Cinterion® PLSx3

Hardware Interface Description

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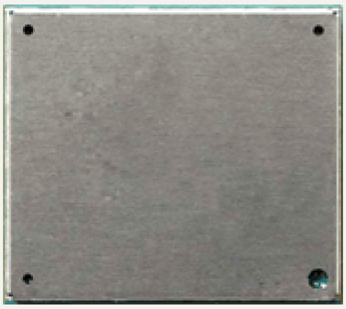

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1 Introduction

This document[1] 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
General	
Frequency bands	PLSx3 integrates all the bands required to have a global coverage across the world (NORAM / LATAM / EMEA /APAC). Please refer to Section 1.2.1 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.

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

Feature	Implementation
3GPP Release 7	UE CAT. 8, 6 for PLS63 HSDPA – DL 7.2Mbps HSUPA – UL 5.7Mbps UE CAT. 14, 6 for PLS83 HSPA+ – DL 21Mbps HSUPA – UL 5.7Mbps Compressed mode (CM) supported according to 3GPP TS25.212
UMTS features	
3GPP Release 4	PS data rate – 384 kbps DL / 384 kbps UL CS data rate – 64 kbps DL / 64 kbps UL
GSM/GPRS/EGPRS features	
Data transfer	GPRS: • Multislot Class 12 • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS: • Multislot Class 12 • EDGE E2 power class for 8 PSK • Downlink coding schemes – CS 1-4, MCS 1-9 • Uplink coding schemes – CS 1-4, MCS 1-9 • SRB loopback and test mode B • 8-bit, 11-bit RACH • 1 phase/2 phase access procedures • Link adaptation and IR • NACC, extended UL TBF • Mobile Station Class B
SMS	Point-to-point MT and MO Cell broadcast Text and PDU mode Storage: SIM card plus SMS locations in mobile equipment
GNSS Features	
Protocol	NMEA
Modes (see Section 2.3)	Standalone GNSS (GPS, GLONASS, Beidou, Galileo)
General	Automatic power saving modes. DC feed bridge and control of power supply for active antenna
Software	
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

Feature	Implementation
Interfaces	
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. 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 (see Section 2.1.3)	USB 2.0 High Speed (480Mbit/s) device interface. Full Speed (12Mbit/s) compliant.
2 serial interfaces (see Section 2.1.4, and Section 2.1.5)	ASC0 (in parts shared with GPIO lines): • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Fixed baud rates: 300bps to 921,600bps • Supports RTS0/CTS0 hardware flow control. ASC1 (shared with GPIO lines): • 4-wire, unbalanced asynchronous interface • Fixed baud rates: 300bps to 921,600bps and 3Mbps • Supports RTS1/CTS1 hardware flow control
2 UICC interfaces (switchable) (see Section 2.1.6)	Supported chip cards: UICC/SIM/USIM 3V, 1.8V
GPIO interface (see Section 2.1.7)	22 GPIO lines comprising: 13 lines shared with ASC0, ASC1 lines, with network status indication, fast shutdown and SIM switch 9 GPIO lines not shared
Digital audio interface (see Section 2.1.8)	1 digital interface can be configured as PCM or I^2S.
RING0	Support RING0 to wake up host from power saving state.
Antenna interface pads (see Section 2.1)	50Ω. UMTS/GSM/LTE main antenna, UMTS/LTE Rx Diversity antenna, GNSS antenna.
ADC inputs (see Section 2.1.9)	Analog-to-Digital Converter with unbalanced analog inputs, for example, for the (external) antenna diagnosis
Power on/off, Reset	
Power on/off	Switch on by hardware signal IGT Switch off by AT command Switch off by hardware signal FST_SHDN instead of AT command Automatic switch off in case of critical temperature or voltage conditions
Reset	Orderly reset by AT command Reset by emergency reset signal EMERG_RST.
Special features	
Real time clock	Timer functions via AT commands.
Evaluation kit	
LGA DevKit	LGA DevKit designed to test Thales LGA modules.
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.

Feature	Implementation
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
GSM/GPRS/EDGE									
850MHz	x		x	x					
900MHz	x		x	x					x
1800MHz	x		x	x					x
1900MHz	x		x	x					
WCDMA									
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				
LTE-FDD									
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

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)[1]	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		
Bd.71(600MHz)		x							
LTE-TDD									
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.
2. For Band 41 (LTE-TDD), the frequency range are partially supported (2535MHz...2675MHz).

1.3 PLSx3 System Overview

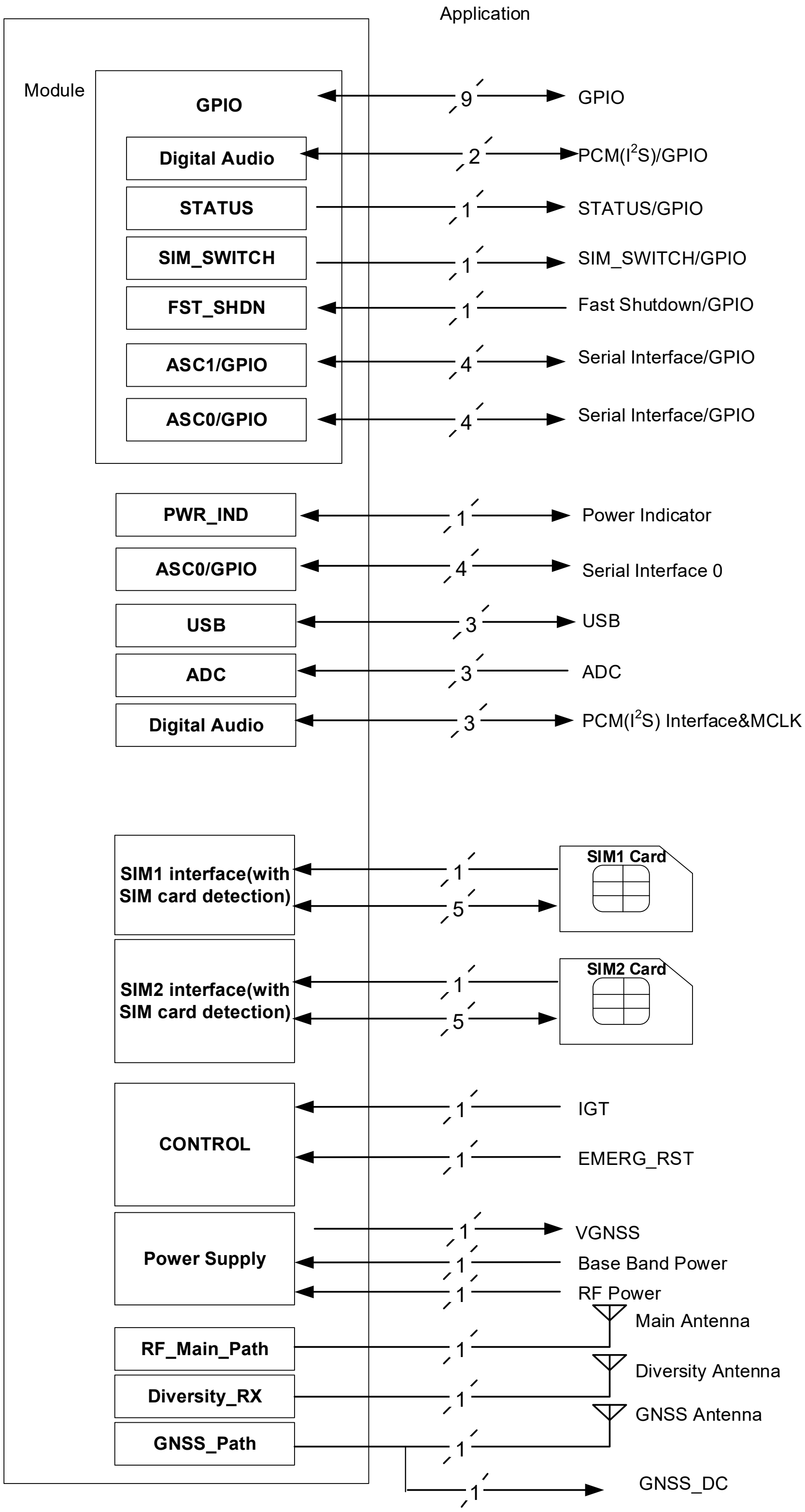


Figure 1: PLSx3 system overview

1.4 Circuit Concept

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

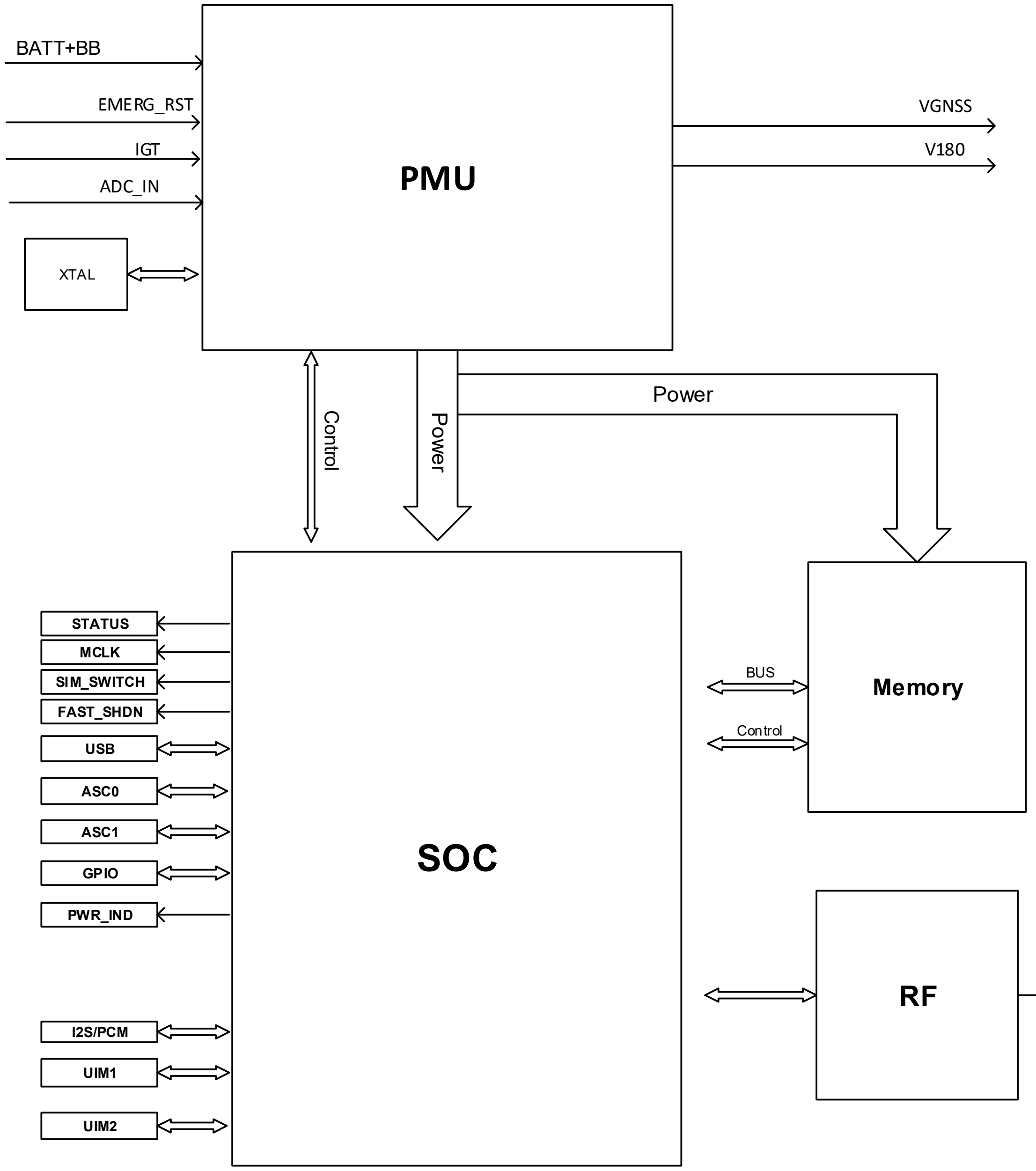


Figure 2: PLSx3 block diagram

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.

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	rfu (dnu)	L16	IGT
B8	GND	F15	rfu (dnu)	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	$BATT+_{RF}$
C10	GND	H14	GPIO4/FST_SHDN	N4	$BATT+_{RF}$
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	$BATT+_{BB}$
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	$BATT+_{BB}$
D16	rfu (dnu)	L1	GND		
E1	ANT_GNSS				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
P				USB_DP	USB_DN	GPIO16 /RXD1	GPIO17 /TXD1	DTR0 /GPIO1	DSR0 /GIPO3	RING0 / GPIO24	RXD0	TXD0	$BATT+_{BB}$			
N			$BATT+_{RF}$	$BATT+_{RF}$	VUSB_ IN	GPIO19 /CTS1	GPIO18 /RTS1	CTS0	DCD0 /GPIO2	RTS0	GND	rfu (dnu)	$BATT+_{BB}$	EMERG_ RST		
M		GND	GND	PWR_IND	V180	GND	GPIO21 /DIN	BCLK	FSC	GPIO20 /DOUT	ADC3_ IN	ADC2_ IN	ADC1_ IN	CCIN1	rfu (nc)	
L	GND	GND	GND	GND	rfu (nc)	CCVC C2	MCLK	rfu (nc)	rfu (nc)	rfu (nc)	SIM_ SWITCH /GPIO26	rfu (nc)	rfu (dnu)	CCRST1	CCCLK1	IGT
K	ANT_ MAIN	GND	GND	GND	GND							rfu (nc)	rfu (dnu)	CCIO1	CCVCC1	VGNSS
J	GND	GND	GND	GND									GND	GPIO15	GPIO14	GPIO13
H	GND	GND	GND	GND									rfu (dnu)	GPIO4 / FST_SH DN	GPIO12	GPIO6
G	GND	GND	GND	GND									rfu (dnu)	GPIO7	GPIO8	GPIO11
F	GND	GND	GND	GND									GND	rfu (dnu)	rfu (dnu)	GPIO25
E	ANT_ GNSS	GND	GND	GND	GND							CCIO2	CCRST2	rfu (nc)	rfu (dnu)	rfu (dnu)
D	GND	GND	GND	GND	ANT_GN SS_DC	GND	GND	GND	GND	GND	GND	CCIN2	rfu (nc)	CCCLK2	rfu (dnu)	rfu (dnu)
C		GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	rfu (nc)	rfu (dnu)	rfu (dnu)	GND	
B			rfu (nc)	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GPIO5 /STATUS		
A				rfu (nc)	GND	GND	GND	GND	GND	GND	GND	ANT_ DRX	GND			

rfu: Reserved for future use (should not be connected to external application)
(nc): Internally not connected (may be arbitrarily connected to external GND)
(dnu): Do not use

Position marker

For internal use: Not to be soldered

Figure 3: PLSx3 bottom view: Pad assignments

	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
P				BATT+BB	TXD0	RXD0	RING0 / GPIO24	DSR0 /GPIO3	DTR0 /GPIO1	GPIO17 /TXD1	GPIO16 /RXD1	USB_DN	USB_DP			
N			EMERG_RST	BATT+BB	rfu (dnu)	GND	RTS0	DCD0 /GPIO2	CTS0	GPIO18 /RTS1	GPIO19 /CTS1	VUSB_IN	BATT+RF	BATT+RF		
M		rfu (nc)	CCIN1	ADC1_IN	ADC2_IN	ADC3_IN	GPIO20/ DOUT	FSC	BCLK	GPIO21 /DIN	GND	V180	PWR_IND	GND	GND	
L	IGT	CCCLK1	CCRST1	rfu (dnu)	rfu (nc)	SIM_SWITCH/GPIO26	rfu (nc)	rfu (nc)	rfu (nc)	MCLK	CCVCC2	rfu (nc)	GND	GND	GND	GND
K	VNGSS	CCVCC1	CCIO1	rfu (dnu)	rfu (nc)							GND	GND	GND	GND	ANT_MAIN
J	GPIO13	GPIO14	GPIO15	GND									GND	GND	GND	GND
H	GPIO6	GPIO12	GPIO4/ FST_SHDN	rfu (dun)									GND	GND	GND	GND
G	GPIO11	GPIO8	GPIO7	rfu (dnu)									GND	GND	GND	GND
F	GPIO25	rfu (dnu)	rfu (dnu)	GND									GND	GND	GND	GND
E	rfu (dnu)	rfu (dnu)	rfu (nc)	CCRST2	CCIO2							GND	GND	GND	GND	ANT_GNSS
D	rfu (dnu)	rfu (dnu)	CCCLK2	rfu (nc)	CCIN2	GND	GND	GND	GND	GND	GND	ANT_GNSS_DC	GND	GND	GND	GND
C		GND	rfu (dnu)	rfu (dnu)	rfu (nc)	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	
B			GPIO5/ STATUS	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	rfu (nc)		
A				GND	ANT_DRX	GND	GND	GND	GND	GND	GND	GND	rfu (nc)			

rfu: Reserved for future use (should not be connected to external application)
(nc): Internally not connected (may be arbitrarily connected to external GND)
(**dnu**): Do not use

For internal use: Not to be soldered

Position marker

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	$BATT+_{BB}$ $BATT+_{RF}$	I	GSM activated: $V_I$max = 4.5V $V_I$norm = 3.8V $V_I$min = 3.0V Imax= see Table 19  n Tx = n x 577µs peak current every 4.616ms WCDMA activated: $V_I$max = 4.5V $V_I$norm = 3.8V $V_I$min = 3.0V during Transmit active. Imax = see Table 20 LTE activated: $V_I$max = 4.5V $V_I$norm = 3.8V $V_I$min = 3.0V during Transmit active. Imax = see Table 21	Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. Minimum voltage must not fall below 3.0V including drop, ripple, spikes and not rise above 4.5V. **Note:** 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.
External supply voltage	V180	O	Normal operation: $V_O$norm = 1.80V ±2% $I_O$max = 10mA SLEEP mode Operation: V_OSleep = 1.80V ±4% $I_O$max = 10mA CImax = 100nF	V180 should be used to supply level shifters at the interfaces. **Note:** V180 is not back powering protected. Wrong usage may back power the module which is forbidden. If unused keep line open. Test point recommended.
	VGNSS	O	CLmax=2.2µ $V_{O=}$3V±2%@I_O =-10mA $I_O$max = 10mA	Available when GNSS antenna DC power is enabled.
Supply voltage for active GNSS antenna	ANT_GNSS_DC	I	$V_I$max_6V The input current has to be limited to 50mA(antenna short circuit protection)	If unused connect to GND

Table 3: Signal properties (Sheet 2 of 5)

<table>
<tr><th>Function</th><th>Signal name</th><th>IO</th><th>Signal form and level</th><th>Comment</th></tr>
<tr><td>Ignition</td><td>IGT</td><td>I</td><td>Do not add any voltage on it. There is a built-in pull up resister, you can test about 0.8V voltage on it.

¯¯|___|¯¯ low impulse width > 300ms</td><td>This signal switches the module on. The IGT signal characteristic is:
Power on triggered and low level triggered. Fall time should be <1ms.

Note: To turn on the module please use an open-drain/collector circuit.

Test point recommended.</td></tr>
<tr><td>Status signaling</td><td>STATUS</td><td>O</td><td>V_{OI}max = 0.45V at I = 1mA
V_{OH}min = 1.35V at I = 1mA
V_{OH}max = 1.8V</td><td>If unused keep line open.</td></tr>
<tr><td>Emergency reset</td><td>EMERG_RST</td><td>I</td><td>Do not add any voltage on it. There is a built-in pull up resistor to pull to GND when Reset.

