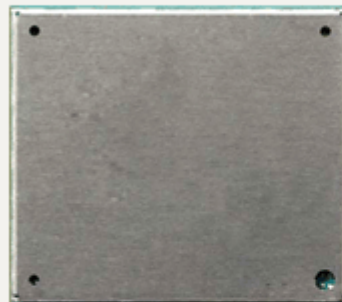


# Cinterion<sup>®</sup> PLSx3

Hardware Interface Description

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# 1 Introduction

This document<sup>1</sup> describes the hardware of the Cinterion® PLSx3 module. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

**Note:** This Hardware Interface Description is a preliminary version and as such subject to change depending on further implementation and measurements.

## 1.1 Product Variants

This document applies to the following Thales module variants:

- Cinterion® PLS63-W Module
- Cinterion® PLS63-EP Module
- Cinterion® PLS63-LA Module
- Cinterion® PLS63-J Module
- Cinterion® PLS63-X Module
- Cinterion® PLS63-X2 Module
- Cinterion® PLS63-X3 Module
- Cinterion® PLS63-X4 Module
- Cinterion® PLS63-I Module
- Cinterion® PLS83-W Module
- Cinterion® PLS83-EP Module
- Cinterion® PLS83-LA Module
- Cinterion® PLS83-J Module
- Cinterion® PLS83-X Module
- Cinterion® PLS83-X2 Module
- Cinterion® PLS83-X3 Module
- Cinterion® PLS83-X4 Module
- Cinterion® PLS83-I Module

**Note:** The PLSx3 variants differ in the fact that PLS63 supports UE CAT 1 (DL 10Mbps, UL 5Mbps) whereas PLS83 supports UE CAT 4 (DL 150Mbps, UL 50Mbps). Wherever necessary a note is made to differentiate between the product variants.

## 1.2 Key Features at a Glance

| Feature         | Implementation  |
|-----------------|---|
| <i>General</i>  |   |
| Frequency bands | PLSx3 integrates all the bands required to have a global coverage across the world (NORAM / LATAM / EMEA / APAC). Please refer to <a href="#">Section 1.2.1</a> for an overview of the frequency bands supported by each PLSx3 product variant. |

1. The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Thales product.



## 1.2 Key Features at a Glance

| Feature  | Implementation   |
|--|--|
| GSM class  | Small MS   |
| Output power (according to release 99)   | Class 4 (+33dBm ±2dB) for GSM850<br>Class 4 (+33dBm ±2dB) for GSM900<br>Class 1 (+30dBm ±2dB) for GSM1800<br>Class 1 (+30dBm ±2dB) for GSM1900<br>Class E2 (+27dBm ± 3dB) for GSM 850 8-PSK<br>Class E2 (+27dBm ± 3dB) for GSM 900 8-PSK<br>Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK<br>Class E2 (+26dBm +3 /-4dB) for GSM 1900 8-PSK   |
| Output power (according to Release 99)   | Class 3 (+24dBm +1/-3dB) for UMTS 850, WCDMA FDD BdXIX<br>Class 3 (+24dBm +1/-3dB) for UMTS 850, WCDMA FDD BdVI<br>Class 3 (+24dBm +1/-3dB) for UMTS 850, WCDMA FDD BdV<br>Class 3 (+24dBm +1/-3dB) for UMTS 900, WCDMA FDD BdVIII<br>Class 3 (+24dBm +1/-3dB) for UMTS 1700, WCDMA FDD BdIII<br>Class 3 (+24dBm +1/-3dB) for UMTS 1900, WCDMA FDD BdII<br>Class 3 (+24dBm +1/-3dB) for UMTS 2100, WCDMA FDD BdIV<br>Class 3 (+24dBm +1/-3dB) for UMTS 2100, WCDMA FDD BdI   |
| Output power (according to Release 8)  | Class 3 (+23dBm ±2dB) for LTE 600, LTE FDD Bd71<br>Class 3 (+23dBm ±2dB) for LTE 700, LTE FDD Bd12 <MFBI Bd17><br>Class 3 (+23dBm ±2dB) for LTE 700, LTE FDD Bd13<br>Class 3 (+23dBm ±2dB) for LTE 700, LTE FDD Bd14<br>Class 3 (+23dBm+2/-2.5dB) for LTE 700, LTE FDD Bd28<br>Class 3 (+23dBm ±2dB) for LTE 850, LTE FDD Bd26<br>Class 3 (+23dBm ±2dB) for LTE 850, LTE FDD Bd18<br>Class 3 (+23dBm ±2dB) for LTE 850, LTE FDD Bd19<br>Class 3 (+23dBm ±2dB) for LTE 800, LTE FDD Bd20<br>Class 3 (+23dBm ±2dB) for LTE 850, LTE FDD Bd5<br>Class 3 (+23dBm ±2dB) for LTE 900, LTE FDD Bd8<br>Class 3 (+23dBm ±2dB) for LTE 1800, LTE FDD Bd3<br>Class 3 (+23dBm ±2dB) for LTE 1900, LTE FDD Bd2<br>Class 3 (+23dBm ±2dB) for LTE 1900, LTE FDD Bd25<br>Class 3 (+23dBm ±2dB) for LTE 2100, LTE FDD Bd1<br>Class 3 (+23dBm ±2dB) for LTE 2100, LTE FDD Bd4<br>Class 3 (+23dBm ±2dB) for LTE 2100, LTE FDD Bd66<br>Class 3 (+23dBm ±2dB) for LTE 2600, LTE FDD Bd7<br>Class 3 (+23dBm ±2dB) for LTE 2300, LTE TDD Bd40<br>Class 3 (+23dBm ±2dB) for LTE 2500, LTE TDD Bd41<br>Class 3 (+23dBm ±2dB) for LTE 2600, LTE TDD Bd38 |
| Power supply<br>(see <a href="#">Section 2.1.2</a> , and <a href="#">Section 3.4</a> ) | Normal operation:<br>$3.0V \leq V_{BATT+} \leq 4.5V$<br>Typ value is 3.8V  |
| Operating temperature<br>(board temperature)<br>(see <a href="#">Section 3.5</a> )     | Normal operation: -30°C to +85°C<br>Extended operation: -40°C to -30°C, +85°C to +95°C;  |
| Physical<br>(see <a href="#">Section 4.1</a> )   | Dimensions: 33mm x 29mm x 2.5mm<br>Weight: approx. 4.8g  |
| RoHS<br>(see <a href="#">Section 5.1</a> )   | All hardware components fully compliant with EU RoHS Directive   |
| <i>LTE features</i>  |  |
| 3GPP Release 10  | UE CAT 1 for PLS63 (DL 10Mbps, UL 5Mbps)<br>UE CAT 4 for PLS83 (DL 150Mbps, UL 50Mbps)   |
| <i>HSPA feature</i>  |  |

## 1.2 Key Features at a Glance

| Feature                                     | Implementation   |
|---|--|
| 3GPP Release 7                              | UE CAT. 8, 6 for PLS63<br>HSDPA – DL 7.2Mbps<br>HSUPA – UL 5.7Mbps<br><br>UE CAT. 14, 6 for PLS83<br>HSPA+ – DL 21Mbps<br>HSUPA – UL 5.7Mbps<br><br>Compressed mode (CM) supported according to 3GPP TS25.212  |
| <i>UMTS features</i>                        |  |
| 3GPP Release 4                              | PS data rate – 384 kbps DL / 384 kbps UL<br>CS data rate – 64 kbps DL / 64 kbps UL   |
| <i>GSM/GPRS/EGPRS features</i>              |  |
| Data transfer                               | GPRS: <ul style="list-style-type: none"> <li>• Multislot Class 12</li> <li>• Mobile Station Class B</li> <li>• Coding Scheme 1 – 4</li> </ul> EGPRS: <ul style="list-style-type: none"> <li>• Multislot Class 12</li> <li>• EDGE E2 power class for 8 PSK</li> <li>• Downlink coding schemes – CS 1-4, MCS 1-9</li> <li>• Uplink coding schemes – CS 1-4, MCS 1-9</li> <li>• SRB loopback and test mode B</li> <li>• 8-bit, 11-bit RACH</li> <li>• 1 phase/2 phase access procedures</li> <li>• Link adaptation and IR</li> <li>• NACC, extended UL TBF</li> <li>• Mobile Station Class B</li> </ul> |
| SMS   | Point-to-point MT and MO<br>Cell broadcast<br>Text and PDU mode<br>Storage: SIM card plus SMS locations in mobile equipment  |
| <i>GNSS Features</i>                        |  |
| Protocol                                    | NMEA   |
| Modes<br>(see <a href="#">Section 2.3</a> ) | Standalone GNSS (GPS, GLONASS, Beidou, Galileo)  |
| General                                     | Automatic power saving modes.<br>DC feed bridge and control of power supply for active antenna   |
| <i>Software</i>                             |  |
| AT commands                                 | Hayes 3GPP TS 27.007, TS 27.005, Thales  |
| SIM Application Toolkit                     | Default (Network) bearer support for BIP   |
| Firmware update                             | Generic update from host application over USB modem  |

## 1.2 Key Features at a Glance

| Feature   | Implementation   |
|---|--|
| <i>Interfaces</i>   |  |
| Module interface  | Surface mount device with solderable connection pads (SMT application interface). Land grid array (LGA) technology ensures high solder joint reliability and allows the use of an optional module mounting socket.<br><br>For more information on how to integrate SMT modules see also [4]. This application note comprises chapters on module mounting and application layout issues as well as on additional SMT application development equipment.   |
| USB<br>(see <a href="#">Section 2.1.3</a> )   | USB 2.0 High Speed (480Mbit/s) device interface. Full Speed (12Mbit/s) compliant.  |
| 2 serial interfaces<br>(see <a href="#">Section 2.1.4</a> , and <a href="#">Section 2.1.5</a> ) | ASC0 (in parts shared with GPIO lines): <ul style="list-style-type: none"> <li>8-wire modem interface with status and control lines, unbalanced, asynchronous</li> <li>Fixed baud rates: 300bps to 921,600bps</li> <li>Supports RTS0/CTS0 hardware flow control.</li> </ul> ASC1 (shared with GPIO lines): <ul style="list-style-type: none"> <li>4-wire, unbalanced asynchronous interface</li> <li>Fixed baud rates: 300bps to 921,600bps and 3Mbps</li> <li>Supports RTS1/CTS1 hardware flow control</li> </ul> |
| 2 UICC interfaces<br>(switchable)<br>(see <a href="#">Section 2.1.6</a> )                       | Supported chip cards: UICC/SIM/USIM 3V, 1.8V   |
| GPIO interface<br>(see <a href="#">Section 2.1.7</a> )  | 22 GPIO lines comprising:<br>13 lines shared with ASC0, ASC1 lines, with network status indication, fast shutdown and SIM switch<br>9 GPIO lines not shared  |
| I <sup>2</sup> C interface  | Supports I <sup>2</sup> C serial interface.  |
| Digital audio interface<br>(see <a href="#">Section 2.1.8</a> )                                 | 1 digital interface can be configured as PCM or I <sup>2</sup> S.  |
| RING0   | Support RING0 to wake up host from power saving state.   |
| Antenna interface pads<br>(see <a href="#">Section 2.1</a> )                                    | 50Ω. UMTS/GSM/LTE main antenna, UMTS/LTE Rx Diversity antenna, GNSS antenna.   |
| ADC inputs<br>(see <a href="#">Section 2.1.9</a> )  | Analog-to-Digital Converter with unbalanced analog inputs, for example, for the (external) antenna diagnosis   |
| <i>Power on/off, Reset</i>  |  |
| Power on/off  | Switch on by hardware signal IGT<br>Switch off by AT command<br>Switch off by hardware signal FST_SHDN instead of AT command<br>Automatic switch off in case of critical temperature or voltage conditions   |
| Reset   | Orderly reset by AT command<br>Reset by emergency reset signal EMERG_RST.  |
| <i>Special features</i>   |  |
| Real time clock   | Timer functions via AT commands.   |
| <i>Evaluation kit</i>   |  |
| LGA DevKit  | LGA DevKit designed to test Thales LGA modules.  |

## 1.2 Key Features at a Glance

---

| Feature           | Implementation  |
|-------------------|---|
| Evaluation module | PLSx3 module soldered onto a dedicated PCB that can be connected to an adapter in order to be mounted onto the DSB75 or DSB mini.   |
| DSB-mini          | DSB-mini Development Support Board designed to test and type approve. It is the cost optimized development board alternative to DSB75.  |
| DSB75             | DSB75 Development Support Board designed to test and type approve Thales modules and provide a sample configuration for application engineering. A special adapter is required to connect the PLSx3 evaluation module to the DSB75. |

## 1.2.1 Supported Frequency Bands

The following table lists the supported frequency bands for each of the PLSx3 product variants mentioned in [Section 1.1](#).

**Table 1:** Supported frequency bands for each PLSx3 variant

| Band                 | PLSx3-W | PLSx3-X | PLSx3-EP | PLSx3-LA | PLSx3-J | PLSx3-X2 | PLSx3-X3 | PLSx3-X4 | PLSx3-I |
|----------------------|---------|---------|----------|----------|---------|----------|----------|----------|---------|
| <b>GSM/GPRS/EDGE</b> |         |         |          |          |         |          |          |          |         |
| 850MHz               | x       |         | x        | x        |         |          |          |          |         |
| 900MHz               | x       |         | x        | x        |         |          |          |          | x       |
| 1800MHz              | x       |         | x        | x        |         |          |          |          | x       |
| 1900MHz              | x       |         | x        | x        |         |          |          |          |         |
| <b>WCDMA</b>         |         |         |          |          |         |          |          |          |         |
| Bd.1 (2100MHz)       | x       |         | x        | x        | x       |          |          |          | x       |
| Bd.2 (1900MHz)       | x       | x       |          | x        |         |          |          |          |         |
| Bd.3 (1800MHz)       | x       |         | x        | x        |         |          |          |          |         |
| Bd.4 (2100MHz)       | x       | x       |          | x        |         |          |          |          |         |
| Bd.5 (850MHz)        | x       | x       |          | x        |         |          |          |          | x       |
| Bd.6 (850MHz)        | x       |         |          |          | x       |          |          |          |         |
| Bd.8 (900MHz)        | x       |         | x        | x        | x       |          |          |          | x       |
| Bd.19 (850MHz)       | x       |         |          |          | x       |          |          |          |         |
| <b>LTE-FDD</b>       |         |         |          |          |         |          |          |          |         |
| Bd.1 (2100MHz)       | x       |         | x        | x        | x       |          |          |          | x       |
| Bd.2 (1900MHz)       | x       | x       |          | x        |         | x        | x        |          |         |
| Bd.3 (1800MHz)       | x       |         | x        | x        | x       |          |          |          | x       |
| Bd.4 (2100MHz)       | x       | x       |          | x        |         | x        | x        | x        |         |
| Bd.5 (850MHz)        | x       | x       | x        | x        |         |          |          |          | x       |

## 1.2 Key Features at a Glance

**Table 1:** Supported frequency bands for each PLSx3 variant

| Band                        | PLSx3-W | PLSx3-X | PLSx3-EP | PLSx3-LA | PLSx3-J | PLSx3-X2 | PLSx3-X3 | PLSx3-X4 | PLSx3-I |
|-----------------------------|---------|---------|----------|----------|---------|----------|----------|----------|---------|
| Bd.7 (2600MHz)              | x       |         | x        | x        |         |          |          |          |         |
| Bd.8 (900MHz)               | x       |         | x        | x        | x       |          |          |          | x       |
| Bd.12 (700MHz)              | x       | x       |          | x        |         | x        | x        |          |         |
| Bd.13 (700MHz) <sup>1</sup> | x       | x       |          |          |         | x        |          | x        |         |
| Bd.14(700MHz)               |         | x       |          |          |         | x        | x        |          |         |
| Bd.17 (700 MHz)             |         |         |          | x        |         |          |          |          |         |
| Bd.18 (850MHz)              | x       |         |          |          | x       |          |          |          |         |
| Bd.19 (850MHz)              | x       |         |          |          | x       |          |          |          |         |
| Bd.20 (800MHz)              | x       |         | x        |          |         |          |          |          |         |
| Bd.25(1900MHz)              |         | x       |          |          |         |          |          |          |         |
| Bd.26 (850MHz)              | x       | x       |          |          | x       |          |          |          |         |
| Bd.28 (700MHz)              | x       |         | x        | x        |         |          |          |          |         |
| Bd.66(2100MHz)              | x       | x       |          | x        |         | x        | x        | x        |         |
| Bd.71(600MHz)               |         | x       |          |          |         |          |          |          |         |
| <b>LTE-TDD</b>              |         |         |          |          |         |          |          |          |         |
| Bd.38 (2600MHz)             | x       |         |          |          |         |          |          |          |         |
| Bd.40 (2300MHz)             | x       |         |          |          |         |          |          |          | x       |
| Bd.41 (2500MHz)             | x       |         |          |          |         |          |          |          | x       |

1. For -W variant module, a sensitivity issue will occur in GNSS when transmitting in band 13, to avoid this issue, it is suggested to use -X variant module.

### 1.3 PLSx3 System Overview

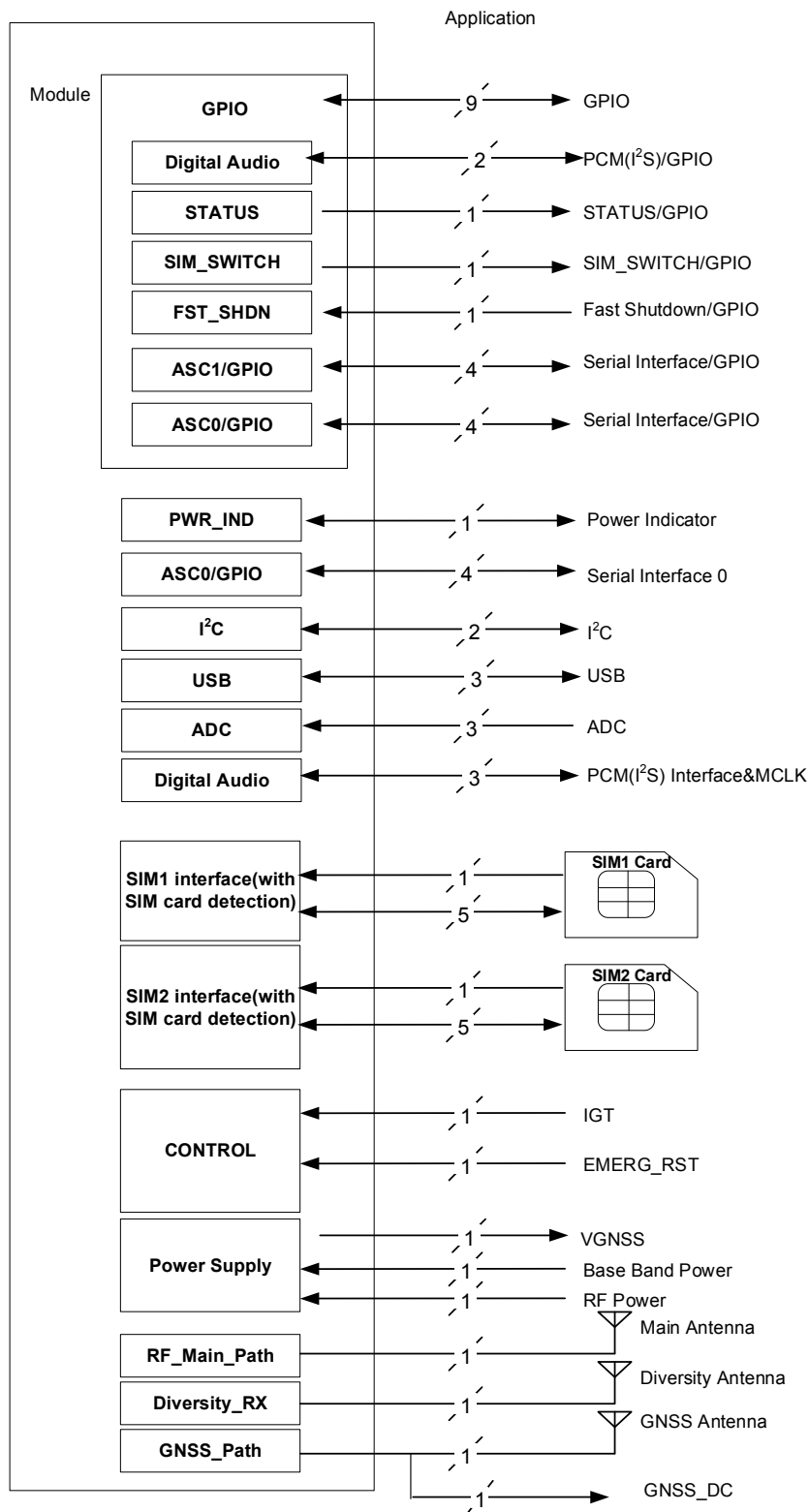


Figure 1: PLSx3 system overview

## 1.4 Circuit Concept

Figure 2 shows block diagrams of the PLSx3 module and illustrate the major functional components:

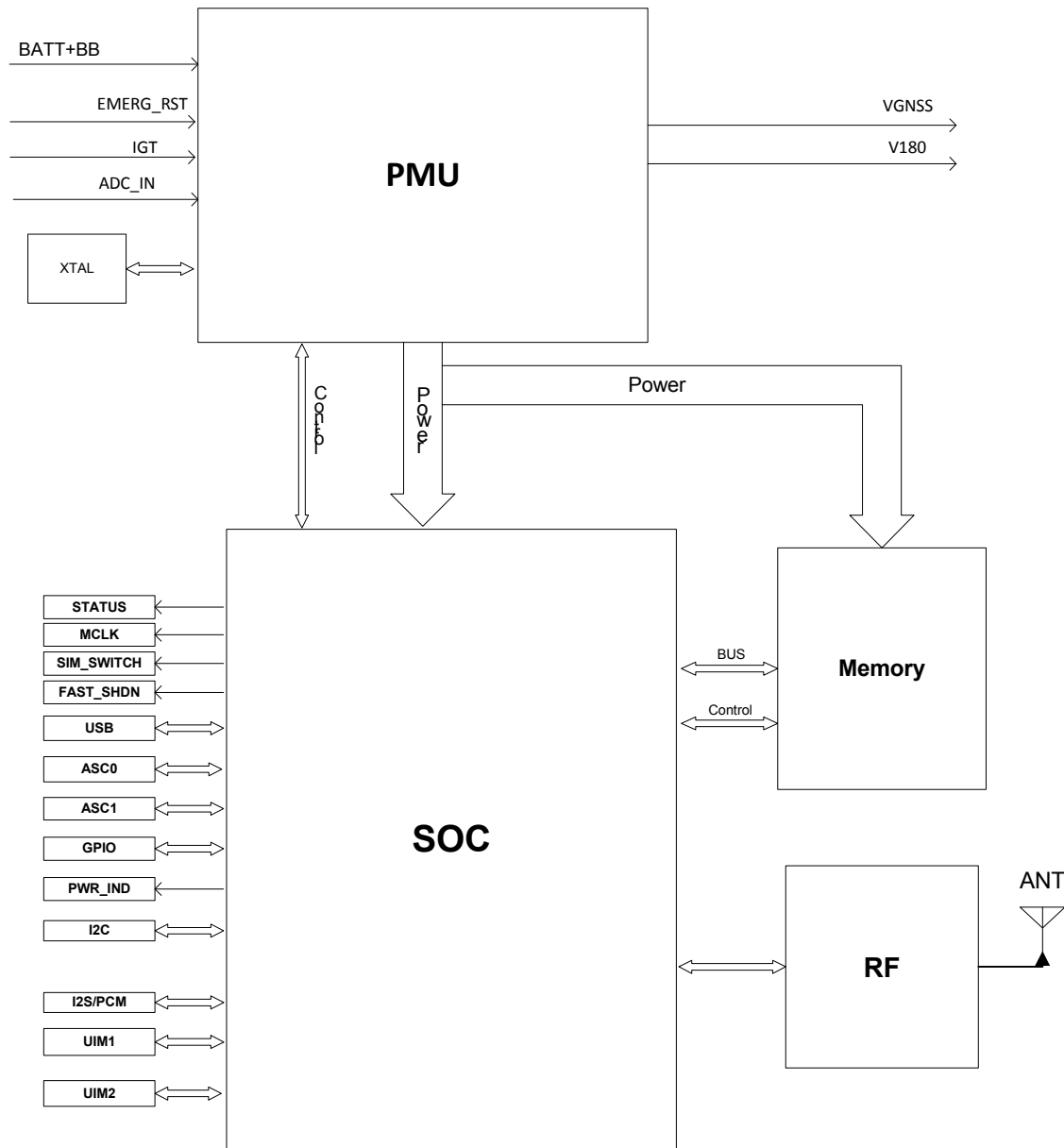


Figure 2: PLSx3 block diagram



## 2 Interface Characteristics

PLSx3 is equipped with an SMT application interface that connects to the external application. The SMT application interface incorporates the various application interfaces as well as the RF antenna interface.

### 2.1 Application Interface

#### 2.1.1 Pad Assignment

The SMT application interface on the PLSx3 provides land grid array pads to integrate the module into external applications. [Table 2](#) lists the pad assignment. [Figure 3](#) shows the pin mapping on the LGA footprint.

Please note that a number of connecting pads are marked as reserved for future use (rfu) and further qualified as either (dnu), (GND) or (nc):

- Pads marked "rfu" and qualified as "dnu" (do not use) shall be soldered but electrically not connected.
- Pads marked "rfu" and qualified as "nc" (not connected) are internally not connected with PLSx3 modules, but shall be soldered.

Thales strongly recommends to solder all connecting pads for mechanical stability and heat dissipation.

## 2.1 Application Interface

Table 2: Overview: Pad assignments

| Pad No. | Signal Name  | Pad No. | Signal Name    | Pad No. | Signal Name         |
|---------|--------------|---------|----------------|---------|---------------------|
| A4      | rfu (nc)     | E2      | GND            | L2      | GND                 |
| A5      | GND          | E3      | GND            | L3      | GND                 |
| A6      | GND          | E4      | GND            | L4      | GND                 |
| A7      | GND          | E5      | GND            | L5      | rfu (nc)            |
| A8      | GND          | E12     | CCIO2          | L6      | CCVCC2              |
| A9      | GND          | E13     | CCRST2         | L7      | MCLK                |
| A10     | GND          | E14     | rfu (nc)       | L8      | rfu (nc)            |
| A11     | GND          | E15     | rfu (dnu)      | L9      | rfu (nc)            |
| A12     | ANT_DRX      | E16     | rfu (dnu)      | L10     | rfu (nc)            |
| A13     | GND          | F1      | GND            | L11     | SIM_SWITCH/GPIO26   |
| B3      | rfu (nc)     | F2      | GND            | L12     | rfu (nc)            |
| B4      | GND          | F3      | GND            | L13     | rfu (dnu)           |
| B5      | GND          | F4      | GND            | L14     | CCRST1              |
| B6      | GND          | F13     | GND            | L15     | CCCLK1              |
| B7      | GND          | F14     | I2CCLK         | L16     | IGT                 |
| B8      | GND          | F15     | I2CDAT         | M2      | GND                 |
| B9      | GND          | F16     | GPIO25         | M3      | GND                 |
| B10     | GND          | G1      | GND            | M4      | PWR_IND             |
| B11     | GND          | G2      | GND            | M5      | V180                |
| B12     | GND          | G3      | GND            | M6      | GND                 |
| B13     | GND          | G4      | GND            | M7      | GPIO21/DIN          |
| B14     | GPIO5/STATUS | G13     | rfu (dnu)      | M8      | BCLK                |
| C2      | GND          | G14     | GPIO7          | M9      | FSC                 |
| C3      | GND          | G15     | GPIO8          | M10     | GPIO20/DOUT         |
| C4      | GND          | G16     | GPIO11         | M11     | ADC3_IN             |
| C5      | GND          | H1      | GND            | M12     | ADC2_IN             |
| C6      | GND          | H2      | GND            | M13     | ADC1_IN             |
| C7      | GND          | H3      | GND            | M14     | CCIN1               |
| C8      | GND          | H4      | GND            | M15     | rfu (nc)            |
| C9      | GND          | H13     | rfu (dnu)      | N3      | BATT+ <sub>RF</sub> |
| C10     | GND          | H14     | GPIO4/FST_SHDN | N4      | BATT+ <sub>RF</sub> |
| C11     | GND          | H15     | GPIO12         | N5      | VUSB_IN             |
| C12     | rfu (nc)     | H16     | GPIO6          | N6      | GPIO19/CTS1         |
| C13     | rfu (dnu)    | J1      | GND            | N7      | GPIO18/RTS1         |
| C14     | rfu (dnu)    | J2      | GND            | N8      | CTS0                |
| C15     | GND          | J3      | GND            | N9      | DCD0/GPIO2          |
| D1      | GND          | J4      | GND            | N10     | RTS0                |
| D2      | GND          | J13     | GND            | N11     | GND                 |
| D3      | GND          | J14     | GPIO15         | N12     | rfu (dnu)           |
| D4      | GND          | J15     | GPIO14         | N13     | BATT+ <sub>BB</sub> |
| D5      | ANT_GNSS_DC  | J16     | GPIO13         | N14     | EMERG_RST           |
| D6      | GND          | K1      | ANT_MAIN       | P4      | USB_DP              |
| D7      | GND          | K2      | GND            | P5      | USB_DN              |
| D8      | GND          | K3      | GND            | P6      | GPIO16/RXD1         |
| D9      | GND          | K4      | GND            | P7      | GPIO17/TXD1         |
| D10     | GND          | K5      | GND            | P8      | DTR0/GPIO1          |
| D11     | GND          | K12     | rfu (nc)       | P9      | DSR0/GPIO3          |
| D12     | CCIN2        | K13     | rfu (dnu)      | P10     | RING0/GPIO24        |
| D13     | rfu (nc)     | K14     | CCIO1          | P11     | RXD0                |
| D14     | CCCLK2       | K15     | CCVCC1         | P12     | TXD0                |
| D15     | rfu (dnu)    | K16     | VGNSS          | P13     | BATT+ <sub>BB</sub> |
| D16     | rfu (dnu)    | L1      | GND            |         |                     |
| E1      | ANT_GNSS     |         |                |         |                     |

