Cinterion® PLS62-W

Hardware Interface Description

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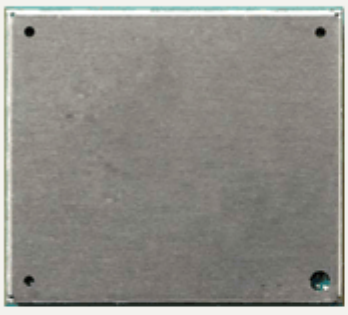

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1 Introduction

This document[1] describes the hardware of the Cinterion® PLS62-W module. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

1.1 Key Features at a Glance

Feature	Implementation
General	
Frequency bands	GSM/GPRS/EDGE: Quad band, 850/900/1800/1900 MHz UMTS/HSPA+: Seven band, 800 (BdXIX) / 850 (BdV) / 900 (BdVIII) / AWS (BdIV) / 1800 (BdIX) / 1900 (BdII) / 2100MHz (BdI) LTE: Twelve band, 700 (Bd12 <MFBI Bd17>, Bd28) 800 (Bd18, Bd19, Bd20) 850 (Bd5) / 900 (Bd8) / AWS (Bd4) / 1800 (Bd3) / 1900 (Bd2) / 2100 (Bd1) / 2600 (Bd7)
GSM class	Small MS
Output power (according to release 99)	Class 4 (+33dBm ±2dB) for EGSM850 Class 4 (+33dBm ±2dB) for EGSM900 Class 1 (+30dBm ±2dB) for GSM1800 Class 1 (+30dBm ±2dB) for GSM1900 Class E2 (+27dBm ± 3dB) for GSM 850 8-PSK Class E2 (+26dBm ± 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 800, WCDMA FDD BdXIX 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 AWS, WCDMA FDD BdIV Class 3 (+24dBm +1/-3dB) for UMTS 1800, WCDMA FDD BdIX Class 3 (+24dBm +1/-3dB) for UMTS 1900, WCDMA FDD BdII Class 3 (+24dBm +1/-3dB) for UMTS 2100, WCDMA FDD BdI
Output power (according to Release 8)	Class 3 (+23dBm ±2dB) for LTE 700, LTE FDD Bd12 <MFBI Bd17> Class 3 (+23dBm ±2dB) for LTE 700, LTE FDD Bd28 Class 3 (+23dBm ±2dB) for LTE 800, LTE FDD Bd18 Class 3 (+23dBm ±2dB) for LTE 800, 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 AWS, LTE FDD Bd4 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 2100, LTE FDD Bd1 Class 3 (+23dBm ±2dB) for LTE 2600, LTE FDD Bd7

1. The document is effective only if listed in the appropriate Release Notes as part of the technical documentation delivered with your Gemalto M2M product.

Feature	Implementation
Power supply	$3.0V \leq V_{BATT+} \leq 4.5V$
Operating temperature (board temperature)	Normal operation: -30°C to +85°C Extended operation: -40°C to +90°C
Physical	Dimensions: 33mm x 29mm x 3.06mm Weight: approx. 5g
RoHS	All hardware components fully compliant with EU RoHS Directive
LTE features	
3GPP Release 9	UE CAT 1 supported DL 10.2Mbps, UL 5.2Mbps
HSPA features	
3GPP Release 8	DL 7.2Mbps, UL 5.7Mbps HSDPA Cat.8 / HSUPA Cat.6 data rates 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 • Full PBCCH support • 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 • PBCCH support • 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
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Gemalto M2M AT commands for RIL compatibility

Feature	Implementation
Java™ Open Platform	Java™ Open Platform with • Java™ profile IMP-NG & CLDC 1.1 HI • Secure data transmission via HTTPS/SSL[1] • Multi-threading programming and multi-application execution Major benefits: seamless integration into Java applications, ease of programming, no need for application microcontroller, extremely cost-efficient hardware and software design – ideal platform for industrial applications. The memory space available for Java programs is 30MB in the flash file system and 18MB RAM. Application code and data share the space in the flash file system and in RAM.
Microsoft™ compatibility	RIL for Pocket PC and Smartphone
SIM Application Toolkit	SAT letter classes b, c, e; with BIP
Firmware update	Generic update from host application over ASC0 or USB modem.
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 [3]. This application note comprises chapters on module mounting and application layout issues as well as on additional SMT application development equipment.
USB	USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant
2 serial interfaces	ASC0 (in parts shared with GPIO lines): • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Adjustable baud rates: 1,200bps to 3Mbps • Autobauding: 1,200bps to 230,400bps • Supports RTS0/CTS0 hardware flow control. ASC1 (shared with GPIO lines): • 4-wire, unbalanced asynchronous interface • Adjustable baud rates: 1,200bps to 921,600bps • Autobauding: 1,200bps to 230,400bps • Supports RTS1/CTS1 hardware flow control
UICC interface	Supported SIM/USIM cards: 3V, 1.8V
GPIO interface	24 GPIO lines comprising: 14 lines shared with ASC0, ASC1 and SPI lines, with network status indication, PWM functionality, fast shutdown, pulse counter, and SIM switch 10 GPIO lines not shared
I^2C interface	Supports I^2C serial interface
SPI interface	Serial peripheral interface, shared with GPIO lines
Antenna switch interface	Control signal for 700MHz antenna switch
TX activity interface	Signal indicating 2G/3G/4G transmit activities
Antenna interface pads	50Ω. UMTS/GSM/LTE main antenna, UMTS/LTE Rx Diversity antenna

Feature	Implementation
Power on/off, Reset	
Power on/off	Switch on by hardware signal IGT Switch off by AT command Switch off by emergency off signal (EMERG_OFF) Switch off by hardware signal FST_SHDN instead of AT command Automatic switch off in case of critical temperature or voltage conditions
Reset	Orderly shutdown and reset by AT command
Special features	
Real time clock	Timer functions via AT commands
Evaluation kit	
Evaluation module	PLS62-W module soldered onto a dedicated PCB that can be connected to an adapter in order to be mounted onto the DSB75.
DSB75	DSB75 Development Support Board designed to test and type approve Gemalto M2M modules and provide a sample configuration for application engineering. A special adapter is required to connect the PLS62-W evaluation module to the DSB75.

1. HTTP/SecureConnection over SSL version 3.0 and TLS versions 1.0, 1.1, and 1.2 are supported. For details please refer to Java User's Guide for Cinterion® PLS62-W.

1.2 PLS62-W System Overview

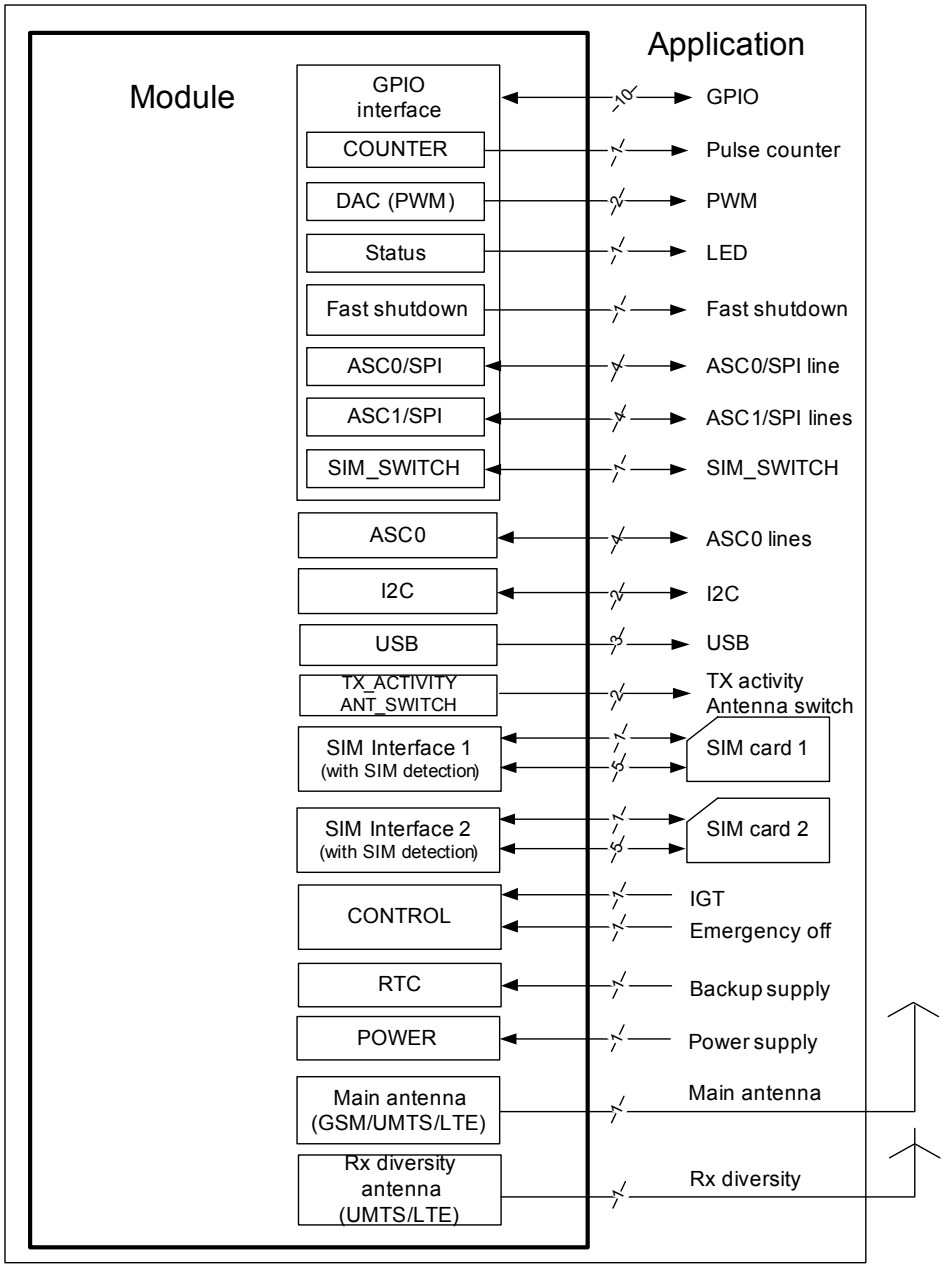


Figure 1: PLS62-W system overview

1.3 Circuit Concept

Figure 2 and Figure show block diagrams of the PLS62-W module and illustrate the major functional components:

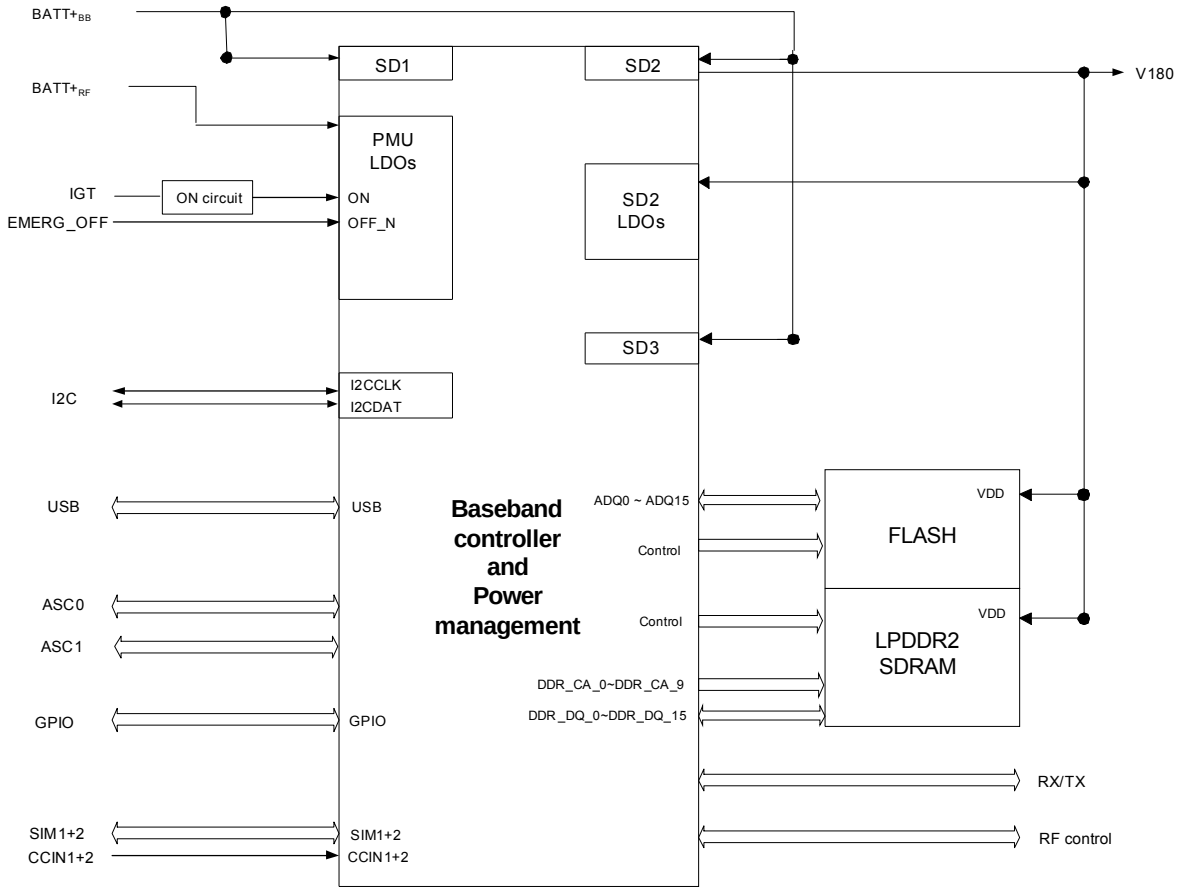


Figure 2: PLS62-W block diagram

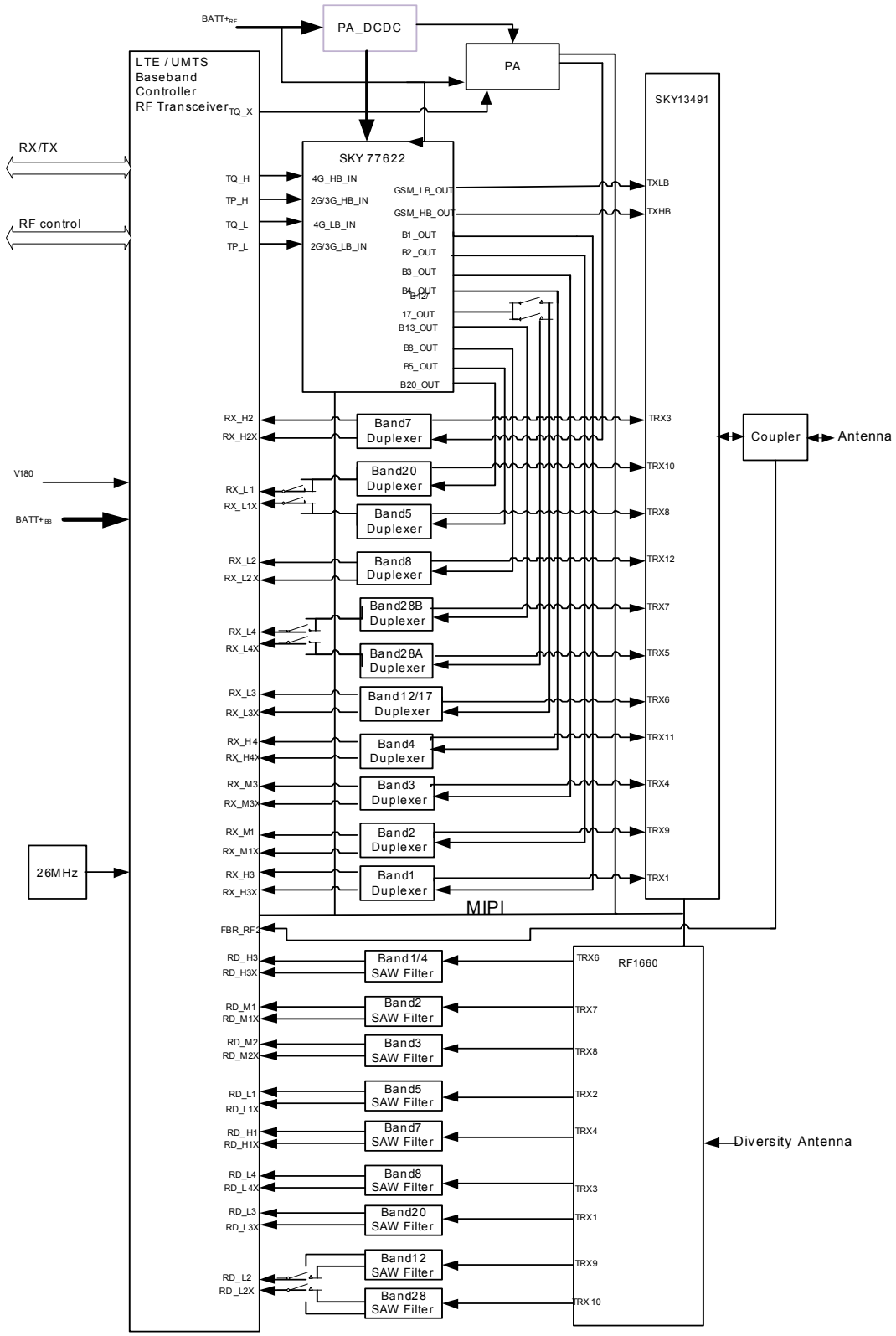


Figure 3: PLS62-W RF section block diagram

2 Interface Characteristics

PLS62-W 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 PLS62-W provides connecting pads to integrate the module into external applications. Table 1 lists the pads' assignment. Figure 4 (bottom view) and Figure 5 (top view) shows the connecting pads' numbering plan.

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) may be soldered but should not be connected to an external application.
- Pads marked "rfu" and qualified as "GND" (ground) are assigned to ground with PLS62-W modules, but may have different assignments with future Gemalto M2M products using the same pad layout.
- Pads marked "rfu" and qualified as "nc" (not connected) are internally not connected with PLS62-W modules, but may be soldered and arbitrarily be connected to external ground.

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

Table 1: Overview: Pad assignments

Pad No.	Signal Name	Pad No.	Signal Name	Pad No.	Signal Name
A4	rfu (dnu)	E2	GND	L2	GND
A5	GND	E3	GND	L3	GND
A6	GND	E4	GND	L4	GND
A7	GND	E5	GND	L5	TX_ACTIVITY
A8	GND	E12	CCIO2	L6	CCVCC2
A9	GND	E13	CCRST2	L7	rfu (dnu)
A10	GND	E14	rfu (nc)	L8	rfu (dnu)
A11	GND	E15	rfu (dnu)	L9	rfu (dnu)
A12	ANT_DRX	E16	rfu (dnu)	L10	ANT_SWITCH
A13	GND	F1	GND	L11	SIM_SWITCH/GPIO26
B3	rfu (dnu)	F2	GND	L12	rfu (dnu)
B4	GND	F3	GND	L13	rfu (nc)
B5	GND	F4	GND	L14	CCRST1
B6	GND	F13	rfu (nc)	L15	CCCLK1
B7	GND	F14	I2CCLK	L16	IGT
B8	GND	F15	I2CDAT	M2	GND
B9	GND	F16	GPIO25	M3	GND
B10	GND	G1	GND	M4	PWR_IND
B11	GND	G2	GND	M5	V180
B12	GND	G3	GND	M6	GND
B13	GND	G4	GND	M7	GPIO21
B14	GPIO5/STATUS	G13	rfu (nc)	M8	GPIO23
C2	GND	G14	GPIO7/PWM1	M9	GPIO22
C3	GND	G15	GPIO8/COUNTER	M10	GPIO20
C4	GND	G16	GPIO11	M11	rfu (nc)
C5	GND	H1	GND	M12	rfu (nc)
C6	GND	H2	GND	M13	ADC1_IN
C7	GND	H3	GND	M14	CCIN1
C8	GND	H4	GND	M15	VDDLP
C9	GND	H13	rfu (nc)	N3	$BATT+_{RF}$
C10	GND	H14	GPIO4/FST_SHDN	N4	$BATT+_{RF}$
C11	GND	H15	GPIO12	N5	VUSB_IN
C12	rfu (nc)	H16	GPIO6/PWM2	N6	GPIO19/CTS1/SPI_CS
C13	rfu (nc)	J1	GND	N7	GPIO18/RTS1
C14	rfu (dnu)	J2	GND	N8	CTS0
C15	rfu (dnu)	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	rfu (dnu)	J16	GPIO13	N14	EMERG_OFF
D6	GND	K1	ANT_MAIN	P4	USB_DP
D7	GND	K2	GND	P5	USB_DN
D8	GND	K3	GND	P6	GPIO16/RXD1/SPI_MOSI
D9	GND	K4	GND	P7	GPIO17/TXD1/SPI_MISO
D10	GND	K5	GND	P8	DTR0/GPIO1
D11	GND	K12	rfu (nc)	P9	DSR0/GPIO3/SPI_CLK
D12	CCIN2	K13	rfu (nc)	P10	RING0/GPIO24
D13	rfu (nc)	K14	CCIO1	P11	RXD0
D14	CCCLK2	K15	CCVCC1	P12	TXD0
D15	rfu (dnu)	K16	rfu (dnu)	P13	$BATT+_{BB}$
D16	rfu (dnu)	L1	GND		
E1	rfu (dnu)				

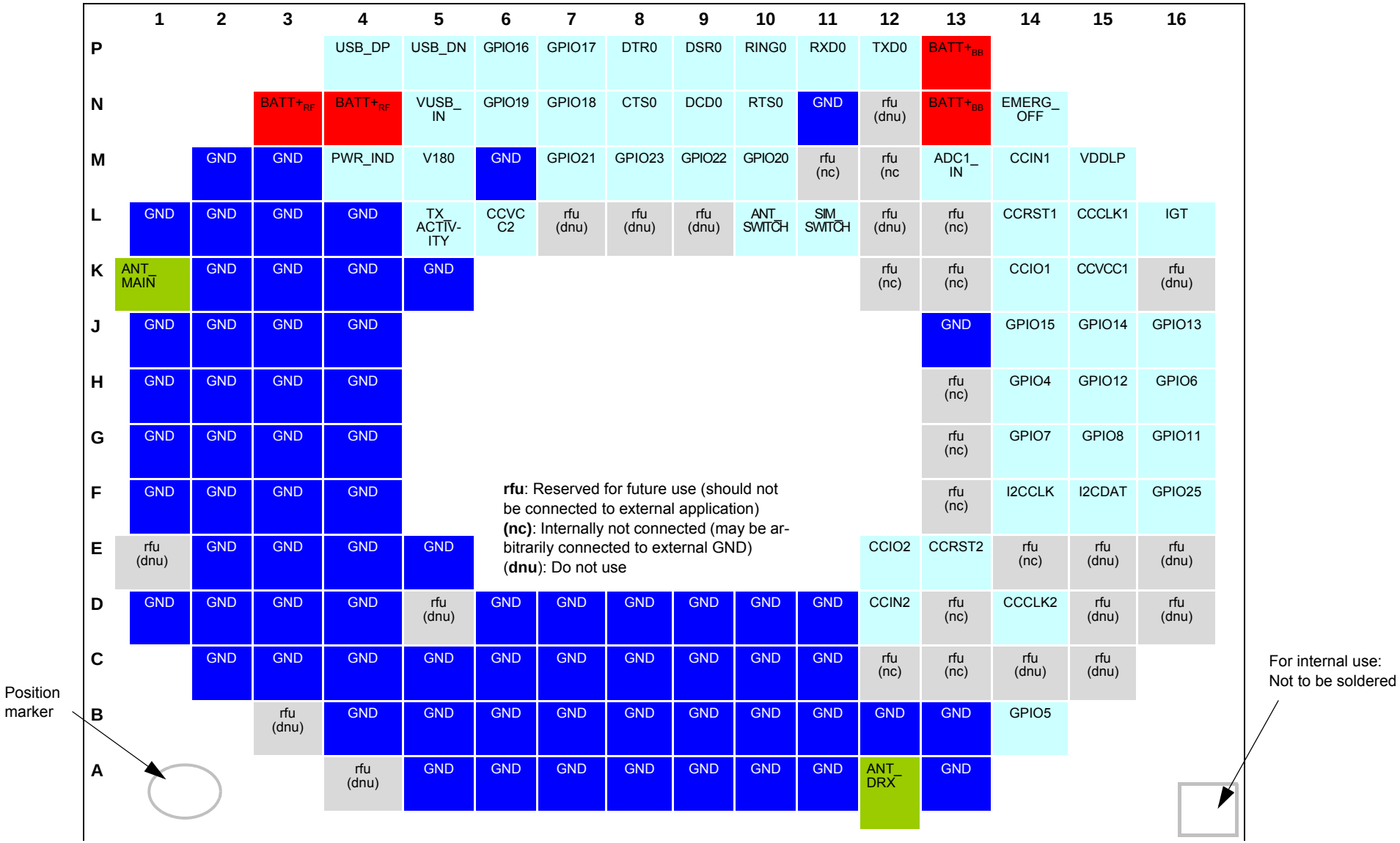


Figure 4: PLS62-W bottom view: Pad assignments

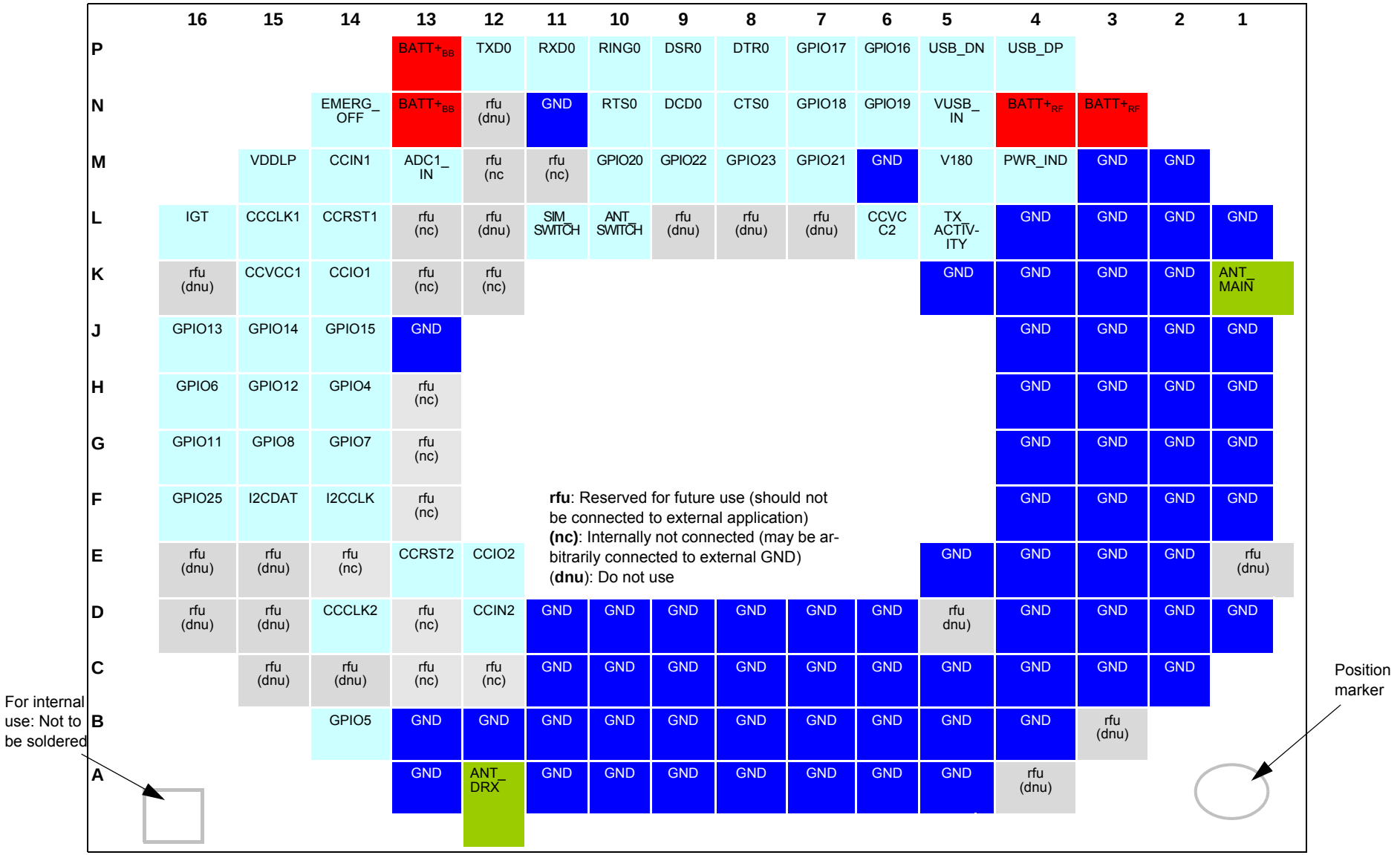


Figure 5: PLS62-W top view: Pad assignments

2.1.2 Signal Properties

Table 2: Signal properties (Sheet 1 of 6)

