Cinterion® TX62/TX82

Hardware Interface Description

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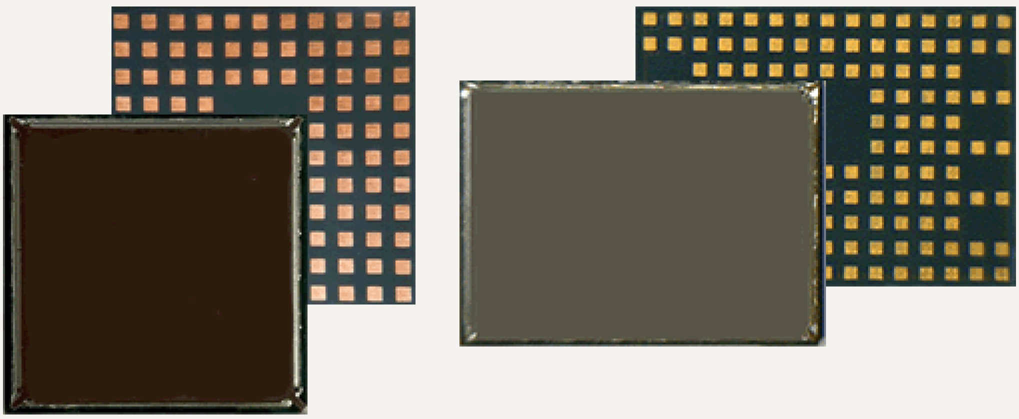

Document Name:	**Cinterion® TX62-W(-B/-C)/TX82-W Hardware Interface Description**
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1 Introduction

This document[1] describes the hardware of the Cinterion® TX62/TX82 module variants optimized for global coverage as they support a comprehensive set of bands required for global deployment. It helps you quickly retrieve interface specifications, electrical and mechanical details and information on the requirements to be considered for integrating further components.

Note: This Hardware Interface Description is an early draft version and as such subject to change depending on further implementation and measurements.

1.1 Product Variants

This document applies to the following Thales module variants:
- Cinterion® TX62-W (as of v01.000)
- Cinterion® TX62-W-B (as of v01.000)
- Cinterion® TX62-W-C (as of v00.168 Engineering Samples)
- Cinterion® TX82-W (as of v01.000)

Note: The TX62/TX82 variants differ in that TX82-W does support GSM (2G) whereas TX62-W, TX62-W-B and TX62-W-C do not support GSM (2G). TX62-W and TX62-W-B/TX62-W-C differ in their RF output power. TX62-W-C supports additional 450MHz bands compared to TX62-W-B. Also, TX82-W, TX62-W-B and TX62-W-C have a different (larger) footprint then TX62-W. Wherever necessary a note is made to differentiate between the product variants.

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

1.2 Key Features at a Glance

Feature	Implementation
General	
Frequency bands (see Section 2.2.1)	GSM (TX82-W only): 850/900/1800/1900 LTE Cat M1 (TX82-W, TX62-W, TX62-W-B): 700 (Bd12, Bd13, Bd28, Bd85), 800 (Bd18, Bd19, Bd20, Bd26, Bd27), 850 (Bd5), 900 (Bd8), AWS-3 (Bd66), AWS-1 (Bd4), 1800 (Bd3), 1900 (Bd2, Bd25), 2100 (Bd1) LTE Cat NB1/2: (TX82-W, TX62-W, TX62-W-B): 600 (Bd71), 700 (Bd12, Bd13, Bd28, Bd85), 800 (Bd18, Bd19, Bd20, Bd26), 850 (Bd5), 900 (Bd8), AWS-3 (Bd66), AWS-1 (Bd4), 1800 (Bd3), 1900 (Bd2, Bd25), 2100 (Bd1) LTE Cat M1 (TX62-W-C): 450 (Bd31, Bd72), 700 (Bd12, Bd13, Bd28, Bd85), 800 (Bd18, Bd19, Bd20, Bd26, Bd27), 850 (Bd5), 900 (Bd8), AWS-3 (Bd66), AWS-1 (Bd4), 1800 (Bd3), 1900 (Bd2, Bd25), 2100 (Bd1) LTE Cat NB1/2 (TX62-W-C): 450 (Bd31, Bd72), 700 (Bd12, Bd13, Bd28, Bd85), 800 (Bd18, Bd19, Bd20, Bd26), 850 (Bd5), 900 (Bd8), AWS-3 (Bd66), AWS-1 (Bd4), 1800 (Bd3), 1900 (Bd2, Bd25), 2100 (Bd1)
GSM class	Small MS
Output power (according to Release 7)	GSM/GPRS (TX82-W only): Class 4 (+33dBm ±2dB) for GSM850 and GSM900 Class 1 (+30dBm ±2dB) for GSM1800 and GSM1900 Class E2 (+27dBm ± 3dB) for GSM850 8-PSK and GSM 900 8-PSK Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK and GSM1900 8-PSK
Output power (according to 3GPP Release 13)	TX62-W and TX82-W: LTE Cat M1: Class 5 (+20dBm ±2dB) for all supported LTE Cat M1 bands LTE Cat NB1/2: Class 5 (+20dBm ±2dB) for all supported LTE Cat NB1/2 bands TX62-W-B: LTE Cat M1: Class 3 (+23dBm ±2dB) for all supported LTE Cat M1 bands LTE Cat NB1/2: Class 3 (+23dBm ±2dB) for all supported LTE Cat NB1/2 bands TX62-W-C: LTE Cat M1: Class 2 (+26dBm ±2dB) for LTE CAT M1 bands Bd31, Bd72 Class 3 (+23dBm ±2dB) for all other supported LTE Cat M1 bands LTE Cat NB1/2: Class 3 (+23dBm ±2dB) for all supported LTE Cat NB1/2 bands

Feature	Implementation
Power supply (see Section 2.1.2 and Section 3.4)	TX82-W: - LTE and GSM: 3.1V to 4.6V - LTE with GSM deactivated: 2.8V to 4.6V TX62-W: - LTE: 2.55V to 4.8V TX62-W-B: - LTE: 2.5V to 4.5V TX62-W-C: - LTE: 3.2V to 4.2V
Operating temperature (board temperature) (see Section 3.5)	Normal operation: -30°C to +85°C Extended operation: -40°C to +90°C
Physical (see Section 4.1)	Dimensions: TX62-W: 15.3 mm x 15.3 mm x 2.9 mm TX82-W, TX62-W-B and TX62-W-C: 15.3 mm x 20.9 mm x 2.28 mm Weight: approx. 2.5g
RoHS (see Section 5.1)	All hardware components fully compliant with EU RoHS Directive
LTE features	
3GPP Release 14	LTE Cat M1 (HD-FDD) DL: max. 300kbps, UL: max. 1.1Mbps LTE Cat NB1 (HD-FDD) DL: max. 27kbps, UL: max. 63kbps LTE Cat NB2 (HD-FDD) DL: max. 124kbps, UL: max. 158kbps

Feature	Implementation
GSM/GPRS/EGPRS features	
Data transfer	GPRS (TX82-W only): • Multislot Class 10 • Full PBCCH support • Mobile Station Class B • Coding Scheme 1 – 4 EGPRS (TX82-W only): • Multislot Class 10 • 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 Text and PDU mode Storage: SIM card plus SMS locations in mobile equipment
GNSS Features	
Modes (see Section 2.3)	Standalone GNSS (GPS, GLONASS, BeiDou, Galileo)
Protocol	NMEA (for GNSS related sentences)
General	Automatic power saving modes
Software	
AT commands	Hayes 3GPP TS 27.007, TS 27.005, Thales AT commands for RIL compatibility
Embedded processing platform **(optional)**	Embedded processing option with API. Memory space available for embedded applications is 512KB for application code, 512KB for File System and 672KB for RAM. Please take into account that the application code is copied into RAM. For more details, please consult software documentation.
SIM Application Toolkit	SAT Release 99
Firmware update	Firmware update from external application over ASC0 and ASC1 interface.
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 [5]. This application note comprises chapters on mounting and application layout issues as well as on additional SMT application development equipment.
USB (see Section 2.1.3)	USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant

Feature	Implementation
2 serial interfaces (see Section 2.1.4 and Section 2.1.5)	ASC0: • 8-wire modem interface with status and control lines, unbalanced, asynchronous • Adjustable baud rates: 300bps to 921,600bps • Supports RTS0/CTS0 hardware flow control (as configuration option). ASC1: • 4-wire, unbalanced asynchronous modem interface • Adjustable baud rates: 300bps to 921,600bps • Supports RTS1/CTS1 hardware flow control (as configuration option).
UICC interface (see Section 2.1.6)	Supported SIM/USIM cards: 1.8V
eUICC interface (see Section 2.1.7	Supports embedded MFF-XS UICC interface (as an option).
GPIO interface (see Section 2.1.8)	TX62-W: 6 I/O pins of the application interface programmable as GPIO. Programming can be done via AT commands. TX82-W, TX62-W-B and TX62-W-C: 7 I/O pins of the application interface programmable as GPIO. Programming can be done via AT commands. With the embedded processing option 12 (TX62-W) or 13 (TX82-W, TX62-W-B and TX62-W-C) I/O pads are programmable as GPIOs and may be shared with other functions (ASC0, ASC1/SPI, fast shutdown, and status).
Status (see Section 2.1.11.1)	Supports status indication LED.
Fast shutdown (see Section 2.1.11.3)	Supports fast shutdown interrupt signal.
ADC Input	Analog-to-Digital Converter with one unbalanced analog inputs
SIM switch (see Section 2.1.11.4)	Supports signal to switch between two externally connected SIMs.
Antenna interface pads (see Section 2.2)	50Ω. GSM/LTE Main antenna, GNSS antenna
I^2C interface (see Section 2.1.9)	I^2C interface only available with embedded processing option.
SPI interface (see Section 2.1.10)	SPI interface only available with embedded processing option.
Power on/off, Reset	
Power on/off	Switch-on by hardware signal ON Switch-off by AT command and hardware signal FST_SHDN Automatic switch-off in case of critical voltage conditions
Reset	Orderly shutdown and reset by AT command Emergency reset by hardware signal EMERG_RST

Feature	Implementation
Special features	
Approval (see Section 5)	RED, CE, FCC, ISED, UL, RoHS, and REACH compliant GCF, PTCRB
Phonebook	SIM and phone
Cinterion® IoT Suite services	(Optionally) supports an IoT Suite client based on the LWM2M protocol. The client can be configured to collect diagnostic information about the module and cellular network and to send it periodically to the Cinterion® IoT Suite server platform, where it can be visualized for further analysis. Communication to Thales Device Management Hub is realized using a resource-efficient protocol specifically designed by Thales in order to keep the energy and data usage to a minimum. The protocol behavior may be influenced by means of configuration. Additionally, the service provides device control functionality. This includes remote flash file system management, module firmware over-the-air updates (FOTA) and remote configuration. The Cinterion® IoT Suite also generates alarms when a specific module or network parameter changes or exceeds a threshold. Alarms can be sent to the platform as soon as possible disregarding the connection interval. For more information, please refer to [7].
Evaluation kit (For ordering information see Section 7.1)	
LGA DevKit	LGA DevKit designed to test Thales LGA modules. For more information see also LGA DevKit.
Evaluation module	TX62/TX82 module soldered onto a dedicated PCB that can be connected to the an approval adapter in order to be mounted onto the DSB75 or DSB-Mini.
DSB75	DSB75 Development Support Board designed to test and type approve Thales modules and provide a sample configuration for application engineering. A special adapter is required to connect the TX62/TX82 evaluation module to the DSB75.

1.3 TX62/TX82 System Overview

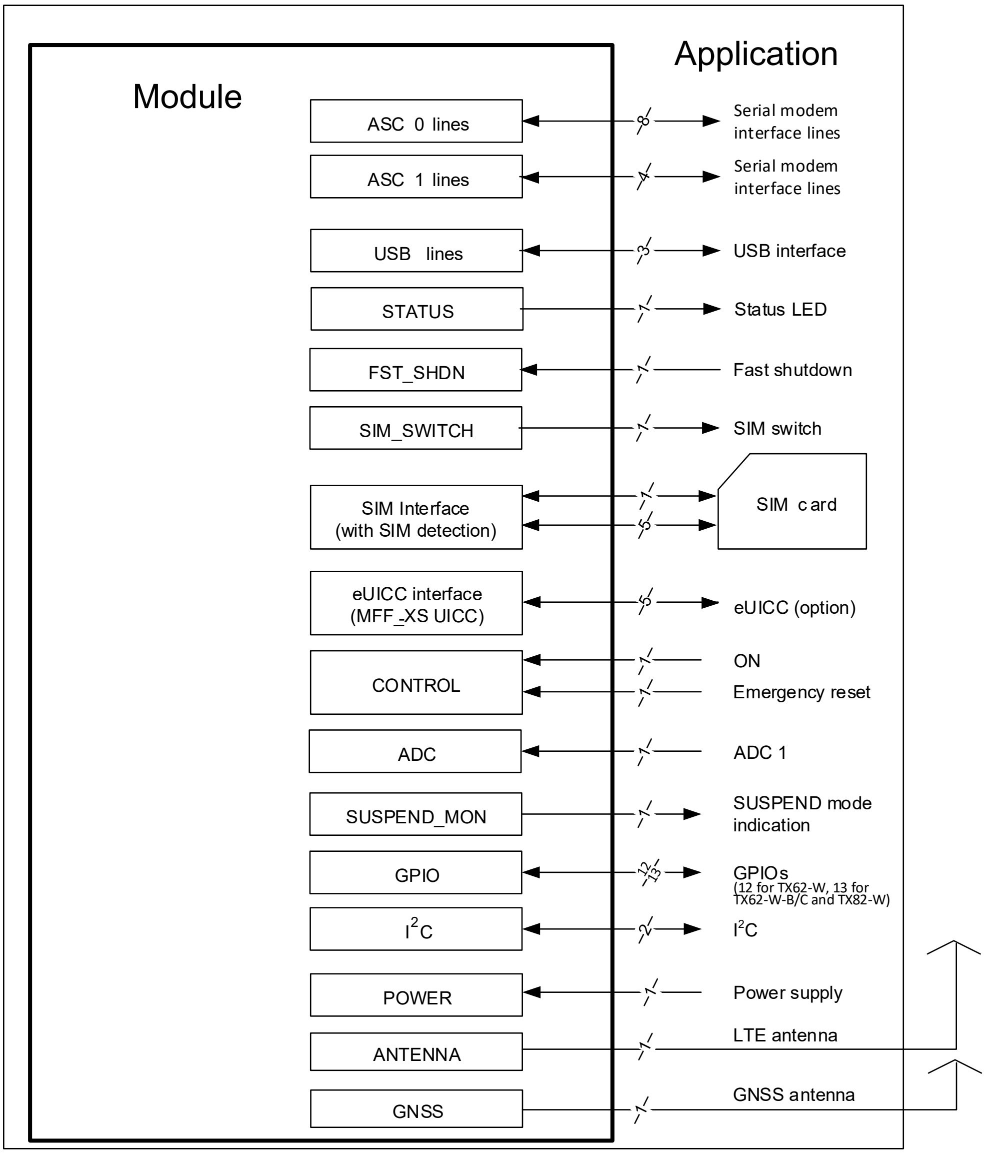


Figure 1: TX62/TX82 system overview

Please note that the I^2C function and some GPIO lines are available with the embedded processing option only. Also, some GPIO lines may be shared with further functions that are also only available with the embedded processing option. For details see Section 2.1, and Section 2.1.8.1.

1.4 Circuit Concept

Figure 2, Figure 3, Figure 4 and Figure 5 show block diagrams for the TX62/TX82 module variants, and illustrate the major functional components:

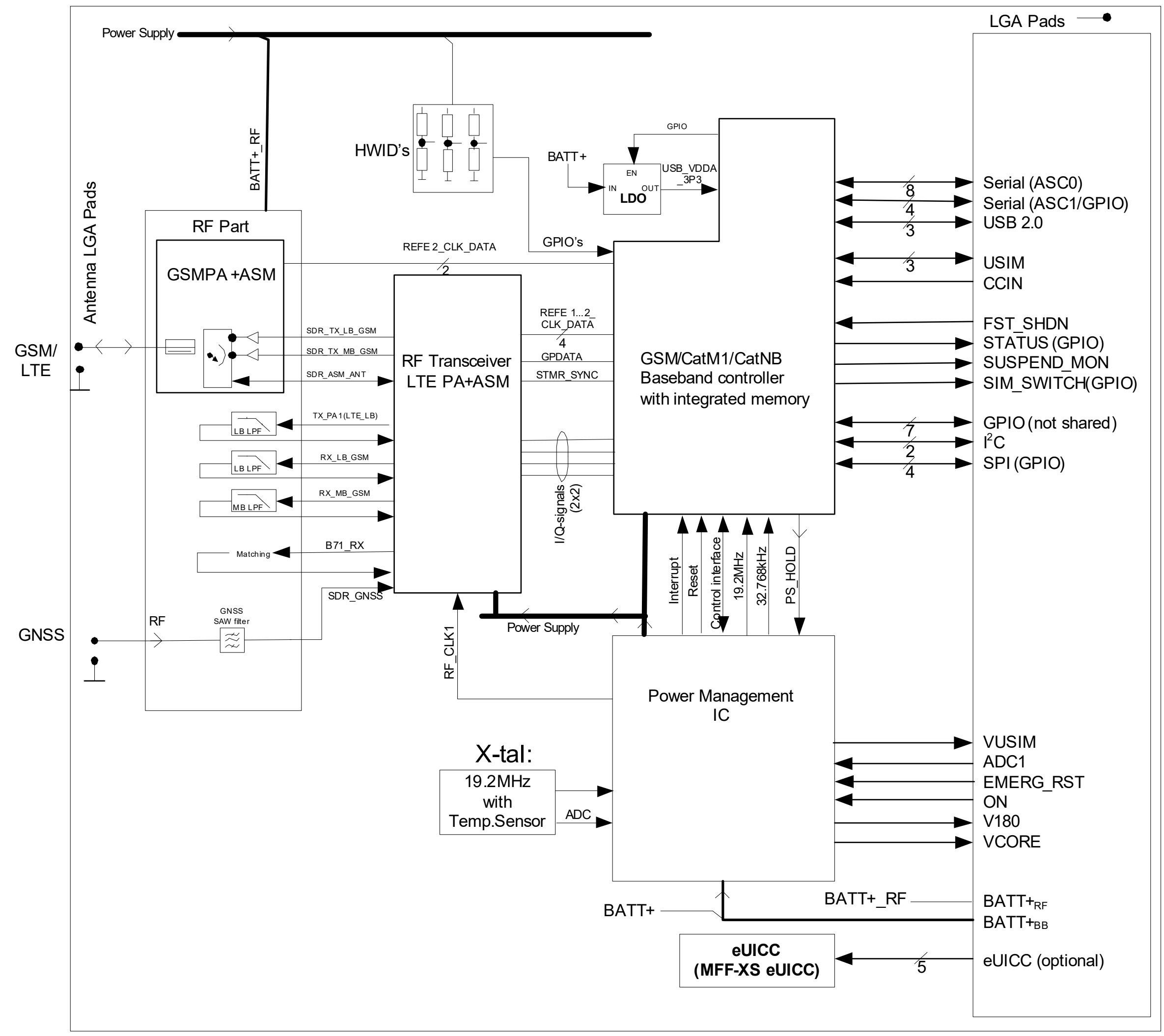


Figure 2: TX82-W block diagram

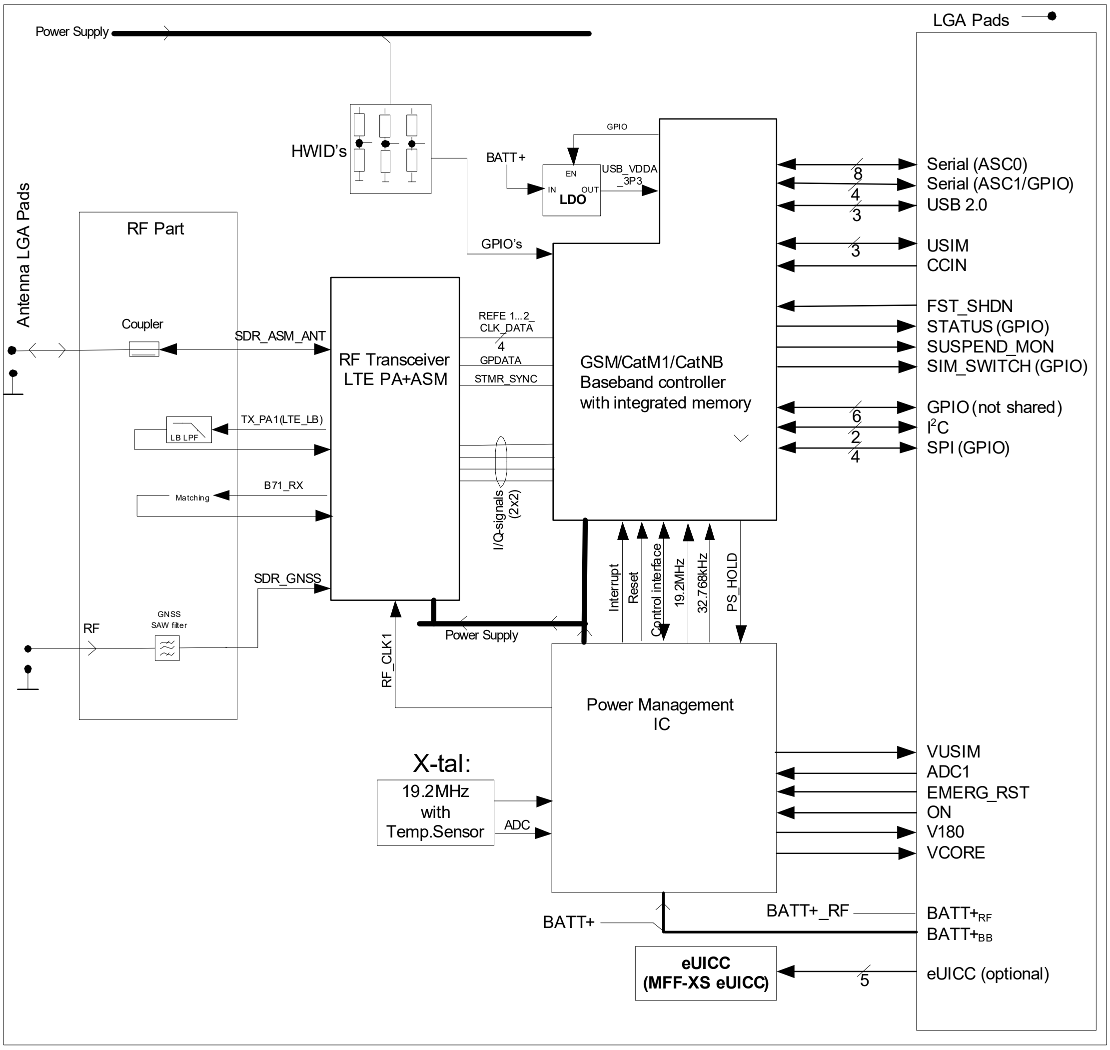


Figure 3: TX62-W block diagram

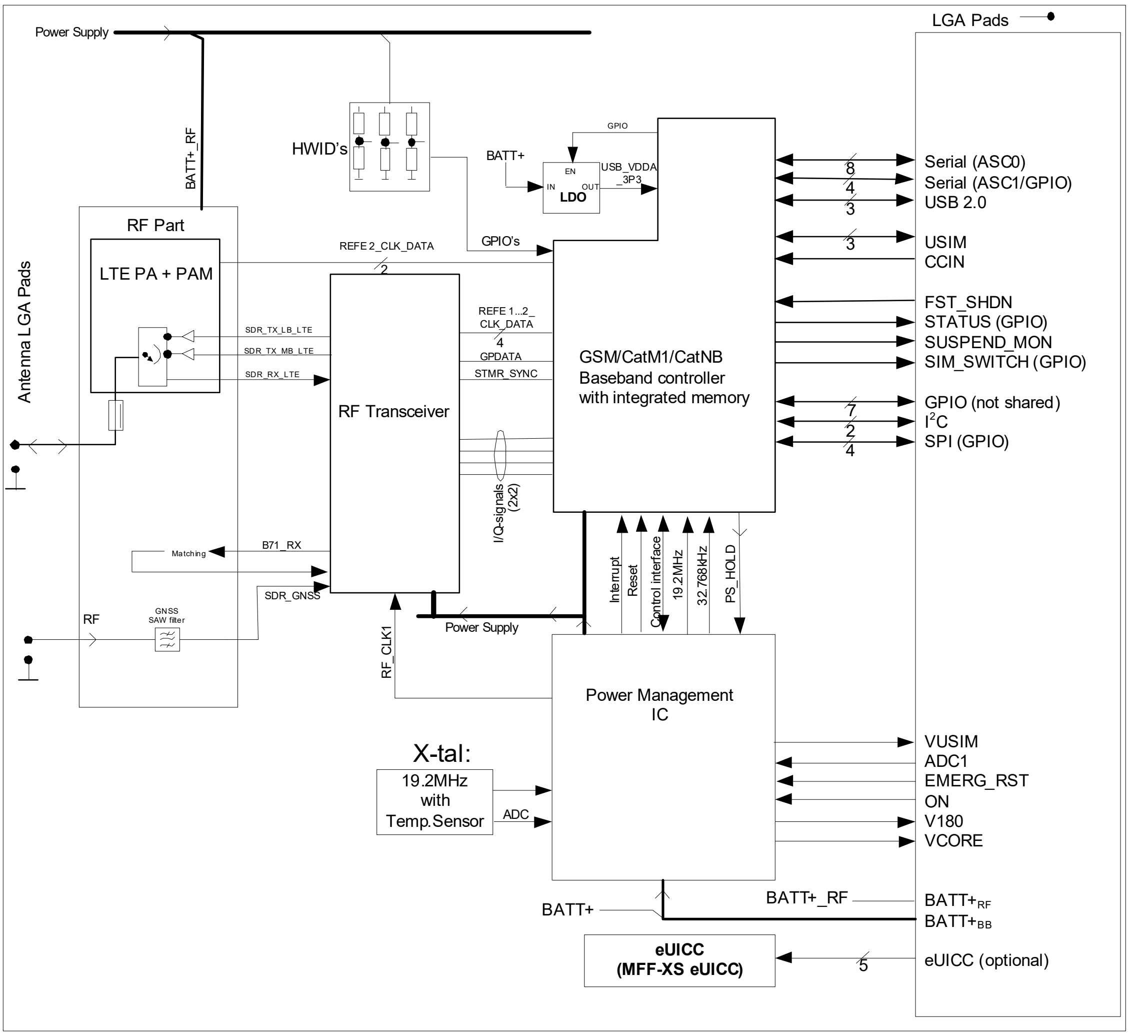


Figure 4: TX62-W-B block diagram

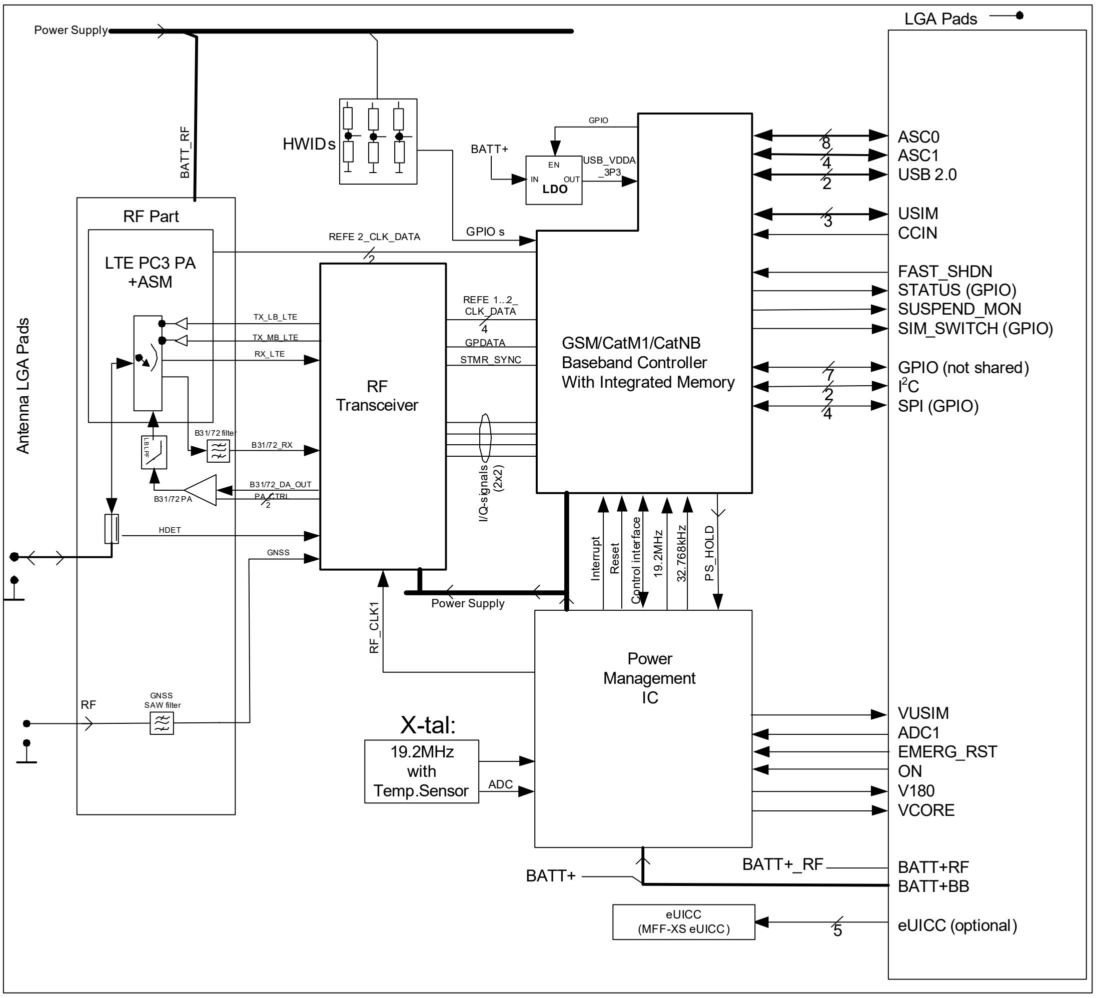


Figure 5: TX62-W-C block diagram

Please note that the I²C function and some GPIO lines are available with the embedded processing option only. Also, some GPIO lines may be shared with further functions that are also only available with the embedded processing option. For details see Section 2.1, and Section 2.1.8.1.

2 Interface Characteristics

TX62/TX82 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 TX62/TX82 provides connecting pads to integrate the module into external applications. The pads listed in Table 1 apply only to TX82-W and TX62-W-B and TX62-W-C. Table 2 lists the common pads of TX62/TX82. Figure 7 (bottom view) and Figure 6 (top view) show the connecting pads' numbering plan of TX62-W (pads inside dark violet rectangle) as well as TX82-W, TX62-W-B and TX62-W-C (pads inside light violet rectangle).

As a rule all pads should be soldered for mechanical stability and heat dissipation.

Signal pads that are not used, i.e., marked as "rfu" (reserved for future use) or "nc" (not connected), need to be soldered, but should not have an electrical connection to the external application or GND. Also, pads marked as "rfu" are further qualified as "dnu" (do not use), indicating that they are currently not supported, but internally connected for possible future usage. In addition, pads mentioned in squared brackets (I2CDAT and I2CCLK pads, SPI pads, as well as shared GPIO pads) are available with the embedded processing option only.

Please note that the reference voltages listed in Table 3 are the values measured directly on the TX62/TX82 module. They do not apply to the accessories connected.

Note: Thales strongly recommends to provide test points for certain signal lines to and from the module while developing SMT applications – for debug, test and/or trace purposes during the manufacturing process. In this way it is possible to detect soldering (and other) problems. Please refer to [5] and [6] for more information on test points and how to implement them. The signal lines for which test points should be provided for are marked as "Test point recommended" in Table 3.

Table 1: Overview: Pad assignments TX82-W, TX62-W-B and TX62-W-C additional pads[1]

Pad no.	Signal name	Pad no.	Signal name	Pad no.	Signal name
B5	GND	E18	nc	L5	nc
B6	nc	E19	nc	L6	nc
B18	nc	G5	nc	L18	nc
B19	GND	G6	rfu (dnu)	L19	nc
C5	nc	G18	nc	M5	GND
C6	nc	G19	nc	M6	nc
C18	nc	J5	nc	M18	nc
C19	nc	J6	nc	M19	GND
E5	nc	J18	nc		
E6	GPIO6	J19	nc		

1. rfu = reserved for future use, i.e., currently not supported; dnu = do not use; nc = internally not connected

Table 2: Overview: Pad assignments common to TX62/TX82[1] [2]

Pad no.	Signal name	Pad no.	Signal name	Pad no.	Signal name
B7	GND	E12	rfu (dnu)	J15	V180
B8	GND	E13	rfu (dnu)	J16	GND
B9	GNSS_ANT	E14	GND	J17	CC2_VPP
B10	GND	E15	EMERG_RST	K7	nc
B11	GND	E16	VCORE	K8	RTS1 [GPIO18/SPI_CS]
B12	RF_OUT	E17	nc	K9	STATUS [GPIO5]
B13	GND	F7	GND	K10	FST_SHDN
B14	GND	F8	GPIO25	K11	nc
B15	rfu (dnu)	F9	SUSPEND_MON	K12	RING0
B16	GND	F10	GND	K13	DTR0
B17	GND	F11	rfu (dnu)	K14	DCD0
C7	rfu (dnu)	F12	rfu (dnu)	K15	CCCLK
C8	SIM_SWITCH [GPIO8]	F13	rfu (dnu)	K16	rfu (dnu)
C9	GND	F14	GND	K17	CC2_CLK
C10	GND	F15	ADC1	L7	nc
C11	GND	F16	nc	L8	TXD1 [GPIO17/MISO]
C12	GND	F17	GND	L9	VUSB_IN
C13	GND	G7	nc	L10	rfu (dnu)
C14	GND	G8	GPIO20	L11	DSR0
C15	GND	G9	nc	L12	RTS0
C16	GND	G10	GND	L13	CTS0
C17	nc	G14	GND	L14	CCVCC
D7	rfu (dnu)	G15	$BATT+_{RF}$[3]	L15	CCRST
D8	GPIO22	G16	$BATT+_{RF}$[3]	L16	CC2_VCC
D9	nc	G17	nc	L17	CC2_RST
D10	GND	H7	nc	M7	GND
D11	GND	H8	GPIO23	M8	GND
D12	GND	H9	[I2CDAT]	M9	USB_DP
D13	GND	H10	[I2CCLK]	M10	USB_DN
D14	GND	H14	GND	M11	GND
D15	ON	H15	$BATT+_{BB}$	M12	RXD0
D16	nc	H16	$BATT+_{BB}$	M13	TXD0
D17	nc	H17	nc	M14	CCIO
E7	GPIO7	J7	nc	M15	CCIN
E8	GPIO21	J8	CTS1 [GPIO19/SPI_CLK]	M16	CC2_IO
E9	rfu (dnu)	J9	RXD1 [GPIO16/MOSI]	M17	GND
E10	GND	J10	GND		
E11	rfu (dnu)	J14	rfu (dnu)		

1. rfu = reserved for future use, i.e., currently not supported; dnu = do not use; nc = internally not connected
2. Pads mentioned in squared brackets (I2CDAT and I2CCLK pads, SPI pads as well as shared GPIO pads) are available with the embedded processing option only.
3. Available with TX82-W, TX62-W-B, TX62-W-C. Internally not connected with TX62-W.

	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5
M	GND	nc	GND	CC2_IO	CCIN	CCIO	TXD0	RXD0	GND	USB_DN	USB_DP	GND	GND	nc	GND
L	nc	nc	CC2_RST	CC2_VCC	CCRST	CCVCC	CTS0	RST0	DSR0	rfu (dnu)	VUSB_IN	TXD1 [GPIO17/ MISO]	nc	nc	nc
K			CC2_CLK	rfu (dnu)	CCCLK	DCD0	DTR0	RING0	nc	FST_SHDN	STATUS [GPIO5]	RTS1 [GPIO18/ SPI_CS]	nc		
J	nc	nc	CC2_VPP	GND	V180	nc	Reserved for future use			GND	RXD1 [GPIO16/ MOSI]	CTS1 [GPIO19/ SPI_CLK]	nc	nc	nc
H			nc	$BATT+_{BB}$	$BATT+_{BB}$	GND				[I2CCLK]	[I2CDAT]	GPIO23	nc		
G	nc	nc	nc	$BATT+_{RF}$	$BATT+_{RF}$	GND	Marking			GND	nc	GPIO20	nc		
F			GND	nc	ADC1	GND	rfu (dnu)	rfu (dnu)	rfu (dnu)	GND	SUSPEND_MON	GPIO25	GND		
E	nc	nc	nc	VCORE	EMERG_RST	GND	rfu (dnu)	rfu (dnu)	rfu (dnu)	GND	rfu (dnu)	GPIO21	GPIO7	GPIO6	nc
D			nc	nc	ON	GND	GND	GND	GND	GND	nc	GPIO22	rfu (dnu)		
C	nc	nc	nc	GND	GND	GND	GND	GND	GND	GND	GND	SIM_SWITCH [GPIO8]	rfu (dnu)	nc	nc
B	GND	rfu (dnu)	GND	GND	nc	GND	GND	RF_OUT	GND	GND	GNSS_ANT	GND	GND	nc	GND

Figure 6: TX62/TX82 top view: Pad assignments

	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
M	GND	nc	GND	GND	USB_DP	USB_DN	GND	RXD0	TXD0	CCIO	CCIN	CC2_IO	GND	nc	GND
L	nc	nc	nc	TXD1 [GPIO17/ MISO]	VUSB _IN	rfu (dnu)	DSR0	RST0	CTS0	CCVCC	CCRST	CC2_VCC	CC2_RST	nc	nc
K			nc	RTS1 [GPIO18/ SPI_CS]	STATUS [GPIO5]	FST_SHDN	nc	RING0	DTR0	DCD0	CCCLK	rfu (dnu)	CC2_CLK		
J	nc	nc	nc	CTS1 [GPIO19/ SPI_CLK]	RXD1 [GPIO16/ MOSI]	GND	Reserved for future use			nc	V180	GND	CC2_VPP	nc	nc
H			nc	GPIO23	[I2CDAT]	[I2CCLK]				GND	$BATT+_{BB}$	$BATT+_{BB}$	nc		
G	nc	rfu (dnu)	nc	GPIO20	nc	GND	Marking			GND	$BATT+_{RF}$	$BATT+_{RF}$	nc		
F			GND	GPIO25	SUSPEND _MON	GND	rfu (dnu)	rfu (dnu)	rfu (dnu)	GND	ADC1	nc	GND		
E	nc	GPIO6	GPIO7	GPIO21	rfu (dnu)	GND	rfu (dnu)	rfu (dnu)	rfu (dnu)	GND	EMERG_ RST	VCORE	nc	nc	nc
D			rfu (dnu)	GPIO22	nc	GND	GND	GND	GND	GND	ON	nc	nc		
C	nc	nc	rfu (dnu)	SIM_SWITCH [GPIO8]	GND	GND	GND	GND	GND	GND	GND	GND	nc	nc	nc
B	GND	nc	GND	GND	GNSS _ANT	GND	GND	RF_OUT	GND	GND	nc	nc GND	GND	ADC2	GND

Figure 7: TX62/TX82 bottom view: Pad assignments

2.1.2 Signal Properties

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Power supply	BATT+$_{BB}$ BATT+$_{RF}$	I	*Normal voltage range:* TX82-W (LTE and GSM): $V_I$min = 3.1 V...$V_I$max = 4.6V during Tx burst on board Imax = 2A, during Tx burst (GSM) __|‾‾|____|‾‾|__ N Tx = n ∗ 577µs peak current every 4.616ms TX82-W (LTE with GSM deactivated): $V_I$min = 2.8 V...$V_I$max = 4.6V TX62-W (LTE): $V_I$min = 2.55 V...$V_I$max = 4.8V TX62-W-B (LTE): $V_I$min = 2.5 V...$V_I$max = 4.5V TX62-W-C (LTE): $V_I$min = 3.2 V...$V_I$max = 4.2V All products: $V_I$norm = 3.8V $I_{Power\ Down}$ = 14µA *Extended voltage range:* All products: $V_I$min = 2.5 V...$V_I$max = 4.8V	Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur. BATT+$_{BB}$ at solder pads needs an additional low ESR 47µF capacitor (e.g, X7R MLCC, taking DCbias into account). BATT+$_{RF}$ at solder pads needs an additional low ESR 150µF capacitor (e.g, X7R MLCC, taking DCbias into account) - except for TX62-W, as in this case BATT+RF is internally not connected. A minimum ESR value <70mΩ is recommended. Minimum voltage must not fall below the specified normal minimum voltage including drops, ripple, spikes. Else the module may perform an uncontrolled shutdown. However, if using the extended voltage range, i.e., down to 2.5V or up to 4.8V, the module remains fully functional and safe while possibly no longer being fully compliant with 3GPP or other wireless standards. Please **note** that the module is in this case switched on at a voltage of >2.65V. Please **note** that if both voltage domains and power supply lines are referred to - i.e., BATT+$_{BB}$ *and* BATT+$_{RF}$ - BATT+ is used throughout the document.
Power supply	GND		Ground	Application Ground

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
External supply voltage	V180	O	Normal operation: $V_O$norm = 1.80V ±2% $I_O$max = 10mA SLEEP mode Operation: V_OSleep = 1.80V ±3.7% $I_O$max = 10mA SUSPEND mode Operation: V_OSuspend = 0V $C_I$max = 1µF	V180 has to be used for the power indication circuit. V180 can also be used to supply level shifters at the interfaces. Test point recommended[1].
	VCORE	O	Normal Operation: $V_O$nom = 1.128V ±2% $I_O$max = 10mA SLEEP Mode Operation: $V_O$sleep = 0.5V...1.304V ±3% $I_O$max = 10mA SUSPEND Mode Operation: $V_O$suspend = 0V $C_I$max = 100nF	Test point recommended.
Ignition	ON	I	V_{IH}max = BATT+$_{BB}$ V_{IH}min = 1.3V V_{IL}max = 0.5V High level pulse width > 30ms ON ___|‾‾‾	This signal switches the module on. The ON signal is low to high edge sensitive triggered, and requires a 10k pull down resistor. Test point recommended.
Status	STATUS	O	V_{OL}max = 0.45V at I = 4.5 mA V_{OH}min = 1.20V at I = 2.5 mA V_{OH}max = 1.95V	If unused keep lines open. With the embedded processing option this line is also available as GPIO: STATUS --> GPIO5
Fast shutdown	FST_SHDN	I	V_{IL}max = 0.5V V_{IH}min = 1.3V V_{IH}max = 1.95V	If unused keep lines open. Fast shutdown period <15ms.

