# Cinterion® TX62/TX82

Hardware Interface Description

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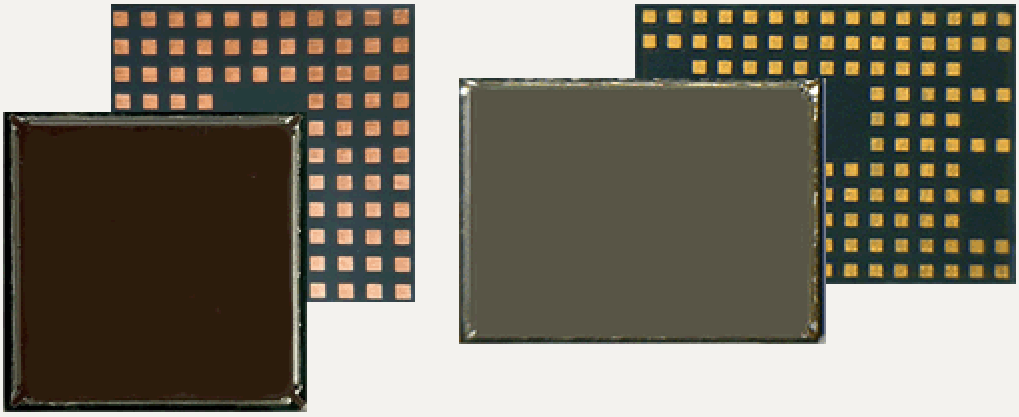

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# 1 Introduction

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 v00.020)
- Cinterion® TX62-W-B (as of v00.022)
- Cinterion® TX82-W (as of v00.018)

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

## 1.2 Key Features at a Glance

| Feature | Implementation |
|---|---|
| *General* | |
| Frequency bands (see Section 2.2.1) | GSM (TX82-W only):<br>850/900/1800/1900<br><br>LTE Cat M1:<br>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)<br><br>LTE Cat NB1/2:<br>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) |
| GSM class | Small MS |
| Output power (according to Release 7) | GSM/GPRS (TX82-W only):<br>Class 4 (+33dBm ±2dB) for GSM850 and GSM900<br>Class 1 (+30dBm ±2dB) for GSM1800 and GSM1900<br>Class E2 (+27dBm ± 3dB) for GSM850 8-PSK and GSM 900 8-PSK<br>Class E2 (+26dBm +3 /-4dB) for GSM 1800 8-PSK and GSM1900 8-PSK |

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

| **Feature** | **Implementation** |
|---|---|
| Output power (according to 3GPP Release 13) | TX62-W and TX82-W:<br>LTE Cat M1:<br>Class 5 (+20dBm ±2dB) for all supported LTE Cat M1 bands<br><br>LTE Cat NB1/2:<br>Class 5 (+20dBm ±2dB) for all supported LTE Cat NB1/2 bands<br><br>TX62-W-B:<br>LTE Cat M1:<br>Class 3 (+23dBm ±2dB) for all supported LTE Cat M1 bands<br><br>LTE Cat NB1/2:<br>Class 3 (+23dBm ±2dB) for all supported LTE Cat NB1/2 bands |
| Power supply<br>(see Section 2.1.2 and Section 3.4) | TX82-W:<br>- LTE and GSM: 3.1V to 4.6V<br>- LTE with GSM deactivated: 2.8V to 4.6V<br><br>TX62-W:<br>- LTE: 2.55V to 4.8V<br><br>TX62-W-B:<br>- LTE: 2.5V to 4.5V |
| Operating temperature (board temperature)<br>(see Section 3.5) | Normal operation: -30°C to +85°C<br>Extended operation: -40°C to +90°C |
| Physical<br>(see Section 4.1) | Dimensions:<br>TX62-W:<br>15.3 mm x 15.3 mm x 2.9 mm<br><br>TX82-W and TX62-W-B:<br>15.3 mm x 20.9 mm x 2.28 mm<br><br>Weight: approx. 2.5g |
| RoHS<br>(see Section 5.1) | All hardware components fully compliant with EU RoHS Directive |
| *LTE features* | |
| 3GPP Release 14 | LTE Cat M1 (HD-FDD)<br>DL: max. 300kbps, UL: max. 1.1Mbps<br><br>LTE Cat NB1 (HD-FDD)<br>DL: max. 27kbps, UL: max. 63kbps<br><br>LTE Cat NB2 (HD-FDD)<br>DL: max. 124kbps, UL: max. 158kbps |

| **Feature** | **Implementation** |
|---|---|
| *GSM/GPRS/EGPRS features* | |
| Data transfer | GPRS (TX82-W only):<br>• Multislot Class 10<br>• Full PBCCH support<br>• Mobile Station Class B<br>• Coding Scheme 1 – 4<br>EGPRS (TX82-W only):<br>• Multislot Class 10<br>• EDGE E2 power class for 8 PSK<br>• Downlink coding schemes – CS 1-4, MCS 1-9<br>• Uplink coding schemes – CS 1-4, MCS 1-9<br>• SRB loopback and test mode B<br>• 8-bit, 11-bit RACH<br>• PBCCH support<br>• 1 phase/2 phase access procedures<br>• Link adaptation and IR<br>• NACC, extended UL TBF<br>• Mobile Station Class B |
| SMS | Point-to-point MT and MO<br>Text and PDU mode<br>Storage: SIM card plus SMS locations in mobile equipment |
| *GNSS Features* | |
| Modes<br>(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<br>AT commands for RIL compatibility |
| Embedded processing platform **(optional)** | Embedded processing option with API.<br>Memory space available for embedded applications is 512KB for application code, 512KB min for File System and 768KB min 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.<br>For more information on how to integrate SMT modules see also [4]. This application note comprises chapters on mounting and application layout issues as well as on additional SMT application development equipment. |
| USB<br>(see Section 2.1.3) | USB 2.0 High Speed (480Mbit/s) device interface, Full Speed (12Mbit/s) compliant<br>The USB interface is used for tracing purposes only. |

| **Feature** | **Implementation** |
|---|---|
| 2 serial interfaces (see Section 2.1.4 and Section 2.1.5) | ASC0:<br>• 8-wire modem interface with status and control lines, unbalanced, asynchronous<br>• Adjustable baud rates: 300bps to 921,600bps<br>• Supports RTS0/CTS0 hardware flow control (as configuration option).<br>ASC1:<br>• 4-wire, unbalanced asynchronous modem interface<br>• Adjustable baud rates: 300bps to 921,600bps<br>• 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:<br>6 I/O pins of the application interface programmable as GPIO. Programming can be done via AT commands.<br>TX82-W and TX62-W-B:<br>7 I/O pins of the application interface programmable as GPIO. Programming can be done via AT commands.<br>With the embedded processing option 17 (TX62-W) or 18 (TX82-W and TX62-W-B) I/O pads are programmable as GPIOs and may be shared with other functions (ASC0, ASC1/SPI, PWM, fast shutdown, counter, and status). |
| Status (see Section 2.1.13.1) | Supports status indication LED. |
| Fast shutdown (see Section 2.1.13.3) | Supports fast shutdown interrupt signal. |
| ADC Input | Analog-to-Digital Converter with one unbalanced analog inputs |
| SIM switch (see Section 2.1.13.4) | Supports signal to switch between two externally connected SIMs. |
| Antenna interface pads (see Section 2.2) | 50Ω. GSM/LTE Main antenna, GNSS antenna |
| I$^2$C interface (see Section 2.1.9) | I$^2$C interface only available with embedded processing option. |
| SPI interface (see Section 2.1.10) | SPI interface only available with embedded processing option. |
| PWM interface (see Section 2.1.11) | Pulse width modulation interface only available with embedded processing option. |
| Counter (see Section 2.1.12) | Pulse counter interface only available with embedded processing option. |
| *Power on/off, Reset* | |
| Power on/off | Switch-on by hardware signal ON<br>Switch-off by AT command and hardware signal FST_SHDN<br>Automatic switch-off in case of critical voltage conditions |
| Reset | Orderly shutdown and reset by AT command<br>Emergency reset by hardware signal EMERG_RST |

| **Feature** | **Implementation** |
|---|---|
| *Special features* | |
| Approval (see Section 5) | RED, CE, FCC, ISED, UL, EuP, RoHS, and REACH compliant<br>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.<br>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.<br>Additionally, the service provides device control functionality. This includes remote flash file system management, module firmware over-the-air updates (FOTA) and remote configuration.<br>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 [6]. |
| *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

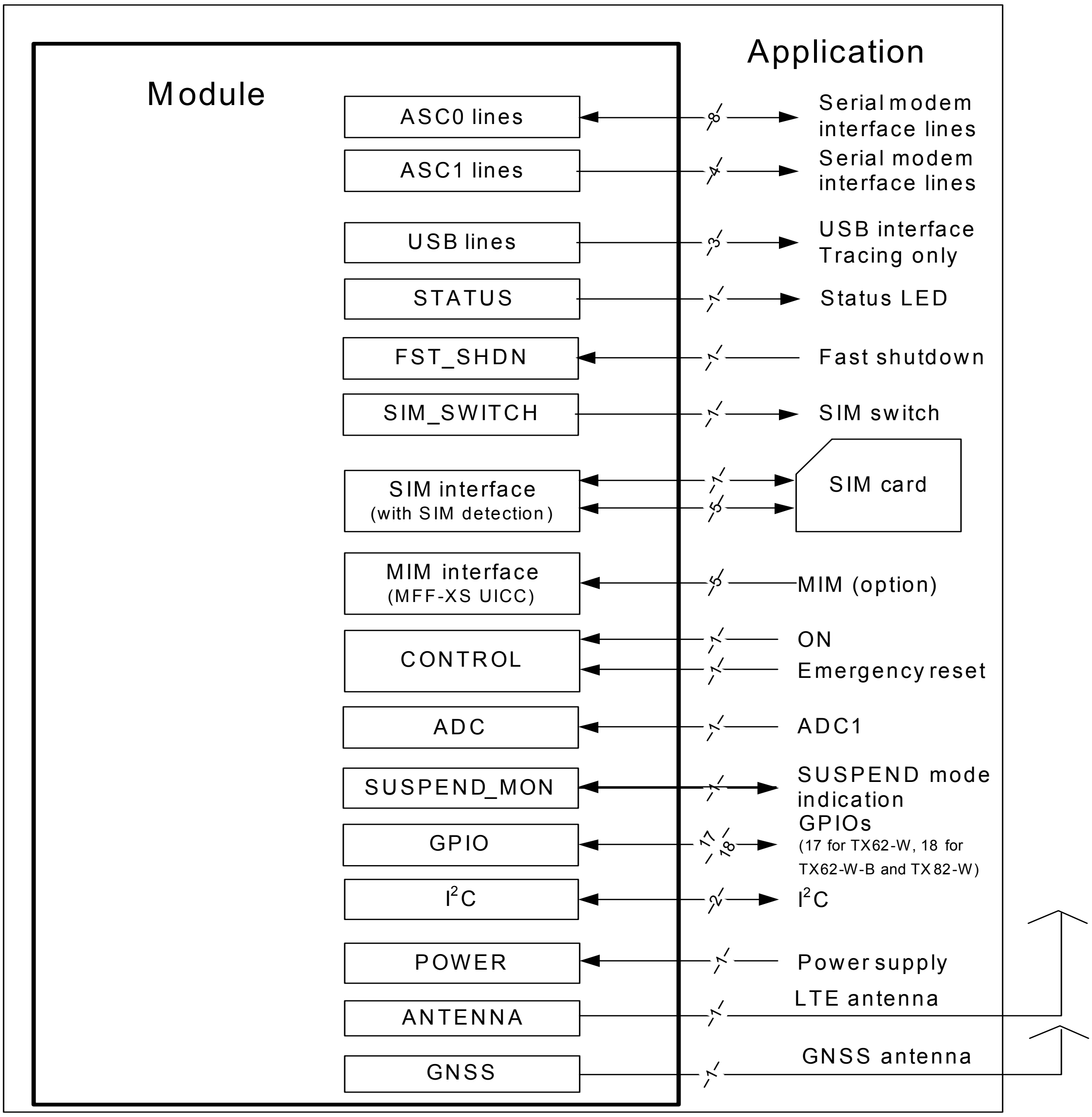


**Figure 1:** TX62/TX82 system overview

Please note that the I$^2$C 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, and Figure 4 show block diagrams for the TX62/TX82 module variants, and illustrate the major functional components:

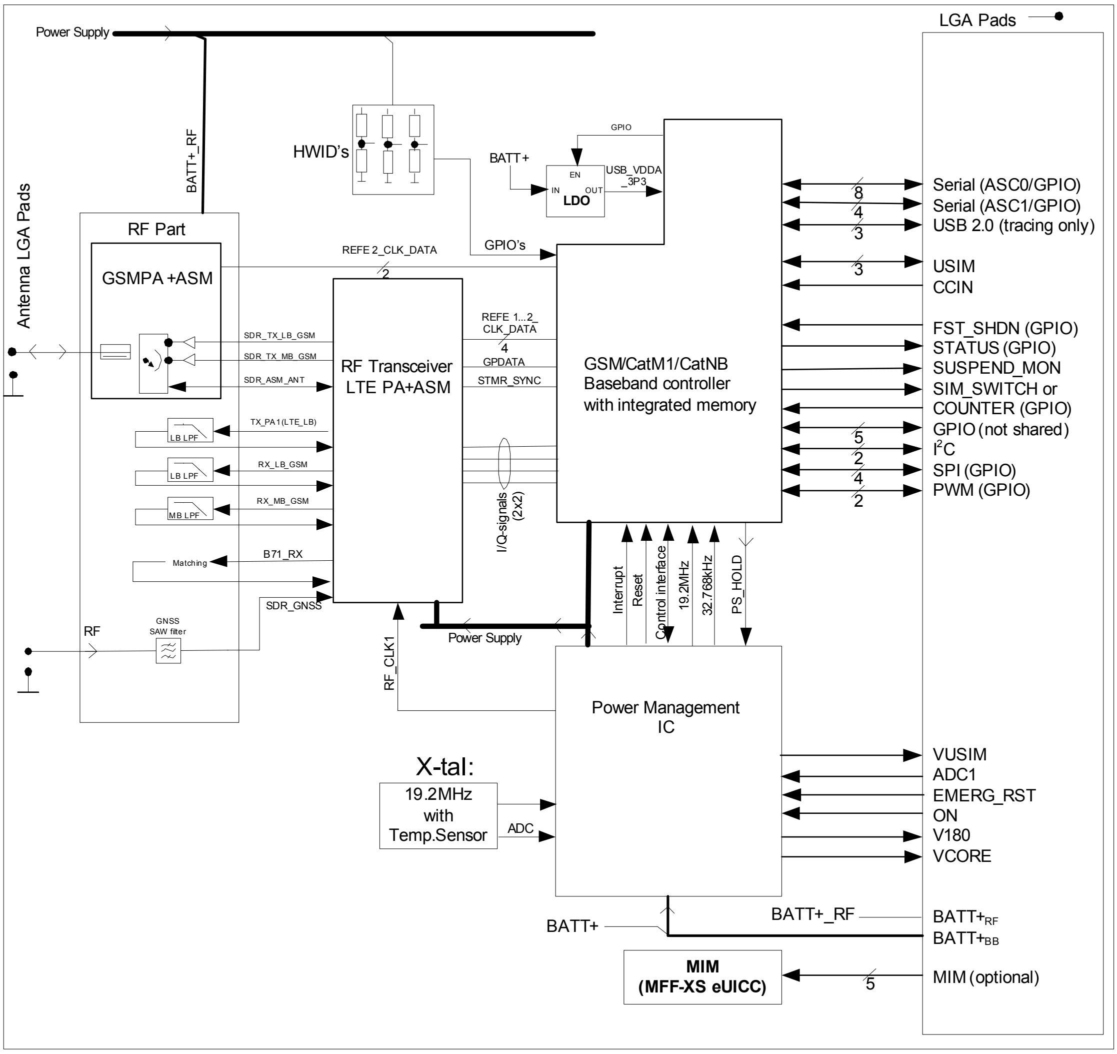


**Figure 2:** TX82-W block diagram

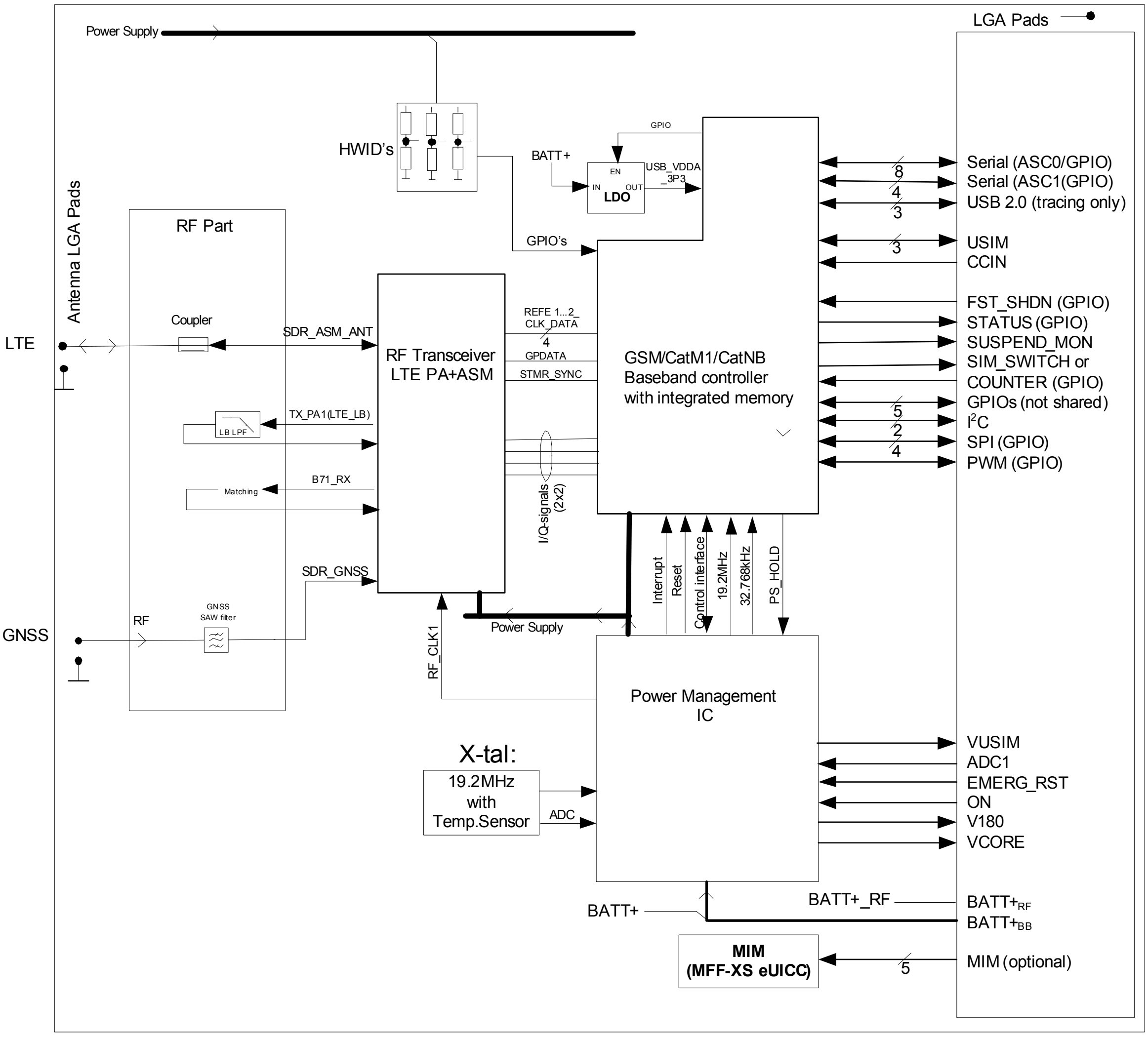


**Figure 3:** TX62-W block diagram

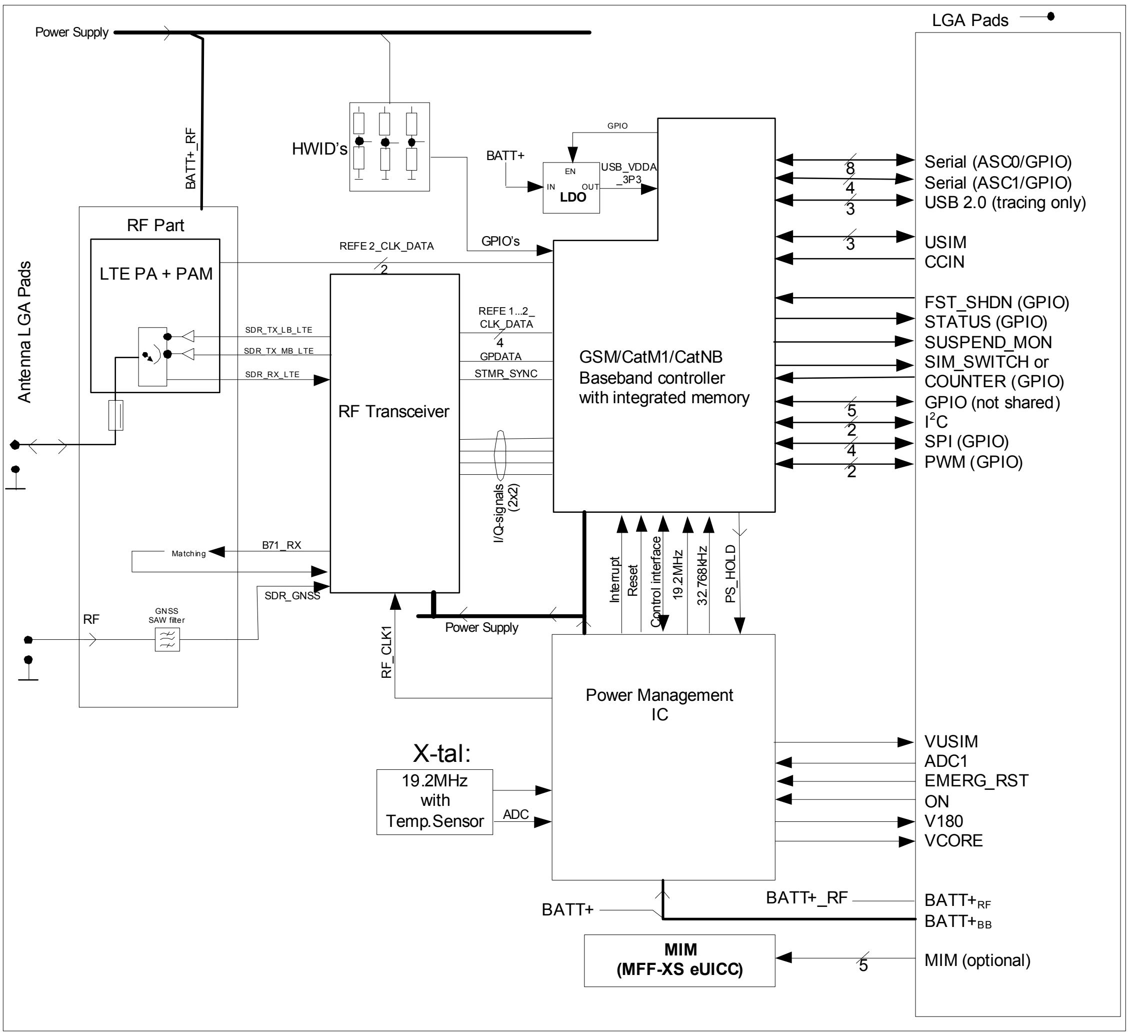


**Figure 4:** TX62-W-B block diagram

Please note that the I$^2$C 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. Table 2 lists the common pads of TX62/TX82. Figure 6 (bottom view) and Figure 5 (top view) show the connecting pads' numbering plan of TX62-W (pads inside dark violet rectangle) as well as TX82-W and TX62-W-B (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" or "nc", 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 either (dnu = do not use) or (<name>), indicating that they are either not used at all, or may be assigned to a named signal for a future product release. In addition, pads mentioned in squared brackets (I2CDAT and I2CCLK pads, SPI, PWM, and Counter 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 [4] and [5] 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 and TX62-W-B additional pads[1]

| Pad no. | Signal name | Pad no. | Signal name | Pad no. | Signal name |
|---|---|---|---|---|---|
| B5 | GND | E18 | rfu (nc) | L5 | rfu (nc) |
| B6 | rfu (nc) | E19 | rfu (nc) | L6 | rfu (nc) |
| B18 | rfu (nc) | G5 | rfu (nc) | L18 | rfu (nc) |
| B19 | GND | G6 | rfu (dnu) | L19 | rfu (nc) |
| C5 | rfu (nc) | G18 | rfu (nc) | M5 | GND |
| C6 | rfu (nc) | G19 | rfu (nc) | M6 | rfu (nc) |
| C18 | rfu (nc) | J5 | rfu (nc) | M18 | rfu (nc) |
| C19 | rfu (nc) | J6 | rfu (nc) | M19 | GND |
| E5 | rfu (nc) | J18 | rfu (nc) | | |
| E6 | GPIO6 [PWM2][2] | J19 | rfu (nc) | | |

1. rfu = reserved for future use; dnu = do not use; nc = internally not connected
2. PWM2 pad mentioned in squared brackets is available with the embedded processing option only.