2.1 Application Interface

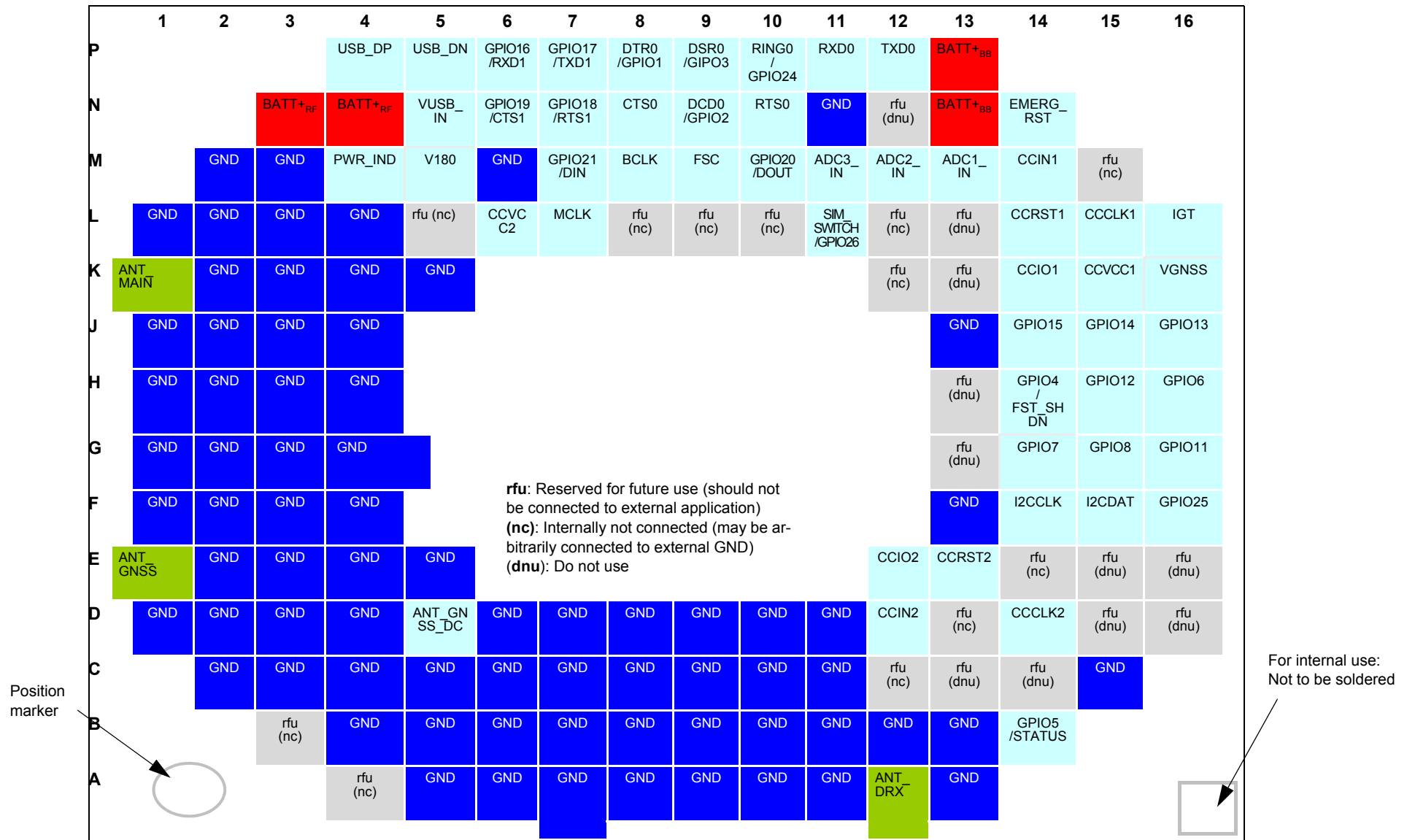


Figure 3: PLSx3 bottom view: Pad assignments

2.1 Application Interface

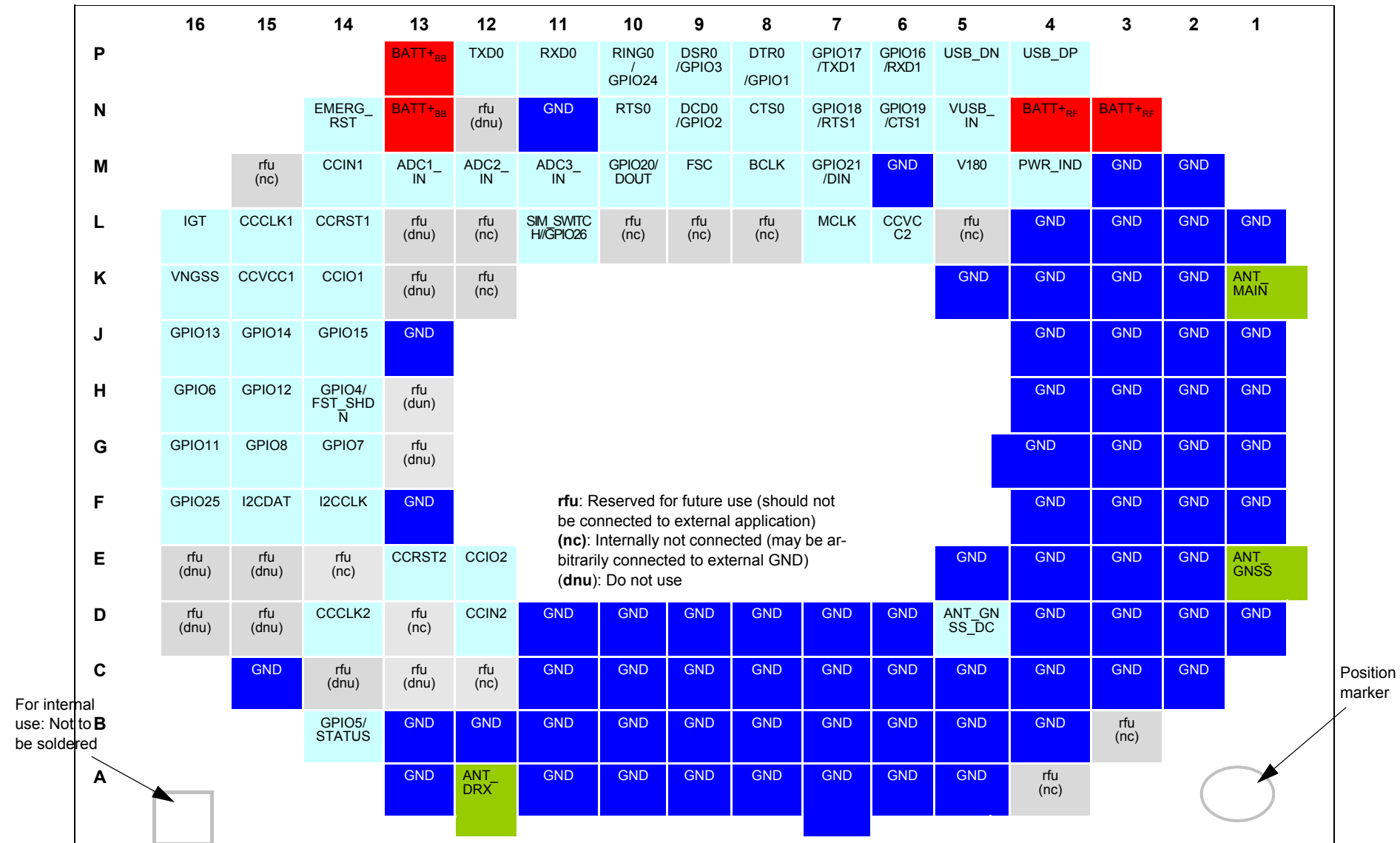


Figure 3: PLSx3 top view: Pad assignments

## 2.1.2 Signal Properties

Table 3: Signal properties (Sheet 1 of 5)

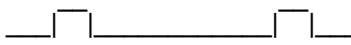
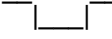


| Function                               | Signal name                                | IO | Signal form and level   | Comment  |
|--|--|----|---|--|
| Power supply                           | BATT <sup>+BB</sup><br>BATT <sup>+RF</sup> | I  | <p><u>GSM activated:</u><br/> <math>V_{I\max} = 4.5V</math><br/> <math>V_{Inorm} = 3.8V</math><br/> <math>V_{I\min} = 3.0V</math><br/> <math>I_{\max} =</math> see <a href="#">Table 18</a></p>  <p><math>n \text{ Tx} = n \times 577\mu\text{s}</math> peak current every 4.616ms</p> <p><u>WCDMA activated:</u><br/> <math>V_{I\max} = 4.5V</math><br/> <math>V_{Inorm} = 3.8V</math><br/> <math>V_{I\min} = 3.0V</math> during Transmit active.<br/> <math>I_{\max} =</math> see <a href="#">Table 19</a></p> <p><u>LTE activated:</u><br/> <math>V_{I\max} = 4.5V</math><br/> <math>V_{Inorm} = 3.8V</math><br/> <math>V_{I\min} = 3.0V</math> during Transmit active.<br/> <math>I_{\max} =</math> see <a href="#">Table 20</a></p> | <p>Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur.</p> <p>Minimum voltage must not fall below 3.0V including drop, ripple, spikes and not rise above 4.5V.</p> <p>BATT<sup>+BB</sup> and BATT<sup>+RF</sup> require an ultra low ESR capacitor respectively of 150<math>\mu</math>F. If using Multilayer Ceramic Chip Capacitors (MLCC) please take DC-bias into account. Note that minimum ESR value is advised at &lt;70m<math>\Omega</math>.</p> <p><b>Note:</b> The module's normal voltage range for operation lies between 3.0V and 4.5V. For USB operation, 3.0V-4.5V is also recommended.</p> |
| External supply voltage                | V180                                       | O  | <p>Normal operation:<br/> <math>V_{O\text{norm}} = 1.80V \pm 2\%</math><br/> <math>I_{O\text{max}} = 10\text{mA}</math></p> <p>SLEEP mode Operation:<br/> <math>V_{O\text{Sleep}} = 1.80V \pm 4\%</math><br/> <math>I_{O\text{max}} = 10\text{mA}</math></p> <p><math>C_{I\text{max}} = 100\text{nF}</math></p>   | <p>V180 should be used to supply level shifters at the interfaces.</p> <p><b>Note:</b> V180 is not back powering protected. Wrong usage may back power the module which is forbidden.</p> <p>If unused keep line open.</p> <p>Test point recommended.</p>  |
|  | VGNSS                                      | O  | <p><math>CL_{\text{max}} = 2.2\mu</math><br/> <math>V_{O} = 3V \pm 2\% @ I_{O} = -10\text{mA}</math><br/> <math>I_{O\text{max}} = 10\text{mA}</math></p>  | <p>Available when GNSS antenna DC power is enabled.</p>  |
| Supply voltage for active GNSS antenna | ANT_GNS-S_DC                               | I  | <p><math>V_{I\text{max}} = 6V</math><br/> The input current has to be limited to 50mA (antenna short circuit protection)</p>  | <p>If unused connect to GND</p>  |

Table 3: Signal properties (Sheet 2 of 5)

| Function         | Signal name | IO  | Signal form and level   | Comment   |
|------------------|-------------|-----|---|---|
| Ignition         | IGT         | I   | Do not add any voltage on it. There is a built-in pull up resistor, you can test about 0.8V voltage on it.<br> low impulse width > 300ms | This signal switches the module on. The IGT signal characteristic is:<br>Power on triggered and low level triggered. Fall time should be <1ms.<br><br><b>Note:</b> To turn on the module please use an open-drain/collector circuit.<br><br>Test point recommended. |
| Status signaling | STATUS      | O   | $V_{OI}max = 0.45V$ at $I = 1mA$<br>$V_{OH}min = 1.35V$ at $I = 1mA$<br>$V_{OH}max = 1.8V$  | If unused keep line open.   |
| Emergency reset  | EMERG_RST   | I   | Do not add any voltage on it. There is a built-in pull up resistor to pull to GND when Reset.<br> low impulse width > 200ms              | This line must be driven low by an open drain or open collector driver connected to GND.<br><br>If unused keep line open.<br><br>Test point recommended.  |
| Fast shut-down   | FST_SHDN    | I   | $V_{L}max = 0.63V$<br>$V_{IH}min = 1.17V$<br>$V_{IH}max = 1.8V$<br> low impulse width > 1ms  | This line must be driven low.<br>If unused keep line open.<br><br>Note that the fast shut-down line is originally available as GPIO line. If configured as fast shut-down, the GPIO line is assigned as follows:<br>GPIO4 --> FST_SHDN                              |
| USB              | VUSB_IN     | I   | $V_{IN}min = 3V$<br>$V_{IN}max = 5.25V$<br>Active and suspend current:<br>$I_{max} < 100\mu A$  | All electrical characteristics according to USB Implementers' Forum, USB 2.0 Specification.   |
|                  | USB_DN      | I/O | Full and high speed signal characteristics according to USB 2.0 Specification.  | If unused keep lines open.  |
|                  | USB_DP      |     |   | Test points recommended.  |

## 2.1 Application Interface

Table 3: Signal properties (Sheet 3 of 5)

| Function              | Signal name      | IO  | Signal form and level   | Comment  |
|-----------------------|------------------|-----|---|--|
| Serial Interface ASC0 | RXD0             | O   | $V_{OLmax} = 0.45V$<br>$V_{OHmin} = 1.35V$  | If unused keep lines open.<br><br>Test points recommended for RXD0, TXD0, RTS0, and CTS0.                                      |
|                       | CTS0             |     |   |  |
|                       | DSR0             |     |   |  |
|                       | DCD0             |     |   |  |
|                       | RING0            |     |   |  |
|                       | TXD0             | I   | $V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$  |  |
|                       | RTS0             | I   | $V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$  |  |
|                       | DTR0             | I   | $V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$  |  |
| Serial Interface ASC1 | RXD1             | O   | $V_{OLmax} = 0.45V$<br>$V_{OHmin} = 1.35V$  | If unused keep lines open<br><br>Test points recommended for RXD1, TXD1, RTS1, and CTS1.                                       |
|                       | CTS1             | O   |   |  |
|                       | TXD1             | I   | $V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$  |  |
|                       | RTS1             | I   | $V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$  |  |
| SIM card detection    | CCIN             | I   | $V_{IHmin} = 1.17V$<br>$V_{IHmax} = 1.97V$<br>$V_{ILmax} = 0.63V$   | CCIN = low, SIM card inserted.<br>CCIN = high, SIM card removed.<br><br>If unused keep line open.                              |
| 3V SIM Card Interface | CCRST1<br>CCRST2 | O   | $V_{OLmax} = 0.4V$<br>$V_{OHmin} = 2.2V$<br>$V_{OHmax} = 3.04V$   | Maximum cable length or copper track to SIM card holder should not exceed 100mm.<br><br>CCIO2 should add 10k pull-up to CCVCC2 |
|                       | CCIO1<br>CCIO2   | I/O | $V_{ILmax} = 0.55V$<br>$V_{IHmin} = 2.128V$<br>$V_{IHmax} = 3.05V$<br><br>$V_{OLmax} = 0.4V$<br>$V_{OHmin} = 2.2V$<br>$V_{OHmax} = 3.04V$ |  |
|                       | CCCLK1<br>CCCLK2 | O   | $V_{OLmax} = 0.4V$<br>$V_{OHmin} = 2.2V$<br>$V_{OHmax} = 3.04V$   |  |
|                       | CCVCC1<br>CCVCC2 | O   | $V_{Omin} = 2.75V$<br>$V_{Otyp} = 2.85V$<br>$V_{Omax} = 3.04V$<br>$I_{Omax} = -30mA$  |  |

## 2.1 Application Interface

Table 3: Signal properties (Sheet 4 of 5)

| Function                | Signal name  | IO               | Signal form and level  | Comment   |
|-------------------------|--|------------------|--|---|
| 1.8V SIM Card Interface | CCRST1<br>CCRST2   | O                | $V_{OLmax} = 0.4V$<br>$V_{OHmin} = 1.36V$<br>$V_{OHmax} = 1.93V$   | Maximum cable length or copper track to SIM card holder should not exceed 100mm.<br><br>CCIO2 should add 10k pull-up to CCVCC2  |
|                         | CCIO1<br>CCIO2   | I/O              | $V_{ILmax} = 0.334V$<br>$V_{IHmin} = 1.351V$<br>$V_{IHmax} = 1.97V$<br><br>$V_{OLmax} = 0.4V$<br>$V_{OHmin} = 1.336V$<br>$V_{OHmax} = 1.93V$ |   |
|                         | CCCLK1<br>CCCLK2   | O                | $V_{OLmax} = 0.4V$<br>$V_{OHmin} = 1.336V$<br>$V_{OHmax} = 1.93V$  |   |
|                         | CCVCC1<br>CCVCC2   | O                | $V_{Omin} = 1.67V$<br>$V_{Otyp} = 1.80V$<br>$V_{Omax} = 1.93V$<br>$I_{Omax} = -30mA$   |   |
| I <sup>2</sup> C        | I2CCLK   | O                | Internal no pull up Resistors  | Open Drain Output.<br><br>External pull-up resistors is required. The maximum load is 680Ohm.<br><br>If lines are unused keep lines open.   |
|                         | I2CDAT   | IO               | $V_{OLmax} = 0.36V@2mA$<br>$V_{ILmax} = 0.54V$<br>$V_{IHmin} = 1.26V$  |   |
| GPIO interface          | GPIO1-<br>GPIO8,<br>GPIO11-<br>GPIO21<br>GPIO24-<br>GPIO26 | IO               | $V_{ILmax} = 0.334V$<br>$V_{IHmin} = 1.351V$<br>$V_{IHmax} = 1.97V$<br><br>$V_{OLmax} = 0.4V$<br>$V_{OHmin} = 1.336V$<br>$V_{OHmax} = 1.93V$ | If unused keep line open.<br><br>Please note that most GPIO lines can be configured by AT command for alternative functions or are by default configured with an alternative functionality:<br>GPIO4: Fast Shut Down (Input)<br>GPIO5: LED status<br>GPIO26: SIM switch |
| Digital Audio Interface | BCLK<br>DIN<br>DOUT<br>FSC                                 | O<br>I<br>O<br>O | $V_{OLmax} = 0.45V$<br>$V_{OHmin} = 1.35V$<br>$V_{OHmax} = 1.8V$<br><br>$V_{ILmax} = 0.63V$<br>$V_{IHmin} = 1.17V$<br>$V_{IHmax} = 1.8V$     | If unused keep line open.   |
|                         | MCLK   | O                | Freq=12.288MHz   |   |



## 2.1 Application Interface

Table 3: Signal properties (Sheet 5 of 5)

| Function                                | Signal name          | IO | Signal form and level  | Comment  |
|---|----------------------|----|--|--|
| ADC_IN<br>(Analog-to-Digital Converter) | ADC1<br>ADC2<br>ADC3 | I  | $R_i = 10\text{Mohm}$<br>$V_i = 0.1\text{V} \dots 1.7\text{V}$ (valid range)<br>$V_{IH\text{max}} = 1.7\text{V}$<br><br>Resolution 15 Bits<br>Offset error $\pm 1\%$ | If unused keep line open.  |
| GPO Interface                           | ANT_SW               | O  | $V_{OL\text{max}} = 0.4$<br>$V_{OH\text{min}} = 1.336\text{V}$<br>$V_{OH\text{max}} = 1.93\text{V}$  | If unused keep line open.  |
| SIM Switch                              | SIM_SWITCH           | O  | $V_{OL\text{max}} = 0.4\text{V}$<br>$V_{OH\text{min}} = 1.336\text{V}$<br>$V_{OH\text{max}} = 1.93\text{V}$  | If unused keep line open.  |
| Power indicator                         | PWR_IND              | O  | $V_{IH\text{max}} = 5.5\text{V}$<br>$V_{OL\text{max}} = 0.4\text{V}$ at $I_{\text{max}} = 2\text{mA}$  | PWR_IND (Power Indicator) notifies the module's on/off state (see <a href="#">Section 2.1.10</a> ).<br><br>PWR_IND is an open collector that needs to be connected to an external pullup resistor. Low state of the open collector indicates that the module is on. Vice versa, high level notifies the power-down mode. Therefore, the signal may be used to enable external voltage regulators which supply an external logic for communication with the module, e.g. level converters.<br>Do not connect to V180. |

### 2.1.2.1 Absolute Maximum Ratings

The absolute maximum ratings stated in [Table 4](#) are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to PLSx3.

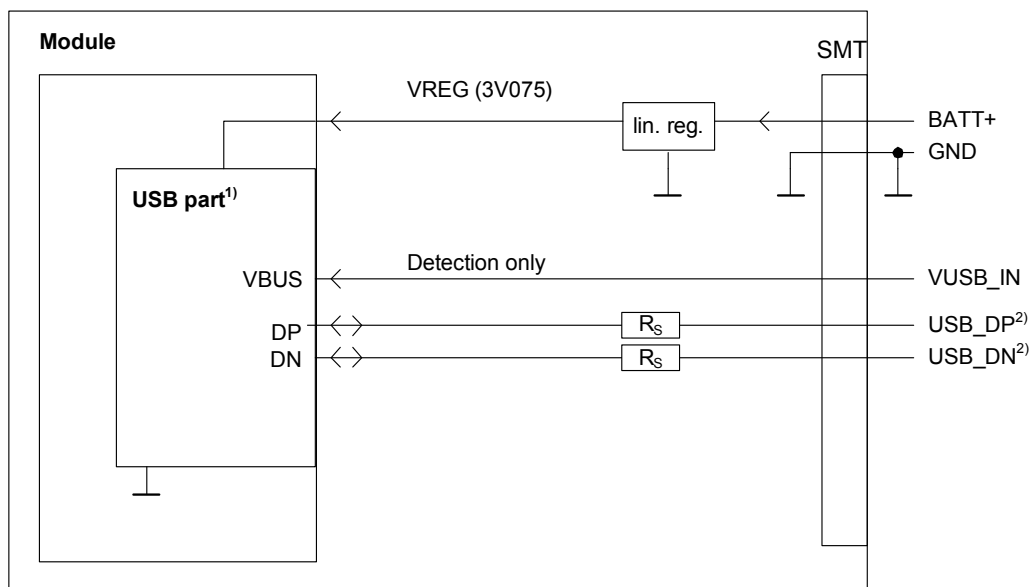
**Table 4:** Absolute maximum ratings

| Parameter   | Min  | Max        | Unit |
|---|------|------------|------|
| Supply voltage BATT+ (no service)                         | -0.3 | +5.5       | V    |
| Voltage at all digital pins in POWER DOWN mode            | -0.3 | +0.3       | V    |
| Voltage at digital pins 1.8V domain in normal operation   | -0.2 | V180 + 0.2 | V    |
| Voltage at SIM interface, CCVCC 1.8V in normal Operation  | 0    | +2.16      | V    |
| Voltage at SIM interface, CCVCC 2.85V in normal Operation | 0    | +3.25      | V    |
| Current at SIM interface in 1.8V and 2.85V operation      |      | -145       | mA   |
| Voltage at ADC pin in normal operation                    | 0.1  | +1.7*      | V    |
| V180 in normal operation                                  | +1.7 | +1.9       | V    |
| USB-Pins  | -0.3 | 3.63       | V    |

### 2.1.3 USB Interface

PLSx3 supports a USB 2.0 High Speed (480Mbit/s) device interface that is Full Speed (12Mbit/s) compliant. The impedances, serial and pull up resistors are implemented according to “Universal Serial Bus Specification Revision 2.0”<sup>1</sup>, No further additional components are required.

The external application is responsible for supplying the VUSB\_IN line. This line is used for cable detection only. The USB part (driver and transceiver) is supplied by means of BATT+. This is because PLSx3 is designed as a self-powered device compliant with the “Universal Serial Bus Specification Revision 2.0”.



<sup>1)</sup> All serial (including  $R_S$ ) and pull-up resistors for data lines are implemented.

<sup>2)</sup> If the USB interface is operated in High Speed mode (480MHz), it is recommended to take special care routing the data lines USB\_DP and USB\_DN. Application layout should in this case implement a differential impedance of 90 ohms for proper signal integrity.

**Figure 4:** USB circuit

To properly connect the module's USB interface to the external application, a USB 2.0 compatible connector and cable or hardware design is required. For more information on the USB related signals see [Table 3](#). Furthermore, the USB modem driver distributed with PLSx3 needs to be installed.

While a USB connection is active, the module will never switch to SLEEP mode. Only if the USB interface is in Suspend mode, the module is able to switch to SLEEP mode.

1. The specification is ready for download on <http://www.usb.org/developers/docs/>

### 2.1.3.1 Reducing Power Consumption

While a USB connection is active, the module will never switch into SLEEP mode. Only if the USB interface is in Suspended state or Detached (i.e., VUSB\_IN = 0) is the module able to switch into SLEEP mode thereby saving power. There are two possibilities to enable power reduction mechanisms:

- **Recommended implementation of USB Suspend/Resume/Remote Wakeup:**

The USB host should be able to bring its USB interface into the Suspended state as described in the “Universal Serial Bus Specification Revision 2.0”<sup>1</sup>. For this functionality to work, the VUSB\_IN line should always be kept enabled. On incoming calls and other events PLSx3 will then generate a Remote Wakeup request to resume the USB host controller.

See also [3] (USB Specification Revision 2.0, Section 10.2.7, p.282):

"If USB System wishes to place the bus in the Suspended state, it commands the Host Controller to stop all bus traffic, including SOFs. This causes all USB devices to enter the Suspended state. In this state, the USB System may enable the Host Controller to respond to bus wakeup events. This allows the Host Controller to respond to bus wakeup signaling to restart the host system."

- **Implementation for legacy USB applications not supporting USB Suspend/Resume:**

As an alternative to the regular USB suspend and resume mechanism it is possible to employ the RING0 line to wake up the host application in case of incoming calls or events signaled by URCs while the USB interface is in Detached state (i.e., VUSB\_IN = 0). Every wakeup event will force a new USB enumeration. Therefore, the external application has to carefully consider the enumeration timings to avoid losing any signaled events. For details on this host wakeup functionality see Section 2.1.10.4. To prevent existing data call connections from being disconnected while the USB interface is in detached state (i.e., VUSB\_IN=0) it is possible to call AT&D0, thus ignoring the status of the DTR line (see also [1]).

---

1. The specification is ready for download on <http://www.usb.org/developers/docs/>

### 2.1.4 Serial Interface ASC0

PLSx3 offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to [Table 3](#).

PLSx3 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

- Port TXD @ application sends data to the module's TXD0 signal line
- Port RXD @ application receives data from the module's RXD0 signal line

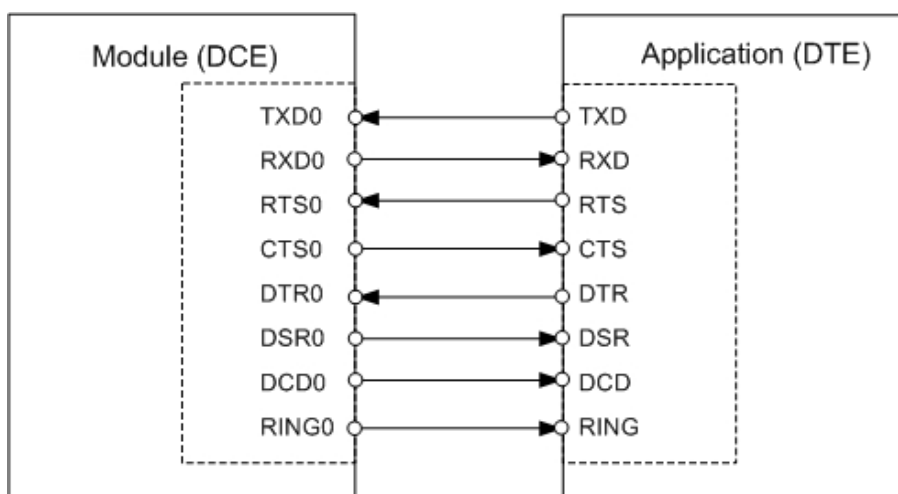


Figure 5: Serial interface ASC0

#### Features:

- Includes the data lines TXD0 and RXD0, the status lines RTS0 and CTS0 and, in addition, the modem control lines DTR0, DSR0, DCD0 and RING0.
- The RING0 signal serves to indicate incoming calls and other types of URCs (Unsolicited Result Code). It can also be used to send pulses to the host application, for example to wake up the application from power saving state.
- Configured for 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 300bps up to 921600bps.
- Supports RTS0/CTS0 hardware flow control. The hardware hand shake line RTS0 has an internal pull down resistor causing a low level signal, if the line is not used and open. Although hardware flow control is recommended, this allows communication by using only RXD and TXD lines.
- Wake up from SLEEP mode by RTS0 activation (high to low transition; see [Section 3.3.4](#))

Note: The ASC0 modem control lines DTR0, DCD0, DSR0 and RING0 can also be configured as GPIO lines. If configured as GPIO lines, these GPIO lines are assigned as follows:

```
GPIO1-->DTR0
GPIO2-->DCD0
GPIO3-->DSR0
GPIO24-->RING0
```

Configuration is done by AT command (see [\[1\]](#)). The configuration is non-volatile and becomes active after a module restart.

Notes: No data must be sent over the ASC0 interface before the interface is active and ready to receive data (see [Section 3.2.1](#)).

### 2.1.5 Serial Interface ASC1

Four PLSx3 GPIO lines can be configured as ASC1 interface signals to provide a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to [Table 3](#).

PLSx3 is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

- Port TXD @ application sends data to module's TXD1 signal line
- Port RXD @ application receives data from the module's RXD1 signal line

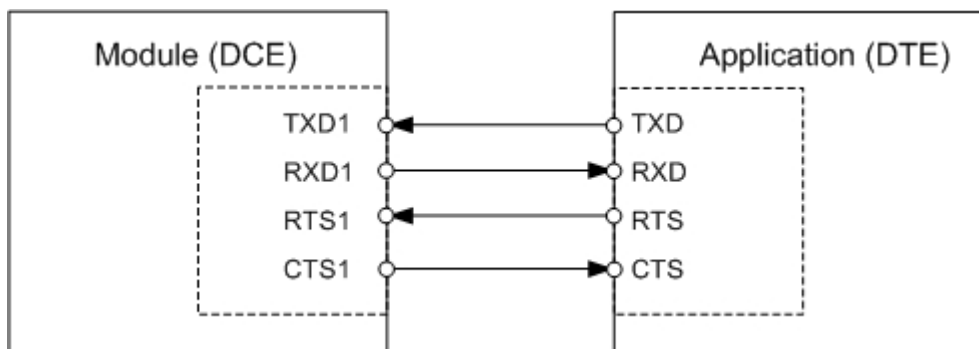


Figure 6: Serial interface ASC1

#### Features

- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware hand-shake.
- On ASC1 no RING line is available.
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300 bps to 921,600bps.
- Supports RTS1/CTS1 hardware flow. The hardware hand shake line RTS1 has an internal pull down resistor causing a low level signal, if the line is not used and open. Although hardware flow control is recommended, this allows communication by using only RXD and TXD lines.

Notes: The ASC1 interface lines are originally available as GPIO lines. If configured as ASC1 lines, the GPIO lines are assigned as follows:

```
GPIO16-->RXD1
GPIO17-->TXD1
GPIO18-->RTS1
GPIO19-->CTS1
```

Configuration is done by AT command (see [\[1\]](#)). The configuration is non-volatile and becomes active after a module restart.

## 2.1.6 UICC/SIM/USIM Interface

PLSx3 has two UICC/SIM/USIM interfaces (includes eSIM interface) compatible with the 3GPP 31.102 and ETSI 102 221. These are wired to the host interface in order to be connected to an external SIM card holder. Five pads on the SMT application interface are reserved for each of the two SIM interfaces.

The UICC/SIM/USIM interface supports 3V and 1.8V SIM cards. Please refer to [Table 3](#) for electrical specifications of the UICC/SIM/USIM interface lines depending on whether a 3V or 1.8V SIM card is used.

The CCINx signal serves to detect whether a tray (with SIM card) is present in the card holder. Using the CCINx signal is mandatory for compliance with the GSM 11.11 recommendation if the mechanical design of the host application allows the user to remove the SIM card during operation. To take advantage of this feature, an appropriate SIM card detect switch is required on the card holder. See [Chapter 7.1](#) as example for a card holder with an internal switch.

**Table 5:** Signals of the SIM interface (SMT application interface)

| Signal           | Description   |
|------------------|---|
| GND              | Ground connection for SIM interfaces. Optionally a separate SIM ground line using e.g., pad N11, may be used to improve EMC.  |
| CCCLK1<br>CCCLK2 | Chipcard clock lines for 1 <sup>st</sup> and 2 <sup>nd</sup> SIM interface.   |
| CCVCC1<br>CCVCC2 | SIM supply voltage lines for 1 <sup>st</sup> and 2 <sup>nd</sup> SIM interface.   |
| CCIO1<br>CCIO2   | Serial data lines for 1 <sup>st</sup> and 2 <sup>nd</sup> SIM interface, input and output.  |
| CCRST1<br>CCRST2 | Chipcard reset lines for 1 <sup>st</sup> and 2 <sup>nd</sup> SIM interface.   |
| CCIN1<br>CCIN2   | Input on the baseband processor for detecting a SIM card tray in the holder. If the SIM is removed during operation the SIM interface is shut down immediately to prevent destruction of the SIM. The CCINx signal is active low.<br>The CCINx signal is mandatory for applications that allow the user to remove the SIM card during operation.<br>The CCINx signal is solely intended for use with a SIM card. It must not be used for any other purposes. Failure to comply with this requirement may invalidate the type approval of PLSx3. |

Note: No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the application must restart PLSx3.

By default, only the module's 1<sup>st</sup> SIM interface is available and can be used. The usage of the module's 2<sup>nd</sup> SIM interface has to be configured by AT command.

As an alternative to connecting the module's two SIM interfaces and switching between these via AT command, it is possible to connect the first of the module's SIM interfaces via an external SIM switch that in turn provides access to a further SIM interface. For details see [Section 2.1.6.2](#).

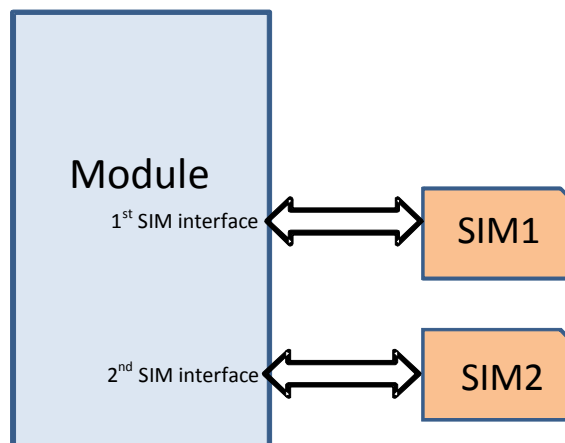


Figure 7: Module's two UICC/SIM/USIM interfaces

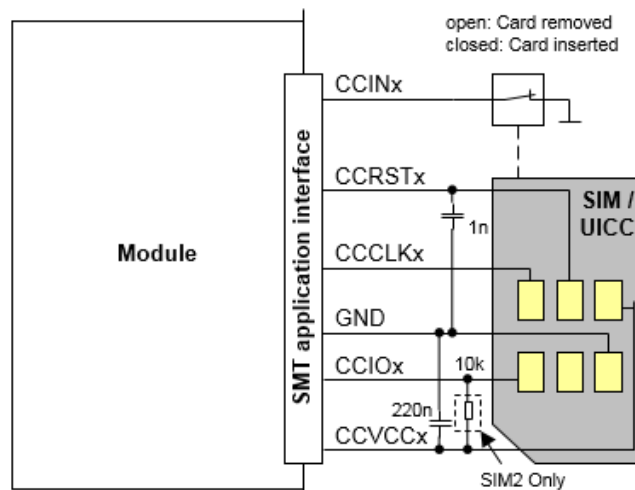


Figure 8: UICC/SIM/USIM interfaces connected

The total cable length between the SMT application interface pads on PLSx3 and the pads of the external SIM card holder must not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the CCCLKx signal to the CCIOx signal be careful that both lines are not placed closely next to each other. A useful approach is using the GND line to shield the CCIOx line from the CCCLKx line.