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 during Tx burst on board I ≈ 2.3A, during Tx burst (GSM) ___|¯¯¯¯¯|_____|¯¯¯¯¯|___ 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 = 750mA during Tx LTE activated: $V_I$max = 4.5V $V_I$norm = 3.8V $V_I$min = 3.0V during Transmit active. Imax = 850mA during Tx	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. $BATT+_{BB}$ and $BATT+_{RF}$ require an ultra low ESR capacitor of 150µF. If using Multilayer Ceramic Chip Capacitors (MLCC) please take DC-bias into account. Note that minimum ESR value is advised at <70mΩ. **Note:** Whereas the module's normal voltage range for operation lies between 3.0V and 4.5V, it is possible to extend the voltage range at the lower limit to 2.8V. This extended voltage range can be configured via AT command, and might be used while the module is in Airplane mode.
	GND		Ground	Application Ground
External supply voltage	V180	O	Normal operation: $V_O$norm = 1.80V ±3% $I_O$max = -10mA SLEEP mode Operation: V_OSleep = 1.80V ±5% $I_O$max = -10mA CImax = 100nF	V180 should be used to supply level shifters at the interfaces or to supply external application circuits. If unused keep line open.
RTC backup	VDDLP	I/O	$V_O$norm = 1.8V ±5% $I_O$max = -25mA $V_I$max = 1.9V $V_I$min = 1.0V in power down mode	It is recommended to use a serial resistor between VDDLP and a possible capacitor (bigger than 1µF). If unused keep line open.

Table 2: Signal properties (Sheet 2 of 6)

Function	Signal name	IO	Signal form and level	Comment
Ignition	IGT	I	R_{PU} ≈ 100kΩ V_{IH}max = VDDLP max. V_{IH}min = 1.3V V_{IL}max = 0.5V Slew rate ≤ 1ms IGT ~~~~|___	This signal switches the module on, and is falling edge sensitive triggered.
Emer-gency off	EMERG_OFF	I	R_{SER} ≈ 1kΩ, C_I ≈ 1nF, R_{PU} ≈ 10kΩ V_{OH}max = VDDLP max V_{IH}min = 1.35V V_{IL}max = 0.5V ~~|___|~~ low impulse width > 20ms	This line must be driven low by an open drain or open collector driver connected to GND. Internal 10k pull-up resistor. If unused keep line open.
USB	VUSB_IN	I	$V_I$min = 3V $V_I$max = 5.25V Active and suspend current: I_{max} < 100µA	All electrical characteristics according to USB Implementers' Forum, USB 2.0 Specification. If unused keep lines open.
	USB_DN	I/O	Full and high speed signal characteristics according to USB 2.0 Specification.	
	USB_DP			
Serial Interface ASC0	RXD0	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V	If unused keep lines open. Note that some ASC0 lines can be configured for alternative functionalities. Possible other functionalities for ASC0 lines are: DTR0 --> GPIO1 DCD0 --> GPIO2 DSR0 --> GPIO3, SPI_CLK RING0 --> GPIO24
	CTS0			
	DSR0			
	DCD0			
	RING0			
	TXD0	I	V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	
	RTS0	I	Pull down resistor active V_{IL}max = 0.35V at > 50µA V_{IH}min = 1.30V at < 240µA V_{IH}max = 1.85V at < 240µA	
	DTR0	I	Pull up resistor active V_{IL}max = 0.35V at < -200µA V_{IH}min = 1.30V at > -50µA V_{IH}max = 1.85V	

Table 2: Signal properties (Sheet 3 of 6)

Function	Signal name	IO	Signal form and level	Comment
SIM card detection	CCIN1 CCIN2	I	R_{SER} ≈ 47kΩ, C_I ≈ 1nF, R_{PU} ≈ 100kΩ V_{IH}min = 1.45V at I = 15µA, V_{IH}max= 1.9V V_{IL}max = 0.3V	CCINx = low, SIM card inserted. For details please refer to Section 2.1.6. If unused keep line open.
3V SIM Card Interface	CCRST1 CCRST2	O	V_{OL}max = 0.30V at I = 1mA V_{OH}min = 2.45V at I = -1mA V_{OH}max = 2.90V	Maximum cable length or copper track to SIM card holder should not exceed 100mm.
	CCIO1 CCIO2	I/O	V_{IL}max = 0.50V V_{IH}min = 2.05V V_{IH}max = 2.90V V_{OL}max = 0.25V at I = 1mA V_{OH}min = 2.50V at I = -1mA V_{OH}max = 2.90V	
	CCCLK1 CCCLK2	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 2.40V at I = -1mA V_{OH}max = 2.90V	
	CCVCC1 CCVCC2	O	$V_O$min = 2.7V $V_O$typ = 2.9V $V_O$max = 3.3V $I_O$max = -30mA	
1.8V SIM Card Interface	CCRST1 CCRST2	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.45V at I = -1mA V_{OH}max = 1.90V	Maximum cable length or copper track to SIM card holder should not exceed 100mm.
	CCIO1 CCIO2	I/O	V_{IL}max = 0.35V V_{IH}min = 1.25V V_{IH}max = 1.85V V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.85V	
	CCCLK1 CCCLK2	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.50V at I = -1mA V_{OH}max = 1.85V	
	CCVCC1 CCVCC2	O	$V_O$min = 1.75V $V_O$typ = 1.80V $V_O$max = 1.85V $I_O$max = -30mA	

Table 2: Signal properties (Sheet 4 of 6)

Function	Signal name	IO	Signal form and level	Comment
I^2C	I2CCLK	O	Internal pull up Resistors I2CCLK = 1k I2CDAT = 1k V_{OL}min = 0.35V at Imax = 4mA (Note) V_{OH}max = 1.85V V_{IL}max = 0.35V V_{IH}min = 1.3V V_{IH}max = 1.85V **Note:** Imax = I max external + I pull up	According to the I^2C Bus Specification Version 2.1 for the fast mode a rise time of max. 300ns is permitted. There is also a maximum V_{OL}=0.4V at 3mA specified. The value of the pull-up depends on the capacitive load of the whole system (I^2C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is 4mA. I^2C interface of the module already has internal 1KOhm pull up resistor to V180 inside the module. Please take this into consideration during application design. If lines are unused keep lines open.
	I2CDAT	IO		
GPIO interface	GPIO1-GPIO8, GPIO11-GPIO26	IO	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V Imax = ±5mA	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: GPIO1-3, 24: ASC0 control lines DTR0, DCD0, DSR0, and RING0 GPIO3: Also SPI_CLK GPIO4: Fast shutdown GPIO5: Status LED line GPIO6/GPIO7: PWM GPIO8: Pulse counter GPIO16-19: ASC1 GPIO16,17,19: Also SPI GPIO26: SIM switch

Table 2: Signal properties (Sheet 5 of 6)

Function	Signal name	IO	Signal form and level	Comment
Serial Interface ASC1	RXD1	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	If unused keep line open. Note that 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
	TXD1	I		
	RTS1	I		
	CTS1	O		
SPI	SPI_CLK	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V	If lines are unused keep lines open. Note that the SPI interface lines are originally available as GPIO lines. If configured as SPI lines, the GPIO lines are assigned as follows: GPIO3(DSR0) --> SPI_CLK GPIO16 --> SPI_MOSI GPIO17 --> SPI_MISO GPIO19 --> SPI_CS
	SPI_MOSI	O		
	SPI_MISO	I		
	SPI_CS	O		
Pulse Counter	COUNTER	I	Internal up resistor active V_{IL}max = 0.35V at < -200µA V_{IH}min = 1.30V at > -50µA V_{IH}max = 1.85V min Pulse width < 1µs min distance of pulses > 9.2µs	If unused keep line open. Note that the pulse counter interface line is originally available as GPIO line. If configured as pulse counter, the GPIO line is assigned as follows: GPIO8 --> COUNTER
Status LED	STATUS	I	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V	If unused keep line open. Note that the status line is originally available as GPIO line. If configured as status line, the GPIO line is assigned as follows: GPIO5 --> STATUS
PWM	PWM1 PWM2	I	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V	If unused keep line open. Note that the PWM lines are originally available as GPIO lines. If configured as PWM lines, the GPIO lines are assigned as follows: GPIO6 --> PWM2 GPIO7 --> PWM1

Table 2: Signal properties (Sheet 6 of 6)

Function	Signal name	IO	Signal form and level	Comment
Fast shutdown	FST_SHDN	I	V_{IL}max = 0.35V V_{IH}min = 1.30V V_{IH}max = 1.85V ~~|___|~~ low impulse width > 1ms	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
ADC (Analog-to-Digital Converter)	ADC1_IN	I	R_I = 1MΩ V_I = 0V ... 1.2V (valid range) V_{IH} max = 1.2V Resolution 10 Bits Integral linearity error ±2 LSB Offset error ±1 LSB	ADC can be used as input for external measurements. If unused keep line open.
TX-Activity	TX_ACTIVITY	O	V_{OL}max = 0.5V at $\|I_{OL}\| \leq$ 5mA V_{OH}min = 1.8V at $\|I_{OH}\| \leq$ 5mA V_{OH}max = 2.3V at $\|I_{OH}\| \leq$ 5mA	If unused keep line open. Line indicates any 2G/3G/4G transmitting activity.
700MHz antenna control switch	ANT_SWITCH	O	V_{OL}max = 0.5V at $\|I_{OL}\| \leq$ 5mA V_{OH}min = 1.8V at $\|I_{OH}\| \leq$ 5mA V_{OH}max = 2.3V at $\|I_{OH}\| \leq$ 5mA	If unused keep line open. Line can be configured as a control signal for a possible external 700MHz antenna switch.
SIM Switch	SIM_SWITCH	O	V_{OL}max = 0.25V at I = 1mA V_{OH}min = 1.55V at I = -1mA V_{OH}max = 1.85V	If unused keep line open. Note that the SIM switch line is originally available as GPIO line. If configured as SIM switch, the GPIO line is assigned as follows: GPIO26 --> SIM_SWITCH
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 2.1.13.2). 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.

2.1.2.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 3 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to PLS62-W.

Table 3: Absolute maximum ratings[1]

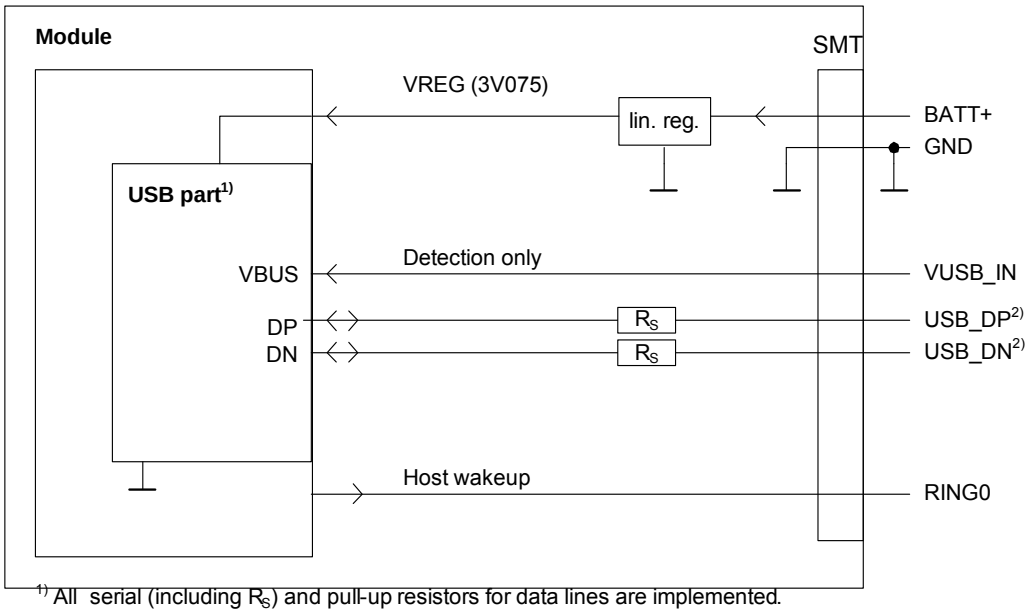
Parameter	Min	Max	Unit
Supply voltage BATT+ (no service)	-0.3	+5.5	V
Voltage at all digital pins in POWER DOWN mode	-0.3	+0.3	V
Voltage at digital pins 1.8V domain in normal operation	-0.2	V180 + 0.2	V
Current at digital pins in normal operation	-	2	mA
Voltage at SIM interface, CCVCC 1.8V in normal Operation	0	+3.3	V
Voltage at SIM interface, CCVCC 2.85V in normal Operation	0	+3.3	V
Current at SIM interface in 1.8V and 2.85V operation	-	-145	mA
Voltage at ADC pin in normal operation	-0	+1.2	V
VDDLP in normal operation	-0.150	+2.0	V
Current at VDDLP in normal operation	-	-25	mA
V180 in normal operation	+1.7	+1.9	V
Current at V180 in normal operation	-	-500	mA
USB-Pins	-0.5	5.75	V

1. Positive noted current means current sourcing from PLS62-W. Negative noted current means current sourcing towards PLS62-W.

2.1.3 USB Interface

PLS62-W supports a USB 2.0 High Speed (480Mbit/s) device interface that is Full Speed (12Mbit/s) compliant. The USB interface is primarily intended for use as command and data interface and for downloading firmware.

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 PLS62-W is designed as a self-powered device compliant with the “Universal Serial Bus Specification Revision 2.0”[1].



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 90Ohm for proper signal integrity.

Figure 6: 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 2. Furthermore, the USB modem driver distributed with PLS62-W needs to be installed.

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 PLS62-W will then generate a Remote Wakeup request to resume the USB host controller.

  See also [5] (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 2.1.13.3. 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

PLS62-W offers an 8-wire unbalanced, asynchronous modem interface ASC0 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 2. For an illustration of the interface line's startup behavior see Figure 8.

PLS62-W 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

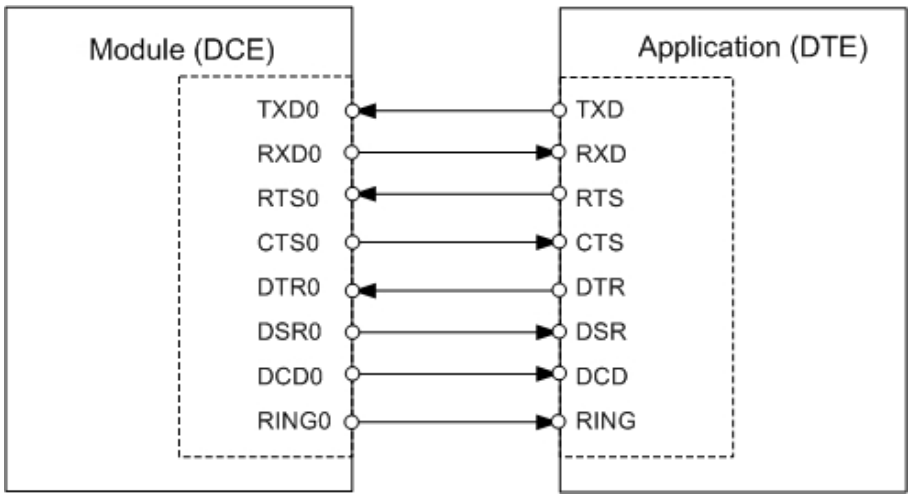
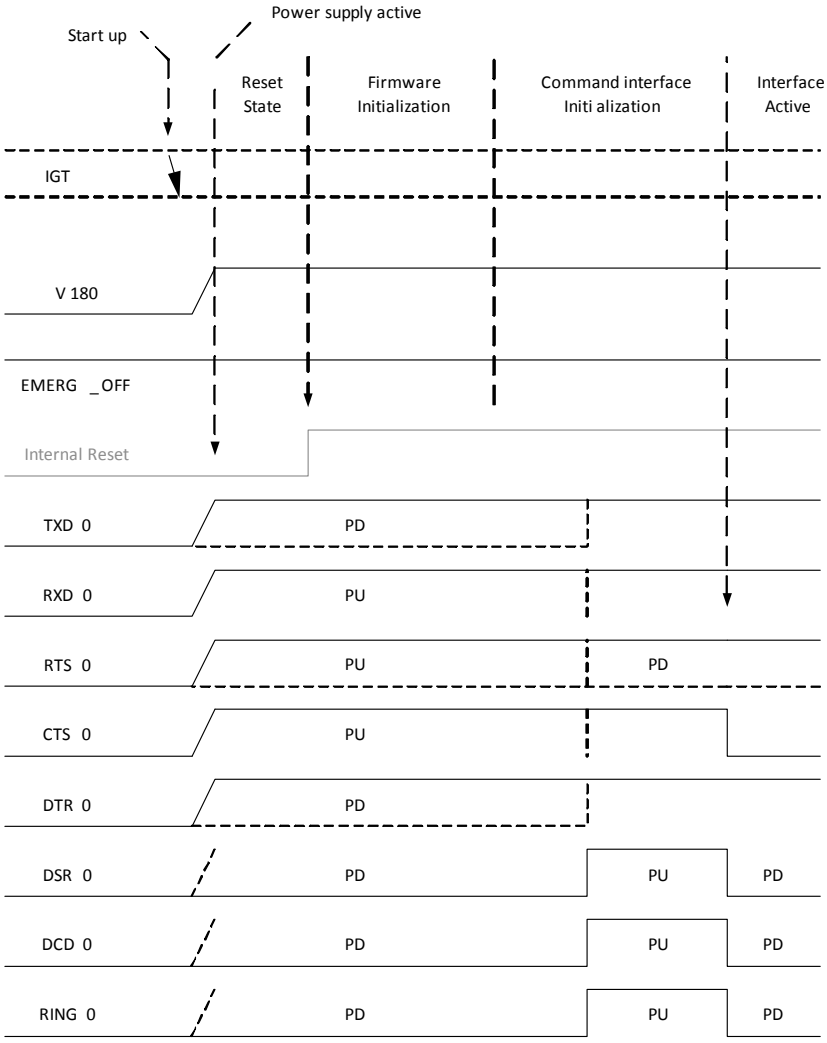


Figure 7: Serial interface ASC0

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 1,200bps up to 3Mbps.
- Autobauding supports bit rates from 1,200bps up to 230,400bps.
- 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 3.4.4).

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: DTR0 --> GPIO1, DCD0 --> GPIO2, DSR0 --> GPIO3 and RING0 --> GPIO24. Also, DSR0 is shared with the SPI_CLK line of the SPI interface and may be configured as such. 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 ASC0.



For pull-up and pull-down values see Table 9.

Figure 8: ASC0 startup behavior

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

2.1.5 Serial Interface ASC1

Four PLS62-W 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 2. For an illustration of the interface line's startup behavior see Figure 10.

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 and GPIO19 --> CTS1. Configuration is done by AT command (see [1]: AT^SCFG). The configuration is non-volatile and becomes active after a module restart.

PLS62-W 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

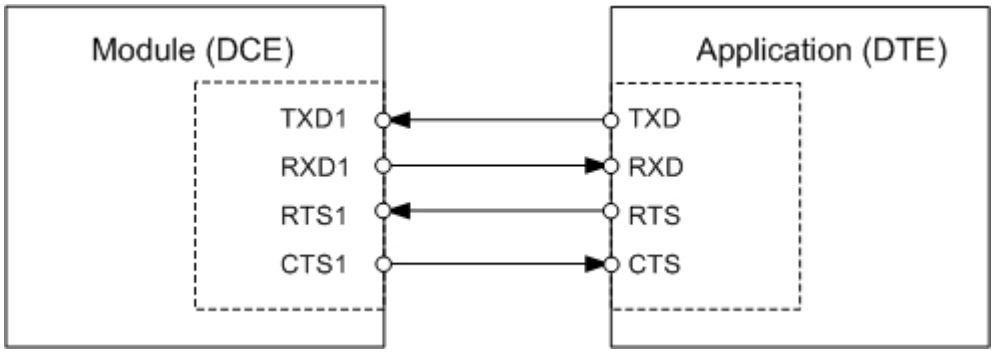
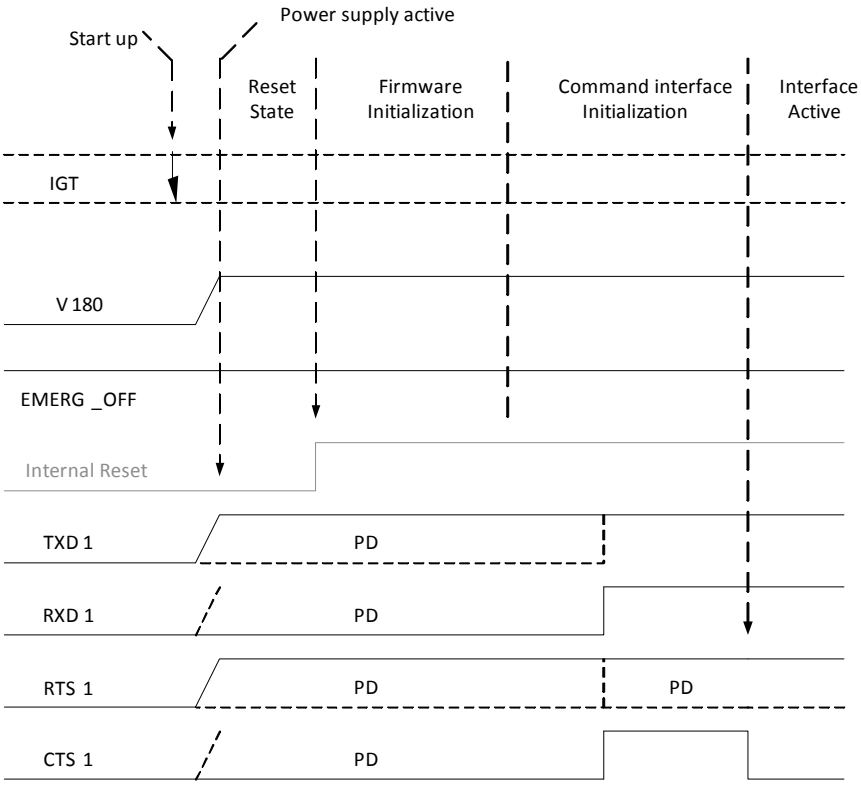


Figure 9: Serial interface ASC1

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 1,200 bps to 921,600 bps.
- Autobauding supports bit rates from 1,200bps up to 230,400bps.
- Supports RTS1/CTS1 hardware flow. 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.

