

## Product Requirement Specification M1

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**Polaris** (EMEA, LAM)

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**Document History:**

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0.2	23-05-2005	Stefan Siebinger	Add. BT part and comments regarding GND contacts
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0.48	22-Sep-05	Thomas Neumann	Easy to Use of SIM Holder removed Review with Eric Hachmann References updated
1.0	30-Sep-05	Andreas Lang	Updated references list Released version

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## References

### Project specific references

No.	File	Revision	Issued
1	<a href="#">M1 Document Polaris</a>	V.05	23-Jun-2005
2	<a href="#">Polaris Risk Assessment M1</a>	V2	03-May-05
3	<a href="#">Polaris Rough Planning M1</a>	V1	16-Sep-05
4	<a href="#">Polaris_Supplier_Profile_M1</a>	V1	21-Mar-2005
5	<a href="#">Polaris_BB_RF_INTERFACE_16062005.xls</a>		16-Jun-2005
6	<a href="#">Mozart Specification</a>	V2.5	30-Jul-2004
7	<a href="#">Software Interface Specification and Accessory Bus Description on IMS</a>		
8	<a href="#">Hardware Interface Specification – Nano I/O – Accessory Interface</a>	V1.2	07-Jun-2005
9	<a href="#">X75/X85 SW Feature List</a>	V41.3	09-Sep-2005
10	<a href="#">MEP</a>	V 6.1	
11	<a href="#">Requirements to Software X75/ X85 S-GOLD2 Software</a>	V2.4/ 004	22-Sep-2005
12	<a href="#">General Quality Requirements</a>	V 4.18	19-May-2004
13	<a href="#">Accessory Sample Orderlist on IMS</a>		
14	<a href="#">PCB Layer Stackup</a>	Rev_1.4.1	20-Mar-2005
15	<a href="#">X75SG2 Platform ComponentsReferenceGuide</a>	Rev1.1_001	31-Mar-2005
16	<a href="#">Global Repair Requirements A0</a>	V3.03	23-Mar-2004
17	<a href="#">Global Repair Requirements A1</a>	V3.03	04-Mar-2004
18	<a href="#">Design Specification for Printed Circuit Boards</a>	V2.5	22-Apr-2004
19	<a href="#">Design rules for Mobile Phone Automation</a>	Draft Version	08-May-2005
20	<a href="#">Testing technical standards for Mobile Phones</a>	V3.8	06-Oct-2004
21	<a href="#">Test &amp; Production Technology-Workshop Polaris</a>	V1.0	25-May-2005
22	<a href="#">Requirement Specification ASP</a>	V7	4-Aug-2004
23	<a href="#">Operator Approval Plan</a>	V1.0_003	20-Sep-05

## General References

- GSM Recommendation Phase 2 / Phase2+ (GSM51.010)
- 3GPP, Release 4
- EN 55022 Limits and Measuring Methods for Radio Disturbances
- CE as per Directive 89/336/EWG
- EN 50361 Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile telephones (300 MHz - 3 GHz); German version EN 50361:2000
- SAR as per Recommendation 1999/519/EG
- CISPR Pub. No. I 16-1
- R&TTE 99/5/EC Guidelines for Telecommunications Terminals (valid as of 2000-04-08) Product Safety as per EN 60950
- Product Safety as per 1999 / 5 / EEC
- DIN EN 50361 Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile telephones (300 MHz - 3 GHz);
- Cellular Telecommunications Systems, (GSM 900 MHz and DCS 1800 MHz)
- ENV 50166 -2 1995 Human Exposure to Electromagnetic Field High Frequency (10 kHz - 300 GHz)
- DIN VDE 0848, Part 2
- CENELC, SC211/B, WGMTE (2<sup>nd</sup> draft, Rome, Feb. 1996, 3<sup>rd</sup> draft, Zurich, April 1996)
- ESD as per ETS 301 489-1
- ETS 300 019-1-0 / ETS 300 019-2-7 (Environmental Requirements)
- EN 301 489-01 Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
- EN 301 489-07 Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
- ETR 051 (Human Factors - Basic Requirements) and ETR 166 (Evaluation Methods)
- IEC 68 ff. (Environmental Requirements)
- DIN 40050 (Climatic Conditions and Protection Classes)
- DIN 40839 (Line-Connected Disturbance Variables Impacting On-Board Networks of Road Vehicles)
- Low-Voltage Guidelines 73/23 EWG (revised in 93/68 EWG)
- VDA Recommendations
- ISO 7637 (1990) Road Vehicles Parts 1 and 2
- DIN/VDE 0879 Part2, Draft 10/88 (for car accessories)
- Internal Auxiliary Specification for VHF Broadcasting Range (-82dBm) (Siemens internal requirement)
- EN 1811 Reference Testing Procedure for Nickel releasing Products in Prolonged Direct Contact with Human Skin
- Laser Guidelines IEC 60825
- DS/ EN 71-1 Safety of toys - Part 1: Mechanical and physical properties
- DIN EN 22248 Packaging; complete, filled transport packages; vertical impact test by dropping
- SN 47030-1 Moulded plastics; thermoplastic moulding materials; Siemens-item-numbers
- SN 27650 Testing of Paint Coatings and Similar Coatings; Test for Abrasive Strength
- EN ISO 2233 Packaging. Complete, filled transport packages. Conditioning for testing
- SN 36350-1 Environment Compatible Products; Part 1: Guide for product development
- USB – Specification Revision 1.1
- Testing technical standards for mobile phones (Version 3.1+; 24.04.2003)

- General Quality Requirements (Rev. 3.1, 2002-01-23)
- DIN VDE 0470 (IP classes - 53/54; German version of EN 60 529)

## **Supplementary Documents for PCS 1900**

- IEEE C95.1-1991 Standard for Safety Values for Electromagnetic Fields
- EIA / TIA 571 Environmental Aspects for Telecommunications Equipment
- EIA / TIA 136, 136A, 136-270B (TDMA)
- Safety Requirements as per CSA 22.2 No.950-95 (UL 1950)

## 1 General

### 1.1 Product Description

For information regarding ID, Feature-Description etc. pls. refer to the 'M1 Document Polaris', which is under responsibility of Product Management [1].

#### 1.1.1 Design

- Reduced, classic style phone focusing on ergonomics and usability
- Premium-value appearance through usage of excellent materials
- Slim format

#### 1.1.2 Key Features

Hardware	
Housing	Slim bar, aluminium upper case
Dimensions	107.5 x 44 x 13.2 mm
Standby Time / Talk Time	up to 300 h / up to 300 min
Display	132 x 176 pixels, 1.8 inch, Enhanced TFT 262k
	Optimal viewing angles, brightness & brilliant colours
Camera/ Flash	– / –
Battery	Slim Li-Ion 660 mAh (GSM typical); new design
Base-band	S-GOLD2/ J11, no Gimmick Chip
RF	Renesas Bright 6E
PMU	Mozart+, Twigo 4+
Acoustic Shock Prevention	2nd Speaker + software solution
Keypad Illumination	8 white LEDs
Memory	512 MBit Flash + 128 MBit SDRAM
PCB	Main (6 layers) and MMI (2 layers)

Software	
Platform	SG2, Release 1
Protocol Stack	Comneon, Release 99 compliant
Data Transfer	GPRS MS Class 10 (no EGPRS, no DTM)
Network Type	Tri-band GSM 900 / 1800 / 1900
Messaging	SMS, full MMS support
Multimedia	ADPCM and MIDI ringing tones
Free Memory Capacity	8 MB
Video Recording / Playback	– / –
Voice Control	–
Internet Access	WAP browser, 2.0 stack
User Interface	SW Rel1 customized MMI
Connectivity	Bluetooth®, no IrDA
Operator Customisation	only for branding (No ID concept), logos & menu tree

## 1.2 Time Line

The complete Project has been planned with Primavera Project Manager. For a rough project plan, please refer to [3]. In Primavera, under Project name 'Polaris', the 'Polaris Main Schedule' and 'Polaris Detailed Level' schedule folder can be found. The latter contains all Polaris sub-projects.

An excerpt on major milestones from the Primavera schedule can be found below:

### 1.2.1 Milestones

	Milestone	Date EMEA
M0	Preliminary Project Plan / Start of Packaging Formation	1-Jul-05 ✓
S0	Requirement Release / Design Decision	23-Sep-05
M1	Implementation Release / Product Contract	23-Sep-05
S15	A1 Module Operable in Basic Function, 100 % Mechanical Data Released	23-Sep-05
S2	Tested Functional Sample (B1)	21-Oct-05
S25	Tested Prototype Device (B1+)	18-Nov-05
S3 HW	Pre-series Release HW based on B2 tested devices / NO SW-S3	13-Jan-06
AS	Approval Start	2-Jan-06
S3	Pre-series Release	24-Jan-06
PS	Production Start	30-Jan-06
DS	Delivery Start	24-Feb-06
S4	Series Production Baseline	31-May-06
M3	Release for Unrestricted Series Delivery	31-May-06

**1.2.2 Prototype Availability**

	Prototype Run	Very First Devices Built
A1	SLA Devices	10-Jun-05✓
B1	Soft Tool Devices	27-Jul-05✓
B1+	1 <sup>st</sup> Hard Tool Devices	30-Sep-05
B2	2 <sup>nd</sup> Hard Tool Devices	01-Dec-05

**1.2.3 Reference Samples**

	Prototype Run	Quantity.	Date
B1+	1 <sup>st</sup> Hard Tool Devices	None	N/A
B2	2 <sup>nd</sup> Hard Tool Devices	303	22-Dec-05

**1.3 Technical Risks**

Following Major Risk have been identified and analyzed:

Like-likelihood	Component	Description	Actions	Backup	Impact
85%	Keypad (only 2 <sup>nd</sup> source)	Static Load test failed	Improve Technology together with Supplier	none	Return rate increased by 1%
75%	Front cover	Free Fall test failed, Screw Bosses fall apart	Improve Gluing Process, Sand Blast Screw Bosses before gluing, Usage of milled Screw Bosses	Die-Cast Mounting Frame	TTM delay
70%	SIM Card Reader	Bad handling, bad solder ability, Static Load Test failed (Flip falls apart)	Improve Design together with Supplier, further improvements started	Usage of R65 SCR	Lower First Pass rate, Increased Return rate 1%, Customer Acceptance low

For a complete Risk Assessment please refer to M1 Risk Analysis document [\[2\]](#).

**1.4 Sourcing**

The List [\[4\]](#) gives an overview about all A-Components and about the number of suppliers.

**1.5 Packaging/ User Manual**

For information on packaging and the user manual, please refer to the 'M1 Document Polaris' [\[1\]](#).

**1.6 Economic Product Plan**

For information on the economic product plan, please refer to the 'M1 Document Polaris' [\[1\]](#).

## 1.7 Patents

For information on patents, please refer to the 'M1 Document Polaris' [\[1\]](#).



## 2 Mechanics

### 2.1 Unit Description Polaris

Polaris is an ultra slim brick phone device with enhanced TFT colour display. The front cover is made of full metal, aluminium. The housing of the back-side will be one piece (Battery-Cover).

### 2.2 Assembly Concept for Customer

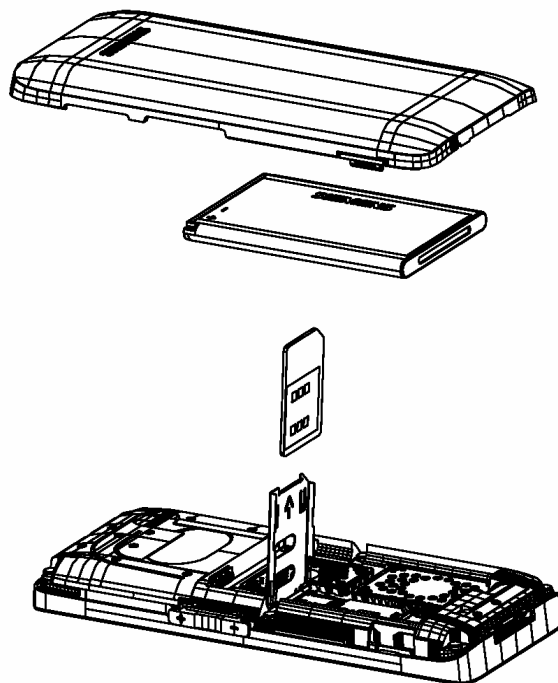


Figure 1 – Assembly concept for customer

### 2.3 Interfaces to Accessories

There is no need for a mechanically compatible interface to X85 accessories. The I/O connector (Nano Lumberg) is centred on the bottom side. The RF connection is made via inductive coupling.

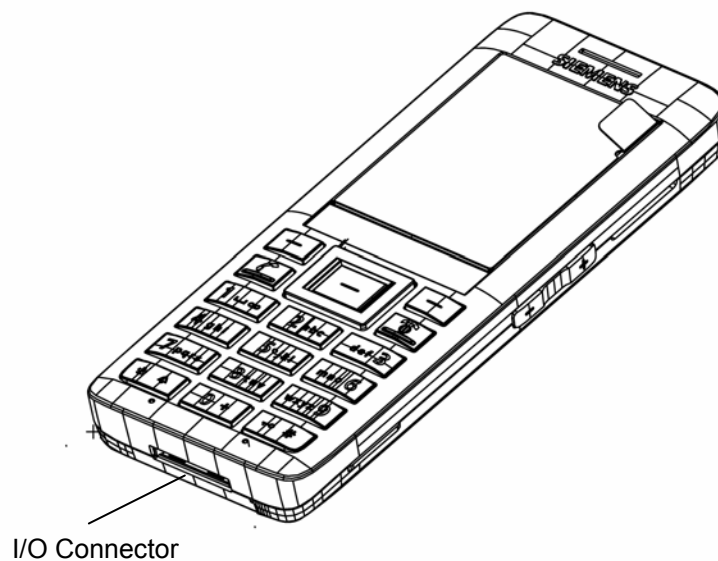


Figure 2 – Complete phone with centred I/O connector

## 2.4 Key-Data

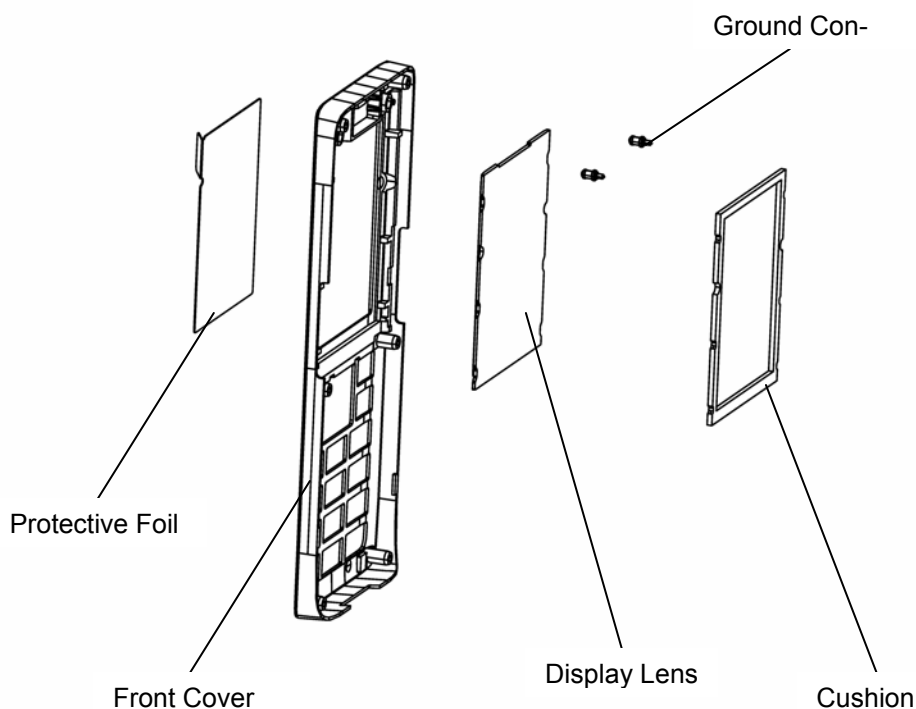
- Volume: 58 ccm
- Weight: 78.5 g
- Length: 107.5 mm
- Width: 44 mm
- Thickness: 13.2 mm

## 2.5 Finish

Part	Material	Colour	Surface Finish
Front-Cover	Aluminium	Silver	Top-Surface: brushed (east-west); Side-Surfaces: matt – polished
Display-Lens	PMMA Plexiglas ZK5BR transparent	Anthracite (slightly bluish)	Top-side: IMD scratch-protection Bottom-side: Tampon printed
No-Id-Logo	Polymatic 50	Silver	brushed
Battery-Cover	PC ABS GF20	Anthracite (slightly bluish)	Soft-touch lacquered

## 2.6 Assembly Concept

### 2.6.1 Front Cover Assembly



**Figure 3 – Front Cover Assembly**

- List of Parts**

No	Part	Material	Dimensions [mm]	Wall thickness [mm]	technology	tooling / assembly
1	Front Cover	Aluminium (plastic areas included)	107 x 44 x 8	0.6	Deep-drawn metal-sheet; anodised (different colours); top-surface: brushed horizontal; side-surfaces: polished semi-mat	Functional plastic areas inside and aluminium screw-bosses are glued-in
2	Connector-Ground	Metal			Pogo-Pins	2 pieces stuck into Front Cover
3	Display Lens	IMD plastic			Front-side IMD for scratch resistance; Back-side Tampon-printed	
4	Protective Foil	Plastic				
5	Cushion	Plastic				Glued in

No	Part	Material	Dimensions [mm]	Wall thickness [mm]	technology	tooling / assembly
		foam				

### 2.6.2 Rear-Cover Assembly

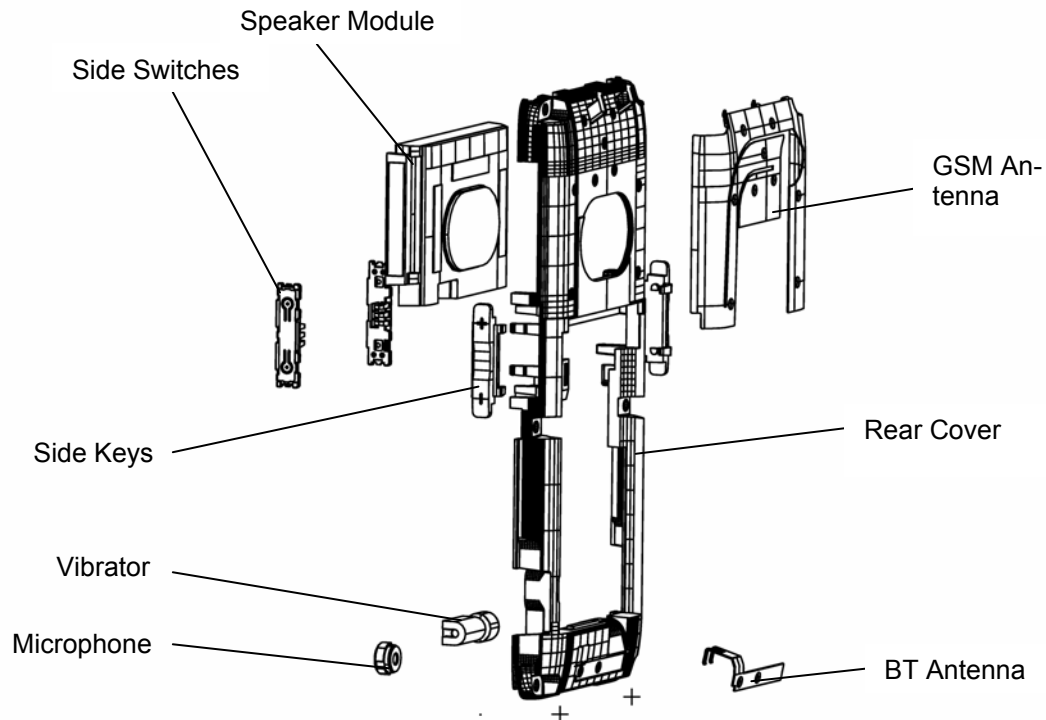


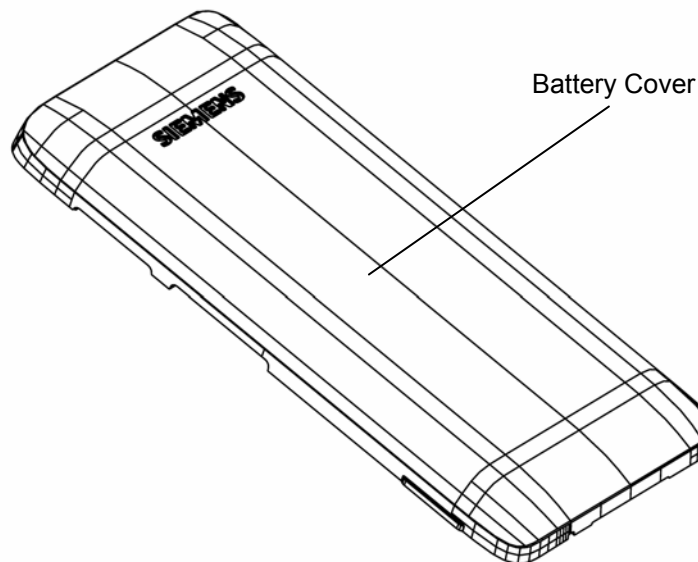
Figure 4 – Rear Cover Assembly

- List of Parts

No	Part	Material	Dimensions [mm]	Wall thickness [mm]	technology	tooling / assembly
1	Rear Cover	PC-ABS gf30 (as synonym for a material with high E-module)	104 x 41.5 x 6	0.8 – 1.2	1k mould; 2 sliders from outside (left- and right-side); 1 slider for acoustic-opening of microphone	
2	Antenna GSM	CuNi18Zn20	35 x 41 x 4	0.2	Stamped, bended and cut sheet-metal; gold-plated contacts	Fixed via rivets on to outside surfaces
3	Side-Switches		18 x 4.4 x 3.3		Electrical component	Stuck into Rear Cover

No	Part	Material	Dimensions [mm]	Wall thickness [mm]	technology	tooling / assembly
5	Speaker-Box	Plastic/Metal	38 x 24 x 5		Electrical component	Stuck into Rear Cover
6	Vibration Motor		13 x 4.4 x Ø5		Electrical component	Stuck into Rear Cover
7	Microphone		Ø4 x 2.9		Electrical component	Glued on to Rear Cover (double sided adhesive on micro); gluing surface has to be polished
8	Antenna BT	CuNi18Zn20	5 x 3 x 25 (variable)	0.2	Stamped, bended and cut sheet-metal; gold-plated contacts	Fixed via rivets on to outside surfaces
9	Side Keys	ABS	21 x 2.5 x 1		1k-mold (ABS); high-glossy galvanised	Stuck into Rear Cover

### 2.6.3 Battery Cover



**Figure 5 – Battery Cover**

- List of Parts**

No	Part	Material	Dimensions [mm]	Wall thickness [mm]	technology	tooling / assembly
1	Battery Cover	PC-ABS GF20	104 x 41.5 x 6	0.8 – 1.2	1k mould; 4 sliders from inside, 2 from outside; soft-touch-lacquered	

#### 2.6.4 Keypad

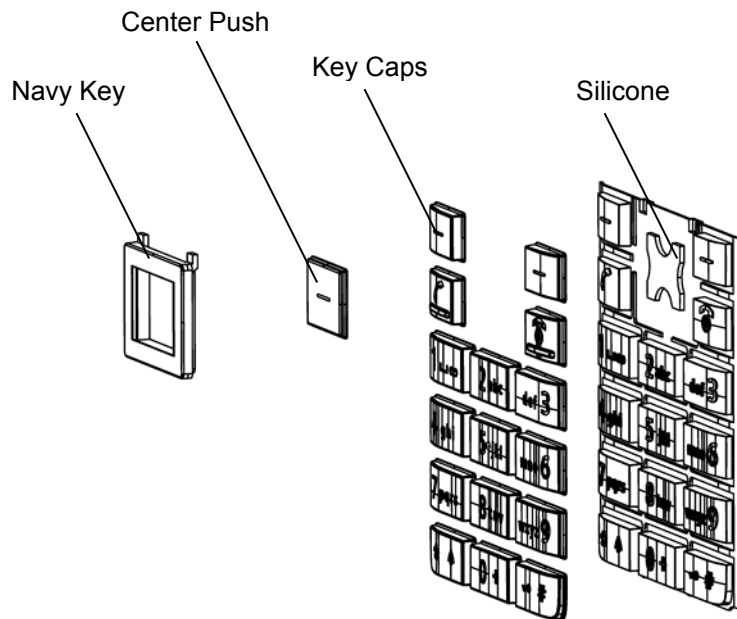


Figure 6 – Keypad

- Keypad Language Variants

Variant	123 (alpha-numeric) etched	1 <sup>st</sup> language etched	2 <sup>nd</sup> language printed
Western Europe/ LAM	123	Latin	N/A
Arabian Countries <sup>1</sup>	123	Latin	Arabic
Taiwan <sup>2</sup>	123	Latin	Bopomofo
PR China <sup>3</sup>	123	Latin	Chinese Strokes
Eastern Europe <sup>4</sup>	123	Cyrillic	Latin

<sup>1</sup> Not planned for Polaris

<sup>2</sup> Not planned for Polaris

<sup>3</sup> Not planned for Polaris

<sup>4</sup> In case keypad supplier is able to etch second language variant

Eastern Europe <sup>5</sup>	123	Latin	Cyrillic
Greece	123	Latin	Greek
Israel <sup>6</sup>	123	Latin	Hebrew
Thailand <sup>7</sup>	123	Latin	Thai

- **List of Parts**

No	Part	Material	Dimensions [mm]	Wall thick-ness [mm]	technology	tooling / assembly
1	Navy-Key	ABS	12.75 x 16.3 x 1.75		Moulded plastic-part; high-glossy galvanised	
2	Centre-push and Key-caps	Stainless-Steel	40.9 x 35.75 x 1.55		Deep drawn stainless steel; Galvanised or PVD plated	
3	Silicone	Silicone	42.0 x 39.8 x 2.14			

## 2.7 Main PCB

- Technology: 6 Layer HDI with FR4 core, thickness 1.1 mm, OSP.
- Population: Double-sided

<sup>5</sup> In case keypad supplier is **not** able to etch 2<sup>nd</sup> language variant.