### 2.1.6.1 Enhanced ESD Protection for SIM Interface

To optimize ESD protection for the SIM interface it is possible to add ESD diodes (eg. NUP4114) to the SIM interface lines as shown in the example given in [Figure 9](#). Please place the ESD protection close to the SIM connector. It is suggested that the load of diode be less than 3pF.

The example was designed to meet ESD protection according ETSI EN 301 489-1/7: Contact discharge: ± 4kV, air discharge: ± 8kV.

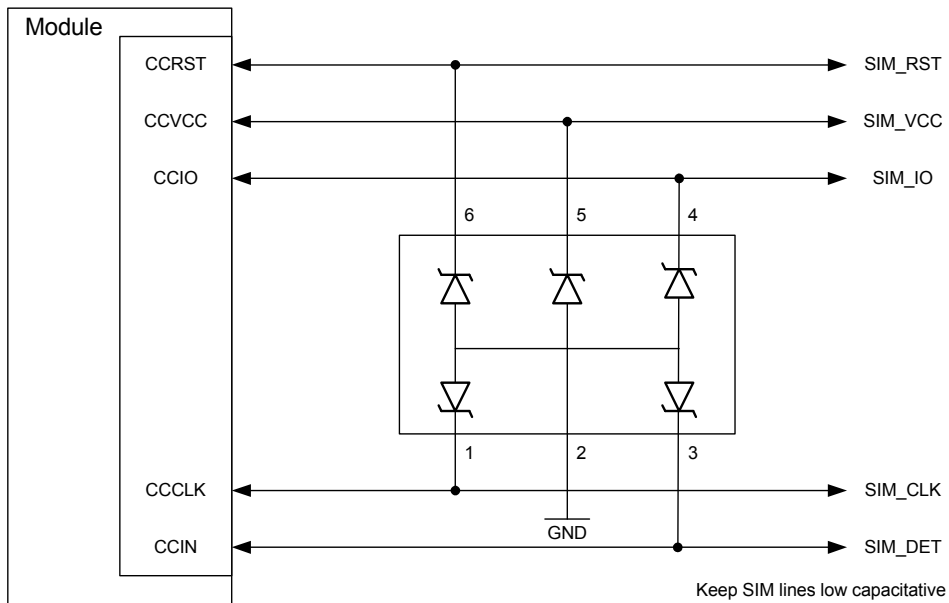


Figure 9: SIM interface - enhanced ESD protection

### 2.1.6.2 SIM\_SWITCH Line

As an alternative to connecting the module’s two SIM interfaces and switching between these interfaces by means of AT command, it is possible to connect the first of the module’s SIM interfaces via an external SIM switch that in turn provides access to a further SIM interface.

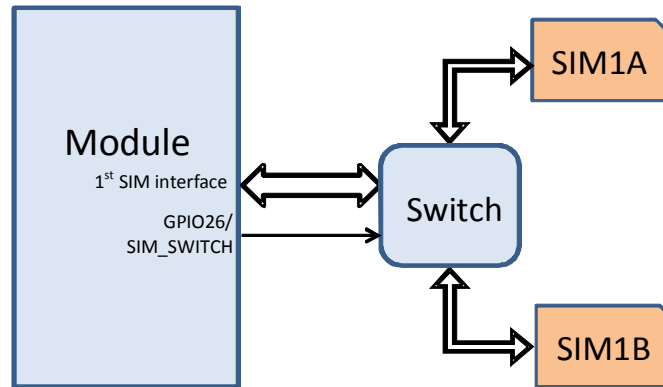


Figure 10: External UICC/SIM/USIM switch

The module’s GPIO26 line can in this case be configured as SIM\_SWITCH line in order to control the external SIM switch as shown in the sample circuit in Figure 11. A low state would then indicate the usage of the first SIM interface (SIM1A), a high state would indicate the usage of the second interface (SIM1B).

The configuration of the SIM\_SWITCH (GPIO26) line is done via AT command, is non-volatile, and available after the next module restart.

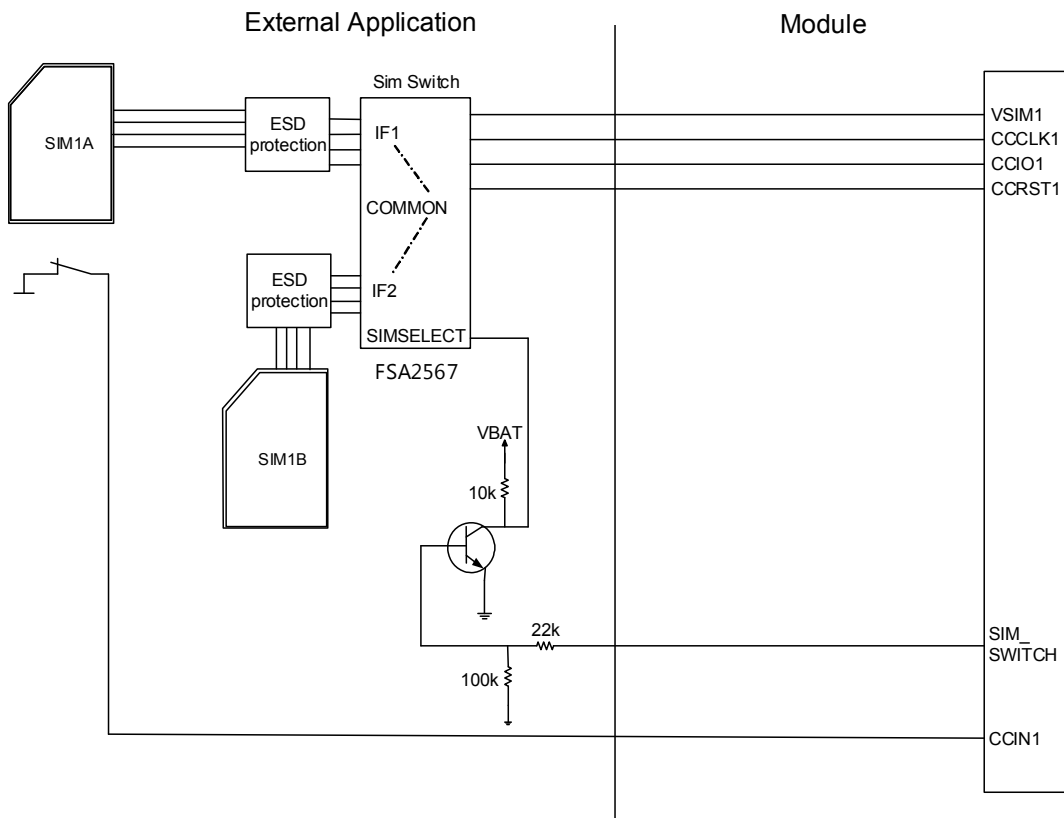


Figure 11: Sample circuit for SIM interface connection via SIM switch

## 2.1.7 GPIO Interface

PLSx3 offers a GPIO interface with 22 GPIO lines. The GPIO lines are shared with other interfaces or functions: Fast shutdown (see [Section 2.1.10.3](#)), Status LED (see [Section 2.1.10.1](#)), ASC0 (see [Section 2.1.4](#)), ASC1 (see [Section 2.1.5](#)) and SIM Switch (see [Section 2.1.6.2](#))

The following table shows the configuration variants for the GPIO pads. All variants are mutually exclusive, i.e. a pad configured for instance as Status LED is locked for alternative usage.

**Table 6:** GPIO lines and possible alternative assignment

| GPIO   | Fast Shutdown | Status LED | ASC0  | ASC1 | SIM SWITCH | DAI  |
|--------|---------------|------------|-------|------|------------|------|
| GPIO1  |               |            | DTR0  |      |            |      |
| GPIO2  |               |            | DCD0  |      |            |      |
| GPIO3  |               |            | DSR0  |      |            |      |
| GPIO4  | FST_SHDN      |            |       |      |            |      |
| GPIO5  |               | Status LED |       |      |            |      |
| GPIO6  |               |            |       |      |            |      |
| GPIO7  |               |            |       |      |            |      |
| GPIO8  |               |            |       |      |            |      |
| GPIO11 |               |            |       |      |            |      |
| GPIO12 |               |            |       |      |            |      |
| GPIO13 |               |            |       |      |            |      |
| GPIO14 |               |            |       |      |            |      |
| GPIO15 |               |            |       |      |            |      |
| GPIO16 |               |            |       | RXD1 |            |      |
| GPIO17 |               |            |       | TXD1 |            |      |
| GPIO18 |               |            |       | RTS1 |            |      |
| GPIO19 |               |            |       | CTS1 |            |      |
| GPIO20 |               |            |       |      |            | DOUT |
| GPIO21 |               |            |       |      |            | DIN  |
| GPIO24 |               |            | RING0 |      |            |      |
| GPIO25 |               |            |       |      |            |      |
| GPIO26 |               |            |       |      | SIM_SWITCH |      |

## 2.1.8 Digital Audio Interface

PLSx3 supports the digital audio interface that can be deployed as PCM or Inter\_IC Sound (I<sup>2</sup>S).

### 2.1.8.1 Pulse Code Modulation Interface

PLSx3's PCM interface can be used to connect audio devices capable of pulse code modulation. The PCM functionality is limited to the use of wideband codec with 16kHz sample rate only. The PCM interface runs at 16 kHz sample rate (62.5µs frame length), while the signal processing maintains this rate in a wideband AMR call or samples automatically down to 8kHz in a narrowband call. Therefore, the PCM sample rate is independent of the audio bandwidth of the call.

The PCM interface has the following characteristics:

- Master mode
- Long frame synchronization
- 16kHz/8kHz sample rate
- 256, 512, 1024 and 4096kHz bit clock at 16kHz sample rate
- 256, 512, and 2048kHz bit clock at 8kHz sample rate

[Table 7](#) lists the available PCM interface signals.

**Table 7:** Overview of PCM pin functions

| Signal name | Signal direction master | Description   |
|-------------|-------------------------|---|
| DOUT        | O                       | PCM Data from PLSx3 to external codec.  |
| DIN         | I                       | PCM Data from external codec to PLSx3.  |
| FSC         | O                       | Frame synchronization signal to external codec.   |
| BCLK        | O                       | Bit clock to external codec. Note: If the BCLK signal is permanently provided (AT^SAIC parameter <clk_mode> = 0), the module will no longer enter its power save (SLEEP) state. |
| MCLK        | -                       | Audio master clock. Be synchronous to BCLK to use in external codec. Can be switched on and off.  |

Note: PCM data is always formatted as 16-bit uncompressed two's complement. Also, all PCM data and frame synchronization signals are written to the PCM bus on the rising clock edge and read on the falling edge.

### 2.1.8.2 Inter-IC Sound Interface

The I<sup>2</sup>S Interface is a standardized bidirectional I<sup>2</sup>S based digital audio interface for transmission of mono voice signals for telephony services.

The I<sup>2</sup>S properties and capabilities comply with the requirements lay out in the Phillips I<sup>2</sup>S Bus Specifications, revised June 5, 1996.

The I<sup>2</sup>S interface has the following characteristics:

- Bit clock mode: Master
- Sampling rate: 8kHz (narrowband), 16kHz (wideband)
- 256kHz bit clock at 8kHz sample rate
- 512kHz bit clock at 16kHz sample rate

[Table 8](#) lists the available I<sup>2</sup>S interface signals

**Table 8:** Overview of I<sup>2</sup>S pin functions

| Signal name on SMT application interface | Signal configuration inactive | Signal direction Master | Description  |
|--|-------------------------------|-------------------------|--|
| DOUT                                     | PD                            | O                       | I <sup>2</sup> S data from PLSx3 to external codec   |
| DIN                                      | PD                            | I                       | I <sup>2</sup> S data from external codec to PLSx3   |
| FSC                                      | PD                            | O                       | Frame synchronization signal to external codec Word alignment (WS)                                     |
| BCLK                                     | PD                            | O                       | Bit clock to external codec. BCLK signal low/high time varies between 45% and 55% of its clock period. |

## 2.1.9 Analog-to-Digital Converter (ADC)

PLSx3 provides three unbalanced ADC input line: ADC[1...3]\_IN. They can be used to measure three independent, externally connected DC voltages in the range of 0.1V to 1.7V. They can be used especially for antenna diagnosing.

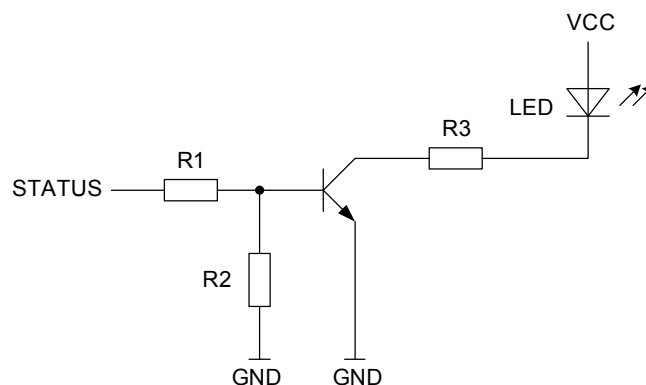
The AT<sup>^</sup>SRADC command can be employed to select the ADC line, set the measurement mode and read out the measurement results.

## 2.1.10 Control Signals

### 2.1.10.1 Status LED

The GPIO5 interface line can be configured to drive a status LED that indicates different operating mode (for GPIOs see [2.1.7](#)). GPIO and LED functionality are mutually exclusive.

To take advantage of this function connect an LED to the GPIO5/STATUS line as shown in [Figure 12](#)

**Figure 12:** Status signaling with LED driver

### 2.1.10.2 Power Indication

The power indication signal PWR\_IND notifies the on/off state of the module. High state of PWR\_IND indicates that the module is switched off. The state of PWR\_IND immediately changes to low when IGT is pulled low. For state detection an external pull-up resistor is required.

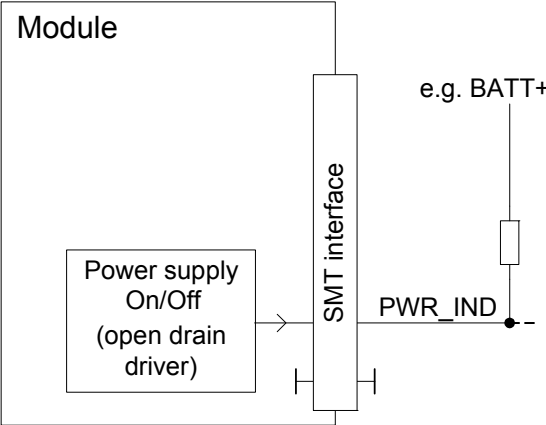


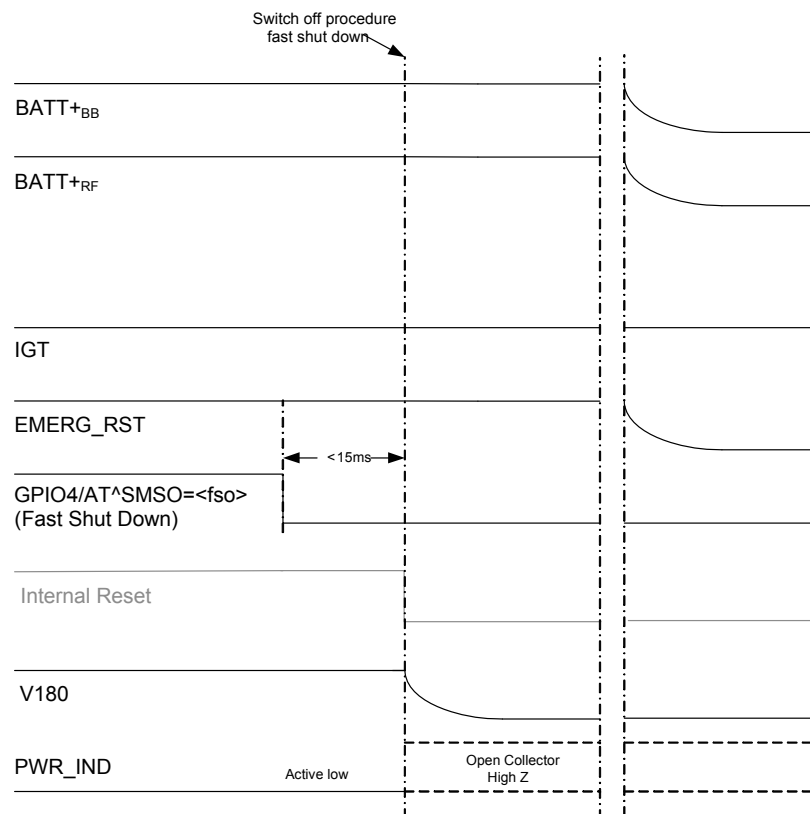
Figure 13: Power indication signal

### 2.1.10.3 Fast Shutdown

The GPIO4 interface line can be configured as fast shutdown signal line FST\_SHDN. The configured FST\_SHDN line is an active low control signal and must be applied for at least 1 millisecond. If unused this line can be left open because of a configured internal pull-up resistor. Before setting the FST\_SHDN line to low, the IGT signal should be set to high (see [Figure 14](#)).

The fast shutdown feature can be triggered using the AT command `AT^SMSO=<fso>`. For details see [\[1\]](#).

If triggered, a low impulse >1 milliseconds on the FST\_SHDN line starts the fast shutdown. The fast shutdown procedure still finishes any data activities on the module's flash file system, thus ensuring data integrity, but will no longer deregister gracefully from the network, thus saving the time required for network deregistration.



**Figure 14:** Fast shutdown timing

Please note that the normal software controlled shutdown using `AT^SMSO` will allow option for a fast shutdown by parameter `<fso>`, i.e., without network deregistration. However, in this case no URCs including shutdown URCs will be provided by the `AT^SMSO` command.

Please also note that the fast shutdown operation does not allow the module deregister from the network, therefore, this practice is not recommended, and should not be conducted on regular basis. If it is used for energy saving reason, for instance, used in battery-driven solutions that require prompt system shutdown before battery depletion, discretion is advised in such case.

### 2.1.10.4 Remote Wakeup

If no call, data or message transfer is in progress, the external host application may shut down its own module interfaces or other components in order to save power. If a call, data, or other request (URC) arrives, the external application can be notified of this event and be woken up again by a state transition of a configurable remote wakeup line. Available as remote wakeup lines are some GPIO signals (recommended is GPIO24). Please refer to [1]: AT^SCFG: "RemoteWakeUp/..." for details on how to configure these lines for defined wakeup events on specified device interfaces. Possible states are listed in Table 9.

If no line is specifically configured as remote wakeup signal, the remote USB suspend and resume mechanism as specified in the "Universal Serial Bus Specification Revision 2.0" applies for the USB interface (see Section 2.1.3). Possible states for the remote wakeup GPIO lines are listed in Table 9.

**Table 9:** Remote wakeup lines

| Signal | I/O/P | Description   |
|--------|-------|---|
| GPIOx  | O     | Inactive to active high transition:<br>0 = No wake up request<br>1 = The host shall wake up |



## 2.2 RF Antenna Interface

The PLSx3 GSM/UMTS/LTE antenna interface comprises a GSM/UMTS/LTE main antenna as well as a UMTS/LTE Rx diversity antenna to improve signal reliability and quality<sup>1</sup>. The RF interface has an impedance of 50Ω. PLSx3 is capable of sustaining a total mismatch at the antenna line without any damage, even when transmitting at maximum RF power.

The external antenna must be matched properly to achieve best performance regarding radiated power, modulation accuracy and harmonic suppression. Antenna matching networks are not included on the PLSx3 module and should be placed in the host application if the antenna does not have an impedance of 50Ω.

Regarding the return loss PLSx3 provides the following values in the active band:

**Table 10:** Return loss in the active band

| State of module | Return loss of module | Recommended return loss of application |
|-----------------|-----------------------|--|
| Receive         | ≥ 8dB                 | ≥ 12dB                                 |
| Transmit        | not applicable        | ≥ 12dB                                 |

1. By delivery default the UMTS/LTE Rx diversity antenna is configured as available for the module since its usage is mandatory for LTE. Please refer to [1] for details on how to configure antenna settings.

## 2.2.1 Antenna Interface Specifications

**Table 11:** RF Antenna interface GSM/UMTS/LTE

| Parameter   | Conditions  | Min. | Typical | Max. | Unit |
|---|---|------|---------|------|------|
| LTE connectivity  | Band 1,2,3,4,5,7,8,12,13,14,17,18,19,20,25,26,28,38,40,41,66,71 |      |         |      |      |
| Receiver Input Sensitivity<br>@ARP, Main Antenna,<br>Channel BW at 5 MHz<br>@25°C, 3.8V | LTE FDD 2100 Band 1   |      | TBD     |      | dBm  |
|   | LTE FDD 1900 Band 2   |      | TBD     |      | dBm  |
|   | LTE FDD 1800 Band 3   |      | TBD     |      | dBm  |
|   | LTE FDD 2100 Band 4   |      | TBD     |      | dBm  |
|   | LTE FDD 850 Band 5  |      | TBD     |      | dBm  |
|   | LTE FDD 2600 Band 7   |      | TBD     |      | dBm  |
|   | LTE FDD 900 Band 8  |      | TBD     |      | dBm  |
|   | LTE FDD 700 Band 12   |      | TBD     |      | dBm  |
|   | LTE FDD 700 Band 13   |      | TBD     |      | dBm  |
|   | LTE FDD 700 Band 14   |      | TBD     |      | dBm  |
|   | LTE FDD 700 Band 17   |      | TBD     |      | dBm  |
|   | LTE FDD 850 Band 18   |      | TBD     |      | dBm  |
|   | LTE FDD 850 Band 19   |      | TBD     |      | dBm  |
|   | LTE FDD 800 Band 20   |      | TBD     |      | dBm  |
|   | LTE FDD 1900 Band 25  |      | TBD     |      | dBm  |
|   | LTE FDD 850 Band 26   |      | TBD     |      | dBm  |
|   | LTE FDD 700 Band 28   |      | TBD     |      | dBm  |
|   | LTE TDD 2600 Band 38  |      | TBD     |      | dBm  |
|   | LTE TDD 2300 Band 40  |      | TBD     |      | dBm  |
| LTE TDD 2500 Band 41  |   | TBD  |         | dBm  |      |
| LTE FDD 2100 Band 66  |   | TBD  |         | dBm  |      |
| LTE FDD 600 Band 71   |   | TBD  |         | dBm  |      |

**Table 11:** RF Antenna interface GSM/UMTS/LTE

| Parameter  | Conditions           | Min. | Typical | Max. | Unit |
|--|----------------------|------|---------|------|------|
| Receiver Input Sensitivity<br>@ARP, Diversity Antenna,<br>Channel BW at 5 MHz<br>@25°C, 3.8V | LTE FDD 2100 Band 1  |      | TBD     |      | dBm  |
|  | LTE FDD 1900 Band 2  |      | TBD     |      | dBm  |
|  | LTE FDD 1800 Band 3  |      | TBD     |      | dBm  |
|  | LTE FDD 2100 Band 4  |      | TBD     |      | dBm  |
|  | LTE FDD 850 Band 5   |      | TBD     |      | dBm  |
|  | LTE FDD 2600 Band 7  |      | TBD     |      | dBm  |
|  | LTE FDD 900 Band 8   |      | TBD     |      | dBm  |
|  | LTE FDD 700 Band 12  |      | TBD     |      | dBm  |
|  | LTE FDD 700 Band 13  |      | TBD     |      | dBm  |
|  | LTE FDD 700 Band 14  |      | TBD     |      | dBm  |
|  | LTE FDD 700 Band 17  |      | TBD     |      | dBm  |
|  | LTE FDD 850 Band 18  |      | TBD     |      | dBm  |
|  | LTE FDD 850 Band 19  |      | TBD     |      | dBm  |
|  | LTE FDD 800 Band 20  |      | TBD     |      | dBm  |
|  | LTE FDD 1900 Band 25 |      | TBD     |      | dBm  |
|  | LTE FDD 850 Band 26  |      | TBD     |      | dBm  |
|  | LTE FDD 700 Band 28  |      | TBD     |      | dBm  |
|  | LTE TDD 2600 Band 38 |      | TBD     |      | dBm  |
|  | LTE TDD 2300 Band 40 |      | TBD     |      | dBm  |
|  | LTE TDD 2500 Band 41 |      | TBD     |      | dBm  |
| LTE FDD 2100 Band 66   |                      | TBD  |         | dBm  |      |
| LTE FDD 600 Band 71  |                      | TBD  |         | dBm  |      |

## 2.2 RF Antenna Interface

**Table 11:** RF Antenna interface GSM/UMTS/LTE

| Parameter  | Conditions           | Min.  | Typical | Max. | Unit |
|--|----------------------|-------|---------|------|------|
| RF Power @ARP with 50Ω Load (Board temperature<85°C, 5 MHz BW, 1RB Position Low) | LTE FDD 2100 Band 1  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 1900 Band 2  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 1800 Band 3  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 2100 Band 4  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 850 Band 5   | +21   | +23.0   |      | dBm  |
|  | LTE FDD 2600 Band 7  | +21   | +22.5   |      | dBm  |
|  | LTE FDD 900 Band 8   | +21   | +23.0   |      | dBm  |
|  | LTE FDD 700 Band 12  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 700 Band 13  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 700 Band 14  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 700 Band 17  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 850 Band 18  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 850 Band 19  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 800 Band 20  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 1900 Band 25 | +21   | +23.0   |      | dBm  |
|  | LTE FDD 850 Band 26  | +21   | +23.0   |      | dBm  |
|  | LTE FDD 700 Band 28  | +21   | +23.0   |      | dBm  |
|  | LTE TDD 2600 Band 38 | +21   | +23.0   |      | dBm  |
|  | LTE TDD 2300 Band 40 | +21   | +23.0   |      | dBm  |
|  | LTE TDD 2500 Band 41 | +21   | +23.0   |      | dBm  |
| LTE FDD 2100 Band 66   | +21                  | +23.0 |         | dBm  |      |
| LTE FDD 600 Band 71  | +21                  | +23.0 |         | dBm  |      |

## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter   | Conditions                      | Min. | Typical | Max. | Unit |
|---|---------------------------------|------|---------|------|------|
| UMTS connectivity                                       | Band I,II,III, IV,V,VI,VIII,XIX |      |         |      |      |
| Receiver Input Main Sensitivity @ ARP @25°C, 3.8V       | UMTS 2100 Band I                |      | TBD     |      | dBm  |
|   | UMTS 1900 Band II               |      | TBD     |      | dBm  |
|   | UMTS 1800 Band III              |      | TBD     |      | dBm  |
|   | UMTS 1700 Band IV               |      | TBD     |      | dBm  |
|   | UMTS 850 Band V                 |      | TBD     |      | dBm  |
|   | UMTS 850 Band VI                |      | TBD     |      | dBm  |
|   | UMTS 900 Band VIII              |      | TBD     |      | dBm  |
|   | UMTS 850 Band XIX               |      | TBD     |      | dBm  |
| Receiver Input Diversity Sensitivity @ ARP @25°C, 3.8V  | UMTS 2100 Band I                |      | TBD     |      | dBm  |
|   | UMTS 1900 Band II               |      | TBD     |      | dBm  |
|   | UMTS 1800 Band III              |      | TBD     |      | dBm  |
|   | UMTS 1700 Band IV               |      | TBD     |      | dBm  |
|   | UMTS 850 Band V                 |      | TBD     |      | dBm  |
|   | UMTS 850 Band VI                |      | TBD     |      | dBm  |
|   | UMTS 900 Band VIII              |      | TBD     |      | dBm  |
|   | UMTS 850 Band XIX               |      | TBD     |      | dBm  |
| RF Power @ ARP with 50Ohm Load Board temperature < 85°C | UMTS 2100 Band I                | +21  | +23.5   |      | dBm  |
|   | UMTS 1900 Band II               | +21  | +23.5   |      | dBm  |
|   | UMTS 1800 Band III              | +21  | +23.5   |      | dBm  |
|   | UMTS 1700 Band IV               | +21  | +23.5   |      | dBm  |
|   | UMTS 850 Band V                 | +21  | +23.5   |      | dBm  |
|   | UMTS 850 Band VI                | +21  | +23.5   |      | dBm  |
|   | UMTS 900 Band VIII              | +21  | +23.5   |      | dBm  |
|   | UMTS 850 Band XIX               | +21  | +23.5   |      | dBm  |
| GPRS coding schemes                                     | Class 12, CS1 to CS4            |      |         |      |      |
| EGPRS   | Class 12, MCS1 to MCS9          |      |         |      |      |
| GSM Class   | Small MS                        |      |         |      |      |
| Static Receiver input Sensitivity @ ARP                 | GSM 850                         |      | TBD     |      | dBm  |
|   | E-GSM 900                       |      | TBD     |      | dBm  |
|   | DCS 1800                        |      | TBD     |      | dBm  |
|   | PCS 1900                        |      | TBD     |      | dBm  |
| RF Power @ ARP with 50Ohm Load Board temperature < 85°C | GSM 850                         |      | 33      |      | dBm  |
|   | E-GSM 900                       |      | 33      |      | dBm  |
|   | DCS 1800                        |      | 30      |      | dBm  |
|   | PCS 1900                        |      | 30      |      | dBm  |

## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter   | Conditions | Min.      | Typical | Max. | Unit |     |
|---|------------|-----------|---------|------|------|-----|
| RF Power @ ARP<br>with 50Ohm Load,<br>(ROPR = 4, i.e. no reduction) | GPRS, 1 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
|   | EDGE, 1 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 2 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
|   | EDGE, 2 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 3 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
|   | EDGE, 3 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 4 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
| EDGE, 4 TX  | GSM 850    |           | 27      |      | dBm  |     |
|   | E-GSM 900  |           | 27      |      | dBm  |     |
|   | DCS 1800   |           | 26      |      | dBm  |     |
|   | PCS 1900   |           | 26      |      | dBm  |     |

## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter   | Conditions | Min.      | Typical | Max. | Unit |     |
|---|------------|-----------|---------|------|------|-----|
| RF Power @ ARP<br>with 50Ohm Load,<br>(ROPR =5, i.e. partial reduction) | GPRS, 1 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
|   | EDGE, 1 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 2 TX | GSM 850   |         | 33   |      | dBm |
|   |            | E-GSM 900 |         | 33   |      | dBm |
|   |            | DCS 1800  |         | 30   |      | dBm |
|   |            | PCS 1900  |         | 30   |      | dBm |
|   | EDGE, 2 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 3 TX | GSM 850   |         | 32.2 |      | dBm |
|   |            | E-GSM 900 |         | 32.2 |      | dBm |
|   |            | DCS 1800  |         | 29.2 |      | dBm |
|   |            | PCS 1900  |         | 29.2 |      | dBm |
|   | EDGE, 3 TX | GSM 850   |         | 27   |      | dBm |
|   |            | E-GSM 900 |         | 27   |      | dBm |
|   |            | DCS 1800  |         | 26   |      | dBm |
|   |            | PCS 1900  |         | 26   |      | dBm |
|   | GPRS, 4 TX | GSM 850   |         | 31   |      | dBm |
|   |            | E-GSM 900 |         | 31   |      | dBm |
|   |            | DCS 1800  |         | 28   |      | dBm |
|   |            | PCS 1900  |         | 28   |      | dBm |
| EDGE, 4 TX  | GSM 850    |           | 27      |      | dBm  |     |
|   | E-GSM 900  |           | 27      |      | dBm  |     |
|   | DCS 1800   |           | 26      |      | dBm  |     |
|   | PCS 1900   |           | 26      |      | dBm  |     |

## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter  | Conditions | Min.      | Typical | Max. | Unit |     |
|--|------------|-----------|---------|------|------|-----|
| RF Power @ ARP<br>with 50Ohm Load,<br>(ROPR = 6, i.e. partial reduction) | GPRS, 1 TX | GSM 850   |         | 33   |      | dBm |
|  |            | E-GSM 900 |         | 33   |      | dBm |
|  |            | DCS 1800  |         | 30   |      | dBm |
|  |            | PCS 1900  |         | 30   |      | dBm |
|  | EDGE, 1 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 2 TX | GSM 850   |         | 32   |      | dBm |
|  |            | E-GSM 900 |         | 32   |      | dBm |
|  |            | DCS 1800  |         | 29   |      | dBm |
|  |            | PCS 1900  |         | 29   |      | dBm |
|  | EDGE, 2 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 3 TX | GSM 850   |         | 30.2 |      | dBm |
|  |            | E-GSM 900 |         | 30.2 |      | dBm |
|  |            | DCS 1800  |         | 27.2 |      | dBm |
|  |            | PCS 1900  |         | 27.2 |      | dBm |
|  | EDGE, 3 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 4 TX | GSM 850   |         | 29   |      | dBm |
|  |            | E-GSM 900 |         | 29   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
| EDGE, 4 TX   | GSM 850    |           | 27      |      | dBm  |     |
|  | E-GSM 900  |           | 27      |      | dBm  |     |
|  | DCS 1800   |           | 26      |      | dBm  |     |
|  | PCS 1900   |           | 26      |      | dBm  |     |



## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter  | Conditions | Min.      | Typical | Max. | Unit |     |
|--|------------|-----------|---------|------|------|-----|
| RF Power @ ARP<br>with 50Ohm Load,<br>(ROPR = 7, i.e. partial reduction) | GPRS, 1 TX | GSM 850   |         | 33   |      | dBm |
|  |            | E-GSM 900 |         | 33   |      | dBm |
|  |            | DCS 1800  |         | 30   |      | dBm |
|  |            | PCS 1900  |         | 30   |      | dBm |
|  | EDGE, 1 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 2 TX | GSM 850   |         | 30   |      | dBm |
|  |            | E-GSM 900 |         | 30   |      | dBm |
|  |            | DCS 1800  |         | 27   |      | dBm |
|  |            | PCS 1900  |         | 27   |      | dBm |
|  | EDGE, 2 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 3 TX | GSM 850   |         | 28.2 |      | dBm |
|  |            | E-GSM 900 |         | 28.2 |      | dBm |
|  |            | DCS 1800  |         | 25.2 |      | dBm |
|  |            | PCS 1900  |         | 25.2 |      | dBm |
|  | EDGE, 3 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 4 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 24   |      | dBm |
|  |            | PCS 1900  |         | 24   |      | dBm |
| EDGE, 4 TX   | GSM 850    |           | 27      |      | dBm  |     |
|  | E-GSM 900  |           | 27      |      | dBm  |     |
|  | DCS 1800   |           | 26      |      | dBm  |     |
|  | PCS 1900   |           | 26      |      | dBm  |     |

## 2.2 RF Antenna Interface

Table 11: RF Antenna interface GSM/UMTS/LTE

| Parameter  | Conditions | Min.      | Typical | Max. | Unit |     |
|--|------------|-----------|---------|------|------|-----|
| RF Power @ ARP<br>with 50Ohm Load,<br>(ROPR = 8, i.e. max reduction) | GPRS, 1 TX | GSM 850   |         | 33   |      | dBm |
|  |            | E-GSM 900 |         | 33   |      | dBm |
|  |            | DCS 1800  |         | 30   |      | dBm |
|  |            | PCS 1900  |         | 30   |      | dBm |
|  | EDGE, 1 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 26   |      | dBm |
|  |            | PCS 1900  |         | 26   |      | dBm |
|  | GPRS, 2 TX | GSM 850   |         | 30   |      | dBm |
|  |            | E-GSM 900 |         | 30   |      | dBm |
|  |            | DCS 1800  |         | 27   |      | dBm |
|  |            | PCS 1900  |         | 27   |      | dBm |
|  | EDGE, 2 TX | GSM 850   |         | 24   |      | dBm |
|  |            | E-GSM 900 |         | 24   |      | dBm |
|  |            | DCS 1800  |         | 23   |      | dBm |
|  |            | PCS 1900  |         | 23   |      | dBm |
|  | GPRS, 3 TX | GSM 850   |         | 28.2 |      | dBm |
|  |            | E-GSM 900 |         | 28.2 |      | dBm |
|  |            | DCS 1800  |         | 25.2 |      | dBm |
|  |            | PCS 1900  |         | 25.2 |      | dBm |
|  | EDGE, 3 TX | GSM 850   |         | 22.2 |      | dBm |
|  |            | E-GSM 900 |         | 22.2 |      | dBm |
|  |            | DCS 1800  |         | 21.2 |      | dBm |
|  |            | PCS 1900  |         | 21.2 |      | dBm |
|  | GPRS, 4 TX | GSM 850   |         | 27   |      | dBm |
|  |            | E-GSM 900 |         | 27   |      | dBm |
|  |            | DCS 1800  |         | 24   |      | dBm |
|  |            | PCS 1900  |         | 24   |      | dBm |
| EDGE, 4 TX   | GSM 850    |           | 21      |      | dBm  |     |
|  | E-GSM 900  |           | 21      |      | dBm  |     |
|  | DCS 1800   |           | 20      |      | dBm  |     |
|  | PCS 1900   |           | 20      |      | dBm  |     |

**Table 12:** RF Antenna interface LTE for -J variant (at operating temperature range)

| Parameter   | Condition           | Min. | Typical | Max. | Unit |
|---|---------------------|------|---------|------|------|
| LTE connectivity  | Band 1,3,8,18,19,26 |      |         |      |      |
| Receiver Input Sensitivity<br>@ARP, Combiner Antenna,<br>Channel BW at 10MHz<br>@25°C, 3.8V | LTE FDD 2100 Band 1 |      | -102.2  |      | dBm  |
|   | LTE FDD 1800 Band 3 |      | -102.2  |      | dBm  |
|   | LTE FDD 900 Band 8  |      | -101.9  |      | dBm  |
|   | LTE FDD 850 Band 18 |      | -101    |      | dBm  |
|   | LTE FDD 850 Band 19 |      | -100.3  |      | dBm  |
|   | LTE FDD 850 Band 26 |      | -100.8  |      | dBm  |

### 2.2.2 Antenna Installation

The antenna is connected by soldering the antenna pads (ANT\_MAIN, ANT\_DRX and ANT\_GNSS) and their neighboring ground pads directly to the application’s PCB.