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



*) For pull-down values see Table 9.

Figure 10: ASC1 startup behavior

2.1.6 UICC/SIM/USIM Interface

PLS62-W has two UICC/SIM/USIM interfaces 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 2 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. For example, this is true for the model supplied by Molex, which has been tested to operate with PLS62-W and is part of the Gemalto M2M reference equipment submitted for type approval. See Chapter 7 for Molex ordering numbers.

Table 4: 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 P12, 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 PLS62-W.

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 PLS62-W.

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 just one 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 2.1.6.1.

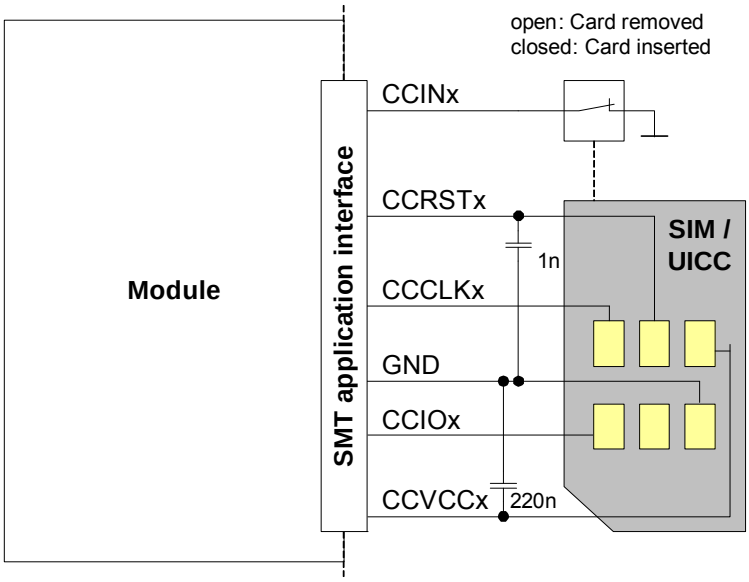


Figure 11: UICC/SIM/USIM interfaces

The total cable length between the SMT application interface pads on PLS62-W 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 SIM_SWITCH Line

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

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 12. A low state would then indicate the usage of the first SIM interface (SIM1), a high state would indicate the usage of the second interface (SIM2).

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

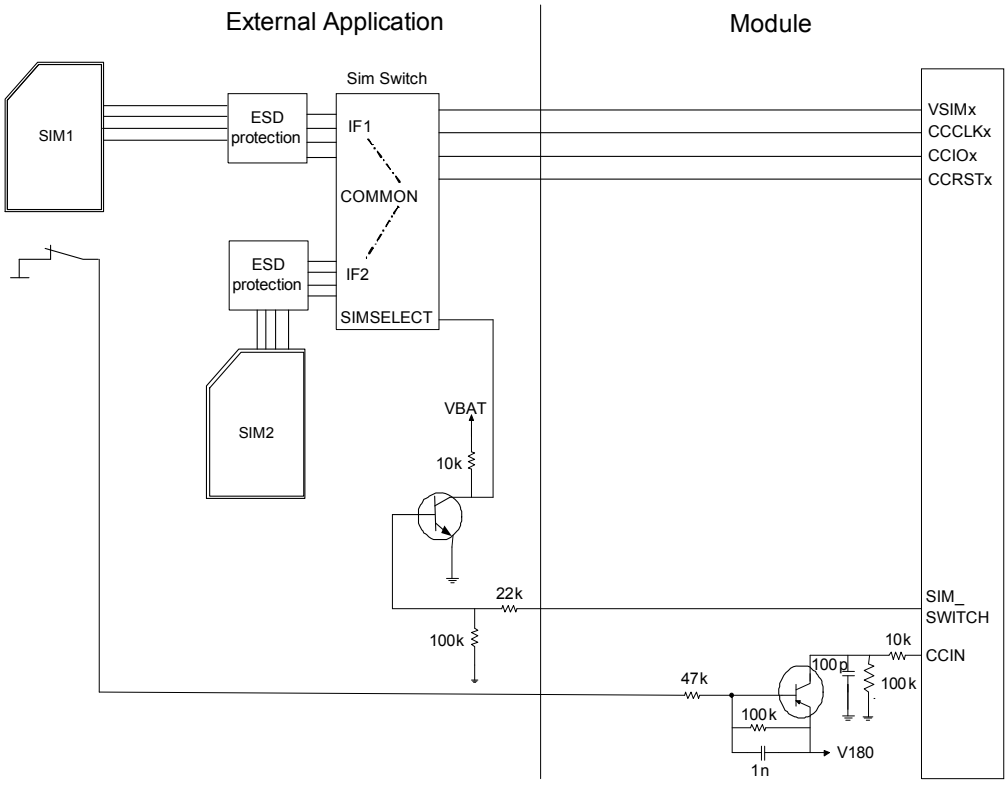


Figure 12: Sample circuit for SIM interface connection via SIM switch

2.1.7 RTC Backup

The internal Real Time Clock of PLS62-W is supplied from a separate voltage regulator in the power supply component which is also active when PLS62-W is in Power Down mode and BATT+ is available. An alarm function is provided that allows to wake up PLS62-W without logging on to the network.

In addition, you can use the VDDLP pad to backup the RTC from an external capacitor. The capacitor is charged from the internal LDO of PLS62-W. If the voltage supply at BATT+ is disconnected the RTC can be powered by the capacitor. The size of the capacitor determines the duration of buffering when no voltage is applied to PLS62-W, i.e. the greater the capacitor the longer PLS62-W will save the date and time. The RTC can also be supplied from an external battery (rechargeable or non-chargeable). In this case the electrical specification of the VDDLP pad (see Section 2.1.2) has to be taken in to account.

Figure 13 shows an RTC backup configuration. A serial 1kΩ resistor has to be placed on the application next to VDDLP. It limits the input current of an empty capacitor or battery.

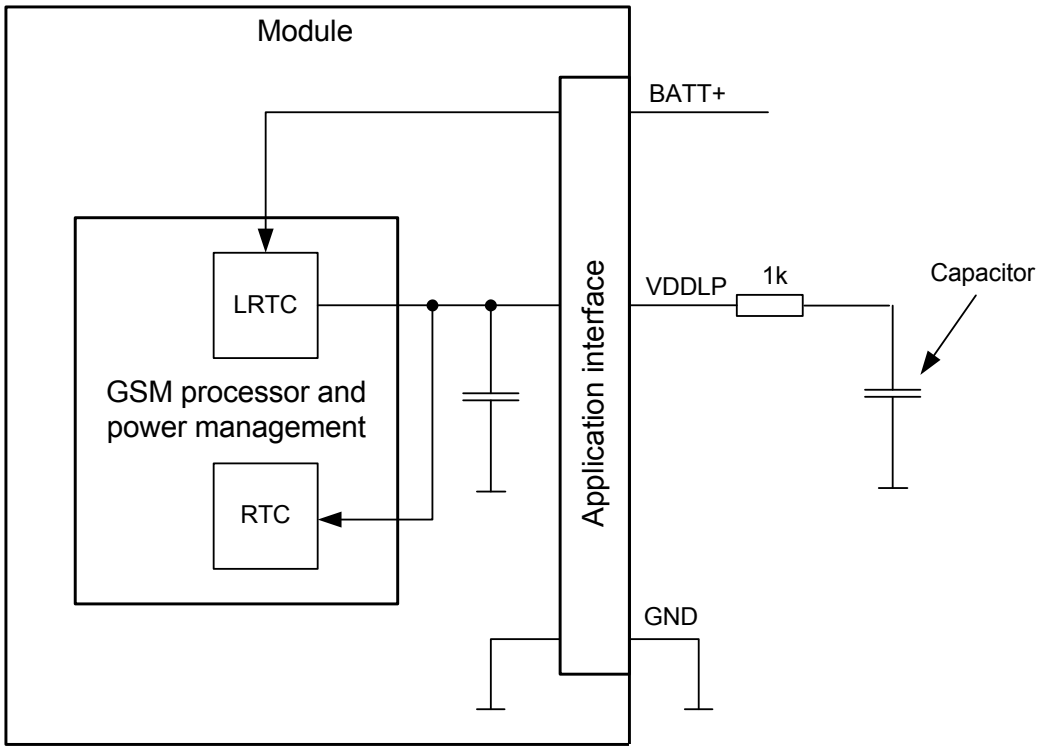


Figure 13: RTC supply variants

2.1.8 GPIO Interface

PLS62-W offers a GPIO interface with 24 GPIO lines. The GPIO lines are shared with other interfaces or functions: Fast shutdown (see Section 2.1.13.4), status LED (see Section 2.1.13.1), the PWM functionality (see Section 2.1.11), an pulse counter (see Section 2.1.12), ASC0 (see Section 2.1.4), ASC1 (see Section 2.1.5), an SPI interface (see Section 2.1.10).

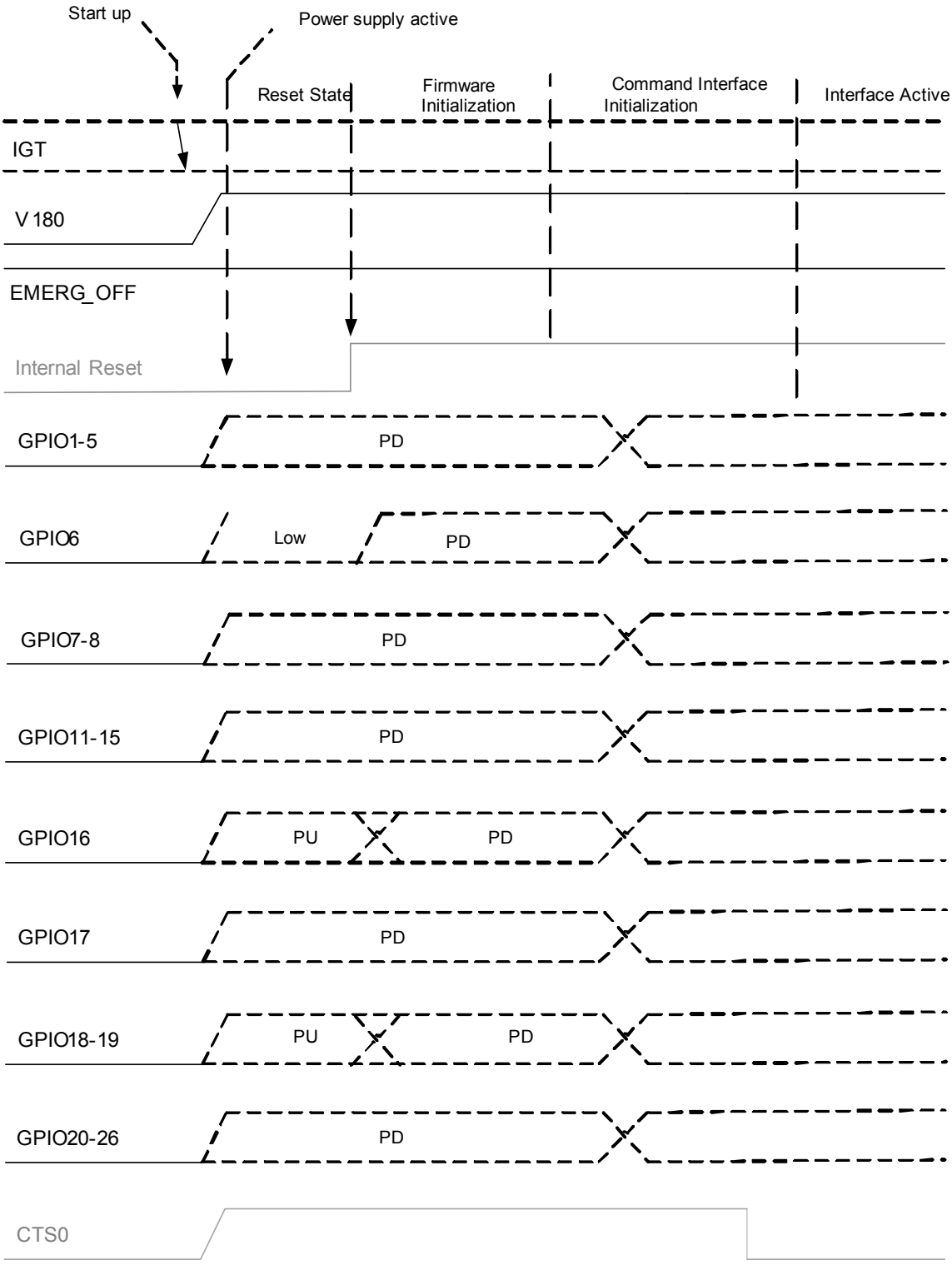
The following table shows the configuration variants for the GPIO pads. All variants are mutually exclusive, i.e. a pad configured for instance as Status LED is locked for alternative usage.

Table 5: GPIO lines and possible alternative assignment

GPIO	Fast Shutdown	Status LED	PWM	Pulse Counter	ASC0	ASC1	SPI	SIM SWITCH
GPIO1					DTR0			
GPIO2					DCD0			
GPIO3					DSR0		SPI_CLK	
GPIO4	FST_SHDN							
GPIO5		Status LED						
GPIO6			PWM2					
GPIO7			PWM1					
GPIO8				COUNTER				
GPIO11								
GPIO12								
GPIO13								
GPIO14								
GPIO15								
GPIO16						RXD1	SPI_MOSI	
GPIO17						TXD1	SPI_MISO	
GPIO18						RTS1		
GPIO19						CTS1	SPI_CS	
GPIO20								
GPIO21								
GPIO22								
GPIO23								
GPIO24					RING0			
GPIO25								
GPIO26								SIM_SWITCH

After startup, the above mentioned alternative GPIO line assignments can be configured using AT commands (see [1]). The configuration is non-volatile and available after module restart.

The following figure shows the startup behavior of the GPIO interface. With an active state of the ASC0 interface (i.e. CTS0 is at low level) the initialization of the GPIO interface lines is also finished.



*) For pull down values see Table 9.

Figure 14: GPIO startup behavior

2.1.9 I²C Interface

I²C is a serial, 8-bit oriented data transfer bus for bit rates up to 400kbps in Fast mode. It consists of two lines, the serial data line I2CDAT and the serial clock line I2CCLK. The module acts as a single master device, e.g. the clock I2CCLK is driven by the module. I2CDAT is a bi-directional line. Each device connected to the bus is software addressable by a unique 7-bit address, and simple master/slave relationships exist at all times. The module operates as master-transmitter or as master-receiver. The customer application transmits or receives data only on request of the module.

To configure and activate the I2C bus use the AT^SSPI command. Detailed information on the AT^SSPI command as well explanations on the protocol and syntax required for data transmission can be found in [1].

The I²C interface can be powered via the V180 line of PLS62-W. If connected to the V180 line, the I²C interface will properly shut down when the module enters the Power Down mode.

In the application I2CDAT and I2CCLK lines need to be connected to a positive supply voltage via a pull-up resistor. For electrical characteristics please refer to Table 2.

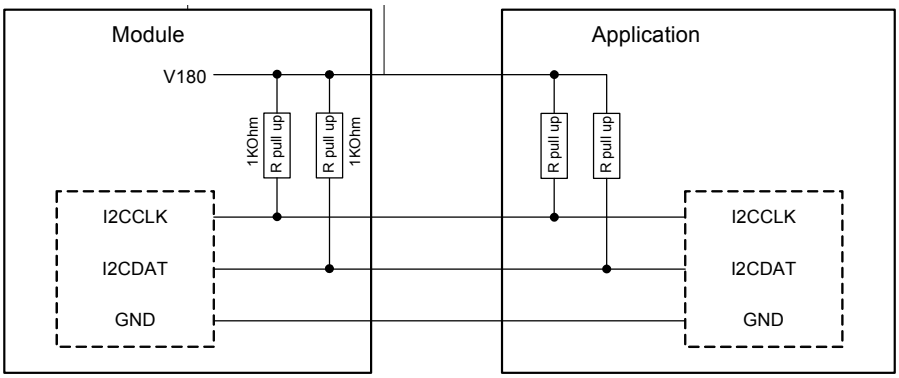


Figure 15: I²C interface connected to V180

Note: Good care should be taken when creating the PCB layout of the host application: The traces of I2CCLK and I2CDAT should be equal in length and as short as possible.

The following figure shows the startup behavior of the I²C interface. With an active state of the ASC0 interface (i.e. CTS0 is at low level) the initialization of the I²C interface is also finished.

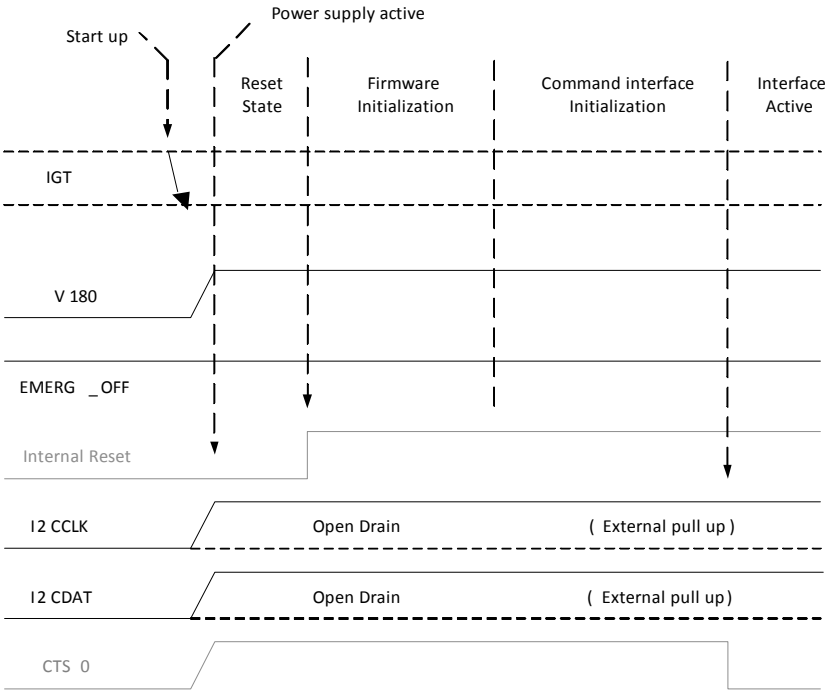


Figure 16: I²C startup behavior

2.1.10 SPI Interface

Four PLS62-W GPIO interface lines can be configured as Serial Peripheral Interface (SPI). The SPI is a synchronous serial interface for control and data transfer between PLS62-W and the external application. Only one application can be connected to the SPI and the interface supports only master mode. The transmission rates are up to 6.5Mbit/s. The SPI interface comprises the two data lines SPI_MOSI and SPI_MISO, the clock line SPI_CLK a well as the chip select line SPI_CS.

The four GPIO lines can be configured as SPI interface signals as follows: GPIO3 --> SPI_CLK, GPIO16 --> SPI_MOSI, GPIO17 --> SPI_MISO and GPIO19 --> SPI_CS. The configuration is done by AT command (see [1]). It is non-volatile and becomes active after a module restart.

The GPIO lines are also shared with the ASC1 signal lines and the ASC0 modem status signal line DSR0.

To configure and activate the SPI interface use the AT^SSPI command. Detailed information on the AT^SSPI command as well explanations on the SPI modes required for data transmission can be found in [1].

In general, SPI supports four operation modes. The modes are different in clock phase and clock polarity. The module's SPI mode can be configured by using the AT command AT^SSPI. Make sure the module and the connected slave device works with the same SPI mode.

Figure 17 shows the characteristics of the four SPI modes. The SPI modes 0 and 3 are the most common used modes. For electrical characteristics please refer to Table 2.

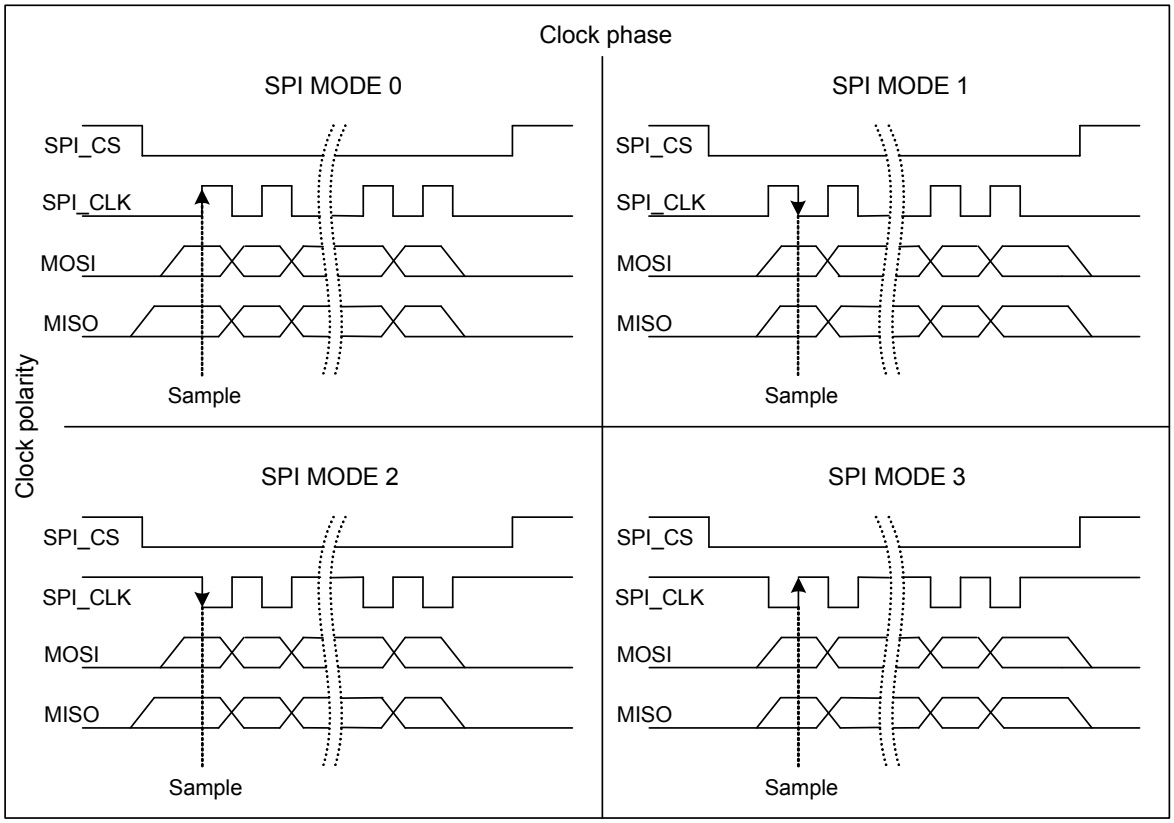


Figure 17: Characteristics of SPI modes

2.1.11 PWM Interfaces

The GPIO6 and GPIO7 interface lines can be configured as Pulse Width Modulation interface lines PWM1 and PWM2. The PWM interface lines can be used, for example, to connect buzzers. The PWM1 line is shared with GPIO7 and the PWM2 line is shared with GPIO6 (for GPIOs see Section 2.1.8). GPIO and PWM functionality are mutually exclusive.

The startup behavior of the lines is shown in Figure 14.

2.1.12 Pulse Counter

The GPIO8 line can be configured as pulse counter line COUNTER. The pulse counter interface can be used, for example, as a clock (for GPIOs see Section 2.1.8).

2.1.13 Control Signals

2.1.13.1 Status LED

The GPIO5 interface line can be configured to drive a status LED that indicates different operating modes of the module (for GPIOs see Section 2.1.8). 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 18.

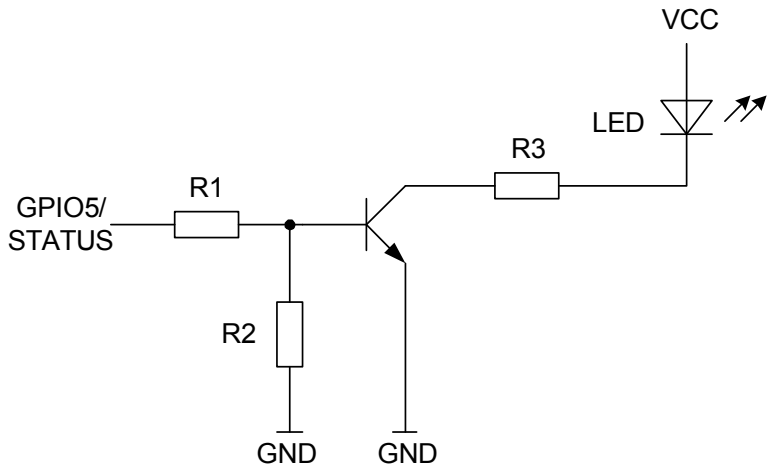


Figure 18: Status signaling with LED driver

2.1.13.2 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.

