TG-ETRX1-PM-01-106

ETRX1 (ZIGBEE™ READY) MODULE

PRODUCT MANUAL

Telegesis

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1. Introduction

This document describes the Telegesis ETRX1 wireless meshing Module which has been designed to be integrated into another device and to provide a fast, simple and low cost (ZigBee compatible with adoption of the EmberZstack) interface.

The Telegesis ETRX1 Module has been designed to be built into any device and provide a low cost low power radio, ZigBee™ ready meshing solution, using the Ember technologies EmberNet stack. Integration into a wide range of applications is made easy using a simple AT style software interface and advanced hardware design.

No RF experience or expertise is required to add this powerful wireless networking capability to your products. The ETRX1 offers fast integration opportunities and the shortest possible time to market for your product.

2. ETRX1 Function Summary

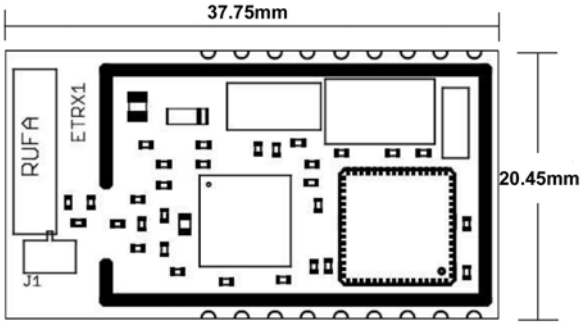
The Telegesis ETRX1 has been designed to be built into any device and provide a low cost, low power, ZigBee™ ready meshing solution, using the proven EmberNet technology. No RF experience or expertise is required to add this powerful wireless networking capability to your products. The ETRX1 offers fast integration opportunities and the shortest possible time to market for your product. The AT style command line interface allows the adopter to quickly integrate meshing radio technology into any product without the need for complex programming or RF design work.

Suggested Applications

- AMR – Automatic Meter Reading
- Wireless Alarm and Security
- Home/Building Automation
- Wireless sensor Networks
- Industrial Control
- ZigBee™ systems
- PC Peripherals
- IEEE 802.15.4 systems

Module Features

- Small form factor, SMT module 37.75mm x 20.45mm x 3.4mm
- Optional board to board or board to cable plug-in connector
- Integrated antenna or alternative Hirose U.FL antenna connector
- UART interface for easy communication
- IEEE 802.15.4 compliant
- Can act as FFD, RFD and Coordinator
- Hosts the Atmel Atmega 128L and the Ember EM2420
- 128k flash, 4kbytes EEPROM and 4kbytes of RAM
- Up to 8 MIPS processing power
- Module comes with standard Telegesis AT style software interface.
- Also available without Telegesis AT style interface or with customer specific firmware
- 8 general purpose I/O lines and 2 analogue inputs
- In System programmable
- Optional JTAG Support
- Supports 5 different power down modes
- Based on the proven EmberNet classic Stack
- Full ZigBee™ compliance will be available with the upcoming EmberZNet stack
- Firmware upgrades via RS232 or over the air (password protected)
- Hardware supported encryption (AES-128)
- Supply voltage 2.7V – 3.6V
- Current Consumption as low as 15uA in sleep mode
- Tested for CE and FCC compliance (with integrated antenna)
- Operating temperature range -20^{0}C to +65^{0}C



Radio Features

- Based on the Ember EM2420, 2.4GHz ISM Band.
- Direct Sequence Spread Spectrum RF transceiver (DSSS)
- 250kbit/s effective data rate
- Very Low Power (– 30mA in Rx)
- 16 channels (802.15.4 Channel 11 to 26)
- Up to –1dBm output power

Development Support

- A Development Kit is available with a development board with RS232 connectivity and I/O break-outs
- For high volume customers the AT style software interface command dictionary can be extended
- Custom software development can be provided on request

Example AT-Style Commands

- AT+SN — Search network & discover devices
- AT+BCAST — Sends a Broadcast
- AT+UCAST:<address> — Sends a Unicast
- AT+ASS:<address> — Associate Node

At Power-up the last configuration is loaded from EEPROM. This can eliminate the need for an additional Host Controller.

3. Product Approvals

3.1. CE & FCC Approvals

The ETRX1 has been designed to meet all national regulations for World-wide use. It has been tested and approved by a certified laboratory for RF Transmission, EMC and for general product safety.

Using the integrated Antenna it conforms with EN300 440 (Europe) and FCC CFR 47 Part 15 (USA).

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: S4GETRX1

Please Note:

The ETRX1 device carries FCC authorization and is marked with the FCC ID Number. Whilst any device into which this authorized module is installed will not normally be required to obtain FCC authorization, this does not preclude the possibility that some other form of authorization or testing may be required for the finished device.

When the ETRX1 module is integrated inside another device/product, then the outside surface of that device/product must display a label referring to the enclosed module. This exterior label can use wording such as **"Contains Transmitter Module FCC ID: S4GETRX1"** or **"Contains FCC ID: S4GETRX1"** although any similar wording that expresses the same meaning may be used.

This module complies with the USA SAR requirements and is not intended to be operated with in 20cm of the body.

3.2. IEEE 802.15.4

IEEE 802.15.4 is a standard for low data rate wireless networks (typically data rates of 250 kbps, 40 kbps, and 20 kbps) 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.

3.3. The ZigBee™ Protocol

The ZigBee™ Protocol is a new set of standards for wireless connectivity between any devices over short distances (100 metres). The specification was 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 endpoint.

4. Frequently Asked Questions

- What is the ZigBee™ Alliance?

The ZigBee™ Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked, monitoring and control products based on an open global standard.

The goal of the ZigBee™ Alliance is to provide the consumer with ultimate flexibility, mobility, and ease of use by building wireless intelligence and capabilities into every day devices. ZigBee™ technology will be embedded in a wide range of products and applications across consumer, commercial, industrial and government markets worldwide. For the first time, companies will have a standards-based wireless platform optimised for the unique needs of remote monitoring and control applications, including simplicity, reliability, low-cost and low-power.

- Why do we need ZigBee™ ?

Until The ZigBee™ Standard was ratified in December of 2004 there was no standard approach that addressed the unique needs of most remote monitoring and control applications. The ZigBee™ Standard enables the broad-based deployment of reliable wireless networks with low complexity, low cost solutions and provides the ability for a product to run for years on inexpensive primary batteries (for a typical monitoring application). It is also, of course, capable of inexpensively supporting robust mesh networking technologies

- What is the EmberZNet Stack?

The Telegesis ETRX1 utilises the EmberNet/EmberZNet protocol stacks and can form a scalable, self-organizing, self-healing wireless networking platform based on the ZigBee™ specifications. The EmberZNet supports a variety of network topologies for wireless monitoring and control applications, including mesh, star, and cluster tree. Applications running the EmberZNet stack can be interoperable with other ZigBee™ nodes. EmberZNet provides all of the standard benefits that come with ZigBee™ including: flexible topologies, high security, broad interoperability, low cost, long battery life, and integrated network management. In addition, EmberZNet applications can take advantage of the industrial strength reliability and unprecedented ease of use of the Ember Transport Layer capabilities.

Until now, much of the cost of deploying sensing and control devices was in installing the network to connect them. With EmberZNet, the value, like the network, is embedded in the devices themselves. EmberZNet's self-organizing, self-healing mesh algorithms produce networks that are reliable, flexible, secure, and easy to use. Adding devices only makes EmberZNet sensing and control networks stronger and more efficient. Designed from the ground up for developers of sensing and control products, the EmberZNet product suite enables rapid development and deployment of embedded wireless networks that virtually "see around corners," and that have no single point of failure.

The EmberZNet Protocol Stack is a compact, scalable implementation of the ZigBee specifications which translates into lower cost MCU options for device manufacturers. The stack is available in different configurations optimized for the various ZigBee node types; PAN coordinators, full function devices, and reduced function devices. The stack is already available for several microprocessor platforms supported by Ember.