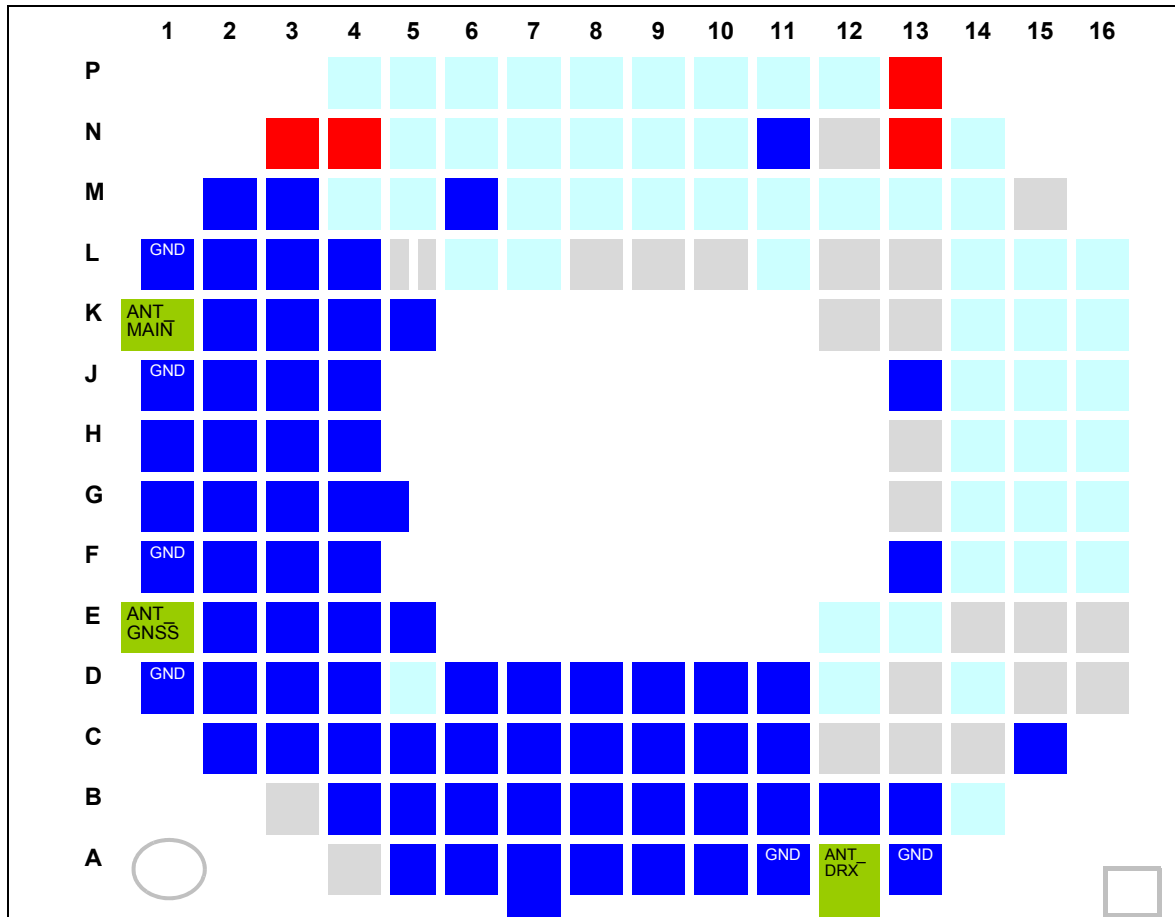


Figure 15: Antenna pads (bottom view)

The distance between the antenna pads and their neighboring GND pads has been optimized for best possible impedance. To prevent mismatch, special attention should be paid to these pads on the application’ PCB.

The wiring of the antenna connection, starting from the antenna pad to the application’s antenna should result in a 50Ω line impedance. Line width and distance to the GND plane need to be optimized with regard to the PCB’s layer stack. Some examples are given in Section 2.2.3.

To prevent receiver desensitization due to interferences generated by fast transients like high speed clocks on the external application PCB, it is recommended to realize the antenna connection line using embedded Stripline rather than Micro-Stripline technology. Please see Section 2.2.3 for examples of how to design the antenna connection in order to achieve the required 50Ω line impedance.

For type approval purposes, the use of a 50Ω coaxial antenna connector (U.FL-R-SMT) might be necessary. In this case the U.FL-R-SMT connector should be placed as close as possible to PLSx3’s antenna pad.

## 2.2.3 RF Line Routing Design

### 2.2.3.1 Line Arrangement Examples

Several dedicated tools are available to calculate line arrangements for specific applications and PCB materials - for example from <http://www.polarinstruments.com/> (commercial software) or from <http://www.awr.com/awr-software/options/tx-line/> (free software).

#### Embedded Stripline

This figure below shows a line arrangement example for embedded stripline.

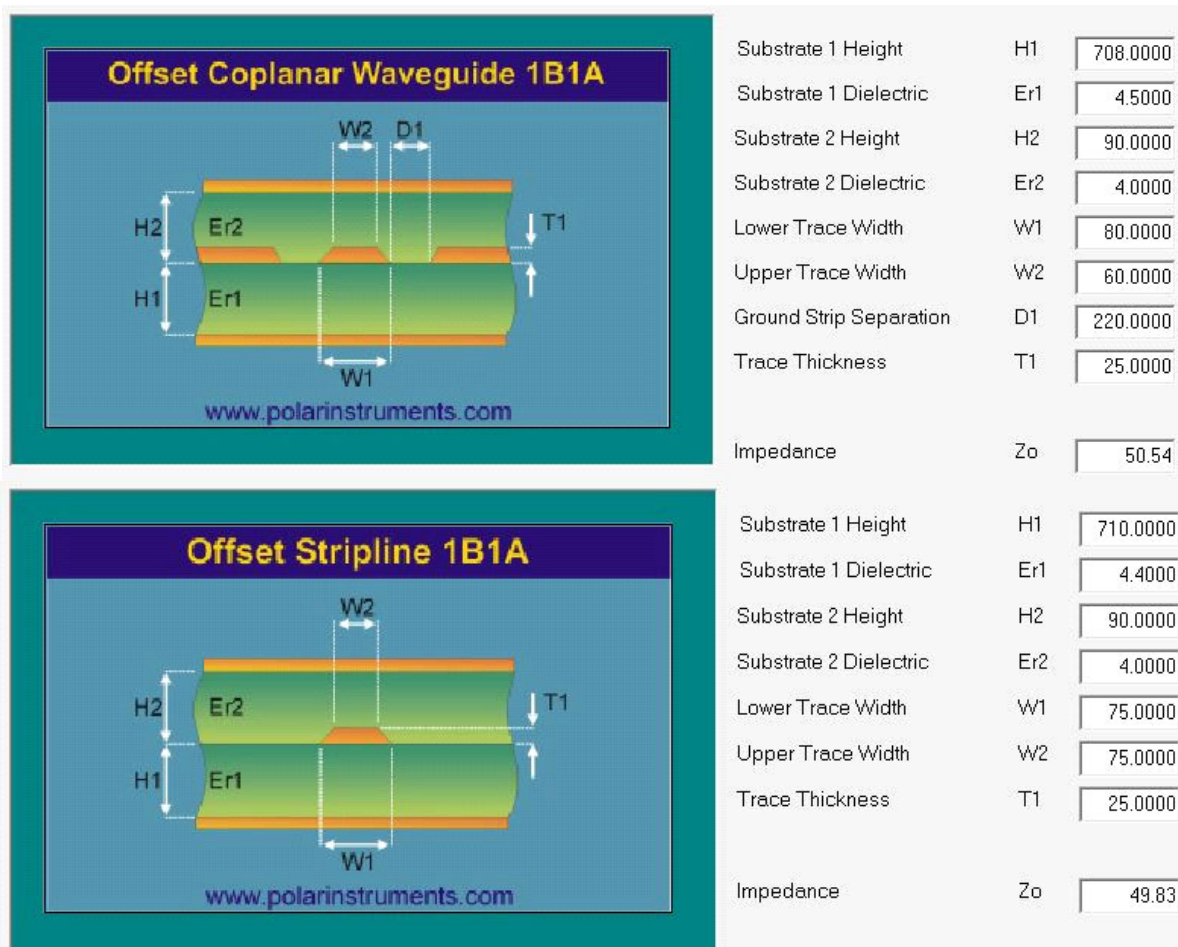


Figure 16: Embedded stripline arrangement example

**Micro-Stripline**

This section gives two line arrangement examples for micro-stripline.



Notes

Figure 17: Micro-Stripline arrangement example

### 2.2.3.2 Routing Example

#### Interface to RF Connector

Figure 18 and Figure show a sample connection of a module's antenna pad at the bottom layer of the module PCB with an application PCB's coaxial antenna connector. Line impedance depends on line width, but also on other PCB characteristics like dielectric, height and layer gap. The sample stripline width of 0.33mm/0.8mm and the space of 0.625mm/0.173mm are only recommended for an application with a PCB layer stack resembling the one of the PLSx3 evaluation board, and with layer 2 as well as layer 3 cut clear. For different layer stacks the stripline width will have to follow stripline routing rules, avoiding 90 degree comers and using the shortest distance to the PCB's coaxial antenna connector.

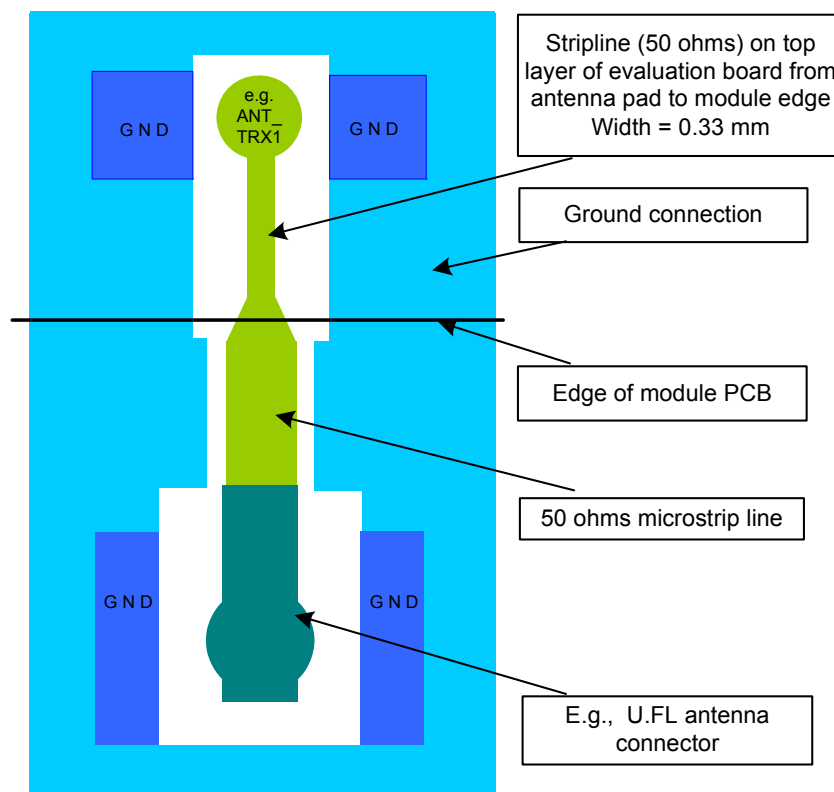


Figure 18: Routing to application's RF connector

2.2 RF Antenna Interface

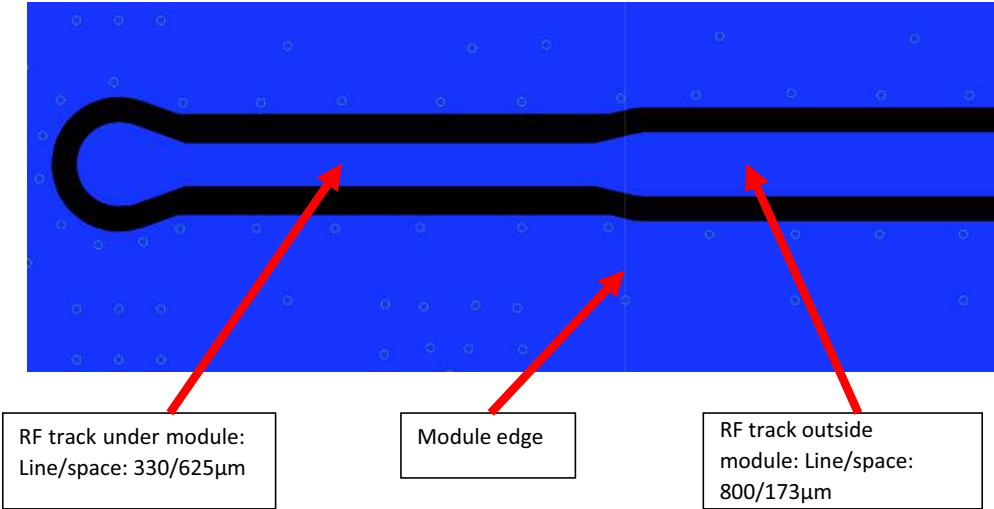


Figure 19: Routing Detail



## 2.3 GNSS Antenna Interface

In addition to the RF antenna interface PLSx3 also has a GNSS antenna interface. See [Section 2.1.1](#) to find out where the GNSS antenna pad is located. The GNSS pad's shape is the same as for the RF antenna interface (see [Section 2.2.2](#)).

It is possible to connect active or passive GNSS antennas. In either case they must have 50Ω impedance. The simultaneous operation of GSM/UMTS/LTE and GNSS is implemented. For electrical characteristics see [Section 2.2](#).

PLSx3 provides the signal VGNSS to enable an active GNSS antenna power supply. [Figure 20](#) shows the flexibility in realizing the power supply for an active GNSS antenna by giving a sample circuit realizing the supply voltage for an active GNSS antenna.

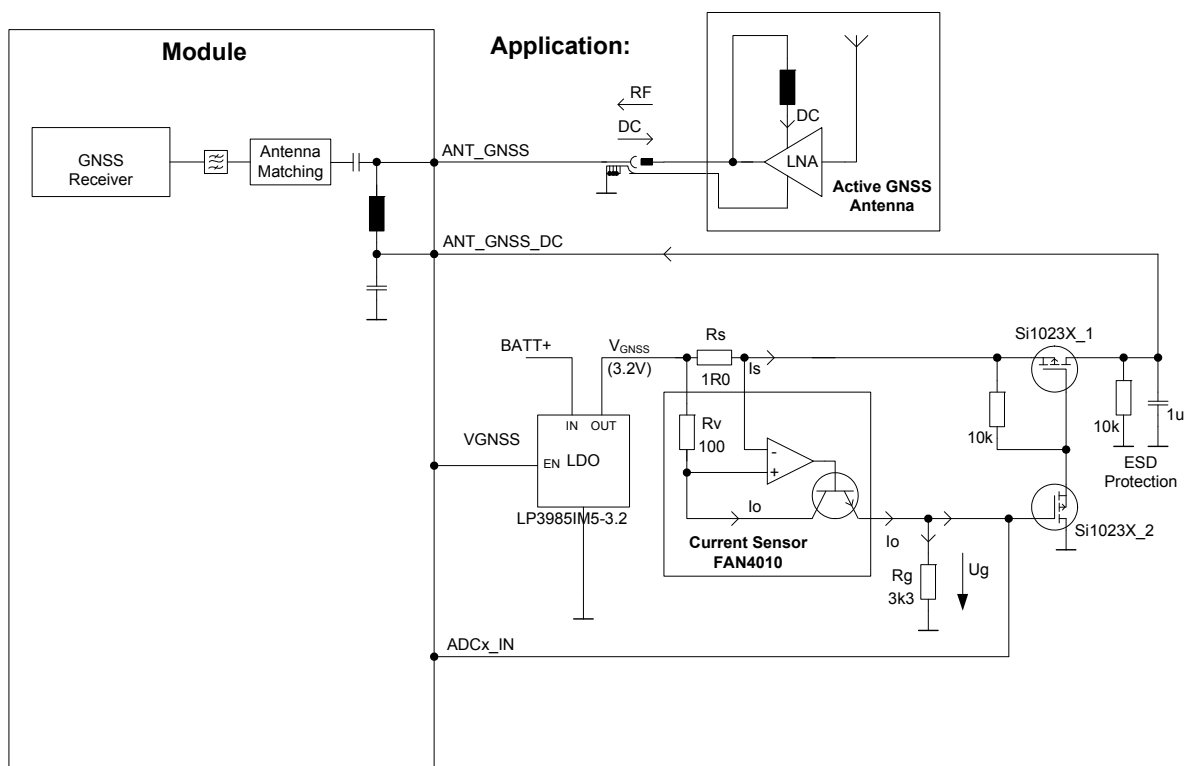


Figure 20: Supply voltage for active GNSS antenna

2.3 GNSS Antenna Interface

Figure 21 shows a sample circuit realizing ESD protection for a passive GNSS antenna. Connecting the input ANT\_GNSS\_DC to GND prevents ESD from coupling into the module.

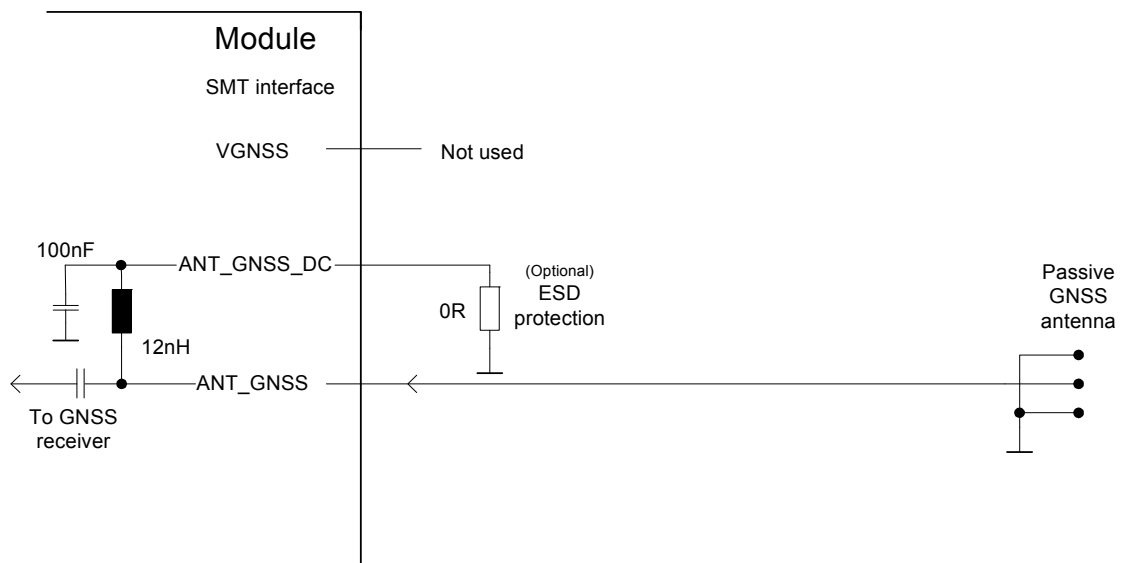


Figure 21: ESD protection for passive GNSS antenna

### 2.3.1 GNSS Antenna Diagnostic

GNSS antenna diagnosis does require an external detection circuit. The antenna DC supply current can be measured via ADCx\_IN. The ADCx\_IN input voltage (Ug) may be generated by a sample circuit shown in Figure 20. The circuit allows to check the presence and the connection status of an active GNSS antenna. Passive GNSS antennas cannot be detected. Therefore, GNSS antenna detection is only available in active GNSS antenna mode. This mode is configured by the AT command: AT^SGPSC (for details see [1])

Having enabled the active GNSS antenna mode the presence and connection status of an active GNSS antenna can be checked using the AT command AT^SRADC to monitor ADCx\_IN. The following table lists sample current ranges for possible antenna states as well as sample voltage ranges as possible decision thresholds to distinguish between the antenna connection states. Please refer to [1] for more information on the command AT^SRADC.

Table 13: Sample ranges of the GNSS antenna diagnostic measurements and their possible meaning

| Antenna connection status   | Current ranges (I <sub>S</sub> ) <sup>1</sup> | Voltage ranges (U <sub>G</sub> ) |
|---|---|----------------------------------|
| Antenna not connected   | <1.4mA  |                                  |
| Decision threshold  |   | 59mV ±20%                        |
| Antenna connected   | 2.2mA...20mA                                  |                                  |
| Decision threshold  |   | 825mV ±20%                       |
| Antenna short circuited to ground   | >30mA   |                                  |
| GNSS antenna detection is not possible because GNSS antenna power supply is switched off. | --  |                                  |

1. Please note that the mA ranges 1.4mA...2.2mA and 20mA...30mA are tolerance ranges. The decision threshold should be defined within these ranges.

## 2.4 Sample Application

Figure 22 shows a typical example of how to integrate a PLSx3 module with an application. Usage of the various host interfaces depends on the desired features of the application.

Because of the very low power consumption design, current flowing from any other source into the module circuit must be avoided, for example reverse current from high state external control lines. Therefore, the controlling application must be designed to prevent reverse current flow. Otherwise there is the risk of undefined states of the module during startup and shutdown or even of damaging the module.

Because of the high RF field density inside the module, it cannot be guaranteed that no self interference might occur, depending on frequency and the applications grounding concept. The potential interferers may be minimized by placing small capacitors (47pF) at suspected lines (e.g. RXD0, VDDL, and ON).

**While developing SMT applications it is strongly recommended to provide test points for certain signals, i.e., lines to and from the module - for debug and/or test purposes. The SMT application should allow for an easy access to these signals. For details on how to implement test points see [4].**

The EMC measures are best practice recommendations. In fact, an adequate EMC strategy for an individual application is very much determined by the overall layout and, especially, the position of components. For example, mounting the internal acoustic transducers directly on the PCB eliminates the need to use the ferrite beads shown in the sample schematic.

### Disclaimer

No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 22 and the information detailed in this section. As functionality and compliance with national regulations depend to a great amount on the used electronic components and the individual application layout manufacturers are required to ensure adequate design and operating safeguards for their products using PLSx3 modules.

2.4 Sample Application

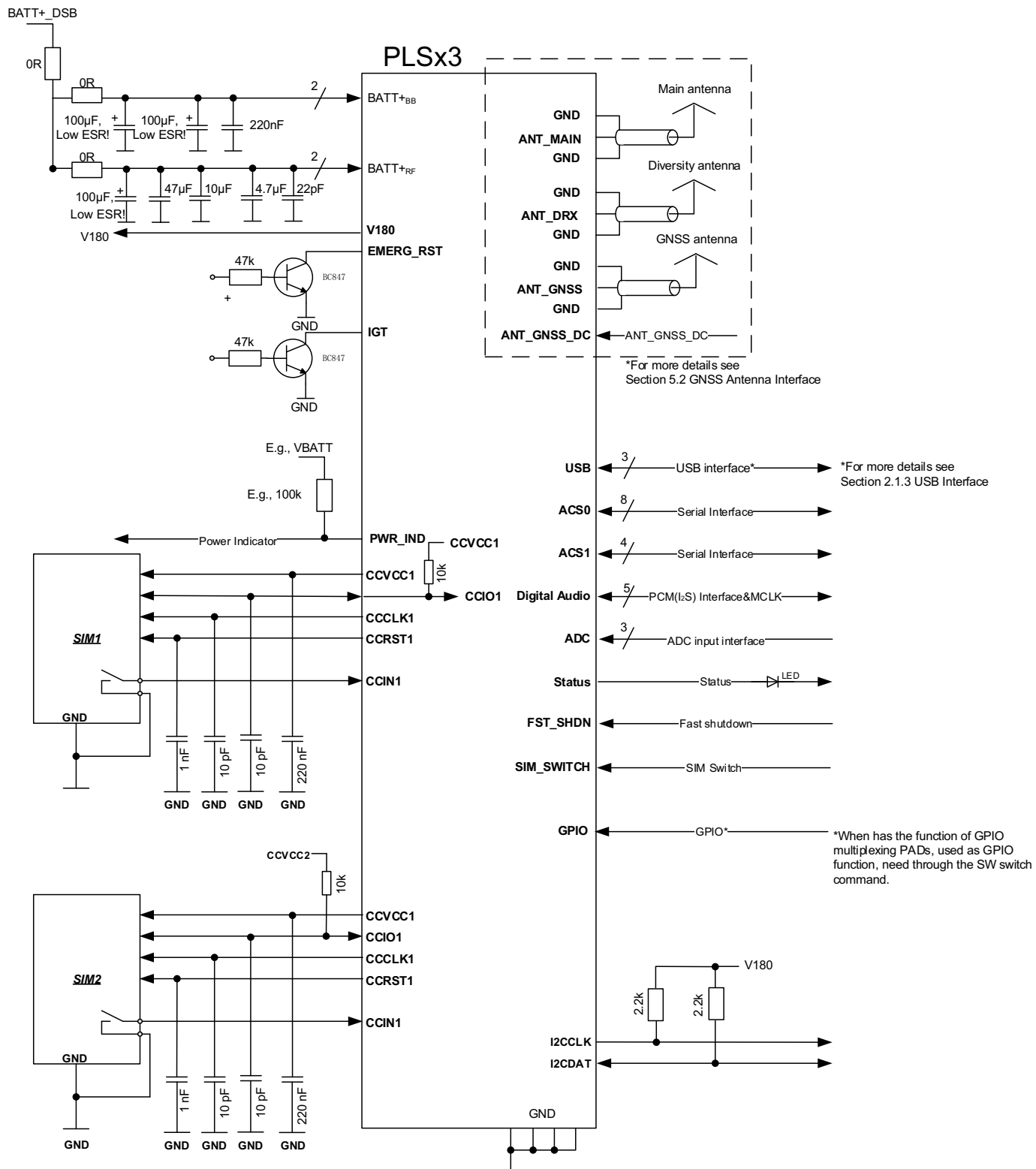


Figure 22: Schematic diagram of PLSx3 sample application

## 3 Operating Characteristics

### 3.1 Operating Modes

The table below briefly summarizes the various operating modes referred to throughout the document.

**Table 14:** Overview of operating modes

| Mode             | Function  |   |
|------------------|---|---|
| Normal operation | GSM / GPRS / UMTS / HSPA / LTE SLEEP  | Power saving set automatically when no call is in progress and the USB connection is suspended by host or not present and no active communication via ASC0.   |
|                  | GSM / GPRS / UMTS / HSPA / LTE IDLE   | Power saving disabled or an USB connection not suspended, but no call in progress.  |
|                  | GSM TALK/ GSM DATA  | Connection between two subscribers is in progress. Power consumption depends on the GSM network coverage and several connection settings (e.g. DTX off/on, FR/EFR/HR, hopping sequences and antenna connection). The following applies when power is to be measured in TALK_GSM mode: DTX off, FR and no frequency hopping. |
|                  | GPRS DATA   | GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).   |
|                  | EGPRS DATA  | EGPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and EGPRS configuration (e.g. used multislot settings).   |
|                  | UMTS TALK/ UMTS DATA  | UMTS data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.  |
|                  | HSPA DATA   | HSPA data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.  |
|                  | LTE TALK/ LTE DATA  | LTE data transfer in progress. Power consumption depends on network settings (e.g. TPC Pattern) and data transfer rate.   |
| Power Down       | Normal shutdown after sending the power down command. Only a voltage regulator is active for powering the RTC. Software is not active. Interfaces are not accessible. Operating voltage remains applied.                                |   |
| Airplane mode    | Airplane mode shuts down the radio part of the module, causes the module to log off from the network and disables all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see [1]). |   |

## 3.2 Power Up/Power Down Scenarios

In general, be sure not to turn on PLSx3 while it is beyond the safety limits of voltage and temperature stated in [Section 2.1.2.1](#). PLSx3 immediately switches off after having started and detected these inappropriate conditions. In extreme cases this can cause permanent damage to the module.

### 3.2.1 Turn on PLSx3

After the operating voltage BATT+ is applied, PLSx3 can be switched on by means of the IGT signal.

The IGT signal turns on the module if the module is in power down mode. The IGT signal is low level triggered. The module starts in the operating mode with a continuous low level signal. It is recommended to pull the IGT signal to GND directly when powering on. The low pulse width must be longer than 300ms as shown in [Figure 23](#).

When a automatic power-on is needed, IGT can always be connected to GND.