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
Emergency reset	EMERG_RST	I	$R_I \approx 1k\Omega$, $C_I \approx 1nF$ (internal low pass filter) $V_{IH}min = 1.3V$ $V_{IL}max = 0.5V$ at ~1µA ¯¯|___|¯¯ low impulse width > 800ms	This line must be driven low by an open drain or open collector driver connected to GND. If unused keep lines open. Test point recommended.
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. Used for tracing purposes only. Test points recommended.
	USB_DN	I/O	Full and high speed signal characteristics according USB 2.0 Specification.	
	USB_DP			
Serial Modem Interface ASC0	RXD0	O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$	If unused keep lines open. RTS0 can be used to wakeup the module from SLEEP mode, but not from SUSPEND/PSM mode. Test points recommended for RXD0, TXD0, RTS0, and CTS0.
	CTS0	O		
	DSR0	O		
	DCD0	O		
	RING0	O		
	TXD0	I	$V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	
	RTS0	I		
	DTR0	I		
Serial Modem Interface ASC1	RXD1	O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$	If unused keep lines open. Test points recommended for RXD1, TXD1, RTS1, and CTS1. With embedded processing option ASC1 lines are shared with SPI interface lines, see Section 2.1.8.
	CTS1	O		
	TXD1	I	$V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	
	RTS1	I		

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
SIM card detection	CCIN	I	Internal pull down resistor: 100k $R_I \approx 110k\Omega$ $V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	CCIN = High, SIM card inserted. If unused keep line open.
1.8V SIM Card Interface	CCVCC	O	$V_Omin = 1.5V$ $V_Otyp = 1.8V$ $V_Omax = 2V$ $I_Omax = -60mA$	Maximum cable length or copper track to SIM card holder should not exceed 100mm. For more information on how to connect the SIM interface pads including possible external capacitors and ESD protection please refer to Section 2.1.6.
	CCRST CCCLK	O O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$	
	CCIO	I/O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$ $V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
1.8V eUICC interface	CC2_VPP	--	Used for single wire protocol (SWP NFC) in MFF-XS eUICC.	SWP NFC is currently not supported and deactivated for the eUICC. Thus, there are two options: If an external SWP master is connected nevertheless (or for future use) the CC2_VPP line should be pulled up by an external 10k resistor to VCC. If there is no plan to use SWP the CC2_VPP line can be grounded.
	CC2_VCC	I	$V_I$min = 1.62V $V_I$typ = 1.8V $V_I$max = 1.98V	Maximum cable length or copper track should be no longer as 100mm to eUICC interface. The signals CC2_RST, CC2_IO, CC2_CLK and CC2_VCC are protected against ESD with a special diode array. If unused keep lines open.
	CC2_CLK	I	V_{IL}max = 0.2*CC2_VCC (at I_{OL}max = -200µA) V_{IL}min = -0.3V (at I_{OL} max = -200µA) V_{IH}max=CC2_VCC+0.3V (at I_{OH}max = +20µA) V_{IH}min = 0.8*CC2_VCC (at I_{OH}max = +20µA)	
	CC2_RST	I	V_{IL}max = 0.2*CC2_VCC (at I_{OL}max = -20µA) V_{IL}min = -0.3V (at I_{OL} max = -20µA) V_{IH}max=CC2_VCC+0.3V (at I_{OH}max = +20µA) V_{IH}min = 0.7*CC2_VCC (at I_{OH}max = +20µA)	
	CC2_IO	I/O	V_{IL}max = 0.2*CC2_VCC (at I_{IH} = +1mA/+20µA) V_{IL}min = -0.3V (at I_{IH} = +1mA/+20 µA) V_{IH}min = 0.7*CC2_VCC (at I_{IH} = -20/+20µA) V_{IH}max = CC2_VCC+0.3V (at I_{IH} = -20/+20µA) V_{OL}max = 0.15*CC2_VCC (at I_{OL} = -1mA) V_{OH}min = 0.7*CC2_VCC (at I_{IH} = -20/+20µA) V_{OH}max = CC2_VCC+0.3V (at I_{IH} = -20/+20µA)	
SIM switch	SIM_SWITCH	O	V_{OL}max = 0.45V at I = 4.5 mA V_{OH}min = 1.20V at I = 2.5 mA V_{OH}max = 1.95V	If unused keep lines open. With embedded processing option SIM_SWITCH is shared with GPIO8, see Section 2.1.8.

Table 3: Signal properties

Function	Signal name	IO	Signal form and level	Comment
I^2C	I2CDAT	I/O	No internal pull up resistors $V_{OL}max = 0.45V$ at Imax = -4.5mA $V_{OH}max = 1.95V$ $V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$ Note: Imax = I max external + I pull up	If unused keep lines open. Compatible with I^2C Bus Specification Version 5.0. Multimaster is not supported. The value of the pull-up depends on the capacitive load of the whole system (I^2C Slave + lines). Only available with embedded processing option.
	I2CCLK	O		
GPIO	GPIO6-GPIO7, GPIO20-GPIO23, GPIO25	I/O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$ $V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	If unused keep lines open. GPIO6 only available on TX82-W, TX62-W-B and TX62-W-C. Further GPIOs shared with other functions are available with embedded processing option (see Section 2.1.8).
SPI	SPI_CLK	O	$V_{OL}max = 0.45V$ at I = 4.5mA $V_{OH}min = 1.20V$ at I = 2.5mA $V_{OH}max = 1.95V$ $V_{IL}max = 0.5V$ $V_{IH}min = 1.3V$ $V_{IH}max = 1.95V$	Shared with ASC1 function (see Section 2.1.8). Only available with embedded processing option.
	SPI_MOSI	O		
	SPI_MISO	I		
	SPI_CS	O		
ADC (Analog-to-Digital Converter)	ADC1	I	$R_I = 10M\Omega$ $V_I = 0.1V ... 1.875V$ (valid range) V_{IH} max = 1.910V Resolution 64.979uV	If unused keep line open.
SUSPEND mode indicator	SUSPEND_MON	O	$V_{OL}max = 0.45V$ at I = 4.5 mA $V_{OH}min = 1.20V$ at I = 2.5 mA $V_{OH}max = 1.95V$	High=Normal mode, Low=SUSPEND mode. If unused keep lines open.

1. Thales strongly recommends to provide test points for certain signal lines to and from the module while developing SMT applications – for debug, test and/or trace purposes during the manufacturing process. In this way it is possible to detect soldering (and other) problems. Please refer to [5] and [6] for more information on test points and how to implement them. The signal lines for which test points should be provided for are marked as “Test point recommended“ in the above table.

2.1.2.1 Absolute Maximum Ratings

The absolute maximum ratings stated in Table 4 are stress ratings under any conditions. Stresses beyond any of these limits will cause permanent damage to TX62/TX82.

Table 4: Absolute maximum ratings

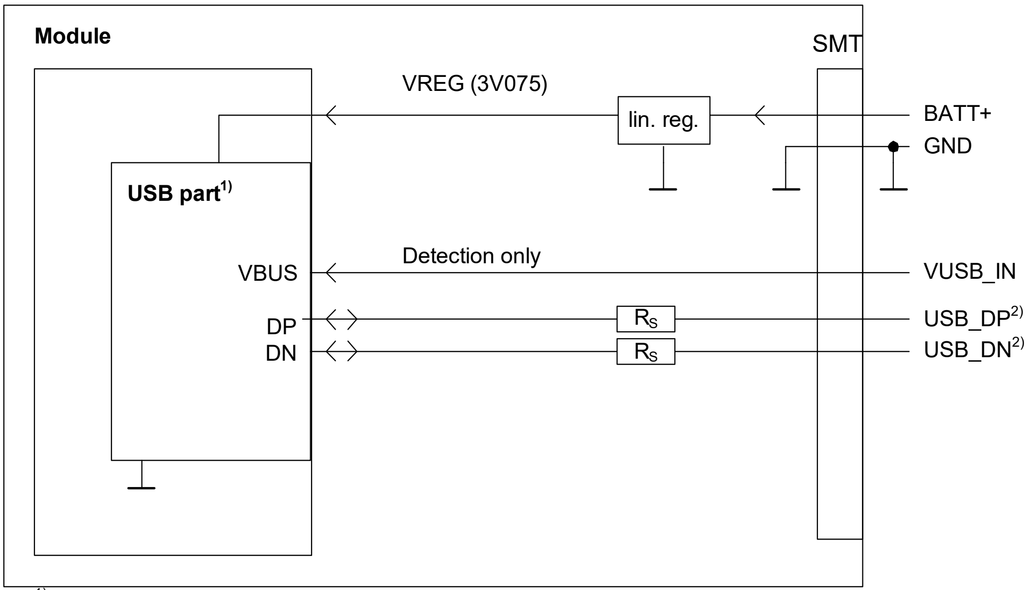
Parameter		Min	Max	Unit
Supply voltage $BATT+_{BB}$ (no service)		-0.5	+6.0	V
Supply voltage $BATT+_{RF}$ (not available with TX62-W)	(TX82-W; no service)	-0.5	+6.0	V
	(TX62-W-B; no service)	-0.5	+6.0	V
	(TX62-W-C; no service)	-0.5	+5.0	V
Voltage at all digital lines in Power Down mode		-0.5	+0.5	V
Voltage at digital lines 1.8V domain in normal operation[1]		-0.3	+2.09	V
Current at digital lines in normal operation		-5	+5	mA
Voltage at SIM interface, CCVCC 1.8V in normal operation		-0.3	+2.0	V
Current at SIM interface in normal 1.8V operation		-	-600	mA
Voltage at ADC line in normal operation		-0.5	+1.910	V
V180 in normal operation		-0.3	+2.09	V
Current at V180 in normal operation		-	-600	mA
VCORE in normal operation		+0.5	+1.304	V
Current at VCORE in normal operation		-	-1200	mA
Voltage at USB lines		-0.5	5.75	V

1. A maximum rating of 1.95V (for $V_{IH}max$) is recommended for all digital lines. Exceeding this value however will not necessarily harm the module as long as the rating remains below the absolute maximum rating of 1.95+0.14V, but it will decrease the safety margin in case of short spikes or ripple.

2.1.3 USB Interface

TX62/TX82 supports a USB 2.0 High Speed (480Mbit/s) device interface that is Full Speed (12Mbit/s) compliant.

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 TX62/TX82 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 90 ohms for proper signal integrity.

Figure 8: USB circuit

To properly connect the module's USB interface to the external application, a USB 2.0 compatible connector and cable or hardware design is required. For more information on the USB related signals see Table 3. Furthermore, the USB modem driver distributed with TX62/TX82 needs to be installed.

1. The specification is ready for download on https://www.usb.org/document-library/usb-20-specification

2.1.4 Serial Interface ASC0

TX62/TX82 offers an 8-wire unbalanced, asynchronous modem interface ASC0 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to Table 3. For an illustration of the interface line's startup behavior see Figure 10.

TX62/TX82 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

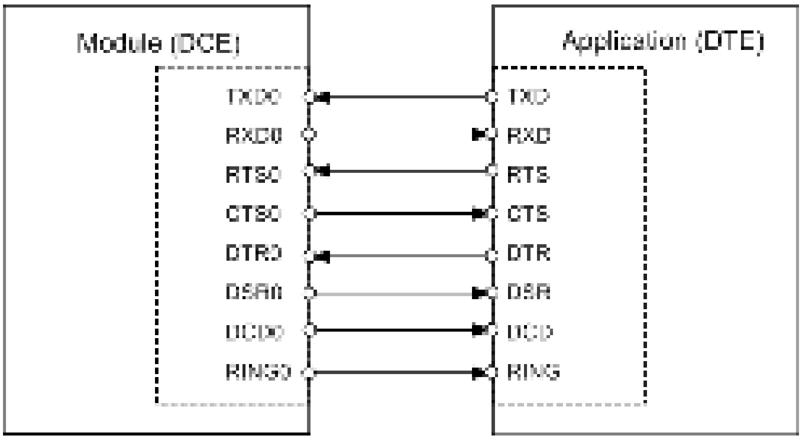
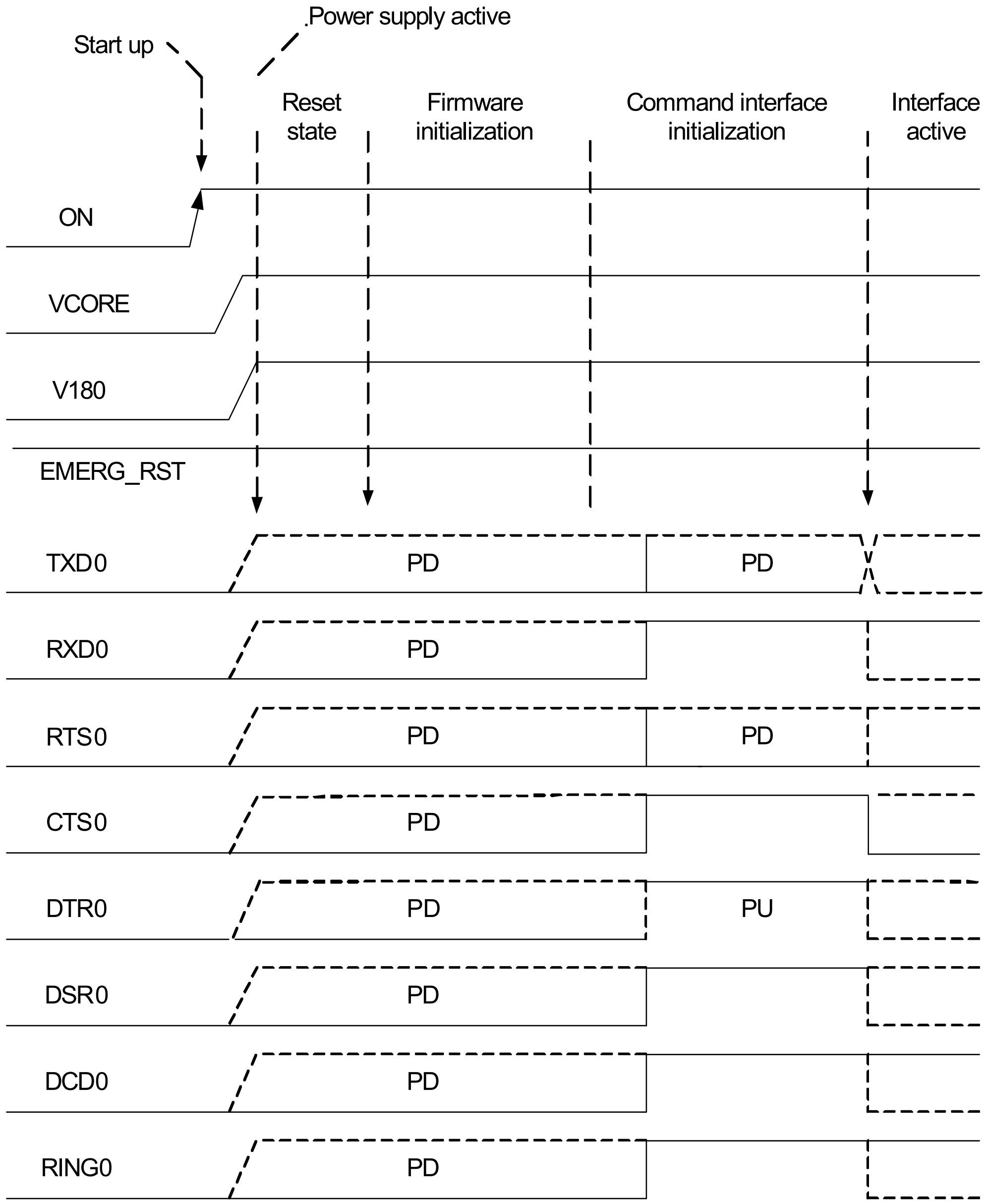


Figure 9: Serial interface ASC0

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.
- By default configured to 8 data bits, no parity and 1 stop bit.
- ASC0 can be operated at fixed bit rates from 300bps up to 921,600bps.
- Supports RTS0/CTS0 hardware flow control as a configuration option (see [1]). The hardware hand shake line RTS0 has an internal pull down resistor causing a low level signal, if the line is not used and open. Although hardware flow control is recommended, this allows communication by using only RXD and TXD lines.
- Wake up from SLEEP mode by RTS0 activation (high to low transition; see Section 3.3.1.1).

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



Dotted lines indicate possible alternative signal states - depending on externally provided signal states.
For pull-up and pull-down values see Table 14.

Figure 10: ASC0 startup behavior

2.1.5 Serial Interface ASC1

TX62/TX82 provides a 4-wire unbalanced, asynchronous modem interface ASC1 conforming to ITU-T V.24 protocol DCE signaling. The electrical characteristics do not comply with ITU-T V.28. The significant levels are 0V (for low data bit or active state) and 1.8V (for high data bit or inactive state). For electrical characteristics please refer to Table 3. For an illustration of the interface line's startup behavior see Figure 12.

TX62/TX82 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

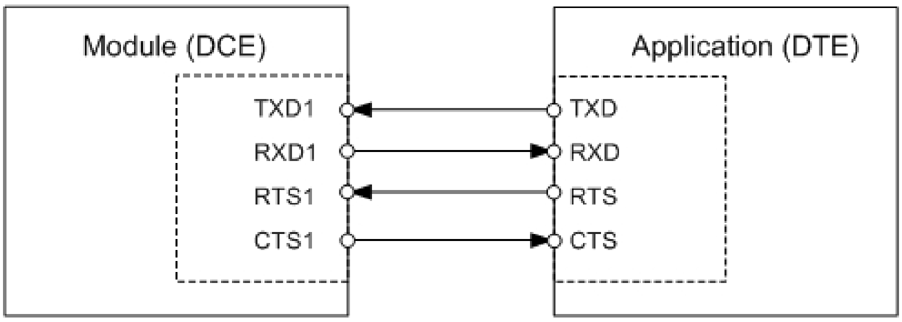
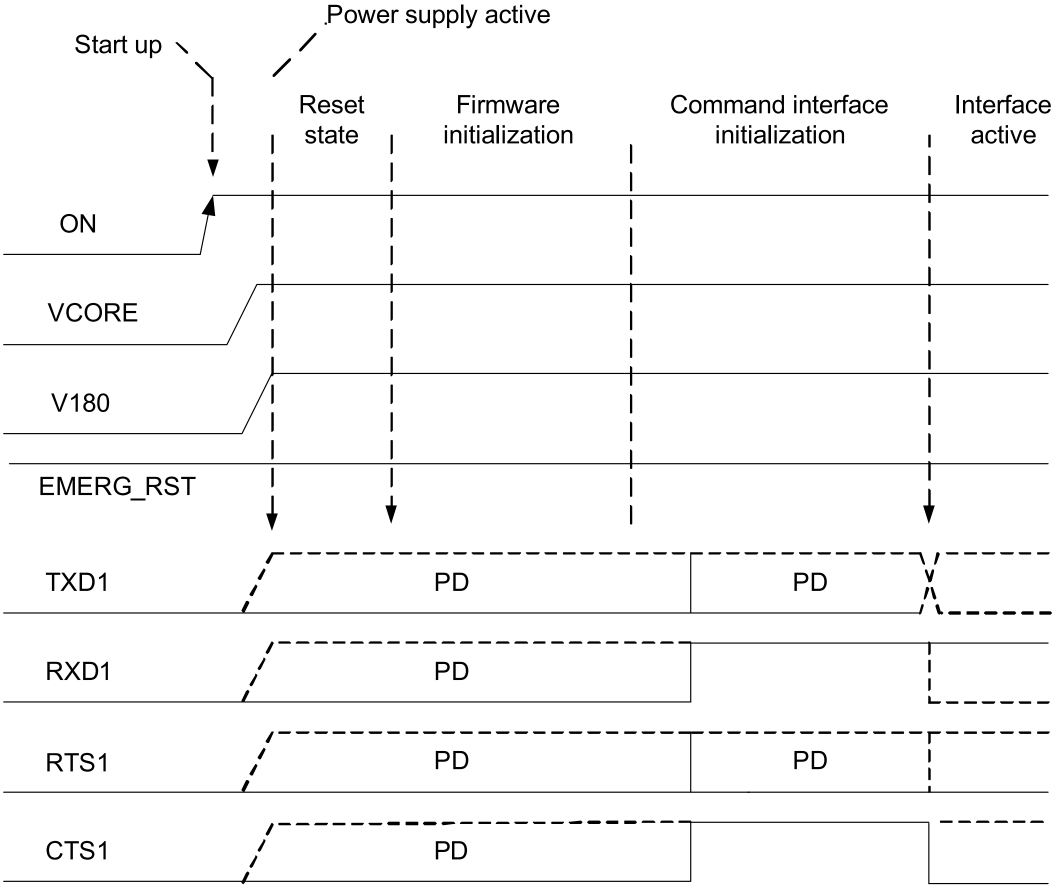


Figure 11: Serial interface ASC1

Features
- Includes only the data lines TXD1 and RXD1 plus RTS1 and CTS1 for hardware handshake.
- Configured for 8 data bits, no parity and 1 or 2 stop bits.
- ASC1 can be operated at fixed bit rates from 300bps to 921,600bps.
- Supports RTS1/CTS1 hardware flow as a configuration option (see [1]). 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.



Dotted lines indicate possible alternative signal states - depending on externally provided signal states.
*) For pull-down values see Table 14.

Figure 12: ASC1 startup behavior

2.1.6 UICC/SIM/USIM Interface

TX62/TX82 has an integrated UICC/SIM/USIM interface compatible with the 3GPP 31.102 and ETSI 102 221. This is 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 the SIM interface.

The UICC/SIM/USIM interface supports 1.8V SIM cards. Please refer to Table 3 for electrical specifications of the UICC/SIM/USIM interface lines.

The CCIN signal serves to detect whether a tray (with SIM card) is present in the card holder. Using the CCIN 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 TX62/TX82 and is part of the Thales reference equipment submitted for type approval. See Section 7.1 for Molex ordering numbers.

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

Signal	Description
GND	Separate ground connection for SIM card to improve EMC. Thales recommends to use pad J16 or pad M17 as ground connection.
CCCLK	UICC clock
CCVCC	SIM supply voltage.
CCIO	Serial data line, input and output.
CCRST	UICC reset
CCIN	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 CCIN signal is by default low and must change to high level if a SIM card is inserted. The CCIN signal is mandatory for applications that allow the user to remove the SIM card during operation. The CCIN 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 TX62/TX82.

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 TX62/TX82.

The figure below shows a circuit to connect an external SIM card holder.

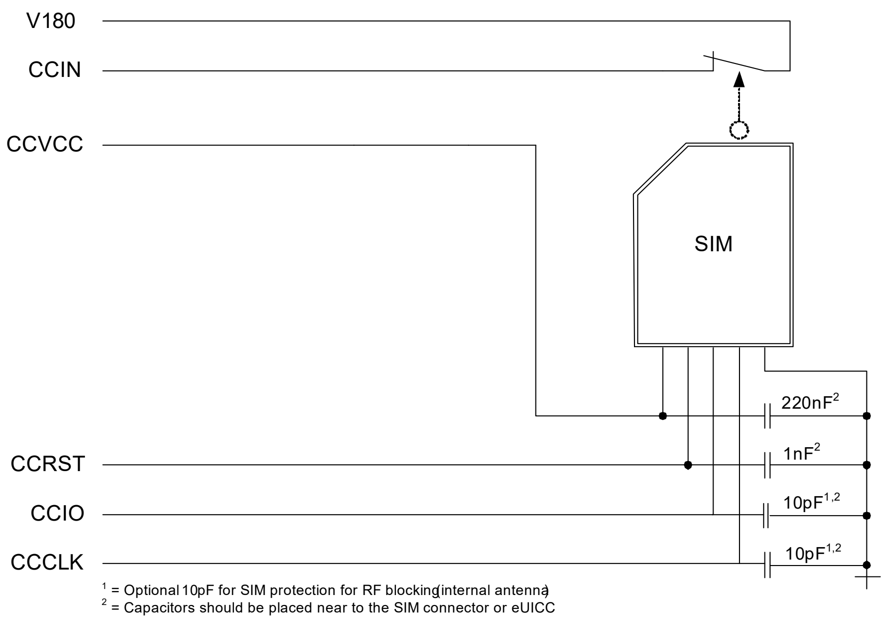


Figure 13: External UICC/SIM/USIM card holder circuit

The total cable length between the SMT application interface pads on TX62/TX82 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 CCCLK signal to the CCIO signal be careful that both lines are not placed closely next to each other. A useful approach is using a GND line to shield the CCIO line from the CCCLK line.

An example for an optimized ESD protection for the SIM interface is shown in Section 2.1.6.1.

It is possible to connect the UICC/USIM/SIM interface lines to an external SIM card multiplexer controlled by the module's SIM_SWITCH signal. Thus, it becomes possible to switch between two networks/subscriptions each with its own UICC, and maybe different connection speeds. See also Section 2.1.11.4.

2.1.6.1 Enhanced ESD Protection for SIM Interface

To optimize ESD protection for the SIM interface it is possible to add ESD diodes (e.g., NUP4114) to the SIM interface lines as shown in the example given in Figure 14.

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

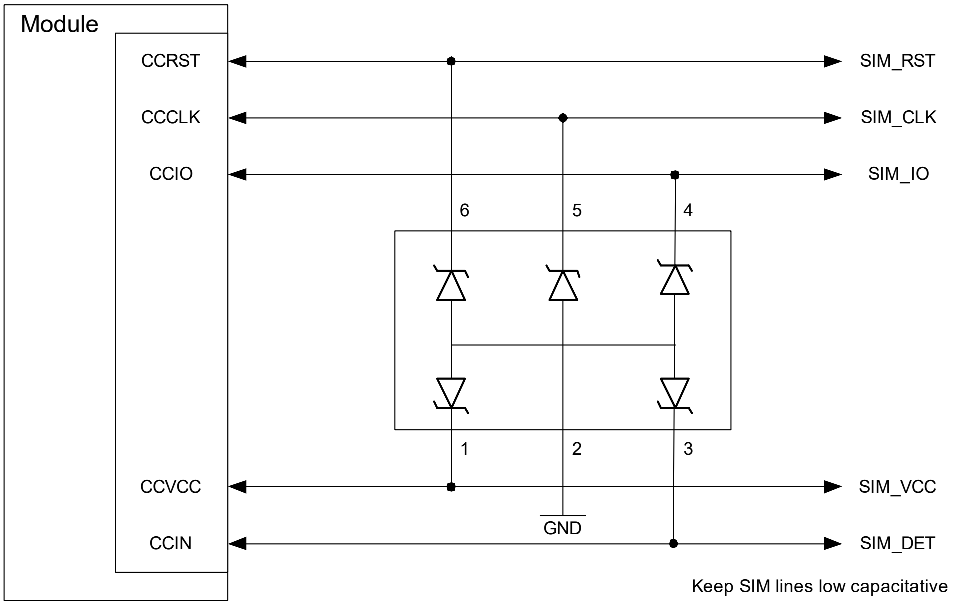


Figure 14: SIM interface - enhanced ESD protection

The capacitors shown in Figure 13 must be placed close to the SIM Connector.

2.1.7 eUICC Interface

As an option TX62/TX82 supports an eUICC in MFF-XS format. This MFF-XS eUICC is located under the shielding, is only connected to specific module pads, and has no physical connections with other circuits inside the module. Figure 15 shows an example of how to connect the eUICC to the module's SIM interface lines as well as a switch to select whether to use the internal MFF-XS eUICC or an external plug-in SIM card. Figure 16 shows an example for a direct connection to the module's SIM interface lines.

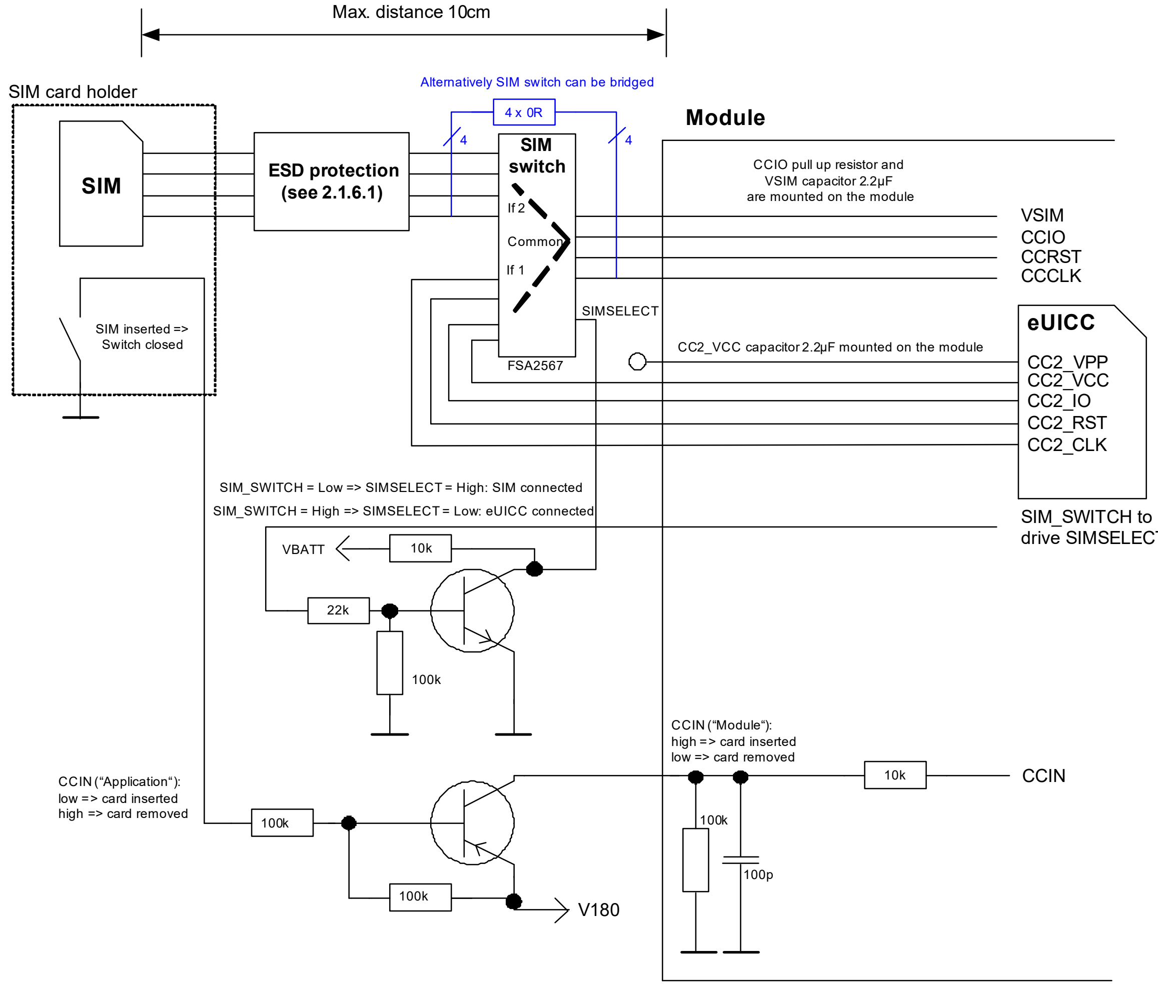


Figure 15: eUICC interface with switch for external SIM

The eUICC interface comprises five lines (plus ground) as listed below in Table 6.

Table 6: Signals of the eUICC interface option (SMT application interface)

Signal	Description
CC2_RST	Chip Card Reset
CC2_CLK	Chip Card Clock
CC2_IO	Chip Card I/O (data line)
CC2_VPP	-
CC2_VCC	Operation voltage for SIM Card (=1.8V)
GND	eUICC Ground

The below Figure 16 shows a direct connection of the internal eUICC to the module's SIM interface lines.

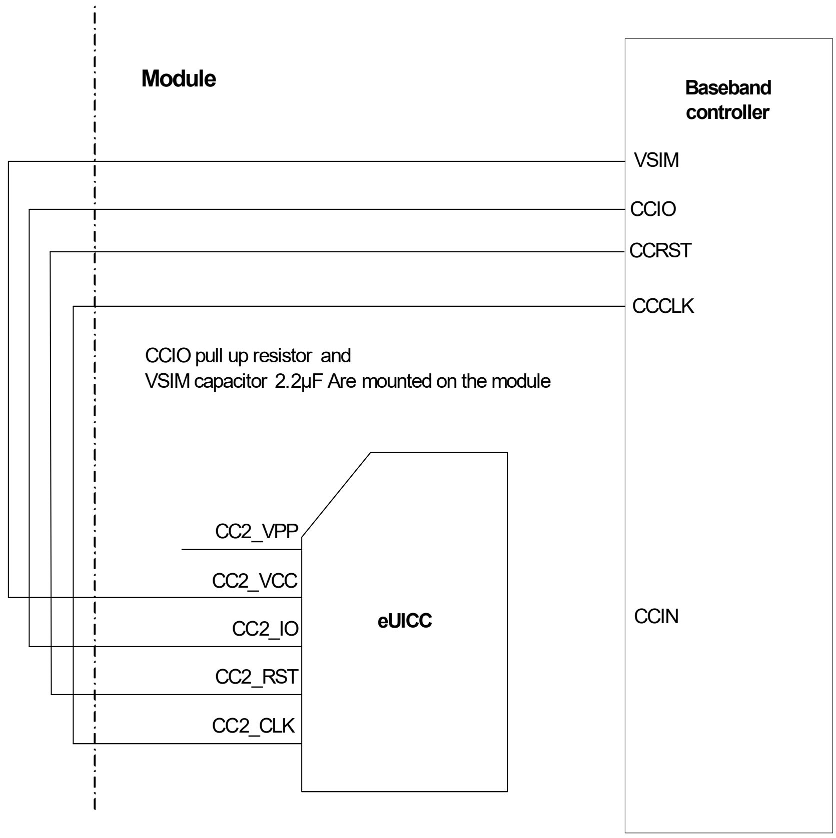


Figure 16: eUICC interface without SIM switch

2.1.8 GPIO

TX82-W, TX62-W-B and TX62-W-C have 7 GPIOs (GPIO6-7,20-23,25) and TX62-W has 6 GPIOs (GPIO7,20-23,25) for external hardware devices. Each GPIO can be configured for use as input or output. All settings are AT command controlled. The configuration is non-volatile and available after module restart.

The IO port driver has to be opened before using and configuring GPIOs. Before changing the configuration of a GPIO pin (e.g. input to output) the pin has to be closed. If the GPIO pins are not configured or the pins/driver were closed, the GPIO pins are high-Z with pull down resistor.

If a GPIO is configured to input, the pin has high-Z without pull resistor.

The following figure shows the start up behavior of the GPIOs interface.

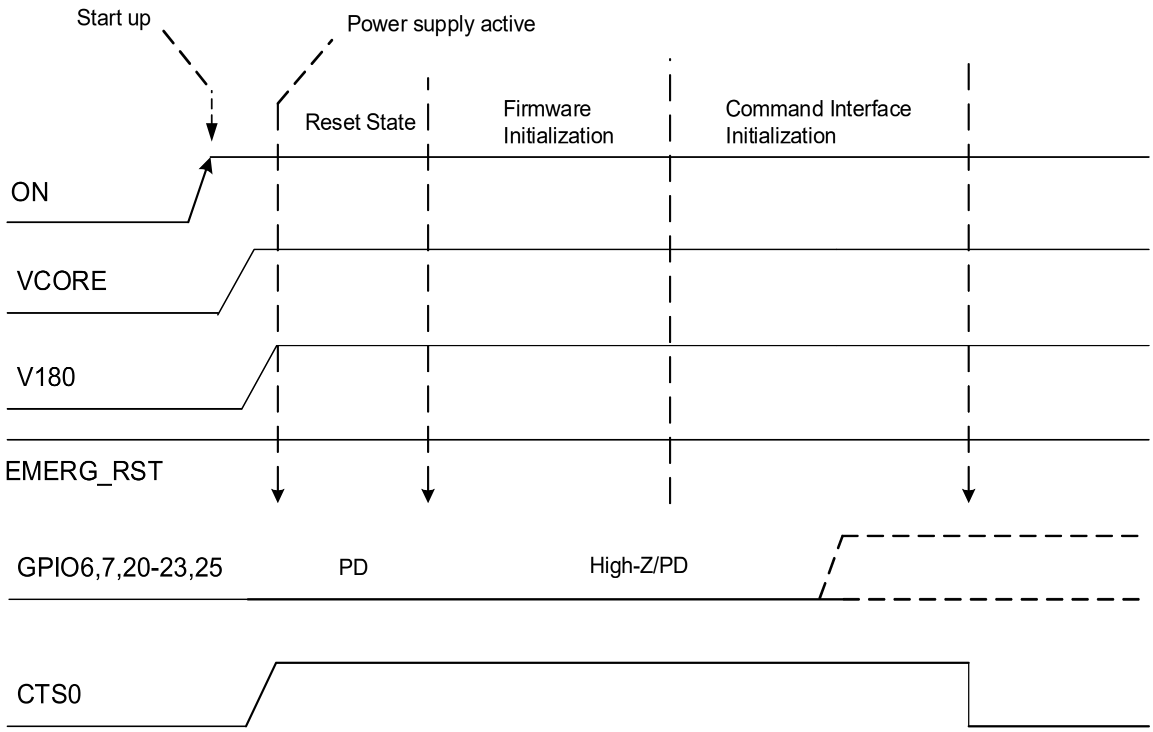


Figure 17: GPIO start up behavior

With the embedded processing option of TX62/TX82 additional GPIOs are provided and can be used - see below Section 2.1.8.1.