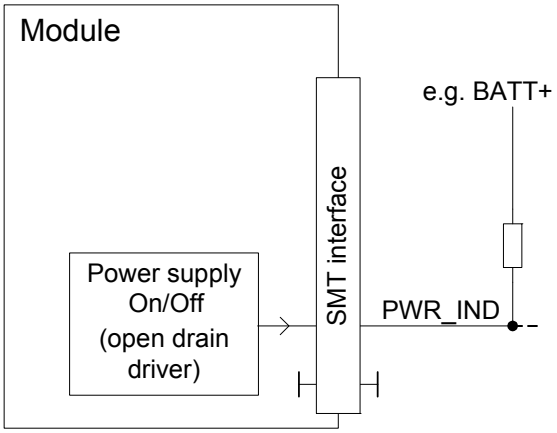


Figure 19: Power indication signal

2.1.13.3 Host Wakeup

If no call, data or message transfer is in progress, the host may shut down its own USB interface to save power. If a call or other request (URC's, messages) arrives, the host can be notified of these events and be woken up again by a state transition of the ASC0 interface's RING0 line. This functionality should only be used with legacy USB applications not supporting the recommended USB suspend and resume mechanism as described in [5] (see also Section 2.1.3.1). For more information on how to configure the RING0 line by AT^SCFG command see [1].

Possible RING0 line states are listed in Table 6.

Table 6: Host wakeup lines

Signal	I/O	Description
RING0	O	Inactive to active low transition: 0 = The host shall wake up 1 = No wake up request

2.1.13.4 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 20).

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.

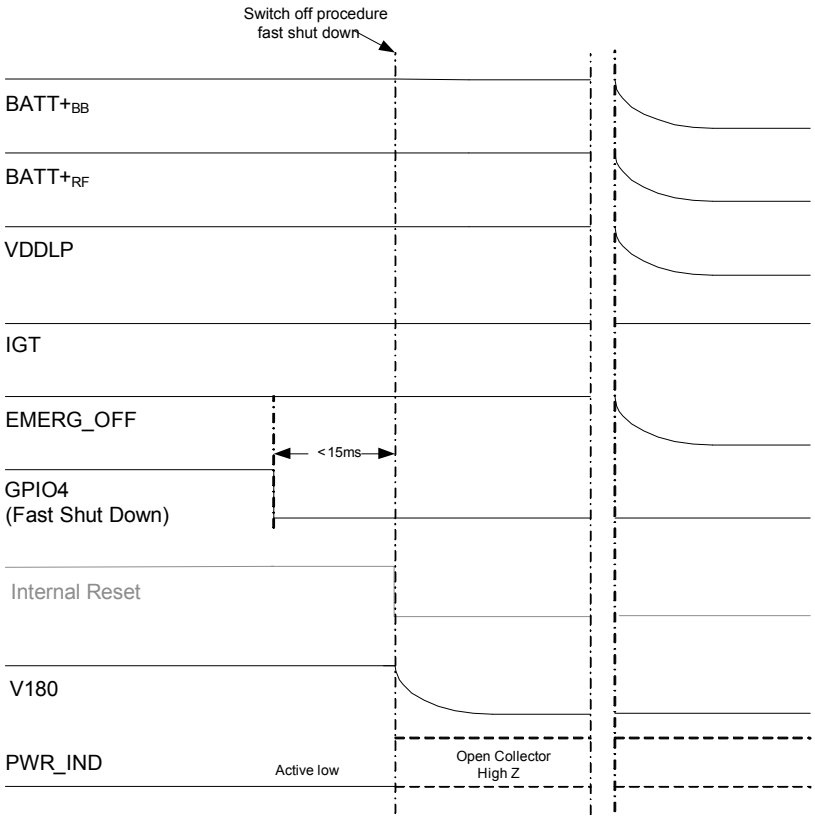


Figure 20: Fast shutdown timing

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.

2.1.14 700MHz Antenna Switch Control

To provide for an antenna optimization over a wide frequency range, the ANT_SWITCH line may act as a control signal for a possible external antenna switch that is able to change between an antenna covering the 700MHz band and an antenna covering all other bands - depending on the frequency band currently being used by the module.

The ANT_SWITCH line is set to "high" (1) if the module is employing frequencies in the 700 MHz range (i.e., LTE band 17) and "low" (0) for all other frequencies, including the 800/850 MHz frequency bands.

The ANT_SWITCH signal is triggered by all module internal activities involving a change of the used frequency, even if only temporary (e.g., inter-band scanning using compressed mode). The maximum delay/deviation between internal usage change of the frequency band, and the GPIO2 signal change is 10 microseconds.

For electrical characteristics of the ANT_SWITCH line see Table 2.

2.1.15 TX Activity Signal

The TX_ACTIVITY line indicates any 2G/3G/4G TX activity of the module, meaning a high level on this line signals that the module is transmitting data.

2.2 RF Antenna Interface

The PLS62-W 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. PLS62-W 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 PLS62-W module and should be placed in the host application if the antenna does not have an impedance of 50Ω.

Regarding the return loss PLS62-W provides the following values in the active band:

Table 7: 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

For approval reasons it is mandatory to connect/apply the Rx diversity antenna to an existing antenna. Not connecting/applying the Rx diversity antenna does not necessarily impact the performance, but may result in approval failures. The minimum antenna efficiency should be better than 50%.

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions	Min.	Typical	Max.	Unit
LTE connectivity[1]	Band 1,2,3,4,5,7,8,12,18,19,20,28				
Receiver Input Sensitivity @ARP, Dual Antenna, Channel BW at 10 MHz @25°C, 3.8V	LTE FDD 2100 Band 1	-97	-100		dBm
	LTE FDD 1900 Band 2	-95	-99		dBm
	LTE FDD 1800 Band 3	-94	-100		dBm
	LTE FDD AWS Band 4	-97	-101		dBm
	LTE FDD 850 Band 5	-95	-100		dBm
	LTE FDD 2600 Band 7	-95	-100		dBm
	LTE FDD 900 Band 8	-94	-101		dBm
	LTE FDD 700 Band 12	-94	-100		dBm
	LTE FDD 800 Band 18	-97	-101		dBm
	LTE FDD 800 Band 19	-97	-101		dBm
	LTE FDD 800 Band 20	-94	-100.5		dBm
	LTE FDD 700 Band 28	-95.5	-99		dBm
RF Power @ ARP with 50Ω Load (Board temperature < 85°C, 5MHz BW, 1R, Position Low)	LTE FDD 2100 Band 1	+21	+23		dBm
	LTE FDD 1900 Band 2	+21	+23		dBm
	LTE FDD 1800 Band 3	+21	+23		dBm
	LTE FDD AWS Band 4	+21	+23		dBm
	LTE FDD 850 Band 5	+21	+23		dBm
	LTE FDD 2600 Band 7	+21	+22.5		dBm
	LTE FDD 900 Band 8	+21	+23		dBm
	LTE FDD 700 Band 12	+21	+23		dBm
	LTE FDD 800 Band 18	+21	+23		dBm
	LTE FDD 800 Band 19	+21	+23		dBm
	LTE FDD 800 Band 20	+21	+23		dBm
	LTE FDD 700 Band 28	+21	+23		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions	Min.	Typical	Max.	Unit
UMTS connectivity	Band I,II,IV,V,VIII,IX,XIX				
Receiver Input Sensitivity @ ARP	UMTS 2100 Band I	-106.7	-109		dBm
	UMTS 1900 Band II	-104.7	-109		dBm
	UMTS AWS Band IV	-106.7	-109		dBm
	UMTS 850 Band V	-104.7	-109		dBm
	UMTS 900 Band VIII	-103.7	-109		dBm
	UMTS 1900 Band IX	-105.7	-109		dBm
	UMTS 800 Band XIX	-103.7	-109		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 AWS Band IV	+21	+23.5		dBm
	UMTS 850 Band V	+21	+23.5		dBm
	UMTS 900 Band VIII	+21	+23.5		dBm
	UMTS 1900 Band IX	+21	+23.5		dBm
	UMTS 800 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	-110		dBm
	E-GSM 900	-102	-110		dBm
	DCS 1800	-102	-109		dBm
	PCS 1900	-102	-109		dBm
RF Power @ ARP with 50Ohm Load	GSM 850		32.5		dBm
	E-GSM 900		32.5		dBm
	DCS 1800		29.5		dBm
	PCS 1900		29.5		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**ROPR = 0**, i.e. no reduction)	GPRS, 1 TX	GSM 850		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		dBm
	EDGE, 4 TX	GSM 850		27		dBm
		E-GSM 900		27		dBm
		DCS 1800		26		dBm
		PCS 1900		26		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**ROPR =1**, i.e. no reduction)	GPRS, 1 TX	GSM 850		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		31.7		dBm
		E-GSM 900		31.7		dBm
		DCS 1800		28.7		dBm
		PCS 1900		28.7		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		30.5		dBm
		E-GSM 900		30.5		dBm
		DCS 1800		27.5		dBm
		PCS 1900		27.5		dBm
	EDGE, 4 TX	GSM 850		27		dBm
		E-GSM 900		27		dBm
		DCS 1800		26		dBm
		PCS 1900		26		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**ROPR = 2**, i.e. no reduction)	GPRS, 1 TX	GSM 850		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		30.5		dBm
		E-GSM 900		30.5		dBm
		DCS 1800		27.5		dBm
		PCS 1900		27.5		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		29.7		dBm
		E-GSM 900		29.7		dBm
		DCS 1800		26.7		dBm
		PCS 1900		26.7		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		28.5		dBm
		E-GSM 900		28.5		dBm
		DCS 1800		25.5		dBm
		PCS 1900		25.5		dBm
	EDGE, 4 TX	GSM 850		27		dBm
		E-GSM 900		27		dBm
		DCS 1800		26		dBm
		PCS 1900		26		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**ROPR = 3**, i.e. no reduction)	GPRS, 1 TX	GSM 850		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		29.5		dBm
		E-GSM 900		29.5		dBm
		DCS 1800		26.5		dBm
		PCS 1900		26.5		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		27.7		dBm
		E-GSM 900		27.7		dBm
		DCS 1800		24.7		dBm
		PCS 1900		24.7		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		26.5		dBm
		E-GSM 900		26.5		dBm
		DCS 1800		23.5		dBm
		PCS 1900		23.5		dBm
	EDGE, 4 TX	GSM 850		27		dBm
		E-GSM 900		27		dBm
		DCS 1800		26		dBm
		PCS 1900		26		dBm

Table 8: RF Antenna interface GSM/UMTS/LTE (at operating temperature range)

Parameter	Conditions		Min.	Typical	Max.	Unit
RF Power @ ARP with 50Ohm Load, (**ROPR = 4**, i.e. no reduction)	GPRS, 1 TX	GSM 850		32.5		dBm
		E-GSM 900		32.5		dBm
		DCS 1800		29.5		dBm
		PCS 1900		29.5		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		29.5		dBm
		E-GSM 900		29.5		dBm
		DCS 1800		26.5		dBm
		PCS 1900		26.5		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		27.7		dBm
		E-GSM 900		27.7		dBm
		DCS 1800		24.7		dBm
		PCS 1900		24.7		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		26.5		dBm
		E-GSM 900		26.5		dBm
		DCS 1800		23.5		dBm
		PCS 1900		23.5		dBm
	EDGE, 4 TX	GSM 850		21		dBm
		E-GSM 900		21		dBm
		DCS 1800		20		dBm
		PCS 1900		20		dBm

1. Applies also to LTE Rx diversity antenna.

2.2.2 Antenna Installation

The antenna is connected by soldering the antenna pads (ANT_MAIN and ANT_DRX) and their neighboring ground pads directly to the application's PCB.

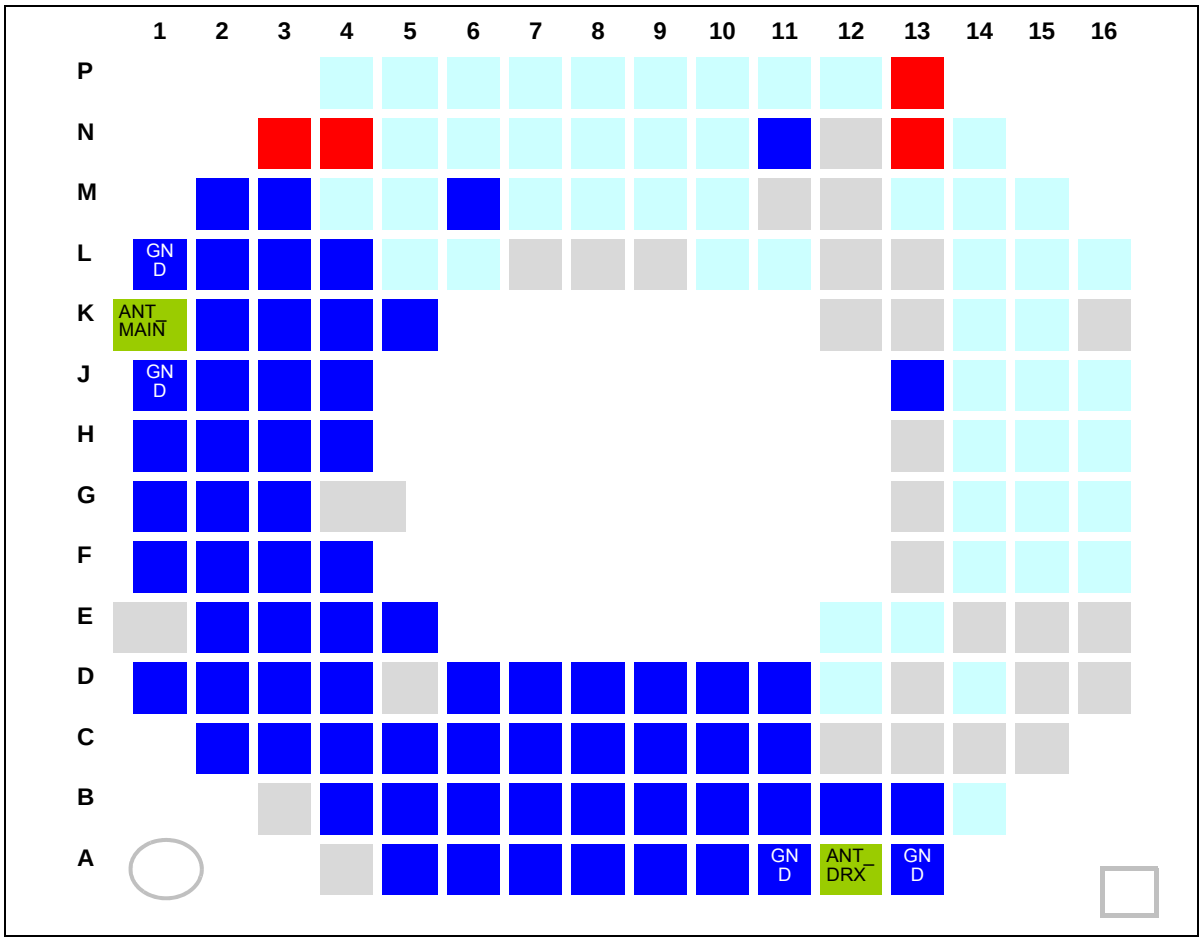


Figure 21: Antenna pads (bottom view)

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 PLS62-W'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://web.awrcorp.com/Usa/Products/Optional-Products/TX-Line/ (free software).

Embedded Stripline
This figure below shows a line arrangement example for embedded stripline with 65µm FR4 prepreg (type: 1080) and 710µm FR4 core (4-layer PCB).

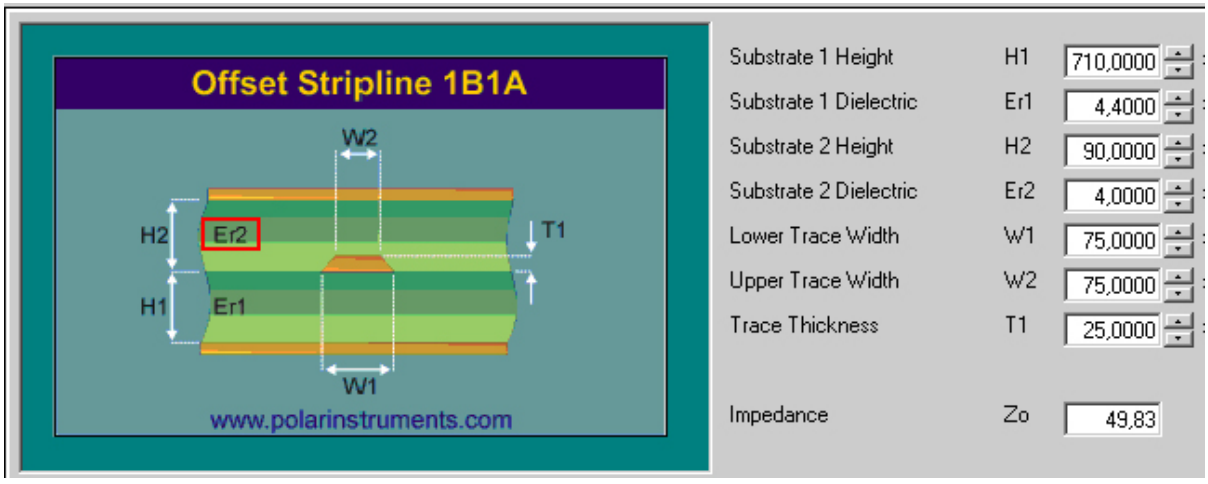
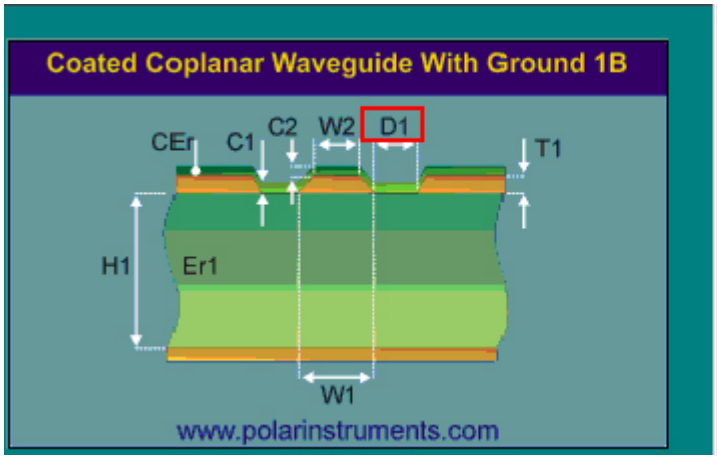


Figure 22: Embedded Stripline with 65µm prepreg (1080) and 710µm core

Micro-Stripline

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

- Micro-Stripline on 1.0mm Standard FR4 2-Layer PCB
  The following two figures show examples with different values for D1 (ground strip separation).



Substrate 1 Height	H1	1000,000
Substrate 1 Dielectric	Er1	4,4000
Lower Trace Width	W1	800,0000
Upper Trace Width	W2	800,0000
Ground Strip Separation	D1	185,0000
Trace Thickness	T1	25,0000
Coating Above Substrate	C1	15,0000
Coating Above Trace	C2	15,0000
Coating Dielectric	CEr	4,0000

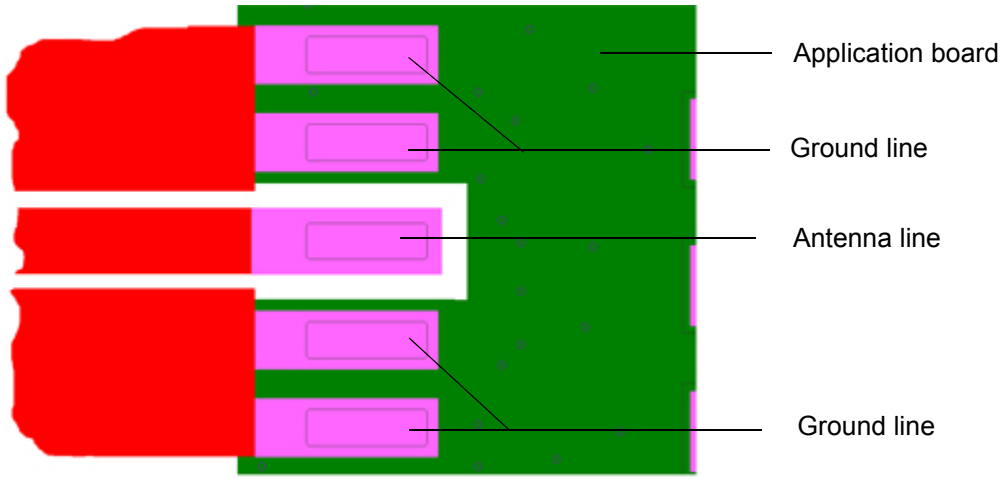


Figure 23: Micro-Stripline on 1.0mm standard FR4 2-layer PCB - example 1

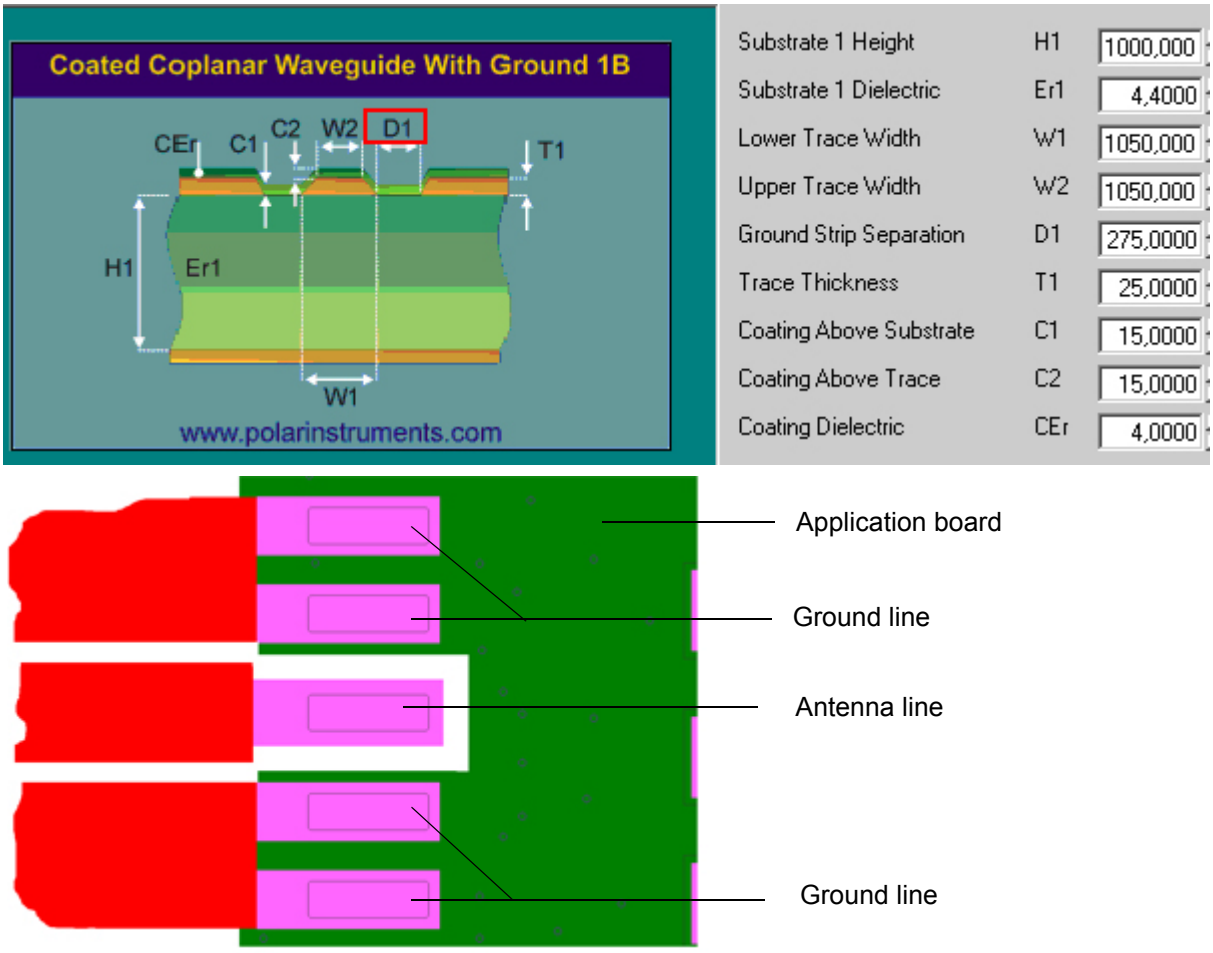


Figure 24: Micro-Stripline on 1.0mm Standard FR4 PCB - example 2

- Micro-Stripline on 1.5mm Standard FR4 2-Layer PCB
  The following two figures show examples with different values for D1 (ground strip separation).