**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 | rfu (nc) |
| B11 | GND | E16 | VCORE | K8 | RTS1 [GPIO18/SPI_CS] |
| B12 | RF_OUT | E17 | rfu (nc) | K9 | STATUS [GPIO5] |
| B13 | GND | F7 | GND | K10 | FAST_SHDN [GPIO4] |
| B14 | GND | F8 | GPIO25 | K11 | rfu (nc) |
| B15 | rfu (dnu) | F9 | SUSPEND_MON | K12 | RING0 [GPIO24] |
| B16 | GND | F10 | GND | K13 | DTR0 [GPIO1] |
| B17 | GND | F11 | rfu (dnu) | K14 | DCD0 [GPIO2] |
| C7 | rfu (dnu) | F12 | rfu (dnu) | K15 | CCCLK |
| C8 | SIM_SWITCH [GPIO8/COUNTER] | F13 | rfu (dnu) | K16 | rfu (dnu) |
| C9 | GND | F14 | GND | K17 | CC2_CLK |
| C10 | GND | F15 | ADC1 | L7 | rfu (nc) |
| C11 | GND | F16 | rfu (nc) | L8 | TXD1 [GPIO17/MISO] |
| C12 | GND | F17 | GND | L9 | VUSB_IN |
| C13 | GND | G7 | rfu (nc) | L10 | rfu (dnu) |
| C14 | GND | G8 | GPIO20 | L11 | DSR0 [GPIO3] |
| C15 | GND | G9 | rfu (nc) | L12 | RTS0 |
| C16 | GND | G10 | GND | L13 | CTS0 |
| C17 | rfu (nc) | G14 | GND | L14 | CCVCC |
| D7 | rfu (dnu) | G15 | rfu (nc) | L15 | CCRST |
| D8 | GPIO22 | G16 | rfu (nc) | L16 | CC2_VCC |
| D9 | rfu (nc) | G17 | rfu (nc) | L17 | CC2_RST |
| D10 | GND | H7 | rfu (nc) | M7 | GND |
| D11 | GND | H8 | GPIO23 | M8 | GND |
| D12 | GND | H9 | [I2CDAT][3] | M9 | USB_DP |
| D13 | GND | H10 | [I2CCLK][2] | M10 | USB_DN |
| D14 | GND | H14 | GND | M11 | GND |
| D15 | ON | H15 | BATT+$_{BB}$ | M12 | RXD0 |
| D16 | rfu (nc) | H16 | BATT+$_{BB}$ | M13 | TXD0 |
| D17 | rfu (nc) | H17 | rfu (nc) | M14 | CCIO |
| E7 | GPIO7 [PWM1] | J7 | rfu (nc) | M15 | CCIN |
| E8 | GPIO21 | J8 | CTS1 [GPIO19/SPI_CLK] | M16 | CC2_IO |
| E9 | rfu (GNSS_LNA_EN) | J9 | RXD1 [GPIO16/MOSI][2] | M17 | GND |
| E10 | GND | J10 | GND[2] | | |
| E11 | rfu (dnu) | J14 | rfu (dnu) | | |

1. rfu = reserved for future use; dnu = do not use; nc = internally not connected
2. Pads mentioned in squared brackets (I2CDAT and I2CCLK pads, SPI, PWM1, and Counter pads as well as shared GPIO pads) are available with the embedded processing option only.
3. Only for TX62-W Rev.A1 the following pads are swapped:
   H10: I2CCLK ↔ J10: GND and H9: I2CDAT ↔ J9: RXD1

| | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | GND | rfu (nc) | GND | CC2_IO | CCIN | CCIO | TXD0 | RXD0 | GND | USB_DN | USB_DP | GND | GND | rfu (nc) | GND |
| L | rfu (nc) | rfu (nc) | CC2_RST | CC2_VCC | CCRST | CCVCC | CTS0 | RST0 | DSR0 [GPIO3] | rfu (dnu) | VUSB_IN | TXD1 [GPIO17/ MISO] | rfu (nc) | rfu (nc) | rfu (nc) |
| K | | | CC2_CLK | rfu (dnu) | CCCLK | DCD0 [GPIO2] | DTR0 [GPIO1] | RING0 [GPIO24] | rfu (nc) | FST_SHDN [GPIO4] | STATUS [GPIO5] | RTS1 [GPIO18/ SPI_CS] | rfu (nc) | | |
| J | rfu (nc) | rfu (nc) | CC2_VPP | GND | V180 | rfu (nc) | Reserved for future use | | | GND | RXD1 [GPIO16/ MOSI] | CTS1 [GPIO19/ SPI_CLK] | rfu (nc) | rfu (nc) | rfu (nc) |
| H | | | rfu (nc) | BATT+$_{BB}$ | BATT+$_{BB}$ | GND | | | | [I2CCLK] | [I2CDAT] | GPIO23 | rfu (nc) | | |
| G | rfu (nc) | rfu (nc) | rfu (nc) | BATT+$_{RF}$ | BATT+$_{RF}$ | GND | Marking | | | GND | rfu (nc) | GPIO20 | rfu (nc) | | |
| F | | | GND | rfu (nc) | ADC1 | GND | rfu (dnu) | rfu (dnu) | rfu (dnu) | GND | SUSPEND_MON | GPIO25 | GND | | |
| E | rfu (nc) | rfu (nc) | rfu (nc) | VCORE | EMERG_RST | GND | rfu (dnu) | rfu (dnu) | rfu (dnu) | GND | rfu (GNSS_LNA_EN) | GPIO21 | GPIO7 [PWM1] | GPIO6 [PWM2] | rfu (nc) |
| D | | | rfu (nc) | rfu (nc) | ON | GND | GND | GND | GND | GND | rfu (nc) | GPIO22 | rfu (dnu) | | |
| C | rfu (nc) | rfu (nc) | rfu (nc) | GND | GND | GND | GND | GND | GND | GND | GND | SIM_SWITCH [GPIO8/CNTR.] | rfu (dnu) | rfu (nc) | rfu (nc) |
| B | GND | rfu (dnu) | GND | GND | rfu (nc) | GND | GND | RF_OUT | GND | GND | GNSS_ANT | GND | GND | rfu (nc) | GND |

**Figure 5:** TX62/TX82 top view: Pad assignments

| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **M** | GND | rfu (nc) | GND | GND | USB_DP | USB_DN | GND | RXD0 | TXD0 | CCIO | CCIN | CC2_IO | GND | rfu (nc) | GND |
| **L** | rfu (nc) | rfu (nc) | rfu (nc) | TXD1 [GPIO17/ MISO] | VUSB _IN | rfu (dnu) | DSR0 [GPIO3] | RST0 | CTS0 | CCVCC | CCRST | CC2_VCC | CC2_RST | rfu (nc) | rfu (nc) |
| **K** | | | rfu (nc) | RTS1 [GPIO18/ SPI_CS] | STATUS [GPIO5] | FST_SHDN [GPIO4] | rfu (nc) | RING0 [GPIO24] | DTR0 [GPIO1] | DCD0 [GPIO2] | CCCLK | rfu (dnu) | CC2_CLK | | |
| **J** | rfu (nc) | rfu (nc) | rfu (nc) | CTS1 [GPIO19/ SPI_CLK] | RXD1 [GPIO16/ MOSI] | GND | Reserved for future use | | | rfu (nc) | V180 | GND | CC2_VPP | rfu (nc) | rfu (nc) |
| **H** | | | rfu (nc) | GPIO23 | [I2CDAT] | [I2CCLK] | | | | GND | BATT+$_{BB}$ | BATT+$_{BB}$ | rfu (nc) | | |
| **G** | rfu (nc) | rfu (dnu) | rfu (nc) | GPIO20 | rfu (nc) | GND | Marking | | | GND | BATT+$_{RF}$ | BATT+$_{RF}$ | rfu (nc) | | |
| **F** | | | GND | GPIO25 | SUSPEND _MON | GND | rfu (dnu) | rfu (dnu) | rfu (dnu) | GND | ADC1 | rfu (nc) | GND | | |
| **E** | rfu (nc) | GPIO6 [PWM2] | GPIO7 [PWM1] | GPIO21 | rfu (GNSS_LNA_EN) | GND | rfu (dnu) | rfu (dnu) | rfu (dnu) | GND | EMERG_ RST | VCORE | rfu (nc) | rfu (nc) | rfu (nc) |
| **D** | | | rfu (dnu) | GPIO22 | rfu (nc) | GND | GND | GND | GND | GND | ON | rfu (nc) | rfu (nc) | | |
| **C** | rfu (nc) | rfu (nc) | rfu (dnu) | SIM_SWITCH [GPIO8/CNTR.] | GND | GND | GND | GND | GND | GND | GND | GND | rfu (nc) | rfu (nc) | rfu (nc) |
| **B** | GND | rfu (nc) | GND | GND | GNSS _ANT | GND | GND | RF_OUT | GND | GND | rfu (nc) | GND | GND | ADC2 | GND |

**Figure 6:** 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+$_{BB}$ | I | Voltage ranges:<br>TX82-W only:<br>LTE and GSM:<br>$V_I$min = 3.1 V...$V_I$max = 4.6V<br>LTE with GSM deactivated<br>$V_I$min = 2.8 V...$V_I$max = 4.6V<br>TX62 only:<br>LTE:<br>$V_I$min = 2.55 V...$V_I$max = 4.8V<br>TX62-W-B only:<br>LTE:<br>$V_I$min = 2.5 V...$V_I$max = 4.5V<br>TX62-W, TX62-W-B and TX82-W:<br>$V_I$norm = 3.8V<br>$I_{Power\ Down}$ = 14µA | Lines of BATT+ and GND must be connected in parallel for supply purposes because higher peak currents may occur.<br>BATT+$_{BB}$ at solder pads needs an additional low ESR 47µF capacitor (e.g, X7R MLCC, taking DCbias into account).<br>BATT+$_{RF}$ is only required if GSM is used. In this case BATT+$_{RF}$ at solder pads needs an additional low ESR 150µF capacitor (e.g, X7R MLCC, taking DCbias into account).<br>A minimum ESR value <70mΩ is recommended.<br>Minimum voltage must not fall below 3.1V (LTE+GSM, TX82-W) or 2.55V (LTE w/o GSM, TX62-W) or 2.5V (LTE w/o GSM, TX62-W-B) including GSM drops, ripple, spikes. Else the module may perform an uncontrolled shutdown.<br>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.<br>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. |
|  | BATT+$_{RF}$<br>GSM activated | I | $V_I$max = 4.6V<br>$V_I$norm = 3.8V<br>$V_I$min = 3.1 V during Tx burst on board<br>Imax = 2.16A, during Tx burst (GSM)<br>__\|¯¯\|____\|¯¯\|__<br>N Tx = n ∗ 577µs peak current every 4.616ms |  |

**Table 3:** Signal properties

| **Function** | **Signal name** | **IO** | **Signal form and level** | **Comment** |
|---|---|---|---|---|
| Power supply | GND | | Ground | Application Ground |
| External supply voltage | V180 | O | Normal operation:<br>$V_O$norm = 1.80V ±2%<br>$I_O$max = 10mA<br><br>SLEEP mode Operation:<br>$V_O$Sleep = 1.80V ±3.7%<br>$I_O$max = 10mA<br><br>SUSPEND mode Operation:<br>$V_O$Suspend = 0V<br><br>$C_I$max = 1µF | V180 has to be used for the power indication circuit.<br><br>V180 can also be used to supply level shifters at the interfaces.<br><br>Test point recommended[1]. |
| | VCORE | O | Normal Operation:<br>$V_O$nom = 1.128V ±2%<br>$I_O$max = 10mA<br><br>SLEEP Mode Operation:<br>$V_O$sleep = 0.5V...1.304V ±3%<br>$I_O$max = 10mA<br><br>SUSPEND Mode Operation:<br>$V_O$suspend = 0V<br><br>$C_I$max = 100nF | Test point recommended. |
| Ignition | ON | I | $V_{IH}$max = BATT+$_{BB}$<br>$V_{IH}$min = 1.3V<br>$V_{IL}$max = 0.5V<br>rising edge followed by high > 1ms<br><br>ON ___\|‾‾‾ | This signal switches the module on.<br><br>The ON signal is rising edge triggered. Rise time should be <1ms.<br><br>Test point recommended. |
| Status | STATUS | O | $V_{OL}$max = 0.45V at I = 4.5 mA<br>$V_{OH}$min = 1.20V at I = 2.5 mA<br>$V_{OH}$max = 1.95V | If unused keep lines open.<br><br>With the embedded processing option this line is also available as GPIO:<br>STATUS --> GPIO5 |
| Fast shutdown | FST_SHDN | I | $V_{IL}$max = 0.5V<br>$V_{IH}$min = 1.3V<br>$V_{IH}$max = 1.95V | If unused keep lines open.<br><br>Fast shutdown period <15ms.<br><br>With the embedded processing option this line is also available as GPIO:<br>FST_SHDN --> GPIO4 |

**Table 3:** Signal properties

| Function | Signal name | IO | Signal form and level | Comment |
|---|---|---|---|---|
| Emergency reset | EMERG_RST | I | $R_I \approx 1k\Omega$, $C_I \approx 1nF$<br>$V_{IH}min = 1.3V$<br>$V_{IL}max = 0.5V$ at ~1µA<br>¯¯\|___\|¯¯ low impulse width > 800ms | This line must be driven low by an open drain or open collector driver connected to GND.<br>If unused keep lines open.<br>Test point recommended. |
| USB | VUSB_IN | I | $V_Imin = 3V$<br>$V_Imax = 5.25V$<br>Active and suspend current:<br>$I_{max} < 100µA$ | All electrical characteristics according to USB Implementers' Forum, USB 2.0 Specification.<br>If unused keep lines open.<br>Used for tracing purposes only.<br>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<br>$V_{OH}min = 1.20V$ at I = 2.5 mA<br>$V_{OH}max = 1.95V$ | If unused keep lines open.<br>RTS0 can be used to wakeup the module from SLEEP mode, but not from SUSPEND/PSM mode.<br>Test points recommended for RXD0, TXD0, RTS0, and CTS0.<br>With embedded processing option some ASC0 lines are shared with GPIOs, see Section 2.1.8. |
| | CTS0 | O | | |
| | DSR0 | O | | |
| | DCD0 | O | | |
| | RING0 | O | | |
| | TXD0 | I | $V_{IL}max = 0.5V$<br>$V_{IH}min = 1.3V$<br>$V_{IH}max = 1.95V$ | |
| | RTS0 | I | | |
| | DTR0 | I | | |
| Serial Modem Interface ASC1 | RXD1 | O | $V_{OL}max = 0.45V$ at I = 4.5 mA<br>$V_{OH}min = 1.20V$ at I = 2.5 mA<br>$V_{OH}max = 1.95V$ | If unused keep lines open.<br>Test points recommended for RXD1, TXD1, RTS1, and CTS1.<br>With embedded processing option ASC1 lines are shared with GPIOs, see Section 2.1.8. |
| | CTS1 | O | | |
| | TXD1 | I | $V_{IL}max = 0.5V$<br>$V_{IH}min = 1.3V$<br>$V_{IH}max = 1.95V$ | |
| | 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<br>$R_I \approx 110k\Omega$<br>$V_{IL}max = 0.5V$<br>$V_{IH}min = 1.3V$<br>$V_{IH}max = 1.95V$ | CCIN = High, SIM card inserted.<br>If unused keep line open. |
| 1.8V SIM Card Interface | CCVCC | O | $V_O min = 1.5V$<br>$V_O typ = 1.8V$<br>$V_O max = 2V$<br>$I_O max = -60mA$ | Maximum cable length or copper track to SIM card holder should not exceed 100mm.<br>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<br>CCCLK | O<br>O | $V_{OL}max = 0.45V$ at $I = 4.5$ mA<br>$V_{OH}min = 1.20V$ at $I = 2.5$ mA<br>$V_{OH}max = 1.95V$ | |
| | CCIO | I/O | $V_{OL}max = 0.45V$ at $I = 4.5$ mA<br>$V_{OH}min = 1.20V$ at $I = 2.5$ mA<br>$V_{OH}max = 1.95V$<br>$V_{IL}max = 0.5V$<br>$V_{IH}min = 1.3V$<br>$V_{IH}max = 1.95V$ | |

**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:<br>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.<br>If there is no plan to use SWP the CC2_VPP line can be grounded. |
| | CC2_VCC | I | $V_{I}$min = 1.62V<br>$V_{I}$typ = 1.8V<br>$V_{I}$max = 1.98V | Maximum cable length or copper track should be no longer as 100mm to eUICC interface.<br>The signals CC2_RST, CC2_IO, CC2_CLK and CC2_VCC are protected against ESD with a special diode array.<br>If unused keep lines open. |
| | CC2_CLK | I | $V_{IL}$max = 0.2*CC2_VCC (at $I_{OL}$max = -200µA)<br>$V_{IL}$min = -0.3V (at $I_{OL}$ max = -200µA)<br>$V_{IH}$max=CC2_VCC+0.3V (at $I_{OH}$max = +20µA)<br>$V_{IH}$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)<br>$V_{IL}$min = -0.3V (at $I_{OL}$ max = -20µA)<br>$V_{IH}$max=CC2_VCC+0.3V (at $I_{OH}$max = +20µA)<br>$V_{IH}$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)<br>$V_{IL}$min = -0.3V (at $I_{IH}$ = +1mA/+20 µA)<br>$V_{IH}$min = 0.7*CC2_VCC (at $I_{IH}$ = -20/+20µA)<br>$V_{IH}$max = CC2_VCC+0.3V (at $I_{IH}$ = -20/+20µA)<br>$V_{OL}$max = 0.15*CC2_VCC (at $I_{OL}$ = -1mA)<br>$V_{OH}$min = 0.7*CC2_VCC (at $I_{IH}$ = -20/+20µA)<br>$V_{OH}$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<br>$V_{OH}$min = 1.20V at I = 2.5 mA<br>$V_{OH}$max = 1.95V | If unused keep lines open.<br>With embedded processing option SIM_SWITCH is shared with GPIO8 and COUNTER, see Section 2.1.8. |

**Table 3:** Signal properties

| Function | Signal name | IO | Signal form and level | Comment |
|---|---|---|---|---|
| I$^2$C | I2CDAT | I/O | Internal pull up Resistors<br>I2CCLK = 2k2<br>I2CDAT = 2k2<br><br>$V_{OL}$max = 0.45V at Imax = -4.5mA<br>$V_{OH}$max = 1.95V<br><br>$V_{IL}$max = 0.5V<br>$V_{IH}$min = 1.3V<br>$V_{IH}$max = 1.95V<br><br>Note: Imax = I max external + I pull up | If unused keep lines open.<br><br>Compatible with I$^2$C Bus Specification Version 5.0<br><br>The value of the pull-up depends on the capacitive load of the whole system (I$^2$C Slave + lines). The maximum sink current of I2CDAT and I2CCLK is TBD.mA.<br><br>Only available with embedded processing option. |
| | I2CCLK | O | | |
| GPIO | GPIO6-GPIO7,<br>GPIO20-GPIO23,<br>GPIO25 | I/O | $V_{OL}$max = 0.45V at I = 4.5 mA<br>$V_{OH}$min = 1.20V at I = 2.5 mA<br>$V_{OH}$max = 1.95V<br><br>$V_{IL}$max = 0.5V<br>$V_{IH}$min = 1.3V<br>$V_{IH}$max = 1.95V | If unused keep lines open.<br><br>GPIO6 only available on TX82-W and TX62-W-B.<br><br>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<br>$V_{OH}$min = 1.20V at I = 2.5mA<br>$V_{OH}$max = 1.95V<br><br>$V_{IL}$max = 0.5V<br>$V_{IH}$min = 1.3V<br>$V_{IH}$max = 1.95V | Shared with GPIO:<br>SPI_MOSI --> GPIO16<br>SPI_MISO --> GPIO17<br>SPI_CS --> GPIO18<br>SPI_CLK --> GPIO19<br><br>Also shared with ASC1 function (see Section 2.1.8). Only available with embedded processing option. |
| | SPI_MOSI | O | | |
| | SPI_MISO | I | | |
| | SPI_CS | O | | |
| Pulse width modulation interface | PWM1<br>PWM2 | O | $V_{OL}$max = 0.45V at I = 4.5 mA<br>$V_{OH}$min = 1.20V at I = 2.5 mA<br>$V_{OH}$max = 1.95V | Shared with GPIO:<br>PWM1 --> GPIO7<br>PWM2 --> GPIO6<br><br>Only available with embedded processing option. |
| Pulse counter | COUNTER | I | Internal up resistor active<br>$V_{IL}$max = 0.6V at < -30µA<br>$V_{IH}$min = 1.22V<br>$V_{IH}$max = 1.87V | Shared with GPIO:<br>COUNTER --> GPIO8<br><br>Only available with embedded processing option. |

**Table 3:** Signal properties

| Function | Signal name | IO | Signal form and level | Comment |
|---|---|---|---|---|
| ADC (Analog-to-Digital Converter) | ADC1 | I | $R_I$ = 10MΩ<br>$V_I$ = 0.1V ... 1.875V (valid range)<br>$V_{IH}$ max = 1.910V<br>Resolution 64.979uV | If unused keep line open. |
| SUSPEND mode indicator | SUSPEND_MON | O | $V_{OL}$max = 0.45V at I = 4.5 mA<br>$V_{OH}$min = 1.20V at I = 2.5 mA<br>$V_{OH}$max = 1.95V | High=Normal mode, Low=SUSPEND mode.<br>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 [4] and [5] 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+$_{RF}$ (TX82-W only; no service) | -0.5 | +6.0 | 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 |

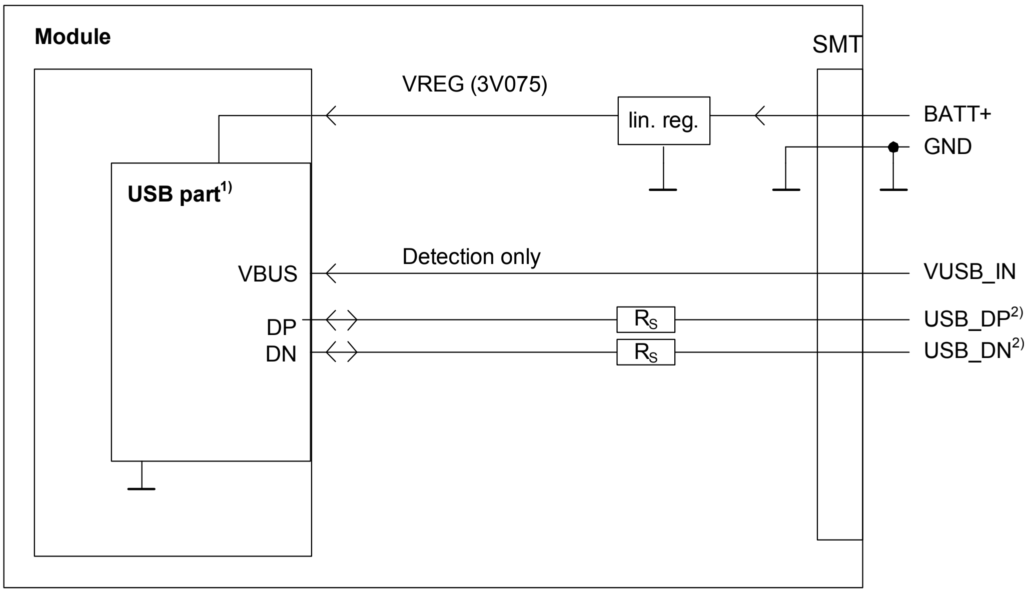
[1] A maximum rating of 1.95V (for $V_{IH}$max) is recommended for all digital lines. Exceeding this value however will not necessarily harm the module as long as the rating remains below the absolute maximum rating of 1.95+0.14V, but it will decrease the safety margin in case of short spikes or ripple.

## 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.

**Note:** The USB interface is intended for use as a trace interface only.

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 7:** 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.

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[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 9.

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

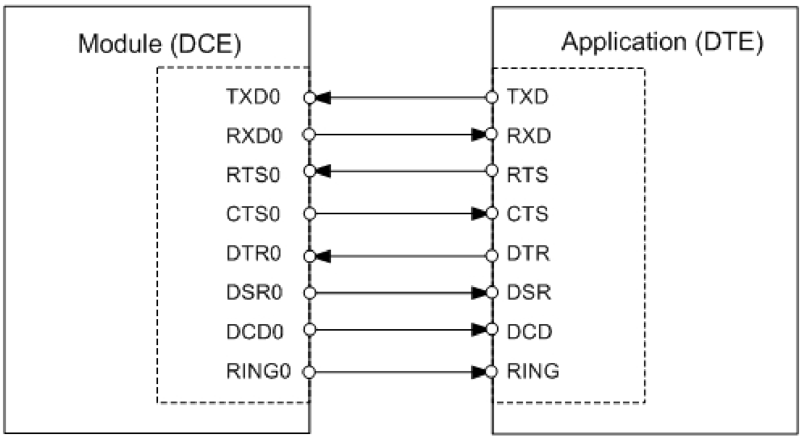
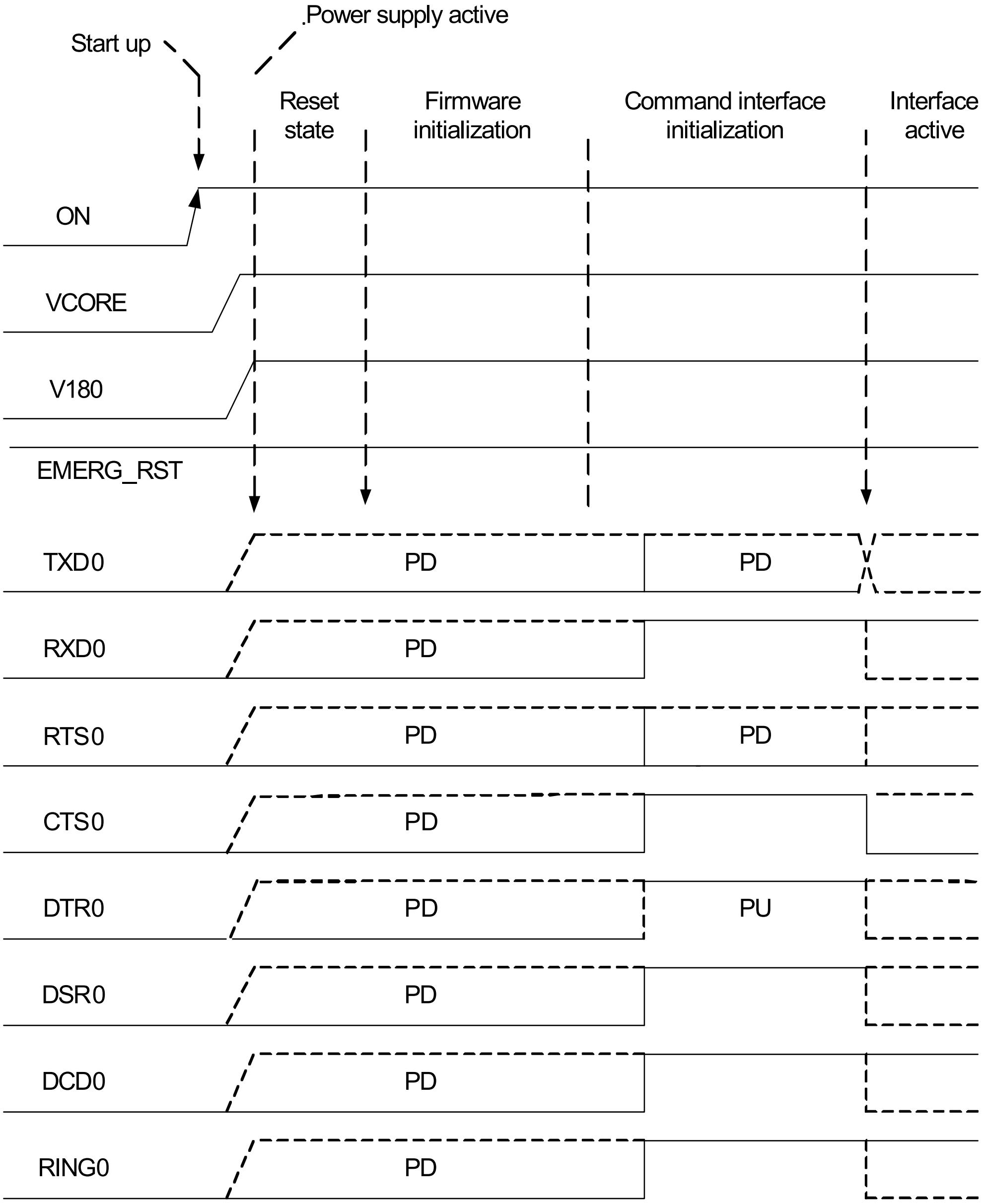


**Figure 8:** Serial interface ASC0

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.



For pull-up and pull-down values see Table 13.

**Figure 9:** 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 11.

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

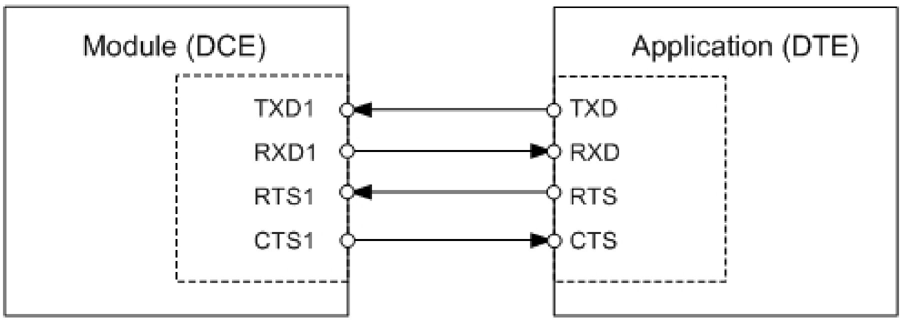
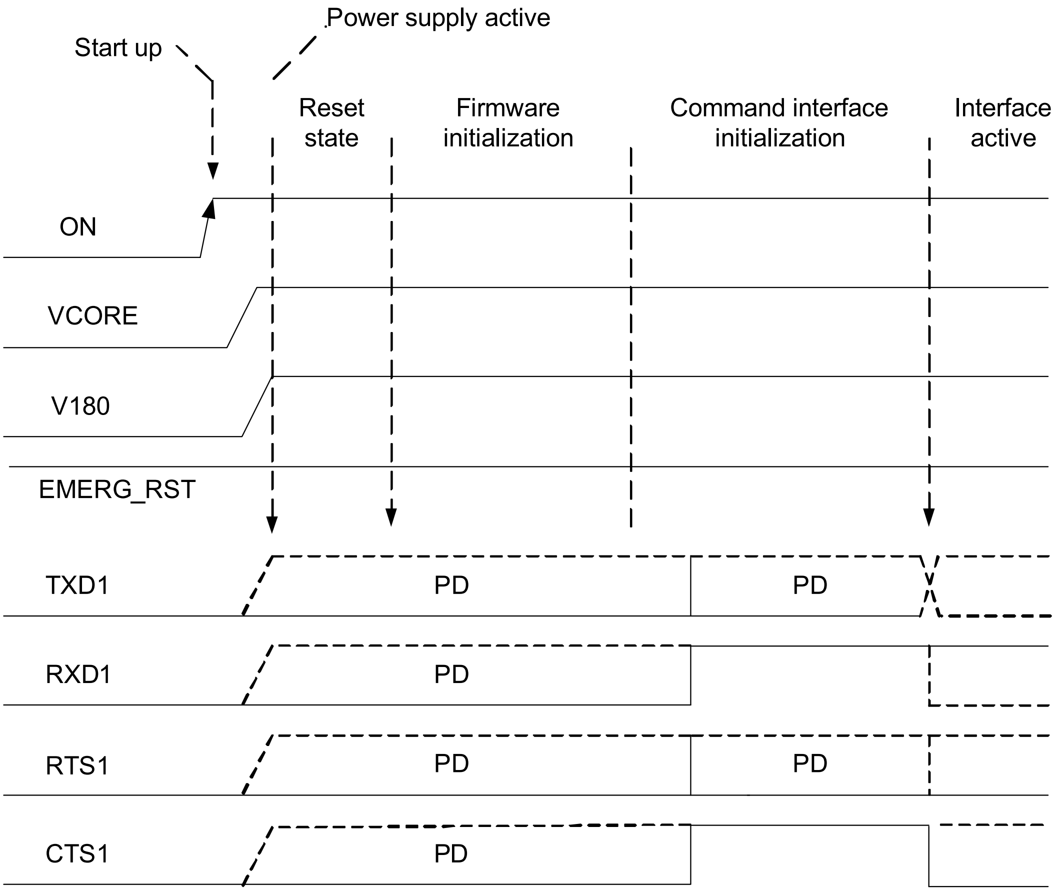


**Figure 10:** Serial interface ASC1

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.



*) For pull-down values see Table 13.

**Figure 11:** 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.<br>The CCIN signal is mandatory for applications that allow the user to remove the SIM card during operation.<br>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.

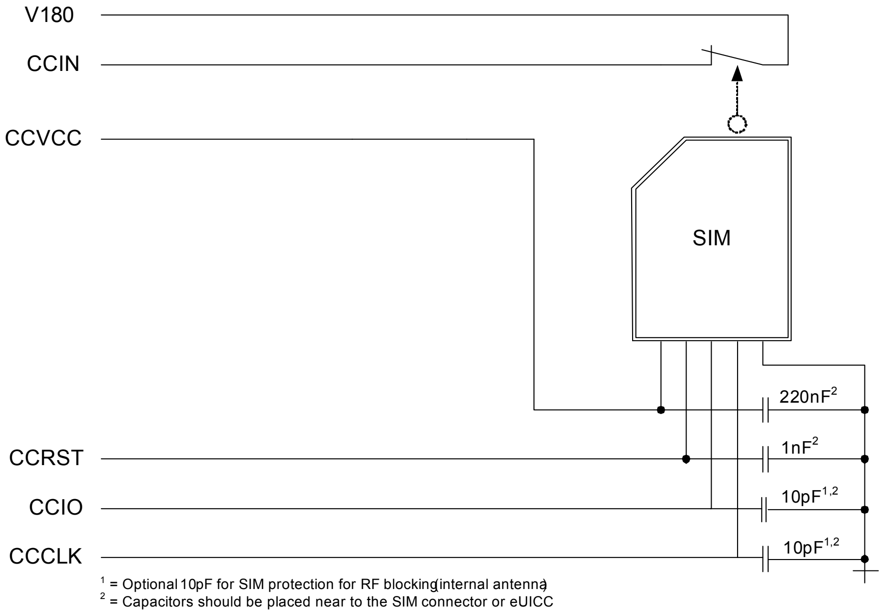


**Figure 12:** External UICC/SIM/USIM card holder circuit

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 2.1.13.4.