- Where would my application sit?

There are a number of options. When using the Telegesis AT style command interface the application sits on a host microcontroller which is external to the ETRX1 Module. Additionally the ETRX1 can be used stand-alone using the pre-defined functionality defined in the non volatile S-Registers. The S-Registers (shown in Section 10) are mostly non-volatile registers holding the configuration data of the ETRX1 wireless meshing module. If you decide to develop your own firmware instead of using the Telegesis "AT style" command interface then it can run on the Atmel ATmega128L on the ETRX1 module.

- What do I need to start my development?

The quickest and easiest way to begin your development is to use a set of ETRX1DV development kits, but if you wish you could integrate the ETRX1 onto your own carrier boards. To connect the ETRX1 to a PC you will need to use an RS232 level converter or alternatively connect the ETRX1 straight to a host microcontroller.

5. Absolute Maximum Ratings

Parameter	Min.	Max.	Units	Condition
Supply Voltage Vdd	-0.3	3.6	V	
Voltage on any pin	-0.3	V_{dd}+0.3, max 3.6	V	
Input RF level		10	dBm	
Storage Temperature range	-50	150	°C	
Reflow Soldering Temperature		260	°C	T=10s

Table 1: 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. Operating Conditions

Typical values at 3.3V 25°C.

Parameter	Min.	Typ.	Max.	Units	Condition
Supply Voltage, Vdd	2.7	3.3	3.6	V	
Supply Current		30		mA	TX –1dBm
		22		mA	TX – 10dBm
		19		mA	TX –20dBm
		18		mA	TX –30dBm
		30		mA	RX
		10		mA	Sleep Mode 1
		3.3		mA	Sleep Mode 2
		4.2		mA	Sleep Mode 3
		4.2		mA	Sleep Mode 4
		15		uA	Sleep Mode 5
Operating ambient temperature range	-20	25	70	°C	

Table 2: Operating Conditions

7. Electrical Specifications

Parameter	Min.	Typ.	Max.	Units	Condition
Radio Characteristics					
Frequency Range	2.405		2.480	GHz	
Adjustable output power	-31		-1	dBm	
Receiver sensitivity		TBA		dBm	PER=1%
Channel Spacing		5		MHz	
Spurious Emissions			TBA	dBm	TX 30-1000MHz
			TBA	dBm	TX 1-12.75GHz
			TBA	dBm	TX 1.8-1.9Ghz
			TBA	dBm	TX 5.15-5.3GHz
			TBA	dBm	RX 0-1000MHz
			TBA	dBm	RX 1-12.75GHz
Optimum load Impedance		50		Ω	Using external Antenna
Adjacent channel rejection		46		dB	+5MHz
		39		dB	-5MHz
Alternate Channel Rejection		58		dB	+10MHz
		55		dB	-10MHz
Frequency error tolerance	-300		300	kHz	
Symbol rate error tolerance			120	ppm	
DC Characteristics					
Input Low Voltage	-0.5		$0.2*V_{CC}$	V	
Input High Voltage	$0.6*V_{CC}$		$V_{CC}+0.5$	V	
Output Low Voltage			0.5	V	V_{CC}=3V I=10mA
Output High Voltage	2.4			V	V_{CC}=3V
IO Pin Pull-up Resistor	20		50	k Ω	
ADC Input Resistance	55	100		M Ω	
AC Characteristics					
UART Baud Rate	1200	38400	38400	Bps	
UART Error					
1200		0.2		%	
2400		0.2		%	
4800		0.2		%	
9600		0.2		%	
14400		-0.8		%	
19200		0.2		%	
28800		2.1		%	
38400					
ADC Conversion Time		2		µs	
ADC Input Bandwidth			38.5	kHz	
Special function Pin output frequency			4MHz		PWM available below 2MHz

Table 3: Electrical Specifications

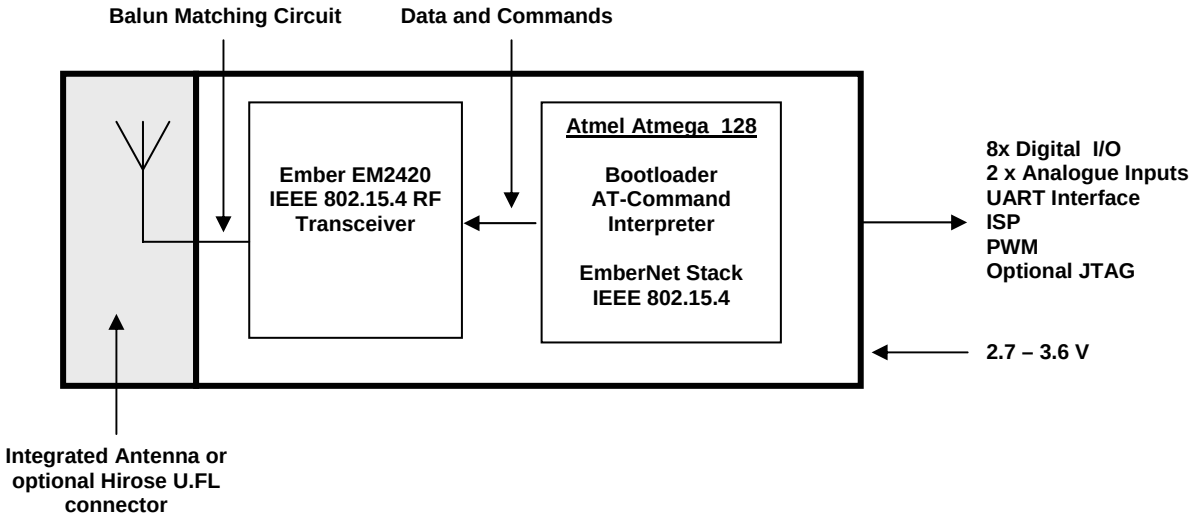
8. Functional Description

The Telegesis ETRX1 Module has been designed to be built into any device and provide a low cost, low power, ZigBee™ ready meshing solution, using the Ember technologies EmberNet stack. Integration into a wide range of applications is made easy using a simple AT style command interface.

As shown in Figure 1, the module hosts the Ember EM2420 802.15.4 Transceiver and the Atmel Atmega 128L. The flexible architecture also allows the module to be used for custom software based on any existing or upcoming software stack.

The on-board antenna allows easy integration without the need for RF expertise. If required the module can be supplied with a U.FL antenna connector to connect an external antenna.

Figure 1. Block Diagram



The Atmel Atmega 128L is clocked at 8MHz delivering up to 8MIPS of processing power. For timekeeping an additional 32.768kHz crystal is used. The microcontroller can be programmed in circuit using an in-circuit programmer. Alternatively the pre-programmed boot-loader can be used to upgrade the firmware via the UART or over the air. Note that in circuit programming using a programmer will erase the boot-loader.

The EM 2420 transceiver uses Direct Sequence Spread Spectrum (DSSS) with 2 Mchip/s chip rate giving a raw data rate of 250k/bits. The modulation format is Offset Quadrature Phase Shift Keying (O-QPSK). The DSSS makes the communication link robust in noisy environments when sharing the same frequency band with other applications.

For full details on the Ember EM2420 2.4GHz transceiver and the Atmel Atmega 128L please consult the respective data sheets.

The use of RF frequencies and maximum allowed RF power is limited by national regulations. The ETRX1 complies with the applicable regulations for the world-wide 2.45GHz ISM band. For full details please see Section 3 on Product Approvals.

8.1. Device Pin-out

There are two ways of interfacing with the ETRX1 module. Firstly, the module can be surface mounted using the 18 pads situated on the edges of the module. Secondly, a 2x8, 1.27mm pitch surface mount header (included) can be attached to the bottom of the board to allow a plug-in solution. The latter is ideally suited for applications where the radio needs to be retrofitted as an upgrade in the field.