¯¯|___|¯¯ low impulse width > 200ms</td><td>This line must be driven low by an open drain or open collector driver connected to GND.

If unused keep line open.

Test point recommended.</td></tr>
<tr><td>Fast shutdown</td><td>FST_SHDN</td><td>I</td><td>V_{IL}max = 0.63V
V_{IH}min = 1.17V
V_{IH}max = 1.8V

¯¯|___|¯¯ low impulse width > 1ms</td><td>This line must be driven low.
If unused keep line open.

Note that the fast shutdown line is originally available as GPIO line. If configured as fast shutdown, the GPIO line is assigned as follows:
GPIO4 --> FST_SHDN</td></tr>
<tr><td rowspan="3">USB</td><td>VUSB_IN</td><td>I</td><td>V_{IN}min = 3V
V_{IN}max = 5.25V
Active and suspend current:
Imax<100µA</td><td rowspan="3">All electrical characteristics according to USB Implementers' Forum, USB 2.0 Specification.

If unused keep lines open.

Test points recommended.</td></tr>
<tr><td>USB_DN</td><td rowspan="2">I/O</td><td rowspan="2">Full and high speed signal characteristics according to USB 2.0 Specification.</td></tr>
<tr><td>USB_DP</td></tr>
</table>

Table 3: Signal properties (Sheet 3 of 5)

Function	Signal name	IO	Signal form and level	Comment
Serial Interface ASC0	RXD0	O	$V_{OL}max = 0.45V$ $V_{OH}min = 1.35V$	If unused keep lines open. Test points recommended for RXD0, TXD0, RTS0, and CTS0.
	CTS0			
	DSR0			
	DCD0			
	RING0			
	TXD0	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.17V$	
	RTS0	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.17V$	
	DTR0	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.17V$	
Serial Interface ASC1	RXD1	O	$V_{OL}max = 0.45V$ $V_{OH}min = 1.35V$	If unused keep lines open Test points recommended for RXD1, TXD1, RTS1, and CTS1.
	CTS1	O		
	TXD1	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.17V$	
	RTS1	I	$V_{IL}max = 0.63V$ $V_{IH}min = 1.17V$	
SIM card detection	CCIN1 CCIN2	I	$V_{IH}min = 1.17V$ $V_{IL}max = 0.63V$	CCIN = low, SIM card inserted. CCIN= high, SIM card removed. If unused keep line open.
3V SIM Card Interface	CCRST1 CCRST2	O	$V_{OL}max = 0.4V$ $V_{OH}min = 2.2V$ $V_{OH}max = 3.04V$	Maximum cable length or copper track to SIM card holder should not exceed 100mm. CCIO2 should add 10k pull-up to CCVCC2
	CCIO1 CCIO2	I/O	$V_{IL}max = 0.55V$ $V_{IH}min = 2.128V$ $V_{IH}max = 3.05V$ $V_{OL}max = 0.4V$ $V_{OH}min = 2.2V$ $V_{OH}max = 3.04V$	
	CCCLK1 CCCLK2	O	$V_{OL}max = 0.4V$ $V_{OH}min = 2.2V$ $V_{OH}max = 3.04V$	
	CCVCC1 CCVCC2	O	$V_{O}min = 2.75V$ $V_{O}typ = 2.85V$ $V_{O}max = 3.04V$ $I_{O}max = -30mA$	

Table 3: Signal properties (Sheet 4 of 5)

Function	Signal name	IO	Signal form and level	Comment
1.8V SIM Card Interface	CCRST1 CCRST2	O	V_{OL}max = 0.4V V_{OH}min = 1.36V V_{OH}max = 1.93V	Maximum cable length or copper track to SIM card holder should not exceed 100mm. CCIO2 should add 10k pull-up to CCVCC2
	CCIO1 CCIO2	I/O	V_{IL}max = 0.334V V_{IH}min = 1.351V V_{IH}max = 1.97V V_{OL}max = 0.4V V_{OH}min = 1.336V V_{OH}max = 1.93V	
	CCCLK1 CCCLK2	O	V_{OL}max = 0.4V V_{OH}min = 1.336V V_{OH}max = 1.93V	
	CCVCC1 CCVCC2	O	$V_O$min = 1.67V $V_O$typ = 1.80V $V_O$max = 1.93V $I_O$max = -30mA	
GPIO interface	GPIO1-GPIO8, GPIO11-GPIO21 GPIO24-GPIO26	IO	V_{IL}max = 0.334V V_{IH}min = 1.351V V_{IH}max = 1.97V V_{OL}max = 0.4V V_{OH}min = 1.336V V_{OH}max = 1.93V	If unused keep line open. Please note that most GPIO lines can be configured by AT command for alternative functions or are by default configured with an alternative functionality: GPIO4: Fast Shut Down (Input) GPIO5: LED status GPIO26: SIM switch
Digital Audio Interface	BCLK DIN DOUT FSC MCLK	O I O O O	V_{OL}max = 0.45V V_{OH}min = 1.35V V_{OH}max = 1.8V V_{IL}max = 0.63V V_{IH}min = 1.17V V_{IH}max = 1.8V Freq=12.288MHz	If unused keep line open.
ADC_IN (Analog-to-Digital Converter)	ADC1 ADC2 ADC3	I	R_I = 10Mohm V_I = 0.1V ... 1.7V (valid range) V_{IH} max = 1.7V Resolution 15 Bits Offset error ±1%	If unused keep line open.
SIM Switch	SIM_SWITCH	O	V_{OL}max = 0.4V V_{OH}min = 1.336V V_{OH}max = 1.93V	If unused keep line open.

Table 3: Signal properties (Sheet 5 of 5)

Function	Signal name	IO	Signal form and level	Comment
Power indicator	PWR_IND	O	V_{IH}max = 5.5V V_{OL}max = 0.4V at Imax = 2mA	PWR_IND (Power Indicator) notifies the module's on/off state (see Section 2.1.10). 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. 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.

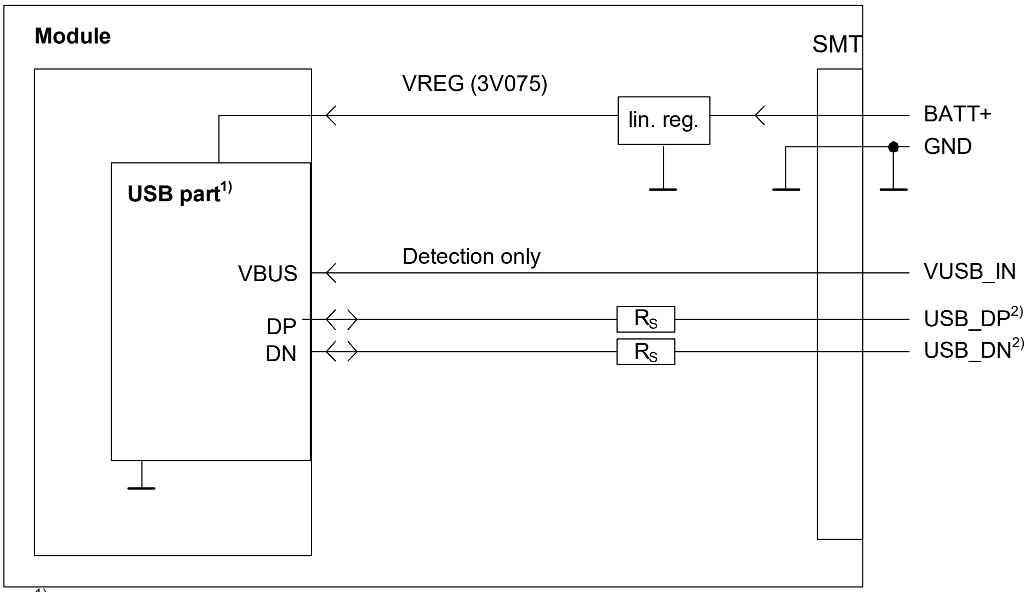
Table 4: Absolute maximum ratings

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”[1], 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”.



1) All serial (including R_S) and pull-up resistors for data lines are implemented.
2) 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“[1]. 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 signalized 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 loosing 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

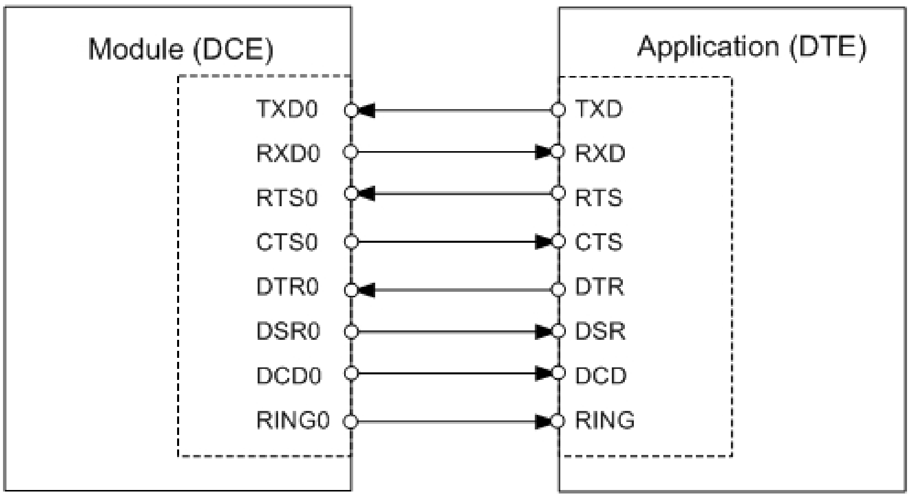


Figure 5: Serial interface ASC0

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)

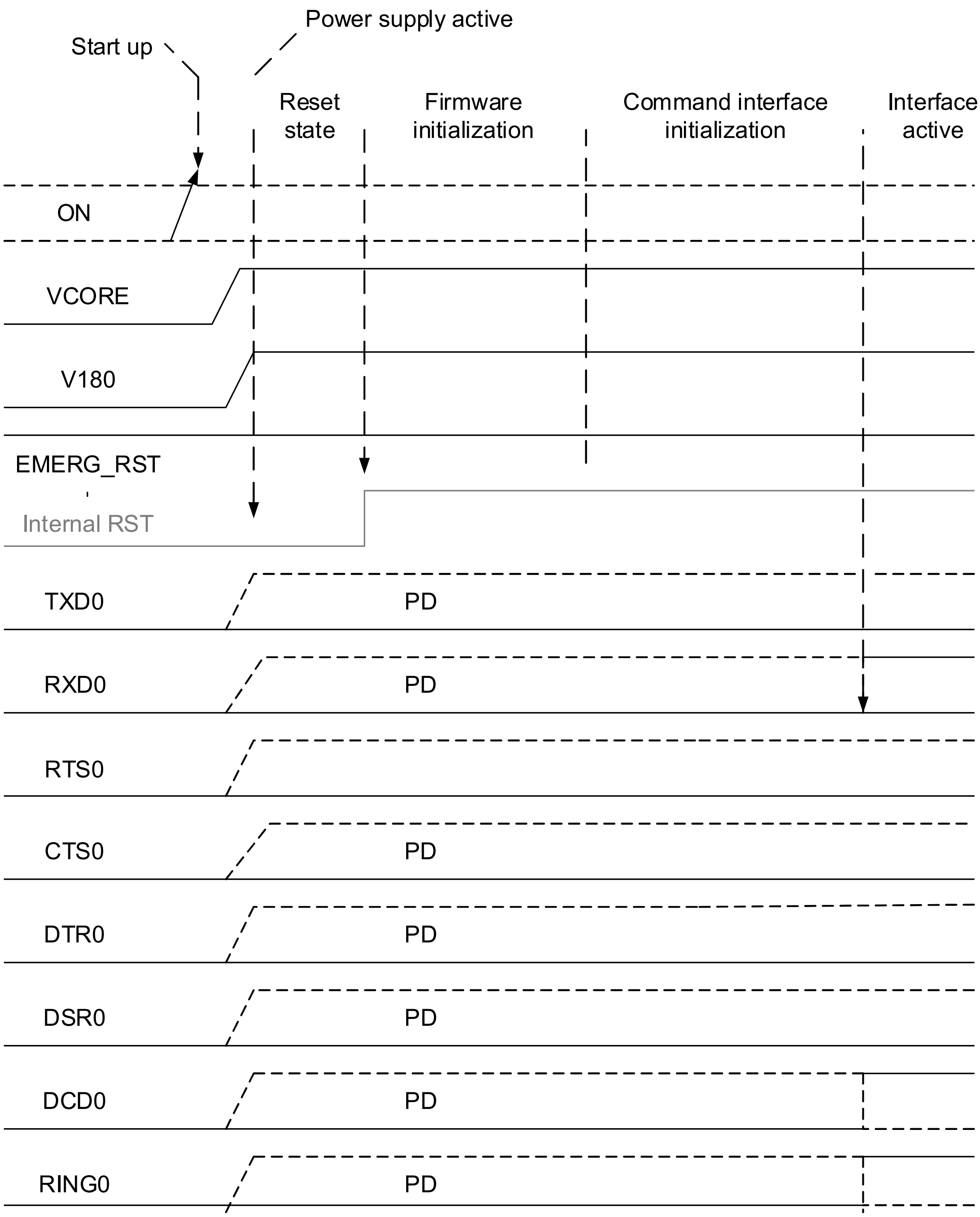
Note: The ASC0 modem control lines DTR0, DCD0, DSR0 and RING0 can also be configured as GPIO lines. If configured as GPIO lines, these GPIO lines are assigned as follows:

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).

The following figure shows the startup behavior of the asynchronous serial interface ASC0.



For pull-up and pull-down values see Table 16.

Figure 6: ASC0 startup behavior

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 signalling. 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

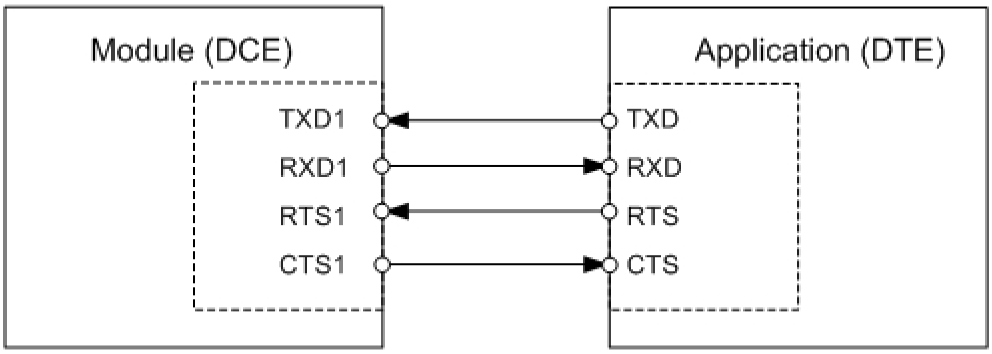


Figure 7: Serial interface ASC1

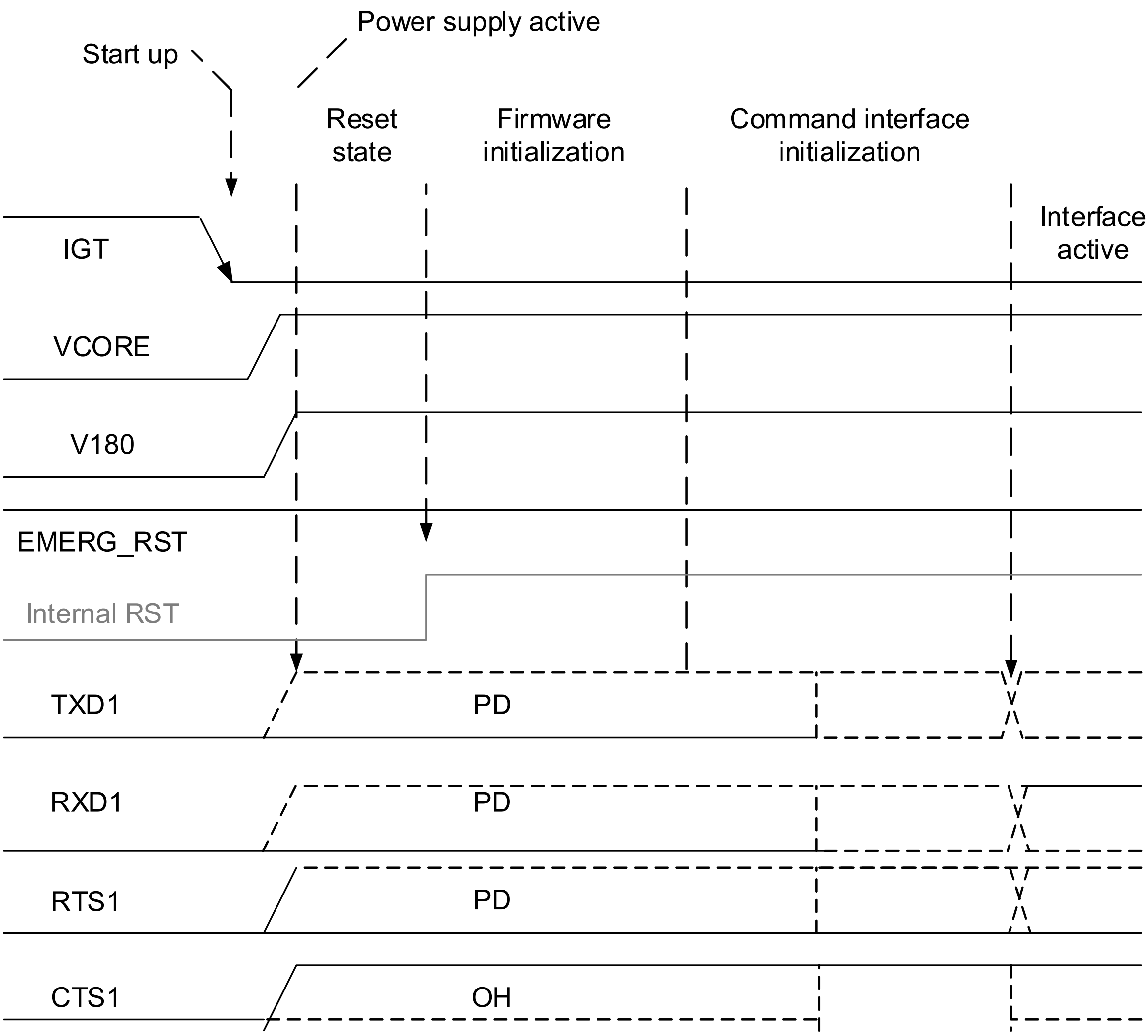
Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- On ASC1 no RING line is available.
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300 bps to 921,600bps.
- Supports RTS1/CTS1 hardware flow. 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.

The following figure shows the startup behavior of the asynchronous serial interface ASC1.



For pull-down values see Table 16.

Figure 8: ASC1 startup behavior

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 CCCLK2	Chipcard clock lines for 1st and 2nd SIM interface.
CCVCC1 CCVCC2	SIM supply voltage lines for 1st and 2nd SIM interface.
CCIO1 CCIO2	Serial data lines for 1st and 2nd SIM interface, input and output.
CCRST1 CCRST2	Chipcard reset lines for 1st and 2nd SIM interface.
CCIN1 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. The CCINx signal is mandatory for applications that allow the user to remove the SIM card during operation. 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 1st SIM interface is available and can be used. The usage of the module's 2nd 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.