2.1.8.1 GPIOs Available with Embedded Processing Option

The embedded processing option of TX62/TX82 provides a GPIO interface with 13 configurable GPIO lines. Some GPIO lines are shared with other interfaces or functions, and are shown in the following table with their default assignments being marked green.

Table 7: GPIO lines and alternative assignments

GPIO	Status LED	ASC1	SPI	SIM Switch
GPIO5	STATUS			
GPIO6[1]				
GPIO7				
GPIO8				SIM_SWITCH
(GPIO16)[2]		RXD1	MOSI	
(GPIO17)[2]		TXD1	MISO	
(GPIO18)[2]		RTS1	SPI_CS	
(GPIO19)[2]		CTS1	SPI_CLK	
GPIO20				
GPIO21				
GPIO22				
GPIO23				
GPIO25				

1. Only available with TX82-W, TX62-W-B and TX62-W-C.
2. Not configurable as GPIO line with the embedded processing option.

After startup, the above mentioned alternative GPIO line assignments can be configured through embedded applications (see [8]), or in the case of GPIO5 and GPIO8 also through AT command. The configuration is non-volatile and available after module restart.

2.1.9 I²C Interface

The embedded processing option of TX62/TX82 provides an inter-integrated circuit interface. I^2C 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.

The I^2C bus can be configured and activated via embedded application. For more information see [8].

The I^2C interface can be powered via the V180 line of TX62/TX82. If connected to the V180 line, the I^2C 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 3.

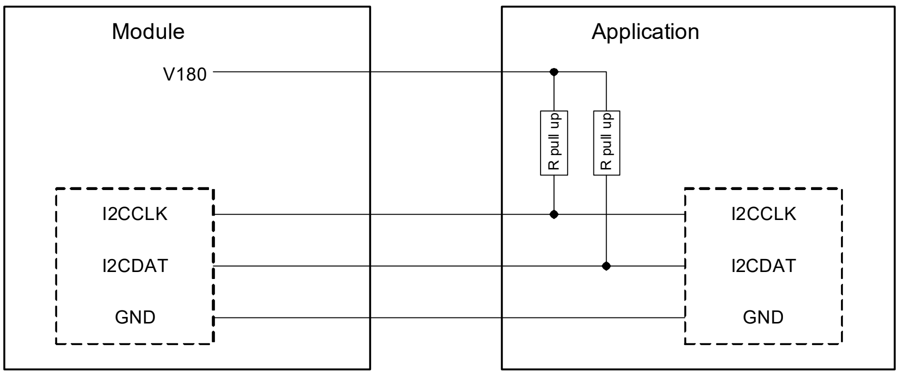


Figure 18: I^2C interface connected to V180

Note 1: 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.

2.1.10 SPI Interface

The embedded processing option of TX62/TX82 provides an SPI interface where four GPIO interface lines can be configured as Serial Peripheral Interface (SPI). The SPI is a synchronous serial interface allowing the module to control external sensors or components. The SPI interface supports only master mode. The transmission rates are up to 6.5Mbit/s. The SPI interface comprises the two data lines MOSI and MISO, the clock line SPI_CLK a well as the chip select line SPI_CS.

The GPIO lines are also shared with the ASC1 signal lines as shown in Section 2.1.8.1.

The SPI interface can be configured and activated via embedded application. For more information see [8].

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 via embedded processing option. Make sure the module and the connected slave device works with the same SPI mode.

Figure 19 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 3.

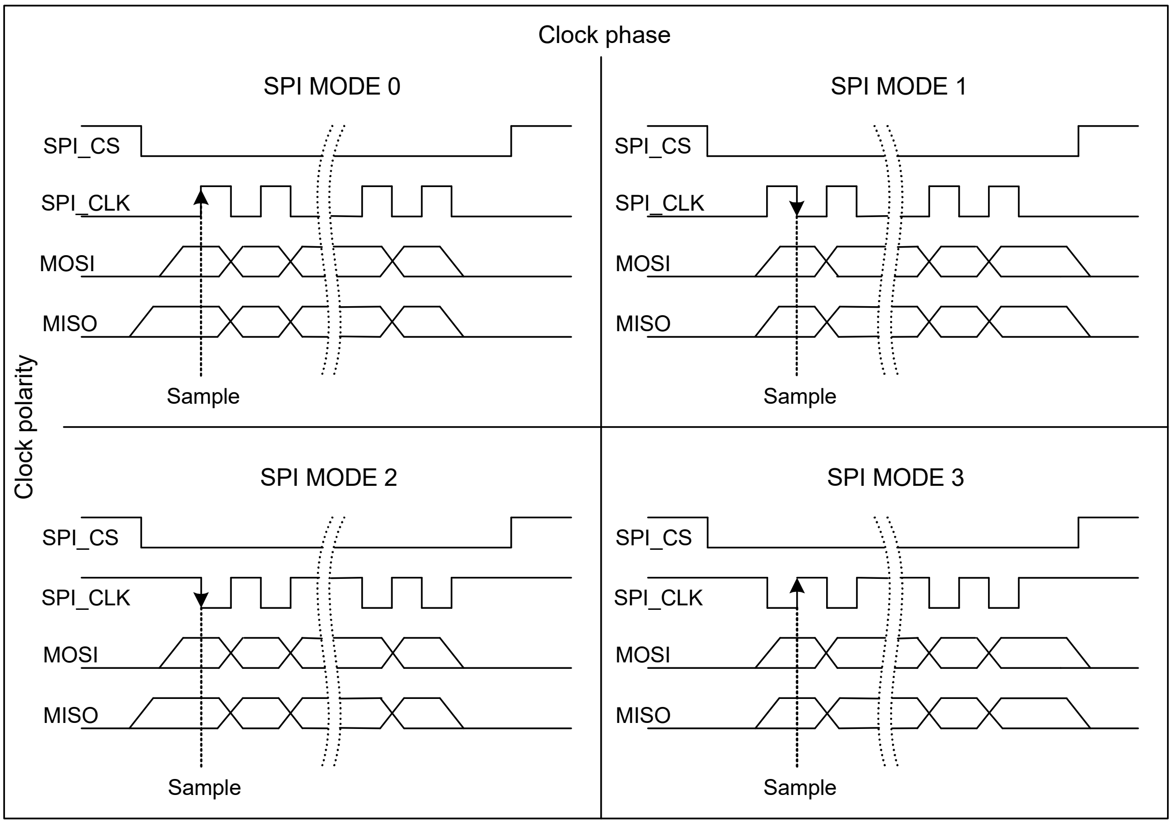


Figure 19: Characteristics of SPI modes

2.1.11 Control Signals

2.1.11.1 Status LED

The STATUS line can be configured to drive a status LED that indicates different operating modes of the module. For details on how to configure status signaling please refer to [1].

To take advantage of this function connect an LED to the STATUS line as shown in Figure 20. The sample circuit is not optimized for low current consumption.

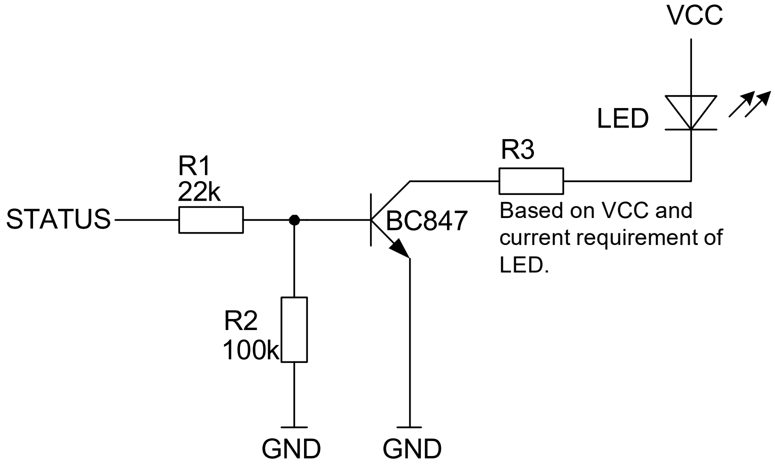


Figure 20: Status signaling with LED driver

2.1.11.2 Power Indication Circuit

In Power Down mode the maximum voltage at any digital or analog interface line must not exceed +0.3V (see also Section 2.1.2.1). Exceeding this limit for any length of time might cause permanent damage to the module.

It is therefore recommended to implement a power indication signal that reports the module's power state and shows whether it is active or in Power Down mode. While the module is in Power Down mode all signals with a high level from an external application need to be set to low state or high impedance state. The sample power indication circuit illustrated in Figure 21 denotes the module's active state with a low signal and the module's Power Down mode with a high signal or high impedance state. The sample circuit is not optimized for low current consumption.

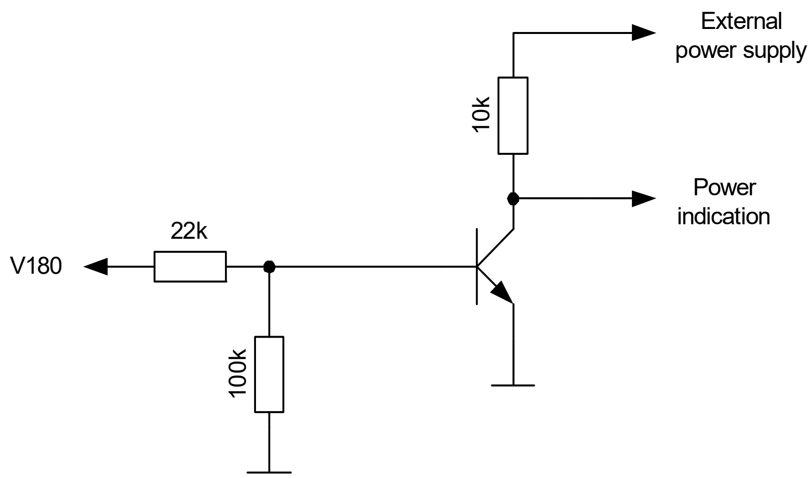


Figure 21: Power indication circuit

2.1.11.3 Fast Shutdown

The FST_SHDN line is an active low control signal and must be applied for at least 15 milliseconds. It is recommended to keep the FST_SHDN line low until the module has shut down. 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 ON signal should be set to low (see Figure 22). Otherwise there might be back powering at the ON line in Power Down mode.

A low impulse on the FST_SHDN line starts the fast shutdown procedure (see Figure 22). 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. The fast shutdown procedure takes less than 15 milliseconds. A low level of the V180 signal indicates that the module has entered the Power Down mode.No shutdown URCs will be issued with a fast shutdown.

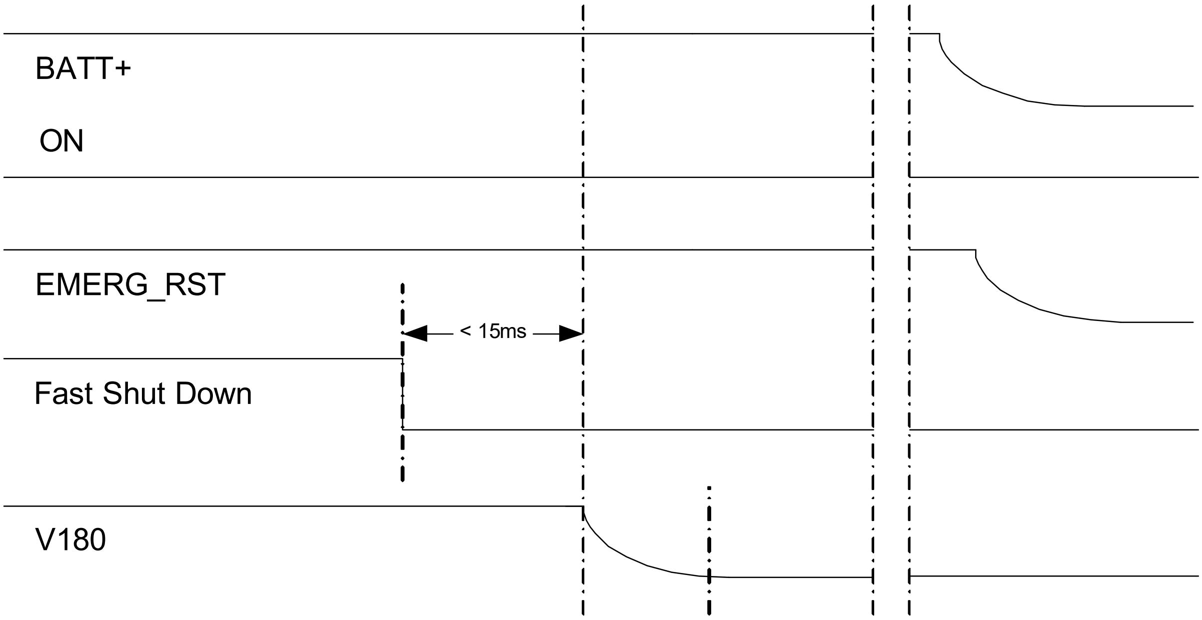


Figure 22: Fast shutdown timing

Please note that the normal software controlled shutdown via AT^SMSO can also be configured as a fast shutdown, i.e., without network deregistration. For details see [1].

2.1.11.4 SIM Switch

The UICC/USIM/SIM interface lines may be connected to an external SIM card multiplexer controlled by the SIM_SWITCH signal as shown in Figure 23. Thus, it becomes possible to switch between two networks/subscriptions each with their own UICC, and maybe different connection speeds. Please note that hot SIM insert/removal is only possible on the first SIM interface. Also note that the SIM_SWITCH can be used to switch between a SIM and the embedded optional eUICC interface as described in Section 2.1.7.

The SIM_SWITCH signal is controlled by AT command (see [1]).

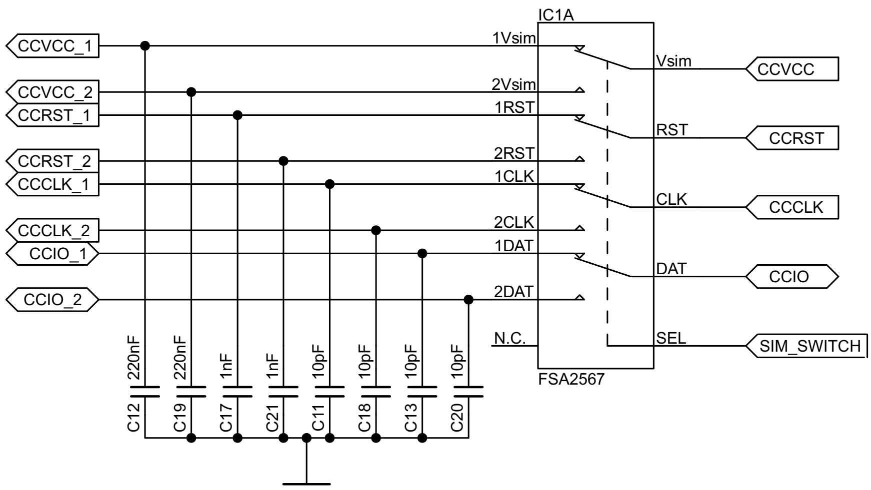


Figure 23: SIM switch circuit

2.1.11.5 SUSPEND Mode Indicator

When all conditions for entering into SUSPEND mode are fulfilled, the SUSPEND_MON signal changes from high to low, indicating that the module has entered its SUSPEND mode.

When leaving the SUSPEND mode, the URC “^SYSRESUME” is triggered, and the SUSPEND_MON signal is set to high again.

SUSPEND_MON usage can be enabled/disabled by AT command (see [1]: AT^SCFG “GPIO/Mode/Suspend”).

2.2 RF Antenna Interface

The RF interface has an impedance of 50Ω. TX62/TX82 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 TX62/TX82 module and should be placed in the host application if the antenna does not have an impedance of 50Ω.

Regarding the return loss TX62/TX82 provides the following values in the active band:

Table 8: 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
Idle	≤5dB	not applicable

2.2.1 Antenna Interface Specifications

Table 9: RF Antenna interface GSM / LTE[1] of TX82-W, and TX62-W

Parameter	Conditions	Min.[2]	Typical		Unit
			TX62-W	TX82-W	
LTE connectivity (Cat M1)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 27, 28, 66, 85				
LTE Cat M1: Receiver Input Sensitivity @NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=6; DL: Modulation: QPSK; N_{RB}=4;	LTE 2100 Band 1	-103	-107	-106	dBm
	LTE 1800 Band 2	-101	-107	-106	dBm
	LTE 1900 Band 3	-100	-107	-105.5	dBm
	LTE AWS-1 Band 4	-103	-107	-106	dBm
	LTE 850 Band 5	-101.5	-107.5	-106	dBm
	LTE 900 Band 8	-100.5	-107	-106.5	dBm
	LTE 700 Band 12	-100	-107	-106.3	dBm
	LTE 700 Band 13	-100	-107	-106.3	dBm
	LTE 800 Band 18	-103	-107.5	-106.2	dBm
	LTE 800 Band 19	-103	-107.5	-106	dBm
	LTE 800 Band 20	-100.5	-107	-106	dBm
	LTE 1900 Band 25	-101	-107.5	-106.2	dBm
	LTE 800 Band 26	-101	-107.5	-106.3	dBm
	LTE 800 Band 27	-101.5	-107.5	-106	dBm
	LTE 700 Band 28	-101.5	-107.5	-106	dBm
	LTE AWS-3 Band 66	-99	-107	-106	dBm
	LTE 700 Band 85	-99.2	-107	-106	dBm

Table 9: RF Antenna interface GSM / LTE[1] of TX82-W, and TX62-W

Parameter	Conditions	Min.[2]	Typical		Unit
			TX62-W	TX82-W	
LTE Cat M1: Power @ ARP with 50Ω Load, NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=1;	LTE 2100 Band 1	+18	+20	+20	dBm
	LTE 1800 Band 2	+18	+20	+20	dBm
	LTE 1900 Band 3	+18	+20	+20	dBm
	LTE AWS-1 Band 4	+18	+20	+20	dBm
	LTE 850 Band 5	+18	+20	+20	dBm
	LTE 900 Band 8	+18	+20	+20	dBm
	LTE 700 Band 12	+18	+20	+20	dBm
	LTE 700 Band 13	+18	+20	+20	dBm
	LTE 800 Band 18	+18	+20	+20	dBm
	LTE 800 Band 19	+18	+20	+20	dBm
	LTE 800 Band 20	+18	+20	+20	dBm
	LTE 1900 Band 25	+18	+20	+20	dBm
	LTE 800 Band 26	+18	+20	+20	dBm
	LTE 800 Band 27	+18	+20	+20	dBm
	LTE 700 Band 28	+18	+20	+20	dBm
	LTE AWS-3 Band 66	+18	+20	+20	dBm
	LTE 700 Band 85	+18	+20	+20	dBm
LTE connectivity (Cat NB1/2)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, 71, 85				
LTE Cat NB1/2: Receiver Input Sensitivity @NTNV DL: Modulation: QPSK; Subcarriers: 12; UL: Modulation: BPSK; Subcarrier spacing: 15KHz; N_{tones}: 1@0	LTE 2100 Band 1	-108.2	-115	-114	dBm
	LTE 1800 Band 2	-108.2	-115.5	-114	dBm
	LTE 1900 Band 3	-108.2	-114.5	-114	dBm
	LTE AWS-1 Band 4	-108.2	-115	-114	dBm
	LTE 850 Band 5	-108.2	-116	-114.5	dBm
	LTE 900 Band 8	-108.2	-115.5	-115	dBm
	LTE 700 Band 12	-108.2	-116	-115	dBm
	LTE 700 Band 13	-108.2	-116	-115	dBm
	LTE 800 Band 18	-108.2	-115.5	-115	dBm
	LTE 800 Band 19	-108.2	-115.5	-114.5	dBm
	LTE 800 Band 20	-108.2	-115.5	-115	dBm
	LTE 1900 Band 25	-108.2	-115.5	-114.5	dBm
	LTE 800 Band 26	-108.2	-116	-115	dBm
	LTE 700 Band 28	-108.2	-116	-115	dBm
	LTE AWS-3 Band 66	-108.2	-115.5	-114	dBm
	LTE 600 Band 71	-108.2	-116	-115	dBm
	LTE 700 Band 85	-108.2	-116	-115.5	dBm

Table 9: RF Antenna interface GSM / LTE[1] of TX82-W, and TX62-W

Parameter		Conditions	Min.[2]	Typical		Unit
				TX62-W	TX82-W	
LTE Cat NB1/2: Power @ ARP with 50Ω Load, NTNV Configuration ID: 1, UL: Modulation: BPSK; Subcarrier: 1;Subcarrier space: 3.75 kHz; N_{tones}: 1@0		LTE 2100 Band 1	+18	+20	+20	dBm
		LTE 1800 Band 2	+18	+20	+20	dBm
		LTE 1900 Band 3	+18	+20	+20	dBm
		LTE AWS-1 Band 4	+18	+20	+20	dBm
		LTE 850 Band 5	+18	+20	+20	dBm
		LTE 900 Band 8	+18	+20	+20	dBm
		LTE 700 Band 12	+18	+20	+20	dBm
		LTE 700 Band 13	+18	+20	+20	dBm
		LTE 800 Band 18	+18	+20	+20	dBm
		LTE 800 Band 19	+18	+20	+20	dBm
		LTE 800 Band 20	+18	+20	+20	dBm
		LTE 1900 Band 25	+18	+20	+20	dBm
		LTE 800 Band 26	+18	+20	+20	dBm
		LTE 700 Band 28	+18	+20	+20	dBm
		LTE AWS-3 Band 66	+18	+20	+20	dBm
		LTE 600 Band 71	+18	+20	+20	dBm
		LTE 700 Band 85	+18	+20	+20	dBm
GPRS coding schemes		Class 10, CS1 to CS4				
EGPRS		Class 10, MCS1 to MCS9				
GSM Class		Small MS				
GPRS Static Receiver input Sensitivity @ PDTCH/CS-1		GSM 850/900	-104		-110	dBm
		GSM 1800/1900	-104		-109	dBm
RF Power @ ARP with 50Ω Load, (**ROPR = 4**, i.e. no reduction)	GSM 850/900	GPRS, 1 TX			32.5	dBm
		GPRS, 2 TX			32.5	dBm
		EDGE, 1 TX			27.0	dBm
		EDGE, 2TX			27.0	dBm
	GSM 1800/1900	GPRS, 1 TX			29.5	dBm
		GPRS, 2 TX			29.5	dBm
		EDGE, 1 TX			26.0	dBm
		EDGE, 2TX			26.0	dBm

Table 9: RF Antenna interface GSM / LTE[1] of TX82-W, and TX62-W

Parameter		Conditions	Min.[2]	Typical		Unit
				TX62-W	TX82-W	
RF Power @ ARP with 50Ω Load, (**ROPR = 5**)	GSM 850/900	GPRS, 1 TX			32.5	dBm
		GPRS, 2 TX			23.5	dBm
		EDGE, 1 TX			27.0	dBm
		EDGE, 2TX			27.0	dBm
	GSM 1800/1900	GPRS, 1 TX			29.5	dBm
		GPRS, 2 TX			29.5	dBm
		EDGE, 1 TX			26.0	dBm
		EDGE, 2TX			26.0	dBm
RF Power @ ARP with 50Ω Load, (**ROPR = 6**)	GSM 850/900	GPRS, 1 TX			32.5	dBm
		GPRS, 2 TX			31.5	dBm
		EDGE, 1 TX			27.0	dBm
		EDGE, 2TX			27.0	dBm
	GSM 1800/1900	GPRS, 1 TX			29.5	dBm
		GPRS, 2 TX			28.5	dBm
		EDGE, 1 TX			26.0	dBm
		EDGE, 2TX			26.0	dBm
RF Power @ ARP with 50Ω Load, (**ROPR = 7**)	GSM 850/900	GPRS, 1 TX			32.5	dBm
		GPRS, 2 TX			29.5	dBm
		EDGE, 1 TX			27.0	dBm
		EDGE, 2TX			27.0	dBm
	GSM 1800/1900	GPRS, 1 TX			29.5	dBm
		GPRS, 2 TX			26.5	dBm
		EDGE, 1 TX			26.0	dBm
		EDGE, 2TX			26.0	dBm
RF Power @ ARP with 50Ω Load, (**ROPR = 8**, i.e. maximum reduction)	GSM 850/900	GPRS, 1 TX			32.5	dBm
		GPRS, 2 TX			29.5	dBm
		EDGE, 1 TX			27.0	dBm
		EDGE, 2TX			24.0	dBm
	GSM 1800/1900	GPRS, 1 TX			29.5	dBm
		GPRS, 2 TX			26.5	dBm
		EDGE, 1 TX			26.0	dBm
		EDGE, 2TX			23.0	dBm

1. GSM (2G) only supported by TX82-W.
2. “Min.” signifies 3GPP limit in case of Receiver Input Sensitivity.

Table 10: RF Antenna interface LTE of TX62-W-B

Parameter	Conditions	Min.[1]	Typical	Unit
LTE connectivity (Cat M1)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 27, 28, 66, 85			
LTE Cat M1: Receiver Input Sensitivity @NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=6; DL: Modulation: QPSK; N_{RB}=4;	LTE 2100 Band 1	-103	-106.5	dBm
	LTE 1800 Band 2	-101	-106.3	dBm
	LTE 1900 Band 3	-100	-105.7	dBm
	LTE AWS-1 Band 4	-103	-106.3	dBm
	LTE 850 Band 5	-101.5	-106.5	dBm
	LTE 900 Band 8	-100.5	-106.3	dBm
	LTE 700 Band 12	-100	-105.7	dBm
	LTE 700 Band 13	-100	-106	dBm
	LTE 800 Band 18	-103	-106.5	dBm
	LTE 800 Band 19	-103	-106.5	dBm
	LTE 800 Band 20	-100.5	-105.5	dBm
	LTE 1900 Band 25	-101	-106.2	dBm
	LTE 800 Band 26	-101	-106.5	dBm
	LTE 800 Band 27	-101.5	-106.4	dBm
	LTE 700 Band 28	-101.5	-105.8	dBm
	LTE AWS-3 Band 66	-99	-106.2	dBm
	LTE 700 Band 85	-99.2	-105.6	dBm
LTE Cat M1: Power @ ARP with 50Ω Load, NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=1;	LTE 2100 Band 1	+21	+23	dBm
	LTE 1800 Band 2	+21	+23	dBm
	LTE 1900 Band 3	+21	+23	dBm
	LTE AWS-1 Band 4	+21	+23	dBm
	LTE 850 Band 5	+21	+23	dBm
	LTE 900 Band 8	+21	+23	dBm
	LTE 700 Band 12	+21	+23	dBm
	LTE 700 Band 13	+21	+23	dBm
	LTE 800 Band 18	+21	+23	dBm
	LTE 800 Band 19	+21	+23	dBm
	LTE 800 Band 20	+21	+23	dBm
	LTE 1900 Band 25	+21	+23	dBm
	LTE 800 Band 26	+21	+23	dBm
	LTE 800 Band 27	+21	+23	dBm
	LTE 700 Band 28	+21	+23	dBm
	LTE AWS-3 Band 66	+21	+23	dBm
	LTE 700 Band 85	+21	+23	dBm

Table 10: RF Antenna interface LTE of TX62-W-B

Parameter	Conditions	Min.[1]	Typical	Unit
LTE connectivity (Cat NB1/2)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, 71, 85			
LTE Cat NB1/2: Receiver Input Sensitivity @NTNV DL: Modulation: QPSK; Subcarriers: 12; UL: Modulation: BPSK; Subcarrier spacing: 15KHz; N_{tones}: 1@0	LTE 2100 Band 1	-108.2	-114	dBm
	LTE 1800 Band 2	-108.2	-114.3	dBm
	LTE 1900 Band 3	-108.2	-114	dBm
	LTE AWS-1 Band 4	-108.2	-114.5	dBm
	LTE 850 Band 5	-108.2	-115	dBm
	LTE 900 Band 8	-108.2	-115	dBm
	LTE 700 Band 12	-108.2	-115.5	dBm
	LTE 700 Band 13	-108.2	-115.5	dBm
	LTE 800 Band 18	-108.2	-115	dBm
	LTE 800 Band 19	-108.2	-115	dBm
	LTE 800 Band 20	-108.2	-115	dBm
	LTE 1900 Band 25	-108.2	-114	dBm
	LTE 800 Band 26	-108.2	-115	dBm
	LTE 700 Band 28	-108.2	-115.5	dBm
	LTE AWS-3 Band 66	-108.2	-114	dBm
	LTE 600 Band 71	-108.2	-115	dBm
	LTE 700 Band 85	-108.2	-115	dBm
LTE Cat NB1/2: Power @ ARP with 50Ω Load, NTNV Configuration ID: 1, UL: Modulation: BPSK; Subcarrier: 1;Subcarrier space: 3.75 kHz; N_{tones}: 1@0	LTE 2100 Band 1	+21	+23	dBm
	LTE 1800 Band 2	+21	+23	dBm
	LTE 1900 Band 3	+21	+23	dBm
	LTE AWS-1 Band 4	+21	+23	dBm
	LTE 850 Band 5	+21	+23	dBm
	LTE 900 Band 8	+21	+23	dBm
	LTE 700 Band 12	+21	+23	dBm
	LTE 700 Band 13	+21	+23	dBm
	LTE 800 Band 18	+21	+23	dBm
	LTE 800 Band 19	+21	+23	dBm
	LTE 800 Band 20	+21	+23	dBm
	LTE 1900 Band 25	+21	+23	dBm
	LTE 800 Band 26	+21	+23	dBm
	LTE 700 Band 28	+21	+23	dBm
	LTE AWS-3 Band 66	+21	+23	dBm
	LTE 600 Band 71	+21	+23	dBm
	LTE 700 Band 85	+21	+23	dBm

1. “Min.” signifies 3GPP limit in case of Receiver Input Sensitivity.

Table 11: RF Antenna interface LTE of TX62-W-C

Parameter	Conditions	Min.[1]	Typical	Unit
LTE connectivity (Cat M1)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 27, 28, 31, 66, 72, 85			
LTE Cat M1: Receiver Input Sensitivity @NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=6; DL: Modulation: QPSK; N_{RB}=4;	LTE 2100 Band 1	-103		dBm
	LTE 1800 Band 2	-101		dBm
	LTE 1900 Band 3	-100		dBm
	LTE AWS-1 Band 4	-103		dBm
	LTE 850 Band 5	-101.5		dBm
	LTE 900 Band 8	-100.5		dBm
	LTE 700 Band 12	-100		dBm
	LTE 700 Band 13	-100		dBm
	LTE 800 Band 18	-103		dBm
	LTE 800 Band 19	-103		dBm
	LTE 800 Band 20	-100.5		dBm
	LTE 1900 Band 25	-101		dBm
	LTE 800 Band 26	-101		dBm
	LTE 800 Band 27	-101.5		dBm
	LTE 700 Band 28	-101.5		dBm
	LTE 450 Band 31	-97.3		dBm
	LTE AWS-3 Band 66	-99		dBm
	LTE 450 Band 72	-97.3		dBm
	LTE 700 Band 85	-100		dBm

Table 11: RF Antenna interface LTE of TX62-W-C

Parameter	Conditions	Min.[1]	Typical	Unit
LTE Cat M1: Power @ ARP with 50Ω Load, NTNV BW: 5 MHz, UL: Modulation: QPSK; N_{RB}=1;	LTE 2100 Band 1	+21	+23	dBm
	LTE 1800 Band 2	+21	+23	dBm
	LTE 1900 Band 3	+21	+23	dBm
	LTE AWS-1 Band 4	+21	+23	dBm
	LTE 850 Band 5	+21	+23	dBm
	LTE 900 Band 8	+21	+23	dBm
	LTE 700 Band 12	+21	+23	dBm
	LTE 700 Band 13	+21	+23	dBm
	LTE 800 Band 18	+21	+23	dBm
	LTE 800 Band 19	+21	+23	dBm
	LTE 800 Band 20	+21	+23	dBm
	LTE 1900 Band 25	+21	+23	dBm
	LTE 800 Band 26	+21	+23	dBm
	LTE 800 Band 27	+21	+23	dBm
	LTE 700 Band 28	+20.5	+23	dBm
	LTE 450 Band 31	+24	+26	dBm
	LTE AWS-3 Band 66	+21	+23	dBm
	LTE 450 Band 72	+24	+25	dBm
	LTE 700 Band 85	+21	+23	dBm

Table 11: RF Antenna interface LTE of TX62-W-C

Parameter	Conditions	Min.[1]	Typical	Unit
LTE connectivity (Cat NB1/2)	Band 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 31, 66, 72, 85			
LTE Cat NB1/2: Receiver Input Sensitivity @NTNV DL: Modulation: QPSK; Subcarriers: 12; UL: Modulation: BPSK; Subcarrier spacing: 15KHz; N_{tones}: 1@0	LTE 2100 Band 1	-108.2		dBm
	LTE 1800 Band 2	-108.2		dBm
	LTE 1900 Band 3	-108.2		dBm
	LTE AWS-1 Band 4	-108.2		dBm
	LTE 850 Band 5	-108.2		dBm
	LTE 900 Band 8	-108.2		dBm
	LTE 700 Band 12	-108.2		dBm
	LTE 700 Band 13	-108.2		dBm
	LTE 800 Band 18	-108.2		dBm
	LTE 800 Band 19	-108.2		dBm
	LTE 800 Band 20	-108.2		dBm
	LTE 1900 Band 25	-108.2		dBm
	LTE 800 Band 26	-108.2		dBm
	LTE 700 Band 28	-108.2		dBm
	LTE 450 Band 31	-108.2		dBm
	LTE AWS-3 Band 66	-108.2		dBm
	LTE 450 Band 72	-108.2		dBm
	LTE 700 Band 85	-108.2		dBm
LTE Cat NB1/2: Power @ ARP with 50Ω Load, NTNV Configuration ID: 1, UL: Modulation: BPSK; Subcarrier: 1;Subcarrier space: 3.75 kHz; N_{tones}: 1@0	LTE 2100 Band 1	+21	+23	dBm
	LTE 1800 Band 2	+21	+23	dBm
	LTE 1900 Band 3	+21	+23	dBm
	LTE AWS-1 Band 4	+21	+23	dBm
	LTE 850 Band 5	+21	+23	dBm
	LTE 900 Band 8	+21	+23	dBm
	LTE 700 Band 12	+21	+23	dBm
	LTE 700 Band 13	+21	+23	dBm
	LTE 800 Band 18	+21	+23	dBm
	LTE 800 Band 19	+21	+23	dBm
	LTE 800 Band 20	+21	+23	dBm
	LTE 1900 Band 25	+21	+23	dBm
	LTE 800 Band 26	+21	+23	dBm
	LTE 700 Band 28	+21	+23	dBm
	LTE 450 Band 31	+21	+23	dBm
	LTE AWS-3 Band 66	+21	+23	dBm
	LTE 450 Band 72	+21	+23	dBm
	LTE 700 Band 85	+21	+23	dBm

1. “Min.” signifies 3GPP limit in case of Receiver Input Sensitivity.

2.2.2 Antenna Installation

The antennas is connected by soldering the antenna pads (RF_OUT, ANT_GNSS) and its neighboring ground pads directly to the application's PCB.

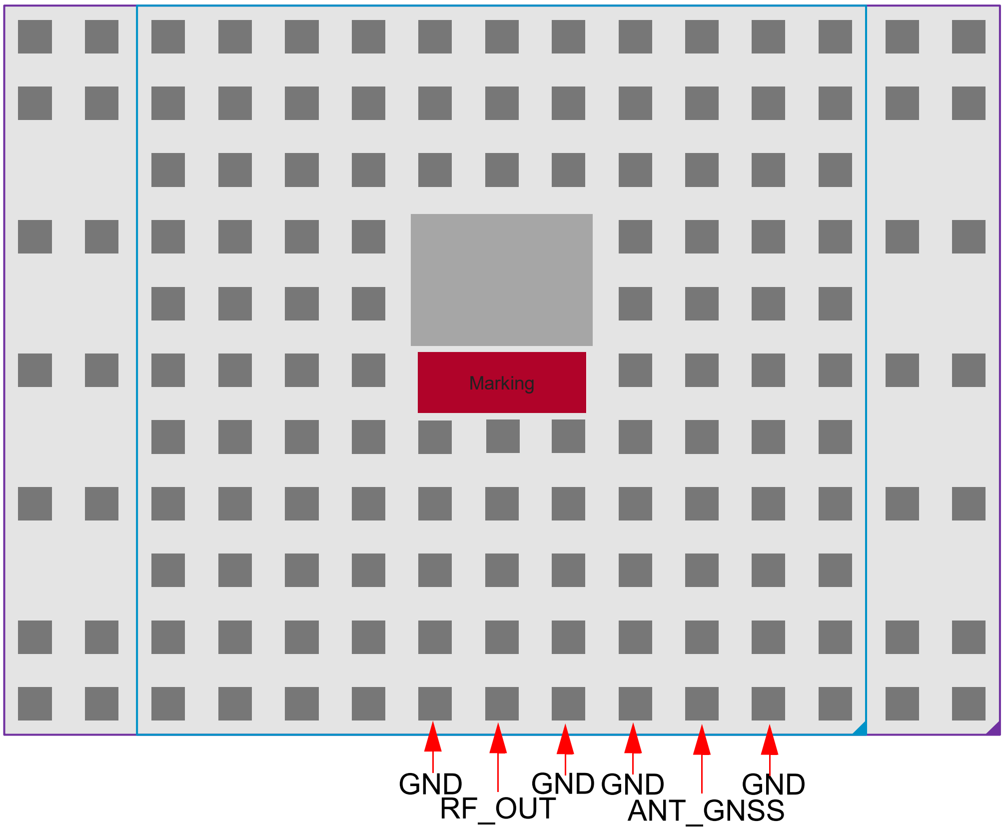


Figure 24: Antenna pads (top view)

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

The wiring of the antenna connection line, starting from the antenna pad to the application antenna should result in a 50Ω line impedance. Line width and distance to the GND plane needs 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 application PCB, it is recommended to realize the antenna connection line using embedded Stripline rather than Micro-Stripline technology. Please see Section 2.2.3.1 for an example.[1]

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 TX62/TX82's antenna pad.

1. Please note that because of KDB 447498.GNSS, it is required to get a dedicated FCC ID, if using a PCB printed antenna.

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).