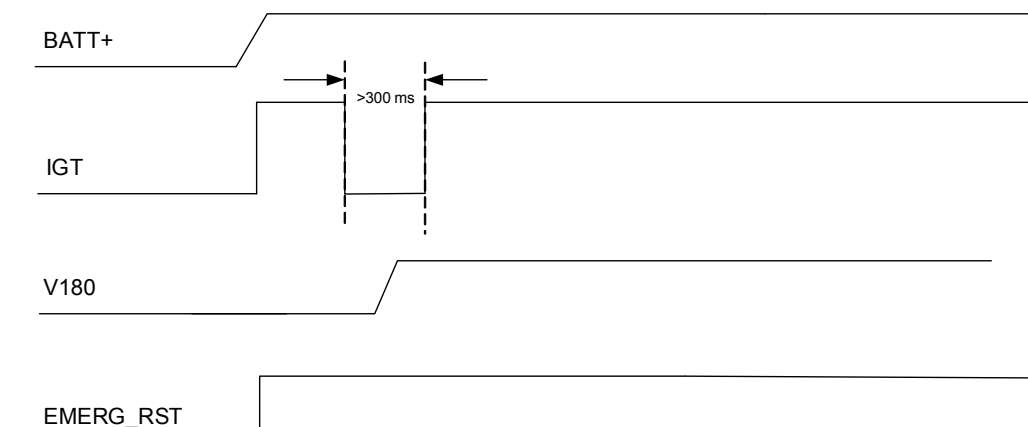


Figure 23: IGT timing

### 3.2.2 Restart PLSx3

To switch the module off the following procedures may be used:

- Software controlled restart procedure: Software controlled by sending an AT command over the serial application interface. See [Section 3.2.2.1](#).
- Hardware controlled restart procedure: Hardware controlled by using the EMERG\_RST line (see [Section 3.2.2.2](#)).

#### 3.2.2.1 Restart PLSx3 Using Restart Command

After startup PLSx3 can be re-started using the AT+CFUN command. For details see [\[1\]](#)

### 3.2.2.2 Restart PLSx3 Using EMERG\_RST

The EMERG\_RST signal is internally connected to the baseband processor. A low level >200ms sets the processor and all signals to the reset states, and thus restart the module.

Please note that if the EMERG\_RST signal is not released, i.e., changed from low to high, after a restart, the module will be repeatedly restarted. When the timer of the EMERG\_RST signal is more than 8000ms, the module will be switched off directly.

It is strongly recommended to control this EMERG\_RST line with an open collector transistor or an open drain field-effect transistor.

*Caution: Use the EMERG\_RST line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG\_RST line causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if PLSx3 does not respond, if reset or shutdown via AT command fails.*

### 3.2.3 Signal States after Startup

Table 15 lists the states each interface signal passes through during reset phase and the first firmware initialization. For further firmware startup initializations the values may differ because of different GPIO line configurations.

After the reset state has been reached the firmware initialization state begins. The firmware initialization is completed as soon as the ASC0 interface lines CTS0, DSR0 and RING0 have turned low (see Section 2.1.4 and Section 2.1.5). Now, the module is ready to receive and transmit data.

Table 15: Pull-up and Pull-down Values

| Signal name       | Reset state | First start up configuration |
|-------------------|-------------|------------------------------|
| RXD0              | PD          | O/H                          |
| TXD0              | PD          | PD                           |
| RTS0              |             |                              |
| CTS0              | PD          | O/L                          |
| STATUS/GPIO5      | PD          | PD                           |
| DSR0/GPIO3        | PD          | O/L                          |
| DCD0/GPIO2        | PD          | O/H                          |
| RING0/GPIO24      | PD          | O/H                          |
| RXD1/GPIO16       | PD          | O/H                          |
| TXD1/GPIO17       | PD          | PD                           |
| RTS1/GPIO18       | PD          | PD                           |
| CTS1/GPIO19       | O/H         | O/H                          |
| GPIO6-8           | PD          | PD                           |
| GPIO11-13         | PD          | PD                           |
| GPIO14-15         |             |                              |
| GPIO25            | I           | I                            |
| DOUT/GPIO20       | PD          | PD                           |
| DIN/GPIO21        | PD          | O/H                          |
| SIM_SWITCH/GPIO26 | PD          | PD                           |
| FAST_SHDN/GPIO4   | PD          | PD                           |

**Note:** the values above are stored as non-volatile, any changes of the value will take effect after next power-cycle and remain effective before any change happens again.

Abbreviations used in above Table 15:

|  |  |
|--|--|
| L = Low level<br>H = High level<br>T = Tristate<br>I = Input | O = Output<br>OD = Open Drain<br>PD = Pull down, 200µA at 1.9V<br>PU = Pull up, -240µA at 0V |
|--|--|



### 3.2.4 Turn off PLSx3

To switch the module off the following procedures may be used:

- Software controlled shutdown procedure: Software controlled by sending an AT command over the serial application interface. See [Section 3.2.4.1](#)
- Hardware controlled shutdown procedure: Hardware controlled by setting the FST\_SHDN line to low. See [Section 2.1.10.3](#)
- Automatic shutdown (software controlled): See [Section 3.2.5](#)
  - Take effect if PLSx3 board temperature exceeds a critical limit, or if
  - Undervoltage or overvoltage is detected.

#### 3.2.4.1 Switch off PLSx3 Using AT Command

The best and safest approach to powering down the module is to issue the AT<sup>^</sup>SMSO command. This procedure lets the module log off from the network and allows the software to enter into a secure state and to save data before disconnecting the power supply. The shutdown procedure will be an active process for about 2 seconds (depending on environmental conditions such as network states) until the module switches off.

A low level of the V180 signal as well as the URC "<sup>^</sup>SHUTDOWN" indicate that the switch off procedure has completed and the module has entered the Power Down mode.

### 3.2.5 Automatic Shutdown

Automatic shutdown takes effect if the following event occurs:

- PLSx3 board is exceeding the critical limits of overtemperature or undertemperature (see [Section 3.2.5.1](#))
- Undervoltage or overvoltage is detected (see [Section 3.2.5.2](#) and [Section 3.2.5.3](#))

The automatic shutdown procedure is equivalent to the power-down initiated with an AT command, i.e. PLSx3 logs off from the network and the software enters a secure state avoiding loss of data.

#### 3.2.5.1 Thermal Shutdown

The board temperature is constantly monitored by an internal NTC resistor located on the PCB. The values detected by the NTC resistor are measured directly on the board and therefore, are not fully identical with the ambient temperature.

Each time the board temperature goes out of range or back to normal, PLSx3 instantly displays an alert (if enabled).

- URCs indicating the level "1" or "-1" allow the user to take appropriate precautions, such as protecting the module from exposure to extreme conditions. The presentation of the URCs depends on the settings selected with the AT<sup>^</sup>SCTM write command (for details see [\[1\]](#)):  
AT<sup>^</sup>SCTM=1: Presentation of URCs is always enabled.  
AT<sup>^</sup>SCTM=0 (default): Presentation of URCs is enabled during the 2 minute guard period after start-up of PLSx3. After expiry of the 2 minute guard period, the presentation of URCs will be disabled, i.e. no URCs with alert levels "1" or "-1" will be generated.
- URCs indicating the level "2" or "-2" are instantly followed by an orderly shutdown after 5 seconds unless the temperature returns to a valid operating level ("1", "0", "-1") or the shutdown ability was disabled with AT<sup>^</sup>SCFG, "MEopMode/ShutdownOnCritTemp", <sdoct>. The presentation of these URCs is always enabled, i.e. they will be output even though the

factory setting AT^SCTM=0 was never changed.

The maximum temperature ratings are stated in [Section 3.6](#). Refer to [Table 16](#) for the associated URCs.

**Table 16:** Temperature associated URCs

| Sending temperature alert (2min after PLSx3 start-up, otherwise only if URC presentation enabled) |   |
|---|---|
| ^SCTM_B: 1  | Board close to overtemperature limit.                                   |
| ^SCTM_B: -1   | Board close to undertemperature limit.                                  |
| ^SCTM_B: 0  | Board back to non-critical temperature range.                           |
| Automatic shutdown (URC appears no matter whether or not presentation was enabled)                |   |
| ^SCTM_B: 2  | Alert: Board equal or beyond overtemperature limit. PLSx3 switches off. |
| ^SCTM_B: -2   | Alert: Board equal or below undertemperature limit. PLSx3 switches off. |

### 3.2.5.2 Undervoltage Shutdown

The undervoltage shutdown threshold is the specified minimum supply voltage VBATT+ given in [Table 3](#). When the average supply voltage measured by PLSx3 approaches the undervoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

^SBC: Undervoltage Shutdown

If the undervoltage persists the module will send the URC several times before switching off automatically.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

### 3.2.5.3 Overvoltage Shutdown

The overvoltage shutdown threshold is the specified maximum supply voltage VBATT+ given in [Table 3](#). When the supply voltage approaches the overvoltage shutdown threshold, the module will send the following URC:

^SBC: Overvoltage Shutdown

The overvoltage warning is sent only once before the module is close to the overvoltage shutdown threshold again.

This type of URC does not need to be activated by the user. It will be output automatically when fault conditions occur.

Keep in mind that several PLSx3 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of PLSx3, even if the module is switched off. Especially the power amplifier is very sensitive to high voltage and might even be destroyed

### 3.2.5.4 Deferred Shutdown at Extreme Temperature Condition

In the following cases, automatic shutdown will be deferred if a critical temperature limit is exceeded:

- While an emergency call is in progress.
- During a two minute guard period after power-up. This guard period has been introduced in order to allow for the user to make an emergency call. The start of any one of these calls extends the guard period until the end of the call. Any other network activity may be terminated by shutdown upon expiry of the guard time.

While in a "deferred shutdown" situation, PLSx3 continues to measure the temperature and to deliver alert messages, but deactivates the shutdown functionality. Once the 2 minute guard period is expired or the call is terminated, full temperature control will be resumed. If the temperature is still out of range, PLSx3 switches off immediately (without another alert message).

**Caution:** Automatic shutdown is a safety feature intended to prevent damage to the module. Extended usage of the deferred shutdown facilities provided may result in damage to the module, and possibly other severe consequences.

## 3.3 Power Saving

PLSx3 is able to reduce its functionality to a minimum (during the so-called SLEEP mode and SUSPEND mode) in order to minimize its current consumption. The following sections explain the module's network dependent power saving behavior. The power saving behavior is further configurable by AT command:

- When all serial interfaces (i.e. ASC0, and ASC1) are idle, the module can enter SLEEP mode by additional configuration settings (i.e. AT^SPOW=2.3000,255).
- AT^SCFG= "MEopMode/ExpectDTR": Power saving will take effect only if there is no transmission data pending on any of the module's USB ports. The expect DTR AT command ensures that data becoming pending on any USB port before an external application has signaled its readiness to receive the data is discarded. By default this behavior is enabled for all available USB CDC ACM.
- Using the AT command AT^SCFG="Radio/OutputPowerReduction" it is possible for the module in GPRS multislots scenarios to reduce its output power according to 3GPP 45.005 section.

### 3.3.1 Power Saving while Attached to GSM Networks

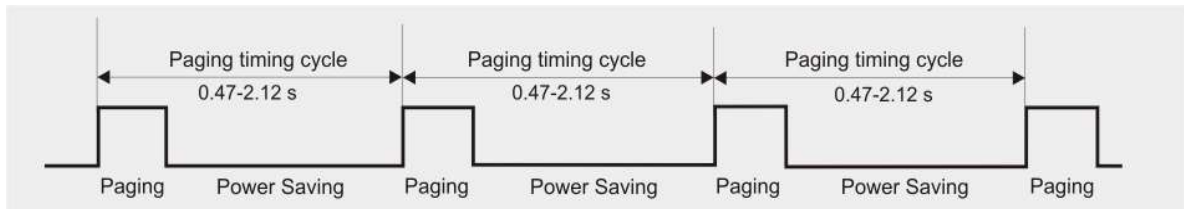
The power saving possibilities while attached to a GSM network depend on the paging timing cycle of the base station. The duration of a power saving interval can be calculated using the following formula:

$$t = 4.615 \text{ ms (TDMA frame duration)} * 51 \text{ (number of frames)} * \text{DRX value.}$$

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals between 0.47 and 2.12 seconds. The DRX value of the base station is assigned by the GSM network operator.

## 3.3 Power Saving

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in [Figure 24](#).



**Figure 24:** Power saving and paging in GSM networks

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.47 seconds or longer than 2.12 seconds.

### 3.3.2 Power Saving while Attached to WCDMA Networks

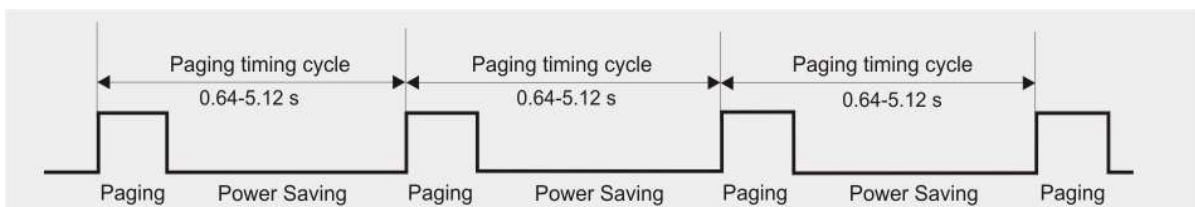
The power saving possibilities while attached to a WCDMA network depend on the paging timing cycle of the base station.

During normal WCDMA operation, i.e., the module is connected to a WCDMA network, the duration of a power saving period varies. It may be calculated using the following formula:

$$t = 2^{\text{DRX value}} * 10 \text{ ms (WCDMA frame duration)}.$$

DRX (Discontinuous Reception) in WCDMA networks is a value between 6 and 9, thus resulting in power saving intervals between 0.64 and 5.12 seconds. The DRX value of the base station is assigned by the WCDMA network operator.

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in [Figure 25](#).



**Figure 25:** Power saving and paging in WCDMA networks

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

## 3.3 Power Saving

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.64 seconds or longer than 5.12 seconds.

### 3.3.3 Power Saving while Attached to LTE Networks

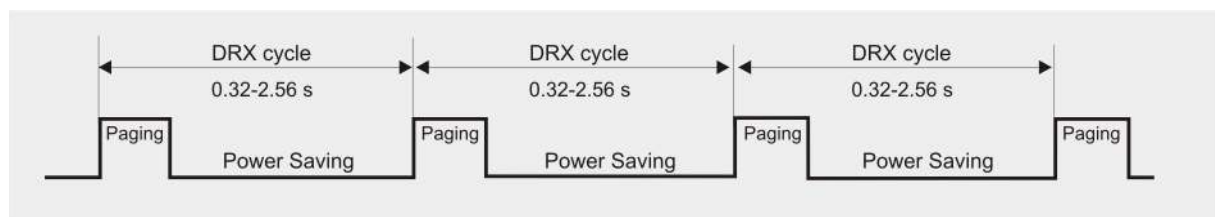
The power saving possibilities while attached to an LTE network depend on the paging timing cycle of the base station.

During normal LTE operation, i.e., the module is connected to an LTE network, the duration of a power saving period varies. It may be calculated using the following formula:

$$t = \text{DRX Cycle Value} * 10 \text{ ms}$$

DRX cycle value in LTE networks is any of the four values: 32, 64, 128 and 256, thus resulting in power saving intervals between 0.32 and 2.56 seconds. The DRX cycle value of the base station is assigned by the LTE network operator.

Now, a paging timing cycle consists of the actual fixed length paging plus a variable length pause before the next paging. In the pauses between listening to paging messages, the module resumes power saving, as shown in [Figure 26](#).



**Figure 26:** Power saving and paging in LTE networks

The varying pauses explain the different potential for power saving. The longer the pause the less power is consumed.

Generally, power saving depends on the module's application scenario and may differ from the above mentioned normal operation. The power saving interval may be shorter than 0.32 seconds or longer than 2.56 seconds.

### 3.3.4 Wake-up via RTS0

RTS0 can be used to wake up PLSx3 from SLEEP mode configured with AT^SPOW. Assertion of RTS0 (i.e., toggle from inactive high to active low) serves as wake up event, thus allowing an external application to almost immediately terminate power saving. After RTS0 assertion, the CTS0 line signals module wake up, i.e., readiness of the AT command interface. It is therefore recommended to enable RTS/CTS flow control (default setting).

Figure 27 shows the described RTS0 wake up mechanism.

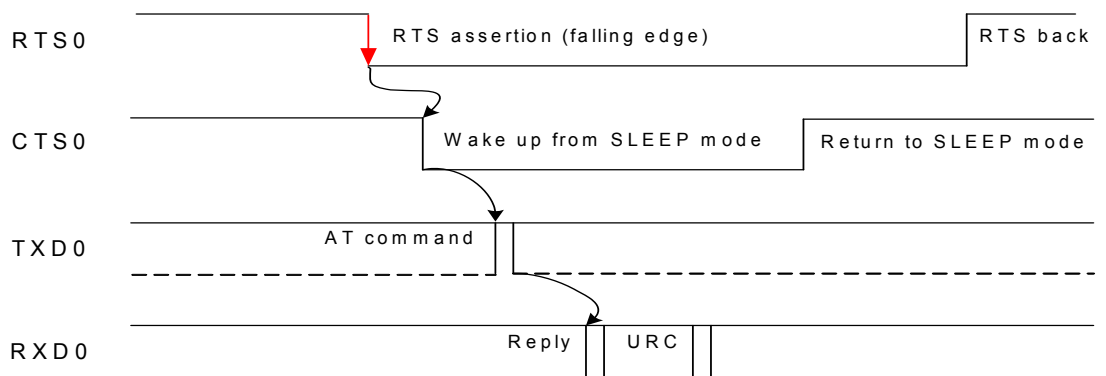


Figure 27: Wake-up via RTS0

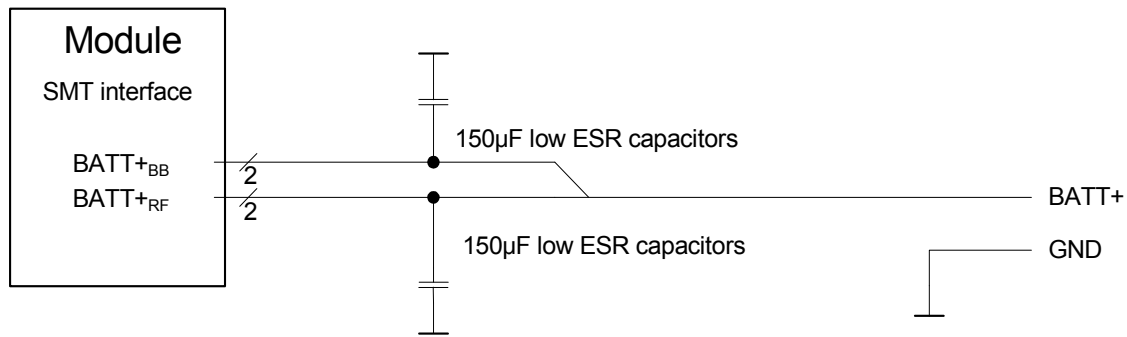
### 3.4 Power Supply

PLSx3 needs to be connected to a power supply at the SMT application interface - 4 lines BATT+, and GND. There are two separate voltage domains for BATT+:

- BATT+<sub>BB</sub> with two lines for the general power management.
- BATT+<sub>RF</sub> with two lines for the RF.

Please note that throughout the document BATT+ refers to both voltage domains and power supply lines - BATT+<sub>BB</sub> and BATT+<sub>RF</sub>.

The main power supply from an external application has to be a single voltage source and has to be expanded to sub paths (star structure). 150µF capacitors should be placed as close as possible to the BATT+ pads. [Figure 28](#) shows a sample circuit for decoupling capacitors for BATT+.



**Figure 28:** Decoupling capacitor(s) for BATT+

The power supply of PLSx3 must be able to provide the peak current during the uplink transmission.

All the key functions for supplying power to the device are handled by the power management section of the analog controller. This IC provides the following features:

- Stabilizes the supply voltages for the baseband using low drop linear voltage regulators and DC-DC step down switching regulators.
- Switches the module's power voltages for the power-up and -down procedures.
- SIM switch to provide SIM power supply.



### 3.4.1 Power Supply Ratings

The tables in this section assemble various voltage supply and current consumption ratings of the module.

**Table 17:** Supply Ratings

|       | Description  | Conditions  | Min | Typ | Max       | Unit                                 |
|-------|--|---|-----|-----|-----------|--------------------------------------|
| BATT+ | Supply voltage                                     | Normal Range<br>(Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes.)<br>The module shall work with supply voltages between 3.0 and 4.5V as normal voltage range. | 3.0 | 3.8 | 4.5       | V                                    |
|       | Maximum allowed voltage drop during transmit burst | Normal condition, power control level for Pout max  |     |     | 400       | mV                                   |
|       | Voltage ripple                                     | Normal condition, power control level for Pout max<br>@ f ≤ 250 kHz<br>@ f > 250 kHz  |     |     | 120<br>90 | mV <sub>pp</sub><br>mV <sub>pp</sub> |

## 3.4 Power Supply

**Table 18:** Current Consumption Ratings -GSM<sup>1</sup>

|  | Description                                | Conditions  |                            | Typical rating<br>(W,EP,LA,J, I) | Unit    |
|--|--|---|----------------------------|----------------------------------|---------|
| $I_{BATT+}^2$<br>(i.e., sum of<br>$BATT+_{BB}$ and<br>$BATT+_{RF}$ ) | OFF State supply current                   | POWER DOWN  |                            | TBD                              | $\mu A$ |
|  | GSM SLEEP State supply current             | SLEEP <sup>3</sup> @ DRX=9<br>(no communication via UART) | USB disconnected           | TBD                              | mA      |
|  |  |   | USB suspended              | TBD                              | mA      |
|  |  | SLEEP <sup>3</sup> @ DRX=5<br>(no communication via UART) | USB disconnected           | TBD                              | mA      |
|  |  |   | USB suspended              | TBD                              | mA      |
|  |  | SLEEP <sup>3</sup> @ DRX=2<br>(no communication via UART) | USB disconnected           | TBD                              | mA      |
|  |  |   | USB suspended              | TBD                              | mA      |
|  | GSM IDLE <sup>4</sup> State supply current | IDLE @ DRX=2<br>(UART active, but no communication)       | USB disconnected           | TBD                              | mA      |
|  |  |   | USB active                 | TBD                              | mA      |
|  | Average GSM850 supply current <sup>5</sup> | GPRS Data transfer GSM850;<br>PCL=5; 1Tx/4Rx              | ROPR=8<br>(max. reduction) | 306                              | mA      |
|  |  |   | ROPR=4<br>(no reduction)   | 300                              | mA      |
|  |  | GPRS Data transfer GSM850;<br>PCL=5; 2Tx/3Rx              | ROPR=8<br>(max. reduction) | 450                              | mA      |
|  |  |   | ROPR=4<br>(no reduction)   | 551                              | mA      |
|  |  | GPRS Data transfer GSM850;<br>PCL=5; 4Tx/1Rx              | ROPR=8<br>(max. reduction) | 600                              | mA      |
|  |  |   | ROPR=4<br>(no reduction)   | 1005                             | mA      |
|  |  | EDGE Data transfer GSM850;<br>PCL=5; 1Tx/4Rx              | ROPR=8<br>(max. reduction) | 187                              | mA      |
|  |  |   | ROPR=4<br>(no reduction)   | 189                              | mA      |
|  |  | EDGE Data transfer GSM850;<br>PCL=5; 2Tx/3Rx              | ROPR=8<br>(max. reduction) | 270                              | mA      |
|  |  |   | ROPR=4<br>(no reduction)   | 330                              | mA      |
|  |  | EDGE Data transfer GSM850;<br>PCL=5; 4Tx/1Rx              | ROPR=8<br>(max. reduction) | 418                              | mA      |
| ROPR=4<br>(no reduction)   |  |   | 583                        | mA                               |         |

## 3.4 Power Supply

**Table 18:** Current Consumption Ratings -GSM<sup>1</sup>

|  | Description                                      | Conditions                                      |                            | Typical rating<br>(W,EP,LA,J, I) | Unit |
|--|--|---|----------------------------|----------------------------------|------|
| I <sub>BATT+</sub> <sup>2</sup><br>(i.e., sum of<br>BATT <sub>BB</sub> <sup>+</sup> and<br>BATT <sub>RF</sub> <sup>+</sup> ) | Average<br>GSM900<br>supply current <sup>5</sup> | GPRS Data transfer<br>GSM900;<br>PCL=5; 1Tx/4Rx | ROPR=8<br>(max. reduction) | 287                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 287                              | mA   |
|  |  | GPRS Data transfer<br>GSM900;<br>PCL=5; 2Tx/3Rx | ROPR=8<br>(max. reduction) | 425                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 530                              | mA   |
|  |  | GPRS Data transfer<br>GSM900;<br>PCL=5; 4Tx/1Rx | ROPR=8<br>(max. reduction) | 613                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 985                              | mA   |
|  |  | EDGE Data transfer<br>GSM900;<br>PCL=5; 1Tx/4Rx | ROPR=8<br>(max. reduction) | 180                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 179                              | mA   |
|  |  | EDGE Data transfer<br>GSM900;<br>PCL=5; 2Tx/3Rx | ROPR=8<br>(max. reduction) | 272                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 315                              | mA   |
|  |  | EDGE Data transfer<br>GSM900;<br>PCL=5; 4Tx/1Rx | ROPR=8<br>(max. reduction) | 422                              | mA   |
|  |  |   | ROPR=4<br>(no reduction)   | 565                              | mA   |

## 3.4 Power Supply

**Table 18:** Current Consumption Ratings -GSM<sup>1</sup>

|  | Description                                       | Conditions                                       |                            | Typical rating<br>(W,EP,LA,J, I) | Unit |
|--|---|--|----------------------------|----------------------------------|------|
| I <sub>BATT+</sub> <sup>2</sup><br>(i.e., sum of<br>BATT <sub>BB</sub> <sup>+</sup> and<br>BATT <sub>RF</sub> <sup>+</sup> ) | Average<br>GSM1800<br>supply current <sup>5</sup> | GPRS Data transfer<br>GSM1800; PCL=0;<br>1Tx/4Rx | ROPR=8<br>(max. reduction) | 194                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 194                              | mA   |
|  |   | GPRS Data transfer<br>GSM1800; PCL=0;<br>2Tx/3Rx | ROPR=8<br>(max. reduction) | 279                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 346                              | mA   |
|  |   | GPRS Data transfer<br>GSM1800; PCL=0;<br>4Tx/1Rx | ROPR=8<br>(max. reduction) | 418                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 625                              | mA   |
|  |   | EDGE Data transfer<br>GSM1800; PCL=0;<br>1Tx/4Rx | ROPR=8<br>(max. reduction) | 141                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 143                              | mA   |
|  |   | EDGE Data transfer<br>GSM1800; PCL=0;<br>2Tx/3Rx | ROPR=8<br>(max. reduction) | 220                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 246                              | mA   |
|  |   | EDGE Data transfer<br>GSM1800; PCL=0;<br>4Tx/1Rx | ROPR=8<br>(max. reduction) | 372                              | mA   |
|  |   |  | ROPR=4<br>(no reduction)   | 443                              | mA   |

## 3.4 Power Supply

**Table 18:** Current Consumption Ratings -GSM<sup>1</sup>

|  | Description  | Conditions  |                         | Typical rating (W,EP,LA,J, I)                   | Unit |     |   |
|--|--|---|-------------------------|---|------|-----|---|
| I <sub>BATT+</sub> <sup>2</sup><br>(i.e., sum of BATT <sub>BB</sub> and BATT <sub>RF</sub> ) | Average GSM1900 supply current <sup>5</sup>                | GPRS Data transfer GSM1900; PCL=0; 1Tx/4Rx          | ROPR=8 (max. reduction) | 190   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 185   | mA   |     |   |
|  |  | GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx          | ROPR=8 (max. reduction) | 270   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 332   | mA   |     |   |
|  |  | GPRS Data transfer GSM1900; PCL=0; 4Tx/1Rx          | ROPR=8 (max. reduction) | 410   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 615   | mA   |     |   |
|  |  | EDGE Data transfer GSM1900; PCL=0; 1Tx/4Rx          | ROPR=8 (max. reduction) | 139   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 142   | mA   |     |   |
|  |  | EDGE Data transfer GSM1900; PCL=0; 2Tx/3Rx          | ROPR=8 (max. reduction) | 216   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 246   | mA   |     |   |
|  |  | EDGE Data transfer GSM1900; PCL=0; 4Tx/1Rx          | ROPR=8 (max. reduction) | 372   | mA   |     |   |
|  |  |   | ROPR=4 (no reduction)   | 448   | mA   |     |   |
|  |  | Peak current during GSM transmit burst <sup>5</sup> |                         | GPRS Data transfer GSM850; PCL=5; 1Tx/1Rx @ 50Ω |      | 2.2 | A |
|  |  |   |                         | GPRS Data transfer GSM900; PCL=5; 1Tx/1Rx @ 50Ω |      | 2.2 | A |
|  | GPRS Data transfer DCS1800; PCL=0; 1Tx/1Rx @ 50Ω           |   |                         |   | 1.4  | A   |   |
|  | GPRS Data transfer PCS1900; PCL=0; 1Tx/1Rx @ 50Ω           |   |                         |   | 1.4  | A   |   |
|  | GPRS Data transfer GSM850; PCL=5; 1Tx/1Rx @ total mismatch |   |                         |   | 2.8  | A   |   |
| GPRS Data transfer GSM900; PCL=5; 1Tx/1Rx @ total mismatch                                   |  |   |                         | 2.9   | A    |     |   |
| GPRS Data transfer DCS1800; PCL=0; 1Tx/1Rx @ total mismatch                                  |  |   |                         | 1.7   | A    |     |   |
| GPRS Data transfer DCS1900; PCL=0; 1Tx/1Rx @ total mismatch                                  |  |   |                         | 1.8   | A    |     |   |

1. Note: Current consumption ratings are based on measurements done in a laboratory test environment, and deviations may occur from the given typical ratings. Under real life conditions however, with e.g., varying network quality, location changes, or changing supply currents, the deviations from these typical ratings may be even bigger, and will have to be taken into account for actual power supply solutions. For more details on power supply design see [3].

2. With an impedance of Z<sub>LOAD</sub>=50Ω at the antenna pad. Measured at 25°C and 3.8V.

3.4 Power Supply

3. Measurements start 6 minutes after switching ON the module, averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes  
Communication tester settings: no neighbor cells, no cell reselection etc., RMC (Reference Measurement Channel)  
SLEEP mode is enabled via AT command AT^SPOW=2, 1000, 3
4. The power save mode is disabled via AT command AT^SPOW=1,0,0
5. The communication tester settings of Channel: Mid Channel

**Table 19:** Current Consumption Ratings - UMTS<sup>1</sup>

|  | Description                                 | Conditions   | Typical rating (W, EP, L A, J, I) | Typical rating (X, X2, X3, X4) | Unit |    |
|--|---|--|-----------------------------------|--------------------------------|------|----|
| I <sub>BATT+</sub> <sup>2</sup><br>(i.e., sum of BATT <sub>BB</sub> <sup>+</sup> and BATT <sub>RF</sub> <sup>+</sup> ) | OFF State supply current                    | POWER DOWN   | TBD                               | TBD                            | µA   |    |
|  | UMTS SLEEP State supply current             | SLEEP <sup>3</sup> @ DRX=9 (no communication via UART) | USB disconnected                  | TBD                            | TBD  | mA |
|  |   |  | USB suspended                     | TBD                            | TBD  | mA |
|  |   | SLEEP <sup>3</sup> @ DRX=8 (no communication via UART) | USB disconnected                  | TBD                            | TBD  | mA |
|  |   |  | USB suspended                     | TBD                            | TBD  | mA |
|  |   | SLEEP <sup>3</sup> @ DRX=6 (no communication via UART) | USB disconnected                  | TBD                            | TBD  | mA |
|  |   |  | USB suspended                     | TBD                            | TBD  | mA |
|  | UMTS IDLE <sup>4</sup> State supply current | IDLE @ DRX=6 (UART active, but no communication)       | USB disconnected                  | TBD                            | TBD  | mA |
|  |   |  | USB active                        | TBD                            | TBD  | mA |
|  | UMTS average supply current <sup>5</sup>    | UMTS Data transfer Band I                              |                                   | 560                            |      | mA |
|  |   | UMTS Data transfer Band II                             |                                   | 530                            | 600  | mA |
|  |   | UMTS Data transfer Band III                            |                                   | 480                            |      | mA |
|  |   | UMTS Data transfer Band IV                             |                                   | 530                            | 710  | mA |
|  |   | UMTS Data transfer Band V                              |                                   | 500                            | 690  | mA |
|  |   | UMTS Data transfer Band VI                             |                                   | 500                            |      | mA |
| UMTS Data transfer Band VIII   |   |  | 530                               |                                | mA   |    |
| UMTS Data transfer Band XIX  |   | 485  |                                   | mA                             |      |    |

1. Note: Current consumption ratings are based on measurements done in a laboratory test environment, and deviations may occur from the given typical ratings. Under real life conditions however, with e.g., varying network quality, location changes, or changing supply currents, the deviations from these typical ratings may be even bigger, and will have to be taken into account for actual power supply solutions. For more details on power supply design see [3].
2. With an impedance of Z<sub>LOAD</sub>=50Ω at the antenna pad. Measured at 25°C and 3.8V.
3. Measurements start 6 minutes after switching ON the module, averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes  
Communication tester settings: no neighbor cells, no cell reselection etc., RMC (Reference Measurement Channel)  
SLEEP mode is enabled via AT command AT^SPOW=2, 1000, 3

3.4 Power Supply

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4. The power save mode is disabled via AT command AT^SPOW=1,0,0

5. The communication tester settings of Channel: Mid Channel

The value is based on the latest test result and may have update in the future releases.

