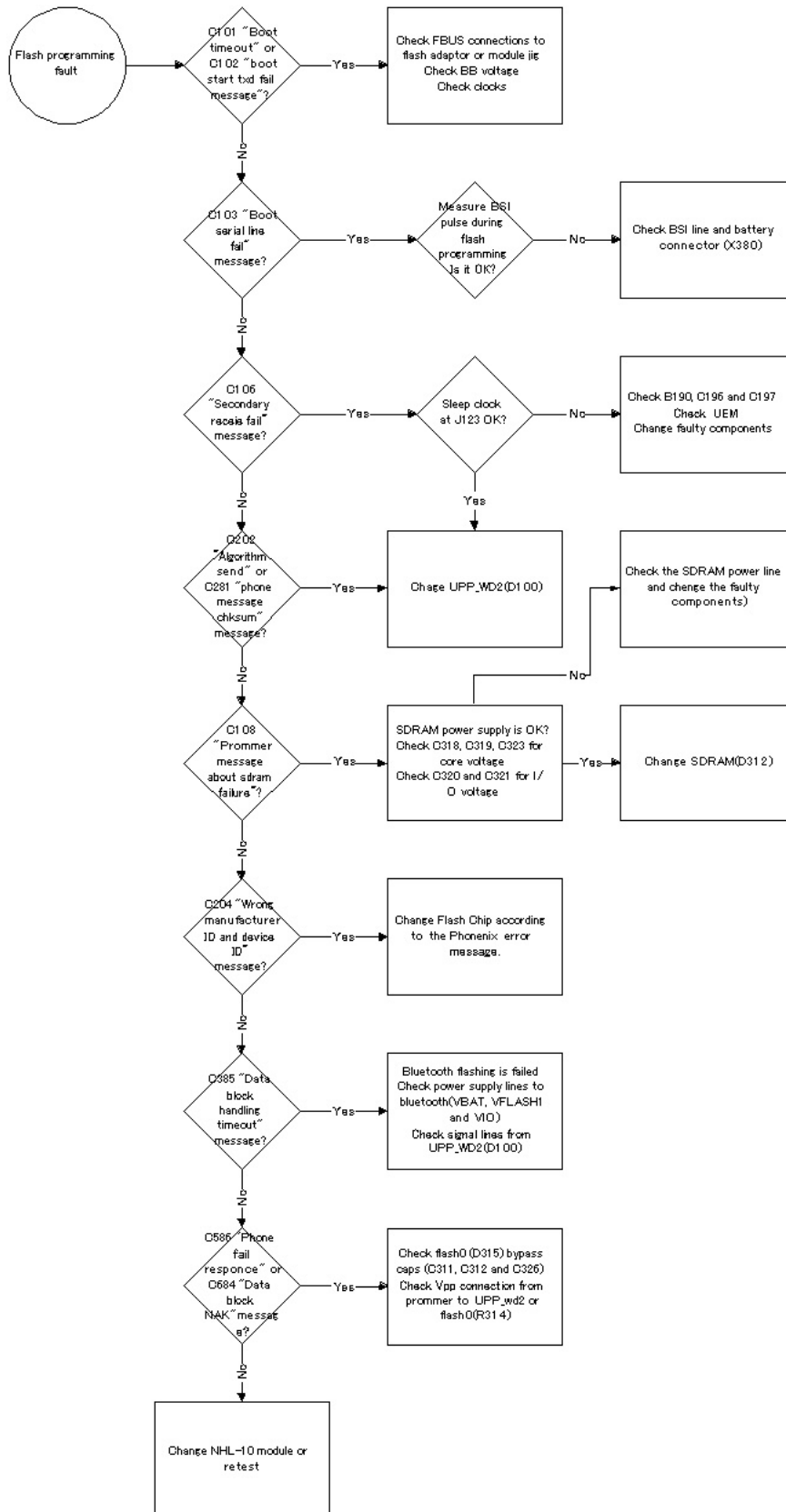
MCU selftest cases can be split into two categories: The ones that are executed during power up and the ones that are executed only with a PC connected. These tests and the items included are as follows:

Figure 3: BB self test items



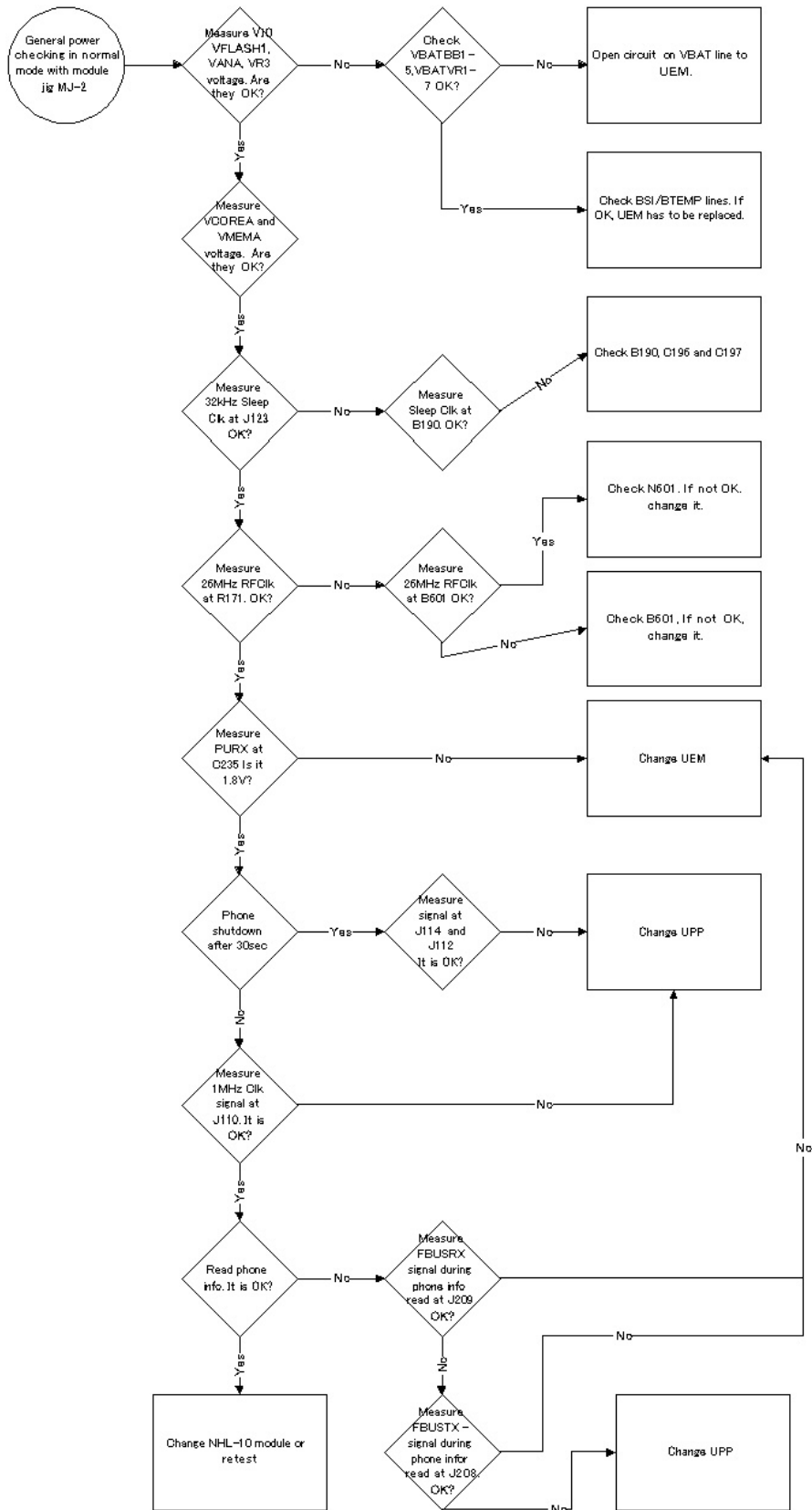
Flash programming fault

Figure 4: Flashing troubleshooting



General Power checking

Figure 5: General Power check



Baseband serial interface troubleshooting

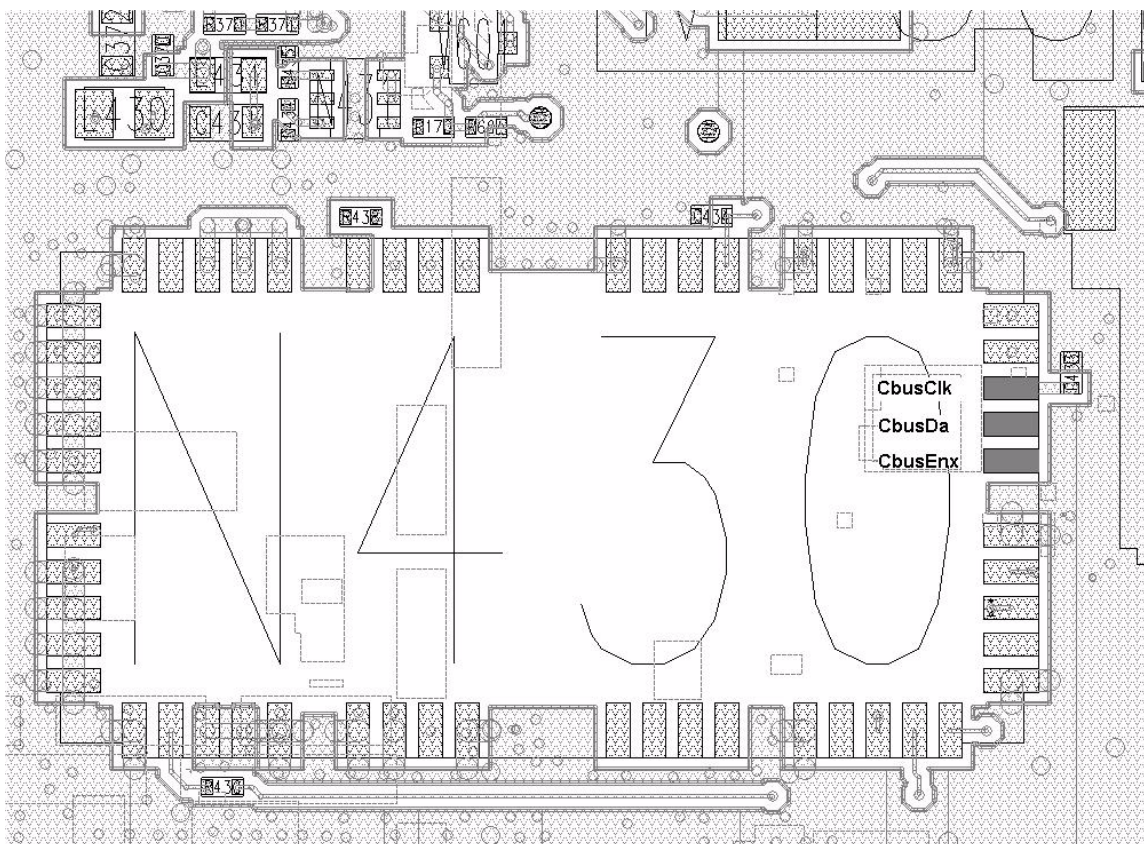
CBUS

CBUS is a three wire serial interface between the main baseband components. The bus consists of data, clock and bus_enable signals. In NHL-10 the bus is connected from UPP_WD2 to UEM and the BT module. UPP_WD2 takes care of controlling the traffic on the bus.

If the interface is faulty from the UPP WD2's end the phone will not boot properly as powering configurations do not work. Traffic on the bus can be monitored from three pins on the BT module.

Pins are shown below.

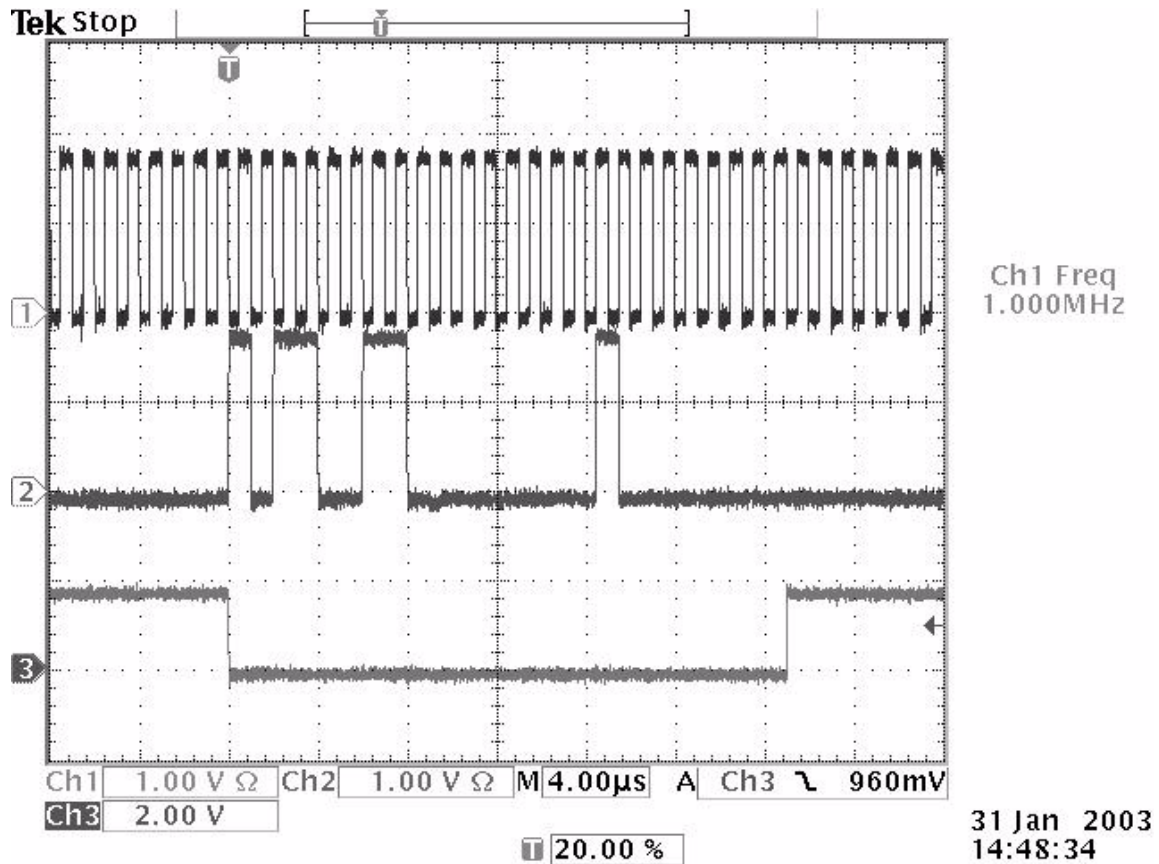
Figure 6: CBUS test points



CBUS traffic is shown in the figure below (Read command to Zocus, LM3819, N380).

CbusClk is connected to Ch1, Cbus Da to Ch2 and CbusEnx to Ch3.

