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Telegesis™	 <b>SILICON LABS</b>	TG-PM-0520-ETRX3585-LRS r2
ETRX3585-LRS and ETRX3585HR-LRS		Product Manual

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## ETRX3585-LRS ZIGBEE® MODULES



## PRODUCT MANUAL

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*Image not shown actual size; enlarged to show detail.*

The Telegesis ETRX3585-LRS and ETRX3585HR-LRS modules are low power 2.4GHz ZigBee modules with an added frontend module (SiGe SE2432L) containing both PA and LNA for highest possible link budget.

Based on the latest Ember EM3585 family of single chip ZigBee solutions the new long range modules are footprint compatible with the entire Telegesis ETRX3 family, thus representing a drop-in replacement for all applications where a high link budget is required.

For custom application development the ETRX3585 series integrates with ease into Ember's InSight development environment.

### Module Features

- Small form factor, SMT module 25mm x 19mm
- Same footprint and pin-out as ETRX357-LRS
- Side Castellations for easy soldering and inspection
- Two antenna options: Integrated chip antenna or U.FL coaxial connector
- Based on 32-bit ARM® Cortex-M3
- Industry standard JTAG Programming and real time network level debugging via the Ember Debug Port
- Up to 512kB of flash and 64kbytes of RAM
- Lowest Deep Sleep Current of sub 1µA with retained RAM and GPIO and multiple sleep modes
- Ultra Wide supply voltage range (2.1 to 3.6V)
- Optional 32.768kHz watch crystal can be added externally
- Can act as an End Device, Router or Coordinator
- 22 general-purpose I/O lines including analogue inputs
- Firmware upgrades via serial port or over the air (password protected)
- Hardware supported encryption (AES-128)
- CE and FCC and IC compliance, IC and FCC modular approval
- Operating temperature range: -40°C to +85°C
- Standard version without LNA and PA available in the same form factor

### Suggested Applications

- ZigBee Smart Energy applications
- Wireless Alarms and Security
- Home/Building Automation
- Wireless Sensor Networks
- M2M Industrial Controls
- Lighting and ventilation control
- Remote monitoring
- Environmental monitoring and control

### Development Kit

- Enhancement kit available to upgrade existing Telegesis and Ember development kits to be used with the new ETRX3585 family
- Custom software development available upon request.

### Radio Features

- Based on the Silicon Labs EM3585 family of single chip ZigBee® SoCs
- 2.4GHz ISM Band
- 250kbit/s over the air data rate – NB: actual usable data throughput with ZigBee is about 20kbps
- 15 channels (IEEE802.15.4 Channel 11 to 25)
- SiGe SE2432L integrated PA and LNA
- +20dBm output power (adjustable down to -41dBm)
- High sensitivity of -106dBm typ. @ 1% packet error rate
- RX Current: 33mA, TX Current: approx 140mA at 20dBm

## 1 Introduction

This document describes the Telegesis ETRX3585-LRS and ETRX3585HR-LRS ZigBee long range modules which have been designed to be easily integrated into another device and to provide a fast, simple and low cost wireless mesh networking interface.

The Telegesis ETRX3 series modules are based on the Silicon Labs ZigBee compliant platform consisting of the single chip family of EM3585 SoCs combined with the ZigBee PRO compliant EmberZNet meshing stack.

The ETRX3585-LRS and ETRX3585HR-LRS modules represent an ideal platform for custom firmware development in conjunction with the Silicon Labs ZigBee development kits.

No RF experience or expertise is required to add this powerful wireless networking capability to your products. The ETRX3585-LRS and ETRX3585HR-LRS offer fast integration opportunities and the shortest possible time to market for your product.

### 1.1 Hardware Description

The main building blocks of the ETRX3585-LRS and ETRX3585HR-LRS are the single chip EM3585 SoC from Silicon Labs, a SiGe SE2432L frontend module combining a Power Amplifier with a Low Noise Amplifier, a 24MHz reference crystal and RF front-end circuitry optimized for best RF performance. The modules are available with on-board antenna or alternatively a U.FL connector for attaching external antennae. Modules with the U.FL connector are identified by the “HR” suffix.

The integrated antenna is an Antenova Rufa, and details of the radiation pattern and further data are available from the Antenova website [5].

Module	Chip	Flash	RAM	Antenna	USB
ETRX3585-LRS	EM3585	512kB	32kB	Chip	No
ETRX3585HR-LRS	EM3585	512kB	32kB	External	No

**Table 1: Memories**

The LNA and RF power amplifier of the LRS devices improve the output power by 12dB and the sensitivity by 5dB which will increase the range by approximately 700% relative to the standard devices (where local regulations permit the use of the maximum output power).

The ETRX3585-LRS and ETRX3585HR-LRS are used for ZigBee ([www.zigbee.org](http://www.zigbee.org)) applications. In case it is desired to develop custom firmware, the Silicon Labs toolchain, consisting of Ember Desktop together with a comprehensive integrated development environment (IDE), is required.

## 2 Product Approvals

The ETRX3585-LRS and ETRX3585HR-LRS have been designed to meet all national regulations for world-wide use. In particular the following certifications have been obtained:

### 2.1 FCC Approvals

The Telegesis ETRX3585-LRS family integrated Antenna as well as the ETRX3585HR-LRS family including the antennas listed in and the power levels listed in section 10.2 have been tested to comply with FCC CFR Part 15 (USA) The devices meet the requirements for modular transmitter approval as detailed in the FCC public notice DA00.1407.transmitter.

FCC statement:

***This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.***



FCC ID: S4GEM358L

This module complies with the USA SAR requirements and is not intended to be operated within 20cm of the body. The following statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF exposure compliance.

***“WARNING: To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operations at closer distances than this are not recommended.”***

Item	Part No.	Manufacturer	Type	Impedance	Gain
1	BT-Stubby (straight)	EAD Ltd. [6]	¼ Wave	50Ω	0dBi
2	BT-Stubby (right-angle)	EAD Ltd. [6]	¼ Wave	50Ω	0dBi
3	CJ-2400-6603	Chang Jia	½ Wave	50 Ω	2.0dBi
4	Rufa (on board)	Antenova	Chip	50Ω	2.1dBi (peak)

**Table 2. Approved Antennae**

An end user deploying an ETRX3585-LRS or an ETRX3585HR-LRS module together with an antenna as listed in Table 2 is not required to obtain a new authorization for the module – BUT this does not preclude the possibility that some other form of authorization or testing may be required for the end product depending upon local territorial regulations.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Telegesis (UK) Ltd. may void the user's authority to operate the equipment. When using the ETRX3585-LRS with approved antennae, it is required to prevent end-users from replacing them with non-approved ones.