3.4 Power Supply

Table 20: Current Consumption Ratings - LTE<sup>1</sup>

|  | Description  | Conditions  | Typical rating (W,EP, LA,J,I) | Typical rating (X,X2,X3,X4) | Unit |    |
|--|--|---|-------------------------------|-----------------------------|------|----|
| I <sub>BATT+</sub> <sup>2</sup><br>(i.e., sum of BATT+ <sub>BB</sub> and BATT+ <sub>RF</sub> ) | OFF State supply current   | POWER DOWN  | TBD                           |                             | µA   |    |
|  | LTE SLEEP State supply current   | SLEEP <sup>3</sup> @ "Paging Cycles = 256"<br>(no communication via UART) | USB disconnected              | TBD                         |      | mA |
|  |  |   | USB suspended                 | TBD                         |      | mA |
|  |  | SLEEP <sup>3</sup> @ "Paging Cycles = 128"<br>(no communication via UART) | USB disconnected              | TBD                         |      | mA |
|  |  |   | USB suspended                 | TBD                         |      | mA |
|  |  | SLEEP <sup>3</sup> @ "Paging Cycles = 64"<br>(no communication via UART)  | USB disconnected              | TBD                         |      | mA |
|  |  |   | USB suspended                 | TBD                         |      | mA |
|  | SLEEP <sup>3</sup> @ "Paging Cycles = 32"<br>(no communication via UART) | USB disconnected  | TBD                           |                             | mA   |    |
|  |  | USB suspended   | TBD                           |                             | mA   |    |
|  | LTE IDLE <sup>4</sup> State supply current                               | IDLE (USB disconnected)   | TBD                           |                             | mA   |    |
|  |  | IDLE (USB active)   | TBD                           |                             | mA   |    |
|  | LTE average supply current <sup>5</sup>                                  | LTE Data transfer Band 1  | 600                           |                             | mA   |    |
|  |  | LTE Data transfer Band 2  | 610                           | 595                         | mA   |    |
|  |  | LTE Data transfer Band 3  | 550                           |                             | mA   |    |
|  |  | LTE Data transfer Band 4  | 560                           | 660                         | mA   |    |
|  |  | LTE Data transfer Band 5  | 540                           | 580                         | mA   |    |
|  |  | LTE Data transfer Band 7(-W)  | 750                           |                             | mA   |    |
|  |  | LTE Data transfer Band 7(-EP, LA)   | 610                           |                             | mA   |    |
|  |  | LTE Data transfer Band 8  | 660                           |                             | mA   |    |
|  |  | LTE Data transfer Band 12   | 640                           | 580                         | mA   |    |
|  |  | LTE Data transfer Band 13   | 615                           | 585                         | mA   |    |
|  |  | LTE Data transfer Band 14   |                               | 520                         | mA   |    |
|  |  | LTE Data transfer Band 17   | 630                           |                             | mA   |    |
|  |  | LTE Data transfer Band 18   | 515                           |                             | mA   |    |
|  |  | LTE Data transfer Band 19   | 545                           |                             | mA   |    |
|  |  | LTE Data transfer Band 20   | 615                           |                             | mA   |    |
|  |  | LTE Data transfer Band 25   |                               | 600                         | mA   |    |
|  |  | LTE Data transfer Band 26   | 620                           |                             | mA   |    |
|  | LTE Data transfer Band 28  | 600   |                               | mA                          |      |    |
| LTE Data transfer Band 38  | 385  |   | mA                            |                             |      |    |
| LTE Data transfer Band 40  | 380  |   | mA                            |                             |      |    |
| LTE Data transfer Band 41  | 385  |   | mA                            |                             |      |    |
| LTE Data transfer Band 66  | 615  |   | mA                            |                             |      |    |
| LTE Data transfer Band 71  |  |   | mA                            |                             |      |    |



### 3.4 Power Supply

- Note: Current consumption ratings are based on measurements done in a laboratory test environment, and deviations may occur from the given typical ratings. Under real life conditions however, with e.g., varying network quality, location changes, or changing supply currents, the deviations from these typical ratings may be even bigger, and will have to be taken into account for actual power supply solutions. For more details on power supply design see [3].
- With an impedance of  $Z_{LOAD}=50\Omega$  at the antenna pad. Measured at 25°C and 3.8V.
- Measurements start 6 minutes after switching ON the module,  
averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes  
Communication tester settings: no neighbor cells, no cell reselection etc.,  
RMC (Reference Measurement Channel)  
SLEEP mode is enabled via AT command `AT^SPOW=2, 1000, 3`
- The power save mode is disabled via AT command `AT^SPOW=1,0,0`
- Communication tester setting:  
Channel: Mid Channel  
Channel Bandwidth: 5MHz  
Number of Resource Blocks: 25 (DL), 1 (UL), RB position: Low  
Modulation: QPSK  
The value is based on the latest test result and may have update in the future releases.

### 3.4.2 Minimizing Power Losses

If the module supports GSM, when designing the power supply for your application, please pay specific attention to power losses. Ensure that the input voltage  $V_{BATT+}$ , never drops below 3.0V on the PLSx3 board, not even in a transmit burst where current consumption can rise to typical peaks. Any voltage drops that may occur in a transmit burst should not exceed 400mV to ensure the expected RF performance in 2G networks.

For example,

$$V_{Imin}=3.0V, D_{max}=0.4V$$

$$V_{BATT+min}=V_{Imin}+D_{max}=3.4V$$

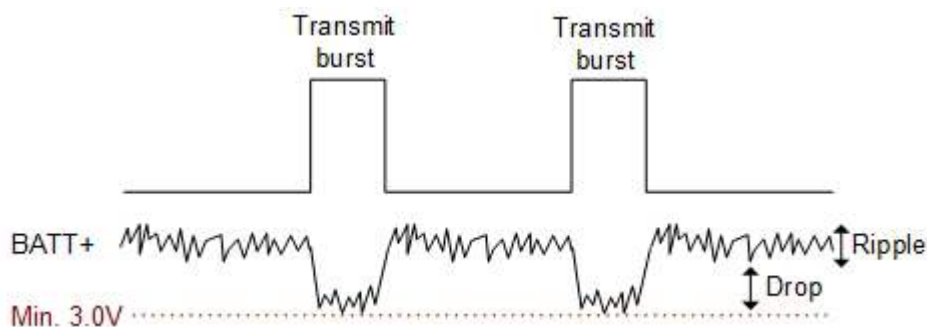


Figure 29: Power supply limits during transmit burst

### 3.4.3 Monitoring Power Supply by AT Command

To monitor the supply voltage, you can use the `AT^SBV` command which returns the current value of the supply voltage using AT interface.

## 3.5 Operating Temperatures

**Table 21:** Board Temperature

| Parameter  | Min  | Typ | Max | Unit |
|--|------|-----|-----|------|
| Operating temperature range  | -30  |     | +85 | °C   |
| Restricted temperature range <sup>1</sup>                              | -40  |     | +95 | °C   |
| Automatic shutdown <sup>2</sup><br>Temperature measured on PLSx3 board | <-40 |     | +95 | °C   |

1. Restricted operation allows normal mode data transmissions for limited time until automatic thermal shutdown takes effect. Within the restricted temperature range (outside the operating temperature range) the specified electrical characteristics may be in- or decreased.

2. Due to temperature measurement uncertainty, a tolerance on the stated shutdown thresholds may occur. The possible deviation is in the range of TBD °C at the over temperature limit.

Note: Within the specified operating temperature ranges the board temperature may vary to a great extent depending on operating mode, used frequency band, radio output power and current supply voltage.

## 3.6 Electrostatic Discharge

The module is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a PLSx3 module.

An example for an enhanced ESD protection for the SIM interface is given in [Section 2.1.6.1](#).

PLSx3 has been tested according to the following standards. Electrostatic values can be gathered from the following table.

**Table 22:** Electrostatic values

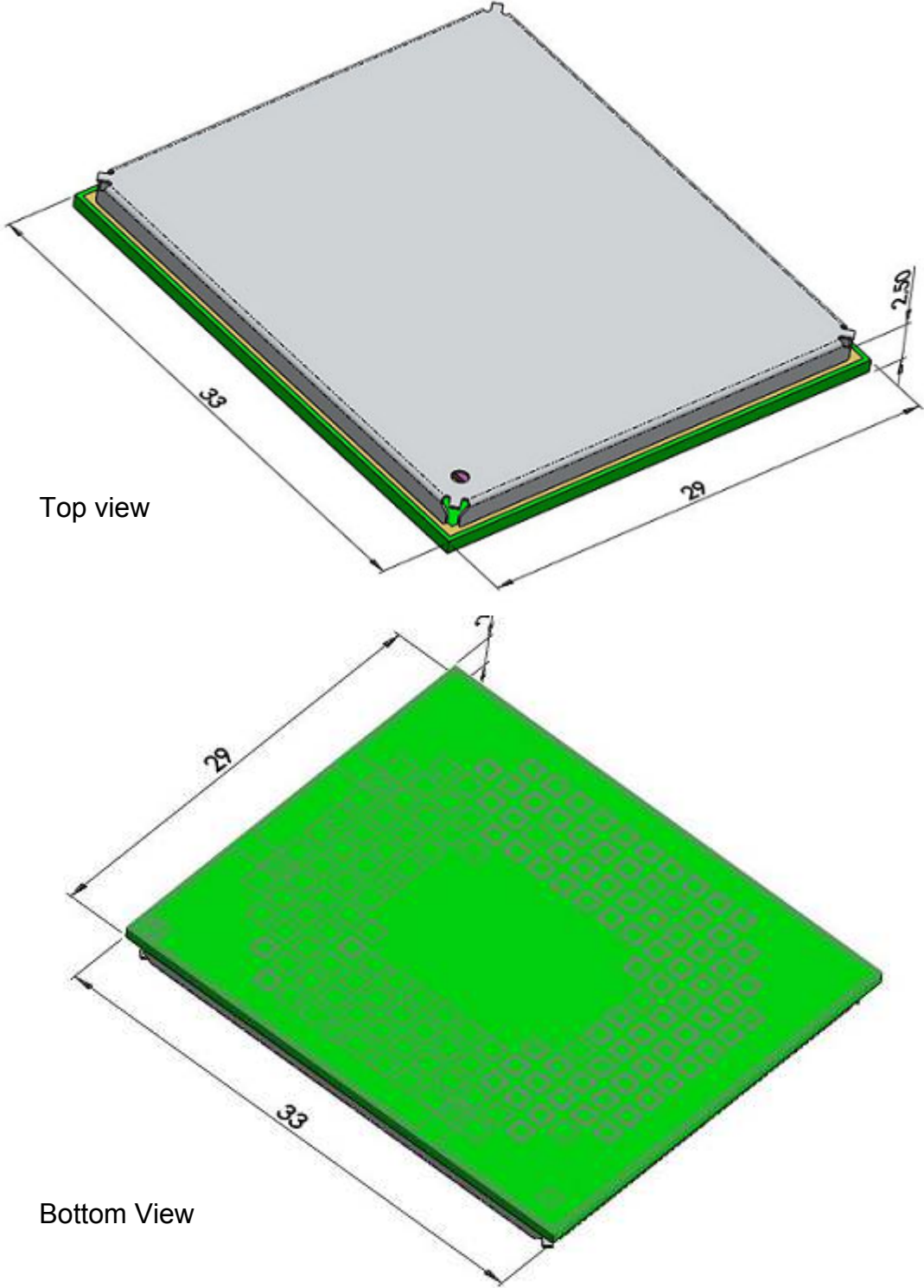
| Specification/Requirement                      | Contact discharge | Air discharge |
|--|-------------------|---------------|
| ANSI/ESDA/JEDEC JS-001-2017 (Human Body Model) |                   |               |
| All LGA pads                                   | ±1.0kV (HBM)      | n.a.          |
| JS-002-2018 (Charged Device Model)             |                   |               |
| All LGA pads                                   | ±250V (CDM)       | n.a.          |
| ETSI EN 301 489-1/7                            |                   |               |
| BATT+  | TBD               | TBD           |
| Antenna pads                                   | TBD               | ±8kV          |

## 4 Mechanical Dimensions, Mounting and Packaging

### 4.1 Mechanical Dimensions of PLSx3

[Figure 30](#) shows the top and bottom view of PLSx3 and provides an overview of the board's mechanical dimensions. For further details see [Figure 31](#).

4.1 Mechanical Dimensions of PLSx3



Top view

Bottom View

Figure 30: PLSx3– top and bottom view

4.1 Mechanical Dimensions of PLSx3

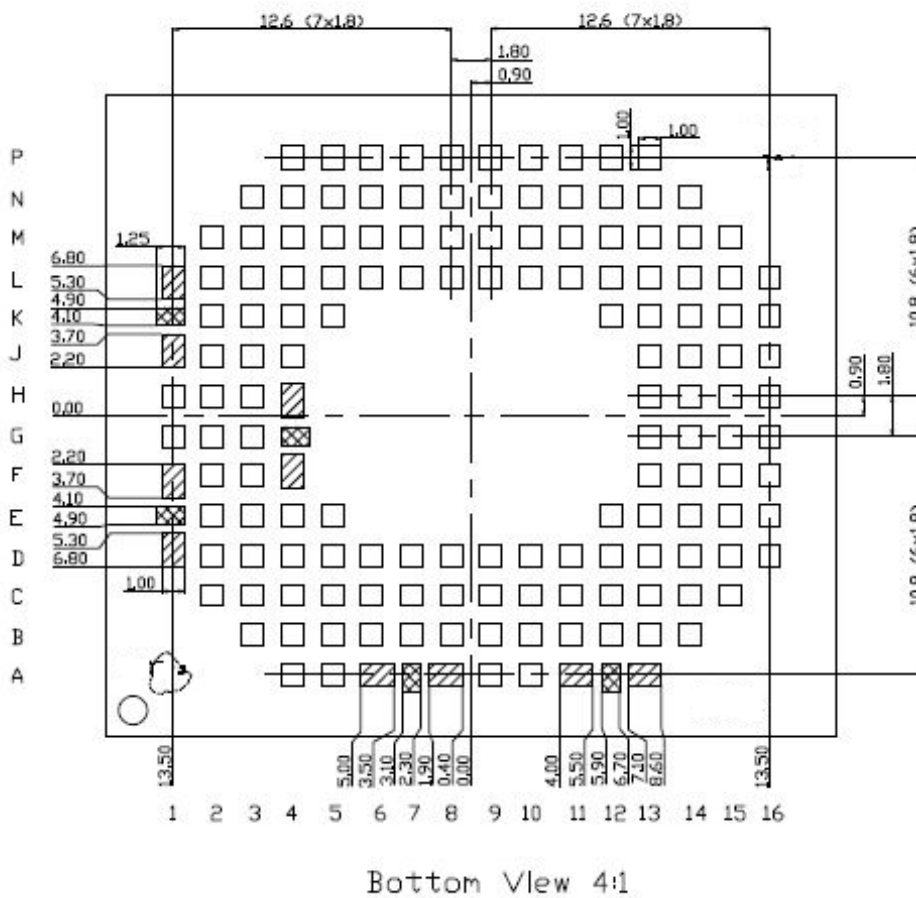
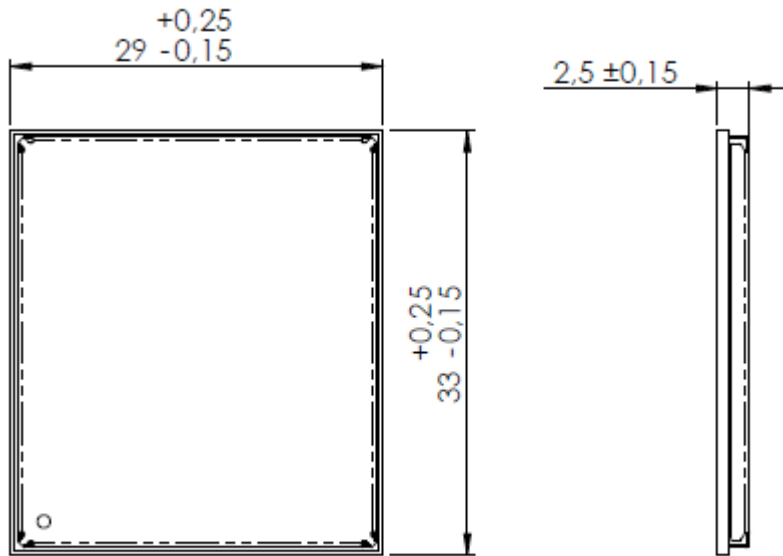


Figure 31: Dimensions of PLSx3 (all dimensions in mm)

4.1 Mechanical Dimensions of PLSx3

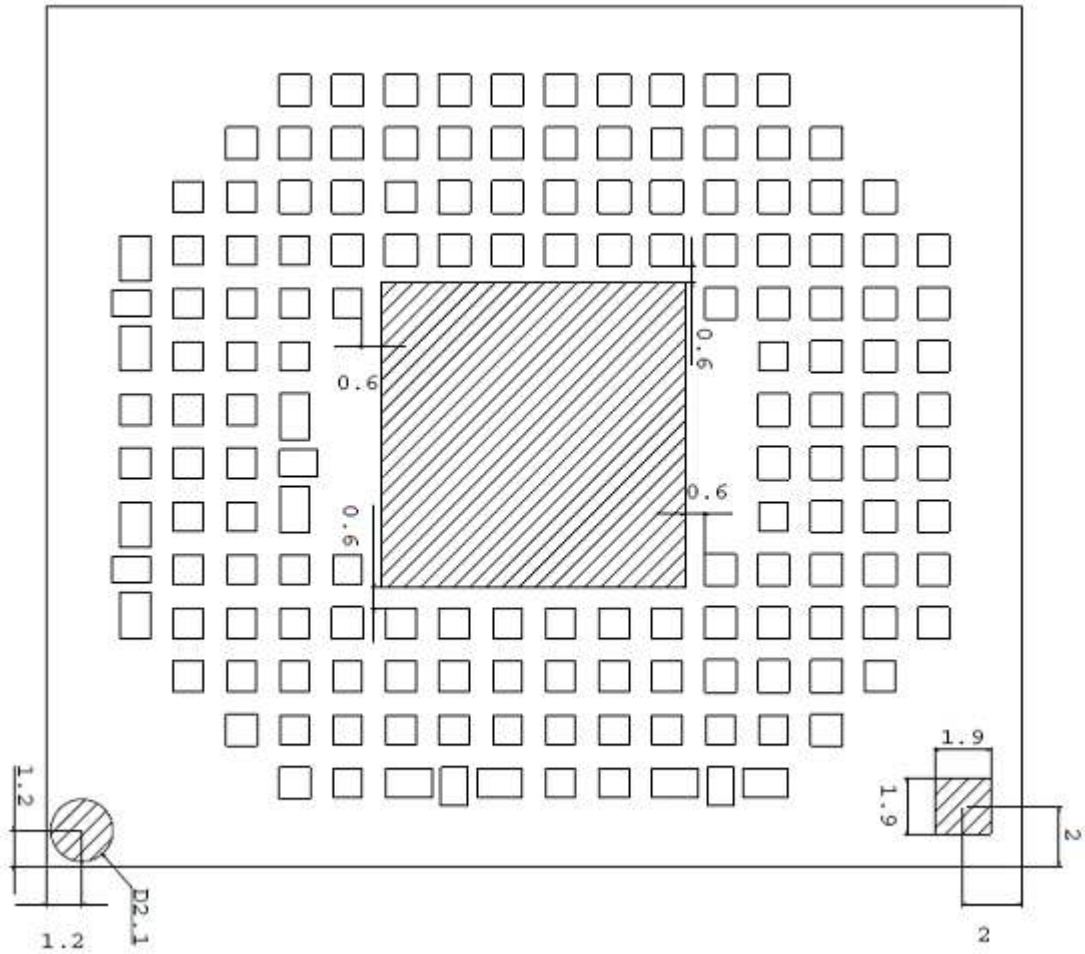


Figure 32: Dimensions of PLSx3 (keepout area recommended)

## 4.2 Mounting PLSx3 onto the Application Platform

This section describes how to mount PLSx3 onto the PCBs, including land pattern and stencil design, board-level characterization, soldering conditions, durability and mechanical handling.

Note: To avoid short circuits between signal tracks on an external application's PCB and various markings at the bottom side of the module, it is recommended not to route the signal tracks on the top layer of an external PCB directly under the module, or at least to ensure that signal track routes are sufficiently covered with solder resist.

### 4.2.1 SMT PCB Assembly

#### 4.2.1.1 Land Pattern and Stencil

The land pattern and stencil design as shown below is based on Thales characterizations for lead-free solder paste on a four-layer test PCB and a 110 respectively 150 micron thick stencil.

The land pattern given in [Figure 33](#) reflects the module's pad layout, including signal pads and ground pads (for pad assignment see [Section 2.1.1](#)).

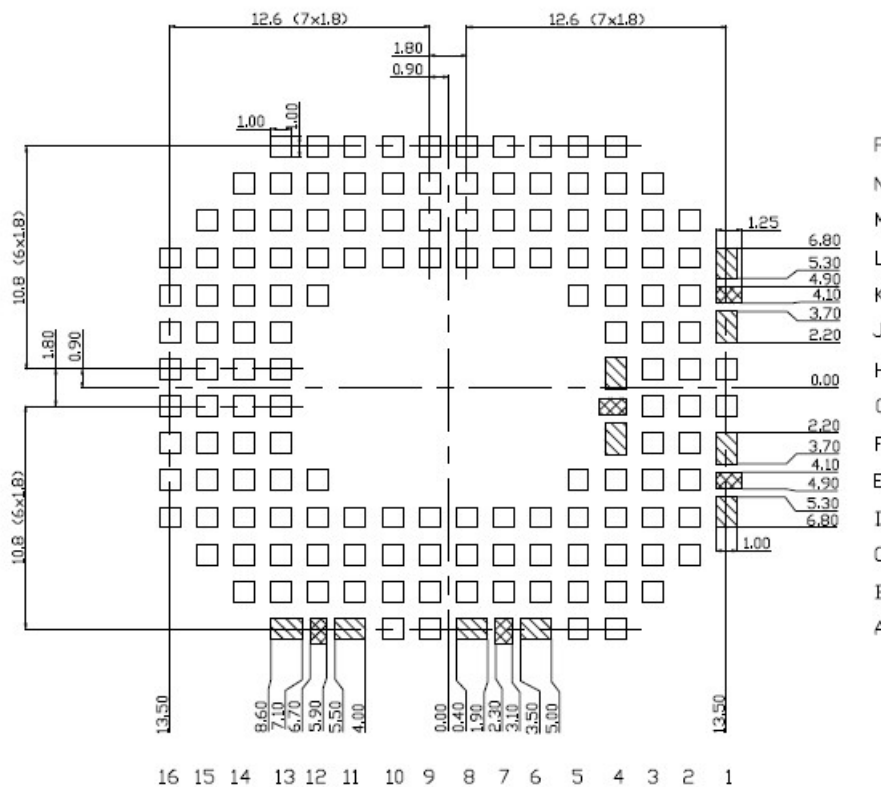


Figure 33: Land pattern (top view)

The stencil designs illustrated in [Figure 34](#) and [Figure 35](#) are recommended by Thales as a result of extensive tests with Thales Daisy Chain modules.

4.2 Mounting PLSx3 onto the Application Platform

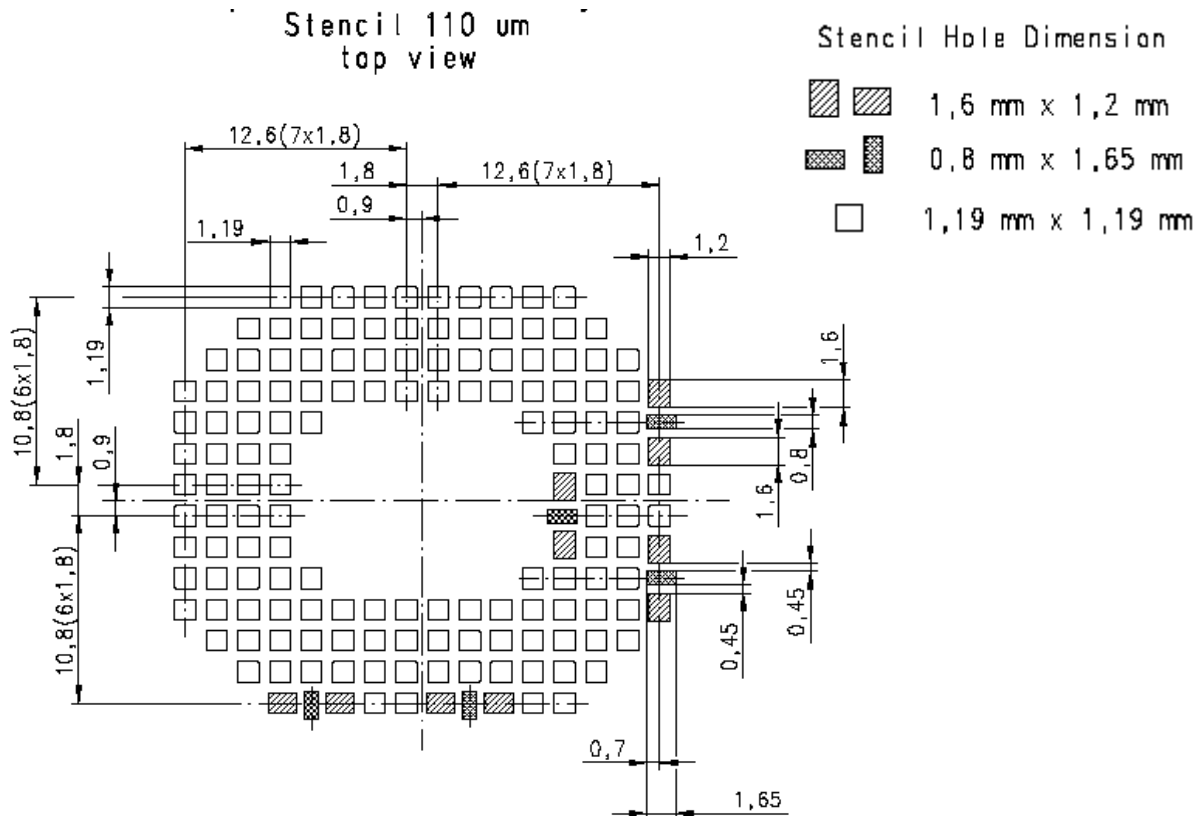


Figure 34: Recommended design for 110 micron thick stencil (top view)

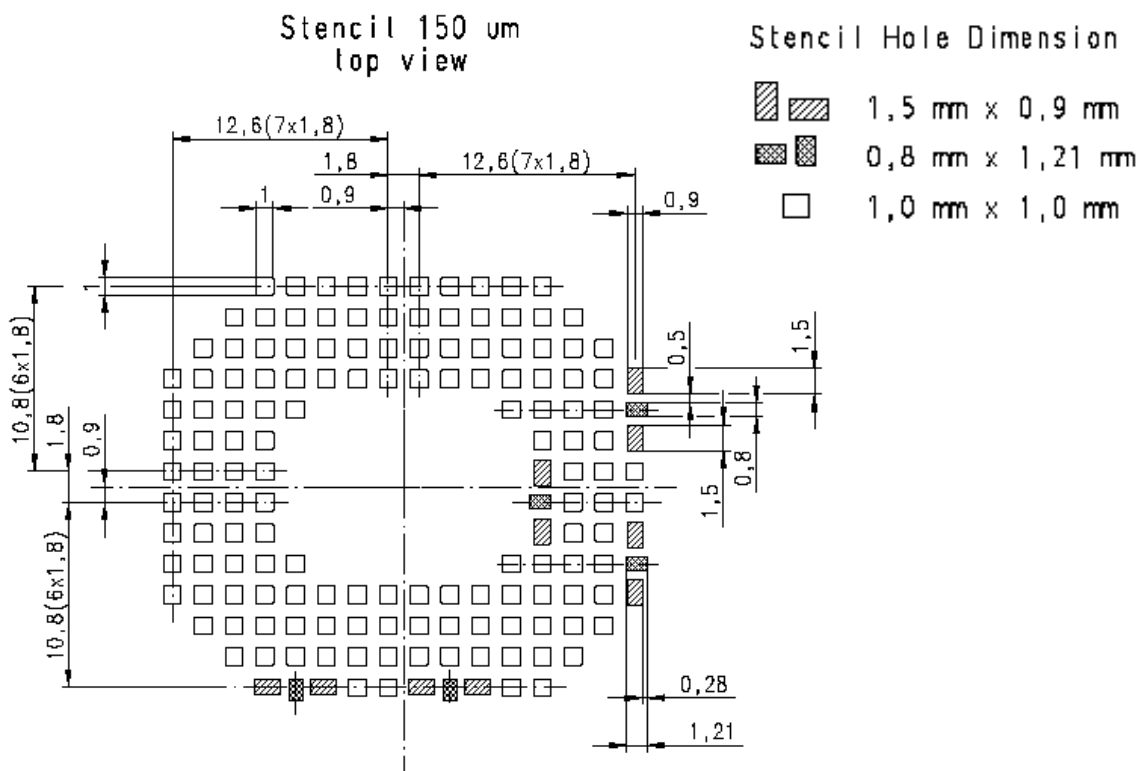


Figure 35: Recommended design for 150 micron thick stencil (top view)



### 4.2.1.2 Board Level Characterization

Board level characterization issues should also be taken into account if devising an SMT process.

Characterization tests should attempt to optimize the SMT process with regard to board level reliability. This can be done by performing the following physical tests on sample boards: Peel test, bend test, tensile pull test, drop shock test and temperature cycling.

It is recommended to characterize land patterns before an actual PCB production, taking individual processes, materials, equipment, stencil design, and reflow profile into account. For land and stencil pattern design recommendations see also [Section 4.2.1.1](#). Optimizing the solder stencil pattern design and print process is necessary to ensure print uniformity, to decrease solder voids, and to increase board level reliability.

Generally, solder paste manufacturer recommendations for screen printing process parameters and reflow profile conditions should be followed. Maximum ratings are described in [Section 4.2.3](#).

## 4.2.2 Moisture Sensitivity Level

PLSx3 comprises components that are susceptible to damage induced by absorbed moisture.

Thales's PLSx3 module complies with the latest revision of the IPC/JEDEC J-STD-020 Standard for moisture sensitive surface mount devices and is classified as MSL 4.

For additional moisture sensitivity level (MSL) related information see [Section 4.2.4](#) and [Section 4.3.2](#).

## 4.2.3 Soldering Conditions and Temperature

### 4.2.3.1 Reflow Profile

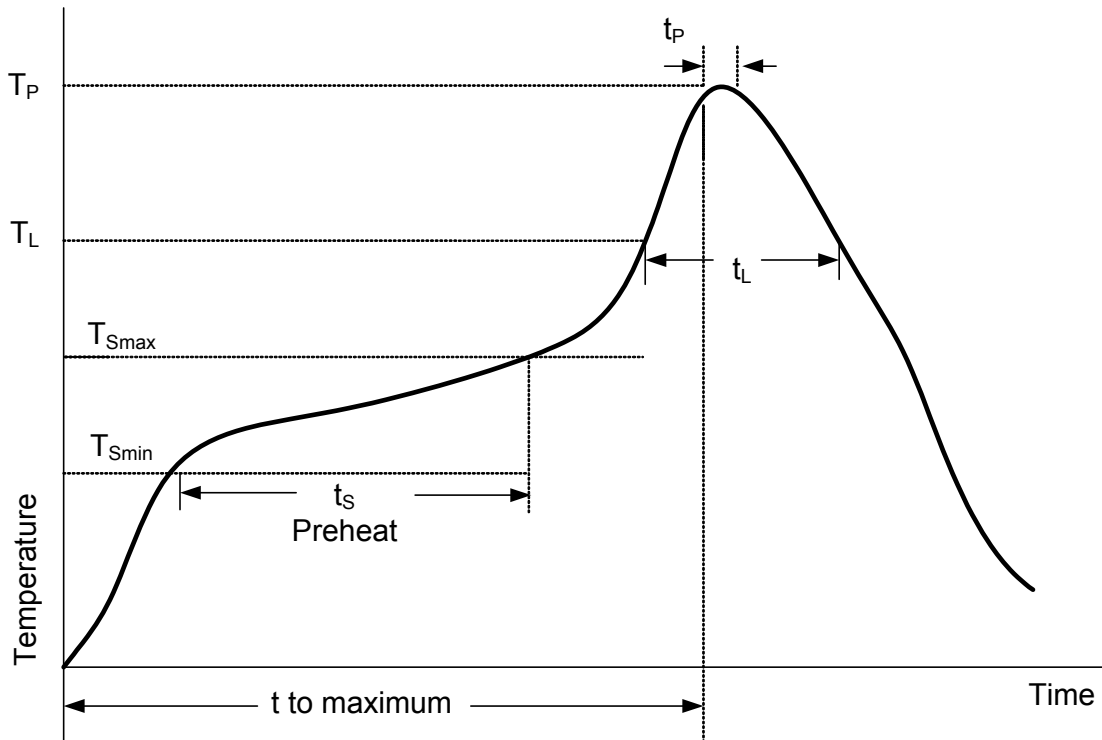


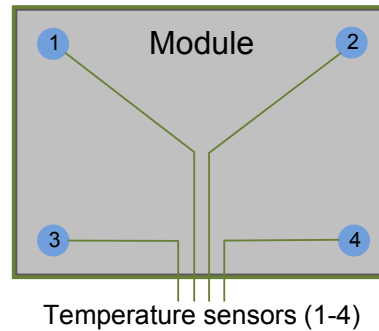
Figure 36: Reflow Profile

Table 23: Reflow temperature ratings<sup>1</sup>

| Profile Feature   | Pb-Free Assembly   |
|---|--|
| Preheat & Soak<br>Temperature Minimum ( $T_{Smin}$ )<br>Temperature Maximum ( $T_{Smax}$ )<br>Time ( $t_{Smin}$ to $t_{Smax}$ ) ( $t_s$ ) | 150°C<br>200°C<br>60-120 seconds                           |
| Average ramp up rate ( $T_L$ to $T_P$ )   | 3K/second max. <sup>2</sup>                                |
| Liquidous temperature ( $T_L$ )<br>Time at liquidous ( $t_L$ )  | 217°C<br>50-90 seconds                                     |
| Peak package body temperature ( $T_P$ )   | 245°C $\pm$ 5°C  |
| Time ( $t_p$ ) within 5 °C of the peak package body temperature ( $T_P$ )   | 30 seconds max.  |
| Average ramp-down rate<br>- Limited ramp-down rate between 225°C and 200°C  | 6K/second max. <sup>2</sup><br>3K/second max. <sup>2</sup> |
| Time 25°C to maximum temperature  | 8 minutes max.   |

1. Please note that the reflow profile features and ratings listed above are based on the joint industry standard IPC/JEDEC J-STD-020D.1, and are as such meant as a general guideline.