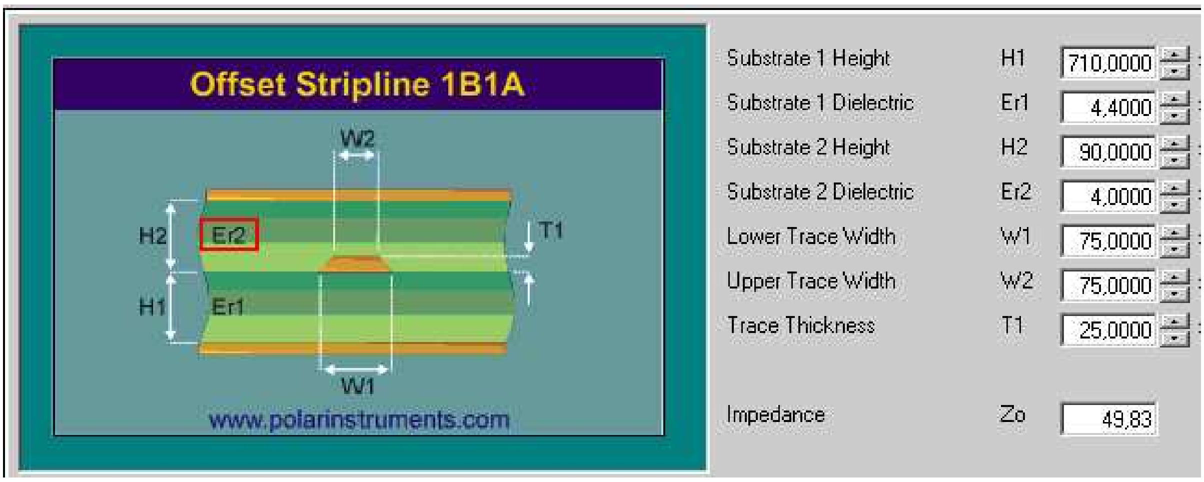


Figure 25: Embedded Stripline with 65µm prepreg (1080) and 710µm core

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).

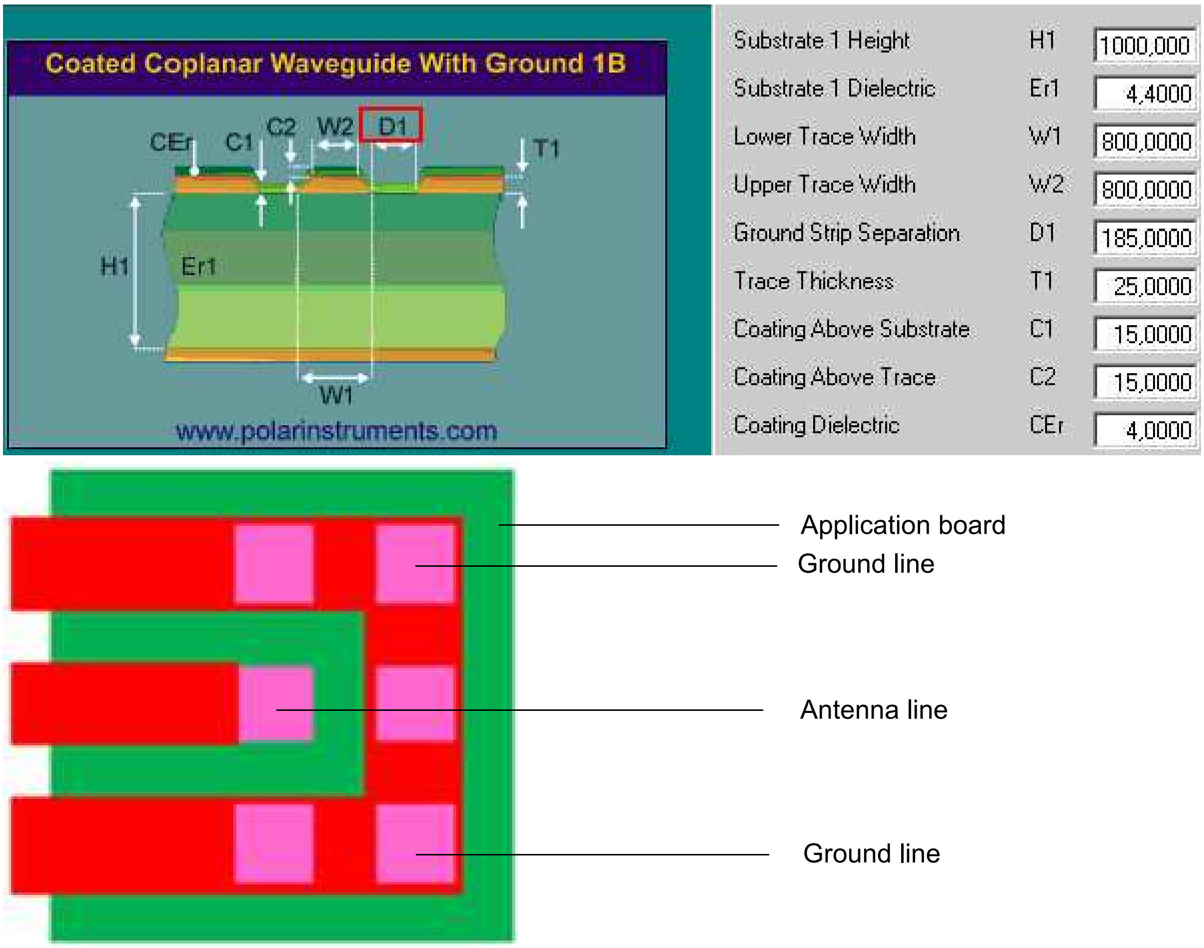


Figure 26: Micro-Stripline on 1.0mm Standard FR4 2-layer PCB - example 1

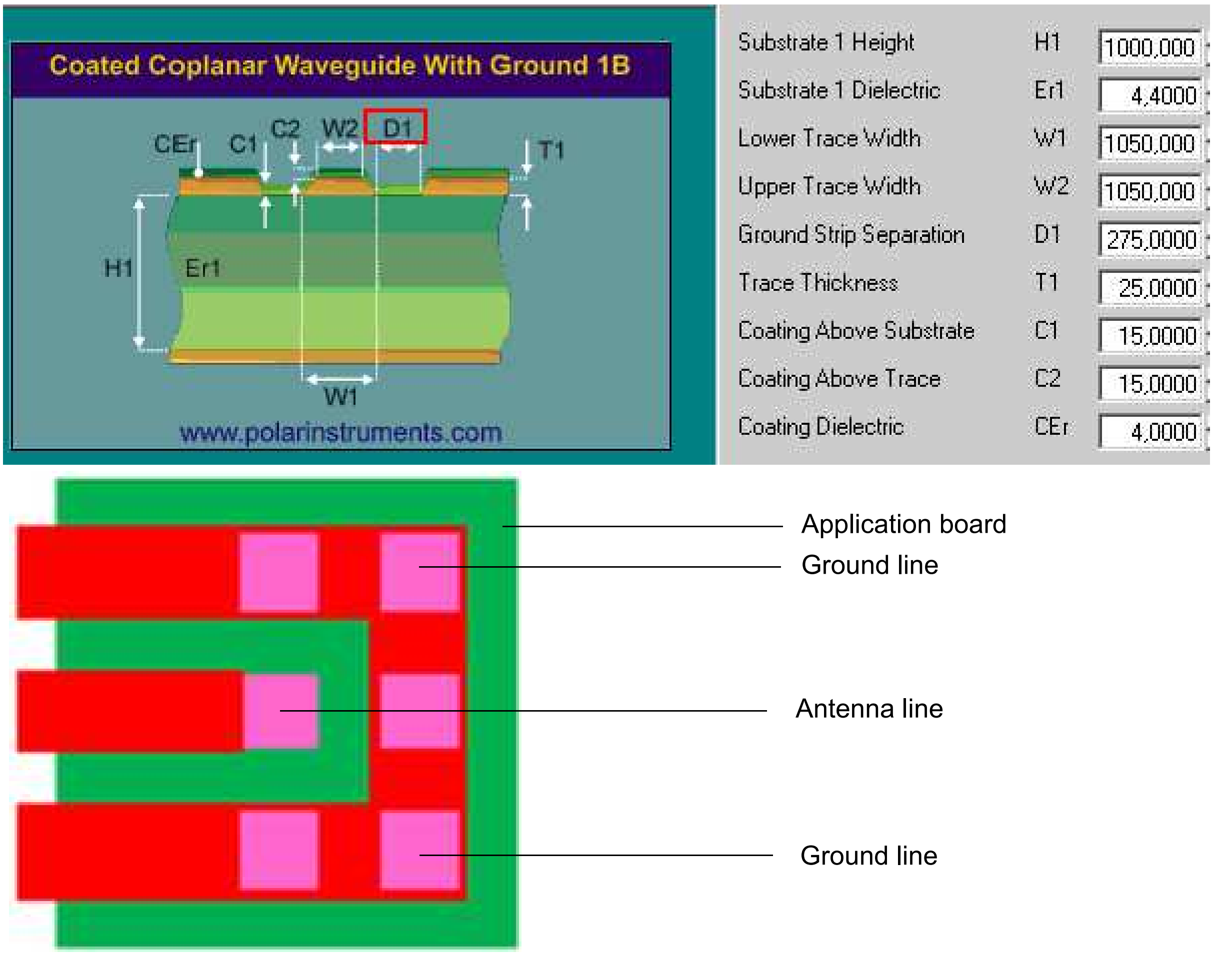


Figure 27: Micro-Stripline on 1.0mm Standard FR4 2-layer PCB - example 2

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

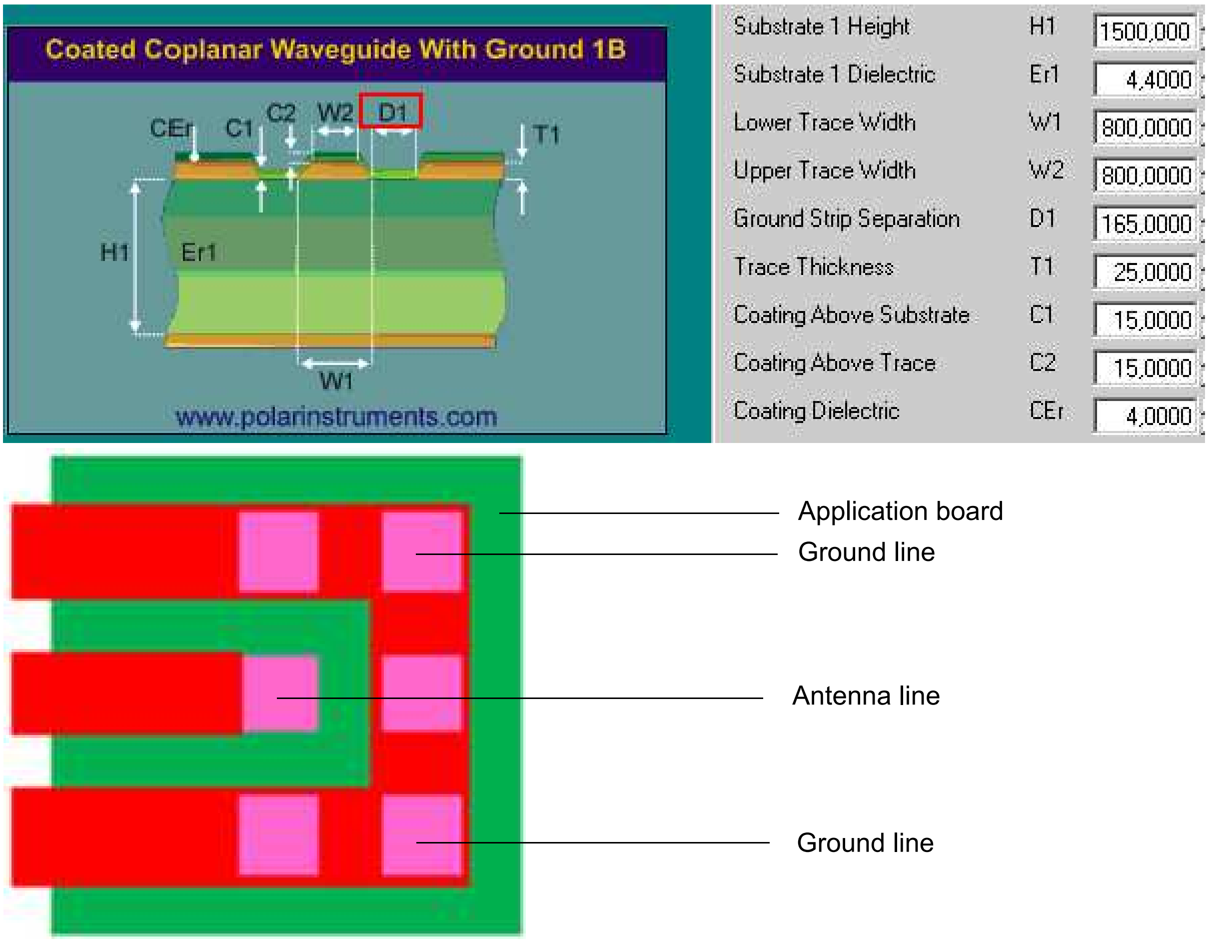


Figure 28: Micro-Stripline on 1.5mm Standard FR4 2-layer PCB - example 1

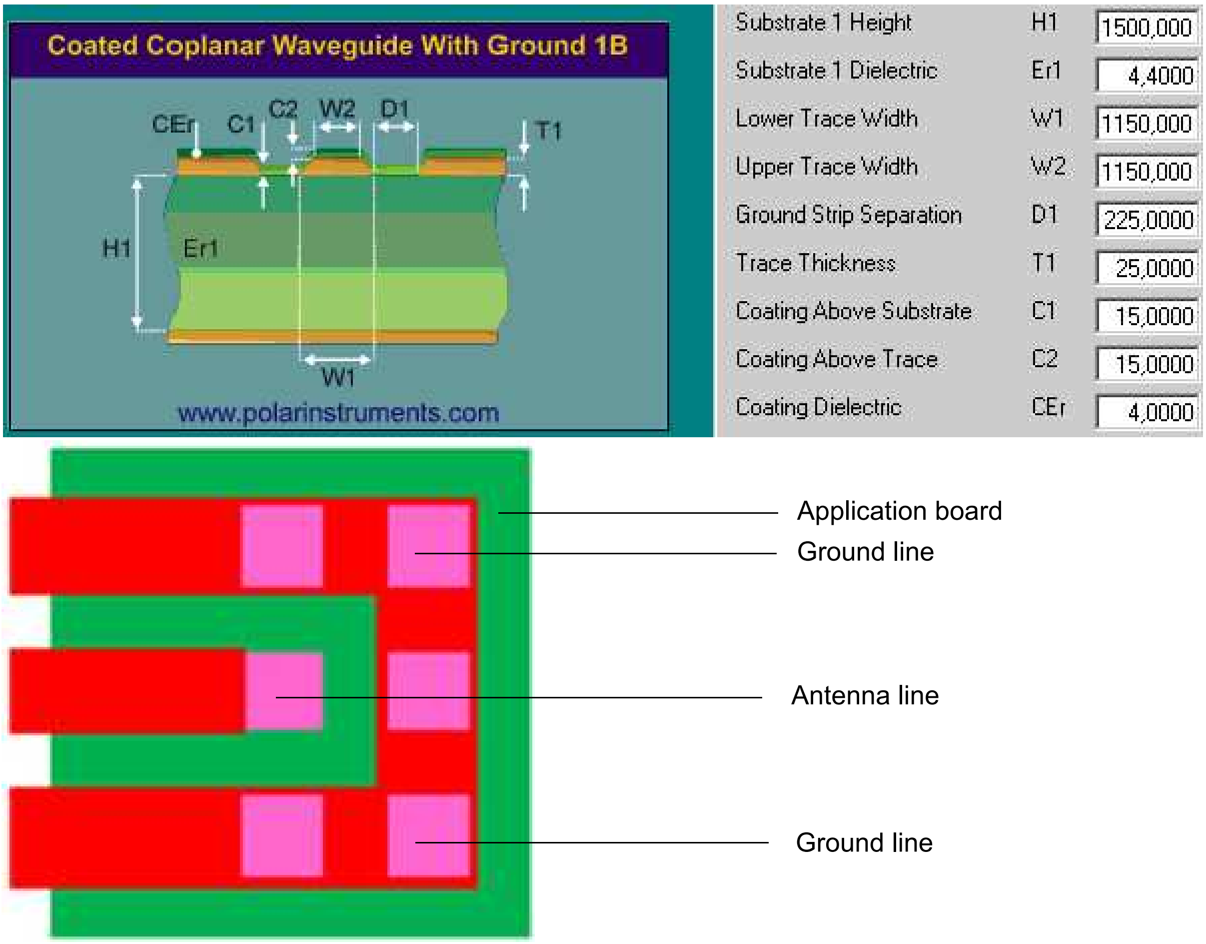


Figure 29: Micro-Stripline on 1.5mm Standard FR4 2-layer PCB - example 2

2.2.3.2 Routing Example

Interface to RF Connector
Figure 30 shows the connection of the module‘s antenna pad with an application PCB‘s coaxial antenna connector. Please note that the TX62/TX82 bottom plane appears mirrored, since it is viewed from TX62/TX82 top side. By definition the top of customer's board shall mate with the bottom of the TX62/TX82 module.

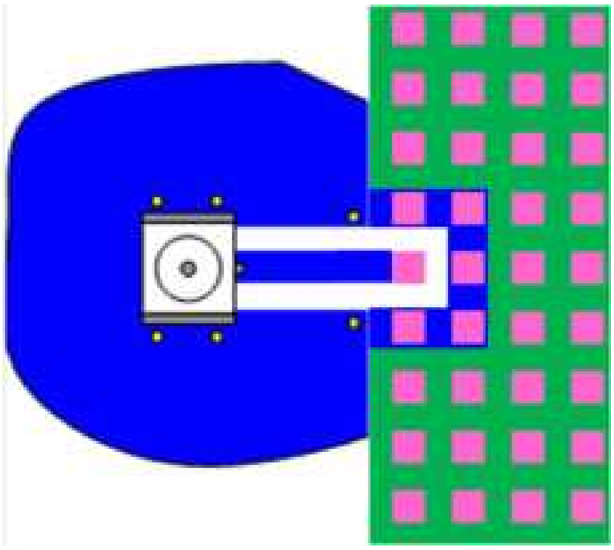


Figure 30: Routing to application‘s RF connector - top view

2.3 GNSS Interface

2.3.1 GNSS Receiver

TX62/TX82 integrates a GNSS receiver that offers the full performance of GPS/GLONASS/BeiDou/Galileo technology. The GNSS receiver is able to continuously track all satellites in view, thus providing accurate satellite position data.

The integrated GNSS receiver supports the NMEA protocol via ASC0 interface. NMEA is a combined electrical and data specification for communication between various (marine) electronic devices including GNSS receivers. It has been defined and controlled by the US based National Marine Electronics Association. For more information on the NMEA Standard please refer to http://www.nmea.org.

Depending on the receiver's knowledge of last position, current time and ephemeris data, the receiver's startup time (i.e., TTFF = Time-To-First-Fix) may vary: If the receiver has no knowledge of its last position or time, a startup takes considerably longer than if the receiver still has knowledge of its last position, time and almanac or has still access to valid ephemeris data and the precise time. For more information see Section 2.3.3. Often, 2D measurements will be used over 3D depending on space vehicle (SV) locations as this will be just as accurate and faster.

By default, the GNSS receiver is switched off. It has to be switched on and configured using AT commands (AT^SGPSC; see [1]). Please note that concurrent GNSS and GSM/LTE operations are not supported (AT^SCFG= "MEopMode/RscMgmt/Rrc"; see [1]).

2.3.2 GNSS Antenna

In addition to the RF antenna interface TX62/TX82 also has a GNSS antenna interface. See Section 2.1.1 to find out where the GNSS antenna pad is located. The GNSS installation is the same as for the RF antenna interface - see Section 2.2.2.

It is possible to connect active or passive GNSS antennas. In either case the antennas must have 50Ω impedance. Please note that if an active GNSS antenna is selected, the voltage for it has to be supplied by the external application, and a capacitor must be added to avoid voltage back-feeding (see Figure 31). If a passive GNSS antenna is selected, this capacitor is optional.

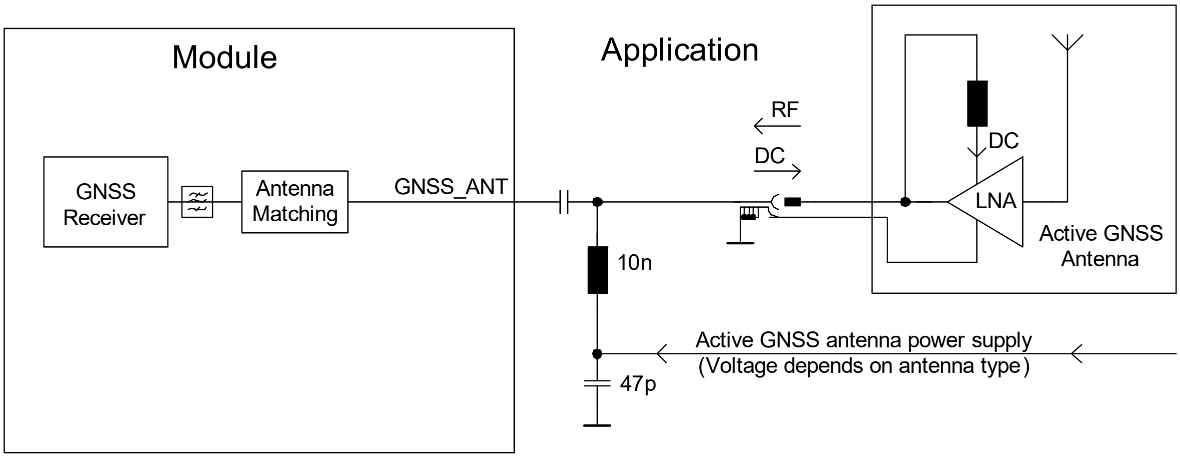


Figure 31: Sample supply voltage circuit for active GNSS antenna

2.3.3 GNSS Antenna Interface Characteristics (TBD.)

Table 12: GNSS properties

Parameter	Conditions	Min.	Typical	Max.	Unit
Horizontal accuracy	50% CEP, open sky		3		m
Maximal update rate			1		Hz
Frequency	GPS	1573.397	1575.420	1576.443	MHz
	GLONASS	1598.563	1602.563	1606.563	
	Beidou	1559.052	1561.098	1563.144	
	Galileo	1573.397	1575.420	1576.443	
Tracking Sensitivity	Open sky Active antenna or LNA Passive antenna: GPS GLONASS Beidou Galileo		-162		dBm
Acquisition Sensitivity	Open sky Active antenna or LNA Passive antenna: GPS GLONASS Beidou Galileo		-159.		dBm
Time-to-First-Fix (TTFF)[1]	Hot (average at -130dBm)		3		s
	Cold (average at -130dBm)		35		s

1. Test conditions: open sky environment

2.4 Sample Application

Figure 32 shows a typical example of how to integrate a TX62/TX82 module with an application. Usage of the various host interfaces depends on the desired features of the application.

Note that the sample application is not optimized for low current consumption.

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.

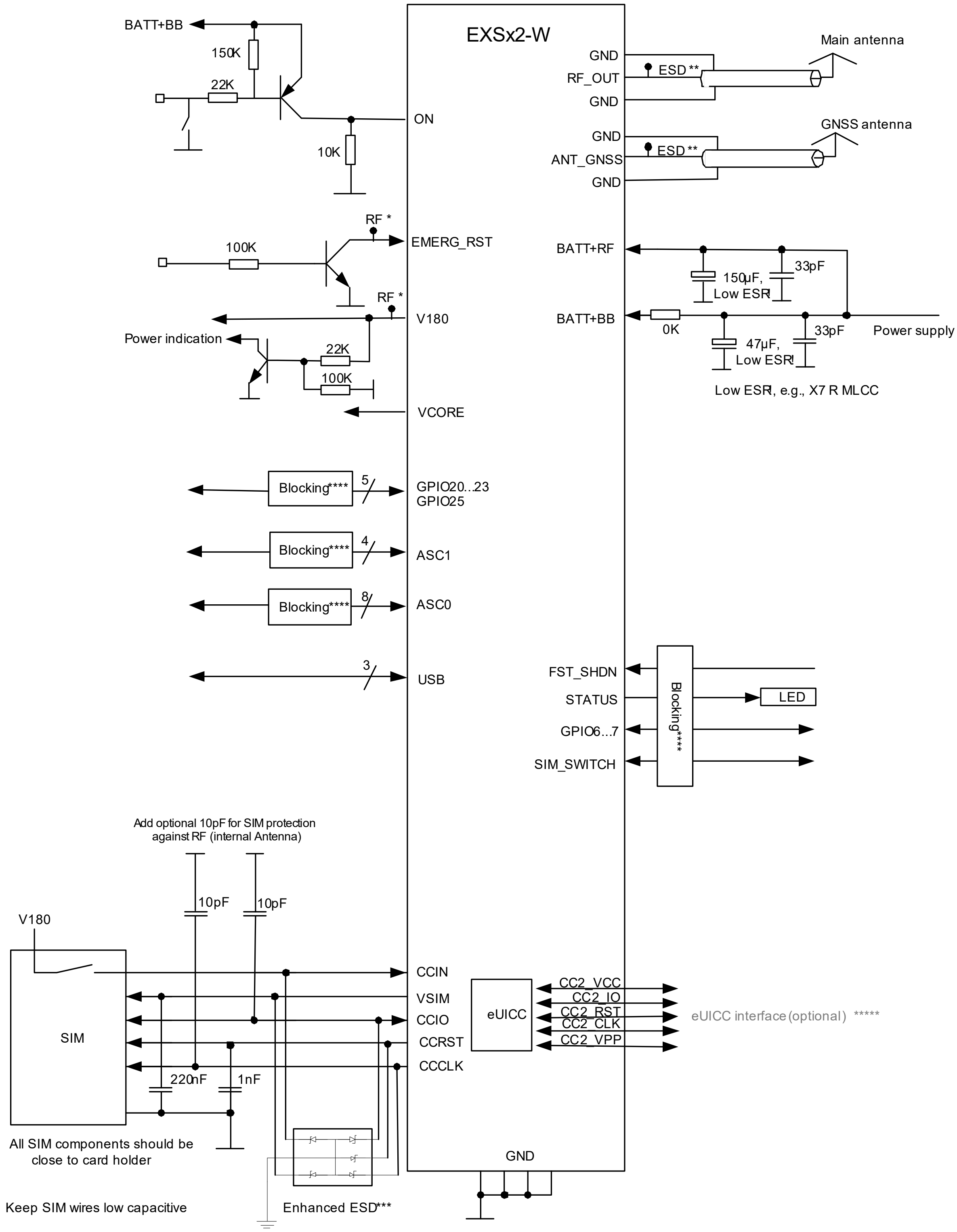
Because of the high RF field density inside the module, it cannot be guaranteed that no self interference might occur, depending on frequency and the applications grounding concept. The potential interferers may be minimized by placing small capacitors (47pF) at suspected lines (e.g. RXD0, TXD0, and 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 [5] and [6]. Possible test points are mentioned in Section 2.1.2.

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

Depending on the micro controller used by an external application TX62/TX82‘s digital input and output lines may require level conversion. Section 2.4.1 shows a possible sample level conversion circuit.

Disclaimer
No warranty, either stated or implied, is provided on the sample schematic diagram shown in Figure 32 and the information detailed in this section. 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 TX62/TX82 modules. Because of the number of frequencies used it is recommended to involve antenna vendors already quite early to maximize performance of the external application’s layout.



RF* = Optional 47pF against self-interference. See also Section 3.6 for measures against RF interference
ESD** = ESD protection for RF antenna interface. For more details see Section 3.6.1
Enhanced ESD*** = Enhanced ESD protection for SIM interface. For more details see Section 2.1.6.1
Blocking**** = For more details see Section 3.6
eUICC interface***** = For more details see Section 2.1.7

Figure 32: Schematic diagram of TX62/TX82 sample application

2.4.1 Sample Level Conversion Circuit

Depending on the micro controller used by an external application TX62/TX82's digital input and output lines (i.e., ASC0, ASC1) may require level conversion. The following Figure 33 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. The sample circuit is not optimized for low current consumption.

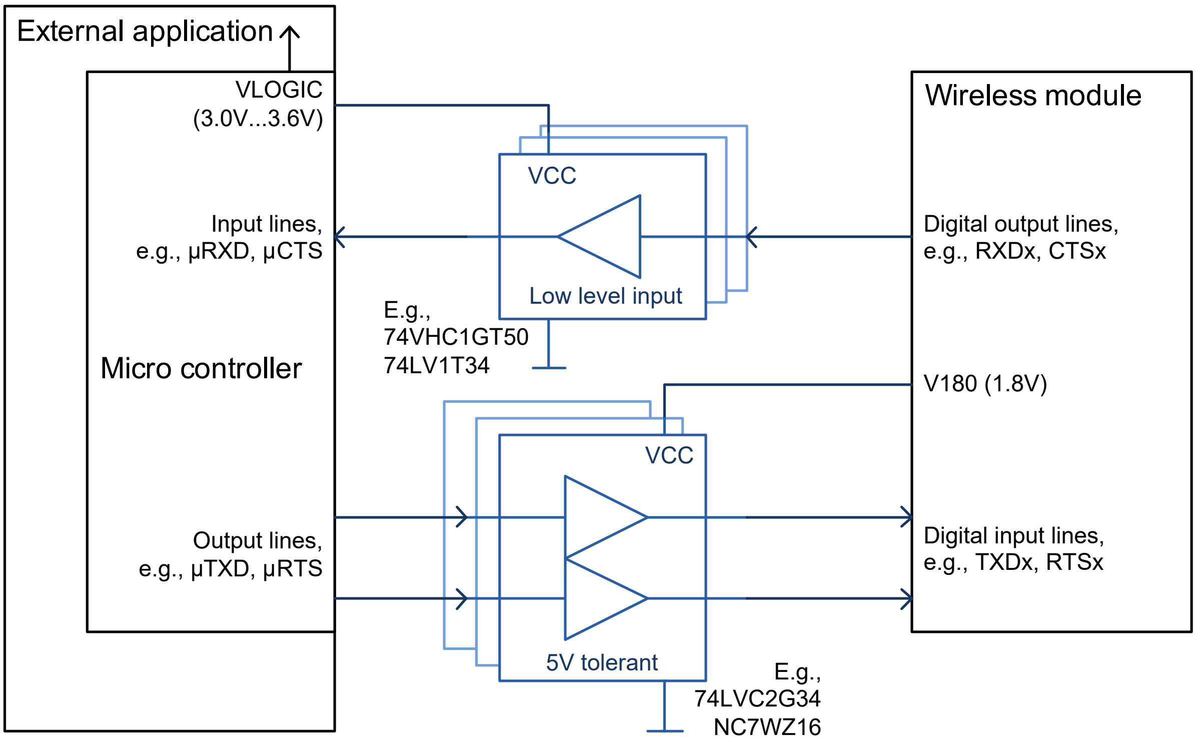


Figure 33: Sample level conversion circuit

3 Operating Characteristics

3.1 Operating Modes

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

Table 13: Overview of operating modes

<table>
<tr><th>Mode</th><th>Function</th><th></th></tr>
<tr><td rowspan="2">Normal operation</td><td>Data transfer</td><td>GSM/(E)GPRS/LTE M1 NB1/2 data transfer in progress.</td></tr>
<tr><td>Idle</td><td>Software and interfaces are active and ready to send and receive, but no GSM/(E)GPRS/LTE M1 NB1/2 data transfer is currently in progress.</td></tr>
<tr><td>SLEEP[1]</td><td colspan="2">Low power mode when no call is in progress and there is no active communication on any serial interface (ASC0, ASC1). During SLEEP mode, the module is in a low power consumption state depending on paging cycles based on network defined DRX values, and optionally network negotiated eDRX (extended DRX) as well as 3GPP PSM values. The firmware is active to a minimum extent, and preserves the state it was in before entering the SLEEP mode. The module stays registered to the network.

SLEEP mode option can be enabled/disabled by AT command (see : AT^SCFG parameter “MEopMode/PwrSave”).</td></tr>
<tr><td>SUSPEND[1]</td><td colspan="2">Low power mode when almost all components are switched off - except for the internal RTC and interrupt triggered wake up mechanisms. The module keeps registered to the network. The module is in its lowest power consumption state. The module can only be woken up by the ON or EMERG_RST signal, or it may wake up and be reachable again after expiration of a 3GPP PSM (Power Saving Mode) periodic TAU cycle (i.e., network timer) that may include DRX and/or eDRX paging cycles for a certain inactivity period. The module wakes up with its signal states being the same as for the first startup configuration, and does not preserve the signal states it had in before entering SUSPEND mode.

The SUSPEND mode option can be enabled/disabled by AT commands (see MEopMode/PowerMgmt/Suspend”).</td></tr>
<tr><td>Airplane</td><td colspan="2">Restricted operating mode where the module’s radio part is shut down, causing the module to log off from the GSM/(E)GPRS/LTE M1 NB1/2 network, and to disable all AT commands whose execution requires a radio connection. Airplane mode can be controlled by AT command (see : AT+CFUN).</td></tr>
<tr><td>POWER DOWN</td><td colspan="2">State after normal shutdown by sending the switch off command (see : AT^SMSO). Software is not active. Interfaces are not accessible. Operating voltage remains applied.</td></tr>
</table>

1. For details on the module’s low power modes and their configuration, please refer to Section 3.3.

3.2 Power Up/Power Down Scenarios

Do not turn on TX62/TX82 while it is beyond the safety limits of voltage stated in Section 2.1.2.1. TX62/TX82 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 TX62/TX82

TX62/TX82 can be turned on as described in the following sections:

- Hardware driven switch on by ON signal: Starts Normal mode (see Section 3.2.1.1 as well as Section 3.2.1.2 (for automatic power on)).

After startup or restart, a high level of the V180 and VCORE lines, as well as the URC ^SYSSTART send by the module indicate that the module has started up (again). The URC notifies the host application that the first AT command can be sent to the module (see also [1]).

3.2.1.1 Switch on TX62/TX82 Using ON Signal

The ON signal switches the module on, if the module is in POWER DOWN mode (or in SUSPEND mode - see Section 3.3.1). This signal is a rising edge sensitive signal. The maximum input voltage can be BATT+. The module starts in the operating mode with a rising edge signal at the ON signal.

The following Figure 34 and Figure 35 show the recommended power on circuit and the startup timings if ON valid.

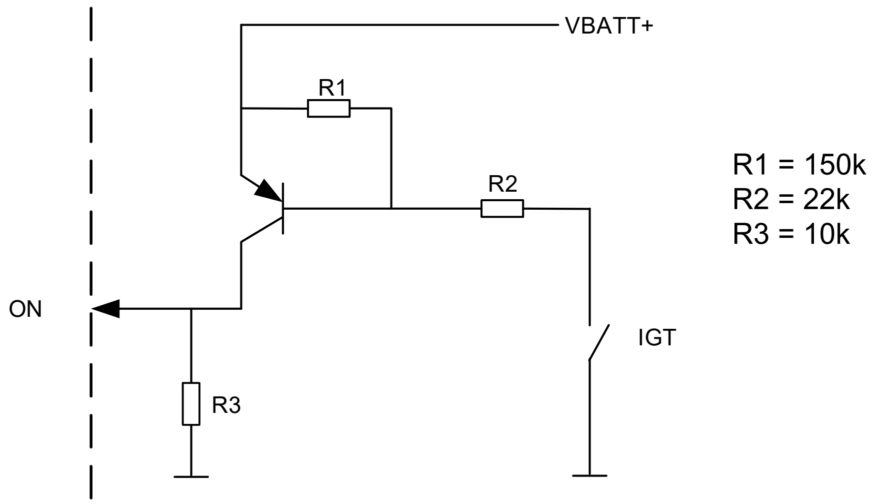


Figure 34: Sample ON circuit

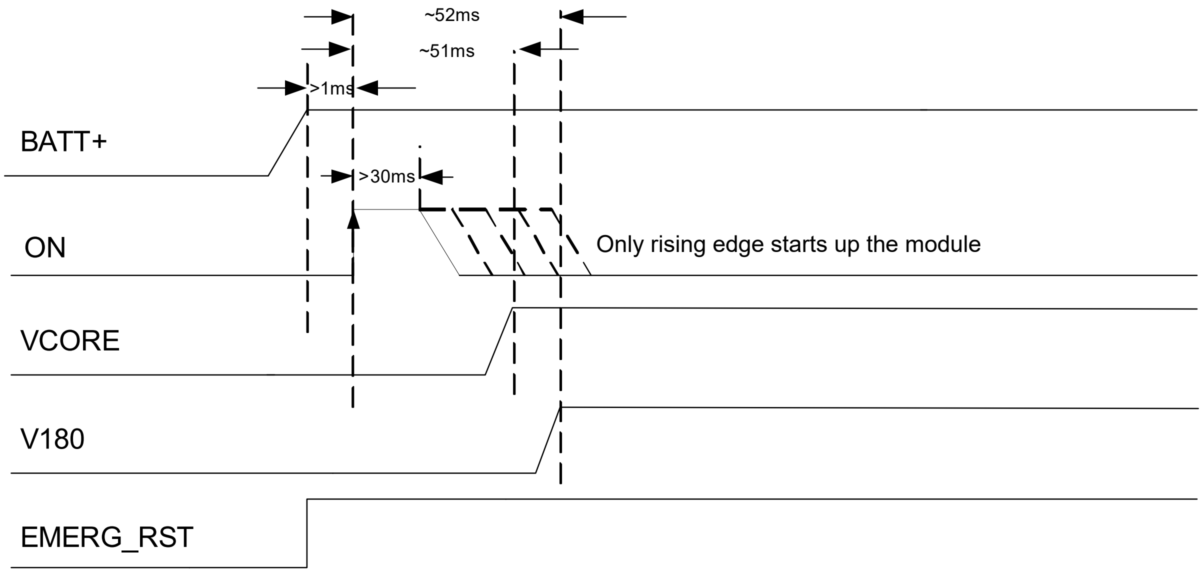


Figure 35: ON startup timing

3.2.1.2 Automatic Power On

When an automatic power on circuit is required for the module application, the ON pulse must be generated after BATT+ is applied. To achieve this, it is recommend to add a monoflop circuit.

With the initial switch on after BATT+ was applied, the pulse of the ON signal must be longer than 1ms. Afterwards, and if the module was already turned off at least once by AT^SMSO, the pulse of the ON signal to switch the module on must be longer than 30ms.

Figure 36 shows a suitable sample circuit.

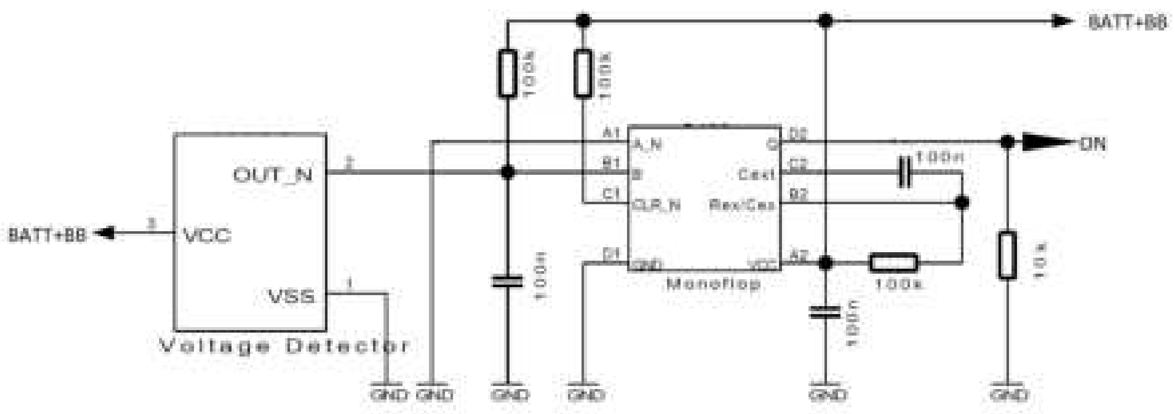


Figure 36: Automatic switch ON circuit sample

For the sample voltage detector circuit it is recommended to use the voltage detector NCP803SN232T1G from ON Semiconductor, and the monoflop 74LVC1G123 from Nexperia.