Figure 7: CBUS waveform



If you are able to get the phone to boot up and can reach Phoenix BB self tests it is possible to test the functionality of each component attached to Cbus. Use:

- ST_UEM_CBUS_IF_TEST to test UEM Cbus interface
- ST_LPRF_IF_TEST to test Bluetooth Cbus interface
- ST_ZOCUS_CBUS_IF_TEST to test Zocus Cbus interface

If an error is found testing any of the above components you should replace or re-solder the failing component.

FBUS

FBUS is a two wire RX and TX interface between UPP and flash/test interface. The bus goes through UEM, which adjusts the voltage levels to suit UPP_WD2. The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V.

The functionality of this interface should not affect the device boot into NORMAL, LOCAL nor TEST modes. Phoenix tests can be performed through the MBUS interface in case of a failure in FBUS interface. Flashing is not possible if there is a problem in FBUS interface.

MBUS

MBUS is a two-wire RX and TX interface between UPP and UEM. From UEM the interface continues to flash/test interface as a one-wire interface. UEM adjusts the voltage levels.

The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V. The MBUS traffic between UPP WD2 and UEM can be tested with PHOENIX (ST_MBUS_RX_TX_LOOP_TEST). Flashing is not possible if there is a problem in MBUS.

Charger Interface troubleshooting

Figure 8: Not charging on display

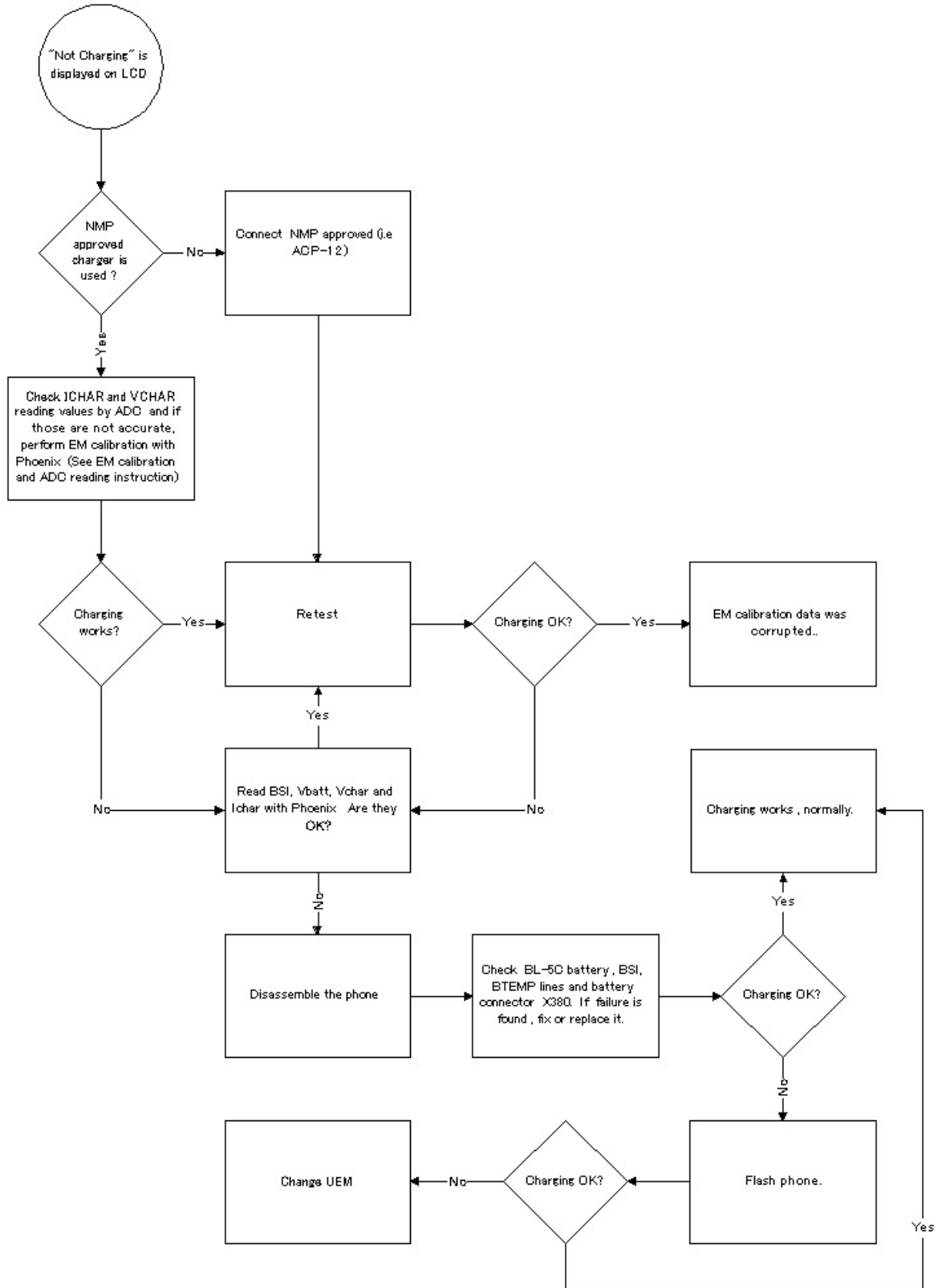
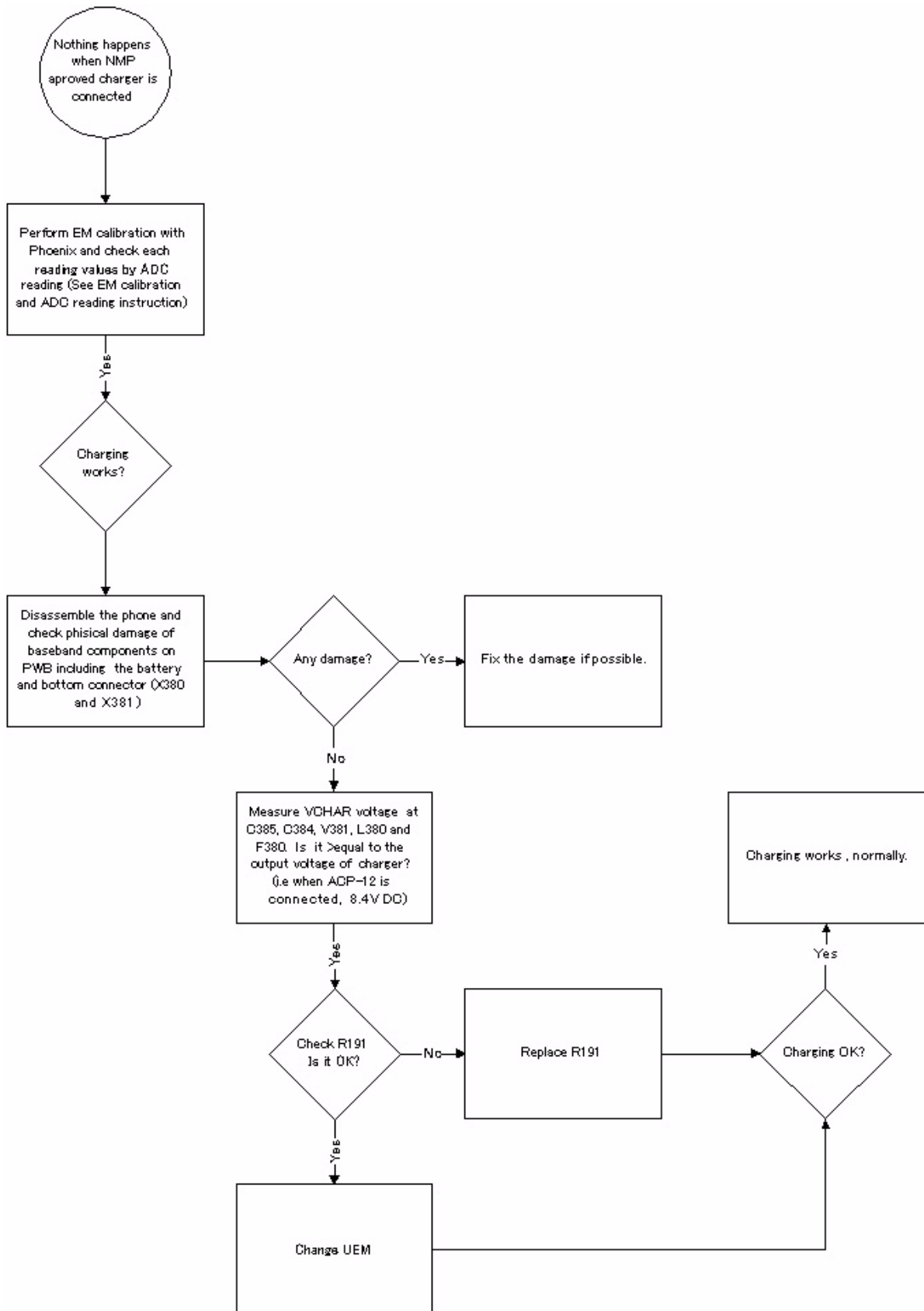


Figure 9: Charger nothing happened



Energy management calibration

During energy management calibration, the A/D converter, BSI, Btemp, Battery voltage, Charger voltage and Charger current are calibrated. For detailed information and instructions see EM-calibration instructions in the service manual.

Troubleshooting tips

ADC-offset over limits

Inspect the BSI line, connectors (hotbar and board to board connector) and components in it (Capacitor C226, ASIP R385, Pull-up resistor R220). If these are OK, change UEM.

BSI Gain over limits

Inspect the BSI line, connectors (hotbar and board to board connector) and components in it (Capacitor C226, ASIP R385, Pull-up resistor R220). If these are OK, change UEM.

Vbatt offset and Gain

Inspect Vbatt lines and components in it.

Vchar over limits

Inspect components that are connected Vchar line: Filtering capacitors C384, C385, TVS V381, L380 and Fuse F380. If those are OK, change UEM.

Ichar over limits

Inspect components that are connected Vchar line: Filtering capacitors C384, C385, TVS V381, L380 and Fuse F380. If those are OK, first change the current sense resistor (R190), if calibration is not still successful change UEM.

Calibration can be checked using ADC-reading. Known voltages, currents and resistances are fed and read by ADC-reading, read values and known values can be compared.

ADC-reading

Divided and scaled battery voltage, Charger voltage, Charger current and BSI values can be read by this tool. Read values a few times before you can be sure that results are accurate.

Figure 10: ADC-reading view

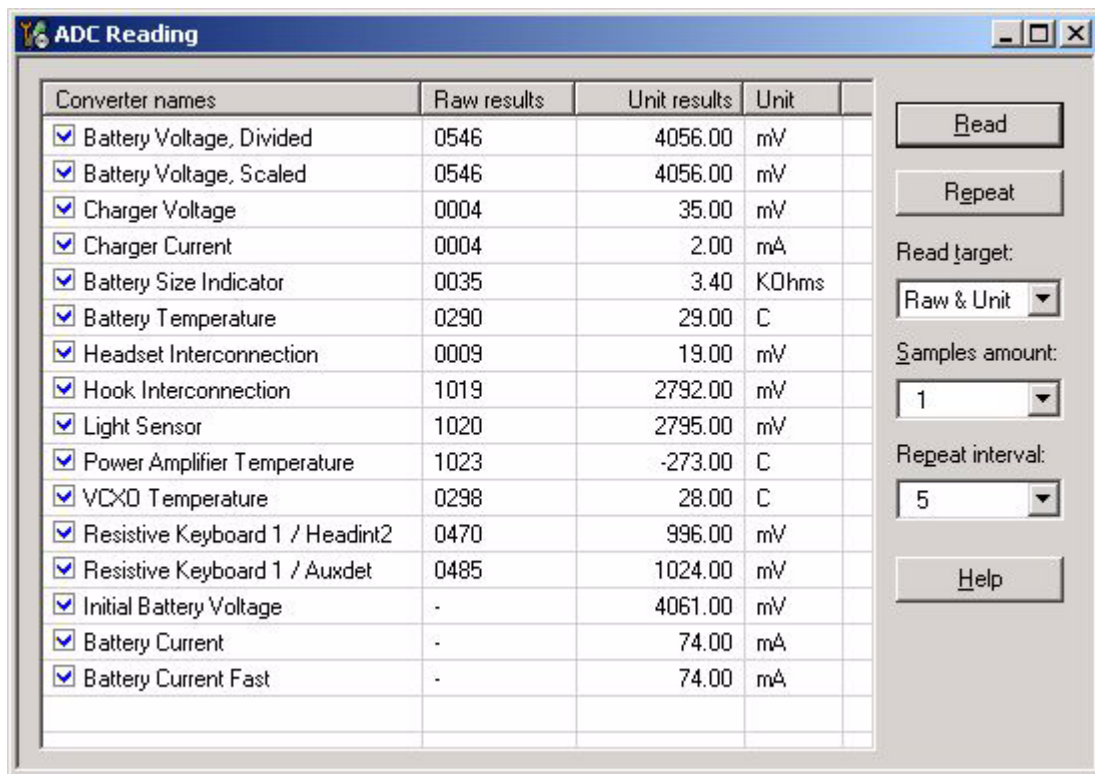


Table 1: Maximum tolerances

Reading	Check point	Tolerance
Vbatt SCAL_	4.2V	±25mV
Vchar	8.4V	±40mV
Ichar	500mA	±20mV
BSI	75k (BL-5C)	±1.3kohm
Btemp	273K (47k)	±5K

Backup battery

Symptom of backup battery fault is:

Real Time Clock loses the correct time during a short main battery removal.

The same symptom can also be seen when the backup battery is empty. About 5 hours is needed to fully charge the backup battery in the device.

Note: The backup battery is charged only at the same time with main battery charging. Or when the device is in LOCAL or TEST mode.

Always check the backup battery visually for any leakage or any other visual defect.

Check that the backup battery is correctly mounted in the device before closing the cover.

Check with Phoenix that the backup battery is OK.

Measure the voltage of the backup battery

- Normal operation when the voltage is > 2.0V
- Fully charged when the voltage is about 3.2V

Enable backup battery charging. (Start to charge the main battery or boot the device to LOCAL or TEST mode.)