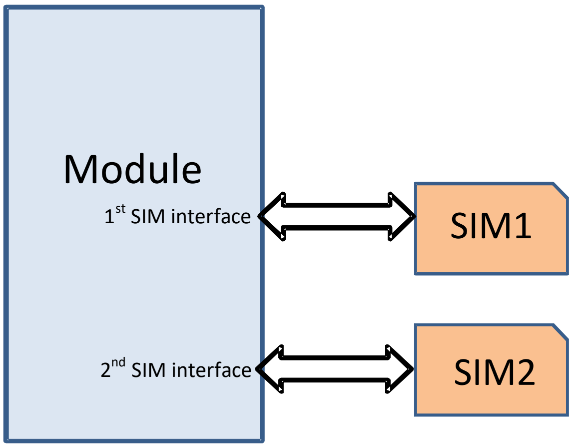


Figure 9: Module's two UICC/SIM/USIM interfaces

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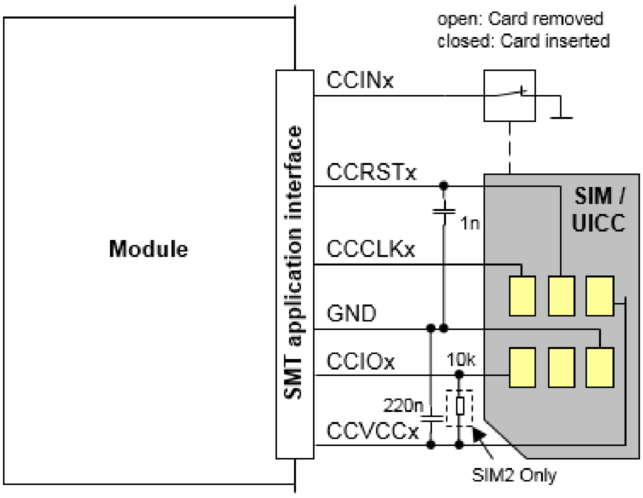


Figure 10: UICC/SIM/USIM interfaces connected

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 11. Please place the ESD protection close to the SIM connector. It is suggested that the cload 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.

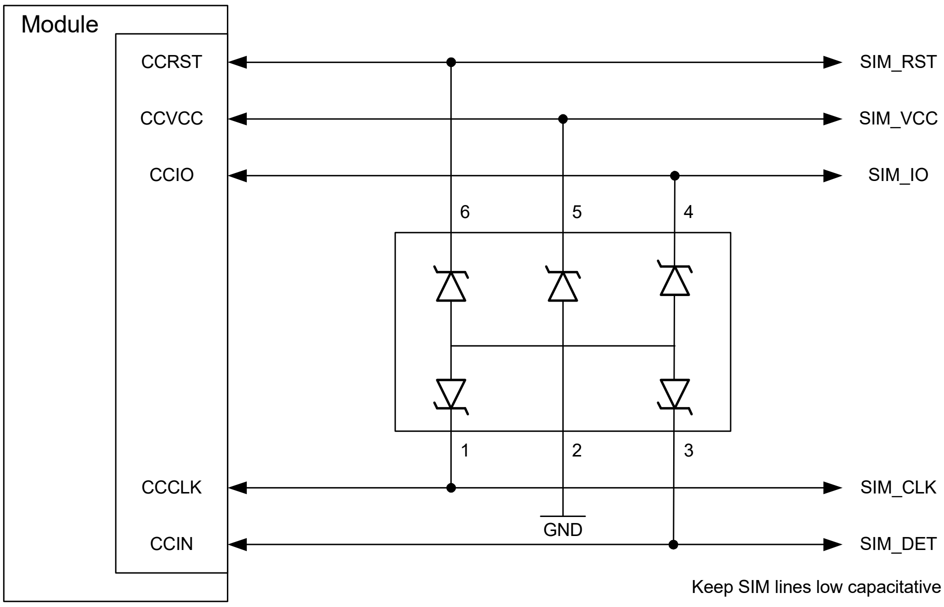


Figure 11: SIM interface - enhanced ESD protection

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.

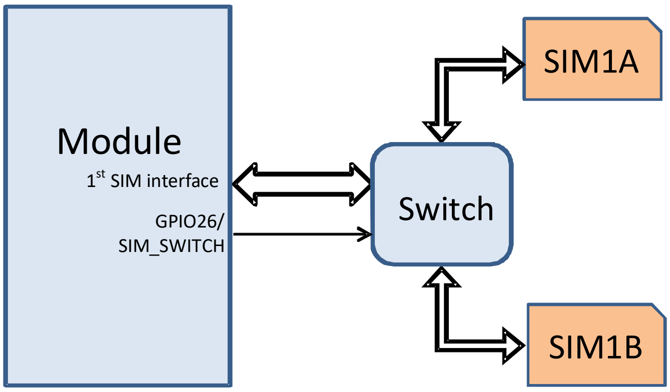


Figure 12: External UICC/SIM/USIM switch

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 13. 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.

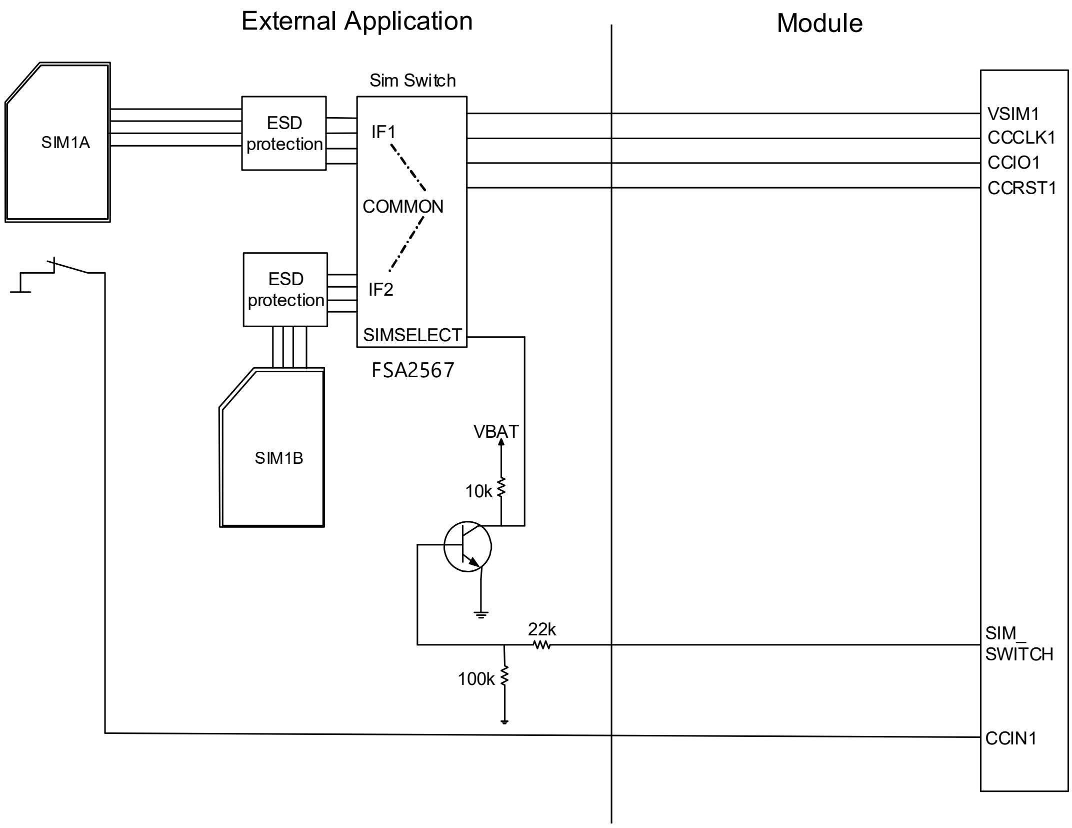


Figure 13: Sample circuit for SIM interface connection via SIM switch

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	

The following figure shows the startup behavior of the GPIO interface.

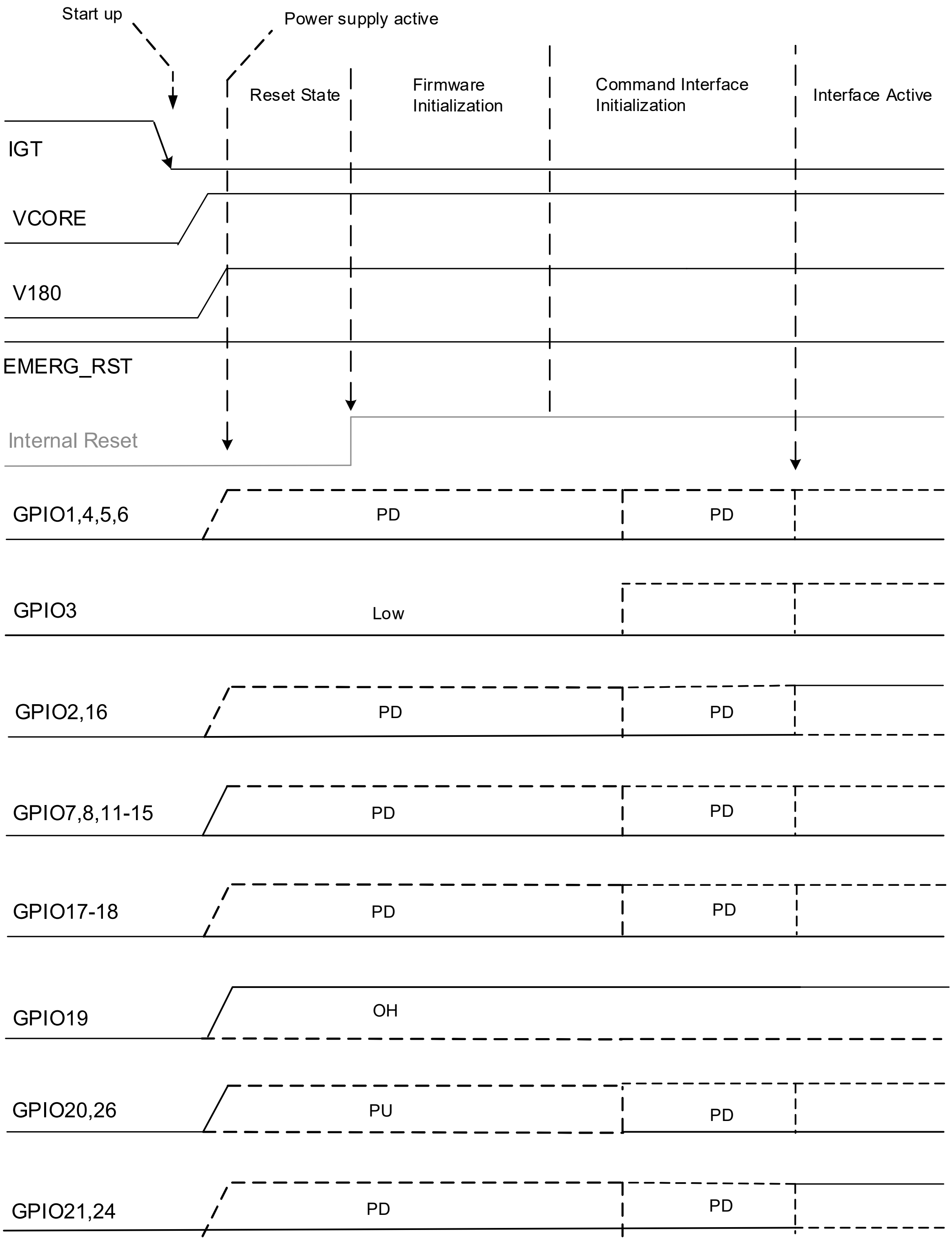


Figure 14: GPIO startup behavior

2.1.8 Digital Audio Interface

PLSx3 supports the digital audio interface that can be deployed as PCM or Inter_IC Sound (I^2S).

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.

The following figure shows an example of short frame PCM timing at 8kHz sample rate and 2048kHz PCM_CLK in the master mode:

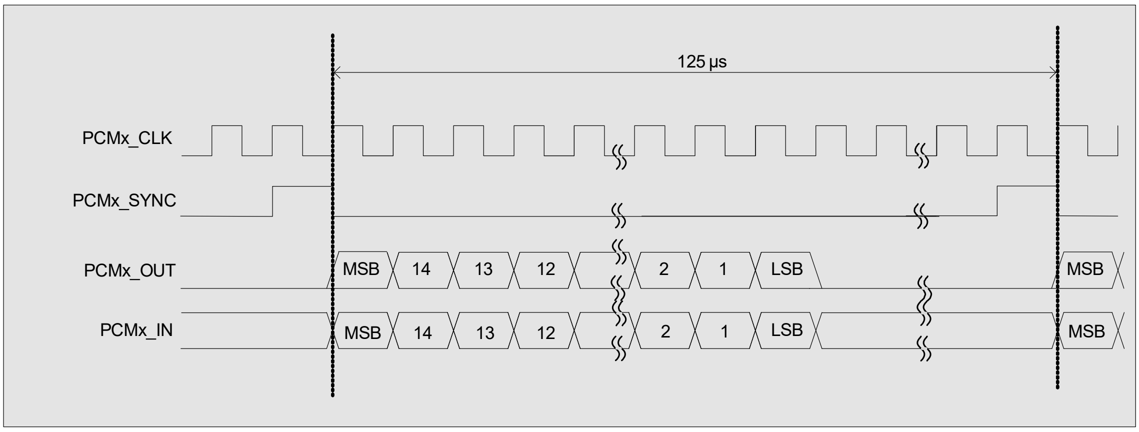


Figure 15: PCM timing short frame

2.1.8.2 Inter-IC Sound Interface

The I²S Interface is a standardized bidirectio zonal I²S based digital audio interface for transmission of mono voice signals for telephony services.
The I²S properties and capabilities comply with the requirements lay out in the Phillips I²S Bus Specifications, revised June 5, 1996.

The I²S 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 I²S interface signals
.
Table 8: Overview of I²S pin functions

Signal name on SMT application interface	Signal configuration inactive	Signal direction Master	Description
DOUT	PD	O	I²S data from PLSx3 to external codec
DIN	PD	I	I²S 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^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 16

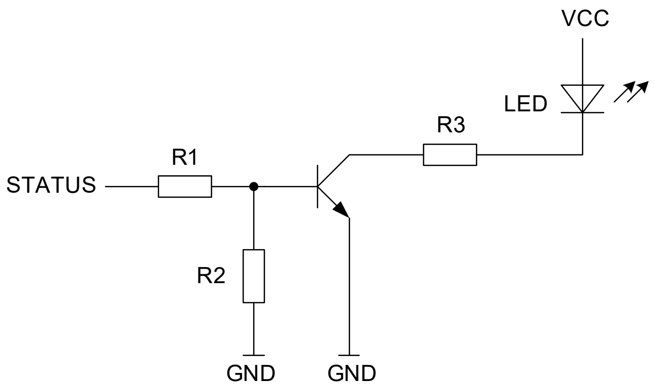


Figure 16: Status signaling with LED driver

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.

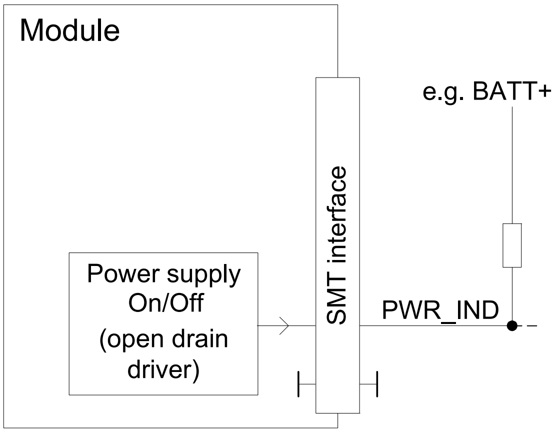


Figure 17: Power indication signal

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 milliseconds. 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 18).

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.

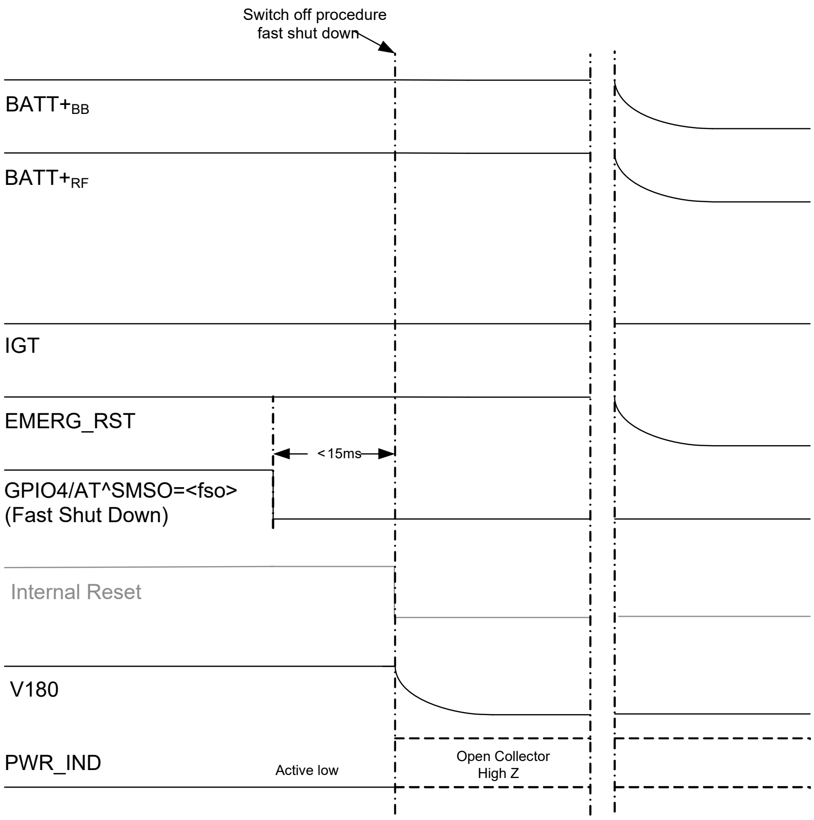


Figure 18: Fast shutdown timing

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: 0 = No wake up request 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[1]. 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 @ARP, Combined Antenna, Channel BW at 5 MHz @25°C, 3.8V	LTE FDD 2100 Band 1	-100.0	-104.3		dBm
	LTE FDD 1900 Band 2	-98.0	-104.7		dBm
	LTE FDD 1800 Band 3	-97.0	-104.3		dBm
	LTE FDD 2100 Band 4	-100.0	-104.1		dBm
	LTE FDD 850 Band 5	-98.0	-103.4		dBm
	LTE FDD 2600 Band 7	-98.0	-102.2		dBm
	LTE FDD 900 Band 8	-97.0	-104.1		dBm
	LTE FDD 700 Band 12	-97.0	-104.8		dBm
	LTE FDD 700 Band 13	-97.0	-105.0		dBm
	LTE FDD 700 Band 14	TBD	TBD		dBm
	LTE FDD 700 Band 17	-97.0	-104.4		dBm
	LTE FDD 850 Band 18	-98.0	-103.3		dBm
	LTE FDD 850 Band 19	-100.0	-102.7		dBm
	LTE FDD 800 Band 20	-97.0	-104.5		dBm
	LTE FDD 1900 Band 25	TBD	TBD		dBm
	LTE FDD 850 Band 26	-98.0	-103.1		dBm
	LTE FDD 700 Band 28	-98.5	-104.9		dBm
	LTE TDD 2600 Band 38	-100.0	-103.6		dBm
	LTE TDD 2300 Band 40	-100.0	-104.6		dBm
	LTE TDD 2500 Band 41	-98.0	-103.5		dBm
	LTE FDD 2100 Band 66	-99.5	-104.0		dBm
	LTE FDD 600 Band 71	TBD	TBD		dBm

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

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	-106.7	-110.2		dBm
	UMTS 1900 Band II	-104.7	-111.3		dBm
	UMTS 1800 Band III	-103.7	-110.6		dBm
	UMTS 2100 Band IV	-106.7	-110.3		dBm
	UMTS 850 Band V	-104.7	-110.9		dBm
	UMTS 850 Band VI	-106.7	-110.2		dBm
	UMTS 900 Band VIII	-103.7	-110.5		dBm
	UMTS 850 Band XIX	-106.7	-110.5		dBm
Receiver Input Diversity Sensitivity @ ARP @25°C, 3.8V	UMTS 2100 Band I	-106.7	-111.5		dBm
	UMTS 1900 Band II	-104.7	-111.6		dBm
	UMTS 1800 Band III	-103.7	-112.1		dBm
	UMTS 2100 Band IV	-106.7	-111.8		dBm
	UMTS 850 Band V	-104.7	-112.0		dBm
	UMTS 850 Band VI	-106.7	-111.3		dBm
	UMTS 900 Band VIII	-103.7	-111.8		dBm
	UMTS 850 Band XIX	-106.7	-111.1		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	-102.0	-108.6		dBm
	E-GSM 900	-102.0	-108.9		dBm
	DCS 1800	-102.0	-109.6		dBm
	PCS 1900	-102.0	-109.6		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

Table 11: RF Antenna interface GSM/UMTS/LTE

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**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

Table 11: RF Antenna interface GSM/UMTS/LTE

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**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

Table 11: RF Antenna interface GSM/UMTS/LTE

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**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

Table 11: RF Antenna interface GSM/UMTS/LTE

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**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

Table 11: RF Antenna interface GSM/UMTS/LTE

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**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 @ARP, Combined Antenna, Channel BW at 10MHz @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.