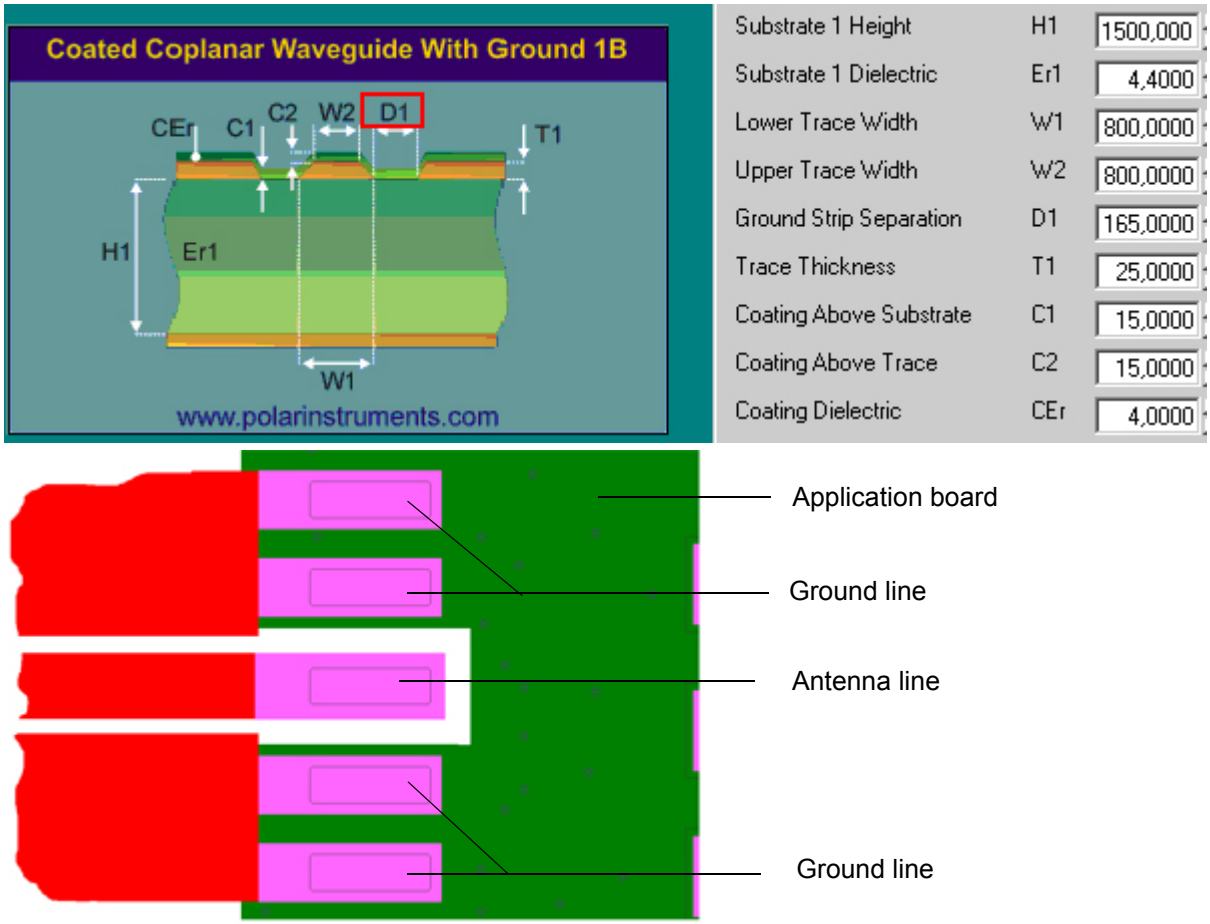


Figure 25: Micro-Stripline on 1.5mm Standard FR4 PCB - example 1

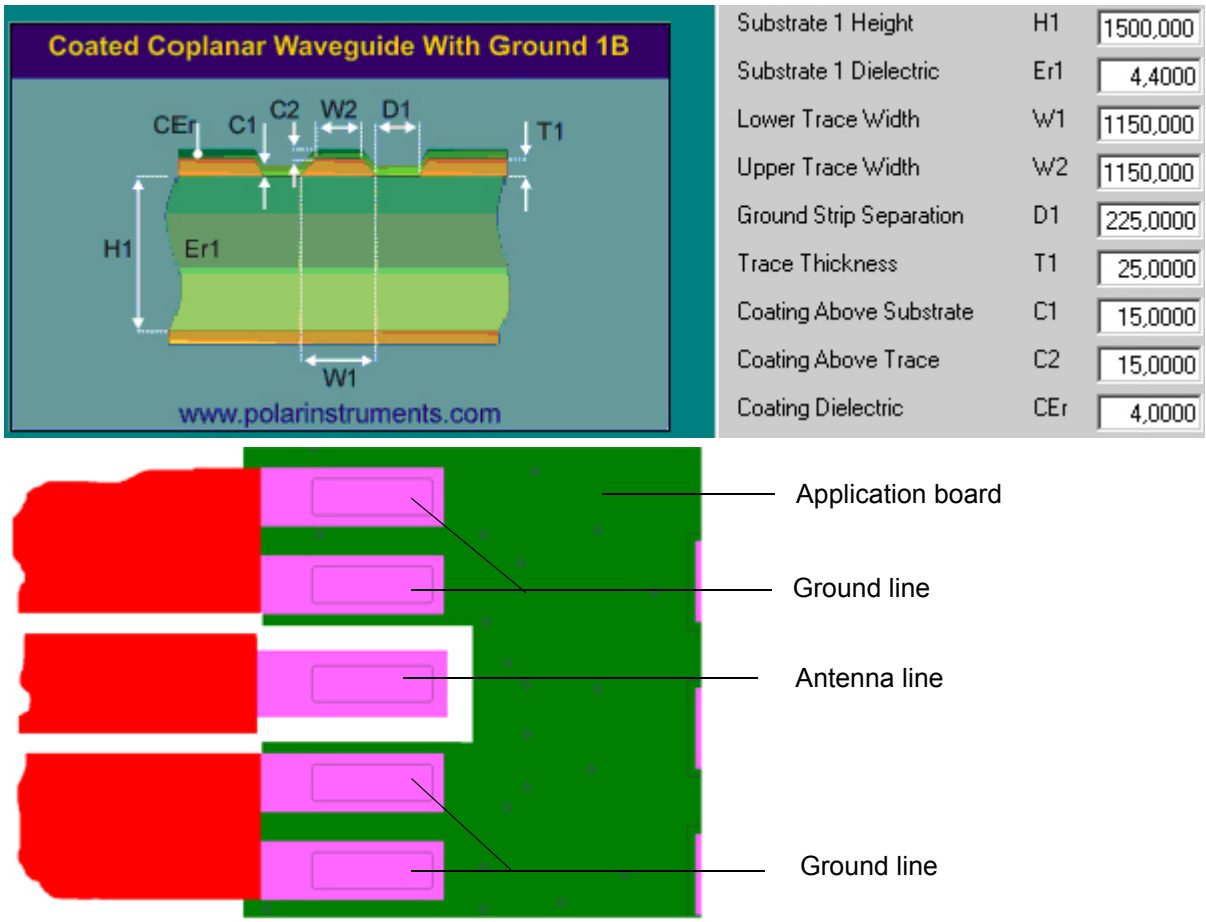


Figure 26: Micro-Stripline on 1.5mm Standard FR4 PCB - example 2

2.2.3.2 Routing Example

Interface to RF Connector

Figure 27 shows 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 is recommended for an application with a PCB layer stack resembling the one of the PLS62-W evaluation board shown in Figure 28. For different layer stacks the stripline width will have to be adapted accordingly.

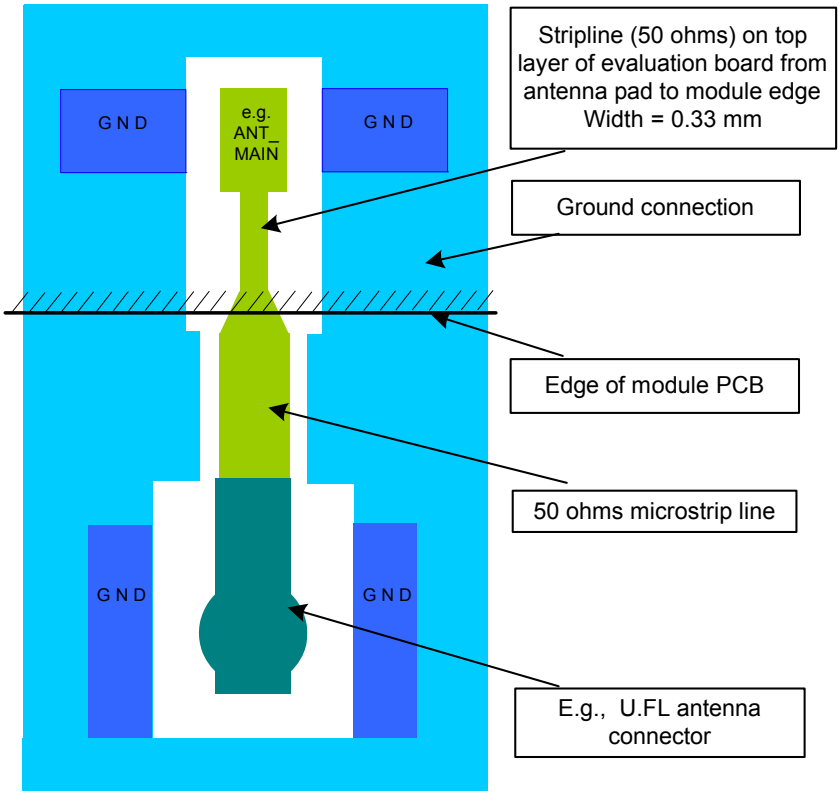


Figure 27: Routing to application's RF connector

Layer No.		Construction	Finished thkness (um)
s/m			15
1			25
		Prepreg :1080X1 RC:64%	65
2			25
		CORE:28mil H/Hoz 7628x4	708
3			25
		Prepreg :1080X1 RC:64%	65
4			25
s/m			15
		Total thickness (including S/M):	**968**

Figure 28: PLS62-W evaluation board layer table

2.3 Sample Application

Figure 29 shows a typical example of how to integrate a PLS62-W 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 [3].

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.

Depending on the micro controller used by an external application PLS62-W's digital input and output lines may require level conversion. Section 2.3.1 shows a possible sample level conversion circuit.

Note: PLS62-W is not intended for use with cables longer than 3m.

Disclaimer
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 29 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 PLS62-W modules.

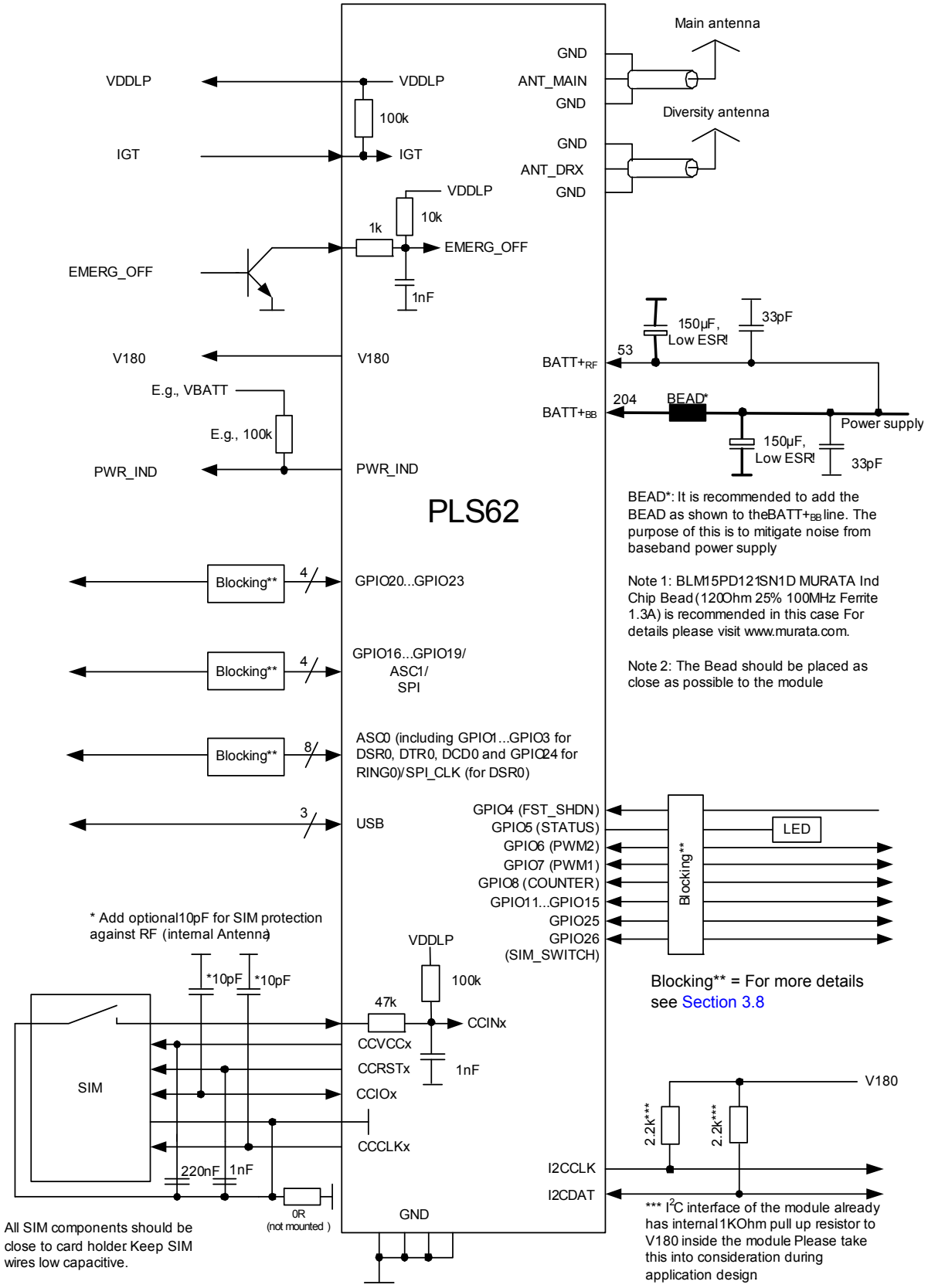


Figure 29: Schematic diagram of PLS62-W sample application

2.3.1 Sample Level Conversion Circuit

Depending on the micro controller used by an external application PLS62-W's digital input and output lines (i.e., ASC0, ASC1 and GPIO lines) may require level conversion. The following Figure 30 shows a sample circuit with recommended level shifters for an external application's micro controller (with VLOGIC between 3.0V...3.6V). The level shifters can be used for digital input and output lines with V_{OH}max=1.85V or V_{IH}max =1.85V.

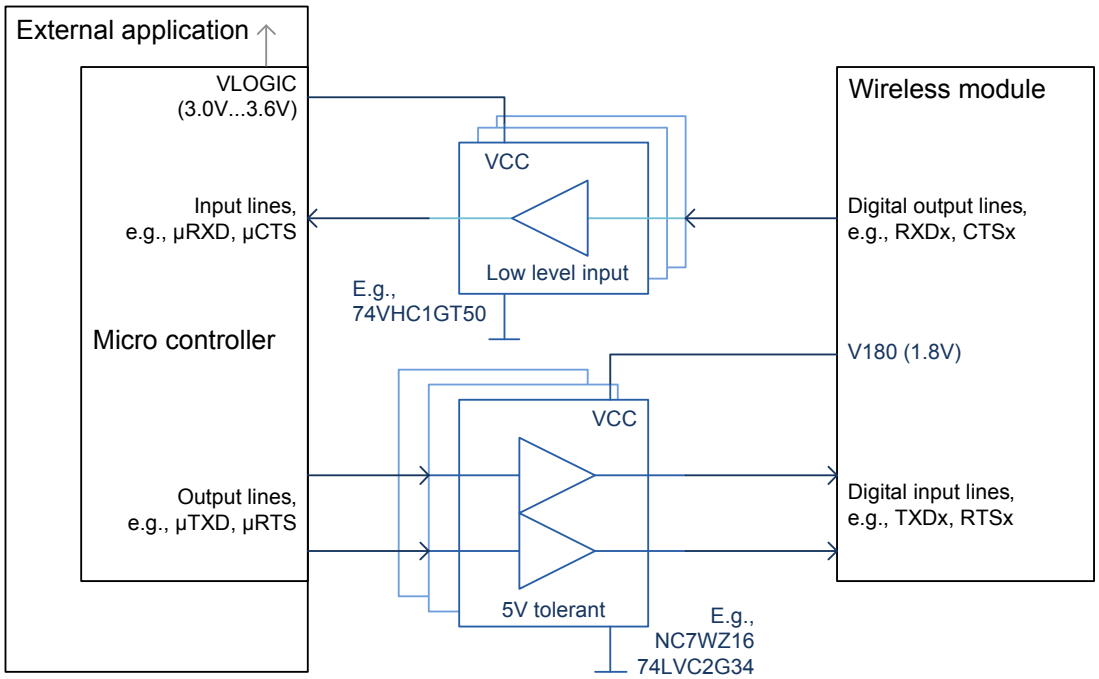


Figure 30: Sample level conversion circuit

3 Operating Characteristics

3.1 Operating Modes

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

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 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 PLS62-W while it is beyond the safety limits of voltage and temperature stated in Section 2.1.2.1. PLS62-W 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 PLS62-W

After the operating voltage BATT+ is applied (see also Section 3.5), PLS62-W can be switched on by means of the IGT signal.

The IGT signal is a falling edge triggered signal and allows the input voltage level up to VDDLP (1.8V). The module starts into normal mode on detecting the falling edge of the IGT signal. The falling edge of the IGT signal must be applied at least 100ms later than BATT+. See Figure 31.

Please note that the IGT signal is an edge triggered signal. This implies that a micro-second low pulse on the signal line suffices to almost immediately switch on the module, as shown in Figure 31. After module startup the IGT signal should always be set to high to prevent possible back powering at this pad.

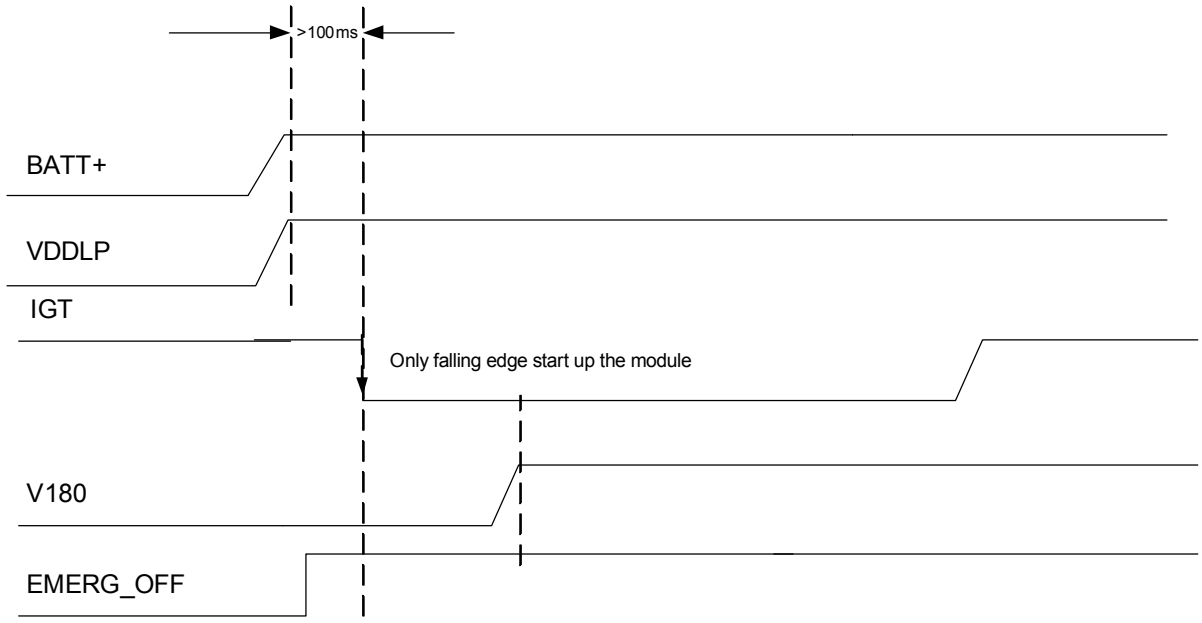


Figure 31: IGT timing

3.2.2 Restart PLS62-W

After startup PLS62-W can be re-started using the AT+CFUN command. For details see [1].

3.2.3 Signal States after Startup

Table 9 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 9: Pull-up and Pull-down Values

Signal name	Reset state	First start up configuration
IGT	H / 100k PU	H / 100k PU
EMERG_OFF	H / 11k PU	H / 11k PU
CCIOx	L	O / L
CCRSTx	L	O / L
CCCLKx	L	O / L
CCINx	T / 150k PU	I / 150k PU
RXD0	T / PU	O / H
TXD0	T / PD	I
CTS0	T / PU	O / H
RTS0	T / PU	I / PD
DTR0	T / PD	T / PD
DCD0	T / PD	T / PD
DSR0	T / PD	T / PD
GPIO4-8	T / PD	T / PD
GPIO5	T / PD	T / PD
GPIO6	L	T / PD
GPIO7-8	T / PD	T / PD
GPIO11-GPIO15	T / PD	T / PD
GPIO16	T / PU	T / PD
GPIO17	T / PD	T / PD
GPIO18-19	T / PU	T / PD
GPIO20-26	T / PD	T / PD
I2CCLK	T / 1k PU	T / 1k PU
I2CDAT	T / 1k PU	I / 1k PU

Abbreviations used in above Table 9:

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 PLS62-W

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 using the EMERG_OFF line (see Section 3.2.4.2).
- *Automatic shutdown (software controlled)*: See Section 3.2.5
  - Takes effect if PLS62-W board temperature or voltage levels exceed a critical limit.

3.2.4.1 Switch off PLS62-W Using AT Command

The best and safest approach to powering down PLS62-W is to issue the appropriate AT command. This procedure lets PLS62-W log off from the network and allows the software to enter into a secure state and safe data before disconnecting the power supply. The mode is referred to as Power Down mode. In this mode, only the RTC stays active. After sending the switch off command AT^SMSO, be sure not to enter any further AT commands until the module was restarted.

CAUTION: Be sure not to disconnect the operating voltage V_{BATT+} before V180 pad has gone low. Otherwise you run the risk of losing data, or in some rare cases even to render the module inoperable.

To monitor the V180 line, it is recommended to implement a power indication circuit as described in Section 2.1.13.2.

While PLS62-W is in Power Down mode the application interface is switched off and must not be fed from any other voltage source. **Therefore, your application must be designed to avoid any current flow into any digital pads of the application interface.**

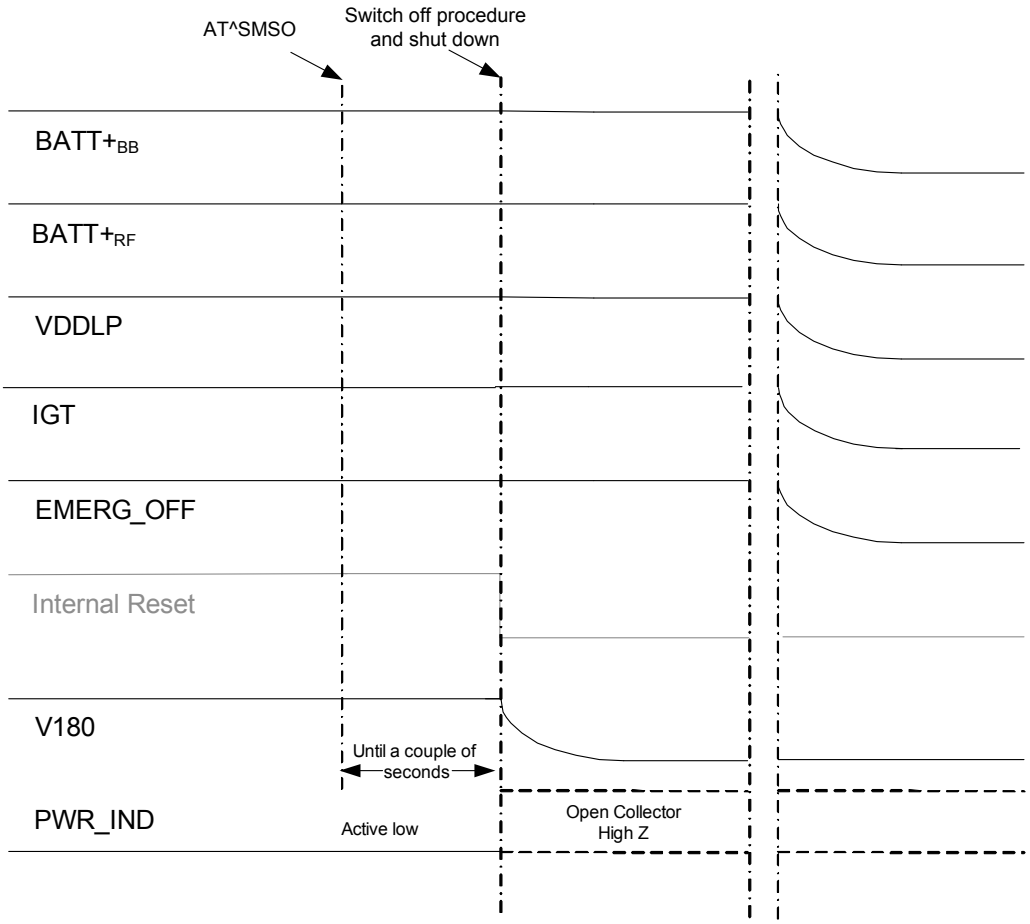


Figure 32: Switch off behavior

3.2.4.2 Switch off PLS62-W Using EMERG_OFF

The EMERG_OFF signal is internally connected to the main module processor. A low level for more than 20ms switches off the module immediately.