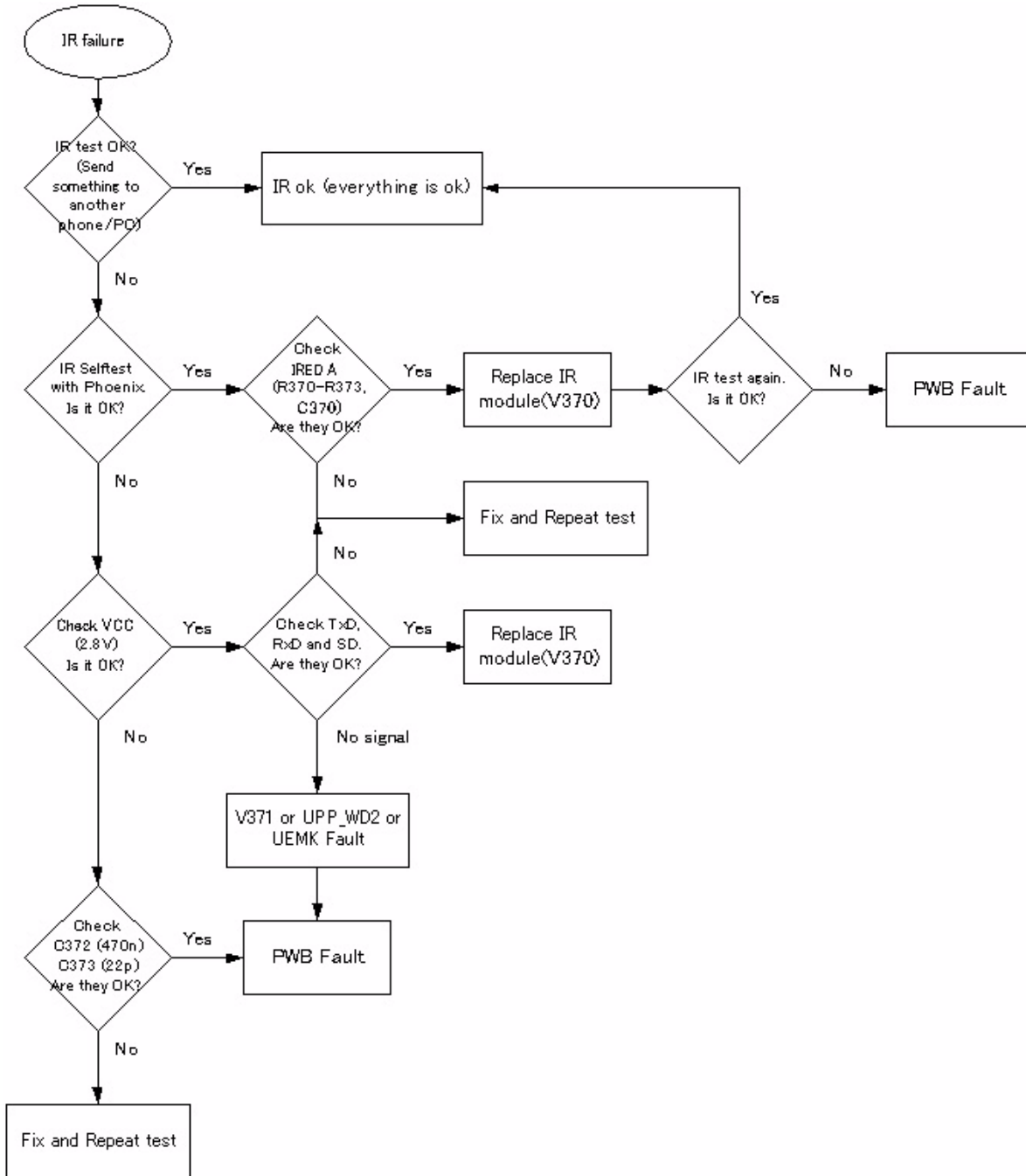
Measure the voltage of the backup battery during charging, it should arise if it is not 3.2V, yet.

When the voltage is over 2.0V for sure, check the backup battery with Phoenix.

IrDA Interface Fault

At this point it is supposed that the problem is in the HW.

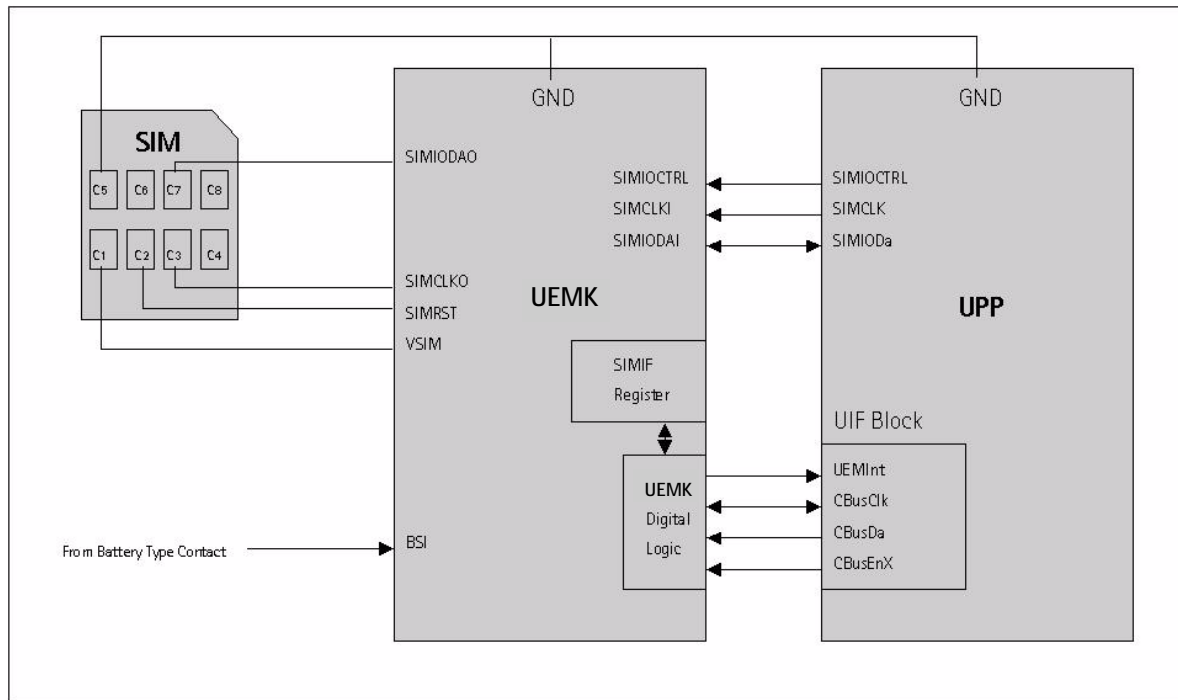
Figure 11: IrDA interface troubleshooting



SIM Card Fault

The whole SIM interface is located in two chips, UPP_WD2 and UEMK. UEMK contains the SIM interface logic level shifting. UPP_WD2 provides SIMClk through UEMK to the SIM. The SIM interface supports both 3V and 1.8V SIMs. There is an EMIF component (3 Lines EMI filter) between the SIM card and UEMK, which isn't shown in the below picture.

Figure 12: UPP_WD2 and UEMK SIM connections

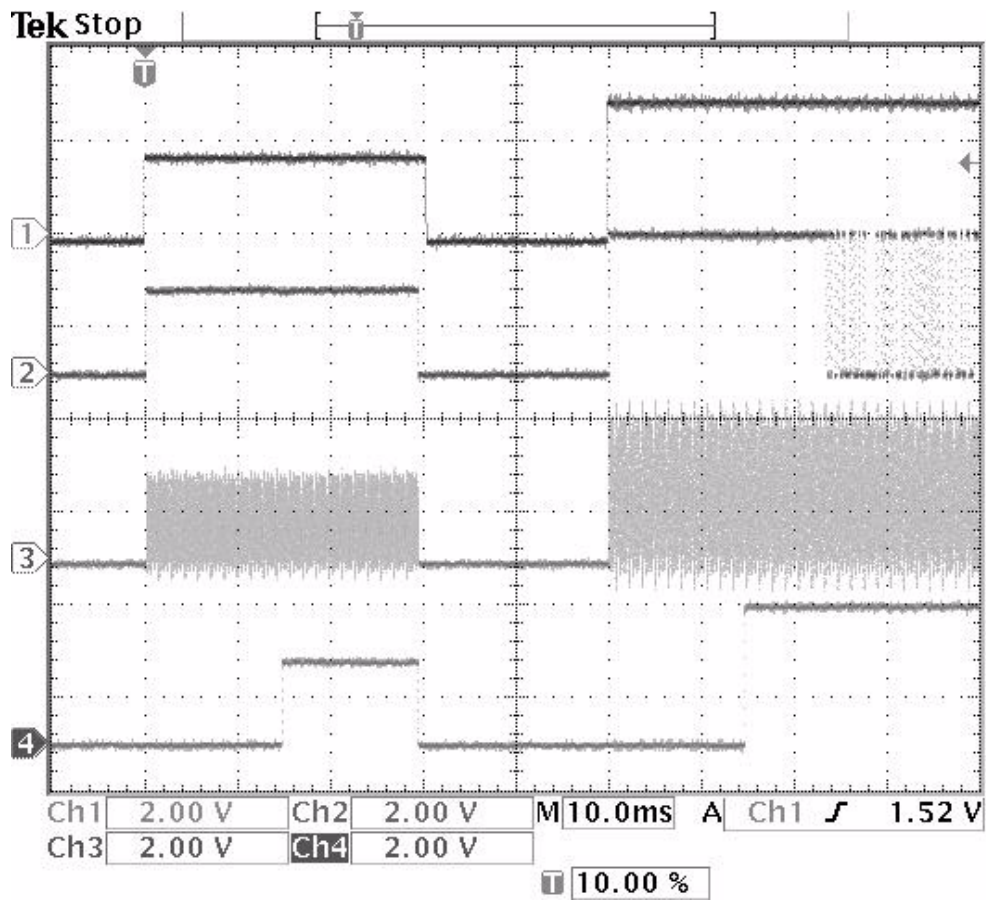


The SIM power up/down sequence is generated in the UEMK. This means that the UEMK generates the RST signal to the SIM. The card detection is taken from the BSI signal, which detects the removal of the battery. Monitoring of the BSI signal is done by a comparator inside UEMK. The threshold voltage is calculated from the battery size specifications.

First the SW attempts to power up the SIM with 1.8V. If this does not succeed, power up is repeated with VSIM switched to 3V.

The data communication between the card and the phone is asynchronous half duplex. The clock supplied to the card is in GSM system 1.083MHz or 3.25MHz. The data baud rate is SIM card clock frequency divided by 372 (by default), 64, 32 or 16.