Table 4. Gives an overview of the pin-out and its functionality.

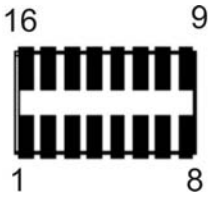
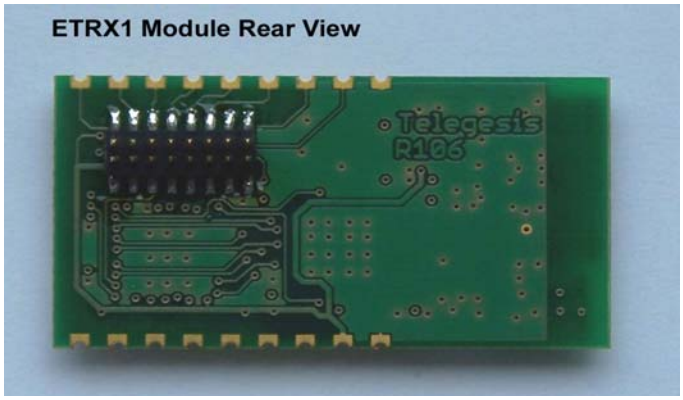


Figure 2: Pin configuration of Socket



The pin configuration shown in Figure 2 is valid when looking down onto the Socket of the carrier PCB (i.e. devboard) with pin 1 facing towards the Antenna of the ETRX1.

Corner Pad	Connector Pin	Name	Functionality	ATMEGA Pin
1	1	GND	GND	GND
2	8	V_{CC}	V_{CC}	V_{CC}
3	1	GND	GND	GND
4	2	A/D1	A/D JTAG[1]	PF7 (ADC7/TDI)
5	3	A/D2	A/D JTAG[1]	PF6 (ADC6/TDO)
6	4	I/O7	I/O JTAG[1]	PF5 (ADC5/TMS)
7	5	I/O6	I/O JTAG[1]	PF4 (ADC4/TCK)
8	6	I/O5	I/O ISP	PE1 (TXD0/PDO)
9	7	I/O4	I/O ISP	PE0 (RXD/PDI)
10	9	SCK	ISP[2]	PB1 (SCK)
11	10	I/O3	I/O	PB4 (OC0)
12	11	I/O2	I/O SFPIN	PB7 (OC2/OC1C)
13	12	RESET	Reset	Reset
14	13	I/O1	I/O INT1 TWI[3]	PD1 (SDA/INT1)
15	14	I/O0	I/O INT0 TWI[3]	PD0 (SCL/INT0)
16	16	TXD	TXD	PD3 (TXD1/INT3)
17	15	RXD	RXD	PD2 (RXD1/INT2)
18	1	GND	GND	GND

Table 4: Pin Configuration

[1] By default JTAG is disabled. Enabling JTAG functionality will sacrifice A/D1, A/D2 as well as I/O7 and I/O6.
[2] SCK must not be used for any other purpose than in-system programming!
[3] The TWI (Two wire interface) is not supported by the current firmware release, but can be used with custom specific firmware.

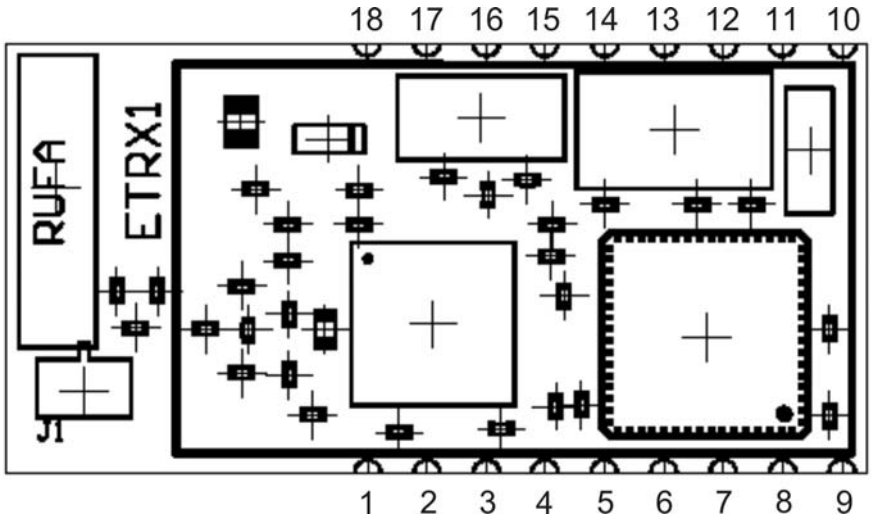


Figure 3: Pin Configuration of the corner pads

8.2. Firmware Description

The modules are pre-loaded with the Ember bootloader which supports over-the-air bootloading as well as serial bootloading of new firmware. The modules also contain the current release of the Telegesis AT style command interface. Check www.telegesis.com for updates.

Each module comes with a unique 64 bit 802.15.4 identifier which is stored in EEPROM.

The default AT-style command interface firmware is based on the EmberNet classic stack which implements a full function device (FFD). The AT style command line interpreter has been developed by Telegesis to allow easy access to the low level functionality.

The module is able to act as a PAN coordinator through external host control. The AT style command line supplies all the tools required to set up and manage mesh and star topologies or a mixture of both.

Using the command line interface RFD or leaf devices are emulated by using the EmberNet classic stack with the routing features disabled. This allows them to go to sleep as they have no routing responsibilities in the network. The ETRX1 uses the full functionality stack, rather than the EmberNet Leaf Stack for RFD's and leaf nodes to overcome some of the routing restraints of classic leaf nodes whilst still allowing them to save power being asleep.

The firmware allows low level access to physical parameters such as channel and power level. Parameters which define the functionality of the ETRX1 module and also allow standalone functionality are saved in non volatile EEPROM organised in so called S-Registers.

The TWI (Two wire interface) is not supported by the current firmware release, but can be used with custom firmware.

8.2.1. Custom Firmware

For high volume customers the firmware can be customised on request.

8.3. Interface Description

ADC

The module has two analogue inputs A/D1 and A/D2. Readings with reference to Vcc can be made locally as well as remotely.

I/O

Pins I/O7 down to I/O0 are bi-directional I/O ports which can be controlled locally as well as remotely by accessing local as well as remote S-registers. Although they are on different ports of the microcontroller they can be controlled using three single 8 bit registers representing the data direction, the output buffer and the input buffer.

ISP

Pins I/O5, I/O4, SCK and reset can be used to in-circuit program the module if required. Reprogramming the flash of the microcontroller will delete the bootloader.

UART

Via the TXD and RXD pins the AT style command interpreter can be accessed. The ETRX1 can buffer up to 128 bytes of incoming data in a software FIFO buffer and uses XON/XOFF flow control. See the datasheet of the Atmel Atmega 128L for more information about the build-in UART.

Interrupt

Level changes on pins I/O0 and I/O1 will cause an interrupt to the module if defined as input in the corresponding data direction register.

Reset

Pulling the reset pin low will cause the module to restart. A external pull-up is not required.

PWM

I/O4 can alternatively act as a special function pin which can generate clocks up to 4MHZ or act as a PWM. This functionality can be controlled locally as well as remotely by accessing local as well as remote S-registers.

Antenna

Matching is provided to match the radio to the integrated antenna or to an optional external general purpose 2.4GHz antenna. The internal Rufa antenna is supplied by GigaAnt. For full data on the Rufa antenna please refer to the gigaAnt Rufa data sheet, www.gigaant.com.

Power

The module is able to operate from 3.6V down to 2.7V which makes it ideally suited for battery powered applications.

9. AT Style Command Conventions

To simplify the communication with the ETRX1 module an AT command set, similar to the industry standard Hayes modem control language, is used.