### 2.1.1 FCC Labelling Requirements

When integrating the ETRX3585-LRS or ETRX3585HR-LRS families into a product it must be ensured that the FCC labelling requirements are met. This includes a clearly visible label on the outside of the finished product specifying the Telegesis FCC identifier (**FCC ID: S4GEM358L**) as well as the notice above. This exterior label can use wording such as “**Contains Transmitter Module FCC ID: S4GEM358L**” or “**Contains FCC ID: S4GEM358L**” although any similar wording that expresses the same meaning may be used.

## 2.2 IC (Industry Canada) Approvals

The Telegesis ETRX3585-LRS family with integrated Antenna as well as the ETRX3585HR-LRS family have been approved by Industry Canada to operate with the antenna types listed in Table 2 with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

**IC-ID:** 8735A-EM358L

- This device complies with Industry Canada license-exempt RSS standard(s). 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.
- Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.
- To comply with Industry Canada RF radiation exposure limits for general population, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times
- This device has been designed to operate with the antennas listed in Table 2, and having a maximum gain of 2.1 dBi. Antennas not included in this list or having a gain greater than 2.1 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

### French Statements

- Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.
- Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout



brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### **OEM Responsibilities**

The ETRX3585-LRS and ETRX3585HR-LRS families of module have been certified for integration into products only by OEM integrators under the following conditions:

1. The antenna(s) must be installed such that a minimum separation distance of 0.75cm is maintained between the radiator (antenna) and all persons at all times.
2. The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

**IMPORTANT NOTE:** In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then Industry Canada certification is no longer considered valid and the IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Industry Canada authorization.

### **2.2.1 IC Labelling Requirements**

The ETRX3585-LRS and ETRX3585HR-LRS family modules are labelled with its own IC Certification Number. If the IC Certification Number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labelled in a visible area with the following:

**“Contains Transmitter Module IC: 8735A-EM358L”**

or

**“Contains IC: 8735A-EM358L”**

The OEM of the ETRX3585-LRS and ETRX3585HR-LRS family modules must only use the approved antenna(s) listed above, which have been certified with this module.

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user's manual of the end product.

## 2.3 European Certification

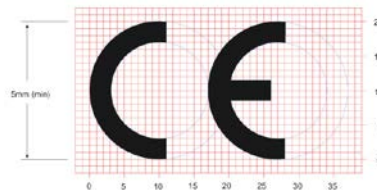
The ETRX3585-LRS and ETRX3585HR-LRS families are with the maximum power settings defined in section 10.2 of this document compliant to the following standards:

- Radio: EN 300 328:V1.9.1
- Safety: EN 60950-1:2006 / A12:2011

All tests have been conducted with the antennae listed in Table 2.

If the ETRX3585-LRS and ETRX3585HR-LRS families of modules are incorporated into an OEM product, the OEM product manufacturer must ensure compliance of the final product to the European Harmonised EMC, and low voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in the R&TTE Directive. The final product must not exceed the specified power ratings, antenna specifications and installation requirements as specified in this user manual. If any of these specifications are exceeded in the final product then a submission must be made to a notified body for compliance testing to all of the required standards.

The 'CE' marking must be applied to a visible location on any OEM product. For more information please refer to <http://ec.europa.eu/enterprise/faq/ce-mark.htm>. Customers assume full responsibility for learning and meeting the required guidelines for each country in their distribution market.



## 2.4 Declarations of Conformity

Telegesis (UK) Ltd has issued Declarations of Conformity for all ETRX3 series ZigBee RF Modules, which cover Radio Emissions and Safety. These documents will be available from our website or on request

## 2.5 IEEE 802.15.4

IEEE 802.15.4 is a standard for low data rate, wireless networks (raw bit-rate within a radio packet of 250kbps @2.4GHz) which focuses on low cost, low duty cycle, long primary battery life applications as well as mains-powered applications. It is the basis for the open ZigBee Protocol.

## 2.6 The ZigBee Protocol

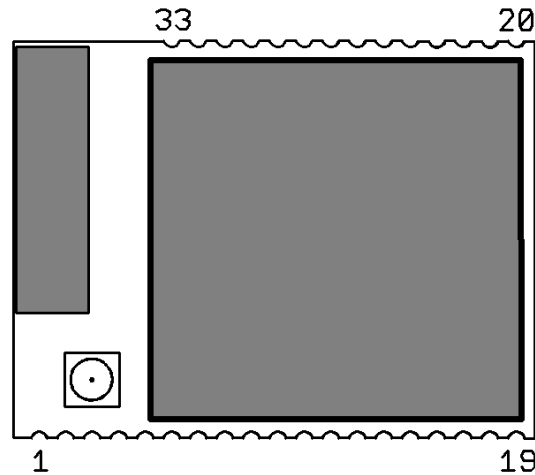
The ZigBee Protocol is a set of standards for wireless connectivity for use between any devices over short to medium distances. The specification was originally ratified in December 2004, paving the way for companies to start making low-power networks a reality.

ZigBee uses an IEEE 802.15.4 radio specification running on the 2.4GHz band, plus three additional layers for networking, security and applications. What makes the specification unique is its use of a mesh network architecture which, in bucket chain style, passes data from one node to the next until it lands at its destination. The network is self-healing and adapts its routing as link quality changes or nodes move. Furthermore, nodes can be defined as End Devices which do not act as routers, but can therefore be put into a low-power sleep state.