### 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 13.

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

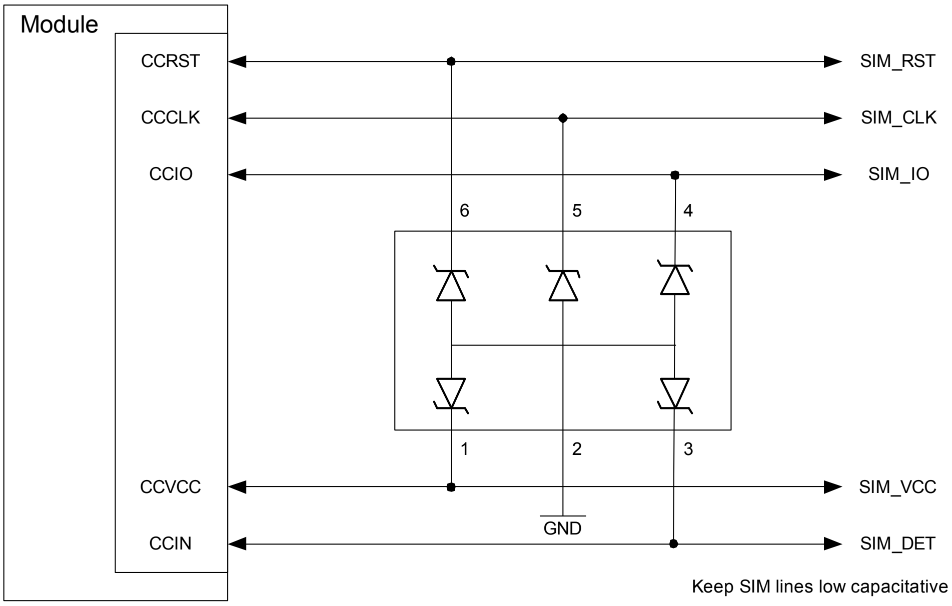


**Figure 13:** SIM interface - enhanced ESD protection

The capacitors shown in Figure 12 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 14 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.

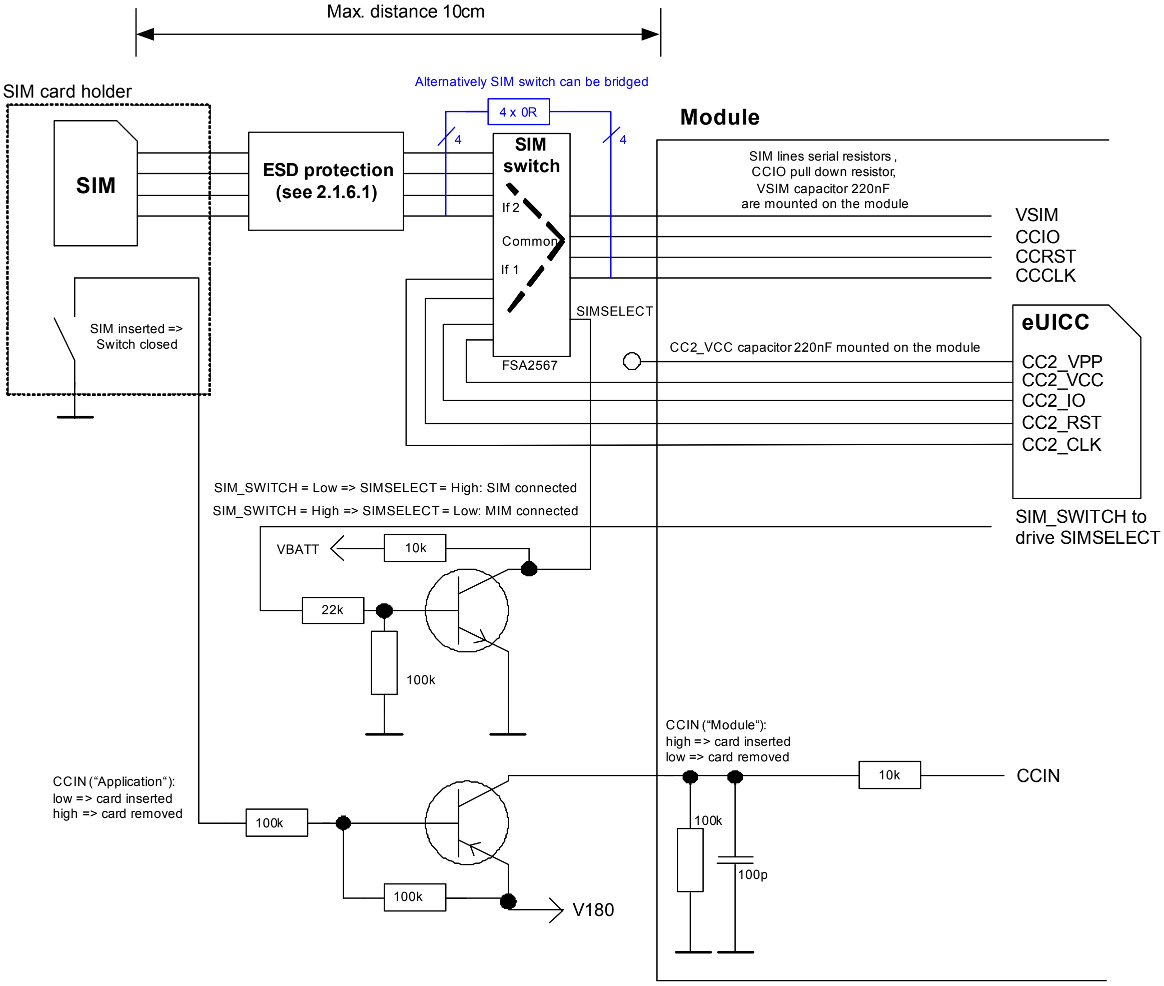


**Figure 14:** eUICC interface

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 |

## 2.1.8 GPIO

TX82-W and TX62-W-B 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.

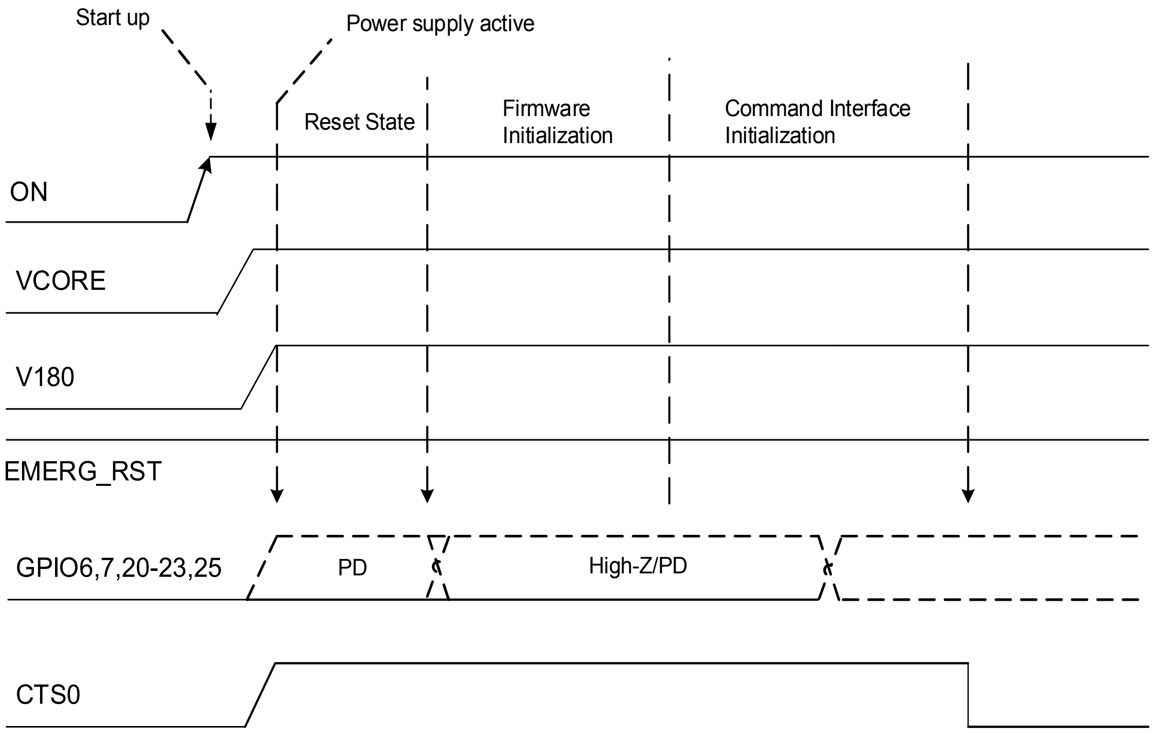


**Figure 15:** GPIO start up behavior

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 18 GPIO lines. Most 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 | Fast Shutdown | Status LED | PWM | Pulse Counter | ASC0 | ASC1 | SPI | Sim Switch |
|---|---|---|---|---|---|---|---|---|
| GPIO1 | | | | | DTR0 | | | |
| GPIO2 | | | | | DCD0 | | | |
| GPIO3 | | | | | DSR0 | | | |
| GPIO4 | FST_SHDN | | | | | | | |
| GPIO5 | | Status LED | | | | | | |
| GPIO6[1] | | | PWM2 | | | | | |
| GPIO7 | | | PWM1 | | | | | |
| GPIO8 | | | | COUNTER | | | | SIM_SWITCH |
| GPIO16 | | | | | | RXD1 | MOSI | |
| GPIO17 | | | | | | TXD1 | MISO | |
| GPIO18 | | | | | | RTS1 | SPI_CS | |
| GPIO19 | | | | | | CTS1 | SPI_CLK | |
| GPIO20 | | | | | | | | |
| GPIO21 | | | | | | | | |
| GPIO22 | | | | | | | | |
| GPIO23 | | | | | | | | |
| GPIO24 | | | | | RING0 | | | |
| GPIO25 | | | | | | | | |

1. Only available with TX82-W and TX62-W-B.

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

The I²C bus can be configured and activated via embedded application. For more information see [7].

The I²C interface can be powered via the V180 line of TX62/TX82. If connected to the V180 line, the I²C interface will properly shut down when the module enters the Power Down mode.

In the application I2CDAT and I2CCLK lines need to be connected to a positive supply voltage via a pull-up resistor. For electrical characteristics please refer to Table 3.

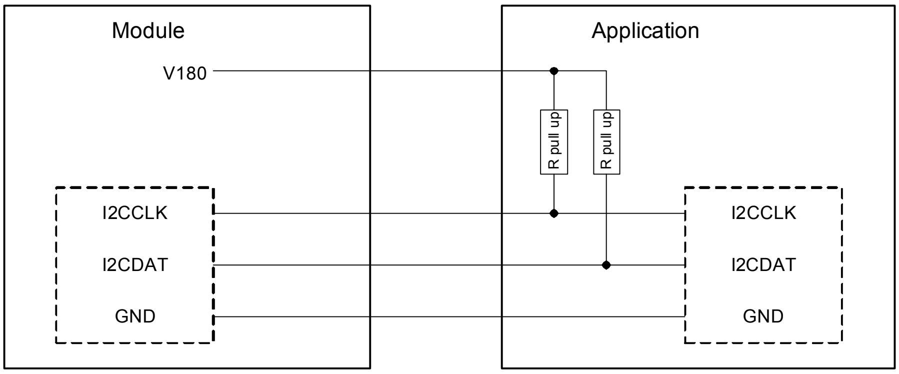


**Figure 16:** I²C interface connected to V180

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 [7].

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

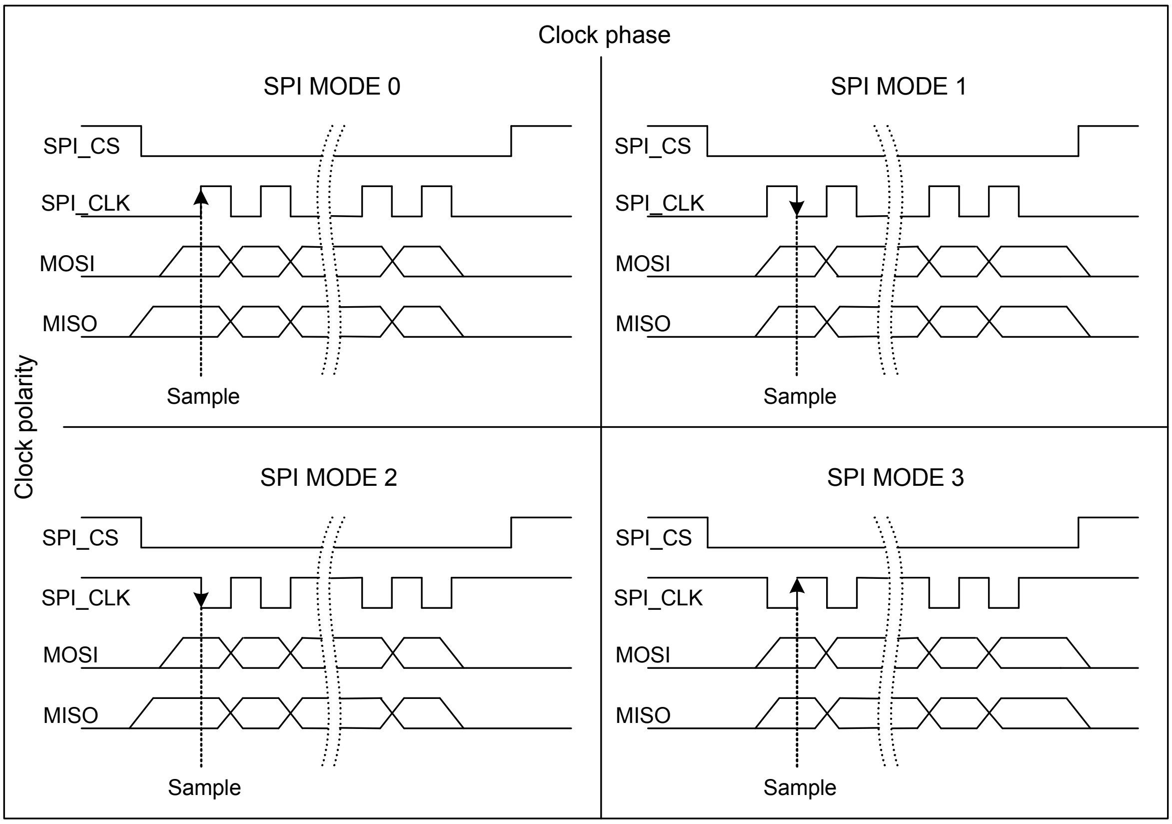


**Figure 17:** Characteristics of SPI modes

### 2.1.11 PWM Interfaces

The embedded processing option of TX62/TX82 provides a PWM interface where the GPIO6 and GPIO7 lines can be configured as pulse width modulation lines PWM1 and PWM2. The PWM interface lines can be used, for example, to connect buzzers.

The PWM1 line is shared with GPIO7 and the PWM2 line is shared with GPIO6 (for GPIOs see Section 2.1.8.1). GPIO and PWM functionality are mutually exclusive.

### 2.1.12 Pulse Counter

The embedded processing option of TX62/TX82 provides a pulse counter the GPIO8 line can be configured as pulse counter line COUNTER. The pulse counter interface can be used, for example, as a clock (for GPIOs see Section 2.1.8.1).

## 2.1.13 Control Signals

### 2.1.13.1 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 18. The sample circuit is not optimized for low current consumption.

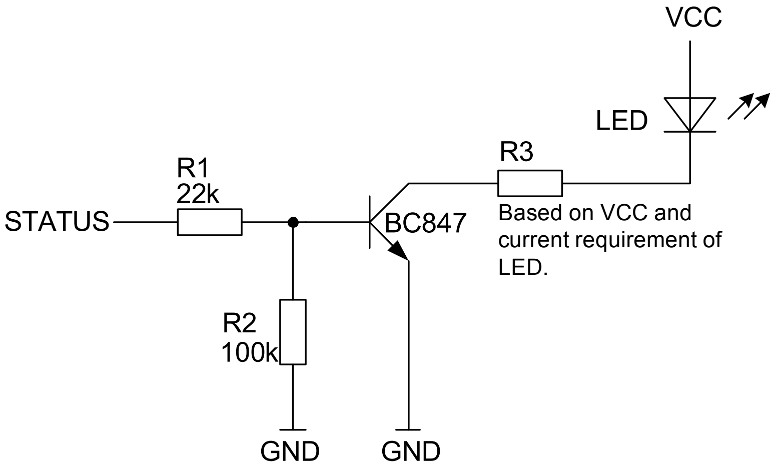


**Figure 18:** Status signaling with LED driver

### 2.1.13.2 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 19 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.

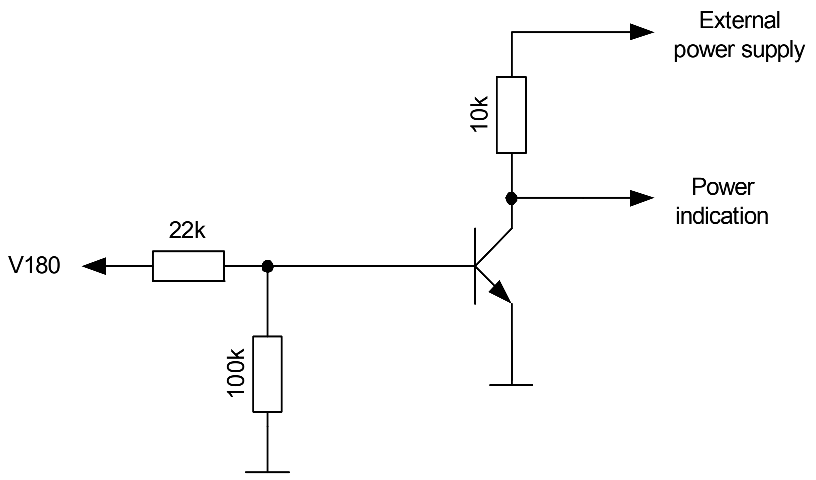


**Figure 19:** Power indication circuit

### 2.1.13.3 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 20). 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 20). 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.

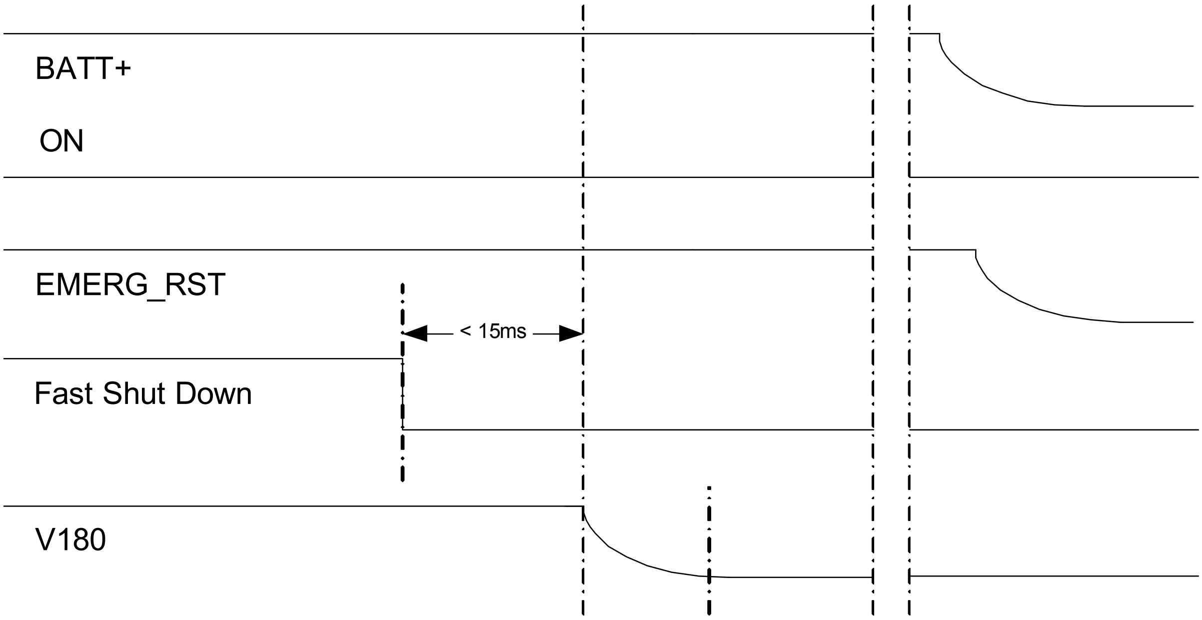


**Figure 20:** Fast shutdown timing

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].

### 2.1.13.4 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 21. 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]).

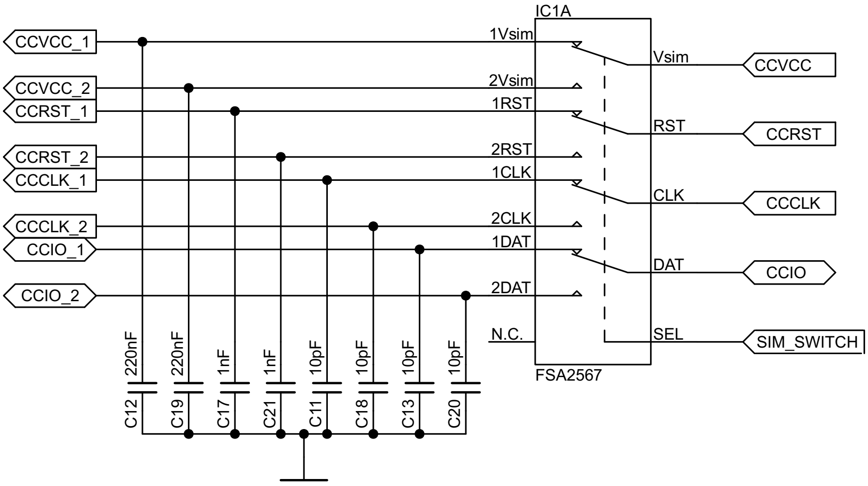


**Figure 21:** SIM switch circuit

### 2.1.13.5 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. | Typical | | Max. | 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:<br>Receiver Input Sensitivity @NTNV<br>BW: 5 MHz,<br>UL: Modulation: QPSK; $N_{RB}$=6;<br>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.** | **Typical** | | **Max.** | **Unit** |
|---|---|---|---|---|---|---|
| | | | **TX62-W** | **TX82-W** | | |
| LTE Cat M1:<br>Power @ ARP with 50Ω Load, NTNV<br>BW: 5 MHz,<br>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:<br>Receiver Input Sensitivity @NTNV<br>DL: Modulation: QPSK; Subcarriers: 12;<br>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. | Typical | | Max. | Unit |
|---|---|---|---|---|---|---|---|
| | | | | TX62-W | TX82-W | | |
| LTE Cat NB1/2:<br>Power @ ARP with 50Ω Load, NTNV<br>Configuration ID: 1,<br>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,<br>(**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.** | **Typical** | | **Max.** | **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.

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

| Parameter | Conditions | Min. | Typical | Max. | 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:<br>Receiver Input Sensitivity @NTNV<br>BW: 5 MHz,<br>UL: Modulation: QPSK; $N_{RB}$=6;<br>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:<br>Power @ ARP with 50Ω Load, NTNV<br>BW: 5 MHz,<br>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. | Typical | Max. | 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:<br>Receiver Input Sensitivity @NTNV<br>DL: Modulation: QPSK; Subcarriers: 12;<br>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:<br>Power @ ARP with 50Ω Load, NTNV<br>Configuration ID: 1,<br>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 |

## 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.

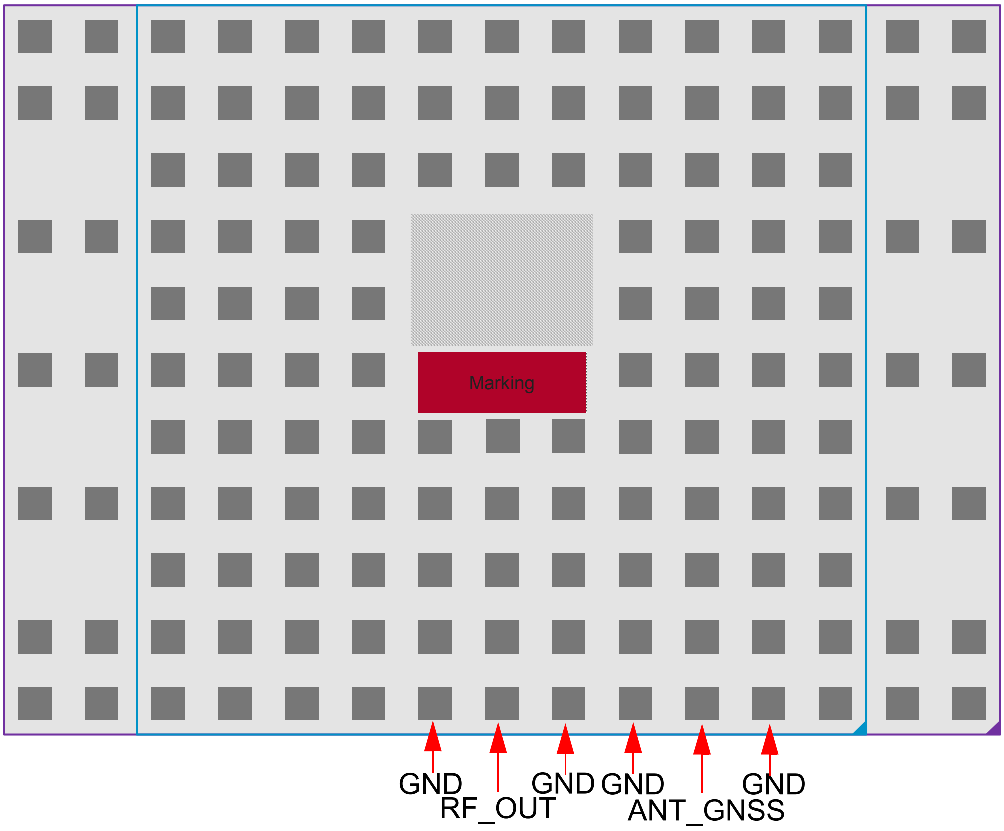


**Figure 22:** Antenna pads (top view)

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.