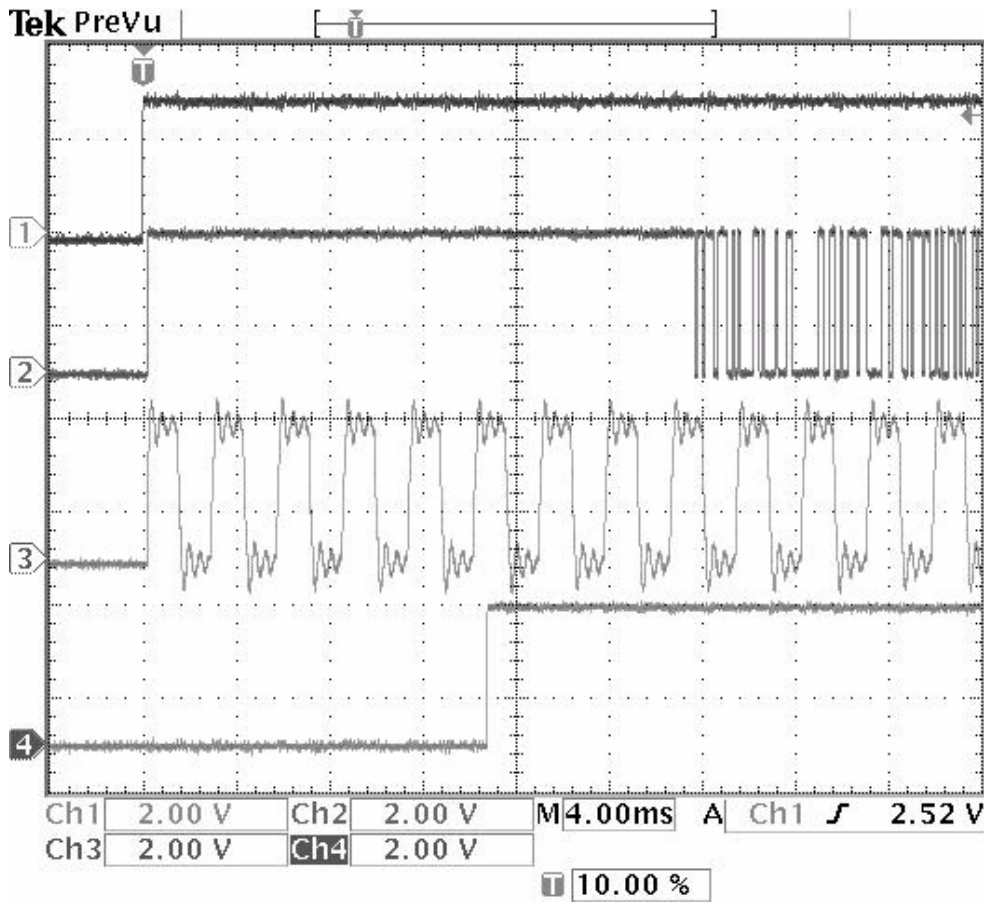
Figure 13: SIM Power up waveform



28 Mar 2003
03:26:11

- Ch1: VSIM
- Ch2: I/O
- Ch3: Clock
- Ch4: Reset

Figure 14: SIM Answer To Reset waveform

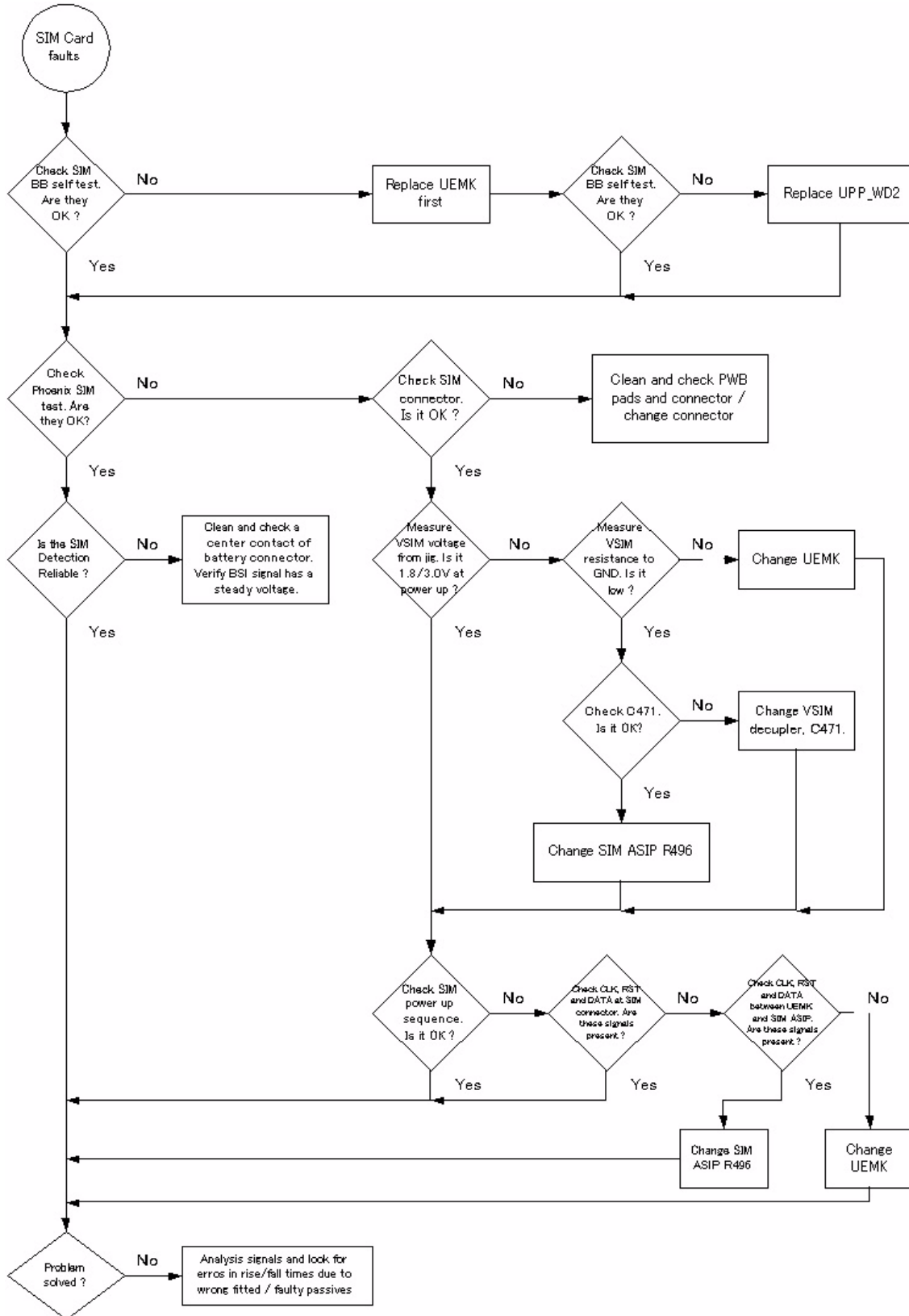


28 Mar 2003
03:30:03

- Ch1: VSIM
- Ch2: I/O
- Ch3: Clock
- Ch4: Reset

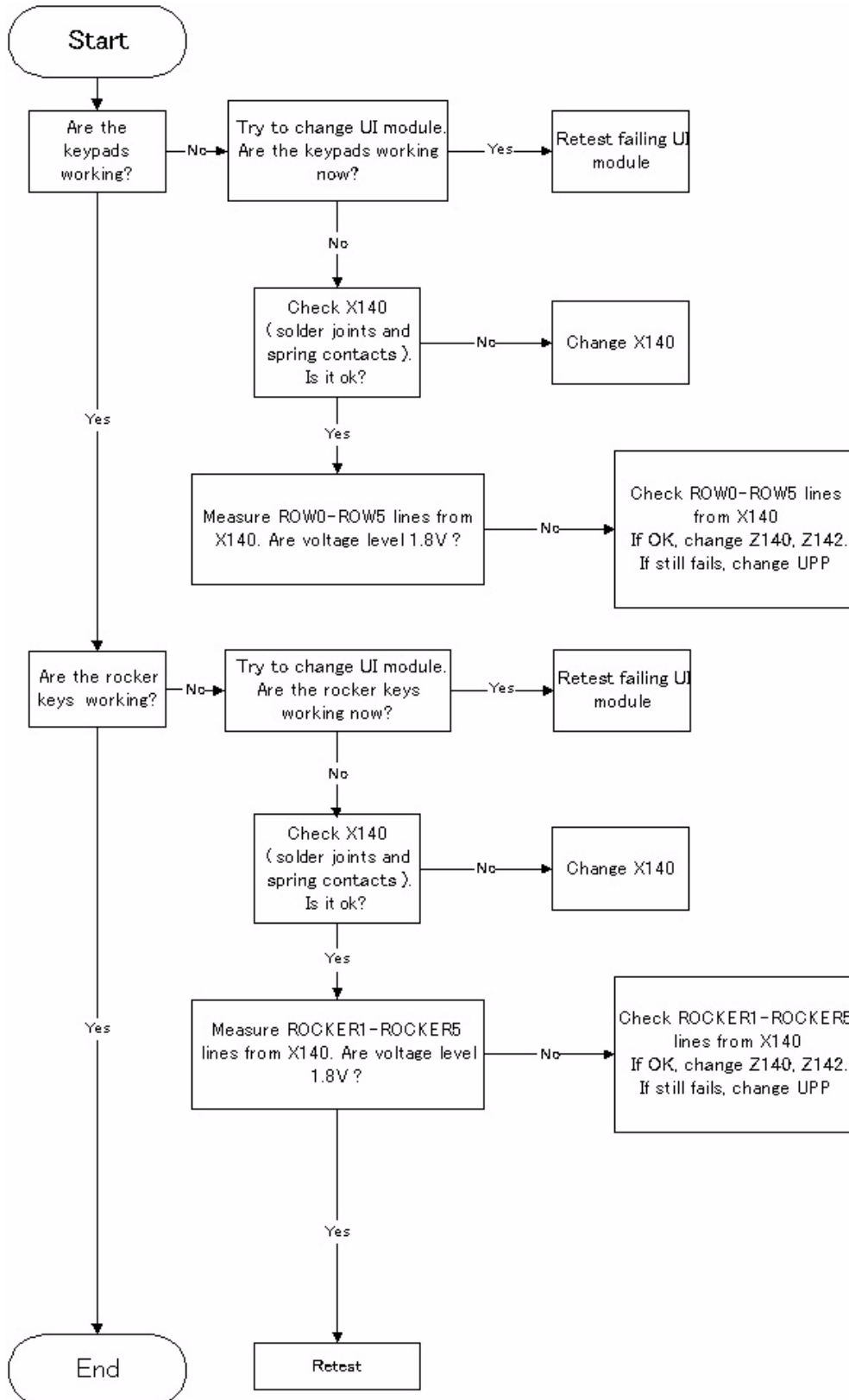
“Insert SIM Card” in device display although card is inserted

Figure 15: Insert SIM Card troubleshooting



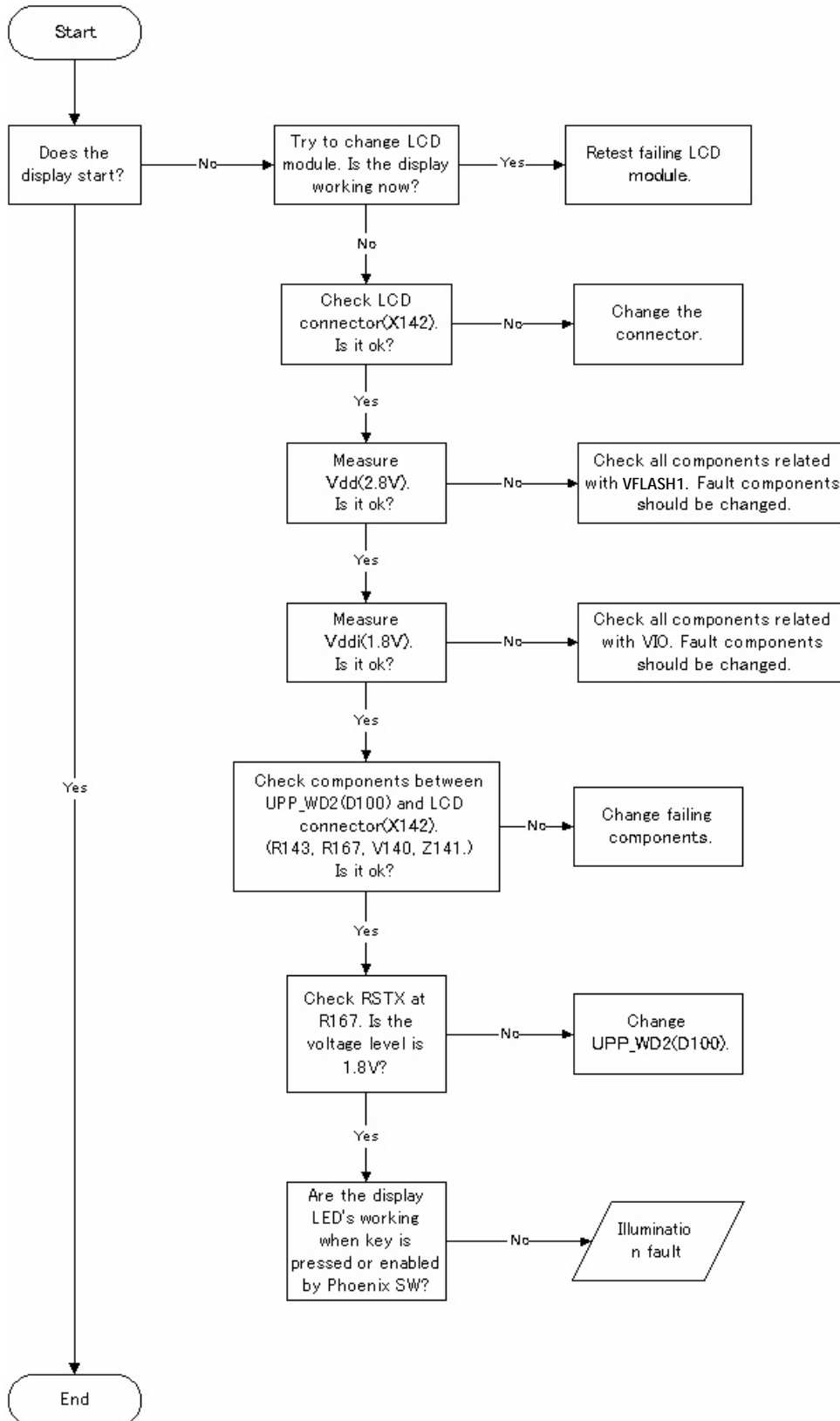
Keypad Interface Fault

Figure 16: Keypad troubleshooting



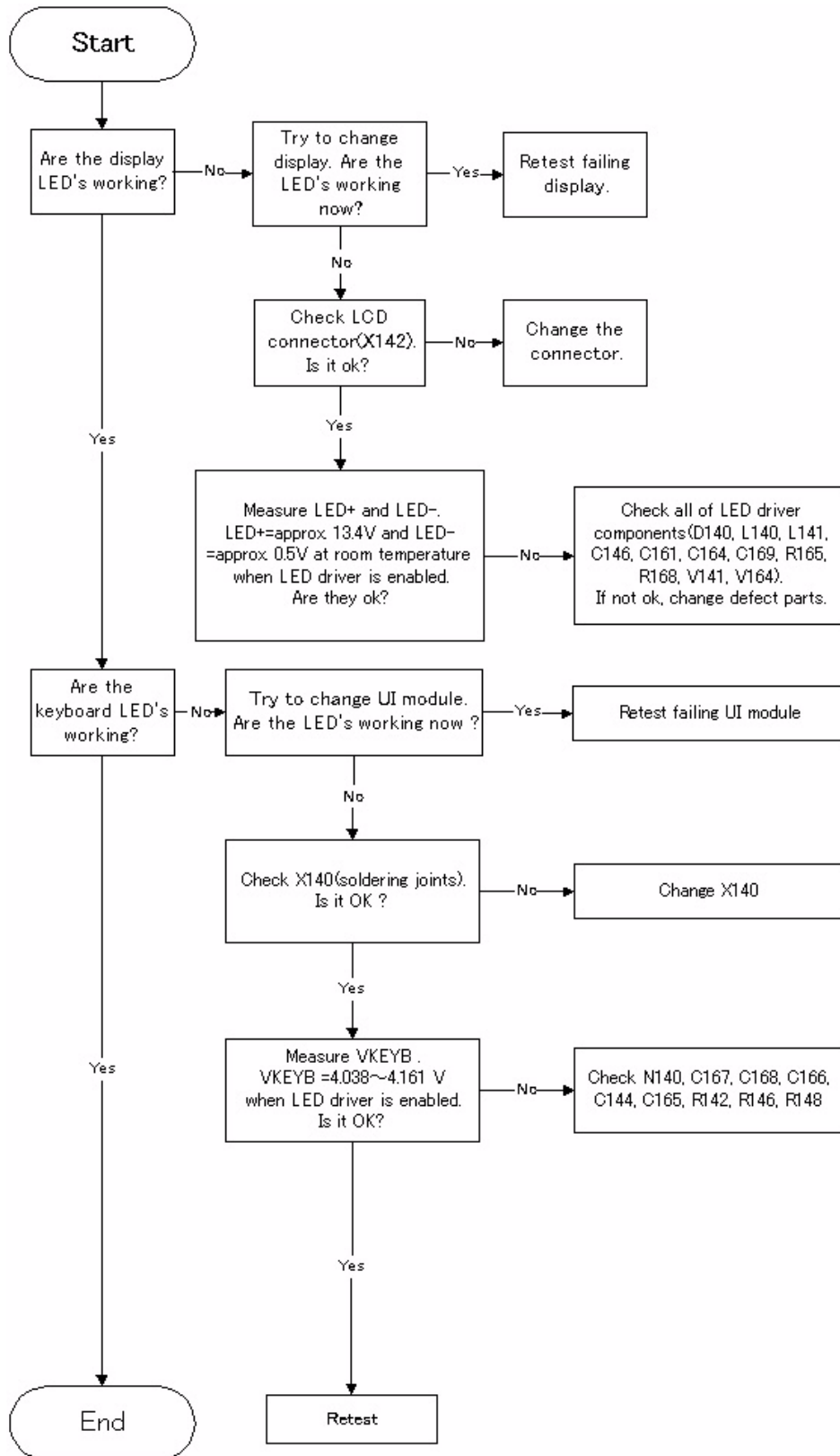
Display Fault

Figure 17: Display troubleshooting



Illumination Fault (Display/Keyboard backlight)