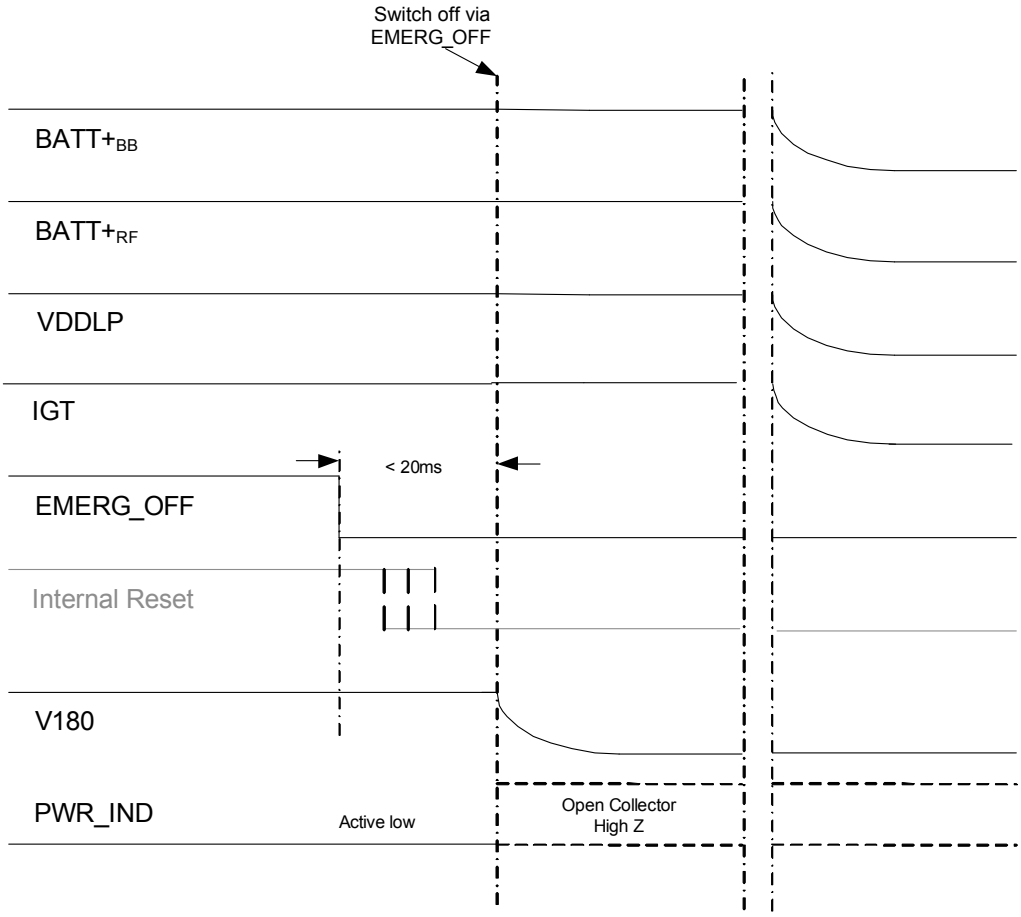


Figure 33: Emergency off timing

It is recommended to control this EMERG_OFF line with an open collector transistor or an open drain field-effect transistor.

Caution: Use the EMERG_OFF line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_OFF 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 PLS62-W does not respond, if reset or shutdown via AT command fails.

3.2.5 Automatic Shutdown

Automatic shutdown takes effect if the following event occurs:
- PLS62-W 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. PLS62-W 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, PLS62-W 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 PLS62-W. 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. 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 10 for the associated URCs.

Table 10: Temperature associated URCs

Sending temperature alert (2min after PLS62-W 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. PLS62-W switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. PLS62-W switches off.

3.2.5.2 Undervoltage Shutdown

The undervoltage shutdown threshold is the specified minimum supply voltage V_{BATT+} given in Table 2. When the average supply voltage measured by PLS62-W approaches the undervoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

^SBC: Undervoltage Warning

The undervoltage warning is sent only once - until the next time the module is close to the undervoltage shutdown threshold.

If the voltage continues to drop below the specified undervoltage shutdown threshold, the module will send the following URC:

^SBC: Undervoltage Shutdown

This alert is sent only once before the module shuts down cleanly without sending any further messages.

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

Note: The undervoltage threshold is calculated for max. 400mV voltage drops during transmit burst. Power supply sources for external applications should be designed to tolerate 400mV voltage drops without crossing the lower limit of 3.0V. For external applications operating at the limit of the allowed tolerance the default undervoltage threshold may be adapted down to a maximum of 2.8V by subtracting an offset. For details see [1]: AT^SCFG= "MEShutdown/sVsup/threshold".

3.2.5.3 Overvoltage Shutdown

The overvoltage shutdown threshold is the specified maximum supply voltage V_{BATT+} given in Table 2. When the average supply voltage measured by PLS62-W approaches the overvoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

^SBC: Overvoltage Warning

The overvoltage warning is sent only once - until the next time the module is close to the overvoltage shutdown threshold.

If the voltage continues to rise above the specified overvoltage shutdown threshold, the module will send the following URC:

^SBC: Overvoltage Shutdown

This alert is sent only once before the module shuts down cleanly without sending any further messages.

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 PLS62-W components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of PLS62-W. Especially the power amplifier linked to $BATT+_{RF}$ is very sensitive to high voltage and might even be destroyed.

3.3 Automatic GPRS Multislot Class Change

Temperature control is also effective for operation in GPRS Multislot Class 10 or 12. If the board temperature increases to 75°C while data is transmitted over GPRS, the module automatically reverts from GPRS Multislot Class 12 (4Tx) or Class 10 (2Tx) to Class 8 (1Tx). This reduces the power consumption and, consequently, causes the board's temperature to decrease. Once the temperature drops to a 70°C, PLS62-W returns to the higher Multislot Class. If the temperature stays at the critical level or even continues to rise, PLS62-W will not switch back to the higher class.

After a transition from Multislot Class 12 or 10 to Multislot 8 a possible switchback to Multislot Class 12 or 10 is blocked for one minute.

Please note that there is not one single cause of switching over to a lower GPRS Multislot Class. Rather it is the result of an interaction of several factors, such as the board temperature that depends largely on the ambient temperature, the operating mode and the transmit power. Furthermore, take into account that there is a delay until the network proceeds to a lower or, accordingly, higher Multislot Class. The delay time is network dependent. In extreme cases, if it takes too much time for the network and the temperature cannot drop due to this delay, the module may even switch off as described in Section 3.2.5.1.

3.4 Power Saving

PLS62-W can be configured in two waysto control power consumption:

- Using the AT command AT^SPOW it is possible to specify a so-called power saving mode for the module (<mode> = 2; for details on the command see [1]). The module's UART interfaces (ASC0 and ASC1) are then deactivated and will only periodically be activated to be able to listen to network paging messages as described in Section 3.4.1, Section 3.4.2 and Section 3.4.3. See Section 3.4.4 for a description on how to immediately wake up PLS62-W again using RTS0.

  Please note that the AT^SPOW setting has no effect on the USB interface. As long as the USB connection is active, the module will not change into its SLEEP state to reduce its functionality to a minimum and thus minimizing its current consumption. To enable switching into SLEEP mode, the USB connection must therefore either not be present at all or the USB host must bring its USB interface into Suspend state. Also, VUSB_IN should always be kept enabled for this functionality. See "Universal Serial Bus Specification Revision 2.0"[1] for a description of the Suspend state.

- Using the AT command AT^SCFG="Radio/OutputPowerReduction" it is possible for the module in GPRS and EGPRS multislot scenarios to reduce its output power according to 3GPP 45.005 section. By default a maximum power reduction is enabled. For details on the command see [1].

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

3.4.1 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.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 34.

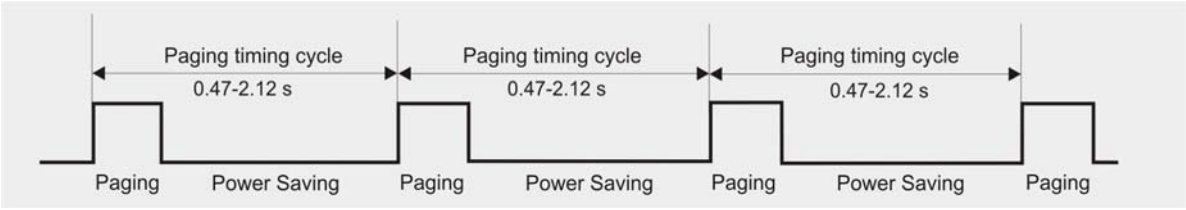


Figure 34: Power saving and paging in GSM networks

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.

3.4.2 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:

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

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 35.

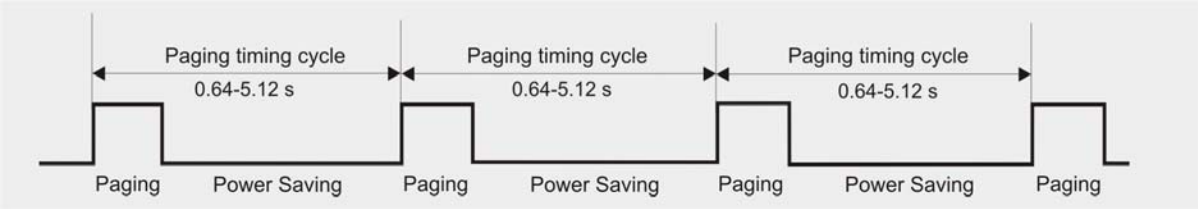


Figure 35: Power saving and paging in WCDMA networks

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.

3.4.3 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.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 36.

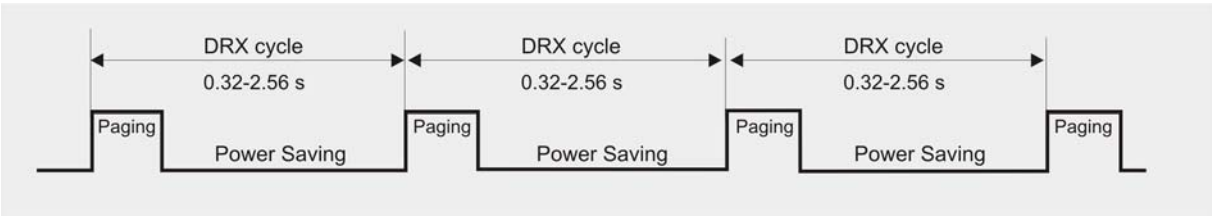


Figure 36: Power saving and paging in LTE networks

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.

3.4.4 Wake-up via RTS0

RTS0 can be used to wake up PLS62-W 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 37 shows the described RTS0 wake up mechanism.

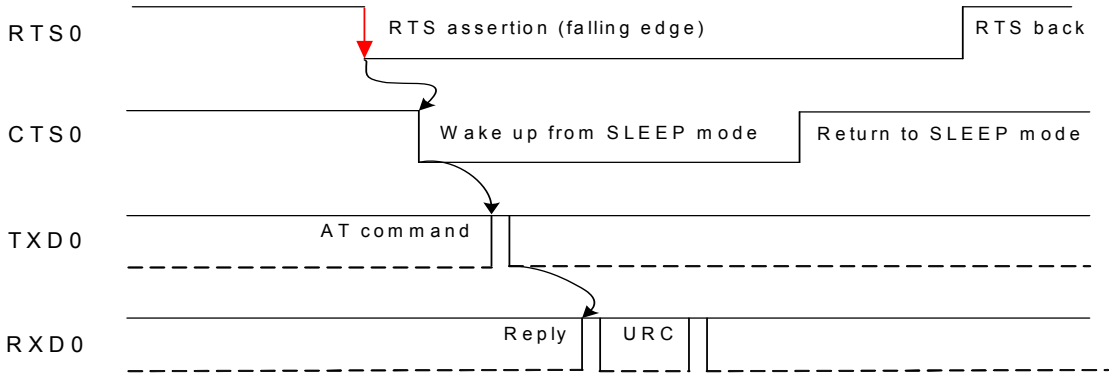


Figure 37: Wake-up via RTS0

3.5 Power Supply

PLS62-W 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 four lines for the GSM power amplifier supply.

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). 150µF capacitors should be placed as close as possible to the BATT+ pads. Figure 38 shows a sample circuit for decoupling capacitors for BATT+.

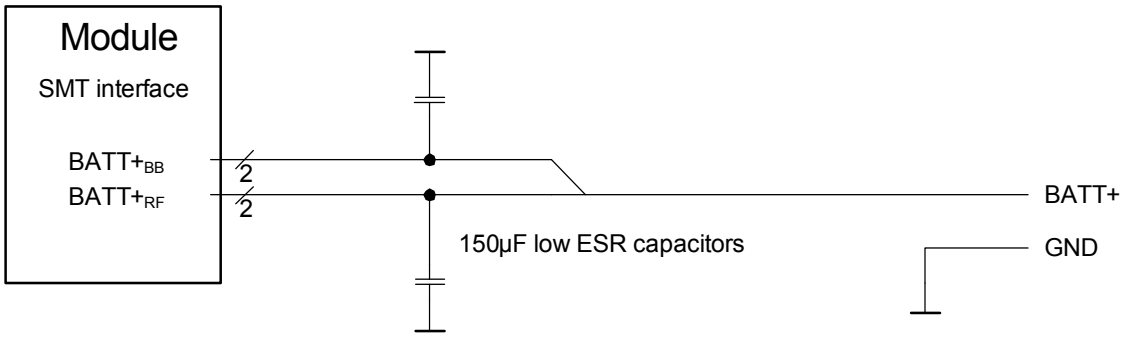


Figure 38: Decoupling capacitor(s) for BATT+

The power supply of PLS62-W 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 a DC-DC step down switching regulator.
- Switches the module's power voltages for the power-up and -down procedures.
- SIM switch to provide SIM power supply.

3.5.1 Power Supply Ratings

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

Table 11: 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.)	3.0		4.5	V
		Extended Range (Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes.)	2.8[1]			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 <= 250 kHz @ f > 250 kHz			 120 90	 mV_{pp} mV_{pp}

1. The extended voltage range is configurable via AT command and intended to be used without RF function (e.g. airplane mode).

Table 12: Current Consumption Ratings -GSM

	Description	Conditions		Typical rating	Unit
I_{VDDLP} @ 1.8V	OFF State supply current	RTC backup @ BATT+ = 0V		0.1	µA
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	OFF State supply current	POWER DOWN		85	µA
	GSM SLEEP State supply current	SLEEP[2] @ DRX=9 (no communication via UART)	USB disconnected	1.9	mA
			USB suspended	1.8	mA
		SLEEP[2)] @ DRX=5 (no communication via UART)	USB disconnected	2.0	mA
			USB suspended	2.0	mA
		SLEEP[2)] @ DRX=2 (no communication via UART)	USB disconnected	2.5	mA
			USB suspended	2.5	mA
	GSM IDLE State supply current	IDLE[3] @ DRX=2 (UART active, but no communication)	USB disconnected	13	mA
			USB suspended	33	mA
	Average GSM850 supply current	GPRS Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	265	mA
			ROPR=0 (no reduction)	265	mA
		GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	360	mA
			ROPR=0 (no reduction)	500	mA
		GPRS Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	490	mA
			ROPR=0 (no reduction)	945	mA
		EDGE Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	160	mA
			ROPR=0 (no reduction)	160	mA
		EDGE Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	235	mA
			ROPR=0 (no reduction)	285	mA
		EDGE Data transfer GSM850; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	330	mA
			ROPR=0 (no reduction)	515	mA

Table 12: Current Consumption Ratings -GSM

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM900 supply current	GPRS Data transfer GSM900; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	240	mA
			ROPR=0 (no reduction)	240	mA
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	345	mA
			ROPR=0 (no reduction)	450	mA
		GPRS Data transfer GSM900; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	465	mA
			ROPR=0 (no reduction)	845	mA
		EDGE Data transfer GSM900; PCL=5; 1Tx/4Rx	ROPR=4 (max. reduction)	160	mA
			ROPR=0 (no reduction)	160	mA
		EDGE Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=4 (max. reduction)	230	mA
			ROPR=0 (no reduction)	280	mA
		EDGE Data transfer GSM900; PCL=5; 4Tx/1Rx	ROPR=4 (max. reduction)	320	mA
			ROPR=0 (no reduction)	495	mA

Table 12: Current Consumption Ratings -GSM

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM1800 supply current	GPRS Data transfer GSM1800; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	170	mA
			ROPR=0 (no reduction)	170	mA
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	225	mA
			ROPR=0 (no reduction)	300	mA
		GPRS Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	300	mA
			ROPR=0 (no reduction)	540	mA
		EDGE Data transfer GSM1800; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	130	mA
			ROPR=0 (no reduction)	130	mA
		EDGE Data transfer GSM1800; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	185	mA
			ROPR=0 (no reduction)	215	mA
		EDGE Data transfer GSM1800; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	255	mA
			ROPR=0 (no reduction)	375	mA

Table 12: Current Consumption Ratings -GSM

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM1900 supply current	GPRS Data transfer GSM1900; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	175	mA
			ROPR=0 (no reduction)	175	mA
		GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	230	mA
			ROPR=0 (no reduction)	315	mA
		GPRS Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	305	mA
			ROPR=0 (no reduction)	570	mA
		EDGE Data transfer GSM1900; PCL=0; 1Tx/4Rx	ROPR=4 (max. reduction)	130	mA
			ROPR=0 (no reduction)	130	mA
		EDGE Data transfer GSM1900; PCL=0; 2Tx/3Rx	ROPR=4 (max. reduction)	190	mA
			ROPR=0 (no reduction)	220	mA
		EDGE Data transfer GSM1900; PCL=0; 4Tx/1Rx	ROPR=4 (max. reduction)	260	mA
			ROPR=0 (no reduction)	385	mA
	Peak current during GSM transmit burst	GPRS Data transfer GSM850; PCL=5; 4Tx/1Rx @ 50Ω		2.3	A
		GPRS Data transfer GSM900; PCL=5; 4Tx/1Rx @ 50Ω		2.3	A
		GPRS Data transfer DCS1800; PCL=0; 4Tx/1Rx @ 50Ω		1.4	A
		GPRS Data transfer PCS1900; PCL=0; 4Tx/1Rx @ 50Ω		1.4	A

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector.Measured at 25°C and 3.8V - except for POWER DOWN which was measured at 2.8V.
2. Measurements start 6 minutes after switching ON the module,
averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes
Communication tester settings:no neighbor cells, no cell reselection etc.,
RMC (Reference Measurement Channel)
SLEEP mode is enabled via AT command AT^SPOW=2, 1000, 3
3. One fix per second.

Table 13: Current Consumption Ratings - UMTS & HSPA

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	OFF State supply current	POWER DOWN		85	µA
	UMTS SLEEP State supply current	SLEEP[2] @ DRX=9 (no communication via UART)	USB disconnected	2.0	mA
			USB suspended	2.0	mA
		SLEEP[2)] @ DRX=8 (no communication via UART)	USB disconnected	2.0	mA
			USB suspended	2.0	mA
		SLEEP[2)] @ DRX=6 (no communication via UART)	USB disconnected	2.7	mA
			USB suspended	2.7	mA
	UMTS IDLE State supply current	IDLE[3] @ DRX=6 (UART active, but no communication)	USB disconnected	14	mA
			USB suspended	33	mA
	UMTS average supply current	UMTS Data transfer Band I; +23dBm		600	mA
		UMTS Data transfer Band II; +23dBm		570	mA
		UMTS Data transfer Band IV; +23dBm		570	mA
		UMTS Data transfer Band V; +23dBm		490	mA
		UMTS Data transfer Band VIII; +23dBm		540	mA
		UMTS Data transfer Band IX; +23dBm		620	mA
		UMTS Data transfer Band XIX; +23dBm		510	mA
		HSDPA Data transfer Band I; +23dBm		600	mA
		HSDPA Data transfer Band II; +23dBm		570	mA
		HSDPA Data transfer Band IV; +23dBm		570	mA
		HSDPA Data transfer Band V; +23dBm		490	mA
		HSDPA Data transfer Band VIII; +23dBm		540	mA
		HSDPA Data transfer Band IX; +23dBm		630	mA
		HSDPA Data transfer Band XIX; +23dBm		510	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector.Measured at 25°C and 3.8V - except for POWER DOWN which was measured at 2.8V.
2. Measurements start 6 minutes after switching ON the module,
averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes
Communication tester settings:no neighbor cells, no cell reselection etc.,
RMC (Reference Measurement Channel)
SLEEP mode is enabled via AT command AT^SPOW=2, 1000, 3
3. One fix per second.

Table 14: Current Consumption Ratings - LTE

	Description	Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	OFF State supply current	POWER DOWN		85	µA
	LTE SLEEP State supply current	SLEEP[2] @ "Paging Cycles = 256" (no communication via UART)	USB disconnected	2.2	mA
			USB suspended	2.2	mA
		SLEEP[2)] @ "Paging Cycles = 128" (no communication via UART)	USB disconnected	2.8	mA
			USB suspended	2.9	mA
		SLEEP[2)] @ "Paging Cycles = 64" (no communication via UART)	USB disconnected	3.8	mA
			USB suspended	3.9	mA
		SLEEP[2)] @ "Paging Cycles = 32" (no communication via UART)	USB disconnected	5.9	mA
			USB suspended	5.9	mA
	LTE IDLE State supply current	IDLE[3)] (USB disconnected)		21	mA
		IDLE[3)] (USB active)		41	mA
	LTE average supply current	LTE Data transfer Band 1; +23dBm[4)]		690	mA
		LTE Data transfer Band 2; +23dBm[4)]		650	mA
		LTE Data transfer Band 3; +23dBm[4)]		660	mA
		LTE Data transfer Band 4; +23dBm[4)]		655	mA
		LTE Data transfer Band 5; +23dBm[4)]		630	mA
		LTE Data transfer Band 7; +23dBm[4)]		620	mA
		LTE Data transfer Band 8; +23dBm[4)]		570	mA
		LTE Data transfer Band 12; +23dBm[4)]		565	mA
		LTE Data transfer Band 18; +23dBm[4)]		600	mA
		LTE Data transfer Band 19; +23dBm[4)]		585	mA
		LTE Data transfer Band 20; +23dBm[4)]		515	mA
		LTE Data transfer Band 28; +23dBm[4)]		590	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector.Measured at 25°C and 3.8V - except for POWER DOWN which was measured at 2.8V.
2. Measurements start 6 minutes after switching ON the module,
averaging times: SLEEP mode – 3 minutes, transfer modes – 1.5 minutes
Communication tester settings:no neighbor cells, no cell reselection etc.,
RMC (Reference Measurement Channel)
SLEEP mode is enabled via AT command AT^SPOW=2, 1000, 3
3. One fix per second.
4. Communication tester settings: - Channel Bandwidth: 5MHz
- Number of Resource Blocks: 25 (DL), 1 (UL), RB position: Low
- Modulation: QPSK

3.5.2 Minimizing Power Losses

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 PLS62-W board, not even in a GSM transmit burst where current consumption can rise (for peak values see the power supply ratings listed in Section 3.5.1).

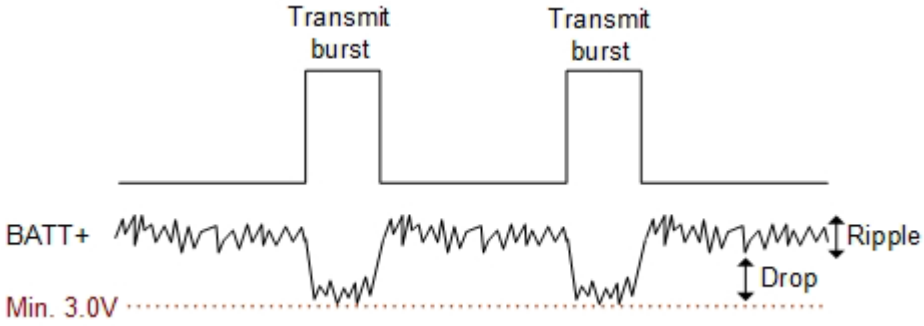


Figure 39: Power supply limits during transmit burst

3.5.3 Monitoring Power Supply by AT Command

To monitor the supply voltage you can also use the AT^SBV command which returns the value related to the reference points BATT+ and GND.

The module continuously measures the voltage at intervals depending on the operating mode of the RF interface. The duration of measuring ranges from 0.5 seconds in TALK/DATA mode to 50 seconds when PLS62-W is in IDLE mode or Limited Service (deregistered). The displayed voltage (in mV) is averaged over the last measuring period before the AT^SBV command was executed.

If the measured voltage drops below or rises above the voltage shutdown thresholds, the module will send an "^SBC" URC and shut down (for details see Section 3.2.5).

3.6 Operating Temperatures

Please note that the module's lifetime, i.e., the MTTF (mean time to failure) may be reduced, if operated outside the extended temperature range.

Parameter	Min	Typ	Max	Unit
Normal operation	-30	+25	+85	°C
Extended operation[1]	-40		+90	°C
Automatic shutdown[2] Temperature measured on PLS62-W board	<-40	---	>+90	°C

1. Extended operation allows normal mode speech calls or data transmission for limited time until automatic thermal shutdown takes effect. Within the extended temperature range (outside the normal operating temperature range) the specified electrical characteristics may be in- or decreased.
2. Due to temperature measurement uncertainty, a tolerance of ±3°C on the thresholds may occur.

See also Section 3.2.5 for information about the NTC for on-board temperature measurement, automatic thermal shutdown and alert messages.

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.

For more information regarding the module's thermal behavior please refer to [4].

3.7 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 PLS62-W module.

PLS62-W has been tested according to group standard ETSI EN 301 489-1 (see Table 20) and test standard EN 61000-4-2. Electrostatic values can be gathered from the following table.

Specification/Requirements	Contact discharge	Air discharge
EN 61000-4-2		
Antenna interfaces	±1kV	n.a.
Antenna interfaces with ESD protection (see Section 3.7.1)	±4kV	±8kV
BATT+	±4kV	±8kV
JEDEC JESD22-A114D (Human Body Model, Test conditions: 1.5 kΩ, 100 pF)		
All other interfaces	±1kV	n.a.

Note: The values may vary with the individual application design. For example, it matters whether or not the application platform is grounded over external devices like a computer or other equipment, such as the Gemalto reference application described in Chapter 5.

3.7.1 ESD Protection for Antenna Interfaces

The following Figure 40 shows how to implement an external ESD protection for the RF antenna interfaces (ANT_MAIN and ANT_DRX) with either a T pad or PI pad attenuator circuit (for RF line routing design see also Section 2.2.3).