The enhanced version of the ZigBee standard (or ZigBee 2006) was released in December 2006, adding new features and improvements to the only global wireless communication standard enabling the development of easily deployable low-cost, low-power, monitoring and control products for homes, commercial buildings and industrial plant monitoring. In 2007 the ZigBee Alliance introduced the PRO feature-set which offers advantages over earlier feature-sets, including

- Truly self-healing mesh networking
- Messages can now travel up to 30 hops
- Source-Routing for improved point to multipoint message transmission
- Improved security including Trust-Centre link keys
- New message types and options

### 3 Module Pinout



**Figure 1. ETRX3 series Module Pinout (top view)**

The table below gives details about the pin assignment for direct SMD soldering of the ETRX3 series modules to the application board. For more information on the alternate functions please refer to [2].

All GND pads are connected within the module, but for best RF performance all of them should be grounded externally.

ETRX3585 pad	Name	Default Use	Alternate function	EM35x pin	Alternate functions
1	GND	GND		GND	
2	PC5 {1}	I/O	TX_ACTIVE	11	TX_ACTIVE. PC5 of the EM3585 is used to control the FEM
3	PC6	I/O		13	OSC32B, nTX_ACTIVE
4	PC7	I/O		14	OSC32A, OSC32_EXT
5	PA7 {4}	I/O		18	TIM1C4
6	PB3 {2}	I/O	CTS	19	SC1nCTS, SC1SCLK, TIM2C3
7	nReset {5}	nReset		12	
8	PB4 {2}	I/O	RTS	20	TIM2C4, SC1nRTS, SC1nSSEL
9	PA0	I/O		21	TIM2C1, SC2MOSI
10	PA1	I/O		22	TIM2C3, SC2SDA, SC2MISO
11	PA2	I/O		24	TIM2C4, SC2SCL, SC2SCLK
12	PA3	I/O		25	SC2nSSEL, TIM2C2
13	GND	GND		GND	
14	PA4	I/O		26	ADC4, PTI_EN, TRACEDATA2
15	PA5 {3}	I/O		27	ADC5, PTI_DATA, nBOOTMODE, TRACEDATA3
16	PA6 {4}	I/O		29	TIM1C3
17	PB1	TXD		30	SC1MISO, SC1MOSI, SC1SDA, SC1TXD, TIM2C1
18	PB2	RXD		31	SC1MISO, SC1MOSI, SC1SCL, SC1RXD, TIM2C2
19	GND	GND		GND	

ETRX3585 pad	Name	Default Use	Alternate function	EM35x pin	Alternate functions
20	GND	GND		GND	
21	JTCK	JTCK		32	SWCLK
22	PC2	I/O		33	JTDO, SWO, TRACEDATA0
23	PC3	I/O		34	JTDI, TRACECLK
24	PC4	I/O		35	JTMS, SWDIO
25	N/C{1}	N/C		36	PB0 of the EM3585 is used to control the FEM
26	PC1	I/O	ADC3	38	ADC3, TRACEDATA3
27	PC0 {4}	I/O		40	JRST, IRQD, TRACEDATA1
28	PB7 {4}	I/O	ADC2	41	ADC2, IRQC, TIM1C2
29	PB6 {4}	I/O	ADC1	42	ADC1, IRQB, TIM1C1
30	PB5	I/O	ADC0	43	ADC0, TIM2CLK, TIM1MSK
31	GND	GND		GND	
32	Vcc	Vcc		Vcc	
33	GND	GND		GND	

**Table 3. Pin Information**
**Notes:**

- {1} When the alternate GPIO function is selected, TX\_ACTIVE becomes an output that indicates that the EM3585 radio transceiver is in transmit mode. PC5 must not be used in this mode as it is needed internally as TX\_ACTIVE to control the external RF front end and power amplifier. PB0 is not available to the user.
- {2} The serial UART connections TXD, RXD, CTS and RTS are PB1, PB2, PB3 and PB4 respectively. The device sends its data on TXD and receives on RXD.
- {3} If PA5 is driven low at power-up or reset the module will boot up in the bootloader
- {4} PA6, PA7, PB6, PB7 and PC0 can drive high current (see section 8)
- {5} nRESET is level-sensitive, not edge-sensitive. The module is held in the reset state while nRESET is low. This signal has a 30kΩ Pull-Up.

**Important Note:** The ETRX3585 series and the ETRX3585-LRS series of modules are footprint compatible, but on the ETRX3585-LRS series pins PB0 and PC5 of the EM3585 are used internally to control the front-end module and are not available to the user. PC5 is still available on Pad2, but it is configured as TX\_ACTIVE signal and cannot be used as a general purpose GPIO.

See also the table “Module pads and functions” in the ETRX357 Development Kit Product Manual. Refer to the Silicon Labs EM358x manual for details of the alternate functions and pin names.

## 4 Hardware Description

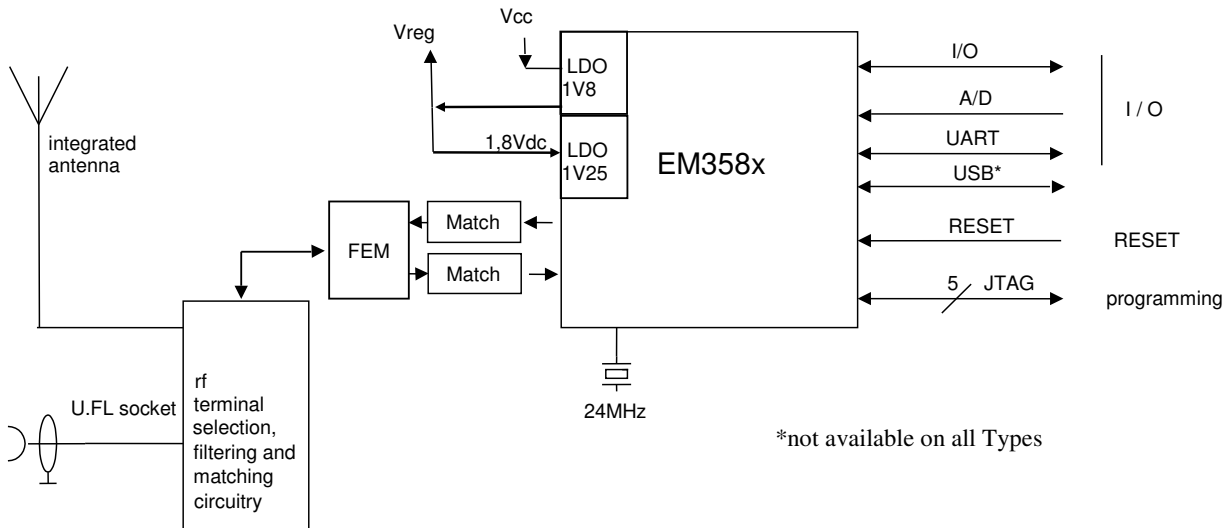


Figure 2. Hardware Diagram

The ETRX3585-LRS and ETRX3585-LRS are based on the Silicon Labs EM3585 family of ZigBee SoCs in addition to a frontend module containing a PA, LNA and RF switch in addition to the RF-frontend circuitry. The EM3585 family of ZigBee SoCs are fully integrated 2.4GHz ZigBee transceivers with a 32-bit ARM® Cortex M3™ microprocessor, flash and RAM memory, and peripherals.