<sup>6</sup> Not planned for Polaris

<sup>7</sup> Not planned for Polaris

## 2.7.1 Top Side

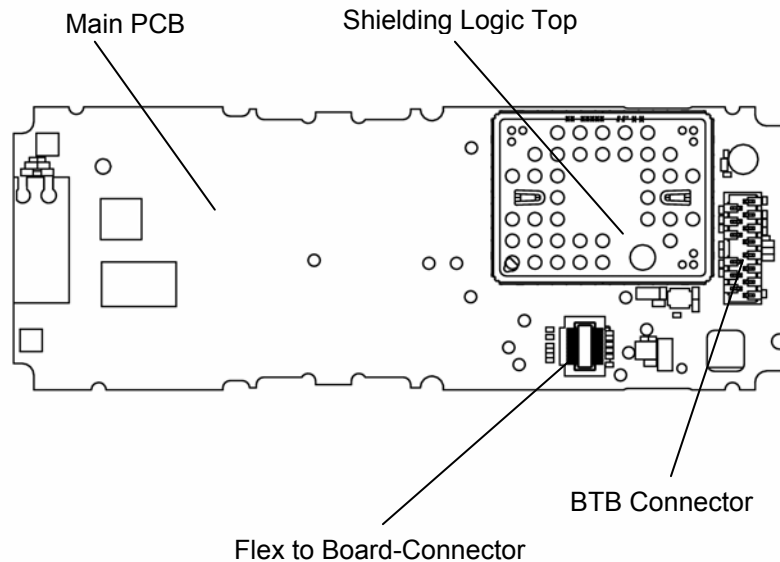


Figure 7 – PCB top

## 2.7.2 Bottom Side

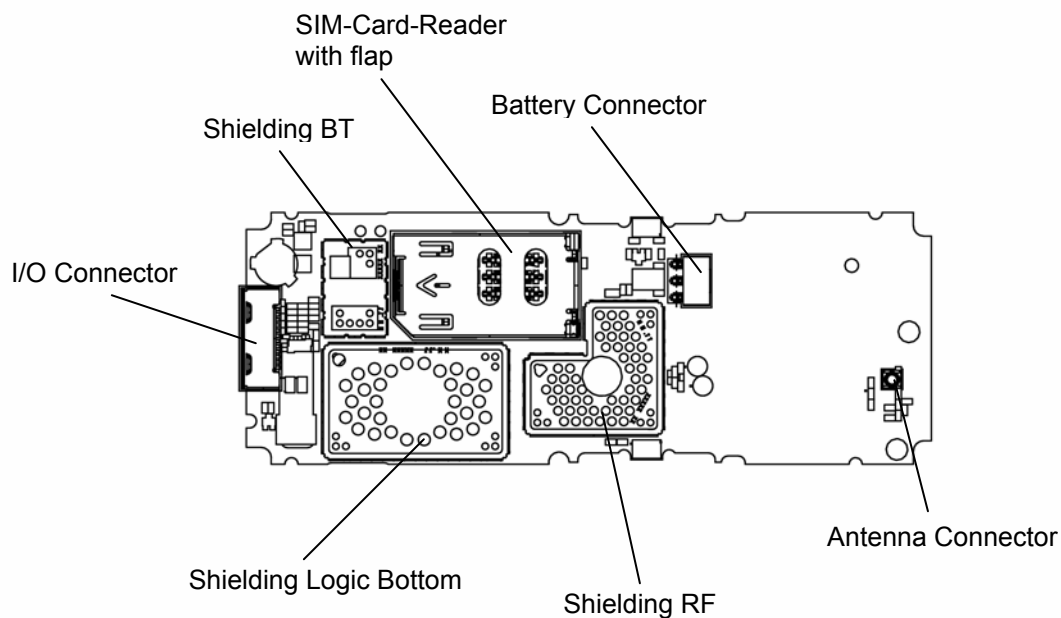
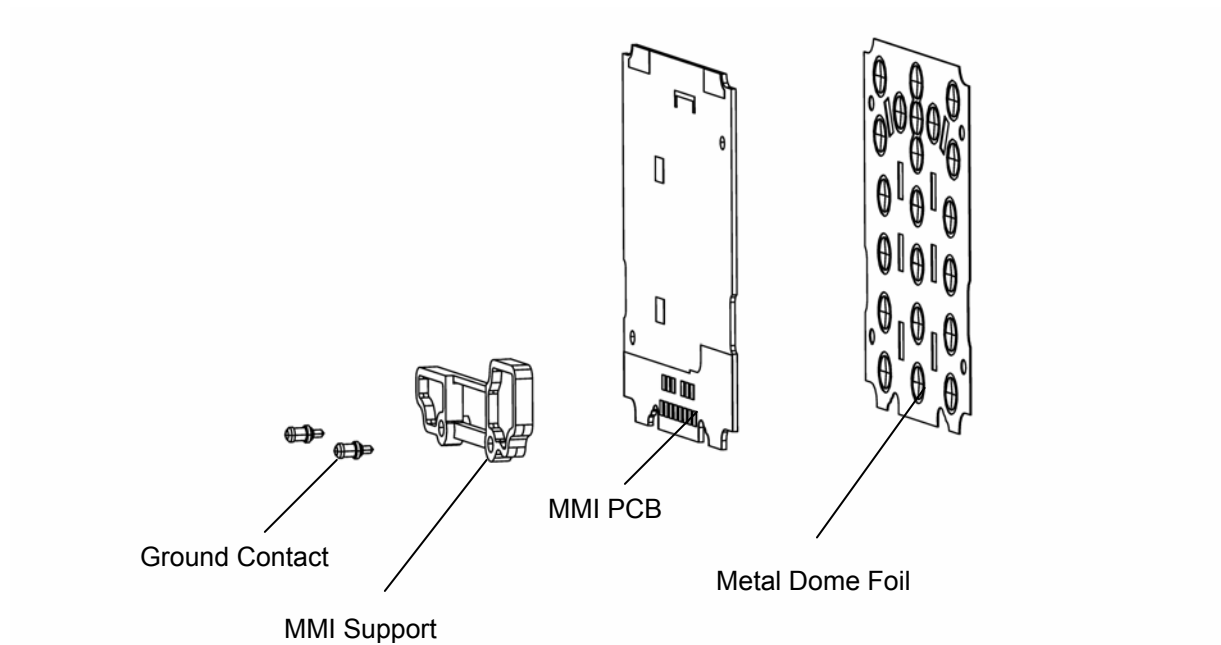


Figure 8 – PCB bottom



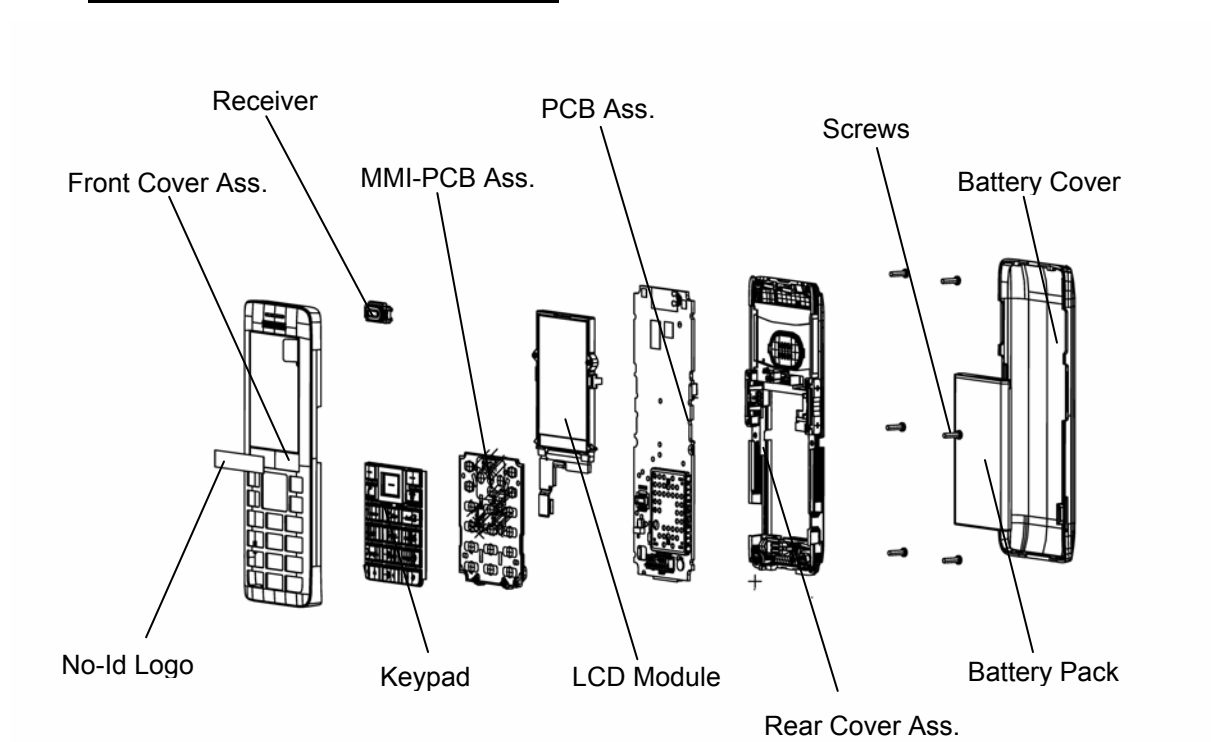
## 2.8 MMI PCB

- Technology: 2 Layer, thickness 0.6 mm, Gold Plated + OSP.
- Population: Single-sided



**Figure 9 – MMI PCB Assembly**

## 2.9 Assembly of complete handset

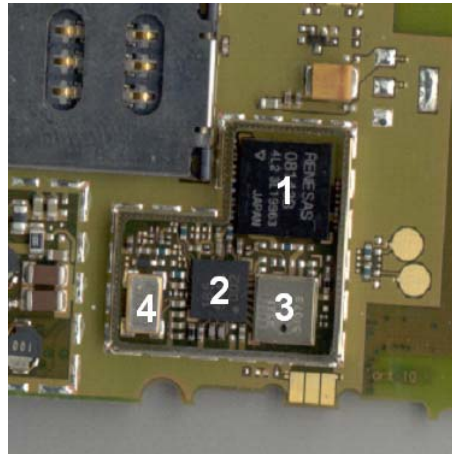


**Figure 10 – Assembly Handset**

### 3 Electronics

#### 3.1 Radio part GSM

##### 3.1.1 Introduction



**Figure 11 – RF Part of Polaris**

The RF Design is closely aligned with the X85 Platform RF Design. Key Components are the Transceiver Chip (Renesas Bright 6E HD155165BP → figure 11: '2'), the Power Amplifier (Renesas PF08143B → figure 11: '1') and the RF Front End (Hitachi Media HWXQ521 → figure 11: '3').

The radio part realises the conversion of the GMSK-HF-signals from the antenna to the base band and vice versa.

In the receiving direction, the signals are split in the I and Q component and led to the D/A converter of the logic part. In the transmission direction, the GMSK-signal is generated in an Up Conversion Modulation Phase Locked Loop by modulation of the I and Q signals which were generated in the logic part. After that the signals are amplified in the power amplifier.

Transmitter and Receiver are never active at the same time. Simultaneous receiving in the EGSM900 and GSM1800 band is impossible. Simultaneous transmission in the EGSM900 and GSM1800 band is impossible, too. However the monitoring band (monitoring timeslot) in the TDMA-frame can be chosen independently of the receiving respectively the transmitting band (RX- and TX timeslot of the band).

The RF-part is dimensioned for triple band operation (EGSM900, DCS1800, PCS1900) supporting GPRS functionality up to multi-class 10.

The RF-circuit consists of the following components:

- Renesas Bright VI E chip set (HD155165BP) with the following functionality:
  - PLL for local oscillator LO1 and LO2 and TxVCO
  - Integrated local oscillators LO1, LO2
  - Integrated TxVCO
  - Direct conversion receiver including LNA, DC mixer, channel filtering and PGC-amplifier
  - 26 MHz reference oscillator
- Renesas LTCC transmitter power amplifier PF08143B with integrated power control circuitry

- Hitachi Front-end Module HWXQ521 including RX / TX switch and EGSM900 / DCS1800 / PCS 1900 receiver SAW-filters
- Quartz and passive circuitry of the 26 MHz VCXO reference oscillator

### **3.1.2 Renesas Bright VI E chipset (HD155165BPEB)**

#### **3.1.2.1 First local oscillator**

The first local oscillator (LO1) consists of a PLL and VCO inside Bright VI E and an internal loop filter.

##### **RF-PLL**

The frequency-step is 400 kHz in GSM1800 mode and 800 kHz in EGSM900 mode due to the internal divider by two for GSM1800 and divider by four for EGSM900. To achieve the required settling-time in GPRS operation, the PLL can operate in fast-lock mode a certain period after programming to ensure a fast settling. After this, the loop filter and currents are switched into normal-mode to get the necessary phase noise performance. The PLL is controlled via the tree-wire-bus of Bright VI E.

##### **RFVCO (LO1)**

The VCO module is switched on with the signal PLLON. The full oscillation range is divided into 256 sub-bands. The choice of the appropriate band is controlled internally by the Bright.

#### **3.1.2.2 Second local oscillator (~640 MHz)**

The second local oscillator (LO2) consists of a PLL and a VCO which are integrated in Bright VI E and a second order loop filter which is realized internally. Due to the direct conversion receiver architecture, the LO2 is only used for transmit-operation. To avoid in-band spurious in the transmit-signal the TX-IF-frequency is not fixed for the whole band. The LO2 covers a frequency range of at least 16 MHz.

Before the LO2-signal gets to the modulator it is divided by 8. So the resulting TX-IF frequencies are 80 / 82 MHz. The LO2 PLL and power-up of the VCO is controlled via the three-wire-bus of Bright VI E.

#### **3.1.2.3 Receiver**

The Bright VI E incorporates three RF LNAs for GSM850 / EGSM900, GSM1800 and GSM1900 operation followed by direct conversion mixers which are IQ-demodulators. The LNA/mixer can be switched in High- and Low-mode. For the 'High Gain' state the mixers are optimised to conversion gain and noise figure, in the 'Low Gain' state the mixers are optimised to large-signal behaviour for operation at a high input level.

Furthermore the IC includes a programmable gain base band amplifier PGA (90 dB range, 2dB steps) with automatic DC offset calibration. In contrast to a conventional heterodyne receiver, the channel-filtering is realized inside the chip with a three stage base band filter for both IQ chains. Only two capacitors which are part of the first passive RC filters are external. The second and third filters are active filters with second order Butterworth characteristics and are fully integrated. The distributed channel filter is necessary to suppress adjacent channel and in-band blocking interferer to avoid compression in each amplifier stage.

The IQ receive signals are fed into the A/D converters of S-GOLD2. The post-switched logic measures the level of the demodulated base band signal and regulates the level to a defined value by varying the PGA amplification and switching the appropriate LNA gains.

### 3.1.2.4 Transmitter

#### Up conversion loop

The generation of the GMSK-modulated signal in Bright VI E is based on the principle of up conversion modulation phase locked loop. The incoming IQ signals from the base-band are mixed with the divided LO2-signal (see above) in the vector modulator. The modulator is followed by a low-pass filter (corner frequency ~80 MHz) which is necessary to attenuate RF harmonics generated by the modulator. A similar filter is used in the feedback-path of the down conversion mixer.

With help of an offset PLL the IF signal becomes the modulated signal at the final transmit frequency. Therefore the GMSK modulated RF signal at the output of the TxVCOs is mixed with the divided LO1-signal to an IF signal (see above) and sent to the phase detector. The I/Q modulated signal with a centre frequency of the intermediate frequency is sent to the phase detector as well.

The output signal of the phase detector is processed by a 3rd order loop filter whose components are internal to the Bright. During the start-up sequence of the T loop the phase detector is operated in the digital (phase / frequency detector) mode to assure safe and fast locking on the desired frequency. During the transmission of the GMSK-modulated burst the analogue phase detector is used

#### TxVCO

The TxVCO is realized inside the Bright VI E chip. Similarly to the LO1, there are 256 bands for GSM 850 / GSM 900 and 256 bands for DCS 1800 / PCS 1900. The choice of the appropriate band is automatic and controlled internally within the Bright.

### 3.1.3 Renesas LTCC transmitter power amplifier (PF08143B)

#### PA Module

The power amplifier is a LTCC (Alumina-oxd-ceramic) PA module from Renesas, matched to 50  $\Omega$  at all signal ports. It contains two separate 3-stage amplifier chains for GSM850 / EGSM900 and DCS1800 / PCS1900 operation. It is possible to control the output-power of both bands via one VAPC-port. The appropriate amplifier chain is activated by a logic signal which is provided by the base band chip (VBAND).

#### Power control

To ensure that the output power and burst-timing fulfils the GSM specification, an internal power control circuitry is used. The power detect circuit consists of a sensing transistor which operates at the same current as the third RF transistor. The current is a measure of the output power of the PA. This signal is square-root converted and converted into a voltage by means of a simple resistor. It is then compared with the PA\_RAMP signal which is provided by the base band.

### 3.1.4 Hitachi Frontend-Module (FEM, HWXQ521)

The FEM includes the RX/TX and band switch-function based on a combined PIN diode and diplexer-circuit.

In the transmit paths a harmonic filtering for EGSM900 and GSM1800 is realized to avoid additional discrete filters. The isolation in TX-OFF mode is used to achieve the isolation which is necessary before the active part of the burst. The band selection of the TX switches is controlled by two lines from the base band.

The three receiver chains include SAW filter for EGSM900, DCS1800 and PCS1900 to protect the receivers from strong blocking-signals according the GSM specification. The matching between the FEM Module and the Transceiver chip is realized integrated in the FEM to minimize component count.

### 3.1.5 Discrete 26MHz VCXO reference oscillator

A Colpitts oscillator is to generate the reference clock signal. As the Polaris has to fulfil GPRS class 10 the active part is realised with an external varactor diode. For temperature measurements of the VCXO a temperature-dependent resistance is used. The frequency of the reference oscillator can be adjusted by the base band via a filtered PNM-modulated AFC-signal. An active buffer stage is included in Bright VI E to give sufficient isolation between the base band chip and the RF-circuit.

### 3.1.6 Block diagram of RF Part

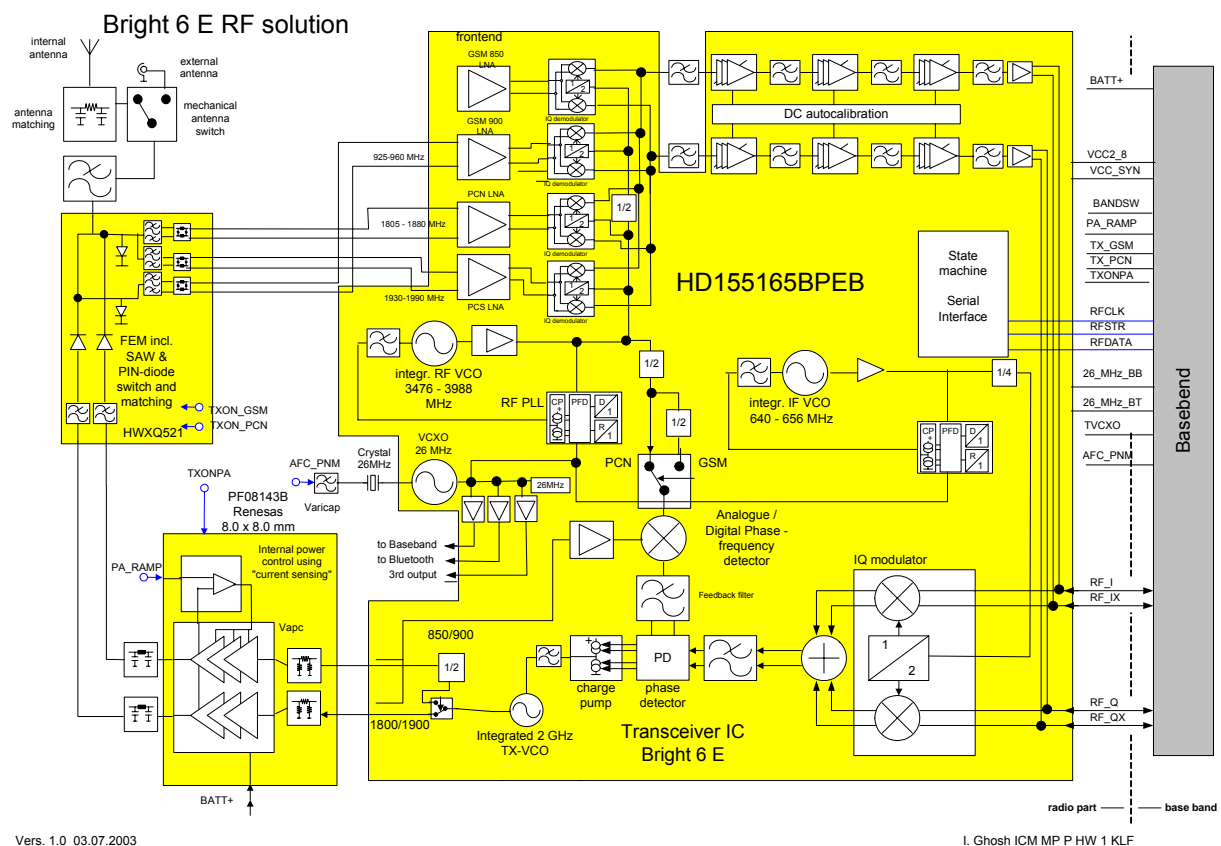


Figure 12 – RF Block Diagram

### 3.1.7 BB-RF Interface description

Please find the Bluetooth interface description in [5].

### 3.1.8 Compliance

#### 3.1.8.1 Receiver Sensitivity:

The Receiver Sensitivity must comply with the GSM 3GPP TS51.010-1 V4.9.0 (2002-07) in all operating conditions (temperature, battery level.....) (reference point is 50 Ohm test connector)

GSM 900: GMSK: -102 dBm (Specification, with fading; static@25°C GMSK: -108.0 dBm)

GSM1800: GMSK: -102 dBm (Specification, with fading; static@25°C GMSK: -107.0 dBm)  
 GSM1900: GMSK: -102 dBm (Specification, with fading; static@25°C GMSK: -106.5 dBm)

### 3.1.8.2 Transmitter Power:

The RF part is compliant to GSM 3GPP TS51.010-1 V4.9.0 (2002-07). The transmitter output power (reference point is 50 Ohm test connector) is compliant to following power classes:

GSM 900: GMSK: power class 4  
 GSM1800/GSM1900: GMSK: power class 1

The following values are valid under normal conditions:

GSM 900 GMSK: >31.1 dBm (31.6 dBm nominal)  
 GSM1800 GMSK: >28.5 dBm (29.25 dBm nominal)  
 GSM1900 GMSK: >28.5 dBm (29.25 dBm nominal)

## 3.2 Radio-Part Bluetooth

The BRF6150 architecture uses a DRP digital radio processor architecture and a point to multipoint base-band core.

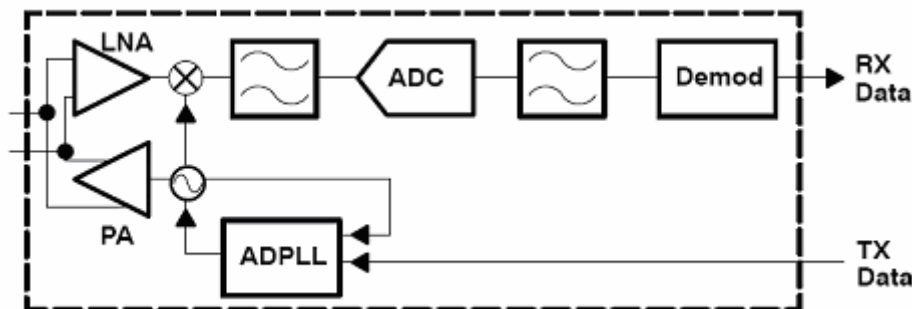


Figure 13 – Block diagram of BT RF part

### 3.2.1 Transmitter:

The transmitter is based on an all-digital sigma delta PLL with a digital controlled oscillator (DCO) at 2.4 GHz (a 4.8 GHz clock divided by two) as RF-clock. The modulation is achieved by directly modulating the digital PLL within a closed loop. The power amplifier is digitally controlled. The power can be adjusted with a HCI command.

### 3.2.2 Receiver:

The receiver uses near zero IF architecture with an IF of 0.5 MHz to convert the RF signal to base-band. The external filter balun followed by a matching network ends to the chip. The signal passes the internal RX-TX switch and is fed into differential LNTA (low noise transconductance amplifier). It amplifies the signal and converts it into a current mode signal. The LNTA feeds a sampling capacitor in the multitab direct sampling mixer (MTDSM). It uses the same oscillator which is set to 0.5 MHz higher as the TX. The IF output of this mixer is filtered to suppress in-band interference. After the filtering the signal is quantised by a sigma delta ADC and passed through a decimation FIR (DFIR) to further re-

duce the level of interference. The demodulator then digitally down-converts the signal to zero IF and performs digital filtering, suppresses the image and recovers the data by adaptive decision. To improve receiver performance, the LNA bandwidth was lowered and a passive pole has been added to the mixer output (anti aliasing, co-channel performance, blocking...)

A maximum likelihood sequence estimation decision block (MLSE) has been added to the detector to increase the sensitivity.

### 3.3 Digital Hardware and Electro Acoustics

#### 3.3.1 Overview

The HW Design is closely aligned with the X75/ 85 SGold2 Platform HW Design; see in Platform Components Reference Document [15].

A short overview and a description of the device specific parts, dedicated to the Polaris, can be found below.

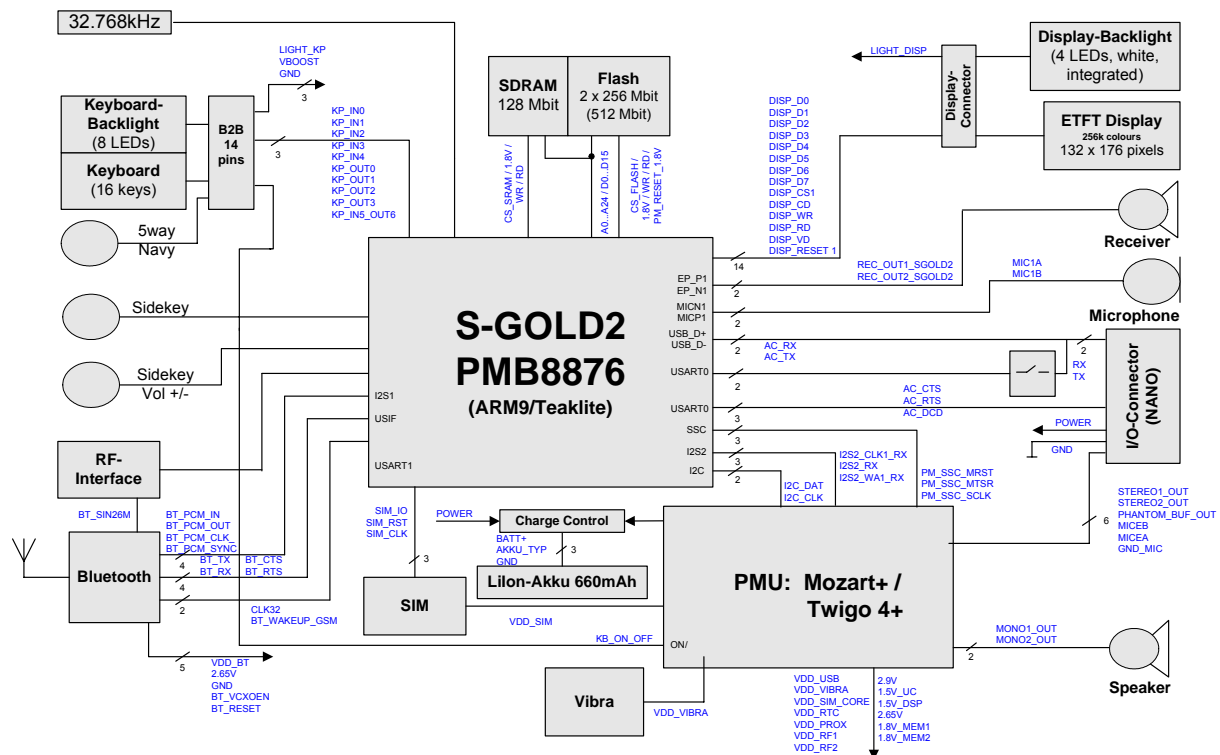


Figure 14 – Block Diagram of Polaris Base-Band

#### 3.3.2 Digital Base-Band

##### 3.3.2.1 Baseband Processor S-GOLD2 (PMB8876)

Please refer to [15] for more detailed information.