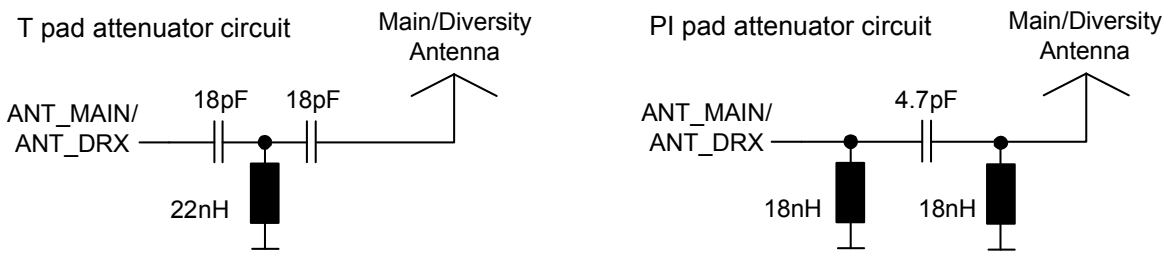


Figure 40: ESD protection for RF antenna interface

Recommended inductor types for the above sample circuits: Size 0402 SMD from Panasonic ELJRF series (22nH and 18nH inductors) or Murata LQW15AN18NJ00 (18nH inductors only).

3.8 Blocking against RF on Interface Lines

To reduce EMI issues there are serial resistors, or capacitors to GND, implemented on the module for the ignition, emergency restart, and SIM interface lines (cp. Section 2.3). However, all other signal lines have no EMI measures on the module and there are no blocking measures at the module's interface to an external application.

Dependent on the specific application design, it might be useful to implement further EMI measures on some signal lines at the interface between module and application. These measures are described below.

There are five possible variants of EMI measures (A-E) that may be implemented between module and external application depending on the signal line (see Figure 41). Pay attention not to exceed the maximum input voltages and prevent voltage overshots if using inductive EMC measures.

The maximum value of the serial resistor should be lower than 1kΩ on the signal line. The maximum value of the capacitor should be lower than 50pF on the signal line. Please observe the electrical specification of the module‘s SMT application interface and the external application‘s interface.

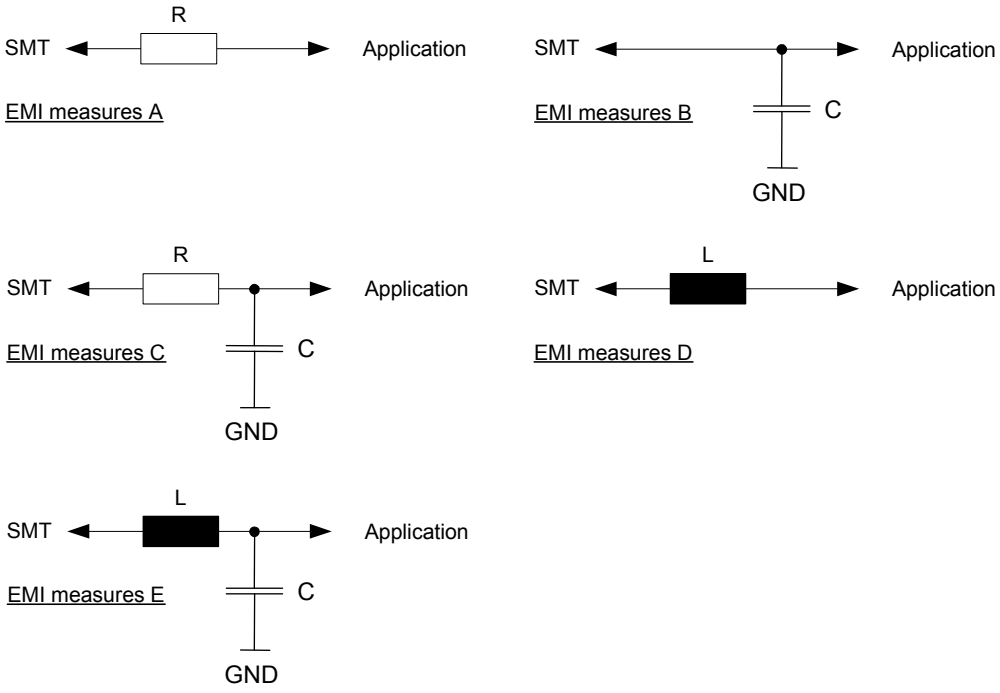


Figure 41: EMI circuits

Note: In case the application uses an internal RF antenna that is implemented close to the PLS62-W module, Gemalto strongly recommends sufficient EMI measures, e.g. of type B or C, for each digital input or output.

The following table lists for each signal line at the module's SMT application interface the EMI measures that may be implemented.

Signal name	EMI measures					Remark
	A	B	C	D	E	
CCINx	x			x		
CCRSTx		x				The external capacitor should be not higher than 10pF. The value of the capacitor depends on the external application.
CCIOx		x				
CCCLKx		x				
RXD0	x	x	x	x	x	
TXD0	x	x	x	x	x	
CTS0	x	x	x	x	x	
RTS0	x	x	x	x	x	
GPIO1/DTR0	x	x	x	x	x	
GPIO2/DCD0	x	x	x	x	x	
GPIO3/DSR0/SPI_CLK	x	x	x	x	x	
GPIO4/FST_SHDN	x	x	x	x	x	
GPIO5/LED	x	x	x	x	x	
GPIO6/PWM2	x	x	x	x	x	
GPIO7/PWM1	x	x	x	x	x	
GPIO8/COUNTER	x	x	x	x	x	
GPIO11-GPIO15	x	x	x	x	x	
GPIO16/RXD1/SPI_-MOSI	x	x	x	x	x	
GPIO17/TXD1/ SPI_MISO	x	x	x	x	x	
GPIO18/RTS1	x	x	x	x	x	
GPIO19/CTS1/SPI_CS	x	x	x	x	x	
GPIO20	x	x	x	x	x	
GPIO21	x	x	x	x	x	
GPIO22	x	x	x	x	x	
GPIO23	x	x	x	x	x	
GPIO24/RING0	x	x	x	x	x	
GPIO25	x	x	x	x	x	
SIM_SWITCH/GPIO26	x	x	x	x	x	
I2CDAT		x		x		The rising signal edge is reduced with an additional capacitor.
I2CCLK		x		x		
V180		x		x	x	
VDDLP		x		x	x	
$BATT+_{RF}$		x	x			Measures required if $BATT+_{RF}$ is close to internal RF antenna - e.g., 39pF blocking capacitor to ground
$BATT+_{BB}$		x	x			

3.9 Reliability Characteristics

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

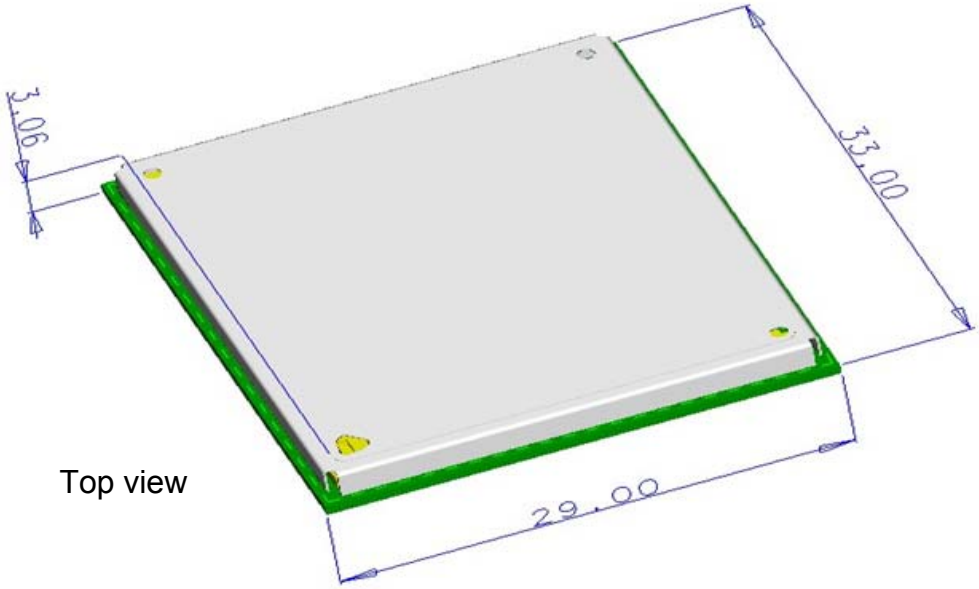
Type of test	Conditions	Standard
Vibration	Frequency range: 10-20Hz; acceleration: 5g Frequency range: 20-500Hz; acceleration: 20g Duration: 20h per axis; 3 axes	DIN IEC 60068-2-6[1]
Shock half-sinus	Acceleration: 500g Shock duration: 1ms 1 shock per axis 6 positions (± x, y and z)	DIN IEC 60068-2-27
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.

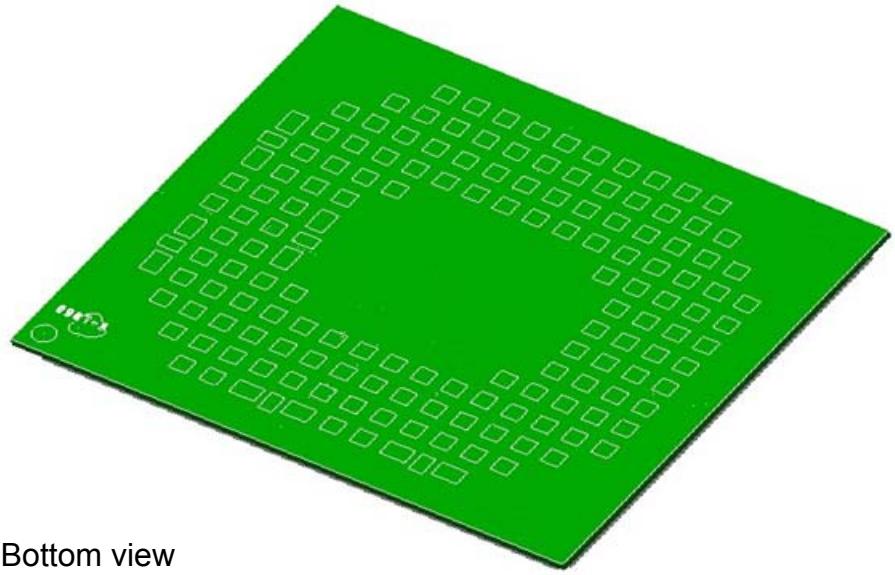
4 Mechanical Dimensions, Mounting and Packaging

4.1 Mechanical Dimensions of PLS62-W

Figure 42 shows the top and bottom view of PLS62-W and provides an overview of the board's mechanical dimensions. For further details see Figure 43.



Top view



Bottom view

Figure 42: PLS62-W– top and bottom view

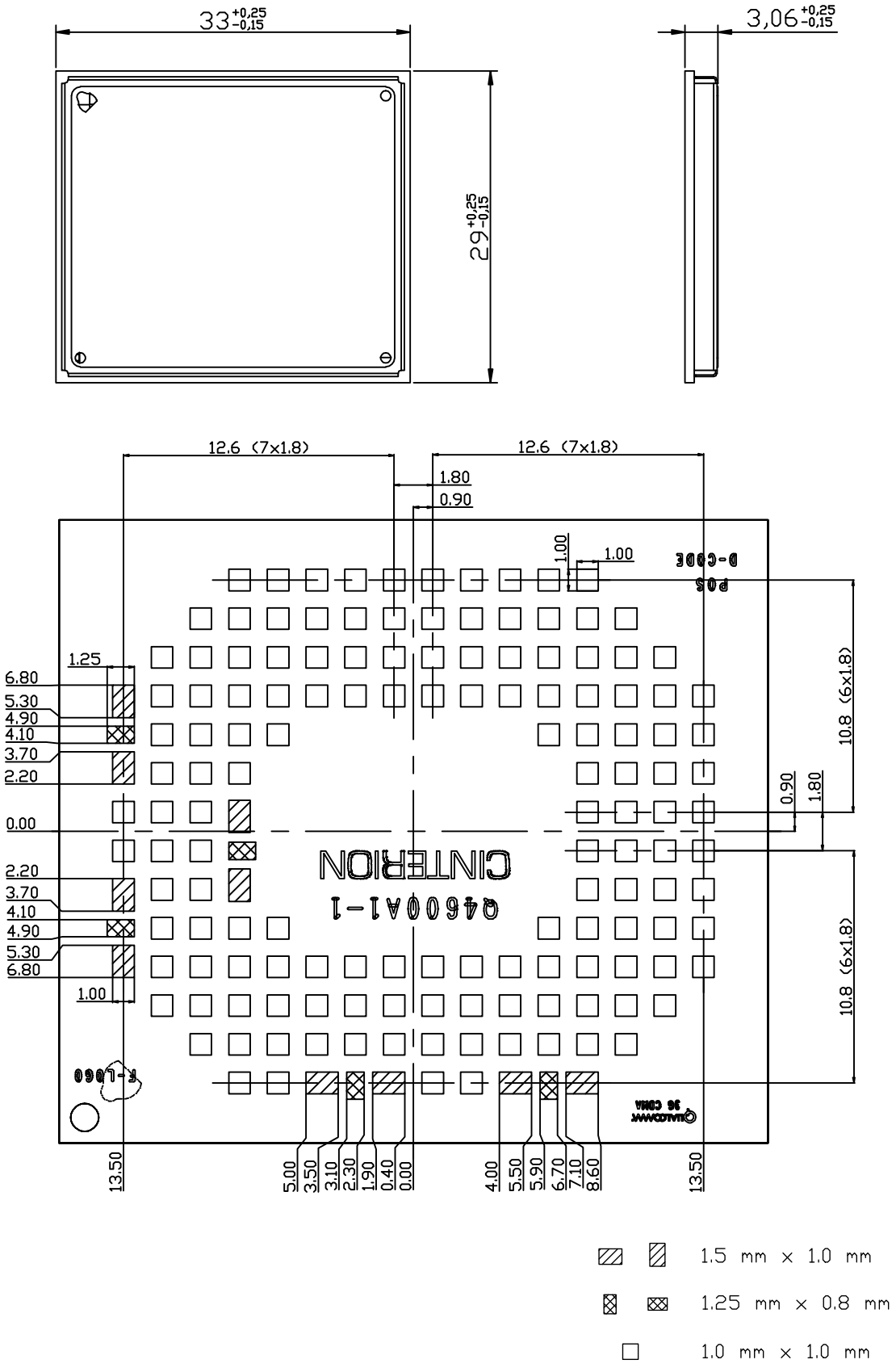


Figure 43: Dimensions of PLS62-W (all dimensions in mm)

4.2 Mounting PLS62-W onto the Application Platform

This section describes how to mount PLS62-W onto the PCBs, including land pattern and stencil design, board-level characterization, soldering conditions, durability and mechanical handling. For more information on issues related to SMT module integration see also [3].

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 Gemalto characterizations for lead-free solder paste on a four-layer test PCB and a 120µm micron thick stencil.

The land pattern given in Figure 44 reflects the module‘s pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1).

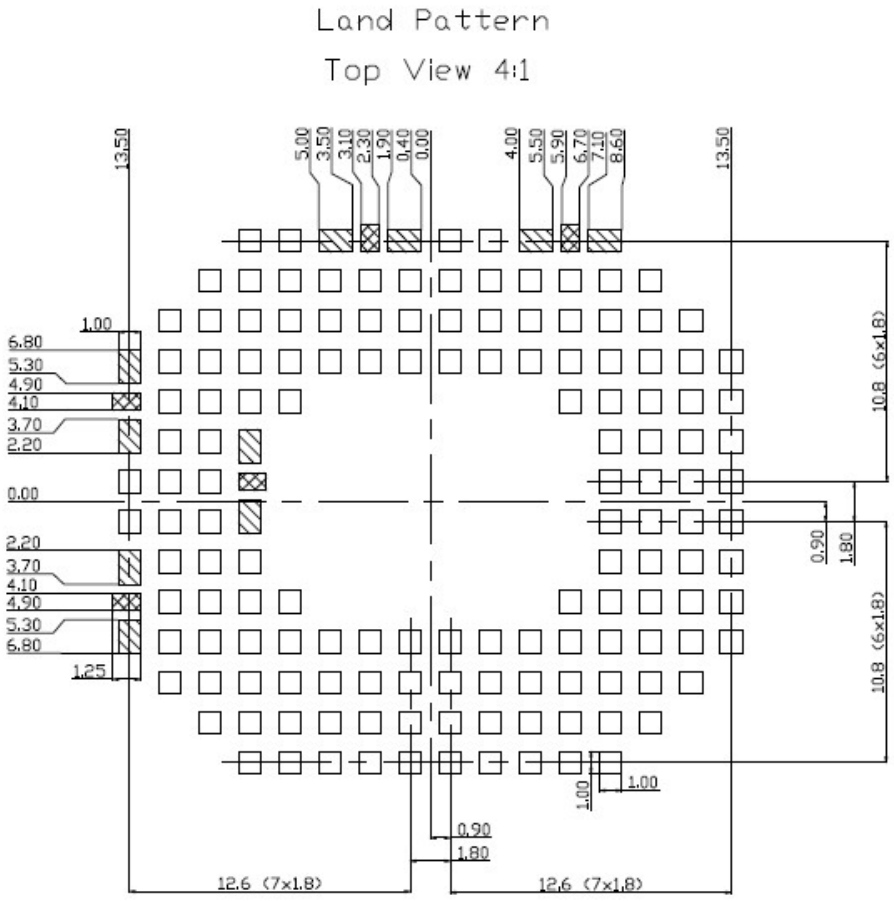


Figure 44: Land pattern (top view)

The stencil designs illustrated in Figure 45 and Figure 46 are recommended by Gemalto M2M as a result of extensive tests with Gemalto M2M Daisy Chain modules.

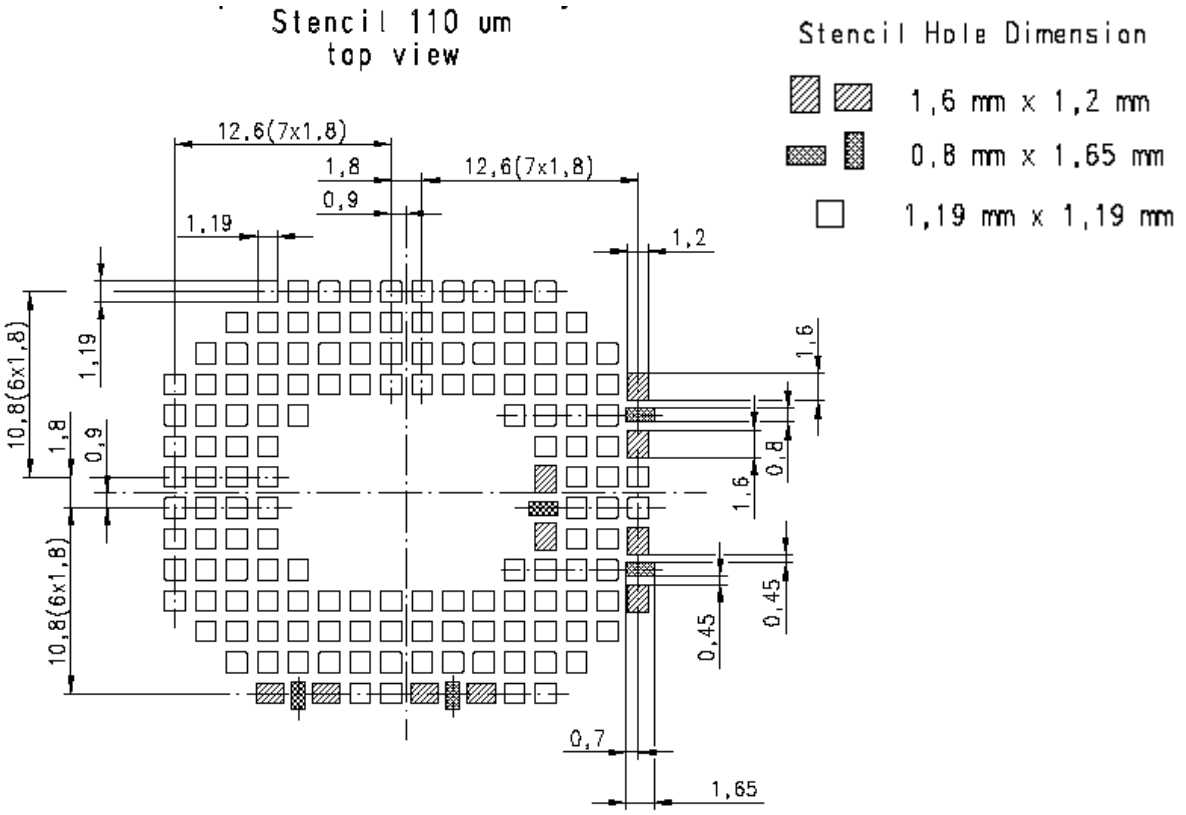


Figure 45: Recommended design for 110 micron thick stencil (top view)

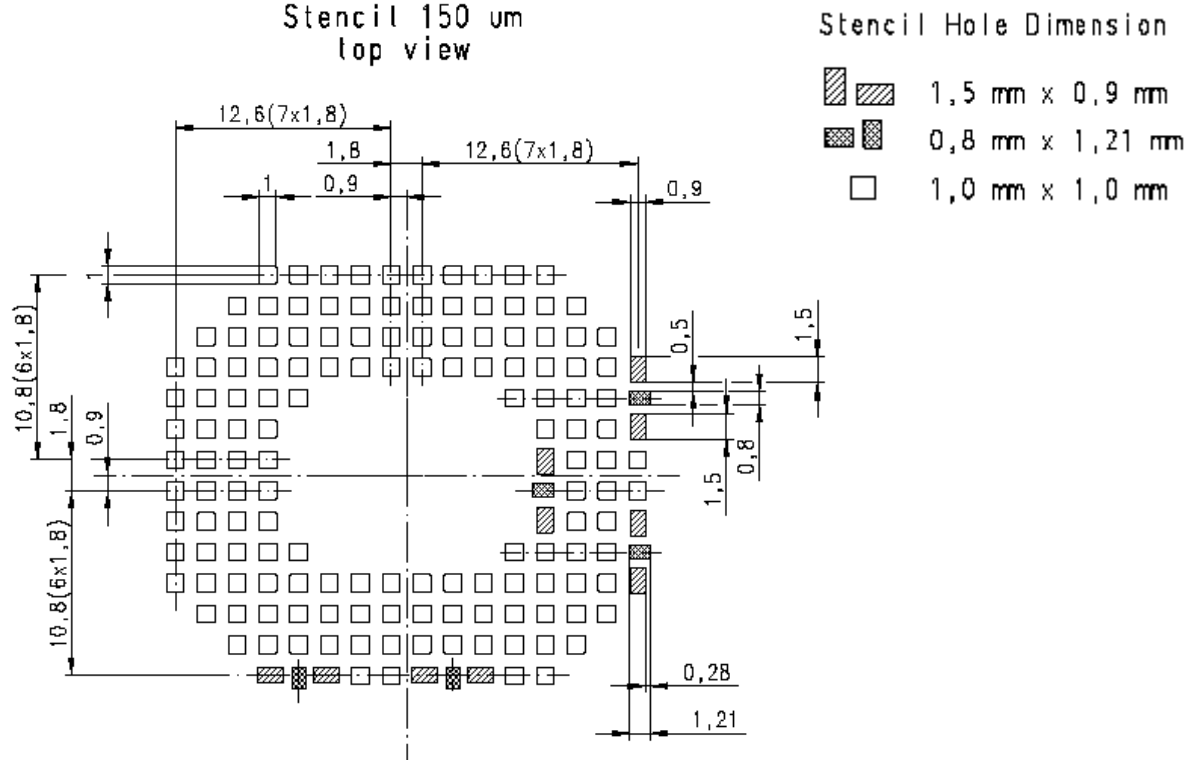


Figure 46: Recommended design for 150 micron thick stencil (top view)

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. Sample surface mount checks are described in [3].

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.

Daisy chain modules for SMT characterization are available on request. For details refer to [3].

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

PLS62-W comprises components that are susceptible to damage induced by absorbed moisture.