2. Temperatures measured on shielding at each corner. See also [3].



### 4.2.3.2 Maximum Temperature and Duration

The following limits are recommended for the SMT board-level soldering process to attach the module:

- A maximum module temperature of 245°C. This specifies the temperature as measured at the module's top side.
- A maximum duration of 30 seconds at this temperature.
- Ramp-down rate from  $T_p$  to 200°C should be controlled in order to reduce thermally induced stress during the solder solidification phase (see [Table 23](#) - limited ramp-down rate). Therefore, a cool-down step in the oven's temperature program between 200°C and 180°C should be considered.

Please note that while the solder paste manufacturers' recommendations for best temperature and duration for solder reflow should generally be followed, the limits listed above must not be exceeded.

PLSx3 is specified for one soldering cycle only. Once PLSx3 is removed from the application, the module will very likely be destroyed and cannot be soldered onto another application.

## 4.2.4 Durability and Mechanical Handling

### 4.2.4.1 Storage Conditions

PLSx3 modules, as delivered in tape and reel carriers, must be stored in sealed, moisture barrier anti-static bags. The conditions stated below are only valid for modules in their original packed state in weather protected, non-temperature-controlled storage locations. Normal storage time under these conditions is 12 months maximum.

**Table 24:** Storage conditions

| Type   | Condition                  | Unit                         | Reference  |
|--|----------------------------|------------------------------|--|
| Air temperature: Low<br>High   | -25<br>+40                 | °C                           | IPC/JEDEC J-STD-033A   |
| Humidity relative: Low<br>High   | 10<br>90 at 40°C           | %                            | IPC/JEDEC J-STD-033A   |
| Air pressure: Low<br>High  | 70<br>106                  | kPa                          | IEC TR 60271-3-1: 1K4<br>IEC TR 60271-3-1: 1K4                                     |
| Movement of surrounding air  | 1.0                        | m/s                          | IEC TR 60271-3-1: 1K4  |
| Water: rain, dripping, icing and frosting                                | Not allowed                | ---                          | ---  |
| Radiation: Solar<br>Heat   | 1120<br>600                | W/m <sup>2</sup>             | ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb<br>ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb |
| Chemically active substances   | Not recommended            |                              | IEC TR 60271-3-1: 1C1L   |
| Mechanically active substances   | Not recommended            |                              | IEC TR 60271-3-1: 1S1  |
| Vibration sinusoidal:<br>Displacement<br>Acceleration<br>Frequency range | 1.5<br>5<br>2-9 9-200      | mm<br>m/s <sup>2</sup><br>Hz | IEC TR 60271-3-1: 1M2  |
| Shocks:<br>Shock spectrum<br>Duration<br>Acceleration                    | semi-sinusoidal<br>1<br>50 | ms<br>m/s <sup>2</sup>       | IEC 60068-2-27 Ea  |

#### 4.2.4.2 Processing Life

PLSx3 must be soldered to an application within 72 hours after opening the moisture barrier bag (MBB) it was stored in.

As specified in the IPC/JEDEC J-STD-033 Standard, the manufacturing site processing the modules should have ambient temperatures below 30°C and a relative humidity below 60%.

#### 4.2.4.3 Baking

Baking conditions are specified on the moisture sensitivity label attached to each MBB (see [Figure 42](#) for details):

- It is *not necessary* to bake PLSx3, if the conditions specified in [Section 4.2.4.1](#) and [Section 4.2.4.2](#) were not exceeded.
- It is *necessary* to bake PLSx3, if any condition specified in [Section 4.2.4.1](#) and [Section 4.2.4.2](#) was exceeded.

If baking is necessary, the modules must be put into trays that can be baked to at least 125°C. Devices should not be baked in tape and reel carriers at any temperature.

#### 4.2.4.4 Electrostatic Discharge

Electrostatic discharge (ESD) may lead to irreversable damage for the module. It is therefore advisable to develop measures and methods to counter ESD and to use these to control the electrostatic environment at manufacturing sites.

Please refer to [Section 3.6](#) for further information on electrostatic discharge.

4.3 Packaging

4.3 Packaging

4.3.1 Tape and Reel

The single-feed tape carrier for PLSx3 is illustrated in Figure 37. The figure also shows the proper part orientation. The tape width is 44mm and the PLSx3 modules are placed on the tape with a 40mm pitch. The reels are 330mm in diameter with 100mm hubs. Each reel contains 400 modules.

4.3.1.1 Orientation

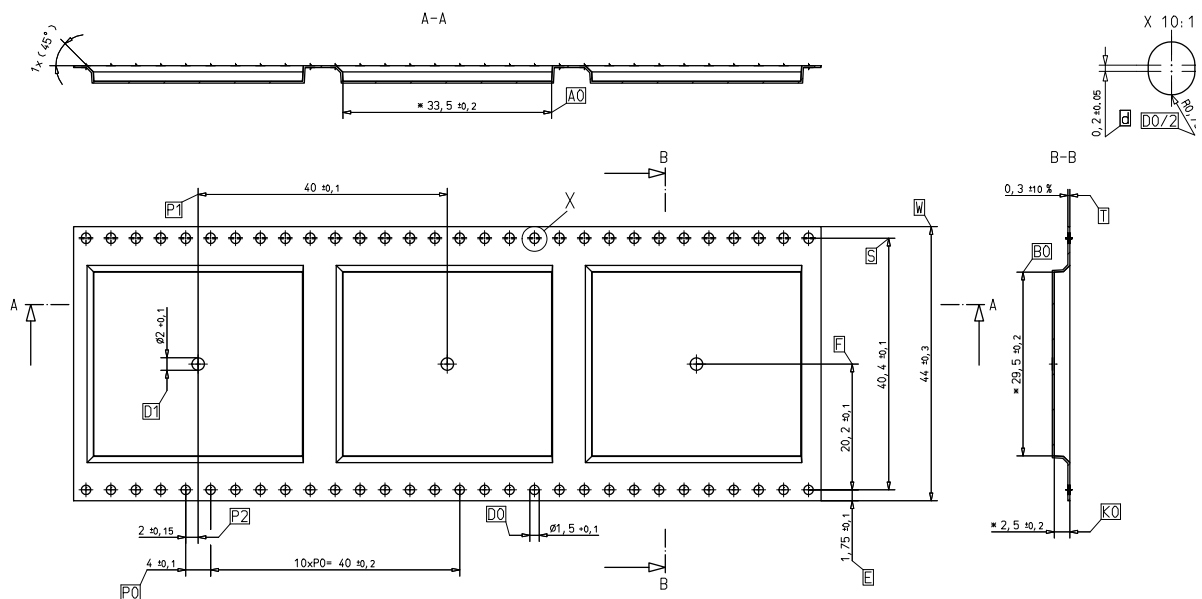


Figure 37: Carrier tape

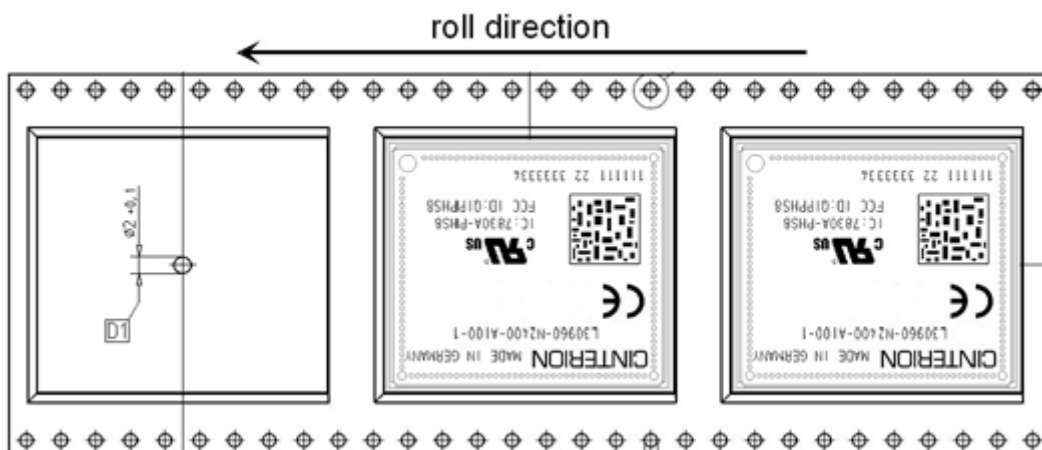


Figure 38: Reel direction

### 4.3.1.2 Barcode Label

A barcode label provides detailed information on the tape and its contents. It is attached to the reel.

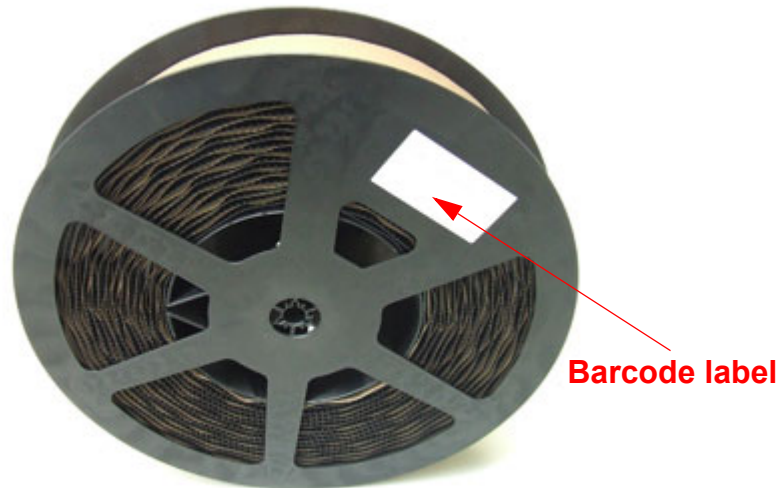


Figure 39: Barcode label on tape reel

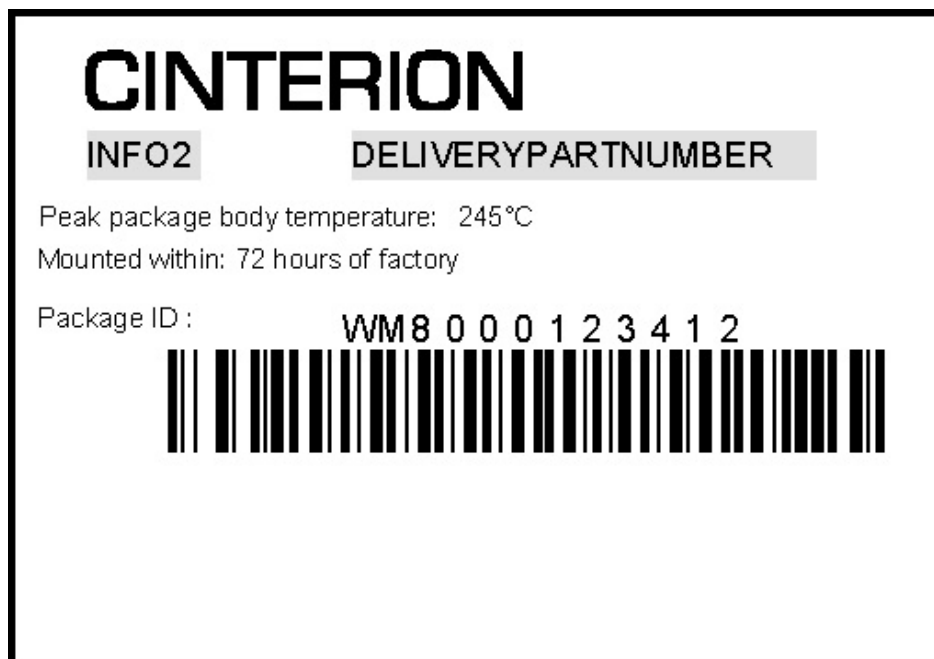


Figure 40: Barcode label on tape reel - layout

Variables on the label are explained in [Table 23](#).

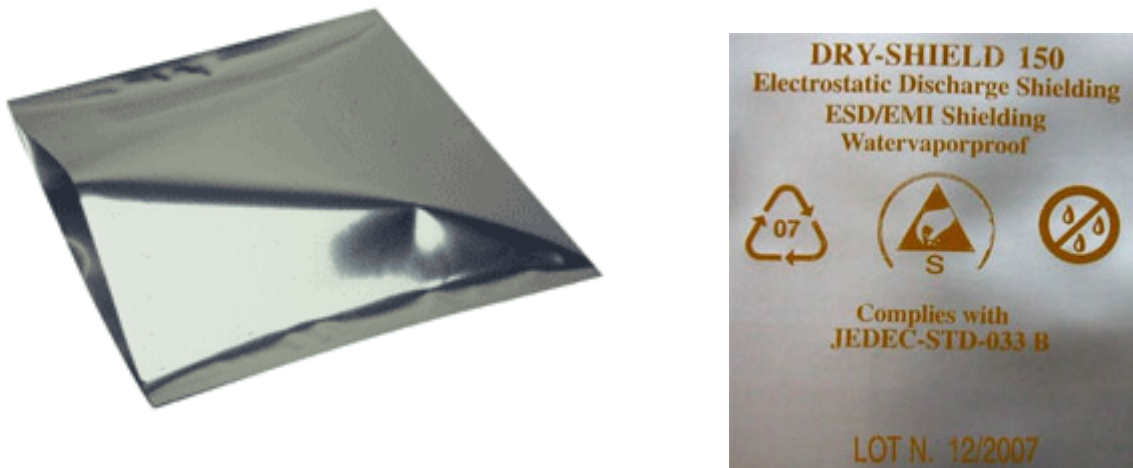
## 4.3.2 Shipping Materials

PLSx3 is distributed in tape and reel carriers. The tape and reel carriers used to distribute PLSx3 are packed as described below, including the following required shipping materials:

- Moisture barrier bag, including desiccant and humidity indicator card
- Transportation box

### 4.3.2.1 Moisture Barrier Bag

The tape reels are stored inside a moisture barrier bag (MBB), together with a humidity indicator card and desiccant pouches - see [Figure 41](#). The bag is ESD protected and delimits moisture transmission. It is vacuum-sealed and should be handled carefully to avoid puncturing or tearing. The bag protects the PLSx3 modules from moisture exposure. It should not be opened until the devices are ready to be soldered onto the application.



**Figure 41:** Moisture barrier bag (MBB) with imprint

The label shown in [Figure 42](#) summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag.



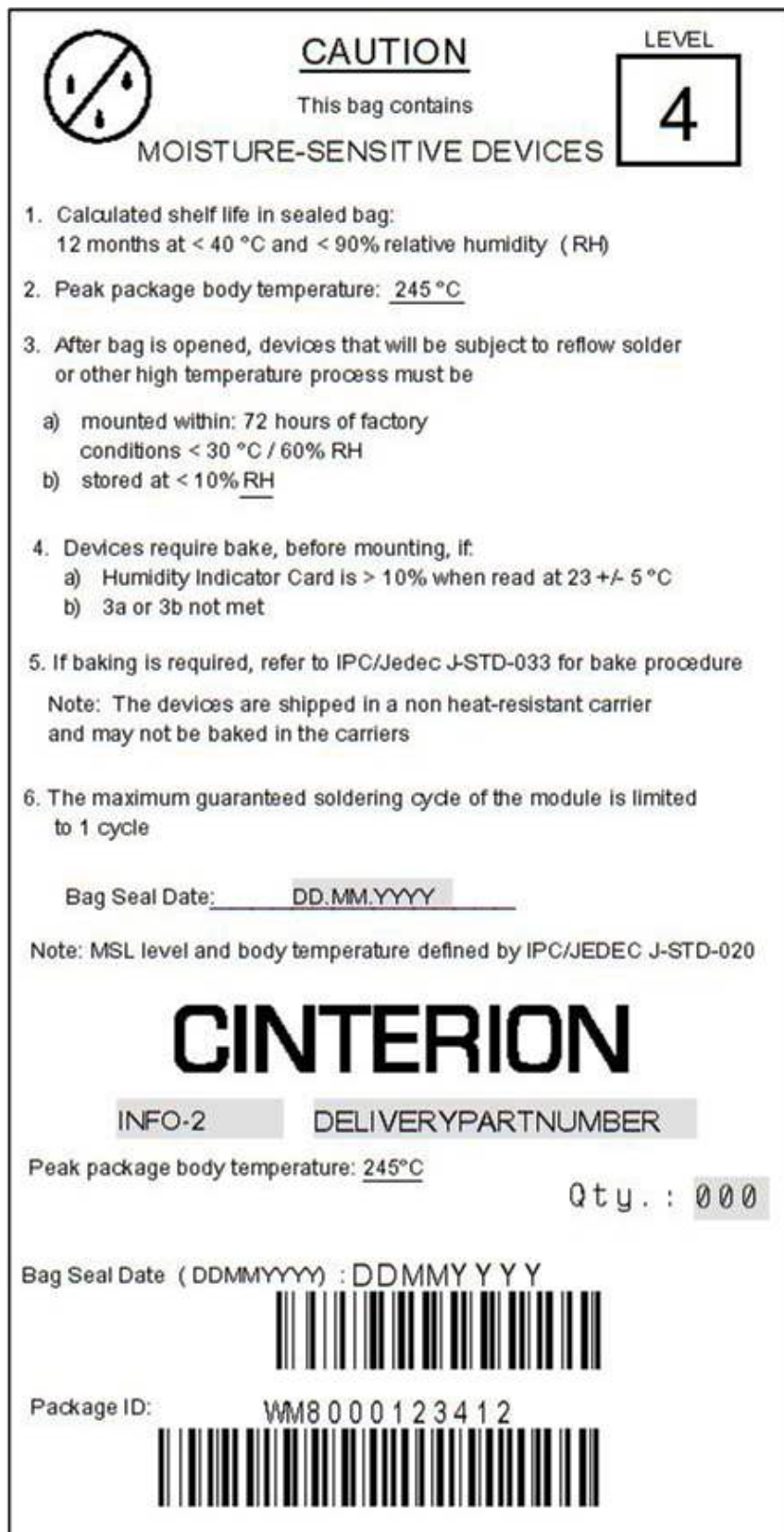


Figure 42: Moisture Sensitivity Label

## 4.3 Packaging

MBBs contain one or more desiccant pouches to absorb moisture that may be in the bag. The humidity indicator card described below should be used to determine whether the enclosed components have absorbed an excessive amount of moisture.

The desiccant pouches should not be baked or reused once removed from the MBB.

The humidity indicator card is a moisture indicator and is included in the MBB to show the approximate relative humidity level within the bag. Sample humidity cards are shown in [Figure 43](#). If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.

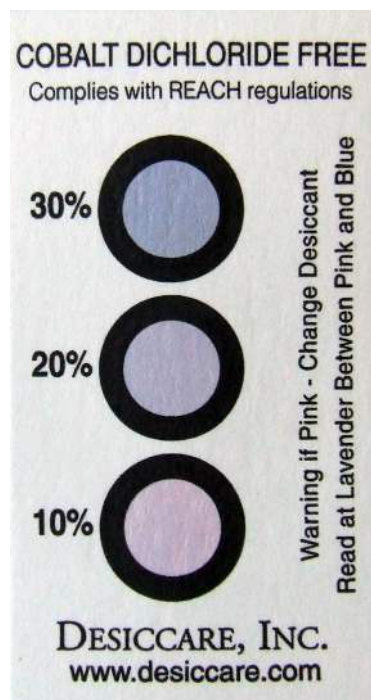


Figure 43: Humidity Indicator Card - HIC

A baking is required if the humidity indicator inside the bag indicates 10% RH or more.

### 4.3.2.2 Transportation Box

Tape and reel carriers are distributed in a box, marked with a barcode label for identification purposes. A box contains two reels with 400 (TBD for -X variant) modules each.

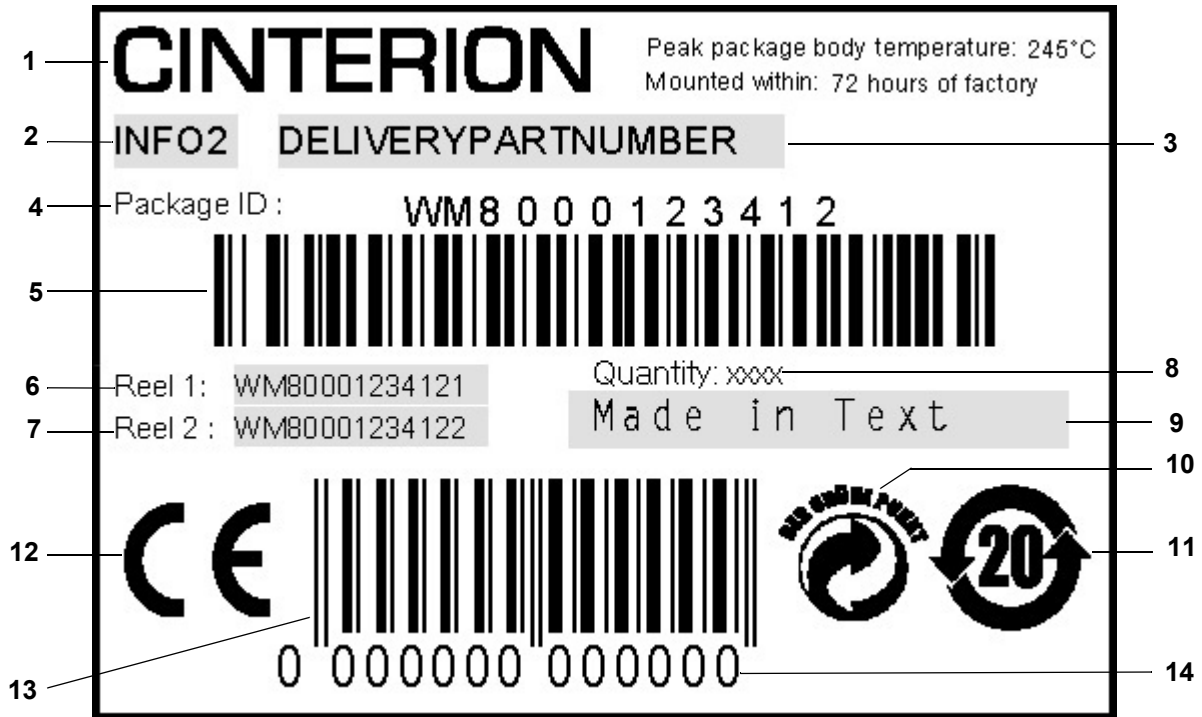


Figure 44: Sample of VP box label

Table 25: VP Box label information

| No. | Information  |
|-----|--|
| 1   | Cinterion logo   |
| 2   | Product name   |
| 3   | Product ordering number  |
| 4   | Package ID number of VP box (format may vary depending on the product)                           |
| 5   | Package ID barcode (Code 128)  |
| 6   | Package ID Reel 1 (format may vary depending on the product)                                     |
| 7   | Package ID Reel 2 (format may vary depending on the product)                                     |
| 8   | Quantity of the modules inside the VP box (max. 1000 pcs)  |
| 9   | Country of production  |
| 10  | Der Grüne Punkt (Green Dot) symbol   |
| 11  | Chinese RoHS symbol (see <a href="#">Table 31</a> )  |
| 12  | CE logo (CE mark on VP box label is present only for modules with CE imprinted on the shielding) |
| 13  | European Article Number (EAN-13) barcode   |
| 14  | European Article Number, consists of 13 digits (EAN-13)  |



## 5 Regulatory and Type Approval Information

### 5.1 Directives and Standards


PLSx3 is designed to comply with the directives and standards listed below.

It is the responsibility of the application manufacturer to ensure compliance of the final product with all provisions of the applicable directives and standards as well as with the technical specifications provided in the "PLSx3 Hardware Interface Description".<sup>1</sup>

**Table 26:** Directives

|  |  |
|--|--|
| 2014/53/EU                                 | <p>Directive of the European Parliament and of the council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/05/EC.</p> <p>The product is labeled with the CE conformity mark.</p>    |
| 2002/95/EC (RoHS 1)<br>2011/65/EC (RoHS 2) | <p>Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)</p>   |
| 1907/2006/EC (REACH)                       | <p>Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directive 91/155/EEC, 93/67/EC and 2000/21/EC.</p> <p>Cinterion® module comply with the REACH regulation that specifies a content of less than 0.1% per substance mentioned in the SVHC candidate list (Release 16.06.2014)</p> |

**Table 27:** Standards of North American type approval

|                                    |   |
|------------------------------------|---|
| CFR Title 47                       | Code of Federal Regulations, Part 22, Part 24; US Equipment Authorization FCC   |
| OET Bulletin 65<br>(Edition 97-01) | Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields  |
| UL 60 950-1                        | Product Safety Certification (Safety requirements)<br>         |
| NAPRD.03 V6.01                     | Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control<br>PCS Type Certification Review board (PTCRB) |
| RSS132 (Issue2)<br>RSS133 (Issue5) | Canadian Standard   |

1. Manufacturers of applications which can be used in the US shall ensure that their applications have a PTCRB approval. For this purpose they can refer to the PTCRB approval of the respective module.

## 5.1 Directives and Standards

**Table 28:** Standards of European type approval

|                                      |   |
|--------------------------------------|---|
| 3GPP TS 51.010-1                     | Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;  |
| GCF-CC V3.79                         | Global Certification Forum - Certification Criteria   |
| ETSI EN 301 511 V12.5.1              | Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU   |
| ETSI EN 301 908-01 V13.1.1           | IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements   |
| ETSI EN 301 908-02 V11.1.2           | IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)  |
| ETSI EN 301 489-52 V1.1.0            | Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication Mobile and portable (UE) radio and ancillary equipment; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU  |
| ETSI EN 301 908-13 V13.1.1           | IMT cellular networks; Harmonized Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 13: evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE).  |
| Draft ETSI EN 301 489-01 V2.2.3      | Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU   |
| ETSI EN 301489-19 V2.1.0             | ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band (ROGNSS) providing positioning, navigation, and timing data; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU |
| ETSI EN 303 413 V1.1.1               | Satellite Earth Stations and Systems (SES); Global Navigation Satellite System (GNSS) receivers; Radio equipment operating in the 1 164 MHz to 1 300 MHz and 1 559 MHz to 1 610 MHz frequency bands; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU   |
| IEC 62368-1 (EN 62368-1, UL 62368-1) | Audio/video, information and communication technology equipment - Part 1: Safety requirements<br><br>(for details see <a href="#">Section 5.1.1</a> )   |

**Table 29:** Requirements of quality


|               |  |
|---------------|--|
| IEC 60068     | Environmental testing  |
| DIN EN 60529  | IP codes   |
| EN 62311:2008 | Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz) |

**Table 30:** Standards of the Ministry of Information Industry of the People's Republic of China

|                 |  |
|-----------------|--|
| SJ/T 11363-2006 | "Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products" (2006-06). |
|-----------------|--|

5.1 Directives and Standards

**Table 30:** Standards of the Ministry of Information Industry of the People’s Republic of China

|                        |  |   |
|------------------------|--|---|
| <p>SJ/T 11364-2006</p> | <p>“Marking for Control of Pollution Caused by Electronic Information Products” (2006-06).</p> <p>According to the “Chinese Administration on the Control of Pollution caused by Electronic Information Products” (ACPEIP) the EPUP, i.e., Environmental Protection Use Period, of this product is 20 years as per the symbol shown here, unless otherwise marked. The EPUP is valid only as long as the product is operated within the operating limits described in the Thales Hardware Interface Description.</p> <p>Please see <a href="#">Table 31</a> for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006.</p> |  |
|------------------------|--|---|

**Table 31:** Toxic or hazardous substances or elements with defined concentration limits

| 部件名称<br>Name of the part                  | 有毒有害物质或元素 Hazardous substances |           |           |                 |               |                 |
|---|--------------------------------|-----------|-----------|-----------------|---------------|-----------------|
|   | 铅<br>(Pb)                      | 汞<br>(Hg) | 镉<br>(Cd) | 六价铬<br>(Cr(VI)) | 多溴联苯<br>(PBB) | 多溴二苯醚<br>(PBDE) |
| 金属部件<br>(Metal Parts)                     | ○                              | ○         | ○         | ○               | ○             | ○               |
| 电路模块<br>(Circuit Modules)                 | X                              | ○         | ○         | ○               | ○             | ○               |
| 电缆及电缆组件<br>(Cables and Cable Assemblies)  | ○                              | ○         | ○         | ○               | ○             | ○               |
| 塑料和聚合物部件<br>(Plastic and Polymeric parts) | ○                              | ○         | ○         | ○               | ○             | ○               |

O:  
表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。  
Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X:  
表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006标准规定的限量要求。  
Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part *might exceed* the limit requirement in SJ/T11363-2006.



### 5.1.1 IEC 62368-1 Classification

With respect to the safety requirements for audio/video, information and communication technology equipment defined by the hazard based product safety standard for ICT and AV equipment - i.e., IEC-62368-1 (EN 62368-1, UL 62368-1) - Cinterion® modules are classified as shown below:

Standalone operation of the modules is not possible. Modules will always be incorporated in an external application (Customer Product).

Customer understands and is responsible that the product incorporating the Cinterion® module must be designed to be compliant with IEC-62368-1 (EN 62368-1, UL 62368-1) to ensure protection against hazards and injuries. When operating the Cinterion® module the external application (Customer Product) must provide safeguards not to exceed the power limits given by classification to Power Source Class 1 (15 Watts) under normal operating conditions, abnormal conditions, or in the presence of a single fault. When using a battery power supply the external application must provide safeguards not to exceed the limits defined by PS-1, as well. The external application (Customer Product) must take measures to limit the power, the voltage or the current, respectively, if required, and must provide safeguards to protect ordinary persons against pain or injury caused by the voltage/current.

In case of a usage of the Cinterion® module not in accordance with the specifications or in single fault condition the external application (Customer Product) must be capable to withstand levels according to ES-1 / PS-1 also on all ports that are initially intended for signalling or audio, e.g., USB, RS-232, GPIOs, SPI, earphone and microphone interfaces.

In addition, the external application (Customer Product) must be designed in a way to distribute thermal energy generated by the intended operation of the Cinterion® module. In case of high temperature operation, the external application must provide safeguards to protect ordinary persons against pain or injury caused by the heat.

**Table 32:** IEC 62368-1 Classification

| Source of Energy   | Class | Limits   |
|--|-------|--|
| Electrical energy source                                 | ES-1  | The Cinterion® modules contain no electrical energy source - especially no battery. The electrical components and circuits have to be externally power supplied:<br><br>DC either smaller 60 V<br>Or less than 2 mA<br>AC up to 1kHz smaller 30 V-rms or 42.4 V peak<br>AC above 100kHz smaller 70 V rms |
| Power Source<br>(potential ignition source causing fire) | PS-1  | Power source provided by the external application must not exceed 15W, even under worst case and any single fault condition defined by IEC-62368-1: Section 6.2.2.3.   |

Table 32: IEC 62368-1 Classification

| Source of Energy   | Class | Limits   |
|--|-------|--|
| Hazardous Substances,<br>Chemical reaction   | -     | Under regular conditions, the Cinterion® modules does not contain any chemically reactive substances, and no chemical energy source, especially no battery.<br><br>Module is compliant with RoHS and REACH.<br><br>In very rare cases however - under abnormal conditions (i.e. wrong supply voltage, burned module) or in the presence of single electrical component faults (i.e. shortcut) - health hazardous substances might be released if the worst comes to the worst. |
| Kinetic / mechanical energy source   | MS-1  | The Cinterion® modules have no sharp edges and corners, no moving parts, no loosening, exploding or imploding parts.<br>The mass is well below 1kg.  |
| Thermal energy source  | TS-2  | Under normal operating conditions, abnormal operating conditions or single fault conditions the temperature does not exceed +100°C on the metal surface (shielding)  |
| Thermal energy source<br><br><b>Note:</b> Valid only for Cinterion® modules with dimensions larger than 50mm and operating board temperatures higher than +80°C. | TS-3  | Special safeguards required.   |
| Radiated energy source   | RS-1  | The Cinterion® module does not contain a radiant energy source, any lasers, lamps, LEDs, X-Ray emitting components or acoustic couplers.   |



## 5.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a GSM/UMTS module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable PLSx3 based applications to be evaluated and approved for compliance with national and/or international regulations.