Each command must be preceded by the "AT" or "at" prefix. To terminate a command line enter <CR>. Any data not following this pattern is either not accepted by the module or will cause an error message in response. Also, a mix of upper and lower case letters like “At+BloAd” will not be accepted. Commands need to be issued either completely in upper case or completely in lower case characters.

Commands are followed by a response that includes .<CR><LF><response><CR><LF>. Any data which is prompted to the user is delivered in the format <prompt><CR><LF>. Prompts may appear whenever the corresponding event occurs. A prompt intersecting a command being entered will not affect the command itself.

Throughout this document, only the responses are presented, <CR><LF> are omitted intentionally. It is recommended to wait for a response before issuing the next command. Also sequences of AT commands in a single line are not supported.

The ETRX1 features a 128 byte receive FIFO to buffer incoming characters. To prevent a buffer overflow caused by incoming data in excess of 128 bytes XON/XOFF handshaking is used.

Read Command **AT+XXX?**	Commands ending with a ‘?’ return the currently set value of the parameter or parameters
Write Command **AT+XXX=<…>**	This command sets user-definable parameters as indicated by the ‘=’ sign.
Execution Command **AT+XXX**	This command executes routines of the module and returns parameters

Table 5: Types of AT commands and responses

9.1. Using parameters

There are no default or optional parameter sets, so each parameter must be entered in the correct format.

<XX>	8 bit hexadecimal number. Valid characters are 0-9, a-f and A-F.
n, <n>	Number from 0-9
S	Sign
C	character
<errorcode>	8 bit hexadecimal error code as explained in 11.
<EUI64>	32 bit 802.15.4 address in hexadecimal e.g. **0123456789ABCDEF**

Table 6: Different formats of parameters

9.2. AT Command Syntax

The AT commands can be divided into the three following sections, namely module control & configuration commands, communication commands and I/O commands. The following table gives a quick reference of all commands available.

Command Overview	
ATZ	**Software Reset**
AT&F	Restore Factory Settings
AT+REMZ	Reset Remote Node
ATI	Display Product Identification Information
AT+BLOAD	Enter the Bootloader Menu
AT+CLONE	Clone Local Node to Remote Node
AT+TEST	Run Self Test
ATSn	S-Register Access
AT+PDWN	Power Control
AT+BTABLE	Display the Devices Binding Table
AT+COO	Display the Devices Coordinator
AT+ESCAN	Scan the Energy of the Current Channel
AT+SN	Scan Network for other Nodes
AT+EN	Establish PANetwork
AT+SORPHAN	Scan for Orphans
AT+EBN	Establish PANetwork using Beacons
AT+SNEIGHBOURS	Scan for Neighbours
AT+PING	Indicate Presence in the Network
AT+ASS	Associate Node
AT+ASACK	Accept Association Request from Coordinator
AT+DASSR	Disassociate Remote device from PAN
AT+DASSL	Disassociate Local device from PAN
AT+BCAST	Transmit a Broadcast
AT+UCAST	Transmit a Unicast
AT+CCAST	Transmit a Unicast to the Coordinator
AT+COST	Cost to Talk to Remote Node
AT+OPCHAN	Open a Channel to a Remote Node
AT+ACKCHAN	Accept Channel
+++	Close Channel
AT+SREMn	Remote S-Register Access
AT+TOKDUMP	Display all local S-Registers
AT+ADLOC	Request a Reading from the Local A/D Converter
AT+ADREM	Request a Reading from a Remote A/D Converter
AT+IDENT	Play a Tune on Remote Devboard

Table 7: Command Overview

9.2.1. Module Control & Configuration Commands

Z – Software Reset	
Execute Command **ATZ**	Response Module Performs a software reset All S Registers keep the user defined values
SW release	R100

&F – Restore Factory Defaults	
Execute Command **AT&F**	Response Module Performs a software reset All non volatile S Registers are updated with the factory defaults
SW release	R100

+REMZ – Reset Remote Node	
Execute Command **AT+REMZ:<EUI64>** Use on: Coordinator FFD's RFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. On receiving this command the remote node will soft reset itself. Note: If the remote node is an FFD, packets which are currently relayed by this node may get lost.
SW release	R103

I – Display Product Identification Information	
Execute Command **ATI**	Response **TELEGESIS** **Ryyy** **<EUI64>** **OK** Where yyy is the software revision and <EUI64> is the IEEE 802.15.4 identifier
SW release	R100

+BLOAD – Enter the bootloader menu	
Execute Command **AT+BLOAD**	Response **<entering bootloader>** The device leaves the AT command line and enters the Ember bootloader menu for downloading new firmware. Please note that the bootloader menu will run at a data rate of 38k4, no parity, 8 data bits regardless of the current data rate and the S3 register setting.
SW release	R100

+CLONE – Clone Local node to remote node	
Execute Command **AT+CLONE:<EUI64>,cccccccc** Use on: Coordinator FFD's RFD's	Response **Cloning…** or **ERROR**<errorcode> Where <errorcode> represents the error code explained in section 11. Clones the firmware of the local node to a remote node which address is given by <EUI64>. cccccccc represents the remote nodes 8 digit cloning protection password. After completion a soft reset is caused on both ends.
SW release	R100

+TEST – Run self test	
Execute Command **AT+TEST** Module Performs a self test in order to check for hardware problems Note: If JTAG is activated by programming the appropriate fuses of the Atmega128, the self test will display an error message which can be ignored.	Response **OK** Or if any problems occur **ERROR**<errorcode> Where <errorcode> represents the error code explained in section 11.
SW release	R100

Sn – S-Register access	
Read Command **ATSn?**	Response **<data>** **OK** or **ERROR**<**errorcode**> The module displays the contents of S-register n or an error message, where <errorcode> represents the error code explained in section 11.
Write Command **ATSn=<data>**	Response **OK** or **ERROR**<**errorcode**> The data is written to S-register number n and if applicable stored in non volatile EEPROM. The data format for each individual S Register is given in the S-Register description. <errorcode> represents the error code explained in section 11.
SW release	R100

+PDWN – Power control	
Read Command **AT+PDWN?**	Response **+PDWN:<N>** **OK**
Write Command **AT+PDWN=<n>**	Response **OK** or **ERROR**<**errorcode**> Where <errorcode> represents the error code explained in section 11. Parameter <n> 0. Module awake 1. Transceiver Power down, processor active 2. Transceiver Power Down, processor runs on reduced clock rate, RS232 baudrate goes down to 4800bps 3. Module power down, complete wakeup by UART or external interrupt (falling edge on I/O0 or I/O1) 4. Module power down, wakeup into mode 1 by UART or external interrupt (falling edge on I/O0 or I/O1) 5. Module Power Down complete wakeup by external interrupt or reset only The default Power mode after reset is defined by register SA.
SW release	R100

+BTABLE – Display the devices binding table	
Read Command **AT+BTABLE?**	Response **<BINDING TABLE>** **OK** or **ERROR**<**errorcode**> <errorcode> represents the error code explained in section 11. The binding table can be displayed for debugging purposes. It lists all nodes registered with the local node. The first entry (if used) represents the binding to the co-ordinator and the last entry is the multicast ID.
SW release	R100

+COO – Display the devices Coordinator	
Read Command **AT+COO?** Use on: Coordinator FFD's RFD's	Response **+COO:NONE** or **+COO:<EUI64>** followed by **OK** or **ERROR**<**errorcode**> <errorcode> represents the error code explained in section 11. <EUI64> id the address of the coordinator. In case the device is not associated to a PAN the result is "none".
SW release	R100

+ESCAN – Scan the energy of the current channel	
Read Command **AT+ESCAN?** Use on: Coordinator FFD's RFD's	Response **+ESCAN:XX** **OK** or **ERROR**<**errorcode**> <errorcode> represents the error code explained in section 11. XX represents the average energy on the current channel. The number represents the RSSI reading of the EM2420. See the manual of the EM2420 for detailed explanation of the RSSI reading. This command can be used to measure channel utilisation.
SW release	R100