The industry standard serial wire and JTAG programming and debugging interfaces together with the standard ARM system debug components help to streamline any custom software development.

In addition to this a number of MAC functions are also implemented in hardware to help maintain the strict timing requirements imposed by the ZigBee and IEEE802.15.4 standards.

The new advanced power management features allow faster wakeup from sleep and new power-down modes allow this 3<sup>rd</sup> generation module to offer a longer battery life than any 2<sup>nd</sup> generation modules on the market.

The EM3585 has fully integrated voltage regulators for both required 1.8V and 1.25V supply voltages. The voltages are monitored (brown-out detection) and the built in power-on-reset circuit eliminates the need for any external monitoring circuitry. A 32.768kHz watch crystal can be connected externally to pads 3 and 4 in case more accurate timing is required.

### 4.1 Hardware Interface

All GPIO pins of the EM3585 chips are accessible on the module's pads. Whether signals are used as general purpose I/Os, or assigned to a peripheral function like ADC is set by the firmware. When developing custom firmware please refer to the EM3585 datasheet [2].

## 5 Firmware Description

By default, the modules will be pre-loaded with a standalone bootloader which supports over-the-air bootloading as well as serial bootloading of new firmware.

In order to enter the standalone bootloader using a hardware trigger pull PA5 to ground and power-cycle or reset the module. To avoid entering the standalone bootloader unintentionally make sure not to pull this pin down during boot-up unless the resistance to ground is  $>10k\Omega$ . (A pull-up is not required).

Each module comes with a unique 64-bit 802.15.4 identifier which is stored in non-volatile memory.

A router is typically a mains powered device whilst a sleepy end device (SED) can be battery powered.

The module is also able to act as a coordinator and Trust Centre through external host control.

## 5.1 Token Settings

The ETRX3585-LRS Series Modules' manufacturing tokens will be pre-programmed with the settings shown in the table below.

Token	Description	TG Default
MFG_CIB_OBS	Option Bytes	<not written>
MFG_CUSTOM_VERSION	Optional Version Number	<not written>
MFG_CUSTOM_EUI_64	Custom EUI	<not written>
MFG_STRING	Device Specific String	TELEGESIS
MFG_BOARD_NAME	Hardware Identifier	<Order Code>
MFG_MANUF_ID	Manufacturer ID	0x1010
MFG_PHY_CONFIG	Default Power Settings	0xFFFF
MFG_BOOTLOAD_AES_KEY	Bootloader Key	<not written>
MFG_EZSP_STORAGE	EZSP related	<not written>
MFG_CBKE_DATA	SE Security	<not written>
MFG_INSTALLATION_CODE	SE Installation	<not written>
MFG_OSC24M_BIAS_TRIM	Crystal Bias	<not written>
MFG_SYNTH_FREQ_OFFSET	Frequency offset	<not written>
MFG_OSC24M_SETTLE_DELAY	Crystal Stabilizing Time	<not written>
MFG_SECURITY_CONFIG	Security Settings	<not written>
MFG_CCA_THRESHOLD	CCA Threshold	0xFEBF
MFG_SECURE_BOOTLOADER_KEY	Secure Bootloader Key	<not written>

**Table 4. Manufacturing tokens**

## 5.2 Custom Firmware

The ETRX3585-LRS series of modules is an ideal platform for developing custom firmware. In order to develop custom firmware the Silicon Labs Ember toolchain is required.

When writing firmware for the ETRX3585-LRS it is important to ensure that pins PB0 and PC5 are correctly configured in order that the RF front-end module can operate correctly. An application note "Writing customised firmware for the ETRX35x-LRS" can be downloaded from the Telegesis website.

## 5.3 Boost Mode vs. Normal Mode

The Ember EM3585 chips support a "boost mode" power setting next to the "normal mode" power setting. The "boost mode" setting increases the sensitivity and output power of the radio transceiver, however with the LRS variants enabling boost mode has no positive effect on neither the output power nor the sensitivity and therefore it is recommended to not use boost mode on this platform.

Section 10.2 lists the requirements for the maximum power settings for use of the LRS family in different countries.



## 6 Absolute Maximum Ratings

No.	Item	Symbol	Absolute Maximum Ratings	Unit
1	Supply voltage	$V_{CC}$	-0.3 to +3.6	Vdc
2	Voltage on any Pad	$V_{in}$	-0.3 to $V_{CC} + 0.3$	Vdc
3	Voltage on any Pad pin (PA4, PA5, PB5, PB6, PB7, PC1), when used as an input to the general purpose ADC with the low voltage range selected	$V_{in}$	-0.3 to +2.0	Vdc
4	Module storage temperature range	$T_{stg}$	-40 to +105	°C
5	Reel storage temperature range	$T_{strgreel}$	0 to 75	°C
6	Operating temperature range	$T_{op}$	-40 to +85	°C
7	Input RF level	$P_{max}$	+6	dBm
8	Reflow temperature	$T_{Death}$	Please refer to chapter 12	°C

**Table 5: Absolute Maximum Ratings**

The absolute maximum ratings given above should under no circumstances be violated. Exceeding one or more of the limiting values may cause permanent damage to the device.



Caution! ESD sensitive device. Precautions should be used when handling the device in order to prevent permanent damage.