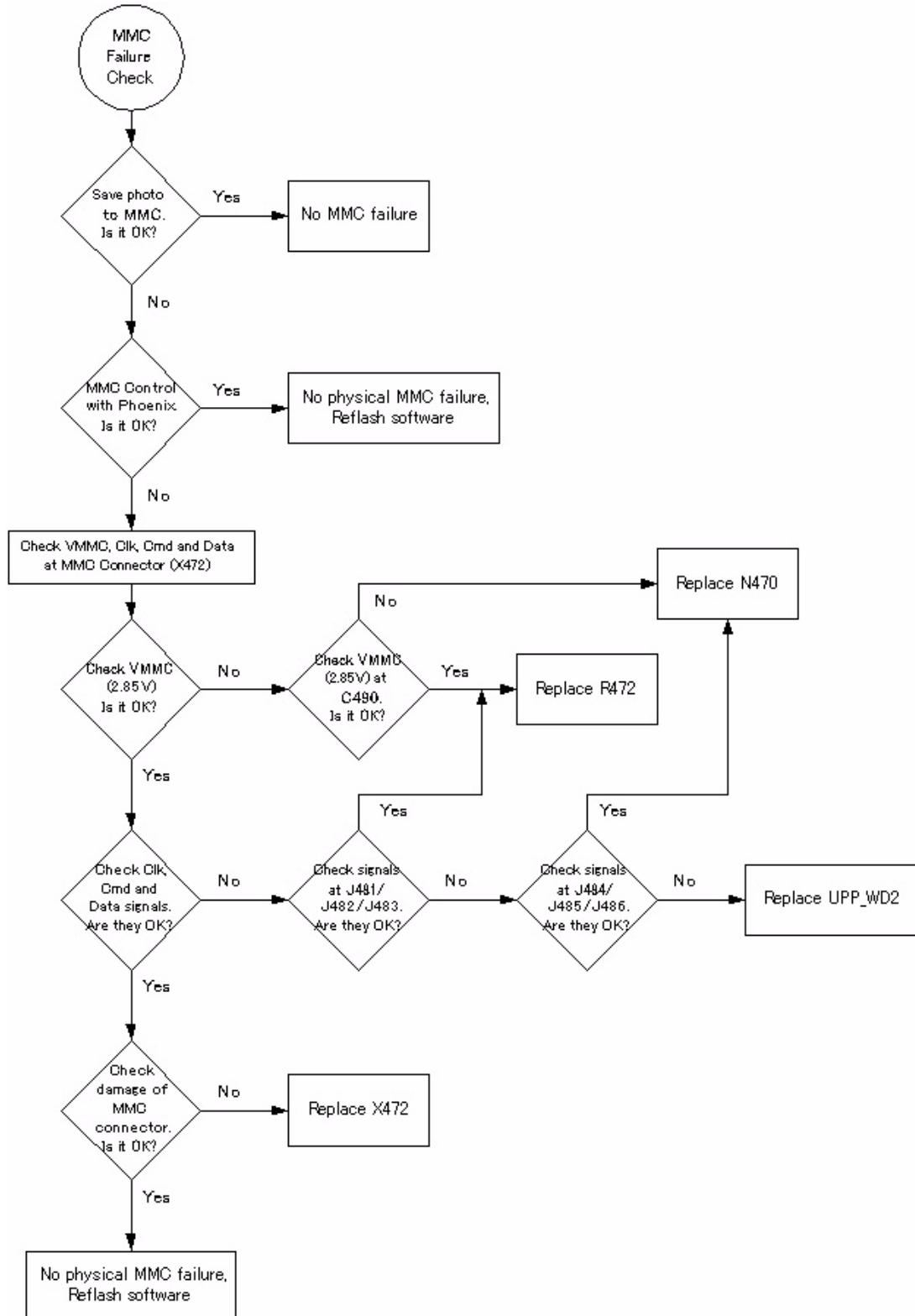
Figure 18: Illumination troubleshooting



MMC Interface Fault

Use with known working MMC to save photo test.

Figure 19: MMC troubleshooting



Audio troubleshooting

Microphone

Figure 20: Internal MIC troubleshooting

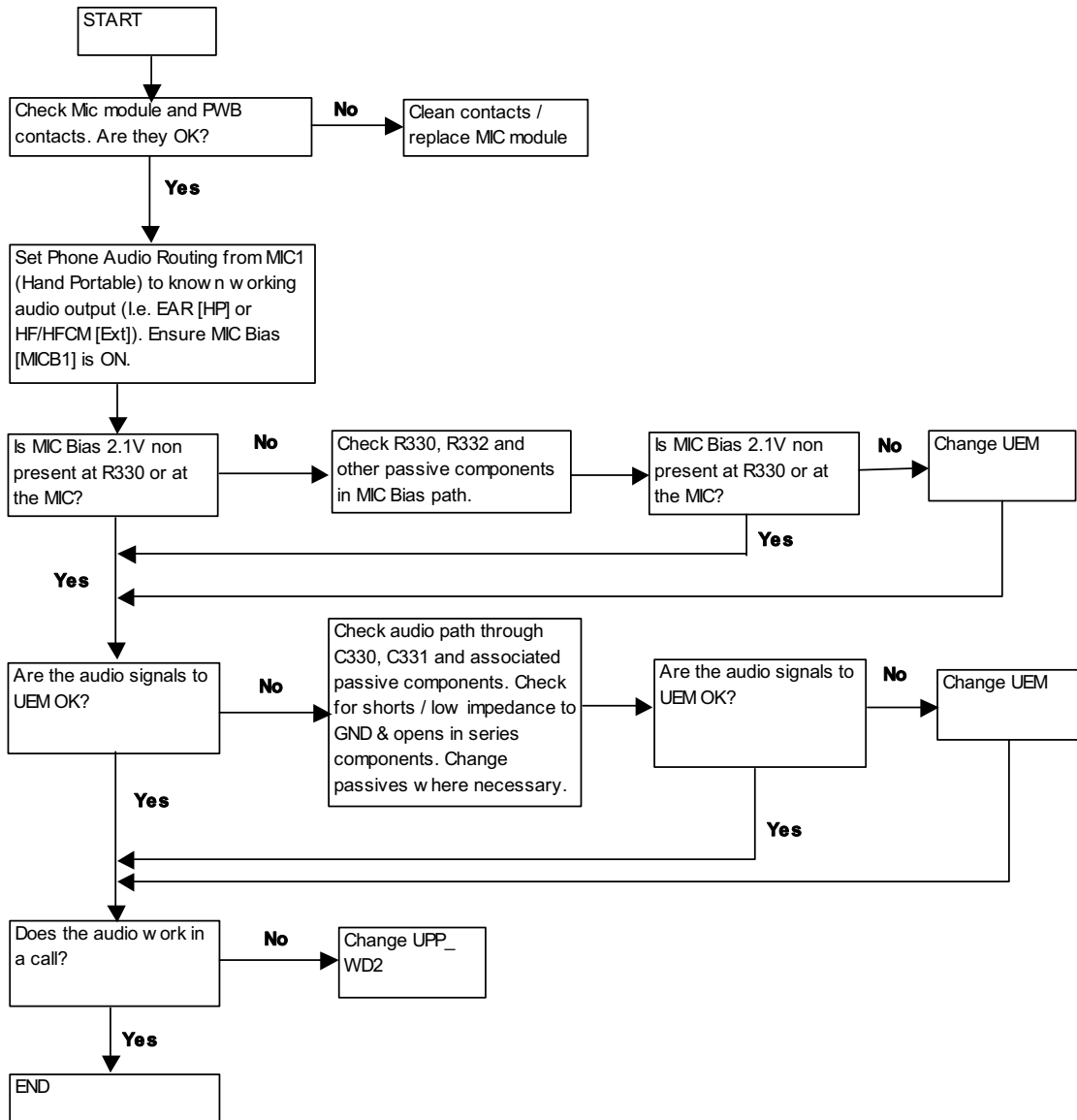
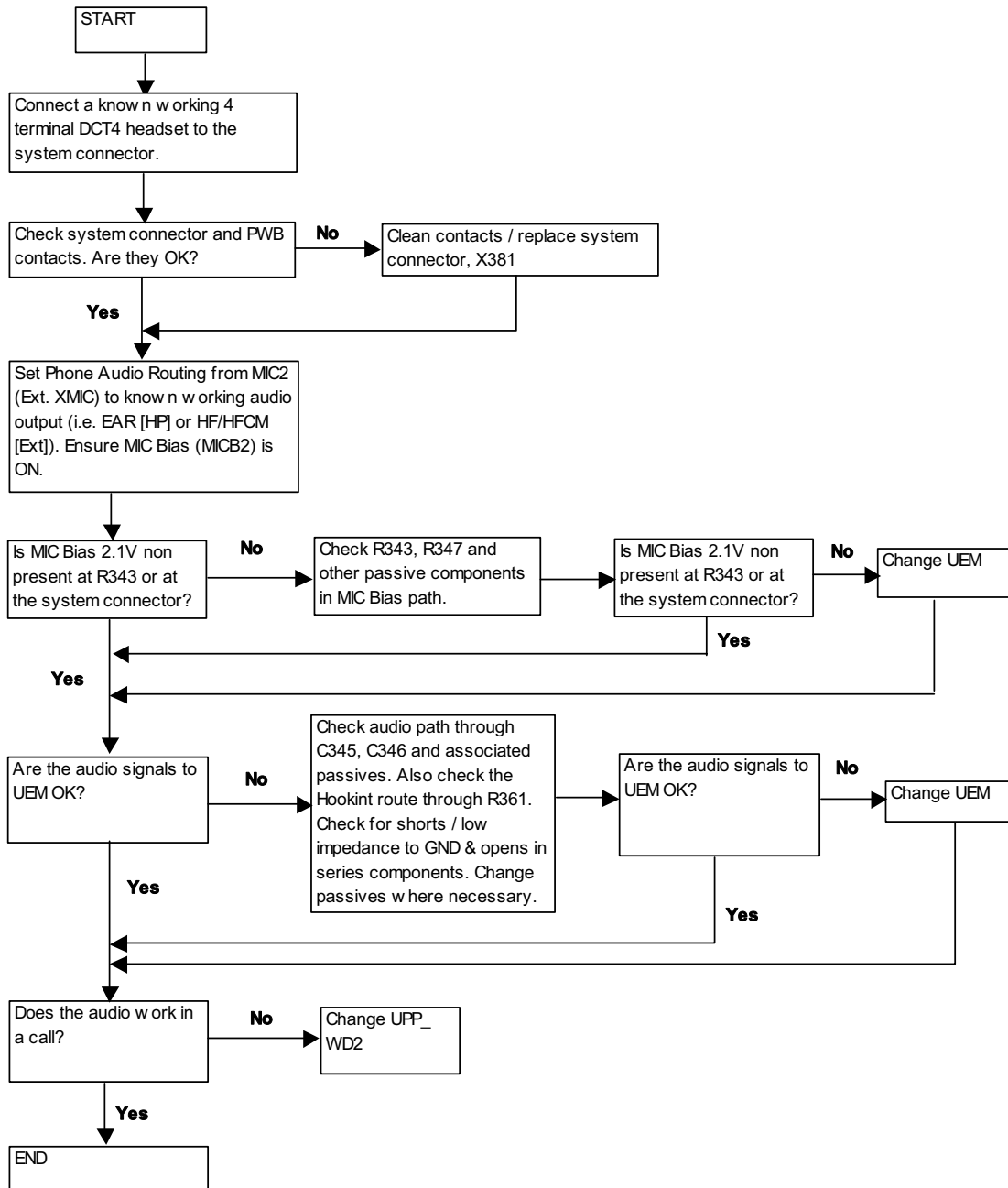


Figure 21: External MIC troubleshooting



Earpiece

Check that holes are not coated.