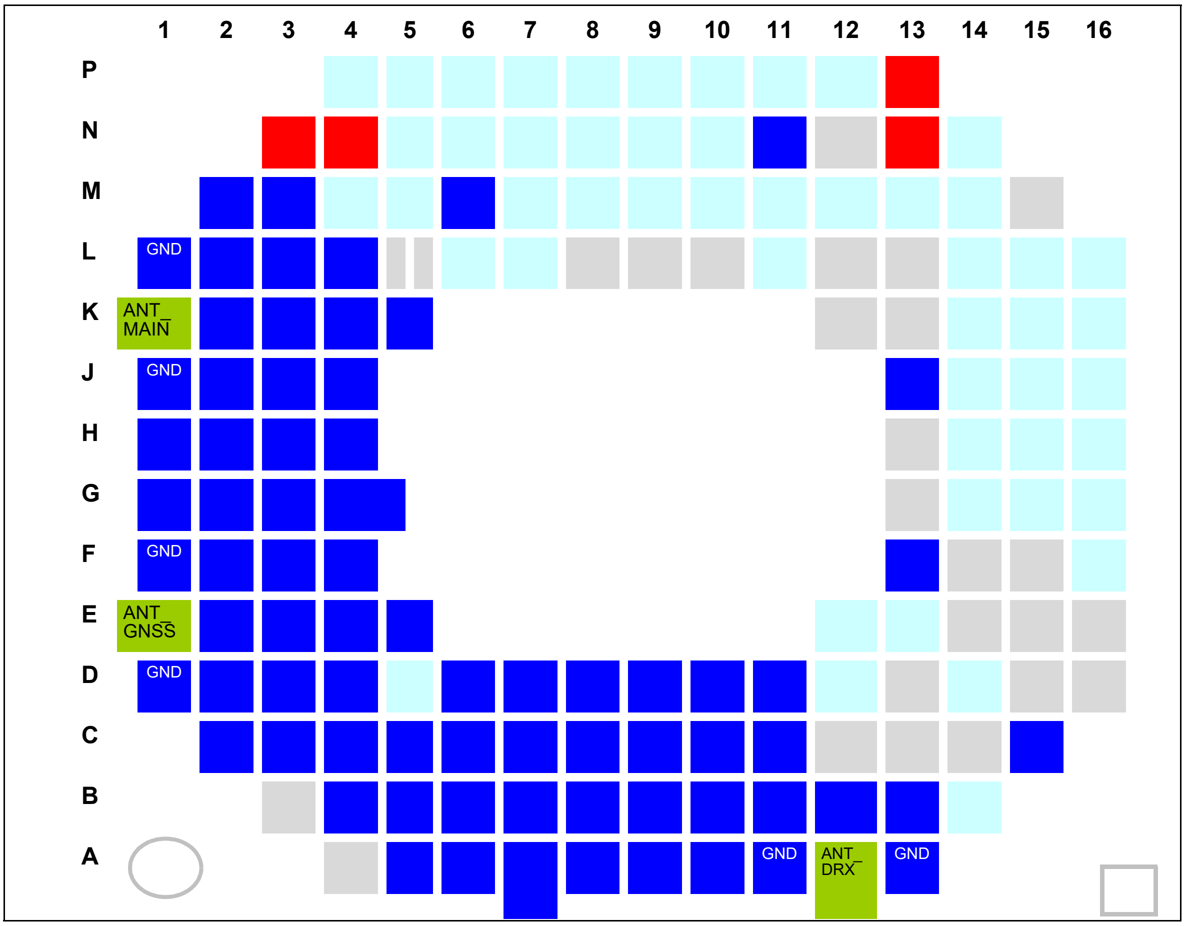


Figure 19: Antenna pads (bottom view)

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.

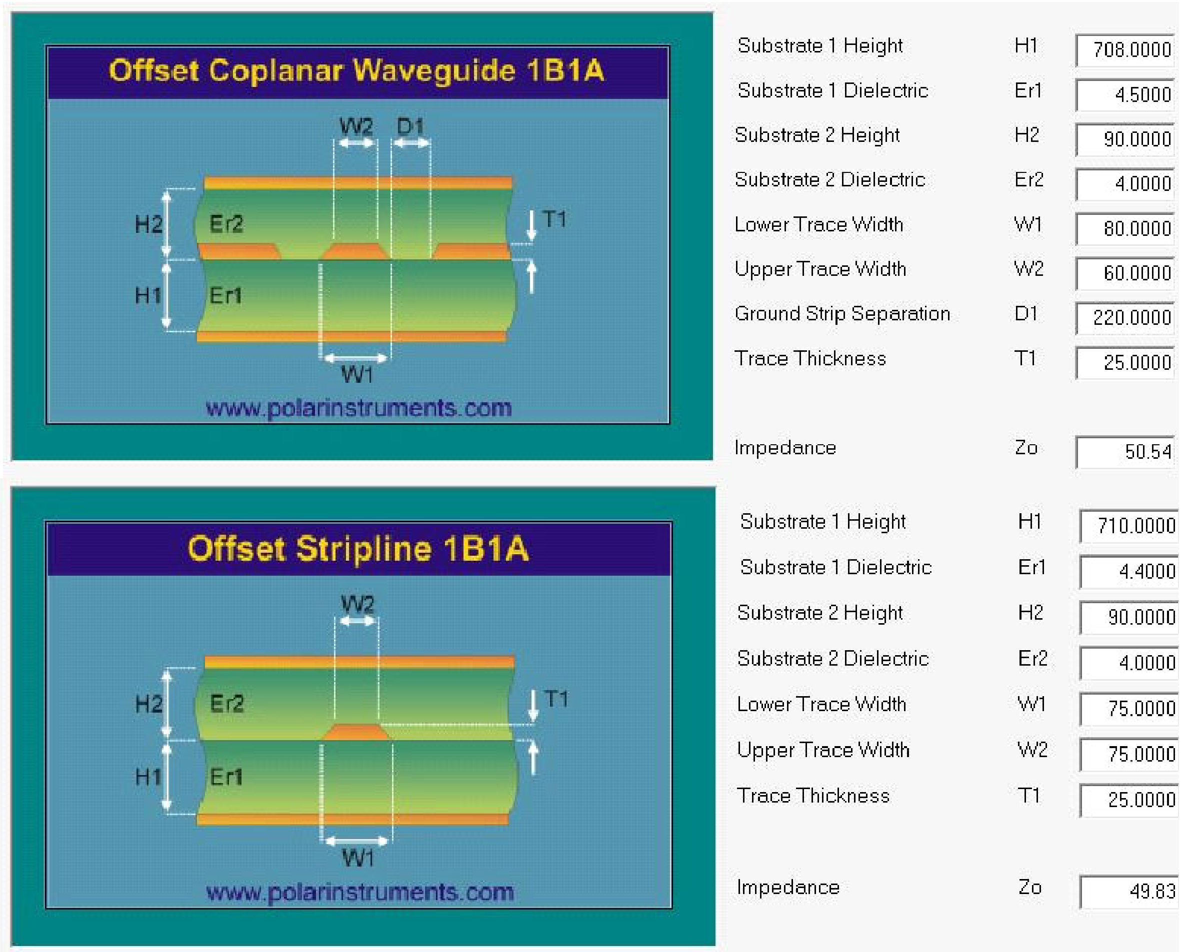


Figure 20: Embedded stripline arrangement example

Micro-Stripline

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

Figure 21: Micro-Stripline arrangement example

2.2.3.2 Routing Example

Interface to RF Connector

Figure 22 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.

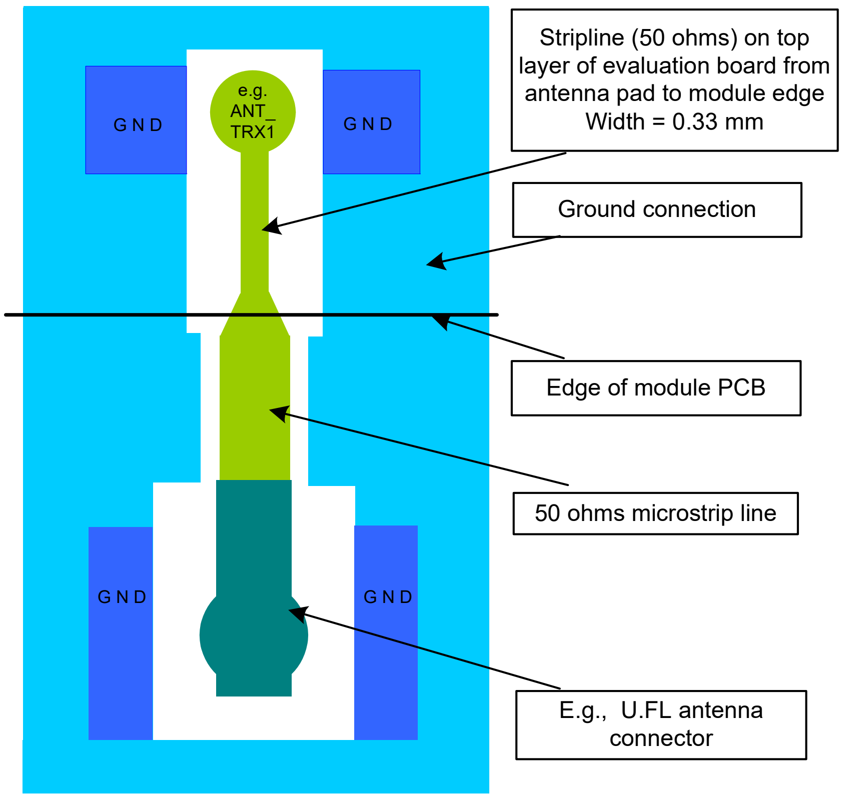


Figure 22: Routing to application‘s RF connector

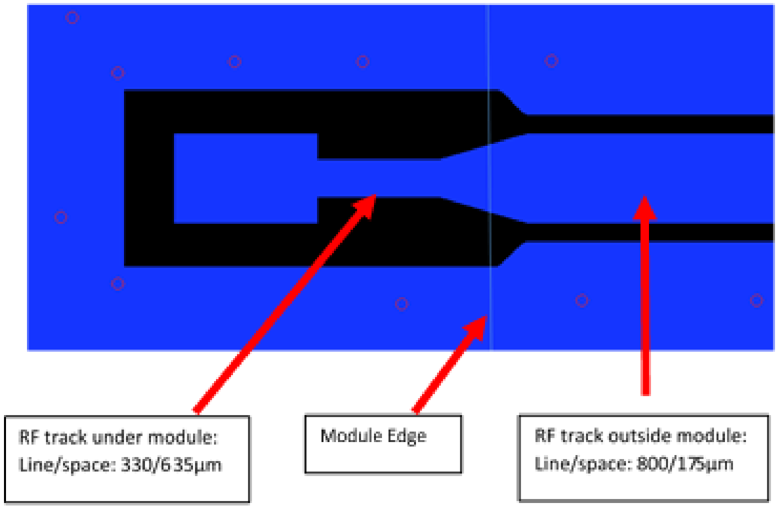


Figure 23: Routing Detail

2.3 GNSS Antenna Interface

2.3.1 GNSS Receiver

PLSx3 integrates a GNSS receiver that offers the full performance of GPS/GLONASS/BeiDou/Galileo technology. The GNSS receiver is able to continuously track all satellites in view, thus providing accurate satellite position data.

The integrated GNSS receiver supports the NMEA protocol. NMEA is a combined electrical and data specification for communication between various (marine) electronic devices including GNSS receivers. It has been defined and controlled by the US based National Marine Electronics Association. For more information on the NMEA Standard please refer to http://www.nmea.org.

Depending on the receiver's knowledge of last position, current time and ephemeris data, the receiver's startup time (i.e., TTFF = Time-To-First-Fix) may vary: If the receiver has no knowledge of its last position or time, a startup takes considerably longer than if the receiver still has knowledge of its last position, time and almanac or has still access to valid ephemeris data and the precise time. For more information see Section 2.3.4. Often, 2D measurements will be used over 3D depending on space vehicle (SV) locations as this will be just as accurate and faster.

By default, the GNSS receiver is switched off. It has to be switched on and configured using AT commands (AT^SGPSC; see[1]).

2.3.2 GNSS Antenna

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 24 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.

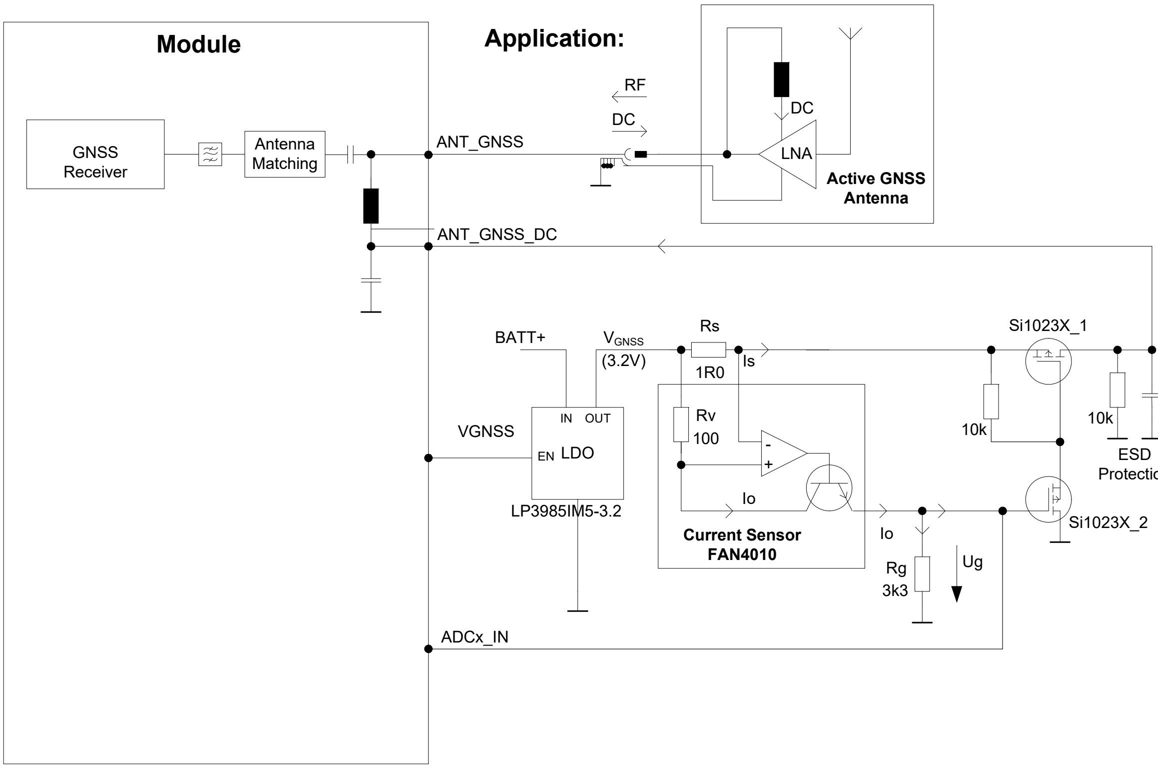


Figure 24: Supply voltage for active GNSS antenna

Figure 25 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.

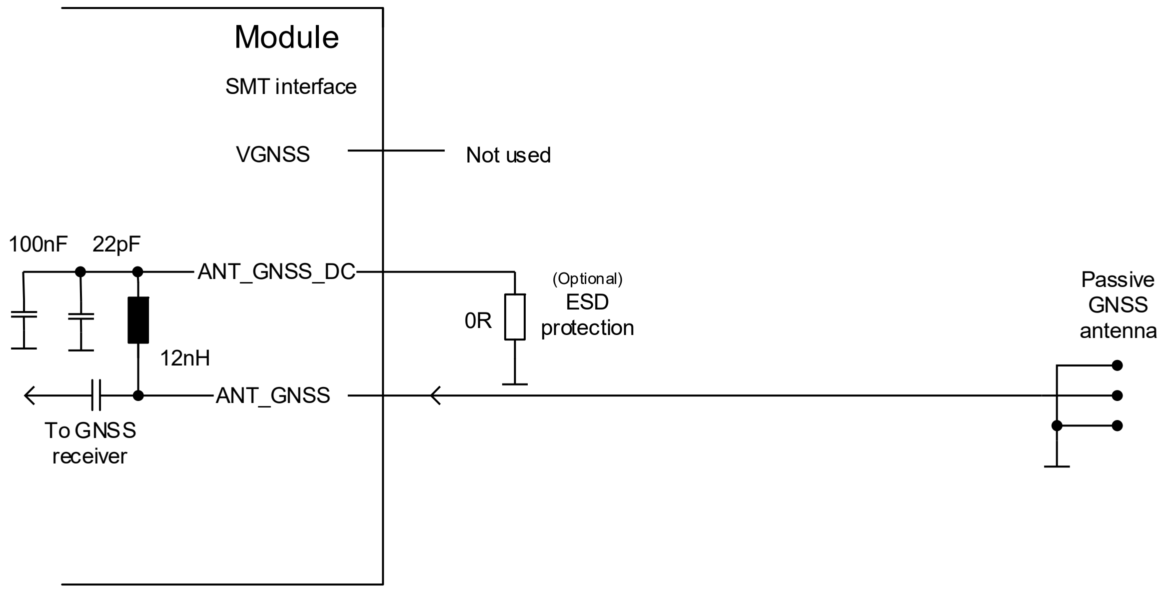


Figure 25: ESD protection for passive GNSS antenna

2.3.3 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 24. 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_S)[1]	Voltage ranges (U_G)
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.