9.2.2. Communication Commands

+SN – Scan Network for other nodes	
Execute Command **AT+SN** Use on: Coordinator FFD's RFD's	Response **OK** or **ERROR**<errorcode> **FFD:<EUI64>** **RFD:<EUI64>** **COO:<EUI64>** <errorcode> represents the error code explained in section 11. Actively Scans the network and requests all devices in the same channel and PAN ID which are up to 16 hops away to report within a few seconds. The prefix FFD,RFD or COO indicates the remote devices functionality as defined by S8. Note that RFD's will not respond if in a power down mode higher than 0.
SW release	R100

+EN – Establish PANetwork	
Execute Command **AT+EN** Use on: Coordinator Note: When issuing this command the local device becomes a Coordinator and bits 1:0 in S8 are set 10 (coordinator). There should only be a single coordinator in a PAN.	Response **OK** or **ERROR**<errorcode> **FFD:<EUI64>** **RFD:<EUI64>** **COO:<EUI64>** <errorcode> represents the error code explained in section 11. Same functionality as AT+SN above with the exception that each RFD and FFD found will be asked to join the PAN.
Remote Action	Prompt Depending on the setting of bit 2 in the remote S8 If unset the node will automatically join the PAN (default) **<NO PROMPT>** if set the remote node will output the request in the format **PAN:<EUI64>** The remote device has to acknowledge the request using the command AT+ASACK in order to join the PAN.
SW release	R100

+SORPHAN – Scan for orphans	
Execute Command **AT+SORPHAN** Use on: Coordinator Note: When issuing this command the local device becomes a Coordinator and bits 1-0 in S8 are set 10 (coordinator). There should only be a single coordinator on a PAN.	Response **OK** or **ERROR**<errorcode> **FFD:<EUI64>** **RFD:<EUI64>** <errorcode> represents the error code explained in section 11. Actively Scans the network and requests all devices in the same channel and PAN ID which are not associated with this particular coordinator to report within a few seconds. Any devices reporting back are asked to join the PAN in case bit 3 in S8 is not set. If bit 3 in S8 is set use AT+ASS to ask them to join the PAN. The prefix FFD or RFD indicates the devices functionality as defined by the remote S8. Note that any nodes will not respond if in a power down mode higher than 0.
Remote Action Will only take place if bit 3 in S8 is not set on the coordinator.	Prompt Depending on the setting of bit 2 in the remote S8 If unset the node will automatically join the PAN (default) **<NO ACTION>** if set the node will display the request in the format **PAN:<EUI64>** The remote device has to acknowledge the request using the command AT+ASACK in order to join the PAN.
SW release	R100

+EBN – Establish PANetwork using beacons	
Execute Command **AT+EBN** Use on: Coordinator Notes: Command sets S8 bit 5. If a orphan is found and does not join the network it will be rediscovered with every beacon. To disable beaconing clear bit 5 of S8.	Response **OK** or **ERROR**<errorcode> **FFD:<EUI64>** **RFD:<EUI64>** **COO:<EUI64>** <errorcode> represents the error code explained in section 11. Same functionality as AT+EN with the exception that following the initial scan an orphan scan is automatically executed every three seconds and any device found is automatically asked to join the PAN if bit 3 of S8 is not set on the Coordinator.
Remote Action	Same as AT+EN
SW release	R100

+SNEIGHBOURS – Scan for Neighbours	
Execute Command **AT+SNEIGHBOURS:XX** Use on: Coordinator RFD's FFD's	Response **OK** or **ERROR**<errorcode> **FFD:<EUI64>** **RFD:<EUI64>** **COO:<EUI64>** Parameters **XX RANGING FROM 00 TO FF** <errorcode> represents the error code explained in section 11. Same functionality as AT+SN with the exception that only neighbours which are up to XX hops away are listed. If X=00 only direct neighbours will reply
SW release	R100

+PING – Indicate presence in the network	
Execute Command **AT+PING** Use on: Coordinator RFD's FFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11.
Remote Action	Prompt **FFD:<EUI64>** **RFD:<EUI64>** **COO:<EUI64>** The prompt above will be displayed on all nodes which can hear the ping. The prefix FFD,RFD or COO indicated the senders functionality as defined by S8. <EUI64> is the identifier of the sending device. If received by a Coordinator which is defined to automatically join any reporting nodes (bit 3 unset in S8) the Node will be asked to join the PAN by the coordinator.
SW release	R100

+ASS – Associate Remote Node	
Execute Command **AT+ASS:<EUI64>** Use on: Coordinator	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Ask remote node to join the PAN. The response will be OK as soon as the command has been received by the remote device even if it refuses to join the network.
Remote Action	Prompt Depending on the setting of bit 2 in the remote S8 If unset the node will automatically join the PAN (default) **<NO ACTION>** if set the node will display the request in the format **PAN:<EUI64>** The remote device has to acknowledge the request using the command AT+ASACK in order to join the PAN.
SW release	R100

+ASACK – Accept association request from coordinator	
Execute Command **AT+ASACK:<EUI64>** Use on: RFD's FFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Join the PAN which coordinator ID is <EUI64> which was previously advertised with: **PAN:<EUI64>**
SW release	R100

+DASSR – Disassociate remote device from PAN	
Execute Command **AT+DASSR:<EUI64>** Use on: Coordinator	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Instruct remote device to leave the PAN. Note: If using AT+EBN the remote device can rejoin the PAN with the next beacon sent by the coordinator.
SW release	R100

+DASSL – Disassociate local device from PAN	
Execute Command **AT+DASSL** Use on: RFD's FFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Instruct local device to leave the PAN. Note: If using AT+EBN on the coordinator the device can rejoin the PAN with the next beacon sent by the coordinator.
SW release	R100

+BCAST – Transmit a Broadcast	
Execute Command **AT+BCAST:<data>** Use on: Coordinator FFD's RFD's	Response **OK** or **ERROR**<errorcode> Where <errorcode> represents the error code explained in section 11. Parameters Up to 70 bytes (50 using encryption) are sent to all devices with the same PAN ID defined in S1. The response OK shows successful transmission. Successful transmission does not guarantee successful reception. To make sure data has been received by a specific node use a uni-cast message.
Remote action	Prompt **BCAST:<EUI64>=<data>** Every node in the same PAN ID defined in S1 which has received the broadcast message will prompt the above message where <EUI64> is the address of the sender and <data> is the data which was attached to the broadcast
SW release	R100

+UCAST – Transmit a Unicast	
Execute Command **AT+UCAST:<EUI64>,<DATA>** Use on: Coordinator FFD's RFD's	Response **OK** or **ERROR**<errorcode> Where <errorcode> represents the error code explained in section 11. Parameters Up to 70 bytes (50 using encryption) are sent to the node with address <EUI64>. The <EUI64> and <DATA> need to be separated by a ','. The response OK shows successful acknowledgement. A missing acknowledgement does not guarantee that the message has not reached its destination.
Remote action	Prompt **UCAST:<EUI64>=<data>** Where <EUI64> is the address of the sender.
SW release	R100

+CCAST – Transmit a Unicast to the Coordinator	
Execute Command **AT+CCAST:<DATA>** Use on: FFD's RFD's	Response **OK** or **ERROR**<errorcode> Where <errorcode> represents the error code explained in section 11. Parameters Up to 70 bytes (50 using encryption) are sent to the coordinator. The response OK shows successful acknowledgement. A missing acknowledgement does not guarantee that the message has not reached its destination.
Remote action	Prompt **UCAST:<EUI64>=<data>** Where <EUI64> is the address of the sender.
SW release	R100