Figure 22: Internal Earpiece troubleshooting

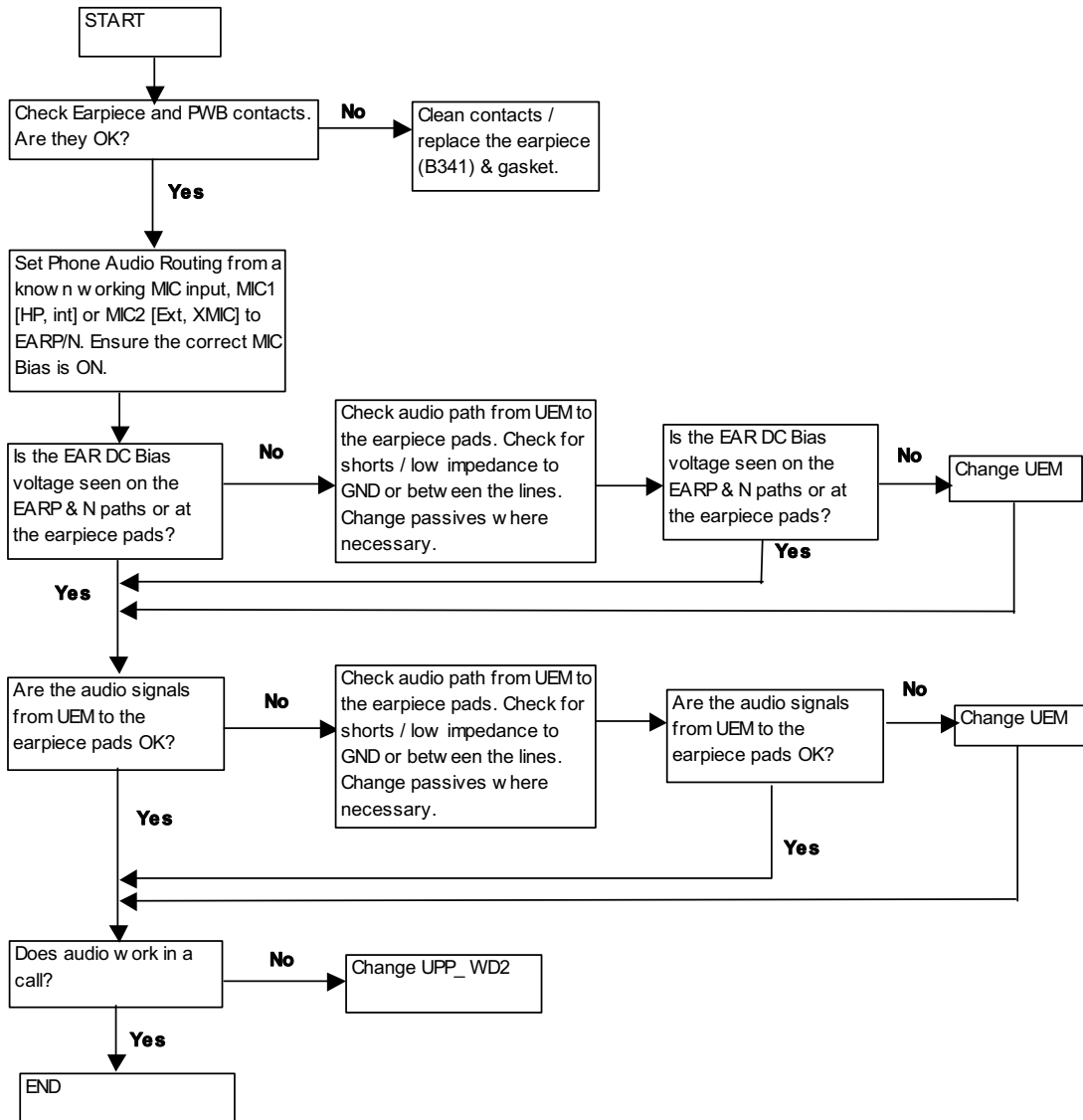
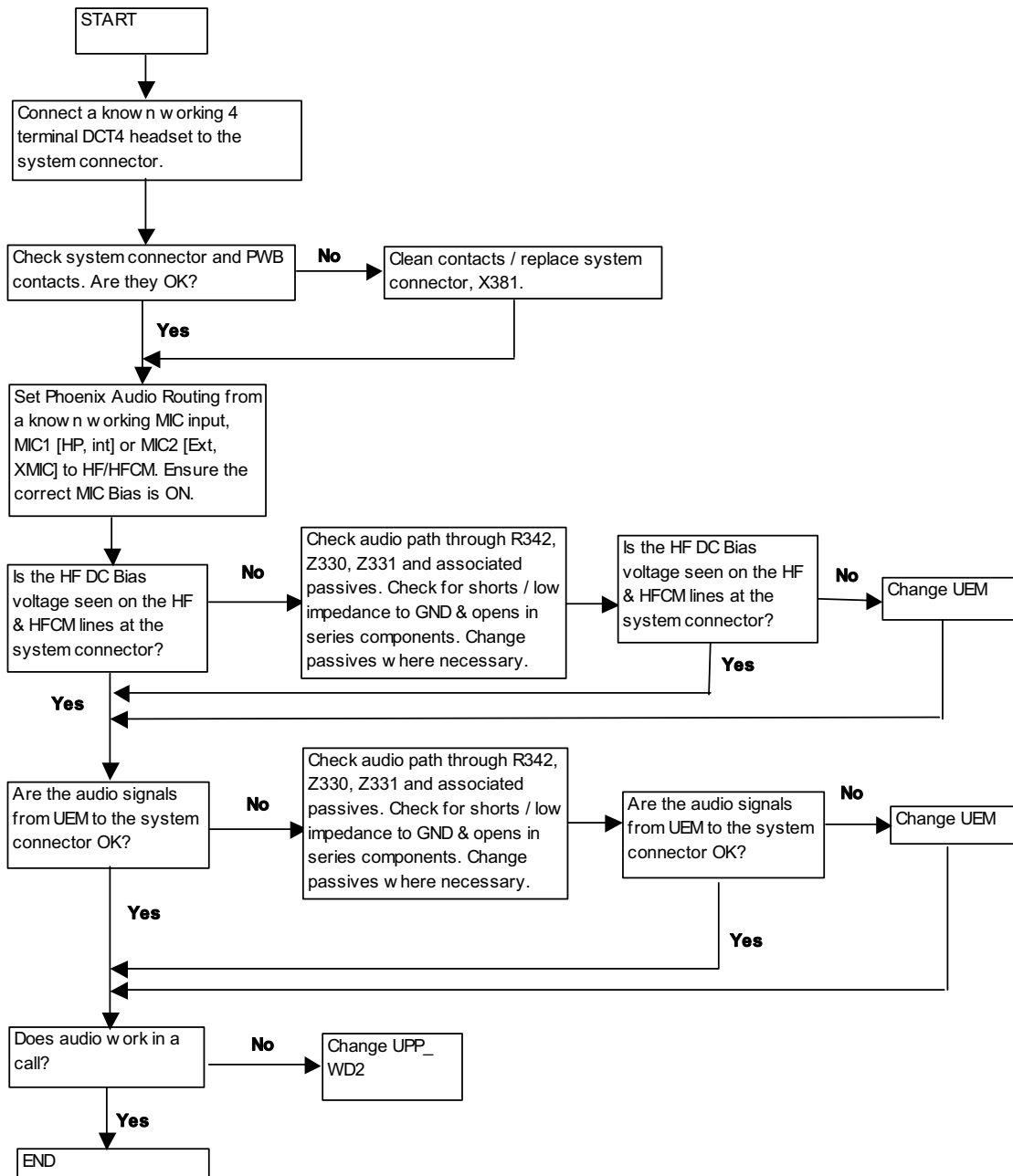
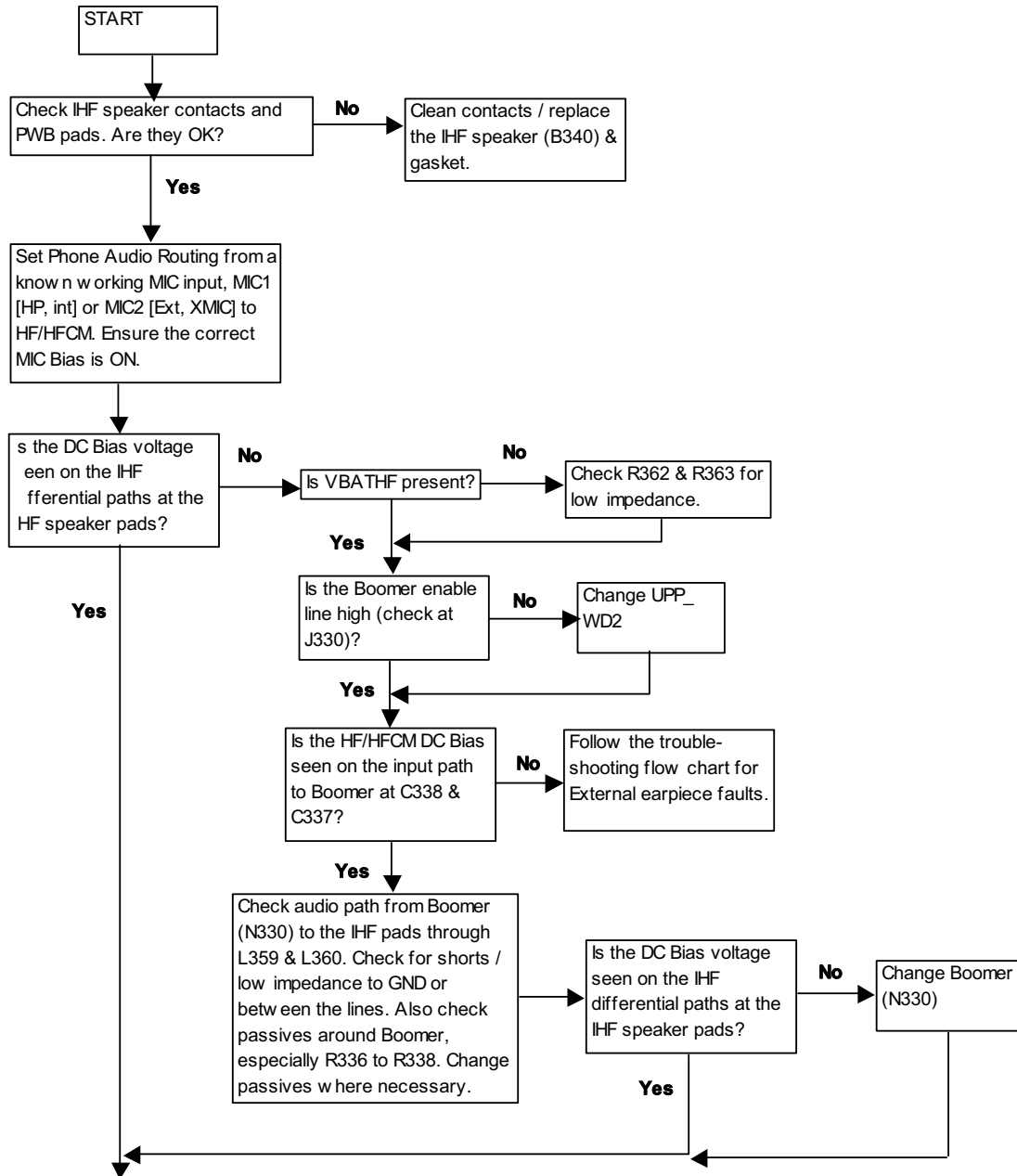


Figure 23: External Earpiece troubleshooting



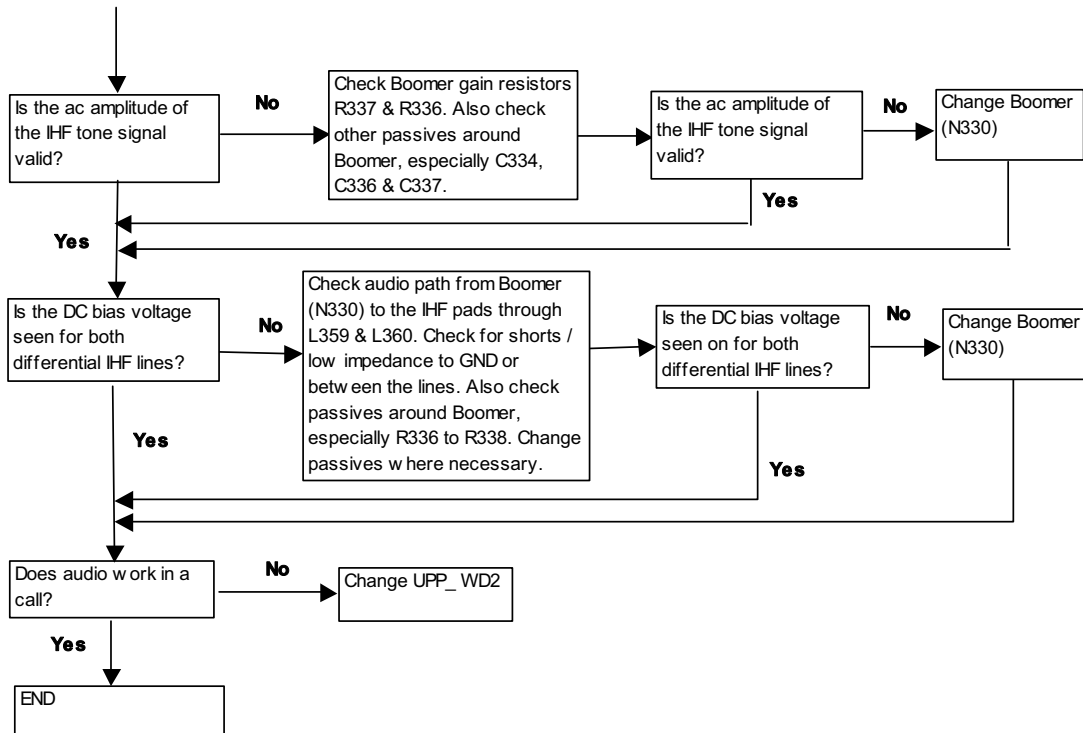
IHF

Figure 24: IHF troubleshooting



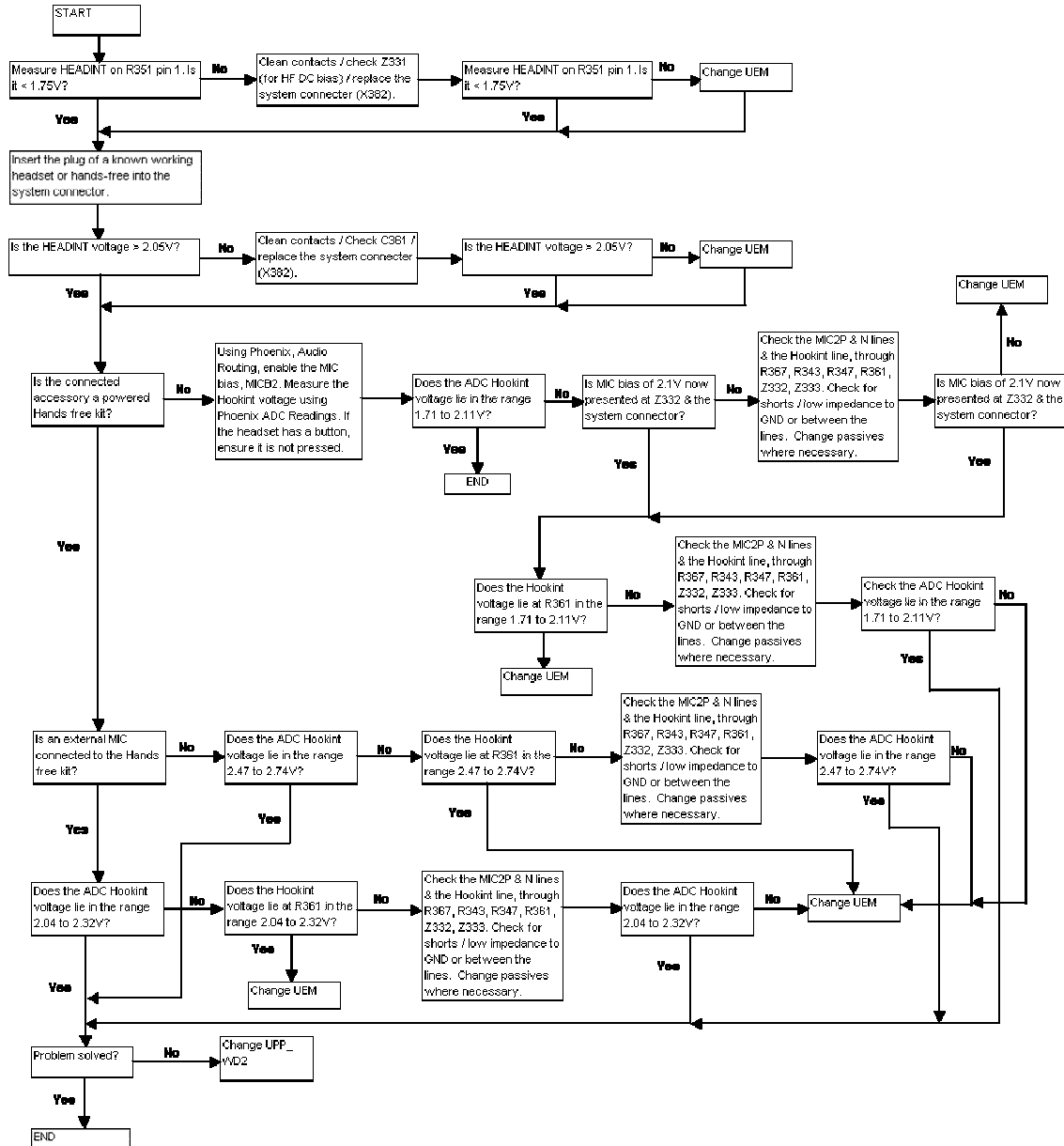
See the following flow chart

See the previous flow chart



Accessory detection troubleshooting

Figure 25: Accessory detection troubleshooting



Camera Module Troubleshooting

A fault associated to camera operation can be roughly categorized to three subgroups:

- 1 Camera is not functional at all, no image can be obtained.
- 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.

Type 1 and 2 faults are most often similar to what traditionally has been found in any electronic devices. Type 3 faults are new to NMP and maybe the most challenging to find and verify.

The image quality is very hard to measure quantitatively, and even comparative measurements are difficult (comparing two images) if the difference is small. Especially, if the user is not satisfied with his/her devices' image quality, and tells e.g. that the images are not sharp, it is very difficult to test the device and get an exact figure which then would tell if the device is OK or not.

Most often, subjective evaluation has to be used for finding out if a certain property of the camera is acceptable or not. Some training and a correctly operating reference device maybe 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 looking images in bad conditions; thus the camera operation has to be checked always in constant conditions (lighting, temperature) or by using a second, known to be good device as a reference. Experience significantly helps in analysing image quality.

Terms

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 the 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 i.e. there is no mechanical moving parts like in film cameras.

Flicker: A phenomena, which is caused by pulsating in scene lighting, typically appearing as wide horizontal stripes in image.

Noise: Variation of response between pixels with the same level of input illumination. See e.g. Figure 29: Noisy image taken in +70 deg, for an example of a noisy image.

Image taking condition effect on image quality

This chapter lists some of the factors, which may cause poor image quality if not taken into account, and thus result in complaints from customers.