### 6.1 Environmental Characteristics

No.	Item	Symbol	Absolute Maximum Ratings	Unit
1	ESD on any pad according to Human Body Model (HBM) circuit description	$V_{THHBM}$	±2	kV
2	ESD on non-RF pads according to Charged Device Model (CDM) circuit description	$V_{THCDM}$	±400	V
3	ESD on RF terminal (HBM)	$V_{THCDM}$	1000	V
4	Moisture Sensitivity Level	MSL	MSL3, per J-STD-033	

**Table 6: Absolute Maximum Ratings**

### 6.2 Recommended Operating Conditions

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Supply voltage		$V_{CC}$	2.1	3.0	3.6	Vdc
2	RF Input Frequency		$f_c$	2405		2480	MHz
3	RF Input Power		$P_{IN}$			0	dBm
4	Operating temperature range		$T_{op}$	-40		+85	°C

**Table 7. Recommended Operating Conditions**

## 7 DC Electrical Characteristics

V<sub>CC</sub> = 3.0V, T<sub>AMB</sub> = 25°C, NORMAL MODE (non-Boost) unless otherwise stated

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Module supply voltage		V <sub>CC</sub>	2.1		3.6	Vdc
<b>Deep Sleep Current</b>							
2	Quiescent current, internal RC oscillator disabled,	4kB RAM retained	I <sub>SLEEP</sub>		1.0		μA
3	Quiescent current, internal RC oscillator enabled	4kB RAM retained	I <sub>SLEEP</sub>		1.25		μA
4	Quiescent current, including 32.768kHz oscillator	4kB RAM retained	I <sub>SLEEP</sub>		1.6		μA
5	Quiescent current including internal RC oscillator and 32.768kHz oscillator	4kB RAM retained	I <sub>SLEEP</sub>		1.9		μA
6	Additional current per 4kB block of RAM retained		I <sub>RAMSLEEP</sub>		0,067		μA
<b>Reset Current</b>							
7	Quiescent current nReset asserted		I <sub>RESET</sub>		2	3	mA
<b>Processor and Peripheral Currents</b>							
8	ARM® Cortex™ M3, RAM and flash memory	25°C, 12MHz Core clock	I <sub>MCU</sub>		7.5		mA
9	ARM® Cortex™ M3, RAM and flash memory	25°C, 24MHz Core clock	I <sub>MCU</sub>		8.5		mA
10	ARM® Cortex™ M3, RAM and flash memory sleep current	25°C, 12MHz Core clock	I <sub>MCU</sub>		4.0		mA
11	ARM® Cortex™ M3, RAM and flash memory sleep current	25°C, 6MHz Core clock	I <sub>MCU</sub>		2.5		mA
12	Serial controller current	Per serial controller at max. clock rate	I <sub>SC</sub>		0.2		mA
13	General purpose timer current	Per timer at max. clock rate	I <sub>TIM</sub>		0.25		mA
14	General purpose ADC current	Max. Sample rate, DMA	I <sub>ADC</sub>		1.1		mA
15	USB Active Current		I <sub>USB</sub>		1		mA
16	USB Suspend Mode Current		I <sub>USBSUSP</sub>			2.5	mA
<b>RX Current</b>							
17	LNA, Radio receiver MAC and Baseband	ARM® Cortex™ M3 sleeping.	I <sub>RX</sub>		26.5		mA
18	Receive current consumption	Total, 12MHz clock speed	I <sub>RX</sub>		30		mA
19	Receive current consumption	Total, 24MHz clock speed	I <sub>RX</sub>		31.5		mA

TX Current							
20	Transmit current consumption	at +20dBm module output power	$I_{TXVCC}$		140		mA
21	Transmit Current consumption	at min module output power	$I_{TXVCC}$		52		mA
Sleep Modes & Peripheral Current							
22	MCU, RAM and flash, FEM, radio off	12MHz clock speed	$I_{MCU}$		7		mA
23	MCU, RAM and flash, FEM, radio off	24MHz clock speed	$I_{MCU}$		8		mA
24	Serial Controller	Max data rate	$I_{SC}$		0.2		mA
25	Timer	Max clock rate	$I_{TMR}$		0.25		mA
26	ADC	Max sample rate	$I_{ADC}$		1.1		mA

**Table 8: DC Electrical Characteristics**

## 8 Digital I/O Specifications

The digital I/Os of the ETRX3585-LRS module have the ratings shown below.

$V_{CC} = 3.0V$ ,  $T_{AMB} = 25^{\circ}C$ , NORMAL MODE unless otherwise stated

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Low Schmitt switching threshold	Schmitt input threshold going from high to low	$V_{SWIL}$	$0.42 \times V_{CC}$		$0.5 \times V_{CC}$	Vdc
2	High Schmitt switching threshold	Schmitt input threshold going from low to high	$V_{SWIH}$	$0.62 \times V_{CC}$		$0.8 \times V_{CC}$	MHz
3	Input current for logic 0		$I_{IL}$			-0.5	$\mu A$
4	Input current for logic 1		$I_{IH}$			0.5	$\mu A$
5	Input Pull-up resistor value		$R_{IPU}$	24	29	34	k $\Omega$
6	Input Pull-down resistor value		$R_{IPD}$	24	29	34	k $\Omega$
7	Output voltage for logic 0	$I_{OL} = 4mA$ (8mA) for standard (high current) pads	$V_{OL}$	0		$0.18 \times V_{CC}$	V
8	Output voltage for logic 1	$I_{OH} = 4mA$ (8mA) for standard (high current) pads	$V_{OH}$	$0.82 \times V_{CC}$		$V_{CC}$	V
9	Output Source Current	Standard current pad	$I_{OHS}$			4	mA
10	Output Sink current	Standard current pad	$I_{OLS}$			4	mA
11	Output Source Current	High current pad (1)	$I_{OHH}$			8	mA
12	Output Sink current	High current pad (1)	$I_{OLH}$			8	mA
13	Total output current		$I_{OH} + I_{OL}$			40	mA

**Table 9. Digital I/O Specifications**

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Low Schmitt switching threshold	Schmitt input threshold going from high to low	$V_{SWIL}$	$0.42 \times V_{CC}$		$0.5 \times V_{CC}$	Vdc
2	High Schmitt switching threshold	Schmitt input threshold going from low to high	$V_{SWIH}$	$0.62 \times V_{CC}$		$0.68 \times V_{CC}$	Vdc
3	Input current for logic 0		$I_{IL}$			-0.5	$\mu A$
4	Input current for logic 1		$I_{IH}$			0.5	$\mu A$
5	Input Pull-up resistor value	Chip not reset	$R_{IPU}$	24	29	34	k $\Omega$
6	Input Pull-up resistor value	Chip reset	$R_{IPURESET}$	12	14.5	17	k $\Omega$

**Table 10. nReset Pin Specifications**

### Notes

1) High current pads are PA6, PA7, PB6, PB7, PC0

## 9 A/D Converter Characteristics

The ADC is a first-order sigma-delta converter. For additional information on the ADC please refer to the EM358x datasheet.