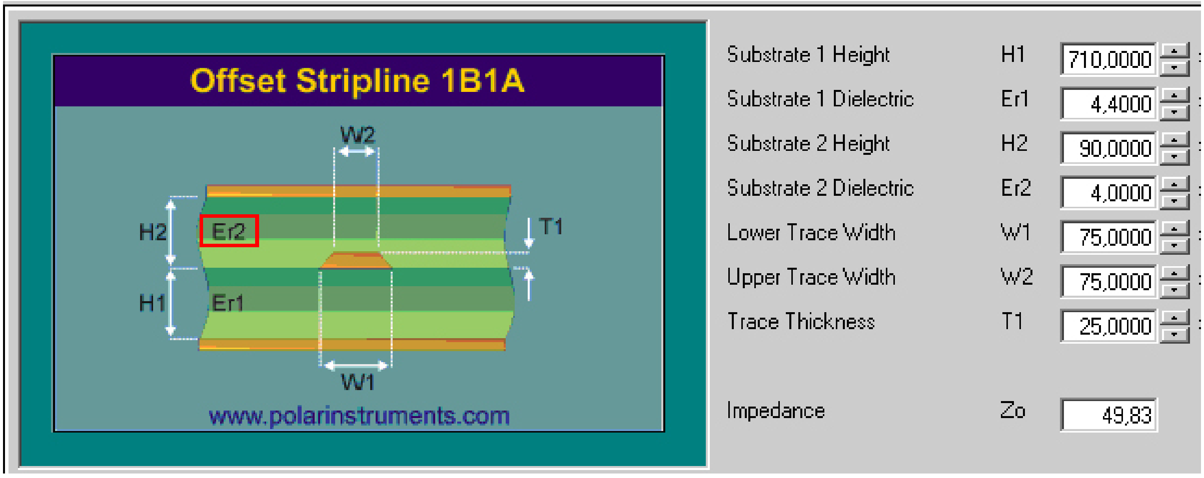
## 2.2.3 RF Line Routing Design

### 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).

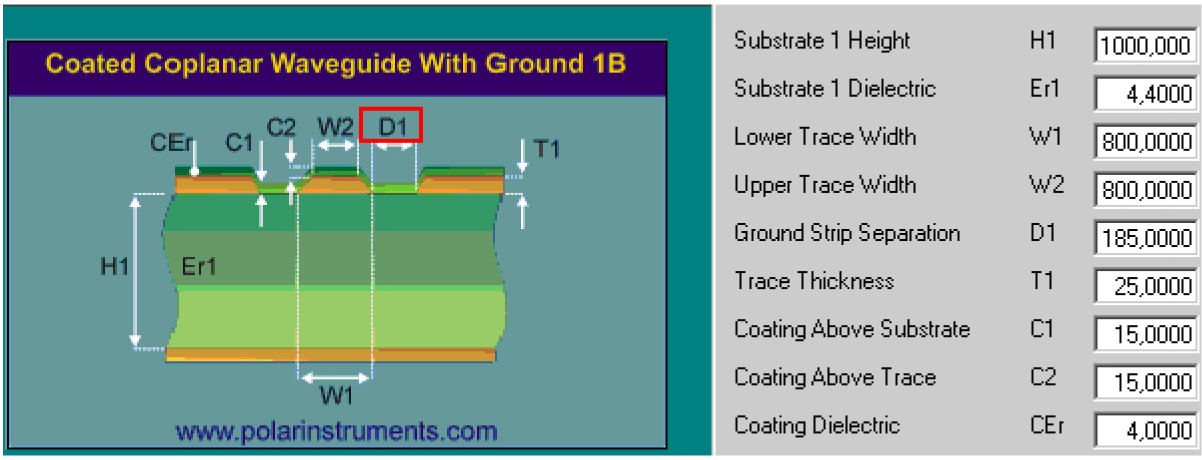


| | | |
|---|---|---|
| Substrate 1 Height | H1 | 710,0000 |
| Substrate 1 Dielectric | Er1 | 4,4000 |
| Substrate 2 Height | H2 | 90,0000 |
| Substrate 2 Dielectric | Er2 | 4,0000 |
| Lower Trace Width | W1 | 75,0000 |
| Upper Trace Width | W2 | 75,0000 |
| Trace Thickness | T1 | 25,0000 |
| Impedance | Zo | 49,83 |

**Figure 23:** Embedded Stripline with 65µm prepreg (1080) and 710µm core

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

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



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

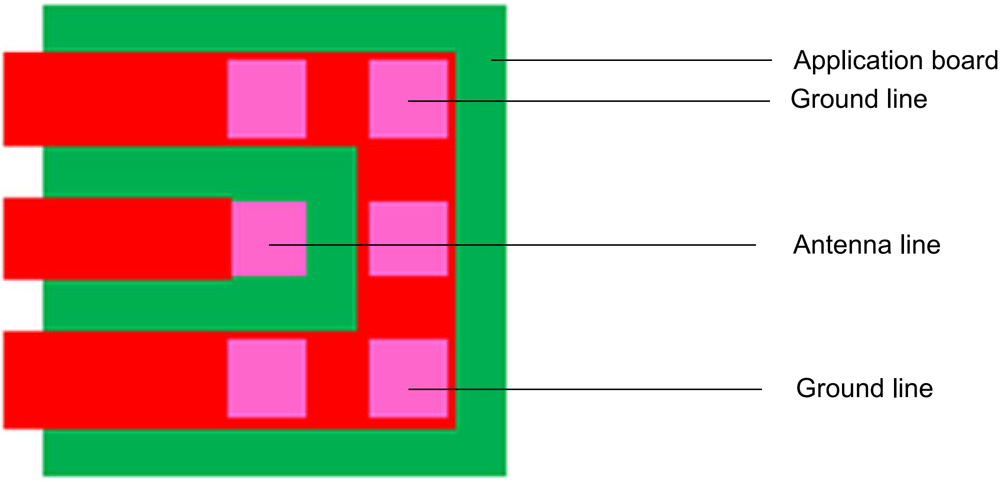
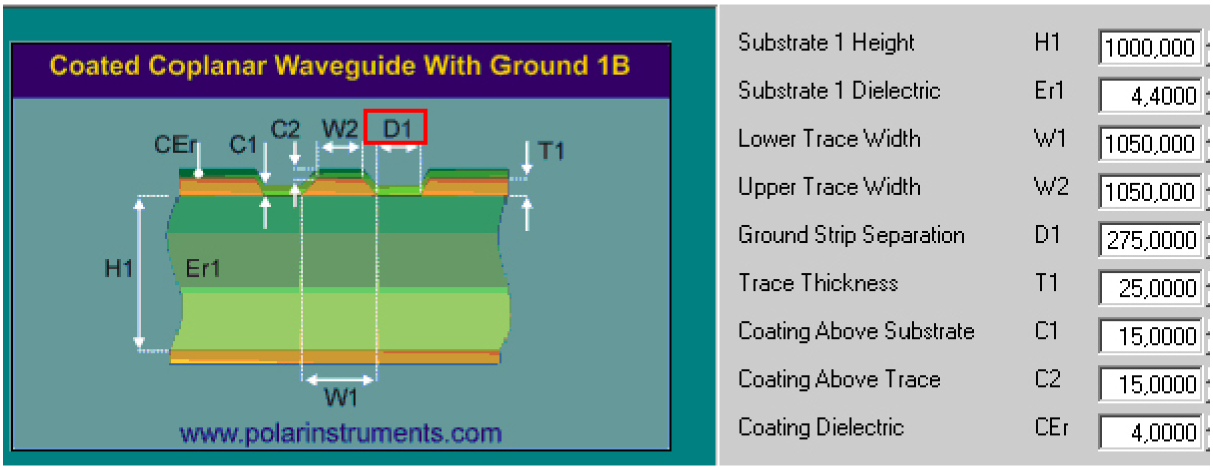


**Figure 24:** Micro-Stripline on 1.0mm Standard FR4 2-layer PCB - example 1



| | | |
|---|---|---|
| Substrate 1 Height | H1 | 1000,000 |
| Substrate 1 Dielectric | Er1 | 4,4000 |
| Lower Trace Width | W1 | 1050,000 |
| Upper Trace Width | W2 | 1050,000 |
| Ground Strip Separation | D1 | 275,0000 |
| Trace Thickness | T1 | 25,0000 |
| Coating Above Substrate | C1 | 15,0000 |
| Coating Above Trace | C2 | 15,0000 |
| Coating Dielectric | CEr | 4,0000 |

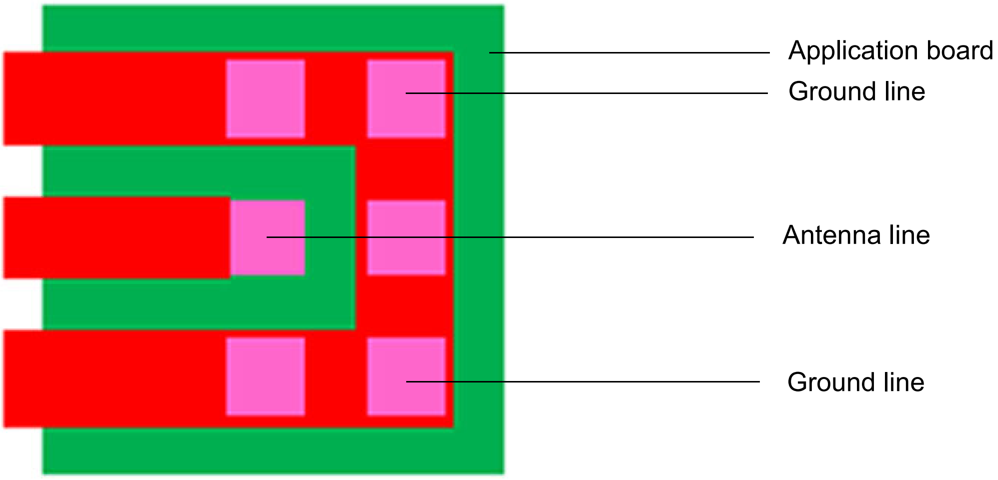
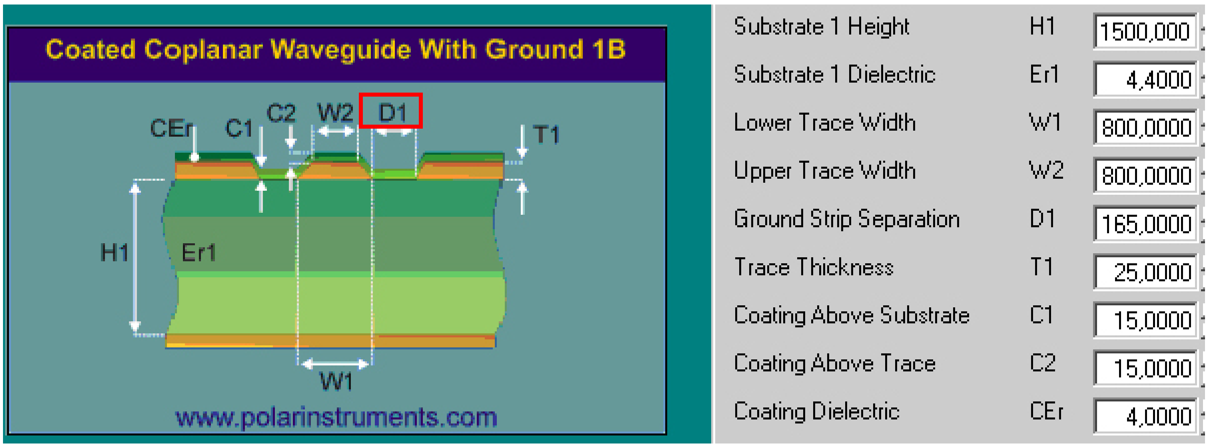


**Figure 25:** Micro-Stripline on 1.0mm Standard FR4 2-layer PCB - example 2

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



| | | |
|---|---|---|
| Substrate 1 Height | H1 | 1500,000 |
| Substrate 1 Dielectric | Er1 | 4,4000 |
| Lower Trace Width | W1 | 800,0000 |
| Upper Trace Width | W2 | 800,0000 |
| Ground Strip Separation | D1 | 165,0000 |
| Trace Thickness | T1 | 25,0000 |
| Coating Above Substrate | C1 | 15,0000 |
| Coating Above Trace | C2 | 15,0000 |
| Coating Dielectric | CEr | 4,0000 |

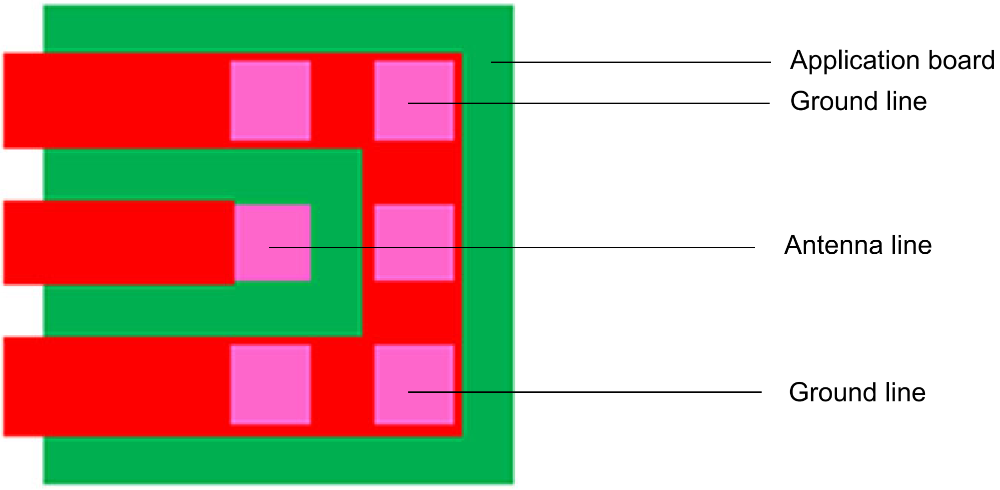
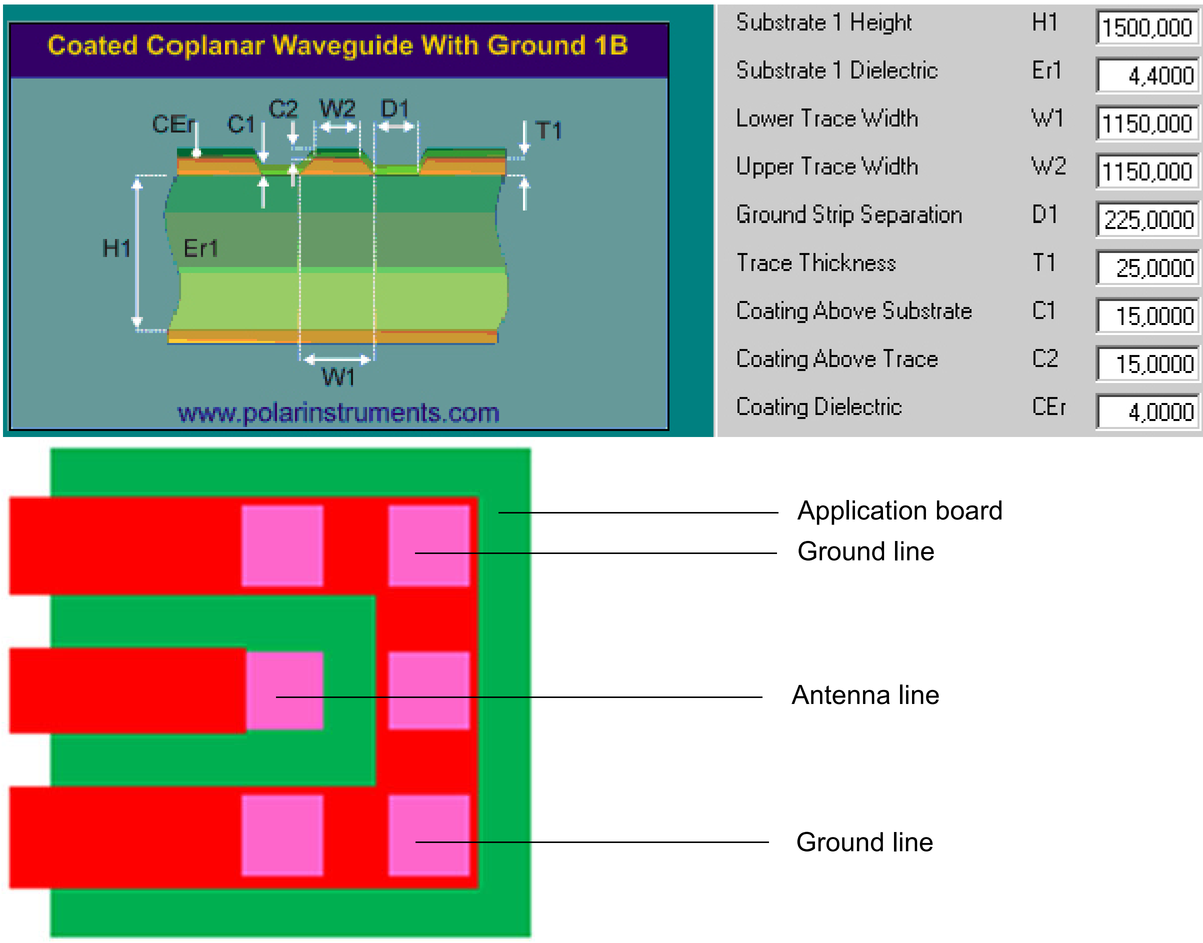


**Figure 26:** Micro-Stripline on 1.5mm Standard FR4 2-layer PCB - example 1



| | | |
|---|---|---|
| Substrate 1 Height | H1 | 1500,000 |
| Substrate 1 Dielectric | Er1 | 4,4000 |
| Lower Trace Width | W1 | 1150,000 |
| Upper Trace Width | W2 | 1150,000 |
| Ground Strip Separation | D1 | 225,0000 |
| Trace Thickness | T1 | 25,0000 |
| Coating Above Substrate | C1 | 15,0000 |
| Coating Above Trace | C2 | 15,0000 |
| Coating Dielectric | CEr | 4,0000 |

**Figure 27:** Micro-Stripline on 1.5mm Standard FR4 2-layer PCB - example 2

### 2.2.3.2 Routing Example

**Interface to RF Connector**
Figure 28 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.

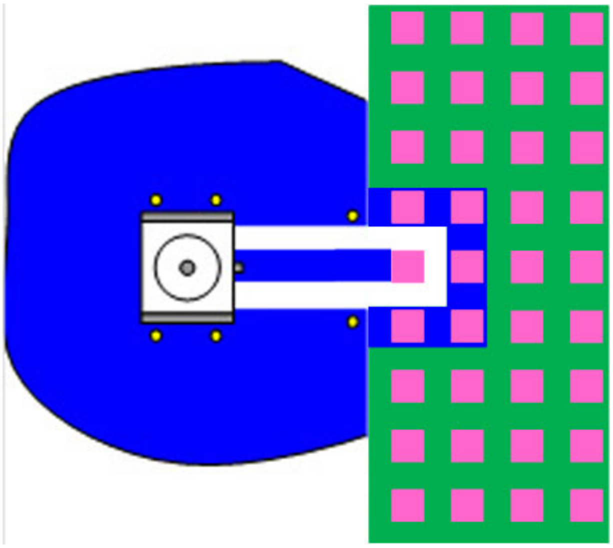


**Figure 28:** Routing to application‘s RF connector - top view

## 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 29). If a passive GNSS antenna is selected, this capacitor is optional.

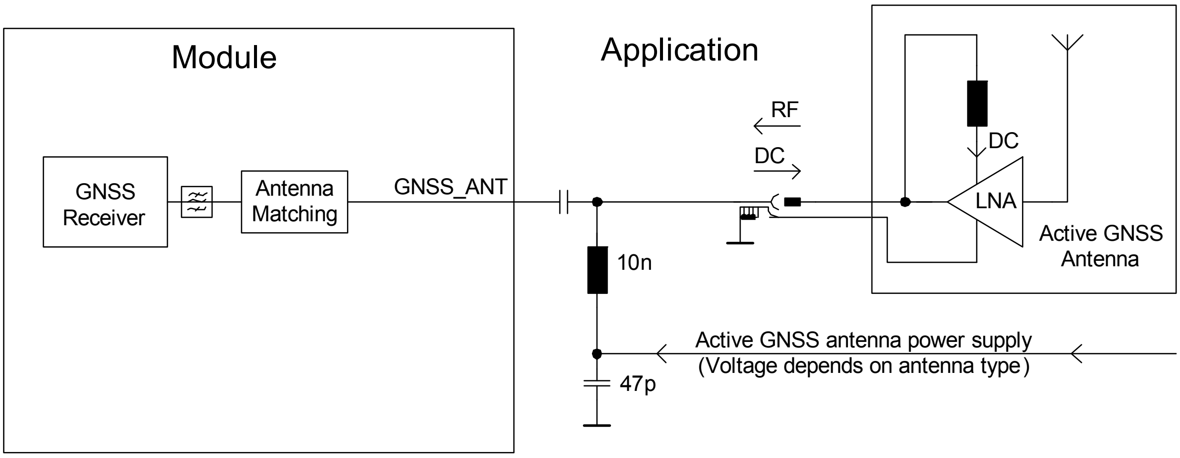


**Figure 29:** Sample supply voltage circuit for active GNSS antenna

## 2.3.3 GNSS Antenna Interface Characteristics (TBD.)

**Table 11:** 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<br>Active antenna or LNA<br>Passive antenna:<br>GPS<br>GLONASS<br>Beidou<br>Galileo | | -162 | | dBm |
| Acquisition Sensitivity | Open sky<br>Active antenna or LNA<br>Passive antenna:<br>GPS<br>GLONASS<br>Beidou<br>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 30 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.

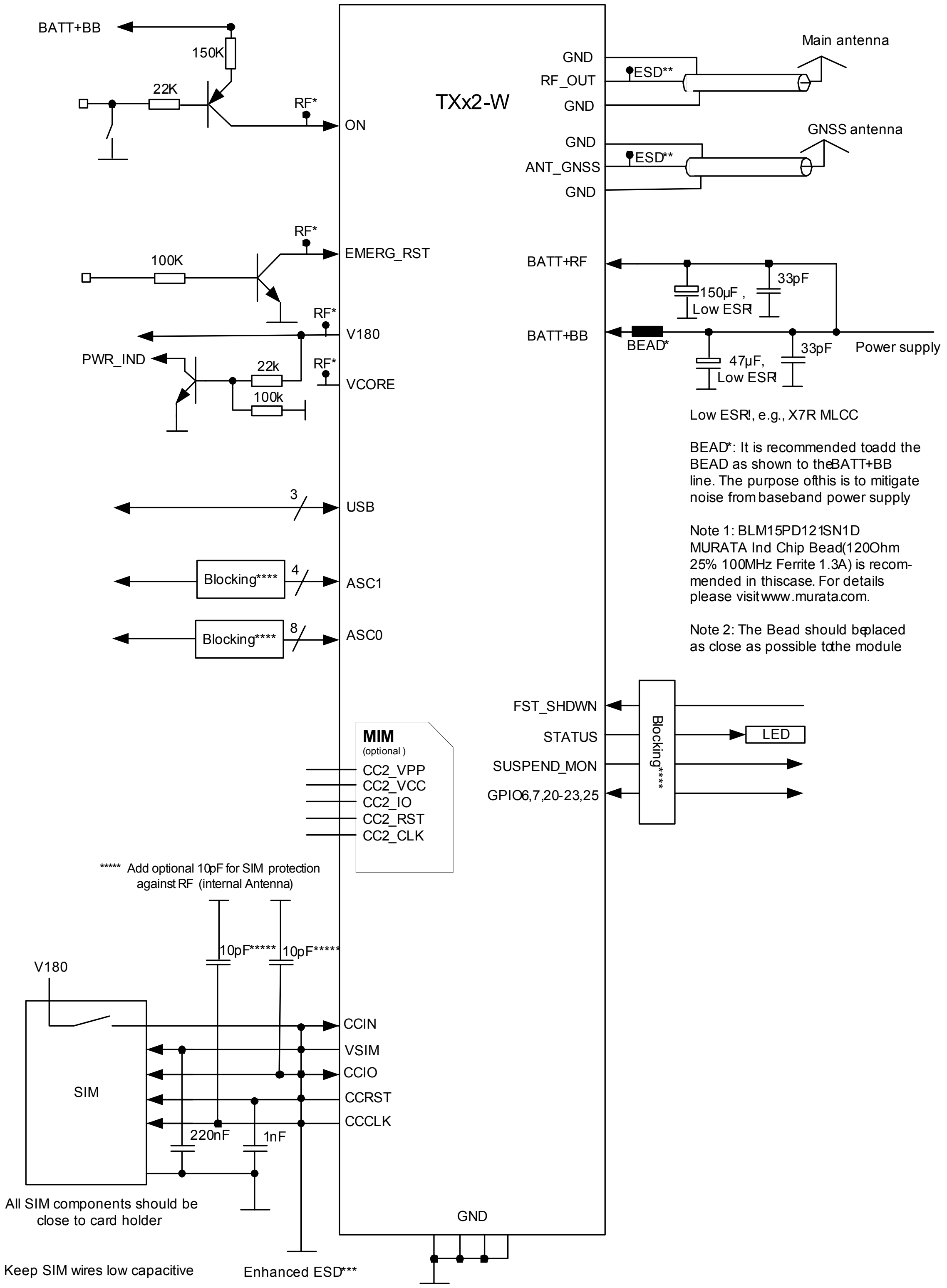
Because of the high RF field density inside the module, it cannot be guaranteed that no self interference might occur, depending on frequency and the applications grounding concept. The potential interferers may be minimized by placing small capacitors (47pF) at suspected lines (e.g. RXD0, TXD0, and 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 [4] and [5]. 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 30 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.



Low ESR!, e.g., X7R MLCC

BEAD*: It is recommended to add the BEAD as shown to the BATT+BB line. The purpose of this is to mitigate noise from baseband power supply

Note 1: BLM15PD121SN1D MURATA Ind Chip Bead(120Ohm 25% 100MHz Ferrite 1.3A) is recommended in this case. For details please visit www.murata.com.

Note 2: The Bead should be placed as close as possible to the module

***** Add optional 10pF for SIM protection against RF (internal Antenna)

All SIM components should be close to card holder

Keep SIM wires low capacitive

RF* = Optional 47pF against self-interference. See also Section 3.7 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 3.7

**Figure 30:** 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 31 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.

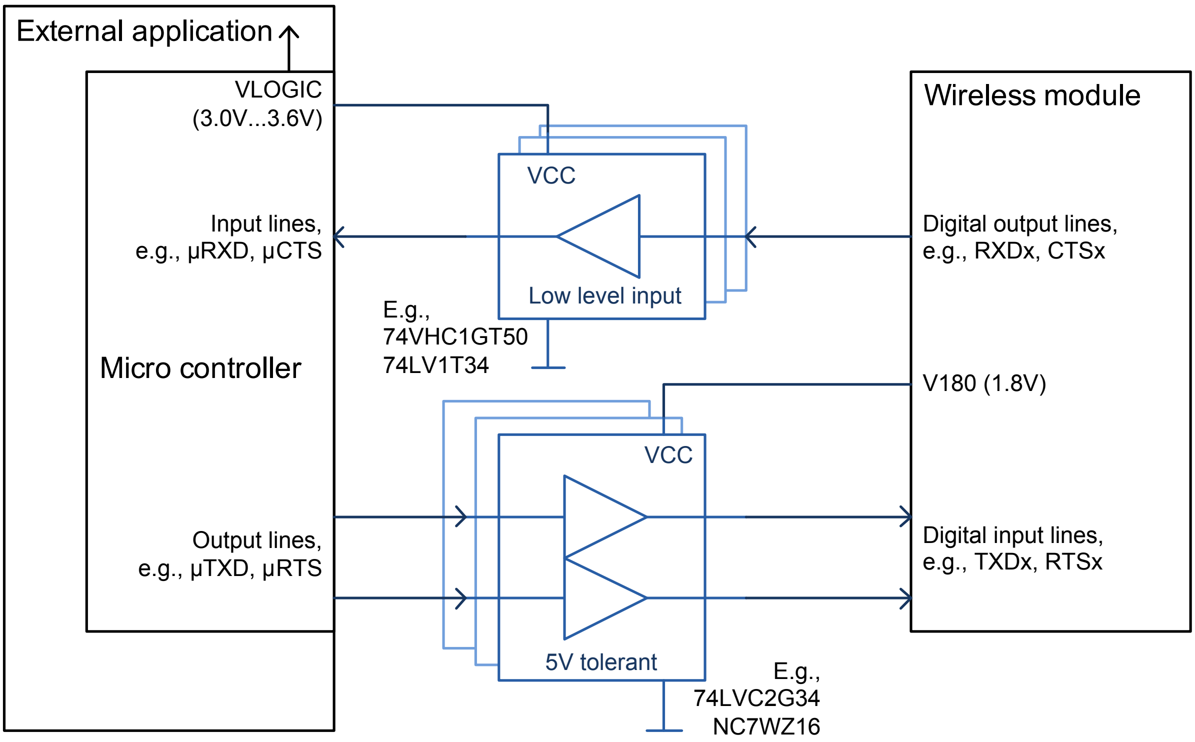


**Figure 31:** Sample level conversion circuit

# 3 Operating Characteristics

## 3.1 Operating Modes

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

**Table 12:** Overview of operating modes

| Mode | Function | |
|---|---|---|
| Normal operation | Data transfer | GSM/(E)GPRS/LTE M1 NB1/2 data transfer in progress. |
| | Idle | 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. |
| SLEEP[1] | 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.<br>SLEEP mode option can be enabled/disabled by AT command (see : AT^SCFG parameter “MEopMode/PwrSave”). | |
| SUSPEND[1] | 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.<br>The SUSPEND mode option can be enabled/disabled by AT commands (see MEopMode/PowerMgmt/Suspend”). | |
| Airplane | 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). | |
| POWER DOWN | 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. | |

[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).

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 32 and Figure 33 show the recommended power on circuit and the startup timings if ON valid.

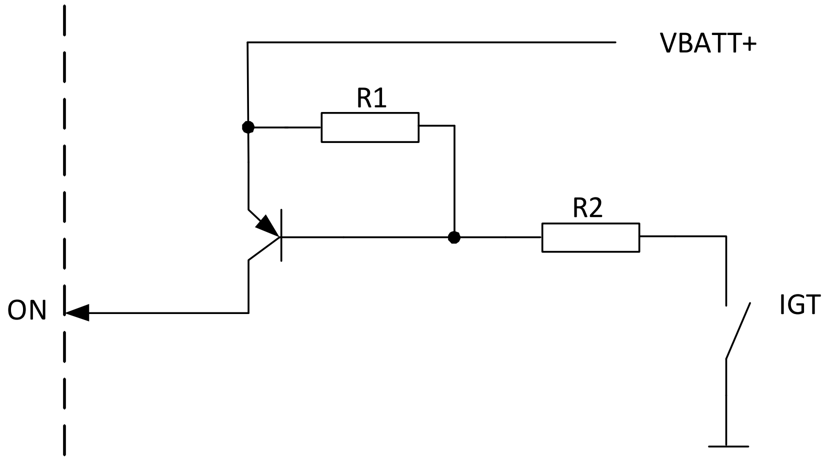


**Figure 32:** Sample ON circuit

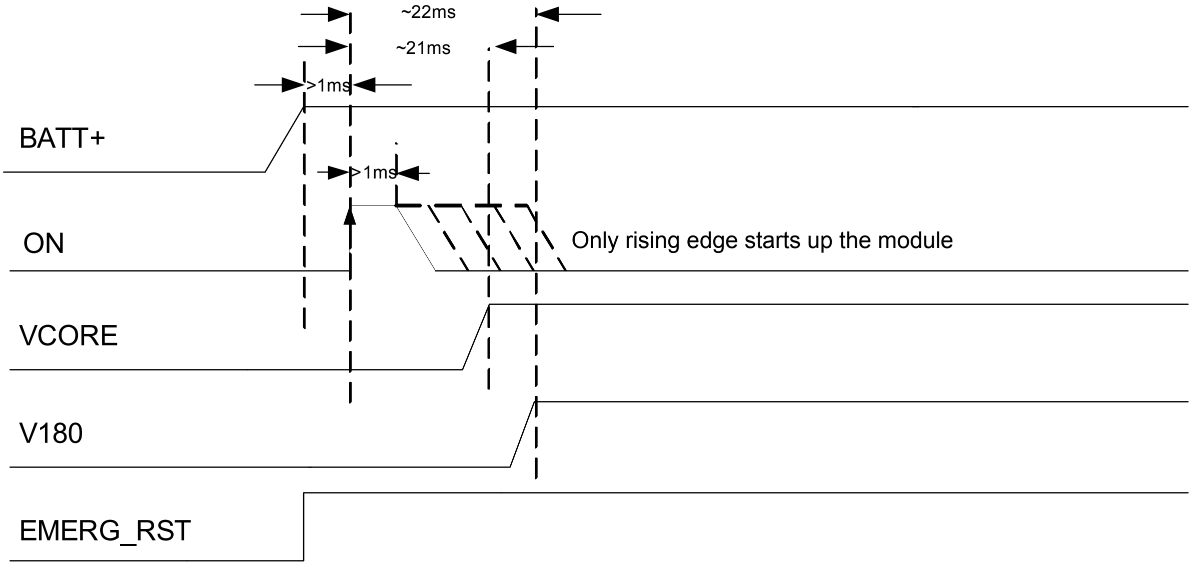


**Figure 33:** ON startup timing

## 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  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 >800ms sets the processor and all signals to their respective reset states, and thus restarts the module. 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.