2.3.4 GNSS Antenna Interface Characteristics

Table 14: GNSS properties

Parameter	Conditions	Min.	Typical	Max.	Unit
Frequency	GPS	1574.4	1575.42	1576.4	MHz
	GLONASS	1597.5	1602	1605.9	
Tracking Sensitivity	Open sky (active antenna or LNA): GPS		-159		dBm
	Open sky (active antenna or LAN): GLONASS		-158		
	Open sky (passive antenna): GPS		-156		
	Open sky (passive antenna): GLONASS		-156		
Acquisition Sensitivity	Open sky (active antenna or LNA): GPS		-147		dBm
	Open sky (active antenna or LNA): GLONASS		-146		
	Open sky (passive antenna): GPS		-145		
	Open sky (passive antenna): GLONASS		-144		
Time-to-First-Fix (TTFF)[1]	Warm (average at -130dBm)		28		s
	Cold (average at -130dBm)		32		s

1. Open sky environment

Note: For PLSx3-W modules, if GNSS works together with LTE Band13 in the field, to avoid Band13 second harmonic interfere GNSS sensitivity in the worst LET network condition, please design the GNSS antenna at least 20dB decoupling with LTE main antenna and use the extra LNA for GNSS.

2.4 Sample Application

Figure 26 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, VDDLP, 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 26 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.

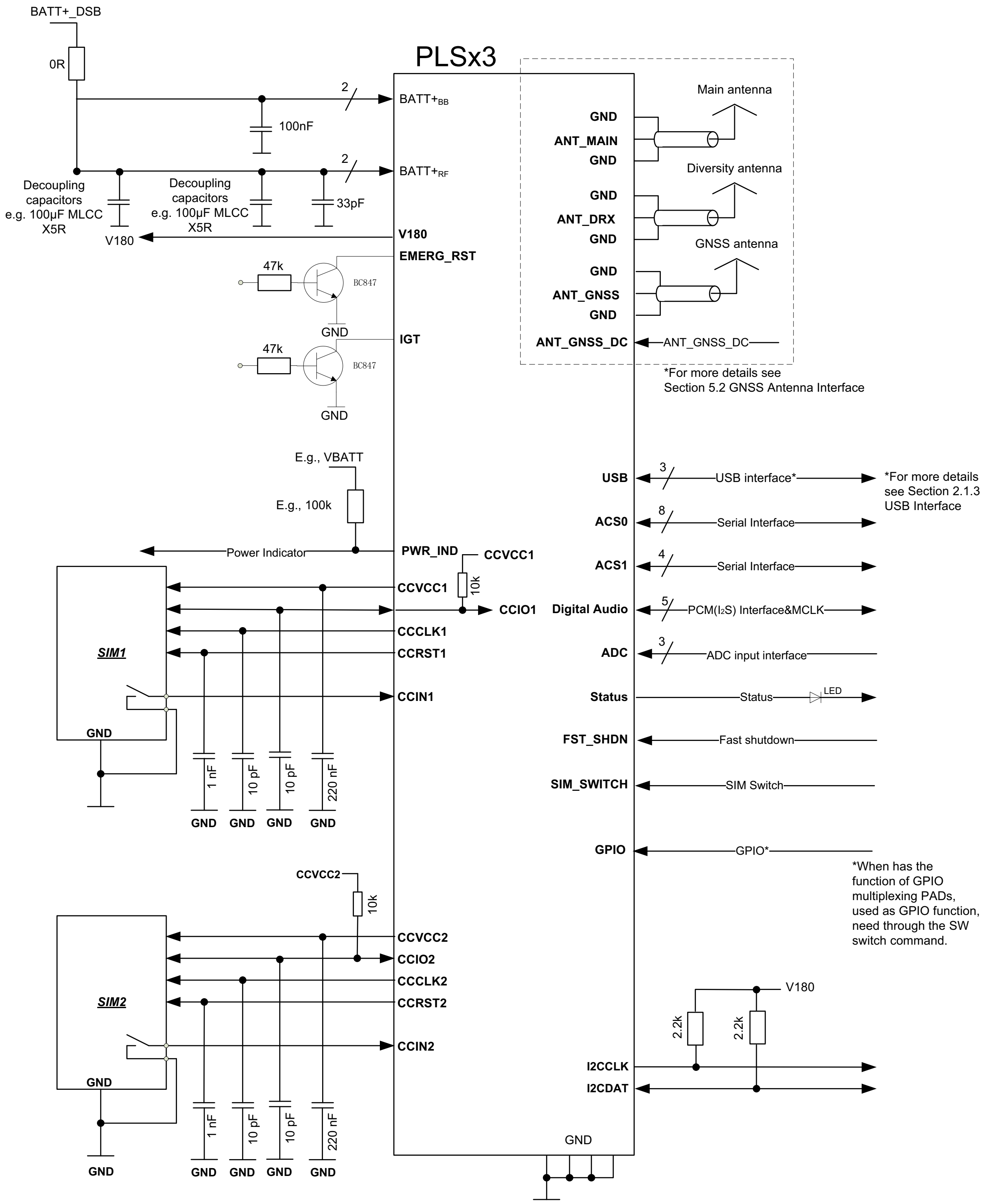


Figure 26: Schematic diagram of PLSx3 sample application

3 Operating Characteristics

3.1 Operating Modes

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

Table 15: 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 sinal to GND directly when powering on. The low pulse width must be longer than 300ms as shown in Figure 27.

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

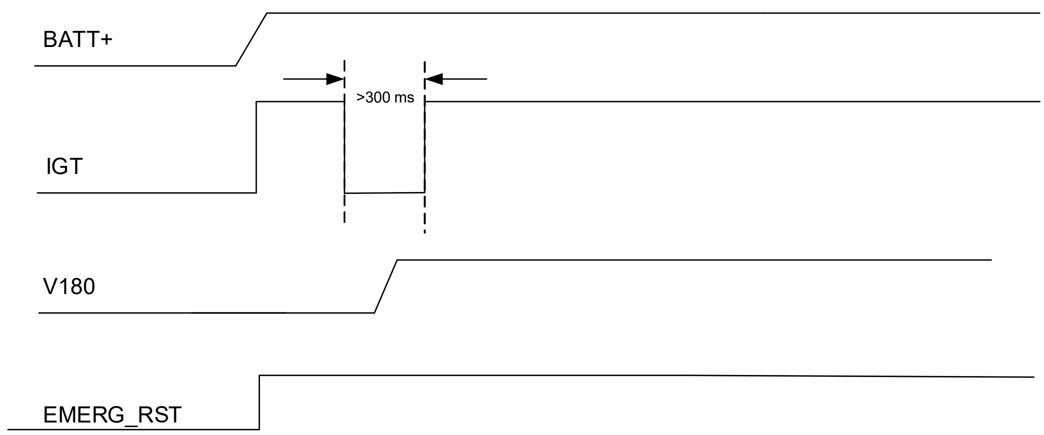


Figure 27: IGT timing

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 >2 00ms 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 16 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 16: 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 16:

L = Low level H = High level T = Tristate I = Input	O = Output OD = Open Drain PD = Pull down, 200µA at 1.9V 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 overvlotage 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^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 "^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^SCTM write command (for details see [1]):
  AT^SCTM=1: Presentation of URCs is always enabled.
  AT^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^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 17 for the associated URCs.

Table 17: 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 multislot 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 ms (TDMA frame duration) * 51 (number of frames) * 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.

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 28.

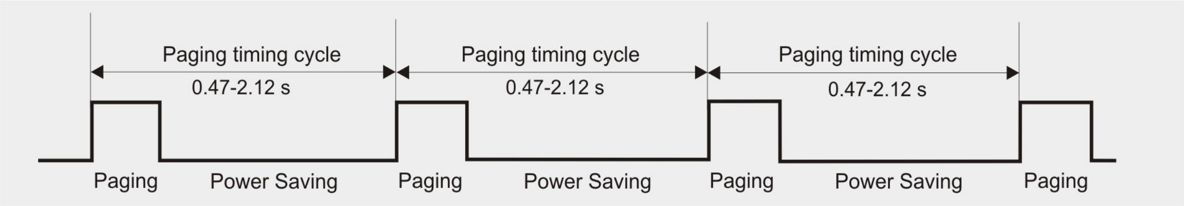


Figure 28: Power saving and paging in GSM networks

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:

$t = 2^{\text{DRX value}} * 10$ 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 29.

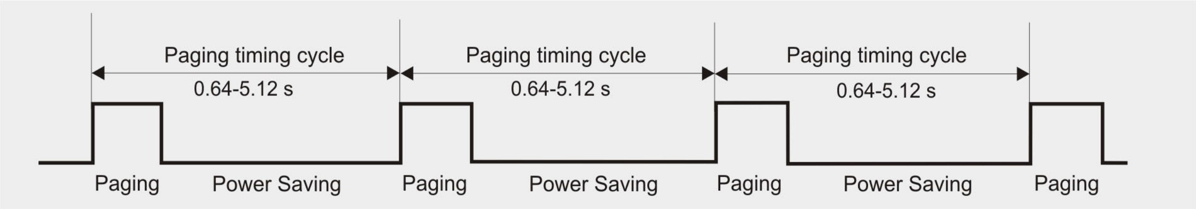


Figure 29: Power saving and paging in WCDMA networks

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

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 = DRX Cycle Value * 10 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 30.

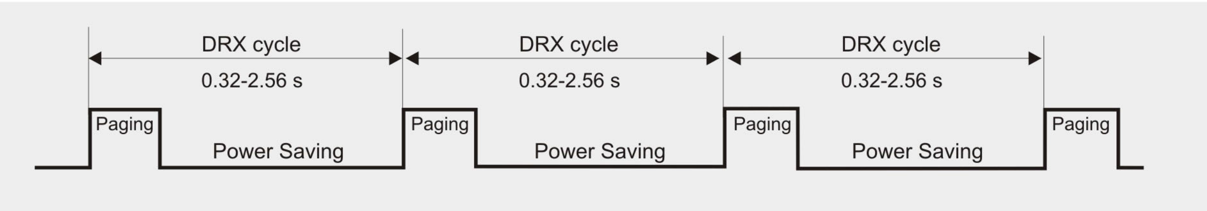


Figure 30: Power saving and paging in LTE networks

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 31 shows the described RTS0 wake up mechanism.

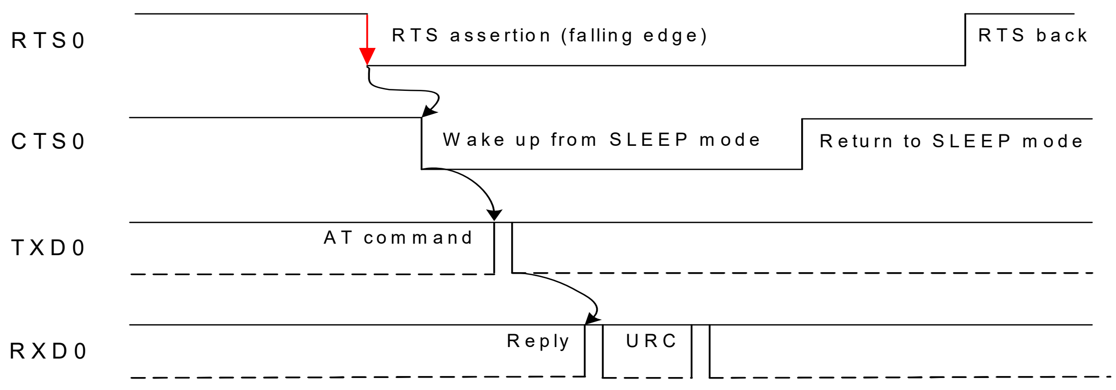


Figure 31: Wake-up via RTS0

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+:

- $BATT+_{BB}$ with two lines for the general power management.
- $BATT+_{RF}$ with two lines for the RF.

Please note that throughout the document BATT+ refers to both voltage domains and power supply lines - $BATT+_{BB}$ and $BATT+_{RF}$.

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). $BATT+_{RF}$ must be decoupled by application with low ESR capacitors(≥ 2x100µF MLCC X5R@$BATT+_{RF}$) as close as possible to LGA pads. Figure 32 shows a sample circuit for decoupling capacitors for BATT+.

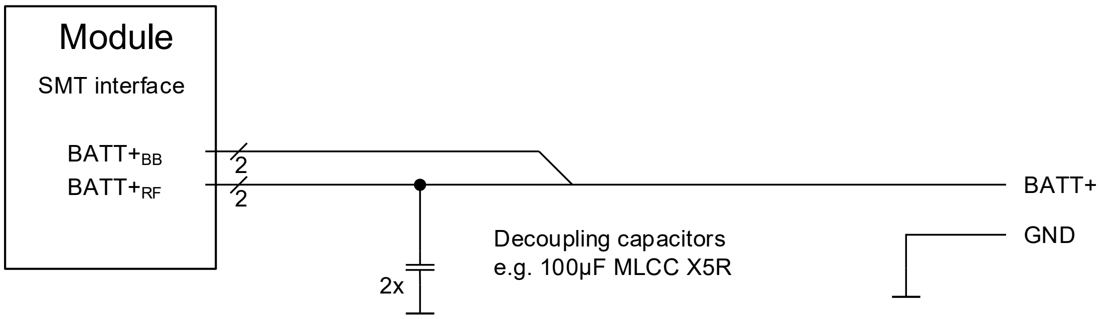


Figure 32: Decoupling capacitor(s) for BATT+

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 18: Supply Ratings

	Description	Conditions	Min	Typ	Max	Unit
BATT+	Supply voltage	Normal Range (Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes.) 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 @ f $\leq$ 250 kHz @ f > 250 kHz			 120 90	 mV_{pp} mV_{pp}

Table 19: Current Consumption Ratings -GSM[1]

	Description	Conditions		Typical rating (W,EP,LA,J, I)	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	GSM SLEEP State supply current	SLEEP[3] @ DRX=9 (no communication via UART)	USB disconnected	2.365	mA
			USB suspended	2.690	mA
		SLEEP[3] @ DRX=5 (no communication via UART)	USB disconnected	2.534	mA
			USB suspended	2.839	mA
		SLEEP[3] @ DRX=2 (no communication via UART)	USB disconnected	2.992	mA
			USB suspended	3.296	mA
	GSM IDLE[4] State supply current	IDLE @ DRX=2 (UART active, but no communication)	USB disconnected	12.083	mA
			USB active	27.706	mA
	Average GSM850 supply current[5]	GPRS Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	315	mA
			ROPR=4 (no reduction)	315	mA
		GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	455	mA
			ROPR=4 (no reduction)	566	mA
		GPRS Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	631	mA
			ROPR=4 (no reduction)	1049	mA
		EDGE Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	203	mA
			ROPR=4 (no reduction)	206	mA
		EDGE Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	303	mA
			ROPR=4 (no reduction)	349	mA
		EDGE Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	486	mA
			ROPR=4 (no reduction)	615	mA

Table 19: Current Consumption Ratings -GSM[1]

	Description	Conditions		Typical rating (W,EP,LA,J, I)	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM900 supply current[5]	GPRS Data transfer GSM900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	307	mA
			ROPR=4 (no reduction)	307	mA
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	446	mA
			ROPR=4 (no reduction)	554	mA
		GPRS Data transfer GSM900; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	638	mA
			ROPR=4 (no reduction)	1009	mA
		EDGE Data transfer GSM900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	198	mA
			ROPR=4 (no reduction)	201	mA
		EDGE Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	301	mA
			ROPR=4 (no reduction)	340	mA
		EDGE Data transfer GSM900; PCL=5; 4Tx/1Rx	ROPR=8 (max. reduction)	487	mA
			ROPR=4 (no reduction)	607	mA

Table 19: Current Consumption Ratings -GSM[1]

	Description	Conditions		Typical rating (W,EP,LA,J, I)	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM1800 supply current[5]	GPRS Data transfer GSM1800; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	209	mA
			ROPR=4 (no reduction)	209	mA
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	295	mA
			ROPR=4 (no reduction)	359	mA
		GPRS Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	433	mA
			ROPR=4 (no reduction)	640	mA
		EDGE Data transfer GSM1800; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	163	mA
			ROPR=4 (no reduction)	163	mA
		EDGE Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	250	mA
			ROPR=4 (no reduction)	269	mA
		EDGE Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	420	mA
			ROPR=4 (no reduction)	471	mA

Table 19: Current Consumption Ratings -GSM[1]

	Description	Conditions		Typical rating (W,EP,LA,J, I)	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM1900 supply current[5]	GPRS Data transfer GSM1900; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	210	mA
			ROPR=4 (no reduction)	208	mA
		GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	295	mA
			ROPR=4 (no reduction)	358	mA
		GPRS Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	433	mA
			ROPR=4 (no reduction)	643	mA
		EDGE Data transfer GSM1900; PCL=0; 1Tx/4Rx	ROPR=8 (max. reduction)	162	mA
			ROPR=4 (no reduction)	163	mA
		EDGE Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=8 (max. reduction)	249	mA
			ROPR=4 (no reduction)	272	mA
		EDGE Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=8 (max. reduction)	417	mA
			ROPR=4 (no reduction)	476	mA
	Peak current during GSM transmit burst[5]	GPRS Data transfer GSM850; PCL=5; 1Tx/1Rx @ 50Ω		2.3	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 GMS850; PCL=5; 1Tx/1Rx @ total mismatch		2.7	A
		GPRS Data transfer GMS900; PCL=5; 1Tx/1Rx @ total mismatch		2.8	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_{LOAD}=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
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 20: Current Consumption Ratings - UMTS[1]

<table>
<tr><th></th><th>Description</th><th colspan="2">Conditions</th><th>Typical rating (W,EP,LA,J,I)</th><th>Typical rating (X, X2, X3, X4)</th><th>Unit</th></tr>
<tr><td rowspan="16">I_{BATT+}[2]
(i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)</td><td rowspan="6">UMTS SLEEP State supply current</td><td rowspan="2">SLEEP[3] @ DRX=9 (no communication via UART)</td><td>USB disconnected</td><td colspan="2">2.336</td><td>mA</td></tr>
<tr><td>USB suspended</td><td colspan="2">2.698</td><td>mA</td></tr>
<tr><td rowspan="2">SLEEP[3] @ DRX=8 (no communication via UART)</td><td>USB disconnected</td><td colspan="2">2.431</td><td>mA</td></tr>
<tr><td>USB suspended</td><td colspan="2">2.778</td><td>mA</td></tr>
<tr><td rowspan="2">SLEEP[3] @ DRX=6 (no communication via UART)</td><td>USB disconnected</td><td colspan="2">2.864</td><td>mA</td></tr>
<tr><td>USB suspended</td><td colspan="2">3.196</td><td>mA</td></tr>
<tr><td rowspan="2">UMTS IDLE[4] State supply current</td><td rowspan="2">IDLE @ DRX=6 (UART active, but no communication)</td><td>USB disconnected</td><td colspan="2">11.785</td><td>mA</td></tr>
<tr><td>USB active</td><td colspan="2">26.138</td><td>mA</td></tr>
<tr><td rowspan="8">UMTS average supply current [5]</td><td colspan="2">UMTS Data transfer Band I</td><td>560</td><td></td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band II</td><td>550</td><td>606</td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band III</td><td>502</td><td></td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band IV</td><td>570</td><td>713</td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band V</td><td>516</td><td>542</td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band VI</td><td>516</td><td></td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band VIII</td><td>534</td><td></td><td>mA</td></tr>
<tr><td colspan="2">UMTS Data transfer Band XIX</td><td>507</td><td></td><td>mA</td></tr>
</table>

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_{LOAD}=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

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.