No.	Item	
1	A/D resolution	Up to 14 bits
2	A/D sample time for 7-bit conversion	5.33μs (188kHz)
3	A/D sample time for 14-bit conversion	682μs
4	Reference Voltage	1.2V

**Table 11. A/D Converter Characteristics**

## 10 AC Electrical Characteristics

$V_{CC} = 3.0V$ ,  $T_{AMB} = 25^{\circ}C$ , NORMAL MODE measured at 50Ω terminal load connected to the U.FL socket

No.	Receiver	Value			Unit
		Min	Typ	Max	
1	Frequency range	2400		2500	MHz
2	Sensitivity for 1% Packet Error Rate (PER)	-107	-106	-100	dBm
4	Saturation (maximum input level for correct operation)	-3	2		dBm
5	High-Side Adjacent Channel Rejection (1% PER and desired signal -82dBm acc. to [1])		41		dB
6	Low-Side Adjacent Channel Rejection (1% PER and desired signal -82dBm acc. to [1])		40		dB
7	2 <sup>nd</sup> High-Side Adjacent Channel Rejection (1% PER and desired signal -82dBm acc. to [1])		54		dB
8	2 <sup>nd</sup> Low-Side Adjacent Channel Rejection (1% PER and desired signal -82dBm acc. to [1])		52		dB
9	Channel Rejection for all other channels (1% PER and desired signal -82dBm acc. to [1])		tbd		dB
10	802.11g rejection centred at +12MHz or -13MHz (1% PER and desired signal -82dBm acc. to [1])		tbd		dB
11	Co-channel rejection (1% PER and desired signal -82dBm acc. to [1])		tbd		dBc
12	Relative frequency error (2x40ppm required by [1])	-120		120	ppm
13	Relative timing error (2x40ppm required by [1])	-120		120	ppm
14	Linear RSSI range	35			dB
15	Output power at highest power setting NORMAL MODE BOOST MODE	20 20	21 21	21.5 21.5	dBm
16	Output power at lowest power setting			-40	dBm
17	Error vector magnitude as per IEEE802.15.4		7	15	%
18	Carrier frequency error	-40 {1}		40 {1}	ppm

**Table 12. AC Electrical Characteristics**

### Notes

{1} Applies across the full ranges of rated temperature and supply voltage.

**Please Note:** For the relationship between EM3585 power settings and module output power please relate to chapter 10.1 of this document. When developing custom firmware the output power settings described in this document relate directly to the EM3585 power settings accessible via the Ember stack API.

No.	Synthesiser Characteristics	Limit			Unit
		Min	Typ	Max	
22	Frequency range	2400		2500	MHz
23	Frequency resolution		11.7		kHz
24	Lock time from off state, with correct VCO DAC settings			100	µs
25	Relock time, channel change or Rx/Tx turnaround			100	µs
26	Phase noise at 100kHz offset		-71dBc/Hz		
27	Phase noise at 1MHz offset		-91dBc/Hz		
28	Phase noise at 4MHz offset		-103dBc/Hz		
29	Phase noise at 10MHz offset		-111dBc/Hz		

**Table 13. Synthesiser Characteristics**

No.	Power On Reset (POR) Specifications	Limit			Unit
		Min	Typ	Max	
30	V <sub>CC</sub> POR release	0.62	0.95	1.2	Vdc
31	V <sub>CC</sub> POR assert	0.45	0.65	0.85	Vdc

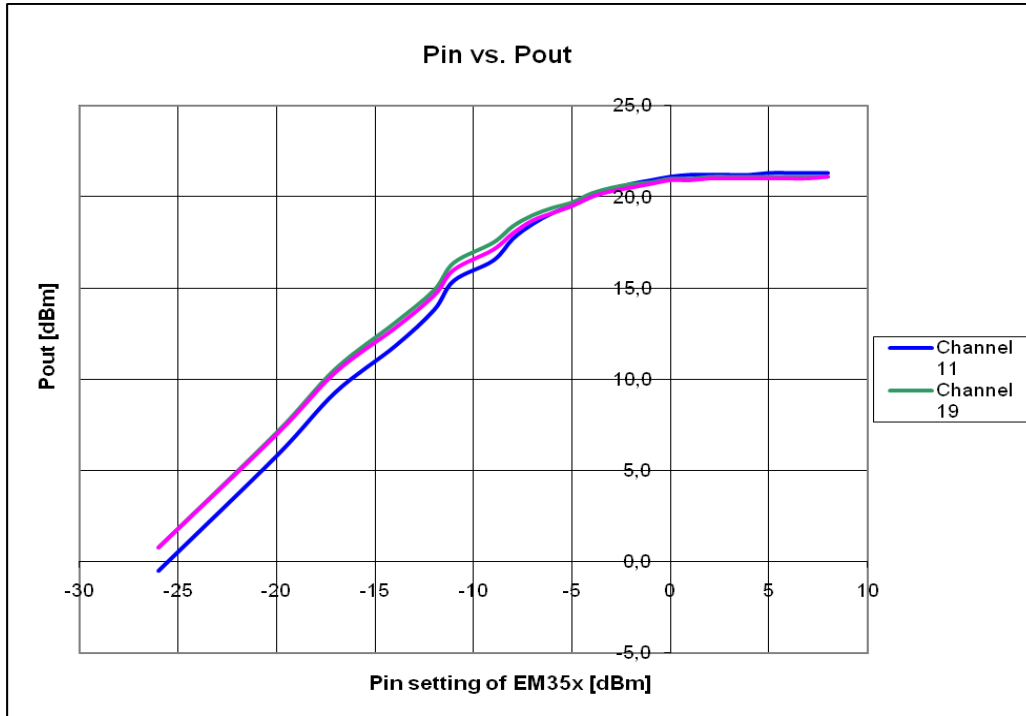
**Table 14. Power On Reset Specifications**