The S-GOLD2 is the EGPRS-capable successor of the S-GOLDlite, and is used as the base-band solution for low to mid range phones as well as for wireless modules. It uses the ARM 926EJ-S core running at 156 MHz (208 MHz are feasible but are for the moment not specified for Com MD), which gives sufficient performance to the X75 series. A MOVE Companion Processor is attached. Furthermore, the Teaklite DSP Sub-system runs at 138.67 MHz.



**Supported Standards**

- EGPRS class 12 MCS 1..9
- GSM speech FR, HR, EFR and AMR-NB
- GSM data 2.4 kbit/s, 4.8 kbit/s, 9.6 kbits, and 14.4 kbit/s
- HSCSD class 10
- GPRS class 12 CS 1..4

**Processing cores**

- ARM926EJ-S 32 bit processor core with operating frequency up to 156 MHz for controller functions. The ARM926EJ-S includes an MMU, and the Jazelle Java extension for Java acceleration.
- TEAKLite® DSP core with operating frequency 138.67 MHz.

**ARM-Memory**

- 8 kByte Boot ROM on the AHB
- 96 kByte SRAM on the AHB, flexibly usable as program or data RAM
- 16kByte Cache for Program (internal)
- 8 kByte tightly coupled memory for Program (internal)
- 8 kByte Cache for Data (internal)
- 8 kByte tightly coupled memory for Data (internal)

**TEAKLite®-Memory (word: 16bit)**

- 104 kwords Program ROM
- 8 kwords Program RAM
- 60 kwords Data ROM
- 37 kwords Data RAM
- Incremental Redundancy (IR) Memory of 35904 words of 16 bit

**Shared Memory Blocks (word: 16bit)**

- 3k words Shared RAM (dual ported) between controller system and TEAKLite®.

**Controller Bus System**

The processing cores and their peripherals are connected by powerful buses:

- Multi-layer AHB for connecting the ARM, the master interfaces of the Camera Interface, of the Flash Controller DMA port and of the free programmable DMA, the main internal and external memory and the peripheral buses.
- FPI-Bus for connecting the controller peripherals which require DMA support, called hereafter FPI1 respectively.
- FPI-Bus for connecting GSM peripherals, called hereafter FPI3 bus
- A controller FPI bus for connecting the low performance controller peripherals such as keypad etc., called hereafter FPI2 bus.
- FPI1, FPI2 and FPI3 are connected asynchronously to the AHB buses. 1 DMA controller with 8 channels releases the controller from data transfers.
- AHB Lite-Bus for connecting multimedia and high performance peripherals, called AHB\_PER hereafter. This peripheral bus is connected to the multilayer AHB 'backbone' by an asynchronous, burst capable AHB2AHB bridge which is shared between accessing masters.
- The DMA controller is enabled to access AHB\_PER by the use of its second Master Interface.

**TEAKLite® Bus System**

- TEAKLite® data bus for connecting the TEAKLite® data memory and the TEAKLite® peripherals. Also the data bus is connected into the controller system via shared RAMs to the FPI3 bus.
- TEAKLite® program buses for connecting the TEAKLite® program memory to the TEAKLite®.

**Clock System**

- The clock system allows widely independent selection of frequencies for the essential parts of the S-GOLDlite™. Thus power consumption and performance can be optimized for each application.

#### Functional Hardware blocks

- CPU and DSP Timers
- Programmable PLL with additional phase shifters for system clock generation
- GSM Timer Module that off-loads the CPU from radio channel timing
- GMSK Modulator according to GSM-standard 05.04 (5/2000)
  - GMSK Modulator: gauss-filter with  $B \cdot T = 0.3$
- Hardware accelerators for equalizer and channel decoding
- A5/1, A5/2, A5/3 Cipher Unit (A5/3 added in S-GOLDlite™ V1.1)
- GEA1, GEA2, GEA3 Cipher Unit to support GPRS data transmission (GEA3 added in S-GOLDlite™ V1.1)
- Advanced static and dynamic power management features including TDMA-Frame synchronous low-power mode and enhanced CPU modes (idle and sleep modes)
- Incremental Redundancy Memory for EDGE class 12 support
- GMSK / 8-PSK Modulator according to GSM-standard 05.04 (5/2000)
  - GMSK Modulator: gauss-filter with  $B \cdot T = 0.3$
  - EDGE Modulator: 8PSK-modulation with linearised GMSK-pulse-filter
- MOVE coprocessor performing motion estimation for video encoding algorithms (H.263, MPEG-4)

#### Interfaces and Features

- Keypad Interface for scanning keypads up to 8 rows and 8 columns (sum of rows and columns up to 16)
- Pulse Number Modulation output for Automatic Frequency Correction (AFC)
- Serial RF Control Interface; support of direct conversion RF
- 2 UARTs with auto-baud detection and hardware flow control
- IrDA Controller integrated in USART0 and USART1 (with IrDA support up to 115.2 kbps) V1.0 : IrDA integrated in USART0 only.
- 1 Serial Synchronous SPI compatible interfaces in the controller domain
- 1 Serial Synchronous SPI compatible interface in the TEAKLite® domain
- I2C-bus interface (e.g. connection to S/M-Power)
- 2 bidirectional and one unidirectional I2S interface accessible from the TEAKLite®
- USB V1.1 mini host interface for full speed devices with up to 2 interfaces and 4 endpoints configurable supporting also USB on-the-go functionality
- IEEE 1149.1 compliant JTAG port for Boundary Scan and debug
- ISO 7816 compatible SIM card interface
- Enhanced digital (phase linearity, adj/ co-channel interference) base-band filters, including analog pre-filters and high resolution analog-to-digital converters.
- Digital and analog audio filters including wideband audio capable digital-to-analog and analog-to-digital converters.
- Audio front-end will be accessible from MCU (via shared memory) and the TEAKLite® (i.e. voice recognition and echo cancellation can run on TEAKLite®)
- HiFi Stereo voice-band with CD-Quality
- Separate analog-to-digital converter for various general purpose measurements like battery voltage, battery, VCXO and environmental temperature, battery technology, transmission power, offset, on-chip temperature, etc.
- Ringer support for highly over-sampled PDM/PWM input signals for more versatility in ringer tone generation
- Differential VMIC generation
- RF power ramping functions
- DAI Interface according to GSM 11.10 is implemented via dedicated I2S mode
- 26 MHz master clock input

- External memory interface:
  - 1.8V interface data bus: 16 bit non-multiplexed and multiplexed, 32 bit multiplexed
  - for each of the 4 address regions 128 MByte with 32-bit access or 64 MByte with a 16-bit access are addressable
  - supports asynchronous devices (i.e. SRAM, display) including write buffer for cache line
  - write supports synchronous devices (SDRAMs and Flash Memory) up to 104 MHz
- Port logic for external port signals
- Comprehensive static and dynamic Power Management
  - Various frequency options during operation mode
  - 32 kHz clock in standby mode
  - Sleep control in standby mode
  - RAMs and ROMs in power save mode during standby mode
  - Additional leakage current reduction in standby mode possible by switching off the power for the TEAKLite® subsystem.
- Debug Features:
  - OCDS level 2+ (run control, non-intrusive program flow trace and limited data flow trace) for ARM and OCDS level 1+ (run control, limited program flow trace) for the TEAKLite® multi-core debug support
  - 4 monitor pins for important internal signals and most pad signals
- 2 General Purpose Timers with 3 32-bit timers
- Serial number
- Real time clock with alarm functions
- 2 capture/compare units with 16 channels
- A fast parallel Display Interface
- Extensive debug support for the controller and the DSP system
- ITU-R BT.656 compatible Camera Interface
- Programmable clock output for a camera
- Multimedia/Secure Digital Card Interface (MMC/SD; SDIO capable)
- Flash Controller DMA Port (FCDP) supporting NAND flash (error correction capability)
- Multimedia extension interface (MMIC-IF) supporting external hardware accelerator
- ICs such as complex display/camera modules or graphic accelerators.
- Fast IrDA Interface supporting IrDA's SIR, MIR and FIR standards
- Universal Serial Interface (USIF) enabling asynchronous or synchronous serial data transmission.

### Signal Processing Firmware Support

- FR, HR, EFR, and AMR NB speech and channel codecs
- Data transmission channel codecs for 2.4, 4.8, 9.6 and 14.4 kbit/s
- HSCDS class 10 support
- GPRS class 12 support with coding schemes CS1..4
- Support for hands-free, side- and signalling tone generation
- MMS-support
- EGPRS class 12 with modulation and coding schemes MCS1..9 (Release 5 compliant)
- Polyphonic ringer for up to 64 voices at sampling rates up to 48kHz
- SAIC
- 64 voices midi (pseudo) stereo
- Enhanced audio visualization
- Voice control

### 3.3.3 External Memory

For more details, please refer to [15].

The memory D1299 is a three die stacked device with one Flash for code, one Flash for data and one LP-SDRAM as main memory. The densities are 256Mbit + 256Mbit + 128Mbit.

All memories are sharing the EBU\_AHB- BUS to SGold2.

### 3.3.3.1 Code/ Data Flash

It is a non-volatile-, re-programmable- memory (SW-updateable), with a high performance interface. The mobile-SW can be executed directly. The Flash has an unchangeable serial number.

#### Intel Tyax (L18):

Memory Size:	256 Mbit (32 MByte)
Data Bus:	16 Bit
IO / Core Voltage Supply:	typ. 1.8V
Boot Block:	Top
Access Time:	
– Asynchronous (Initial) Mode:	85 ns
– Synchronous Burst Mode:	54 MHz / 14ns clock to data output
	Support 4-, 8-, 16-, or continuous-burst-read
Dual Operations:	Read while Write (RWW) or Read while Erase (RWE)
Program Feature:	Single Word and Buffer Programming
	Factory Programming (VPP = 9.5 V)

#### Spanion WS256N:

Memory Size:	256 Mbit (32 MByte)
Data Bus:	16 Bit
IO / Core Voltage Supply:	typ. 1.8V
Boot Block:	Top + Bottom
Access Time:	
– Asynchronous (Initial) Mode:	70 ns
– Synchronous Burst Mode:	54 MHz / 14ns clock to data output
	Support , 8-, 16-, 32-, or continuous-burst-read
Dual Operations:	Read while Write (RWW) or Read while Erase (RWE)
Program Feature:	Single Word and Buffer Programming
	Factory Programming (VPP = 9.0 V)

### 3.3.3.2 Low Power SDRAM

The SDRAM (Synchronic Dynamic Random Access Memory) is for volatile data.

Memory Size:	128 Mbit (16 MByte)
Data Bus:	16Bit
IO / Core Voltage Supply:	typ. 1.8 V
Synchronous Burst Mode:	105 MHz (CL=3) Burst
Features:	Four banks operation / Burst read single bit write operation / Auto refresh

### 3.3.4 Display Module

#### 3.3.4.1 General description

In the mobile phone a display module (APUS) with an intelligent graphic Liquid Crystal Display (LCD) is used (Pluto Display panel, used in Hydra project with modified plastic and FPC).

The APUS display has a resolution of 132x176 pixels with a colour depth of 262144 colours (6-6-6 RGB). It contains an Active Matrix panel (Vertical Aligned Molecules) normally black panel. The panel is built in accordance to Pluto panel mechanical design. Driving technology is TFD, the controller is mounted on the glass (COG). Read functionality is enabled in order to perform status and/or ID read commands. Contrast adjust is fixed and cannot be changed by mobile user. The display (Type 4 Epson) enables wide viewing angle, no colour inversion, high contrast and high colour gamut. Luminance

is set to meet 75 generation (using 4 high brightness white LED in series). FPC including components has been placed below the display module in order to reduce thickness of the module. Interconnection is done by 20-pin B2B connector.

The display controller is supplied only with 2.9 V VDD. The 4 white LEDs are mounted in serial. The maximum current is set to 15 mA. The voltage for the 4 LEDs is about 18 V. The luminance is targeted to be 200cd/m<sup>2</sup> with an in-homogeneity of max. 30%.

The typical operation temperatures are: -20°C to +55°C. The reduced functional temperature range is -25°C to +65°C. The contrast ratio is targeted in transmissive mode to be 200 perpendicular to the display, in a viewing cone @ 65 degrees contrast ratio is target to 20.

No contrast adjustment is necessary. It is not possible to change the contrast by the mobile phone software. The colour adjustment of the display panel is also fixed by the supplier. The display contrast is pre-adjusted by the supplier and can be factory set in Siemens production.

Maximum frame rate guaranteed by supplier is 15 fps @ 25°C.

Partial mode current consumption is target to 300 uA.

### 3.3.4.2 Expected optical performance

Items	Reflective Mode		Transmissive Mode		Unit
Main-Display	Min	Typ	Min	Typ	
Contrast Ratio	15:1	20:1	225:1	300:1	-
Luminance				200	cd/m <sup>2</sup>
Colour Gamut Ratio Related to NSTC	TBC	10	TBC	73	%

### 3.3.4.3 Mechanical Performance

Resolution :	132x176 pixels	
Dimensions :	Panel dimensions: 32,3 x 47,1 mm <sup>2</sup> Active area : 27,72 x 36,96 mm <sup>2</sup> Module: 34,7 x 50 x 2,6 mm <sup>3</sup>	
Pixel Pitch :	0,21 x 0,21 mm <sup>2</sup>	1 pixel consists of 3 sub-pixels red, green and blue
Technology :	Vertical Alignment, Normally Black	
Operating Temperature:	-20°C to +55°C	
Backlight :	4 high brightness white LED's	Nichia

### 3.3.4.4 Available Display modules

Supplier	Supplier Part Nr.	Controller / Sub controller	Siemens SAP
Epson	Referred to as "APUS"	L2F50333T (Seiko Epson)	A5B00075535157

3.3.4.5 Interfaces of the Display Module

DISPLAY\_CONNECTOR

2200-2299

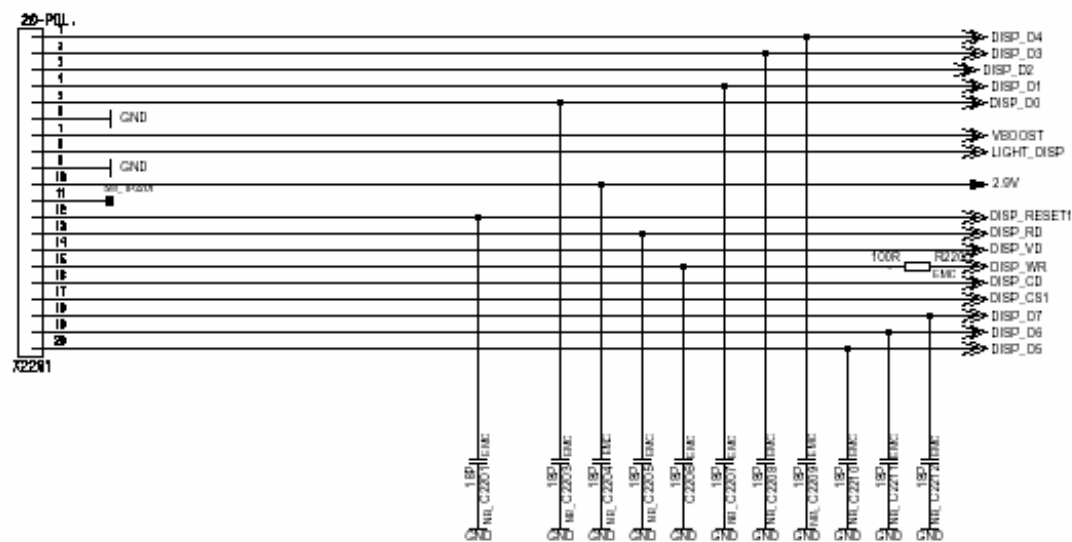


Figure 15 – Display Interface

The signal lines are described in the table below:

No.	Name	Function	I/O	Remarks
1	D4	D0~D7:connects to the 8-bit standard MPU data bus, bi-directional data bus	I/O	
2	D3		I/O	
3	D2		I/O	
4	D1		I/O	
5	D0		I/O	
6	GND	Ground	P	
7	VBOOST	Power supply for LED	P	
8	LIGHT_DISP	LED Ground	P	
9	GND	Ground	P	
10	VDD	Power supply for logic	P	
11	GND	Ground	P	
12	XRES (RS)	Initialized when XRES is set to "L". Reset is performed at the XRES signal level.	I	
13	XRD	Read signal	I	
14	TE (VD)	Synch Pin to avoid tearing effect	⊙	
15	XWR	Write signal	I	
16	A0 (CD)	Data command select signal "L" = Command, "H" = Data	I	
17	XCS	Chipset signal	I	
18	D7	D0~D7:connects to the 8-bit standard MPU data bus, bi-directional data bus	I/O	
19	D6		I/O	
20	D5		I/O	

Note)

P :power supply I: Input O: Output

### 3.3.4.6 Realization Principles / Boundary Conditions

The typical operation temperatures are: -20°C to +55°C. The reduced functional temperature range is -25°C to +65°C (the contrast will not be according to the specifications, but will still be readable).

### 3.3.4.7 Contrast and Colour Adjustment

For all display modules no contrast adjustment is necessary. The contrast is fixed in the module. It is not possible to change the contrast by the mobile phone software. Also the colour adjustment of the display panel is fixed by the supplier.

### 3.3.4.8 Illumination

The four serial LEDs for the display are supplied by one constant current source, to ensure the same brightness and colour of the white LEDs and thus an even backlight.

### 3.3.5 MMI

#### 3.3.5.1 Keyboard

##### 3.3.5.1.1 General description

The Keypad matrix consists of the keys '0' to '9', '\*', '#', two soft keys, a 5-way navy key, a 'SEND', and an 'END' key.

The placing of the keys depends on the telephone type. These keys are located at the MMI board. In addition, four side keys are connected to the matrix. They are located on the main PCB.

The 'END' key has a double-function. If the mobile phone is switched off and the 'END' key is supported via a resistor with RTC-Voltage. By pressing the key brings the voltage goes down to zero and the power supply ASIC switches on the mobile phone. If the mobile phone is ON, the 'END' key acts as a normal key same as the other ones. However, the 'END' key depressed for a longer time, then the software recognizes this and switches the power supply ASIC off via I<sup>2</sup>C commando.

##### 3.3.5.2 Block Diagram

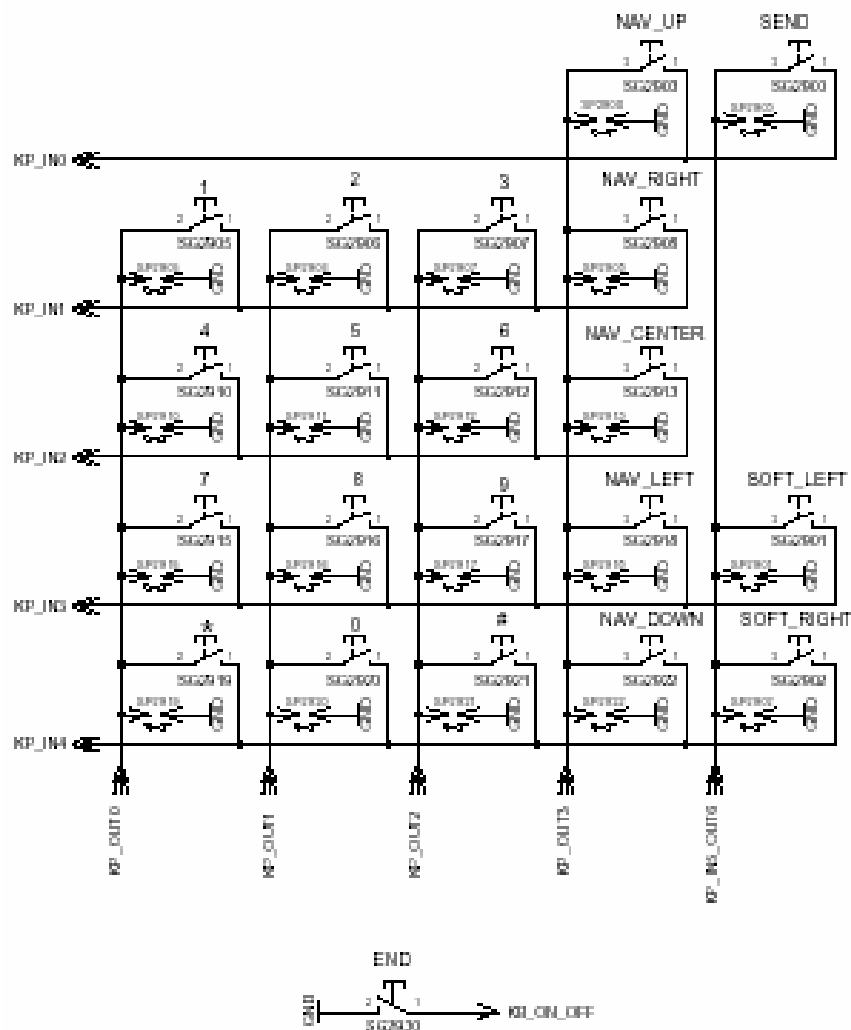


Figure 16 – Keypad Matrix



### 3.3.5.3 Keypad Illumination

The illumination of the keypad is made by eight white LEDs, mounted on the MMI PCB. The LEDs are directly supplied by the battery voltage. To reduce the influence of the battery voltage to the illumination of the LEDs, the LEDs are regulated by PWM.

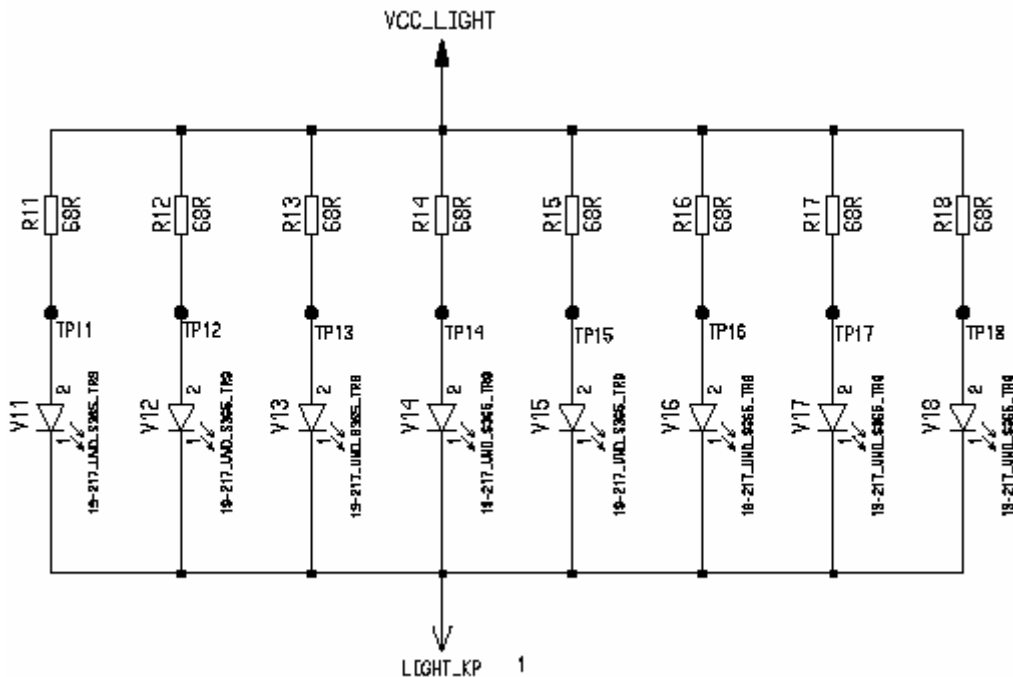


Figure 17 – Keypad Illumination

### 3.3.6 SIM

SIM cards with supply voltages of 1.8 V and 3 V will be supported.

#### Interface SIM Module:

For the levels please refer to the GSM 11.10 V 4.18.0.

Pin Name	IN/OUT	Level	Remarks
CCLK	O	HIGH: $0.7 \times CCVCC \leq U \leq CCVCC$ ( $I = \pm 20 \mu A$ ) LOW: $0V \leq U \leq 0.1 \times CCVCC$ ( $I = -100 \mu A / +20 \mu A$ )	Pulse for chip card. The chip card is controlled directly from the S-GOLD2.
CCRST	O	HIGH: $0.8 \times CCVCC \leq U \leq CCVCC$ ( $I = -20 \mu A / +150 \mu A$ ) LOW: $0V \leq U \leq 0.12 \times CCVCC$ ( $I = -200 \mu A / +20 \mu A$ )	Reset for chip card

Pin Name	IN/OUT	Level	Remarks
CCIO	I	HIGH: $0.7 \times CCVCC \leq U \leq CCVCC$ ( $I = -300 \mu A / +20 \mu A$ ) LOW: $0V \leq U \leq 0.2 \times CCVCC$ ( $I = -1000 \mu A / +20 \mu A$ )	Data pin for chip card; 6.8 k $\Omega$ pull up at the CCVCC pin
	O	HIGH: $0.7 \times CCVCC \leq U \leq CCVCC$ ( $I = +20 \mu A$ ) LOW: $0V \leq U \leq 0.15 \times CCVCC$	
CCVCC	O	$2.7 V \leq CC\_VCC \leq 3.3 V$ ( $I_{max} = 100 mA$ )	Switchable power supply for chip card; 220 nF capacitors are situated close to the chip card pins and are necessary for buffering current spikes.

### 3.3.7 Bluetooth

Please refer to [15] for more detailed information.