+COST – Cost to talk to remote node	
Read Command **AT+COST:<EUI64>?** Use on: Coordinator RFD FFD	Response **+COST:YY** **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. YY represents the cost to transmit to a device. The cost is higher the more hops are required and/or the worse the link quality is.
SW release	R100

+OPCHAN – Opens a channel to a remote node	
Execute Command **AT+OPCHAN:<EUI64>** Use on: Coordinator FFD's RFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Once the channel is established it acts like a virtual wire and transmits any data entered bi-directionally. There is no local echo of the data entered. To close the channel enter +++ on any end of the virtual wire. Parameters The module's address <EUI64>. Examples **AT+OPCHAN:01234567890ABCDEF** **OK** **>Hello world** **My second data line** **And the third one** **The last one +++** **CLOSED** Prompt **ERROR**<errorcode> In case the channel breaks down an error message is displayed on both ends, where <errorcode> represents the error code explained in section 11.
Remote Action	Prompt Depending on the setting of bit 4 in the remote S8 If unset the node will automatically accept the channel. **<NO ACTION>** if set the node will display the request in the format **CHAN:<EUI64>** The remote device has to acknowledge the request using the command AT+ACKCHAN command. If this command is not issued within 10 seconds the channel request will time out.
SW release	R100

AT+ACKCHAN – Accept Channel	
Execute Command **AT+ACKCHAN** After an attempt to connect has been prompted the unit has a window of 10 seconds to accept the channel using this command.	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11.
Example Prompt: **CHAN:<EUI64>** Reply: **AT+ACKCHAN**	The unit gets prompted that a remote unit is trying to establish a channel to this unit. If required the channel can be acknowledged which will cause the channel to open. In S8 the unit can be configured to automatically accept every incoming channel if not connected to another active channel.
SW release	R100

+++ – Close channel and leave transmit terminal mode	
Execute Command **+++**	Response **Close** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11.
Remote Action	Prompt **Close**
SW release	R100

SREMn – Remote S-Register access	
Read Command **ATSREMn:<EUI64>?** Use on: Coordinator FFD's RFD's	Response **<data>** **OK** Or **ERROR<errorcode>** The module displays the contents of S-register n or an error message, where <errorcode> represents the error code explained in section 11. The data format for each individual S Register is given in the S-Register description.
Write Command **ATSREMn:<EUI64>=<data>**	The hexadecimal value is written to remote S-register number n and if applicable stored in non volatile eeprom. Response **OK** Or if any problems occur **ERROR<errorcode>** Where <errorcode> represents the error code explained in section 11. Note that some S- registers are read only and will return an error when trying to write to them
SW release	R100

TOKDUMP – Display all S-Registers	
Read Command **AT+TOKDUMP** Use on: Coordinator FFD's RFD's	Response **<data>** **OK** Or **ERROR<errorcode>** The module displays the contents of all S-registers on the local node or an error message, where <errorcode> represents the error code explained in section 11. The data format for each individual S Register is given in the S-Register description.
SW release	R104

9.2.3. I/O Commands

Except with the A/D converter the I/O is controlled via registers Sx to Sy, whereas remote I/O can be controlled by accessing the remote S registers Sx to Sy.

+ADLOC? – Request a reading from the local A/D converters	
Execute Command **AT+ADLOC?**	Response **+ADLOC: XXX,YYY** **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. XXX is the 10 bit reading of A/D1 and YYY is the 10 bit reading of A/D2
SW release	Extended to 10 bits in R102

+ADREM? – Request a reading from remote A/D converters	
Execute Command **AT+ADREM:<EUI64>?** Use on: Coordinator FFD's RFD's	Response **+ADREM: XXX,YYY** **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. XXX is the 10 bit reading of the remote A/D1 and YYY is the 10 bit reading of the remote A/D2
SW release	Extended to 10 bits in R102

+IDENT – Play a tune on remote devboard	
Execute Command **AT+IDENT:<EUI64>** Use on: Coordinator RFD's FFD's	Response **OK** or **ERROR**<errorcode> <errorcode> represents the error code explained in section 11. Plays a tune on a remote devboard if the Beeper is connected. Useful to identify remote nodes. See devkit manual for details about connecting a beeper to the ETRX1.
SW release	R100

10. S-Registers

Most of the S-Registers of the ETRX1 can be read and written locally as well as remotely. With the exception of S4, S5 and S9 the S-registers are stored in non-volatile memory and will keep their user defined settings unless reset to the factory defaults using the "AT&F" command. S4,S5 and S9 are directly accessing the volatile I/O registers to prevent EEPROM corruption due to constant I/O access. The non-volatile registers SC, SD and SE represent the non volatile registers which define the contents of S4, S5 and S9 respectively after booting up.

The standard set of S-registers ranging from S0 to S7 determines the modules standard feature set, whereas the extended S-register set from S8 to SC allows the user to customise the modules' behaviour after start-up to allow standalone operation without the need for a host processor. Altering the extended S-registers is only required for custom specific applications. The S-Registers are summarised in table 8 below.

S-Register Overview	
S0	**Channel Number**
S1	PAN ID
S2	Transmit Power Level
S3	Baudrate
S4	Data Direction of I/O Port (DDR) (volatile)
S5	Output Buffer of I/O Port (PORT) (volatile)
S6	Input Buffer of I/O Port (PIN)
S7	Encryption key
S8	Main Function
S9	Operation of the Special Function Pin
SA	Functionality at Start-up
SB	Timer at Start-up
SC	Clone Password
SD	Initial value of S4
SE	Initial value of S5
SF	Initial value of S9
SG	User Definable name

Table 8: S-Register Overview

10.1. Standard S-Registers

S0 – Channel Number	
Description The 802.14.2 channel number. Sets the frequency to the defined channel. Operations **R/W LOCAL** **R/W REMOTE** Execution **After Soft or Hard Reset** Storage **Non Volatile**	Parameters **NN** Where nn represents a 8 bit decimal number. Range **0-15** representing 802.14.2 channel numbers 11-26 Factory Default **7**
SW release	Changed default to 7 in R102

S1 – PAN ID	
Description The devices PAN ID Only devices with the same PAN ID will be able to hear one another. Operations **R/W LOCAL** **R/W REMOTE** Execution **After Soft or Hard Reset** Storage **Non Volatile**	Parameters **XXXX** Where XXXX represents a 16 bit hexadecimal number. Range **0000-FFFF** Factory Default **2A2A**
SW release	R100

S2 – Transmit Power Level	
Description The devices transmit power level in dBm. Operations **R/W LOCAL** **R/W REMOTE** Execution **After Soft or Hard Reset** Storage **Non Volatile**	Parameters **SNN** Where snn represents a signed 8 bit decimal number. Range **-1 TO -32** Factory Default **-1**
SW release	R100

S3 – Baudrate	
Description The devices RS232 Baudrate and mode. The default setting of 0500 results in: 19200bps, no parity, 1 stop bit, 8 data bits. Operations **R/W LOCAL** **R/W REMOTE** Execution **After Soft or Hard Reset** Note Ember does only guarantee proper operation of the stack up to 19200 baud. Storage Non Volatile	Parameters **XXXX** Where XXXX represents an 16 bit hexadecimal number. Range of 1st two digits **00 TO 07** 0. 1200 baud 1. 2400 baud 2. 4800 baud 3. 9600 baud 4. 14400 baud 5. 19200 baud 6. 28800 baud 7. 38400 baud Range of 2nd two digits **00 TO FF** bit 0 set: even parity enabled bit 1 set: odd parity enabled bit 2 set: 2 stop bits instead of one bit 3 set: 7 data bits instead of 8 bit 4 set: reserved bit 5 set: reserved bit 6 set: reserved bit 7 set: reserved Factory Default **0500**
SW release	Revised in R101 (see update guide if using R100)