No.	nRESET Specifications	Limit			Unit
		Min	Typ	Max	
32	Reset Filter Time constant	2.1	12	16	µs
33	Reset Pulse width to guarantee a reset	26			µs
34	Reset Pulse width guaranteed not to cause reset	0		1	µs

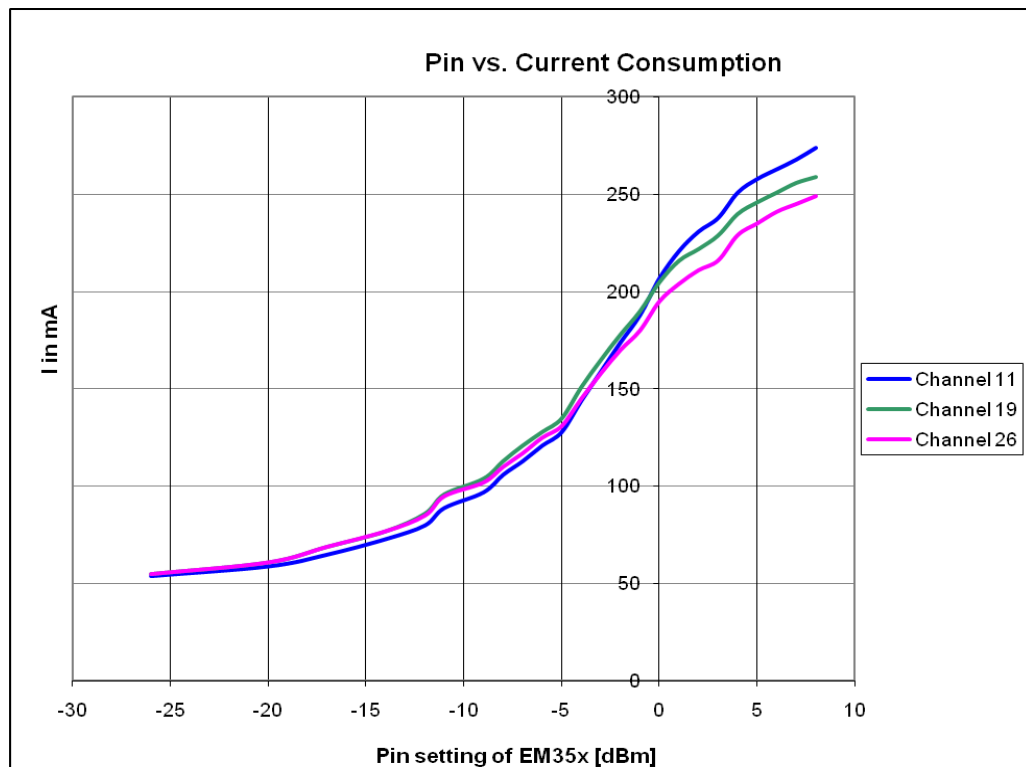
**Table 15. nReset Specifications**

### 10.1 TX Power Characteristics

The diagrams below show the typical output power and module current in dependency on EM3585-LRS power setting in NORMAL MODE at 3.6V and room temperature.



**Figure 3. Output Power vs. Power Setting**



**Figure 4. Module Current vs. Power Setting**

## 10.2 Power Settings for Regulatory Compliance

Because of the high gain of the frontend module output power of up to 22dBm can be achieved. When the antenna gain is included the output power of the EM3585 transceivers needs to be reduced for regulatory compliance. The following tables list the maximum permitted power setting for the antenna types listed in Table 2. Note that this is the power out of the EM3585 chip, and the power delivered to the antenna will be higher by the gain of the RF power amplifier.

( $V_{CC} = 3.3V$ ,  $T_{AMB} = 25^{\circ}C$ , NORMAL MODE)

Antenna	Channels 11-24	Channel 25	Channel 26
1/2 Wave	-17	-17	-17
1/4 Wave	-17	-17	-17
On Board	-17	-17	-17

**Table 16: Maximum Power Settings for European Compliance**

Finally Table 17 the maximum Power settings for FCC and IC compliance.

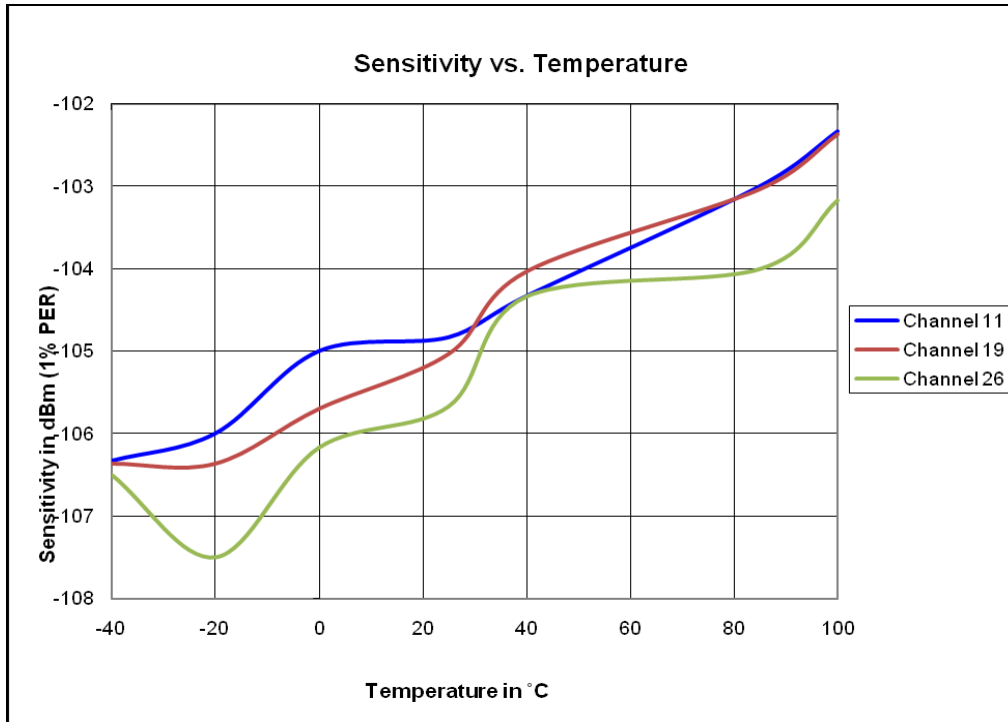
Antenna	Channels 11-24	Channel 25	Channel 26
1/2 Wave	-8	-12	-43
1/4 Wave	-8	-8	-26
On Board	-7	-7	-26