Several issues affect the image quality and will need to be taken into account when shooting pictures. The listed items are normal to camera operation:

Distance to target:

The lens in the module is specified to operate satisfactorily from 30 cm to infinite distance of

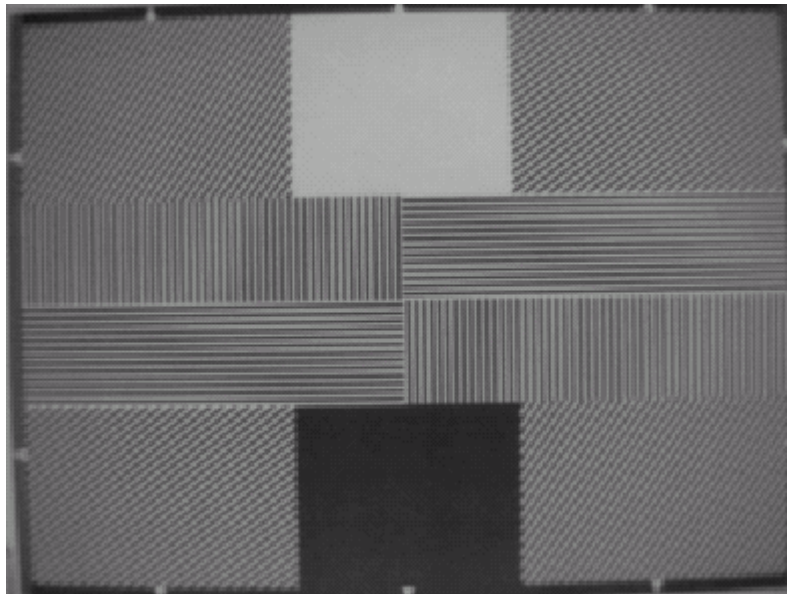
scene objects. In practice, the operation is such that close objects may be noticed to get more blurred when the distance to them is shortened from 40 cm. Lack of sharpness will be first visible in full resolution (VGA) images. If observing just the viewfinder, even very close objects may seem to appear sharp.

Sharpness of picture edges:

Lens performance degrades in image edges, and generally the image is sharpest in centre part. This applies particularly to distant objects (> 1 meter).

See below:

Figure 26: Sharpness of picture is worse in edge than in centre



Geometrical distortion:

The camera lens will cause some amount of so called barrel distortion in images. In practice, this appears as bending of straight objects in edges of the image.

See the following figure. Note the geometrical barrel distortion in background, for example (wall in the background).

Amount of light available:

In dim condition camera runs out of sensitivity. Exposure time is long (especially in night mode) and the risk of getting shaken images grows. Image noise level grows. The maximum exposure time in night mode is approximately $\frac{1}{4}$ seconds, so images need to be taken with extreme care when the amount of light reflected from the target is low.

Figure 27: Shaking hands caused blurring of this image. Note the geometrical barrel distortion in background



Movement in bright light:

If pictures of moving objects are taken or if the device is used in a moving car, object 'skewing' or 'tilting' will occur. This phenomena is fundamental to most CMOS camera types and normal, and can not be helped. Movement of camera or object will usually cause blurring indoors or in dim lighting conditions due to long exposure time.

Figure 28: Near objects in image get skewed when shooting from a moving car



Temperature:

High temperatures inside the mobile phone will cause more noise to appear in images, e.g. in +70 degree of Celsius the noise level may be very high, and it further grows if the conditions are dim. This is also normal to camera operation. (See the following figure.)

Figure 29: Noisy image taken in +70deg



Display:

If the display contrast is set too dark, the image quality degrades quite much: the images may be very dark, naturally depending on the setting. This flaw is easily cured by setting the display contrast to correct value.

Basic rules of photography, especially when shooting against light:

Electronic image sensors typically have much lower dynamic range than films. In practice this means that when taking a picture indoors, e.g. having a window behind object, will produce poor results.

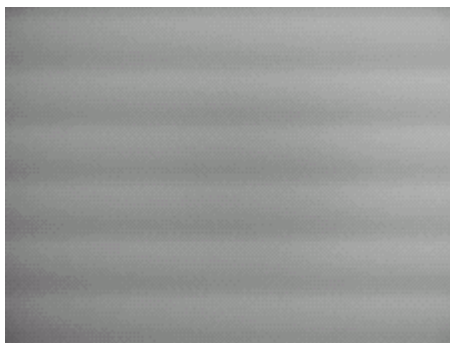
Figure 30: Image which has been taken "against the light". The actual object (a squirrel) can't be seen well



Flicker:

In some rare occasions a very bright fluorescent light may cause flicker to be seen in the viewfinder image.

Figure 31: Flicker in image of white uniform object illuminated by strong fluorescent light



Bright light outside of image view:
Especially sun causes clearly visible 'halo' effects and poor contrast in images. This happens due to unwanted reflections inside camera optics.

Figure 32: A lens reflection effect caused by sun shining above the scene



Figure 33: A good quality picture taken indoors



Note: The camera module as a component is not a repairable part i.e. components in the module may not be changed. Cleaning dust from the front face is the only allowable operation.

Image quality analysis

Possible faults in image quality

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

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

In addition, there are many other kinds of possibilities for getting bad image quality, but those are ruled out from the scope of this document since probability of their appearance is going to be minimized by production testing.

Testing for dust

For detecting this kind of problems, take an image of uniform white surface and analyse it in full resolution; search carefully – finding these defects is not always easy.

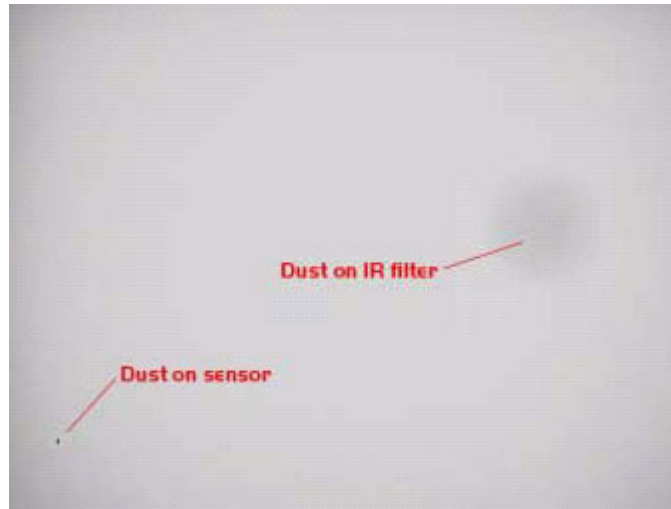
Effects of dust in optical path are an example of image containing easily detectable dust problems.

Black spots in image are caused by dirt particles trapped into the optical system: clearly visible and sharp edged black dots in the image are typically dust particles on the image sensor.

These spots are searched for in the manufacturing phase, but it is possible that the lens holder cavity contains a particle, which may move onto the image sensor active surface, e.g. 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 it has been in some phase verified that the problem has been present.

If dust particles are located on the infrared filter surface on either side, they are much harder to locate because they will be out of focus, and appear in the image as large, greyish and fading-edge 'blobs'. Sometimes they will be very hard to find, and thus the user probably will not notice them at all since they do no harm. But it is possible that a larger particle disturbs the user, causing the need for service.

Figure 34: Effects of dust in optical path



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

If dust particles are found on the sensor or are suspected to be inside the camera module, this is classified as a manufacturing error of the module and thus the camera should be replaced. The particles inside the cavity between window and lens have most probably been trapped there in assembly phase in Nokia factory. It is of course also possible that the user has disassembled the device and caused the problem. However, in most cases it should be possible to remove the particle(s) by using 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 for sharpness

If pictures taken with some device are claimed to be blurry, there are four possible sources for the clam:

- 1 The user has tried to take pictures in too dark conditions and images are blurred due to handshake or movement. This is no cause to replace the camera module.
- 2 There is dirt between the back window and camera lens. The back window is defective (somehow passed through window manufacturer's inspection). The window should be changed.
- 3 The back window is visibly scratched, broken or dirty.
- 4 Camera lens is misfocused.

Quantitative analysis of sharpness is very difficult to conduct in other than optics laboratory environment. Thus subjective analysis should be used.

If no visible defects (items 2-4) can be found, a couple of test images should be taken and checked. Generally, a well illuminated typical indoor office scene, such as the one in Figure 33: A good quality picture taken indoors, can be used as a target.

The main considerations are:

The amount of light, 300 – 600 lux (bright office lighting), is sufficient.

The scene should contain e.g. small objects for checking sharpness and distance to them should be in order of 1 – 2 meters

If possible, compare the image to another image of the same scene, taken by different device.

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

If there appears to be a clearly noticeable difference between the reference image and the test images, the module might have a misfocused lens. In this case, the module should be changed.

Always re-check the resolution after changing the camera. If a different module produces the same result, the fault is probably in the camera window. Check that you can see through the window when replacing the module.

Bit errors

Bit errors are defects in image caused by a data transmission error between camera and phone baseband. This type of error is expected to be rare since usually missing bits will cause a hardware failure message. Bit errors can be typically seen in images taken of any object, and they should be most visible in full VGA resolution images.

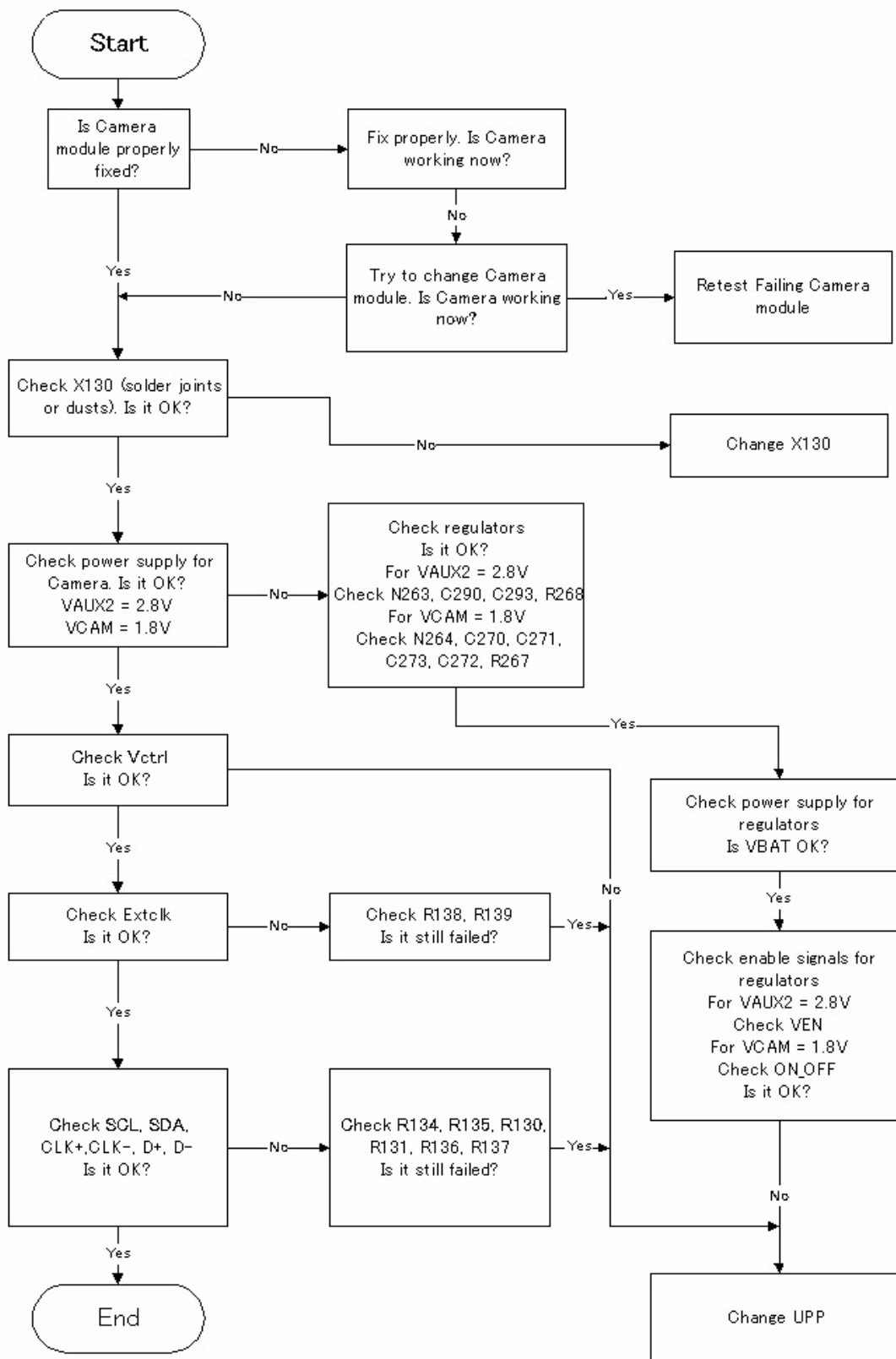
Viewfinder images may not contain the errors at all due to lower bit rate used in this mode.

A good practice is to use uniform white test target.

The errors will be clearly visible as colourful sharp dots or lines in camera VGA images.