Since the SAR value varies significantly with the individual product design manufacturers are advised to submit their product for approval if designed for portable use. For European/US/Australian-markets the relevant directives are mentioned below. The manufacturer of the end device is in the responsibility to provide clear installation and operating instructions for the user, including the minimum separation distance required to maintain compliance with SAR and/or RF field strength limits, as well as any special usage conditions required to do so, such as a required accessory, the proper orientation of the device, the max antenna gain for detachable antennas, or other relevant criteria. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

### *Products intended for sale on US markets*

ES 59005/ANSI C95.1 Considerations for evaluation of human exposure to Electromagnetic Fields (EMFs) from Mobile Telecommunication Equipment (MTE) in the frequency range 30MHz - 6GHz

### *Products intended for sale on European markets*

|               |   |
|---------------|---|
| EN 50360      | Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300MHz - 3GHz) |
| EN 62311:2008 | Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)                            |

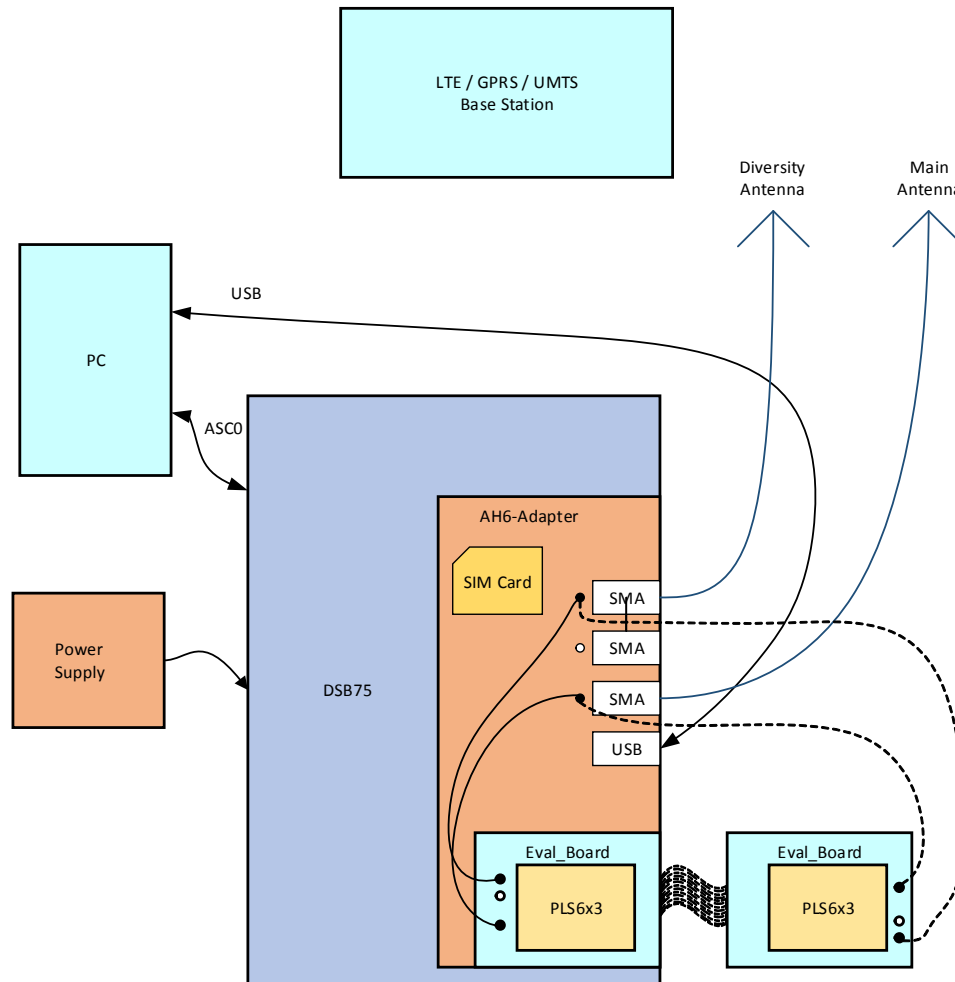
Please note that SAR requirements are specific only for portable devices and not for mobile devices as defined below:

- **Portable device:**  
A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.
- **Mobile device:**  
A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location.

## 5.3 Reference Equipment for Type Approval

## 5.3 Reference Equipment for Type Approval

The Thales reference setup submitted to type approve PLSx3 (including a special approval adapter for the DSB75) is shown in the following figure<sup>1</sup>:



**Figure 45:** Reference equipment for Type Approval

1. For RF performance tests a mini-SMT/U.FL to SMA adapter with attached 6dB coaxial attenuator is chosen to connect the evaluation module directly to the GSM/UMTS test equipment instead of employing the SMA antenna connectors on the PLSx3-DSB75 adapter as shown in Figure 45. The following products are recommended:

Hirose SMA-Jack/U.FL-Plug conversion adapter HRMJ-U.FLP(40)

(for details see <http://www.hirose-connectors.com/> or <http://www.farnell.com/>)

Aeroflex Weinschel Fixed Coaxial Attenuator Model 3T/4T

(for details see <http://www.aeroflex.com/ams/weinschel/pdfs/wmod3&4T.pdf>)

## 5.4 Compliance with FCC and ISED Rules and Regulations

The Equipment Authorization Certification for the Thales reference application described in [Section 5.3](#) will be registered under the following identifiers:

*FCC Identifier: QIPPLS63-W  
Industry Canada Certification Number: 7830A-PLS63W  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS83-W  
Industry Canada Certification Number: 7830A-PLS83W  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS63-X  
Industry Canada Certification Number: 7830A-PLS63X  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS83-X  
Industry Canada Certification Number: 7830A-PLS83X  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS63-X2  
Industry Canada Certification Number: 7830A-PLS63X2  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS83-X2  
Industry Canada Certification Number: 7830A-PLS83X2  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS63-X3  
Industry Canada Certification Number: 7830A-PLS63X3  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS83-X3  
Industry Canada Certification Number: 7830A-PLS83X3  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS63-X4  
Industry Canada Certification Number: 7830A-PLS63X4  
Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPPLS83-X4  
Industry Canada Certification Number: 7830A-PLS83X4  
Granted to THALES DIS AIS Deutschland GmbH*

Manufacturers of mobile or fixed devices incorporating PLSx3 modules are authorized to use the FCC Grants and ISED Certificates of the PLSx3 modules for their own final products according to the conditions referenced in these documents. In this case, an FCC/IC label of the module shall be visible from the outside, or the host device shall bear a second label stating "Contains FCC ID: QIPPLS63-W", "Contains FCC ID: QIPPLS83-W", "Contains FCC ID: QIPPLS63-X", "Contains FCC ID: QIPPLS83-X", "Contains FCC ID: QIPPLS63-X2", "Contains FCC ID: QIPPLS83-X2", "Contains FCC ID: QIPPLS63-X3", "Contains FCC ID: QIPPLS83-X3", "Con-

## 5.4 Compliance with FCC and ISED Rules and Regulations

tains FCC ID: QIPPLS63-X4”, "Contains FCC ID: QIPPLS83-X4”, and accordingly “Contains IC: 7830A-PLS63W”, “Contains IC: 7830A-PLS83W”, “Contains IC: 7830A-PLS63X”, “Contains IC: 7830A-PLS83X”, “Contains IC: 7830A-PLS63X2”, “Contains IC: 7830A-PLS83X2”, “Contains IC: 7830A-PLS63X3”, “Contains IC: 7830A-PLS83X3”, “Contains IC: 7830A-PLS63X4”, “Contains IC: 7830A-PLS83X4”.

The integration is limited to fixed or mobile categorized host devices, where a separation distance between the antenna and any person of min. 20cm can be assured during normal operating conditions.

For mobile and fixed operation configuration the antenna gain, including cable loss, must not exceed the limits listed in the following [Table 33](#) and [Table 34](#) for FCC and ISED.

**Table 33:** Antenna gain limits for FCC and ISED (for W and EP variants)

| Operation band               | FCC limit | ISED limit | Unit |
|------------------------------|-----------|------------|------|
| Maximum gain in GSM/GPRS 850 | 8.60      | 5.30       | dBi  |
| Maximum gain in PCS 1900     | 10.20     | 10.20      | dBi  |
| Maximum gain in WCDMA Band 2 | 8.01      | 8.01       | dBi  |
| Maximum gain in WCDMA Band 4 | 5.00      | 5.00       | dBi  |
| Maximum gain in WCDMA Band 5 | 9.40      | 6.10       | dBi  |
| Maximum gain in LTE Band 2   | 8.01      | 8.01       | dBi  |
| Maximum gain in LTE Band 4   | 5.00      | 5.00       | dBi  |
| Maximum gain in LTE Band 5   | 9.40      | 6.10       | dBi  |
| Maximum gain in LTE Band 7   | 8.01      | 8.01       | dBi  |
| Maximum gain in LTE Band 12  | 8.70      | 5.61       | dBi  |
| Maximum gain in LTE Band 13  | 9.16      | 5.93       | dBi  |
| Maximum gain in LTE Band 26  | 9.30      | 6.10       | dBi  |
| Maximum gain in LTE Band 38  | 8.01      | 8.01       | dBi  |
| Maximum gain in LTE Band 41  | 8.01      | 8.01       | dBi  |
| Maximum gain in LTE Band 66  | 5.00      | 5.00       | dBi  |

**Table 34:** Antenna gain limits for FCC and ISED (for X, X2, X3, X4 variants)

| Operation band               | FCC limit | ISED limit | Unit |
|------------------------------|-----------|------------|------|
| Maximum gain in WCDMA Band 2 | 8.01      | 8.01       | dBi  |
| Maximum gain in WCDMA Band 4 | 5.00      | 5.00       | dBi  |
| Maximum gain in WCDMA Band 5 | 9.40      | 6.10       | dBi  |
| Maximum gain in LTE Band 2   | 8.01      | 8.01       | dBi  |
| Maximum gain in LTE Band 4   | 5.00      | 5.00       | dBi  |
| Maximum gain in LTE Band 5   | 9.40      | 6.10       | dBi  |
| Maximum gain in LTE Band 12  | 8.70      | 5.61       | dBi  |
| Maximum gain in LTE Band 13  | 9.16      | 5.93       | dBi  |
| Maximum gain in LTE Band 14  | 9.23      | N.A.       | dBi  |
| Maximum gain in LTE Band 25  | 8.01      | 8.01       | dBi  |

## 5.4 Compliance with FCC and ISED Rules and Regulations

**Table 34:** Antenna gain limits for FCC and ISED (for X, X2, X3, X4 variants)

| Operation band              | FCC limit | ISED limit | Unit |
|-----------------------------|-----------|------------|------|
| Maximum gain in LTE Band 26 | 9.30      | 6.10       | dBi  |
| Maximum gain in LTE Band 66 | 5.00      | 5.00       | dBi  |
| Maximum gain in LTE Band 71 | 8.48      | 5.45       | dBi  |

**IMPORTANT:**

Manufacturers of portable applications incorporating PLSx3 modules are required to have their final product certified and apply for their own FCC Grant and ISED Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see [Section Table 31](#): for detail).

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules and with ISED license-exempt RSS standard(s). These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This Class B digital apparatus complies with Canadian ICES-003.

**FCC Part 15.19 Warning Statement**

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.

If Canadian approval is requested for devices incorporating PLSx3 modules the below notes will have to be provided in the English and French language in the final user documentation. Manufacturers/OEM Integrators must ensure that the final user documentation does not contain any information on how to install or remove the module from the final product.

**Notes (ISED):**

(EN) This Class B digital apparatus complies with Canadian ICES-003 and RSS-210. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

(FR) Cet appareil numérique de classe B est conforme aux normes canadiennes ICES-003 et RSS-210. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférence et (2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.

**(EN) Radio frequency (RF) Exposure Information**

The radiated output power of the Wireless Device is below the Innovation, Science and Economic Development Canada (ISED) radio frequency exposure limits. The Wireless Device should be used in such a manner such that the potential for human contact during normal operation is minimized.

This device has also been evaluated and shown compliant with the ISED RF Exposure limits under mobile exposure conditions. (antennas at least 20cm from a person's body).

**(FR) Informations concernant l'exposition aux fréquences radio (RF)**

La puissance de sortie émise par l'appareil de sans fil est inférieure à la limite d'exposition aux fréquences radio d'Innovation, Sciences et Développement économique Canada (ISDE). Utilisez l'appareil de sans fil de façon à minimiser les contacts humains lors du fonctionnement normal.

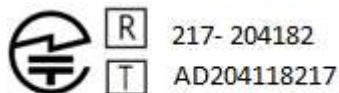
Ce périphérique a également été évalué et démontré conforme aux limites d'exposition aux RF d'IC dans des conditions d'exposition à des appareils mobiles (les antennes se situent à moins de 20cm du corps d'une personne).

## 5.5 Compliance with Japanese Rules and Regulations

The PLSx3 reference application described in [Section 5.3](#) complies with the requirements of the Japanese "Telecommunications Business Law" and "Ordinance Concerning Technical Regulations Conformity Certification of Specified Radio Equipment" as well as with the requirements of the Japanese "Radio Law" and "Ordinance Concerning Technical Conditions Compliance Approval and Certification of the Type for Terminal Equipment".

- The certificate granted in accordance with the "Telecommunications Business Law" has the identifier:  
AD204118217 (for -J)  
AD210086217 (for -W)
- The certificate granted in accordance with the "Radio Law" has the identifier:  
217-204182 (for -J)  
217-210086 (for -W)

Please refer to [Figure 47](#) for the JATE/TELEC mark with identifiers:



**Figure 46:** JATE/TELEC mark for -J

:



**Figure 47:** JATE/TELEC mark for -W

## 6 Document Information

### 6.1 Revision History

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 01.002

New document: "Cinterion® PLSx3 Hardware Interface Description" Version **01.003**

| Chapter  | What is new   |
|--|---|
| <a href="#">2.2</a>                              | Updated <a href="#">Table 12</a> .                            |
| <a href="#">2.1.2</a><br><a href="#">3.2.2.2</a> | Updated the low level impulse.                                |
| <a href="#">3.2.3</a>                            | Updated <a href="#">Table 15</a> and added a note.            |
| <a href="#">5.4</a>                              | Added <a href="#">Table 33</a> and <a href="#">Table 34</a> . |

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.906a

New document: "Cinterion® PLSx3 Hardware Interface Description" Version **01.002**

| Chapter               | What is new   |
|-----------------------|---|
| <a href="#">1.1</a>   | Updated the supported product in the list.                              |
| <a href="#">1.2.1</a> | Added new products and the supported bands in <a href="#">Table 1</a> . |
| <a href="#">3.4.2</a> | Added this section.   |
| <a href="#">3.4.1</a> | Updated <a href="#">Table 19</a> and <a href="#">Table 20</a> .         |
| <a href="#">3.3.4</a> | Added this section.   |
| <a href="#">3.2.1</a> | Updated <a href="#">Figure 23</a> .                                     |
| <a href="#">5.1.1</a> | New chapter regarding <a href="#">IEC 62368-1 Classification</a>        |
| <a href="#">7</a>     | Added the supported products in <a href="#">Table 35</a> .              |

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.906

New document: "Cinterion® PLSx3 Hardware Interface Description" Version **00.906a**

| Chapter             | What is new                                 |
|---------------------|---|
| <a href="#">1.2</a> | Updated the extended operating temperature. |

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.024

New document: "Cinterion® PLSx3 Hardware Interface Description" Version **00.906**

| Chapter | What is new |
|---------|-------------|
|---------|-------------|



## 6.1 Revision History

|                       |  |
|-----------------------|--|
| 2.1.3.1               | Add Reducing Power Consumption section.                              |
| 2.1.9                 | Added Analog-to-Digital Converter (ADC) section.                     |
| 2.1.10.3,<br>2.1.10.4 | Added Fast shutdown and Remove Wakeup sections.                      |
| 3.1                   | Added Operation Mode section.  |
| 3.2.5                 | Added Automatic shutdown with sub sections.                          |
| 3.3                   | Added Power Saving section.  |
| 3.6                   | Added Electrostatic Discharge section.                               |
| 4.3.1.2               | Added <a href="#">Figure 40</a> .                                    |
| 4.3.2.2               | Added <a href="#">Figure 44</a> and <a href="#">Table 25</a> .       |
| 5                     | Added chapter 6 Regulatory and Type Approval Information.            |
| 7.2                   | Added Module Label Information section.                              |
| 3.2.1                 | Updated <a href="#">Figure 23</a> and the description of IGT signal. |
| 2.1.2                 | Updated Ignition signal description in <a href="#">Table 3</a> .     |

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.012

New document: "Cinterion® PLSx3 Hardware Interface Description" Version **00.024**

| Chapter | What is new  |
|---------|--|
| --      | Added new variants of -X, -EP, -LA and -J as well as their supported bands.  |
| --      | Update the height of the module.   |
| 2.1.1   | Updated the pad assignment. Update the number of GPIO to 22.   |
| 2.1.6   | Updated <a href="#">Figure 8</a> .   |
| 2       | Added the following chapters: <a href="#">2.1.10.1</a> , <a href="#">2.2</a> , <a href="#">2.3</a> , <a href="#">2.4</a> . |
| 3.2.5   | Added Automatic Shutdown section.  |
| 3.4.1   | Updated power consumption.   |
| 3.5     | Added Operating Temperatures section.  |
| --      | Removed TX-activity.   |

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.002

New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.012

| Chapter | What is new  |
|---------|--|
| 2       | Added the following new sections: <a href="#">2.1.7</a> , <a href="#">2.1.8.1</a> , <a href="#">2.1.10</a> , <a href="#">2.1.6.1</a> |
| 3       | Added the following new sections: <a href="#">3.2.2</a> , <a href="#">3.2.4</a> , <a href="#">3.2.2</a>                              |
| 4       | Added the following new sections: <a href="#">4.2.4</a> , <a href="#">4.3</a>  |
| 2.1.1   | Updated the pad assignment   |
| 1.3     | Updated <a href="#">Figure 1</a>   |

## 6.2 Related Documents

|   |                                |
|---|--------------------------------|
| - | Updated company name and logo. |
|---|--------------------------------|

Proceeding document New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.001

New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.002

| Chapter | What is new   |
|---------|---|
| 1.4     | Updated the <a href="#">Figure 2</a> .  |
| 2.1     | Added the following new sections: <a href="#">2.1.3</a> , <a href="#">2.1.4</a> <a href="#">2.1.5</a> , <a href="#">2.1.6</a> |
| 3       | Added section <a href="#">3.2</a>   |

New document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.001

| Chapter | What is new             |
|---------|-------------------------|
| --      | Initial document setup. |

## 6.2 Related Documents

- [1] PLSx3 AT Command Set
- [2] PLSx3 Release Note
- [3] Universal Serial Bus Specification Revision 2.0, April 27, 2000
- [4] Application Note 48: SMT Module Integration
- [5] Differences between Selected Cinterion® Modules, Hardware Migration Guide

## 6.3 Terms and Abbreviations

| Abbreviation | Description  |
|--------------|--|
| ADC          | Analog-to-digital converter  |
| AGC          | Automatic Gain Control   |
| ANSI         | American National Standards Institute  |
| ARFCN        | Absolute Radio Frequency Channel Number  |
| ARP          | Antenna Reference Point  |
| ASC0/ASC1    | Asynchronous Controller. Abbreviations used for first and second serial interface of PLSx3 |
| B            | Thermistor Constant  |
| BER          | Bit Error Rate   |
| BIP          | Bearer Independent Protocol  |
| BTS          | Base Transceiver Station   |
| CB or CBM    | Cell Broadcast Message   |
| CE           | Conformité Européene (European Conformity)   |
| CHAP         | Challenge Handshake Authentication Protocol  |

## 6.3 Terms and Abbreviations

| Abbreviation | Description   |
|--------------|---|
| CPU          | Central Processing Unit   |
| CS           | Coding Scheme   |
| CSD          | Circuit Switched Data   |
| CTS          | Clear to Send   |
| DAC          | Digital-to-Analog Converter   |
| dBm0         | Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law |
| DCE          | Data Communication Equipment (typically modems, e.g. Thales module)     |
| DRX          | Discontinuous Reception   |
| DSB          | Development Support Box   |
| DSP          | Digital Signal Processor  |
| DSR          | Data Set Ready  |
| DTR          | Data Terminal Ready   |
| DTX          | Discontinuous Transmission  |
| EFR          | Enhanced Full Rate  |
| EIRP         | Equivalent Isotropic Radiated Power                                     |
| EMC          | Electromagnetic Compatibility   |
| ERP          | Effective Radiated Power  |
| ESD          | Electrostatic Discharge   |
| ETS          | European Telecommunication Standard                                     |
| ETSI         | European Telecommunication Standards Institute                          |
| FCC          | Federal Communications Commission (U.S.)                                |
| FDMA         | Frequency Division Multiple Access                                      |
| FR           | Full Rate   |
| GMSK         | Gaussian Minimum Shift Keying   |
| GPIO         | General Purpose Input/Output  |
| HiZ          | High Impedance  |
| HR           | Half Rate   |
| I/O          | Input/Output  |
| IC           | Integrated Circuit  |
| IMEI         | International Mobile Equipment Identity                                 |
| ISO          | International Standards Organization                                    |
| ITU          | International Telecommunications Union                                  |
| kbps         | kbits per second  |
| LED          | Light Emitting Diode  |
| Li-Ion/Li+   | Lithium-Ion   |
| Li battery   | Rechargeable Lithium Ion or Lithium Polymer battery                     |
| LPM          | Link Power Management   |

## 6.3 Terms and Abbreviations

| Abbreviation | Description  |
|--------------|--|
| Mbps         | Mbits per second   |
| MMI          | Man Machine Interface  |
| MO           | Mobile Originated  |
| MS           | Mobile Station ( module), also referred to as TE   |
| MSISDN       | Mobile Station International ISDN number   |
| MT           | Mobile Terminated  |
| NTC          | Negative Temperature Coefficient   |
| OEM          | Original Equipment Manufacturer  |
| PA           | Power Amplifier  |
| PAP          | Password Authentication Protocol   |
| PBCCH        | Packet Switched Broadcast Control Channel  |
| PCB          | Printed Circuit Board  |
| PCL          | Power Control Level  |
| PDU          | Protocol Data Unit   |
| PLL          | Phase Locked Loop  |
| PPP          | Point-to-point protocol  |
| PSK          | Phase Shift Keying   |
| PSU          | Power Supply Unit  |
| PWM          | Pulse Width Modulation   |
| R&TTE        | Radio and Telecommunication Terminal Equipment   |
| RAM          | Random Access Memory   |
| RF           | Radio Frequency  |
| RLS          | Radio Link Stability   |
| RMS          | Root Mean Square (value)   |
| RoHS         | Restriction of the use of certain hazardous substances in electrical and electronic equipment. |
| ROM          | Read-only Memory   |
| RTC          | Real Time Clock  |
| RTS          | Request to Send  |
| Rx           | Receive Direction  |
| SAR          | Specific Absorption Rate   |
| SAW          | Surface Accoustic Wave   |
| SELV         | Safety Extra Low Voltage   |
| SIM          | Subscriber Identification Module   |
| SMD          | Surface Mount Device   |
| SMS          | Short Message Service  |
| SMT          | Surface Mount Technology   |
| SPI          | Serial Peripheral Interface  |







## 6.3 Terms and Abbreviations

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| Abbreviation | Description                                 |
|--------------|---|
| SRAM         | Static Random Access Memory                 |
| TA           | Terminal adapter (e.g. module)              |
| TDMA         | Time Division Multiple Access               |
| TE           | Terminal Equipment, also referred to as DTE |
| TLS          | Transport Layer Security                    |
| Tx           | Transmit Direction                          |
| UART         | Universal asynchronous receiver-transmitter |
| URC          | Unsolicited Result Code                     |
| USSD         | Unstructured Supplementary Service Data     |
| VSWR         | Voltage Standing Wave Ratio                 |

## 6.4 Safety Precaution Notes

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating PLSx3. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Thales assumes no liability for customer's failure to comply with these precautions.

|   |   |
|---|---|
|    | <p>When in a hospital or other health care facility, observe the restrictions on the use of mobiles. Switch the cellular terminal or mobile off, if instructed to do so by the guidelines posted in sensitive areas. Medical equipment may be sensitive to RF energy. The operation of cardiac pacemakers, other implanted medical equipment and hearing aids can be affected by interference from cellular terminals or mobiles placed close to the device. If in doubt about potential danger, contact the physician or the manufacturer of the device to verify that the equipment is properly shielded. Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker, while it is on.</p>  |
|    | <p>Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it cannot be switched on inadvertently. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.</p>  |
|  | <p>Do not operate the cellular terminal or mobile in the presence of flammable gases or fumes. Switch off the cellular terminal when you are near petrol stations, fuel depots, chemical plants or where blasting operations are in progress. Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.</p>  |
|  | <p>Your cellular terminal or mobile receives and transmits radio frequency energy while switched on. Remember that interference can occur if it is used close to TV sets, radios, computers or inadequately shielded equipment. Follow any special regulations and always switch off the cellular terminal or mobile wherever forbidden, or when you suspect that it may cause interference or danger.</p>  |
|  | <p>Road safety comes first! Do not use a hand-held cellular terminal or mobile when driving a vehicle, unless it is securely mounted in a holder for speakerphone operation. Before making a call with a hand-held terminal or mobile, park the vehicle. Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard.</p>   |
|  | <p><b>IMPORTANT!</b><br/>Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls. Remember, in order to make or receive calls, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength. Some networks do not allow for emergency calls if certain network services or phone features are in use (e.g. lock functions, fixed dialing etc.). You may need to deactivate those features before you can make an emergency call. Some networks require that a valid SIM card be properly inserted in the cellular terminal or mobile.</p> |

## 7 Appendix

### 7.1 List of Parts and Accessories

**Table 35:** List of parts and accessories

| Description | Supplier | Ordering information  |
|-------------|----------|---|
| PLS63-X     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6500-A100<br>Module label number: S30960-S6500-A100-1 <sup>1</sup> |
| PLS83-X     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6510-A100<br>Module label number: S30960-S6510-A100-1              |
| PLS63-W     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6520-A100<br>Module label number: S30960-S6520-A100-1              |
| PLS83-W     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6530-A100<br>Module label number1: S30960-S6530-A100-1             |
| PLS63-LA    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6540-A100<br>Module label number: S30960-S6540-A100-1              |
| PLS83-LA    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6550-A100<br>Module label number: S30960-S6550-A100-1              |
| PLS63-EP    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6560-A100<br>Module label number: S30960-S6560-A100-1              |
| PLS83-EP    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6570-A100<br>Module label number: S30960-S6570-A100-1              |
| PLS63-J     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6580-A100<br>Module label number: S30960-S6580-A100-1              |
| PLS83-J     | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6590-A100<br>Module label number: S30960-S6590-A100-1              |
| PLS63-X2    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6506-A100<br>Module label number: S30960-S6506-A100-1              |

## 7.1 List of Parts and Accessories

**Table 35:** List of parts and accessories

| Description                | Supplier | Ordering information   |
|----------------------------|----------|--|
| PLS83-X2                   | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6516-A100<br>Module label number: S30960-S6516-A100-1 |
| PLS63-X3                   | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6508-A100<br>Module label number: S30960-S6508-A100-1 |
| PLS83-X3                   | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6518-A100<br>Module label number: S30960-S6518-A100-1 |
| PLS63-X4                   | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6512-A100<br>Module label number: S30960-S6512-A100-1 |
| PLS83-X4                   | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6522-A100<br>Module label number: S30960-S6522-A100-1 |
| PLS63-I                    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6526-A100<br>Module label number: S30960-S6526-A100-1 |
| PLS83-I                    | Thales   | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6536-A100<br>Module label number: S30960-S6536-A100-1 |
| PLS63-X Evaluation Module  | Thales   | Ordering number: L30960-N6501-A100   |
| PLS83-X Evaluation Module  | Thales   | Ordering number: L30960-N6511-A100   |
| PLS63-W Evaluation Module  | Thales   | Ordering number: L30960-N6521-A100   |
| PLS83-W Evaluation Module  | Thales   | Ordering number: L30960-N6531-A100   |
| PLS63-LA Evaluation Module | Thales   | Ordering number: L30960-N6541-A100   |
| PLS83-LA Evaluation Module | Thales   | Ordering number: L30960-N6551-A100   |
| PLS63-EP Evaluation Module | Thales   | Ordering number: L30960-N6561-A100   |
| PLS83-EP Evaluation Module | Thales   | Ordering number: L30960-N6571-A100   |
| PLS63-J Evaluation Module  | Thales   | Ordering number: L30960-N6581-A100   |
| PLS83-J Evaluation Module  | Thales   | Ordering number: L30960-N6591-A100   |
| PLS63-X2 Evaluation Module | Thales   | Ordering number: L30960-N6507-A100   |
| PLS83-X2 Evaluation Module | Thales   | Ordering number: L30960-N6517-A100   |
| PLS63-X3 Evaluation Module | Thales   | Ordering number: L30960-N6509-A100   |
| PLS83-X3 Evaluation Module | Thales   | Ordering number: L30960-N6519-A100   |
| PLS63-X4 Evaluation Module | Thales   | Ordering number: L30960-N6513-A100   |
| PLS83-X4 Evaluation Module | Thales   | Ordering number: L30960-N6523-A100   |



## 7.1 List of Parts and Accessories

**Table 35:** List of parts and accessories

| Description   | Supplier | Ordering information   |
|---|----------|--|
| PLS63-I Evaluation Module   | Thales   | Ordering number: L30960-N6527-A100   |
| PLS83-I Evaluation Module   | Thales   | Ordering number: L30960-N6537-A100   |
| DSB-mini  | Thales   | Ordering number: L30960-N0030-A100   |
| DSB75 Evaluation Kit  | Thales   | Ordering number: L36880-N8811-A100   |
| EVAL DSB Adapter for mounting PLSx3 evaluation modules onto DSB75 | Thales   | Ordering number: L30960-N0100-A100   |
| LGA DevKit  | Thales   | LGA DevKit consists of<br>Cinterion® LGA DevKit L Base PCB:<br>Ordering number: L30960-N0112-A100<br>Cinterion® LGA DevKit Socket SML:<br>Ordering number: L30960-N0110-A100 |

1. Note: At the discretion of Thales, module label information can either be laser engraved on the module's shielding or be printed on a label adhered to the module's shielding.

**Table 36:** Molex sales contacts (subject to change)

|  |  |  |
|--|--|--|
| Molex<br>For further information please click:<br><a href="http://www.molex.com">http://www.molex.com</a>  | Molex Deutschland GmbH<br>Otto-Hahn-Str. 1b<br>69190 Walldorf<br>Germany<br>Phone: +49-6227-3091-0<br>Fax: +49-6227-3091-8100<br>Email: <a href="mailto:mxgermany@molex.com">mxgermany@molex.com</a> | American Headquarters<br>Lisle, Illinois 60532<br>U.S.A.<br>Phone: +1-800-78MOLEX<br>Fax: +1-630-969-1352  |
| Molex China Distributors<br>Beijing,<br>Room 1311, Tower B, COFCO Plaza<br>No. 8, Jian Guo Men Nei Street, 100005<br>Beijing<br>P.R. China<br>Phone: +86-10-6526-9628<br>Fax: +86-10-6526-9730 | Molex Singapore Pte. Ltd.<br>110, International Road<br>Jurong Town,<br>Singapore 629174<br><br>Phone: +65-6-268-6868<br>Fax: +65-6-265-6044   | Molex Japan Co. Ltd.<br>1-5-4 Fukami-Higashi,<br>Yamato-City,<br>Kanagawa, 242-8585<br>Japan<br><br>Phone: +81-46-265-2325<br>Fax: +81-46-265-2365 |

## 7.2 Module Label Information

The label engraved on the top of PLSx3 comprises the following information.



Figure 48: PLSx3 Label

Table 37: PLSx3 label information

| No. |  |
|-----|--|
| 1   | Cinterion logo   |
| 2   | Manufacturing country (e.g., “Made in China”)                            |
| 3   | Factory Code   |
| 4   | Product name/variant   |
| 5   | Product order code   |
| 6   | Manufacturer 2D barcode  |
| 7   | Product IMEI   |
| 8   | 2-digital date code of product production (for decoding see Table below) |

Table 38: Date code table

| Date Code |      |      |      |      |      |      |      |      |       |      |      |      |
|-----------|------|------|------|------|------|------|------|------|-------|------|------|------|
| Code      | L    | M    | N    | P    | R    | S    | T    | U    | V     | W    | X    | A    |
| Year      | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027  | 2028 | 2029 | 2030 |
| Code      | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9     | O    | N    | D    |
| Month     | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |



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