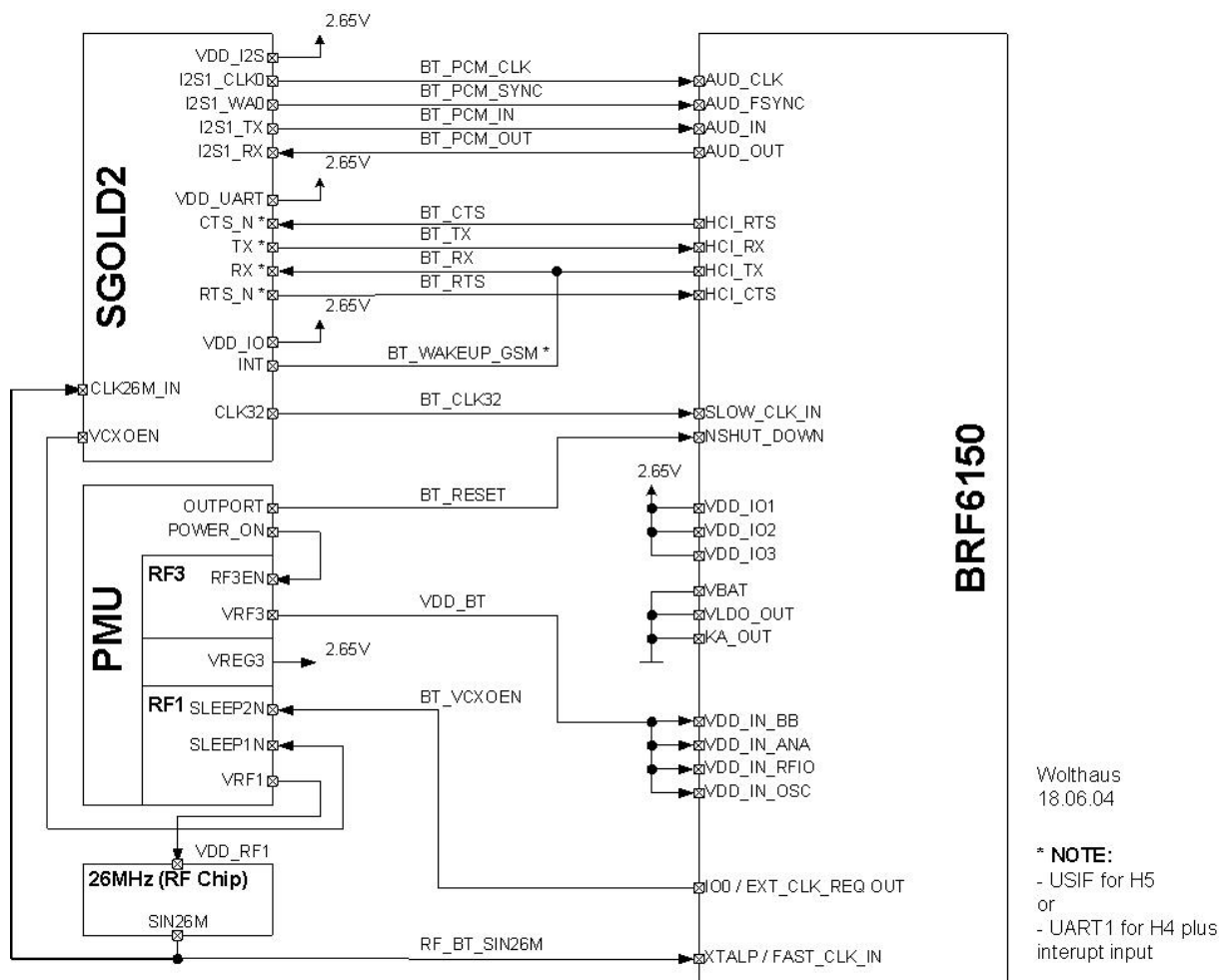
The Bluetooth Interface is based on the BRF6150 (D5100) from Texas Instruments. The BRF6150 is a single chip, this means the digital base-band and the radio part are implemented on the same silicon. The necessary firmware up to the HCI interface is stored in a diffusion ROM. As package a 4.6 mm by 4.6 mm S-PGBA-N63 package is used.

The Bluetooth-Device-Address and the initialisation settings and values are stored in the GSM-Flash (EESIMU). During the start up of the BRF6150 the Mobile software writes this information to the device. Each Mobile Phone needs a unique Bluetooth-Device-Address. The BRF6150 support the possibility to use a patch RAM for bug fixes. The needed patch must also be stored in the EESIMU. It is important that the patch is stored in an additional Block.

The interface between the BRF6150 and GSM-Host-System consists of the following parts:

- Power supply (Power supply RF and base-band, I/O power supply)
- Clock supply (26MHz, 32,768 kHz)
- PCM interface (four lines, for voice sample)
- UART interface (four lines, for data and control)
- Miscellaneous (RESET, Wakeup optional for H4 protocol)

The following picture gives an overview about interfaces between the BRF6150 and the GSM Mobile system.



**Figure 18 – Interface between GSM Mobile and BRF6150**

### 3.3.8 Vibration Motor

All details are specified in [15].

The vibration motor is assembled in the lower case. The electrical connection to the PCB is realized with spring contacts.

The modified SL65 Vibration motor will be reused. The vibration motor uses a silicon grommet motor housing to improve drop shock performance.

### 3.3.9 Electro Acoustics

A dedicated receiver is used for telephony (no hands free) only. It is mounted into the upper case. The receiver is connected directly to the analogue audio front-end (AFE) of the S-GOLD2. There is no routing over the ASIC 'Mozart' necessary.

A second speaker on the rear side is used for all hands-free operations, ringing and music playback consists of a speaker core and a sealed back volume, which is specially adapted to the mobile phone geometry. The back volume is leak free and improves the acoustic performance, as it is avoiding mobile phone housing leakage effects.

The speaker-signal comes from the S-GOLD2. For music playback or ringing tones the signal will be provided over the digital interface I2S to the Mozart, here it will be converted to an analog signal, am-

plified and routed to the speaker. For hands-free-telephony or service-tone-playback the signal comes from the AFE to the Mozart, will be amplified there and routed to the speaker.

The microphone is built into the Mounting Frame Lower Part and is mechanically fixed and sealed with self-adhesive tape. The contact on the PCB is realised via spiral springs, which are integrated into the plastic holder of the ECM (Electrical Condenser Microphone). Due to using an omni-directional Microphone type, only one sound inlet is necessary. The plastic holder of the microphone has three asymmetrical slits in order to provide non-rotating and to ensure proper contacting. The microphone is water protected (water repellent cloth).

The microphone supply voltage will be delivered from the S-GOLD2. The microphone signal will be delivered to the S-GOLD2.

### **3.3.9.1 Acoustic Shock Protection**

To protect the user against acoustic shock, all signals, which can harm the ear because of higher loudness, will be routed to the loudspeaker. For the normal use case (user holds the mobile with the outlet of the receiver at his ear), there is an acoustic damping between receiver and speaker because of the distance between both and the mechanic properties of the speaker and receiver (sealed back volume of the speaker).

If that damping is not high enough, the SW solution from the 65er generation will be used additionally. That means, either a volume limitation or a volume ramping regarding the acoustic shock requirements will be inserted.

The Acoustic Shock Protection will be realized in accordance with [22].

## **3.3.10 Power Supply, Battery, Charging**

### **3.3.10.1 Overview**

Most of the important functions for the power supply of the phone are carried out by the power supply ASIC Mozart+/ Twigo4+. There are some additional power supply regulators. The POWER pin of the I/O-Connector is for charging the battery with an external power supply. The standard X75 platform power supply is an unregulated open loop switched-mode charger.

### **3.3.10.2 PMU Mozart+ / Twigo 4+**

The power supply ASIC [6] is composed of the following functions:

- Power-down-Mode
- Sleep Mode
- Trickle Charge Mode
- Power on Reset
- Digital state machine to control switch on and supervise the  $\mu$ C with a watchdog
- 17 Voltage regulators
- Internal DC/DC converter (Step-up and Step-down converter)
- Low power voltage regulator
- Additional output ports
- Voltage supervision
- Temperature supervision with external and internal sensor
- Battery charge control
- TWI Interface (I<sup>2</sup>C interface)
- Band-gap reference
- High performance audio quality

- Audio multiplexer for selection of audio input
- Audio amplifier stereo/mono
- 16 bit Sigma/Delta DAC with Clock recovery and I<sup>2</sup>S Interface

### 3.3.10.3 Voltage Regulators and DC/ DC Converters

Please refer to the table below:

	Voltage	Voltage option change per	Current [mA]	start up default	ON/OFF by	Power supply name Polaris	Domain
REG 1	2,9V (+/-2%)	I2C default per metal	0...140	on	I2C	2.9V	SGOLD, Display
	2,65V (+/-2%)						
REG 2a	1,5V (+/-2%) 1,3V...1,5V in 100mV steps	I2C default per metal	0...300	on		1.5V_UC	not used
REG 2b	1,5V (+/-2%) 1,3V...1,5V in 100mV steps	I2C default per metal	0...100	on	I2C	1.5V_DSP	not used
REG 3	2,65V (+/-2%)	I2C default per metal	0...140	on		2.65V	SGOLD, IrDA, Bluetooth, Hall Switch, Audio/Video Interface
	2,5V (+/-2%)						
MEM REG1	1,8V (+/-2%)	I2C default per metal	0...250	on	I2C	1.8V_MEM1	SGOLD, Flash/SDRAM, Audio/Video Interface
	2,5V (+/-2%)						
MEM REG2	1,8V (+/-2%)	metal	0...150	on	I2C	1.8V_MEM2	Flash/SDRAM
	2,5V (+/-2%)						
AUDIO REGa	2,9V (+/-2%)	n.a.	0...190	off	I2C	VAUDREGA	internal use
AUDIO REGb	2,65 (+/- 2%)	n.a.	0...30	off	I2C	n/a (Mozart internal use)	internal use
RF REG1	2,74V (+/-2%)	I2C default per metal	0...150	Sleep1_N or Sleep2_N	I2C	VDD_RF1	RF Tranceiver
	2,54V (+/-2%)						
	2,85V (+/-2%)						
RF REG2	1,53V (+/-2%) (CA Version)	I2C default per metal	0...180mA	depends on RF2_EN input	I2C	VDD_RF2	RF Tranceiver
	2,7V (+/-2%)						
	2,85V (+/-2%)						
RF REG3	1,8V (+/-2%)	I2C default per metal	0...180	depends on RF3_EN input	I2C	VDD_BT	Bluetooth
	2,7V (+/-2%)						
	2,85V (+/-2%)						
AFC REG	2,65V (+/-2%)	I2C default per metal	0...2	always active	n.a.	VDD_AFC	SGOLD

LP_REG	2,0V	I2C default per metal	0...2	always active	n.a.	VDD_RTC	SGOLD
SIM REGa	2,9V (+/-2%)	I2C	0...70	off	I2C	VDD_SIM	SIM
	1,8V (+/-2%)	default per metal					
SIM REGb	2,9V (+/-2%)	I2C	0...10	on	I2C	n/a (not used)	not used
	1,8V (+/-2%)	default per metal					
USB REG	3,1V (+/-2%)	n.a.	0...40	on	I2C	VDD_USB	SGOLD
VIBRA	2,8V (+/-2%)	n.a.	0...140	off	I2C	VDD_VIBRA	Vibra
DCDC STEP DOWN (BUCK-Converter)	1,5V	I2C	700	on	I2C	VBUCK	SGOLD
	2,1V						

### Non Mozart power supplies

	Voltage	Voltage option change per	Current [mA]	start up default	ON/OFF by	Power supply name VIRGO/TAURUS	Domain
BOOST-Converter: LM2733	19,7V	ext. Resistor divider	60mA for 400ms 30mA continuous	off	SHDN pin	VBOOST	Keypad backlight, Display backlight

### 3.3.10.4 Power Management Concept

A double MOSFET is placed between the battery and the charge pin at the IO connector. This enables both normal charging as well as reverse supply from the battery to external accessories, requiring power from the phone. The PA is supplied directly from the battery. A number of different LDOs supply different parts of the phone. The external LDO's are supplied directly from the battery.

A DC/DC step-down converter with additional input filters was foreseen to supply the LDOs with the highest current limitation (VREG2, VREGMEM). This solution was chosen in former projects to get an efficient energy transformation from the battery to the step-down output (2.1 V), and at the same time get a low noise supply at the regulated outputs. For increased efficiency of the power supply concept the domains 1.5V\_UC and 1.5V\_DSP can be connected now directly to the step-down converter while VREG2a/b are switched off. Therefore the output voltage of the step-down converter has to be reduced to 1.5 V by default from start-up on. This is done by using the Mozart Plus / Twigo 4 Plus as PMU.

A step-up converter generates 19.7V for display and keypad backlight supply. Care must be taken to avoid to big voltage drop caused by currents drawn during start-up of the step-up converter and a TX burst.

### 3.3.10.5 Reference Section

The 100k resistor R1300 connected to RREF is used as current reference for the Power-ASIC and it must be 1% tolerance, see ASIC specification.

VDD\_RTC is used for 32 kHz clock supply. In case the battery is removed, the clock is supplied by the 100 uF capacitor C1344 for around 1 min.

### **3.3.10.6 Low Drop-Out Regulators (LDO's)**

All supply domains are supplied via LDOs, except for the backlight supply. The LDOs must have a 100nF capacitor on the input and a capacitor on the output to ensure stability. The output capacitor size is given in the Power-ASIC specification.

The RF1 and RF2 supply has an extra ferrite bead (L1320, L1303). This was inserted to reduce the noise on the RF supply.

### **3.3.10.7 DCDC Step-Down Converter**

The power from the battery is fed to the PMU input VDDBUCK 1 and VDDBUCK2 through a Phi-type LC low pass filter build up with C1304, C1307, L1300, C1306-1 and C1306-2. This filter is required to suppress 900 and 1800 kHz noise generated from the step-down converter backwards to the battery. The current sense resistor R1302 is used for the coil current limitation. The component values of the output stage (V1302, L1301, C1354, C1359) are given by the Power-ASIC specification.

### **3.3.10.8 DCDC Step-Up Converter (backlight supply)**

The power from the battery is fed to the switching circuit through the same Phi-type filter as used for the step-down converter (, C1307, L1300, C1306-1 and C1306-2). This filtered voltage is named BATT\_DCDC. For additional filtering a second filter can be build up by placing components on C1336; R1334 and C1345. R1334 can be replaced by a ferrite bead.

The switching circuit is built up by L1302, the diode V1303, two capacitors C1355 and C1363 in parallel and a switching transistor N1330 (LM2733). The capacitance of the used ceramic capacitor decreased with higher DC voltages (DC-biasing), so two 4u7 capacitors 1206 with 25 V in parallel must be used to reach the required capacity of 4u7 at 19.7 V output voltage.

The output voltage is determined by the resistive voltage divider from the output voltage VBOOST.

The internal reference voltage is 1.25 V. The tolerance of the divider resistors has a big influence; therefore 1% resistors are used for R1340 and R1341. When the step-up converter is not in use the voltage divider is connected through V1303, L1302 and the noise filter directly to the battery. So the divider must be designed high resistive to keep the quiescent current as low as possible. Two parallel capacitors to the resistors increase the AC stability without increasing the quiescent current.

### **3.3.10.9 Illumination Control**

The brightness control of the display and keypad LEDs works with the two PWM outputs, LIGHT\_PWM1 and LIGHT\_PWM2. With one of these signals a constant current sink, built up around the double transistor V2302 is controlled in duty cycle. The resistor R2311 determine the current approximately by  $I=0.6/R$ . At the moment the second current sink is replaced by a simple switching FET V2801 for the keypad illumination. This FET is a double FET, with one device shortened by R2859. So it acts as a single FET placed on the footprint of a double transistor. The LEDs of the keypad are connected to the VBoost directly. In a later stage of the project this can be changed back to a common supply of display and keypad from the step-up, if for the PMU a Mozart+ VBOOST or the Twigo 4+ is used. In that case the step-up voltage can deliver more current than today the Mozart Plus, which is limited to round about 30 mA. This requires also changes in the external switching circuit.

### **3.3.10.10 Vibra Motor Supply**

The vibra motor can be supplied in two modes:

1. Regulated output voltage of 2.8V: In this case the output capacitor C1337 must be mounted to ensure LDO stability. This mode is not used in Polaris
2. PWM mode: In this case the supply works as a step-down converter at 21 kHz, and the capacitor



C1337 must not be mounted. The speed of the vibra is easily controlled by changing the PWM in several steps.

The diode V2100 serves as ESD protection. But in PWM mode it is also used for freewheeling when the vibra switch in the Power-ASIC is off. Because of this functionality it is necessary to use a Schottky diode, otherwise the negative voltage on the Power-ASIC VIBRA ball will exceed the permitted value (see [6])

### **3.3.10.11 Audio Amplifier**

#### **3.3.10.11.1 General Description**

The audio part of the ASIC can be used with stereo single ended and with mono differential outputs. Both paths can be seen completely independent. It is possible to use different signals for mono and stereo in parallel. The following operating modes need to be supported:

1. Supply the speaker in the phone with audio signals including the possibility of hands-free and anti-pop switch on and off via the audio mono amplifier.
2. Supply of the headset with mono differential signals with audio performance via the audio stereo amplifier.
3. Supply the speaker in the phone with ringing signal.
4. Transfer a key click, generated in digital part to the speaker.
5. Fast start-up with ringer time constant, but with audio multiplexer possibility for stereo and for mono mode.

Both audio amplifiers are adjustable by gain via TWI/SSC register separately.

#### **3.3.10.11.2 Audio Mono Amplifier**

The audio mono mode is done with a differential signal with the speaker as external load. The differential signal allows the maximum power, also in low voltage mode. The supply for the audio mono amplifier is VREGA. Only the last output stage is supplied by the battery.

Both amplifier paths are inverting amplifiers with external AC coupling at the input to compensate input offset. The gain of the amplifier is controllable over the TWI/SSC register separate for each channel in 1.5 dB steps from 21 dB to -54 dB and in 3 dB steps from -54 dB to -75 dB.

The output stage of the amplifiers can drive a low impedance load (8 Ohms) for the hands-free application. To guarantee an 'ANTI-POP' behaviour for switch on and off, a soft start-up with symmetrical ramp-up at each output is implemented.

In Polaris the Mono Amplifier is used only to drive the speaker. The receiver will be driven from the S-GOLD2 to realise a double speaker concept to avoid acoustic shock.

#### **3.3.10.11.3 Audio Stereo Amplifier**

For stereo mode two single ended buffers are used. These buffers will be supplied by the additional regulator with 2.9 V to be more stable against the GSM ripple on the battery voltage. Also the reference voltage for the buffers is generated by a high precision, low noise band-gap reference for better performance.

An external capacitor is needed to filter this reference additionally. The gain steps for the programmable gain amplifier are identical with the mono amplifier. No key-click and ringer needed for the stereo part. Gain can be controlled with the TWI/SSC registers STEREO\_CH1\_AMPLITUDE and STEREO\_CH2\_AMPLITUDE. The connected speaker has an impedance of typical 16 Ohms. To guarantee an ANTI-POP noise a digital start-up is implemented. This will allow a soft start of the VMID and creates a "clean" audio band during the start-up. To eliminate the external coupling capacitor for the speaker, a 3rd amplifier was added. This amplifier creates the virtual ground node for both speakers. Therefore the current capability must be two times of the regular output amplifier. The purpose of this amplifier is to define the DC operating point with no DC current. The gain of the amplifier is controlla-



ble over the TWI register separate for each channel in 1.5 dB steps from 21 dB to -54 dB and in 3 dB steps from -54 dB to -75 dB.

### **3.3.10.12 Ringer Mode**

In ringer mode the ringing signal is transferred directly as audio signal to the speaker. This architecture does not need an additional buzzer. The speaker is controlled with a rectangular signal created supplied by RINGIN pin. Input signal is a digital signal with variable frequency and comes from the S-GOLD2™. The amplitude can be adjusted with the MONO\_RINGER\_AMPLITUDE register values. For start-up a smaller time constant must be used to allow a fast switch on behaviour. Ringing function can be started at any time. If the audio is off, the start-up is done with RINGER time constant. If audio is starting with AUDIO start-up, the time constant is switched to RINGER mode, too. If the audio amplifier is already up and running, the RINGIN is connected to the amplifier and audio signal is muted due to open multiplexer.

### **3.3.10.13 Key-Click Function**

It is possible to program a key-click to accompany each pushing of a key. The key-click is created in digital part as defined in the MONO\_CLICK\_AMPLITUDE and CLICK\_CONTROL registers. A PWM signal with a selectable frequency (1.5, 3.0, 4.5 or 6.0 kHz) is created and can be varied for the pulse width. The start-up is similar to the RINGER function. If the audio is off, the start-up is done with KEYCLICK time constant. If audio is starting with AUDIO start-up, the time constant is switched to KEYCLICK, too. If the audio amplifier is already up and running, the KEYCLICK is connected to the amplifier and audio signal is muted due to open multiplexer.

### **3.3.10.14 Audio Mono Fast**

The audio fast mode is close to standard audio mode. In operating mode, the MONO FAST time constant is dominated by the external coupling capacitor  $C_{inext}$  and the internal input resistance,. The purpose of this mode is to allow an external ringer or key-click signal to be supplied to the mono amplifier via the audio multiplexer. For this mode, the start-up must be faster compared to standard audio mono mode.

### **3.3.10.15 Audio Stereo Fast**

The stereo fast mode is close to standard stereo mode. In operating mode, the STEREO FAST time constant is dominated by the external coupling capacitor  $C_{inext}$  and the internal input resistance. The purpose of this mode is to allow an external ringer or key-click signal to be supplied to the mono amplifier via the audio multiplexer. For this mode, the start-up must be faster compared to standard audio stereo mode.

### **3.3.10.16 Output Audio Multiplexer**

The audio multiplexer will allow switching line inputs or DAC outputs to mono and stereo amplifiers. Line inputs are left open and only connected to SW test points. An inversion of the supplied audio signals can be done. This is necessary to convert the single line signal to a differential signal driving the speaker with the doubled output voltage in a bridge circuit. For this an analogue inverter in the multiplexer makes a phase shift of 180° of one channel. It is possible to do this phase shift also directly by the input signal or by a special function of the DAC.

### **3.3.10.17 Audio ADC and DAC**

#### **3.3.10.17.1 Clock Scheme**

The Power ASIC receives the 26 MHz sine wave signal from the RF part and generates with a shaper and a PLL the 104 MHz master clock for the modulator and DSP.

#### **3.3.10.17.2 Serial Audio I2S Interface**

The audio interface is a bi-directional serial interface. The TX and RX path are independent. The I2S bus is a three-wire connection that handles two time-multiplexed data channels for the DAC and the ADC. The three lines are the clock (CLO), the serial data line (DAO) and the word select line (WAO). The data is transmitted MSB first. The word select line indicates the channel being transmitted.

Since the S-GOLD2™ is I2S master in all cases, and since data is transferred in parallel over both interfaces, the CLO signal and the WAO signal is connected to the same pin on the S-GOLD2™.

#### **3.3.10.17.3 Audio DAC**

For audio signals a 24 bit sigma delta converter with 5 bit feedback is implemented. The digital information is delivered via the I2S interface. To be able to work with all possible operating modes, the sampling frequency can vary from 8 kHz to 48 kHz. In the R65 phones a resolution of 16 bit and sample rates of 8 kHz and 32 kHz are used. The performance of the audio output signal must be guaranteed over the full range the human ear is able to hear. This means for FS=8 kHz the noise at frequencies higher than FS/2 must be suppressed.

#### **3.3.10.17.4 DSP section**

The interpolation filter is organised in 3 sections: the high pass filter (HPF), the low pass filter (LPF) and the high-speed low pass filter (HSLPF). The interpolator and the modulator follow this.

#### **3.3.10.17.5 Audio ADC**

The ADC is able to digitise analogue input signals in stereo with a resolution of 16 bit, with output to the I2S interface. A digital high pass filter is implemented, which can be bypassed. The signal path includes also two amplifier stages with programmable gains. Inverting amplifiers are used to reduce the offset.

### **3.3.10.18 ADC Audio Multiplexer**

The audio multiplexer will allow the switching of each of the different input sources to the mono and stereo output signals and to the ADC. For the ADC the selectable sources are the MIC1 and MIC2 inputs from the internal microphone and MICE1 and MICE2 for the external microphone. Also the line inputs LINE 1 and LINE2 can be switched to the ADC. For the speaker and the headset the input can come either from the line inputs or from the DAC1 and DAC2. Additionally, a conversion from mono single ended to differential signals can be done. For this a selectable inverter is integrated.

### **3.3.10.19 TWI Interface**

The TWI interface is an I2C-compatible two-wire interface with an additional interrupt pin to inform the S-GOLD2™ about special conditions. The TWI bus interface is configured as a slave unit with 1bit int(), 1bit SDA(serial data) and 1bit SCL (serial clock). The data and the address of the register files are defined including read/write bit, control status bits and the data bits shown on the next pages. The TWI interface is asynchronous to the internal clock. The TWI bus is enabled at RESET\_N = HIGH and disabled when the RESET\_N becomes LOW for all standard registers. The interrupt function is active after the first read-out of both status registers. If an event occurs before the S-GOLD2™ reads out the status registers, this event will set the dedicated bit, but doesn't set the I2C\_INT signal. Afterwards the

two status registers will be handled separately. Therefore it is recommended to do a read-out for both status registers after the S-GOLD2™ initialised itself. If more than one interrupt event occurs before the S-GOLD2™ read out the status register, only the current status at interrupt generation and the newest status after read-out will be detected.

### 3.3.10.20 SSC Interface

The SSC interface enables high-speed synchronous data transfer between the S-GOLD2™ and the PMU registers.

SCLK – Serial Clock Signal: As the SSC interface is configured as a slave only; this is an input pin to the SSC.

MTSR – Master Transmit Slave Receive: As the device operates as a slave this is an input pin.

MRST – Master Receive Slave Transmit: This is an output of the PMU used to transfer data to S-GOLD2™ MRST input.

/SSCSSEL – SSC Select, active low: This is an input to the PMU and is generated by the S-GOLD2™ that it is controlling the PMU. When this signal is held low, data communication is enabled.

### 3.3.10.21 Digital Input Signals

Input Signals						
Name	Sym	Type		Min.	Max.	Unit
RINGIN	VIL	VMEM REG1 level + PD	Permanent Pull down 50..500kOhm	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
CHARGE_UC	VIL	VMEM REG1 level + PD	Permanent Pull down 50..500kOhm	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
RF2_EN, RF3_EN WDOG	VIL	VMEM REG1 level + PD	Pull down 50..500kOhm from battery insertion until first WDOG edge occurs	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
SLEEP1_N *)	VIL	VMEM REG1 level + PU (connected to REG3)	Pull up 25..250kOhm from Power-On until first WDOG edge occurs	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
SLEEP2_N	VIL	VMEM REG1 level + PD	Permanent pull down 50..500kOhm	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
TWI_DATA (I)	VIL	external pull-up	Open Drain with external Pull-up resistor (3.3k .. 100kOhm Ext.)	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
TWI_CLK	VIL	VLPREG level		-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V
TWI_INT_CTRL	VIL			-0.3	$0.3 \cdot V_{\text{LPREG}}$	V
	VIH			$0.7 \cdot V_{\text{LPREG}}$	VBAT+0.3	
	VIH			$0.7 \cdot V_{\text{MEM REG1}}$	VBAT+0.3	
ON_OFF	VIL	LPREG level		-0.3	$0.3 \cdot V_{\text{LPREG}}$	V
	VIH			$0.7 \cdot V_{\text{LPREG}}$	$V_{\text{LPREG}} + 0.3$	
ON_OFF2	VIL	VLPREG level + PD	Permanent Pull down with 50..500kOhm	-0.3	$0.3 \cdot V_{\text{LPREG}}$	V
	VIH			$0.7 \cdot V_{\text{LPREG}}$	VBAT+0.3	
SSC (CLOCK, DATA)	VIL	VMEM REG1 level + PD	Pull down 50..500kOhm from battery insertion until first WDOG edge occurs	-0.3	$0.3 \cdot V_{\text{MEM REG1}}$	V

Input Signals						
	VIH			$0.7 \cdot V_{MEM\ REG1}$	VBAT+0.3	
SSC (CHIPSELECT*)	VIL	VMEM REG1 level + PU (connected to REG3)	Pull up 25..250kOhm from Power-On until first WDOG edge occurs	-0.3	$0.3 \cdot V_{MEM\ REG1}$	V
	VIH			$0.7 \cdot V_{MEM\ REG1}$	VBAT+0.3	
CLO DAO WAO	VIL	VMEM REG1 level + PD	Pull down 50..500kOhm from battery insertion until first WDOG edge occurs	-0.3	$0.3 \cdot V_{MEM\ REG1}$	V
	VIH			$0.7 \cdot V_{MEM\ REG1}$	VBAT+0.3	

### 3.3.10.22 Digital Output Signals

Output Signals						
Name	Sym	Type		Min.	Max.	Unit
TWI_INT	VOL	-IO<100μA			0.2	V
	VOH	+IO<100μA		V <sub>LPREG</sub> −0.2	V <sub>LPREG</sub>	
TWI_DATA (O)	VOL	-IO<1.4mA	Open Drain with external Pull-up resistor (3.3k .. 100kOhm Ext.), max. level is VBAT		0.2	
	VOH					
RESET_N	VOL	-IO<100μA	Low level guaranteed without VLPREG voltage		0.2	V
	VOH	+IO<100μA		V <sub>LPREG</sub> −0.2	V <sub>LPREG</sub>	
RESET2_N Default: Open drain	VOL	-IO<100μA	Low level guaranteed without VMEM REG1 voltage, should be tolerant to VBAT		0.2	V
	VOH	+IO<100μA		V <sub>MEM REG1</sub> −0.2 (**)	V <sub>MEM REG1</sub> (**)	
POWER_ON	VOL	-IO<80μA			0.18	V
		-IO<500μA			0.4	V
	VOH	-IO<500μA		V <sub>VDDREF</sub> − 0.5	V <sub>VDDREF</sub>	V
OUTPORT	VOL	ANALOG OUT	Low level guaranteed without REG1, REG2 and REG3 and MEM REG1 voltage			V
	VOH	ANALOG OUT				
SSC (DATA) Default VREG3 can be changed to VMEM REG1 by metal mask change	VOL	-IO<100μA	Low level guaranteed without VREG3 voltage		0.2	V
	VOH	+IO<100μA		V <sub>REG3</sub> −0.2	V <sub>REG3</sub>	
CLO DAO WAO Default VREG3 can be changed to VMEM REG1 by metal mask change	VOL	-IO<100μA	Low level guaranteed without VREG3 voltage, should be tolerant to VDD_REF		0.2	V
	VOH	+IO<100μA		V <sub>REG3</sub> −0.2	V <sub>REG3</sub>	

Output Signals						
ON_OFF_OUT	VOL	-IO<500μA	Open drain: Pull up in BB against LPREG , should be tolerant to VDD_REF		0.2	
	VOH					

**3.3.10.23 Control Signals**

Pin	Min.	Max.	Unit	Port
TBATT	0,85	VREG1	V	input
VSIM1CTRL	0	2.9 +/- 2%	V	output
VSIM2CTRL	0	2.9 +/- 2%	V	output
LED1	0	2.9 +/- 2%	V	output
LED2	0	2.9 +/- 2%	V	output
LIGHT_PWM1	0	VBATT *	V	output
LIGHT_PWM2	0	VBATT *	V	output
OUTPORT	0	REG1, REG2, REG3 each with +/- 2%	V	output

\*Note: The voltage can increase to a maximum of 6.0 Volts across Pin LIGHT\_PWMx, if the battery is removed while charging.