3.2.2 Restart TX62/TX82

After startup TX62/TX82 can be re-started as described in the following sections:

- Software controlled reset by AT+CFUN command: Starts Normal mode (see Section 3.2.2.1).
- Hardware controlled reset by EMERG_RST line: Starts Normal mode (see Section 3.2.2.2)

3.2.2.1 Restart TX62/TX82 via AT+CFUN Command

To reset and restart the TX62/TX82 module use the command AT+CFUN. See [1] for details.

3.2.2.2 Restart TX62/TX82 Using EMERG_RST

The EMERG_RST signal is internally connected to the central processor. A low level phase >800ms triggers the module restart process, and sets the processor and all signals to their respective reset states. With a low level phase <800ms no module restart is triggered, and the module state remains unchanged. The reset state is described in Section 3.2.3 as well as in the figures showing the startup behavior of an interface.

Please note that if the EMERG_RST signal is not released, i.e., changed from low to high, after a restart, the module will be repeatedly restarted.

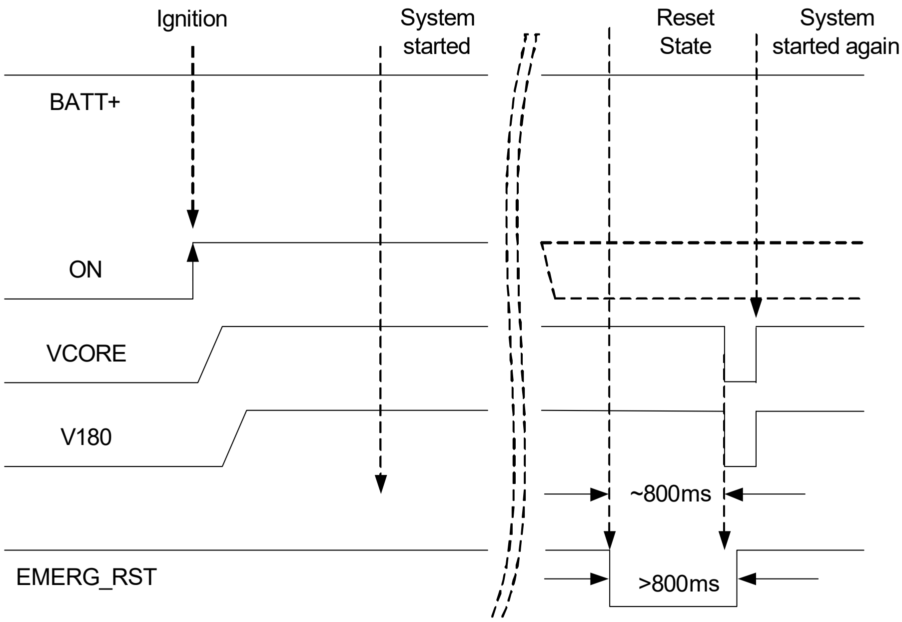


Figure 37: Emergency restart timing

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

Caution: Use the EMERG_RST line only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the EMERG_RST line causes the loss of all information stored in the volatile memory. Therefore, this procedure is intended only for use in case of emergency, e.g. if TX62/TX82 does not respond, if reset or shutdown via AT command fails.

3.2.3 Signal States after Startup

Table 14 describes various states interface signals pass through after startup until the system is active.

Signals are in an initial state while the module is initializing. Once the startup initialization has completed, i.e. when the software is running, all signals are in a defined state, the module is ready to receive and transmit data. The state of some signals may change again once a respective interface is activated or configured by AT command. For details on certain other signal state changes during startup see also Section 3.2.1 (ON, VCORE, V180), Section 3.2.2 (EMERG_RST), and Section 2.1.4 (ASC0 signals).

Table 14: Signal states

Signal name	Reset state	First start up configuration
CCIO	PD	O / L
CCRST	PD	O / L
CCCLK	PD	O / L
CCIN	PD	I / PD
RXD0	PD	O / H
TXD0	PD	I / PD
CTS0	PD	O / H
RTS0	PD	I / PD
DTR0	PD	I / PU
DCD0	PD	O / H
DSR0	PD	O / H
RING0	PD	O / H
RXD1	PD	O / H
TXD1	PD	I / PD
CTS1	PD	O / H
RTS1	PD	I / PD
STATUS	PD	I / PD
FST_SHDN	PD	I / PU
I2CDAT[1]	PD	OD
I2CCLK[1]	PD	OD
SIM_SWITCH	PD	I / PD
SUSPEND_MON	PD	I / PD
GPIO6,7,20-23,25	PD	High-Z / PD

1. Available with embedded processing option only.

Abbreviations used in above Table 14:

L = Low level H = High level High-Z = High Impedance I = Input	O = Output OD = Open Drain PD = Pull down, 55kΩ ~390kΩ PU = Pull up, 55kΩ ~390kΩ

3.2.4 Turn off TX62/TX82

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

- *Software controlled shutdown procedure*: Software controlled by sending an AT command over the serial application interface. See Section 3.2.4.1.
- *Hardware controlled shutdown procedure*: Hardware controlled by setting the FST_SHDN line to low. See Section 2.1.11.3.
- *Automatic shutdown (software controlled)*: See Section 3.2.5
  - Takes effect if TX62/TX82 board temperature exceeds a critical limit, or if
  - Undervoltage or overvoltage is detected.

3.2.4.1 Switch off TX62/TX82 Using AT Command

The best and safest approach to powering down the module is to issue the AT^SMSO command. This procedure lets the module log off from the network and allows the software to enter into a secure state and to save data before disconnecting the power supply. The shutdown procedure will be an active process for about 2 seconds (depending on environmental conditions such as network states) until the module switches off. It cannot be specified how long the shutdown procedure may take at the worst.

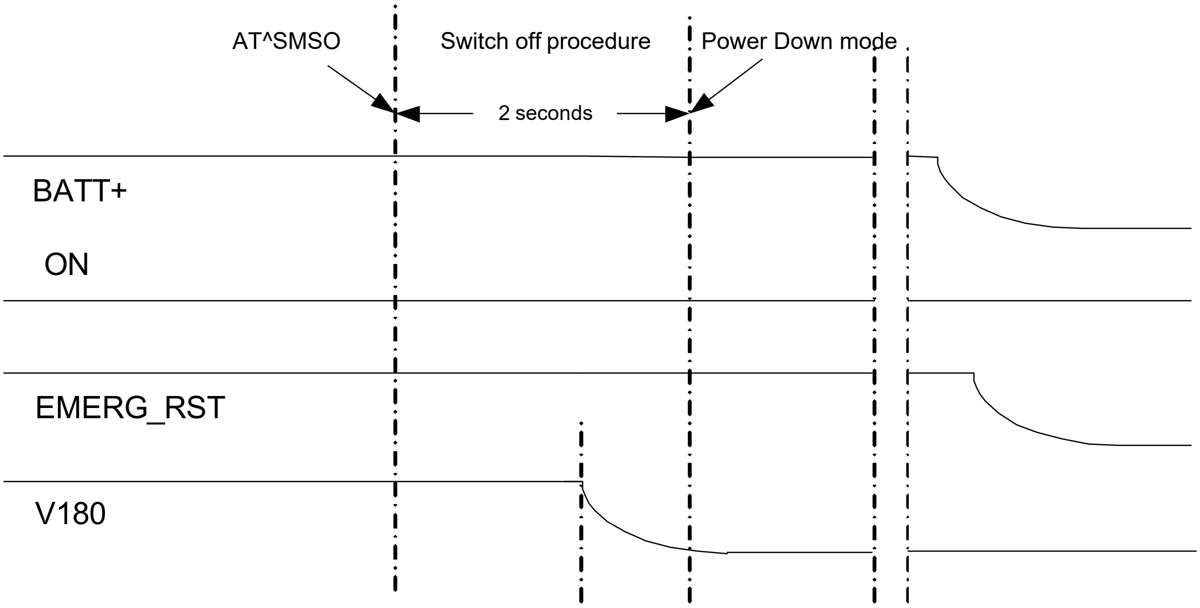


Figure 38: Switch off behavior

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

3.2.5 Automatic Shutdown

Automatic shutdown takes effect if the following event occurs:
- The TX62/TX82 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. TX62/TX82 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, TX62/TX82 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):
  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 TX62/TX82. 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 followed by an orderly shutdown after 5 seconds unless the temperature returns to a valid operating level ("1", "0", "-1") or or the shutdown ability was disabled with AT^SCFG, "MEopMode/ShutdownOnCritTemp",<sdoct>. The presentation of these URCs is always enabled, i.e. they will be output even though the factory setting AT^SCTM=0 was never changed.

The maximum temperature ratings are stated in Section 3.5. Refer to Table 15 for the associated URCs.

Table 15: Temperature dependent behavior

Sending temperature alert (2min after module 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 after 5 seconds (URC appears no matter whether presentation was enabled or not)	
^SCTM_B: 2	Alert: Board equal or beyond overtemperature limit. TX62/TX82 switches off.
^SCTM_B: -2	Alert: Board equal or below undertemperature limit. TX62/TX82 switches off.

3.2.5.2 Undervoltage Shutdown

The undervoltage shutdown threshold is the specified minimum supply voltage V_{BATT+} given in Table 3. When the average supply voltage measured by TX62/TX82 approaches the undervoltage shutdown threshold (i.e., 0.05V offset) the module will send the following URC:

^SBC: Undervoltage

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

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

Note: For battery powered applications it is strongly recommended to implement a BATT+ connecting circuit in order to not only be able save power, but also to restart the module after an undervoltage shutdown where the battery is deeply discharged. Also note that 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 3.3V. For external applications operating at the limit of the allowed tolerance the default undervoltage threshold may be adapted 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 3. When the average supply voltage measured by TX62/TX82 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 TX62/TX82 components are directly linked to BATT+ and, therefore, the supply voltage remains applied at major parts of TX62/TX82. Especially the power amplifier linked to $BATT+_{RF}$ is sensitive to high voltage and might even be destroyed.

3.3 Power Saving

TX62/TX82 can control its power consumption through specific features as summarized in Table 16, and further detailed in the following sections. The mentioned operating modes are detailed in Section 3.1. For typical power supply ratings during power saving please refer to Section 3.4.1.

Table 16: Power saving features

Module operation mode	Network actions	Power Saving Features
Normal operation (network connected)		
Data transfer	Active transfer	Radio Output Power Reduction (ROPR) for GSM only
IDLE	DRX paging	Paging cycles based on DRX values provided by network
	eDRX paging	Paging cycles based on eDRX values negotiated with network
	3GPP PSM paging	Paging cycles based on 3GPP PSM values negotiated with network
Low power operation (network connected)		
SLEEP	DRX paging	Serial interface (ASC0, ASC1) shut down - except for RTS0/1 available as possible wakeup signal Paging cycles based on DRX values provided by network
	eDRX paging	Serial interface (ASC0, ASC1) shut down - except for RTS0/1 available as possible wakeup signal Paging cycles based on provided DRX and negotiated eDRX values
	3GPP PSM paging	Serial interface (ASC0, ASC1) shut down - except for RTS0/1 available as possible wakeup signal Paging cycles based on provided DRX, negotiated optional eDRX, as well as 3GPP PSM values
SUSPEND	DRX paging	All components shut down - except for RTC and certain signal triggered wake-up mechanisms Paging cycles based on DRX values provided by network
	eDRX paging	All components shut down - except for RTC and certain signal triggered wake-up mechanisms Paging cycles based on provided DRX and negotiated eDRX values
	3GPP PSM paging	All components shut down - except for RTC and certain signal triggered wake-up mechanisms Paging cycles based on provided DRX, negotiated optional eDRX, as well as 3GPP PSM values
No network connection		
Airplane	--	Module radio part shut down
POWER DOWN	--	Module switched off. Standby state with BATT+ connected
Power off	--	Module switched off. BATT+ not connected

3.3.1 Low Power Modes

There are two specific low power modes available that can be configured to allow TX62/TX82 to save power - SLEEP mode (Section 3.3.1.1) and SUSPEND mode (Section 3.3.1.2).

Figure 39 illustrates how the module transits between its operating modes including SLEEP and SUSPEND modes.

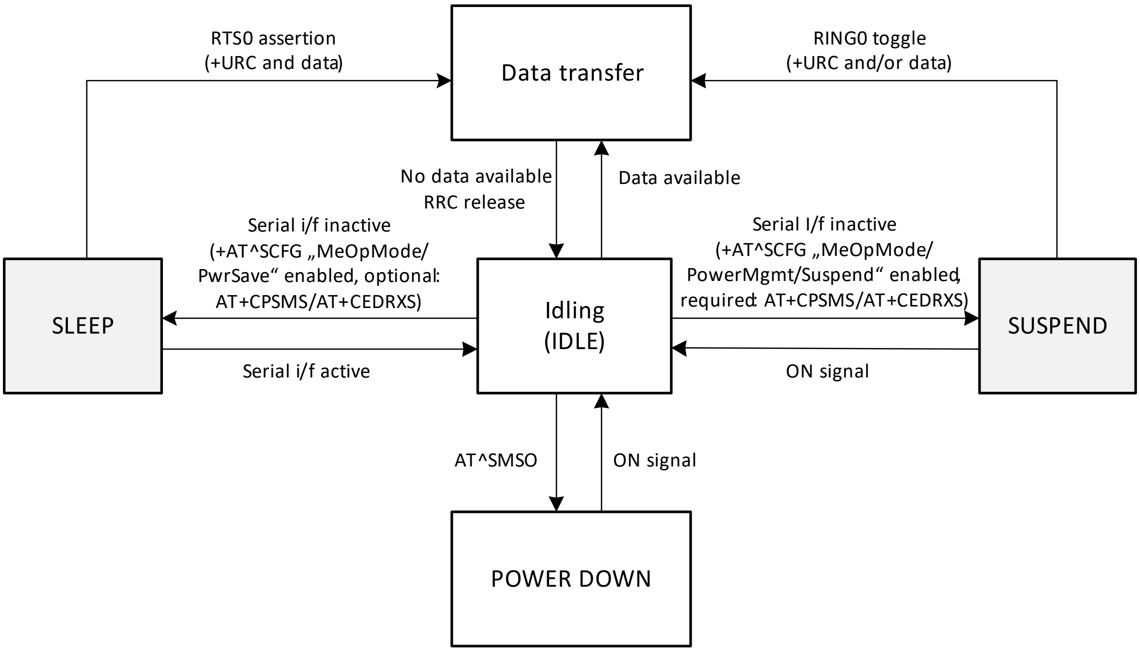


Figure 39: Low power modes with state transitions

Notes:
- When all serial interfaces (i.e. ASC0, and ASC1) are idle, the module can enter SLEEP or SUSPEND mode depending on additional configuration settings.
- The serial interfaces are not idle if there is any response message not read out from any of them.

3.3.1.1 SLEEP Mode

SLEEP mode is a module's low power mode when no call is in progress and there is no active communication on any serial interface (ASC0, ASC1). During SLEEP mode, the serial interfaces are shut down except for RTS0 that may be used to wake up TX62/TX82 from SLEEP mode (see below). The module is in a low power consumption state depending on paging cycles based on network defined DRX values, and possibly network negotiated eDRX (extended DRX) as well as 3GPP PSM values - if configured.

The firmware is active to a minimum extent, and preserves the state it was in before entering the SLEEP mode. The module stays registered to the network.

For details on the network based DRX values see Section 3.3.2.1 (GSM/(E)GPRS) and Section 3.3.3.1 (LTE M1 NB1/2). For details on the network negotiated eDRX values see Section 3.3.3.2, for network negotiated 3GPP PSM values see Section 3.3.3.3.

The SLEEP mode option an be enabled/disabled by AT command (see [1]: AT^SCFG parameter "MEopMode/PwrSave").

RTS0 can be used to wake up TX62/TX82 from SLEEP mode between paging cycles. 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 40 shows the described RTS0 wake up mechanism.

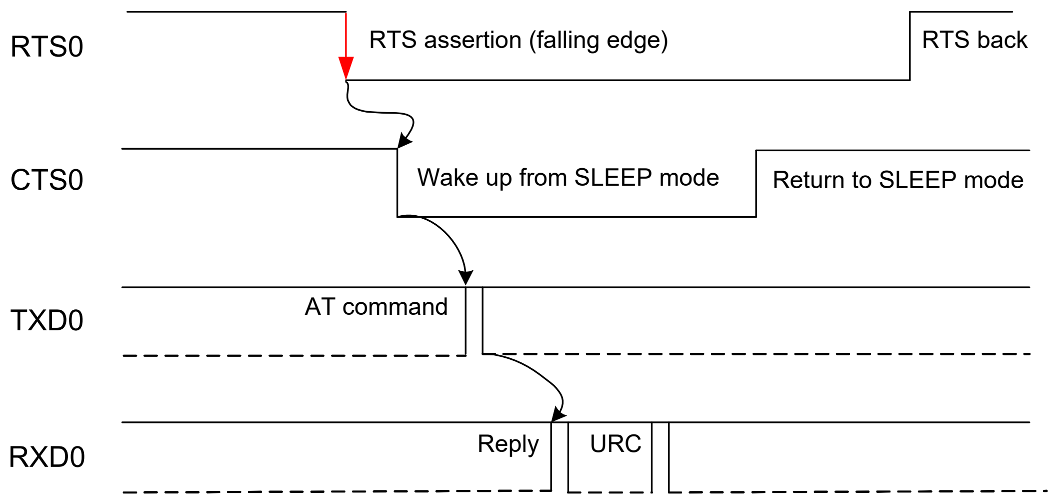


Figure 40: Wake-up via RTS0

3.3.1.2 SUSPEND Mode

In contrast to SLEEP mode, SUSPEND mode is a module's low power mode with almost all components switched off - except for the internal RTC and interrupt triggered wake up mechanisms. The module stays registered to the network, and the RRC connection is released. The module is in its lowest power consumption state.

Once the SUSPEND mode is enabled via AT command (see MEopMode/PowerMgmt/Suspend"), and the appropriate SUSPEND mode indicators are enabled (see PSM and possible eDRX settings need to be negotiated with the network. eDRX and PSM network settings are described in more detail in Section 3.3.3.2 and Section 3.3.3.3.

If the PSM settings are agreed upon with the network, TX62/TX82 is able to enter SUSPEND mode, and the following AT^SIND URC is generated:

+CIEV: “suspendAvailable”,1

In addition, if there is no further communication with the network, and the module is ready to enter SUSPEND mode, the following AT^SIND URC is generated:

+CIEV: "suspendReady",1

Also, the SUSPEND_MON signal will turn low as soon as the module enters SUSPEND mode (see Section 2.1.11.5).

Figure 41 shows the handshake between external application, module and the network for entering SUSPEND mode or possibly SLEEP mode depending on configuration and network response.

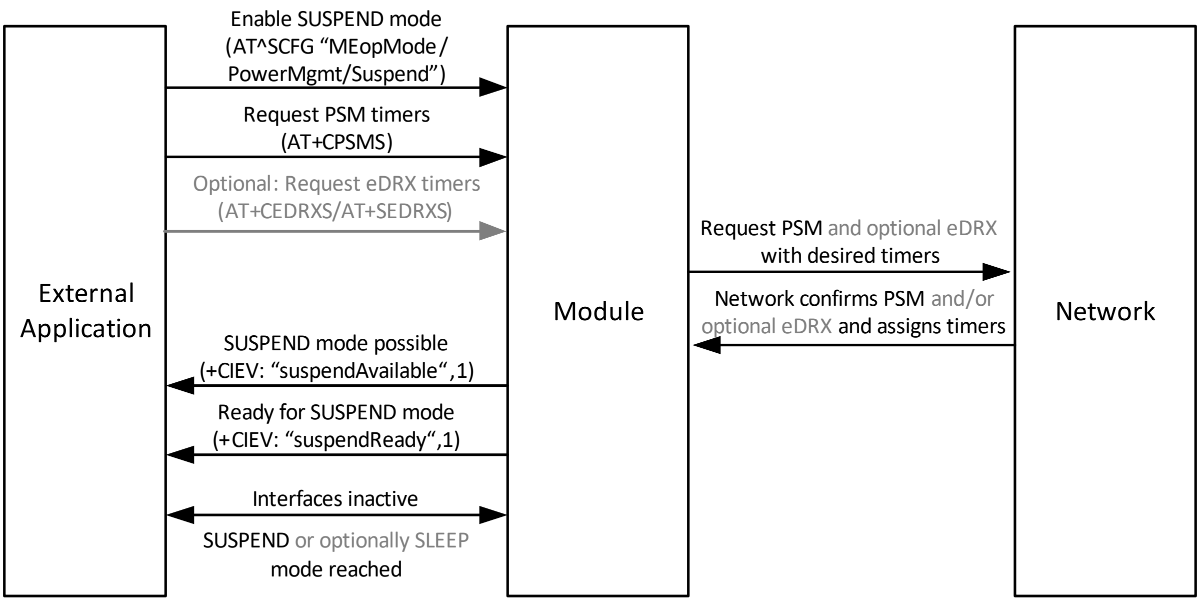


Figure 41: Handshake for entering the module's SUSPEND mode

From SUSPEND mode the module can only be woken up by the ON or EMERG_RST signals, or it may wake up and be reachable again after expiration of a negotiated 3GPP PSM periodic TAU cycle (i.e., network timer) that may include DRX as well as eDRX paging cycles for an inactivity period (see Section 3.3.3.3 for details).

The module wakes up with its signal states being the same as the first startup configuration (see Section 3.2.3), and does not preserve the signal states it had in before entering SUSPEND mode.

Figure 42 shows the handshake between external application, module and network for waking up the module via ON/EMERG_RST signal.

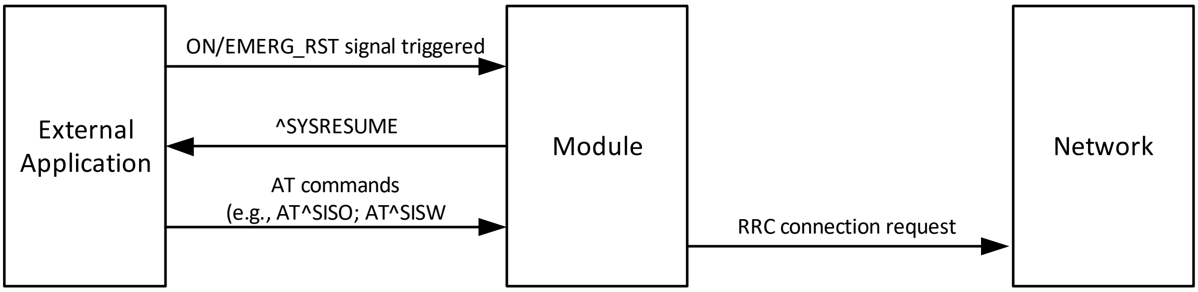


Figure 42: Handshake for module wake up via ON signal

Figure 43 shows the handshake between external application, module and network for waking up the module after expiry of the 3GPP PSM periodic TAU cycle (Tracking Area Update).

In this case the module automatically wakes up, and is reachable by the network to receive data (e.g., an SMS). The module wakeup can be indicated to the external application by toggling the RING0 line. See [1] for the AT^SGPICFG command to control the RING0 logic level. The external application should now activate the appropriate communication interfaces to wake up the module from SUSPEND mode, to receive the ^SYSRESUME URC, and to be able to transfer data.

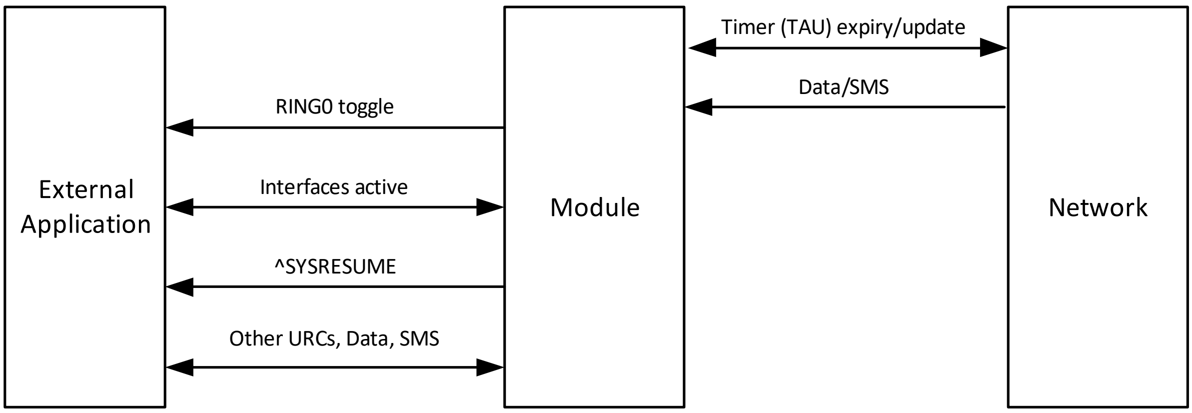


Figure 43: Handshake for module wake up after eDRX/PSM timer expiry

3.3.2 Power Saving while Attached to GSM Networks (TX82-W only)

Power saving while attached to GSM networks is based on standard DRX values defined for the network (see Section 3.3.2.1).

Apart from network based power saving it is possible to use the AT command AT^SCFG="Radio/OutputPowerReduction" for the module in (E)GPRS multislot scenarios to reduce its output power according to 3GPP 45.005. By default a maximum power reduction is enabled. For details on this AT command see [1].

3.3.2.1 DRX (Standard Configuration)

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, i.e., SLEEP mode, as shown in Figure 44.

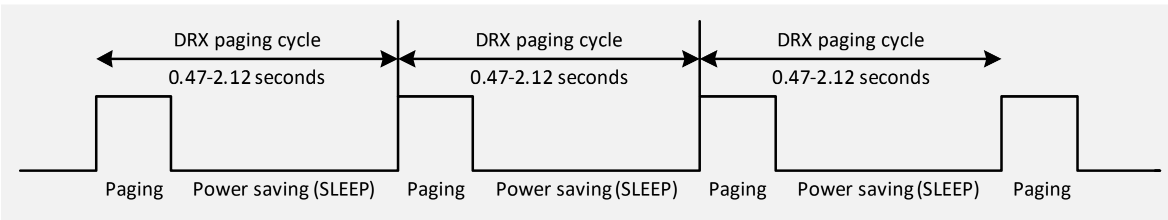


Figure 44: DRX based paging and power saving (SLEEP) in GSM networks

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

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

3.3.2.2 eDRX (Extended DRX Configuration)

Note: eDRX support for GSM networks is disabled. eDRX support is only available for LTE Cat M1 and Cat NB1/2 networks (see Section 3.3.3.2).

3.3.3 Power Saving while Attached to LTE M1 NB1/2 Networks

This section describes the power saving possibilities in LTE Cat M1 and LTE Cat NB1/2 networks through DRX (see Section 3.3.3.1) values, as well as configurable eDRX (see Section 3.3.3.2), and 3GPP PSM (see Section 3.3.3.3) timers.

3.3.3.1 DRX (Standard Configuration)

TX62/TX82 can be enabled to use DRX (Discontinuous Reception) in RRC idle mode to reduce power consumption (see also Section 3.3.1.1). The power saving possibilities while attached to an LTE Cat M1 or LTE Cat NB1/2 network depend on the paging timing cycle of the base station.

During normal operation, i.e., the module is connected to an LTE Cat M1 or LTE Cat NB1/2 network, the duration of power saving period varies. It may be calculated using the following formula:

t = DRX Cycle Value * 10 ms

DRX cycle value in LTE Cat M1 or LTE Cat NB1/2 networks is any of the four values: 128, 256, 512 and 1024, thus resulting power saving intervals between 1.28 and 10.24 seconds. The DRX cycle value of the base station is assigned by the network operator.

In the pauses between listening to paging messages, the module resumes power saving, as shown in Figure 45.

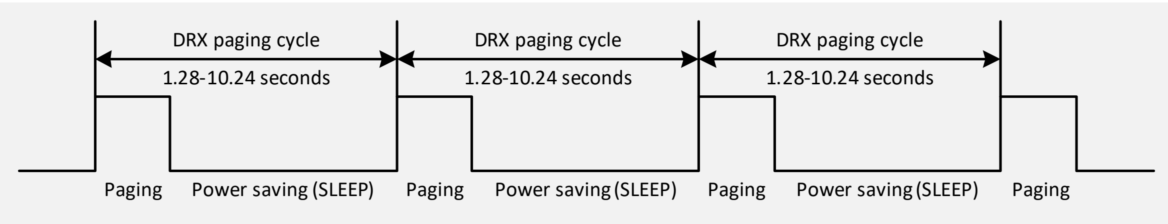


Figure 45: DRX based paging and power saving (SLEEP) in LTE Cat M1 and Cat NB1/2 networks

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

3.3.3.2 eDRX (Extended DRX Configuration)

TX62/TX82 and the network may negotiate the use of eDRX (extended DRX) to reduce power consumption, while being available for mobile terminating data and/or network originated procedures within a certain delay dependent on the network negotiated eDRX cycle value (see also Section 3.3.1.2). If the network supports eDRX, the module monitors the paging messages during a periodic Paging Time Window (PTW) configured for TX62/TX82.

The possible eDRX paging cycle length (PCL) ranges from 5.12s up to a maximum of 10485.76s (almost 3 hours).

The PTW length can be calculated using the following formula:

t_ptw = (PTW value +1)* 2560 ms

Figure 46 shows the eDRX timings, with the module listening to paging messages during a paging time window (PTW).

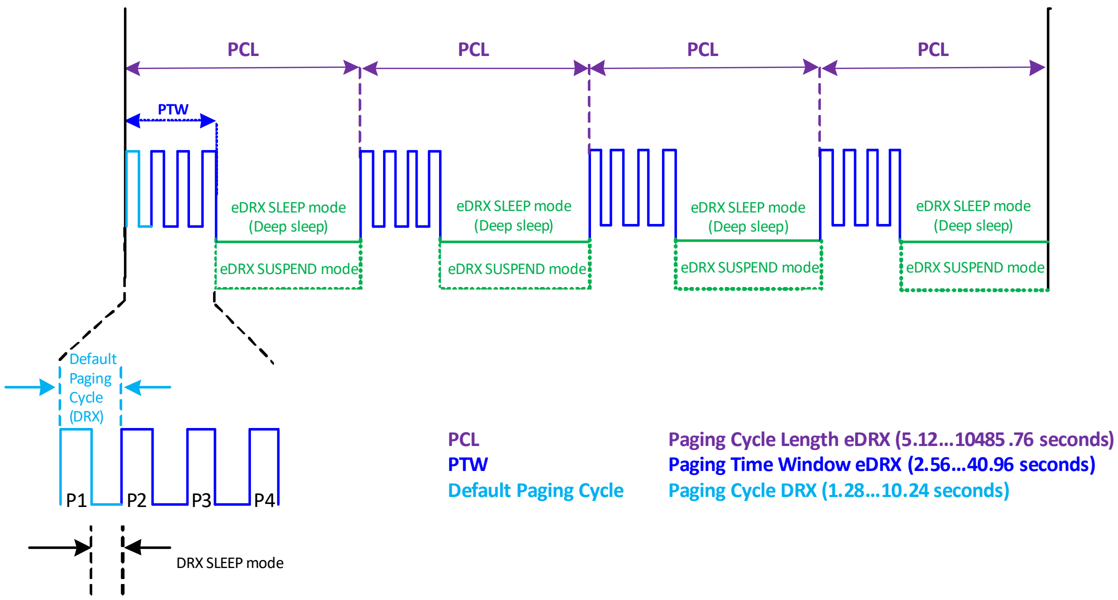


Figure 46: eDRX based paging and power saving in LTE Cat M1 and Cat NB1/2 networks

The eDRX timer can be configured with AT+CEDRXS (or AT^SEDRXS with a PTW timer request) that negotiates the eDRX settings with the network. The dynamic parameters are readable with AT+CEDRXRDP. For more information on these AT commands see [1].

Note 1: If SUSPEND mode is enabled in addition to SLEEP mode and eDRX settings, the module is able to reduce its current consumption even further during the eDRX paging cycle (see Figure 46). This optional so-called eDRX SUSPEND mode can be enabled with the AT^SCFG command "Radio/Suspend,<suspendmode>". However, the module will in this case not longer be able to change into the regular 3GPP PSM SUSPEND mode.

Note 2: eDRX can be configured together with 3GPP PSM (AT+CPSMS) as it will not only affect SLEEP mode (deep sleep) and eDRX SUSPEND mode, but also the 3GPP PSM SUSPEND mode - see Section 3.3.3.3.

3.3.3.3 3GPP PSM Configuration

TX62/TX82 can be configured to use 3GPP PSM to reduce power consumption. PSM is similar to power off, while TX62/TX82 remains registered with the network. There is no need to re-attach or re-establish PDN connections. TX62/TX82 in PSM is not immediately reachable for mobile terminating services (see also SUSPEND mode in Section 3.3.1.2)

The network accepts and negotiates the use of PSM by providing specific values for periodic TAU cycles (T3412) as well as an active timer (T3324). Upon expiry of the active timer, or if the value provided by the network is zero, TX62/TX82 may activate PSM.

Note: If TX62/TX82 negotiates to enable both PSM (requesting an active timer and possibly a periodic TAU cycle value) as well as eDRX (requesting a specific extended idle mode DRX cycle value and possibly a paging time window), it is up to the network to decide whether to:
1. Enable only PSM, i.e. not accept the request for eDRX.
2. Enable only eDRX, i.e. not accept the request for an active timer.
3. Enable both PSM (i.e. negotiate and provide requested PSM timers) and eDRX (i.e. negotiate and provide extended DRX parameters).

Figure 47 shows the module's eDRX and PSM timings for the third case where module and network negotiate PSM and eDRX simultaneously (for eDRX see also Section 3.3.3.2). For the second case the module will not reach SUSPEND mode and will continue with the eDRX paging cycles. For the first case the module will not extend the DRX paging cycles, but will continue with the DRX paging cycles until the active timer (T3324) expires.

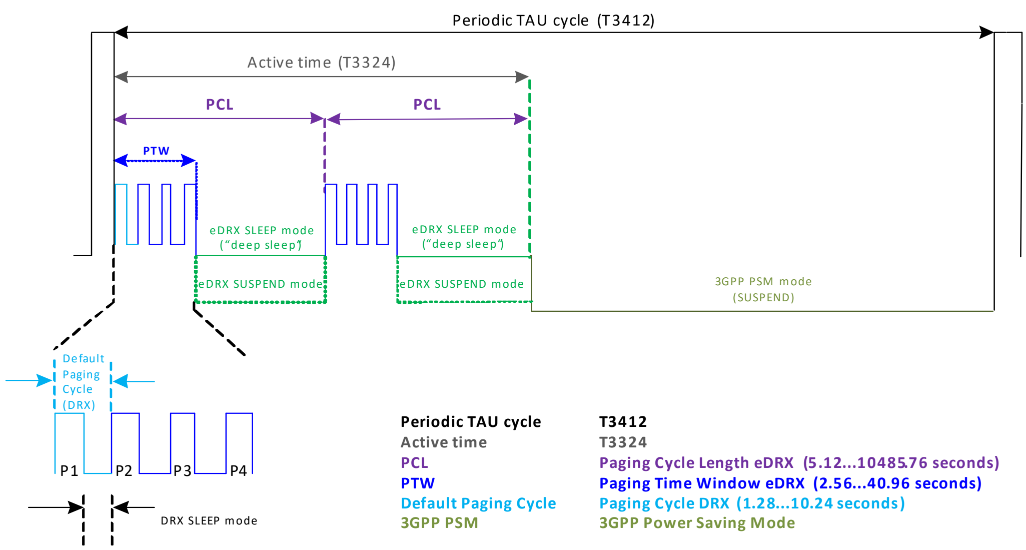


Figure 47: eDRX/PSM based paging and power saving in LTE Cat M1 or Cat NB1/2 networks

TX62/TX82 monitors paging message only while the active timer (T3324) has not expired. If the module has uplink data or signal, it will not change to PSM.

The active timer (T3324) and periodic tracking area update (TAU) timer (T3412) can be negotiated/requested with AT+CPSMS. For more information on this AT command see [1].

3.4 Power Supply

TX62/TX82 needs to be connected to a power supply at the SMT application interface - 2 lines BATT+, and GND. There are two separate voltage domains for BATT+:

- $BATT+_{BB}$ with a line mainly for the baseband power supply.
- $BATT+_{RF}$ with a line for the GSM/LTE power amplifier supply. Please note that this line does not have to be connected with TX62-W.

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

The power supply of TX62/TX82 has to be a single voltage source at $BATT+_{BB}$ and $BATT+_{RF}$. It should be of type PS1, according to IEC 62368-1, and must be able to provide the peak current during the uplink transmission.

Suitable low ESR capacitors should be placed as close as possible to the BATT+ pads, e.g., X7R MLCC (see also Section 2.1.2).

All key functions for supplying power to the device are handled by the power management IC. It 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.

3.4.1 Power Supply Ratings

Table 17, Table 18, Table 19, Table 20, and Table 21 assemble various voltage supply and current consumption ratings (GSM, Cat M1 and Cat NB1/2) of the module.

Table 17: Voltage supply ratings

	Description	Conditions	Min	Typ	Max	Unit
BATT+	TX82-W Supply voltage (LTE and GSM)	Directly measured at Module. Voltage must stay within the min/ max values, including voltage drop, ripple, spikes For every BATT+ transition/reinsertion from 0V, BATT+ should be at least 2.65V to power on the module.	3.1		4.6	V
	TX82-W Supply voltage (GSM deactivated)		2.8		4.6	V
	TX62-W Supply voltage		2.55		4.8	V
	TX62-W-B Supply voltage		2.5		4.5	V
	TX62-W-C Supply voltage		3.2		4.2	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			 70 20	 mV_{pp} mV_{pp}

Table 18: General current consumption ratings (TX62/TX82)

Description		Conditions	Typical rating				Unit
			TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$[2])	OFF state supply current	State after initially connecting V_{BATT+} and/or after a fast shutdown triggered via FST_SHDN	14	14	14	14	µA
		State after switching a running module off via AT^SMSO	4.5	4.5	4.7	4.5	
	Airplane mode (CFUN = 4)	UART (RTS) active	12	12	12	12	mA
		UART (RTS) inactive	0.55	0.54	0.54	0.49	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. $BATT+_{RF}$ is available with TX82-W only.