S4 – Data Direction of I/O Port	
Description The data direction of the module's I/O port Operations **R/W LOCAL** **R/W REMOTE** Execution **Instantly** Storage **Volatile**	Parameters **XX** Where XX represents an 8 bit hexadecimal number. Range **00 TO FF** representing I/O pins 76543210 (little endian) e.g. setting bit 7 to 1 will turn I/O pin 7 into an output, setting it to 0 will make it an input respectively. Factory Default **Defined in SD**
SW release	R100

S5 – Output Buffer of I/O Port	
Description The output buffer of the module's I/O port Operations **R/W LOCAL** **R/W REMOTE** Execution **Instantly** Storage **Volatile**	Parameters **XX** Where XX represents a 8 bit hexadecimal number. Range **00 TO FF** representing I/O pins 76543210 (little endian) If the I/O pin has been defined as an output in S4 the pin will drive the logic level defined by S5. If defined as an input setting the output buffer to 1 activates the internal pull-up, which should be avoided if power consumption is critical. Factory Default **DEFINED IN SE**
SW release	R100

S6 – Input Buffer of I/O Port	
Description The Logical Levels at the I/O Pins Operations **R LOCAL** **R REMOTE** Execution **Instantly** Storage **Instant Reading of Port Status**	Range **00 TO FF** representing I/O pins 76543210 (little endian) S6 represents the logic level at each pin of the I/O port.
SW release	R100

S7 – Encryption Key	
Description The encryption key Operations **W LOCAL** Execution **After Soft or Hard Reset** Storage **Non Volatile**	Range **FROM 0 TO 2^{128}-1** The 128 bit AES encryption key. If set to 0 encryption is switched off. Note that using encryption reduces the payload for all transmission types down to 50 bytes.
SW release	Since R102 write only for security reasons

10.2. Extended S-Registers

S8 – Main Function	
Description Defines the behaviour of the Device. Operations **R/W LOCAL** **R/W REMOTE** Action **Instantly** Storage **Non Volatile**	Parameters **XX** Where XX represents a 8 bit hexadecimal number. Range **00 TO FF** **Bit 7 (MSB):** Set: Behaviour of I/O3 is defined by S9. Unset: I/O acts as a standard I/O pin. **Bit 6:** **RESERVED, SHOULD BE ALWAYS CLEARED** **Bit 5:** Set: Coordinator beaconing enabled is automatically set when executing AT+EBN Unset: Coordinator beaconing disabled **Bit 4:** Set: Prompt user if a channel has been requested Unset: Automatically accept channel **Bit 3: (Coordinator only)** Set: Coordinator does not ask to join when doing an orphan scan or receiving a ping Unset: Coordinator automatically joins RFD's and FFD's pinging in and any devices found running an orphan scan **Bit2:** Set: RFD's and FFD's prompt user when asked to join by AT+EN, AT+EBN, AT+SORPHAN, AT+ASS Unset: Devices auto join a coordinator when asked to. **Bit 1 & Bit 0 (LSB):** The mode of the local device 00 FFD 01 RFD 10 Coordinator Factory Default **00**
SW release	R100

S9 – Operation of the special function pin	
Description The mode of operation for the special function pin Operations **R/W LOCAL** **R/W REMOTE** Action **Instantly** Storage **Volatile**	Parameters **XXXX** Range **0000 TO FFFF** If the special function pin is enabled by setting bit 7 of S8, the first byte of S9 is written to the OCR2 register of the Atmega128 and the second byte of S9 is written to the TCCR2 register of the Atmel Atmega 128L. This allows I/O3 to output a PWM or constant carrier signal. For more information see the Atmega128 datasheet. Factory Default **DEFINED IN SF**
SW release	R100

SA – Functionality at start-up	
Description Custom functionality which the node fulfils after power up. If required customer specific functionality can be added on request. Operations **R/W LOCAL** **R/W REMOTE** Action **Instantly** Note: If 3 messages to a coordinator fail the coordinator is assumed unavailable and a ping is sent from thereon. If using mode 02 or 03 the node should be set to be a RFD as it cannot have routing responsibility. Storage **Non Volatile**	Parameters **XX** Range **00 TO 04** **00:** Normal operation. **01:** A falling edge on I/O1 (devboard Button 3) sends the reading of the I/O port and both A/D ports to the coordinator and if no coordinator is known unit sends a ping. **02:** Same as 01, but unit wakes up from sleep, transmits and goes back to sleep mode 5. Unit goes to sleep after 1st falling edge or after soft or hard reset. A falling edge on I/O0 (devboard Button 4) wakes the unit up permanently. **03:** Same as 02, but after transmission the unit stays awake for 20 seconds to allow for incoming data. **04:** In predefined intervals the unit sends a reading of the I/O port and both A/D ports to the coordinator and if no coordinator is known unit sends a ping. The interval of the transmissions is the content of SB in seconds. Factory Default **00**
Remote Action	Prompt **CDATA:<EUI64>=XX,YYY,ZZZ** Where XX is the reading of the remote port, YYY is the reading of the remote A/D1 and ZZZ is the reading of the remote A/D2.
SW release	A/D reading extended to 10 bits in R102

SB – Timer at start-up	
Description Times seconds for any functionality defined in SA. Operations **R/W LOCAL** **R/W REMOTE** Action **Instantly** Storage **Non Volatile**	Parameters **XX** Range **00-FF** Note:00 equals an interval of 256 seconds Factory Default **0A**
SW release	R100

SC – Clone Password	
Description The password needed when trying to clone a remote nodes firmware onto the local node Operations **W LOCAL** Action **Instantly** Storage **Non Volatile**	Parameters cccccccc 8 case sensitive characters (8 bytes). In order to clone itself to a remote node using the AT+CLONE command, the password of the remote node must be known. Factory Default **TG-ETRX1**
SW release	Since R102 write only for security reasons

SD – Initial Setting of S4	
Description The initial setting of S4 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Action **After Soft or Hard Reset** Storage **Non Volatile**	Parameters XX Where XX represents the initial value of S4 which is loaded after boot-up, soft or hard reset. Factory Default **F8**
SW release	R103

SE – Initial Setting of S5	
Description The initial setting of S5 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Action **After Soft or Hard Reset** Storage **Non Volatile**	Parameters XX Where XX represents the initial value of S5 which is loaded after boot-up, soft or hard reset. Factory Default **F0**
SW release	R103

SF – Initial Setting of S9	
Description The initial setting of S9 stored in non volatile memory Operations **R/W LOCAL** **R/W REMOTE** Action **After Soft or Hard Reset** Storage **Non Volatile**	Parameters XXXX Where XXXX represents the initial value of S9 which is loaded after boot-up, soft or hard reset in case Bit 7 of S8 is set. Factory Default **0000**
SW release	R103

SG – User Readable Name	
Description A Used defined name which can be used to identify the node Operations **R/W LOCAL** **R/W REMOTE** Action **Instantly** Storage **Non Volatile**	Parameters ccccccccccccccccccc Any name with up to 20 characters. Factory Default **NoName**
SW release	R103

11. List of Error codes

01 Too many characters have been entered on the command line
02 Unknown command
03 Reserved
04 Invalid S-Register
05 Invalid Parameter
06 Unicast could not be sent
07 Unicast was not acknowledged
08 Reserved
09 Channel Failed
0A Awaiting channel from different node
0B No channel has been stated when issuing the command acknowledge channel
0C Reserved
0D A/D reading not possible
0E Reserved
0F No response from remote device
10 Reserved
11 Association Failed
12 Message Payload too long
13 I/O problem
14 Binding Problem
15 No Coordinator Known
16 Cost unknown
17 Binding in use
18 Error sending Broadcast
19 Out of Buffers
20 Invalid clone password
21 Invalid S-Register selected
22 Co-ordinator Lost
23 PWM currently not in use
24 Channel is Engaged

12. Physical Dimensions

The physical dimensions are shown in table 9. Units are in mm.