Table 21: Current Consumption Ratings - LTE[1]

	Description	Conditions		Typical rating (W,EP, LA,J,I)	Typical rating (X,X2,X3,X4)	Unit
I_{BATT+}[2] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	LTE SLEEP State supply current	SLEEP[3] @ "Paging Cycles = 256" (no communication via UART)	USB disconnected	2.496		mA
			USB suspended	2.793		mA
		SLEEP[3] @ "Paging Cycles = 128" (no communication via UART)	USB disconnected	2.740		mA
			USB suspended	3.098		mA
		SLEEP[3] @ "Paging Cycles = 64" (no communication via UART)	USB disconnected	3.291		mA
			USB suspended	3.623		mA
		SLEEP[3] @ "Paging Cycles = 32" (no communication via UART)	USB disconnected	4.399		mA
			USB suspended	4.717		mA
	LTE IDLE[4] State supply current	IDLE (USB disconnected)		12.991		mA
		IDLE (USB active)		28.465		mA
	LTE average supply current[5]	LTE Data transfer Band 1		604		mA
		LTE Data transfer Band 2		622	596	mA
		LTE Data transfer Band 3		557		mA
		LTE Data transfer Band 4		570	674	mA
		LTE Data transfer Band 5		564	535	mA
		LTE Data transfer Band 7(-W)		758		mA
		LTE Data transfer Band 8		658		mA
		LTE Data transfer Band 12		669	565	mA
		LTE Data transfer Band 13		641	579	mA
		LTE Data transfer Band 14			520	mA
		LTE Data transfer Band 17		640		mA
		LTE Data transfer Band 18		520		mA
		LTE Data transfer Band 19		561		mA
		LTE Data transfer Band 20		634		mA
		LTE Data transfer Band 25			600	mA
		LTE Data transfer Band 26		636	529	mA
		LTE Data transfer Band 28		630		mA
		LTE Data transfer Band 38		397		mA
		LTE Data transfer Band 40		405		mA
		LTE Data transfer Band 41		399		mA
		LTE Data transfer Band 66		650	675	mA
		LTE Data transfer Band 71			594	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_{LOAD}=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
4. The power save mode is disabled via AT command AT^SPOW=1,0,0
5. Communication tester setting:
Channel: Mid Channel
Channel Bandwidth: 5MHz
Number of Resource Blocks: 25 (DL), 1 (UL), RB position: Low
Modulation: QPSK

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

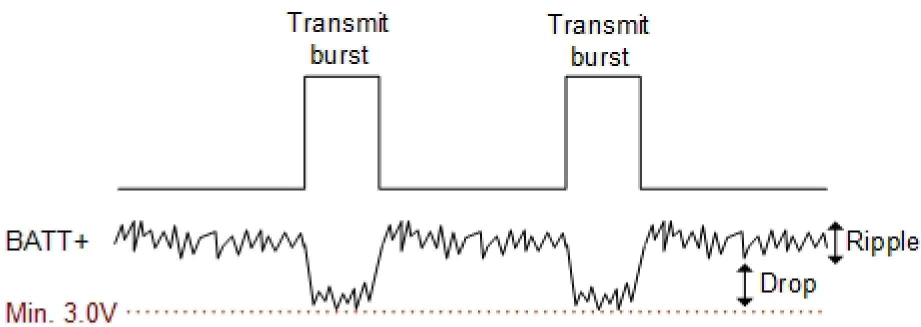


Figure 33: Power supply limits during transmit burst

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 22: Board Temperature

Parameter	Min	Typ	Max	Unit
Operating temperature range	-30		+85	°C
Restricted temperature range[1]	-40		+95	°C
Automatic shutdown[2] 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 23: 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

3.7 Reliability Characteristics

The test conditions stated below are an extract of the complete test specifications.

Table 24: Summary of reliability test conditions

Type of test	Conditions	Standard
Vibration	Frequency range: 10-20Hz; acceleration: 5g Frequency range: 20-500Hz; acceleration: 20g Duration: 20h per axis; 3 axes	DIN IEC 60068-2-6[1]
Shock half-sinus	Acceleration: 500g Shock duration: 1ms 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
Dry heat	Temperature: +70 ±2°C Test duration: 16h Humidity in the test chamber: < 50%	EN 60068-2-2 Bb ETS 300 019-2-7
Temperature change (shock)	Low temperature: -40°C ±2°C High temperature: +85°C ±2°C Changeover time: < 30s (dual chamber system) Test duration: 1h Number of repetitions: 100	DIN IEC 60068-2-14 Na ETS 300 019-2-7
Damp heat cyclic	High temperature: +55°C ±2°C Low temperature: +25°C ±2°C Humidity: 93% ±3% Number of repetitions: 6 Test duration: 12h + 12h	DIN IEC 60068-2-30 Db ETS 300 019-2-5
Cold (constant exposure)	Temperature: -40 ±2°C Test duration: 16h	DIN IEC 60068-2-1

1. For reliability tests in the frequency range 20-500Hz the Standard's acceleration reference value was increased to 20g.

4 Mechanical Dimensions, Mounting and Packaging

4.1 Mechanical Dimensions of PLSx3

Figure 34 shows the top and bottom view of PLSx3 and provides an overview of the board's mechanical dimensions. For further details see Figure 35.

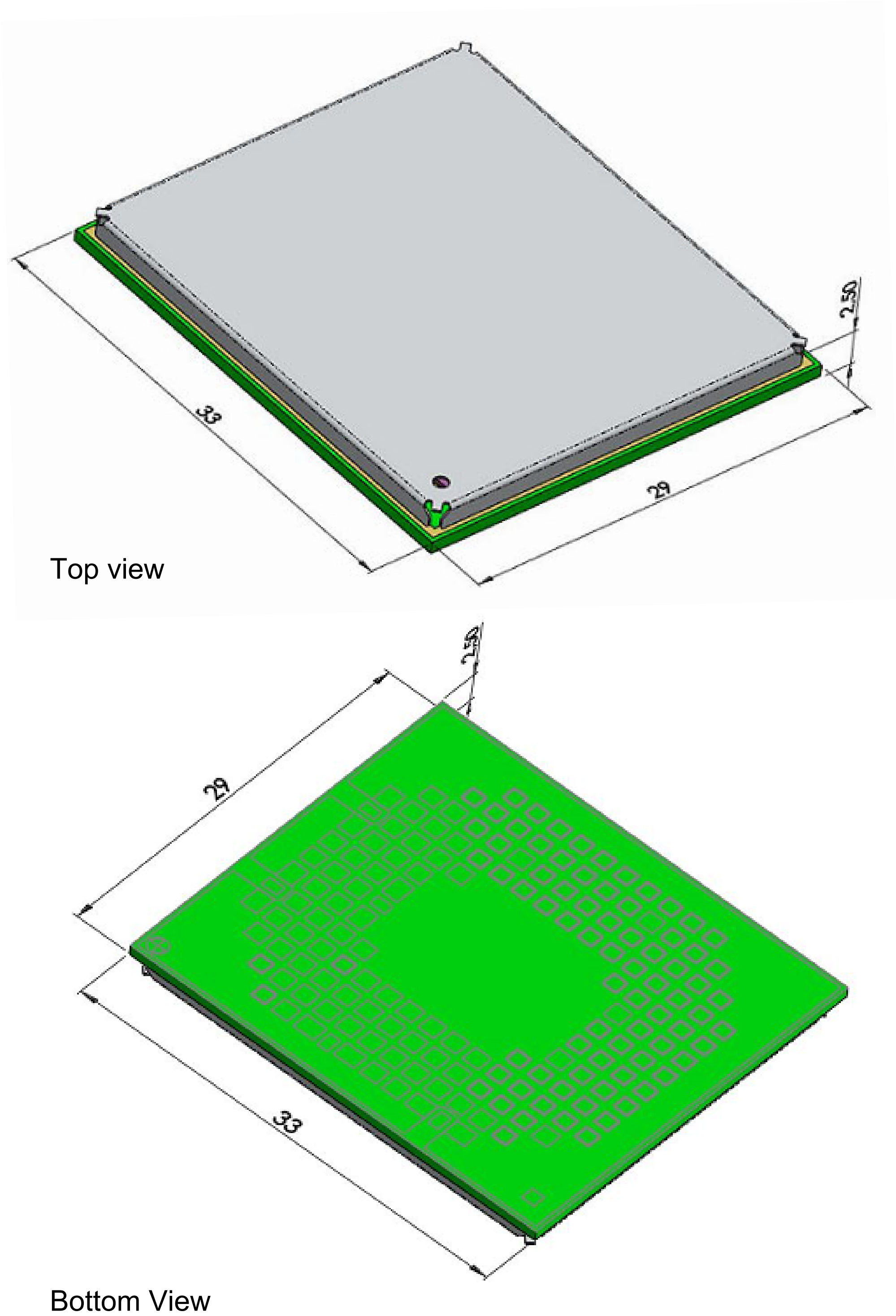


Figure 34: PLSx3– top and bottom view

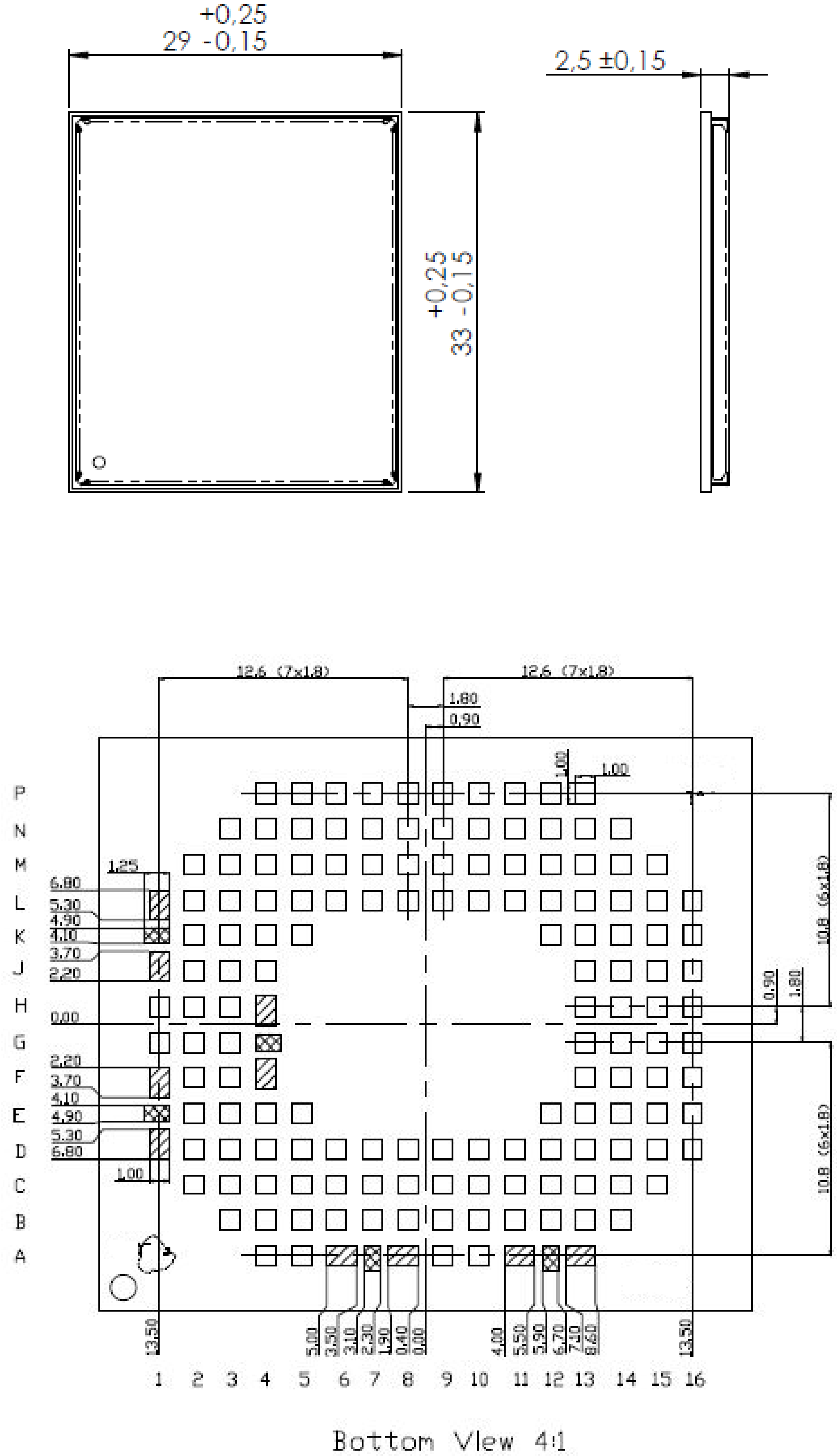


Figure 35: Dimensions of PLSx3 (all dimensions in mm)

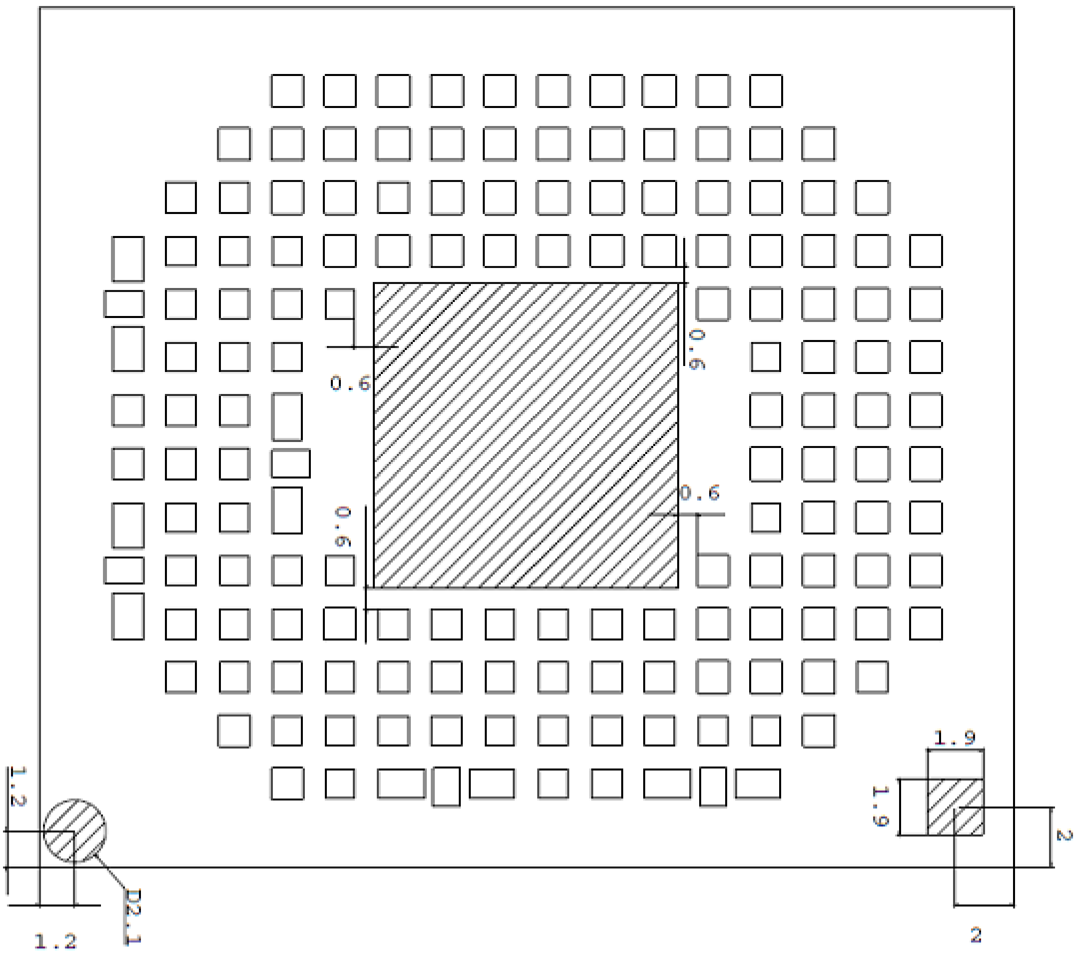


Figure 36: Dimensions of PLSx3 (keepout area recommended)

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 37 reflects the module's pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1).

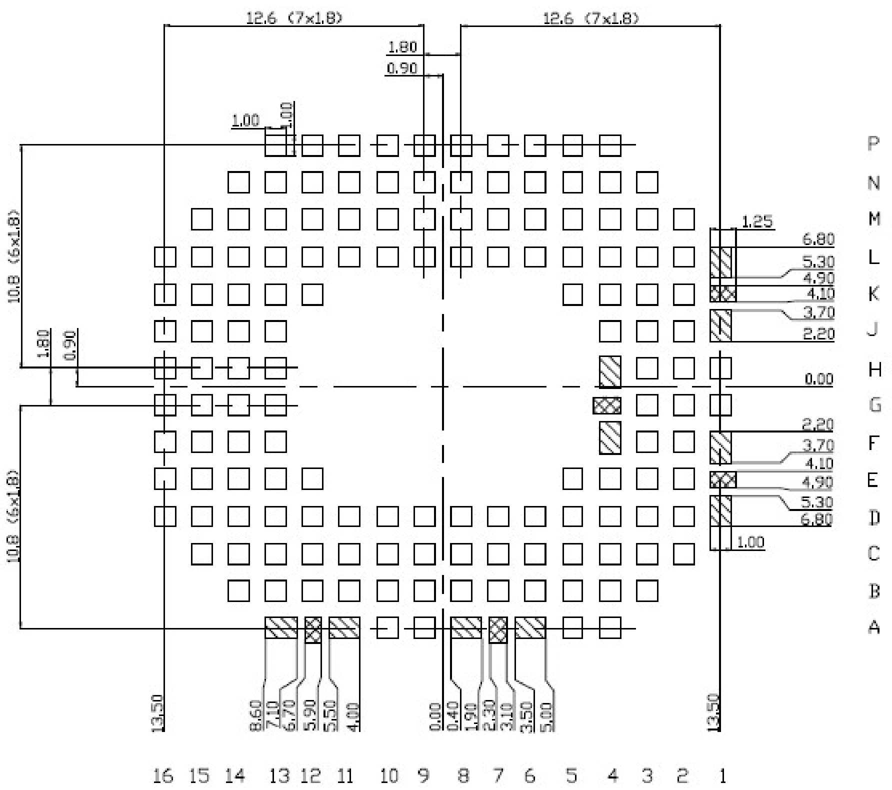


Figure 37: Land pattern (top view)

The stencil designs illustrated in Figure 38 and Figure 39 are recommended by Thales as a result of extensive tests with Thales Daisy Chain modules.