Table 19: Current consumption ratings Cat M1 (TX62/TX82)

Description		Conditions			Typical rating				Unit
					TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE CAT-M1 supply current	SUSPEND[2]	Power save mode		3.8	4.5	4.5	4.5	µA
		RRC idle (SLEEP)[2]	DRX=256		0.90	0.93	0.93	0.97	mA
			DRX=128		1.34	1.40		1.44	mA
			DRX=64		2.21	2.28		2.30	mA
			20,48s eDRX	3,84s paging window (DRX=1.28s)	0.65	0.69		0.70	mA
			81,92s eDRX	2,56s paging window (DRX=1.28s)	0.44	0.48		0.49	mA
			163,84s eDRX	3,84s paging window (DRX=1.28s)	0.43	0.46	0.69	0.47	mA
			163,84s eDRX	10,24s paging window (DRX=1.28s)	0.46	0.50		0.51	mA
		RRC idle (SUSPEND)[2]	81,92s eDRX	2,56s paging window (DRX=1.28s)	0.62	0.64		0.66	mA
			163,84s eDRX	3,84s paging window (DRX=1.28s)	0.33	0.34	0.34	0.35	mA
			163,84s eDRX	10,24s paging window (DRX=1.28s)	0.39	0.41		0.42	mA
		Connected DRX[3]	Short C-DRX		40	44		45	mA
			Long C-DRX		10	13		14	mA

Table 19: Current consumption ratings Cat M1 (TX62/TX82)

Description		**Conditions**		**Typical rating**				**Unit**
				TX62-W	**TX62-W-B**	**TX62-W-C**	**TX82-W**	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE CAT-M1 supply current	RRC connected Active Transmission[3] **TX62-W-B and TX62-W-C only**	Band1, 23dBm	-	226	226	-	mA
			Band2, 23dBm	-	224		-	mA
			Band3, 23dBm	-	230		-	mA
			Band4, 23dBm	-	235		-	mA
			Band5, 23dBm	-	228		-	mA
			Band8, 23dBm	-	235		-	mA
			Band12, 23dBm	-	208		-	mA
			Band13, 23dBm	-	220		-	mA
			Band18, 23dBm	-	216		-	mA
			Band19, 23dBm	-	224		-	mA
			Band20, 23dBm	-	225		-	mA
			Band25, 23dBm	-	226		-	mA
			Band26, 23dBm	-	226		-	mA
			Band27, 23dBm	-	213		-	mA
			Band28, 23dBm	-	214		-	mA
			Band31, 26dBm (TX62-W-C)	-	-		-	mA
			Band66, 23dBm	-	231		-	mA
			Band72, 26dBm (TX62-W-C)	-	-		-	mA
			Band85, 23dBm	-	201		-	mA
		RRC connected Active Transmission[3]	Band1, 20dBm	168	-		177	mA
			Band2, 20dBm	177	-		171	mA
			Band3, 20dBm	167	-		172	mA
			Band4, 20dBm	167	-		169	mA
			Band5, 20dBm	175	-		187	mA
			Band8, 20dBm	180	-		180	mA
			Band12, 20dBm	173	-		164	mA
			Band13, 20dBm	183	-		185	mA
			Band18, 20dBm	179	-		184	mA
			Band19, 20dBm	180	-		186	mA
			Band20, 20dBm	179	-		185	mA
			Band25, 20dBm	176	-		173	mA
			Band26, 20dBm	183	-		180	mA
			Band27, 20dBm	181	-		183	mA
			Band28, 20dBm	170	-		185	mA
			Band66, 20dBm	166	-		169	mA
			Band85, 20dBm	168	-		164	mA

Table 19: Current consumption ratings Cat M1 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE CAT-M1 supply current	RRC connected Active Transmission[3]	Band1, 0dBm	103	131	131	105	mA
			Band2, 0dBm	102	123		105	mA
			Band3, 0dBm	103	120		105	mA
			Band4, 0dBm	103	121		105	mA
			Band5, 0dBm	102	129		105	mA
			Band8, 0dBm	103	135		105	mA
			Band12, 0dBm	102	126		104	mA
			Band13, 0dBm	102	135		105	mA
			Band18, 0dBm	103	130		105	mA
			Band19, 0dBm	102	130		106	mA
			Band20, 0dBm	103	130		106	mA
			Band25, 0dBm	103	124		105	mA
			Band26, 0dBm	103	130		105	mA
			Band27, 0dBm	103	130		105	mA
			Band28, 0dBm	103	127		105	mA
			Band66, 0dBm	103	121		106	mA
			Band85, 0dBm	103	117		105	mA
	Peak Current @ RRC connected Active Transmission[3] VBATT = 3.8V **TX62-W-B and TX62-W-C only**		Band1, 23dBm	-	576	576	-	mA
			Band2, 23dBm	-	564		-	mA
			Band3, 23dBm	-	576		-	mA
			Band4, 23dBm	-	576		-	mA
			Band5, 23dBm	-	552		-	mA
			Band8, 23dBm	-	588		-	mA
			Band12, 23dBm	-	516		-	mA
			Band13, 23dBm	-	552		-	mA
			Band18, 23dBm	-	528		-	mA
			Band19, 23dBm	-	552		-	mA
			Band20, 23dBm	-	552		-	mA
			Band25, 23dBm	-	564		-	mA
			Band26, 23dBm	-	552		-	mA
			Band27, 23dBm	-	516		-	mA
			Band28, 23dBm	-	516		-	mA
			Band31, 26dBm (TX62-W-C)	-	-		-	mA
			Band66, 23dBm	-	564		-	mA
			Band72, 26dBm (TX62-W-C)	-	-		-	mA
			Band85, 23dBm	-	504		-	mA

Table 19: Current consumption ratings Cat M1 (TX62/TX82)

Description	Conditions		Typical rating				Unit
			TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Peak Current @ RRC connected Active Transmission[3] VBATT = 3.8V	Band1, 20dBm	412	-		408	mA
		Band2, 20dBm	396	-		388	mA
		Band3, 20dBm	388	-		376	mA
		Band4, 20dBm	376	-		396	mA
		Band5, 20dBm	396	-		456	mA
		Band8, 20dBm	452	-		428	mA
		Band12, 20dBm	388	-		372	mA
		Band13, 20dBm	420	-		452	mA
		Band18, 20dBm	432	-		452	mA
		Band19, 20dBm	440	-		456	mA
		Band20, 20dBm	448	-		452	mA
		Band25, 20dBm	388	-		400	mA
		Band26, 20dBm	420	-		436	mA
		Band27, 20dBm	440	-		444	mA
		Band28, 20dBm	404	-		404	mA
		Band66, 20dBm	368	-		384	mA
		Band85, 20dBm	384	-		372	mA
	Peak Current @ RRC connected Active Transmission[3] VBATT = 2.5V **TX62-W-B and TX62-W-C only**	Band1, 23dBm	-	624		-	mA
		Band2, 23dBm	-	648		-	mA
		Band3, 23dBm	-	636		-	mA
		Band4, 23dBm	-	624		-	mA
		Band5, 23dBm	-	660		-	mA
		Band8, 23dBm	-	612		-	mA
		Band12, 23dBm	-	564		-	mA
		Band13, 23dBm	-	648		-	mA
		Band18, 23dBm	-	624		-	mA
		Band19, 23dBm	-	612		-	mA
		Band20, 23dBm	-	648		-	mA
		Band25, 23dBm	-	612		-	mA
		Band26, 23dBm	-	612		-	mA
		Band27, 23dBm	-	588		-	mA
		Band28, 23dBm	-	624		-	mA
		Band31, 26dBm (TX62-W-C)	-	-		-	mA
		Band66, 23dBm	-	648		-	mA
		Band72, 26dBm (TX62-W-C)	-	-		-	mA
		Band85, 23dBm	-	588		-	mA

Table 19: Current consumption ratings Cat M1 (TX62/TX82)

Description	Conditions		Typical rating				Unit
			TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Peak Current @ RRC connected Active Transmission[3] VBATT = 2.55V (TX62-W) VBATT = 2.8V (TX82-W)	Band1, 20dBm	572	-		528	mA
		Band2, 20dBm	556	-		516	mA
		Band3, 20dBm	564	-		492	mA
		Band4, 20dBm	528	-		500	mA
		Band5, 20dBm	576	-		608	mA
		Band8, 20dBm	656	-		556	mA
		Band12, 20dBm	548	-		476	mA
		Band13, 20dBm	604	-		592	mA
		Band18, 20dBm	624	-		596	mA
		Band19, 20dBm	632	-		588	mA
		Band20, 20dBm	636	-		580	mA
		Band25, 20dBm	556	-		516	mA
		Band26, 20dBm	604	-		560	mA
		Band27, 20dBm	640	-		596	mA
		Band28, 20dBm	588	-		508	mA
		Band66, 20dBm	520	-		496	mA
		Band85, 20dBm	556	-		496	mA
	Average idle supply current (GNSS on)	CAT-M1 active (UART active) @ DRX=128 GNSS NMEA output off	65	66		64	mA
		GPRS active (UART active) @ DRX=128 GNSS NMEA output on	64	66		64	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. Measurements start 6 minutes after switching ON the module,
   Averaging times:
   SUSPEND mode: 3 minutes (T3324 = 3s, T3412 = 14400s)
   SLEEP mode: 10 minutes, (PSM disabled, eDRX disabled)
   Idle eDRX mode: 30 minutes, (PSM disabled, eDRX enabled)
   Connected DRX mode: 10 minutes,
   RRC connected modes: 3 minutes,
   Communication tester settings: no neighbor cells, no cell re-selection etc, RMC (reference measurement channel),
   SUSPEND/SLEEP (with PSM/eDRX) is enabled via AT command
3. Communication tester settings:
   RMC mode, Half Duplex,
   Cat M1 Channel Bandwidth: 10MHz
   Modulation: QPSK.
   RB setting: 1 UL RBs, 4 DL RBs

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

<table>
<tr><th rowspan="2" colspan="2">Description</th><th rowspan="2" colspan="3">Conditions</th><th colspan="4">Typical rating</th><th>Unit</th></tr>
<tr><th>TX62-W</th><th>TX62-W-B</th><th>TX62-W-C</th><th>TX82-W</th><th></th></tr>
<tr><td rowspan="31">I_{BATT+}[1]

(i.e., only $BATT+_{BB}$)</td><td rowspan="31">Average LTE NB1/2 supply current</td><td>SUSPEND[2]</td><td colspan="2">Power save mode</td><td>3.8</td><td>4.5</td><td>4.5</td><td>4.5</td><td>µA</td></tr>
<tr><td rowspan="9">RRC idle (SLEEP)[2]</td><td colspan="2">DRX=1024</td><td>0.77</td><td>0.79</td><td></td><td>0.88</td><td>mA</td></tr>
<tr><td colspan="2">DRX=512</td><td>1.08</td><td>1.09</td><td></td><td>1.17</td><td>mA</td></tr>
<tr><td colspan="2">DRX=256</td><td>0.85</td><td>0.86</td><td>0.86</td><td>0.94</td><td>mA</td></tr>
<tr><td colspan="2">DRX=128</td><td>1.23</td><td>1.26</td><td></td><td>1.35</td><td>mA</td></tr>
<tr><td>20,48s eDRX</td><td>2,56s paging window (DRX=1.28s)</td><td>1.15</td><td>1.14</td><td></td><td>1.19</td><td>mA</td></tr>
<tr><td>81,92s eDRX</td><td>2,56s paging window (DRX=1.28s)</td><td>0.49</td><td>0.49</td><td></td><td>0.55</td><td>mA</td></tr>
<tr><td>163,84s eDRX</td><td>2,56s paging window (DRX=1.28s)</td><td>0.45</td><td>0.44</td><td>0.44</td><td>0.50</td><td>mA</td></tr>
<tr><td>163,84s eDRX</td><td>10,24s paging window (DRX=1.28s)</td><td>0.51</td><td>0.50</td><td></td><td>0.59</td><td>mA</td></tr>
<tr><td rowspan="3">RRC idle (SUSPEND)[2]</td><td>81,92s eDRX</td><td>2,56s paging window (DRX=1.28s)</td><td>0.62</td><td>0.66</td><td></td><td>0.66</td><td>mA</td></tr>
<tr><td>163,84s eDRX</td><td>2,56s paging window (DRX=1.28s)</td><td>0.31</td><td>0.33</td><td>0.33</td><td>0.34</td><td>mA</td></tr>
<tr><td>163,84s eDRX</td><td>10,24s paging window (DRX=1.28s)</td><td>0.38</td><td>0.40</td><td></td><td>0.40</td><td>mA</td></tr>
<tr><td rowspan="19">RRC connected Active Transmission DL RMC[3]

TX62-W-B and TX62-W-C only</td><td colspan="2">Band1, 23dBm</td><td>-</td><td>77</td><td>232</td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band2, 23dBm</td><td>-</td><td>78</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band3, 23dBm</td><td>-</td><td>77</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band4, 23dBm</td><td>-</td><td>76</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band5, 23dBm</td><td>-</td><td>76</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band8, 23dBm</td><td>-</td><td>79</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band12, 23dBm</td><td>-</td><td>74</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band13, 23dBm</td><td>-</td><td>76</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band18, 23dBm</td><td>-</td><td>75</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band19, 23dBm</td><td>-</td><td>76</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band20, 23dBm</td><td>-</td><td>77</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band25, 23dBm</td><td>-</td><td>77</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band26, 23dBm</td><td>-</td><td>75</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band28, 23dBm</td><td>-</td><td>74</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band31, 26dBm (TX62-W-C)</td><td>-</td><td>-</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band66, 23dBm</td><td>-</td><td>78</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band71, 23dBm (TX62-W-B)</td><td>-</td><td>73</td><td>-</td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band72, 26dBm (TX62-W-C)</td><td>-</td><td>-</td><td></td><td>-</td><td>mA</td></tr>
<tr><td colspan="2">Band85, 23dBm</td><td>-</td><td>74</td><td></td><td>-</td><td>mA</td></tr>
</table>

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE NB1/2 supply current	RRC connected Active Transmission DL RMC[3]	Band1, 20dBm	63	-		65	mA
			Band2, 20dBm	62	-		64	mA
			Band3, 20dBm	62	-		63	mA
			Band4, 20dBm	61	-		63	mA
			Band5, 20dBm	65	-		70	mA
			Band8, 20dBm	66	-		68	mA
			Band12, 20dBm	63	-		64	mA
			Band13, 20dBm	66	-		69	mA
			Band18, 20dBm	66	-		69	mA
			Band19, 20dBm	66	-		69	mA
			Band20, 20dBm	66	-		70	mA
			Band25, 20dBm	63	-		65	mA
			Band26, 20dBm	66	-		69	mA
			Band28, 20dBm	64	-		68	mA
			Band66, 20dBm	62	-		63	mA
			Band71, 20dBm	61	-		62	mA
			Band85, 20dBm	63	-		64	mA
			Band1, 0dBm	44	57		45	mA
			Band2, 0dBm	43	55		45	mA
			Band3, 0dBm	44	54		45	mA
			Band4, 0dBm	44	54		44	mA
			Band5, 0dBm	44	57		45	mA
			Band8, 0dBm	44	58		45	mA
			Band12, 0dBm	44	56		44	mA
			Band13, 0dBm	44	58		45	mA
			Band18, 0dBm	44	57		45	mA
			Band19, 0dBm	44	57		45	mA
			Band20, 0dBm	44	56		45	mA
			Band25, 0dBm	44	55		44	mA
			Band26, 0dBm	44	57		45	mA
			Band28, 0dBm	44	56		45	mA
			Band66, 0dBm	44	54		45	mA
			Band71, 0dBm	43	55		43	mA
			Band85, 0dBm	44	56		44	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE NB1/2 supply current	RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3] **TX62-W-B and TX62-W-C only**	Band1, 23dBm	-	232		-	mA
			Band2, 23dBm	-	237		-	mA
			Band3, 23dBm	-	228		-	mA
			Band4, 23dBm	-	221		-	mA
			Band5, 23dBm	-	219		-	mA
			Band8, 23dBm	-	240		-	mA
			Band12, 23dBm	-	207		-	mA
			Band13, 23dBm	-	218		-	mA
			Band18, 23dBm	-	217		-	mA
			Band19, 23dBm	-	223		-	mA
			Band20, 23dBm	-	224		-	mA
			Band25, 23dBm	-	235		-	mA
			Band26, 23dBm	-	219		-	mA
			Band28, 23dBm	-	207		-	mA
			Band31, 26dBm (TX62-W-C)	-	-		-	mA
			Band66, 23dBm	-	258		-	mA
			Band71, 23dBm (TX62-W-B)	-	203	-	-	mA
			Band72, 26dBm (TX62-W-C)	-	-		-	mA
			Band85, 23dBm	-	208		-	mA
		RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3]	Band1, 20dBm	178	-		186	mA
			Band2, 20dBm	172	-		180	mA
			Band3, 20dBm	166	-		170	mA
			Band4, 20dBm	164	-		168	mA
			Band5, 20dBm	183	-		203	mA
			Band8, 20dBm	191	-		196	mA
			Band12, 20dBm	168	-		171	mA
			Band13, 20dBm	191	-		202	mA
			Band18, 20dBm	186	-		200	mA
			Band19, 20dBm	187	-		203	mA
			Band20, 20dBm	189	-		203	mA
			Band25, 20dBm	180	-		182	mA
			Band26, 20dBm	192	-		200	mA
			Band28, 20dBm	175	-		190	mA
			Band66, 20dBm	167	-		166	mA
			Band71, 20dBm	164	-		169	mA
			Band85, 20dBm	173	-		169	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE NB1/2 supply current	RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3]	Band1, 0dBm	61	111	111	62	mA
			Band2, 0dBm	61	98		61	mA
			Band3, 0dBm	61	93		61	mA
			Band4, 0dBm	61	92		61	mA
			Band5, 0dBm	60	107		60	mA
			Band8, 0dBm	60	116		61	mA
			Band12, 0dBm	58	102		59	mA
			Band13, 0dBm	60	116		60	mA
			Band18, 0dBm	60	107		60	mA
			Band19, 0dBm	60	107		61	mA
			Band20, 0dBm	60	107		61	mA
			Band25, 0dBm	61	98		61	mA
			Band26, 0dBm	60	107		60	mA
			Band28, 0dBm	60	103		60	mA
			Band66, 0dBm	61	92		62	mA
			Band71, 0dBm	58	101		58	mA
			Band85, 0dBm	58	102		59	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE NB1/2 supply current	RRC connected Active Transmission UL RMC, multi-tone mode (12 subcarrier),15kHz spacing[3] **TX62-W-B and TX62-W-C only**	Band1, 23dBm	-	71		-	mA
			Band2, 23dBm	-	72		-	mA
			Band3, 23dBm	-	72		-	mA
			Band4, 23dBm	-	71		-	mA
			Band5, 23dBm	-	70		-	mA
			Band8, 23dBm	-	73		-	mA
			Band12, 23dBm	-	69		-	mA
			Band13, 23dBm	-	71		-	mA
			Band18, 23dBm	-	70		-	mA
			Band19, 23dBm	-	71		-	mA
			Band20, 23dBm	-	72		-	mA
			Band25, 23dBm	-	72		-	mA
			Band26, 23dBm	-	70		-	mA
			Band28, 23dBm	-	70		-	mA
			Band31, 26dBm (TX62-W-C)	-	-		-	mA
			Band66, 23dBm	-	72		-	mA
			Band71, 23dBm (TX62-W-B)	-	68	-	-	mA
			Band72, 26dbm (TX62-W-C)	-	-		-	mA
			Band85, 23dBm	-	70		-	mA
		RRC connected Active Transmission UL RMC, multi-tone mode (12 subcarrier),15kHz spacing[3]	Band1, 20dBm	57	-		59	mA
			Band2, 20dBm	56	-		58	mA
			Band3, 20dBm	57	-		58	mA
			Band4, 20dBm	56	-		57	mA
			Band5, 20dBm	58	-		62	mA
			Band8, 20dBm	60	-		61	mA
			Band12, 20dBm	56	-		58	mA
			Band13, 20dBm	58	-		62	mA
			Band18, 20dBm	59	-		61	mA
			Band19, 20dBm	59	-		62	mA
			Band20, 20dBm	59	-		62	mA
			Band25, 20dBm	56	-		59	mA
			Band26, 20dBm	58	-		62	mA
			Band28, 20dBm	58	-		61	mA
			Band66, 20dBm	55	-		59	mA
			Band71, 20dBm	54	-		57	mA
			Band85, 20dBm	58	-		59	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description		Conditions		Typical rating				Unit
				TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Average LTE NB1/2 supply current	RRC connected Active Transmission UL RMC, multi-tone mode (12 subcarrier),15kHz spacing[3]	Band1, 0dBm	45	57		46	mA
			Band2, 0dBm	45	55		46	mA
			Band3, 0dBm	46	55		46	mA
			Band4, 0dBm	45	55		46	mA
			Band5, 0dBm	46	57		46	mA
			Band8, 0dBm	46	58		46	mA
			Band12, 0dBm	45	56		46	mA
			Band13, 0dBm	46	58		46	mA
			Band18, 0dBm	45	57		46	mA
			Band19, 0dBm	45	57		46	mA
			Band20, 0dBm	46	57		47	mA
			Band25, 0dBm	45	56		46	mA
			Band26, 0dBm	46	57		46	mA
			Band28, 0dBm	46	57		47	mA
			Band66, 0dBm	46	55		48	mA
			Band71, 0dBm	44	55		45	mA
			Band85, 0dBm	46	57		47	mA
	Peak Current @ RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3] VBATT=3.8V **TX62-W-B and TX62-W-C only**		Band1, 23dBm	-	576	576	-	mA
			Band2, 23dBm	-	588		-	mA
			Band3, 23dBm	-	588		-	mA
			Band4, 23dBm	-	588		-	mA
			Band5, 23dBm	-	588		-	mA
			Band8, 23dBm	-	600		-	mA
			Band12, 23dBm	-	540		-	mA
			Band13, 23dBm	-	576		-	mA
			Band18, 23dBm	-	576		-	mA
			Band19, 23dBm	-	588		-	mA
			Band20, 23dBm	-	588		-	mA
			Band25, 23dBm	-	576		-	mA
			Band26, 23dBm	-	588		-	mA
			Band28, 23dBm	-	552		-	mA
			Band31, 26dBm (TX62-W-C)	-	-		-	mA
			Band66, 23dBm	-	588		-	mA
			Band71, 23dBm (TX62-W-B)	-	540	-	-	mA
			Band72, 26dBm (TX62-W-C)	-	-		-	mA
			Band85, 23dBm	-	552		-	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description	Conditions		Typical rating				Unit
			TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only BATT+$_{BB}$)	Peak Current @ RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3] VBATT=3.8V	Band1, 20dBm	388	-		380	mA
		Band2, 20dBm	396	-		372	mA
		Band3, 20dBm	380	-		364	mA
		Band4, 20dBm	352	-		368	mA
		Band5, 20dBm	416	-		448	mA
		Band8, 20dBm	436	-		432	mA
		Band12, 20dBm	388	-		376	mA
		Band13, 20dBm	444	-		436	mA
		Band18, 20dBm	420	-		436	mA
		Band19, 20dBm	420	-		440	mA
		Band20, 20dBm	428	-		440	mA
		Band25, 20dBm	396	-		376	mA
		Band26, 20dBm	436	-		428	mA
		Band28, 20dBm	396	-		408	mA
		Band66, 20dBm	376	-		368	mA
		Band71, 20dBm	372	-		368	mA
		Band85, 20dBm	388	-		368	mA
	Peak Current @ RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3] VBATT =2.5V **TX62-W-B and TX62-W-C only**	Band1, 23dBm	-	624		-	mA
		Band2, 23dBm	-	612		-	mA
		Band3, 23dBm	-	612		-	mA
		Band4, 23dBm	-	612		-	mA
		Band5, 23dBm	-	624		-	mA
		Band8, 23dBm	-	648		-	mA
		Band12, 23dBm	-	576		-	mA
		Band13, 23dBm	-	624		-	mA
		Band18, 23dBm	-	624		-	mA
		Band19, 23dBm	-	624		-	mA
		Band20, 23dBm	-	648		-	mA
		Band25, 23dBm	-	612		-	mA
		Band26, 23dBm	-	624		-	mA
		Band28, 23dBm	-	588		-	mA
		Band31, 26dBm (TX62-W-C)	-	-		-	mA
		Band66, 23dBm	-	624		-	mA
		Band71, 23dBm (TX62-W-B)	-	576	-	-	mA
		Band72, 26dBm (TX62-W-C)	-	-		-	mA
		Band85, 23dBm	-	588		-	mA

Table 20: Current consumption ratings Cat NB1/2 (TX62/TX82)

Description	Conditions		Typical rating				Unit
			TX62-W	TX62-W-B	TX62-W-C	TX82-W	
I_{BATT+}[1] (i.e., only $BATT+_{BB}$)	Peak Current @ RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[3] VBATT = 2.55V (TX62-W) VBATT = 2.8V (TX82-W)	Band1, 20dBm	560	-		512	mA
		Band2, 20dBm	564	-		496	mA
		Band3, 20dBm	544	-		480	mA
		Band4, 20dBm	504	-		484	mA
		Band5, 20dBm	608	-		604	mA
		Band8, 20dBm	620	-		572	mA
		Band12, 20dBm	548	-		488	mA
		Band13, 20dBm	628	-		588	mA
		Band18, 20dBm	600	-		584	mA
		Band19, 20dBm	600	-		588	mA
		Band20, 20dBm	612	-		584	mA
		Band25, 20dBm	572	-		504	mA
		Band26, 20dBm	628	-		576	mA
		Band28, 20dBm	560	-		548	mA
		Band66, 20dBm	536	-		488	mA
		Band71, 20dBm	532	-		488	mA
		Band85, 20dBm	560	-		488	mA
	Average idle supply current (GNSS on)	LTE NB1/2 active (UART active) @ DRX=128 GNSS NMEA output off	57	65		64	mA
		LTE NB1/2 active (UART active) @ DRX=128 GNSS NMEA output on	57	66		64	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. Measurements start 6 minutes after switching ON the module,
Averaging times:
SUSPEND mode: 3 minutes (T3324 = 3s, T3412 = 14400s)
SLEEP mode: 10 minutes, (PSM disabled, eDRX disabled)
Idle eDRX mode: 30 minutes, (PSM disabled, eDRX enabled)
Connected DRX mode: 10 minutes,
RRC connected modes: 3 minutes,
Communication tester settings: no neighbor cells, no cell re-selection etc, RMC (reference measurement channel), SUSPEND/SLEEP (with PSM/eDRX) is enabled via AT command
3. Communication tester settings:
Cat NB1/2 Channel Bandwidth: 10MHz
Modulation: BPSK for 1 UL subcarrier mode, QPSK for multi-subcarrier mode

Table 21: Current consumption ratings General and GSM (TX82-W only)

Description		Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM supply current (GNSS off)	SLEEP[2]@DRX=9 (no communication via UART)		0.78	mA
		SLEEP[2]@DRX=5 (no communication via UART)		0.95	mA
		SLEEP[2]@DRX=2 (no communication via UART)		1.58	mA
		SLEEP[3]@DRX=2 (no communication via UART)		13	mA
		GPRS Data transfer GSM850; PCL=5,1Tx/4RX	ROPR=8 (max. reduction)	230	mA
			ROPR=4 (no reduction)	232	mA
		GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	323	mA
			ROPR=4 (no reduction)	407	mA
		EDGE Data transfer GSM850; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	155	mA
			ROPR=4 (no reduction)	156	mA
		EDGE Data transfer GSM850; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	231	mA
			ROPR=4 (no reduction)	259	mA
		GPRS Data transfer GSM900; PCL=5,1Tx/4RX	ROPR=8 (max. reduction)	260	mA
			ROPR=4 (no reduction)	259	mA
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	328	mA
			ROPR=4 (no reduction)	464	mA
		EDGE Data transfer GSM900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	153	mA
			ROPR=4 (no reduction)	152	mA

Table 21: Current consumption ratings General and GSM (TX82-W only)

Description		Conditions		Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Average GSM supply current (GNSS off)	EDGE Data transfer GSM900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	229	mA
			ROPR=4 (no reduction)	256	mA
		GPRS Data transfer GSM1800; PCL=5,1Tx/4RX	ROPR=8 (max. reduction)	182	mA
			ROPR=4 (no reduction)	183	mA
		GPRS Data transfer GSM1800; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	248	mA
			ROPR=4 (no reduction)	310	mA
		EDGE Data transfer GSM1800; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	147	mA
			ROPR=4 (no reduction)	145	mA
		EDGE Data transfer GSM1800; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	226	mA
			ROPR=4 (no reduction)	244	mA
		GPRS Data transfer GSM1900; PCL=5,1Tx/4RX	ROPR=8 (max. reduction)	185	mA
			ROPR=4 (no reduction)	184	mA
		GPRS Data transfer GSM1900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	250	mA
			ROPR=4 (no reduction)	315	mA
		EDGE Data transfer GSM1900; PCL=5; 1Tx/4Rx	ROPR=8 (max. reduction)	149	mA
			ROPR=4 (no reduction)	147	mA
		EDGE Data transfer GSM1900; PCL=5; 2Tx/3Rx	ROPR=8 (max. reduction)	229	mA
			ROPR=4 (no reduction)	247	mA
	Peak current during GSM transmit burst @ 3.8V	GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx		1.79	A
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx		1.99	A
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx		1.26	A
		GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx		1.29	A

Table 21: Current consumption ratings General and GSM (TX82-W only)

Description		Conditions	Typical rating	Unit
I_{BATT+}[1] (i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$)	Peak current during GSM transmit burst @ 3.0V	GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx	1.76	A
		GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx	1.76	A
		GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx	1.23	A
		GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx	1.26	A
	Average GSM IDLE supply current (GNSS on)	GPRS active (UART active) @ DRX=2 GNSS NMEA output off	68	mA
		GPRS active (UART active) @ DRX=2 GNSS NMEA output on	68	mA

1. With an impedance of Z_{LOAD}=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. Measurements start 6 minutes after switching ON the module,
   Averaging times:
   OFF mode: 3 minutes
   SLEEP and IDLE mode - 10 minutes
   Transfer modes - 3 minutes
   Communication tester settings: no neighbor cells, no cell re-selection etc,, RMC (reference measurement channel), SLEEP mode is enabled via AT command
3. The power save mode (PSM) is disabled via AT command

3.4.2 Minimizing Power Losses

For TX82-W only: When designing the power supply for your application (and with GSM enabled) please pay specific attention to power losses. Ensure that the input voltage V_{BATT+} never drops below 3.1V on the TX82-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 3.4.1).

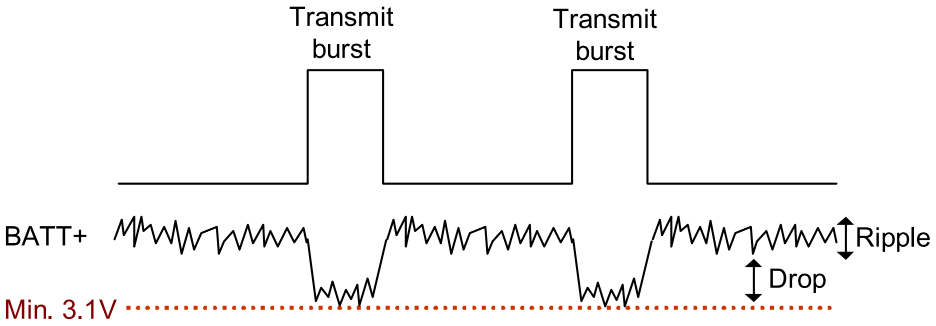


Figure 48: Power supply limits during transmit burst

3.4.3 Measuring the Supply Voltage (V_{BATT+})

To measure the supply voltage V_{BATT+} it is possible to define two reference points GND and BATT+. GND and BATT+ should be a test pad on the external application the module is mounted on. The eternal GND reference point has to be connected to and positioned close to the SMT application interface's GND pad F17 and the external BATT+ reference point has to be connected to and positioned close to the SMT application interface's BATT+ pads G15 and G16 ($BATT+_{RF}$) or H15 and H16 ($BATT+_{BB}$) as shown in Figure 49.

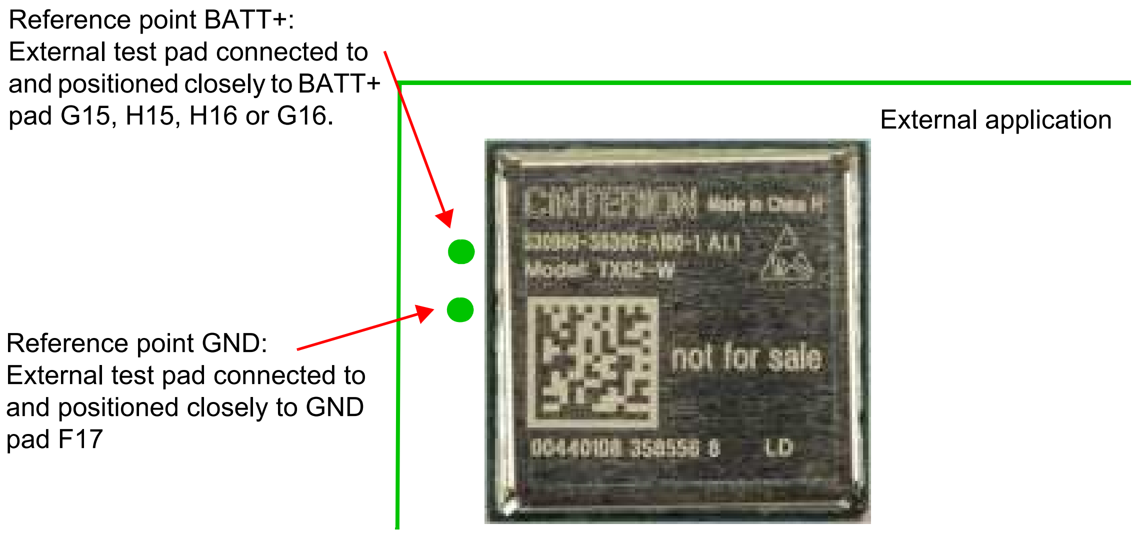


Figure 49: Position of reference points BATT+ and GND

3.4.4 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 TX62/TX82 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).

3.5 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.

Table 22: Board temperature

Parameter	Min	Typ	Max	Unit
Normal operation	-30		+85	°C
Extended operation[1]	-40		+90	°C
Automatic shutdown[2] Temperature measured on TX62/TX82 board	<-40	---	>+90	°C

1. Extended operation allows normal mode speech calls or data transmission for limited time. 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.

The below Table 23 lists the ambient temperature ranges the TX62/TX82 is able to operate in.

Table 23: Ambient temperature

Parameter	Min	Typ	Max	Unit
Normal operation (GSM)	-40		+60	°C
Normal operation (LTE)	-40		+70	°C

3.6 Electrostatic Discharge

The module is not protected against Electrostatic Discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates a TX62/TX82 module.

Special ESD protection provided on TX62/TX82:
Main antenna interface: Inductor/capacitor
BATT+: Inductor/capacitor
An example for an enhanced ESD protection for the SIM interface is given in Section 2.1.6.1.

TX62/TX82 has been tested according to group standard ETSI EN 301 489-1 (see Table 32). Electrostatic values can be gathered from the following table.

Table 24: Electrostatic values

Specification/Requirements	Contact discharge	Air discharge
ETSI EN 301 489-1		
Main antenna interface	± 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 Thales reference application described in Chapter 5.

3.6.1 ESD Protection for RF Antenna Interface

The following Figure 50 shows how to implement an external ESD protection for the RF antenna interface with either a T pad or PI pad attenuator circuit (for RF line routing design see also Section 2.2.3).

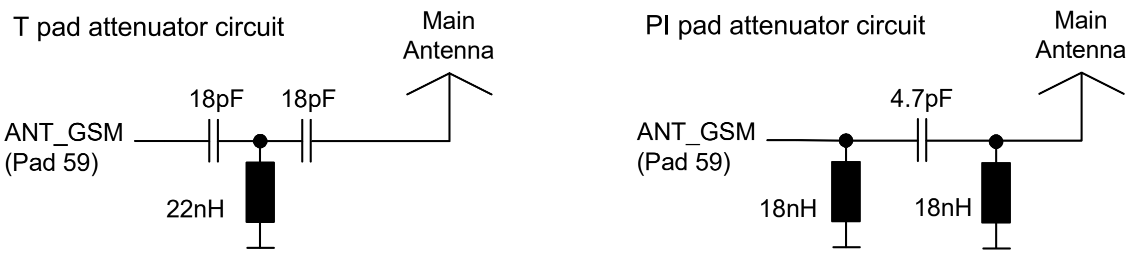


Figure 50: ESD protection for RF antenna interface

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).

3.7 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 2.4). 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 51 and Table 25). 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.

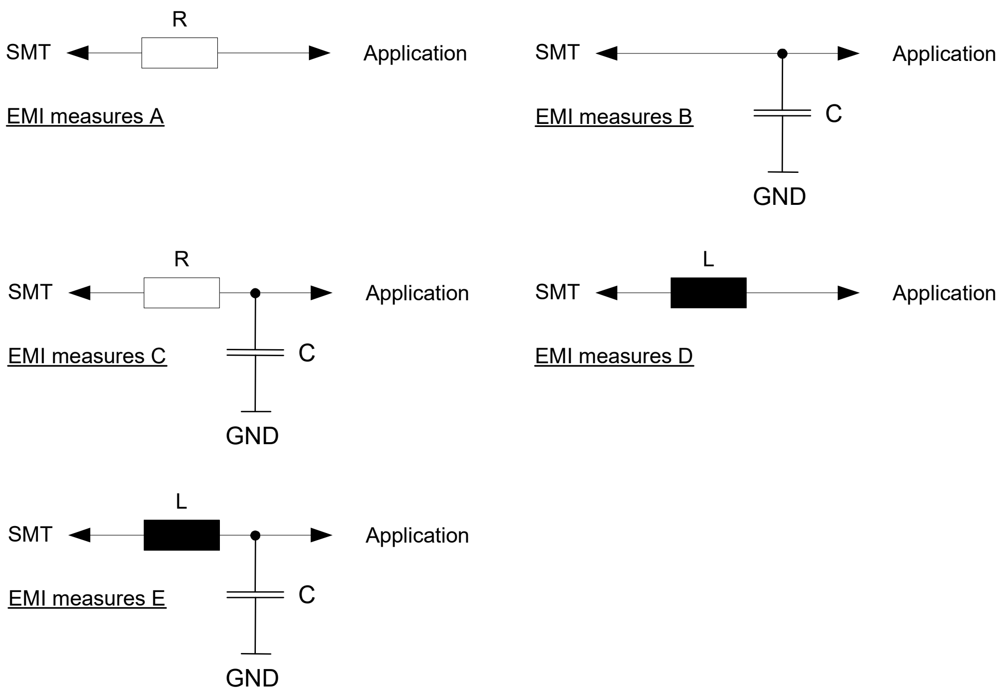


Figure 51: EMI circuits

Note: In case the application uses an internal GSM/LTE antenna that is implemented close to the TX62/TX82 module, Thales 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.

Table 25: EMI measures on the application interface

Signal name	EMI measures					Remark
	A	B	C	D	E	
CCIN				x		
CCRST		x				The external capacitor should be not higher than 1nF. The value of the capacitor depends on the external application and should be placed close to SIM connector/ eUICC.
CCIO		x				The external capacitor should be not higher than 10pF. The value of the capacitor depends on the external application and should be placed close to SIM connector/ eUICC.
CCCLK		x				
VUSB		x		x	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	
DTR0	x	x	x	x	x	
DCD0	x	x	x	x	x	
DSR0	x	x	x	x	x	
RXD1	x	x	x	x	x	
TXD1	x	x	x	x	x	
RTS1	x	x	x	x	x	
CTS1	x	x	x	x	x	
RING0	x	x	x	x	x	
FST_SHDN	x	x	x	x	x	
STATUS	x	x	x	x	x	
SIM_SWITCH	x	x	x	x	x	
SUSPEND_MON	x	x	x	x	x	
GPIO6,7,20-23,25	x	x	x	x	x	
I2CDAT[1]		x		x		The rising signal edge is reduced with an additional capacitor.
I2CCLK[1]		x		x		
V180		x		x	x	
BATT+$_{RF}$ (pad G15, G16)		x	x			Measures required if BATT+$_{RF}$ is close to internal GSM antenna - e.g., 39pF blocking capacitor to ground
BATT+$_{BB}$ (pad H15, H16)		x	x			

1. Available with embedded processing option only.

3.8 Reliability Characteristics

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

Table 26: Summary of reliability test conditions

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

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

4 Mechanical Dimensions, Mounting and Packaging

4.1 Mechanical Dimensions of TX62-W

Figure 52 shows the top and bottom view of TX62-W and provides an overview of the board's mechanical dimensions. For further details see Figure 53. Figure 54 shows the area at the module's bottom side where possible markings might be printed.