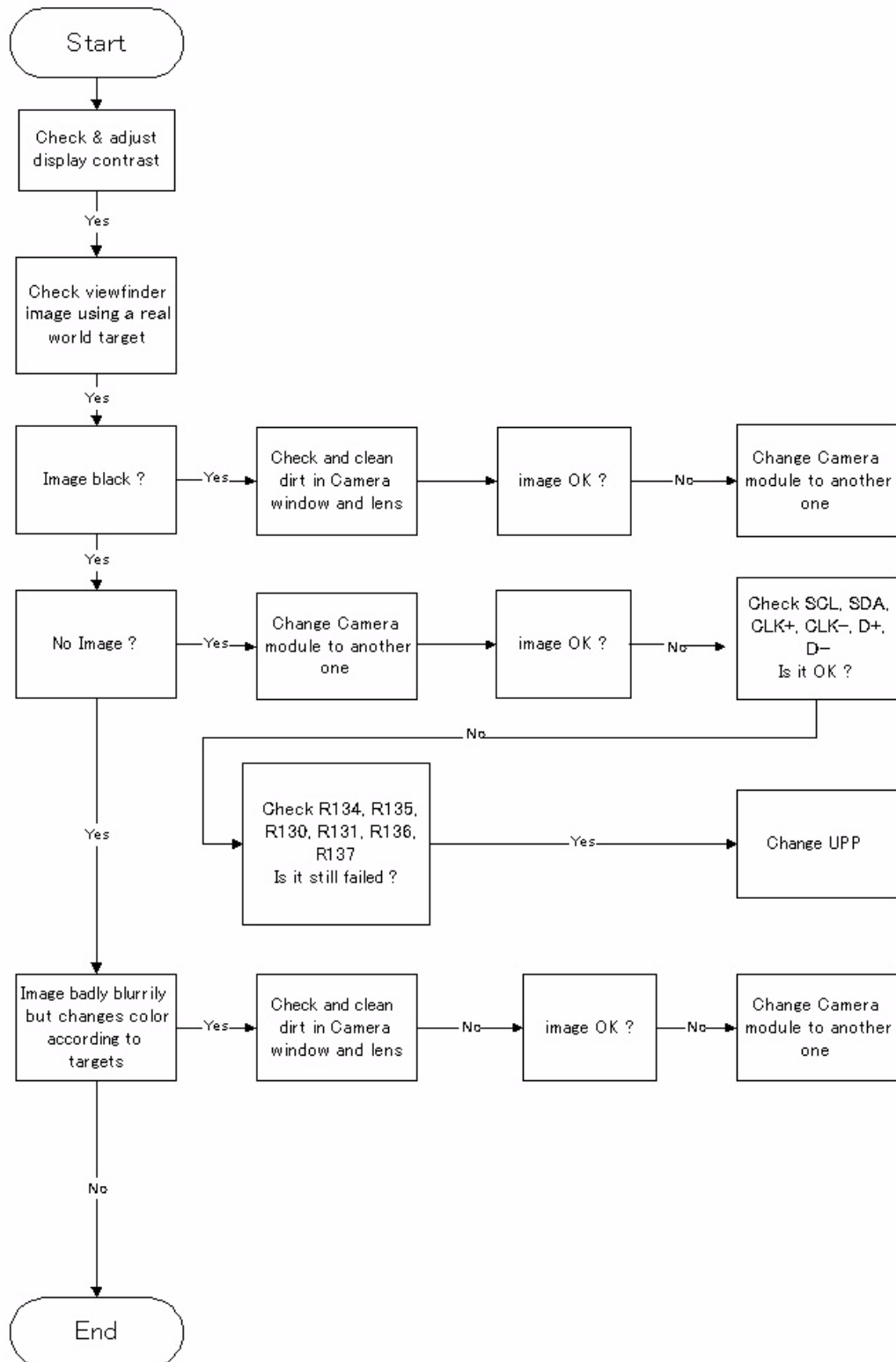
Hardware failure message

Figure 35: Hardware failure troubleshooting



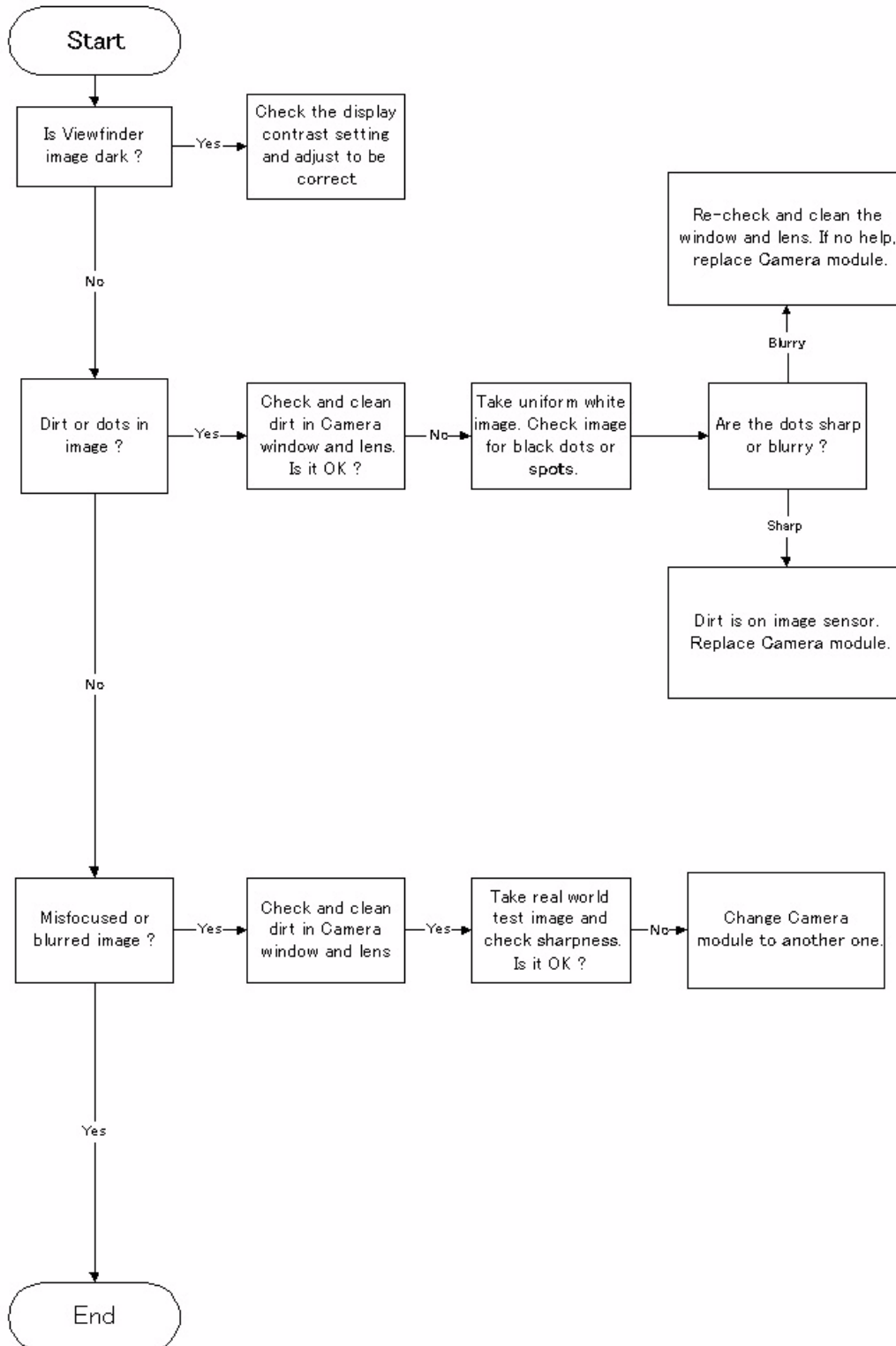
No recognizable viewfinder image

Figure 36: No recognizable viewfinder image



Bad image quality

Figure 37: Bad image quality troubleshooting



Baseband Tuning operation

Energy management calibration

EM calibration is performed to calibrate the setting (Gain and offset) of AD converters in several channels (i.e. Battery Size, Battery voltage, Charger voltage, Charger current, Battery Current). This is to get accurate conversion result of AD converter.

Connections

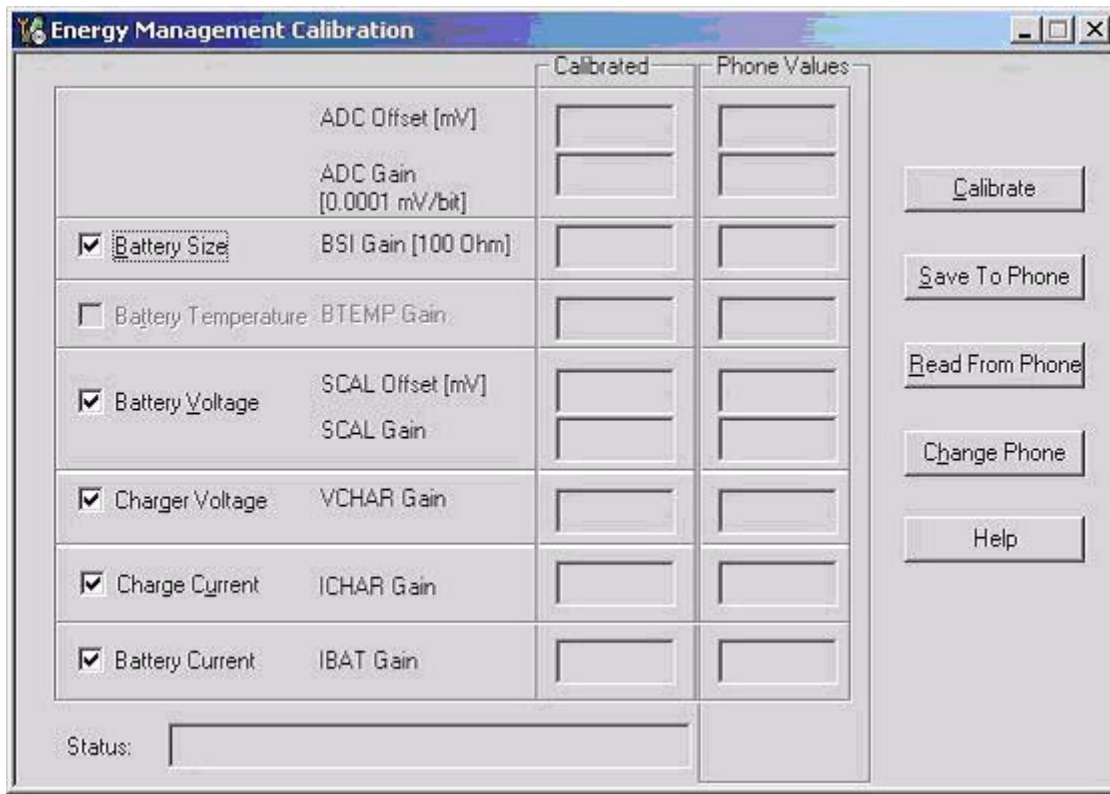
The NHL-10 phone must be connected to JBV-1 (Docking station) with DA-2 (Docking station adapter).

- Connect SCB-3 (DC-DC cable) between JBV-1 and charger connector of phone for charger channel calibration.
- Supply 11-16 V DC from external power supply to JBV-1 to power up phone.

Phoenix Setup

- Start Phoenix service software.
- Select FBUS connection.
- Choose Main -> Choose product-> NHL-10.
- Choose Tuning-> Energy Management Calibration.

Figure 38: Energy Management Calibration window



Calibration procedure with JBV-1

- 1 Select **Read from phone** to display the current calibration values that stored in the phone memory. The values are displayed in the **Phone Values** field.
- 2 Select the ADC channel(s) you intend to calibrate.
- 3 Press **Calibrate**.
- 4 Calibration is automatically done regarding the calibration channel(s) that you selected.
- 5 The candidate of the new calibration values is shown in the "calculated" field. If the new calibration values are within the limit (please refer to the calibration value limit table), Press **Save to phone** to store the new calibration value(s) into the phone.
- 6 Select **Read from phone** to confirm if the new calibration value(s) are stored into phone, correctly. If not, please try to store by selecting **Write to PM** again.
- 7 Close the Energy Management Calibration window.

Table 2: Calibration value limit

Parameter	Min.	Max.
ADC Gain	25400	29000
ADC Offset	-50	50
BSI Gain	970	1100
VBAT Gain	10000	11000
VBAT Offset	2300	2900
VCHAR	58000	62000
ICHAR	4050	4800
IBAT GAIN	0	255

Zocus (IBAT) calibration with MJ-2 module jig

Zocus (IBAT) calibration can be performed manually with module jig instead of JBV-1.

Connections

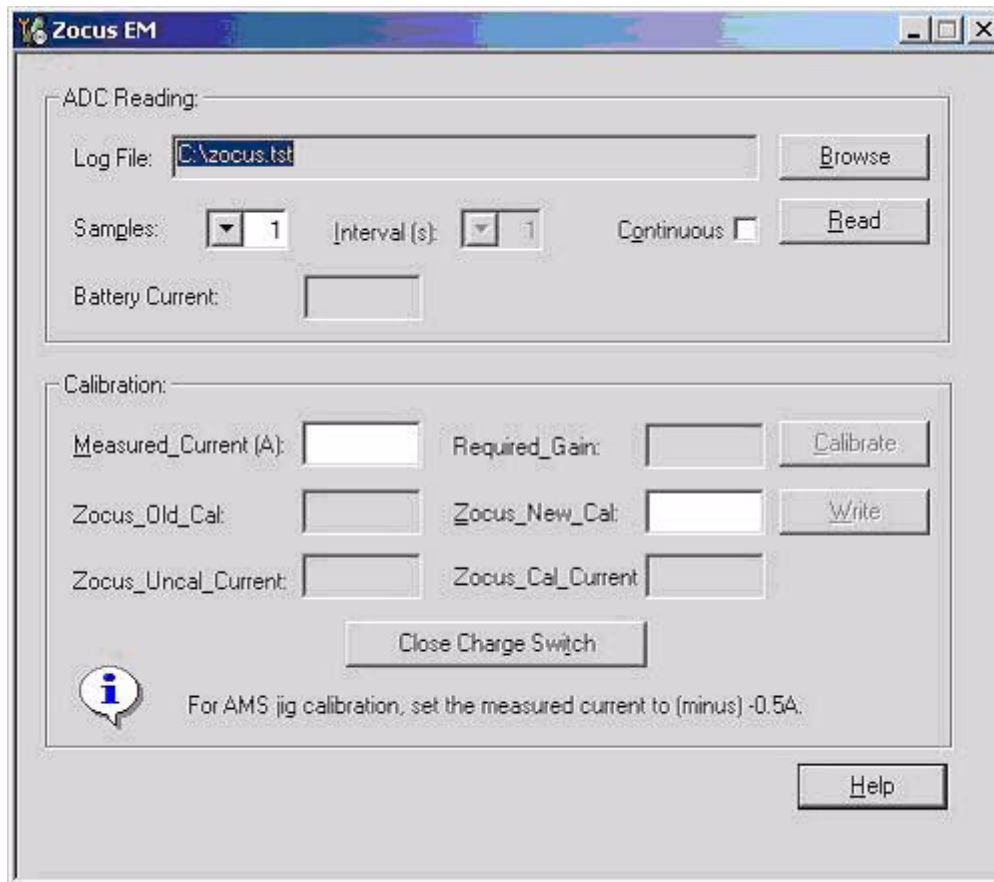
The NHL-10 phone must be placed in MJ-2 (Module jig). Two external power supplies and an ammeter are needed.

- Supply 3.7-4.0 V DC from external power supply to module jig.

Phoenix Setup

- Start Phoenix service software.
- Select FBUS connection.
- Choose **Main** -> Choose product-> **NHL-10**.
- Choose **Tuning** -> **Zocus EM**.

Figure 39: Zocus EM window



Zocus (IBAT) calibration procedure with MJ-2 module jig

- 1 Place the PWB in the module jig.
- 2 Connect an ammeter to Ammeter sockets to check the current flowing on the line.
Be careful for the shunt resistor value of ammeter. Large shunt resistor value causes the difficulty of phone power up.
- 3 Set the S1: Passed and S2: Calibration.
- 4 Power up the module jig in local mode – the ammeter will indicate the local mode current.
- 5 Connect the charger input to a power supply set to 8.4V and current limited to 500mA.
- 6 Turn the power supply on.
- 7 Open the **Zocus EM** window in Phoenix.

- 8 Press **Read** in the ADC reading field to confirm the communication between the phone and phoenix is no problem.
- 9 Press **Close Charge Switch**.
- 10 Adjust the current limit on the power supply until the ammeter reads 500mA +/- 5mA.
- 11 Type the measured current (read this from the ammeter) into the **Measured Current** box. The value is negative and presented in Amps, e.g. if you measure 502mA, then type -0.502. The reading should be to the nearest mA.
- 12 The calibration value appears in the box Zocus_New_Cal. To write this to the phone, press **Write**.
- 13 Press **Open Charge Switch** to stop current flowing.
- 14 Go to the EM calibration window, and then check if the battery current (IBAT Gain) is stored correctly.

Caution: Do not leave the module jig with being "Close Charger Switch" condition for a long time, i.e. 5 min or longer. The transistor used for this calibration on the module jig will get hot due to the current of 500mA.

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