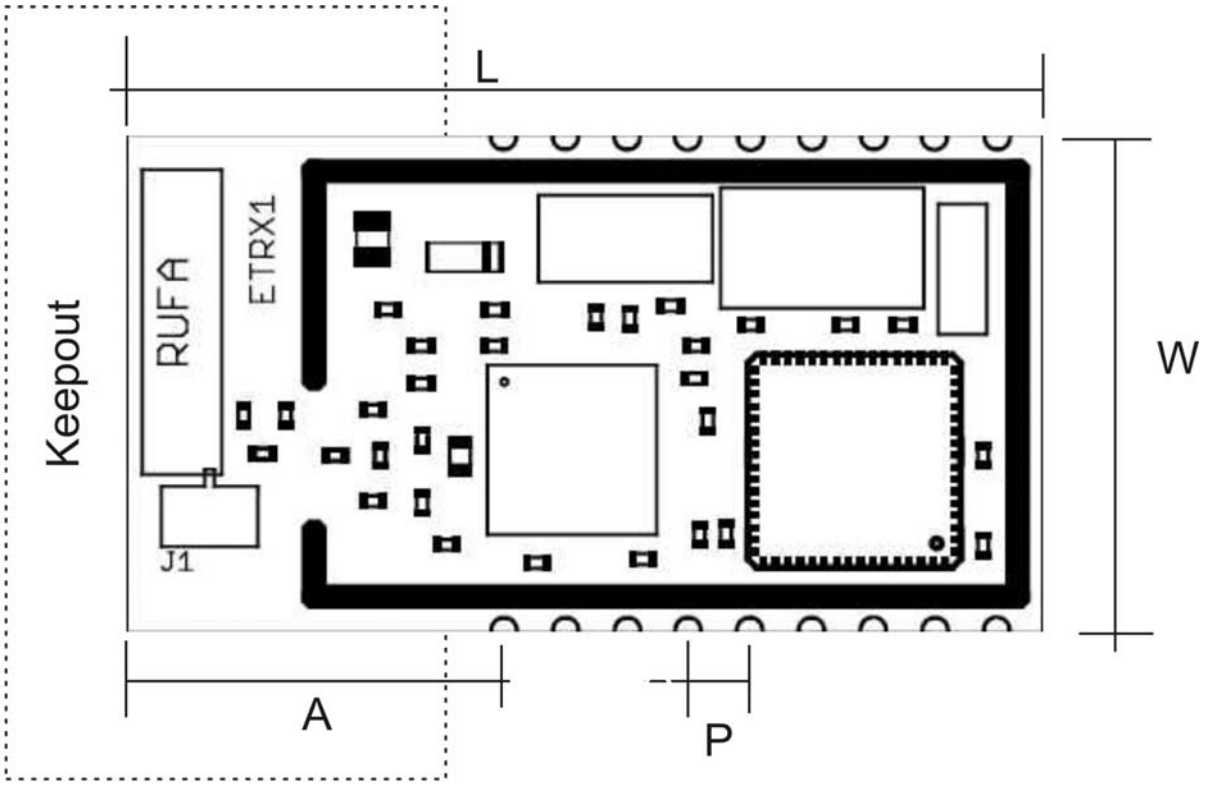


Figure 4. Physical Dimensions of Module

For ideal RF-Performance when using the on-board antenna, the antenna should be located at the edge 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, preferably 10-15mm around the antenna.

If using the U.FL RF-Connector the keep out area can be significantly reduced. The Module transmit/receive range will depend strongly on the antenna used and also the housing of the finished product.

Label	Min.	Typ.	Max.	Description
L		37.75		Length of the module
W		20.45		Width of the module
P		2.54		Pitch
A		15.5		Distance corner/centre 1st pad
H		3.4	3.6	Height of the Module

Table 9: Dimensions of module in mm

13. Recommended Footprint

In order to surface mount the module, it is recommended to use pads which are 1.5mm wide and 1.2mm high as shown in table 10.

Care must be taken to ensure that on the surface underneath the module there are no exposed pads or vias which might contact with the pads for the optional connector or any vias of the module itself.

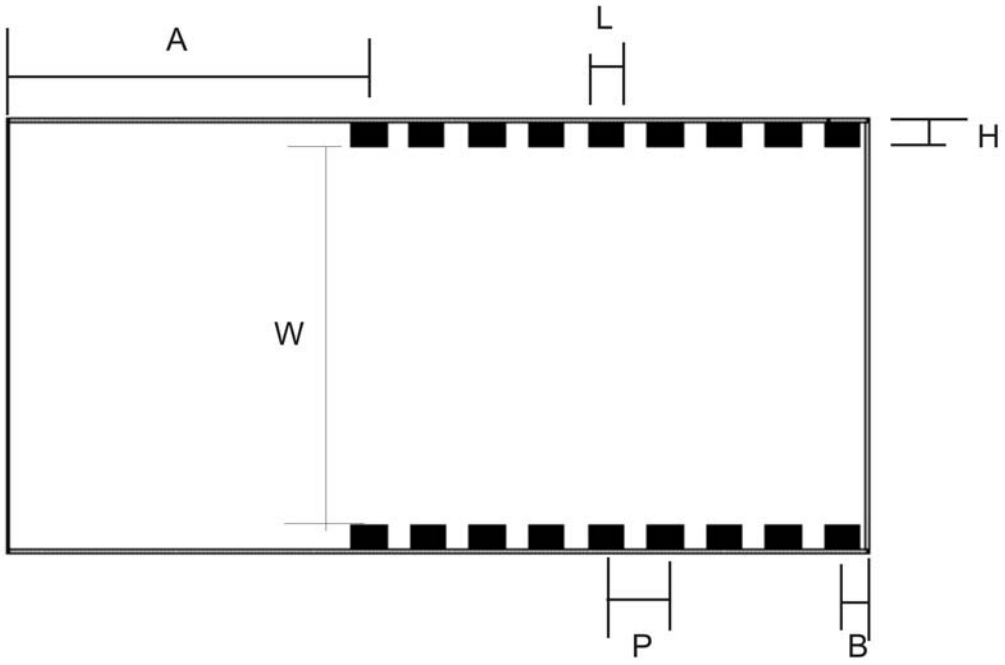


Figure 5. Recommended Footprint

Label	Min.	Typ.	Max.	Description
L		1.5		Length of a Pad
H		1.5		Width of a Pad
P		2.54		Pitch
B		1.9		Distance right corner/ centre pad 9
A		15.5		Distance left corner/centre pad 1
W		18.5		Distance between pad inside edges

Table 10: Dimensions of Footprint in mm

14. Ordering Information

Ordering/Product Code	Description
ETRX1 *	Ember ZigBee Ready Module with: • AT Style Command Interpreter • Integrated 2.4Ghz Antenna • No Harwin Connector included
ETRX1HR *	Ember ZigBee Ready Module with: • AT Style Command Interpreter • Hirose U.FL Antenna Connector • No Harwin Connector included
ETRX1DVK *	Ember ETRX1 Development Kit with: • 1 x ETRX1 Module • 1 x ETRX1HW Module (with Harwin Connector fitted) • 1 x ETRX1DV Development Board • 1 x PSU • 1 x RS232 Cable
Notes: • Customers' PO's must state the Ordering/Product Code. • There is no "blank" version of the ETRX1 Module available. All Modules carry both the EmberNet Stack and the Telegesis AT style Command Layer. (Where customers wish to add their own firmware they can erase and write it to the flash memory of the Atmel). • Please contact Telegesis if you require additional AT style commands or specific integration assistance.	

Table 11. Ordering Information

15. Trademarks

All trademarks, registered trademarks and products names are the sole property of their respective owners.

16. Disclaimer

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18. References

Telegesis - www.telegesis.com/etrx1

Ember - www.ember.com

Atmel - www.atmel.com

Gigaant - www.gigaant.com