**3.3.10.24 Charging Circuit**

The charge voltage is detected by the signal VDD\_CHARGE. A 100Ohms resistor R1353 is inserted between POWER and VDD\_CHARGE. The purpose is to limit the current in case the polarity of the charge voltage is inverted by accident.

The DUAL-MOSFET for charging is controlled by the Power-ASIC via the CHARGE\_CNTRL signal. The charge FET is either off, fully conducting or current controlled. See the Power-ASIC specification for further details. R1344 is a current sense resistor and the voltage drop is fed into the Power-ASIC for current control and current supervision.

The phone can also supply external accessories from the battery via the charge circuit. In this case the MOSFET is fully on and the battery voltage appears at POWER pin of the accessory connector.

**3.3.10.25 Battery**

A Li-Ion Battery with a typical capacity<sup>8</sup> of 690 mAh @ 0.2 C (at relevant time frame) will be used. Under GSM-discharge conditions<sup>9</sup> the battery will provide a discharge typical capacity of 660 mAh @ GSM.

An internal safety circuit prevents from over-charging, over-discharging and over-current.

The different batteries (suppliers) will be encoded by different resistors within the battery pack itself.

**3.3.10.26 Charging****3.3.10.26.1 General**

The battery is charged in the phone. The hardware and software is designed for Lilon with 4.2 V technology. Charging is started as soon as the phone is connected to an external charger. If the phone is not switched on, then charging shall take place in the background (the customer can see this via the 'Charge' symbol in the display). During normal use the phone is being charged. Charging is enabled via a PMOS switch in the phone. This PMOS switch closes the circuit for the external charger to the battery. The processor takes over the control of this switch depending on the charge level of the battery, whereby a disable function in the PMU hardware can override/interrupt the charging in the case of over voltage of the battery.

For controlling the charging process it is necessary to measure the ambient (phone) temperature and the battery voltage. The temperature sensor will be an NTC resistor with a nominal resistance of 22

<sup>8</sup> Battery will be discharged with 140mA, down to a voltage of 3.0V

<sup>9</sup> Battery will be discharged with 2A (0.6 ms) + 0.25A (0.4 ms) down to 3.1V

k $\Omega$  at 25°C. The determination of the temperature is achieved via a voltage measurement on a voltage divider in which one component is the NTC. Charging is ongoing as long the temperature is within the range +5°C to 45°C. The maximal charge time will be 2 hours ( $I_{\max} = 750\text{mA}$ ).

### **3.3.10.26.2 Measurement of Battery voltage, Battery Type and Ambient Temperature**

Measurement of Battery voltage, Battery Type and Ambient Temperature is done with an Analog to Digital Converter in S-GOLD2.

### **3.3.10.26.3 Timing of the Battery Voltage Measurement**

In GSM talk mode the battery voltage is measured inside and outside (shortly before) the TX burst, otherwise it is measured outside TX slot only.

### **3.3.10.26.4 Recognition of the Battery Type**

The different batteries will be encoded by different resistors within the battery pack itself. The final values of the resistors will be fixed after M1.

### **3.3.10.26.5 Charging Characteristic of Lithium-Ion Cells**

Li-Ion batteries are charged with a U/I characteristic, i.e. below the maximum voltage (4.2 V) the current shall be constant, after reaching the maximum voltage the average charging current has to be decreased in order to keep the unloaded voltage constant (4.2 V). The maximum charging current is given by the connected charger. The battery voltage must not exceed 4.2 V (@no current). During the charging pulse the voltage may reach 4.3 V. The temperature range in which charging of the phone may be performed is from 0...50°C. Outside this range no charging takes place, the battery only supplies current.

### **3.3.10.26.6 Trickle Charging**

The PMU is able to charge the battery at voltages below 3.2 V without any support from the charge SW. The current will be measured indirectly via the voltage drop over a shunt resistor and linearly regulated inside the PMU by means of the external FET. The current level during trickle charge for voltages <2.8 V is in a range of 20-50 mA and in a range of 50-100 mA for voltages up to 3.2 V. To limit the power dissipation of the dual charge FET the trickle charging is stopped in case the output voltage of the charger exceeds 10 Volt. The maximum trickle time is limited to 1 hour. As soon as the battery voltage reaches 3.2 V the PMU will switch on the phone automatically and normal charging will be initiated by software.

### **3.3.10.26.7 Normal Charging (Rapid charge)**

For battery voltages above 3.2 Volt and normal ambient temperature between 0 and 50°C (for start of charge a reduced range from 5°C to 45°C is applied) the battery can be charged with a charge current up to 1C. This charging mode is SW controlled and starts if an accessory (charger) is detected with a supply voltage above 6.4 Volt by the PMU ASIC. The level of charge current is only limited by the charger. When the maximum voltage of 4.2 V with continuous current is reached the duty cycle is reduced in a way that a small pause is generated. During the pause the unloaded voltage is measured and is kept constant to 4.2 V. This is achieved by reducing the duty cycle correspondingly until the end of charge criteria is reached.

### **3.3.10.26.8 USB Charging**

The PMU supports USB charging. If charge voltage is in the range 4.4 V to 5.25 V USB charging is ongoing. During USB charging only limited charging is possible. Charge current is limited to 400 mA for the main charging period. For top off charging the current level is reduced in 2 steps (300 mA, 150 mA).

### **3.3.11 Interfaces**

#### **3.3.11.1 Main Board – MMI Board**

Refer to chapter 3.3.5.

#### **3.3.11.2 Interface to SIM Module**

Refer to chapter 3.3.6.

#### **3.3.11.3 Interface Vibra**

Refer to chapter 3.3.8.

#### **3.3.11.4 Interface Speaker Module**

Refer to chapter 3.3.9.

#### **3.3.11.5 Interface Receiver**

Refer to chapter 3.3.9.

#### **3.3.11.6 Interface Microphone**

Refer to chapter 3.3.9.

#### **3.3.11.7 Interface Battery Module**

Refer to chapter 3.3.10.25.

#### **3.3.11.8 Interface Radio Control**

Refer to chapter 3.1.7.

#### **3.3.11.9 Accessory Interface**

All details are specified in the Hardware Interface Specification [8].

The IO-Connector for the X85 Platform is the 12 pins 'Nano IO Connector'. It is a new connector compared to the predecessor platforms. Generally the following functions will be supported by the X85 Platform:

- Mono / Stereo analogue output
- Mono analogue input (microphone)
- Asynchronous serial interface RS232



- USB (slave mode), incl. charging
- Charging

Via the accessory interface the available accessories like chargers, boot-boxes, headsets, data cables and car kits can be attached to the phone.

### 3.3.12 Power Supply Unit

For the Power Supply Unit is used a Standard Charger (Single Range) and a Travel Charger (Wide Range) with Nano I/O plug and new V/I curve see the following figure:

SR, Output VI-Envelope

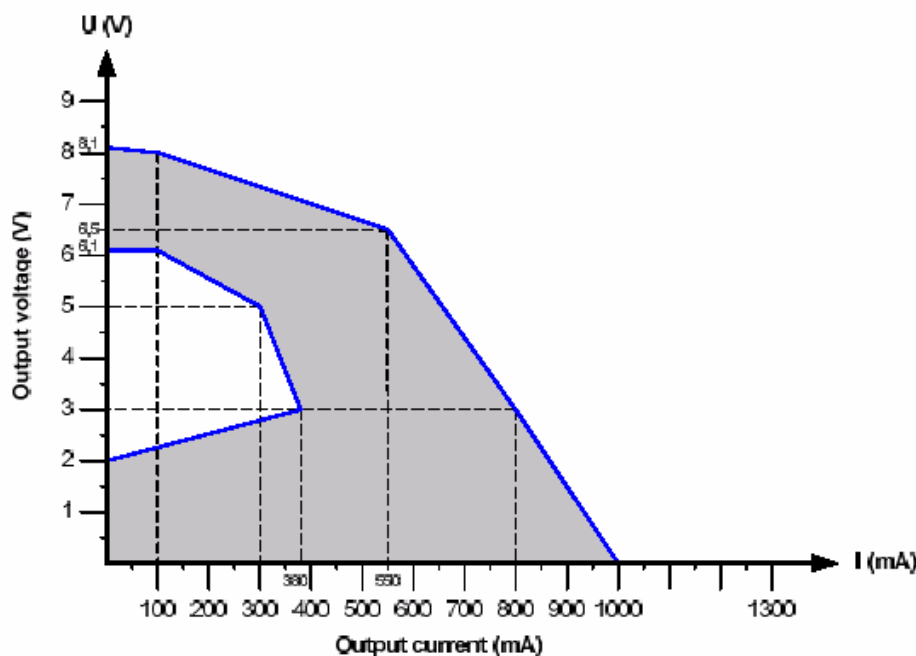


Figure 19 – V/I curve

The power supply consists of a switch mode power supply.

Single Range means that it can handle an input voltage of 120 V<sub>AC</sub> or 230 V<sub>AC</sub> but not both at the same time. The charge current of the single range charger has a nominal value of 420 mA at 5 V. The SAP Numbers and the variant for the charger are listed in [Figure 20 – SAP Numbers of SR X85 Charger].

The Wide Range means that the same Standard charger can handle any input voltage from 90 V<sub>AC</sub> to 264 V<sub>AC</sub>. The SAP Numbers and the variant for the charger are listed in Figure 21 – SAP Numbers of WR X85 Charger. The wide range charger has a nominal value of 620 mA at 5 V.

#### 3.3.12.1 Country Variations (for single range charger)

In order to cover all the countries planned, the following variations are necessary:

- Europe 230 V<sub>AC</sub> nom. /50Hz
- UK 240 V<sub>AC</sub> nom. /50Hz

- Australia 240 V<sub>AC</sub> nom. /50Hz
- US/Taiwan 120 V<sub>AC</sub> nom. /60Hz
- China 220 V<sub>AC</sub> nom. /50Hz
- Argentina 220 V<sub>AC</sub> nom. /50Hz

**Part numbers**

Each supplier will use different part numbers. So please refer to your specific table.

Table 1. Part numbers valid for supplier 1: FRIWO

Variant	SAP number / Stock-material-number	Supplier specific part number	Siemens Internal part number	Valid spec. revision	Remarks
EU	A5B00075532638	A5BHTN00180689	C39280-Z4-C540-1		
UK	A5B00075532639	A5BHTN00180748	C39280-Z4-C541-1		
Australia	A5B00075532640	A5BHTN00180750	C39280-Z4-C542-1		
US/ Taiwan	A5B00075532641	A5BHTN00180771	C39280-Z4-C543-1		
China	A5B00075532732	A5BHTN00180762	C39280-Z4-C544-1		
Brazil					

Table 2. Part numbers valid for supplier 2: ASTEC

Variant	SAP number / Stock-material-number	Supplier specific part number	Siemens Internal part number	Valid spec. revision	Remarks
EU	A5B00075532638	A5BHTN00180690	C39280-Z4-C540-1		
UK	A5B00075532639	A5BHTN00180749	C39280-Z4-C541-1		
Australia	A5B00075532640	A5BHTN00180761	C39280-Z4-C542-1		
US/ Taiwan	A5B00075532641	A5BHTN00180772	C39280-Z4-C543-1		
China	A5B00075532732	A5BHTN00180763	C39280-Z4-C544-1		
Brazil					

**Figure 20 – SAP Numbers of SR X85 Charger**

### 3.3.12.2 Country Variations (for wide range charger)

In order to cover all the countries planned, the following variations are necessary:

- Europe 90 → 264 V<sub>AC</sub> 50/60Hz
- UK 90 → 264 V<sub>AC</sub> 50/60Hz
- Australia 90 → 264 V<sub>AC</sub> 50/60Hz<sup>10</sup>
- US/Taiwan 90 → 264 V<sub>AC</sub> 50/60Hz
- China 90 → 264 V<sub>AC</sub> 50/60Hz
- Brazil 90 → 264 V<sub>AC</sub> 50/60Hz

Table 1. Part numbers valid for supplier 1: FRIWO

Variant	SAP number / Stock-material-number	Supplier specific part number	Siemens Internal part number	Valid spec. revision	Remarks
EU	A5B00075532379	A5BHTN00180740	C39280-Z4-C530-1		
UK	A5B00075532395	A5BHTN00180742	C39280-Z4-C531-1		
Australia	A5B00075532473	A5BHTN00180679	C39280-Z4-C532-1		
US/ Taiwan	A5B00075532474	A5BHTN00180751	C39280-Z4-C533-1		
China	A5B00075532475	A5BHTN00180744	C39280-Z4-C534-1		
Brazil	A5B00075532493	A5BHTN00180746	C39280-Z4-C535-1		

Table 2. Part numbers valid for supplier 2: ASTEC

Variant	SAP number / Stock-material-number	Supplier specific part number	Siemens Internal part number	Valid spec. revision	Remarks
EU	A5B00075532379	A5BHTN00180741	C39280-Z4-C530-1		
UK	A5B00075532395	A5BHTN00180743	C39280-Z4-C531-1		
Australia	A5B00075532473	A5BHTN00180680	C39280-Z4-C532-1		
US/ Taiwan	A5B00075532474	A5BHTN00180752	C39280-Z4-C533-1		
China	A5B00075532475	A5BHTN00180745	C39280-Z4-C534-1		
Brazil	A5B00075532493	A5BHTN00180747	C39280-Z4-C535-1		

Figure 21 – SAP Numbers of WR X85 Charger

<sup>10</sup> Not needed for Polaris

**3.3.12.3 Housing, Size and Weight of Power Supply Unit**

Single range charger			Wide range charger		
Manufacturer	Size (w x l x h)	Weight	Manufacturer	Size (w x l x h)	Weight
ASTEC	58 x 27 x 17 mm	~ 55 g	ASTEC	58 x 28 x 26 mm	~ 65 g
FRIWO	57 x 28 x 18 mm	~ 55 g	FRIWO	61 x 28 x 21 mm	~ 58 g
Delta	60 x 22 x 19 mm	~ 55 g	Delta	67 x 28 x 22 mm	~ 59 g
			Salcomp	62 x 27 x 22 mm	~ 61 g

All data have been measured with EU plug and cable. The plug itself is not included in the dimension.  
The color will be dark grey.

**3.3.12.4 Connection Lead**

The connection lead will have two wires (strands).

The cross-section of the leads shall be for power and GND: AWG26 or AWG30.

The length of the leads shall be nominally 1.8 m.

The plug-in connection is the 12-pole Nano-IO plug. For the power supply unit, only 2 poles will be occupied.

**3.3.12.5 Electrical Concept**

The power supply consists of a switch mode, which is configured as a current source. The power supply is internally regulated so that input voltage and temperature variations have a minimal impact on the output. The output current is dependent on the output voltage but the highest current is available at an output voltage from 3 to 5 V.

The charge regulation is controlled by a voltage measurement and a MOSFET switch inside the phone. The current from the power supply is transferred directly to the battery via the switch until the battery is almost full. The remaining portion of the capacity is charged by a dedicated pulse charge system, where the switch in the phone is opened and closed.

### 3.3.13 PCB

The Polaris has following layer build up, assembly and part-list of the printed circuit boards (PCBs). The PCBs are a main board with 6 Layer HDI (FR4 core) and a MMI Board with 2 layer and Single-sided population. The main board has a double sided population.

#### 3.3.13.1 Main PCB

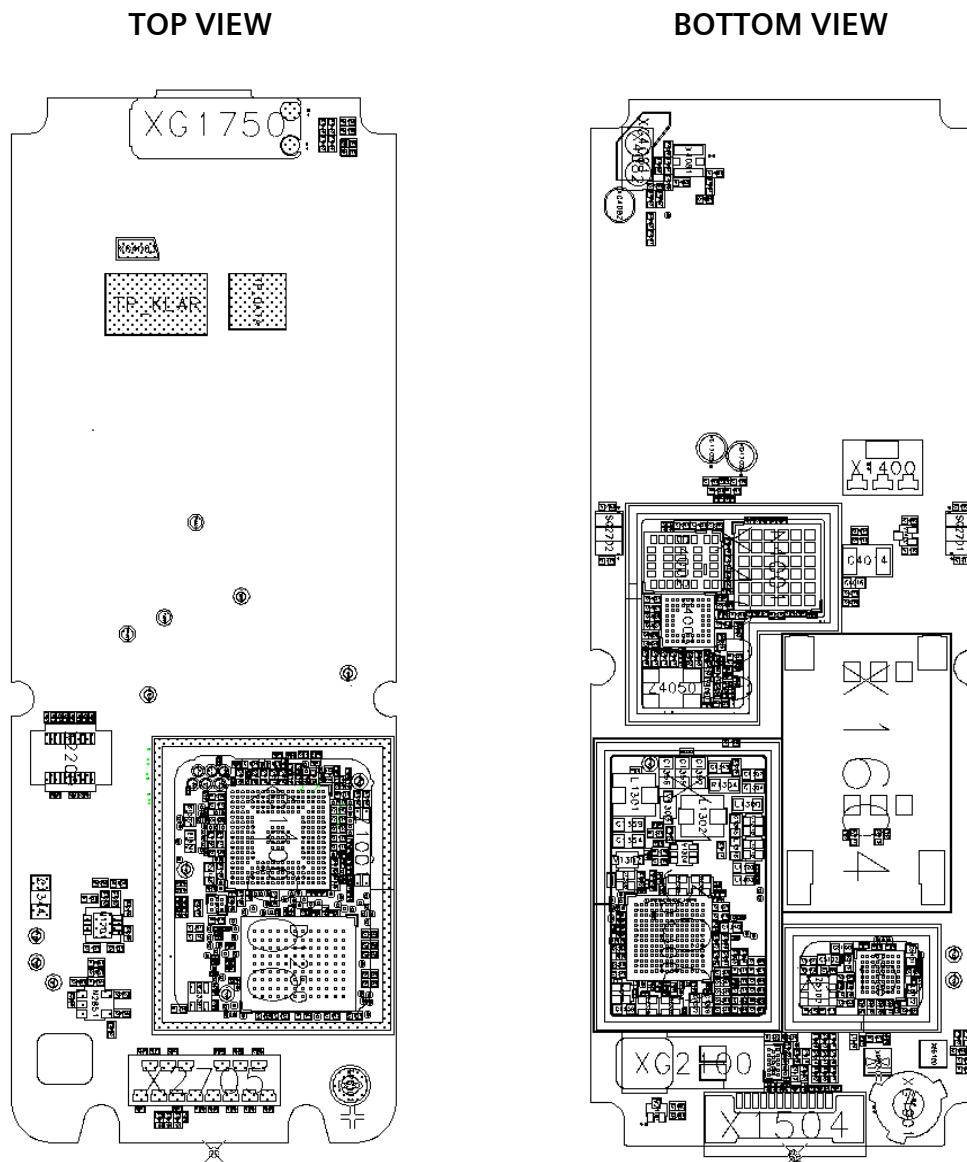


Figure 22 – Main PCB Assembly Top- and Bottom-Side

**3.3.13.2 Part list of Main Board**

Subitem	Component no.	Object description	# Mentor component value	# Package
	A5B00900176214	PCB/POLARIS/A1-LAYOUT		
D1000	A5B00075436336	ICTELEC PMB8876V2.1J11 LF2BGA293 SGOLD2	PMB8876-V2.1	SGLF2BGA293
D1250	A5B00075415970	IC FLASH 2*256MB/SDRAM 128MB TOP/BOT LF	PF38F4460LVYTB0	SCSP103
D1300	A5B00075380609	IC ASIC D1094ED-MOZART+/TWIGO4+AA BGA196	MOZART+/TWIGO4+	BGA196
D4002	A5B00075205205	IC FEM HITACHI TRIPLE-BAND EU-VERSION	HWXQ521	SMD
D4003	A5B00075361816	IC TELEC HD155165BP BGA57 LEADFREE	HD155165BP-LF	BGA57
D5100	A5B00075152653	IC TELEC BRF6150 BGA63 LEADFREE	BRF6150	BGA
N4001	A5B00075200770	IC MODUL PA PF08143B SMD	PF08143B	SMD
V1302	A5B00075001429	DISDIODE SCHOTTKY BARRIER SOD323	BAT760	SOD323
V1303	A5B00075001429	DISDIODE SCHOTTKY BARRIER SOD323	BAT760	SOD323
V1304	A5B00075015190	DIS TRANS N-CH MOSFET FDG313N SC70-6	FDG313N	SC70-6
V1305	A5B00026021763	DISTRANSSI5933/V20830-C1107-D670	SI5933DC	1206-8 CHIPFET
V1400	A5B00075365936	DISDIODE BAV99T SC-75	BAV99T	SC-75
V2100	A5B00075275865	DISDIODE DUAL-SCHOTTKY RB548W EMD3	RB548W	SMT
V2302	A5B00026017902	DISTRANSBC847BS/BC846S	BC846S	SOT363
V2801	A5B00075159214	DIS TRANS FET2 N-CHANNEL SWITCH SC70-6	SI1902DL	SC70-6
V4050	A5B00026020014	DISDIODE1SV305/V20840-D61-D670	1SV305	SCD-80
X1000	A5B00075521035	DME SHIELDING BB TOP 85 POLARIS	SR-POLARIS-FCS-BB-TOP	
X1300	A5B00075521037	DME SHIELDING BB BOTTOM 85 POLARIS	SR-POLARIS-FCS-BB	
X1400	A5B00075536067	CONNECTOR/BATTERY 3-POL/X85	BC-X85-POLARIS	SMT
X1504	A5B00075411792	IO-JACK/12-POL/0,8MM/H=2,0MM/SMD/NANO	Nano_IO_LUMBERG	SMT
X1604	A5B00075371286	CONNECTOR/SIM CARD READER/X75	SCR-X75	SMT
X2201	A5B00075008340	BOARD TO BOARD/20-POL/0,5MM/SMD/MALE	20-POL.	SMT
X2705	A5B00075238693	CONNECTOR BOARD TO BOARD 14-POL. X75	14-POL	SMT
X4000	A5B00075342391	DME SHIELDING RF X75 FISHCAN	SR-RF-X75-FC	
X4081	A5B00075102160	CONNECTOR COAX SOCKET SWITCHED SMD	COAX_SOCKET	SMT
X4085	A5B00075446186	CONNECTOR/POGOPIN/1-POL/VIRGO/TAURUS	Con_Pogopin	SMT
X4086	A5B00075446186	CONNECTOR/POGOPIN/1-POL/VIRGO/TAURUS	Con_Pogopin	SMT
X5100	A5B00075508457	DME SHIELDING BT COMPLETE POLARIS	SR-BT-COMPL	
Z1001	A5B00075390114	OSCCRYST 32,768KHZ 12,5PF 30PPM SMD LF	32.768KHZ	SMD
Z1501	A5B00075277428	FILEMI EMIF05-MUX01F2 CSP17 LEADFREE	EMIF05MUX	CSP17
Z1601	A5B00075094021	FILEMI SIM PROTECTION CSP8 LEADFREE	IP4044CX8_LF	CSP8
Z4050	A5B00027011829	OSCCRYSTNX5032/V30145-F260-Y17	26.0MHZ	NX5032SA
Z5100	A5B00075370883	FIL BP 2450MHZ SMD	BP-Filter_2450MHz	SMD

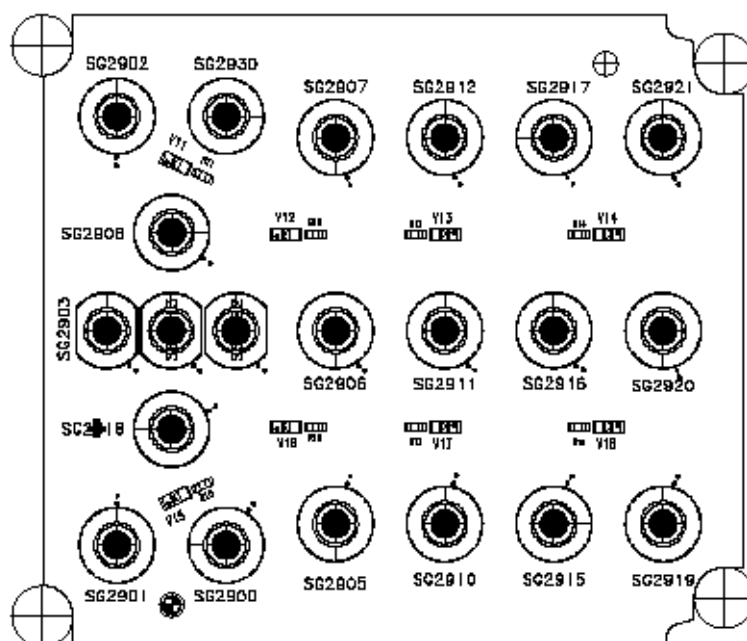
3.3.13.3 MMI PCB

Figure 23 – MMI PCB Assembly Top- Side

3.3.13.4 Part list of MMI

Subitem	Component no.	Object description	# Mentor component value	Subtext 1
	A5B00900179116	MMI SPACER/POLARIS		
	A5B00075082565	PC/ABS CYCOLOY C1200HF GY7A119 SILVER		
	A5B00900176629	PCB-MMI/POLARIS A1 LAYOUT		
R11	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R12	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R13	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R14	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R15	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R16	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R17	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
R18	A5B00026475524	RES0402KS68R0F/V24852-C680-F2	68R	2SMD
V11	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V12	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V13	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V14	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V15	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V16	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V17	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC
V18	A5B00075402031	DISOPT FLATLED WHITE 0603 (0.4MM HEIGHT)	19-217_UWD_S365_TR8	2SMD LOGIC

More details of the layer build up see in [14].