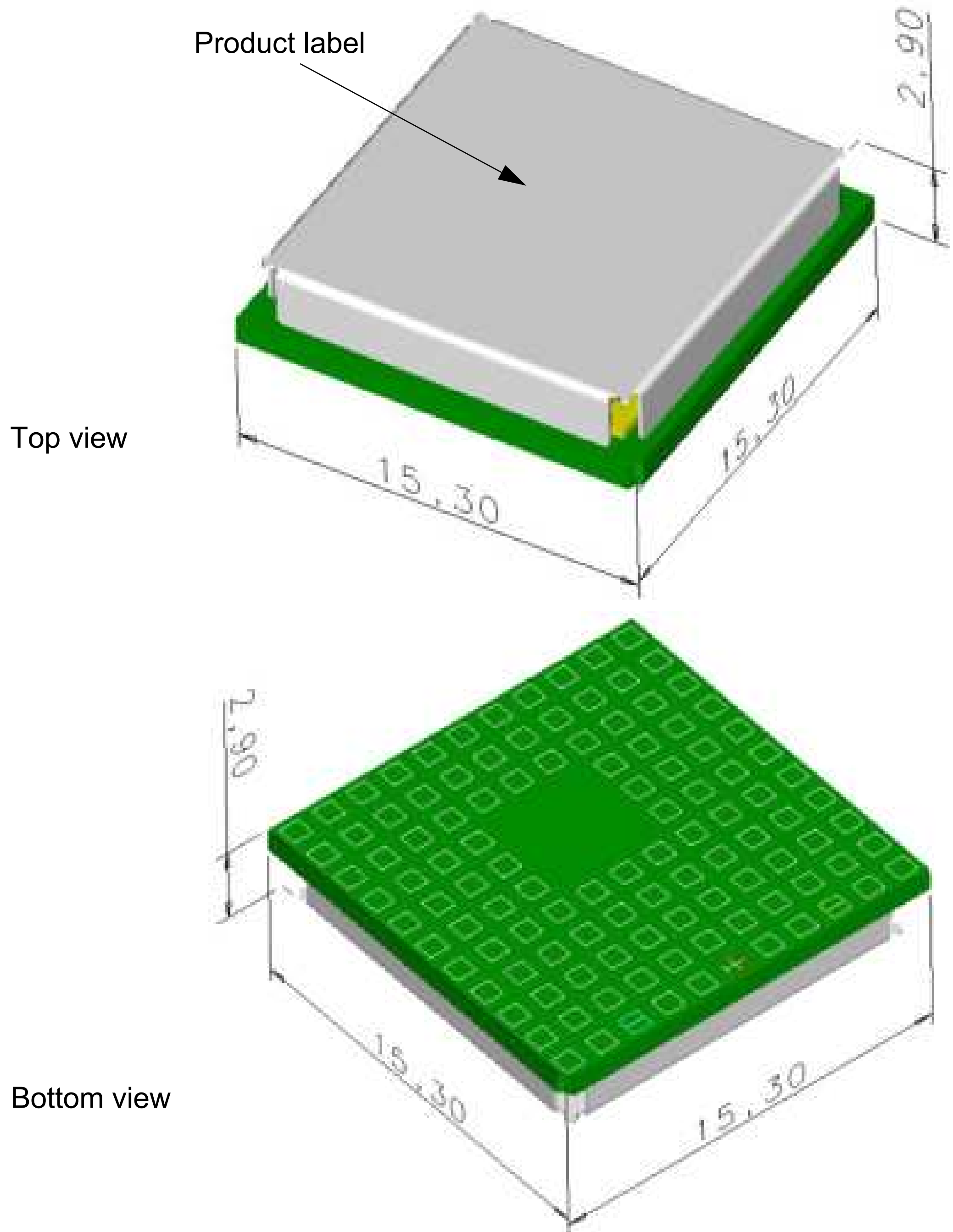


Figure 52: TX62-W– top and bottom view

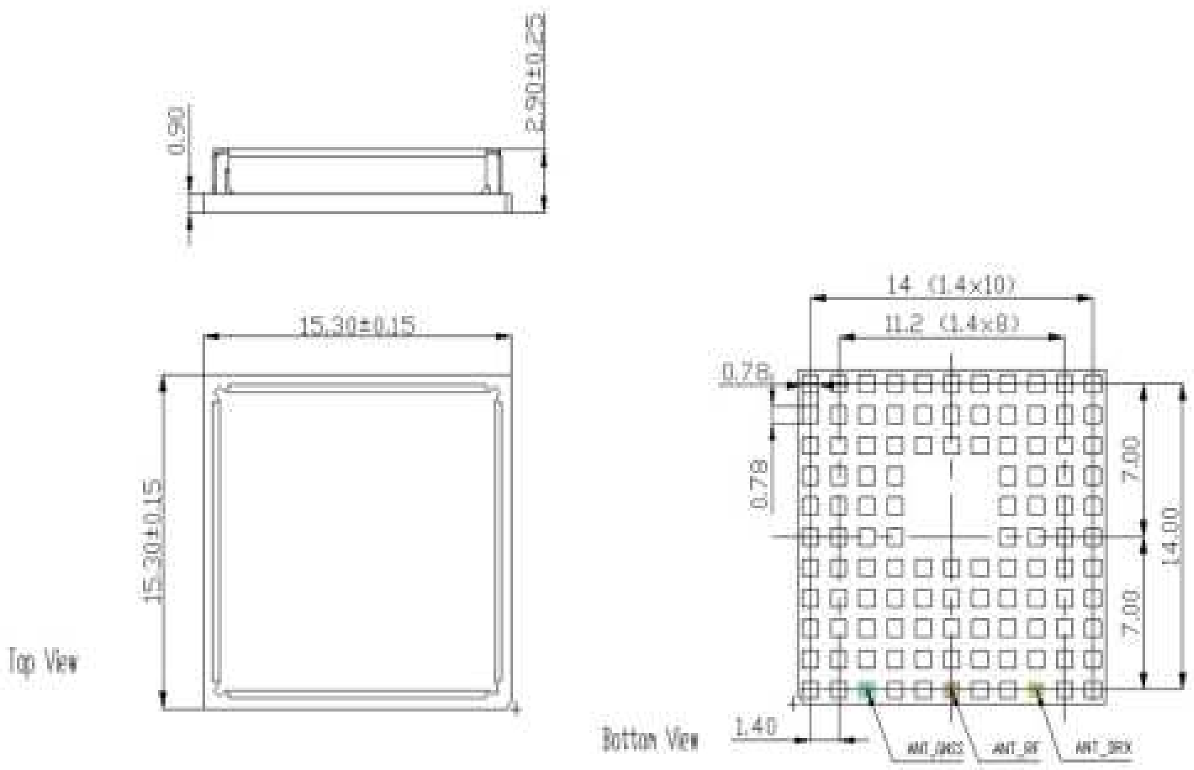


Figure 53: Dimensions of TX62-W (all dimensions in mm)

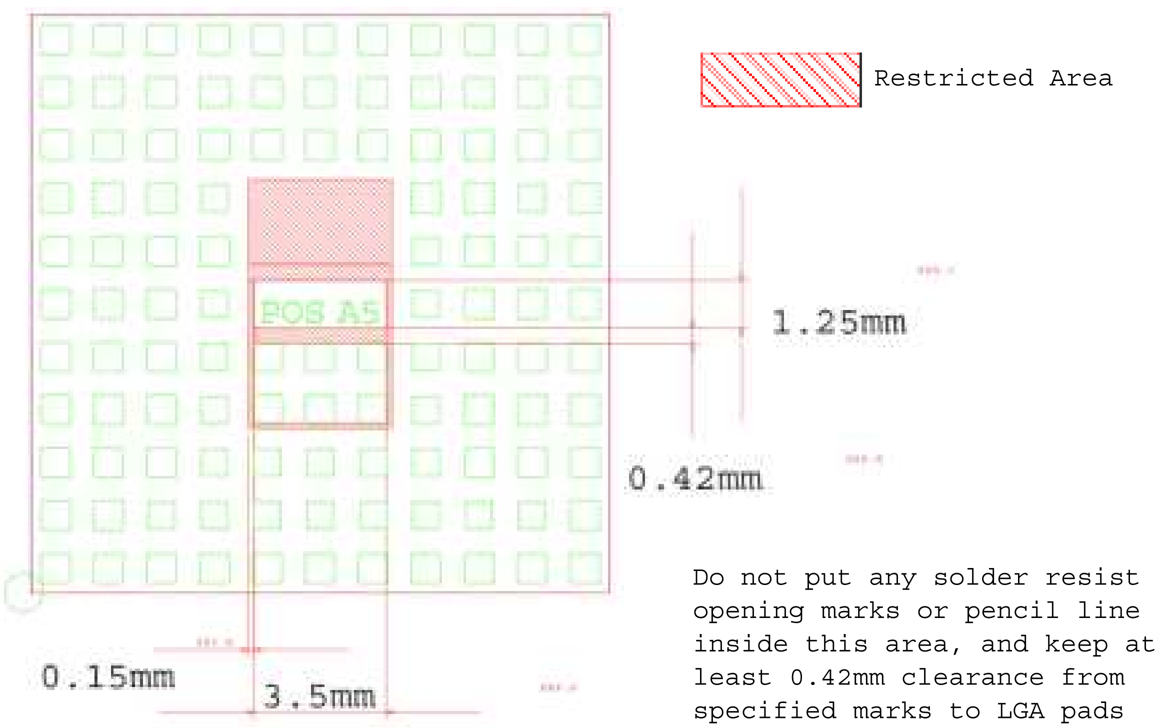


Figure 54: Dimensions of area for possible markings TX62-W (bottom view)

4.2 Mechanical Dimensions of TX82-W, TX62-W-B and TX62-W-C

Figure 55 shows the top and bottom view of TX82-W, and TX62-W-B, and provides an overview of the board's mechanical dimensions. For further details see Figure 56. Figure 57 shows the area at the module’s bottom side where possible markings might be printed.

Note: With TX62-W-C the module height is TBD. The below mentioned height dimensions apply therefore only to TX82-W, and TX62-W-B.

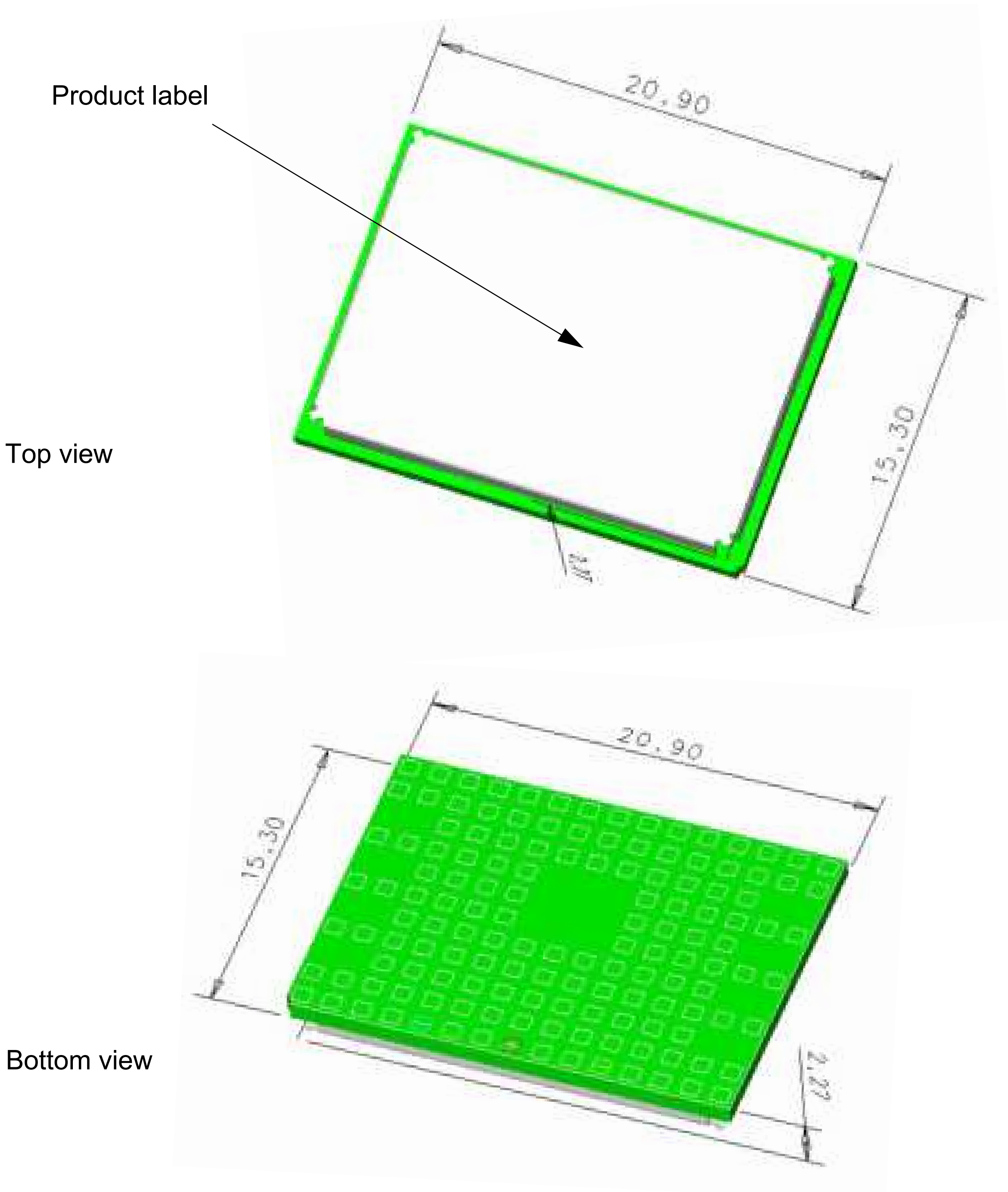


Figure 55: TX82-W– top and bottom view

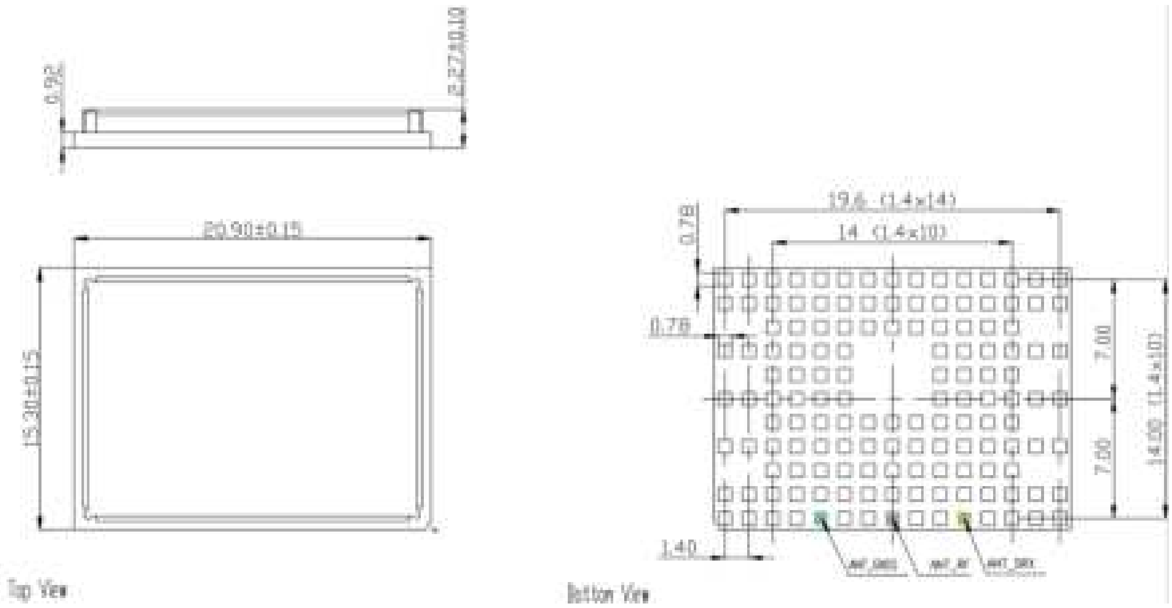


Figure 56: Dimensions of TX82-W, TX62-W-B and TX62-W-C (all dimensions in mm)

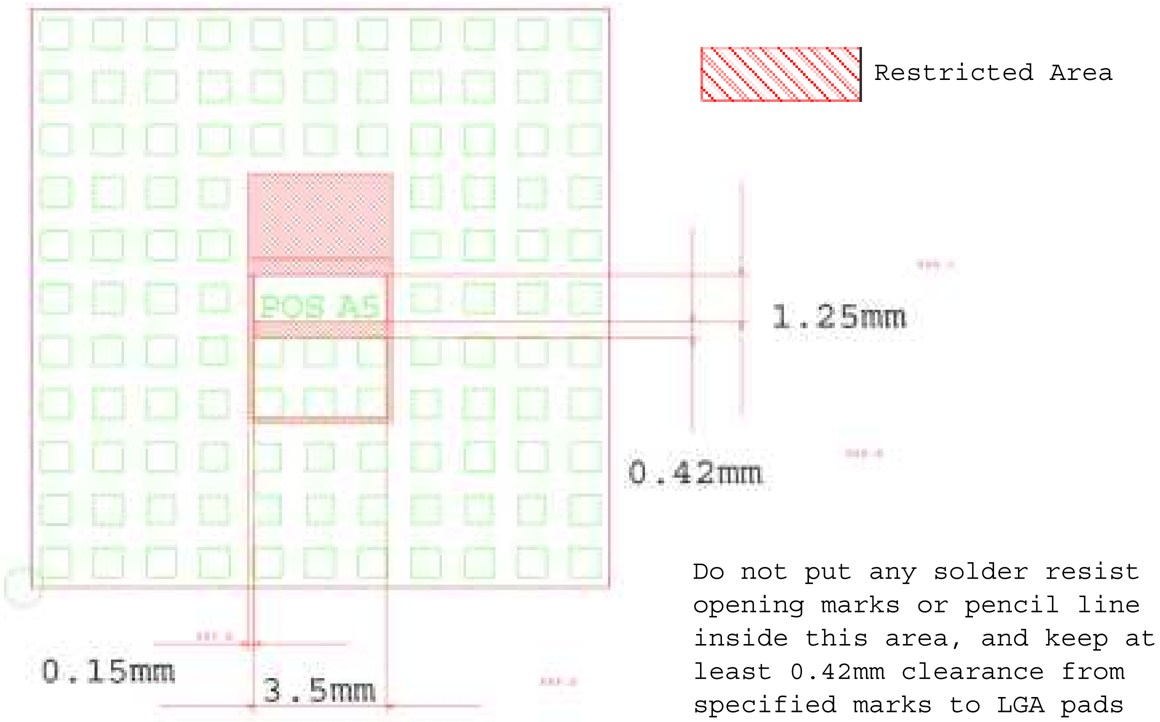


Figure 57: Dimensions of area for possible markings TX82-W, TX62-W-B and TX62-W-C (bottom view)

4.3 Mounting TX62/TX82 onto the Application Platform

This section describes how to mount TX62/TX82 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 [5].

Note: To avoid short circuits between signal tracks on an external application's PCB and various markings at the bottom side of the module (see Figure 54 and Figure 57), 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.

Note: Do not place external components or devices that might cause any pressure on the module's shielding. See [4] and [5] for further details of thermal and integration guidance.

4.3.1 SMT PCB Assembly

4.3.1.1 Land Pattern and Stencil

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

The land pattern given in Figure 58 and Figure 59 reflects the module's pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1).

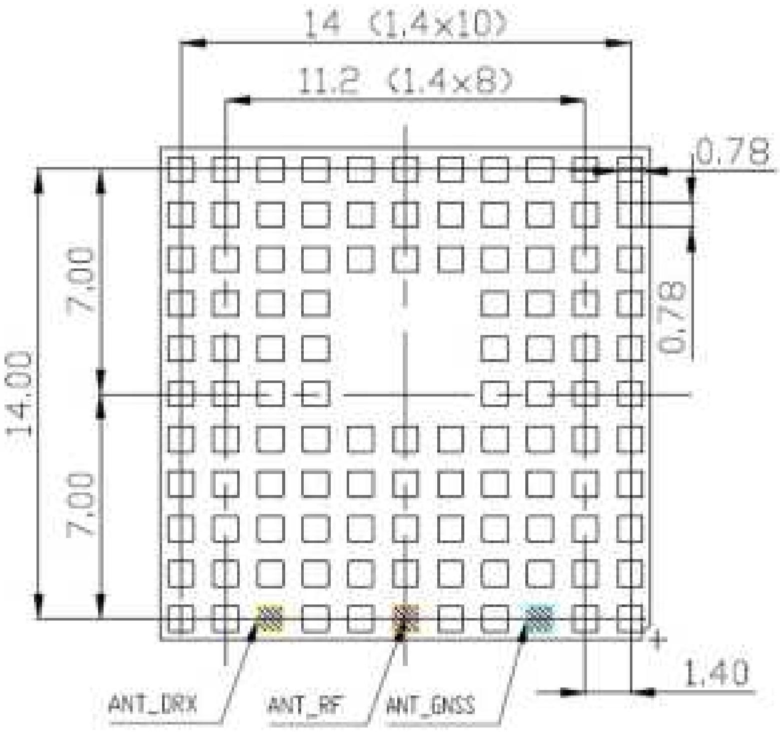


Figure 58: Land pattern TX62-W (top view)

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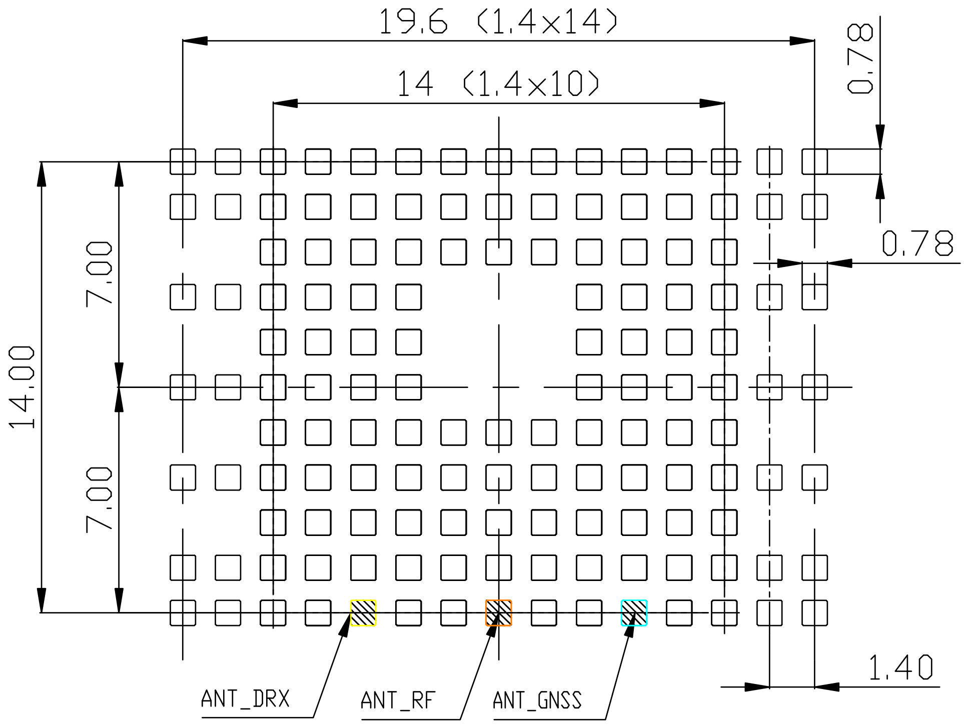


Figure 59: Land pattern TX82-W, TX62-W-B and TX62-W-C (top view)

The stencil design illustrated in Figure 60 and Figure 61 is recommended by Thales as a result of extensive tests with Thales Daisy Chain modules.

The central ground pads are primarily intended for stabilizing purposes, and may show some more voids than the application interface pads at the module's rim. This is acceptable, since they are electrically irrelevant.

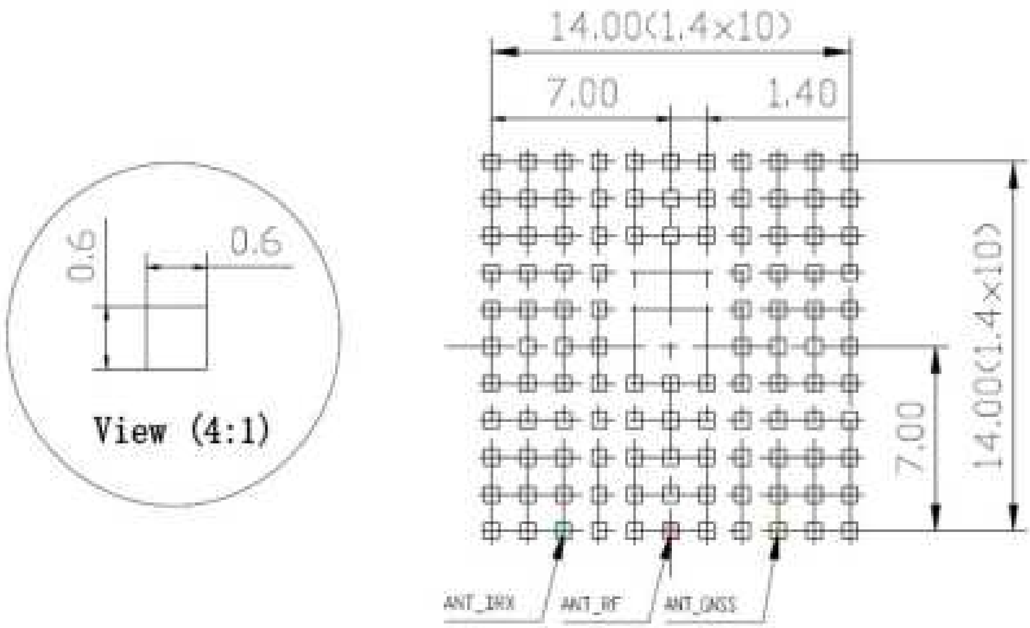


Figure 60: Recommended design for 110µm thick stencil for TX62-W (top view)

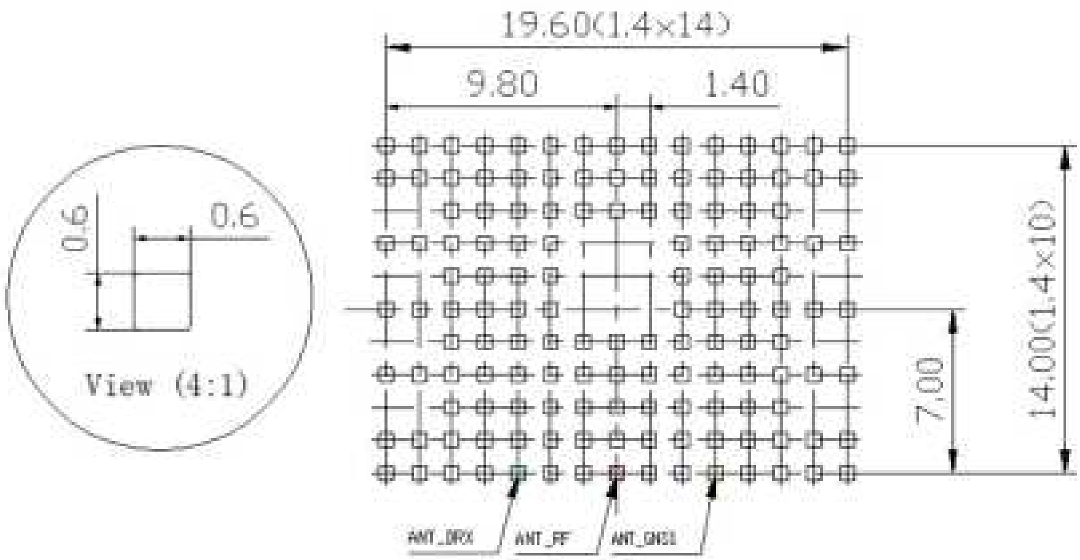


Figure 61: Recommended design for 110µm thick stencil for TX82-W, TX62-W-B and TX62-W-C (top view)

4.3.1.2 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 [5].

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 4.3.1.1. Optimizing the solder stencil pattern design and print process is necessary to ensure print uniformity, to decrease solder voids, and to increase board level reliability.

Generally, solder paste manufacturer recommendations for screen printing process parameters and reflow profile conditions should be followed. Maximum ratings are described in Section 4.3.3.

4.3.2 Moisture Sensitivity Level

TX62/TX82 comprises components that are susceptible to damage induced by absorbed moisture.

Thales's TX62/TX82 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 4.3.4 and Section 4.4.2.

4.3.3 Soldering Conditions and Temperature

4.3.3.1 Reflow Profile

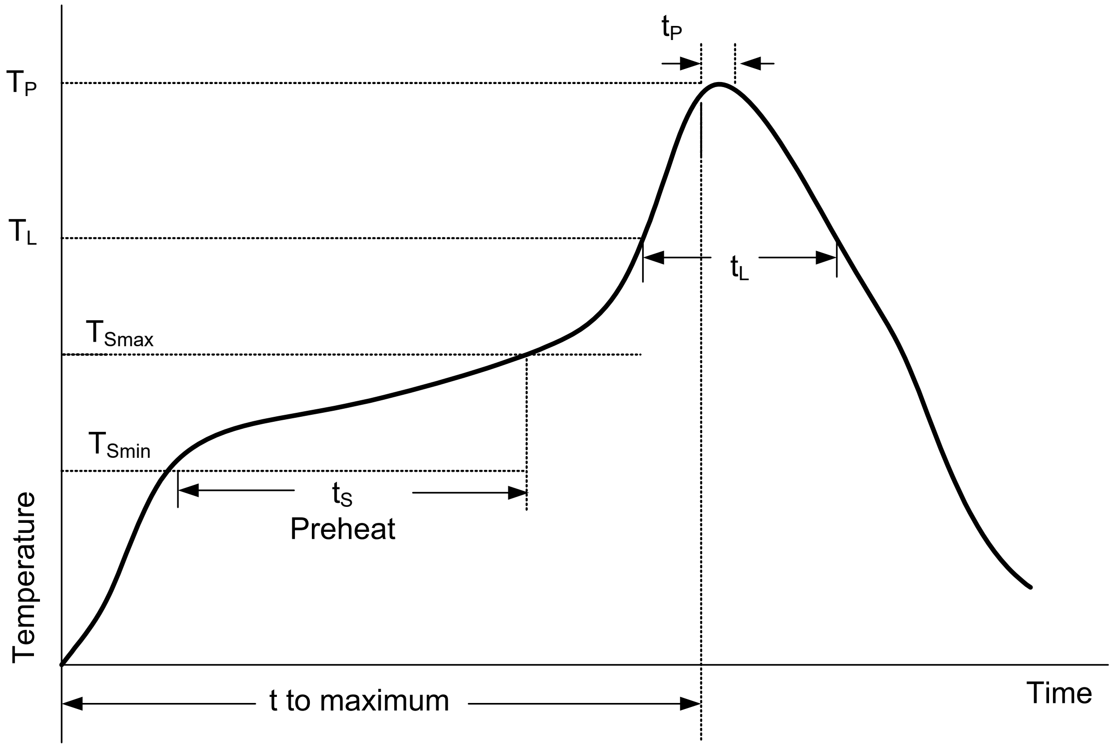


Figure 62: Reflow Profile

Table 27: 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 180°C 60-120 seconds
Average ramp up rate (T_{Smax} to T_P)	3K/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	217°C 50-90 seconds
Peak package body temperature (T_P)	245°C +0/-5°C
Time (t_P) within 5 °C of the peak package body temperature (T_P)	30 seconds max.
Average ramp-down rate (T_P to T_L)	1 K/second max.
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 [5].

4.3.3.2 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 240°C. This specifies the temperature as measured at the module’s top side.
- A maximum duration of 15 seconds at this temperature.

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.

TX62/TX82 is specified for one soldering cycle only. Once TX62/TX82 is removed from the application, the module will very likely be destroyed and cannot be soldered onto another application.

4.3.4 Durability and Mechanical Handling

4.3.4.1 Storage Conditions

TX62/TX82 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 28: 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

4.3.4.2 Processing Life

TX62/TX82 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%.

4.3.4.3 Baking

Baking conditions are specified on the moisture sensitivity label attached to each MBB (see Figure 68 for details):
- It is *not necessary* to bake TX62/TX82, if the conditions specified in Section 4.3.4.1 and Section 4.3.4.2 were not exceeded.
- It is *necessary* to bake TX62/TX82, if any condition specified in Section 4.3.4.1 and Section 4.3.4.2 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.

4.3.4.4 Electrostatic Discharge

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

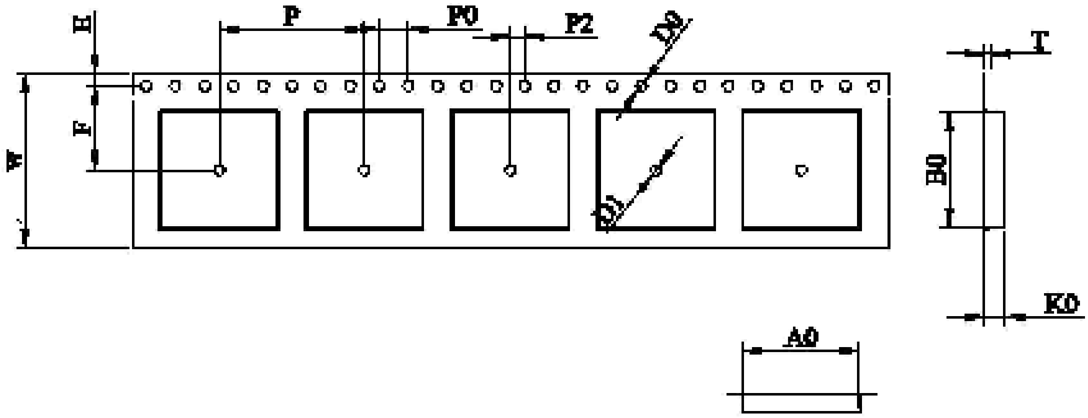
Please refer to Section 3.6 for further information on electrostatic discharge.

4.4 Packaging

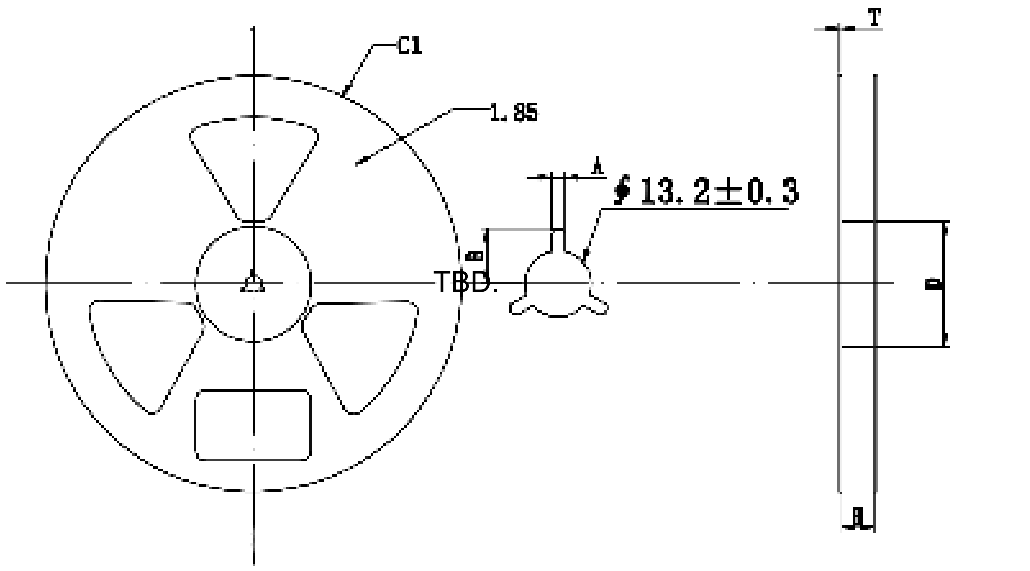
4.4.1 Tape and Reel

The single-feed tape carrier for TX62/TX82 is illustrated in Figure 63. The figure also shows the proper part orientation. The tape width is 24mm and the TX62/TX82 modules are placed on the tape with a 22mm pitch. The reels are 330mm in diameter with a core diameter of 99.50mm. Each reel contains 500 modules.