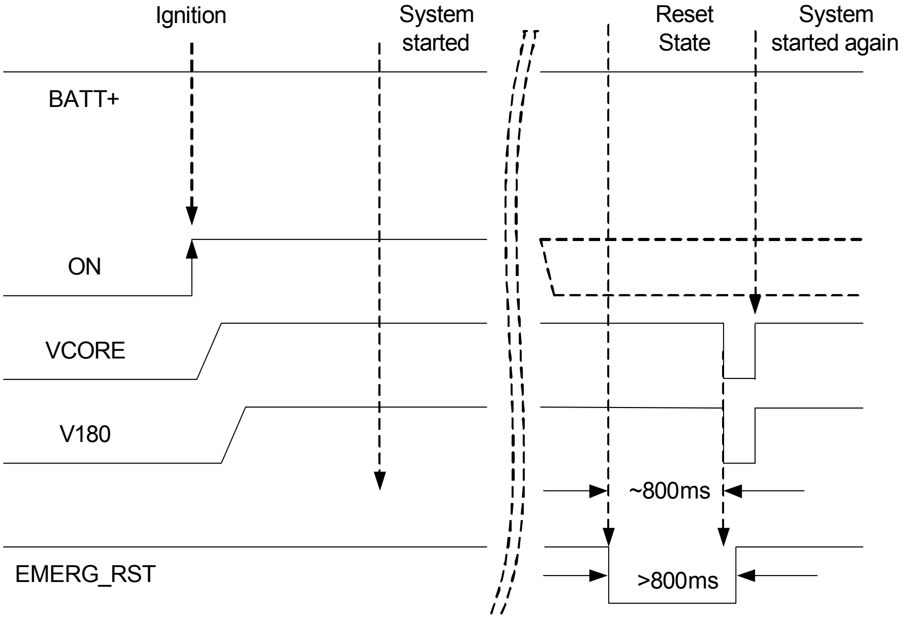


**Figure 34:** Emergency restart timing

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 13 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 13:** 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 13:

| | |
|---|---|
| L = Low level<br>H = High level<br>High-Z = High Impedance<br>I = Input | O = Output<br>OD = Open Drain<br>PD = Pull down, 55kΩ ~390kΩ<br>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 2.1.13.3.
- *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.

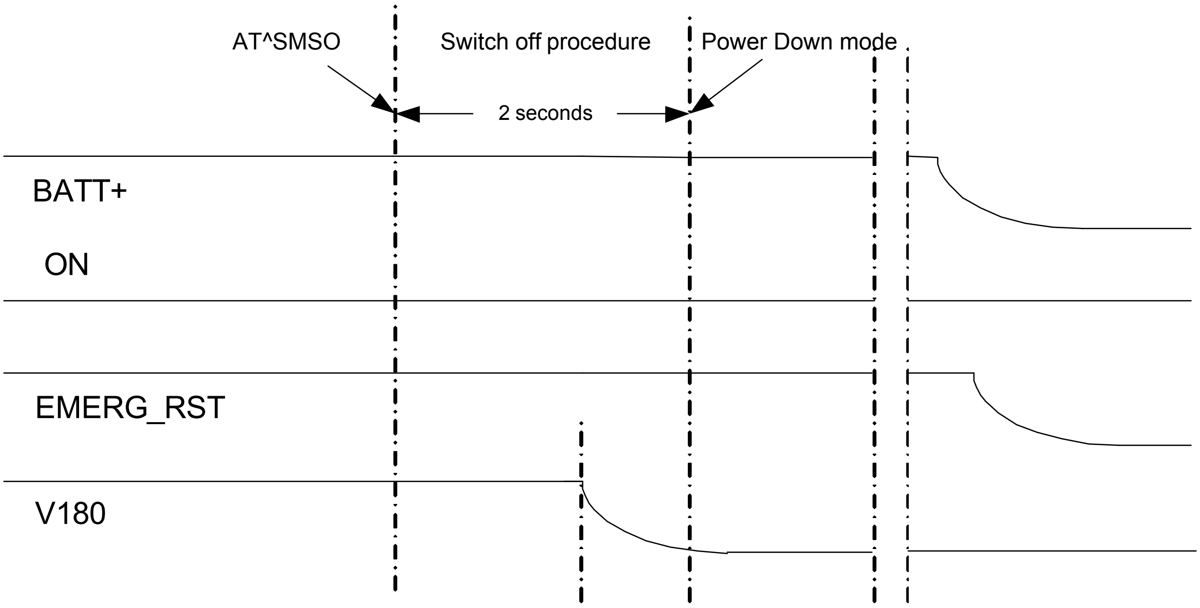


**Figure 35:** Switch off behavior

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 14 for the associated URCs.

**Table 14:** 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 15, 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 15:** 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<br>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<br>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<br>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<br>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<br>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<br>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 36 illustrates how the module transits between its operating modes including SLEEP and SUSPEND modes.

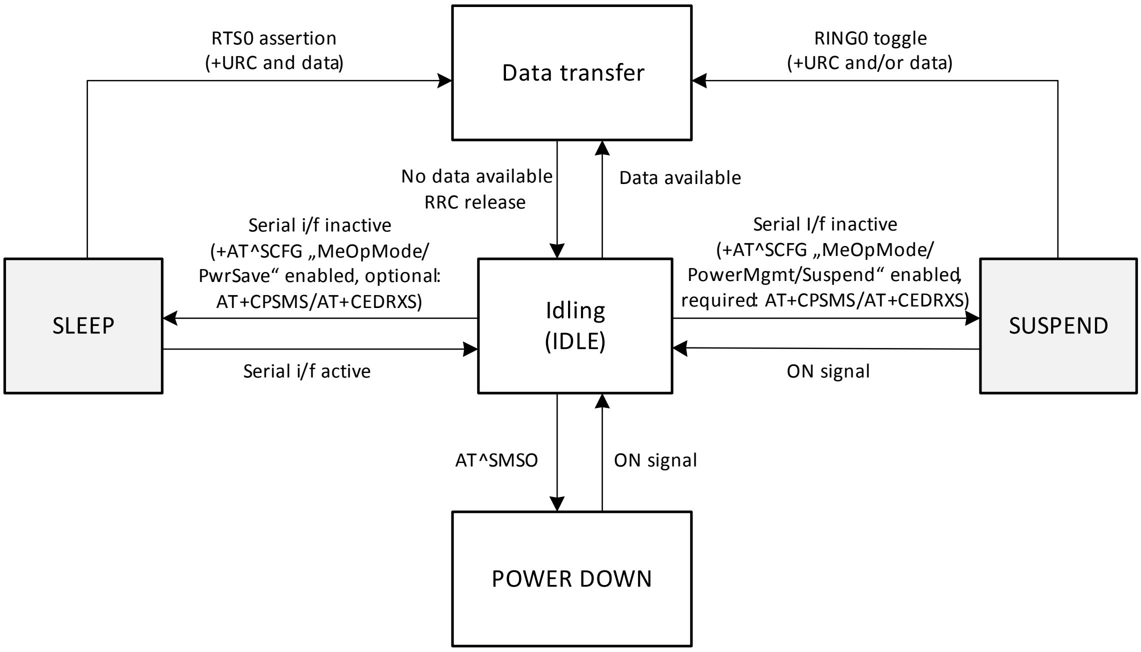


**Figure 36:** Low power modes with state transitions

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 37 shows the described RTS0 wake up mechanism.

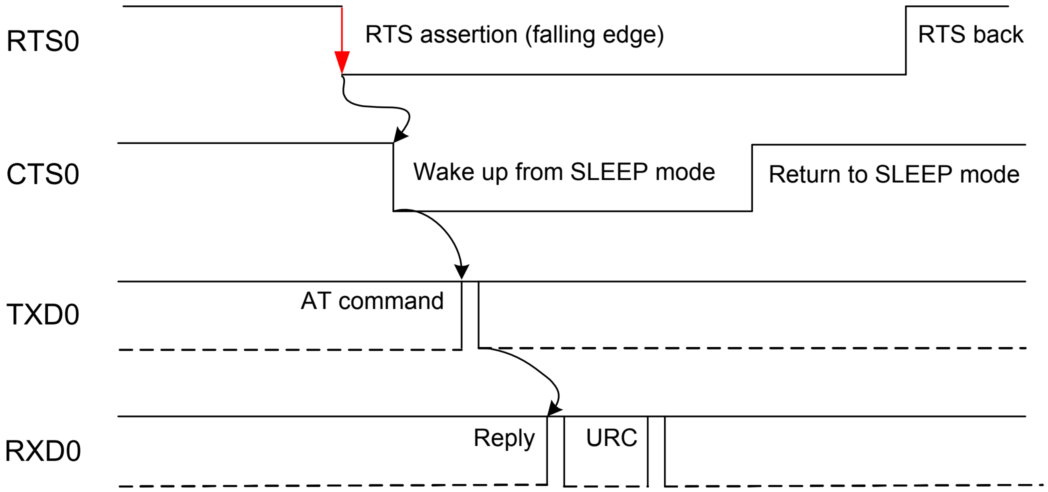


**Figure 37:** Wake-up via RTS0

### 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 2.1.13.5).

Figure 38 shows the handshake between external application, module and the network for entering SUSPEND mode or possibly SLEEP mode depending on configuration and network response.

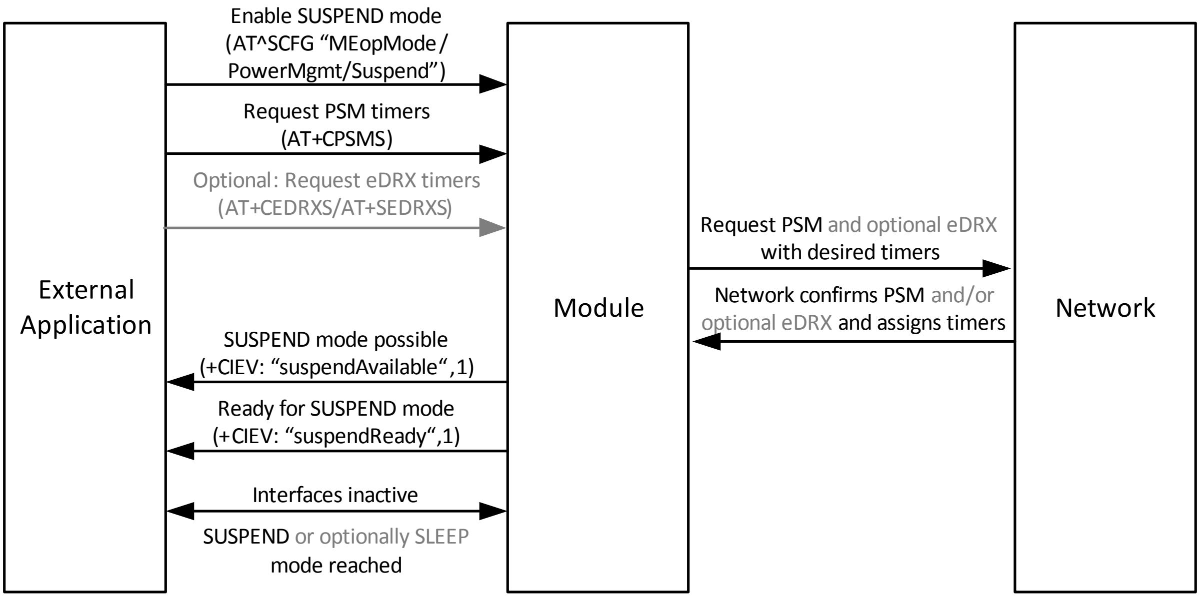


**Figure 38:** Handshake for entering the module's SUSPEND mode

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

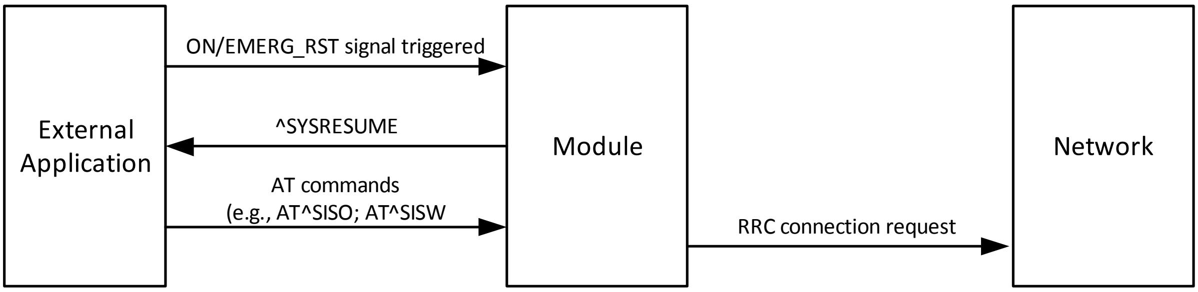


**Figure 39:** Handshake for module wake up via ON signal

Figure 40 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.

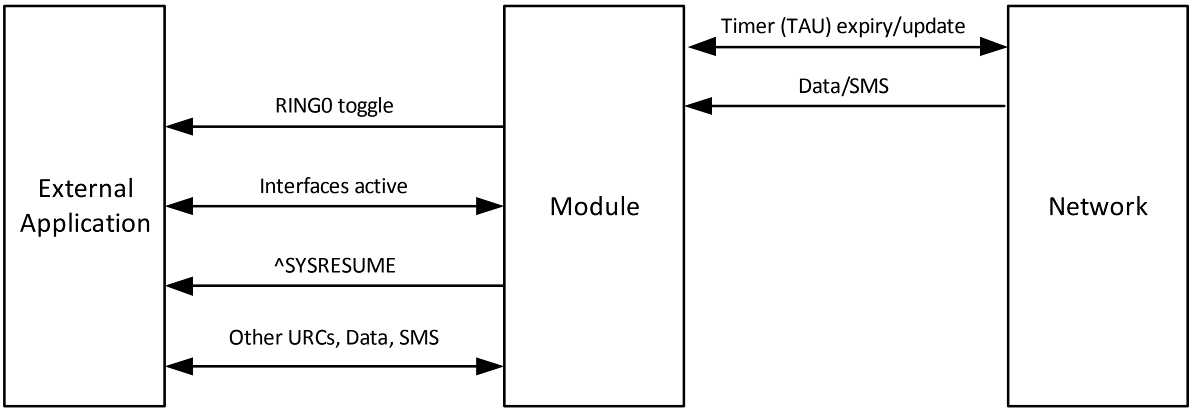


**Figure 40:** Handshake for module wake up after eDRX/PSM timer expiry

## 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 41.

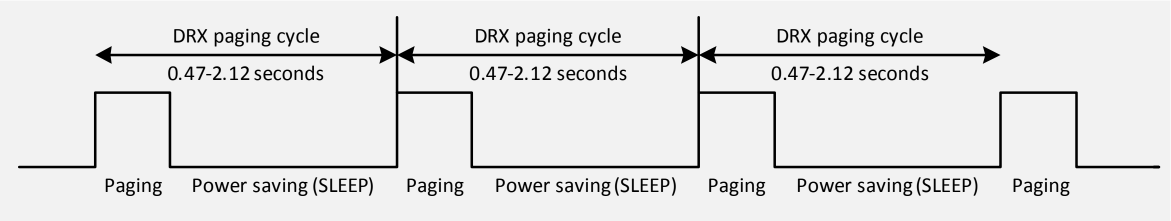


**Figure 41:** DRX based paging and power saving (SLEEP) in GSM networks

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 42.

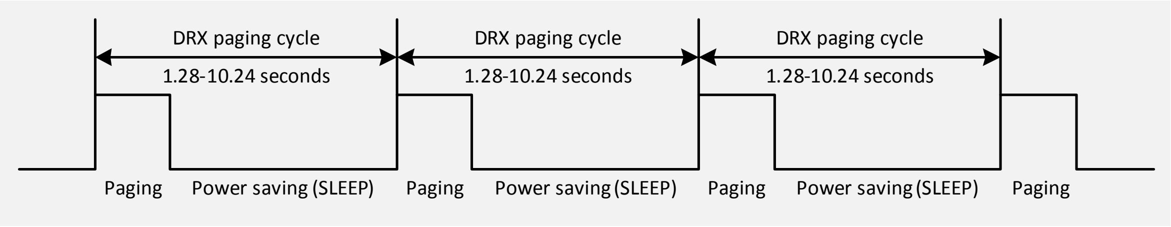


**Figure 42:** DRX based paging and power saving (SLEEP) in LTE Cat M1 and Cat NB1/2 networks

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

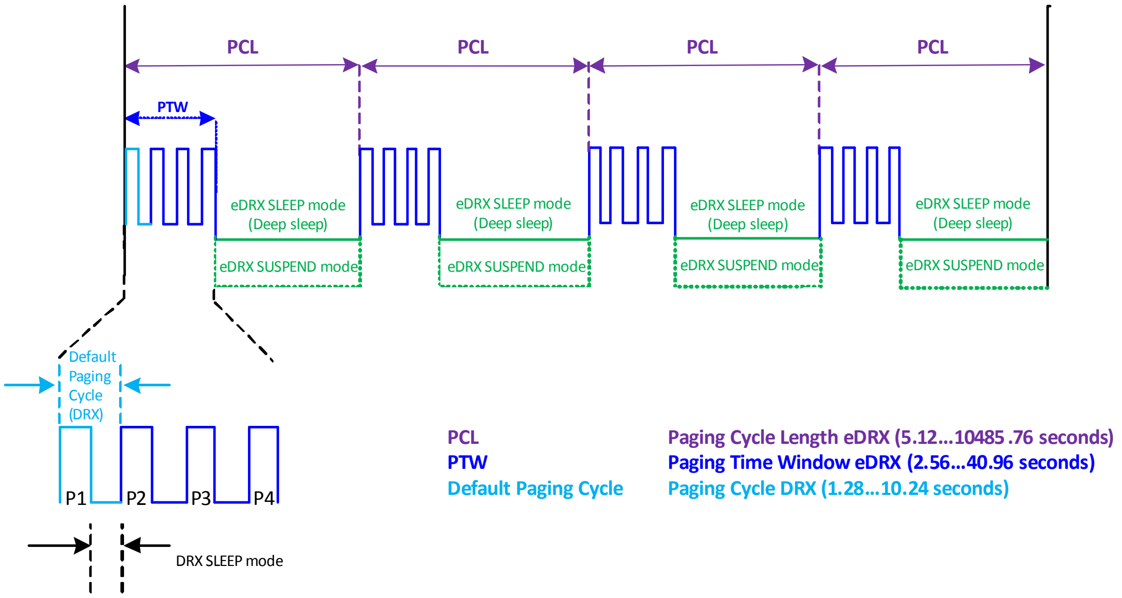


**Figure 43:** eDRX based paging and power saving in LTE Cat M1 and Cat NB1/2 networks

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 43). 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 44 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.

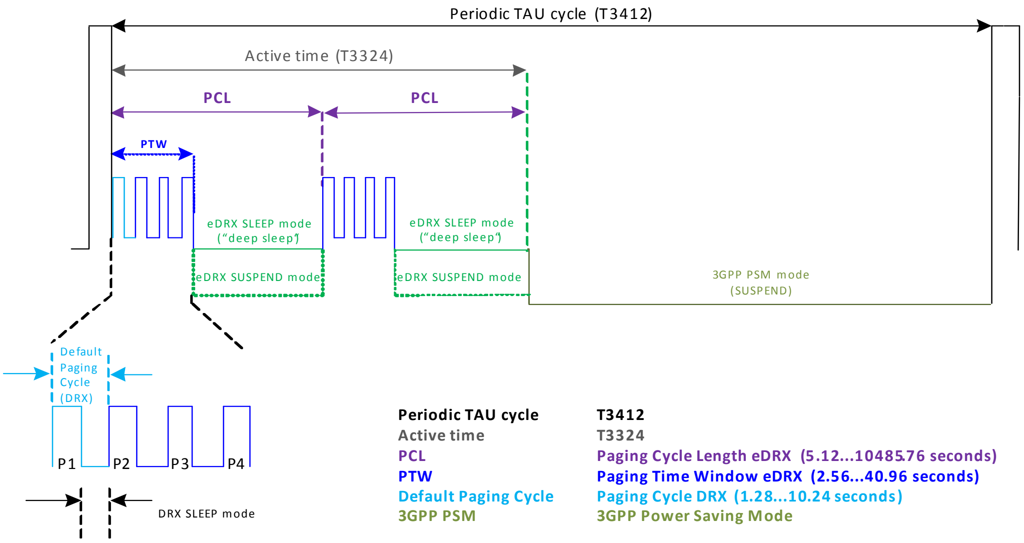


**Figure 44:** eDRX/PSM based paging and power saving in LTE Cat M1 or Cat NB1/2 networks

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 power amplifier supply. Please note that this line needs only be connected for GSM (2G/3G) availability.

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 (TBD.)

Table 16, Table 17, Table 18, and Table 19 assemble various voltage supply and current consumption ratings (GSM, Cat M1 and Cat NB1/2) of the module.

**Table 16:** 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 | 3.1 | | 4.6 | V |
| | TX82-W Supply voltage (GSM deactivated) | | 2.8 | | 4.6 | V |
| | TX62-W Supply voltage | Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes | 2.55 | | 4.8 | V |
| | TX62-W-B Supply voltage | Directly measured at Module. Voltage must stay within the min/max values, including voltage drop, ripple, spikes | 2.5 | | 4.5 | V |
| | Maximum allowed voltage drop during transmit burst | Normal condition, power control level for Pout max | | | 400 | mV |
| | Voltage ripple (TX82-W only) | Normal condition, power control level for Pout max<br>@ f <= 250 kHz<br>@ f > 250 kHz | | <br><br>70<br>20 | | <br><br>$mV_{pp}$<br>$mV_{pp}$ |

**Table 17:** Current consumption ratings General and GSM (TX82-W only)

| Description | | Conditions | | Typical rating | Unit |
|---|---|---|---|---|---|
| $I_{BATT+}$[1]<br>(i.e., sum of BATT+$_{BB}$ and BATT+$_{RF}$) | OFF State supply current | POWER DOWN | | TBD. | µA |
| | Airplane mode | UART active | | TBD. | mA |
| | | UART inactive | | TBD. | mA |
| | Boot[2] | | | TBD. | mA |
| | Cell search | No coverage[3] | UART inactive | TBD. | mA |
| | GSM Cell search | Initial cell search[4] | Fast Search | TBD. | mA |
| | | | Full Search | TBD. | mA |
| | Average GSM supply current (GNSS off) | SLEEP[5]@DRX=9 (no communication via UART) | | TBD. | mA |
| | | SLEEP[5]@DRX=5 (no communication via UART) | | TBD. | mA |
| | | SLEEP[5]@DRX=2 (no communication via UART) | | TBD. | mA |
| | | GPRS Data transfer GSM850; PCL=5,1Tx/4RX | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM850; PCL=5; 1Tx/4Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM850; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM900; PCL=5,1Tx/4RX | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM900; PCL=5; 1Tx/4Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |

**Table 17:** Current consumption ratings General and GSM (TX82-W only)

| Description | | Conditions | | Typical rating | Unit |
|---|---|---|---|---|---|
| $I_{BATT+}$[1]<br>(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) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM1800; PCL=5,1Tx/4RX | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM1800; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM1800; PCL=5; 1Tx/4Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM1800; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM1900; PCL=5,1Tx/4RX | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | GPRS Data transfer GSM1900; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM1900; PCL=5; 1Tx/4Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | | EDGE Data transfer GSM1900; PCL=5; 2Tx/3Rx | ROPR=8 (max. reduction) | TBD. | mA |
| | | | ROPR=4 (no reduction) | TBD. | mA |
| | Peak current during GSM transmit burst @ 3.8V | GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx | | TBD. | A |
| | | GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx | | TBD. | A |
| | | GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx | | TBD. | A |
| | | GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx | | TBD. | A |

**Table 17:** Current consumption ratings General and GSM (TX82-W only)

| Description | | Conditions | Typical rating | Unit |
|---|---|---|---|---|
| $I_{BATT+}$[1]<br>(i.e., sum of $BATT+_{BB}$ and $BATT+_{RF}$) | Peak current during GSM transmit burst @ 3.1V | GPRS Data transfer GSM850; PCL=5; 2Tx/3Rx | TBD. | A |
| | | GPRS Data transfer GSM900; PCL=5; 2Tx/3Rx | TBD. | A |
| | | GPRS Data transfer GSM1800; PCL=0; 2Tx/3Rx | TBD. | A |
| | | GPRS Data transfer GSM1900; PCL=0; 2Tx/3Rx | TBD. | A |
| | Average GSM IDLE supply current (GNSS on) | GPRS active (UART active) @ DRX=2<br>GNSS NMEA output off | TBD. | mA |
| | | GPRS active (UART active) @ DRX=2<br>GNSS NMEA output on | TBD. | mA |

1. With an impedance of $Z_{LOAD}$=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. The boot procedure from ON pin pulse to ^SYSSTART URC.
3. No network coverage, SLEEP mode, measured 3 minutes after power on for 10 minutes.
4. The procedure from activation of full functionality (AT+CFUN=1) to registered state on the network,
   Full Search: without assigned frequency band.
   Fast Search: with assigned frequency band
5. 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

**Table 18:** Current consumption typical ratings Cat M1

| **Description** | | **Conditions** | | | **TX62-W** | **TX62-W-B** | **TX82-W** | **Unit** |
|---|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE Cat M1 supply current | Cat M1 Cell search | Initial cell search[2] | Fast Search | TBD. | TBD. | TBD. | mA |
| | | | | Full Search | TBD. | TBD. | TBD. | mA |
| | | SUSPEND (PSM) | 3GPP Power saving mode | | TBD. | TBD. | TBD. | uA |
| | | RRC idle (SLEEP)[3] | DRX =256 | | TBD. | TBD. | TBD. | mA |
| | | | DRX =128 | | TBD. | TBD. | TBD. | mA |
| | | | DRX =64 | | TBD. | TBD. | TBD. | mA |
| | | | 20,48s eDRX | 3,84s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 81,92s eDRX | 2,56s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 163,84s eDRX | 3,84s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 163,84s eDRX | 10,24s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | Connected DRX[4] | Short C-DRX | | TBD. | TBD. | TBD. | mA |
| | | | Long C-DRX | | TBD. | TBD. | TBD. | mA |

**Table 18:** Current consumption typical ratings Cat M1

| Description | | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE Cat M1 supply current | RRC connected Active Transmission[4]<br>TX62-W-B only | Band1, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3 , 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4 , 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band27, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 23dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 23dBm | TBD. | TBD. | TBD. | mA |
| | | RRC connected Active Transmission[4] | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3 , 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4 , 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band27, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |

**Table 18:** Current consumption typical ratings Cat M1

| Description | | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE Cat M1 supply current | RRC connected Active Transmission[4] | Band1, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band27, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 0dBm | TBD. | TBD. | TBD. | mA |
| | Peak Current @ RRC connected Active Transmission[4]<br>Vbatt = 3.8V<br>TX62-W-B only | | Band1, 23dBm | | TBD. | - | mA |
| | | | Band2, 23dBm | | TBD. | - | mA |
| | | | Band3 , 23dBm | | TBD. | - | mA |
| | | | Band4 , 23dBm | | TBD. | - | mA |
| | | | Band5, 23dBm | | TBD. | - | mA |
| | | | Band8, 23dBm | | TBD. | - | mA |
| | | | Band12, 23dBm | | TBD. | - | mA |
| | | | Band13, 23dBm | | TBD. | - | mA |
| | | | Band18, 23dBm | | TBD. | - | mA |
| | | | Band19, 23dBm | | TBD. | - | mA |
| | | | Band20, 23dBm | | TBD. | - | mA |
| | | | Band25, 23dBm | | TBD. | - | mA |
| | | | Band26, 23dBm | | TBD. | - | mA |
| | | | Band27, 23dBm | | TBD. | - | mA |
| | | | Band28, 23dBm | | TBD. | - | mA |
| | | | Band66, 23dBm | | TBD. | - | mA |
| | | | Band85, 23dBm | | TBD. | - | mA |