### 3.4 EMC/ Antenna

#### 3.4.1 EMC

##### 3.4.1.1 Introduction

To reduce EMC components on the PCB and to increase manufacturing capacity all EMC components which may not be needed are left empty at the beginning. Via correspondingly intensive measurements in the EMC chamber we will attempt to calculate the minimally required number of EMC capacitors. We assume, that the necessary chambers, equipment, software, time and staff will be available for this in good time and in sufficient quantities.

##### 3.4.1.2 ESD

The conductive aluminium front cover will be a main part of ESD protection of Display, Keypad, and etc. Therefore a proper conductive contact from the Upper case to the PCB's GND has to be guaranteed. Because of no additional mechanical Part between the Battery and the PCB it will be possible to access the electrical components. The metallic caps over the keys can influence the ESD behaviour of the phone this has to be investigated during development.

##### 3.4.1.3 SIM

The SIM contacts will possibly be open, so that – as in former projects – contact de-charging with 8 kV (internal limit) could lead to the destruction of the S-GOLD2. A limit of 5 kV seems to be reachable and fulfils the CE limit. It takes an excessive amount of ESD actions to reach the target of 8 kV while 5 kV can be reached much easier. In this way a possible solution to the ESD problem can probably be found within the framework of CE, but not for the internal requirement of 8 kV.

##### 3.4.1.4 Keypad

The Keypad for the Polaris is a standard silicone carrier with metallic keypad caps. These caps are floated conductive parts. Non grounded metallic parts can have an influence on EMC behaviour of the complete phone during the whole development phase also on SW points of view.

##### 3.4.1.5 Display

The Display is covered by the aluminium Upper case and a plastic display lens. To protect the display towards ESD it is necessary to have a sufficient ground connection between the cover and the main PCB. The resistance between PCB and cover have to be below 1 Ohm. To reduce the influence of the Display signals on the receiver an amount of filter components at the display interface signals are foreseen.

##### 3.4.1.6 Aluminium Upper Case

The metallic upper case highly influences the EMC/ESD and Antenna/SAR behaviour of the Polaris. Therefore it is necessary to have sufficient ground connections from the metallic cover to the main PCB. These connections have to be placed at defined positions. The contact resistance of each contact point have to be below 1 Ohm also over ageing processes.



### 3.4.1.7 Electromagnetic Compatibility

According to General Quality Requirements, Rev. 3.0, 2001-10-08, Part 4 EMC.

The thresholds and test procedures set out in EN 301 489 shall apply. Please note that the EMC Test Plan applies for all tests.

**The internal block must meet the minimum requirements stipulated in EN 301 489.**

The device must be in compliance with the limiting values set for human exposure to RF waves (SAR values = specific absorption rate) as stipulated in the draft versions of the standards ENV 50166-2 and DIN VDE 0848, Part 2. Measurements are to be carried out in accordance with the requirements set out in the CENELEC draft:

Comité Européen de Normalisation Electrotechnique, SC211/B, WGMTE: Safety considerations for human exposure to EMF from MTE in the frequency range 30 MHz to 6 GHz, second draft, Rome, Feb. 1996, third draft, Zurich, April 1996.

The limits stipulated in ANSI C95.1 have to be met as well. The measurements are described in the Supplement C (Edition 01-01) to OET-Bulletin 65 (Edition 97-01) from FCC.

### 3.4.1.8 General

It must be noted in the Manual that the Device has to be switched off, before the Battery Cover is disassembled.

## 3.4.2 Antenna

The antenna concept is based on same punch bending concept as Neo (PIFA antenna). It will be mounted between the plastic of the lower case and the plastic of the rear-cover.

For a sufficient antenna performance and a low SAR value it is essential that 6 grounding contacts between the metallic upper case and the main PCB are placed at certain points. Any deviation in placing of this contacts can cause suffering antenna performance and higher SAR values. The contact resistance of each contact have to be smaller than 1 Ohm.

### 3.4.2.1 Performance

With the Polaris the antenna is integrated in the mobile. It is mounted on the lower mounting frame. It is covered by the battery cover and will be visible and touchable if the battery cover is disassembled. The Antenna will be a triple band antenna.

Two Bands GSM900 and GSM1800 will fulfil FBT requirements. The third Band PCS1900 only fulfils 70% of the FBT requirements.

Band	Performance Requirements [dBm]					
	TX Low	TX Mid	TX high	RX low	RX mid	RX high
EGSM	≥28	≥28	≥28	<-101	<-101	<-101
PCN	≥25	≥25	≥25	<-101	<-101	<-101
PCS	≥25 <sup>11</sup>	≥ 25	≥ 25	<-101	<-101	<-101

To reach the FBT requirements it is necessary to have a conducted output power of at least 29.25 dBm.

<sup>11</sup> Violating Siemens internal FBT Requirements for 30% of all channels

**NOTE:**

The FBT requirements are: (minimum per channel):

	TX	RX
<b>EGSM</b>	28 dBm	-101 dBm
<b>PCN</b>	25 dBm	-101 dBm
<b>PCS</b>	25 dBm	-101 dBm

**3.4.2.2 SAR**

**Target: SAR value of 0.8 W/kg (1 g).** A final confirmation can only be given after B2 Prototype Build.

But for Data Transfer Mode the Handset Device may be held on close to the head with 2 TX radiating. A value less than 0.8 W/kg is not possible in this certain case.

The International SAR value limits as shown in the table below will be satisfied anyway.

Limit	Head/ Body worn	Based on Standard	Countries
1.6 W/kg (1 g)	Head	IEEE	Canada, S. Korea, Taiwan, USA
1.6 W/kg (1 g)	Body worn	IEEE	Canada, Taiwan, USA
2.0 W/kg (10 g)	Head	ICNIRP	EMEA, APAC
2.0 W/kg (10 g)	Head, Body Worn	IEEE	Australia

**NOTE:**

The new Siemens guideline for body-worn requirements has to be applied. For actual version of SAR Body Worn guideline please contact responsible persons.

**3.4.3 Bluetooth Antenna**

The Bluetooth-Antenna will be a PIFA type punch bending part with two contacts (ground + feeding). It will be mounted in the lower case. Because of low distance to the Lumberg connector and the Trembler the antenna will not have an omni directional radiation characteristic. The variations of position and tolerances of the Trembler can cause range variations. The minimum range requirement from BT-spec is 10 m.

## 4 Software

### 4.1 Software Feature List

All SW features are described in the X75/85 SW Feature List [\[9\]](#).

### 4.2 Requirements to SW

This paragraph refers to those requirements, which all involved parties in the phone development pose to the software department, e.g. software for RF adjustment. The scope is not on the software-related features for the customer.

For the current X75/85 ReqToSwList please refer to [\[11\]](#). This ReqToSwList was frozen and will be reviewed in the next days.

### 4.3 Customisation

Based on a variant specification from the customer (Operator), R&D will create the required initialization files for the different operator variants. This is necessary because of the complexity of these variants. They have to be tested by the system test group and CCQ (field test).

Standard customer variants will support only a limited functionality concerning the customization. This does not include the customer specific initialization of the Flex Menu Tree, Skins, Themes and certificates (i.e. not included in customization guide). A customer may request a more complex customization variant which cannot be handled based on the standard customization guide. Those variants can be supported but the time schedule and the availability of resources has to be agreed with R&D and all parties involved for each variant individually.

At release date of the document, Polaris has not been short-listed with any operator.

## 5 Accessories

### 5.1 General

Several accessories are provided for the launch of Polaris and to ease customers use:

### 5.2 Portfolio

Original Accessories – Portfolio All Regions					launch 02/06
For Mobile Phone: POLARIS					(Bar, SG2, Nano I/O in central position)
Fashion & Carry	Energy	Handsfree Portable	Car Solutions	Multi-tainment	Office
Leather Case FCL-720	Li-Ion Battery 690 mAh	Headset Basic HHS-100	Passive Holder Universal 2)		Data Cable serial DCA-100
	Travel Charger EU/UK ETC-100/110	Headset HHS-110	Car Kit Portable HKP-100		Data Cable USB DCA-140
	Car Charger Plus ECC-100	Headset Purestyle HHS-120 1)	Car Kit Bluetooth Portable Low 1)		Sync Station DSC-100
	DeskTop Stand EDS-100	Headset Bluetooth BASIC 1)	Car Kit Bluetooth® Portable HKW-700		
		Headset Bluetooth PREMIUM 1)	Car Kit Bluetooth® HKW-710		
		Headset Bluetooth CLIP	Car Kit Bluetooth® SIM HKW-720 1)		
		Headset Bluetooth HHB-700/710			

Products compatible with 65 or 75 series\*  
 Products compatible with 85 series  
 Phone only  
 For bulk only  
 \* Backwards compatible

**Remarks:**

1) New AD product, launch in 02/06

2) New AD product, launch in 01/06

**SIEMENS**

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Figure 24 – Accessory Portfolio

### 5.3 Feature List

Please refer to [9].

### 5.4 Hardware Interface Specification

Please refer to [8]

### 5.5 Software Interface

Please refer to Product Specifications for Accessories [7].

## 5.6 Accessory Bus Description

Please refer to Product Specifications for Accessories [\[7\]](#).

## 5.7 Samples

For combined support of development samples of Accessories on all MD development locations worldwide you find attached the Global 85 AD samples order list. All relevant departments are taken into account and will receive samples according ordered quantities and locations. You will find the availability of the samples on sheet 'Overall sum for AD'. We will ship the samples to the assigned 'single-entry points', i.e.

- Aalborg: Uffe Lind Svejgaard
- Kamp Lintfort: Christian Rexfort
- Manaus: Oliver Zeiler
- München: Herbert Ziegler
- Beijing: Jun Yang Xiao
- San Diego: Joel Rabasco
- Taipei: Christian Hernaut
- Ulm: Peter Schwer

Updates on availability of samples will follow.

The Global 85 AD Samples Order List [\[13\]](#) is available in IMS.

Note, besides the regular new 85 accessories there exist a number of 'old' accessories that will get the new Nano-Lumberg plug.

They are called 'NLA-projects' (Nano-Lumberg-Adaptation). They may be found in this list, too.

## 6 Manufacturing Concept

### 6.1 Overview and general requirements

The production of the Polaris PCBA will be done on the standard SMD production lines for mobile phones with a complete lead-free process (lead-free components and lead free solder paste). Thus, it is absolutely essential to comply with the following design rules and to consider these within the product definition.

Topic: Design Specification for Printed Circuit Boards  
(SAP Doc.-No.: 27867, Rev.: 05)

Author: COM SD TLM MD PT1, Mr. Lars Mittelstädt

Please refer to the document 'Design Specification for Printed Circuit Boards' (Version, 2.5, 22.04.04 [18]).

### 6.2 Modules

The differences of SMT-components from top to bottom side will be compensated by the usage of certain PCB panel comprised of 3 times top/bottom PCBs (6 times mirror panel).

### 6.3 Components Spectrum

#### 6.3.1 SMD – Number of Components and Component-Types (as of 31-03-2005)

Main PCB:

	Number of Components		Number of Component Types	
	Side 1 (Top)	Side 2 (Bottom)	Side 1 (Top)	Side 2 (Bottom)
	104	194	45	93
Sum	298		122	

#### 6.3.2 SMD – Component-Spectrum (as of 31-03-2005)

The smallest passive design form is Chip 0201, the smallest pitch used is 0.5 mm.

8 Components with CSP Housing:

- S-GOLD2 (PMB8876, Pitch 0.5 mm)
- Flash-Memory (512MBit, Intel/STM & opt. AMD, Pitch 0.8 mm)
- Protection circuit SIM-Card Reader (Pitch 0.5 mm)
- BT-Chip (TI)
- PMU ASIC (Mozart+ / Twigo 4+)
- Transceiver IC BRIGHT 6E
- Protection circuit I/O-Connector (EMI-Filter, Pitch 0.5mm)

Components for special SMD-Processing (F-Machines):

- I/O Connector (Nano-I/O)
- SIM-Reader (Hinge-Type)
- Board-to-Flex-Connector (for LCD, 20-pol., Pitch 0.5mm)

- Battery-Connector (front-side contacting)
- RF-Plug (Hirose Test plug)
- 4 shieldings for SMD processing (3pcs. fish-can-technology, 1pcs. prem-can-technology)
- Board-to-Board-Connector (for MMI, 14 pol.)
- Flash-Memory (512MBit)

### 6.3.3 Manual Soldering

No manual soldering planned.

### 6.3.4 Delivered Form of the Components

All SMD-Components have to be delivered in 13" tape and reel. Any deviation from this packaging has to be agreed & released by COM SD TLM MD PT1.

## 6.4 Production Stages and Means

### Overview of all production steps

- A. SMT-Placement
- B. Panel-Separation
- C. Testing PCB
- D. Mobile-Assembly
- E. Testing and Customization of Mobile
- F. Packaging

#### A. SMT-Placement

Automatic Loading of panels

Soldering pasting side 1

SMD placement side 1

Optical Revision side 1

SMD placement shielding and special components

Reflow soldering side 1

DEK Screen printing machine

Siplace 80S/HS50/80F

Opto-Control AOI

Siplace 80F

Soltec reflow soldering unit

Automatic flipping of panels

Soldering pasting side 2

SMD placement side 2

Optical Revision side 2

SMD placement shielding and special components

Reflow soldering side 2

DEK Screen printing machine

Siplace 80S/HS50/80F

Opto-Control AOI

Siplace 80F

Soltec reflow soldering unit

#### B. Panel-Separation

Automatic panel separation

Sort out of defect PCB by FABEL-Database automatically

Put PCB into test carrier automatically

Automatic loading of test carrier

Pematech Saw Separation Station

Pematech Saw Separation Station

Pematech Saw Separation Station

Pematech Saw Separation Station

#### C. Testing PCB

Inline testing of main PCB automatically

Pematech Test-Line

#### D. Mobile-Assembly

Preassembly of mech. parts manually & automatically

Baumann automatic assembly line & manual assembly line with product specific fixtures.

Final assembly of mobile manually & automatically

Baumann automatic assembly line & manual assembly line with product specific fixtures

Automatic screw of mobile

Weber screwing station with product specific fixtures

### **E. Testing and Customization of Mobile**

Testing of Mobile in Device Test Station

Pematech automatic device test

Software-Customization of Mobile

Pematech Multibooter

Hardware-Customization of Mobile

Semiautomatic applying of Logo sheet below display lens

### **F. Packaging**

Packaging of Mobile and all accessories

semiautomatic packaging line

## **6.5 Basic Assembly Concept**

See [chapter 2](#) for details.

The product is designed for automatic assembly and is fully compliant to the design rules of COM SD TLM MD PT3.

For more details, please refer to the document "Design rules for Mobile Phone Automation" (Draft Version, 08.05.2005 [19]).

## **6.6 Basic Packaging Concept**

The packaging concept is designed for the automatic packaging line and is fully compliant to the design rules of COM SD TLM MD PT3. In detail, the following requirements must be fulfilled:

- A1 or A1+<sup>12</sup> packaging must be used.
- Only one label must be glued (Label-Type Z6)
- Battery Cover must be applied automatically (Tray design acc. to design rules of COM SD TLM MD PT3)
- Mobile Phone must be applied automatically (Tray design acc. to design rules of COM SD TLM MD PT3)
- "Faserform"-Inlay must be used.

## **6.7 No-ID-Phone Support**

The current mechanical build-up concept of Polaris does not fully support the production of No-ID-Phones. The Variant-Spread-Point is set within the production-step "final assembly" by applying of country/language specific Keypads.

## **6.8 New production technology**

- New I/O-Connector (Nano-I/O)
- New SIM-Reader (Hinge-Type)

---

<sup>12</sup> A1+ Package will be used



- New Battery-Connector (front-side contacting)

## 6.9 Quality Targets

The following quality figures are targeted:

Production Step	Target value
Placement Quality	100 dpm
Soldering	10 dpm
BE faults	50 dpm

The target values will not be achieved during the run-in phase. They can only be achieved in a stable production line.

## 6.10 Expected Production Quantities/Production Capacity

For Polaris, it is targeted to produce approx. 1.220k units in worldwide over lifecycle (14 month). The peak quantity is planned to be 122,5 kpcs./month and is expected for October '06. Start of pilot series is planned for CW03/06.

(Source: Time schedule and Ramp-Up-Plan in State of M1, as of 02-09-2005)

## 6.11 Test Set-Up

### 6.11.1 General Requirements

It is absolutely essential to comply with the following requirements and to consider these within the product definition.

**The most important requirements are as follows:**

- The central module can be switched on and operated via the I/O-Connector.
- No mechanical adjustments.
- Make sure that the necessary RF measuring points are given with a 50 Ohm impedance or make available any necessary impedance transformation circuitry.
- Electrical adjustments with higher requirements regarding accuracy (transmitter output, RX sensitivity, etc.) are only possible within the testing stage Adjustment- & System-Test.
- The design rules for testing points must be kept according to the design regulation (Test point diameters, free areas around testing points, etc.). For further details, please refer to the attached document: 'Testing technical standards for mobile phones'.
- The PCB requirements must be fulfilled with regards to the carrier fixings and reference holes. For further details, please refer to the attached document: 'Testing technical standards for mobile phones'.
- Make available a Windows NT software library for controlling the mobile phone functions.

In addition to the above given requirements, a test technology workshop has been carried out (03.05.05; Detlev Manser - COM SD TLM MD LCM4). Any deviation to both above requirements and to the workshop-protocol must be agreed & released by PT2 & LCM4 (PTM).

For more details, please refer to the documents 'Testing technical standards for mobile phones' (Prüftechnische Anforderungen; pv1pta38.doc; Version 3.8; 06.10.2004 [20]) and 'Test- & Production-Technology Workshop Polaris' ('Test&Production\_TechnologyWS\_Polaris\_Minutes\_V1\_0.doc'; Version 1.0; 25.05.2005 [21]).

### 6.11.2 Quality Targets

The following Yields are targeted for the testing stages:

Test level	Quality Target (Yield)
Functional Test	96.0%
Adjustment-/System test	98.5%
Customer-/Camera test	96.0% <sup>13</sup>
Customer Init	99.0%

The Cpk-Value of each test case in the test levels has to be equal or larger than 1.5 (for all Gaussian distributed processes). Further on, each failure mode on test-case-level must be lower than 1%.

The following testing times are targeted for the testing stages:

Board-Level Testing		Phone-Level Testing	
Functional Test	35 sec	Device Test	23 sec
Adjustment & System Test	40 sec		

<sup>13</sup> value for this test station will be calculated by multiply (value customer test) x (value camera test)

## 7 Quality

Any deviations in quality which may occur and the decision as to whether these are to be accepted shall be made by PM, PL-T and PL PGM (MD QM).

### 7.1 **General Quality Requirements**

The general quality requirements for phone and accessories are contained in the document 'General Quality Requirements for Cellular Deliverables (Cellular Phones / Pocket PCs and Accessories)' that was agreed between Development, Product Marketing, Purchasing and Quality Management.

Currently in force and valid for this project is [12].

In case of new revisions of the document after M1, Product Marketing, Product Development, Business Administration and Quality Management have to agree if any updated requirements shall be applied in this project.

The remainder of this subsection outlines some basic requirements. For details and additional requirements refer to the General Quality Requirements [12].

#### 7.1.1 **Temperature Ranges for Mobile Phones**

Warehousing	-40°C to +85°C	Mobile phone without packaging
Non-deformation (plastics)	-40°C to +85°C	-30°C for LCD display/ camera
Solar radiation (outdoor)	1120 W/m <sup>2</sup> at +55°C	
Battery operation	-10°C to +55°C	Fully operable according to relevant specifications
Operation with external power source	-20°C to +65°C	Additional check for making/ receiving calls (emergency call)
Nondestructive range in switched on mode	-30°C to +70°C	

#### 7.1.2 **Ease of Operation**

Standards regarding the ease of operation / user-friendliness for different components include, amongst others:

##### Housing

The casings must keep their shape when pressed in the user's hand. Manual pressure on the casings may not lead to physical damage or impact the function of the test device.

The front and back casings must fit tight; no noticeable play between the casings is allowed. No creaking and grating is accepted. There may be no noticeable projections or protrusions (seam or ridge / overflow). The join must be uniform.

The surface must have a good feel and be dirt resistant. In particular, fingerprints (oil and sweat marks) must not be visible on the housing surface.

The materials used (housing parts and adhesives) may not be hazardous to the user's health. Also, the housing may not have a noticeable smell.

Bridges are not allowed to strut on PCB (damaging of copper-tracks).

The temperature of the housing at the front side must not exceed 32° degrees at room temperature.

### Keypad

Keys must have a noticeable mechanical pressure point supported by a mechanical resistance or acoustic 'click'.

The number "5" key must have a nub or other tangible means of orientation (ETSI-Standard; ES201381).

Incorrect pressing of keys (off-center, forceful pressing) may not lead to a mechanical sticking of the keys.

The artwork and/or key markings must be clearly legible in dark or in light environment. The inhomogeneity of illumination must not be apparent to the user.

The individual operating elements must be designed in such a way that they are easy to operate (applies, in particular, to the keypad). The power ON / OFF key must be secured against inadvertent switching on.

The Metal Dome keypad has to be dustproof connected to the PCB (glued).

As of now the solution of the 2<sup>nd</sup> supplier (Stainless Steel caps, back molded) shows cosmetic failures (dips, dulls) when exposed to a static load > 25N.

A Pre-Development Project within the PD-Team has been started, to find a technical solution which fulfills the 'General Quality Requirements [12]' until DS. But however it is not secured yet.

### Display and Window

The contrast and read-out angle should be optimized so that the display is as free from distortion and reflection as possible. The display must be designed in such a way that the user cannot see the insides of the unit. The illumination must be homogenous.

The window must be designed in such a way (form and placement) that it is largely protected against inadvertent scratching (for example, the housing may be designed so that it protects the window). At the same time, the window must be designed in such a way that the underlying display is not destroyed if placed under pressure.

The display window shall be designed in such a way that an accumulation of dirt or grime between the glass and the window due to static charging is avoided.

The clearness of the display window may not change (become opaque) due to exposure to climatic factors (neither before nor during nor after testing). There may be no permanent changes in the colors shown on the display after the various climatic tests have been performed.

The visibility of the display must be correct when using polarization glasses.

### SIM Card Reader

The reader may not tilt or jam. To prevent incorrect operation, there must be a clear control to show that the SIM card has been inserted properly. The system must tolerate a possible incorrect operation. The card (holder and reader) may not be damaged if incorrectly inserted. If incorrectly inserted, the card must be easy to remove.

Removal during operation of the phone may not lead to damage of the SIM card.

### Plug System

The plug must be easy to plug in, without noticeable play. The plug must go in straight and may not jam. The patch plug must lock cleanly into place.

An incorrect insertion of the plug (upside down, i.e. 180° flip-over) must be prohibited.

Mechanical stress to the soldering points must be avoided.

### I/O connector

All pins of the I/O-connector must withstand a short circuit to 0 V or to any other pin without a remaining impact. This is also valid for the external connectors of the battery pack and the contacts of the whole accessory as well. The inversely polarized feed of external voltages to accessories and / or unit may not lead to a hazard of the customer.

### Battery Pack

The battery pack must allow smooth movement, with only marginal play. The pack may not tilt or jam when inserted or removed. The lock may not jam, must be easy to operate and may not show any wear and tear for the life of the unit. All moveable parts must be covered to prevent injury to the user. The battery pack must be designed in such a way that it cannot be inserted incorrectly. If the housing should be specially designed, the color of all related parts must be uniform to ensure a suitable match.

### 7.1.3 Lifetime and Utilization

For the complete life of the phone the following functions of the phone must be guaranteed and must remain preserved without any optically visible wear (excerpt from Standard Test Plan):

#### Number of cycles for operation elements

Operating element:	Number of repetitions:
1. Normal key	150,000
2. Navi key	400,000
3. Soft key	200,000
4. I/O connector	10,000
5. SIM contacts	2,000
6. Flexible cables	80,000
7. Battery lock	2,000
8. Battery contact	2,000
9. Vibrator (tremblings)	250,000

#### Other requirements

- The contrast of the LCD display must not reduce by more than 50% within 5 years.
- No changes of vibrator performance (loudness and vibration) over the lifetime.
- The phone must (with or without a battery) withstand a fall on to a concrete floor from a height of 1.52 m in any situation without incurring functional damage, refer [12]). Due to a real metal front cover, stronger deformations of cosmetic nature compared to phones with plastic housing have to be accepted.  
The battery must withstand a fall from 1.00 m on to concrete or steel.
- The life of the battery under GSM conditions is around 500 charge cycles and within this time the battery performance must not fall below 80% of its nominal capacity.

#### Scratch proof-ness

Tested with hardness tester - Erichsen, model 318 (engraving stylus type Bosch Ø 0.75 mm, speed 10 mm/sec., length 10 mm)

- a) Display window: 10 N
- b) metal surface , Aluminium coated, top cover N/A
- c) metal surface , keypad caps, stainless steel N/A
- d) Painted surface: 7 N

The real metal front cover and real metal key caps are more susceptible to scratches compared to painted plastic parts, which has to be accepted.

Very faint marks that only change the surface shine are not to be considered as scratches.

#### **7.1.4 Mechanical, Climatic and Ageing Requirements**

Mechanical, Climatic and Ageing Requirements for mobile phones and accessories (test specifications and assessment criteria) are contained in detail in [12].

#### **7.1.5 Electromagnetic Compatibility, SAR and Others**

Standards and additional Siemens requirements regarding EMC, ESD, SAR and other issues are contained in detail in [12].

These requirements include the Siemens requirements for robustness against ESD discharges (+/- 8 kV direct contact discharge and +/- 15 kV air discharge without ground connection, with permissible functional disturbances but without any damage).

### **7.2 Environmental Protection**

Siemens AG places great emphasis on the importance of environmental protection. The law is also making greater demands on the recycle-ability of products. One of the most significant publications in this respect is the "Electronic Waste Regulation", which prescribes as obligatory the recycling of used electrical appliances. In order to do full justice to these requirements and to our own ecological aims, the following considerations are paramount when dealing with new products:

- The product must be able to be dismantled easily
- No use of welds and adhesives
- A reduction in the variety of materials used
- Avoidance of compound materials
- Marking of plastic parts
- No pollutants must be used
- Recycling/disposal documentation must be drawn up

#### **7.2.1 Requirements of Recycling Process**

As we cannot make any safe predictions on the nature of future recycling technology, the following recommendations are based on the trends recognizable today for future recycling technology. In this respect recycling technology requires that old machines can be dismantled, taken to pieces and sorted out into those materials for which reprocessing capacities exist or which have to be taken to depots or incinerators.