4.4.1.1 Orientation



A0: 15.80mm B0: 15.80mm D0: 1.50mm D1: 1.5mm E: 1.75mm
F: 11.50mm K0: 2.80mm P: 20.00mm P0: 4.00mm P2: 2.00mm
T: 0.30mm W: 24.00mm



A: 2.50mm B: 11.00mm C1: 330mm D: 99.50mm H: 24.50mm
T: 2.30mm

Figure 63: Carrier tape (TX62-W only)

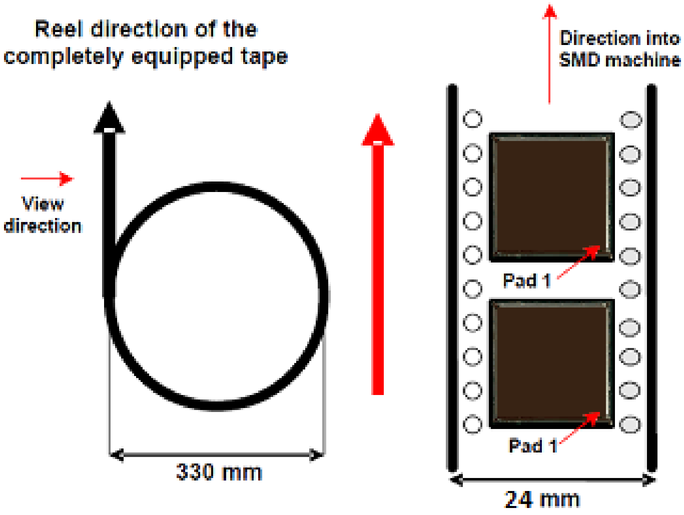


Figure 64: Reel direction (TX62-W only)

4.4.1.2 Barcode Label

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

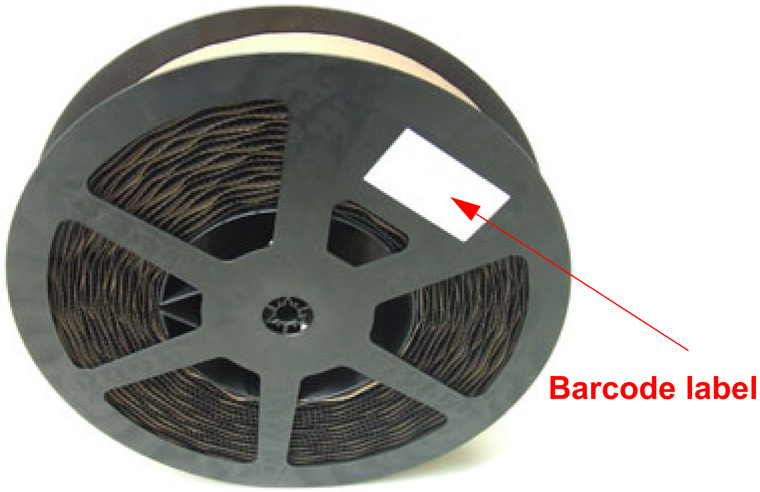


Figure 65: Barcode label on tape reel

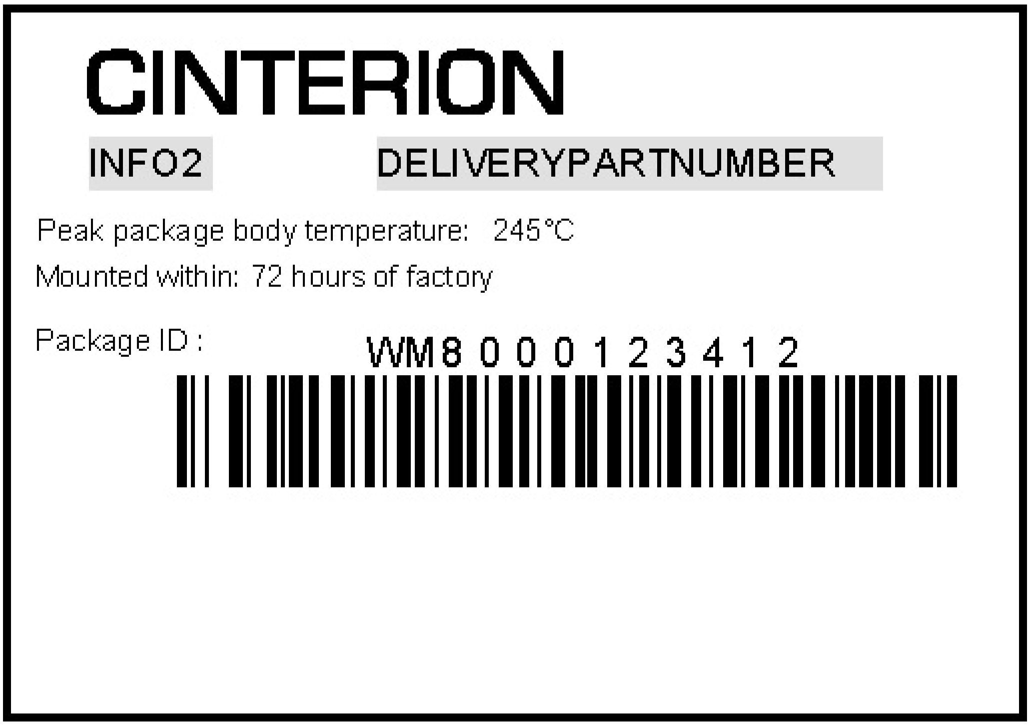


Figure 66: Barcode label on tape reel - layout

Variables on the label are explained in Table 29.

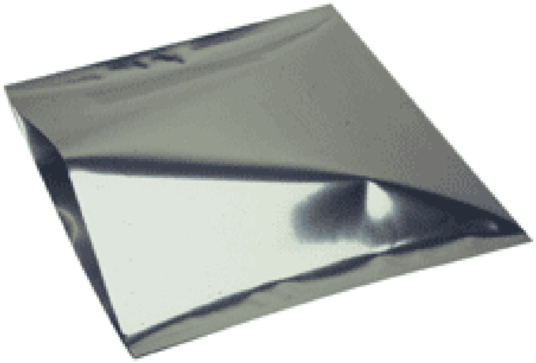
4.4.2 Shipping Materials

TX62/TX82 is distributed in tape and reel carriers. The tape and reel carriers used to distribute TX62/TX82 are packed as described below, including the following required shipping materials:

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

4.4.2.1 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 67. 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 TX62/TX82 modules from moisture exposure. It should not be opened until the devices are ready to be soldered onto the application.



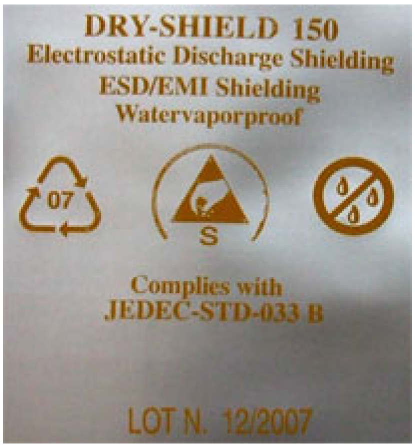
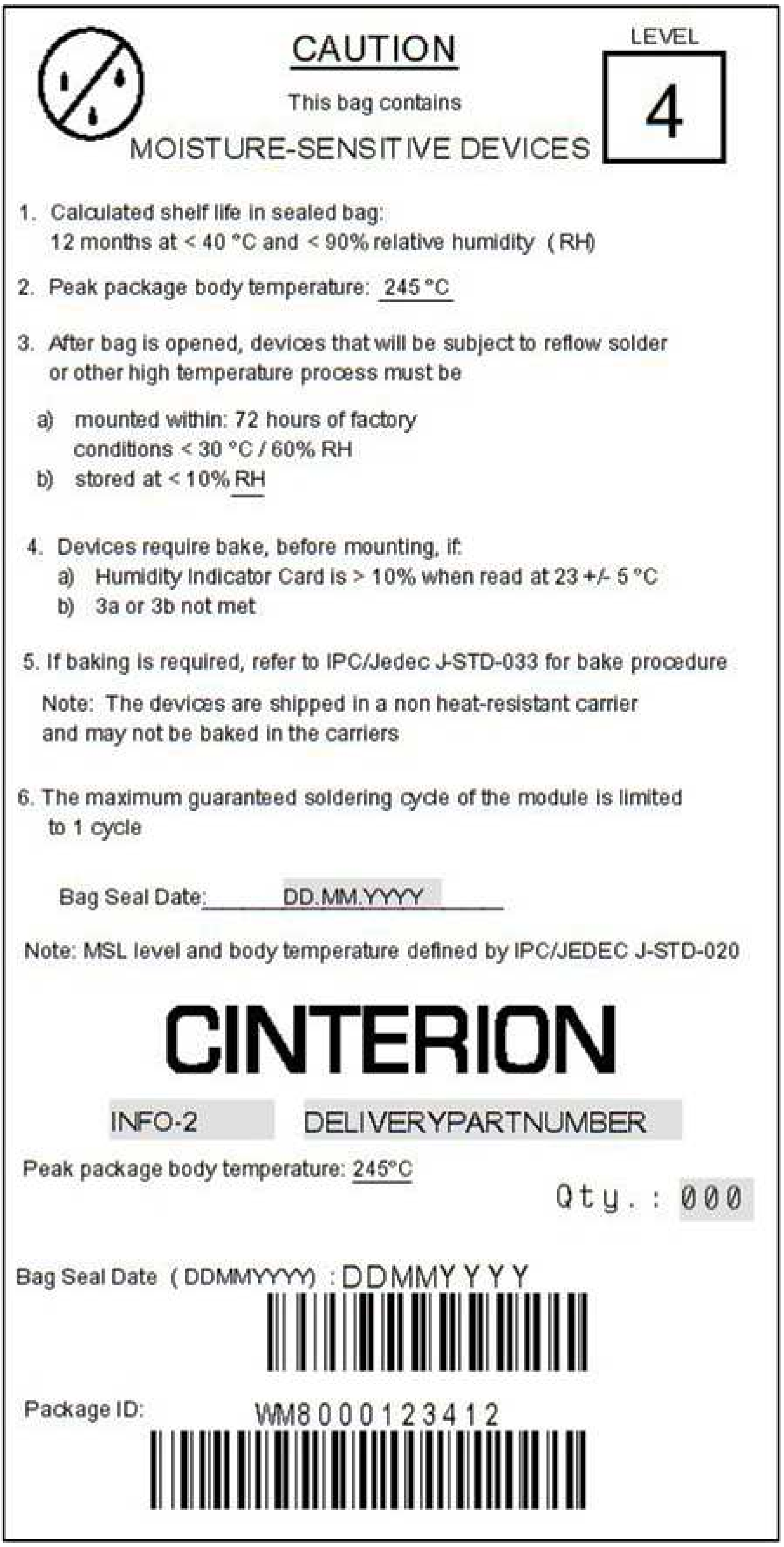


Figure 67: Moisture barrier bag (MBB) with imprint

The label shown in Figure 68 summarizes requirements regarding moisture sensitivity, including shelf life and baking requirements. It is attached to the outside of the moisture barrier bag. Variables on the label are explained in Table 29.


CAUTION

This bag contains

MOISTURE-SENSITIVE DEVICES

LEVEL

4

1. Calculated shelf life in sealed bag:
   12 months at < 40 °C and < 90% relative humidity (RH)
2. Peak package body temperature: 245 °C
3. After bag is opened, devices that will be subject to reflow solder or other high temperature process must be
   a) mounted within: 72 hours of factory conditions < 30 °C / 60% RH
   b) stored at < 10% RH
4. Devices require bake, before mounting, if:
   a) Humidity Indicator Card is > 10% when read at 23 +/- 5 °C
   b) 3a or 3b not met
5. If baking is required, refer to IPC/Jedec J-STD-033 for bake procedure

   Note: The devices are shipped in a non heat-resistant carrier and may not be baked in the carriers
6. The maximum guaranteed soldering cycle of the module is limited to 1 cycle

Bag Seal Date: DD.MM.YYYY

Note: MSL level and body temperature defined by IPC/JEDEC J-STD-020

CINTERION

INFO-2 DELIVERYPARTNUMBER

Peak package body temperature: 245°C

Qty.: 000

Bag Seal Date (DDMMYYYY) : DDMMYYYY

Package ID: WM8000123412

Figure 68: 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 69. If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.

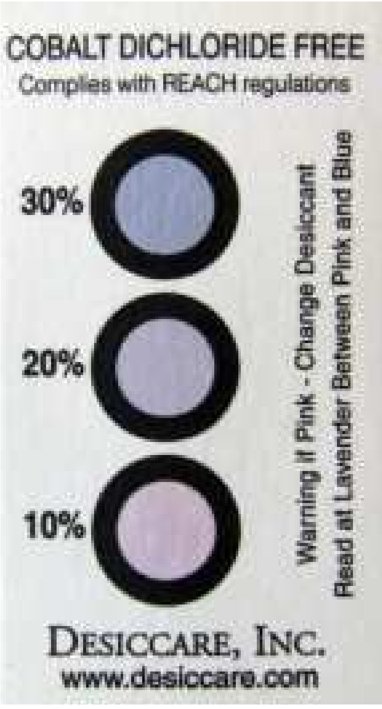


Figure 69: Humidity Indicator Card - HIC

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

4.4.2.2 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 500 modules each.

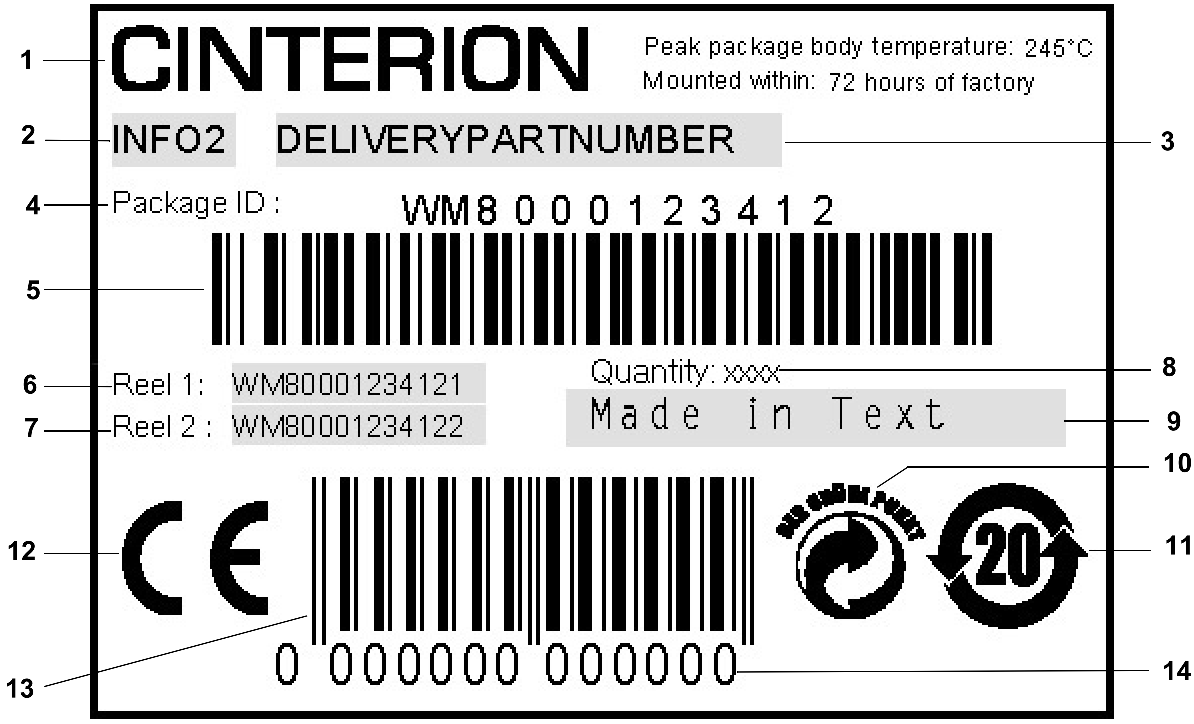


Figure 70: Sample of VP box label

Table 29: VP Box label information

No.	Information
1	Cinterion logo
2	Product name
3	Product ordering number
4	Package ID number of VP box (format may vary depending on the product)
5	Package ID barcode (Code 128)
6	Package ID Reel 1 (format may vary depending on the product)
7	Package ID Reel 2 (format may vary depending on the product)
8	Quantity of the modules inside the VP box (max. 1000 pcs)
9	Country of production
10	Der Grüne Punkt (Green Dot) symbol
11	Chinese RoHS symbol (see Table 34)
12	CE logo (CE mark on VP box label is present only for modules with CE imprinted on the shielding)
13	European Article Number (EAN-13) barcode
14	European Article Number, consists of 13 digits (EAN-13)

4.4.3 Trays (TBD)

If small module quantities are required, e.g., for test and evaluation purposes, TX62/TX82 may be distributed in trays (for dimensions see Figure 74). The small quantity trays are an alternative to the single-feed tape carriers normally used. However, the trays are not designed for machine processing. They contain modules to be (hand) soldered onto an external application

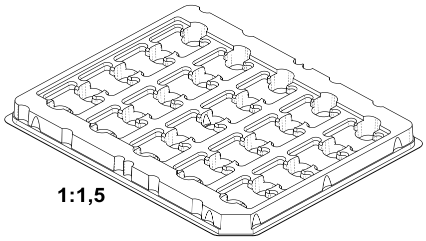


Figure 71: Small quantity tray

Trays are packed and shipped in the same way as tape carriers, including a moisture barrier bag with desiccant and humidity indicator card as well as a transportation box (see also Section 4.4.2).

Figure 72: Tray to ship odd module amounts

Figure 73: Trays with packaging materials

T.B.D.

Figure 74: Tray dimensions (TBD.)

5 Regulatory and Type Approval Information

5.1 Directives and Standards

TX62/TX82 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 "Cinterion® TX62-W(-B/-C)/TX82-W Hardware Interface Description".[1]

Table 30: Directives

2014/53/EU	Directive of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC. The product is labeled with the CE conformity mark
2002/95/EC (RoHS 1) 2011/65/EC (RoHS 2)	Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
1907/2006/EC (REACH)	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. Cinterion® modules comply with the REACH regulation that specifies a content of less than 0.1% per substance mentioned in the SVHC candidate list (Release 16.06.2014).

Table 31: Standards of North American type approval

CFR Title 47	Code of Federal Regulations, Part 22 and Part 24 (Telecommunications, PCS); US Equipment Authorization FCC
OET Bulletin 65 (Edition 97-01)	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
UL 62368-1	Audio/video, information and communication technology equipment - Part 1: Safety requirements (for details see Section 5.1.1)
NAPRD.03 V5.35	Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control PCS Type Certification Review board (PTCRB)
RSS132 (Issue2) RSS133 (Issue5)	Canadian Standard

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

Table 32: Standards of European type approval

3GPP TS 51.010-1	Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification;
GCF-CC V3.71	Global Certification Forum - Certification Criteria
ETSI EN 301 511 V12.5.1	Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
ETSI EN 301 908-1 V11.1.1	IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements
ETSI EN 301 908-2 V11.1.2	IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)
ETSI EN 301 489-52 V1.1.0	Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication Mobile and portable (UE) radio and ancillary equipment; Harmonized Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
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
ETSI EN 301489-19 V2.1.0	ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band (ROGNSS) providing positioning, navigation, and timing data; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
ETSI EN 303 413 V1.1.1	Satellite Earth Stations and Systems (SES); Global Navigation Satellite System (GNSS) receivers; Radio equipment operating in the 1 164 MHz to 1 300 MHz and 1 559 MHz to 1 610 MHz frequency bands; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
IEC 62368-1 (EN 62368-1, UL 62368-1)	Audio/video, information and communication technology equipment - Part 1: Safety requirements (for details see Section 5.1.1)

Table 33: Requirements of quality

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

Table 34: 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 Thales Hardware Interface Description. Please see Table 35 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 35: Toxic or hazardous substances or elements with defined concentration limits

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

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

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

5.1.1 IEC 62368-1 Classification

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

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

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

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

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

Table 36: IEC 62368-1 Classification

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

Table 36: IEC 62368-1 Classification

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

5.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a module must be in accordance with the guidelines for human exposure to radio frequency energy. This requires the Specific Absorption Rate (SAR) of portable TX62/TX82 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 and US markets the relevant directives are mentioned below. The manufacturer of the end device is in the responsibility to provide clear installation and operating instructions for the user, including the minimum separation distance required to maintain compliance with SAR and/or RF field strength limits, as well as any special usage conditions required to do so, such as a required accessory, the proper orientation of the device, the max antenna gain for detachable antennas, or other relevant criteria. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

Products intended for sale on US markets

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

Products intended for sale on European markets

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

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

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

5.3 Reference Equipment for Type Approval

The Thales reference setup submitted to type approve TX62/TX82 (including a special approval adapter for the DSB75) is shown in the following figure[1]:

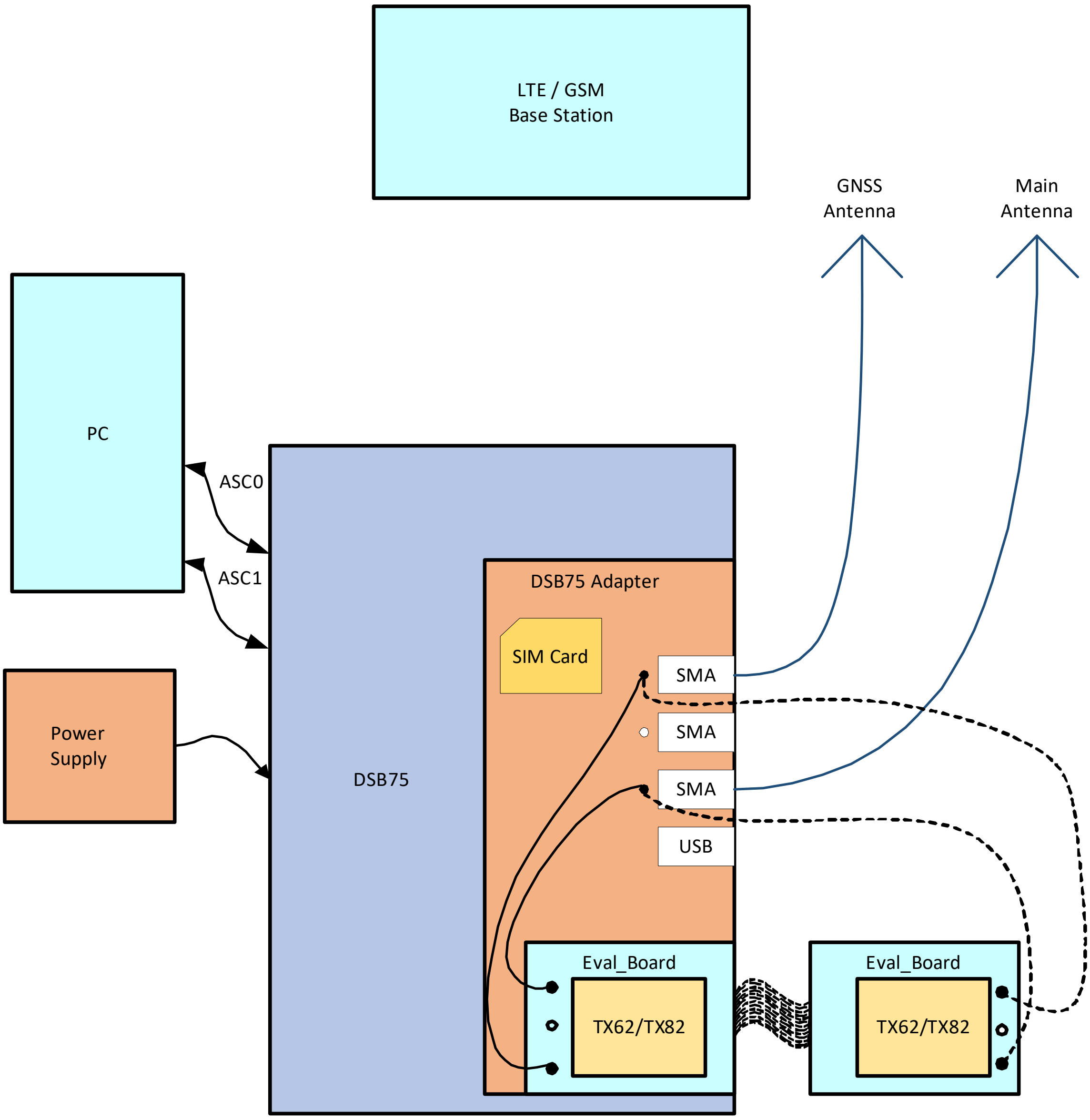


Figure 75: Reference equipment for type approval

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 LTE/GSM/GNSS test equipment instead of employing the SMA antenna connectors on the TX62/TX82-DSB75 adapter as shown in Figure 75. The following products are recommended:
Hirose SMA-Jack/U.FL-Plug conversion adapter HRMJ-U.FLP(40)
(for details see http://www.hirose-connectors.com/ or http://www.farnell.com/
Aeroflex Weinschel Fixed Coaxial Attenuator Model 3T/4T
(for details see http://www.aeroflex.com/ams/weinschel/pdfiles/wmod3&4T.pdf)

5.4 Compliance with FCC and ISED Rules and Regulations

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

FCC Identifier: QIPTX82-W
ISED Certification Number: 7830A-TX82W
Granted to THALES DIS AIS Deutschland GmbH

FCC Identifier: QIPTX62-W
ISED Certification Number: 7830A-TX62W
Granted to THALES DIS AIS Deutschland GmbH

FCC Identifier: QIPTX62-W-B
ISED Certification Number: 7830A-TX62WB
Granted to THALES DIS AIS Deutschland GmbH

Manufacturers of mobile or fixed devices incorporating TX62/TX82 modules are authorized to use the FCC Grants and ISED Certificates of the TX62/TX82 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: QIPTX82-W" or "Contains FCC ID: QIPTX62-W" or "Contains FCC ID: QIPTX62-W-B", and accordingly “Contains IC: 7830A-TX82W“ or “Contains IC: 7830A-TX62W“ or “Contains IC: 7830A-TX62WB“. 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 37, Table 38, and Table 39 for FCC and/or ISED.

Table 37: Antenna gain limits for FCC and ISED for TX82-W

Maximum gain in operating band	FCC limit	ISED limit	All limits	Unit
LTE Band 2	11.01	11.01	11.01	dBi
LTE Band 4	8.00	8.00	8.00	dBi
LTE Band 5	12.41	9.10	9.10	dBi
LTE Band 12	11.70	8.61	8.61	dBi
LTE Band 13	12.16	8.93	8.93	dBi
LTE Band 25	11.01	11.01	11.01	dBi
LTE Band 26	12.41	9.10	9.10	dBi
LTE Band 66	8.00	8.00	8.00	dBi
LTE Band 71	11.47	8.45	8.45	dBi
GSM850	8.60	5.30	5.30	dBi
PCS1900	10.20	10.20	10.20	dBi

Table 38: Antenna gain limits for FCC and ISED for TX62-W

Maximum gain in operating band	FCC limit	ISED limit	All limits	Unit
LTE Band 2	11.01	11.01	11.01	dBi
LTE Band 4	8.00	8.00	8.00	dBi
LTE Band 5	12.41	9.10	9.10	dBi
LTE Band 12	11.70	8.61	8.61	dBi
LTE Band 13	12.16	8.93	8.93	dBi
LTE Band 25	11.01	11.01	11.01	dBi
LTE Band 26	12.41	9.10	9.10	dBi
LTE Band 66	8.00	8.00	8.00	dBi
LTE Band 71	11.47	8.45	8.45	dBi

Table 39: Antenna gain limits for FCC and ISED for TX62-W-B

Maximum gain in operating band	FCC limit	ISED limit	All limits	Unit
LTE Band 2	8.01	8.01	8.01	dBi
LTE Band 4	5.00	5.00	5.00	dBi
LTE Band 5	9.41	6.10	6.10	dBi
LTE Band 8	9.70	---	9.70	dBi
LTE Band 12	8.70	5.61	5.61	dBi
LTE Band 13	9.16	5.93	5.93	dBi
LTE Band 25	8.01	8.01	8.01	dBi
LTE Band 26	9.41	6.10	6.10	dBi
LTE Band 66	5.00	5.00	5.00	dBi
LTE Band 71	8.47	5.45	5.45	dBi

IMPORTANT:
Manufacturers of portable applications incorporating TX62/TX82 modules are required to have their final product certified and apply for their own FCC Grant and ISED Certificate related to the specific portable mobile. This is mandatory to meet the SAR requirements for portable mobiles (see Section 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 and with ISED license-exempt RSS standard(s). These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or televi-

sion 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 TX62/TX82 modules the below notes will have to be provided in the English and French language in the final user documentation. Manufacturers/OEM Integrators must ensure that the final user documentation does not contain any information on how to install or remove the module from the final product.

Notes (ISED):
(EN) This Class B digital apparatus complies with Canadian ICES-003 and RSS-210. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
(FR) Cet appareil numérique de classe B est conforme aux normes canadiennes ICES-003 et RSS-210. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférence et (2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.
(EN) Radio frequency (RF) Exposure Information
The radiated output power of the Wireless Device is below the Innovation, Science and Economic Development Canada (ISED) radio frequency exposure limits. The Wireless Device should be used in such a manner such that the potential for human contact during normal operation is minimized.
This device has also been evaluated and shown compliant with the ISED RF Exposure limits under mobile exposure conditions. (antennas are greater than 20cm from a person‘s body).
(FR) Informations concernant l'exposltion aux fréquences radio (RF)
La puissance de sortie émise par l'appareil de sans fil est inférieure à la limite d'exposition aux fréquences radio d‘Innovation, Sciences et Développement économique Canada (ISDE). Utilisez l'appareil de sans fil de façon à minimiser les contacts humains lors du fonctionnement normal.
Ce périphérique a également été évalué et démontré conforme aux limites d'exposition aux RF d'ISDE 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® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026b
New document: "Cinterion® TX62-W(-B/-C)/TX82-W Hardware Interface Description" **v01.000**

Chapter	What is new
---	Added new Variant: TX62-W-C.
2.1.2, 3.2.1.1	Revised high level pulse width for ON signal (1ms --> 30ms).
2.4	Revised Figure 32.
3.2.1.1	Added pull-down resistor in Figure 34.
3.2.1.2	New section Automatic Power On.
4.3	Added note regarding placement of external components.
5.4	Added Table 37, Table 38, and Table 39 with FCC and ISED antenna gain limits.

Preceding document: “Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026a
New document: "Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026b

Chapter	What is new
2.1.1	Revised G15/G16 pad assignments, and removed superfluous footnote in Table 2.
2.1.2	Revised Table 3: No internal pull up resistors for I^2C lines.
2.1.4, 2.1.5	Added note below Figure 10 and Figure 12 explaining dotted lines.
2.1.7	Revised Figure 15. Added Figure 16 showing how to connect eUICC to module’s SIM interface lines.
2.1.8.1	Revised GPIO availability with embedded processing option, and adapted whole document accordingly.
2.2.1	Removed “Max.” column from Table 9 and Table 10.
3.2.2.2	Revised description of the emergency restart process.
3.2.4.1	Added note that worst fast shutdown time cannot be specified.
3.4.1	Added power supply ratings for TX62-W-B and TX82-W.
5.1	Replaced UL 60950 with UL 62368-1 in Table 31.
5.1.1	Completed Table 36 regarding hazardous substances, chemical reaction.
5.2	Added remark regarding responsibility of the end device manufacturer.

Preceding document: “Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026
New document: "Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026a

Chapter	What is new
3.4.1	Added power supply ratings for TX62-W.

Preceding document: “Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.022a
New document: "Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.026

Chapter	What is new
1.1	Revised version of TX62-W-B
2.1.8	Revised Figure 17
5.1	Added REACH directive to Table 30
5.1	Change Safety Standard to IEC 62368-1 in Table 32
5.1.1	New chapter regarding IEC 62368-1 Classification
7.1	Revised ordering and module label numbers inn Table 40

Preceding document: “Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.022
New document: "Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.022a

Chapter	What is new
Throughout document	Adapted GSM voltage range (3.1V...4.6V)
1.4	Revised block diagrams Figure 2, Figure 3, and Figure 4.
2.1.4	Revised Figure 10, and changed Table 14 accordingly.
2.2.1	Revised receiver input sensitivity ratings in Table 9 and Table 10.
3.2.2.2	Revised Figure 37.

Preceding document: “Cinterion® TXx2-W Hardware Interface Description" v00.016
New document: "Cinterion® TX62-W(-B)/TX82-W Hardware Interface Description" v00.022

Chapter	What is new
Throughout document	Added details about the embedded processing option. Revised supported footprint for TX62-W-B. Replaced MIM with eUICC.
2.1.2	Added signal properties for eUICC interface lines.
2.1.4	Revised Figure 10.
4.3.1.1	Revised stencil shown in Figure 61.
7.1	Updated ordering information.

Preceding document: “Cinterion® TXx2-W Hardware Interface Description" v00.002
New document: "Cinterion® TXx2-W Hardware Interface Description" v00.016

Chapter	What is new
Throughout document	Added product TX82-W and TX62-W-B
1.2	Added GPIO to Key Feature at a Glance
2.1.1	Added Table 1 for Pad Assignment of additional Pads of TX82-W
2.1.1	Revised Pad Assignment regarding GPIO in Table 1, Table 2, Figure 6 and Figure 7

Chapter	What is new
2.1.2	Revised Signal Properties regarding GPIO in Table 3
2.1.8	Added new chapter for GPIO
2.4	Revised Sample Application regarding GPIO and USB in Figure 32
3.2.3	Revised Table 14 regarding GPIO, corrected some signal states
3.7	Revised Table 25 regarding GPIO, removed USB signals
6.1	Revised changes for document version 00.002

Preceding document: “Cinterion® TXx2-W Hardware Interface Description" v00.200a
New document: "Cinterion® TXx2-W Hardware Interface Description" v00.002

Chapter	What is new
Throughout document	Removed product TX82-W, thus the document version number restarted to 00.002
1.2, 2.1.2, 3.4.1	Changed minimum $BATT+_{BB}$ from 2.5V to 2.55V in Table 3 and Table 17
1.2, 4.1	Changed hight of the module in Feature at a Glance and in Figure 52 and Figure 53
2.1.2	Revised ON signal description in Table 3
2.1.6	Added in Figure 13 hint where to place the capacitors
2.1.6.1	Added hint where to place the capacitors
2.1.7	Revised Figure 15 added reference to chapter 2.1.6.1
2.2.1	Updated Table 9
2.2.3	Revised Figure 26, Figure 27, Figure 28, Figure 29 and Figure 30 according to the footprint of TX62-W
3.4.3	Revised chapter and Figure 49 regarding GND reference point
3.7	Added placement of capacitors in Table 25 for SIM interface signals
4.1	Revised Figure 54
4.3.1.1	Changed Stencil thickness to 110µm and Stencil pattern in Figure 60
4.4.1.1	Revised Figure 63 and Figure 64

Preceding document: "Cinterion® TXx2-W Hardware Interface Description" v00.200
New document: "Cinterion® TXx2-W Hardware Interface Description" v00.200a

Chapter	What is new
1.2	Removed extended voltage range and changed eUICC size MFF2 to MFF-XS
1.3	Revised Figure 1 regarding eUICC size
1.4	Removed in Figure 2 signal ADC2
2.1.2	Removed extended voltage range in Table 3
2.4	Removed in Figure 32 wrong PAD numbers
3.4.1	Removed extended voltage range in Table 17
4.2	Revised Figure 55

Preceding document: "Cinterion® TXx2-W Hardware Interface Description" v00.038
New document: "Cinterion® TXx2-W Hardware Interface Description" v00.200

Chapter	What is new
-	New document layout
Throughout document	Removed LTE Bd14. Renamed LTE Bd4 (AWS --> AWS-1), LTE Bd66 (1700MHz --> AWS-3).
Throughout document	Added support for optional eUICC interface.
1.2	Added references from key feature list to appropriate document sections.
1.2	Added support for Cinterion® IoT Module services (MODS) as key feature.
2.1.1	Revised Note 2 of Table 2
2.1.2	Revised Table 3 related to power supply
2.1.2.1	Added absolute maximum ratings for digital lines in normal operation.
2.1.7	New section eUICC Interface.
2.1.11.2	Adapted power indication circuit shown in Figure 21.
2.1.11.3	Revised fast shutdown description.
2.3.1	Added note that concurrent GNSS and GSM/LTE operations are not supported.
2.3.2	Revised description for active GNSS antenna and Figure 31
2.3.3	Revised Table 12 listing GNSS antenna interface characteristics.
2.4	Revised Figure 32
3.2.3	Revised section Signal States after Startup including Table 11.
3.4.1	Revised Table 17 related to power supply
4.2	New section Mechanical Dimensions of TX82-W, TX62-W-B and TX62-W-C
4.3.1.1	Added Land pattern and Stencil for TX82-W

New document: "Cinterion® TX62-W/TX82-W Hardware Interface Description" v00.038

Chapter	What is new
--	Initial document setup.

6.2 Related Documents

[1] TX62/TX82 AT Command Set
[2] TX62/TX82 Release Note
[3] Universal Serial Bus Specification Revision 2.0, April 27, 2000
[4] Application Note 40: Thermal Solutions for Cinterion® TXx2-W Applications
[5] Application Note 48: SMT Module Integration
[6] Differences between Selected Cinterion® Modules, Hardware Migration Guide, v11
[7] Cinterion® IoT Module Services User Guide, v01
[8] Cinterion® IoT SDK User Guide, v01

6.3 Terms and Abbreviations

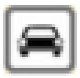
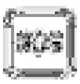
Abbreviation	Description
ADC	Analog-to-digital converter
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
ASC0/ASC1	Asynchronous Controller. Abbreviations used for first and second serial interface of TX62/TX82
B	Thermistor Constant
BER	Bit Error Rate
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
DAI	Digital Audio Interface
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Thales module)
DCS 1800	Digital Cellular System, also referred to as PCN
DRX	Discontinuous Reception
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic Compatibility

Abbreviation	Description
EMI	Electromagnetic Interference
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
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 (GSM 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
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800

Abbreviation	Description
PDU	Protocol Data Unit
PLL	Phase Locked Loop
PPP	Point-to-point protocol
PSK	Phase Shift Keying
PSU	Power Supply Unit
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 Acoustic 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. GSM 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 TX62/TX82. Manufacturers of the cellular terminal are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product. Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Thales assumes no liability for customer's failure to comply with these precautions.

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

7 Appendix

7.1 List of Parts and Accessories

Table 40: List of parts and accessories

Description	Supplier	Ordering information
TX62-W	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6300-A100 Module label number[1]: S30960-S6300-A100-1 Standard module with embedded MFF-XS eUICC Thales IMEI: Packaging unit (ordering) number: L30960-N6307-A100 Module label number[1]: S30960-S6307-A100-1 Customer IMEI mode: Packaging unit (ordering) number: L30960-N6305-A100 Module label number[1]: S30960-S6305-A100-1
TX62-W-B	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6650-A100 Module label number[1]: S30960-S6650-A100-1 Standard module with embedded MFF-XS eUICC Thales IMEI: Packaging unit (ordering) number: L30960-N6657-A100 Module label number[1]: S30960-S6657-A100-1 Customer IMEI mode: Packaging unit (ordering) number: L30960-N6655-A100 Module label number[1]: S30960-S6655-A100-1
TX62-W-C	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: t.b.d Module label number[1]: t.b.d Standard module with embedded MFF-XS eUICC Thales IMEI: Packaging unit (ordering) number: t.b.d. Module label number[1]: t.b.d Customer IMEI mode: Packaging unit (ordering) number: t.b.d Module label number[1]: t.b.d.

Table 40: List of parts and accessories

Description	Supplier	Ordering information
TX82-W	Thales	Standard module Thales IMEI: Packaging unit (ordering) number: L30960-N6600-A100 Module label number[1]: S30960-S6600-A100-1. Standard module with embedded MFF-XS eUICC Thales IMEI: Packaging unit (ordering) number: L30960-N6607-A100 Module label number[1]: S30960-S6607-A100-1 Customer IMEI mode: Packaging unit (ordering) number: L30960-N6605-A100 Module label number[1]: S30960-S6605-A100-1.
TX62-W Evaluation Module	Thales	Standard module Ordering number: L30960-N6301-A100 Standard module with embedded MFF-XS eUICC Ordering number: L30960-N6308-A100
TX62-W-B Evaluation Module	Thales	Standard module Ordering number: L30960-N6651-A100 Standard module with embedded MFF-XS eUICC Ordering number: L30960-N6658-A100
TX62-W-C Evaluation Module	Thales	Standard module Ordering number: t.b.d Standard module with embedded MFF-XS eUICC Ordering number: t.b.d.
TX82-W Evaluation Module	Thales	Standard module Ordering number: L30960-N6601-A100 Standard module with embedded MFF-XS eUICC Ordering number: L30960-N6608-A100
DSB75 Evaluation Kit	Thales	Ordering number: L36880-N8811-A100
DSB Mini Compact Evaluation Board	Thales	Ordering number: L30960-N0030-A100
LGA DevKit	Thales	LGA DevKit consists of Cinterion® LGA DevKit T Base PCB: Ordering number: L30960-N0113-A100 Cinterion® LGA DevKit Socket T: Ordering number: L30960-N0114-A100
EVAL DSB Adapter for mounting TX62/TX82 evaluation modules onto DSB75	Thales	Ordering number: L30960-N0100-A100
SIM card holder incl. push button ejector and slide-in tray	Molex	Ordering numbers: 91228 91236 Sales contacts are listed in Table 41.

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

Table 41: Molex sales contacts (subject to change)

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

7.2 Module Label Information

The label engraved on the top of TX62/TX82 comprises the following information[1].

Figure 76: TX62/TX82 label

Table 42: TX62/TX82 label information

No.	
1	Cinterion logo
2	Manufacturing country (e.g., “Made in China”)
3	Factory code
4	Product name/variant (e.g., “TX62-W”)
5	Product order code
6	Manufacturer 2D barcode
7	Product IMEI
8	2-digit date code of product production (for decoding see Table 43 below)

Table 43: Date code table

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

1. To be continued - full label information will be available with a next document version.

THALES DIS AIS Deutschland GmbH
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