**Table 18:** Current consumption typical ratings Cat M1

| Description | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|
| $I_{BATT+BB1}$ | Peak Current @ RRC connected Active Transmission[4]<br>Vbatt = 3.8V | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band3 , 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band4 , 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band27, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | Peak Current @ RRC connected Active Transmission[4]<br>Vbatt = 2.55V<br>TX62-W-B only | Band1, 23dBm | | TBD. | - | mA |
| | | Band2, 23dBm | | TBD. | - | mA |
| | | Band3, 23dBm | | TBD. | - | mA |
| | | Band4, 23dBm | | TBD. | - | mA |
| | | Band5, 23dBm | | TBD. | - | mA |
| | | Band8, 23dBm | | TBD. | - | mA |
| | | Band12, 23dBm | | TBD. | - | mA |
| | | Band13, 23dBm | | TBD. | - | mA |
| | | Band18, 23dBm | | TBD. | - | mA |
| | | Band19, 23dBm | | TBD. | - | mA |
| | | Band20, 23dBm | | TBD. | - | mA |
| | | Band25, 23dBm | | TBD. | - | mA |
| | | Band26, 23dBm | | TBD. | - | mA |
| | | Band27, 23dBm | | TBD. | - | mA |
| | | Band28, 23dBm | | TBD. | - | mA |
| | | Band66, 23dBm | | TBD. | - | mA |
| | | Band85, 23dBm | | TBD. | - | mA |

**Table 18:** Current consumption typical ratings Cat M1

| Description | | Conditions | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Peak Current @ RRC connected Active Transmission[4]<br>Vbatt = 2.55V | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band27, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | Average IDLE supply current<br>(GNSS on) | Cat M1 active (UART active) @ DRX=128<br>GNSS NMEA output off | TBD. | TBD. | TBD. | mA |
| | | Cat M1 active (UART active) @ DRX=128<br>GNSS NMEA output on | TBD. | TBD. | TBD. | mA |

1. With an impedance of $Z_{LOAD}$=50Ω at the antenna connector, Measured at 25°C at 3.8V.
2. The procedure from activation of full functionality (AT+CFUN=1) to registered state on the network,
   Full Search: without assigned frequency band.
   Fast Search: with assigned frequency band
3. Measurements start 6 minutes after switching ON the module,
   Averaging times:
   PSM 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), PSM mode is enabled via AT command
4. Communication tester settings:
   Cat M1 Channel Bandwidth: 5MHz
   Modulation: QPSK.
   RB setting: 4 UL RBs, 6 DL RBs, Half Duplex

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | | Conditions | | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE NB1/2 supply current | NB1/2 cell search | Initial cell search[2] | Fast Search | TBD. | TBD. | TBD. | mA |
| | | | | Full Search | TBD. | TBD. | TBD. | mA |
| | | SUSPEND (PSM) | 3GPP Power saving mode | | TBD. | TBD. | TBD. | uA |
| | | RRC idle (SLEEP)[3] | DRX =1024 | | TBD. | TBD. | TBD. | mA |
| | | | DRX =512 | | TBD. | TBD. | TBD. | mA |
| | | | DRX =256 | | TBD. | TBD. | TBD. | mA |
| | | | DRX =128 | | TBD. | TBD. | TBD. | mA |
| | | | 20,48s eDRX | 3,84s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 81,92s eDRX | 2,56s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 163,84s eDRX | 3,84s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | | 163,84s eDRX | 10,24s paging window (DRX = 1,28s) | TBD. | TBD. | TBD. | mA |
| | | RRC connected Active Transmission DL RMC[4]<br>TX62-W-B only | Band1, 23dBm | | | TBD. | - | mA |
| | | | Band2, 23dBm | | | TBD. | - | mA |
| | | | Band3, 23dBm | | | TBD. | - | mA |
| | | | Band4, 23dBm | | | TBD. | - | mA |
| | | | Band5, 23dBm | | | TBD. | - | mA |
| | | | Band8, 23dBm | | | TBD. | - | mA |
| | | | Band12, 23dBm | | | TBD. | - | mA |
| | | | Band13, 23dBm | | | TBD. | - | mA |
| | | | Band18, 23dBm | | | TBD. | - | mA |
| | | | Band19, 23dBm | | | TBD. | - | mA |
| | | | Band20, 23dBm | | | TBD. | - | mA |
| | | | Band25, 23dBm | | | TBD. | - | mA |
| | | | Band26, 23dBm | | | TBD. | - | mA |
| | | | Band28, 23dBm | | | TBD. | - | mA |
| | | | Band66, 23dBm | | | TBD. | - | mA |
| | | | Band71, 23dBm | | | TBD. | - | mA |
| | | | Band85, 23dBm | | | TBD. | - | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE NB1/2 supply current | RRC connected Active Transmission DL RMC[4] | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band71, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band1, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band71, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 0dBm | TBD. | TBD. | TBD. | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE NB1/2 supply current | RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4]<br>TX62-W-B only | Band1, 23dBm | | TBD. | - | mA |
| | | | Band2, 23dBm | | TBD. | - | mA |
| | | | Band3, 23dBm | | TBD. | - | mA |
| | | | Band4, 23dBm | | TBD. | - | mA |
| | | | Band5, 23dBm | | TBD. | - | mA |
| | | | Band8, 23dBm | | TBD. | - | mA |
| | | | Band12, 23dBm | | TBD. | - | mA |
| | | | Band13, 23dBm | | TBD. | - | mA |
| | | | Band18, 23dBm | | TBD. | - | mA |
| | | | Band19, 23dBm | | TBD. | - | mA |
| | | | Band20, 23dBm | | TBD. | - | mA |
| | | | Band25, 23dBm | | TBD. | - | mA |
| | | | Band26, 23dBm | | TBD. | - | mA |
| | | | Band28, 23dBm | | TBD. | - | mA |
| | | | Band66, 23dBm | | TBD. | - | mA |
| | | | Band71, 23dBm | | TBD. | - | mA |
| | | | Band85, 23dBm | | TBD. | - | mA |
| | | RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4] | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band71, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| **Description** | | **Conditions** | | **TX62-W** | **TX62-W-B** | **TX82-W** | **Unit** |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE NB1/2 supply current | RRC connected Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4] | Band1, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band71, 0dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 0dBm | TBD. | TBD. | TBD. | mA |
| | | RRC connected Active Transmission UL RMC, multi- tone mode (12 subcarrier),15KHz spacing[4]<br>TX62-W-B only | Band1, 23dBm | | TBD. | - | mA |
| | | | Band2, 23dBm | | TBD. | - | mA |
| | | | Band3, 23dBm | | TBD. | - | mA |
| | | | Band4, 23dBm | | TBD. | - | mA |
| | | | Band5, 23dBm | | TBD. | - | mA |
| | | | Band8, 23dBm | | TBD. | - | mA |
| | | | Band12, 23dBm | | TBD. | - | mA |
| | | | Band13, 23dBm | | TBD. | - | mA |
| | | | Band18, 23dBm | | TBD. | - | mA |
| | | | Band19, 23dBm | | TBD. | - | mA |
| | | | Band20, 23dBm | | TBD. | - | mA |
| | | | Band25, 23dBm | | TBD. | - | mA |
| | | | Band26, 23dBm | | TBD. | - | mA |
| | | | Band28, 23dBm | | TBD. | - | mA |
| | | | Band66, 23dBm | | TBD. | - | mA |
| | | | Band71, 23dBm | | TBD. | - | mA |
| | | | Band85, 23dBm | | TBD. | - | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Average LTE NB1/2 supply current | RRC connected Active Transmission UL RMC, multi- tone mode (12 subcarrier),15KHz spacing[4] | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band71, 20dBm | TBD. | TBD. | TBD. | mA |
| | | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | Peak Current @ RRC connected<br>Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4]<br>Vbatt = 3.8V<br>TX62-W-B only | | Band1, 23dBm | | TBD. | - | mA |
| | | | Band2, 23dBm | | TBD. | - | mA |
| | | | Band3, 23dBm | | TBD. | - | mA |
| | | | Band4, 23dBm | | TBD. | - | mA |
| | | | Band5, 23dBm | | TBD. | - | mA |
| | | | Band8, 23dBm | | TBD. | - | mA |
| | | | Band12, 23dBm | | TBD. | - | mA |
| | | | Band13, 23dBm | | TBD. | - | mA |
| | | | Band18, 23dBm | | TBD. | - | mA |
| | | | Band19, 23dBm | | TBD. | - | mA |
| | | | Band20, 23dBm | | TBD. | - | mA |
| | | | Band25, 23dBm | | TBD. | - | mA |
| | | | Band26, 23dBm | | TBD. | - | mA |
| | | | Band28, 23dBm | | TBD. | - | mA |
| | | | Band66, 23dBm | | TBD. | - | mA |
| | | | Band71, 23dBm | | TBD. | - | mA |
| | | | Band85, 23dBm | | TBD. | - | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Peak Current @ RRC connected<br>Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4]<br>Vbatt = 3.8V | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band71, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | Peak Current @ RRC connected<br>Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4]<br>Vbatt = 3.0V<br><br>TX62-W-B only | Band1, 23dBm | | TBD. | - | mA |
| | | Band2, 23dBm | | TBD. | - | mA |
| | | Band3, 23dBm | | TBD. | - | mA |
| | | Band4, 23dBm | | TBD. | - | mA |
| | | Band5, 23dBm | | TBD. | - | mA |
| | | Band8, 23dBm | | TBD. | - | mA |
| | | Band12, 23dBm | | TBD. | - | mA |
| | | Band13, 23dBm | | TBD. | - | mA |
| | | Band18, 23dBm | | TBD. | - | mA |
| | | Band19, 23dBm | | TBD. | - | mA |
| | | Band20, 23dBm | | TBD. | - | mA |
| | | Band25, 23dBm | | TBD. | - | mA |
| | | Band26, 23dBm | | TBD. | - | mA |
| | | Band28, 23dBm | | TBD. | - | mA |
| | | Band66, 23dBm | | TBD. | - | mA |
| | | Band71, 23dBm | | TBD. | - | mA |
| | | Band85, 23dBm | | TBD. | - | mA |

**Table 19:** Current consumption typical ratings Cat NB1/2

| Description | Conditions | | TX62-W | TX62-W-B | TX82-W | Unit |
|---|---|---|---|---|---|---|
| $I_{BATT+BB}$[1] | Peak Current @ RRC connected<br>Active Transmission UL RMC, single tone mode (1subcarrier),15KHz spacing[4]<br>Vbatt = 3.0V | Band1, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band2, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band3, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band4, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band5, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band8, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band12, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band13, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band18, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band19, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band20, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band25, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band26, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band28, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band66, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band71, 20dBm | TBD. | TBD. | TBD. | mA |
| | | Band85, 20dBm | TBD. | TBD. | TBD. | mA |
| | Average IDLE supply current<br>(GNSS on) | NB1/2 active (UART active) @ DRX=128<br>GNSS NMEA output off | TBD. | TBD. | TBD. | mA |
| | | NB1/2 active (UART active) @ DRX=128<br>GNSS NMEA output on | TBD. | TBD. | TBD. | mA |

1. With an impedance of $Z_{LOAD}=50\Omega$ at the antenna connector, Measured at 25°C at 3.8V.
2. The procedure from activation of full functionality (AT+CFUN=1) to registered state on the network,
   Full Search: without assigned frequency band.
   Fast Search: with assigned frequency band
3. Measurements start 6 minutes after switching ON the module,
   Averaging times:
   PSM 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), PSM mode is enabled via AT command
4. Communication tester settings:
   Cat NB1/2 Channel Bandwidth: 5MHz
   Modulation: BPSK for 1 sub-carrier mode, QPSK for multi-sub-carrier mode.

### 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).

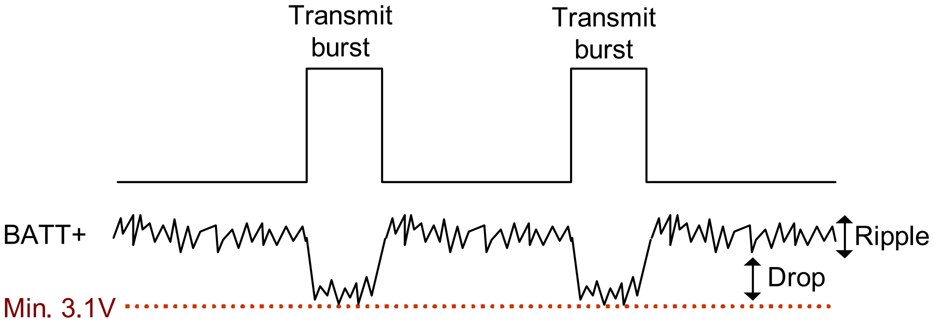


**Figure 45:** Power supply limits during transmit burst

### 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 46.

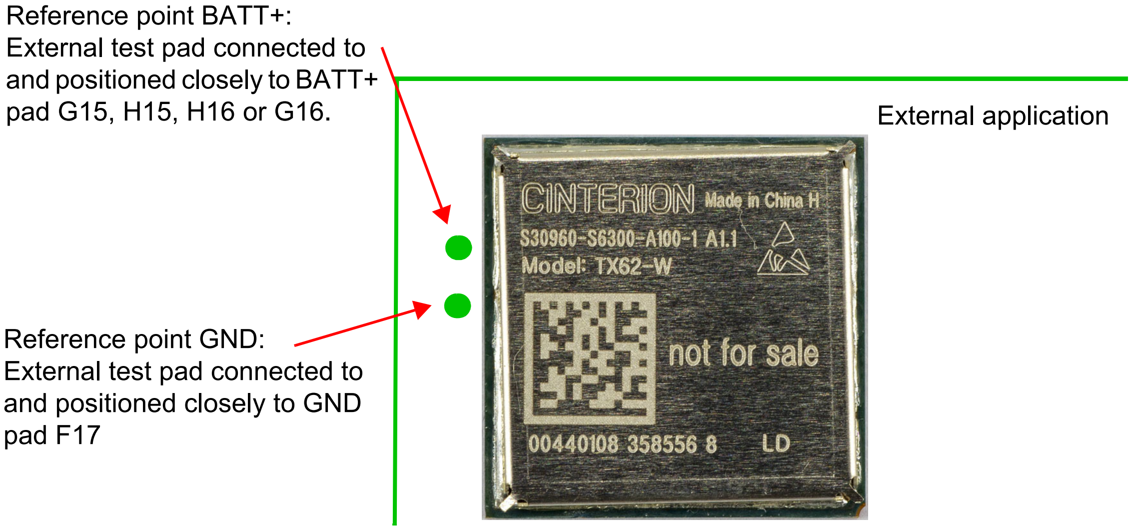


**Figure 46:** Position of reference points BATT+ and GND

### 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 20:** Board temperature

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Normal operation | -30 | | +85 | °C |
| Extended operation[1] | -40 | | +90 | °C |
| Automatic shutdown[2]<br>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 21 lists the ambient temperature ranges the TX62/TX82 is able to operate in.

**Table 21:** 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 30). Electrostatic values can be gathered from the following table.

**Table 22:** 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 47 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).

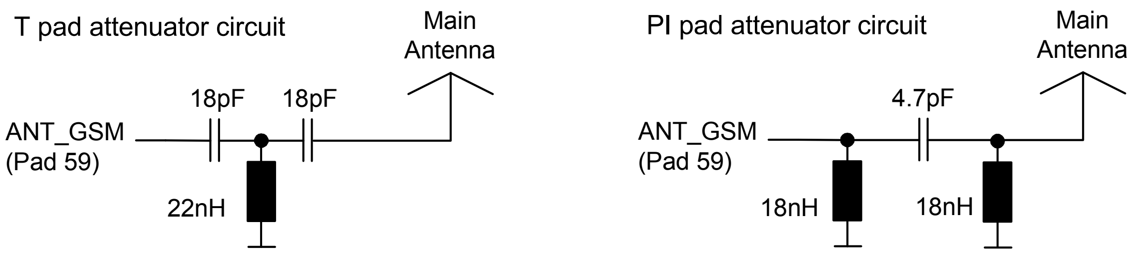


**Figure 47:** ESD protection for RF antenna interface

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 48 and Table 23). 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.

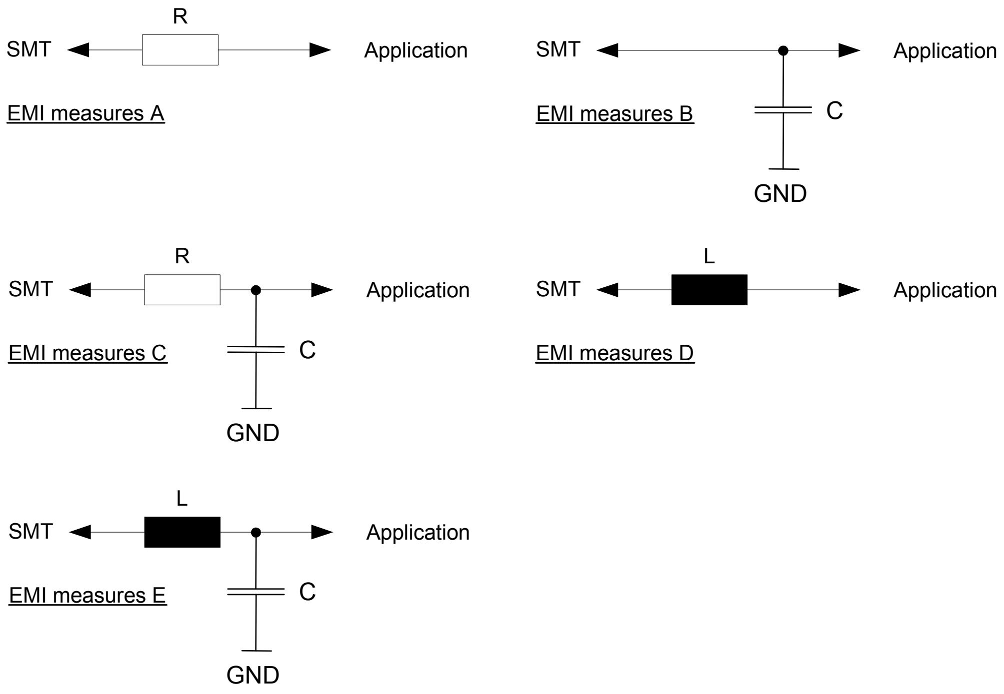


**Figure 48:** EMI circuits

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 23:** 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 -<br>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 24:** Summary of reliability test conditions

| Type of test | Conditions | Standard |
|---|---|---|
| Vibration | Frequency range: 10-20Hz; acceleration: 5g<br>Frequency range: 20-500Hz; acceleration: 20g<br>Duration: 20h per axis; 3 axes | DIN IEC 60068-2-6[1] |
| Shock half-sinus | Acceleration: 500g<br>Shock duration: 1ms<br>1 shock per axis<br>6 positions (± x, y and z) | DIN IEC 60068-2-27 |
| Dry heat | Temperature: +70 ±2°C<br>Test duration: 16h<br>Humidity in the test chamber: < 50% | EN 60068-2-2 Bb<br>ETS 300 019-2-7 |
| Temperature change (shock) | Low temperature: -40°C ±2°C<br>High temperature: +85°C ±2°C<br>Changeover time: < 30s (dual chamber system)<br>Test duration: 1h<br>Number of repetitions: 100 | DIN IEC 60068-2-14 Na<br>ETS 300 019-2-7 |
| Damp heat cyclic | High temperature: +55°C ±2°C<br>Low temperature: +25°C ±2°C<br>Humidity: 93% ±3%<br>Number of repetitions: 6<br>Test duration: 12h + 12h | DIN IEC 60068-2-30 Db<br>ETS 300 019-2-5 |
| Cold (constant exposure) | Temperature: -40 ±2°C<br>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 49 shows the top and bottom view of TX62-W and provides an overview of the board's mechanical dimensions. For further details see Figure 50. Figure 51 shows the area at the module's bottom side where possible markings might be printed.

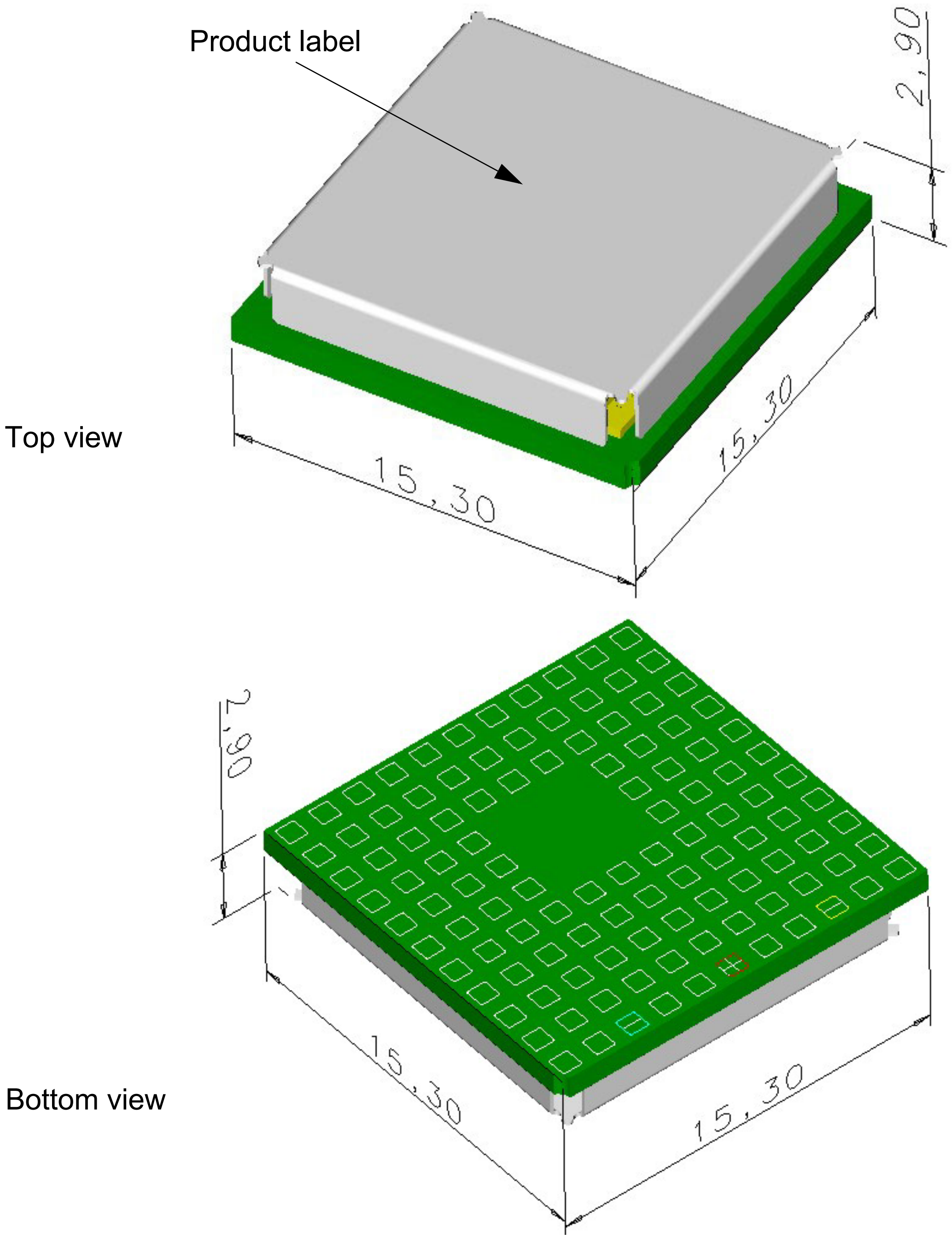


**Figure 49:** TX62-W– top and bottom view

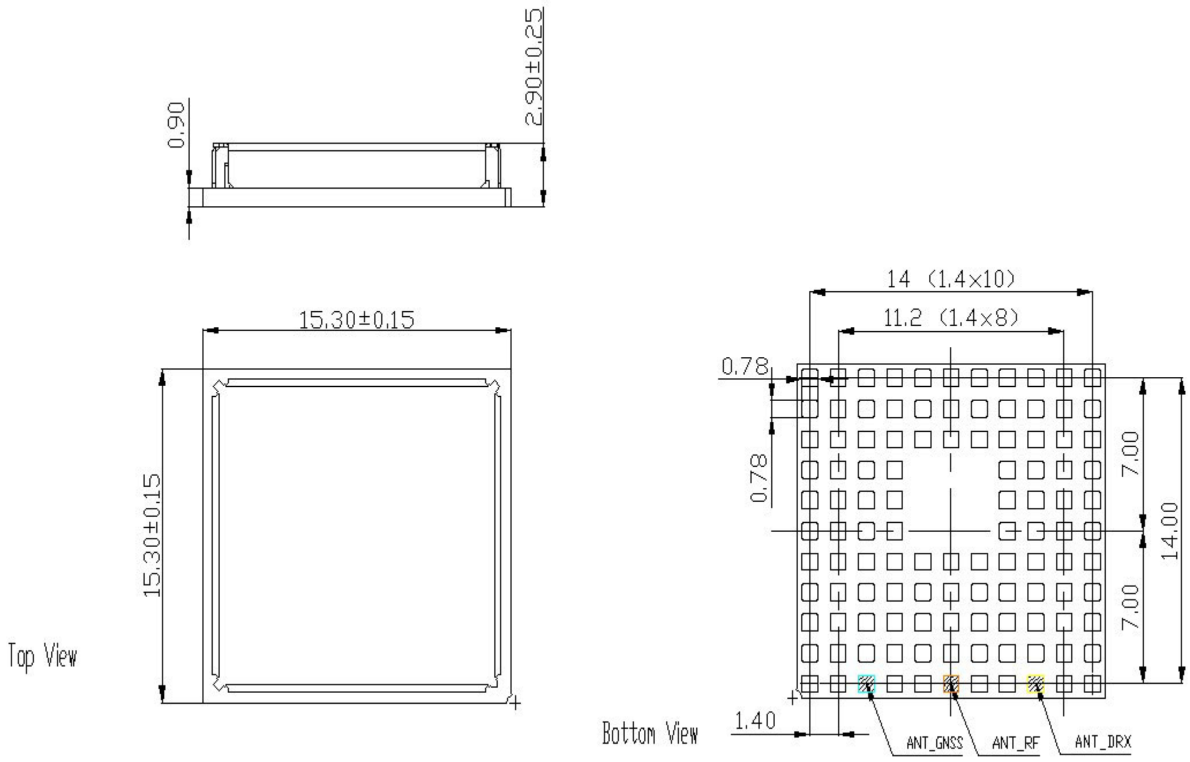
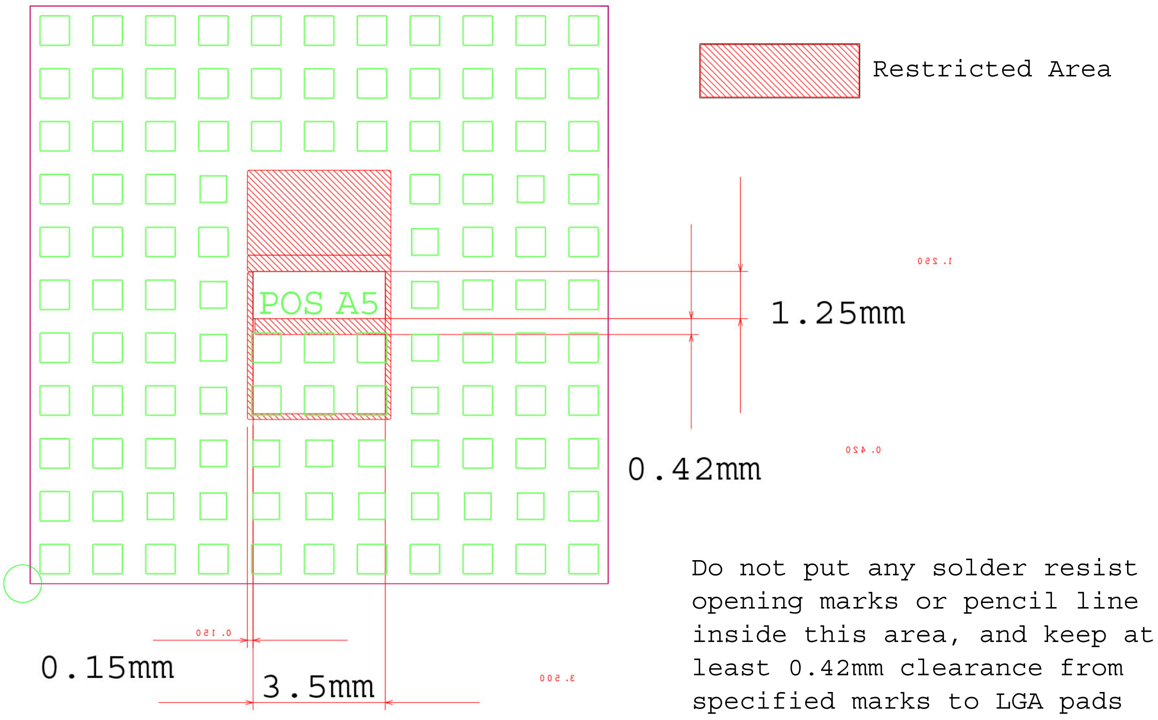


**Figure 50:** Dimensions of TX62-W (all dimensions in mm)



Do not put any solder resist opening marks or pencil line inside this area, and keep at least 0.42mm clearance from specified marks to LGA pads

**Figure 51:** Dimensions of area for possible markings TX62-W (bottom view)

## 4.2 Mechanical Dimensions of TX82-W and TX62-W-B

Figure 52 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 53. Figure 54 shows the area at the module's bottom side where possible markings might be printed.