Dismantling or taking to pieces of telephones in:

- |                                    |                                |
|------------------------------------|--------------------------------|
| • Electronic/electrical components | (assembled FBG, display, ....) |
| • Plastics (by type)               | (housing, ...)                 |
| • Cable and leads                  | (coax cable, ...)              |
| • Metal                            | (screws, ...)                  |
| • Paper/cardboard                  | (IMEI plate, ...)              |
| • Waste/other                      | (Keypad mat, earpiece, ...)    |

#### **7.2.2 Recycling Concept**

Depending on the structure of the components the requirements on materials must satisfy motor car requirements:

- No use of Cadmium
- No CFCs

- As far as possible components made of polymer materials must be marked (depending on size)
- Emission of organic compounds
- Free from Asbestos
- Marking of the battery pack (Recycling Instructions: don't throw into fire, etc.)

### 7.2.3 Construction

For a construction sequence, which does justice to recycling factors those operational steps, are important which determine the choice of material and the method of jointing them.

An easy-to-assemble automated construction normally also fulfils the criteria for easy disassembly.

From the point of view of recycling, the rules and basic premises of the standard design and the standard constructional design must be kept and extended.

The following recommendations are a general aid for making sure that when the product is designed and developed, the parts of the newly developed products can be recycled.

#### General

- As few separate parts as possible
- Avoid material compounding (e.g. sticking together of different materials and laminates) (Exceptions: Keypad with copper laminated plastic foil).
- Joining and de-jointing wherever possible in one direction
- Guarantee accessibility of disassembly tooling
- Use unified screw heads in respect of type and size

#### Connections

- Connections should be used which can still be separated easily even after the planned product utilization life. (Exceptions: Front Cover with glued Mounting Frame, Screw Bosses, Display Lens)
- The number of different types of connection should be minimized.
- Standardized connection processes should be selected.
- Self-retaining connection processes (clipping and snapping) should be used.
- In the case of snap connections, one unlocking possibility should always be foreseen. If this is not possible, then the connection should be easy to take apart by knocking.

#### Materials Selection

- Reduce the number of different materials used
- Only use plastic from the selected or preferred list (Exceptions: Keypad with copper laminated plastic foil)
- Do not use any materials which are difficult to recycle
- Plastic parts should be marked in line with MP-specific regulations
- Avoid using material compounding (e.g. injected plugs, sticking of different materials, laminates). If it is not possible to avoid these compound structures, then separating aids should be foreseen, e.g. easy opening points, and these should be included in the User Manual.

## 7.3 Quality Plan

A project specific quality plan is created and maintained by the QM department. This document contains:

- Checklist of basic failures from former products
- FMEAs (responsible: PD)
- Environmental Tests (status of device, variants, amount; PD responsible before B2, QM responsible from B2)

- Field trial (status of device, amount)
- Product audit
- Milestone review
- Checklist risk analysis
- Checklist safety instructions in the user manual

## 7.4 Department PSQA-plans

Project specific quality assurance plans (PSQA-plans) are defined by the relevant departments and responsible persons are named. These departments are, according to MEP [10].

The PSQA-plans should contain, amongst others:

- Planning of failure mode and effect analysis (FMEAs)
- Planning of design reviews
- Test plans for components / sub-systems / assemblies
- For the mechanical PSQA-plan: Test plans for environmental testing (shock, drop, climatic factors, aging, etc.) in the mechanical test plan
- For the Electrical and EMC PSQA-plans: Test plans for electrical and EMC tests to ensure compliance with the requirements set out in the specifications for the device and the interfaces

## 7.5 Product Safety and Technical Risk Assessment

A technical risk assessment for this project will be created until M1. The technical risk assessment contains, amongst others, acoustic shock, short circuits, charger, battery.

For reasons of product liability, the user must be protected from electric shock caused by voltages applied to the outside of the device or the accessories.

The product and supplied accessories (in the following called only "product") must comply with all relevant international and/or national standards in accordance of the country of distribution.

For Europe the product must comply with all relevant EU directives in order to fulfill the requirements for CE marking.

- The Radio and Telecommunications Terminal Equipment Directive
- Low Voltage Directive (LVD)
- EMC Directive
- SAR
- VDA guidelines (Accessories)

For each of the directive the applicable international harmonized standard(s) have to be applied. National deviations or standards (in case international standards are not existing) in accordance to the country of distribution have to be considered.

Where harmonized standards do not exist, latest technical publications have to be considered.

### 7.5.1 Special Precautions:

- Precautions (mechanical, software engineering) must be taken to prevent danger to or injury of the user through inadvertent switching on of the device.
- Software engineering precautions are to be taken to prevent danger to or injury of the user through an acoustic shock as the ringer function or Hands-free are implemented over the receiver. A separate review must be carried out to ensure that this requirement is met.



### **7.5.2 Product Safety and the Software**

- Precautions (mechanical, software engineering) must be taken to prevent danger to or injury of the user through inadvertent switching on of the device.
- Software engineering precautions are to be taken to prevent danger to or injury of the user through an acoustic shock as the ringer function or hands-free mode is implemented over the receiver. A separate review must be carried out by R&D-Department to ensure that this requirement is met also with two separate loud speakers.

## **7.6 Software Quality**

### **7.6.1 Software QA Plan**

A Software Quality Assurance Plan will be set in place until M1 that sets out both the general and project-specific requirements and stipulates the quality assurance measures that are to be taken during the development process. Reviews by Quality Management are done on the basis of the currently valid milestone checklists and the stipulations set out in the Software Quality Assurance Plan.

### **7.6.2 Software Process Code**

Software is to be developed in accordance with the Software Process Code (QMS – VA T010 SW-Pro) set out in the Software Project Management Guidelines (currently in the pipeline) and the Software Quality Assurance Process (QMS – VA Q025-MP SW-QA in projects).

## **7.7 Field Trials**

### **7.7.1 Aim and Focus of the Field Trial**

- Confirmation of compliance in home and foreign networks. Tests according to GCF AP (GSM Certification Forum - Application Procedure)
- Confirmation of hardware and software quality (ready to be introduced into the market)
- Detection of weak points in the HW construction of the mobile phone and accessories, SW errors/bugs by functional tests as well the check of user manual.

### **7.7.2 Realization**

- Dependent on the product specification, GCF Field Trial tests in different GSM networks (see also chapter 4.4.2.3) will be performed
- End User Acceptance Test with tested and complete pre-production samples (SIEMENS B2-samples, with S3 SW, packaging, power supply, battery, field test key, ...)
- Extended End User Test with tested and complete samples from pilot series (with S3 or DS SW, packaging, power supply, battery, field test key, ...)
- The accessories for the product shall be included in the Field Trial

### **7.7.3 Technical Field Trial**

Tests in GSM 900/1800/1900 shall be coordinated and performed by QM PV. QM PV will create the corresponded test list.

### **7.7.4 Time Frame**

The official Field Trial shall start with the provision of B2 pre-production samples at S3 and shall end with S4 (at least five weeks testing time until DS). The extended Field Trial shall start with the production of the first samples from the pilot series (at least four weeks testing time).

The beginning of the Field Trial shall start under the following conditions:

#### **Hardware**

- B2 Field Trial samples are available. Those samples shall have the final layout ready for approval. For the Field Trial it will be taken into account that HW - variants (e.g. alternate display manufacturers) exist. Such different variants shall be available for the Field Trial. The number of samples shall be defined according to Six Sigma tools and depends on the number of different variants.
- For the extended Field Trial, samples from pilot series shall be made available. The number of samples shall be defined according to Six Sigma tools and depends on the number of different variants.
- Agreed accessories shall be available for Field Trial
- The Field Trial samples shall have a valid test IMEI
- Access to mobile engineering functions shall be possible
- Full scope of supply is needed

To avoid any time delay during the Field Trial phase the following shall be ensured:

- The samples shall have the possibility to record a mobile trace via PC – software (not only in office environment, but also in the field). Necessary HW (e.g. tracing cable, adapted devices with 2<sup>nd</sup> BfCbus - connector) and tracing SW shall be made available at S25.
- The provision of a monitor mode in the mobile shall be ensured
- Field Trial samples shall not have a SIMLOCK

#### **Software**

- The SW shall be stable and has to have the field trial maturity (frozen).
- All agreed features are implemented and tested. (Note: Implementation of features during the Field Trial phase will lead to re-tests)
- At milestone S3 (prior to the Field Trial), all known errors shall be recorded and evaluated in a review between R&D and Software Quality Assurance. Errors, which hinder the realization of the Field Trial, shall be closed.
- In the case of (E)DS, the field trial will start with S25 milestone. The duration of the field trial must not fall below five weeks until (E)DS.

To avoid any time delay during the Field Trial phase the following shall be ensured:

- During the Field Trial phase, the SW of the mobile phone shall be upgradeable also outside the factory (e.g. SIEMENS LG's). The necessary SW tools + HW (upgrade cable) shall be made available to QM PV at S25. QM PV shall have at least limited EEPROM read/write access (SW exit codes etc.)
- Any SW feature implementation, which leads to the need of a SW update which can not be done in the field (e.g. re-writing the IMEI because of implementation of security features) shall be implemented prior to the start of the Field Trial.

#### **Engineering equipment**

The following equipment shall be made available to Com MD QM PL PV:

Description	Number	Date
Mobile phones (B1+) including charger (The voltage range of the charger shall include AC220-240V; 50/60Hz or if applicable AC100-120V; 50/60Hz. A plug adapter for standard European socket outlets – if necessary – shall be available).	-	S25

Description	Number	Date
(Note: Those samples are needed to test the Tracer SW, SW upgrade etc. prior to the Field Trial )		
Tracer Software	-	S25
Tracing Hardware (cable)	25	S25
Tracing Hardware (adapted devices; 2 <sup>nd</sup> BfBus connector)	16	S25
Mobile – Boot Configuration (e.g. Upgrade cable if different from tracing cable, service box etc.)	25	S25
SW upgrade tools (e.g. SWUP, Initialization tool )	-	S25
External Antenna (possibility to connect the mobile to a CMD)	-	S25
Access to SW and HW – error tracking database	-	S25
Others: Overview to the planned SW “standard – variant” (Documentation)	-	S3

It shall be ensured that those engineering equipment can be used during the whole Field Trial phase (no changes after S25).

#### 7.7.5 Performance aspects covered by Field Trial (Overview)

The following general functions and aspects of the mobile phone shall be tested during the GCF and End User Acceptance Test. For the End User Acceptance Test a questionnaire shall be prepared and evaluated.

- Basic handling, including set up, clear and in-call functions
- Cell selection and reselection
- Automatic & manual PLMN selection
- Handover
- Operation of each basic service, supplementary service and features within the scope of GCF and which is supported by mobile. (fax / data services / GPRS). For speech it includes a degree of subjective speech testing sufficient.
- SMS (MO – PP, MT – PP and CB)
- Inter-working with different SIM cards (using different types of SIM/card / profile)
- Inter-working with agreed accessories
- Review of user manual
- HW Construction of the mobile phone

#### 7.7.6 Documentation

SW / HW - errors from the Field Trial will be recorded in the relevant error tracking data base (e.g. Clearquest for SW; equivalent HW tracking data base).

At the end of the official Field Trial, a summary report shall be prepared.

The successfully finished Field Trial is the basis for the milestone S4.

### 7.8 Miscellaneous

#### 7.8.1 Quantity Planning Pre-Validation

For the Pre-Validation a quantity of 20 pieces of B1+ samples is needed.

### 7.8.2 Quantity Planning GCF

For the GCF Field Trial a quantity of 25 pieces of B2 or newer samples is needed.

### 7.8.3 Quantity Planning End User Acceptance Test

For the End User Acceptance Test a quantity of 250pcs of B2 or newer samples for field trial mobiles is needed:

GCF	25
EMEA	50
AMEA <sup>14</sup>	30
China Variant	30
End User Acceptance Test	80
US	20
SWAP	15
Total	250

Samples have to be available latest 2 weeks prior start of field test (End user test / GCF)

Quantity has to be split into different HW-Variants (variants not yet available)  
Complete selling volume is needed.

### 7.8.4 Remarks

- **all mobiles need the same boot-kernel**
- **all mobiles have to be signed with the Field Test key**
- **all mobiles have to be without any kind of SIM lock**
- open BF Bus (will be done by field test team)
- Information about booting and tooling
- Delta Description for new software versions
- New software has to be available latest until Friday 09:00h (weekly)
- Access to developer drives
- Actual SW has to be available as \*.exe file by start of validation (update via data cable)
- Change of blocks, e.g. new NF parameters, have to be available also as \*.exe files
- It is not possible to update mapping files global
- Development environment is not global wide available
- Delta map file (e.g. BRD-Handel) should be available before shipping

### 7.8.5 Customization

Customization will be tested within End user test. We are able to perform tests in countries and networks we support with field test activities.

Information and tooling (SW tools, test list etc.) should be available latest 2 weeks before pre-validation starts.

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<sup>14</sup> Not needed for Polaris

### 7.8.6 Accessory

Accessory field test will be performed in parallel.

Accessory has to be available 2 weeks before start of field trial.

### 7.8.7 Realization:

The End User Acceptance Test will start with a maturity (SW) of S3 and B2 HW. It will take at least 5 weeks.

The GCF field-test will start with a maturity (SW) of S3 and B2 HW. It will take approximately 3 weeks of testing (incl. GCF report).

### 7.8.8 Requirements for Product and Project Audit

If no antenna connector is accessible for the Product/Project Audit, an antenna tube must be made available for measuring purposes at the Product/Project Audit.

- The responsible department for the developing of this antenna tube must be the RD (the Product/Project Audit has only the possibility to support the RD)
- Latest at the availability of the B1 samples for the environmental test, the antenna tube must also be available. 30 pieces are required.
- The coupling between mobile antenna and coupling antenna must be < 12dB
- Reproducibility TX +/- 0,3dB
- In case of different RF-chipsets (e.g. Hitachi/ Infineon), it must be possible to use the tube for both variants
- With the antenna tube, it must be possible to test all items of the Product Audit (excluding spurious emissions). These test items are contained in a separate file which is available to RD.

### 7.8.9 Requirements for Outgoing Inspection

A Device Check must be implemented in the software based on the implemented feature set and the current requirements for the factory's outgoing inspection and box opening.

## 7.9 Robust Development

There is no module, which is planned to be developed using the Robust Development Process.

### 7.10 Field Return Rate

Target Return rate DS	12%
HW RR at DS;	6%
SW RR at Delivery Start:	4%
Keypad	1%
SCR	1%

HW and SW RR are derived from the average RR of past products within same tier. Additionally a Return Rate of 1% due to Problems with the Keypad (Static Load) and 1% due to SCR design (risk of damage of flap hinge) is expected.

### 7.11 Quality of Suppliers and Components

See separate Quality Assurance Agreements (QAAs) for each supplier and component.

## 7.12 Deviations from Agreed Quality Level

Any deviations in quality which may occur and the decision as to whether these are to be accepted shall be made by Product Management, Business Administration, Product Development and Quality Management.

## 8 System Test

### 8.1 Introduction

This document describes the system requirements for GSM/GPRS terminals in terms of regulatory and voluntary requirements in different regions and for the different functionalities of the terminals. The requirements on GSM terminals are applicable for 900/1800/1900 MHz if supported by the terminal. Additionally the document describes requirements from the network operator TIM, Italy, on GSM terminals.

### 8.2 Abbreviations and Definitions

Bluetooth SIG	Bluetooth Special Interests Group
CTIA	Cellular Telecommunications and Internet Association, US.
CTR	Common Technical Regulation
EC	The European Community
EMC	Electro-Magnetic Compatibility
FCC	Federal Communications Commission
GCF	Global Certification Forum
GSMA	GSM Association. The Association of GSM Network Operators worldwide.
GSMNA	GSM North America. The North American Regional Interest Group of the GSM Association
ME	Mobile Equipment
PTCRB	PCS Type Certification Review Board
R&TTE	Directive 1999/5/EEC – Radio Equipment and Telecommunications Terminal Equipment Directive
SAR	Specific Absorption Rate
SIM	Subscriber Identity Module
SDO	Standards Development Organization
TOG	The Open Group. WAP testing & Certification
3GPP	Third Generation Partnership Project. A project of SDOs in charge of elaboration of specifications for a 3. Generation mobile radio system (UMTS)

### 8.3 Type Approval (TA)

Following chapter describe the requirements Polaris has to meet to gain required type approvals and certifications. In this content the string “Polaris” is placeholder for a mobile supporting the frequency 900MHz, 1800MHz and 1900MHz.

### 8.4 Regulatory requirements – Overview European Community

GSM and UMTS terminals are under the scope of Directive 1999/5/EEC, Radio Equipment & Telecommunications Terminal Equipment(R&TTE). Directive 1999/5/EC is the overall framework for radio equipment and telecommunications terminal equipment for all countries in the European Community (EC) and defines requirements for:

- Health and safety aspects
- EMC aspects
- Spectrum usage aspects

### 8.4.1 Outside Europe

For North America and other countries outside the EC, the technical requirements are almost identical to those applied in the EC. Additional requirements are listed in the requirements matrix.

China / APAC<sup>15</sup> approval requirements are under PM responsibility and listed in a separate chapter below.

## 8.5 Voluntary requirements – Overview

### 8.5.1 GCF

Within GCF, manufacturers are required to fill in a list of Core Specs (e.g. 3GPP TS 45.005 for RF) applied to the design. Moreover, the exact version of Core Specs shall be listed for a range of Core Specs. The GCF Steering Group defines minimum requirements to Versions of Standards. By default, the terminal design shall therefore be made based on Core Specs.

The GCF requirements are defined in the current version of GCF-CC.

### 8.5.2 PTCRB

The PTCRB requirements are defined in the current version of the NAPRD. PTCRB is required for customers roaming into the networks of operator's part of the PTCRB group (North America).

### 8.5.3 Additional voluntary requirements

Besides regulatory requirements, the product shall comply with a range of supplementary, "voluntary" certification schemes.

Voluntary certification schemes are developed by various entities defining requirements for specific functionalities e.g. Bluetooth, IrDA and WAP as described in the requirements matrix.

An additional requirement for TIM, Italy, regarding Network selection from SIM Card Preferred List for GSM terminals is included.

## 8.6 Requirements Matrix

### 8.6.1 Regulatory requirements

Aspect	Aspect			
			US (& Canada)	
		Technical requirement	Mandated by	Technical requirement
Health and safety	Health and safety	Health aspect: Specific Absorption Rate (SAR) according to EN 50 360 and EN 50 361.	FCC	FCC SAR Regulation OET 65

<sup>15</sup> Not needed for Polaris



Aspect	Aspect			
			US (& Canada)	
		Technical requirement	Mandated by	Technical requirement
		Safety aspect: Electrical safety according to EN 60 950.	-	-
EMC	EMC	EN 301 489-1 EN 301 489-7 EN 55013:2001 EN 55020:2002 EN 55022:1998 Bluetooth: EN 301 489-17	FCC	FCC Part 2 FCC Part 15 FCC part 22 FCC Part 24  HAC: ANSI C63.19
Radio Spectrum	Radio Spectrum	GSM: EN 301 511		
		Bluetooth: EN 300 328		
Special requirements	Special requirements	None specified for Europe at the moment; IMEI security is discussed	FCC	TTY: Cellular text Telephone Modem according to 3GPP TS 26.226 TS 26.230 TS 26.231
				USA FCC Wireless E911 Rules
Inter-operability	Inter-operability	-	GSMNA	PTCRB

<sup>1</sup> Conformity to this requirement is not a must but helps to prevent extra declarations for France. Approval for Canada (Industry Canada, IC) will be done jointly with FCC approval.

### 8.6.2 'Voluntary' requirements

Aspect	Certification planned for typical Product	Specified by	Technical requirements
Mobile <-> Network Inter-operability	Yes	GSM and UMTS: Global Certification	GCF-CC Field Trials

Aspect	Certification planned for typical Product	Specified by	Technical requirements
Bluetooth functionality <sup>16</sup>	Yes Bluetooth certification shall be printed on the box	Forum (GCF) Bluetooth Special Interest Group	Bluetooth Qualification Program Reference Document V1.0 or V2.0 (BT Qualification Program is subject to change from 1.0 to 2.0 without grace period in 2005)
WAP functionality	No	The Open Group	WAP Certification and Testing Process
OpenWave Browser	Yes Mandatory if OpenWave Browser is included.	OpenWave	Browser Compliance Verification
USB functionality	Yes The certification is mandatory if the USB logo shall be used.	USB Implementers Forum	USB Compliance Program
Network Selection from SIM Card Preferred List	Yes This test shall be performed.	TIM	TIM Proprietary specification
CTIA	No	CTIA	CTIA GSM-1900 Terminal Unit Certification Program Management Document
Sync ML (OMA DS&DM)	No (voluntary)	OMA / Data Sync (DS), Device Management (DM)	
Java (Engine)	Yes (mandatory) Sun requires it	Sun	
MMS (OMA)	No (voluntary)	OMA / MMS	
IMPS (Instant Messaging and Presence Services) (OMA)	No (voluntary) Mandatory if we want to use the Wireless Village Logo	OMA / Wireless Village	

## 8.7 Regulatory requirements – detailed

### 8.7.1 Health aspect

Health is a new aspect introduced by Article 3.1.a of Directive 1999/5/EEC in EC. Specific Absorption Rate is subject to regulatory approval within EC. Harmonized Standards for SAR; i.e. EN 50 360 and EN 50 361 are available and can be used for Annex III of R&TTE.

<sup>16</sup> Bluetooth certification mandatory if Bluetooth is activated

Relevant harmonized standard for article 3.1a)	Version	Purpose	Date of cessation of presumption of conformity
EN 50360	2001	Requirements for mobile phones for human expose to EM fields	---

As of today the question remains when the new phantom will be available. Currently testing has still to be done according to EN50 360 but with the old phantom of ES59005. The new phantom is expected within the timeframe of terminals currently under development.

Actual limits currently given by Council Recommendation 1999/519/EEC will be applicable using the Harmonized Standards.

In addition to demonstrating technical compliance it is required to disclose actual SAR values to the public by means of a company WEB page.

Health aspects are handled by both FCC and CTIA in US.

The FCC and CTIA have continuously further developed SAR limits to include requirements for e.g. Body-worn configurations. Requirements as of today are known, however these may not be valid within the timeframe of terminals currently under development.

SAR values for US are made public available at FCC Website. In addition, both FCC and CTIA require detailed wordings to be included in user manuals.

### 8.7.2 Safety aspect

Safety for stand-alone terminals operating at a few Volts is a new aspect introduced by Article 3.1.a of Directive 1999/5/EEC in EC.

EN 60 950 is the corresponding Harmonized Standard applicable within the EC.

EN 60 950 concerns:

- Protection against electrical shock and hazards
- Protection against thermal rises
- Resistance to heat and fire

Relevant harmonized standard for article 3.1a)	Version	Purpose	Date of cessation of presumption of conformity
EN 60 950	2001	Safety of information technology equipment	

National standards for other regions e.g. AS 3260 for Australia and UL1950 for US are all based on IEC 950, from which also EN 60 950 is derived.

Compliance to safety regulations includes flammability requirements for plastic materials documented by corresponding UL File Listings (Yellow Cards) and Certificates of Conformity with all deliveries.

PCBs as well as batteries need to be UL recognized.

### 8.7.3 EMC aspect

EMC is an integrated requirement of Directive 1999/5/EEC, identified as an essential requirement in Article 3.1.b.

Under previous European legislation, the EMC standard for GSM terminals ETS 300 342-1 was not harmonized. A range of product specific EMC standards for telecommunications terminal equipment are now restructured into the following relevant harmonized standards for article 3.1 b): (listed in the OJ 10<sup>th</sup> August 2002)

Relevant harmonized standard for article 3.1b)	Version	Purpose	Date of cessation of presumption of conformity

Relevant harmonized standard for article 3.1b)	Version	Purpose	Date of cessation of presumption of conformity
EN 301 489-1	V1.4.1	common requirements for a large range of product types	
EN 301 489-3	V1.4.1	specific requirements for short-range devices; i.e. Bluetooth functionality.	
EN 301 489-7	V1.2.1	specific requirements for GSM terminals operating in the 900 MHz and 1800 MHz frequency range	
EN 301 489-17	V1.2.1	specific requirements for short-range devices; i.e. Bluetooth functionality	
EN 55020	2002	FM Radio receiver – Immunity aspects	
EN 55013	2001	Fm Radio receiver – Emission aspects	

Updated information's on Harmonized Standards for EMC can always be found at the European Commissions website:

For US, the FCC, who is in charge of radio spectrum management, handles the EMC aspect. The corresponding technical requirements are defined in FCC Part 2, Part 15, Part 22 and Part 24. Separate EMC testing and certification is mandatory in US.

The FCC EMC requirements only concern emission. No immunity requirements are applied in US.

#### 8.7.4 Radio spectrum usage aspect

Directive 1999/5/EEC identifies in Article 3.2 radio spectrum usage as an essential requirement because radio spectrum is a limited resource.

Under previous European legislation under Directive 91/263/EEC not only radio spectrum usage requirements were defined. At that time, the regulatory requirements for GSM terminals included signaling aspects, acoustics and SIM/ME interface. The corresponding technical requirements were defined in Common Technical Regulations (CTRs) with references to GSM 11.10. Approximately 400+ test cases were included for compliance to the CTRs and/or TBRs for GSM terminals.

Under Directive 1999/5/EEC the only applicable requirements in EC concerns effective radio spectrum usage.

##### 8.7.4.1 Harmonized standards for GSM article 3.2

Relevant harmonized standard for GSM article 3.2	Version	Purpose	Date of cessation of presumption of conformity
EN 301 511	V7.0.1 WKI_ID=9225	specific requirements for GSM terminals operating in the 900 MHz and 1800 MHz frequency range pointing to GSM 11.10	
EN 301 511	V9.0.2 (in the approval process) WKI_ID=13302	Includes EGPRS and pointing to TS 151 010	

#### 8.7.4.2 Harmonized standards article 3.2 for Bluetooth

Relevant harmonized standard for Bluetooth for article 3.2	Version	Purpose	Date of cessation of presumption of conformity
EN 300 328	V1.6.1	Short range device ISM 2.4 GHz	

For US, the FCC handles radio spectrum aspects. See EMC section above.

#### 8.7.5 Special requirements

##### 8.7.5.1 European Community

Directive 1999/5/EEC provides in Article 3.3 several options to include further special requirements concerning:

- Network inter-operability / support for certain network interface connecting points.
- Avoiding harm to the network and degradation of service.
- Safeguards to ensure personal data and privacy of users and subscribers.
- Support of certain features to avoid fraud.
- Support of certain features ensuring access to emergency features.
- Support of certain features to facilitate terminal usage by users with a disability.

By January 2003, no such requirements are defined under Article 3.3 in EC but inclusion of IMEI security is under discussion.

##### 8.7.5.2 USA

###### 8.7.5.2.1 TTY<sup>17</sup>

For US, there is a special requirement under Telecommunications Act Section 255 regarding terminal usage by users with a disability. Deaf, hard of hearing, and speech-impaired persons have been using specific Text Telephone (referred to as TTY in North America) equipment in the fixed network for many years to transmit text and speech through ordinary speech traffic channels. Modern digital cellular systems, however, do not provide satisfactory character error rates for text transmitted in the speech channel with the traditional modulation developed for the fixed network. The FCC under the US Government has required an urgent solution for all emergency (911) calls for one specific text telephone protocol called *Baudot Code*.