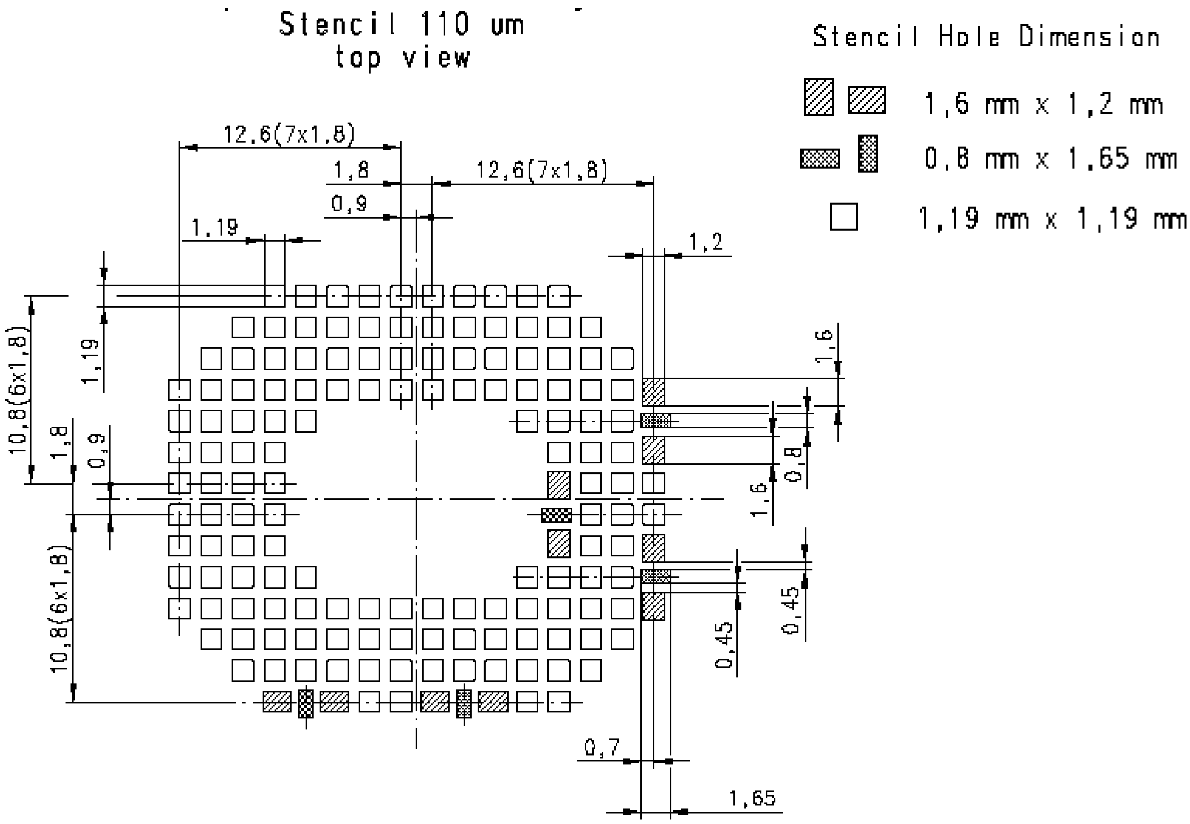


Figure 38: Recommended design for 110 micron thick stencil (top view)

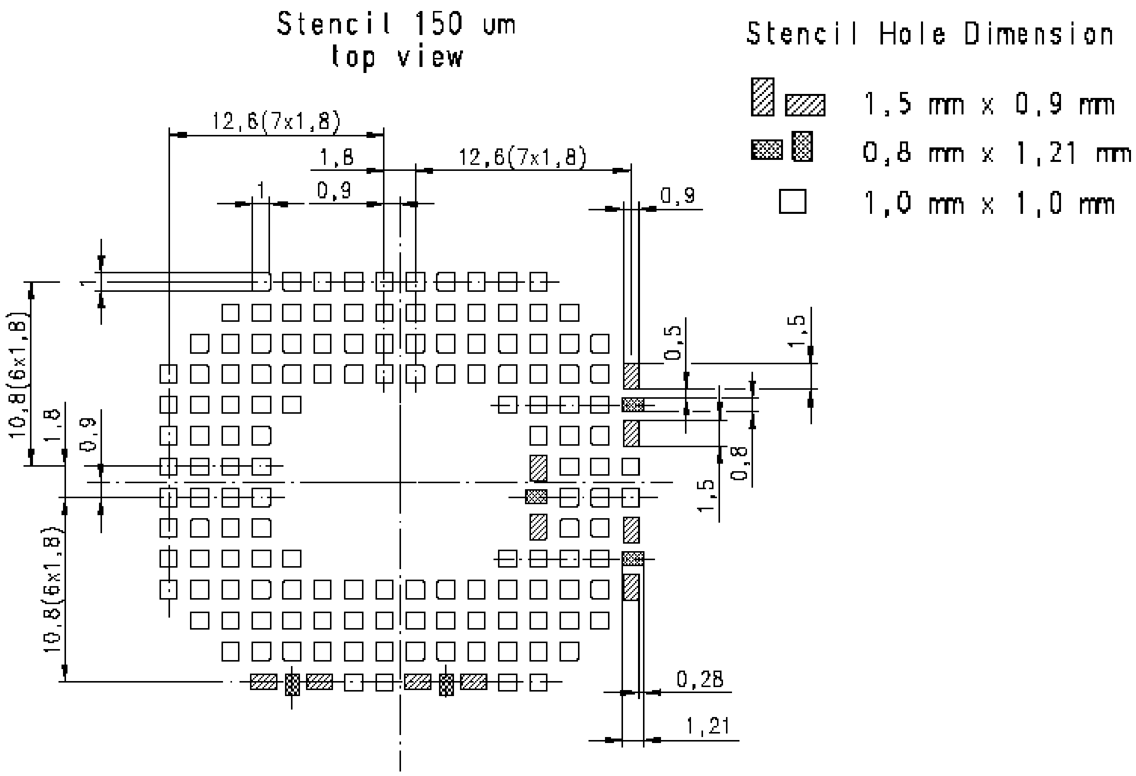


Figure 39: Recommended design for 150 micron thick stencil (top view)

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

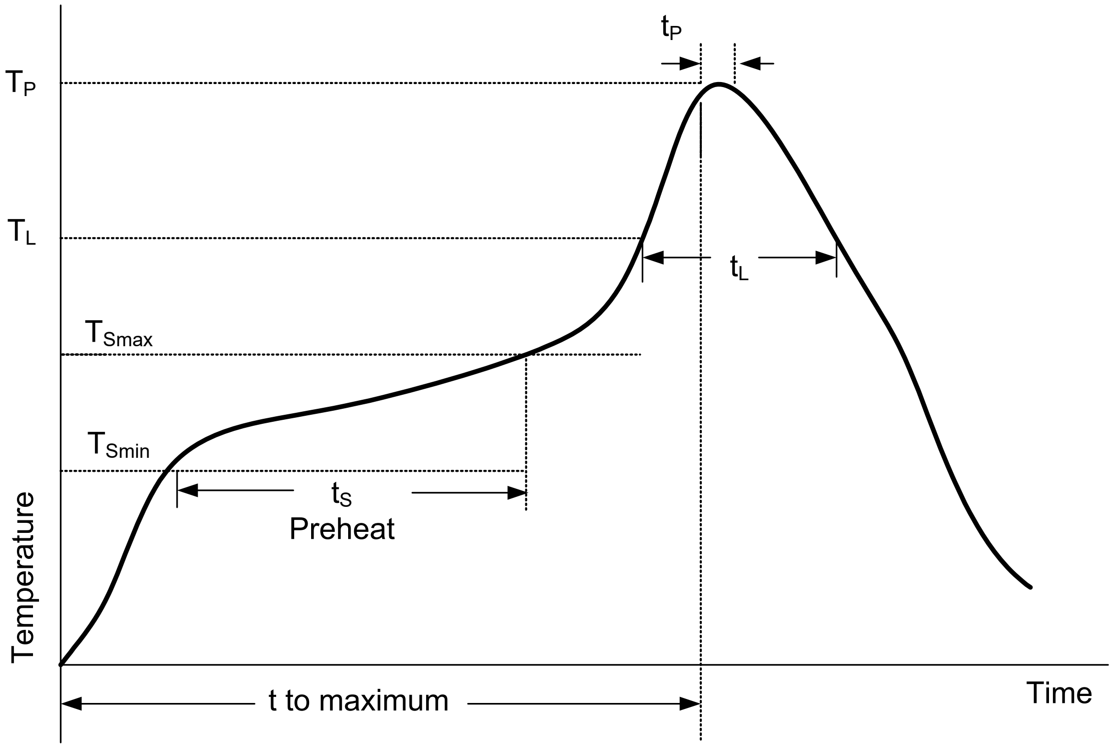


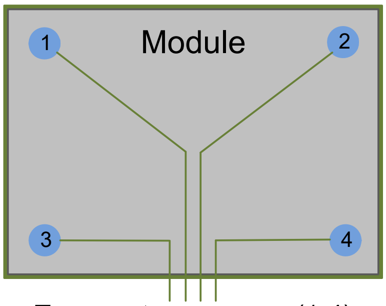
Figure 40: Reflow Profile

Table 25: Reflow temperature ratings[1]

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_{Smin} to t_{Smax}) (t_S)	 150°C 200°C 60-120 seconds
Average ramp up rate (T_L to T_P)	3K/second max.[2]
Liquidous temperature (T_L) Time at liquidous (t_L)	217°C 50-90 seconds
Peak package body temperature (T_P)	245°C ±5°C
Time (t_P) within 5 °C of the peak package body temperature (T_P)	30 seconds max.
Average ramp-down rate - Limited ramp-down rate between 225°C and 200°C	6K/second max.[2] 3K/second max.[2]
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].



Temperature sensors (1-4)

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 25 - 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 26: Storage conditions

Type	Condition	Unit	Reference
Air temperature: Low High	-25 +40	°C	IPC/JEDEC J-STD-033A
Humidity relative: Low High	10 90 at 40°C	%	 IPC/JEDEC J-STD-033A
Air pressure: Low High	70 106	kPa	IEC TR 60271-3-1: 1K4 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 Heat	1120 600	W/m^2	ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb 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: Displacement Acceleration Frequency range	 1.5 5 2-9 9-200	 mm m/s^2 Hz	IEC TR 60271-3-1: 1M2
Shocks: Shock spectrum Duration Acceleration	 semi-sinusoidal 1 50	 ms m/s^2	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 46 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

4.3.1 Tape and Reel

The single-feed tape carrier for PLSx3 is illustrated in Figure 41. 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

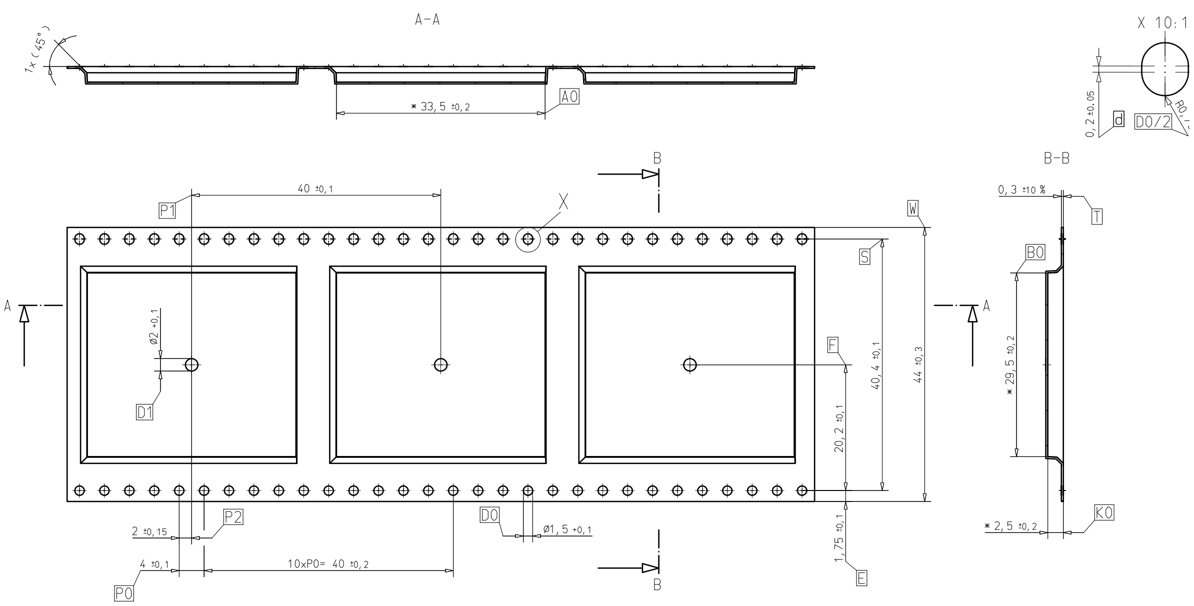


Figure 41: Carrier tape

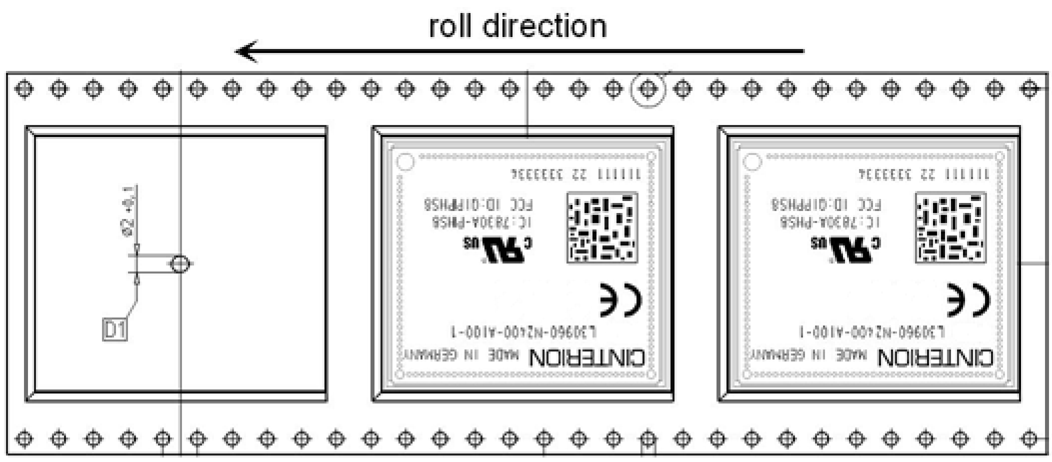


Figure 42: Reel direction

4.3.1.2 Barcode Label

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

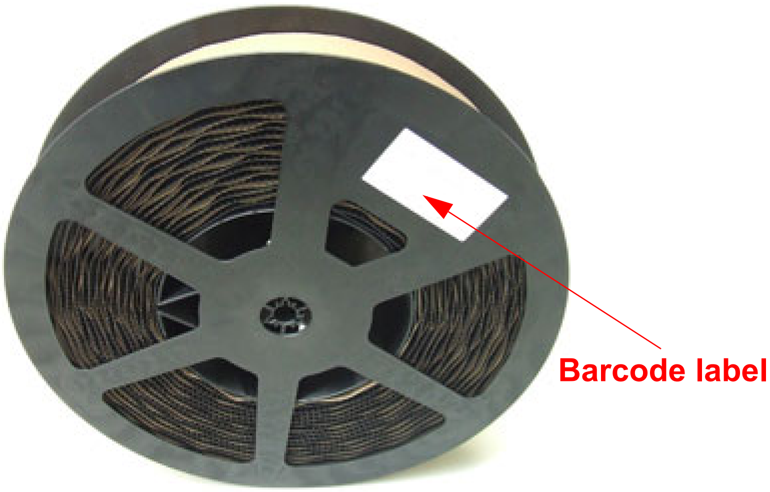


Figure 43: Barcode label on tape reel

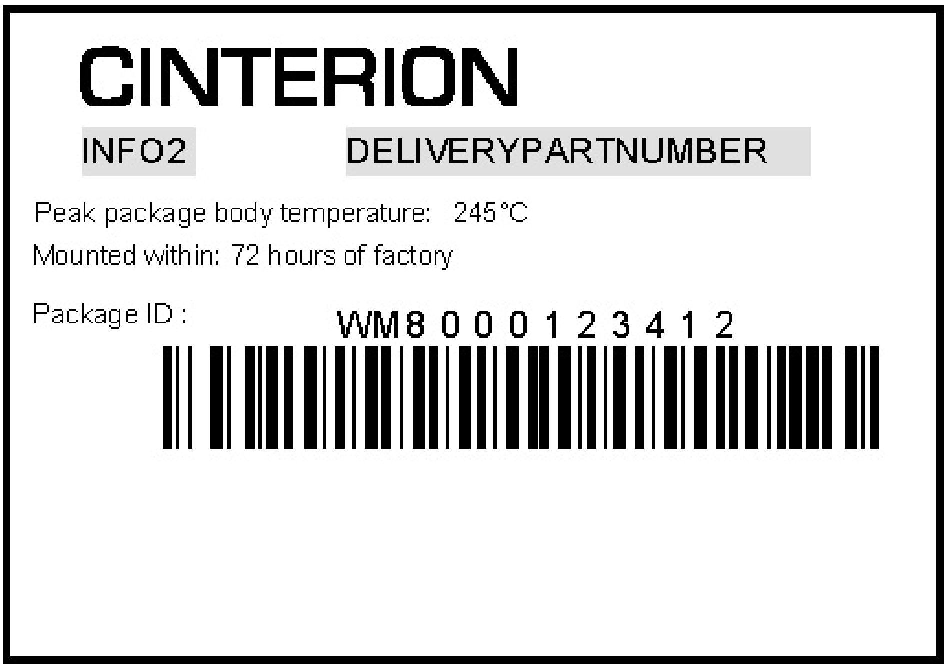


Figure 44: Barcode label on tape reel - layout

Variables on the label are explained in Table 27.

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 45. 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.

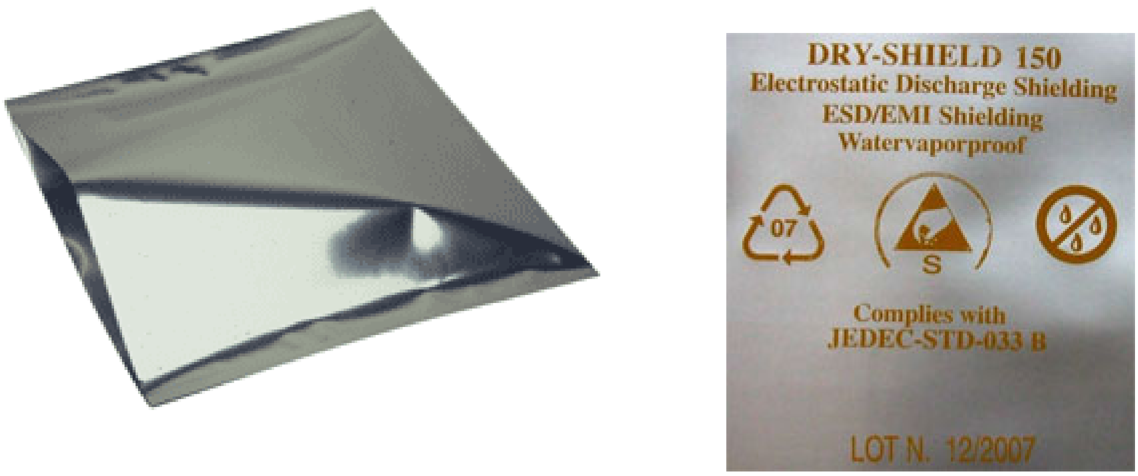


Figure 45: Moisture barrier bag (MBB) with imprint

The label shown in Figure 46 summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag.