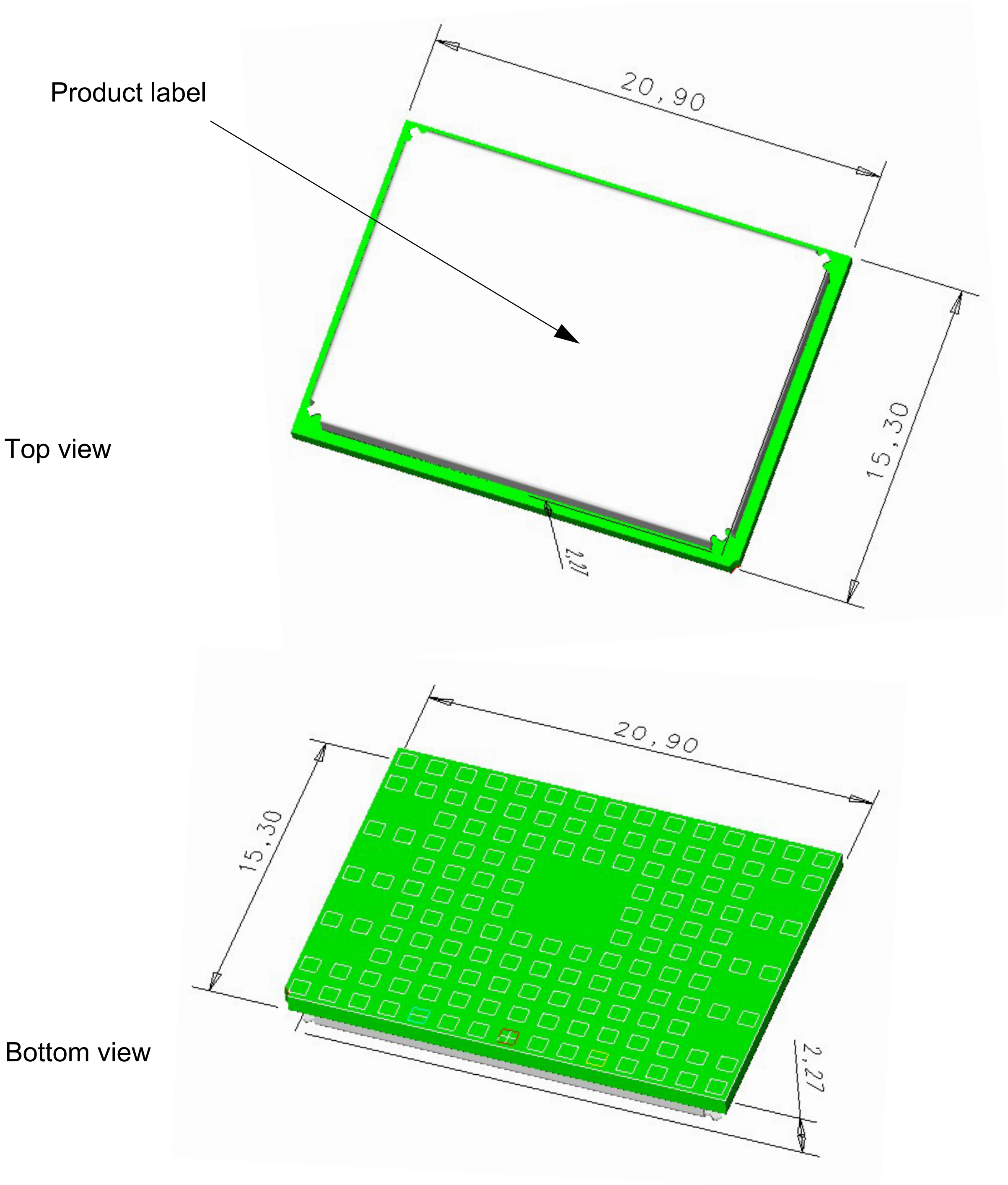


**Figure 52:** TX82-W– top and bottom view

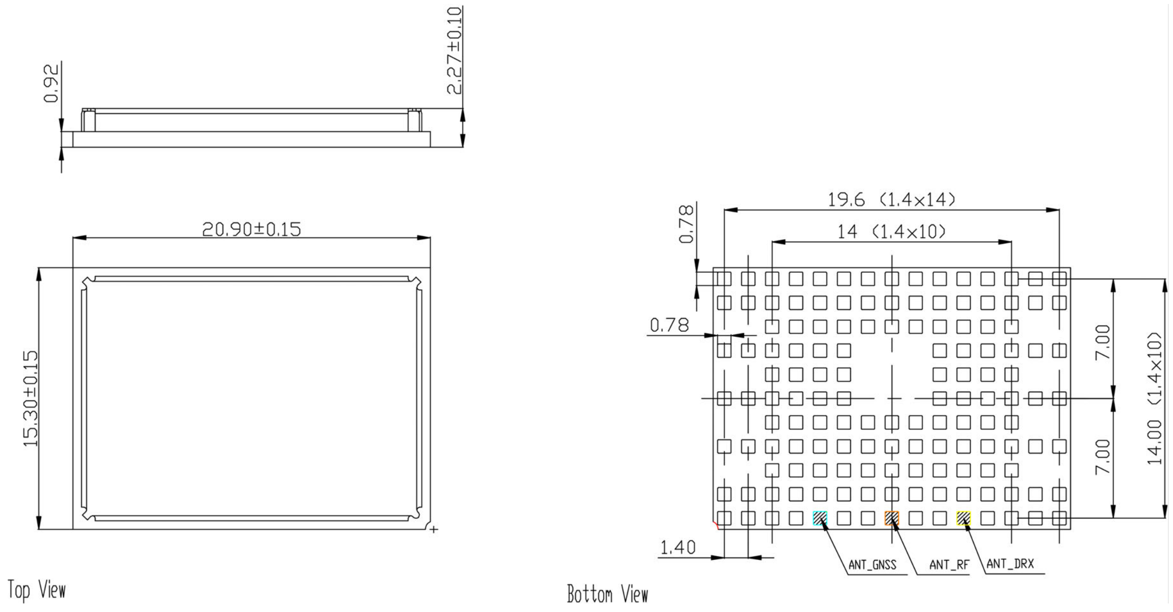
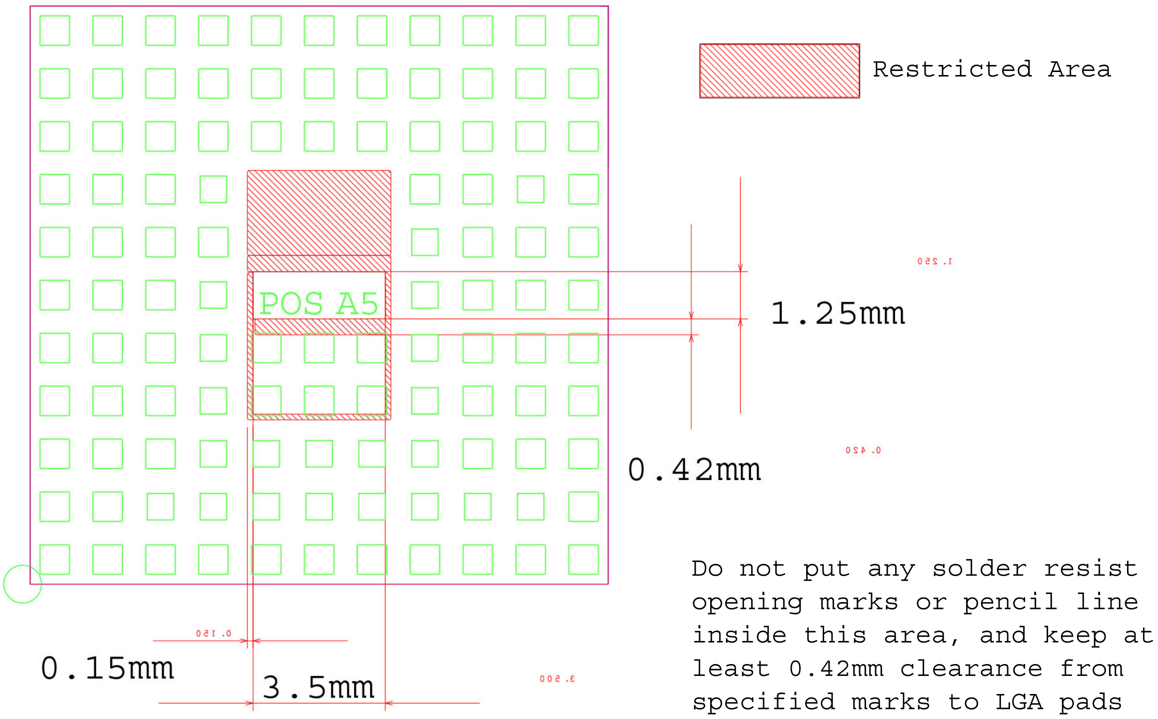


**Figure 53:** Dimensions of TX82-W and TX62-W-B (all dimensions in mm)



Do not put any solder resist opening marks or pencil line inside this area, and keep at least 0.42mm clearance from specified marks to LGA pads

**Figure 54:** Dimensions of area for possible markings TX82-W and TX62-W-B (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 [4].

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 51 and Figure 54), it is recommended not to route the signal tracks on the top layer of an external PCB directly under the module, or at least to ensure that signal track routes are sufficiently covered with solder resist.

### 4.3.1 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 55 and Figure 56 reflects the module‘s pad layout, including signal pads and ground pads (for pad assignment see Section 2.1.1).

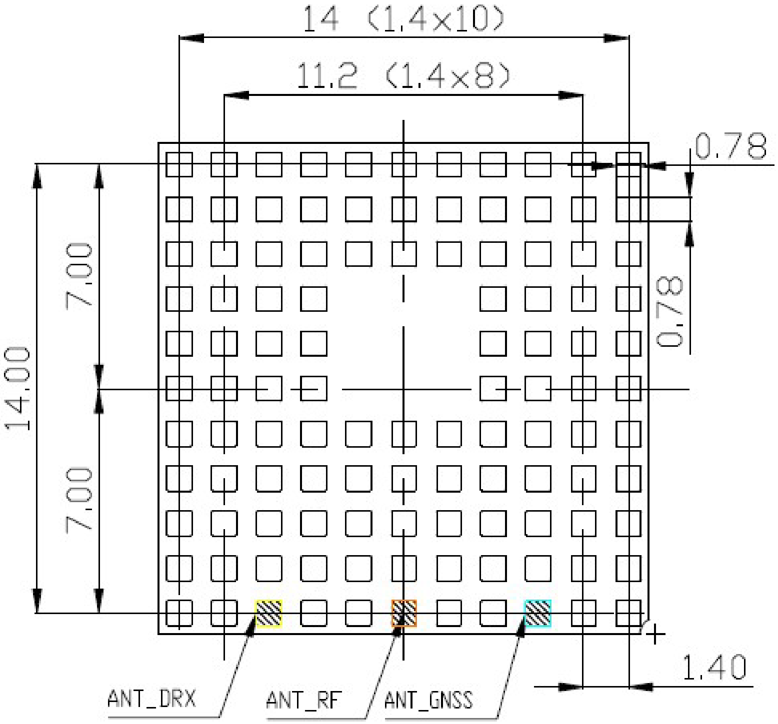


**Figure 55:** Land pattern TX62-W (top view)

.

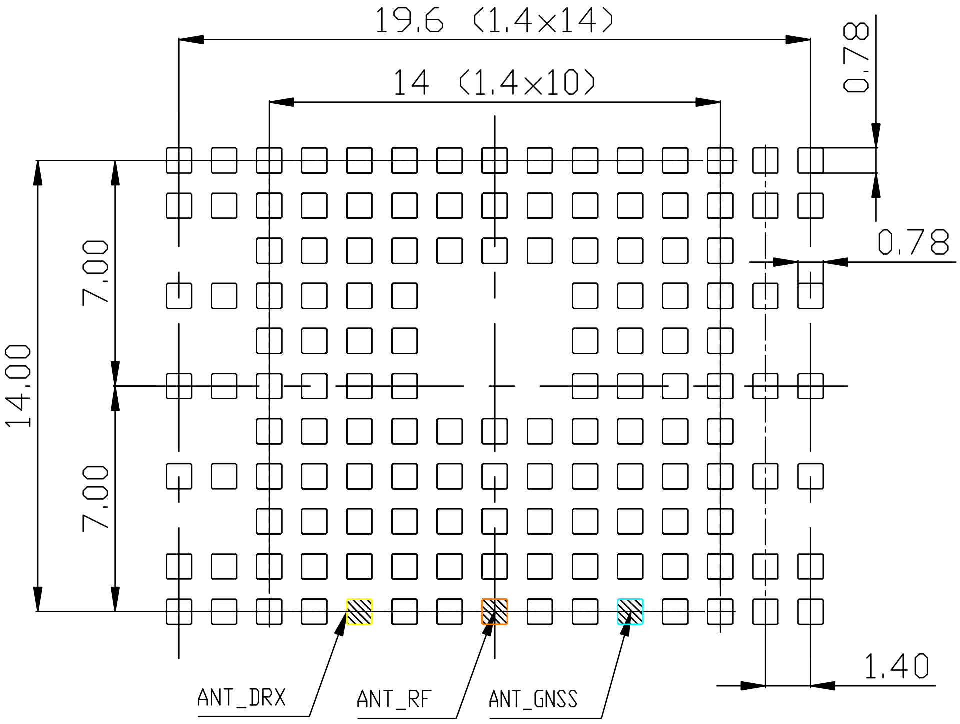


**Figure 56:** Land pattern TX82-W and TX62-W-B (top view)

The stencil design illustrated in Figure 57 and Figure 58 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.

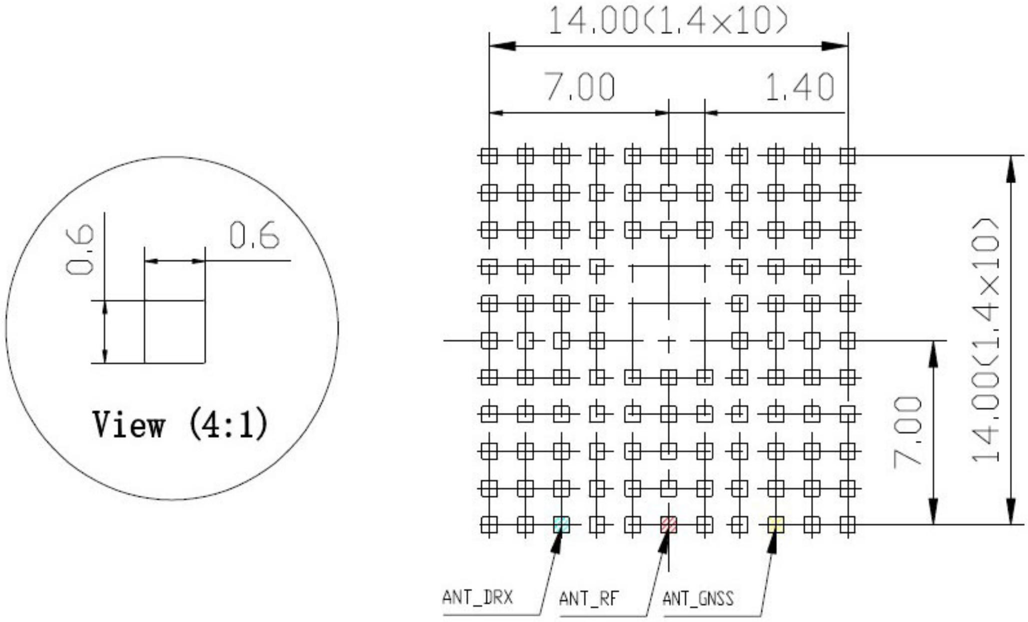


**Figure 57:** Recommended design for 110µm thick stencil for TX62-W (top view)

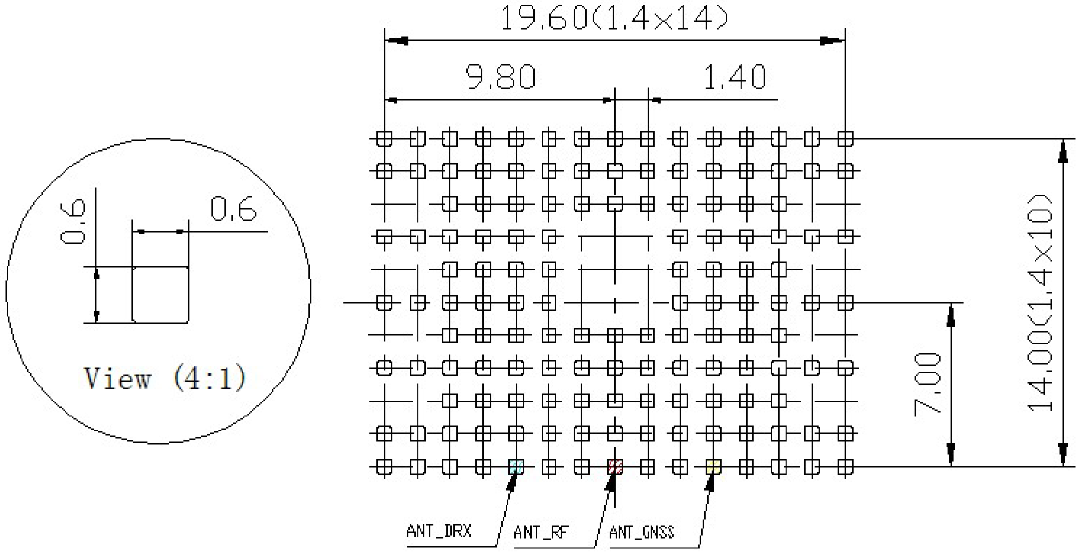


**Figure 58:** Recommended design for 110µm thick stencil for TX82-W and TX62-W-B (top view)

#### 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 [4].

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.

Daisy chain modules for SMT characterization are available on request. For details refer to [4].

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

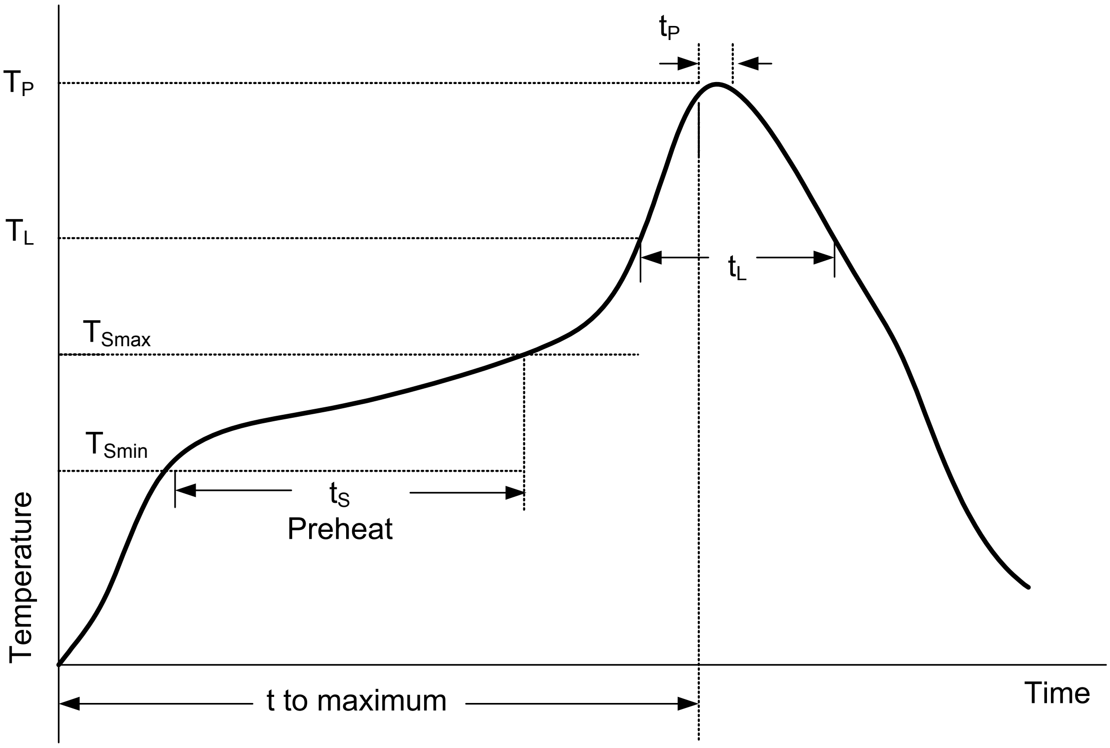


**Figure 59:** Reflow Profile

**Table 25:** Reflow temperature ratings[1]

| Profile Feature | Pb-Free Assembly |
|---|---|
| Preheat & Soak<br>Temperature Minimum ($T_{Smin}$)<br>Temperature Maximum ($T_{Smax}$)<br>Time ($t_{Smin}$ to $t_{Smax}$) ($t_S$) | <br>150°C<br>180°C<br>60-120 seconds |
| Average ramp up rate ($T_{Smax}$ to $T_P$) | 3K/second max. |
| Liquidous temperature ($T_L$)<br>Time at liquidous ($t_L$) | 217°C<br>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 [4].

## 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 26:** Storage conditions

| Type | Condition | Unit | Reference |
|---|---|---|---|
| Air temperature: Low<br>High | -25<br>+40 | °C | IPC/JEDEC J-STD-033A |
| Humidity relative: Low<br>High | 10<br>90 at 40°C | % | <br>IPC/JEDEC J-STD-033A |
| Air pressure: Low<br>High | 70<br>106 | kPa | IEC TR 60271-3-1: 1K4<br>IEC TR 60271-3-1: 1K4 |
| Movement of surrounding air | 1.0 | m/s | IEC TR 60271-3-1: 1K4 |
| Water: rain, dripping, icing and frosting | Not allowed | --- | --- |
| Radiation: Solar<br>Heat | 1120<br>600 | W/m$^2$ | ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb<br>ETS 300 019-2-1: T1.2, IEC 60068-2-2 Bb |
| Chemically active substances | Not recommended | | IEC TR 60271-3-1: 1C1L |
| Mechanically active substances | Not recommended | | IEC TR 60271-3-1: 1S1 |
| Vibration sinusoidal:<br>Displacement<br>Acceleration<br>Frequency range | <br>1.5<br>5<br>2-9 9-200 | <br>mm<br>m/s$^2$<br>Hz | IEC TR 60271-3-1: 1M2 |
| Shocks:<br>Shock spectrum<br>Duration<br>Acceleration | <br>semi-sinusoidal<br>1<br>50 | <br><br>ms<br>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 65 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.

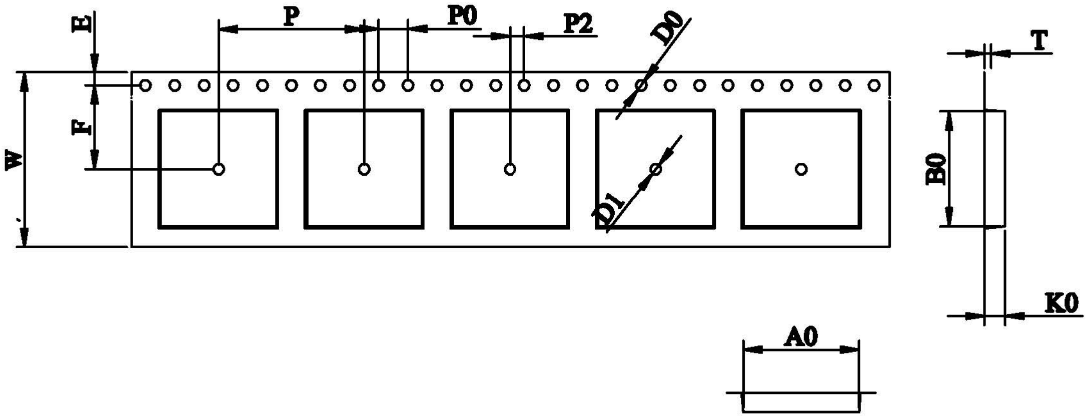
Please refer to Section 3.6 for further information on electrostatic discharge.

# 4.4 Packaging

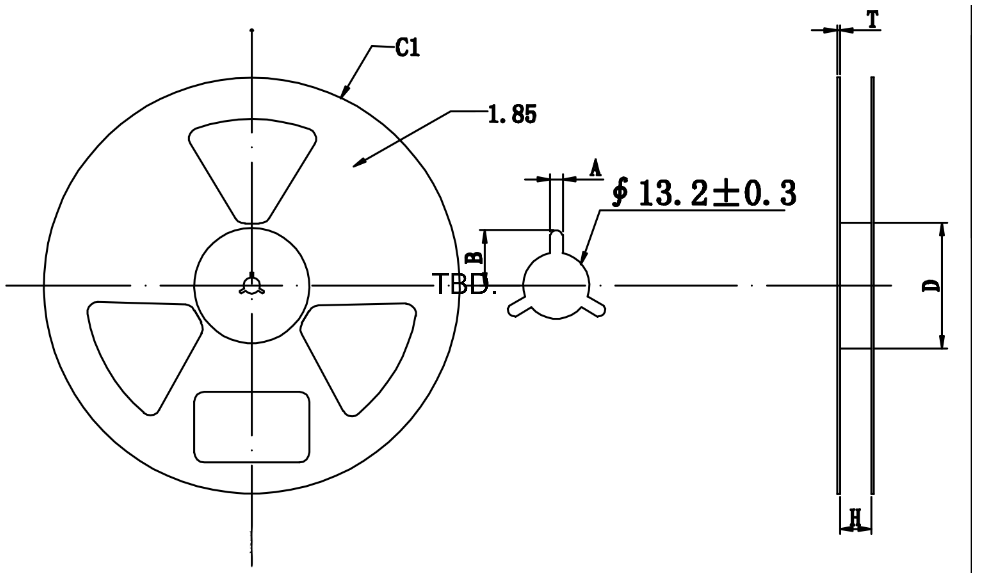
## 4.4.1 Tape and Reel

The single-feed tape carrier for TX62/TX82 is illustrated in Figure 60. 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 60:** Carrier tape

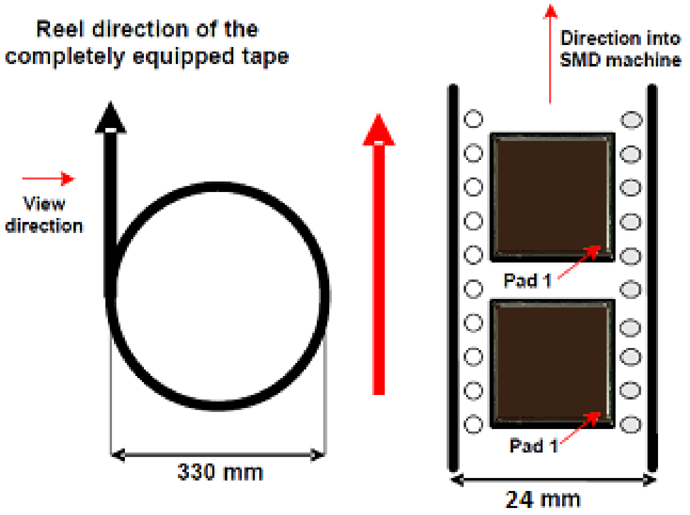


**Figure 61:** Reel direction

### 4.4.1.2 Barcode Label

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

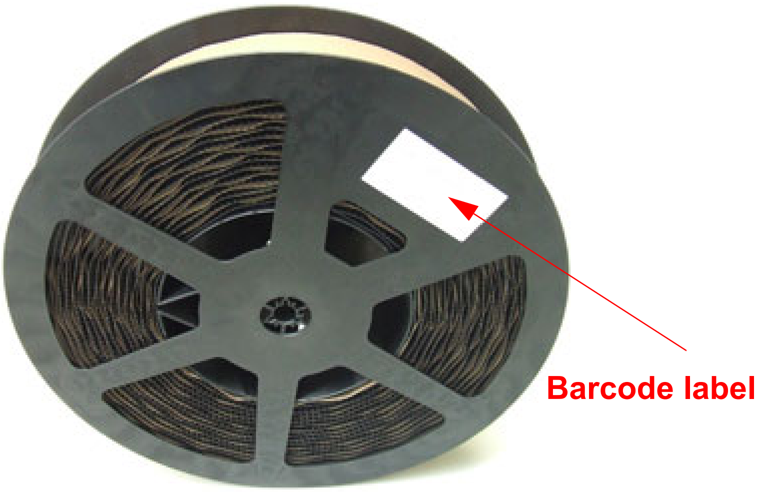
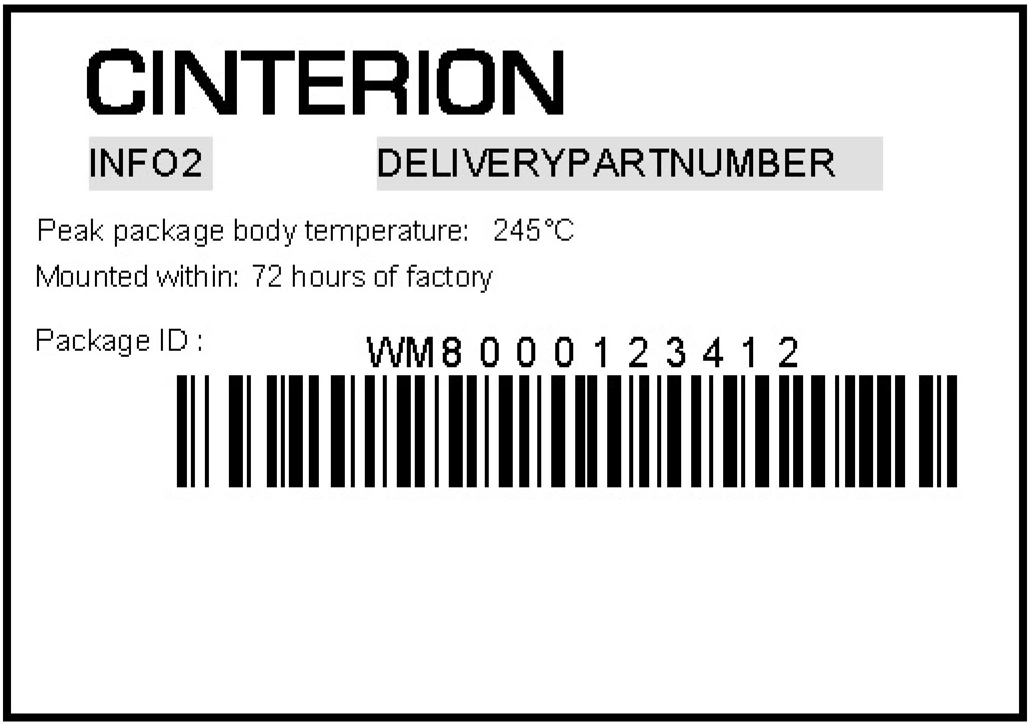


**Figure 62:** Barcode label on tape reel



CINTERION

INFO2 DELIVERYPARTNUMBER

Peak package body temperature: 245°C

Mounted within: 72 hours of factory

Package ID : WM8 0 0 0 1 2 3 4 1 2

**Figure 63:** Barcode label on tape reel - layout

Variables on the label are explained in Table 27.