**Table 17: Maximum Power Settings for FCC, IC Compliance**

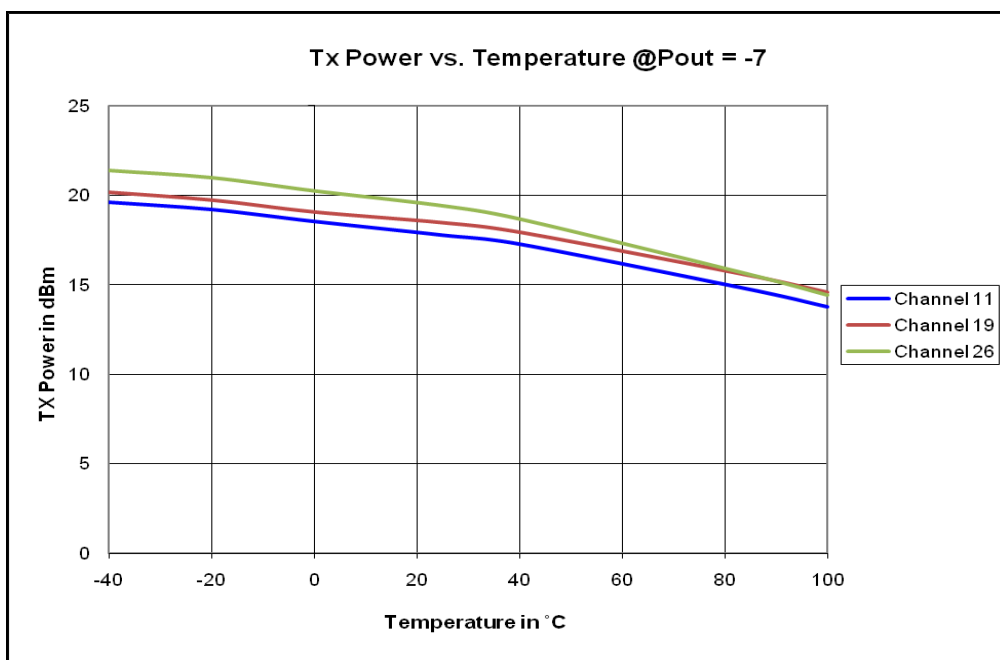


### 10.3 Temperature behaviour

Figure 5 and Figure 6 illustrate the temperature behaviour of the ETRX3585-LRS series of modules. Please note that although the temperature behaviour was measured to up to 100 degrees Celsius the absolute maximum rating is 85 degrees Celsius.

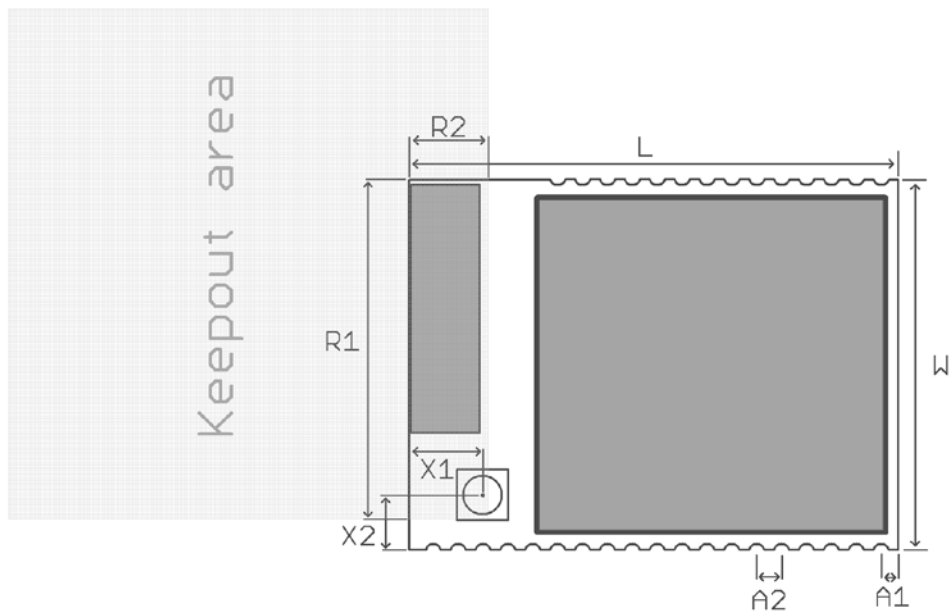


**Figure 5. Sensitivity vs. Temperature**



**Figure 6. TX Power vs. Temperature**

## 11 Physical Dimensions



**Figure 7. ETRX3 Physical Dimensions**

Symbol	Explanation	Distance
L	Length of the module	25.0mm
W	Width of the module	19.0mm
H	Height of the module	3.8mm
A1	Distance centre of pad PCB edge	0.9mm
A2	Pitch	1.27mm
R1	Keep-out Zone from corner of PCB	17.5mm
R2	Keep-out Zone from corner of PCB	4.1mm
X1	Distance centre of Antenna connector PCB edge	3.8mm
X2	Distance centre of Antenna connector PCB edge	2.8mm

**Table 18. ETRX3 Physical Dimensions**

For ideal RF performance when using the on-board antenna, the antenna should be located at the corner of the carrier PCB. There should be no components, tracks or copper planes in the “keep-out” area which should be as large as possible. When using the U.FL RF connector the “keep-out” area does not have to be kept. **NB:** The modules’ transmit/receive range will depend on the antenna used and also the housing of the finished product.