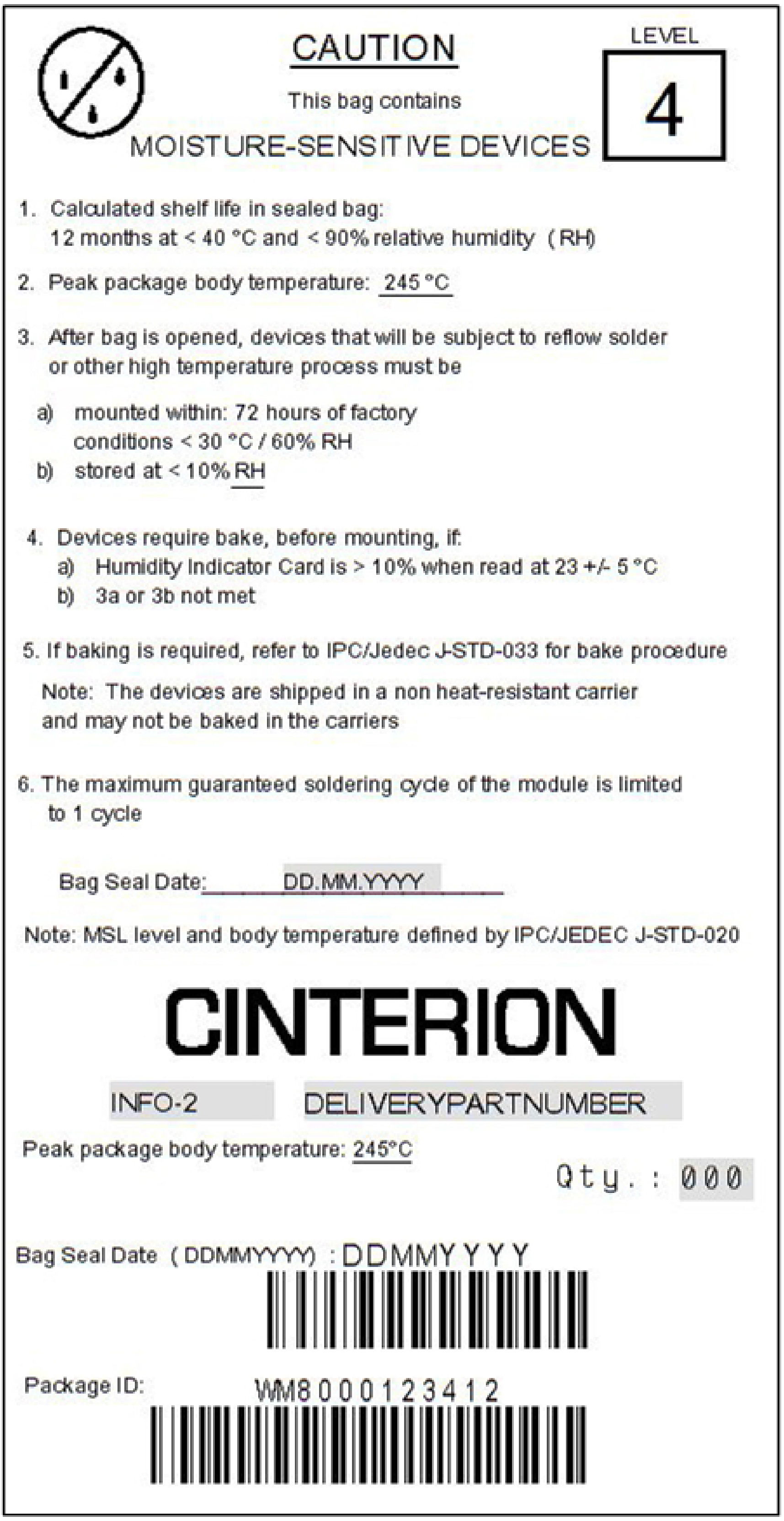


Figure 46: Moisture Sensitivity Label

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 47. If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.

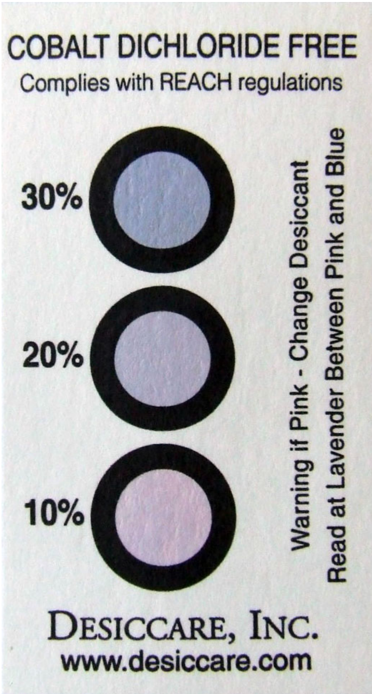


Figure 47: Humidity Indicator Card - HIC

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.

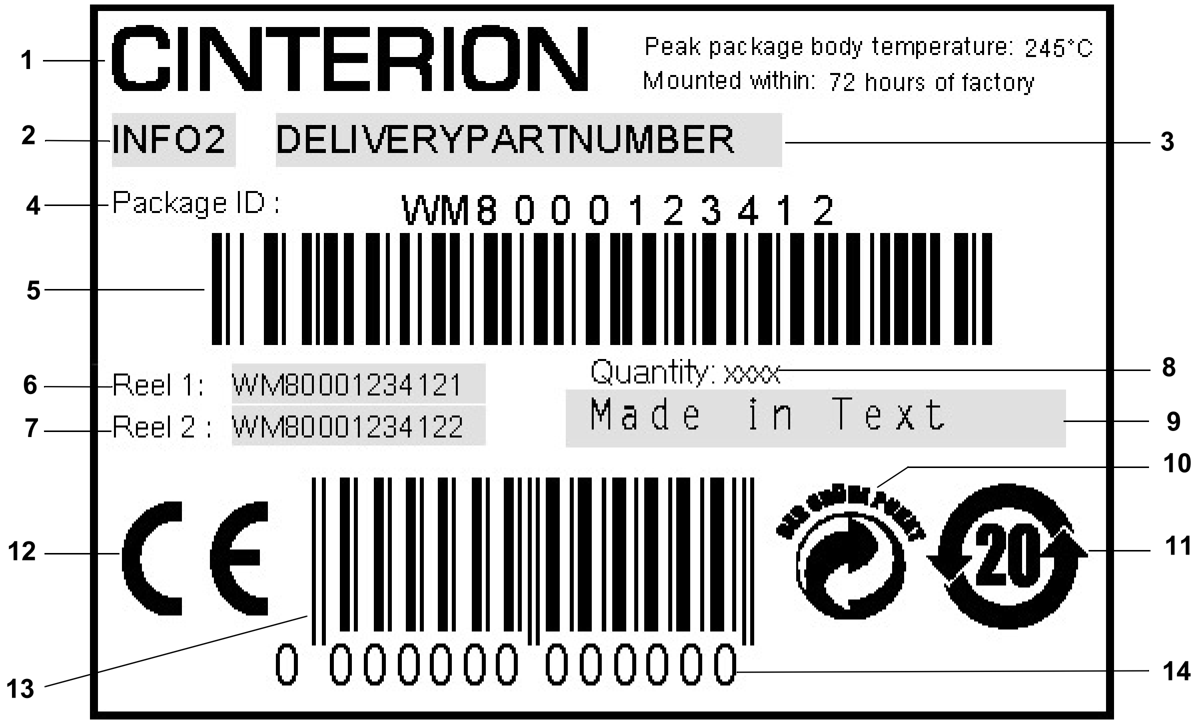


Figure 48: Sample of VP box label

Table 27: 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 Table 31)
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".[1]

Table 28: Directives

2014/53/EU	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. The product is labeled with the CE conformity mark.
2002/95/EC (RoHS 1) 2011/65/EC (RoHS 2)	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)
1907/2006/EC (REACH)	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. 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)

Table 29: Standards of North American type approval

CFR Title 47	Code of Federal Regulations, Part 22, Part 24; US Equipment Authorization FCC
OET Bulletin 65 (Edition 97-01)	Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields
UL 62368-1	Audio/video, information and communication technology equipment - Part1: Safety requirements (for details see Section 5.1.1)
NAPRD.03 V6.01	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132 (Issue2) 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.

Table 30: 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 (for details see Section 5.1.1)

Table 31: 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 32: 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).

Table 32: Standards of the Ministry of Information Industry of the People's Republic of China

SJ/T 11364-2006	"Marking for Control of Pollution Caused by Electronic Information Products" (2006-06). 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. Please see Table 33 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.

Table 33: Toxic or hazardous substances or elements with defined concentration limits

部件名称 Name of the part	有毒有害物质或元素 Hazardous substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 (Metal Parts)	O	O	O	O	O	O
电路模块 (Circuit Modules)	X	O	O	O	O	O
电缆及电缆组件 (Cables and Cable Assemblies)	O	O	O	O	O	O
塑料和聚合物部件 (Plastic and Polymeric parts)	O	O	O	O	O	O
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 34: 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: DC either smaller 60 V Or less than 2 mA AC up to 1kHz smaller 30 V-rms or 42.4 V peak AC above 100kHz smaller 70 V rms
Power Source (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 34: IEC 62368-1 Classification

Source of Energy	Class	Limits
Hazardous Substances, Chemical reaction	-	Under regular conditions, the Cinterion® modules does not contain any chemically reactive substances, and no chemical energy source, especially no battery. Module is compliant with RoHS and REACH. In very rare cases however - under abnormal conditions 9i.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 loosing, exploding or imploding parts. 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 **Note:** 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 expo-sure 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

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

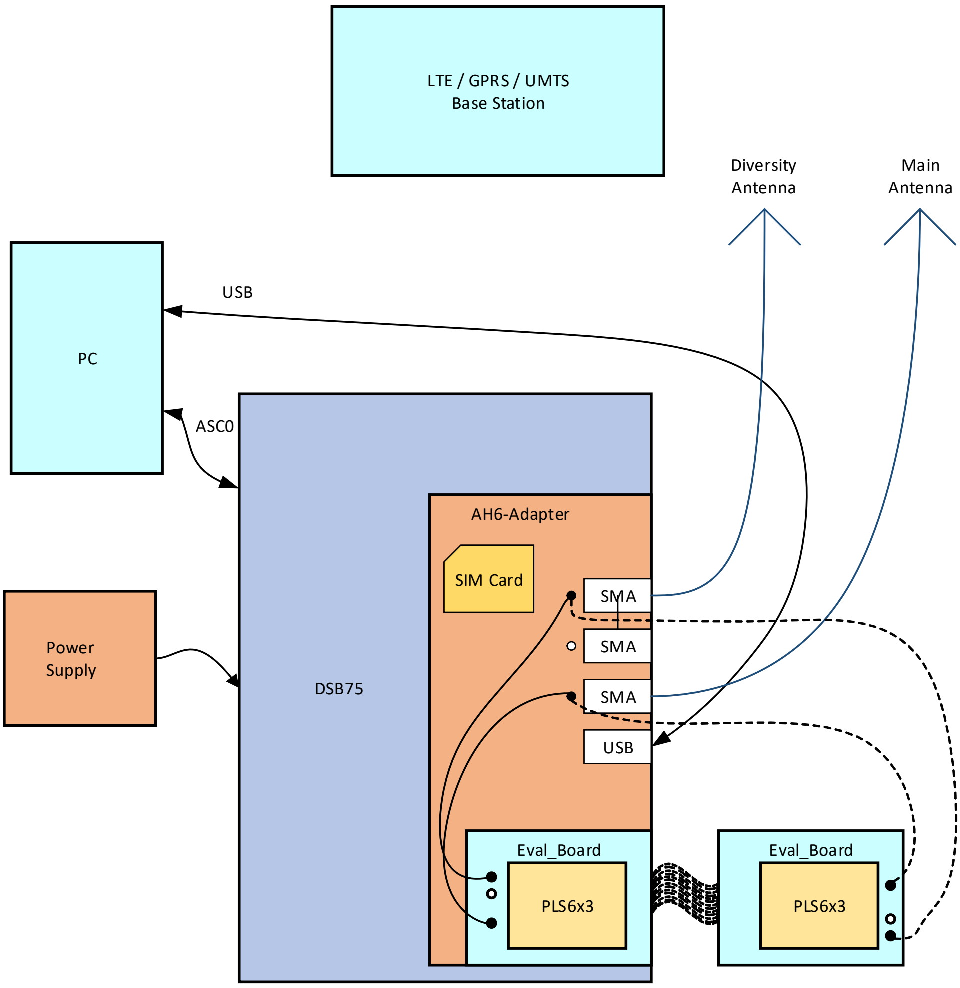


Figure 49: Reference equipment for Type Approval

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 49. 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/pdfiles/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", "Contains 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 35 and Table 36 for FCC and ISED.

.

Table 35: 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 8	9.70	-	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 36: 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

Table 36: 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 25	8.01	8.01	dBi
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 33: 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 UNDESIRED 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'exposltion 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 51 for the JATE/TELEC mark with identifiers:

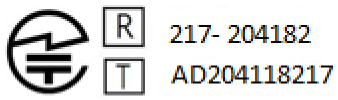


Figure 50: JATE/TELEC mark for -J

:

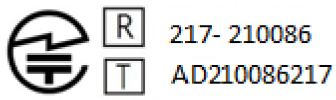


Figure 51: JATE/TELEC mark for -W

6 Document Information

6.1 Revision History

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

Chapter	What is new
2.1.2	Updated CCIN to CCIN1 and CCIN2.
2.4	Updated Figure 26.
3.4	Updated Figure 32.
5.4	Added LET Band8 in Table 35.

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

Chapter	What is new
2.4	Updated Figure 26.

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

Chapter	What is new
2.1.2	Deleted GPO interface in Table 3.
2.1.4	Added Figure 6.
2.1.5	Added Figure 7.
2.1.7	Added Figure 14.
2.1.8.1	Added Figure 15.
2.2.1	Updated Table 11 and Table 12.
2.3.2	Update Figure 25.
2.3.4	Added new chapter for GNSS Antenna Interface Characteristics.
2.4	Updated Figure 26 for Sample Application.
3.4	Updated Table 19, Table 20, and Table 21.
3.7	Added new chapter Reliability Characteristics.
-	Remove I^2C.

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

Chapter	What is new
1.2.1	Added a note to Table 1.
2.2	Updated Table 12.
2.2.3.2	Updated Figure 23.
2.1.2 3.2.2.2	Updated the low level impulse.
3.2.3	Updated Table 16 and added a note.
5.1	Added 1907/2006/EC (REACH) in Table 28.
5.1.1	New chapter regarding IEC 62368-1 Classification
5.2	Updated SAR requirement.
5.4	Added Table 35 and Table 36.
7.2	Updated Figure 52.

Proceeding document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.906a
New document: "Cinterion® PLSx3 Hardware Interface Description" Version 01.002

Chapter	What is new
1.1	Updated the supported product in the list.
1.2.1	Added new products and the supported bands in Table 1.
3.4.2	Added this section.
3.4.1	Updated Table 20 and Table 21.
3.3.4	Added this section.
3.2.1	Updated Figure 27.
5.1.1	New chapter regarding IEC 62368-1 Classification
7	Added the supported products in Table 37.

Proceeding document: "Cinterion® PLSx3-W Hardware Interface Description" Version 00.024
New document: "Cinterion® PLSx3 Hardware Interface Description" Version 00.906

Chapter	What is new
2.1.3.1	Add Reducing Power Consumption section.
2.1.9	Added Analog-to-Digital Converter (ADC) section.
2.1.10.3, 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 Figure 44.
4.3.2.2	Added Figure 48 and Table 27.
5	Added chapter 6 Regulatory and Type Approval Information.
7.2	Added Module Label Information section.
3.2.1	Updated Figure 27 and the description of IGT signal.
2.1.2	Updated Ignition signal description in Table 3.

Proceeding 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 Figure 10.
2	Added the following chapters: 2.1.10.1, 2.2, 2.3, 2.4.
3.2.5	Added Automatic Shutdown section.
3.4.1	Updated power consumption.
3.5	Added Operating Temperatures section.
--	Removed TX-activity.

Proceeding 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: 2.1.7, 2.1.8.1, 2.1.10, 2.1.6.1
3	Added the following new sections: 3.2.2, 3.2.4
4	Added the following new sections: 4.2.4, 4.3
2.1.1	Updated the pad assignment
1.3	Updated Figure 1
-	Updated company name and logo.

Proceeding 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 Figure 2.
2.1	Added the following new sections: 2.1.3, 2.1.4 2.1.5, 2.1.6
3	Added section 3.2

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

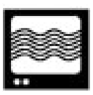
Abbreviation	Description
ADC	Analog-to-digital converter
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of PLSx3
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
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

Abbreviation	Description
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
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

Abbreviation	Description
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
RFFE	RF front-end
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
SD	Secure Digital
SDC	Secure Digital Controller
SGMII	Serial Gigabit Media Independent Interface
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
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.

	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.
	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.
	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.
	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.
	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.
	IMPORTANT! 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.

7 Appendix

7.1 List of Parts and Accessories

Table 37: List of parts and accessories

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

Table 37: List of parts and accessories

Description	Supplier	Ordering information
PLS83-X2	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6516-A100 Module label number: S30960-S6516-A100-1
PLS63-X3	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6508-A100 Module label number: S30960-S6508-A100-1
PLS83-X3	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6518-A100 Module label number: S30960-S6518-A100-1
PLS63-X4	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6512-A100 Module label number: S30960-S6512-A100-1
PLS83-X4	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6522-A100 Module label number: S30960-S6522-A100-1
PLS63-I	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6526-A100 Module label number: S30960-S6526-A100-1
PLS83-I	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6536-A100 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

Table 37: 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 Cinterion® LGA DevKit L Base PCB: Ordering number: L30960-N0112-A100 Cinterion® LGA DevKit Socket SML: 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 38: Molex sales contacts (subject to change)

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

7.2 Module Label Information

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

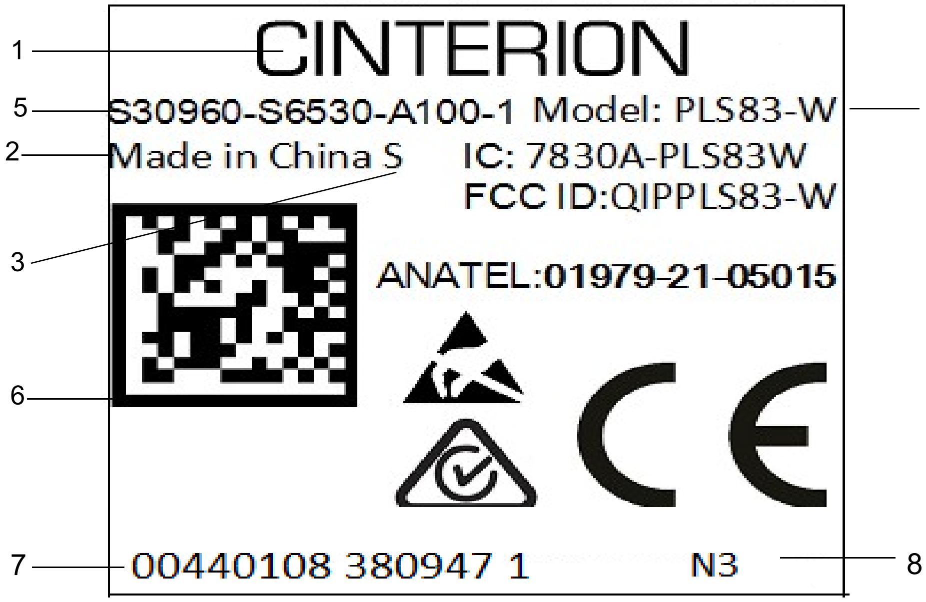


Figure 52: PLSx3 Label

Table 39: PLSx3 label information

No.	
1	Cinterion logo
2	Manufacturing country (e.g., “Made in China”)
3	Factory Code
4	Product name/variant (e.g. “PLS83-W”)
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 40: 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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