## 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 64. 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.

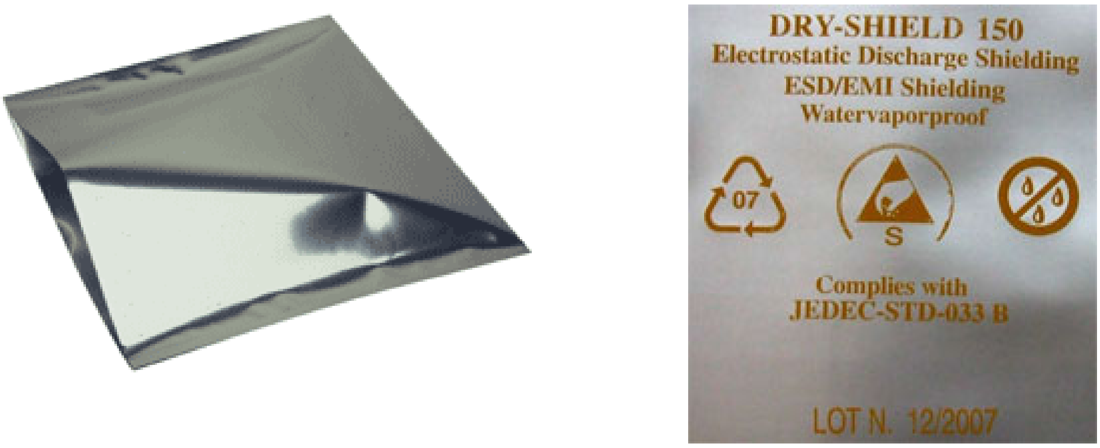
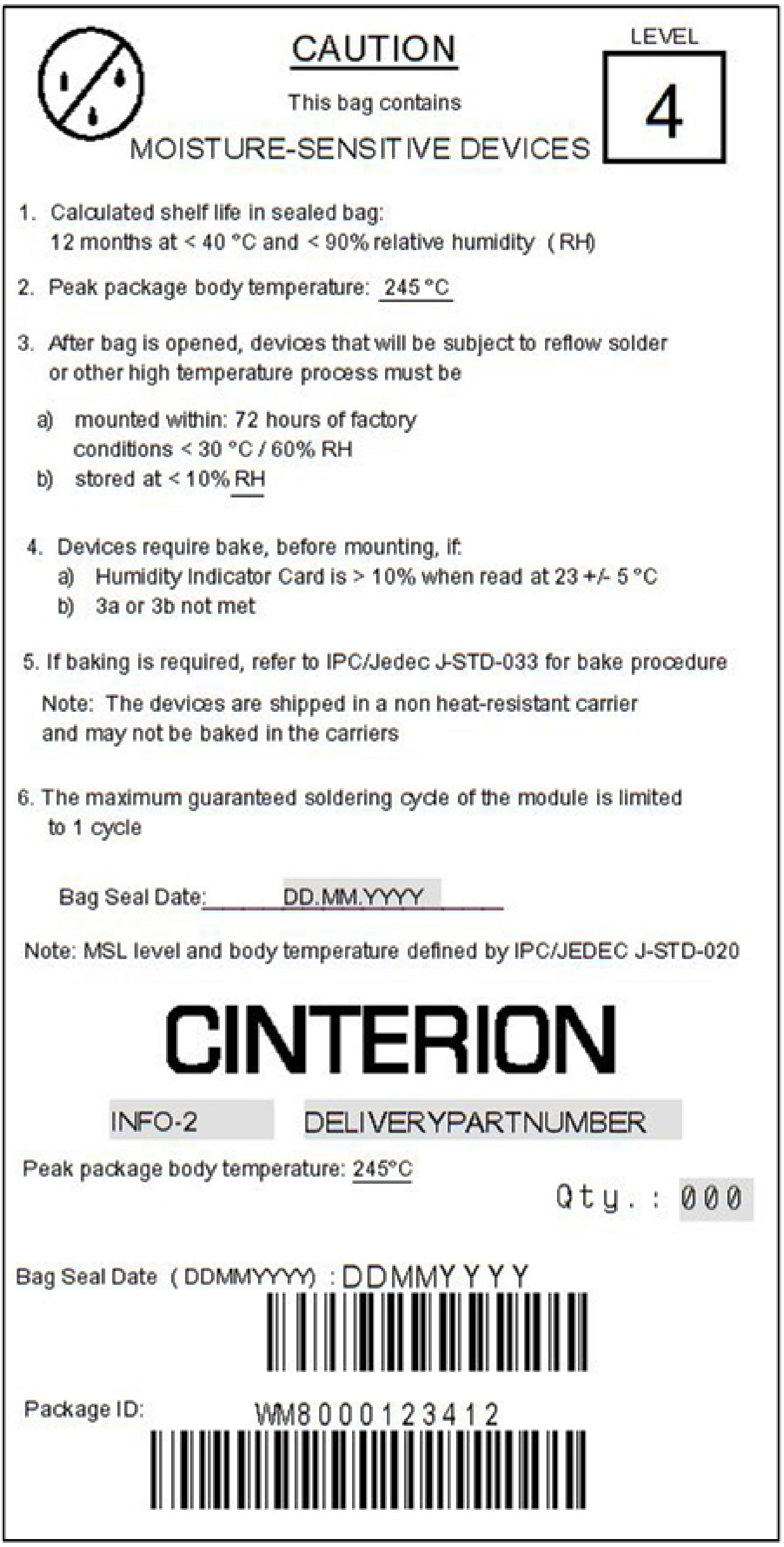


**Figure 64:** Moisture barrier bag (MBB) with imprint

The label shown in Figure 65 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 27.



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 65:** 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 66. If the components have been exposed to moisture above the recommended limits, the units will have to be rebaked.

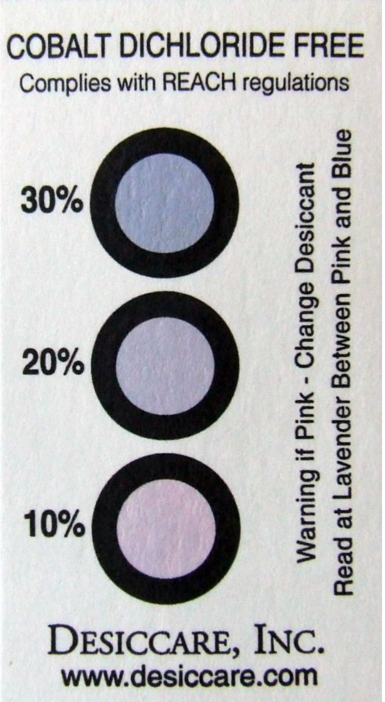


**Figure 66:** Humidity Indicator Card - HIC

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.

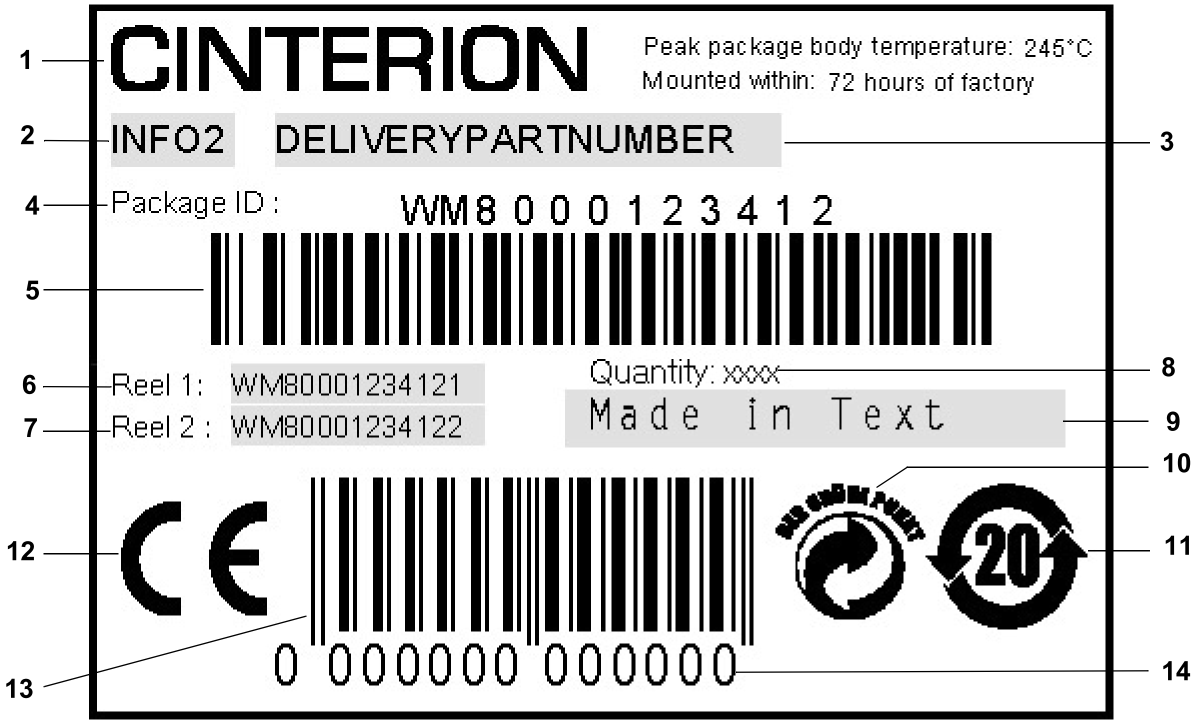


**Figure 67:** Sample of VP box label

**Table 27:** VP Box label information

| No. | Information |
|---|---|
| 1 | Cinterion logo |
| 2 | Product name |
| 3 | Product ordering number |
| 4 | Package ID number of VP box (format may vary depending on the product) |
| 5 | Package ID barcode (Code 128) |
| 6 | Package ID Reel 1 (format may vary depending on the product) |
| 7 | Package ID Reel 2 (format may vary depending on the product) |
| 8 | Quantity of the modules inside the VP box (max. 1000 pcs) |
| 9 | Country of production |
| 10 | Der Grüne Punkt (Green Dot) symbol |
| 11 | Chinese RoHS symbol (see Table 32) |
| 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 71). 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

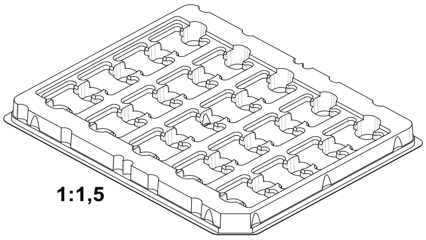


**Figure 68:** Small quantity tray

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 69:** Tray to ship odd module amounts

**Figure 70:** Trays with packaging materials

**T.B.D.**

**Figure 71:** Tray dimensions (TBD.)

# 5 Regulatory and Type Approval Information

## 5.1 Directives and Standards (TBD.)

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)/TX82-W Hardware Interface Description".[1]

**Table 28:** Directives

| | |
|---|---|
| 2014/53/EU | Directive of the European Parliament and of the Council of 16 April 2014 on the 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.<br>The product is labeled with the CE conformity mark |
| 2002/95/EC (RoHS 1)<br>2011/65/EC (RoHS 2) | Directive of the European Parliament and of the Council of 27 January 2003 (and revised on 8 June 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) |

**Table 29:** 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 60 950-1 | Product Safety Certification (Safety requirements) |
| NAPRD.03 V5.35 | Overview of PCS Type certification review board Mobile Equipment Type Certification and IMEI control<br>PCS Type Certification Review board (PTCRB) |
| RSS132 (Issue2)<br>RSS133 (Issue5) | Canadian Standard |

**Table 30:** Standards of European type approval

| | |
|---|---|
| 3GPP TS 51.010-1 | Digital cellular telecommunications system (Release 7); Mobile Station (MS) conformance specification; |
| GCF-CC V3.71 | 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 |

---

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

**Table 30:** Standards of European type approval

| | |
|---|---|
| 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 |
| EN 60950-1: 2006 +A11:2009+A1:2010+A12:2011+A2:2013 | Safety of information technology equipment |

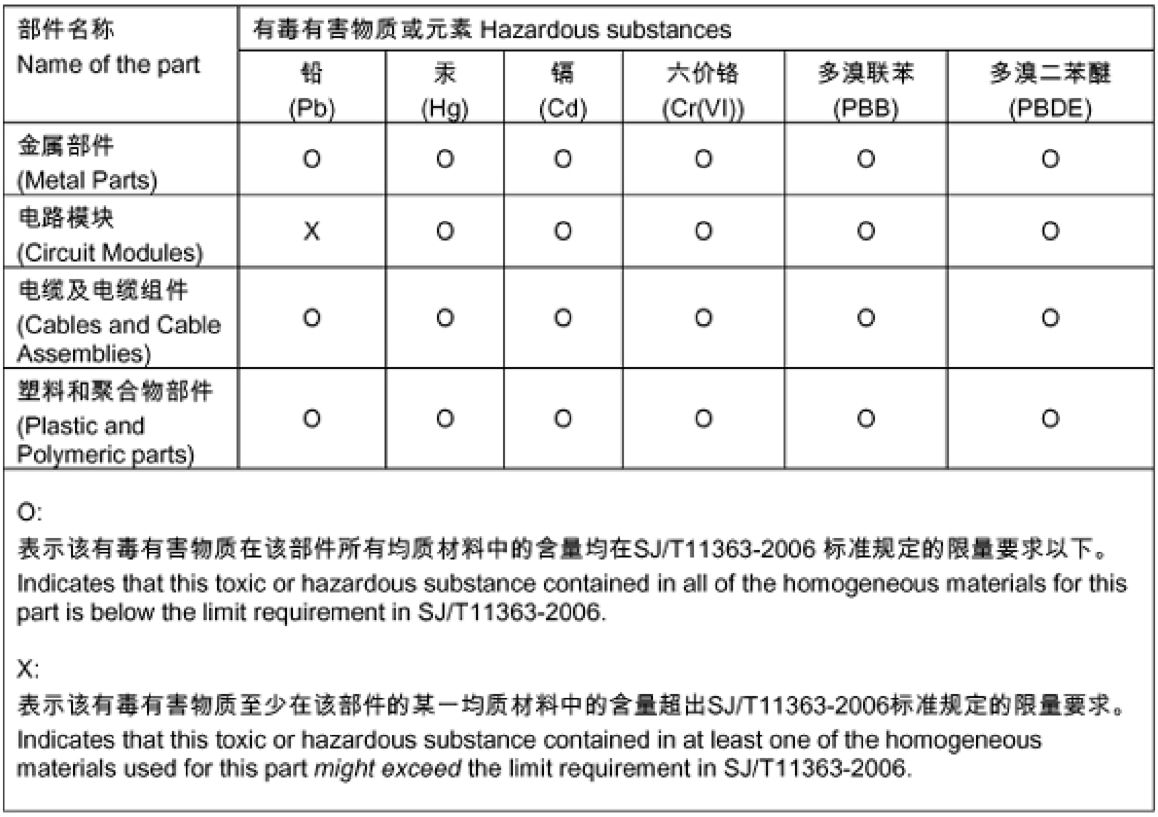
**Table 31:** Requirements of quality

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

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

| | |
|---|---|
| SJ/T 11363-2006 | “Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products” (2006-06). |
| SJ/T 11364-2006 | “Marking for Control of Pollution Caused by Electronic Information Products” (2006-06).<br><br>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.<br>Please see Table 33 for an overview of toxic or hazardous substances or elements that might be contained in product parts in concentrations above the limits defined by SJ/T 11363-2006. |

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



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

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

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

## 5.2 SAR requirements specific to portable mobiles

Mobile phones, PDAs or other portable transmitters and receivers incorporating a 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 USmarkets the relevant directives are mentioned below. It is the responsibility of the manufacturer of the final product to verify whether or not further standards, recommendations or directives are in force outside these areas.

*Products intended for sale on US markets*

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

*Products intended for sale on European markets*

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

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

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

## 5.3 Reference Equipment for Type Approval

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

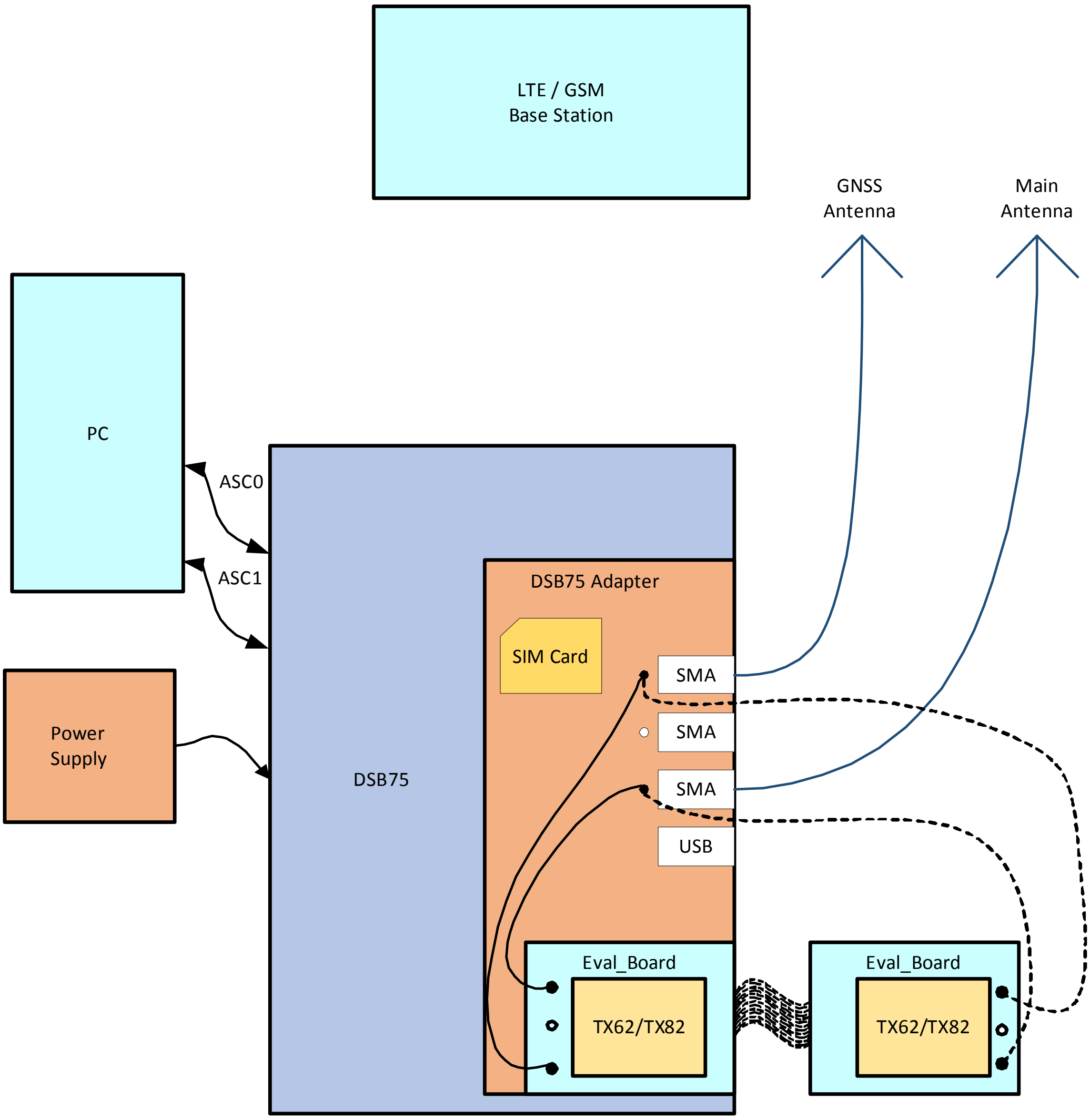


**Figure 72:** Reference equipment for type approval

---

[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 72. 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 (not granted yet)*
*ISED Certification Number: 7830A-TX82W (not granted yet)*
*Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPTX62-W (not granted yet)*
*ISED Certification Number: 7830A-TX62W (not granted yet)*
*Granted to THALES DIS AIS Deutschland GmbH*

*FCC Identifier: QIPTX62-W-B (not granted yet)*
*ISED Certification Number: 7830A-TX62WB (not granted yet)*
*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", and accordingly “Contains IC: 7830A-TX82W“ or “Contains IC: 7830A-TX62W“. 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 TBD. dBi (850MHz) and TBD. dBi (1900MHz).

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 television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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

If Canadian approval is requested for devices incorporating 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® TXx2-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 9, and changed Table 13 accordingly. |
| 2.2.1 | Revised receiver input sensitivity ratings in Table 9 and Table 10. |
| 3.2.2.2 | Revised Figure 34. |

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.<br>Revised supported footprint for TX62-W-B.<br>Replaced MIM with eUICC. |
| 2.1.2 | Added signal properties for eUICC interface lines. |
| 2.1.4 | Revised Figure 9. |
| 4.3.1.1 | Revised stencil shown in Figure 58. |
| 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 5 and Figure 6 |
| 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 30 |
| 3.2.3 | Revised Table 13 regarding GPIO, corrected some signal states |
| 3.7 | Revised Table 23 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 16 |
| 1.2, 4.1 | Changed hight of the module in Feature at a Glance and in Figure 49 and Figure 50 |
| 2.1.2 | Revised ON signal description in Table 3 |
| 2.1.6 | Added in Figure 12 hint where to place the capacitors |
| 2.1.6.1 | Added hint where to place the capacitors |
| 2.1.7 | Revised Figure 14 added reference to chapter 2.1.6.1 |
| 2.2.1 | Updated Table 9 |
| 2.2.3 | Revised Figure 24, Figure 25, Figure 26, Figure 27 and Figure 28 according to the footprint of TX62-W |
| 3.4.3 | Revised chapter and Figure 46 regarding GND reference point |
| 3.7 | Added placement of capacitors in Table 23 for SIM interface signals |
| 4.1 | Revised Figure 51 |
| 4.3.1.1 | Changed Stencil thickness to 110µm and Stencil pattern in Figure 57 |
| 4.4.1.1 | Revised Figure 60 and Figure 61 |

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 30 wrong PAD numbers |
| 3.4.1 | Removed extended voltage range in Table 16 |
| 4.2 | Revised Figure 52 |

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.<br>Renamed LTE Bd4 (AWS --> AWS-1), LTE Bd66 (1700MHz --> AWS-3). |

| Chapter | What is new |
|---|---|
| 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. |
| 2.1.13.2 | Adapted power indication circuit shown in Figure 19. |
| 2.1.13.3 | 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 29 |
| 2.3.3 | Revised Table 11 listing GNSS antenna interface characteristics. |
| 2.4 | Revised Figure 30 |
| 3.2.3 | Revised section Signal States after Startup including Table 11. |
| 3.4.1 | Revised Table 16 related to power supply |
| 4.2 | New section Mechanical Dimensions of TX82-W and TX62-W-B |
| 4.3.1.1 | Added Land pattern and Stencil for TX82-W |

New document: "Cinterion® TX62-W/TX82-W Hardware Interface Description" **v00.022a**

| 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 48: SMT Module Integration
[5] Differences between Selected Cinterion® Modules, Hardware Migration Guide, v11
[6] Cinterion® IoT Module Services User Guide, v01
[7] 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 |
| EMI | Electromagnetic Interference |
| ERP | Effective Radiated Power |

| Abbreviation | Description |
|---|---|
| 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 |
| PDU | Protocol Data Unit |
| PLL | Phase Locked Loop |

| Abbreviation | Description |
|---|---|
| PPP | Point-to-point protocol |
| PSK | Phase Shift Keying |
| PSU | Power Supply Unit |
| PWM | Pulse Width Modulation |
| R&TTE | Radio and Telecommunication Terminal Equipment |
| RAM | Random Access Memory |
| RF | Radio Frequency |
| RLS | Radio Link Stability |
| RMS | Root Mean Square (value) |
| RoHS | Restriction of the use of certain hazardous substances in electrical and electronic equipment. |
| ROM | Read-only Memory |
| RTC | Real Time Clock |
| RTS | Request to Send |
| Rx | Receive Direction |
| SAR | Specific Absorption Rate |
| SAW | Surface 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.<br>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.<br>Speakerphones must be installed by qualified personnel. Faulty installation or operation can constitute a safety hazard. |
| SOS | IMPORTANT!<br>Cellular terminals or mobiles operate using radio signals and cellular networks. Because of this, connection cannot be guaranteed at all times under all conditions. Therefore, you should never rely solely upon any wireless device for essential communications, for example emergency calls.<br>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.<br>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.<br>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 34:** List of parts and accessories

| Description | Supplier | Ordering information |
|---|---|---|
| TX62-W | Thales | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6300-A100<br>Module label number[1]: S30960-S6300-A100-1.<br><br>Standard module with embedded MFF-XS eUICC<br>Thales IMEI:<br>Packaging unit (ordering) number: L30900-N6307-A100<br>Module label number[1]: S30900-S6307-A100-1<br><br>Customer IMEI mode:<br>Packaging unit (ordering) number: L30960-N6305-A100<br>Module label number[1]: S30960-S6305-A100-1. |
| TX62-W-B | Thales | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6650-A100<br>Module label number[1]: S30960-S6650-A100-1.<br><br>Standard module with embedded MFF-XS eUICC<br>Thales IMEI:<br>Packaging unit (ordering) number: L30900-N6657-A100<br>Module label number[1]: S30900-S6657-A100-1<br><br>Customer IMEI mode:<br>Packaging unit (ordering) number: L30960-N6655-A100<br>Module label number[1]: S30960-S6655-A100-1. |
| TX82-W | Thales | Standard module<br>Thales IMEI:<br>Packaging unit (ordering) number: L30960-N6600-A100<br>Module label number[1]: S30960-S6600-A100-1.<br><br>Standard module with embedded MFF-XS eUICC<br>Thales IMEI:<br>Packaging unit (ordering) number: L30900-N6607-A100<br>Module label number[1]: S30900-S6607-A100-1<br><br>Customer IMEI mode:<br>Packaging unit (ordering) number: L30960-N6605-A100<br>Module label number[1]: S30960-S6605-A100-1. |
| TX62-W Evaluation Module | Thales | Standard module<br>Ordering number: L30900-N6301-A100<br><br>Standard module with embedded MFF-XS eUICC<br>Ordering number: L30900-N6308-A100 |

**Table 34:** List of parts and accessories

| Description | Supplier | Ordering information |
|---|---|---|
| TX62-W-B Evaluation Module | Thales | Standard module<br>Ordering number: L30900-N6651-A100<br><br>Standard module with embedded MFF-XS eUICC<br>Ordering number: L30900-N6658-A100 |
| TX82-W Evaluation Module | Thales | Standard module<br>Ordering number: L30900-N6601-A100<br><br>Standard module with embedded MFF-XS eUICC<br>Ordering number: L30900-N6608-A100 |
| DSB75 Evaluation Kit | Thales | Ordering number: L36880-N8811-A100 |
| DSB Mini<br>Compact Evaluation Board | Thales | Ordering number: L30960-N0030-A100 |
| LGA DevKit | Thales | LGA DevKit consists of<br><br>Cinterion® LGA DevKit T Base PCB:<br>Ordering number: L30960-N0113-A100<br><br>Cinterion® LGA DevKit Socket T:<br>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<br>91236<br>Sales contacts are listed in Table 35. |

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 35:** Molex sales contacts (subject to change)

| | | |
|---|---|---|
| Molex<br>For further information please click:<br>http://www.molex.com | Molex Deutschland GmbH<br>Otto-Hahn-Str. 1b<br>69190 Walldorf<br>Germany<br>Phone: +49-6227-3091-0<br>Fax: +49-6227-3091-8100<br>Email: mxgermany@molex.com | American Headquarters<br>Lisle, Illinois 60532<br>U.S.A.<br>Phone: +1-800-78MOLEX<br>Fax: +1-630-969-1352 |
| Molex China Distributors<br>Beijing,<br>Room 1311, Tower B, COFCO Plaza<br>No. 8, Jian Guo Men Nei Street, 100005<br>Beijing<br>P.R. China<br>Phone: +86-10-6526-9628<br>Fax: +86-10-6526-9730 | Molex Singapore Pte. Ltd.<br>110, International Road<br>Jurong Town,<br>Singapore 629174<br><br>Phone: +65-6-268-6868<br>Fax: +65-6-265-6044 | Molex Japan Co. Ltd.<br>1-5-4 Fukami-Higashi,<br>Yamato-City,<br>Kanagawa, 242-8585<br>Japan<br>Phone: +81-46-265-2325<br>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 73:** TX62/TX82 label

**Table 36:** 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 37 below) |

**Table 37:** 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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81541 Munich
Germany