Gemalto M2M's PLS62-W 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

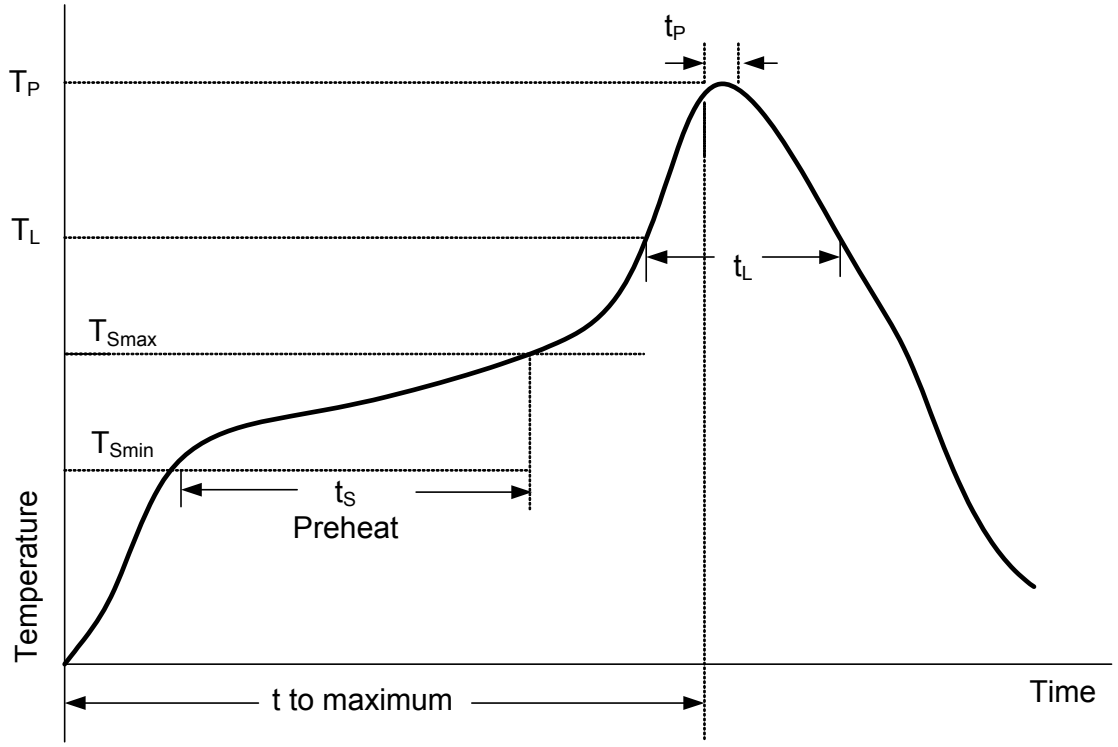
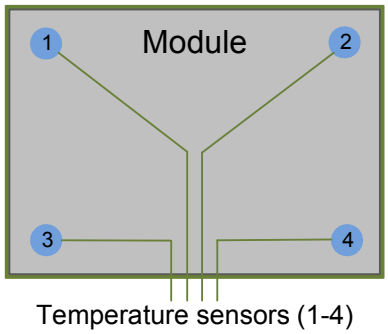


Figure 47: Reflow Profile

Table 15: 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. For more information on reflow profiles and their optimization please refer to [3].
2. Temperatures measured on shielding at each corner. See also [3].



4.2.3.2 Maximum Temperature and Duration

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

- A maximum module temperature of 245°C. This specifies the temperature as measured at the module's top side.
- A maximum duration of 30 seconds at this temperature.
- Ramp-down rate from T_P to 200°C should be controlled in order to reduce thermally induced stress during the solder solidification phase (see Table 15 - limited ramp-down rate). Therefore, a cool-down step in the oven's temperature program between 200°C and 180°C should be considered. For more information on reflow profiles and their optimization see [3].

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.

PLS62-W is specified for one soldering cycle only. Once ELS61-US 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

PLS62-W 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 16: 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

PLS62-W 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 52 for details):

- It is *not necessary* to bake PLS62-W, if the conditions specified in Section 4.2.4.1 and Section 4.2.4.2 were not exceeded.
- It is *necessary* to bake PLS62-W, 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 3.7 for further information on electrostatic discharge.

4.3 Packaging

4.3.1 Tape and Reel

The single-feed tape carrier for PLS62-W is illustrated in Figure 48. The figure also shows the proper part orientation. The tape width is 44mm and the PLS62-W 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

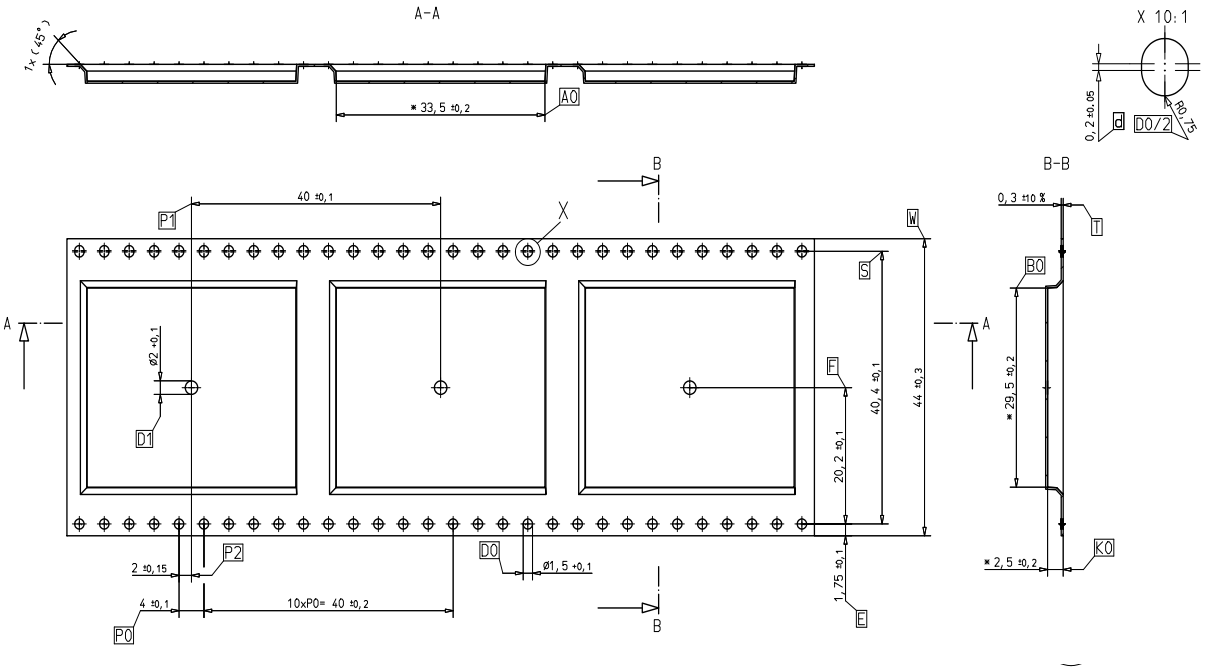


Figure 48: Carrier tape

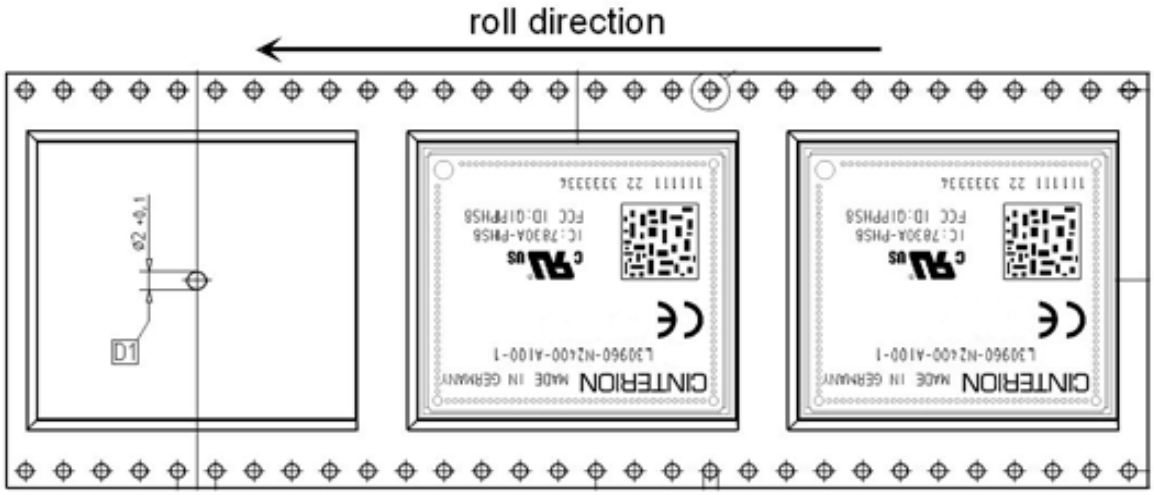


Figure 49: Reel direction

4.3.1.2 Barcode Label

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

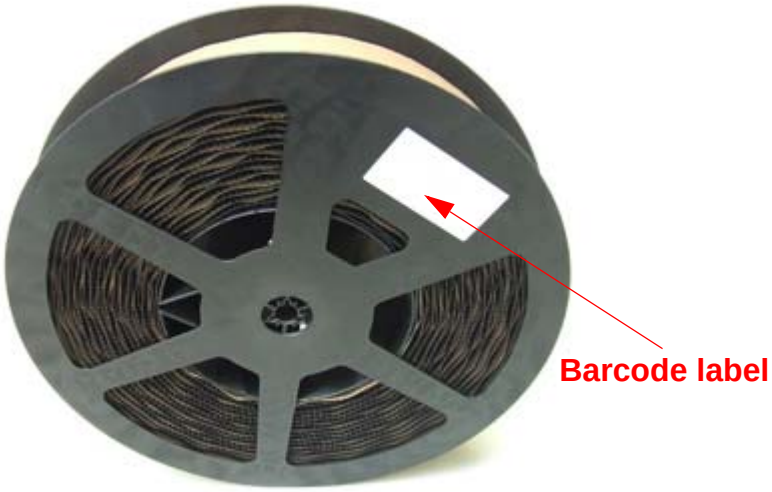


Figure 50: Barcode label on tape reel

4.3.2 Shipping Materials

PLS62-W is distributed in tape and reel carriers. The tape and reel carriers used to distribute PLS62-W 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 51. 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 PLS62-W modules from moisture exposure. It should not be opened until the devices are ready to be soldered onto the application.

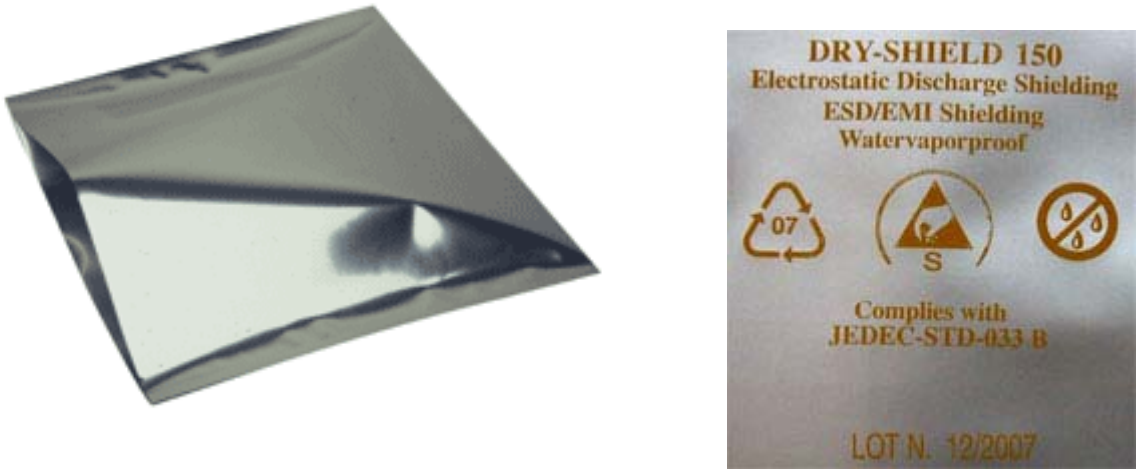


Figure 51: Moisture barrier bag (MBB) with imprint

The label shown in Figure 52 summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag.

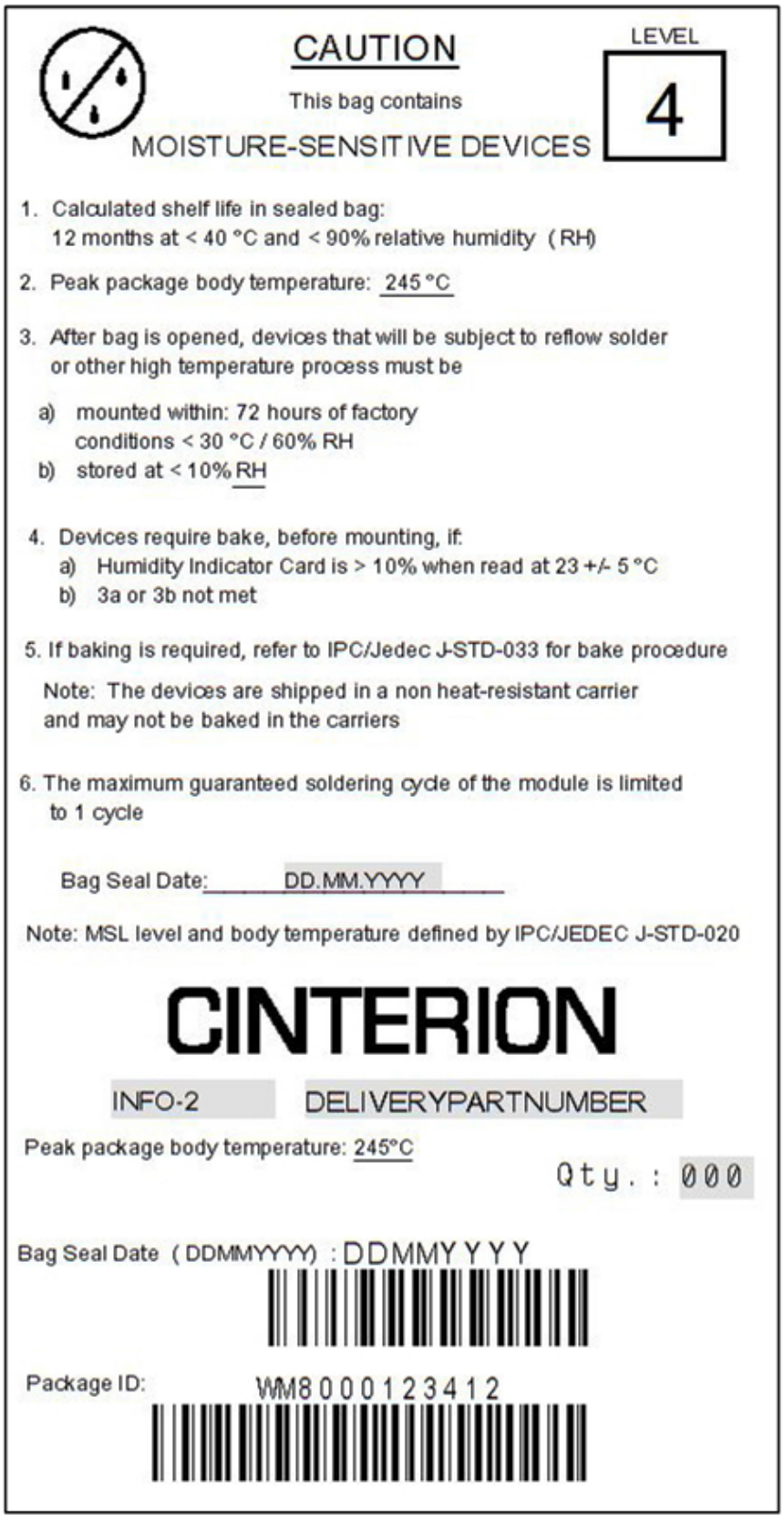


Figure 52: Moisture Sensitivity Label

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

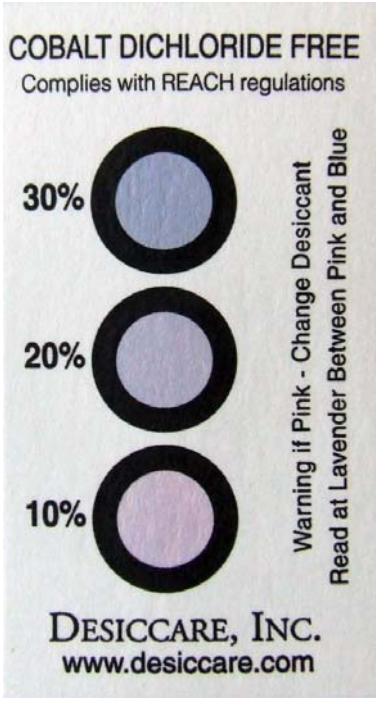


Figure 53: Humidity Indicator Card - HIC

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 modules each.

5 Regulatory and Type Approval Information

5.1 Directives and Standards

PLS62-W 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 "PLS62-W Hardware Interface Description".[1]

Table 17: 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)

Table 18: 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 Radiofrequency Electromagnetic Fields
UL 60 950-1	Product Safety Certification (Safety requirements)
NAPRD.03 V5.24	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132, RSS133, RSS139	Canadian Standard

Table 19: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
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
GCF-CC V3.62.1	Global Certification Forum - Certification Criteria

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 19: Standards of European type approval

Draft ETSI EN 301 489-01 V2.2.0	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
Draft 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 301 908-01 V11.1.1	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 V11.1.1	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 301 908-13 V11.1.1	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)
EN 60950-1:2006/ A11:2009+A1:2010+A12:2011+A2:2013	Safety of information technology equipment

Table 20: Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP codes

Table 21: 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).
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 Gemalto M2M Hardware Interface Description. Please see Table 22 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 22: 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.

5.2 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 PLS62-W 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. 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 Gemalto M2M reference setup submitted to type approve PLS62-W (including a special approval adapter for the DSB75) is shown in the following figure[1]:

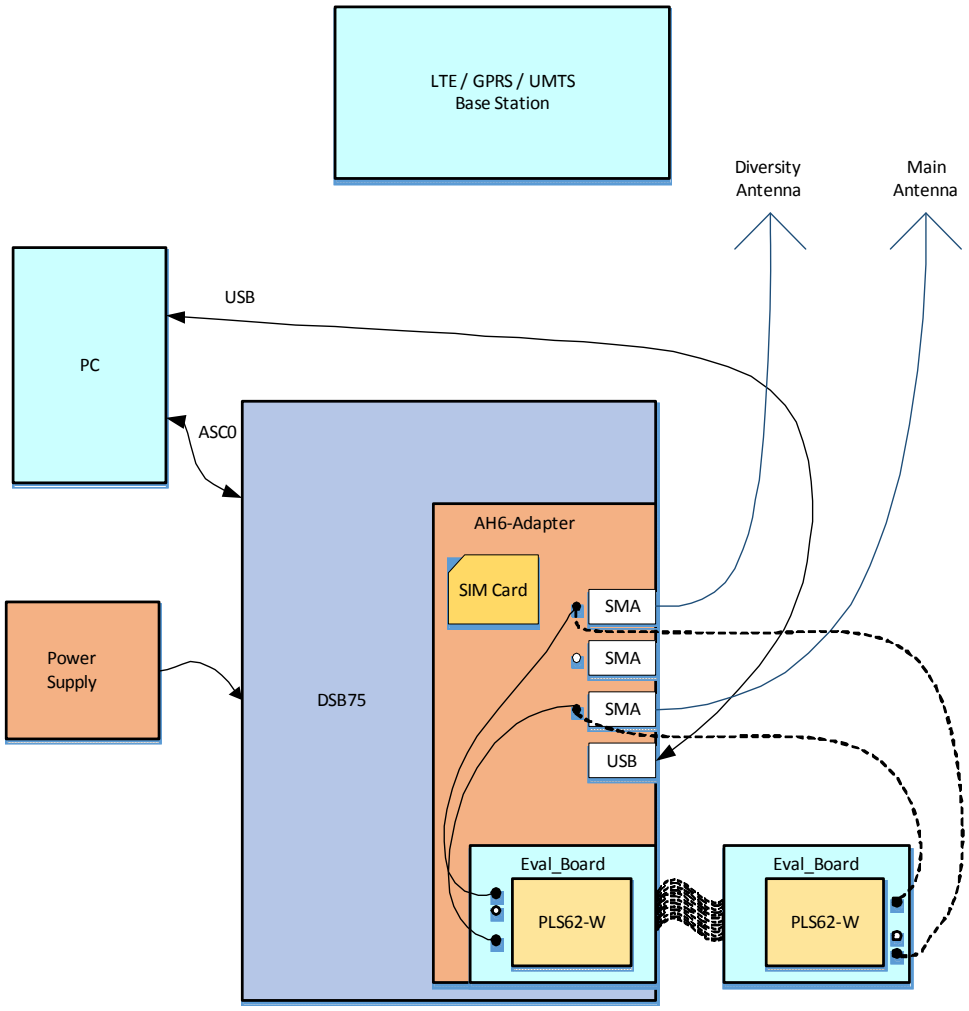


Figure 54: Reference equipment for Type Approval

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 PLS62-W-DSB75 adapter as shown in Figure 54. 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 Rules and Regulations

The Equipment Authorization Certification for the Gemalto M2M reference application described in Section 5.3 will be registered under the following identifiers:

FCC Identifier: QIPPLS62-W
Industry Canada Certification Number: 7830A-PLS62W
Granted to Gemalto M2M GmbH

Manufacturers of mobile or fixed devices incorporating PLS62-W modules are authorized to use the FCC Grants and Industry Canada Certificates of the PLS62-W 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: QIPPLS62-W", and accordingly "Contains IC: 7830A-PLS62W". 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 configurations the antenna gain, including cable loss, must not exceed the limits listed in the following Table 23 for FCC and IC.

Table 23: Antenna gain limits for FCC and IC

Operating band	FCC limit	IC limit	Unit
Maximum gain in LTE band1	5	5	dBi
Maximum gain in LTE band2	2.15	2.15	dBi
Maximum gain in LTE band3	5	5	dBi
Maximum gain in LTE band4	2.15	2.15	dBi
Maximum gain in LTE band5	5.15	5.15	dBi
Maximum gain in LTE band7	4.2	4.2	dBi
Maximum gain in LTE band8	4.2	4.2	dBi
Maximum gain in LTE band12	2	2	dBi
Maximum gain in LTE band18	5.15	5.15	dBi
Maximum gain in LTE band19	5.15	5.15	dBi
Maximum gain in LTE band20	5.15	5.15	dBi
Maximum gain in LTE band28	4.2	4.2	dBi
Maximum gain in GSM850	5.15	5.15	dBi
Maximum gain in GSM1900	2.15	2.15	dBi
Maximum gain in UMTE Band2	2.15	2.15	dBi
Maximum gain in UMTE Band 4	2.15	2.15	dBi
Maximum gain in UMTE Band 5	5.15	5.15	dBi

IMPORTANT:
Manufacturers of portable applications incorporating PLS62-W modules are required to have their final product certified and apply for their own FCC Grant related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Section 5.2 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. 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.

If Canadian approval is requested for devices incorporating ELS61-US 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 (IC):
(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 Industry Canada (IC) 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 IC 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‘Industry Canada (IC). 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).

6 Document Information

6.1 Revision History

Preceding document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.140
New document: "Cinterion® PLS62-W Hardware Interface Description" Version **00.140a**

Chapter	What is new
2.1.1	Revised properties for IGT, EMERG_OFF, and CCIN in Table 2.
2.3	Revised Figure 29.
3.2.3	Added IGT and EMERG_OFF to table showing signal states after startup.
3.5.1	Revised power consumption ratings.
3.5.2	Revised value for V_{BATT+}min (3.3V --> 3.0V).
5.3	Removed audio test system from Figure 54.

Preceding document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.090
New document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.140

Chapter	What is new
2.1.4	Revised maximum supported fixed baud rate for ASC0.
2.3	Revised UICC interface circuit illustrated in Figure 29.
5.4	Table 23 updated.

Preceding document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.080
New document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.090

Chapter	What is new
2.1	Revised characteristics for EMERG_OFF in Table 2.
2.1.6.1	Revised complete section SIM_SWITCH Line.
2.1.13.4	Revised state of IGT signal in description and Figure 20.

New document: "Cinterion® PLS62-W Hardware Interface Description" Version 00.080

Chapter	What is new
--	Initial document setup.

6.2 Related Documents

[1] PLS62-W AT Command Set
[2] PLS62-W Release Note
[3] Application Note 48: SMT Module Integration
[4] Application Note 40: Thermal Solutions
[5] Universal Serial Bus Specification Revision 2.0, April 27, 2000

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 PLS62-W
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. Gemalto M2M 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
RLS	Radio Link Stability
RMS	Root Mean Square (value)
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment.
ROM	Read-only Memory
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SAW	Surface Accoustic Wave
SELV	Safety Extra Low Voltage
SIM	Subscriber Identification Module
SMD	Surface Mount Device
SMS	Short Message Service
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
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 PLS62-W. 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. Gemalto M2M 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 24: List of parts and accessories

Description	Supplier	Ordering information
PLS62-W	Gemalto M2M	Standard module Gemalto M2M IMEI: Packaging unit (ordering) number: L30960-N4600-A100 Module label number: S30960-S4600-A100-1[1]
PLS62-W Evaluation Module	Gemalto M2M	Ordering number: L30960-N4601-A100 (PLS62-W)
DSB75 Evaluation Kit	Gemalto M2M	Ordering number: L36880-N8811-A100
DSB Mini Compact Evaluation Board	Gemalto M2M	Ordering number: L30960-N0030-A100
Starter Kit B80	Gemalto M2M	Ordering Number L30960-N0040-A100
Multi-Adapter R1 for mounting PLS62-W evaluation modules onto DSB75	Gemalto M2M	Ordering number: L30960-N0010-A100
Approval adapter for mounting PLS62-W evaluation modules onto DSB75	Gemalto M2M	Ordering number: L30960-N2301-A100
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 25.

1. Note: At the discretion of Gemalto M2M, 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 25: 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

About Gemalto

Since 1996, Gemalto has been pioneering groundbreaking M2M and IoT products that keep our customers on the leading edge of innovation.

We work closely with global mobile network operators to ensure that Cinterion® modules evolve in sync with wireless networks, providing a seamless migration path to protect your IoT technology investment.

Cinterion products integrate seamlessly with Gemalto identity modules, security solutions and licensing and monetization solutions, to streamline development timelines and provide cost efficiencies that improve the bottom line.

As an experienced software provider, we help customers manage connectivity, security and quality of service for the long lifecycle of IoT solutions.

For more information please visit
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