The standardization of Cellular Text Telephone Modem takes place within 3GPP. The corresponding technical requirements are defined in

- 3GPP TS 26.226: General description
- 3GPP TS 26.230: Transmitter Bit Exact C-Code
- 3GPP TS 26.231: Minimum Performance Requirements

These special requirements are mandatory as of January 1, 2002. However, a manufacturer fulfils these special requirements if the manufacturer has at least one product supporting TTY on the US market. For the Polaris project, TTY will be tested within the platform according to the PTCRB requirements.

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<sup>17</sup> Not needed for Polaris

#### **8.7.5.2.2 5-key knob**

To ease blind people's use of cellular telephones, a special knob shall be located on the 5-key or just below the 5-key. The knob shall be easily detectable and durable.

For US, the FCC has adopted revisions to USA FCC Wireless E911 Rules according to 3GPP TS 22.071 Annex B. Location of Emergency Calls can be provided by different means. This area is subject to further standardization.

#### **8.7.5.3 IMEI Security**

For PTCRB the manufacturer has to confirm IMEI security by "a letter certifying sound engineering practices in securing the IMEI in accordance with 3GPP TS 22.016, section 2. All terminals must comply by June 1<sup>st</sup>, 2002".

For GCF IMEI security as specified in the relevant core specification is also required. Following shall the manufacturer declare:

He has taken necessary and sufficient steps to ensure that any individual or organization cannot economically change the IMEI after the ME's final production process.

And that the IMEI resists tampering, i.e. manipulation and change, by any means (e.g. physical, electrical and software).

#### **8.7.6 Interoperability (for PTCRB only)**

In EC, inter-operability requirements are removed from the regulatory requirements. See above for special requirements under Article 3.3 of Directive 1999/5/EEC.

By contrast, this is not the case for US. GSMNA have set up the PCS1900 Type Certification Review Board (PCTRB) and entitled PCTRB to undertake type approval matters including inter-operability aspects for US.

Technical and procedural requirements are given in Permanent Reference Document NATWG.03. PTCRB type certification is based on GSM Specifications with modifications per North American Standards and additional requirements from FCC rules, or any other government agency that may have jurisdiction and or competence in the matter.

In addition, also CTIA operates the CTIA GSM-1900 Terminal Unit Certification scheme.

Both CTIA and PCTRB schemes are considered regulatory in US.

### **8.8 Voluntary requirements**

#### **8.8.1 Global Certification Forum - Inter-operability**

Under earlier EU-legislation, GSM terminals were subject to a substantial amount of regulatory testing and certification or type approval before market launch following the provisions of Directive 91/263/EEC.

The amount of tests provided a high degree of confidence that relatively few and small inter-operability problems would occur between handsets and infrastructure of live networks.

Following the implementation of Directive 1999/5/EEC the amount of regulatory testing is reduced to radio spectrum aspects.

Consequently, type approval does not provide the same level of confidence. In particular, inter-operability aspects are not covered by regulatory testing under Directive 1999/5/EEC.

On this background, the GSM Certification Forum (GCF) was established as a voluntary certification scheme for GSM terminals in December 1999 after some years discussions between network operators and handset manufacturers mainly concerning the organization of GCF, the technical requirements, the relations to authorities and corresponding regulatory requirements etc.

Since January 2002 GCF covers not only GSM terminals, but also UMTS terminals. Consequently GCF was renamed as Global Certification Forum. The scope of GCF is basically to provide a common

set of Certification Criteria's to re-establish the confidence needed from both sides of the mobile industry, that inter-operability problems can be avoided. During mutual recognition of manufacturer's declarations, duplicate testing can be avoided.

A more detailed description of the principles and procedures of GCF is given in

- GCF-PD: Principles Document
- GCF-AP: Application Procedures
- GCF-AD: Abbreviations and Definitions
- GCF-OP: Operating Procedures
- GCF-OB: Operating Budget

The corresponding technical requirements are defined in document

- GCF-CC: Certification Criteria's

The valid versions of the above mentioned documents is available at

<http://gcf.gsm.org>

Note that a user login and a password is required to access the GCF web site.

Document CC incorporates basically the same technical requirements as were contained in the now expired CTRs. However, new tests are continuously added as new features and services are introduced in the GSM system the roll-out is expected to happen at the end of 2002. Compliance can be demonstrated by conducting tests in test laboratories using validated test cases running on commercially available test equipment.

In addition there is a new requirement for Field Trials. Field Trials are performed on live networks and intended to cover dynamic scenarios, which can not be performed in laboratory environments. Field Trials shall be performed in at least five network configurations per supported band, representing infrastructure implementations from all major suppliers.

IMEI security for GCF: see Chapter 9.7.5.3

Within GCF, manufacturers are required to fill in a list of Core Specs (e.g. 3GPP TS 45.005 for RF) applied to the design. Moreover, the exact version of Core Specs shall be listed for a range of Core Specs. The GCF Steering Group defines minimum requirements to Versions of Standards. By default, the terminal design shall therefore be made based on Core Specs.

### **8.8.2 Bluetooth functionality**

Bluetooth is standardized by Bluetooth Special Interest Group (SIG). SIG also specified the Bluetooth Qualification Process. Bluetooth functionality of terminals shall be qualified following the provisions of Bluetooth Qualification Program Reference Document (Feb. 2002: Version 1.0).

The PRD specifies the framework of the qualification process. The details, such as the forms, templates, and checklists used to support this process, are provided in companion documents, which are referred to by the PRD, and/or are accessible using hyperlinks imbedded inside the PRD. Apart from these resources, supplemental information is available at the Bluetooth Web Site, including answers to frequently asked questions (FAQ). The Bluetooth Qualification Program is subject to change in 2005. The certification process will be changed to a self certification process in addition to other program enhancements and a after certification control mechanism. The PRD version 1.0 is intended to be replaced by PRD 2.0 without grace period.

A number of Profiles exists for various Bluetooth functionalities. Specific test suites apply to Profiles.

### **8.8.3 USB functionality**

The Universal Serial Bus is specified by USB Implementers Forum. Corresponding test requirements are defined in USB Compliance Program. More detailed information on USB is available at

[www.usb.org](http://www.usb.org)



#### 8.8.4 Network Selection from SIM Card Preferred List

This requirement solely applies to TIM, Italy.

The purpose of the test is to check, that a Ph2 GSM terminal equipped with a non-empty SIM card Preferred List, selects a network in an International Roaming scenario, according to Core specification GSM 03.22.

### 8.9 Marking and Labeling

A range of mandatory marking and labeling requirements are hereby defined.

Markings shall be visible for inspection without the need for tools.

The size of the IMEI label shall be large enough for all needed signs, numbers, etc. (e.g. IMEI, CE sign, FCC ID, CCC for China).

Requirement basis	Corresponding marking
Directive 1999/5/EEC for EC	<p>99/05/EC article 12 and annex VII:</p> <p>Marking required on mobile:  <b>CE 0168</b> (if opinion of BABT as notified body is used) For Bluetooth with higher power classes, additionally the Alert symbol (!) (exclamation mark in a circle) (e.g. CE 0168 (!))</p> <p>Requirements from 99/05/EC annex VII:  The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.  3. The CE marking must be affixed to the product or to its data plate. Additionally it must be affixed to the packaging, if any, and to the accompanying documents.  4. The CE marking must be affixed visibly, legibly and indelibly.  5. The equipment class identifier must take a form to be decided by the Commission in accordance with the procedure laid down in <a href="#">Article 14</a>.  Where appropriate it must include an element intended to provide information to the user that the apparatus makes use of radio frequency bands where their use is not harmonised throughout the Community.  It must have the same height as the initials 'CE'.  Notified body numbers and the equipment class identifier, (e.g. !) being part of the CE marking need <b>to be put on the packaging and in the manual as follows:</b></p> <p>99/05/EC Article 6.3  Member States shall ensure that the manufacturer or the person responsible for placing the apparatus on the market provides <b>information for the user</b> on the <b>intended use</b> of the apparatus, together with the <b>declaration of conformity</b> to the essential requirements. Where it concerns radio equipment, such information shall be sufficient to identify on the <b>packaging and the instructions for use</b> of the apparatus the Member States or the <b>geographical area within a Member State where the equipment is intended to be used</b> and shall alert the user by the marking on the apparatus referred to in Annex VII, paragraph 5, to potential restrictions or requirements for authorization of use of the radio equipment in certain Member States. Where it concerns telecommunications terminal equipment, such information shall be sufficient to identify interfaces of the public telecommunications networks to which the equipment is intended to be connected.  <b>For all apparatus such information shall be prominently displayed.</b></p> <p><b>Siemens Type Designation</b></p>



Requirement basis	Corresponding marking
R&TTE Directive 1999/5/EEC for EC: Article 12 (4)	Apparatus shall be identified by the manufacturer by means of type, batch and/or serial numbers and by the name of the manufacturer or the person responsible for placing the apparatus on the market: Product Name
	Serial Number / IMEI
	Manufacturer Name
EN 60 950 and other safety standards	Max. rated voltage and current consumption
CTIA	CTIA logo (CTIA Certification not mandatory)
FCC	FCC-ID number Country of Origin
IC	Canada ID
Additional	Siemens stock number IMEI in bar-code format and writing
CCC <sup>18</sup>	CCC label is mandatory for China (MII)

### 8.9.1 China / APAC

#### 8.9.1.1 General APAC & China requirements

The APAC variants must comply with or have declaration on:

- Declaration of Conformity (Siemens self-declaration) for
- EN301 511 ("Spectrum Usage" for GSM)
- EMC: EN 301 489- 1 (V1.3.1 valid until 30.11.05 or V1.4.1)
- EN 301-489-7 (V1.1.1 valid until 30.11.2005 or V1.2.1)
- Safety: EN 60950
- BABT Certificate for R&TTE Directive 1999/5/EC (Opinion of Notified Body)
- Test reports for above norms (GSM Report from e.g. Cetecom, 7 layers etc.)
- Declaration of Conformity (Self-declaration document by Siemens) which declares the charger and adapter (3-pin UK plug) for the Siemens product complies with the Safety regulation BS1363
- Commercial Product photographs including front shot, back, PCB board and the "commercial" IMEI number. (Photos has to be taken by a digital camera)
- CB Test Report (by International Electro technical Commission (IEC)) or Test Report from other approved authority
- ICNIRP report/certificate meeting International SAR standard the GPRS IOT reports against 5 different Networks. ( Ericsson, Nortel and Nokia infrastructure)
- Australian safety approval certification of charger (i.e. copy of certificate issued by Australian regulatory to manufacturer) - see attached pdf file.

#### 8.9.1.2 Bluetooth Products

- ETSI Standard EN300 328 or EN300 836

#### 8.9.1.3 Additional APAC & China Requirements

Additionally APAC variants must comply with or have declaration on:

<sup>18</sup> Not needed for Polaris

- Charger type approval must be done by charger supplier for Singapore - <http://www.safety.org.sg>
- Australia additional requirement where charger pins must be partially isolated - [http://www.aeema.asn.au/docs/insulated\\_pins.pdf](http://www.aeema.asn.au/docs/insulated_pins.pdf)

Additionally China variants must comply with or have declaration on:

- NA test sample drawing:  
R&D / PM in HQ send an IMEI list of 500 samples for MII Lab to choose from freely first, then R&D/PM send samples with those with IMEI chosen by the MII Lab to China for EMC testing, RF testing and MT net testing. Samples are not allowed to be replaced and modified during NA testing.
- OEM product:  
Must be clearly stated any specified relationship between manufacturer, ODM vendor and the owner of the product in a product investigation form
- Test failure:  
If the units failed in testing, there is only one chance to modify, and retest should be conducted after 1 month with new samples re-drawn by MII lab. If the test is still failed, then NA application stop and the product can be re-applied for NA half a year later!

### 8.9.2 Variant Overview and Summary of Approvals

Requirement	Polaris (900/1800/1900)	Polaris China <sup>19</sup>
R&TTE	Y	Y
FCC	Y	Y
PTCRB* (approved by CTIA)	N	N
Bluetooth according BT SIG	Y	Y
GCF 3.20 (or higher)	Y	Y
NA/TA (MII China)	N	N
USB Logo (official Certification)	Y	Y
Java SUN Certification	Y	Y
TTY	N	N
HAC	N	N
IMEI Security Declaration	Y	Y
5-key nob	Y	Y

\*As a consequence, the EMEA variant of Polaris must not be marketed in North America (PTCRB requirements regarding accredited lab testing for 900/1800 bands are not fulfilled).

<sup>19</sup> Not needed for Polaris

### 8.9.3 Additional System Test requirements

#### 8.9.3.1 Interfaces

##### 8.9.3.1.1 50 Ohm RF Interface

The phone needs a 50 Ohm RF interface for approval testing. The interface will be realized by a coax test connector from Hirose, which is accessible and mechanically suitable for approval testing. The related GSM specification is 3GPP TS 51.010-1 Annex A.

##### 8.9.3.1.2 BFC/RCCP Interface

For remote control during type approval testing (FTA "Auto mode"), the mobile supports BFB, BFC (or equivalent) and AT-C/RCCP commands via serial interface for basic call procedures and GPRS testing.

If the BFB library is replaced by BFC, in principal the same functionality (remote control) for the mobile has to be provided.

For the product these functionality has to be provided in a way which can be implemented in the Test machine setup of System test.

### 8.9.4 New type approval and certification requirements

Within the certification schemes GCF and PTCRB new approval/certification requirements came up, which will be applicable for Polaris. Some of those are driven by the so called Application enabler group; others are driven by PTCRB/CTIA (OTAP).

Those requirements are:

Requirements	Scheme	Type of testing	Responsibility	Status
OTAP (Over The Air Performance)	PTCRB/CTIA	Emission testing	EMV	mandatory
MMS	PTCRB / GCF	IOT testing	ST	mandatory
		Conformance testing		mandatory
EMS	PTCRB / GCF	IOT	ST	See Note
		Conformance testing		See Note

Note:

Additional requirements might be defined by a so called application enabler group. Those additional requirements might become mandatory for Polaris, as this product will go through type approval and certification beginning January of 2006. For Polaris M1, no PTCRB/GCF approval requirements known for EMS.

### 8.10 Operator Approval Plan

For information on operator approvals for Polaris and their time line please refer to [23].

## 9 Customer Care

### 9.1 Customer Care strategy

The diagram below documents the modular care concept which fulfils the specific customer needs for our products:

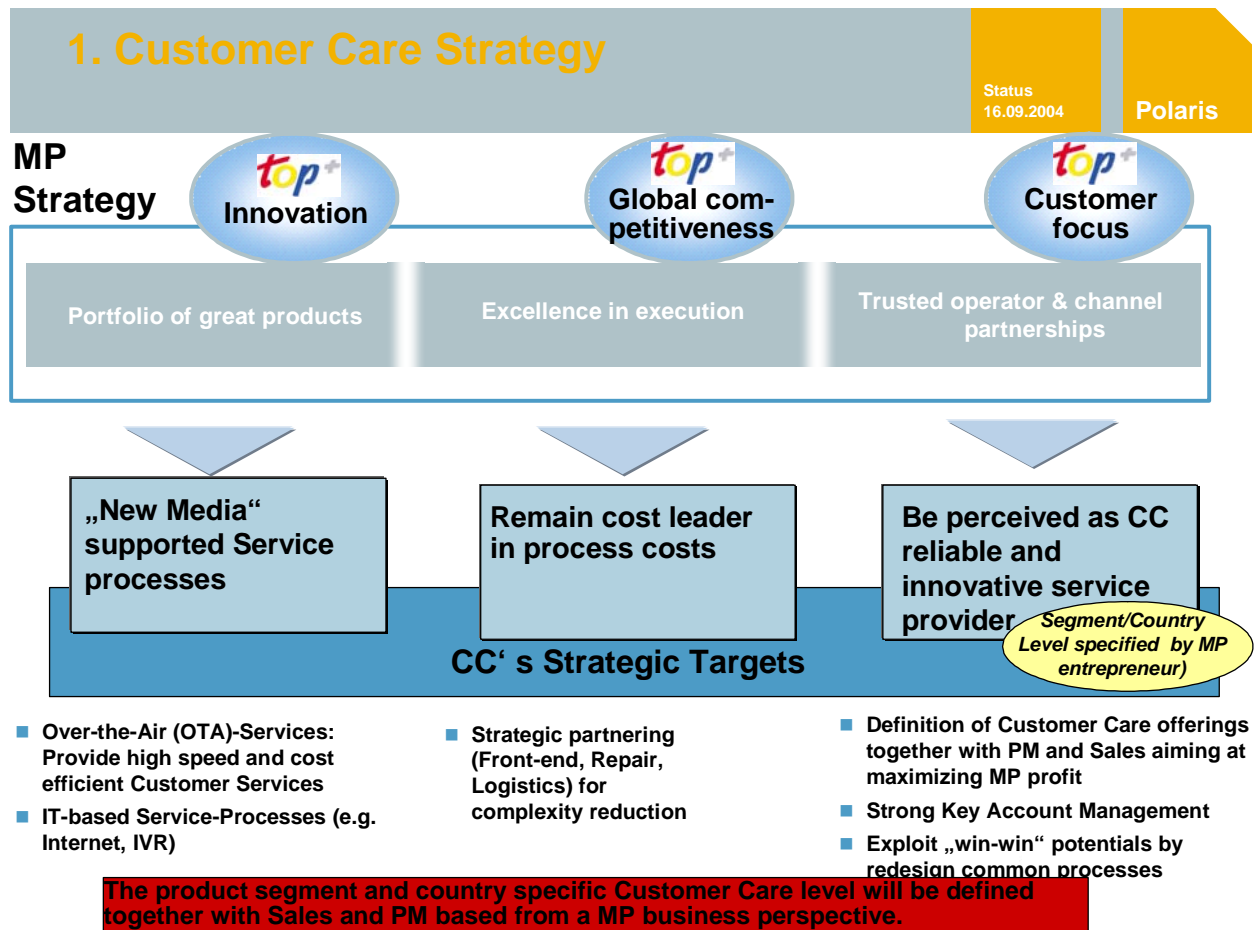


Figure 25 – Customer Care Strategy

### 9.2 Service Objectives

- Siemens bears responsibility for the products with a Siemens logo and co- branded products.
- Local Service Organisations (LSOs) will ensure the international service for a country or a region.
- Implementation of hotline for customers (end users).
- Supply of small parts to end users via hotline.
- Standard repair fees will be charged for out-of-warranty repairs.
- Car mounting and accessory-service will be rendered by business partners (retailers).
- Supply of parts of wear and tear through business partners (retailers).

- SW update over the air (SWUOTA) as a mandatory feature starting with product launch after 03/06 in order to reduce Level0 returns.
- Strategic wireless Services like phone settings over the air (OTA Standard - SyncMLDM) will be continuously enhanced in order to reduce hotline calls.
- SW update and download of phone settings should be possible for end customer directly via Internet.
- Self help tool via internet for the end customer based on the CC knowledge database.

### 9.3 Repair level definition

In order to realize most effective handling / costs for repair of mobile products at Siemens and Siemens repair partners (LSO/LSP) the mobile shall comply with the 6 defined repair levels.

- Level 0:  
Phone is NOT disassembled: SW update, un-blocking variant configuration, logistics, in-warranty-check, error reproduction.
- Level 1:  
Change of non soldered components, e.g. parts of housing, antenna, keys or keypads, display without adjustment. Exceptions: adjustment for display.
- Level 2:  
Change of complete boards, no adjustment necessary.
- Level 2.5:  
Trouble shooting and repair of defined soldered components without adjustment
- Level 2.5e (extended):  
Trouble shooting and repair of defined soldered components including adjustment
- Level 3:
  - Trouble shooting and repair of all components including complete adjustment
  - Use of automated test equipment

### 9.4 World-wide distribution of service level

- Europe / Near East/RSA / America
  - level 1 / 2 / 2.5 / 2.5e repairs at the LSO and/or service partners
  - swap and/or repair of devices for end users
  - level 3 repair at Siemens workshops
- Far East / Australia<sup>20</sup>
  - level 1 / 2 / 2.5 / 2.5e repairs at the LSO and/or service partners
  - swap and/or repair of devices for end users
  - level 3 repair at Siemens workshops

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<sup>20</sup> Not needed for Polaris

- Republic of China<sup>21</sup>
  - level 1 / 2 / 2.5 / 2.5e repairs at service partners
  - repair of devices for end users
  - level 3 repairs at the Service Centre Shanghai

## 9.5 **Roll out plan for the service concept**

- Service quantities for spare parts, swap boards and swap units will be estimated at M1, based on sales planning.
- Acceptable care standard and additional service packages are defined together with PM and sales between M1 and market launch depending on required implementation period.
- Definition of the service parts when the mechanical design is available (or samples) but 4 months before market launch at the latest.
- Service parts will be planned on a basis of the expected return rate and quantities (1 month after the availability of the planned quantities of the sales department).
- The procurement of these planned service parts will be initiated.
- The prices for service parts and repair fees will be available via e-commerce two weeks prior to market launch.
- Quantity of swap units/delivery units for the affected LSO's are agreed and delivery is initiated at market launch at the latest.
- Investment for repair line will be planned (in time, depending on lead time after M1). This planning is put into action at market launch at the latest.
- Carry out of the training for the service partners (LSP) is planned and will be put into action at market launch.
- Service documentation and training documents will be available via Internet on market launch at the latest.
- Crosscheck of the user guide by the frontline staff.
- Training of the hotline 6 weeks before market launch at the latest, sample units have to be available!
- Enabling repair locally
- Definition and procurement/making of test equipment and test software. This will be available on market launch at the latest.

## 9.6 **Service parts**

As soon as the mechanical design is available the service parts will be defined. In principle the following parts will be defined:

- Swap:
  - mobile phone without battery and covers for variants which will be distributed in Germany, China and NAFTA
  - control board without SIM lock
  - control boards for each SIM lock type as prepared SIM lock

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<sup>21</sup> Not needed for Polaris

- Spare parts:
  - display module
  - board
  - lower case frame with pre-assembled antenna but without vibra and microphone
  - vibra motor
  - microphone
  - upper case shell (cover)
  - lower case shell (battery cover)
  - shielding covers
  - keypad
  - acoustic sealing
  - accessory components

Note: final decision on spare parts will be made after B1+ prototyping

## 9.7 Test Equipment

The test concept will be deduced by the concept the production line applies.

All necessary information regarding change of used hard and software for testing must be informed the service project responsible immediately by the product implementation responsible.

## 9.8 Global Repair Requirements

This is only a short overview. The complete 'Global Repair Requirements' are written down in the M0 Document and available in the appropriate project folder to the documents:

X75\_X85\_SG2\_SW\_Feature\_List [\[9\]](#).

All Technical Service Requirements of the M0 Document will be fulfilled.

### 9.8.1 Main Technological

It must be possible to completely disassemble and assemble the mobile with standard tools. Reuse of case shells shall be possible. The battery shall be exchangeable by customer. System relevant data shall not be stored on an external memory card. Software updates shall be possible via the Siemens Global Repair Tool (GRT) respective a maximum time of 5 minutes preferably using USB terminal.

### 9.8.2 Main Requirements for the Hardware

Mechanically (separately) exchangeable shall be all housing parts, e.g. display, microphone, loud-speaker, keypad, main PCB, vibra, shielding frames etc. in order to allow access to the electronic parts.

### 9.8.3 Main Requirements for the Software

It shall be possible to program specific initialisations (customisation) locally at the LSO side inclusive 'cross booting'. These initialisations are variant or customer / operator specific data like welcome text, ringer melodies, WAP/GPRS profiles, SIM lock, IMEI, SW etc.

In order to support trouble shooting via the GRT, the device shall support all API / AT commands as defined in chapter 7.3 of the Global Repair Requirements A0 [16].

A call centre monitor according to the Siemens specifications has to be implemented in the mobile SW. This shall allow qualified remote diagnostics of the customer's phone through call centres as defined in chapter 7.4 of the Global Repair Requirements A0 [16] and A1 [17].

## **9.9 Training**

Samples of the terminals must be available in time and defined quantity in order to perform the training sequence for all technical matters at least 6 weeks before market launch.

In order to prepare trainings the manufacturer has to finish and send the required documentation 6 weeks before market launch to Siemens Customer Care for review.

Required documents:

- Level 2 manual
- Level 2.5 manual
- SW update manual and customisation
- Video for disassembling and assembling
- Video for SW update and customisation

Additional documents for CC are required and must be available at least 6 weeks before market launch.

- Circuit diagrams
- Exploded view drawings
- IC descriptions
- Circuit diagram descriptions
- Description how to test the battery and how to define a 'good' and 'fault' battery



9.10 Hotline

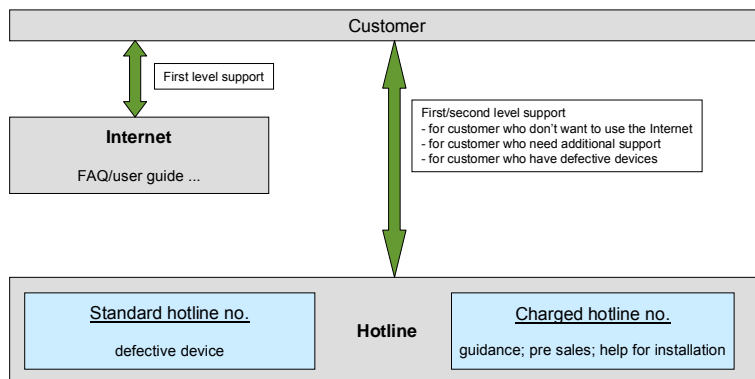
## Hotline concept

Status  
16.09.2004

Polaris

SIEMENS

## Concept for customer support



ICM MP CCQ SLI

1

**SIEMENS**  
**mobile**

Source: Sandra Meermann, ICM MP CCQ SLI

Figure 26 – Hotline

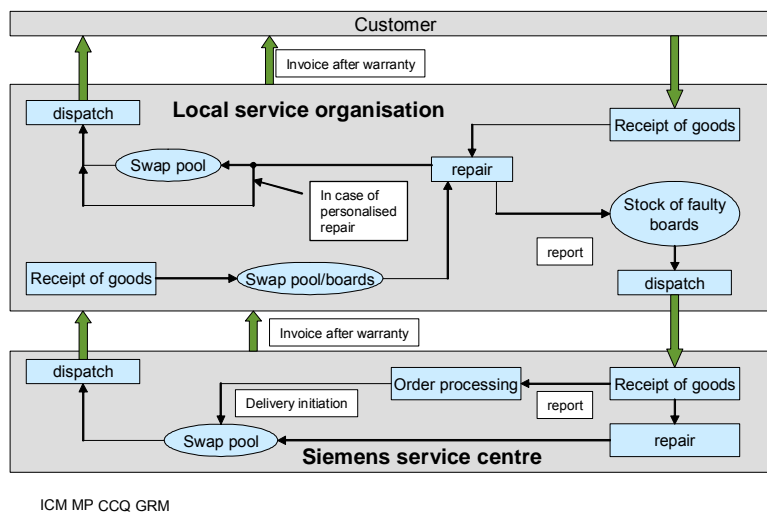
9.11 Repair Concept

## Repair concept

Status  
16.09.2004

Polaris

## Service/repair concept



1

**SIEMENS**  
 mobile

Source: Sandra Meermann, ICM MP CCQ SLI

Figure 27 – Repair Concept